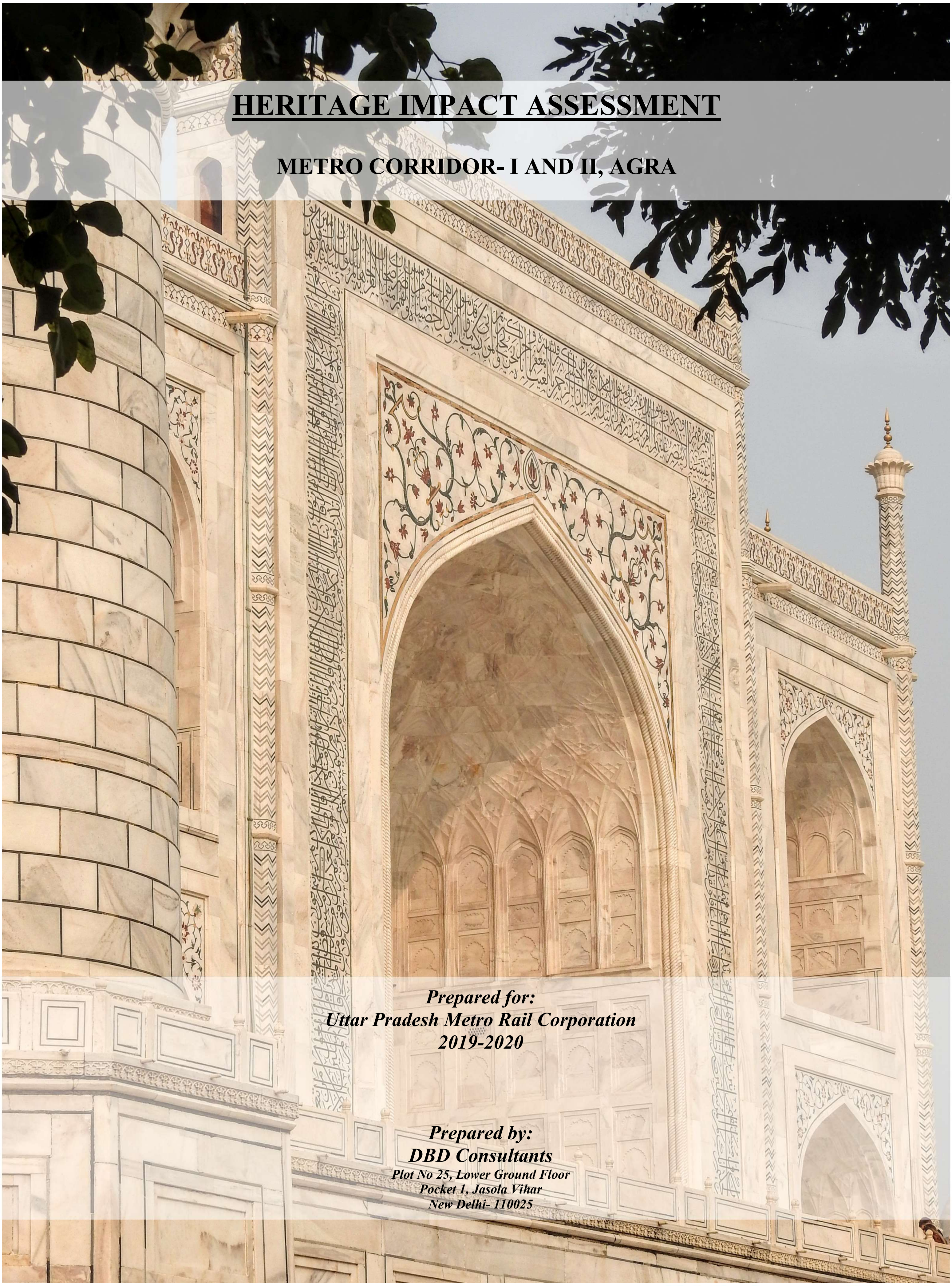

HERITAGE IMPACT ASSESSMENT

METRO CORRIDOR- I AND II, AGRA

Prepared for:
Uttar Pradesh Metro Rail Corporation
2019-2020

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HERITAGE IMPACT ASSESSMENT (HIA): PROPOSED METRO CORRIDOR- I AND II AND THE HERITAGE RESOURCES OF AGRA INCLUDING THE TWO WORLD HERITAGE PROPERTY OF TAJ MAHAL AND AGRA FORT

Authorship: An interdisciplinary team in consultation with stakeholders led by Sangeeta Bais, *Principal Architect, Dharohar* along with Mr. Arun Menon, *National Centre of Safety of Heritage Structures Indian Institute of Technology, Madras*, Tara Sharma, *Heritage management expert* and Mr. A. K.Sinha, *Senior Archaeologist* with Ms. Kanishka Sharma, *Conservation Architect*, Ms. Meenu Kushawah, *Conservation Architect*, Ms. Abantika Mukherjee, *Conservation Architect*, Mr. Sameer Dhanda, *Architect*, Ms. Subarna Sadhu, *Architect*, Ms. Priyanka Baghel, *Intern Architect*

Specific HIA focus: Proposed Metro corridor- I Sikandara to Taj East Gate, Agra, Uttar Pradesh

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Cover photo: View of the World Heritage property of the Taj Mahal

ABBREVIATIONS

AMASR	Ancient Monuments and Archaeological Sites and Remains
ADA	Agra Development Authority
ANN	Agra Nagar Nigam
ASI	Archaeological Survey of India
CPCB	Central Pollution Control Board
DPR	Detail Project Report
GPRS	Ground Penetrating Radar Survey
HIA	Heritage Impact Assessment
IAIA	International Association of Impact Assessment
ICOMOS	International Council on Monuments and Sites
ICCORM	International Centre for the Study of the Preservation and Restoration of Cultural Property
INTACH	Indian National Trust for Art and Cultural Heritage
LMRC	Lucknow Metro Rail Corporation
MoU	Memorandum of Understanding
MRTS	Mass Rapid Transit System
NATM	New Austrian Tunneling Method
NMA	National Monuments Authority
PAC	Public Accounts Committee
RBS	Raja Balawant Singh
SC	Supreme Court
SoC	State of Conservation
SPA	School of Planning and Architecture
TTZ	Taj Trapezium Zone
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHS	World Heritage Site

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1. INTRODUCTION

1.1 CONTEXT OF HIA

This Heritage Impact Assessment is prepared for the proposed Agra Metro Corridor-1 and II and the existing heritage resources of Agra city along it including the two world heritage sites Taj Mahal and Agra Fort. The report aims to evaluate the proposed actions that may have an impact on the Outstanding Universal Value (OUV) of Taj Mahal and Agra Fort as World Heritage Sites (WHS) and the heritage value of other significant heritage resources are the prime concern for any intervention/ development in and around the heritage components.

This document has been prepared by DBD consultants, New Delhi, on behalf of Uttar Pradesh Metro Rail Corporation (UPMRC), to address the predicted impacts of the proposed developments around heritage monuments along the proposed Metro corridor- I in the city of Agra.

This assessment should be seen as complementary to the referred documents provided by UPMRC officials. The HIA for Metro Corridor-I and II , Agra draws its assessment based on the information provided by LMRC officials. The historical information on the National monuments is referred from data provided by officials, website, libraries and digitization department of Agra Circle, Archaeological Survey of India (ASI). Data further developed referring to archival maps, archival images, drawings and site plans of protected and regulatory boundaries of protected monuments.

The distance of the proposed Metro works is measured as per survey drawings and data provided by LMRC officials. If felt necessary the accuracy of the distance shall be re-checked by the Archaeological Survey of India.

The report will abide all rules, regulations and policies for preparing Heritage Impact Assessment following international and national guidelines.

1.2 TOR OF HIA

- Analytical study of Outstanding Universal Value (OUV) of World Heritage Sites of Agra and analysis to determine the positive and negative impact of proposed works
- Historical research and archival mapping to explore the historic areas along the Metro route
- Archaeological studies by senior archaeologist to understand the previous excavations, studies and findings
- Site survey along the Metro route to map the historic sites
- Study of existing heritage structure along the route, structural, material and architectural study, extents and historical context
- Visual and spatial relationship studies of historic areas, proposed Metro routes- underground and over ground, Metro stations
- Overlaying all the above mentioned layers and proposed Metro routes, regulated and protected zones, monuments etc. and analysing the interface of both to understand the impact
- Identifying and proposing areas for scientific and geo technical studies such as GPRS, impact echo assessment, excavations, core drilling or others as required
- Technical evaluation of GPRS studies (to be done as proposed in mitigation measures) and incorporating it in HIA

- Identifying and proposing areas for vibration studies to analyse the impact of proposed excavations and constructions details
- Providing recommendations based on available scientific data on soil profiles, ground water levels of the concerned areas
- Preparing anticipated structural damage map
- Study and analysis of existing management plans, bye laws, rules, regulations and acts applicable for the concerned area with the special focus on protected and regulated zones
- Preparing matrix for positive and negative impacts on World Heritage Sites, protected monuments and other historic structures
- Compiling the HIA report
- Preparing strategy for HIA before, during and after execution of the project.

1.3 DEFINING HERITAGE IMPACT ASSESSMENT (HIA)

Heritage Impact Assessment is a prospective study of impacts due to proposed developments actions where process starts from the evaluation or investigation of something as part of a methodical survey assessing suitability to observe and check the progress or quality of over a period of time at strategic levels. This practice of impact analysis is not unusual or special process; it is simply a codification of basic analysis undertaken by competent adviser. Worldwide experts have been identifying, quantifying and expressing considerations about the impacts of particular changes in relation to cultural heritage assets.

Heritage impact assessments (HIA) applied to cultural heritage assets is a recent notion grounded in the requirements to perform environmental assessments at the project or more strategic levels. Heritage impact assessments applied to cultural heritage assets is a recent notion grounded in the requirements to perform environmental assessments at the project or more strategic levels. International Association of Impact Assessment (IAIA) defines HIA as *a process of identifying, predicting, evaluating and communicating the probable effects of a current or proposed development policy or action on the cultural life, institutions and resources of communities, then integrating the findings and conclusions into the planning and decision making process, with a view to mitigating adverse impacts and enhancing positive outcomes.*

When ratifying the World Heritage Convention, the national governments (States Parties) agree "*to ensure, as far as possible, the proper identification, protection, conservation and presentation of the world's heritage*". "*States Parties are responsible for implementing effective management activities for a World Heritage property*", with "*appropriate policy, legal, scientific, technical, administrative and financial measures*" as per Operational Guidelines (OGs) adopted and proposed to maintain or enhance in the future the Outstanding Universal Value (OUV) and the "*conditions of integrity and/or authenticity*" of the property at the time of inscription. Among other actions, States Parties are requested to "*adopt general policies to give the heritage a function in the life of the community; integrate heritage protection into comprehensive planning programmes and establish services for the protection, conservation and presentation of the heritage; and not take any deliberate measures that directly or indirectly damage their heritage or that of another State Party to the Convention*. A study undertaken by the International Council on Monuments and Sites (ICOMOS) on *Threats to World Heritage Sites 1994-2004* analysed 1,570 threats reported for 641 properties in the State of Conservation (SoC) reports and other ICOMOS mission reports. This analysis identified that the majority of threats to cultural WH properties were related to management deficiencies and aggressive development.
Considering that HIA are part of the management plan or another documented management system, standards for efficiency are foreseen to be reliant on those agreed for the management

systems. According to UNESCO an effective management "*involves a cycle of long-term and day-to-day actions to protect, conserve and present the nominated property"*[1] and could include:

- a thorough shared understanding of the property by all stakeholders;
- a cycle of planning, implementation, monitoring, evaluation and feedback;
- the involvement of partners and stakeholders;
- the allocation of necessary resources;
- capacity building; and
- an accountable, transparent description of how the management system functions.

OGs, as well as the chapter on "*Factors affecting the property"*, do recommend that "*an assessment should also be given if the impact of these factors on the property is increasing or decreasing and what actions to address them have been effectively taken or are planned for the future*". One probable reason for an increasing reference to HIA is the recent ICOMOS guidance on HIA specific to cultural WH properties. The main aim was to fill the gap and contribute to an effective impact assessment "*of potential development on the Outstanding Universal Value (OUV) of properties*". It is addressed to managers, developers, consultants and decision makers, but also to the WH Committee and States Parties. ICOMOS is the Advisory Body to the WH Committee for cultural WH properties. HIA is a 'pro-active' instrument for planning, communication, mitigation.

ICOMOS. 2005a. Threat to World Heritage Sites 1994-2004: An Analysis. Paris, France: ICOMOS.
ICOMOS. 2011. Guidance on Heritage Impact Assessments for Cultural World Heritage Properties. Paris, France: ICOMOS.
ICOMOS. 2014. ICOMOS Statutes. Paris, France: ICOMOS.UNESCO. 2011. Recommendation on the Historic Urban Landscape adopted by the General Conference at its 36th
session, Paris, France: UNESCO World Heritage Centre.
UNESCO.2012. "World Heritage Committee Places Liverpool on List of World Heritage in Danger.". http://whc.unesco.org/en/news/890/
UNESCO. 2013. Managing Cultural World Heritage: Resource Manual. Paris, France: UNESCO World Heritage Centre.
UNESCO. 2015. Operational Guidelines for the Implementation of the World Heritage Convention. Paris, France: UNESCO World Heritage Centre.

2. METHODOLOGY

The methodology was mainly based on ICOMOS's 2011 Guidance on Heritage Impact Assessments for Cultural World Heritage Properties in conjunction with the UNESCO World Heritage Operational Guidelines and, when appropriate, other best practices for impact assessments. Owing to the nature of the objectives, the study is carried out in various steps which are as follows:

STEP- 1 Background studies

- Develop understanding about the Metro Corridor-I Sikandara to Taj East Gate from LMRC officials and collect information about the project from LMRC team.
- Outline the area of study for HIA.
- Formulation of HIA Team comprising various experts from diverse knowledge base.
- Case studies of various national and international examples of HIA.
- Data collate as per requirement of HIA report from Agra Circle ASI, UNESCO Documents.
- Detail archival studies with help of archival maps of Agra, archival photographs, books, scholarly works to study site and surroundings to understand historic developments of Agra during different eras.

STEP- 2 Listing and mapping of heritage resources

Team conducted reconnaissance survey to identify built heritage to be considered for the study within 300m threshold limit on either side of proposed Metro alignment overlapping Metro alignment with list of heritage prepared by Lucy Peck. Mapping of boundaries of identified complexes were done to measure the nearest proposed Metro alignment component and nearest proposed Metro station with help of site plans provided by digitisation department Agra Circle, ASI. The outcome was the identification of the following types of heritage resources and their complex boundaries in the study area:

- World Heritage Sites
- Nationally protected monuments
- Locally significant heritage resources

STEP- 3 Review of institutional and legislative framework

Study of institutional legislative framework to understand the status of protection of heritage resources. A detailed review of the existing institutional and legal framework towards the protection, development and maintenance of heritage resources has been carried out. The outcome was the identification of the following types of heritage resources and their complex boundaries in the study area:

- World Heritage Sites
- Nationally protected monuments
- Unprotected heritage resources.

STEP- 4 Baseline survey of heritage resources

Based on the available archival data and secondary reports, discussion with stakeholders and experts, a base line survey was conducted to assess the present condition of the identified heritage and identify the areas where detailed scientific study is required. The outcome of this stage is a draft baseline profile of the protected monuments, unprotected tangible and intangible heritage resources and existing measures for protection, conservation and infrastructure facilities. The list of further surveys, technical assessments, required documentations were identified.

STEP-5 Structure damage risk assessment

The investigation procedure is divided into two major parts, Underground metro line and elevated metro line as outlined in Figure 1, hereunder. The underground metro line in further divided into two major parts .The first part includes a study of the soil profile to assess the induced soil settlement and to generate a settlement profile near the excavation or tunnelling of the metro construction. The second part involves a visual inspection of all the heritage structures located within the 300 m radius of the metro line, to assess its structural typology, material of construction and current state of preservation. The structures along the elevated metro line have been assessed based on visual inspection as described before. Further, expected vibration levels (Peak Particle Velocity: PPV) due to metro construction activities such as tunnelling using tunnel boring machines, use of excavators, pile driving equipment and other construction equipment are estimated for all the structures which are located in close proximity to the proposed elevated or underground metro line.

The building assessment when convolved with the settlement contour could provide a rational basis to identify the level of distress that the identified buildings could be expected to suffer during the construction activities. Based on the structural typology and the current condition of the historical structures surveyed, acceptable limits on the differential settlement and vibrations, as identified from internationally accepted norms, have been applied to identify historical structures in different risk categories, namely low, medium and high. The study in closing provides recommendations for suitable mitigation measures for the protection of the historical structures in the vicinity of the proposed alignment, or ideally a change in the alignment of the metro in extreme cases.

STEP- 6 Study and analysis of proposed Metro works

The detailed project report of the proposed Metro works has been studied and mapped with respect to the identified heritage structure. Also, the kinds of construction work associated with each of the Metro station and the overall Metro route has been analysed with respect to its potential impacts on the heritage resources during both the construction and operational phases.

STEP- 7 Identification of approaches and detailed assessment

The identified heritage resources are categorised according to their legal protection status, which are, World Heritage Sites, nationally protected monuments and unprotected heritage resources. Distinctive approaches have been adopted for the assessment formats of each of the categories. For the World Heritage Sites, the international guidelines and case studies have been referred, for the nationally protected monuments framework provided by National Monuments Authority has been adopted whereas for the unprotected monuments, a comprehensive approach has been developed based on case studies and study of national and international guidelines. The following are the steps of assessment adopted:

1. Value assessment: Values are identified with respect to the attributes identified from site survey and the ones mentioned in their OUV (for World Heritage Sites) which has

generated specific statements of significance. The condition and impacts have been assessed with respect to these statements.

2. Condition assessment: The present condition of each of the identified heritage has been assessed on site by a team of conservation professionals and structural experts in order to identify most vulnerable areas which might be impacted during construction and operation of Metro
3. Impact assessment: Visual, structural, architectural and contextual impacts have been assessed with the help of distinctive assessment methods and dedicated team of experts which have been elaborated in the respective chapters. The details of the assessment criterion for each category has been mentioned in their respective sections.

STEP- 8 Mitigation measures

Mitigation measures have been for each of the identified heritage resources with respect to the severity of the predicted impacts.

Summary and conclusion

The results of the assessment have been summarised to prepare a concluding statement which gives a comprehending the scale of impact on heritage resources and provides a way forward.

2.1 DATA SOURCES

Lucknow Rail Metro Corporation (LMRC), made available all the information related to the Heritage Impact Assessment of Metro corridor-I project, including various report, proposed Metro alignment drawings, proposed Metro work, DPR. Agra circle, Archaeological Survey of India, has provided records of all listed monuments, maps, files and information on archaeological excavations and other information. Directorate of Tourism, Uttar Pradesh is the source for Year-wise Tourist Statistics data (2014, 2015, 2016, 2017 and 2018).

The research on archaeological excavations and remains of the area have been conducted on the basis of the following references:

1. *District Gazetteers of the United Provinces of Agra and Oudh*, 1904.
2. Pradhan, A. (2013). *Cultural Study of Agra Region in the Perspective of Archaeological Excavations and Explorations*.
3. Tucker, R. F. (1907-08). *The Akbari Mahal in Agra Fort.* ASI Annual Report.
4. Carlleyle, A. (n.d.). *Archaological Survey of India Report, Vol IV*.
5. (1953-54 to 2003-04). *Indian Archaology- A Review* . ASI, New Delhi .

Framework for the Heritage Impact Assessment was developed and adopted following the below mentioned reference:

1. Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO 2015)Write complete reference
2. Heritage Impact Assessment of Lahore Orange Line Metro Train Project, Rogers Kolachi Khan & Associates Ltd for Lahore Development Authority, February 2016
3. Old town of Galle and its Fortifications Heritage Impact Assessment, August 2015 by studio Thompson
4. Randl (2001) protecting a historical structure during adjacent construction. US National parks service

5. Asian Academy for Heritage Management (AHHM)- World Heritage Institute for Training and Research in Asia and pacific (WHITRAP)-ICCROM HIA online manual Year
6. Australia ICOMOS (2015), Burra charter
7. IAIA (1999) Principles of Environmental Impact Assessment best practice
8. India: Jaipur Metro Rail Line 1 Phase-B Project June 2013 Prepared by Jaipur Metro Rail Corporation for the Asian Development Bank.
9. Heritage Impact Assessment Union Station Trainshed GO Rail Network Electrification project environmental Prepared by GS/JN
10. Cultural Heritage Resource Assessment Lower Yonge Precinct City of Toronto, Ontario
11. Transport for NSW Transport Access program 3 Glenbrook station upgrade- statement of Heritage impact Prepared by RPS Australia east pty ltd
12. Guidelines for Writing Effective Statements of Significance British Columbia, Heritage branch
13. Environmental impact assessment for the proposed national road 3: Keeversfontein to warden (De beers pass section) Prepared by Thembeni Cultural Heritage
14. Improving Heritage Impact Assessment Patiwael, Patrick; Groote, Peter; Vanclay, Frank
    a. Published in: International Journal of Heritage Studies
15. Melbourne Metro rail: Parkville station VHR H0918 main entrance gates, pillars & fence heritage impact statement, Purcell GJM heritage
16. Melbourne Metro rail project assessment under environment effects act 1978, Minister for Planning
17. Historical Cultural Heritage Impact Assessment Prepared by Jon Howell-Meurs (Andrew Long and Associates)
18. Heritage Impact statement Sydney Metro City & Southwest Pitt Street North Over Station Development Author GML Heritage
19. (2018). *Taj Trapezium Zone: Preparation of Draft Vision Document Volume I and II.*

The following are the sources referred for developing a framework for impact assessment: predicted impact study references

1. Protecting a Historic Structure during Adjacent Construction, Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf
2. *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86
3. Environmental Impact Assessment, Delhi Metro, http://www.delhiMetrorail.com/eia_report/Janakpuridscorridor.pdf
4. Environmental management during Metro railway construction especially in highly polluted and densely populated city, M. Kumar Delhi Metro Rail Corporation Ltd., India, Transactions on the Built Environment vol. 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509
5. Environmental Impact Assessment Study for Najafgarh- Dhansa Bus Stand Corridor of Delhi Metro
6. *"Goel, Deepti; Gupta, Sonam. 2015.* The Effect of Metro Expansions on Air Pollution in Delhi. *Policy Research Working Paper; No. 7448. World Bank, Washington, DC. © World Bank, https://openknowledge.worldbank.org/handle/10986/22878 License: CC BY 3.0 IGO."*

The following are the sources referred for developing a framework for developing mitigation measures:

1. Heritage Impact Assessment of Lahore Orange Line Metro Train Project, Rogers Kolachi Khan & Associates Ltd for Lahore Development Authority, February 2016
2. Guidance on Heritage Impact Assessments for Cultural World Heritage Properties by ICOMOS in 2011
3. District Census 2011". Census2011.co.in. 2011. Retrieved 30 September 2011
4. http://www.uptourism.gov.in/site/writereaddata/siteContent/201904301103477451Monument-small-chart-2014-to-2018.pdf
5. Critical issues related to Metro Rail Projects in India, Sharma Niraj, Rajni Dhayani, S. Gangopadhaya, Journal of Infrastructure Development 5 (1) 67-86, 2013
6. Protecting a Historic Structure during Adjacent Construction, Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03. pdf .
7. Effects of Underground Metro on historic Monuments in Delhi by Kamal Kishore, 2017
8. Environmental management during Metro railway construction especially in highly polluted and densely populated city, M. Kumar Delhi Metro Rail Corporation Ltd., India, Transactions on the Built Environment vol 64, 2003 WIT Press, www.witpress.com, ISSN 1743-3509.

3. LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

The study area consists of World Heritage Sites, nationally protected monuments as well as unprotected heritage resources. The following guidelines, acts and documents constitute the legal and institutional framework for carrying out the HIA study.

NATIONAL MONUMENTS AUTHORITY (NMA)

While the monuments are conserved and managed by ASI, the protected and regulated areas as per the AMASR Act are to be managed by NMA along with the local competent authority.

Archaeological Impact Assessment Format

Heritage Impact Assessment as a tool has been introduced by National Monuments Authority to ensure that new construction around ASI protected sites do not affect the heritage value of the place. NMA has provided a format for Archaeological Impact Assessment Report and has referred to Schedule II of AMASR Act for detailed information but there are no formulated guidelines for Heritage Impact Assessment in India. The report format mentions the basic attributes of the value assessment and mitigation measures but the detail methodology that needs to be adopted has not been defined.

ARCHAEOLOGICAL SURVEY OF INDIA

The Archaeological Survey of India (ASI), under the Ministry of Culture, is the premier organization for the archaeological researches and protection of the cultural heritage of the nation. Maintenance of ancient monuments and archaeological sites and remains of national importance is the prime concern of the ASI. Besides it regulates all archaeological activities in the country as per the provisions of the Ancient Monuments and Archaeological Sites and Remains Act, 1958, Ancient Monuments and Archaeological Sites and Remains Rules, 1959 and Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010. It also regulates Antiquities and Art Treasure Act, 1972.

The Agra Circle erstwhile Northern Circle is one of the oldest circle of the ASI. It was established in the year 1885, with its headquarters at 22, the Mall, Agra. There are 266 monuments/sites under the jurisdiction of Agra Circle spreading in 26 districts of Western Uttar Pradesh including three World Heritage Monuments viz. Taj Mahal, Agra Fort and Fatehpur Sikri, all of the Mughal period and located in district of Agra. The Circle is conserving and managing the monuments and sites through its 08 sub-circle viz. Taj Mahal, Agra Fort, Fatehpur Sikri, Sikandara, Itimad-ud-Daulah, Mathura, Kannauj and Meerut.

Indian Treasure Trove Act 1878

An Act to amend the law relating to treasures found in India. It defines treasure specifically as "anything of any value hidden in the soil" and worth as little as 10 rupees. The finder of such treasure, according to this law, needs to inform the most senior local official of the "nature and amount or approximate value of such treasure and the place where it was found". All major metal detecting, excavations and treasure hunts are carried out by India's nodal agency setup for the purpose, the Archaeological Survey of India.

Ancient Monuments, Archaeological Sites and Remains (AMASR) Act 1958 and Amendment, 2010

An Act to provide for the preservation of ancient and historical monuments and archaeological sites and remains of national importance, for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects. The AMASR Act is aimed at authorizing government bodies, Archaeological Survey of India (ASI) and National Monuments Authority (NMA), to intervene with the intention to preserve ASI designated monuments that are under any threat. This also includes making policies and guidelines for the area around the monuments. The protected area identified around the monument is 100 meters from the edge of the site, 200 meters beyond the protected area is a regulated area.

The Antiquities and Art 1972 and Antiquities and Art Treasure Rules 1973

An Act to regulate the export trade in antiquities and art treasures, to provide for the prevention of smuggling of, and fraudulent dealings in, antiquities, to provide for the compulsory acquisition of antiquities and art treasures for preservation in public places and to provide for certain other matters connected therewith or incidental or ancillary thereto.

The Ancient Monuments Preservation Act, 1904

An Act to provide for the preservation of Ancient Monuments and objects of archaeological, historical, or artistic interest. The Ancient Monuments Preservation Act, 1904 was passed in 18, March 1904 by British India during the times of Lord Curzon. It is expedient to provide for the preservation of ancient monuments, for the exercise of control over traffic in antiquities and over excavation in certain places.

AGRA MUNICIPAL CORPORATION

The civic administration in the city of Agra is in the jurisdiction of the Agra Municipal Corporation. The urban local bodies in the state of Uttar Pradesh are governed by two important legislations:

UP Municipalities Act, 1916

An Act to consolidate and amend the law relating to Municipalities in Uttar Pradesh.

UP Municipal Corporations Adhiniyam, 1959

An Act to provide for the establishment of Municipal Corporations for certain cities in Uttar Pradesh with a view to ensure better municipal government of the said cities. The Act also mentions the Duties and Powers of the Corporation and Corporation Authorities

AGRA DEVELOPMENT AUTHORITY

The Uttar Pradesh Urban Planning and Development Act 1973

An Act to provide for the development of certain areas of Uttar Pradesh according to plan. It extends to the whole of Uttar Pradesh, excluding Cantonment areas and lands, owned, requisitioned or taken on lease by the Central Government for the purposes of defence. The Act mentions the need to create a Development Authority and mentions the purpose of it and also mentions the need to develop a Master Plan or Zonal Plan.

Taj Dharohar Kshetra regulations and defined zone under Master Plan 2021

Master Plan of 2002 had identified an area around the Taj Mahal, and extending on both sides of Yamuna River demarcating the Taj Dharohar Khsetra. This included the buffer areas around the Taj, Agra Fort and most importantly, the River Front Gardens of Agra as identified in previous scholarly works. It also identifies area of Sikandara Fort as important heritage Site. However, in that Plan or in any subsequent Master Plan there have been no regulations outlined that would enable and facilitate protection of heritage in these area.

- Industries within the boundary to the proposed industrial area to be shifted out
- Slums within the area are not to be relocated. The industries within the area between waterworks and Jeevni Mandi Crossing are to be retained. Beautification and redevelopment proposals to be carried out. The following guidelines are applicable to the mentioned area:
    a. For ASI protected monuments, no development is allowed within 100meters of the defined protection boundary and regulated development is allowed within the next 200 meters
    b. For the area between 100 meters to 300 meters of the protected boundary only one floor (up to height 3.75m) is allowed for residential buildings and two floors (up to height 7.5m) are allowed for other building uses
    c. All constructions and redevelopment in the area should follow the Mughal style of architecture
- A dam is to be constructed between the Taj Mahal and Agra Fort as the width of the river is comparatively more in this area. Also, land is to reclaimed for developing parks and other regulated recreational spaces
- National park to be developed to the north of Taj Mahal, on the opposite bank in the area including Mehtab bagh and other charbaghs
- A barrage is to be constructed downstream from Taj Mahal and the area to be developed for boating and other recreational facilities.
- No new constructions or redevelopment is allowed within 500 meters of Taj Mahal.
- The dam and the barrage are to be connected through road networks to develop an integrated circuit
- Beautification and development of amenities for tourism (pedestrian) in the Taj Ganj area to be carried out
- All sewage and drainage lines connected to the Yamuna river should be tapped and redirected beyond the defined area to protect the river from pollution.

TAJ TRAPEZIUM ZONE

Taj Trapezium Zone (TTZ) is a defined area of 10,400 sq. km around the Taj Mahal to protect the monument from pollution. The Supreme Court of India delivered a ruling on December 30, 1996 regarding industries covered under the TTZ, in response to a PIL seeking to protect the Taj Mahal from environmental pollution. It banned the use of coal/coke in industries located in the TTZ with a mandate for switching over from coal/coke to natural gas, and relocating them outside the TTZ or shutting down. The TTZ comprises monuments including three World Heritage Sites the Taj Mahal, Agra Fort and Fatehpur Sikri.

Section-31A of Air (Prevention and Control of Pollution) Act, 1981

The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board. The Government passed this Act in 1981 to clean up our air by controlling pollution. It states that sources of air pollution such as industry, vehicles, power plants, etc., are not permitted to release particulate matter, lead, carbon monoxide, sulfur dioxide, nitrogen oxide, volatile organic compounds or other toxic substances beyond a prescribed level. To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air.

Environmental Protection Act

The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environment. They relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property. The Act is an "umbrella" legislation designed to provide a framework for central government coordination of the activities of various central and state authorities established under previous laws, such as the Water Act and the Air Act.
Section 5 of Act

AGRA CANTONMENT BOARD

Cantonment Board Agra has been established in the year 1805. It spreads over an area of 1156.474 hectares which includes civil area of 952.55 acres. Agra cantonment is administered by cantonment board for the municipal and development functions. Apart from the army, the board caters to the civil population of the cantonment numbering more than 42,869 which predominantly lives in various civil areas like Sadar Bazar, Naulakha, Shahzadi Mandi, Sultanpura, Lalkurti, Pratappura, Nai Basti and partly in Bungalow area.

3.1 STATUS OF LEGAL PROTECTION OF IDENTIFIED HERITAGE RESOURCES

Agra fort and Taj Mahal are inscribed on the UNESCO World Heritage List. Protected structures under discussion have legal protection under AMSAR (amendment and validation) Act, 2010. These instrument provide various forms of legal protection in support of preservation and best practice in management of heritage resources.

PART I

AGRA METRO CORRIDOR- I

TABLE: 3.1 STATUS OF PROTECTION OF IDENTIFIED HERITAGE RESOURCES

S. NO.	NAME OF HERITAGE RESOURCE	STATUS OF LEGAL PROTECTION			
		UNESCO World Heritage Incription	AMASR Act	Taj Mahal Buffer of 500m	Unprotected
1	Taj Mahal	✓	✓	✓	
2	Agra Fort	✓	✓		
3	Akbar's Tomb		✓		
4	Kanch Mahal		✓		
5	Lodhi Tomb		✓		
6	Guru Ka Taal		✓		
7	Pathar Ka Ghoda		✓		
8	Itibari Khan Mosque		✓		
9	Tomb of Salabat Khan		✓		
10	Tomb of Sadiq Khan		✓		
11	Barah Khamba		✓	✓	
12	Old Delhi Gate of City		✓		
13	Jama Masjid		✓		
14	Ladli Begum Ka Tila		✓		
15	Shahjahan Park			✓	
16	Fatehpuri Mosque		✓	✓	
17	Satti-un-Nissa's Tomb		✓		
18	Bhuri Khan's Mosque				✓
19	Baoli-1, Fatehabad Road				✓
20	Khadari Begam Tomb/ Bharatpur house/RBS College				✓
21	Baradari Temple				✓
22	Suraj Bhan Gateway				✓
23	Tomb-I				✓
24	Tomb-II				✓
25	St. John's College				✓
26	Agra College				✓
27	Medical Building Complex (Lady Lyall Complex)				✓
28	St. Pauls Church				✓
29	Queen Victoria School				✓
30	RBS College				✓
31	Kalan Masjid				✓
32	Sarojini Naidu Hospital and College				✓
33	Senior Boy Hostel				✓
34	Agra Fort Railway Station				✓
35	Baoli-1, Agra University				✓

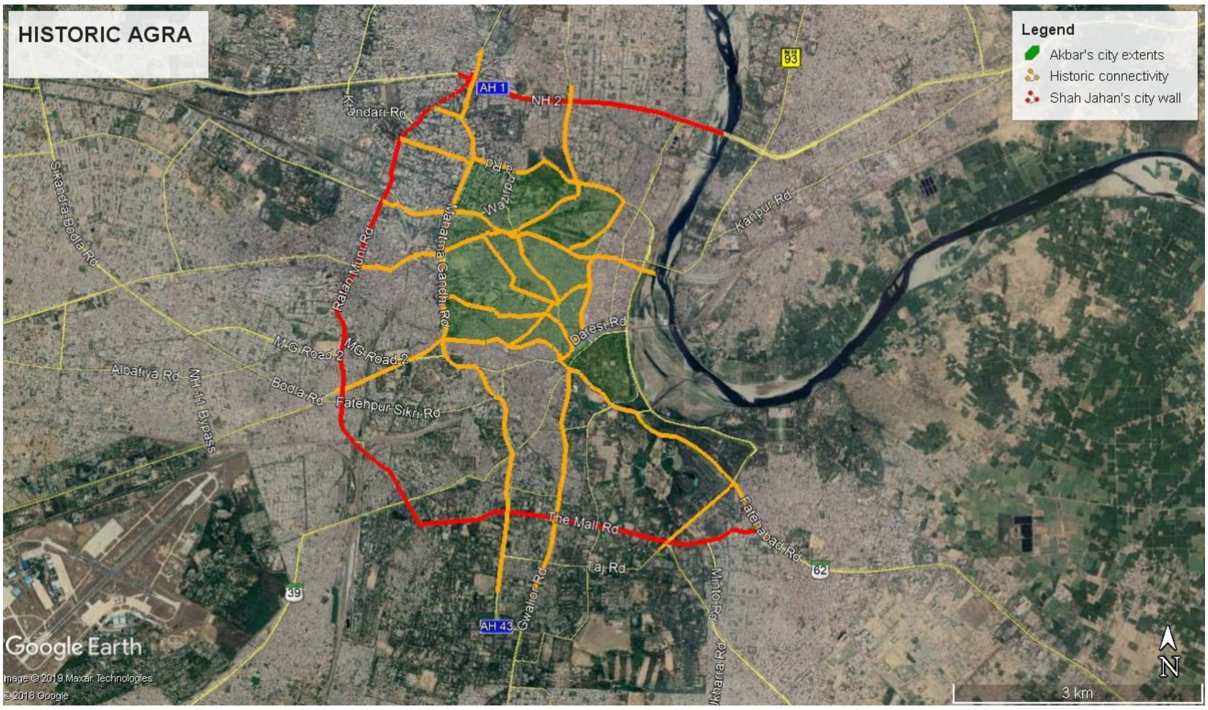
Note: Shahjahan Park itself is not protected but lies partially in 500m buffer of Taj Mahal.

4. HISTORICAL BACKGROUND OF AGRA

During the Lodi and subsequent periods, people inhabited the right bank area of the Yamuna. For over fifty years the Lodi sultans and then the early Mughal rulers occupied the pre-existing fort, Badalgarh, as their residence[2]. Meanwhile, the shift in capital encouraged growth in occupancy of both the political elite and other members of society. However, except for a Baradari[3] and some tombs, no other building from the pre-Mughal days could be found by the preservation authorities of modern times.

Babur, who was more often critical of what he saw or experienced in India, was, nonetheless, highly impressed with the number of construction workers and their skills not only in Agra[4] but elsewhere as well. He has, however, only recorded the construction of his garden, Charbagh, across the Yamuna. He encouraged his companions to follow suit which earned the area the name Kabul in local parlance.

In the Charbagh complex, a small building of red sandstone for his residence, a mosque, a tank, and a well were constructed. From that time onwards, the left bank of the Yamuna and the adjoining areas emerged as a favourite destination for the gardens of the Mughals.



Map 4.1 Map of Agra showing historic network of Agra and city walls of Agra [5]

No effort to develop or change the appearance of the city was made by Humayun. Only a mosque in the trans-Yamuna area reminds us of his association with Agra. In fact, he had to run from one place to another to save his territories from the designs of his brothers and their supporters as well as from Sher Shah in the north, and Bahadur Shah of Malwa-Gujarat region.

[2] Carllyle in Cunningham's Report's Report for the year 1871-72, Delhi, Agra, vol.IV, pg.104-105
[3] ASI, Delhi Office, UP, vol. 15-2114004 (1910-11). Baradari is a square shaped pavilion with three arch-ways on each side.
[4] Baburnama, p.520
[5] Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.

Finally, Humayun lost to Sher Shah and left the subcontinent to save himself. Though Sher Shah had possession of Badalgarh fort, his efforts towards consolidation of his empire through military expeditions and his preference for Delhi did not contribute towards any noticeable development of Agra. After more than a decade of loss of power and exile, Humayun recaptured his lost territories in 1555 from the weak successors of Sher Shah.

Between 1530 and early 1556 Agra did not enjoy any kind of political privilege. Yet Akbar preferred Agra over Delhi as the seat of governance. From then onwards Agra continued as capital of the Mughals right up till the middle of the seventeenth century. Akbar inherited the conquered territories along with the onerous task of keeping them intact, not only from the vanquished rulers but also from the saboteurs and aspirants from within. On reaching Agra in October 1558. Akbar had conveyed his preference and decision about Agra by earmarking land for residential purposes to the nobility.[6]

Akbar stayed at the Badalgarh fort during the early years of his reign. The Badalgarh fort was also demolished and on its ground an entirely new structure was raised that took eight years to complete. Built with red sandstone, massive in size, semi-circular on plan with huge bastions, the fort is an awe-inspiring structure that is spread over 94 acres of land. It is so strongly built that it has withstood the vagaries of time and weather for more titan four centuries and is still showing no sign of wither.[7]

Once Akbar made clear his choice for Agra, the nobles or political elite get busy constructing their havelis along the course of the river, on its right bank.[8] This area emerged as the prime location of the city and was, perhaps, controlled by the ruler as it remained associated only with the Mughal nobility of successive periods. Some of them had built more than one unit, one of which they sometimes offered to others on political considerations.

Exclusivity of the right bank of the river was maintained, by the ruler, by resuming the land and allocating it to some other noble once a noble had ceased to be in active service of the state. Other sections of people settled on areas lying further west of these havelis. For the protection of the residents, a wall encircling the city from three sides was constructed. This followed the course of a drain which discharged into the Yamuna on the south-eastern end of the fort on one side; its other end reached the Yamuna between the space subsequently occupied by the havelis of Jafar Khan and Shaina Khan. Entry and exit from the city, a responsibility of the City hovel, was monitored through several gates and khidkis (small gates) provided in the wall. However, the city continued to expand and soon residential localities emerged beyond the limits of this boundary wall.

The fort stands close to the bank of the river Yamuna, and any construction between the fort and the river was prohibited. The same rule was followed later in the case of the Agra Fortin Delhi. Built to act as the official headquarters and as the residence of the ruler, its buildings were constructed to serve the purposes of business as well as comfort and pleasure.[9] Jahangir hardly added any important building or made changes in the existing ones inside the fort.

During the rule of the next emperor, Shah Jahan, major changes both in designing and the use of construction material, inside the fort and elsewhere, took place. His successors lacked the time, the interest or inspiration, and the resources to undertake any innovative change or

[6] Journal of the Royal Asiatic society of Great Britain and Ireland, n.s.,1698, pp.29-36
[7] Abul Fazl, Akbarnama, vol.II, pp 247
[8] Abul Fazl, Akbarnama, vol.II, pp 188-9
[9] Franciso Pelsaert,'Remostrantie', c.1656, English translation by W.H. Moreland

addition inside the fort. Residential area of the royalty was not accessible to an outsider. As such these do not find any description in the contemporary accounts.

The most destructive phase occurred during the period of British occupancy. The living quarters within the fort, which could have provided glimpses of the lifestyle of the Mughal emperors, especially their harem, were replaced by ugly box-type living quarters for the use of British soldiers. This harsh act has erased traces of these buildings, leaving no possibility of reconstructing any semblance of either those structures or the lifestyle inside the fort.

Map. 4.2 Image showing Jaipur map of Agra[10] along with schematic depiction of Metro corridor-I

The "Jaipur Map of Agra' (Map 4.2) shows an extensive network of roads and streets that had developed corresponding with the expansion of the city. A wide road, apparently paved with red sandstone, connected Tripolia outside the fort with the Dilli Darwaza. Width and material used in other roads/ streets is difficult to make out as all roads seem to be of similar width and

[10] Jaipur Map of Agra, Pothikhana collection no 126, Sawai Man Singh Museum, City Palace, Jaipur

were lined with yellow color, where yellow apparently was used to indicate the unpaved surface of the road.[11] The north-western part of the city, in the map, is strewn with a heavy network of roads suggesting concentration of population in this part. Residential markings and localities, by and large called basti, could be noticed in all parts of the city. A large number of houses there, for instance, near Mandi Saeed Khan, Noori Darwaza, Gokulpura, Nai ki Mandi, Shahdara, etc., appear to be more than one storey high and probably belonged to the economically better placed section of residents.

Pelsaert, for the period of Jahangir's reign, has given a list of the havelis of the nobles that he found on the right bank of the river Yamuna. By and large, many of the mansions of earlier nobles do not seem to have survived around the time Pelsaert visited Agra, c.1626. During a recent visit to the town, none of the havelis listed by Pelsaert or any other source could be traced, nor do these find any mention as protected monument in the records of the Archaeological Survey of India (AS1).

The second attempt to encircle the habitation area was made during Shah Jahan's time[12]. The second city wall was wider than the earlier one and semi-circular in shape. It encircled the expanded city from three sides except the river. While a major part of the completed wall, in the map, is shown by brick red color indicating the use of red sandstone, the portion in the south of the Taj complex as well as a small portion in the north-east between Bagh Hakim Kazim Ali and Bagh Seodas, is coloured in yellow with similar architectural features. The use of the colour yellow is perhaps to convey that the stone work was incomplete there.

The location of terminal point of the kachcha wall, in the south-east of Khan Dauran's haveli, suggests that boundary wall was built before the construction of that haveli. Large and small-sized gates and doors, called darwaza and khidki respectively, were provided through the length of the wall for easy access to places outside the wall.[13]

The nobility's preference for the right riverbank continued unabated during Shah Jahan's time too. Leading nobles and some princes of royal blood occupied the entire length of the river passing through the city. A few of them had managed to build more than one haveli in that area. Each haveli was spread over a large area and was exposed to air on all its sides. These had large courtyards, tanks that were filled daily with fresh water from the wells, sweet smelling Hower gardens, and water fountains and trees for cool breeze. The havelis occupied sizable space to accommodate the large households of the nobles, with separate commodious lodgings for their wives, normally more than one at any given time. In these lavish living styles, display of fortune and status seem to have been a common sight.

To this Thevenot (1666-7) noted[14]

This place (fort) is accompanied with five and twenty or thirty other very large ones (i.e. mansions), all in -a line, which belong to the Princes and other great Lords of Court; and all together afford a most delightful prospect to those who are on the other side of the River, which would be a great deal more agreeable, were it not for the long Garden-walls, which contribute much to the rendering the Town so long as it is. There are upon the same line several less

[11] Chandramani Singh, 'Early 18th cen painted city Maps on Cloth', in Facets of Indian Arts. London Victoria Albert Museum.

[12] Koch, Mughal Agra, vol. I pp.555-558 and Amita Sinha, The Heritage Corridor and Culture on the Yamuna Riverfront', Places: Forum of Design for the Public Realm, vol.16, no. 2004 , pp.62-9

[13] Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.

[14] Jean de Thevenot, 'Relation de I' Indostan, 1666-67, Lovell's translation, reprinted with notes, corrections and introduction by S.N. Sen in The Indian Travels of Thevenot and Carei, Delhi: NAI, 1949,pp-47-8

Palaces and other Buildings. All being desirous to enjoy the lovely prospect and convenience of the Water of the Gemna, endeavoured to the purchase ground on that side, which is the cause that the Town is very long but narrow, and excepting some fair streets that are in it, all the rest are very narrow and without symmetry.

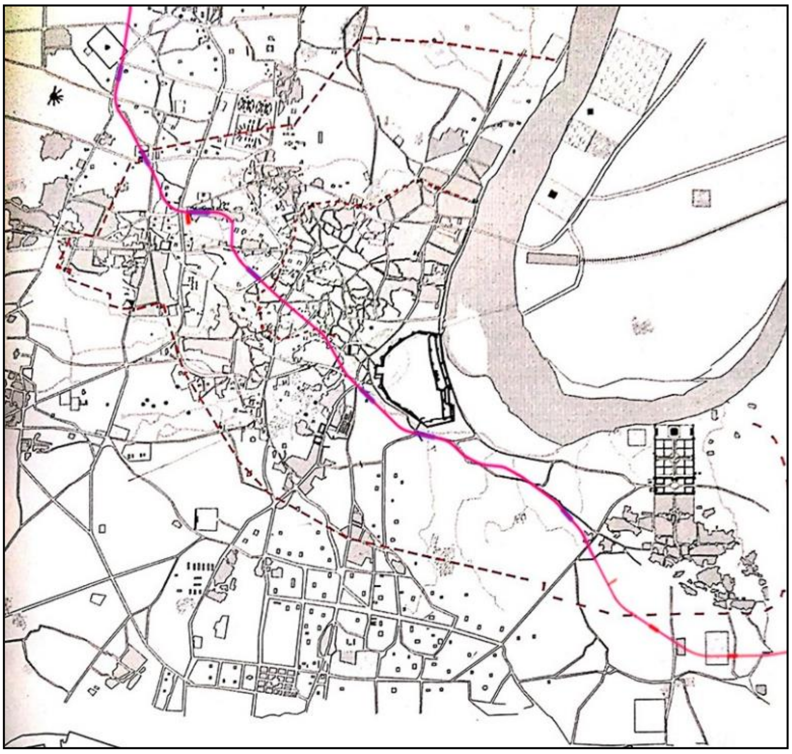
Maithan located close to Noori Gate, was a residential area apparently inhabited entirely by the business community. According to local tradition, this locality was primarily inhabited by Khatri and Brahmin sarmfs and financiers. However, with change in fortunes and diversion of business activities many of those families shifted elsewhere, selling their properties to other trading communities, mainly the Jains. The entire locality is approachable through narrow lanes. Beautifully carved stone/masonry gateways, on both sides of these lanes, remind one of the pleasant architecture of the seventeenth and eighteenth centuries. Some of these houses still provide glimpses of the large enclosures inside, which, however, have been broken into much smaller dwelling units. At places broken walls and dilapidated terraces do tell us that by and large these houses were more than one storey high. [15]

Residential-cum-market areas, on the right bank of the Yamuna, were normally known after the product or merchandise sold there. We thus come across such names as Sabun Katra, Loha Mandi, Nai ki Mandi/Hajjarn Mandi, Dal Mandi, Heeng ki Mandi, Neelpara/ Chhipitola, Jauhari Bazar, Kinari Bazar. Tajganj area was conceived to grow into one of the most important market centres of the city.[16]

Here, four enclosures with access only through their specific gates still exist and carry their original names: Katra Resham (locality of silk workers) and Katra Phulel (locality for perfume sellers), Katra Jogidas, and Katra Umar Khan.Several other enclosed markets, called katra, built by individuals were located in different parts of the town.

A number of religious structures constructed by both the Hindus and the Muslims could still be found in different parts of the city. The earliest known religious structure seems to be the mosque of Shah Vilayat,[17] which is located in Nai ki Mandi area.In Sabun Katra area (near present St. John's college) is located the mosque built by Muzaffar Hussain, the father of Khandari Begum, one of the queens of Shah Jahan. Originally this mosque, called Masjid-I Kalan, but now it known as Kali Masjid.

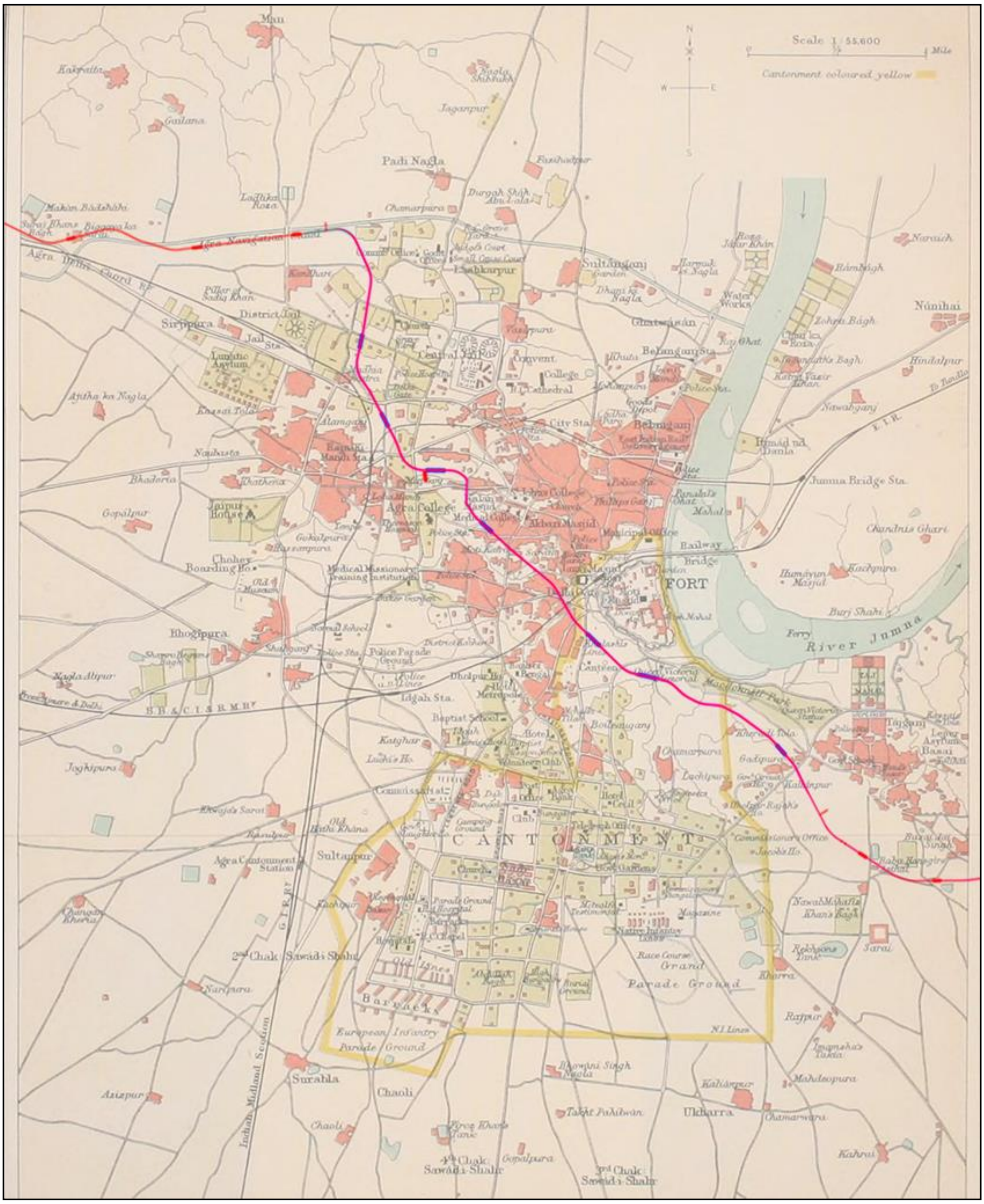
Propose Metro passes in close proximity of historic areas



Map 4.3 Map of Agra, 1868 | Peck, L. (2008). Agra The Architectural Heritage. New Delhi: Lotus Collection

[15] Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.
[16] Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.
[17] Keene, Keene's Handbook for Visitors of Agra, pp 191.

likeNai ki Mandi and Maithan area



Map.4.4 Map of Agra | Murray, John (1911) John Murray's handbook India Burma and Ceylon

5. DESCRIPTION OF IDENTIFIED MONUMENTS AND ARCHAEOLOGICAL REMAINS

There are two World Heritage Sites in Agra city, one of them is the Taj Mahal and its structures and the other is the Agra Fort and structures within. Both these sites are managed by the ASI. Part of the Agra Fort however is controlled by the defence and is inaccessible to other visitors. In Agra only seven protected monuments are ticketed, implying that the rest are not accessed by the tourists. Based on the literature and the site studies, the heritage assets within Agra city limits are as of now identified in three categories; The World Heritage Sites, Nationally Protected Monuments, approximately 1086 heritage structures listed by Lucy Peck in the INTACH publication.

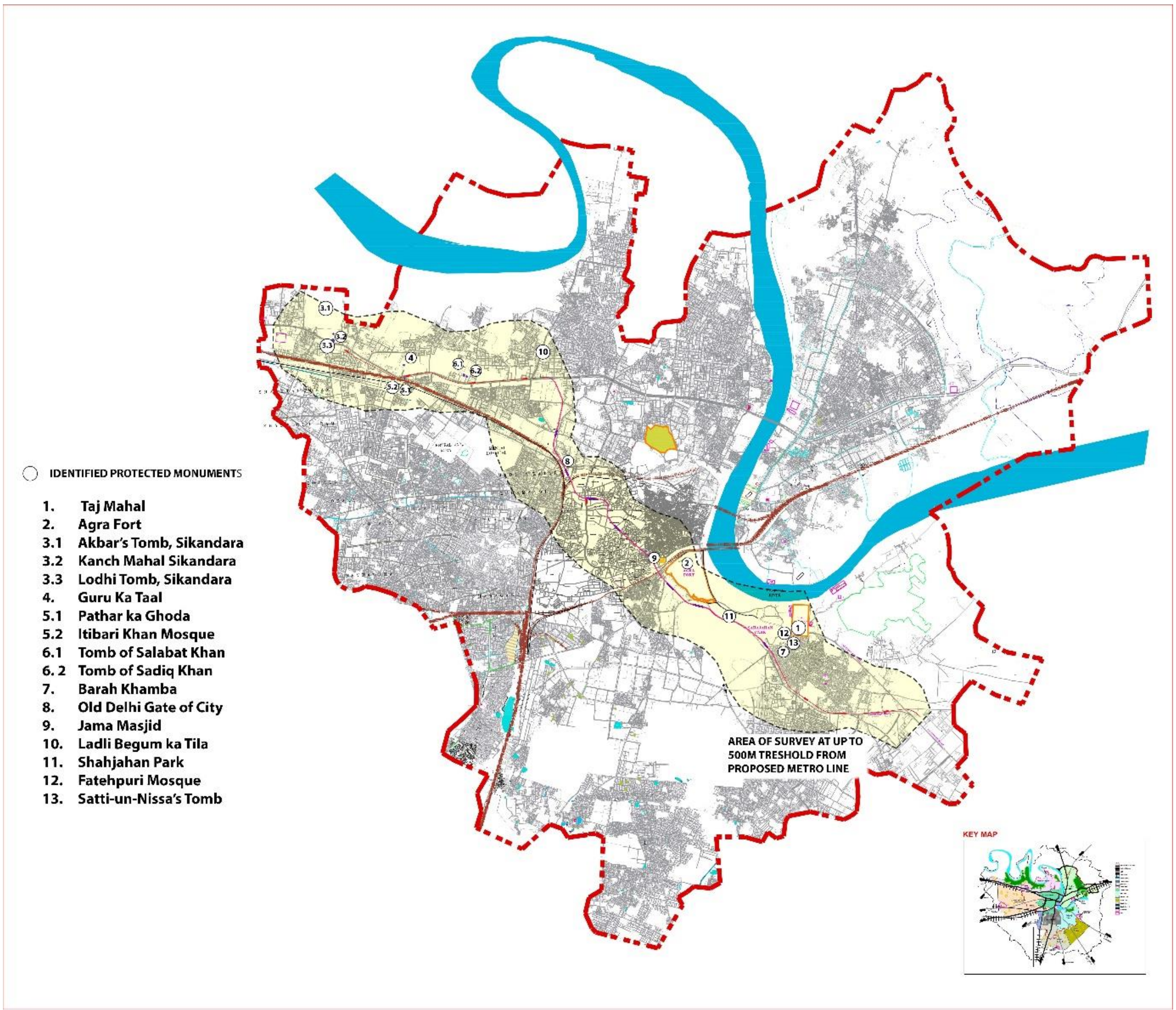
Historic Architecture and Archaeological Remains in study area

The survey has led to identification of total 2 World Heritage Sites, 60 protected monuments and 18 unprotected built heritage resources which needs to be assessed for predicted impacts of the Metro construction.Listing and mapping of following protected monuments;

1 Taj Mahal
1.1 Mausoleum
1.2.a Minaret Southwest
1.2.b Minaret Northwest
1.2.c Minaret Northeast
1.2.d Minaret Southeast
1.3 Riverfront Terrace
1.4 Mosque
1.5 Mehmaan Khana
1.6 Char Bagh
1.7 Great Gate
1.8 Jilau khana
1.9 Well at the Taj Garden
1.10 Dalans around Taj Quadrangle (Southern galleries)
1.11 Saheli burj no. 1 Fatehpuri
1.12 Saheli burj no. 2 Akbari
1.13.a West Gate
1.13.b East Gate
1.14 Sirhi darwaja (South Gate)
1.15.a Wall towers Southwest
1.15.b Wall towers West
1.15.c Wall towers Northwest
1.15.d Wall towers Northeast
1.15.e Wall towers East
1.15.f Wall towers Southeast
1.16 Central pool
1.17.a Garden wall Pavillion (Naubat Khana) West
1.17.b Garden wall Pavillion (Naubat Khana) East
1.18.a Bazaar street West
1.18.b Bazaar street East

2 Agra Fort
2.1 Delhi Gate
2.2 Amar Singh Gate
2.3 Akbari Mahal
2.4 Jahangiri Mahal
2.5 Jahangir's Bath
2.6 Shahjahan's Apartment
2.7 Khas Mahal
2.8 Roshan Ara Pavilion
2.9 Zara Ara Pavilion
2.10 Shish Mahal
2.11 Saman Burj
2.12 Mina Masjid
2.13 Anguri Bagh
2.14 Shah Burj
2.15 Diwan I Khas
2.16 Macchi Bhawan
2.17 Royal Baths / Hamams
2.18 Diwan -I-Am
2.19 Nagina Masjid
2.20 Salimgarh
2.21 Hon'ble John Russell Colvin's Tomb
2.22 Ladies Bazaar
2.23 Moti Masjid
2.24 Chitor Gates
2.25 Somnath Gate
2.26 Fort Wall
2.27 Moat along Fort Wall
3.1 Akbar's Tomb, Sikandara
3.2 Kanch Mahal, Sikandara
3.3 Lodhi Tomb, Sikandara
4 Guru Ka Taal

5.1 Pathar Ka Ghoda
5.2 Itibari Khan Mosque
6.1 Tomb of Salabat Khan
6.2 Tomb of Sadiq Khan
7 Barah Khamba
8 Old Delhi Gate of City
9 Jama Masjid
10 Ladli Begum Ka Tila
11 Shahjahan Park (partially part of Taj buffer)
12 Fatehpuri mosque
13 Satti-un-Nissa's Tomb

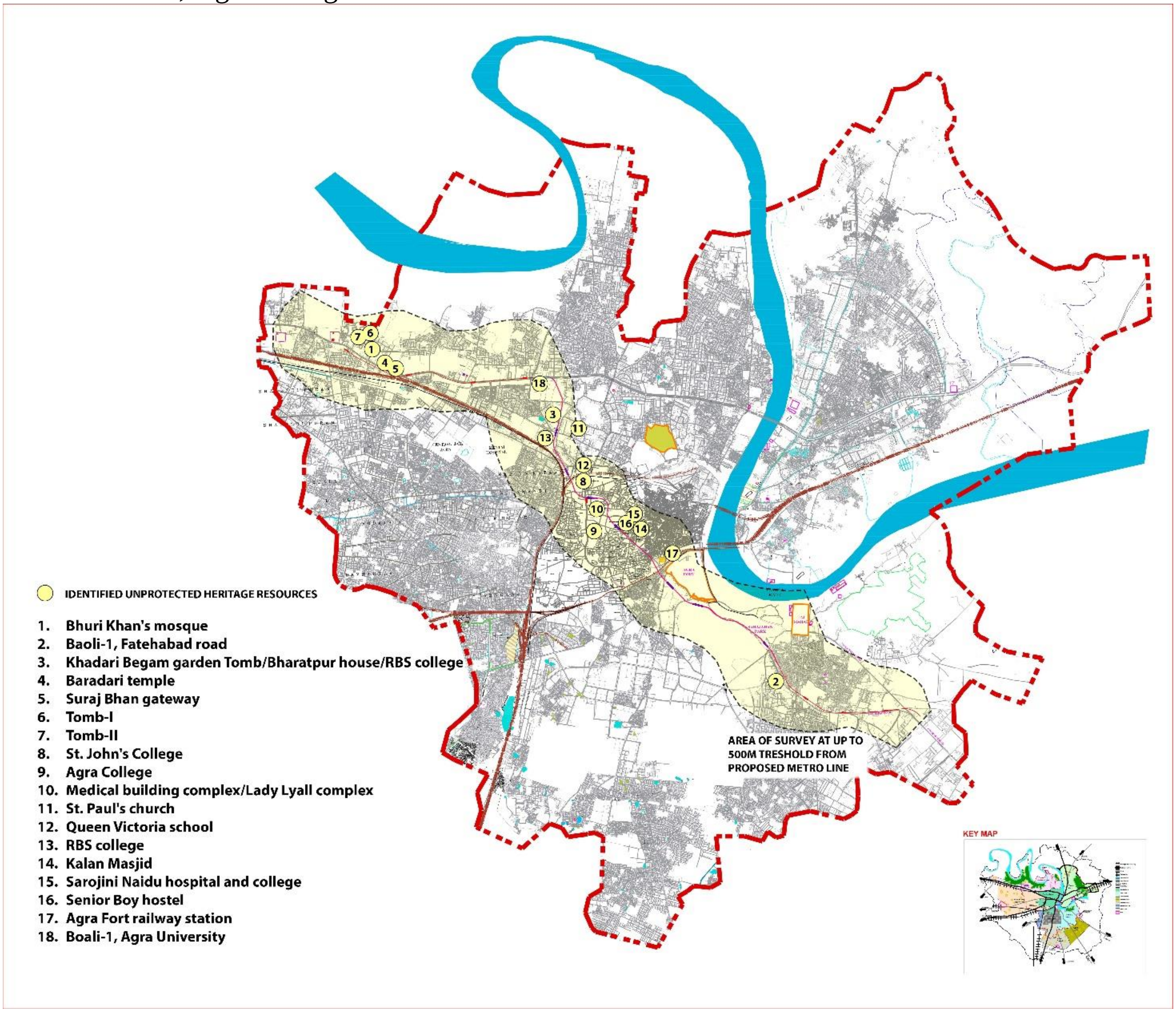


Map:5.1 Identified Protected monuments along proposed Metro corridor-I

Listing and mapping of following unprotected monuments

1 Bhuri Khan's Mosque
2 Baoli-1, Fatehabad Road
3 Khandari Begam Garden Tomb
4 Baradari and Temple
5 Suraj Bhan Gateway
6 Tomb-1
7 Tomb-2
8 St. John's College
9 Agra College
10 Medical Building Complex (Lady Lyall Complex)
11 St. Paul's Church
12 Queen Victoria School
13 RBS College

14 Kalan Masjid
15 Sarojani Nadu Hospital and College
16 Senior boy's Hostel
17 Agra Fort Railway Station
18 Baoli-2, Agra College



Map:5.2 Identified unprotected monuments along proposed Metro corridor-I

5.1 WORLD HERITAGE SITES

5.1.1 Taj Mahal

Image: 5.1.1.1 External view of Taj Mahal's mausoleum from southside

COORDINATES: 27.1751° N, 78.0421° E
DATE OF INSCRIPTION: 1983

An immense mausoleum of white marble, built in Agra between 1631 and 1648 by order of the Mughal emperor Shah Jahan in memory of his favorite wife, the Taj Mahal is the jewel of Muslim art in India and one of the universally admired masterpieces of the world's heritage. Taj Mahal was inscribed onto World Heritage List in 1983 under criteria (i). Taj Mahal located in Agra district, Uttar Pradesh.

It was recommended by ICOMOS that "the proposed cultural property and that of the Agra ort form a joint preposition for inscription of the World Heritage List".[18]
As site was inscribed on World Heritage list in 1983, at that time a formal Statement of Outstanding Universal Value (SOUV) was not put forward for approval by the World Heritage Committee (this has been a requirement only since 2007). World Heritage Committee had adopted the retrospective Statements of Outstanding Universal Value in 2012 as mentioned in document WHC-12/36.COM/8E.[19]

The extent of the property is defined in map no…. which depicts the inscribed core area of the site of 16.8145 hectare with an area of buffer zone of 165.6 hectare. The legal protection of the monument and the control over the regulated area around the monument is through the various legislative and regulatory frameworks, including the Ancient Monument and

[18] Advisory Body Evaluation (ICOMOS),https://whc.unesco.org/en/list/252/documents/
[19] Information taken from https://whc.unesco.org/en/decisions/4841

Archaeological Sites and Remains Act 1958 and Rules 1959 Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation).

Description

Taj Mahal is the pinnacle of Mughal architecture built by the Mughal emperor Shahjahan (1628-1658), in the memory of his queen Arjumand Bano Begum, entitled 'Mumtaz Mahal'. The mausoleum, located on the right bank of the river Yamuna at a point where it takes a sharp turn and flows eastwards, harmoniously combines the great building traditions of Central Asia, Iran and India, all of which placed great emphasis on the geometrical relationships contained within a building.

The domed white marble structure is situated on a high plinth at the northern end of a four-quartered garden, evoking the gardens of paradise, enclosed within walls measuring 305 by 549 meters. Outside the walls, in an area known as Mumtazabad, were living quarters for attendants, markets, serais and other structures built by local merchants and nobles. The tomb complex and the other imperial structures of Mumtazabad were maintained by the income of thirty villages given specifically for the tomb's support. The name Taj Mahal is unknown in Mughal chronicles, but it is used by contemporary Europeans in India, suggesting that this was the tomb's popular name. In contemporary texts, it is generally called simply the Illumined Tomb (Rauza-I Munawara).

Work on the mausoleum was commenced early in 1632. Inscriptional evidence indicates much of the tomb was completed by 1636. By 1643, when Shahjahan most lavishly celebrated the Urs ceremony for Mumtaz Mahal, the entire complex was virtually complete… The entire complex was proportionally designed according to a series of geometrically related grids, hence explaining not only the tomb's perfect balance but also that of the entire complex. The initial part of the complex is a red sandstone forecourt (*chowk-i jilo khana*) south of the walled garden. This area was intended for the imperial retinue. A magnificent red sandstone gateway, about 30 meters high and leading into the walled garden, also serves as the northern wall of the forecourt. The entrance is within a deeply recessed central arch that is surmounted by small domed chattris. The entire central *pishtaq* is framed by a rectangular panel composed of black Arabic lettering inlaid into a white marble ground and dated 1647. Four chapters from the Quran comprise this text, including the final verses from a chapter entitled Daybreak that invites the faithful to enter paradise.

Beyond the forecourt is a four-part garden divided into quadrants by wide waterways that resemble the streams of paradise mentioned in the Quran more than the much narrower courses at earlier Mughal tombs. They meet at a large tank in the garden's center. The garden is clearly modeled on a well-established concept, the garden of paradise. At the garden's northern end, not in its center, is the splendid tomb. It is flanked on the west by a red sandstone mosque surmounted by white marble domes and on the east by a nearly identical structure called in contemporary texts a guest house or mehman khana. The mosque's facade is delicately inlaid with white marble and in its spandrels are colored stones, while the interior is richly polychromed. Mumtaz Mahal's superbly proportioned mausoleum is seated on the center of a high square marble plinth that elevates the tomb above the garden. The plinth is at the river's edge, and to compensate for the effects of flooding it rests on deeply sunk wells. At each corner of the plinth is a four-storied marble minaret. Surmounted by a bulbous white dome, the tomb is essentially square in plan with corners chamfered to form a Baghdadi octagon. Each of the tomb's four faces is marked by a high central pishtaq flanked by deeply recessed arched apertures. The design is controlled and balanced, creating a unique architectural achievement that many consider one of the wonders of the world.

The exterior of the mausoleum is primarily white marble. Inlaid colored stones are more sparsely used here than on his palace architecture constructed at the same time. As on the gate facade, rectangular panels with black calligraphy rendering verses from the Quran are inlaid into the tomb's white surface. The play of light, reflected and absorbed by the marble surface, is a dominant decorative device. …A series of panels carved with sprays of floral motifs form dadoes along the tomb's base. Although the matching of flowers with the leaves on a single spray defies botanical identification, the flowers depicted - roses, narcissus and tulips among others - came in Persianate culture to be associated with the flowers of paradise; moreover, they are the flowers used to describe the features of the beloved in Persian mystic poetry. The beloved on the most profound level is a metaphor for God and also might refer to the beloved of the emperor, his deceased wife here entombed. The layout of the tomb's ground floor is similar to that at Humayun's tomb... The central chamber is octagonal. In its center is a magnificent inlaid marble cenotaph marking the placement of Mumtaz Mahal's interred body in the crypt below. Shahjahan's cenotaph, similarly embellished, is to the west of the deceased queen's. The off-center position of Shahjahan's cenotaph in no way indicates that it was added as an afterthought.

Surrounding the cenotaphs of Shahjahan and Mumtaz Mahal is a carved latticed marble screen that Shahjahan ordered to replace the gold one designed by Bebadal Khan, his master goldsmith. Shahjahan became worried that the gold one would be looted. The interior, like the exterior, bears rectangular bands of Quranic verses, more than on any earlier Mughal building. Quranic passages, many of them entire chapters, are inscribed on the tomb complex. All those chosen for inclusion here have a common theme, the reward promised to believers and the fate of eternal doom that awaits non-believers on the Day of Judgment. This theme is appropriate for funereal architecture. The number of Quranic verses and their emphasis on the Day of Judgment is reinforced by the location of the mausoleum, not only at the end of the paradisiacal gardens but also on the platform above them. That position matches the very location of God's throne, which, according to Islamic tradition, will be above the gardens of paradise.[20]"

Outstanding Universal Value[21]

Criterion (i): Taj Mahal represents the finest architectural and artistic achievement through perfect harmony and excellent craftsmanship in a whole range of Indo-Islamic sepulchral architecture. It is a masterpiece of architectural style in conception, treatment and execution and has unique aesthetic qualities in balance, symmetry and harmonious blending of various elements.

An immense mausoleum of white marble, built in Agra between 1631 and 1648 by order of the Mughal emperor Shahjahan in memory of his favourite wife, the Taj Mahal is the jewel of Muslim art in India and one of the universally admired masterpieces of the world's heritage. The Taj Mahal is located on the right bank of the Yamuna River in a vast Mughal garden that encompasses nearly 17 hectares, in the Agra District in Uttar Pradesh. It was built by Mughal Emperor Shahjahan in memory of his wife Mumtaz Mahal with construction starting in 1632 AD and completed in 1648 AD, with the mosque, the guest house and the main gateway on the south, the outer courtyard and its cloisters were added subsequently and completed in 1653 AD. The existence of several historical and Quranic inscriptions in Arabic script have facilitated setting the chronology of Taj Mahal. For its construction, masons,

[20] Asher, Catherine B. (1992), Architecture of Mughal India, Cambridge University Press.
[21] WHC UNESCO website accessed on 10 Sept, 2019 Link: https://whc.unesco.org/en/list/252/

stone-cutters, inlayers, carvers, painters, calligraphers, dome builders and other artisans were requisitioned from the whole of the empire and also from the Central Asia and Iran. Ustad-Ahmad Lahori was the main architect of the Taj Mahal.

The Taj Mahal is considered to be the greatest architectural achievement in the whole range of Indo-Islamic architecture. Its recognized architectonic beauty has a rhythmic combination of solids and voids, concave and convex and light shadow; such as arches and domes further increases the aesthetic aspect. The colour combination of lush green scape reddish pathway and blue sky over it show cases the monument in ever changing tints and moods. The relief work in marble and inlay with precious and semi-precious stones make it a monument apart.

The uniqueness of Taj Mahal lies in some truly remarkable innovations carried out by the horticulture planners and architects of Shahjahan. One such genius planning is the placing of tomb at one end of the quadripartite garden rather than in the exact centre, which added rich depth and perspective to the distant view of the monument. It is also, one of the best examples of raised tomb variety. The tomb is further raised on a square platform with the four sides of the octagonal base of the minarets extended beyond the square at the corners. The top of the platform is reached through a lateral flight of steps provided in the centre of the southern side. The ground plan of the Taj Mahal is in perfect balance of composition, the octagonal tomb chamber in the centre, encompassed by the portal halls and the four corner rooms. The plan is repeated on the upper floor. The exterior of the tomb is square in plan, with chamfered corners. The large double storied domed chamber, which houses the cenotaphs of Mumtaz Mahal and Shahjahan, is a perfect octagon in plan. The exquisite octagonal marble lattice screen encircling both cenotaphs is a piece of superb workmanship. It is highly polished and richly decorated with inlay work. The borders of the frames are inlaid with precious stones representing flowers executed with wonderful perfection. The hues and the shades of the stones used to make the leaves and the flowers appear almost real. The cenotaph of Mumtaz Mahal is in perfect centre of the tomb chamber, placed on a rectangular platform decorated with inlaid flower plant motifs. The cenotaph of Shahjahan is greater than Mumtaz Mahal and installed more than thirty years later by the side of the latter on its west. The upper cenotaphs are only illusory and the real graves are in the lower tomb chamber (crypt), a practice adopted in the imperial Mughal tombs.

The four free-standing minarets at the corners of the platform added a hitherto unknown dimension to the Mughal architecture. The four minarets provide not only a kind of spatial reference to the monument but also give a three dimensional effect to the edifice.

The most impressive in the Taj Mahal complex next to the tomb, is the main gate which stands majestically in the centre of the southern wall of the forecourt. The gate is flanked on the north front by double arcade galleries. The garden in front of the galleries is subdivided into four quarters by two main walk-ways and each quarters in turn subdivided by the narrower cross-axial walkways, on the Timurid-Persian scheme of the walled in garden. The enclosure walls on the east and west have a pavilion at the centre.

The Taj Mahal is a perfect symmetrical planned building, with an emphasis of bilateral symmetry along a central axis on which the main features are placed. The building material used is brick-in- lime mortar veneered with red sandstone and marble and inlay work of precious/semi-precious stones. The mosque and the guest house in the Taj Mahal complex are built of red sandstone in contrast to the marble tomb in the centre. Both the buildings have a large platform over the terrace at their front. Both the mosque and the guest house are the identical structures. They have an oblong massive prayer hall consist of three vaulted bays arranged in a row with central dominant portal. The frame of the portal arches and the spandrels are veneered in white marble. The spandrels are filled with flowery arabesques of stone intarsia and the arches bordered with rope moulding.[22]

Attributes that carry Significance

1. Plan and design of the mausoleum and associated structures
   - Its setting one end of the char bagh with the river Yamuna flowing to the rear
   - Bilateral symmetry along a central axis on which the main features are placed
   - Raised podium on which the tomb rests
   - The four minarets at the corners of the raised platform framing the main tomb
   - Plan of the tomb with the octagonal tomb chamber in the centre surrounded by the portal halls and the four corner rooms. The exterior of the tomb is square in plan, with chamfered corners. The large double storied domed chamber, which houses the cenotaphs of Mumtaz Mahal and Shahjahan, is a perfect octagon in plan.
   - The double domes over the central chamber
   - The Timurid Persian layout of the walled garden *(charbagh)*
   - Enclosure within a walled quadrangle.
2. Decorative style and features including the white marble inlaid with precious and semi- precious stones on the cenotaphs and the external walls of the tomb, the floral marble carvings, the carved lattice screen and the calligraphic inscriptions of the mausoleum and associated structures.
3. The materials and substance of the construction including brick in lime mortar with a veneer cladding of white marble and red sandstone.
4. Function as a tomb with an annual Urs carried out to the graves every year.

Integrity

Integrity is maintained in the intactness of tomb, mosque, guest house, main gate and the whole Taj Mahal complex. The physical fabric is in good condition and structural stability, nature of foundation, verticality of the minarets and other constructional aspects of Taj Mahal have been studied and continue to be monitored. To control the impact of deterioration due for atmospheric pollutants, an air control monitoring station is installed to constantly monitor air quality and control decay factors as they arise. To ensure the protection of the setting, the adequate management and enforcement of regulations in the extended buffer zone is needed. In addition, future development for tourist facilities will need to ensure that the functional and visual integrity of the property is maintained, particularly in the relationship with the Agra Fort.[23]

Authenticity

The tomb, mosque, guest house, main gate and the overall Taj Mahal complex have maintained the conditions of authenticity at the time of inscription. Although an important amount of repairs and conservation works have been carried out right from the British period in India these have not compromised to the original qualities of the buildings. Future conservation work will need to follow guidelines that ensure that qualities such as form and design continue to be preserved.[24]

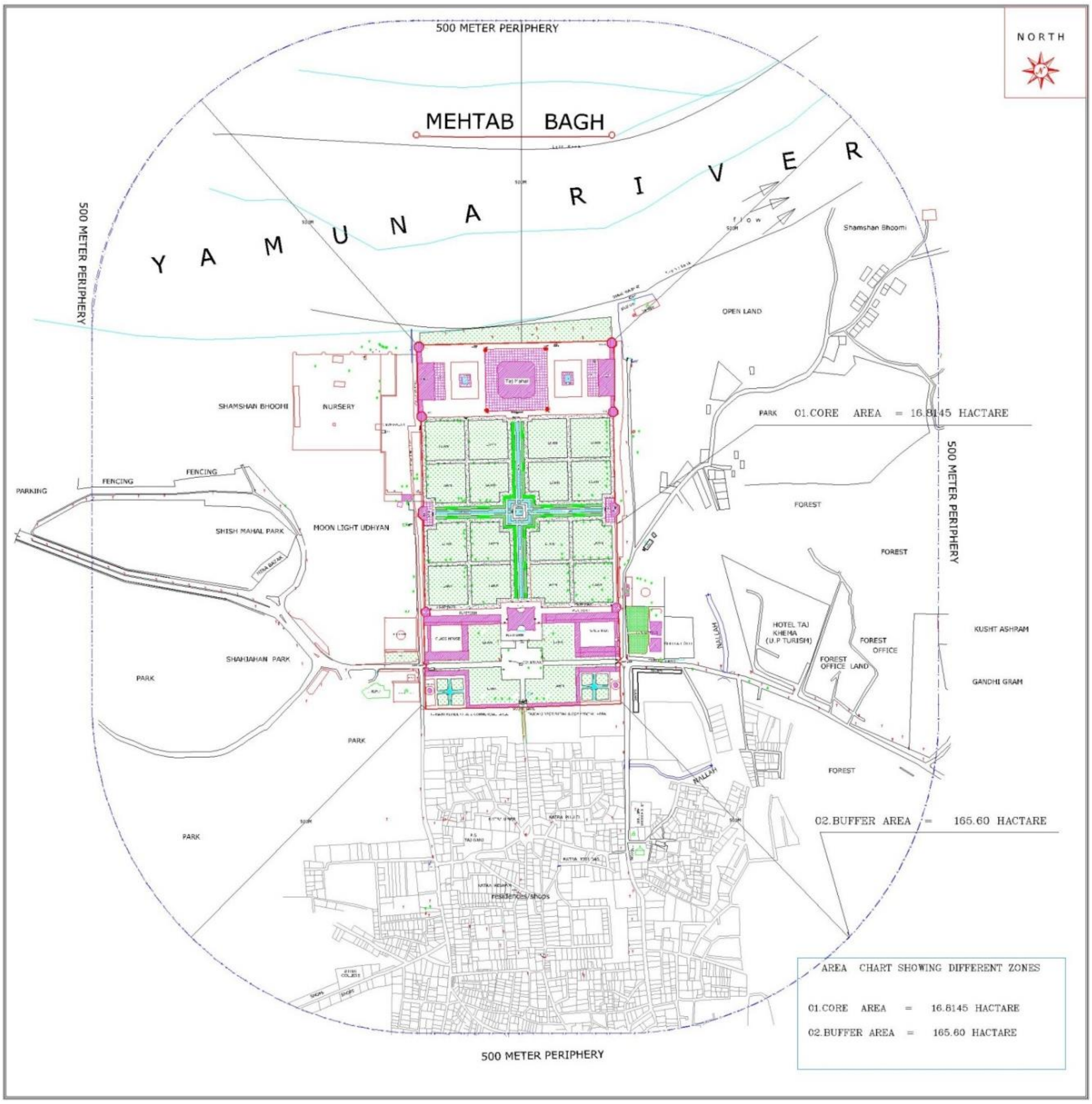
Buffer Zone

[22] https://whc.unesco.org/en/list/252
[23] https://whc.unesco.org/en/list/252
[24] https://whc.unesco.org/en/list/252

World Heritage Property of Taj Mahal has a buffer area of 165.60 hectare which consist of an area upto 500 m from the boundary of World Heritage property (Map.5.1.1.2).

Protection zone

An area of 10,400 sq km around the Taj Mahal is defined to protect the monument from pollution. The Supreme Court of India in December, 1996, delivered a ruling banning use of coal/coke in industries located in the Taj Trapezium Zone (TTZ) and switching over to natural gas or relocating them outside the TTZ. The TTZ comprises of 40 protected monuments including three World Heritage Sites - Taj Mahal, Agra Fort and Fatehpur Sikri[25].



Map 5.1.1.1 Buffer zone of Taj Mahal (500 m) from the protected World Heritage Boundary)[26]

5.1.2 AGRA FORT

CORDINATES: 27°10′46″N, 78°01′16″E

[25] Adoption of retrospective Statements of Outstanding Universal Value, https://whc.unesco.org/archive/2012/whc12-36com-8Ee.pdf

[26] Digitalisation department, Archaeological Survey of India, Agra Circle

DATE OF INSCRIPTION: 1983

The Agra Fortof Agra is a powerful fortress founded by the emperor Akbar (1156-1605) on the right bank of the river Yamuna; it is placed on the northwest extremity of the Jahan gardens which surround the Taj Mahal and form with them an evident monumentality. (Source: COMOS Advisory Board Evaluation, 1983) It was inscribed onto World Heritage List in 1983 under the criteria (iii). This powerful fortress of red sandstone encompasses, within its 2.5-km-long enclosure walls, the imperial city of the Mughal rulers. It comprises many fairy-tale palaces, such as the Jahangir Palace and the Khas Mahal, built by Shah Jahan; audience halls, such as the Diwan-i-Khas; and two very beautiful mosques.

Image 5.1.2.1 Entry to world heritage site of Agra fort through Amar Singh gate.

Description

Agra Fort was built on the site of an earlier Lodi era fort, Badalgarh with construction commencing in 1565 in the reign of the Mughal emperor Akbar. It was completed in 8 years under the direction of Qasim Khan Mir Barr o Bahr, replacing the older brick fort, with a stone fortification that would have unprecedented strength. The plan of the buttressed and crenelated walls, 22 meters high, roughly resembles a semicircle about 2.5 km in circumference. The red sandstone facing inlaid with white marble detail gives a sense of majesty to the massive Delhi gate, the fort's main entrance.

Within the fort the so-called Jahangiri Mahal is the most notable remaining building of Akbar's time. Overlooking the river, this palace was probably one of a series that originally lined the waterfront. In plan and elevation the exterior of this Jahangiri Mahal closely resembles the so-called Jodh Bai's palace at Fatehpur Sikri or what remains of the small fortified appearing enclosure at Akbar's Ajmer palace. The main fabric of the exterior is intricately carved red sandstone trimmed with white marble. The main entrance of the edifice opens onto a large central courtyard flanked on its north and south sides by pillared halls, whose red sandstone bracketed supports are even more intricate Versions. The interior walls, too, are ornately carved. Typical of several Islamic palaces in Central Asia, the Jahangiri Mahal's interior is symmetrically arranged around a central courtyard; a second courtyard on the east overlooks the river. A number of ancillary chambers and passages lead off from the central courtyard. Among these on the north is a large chamber with a flat roof supported by serpentine brackets. The source for such brackets is usually cited as Gujarat, especially Hindu or Jain architecture there. But such brackets long had been used in the Sultanate architecture of Gujarat and Bengal as well as at the Gwalior palace. On the roof of this multi-storied building is a small rectangular pavilion with a veranda on three of its sides, whose exquisitely carved brackets in the shape of peacocks earlier appeared on the Gwalior palace. It was one of the few Akbari buildings in this fort that Shahjahan maintained. Aspects of this palace, especially the carved geometric patterns and even its trabeated form, may draw from the Timurid tradition. But its overall appearance reflects the form of domestic architecture, both Hindu and Muslim, popular across north India prior to Akbar's time.

Shahjahan dismantled nearly all the structures that Akbar and Jahangir had built inside the Agra fort. He replaced them with white marble and stucco covered buildings, all contained in walled quadrangles. With the exception of the mosque known today as the Moti mosque, which was not completed until 1653, Shahjahan commenced his other structures in the Agra fort as early as 1628, his first regnal year, and completed them by the beginning of 1637, when he first used them for ceremonial purposes. As at Shahjahan's other palaces, the buildings reserved solely for the emperor are made of white marble and overlook the river, while the others he built, for example the Moti mosque and the Public Audience Hall, are away from the waterfront. In the first year of his accession Shahjahan ordered a Chehil Sutun to be placed inside the courtyard of the Public Audience Hall. This flat-roofed rectangular structure, today called a Diwan-i Amm, is divided into three aisles of ten bays each. Faceted pillars support cusped arches with acanthus leaves in each apex, typical of much of Shahjahan's architecture. Constructed of red sandstone, this pavilion is covered with a veneer of highly burnished plaster *(chuna),* giving it the appearance of white marble.

The east wall of the Audience Hall contains a raised rectangular chamber with three tri-lobed openings that serves as *jharoka* from which the emperor presented himself to those assembled in the Chehil Sutun. Unlike the nobles' area, covered with a burnished plaster veneer, this area reserved for the emperor is constructed of marble that in many places is richly inlaid with precious stones. The lower portion of the chamber's walls is carved with a row of baluster columns, that is, bulbous looking columns that appear to grow from a pot.

To the east of the Public Audience Hall is a quadrangle now called the Macchi Bhavan, for the storage of treasure. It contains a courtyard lined on three sides by two-storied arched galleries. The upper story's south projecting central bay was designed as a throne niche whose appearance was enhanced by powerful imagery. It consists of four bulbous baluster columns supporting a rounded baldachin. Beside these structural baluster columns, the baldachin's carving is embellished with relief representations of baluster columns and a sun medallion at the top. On the quadrangle's eastern side, overlooking the river, is a raised white marble platform. At its northern and southern ends are marble pavilions facing each other. The northern one, originally faced with a gallery of inlaid marble pillars, is the royal multi-roomed bath, or *hammam.* Here, in addition to bathing, private conferences were held. The Private Audience Hall (Daulat Khana-i Khass), popularly today called the Diwan-i Khass, is the pavilion at the southern end of the platform. This double-chambered structure is entered through five openings flanked by double pillars supporting cusped arches. Inside is a lengthy Persian inscription dated 1636-37 inlaid in black stone. It compares this room to the highest heavens, while the emperor himself is likened to the sun in the sky. Enhancing this celestial imagery is the ceiling that was once covered with gold and silver like the rays of the sun. Shahjahan's private residential quarters, inside another quadrangle, stand on a plinth that overlooks the river. On the north is the octagonal tower known today as the Musamman Burj. At this site Shahjahan demolished Jahangir's palaces and in its place erected this multi-storied tower whose marble fabric is richly inlaid with precious stones. Adjoining the tower to the west is a small pavilion, known as the Shah Burj, with an exquisitely carved sunken tank in its center. This pavilion, decorated with inlay over most of its marble surface, is perhaps the most ornate building in the entire Agra fort. Its materials and design indicate imperial use, as does its location between the Private Audience Hall and the king's sleeping quarters. The central pavilion on this platform is Shahjahan's sleeping quarters, known today as the Khass Mahal, but in contemporary texts as the Aramgah, or place of rest. Flanking it on either side are two almost identical rectangular pavilions within screened enclosures. From the north one, Shahjahan presented himself to the public outside the fort on the terrain below. This pavilion was surmounted by curved sloping eaves and a *bangala* roof that was gilded. The nearly identical pavilion on the other side of the Aramgah was the living quarters of Jahan Ara, Shahjahan's eldest and most devoted daughter.

There are two small marble mosques inside the fort. The more important of them, known today as the Nagina mosque, is approached from the throne chamber of the Public Audience Hall and the Macchi Bhavan, suggesting that it was built as Shahjahan's personal chapel. Its imperial character is further corroborated by baluster columns, used only on royal buildings at this time. This mosque consists of two aisles divided into six bays by slender piers supporting cusped arches. The parapet and eaves above the central bay are curved, recalling the exterior facade of the pavilion for public presentation near the imperial sleeping chamber and emphasizing its regnal character.

In addition to the small mosques is the fort's Jami mosque, today known as the Moti or Pearl mosque. It was not completed until October 1653, about five years after the imperial residence had shifted to Delhi. It is constructed entirely of white marble; each is divided internally into multi-bayed aisles; and each bears lengthy Persian inscriptions executed in black marble under the eaves. The Agra mosque is situated in a walled enclosure following the Mughal version of a standard four *iwan* mosque-type and has twelve-sided piers, typical of Shahjahan's later architecture, that support cusped arches. Three high bulbous domes as well as marble *chattris* surmount the roof of the Agra Jami mosque. The Agra fort mosque, more than any other, is a perfectly balanced marriage of form, mass and scale.

Outstanding Universal Value

Criterion (iii): to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;

The Agra Fortof Agra is a powerful fortress founded by the emperor Akbar on the right banks of the river Yamuna. It is placed on the northwest extremity of the Shahjahan gardens which surround the Taj Mahal and form with them an evident monumental unity. This bastioned fortress with walls of red sandstone rising above a moat, encompasses within its enclosure walls of 2.5 kms the imperial city of the Mughal rulers. Like the Delhi Fort, that of Agra, is one of the most evident symbols of Mughal grandeur which asserted itself under Akbar, Jahangir and Shahjahan. The citadel comprises a large number of fairy like palaces: the Khas Mahal, the Shish Mahal, the octagonal tower of Mussaman Burj, as well as reception room: Diwan i Khas built in 1637 and Diwan i Am, constructed as well under the reign of the luxury loving Shahjahan. One may also note within the palatial complex, two very beautiful mosques of white marble, the Moti Masjid or Pearl mosque, constructed from 1646-1653 by Shahjahan and the Nagina Masjid built in the reign of Aurangzeb (1658-1707).

All these monuments mark an apogee of an Indo Muslim art strongly marked by influences from Persia which already manifested itself in Timurid art.[27] It is one of the most important and robustly built strongholds of the Mughal Period, embellished with number of richly decorated buildings encompassing the imposing Mughal style of art and architecture. The Fort, semi-circular on plan and surrounded by 70 feet high double rampart and moat successfully withstood the onslaught of time, nature and men, and still survives in fairly good condition of preservation.[28]

Attributes that carry Significance

- Setting of the Fort along the banks of the river Yamuna and its visual link with the Taj Mahal.
- The Mughal building traditions and techniques combining Indian, Persian, Central Asia and European elements
- The materials and substance of the construction including brick in lime mortar with a veneer cladding of white marble and red sandstone.

Integrity

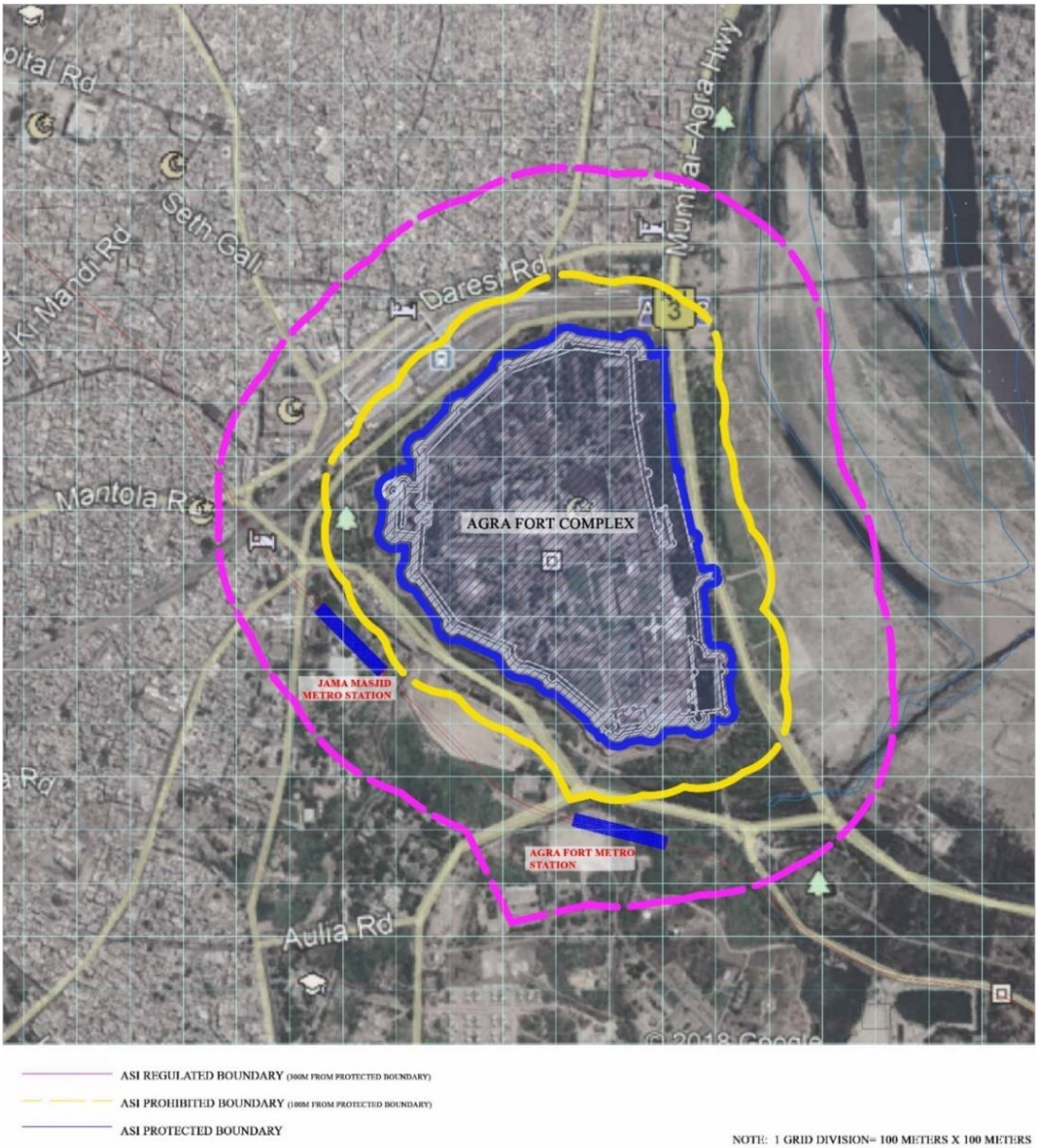
The visual integrity of the fort with the Taj Mahal is retained. However, the link with the city was largely destroyed with the laying of the railway line and the demolition of the old enclosed market square that stood between the fort and the Jama Masjid.

Within the fort, Abul Fazl states more than 500 buildings were constructed in stone during the reign of Akbar. Many of these were later demolished by Shahjahan who erected new buildings in their place. Mughal structures were later destroyed by the British in the south eastern part of the fort to make way for the barracks. Today, a little more than two dozen Mughal era buildings remain including some of the imperial residential quarters as well as administrative buildings and audience halls. The complex enclosed by the massive fortification walls retains its integrity.

Authenticity

The monuments of the fort complex largely retain their authenticity in terms of material, design and layout.

27 ICOMOS Advisory Body Evaluation, 1983
28 Periodic Reporting Cycle 1, Section II



Map 5.1.2.1 Protected (100 m) and regulated (300 m) boundaries of protected site of Agra Fort.

In this section all heritage resources all identified protected and unprotected heritage resources attributes that carry significance are identified along with their brief description.

5.2 PROTECTED MONUMENTS

5.2.1 Heritage Resources at Taj Mahal

Taj World heritage is comprised of many protected heritage resources in the complex itself. The table and map provided detail of all the significant heritage resources inside the complex.

The details of all these are provided in inventories as annexures. Among these are many notified monuments.

TABLE 5.2.1 HERITAGE RESOURCES AT TAJ MAHAL

S. NO.	NAME OF HERITAGE RESOURCE	ATTRIBUTES CARRYING SIGNIFICANCE
1.1	Mausoleum	• Form and design • Material and design • Decorative style and features of the structures: inlaid with precious stones representing flowers. Geometrical pattern, formed octagonal stars alternating, black marble inlaid in white, dado flower in the pishtaqs, plant motifs, intricate lattice work, Arabic calligraphic inscriptions. • Public access. • Function as a tomb. • The ensemble value of the mausoleum and its setting.
1.2	Minarets	• Form and design • Material and design • Decorative style and features • The ensemble value and its setting.
1.3	Riverfront Terrace	• Public access • Setting • Floor design pattern and material.
1.4	Mosque	• Form and design • Material and design • Public access • Continued use for its original purpose as a mosque. • Decorative style and features of the building. • Incised painting work •
1.5	Mehmaan Khana	• Form and design • Material and design • Public access • Decorative style and features of the building. • Incised painting work

1.6	Char Bagh	• Persian layout and design • Historic fabric • Public access • Historic landscape
1.7	Great Gate	• Nine-fold/ hasht- bihisht plan. • Perfect centrality and perfect symmetry • Decorative style and features of the gateway, tile work.
1.8	Jilau Khana	• Public access • Form and design
1.9	Well at the Taj Garden	• Continued use as a water resource.
1.10	Dalans around Taj Quadrangle (Southern galleries)	• Design of the façade elevation. • Public access • Form and design
1.11	Saheli burj no. 1 Fatehpuri	• Octagonal design of the building. • Associated tomb
1.12	Saheli burj no. 2 Akbari	• Octagonal design of the building. • Associated tomb
1.13	West Gate and East Gate	• Design of the gateway • Continued use for its original purpose as a gate. • Ornamental pinnacles extending above roof level
1.14	Sirhi Darwaja (South Gate)	• Decorative style and features of the building. • Public access • Material and design
1.15	Wall towers Southwest	• Hasht bihisht design. • Decorative style and features of the building
1.16	Central pool	• Decorative style and elements. • Public access • Form and design
1.17	Garden wall Pavillion (Naubat Khana)	• Form and design • Material • Public access • Decorative style and features of the building
1.18	Bazaar street	• Design features. • Design of the façade elevation.

Map.5.2.1 Mapping of protected heritage inside Taj Mahal Complex

5.2.2 Heritage Resources at Agra Fort

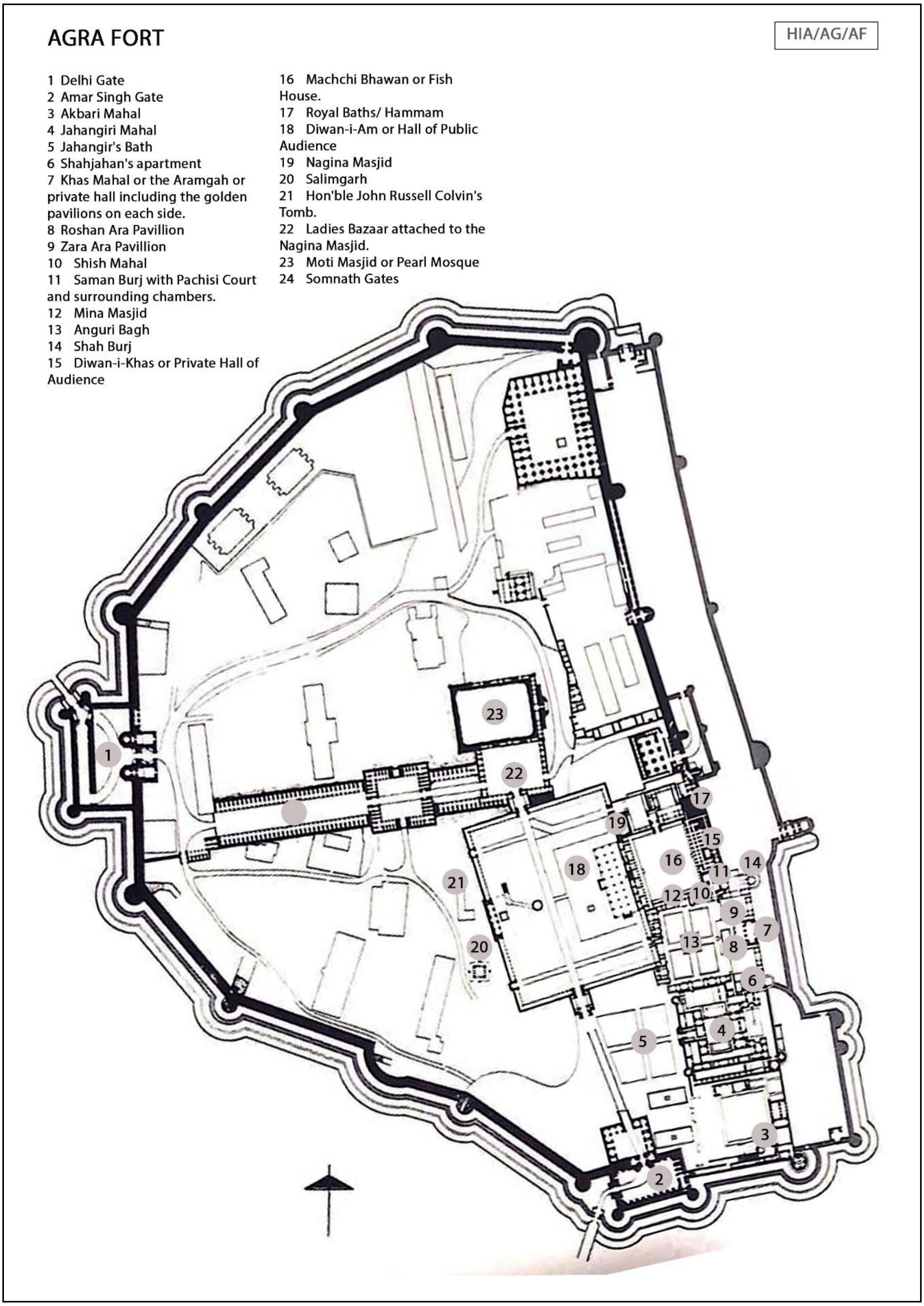
Taj World heritage is comprised of many protected heritage resources in the complex itself. The table and map provided detail of all the significant heritage resources inside the complex.

The details of all these are provided in inventories as annexures. Among these are many notified monuments.

TABLE 5.2.2 HERITAGE RESOURCES AT AGRA FORT

S. NO.	NAME OF HERITAGE RESOURCE	ATTRIBUTES CARRYING SIGNIFICANCE
2.1	Delhi Gate	• Red sand stone • Enamelled Tilework • Octagonal plan • Design and features of the building
2.2	Amar Singh Gate	• Octagonal plan • Decorative style and features of the building. • Main entry gate
2.3	Akbari Mahal	• Historical fabric • Public access
2.4	Jahangiri MAHAL	• Decorative style and features of the building • Public access
2.5	Jahangir's Bath	• Monolithic tank • Inscription •
2.6	Shahjahan's Apartment	• Historic fabric • Public access
2.7	Khas Mahal	• Decorative style and features of the building • View point for Taj Mahal • Public access
2.8	Roshan Ara Pavilion	• Decorative style • View point for the Taj Mahal • Historical fabric
2.9	Zara Ara Pavilion	• Decorative style • View point for the Taj Mahal • Historical fabric
2.10	Shish Mahal	• Decorative style and features of the building • Historical fabric
2.11	Samman Burj	• Decorative style and features of the building. • Design of the façade elevation. • Water features
2.12	Mina Masjid	• Decorative style • Public access
2.13	Anguri Bagh	• Layout and architectural features.

		• Public access
2.14	Shah Burj	• Octagonal plan • Octagonal pavilions • Decorative style
2.15	Diwan I Khas	• Decorative style and design • Inlaid work, carved with floral types, flowerbeds
2.16	Macchi Bhawan	• Layout • Design and Decorative style
2.17	Royal Baths / Hamams	• Historical fabric
2.18	Diwan -I-Am	• Form, Design and Decorative style
2.19	Nagina Masjid	• Decorative style • Public access
2.20	Salimgarh	• Design and decorative features
2.21	Hon'ble John Russell Colvin's Tomb	• Decorative style • Associated grave
2.22	Ladies Bazaar	• Design and decorative features
2.23	Moti Masjid	• Harmony of constructive design. • Inscription • Decorative style
2.24	Chitor Gates	
2.25	Somnath Gate	• Historical fabric • decorative features
2.26	Fort Wall	• Historical fabric • Planning and design
2.27	Moat along Fort Wall	• Planning and design • Historical fabric



Map.5.2.2 Mapping of protected heritage inside Agra Fort complex[29]

[29] Murray, John (1911) John Murray's handbook India Burma and Ceylon

5.2.3.1 AKBAR’S TOMB, SIKANDARA

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27° 13′ 13.7″ N, 77° 57′ 1.7″ E

Image 5.2.3 External view of Akbar’s Tomb, Sikandara

Description

The construction of Akbar's large multi-storied tomb within a *charbagh* was completed between 1612 and 1615, during the reign of Jahangir. The tomb's garden setting comprises of a square walled garden sub- divided into four major sections by watercourses evoking the rivers of paradise. Akbar's tomb consists of five tiered stories. The top floor has no superstructure but consists of an open-air courtyard enclosed on all four sides by walls of carved "white marble screening.

The tomb's pillared terraces and the numerous domed *chattris* of the upper stories yield a delicate silhouette. The tomb's first floor, measuring nearly 105 meters per side, serves as a large square plinth for the top four stories. It houses the sarcophagus in a square central chamber; a continuous domed and vaulted gallery is on the building's perimeter. The central bay of each side is marked by a high *pishtaq* surmounted by a rectangular *chattri*. White marble inlay is used copiously both to form panels of geometric patterns along the sides of the central *pishtaq* and arabesques in their spandrels. The red sandstone fabric serves as a backdrop for the white marble.

Of the interior vaulted chambers behind the four *pishtaqs*, the south one, which leads to the central domed chamber via a narrow corridor, is the most elaborate. The lower portions of the walls are inlaid with brown, yellow and black stones, while the upper walls and flat domed roof are richly ornamented with incised and polychromed stucco forming floral patterns and arabesques. Gold-painted calligraphy against a deep blue background reproduces Quranic verses.

A long narrow corridor leads to an interior domed chamber that contains Akbar's sarcophagus. This square room, about 18 meters high, reaches the level of the tomb's third story. Although this interior was later white washed, European visitors report that originally it was painted with Christian subjects including angels and the Virgin Mary.

Three stories rise above the ground level, each smaller than the previous one. Delicate red sandstone *chattris* are placed at frequent intervals along the exterior walls. The uppermost story consists of a square high walled enclosure composed entirely of white marble screens used increasingly into the seventeenth century for imperial mausolea. Since white marble previously had been associated with saints' shrines, the distinction between royalty and saints was now blurred. At each corner is a large domed *chattri;* the tomb has no other finials. Above the veranda's arch-shaped entrances are lintels that bear verses eulogizing the deceased emperor.

The tomb's upper story remains open to the sky. In the center is a magnificently carved white marble cenotaph; at its north end is a lamp stand *(chiraqdan),* also rendered in finely carved white marble.

The imposing gate leading into the complex bears the dates 1612-13 and 1613-14. It consists of an enormous recessed central arch flanked on either side by double-stacked side arches. Surmounting the gate are four towering white marble minarets, one at each corner. The ornamentation of this gate is more elaborate than that embellishing the tomb. Geometric patterns and large floral motifs formed from inlaid white marble and multi-colored stones stand out against the red sandstone ground. Continuous inscriptional bands of white marble follow the shape of the recessed arch on both the north and south facades.

Statement of Significance

The tomb of Emperor Akbar, the greatest of the Mughal emperors under whose reign the empire was consolidated and expanded, was the first major building constructed by Emperor Jahangir. It combines the Timurid inspired vaulted masonry with the indigenous trebeate sandstone mode and demonstrates the close relationship between residential and sepulchral architecture. It features the first hierarchical use of white marble for the topmost open storey of the mausoleum and the minarets topping the southern gateway; the first use of multiple minarets in Mughal architecture. The highly decorated surfaces using rich stone intarsia, finely carved marble and polychrome stucco work seen here become typical of the architecture of this period. The garden setting of the tomb follows the format set by Akbar's predecessor, Humayun.

Integrity

The tomb situated in the centre of an enclosed garden retains its overall architectural integrity with the main tomb building, the southern gateway and three blind gates as well as the enclosure wall being intact. Some of the gold, silver and precious stones inlaid in the main tomb chamber were pillaged by the Jats in the 17th century.

Authenticity
The monuments of the tomb complex largely retain their authenticity in terms of material, design and layout.

Attributes that carry Significance

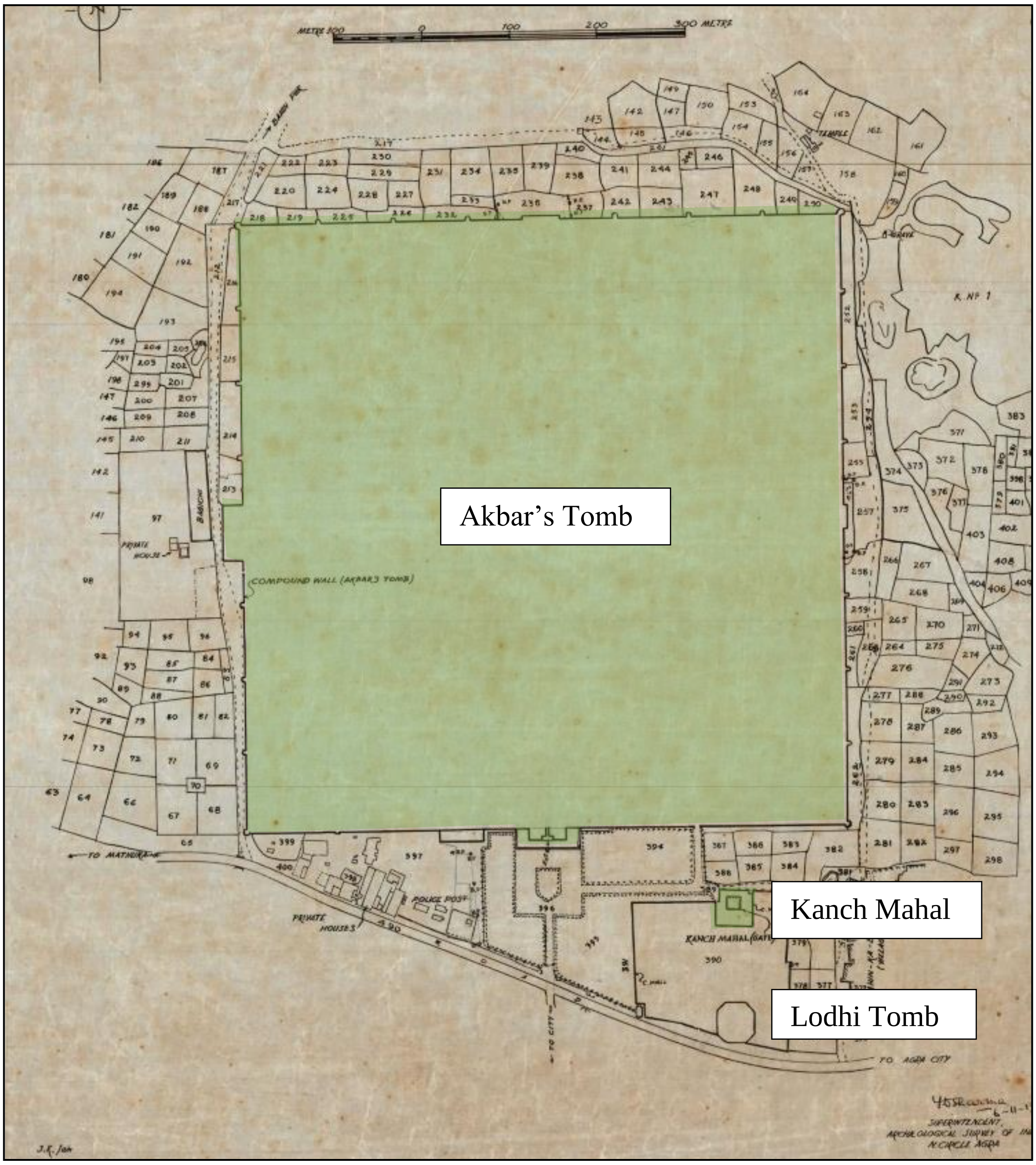
- Setting of the tomb within a charbagh
- The form and design of the tomb including its richly decorated surfaces using stone intarsia, polychrome stucco, finely carved marble; multiple minarets; calligraphy
- Function as a tomb with the sepulchre of Akbar.

5.2.3.2 KANCH MAHAL, SIKANDARA

SIGNIFICANCE: HIGH

STATUS: NATIONALLY PROTECTED MONUMENT

CORDINATES: 27.2165° N, 77.9524°



Map.5.2.4 Site plan of Akbar's tomb along with Kanch Mahal and Lodhi Tomb

Description

The Kanch Mahal is outside the enclosure of Akbar's tomb, a little to the east of the principal entrance is a rare and remarkably fine example of Mugal architecture. This is a two storied building, known as the Kanch Mahal and supposed to have been built by Jahangir as a country seat. In its extremely elaborate ornamentation inlaid stone and enameled tiles have been most effectively combined with the carving.

Attributes that carry Significance

The form and design of the Mahal including its richly decorated surfaces using stone intarsia, polychrome stucco, finely carving, enameled tiles.

Image.5.2.5 North view of Kanch Mahal

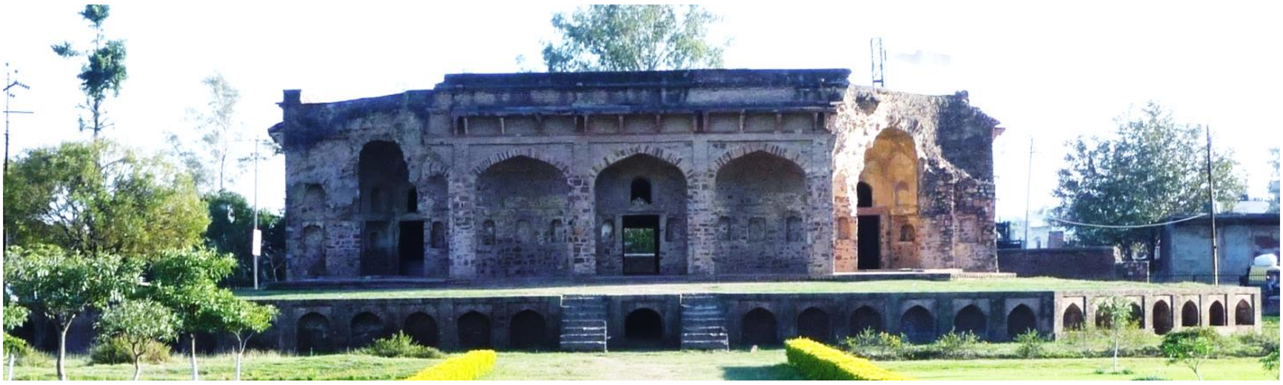


Image 5.2.6 West view of Lodhi Tomb

5.2.3.3 LODHI TOMB, SIKANDARA

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'55.13''N, 77°57'8.80''E

Description

This structure is attached to the south wall of Akbar's Tomb. A single-storey platform-types tomb with a nine –fold each side and chamfered corners cresting a typical Baghdad octagon. Not much is known about the structure. Most documents mention it to be Lodhi Tomb.

Attributes that carry Significance

- The form and design of the tomb

- Historic material along with construction system.

5.2.4. GURU KA TAAL

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'40.50"N, 77°57'57.93"E

Image.5.2.7 View of one of eight chattri's of Guru Ka Taal

Description

To the right hand or north side of the Sikandara Road(presently NH19), about four and half miles from Agra, there was enormous ornamental stone tank, or artificial lake as it might almost be called, the sides of which are built of red sandstone, with ornamental octagonal towers, surmounted by cupolas projecting into it. The great tank measured 542 feet from north to south, and 548 feet from east to west. On the south side there are three broad flights of the steps leading down into the tank, with four octagonal towers(each of 13 feet in diameter) projecting from the four piers in to the tank; and to the right, or east of these steps, there was a long and broad channel, or canal, of masonry, of the grand dimensions, for the admission of water into the tank, and which formerly had evidently sluice gates; and there is a bridge passing over this canal about half way between the tank and Sikandara Road. The admission of the water, however into the tank, by this canal, has been stopped by the new Sikandara Road having passed at a considerable distance from the tank towards the north. There are also four separate stairs on the south side passing down from the wall into the tank. On the east side there are two projections, with flights of steps which runs into the tank.[30]

Integrity

The integrity of the tomb is very poor and the complete structure is in dilapidated state. Guru Ka Taal has lost its integrity due to modern and high constructions in and around the structure. Most of the retaining wall and steps are in dilapidated state. The Guru ka taal is now not

[30] Acc. to Cunningham's report in 1871-72, this great tank or artificial lake was constructed by Sikandra Lodi.

approachable easily and has lost its connectivity from the Sikandara road. Tank is now completely dry.

Authenticity

The monuments has largely lost its authenticity with new additions and alterations to the historic built fabric of the main tank.

Attributes that carry Significance

- Form and design of the tank
- Historic lakhori brick fabric- Remains of the original retaining wall, steps
- Decorative style- Existing chattries

5.2.5.1 PATHAR KA GHODA

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'34.54"N, 77°57'58.39"E

Image 5.2.8 View of Pathar Ka Ghoda infront of Itibari Khan's Mosque

Image 5.2.9 View of Itibari Khan's Mosque.

Description

On the left hand, or south side of Sikandara Road (presently NH19), nearly four miles from the Agra, about a mile and quarter from Sikandara, and nearly opposite the great and lofty arched gateway of an ancient serai called the "Kachi-ki Serai," there is the statue of a horse formerly stood on a pedestal of its own, on which there was an inscription.

The dimensions of this stone horse are as follows; Straight measurement from the nostril to the tail, 7 feet 1 inch; measurement from the nostrils, over the head, along the curve of the neck and back to the tail, 8 feet 10 inches; from the shoulders to above the knees (where the legs are broken off), 2 feet 4 inches; from the crup to the hocks, 2 feet $5^{1/2}$ inches girth 6 feet 5 inches. There is, however, the following tradition preserved concerning this horse. It is said that some Badshah, arriving from foreign parts, encamped there, and that he had a very favorite horse which died on the spot where the statue is and that, on account of his sorrow at losing his favorite horse, he erected a statue to its memory on the spot where the horse died and was buried.

5.2.5.2 ITIBARI KHAN MOSQUE

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'34.54"N, 77°57'58.39"E

Description

Along with horse statue there is a small three-arched mosque surmounted by a dome, measures 13 x 10 feet. A Persian inscription carved in relief on three panels above the arches recorded that Itibari Khan, who had a noble status by the grace of King Jahangir, built this mosque for Khwajah Kafur on the road (from Agra to Delhi) in Hijri 1015/1605 A.D. The interior of the mosque is highly decorated with stucco work with muqarana ceiling pattern, wall paitings and floral decorations. Itibari Khan Khawajasara was an important noble and Nazir (Superintendent) of Jahangir's Harem. He was extremely loyal, true to the title "Itibari', and Jahangir reposed total faith in him. Itibari Khan was Governor of Agra in 1622 A.D. with charge of the defense of the fort and the treasury. In A.D. 1623 when the rebel prince Shahjahan tried to take Agra, Itibari Khan successfully defended it against him. He was given the new title of 'Mumtaz Khan' and Mansab of 6000 Zat and 500 Sawar. He died in the same year. It seems that Khwajah Kafur was a Sufi saint and Itibari Khan built this mosque for him and also a few living rooms and a well.

Integrity

The building retain its original size and layout and include all the elements necessary to express the significance. The floor levels of the mosque have been lost and original floor level seem to be down the existing floor level. It stands in isolation on the Sikadara Road. It is enclosed and protected within a boundary but rarely have any visitor. The horse has now lost the lower part of its legs, its original pedestal and inscription are gone, and it now stands on a raised platform of masonry on the left hand side of the road looking towards Sikandara. Most of the calligraphy bands and floral panels are in decayed condition.

Authenticity

The mosque and Pathar Ka Ghoda still contain the original material and construction details. The authenticity of the mosque is still visible as it has not gone through any major change and alteration. The original stucco muqarna ceiling work still present in good condition with few patches of decayed elements.

Attributes that carry Significance

- Red sand stone statue of a horse
- Historic stone masonry and structural elements of the mosque
- Decorative style and features including stucco muqarna ceiling works, calligraphy works over plastered surface and wall paintings
- Original Persian inscription

5.2.6.1 TOMB OF SALABAT KHAN

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'39.10"N, 77°58'37.29"E

Image 5.2.10 External view from of Tomb of Salabat Khan from westward direction

Description

The tomb to the west is a square open hall standing on a high plinth. The flat roof, roof which is like rest of the building is of red sandstone, is supported by six rows of six pillars, those on the outside being double as those at the corners quadruple. At each corner of the platform are square domed cupolas, with four pillars; the ceiling is beautifully adorned with floral paintings on polished stucco. This is said to be the tomb of Salabat Khan, The chief treasurer of Shahjahan, who was killed at court by the Rathor, Amar Singh; but the identification is disputed.

Authenticity

Original design and layout. Authenticity is retained material–red sandstone including original frescos work of Jehangir's period.

Integrity

The Tomb of Salamat Khan stands together with the Tomb of Sadiq Khan and retains its overall integrity though visual integrity is compromised with incompatible modern construction outside the complex.

Attributes that carry Significance

- Design and form of the building- Columned structure, raised platform
- Historic fabric- Stone surfaces
- Decorative style and features of the building- stone carving, ceiling paintings

5.2.6.2 TOMB OF SADIQ KHAN

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'38.13"N, 77°58'39.81"E

Image 5.2.11 Image showing external view of Sadiq Khan

Description

On the right, or north side of the Sikandara(presently NH 19) road not far from Ladli Bagh is are two mausoleums standing close together in the middle of fields, named respectively after Sadiq Khan and Salbat Khan.

Sadiq Khan, one of Akbar's pirs or spiritual guides and a masabdar. Sadiq Khan was the nephew (brother's son) and son-in-law of Mirza Ghiyath Beg, entitled Itimad-ud-Daulah. He served under Jahangir and Shahjahan. Jahangir had appointed him Mir-Bakshi in A.D.1622 and governor of Punjab in A.D.1623. On accession, Shahjahan confirmed him in his mansab of 4000 zat (personal) and 4000 sawar (horsemen) with flag and drums

Sadiq Khan died on 3rd September 1633 A.D. His tomb was built by his son Salabat Khan, Mir Bakishi 'Raushan-Zamir' between A.D.1633 and 1635. The tomb is a large octagonal building on a raised platform and surmounted a dome. In the centre of each side is a deep recess with an engrailed arch, and on either side of this is a rectangular doorway, while above are three arched windows.

Authenticity

Original design and layout. Authenticity is retained material –Lime in Lakhori brick masonry including original stucco works.

Integrity

The Tomb of Salamat Khan stands together with the Tomb of Sadiq Khan and retains its overall integrity though visual integrity is compromised with incompatible modern construction outside the complex

Attributes that carry attributes

- Forms and design of the monument octagonal shape
- Historic masonry works
- Decorative style and features of the building
- Visibility to passer-by as a landmark
- Public access

5.2.7 BARAH KHAMBA

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°10'8.45"N, 78° 2'21.22"E

Image 5.2.12 External view of Barah Khamba

Description

Barah Khamba located near Taj Mahal, is very close to the Fatehpuri Masjid. The structure built partly of red sand stone and partly of brick and lime, is octagonal on plan. A dome supported by eight red sand stone pillars surmounts its open pavilion. Two graves, one of a male and other a female, are located inside. However, local tradition says that the graves belong to an elephant rider and his son, who lived during Shah Jahan's time. The exact identification of those interned could not be ascertained due to lack of any inscription. The structure on stylistic ground may be assigned to the reign of Jahangir / Shah Jahan (A. D. 1605 to 1658)

Authenticity
The structure retains its original design and layout as well as its material authenticity.

Attributes that carry attributes

- Forms and design of the monument- octagonal shape
- Historic masonry works

- Decorative style and features of the building,
- Function as a tomb with the tombstones inside.

5.2.8 OLD DELHI GATE OF CITY

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED
MONUMENT CORDINATES: 27°11'46.60"N,
77°59'54.20"E

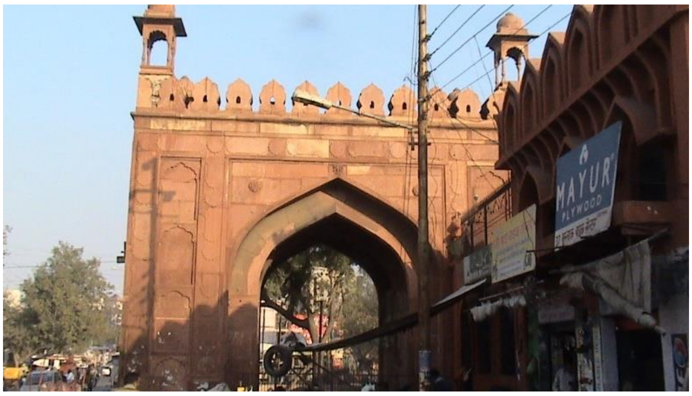


Image 5.2.13 External view of Old Delhi Gate of City

Description

This was probably built as part of new wall constructed by Raja Jai Singh Sawai of Jaipur while he was governor of Agra in the early years of Muhammad Shah's reign.

Attributes that carry Significance

Design of gateway
Historic Fabric
Visibility to passer-by as a landmark

5.2.9 JAMA MASJID

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°10'55.27"N, 78° 0'58.55"E

Image 5.2.14 External view of Jama Masjid bays from internal courtyard

Description

The Jami Masjid was the city's principal mosque and was completed in 1648 by the Mughal Emperor Shahjahan's eldest daughter, Jahanara Begum. It rests on a raised platform located on the north-western side of the Agra Fort.

The Jami mosque is elevated well above ground level and in Mughal times was visible from a considerable distance. Its large prayer chamber composed mainly of red sandstone and white marble trim is surmounted by three domes embellished with narrow rows of red and white stone. The prayer chamber's east façade is pierced by five entrance arches, the central one within a high pishtaq. Framing the pishtaq is a rectangular band of black lettering inlaid into the white marble ground similar to that at the Taj Mahal. The inscriptions in Persian largely praise Shah Jahan and his just rule.

Quranic inscriptions are inlaid in black stone above a recessed mihrab. The minbar, or pulpit, only found in Jami mosques, is carved with a illustration of this mosque's east façade, a unique feature. The side wings are divided into double aisles of three bays each following the standard pattern on imperial Mughal congregational mosques. (Asher, Catherine, 1992)

Pre dating the mosque, Shahjahan constructed a public area (chowk) in the shape of a Baghdadi octagon in front of the fort which visually and spatially connected the mosque and the fort. The enclosure with its three gates, Tripolia, was demolished by the British in 1871 - 74 when the area was cleared for the railway lines and station.

The mosque continues to be used in worship and is the major congregational mosque for the city.

Statement of significance

Jama Masjid is the principal public congregational mosque for the city of Agra built during the reign of Shah Jahan, the greatest patron of Mughal architecture, soon after he carried out extensive rebuilding works at the Agra Fort with which it was historically linked. It combines Persian and Indian designs and building techniques, and was the forerunner to the Jama Masjid of Delhi built some years later by the emperor. It demonstrates the decorative use of white marble inlaid with stones, a characteristic of the architecture of Shahjahan's reign and the combination of red sandstone and marble a hallmark of Mughal architecture. .

Attributes conveying Significance

- Plan features a large square courtyard enclosed by three narrow arcades and a prayer hall all built on an elevated platform dominating the cityscape. Three axial gates punctuate the three arcade wings. The prayer hall is topped by three domes and flanked by two tall, domed minarets
- The side wings are divided into double aisles of three bays each following the standard pattern on imperial Mughal congregational mosques.
- The combination of red sandstone and marble as building materials favoured by the Mughals is seen here.
- A characteristic of the profusely embellished architecture patronized by Shah Jahan is the marble inlaid with stone seen here in the zig zag pattern of the dome and the Persian inscriptions in black framing.

- The minbar, or pulpit, only found in Jami mosques, is carved with an illustration of this mosque's east façade, a unique feature. In terms of function, it continues to be used as a congregational mosque

Authenticity

The Jama Masjid retains its authenticity in terms of function as the largest mosque in Agra city. The overall internal plan and layout of the mosque are retained with some minor modifications. Significant elements of the original form and design of the mosque such as the striking combination of red sandstone and marble and the stone inlay and carvings largely retain their authenticity. However, repairs carried out using cement and whitewash in some have impacted the material authenticity replacement of original architectural members.

Integrity

The mosque has lost its historic connection to the Fort with the demolition of the original chowk. Spatially, the original setting of the mosque with a large open courtyard in front is also lost. The road runs adjacent to the mosque today. Archaeological investigations may reveal remains of the original enclosed chowk.

The integrity of architectural elements inside the mosque is compromised.

5.2.10 LADLI BEGUM KA TILA

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'47.81"N, 77°59'21.42"E

Description

Tomb of Ladli Begum, sister of Abu Fazl, the friend and historian of Akbar is situated about a mile to the north of Sikandara road (presently NH19) Alamganj and immediately behind the Kandhari bagh. That this palace was built in the year 1596 A.D. But, a few year ago the ground was purchased by Hindu named Lakhmi chand seth, who pulled down the mausoleum and destroyed the tombs and built a small ornamental 'chatri' or pavilion in their place. Today only a mound remains with dense vegetation growth in society park.

Image 5.2.15 View of Ladli Begum Ka Tila

Attributes conveying Significance

- Associated value to Ladli Begum
- Possibility of underground Archaeology

5.2.11 SHAHJAHAN PARK

SIGNIFICANCE: HIGH
STATUS: PARTIALLY BUFFER OF TAJ MAHAL
CORDINATES: 27°10'20.57"N, 78° 1'49.10"E

Image 5.2.16 View of Shahjahan Park

Description

Shahjahan Park is located at Agra city situated on the banks of the river Yamuna in the Northern state of Uttar Pradesh, India. Shahjahan Park occupies a very strategic location between the two World Heritage Sites. Shahjahan built this garden after the construction of Taj Mahal. Exact year of construction of the garden is not known. The main purpose of the garden was to give a good view of the mausoleum and a good resting place.

Attributes conveying Significance

- Historic fabric
- Visible traces of historic remains with possibility of underground Archaeology
- Setting and layout of park that adds to ensemble value of Taj Mahal and Agra Fort

5.2.12. FATEHPURI MOSQUE

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°10'14.30"N, 78° 2'25.37"E

Figure 5.2.17 View of Fatehpuri Mosque

Description

The mosque is stands on a platform which in its present state has on the northern side an extension towards the east. The platform is fronted by an arch by Shahjahani columns with capital formed of acanthus leaves rather than muqarnas, evidence of the wider spread of imperial floral decoration. The oblong structure of the prayer hall with four elongated chhatris on minaret at its corners is set back on the platform.

Attributes conveying Significance

- Historic fabric
- Form and design

- Continued use as a mosque
- Decorative features; Shahjahani columns with capital formed of acanthus leaves rather than muqarnas

5.2.13. SATTI-UN-NISSA'S TOMB

SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°10'17.35"N, 78° 2'24.87"E

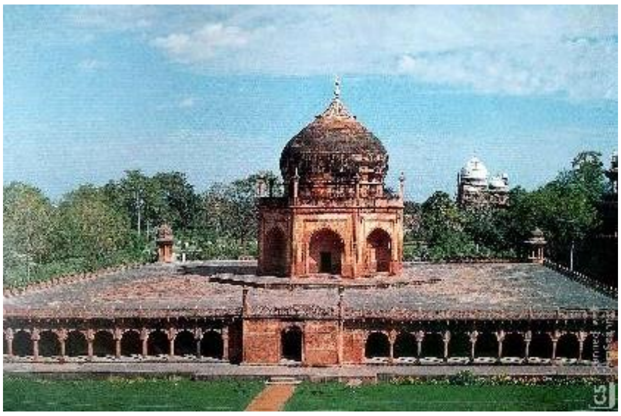


Image 5.2.18 Satti-Un-Nissa's tomb

Description

This tomb has been known as that of Fatehpuri Begam and the plan in the Taj Museum identifies it as that of Fatehpuri Mahal. The design is a variant of that of the tomb inside the complex in more compact form. The inner octagonal body is surrounded not by an arcaded gallery but by eight pishtaqs, separated by engaged shafts that terminate in freestanding guldastas. The setting too is different the octagon is placed not in a garden but on a wide and low platform.

Attributes conveying Significance

- Historic fabric
- Form and design- wide platform, octagonal tomb with eight pishtaqs,
- Associated value to wife of Shahjahan
- Use as tomb
- Decorative features: Shahjahani columns with capital formed of acanthus leaves rather than muqarnas.
- Adds to ensemble value of the Taj Mahal

5.3 UNPROTECTED HERITAGE RESOURCES

There are many locally significant heritage resources identified which were not notified Following is complete list of such heritage resources along with carrying significance.

TABLE 5.3.1 SIGNIFICANCE OF UNPROTECTED HERITAGE RESOURCES

SR. NO	NAME OF HERITAGE RESOURCE	ATTRIBUTES CARRYING SIGNIFICANCE	SIGNIFICANCE
1	Bhuri Khan's Mosque	• Form and design of Building • Setting of the mosque • Historic masonry work	Medium
2	Baoli-1, Fatehabad Road	• Remains historic fabric	Medium
3	Khandari Begam Garden Tomb	• Historic fabric garden tomb with historic design and layout • Colonial design structure	Medium

		• Continued use for educational purpose	
4	Baradari and Temple	• Form and design of gateway and baradari. • Traditional associated activity with temple in bagichi. • Decorative features • Public access • Historic fabric of temple and baradari • Remains of older historic fabric	Medium
5	Suraj Bhan Gateway	• Form and design of gateway • Historical fabric • Setting of gateway • Mughal design and decorative features	Medium
6	Tomb-1	• Historic masonary work • Public access	Medium
7	Tomb-2	• Historic masonary work • Public access	Medium
8	St. John’s College	• Indo-saracenic design of building • Decorative style and features • Access to public • Historic fabric • Continued use for education purpose	Medium
9	Agra College	• Colonial design of building • Decorative style and features Access to public • Historic fabric • Continued use for education purpose	Medium
10	Medical Building Complex (Lady Lyall Complex)	• Colonial design of building • Decorative style and features • Access to public • Historic fabric • Continued use for medical facilities	Medium
11	St. Paul's Church	• Colonial design of building • Decorative style and features Access to public • Historic fabric • Continued use for education purpose	Medium
12	Queen Victoria School	• Colonial design of building • Decorative style and features Access to public • Historic fabric	Medium

		• Continued use for education purpose	
13	RBS College	• Colonial design of building • Decorative style and features Access to public • Historic fabric • Continued use for education purpose	Medium
14	Kalan Masjid	• Form and design of mosque • Continued use of structure as mosque • Historical fabric • Decorative features • Earliest mosque of Agra • Possibility of underground archaeology	Medium
15	Sarojani Nadu Hospital and College	• Colonial design of building • Decorative style and features • Access to public • Historic fabric • Continued use for medical facilities	Medium
16	Senior Boy's Hostel	• Colonial design of building • Decorative style and features • Access to public • Historic fabric • Continued use for hostel facilities	Medium
17	Agra Fort Railway Station	• Historic fabric • Public use • Colonial design of building • Decorative style and features	Medium
18	Baoli-2, Agra University	• Historic fabric • Public use of surrounding as a university	Medium

5.4 VALUE ASSESSMENT OF HERITAGE

The values embodied in cultural heritage are identified in order to assess significance, prioritize resources, and inform conservation decision-making. Significance assessment typically includes consideration of the rarity, representativeness, and communicative power of assets and their values. These are then managed in order to sustain and valorise that significance. Engagement with the economic value of heritage may help promote its preservation.[31]

[31] "Economics and Heritage Conservation". Getty Conservation Institute. p. 54.

Cultural Significance is said to be 'embodied' in the fabric, setting, use, associations, and meanings of a place, and includes aesthetic, historic, scientific, social and spiritual values for past, present and future generations. In order to preserve such values a 'cautious approach'.[32]
The UNESCO World Heritage Convention addresses cultural sites of outstanding universal value, from a historical, associational, social, cultural, architectural, and archaeological and highlights the need for authenticity and integrity.
The following three grades of significance have assigned as a cumulative of the assessed values.

- **Very High:** Sites or structures of Acknowledged international importance inscribed as of universal importance as WH property. Individual attributes that convey OUV of the WH property. Other buildings or urban landscapes of recognised international importance.

- **High:** Nationally-designated structures with standing remains. Other buildings that can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the listing grade. Conservation Areas containing very important buildings. Undesignated structures of clear national importance.

- **Medium:** Designated buildings. Historic (unlisted) buildings that can be shown to have exceptional qualities or historical associations. Conservation Areas containing buildings that contribute significantly to its historic character. Historic townscapes or built-up areas with important historic integrity in their buildings, or built settings.

- **Low:** “Locally Listed” buildings. Historic (unlisted) buildings of modest quality in their fabric or historical associations. Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings.

[32] "Burra Charter (Preamble, Articles 1, 3, Guidelines)" Australia ICOMOS. retrieved 14 October 2019.
Worthing, Derek; Bond, Stephen (2008). *Managing Built Heritage: The Role of Cultural Significance*. Blackwell Publishing. p. 94

TABLE 5.4.1 HERITAGE VALUE ASSESSMENT OF ALL THE PROTECTED HERITAGE RESOURCES.

	HERITAGE RESOURCE	VALUES						SIGNIFICANCE
		historical	archaeological	architectural	associational	cultural	social	
1	Taj Mahal							VERY HIGH
2	Agra Fort							VERY HIGH
3.1	Akbar's Tomb, Sikandara							HIGH
3.2	Kanch Mahal, Sikandara							HIGH
3.3	Lodhi Tomb, Sikandara							HIGH
4	Guru Ka Taal							HIGH
5.1	Pathar Ka Ghoda							HIGH
5.2	Itibari Khan Mosque							HIGH
6.1	Tomb of Salabat Khan							HIGH
6.2	Tomb of Sadiq Khan							HIGH
7	Barah Khamba							HIGH
8	Old Delhi Gate of City							HIGH
9	Jama Masjid							HIGH
10	Ladli Begum Ka Tila							HIGH
11	Shahjahan Park (partially part of Taj buffer)							HIGH
12	Fatehpuri Mosque							HIGH
13	Satti-un-Nissa's Tomb							HIGH

TABLE 5.4.2 HERITAGE VALUE ASSESSMENT OF ALL THE HERITAGE RESOURCES PRESENT INSIDE TAJ MAHAL.

VALUE ASSESSMENT CHART OF HERITAGE RESOURCES AT TAJ MAHAL

	HERITAGE RESOURCE AT TAJ MAHAL	VALUES						SIGNIFICANCE
		Historical	Archaeological	Architectural	Associational	Cultural	Social	
1	Mausoleum							VERY HIGH
2	Minaret Southwest							VERY HIGH
	Minaret Northwest							VERY HIGH
	Minaret Northeast							VERY HIGH
	Minaret Southest							VERY HIGH
3	Riverfront Terrace							VERY HIGH
4	Mosque							VERY HIGH
5	Mehmaan Khana							VERY HIGH
6	Char Bagh							VERY HIGH
7	Great Gate							VERY HIGH
8	Jilau khana							VERY HIGH
9	Well at the Taj Garden							VERY HIGH
10	Dalans around Taj Quadrangle (Southern galleries)							VERY HIGH
11	Saheli burj no. 1 Fatehpuri							VERY HIGH
12	Saheli burj no. 2 Akbari							VERY HIGH
13	West Gate							VERY HIGH
	East Gate							VERY HIGH
14	Sirhi darwaja (South Gate)							VERY HIGH
15	Wall towers Southwest							VERY HIGH
	Wall towers West							VERY HIGH
	Wall towers Northwest							VERY HIGH
	Wall towers Northeast							VERY HIGH
	Wall towers East							VERY HIGH
	Wall towers Southeast							VERY HIGH
16	Central pool							VERY HIGH
17	Garden wall Pavillion (Naubat Khana) West							VERY HIGH
	Garden wall Pavillion (Naubat Khana) East							VERY HIGH
18	Bazaar street West							VERY HIGH
	Bazaar street East							VERY HIGH

TABLE 5.4.3 HERITAGE VALUE ASSESSMENT OF ALL THE HERITAGE RESOURCES PRESENT INSIDE AGRA FORT.

VALUE ASSESSMENT CHART OF HERITAGE RESOURCES AT AGRA FORT

HERITAGE RESOURCE AT TAJ MAHAL	**VALUES**						**SIGNIFICANCE**
	Historical	Archaeological	Architectural	Associational	Cultural	Social	
1. Delhi Gate							VERY HIGH
2. Amar Singh Gate							VERY HIGH
3. Akbari Mahal							VERY HIGH
4. Jahangiri Mahal							VERY HIGH
5. Jahangir's bath							VERY HIGH
6. Shahjahan's apartment							VERY HIGH
7. Khas Mahal							VERY HIGH
8. Roshan Ara Pavilion							VERY HIGH
9. Zara Ara Pavilion							VERY HIGH
10.Shish Mahal							VERY HIGH
11. Saman Burj							VERY HIGH
12. Mina Masjid							VERY HIGH
13. Anguri Bagh							VERY HIGH
14. Shah Burj							VERY HIGH
15. Diwan I Khas							VERY HIGH
16.Macchi bhawan							VERY HIGH
17. Royal Baths / hamams							VERY HIGH
18. Diwan - I am							VERY HIGH
19. Nagina Masjid							VERY HIGH
20. Salimgarh							VERY HIGH
21. Hon'ble John Russell Colvin's Tomb							VERY HIGH
22. Ladies Bazaar							VERY HIGH
23. Moti masjid							VERY HIGH
24. Chitor Gates							VERY HIGH
25. Somnath Gate							VERY HIGH
26. Fort wall							VERY HIGH
27. Moat along fort wall							VERY HIGH

TABLE 5.4.4 HERITAGE VALUE ASSESSMENT OF ALL THE UNPROTECTED HERITAGE RESOURCES

	HERITAGE RESOURCE	VALUES						SIGNIFICANCE
		historical	archaeological	architectural	associational	cultural	social	
1	Bhuri Khan's Mosque							MEDIUM
2	Baoli-1, Fatehabad Road							MEDIUM
3	Khadari Begam Tomb/ Bharatpur house/RBS College							MEDIUM
4	Baradari Temple							MEDIUM
5	Suraj Bhan Gateway							MEDIUM
6	Tomb-I							MEDIUM
7	Tomb-II							MEDIUM
8	St. John's College							MEDIUM
9	Agra College							MEDIUM
10	Medical Building Complex (Lady Lyall Complex)							MEDIUM
11	St. Pauls Church							MEDIUM
12	Queen Victoria School							MEDIUM
13	RBS College							MEDIUM
14	Kalan Masjid							MEDIUM
15	Sarojini Naidu Hospital and College							MEDIUM
16	Senior Boy Hostel							MEDIUM
17	Agra Fort Railway Station							MEDIUM
18	Baoli-1, Agra University							MEDIUM

6. PRESENT CONDITION OF HERITAGE RESOURCES

Present condition survey of identified heritage resources along the proposed Metro route was carried out by team of architects and structural experts to understand the baseline conditions of the heritage resources before construction and operation of elevated/underground Metro corridor. Present condition refers to current state of conservation of the heritage resource and any impacts resulting from previous actions, development or other agents of change.

The following parameters were studied for the HIA study;

- Setting (immediate surroundings)
- Functional (existing use, circulation of tourist and others)
- Visual (characteristic view points, landmarks, everyday views and street views)
- Architectural (building heritage, material, quality and scale)
- Structural stability
- Cultural context

Overall condition and other factors affecting the heritage values need to be considered along with the predicted impacts from any proposed development or action for each heritage resource. New proposals may have less impact because the heritage has already been severely compromised by previous agents of change; or they may add to the existing impacts in a cumulative manner making existing situations much worse.

TABLE 6.1 PRESENT CONDITION AND FACTORS AFFECTING HERITAGE VALUES OF PROTECTED HERITAGE (PRE-METRO CONSTRUCTION WORKS)

S. NO.	NAME OF HERITAGE RESOURCE	OVERALL CONDITION OF HERITAGE RESOURCE	FACTORS AFFECTING HERITAGE VALUES (PRE METRO CONSTRUCTION WORK)
1	Taj Mahal	The Taj Mahal is in an overall good state of conservation. Heritage resources inside Taj Mahal are in stable condition. There is no severe structural damage or material deterioration Various stone defects (delamination and chipping), cracks and blackening were found on the stone works. Taj Mahal is facing a major threat from air pollution.	Air-borne pollution and biological agents affecting the historic surfaces. Increased visitor numbers impacting the wear and tear on the monument. Change in use of the complex which was originally was and is now only a tourist destination while mosque is still used for Friday prayers. Construction of multi storied new houses in the Tajganj area visual relationship with Tajganj area. Poor condition of the river Yamuna particularly in lean winter months, affects the setting. Green/ black stains on intricate marble surfaces of Taj Mahal due to excreta deposits by insect (Goeldichironomus)

			that breed in polluted and stagnant Yamuna water.
2	Agra Fort	No structural distress was observed in the structural members but other defects such as blackening, loss of cladding and vegetation was observed. Multiple cracks and broken members are found in the interior of the structure. Traces of repair work by filling plaster into cracks is also visible. External surface of the west side has algae deposits. Wall external façade had algae deposits and stone work is decayed. Stone defects like delamination, chipping and cracks are found on the external surfaces of the wall. Some of the stones in flooring and cladding were defected.	Former nallah running along the moat of the fort functions as an open sewer. Loss of historical connectivity with the Jama Masjid Loss of historical setting with the destruction of the Tripolia chowk. Heavy vehicular traffic on road connecting Taj Mahal and Agra Fort and Jama Masjid adding to air pollution. Change in original use with part of the fort being with the Army. Open areas along the road in surrounding of fort are mainly used for parking.
3	Akbar's Tomb, Sikandara	Structures within the complex including gateway, enclosure wall and mausoleum are in good state of structural condition. Deterioration of masonry is observed in enclosure wall. Only south gate is open to access the garden. Other gates are closed and in bad state of conservation. Conservation work is in progress.	Air pollution affecting the historic surfaces and loss of original setting contributed by: • Heavy vehicular traffic on NH 19 • New construction works along the NH 19 as well as in the immediate surrounding • New flyover constructed on Bodla road immediately infront of West Gateway of Akbar's tomb at a distance of approx. 350 mts.

	Lodhi's tomb Sikandara	Several structural cracks have been observed in walls and ceiling. Tomb of Lodhi show signs of distress. Masonry loss at the edges of the external walls. The entry to cenotaph is blocked. Repair works are done with lakhori bricks.	Air pollution affecting the historic surfaces and loss of original setting contributed by: • Heavy vehicular traffic on NH 19 • New construction works along the NH 19 as well as in the immediate surrounding • New flyover constructed on Bodla road immediately infront of West Gateway of Akbar's tomb at a distance of approx. 350 mts. • Platform of the tomb is partially missing owing to extension of the present road.
	Kanch Mahal, Sikandara	Kanch Mahal is structurally stable and have no severe sign of structural dilapidation Kanch Mahal also shows structural crack in column. Stone surfaces are showing sign of deterioration at different places which mainly includes delamination of the cladding stones. Mughal glazed works over the domes of the jharokhas are partially missing but complete pattern can be identified out from the profile.	Air pollution affecting the historic surfaces of the Kanch Mahal which has intricate stone carving and glazed tile works. • Heavy vehicular traffic on NH 19 running along the edge of the monument. • New construction works along the NH 19 as well as in the immediate surroundings. • New flyover constructed on Bodla road immediately just in front of West Gateway of Akbar's tomb at a distance of approx. 265 mts.
4	Guru Ka Taal	There is no water in the Guru Ka Taal. The eight chhatris show major distress signs and some of their architectural members are now missing. Most of the retaining wall and ghats are decayed, partly missing and not visible. Decrease in the larger catchment area of Taal because of urban development. The leftover fertile land of	Guru Ka Taal is not approachable from the NH 19. New Gurudwara buildings are constructed around the Taal and has blocked the visibility and connectivity from the NH 19. New construction over the retaining walls and ghats of the Taal. Few chattries are encroached and people are living there.

		water body is used for small scale farming activities.	
5	Pathar Ka Ghoda and Itibari Khan ki Mosque	The main structure of mosque and Pathar Ka Ghoda are in quite stable condition as no structural distress was observed.	Heavy vehicular traffic on NH 19. Flyover was constructed in close proximity of the complex. Heavy traffic movement on NH 19. Pollution level is high around the area. Railway line is at close proximity at a distance of 15 mtrs. Vibrations can be felt while standing in the monument.
6.1	Tomb of Salabat Khan	Stone members are eroded due to wind resulting rounding of the stone columns at the base. It has affected many structural members severely where it has lost significant depth of the member. Cracks in the ceiling were also observed.	The original entry of the monument is now lost and is now approachable through a 2.5 mtr wide passage which has marble house on one side and new construction on other side. Severe water logging during rainy season adversely affects entry to the monument. The original setting of the complex is lost and most of the open area in the front is now used for commercial purpose.
6.2	Tomb of Sadiq Khan	The Tall structure stands on a mound. Repair works to the structure were in process during surveys. Several cracks were observed in the engrailed arches and exterior surfaces.	
7	Barah Khamba	The main structure of Barah Khambha is in stable condition.	The monument has lost its original context and is now surrounded by several new buildings. The monument has lost its original entry and is now approachable through narrow lanes.
8	Old Delhi Gate of City	Blackening and other deposits are visible on the internal surfaces of the gate. The Gate shows no severe sign of structural damage and material deterioration.	The gateway has lost its original context and stands in isolation enclosed by a boundary wall in close proximity to Raja Ki Mandi railway station. Railway station is just 25 mtrs away from the monument. The vehicular traffic previously used to pass through the gateway which has now been diverted outside the gate (date is unknown).

			The monuments is already exposed to heavy traffic. The surfaces are exposed to air pollution caused by vehicular traffic.
9	Jami Masjid	Building is structurally stable and showing no sign of structural distress. There are material deterioration taking place in different places mainly due to water penetration. Red sand stone cladding members are decayed at several place due to delamination and erosion There are vegetation growth in the dome and external walls where roots are penetrating inside the masonry. The external wall of the sanctuary chambers are covered with algae deposits.	Jama Masjid has lost its historical context and connectivity with Red fort. Tripolia gate and octagonal chowk named as Muthamman chowk do not exist anymore. Agra Fort Station is at 150 mtrs and railway line is at 18 mtrs away. Monument is exposed to continuous vibrations from rail movement as well as road traffic. Original drain is now converted into nala and has lost its original character and connection. There are several alterations made in the historic fabric of the building such as added shops, shutters, white wash, cement repair works, finishing works, repairs and replacement of original architectural members.
10	Ladli Begum Ka Tila	The undefined boundary of protected area is lies a society park. The access to structures is from Mau road.	No historic structure is visible now and it is used as a society park.
11	Shahjahan Park (partially part of Taj buffer)	The heritage structures in Shahjahan park shows no severe sign of structural damage and material deterioration. Missing decorative plasters can be found in patches in the interior surfaces of the structure. Broken members are found in the exterior of the structure.	The heritage structures in the Shahjahan park has lost its original setting and now stands in isolation. Heavy vegetation growth in and around the heritage structures. There is no accessibility to the monuments.
12	Fatehpuri mosque	The mosque shows no severe sign of structural damage and material deterioration. Blackening and other deposits are visible on the internal surfaces of the mosque.	The mosque has lost its original context and is now approachable from Tajganj and Shahajahan Park.

13	Satti-un-Nissa's Tomb	The tall structure stands on a mound. Repair works to the structure pathway were in process during the survey. Cladding stones are deteriorated in different locations.	The tomb is presently used as tourist facility centre for ticketing, lockers rooms and offices for tourists arriving from the west. Main tomb chamber is locked and not accessible.

TABLE 6.2 PRESENT CONDITION AND FACTORS AFFECTING HERITAGE VALUES OF UNPROTECTED HERITAGE (PRE-METRO CONSTRUCTION WORKS)

S. NO.	NAME OF HERIATGE RESOURCE	OVERALL CONDITION OF HERITAGE RESOURCE	FACTORS AFFECTING HERITAGE VALUES (PRE-METRO CONSTRUCTION WORK)
1	Bhuri Khan's Mosque	Bhuri Khan mosque shows major signs of distress. Masonry of the mosque is loose and partly collapsed. There is dust and debris inside and outside the structure. In addition, other defects such as blackening, fine cracks and vegetation was observed. Wide cracks running from the dome to the walls were observed, which are signs of structural distress.	Mosque is abandoned, neglected and not in use. The original context of the structure has changed and new two to three storied construction all around the monument with an open area on the western side. The surfaces are exposed to air pollution caused by vehicular traffic and new construction activities
2	Baoli-1, Fatehabad Road	The baoli is encroached by private owner. The baoli was filled with dust and debris. After every rainy season there is soil settlement.	The baoli already have lost its visibility due to fill and construction over the site.
3	Khandari Begam Garden Tomb	Access to structure is blocked by vegetation growth. Various new addition and alteration have been made to the historic parts of the structure.	Original form and setting of the complex has already changed due to additions and alterations and change of its use.

4	Baradari Temple	No major cracks in the buildings and structures in a good state. There is no severe structural or material deterioration.	Original context and use of the temple complex has changed due to construction within and outside the complex. The surfaces are exposed to air pollution caused by vehicular traffic and new construction activities.
5	Suraj Bhan Gateway	Structure has partly collapsed. Vegetation growth over the walls. Rear side of the building is deteriorated and damaged. Red sandstone cladding is decayed all over. Lime plaster is flaked off and exposed lakhori brick arches with dead mortar joints. Additions and alterations are done in the structure.	The original context of the gateway has lost and is presently used for marriage hall Wall and ceiling surfaces are distorted due to inappropriate electrical wiring and fixtures. Rear side of the building is being used as dumping yard. The surfaces are exposed to air pollution caused by vehicular traffic and new construction activities.
6	Tomb-I	Masonry of the mosque is loose and partly collapsed. The tomb structure stands on an uneven mound. There is dust and debris inside and outside the structure. There is vegetation growth on the dome and external walls where roots are penetrating inside the masonry.	The original context of the structure has lost and it is being used as animal shelter.
7	Tomb-II	Structure is in extremely dilapidated condition due to severe masonry loss and structural detachments. There is dust and debris inside and outside the structure. Masonry of the tomb is loose and partly collapsed.	The original context of the structure has lost; structure is left abundant with animal shelter around it.

8	St. John's College	Building structures in a good state. There is no severe structural or material deterioration.	There is heavy traffic movement in the area and thus the pollution level is high.
9	Agra College	The building is well maintained and structurally stable. Building shows no severe sign of structural damage and material deterioration.	There is heavy traffic movement in the area and thus the pollution level is high.
10	Medical building complex (Lady Lyall Complex)	Few historic structures are in poor condition and are left abundant. Vegetation growth in an around the abundant structures.	There is heavy traffic movement in the area and thus the pollution level is high. There are new constructions within the complex which is altering the historic context.
11	St. Pauls Church	The structure is undergoing repair works	There is heavy traffic movement in the area and thus the pollution level is high.
12	Queen Victoria School	Structures in a good state. There is no severe structural or material deterioration.	There is heavy traffic movement in the area and thus the pollution level is high.
13	RBS College	No major cracks in the buildings and structures in a good state. Sign of flaking of plaster and deterioration of red sandstone of the facades.	There is heavy air pollution in the area.
14	Kalan Masjid	The building is structurally in good condition and stable. In appropriate repair works have been done. There is no severe structural or material deterioration. Domes of the mosques had accumulated a layer of dust.	High addition/alteration in interiors and exteriors. There are developmental pressures around the structure which has altered the historical context.
15	Sarojini Naidu Hspital and College	The building is structurally in good condition and stable. The building is under maintenance. There are visible plaster flaking and blackening due to algae deposit.	There is heavy traffic movement in the area and thus the pollution level is high. There are vendor encroachments all around the boundary of the complex pollution level.

16	Senior Boy hostel	There are visible water seepage, plaster flaking and blackening due to algae deposit. Two arches from the historic structure has been demolished and replaced with new beams. This has hampered the overall structural stability of the building.	Although the structural condition is poor there are users in the hostel adding to the live load. There is heavy traffic movement in the area increasing the pollution.
17	Agra Fort railway station	Building is structurally stable but there is lack of maintenance.	There is heavy vehicular and pedestrian movement in the area The regular vibration from the train movement affects the structure. Pollution level in the area is high.
18	Baoli-1, Agra college	Baoli in the Agra university shows major signs of distress. Building structures not in a good state. There is severe structural or material deterioration. There is heavy vegetation growth in and around the structure.	The Baoli is in a state of neglect which has affected the structural condition. Loss of historical connectivity to the structure.

7. DESCRIPTION OF PROPOSED METRO WORKS

7.1 OVERVIEW OF AGRA METRO PROJECT

The Agra Metro is a proposed rapid transit network in Agra, the fourth largest city in the state of Uttar Pradesh (India). The feasibility study was conducted in 2016, with government approving the project in early 2019. The Agra Metro is set to consist of two Metro lines, with a total length of about 30 kilometres (19 mi). As of July 2016, DPR has been prepared by RITES and submitted to state government. On 28 February 2019, Union Cabinet approved Metro project in Agra.

Agra Metro Rail Project will have two corridors which will pass through heart of the city and will connect prominent tourist places including Taj Mahal, Agra Fort and Sikandara as well as ISBT, Raja Ki Mandi Railway Station, Medical College, Agra Cant Railway Station, Collect orate, Sanjay Place and surrounding densely populated residential areas.

The length of Sikandara to Taj East Gate corridor 14.00 km, which is partly elevated and partly underground and comprises 15 Stations (7-Elevated and 7-Underground).[33]

The length of Agra Cantt. to Kalindi Vihar corridor is 15.40 km comprising 14 stations all elevated.[34] In this report Heritage Impact Assessment of corridor -I assessment is being carried out.

Alignment Description

Considering centre line of Sikandara station as 0.00 m, this corridor is 14000 m long starting from -50 m and running upto 13950 m. This corridor consists of elevated and underground stretches along with Switch Over Ramps (SOR)**.**

TABLE: 7.1.1 ALIGNMENT OF CORRIDOR -1[35]

ALIGNMENT TYPE	FROM (M)	TO (M)	LENGTH(M)
Elevated	-50	3551	3601
Switch over Ramp (+)8.0m to (-)8.0m	3551	4010	459
Underground	4010	11175	7165
Switch over Ramp (-)8.0m to (+)8.0m	11175	11600	425
Elevated	11600	13950	2350
Total			14,000

The Alignment in divided in following sub sections:

- Sikandara to Shastri Nagar Section
- Switch Over Ramp from Elevated to Underground
- RBS College to Taj Mahal

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33 Detailed Project Report for railed base mass rapid transit system in Agra, 2017 by RITES
34 Detailed Project Report for railed base mass rapid transit system in Agra, 2017 by RITES
35 Detailed Project Report for railed base mass rapid transit system in Agra, 2017 by RITES
| *Source of information: Data received from LMRC*

- Switch Over Ramp from Underground to Elevated
- Fatehabad Road to Taj East Gate

Sikandara to Shastri Nagar Section

In accordance with the provision of the Ancient Monuments and Archaeological Sites and Remains Act, 1958, as amended by the Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010, the area falling within 100 m of the limits of the Lodhi's Tomb (protected monument) has been declared to be the Prohibited area for the purpose of construction. Accordingly, the proposed alignment of Corridor-1 starts about 103 m before Lodhi Tomb, Sikandara along NH-2 as elevated and heads in East direction.

Total length of the section is about 3.60 km and is completely elevated. Four elevated stations namely Sikandara, Guru Ka Taal, ISBT and Shastri Nagar have been proposed in this section. Sikandara Station, first elevated station has been proposed along NH-2 with island platform and is about 105 m from the Akbar's Tomb, Sikandara.

Guru ka Taal, second elevated station on the alignment, has been proposed along NH- 2 in front of Guru ka Taal Gurudwara**.** Alignment and proposed Metro station falls in the prohibited zone of ASI Monuments i.e. Pathar ka Ghoda and Itibari Khan Mosque. Permission of Competent Authority will be required before undertaking Metro construction in the prohibitive zone.

Next elevated station on the alignment is ISBT which has been proposed near Agra ISBT. Alignment near ISBT falls in the prohibited zone of ASI Monuments i.e. Tomb of Salabat Khan and Tomb of Sadiq Khan. Permission of Competent Authority will be required before undertaking Metro construction in the prohibitive zone.

Last station of this segment is Shastri Nagar station which is now a future station.

Ramp from At-grade to Underground

In this stretch, ramp is required to provide transition from elevated to underground alignment after Shastri Nagar station.

The alignment runs elevated till Ch: 3551 m, thereafter, from Ch: 3551 m to Ch: 4010 m ramp (to become underground) has been proposed with a gradient of 4.0% and 3.87% in open land of state government and Private land of RBS College.

RBS College to Taj Mahal Section

This section is completely underground consisting of total seven underground stations namely, RBS College, Raja Ki Mandi, Agra College, Medical College, Jama Masjid, Agra Fort and Taj Mahal Station. All the stations have been proposed by Cut & Cover method/NATM. All the underground stations are off the road and are proposed in open land leading to ease in construction and avoidance to disruption in road traffic.

RBS College stations have been proposed inside open land of Raja Balwant Singh (RBS) College. Raja Ki Mandi Station has been proposed inside the parking/circulating area of Raja Ki Mandi Railway Station for better integration with existing Railway station. Agra College station has been proposed in the open ground of Agra College and has been proposed. This station will serve as the interchange station with proposed Agra College elevated station of

Corridor-2. Medical College station has been proposed in ground of SN Medical College. This station will serve Medical College and Hing Ki Mandi area.

The area between Medical College and Jama Masjid i.e. Hing Ki Mandi is densely populated with very narrow lanes and bye lanes leading to no path for movement of construction equipment and machinery as well as any open space for initiating underground station construction. Hence, next station is proposed near Jama Masjid at inter station distance of 1.40 km. This station will primarily serve Jama Masjid, Agra Fort Railway Station and Mantola.

Agra Fort station has been proposed in the open land in front of Agra Fort. As Agra Fort is a Protected Monument with 100 m Prohibited area, the alignment and station has been kept about 105 m away from protected moat of Agra Fort so as to clear the designated Prohibited area.

After Agra Fort station, the alignment passes through Shahjahan Park partially part of Taj Buffer area. The underground alignment has been proposed to be done by cut & cover. Accordingly, depth of the tunnels and track centre has been reduced. Also, to avoid infringement /obstruction to the view of Taj Mahal, Taj Mahal station has been proposed as underground.

An area of 20.80 ha of govt. land has been proposed for depot facilities in PAC (State govt. land) Out of the total of 20.80 ha, depot has been planned in 16.30 ha land and 4.5 ha land has been proposed for construction of depot, staff quarters, parking & property development.

Switchover Ramp from Underground to Elevated

Further, the alignment after Taj Mahal station heads in east direction along Fatehabad Road and terminates at Taj East Gate. To become elevated from underground, ramp has been provided along Fatehabad Road after Taj Mahal Station.

The switch over ramp has been proposed from Ch: 11175 m to Ch: 11600 m.

Fatehabad Road to Taj East Gate

The proposed section is completely elevated with total length of 2.30 Km and consists of total 3 elevated stations namely, Fatehabad Road, Basai and Taj East Gate. Taj East Gate station has been proposed in front of Pacific Mall and alignment ends here with provision of future extension.

Construction Method

Construction of elevated, underground alignment involves following type of constructions:[36]

- Sub-structure - Columns on open/pile foundations with pier cap at top of columns. Alternatively, portal arrangement is provided at certain locations.
- Superstructure by segmental construction of whole unit construction. Box segments are most common type of segmental construction. I-Girder and U-girder are most common type of non-segmental construction methods where the structural element for whole span length is pre casted and launched in position.

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[36] | *Source of information: Data received from LMRC*

- Underground alignment by means of tunnels made through Tunnel Boring Machine / open cut and cover method/ NATM method.
- Underground stations by means of cut and cover method or NATM method.
- Earth retaining structures like diaphragm walls, sheet piles, secant piles, shoulder etc.

7.2 PROPOSED METRO WORKS TO IDENTIFIED PROTECTED AND UNPROTECTED HERITAGE RESOURCES

TABLE: 7.2.1 DESCRIBING MAJOR PROPOSED METRO WORKS WHICH WILL TAKE PLACE IN PROXIMITY TO PROTECTED HERITAGE RESOURCES

SR. NO.	NAME OF MONUMENTS	NEAREST METRO STATION	ALIGNMENT ELEMENT	CONSTRUCTION METHOD	PROPOSED WORKS
1	Taj Mahal	Taj Mahal	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NATM.	Site formation
					Installation of secant, tangent and shoulder piles
					Excavation works by Tunnel Boring Machine
					Laying of tunnel components
					Station construction by top down method using diaphragm wall.
2	Agra Fort	Agra Fort and Jama Masjid	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NATM.	Site formation
					Installation of secant, tangent and shoulder piles
					Excavation works by Tunnel Boring Machine
					Laying of tunnel components
					Station construction by top down method using diaphragm wall.
3.1	Akbar's Tomb	Sikandara	Elevated	Viaducts on piers	Site formation
					Pile boring
					Construction of viaduct structure
					Erection of girders
3.2	Kanch Mahal	Sikandara	Elevated	Viaducts on piers	Site formation
					Pile boring
					Construction of viaduct structure
					Erection of girders
3.3	Lodhi Tomb	Sikandara	Elevated	Viaducts on piers	Site formation
					Pile boring
					Construction of viaduct structure
					Erection of girders
4	Guru Ka Taal	Guru Ka Taal	Elevated	Viaducts on piers	Site formation
					Pile boring

					Construction of viaduct structure Erection of girders
5.1	Pathar Ka Ghoda	Guru Ka Taal	Elevated	Viaducts on piers	Site formation Pile boring Construction of viaduct structure Erection of girders
5.2	Itibari Khan Mosque	Guru Ka Taal	Elevated	Viaducts on piers	Site formation Pile boring Construction of viaduct structure Erection of girders
6.1	Tomb of Sadiq Khan	ISBT	Elevated	Viaducts on piers	Site formation Pile boring Construction of viaduct structure Erection of girders
6.2	Tomb of Salabat Khan	ISBT	Elevated	Viaducts on piers	Site formation Pile boring Construction of viaduct structure Erection of girders
7	Barah Khamba	Taj Mahal	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NAT M.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.
8	Old Delhi Gate of City	Raja Ki Mandi	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NAT M.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.
9	Jama Masjid	Jama Masjid	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NAT M.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.
10	Ladli Begum Ka Tila		Elevated	Viaducts on piers	Site formation Pile boring

		Shastri Nagar (Future)			Construction of viaduct structure Erection of girders
11	Shahjahan Park(partially part of Taj Buffer)	Taj Mahal	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NATM.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.
12	Fatehpuri mosque	Taj Mahal	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NATM.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.
13	Satti-un-Nissa's tomb	Taj Mahal	Underground, with station building at-surface	Construction of tunnels by Cut & Cover method/NATM.	Site formation Installation of secant, tangent and shoulder piles Excavation works by Tunnel Boring Machine Laying of tunnel components Station construction by top down method using diaphragm wall.

TABLE: 7.2.2. DISTANCE OF METRO TUNNEL AND METRO STATION OF PROPOSED METRO WORKS NEAR PROTECTED HERITAGE RESOURCES

S. NO.	NAME OF HERITAGE RESOURCE	NEAREST METRO STATION	DISTANCE FROM METRO TUNNEL (IN METRES)	DISTANCE FROM METRO STATION (IN METRES)
1	Taj Mahal	Taj Mahal	514	516
2	Agra Fort	Agra Fort / Jama Masjid	107	104
3.1	Akbar's Tomb, Sikandara	Sikandara	343	478
3.2	Kanch Mahal, Sikandara	Sikandara	221	436
3.3	Lodhi Tomb, Sikandara	Sikandara	103	294
4	Guru Ka Taal	Guru Ka Taal	111	109
5.1	Pathar Ka Ghoda	Guru Ka Taal	25	58.5
5.2	Itibari Khan Mosque	Guru Ka Taal	25	58.5
6.1	Tomb of Salabat Khan	ISBT	18	158
6.2	Tomb of Sadiq Khan	ISBT	18	158
7	Barah Khamba	Taj Mahal	317	332
8	Old Delhi Gate of City	Raja Ki Mandi	148	146
9	Jama Masjid	Jama Masjid	101	327
10	Ladli Begum Ka Tila	Shastri Nagar	295	305

11	Shahjahan Park(partially part of Taj buffer)	Taj Mahal	0	0
12	Fatehpuri mosque	Taj Mahal	508	501
13	Satti-un-Nissa's Tomb	Taj Mahal	535	528

TABLE: 7.2.3 DISTANCE OF METRO TUNNEL AND METRO STATION OF PROPOSED METRO WORKS NEAR TAJ MAHAL PROTECTED HERITAGE RESOURCES

S. NO.	NAME OF HERITAGE RESOURCE	NEAREST METRO STATION	DISTANCE FROM METRO TUNNEL (IN METRES)	DISTANCE FROM METRO STATION (IN METRES)
1.1	Mausoleum	Taj Mahal	940	935
1.2.a	Minaret Southwest	Taj Mahal	905	900
1.2.b	Minaret Northwest	Taj Mahal	972	968
1.2.c	Minaret Northeast	Taj Mahal	1037	1032
1.2.d	Minaret Southest	Taj Mahal	973	968
1.3	Riverfront Terrace	Taj Mahal	847	845
1.4	Mosque	Taj Mahal	847	845
1.5	Mehmaan Khana	Taj Mahal	1060	1055
1.6	Char Bagh	Taj Mahal	628	623
1.7	Great Gate	Taj Mahal	697	692
1.8	Jilau khana	Taj Mahal	583	578
1.9	Well at the Taj Garden	Taj Mahal	669	663
1.10	Dalans around Taj Quadrangle (Southern galleries)	Taj Mahal	609	604
1.11	Saheli burj no. 1 Fatehpuri	Taj Mahal	526	521
1.12	Saheli burj no. 2 Akbari	Taj Mahal	730	728
1.13.a	West Gate	Taj Mahal	559	553
1.13.b	East Gate	Taj Mahal	807	803
1.14	Sirhi darwaja (South Gate)	Taj Mahal	647	646
1.15.a	Wall towers Southwest	Taj Mahal	615	610
1.15.b	Wall towers West	Taj Mahal	828	823
1.15.c	Wall towers Northwest	Taj Mahal	908	902
1.15.d	Wall towers Northeast	Taj Mahal	1111	1106
1.15.e	Wall towers East	Taj Mahal	1037	1032
1.15.f	Wall towers Southeast	Taj Mahal	844	843
1.16	Central pool	Taj Mahal	805	800
1.17.a	Garden wall Pavillion (Naubat Khana) West	Taj Mahal	715	710
1.17.b	Garden wall Pavillion (Naubat Khana) East	Taj Mahal	919	914
1.18.a	Bazaar street West	Taj Mahal	566	561
1.18.b	Bazaar street East	Taj Mahal	750	749

TABLE: 7.2.4 DISTANCE OF METRO TUNNEL AND METRO STATION OF PROPOSED METRO WORKS NEAR AGRA FORT PROTECTED HERITAGE RESOURCES

2.1	Delhi Gate	Jama Masjid	173	169
2.2	Amar Singh Gate	Agra Fort	141	139
2.3	Akbari Mahal	Agra Fort	221	217
2.4	Jahangiri Mahal	Agra Fort	274	269
2.5	Jahangir's Bath	Agra Fort	289	284
2.6	Shahjahan's Apartment	Agra Fort	344	339
2.7	Khas Mahal	Agra Fort	385	381
2.8	Roshan Ara Pavilion	Agra Fort	370	365
2.9	Zara Ara Pavilion	Agra Fort	412	407
2.10	Shish Mahal	Agra Fort	419	414
2.11	Saman Burj	Agra Fort	435	430
2.12	Mina Masjid	Agra Fort	418	413
2.13	Anguri Bagh	Agra Fort	352	347
2.14	Shah Burj	Agra Fort	435	430
2.15	Diwan I Khas	Agra Fort	443	438
2.16	Macchi Bhawan	Agra Fort	406	401
2.17	Royal Baths / Hamams	Agra Fort	487	482
2.18	Diwan -I-Am	Agra Fort	397	392
2.19	Nagina Masjid	Agra Fort	465	460
2.20	Salimgarh	Agra Fort	346	341
2.21	Hon'ble John Russell Colvin's Tomb	Agra Fort	401	396
2.22	Ladies Bazaar	Jama Masjid	236	231
2.23	Moti Masjid	Agra Fort	429	424
2.24	Chitor Gates	Agra Fort	need to verify location	need to verify location
2.25	Somnath Gate	Agra Fort	363	358
2.26	Fort Wall	Jama Masjid	121	120
2.27	Moat along Fort Wall	Jama Masjid	107	104

TABLE: 7.2.5 DESCRIBING MAJOR PROPOSED METRO WORKS WHICH WILL TAKE PLACE IN PROXIMITY TO UNPROTECTED HERITAGE RESOURCES

Serial no.	**Name of Heritage Resource**	**Nearest Metro Station**	**Alignment element**	**Distance from Metro Tunnel (in metres)**	**Distance from Metro Station (in metres)**
1	Bhuri Khan's mosque	Sikandara	Elevated	180	290
2	Baoli-1, Fatehabad road	Fatehabad Road	Elevated	35	454m(distance from switch over ramp - 32m)
3	Khadari Begam garden Tomb/Bharatpur house/RBS college	RBS College	Underground	0	243
4	Baradari Temple	Guru Ka Taal	Elevated	15	320
5	Suraj Bhan gateway	Guru Ka Taal	Elevated	15	380
6	Tomb-I	Sikandara	Elevated	332	312

7	Tomb-II	Sikandara	Elevated	350	346
8	St. John's College	Raja Ki Mandi	Elevated	0	63
9	Agra College	Agra College	Underground	45	61
10	Medical building complex/Lady Lyall complex	Agra College	Underground	80	113
11	St. Paul's church	RBS College	Underground	300	328
12	Queen Victoria school	Raja Ki Mandi	Underground	150	88
13	RBS college	RBS college	Underground	30	30
14	Kalan Masjid	Medical College	Underground	154	344
15	Sarojini Naidu hospital and college	Medical College	Underground	107	114
16	Senior Boy hostel	Medical College	Underground	0	0
17	Agra Fort railway station	Jama Masjid	Underground	163	230
18	Baoli-1, Agra university	Shastri Nagar	Elevated	150	213

8. HERITAGE IMPACT ASSESSMENT

8.1 TERMINOLOGY USED IN THE HERITAGE IMPACT ASSESSMENT[59].

The vocabulary used for the impacts assessment of heritage structures are refereed and adopted from different international and national HIA case studies, ICOMOS publication on "Guidance on Heritage Impact Assessments for Cultural World Heritage Properties" 2011. The following vocabulary is used for the assessment of impacts and is defined below to create a common understanding of terms through the assessment process.

Impact: A change in the values or resources attributable to a human activity. An effect, positive or negative, on a heritage resources caused by some form of outside action or force.

TYPES OF IMPACTS [60]

Direct Impact: Impact which cause measurable change to the fabric or materials of a resource or, in the intangible heritage or practices, results in measurable change to performance

Indirect Impact: Impacts which do not directly affect a heritage resource, but alter its environment, setting or context in ways that ultimately affect the resource itself.

No Impact: No impact predicted due to proposed work and resulting changes.

Cumulative Impacts: A situation where individual impacts may be negligible, but when they occur simultaneously or in a sequence result in measurable impact on a heritage resource.

Beneficial Impact: The impact is beneficial if the project will complement the setting of a heritage resource, stabilize or enhance its function and environment or improve its maintenance and management.

Adverse Impact: The impact is beneficial if the project will degrade the setting of a heritage resource, stabilize or diminish its function and environment or worsen its maintenance and management.

Visual Impact: The impact caused by visual changes due to proposed works. This is due visual barriers to and from heritage resources.

Residual Impact: The impacts which can be expected to still exist even after mitigation.

DESCRIPTION ON IMPACT

Intensity of impact- Measure of the amount of change likely to be imposed on the heritage

Duration of impact: Period of time over which the impact is likely to occur.

Severity of Impact: Combined measure of type of impact and its description.

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[59] Heritage Impact Assessment of Lahore Orange Line Metro Train Project, Rogers Kolachi Khan & Associates Ltd for Lahore Development Authority, February 2016

[60] Heritage Impact Assessment of Lahore Orange Line Metro Train Project, Rogers Kolachi Khan & Associates Ltd for Lahore Development Authority, February 2016

The heritage assessment process is used here is referred from Guidance on Heritage Impact Assessments for Cultural World Heritage Properties, ICOMOS 2011.

The Heritage Impact Assessment identifies all possible potential impacts, adverse or beneficial on heritage resources of Agra along the corridor 1 which may result from the proposed constructions works and Metro operation works after the construction works.
Assessment is carried out separately for potential impacts during the construction phase and operations phase when Metro.

The assessment comprises of the following steps:

1) Identification, structural assessment and photographic condition assessment of heritage resources along the Metro line including World Heritage sites, protected monuments and unprotected monuments
2) Identification of potential sources of impacts on Heritage resource-by cross referencing proposed works with all heritage resources to evaluate the type, duration, severity of impacts.
3) Evaluation of acceptability of the identified potential impact and highlighting the need for mitigation along with significance
4) Design of mitigation measures to address negative impacts and enhance potential for the benefit to the heritage sites.
5) Recommendations of monitoring during construction works and during operation to:

    - To verify mitigation is carried out as described in the HIA
    - Monitor the effectiveness of proposed mitigation and suggest modifications to the modifications to the Mitigation Plan as needed.

Scale or severity of impacts[61] or changes can be judged taking into account their direct and indirect effects and whether they are temporary or permanent, reversible or irreversible. The cumulative effect of separate impacts should also be considered. The scale or severity of impact can be ranked without regard to the value of the asset as:

- No change
- Negligible change
- Minor change
- Moderate change
- Major change

The significance of the effect of change – i.e. the overall impact - on an attribute is a function of the importance of the attribute and the scale of change. This can be summarized for each attribute described using the following descriptors. As change or impacts may be adverse or beneficial, there is a nine-point scale with "neutral" as its centre point:

- Major beneficial
- Moderate beneficial
- Slight beneficial
- Negligible beneficial
- Neutral

[61] Guidance on Heritage Impact Assessments for Cultural World Heritage Properties by ICOMOS in 2011

- Negligible adverse
- Slight adverse
- Moderate adverse
- Major adverse

TABLE: 8.1.1 SCALE OF ASSESSMENT IN CASE BENEFICIAL IMPACTS

VALUE OF HERITAGE ASSET	SCALE & SEVERITY OF CHANGE/IMPACT				
	No Change	**Negligible change**	**Minor change**	**Moderate change**	**Major change**
For attributes which convey OUV	**SIGNIFICANCE OF EFFECT OR OVERALL IMPACT BENEFICIAL**				
	Neutral	Slight	Moderate/ Large	Large/very Large	Very Large

TABLE: 8.1.2 SCALE OF ASSESSMENT IN CASE ADVERSE IMPACTS

VALUE OF HERITAGE ASSET	SCALE & SEVERITY OF CHANGE/IMPACT				
	No Change	**Negligible change**	**Minor change**	**Moderate change**	**Major change**
For attributes which convey OUV	**SIGNIFICANCE OF EFFECT OR OVERALL IMPACT ADVERSE**				
	Neutral	Slight	Moderate/ Large	Large/very Large	Very Large

TERMS USED FOR STRCTURE ASSESSMENT-LEVEL OF DISTRESS

Based on these parameters the heritage structures are classified into varying levels of distress:

Nil: The structures where no structural distress and negligible material degradation is visibly observed are classified in this category.

Minor: The structures where deterioration in material due to weathering, cracks in plaster (non-structural) and fine cracks in few structural elements are observed are classified in this category.

Moderate: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in few to many structural elements are classified in this category.

Major: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in most structural elements are classified in this category.

TERMS USED FOR ASSESSMENT OF RISK ASSESSEMENT

Based on the combined analysis of the geotechnical assessment, vibration assessment and condition assessment the heritage buildings have been categorised into varying degrees of risk; low, medium and high.

Risk Category: Low
All the buildings that are in nil, minor, moderate and severe levels of distress, experiencing nil to negligible ground settlement and no vibration effects would be placed in the Low risk category.

Risk Category: Medium
All the buildings that are in nil and minor levels of distress and experiencing slight and moderate ground settlement, moderate and severe levels of distress and experiencing slight ground settlement, and nil and minor levels of distress and experiencing vibrations due to excavation or tunnelling are placed in the Medium risk category.

Risk Category: High
All the buildings that are in nil and minor levels of distress and experiencing severe ground settlement, moderate and severe levels of distress and experiencing moderate and severe ground settlement, nil and minor levels of distress and experiencing vibrations due to excavation and tunnelling, moderate and severe levels of distress and experiencing vibrations due to excavation or tunnelling, and excavation and tunnelling are placed in the High risk category.

TERMS USED FOR ASSESSMENT MAGNITUDE OF IMPACT

For Built heritage or Historic Urban Landscape\attributes

Major: Change to key historic building elements that contribute to OUV, such that the resource is totally altered. Comprehensive changes to the setting.

Moderate: Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.

Minor: Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.

Negligible: Slight changes to historic building elements or setting that hardly affect it.

No Change: No change to fabric or setting.

8.2 PREDICTED IMPACTS

Heritage resources in Agra plays a major role in the tourism industry of Agra making recording as the district with highest tourist footfall in 2018 of 10 million as mentioned by the Regional Offices of Department of Tourism, U.P.

Each instance of new construction or demolition next to an existing historic structure will involve varying risks to that structure. The proximity of the historic site to the project and the scope of the project are two of the most significant variables. Construction of a high rise building with deep foundations is more likely to affect a neighbouring structure than the rehabilitation of a nearby row house. However, the converse may be true if the row house is directly adjacent to and sharing a wall with the historic structure. Other factors influencing the degree of likely impact include the age, construction type and structural integrity of the historic building, as well as the depth and makeup of its foundation and its surrounding soil types.[62]

Considering the need of Mass Rapid Transit System (MRTS) for Agra and high significance of the heritage resources of historic city of Agra, heritage impact assessment was conducted in all the heritage resources along the proposed Metro corridor I. HIA study has identified several predicted positive and negative impacts during construction phase and the operation phase. The following potential impacts on heritage resources along the Metro corridor-I are identified through assessment process:

8.2.1 IDENTIFIED IMPACTS DURING CONSTRUCTION OF CORRIDOR-I

Ground surface settlement

"Demolition activities and new construction on neighboring sites, can however cause immediate harm to the physical integrity of a historic structure." as described in the document *Protecting a historic structure during adjacent construction* published by U S National Park Service in 2001.[63]

Excavations and foundation works can cause soil slippage and ground displacement causing movement of an adjacent historic building. New construction almost invariably means new excavation works that is deeper than the foundations of historic buildings in the surroundings. This can especially the case when underground tunnel and underground stations facilities are proposed.

A Metro project in urban city requires braced excavation for Metro station, launch and reception pits for tunnel boring machine (TBM) and tunnelling operations. Alignment of tunnel usually passes through difficult ground conditions, soft soils, in close proximity to the major sensitive structures and historic buildings. The existing buildings or structures in the close proximity are subject to various level of risk or damage due to the tunnelling and construction of Metro station induced ground deformation or surface settlements. These surface settlements are usually more at the vicinity of the tunnel and underground Metro station and reduce with the increasing distance perpendicular to the tunnel alignment. The existing buildings and heritage structures are often subjected to the differential settlements due to the excavation and tunnel induced ground settlements. The rough estimation of the tunnel and excavation induced

[62] Protecting a Historic Structure during Adjacent Construction, Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf

[63] Protecting a Historic Structure during Adjacent Construction, Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf

settlements helps in planning the tunnel alignment, structural assessment of the existing buildings and heritage structures, adopting suitable construction strategies, and selecting suitable ground improvement technique to mitigate the deferential settlements.

Vibration from piling, machinery and equipment

Noise and vibration-related issues along the corridor(s) are one of the major issues which may be significant during both the construction as well as the operational phase of the project. During the construction phase, the use of heavy machinery and construction equipment may cause vibrations and also increase the ambient noise levels. Vibrations generated during the construction phase may have several adverse impacts, including cracks developed on the surrounding buildings which can have serious implications on the structural safety.[64]

In all cases, the force of the vibrations reaching the adjacent historic structure depends upon the activity generating the vibrations, the distance between the source and the existing structure, and the type of soil or pavement found between the two.[65]

The manner in which building respond dynamically to strong ground vibrations depends on the soil the building is constructed, the type of buildings foundation, the mass of building and the structural system of building. The term threshold damage vibration level is defined as the highest vibration level at which no minor or major damage occurs.

TABLE 8.2.1 EXPECTED IMPACTS DUE TO GROUND SURFACE SETTLEMENT AND VIBRATIONS FOR PROTECTED MONUMENTS

TABLE 8.2.2 EXPECTED IMPACTS DUE TO GROUND SURFACE SETTLEMENT AND VIBRATIONS FOR UNPROTECTED

[64] *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86

[65] Protecting a Historic Structure during Adjacent Construction, Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf

TABLE 8.2.1 EXPECTED IMPACTS DUE TO GROUND SURFACE SETTLEMENT AND VIBRATIONS FOR PROTECTED MONUMENTS							
S. No.	**Name of Heritage Resource**	**Nearest Metro Station**	**Alignment element**	**Distance from Metro Tunnel (in metres)**	**Distance from Metro Station (in metres)**	**Expected ground settlement***	**Expected Vibration Impacts****
1	Taj Mahal	Taj Mahal	Underground	514	516	No ground settlement expected	No major vibration impact expected as per structural studies
1.1	Mausoleum	Taj Mahal	Underground	940	935	No ground settlement expected	No major vibration impact expected as per structural studies
1.2.a	Minaret Southwest	Taj Mahal	Underground	905	900	No ground settlement expected	No major vibration impact expected as per structural studies
1.2.b	Minaret Northwest	Taj Mahal	Underground	972	968	No ground settlement expected	No major vibration impact expected as per structural studies
1.2.c	Minaret Northeast	Taj Mahal	Underground	1037	1032	No ground settlement expected	No major vibration impact expected as per structural studies
1.2.d	Minaret Southest	Taj Mahal	Underground	973	968	No ground settlement expected	No major vibration impact expected as per structural studies
1.3	Riverfront Terrace	Taj Mahal	Underground	847	845	No ground settlement expected	No major vibration impact expected as per structural studies
1.4	Mosque	Taj Mahal	Underground	847	845	No ground settlement expected	No major vibration impact expected as per structural studies
1.5	Mehmaan Khana	Taj Mahal	Underground	1060	1055	No ground settlement expected	No major vibration impact expected as per structural studies
1.6	Char Bagh	Taj Mahal	Underground	628	623	No ground settlement expected	No major vibration impact expected as per structural studies
1.7	Great Gate	Taj Mahal	Underground	697	692	No ground settlement expected	No major vibration impact expected as per structural studies
1.8	Jilau khana	Taj Mahal	Underground	583	578	No ground settlement expected	No major vibration impact expected as per structural studies
1.9	Well at the Taj Garden	Taj Mahal	Underground	669	663	No ground settlement expected	No major vibration impact expected as per structural studies
1.10	Dalans around Taj Quadrangle	Taj Mahal	Underground	609	604	No ground settlement expected	No major vibration impact expected as per structural studies
1.11	Saheli burj no. 1 Fatehpuri	Taj Mahal	Underground	526	521	No ground settlement expected	No major vibration impact expected as per structural studies
1.12	Saheli burj no. 2 Akbari	Taj Mahal	Underground	730	728	No ground settlement expected	No major vibration impact expected as per structural studies
1.13.a	West Gate	Taj Mahal	Underground	559	553	No ground settlement expected	No major vibration impact expected as per structural studies

S. No.	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro Tunnel (in metres)	Distance from Metro Station (in metres)	Expected ground settlement*	Expected Vibration Impacts**
1.13.b	East Gate	Taj Mahal	Underground	807	803	No ground settlement expected	No major vibration impact expected as per structural studies
1.14	Sirhi darwaja (South Gate)	Taj Mahal	Underground	647	646	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.a	Wall towers Southwest	Taj Mahal	Underground	615	610	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.b	Wall towers West	Taj Mahal	Underground	828	823	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.c	Wall towers Northwest	Taj Mahal	Underground	908	902	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.d	Wall towers Northeast	Taj Mahal	Underground	1111	1106	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.e	Wall towers East	Taj Mahal	Underground	1037	1032	No ground settlement expected	No major vibration impact expected as per structural studies
1.15.f	Wall towers Southeast	Taj Mahal	Underground	844	843	No ground settlement expected	No major vibration impact expected as per structural studies
1.16	Central pool	Taj Mahal	Underground	805	800	No ground settlement expected	No major vibration impact expected as per structural studies
1.17.a	Garden wall Pavillion (Naubat Khana) West	Taj Mahal	Underground	715	710	No ground settlement expected	No major vibration impact expected as per structural studies
1.17.b	Garden wall Pavillion (Naubat Khana) East	Taj Mahal	Underground	919	914	No ground settlement expected	No major vibration impact expected as per structural studies
1.18.a	Bazaar street West	Taj Mahal	Underground	566	561	No ground settlement expected	No major vibration impact expected as per structural studies
1.18.b	Bazaar street East	Taj Mahal	Underground	750	749	No ground settlement expected	No major vibration impact expected as per structural studies
2	Agra Fort	a Fort / Jama Ma	Underground	107	104	No ground settlement expected	No major vibration impact expected as per structural studies
2.1	Delhi Gate	Jama Masjid	Underground	173	169	No ground settlement expected	No major vibration impact expected as per structural studies
2.2	Amar Singh Gate	Agra Fort	Underground	141	139	No ground settlement expected	No major vibration impact expected as per structural studies

S. No.	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro Tunnel (in metres)	Distance from Metro Station (in metres)	Expected ground settlement*	Expected Vibration Impacts**
2.3	Akbari Mahal	Agra Fort	Underground	221	217	No ground settlement expected	No major vibration impact expected as per structural studies
2.4	Jahangiri Mahal	Agra Fort	Underground	274	269	No ground settlement expected	No major vibration impact expected as per structural studies
2.5	Jahangir's Bath	Agra Fort	Underground	289	284	No ground settlement expected	No major vibration impact expected as per structural studies
2.6	Shahjahan's Apartment	Agra Fort	Underground	344	339	No ground settlement expected	No major vibration impact expected as per structural studies
2.7	Khas Mahal	Agra Fort	Underground	385	381	No ground settlement expected	No major vibration impact expected as per structural studies
2.8	Roshan Ara Pavilion	Agra Fort	Underground	370	365	No ground settlement expected	No major vibration impact expected as per structural studies
2.9	Zara Ara Pavilion	Agra Fort	Underground	412	407	No ground settlement expected	No major vibration impact expected as per structural studies
2.10	Shish Mahal	Agra Fort	Underground	419	414	No ground settlement expected	No major vibration impact expected as per structural studies
2.11	Saman Burj	Agra Fort	Underground	435	430	No ground settlement expected	No major vibration impact expected as per structural studies
2.12	Mina Masjid	Agra Fort	Underground	418	413	No ground settlement expected	No major vibration impact expected as per structural studies
2.13	Anguri Bagh	Agra Fort	Underground	352	347	No ground settlement expected	No major vibration impact expected as per structural studies
2.14	Shah Burj	Agra Fort	Underground	435	430	No ground settlement expected	No major vibration impact expected as per structural studies
2.15	Diwan I Khas	Agra Fort	Underground	443	438	No ground settlement expected	No major vibration impact expected as per structural studies
2.16	Macchi Bhawan	Agra Fort	Underground	406	401	No ground settlement expected	No major vibration impact expected as per structural studies
2.17	Royal Baths / Hamams	Agra Fort	Underground	487	482	No ground settlement expected	No major vibration impact expected as per structural studies
2.18	Diwan -I-Am	Agra Fort	Underground	397	392	No ground settlement expected	No major vibration impact expected as per structural studies
2.19	Nagina Masjid	Agra Fort	Underground	465	460	No ground settlement expected	No major vibration impact expected as per structural studies

S. No.	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro Tunnel (in metres)	Distance from Metro Station (in metres)	Expected ground settlement*	Expected Vibration Impacts**
2.20	Salimgarh	Agra Fort	Underground	346	341	No ground settlement expected	No major vibration impact expected as per structural studies
2.21	Hon'ble John Russell Colvin's Tomb	Agra Fort	Underground	401	396	No ground settlement expected	No major vibration impact expected as per structural studies
2.22	Ladies Bazaar	Jama Masjid	Underground	236	231	No ground settlement expected	No major vibration impact expected as per structural studies
2.23	Moti Masjid	Agra Fort	Underground	429	424	No ground settlement expected	No major vibration impact expected as per structural studies
2.24	Chitor Gates	Agra Fort	Underground	eed to verify locati	ed to verify locati	No ground settlement expected	No major vibration impact expected as per structural studies
2.25	Somnath Gate	Agra Fort	Underground	363	358	No ground settlement expected	No major vibration impact expected as per structural studies
2.26	Fort Wall	Jama Masjid	Underground	121	120	No ground settlement expected	No major vibration impact expected as per structural studies
2.27	Moat along Fort Wall	Jama Masjid	Underground	107	104	No ground settlement expected	No major vibration impact expected as per structural studies
3.1	Akbar's Tomb, Sikandara	Sikandara	Elevated	343	478	No ground settlement expected	No major vibration impact expected as per structural studies
3.2	Kanch Mahal, Sikandara	Sikandara	Elevated	221	436	No ground settlement expected	No major vibration impact expected as per structural studies
3.3	Lodhi Tomb, Sikandara	Sikandara	Elevated	103	294	No ground settlement expected	No major vibration impact expected as per structural studies
4	Guru Ka Taal	Guru Ka Taal	Elevated	111	109	No ground settlement expected	No major vibration impact expected as per structural studies
5.1	Pathar Ka Ghoda	Guru Ka Taal	Elevated	25	58.5	No ground settlement expected	Vibration impact expected as per structural studies.Mitigation measures are required during execution works
5.2	Itibari Khan Tomb	Guru Ka Taal	Elevated	25	58.5	No ground settlement expected	Vibration impact expected as per structural studies. Mitigation measures during execution stage would be required in consultation with ASI.
6.1	Tomb of Salabat Khan	ISBT	Elevated	18	158	No ground settlement expected	No major vibration impact expected as per structural studies
6.2	Tomb of Sadiq Khan	ISBT	Elevated	18	158	No ground settlement expected	No major vibration impact expected as per structural studies

S. No.	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro Tunnel (in metres)	Distance from Metro Station (in metres)	Expected ground settlement*	Expected Vibration Impacts**
7	Barah Khamba	Taj Mahal	Underground	317	332	No ground settlement expected	No major vibration impact expected as per structural studies
8	Old Delhi Gate of City	Raja Ki Mandi	Underground	148	146	No ground settlement expected	No major vibration impact expected as per structural studies
9	Jama Masjid	Jama Masjid	Elevated	101	327	No ground settlement expected	No major vibration impact expected as per structural studies
10	Ladli Begum Ka Tila	Shastri Nagar	Elevated	295	305	No ground settlement expected	No major vibration impact expected as per structural studies
11	Shahjahan Park(partially part of Taj buffer)	Taj Mahal	Elevated	0	0	No ground settlement expected	No major vibration impact expected as per structural studies
12	Fatehpuri mosque	Taj Mahal	Underground	508	501	No ground settlement expected	No major vibration impact expected as per structural studies
13	Satti-un-Nissa's Tomb	Taj Mahal	Underground	535	528	No ground settlement expected	No major vibration impact expected as per structural studies

*From the geotechnical assessment it can be inferred that the primary and secondary settlements, along the metro line and metro stations, can be experienced to a distance of 20 m and 75 m respectively. Therefore taking 50 m and 100 m as the upper bound of expected settlement along the metro line and metro. Refer structure report in annexure

**The proposed metro alignment runs close to two World heritage sites; the Taj Mahal and the Agra Fort. On comparison with international standards , the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling and excavation.

**ASI Protected Heritage Sites: The proposed metro alignment runs close to few ASI protected heritage sites. On comparison with international standards ([1] and [2]), the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling, construction of foundations and excavation.

Table 8.2.2 EXPECTED IMPACTS DUE TO GROUND SURFACE SETTLEMENT AND VIBRATIONS FOR UNPROTECTED MONUMENTS							
Serial no.	**Name of Heritage Resource**	**Nearest Metro Station**	**Alignment element**	**Distance from Metro Tunnel (in metres)**	**Distance from Metro Station (in metres)**	**Expected ground settlement**	**Expected Vibration Impacts***
1	Bhuri Khan's mosque	Sikandara	Elevated	180	290	No settlment expected	No major vibration impact expected as per structural studies
2	Baoli-1, Fatehabad road	Fatehabad Road	Elevated	35	454m (distance from switch over ramp - 32m)	No settlment expected	No major vibration impact expected as per structural studies
3	Khadari Begam garden Tomb/Bharatpur house/RBS college	RBS College	Underground	0	243	Settlment expected in the walls and chatri	No major vibration impact expected as per structural studies
4	Baradari Temple	Guru Ka Taal	Elevated	15	320	No settlment expected	Mitigation measures would be needed during execution of the metro work including close monitoring of the structure, supervision, providing required propping and supports, consolidation of the structure or as per site condition
5	Suraj Bhan gateway	Guru Ka Taal	Elevated	15	380	No settlment expected	No major vibration impact expected as per strcutural studies
6	Tomb-I	Sikandara	Elevated	332	312	No settlment expected	No major vibration impact expected as per strcutural studies
7	Tomb-II	Sikandara	Elevated	350	346	No settlment expected	No major vibration impact expected as per strcutural studies
8	St. John's College	Raja Ki Mandi	Underground	0	63	Settlment expected	Mitigation measures would be needed during execution of the metro work including close monitoring of the structure, supervision, providing required propping and supports, consolidation of the structure or as per site condition
9	Agra College	Agra College	Underground	45	61	No settlment expected	No major vibration impact expected as per structural studies

Serial no.	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro Tunnel (in metres)	Distance from Metro Station (in metres)	Expected ground settlement	Expected Vibration Impacts*
10	Medical building complex/Lady Lyall complex	Agra College	Underground	80	113	No settlment expected	No major vibration impact expected as per structural studies
11	St. Paul's church	RBS College	Underground	300	328	No settlment expected	No major vibration impact expected as per structural studies
12	Queen Victoria school	Raja Ki Mandi	Underground	150	88	No settlment expected	No major vibration impact expected as per structural studies
13	RBS college	RBS college	Underground	30	30	No settlment expected	No major vibration impact expected as per structural studies
14	Kalan Masjid	Medical College	Underground	154	344	No settlment expected	No major vibration impact expected as per structural studies
15	Sarojini Naidu hospital and college	Medical College	Underground	107	114	No settlment expected	No major vibration impact expected as per structural studies
16	Senior Boy hostel	Medical College	Underground	0	0	Settlment expected	Mitigation measures would be needed during execution of the metro work including close monitoring of the structure, supervision, providing required propping and supports, consolidation of the structure or as per site condition
17	Agra Fort Railway Station	Jama Masjid	Underground	163	230	No settlment expected	No major vibration impact expected as per structural studies
18	Baoli-1, Agra university	Shastri Nagar	Elevated	150	213	No settlment expected	No major vibration impact expected as per structural studies

*Unprotected Heritage Sites: The proposed metro alignment runs close to mentioned unprotected heritage sites. On comparing the first stage predictions calculated for these structures with ground vibration threshold values prescribed by DIN 4150 Part 3, 1984 [1] and Directorate General of Mines Safety, India [2], St. John’s College and Sarojini Naidu Boy’s Hostel was found unsafe against ground vibrations induced by tunnelling. Sarojini Naidu Boy’s hostel was found unsafe against ground vibrations induced by excavation of proposed metro station in a similar manner. Temple gateway, Bagichi was found unsafe against ground vibrations induced by construction of foundations for proposed elevated metro alignment.

Damage to historic fabric

Vibrations caused during construction, movement of heavy vehicles, soil settlements during excavations and noise generated by equipment and machineries used in construction can cause damage to the heritage structures which are in the limit of the extent of these effects.

Possible impacts of heritage resources in the range of effect of vibration and soil settlements:

1. Development of hairline cracks on the surfaces of the plaster and the stone surfaces
2. Flaking and spalling of the lime plaster works and pointing works specially which are in deteriorated state and already hollowed
3. New structural problems such as development of new cracks, movement and bulging of the walls
4. Monuments with severe structural cracks and distress may show severe decay and damage during the execution of the project (refer table 16, structure report)
5. Propagation of existing structural cracks and other deteriorated masonry areas
6. Appearance of non-structural cracks such as plaster cracks
7. Detachment of the cladding stone which is prevalent in most of the historic buildings
8. Detachment of flaking of precious stone laid within marble and red sand stone

First stage predictions depictions that World Heritage sites of Taj Mahal is at more than 500 meters away and Agra Fort is at distance of 104 meters from Jama Masjid Metro station. All the heritage sites are at the distance of more than 100 meters except Pathar Ka Ghoda which is at 25 meters from the elevated Metro line. It is expected least concern for heritage structures beyond 100 years due to vibrations and soil settlement (Refer table no 7.2.1).

Initial condition assessment was commencement during the HIA study.

Temporary loss or restriction of access during construction phase

Traffic needs to be diverted temporarily (or only a narrow width of the existing road is allowed to be used for traffic flow) for carrying out construction activities smoothly and to avoid any accident involving construction machinery/equipment. This diversion of road traffic further from the existing road corridors increases the traffic loads on the adjoining roads leading to congestion and traffic jams during peak hours during the construction phase of the project. [66]

Analysis of the existing Metro proposals depicts that's access to historic buildings would be restricted or changed during the construction phase of Metro corridor 1 in Agra. This can be a temporary problem for the visitors to some of the heritage resources specially for e.g. World Heritage Site of Agra Fort, VIP entry of Taj Mahal, Jama Masjid, Sikandara monument, temples and others institutional buildings to access these sites.

Air pollutants

The concern regarding the environmental threat to the Taj has been articulated in the landmark judgement of Hon'ble Justice Shri Kuldeep Singh dated 30/12/96, "The Taj is threatened with deterioration and damage not only by the traditional causes of decay, but also by the changing

[66] *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86

social and economic conditions which aggravate the situation with even more formidable phenomena of damage and destruction."[67]

Air pollutants caused by industries located in the region are a major cause identified as being responsible for the discolouration of historic surfaces mainly Taj Mahal and Agra Fort where white marble was used as chief building materials. Although there is no data is available which depicts the percentage of air pollutants which are mainly caused due to construction activities during Metro. The proposed Metro activities are expected to generate air pollutants, dust and debris during the construction period which may harm the historic surfaces for short term.

Environment impact study of Delhi Metro had predicted that the Metro systems after construction and commissioning will certainly reduce the pollution level and add convenience to the public, but such project may grossly aggravate the pollution problem during construction stage, especially in respect of noise and air pollution which are generally at their peak in the city just before such projects are taken up for implementation. During construction phase, SPM (PM10 & PM2.5) is expected to be the main pollutant associated with the earthwork activities and material handling, mainly confined to the project site, within a few metres from the source and within the site. During the construction of the proposed section poor air quality is likely scenario in the surrounding region. However, all preventive measure can be taken at the construction site to minimize the impact on air quality.[68]

Every two kilometre of underground Metro construction, during its intense period of physical activity of say two years, will add to the pollution level which will be equivalent to plying 500 bus trips per day for only transporting men, material and machine. Therefore, in a tunnel construction the location of shaft to bring out the excavated material (mucking) and supply of construction material should not be decided merely on economy and convenience in construction but also on the impact on existing pollution level at the exit point as well as all along the route of movement. Hence selection of the route for movement of material etc. should avoid polluted and congested areas even if amount to some detour and additional costs [69]

Dust and Debris

Transportation of earth and establishment of the material will involve use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. Simultaneously there would be fugitive gas emissions due to vehicular and machinery exhausts during their working during construction. However, this activity will be only short-term. Protective measures shall be undertaken during construction phase. Movement of trucks and other heavy equipment at construction site would generate dust during construction phase.[70]

Dust and pollution can exacerbate damage to sensitive materials of heritage buildings and cause deterioration of delicate building fabric during the construction phase. Soiling is the visible dirtying of building exteriors and interiors due to accumulation of dust caused by excavation and construction works. Soiling may be harmless in itself, but it could necessitate frequent

[67] Taj Trapezium Zone, July 2018, First Draft Report Volume I PREPARATION OF VISION DOCUMENT, First draft report, vision document

[68] Environmental Impact Assessment, Delhi Metro, http://www.delhiMetrorail.com/eia_report/Janakpuridscorridor.pdf

[69] Environmental management during Metro railway construction especially in highly polluted and densely populated city, M. Kumar Delhi Metro Rail Corporation Ltd., India, Transactions on the Built Environment vol. 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

[70] Environmental Impact Assessment Study for Najafgarh- Dhansa Bus Stand Corridor of Delhi Metro

cleaning in order to meet aesthetic expectation especially in case of two World Heritage Sites and their surrounding for visitors.

Noise during proposed construction works

During the construction phase, the use of heavy machinery and construction equipment may cause vibrations and also increase the ambient noise levels. Vibrations generated during the construction phase may have several adverse impacts, including cracks developed on the surrounding buildings which can have serious implications on the structural safety as described in the article [71]

Fire Risk

The increased possibility of fire accompanies many demolition and new construction activities. Temporary heating, torches, sparks, molten metal and electric utility panels are some of the most common sources of fire at construction sites. Additionally, the improper storage of fuels, flammable chemicals, cloths rags, brushes also present opportunities for fire to ignite and spread.

Visual barriers due to construction activities

Barricading during construction activities becomes not just an access barrier but also visual barrier from viewpoints to heritage resources and views from heritage resources.

The elevated corridors are opposed by a few town planners and others on plea that these elevated corridors will not only adversely affect the aesthetics of the city, but will also reduce the visibility of various historical monuments by obstructing the line of sight and will further increase concretization of the whole city which might led to irreversible micro-climatic changes including increased heat-island effects. a large number of properties/buildings which might be affected and due to various technical difficulties, which might occur during the construction phase of the project. Because of concerns related to obstruction, visibility and aesthetic reasons, underground corridors are provided near important historical monuments, as described in the article *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86

Water ingress

Construction activities of Metro can result in water ingression in heritage resources when natural hydrological disturbed around the Agra Fort and Taj Mahal Area. Therefore, existing hydrological channels of study area to be evaluated before the construction system.

8.2.2 IDENTIFIED IMPACTS DURING OPERATION OF METRO CORRDIOR I

Continuous occurring vibration from Metro traffic

During operation of Metro factors such as high speed, stiff primary suspensions on the vehicle, and flat or worn wheels will increase the possibility of problems from ground borne vibration. Adverse effects are predicted to historic fabric located less than 50 meters from the source of vibrations from operation of Metro Metros.

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71 Critical Issues Related to Metro Rail Projects in India published in Journal of Infrastructure Development 5 (I) 67-86

TABLE 8.2.3.1 IMPACT OF PROPOSED METRO CONSTRUCTIONS ON VISUAL CONNECTIONS

Sr.no.	Heritage Resource	Image showing existing visual connection	Existing visual connection	Impact on visual connection
1	**Taj Mahal**		Viewpoint locations were established through Research identified 16 viewpoints of Taj (TMV1, TMV2,TMV3,TMV4,TMV5,TMV6,TMV7,TMV8,TMV9,TMV10,TMV11,TMV12,TMV13,TMV14,TMV15, TMV16) which is then verified through fieldwork. (View from Fatehabad road at Taj ganj, looking North of the site) one viewpoint (TMV17) was identified on Fatehbad Road. At present the dome and a part of Taj Mahal is partially visible from this point. Located 1.08 km south of the site, this point on the Fatehabad provides the first views of Taj Mahal.	1.Proposed Underground Metroline in Taj area do not have any impact of Taj view points as well as visaul relationship of Taj Mahal, Red Fort and Jama Masjid . 2.It has been observed from the study that the proposed elevated alignment on Fatehbad road do not causes any visual impact on these 16 viewpoints. 3.An elevated Metro line is proposed over Fatehahbad road,is likely improve the visual connections of the visitors which is at present hidden behind modern constructions 4.The net result will potentially provide the historic building with an improved visual character.
2	**Agra Fort**		The visual analysis is based on views from external spaces within the public domain and not from inside buildings or private spaces. (View from Red Fort road, looking north of the site) A highly trafficked road,the northern stretch of the Red Fort Road is the portion of the site visibility, this location lies 100m from the site and is a primary entry point for Agra Fort. South wall of the Agra Fort is visible from road along the proposed Metro station of Agra Fort.	1.An underground Metro line is proposed along the stretch of Agra Fort therefore do not impact the existing visual coonectivity. 2.Underground alignment parallel to the road do not imapct the visual connecitiy between the two World Heritage Sites 3.There are two proposed Metro stations in close vicinity to the Agra Fort.After visual analysis it can be concluded that the location of these two stations do not pose any visual obstruction to the monument.
3	**Akbar's Tomb, Lodhi tomb and Kanch Mahal Sikandara**		(View from the NH19 looking northeast) Located 600 m from the site.This viewpoint is taken from the newly constructed building at the edge of the road, located adjacent to the site without intervening structures or vegetation to mitigate the view, multiple structures of the proposals become visible. The main gate of the complex is visible from NH19 (viewpoint SKV1) along the proposed Metro station of Sikandara. Another viewpoint was identified on NH19, located 700m from the site, from this veiw poit Minarets of the gate are visible.	1. Elevated Metroline on Sikandara road will not have any impact on the visual connectivity. 2.Elevated Metroline would provide better views of the Akbar's tomb and enhance the visitor's experience 3. There will be no visual impact on Kanch Mahal 4.The context of Lodhi tomb would be changed sue to elevated Metro station and Metro line at a distance of 103 meters.

4	**Guru Ka Taal**		(View from the NH19 looking north of the site) At present, a newly constructed Gurudwara obstructs the view of Guru Ka Taal. thus there are no visual connections from road.	1. Alignment of proposed Metro line will have not negative impact on current view. 2, Instead, proposed elevated Metro route has the potential to provide a good visual angle of existing remaianing architectural elements of Guru Ka Taal for the Metro users.
5	**Pathar Ka Ghoda and Itwari Khan mosque**		(View from the NH19 looking south of the site) Located 40 m from the site. Pathar ka ghoda is visible from the road(NH19).	Proposed Metro line on NH19 is elevated, the Metro line will have a negative impact on the view of Pathar ka Ghoda. As Metroline passes through the close proxmity to the monument.
6.1	**Tomb of Salabat Khan**		(View from the NH19 looking north of the site) – Although not visible from the road itself.	1.Visual analysis of the area it can be concluded that the proposed elevated Metro line would impact the context of the complex (refer Fig. VII/SQ/01) 2.Elevated Metroline would provide complete view of the complex

6.2	**Tomb of Sadiq Khan**		(View from the NH19 looking north of the site) – Located 100m south of the site (view point SQV1), the NH19 is the primary access point in to Sadiq khan tomb for those travelling on the NH19 from the Sikandara. At present, the dome of Tomb of Sadiq Khan is visible from the road. and main enty of the tomb.	
7	**Barah Khamba**		The structure in the the Taj ganj area near the Taj Mahal so the building is cover with residennce and the is vesy dence No any visual connection from the Fatehabad road.	No impact on visual connectivity
8	**Old Delhi Gate of City**		(View from the hariparwat road looking south site of the site) Old Delhi gate viewpoint was identified on hariparwat road. At present the whole structure visible from the Raja ki mandi railway station road.	1.Metro line to be underground this stretch and no visual impact on visual connections and context 2.There are one proposed Metro stations in close vicinity to the Delhi gate. After visual analysis that the location of station do not pose any visual obstruction to the monument.

9	**Jami Masjid**		(View from jama masjid road, looking south of the site).A highly traffic corridor, this portion of the market Road and primary shopping area in town and , At present multiple tall structures obstruct view of Jama Masjid along the proposed route, leaving no clear view points.	The proposed corridor 1 Metro line continues to be underground along this stretch. Therefore, visually there won't be any negative impact of proposed Metro line and station on Jama Masjid.
10	**Ladli Begum Ka Tila**		(View from NH19, looking south of the site) No visual connection from road.	No visual impact
11	**Shahjahan Park(partially part of Taj buffer)**		The heritage structures within Shahjahan park are covered with heavy vegetation growth and are thus there are no visual connections from Agra Fatehabad road.. Only we can see the structure opposite of the Metro line from the yamuna kinara road..	1.Proposed underground Metro line along the stretch of Shahjjahan park will have no visual imact on Shahjahan park and its historic strctures 2.Construction of elevated entry and exit points would slightly affect the visal setting .

12	**Fatehpuri mosque**		(View from Fatehabad road, looking south of the site) No visual connection from the fatehabad road.	No visual impact
13	**Satti-un-Nissa's Tomb**		(View from Fatehabad road, looking south of the site) No visual connection from the fatehabad road.	No impact

Visual barrier created by elevated Metro

The concept of visual integrity is frequently considered a crucial element related to the preservation of heritage sites. Visual integrity may pertain specially to vistas, panoramas, viewpoints, and silhouettes. Visual integrity can also be taken to mean the capacity of heritage to maintain visual distinctiveness and visually demonstrate its relationship with its surroundings.

Visual impact refers to the direct impacts of the development on views as a result of instruction or obstruction; the overall impact on the visual amenity, be it degradation or enhancement and the reaction of viewers who may be affected. This includes the view of passerby, from the street level and from elevated Metro level, and visitors inwards to the heritage site and the view outwards from the site or building towards the elevated sections of the alignment. Visual impact is relevant for Lodhi Tomb, Kanch Mahal, Pathar Ka Ghoda, Guru Ka Taal, Tomb of Sadiq Khan, Tomb of Salabat Khan, Taj Mahal, and Agra Fort.

The underground portion of the alignment in the operational phase will be have negligible impacts limited to those arising from the small-scale station entry and exit only.

Two points are of importance assessing visual impacts: firstly, the height of the elevated track in relation to the view-lines to and from the heritage sites, and secondly, the current visual character of the heritage site in its setting. This refers to the value and character of existing views may be affected, the area within the Visual Envelope that shield the view and break the view-line.

Views into heritage sites from some points at street level will be unavoidably framed beneath the elevated viaduct, the bottom of which be 12 meters above the ground. Views of heritage from the elevated train itself will be excellent.

Noise from Metro operation and associated activities

During the operation phase the main source of noise will be from running of Metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. The noise level reduces with distance logarithmically.[72]

Elevated noise levels, while not actually harmful to the physical historic environment, reduce the quality of life of communities (along with traditional fairs and festivities) and the quality of the experience and enjoyment of visitors to historic places. This particularly in case of shrines and other religious structures.

Noise from Metro operating on elevated viaducts is airborne and can be perceived by individuals outside of a building or inside at an attenuated level after the noise has passed through the windows, doors or walls of the building. On the other hand, noise from trains operating underground is ground borne and can be perceived only when an individual is inside a building near the subway. Outdoors ground borne is inaudible.

Heritage buildings are sensitive receivers and ambient noise levels in their immediate environment must adhere to those set out by CPCB, Ministry of Environment, Forest and Climate Change in respect of noise for different categories of areas (residential, commercial, industrial) and silence zones have been notified under the Environment (Protection) Act, 1986.

[72] Environmental Impact Assessment Study for Najafgarh- Dhansa Bus Stand Corridor of Delhi Metro

During the operation of the Metro rail, rail–wheel contacts with tracks generate noise and vibration. Engine, cooling fans and generators further increase ambient noise and vibration levels inside the coaches and also outside the Metro rail corridor as described in the article [73]

8.2.3 IDENTIFIED POSITIVE IMPACTS

Improved air quality

The Supreme court, in its 1996 judgement have asked for many other things to be done such as creating a green belt; building a bypass for heavy traffic; ban on brick kilns within 20 km from the Taj; supply of uninterrupted power so that the use of generators is negated; and ban on diesel-driven, light-duty vehicles and three-wheelers within 500 metres of the monument. The court-ordered air quality-monitoring stations, located both near the Taj and in the industrial outskirts of the city, to prove the difference.[74]

Proposed Metro project is outside the 500 meters of the boundary of Taj complex. The proposed MRTS project in Agra city would in long term would be an important factor responsible for reducing the road traffic in the Agra City and in a resultant air pollutant caused by traffic in Agra city would also be reduced[75]. Opportunities in MRTS Projects due to predicted reduction in air pollutants. It is extremely essential to reduce the air pollutants in the sensitive one of Taj Trapezium Zone (TTZ). MRTS would be a definitely a positive step towards minimizing the air pollutants in this area where air quality is extremely important to save the World Heritage Site of Taj Mahal and Red Fort.

Reference should be considered from the results of The Delhi Metro (DM), which is a mass rapid transit system serving the National Capital Region of India. It is also the world's first rail project to earn carbon credits under the Clean Development Mechanism of the United Nations for reductions in CO^2 emissions. Looking at the period 2004–2006, one of the larger rail extensions of the DM led to a 34 percent reduction in localized CO at a major traffic intersection in the city. Results for NO^2 are also suggestive of a decline, while those for PM25 are inconclusive due to missing data. These impacts of pollutant reductions are for the short run. A complete accounting of all long run costs and benefits should be done before building capital intensive Metro rail projects[76].

On implementation of the project, it is estimated that both petrol and diesel consumption will get reduced. The saving will be due to two factors namely Reduction in vehicles and decongestion on roads. CO2 emission reduction from various MRTS projects like Metro rail can also be utilized to earn 'Carbon Credits' by developing countries like India through the Clean Development Mechanism as per the provisions of the Kyoto Protocol (1997) as described in the article *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86. It can be expected that resultant air pollutants would be reduce with the introduction of MRTS in Agra City which is an essential requirement to save significant monuments.

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[73] *Critical Issues Related to Metro Rail Projects in India* published in Journal of Infrastructure Development 5 (I) 67-86.
[74] Taj Trapezium Zone, July 2018, First Draft Report Volume I PREPARATION OF VISION DOCUMEN, First draft report, vision document
[75] Transportation is the largest source of air pollution in Delhi, contributing 18-39% to the city's pollution, according to an April 2019 analysis by the Council on Energy, Environment and Water (CEEW), a Delhi-based think-tank.
[76] "Goel, Deepti; Gupta, Sonam. 2015. The Effect of Metro Expansions on Air Pollution in Delhi. Policy Research Working Paper;No. 7448. World Bank, Washington, DC. © World Bank, https://openknowledge.worldbank.org/handle/10986/22878 License: CC BY 3.0 IGO."

Improved quality of life

Development of Metro rail in the city would lead to overall improvement of quality of life of local populace by virtue of availability of better transport facility at competitive rates, better road safety, reduced pollution, improved general health etc. It would be very beneficial for the large number of tourists visiting Taj every year. It would also be convenient for the tourist to visit all the significance World Heritage Sites of Agra, protected and unprotected heritage sites located on the proposed corridor I.

Reduced noise pollution

The main sources of noise from the operation of trains include: engine noise, cooling fan noise, wheel-rail interaction, electric generator and miscellaneous noise like passenger's chatting. However, since the proposed corridor near World Heritage Site of Taj Mahal and Agra Fortis underground there will be no impact on the ambient noise. In addition, due to reduction of vehicular traffic, the road traffic noise will come down.

Visual Impacts

All several viewpoints of all the monuments were identified, numbered, mapped, photographed and analysed to evaluate the impact of the proposed Metro corridor. The existing visual connectivity of a view was evaluated in terms of its:

1. Viewpoints providing visual connectivity from different locations
2. Transformations in the views due to Metro constructions

Visual quality of views to and from the heritage resources were analysed (annexure VII) and following observations were made and recorded in the Table 8.1.

The predicted levels of visual change looking into the site from the underground and elevated Metro train will be:

Elevated Metro line – Metro line from Taj East gate to Fatehabad road is elevated Metro rail. The road presently do not have significant viewpoints of Taj Mahal which are presently hidden behind the modern constructions. The elevated line on this stretch is expected to provide spectacular view of Taj from elevated Metro line.

Underground Metro line- As Metro line from Taj Mahal to RBS College would be underground and will have minimal impact in the views. There will be little change in the views of the Taj Complex and Red Fort Complex which includes the only change in the context would be construction of the elevated entry and exit points.

Elevated Metro line- From RBS to Sikandara, the proposed Metro corridor would be elevated Metro line and stations. Monuments except Sikandara monuments and Tomb of Sadiq Khan are not visible from the road and their access is not well defined at the moment. The elevated Metro line is expected to enhance the viewpoints of all the monuments on the Sikandara. It is also expected that view points of the Taj Mahal from the elevated Metro line up to Fatehabad station would be largely enhanced and would make experience better for the tourists.

8.2.4 ACCEPTIBILITY OF IMPACTS AND IMPACTS OF MITIGATION

All of the identified potential impacts can be directly affect the significance of the heritage buildings under discussion. Deciding on the acceptability of Impacts requires a professional advice about the severity and importance of a case.

The impact is **acceptable** if the assessment indicates that there will be no significant effects on fabric, setting or values of a heritage place or on the function or performance of intangible heritage.

The impact **requires mitigation measures** if there will be some adverse effects, but these can be eliminated or reduced to a large extent by specific mitigation measures.

The impact is unacceptable if the adverse effects are considered in extreme cases which are unable to mitigate practically

The impact is **undetermined** if the significant adverse effects are likely, but the extent to which they may occur or may be mitigated cannot be determined from the study. Further detail study will be required.

8.2.5 ASSESMENT

Ground surface settlement

There are two types of settlements are studied as a part of study.

1. Excavation induced ground surface settlement
2. Tunnelling induced ground surface settlement

From the geotechnical assessment (Annexure I from page 5 to page 24) it can be inferred that the primary and secondary settlements, along the Metro line and Metro stations, can be experienced to a distance of 20 m and 75 m respectively. Therefore taking 50 m and 100 m as the upper bound of expected settlement along the Metro line and Metro station respectively, the unprotected heritage structures for further assessment have been decided, which are Bhuri Khans mosque, Suraj Bhan gateway, Temple gateway, St John's College, Sarojani Naidu boys' hostel and Khandari Begum's Tomb. (Annexure I Table 17). Refer structure assessment report Annexure no I for details.

Vibration from piling, machinery and equipment

Detailed analysis is carried out by National Center for Safety of Historic Structures, IIT Madras to find out the potential vibration-producing heavy machinery to ensure that they are within internationally accepted ranges. All the monuments and unprotected heritage sites are mapped to analyze the proposed distances from Metro line and Metro stations along with the soil settlement studies. Study is carried out to analyses the vibrations due to tunneling and due to additional construction works equipment. The first stage predictions of ground vibrations were calculated and compared to international standards.[77] The following inferences were made based on these calculations (Annexure I table 10,11,12,13 & 13).

- **World Heritage Sites**: The proposed Metro alignment runs close to two world heritage sites; the Taj Mahal and the Agra Fort. On comparison with international standards,

[77] German Standard DIN 4150 Part 3, 1984 and Directorate General of Mines Safety, India

the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling and excavation.

- **ASI Protected Heritage Sites**: The proposed Metro alignment runs close to few ASI protected heritage sites. On comparison with international standards, the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling, construction of foundations and excavation.

- **Unprotected Heritage Sites**: The proposed Metro alignment runs close to a number of unprotected heritage sites. On comparing the first stage predictions calculated for these structures with ground vibration threshold values prescribed by international standard[78], St. John's College and Sarojini Naidu Boy's Hostel was found unsafe against ground vibrations induced by tunnelling. Sarojini Naidu Boy's hostel was found unsafe against ground vibrations induced by excavation of proposed Metro station in a similar manner. Temple Gateway, Bagichi was found unsafe against ground vibrations induced by construction of foundations for proposed elevated Metro alignment.

- More rigorous estimates of PPV levels due to tunnelling or other construction equipment would require calibration of the constants (or reference PPV) with measurements made at the sites of interest along Corridor 1 of Agra Metro. Moreover, measurements of current levels of PPV due to existing traffic and human activities at the sites of interest along Corridor 1 of Agra Metro are essential to differentiate vibrations caused due to Metro construction activities and those due to other forms of existing traffic and human activities. Refer structure assessment report Annexure no I for details.

[78] German Standard DIN 4150 Part 3, 1984 and Directorate General of Mines Safety, India

NAME OF THE BUILDING: TAJ MAHAL
STATUS OF THE PROTECTION: WORLD HERITAGE SITE
YEAR OF INSCRPTION: 1983

TABLE 8.2.5.1 VALUE AND ATTRIBUTES OF TAJ MAHAL CONVEYING OUTSTANDING UNIVERSAL VALUE

GRADING	NAME OF THE MONUMENT	STATEMENT OF SIGNIFICANCE	ATTRIBUTES CONVEYING STATEMENT OF SIGNIFICANCE			
			ARCHAEOLOGY	BUILT HERITAGE	HISTORIC LANDSCAPE	INTANGIBLE CULTURAL HERITAGE
VERY HIGH	**Taj Mahal**	*Based on criteria (i)* Taj Mahal represents the finest architectural and artistic achievement through perfect harmony and excellent craftsmanship in a whole range of Indo-Islamic sepulchral architecture. It is a masterpiece of architectural style in conception, treatment and execution and has unique aesthetic qualities in balance, symmetry and harmonious blending of various elements.	*No Under Archaeology expected.*	Plan and design of the mausoleum and associated structures.	Timurid Persian layout of the walled garden (char bagh) is an type of historic landscape entity present at Taj Mahal complex.	Urs of Shah Jahan is held annually on the 25th, 26th and 27th of the Islamic month of Rajab. On the last day of the Urs a saptrangi chadar is offered and sandalwood powder sprinkled over the grave. Large number of devotees gather at the tomb during this time. The mosque is open for Friday prayers when the monument is closed to the public.
				Its setting one end of the charbagh with the river Yamuna flowing to the rear.		
				Bilateral symmetry along a central axis on which the main features are placed.		
				Raised podium on which the tomb rests		
				The four minarets at the corners of the raised platform framing the main tomb.		
				Plan of the tomb with the octagonal tomb chamber in the centre surrounded by the portal halls and the four corner rooms. The exterior of the tomb is square in plan, with chamfered corners. The large double storied domed chamber, which houses the cenotaphs of Mumtaz Mahal and Shah Jahan, is a perfect octagon in plan.		
				The double domes over the central chamber		
				The Timurid Persian layout of the walled garden (char bagh)		
				Enclosure within a walled quadrangle		
				Decorative style and features including the white marble inlaid with precious and semi-precious stones on the cenotaphs and the external walls of the tomb, the floral marble carvings, the carved lattice screen and the calligraphic inscriptions of the mausoleum and associated structures.		
				The materials and substance of the construction including brick in lime mortar with a veneer cladding of white marble and red sandstone.		
				Function as a tomb with an annual Urs carried out to the graves every year.		

TABLE: 8.2.2 PREDICTED IMPACTS DURING CONSTRUCTION PHASE OF METRO WORKS IN WORLD HERITAGE SITE OF			
TYPE OF POTENTIAL IMPACTS	**EXPECTED IMPACTS**	**SCIENTIFIC TESTS PROPOSED**	**MITIGATION MEASURES**
Vibrations from piling, machinery and heavy vehicles	Taj complex is beyond the permissibile limit of affect of vibrartion. Considering the high value of Taj Mahal, few vibrartions needs to be done to understand the possible impact. It has to be done during construction and after construction	No tests are required.	Considering the high signficance of Taj Mahal as World Heritage Site, Mitigation measures as suggested in chapter 9 as precationary measures.
Temporary loss access specially during Urs and Friday prayers	As metro construction works are proposed at the west gate entry of Taj Mahal. This will temporarily effect the visitor experience to the Taj Mahal.	No tests are required.	Mitigation measures have been worked out and will be executed by working agency during execution of works. An action action plan for visitors management especially regarding barricading of access routes regularly to ensure minimum temporary loss to visitor access to Taj mahal complex.
Impact on historic fabric due to metro construction works	Air pollution may lead to depositions on historic material and decorative finish layers of Taj Mahal and monuments within the complex	Monitoring on pollution raised during metro is required to be monitored during construcion of the mtero works including activities of the contruction yard	Mitigation measures have been worked out and will be executed by working agency during execution of works.
Dust and debris	Dust and debris will impact on site surroundings of Taj Mahal during metro construction.	Monitoring on pollution raised during metro is required to be monitored during construcion of the mtero works including activities of the contruction yard	Mitigation measures to control dust pollution during the construction works as suggested in chapter 9 have been worked out.
Noise from construction, operations, stations and associated activities	Noise related issues along the corrdior are one of the major issue specially during the construction works	Scientific tests to have been identified to ensure that noise during construction and operation is within permissible limits	Mitigation measures have been worked out and will be executed by working agency during execution of works.

Soil flow	The boundary of the Taj Mahal complex is much beyond permissible limits of soil settlements impacts	No tests are required.	No mitigation measures required
Water ingress	As per analsysis of the eixtsing provided data, water ingress is not expected	Study of previous underground Hydrological channels in the surrounding of Taj has be done to avoid future water logging problems considering the possibility of presence of active aquifers around river belts.	Mitigation measures have been worked out and will be executed by working agency during execution of works.
Visual barrier created by elevated metro	Underground metroline is proposed in Taj area and thereofore no visual barriers are predicted. Elevated metroline and stations from 3 metro stations would be improved which is at presently blocked due to new construction works.	No tests are required.	No mitigation measures required
Fire risk	In case of fire, it may affect the monuments of the Taj Mahal due to smoke and fumes generated during the fire	No tests are required.	Mitigation measures following Uttar Pradesh fire prevention and fire safety rules, 2005 have been worked out and will be executed by working agency during execution of works.

NAME OF THE BUILDING: TAJ MAHAL
STATUS OF THE PROTECTION: WORLD HERITAGE SITE
YEAR OF INSCRPTION: 1983

8.2.5.2 PREDCITED IMPACTS AT WORLD HERITAGE SITE OF TAJ MAHAL						
SIGNIFICANCE	**ATTRIBUTES- OUV**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**		**RECOMMENDATION**
				During construction	**During operation of Metro**	
ARCHAEOLOGICAL SIGNIFICANCE	**Very High**	No predicted impacts	No change	Neutral	Neutral	No action required
	Plan and design of the mausoleum and associated structures.	No predicted impacts on plan and design of the World Heritage Site as proposed metro line is underground and out of buffer zone of the site	No change	Neutral	Neutral	No action required
	Its **setting** one end of the charbagh with the river Yamuna flowing to the rear.	No impacts on setting of the complex. The only predicted change is outsdie the buffer zone where metro entry and exit points would be planned.	No change	Neutral	Neutral	No action required
	Bilateral symmetry along a central axis on which the main features are placed.	No predicted impacts	No change	Neutral	Neutral	No action required
	Raised podium on which the tomb rests.	No predicted impacts	No change	Neutral	Neutral	No action required
	The **four minarets** at the corners of the raised platform framing the main tomb.	No predicted impacts	No change	Neutral	Neutral	No action required
	Plan of the tomb with the octagonal tomb chamber in the centre surrounded by the portal halls and the four corner rooms. The exterior of the tomb is square in plan, with chamfered corners. The large double storied domed chamber, which houses the cenotaphs of Mumtaz Mahal and Shah Jehan, is a perfect octagon in plan.	No predicted impacts	No change	Neutral	Neutral	No action required
	The double domes over the central chamber	No predicted impacts	No Impacts	Neutral	Neutral	No action required
	The **Timurid Persian layout** of the walled garden (char bagh)	No predicted impacts	No change	Neutral	Neutral	No action required
	Enclosure within a walled quadrangle	The poposed entry and exits strctures would be constructed at a distance of 515 mts which do not affect the seeting of the enclousre much	Slight change	Neutral	Neutral	No action required

8.2.5.2 PREDCITED IMPACTS AT WORLD HERITAGE SITE OF TAJ MAHAL						
SIGNIFICANCE	**ATTRIBUTES- OUV**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**		**RECOMMENDATION**
				During construction	**During operation of Metro**	
BUILT HERITAGE	**Decorative style and features** including the white marble inlaid with precious and semi-precious stones on the cenotaphs and the external walls of the tomb, the floral marble carvings, the carved lattice screen and the calligraphic inscriptions of the mausoleum and associated structures.	During construction- Dust debris during metro construction works would definitly raise the cotaminants in air which would be a threat to material or decorative finish layers. During operation- After the construction, the air quality would improve and affect the monument benefinally	Minor change temporary in nature	Slight adverse	Very Large Beneficial	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.
	The **materials and substance of the construction** including brick in lime mortar with a veneer cladding of white marble and red sandstone.	**During construction**- Dust debris during metro construction works would definitly raise the cotaminants in air which would be a threat to material or decorative finish layers. **During operation**- After the construction, the air quality is expected to improve and affect the monument benefinally	Moderate change	Slight adverse	Very Large Beneficial	Mitigation measures have been worked out and will be executed by working agency during execution of works including use of modern equipments, prefab constrcuction methods, dust mitigation etc.
	Function as a tomb with an annual Urs carried out to the graves every year.	**During construction**- Construction activities may hurdle the visitor's movement during the construction period. **During operation period**- Proposed metro would surely benefit the visitors during Urs and also reduce the vehicular movement.	No change	Neutral	Very Large Beneficial	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.

8.2.5.2 PREDCITED IMPACTS AT WORLD HERITAGE SITE OF TAJ MAHAL						
SIGNIFICANCE	**ATTRIBUTES- OUV**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**		**RECOMMENDATION**
				During construction	**During operation of Metro**	
HISTORIC LANDSCAPE	**Timurid Persian layout** of the walled garden (char bagh) is an type of historic landscape entity present at Taj Mahal complex.	No predicted impacts	No change	Neutral	Neutral	No action required
INTANGIBLE CULTURAL HERITAGE	**Urs of Shah Jahan** is held annually on the 25th, 26th and 27th of the Islamic month of Rajab. On the last day of the Urs a saptrangi chadar is offerred and sandalwood powder sprinkled over the grave. Large number of devotees gather at the tomb during this time. The mosque is open for Friday prayers when the monument is closed to the public.	**During construction-** Construction activities may hurdle the visitor's movement during the construction period. **During Operation-** Metro construction would have a positive impact on cultural activities as it would help in minimizing the traffic in the area	Negligible change	Slight adverse	Very Large Beneficial	Mitigation measures would be required including traffic management.

NAME OF THE BUILDING: AGRA FORT
STATUS OF THE PROTECTION: WORLD HERITAGE SITE
YEAR OF INSCRPTION: 1983

Table 8.2.5.3 VALUE AND ATTRIBUTES OF AGRA FORT AS PER OUV

GRADING	NAME OF THE HERITAGE RESOURCE	STATEMENT OF SIGNIFICANCE	ATTRIBUTES CONVEYING STATEMENT OF SIGNIFICANCE			
			ARCHAEOLOGY	BUILT HERITAGE	HISTORIC LANDSCAPE	INTANGIBLE CULTURAL HERITAGE
VERY HIGH	**Agra Fort**	**Criterion (iii):** to bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared; All these monuments mark an apogee of an Indo Muslim art strongly marked by influences from Persia which already manifested itself in Timurid art. (Source: ICOMOS Advisory Body Evaluation, 1983)	Underground archaeology is expected at south of Amar Singh Gate, at Akbari Mahal, Jehangiri Mahal and the temple across the road as per archival studies.	Setting of the Fort along the banks of the river Yamuna and its visual link with the Taj Mahal The Mughal building traditions and techniques combining Indian, Persian, Central Asia and European elements The materials and substance of the construction including brick in lime mortar with a veneer cladding of white marble and red sandstone	Designed on the bank on River. Anguri Bagh. Gardens at Macchi Bhavan.	Associated continued use of traditional knowledge of marble carving techniques.

NAME OF THE BUILDING: AGRA FORT
STATUS OF THE PROTECTION: WORLD HERITAGE SITE
YEAR OF INSCRPTION: 1983

TABLE :8.2.5 PREDICTED IMPACTS DURING CONSTRUCTION PHASE OF METRO WORKS IN WORLD HERITAGE SITE OF RED FORT

TYPE OF POTENTIAL IMPACT	EXPECTED IMPACTS ON HERITAGE RESOURCE	SCIENTIFIC TESTS REQUIRED	MITIGATION MEASURES
Vibrations from piling, machinery and heavy vehicles	Fortification wall and Amar Singh Gate on the west side is at 121 mrts away from tunnel and metro station.Vibrations may be impact existing condition of structure specially the fortification running along the proposed metro line.	Vibration tests should be carried as mitigation measure before commencement of metro construction works and during operation works	Requires mitigation measures as per results of vibrartion tests
Temporary loss of access	As metro construction works are proposed near visitor plaza of Agra Fort.Barricading and other associated activities will place. This will temporarily effect the visitor experience to the Agra Fort.		Requires mitigation measures. Visitors access management plan is required during the construction period
Impact on historic fabric due to metro construction works	Air pollution may lead to depositions on historic material and decorative finish layers of Agra Fort and monuments within the complex.	Monitoring on pollution raised during metro is required to be monitored during construcion of the mtero works including activities of the contruction yard	Requires mitigation measures to control dust pollution during the construction works as suggested in chapter 9
Dust and debris	Dust and debris will impact on site surroundings of Agra Fort during metro construction.		Requires mitigation measures to control dust pollution during the construction works as suggested in chapter 9
Noise from construction, operations, stations and associated activities	Continous noise will effect the visitors experience at Agra Fort and locals in the surroundings of Agra Fort.		Requires mitigation measures to control dust pollution during the construction works as suggested in chapter 9
Soil flow	This may impact the Fortification wall of Agra Fort and Amar Singh Gate	Vibration tests should be carried as mitigation measure before commencement of metro construction works and during operation works	Requires mitigation measures as per results of vibrartion tests

Water ingress	As per analsysis of the eixtsing provided data, water ingress is not expected in Agra Fort.	Study of underground Hydrological channels in the surrounding of Agra Fort be done to avoid issues	Requires mitigation measures following the analsis of the aquifers if present in the area
Visual barrier created by elevated metro	Underground metroline is proposed in Taj and Red Fort area and thereofore no visual barriers are predicted	Refer visual study in annexure	
Fire risk	In case of fire, it may affect the monuments of the Taj Mahal due to smoke and fumes generated during the fire		Requires mitigation measures following UTTAR PRADESH FIRE PREVENTION & FIRE SAFETY RULES, 2005

TABLE 8.2.5.4 PREDICTED IMPACTS AT WORLD HERITAGE SITE OF AGRA FORT						
SIGNIFICANCE	**ATTRIBUTES**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**		**RECOMMENDATION**
				During Construction	**During operation**	
BUILT HERITAGE (Derived from existing available descriptions from different sources from https://whc.unesco.org/en/list/251/documents/	Setting of the Fort along the banks of the river Yamuna and its visual link with the Taj Mahal	**During construction-** Construction activities may hurdle the visitor's movement during the construction period. **During operation-**As proposed metro line is underground there will no major change to setting ofAgra Fort . Metro entry and exit point would be elevated over ground and would have minimal impact on the setting of the fort	Negligible change	Slight adverse	Slight adverse	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.
	The Mughal building traditions and techniques combining Indian, Persian, Central Asia and European elements.	No predicted impact	No change	Neutral	Neutral	
	The materials and substance of the construction including brick in lime mortar with a veneer cladding of white marble and red sandstone	**During construction** -Air pollution would lead to depositions on historic material and decorative finish layers of Agra Fort and monuments within the complex. Vibrations may be impact existing condition of structure. **During operation period-** After the construction, the air quality is expected to improve and affect the monument benefinally	Moderate change	Slight adverse	Very Large Beneficial	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.
OTHER ATTRIBUTES						
HISTORIC LANDSCAPE	Designed on the bank on River. Anguri Bagh. Gardens at Macchi Bhavan.	Proposed metro line is underground in the area and passes through west side of the fort. There would be no impact on relationship of fort and the river.	No change	Neutral	Neutral	

TABLE 8.2.5.4 PREDICTED IMPACTS AT WORLD HERITAGE SITE OF AGRA FORT						
SIGNIFICANCE	**ATTRIBUTES**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**		**RECOMMENDATION**
				During Construction	**During operation**	
INTANGIBLE CULTURAL HERITAGE	Associated continued use of traditional knowledge of marble carving techniques.	No predicted impact	No change	Neutral	Neutral	
ARCHAEOLOGICAL SIGNIFICANCE	Underground archaeology expected in south of Amar Singh Gate	Historic archaelogic remains of ancient Badalgarh Fort may get distrubed during execution of the project.	Minor change	Slight adverse	Neutral	
	Akbari Mahal	It is located at a distance of 217 mrts from metro station and 221 from metro tuunel. No predicted impact due to vibration and soil settlement.	No change	Neutral	Neutral	
	Jehangiri Mahal	It is located at a distance of 269 mrts from Agra Fort metro station and 274 from metro tuunel. No predicted impact due to vibration and soil settlement.	No change	Neutral	Neutral	

NAME OF THE BUILDING: AKBAR'S TOMB
STATUS OF THE PROTECTION: ASI PROTECTED MONUMENT
YEAR OF INSCRPTION: 1920

<table>
<tr><th colspan="8">TABLE: 8.2.5.5 AKBAR'S TOMB SIGNIFICANCE ASSESSMENT</th></tr>
<tr><th>GRADING</th><th>NAME OF THE MONUMENT</th><th>STATEMENT OF SIGNIFICANCE</th><th colspan="5">ATTRIBUTES CONVEYING STATEMENT OF SIGNIFICANCE</th></tr>
<tr><th></th><th></th><th></th><th>ARCHAEOLOGY</th><th colspan="2">BUILT HERITAGE</th><th>HISTORIC LANDSCAPE</th><th>INTANGIBLE CULTURAL HERITAGE</th></tr>
<tr><td rowspan="5">HIGH</td><td rowspan="3">Akbar's tomb</td><td rowspan="3">The tomb of Emperor Akbar, the greatest of the Mughal emperors under whose reign the empire was consolidated and expanded, was the first major building constructed by Emperor Jahangir. It combines the Timurid inspired vaulted masonry with the indigenous trebeate sandstone mode and demonstrates the close relationship between residential and sepulchral architecture. It features the first hierarchical use of white marble for the topmost open storey of the mausoleum and the minarets topping the southern gateway; the first use of multiple minarets in Mughal architecture.
The highly decorated surfaces using rich stone intarsia, finely carved marble and polychrome stucco work seen here become typical of the architecture of this period. The garden setting of the tomb follows the format set by Akbar’s predecessor, Humayun.</td><td rowspan="3">Archaeology expected.</td><td colspan="2">Setting of the tomb within a char bagh</td><td rowspan="3">Timurid Persian layout of the walled garden (char bagh) is an type of historic landscape entity present at Skiandara complex.</td><td rowspan="3"></td></tr>
<tr><td colspan="2">The form and design of the tomb including its richly decorated surfaces using stone intarsia, polychrome stucco, finely carved marble; multiple minarets; calligraphy</td></tr>
<tr><td colspan="2">Function as a tomb with the sepulchre of Akbar</td></tr>
<tr><td>Lodhi Tomb</td><td></td><td></td><td colspan="2">Form and design of the tomb
Historic materials and constructions systems</td><td></td><td></td></tr>
<tr><td>Kanch Mahal</td><td></td><td></td><td colspan="2">Form and design of the tomb
Historic materials and constructions systems</td><td></td><td></td></tr>
</table>

NAME OF THE BUILDING: AKBAR'S TOMB
STATUS OF THE PROTECTION: ASI PROTECTED MONUMENT
YEAR OF INSCRIPTION: 1920

TABLE 8.2.5.6 AN ANALYSIS OF IMPACTS- AKBAR'S TOMB

SIGNIFICANCE	ATTRIBUTES	PREICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGNIFICANCE OF IMPACT	RECOMMENDATION
ARCHAEOLOGICAL SIGNIFICANCE			No change	Neutral	No Mitigation measure required
	The form and design of the tomb including its richly decorated surfaces using stone intarsia, polychrome stucco, finely carved marble: multiple minaret ; calligraphy	1. Vibrations from machinery-Threats to significance would be high during the construction phase due to expected vibrations and sounds. 2. Once the construction is over, the main concern would be to monitor any impacts from metro noise and vibration when metro operations start. 3. Risk to fabric- Air pollution during metro construction would cause surface deposits over stone surface	No change	Neutral	No Mitigation measure required
	Functions as a tomb with the sepulchre of Akbar	No predicted impacts	No change	Neutral	No Mitigation measure required
HISTORIC LANDSCAPE	Timurid Persian layout of the walled garden (char bagh) is a type of historic landscape entity present at Sikandara complex	No predicted impacts	No change	Neutral	No Mitigation measure required
INTANGIBLE CULTURAL HERITAGE		Metro construction would have a positive impact on cultural activities as it would help in minimizing the traffice in the area	Moderate change	Very large Beneficial	Detail of Urs festival rites and rituals studied. Impact is more beneficial

NAME OF THE BUILDING: KANCH MAHAL
STATUS OF THE PROTECTION: ASI PROTECTED MONUMENT
YEAR OF INSCRPTION: 1920

TABLE:8.2.5.6 AN ANALYSIS OF IMPACTS- KANCH MAHAL					
SIGNIFICANCE	**ATTRIBUTES**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**	**RECOMMENDATION**
BUILT HERITAGE	The form and design of the mahal	No change	No change	Neutral	No Mitigation measure required
	Historic materials and constructions systems	1. Vibrations from machinary- Threats to significance would be high during the construction phase due to expected vibrartions and sounds. 2. Once the construction is over, the main concren would be to monitot any impacts from metro noise and vibration when metro operations starts. 3. Risk to fabric- Air pollution during metro construction would cause surface deposits over stone surface	No change	Neutral	No Mitigation measure required

NAME OF THE BUILDING: LODHI TOMB
STATUS OF THE PROTECTION: ASI PROTECTED MONUMENT
YEAR OF INSCRPTION: 1920

TABLE 8.2.5.7 AN ANALYSIS OF IMPACTS- LODHI TOMB					
SIGNIFICANCE	**ATTRIBUTES**	**PREDICTED IMPACTS**	**SCALE OF SEVERITY OF IMPACT**	**SIGIFICANCE OF IMPACT**	**RECOMMENDATION**
BUILT HERITAGE	The form and design of the tomb	No change	No change	Neutral	No Mitigation Measure required
	Historic materials and constructions systems	1. Vibrations from machinary- Threats to significance would be high during the construction phase due to expected vibrartions and sounds. 2. Once the construction is over, the main concren would be to monitot any impacts from metro noise and vibration when metro operations starts. 3. Risk to fabric- Air pollution during metro construction would cause surface deposits over stone surface	Moderate change	Slight adverse	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.

NAME OF THE BUILDING: JAMA MASJID
STATUS OF THE PROTECTION: ARCAHEOLOGICAL SURVEY OF INDIA
YEAR OF INSCRPTION: 1920

Table 8.2.5.8 JAMA MASJID SIGNIFICANCE ASSESSMENT

GRADING	NAME OF THE HERIATGE RESOURCE	STATEMENT Of SIGNIFICANCE	ATTRIBUTES CONVEYING STATEMENT OF SIGNIFICANCE			
			ARCHAEOLOGY	BUILT HERITAGE	HISTORIC LANDSCAPE	INTANGIBLE CULTURAL HERITAGE
HIGH	**JAMA MASJID**	17th Century mosque was built by Shahjahan's daughter is the largest mosque of Agra city till date. Inspired by persian design prinicples and Indian architecture, building still dominates the cityscape with onion shaped dome decorated with white marble inlay in zig zag pattern over red stone cladding. The square shape mosque raised over a platform ,with covered iwan on two sides topped with rows of small chatires, three arched entrances has inspired the design of Jama Masjid Delhi constructed few years later by Shahjahan.	***Underground archaeology*** is expected around the mosque- ***octogonal courtyard, bazaars, city wall, arches and brigde***s as shown in archival images	**Form and design**- Plan features a large square courtyard enclosed by three narrow arcades and a prayer hall all built on an elevated platform dominating the cityscape. Three axial gates punctuate the three arcade wings. The prayer hall is topped by three domes and flanked by two tall, domed minarets • The side wings are divided into double aisles of three bays each following the standard pattern on imperial Mughal congregational mosques. **Material attributes**- The combination of red sandstone and marble as building materials favoured by the Mughals is seen here. • A characteristic of the profusely embellished architecture patronized by Shah Jahan is the marble inlaid with stone seen here in the zig zag pattern of the dome and the Persian inscriptions in black framing. • The minbar, or pulpit, only found in Jami mosques, is carved with an illustration of this mosque's east façade, a unique featureIn terms of function, it continues to be used as a congregational mosque	_	Traditionally Friday namaz is offered in Jama Mazid since last 3 centuries. During festival of Eid activities in the area increase manifold. Traditional shops provides items for offering in the mosque. Local people from every corner of the Agra visit Jama Masjid for prayers and festivals.

NAME OF THE BUILDING: JAMA MASJID
STATUS OF THE PROTECTION: ARCHAEOLOGICAL SURVEY OF INDIA
YEAR OS INSCRPTION: 1920

TABLE 8.2.5.9 AN ANALYSIS OF IMPACTS- JAMA MASJID

SIGNIFICANCE	ATTRIBUTE	EXPECTED IMPACT	SCALE OF SEVERITY	SIGNIFICNACE OF IMPACT	FURTHER STUDIES SUGGESTED
BUILT HERITAGE	***From and design*** - Plan features a large square courtyard enclosed by three narrow arcades and a prayer hall all built on an elevated platform dominating the cityscape. Three axial gates punctuate the three arcade wings. The prayer hall is topped by three domes and flanked by two tall, domed minarets • The side wings are divided into double aisles of three bays each following the standard pattern on imperial Mughal congregational mosques	Vibrations are not expected	No Change	Neutral	Metro line is 106 m away(proposed Metro chainage to Jama Masjid protected boundary) therefore vibration testing would be required to evlauate the impact to vibration. Vibration study would be required for during construction period as well as post construction period to evaluate the impact of prolonged impact.
	Material attributes -• The combination of red sandstone and marble as building materials favoured by the Mughals is seen here. • A characteristic of the profusely embellished architecture patronized by Shah Jahan is the marble inlaid with stone seen here in the zig zag pattern of the dome and the Persian inscriptions in black framing. • The minbar, or pulpit, only found in Jami mosques, is carved with an illustration of this mosque's east façade, a unique feature in terms of function, it continues to be used as a congregational mosque	Vibrations are not expected	No Change	Neutral	

SIGNIFICANCE	ATTRIBUTE	EXPECTED IMPACT	SCALE OF SEVERITY	SIGNIFICNACE OF IMPACT	FURTHER STUDIES SUGGESTED
INTANGIBLE CULTURAL HERITAGE	Popular place for daily, Friday and festive religious activities	Proposed Metro Jama Masjid 327 m away from the Jama Masjid is expected to reduce the traffic in the area. It would also provide easy accesibility to the mosque from diffferent part of the city for daily rituals	Moderate change	Moderate beneficial	Beneficial change
	Visual landmark - Masjid dominates the existing market area	As Metro in this stretch in underground so no change is expected on the ground	No Change	Neutral	No tests are required

NAME OF THE BUILDING: GURU KA TAAL
STATUS OF THE PROTECTION: ARCHAEOLOGICAL SURVEY OF INDIA
YEAR OF INSCRPTION: 1920

TABLE: 8.2.5.10 AN ANALYSIS OF IMPACTS - GURU KA TAAL

SIGNIFICANCE	ATTRIBUTES TO SIGNIFICANCE	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	RECOMMENDATION
BUILT HERITAGE	Form and design of the tank	No Change	No change	Neutral	No mitigation measure required.
	Historic lakhori brick fabric- Remains of the original retaining wall, steps	Vibrations and sounds are expected during and after the construction.	Minor Change	Slight adverse	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. Vibration testing would be required to evlauate the impact to vibration. Vibration study would be required for during construction period as well as post construction period toevaluate the impact of prolonged impact. Trial pit excavation to understand the foundation typology will be undertaken before metro works
	Decorative style- Existing chatries	Vibrations and sounds are expected during and after the construction.	Minor Change	Slight adverse	

NAME OF THE BUILDING: PATHAR KA GHODA AND ITIBARI'S KHAN MOSQUE
STATUS OF THE PROTECTION: ARCHAEOLOGICAL SURVEY OF INDIA
YEAR OF INSCRPTION: 1920

TABLE: 8.2.5.11 AN ANALYSIS OF IMPACTS - PATHAR KA GHODA COMPLEX AND MOSQUE OF ITIBARI KHAN'S MOSQUE

SIGNIFICANCE	ATTRIBUTES TO SIGNIFICANCE	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	RECOMMENDATIONS
BUILT HERITAGE	Red sand stone statue of a horse	1. **Vibrations from machinary**- Threats to significance would be high during the construction phase due to expected vibrartions and sounds. 2. Once the construction is over, the main concren would be to monitot any impacts from metro noise and vibration when metro operations starts. 3. **Risk to fabric**- Air pollution during metro construction would cause surface deposits over stone surface	No Change	Neutral	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. Vibration testing would be required to evlauate the impact to vibration. Vibration study would be required for during construction period as well as post construction period toevaluate the impact of prolonged impact. Trial pit excavation to understand the foundation typology will be undertaken before metro works Appropriate landscape proposal would be prepared for along with proposed elevated Guru Ka Taal metro station design which is 58.5 m away integrating the neglected monument within. This would encourage commuters to visit these monuments.
	Historic stone masonry and structural elements		Minor Change	Slight adverse	
	Decorative style and features including stucco muqarna ceiling works, calligraphy works over plastered surface and wall paintings		Minor Change	Slight adverse	
	Original Persian inscription		Minor Change	Slight adverse	

NAME OF THE BUILDING: TOMB OF SALABAT KHAN
STATUS OF THE PROTECTION: ARCHAEOLOGICAL SURVEY OF INDIA
YEAR OF INSCRPTION: 1920

TABLE: 8.2.5.12 AN ANALYSIS OF IMPACTS - TOMB OF SALABAT KHAN

SIGNIFICANCE	ATTRIBUTES TO SIGNIFICANCE	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	RECOMMENDATION
BUILT HERITAGE	Design and form of the building- Columned structure, raised platform	1. **Vibrations from machinary**- Threats to significance would be high during the construction phase due to expected vibrartions and sounds. 2. Once the construction is over, the main concren would be to monitot any impacts from metro noise and vibration when metro operations starts. 3. **Risk to fabric**- Air pollution during metro construction would cause surface deposits over stone surface	No change	Neutral	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project. Vibration testing would be required to evlauate the impact to vibration. Vibration study would be required for during construction period as well as post construction period to evaluate the impact of prolonged impact. Trial pit excavation to understand the foundation typology will be undertaken before metro works
	Historic fabric- Stone surfaces, arches, domes and ceiling		Negligible change	Slight adverse	
	Decorative style and features of the building- Stone carving, ceiling paintings		Negligible change	Slight adverse	

NAME OF THE BUILDING: TOMB OF SADIQ KHAN
STATUS OF THE PROTECTION: ARCHAEOLOGICAL SURVEY OF INDIA
YEAR OF INSCRPTION: 1920

<table>
<tr><th colspan="6">TABLE: 8.2.5.13 AN ANALYSIS OF IMPACTS - TOMB OF SADIQ KHAN</th></tr>
<tr><th>SIGNIFICANCE</th><th>ATTRIBUTES TO SIGNIFICANCE</th><th>PREDICTED IMPACTS</th><th>SCALE OF SEVERITY OF IMPACT</th><th>SIGIFICANCE OF IMPACT</th><th>RECOMMENDATION</th></tr>
<tr><td rowspan="4">BUILT HERITAGE</td><td>Forms and design of the monument- octagonal shape</td><td></td><td>No change</td><td>Neutral</td><td rowspan="4">Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.

Vibration testing would be required to evlauate the impact to vibration. Vibration study would be required for during construction period as well as post construction period toevaluate the impact of prolonged impact.

Trial pit excavation to understand the foundation typology will be undertaken before metro works</td></tr>
<tr><td>Historic masonry works</td><td rowspan="2">1. Vibrations from machinary- Threats to significance would be high during the construction phase due to expected vibrartions and sounds.
2. Once the construction is over, the main concren would be to monitot any impacts from metro noise and vibration when metro operations starts. 3. Risk to fabric- Air pollution during metro construction would cause surface deposits over stone surface</td><td>Negligible change</td><td>Slight adverse</td></tr>
<tr><td>Decorative style and features of the building</td><td>Negligible change</td><td>Slight adverse</td></tr>
<tr><td>Visibility to passerby as a landmark</td><td>No Change</td><td>No Change</td><td>Neutral</td></tr>
</table>

9. MITIGATION OF NEGATIVE IMPACTS ON HERITAGE RESOURCES

9.1 ASSESSMENT OF THE "NO DEVELOPMENT" OPTION

Historic city of Agra which is still a living city and evolved throughout the years. Agra city is one of the popular tourist destinations for national and international tourists. According to the 2011 census Agra district has a population of 4,418,797. This gives it a ranking of 41st in India (out of a total of 640)[79]. The existing city demands modernized transport infrastructure to deal with growing population and subsequent traffic.

Before discussing possible approaches to mitigating the impacts that may arise from the project, it is necessary in the impact assessment process to evaluate the option of "no development". Development in such close proximity to local, national and World Heritage Sites can be justified only if it delivers substantial public benefits that outweigh any harm it may cause to the values of that heritage. The primary objective of the Agra Metro project is to address problems of traffic congestion, developing transport infrastructure to facilitate the large number of tourist (10 million annual)[80,] to resolve public transport issues, to provide safe, efficient, -comfortable, and affordable transport to the public and to cater for future transport demand for tourist as well as for the local community.

As per article by Greenpeace, Uttar Pradesh, the densely populated State of India bordering Delhi, is also witnessing hazardous air pollution levels and constantly witnessing high PM 2.5 concentration. According to the Central Pollution Control Board data, the air quality in these cities (which includes Agra) has reached way beyond “severe” category[81] Considering the continuous hike in air pollution where vehicular traffic contributes approximately 19% -39 % of the air pollution (Delhi Case), [82] considering these figures there is an essential need to MRTS in Agra, Uttar Pradesh in order to reduce the consumptions of pollution causing fuels like petrol and diesel.

Rail-based ‘Mass Rapid Transit System’ has been widely accepted as a solution for most of the traffic and environmental pollution related problems which major cities throughout the world are facing now. Predicted long-term benefits of the Agra Metro Corridor 1 are very significant and are very essential to improve the transport infrastructure and air quality in the Agra city. Considering the long-term positive impacts of the proposed project in sensitive zone of Taj Trapezium Zone (TTZ), assessment of the exiting heritage resources, the current status of some of the monuments and projections for their future in terms of conservation and interpretation of their significance to the public is poor and above all, the most of the negative potential impacts identified can be mitigated , HIA concludes that there is no need to pursue the option of “ no development” and that specific mitigation measures should be identified and recommended to address the various potential negative impacts which have been identified in this HIA.

Introduction to Mitigation

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[79] District Census 2011". Census2011.co.in. 2011. Retrieved 30 September 2011

[80]http://www.uptourism.gov.in/site/writereaddata/siteContent/201904301103477451Monument-small-chart-2014-to-2018.pdf

[81] Greenpeace India demands Regional Action Plan to control air pollution in Uttar Pradesh, https://www.greenpeace.org/india/en/press/509/greenpeace-india-demands-regional-action-plan-to-control-air-pollution-in-uttar-pradesh/

[82] Transportation is the largest source of air pollution in Delhi, contributing 18-39% to the city’s pollution, according to an April 2019 analysis by the Council on Energy, Environment and Water (CEEW), a Delhi-based think-tank.

Mitigation is defined by the European Union Directive 2011/92/EU (the current version of the 1985 E1A Directive) as "measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects. The first aim of mitigation should be to avoid all adverse impacts; where this is not possible the aim must be to minimize adverse impacts that cannot be avoided. The final resort is to compensate in some way for impacts which cannot be avoided or minimized."

The proposed Metro project has adopted an approach to avoid all predicted impacts by reasonable changes to project planning and/or design and impact reduction (to reduce impacts to acceptable levels as reasonably possible). Many alterations are design already have been adopted during the project planning phase. Many impacts which are identified during the assessment would be during project implementing phase. World heritage sites, protected monuments and unprotected heritage resources are studied scientifically to assess the effect of vibrations during constructions and operational period. However, as with any project of this scale and nature, there are certain impacts that cannot be entirely eliminated, i.e. certain impacts which still remain even after implementing mitigation measures.

Key impacts during construction and operational periods are identified for each of the heritage which are considered here to identify an appropriate mitigation measure to reduce the predicted negative impacts to accepted levels, at a generic level applicable to all heritage resources located along the proposed Metro corridor I.

9.2 MITIGATION AND MONITORING PLAN

The negative impacts on all heritage resources on proposed Metro Corridor I which are expected during construction phase and operational period of Metro. There is a need to develop and implement a mitigation plan assessing all possible impacts together and working out a mitigation measures for the construction period as well as for operational period. The most effective way to handle complex mitigation measures for the Proposed Metro Corridor I will be preparation of Mitigation Plan which will include the required identification of mitigation measures in consultation with experts and ASI, schedule of implementation, regular monitoring the condition of the heritage resources and working out required support and repair strategy following the specifications suited for conservation of heritage resources. Mitigation requirements should be integrated with the agreement of the contractors executing the project.

9.2.1 Mitigation during the Construction Phase

The following are the mitigation measures which will be implemented during the construction phase in order to address each impact assessed in the HIA as requiring mitigation. They form the basis of a Mitigation Plan for the project.

Potential Impact of ground-borne vibration damage

Noise and vibration-related issues along the corridor are one of the major issues which may be significant during both the construction as well as the operational phase of the project. During the construction phase, the use of heavy machinery and construction equipment may cause vibrations and also increase the ambient noise levels. Vibrations generated during the construction phase may have several adverse impacts, including cracks developed on the surrounding buildings which can have serious implications on the structural safety. During the operation of the Metro rail, rail–wheel contacts with tracks generate noise and vibration.

Engine, cooling fans and generators further increase ambient noise and vibration levels inside the coaches and also outside the Metro rail corridor[83.]

To mitigate the risk of ground-borne vibration damage to sensitive historical fabric the following measures will be taken:

- Documentation of baseline condition of heritage buildings for monitoring comparison is required. It needs to be done before, during and after implementations of the project.

- Avoiding heavy vehicular movement nearby the monuments during the implementation of the project to reduce the vibration intensity.

- Keeping vibration limits below permissible limes or appropriate agreed level to reduce vibration impacts to an acceptable level. It would require regular monitoring of the vibrations during the construction phase.

- It would be advisable to use of non-displacement piles that are inserted in bored holes rather than impact driven.

- Adopting learnings from Delhi Metro who has used modern equipment to minimize the effects of noise and vibration during operational period.[84] It would be advisable to use similar equipment during construction period to minimize of effects of vibrations.

It would be important to install monitoring equipment such as tell-tales or digital monitoring machines on monuments along the Metro corridor 1 to assess the crack measurements and movements on regular basis on monuments as mentioned in Table 9.1. Regular monitoring of the devices will warn of any change in the condition of the building's fabric due to vibrations. With advanced notice of adjacent construction activity, a crack monitor can be used to determine whether existing cracks in the historic building are stable or still experiencing movement. Compared with measurements taken during the monitoring phase, such information can help determine if subsequent movement resulted from work on the construction site.

The first stage predictions of ground vibrations depict that most of the monuments are safe for vibrations except few unprotected heritage sites. Considering the high values, it is advisable to use monitoring measures on World Heritage Sites of Taj Mahal and Red Fort and protected monuments of Sikandara to provide the extra protection in near future against unpredicted vibrations effects.

TABLE 9.1 PROPOSED MITIGATION MEASURES FROM VIBRATION AND STRUCTURE MONITORING

Name of the monument	**Value**	**Proposed mitigation measures for vibration and structure monitoring**
World Heritage Sites of Red Fort and Taj Mahal	Very High	Establishing ***vibration and structural monitoring stations*** at WHS: • Establishing vibration monitoring equipment in different locations at Taj Mahal complex

[83] Critical issues related to Metro Rail Projects in India, Sharma Niraj, Rajni Dhayani, S. Gangopadhaya, Journal of Infrastructure Development 5 (1) 67-86, 2013
[84] Critical issues related to Metro Rail Projects in India, Sharma Niraj, Rajni Dhayani, S. Gangopadhaya, Journal of Infrastructure Development 5 (1) 67-86, 2013

		for regular monitoring and analysis. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards. • Structural monitoring devices such as tale-tele and digital monitoring systems should be installed in different specified locations. • The collected data need to be evaluated regularly for the conservation professionals • In case of any effect, it should bring to the notice of ASI and LMRC for working out appropriate mitigation measures to minimize the affects
Lodhi Tomb, Kanch Mahal	High	• Establishing vibration and structural monitoring equipment in Lodhi tomb • Establishing structural monitoring system in Kanch Mahal as structural cracks were observed during the condition survey. • Structural monitoring devices such as tale-tele and digital monitoring systems should be installed in different specified locations as suggested by conservation professionals. • The collected data need to be evaluated regularly for the conservation professionals. • In case of any effect, it should bring to the notice of ASI and LMRC for working out appropriate mitigation measures to minimize the effects.
Pathar ka Ghoda Itibari Khan's mosque, Salabat Khan's tomb, Sadiq Khan's tomb	High	• Structural and vibration monitoring during construction works as precautionary measures

Potential physical damage to historic fabric

When historic structures are exposed to adjacent construction or demolition work, a protective plan including documentation, monitoring and specific safeguards should be implemented to prevent damage and loss of historic fabric.[85]

All the heritage resources studied along the Metro corridor 1 are found structurally stable. The risk of accidental damage to historic fabric as a result of the use of machinery, excavations, plant or vehicles during nearby construction activities will be mitigated by the following:

1. Photo documentation of each monument and unprotected heritage before implementation starts. The need and guidelines for documentation for World Heritage Sites has been provided in (2010). *Managing Disaster Risks for World Heritage Sites* published under the World Heritage Resource Manual Series.

[85] Protecting a Historic Structure during Adjacent Construction , Chad Randl Technical Preservation Services National Park Service, https://www.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Protection03.pdf

2. Documentation of baseline condition of heritage buildings for monitoring comparison. It has to be done mainly for masonry, structural members such as arches, vaults, domes and decorative features.

3. Condition mapping needs to be carried out keeping in mind the attributes contributing to significance of the heritage resource.

4. Contract clauses needs to be included regarding special protection needs of heritage properties along the Metro corridor-I

5. Temporary protection measures to reduce the potential for damage to the heritage item during construction in the immediate area:

   - Barriers and warning signage around the building
   - Protective netting over exposed facades
   - Plastic sheeting or cushioning materials over delicate building features
   - Plywood sheets or horizontal netting placed over the roof and over decorative roof embellishments

Soil movement and resulting structural damage

Soil flow risk will be monitored while open pit works proceed; where movement is considered a risk near historical buildings the following will be implemented:

- Shoring and bracing systems
- Use of secant piling during deep cut and cover excavations
- Monitoring of potential settlement and displacement which may lead to structural damage
- Use of tell-tales on structural cracks identified by the condition assessment

Restricted access for users of heritage properties

Access to world Heritage Sites, protected monuments and unprotected heritage need to be planned in such a way that do not disturb the public access. Safety measures also need to be considered as one of the priorities for mitigation plan for the tourists as well as for the local community. Debris and waste management also need to be planned efficiently which do not affect the daily activities.

Mitigation for Dust and debris on and in historic buildings

Dust pollution is the major predicted impact on World Heritage sites and protected monuments. Therefore, dust and debris control measures adopted during the project execution is very essential. The major construction material to be used for construction of the proposed corridor are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labourer at both the locations by the contractor. Measures will be taken to mitigate raised levels of dust deposit on and infiltration into historic properties especially for the case of World Heritage Sites of Taj Mahal and Agra Fort:

- The duties of the contractor would include monitoring all aspects of construction activities generating dust and waste, commencing with the storing, loading of construction materials and equipment in order to minimize the dust and waste. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste.
- Barricading the construction site up to required height to avoid dust spreading in the immediate surroundings.
- Regular watering and spray of dust producing surfaces and materials close to historic properties in order to suppress the dust deposition

Fire risk mitigation plan

Fire poses the greatest risk of sudden catastrophic loss during construction activities in or near historic buildings. Mitigation of the risk includes:

- Adopting and following The U.P. Fire Prevention and Fire Safety Rules, 2005
- Safety equipments and procedures as part of the overall safety policy of the project
- Preparation of a fire-protection strategy plan is necessary for both the construction and operation phases. Detailed guidelines are provided for preparation of the strategy plan is provided in Stovel, H. (1998), *Risk Preparedeness: A Management Manual for World Cultural Heritage.* Rome: ICCROM
- Special care when using portable heating equipment; cutting, welding and use of torches
- Control of wood firing, matches and smoking on the construction yards around the heritage resources
- Full adherence by contractor operations on the site to the project specifications is needed to reduce, or eliminate, these and all causes of fire
- Contractor should provide eco-friendly cooking facilities at labour camps to avoid fire and smoke
- A fire protection officer should be designated who should also be responsible for security, health and general safety during the construction and operation phases, he would also be responsible for overseeing the fire protection strategy plan

Mitigation for increased noise levels

Construction noise control measures have been incorporated into the construction method design. Noise levels will be monitored and mitigation implemented where needed, including:

- Use of temporary noise barriers, shields and loaded vinyl curtains
- Selection of locations for noisy equipment away from sensitive receivers
- Sequencing of noisy activities in groups to minimize impact
- Selection of quietest piling methods (reverse rotary and/or dry augur)
- Use of specially quieted equipment and muffle engines

Mitigation for water ingress into heritage properties

Proximity to river Yamuna and possibility of presence underground aquifers may create water logging or capillary water rise in few monuments. Therefore, it is required to adopt following mitigation measures:

- Regular visual inspections as part of the monitoring program to identify increased moisture levels

- Construction site runoff from cement mixing and cleaning and dust suppression activities will not flow toward the historic property.
- Screens and wire cages will be placed over exposed areas of the drainage system to provide some protection from obstructions.

9.2.2 Mitigation plan for special cases

There are two World Heritage Sites, 15 protected monuments and 18 unprotected monuments which are analysed to assess the need for application of these generic mitigation measures during construction phase.

The following mitigation would be required for particular heritage buildings along the corridor I:

Vibration and noise impact on Agra Fort

As per first stage study, Agra Fort is in safe category, as the proposed Metro line is parallel to the historic fort wall, gateway and moat of the World Heritage Site of Agra Fort. Although fort wall is at distance 121 meters and moat is at a distance of 107 meters respectively from proposed underground Metro line, due to complexity of the historic construction system, it is essential to take extra precaution and install structural monitoring systems in place to avoid any unpredicted damage. Frequent ground borne vibration and soil settlement monitoring is very essential to avoid any damage to heritage property.

Dust pollution near Taj and Agra Fort area due to presence of construction yard

Monuments of Taj Mahal complex and Agra Fort complex are prone to dust deposition generated during construction phase. The proposed mitigation measures for dust should be adopted and modified as per prevailing site conditions during execution stage.

Tomb of Salabat Khan and Tomb of Sadiq Khan

The entry of Salabat Khan and Sadiq Khan complex is just 18 meters. Actual distance of Tomb of Salabat Khan from Metro line is 125 meters and distance of tomb of Sadiq Khan is 106 meters. Although, the monuments are found structurally safe during the site survey, mitigation measures may be required to assess the change in structure or development of any cracks.

Structural repair of the protected monuments

Heritage structures with existing structural cracks would require to be repaired prior to execution of the project. Structural crack was observed in Kanch Mahal which should be repaired to avoid any damage to the structure.

Unprotected heritage under medium or high-risk categories

At least three unprotected structures are in the medium or high-risk categories including Temple gateway, St John College and Sarojini Naidu boy's hostel, implying potential damage to non-structural and/or structural elements during the Metro construction activities. In these segments, a change of alignment can be considered to ensure that the heritage structure are further away from the alignment: ideally, 25 metres from the centreline of the tunnel alignment or 40 metres from the edge of the station. Therefore, it is required to adopt a series of mitigative measure comprising of temporary structural stabilisation (propping, bracing and confining), ground improvement interventions (soil grouting) and/or sheet piling must be adopted to reduce potential damage to the structures

Structural repair of Bhuri Khan's mosque and Suraj Bhan's gateway

Bhuri Khan's mosque is already in very poor state and have severe structural issues. A minor ground borne vibration may impact the historic structure. Structural consolidation including reconstruction of the missing masonry would be required prior to execution of the project to avoid structural failure in Bhuri Khan's mosque. Similarly, Suraj Bhan's Gateway also need repair works prior to execution of the project to avoid any damage to the heritage structure.

Structure mitigation measures

St Jonh's college, Sarojini Naidu boy's hostel and temple gateway Bagichi are found at high risk category during assessment. Therefore, mitigation measures would be required for these heritage structures.

The proposed scheme of mitigation measures are only an initial suggestion of possibilities based on the risk categorisation and structural typologies involved. It is underlined that mitigation interventions, ranging from temporary structural stabilisation and ground improvement techniques have to be designed and detailed by consultants who will be executing the metro segments in Corridor 1.

Observation should also be carried out for condition assessment of all the heritage structures during the construction of metro works and mitigation measures should be designed and adopted as per site requirement.

TABLE 9.5- MITIGATION MEASURES FOR STRUCTURAL WORKS

S.no	Heritage Structure	Risk Category	Mitigation Measures
1	**St John's College**	High	**Building:** The structure has moderate structural distress and with 64 mm settlement expected due to tunneling. Temporary structural stabilization of distressed locations has to be carried out by adequate propping and bracing, and confinement for brick columns. It is recommended that the building be evacuated during tunneling operations, and until stabilization of ground conditions post-tunneling. Structural health monitoring using tilt meters, crack meters and building and ground settlement meters must be continuously recorded.

			Soil: Since the proposed metro line passes right under the structure, ground improvement by grouting has to be carried out with appropriately designed grout mix. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards.
2	**Sarojini Naidu Boys Hostel**	High	**Building:** The structure has moderate structural distress and with 200 mm settlement expected due to vicinity to proposed station. Temporary structural stabilization of distressed locations has to be carried out by adequate propping and bracing and confinement for brick columns. It is recommended that the building be evacuated station excavation and tunneling, and until stabilization of ground conditions post-tunneling/excavation. Structural health monitoring using tilt meters, crack meters and building and ground settlement meters must be continuously recorded. **Soil:** Ground improvement by grouting has to be carried out with appropriately designed grout mix. Sheet piling prior to D-wall construction can be carried out. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards.
3	**Temple Gateway, Bagichi**	Medium	**Building:** Since the structure is composed of arches supported on stone columns, and surmounted by domes, it is recommended that the arches be provided with temporary steel ties in order to ensure that lateral support movement of the columns do not endanger the arches and domes. **Soil:** Trenches can be executed around the monument, and/or ground improvement by grouting can be carried out with appropriately designed grout mix. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards.

TABLE: 9.2 IDENTIFICATION OF MITIGATION MEASURES FOR PROTECTED MONUMENTS

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
1	**Taj Mahal**	Very high	Site formation	Dust and debris	Indirect	Temporary during construction	Neutral	LOW RISK	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	No impact	Neutral		
			Laying of tunnel components	Vibration	No Impact	No Impact	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	No Impact	No Impact	Neutral		
			Metro Depot	Vibration	No Impact	Temporary during construction	Neutral		
			Construction yard	Vibration	Direct	No Impact	Neutral		
				Dust and debris	Indirect	Temporary during construction	Slight adverse		
			During operation period	Vibration	Direct	No Impact	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
2	**Agra fort**	Very High	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Slight adverse	LOW RISK	Detailed mitigation measures required by UPMRC for the reduce the dust pollution during the excecution of the project. Mitigation measures include use of modern equiments for excavation, use of prefabricated materials, modern equipments, dust mitigation and as and when required. Besides regular monitoring would be required during the execution of the project. Trial pit excavation to understand the foundation typology would be undertaken before execution of metro
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles,	Vibration	Direct	Temporary during construction	Slight adverse		
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	Temporary during construction	Slight adverse		
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction	Slight adverse		
			Counstruction yard	Vibration	Direct	Temporary during constructio	Slight adverse		

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
				dust and debris	Indirect	Temporary during constructio	Slight adverse		works
			Metro Depot	Vibration,	No impact	No impact	Neutral		
			During operation period	Vibration	Direct	No Impact	Slight adverse		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial		
3.1	**Akbar's Tomb**	High	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	LOW RISK	No Mitigation Measures required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Indirect	no impact	Neutral		
			During operation period	Vibration	Direct	No impact	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
3.2	**Kanch Mahal**	High	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	LOW RISK	No Mitigation Measures required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Indirect	NA	Neutral		
				Soil settlement	Direct	NA	Neutral		
			During operation period	Vibration	Direct	NA	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
			Site formation	Vibration, dust and debris	Direct	Temporary during construction	Slight adverse		Mitigation measures required have been worked out and will be executed by working agency during the execution of the project.

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
3.3	**Lodhi Tomb**	High	Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Neutral	LOW RISK	No Mitigation Measures required
				Soil settlement	Direct	NA	Neutral		
			During operation period	Vibration	Direct	Temporary during construction	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
4	**Guru Ka Taal**		Site formation	Vibration, dust and debris	Direct	Temporary during construction	Neutral	LOW RISK	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Slight adverse		Mitigation measures required have been worked out and will be executed by working agency during the execution of the project.
				Soil settlement	Direct	No impact	Neutral		No Mitigation Measure required
			During operation period	Vibration	Direct	Permanent	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
5.1	**Pathar Ka Ghoda**	High	Site formation	Vibration, dust and debris	Direct	Temporary during construction	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during execution of works Trial pit excavation to understand the foundation typology would be undertaken before metro works
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during	Slight adverse		
				Soil settlement	Indirect	NA	Neutral		
			During operation period	Vibration	Direct	Permanent	Slight adverse		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
				Accessibility	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
5.2	**Itibari Khan Ka Mosque**	High	Site formation	Vibration, dust and debris	Direct	Temporary during construction	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. Trial pit excavation to understand the foundation typology would be undertaken before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Slight adverse		
				Soil settlement	Direct	NA	Neutral		
			During operation period	Vibration	Direct	Permanent	Slight adverse		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial		
6.1	**Tomb of Sadiq Khan**	High	Site formation	Vibration, dust and debris	Direct	Temporary during construction	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. Trial pit excavation to understand the foundation typology would be undertaken before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Neutral		No Mitigation Measure required
				Soil settlement	No impact	NA	Neutral		
			During operation period	Vibration	Direct	Temporary during construction	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
6.2	**Tomb of Salabat Khan**	High	Site formation	Vibration, dust and debris	Direct	Temporary during construction	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. Trial pit excavation to understand the foundation typology would be undertaken before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Neutral		No Mitigation Measure required
				Soil settlement	No impact	Temporary during construction	Neutral		
			During operation period	Vibration	Direct	Temporary during construction	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
7	**Barah Khamba**	HIGH	Site formation	Vibration, dust and debris	Indirect	Temporary during construction, low intensity	Neutral	VERY LOW RISK	No Mitigation Measure required
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles,	Vibration	Direct	NA	Neutral		
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	NA	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	Direct	NA	Neutral		
			Counstruction yard	Vibration	Direct	NA	Neutral		
				dust and debris	Indirect	Temporary during construction, low intensity	Neutral		
			Metro Depot	Vibration,	No impact	NA	Neutral		
			During operation period	Vibration	Direct	NA	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
8	**Old Delhi gate of city**		Site formation	Vibration, dust and debris	Indirect	Temporary during construction, low intensity	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles,	Vibration	Direct	Temporary during construction, low intensity	Neutral		No Mitigation Measure required
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Neutral		
			During operation period	Vibration	Direct	Permanent	Slight adverse		Mitigation Measures required
				Low air pollution	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial		
9	**Jama Masjid**	High	Site formation	Vibration, dust and debris	Indirect	Temporary during construction, low intensity	Slight adverse	LOW RISK	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles,	Vibration	Direct	Temporary during construction, low intensity	Neutral		No Mitigation Measure required
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	Direct	NA	Neutral		
			During operation period	Vibration	Direct	Permanent	Slight adverse		Mitigation Measures required
				Low air pollution	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
				Accessibility	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
10	**Ladli begum ka tila**		Site formation	Vibration, dust and debris	Direct	Temporary during construction	Neutral	NO RISK	No Mitigation Measures required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Neutral		
				Soil settlement	No impact	NA	Neutral		
			During operation period	Vibration	Direct	Temporary during construction	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		
11	**Shahjahan Park heritage structures**	High	Site formation	Vibration, dust and debris	Indirect	Temporary during construction, low intensity	Slight adverse	LOW RISK	Mitigation Measures required. GPRS study to identify under ground archaeology will be undertaken before execution of metro works.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles,	Vibration	Direct	Temporary during construction, low intensity	Slight adverse		
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Slight adverse		
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Slight adverse		
			During operation period	Vibration	Direct	Permanent	Slight adverse		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial		
			Site formation	Vibration, dust and debris	Indirect	NA	Neutral		
			Excavation works by	Vibration	Direct	NA	Neutral		

S. NO	NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY		RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	CUMULATIVE	
12	**Fatehpuri Mosque**	High	Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Soil settlement	Direct	NA	Neutral	NO RISK	No Mitigation Measure required
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	Direct	NA	Neutral		
			During operation period	Vibration	Direct	NA	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large		
13	**Satti-un-Nissa's Tomb**	High	Site formation	Vibration, dust and	Indirect	NA	Neutral	NO RISK	No Mitigation Measure required
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	NA	Neutral		
				Soil settlement	Direct	NA	Neutral		
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Neutral		
			Station construction by top down method using diaphram wall.	Vibration	Direct	NA	Neutral		
			During operation period	Vibration	Direct	NA	Neutral		
				Low air pollution	Indirect	Permanent	Very Large Beneficial		
				Accessibility	Indirect	Permanent	Very Large Beneficial		

TABLE: 9.3 IDENTIFICATION OF MITIGATION MEASURES FOR UNPROTECTED HERITAGE SITES								
S. NO	**NAME OF HERITAGE**	**VALUE**	**PROPOSED WORKS**	**TYPE OF IMPACT**		**DURATION OF IMPACT**	**SEVERITY**	**RECOMMENDATION**
				CAUSE	**TYPE**		**INDIVIDUAL**	
1	**Bhuri Khan's Mosque**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Slight adverse	Mitigation Measures required for structural consolidation before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Indirect	Temporary during construction	Slight adverse	
			During operation period	Vibration	Direct	No impact	Neutral	No Mitigation Measure required
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
2	**Baoli 1`**	Medium	Site formation	Vibration, dust and debris	Indirect	NA	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	NA	Neutral	
				Accessibility	Indirect	NA	Neutral	
3	**Khadari Begam Tomb/ Bharatpur house/RBS College**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Slight adverse	Mitigation measures required have been worked out and will be executed by working agency during the execution of the project. GPRS study to identify under ground archaeology will be undertaken before execution of metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Slight adverse	
			During operation period	Vibration	Direct	Temporary during construction	Slight adverse	
				Low air pollution	Indirect	NA	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	NA	Very Large Beneficial	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
4	**Baradari Temple gateway**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Slight adverse	Mitigation Measures required for structural consolidation before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Moderate adverse	
			During operation period	Vibration	Direct	Permanent	Moderate adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
5	**Suraj Bhan Gateway**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Slight adverse	Mitigation Measures required for structural consolidation before metro works.
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	Temporary during construction	Slight adverse	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
6	**Tomb-I**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
7	**Tomb-II**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
8	**St. John's College**	Medium	Site formation	Vibration, dust and debris	Indirect	NA	Slight adverse	Due to close proximity to metro tunnel, major structural mitigation measures are required in terms of structural consolidation before metro works and structural monitoring during execution of the metro works.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
				Soil settlement	Direct	Temporary during construction, low intensity	Moderate adverse	
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
			Site formation	Vibration, dust and debris	Indirect	NA	Slight adverse	Due to close proximity to metro tunnel, major structural mitigation measures are

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
9	**Agra College**	Medium	Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	required in terms of structural consolidation before metro works and structural monitoring during execution of the metro works.
				Soil settlement	Direct	Temporary during construction, low intensity	Moderate adverse	
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
10	**Medical building complex/Lady Lyall complex**	Medium	Site formation	Vibration, dust and debris	Indirect	NA	Neutral	No Mitigation Measure required
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	Temporary during construction, low intensity	Neutral	
				Soil settlement	Direct	Temporary during construction, low intensity	Neutral	
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Neutral	
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Neutral	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
11	**St. Pauls Church**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
12	**Queen Victoria school**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
			Site formation	Vibration, dust and debris	Indirect	NA	Slight adverse	Due to close proximity to metro tunnel, major structural mitigation measures are required in terms of structural consolidation before metro works and structural monitoring during execution of the metro works.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
				Soil settlement	Direct	Temporary during construction, low intensity	Moderate adverse	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
13	**RBS College**	Medium	Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
14	**Kalan Masjid**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
15	**Sarojini Naidu Hospital**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
16	**Senior Boys Hostel**	Medium	Site formation	Vibration, dust and debris	Indirect	NA	Slight adverse	Due to close proximity to metro tunnel, major structural mitigation measures are required in terms of structural consolidation before metro works and structural monitoring during execution of the metro works.
			Excavation works by Tunnel Boring Machine and Installation of secant, tangent and shoulder piles	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
				Soil settlement	Direct	Temporary during construction, low intensity	Moderate adverse	
			Laying of tunnel components	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			Station construction by top down method using diaphram wall.	Vibration	Direct	Temporary during construction, low intensity	Slight adverse	
			During operation period	Vibration	Direct	Permanent	Slight adverse	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	No Mitigation Measure required
				Accessibility	Indirect	Permanent	Very Large Beneficial	
17	**Agra Fort Railway staition**	Medium	Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	No Mitigation Measure required
			Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	
			Site formation	Vibration, dust and debris	Indirect	Temporary during construction	Neutral	

S. NO	NAME OF HERITAGE	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SEVERITY	RECOMMENDATION
				CAUSE	TYPE		INDIVIDUAL	
18	**Baoli- Agra University**	Medium	Pile boring, Construction of viaduct structure and Erection of girders	Vibration	Direct	NA	Neutral	No Mitigation Measure required
			During operation period	Vibration	Direct	NA	Neutral	
				Low air pollution	Indirect	Permanent	Very Large Beneficial	
				Accessibility	Indirect	Permanent	Very Large Beneficial	

9.4 IDENTIFICATION OF MITIGATIONS MEASURES AND RISK CATEGORY FOR UNPROTECTED HERITAGE							
S. no.	**Name of Heritage Resource**	**Nearest Metro Station**	**Alignment element**	**Distance from Metro Tunnel (in metres)**	**Distance from Metro Station (in metres)**	**Risk Category**	**Recommendations**
1	Bhuri Khan's mosque	Sikandara	Elevated	180	290	High risk	Mitigation Measures Required
2	Baoli-1, Fatehabad road	Fatehabad Road	Elevated	35	454m (distance from switch over ramp -32m)	No risk	No Mitigation Measures Required
3	Khadari Begam garden Tomb/Bharatpur house/RBS college	RBS College	Underground	0	243	Low risk	Mitigation Measures Required
4	Baradari Temple	Guru Ka Taal	Elevated	15	320	Medium risk	Mitigation Measures Required
5	Suraj Bhan gateway	Guru Ka Taal	Elevated	15	380	High risk	Mitigation Measures Required
6	Tomb-I	Sikandara	Elevated	332	312	Low Risk	Mitigation Measures Required
7	Tomb-II	Sikandara	Elevated	350	346	Low Risk	Mitigation Measures Required
8	St. John's College	Raja Ki Mandi	Elevated	0	63	High Risk	Mitigation Measures Required
9	Agra College	Agra College	Underground	45	61	High Risk	Mitigation Measures Required
10	Medical building complex/Lady Lyall complex	Agra College	Underground	80	113	Low Risk	Mitigation Measures Required
11	St. Paul's church	RBS College	Underground	300	328	No risk	No Mitigation Measures Required
12	Queen Victoria school	Raja Ki Mandi	Underground	150	88	No risk	No Mitigation Measures Required
13	RBS college	RBS college	Underground	30	30	High Risk	Mitigation Measures Required
14	Kalan Masjid	Medical College	Underground	154	344	No risk	No Mitigation Measures Required
15	Sarojini Naidu hospital and college	Medical College	Underground	107	114	No risk	No Mitigation Measures Required
16	Senior Boy hostel	Medical College	Underground	0	0	High risk	Mitigation Measures Required
17	Agra Fort railway station	Jama Masjid	Underground	163	230	No risk	No Mitigation Measures Required
18	Baoli-1, Agra university	Shastri Nagar	Elevated	150	213	No risk	No Mitigation Measures Required

9.2.3 Required scientific studies

The following mitigation would be required for particular heritage buildings along the corridor-I:

Vibration Studies

- The background vibration levels due to existing sources of vibration, namely vehicular or rail traffic, movement of people and other activities must be recorded at all the sites of heritage structures identified in Table 18 along Corridor 1 to benchmark existing levels of vibration, prior to commencement of metro construction activities.
- More rigorous estimates of PPV levels due to tunnelling or other construction equipment would require calibration of the constants (or reference PPV) with measurements made at the sites of interest along Corridor 1 of Agra Metro. Moreover, measurements of current levels of PPV due to existing traffic and human activities at the sites of interest along Corridor 1 of Agra Metro are essential to differentiate vibrations caused due to metro construction activities and those due to other forms of existing traffic and human activities.
- Measurement of Ambient Ground Vibration should be studied as proposed in Annexure 1. It is essential that ambient ground vibration measurements should be at least taken at the point of measurement specified in Table 9.5 for each heritage structure.
- Refer table 9.5 for the proposed locations of the vibrations tests to be carried out.
- Detailed scientific study annexure I should be referred time to time for references

TABLE 9.6 VIBRATION TEST LOCATIONS

No.	**Structure**	**Test Location Points**	**Closest face/ corner of the structure to metro alignment**
1	Lodhi's Tomb	PPV TEST PT.1	South-East corner on the ground floor
2	Kanch Mahal	PPV TEST PT.2	South- East corner on the ground floor
3	Bhuri Khan's Mosque	PPV TEST PT.3	South-West corner on the ground floor
4	SurajBhan Gateway	PPV TEST PT.4	South- West corner on the ground floor
5	Temple Gateway, Bagichi	PPV TEST PT.5	South- West corner on the ground floor
6	Pathar ka Ghoda	PPV TEST PT.6.1	North-West corner on the ground floor
		PPV TEST PT.6.2	South-West corner on the ground floor
7	Guru kaTaal	PPV TEST PT.7	South- West corner on the ground floor

8	Tomb of Sadiq Khan	PPV TEST PT.8	South edge on the ground floor
9	Tomb of Salamat Khan	PPV TEST PT.9	South-East corner on the ground floor
10	Khandari Begum's Tomb	PPV TEST PT.10	East corner on the ground floor
11	Old Delhi Gate	PPV TEST PT.11	South- West edge on the ground floor
12	St. John's College	PPV TEST PT.12	North edge of Physical Education Department on the ground floor
13	Lady Lyall Complex	PPV TEST PT.13	North-East corner on the ground floor
14	Sarojini Naidu Boys Hostel	PPV TEST PT.14.1 PPV TEST PT.14.2	North edge on the ground floor
15	Kalan Maszid	PPV TEST PT.15	South-West corner on the ground floor
16	Jami Masjid	PPV TEST PT.16	South-West corner on the ground floor
17	Agra Fort	PPV TEST PT.17	South-West corner on the ground floor
18	Bara Khamba	PPV TEST PT.18	South-West corner on the ground floor

Ground Penetrating Radar Survey

Possibility of Underground Archaeology in Shahjahan Park

Archaeological remains and ruined structures were found in the Shahjahan Park, which is also a part of Buffer zone of the World Heritage Site of Taj Mahal. Although the proposed underground Metro line is outside the buffer zone, it is recommended to conduct the Ground Penetrating Radar Survey of the adjacent of the buffer zone to explore the possibility of underground archaeology so that mitigation measures can be worked out prior to execution of the project.

Possibility of underground archaeology near Lodhi Tomb, Sikandara

Archival texts have depicted the presence of Lodhi settlements around the Akbar’s tomb complex including Lodhi Tomb. It is therefore essential to ensure the presence of underground archaeology if any before excavation of pillar foundation to minimize the impacts. Therefore, it is suggested to conduct Ground Penetrating Radar Survey (GPRS) to ascertain the presence of Underground archaeology and adopt appropriate mitigation measures.

Trial pits for monuments

A more detailed study and analysis on the foundation typology is recommended for Agra Fort, Lodhi’s Tomb, Guru Ka Taal, RBS college, Lady Lyall complex, Agra college, Baoli, Kandhari Begum’s tomb and Suraj Bhan Gateway. Trial pits would provide results for further analyses.

Monitoring of mitigation measures during construction phase

The purpose of monitoring is to investigate the site practice of the contractors and workers and their compliance with the approved cultural heritage mitigation. The Monitoring Plan gives details of performance and monitoring indicators, the frequency of the monitoring, documentation and reporting requirements. It is undertaken to detect, gauge, record and interpret structural movement, the effects of vibration and other changes to the historic building that result from neighbouring construction or demolition work. "Data collected during the monitoring program can serve as a baseline for any subsequent movement or changes to site drainage patterns that arise within the first years after construction is completed. Ultimately, monitoring shows the degree to which steps taken to protect an historic structure from adjacent construction are sufficient and successful."[86]

A monitoring plan need to prepare including detailed schedule, formats of recording, photographic documentation, taking readings of the digital equipment fixed on the monuments and visual survey finding. Regularly planned monitoring of cultural heritage resources would be essential in the construction phase by a team led by an independent experienced Conservation professional familiar with baseline conditions of each of the properties. Each building would need to be monitored on site weekly, when all mitigation measures will be checked, photographed and documented on record sheets. Collated record sheets will be submitted to the designated officer(s) to concerned officer of Archaeological Survey of India for review.

If monitoring finds that mitigation is not being applied, or that impacts have been found to exceed the allowable values or if damage to either structural or non-structural elements of the historic buildings have been identified, the construction work should be stopped and the construction method and appropriate mitigation measures should be the reviewed and submitted to the authority.

9.3 MITIGATION DURING THE OPERATION PHASE

The assessment of impacts identified four key potential impacts on the identified heritage buildings during the operational phase of the project:

- Continuous low-level vibration from train traffic and stations which may cause structural damage to historic fabric only for the monuments which are in proximity
- Noise from trains operating on elevated viaducts and stations
- Visual barriers and intrusions created by the elevated train viaduct and stations
- Impacts on the setting of monuments

Low-level continuous vibrations:

The levels of ground borne vibration from operation of the train will be far below internationally accepted standards for structures more than 50 m/ 100 m. from the alignment/stations. All the heritage structures along the Metro corridor 1 are far more than 50m /100 m. So, less chances of impact of vibrations caused by operation of Metro.

Noise from train operations, stations and associated activities

[86] Randl. (2001). *Protecting a Historic Structure during Adjacent Construction.* US National Parks Service.

The need for mitigation or noise impacts will be measured during both the construction and operation phases and will be applied at locations where impact is identified. Severe impacts, as measured by the Noise Pollution (Regulation and Control) Rules, 2000; generally, require noise mitigation. It is essential to minimize vibration generated by the Metro rails, both at the source as well as receptor levels. Delhi Metro already have adopted following measures in order to minimize the vibrations which can be further modified and adopted in Agra Metro too[87]:

- Adopting new and advance technology in rails and brake systems, namely, by providing damping wheels and tracks, reducing the roughness of the rails;
- noise levels can be further reduced by providing mass spring system technology and noise barriers along the corridor at critical locations along the corridor.
- Coaches with advanced sound-absorbing cushions lining on the walls with better buffing have been

Visual barrier and intrusions created by elevated train, stations and other elements of the system

Proposed mitigation measures to enhance the visual experience:

- The proposed Metro entry and exist points in station located along the underground Metro and elevated stations need to be designed keeping in mind the historical architectural character of the place so that it merges well with the context
- Pathar Ka Ghoda which is in close proximity of 25 mts from the proposed Metro line and is presently not visited by tourist. It is unknown to most the visitors and therefore neglected. Appropriate landscape proposal should be prepared for the nearest Metro station which is 58.5 mts away integrating the monument within. It would surely would enhance the setting of the monument as well as it would encourage commuters to visit the site
- Setting of Tomb of Salabat Khan and Tomb of Sadiq Khan also need enhancement with appropriate landscape proposal.
- Metro stations should be used for interpretation of the historic sites along the proposed Metro corridor 1. It would enhance the visitor’s experience as well as make them aware about the unknown heritage areas of Agra
- Proposed Metro stations, entry and exit points have lot of potential to be developed to include interpretation the history and heritage of Agra. Station close to monuments may emphasis on the particular monument. It would not only enhance the visitors experience but also it would be tool for awareness for preserving our heritage
- The interior of the proposed Metro station should also include application of local traditional building craft in selected areas and stations.

Impacts on the setting of monuments

The setting of a heritage building includes the area immediately around it which provides some degree of "buffer" between it and the outside environment. Impacts on setting are predicted to be substantial at the following sites:

[87] Critical issues related to Metro Rail Projects in India, Sharma Niraj, Rajni Dhayani, S. Gangopadhaya, Journal of Infrastructure Development 5 (1) 67-86, 2013

- Tomb of Salabat Khan and Tomb of Sadiq Khan
- Akbar 's Tomb
- Pathar Ka Ghoda

It would be essential to enhance the setting with creative landscaped interventions and integrating the proposed development as a part of the historic city of Agra.

9.4 MONIOTIRNG MITIGATION DURING OPERATIONAL PHASE

"Data collected during the monitoring program can serve as a baseline for any subsequent movement or changes to site drainage patterns that arise within the first years after construction is completed. Ultimately, monitoring shows the degree to which steps taken to protect an historic structure from adjacent construction are sufficient and successful."[88]

The purpose of monitoring is to investigate the site practice of the contractors and workers and their compliance with the approved cultural heritage mitigation. The Monitoring Plan gives details of performance and monitoring indicators, the frequency of the monitoring, documentation and reporting requirements. It is undertaken to detect, gauge, record and interpret structural movement, the effects of vibration and other changes to the historic building that result from neighbouring construction or demolition work.

Regular monitoring of cultural heritage would need to be carried out in the operational phase by a team led by an independent experienced conservation professional familiar with the baseline conditions of each of the properties. Each building will be monitored on site at agreed intervals, when all mitigation measures will be checked, photographed and documented on record sheets to be developed as per site conditions (collated record sheets should be analysed by the conservation professionals and submitted to Agra Circle, Archaeological Survey of India). Regular site visits should be done in coordination with ASI official for reviews and analysis.

If monitoring finds that mitigation is not being applied, or that impacts have been found to exceed the allowable values or if damage to either structural or non-structural elements of the historic buildings have been identified, the construction work should be stopped and the construction method and appropriate mitigation measures should be the reviewed and submitted to the authority.

9.5 AIR AND DUST MITIGATION PLAN

During transport of material

a) The working agency will take precautions to minimise visible particulate matter from being deposited upon public roadways as a result of project activities. Precautions include removal of particulate matter/muck/slurry from equipment before movement to paved streets or prompt removal of material from paved streets onto which such material has been dropped.

b) All construction equipment should be washed clean of visible dirt/mud before exiting the construction sites. Any deposition of material on public streets by construction equipment should be removed by manual sweeping, or by deploying electro-mechanical devices.

[88] Randl. (2001). *Protecting a Historic Structure during Adjacent Construction.* US National Parks Service.

c) The working agency will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots, batching plants and site locations. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Water shall be pumped through an electrically operated pump set, to hydrants attached with rubber hoses, by activation of push button located at the hydrant, allowing for up to 10 minutes of wash time.

d) Wheel washing facilities will be provided with efficient drainage, incorporating silt traps to prevent any excessive build-up of water. These facilities could include water re-circulation apparatus to minimise water consumption. At the wheel wash facility, water, dirt, gravel etc. will be drained into precast trench drains with removable grated cover. This dirty water shall flow, through a piping, into solids separator and from there to oil separator before final discharge.

e) Where wheel-washing, facility is not possible, the working agency will ensure manual cleaning of wheels by wire brushes or similar suitable means.

f) The working agency will ensure that vehicles with an open load carrying area used for moving potentially dust-producing materials shall have properly fitting side and tailboards. Materials having the potential to create dust shall not be loaded to a level higher than the side and tail boards, and shall be carried in vehicles fitted with covers.

At dumping sites

a) The working agency will place excavated materials in the dumping/disposal areas designated in the drawings.

b) The working agency will place material in a manner that will minimise dust production. Material shall be stabilised each day by water sprinkling or other accepted dust suppression techniques.

c) The heights from which materials are dropped shall be the minimum practical height to limit fugitive dust generation.

d) The working agency will stockpile material in the designated locations with suitable slopes. Access to the site shall be regulated for entry of men, material and machine.

e) During dry weather, dust control methods such as water sprinkling must be used daily especially on windy, dry day to prevent any dust from blowing. During rain, the stockpile may be covered with tarpaulin or similar material to prevent run off.

f) The working agency will provide water sprinkling at any time that it is required for dust control use.

g) Sufficient equipment, water, and personnel shall be available on dumping sites at all time to minimise dust formation and movements to prevent nuisance.

h) Dust control activities shall continue even during work stoppages.

At construction site

a) At each construction site, the working agency will provide storage facilities for dust generating materials and will be closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction. The waiting agency will spray water at construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition.

b) Stockpiles of sand and aggregate greater than $20m^3$; for use in concrete manufacture shall be enclosed on three sides, with walls extending above the stockpile.

c) Effective water sprays shall be used during the delivery and handling of all raw sand and aggregate and other similar materials, when dust is likely to be created and to dampen all stoned materials during dry and windy weather.

d) Areas within the site such as construction depots and batching plants, where there is a regular movement of vehicles shall have an approved hard surface that is kept clear of loose surface material. An approved hard surface includes but not limited to a surface which is not eroded easily during slight winds or during the passage of construction vehicles so as to cause dust nuisance.

e) The working agency will restrict all motorised vehicles on the site to a maximum speed of 15 kilometres per hour and confine haulage and delivery vehicles to the designated roadways inside the site.

f) At the batching plant the following additional conditions will be complied with: The working agency will undertake at all times the prevention of dust nuisance as a result of his activities. The working agency will frequently clean and water the concrete batching plant and crushing plant sites and ancillary areas to minimise any dust emission.

g) The working agency will erect hoardings/barricades as specified, securely around all construction work sites during the main construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic. The barricade shall be safely secured to the ground to prevent from toppling with minimum or no gap between the base of the hoarding and good surface.

Vehicle and plant emissions

The adverse impacts of vehicle and plant emissions will be controlled. Measures to be considered for linking emissions and avoiding nuisance will include:

a) Ensuring that the engines of all vehicles and plant on site are not left running unnecessarily.

b) Using low emission vehicles and plant fitted with Emission control devices.

c) Using construction vehicles which meet the BS III specification. The Contractor will 'promote' the use of vehicles which meet BS IV standard.
d) Ensuring that plant is well maintained, with routine servicing of plant and vehicles to be completed in accordance with the manufacturers' recommendations and records maintained for the work undertaken.

e) Ensuring that all project vehicles, including off-road vehicles, hold current MOT certificates, where required due to the age of the vehicle, (or to be tested to an equivalent standard) and that they comply with exhaust emission regulations for their class.

f) Maximising energy efficiency (this may include using alternative modes of transport, maximising vehicle utilisation by ensuring full loading and efficient routing), use of electric vehicles, if available.

Site Planning

a) Plan site layout work compounds will be laid out in a manner such that accesses and loading areas and machinery and dust causing activities are located as far away from sensitive receptors as practicable and, where practicable, temporary structures can be placed as screens to these activities.

b) Erect solid barriers to site boundary and prevent site runoff of water or mud.

c) All site personnel to be fully trained.

d) Trained and experienced Environmental Manager on site during working times to undertake observations of environmental conditions, and carry out site inspections.

e) Put in place Air pollutant monitors at the perimeter of the site, as mandated by the Employer and conforming the requirements of Notification on National Ambient Air Quality Standards, 2009.

Construction traffic

a) Effective vehicle cleaning and wheel washing on leaving site and damping down of haul routes

b) All loads entering and leaving site to be covered with tarpaulin sheets

c) Provision of easily cleaned hard surfacing for vehicles and the effective cleaning of haul routes and

d) Appropriate speed limit around site, including limiting vehicle speeds on unpaved surfaces to 10-15 kmph.

Demolition works

a) Carry out orderly demolition so as to maximize reuse of demolished matter

b) Use water as dust suppressant

c) Cutting equipment to use water as suppressant or suitable local extract ventilation

d) Use enclosed chutes and covered skips and

e) Wrap the structures) / buildings) to be demolished.

Site activities

a) The working agency will minimise dust generating activities to the extent possible.

b) Use water as dust suppressant/chemicals (on employers demand) where applicable; cover, seed or fence stockpiles to prevent wind whipping.

c) Drilling and excavation surfaces to be wetted where appropriate.

d) Debris piles to be kept watered or sheeted as necessary.

e) The enclosure of material stockpiles at all times and damping down of dusty materials using water sprays during dry weather.

f) The working agency will take precautions to prevent the occurrence of smoke emissions or fumes from site plant or stored fuel oils. Plant will be well maintained and measures will be taken to ensure that It Is not left running for long periods when not in use.

10. CONCLUSION AND SUMMARY OF IMPACTS

None of the protected structures under the purview of the Archaeological Survey of India, including the World Heritage Sites of Taj Mahal and Agra Fort should be expected to suffer damage due to metro construction induced vibrations or ground settlement therefore no structure damage is expected as per initial predictions. Therefore, from a structural risk assessment perspective, the proposed alignment of the metro corridor does not pose any threat to these protected structures.

Although Metro has long term benefits especially for reducing the air pollution but minor air pollution is expected around the World Heritage Sites during construction period. Therefore, is strongly recommended to adopt all mitigation measures to reduce its impact to achieve long terms benefits.

At least three unprotected structures namely St John's College, Sarojini Naidu hospital and Temple gateway, Baradari are in the medium or high-risk categories, implying potential damage to non-structural and/or structural elements during the metro construction activities. It is high recommended to mitigate all issues before commencement of metro construction works.

All the expected impacts are based on visual survey of the historic buildings and analysis with the available data (from LMRC and other sources) therefore it is recommended to collect first hand data (as suggested in the report) before and during construction and operation of proposed metro.

PART 2

AGRA METRO CORRIDOR- II

Lal masjid, RC Cemetry and Rambagh

HERITAGE IMPACT ASSESSMENT

LAL MASJID AND TOMB

AGRA METRO RAIL PROJECT

Prepared for:
Uttar Pradesh Metro Rail Corporation

Near Dr. Bhimrao Ambedkar Samajik Parivartan Sthal
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Prepared by:
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Plot No 25, Lower Ground Floor
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New Delhi- 110025

CONTENTS

LAL MASJID AND TOMB

Image showing Shahi Lal Masjid and Tomb

LAL MASIJD AND TOMB
SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'25.92"N, 78° 2'19.03"E

Description: Behind the garden enclosure of are the remains of a mosque called the Shahi Lal Masjid and an adjoining tomb, said to a have belong to one Mir Jumla. These two ruined and neglected buildings seem once to have stood on a substantial platform. An examination of the platform at the rear of the mosque seems to indicate that it was built on a slightly different from the mosque and tomb, indicating that it may have predated them. These are clearly Mughal, the tomb being conventional in design while the mosque is distinguished by unusually closely packed domes.[1]

Integrity

The complex does not completely retains its design and layout. There have been many alterations/ additions done to building. A part of the tomb structure has collapsed. Besides there is a loss of original architectural and decorative features. The context of the site is also has transformed.

Authenticity

Historic buildings still retain the original forms of the buildings although context has changed. Alterations/ additions done to building with new incompatible materials.

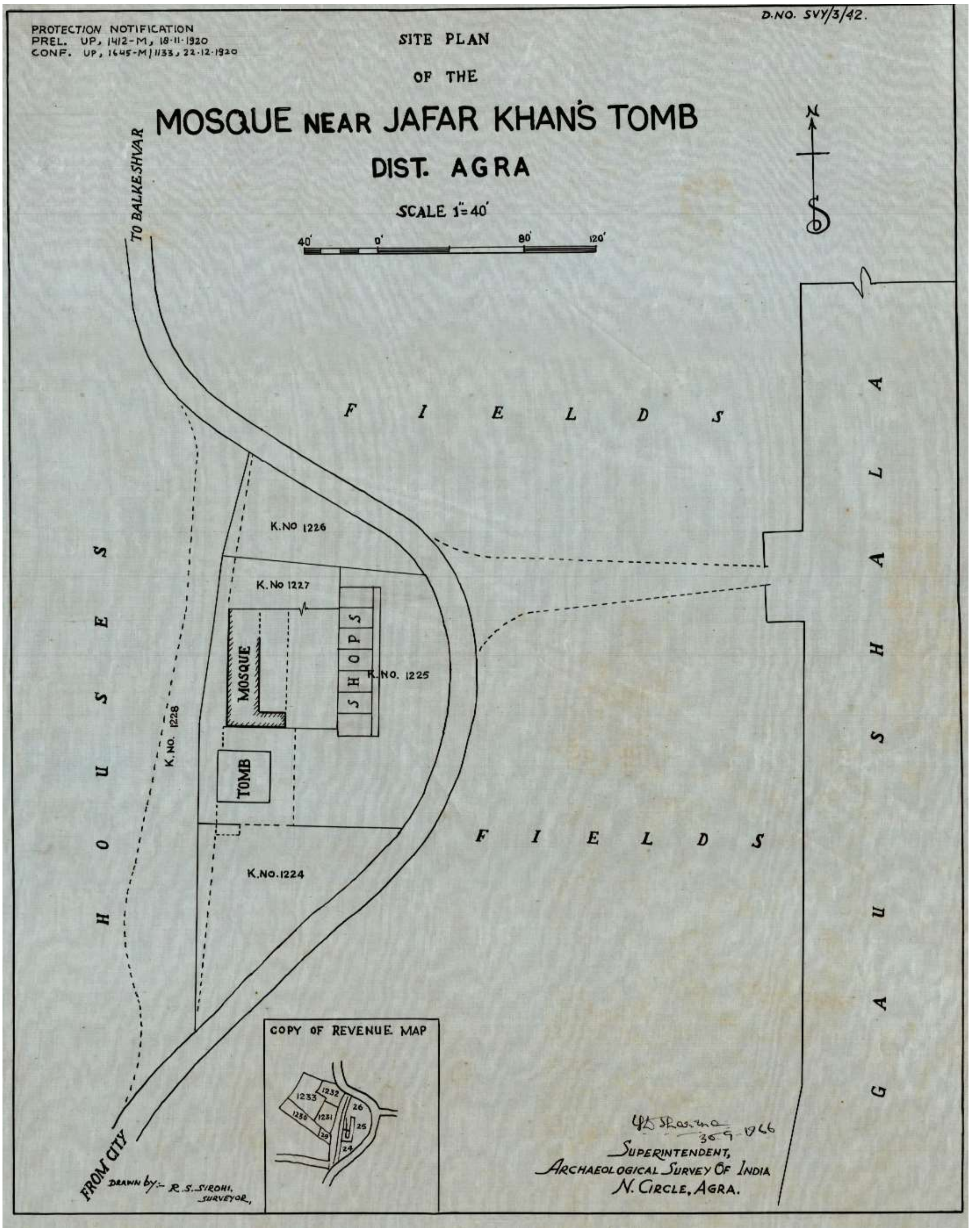
Attributes that carry Significance

- ✓ Design and layout of mosque and tomb
- ✓ Elevated platforms
- ✓ Historic lakhori brick masonry cladded with carved stone in cusped arche profiles

[1] Peck, Lucy (2008) Agra, the Architectural Heritage *An Intach roli guide lotus collection*

- ✓ Structural systems- Arches and domes
- ✓ Decorative features- Chhatris, stone carving, bands, miniature minarets, stone finials with inverted leaf petals

SITE PLAN



Site plan of the Shahi Lal Masjid and Tomb[2]

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[2] Digitisation Department, Agra circle, ASI

PRESENT CONDITION AND FACTORS AFFECTING HERITAGE VALUES OF LAL MASJID AND TOMB (PRE-METRO CONSTRUCTION WORKS)

Present visual condition survey of Lal Masjid and Tomb along the proposed Metro route was carried out by team of architects and structural experts to understand the baseline conditions of the Lal Masjid and Tomb before construction and operation of elevated/underground Metro corridor. Present condition refers to current state of conservation of the heritage and any impacts resulting from previous actions, development or other agents of change.

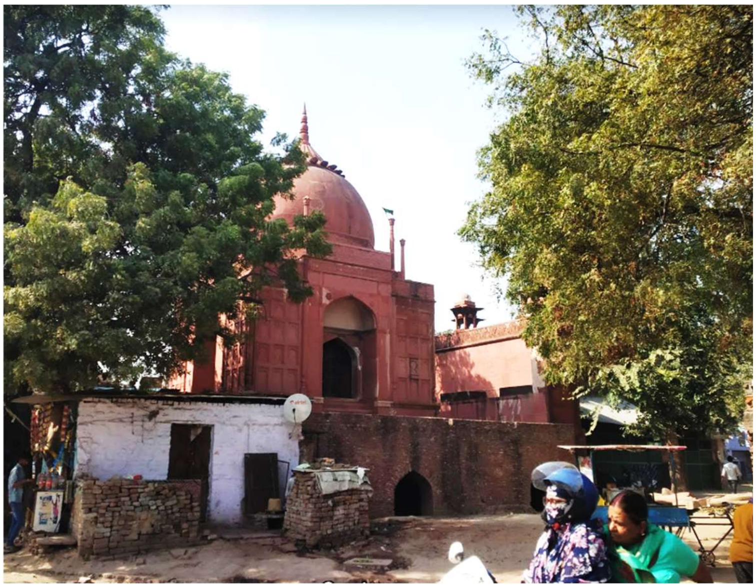
Lal Masjid and Tomb

Present Condition

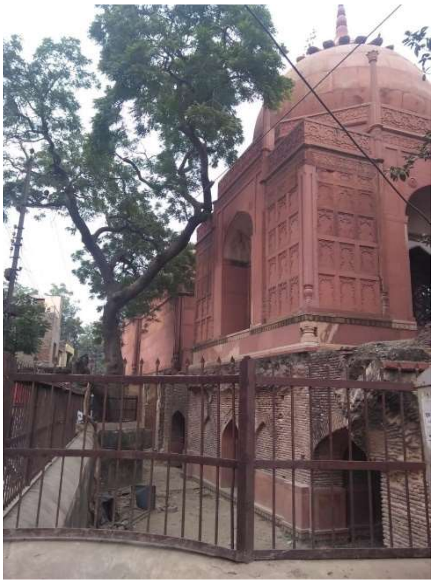
The condition of the Lal masjid structure is unstable. Masonry walls and a dome is partially collapsed. Severe sign of material and structure decay is visible. Temporary support has been added to collapsed part of the structure to avoid further damage. Alteration with modern materials have been done to the mosque.

Existing Impacts

- The immediate surrounding area in encroached.
- The mosque is in use.
- Threat of vandalism
- The mosque is partly collapsed



The tomb view from the road with adjacent shop structure in immediate surrounding



South east corner of tomb with arcaded platform and existing site boundary wall

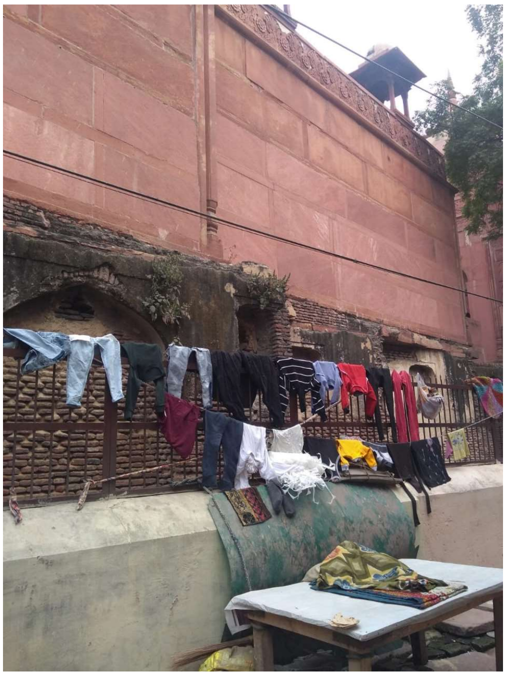
The east side view of the tomb over a high platform

The rear view of the tomb with drainage nala along boundary wall

The view Shahi lal mosque from north east direction which got partly collapsed. As the mosque is in use, temporary shed has been added at entry

The image showing collapsed third dome of the mosque and temporary supports of brick masonry.

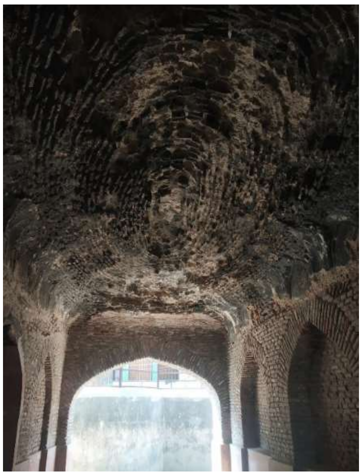
The view of mosque from north west direction showing a brick masonry supporting the mosque from further collapse



The rear view of the mosque there used to be a larger platform which does not existing anymore.

The grave stone inside the tomb

The loose masonry and deteriorated stones of the exterior wall surface



Exposed ceiling masonry of platform of the tomb

PROPOSED METRO WORKS TO LAL MASJID AND TOMB

SHAHI LAL MASJID AND TOMB

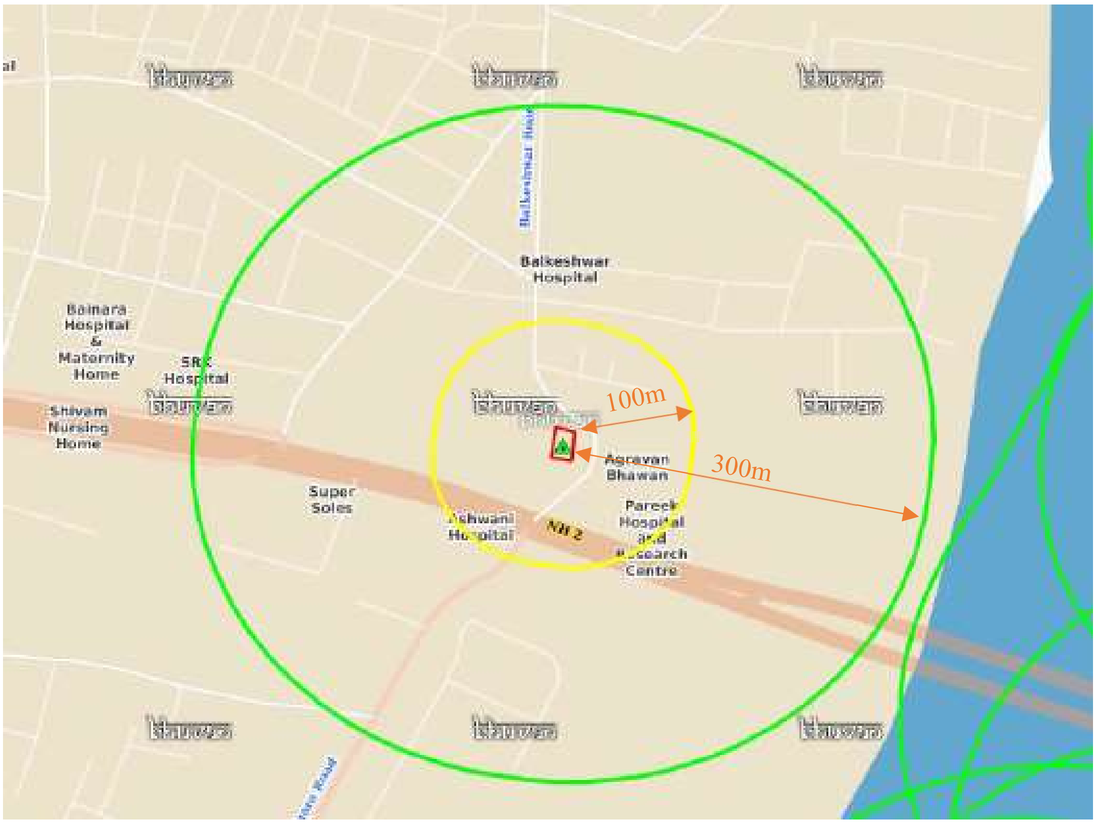
NEAREST METRO STATION: MG ROAD METRO STATION

DISTANCE FROM METRO LINE (IN METRES). 86 mtrs

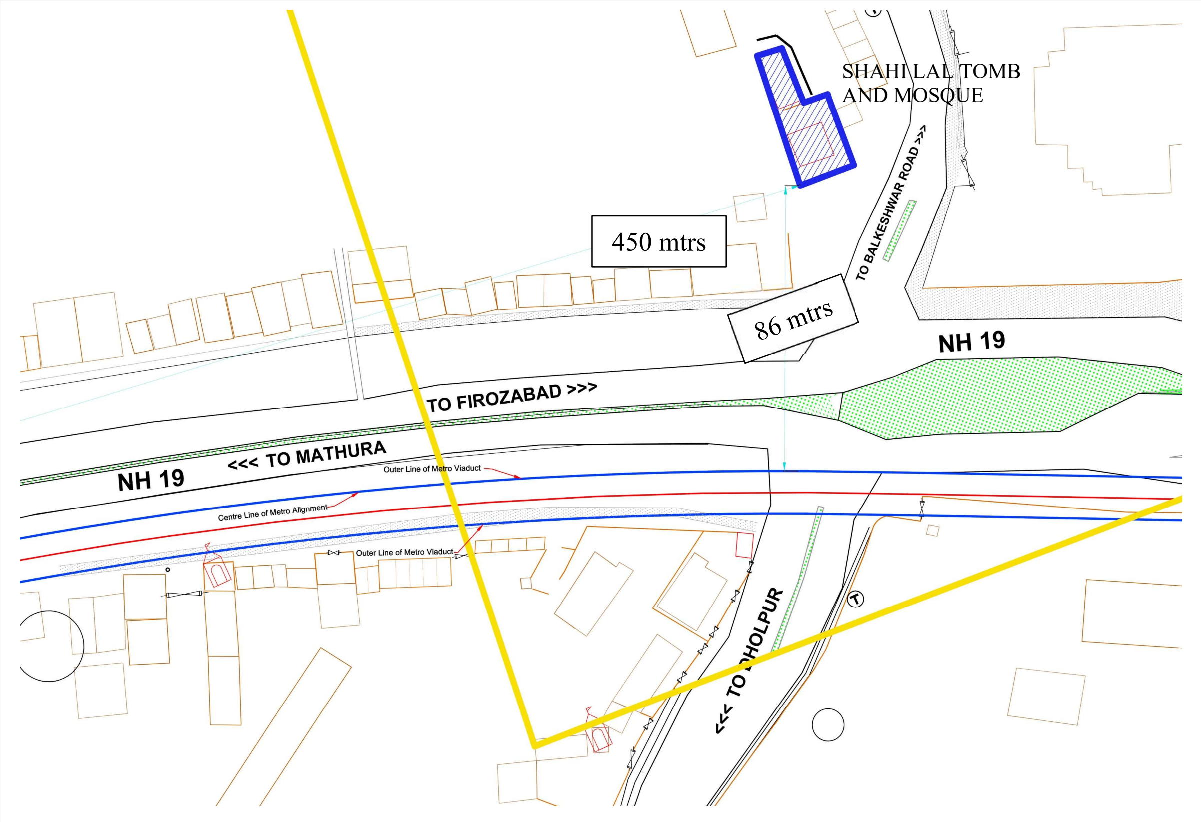
DISTANCE FROM METRO STATION (IN METRES): 450 mtrs

NAME OF MONUMENT	NEAREST METRO STATION	ALIGNMENT ELEMENT	CONSTRUCTION METHOD	PROPOSED WORKS
SHAHI LAL MASJID AND TOMB	KAMLA NAGAR	Elevated	Viaducts on piers	Site formation
				Pile boring
				Construction of viaduct structure
				Erection of girders

Table 1- Proposed metro work



Site plan of Shahi Lal masjid and tomb showing protected (red), prohibited (yellow) and regulated (green) boundaries |Source: Bhuvan



Observations:

Proposed elevated Metro line is at a distance of 86 mts from Lal Masjid and Tomb is within the prohibited boundary of 100 mts of Shahi Lal Masjid and Tomb.

Proposed elevated Kamla Nagar metro station is at a distance of 450 mts Shahi Lal Masjid and Tomb is outside the regulated boundary of 300 mts of Shahi Lal Masjid and Tomb.

Table 2- Distances from monuments

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
2a	**Shahi Tomb**	**Shahi Tomb**	ASI	450	68
2b		**Masjid**	ASI	450	86

HERITAGE IMPACT SUMMARY

- **TABLE DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES OF SHAHI LAL MASJID AND TOMB**

- **VISUAL IMPACT ASSESSMENT**

- **STRUCTURE ASSESSMENT**

TABLE DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES OF SHAHI LAL MASJID AND TOMB

SIGNIFICANCE	ATTRIBUTES	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	FURTHER STUDIES OR TESTS PROPOSED	RECOMMENDATION
High	Design and layout of and mosque and tomb	Vibration due to construction activities Dust deposits during construction phase	No Change	Neutral	Expected PPV from construction on activities in within limits Existing ambient vibration levels to be measured Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day for further analysis	No mitigation measures required
	Elevated platforms, Historic masonry with cladded with decorative stones		Negligible change	Slight adverse *(due to existing condition of the monuments)*		*Due to present status of the monuments-* Structural consolidation of both the structures is essential prior to the metro construction works Documentation and monitoring of the historic monuments during the execution of the project is reaccommodate
	Structural members and system- Domes and arches		Negligible change	Slight adverse *(due to existing condition of the monuments)*		
	Decorative features- Chatries, arches, stone carving, bands miniature minarets, finial with inverted leaves		Negligible change	Slight adverse *(due to existing condition of the monuments)*		

VISUAL IMPACT ASSESSMENT

SHVI View of Shahi Lal Masjid and Tomb from the nursery across the road

Existing visual connection

Presently the flyover on National Highway 19 and other street infrastructure blocks the view from the proposed location of metro line. The building structure is partially visible as of now.

Earth view of the site of Shahi Lal Masjid &Tomb and immediate surrounding

Impact on visual connection:

Proposed metro line is elevated but it will be blocked by the existing flyover on national highway NH 2/NH 19. Therefore, will the metro line will have ***negligible impact on the present view of Lal Masjid and Tomb***

STRUCTURE ASSESSMENT INVENTORY, *preliminary*

Shahi Lal Masjid and Tomb

1. **Protection status :** Archaeological Survey of India

2. **Proposed development actions:** Elevated metro line

3. **Structural system:** Both the structures are load bearing structures with lakhori brick masonry in lime mortar cladded with decorative stones, arches and domes. The structures are standing on an elevated platform with arches and vaults.

4. **Condition of structural members**
   a. Loose brick masonry and collapse at few locations. A dome is partially collapsed.
   b. Cracks were observed, which could be a sign of structural distress.

5. **Level of distress:** Moderate due to severe material and structure decay

6. **Expected impacts**
   - Impact of soil settlement: No impact
   - Impact of vibrations due to tunnelling: No impact
   - Impact of vibrations due to excavation: No impact

7. **Permissible limit:** Expected PPV is within limits. Actual locations of the columns would be identified and their distance from individual monuments would be measured for further analysis. Analysis would be conducted considering the existing condition of the monuments

8. **Expected settlement:** None

9. **Category of risk:** Low risk

10. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure. It is highly recommended to do structural conservation works of both the monuments.

TABLE 5- IMPACT SUMMARY –LAL TOMB AND MASJID

VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SIGNIFICANCE OF IMPACT	
					SEVERITY	**RISK CATEGORY**
HIGH	Site formation	Vibration, dust and debris	Direct	During construction	Slight Adverse	*Low risk*
	Pile boring	Soil settlement	Negligible	During construction	Neutral	
	Construction of viaduct structure	Visual, Vibrations, noise	Direct	During construction	Slight Adverse	
	Erection of girders	Vibrations, noise	Direct	During construction	Slight Adverse	
	During operation	Vibrations	Indirect	Permanent	Slight Adverse	
		Low air pollution	Indirect	Permanent	Major Beneficial	
		Accessibility	Indirect	Permanent	Major Beneficial	

CONCLUSION

The conclusions are based on the visual studies conducted on site in March 2020 before Covid 19 Pandemic. Further studies would be required for more analysis which includes measured drawings, material and structural decay mapping

The proposed metro line along the corridor 2 is elevated line. As per structure assessment studies, all the monuments are required only vibration studies at assess the PPV values expected during the construction works which are found withing permissible limit referring to provided data.

Due to existing structure condition of the monument, further assessment of the structures would be carried out to analyse the effects and to work out the mitigation measures for the monuments.

From visual study, there will be negligible change. There will be change from present context of the Lal Masjid and Tomb with introduction of proposed metro.

The proposed elevated metro line and metro station would provide opportunity for better access and interpretation of Lal Masjid and Tomb. Appropriate design proposal would be prepared for along with proposed elevated Kamla Nagar metro station design which is 450 mts away.

To ensure precautionary measures in place scientific tests would be conducted by professionals and regular monitoring of heritage complex would be conducted.

ROMAN CATHOLIC CEMETERY

AGRA METRO RAIL PROJECT

CONTENTS

ROMAN CATHOLIC CEMETERY

Image showing the Red Taj from the entry of the complex

ROMAN CATHOLIC CEMETERY
SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'34.84"N, 78° 0'17.58"E

This is a peaceful place, apart from the noise of heavy traffic on neighbouring roads. It is also well maintained, so it is easy to walk around. The cemetery dates 1550, the first burials being the Armenian Christians who settled in Agra during Akbar's reign. Other denominations of Christians followed and lived here in an area that became known as Padri Tola, so the Armenian burials were followed by others. Many of the Europeans known to have lived and died in Agra were buried here, including John Midendall who died in 1614 but whose gravestone has been remade. The two most prominent tombs are near the entrance. The octagonal one on the left is the tomb of Walter Reinhardt (Samru), the red sandstone one is that of John Hessing. Elsewhere there are a few other tomb buildings, two chapels and numerous gravestones. The lettering on the earliest of these was carved in relief rather than recessed, a far more complicated bit of work.[1]

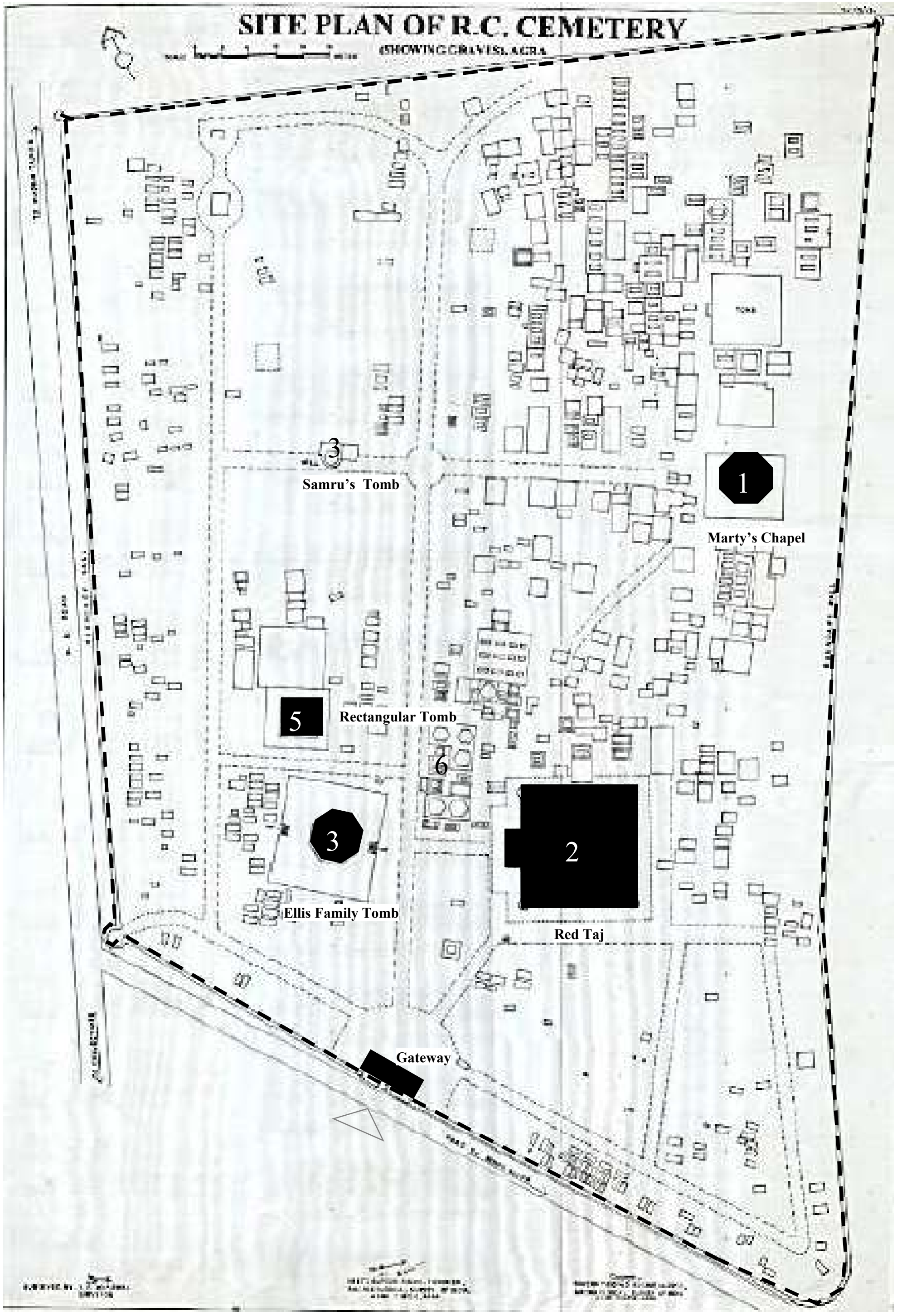
Authenticity and Integrity
The complex retains its original design and layout. The place continues to be cemetery from 1614 AD onwards. Many graves, gravestones and tomb are part of the oldest cemetery in North India. Most of original stones inscriptions and other masonry stones exists as a part of the structure. The complex is considered sacred and maintained as green, and peaceful area.

Attributes that carry Significance

- ✓ Design and layout of Roman Catholic Cemetery complex
- ✓ Original form of the tombs, chapel
- ✓ Decorative features and historic inscriptions on gravestones and other decorative features

[1] Peck, Lucy (2008) Agra, the Architectural Heritage *An Intach roli guide lotus collection*

SITE PLAN



Site plan of the Roman Catholic Cemetery complex[2]

[2] Digitisation Department, Agra circle, ASI

PRESENT CONDITION AND FACTORS AFFECTING HERITAGE VALUES OF ROMAN CATHOLIC CEMETERY (PRE-METRO CONSTRUCTION WORKS)

Present visual condition survey of Roman Catholic Cemetery along the proposed Metro route was carried out by team of architects and structural experts to understand the baseline conditions of the Roman Catholic Cemetery before construction and operation of elevated/underground Metro corridor. Present condition refers to current state of conservation of the heritage and any impacts resulting from previous actions, development or other agents of change.

ROMAN CATHOLIC CEMETERY

Present Condition

The cemetery is enclosed within high walls. The place is considered sacred and bounded by high walls and trees therefore disconnected from the rush at MG Road. The place is considered sacred and is well maintained by ASI.

Existing Impacts

- The R C Cemetery is located along the high traffic node of National Highway and MG road. The Baghwan Talkies in the north the cemetery. Many commercial activities are being carried out is the neighbourhood of the complex
- There are many masonry structures showing various degrees of distress and deterioration.

The entry gateway to the Roman Catholic cemetery complex

1. Marty's Chapel

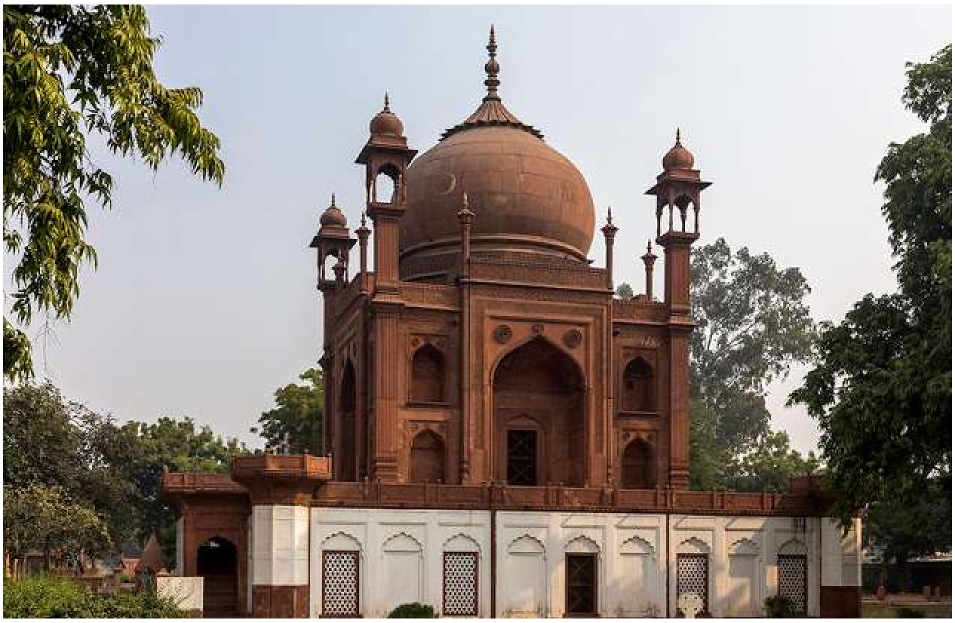
The view of Marty Chapel in cemetery complex

Marty's Chapel is the oldest structure inside this cemetery. It gets its name from Khoja Mortinepus, an Armenian merchant who was buried here in 1611 AD. The octagonal, domed monument has an arched entrance and jaali screens on two sides. The structure is maintained by visitors who light candles and incense sticks and leave flowers on the tombstones. The structure is structurally stable and safe. There is algae deposits on the exterior wall and dome surface. Overall condition of the monument is good.

There are many inscriptions in Portuguese inside the chapel. Many on these have which have partially vanquished.

Portuguese inscriptions inside the chapel

2. Red Taj

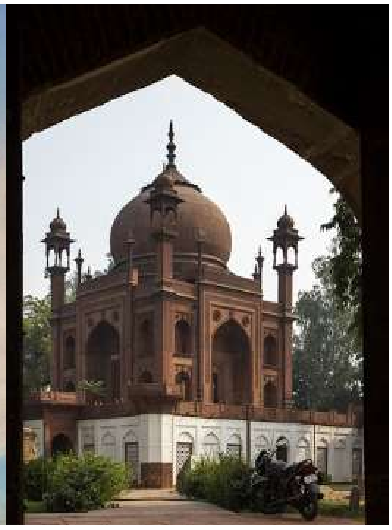


The John William Hessing's tomb

The centrepiece of this enclave is the Red Taj built in red sandstone. This elegant monument was built by a wife, in memory of a Dutch soldier, Col John William Hessing. The Red Taj also stands on a high plinth and within is a square platform with a crypt which contains the grave. The monumental tomb sports a bulbous double dome covered by a sheath of lotus petals and a *kalash*, and arched niches on the façade and fluted turrets topped with square *chhatris* on four sides. The ground level is surrounded by *jaali* screens on all sides and has doors to the *taikhana.*

The view of interior chamber of tomb

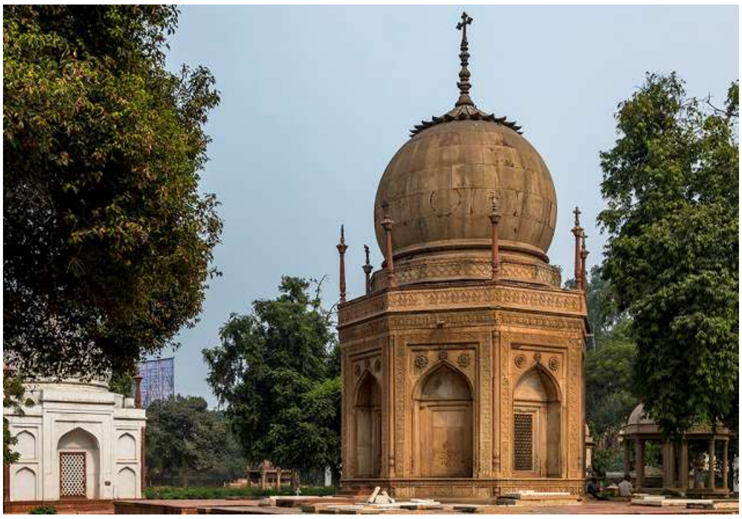
The fluted turret with square chattri



View of tomb from the entry gateway

This Red Taj is well maintained and in stable condition. The Hessing's family still visits the structure.

3. Ellis Family Tomb



View of Ellis family tomb

This octagonal domed tomb is from the 18th century. But this beautiful monument is actually the Ellis family tomb. The yellow mausoleum was built on a red sandstone plinth. Inside is the gravestone of Francis Ellis who died in Agra in 1868 AD. Surrounding the edifice, on the plinth are the markers of seven more members of the Ellis family. The final burial is comparatively recent: Christopher Ernest Ellis died on 9 April 1921 AD. The built structure and even decorative features and finials are in good condition.

4. Walter Rhinehardt Sombre(Samru's) Tomb

View of Samru's octagonal tomb structure

Walter Reinhardt Sombre, aka Samru, is one of the most infamous soldiers of fortune from 18th century India. He married Kashmiri girl and they moved to Agra, where she converted in Akbar's Church to Christianity, taking the name Johanna Nobilis Sombre, Begum Samru to Indians. He was to become the Governor of Agra and ruler of the principality of Sardhana before his death. He died in Agra on 4 May 1778 AD. His tomb is an octagonal, domed monument with a stone tablet in Portuguese and Persian.

Interior view of Samru Tomb

Plaster cracks on exterior surface

The gravestone of Walter R. Sombre

The interior wall plaster is deteriorated and there are plaster cracks on exterior surfaces. The tomb and original gravestone are is good condition.

5. Unknown Tomb

The square tomb with bulbous dome is unknown tomb of some Englishman. The tomb is in stable condition. Only the stones plinth of the tomb is deterioration. There is blackening on wall exterior plaster surfaces.

Unknown square tomb structure

Mughal style graves as visible from the terrace of Red Taj

6. Chhatris like Tombs

There few graves with Mughal style chhatris built in 20th century. These chhatris are in are built in yellow sandstone have decorative Mughal elements. All these are in good condition.

High walls encloses the cemetery complex

Other small tombs are in stable condition

Few of many inscriptions on the gravestones which are found all across the complex. Some of them are damaged.

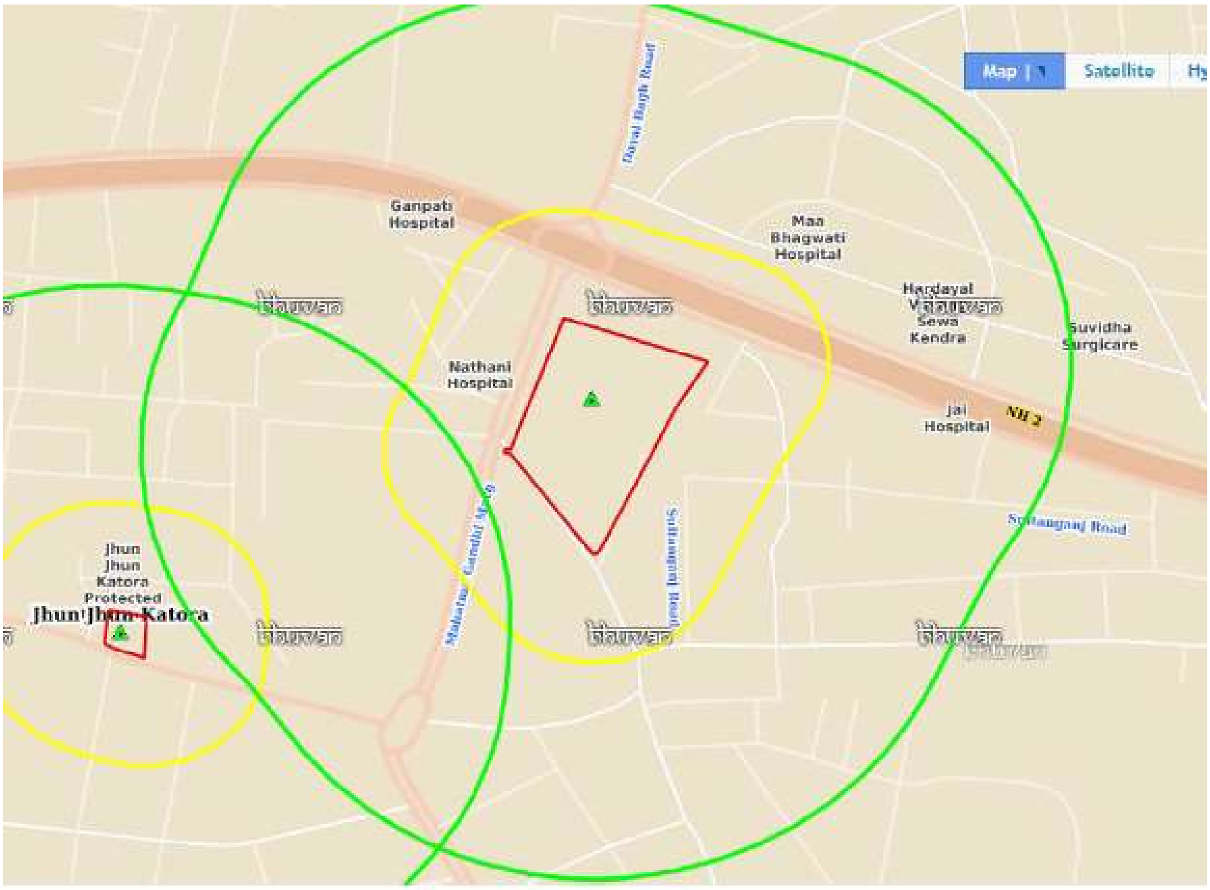
PROPOSED METRO WORKS TO ROMAN CATHOLIC CEMETERY

ROMAN CATHOLIC CEMETERY

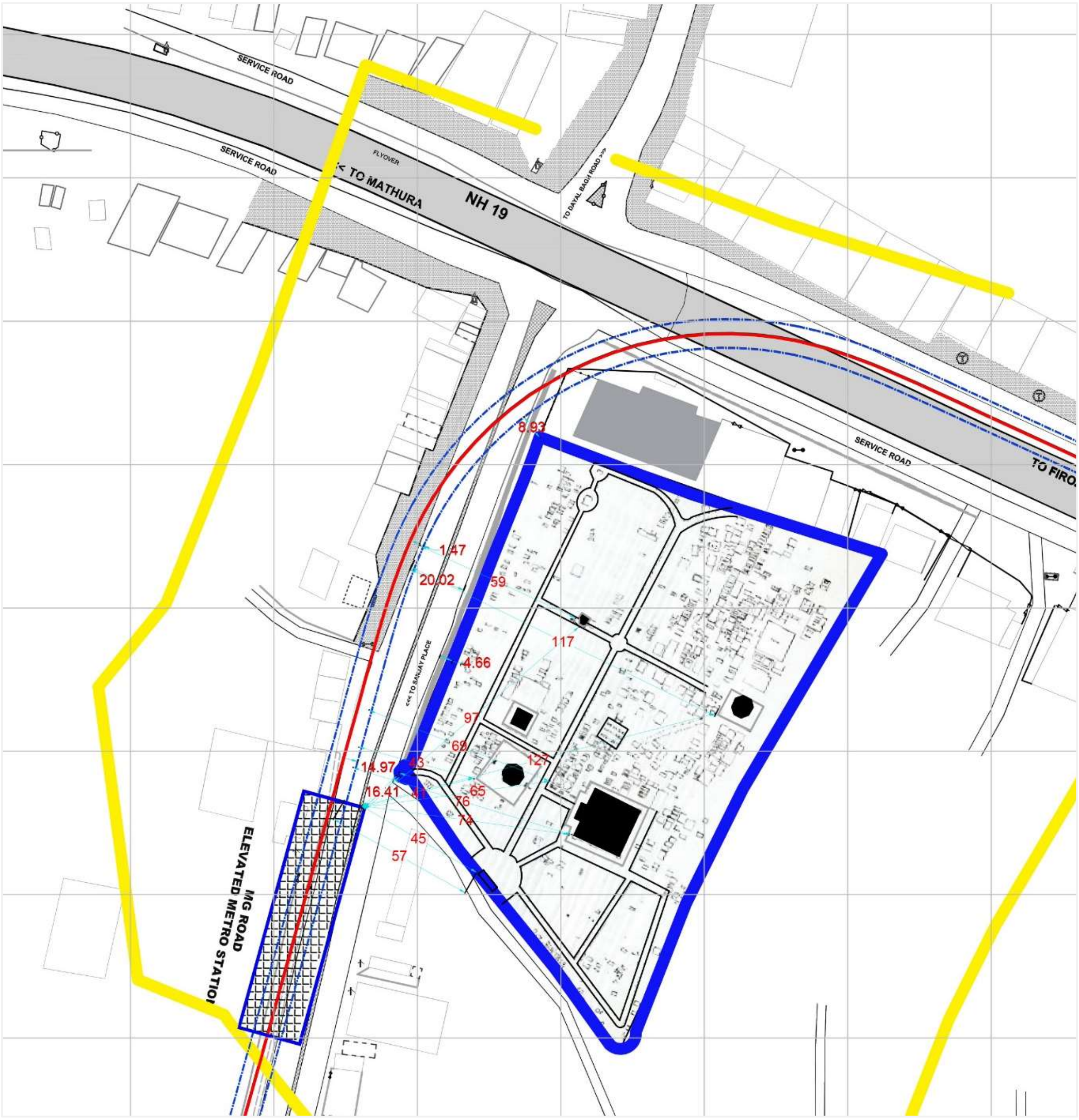
NEAREST METRO STATION	: MG ROAD METRO STATION
DISTANCE FROM METRO LINE (IN METRES)	: 14 mtrs
DISTANCE FROM METRO STATION (IN METRES)	:18 mtrs

NAME OF MONUMENTS	NEAREST METRO STATION	ALIGNMENT ELEMENT	CONSTRUCTION METHOD	PROPOSED WORKS
ROMAN CATHOLIC CEMETERY	MG ROAD	Elevated	Viaducts on piers	Site formation
				Pile boring
				Construction of viaduct structure
				Erection of girders

Table 1- Describing proposed metro work



Map showing protected (red color), prohibited (green (100m)) and regulated (green 300m) boundaries of Roman Catholic Cemetery | Source: Bhuvan Website



The shows closest distance from the metro line and metro station from the protected site boundary and structures inside the complex

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
1a	**R. C Cemetery**	**Marty's Chapel**	ASI	132	120
1b		**The Red Taj**	ASI	73	79.5
1c		**Ellis Family Tomb**	ASI	48.5	49.5
1d		**Samru's Tomb**	ASI	97.5	59
1e		**Unknown Tomb**	ASI	58	47.5
1f		**Chhatris like Tombs**	ASI	84	78
1g		**Gateway**	ASI	43.5	50.5

Table 2- Distances from the proposed metro line and metro station

Observations:

Proposed elevated Metro line is at a distance of 14 mts from protected boundary of Roman Catholic Cemetery complex which is within the prohibited boundary of 100 mts of Roman Catholic Cemetery.

Proposed elevated MG Road metro station is at a distance of 18 mts Roman Catholic Cemetery which is within the prohibited boundary of 100 mts of Roman Catholic Cemetery.

HERITAGE IMPACT SUMMARY

The heritage impact assessment is carried out under three heads:

- **TABLE DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES OF ROMAN CATHOLIC CEMETERY**

- **VISUAL IMPACT ASSESSMENT**

- **STRUCTURE ASSESSMENT**

TABLE 3- DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES OF ROMAN CATHOLIC CEMETERY

SIGNIFICANCE	ATTRIBUTES	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	FURTHER STUDIES OR TESTS PROPOSED	RECOMMENDATION
BUILT HERITAGE	Design and layout RC cemetery		No Change	Neutral		No mitigation measures required
	Original architecture of the tombs and chapels	Vibration due to construction activities	Negligible change	Neutral	Expected PPV from construction on activities in within limits	Documentation and monitoring of the historic monuments during the execution of the project is reaccommodate
	Decorative features and Historic inscriptions on gravestones	Dust deposits during construction phase	Negligible change	Slight Beneficial	Existing ambient vibration levels to be measured	
	Decorative features	Long term benefits during operation of metro	Negligible change	Slight Beneficial	Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day for further analysis	

VISUAL IMPACT ASSESSMENT

View of RC Cemetery from MG Road

Existing visual connection:

The entire cemetery complex is bounded by high walls. Therefore, most of the smaller tombs and gravestones are not visible from either the MG Road or National Highway-19.

The Bagwan Talkies in the north restricts the view from the north direction. Only the domes of Red Taj and Elis tomb are visible from MG Road. No major viewpoint of the complex from the outside as of present

View of RC cemetry from National Highway 19(RCV1)

Impact on visual connection:

Proposed elevated metro line and the ***elevated metro station will have no negative impact*** as there is no visual connection (from the distant viewpoints of the complex) from the existing flyover (NH19) as seen in above image.

Though the elevated viaducts and elevated metro station on MG road will be visible from the inside of the cemetery complex. ***This view is also partially blocked by the large trees along the high boundary wall in the complex***.

STRUCTURE ASSESSMENT

Roman Catholic Cemetery

1. **Protection status: Archaeological Survey of India**

2. **Proposed development actions:** Elevated metro line

3. **Structural system:**
    a) Square and octagonal shaped structures with load bearing structures with masonry walls, arches and dome
    b) Horizontal structural system: Needs investigations
    c) Vertical structural system: The vertical structural system comprises of columns, arches and masonry walls.

4. **Condition of historic structures**
    a) Visual survey of the monuments was done in March 2020 before lockdown and all the structures were found structurally stable.
    b) Detailed survey would be carried out as and when situation allows. Minor distress was observed in few locations. Detailed investigations required to map material and structure decay

5. **Level of distress:** No major distress expected as per existing available data

6. **Expected impacts**
    a) Impact of soil settlement: No impact
    b) Impact of vibrations due to tunnelling: No impact
    c) Impact of vibrations due to excavation: No impact

7. **Permissible limit:** Expected PPV is within limits. Actual locations of the columns would be identified and their distance from individual monuments would be measured for further analysis. Analysis would be conducted considering the existing condition of the monuments

8. **Expected settlement:** None

9. **Category of risk:** Low risk

10. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure. Regular monitoring of the historic monuments is recommended during the execution of the project as well as during the operation of the metro line.

TABLE 4- EXPECTED IMPACTS DUE TO VIBRATIONS FOR PROTECTED MONUMENTS

S. no	Name of Heritage Resource	Nearest Metro Station	Alignment element	Distance from Metro line (in meters)	Distance from Metro Station (in meters)	Expected Vibration Impacts**
1	RC Cemetery boundary wall	MG ROAD	Elevated	14	18	PPV values expected during proposed construction activities are within limits
1	Marty's Chapel	MG ROAD	Elevated	120	132	
2	Red Taj	MG ROAD	Elevated	79.5	73	
3	Ellis Family Tomb	MG ROAD	Elevated	49.5	48.5	
4	Unknown rectangular tomb	MG ROAD	Elevated	58	47.5	
5	Samru's Tomb	MG ROAD	Elevated	59	97.5	
6	Chhatries like tomb	MG ROAD	Elevated	84	78	
7	Gateway	MG ROAD	Elevated	50.5	43.5	

TABLE 5- IMPACT SUMMARY ROMAN CATHOLIC CEMETERY ROMAN CATHOLIC CEMETERY							
	VALUE	**PROPOSED WORKS**	**TYPE OF IMPACT**		**DURATION OF IMPACT**	**SIGNIFICANCE OF IMPACT**	
						EXPECTED SEVERITY	**RISK CATEGORY**
	HIGH	Site formation	Vibration, dust and debris	Direct	During construction	Slight Adverse	*Low risk*
		Pile boring	Vibration	During construction	During construction	Neutral	
		Construction of viaduct structure	Vibrations, noise	Direct	During construction	Slight Adverse	
		Erection of girders	Vibrations, noise	Direct	During construction	Slight Adverse	
		During operation	Vibrations	Indirect	Permanent	Slight Adverse	
			Low air pollution	Indirect	Permanent	Major Beneficial	
			Accessibility	Indirect	Permanent	Major Beneficial	

CONCLUSION

The proposed metro line along the corridor 2 is elevated line. As per structure assessment studies, all the monuments are required only vibration studies at assess the PPV values expected during the construction works which are found withing permissible limit referring to provided data.

Further assessment of the structures would be carried out to analyse the effects and to work out the mitigation measures for the monuments.

The proposed elevated metro line and metro station would provide opportunity for better access and interpretation of Roman Catholic Cemetery. Appropriate design proposal would be prepared for along with proposed elevated MG Road metro station design which is 18 mts away.

To ensure precautionary measures in place scientific tests would be conducted by professionals and regular monitoring of heritage complex would be conducted.

RAM BAGH

AGRA METRO RAIL PROJECT

RAM BAGH: HOUSES, KIOSKS, TERRACES AND KATRA

Image showing Ram Bagh houses and terraces

RAM BAGH
SIGNIFICANCE: HIGH
STATUS: NATIONALLY PROTECTED MONUMENT
CORDINATES: 27°12'19.38"N, 78° 2'19.03"E

The Ram Bagh is said to have been constructed by Babur. It is commonly believed that when Babur died in 1530 his mortal remains were temporarily kept in Chaubureja a place close to Itimad-ud-Daula tomb till these were taken for the final resting place at Kabul. The original name of the bagh was Aram Bagh, which was later corrupted to Ram Bagh under the Marathas, when they occupied Agra from 1775 to 1803 AD The first historical mention of this garden site as the Bagh-Nur-Afshan led some historians to believe that this name had been derived from a garden (Bagh –Gul- Afshan or Nur Afshan) in Kabul. The garden was in good maintenance under Jahangir as confirmed by Tazuk-I- Jahangiri. It gets additional support from the paintings and epigraphical evidences found in some of the remaining structures of this garden. Colossal walls enclose the garden with corner towers crowned by pillared pavilions. The garden is divided into quarters by stone paved pathways. On the north- eastern side of this building, there exists another terrace, from which steps leads to a Hammam. The rooms of the Hammam, now in ruins bear evidence of a vaulted one roof. Immediately north side of this garden, there is a row of ruined houses with a gateway, built of red sandstone at each end.

The layout of the garden complex is not on the formal Char Bagh pattern, but confirms rather to the pattern of Bagh- Hasht-Behisht. In the garden three levels have been maintained, one for flowers and vegetables, second for flower beds, with fine stone paved terraces and kiosk and the third one has structures, terraces and tanks.[1] This arrangement was described by an anonymous 1796, who remarked that the high walkways must been created so that 'her majesty might not trouble of stretching out her hand to pull the fruit from the branches, she was a most luxurious woman'.

Entered through a colonial arch clearly visible from the Aligarh Road. An ASI entry fee is charged.

[1] Description retrieved from ASI Agra circle website on 30 ' Nov 2019 https://www.asiagracircle.in/some-other.html#4

Integrity

The complex retains its original size and layout and include all the elements necessary to express the significance of the Mughal Garden. The existing buildings, pavilions, chhatries, water channels, chadars, enclosure walls and others still has its original form, profile and features. Archival records show that his garden was much restored during colonial times and used for recreational purposes. While some features of the buildings such as their layout (the alternate open and closed rooms) and the post and beam arcades continued into Mughal architectural styles, other elements did not, such as peacock brackets supporting the chajja and the complicated vault decorations and realistic paintings of people, birds and beasts inside.

Authenticity

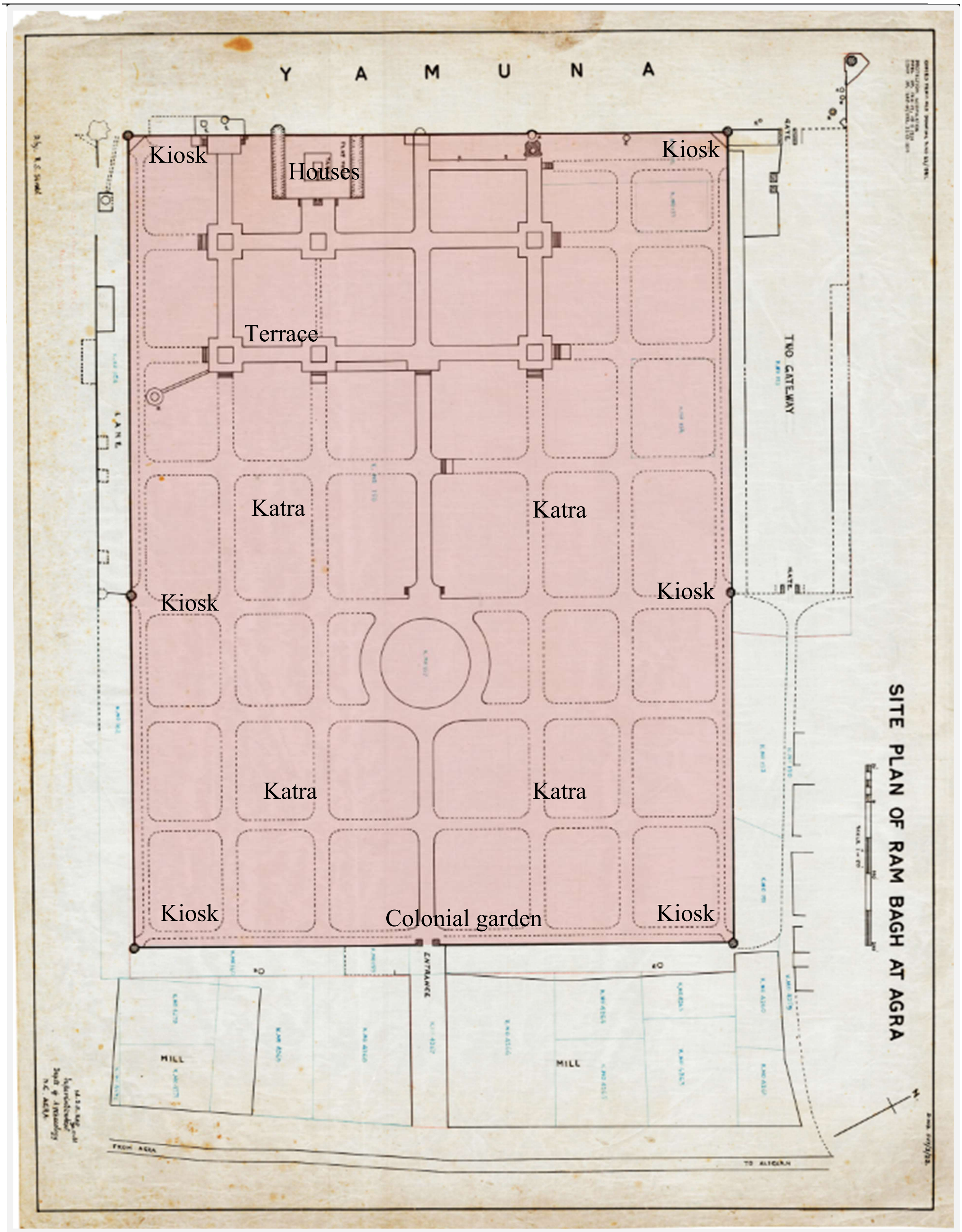
Principal buildings of the Mughal garden are still stand in original forms on a platform overlooking the river. Original building material, construction details and decorative features such as columns, brackets, jalies etc are still in original forms. These buildings were restored and extra floor was added in the nineteenth century has been removed to revive the original form. Layout and sculpted details remain, the interior and exterior walls were probably once covered in painted decoration most of which has vanquished today, some of comparatively recently.

Existing remains still depicts the original Landscape layout and features. These altogether are sufficient to express the original form and layout of the Mughal garden of Rambagh.

Attributes that carry Significance

- ✓ ***Archaeological remains***
- ✓ ***Design and layout*** of charbagh gardens (alternate open and closed rooms)
- ✓ ***Landscape features***-Stoned paved terraces, high walkways, kiosks and arch gateways, water channels and chadars, water tanks
- ✓ ***Colonial Structures***- Colossal walls enclose and entrance gateways with corner towers crowned by pillared pavilions
- ✓ ***Structures within the gardens***- Pavilions, chatries, hamams and other structures
- ✓ ***Decorative elements***- paintings work on the vaults, stone jalies, leaf pattern bands, peacock brackets and columns with projected chajjas
- ✓ **Historic water systems**- wells, water channels, tanks etc
- ✓ ***River platform*** -overlooking river Yamuna with bastions, chatries and stone jalies

SITE PLAN



Site plan of the Ram Bagh complex[2]

[2] Digitisation Department, Agra Circle, ASI

PRESENT CONDITION AND FACTORS AFFECTING HERITAGE VALUES OF RAM BAGH (PRE-METRO CONSTRUCTION WORKS)

Present condition survey of identified heritage resources along the proposed Metro route was carried out by team of architects and structural experts to understand the baseline conditions of the heritage resources before construction and operation of elevated/underground Metro corridor. Present condition refers to current state of conservation of the heritage resource and any impacts resulting from previous actions, development or other agents of change.

RAM BAGH

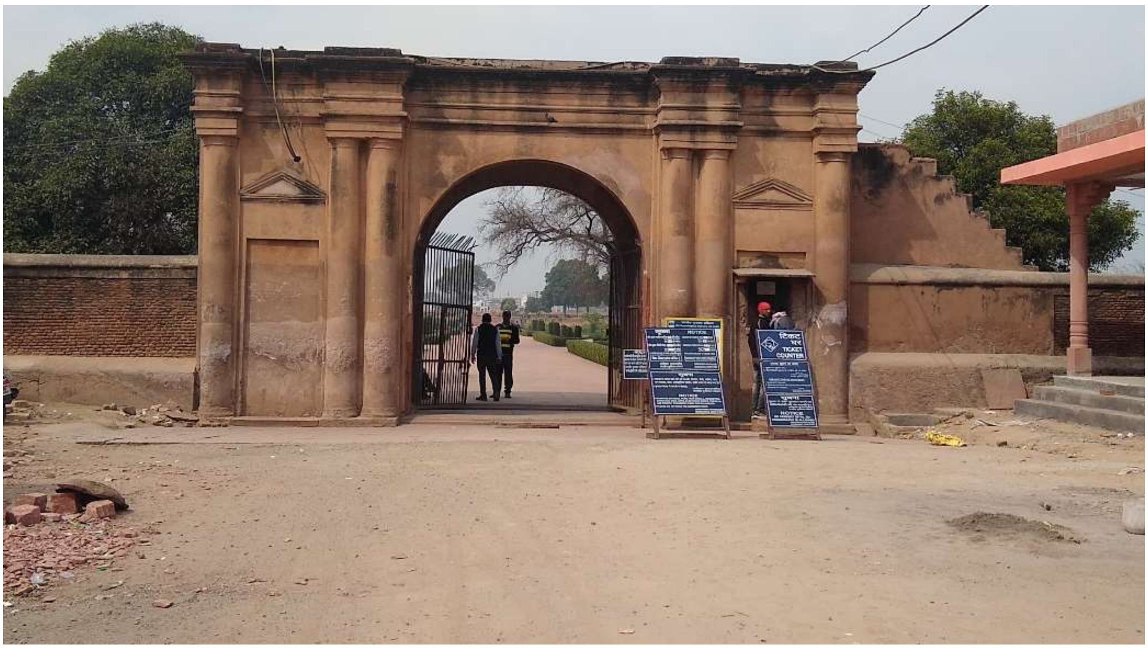
Present Condition

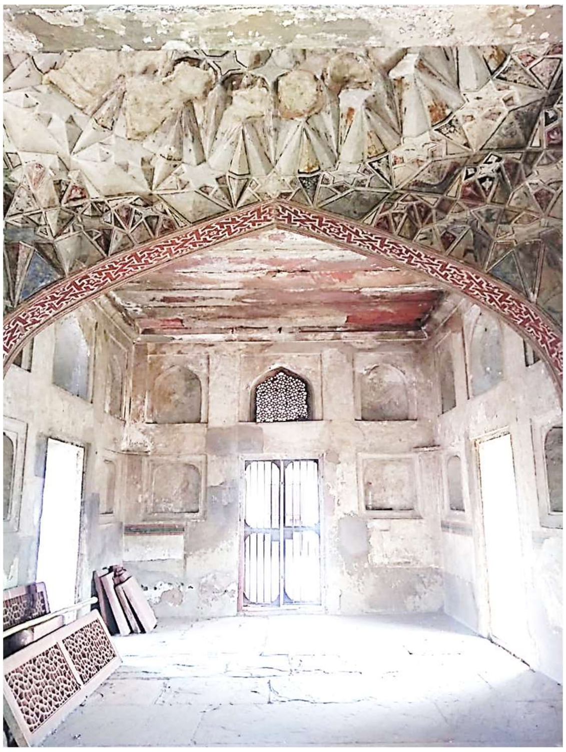
Mughal garden still has its elements but not completely in original shape in profile. The original water system in not in working condition due to lost original water system of the Mughal garden. Original flora and fauna are not intact and required further research to explore the original flora. Original profile of the Mughal can be seen through existing pathways, water channels, water tanks, chadars and archaeological remains. Existing landscape features are in good condition and were repaired in recent past. Original wells are in decayed condition. Few open areas in decayed status. Historic structures like Houses, Kiosks, Terraces, chhatires, terraces and Katra are quite in stable condition but sign of material decay is visible at few places.

Existing Impacts

- Heavy vehicular traffic on NH 19 and flyover in the front cause vibrations. It is also caused the visual dis-connectivity
- Conditions of various structure shows signs of deterioration at several locations
- Few of the original decorative painting works have decayed and partly lost
- Immediate surrounding has number small scale of commercial activities and encroachments

A colonial gateway to Rambagh complex





Decorative features in the interiors of pavilions showing sign of deterioration

Condition of terraces are stable. There are signs of stone deterioration in patches all over.

Condition of terraces of charbagh are stable. Signal storey houses are also in stable condition. There are signs of stone deterioration.

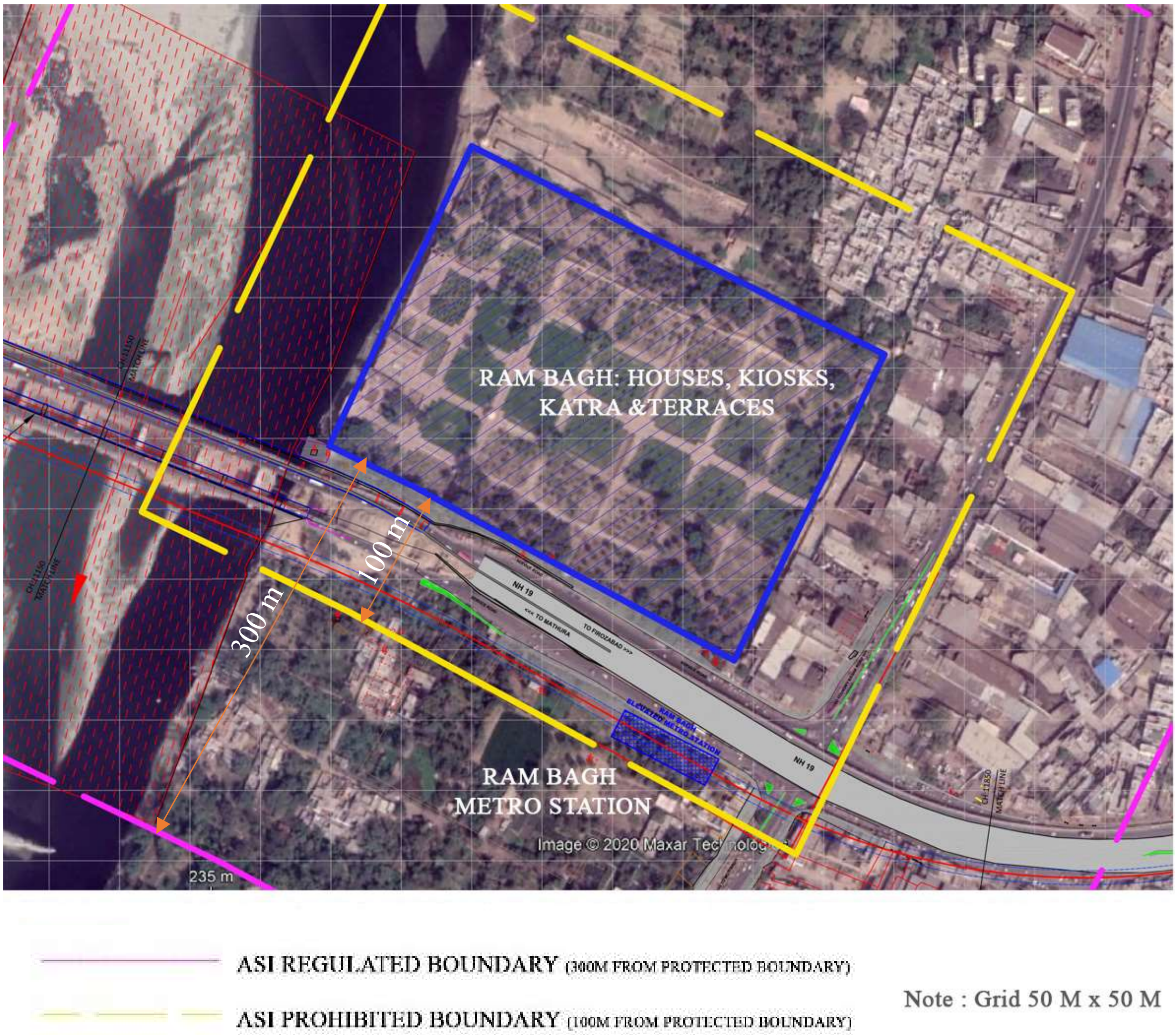
PROPOSED METRO WORKS TO IDENTIFIED RAM BAGH: HOUSES, KIOSKS, TERRACES AND KATRA

NEAREST METRO STATION: RAM BAGH METRO STATION

DISTANCE FROM METRO LINE (IN METRES): 67 mtrs

DISTANCE FROM METRO STATION (IN METRES): 67 mtrs

NAME OF MONUMENTS	NEAREST METRO STATION	ALIGNMENT ELEMENT	CONSTRUCTION METHOD	PROPOSED WORKS
Ram Bagh: Houses, Kiosks, Terraces and Katra	Ram Bagh	Elevated	Viaducts on piers	Site formation
				Pile boring
				Construction of viaduct structure
				Erection of girders



Protected, prohibited and regulated boundaries of Rambagh Complex

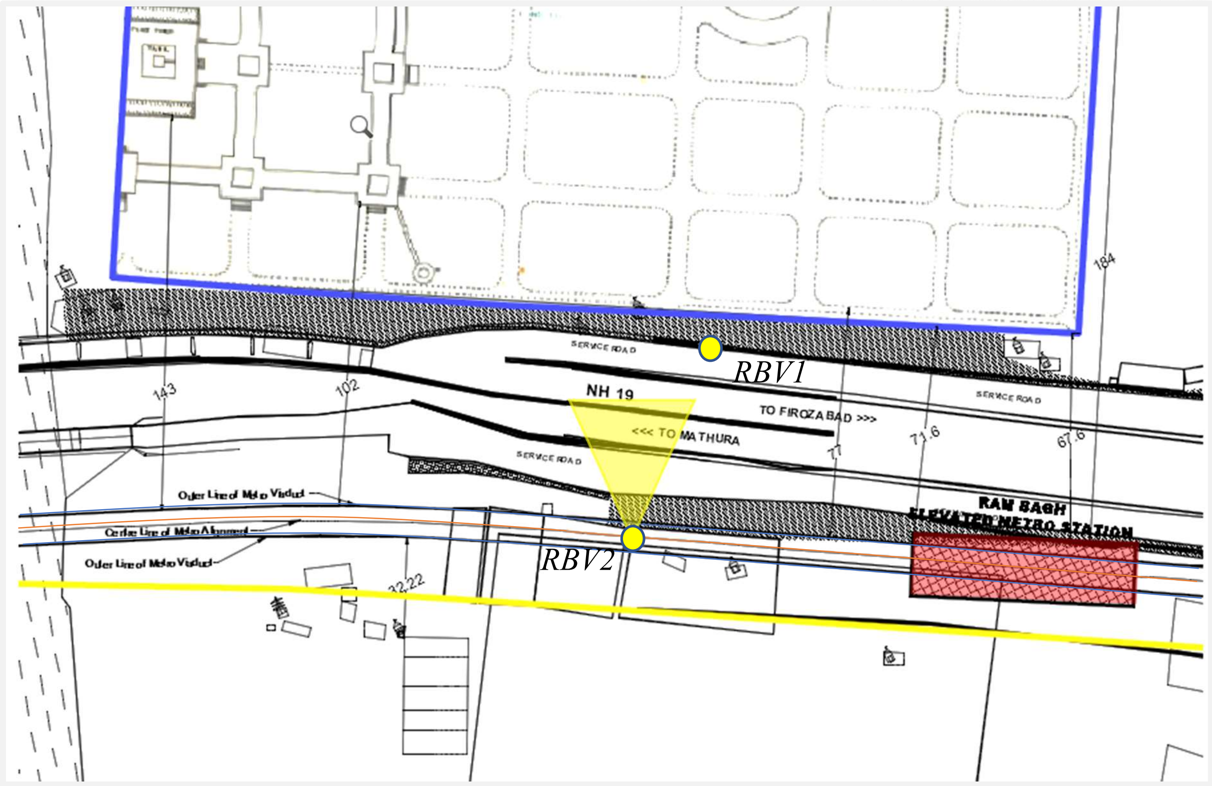


Image showing the nearest distances to structures inside the Ram Bagh Complex

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
1	**Ram Bagh**		ASI	67	67

Observations:

Proposed elevated Metro line is at a distance of 67 mts from protected boundary of Rambagh is within the prohibited boundary of 100 mts. Most the structures of the complex are beyond the 67 mts.

Proposed elevated Ram Bagh station is at a distance of 67 mtrs Rambagh: Houses, Kiosks Terraces and Katra is within the prohibited boundary of 100 mts.

HERITAGE IMPACT SUMMARY

- **TABLE DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES**
- **OF RAMBAGH**

- **VISUAL IMPACT ASSESSMENT**

- **STRUCTURE ASSESSMENT**

TABLE DESCRIBING PREDICTED IMPACTS ON ATTRIBUTES OF RAMBAGH: HOUSES, KIOSKS TERRACES AND KATRA

- ✓ ***Archaeological remains***
- ✓ ***Design and layout*** of charbagh gardens (alternate open and closed rooms)
- ✓ ***Historic landscape features***-Stoned paved terraces, high walkways, kiosks and arch gateways, water channels and chadars, water tanks
- ✓ ***Colonial Structures***- Colossal walls enclose and entrance gateways with corner towers crowned by pillared pavilions
- ✓ ***Structures within the gardens***- Pavilions, chatries, hamams and other structures
- ✓ ***Decorative elements***- paintings work on the vaults, stone jalies, leaf pattern bands, peacock brackets and columns with projected chajjas
- ✓ **Historic water systems**- wells, water channels, tanks etc
- ✓ ***River platform*** -overlooking river Yamuna with bastions, chatries and stone jalies

SIGNIFICANCE	ATTRIBUTES	PREDICTED IMPACTS	SCALE OF SEVERITY OF IMPACT	SIGIFICANCE OF IMPACT	FURTHER STUDIES OR TESTS PROPOSED	RECOMMENDATION
ARCHAEOLOGICAL SIGNIFICANCE	Archaeological remains	None	No Change	Neutral	None	No mitigation measures required
BUILT HERITAGE AND HISTORIC LANDSCAPE	Design and layout	None	No Change	Neutral	None	No mitigation measures required
	Historic landscape features	None	Negligible change	Neutral	None	No mitigation measures required
	Colonial Structures	Vibration	Negligible change	Neutral	Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day for further analysis	Regular monitoring of the structure during execution of the project is required
	Structures within garden complex	None	No Change	Neutral	None	No mitigation measures required
	Decorative elements	None	Negligible change	Slight beneficial	None	No mitigation measures required
	Historic water systems	None	No Change	Neutral	None	No mitigation measures required
	Platform over-looking river Yamuna	None	Negligible change	Neutral	None	No mitigation measures required

VISUAL IMPACT ASSESSMENT

RBV1 View of Ram bagh complex boundary wall from the edge of highway

Existing visual connection:

The present visual connection across the national highway 19 is blocked by flyover. There is a major difference with heights and that even boundary wall of the complex will not be visible from human eye level from the proposed location of metro station. Partial view of kiosk dome and trees inside are visible.

Impact on visual connection:

Proposed metro line will elevated but it will be blocked by the existing national highway NH 2/NH 19 . Therefore, will the metro line will have negligible impact on the view of Ram Bagh.

STRUCTURE ASSESSMENT INVENTORY

Rambagh

1. **Protection status:** Archaeological Survey of India

2. **Proposed development actions:** Elevated metro line

3. **Structural system:**
   a. Enclosure walls and arches gateways are load bearing structures with brick masonry in lime mortar
   b. Structures within garden complex are columned structure with stone columns, beams and projected decorative brackets supporting the chajja. Internal areas are covered with flat roof comprising stone panels resting on the walls.
   c. Garden chhatries are composed of stone columns with beams and covered with domes
   d. Retaining walls towards river side are of brick masonry in lime mortar

4. **Condition of historic structures**
   a. Sign of material deterioration is visible in all the structures
   b. Sign of structural distress at few locations in the enclosure walls and river side walls
   c. Detailed investigation works would be carried out soon

5. **Level of distress:** No major distress detected as per existing available data.

6. **Expected impacts**
   - Impact of soil settlement: No impact
   - Impact of vibrations due to tunnelling: No impact
   - Impact of vibrations due to excavation: No impact

7. **Permissible limit:** Expected PPV is within limits as per available data. Actual locations of the columns would be identified and their distance from individual monuments would be measured for further analysis. Further analysis would be conducted considering the existing condition of the monuments.

8. **Expected settlement:** None

9. **Category of risk:** Low

10. **Recommendations:** The proposed alignment of the metro corridor does not pose any

threat to this protected structure. Regular monitoring of the historic monuments is recommended during the execution of the project as well as during the operation of the metro line.

TABLE 4- EXPECTED IMPACTS PROTECTED MONUMENTS

NAME OF MONUMENT	VALUE	PROPOSED WORKS	TYPE OF IMPACT		DURATION OF IMPACT	SIGNIFICANCE OF IMPACT	
						SEVERITY	RISK CATEGORY
RAM BAGH	HIGH	Site formation	Vibration, dust and debris	Direct	During construction	Nil or Negligible	*Low risk*
		Pile boring	Soil settlement	None	None	Nil or Negligible	
		Construction of viaduct structure	Vibrations, noise	Direct	During construction	Nil or Negligible	
		Erection of girders	Vibrations, noise	Direct	During construction	Nil or Negligible	
		During operation	Vibrations	Indirect	Permanent	Nil or Negligible	
			Low air pollution	Indirect	Permanent	Major Beneficial	
			Accessibility	Indirect	Permanent	Major Beneficial	

CONCLUSION

The proposed metro line along the corridor 2 is elevated line. As per structure assessment studies, all the three monuments are required only vibration studies at assess the PPV values expected during the construction works which are found withing permissible limit referring to provided data.

As per structure assessment studies, proposed alignment of the metro corridor poses nil to negligible threat to Rambagh due to ground settlement or vibrations expected during the construction of the metro line.

From visual study, there will be negligible change. There will be change from present context of the Rambagh with introduction of proposed metro.

The proposed elevated metro line and metro station would provide opportunity for better access and interpretation of Rambagh. Appropriate design proposal would be prepared for along with proposed elevated Ram Bagh metro station design which is 67 mts away.

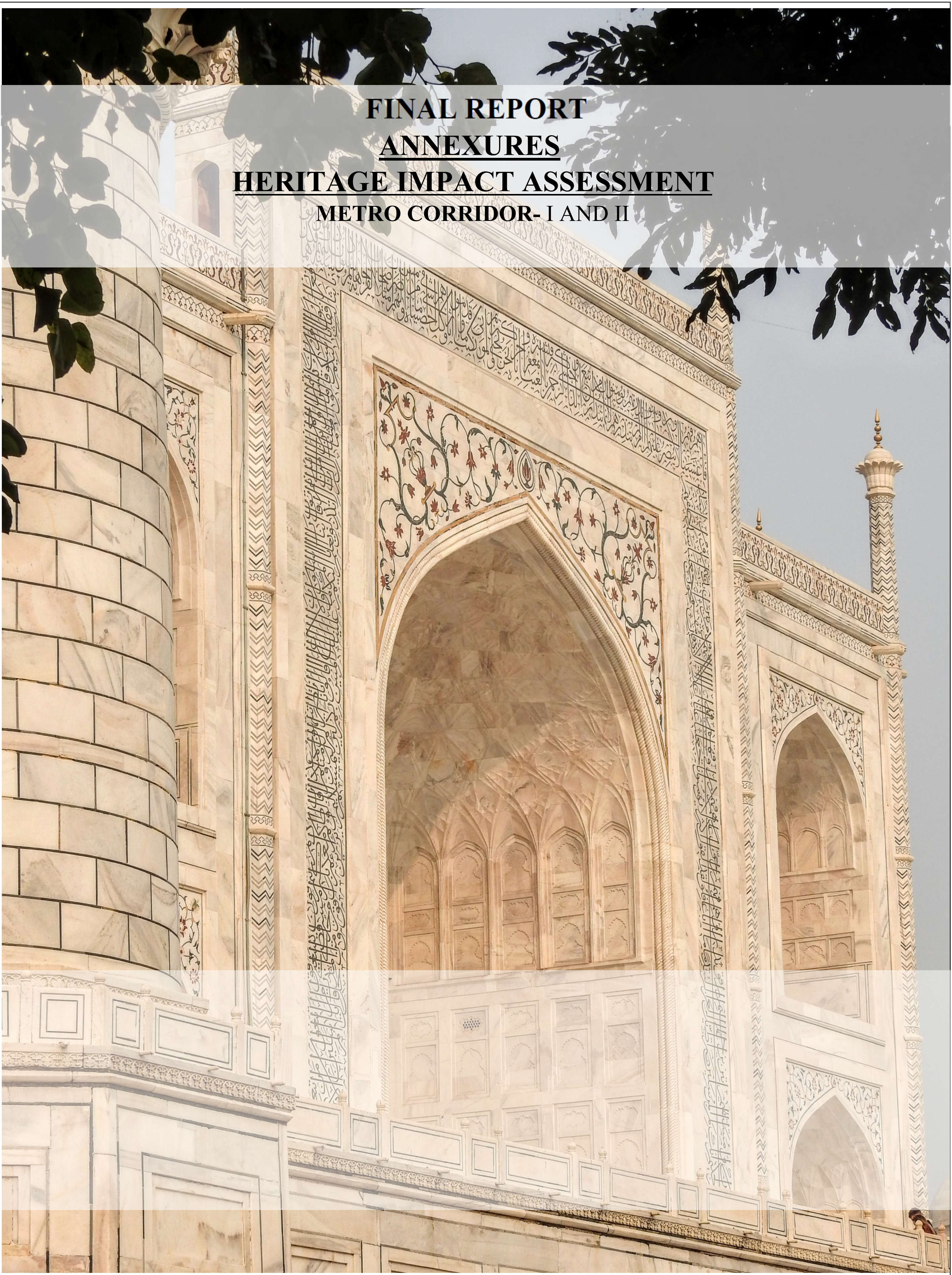
To ensure precautionary measures in place scientific tests would be conducted by professionals and regular monitoring of heritage complex would be conducted during execution of the project and during operation of metro.

FINAL REPORT

ANNEXURES

HERITAGE IMPACT ASSESSMENT

METRO CORRIDOR- I AND II



Lucknow Metro Rail Corporation Limited
लखनऊ मेट्रो रेल कॉर्पोरेशन लिमिटेड
A Joint Venture of Govt. of India and Govt. of Uttar Pradesh
(An ISO 14001:2015 & OHSAS 18001:2007 Certified Organisation)

DBD Consultants
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Branch Off. : Gurgaon (Haryana), Noida (U.P.), Hyderabad (A.P.), Mohali (Punjab), Baddi (HP)

HERITAGE IMPACT ASSESSMENT (HIA): PROPOSED METRO CORRIDOR- I SIKANDARA TO TAJ EAST GATE TO THE HERITAGE RESOURCES OF AGRA INCLUDING THE TWO WORLD HERITAGE PROPERTY OF TAJ MAHAL AND AGRA FORT

Authorship: An interdisciplinary team formed by DBD consultants led by Sangeeta Bais, *Principal Architect, Dharohar* along with Mr. Arun Menon, *National Centre of Safety of Heritage Structures Indian Institute of Technology, Madras*, Tara Sharma, *Heritage management expert* and Mr. A. K.Sinha, *Senior Archaeologist as advisor* with Ms. Kanishka Sharma, *Conservation Architect*, Ms. Meenu Kushawah, *Conservation Architect*, Ms. Abantika Mukherjee, *Conservation Architect*, Mr. Sameer Dhanda, *Architect*, Ms. Subarna Sadhu, *Architect*, Ms. Priyanka Baghel, *Intern Architect*

Specific HIA focus: Proposed Metro corridor- I Sikandara to Taj East Gate, Agra, Uttar Pradesh

Prepared for:

Lucknow Metro Rail Corporation Limited
लखनऊ मेट्रो रेल कॉर्पोरेशन लिमिटेड
A Joint Venture of Govt. of India and Govt. of Uttar Pradesh
(An ISO 14001:2015 & OHSAS 18001:2007 Certified Organisation)

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NCSHS

National Centre of Safety of Heritage Structures
Department of Civil, Engineering IIT Madras, Chennai, 600 036

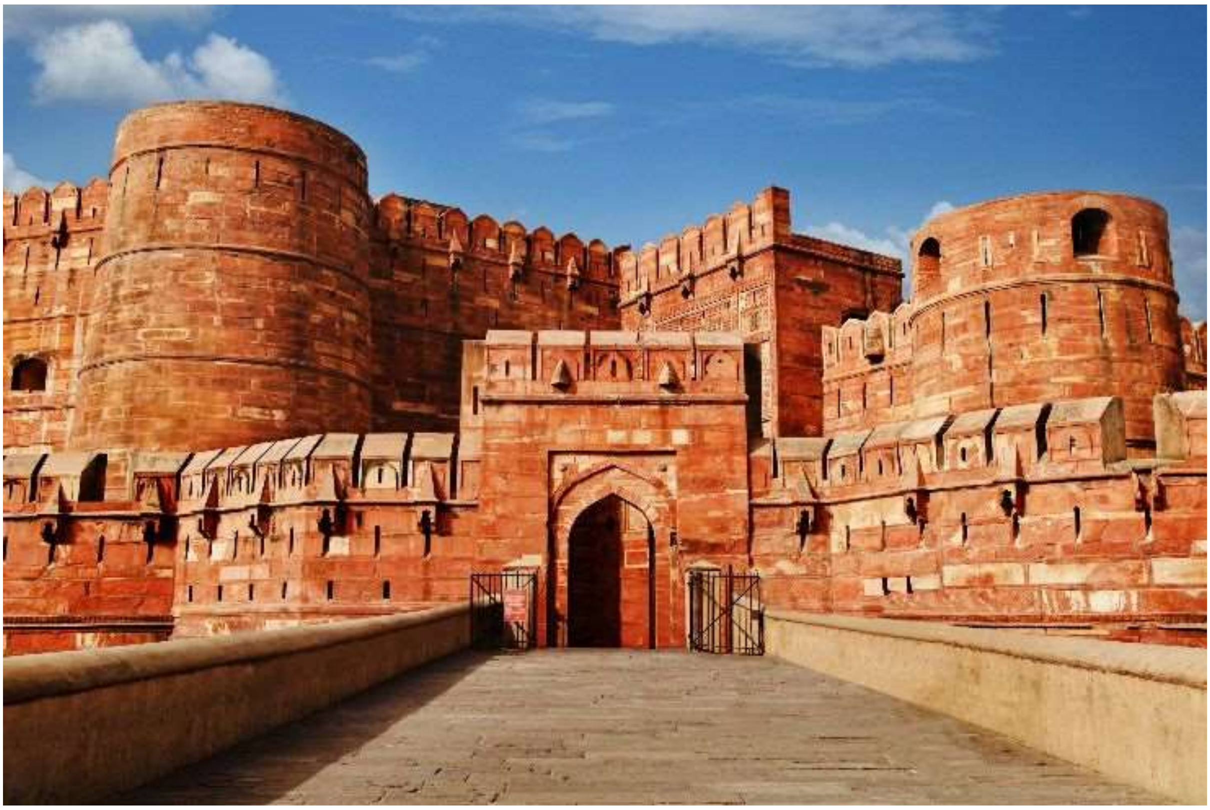
Cover photo: View of the World Heritage property of the Taj Mahal

Table of contents

Annexure-I

Final Report
on

Structural Damage Risk Assessment for Heritage Impact Assessment (HIA) of Agra Metro



Submitted to

M/s. Dharohar, New Delhi

by

National Centre of Safety of Heritage Structures
Department of Civil Engineering IIT Madras, Chennai, 600 036

27 November 2019

Investigation Report prepared by:
Ms. Angel Paul - Geotechnical Engineer
Dr Jitesh Chavda - Geotechnical Engineer
Ms. Aishwarya K.V. - Conservation Architect
Ms. Aarthy Lakshmi -Structural Engineer

Verified by:
Dr Arun Menon - Structural Engineer

National Centre for Safety of Heritage Structures (NCSHS)
Department of Civil Engineering, IIT Madras
16 November 2019

1 INTRODUCTION:

National Centre of Safety of Heritage Structure (NCSHS), Department of Civil Engineering, Indian Institute of Technology, Madras was approached to carry out a structural damage risk assessment within the Heritage Impact Assessment (HIA) of Agra Metro. The proposed alignment of the metro line runs elevated/underground in proximity to several heritage structures, thereby exposing these structures to varied levels of vibration during construction activities and metro operations, and the possibility of ground settlement during excavation. Therefore, an assessment to examine the vulnerability of these structures to the proposed construction is being carried out. The current document is the final report on Damage Risk Assessment that outlines the methodology, expected settlements at the ground near the excavation or tunnelling, methodology to estimate vibrations during metro construction and the expected effects on the historical structures in the vicinity of the alignment, the latter based on a structural typology and visual condition survey of the historical structures and risk category that the heritage structure are categorised in. The heritage buildings present along Corridor 1 and their subsequent distance from the metro line considered for the above discussed assessment are listed in Table 1.

2 METHODOLOGY:

The investigation procedure is divided into two major parts, Underground metro line and elevated metro line as outlined in Figure 1, hereunder. The underground metro line in further divided into two major parts .The first part includes a study of the soil profile to assess the induced soil settlement and to generate a settlement profile near the excavation or tunnelling of the metro construction. The second part involves a visual inspection of all the heritage structures located within the 300 m radius of the metro line, to assess its structural typology, material of construction and current state of preservation. The structures along the elevated metro line have been assessed based on visual inspection as described before. Further, expected vibration levels (Peak Particle Velocity: PPV) due to metro construction activities such as tunnelling using tunnel boring machines, use of excavators, pile driving equipment and other construction equipment are estimated for all the structures which are located in close proximity to the proposed elevated or underground metro line.

The building assessment when convolved with the settlement contour could provide a rational basis to identify the level of distress that the identified buildings could be expected to suffer during the construction activities. Based on the structural typology and the current condition of the historical structures surveyed, acceptable limits on the differential settlement and vibrations, as identified from internationally accepted norms, have been applied to identify historical structures in different risk categories, namely low, medium and high. The study in closing provides recommendations for suitable mitigation measures for the protection of the historical structures in the vicinity of the proposed alignment, or ideally a change in the alignment of the metro in extreme cases.

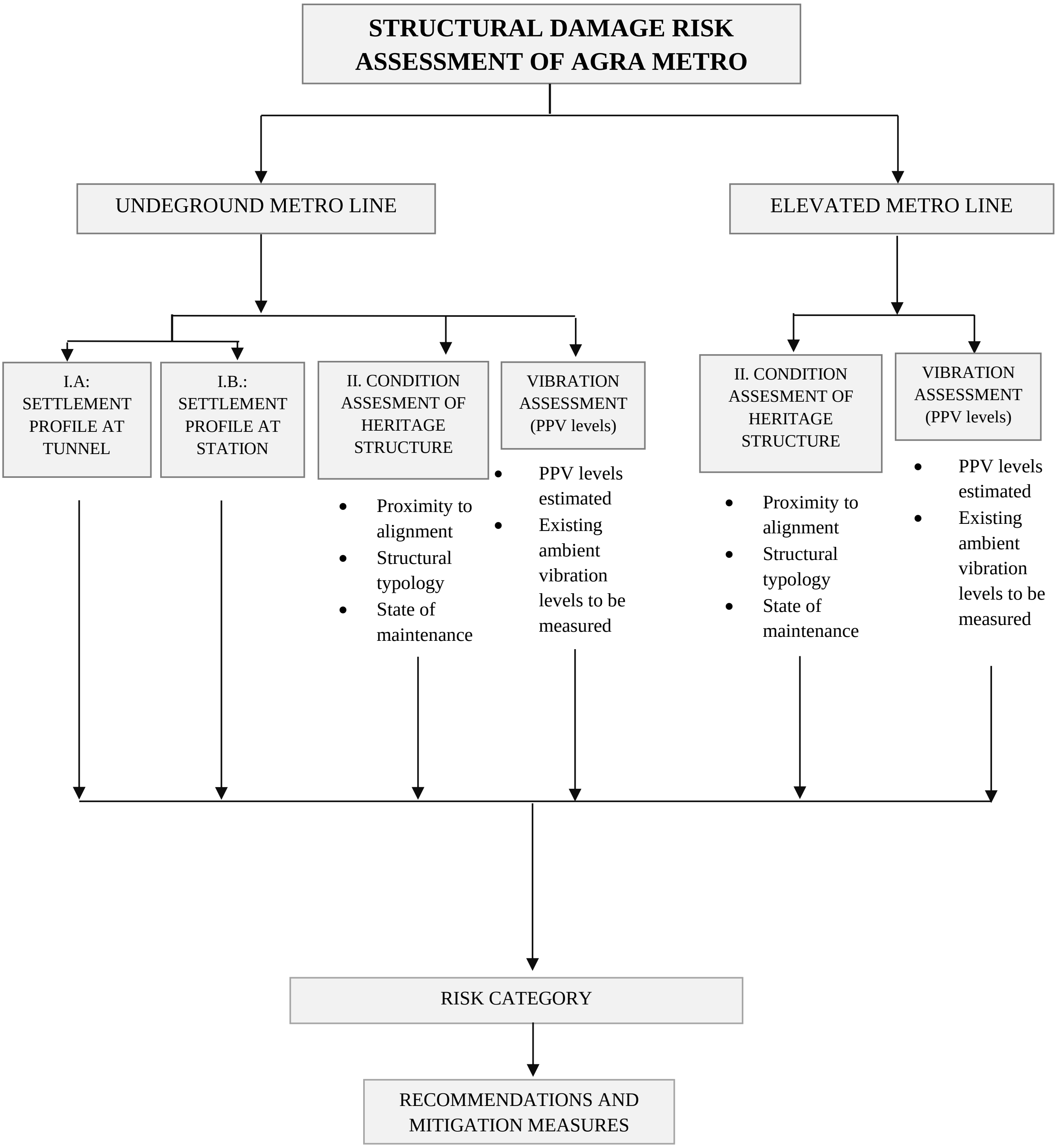


Figure 1 Proposed Methodology for Structural Damage Risk Assessment

Table 1: Evaluated Heritage Sites along Corridor 1

No.	Structure	Protection Status	Metro Construction	Distance from Metro station (m)	Distance from Metro line (m)
1	Agra Fort	World Heritage Site	Underground	97	108
2	Lodhi's Tomb	ASI	Elevated	297	291
3	Kanch Mahal	ASI	Elevated	370	361
4	Guru ka Taal	ASI	Elevated	173	188
5	Pathar ka Ghoda	ASI	Elevated	79	49
6	Tomb of Sadiq Khan	ASI	Elevated	185	157
7	Tomb of Salamat Khan	ASI	Elevated	248	176
8	Ladli Begum ka Tila	ASI	Elevated	253	255
9	Old Delhi Gate	ASI	Underground	158	160
10	Jami Masjid	ASI	Underground	321	127
11	Bara Khamba	ASI	Underground	353	321
12	Bhuri Khan's Mosque	Unprotected	Elevated	350	180
13	Suraj Bhan Gateway	Unprotected	Elevated	396	40
14	Temple Gateway, Bagichi	Unprotected	Elevated	330	17
15	Khandari Begum's Tomb	Unprotected	Underground	380	45
16	St John's College	Unprotected	Underground	170	0
17	Sarojini Naidu Boys Hostel	Unprotected	Underground	11	15

3 GEOTECHNICAL ASSESSMENT FOR EXCAVATION AND TUNNEL INDUCED GROUND SURFACE SETTLEMENT ESTIMATION

3.1 Introduction

A metro project in urban city requires braced excavation for metro station, launch and reception pits for tunnel boring machine (TBM) and tunnelling operations. Alignment of tunnel usually passes through difficult ground conditions, soft soils, in close proximity to the major sensitive structures and historic buildings. The existing buildings or structures in the close proximity are subject to various level of risk or damage due to the tunnelling and construction of metro station induced ground deformation or surface settlements. These surface settlements are usually more at the vicinity of the tunnel and underground metro station and reduce with the increasing distance perpendicular to the tunnel alignment. The existing buildings and heritage structures are often subjected to the differential settlements due to the excavation and tunnel induced ground settlements. The rough estimation of the tunnel and excavation induced settlements helps in planning the tunnel alignment, structural assessment of the existing buildings and heritage structures, adopting suitable construction strategies, and selecting suitable ground improvement technique to mitigate the deferential settlements.

Empirical and semi empirical methods are often used for estimating the ground surface settlements induced by an excavation (Peck 1969, Bowles 1988, Clough and O'Rourke 1990, Ou et al. 1993, Hsieh and Ou 1998, Kung et al. 2007) and tunnelling (Peck 1969, Atkinson and Potts 1977; Einstein et al.1981, Attewell and Woodman 1982, New and O'Reilly 1991, Mair et al. 1993, Lai et al. 2019). In this report, the empirical methods for the estimation of excavation and tunnel induced ground surface settlements are discussed and presented. For excavation induced settlements, semi empirical method by Hsieh and Ou (1998) and Kung et al. (2007) are adopted. Whereas for tunnelling induced settlements, semi empirical method by Peck (1969) and Mair et al. (1993) are adopted.

3.2 Excavation Induced Ground Surface Settlement

In this section, the empirical methods to estimate excavation induced ground surface settlement by Ou and Hsieh's (1998) and Kung et al. (2007) are explained in brief.

3.2.1 Hsieh and Ou (1998)

Hsieh and Ou (1998) proposed a procedure for estimating the excavation induced surface settlement profiles. These profiles are divided into two parts, the primary influence zone and the secondary influence zone, and can be determined with the prerequisite that δ_{vm} is known. δ_{vm} is the maximum surface settlement.

The primary influence zone has relatively a steep slope, which may induce large angular distortion on the adjacent buildings if δ_{vm} is large. The safety of the buildings should be checked under such circumstances. On the other hand, secondary influence zone has a gentler slope (see Figure 2).

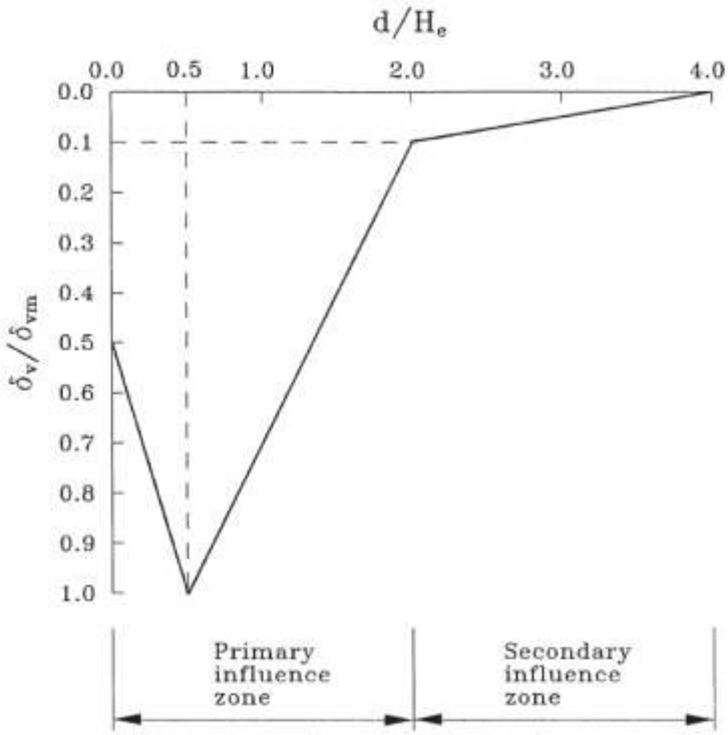


Figure 2: Excavation induced settlement profile (Hsieh and Ou 1998)

Generally two types of settlement profile are caused by excavation: (i) spandrel type, in which maximum surface settlement occurs very close to the wall; and (ii) concave type, in which maximum surface settlement occurs at a distance away from the supported wall. In case of braced excavations, the concave type of settlement profile is observed (Clough and O'Rourke 1990, Ou *et al.* 1993, Hsieh and Ou 1998, Ou 2006). In Agra metro, the cut and cover method is used for underground metro station; which represents the braced excavation. Hence, the concave type settlement profile is used in the estimation of surface settlement profile (see Fig. 1).

Case histories compiled by Clough and O'Rourke (1990) showed that the maximum lateral displacement of the wall (δ_{hm}), for soft to medium clay, is about in the range 0.5 to 0.7δ_{vm}. A value of 0.5δ_{vm} is generally adopted for establishing the complete settlement profile (Ou 2006). Also, for calculating the value of δ_{hm}, the relation represented as chart will be used (see Figure 3). In the figure, EI is wall stiffness, γ_w is unit weight of water, and h_{avg} is the average support spacing. The factor of safety (FOS = N_c/N_b) against basal heave will be taken based on the value of Skempton's bearing capacity factor N_c (see Fig. 3). The stability number of the soil (N_b), is defined as $\gamma H_e/c_u$. The value of δ_{hm} is also obtained using δ_{hm} = 1 to 0.5% of H_e (Ou *et al.* 1993). Since, the ration δ_{vm}/δ_{hm} ranges from 0.5 to 1, more reliable relation (Eq. 2) explained in proceeding section will be used in the calculation of maximum surface settlement, δ_{hm}. The settlement profile is obtained using the δ_{hm} and the settlement vs. horizontal distance relation given in Figure 2.

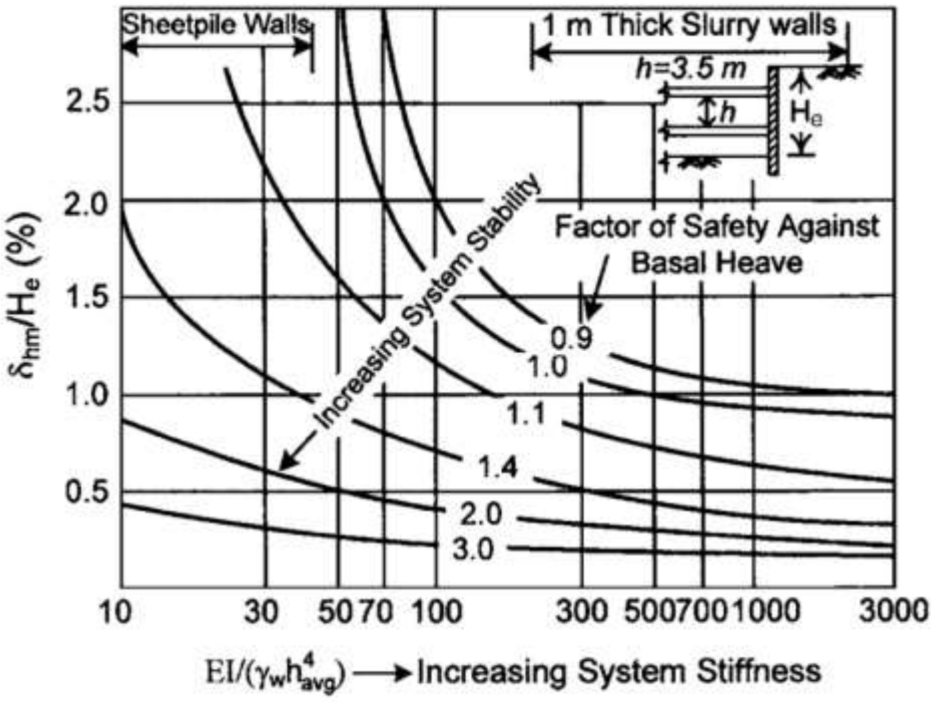


Figure 3: Design curves for maximum lateral wall movement for excavations in soft to medium clays (Clough and O'Rourke 1990)

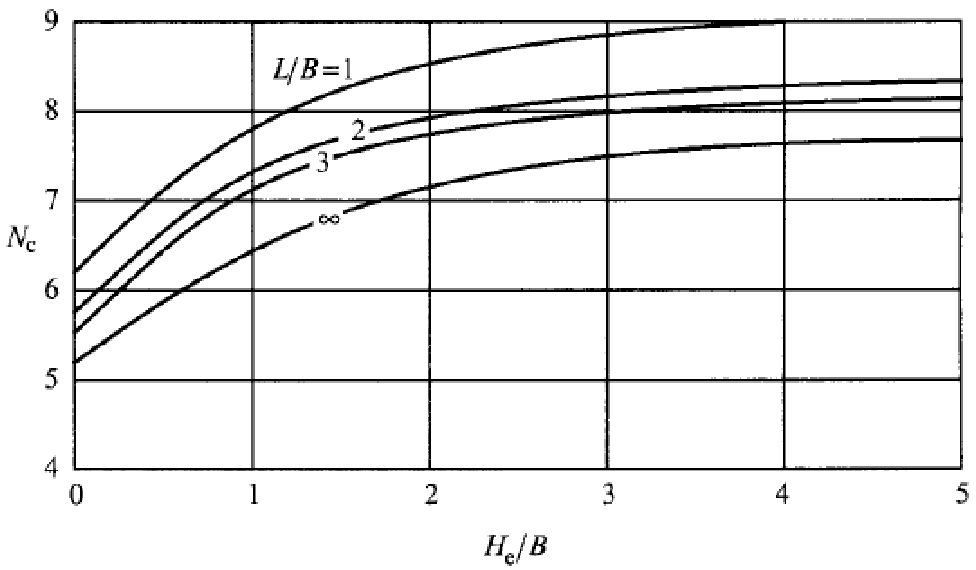


Figure 4: Skempton's bearing capacity factor (Skempton, 1951)

3.2.2 Kung et al (2007)

Kung *et al.* (2007) proposed a simplified semi-empirical model for predicting maximum wall deflection, maximum surface settlement, and surface-settlement profile due to excavations in soft to medium clays.

The estimation of excavation-induced wall and ground movements consists of the following steps:

1. Estimate the maximum lateral wall deflection, δ_{hm}
2. Estimate the deformation ratio, $R = \delta_{vm} / \delta_{hm}$
3. Calculate the maximum surface settlement, δ_{vm}
4. Estimate the surface settlement profile

3.2.3 Maximum Wall Deflection δ_{hm}

The maximum wall deflection induced in a braced excavation is affected essentially by six factors: excavation depth (H_e), system stiffness ($EI/\gamma_W h_{avg}^4$), excavation width (B), ratio of the average shear strength over the vertical effective stress (s_u/σ_v'), ratio of the average initial Young's modulus over the vertical effective stress (E_i/σ_v'), and ratio of the depth to hard stratum measured from the current excavation level over the excavation width (*T/B*).

The maximum wall deflection is expressed as:

$$\delta_{hm}(\mathrm{mm}) = \mathrm{b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_1X_2 + b_7X_1X_3 + b_8X_1X_5} \quad (1)$$

Where X1-5 = t(x) = a1x2 + a2x + a3 , x is each of the input variables (He, $\mathrm{Ln}(\mathrm{EI}/\gamma_W h_{avg}^4)$, B/2, s_u/σ_v' and E_i/σ_v'. The coefficients (b1-8) for above equation are determined through the least-square regression, are as follows: b0 = −13.41973, b1 = −0.49351, b2 = −0.09872, b3 = 0.06025, b4 = 0.23766, b5 = −0.15406, b6 = 0.00093, b7 = 0.00285, and b8 = 0.00198. The valid units and values for the above equation are noted as: 0 ≤ He ≤ 30 m; 0 ≤ EI/γwhavg4; 0 ≤ B ≤ 100 m; 0.2 ≤ su/σ'v ≤ 0.4, and 200 ≤ Ei/σ'v ≤ 1200.

3.2.4 Deformation ratio, R

The deformation ratio is influenced by three parameters: the shear strength, Young's modulus, and the clay-layer thickness relative to wall length. These three parameters are expressed hereinafter as normalized parameters namely, the normalized clay-layer thickness with respect to the wall length ($\sum H_{clay}/H_{wall}$), the normalized shear strength with respect to the vertical effective stress (s_u/σ_v'), and the normalized Young's modulus with respect to the vertical effective stress ($E_i/1000\sigma_v'$). The R is obtained using the expression as:

$$R = c_0 + c_1Y_1 + c_2Y_2 + c_3Y_3 + c_4Y_1Y_2 + c_5Y_1Y_3 + c_6Y_2Y_3 + c_7Y_3^3 + c_8Y_1Y_2Y_3 \quad (2)$$

Where $Y_{1\text{-}3}$ are input variables ($\sum \mathrm{H_{clay}/H_{wall}}$, s_u/σ_v', $E_i/1000\sigma_v'$). The coefficients ($c_{1\text{-}8}$) are as follows: c_0 = 4.55622, c_1 = −3.40151, c_2 = −7.37697, c_3 = −4.99407, c_4 = 7.14106, c_5 =

4.60055, c_6 = 8.74863, c_7 = 0.38092, and c_8 = −10.58958. The deformation ratio is used to obtain the value of δ_{vm} for the estimation of surface settlement profile.

3.2.5 Surface Settlement Profile

The surface settlement profiles are expressed as:

$$\delta_v/\delta_{vm} = (1.6 \times d/H_e + 0.2) \qquad 0 \leq d/H_e \leq 0.5 \qquad (3a)$$

$$\delta_v/\delta_{vm} = (-0.6 \times d/H_e + 1.3) \qquad 0.5 \leq d/H_e \leq 2 \qquad (4b)$$

$$\delta_v/\delta_{vm} = (-0.05 \times d/H_e + 0.2) \qquad 2 \leq d/H_e \leq 4 \qquad (5c)$$

where d = distance from the wall; H_e = excavation depth; δ_v = vertical settlement at the distance d; and δ_{vm} = maximum vertical settlement.

3.3 Tunnelling induced ground surface settlements

One of the most well-known empirical methods is the Peck (1969) method which was developed based on the measured data of ground surface settlement from case histories. Using this method, the ground surface settlement in the transverse direction can be represented by a Gaussian distribution function (see Fig. 5).

$$S(x) = S_{max}\, e^{\left(\frac{-x^2}{2i^2}\right)} \qquad (6)$$

where, S(x) is the surface settlement at a horizontal distance x from the tunnel centreline; S_{max} is the maximum settlement at the symmetric point (at the tunnel centreline) of the settlement curve; and i is the horizontal distance from the tunnel centreline to the point of inflexion on the settlement curve and is usually called the width of the settlement trough. The width of the settlement trough (i) is obtained using following relation (Mair *et al.* 1993):

$$i = Kz_0 \qquad (7)$$

Where K is called the width parameter of the settlement trough. Based on a large quantity of data from tunnelling projects in clayey and sandy soils, it is found that for tunnels in clayey soil, the K values range from 0.4 to 0.6 with an average of 0.5, while for tunnels in sandy soil, the K values range from 0.25 to 0.45 with an average of 0.35 (Mair and Taylor, 1997). The S_{max} is obtained using following relation (Mair *et al.* 1993):

$$S_{max} = \frac{0.313\, V_L\, D^2}{Kz_o} \qquad (8)$$

Where D is the diameter of the circular tunnel and V_L is volume loss. The settlement caused by tunnelling is often characterized by a parameter called volume loss or ground loss V_L, defined as the ratio of the surface settlement trough volume to the tunnel volume per unit length of tunnel. According to Mair *et al.* (1993), Mair and Taylor (1997) and Mair (2008), typical V_L values for open-cut tunnel construction in clay generally range from 1% to 3%, while lower V_L values are obtained for closed-cut tunnel construction.

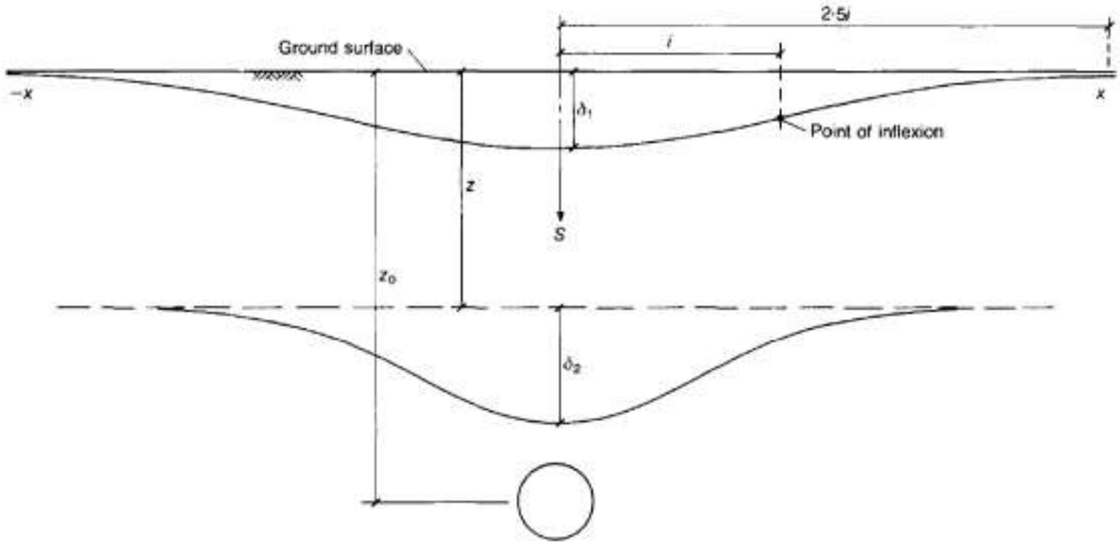


Figure 5: Tunnelling induced surface Settlement Profile at Ground Surface and at Depth z

3.4 Assumptions and Remarks

1. Cut and cover construction method is used for metro station construction. Hence, metro station excavation can be considered as braced excavation.
2. Dewatering is not considered in the estimation of surface settlement profile.
3. The settlement profile calculation does not account the additional ground settlement caused due to over excavation by TBM.
4. Metro station excavation induced settlements are calculated assuming retention system consist of diaphragm wall. The type of soil between the metro station and tunnel alignment, and the existing structures and heritage structures are same as obtained from the borehole investigation provided at the metro station and over the tunnel alignment.
5. The appropriate value of the following terms are taken from the DPR report: height of excavation, height of diaphragm wall, thickness of diaphragm wall, grade of concrete of diaphragm wall, length and width of metro station.
6. An appropriate value, h_{avg} = $H_e/3$ is considered as average support spacing in the strutted excavations. The value is arrived using Fig. 5.41 (DPR report).
7. The engineering/index parameters of soil with heterogeneity are converted into an equivalent value.
8. The unit weight of soil is estimated using the correlation by Fang (2013).
9. The lower bound and upper bound tunnel induce settlement profile is given in this report. However, the volume loss of tunnel can be estimated using the Fig. 6 and Fig. 7. The C/D ratio for Agra metro project is taken as ~1.4($C = z_o - D/2$ ~ 8.85 m, D = 6.3 m, z_o ~ 12 m).

10. The settlement profiles for the tunnel induced settlement and excavation induced settlement (metro station construction) are provided after the references.
11. The settlement profile estimated using the empirical equations by Kung et al. (2007) and Hsieh and Ou (1998) are sensitive to height of excavations (H_e) and average strut spacing (h_{avg}).

3.5 Results

The geo-technical survey presents the values and corresponding graphs for the estimated settlement profile using the empirical equations by Kung et al. (2007) and Hsieh and Ou (1998). Initially, the shortest perpendicular distance between the Heritage Structure to the nearest metro station and to the centre of the tunnel alignment is identified (See Figure 6). With the distance known and the depth of excavation, the two types of induced ground settlements, namely Tunnel Induced Settlements and Excavation Induced Settlements were calculated.

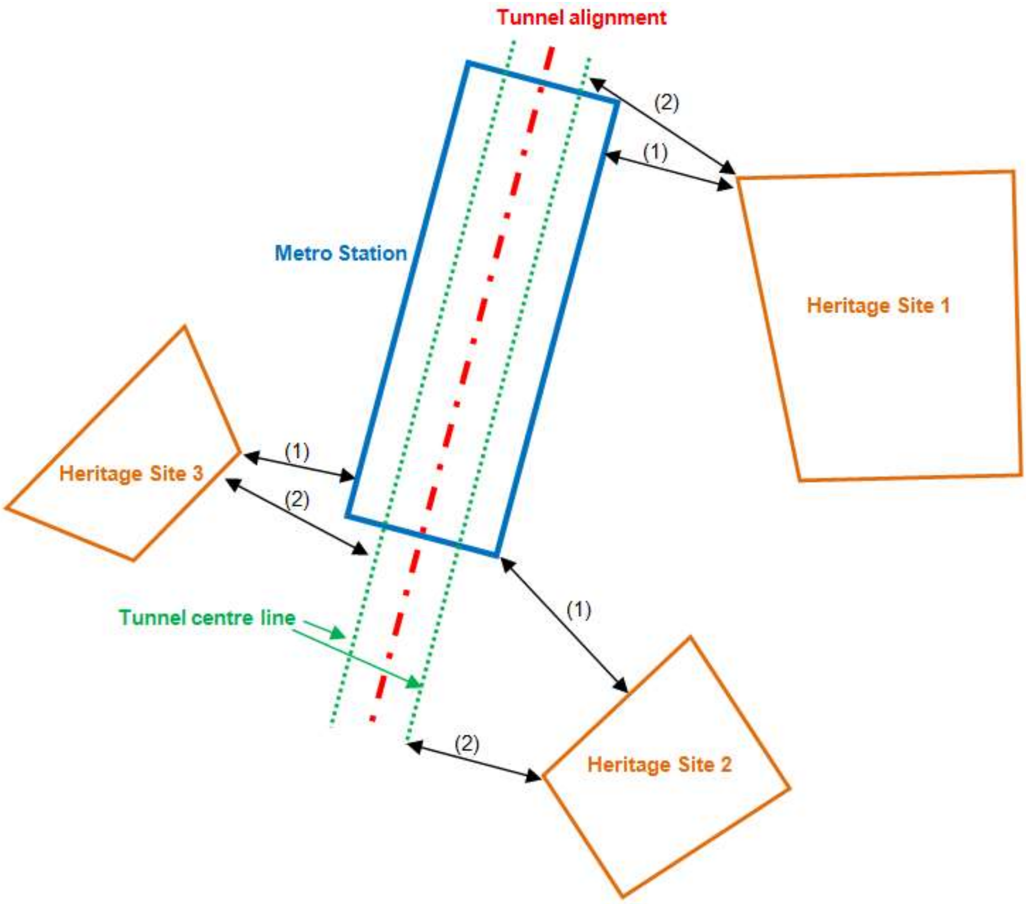


Figure 6: Schematic showing details of perpendicular distance between heritage structure and tunnel centre line/metro station

3.5.1 Tunnel Induced Settlement Profile

The underground transit includes two-tunnels which have to be bored using a Tunnel Boring Machine (TBM), inducing settlement of the soil profile which in turn may cause differential settlement in the structures. Hence it is essential to calculate the tunnel induced ground settlement for the entire stretch of the metro line. The cross – section of the tunnel excavation is shown in Figure 7.

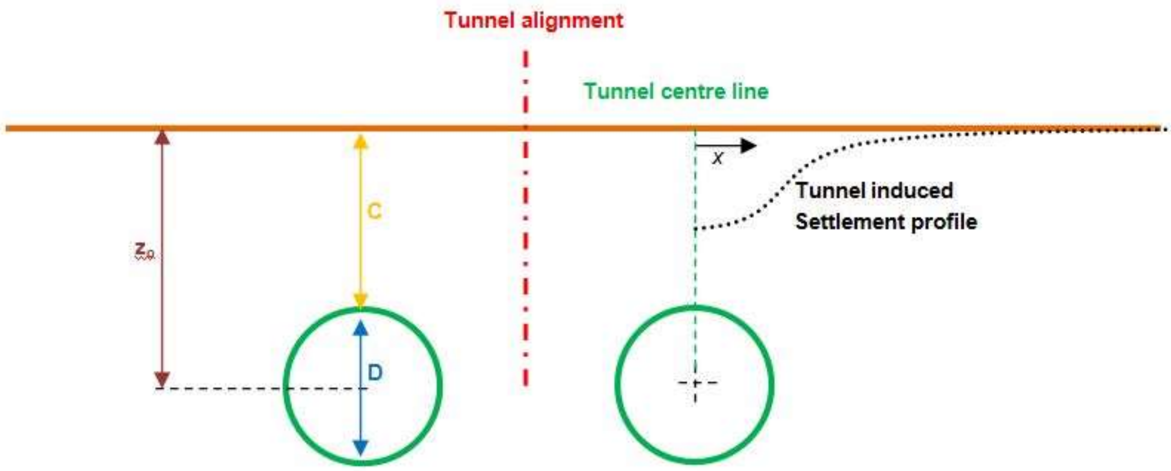


Figure 7: Cross-Section of tunnel Excavation

Where, *x* represents the centre line of tunnel

D = diameter of tunnel = 6.3 m (Page 5.78, DPR)

z_o = depth of tunnel = 12 to 15 m (Page 5.78 - 5.79) [lower value as z_o = 12 m is considered in the calculations]

The relationship between the load factor LF and *C*/*D* ratio for a tunnel with diameter *D* = 6 m in clay (Vu et al. 2016) is depicted in Figure 8. Here, s_{min} is the minimum pressure applied to the internal surface of tunnel. In the estimate of LF, s_{min} shall be used.

The load factor LF for the specified C/D ratio is identified and the Volume loss (V_L) is calculated for the corresponding load factor based on the Volume Loss- Load Factor graph given in Macklin (1999) (See Figure 9). The tunnel induced ground settlement for Volume loss of 1%, 2% and 3% is then calculated (Table 1) and plotted (Figure 10).

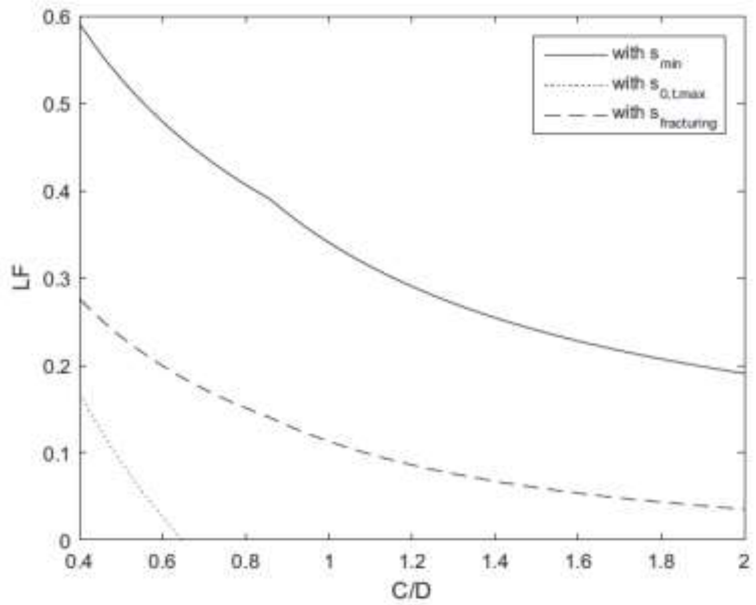


Figure 8: Relationship between load factor LF and C/D ratio for a tunnel

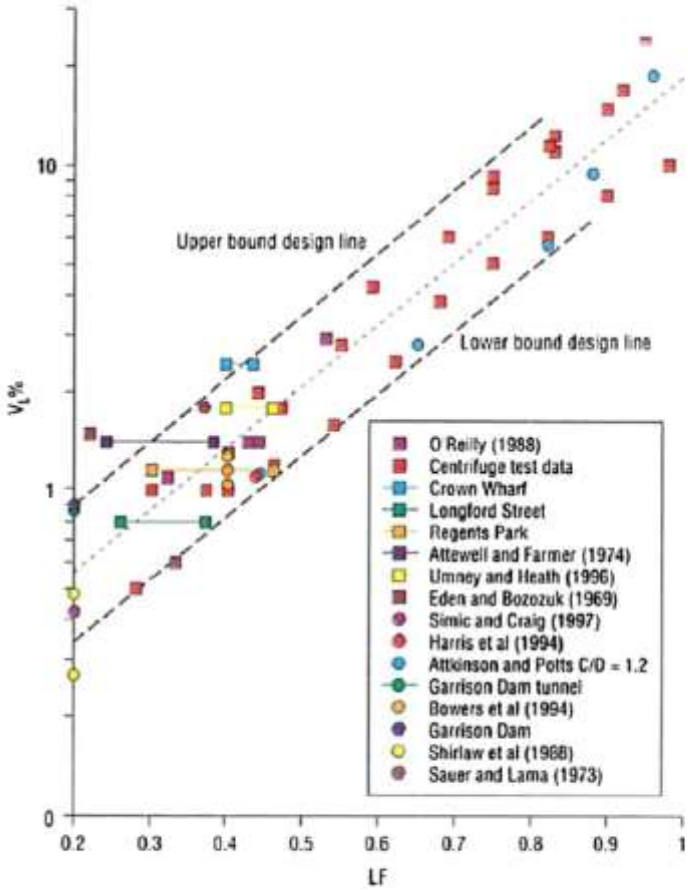


Figure 9: Volume loss VL and Load factor LF (Macklin 1999)

Table 2: Tunnel induced ground settlement

Distance, x (m)	Surface settlement (mm)		
	Volume Loss (1%)	Volume Loss (2%)	Volume Loss (3%)
0	20.704	41.409	62.114
5	14.631	29.262	43.893
10	5.162	10.325	15.488
15	0.909	1.819	2.729
20	0.080	0.16	0.24
25	0.003	0.007	0.011
30	7.7E-05	1.00E-04	2.00E-04
35	8.5E-07	1.69E-06	2.54E-06
40	4.6E-09	9.25E-09	1.39E-08
45	1.3E-11	2.53E-11	3.79E-11
50	1.7E-14	3.45E-14	5.17E-14
55	1.2E-17	2.35E-17	3.52E-17
60	4E-21	7.99E-21	1.20E-20
65	6.8E-25	1.36E-24	2.03E-24
70	5.8E-29	1.15E-28	1.73E-28
75	2.4E-33	4.87E-33	7.31E-33
80	5.2E-38	1.03E-37	1.55E-37
85	5.4E-43	1.09E-42	1.63E-42
90	2.9E-48	5.74E-48	8.61E-48
95	7.6E-54	1.51E-53	2.27E-53
100	9.9E-60	1.99E-59	2.98E-59

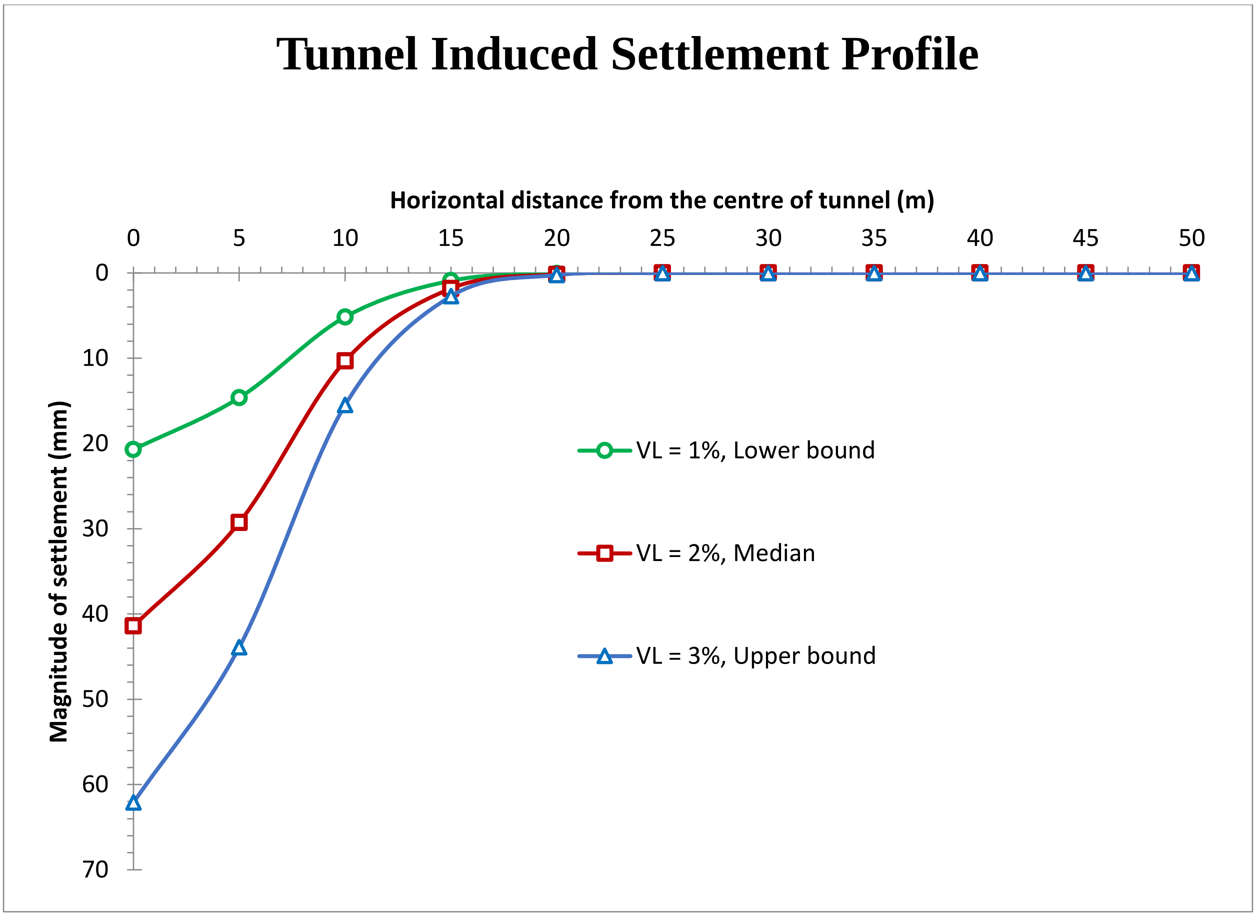


Figure 10: Tunnel induced settlement profile

3.5.2 Excavation induced settlement

The construction of metro stations involve excavation to be carried out which also may lead to settlement in the surrounding locations (See Figure 11). The inputs required for calculating the settlement profile is given in Table 2 and Table 3. The settlement values are given in Table 4 and the corresponding settlement profiles are shown in Figures 12 to 19.

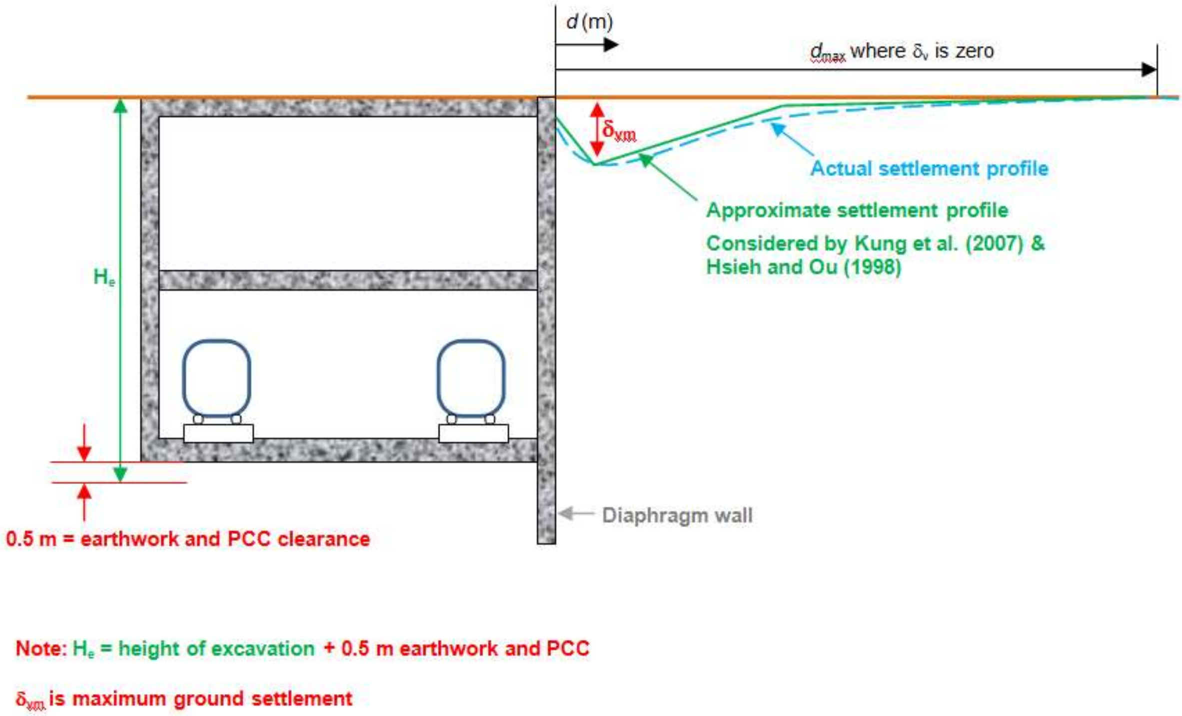


Figure 11: Schematic showing excavation induced settlement

Table 3 Input values used for the estimation of tunnel and metro station excavation induced settlements

Sr. No.	Metro Station	H_e (m)	c_u (kPa)	γ (kN/m^3)	L (m)	B (m)
1	University	13.4	63.76	21.20	130	26.55
2	RBS College	19.4	88.29	20.02	130	26.55
3	Raja Ki Mandi	19.6	79.95	21.19	140	26.55
4	Agra College	15.9	59.35	17.01	180	26.55
5	Medical College	19.1	88.29	19.57	140	26.55
6	Jama Masjid	18.5	88.29	19.03	170	24.60
7	Agra Fort	10	88.29	19.03	180	24.60
8	Taj Mahal	8	83.385	18.84	130	26.55

Where, H_e = height of excavation (Page No. 5.51, DPR); c_u = average soil cohesion for depth H_e (Table 5.31-5.33, DPR); γ = unit weight of soil, correlated from the average SPT N value for depth H_e (Fang 2013); L and B = length and width of metro station (Page No. 5.51, DPR)

Table 4: Excavation induced settlement (mm)

Station	Distance from excavation	Settlement based on Kung et al. (2007)	Settlement based on Hsieh and Ou (1998)
1. RBS college	0.00	43.53	64.50
	4.75	130.58	96.74
	9.50	217.64	128.99
	14.25	184.99	109.64
	19.00	152.35	90.29
	23.75	119.70	70.95
	28.50	87.06	51.60
	33.25	54.41	32.25
	38.00	21.76	12.90
	42.75	19.04	11.29
	47.50	16.32	9.67
	52.25	13.60	8.06
	57.00	10.88	6.45
	61.75	8.16	4.84
	66.50	5.44	3.22
	71.25	2.72	1.61
	76.00	0.00	0.00
2. Raja Ki Mandi	0.00	53.25	84.80
	4.90	159.75	127.20
	9.80	266.25	169.60
	14.70	226.32	144.16
	19.60	186.38	118.72
	24.50	146.44	93.28
	29.40	106.50	67.84
	34.30	66.56	42.40
	39.20	26.63	16.96
	44.10	23.30	14.84
	49.00	19.97	12.72
	53.90	16.64	10.60
	58.80	13.31	8.48
	63.70	9.98	6.36
	68.60	6.66	4.24
	73.50	3.33	2.12
	78.40	0.00	0.00
3. Agra College	0.00	36.02	51.31
	3.98	108.05	76.97

	7.95	180.08	102.62
	11.93	153.07	87.23
	15.90	126.06	71.84
	19.88	99.04	56.44
	23.85	72.03	41.05
	27.83	45.02	25.66
	31.80	18.01	10.26
	35.78	15.76	8.98
	39.75	13.51	7.70
	43.73	11.25	6.41
	47.70	9.00	5.13
	51.68	6.75	3.85
	55.65	4.50	2.57
	59.63	2.25	1.28
	63.60	0.00	0.00

4. Medical College	0.00	43.07	64.40
	4.78	129.21	96.60
	9.55	215.35	128.81
	14.33	183.05	109.48
	19.10	150.75	90.16
	23.88	118.44	70.84
	28.65	86.14	51.52
	33.43	53.84	32.20
	38.20	21.54	12.88
	42.98	18.84	11.27
	47.75	16.15	9.66
	52.53	13.46	8.05
	57.30	10.77	6.44
	62.08	8.08	4.83
	66.85	5.38	3.22
	71.63	2.69	1.61
	76.40	0.00	0.00

5. Jama Masjid	0.00	38.33	56.77
	4.63	114.99	85.15
	9.25	191.65	113.53
	13.88	162.90	96.50
	18.50	134.16	79.47
	23.13	105.41	62.44
	27.75	76.66	45.41
	32.38	47.91	28.38
	37.00	19.17	11.35
	41.63	16.77	9.93
	46.25	14.37	8.51
	50.88	11.98	7.10
	55.50	9.58	5.68
	60.13	7.19	4.26
	64.75	4.79	2.84
	69.38	2.40	1.42
	74.00	0.00	0.00

6. Agra Fort	0.00	2.85	8.15
	2.50	8.56	12.22
	5.00	14.27	16.29
	7.50	12.13	13.85
	10.00	9.99	11.41
	12.50	7.85	8.96
	15.00	5.71	6.52
	17.50	3.57	4.07
	20.00	1.43	1.63
	22.50	1.25	1.43
	25.00	1.07	1.22
	27.50	0.89	1.02
	30.00	0.71	0.81
	32.50	0.54	0.61
	35.00	0.36	0.41
	37.50	0.18	0.20
	40.00	0.00	0.00

7. Taj Mahal	0.00	1.13	2.20
	2.00	3.39	3.31
	4.00	5.65	4.41
	6.00	4.80	3.75
	8.00	3.95	3.08
	10.00	3.11	2.42
	12.00	2.26	1.76
	14.00	1.41	1.10
	16.00	0.56	0.44
	18.00	0.49	0.39
	20.00	0.42	0.33
	22.00	0.35	0.28
	24.00	0.28	0.22
	26.00	0.21	0.17
	28.00	0.14	0.11
	30.00	0.07	0.06
	32.00	0.00	0.00

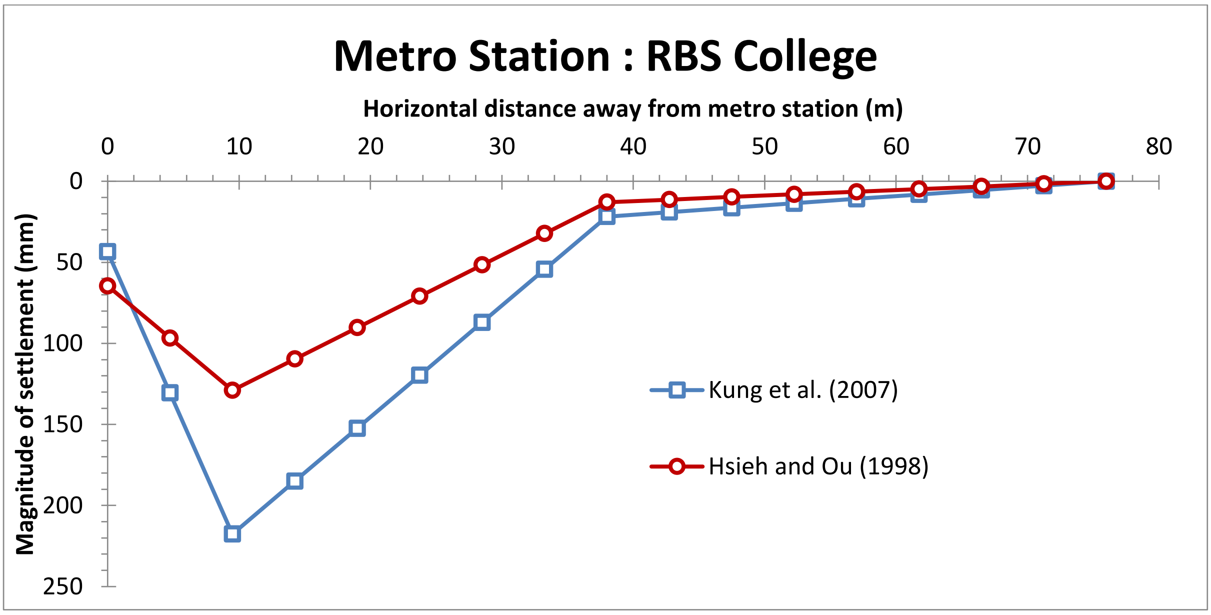


Figure 12: Excavation induced settlement for RBS College Metro Station

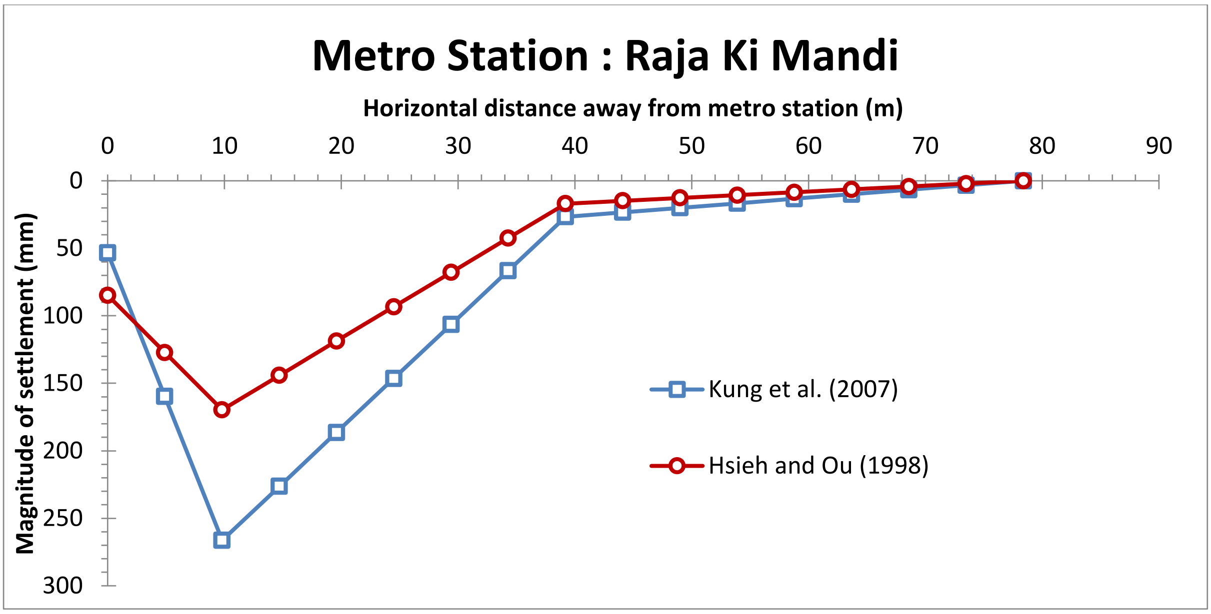


Figure 13: Excavation induced settlement for Raja Ki Mandi Metro Station

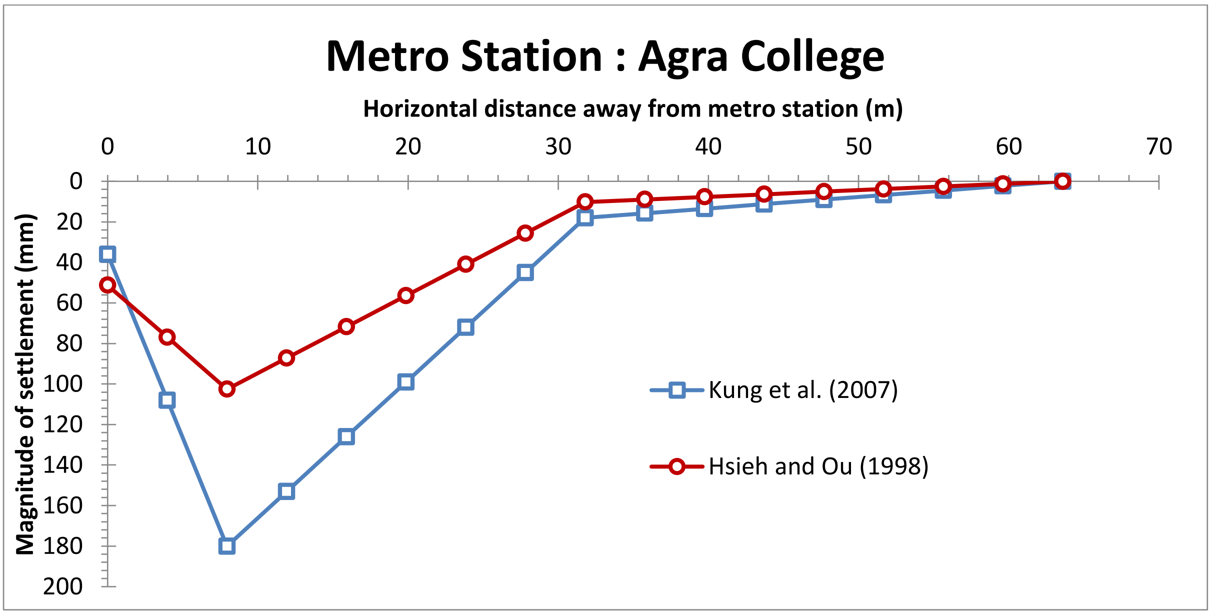


Figure 14: Excavation induced settlement for Agra College Metro Station

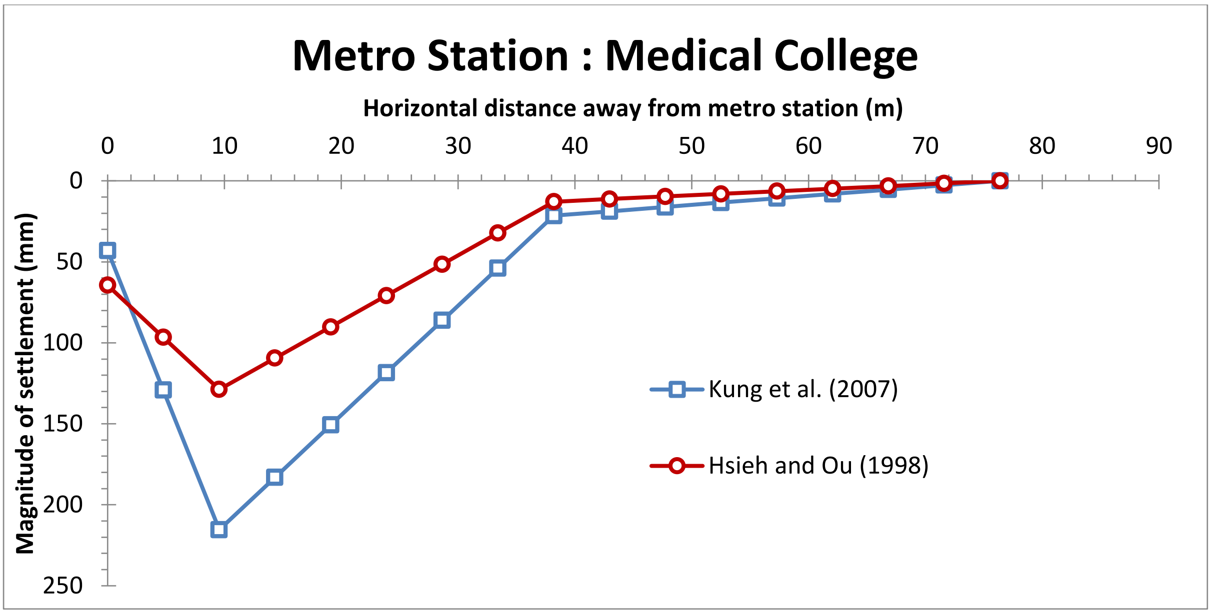


Figure 15: Excavation induced settlement for Medical College Metro Station

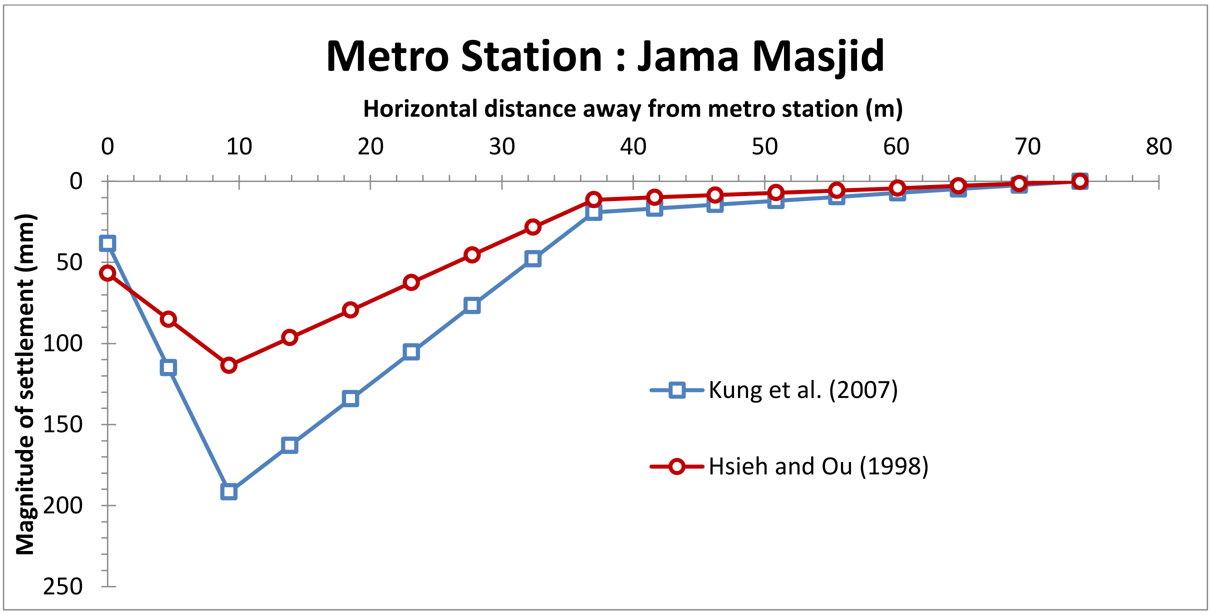


Figure 16: Excavation induced settlement for Jama Masjid Metro Station

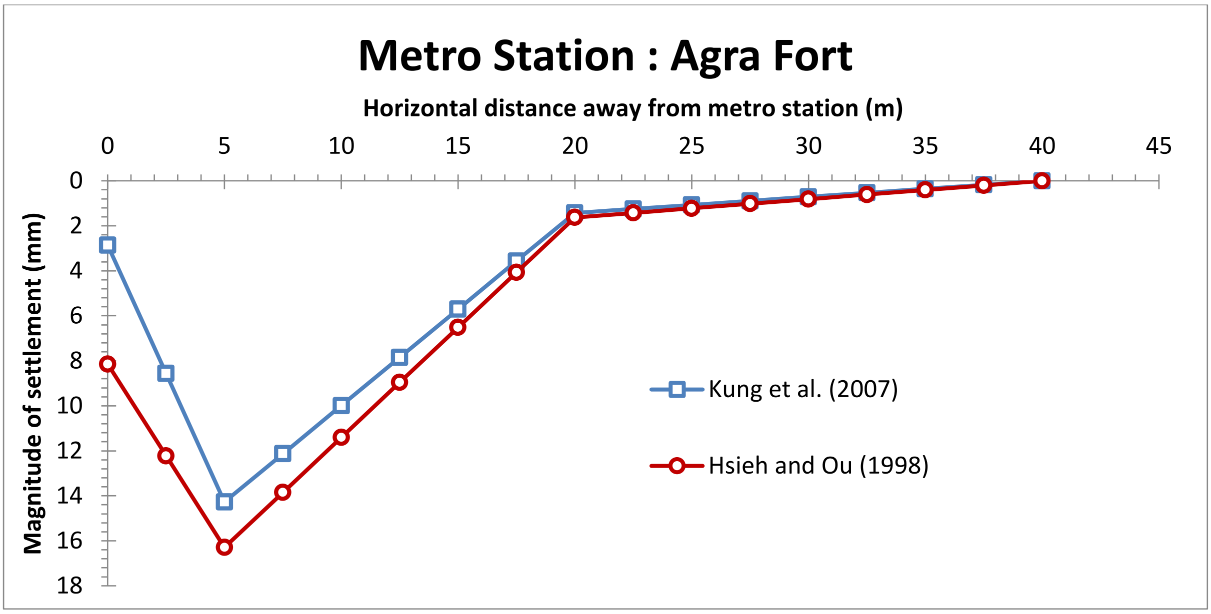


Figure 17: Excavation induced settlement for Agra Fort Metro Station

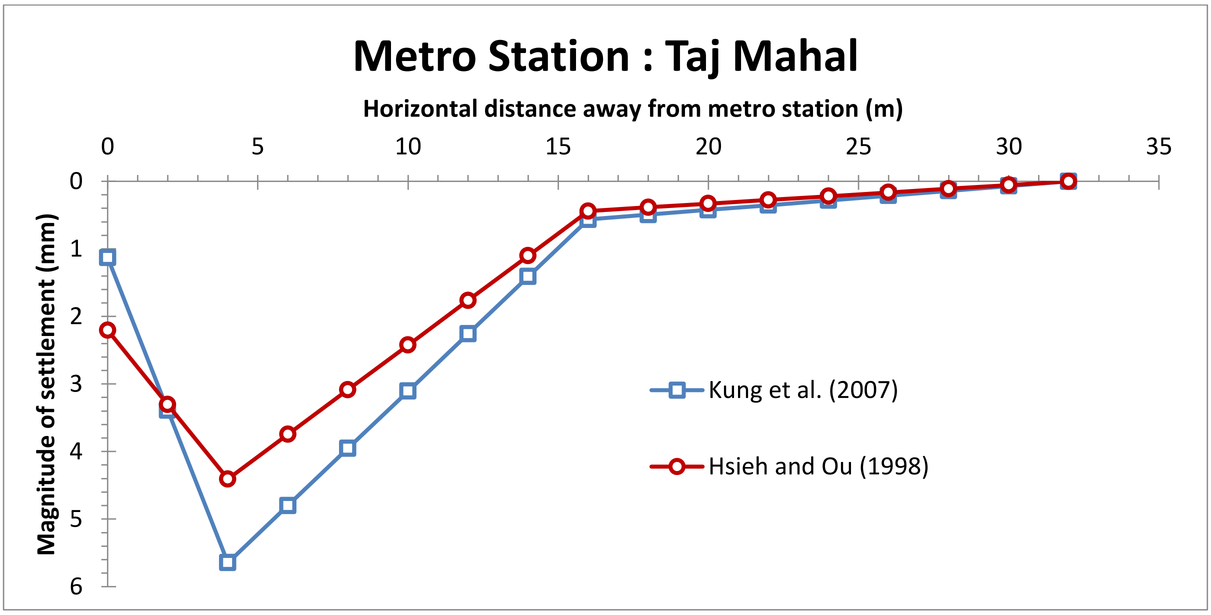


Figure 18: Excavation induced for Taj Mahal Metro Station

From the geotechnical assessment it can be inferred that the primary and secondary settlements, along the metro line and metro stations, can be experienced to 20m and 75m respectively. Therefore taking 50m and 100m as the upper bound of expected settlement along the metro line and metro station respectively, the unprotected heritage structures for further assessment have been decided, which are Bhuri Khans mosque, Suraj Bhan gateway, Temple gateway, St John’s College, Sarojani Naidu boys’ hostel and Khandari begum’s tomb.

4 GROUND VIBRATION ASSESSMENT DUE TO METRO CONSTRUCTION

4.1 Introduction

The mechanical vibration induced due to tunnelling of the underground metro line or excavations for stations or piling activity may cause distress in the heritage buildings near the proposed Metro Alignment. Strong vibration can also cause settlement of soil, primarily in the case of loose to medium-dense, non-cohesive soil such as sand and gravel; this can lead to foundation settlement, especially where there is frequent vibration or uniformly graded sand or soil beneath the ground level. Ground vibration is measured in terms of Peak Particle Vibration (PPV). Therefore it is necessary to predict the Peak Particle Velocity (PPV) to evaluate the extent of possible damage caused by the vibrations to the adjacent heritage structures.

The vibration at buildings in the vicinity of the tunnels alignment and station or elevated metro line construction sites can be predicted as follows:

1. Guideline thresholds for ground vibration is established using Indian and international standards and guidelines.
2. Vibration source levels were determined for the proposed vibration intensive equipment. Ground vibration is measured in terms of Peak Particle Vibration (PPV).
   - The vibration induced due to tunnelling equipment is assessed in terms of PPV.
   - The vibration induced due to additional construction equipment (excavators, pile drivers, etc.) is assessed in terms of PPV.
   - The overall Peak Particle Vibration (PPV) is then calculated for comparison with the Guideline Targets for structural damage.
3. Comparison of the predicted PPV values with the established threshold levels are used to predict the potential danger to adjacent heritage structures during the metro construction.

4.2 Vibration Estimate

In this section, the empirical methods to estimate excavation and tunnelling induced ground vibrations by Hiller and Crabb (2000), Speakman and Lyons (2009) and Federal Transit Administration document on Transit Noise and Vibration Impact Assessment [15] are explained in brief.

4.2.1 Vibration Due to Tunnelling Equipment

Vibration source levels and spectral characteristics are dependent on machine type / size and the ground conditions through which tunnelling is to occur. Tunnel Boring Machine (TBM) vibration source levels and spectral characteristics can be determined based on literature and test results for similar size / type machines in comparable soil / rock conditions. Tunnelling does not relate to excavation works.

Hiller and Crabb (2000) established a useful first estimate for prediction of the upper bound vibration levels likely to be generated by future mechanised bored tunnelling works. Taking a line similar to, but enclosing, the upper bound to the data from Godio *et al.* (1992) yields the expression:

$$v_{res} \leq \frac{180}{r^{1.3}} \quad (1)$$

$$10 \leq r \leq 100$$

Where v_{res} = resultant peak particle velocity (mm/s)

r = slope distance from the receiver location to the source

The estimation of ground vibrations due to tunnelling for heritage structures in Agra are done using the above method and are presented in the following section.

Speakman and Lyons (2009) proposed a more reliable method to predict ground vibrations due to tunnelling. The estimate of the ground vibration at the receiver location (nearest building foundation) is using the following formula (Speakman and Lyons, 2009):

$$PPV = \frac{K}{d} e^{-\alpha d} \quad (1)$$

Where PPV = peak particle velocity, in mm/s

K = site/machine specific constant

α = site specific ground attenuation constant (varies with frequency)

d = distance in meters from the source

$$\alpha = \frac{\ln(V_2 d_2 / V_1 d_1)}{(d_2 - d_1)} \quad (2)$$

$$K = \frac{V_1 d_1}{e^{-\alpha d_1}} \quad (3)$$

V_1, V_2 Measured PPV at distance d_1 and d_2 respectively.

The site and machine specific constants K and α can be determined only from vibration monitoring data. Due to the absence of such data, this method of estimation of ground vibrations due tunnelling cannot be carried out at this stage of the study.

4.2.2 Vibration Due to Additional Construction Works Equipment

The Additional Construction Works include all non-tunnelling construction activities. They include construction of the stations. Vibration due to any other equipment other than tunnelling equipment can be predicted using the following formula obtained from FTA guidelines:

$$PPV_{Receiver} = PPV_{Ref}\left(\frac{d_{ref}}{d}\right)^{1.5}$$

Where, $PPV_{Receiver}$ = peak particle velocity at the nearest building foundation in mm/s

$PPV_{Equipment\ Ref}$ = peak particle velocity of the source (construction equipment), measured at the reference distance (7.6 m)

d_{ref} = reference distance for the vibration source (7.6 m)

d = horizontal distance from the source to the receiver (m)

Source vibration levels used to estimate the vibrations generated due to Additional Construction Works equipment are presented in Table 6-10.

Table 5 Source vibration reference levels for equipment obtained from vibration monitoring data for Lucknow metro for predicting ground vibrations induced by excavation for proposed underground metro stations

Description of vibration source	PPV at 7.6 m (mm/s)	Reference/comment
Road Breaking: Excavator breaker Hyundai 210; 21 Tonne	2.93	Vibration monitoring data for Lucknow Metro
Roof Slab Excavation: Excavator breaker Hyundai 200; 20 tonne	0.33	Vibration monitoring data for Lucknow Metro
D- Wall Construction: Casagrande Grab	0.9	Vibration monitoring data for Lucknow Metro
D wall/Road Breaking with JCB breaker: JCB 3DX	0.002	Vibration monitoring data for Lucknow Metro

Table 6 Source vibration reference levels obtained from published literature for the identified equipment from the provided list for predicting ground vibrations induced by excavation for proposed underground metro stations

Description of vibration source	PPV at 7.6 m (mm/s)	Reference/comment
20 Tonne Excavator with Hydraulic Breaker	4.7	Melbourne metro rail report from field observations
12-15 Tonne excavator with hydraulic rockbreaker	3.3	Melbourne metro rail report from field observations
7 tonne excavator with hydraulic rockbreaker	2.4	Melbourne metro rail report from field observations
Hydromill in soil (diaphragm wall construction)	0.2	FTA guidelines
Piling rig (bored)	1.0	British Standard BS5228

Table 7 Source vibration reference levels for equipment obtained from vibration monitoring data for Lucknow metro for predicting ground vibrations induced by excavation for proposed elevated metro stations

Description of vibration source	PPV at 7.6 m (mm/s)	Reference/comment
D wall/Road Breaking with JCB breaker: JCB 3DX	0.002	Vibration monitoring data for Lucknow Metro
Road Breaking: Excavator breaker Hyundai 210	2.93	Vibration monitoring data for Lucknow Metro
Roof Slab Excavation: Excavator breaker Hyundai 200	0.33	Vibration monitoring data for Lucknow Metro

Table 8 Source vibration reference levels obtained from published literature for the identified equipment from the provided list for predicting ground vibrations induced by excavation for proposed elevated metro stations

Description of vibration source	PPV at 7.6 m (mm/s)	Reference/comment
20 Tonne Excavator with Hydraulic Breaker	4.7	Melbourne metro rail report from field observations
12-15 tonne excavator with hydraulic rockbreaker	3.3	Melbourne metro rail report from field observations
7 tonne excavator with hydraulic rockbreaker	2.4	Melbourne metro rail report from field observations
Piling rig (bored)	1.0	British Standard BS5228

Table 9 Source vibration reference levels obtained from published literature for the identified equipment from the provided list for predicting ground vibrations induced by the construction of foundation for proposed elevated metro alignment

Description of vibration source	PPV at 7.6 m (mm/s)	Reference/comment
20 Tonne Excavator with Hydraulic Breaker	4.7	Melbourne metro rail report from field observations
12-15 tonne excavator with hydraulic rockbreaker	3.3	Melbourne metro rail report from field observations
7 tonne excavator with hydraulic rockbreaker	2.4	Melbourne metro rail report from field observations
Piling rig (bored)	1.0	British Standard BS5228

The calculations for estimating the ground vibrations for heritage structures near the proposed metro stations and metro alignment (to estimate ground vibrations due to construction of foundations) are done using the reference PPV values for additional construction equipment obtained from vibration monitoring data for Lucknow metro and published literature and presented in the following section. The overall PPV obtained from the above methods can be compared with the Guideline Targets for structural damage established in the section 5 of this document.

4.3 Results

The following survey presents the values for the estimated ground vibrations induced due to tunnelling equipment and excavation. The tunnelling induced ground vibrations are estimated using the empirical equation by Hiller and Crabb (2000). The excavation induced ground vibrations are estimated using the predictive methodology prescribed by the Federal Transit Administration document on Transit Noise and Vibration Impact Assessment [15].

4.3.1 Ground Vibrations Estimates due to Tunnelling Equipment

The calculations for estimating the ground vibrations due to tunnelling for the surrounding heritage structures along the proposed Agra Metro alignment is carried out and are presented in Table 10. The estimated values are compared with PPV threshold limits ([1] and [2]) established in section 5 of this report. The frequency spectra defined for the tunnelling equipment is based on the assumption that the majority of vibration is in the 10 to 100 Hz frequency bands.

Table 10 Ground vibration estimates due to Tunnelling Construction

Station	S. no	Heritage Structure	Closest distance from Tunnel d (m)	PPV (mm/s) Based on Hiller and Crabb (2000)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)				PPV Limits Based on Directorate General of Mines Safety (DGMS), India (mm/s)			
					Limits (Frequency range: 10-50 Hz)	Less Than Limit	Limits (Frequency range: 50-100 Hz)	Less Than Limit	Limits (Frequency range: 8-25 Hz)	Less Than Limit	Limits (Frequency range: >25 Hz)	Less Than Limit
	1	Khandari Begam Garden	45	1.28	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	2	St. Paul's Church	374	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
RBS College	3	RBS College	119	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	4	Old Delhi Gate of City	160	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Raja Ki Mandi	5	Queen Victoria School	250	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	6	St. John's College	11.9+	7.20	3-8	No	8-10	Yes	5	No	10	Yes
	7	Agra College	63	0.82	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Agra College	8	Medical Building Complex (Lady Lyall Complex)	71	0.71	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	9	Sarojani Naidu Boy's Hostel	11.9+	7.20	3-8	No	8-10	Yes	5	No	10	Yes
	10	Kalan Maszid	169	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Medical College	11	Sarojani Naidu Hospital and College	152	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Jama Masjid	12	Jami Masjid	127	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	13	Agra Fort	108	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Agra Fort	14	Bhurj	95	0.48	3-8	Yes	S	Yes	5	Yes	10	Yes
	15	Bara Khamba	321	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Taj Mahal	16	Taj Mahal	522	0.45*	3-8	Yes	8-10	Yes	5	Yes	10	Yes

* *For structures where the proposed metro tunnel line passes below, tunnel depth is considered as the distance to the structure for the estimation of ground vibrations. Tunnel depth is obtained from Agra DPR Report (Page 5.78 and 5.79). The tunnel depth is the distance from ground level to the top of excavation for the tunnel.*

\+ *Hiller and Crabb (2000) method of estimation of ground vibration is not applicable for distances greater than 100 m. For structures beyond 100 m, the PPV value calculated at 100 m is considered.*

5. CONDITION ASSESSMENT

A visual investigation of heritage structures along Corridor 2 is carried out ,following which the heritage structures are examined on the basis of structural typology, material and current state of preservation identifying visible structural and non-structural distresses (cracks, material degradation due to weather, bulging of walls, tilting of structural members, deflection in structural members, subsidence of floors, etc.) and their extent. Based on these parameters the heritage structures are classified into varying levels of distress:

Nil: The structures where no structural distress and negligible material degradation is visibly observed are classified in this category.

Minor: The structures where deterioration in material due to weathering, cracks in plaster (non-structural) and fine cracks in few structural elements are observed are classified in this category.

Moderate: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in few to many structural elements are classified in this category.

Major: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in most structural elements are classified in this category.
(Note: In accordance with standard literature, few refers to about 5%, many refers to 50% and most refers to 75% or more)

The matrix – Table A2-9, below is a compilation of the buildings that would be visited during the visual investigation, the expected vibration and the subsequent risk category that they lie in.

Table A2-9 Building assessment

S. no	Structure	Sub Structure	Protection Type	Dimension	Subterranean chambers /Foundation	Description	Horizontal structural system	Vertical structural systems	Construction materials	Distance from metro line	Observations on Structural Distress	Level of distress	PPV Construction activities	Risk Category
2a	**Shahi Tomb**	**Shahi Tomb**	ASI	Data yet to be received	Data yet to be received	Square masonry structure covered with dome			Brick masonry, stone cladding, lime works	68 mtts		Structurally dilapidated	Within limit	**Low**
2b		**Masjid**	ASI	Data yet to be received	Data yet to be received	Masonry structure with arches, vaults and dome			Brick masonry, stone cladding, lime works	86 mtrs		Structurally dilapidated	Within limit	**Low**

4.3.1 Ground Vibration Estimates Due to Additional Construction Works Equipment

The calculations for estimating the ground vibrations due to excavation for the surrounding heritage structures near the proposed Agra Metro stations is carried out and are presented in Table 4. The estimated values are compared with PPV Threshold limits guideline targets ([1] and [2]) established in section 5 of this report. The frequency spectra defined for the equipments is based on the assumption that the majority of vibration is in the 10 to 100 Hz frequency bands.

Table 11 Ground vibration estimates due to Excavation for proposed underground metro stations

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table 1 as input (PPV1)	Overall PPV(mm/s) using Table 2 as input (PPV2)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety (DGMS), India (mm/s)					
						Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
							PPV1	PPV2		PPV1	PPV2		PPV1	PPV2		PPV1	PPV2
RBS College	1	Khandari Begam Garden	380	0.01	0.03	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	2	St. Paul's Church	419	0.01	0.03	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	3	RBS College	113	0.07	0.20	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Raja Ki Mandi	4	Old Delhi Gate	158	0.04	0.12	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	5	Queen Victoria School	245	0.02	0.06	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Agra College	6	St. John's College	170	0.04	0.11	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	7	Agra College	72	0.14	0.40	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	8	Medical Building Complex (Lady Lyall Complex)	128	0.06	0.17	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Medical College	9	Sarojani Naidu Boy's Hostel	11	2.39	6.66	3-8	Yes	No	8-10	Yes	Yes	5	Yes	No	10	Yes	Yes
	10	Kalan Maszid	357	0.01	0.04	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	11	Sarojani Naidu Hospital and College	113	0.07	0.20	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Jama Masjid	12	Jami Masjid	321	0.02	0.04	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Agra Fort	13	Agra Fort	97	0.09	0.25	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Taj Mahal	14	Bara Khamba	353	0.01	0.04	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	15	Taj Mahal	522	0.01	0.02	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table 12 Ground vibration estimates due to Excavation for proposed elevated metro stations

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table 3 as input (PPV1)	Overall PPV(mm/s) using Table 4 as input (PPV2)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
						Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
							PPV1	PPV2		PPV1	PPV2		PPV1	PPV2		PPV1	PPV2
Sikandra	1	Lodhi's Tomb	297	0.01	0.05	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	2	Kanch Mahal	370	0.01	0.03	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	3	Akbar's Tomb	780	0.00	0.01	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	4	Bhuri Khan's Mosque	350	0.01	0.04	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Guru Ka taal	5	Guru Ka Taal	173	0.03	0.10	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	6	Suraj Bhan Gateway	396	0.01	0.03	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	7	Pathar ka Ghoda	79	0.10	0.34	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	8	Temple Gateway, Bagichi	330	0.01	0.04	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
ISBT	9	Tomb of Sadiq Khan	185	0.03	0.09	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	10	Tomb of Salamat Khan	248	0.02	0.06	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
Shathri Nagar	11	Ladli Begum ka Tila	253	0.02	0.06	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table 13 Ground vibration estimates due to construction of foundation for proposed elevated metro alignment

Station	S. no	Heritage Structure	Closest distance from Metro Tunnel d (m)	Overall PPV(mm/s) using Table 5 as input (PPV1)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)				PPV Limits Based on Directorate General of Mines Safety, India (mm/s)			
					Limits (Frequency range: 10-50 Hz)	Less Than Limit PPV1	Limits (Frequency range: 50-100 Hz)	Less Than Limit PPV1	Limits (Frequency range: 8-25 Hz)	Less Than Limit PPV1	Limits (Frequency range: >25 Hz)	Less Than Limit PPV1
Sikandra	1	Lodhi's tomb	291	0.05	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	2	Kanch Mahal	361	0.03	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	3	Akbar's Tomb	862	0.01	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	4	Bhuri Khan's Mosque	180	0.10	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Guru Ka taal	5	Guru Ka Taal	188	0.09	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	6	Suraj Bhan Gateway	40	0.94	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	7	Pathar ka Ghoda	49	0.70	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	8	Temple Gateway, Bagichi	17	3.41	3-8	No	8-10	Yes	5	Yes	10	Yes
ISBT	9	Tomb of Sadiq Khan	157	0.12	3-8	Yes	8-10	Yes	5	Yes	10	Yes
	10	Tomb of Salamat Khan	176	0.10	3-8	Yes	8-10	Yes	5	Yes	10	Yes
Shathri Nagar	11	Ladli Begam ka la	255	0.06	3-8	Yes	8-10	Yes	5	Yes	10	Yes

4.4 Inferences

The first stage predictions of ground vibrations were calculated and compared to international standards (DIN 4150 Part 3, 1984 [1] and Directorate General of Mines Safety, India [2]). The following inferences were made based on these calculations.

- World Heritage Sites: The proposed metro alignment runs close to two world heritage sites; the Taj Mahal and the Agra Fort. On comparison with international standards ([1] and [2]), the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling and excavation.
- ASI Protected Heritage Sites: The proposed metro alignment runs close to few ASI protected heritage sites. On comparison with international standards ([1] and [2]), the first stage predictions calculated for these structures indicate that they are safe against ground vibrations induced by tunnelling, construction of foundations and excavation.
- Unprotected Heritage Sites: The proposed metro alignment runs close to a number of unprotected heritage sites. On comparing the first stage predictions calculated for these structures with ground vibration threshold values prescribed by DIN 4150 Part 3, 1984 [1] and Directorate General of Mines Safety, India [2], St. John's College and Sarojini Naidu Boy's Hostel was found unsafe against ground vibrations induced by tunnelling. Sarojini Naidu Boy's hostel was found unsafe against ground vibrations induced by excavation of proposed metro station in a similar manner. Temple gateway, Bagichi was found unsafe against ground vibrations induced by construction of foundations for proposed elevated metro alignment.
- More rigorous estimates of PPV levels due to tunnelling or other construction equipment would require calibration of the constants (or reference PPV) with measurements made at the sites of interest along Corridor 1 of Agra Metro. Moreover, measurements of current levels of PPV due to existing traffic and human activities at the sites of interest along Corridor 1 of Agra Metro are essential to differentiate vibrations caused due to metro construction activities and those due to other forms of existing traffic and human activities.

5 PERMISSIBLE LIMITS

5.1 Permissible Differential Settlement and Tilt

The metro line construction may have several effects on the structures in its close vicinity. There might be vibrations induced due to the rail traffic or soil settlement as a result of the boring, excavation and tunnelling operations, leading to differential settlement in the surroundings, therein making it essential to evaluate the extent of differential settlement and tilt and check if it is within the permissible limits. The Table 1 in the IS Code for 'Design and Construction of Foundations in Soils' (IS: 1904-1986) provides an insight on the Permissible limits for Differential Settlement and Tilt. (see extract in Figure 21). The differential settlement values that may occur in the Load Bearing Walls of the surrounding Historical Buildings are to be necessarily within the permissible limits mentioned in the table.

TABLE 1 PERMISSIBLE DIFFERENTIAL SETTLEMENTS AND TILT (ANGULAR DISTORTION) FOR SHALLOW FOUNDATION IN SOILS

(*Clause* 16.3.4)

Sl No.	Type of Structure	Isolated Foundations						Raft Foundations					
		Sand and Hard Clay			Plastic Clay			Sand and Hard Clay			Plastic Clay		
		Maximum settlement	Differential settlement	Angular distortion	Maximum settlement	Differential settlement	Angular distortion	Maximum settlement	Differential settlement	Angular distortion	Maximum settlement	Differential settlement	Angular distortion
		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	For steel structure	50	·003 3L	1/300	50	·003 3L	1/300	75	·003 3L	1/300	100	·003 3L	1/300
ii)	For reinforced concrete structures	50	·001 5L	1/666	75	·001 5L	1/666	75	·002 1L	1/500	100	·002L	1/500
iii)	For multistoreyed buildings												
	a) RC or steel framed buildings with panel walls	60	·002L	1/500	75	·002L	1/500	75	0·002 5L	1/400	125	0·003 3L	1/300
	b) For load bearing walls												
	1) L/H = 2+	60	·000 2L	1/5 000	60	·000 2L	1/5 000	Not likely to be encountered					
	2) L/H = 7+	60	·000 4L	1/2 500	60	·000 4L	1/2 500						
iv)	For water towers and silos	50	·001 5L	1/666	75	·001 5L	1/666	100	·002 5L	1/400	125	·002 5L	1/400

NOTE — The values given in the table may be taken only as a guide and the permissible total settlement/different settlement and tilt (angular distortion) in each case should be decided as per requirements of the designer.

L denotes the length of deflected part of wall/raft or centre-to-centre distance between columns.

H denotes the height of wall from foundation footing.

+For intermediate ratios of L/H, the values can be interpolated.

Figure 19 Permissible Differential Settlements and Tilt

5.2 Permissible PPV Values

The vibration tests are to be carried out for the entire stretch of the proposed metro line to measure the existing ambient levels of ground vibration. The tests are to be done necessarily for the Heritage Structures within a radius of 100m from the metro line and compulsorily for those within 50m radius from the metro line. The permissible limit for the PPV value is given in the following table. This chart also serves as the guideline target for determining the possible structural damage to the adjacent heritage structures while estimating ground vibrations during metro construction.

Table 14: Permissible Limit for PPV Values

Code	Type of Building	PPV suggested (mm/sec)		Remarks
DIN 4150 part 3, 1984 Structural Vibration [1]	Sensitive buildings under preservation	3	1 to 10	Measured at the maximum points of amplitude for short term vibrations
		3 to 8	10 to 50	
		8 to 10	50 to 100	
		2.5		Measured at highest floor for long-term vibrations
SN 640 312, 1978 Association of Swiss Highway Engineers[2]	Historical buildings	3	10 to 30	
ISO 4866, 1990 Mechanical vibration and shock, Vibration of fixed structures [3]		5		Measured at base of the building facing the source, A range of PPV for various sources is mentioned with frequency
BS 7385 part 1 and 2, 1993 Evaluation and measurement for vibration in buildings [4]	Unreinforced or light framed structures, residential or light commercial type	15 to 20	4 to 15	Follows ISO 4866, 1990 for the measurement point, for <4 Hz low peak component particle velocity value a maximum displacement of 0.6 mm
		20 to 50	> 15	
RI 8507, Report of Investigation, US Bureau of mines [5]	Residential buildings with older walls	1.27	< 40	1.91 mm/sec is safest approach usually 5 mm/sec for >40 Hz, Vibration is from blasting
		1.91	> 40	

Code	Type of Building	PPV suggested (mm/sec)		Remarks
CA 23, 1967 Australian Standard [6]	Heritage Structures	0.63	5	0.2mm displacement <15 Hz
		1.27	10	
		1.91	>15	
UNI 9916, 1991 Italian standards [2]	Historical Structures	3	<10	Measured at foundation
		8		
Directorate General of Mines Safety, India [7]	Objects of historical importance and sensitive structures	2 5 10	<8 8 to 25 >25	
Ashley [4]	Historical monuments	7.5		
Esteves [4]	Historical monuments and special care buildings	2.5	Based on soil type	Incoherent loose, soft coherent, rubble mixtures (c<1000m/sec, propagation velocity)
		5		Very hard to medium consistence coherent, uniform or well graded sand (c=1000 to 2000m/sec)
		10		Coherent hard and rock (c>2000m/sec)
Skipp, Czechoslovakian [4]	Old monuments	10		
	Human perception	2.5	4 to 13 Hz for vertical and 0.5 to 2 Hz for horizontal directions	

5.3 Permissible limits as per Deep Foundations Institute

a. Removal of subsoil between the diaphragm walls during the excavation allows the walls to move towards the excavation. The permissible limit for prediction of ground movements based on empirical method is given below.
   - Maximum wall deflection - 0.1% to 0.2% H
   - Point of inflexion - 0.5H to 1.0H from the excavation
   - Point of occurrence of maximum settlement - 0.5H
   - Zero settlement occurs at - 1.5H to 2.5H

   Where, H= excavation depth

b. Angular Distortion (Δ/L) causes cracking if (Δ/L) > 1/300 and structural damages if (Δ/L)> 1/150
c. Critical tensile strain (ε_{crit}) should be within 0.05% to 0.1% with an average of 0.075%
d. The damage assessment is carried out based on building condition survey (BCS) in stages.

Table 15: Stage 1 Assessment: Rankin's Building Risk Classification

Risk category	Maximum slope of the building	Maximum settlement of the building (mm)	Description of the risk
1	<1/500	<10	Negligible: Superficial Damage unlikely
2	1/500 to 1/200	10 to 50	Slight: Possible Superficial Damage which is unlikely to have structural significance
3	1/200 to 1/50	50 to 75	Moderate: Expected Superficial damage and possible structural damage to the building. Possible damage to relatively rigid pipelines.
4	>1/50	>75	High: Expected structural damage to buildings and rigid pipelines or possible damage to other pipelines

Those under negligible category can be eliminated from further assessment.

Table 16: Stage 2 assessment: Building Damage Classification

Building Damage Classification (after Burland et al. 1977 and Boscadin and Cordung 1989)				
Risk Category	**Description of Degree of Damage**	**Description of Typical Damage and Likely Form of Repair for Typical Masonry Building**	**Approx. Crack width (mm)**	**Max Tensile Strain (%)**
0	Negligible	Hairline Cracks		Less than 0.05
1	Very Slight	Fine cracks easily treated during normal redecorations. Perhaps isolated slight fracture in building. Cracks in exterior brickwork visible upon close inspection	0.1 to 1	0.05 to 0.075
2	Slight	Cracks easily filled. Redecoration properly required. Several slight fractures inside building. Exterior cracks visible. Some repointing maybe required for weather tightness. Doors and windows may stick slightly.	1 to 5	0.075 to 0.15
3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Tack-pointing and possibly replacement of a small amount if exterior brickwork may be required. Doors and windows sticking. Utility services maybe interrupted. Water tightness often impaired.	5 to 15. Number of cracks greater than 3.	0.15 to 0.3
4	Severe	Extensive repair involving removal and replacement of sections of walls, especially over doors and windows required. Windows and doors frame distorted. Floor slopes noticeably, some loss of bearing in beams.	15 to 25. but also depends on no. of cracks	Greater than 0.3
5	Very Severe	Major repair required involving partial or complete reconstruction. Beams, load bearing walls lean badly and require shoring. Windows broken by distortion. Danger of instability.	Usually greater than 25but depends on number of cracks.	

Those under moderate and higher categories need further stage 3 assessment of detailed structural study.

6 CONDITION ASSESSMENT

A visual investigation of heritage structures along Corridor 1 was carried out in August and September 2019. During the investigation, the heritage structures were examined on the basis of structural typology, material and current state of preservation identifying visible structural and non-structural distresses (cracks, material degradation due to weather, bulging of walls, tilting of structural members, deflection in structural members, subsidence of floors, etc.) and their extent. Based on these parameters the heritage structures are classified into varying levels of distress:

Nil: The structures where no structural distress and negligible material degradation is visibly observed are classified in this category.

Minor: The structures where deterioration in material due to weathering, cracks in plaster (non-structural) and fine cracks in few structural elements are observed are classified in this category.

Moderate: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in few to many structural elements are classified in this category.

Major: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in most structural elements are classified in this category.

(Note: In accordance with standard literature, few refers to about 5%, many refers to 50% and most refers to 75% or more)

The matrix – table 17, below is a compilation of the buildings visited during the visual investigation, the expected settlements around each structure, the expected vibration and the subsequent risk category that they lie in.

7 RISK ASSESSMENT

Based on the combined analysis of the geotechnical assessment, vibration assessment and condition assessment the heritage buildings have been categorised into varying degrees of risk; low, medium and high.

Risk Category: Low

All the buildings that are in nil, minor, moderate and severe levels of distress, experiencing nil to negligible ground settlement and no vibration effects would be placed in the Low risk category.

Risk Category: Medium

All the buildings that are in nil and minor levels of distress and experiencing slight and moderate ground settlement, moderate and severe levels of distress and experiencing slight ground settlement, and nil and minor levels of distress and experiencing vibrations due to excavation or tunnelling are placed in the Medium risk category.

Risk Category: High

All the buildings that are in nil and minor levels of distress and experiencing severe ground settlement, moderate and severe levels of distress and experiencing moderate and severe ground settlement, nil and minor levels of distress and experiencing vibrations due to excavation and tunnelling, moderate and severe levels of distress and experiencing vibrations due to excavation or tunnelling, and excavation and tunnelling are placed in the High risk category.

Table 17 Building Assessment

S.no	Structure	Protection Type	Dimension	Subterranean chambers /Foundation	Description	Horizontal structural system	Vertical structural systems	Construction materials	Distance from metro line	Observations on Structural Distress	Level of distress	Expected ground settlement (mm)	Risk Class (Settlement)	PPV Tunnelling	PPV Excavation	Risk Category
1	**Agra Fort**	ASI	Data yet to be received	Data yet to be received	The fort wall is a multileaf masonry load bearing wall		Walls	Brick masonry with lime mortar, sandstone cladding	97m (UG)	A staggered crack was observed in one of the bastions that extended from the top to its mid height	Moderate	0	Negligible	Within limit	Within limit	**Low**
2	**Taj Mahal**	ASI	Data yet to be received	Data yet to be received	The system is composed of four arches placed in an octagonal plan supporting the central dome. The structure also has chathris and minarets	Domes and Arches	Walls	Brick masonry with lime mortar, white marble cladding	522m (UG)	No structural distress was observed	Nil	0	Negligible	Within limit	Within limit	**Low**
3	**Lodhi's Tomb**	ASI	Data yet to be received	Data yet to be received	The system is composed of a series of arches placed in an octagonal plan supporting the central dome. The structure also has chajjas supported by stone brackets	Domes and Arches	Walls	Combination of stone masonry and brick masonry with lime mortar	291m (Elev)	Multiple cracks running along the wall and column edges have been observed. Several wide cracks were also seen on dome and arch which could be plaster or structural cracks.	Minor	NA	NA	NA	Within limit	**Low**
4	**Kanch Mahal**	ASI	Data yet to be received	Data yet to be received	The system consists of two arched gateways leading to a central place surmounted by a dome. The dome is supported by arches and columns in the first floor level and post and lintels in the ground floor. The system also consists of Jarokhas (projected balcony)	The structure has multiple systems 1. Dome, arches and lintels 2. Flat roof and lintel	Columns and Walls	Brick masonry with lime mortar, sandstone cladding	361m (Elev)	Cracks were observed to running from the columns in the first floor to the columns in the ground floor	Moderate	NA	NA	NA	Within limit	**Low**
5	**Guru ka Taal**	ASI	Data yet to be received	Data yet to be received	The chathri comprises of a dome resting on a series of columns which rests on a load bearing wall	The structure has multiple systems 1. Domes and lintel 2. Flat roof	The structure has multiple systems 1. Columns 2.Walls	Brick masonry with lime mortar, sandstone cladding	173m (Elev)	No structural distress was observed	Minor	NA	NA	NA	Within limit	**Low**
6	**Pathar ka Ghoda**	ASI	Data yet to be received	Data yet to be received	The masjid comprises of three arched openings surmounted by a dome which is approached through an octagonal flat roofed chamber.	The structure has multiple systems 1. Dome and arches 2. Flat roof	Walls	Brick masonry with lime mortar	49m (Elev)	No structural distress was observed	Nil	NA	NA	NA	Within limit *	**Low**

7	**Tomb of Salamat Khan**	ASI	Data yet to be received	Data yet to be received	The structure is a pillared hall with small domes resting on arched columns	Domes and arches	Columns	Brick masonry with lime mortar, Stone columns sandstone cladding	176m (Elev)	Cracks were observed on the dome interiors and the columns have been subjected to wind erosion in various locations	Moderate	NA	NA	NA	Within limit	**Low**
8	**Tomb of Sadiq Khan**	ASI	Data yet to be received	Data yet to be received	The system is composed of a series of arches placed in an octagonal plan leading to the central dome. The structure also has chajjas supported by stone brackets	Dome and Arches	Walls	Brick masonry with lime mortar	157m (Elev)	Wide cracks were observed in several arch doorways which could be plaster or structural cracks.	Minor	NA	NA	NA	Within limit	**Low**
9	**Ladli Begam ka Tila**	ASI	Data yet to be received	Data yet to be received	An archaeological park	No structure	No structure	No structure	253m (Elev)		NA	NA	NA	NA	Within limit	**Low**
10	**Old Delhi Gate**	ASI	Data yet to be received	Data yet to be received	The system consists of two arched gateways with four small chathris resting in the corners of a flat roof	Arch and flat Roof	Walls	Brick masonry with lime mortar, sandstone cladding	158m (UG)	No structural distress was observed	Nil	0	Negligible	Within limit	Within limit	**Low**
11	**Jami Masjid**	ASI	Data yet to be received	Data yet to be received	The structure comprises of different systems. The prayer hall has arched opening surmounted by domes. They also consist of a minaret and small chathris on the roof. The structure also consists of semi open spaces having flat roof supported by the main wall on one side and colonnade on the other side.	The structure has multiple systems 1. Domes and arches 2. Flat roof and lintels	The structure has multiple systems 1. Walls 2.Columns	Brick masonry with lime mortar, sandstone cladding	127m (UG)	No structural distress was observed	Nil	0	Negligible	Within limit	Within limit	**Low**
12	**Bara Khamba**	ASI	Data yet to be received	Data yet to be received	The chathri comprises of a dome resting on a lintel supported by eight columns that rests on a raised plinth. The structure also has chajjas supported by stone brackets	Dome and Lintel	Columns	Brick masonry with lime mortar, Stone columns sandstone cladding	321m (UG)	No structural distress was observed	Nil	0	Negligible	Within limit	Within limit	**Low**
13	**Bhuri Khan's Mosque**	U.P	Data yet to be received	Data yet to be received	The mosque comprises of three arched openings surmounted by small domes	Dome and arches	Walls	Brick masonry with lime mortar	180m (Elev)	The structure has partially collapsed. Wide cracks are observed to be running from the arches to the dome.	Major	NA	NA	NA	Within limit	**Low**

14	**Suraj Bhan Gateway**	U.P	Data yet to be received	Data yet to be received	The system consists of two arched gateways leading to a central space and two chathris resting on flat roof.	Flat roof and Arch	Walls	Brick masonry with lime mortar, sandstone cladding	40m (Elev)	Wide cracks were observed in multiple locations on the ceiling of the first floor. The plaster has been removed	Major	NA	NA	NA	Within limit	**Low**
15	**Temple Gateway, Bagichi**	U.P	Data yet to be received	Data yet to be received	The complex consists of multiple systems. The entry gateway comprises of two chathri like structures on either sides which are surmounted by domes.	The structure has multiple systems 1. Domes and arches 2. Flat roof	The structure has multiple systems 1. Columns 2.Walls	Brick masonry with lime mortar, sandstone cladding	17m (Elev)	No structural distress was observed	Nil	NA	NA	NA	Exceeding limit	**Medium**
16	**St John's College**	U.P	Data yet to be received	Data yet to be received	The system comprises of colonnade corridors with jack arch roofs ,around the structure leading to rooms	Flat roof and Jack Arch	The structure has multiple systems 1. Walls 2.Columns	Brick masonry with lime mortar	0m (UG)	Cracks were observed to be running on the walls where the jack arches are supported, which could be due to the corrosion of the I sections	Moderate	64	Moderate	Exceeding limit *	Within limit *	**High**
17	**Khandari Begums Tomb**	U.P	Data yet to be received	Data yet to be received	Building interior inaccessible (entry restricted due to lack of permission)				45m (UG)	Building interior inaccessible (entry restricted due to permission)	NA	0	Negligible	Within limit	Within limit	-
18	**Sarojini Naidu Boys Hostel**	U.P	Data yet to be received	Data yet to be received	The system comprises of colonnade corridors with jack arch roofs ,around the structure leading to rooms	Flat roof and Jack Arch	The structure has multiple systems 1. Walls 2.Columns	Brick masonry with lime mortar	11m (UG)	Cracks were observed to be running at the junctions of joining between jack arches, which could be due to the corrosion of the I sections	Moderate	200	High	Exceeding limit	Exceeding limit	**High**

NB :

*	PPV during transit of Indian Railway trains to be measured
Elev	Elevated Metroline
UG	Underground Metroline
UP	Unprotected monuments

8 INFERENCES

1. The World Heritage Sites of Agra Fort and Taj Mahal lying along Corridor 1, protected by the ASI, are found to be in the **Low Risk Category**, as they would experience nil to negligible effect of ground settlement or vibrations during the construction of the metro line.

2. All the heritage structures lying along corridor 1, protected by the ASI namely, Lodhi's Tomb, Kanch Mahal, Pathar ka Ghoda, Guru Ka Taal, Ladli Begam ka Tila, Old Delhi Gate, Jami Masjid and Bara Khamba are found to be in the **Low Risk Category**, as they would experience nil to negligible effect of ground settlement or vibrations during the construction of the metro line.

3. The Unprotected heritage structures namely, Bhuri Khan's Mosque, Suraj Bhan Gateway and Khandari Begums Tomb are found to be in the **Low Risk Category** and therefore would experience nil to negligible effect of ground settlement or vibrations during the construction of the metro line.

4. The Unprotected heritage structure: Temple Gateway Bagichi is found to be in the **Medium Risk Category** and therefore would experience moderate effect of vibrations during the construction of the metro line.

5. Whereas the Sarojini Naidu's Boys Hostel and St Johns College are placed in the **High Risk Category**, the former owing to its poor condition, ground settlement and exceedance of PPV values during the construction of the metro line, and the latter owing to its poor condition and ground settlement values during the construction of the metro line.

6. The heritage structures along the metro line extending from Guru Ki Taal to Raja Ki Mandi and Medical College to Taj East Gate would experience nil to negligible effect of ground settlement or vibrations during the construction of the metro line. The Temple gateway Bagichi that lies along the metro line extending from Sikandra to Guru Ka Taal would experience moderate effect of vibrations during the construction of the metro line. The St. Johns College and Sarojini Nadu Boys hostel that lie in the High Risk Category in the metro line extending from Raja Ki Mandi to Medical College would experience significant effect of vibrations and settlement during the construction of the metro line.

7. The above conclusions are based on the information on alignment Corridor 1 and depth, length and breadth of excavation for stations and depth and diameter of excavation for tunnels provided in Agra Metro DPR.

8. It is also pointed out that the estimates of PPV due to tunnelling activities and excavation activities are not obtained from actual site measurements in Agra, but from published literature and vibration data from Lucknow Metro. Therefore, these must be considered only as a first estimate, and must be followed up with vibration measurements during trial operations.

9 RECOMMENDATIONS

1. None of the protected structures under the purview of the Archaeological Survey of India, including the World Heritage Sites of Taj Mahal and Agra Fort should be expected to suffer damage due to metro construction induced vibrations or ground settlement. Therefore, from a structural risk assessment perspective, the proposed alignment of the metro corridor does not pose any threat to these protected structures.

2. At least three unprotected structures are in the medium or high risk categories, implying potential damage to non-structural and/or structural elements during the metro construction activities. In these segments, a change of alignment can be considered to ensure that the heritage structure are further away from the alignment: ideally, 25 metres from the centreline of the tunnel alignment or 40 metres from the edge of the station.

3. Alternatively, at the sites referred to in point no.2 (and point no. 3 and 4 in section 8: Inferences), a series of mitigative measure comprising of temporary structural stabilisation (propping, bracing and confining), ground improvement interventions (soil grouting) and/or sheet piling must be adopted to reduce potential damage to the structures, as discussed in Section 10.

4. The background vibration levels due to existing sources of vibration, namely vehicular or rail traffic, movement of people and other activities must be recorded at all the sites of heritage structures identified in Table 18 along Corridor 1 to benchmark existing levels of vibration, prior to commencement of metro construction activities.

Table 18 Vibration test locations

No.	Structure	Test Location Points	Closest face/ corner of the structure to metro alignment
1	Lodhi's Tomb	PPV TEST PT.1	South-East corner on the ground floor
2	Kanch Mahal	PPV TEST PT.2	South- East corner on the ground floor
3	Bhuri Khan's Mosque	PPV TEST PT.3	South-West corner on the ground floor
4	SurajBhan Gateway	PPV TEST PT.4	South- West corner on the ground floor
5	Temple Gateway, Bagichi	PPV TEST PT.5	South- West corner on the ground floor
6	Pathar ka Ghoda	PPV TEST PT.6.1	North-West corner on the ground floor
		PPV TEST PT.6.2	South-West corner on the ground floor
7	Guru kaTaal	PPV TEST PT.7	South- West corner on the ground floor
8	Tomb of Sadiq Khan	PPV TEST PT.8	South edge on the ground floor
9	Tomb of Salamat Khan	PPV TEST PT.9	South-East corner on the ground floor
10	Khandari Begum's Tomb	PPV TEST PT.10	East corner on the ground floor
11	Old Delhi Gate	PPV TEST PT.11	South- West edge on the ground floor
12	St. John's College	PPV TEST PT.12	North edge of Physical Education Department on the ground floor
13	Lady Lyall Complex	PPV TEST PT.13	North-East corner on the ground floor
14	Sarojini Naidu Boys Hostel	PPV TEST PT.14.1 PPV TEST PT.14.2	North edge on the ground floor
15	Kalan Maszid	PPV TEST PT.15	South-West corner on the ground floor
16	Jami Masjid	PPV TEST PT.16	South-West corner on the ground floor
17	Agra Fort	PPV TEST PT.17	South-West corner on the ground floor
18	Bara Khamba	PPV TEST PT.18	South-West corner on the ground floor

5. **Measurement of Ambient Ground Vibration**

   The specifications of points of measurement for a structure for measuring ambient vibrations by DIN 4150, part 3, 1999 are explained below.

   To measure vibration in foundations, the pick-ups for the three direction of measurements should be placed close together on the ground floor of the building to be investigated, either at the foundation of the outer wall, on the outer wall itself, or in a recess in that wall. In buildings without a basement, the point of measurement should be no more than 0.5 m above the ground. Measurement points should preferably be on the side of the structure that faces the source of excitation. The time history of the vertical vibrations (z- axis) and horizontal vibrations (x- and y- axes, at right angles to each other) should be recorded, with one of the directions of measurement running parallel to a side wall of the building.

   For structures with a large ground floor area, simultaneous measurements should be made at several locations. In addition to the measurements made at the ground floor and the highest floor, a measurement in the vertical direction has to be made on the floors on which the strongest vibration is expected. The point of measurement should be in the centre of the floor (DIN 4150, part 3, 1999, Clause 5.4).

   It is essential that ambient ground vibration measurements should be at least taken at the point of measurement specified in Table 18for each heritage structure.

10 PROPOSED SCHEME OF MITIGATION MEASURES

The proposed scheme of mitigation measures are only an initial suggestion of possibilities based on the risk categorisation and structural typologies involved. It is underlined that mitigation interventions, ranging from temporary structural stabilisation and ground improvement techniques have to be designed and detailed by consultants who will be executing the metro segments in Corridor 1.

Table 19 Mitigation measures

S.no	Heritage Structure	Risk Category	Mitigation Measures
1	**St John's College**	High	**Building:** The structure has moderate structural distress and with 64 mm settlement expected due to tunneling. Temporary structural stabilization of distressed locations has to be carried out by adequate propping and bracing, and confinement for brick columns. It is recommended that the building be evacuated during tunneling operations, and until stabilization of ground conditions post-tunneling. Structural health monitoring using tilt meters, crack meters and building and ground settlement meters must be continuously recorded.

			Soil: Since the proposed metro line passes right under the structure, ground improvement by grouting has to be carried out with appropriately designed grout mix. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards.
2	**Sarojini Naidu Boys Hostel**	High	**Building:** The structure has moderate structural distress and with 200 mm settlement expected due to vicinity to proposed station. Temporary structural stabilization of distressed locations has to be carried out by adequate propping and bracing and confinement for brick columns. It is recommended that the building be evacuated station excavation and tunneling, and until stabilization of ground conditions post-tunneling/excavation. Structural health monitoring using tilt meters, crack meters and building and ground settlement meters must be continuously recorded. **Soil:** Ground improvement by grouting has to be carried out with appropriately designed grout mix. Sheet piling prior to D-wall construction can be carried out. Vibration measurements must be continuously recorded during execution of work, and they must not exceed threshold PPV level as identified in the DGMS and DIN 4150-3 standards.
3	**Temple Gateway, Bagichi**	Medium	**Building:** Since the structure is composed of arches supported on stone columns, and surmounted by domes, it is recommended that the arches be provided with temporary steel ties in order to ensure that lateral support movement of the columns do not endanger the arches and domes. **Soil:** Trenches can be executed around the monument, and/or ground improvement by grouting can be carried out with appropriately designed grout mix.

1. LAL MASJID

National Centre of Safety of Heritage Structure (NCSHS), Department of Civil Engineering, Indian Institute of Technology, Madras was approached to carry out a structural damage risk assessment within the Heritage Impact Assessment (HIA) of Agra Metro. The proposed alignment of the metro line runs elevated in proximity to several heritage structures, thereby exposing these structures to varied levels of vibration during construction activities and metro operations. Therefore, an assessment to examine the vulnerability of these structures to the proposed construction is being carried out. The current document is the interim report on Damage Risk Assessment that outlines the methodology of the complete study, process of estimating vibrations during metro construction, the condition survey and levels of distresses of the historical structures and risk category that the **Shahi Masjid and Tomb** are to be categorised in. The heritage buildings assessed in this report are present along Corridor 2, which is elevated along the structures and their subsequent distance from the metro line is considered for the above discussed assessment (Table A2-1)

Table A2-1 Evaluated Heritage Sites along Corridor 2

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
2a	**Shahi Tomb**	**Shahi Tomb**	ASI	453.5	68
2b		**Masjid**	ASI	453	86

Table A2-5 Ground vibration estimates due to Construction of proposed elevated metro stations

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-2 as input (PPV1)	Overall PPV(mm/s) using Table A2-3 as input (PPV2)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
						Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
							PPV1	PPV2		PPV1	PPV2		PPV1	PPV2		PPV1	PPV2
Kamla Nagar	1	**Shahi Tomb**															
	1 a	**Shahi Tomb**	453.5	0.01	0.02	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 b	**Masjid**	453	0.01	0.02	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table A2-6 Ground vibration estimates due to construction of foundation for proposed elevated metro alignment

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-4 as input (PPV1)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
					Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
						PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2
Kamla Nagar	2	**Shahi Tomb**														
	2 a	**Shahi Tomb**	71	0.40	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	2 b	**Masjid**	84.5	0.31	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

5. CONDITION ASSESSMENT

A visual investigation of heritage structures along Corridor 2 is carried out ,following which the heritage structures are examined on the basis of structural typology, material and current state of preservation identifying visible structural and non-structural distresses (cracks, material degradation due to weather, bulging of walls, tilting of structural members, deflection in structural members, subsidence of floors, etc.) and their extent. Based on these parameters the heritage structures are classified into varying levels of distress:

Nil: The structures where no structural distress and negligible material degradation is visibly observed are classified in this category.

Minor: The structures where deterioration in material due to weathering, cracks in plaster (non-structural) and fine cracks in few structural elements are observed are classified in this category.

Moderate: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in few to many structural elements are classified in this category.

Major: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in most structural elements are classified in this category.
(Note: In accordance with standard literature, few refers to about 5%, many refers to 50% and most refers to 75% or more)

The matrix – Table A2-9, below is a compilation of the buildings that would be visited during the visual investigation, the expected vibration and the subsequent risk category that they lie in.

Table A2-9 Building assessment

S. no	Structure	Sub Structure	Protection Type	Dimension	Subterranean chambers /Foundation	Description	Horizontal structural system	Vertical structural systems	Construction materials	Distance from metro line	Observations on Structural Distress	Level of distress	PPV Construction activities	Risk Category
2a	**Shahi Tomb**	**Shahi Tomb**	ASI			Square masonry structure covered with dome			Brick masonry, stone cladding, lime works	68 mtts		Structurally dilapidated	Within limit	**Low**
2b		**Masjid**	ASI			Masonry structure with arches, vaults and dome			Brick masonry, stone cladding, lime works	86 mtrs		Structurally dilapidated	Within limit	**Low**

1. ROMAN CATHOLIC CEMETERY

National Centre of Safety of Heritage Structure (NCSHS), Department of Civil Engineering, Indian Institute of Technology, Madras was approached to carry out a structural damage risk assessment within the Heritage Impact Assessment (HIA) of Agra Metro. The proposed alignment of the metro line runs elevated in proximity to several heritage structures, thereby exposing these structures to varied levels of vibration during construction activities and metro operations. Therefore, an assessment to examine the vulnerability of these structures to the proposed construction is being carried out. The current document is the interim report on Damage Risk Assessment that outlines the methodology of the complete study, process of estimating vibrations during metro construction, the condition survey and levels of distresses of the historical structures and risk category that the heritage structure within **Roman Catholic Cemetery** are to be categorised in. The heritage buildings assessed in this report are present along Corridor 2, which is elevated along the structures and their subsequent distance from the metro line is considered for the above discussed assessment (Table A2-1)

Table A2-1 Evaluated Heritage Sites along Corridor 2

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
1	**R. C Cemetery**	**Marty's Chapel**	ASI	132	120
2		**The Red Taj**	ASI	73	79.5
3		**Ellis Family Tomb**	ASI	48.5	49.5
5		**Samru's Tomb**	ASI	97.5	59
4		**Unknown Tomb**	ASI	58	47.5
6		**Chhatris like Tombs**	ASI	84	78
7		**Gateway**	ASI	43.5	50.5

Table A2-5 Ground vibration estimates due to Construction of proposed elevated metro stations

Station	S.no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-2 as input (PPV1)	Overall PPV(mm/s) using Table A2-3 as input (PPV2)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
						Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
							PPV1	PPV2		PPV1	PPV2		PPV1	PPV2		PPV1	PPV2
MG Road	1	R. C Cemetery															
	1a	Marty's Chapel	132	0.05	0.16	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1b	The Red Taj	73	0.11	0.38	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1c	Ellis Family Tomb	48.5	0.20	0.71	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1d	Samru's Tomb	97.5	0.07	0.25	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1f	Unknown Tomb	58	0.15	0.54	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1e	Chhatris like Tombs	84	0.09	0.31	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1g	Gateway	43.5	0.24	0.83	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table A2-6 Ground vibration estimates due to construction of foundation for proposed elevated metro alignment

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-4 as input (PPV1)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
					Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
						PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2
MG Road	**1**	**R. C Cemetery**														
	1 a	**Marty's Chapel**	120	0.18	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 b	**The Red Taj**	79.5	0.34	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 c	**Ellis Family Tomb**	49.5	0.69	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 d	**Samru's Tomb**	59	0.53	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1f	**Unknown Tomb**	47.5	0.73	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 e	**Chhatris like Tombs**	78	0.35	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes
	1 g	**Gateway**	50.5	0.67	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table A2-9 Building assessment

S.no	Structure	Sub Structure	Protection Type	Dimension	Subterranean chambers /Foundation	Description	Horizontal structural system	Vertical structural systems	Construction materials	Distance from metro line	Observations on Structural Distress	Level of distress	PPV Construction activities	Risk Category
1a	**R. C Cemetery**	**Marty's Chapel**	ASI	Data yet to be received	Data yet to be received					120m			Within limit	
1b		**The Red Taj**	ASI	Data yet to be received	Data yet to be received					73m			Within limit	
1c		**Ellis Family Tomb**	ASI	Data yet to be received	Data yet to be received					48.5m			Within limit	
1d		**Samru's Tomb**	ASI	Data yet to be received	Data yet to be received					59m			Within limit	
1e		**Unknown Tomb**	ASI	Data yet to be received	Data yet to be received					47.5m			Within limit	
1f		**Chatris like Tombs**	ASI	Data yet to be received	Data yet to be received					78m			Within limit	
1g		**Gateway**	ASI	Data yet to be received	Data yet to be received					43.5m			Within limit	

1. RAMBAGH STRCTURAL ASSESSMENT HIA

National Centre of Safety of Heritage Structure (NCSHS), Department of Civil Engineering, Indian Institute of Technology, Madras was approached to carry out a structural damage risk assessment within the Heritage Impact Assessment (HIA) of Agra Metro. The proposed alignment of the metro line runs elevated in proximity to several heritage structures, thereby exposing these structures to varied levels of vibration during construction activities and metro operations. Therefore, an assessment to examine the vulnerability of these structures to the proposed construction is being carried out. The current document is the interim report on Damage Risk Assessment that outlines the methodology of the complete study, process of estimating vibrations during metro construction, the condition survey and levels of distresses of the historical structures and risk category that the heritage structures within **Ram Bagh** are to be categorised in. The heritage buildings assessed in this report are present along Corridor 2, which is elevated along the structures and their subsequent distance from the metro line is considered for the above discussed assessment (Table A2-1)

Table A2-1 Evaluated Heritage Sites along Corridor 2

No.	Structure	Sub- Structure	Protection Status	Distance from Metro station (m)	Distance from Metro line (m)
1	**Ram Bagh**		ASI	69.5	74.5

Table A2-5 Ground vibration estimates due to Construction of proposed elevated metro stations

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-2 as input (PPV1)	Overall PPV(mm/s) using Table A2-3 as input (PPV2)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
						Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
							PPV1	PPV2		PPV1	PPV2		PPV1	PPV2		PPV1	PPV2
Ram Bagh	1	Ram Bagh															
	1a	Ram Bagh Site	69.5	0.12	0.41	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

Table A2-6 Ground vibration estimates due to construction of foundation for proposed elevated metro alignment

Station	S. no	Heritage Structure	Closest distance from Station d (m)	Overall PPV(mm/s) using Table A2-4 as input (PPV1)	PPV Limits Based on DIN 4150 Part 3, 1984 (mm/s)						PPV Limits Based on Directorate General of Mines Safety, India (mm/s)					
					Limits (Frequency range: 10-50 Hz)	Less Than Limit		Limits (Frequency range: 50-100 Hz)	Less Than Limit		Limits (Frequency range: 8-25 Hz)	Less Than Limit		Limits (Frequency range: >25 Hz)	Less Than Limit	
						PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2		PPV 1	PPV 2
Ram Bagh	1	Ram Bagh														
	1a	Ram Bagh Site	74.5	0.37	3-8	Yes	Yes	8-10	Yes	Yes	5	Yes	Yes	10	Yes	Yes

5. CONDITION ASSESSMENT

A visual investigation of heritage structures along Corridor 2 is carried out ,following which the heritage structures are examined on the basis of structural typology, material and current state of preservation identifying visible structural and non-structural distresses (cracks, material degradation due to weather, bulging of walls, tilting of structural members, deflection in structural members, subsidence of floors, etc.) and their extent. Based on these parameters the heritage structures are classified into varying levels of distress:

Nil: The structures where no structural distress and negligible material degradation is visibly observed are classified in this category.

Minor: The structures where deterioration in material due to weathering, cracks in plaster (non-structural) and fine cracks in few structural elements are observed are classified in this category.

Moderate: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in few to many structural elements are classified in this category.

Major: The structures where structural distresses such as cracks, bulging of wall, etc. are seen in most structural elements are classified in this category.
(Note: In accordance with standard literature, few refers to about 5%, many refers to 50% and most refers to 75% or more)

The matrix – Table A2-9, below is a compilation of the buildings that would be visited during the visual investigation, the expected vibration and the subsequent risk category that they lie in.

Table A2-9 Building assessment

S. no	Structure	Sub Structure	Protection Type	Dimension	Subterranean chambers /Foundation	Description	Horizontal structural system	Vertical structural systems	Construction materials	Distance from metro line	Observations on Structural Distress	Level of distress	PPV Construction activities	Risk Category
1	**Ram Bagh**		ASI			Masonry walls and a gateway runs parallel to the line			Brick, stone and lime mortar	67 mtrs		Nil	Within limit	*Low*

6. REFERENCES

1. Mair RJ, Taylor RN and Bracegirdle A (1993) Subsurface settlement profiles above tunnels in clay. *Géotechnique*, 43(2): 315-320.

2. Peck RB (1969) Deep excavations and tunnelling in soft ground. *Proceedings of 7th International Conference on Soil Mechanics and Foundation Engineering*, ISSMGE, Mexico City, Mexico, pp. 225-290.

3. Lai H, Zhang J, Zhang L, Chen R and Yang W (2019) A New Method based on Centrifuge Model Test for Evaluating Ground Settlement Induced by Tunnelling. *KSCE Journal of Civil Engineering*, 23(6): 2426-2436.

4. Atkinson JH and Potts DM (1977) Subsidence above shallow tunnels in soft ground. *Journal of Geotechnical Engineering*, 103(4): 307- 325.

5. Einstein Z, El-Nahhas F and Thomson S (1981) Strain field around a tunnel in stiff soil. *Proceedings of 10th International Conference on Soil Mechanics and Foundation Engineering*, ISSMGE, Stockholm, Sweden, pp. 283-288.

6. Attewell PB and Woodman JP (1982) Predicting the dynamics of ground settlements and its derivatives by tunnelling in soil. *Ground Engineering*, 15(8): 13-22.

7. New BM and O'Reilly MP (1991) Tunnelling induced ground movements, predicting their magnitude and effects. *Proceedings of 4th International Conference on Ground Movements and Structure*, Pentech Press, Cardiff, Wales, pp. 671-697.

8. FTA Predictive Methodology from FTA document (2006), *Transit Noise and Vibration Impact Assessment* FTA-VA90-1003-06, FTA

11 APPENDIX 1 – Building inventories

1. Name of heritage resource: Agra Fort

1. **Protection status :** World Heritage site, ASI
2. **Proposed development actions:** Underground metro line
3. **Structural system**
   The fort wall has been a major focus for the HAI. The fort wall is a multi-leaf masonry load bearing wall.
   - Vertical structural system: The vertical structural system comprises of walls
4. **Condition of structural members :**
   No structural distress was observed in the structural members but other defects such as blackening, loss of cladding and vegetation was observed.
5. **Condition of structural system :**
   A staggered crack was observed in one of the bastion that extended from the top to its mid area. No structural distress was observed in the structural system.
6. **Level of distress:** Moderate
7. **Expected impacts**
   - Impact of soil settlement : No impact
   - Impact of vibrations due to tunnelling: No impact
   - Impact of vibrations due to excavation: No impact
8. **Expected settlement:** 0
9. **Permissible limit:** Negligible
10. **Proposed scientific studies:**
    - Trial pit excavation to understand the foundation typology
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 21: Agra fort

Figure 22: Vertical Crack

Figure 23: Loss of Cladding

2. Heritage resource: Lodhi's Tomb, Sikandara

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**

   The system is composed of a series of arches placed in an octagonal plan leading to the central dome. The structure also has chajjas supported by stone brackets

   - Horizontal structural system: The Horizontal structural system consists of Domes and arches
   - Vertical structural system: The vertical structural system comprises of walls
4. **Condition of structural members :**

   Wide cracks were observed in the dome which could be structural or plaster cracks. Other defects such as blackening, fine cracks, vegetation, delamination and dampness was observed.
5. **Condition of structural system :**

   A long crack running from the interiors of the dome to the arch was observed in the north east part of the structure, could be a structural distress.
6. **Level of distress:** Minor
7. **Expected impacts**
   - Impact of soil settlement: Not Applicable
   - Impact of vibrations due to tunnelling: Not Applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not Applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Trial pit excavation to understand the foundation typology
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 24: Lodhi's Tomb

Figure 25: Vertical Crack

Figure 26: Horizontal Crack

Figure 27 Cracks in the ceiling

Figure 28: Vegetation Growth and structural damage

3. Name of heritage resource: Kanch Mahal, Sikandara

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**

   The system consists of two arched gateways leading to a central place surmounted by a dome. The dome is supported by arches and columns in the first floor level and post and lintels in the ground floor. The system also consists of Jarokhas

   - Horizontal structural system: The structure has multiple systems. The first system consists of Domes and arches and the second system consists of flat roof and lintels
   - Vertical structural system: The vertical structural system comprises of walls and columns
4. **Condition of structural members :**

   Cracks were observed in the entrance archway, columns and beams around the central dome. In addition to Cracks, blackening, delamination and loss of plaster was observed.
5. **Condition of structural system :**

   Cracks were observed to running from the columns in the first floor to the columns in the ground floor, which could be signs of structural distress.
6. **Level of distress**: Moderate
7. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations due to tunnelling: Not applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 29:Kanch Mahal

Figure 30: Vertical Crack

Figure 31: horizontal crack

Figure 32: Structural crack

Figure 33: Soot formation

4. Name of heritage resource: Guru Ka Taal

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**

   The chathris comprises of a dome resting on a series of columns which rests on a load bearing wall

   - Horizontal structural system: The structure has multiple systems. The first system consists of Domes and lintels, the second system consists of flat roof
   - Vertical structural system: The vertical structural system comprises of walls and columns
4. **Condition of structural members :**

   Cracks were observed in the columns and beams. In addition to Cracks, blackening, delamination and loss of plaster was observed.
5. **Condition of structural system :**

   No structural distress was observed in the structural system.
6. **Level of distress:** Minor
7. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations due to tunnelling: Not Applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Trial pit excavation to understand the foundation typology
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.


Figure 34: Guru Ka Taal


Figure 35: Chathri at Guru ka taal


Figure 36: Vertical Crack


Figure 37:Horizontal Crack


Figure 38: Structural Crack


Figure 39: Vegetation Growth

5. Name of heritage resource: Pathar Ka Ghoda

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**
   The masjid comprises of three arched opening surmounted by a dome which is approached through an octagonal flat roofed chamber.
   - Horizontal structural system: The structure has multiple systems. The first system consists of Domes and arches the second system consists of flat roof
   - Vertical structural system: The vertical structural system comprises of walls.
4. **Condition of structural members :**
   No structural distress was observed but other defects such as blackening and plaster damage was observed.
5. **Condition of structural system :**
   No structural distress was observed.
6. **Level of distress:** Nil
7. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations due to tunnelling: Not Applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 40: Pathar ka Ghoda

Figure 41: Vertical cracks

Figure 42: Plaster Delamination

6. Name of heritage resource: Tomb of Salabat Khan

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**

   The structure is a pillared hall with small domes resting on arched columns

   - Horizontal structural system: The structure consists of Domes and arches.
   - Vertical structural system: The vertical structural system comprises of columns
4. **Condition of structural members :**

   Cracks were observed on the dome interiors and the columns has been subjected to wind erosion in various locations
5. **Condition of structural system:**

   Cracks were observed to running from the domes to the arches, which could be a sign of structural distress.
6. **Level of distress:** Moderate
7. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations due to tunnelling: Not Applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk:** Low
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 43: Tomb of Salamat khan

Figure 44: Vertical Crack

Figure 45: Horizontal Crack

Figure 46: Structural Crack

Figure 47: Wind Erosion

7. Name of heritage resource: Tomb of Sadiq Khan

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**
   The system is composed of a series of arches placed in an octagonal plan leading to the central dome. The structure also has chajjas supported by stone brackets
   - Horizontal structural system: The structure consists of Domes and arches.
   - Vertical structural system: The vertical structural system comprises of load bearing walls
4. **Condition of structural members :**
   Cracks were observed on the dome interiors and in the entry archways which might be plaster cracks.
5. **Condition of structural system:**
   No structural distress was observed.
6. **Level of distress:** Minor
7. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations due to tunnelling: Not Applicable
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Not applicable
9. **Expected settlement:** Nil
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk:** Low
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 48: Tomb of Sadiq Khan

Figure 49: Vertical Crack

Figure 50: Horizontal Crack

Figure 51: Structural Crack

Figure 52: Openings at Base

8. Name of heritage resource: Ladli Begam Ka Tila

1. **Protection status :** ASI
2. **Proposed development actions:** Elevated metro line
3. **Structural system**
   An archaeological park
4. **Condition :**
   The site does not have a structure.
5. **Level of distress:** Not applicable
6. **Expected impacts**
   - Impact of soil settlement : Not applicable
   - Impact of vibrations : Not applicable
7. **Permissible limit:** Not applicable
8. **Expected settlement:** Nil
9. **Proposed scientific studies:** Not applicable
10. **Category of risk: Low**
11. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 53: Ladli begum's tila

9. Name of heritage resource: Old Delhi Gate of city

1. **Protection status :** ASI
2. **Proposed development actions:** Underground metro line
3. **Structural system**
   The system consists of two arched gateways with four small chathris resting on a flat roof in the corners
   - Horizontal structural system: The Horizontal structural system consists of arches and flat roof.
   - Vertical structural system: The vertical structural system comprises of load bearing walls
4. **Condition of structural members :**
   Cracks were observed on the dome interiors and in the entry archways which might be plaster cracks.
5. **Condition of structural system:**
   No structural distress was observed.
6. **Level of distress:** Nil
7. **Expected impacts**
   - Impact of soil settlement : No impact
   - Impact of vibrations due to tunnelling: No impact
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:** Negligible
9. **Expected settlement: 0**
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**
12. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.


Figure 54: Old Delhi Gate


Figure 55: Moisture ingress


Figure 56: Horizontal Crack


Figure 57: Plaster removal


Figure 58: Vegetation Growth

10. Name of heritage resource: Jama Masjid

1. **Protection status :** ASI
2. **Proposed development actions:** Underground metro line
3. **Structural system**

   The structure comprises of different systems. The prayer hall has arched opening surmounted by domes. They also consist of a minaret and small chathris on the roof. The structure also consists of semi open spaces having flat roof supported by the main wall on one side and colonnade on the other side.

   - Horizontal structural system: The structure has multiple systems. The first system consists of Domes and arches and the second system consists of flat roof and lintels
   - Vertical structural system: The structure has multiple systems. The first system consists of load bearing walls and the second system consists of columns
4. **Condition of structural members :**

   No structural distress was observed in the structural members but other defects such as blackening, fine cracks, vegetation, delamination and dampness was observed.
5. **Condition of structural system :**

   No structural distress was observed in the structural system
6. **Level of distress:** Nil
7. **Expected impacts**
   - Impact of soil settlement : No impact
   - Impact of vibrations due to tunnelling: No impact
   - Impact of vibrations due to excavation: No impact
8. **Permissible limit:**Negligible
9. **Expected settlement:** 0
10. **Proposed scientific studies:**
    - Vibration test at a point closest to the road, during peak activity hour and low activity hour during a working day
11. **Category of risk: Low**

13. **Recommendations:** The proposed alignment of the metro corridor does not pose any threat to this protected structure.

Figure 59: Jama masjid

Figure 60: Vertical Crack

Figure 61: Vegetation Growth

Figure 62: Water Ingress in roof

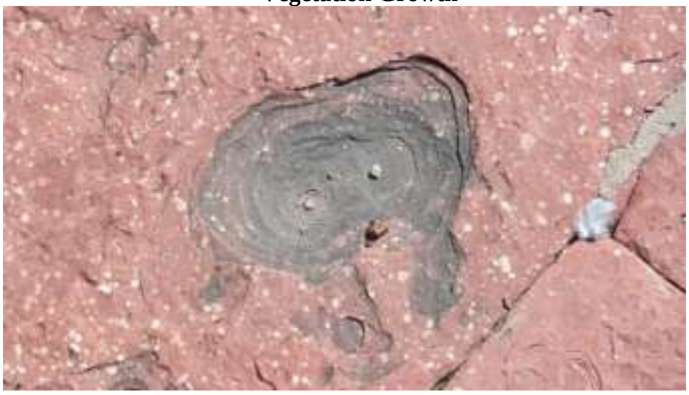


Figure 63: Contouring in stone

12 REFERENCES

1. Mair RJ, Taylor RN and Bracegirdle A (1993) Subsurface settlement profiles above tunnels in clay. *Géotechnique*, 43(2): 315-320.

2. Peck RB (1969) Deep excavations and tunnelling in softground. *Proceedings of 7th International Conference on Soil Mechanics and Foundation Engineering*, ISSMGE, Mexico City, Mexico, pp. 225-290.

3. Lai H, Zhang J, Zhang L, Chen R and Yang W (2019) A New Method based on Centrifuge Model Test for Evaluating Ground Settlement Induced by Tunnelling. *KSCE Journal of Civil Engineering*, 23(6): 2426-2436.

4. Atkinson JH and Potts DM (1977) Subsidence above shallow tunnels in soft ground. *Journal of Geotechnical Engineering*, 103(4): 307- 325.

5. Einstein Z, El-Nahhas F and Thomson S (1981) Strain field around a tunnel in stiff soil. *Proceedings of 10th International Conference on Soil Mechanics and Foundation Engineering*, ISSMGE, Stockholm, Sweden, pp. 283-288.

6. Attewell PB and Woodman JP (1982) Predicting the dynamics of ground settlements and its derivatives by tunnelling in soil. *Ground Engineering*, 15(8): 13-22.

7. New BM and O'Reilly MP (1991) Tunnelling induced ground movements, predicting their magnitude and effects. *Proceedings of 4th International Conference on Ground Movements and Structure*, Pentech Press, Cardiff, Wales, pp. 671-697.

8. Bowles JE (1988) *Foundation analysis and design*, 4th edition, McGraw-Hill, New York.

9. Clough GW and O'Rourke TD (1990) Construction induced movements of in situ walls. *Proceedings of Design and performance of earth retaining structures*, ASCE, Ithaca, New York, pp.439-470.

10. Ou CY, Hsieh PG and Chiou DC (1993) Characteristics of ground surface settlement during excavation. *Canadian Geotechnical Journal*, 30(5): 758-767.

11. Hsieh PG and Ou CY (1998) Shape of ground surface settlement profiles caused by excavation. *Canadian Geotechnical Journal*, 35(6): 1004-1017.

12. Kung GT, Juang CH, Hsiao EC and Hashash YM (2007) Simplified model for wall deflection and ground-surface settlement caused by braced excavation in clays. *Journal of Geotechnical and Geoenvironmental Engineering*, 133(6): 731-747.

13. Ou CY (2014) *Deep excavation: Theory and practice*. CRC Press.

14. Aurecon Jacobs Mott Macdonald and Grimshaw (2016) *Melbourne Metro Rail Project, Noise and Vibration Impact Assessment*

15. FTA Predictive Methodology from FTA document (2006), *Transit Noise and Vibration Impact Assessment* FTA-VA90-1003-06, FTA

16. Chandler RJ, de Freitas MH, Marinos P (2004): Geotechnical characterization of soils and rocks: a geological perspective. In: *Proceedings of the Advances in Geotechnical Engineering: The Skempton Conference*. Vol 1. London: Thomas Telford, 67–102.

Annexure-II

1. Archival photos

A. Akbar’s tomb, Sikandara

Image 1 A view of Akbar gate taken from the south, Tomb of the Emperor Akbar at Sikandara, Agra, Source: British Library Collection

Image 2 A view of Akbar mausoleum taken from the south, Tomb of the Emperor Akbar at Sikandara, Agra, Source: British Library Collection

Image 3 A view of Akbar mausoleum taken from the south east, Tomb of the Emperor Akbar at Sikandara, Agra, 1851, Source: The J. Paul Getty Museum Collection, Los Angeles, United States

Image 4 A view of Akbar mausoleum taken from the south east, Tomb of the Emperor Akbar at Sikandara, Agra, Source: The J. Paul Getty Museum Collection, Los Angeles, United States

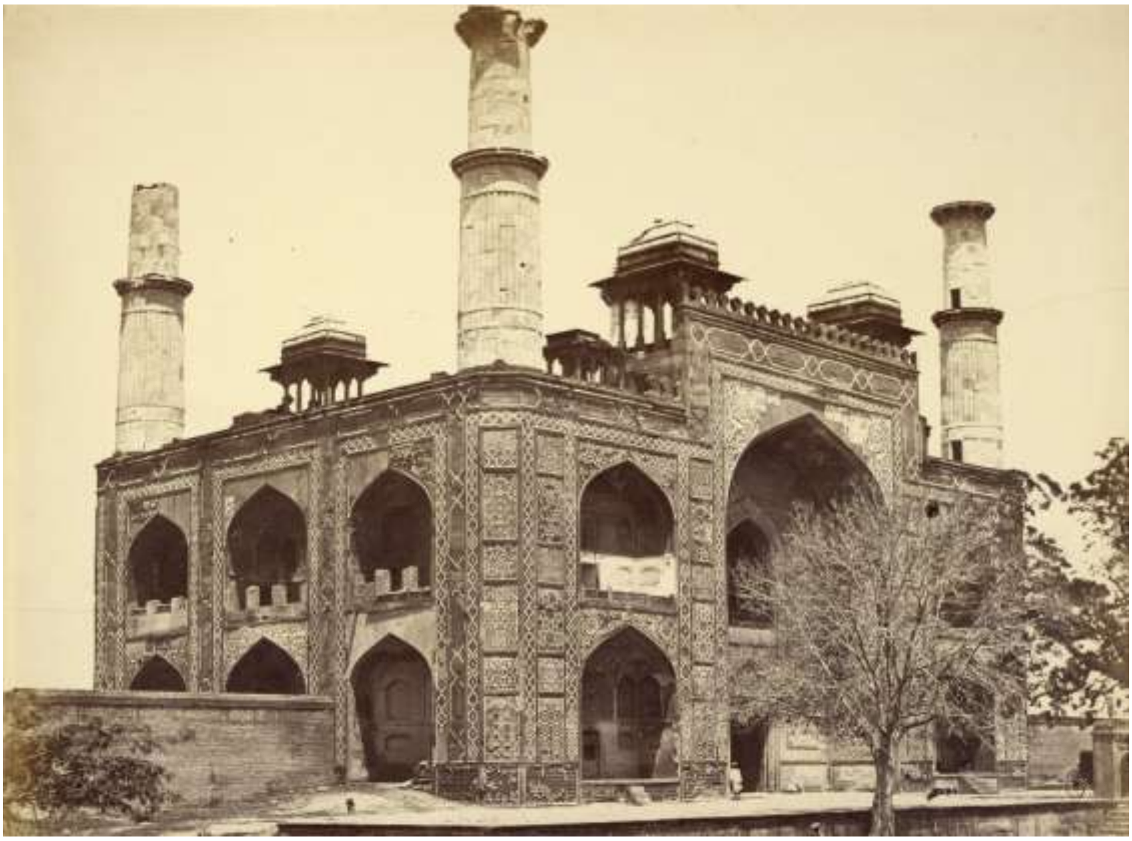


Image 6 A view of Akbar gate taken from the south west, Tomb of the Emperor Akbar at Sikandara, Agra, Source: The J. Paul Getty Museum Collection, Los Angeles, United States

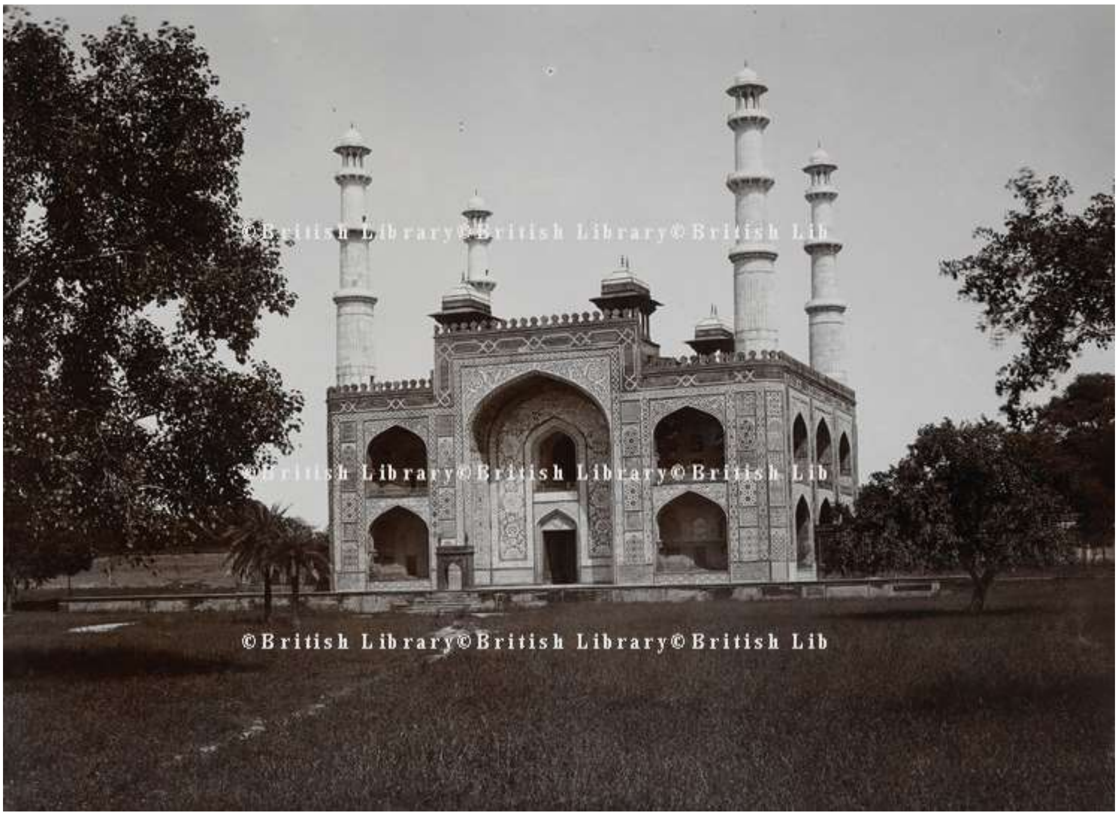


Image 5 A view of Akbar gate taken from the south east, Tomb of the Emperor Akbar at Sikandara, Agra 1900, Source: British Library Collection

B. Agra fort

Image 7 A view of Agra fort taken from the south east., Source: British Library Collection

Image 8 A View of Agra Fort, by a Calcutta artist after William Hodges, Source: British Library Collection

Image 9 The Delhi gate to the Agra Fort from inside the barbican, with the Union flag flying, Source: British Library Collection

Image 10 British India: Palace and Fort at Agra., Source: British Library Collection

Image 11 A view of Delhi gate taken from the north west, Agra fort, Agra, Source: The Metropolitan Museum of Art Collection, New York City, United States

Image 12 A view of Agra fort taken from the east, Agra Fort, 1855, Source: British Library Collection

Image 13 A view of Diwan-i-Khas from the west, Agra fort, Agra, Source: The J. Paul Getty Museum Collection, Los Angeles, United States

Image 14 The Delhi gate to the Agra Fort from inside the octagonal bazar, Agra Fort, Agra, Source: British Library Collection

Image 15 A view of Diwan-i-khas taken from the north west, Agra fort, Source: Los Angeles County Museum of Art, Los Angeles, United States

Image 16 A view of Agra fort taken from the south east, Agra fort, Source: Nicephore Niepce Museum, France

Image 18 N° 1217 - A view of Saman Burj taken from the east, Agra fort, Source: British Library Collection

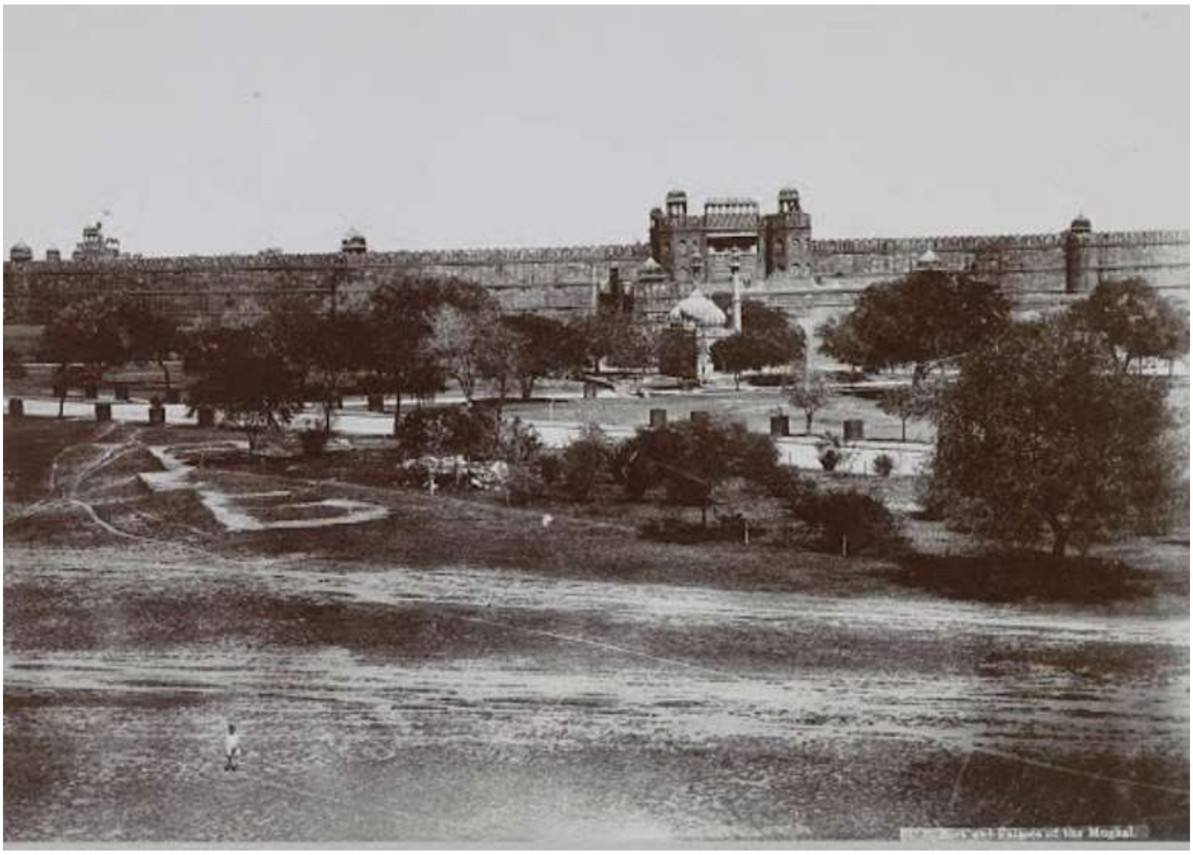


Image 17 A view of Agra fort taken from the south, Agra fort, Agra, Source: RUKS Museum, Amsterdam, Netherlands

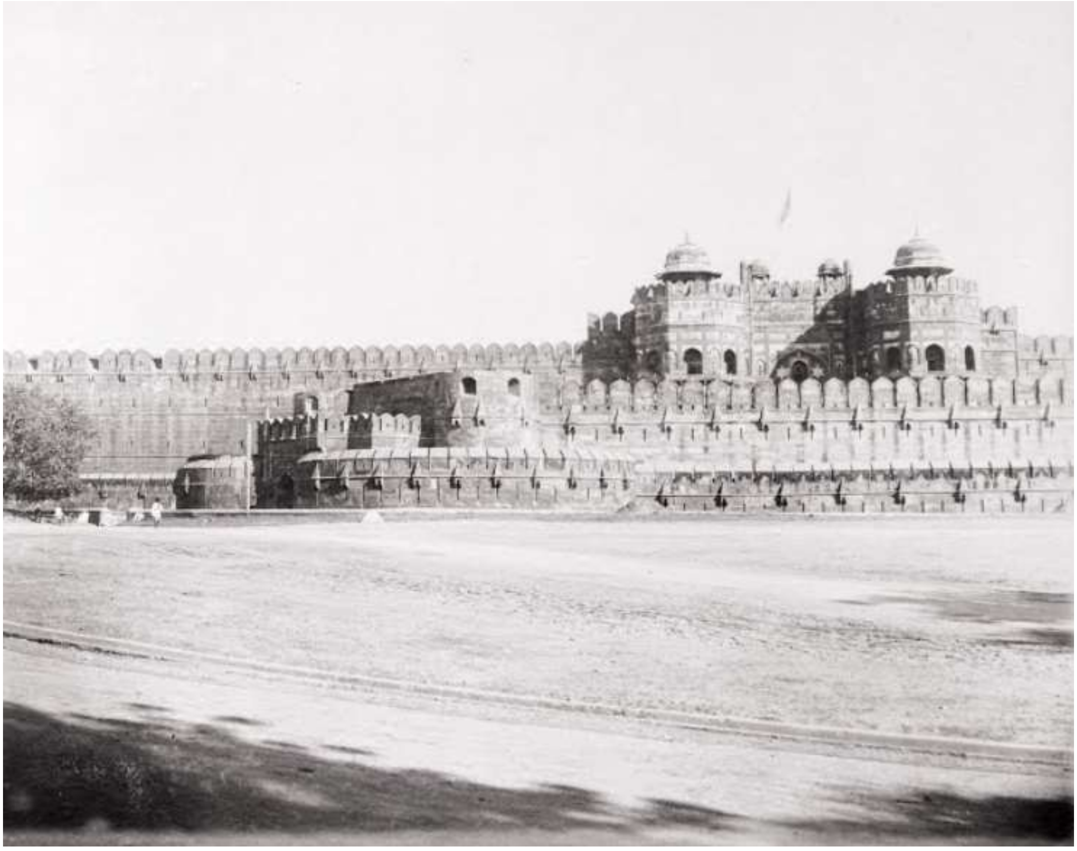


Image 19 A view of Agra fort taken from the south east; Agra fort, Agra, Source: Los Angeles County Museum of Art, Los Angeles, United States

Image 20 A view of Delhi gate taken from the south west, Agra fort, Agra, Source: British Library Collection

Image 21 A view of Agra fort taken from the south east, Agra fort, Agra, Source: British Library Collection

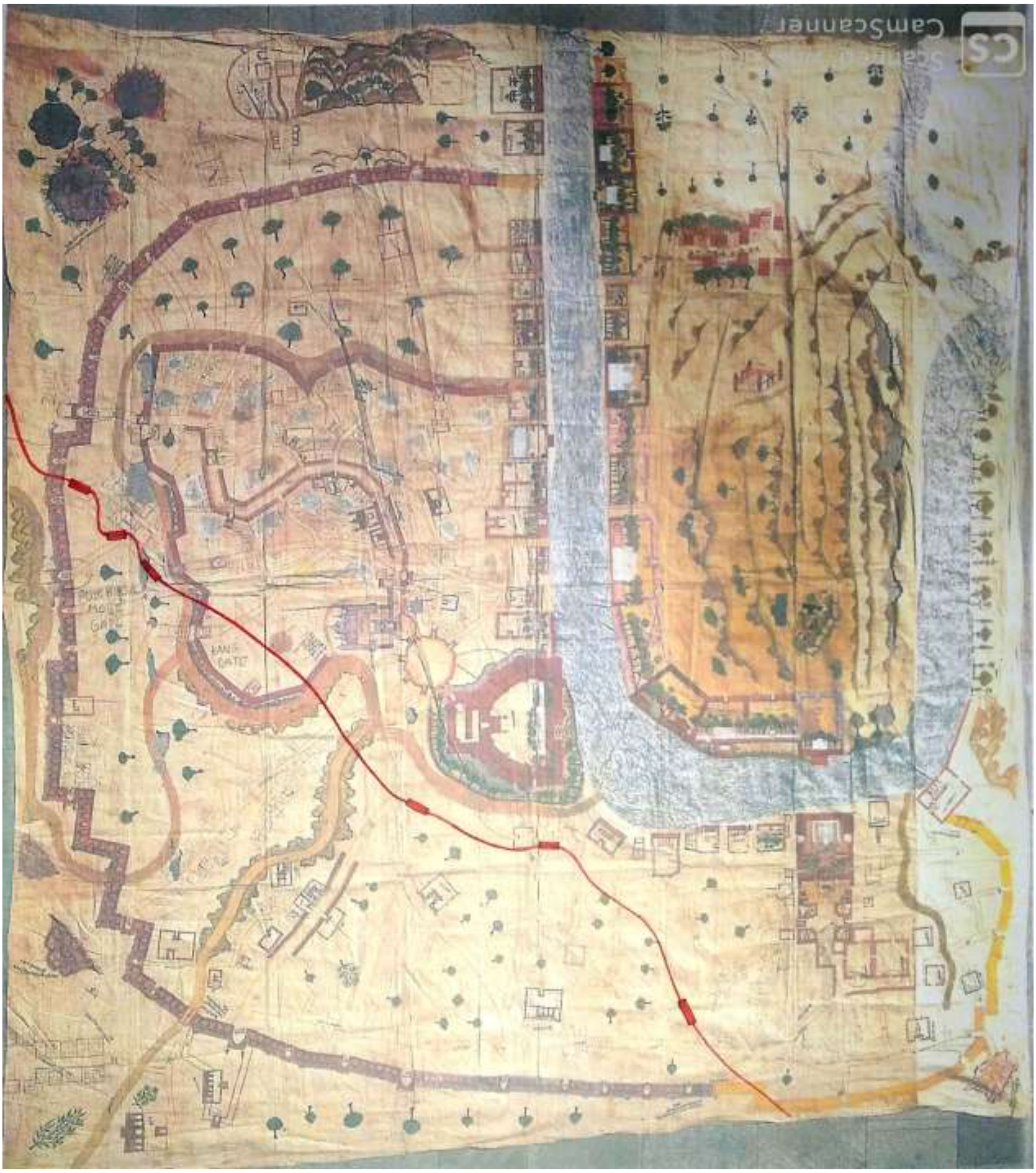
2. List of maps of Agra referred for study

	TITLE	PUBLICATION DETAILS	UIN / SHELFMARK	PHYSICAL DESCRIPTION
1	A view of the city of Agra, represented on one plane; painted in distemper on muslin.	ca. 1800-1840	• **UIN:** BLL01004986369 • **Shelf-mark(s):** Cartographic Items Egerton MS.1063.	Ms. 10 f. 8 in. x 1 f. 5 in.; 325 x 43 cm.
2	Agra Guide Map. Surveyed 1918-19, 1924. Scale 4 inches = 1 mile. Revised edition ... 2nd, 1925. Reprinted 1944 ... without corrections.	[Calcutta]: Survey of India Offices (H.L.O), 1944.	• **UIN:** BLL01004786893 • **Shelfmark(s):** Cartographic Items Maps 52955. (3.)	557 x 500 mm; Scale 1: 15 840.
3	Map of the District of Agra Surveyed by Captain R. Wroughton, etc. ... in 1838-39. Scale, 2 Miles to 1 inch. Second Edition.	Allahabad, 1862.	• **UIN:** BLL01004786884 • **Shelfmark(s):** Cartographic Items Maps 52955. (1.)	Scale, 2 Miles to 1 inch.
4	Agra Cantonment, City and Environs. ... 1868-69. [Scale, 6 Inches to 1 Mile]	Calcutta, 1870	• **UIN:** BLL01004786890 • **Shelfmark(s):** Cartographic Items Maps I.S.36.	6 Sh.; [Scale, 6 Inches to 1 Mile].
5	Map of the Agra Division ... Scale, 1 inch = 4 miles.	Calcutta: Survey of India Offices, 1892.	• **Shelfmark(s):** Cartographic Items Maps I.S.36. • **UIN:** BLL01004786881	2 Sh.; Scale, 1 inch = 4 miles.

	TITLE	PUBLICATION DETAILS	UIN / SHELFMARK	PHYSICAL DESCRIPTION
6	Agra Cantonment, City and Environs. ... 1868-69. [Scale, 6 Inches to 1 Mile]	Calcutta, 1870	**Shelfmark(s):** Cartographic Items Maps I.S.36. **UIN:** BLL01004786890	6 Sh.; [Scale, 6 Inches to 1 Mile].
7	Agra Cantonment, City and Environs ... 1868-69. Scale, 12 Inches = 1 Mile.	Calcutta, 1870.	• **Shelfmark(s):** Cartographic Items Maps I.S.36. **UIN:** BLL01004786889	15 Sh.; Scale, 12 Inches = 1 Mile.
8	Map of Agra City and Cantonments. Scale, 3 inches = 1 mile.	London: Harrison & Sons, [1916]	• **Shelfmark(s):** Cartographic Items 10055.aa.40. • **UIN:** BLL01004786892	290 x 360 mm (8º); Scale, 3 inches = 1 mile.
9	Agra and Environs. [Scale,] one English mile[= 30 mm]	1909.	• **Shelfmark(s):** Cartographic Items 2059.b. • **UIN:** BLL01004786891	249 x 192 mm; [Scale,] one English mile[= 30 mm].

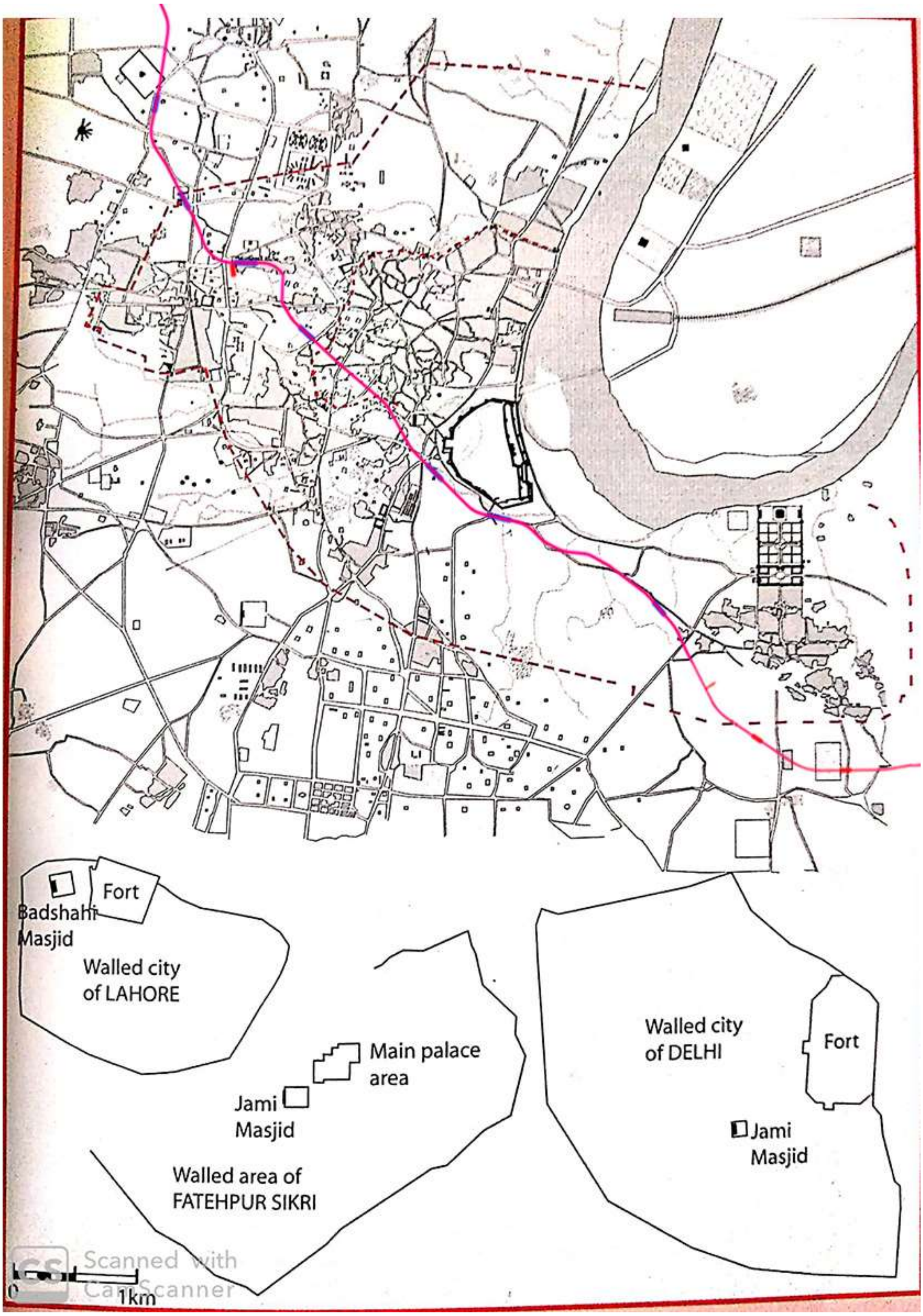
3. Maps of Agra

A. Map of Agra, 1720



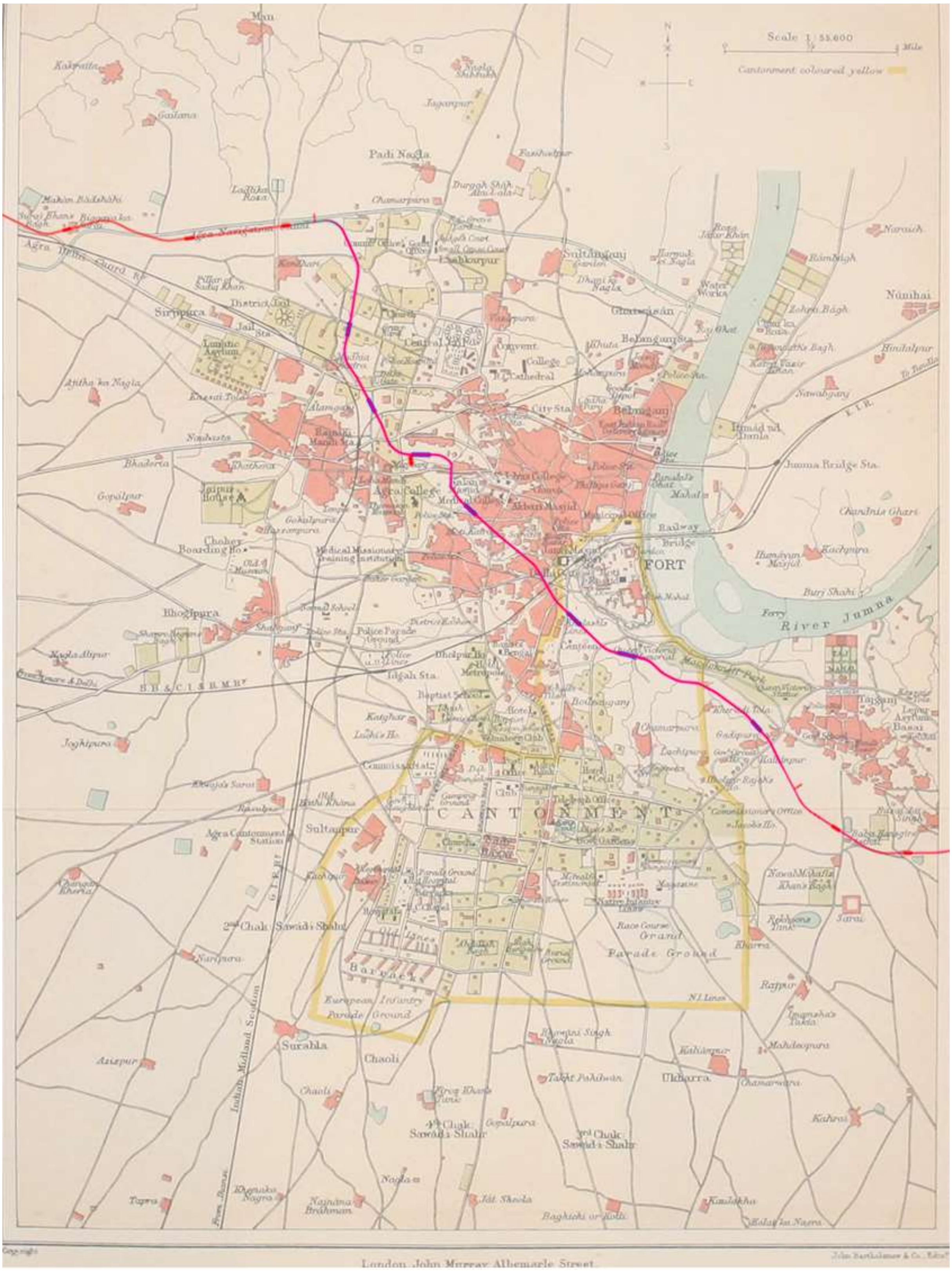
Map 1 Schematic mapping of the metro line on Jaipur map of Agra, 1720 to show the approximate locations of archaeological remains, Source: Jaipur map of Agra, Pothikhana Collection Number 126, Sawai Man Singh Museum, City Palace, Jaipur

B. Map of Agra, 1868



Map 2 Schematic mapping of the metro line on map of Agra, 1868, Source: Map of Agra, 1868 from Peck, L. (2008). Agra, The Architectural Heritage. New Delhi

C. Map of Agra, 1911



Map 3 Schematic mapping of the metro line on map of Agra, 1911, Source: Map of Agra, 1911 by John Murray

4. Archival description regarding archaeological data

Background

An archival research on the pre-Mughal and the Mughal period creates a base for identification of the areas of archaeological significance within the study area. The extracts of archival resources referred to are as follows:

Excerpts on ancient period in Agra:

- On the right bank of the river, about three mile above the fort, there is the site of an ancient garden palace called the garden and palace of Raja Bhoj of Malwa of the fifth to sixth century but at any rate all agree as to fact that this garden palace of Raja Bhoj (successor of Guhila Sri) was in existence previous to Muhammandan conquest of this part of country.
- Two thousand and odd small silver coins of Guhila Sri which were dug up at Agra in 1869.
- The fort of Akbar at Agra has been supposed to build on the site of a more ancient Hindu work;
- The Badalgarh is supposed to have been either on or near the site of the site present fort, while others say that it was on the inhabited high ground within the city of Agra, now called the Lodi-Khan-ka Tila. Apparently Badalgarh must originally have been founded by Hindus, but was appropriately by, added to, and strengthened by, the Lodi sovereigns.
- Before Lodi's Agra is said to have constituted a perganah of Biana. Excerpts on Islamic period in Agra:

Calleyle, A. (1871). Agra ASI report

- The house of Lodi appears to have been the first of Muhammad a dynasty of India who made Agra their occasional residence.
- Sikandar bin Bahlol Lodi died at Agra in 1515. He is said to have strengthened and added to the fort Badalgarh.
- Of the residence of the Lodi family at Agra, the Badalgarh no longer exits, but there are two vestiges remaining namely, the Baradari (palace) near Sikandara, and the Lodi ka Tila. The Baradari was built, as a palace, by Sikandar Lodi in 1495.It is square building red sandstone, 142 feet 6 inches each side, comprises two storeys with a vault below, the ground contains about forty chambers or apartments. Each corner of the building is surmounted by a short ornamental octagonal tower
- It was from Sikander Lodi that the suburb near Agra, called Sikandra, received its name.
- The Lodi-Khan-ka-Tila (or Lodi khan mound), situated in Agra, itself is as its name implies a mere mound now, composed of debris of former edifices. There are, however, still some few remains of the foundations of the old walls visible on the spot. It is now quite built over with modern houses and streets, and is, except in its name, undistinguishable from the rest of the city of Agra. Some say that the Lodi-Khan-Ka Tila occupies the site of Badalgarh
- I am doubtful as to whether this latter spot was really the site of a residence of one of the royal family of Lodi. From the name Lodi-Khan'ka Tila, I should rather be inclined to suppose it may have been a residence of Khan Khanan Lodi, who was a famous general under both Babar and Humayun. There was also a Khan Jahan Lodi, a general in the service of Jahangir.
- Agra was a royal residence in the time of Ibrahim Lodi, as well as his father Sikandar. Babar took possession of Agra (as well as Delhi) in May 1526, after having defeated Ibrahim, son of Sikander Lodi.

- Babar is said to have had a garden palace on the other or south-east side of the Jamna from Agra, nearly opposite the Taj. I have examined that locality, and I find that the space on the river bank immediately and exactly opposite the Taj was formerly occupied by a garden, or garden residence, called Mehtab Khan ka Bagh, or the garden residence of Mehtab Khan; and the ground is still known by that name. It was on this ground that Shah Jahan is said to have intended to build a mausoleum for himself, which was to have corresponded to the Taj across the river opposite. The former extent of this garden, on the river front, is indicated by two ornamental corner towers, surmounted by cupolas, on the bank of the river, one which is in a pretty perfect condition, and other in a state.

Image 22 Baradari of Sikander Lodi, Source: Archaeological Survey of India, Delhi Office, UP, Vol.159, No.2614004 (1910-11)

Keene, M. H. (1899). A handbook for visitors to Agra and its neighbourhood. Calcutta: Thacker, Spink and Co.

The road which the old Mughals used to go north ward to Lahore and Kashmir passes north-west by an arch of red stone and bastion the remains of the outer walls of the enceinte. This road may be called the 'Appian way' of Agra, being bordered by tombs on either side. In nearing Sikandara will be observed a handsome gateway of carved stone in the modern Hindu style, leading to an enclosure in which is a very beautiful carved sandstone building of the time of Jahangir in good preservation. About five miles from Agra at the tomb of emperor Akbar very beautiful gateway opens into a garden, the upper chamber being of white marble with lattice windows and or owned by four small kiosks. It was not completed during the emperor's lifetime the inscription setting forth that it was erected in the reign of his son and successor.

Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.

During the early medieval period, several political and trading centres were active in the region. One or more of these related routes might have touched the site of Agra, however, references that could establish that Agra participated as a transit point or contributed any product in intra –regional trade during the years earlier to 1134, or even till about the early sixteen centuries, have not come to light.

Several anecdotes are popular with Agra's past. Accordingly, the antiquity of Agra, as agraban, is taken from the Mythological Mahabharata period; some consider the name a derivation or the mythological Mahabharata period; some consider the name a derivation or offshoot of one of these agar(salt), ag(fire), agu(prior or first). It is also suggested that the town was named after the Agarwal banias. However, the historicity of none of these claims can be substantiated. If ever this settlement had any had any recognizable reference then that can only be related with the capture of the fort of Agra by Mahmud of Ghazni. The information is contained in a poem written in 1134 AD by a Persian poet, Masud ibn Saad salman eulogizing the expoits of Mahmud. Apparently, the place devasted to the extent that it could never recover its lost glory till the beginning of the sixteen centuries; until then it continued as a dependency of Bayana. Towards the latter half of the fifteen centuries, one of the Badal Singh had constructed here a brick fort called Badalgarh. Other than that, we do not come across mention of this place, even once, in any context whatsoever, during the entire period of the rule of the sultans of Delhi till the selection of the site by Sultan Sikandar Shah Lodi in 1504 as the seat of his government.

Edmund W. Smith, M. (1994). Akbar's Tomb, Sikandarah, Near Agra. New Delhi: ASI

Sikandarah, the village where the remains of Akbar the Great are interred, is situated some six miles to the north of Agra on the Delhi and Lahore road. It has been supposed that the Agra of the earlier period of the Lodi dynasty was at Sikandara, or divided between Sikandara and Lodi Khan ka Tila, a quarter of the present city of Agra. Remains of the sites of innumerable buildings on each side of the Agra to Sikandara and round about Sikandara itself are to be seen, of many of which it is impossible now to discover who the founder. was.

The present village bears the marks of former opulence and greatness, but now only affords a shelter to a few of the poorest peasant's content to dwell beneath the crumbling roofs of decaying grandeur.

The most important buildings at Sikandarah besides Akbar's tomb is the Baradari of Sikandar Lodi, built in A.D. 1495. It is a square building of red sandstone, 142 feet on each side, and comprises two storeys with a vault below the ground-floor containing about forty chambers

Another interesting building at Sikandarah is the Kanch Mahal, a little to the east of Akbar's Tomb within a walled garden belonging to Jehangir period.

Identified areas of archaeological significance

It is important to ensure that no archaeological remains are damaged or destroyed during the following are the sites and areas of archaeological significance within the study area and its vicinity.

Fortification wall and City Gates

There were sixteen gates and many towers or bastions to the city wall of Agra. The gates were named as follows-

1. The Purbi Gate
2. The Kashmir Gate
3. The Delhi Gate
4. The Alam Ganj gate
5. The Fateh Muhammad gate
6. Pul Changh Modi gate
7. Futa fatak
8. The Gungam gate
9. The Kans gate
10. Smaller Gwalior gate
11. Ajmer gate
12. The Dakhini gate
13. Greater Gwalior gate
14. Amar Singh gate
15. Unidentified gate 1
16. Unidentified gate 2

Apart from these there are remains of the fortification wall. Of the gates, the Delhi gate, small part of the Fateh Muhammad gate, the Pul Changh Modi gate, the Futa Fatak and the Kans Gate are the only standing structures.

Ladli Begum ka Tila

It is situated about a mile the friend and historian of Akbar. It is situated about a mile to the north of Sikandara road Alamganj and immediately behind the Khandhari bagh. This palace was built in the year 1596 A.D. But, a few year ago the ground was purchased by Hindu named Lakhmi Chand Seth, who pulled down the mausoleum and destroyed the tombs and built a small ornamental 'chatri' or pavilion in their place.

Kaman masjid

This Masjid is certainly at any the oldest looking Masjid about Agra and is in a very ruinous state. It is built old Hindu brick of larger size and of a flatter shape than the bricks generally used in such buildings. It was the first great mosque that was ever built in Agra. About 250 feet distant to the east of the Kalan Masjid. But now surrounded by houses, there is a lofty building surmounted by a vast dome of extraordinary diameter, which was originally a Hammam connected with the masjid.

Kanchi -ki-Serai in Sikandara road

On the left hand, or south of the Sikandara road nearly four miles from Agra and a mile and a quarter from Sikandara and nearly opposite the great and lofty arched gateway of an ancient serai called the 'Kanchi-ki-Serai' there is the statue of the horse sculptured in red sandstone. But the horse has now lost the lower part of its legs, it original pedestal and the inscription are gone and it now stands on a raised platform of masonry on the left side of the road looking towards Sikandara.

Lodi Khan ka Tila

There are evidences of the fort wall of the Lodi khan ka Tila along the present Agra-Sikandara road, near Sikandara. It has no visible traces at present. At present, the area has building constructions and thus no traces are available.

Sikandara

A short distance away on the other side of the road to Agra. There is Suraj Bhan ka Bagh which dates from Mughal times. It is built of red sandstone with very minute carving. Further cast on the same side of the road there is a remarkable life size statue of a horse carved out of solid sandstone but with no reliable account of its history. Opposite this to the north of the road there stands a lofty arched gateway of Serai (said to be that of Itibar Khan although it is attributed by some to Sikandara Lodi) Across the fields there are two more tombs – one that of Sadiq Khan a lofty octagonal building on a raised platform surmounted by a dome and the other said to be the tomb of Salabat Khan who was killed by Amar Singh rather in the fort of Agra a, a building of red sandstone with a ceiling beautifully adorned with painting on polished stucco.

Archival reference of Jami Masjid

Historical context:

The literature sources have provided vivid description on the construction of the Jama masjid in Agra, one of the descriptions is provided as follows:

Desai, W. B. (1990). Shahjahan Nama Tanslation. Delhi: Oxford University Press.

Formerly at Akbarabad, the area just in front of the gate of the fort was congested with various public buildings, offices and private dwellings, leaving no space for a forecourt (Jilau-khana). As a result, every morning and evening, when the nobles and all the officers of the state came to pay their respects, great inconvenience was caused to the public by the concourse of men and horses, especially on the days of Id and Nauroz, royal birthdays and other festivals and during the occasions of a royal procession. Infact, due to the immense crowds that thronged together, the people's lives were constantly endangered. Therefore, at this time, on the return of the imperial standards from Daulatabad, His Majesty ordered that a spacious plaza, which the natives of Hind call Chauk be constructed in front of the fort gate with a large bazaar laid out in octagonal Baghdadi style; along each larger side of which there were to be cells and apartments, with several shops on each shorter side. Having laid the foundation at was an auspicious moment, it was further commanded that at one side of the plaza, which would form a place of assembly for all denizens of the world, a stately metropolitan mosque should be built at His majesty's private expense.

The ground on which the chauk, and mosque were to be constructed belonged chiefly to the royal domains. And as for the little which was the property of others, some of the owners were gratified by receiving 10 or 15 times the actual value, and the others by the grant of neighbouring estates out of the crown lands.

Chand, S. (n.d.). Tafrih-ul-Imarat.

This was the time when one of large masjid, situated near to the bank of Yamuna and the construction of Nawab Mumtaz Rouza was in full-fledged was stopped for a while. As mentioned, masjid was away from the city population from general people approach. Hence forth, Emperor's heart felt that one big and heaven like beautiful masjid should be erected inside the densely populated city so that common people may do Ibadat (prayer) inside it conveniently. Therefore, in that situation Jahan Ara, whose title was Begum Sahiba, requested her father to allow her this noble and blissful work to do. Emperor agreed and thereafter, the owner of land (those who were out of khalsa land) were paid in cash according to their wish and those who did not wish to accept land were given beautiful houses and fruitful land.

Other literature sources referred for establishing the historical significance are as follows:

- Koch, E. (2002). Mughal Architecture An Outline of its History and Development (1526-1858). Delhi: Oxford University Press.
- Peck, L. (2008). Agra The Architectural Heritage. New Delhi: Lotus Collection.
- Koch, E. (2006). The Complete Taj Mahal and the Riverfront Gardens of Agra. New Delhi: Bookwise (India) Pvt. Ltd.
- Trivedi, K. K. (2018). Medieval City of Agra. New Delhi: Primus Books.
- (1904). District Gazetteers of the United Provinces of Agra and Oudh. Government Press.
- Apart from literature sources, the archival images are an important source for the establishment of historical significance.

The available sources are as follows:

Image 23 Photograph of Jama masjid showing nala arches to the south side, Source: British Library Collection

Archaeological context:

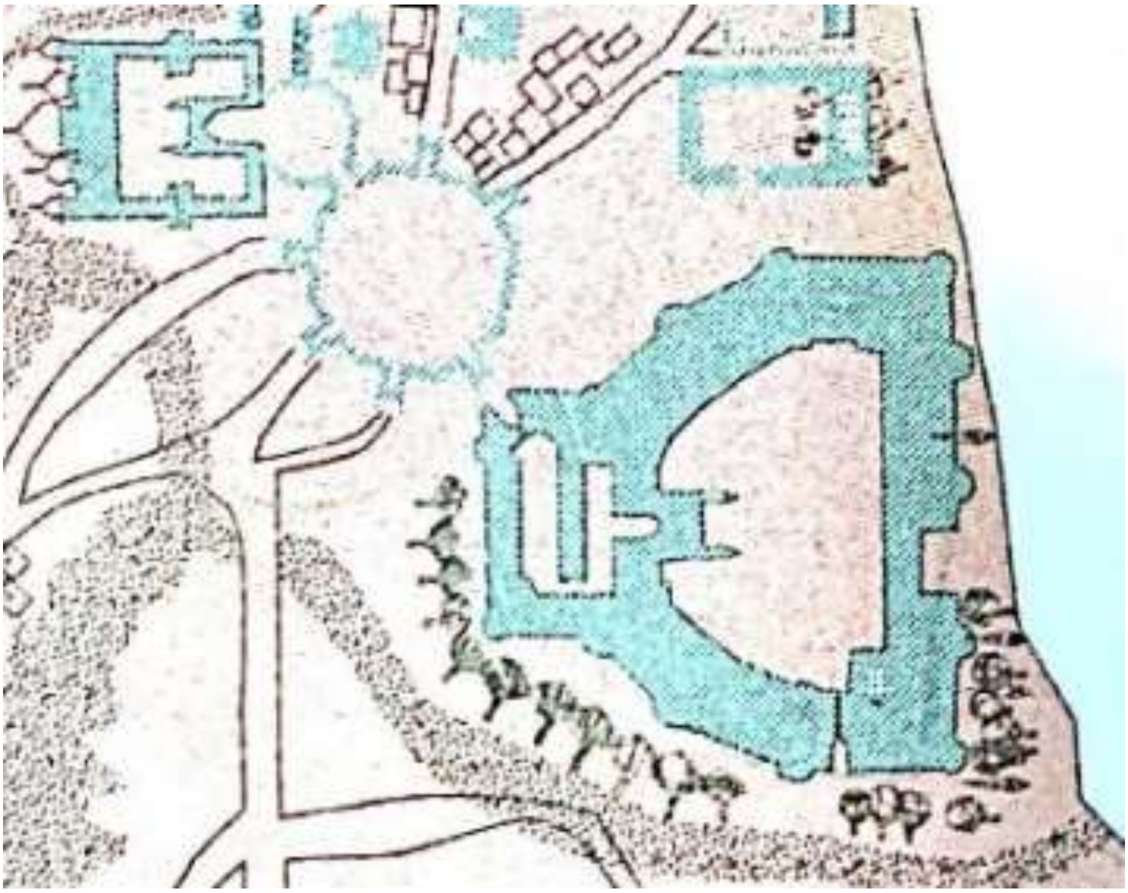
Peck, L. (2008). Agra The Architectural Heritage. New Delhi: Lotus Collection.

Jama masjid was once surrounded by a market place called Tripolia set in an octagonal (Muthamman) Chowk that was built between the Delhi Gate and the Jami Masjid. It was later destroyed in 1871-73 A.D. to acquire space for laying down the railway tracks for the city.

Koch, E. (2006). The Complete Taj Mahal and the Riverfront Gardens of Agra. New Delhi: Bookwise (India) Pvt. Ltd.

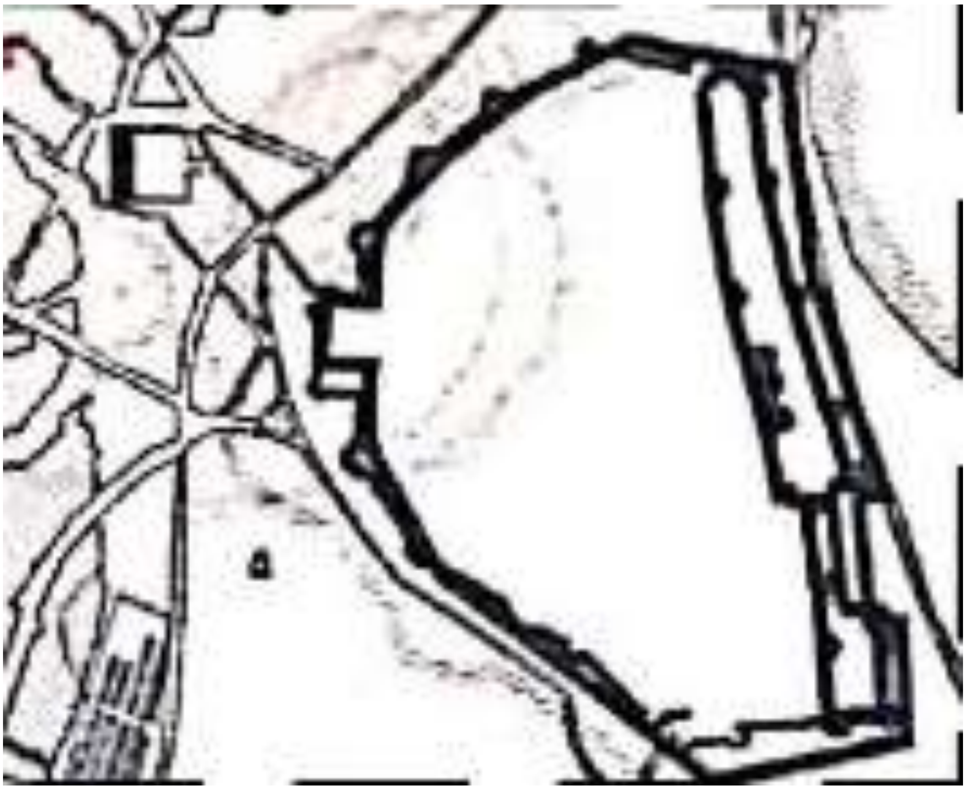
Jahan Ara convinced her father to build a Jama masjid congregational mosque infront of the fort. The Mosque was built by the Mughal emperor, Shahjahan in 1648 A.D and was once linked to the Delhi gate of the fort via a small octagonal bazaar, which gave access to the Tripolia gate. A larger octagonal enclosure immediately outside the Delhi gate. It survived as a market until the railway was built in the 1870. The main gate of the mosque was demolished by the British the great uprising and was replaced by the present curious arrangement steps projecting into the street.

Jaipur map of Agra, Pothikhana Collection Number 126, Sawai Man Singh Museum, City Palacae, Jaipur



Map 4 Jaipur map of Agra of 1720s, Source: Pothikhana Collection Number 126, Sawai Man Singh Museum, City Palacae, jaipur

Map of Agra, 1868, Peck, L. (2008). Agra The Architectural Heritage. New Delhi: Lotus Collection**.**



Map 5 showing the demolished bazaar area near Tripolia, Source: Map of Agra, 1868 from Peck, L. (2008). Agra, The Architectural Heritage. New Delhi

Map 6 Map of Agra showing railways near Jama Masjid, 1914 Source: Map of Agra, 1911 by John Murray

Architectural context:

Ansari, S. (2015). *Studying Mughal Architecture Under Shah Jahan: Mosques of Agra.* Centre of Advanced Study, Department of History, Aligarh Muslim University

Jami masjid is based on the traditional 4-aiwan plan, having two gateways towards north and south and the main gateway to the east side facing the western prayer hall. The gateway towards north and south are approached by flight of steps from both the sides.

The eastern corners of the mosque are comprised of two pentagonal-shaped projected towers. The ground plan of the eastern gateway remains merely as octagonal shape floor with some newly constructed flight of steps since the original gate was demolished in 1857. Stairs are provided to get over the eastern corner towers and then to the roof of the cloisters (north & south). Water tank is situated at the center of the sahn. Mukabbir, a separate structure is situated just Infront of the pishtaaq of the prayer hall.

Jami masjid is built of red sandstone, but certainly somewhere artisans tried to utilize semi-precious stones too. White marble has been utilized for specific places like the pishtaq arch which is framed by white and black marble as in the form of rectangular band inscriptions and also same is the case with main mihrab arch.

The ground plan of the eastern gateway remains merely as octagonal shape floor with some newly constructed flight of steps since the original gate was demolished in 1857. Stairs are provided to get over the eastern corner towers and then to the roof of the cloisters (north & south).

Image 24 Traces of historical entry gate, Source: Dharohar team

The demolished eastern gate was certainly larger and higher and designed more elaborately than the other two gates. 25 About the tentative assumption of its dimensions and design we must take the help of existing other Shahjahani mosques evidences based on 4-aiwan plan, generally it is seen that the eastern gate remained to be the larger and more elaborately decorated.

Image 25 East gate of Jama Masjid, source: Dharohar team

Later reconstructed eastern gateway entrance through flight of steps. The design details of the (demolished 1857) eastern gateway and the complex overall of the Agra mosque makes references to contemporary imperial mosque complexes and followed a similar pattern in its overall layout and construction to the Moti masjid in Agra Fort and the Delhi mosque in Shah Jahan's new capital.

Abd-al-Rahim, K. a. (1866). *Badshah Nama.* Calcutta: Royal Asiatic Society of Bengal.

Octagonal Bazaar (also known as Muthamman chowk) was laid out on Baghdadi Muthamman plan, octagonal plan wherein each angle side is less than half of each front side. Its diameter was 170 Imperial (Badshahi) yards (zira). On each of its longer sides (zila) were fourteen arched chambers (Hujrah va Aiwan) (which were used as shops and godowns), and on each of smaller sides were 5 shops (panja chashma dukaan bashad). And as par the order (farman) towards the west of above mentioned chowk, a beautiful and spacious mosque of which its length should be 130 Badshahi yards; 3 domes on the Qiblah side (on the western liwan) and 53 arches internally on the three sides of the sahn which be 80x80 yards. All this was founded by Shahjahan himself. Moreover, at one place Lahouri specifically recorded that the

Badshahzadi Jahaniyan ordered it to be built for religious merit and also for the benefit of this world and reward for hereafter, therefore she's nature reflect her praiseworthy work (Razia).
About the planned mosque to be found infront of the fort and some specific architectural dimensions and synthesis as par the wish of Emperor were about to bring in mosque. There were some houses of the people of the city on the land where the mosque was proposed to be built. It was, therefore, ordered that these houses may be purchased by paying 10-15 times of the (market) value to the owners of those houses satisfactory compensation was accordingly paid and the land was, thus, legitimately acquired.
Available documentation sources of the complex provide the base for establishing the architectural significance. Sources analysed are provided as follows:

Ansari, S. (2015). *Studying Mughal Architecture Under Shah Jahan: Mosques of Agra.* Centre of Advanced Study, Department of History, Aligarh Muslim University

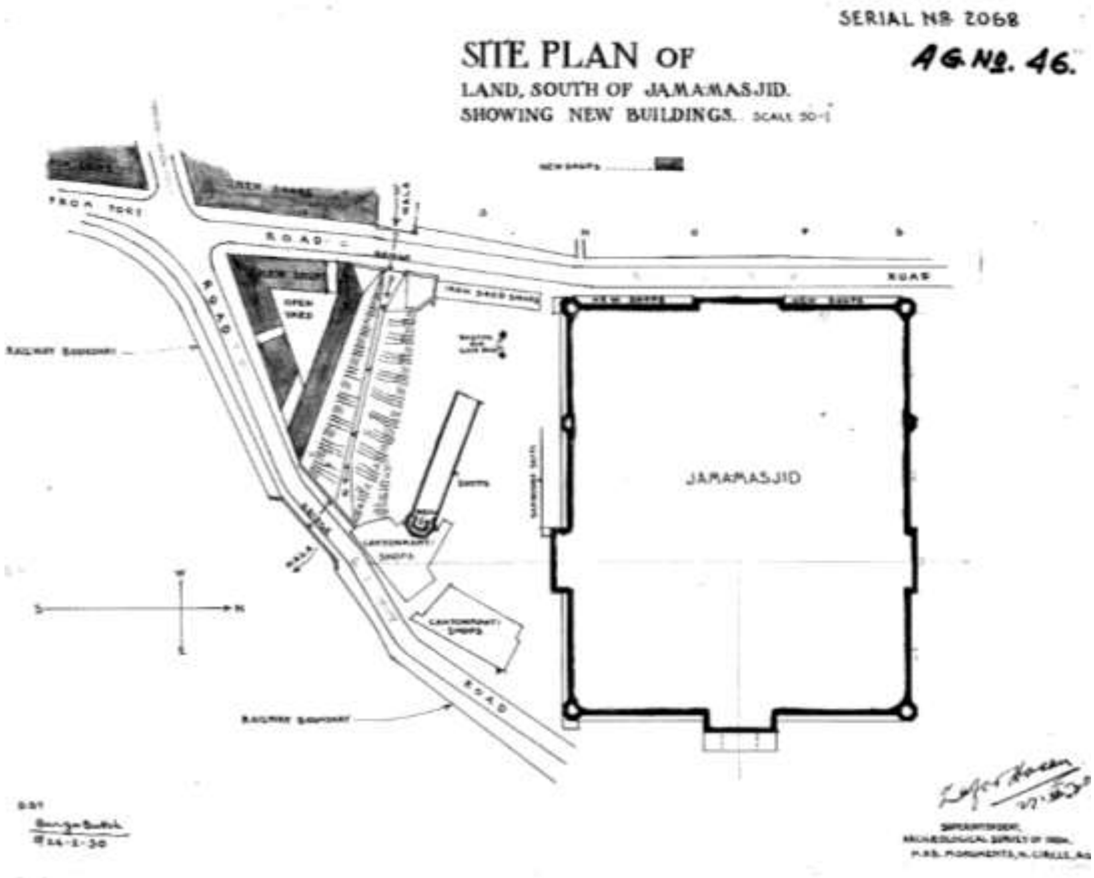


Figure 1 Site Plan of Jama Masjid complex, Source: Archaeological Survey of India, Agra circle, Agra

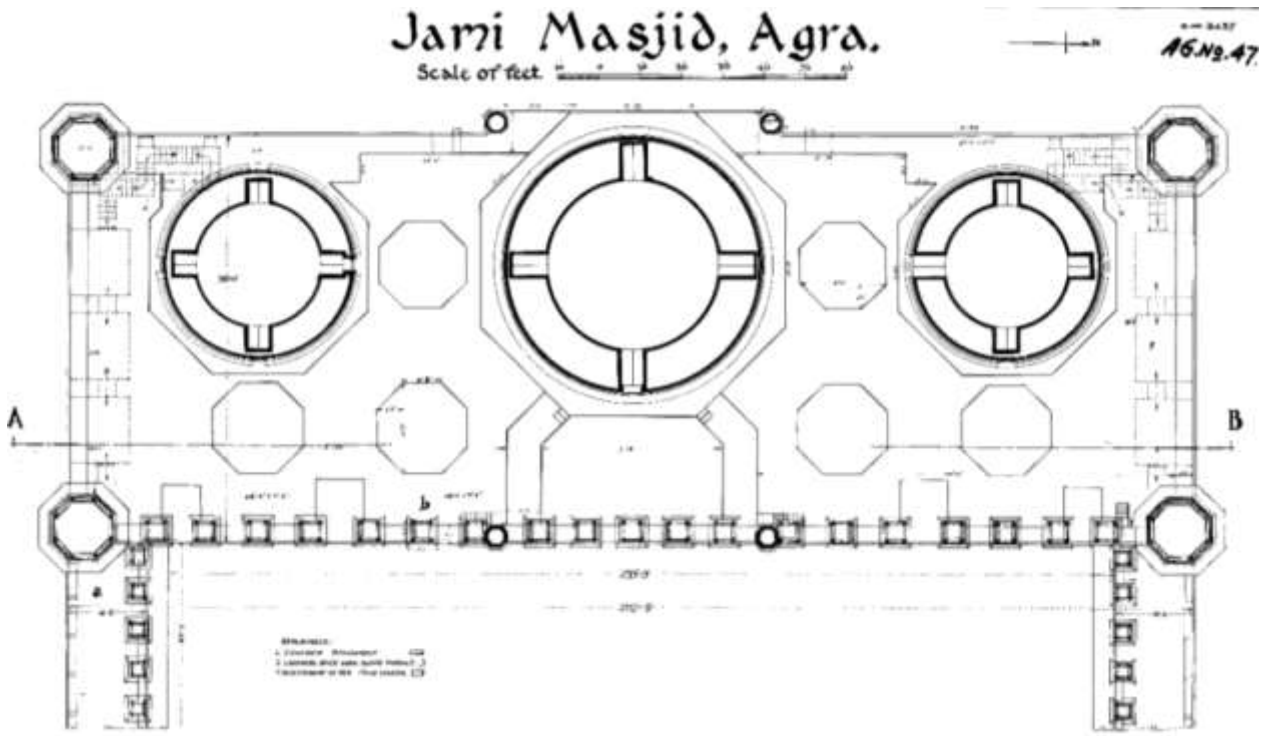


Figure 2 Part plan of Jama Masjid complex, *Source: Archaeological Survey of India, Agra circle, Agra*

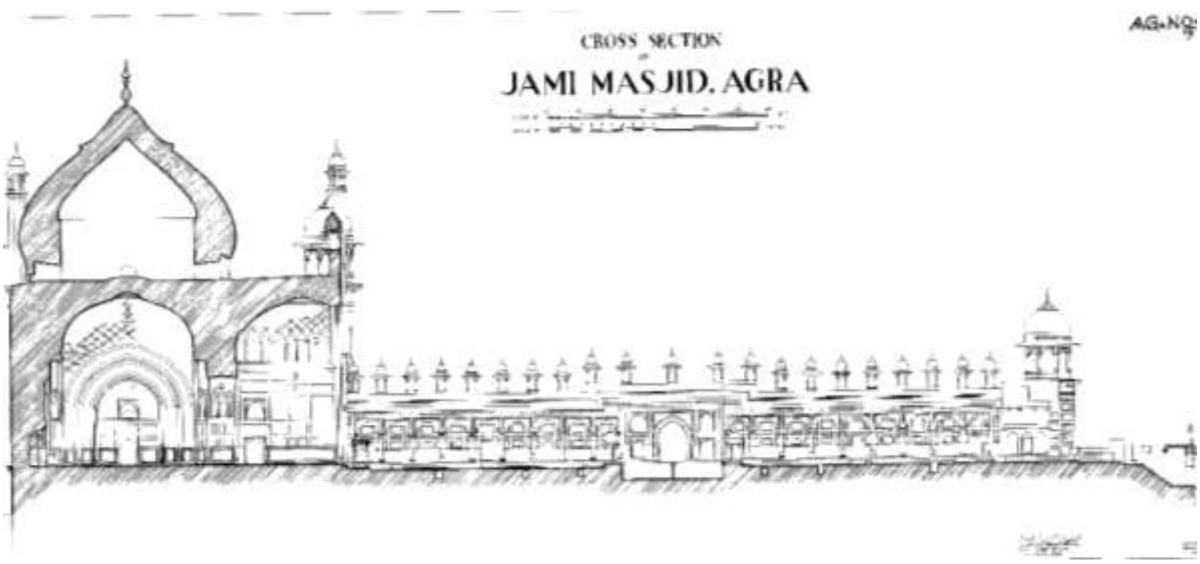


Figure 3 Section through Jama Masjid complex, *Source: Archaeological Survey of India, Agra circle, Agra*

Figure 4 Part plan of Jama Masjid complex, Source: Archaeological Survey of India, Agra circle, Agra

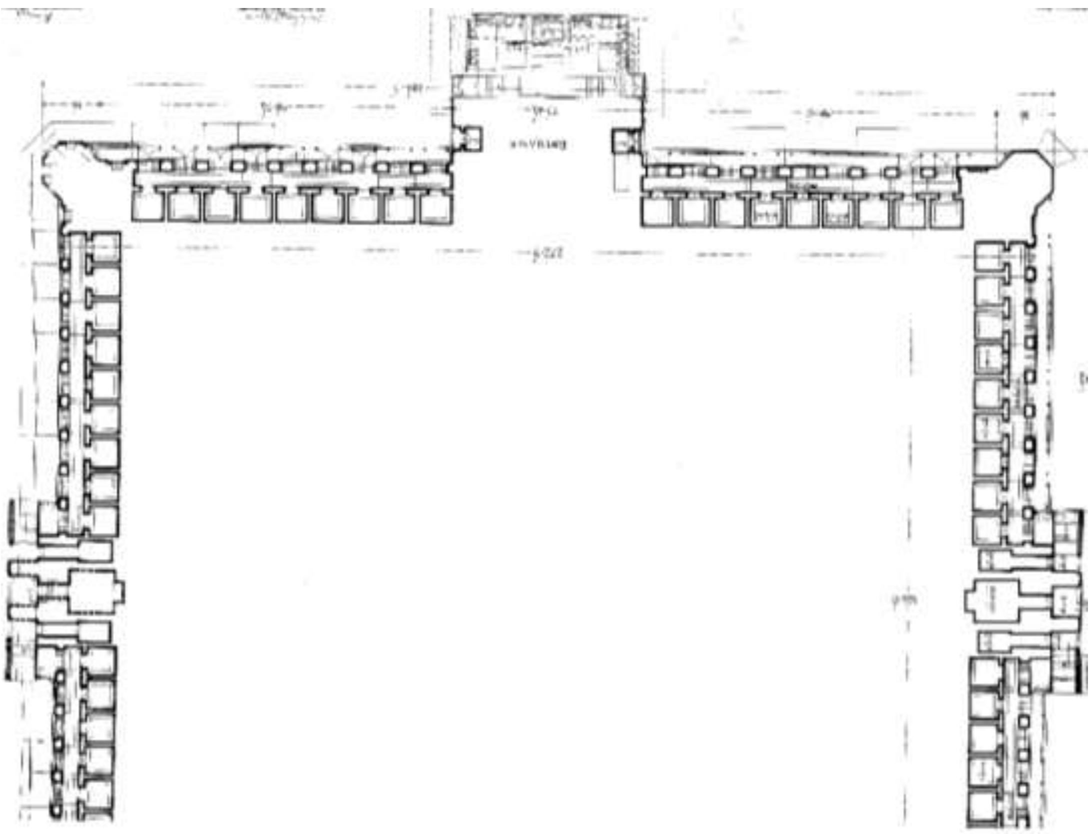


Figure 5 Part plan of Jama Masjid complex, Source: Archaeological Survey of India, Agra circle, Agra

Socio-Cultural context:

Jama Masjid's eternal life as a functional religious place of islamic worship. Mosques are also used throughout the week for prayer, study, simply as a place for rest and reflection. used for the Friday communal prayer. This holy mosque of God is built for the worship of the faithful of the world.

The Jama Masjid of Agra as is well known is situated opposite to the Delhi Gate of the fort, between which and the masjid there is the walled enclosure called the Tripolia. which formerly constituted a screen between the masjid and the fort, but is now used as a market.

Image 26 Showing market in front of Jama masjid, Source: http://www.columbia.edu/

Akbar's Tomb, Sikandara

Historical context:
The literature sources have provided vivid description on the construction of the Jama masjid in Agra, the excerpts are provided as follows:

E. B. HAVELL, A. (1904). A handbook to Agra and the Taj Sikandara Fatehpur- Sikri and neighbourhood. New York and Bombay: Longmans, Green and Co.

Sikandara, a village about five miles from Agra and the place of Akbar is reached by two roads. The older one alignment of the great military road to Lahore and Kashmir planned by Babar and completed by his successors. A few of the kos-minars pillars which marked off the kosa distance of about two and a half miles can still be seen along the road or in the adjoining fields. About a mile further along the road on the left-hand side is a curious statue of a horse in red sandstone which tradition says was put up by a nobleman whose favorite horse was killed at this spot the syce who was killed at the same time has his tomb close by. Nearly opposite to this is a large dried-up tank, called the Guru-ka-Tal which with the adjacent ruined buildings are attributed to Sikandar Lodi, one of the Afghan predecessors of the Mughal emperors who has given his name to Sikandara.

Edmund W. Smith, M. (1994). Akbar's Tomb, Sikandarah, Near Agra. New Delhi: ASI.

Akbar's tomb is the tomb of the Mughal emperor Akbar. It was built in 1605–1613 in Sikandara, Agra. Akbar planned the tomb and selected a suitable site for it. After his death, Akbar's son Jahangir completed the construction in 1605–1613.

Akbar's Tomb is set in the middle of a vast garden which has false gate on the west, north and east, the mail entrance being through the marvelous south gate. This is superbly decorated both front and back with red sand stone inlaid with colored stone with floral patterns around the openings and geometric patterns elsewhere. Four white marble minarets rise up from the roof on each corner. These have been restored having fallen in an earthquake or according to many sources demolished when used as target practice by Jats in the late eighteenth century.

Image 27 Akbar's Tomb at Sikandra, near Agra, 1859, Source: The J. Paul Getty Museum Collection, Los Angeles, United States

Archaeological context:

E. B. HAVELL, A. (1904). A handbook to Agra and the Taj Sikandara Fatehpur- Sikri and neighbourhood. New York and Bombay: Longmans, Green and Co.

Numerous remains of archaeological interest are passed on the way of the old road. First the Delhi gate of the old city walls. About a mile further on the right-hand side is a great walled enclosure, named after Ladli Begum the sister of Abul Fazl, Akbar's famous Prime Minister and biographer. It formerly contained her tomb, as well as that of Sheikh Mubarak her father and of Faizi her eldest brother.

The literature sources for Lodi Khan ka Tila are provided as follows:

Calleyle, A. (1871). Agra ASI Report. Agra: ASI.

The residence of the Lodi family at Agra the Badalgarh no longer exists, but there are two vestiges remaining namely the Baradari near Sikandara and the Lodi Khan ka Tila. The Baradari was built as a palace by Sikandara Lodi in 1495. The Lodi Khan ka Tila (the Lodi Khan mound) situated in Agra, itself is, as its name implies, a mound now, composed of the debris of the former edifices. There are however still some few remains of the foundation of old wall visible on the spot. Some say that the Lodi Khan ka Tila occupies the site of the Badalgarh.

Keene, M. H. (1899). A handbook for visitors to Agra and its neighbourhood. Calcutta: Thacker, Spink and Co. .

The road which the old Mughals used to go north ward to Lahore and Kashmir passes north-west by an arch of red stone and bastion the remains of the outer walls of the enceinte. This road may be called the ‘Appian way’ of Agra being bordered by tombs on either side.

In nearing Sikandara will be observed a handsome gateway of carved stone in the modern Hindu style, leading to an enclosure in which is a very beautiful carved sandstone building of the time of Jahangir in good preservation. About five miles from Agra at the tomb of emperor Akbar a very beautiful gateway opens into a garden, the upper chamber being of white marble with lattice windows and or owned by four small kiosks. It was not completed during the emperor’s lifetime the inscription setting forth that it was erected in the reign of his son and successor.

The literature sources for Akbar’s Tomb are provided as follows:

E. B. Havell, A. (1904). A handbook to Agra and the Taj Sikandara Fatehpur- Sikri and neighbourhood. New York and Bombay: Longmans, Green and Co.

Akbar's tomb stands in the midst of a garden, enclosed by four high battlemented walls. In the centre of each wall is an imposing gateway seventy feet high. The principal one, on the west side, has an inscription in Persian which states that the mausoleum was completed by the Emperor Jahangir in the seventh year of his reign 1613 A.D. It is elaborately ornamented with bold but rather disjointed inlaid patterns which seem to show that the designers were unaccustomed to this method of decoration. Neither are the four minarets at the corners of the roof, which are said to have been broken by the Jats, contrived with the usual skill of the Mogul architects. Above the gateway is the Nakkar Khana, an arcaded chamber with a balcony, where at dawn and one watch after sunrise the drums and pipes sounded in honor of the dead.

The mausoleum was commenced by Akbar himself. It is different in plan from any other Mughal monument and contrary to the usual Muhammadan custom the head of the tomb of

Akbar is turned towards the rising sun, and not towards Mecca. The whole structure gives the impression of a noble but incomplete idea both in its greatness and in its incompleteness, it is typical of Akbar and his work.

The original design was somewhat modified by Jahangir. He has stated in his memoirs that on his first visit to the tomb after his accession he was dissatisfied with the work which had been done, and ordered certain parts of it to be rebuilt. Fergusson supposes that the original intention was to cover the tombstone and raised platform of the uppermost story with a domed canopy.

Architectural context:

The literature sources for architecture of Sikandara are provided as follows:

Calleyle, A. (1871). Agra ASI Report. Agra: ASI.

A short distance away on the other side of the road to Agra. There is surajbhag ka bagh which dates from Mughal times. It is built of red sandstone with very minute carving. Further cast on the same side of the road there is a remarkable life size statue of a horse carved out of solid sandstone but with no reliable account of its history. Opposite this to the North of the road there stands a lofty arched gateway of Sarai(said to be that of Itibar khan although it is attributed by some to Sikandar Lodi) Across the fields there are two more tombs – one that Sadiq khan a lofty octagonal building on a raised platform surmounted by a dome and the other said to be the tomb of Salabat Khan who was killed by Amar Singh rather in the fort of Agra, a building of red sandstone with a ceiling beautifully adorned with painting on polished stucco.

The literature sources for architecture of Akbar’s Tomb are provided as follows:

E. B. Havell, A. (1904). A handbook to Agra and the Taj Sikandara Fatehpur- Sikri and neighbourhood. New York and Bombay: Longmans, Green and Co.

The approach to the interior of the mausoleum is through the central archway of the lower story, which opens into a vestibule richly ornamented with raised stucco work, and colored in blue and gold somewhat in the style of the Alhambra. A part of this decoration has been lately restored. An inclined passage, like the entrance to an Egyptian pyramid, leads down into a high vaulted chamber, dimly lighted from above where a simple sarcophagus of white marble contains the mortal remains of the great Akbar. Whatever decoration there may have been on the walls is now covered with whitewash. The Emperor's armour, clothes and books which were placed beside the tomb, are said to have been carried off by those insatiable marauders, the Jats of Bharatpur.

Smaller chambers surrounding the central one on the level of the platform, contain the tombs of two of Akbar's daughters and a son of the Emperor Shah Alam. These also have suffered much from neglect and whitewash. The whole of the facade of the lower story was originally faced with red sandstone or perhaps with fine stucco decorated in fresco. The present coat of common plaster is modern work which except as a protection for the brickwork, would have been better left undone.

The lower story is 320 feet square. Above this are three others, diminishing in size up to the highest which is just half these dimensions. The roof of the topmost is surrounded by cloisters the outer arches of which are filled with very fine marble tracery. In the center on a raised platform is a solid block of pure white marble, delicately carved with flowers and sacred texts representing the real tomb in the vault beneath.

Gulzar, F. J. (n.d.). Historical Development of Dado Ornamentation in Mughal Architecture. Pakistan: School of Architecture and Planning, University of Management and Technology.

Akbar’s time were used in a new way, in luxurious masterpieces in Akbar’s tomb. Akbar’s tomb at Sikandara beautifies with the combination of white marble and red sandstone with their contrasting colors and textures mentioned in Klingelhofer As analyzed from visual surveys the wall surfaces indicate geometric and arabesque designs were followed in his reign, abri stars were in laid in geometrical oblong dado panels and also arrangement of square and rectangular pieces of multihued stones in floral patterns. The three surviving marble dadoes on the second-story hall of the western gateway are undoubtedly finest examples of dado art which are an example of usage of hashiyas (borders), beautifully inlaid borders in white marble. Each of the white marble borders on dado panel with floral motifs is defined by black marble to highlight it on the red sandstone surface. Similarly, inlaid borders are used on the dado panels of Itmad-ud-daula tomb with colored and textured patterns are created by white marble interlocking six pointed stars and figures with multi-pointed stars surrounded by diamond shaped elements.

The literature sources for architecture of Lodi Tomb are provided as follows:

Peck, L. (2008). Agra The Architectural Heritage. New Delhi: Lotus Collection.

A single-storey platform-types tomb with a nine –fold Basht each side and chamfered corners cresting a typical Baghdad octagon. At first glance the building looks octagonal and has therefore been misinterpreted as a Lodi tomb.

The literature sources for Kanch Mahal are provided as follows:

E. B. Havell, A. (1904). A handbook to Agra and the Taj Sikandara Fatehpur- Sikri and neighbourhood. New York and Bombay: Longmans, Green and Co.

The Kanch Mahal outside the enclosure of Akbar's tomb, a little to the east of the principal entrance is a rare and remarkably fine example of Mogul domestic architecture. This is a two storied building, known as the Kanch Mahal and supposed to have been built by Jahangir as a country seat. In its extremely elaborate ornamentation inlaid stone and enameled tiles have been most effectively combined with the carving. The repairs lately carried out under Lord Curzon's orders have been very carefully done, though it is easy to see the inferiority of the new work where the old carving had to be reproduced. Our fatuous policy of adopting European styles in all public buildings in India is bound to cause a deterioration in the native art handicrafts, for it closes the principal source from which they have sprung. Unless this policy is reversed, nothing will prevent the ultimate extinction of Indian art.

Image 28 Kanch Mahal Sikandara Agra-1977, Source: British Library Collection

Image 29 Gate of the Tomb of the Emperor Akbar at Sikandra, Agra-2019, Source: Dharohar team

Image 30 Showing restriction of wearing shoes in the sacred complex, Source: Dharohar team

Annexure-III

1. SITE PLANS AND DRAWINGS

A. Taj mahal

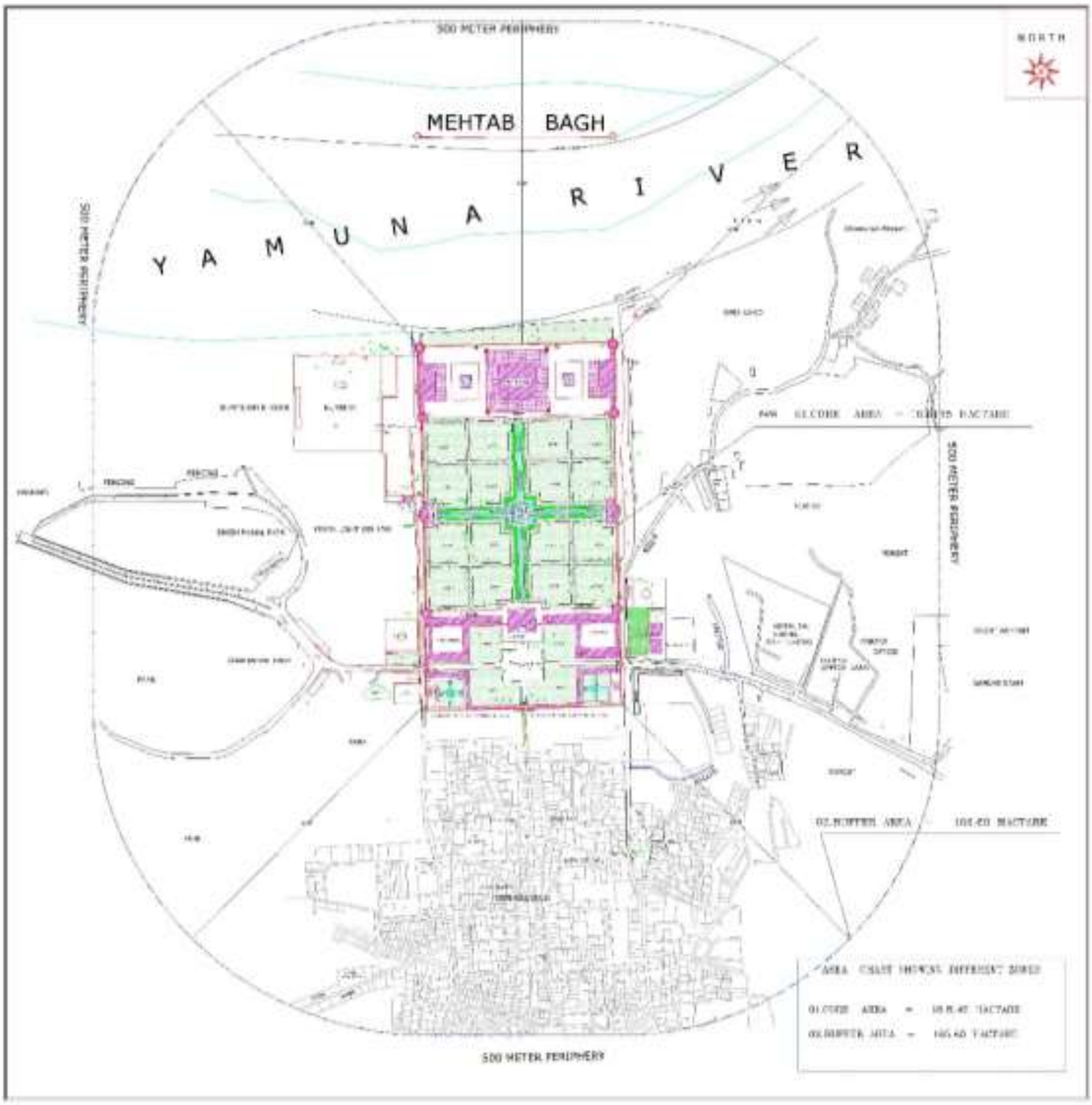


Figure 1 Site plan of the Taj Mahal, Source: Archaeological Survey of India, Agra circle, Agra

B. Agra fort

Figure 2 Site plan of the Agra fort, Source: Archaeological Survey of India, Agra circle, Agra

C. Monuments, Sikandara

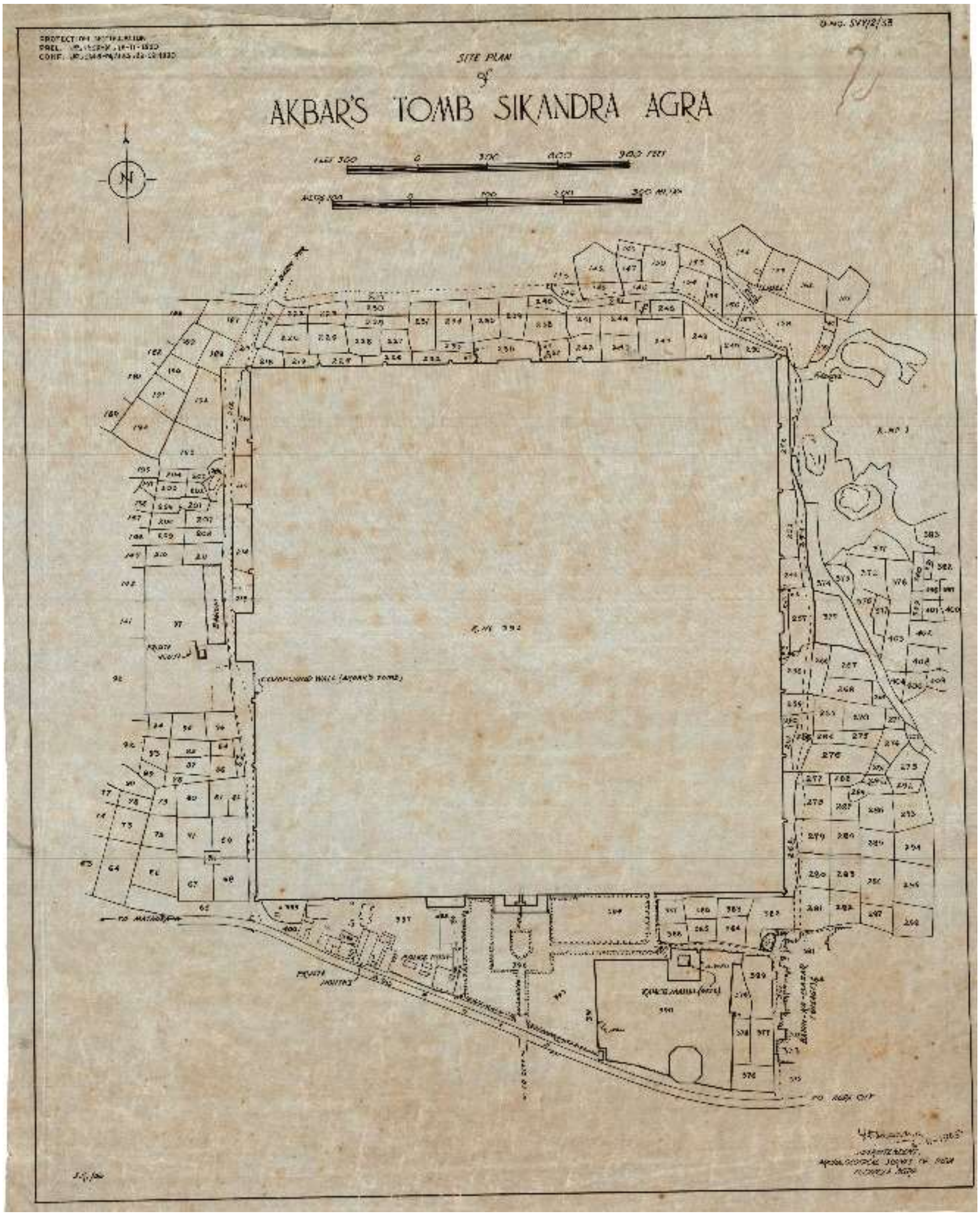


Figure 3 Site plan of the Akbar's Tomb, Sikandara Source: Archaeological Survey of India, Agra circle, Agra

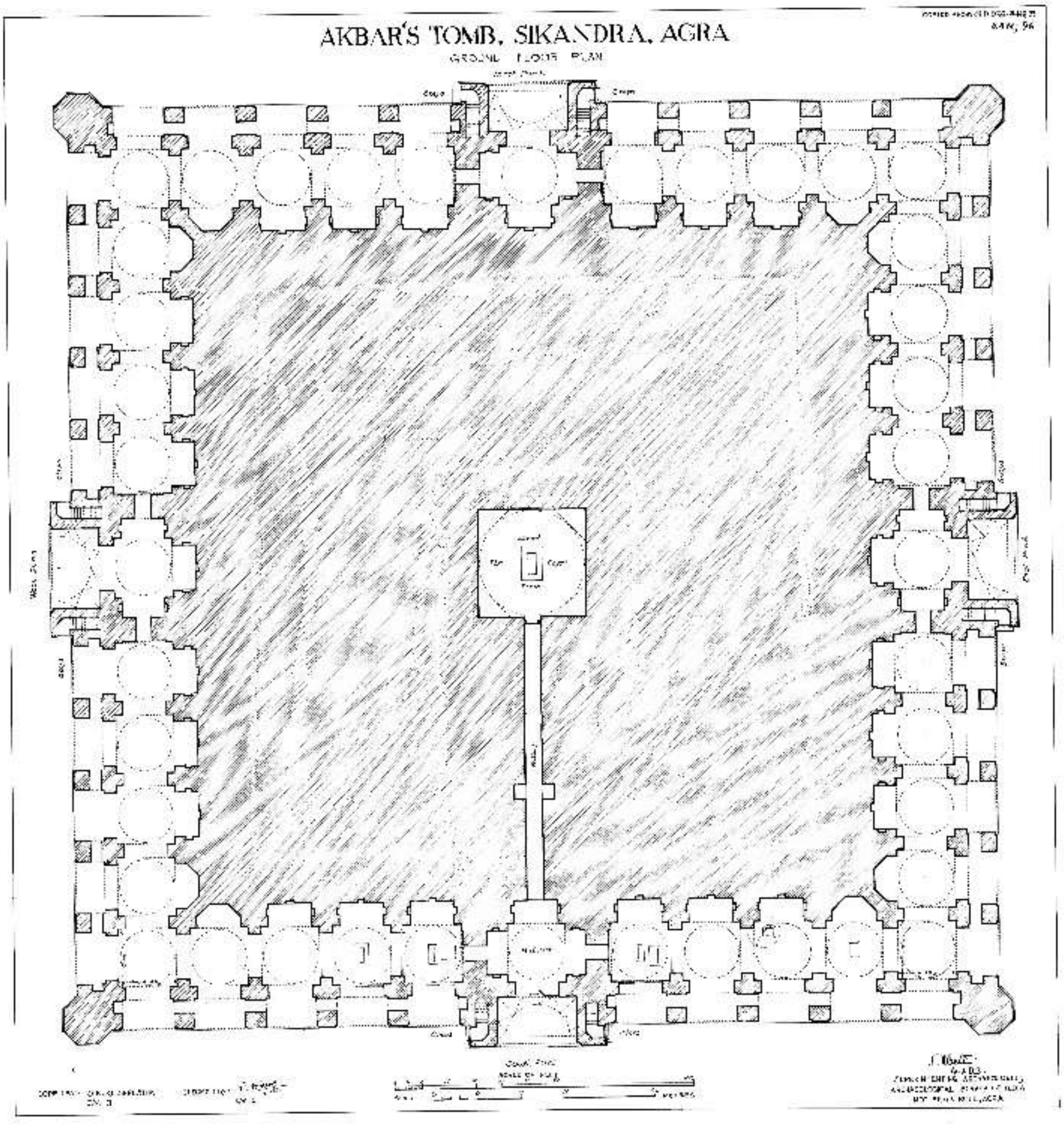


Figure 4 Upper most floor plan of Akbar's Tomb Source: Archaeological Survey of India, Agra circle, Agra

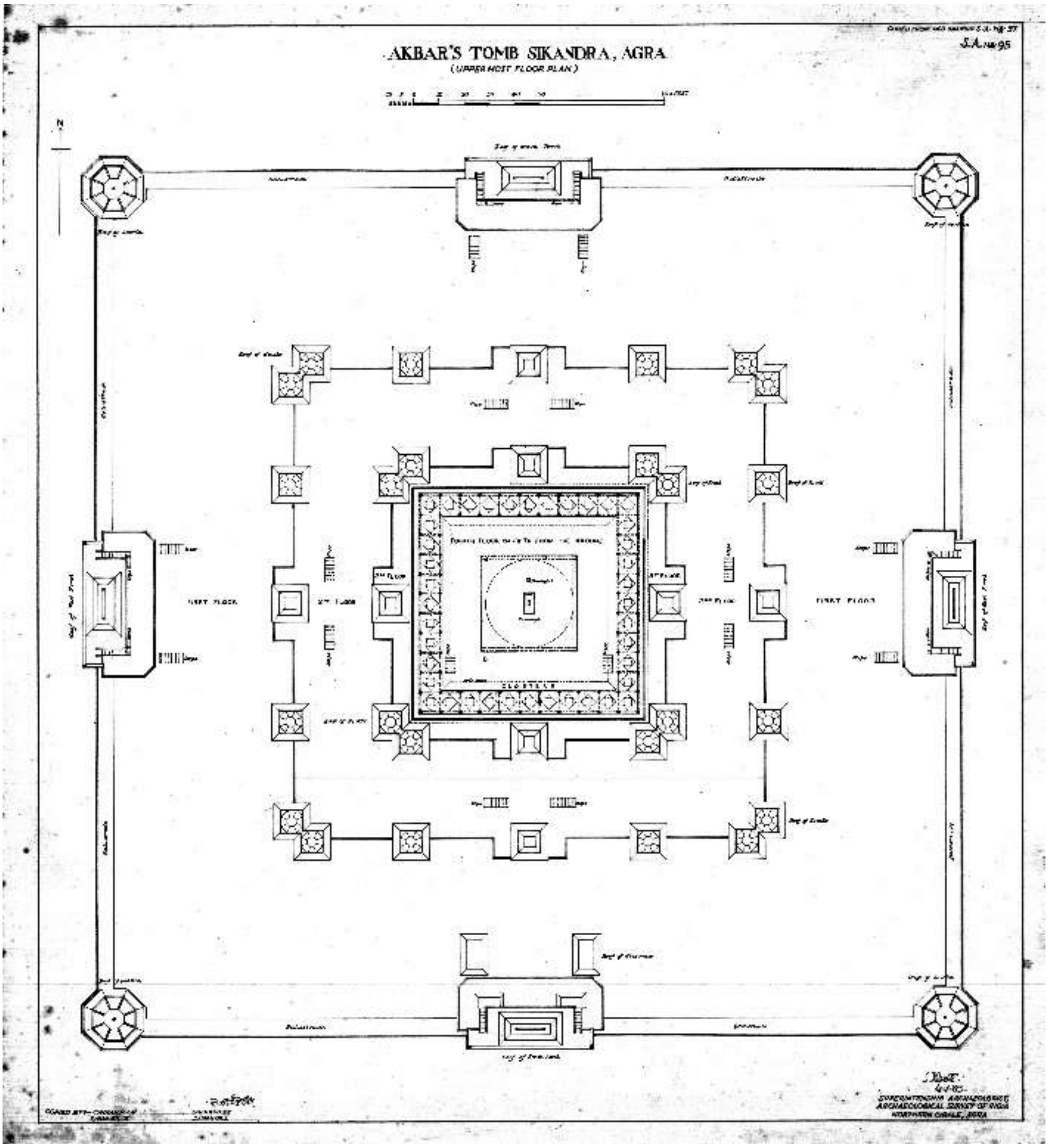


Figure 5 Ground floor plan of Akbar's Tomb Source: Archaeological Survey of India, Agra circle, Agra

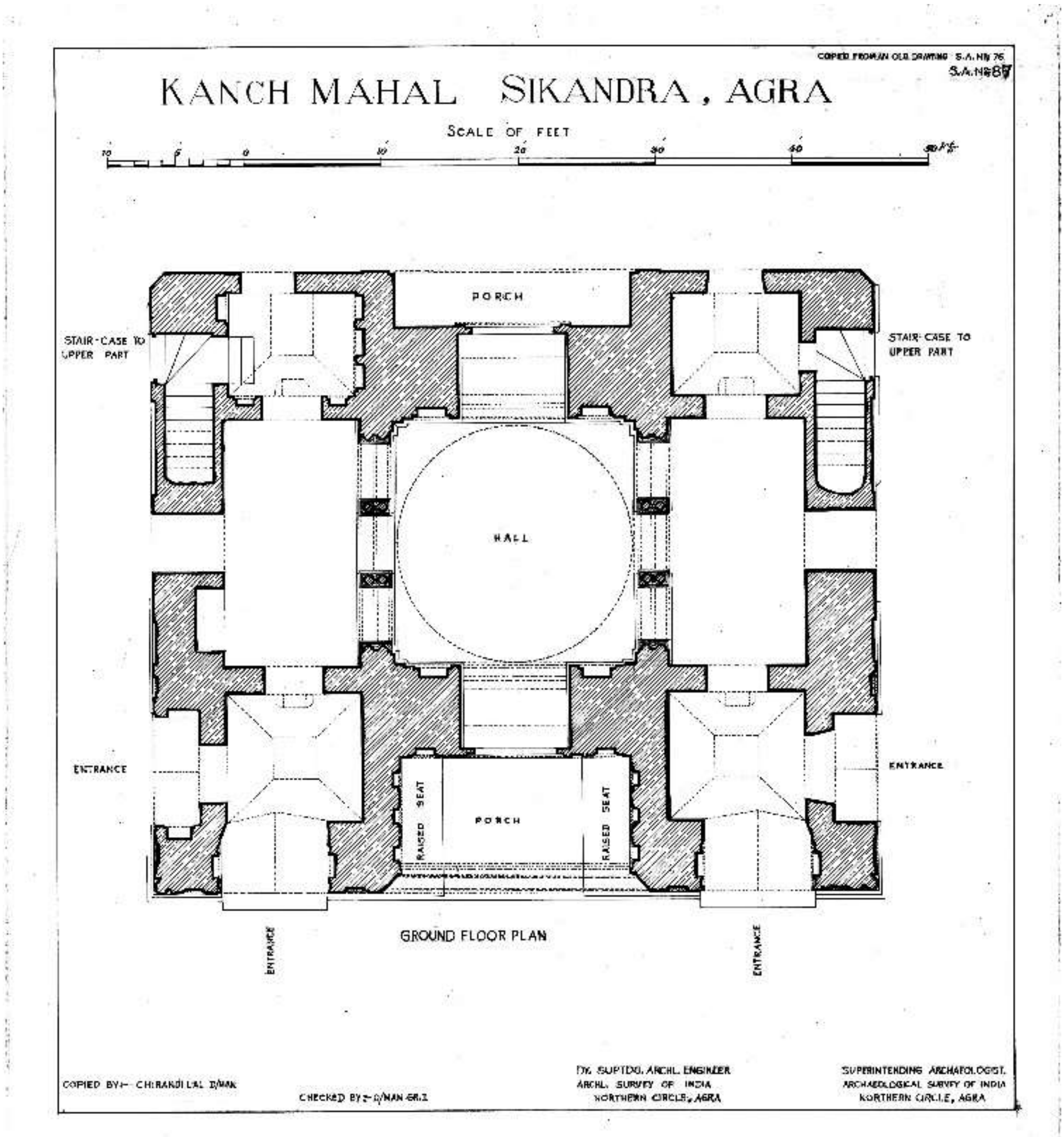


Figure 6 Ground floor plan of Kanch Mahal, Sikandara Source: Archaeological Survey of India, Agra circle, Agra

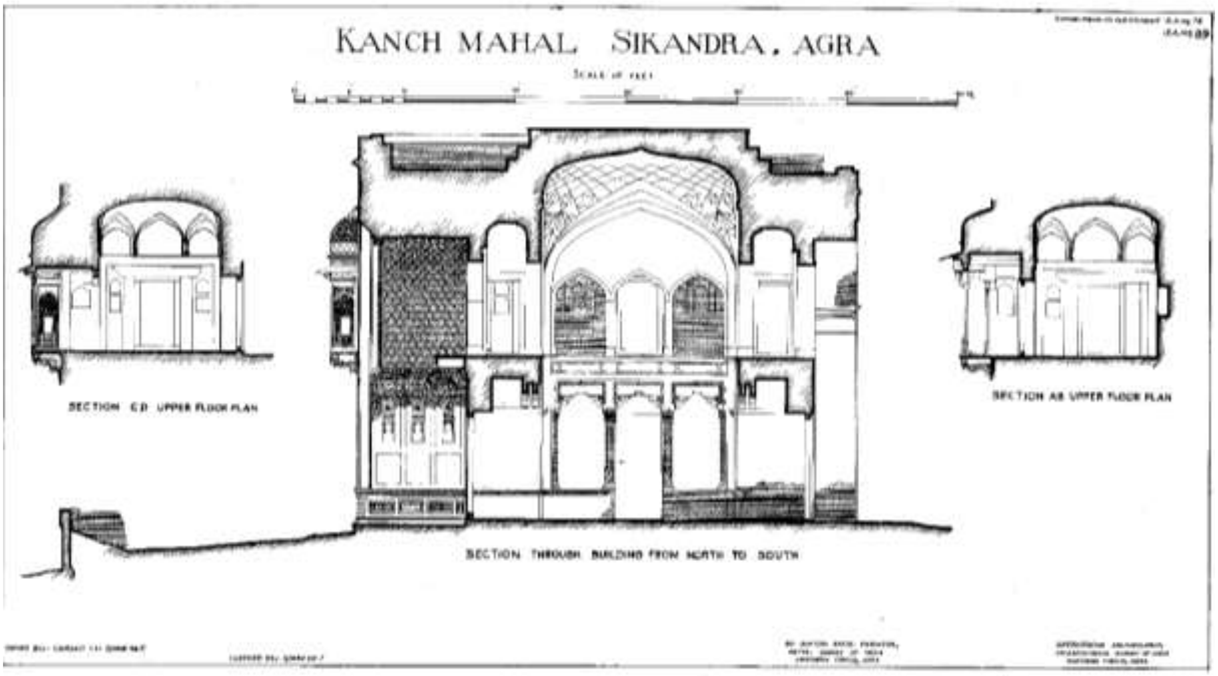


Figure 7 Section through building from north to south of Kanch Mahal, Sikandara, Source: Archaeological Survey of India, Agra circle, Agra

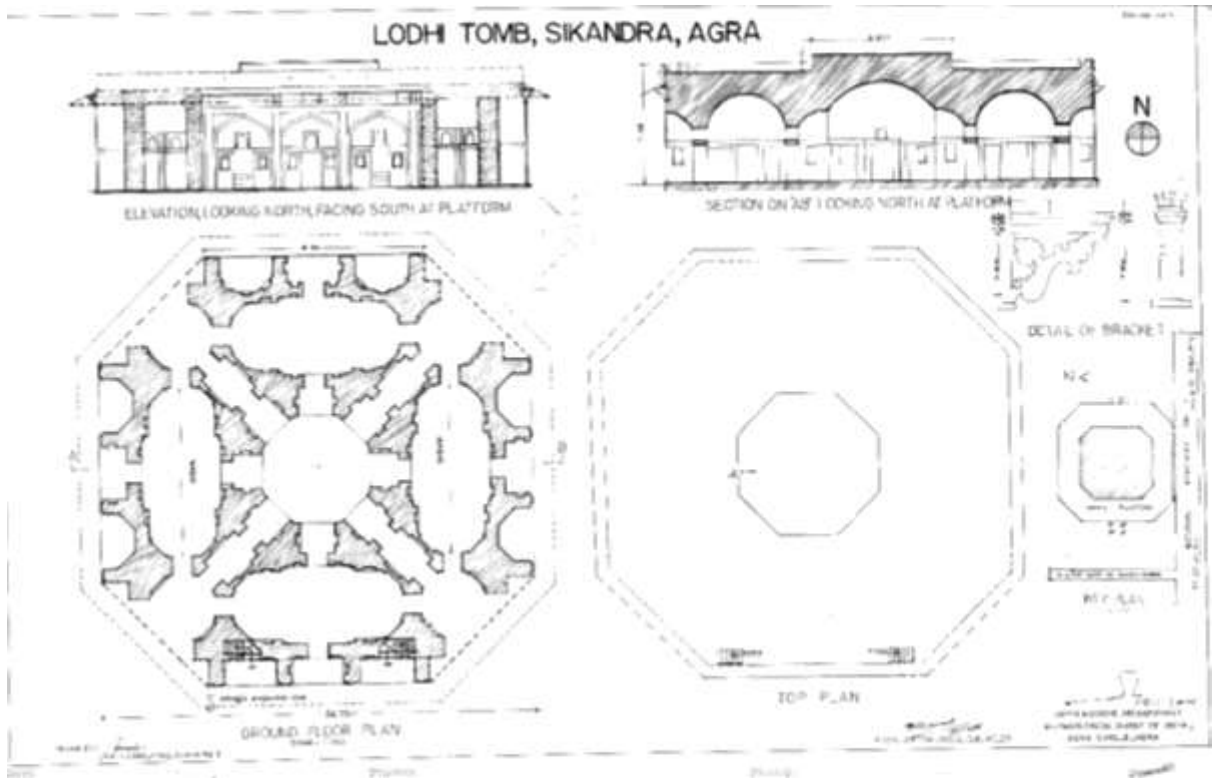


Figure 8 Lodhi Tomb, Sikandara, Source: Archaeological Survey of India, Agra circle, Agra

D. Guru ka Taal

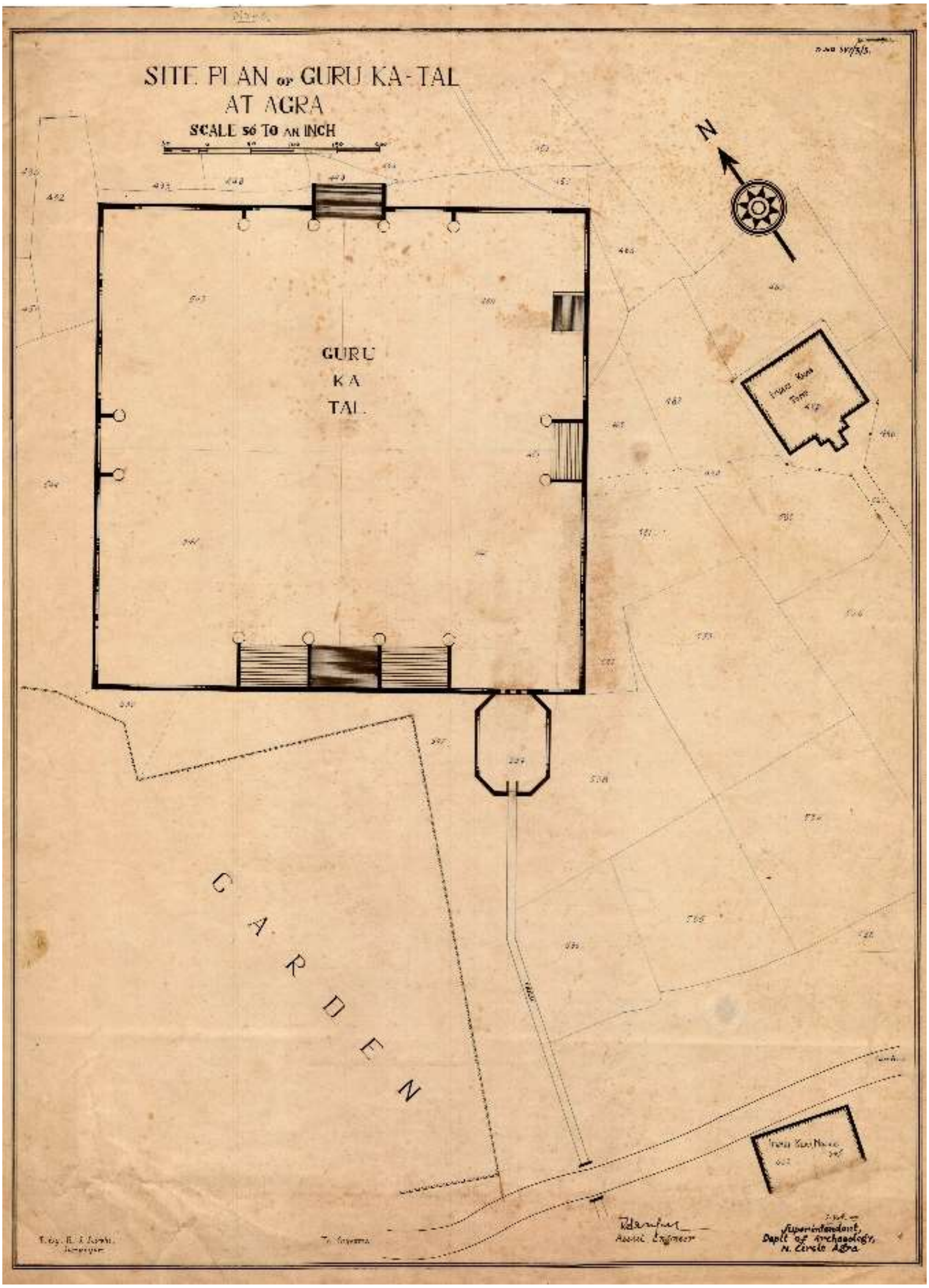


Figure 7 Site plan of the Guru ka Taal, Source: Archaeological Survey of India, Agra circle, Agra

E. Pathar ka Ghoda

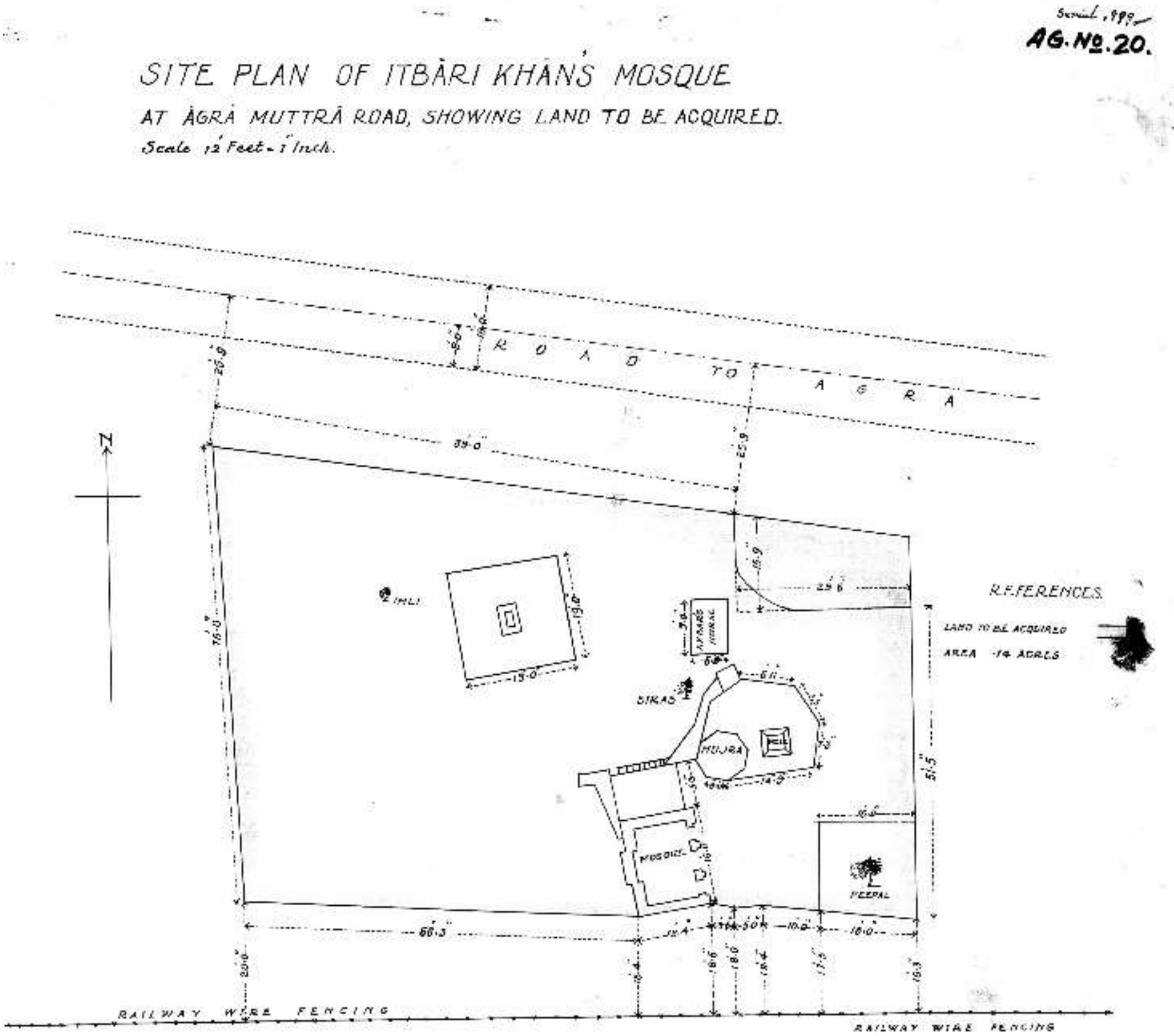


Figure 8 Site plan of the Pathar ka Ghoda, Source: Archaeological Survey of India, Agra circle, Agra

F. Tomb of Salabat Khan, Tomb of Sadiq Khan

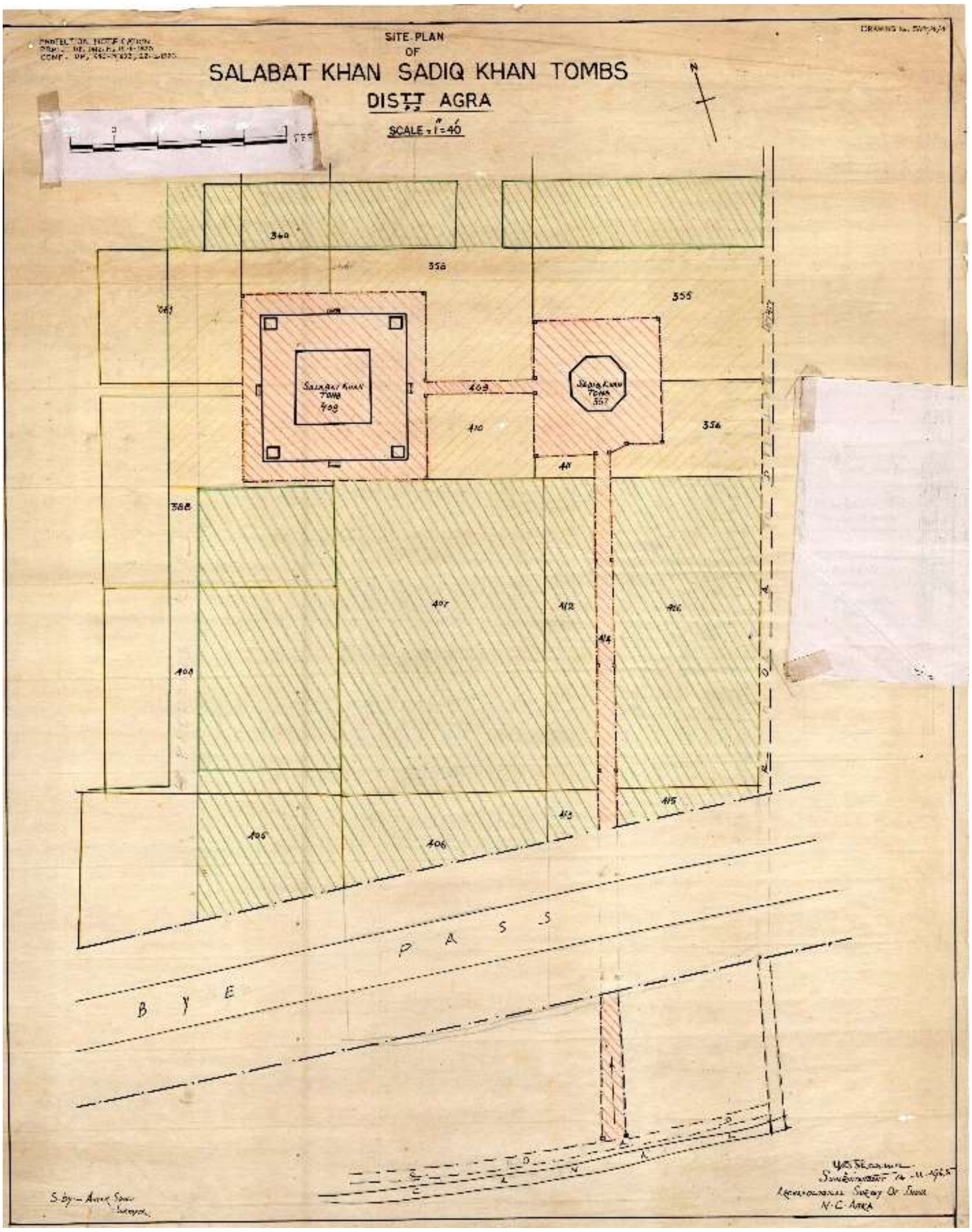


Figure 9 Plan of the tomb of the Salabat Khan and Sadiq Khan, Source: Archaeological Survey of India, Agra circle, Agra

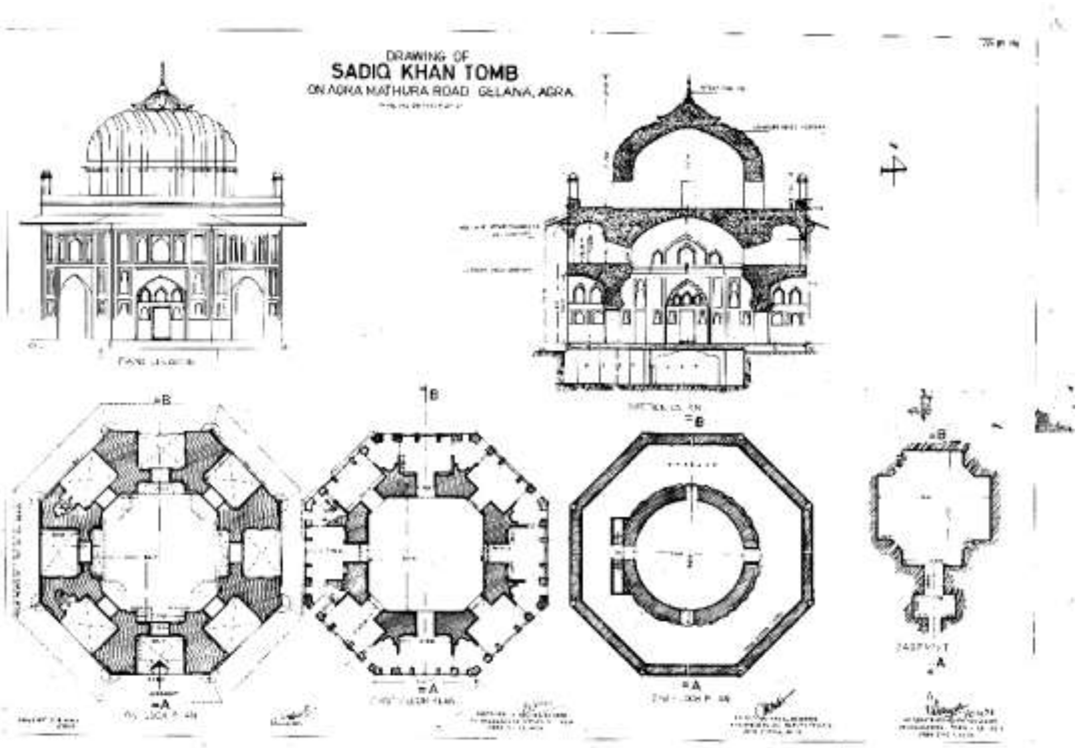


Figure 10 Plans, elevation, section of the Salabat khan and Sadiq Khan tomb Source: Archaeological Survey of India, Agra circle, Agra

G. Barah Khamba

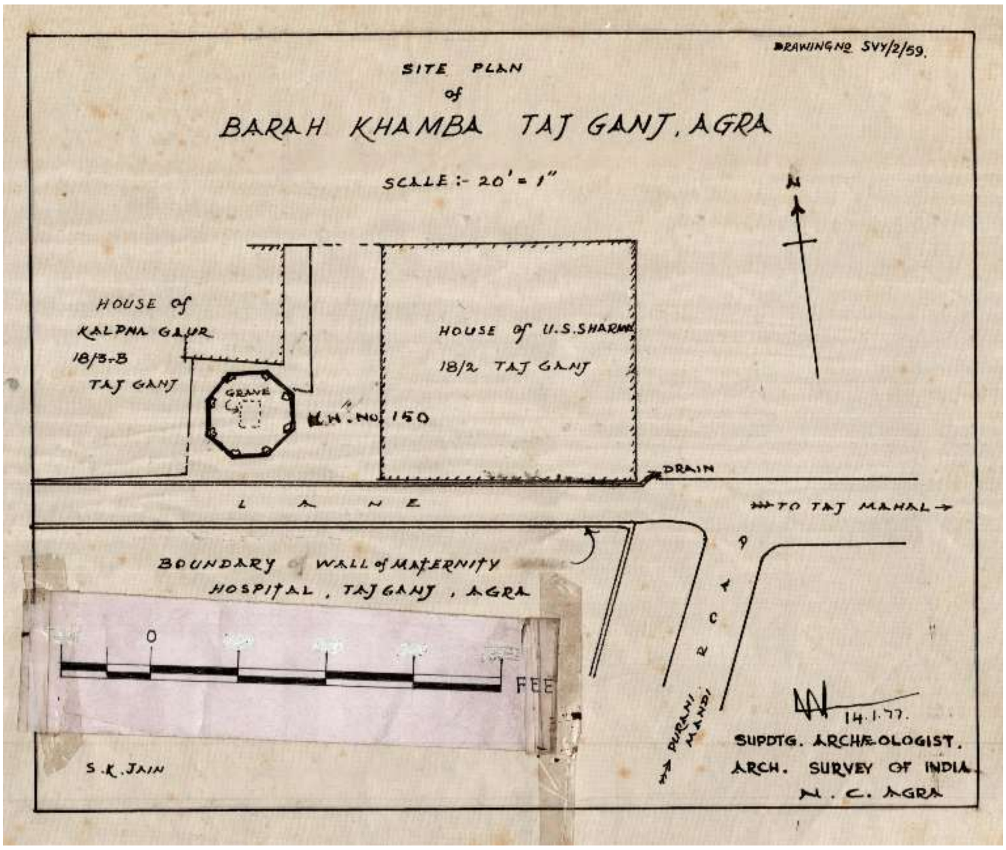


Figure 11 Site plan of Barah Khamba, Source: Archaeological Survey of India, Agra circle, Agra

H. Old Delhi Gate of City

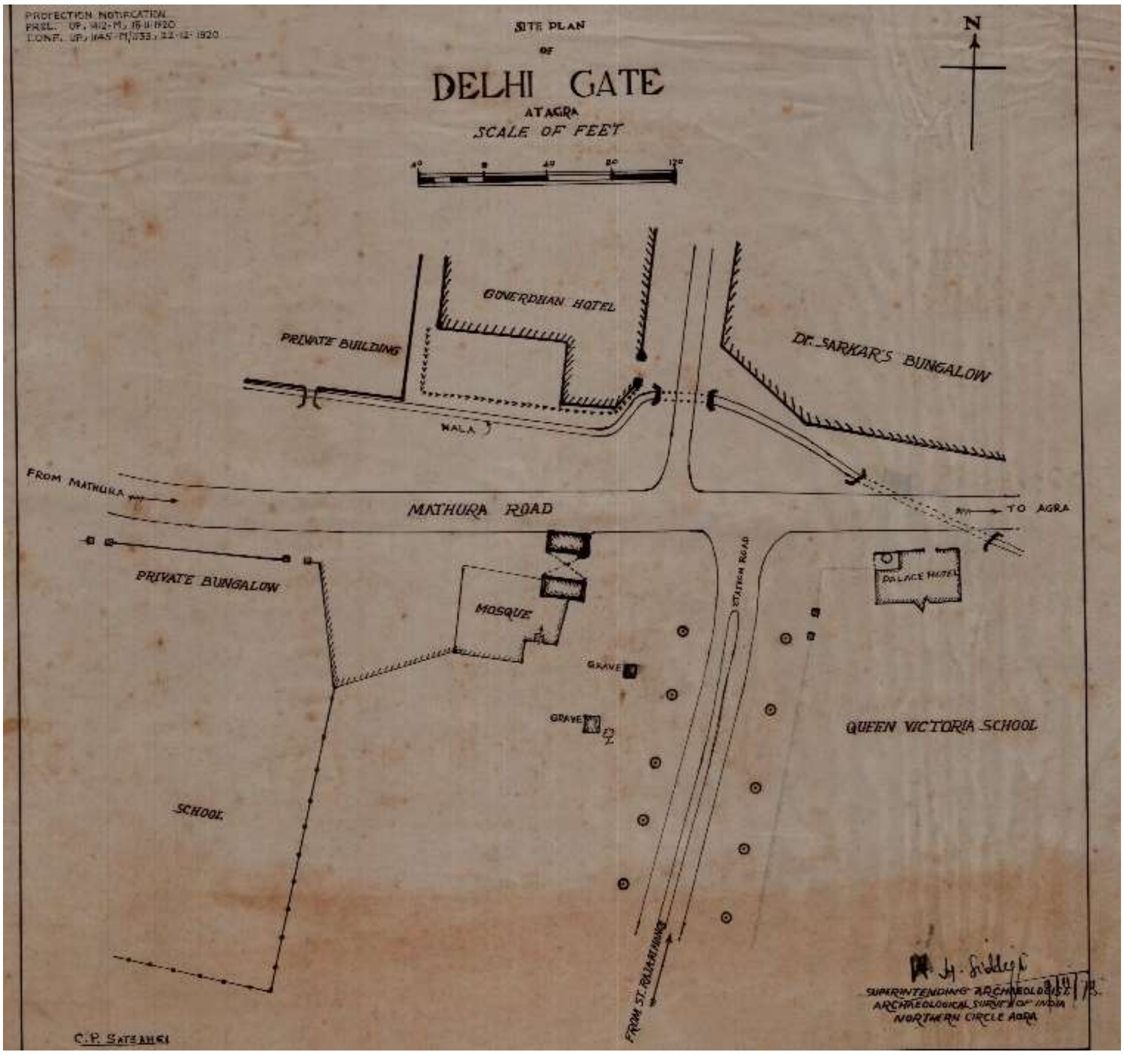


Figure 12 Site plan of the Old Delhi Gate, Source: Archaeological Survey of India, Agra circle, Agra

I. Jama Masjid

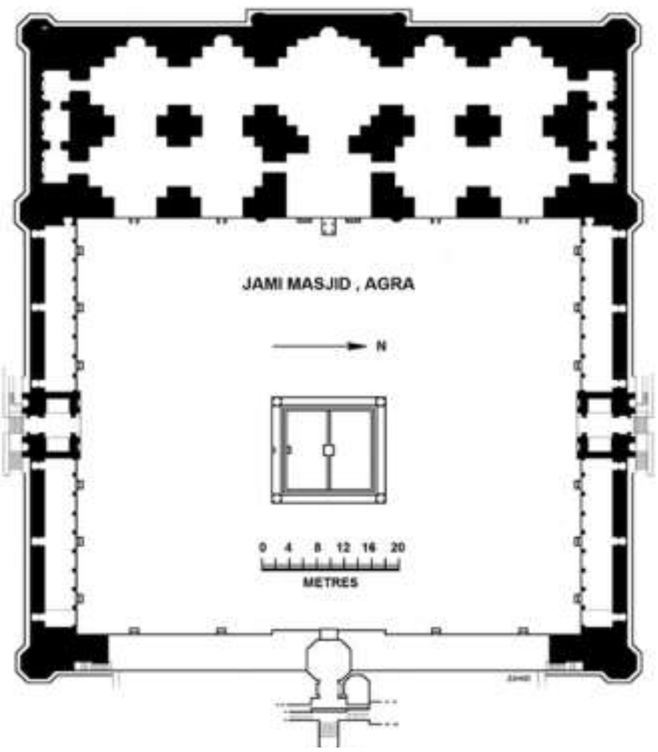


Figure 13 Floor plan of Jama Masjid, Source: Archaeological Survey of India, Agra circle, Agra

J. Ladli Begum ka Tila

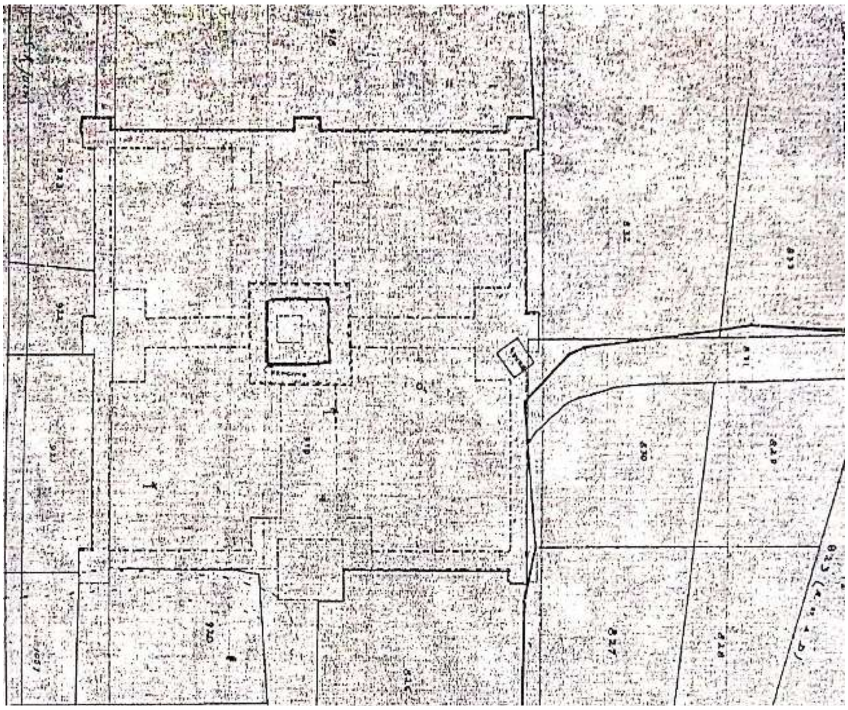


Figure 14 Site plan of the Ladli Begum ka Tila, Source: Archaeological Survey of India, Agra circle, Agra

K. Shahjahan Park (partially part of Taj buffer)

Figure 15 Site plan of the Shahjahan park, Source: Environmental assessment report for revitalization of Shahjahan park walk way between Taj and Agra fort, Agra by ICSC Ahmedabad, India

L. Fatehpuri mosque

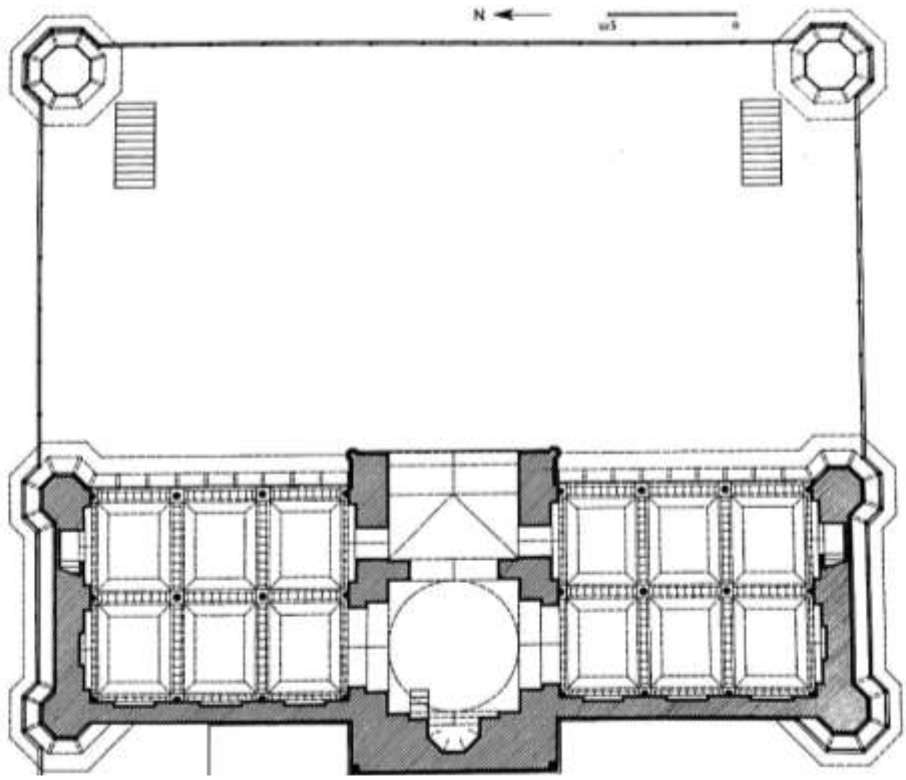


Figure 16 Plan of the Fatehpuri mosque, Source: Koch, E. (2006). The Complete Taj Mahal and the Riverfront Gardens of Agra. New Delhi: Bookwise (India) Pvt. Ltd.

M. Satti-un-Nissa's Tomb

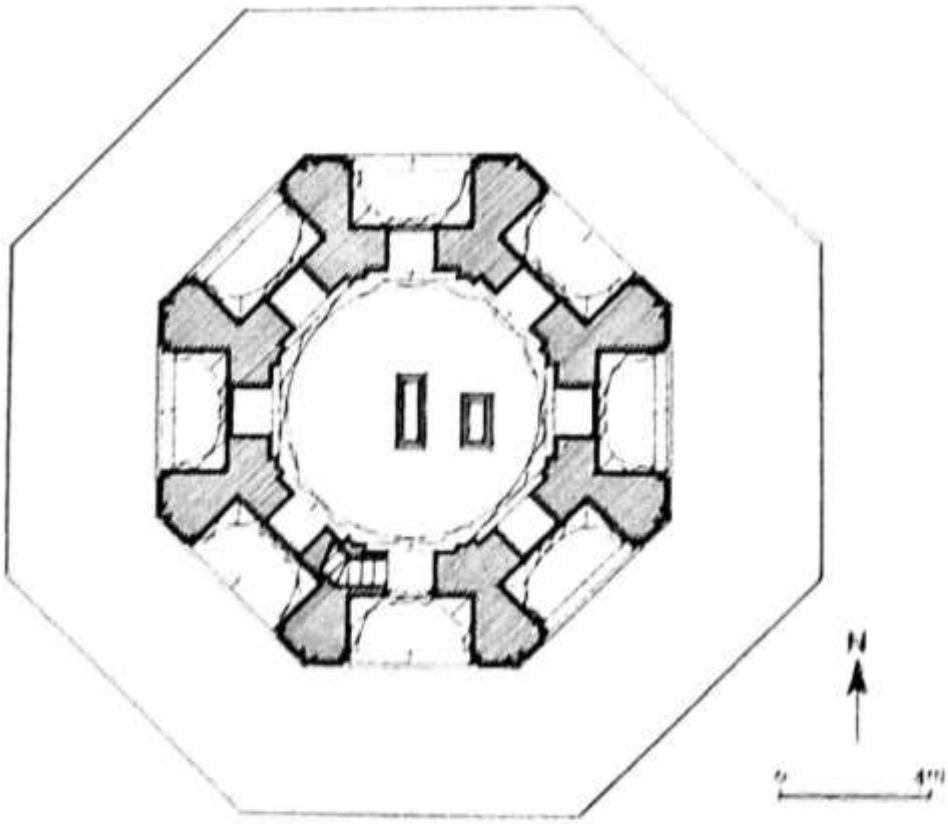


Figure 17 Site plan of the Satti-un-Nissa, Source: Koch, E. (2006). The Complete Taj Mahal and the Riverfront Gardens of Agra. New Delhi: Bookwise (India) Pvt. Ltd.

Annexure-IV

1. CONDITION SURVEY

Condition survey based on visual inspection as a first step of safety of heritage buildings along Corridor 1 Taj East Gate to Sikandara was carried out during the month of September, 2019. During the investigation the heritage buildings were examined on basis structural typology, material and current state of preservation, visual observation which leads to detailed analysis and data includes damage state and physical condition of the building. Damage assessment which is the main part of condition survey requires both qualitative and quantitative data bases. The matrix below is a compilation of the buildings visited during the visual investigation earlier this month.

A. Taj mahal

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Main Mausoleum

Platform

- ■ Vegetation growth on the plinth
- ☐ Decayed material
- ■ Stone defects in cladding
- ■ Defects in decorative bands
- ■ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ■ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ■ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ■ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ■ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ■ Algae deposition/ blackening

External wall surfaces

- ■ Vegetation growth
- ■ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ■ Graffiti
- ■ Closed openings/ alterations
- ☐ Non-accessible openings
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Minarets

Platform

■ Vegetation growth on the plinth
☐ Decayed material
■ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
■ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

■ Water seepage
■ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
■ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
■ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

■ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
■ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
■ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
■ Graffiti
☐ Closed openings/ alterations
■ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
■ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Riverfront Terrace

Platform

■ Vegetation growth on the plinth
☐ Decayed material
■ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
■ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Mosque

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ■ Plaster deterioration
- ■ Exposed masonry
- ☐ Structural cracks
- ■ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces

- ■ Vegetation growth
- ■ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks on the surface
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ■ Decayed decorative work
- ☐ Missing decorative members
- ■ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ■ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ■ Cracks over the arches
- ■ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ■ Repair works in patches
- ■ Graffiti
- ■ Missing decorative bands in patches
- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ■ Stone cracks
- ■ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ■ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ■ Missing/ broken decorative bands

Flooring –Verandah/External

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ■ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ■ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Mehmaan khana

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
■ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
■ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
■ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
■ Blackening/ other deposits
■ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
■ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces

■ Vegetation growth
■ Algae deposition/ blackening
■ Sign of dampness
■ Sign of water seepage from the stone joints
☐ Capillary water rise
■ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
■ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
■ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
■ Decayed decorative work
☐ Repair works in patches
■ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
■ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Char Bagh

Platform
- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ■ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface
- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace
- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces
- ☐ Vegetation growth
- ■ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ■ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ■ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ■ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ■ Decayed decorative work
- ☐ Repair works in patches
- ■ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ■ Blackening/ other deposits

Flooring –internal chamber
- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ■ Stone cracks
- ■ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ■ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External
- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ■ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ■ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Great Gate

Platform

- [ ] Vegetation growth on the plinth
- [ ] Decayed material
- [ ] Stone defects in cladding
- [x] Defects in decorative bands
- [ ] Cracks on plinth
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [ ] Poor drainage

Dome external surface

- [ ] Deep cracks in the plaster layer
- [ ] Holes in the masonry
- [ ] Exposed masonry
- [x] Vegetation growth
- [ ] Algae deposition in patches
- [ ] New finishing all over
- [ ] Repaired in patches
- [ ] Tilted/ loosely fitted finial
- [ ] Partially decayed finial
- [ ] Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

- [ ] Water seepage
- [ ] Plaster deterioration
- [ ] Exposed masonry
- [ ] Structural cracks
- [x] Blackening/ other deposits
- [ ] Stone defects
- [ ] Cracks in plaster/ masonry
- [ ] New plaster work
- [ ] Layers of new lime wash
- [x] Deteriorating artwork
- [ ] Sign of dampness
- [ ] Salt deposits/ efflorescence

Terrace

- [x] Vegetation growth
- [ ] Water logging areas
- [x] Cracks on the roof
- [x] Deteriorated materials
- [x] Added new cement/ concrete layers
- [ ] Closed water outlets
- [x] Algae deposition/ blackening

External wall surfaces

- [ ] Vegetation growth
- [x] Algae deposition/ blackening
- [ ] Sign of dampness
- [ ] Sign of water seepage from the stone joints
- [ ] Capillary water rise
- [ ] Salt deposits/ efflorescence
- [x] Cracks on the surface
- [x] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [ ] Decayed decorative work
- [ ] Missing decorative members
- [x] Missing decorative bands in patches
- [ ] Exposed/ weak masonry
- [ ] Cement pointing/ cement repair works
- [ ] Graffiti
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- [ ] Sign of dampness
- [ ] Capillary water rise
- [ ] Cracks over the arches
- [ ] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [ ] Decayed decorative work
- [ ] Repair works in patches
- [ ] Graffiti
- [x] Missing decorative bands in patches
- [x] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)
- [ ] Stone cracks
- [x] Blackening/ other deposits

Flooring –internal chamber

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [ ] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands

Flooring –Verandah/External

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [x] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands
- [ ] Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Jalaukhana

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Well inside the Taj garden

Platform
- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ■ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface
- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace
- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces
- ☐ Vegetation growth
- ■ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ■ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Dalans

Platform

- [ ] Vegetation growth on the plinth
- [ ] Decayed material
- [ ] Stone defects in cladding
- [ ] Defects in decorative bands
- [ ] Cracks on plinth
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [ ] Poor drainage

Dome external surface

- [ ] Deep cracks in the plaster layer
- [ ] Holes in the masonry
- [ ] Exposed masonry
- [ ] Vegetation growth
- [ ] Algae deposition in patches
- [ ] New finishing all over
- [ ] Repaired in patches
- [ ] Tilted/ loosely fitted finial
- [ ] Partially decayed finial
- [ ] Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

- [x] Water seepage
- [ ] Plaster deterioration
- [ ] Exposed masonry
- [ ] Structural cracks
- [ ] Blackening/ other deposits
- [ ] Stone defects
- [ ] Cracks in plaster/ masonry
- [x] New plaster work
- [ ] Layers of new lime wash
- [ ] Deteriorating artwork
- [ ] Sign of dampness
- [ ] Salt deposits/ efflorescence

Terrace

- [ ] Vegetation growth
- [ ] Water logging areas
- [ ] Cracks on the roof
- [ ] Deteriorated materials
- [ ] Added new cement/ concrete layers
- [ ] Closed water outlets
- [ ] Algae deposition/ blackening

External wall surfaces

- [ ] Vegetation growth
- [x] Algae deposition/ blackening
- [ ] Sign of dampness
- [ ] Sign of water seepage from the stone joints
- [ ] Capillary water rise
- [ ] Salt deposits/ efflorescence
- [ ] Cracks on the surface
- [ ] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [ ] Decayed decorative work
- [x] Missing decorative members
- [x] Missing decorative bands in patches
- [ ] Exposed/ weak masonry
- [ ] Cement pointing/ cement repair works
- [ ] Graffiti
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- [x] Sign of dampness
- [ ] Capillary water rise
- [ ] Cracks over the arches
- [x] Plaster work with shrinkage cracks
- [x] Decayed plain plaster work
- [ ] Decayed decorative work
- [ ] Repair works in patches
- [x] Graffiti
- [ ] Missing decorative bands in patches
- [ ] Missing/broken stones
- [ ] Stone defects (chipping, erosion, delamination, broken, flaking)
- [ ] Stone cracks
- [ ] Blackening/ other deposits

Flooring –internal chamber

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [ ] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands

Flooring –Verandah/External

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [ ] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands
- [ ] Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Sahelio ka gumbaz number-1

Platform

■ Vegetation growth on the plinth
☐ Decayed material
■ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
■ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

■ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
■ Blackening/ other deposits
■ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
■ Sign of dampness
■ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
■ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
■ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Sahelio ka gumbaz number-2

Platform
■ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
■ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface
☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
■ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
■ Blackening/ other deposits
■ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
■ Sign of dampness
■ Salt deposits/ efflorescence

Terrace
☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces
☐ Vegetation growth
■ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
■ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
■ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External
■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: West and East Gate

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
■ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
■ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Sirhi Darwaza

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
■ Sign of dampness
■ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
■ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
■ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
■ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
■ Decayed decorative work
■ Repair works in patches
■ Graffiti
■ Missing decorative bands in patches
■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
■ Stone cracks
■ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
■ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage Resource: Wall Towers

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
■ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
■ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
■ Algae deposition/ blackening
■ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

B. Agra fort

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Akbari Mahal

Platform
☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface
☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace
☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces
■ Vegetation growth
■ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber
☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External
■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
■ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Jahangiri Mahal

Platform

- [ ] Vegetation growth on the plinth
- [ ] Decayed material
- [ ] Stone defects in cladding
- [x] Defects in decorative bands
- [ ] Cracks on plinth
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [ ] Poor drainage

Dome external surface

- [ ] Deep cracks in the plaster layer
- [ ] Holes in the masonry
- [ ] Exposed masonry
- [ ] Vegetation growth
- [ ] Algae deposition in patches
- [ ] New finishing all over
- [ ] Repaired in patches
- [ ] Tilted/ loosely fitted finial
- [ ] Partially decayed finial
- [ ] Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- [ ] Water seepage
- [ ] Plaster deterioration
- [ ] Exposed masonry
- [ ] Structural cracks
- [ ] Blackening/ other deposits
- [ ] Stone defects
- [ ] Cracks in plaster/ masonry
- [ ] New plaster work
- [ ] Layers of new lime wash
- [ ] Deteriorating artwork
- [ ] Sign of dampness
- [ ] Salt deposits/ efflorescence

Terrace

- [x] Vegetation growth
- [ ] Water logging areas
- [x] Cracks on the roof
- [x] Deteriorated materials
- [ ] Added new cement/ concrete layers
- [ ] Closed water outlets
- [x] Algae deposition/ blackening

External wall surfaces

- [ ] Vegetation growth
- [x] Algae deposition/ blackening
- [ ] Sign of dampness
- [ ] Sign of water seepage from the stone joints
- [ ] Capillary water rise
- [x] Salt deposits/ efflorescence
- [ ] Cracks over the surfacs
- [ ] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [x] Decayed decorative work
- [ ] Missing decorative members
- [ ] Missing decorative bands in patches
- [ ] Exposed/ weak masonry
- [ ] Cement pointing/ cement repair works
- [ ] Graffiti
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- [x] Sign of dampness
- [x] Capillary water rise
- [x] Cracks over the arches
- [ ] Plaster work with shrinkage cracks
- [x] Decayed plain plaster work
- [x] Decayed decorative work
- [ ] Repair works in patches
- [x] Graffiti
- [ ] Missing decorative bands in patches
- [x] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)
- [x] Stone cracks
- [x] Blackening/ other deposits

Flooring –internal chamber

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [x] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands

Flooring –Verandah/External

- [x] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [x] Salt deposits/ efflorescence
- [x] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [x] Missing/ broken decorative bands
- [ ] Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Jahangiri's Bath

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
■ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
■ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Shahjahan's apartment

Platform
- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface
- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ■ Vegetation growth
- ■ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
- ☐ Water seepage
- ■ Plaster deterioration
- ■ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ■ New plaster work
- ■ Layers of new lime wash
- ■ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace
- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ■ Algae deposition/ blackening

External wall surfaces
- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
- ☐ Sign of dampness
- ■ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ■ Decayed decorative work
- ☐ Repair works in patches
- ■ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ■ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Khas Mahàl

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
■ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

■ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
■ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

■ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Roshan ara pavillion

Platform

- [ ] Vegetation growth on the plinth
- [ ] Decayed material
- [x] Stone defects in cladding
- [ ] Defects in decorative bands
- [ ] Cracks on plinth
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [ ] Poor drainage

Dome external surface

- [ ] Deep cracks in the plaster layer
- [ ] Holes in the masonry
- [ ] Exposed masonry
- [ ] Vegetation growth
- [x] Algae deposition in patches
- [ ] New finishing all over
- [ ] Repaired in patches
- [ ] Tilted/ loosely fitted finial
- [ ] Partially decayed finial
- [ ] Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- [ ] Water seepage
- [ ] Plaster deterioration
- [ ] Exposed masonry
- [ ] Structural cracks
- [ ] Blackening/ other deposits
- [ ] Stone defects
- [ ] Cracks in plaster/ masonry
- [x] New plaster work
- [ ] Layers of new lime wash
- [ ] Deteriorating artwork
- [ ] Sign of dampness
- [ ] Salt deposits/ efflorescence

Terrace

- [ ] Vegetation growth
- [ ] Water logging areas
- [ ] Cracks on the roof
- [ ] Deteriorated materials
- [ ] Added new cement/ concrete layers
- [ ] Closed water outlets
- [x] Algae deposition/ blackening

External wall surfaces

- [ ] Vegetation growth
- [ ] Algae deposition/ blackening
- [ ] Sign of dampness
- [ ] Sign of water seepage from the stone joints
- [ ] Capillary water rise
- [ ] Salt deposits/ efflorescence
- [ ] Cracks over the surfacs
- [ ] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [ ] Decayed decorative work
- [ ] Missing decorative members
- [ ] Missing decorative bands in patches
- [ ] Exposed/ weak masonry
- [ ] Cement pointing/ cement repair works
- [ ] Graffiti
- [ ] Closed openings/ alterations
- [ ] Non-accessible openings
- [ ] Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- [ ] Sign of dampness
- [ ] Capillary water rise
- [ ] Cracks over the arches
- [ ] Plaster work with shrinkage cracks
- [ ] Decayed plain plaster work
- [ ] Decayed decorative work
- [ ] Repair works in patches
- [x] Graffiti
- [ ] Missing decorative bands in patches
- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking)
- [ ] Stone cracks
- [ ] Blackening/ other deposits

Flooring –internal chamber

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [ ] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands

Flooring –Verandah/External

- [ ] Missing/broken stones
- [x] Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- [ ] Stone cracks
- [ ] Salt deposits/ efflorescence
- [ ] Algae deposition/ blackening
- [ ] Original stone floor with cement pointing
- [ ] Water logging
- [ ] Sign of dampness
- [ ] Missing/ broken decorative bands
- [ ] Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Zara ara pavillion

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ■ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ■ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ■ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces

- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Shish Mahàl

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
■ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfaces
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
■ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

■ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Saman burj

Platform
☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface
☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace
■ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces
☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External
☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Mina masjid

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces

- ☐ Vegetation growth
- ■ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ■ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Anguri bagh

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ■ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ■ Blackening/ other deposits
- ■ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ■ Salt deposits/ efflorescence

Terrace

- ■ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ■ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ■ Algae deposition/ blackening

External wall surfaces

- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ■ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ■ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ■ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ■ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ■ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ■ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ■ Blackening/ other deposits

Flooring –internal chamber

- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Saman burj

Platform
- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface
- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)
- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace
- ■ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ■ Algae deposition/ blackening

External wall surfaces
- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces
- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Diwan- i- khas

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
■ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
■ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

■ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
■ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
☐ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Malchchi bhawan

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ■ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ■ Algae deposition/ blackening

External wall surfaces

- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ■ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ■ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ■ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ■ Missing/broken stones
- ■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Mina masjid

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
☐ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
☐ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
☐ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

☐ Vegetation growth
■ Algae deposition/ blackening
☐ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
☐ Cracks over the surfacs
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Missing decorative members
☐ Missing decorative bands in patches
☐ Exposed/ weak masonry
☐ Cement pointing/ cement repair works
☐ Graffiti
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

☐ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
☐ Graffiti
☐ Missing decorative bands in patches
☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
■ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
■ Vegetation growth

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Heritage resource : Somnath gate

Platform

- ☐ Vegetation growth on the plinth
- ☐ Decayed material
- ☐ Stone defects in cladding
- ☐ Defects in decorative bands
- ☐ Cracks on plinth
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Poor drainage

Dome external surface

- ☐ Deep cracks in the plaster layer
- ☐ Holes in the masonry
- ☐ Exposed masonry
- ☐ Vegetation growth
- ☐ Algae deposition in patches
- ☐ New finishing all over
- ☐ Repaired in patches
- ☐ Tilted/ loosely fitted finial
- ☐ Partially decayed finial
- ☐ Missing finial

Internal Ceiling (including Dome/ vault surfaces)

- ☐ Water seepage
- ☐ Plaster deterioration
- ☐ Exposed masonry
- ☐ Structural cracks
- ☐ Blackening/ other deposits
- ☐ Stone defects
- ☐ Cracks in plaster/ masonry
- ☐ New plaster work
- ☐ Layers of new lime wash
- ☐ Deteriorating artwork
- ☐ Sign of dampness
- ☐ Salt deposits/ efflorescence

Terrace

- ☐ Vegetation growth
- ☐ Water logging areas
- ☐ Cracks on the roof
- ☐ Deteriorated materials
- ☐ Added new cement/ concrete layers
- ☐ Closed water outlets
- ☐ Algae deposition/ blackening

External wall surfaces

- ☐ Vegetation growth
- ☐ Algae deposition/ blackening
- ☐ Sign of dampness
- ☐ Sign of water seepage from the stone joints
- ☐ Capillary water rise
- ☐ Salt deposits/ efflorescence
- ☐ Cracks over the surfacs
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Missing decorative members
- ☐ Missing decorative bands in patches
- ☐ Exposed/ weak masonry
- ☐ Cement pointing/ cement repair works
- ☐ Graffiti
- ☐ Closed openings/ alterations
- ☐ Non-accessible openings
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

- ☐ Sign of dampness
- ☐ Capillary water rise
- ☐ Cracks over the arches
- ☐ Plaster work with shrinkage cracks
- ☐ Decayed plain plaster work
- ☐ Decayed decorative work
- ☐ Repair works in patches
- ☐ Graffiti
- ☐ Missing decorative bands in patches
- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking)
- ☐ Stone cracks
- ☐ Blackening/ other deposits

Flooring –internal chamber

- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands

Flooring –Verandah/External

- ☐ Missing/broken stones
- ☐ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
- ☐ Stone cracks
- ☐ Salt deposits/ efflorescence
- ☐ Algae deposition/ blackening
- ☐ Original stone floor with cement pointing
- ☐ Water logging
- ☐ Sign of dampness
- ☐ Missing/ broken decorative bands
- ☐ Vegetation growth

C. Jama masjid

INVENTORY OF HERITAGE RESOURCES

CONDITION ASSESMENT

Platform

☐ Vegetation growth on the plinth
☐ Decayed material
☐ Stone defects in cladding
■ Defects in decorative bands
☐ Cracks on plinth
☐ Closed openings/ alterations
☐ Non-accessible openings
☐ Poor drainage

Dome external surface

☐ Deep cracks in the plaster layer
☐ Holes in the masonry
☐ Exposed masonry
☐ Vegetation growth
☐ Algae deposition in patches
■ New finishing all over
☐ Repaired in patches
☐ Tilted/ loosely fitted finial
☐ Partially decayed finial
☐ Missing finial/ element

Internal Ceiling (including Dome/ vault surfaces)

☐ Water seepage
☐ Plaster deterioration
☐ Exposed masonry
☐ Structural cracks
☐ Blackening/ other deposits
■ Stone defects
☐ Cracks in plaster/ masonry
☐ New plaster work
☐ Layers of new lime wash
☐ Deteriorating artwork
☐ Sign of dampness
☐ Salt deposits/ efflorescence

Terrace

☐ Vegetation growth
☐ Water logging areas
☐ Cracks on the roof
☐ Deteriorated materials
☐ Added new cement/ concrete layers
☐ Closed water outlets
☐ Algae deposition/ blackening

External wall surfaces

■ Vegetation growth
☐ Algae deposition/ blackening
■ Sign of dampness
☐ Sign of water seepage from the stone joints
☐ Capillary water rise
☐ Salt deposits/ efflorescence
■ Cracks on the surface
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
■ Missing decorative members
■ Missing decorative bands in patches
☐ Exposed/ weak masonry
■ Cement pointing/ cement repair works
■ Graffiti
☐ Closed openings/ alterations
■ Non-accessible openings
■ Stone defects (chipping, erosion, delamination, broken, flaking)

Internal surfaces

■ Sign of dampness
☐ Capillary water rise
☐ Cracks over the arches
☐ Plaster work with shrinkage cracks
☐ Decayed plain plaster work
☐ Decayed decorative work
☐ Repair works in patches
■ Graffiti
■ Missing decorative bands in patches
■ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking)
☐ Stone cracks
☐ Blackening/ other deposits

Flooring –internal chamber

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands

Flooring –Verandah/External

☐ Missing/broken stones
■ Stone defects (chipping, erosion, delamination, broken, flaking, contouring)
☐ Stone cracks
☐ Salt deposits/ efflorescence
☐ Algae deposition/ blackening
☐ Original stone floor with cement pointing
☐ Water logging
☐ Sign of dampness
☐ Missing/ broken decorative bands
☐ Vegetation growth

Annexure-V

क्षेत्रवार उ0प्र0 के प्रमुख ऐतिहासिक स्थलों/स्मारकों पर आये पर्यटकों की सांख्यिकी वर्ष– 2014, 2015, 2016, 2017, 2018

क0सं0	क्षेत्रीय कार्यालय	ऐतिहासिक स्थल/स्मारक	2014			2015			2016			2017			2018		
			भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	**18**
1	**उप निदेशक पर्यटन कार्यालय, आगरा**	1–ताजमहल	5377796	694467	**6072263**	5842287	671256	**6513543**	5547949	694231	**6242180**	5618738	861539	**6480277**	5675989	883770	**6559759**
		2–आगरा किला	1880931	343983	**2224914**	2000484	343776	**2344260**	1838440	377499	**2215939**	1978079	526930	**2505009**	2028509	526886	**2555395**
		3–फतेहपुर सीकरी	525401	231365	**756766**	615502	199279	**814781**	505195	146340	**651535**	498581	180336	**678917**	506900	164835	**671735**
		4–सिकन्दरा	482042	42093	**524135**	471009	29662	**500671**	392458	28427	**420885**	379590	26801	**406391**	365519	26623	**392142**
		5–एतमातुददौला	145216	69884	**215100**	141511	68405	**209916**	127903	75652	**203555**	128886	76000	**204886**	166782	100910	**267692**
		6–महताब बाग	142161	21795	**163956**	181651	24924	**206575**	175007	29345	**204352**	169261	49686	**218947**	232496	83966	**316462**
		7–मरियम टाम्ब	57584	292	**57876**	59668	286	**59954**	30733	191	**30924**	28780	225	**29005**	34543	200	**34743**
		8–राम बाग	72550	231	**72781**	74558	177	**74735**	57441	161	**57602**	51084	1907	**52991**	89432	423	**89855**
		9–राजकीय संग्रहालय मथुरा	11595	936	**12531**	13572	1068	**14640**	11910	884	**12794**	14069	904	**14973**	15181	881	**16062**
		10–राजकीय जैन संग्रहालय मथुरा	1321	0	**1321**	1237	0	**1237**	1017	0	**1017**	857	0	**857**	947	0	**947**
		योग–आगरा परिक्षेत्र	**8696597**	**1405046**	**10101643**	**9401479**	**1338833**	**10740312**	**8688053**	**1352730**	**10040783**	**8867925**	**1724328**	**10592253**	**9116298**	**1788494**	**10904792**
2	**क्षेत्रीय पर्यटक अधिकारी कार्यालय, लखनऊ**	1–बड़ा इमामबाड़ा/छोटा इमामबाड़ा/पिक्चर गैलरी/शाहनजफ इमामबाड़ा	704602	3897	**708499**	677482	3743	**681225**	704649	4276	**708925**	756050	4657	**760707**	788560	4482	**793042**
		2–रेजीडेन्सी	407139	3692	**410831**	407549	3749	**411298**	410508	3855	**414363**	448868	3950	**452818**	282617	3860	**286477**
		3–चिड़ियाघर, लखनऊ	1197477	0	**1197477**	1221372	0	**1221372**	1290674	0	**1290674**	1292184	0	**1292184**	1239109	0	**1239109**
		4– म्यूजियम	277975	310	**278285**	278475	319	**278794**	290103	322	**290425**	290408	331	**290739**	252773	212	**252985**
		5–इन्दिरागांधी नक्षत्रशाला, लखनऊ	65385	0	**65385**	65429	0	**65429**	65958	0	**65958**	70173	0	**70173**	51134	0	**51134**
		6–बौद्ध विहार शान्ति उपवन लखनऊ	19561	0	**19561**	17040	0	**17040**	19994	0	**19994**	17996	0	**17996**	23367	0	**23367**
		7–मान्यवर श्री कांशीराम जी ग्रीन (इको) गार्डेन लखनऊ	232358	0	**232358**	301368	0	**301368**	351696	0	**351696**	323793	0	**323793**	396597	0	**396597**
		8–मान्यवर श्री कांशीराम जी स्मारक स्थल लखनऊ	69323	0	**69323**	92884	0	**92884**	117331	0	**117331**	147549	0	**147549**	124080	0	**124080**
		9–डॉ0 भीमराव अम्बेडकर सामाजिक परिवर्तन स्थल गोमतीनगर लखनऊ	480702	0	**480702**	615286	0	**615286**	650095	0	**650095**	598617	0	**598617**	643028	0	**643028**
		10–डॉ0 भीमराव अम्बेडकर सामाजिक परिवर्तन स्थल से सम्बद्ध वाहय क्षेत्र गोमतीनगर लखनऊ	115315	0	**115315**	138075	0	**138075**	95407	0	**95407**	85296	0	**85296**	76079	0	**76079**

क0सं0	क्षेत्रीय कार्यालय	ऐतिहासिक स्थल / स्मारक	2014			2015			2016			2017			2018		
			भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		योग–लखनऊ परिक्षेत्र	**3569837**	**7899**	**3577736**	**3814960**	**7811**	**3822771**	**3996415**	**8453**	**4004868**	**4030934**	**8938**	**4039872**	**3877344**	**8554**	**3885898**
		नोट : चिड़ियाघर लखनऊ तथा कम सं0–6, 7, 8, 9, 10 में भारतीय एंव विदेशी पर्यटको हेतु पृथक–पृथक टिकट की व्यवस्था नही है।															
3	उप निदेशक पर्यटन कार्यालय, प्रयागराज	1–स्वराज भवन स्मारक, प्रयागराज	एक वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	एक वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	एक वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	विगत वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	विगत वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	विगत वर्ष से बन्द है, स्मारक में निर्माण कार्य चल रहा है	39467	0	**39467**	347285	278	**347563**	320531	607	**321138**
		2–आनन्द भवन	2613000	1784	**2614784**	457139	1523	**458662**	455025	1425	**456450**	494817	1285	**496102**	448024	943	**448967**
		3–प्रयागराज संग्रहालय (चन्द्रशेखर आजाद पार्क, प्रयागराज)	128485	444	**128929**	72243	188	**72431**	86886	133	**87019**	79458	78	**79536**	55969	132	**56101**
		4–जवाहर प्लेनेटोरियम	153823	0	**153823**	115764	0	**115764**	116042	0	**116042**	101727	0	**101727**	97378	0	**97378**
		5–गंगा गैलरी मम्फोर्डगंज	NA	NA		NA	NA		2557	4	**2561**	3500	0	**3500**	4500	0	**4500**
		6–राजकीय उद्यान (चन्द्रशेखर आजाद पार्क, प्रयागराज)	NA	NA		NA	NA		NA	NA		**2366588**	70	**2366658**	2449310	1515	**2450825**
		योग–प्रयागराज परिक्षेत्र	**2895308**	**2228**	**2897536**	**645146**	**1711**	**646857**	**699977**	**1562**	**701539**	**3393375**	**1711**	**3395086**	**3375712**	**3197**	**3378909**
		नोटः स्वराज भवन स्मारक प्रयागराज में वर्ष 2016 में आये पर्यटक नवम्बर, 2016 एवं दिसम्बर 2016 के आधार पर है इसके पूर्व निर्माण कार्य चल रहा है।															
4	उप निदेशक पर्यटन कार्यालय, बरेली	1–रामनगर अहिच्छत्र जैन मंदिर, बरेली	388893	139	**389032**	392716	152	**392868**	395083	177	**395260**	401431	199	**401630**	423586	224	**423810**
		2–अहिच्छत्र के किले के पुरातात्विक अवशे` ष	23461	66	**23527**	24431	74	**24505**	27140	104	**27244**	30122	128	**30250**	38059	151	**38210**
		3–बड़ी ज्यारत, बदायूॅ	437689	122	**437811**	441376	133	**441509**	443804	163	**443967**	447443	177	**447620**	458884	201	**459085**
		4–पत्थरगढ़ (नजीबुददौला का किला) नजीबाबाद, बिजनौर	13768	4	**13772**	14545	9	**14554**	17252	17	**17269**	20050	29	**20079**	27283	48	**27331**
		5–रजा लाइब्रेरी (रामपुर का किला), रामपुर	46607	126	**46733**	48037	135	**48172**	50664	163	**50827**	54042	174	**54216**	99201	217	**99418**
		6–विदुरकुटी	1077647	27	**1077674**	1096142	39	**1096181**	1098810	68	**1098878**	1531065	91	**1531156**	1548575	116	**1548691**
		योग–बरेली परिक्षेत्र	**1988065**	**484**	**1988549**	**2017247**	**542**	**2017789**	**2032753**	**692**	**2033445**	**2484153**	**798**	**2484951**	**2595588**	**957**	**2596545**
5	क्षेत्रीय पर्यटक अधिकारी कार्यालय, मेरठ	1–सरधना	686157	880	**687037**	723895	924	**724819**	761950	970	**762920**	798140	1020	**799160**	834060	1075	**835135**
		2–हस्तिनापुर	692734	156	**692890**	731872	165	**732037**	772125	174	**772299**	809180	185	**809365**	847210	194	**847404**
		3–गढ़मुक्तेश्वर	1357184	0	**1357184**	1417579	0	**1417579**	1481370	0	**1481370**	1552475	0	**1552475**	1623850	0	**1623850**
		4–शुकताल	1072830	0	**1072830**	1129690	0	**1129690**	1188990	0	**1188990**	1246060	0	**1246060**	1304280	0	**1304280**
		योग–मेरठ परिक्षेत्र	**3808905**	**1036**	**3809941**	**4003036**	**1089**	**4004125**	**4204435**	**1144**	**4205579**	**4405855**	**1205**	**4407060**	**4609400**	**1269**	**4610669**

क0सं0	क्षेत्रीय कार्यालय	ऐतिहासिक स्थल / स्मारक	2014			2015			2016			2017			2018		
			भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग	भारतीय	विदेशी	योग
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	**18**
6	उप निदेशक पर्यटन कार्यालय, झाँसी	1–झाँसी किला	280004	567	**280571**	*271469*	*483*	***271952***	256740	709	**257449**	266854	742	**267596**	361069	637	**361706**
		2–रानी महल	16956	31	**16987**	18405	38	***18443***	14439	35	**14474**	12244	47	**12291**	15527	48	**15575**
		योग–झाँसी परिक्षेत्र	**296960**	**598**	**297558**	**289874**	**521**	**290395**	**271179**	**744**	**271923**	**279098**	**789**	**279887**	**376596**	**685**	**377281**
7	संयुक्त निदेशक पर्यटन कार्यालय, वाराणसी	1–ए0एस0आई0 संग्रहालय, सारनाथ	268752	179166	**447918**	271570	181305	**452875**	281386	192667	**474053**	301993	206945	**508938**	330132	215279	**545411**
		2–ए0एस0आई0 उत्खनित क्षेत्र एंव धमेख स्तूप सारनाथ	522481	119034	**641515**	526560	120239	**646799**	543351	125912	**669263**	589034	133004	**722038**	602920	139322	**742242**
		3–चुनार किला	40700	225	**40925**	62934	1055	**63989**	69984	48	**70032**	70551	844	**71395**	72827	890	**73717**
		4–श्री सीता समाहित स्थल ट्रस्ट, भदोही	505714	203	**505917**	790581	356	**790937**	925866	344	**926210**	1175879	433	**1176312**	1196043	475	**1196518**
		5–रामनगर किला, वाराणसी	292450	59725	**352175**	293949	59854	**353803**	295546	59952	**355498**	296599	60001	**356600**	298727	60705	**359432**
		योग–वाराणसी परिक्षेत्र	**1630097**	**358353**	**1988450**	**1945594**	**362809**	**2308403**	**2116133**	**378923**	**2495056**	**2434056**	**401227**	**2835283**	**2500649**	**416671**	**2917320**
8	क्षेत्रीय पर्यटक अधिकारी कार्यालय, गोरखपुर	1–कुशीनगर	151125	18750	**169875**	161252	20225	**181477**	172438	21876	**194314**	182122	23591	**205713**	195985	25812	**221797**
		2–कपिलवस्तु	8125	30455	**38580**	8750	30820	**39570**	9490	31213	**40703**	10310	32064	**42374**	11048	32791	**43839**
		योग–गोरखपुर परिक्षेत्र	**159250**	**49205**	**208455**	**170002**	**51045**	**221047**	**181928**	**53089**	**235017**	**192432**	**55655**	**248087**	**207033**	**58603**	**265636**
9	क्षेत्रीय पर्यटक अधिकारी कार्यालय, अयोध्या	1–श्रावस्ती	39094	57125	**96219**	39153	57925	**97078**	39675	60654	**100329**	40488	91086	131574	48919	96523	**145442**
		योग–अयोध्या परिक्षेत्र	**39094**	**57125**	**96219**	**39153**	**57925**	**97078**	**39675**	**60654**	**100329**	**40488**	**91086**	**131574**	**48919**	**96523**	**145442**
		योग– उत्तर प्रदेश	**23084113**	**1881974**	**24966087**	**22326491**	**1822286**	**24148777**	**22230548**	**1857991**	**24088539**	**26128316**	**2285737**	**28414053**	**26707539**	**2374953**	**29082492**

नोट : NA-उपलब्ध नही है।

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Annexure-VI

ICOMOS

Guidance on Heritage Impact Assessments for Cultural World Heritage Properties

A publication of the International Council on Monuments and Sites

January 2011

United Nations
Educational, Scientific and
Cultural Organization

World Heritage Convention

ICOMOS, 49-51 rue de la Fédération 75015 Paris, France
In collaboration with the World Heritage Centre

Guidance on Heritage Impact Assessments for Cultural World Heritage Properties

Purpose

To offer guidance on the process of commissioning HERITAGE IMPACT ASSESSMENTS (HIAs) for World Heritage (WH) properties in order to evaluate effectively the impact of potential development on the Outstanding Universal Value (OUV) of properties.

The guidance is addressed at managers, developers, consultants and decision-makers and is also intended to be relevant to the World Heritage Committee and States Parties.

The concept of OUV underpins the whole World Heritage Convention and all activities associated with properties inscribed on the List.

The World Heritage Convention, for the protection of World's Cultural & Natural Heritage, which came into being in 1972, recognises properties of **'Outstanding Universal Value'** which are part of the "world heritage of mankind as a whole" and deserve "protection and transmission to future generations". Such properties are recognised through inscription on the World Heritage list by the World Heritage Committee, which consists of representatives from 21 States Parties.

Their OUV is fixed by the World Heritage Committee at the time of inscription and since 2007 has been encapsulated in a Statement of OUV. **OUV thus defines the thinking at the time of inscription and is non-negotiable.**

The World Heritage Convention is ratified by States Parties, who agree to conserve properties on their territories that are seen to be of OUV, and thus contribute towards protecting the shared heritage of humanity. This means that OUV needs to be sustained over time through the protection of attributes that are seen to convey OUV.

World Heritage sites are thus single heritage assets with an international value that has been clearly articulated. Not everything within them contributes to OUV, but those attributes that do must be appropriately protected.

This guidance sets out a methodology to allow HIAs to respond to the needs of World Heritage sites, through considering them as discrete entities and evaluating impact on the attributes of OUV in a systematic and coherent way.

The Guidance was developed following an international workshop organised by ICOMOS in Paris in September 2009.

Contents

1 Background

In recent years the UNESCO World Heritage Committee has addressed considerable numbers of State of Conservation Reports related to threats to World Heritage properties from various forms of large-scale development. These developments include roads, bridges, tall buildings, "box" buildings (e.g. malls), inappropriate, acontextual or insensitive developments, renewals, demolitions and new infrastructure typologies like wind farms, as well as land-use policy changes and large scale urban frameworks. The Committee has also examined threats from excessive or inappropriate tourism. Many of these projects have had the potential to impact adversely on the appearance, skyline, key views and other different attributes that contribute to Outstanding Universal Value (OUV).

In order for the ICOMOS and the Committee to evaluate satisfactorily these potential threats, there is a need to be specific about the impacts of proposed changes on OUV. While heritage impact assessment exists in many countries, these seem less reliably used in the World Heritage context.

Where formal evaluations are undertaken, many of these make use of procedures for environmental impact assessment (EIA). Whilst there is merit at looking at the experience of EIA, this is not likely to be immediately useful without some adaptation. EIA frequently disaggregates all the possible cultural heritage attributes and assesses impact on them separately, through discrete receptors such as protected buildings, archaeological sites, and specified view-points with their view cones, without applying the lens of OUV to the overall ensemble of attributes. A more global approach to the site is required, one directly linked to the expression of the site's OUV.

EIA therefore often produces disappointing results when applied to cultural World Heritage properties as the assessment of impacts is not clearly and directly tied to the attributes of OUV. Cumulative impacts and incremental changes (adverse) may also more easily pass undetected. The recent work done to assess the impacts of the proposed bridge on the World Heritage site of the Middle Rhine Valley is an example of this problem.

Currently, there are limited formal tools for identifying receptors and for assessing impact and few examples of excellence for Heritage Impact Assessment (HIA) undertaken for cultural WH properties. However, progress in 3D virtual representations and digital tools open new means to operate HIA.

a) World Heritage context within which HIA are undertaken

World Heritage properties need to be seen as single entities that manifest OUV. Their OUV is reflected in a range of attributes, and in order to sustain OUV it is those attributes that need to be protected. Thus the HIA process needs to consider the impact of any proposed project or change on those attributes, both individually and collectively, rather than on a standard range of receptors.

The development of Statements of OUV (SoOUV) for all World Heritage properties, a requirement set out in the *Operational Guidelines for the implementation of the World Heritage Convention* (UNESC0, 2008) paragraph 154-5, should assist through setting out clearly the attributes that reflect OUV and the links between them. The examination of integrity and authenticity is also a useful starting point.

In terms of assessing the effect of any impact on OUV, concepts such as 'limits of acceptable change' and 'absorption capacity' are being discussed, although there is no consensus yet on the usefulness of these concepts, or on how to operationalise them. There is also no consensus on how to revive heritage value that has been eroded.

Numerous visual assessment tools have been adapted to the assessment of impacts of proposed developments on the OUV of various World Heritage properties, especially those located within dynamic urban contexts, but so far these have rarely been linked to a more in-depth assessment of impact on all the attributes of OUV. There are also new tools on recording and mapping intangible heritage and multiple layers of attributes that have not been exploited for use in WH properties.

World Heritage properties are very diverse, as are the potential impacts. Although development of new tools is potentially useful, for the foreseeable future, impact assessment processes need to be able to access a variety of existing tools, without relying entirely on any one of them.

The 2nd cycle of the World Heritage Periodic Reporting should provide ICOMOS with a new data set relevant to this issue. The goal to have SoOUVs for all World Heritage properties by 2012 will also be an important underpinning of the guidance provided by ICOMOS.

b) The diverse regulatory, planning and management contexts

Neither EIA nor HIA are mandated in many countries and there is often no national regulatory framework within which they can operate.

The capacity of heritage authorities varies globally and some are not strong within the national government structures. In some countries there are strong environmental systems that provide a basis for EIA, but the heritage elements (including World Heritage) are underdeveloped or non-existent. In others, HIA are undertaken but the identified “triggers” for their use are often basic (usually in the form of lists of activities) or age.

This guidance aims to support the use and influence of HIAs, even where there are few legal structures that support the EIA/HIA processes.

Industry codes of practice should be influential in ensuring that HIA processes occur, and that the methods employed meet internationally-recognised standards of practice.

However, in many countries specific sectors considered to be of national interest are permitted to override EIA or HIA requirements.

Management plans for WH properties are potentially very important. They should be well anchored in planning arrangements at national, regional and local levels, and although embedded in national systems of protection in different ways, could be utilised more to define how change will be assessed. The sustainable development of WH properties is extremely important, including the protection of OUV elements. If the management plan is sufficiently robust and has undergone a thorough consultation process in its development, it should be possible to implement cooperative approaches to potential problems within the framework of the plan.

Potential threats should be anticipated in the management system in a property-specific way – not “one size fits all”. Conservation policies embedded in the management system may also be used as a measure to assess potential adverse impacts.

A large number of World Heritage properties do not have a well-functioning management system (for some even where there is a management plan). This is an underlying issue for many properties selected for State of Conservation reporting.

c) Tools, resources and capacities needed to undertake a HIA

State of the art techniques are possible in many countries, but in many others, the levels of skills, knowledge and resources are quite basic. This guidance attempts to be applicable to all situations.

The skills required to do a HIA, using modern IT based and highly technical tools are only held by a limited number of people. These can be very helpful, particularly in complex situations, but HIA should not depend on them. On the other hand, diffusion of new HIA tools should be encouraged when their efficiency is proven.

In some cases, the level of analysis undertaken is very deep and expensive to produce but the outcome is difficult to understand and to operationalise. A key issue is identifying the optimum resources to get the job done, and not requiring more than is necessary.

Training of managers and staff at World Heritage properties and in the approvals agencies of all levels of government within a country will be important in order to ensure that the commissioning process for HIA is appropriate and that full and effective use is made of the output.

The backgrounds and professional skills of those who conduct HIA are diverse, but training and capacity-building will often be needed. Single professionals cannot always do a total HIA – there is most often a need to bring together an HIA team with the specific analytical skills needed for a particular project or site. A number of professional environmental management institutions provide archiving and other tools. In some circumstance opportunities for partnerships could be explored.

Although proposals for WH nominations should make sure adequate data and documentation are in place, and that realistic and relevant monitoring arrangements are in use, there is often a lack of baseline documentation.

Good documentation does not require a Geographic Information System (GIS), although this has been a powerful and useful tool where it is available. All approaches need to be systematic and follow rational guidelines.

2 Suggested procedures for Heritage Impact Assessment

2-1 Introduction

2-1-1 This section is intended to help to States Parties, heritage managers and decision-makers or others in managing their WH properties in circumstances where some form of change may affect the Outstanding Universal Value (OUV) of those sites. Change may be adverse or beneficial, but both need to be assessed as objectively as possible, against the stated OUV as reference point.

2-1-2 The guidance is a tool to encourage managers and decision-makers to think about key aspects of heritage management and to make decisions based on evidence within the framework of the 1972 World Heritage Convention. It is also designed to encourage potential developers or other agents of change to consider key factors at an appropriate time and at an appropriate level of detail. Heritage Impact Assessments (HIAs) may also be useful in the general management of cultural WH properties by collating information at a given point in time.

2-1-3 There are many ways of assessing impact on heritage assets, some formalised in law, some very technical and sophisticated, others less so. This guidance sets down some principles and options. But whatever route is chosen, the assessment must be "fit-for-purpose" – suitable for the WH property and for the changes proposed, and suitable to the local environment. It must provide the evidence on which decisions can be made in a clear, transparent and practicable way.

2-1-4 In any proposal for change there will be many factors to be considered. Balanced and justifiable decisions about change depend upon understanding who values a place and why they do so. This leads to a clear statement of a place's significance and with it the ability to understand the impact of the proposed change on that significance.

2-1-5 In the case of WH properties, their international significance is established at the time of inscription and defined as their Outstanding Universal Value (OUV). States Parties undertake to retain and guard this OUV through protecting and conserving the attributes that convey OUV. The Statement of Outstanding Universal Value (SoOUV) which sets out why a property is deemed to have OUV and what the attributes are that convey OUV will be central to the HIA. Every reasonable effort should be made to eliminate or minimise adverse impacts on significant places. Ultimately, however, it may be necessary to balance the public benefit of the proposed change against the harm to the place. It is therefore also important to know who benefits from the proposed change and for what reasons. In such cases the weight given to heritage values should be proportionate to the significance of the place and the impact of the change upon it. WH properties *de facto* are seen to have global value and thus logically have a higher significance that national or local heritage value.

2-1-6 Where change may affect the OUV of a WH property, consideration of the cultural [and/or natural] heritage attributes should be central to planning any proposal and should be presented early on in any general assessment (such as an Environmental Impact Assessment - EIA). Managers and decision-makers should consider whether the heritage conservation needs should be given greater weight than competing uses and developments. A key consideration is the threat or risk to the WH status and this should be clearly addressed in the HIA report.

2-1-7 Where statutory environmental impact assessments apply, the cultural heritage sections must take account of this ICOMOS guidance where the EIA relates to a WH property. An HIA undertaken as part of an EIA in these circumstances is not additional to normal EIA requirements, but uses a different methodology which clearly focuses on OUV and attributes that convey that OUV. The HIA should be summarised early on in the Environmental Statement, and the full technical HIA report should be included as a technical appendix. The requirements should be made clear at the planning or scoping stage. ICOMOS and the World Heritage Centre will encourage States Parties to ensure that HIAs in line with this guidance are undertaken in line with best practice. Where cultural heritage sections of EIAs clearly do not focus on the attributes of OUV, they would not meet desired standards in managing change at WH properties.

2-2 Understanding what needs to be undertaken before starting an HIA

2-2-1 The assessment process is in essence very simple:

- What is the heritage at risk and why is it important – how does it contribute to OUV?
- How will change or a development proposal impact on OUV?

- How can these effects be avoided, reduced, rehabilitated or compensated?

2-2-2 The overall process is summarised in Appendix 1, but key elements include early and continued consultation with all relevant parties and agreement on the scope and expectations of the HIA before work commences. It is also important to identify possible negative impacts very early on in the process, in order to inform both the development design and the planning process in a pro-active rather than reactive manner.

2-2-3 The basis for management and decision making is a good understanding of the WH property, its significance and OUV, its attributes and its context. The Management Plan will often be the important first step in building an ability to have clear and effective impact assessments. Establishment of baseline data about the WH property and its condition is critical.

2-2-4 The starting point for any heritage assessment, once an initial development proposal or change of use is identified, should be to set out the scope of work necessary for an HIA which will provide the evidence for decision-making. Early consultation with relevant parties, including any affected community, is important. The HIA may also be useful in collating information about WH properties not otherwise easily accessible. HIA is a useful cooperative tool for all stakeholders.

2-2-5 A Scoping Report (or HIA brief) should be agreed with all relevant parties – the State Party, regional or local government, heritage advisors or managers, local communities or others as necessary. The scoping report should make it clear what is to be done, why and how, when and what are the expected outputs. It is important to include an agreed calendar between all stakeholders and the development programme (Appendix 2)

2-2-6 The Scoping Report should provide an outline description of the WH property and set out its OUV. It should have an outline of the proposed change or development including the need for change or development, a summary of the conditions present on the site and its environs, details of any alternative development being considered, an outline methodology and terms of reference for the HIA. The methodology should include organisations or people to be consulted, determining, for example, who are stakeholders and who is part of a heritage community related to the site, details of the baseline information to be collected including methods and appropriate study areas, likely sensitive heritage receptors and proposed survey and assessment methodology. It is also important at this stage to identify whether the proposed development is within a WH property or within a buffer zone or within the setting of the property but outside both. A Scoping Report should be used to flag large or critical impacts – the full HIA Report can then assess any positive reaction in terms of the altered development.

2-2-7 The Scoping Report should also give (as far as is practicable) a clear indication of what knowledge exists about the site and where lacunae exist – how good is the information base and what level of confidence may be placed on the assessment. This should be followed through in the actual assessment itself.

2-2-8 It is not only big developments that need an assessment of impact. WH properties may also be vulnerable to changes of policy which could have significant consequences – for example changes in land use and urban planning policies. Tourism infrastructure and increased visits may have unintended consequences. Major archaeological excavations could also adversely affect the OUV of properties, though possibly compensating by the gaining of knowledge.

2-2-9 It is also important at this stage to ensure that organisations or individuals undertaking the HIA are suitably qualified and experienced, and that their expertise matches the demands of the site, its material and intangible content, its OUV and the nature and extent of the proposed changes. Single professionals can rarely do a total HIA, and the composition of the HIA team - heritage professionals and all other necessary competences - is crucial: the team will need specific analytical skills for a particular project or site. Opportunities for partnerships could be explored. This may also bring benefits in terms of developing capacity for HIA, and in developing and sharing best practice.

3 Data and documentation

3-1 There are no agreed minimum standards for inventories, data review or condition surveys, though it may in due course be useful to define these. Such matters need to be proportionate to the property and its management needs. It is desirable that the HIA documentation stage is as comprehensive as possible, including developing an archive.

3-2 For WH properties the core documentation is the Statement of OUV and the identification of attributes that convey OUV. Hence this guidance concentrates on identifying impact on attributes that convey that OUV. However, the HIA should collect and collate information on all aspects and attributes of the cultural heritage within the agreed study area, so that the historical development of the property, its context, setting and where appropriate other values (for example national and local) can be fully understood.

3-3 It is useful, if not essential, to document and manage the collection of data. Assessment processes can be very lengthy and data sources may require periodic "refreshment". When data sources are in a state of flux or the timetable for assessment is lengthy, it may be necessary to agree a "data freeze" so that the HIA team can compare like with like information.

3-4 Inventories should be included in the HIA reports, as tables or gazetteers in appendices to the main text. Underpinning archives of material and information collected should be retained for future use and properly referenced, including location and accessibility. Good documentation does not require sophisticated techniques such as GIS or complex databases; it needs a common sense, systematic and consistent approach which is suitable to the needs of the property.

3-5 In more complex cases, more sophisticated approaches could be considered. However, the use of databases and GIS, or 3D-modelling, changes the way in which HIAs are undertaken. The systems allow assessment to be a far more iterative process, and as a result HIA can be more effectively fed back into the design processes. But this also allows for more "what if" scenarios to be requested of the HIA team. The scoping report would need to set down the principles for this iteration so that the HIA team can work effectively.

4 Methods and approaches appropriate to the property - optimising available tools, techniques and resources

4-1 The collection of information during HIA should consider all potential sources of data. Techniques will include desk study or historical research, and site visits to check condition, authenticity and integrity, sensitive viewpoints and so on. They may include terrain modelling, or inter-visibility modelling to predict impacts on heritage assets. It is necessary to capture and explain in clear text evidence of both tangible and intangible heritage attributes, and wherever possible to relate the latter to the physical features which embody them.

4-2 Field studies are also generally essential to ensure that the HIA is robust. Techniques should be linked to the development proposal and could include non-intrusive evaluation or field testing by topographic survey, geophysical survey, virtual 3D scale models or more intrusive methods such as artefact collection, scientific survey, test pitting or trial trenching. In some circumstances the collection of oral histories or evidence may also be valid and useful.

4-3 The data collection must enable the heritage attributes to be quantified and characterised, and allow their vulnerability to proposed changes to be established. It is also necessary to look at the interrelationship/s between discrete heritage resources, in order to understand the whole. There is often a relationship between a material aspect and an intangible aspect which must be brought to the fore.

4-4 Collection of information during the HIA is an iterative process which can often lead to the emergence of alternatives and options for the development proposal.

4-5 Understanding the full meaning of the OUV of a WH property (and other values of heritage) is a crucial part of the HIA process. The evaluation of the overall significance of the effect (overall impact) is a function of the heritage value and assessment of scale of changes and impact.

4-6 When describing WH properties, it is essential to start by describing the attributes of OUV. This is the "baseline data" against which impacts must be measured, and includes both tangible and intangible aspects. A statement of condition may be useful for each key attribute of OUV.

4-7 However, while the SoOUV is an essential starting point, sometimes they are not detailed enough in terms of attributes to be directly useful to impact assessment work. Each property will need to be assessed and where necessary, the attributes may need to be more specifically defined during the HIA process.

4-8 Such definition of attributes should not seek to re-define the SoOUV, but to describe the attributes in a way which assists decision-making on the proposed change. It should be noted that OUV is defined at the time a WH property is inscribed on the WH List and cannot be changed without a re-nomination which goes through a full evaluation process.

4-9 The production of location or themed maps or plan views is almost always needed to demonstrate the findings and issues raised. Spatial rendering is useful to show the disposition of attributes, the relationships between the attributes (which may be processes), and the associations attributes have such as visual, historical, religious, communal, aesthetic or evidential. It is necessary to link the attributes back to the components of the SoOUV in a clear and readable manner, which does not oversimplify but retains cultural or other complexities in synoptic statements or diagrams. HIA teams should, however, be wary of too much reliance on maps, as our human experience of places is in 3D – ground-truthing is always required to check spatial relationships.

4-10 One option for assessing value is set out in Appendix 3A. In this system the value of heritage attributes is assessed in relation to statutory designations, international or national, and priorities or recommendations set out in national research agendas, and ascribed values. Professional judgement is then used to determine the importance of the resource. Whilst this method should be used as objectively as possible, qualitative assessment using professional judgement is inevitably involved. The value of the asset may be defined using the following grading scale:

- Very High
- High
- Medium
- Low
- Negligible
- Unknown

4-11 In the HIA Report there should be a clear and comprehensive text description of individual and/or groups of heritage attributes, which sets out their individual and/or collective condition, importance, inter-relationships and sensitivity, and possibly also an indication of capacity for change. This should be accompanied by appropriate mapping to aid the reader. All heritage elements should be included, but the components contributing to the WH property's OUV will be particularly relevant and may merit a further detailed section. A detailed inventory should be included in supporting appendices or reports so that the reader may check the assessment of each element. An example is included in Appendix 3C.

5 A defendable system for assessing/evaluating impact

5-1 Effects on cultural heritage attributes from development or other changes may be adverse or beneficial. It is necessary to identify all changes on all attributes, especially those attributes which give the property its OUV, on which this guidance concentrates. It is also important to identify the scale or severity of a specific change or impact on a specific attribute – as this combination is what defines the significance of the impact, otherwise called "significance of effect".

5-2 There is sometimes a tendency to see impacts as primarily visual. While visual impacts are often very sensitive, a broad approach is needed as outlined in the ICOMOS Xi'an Declaration. Impacts take many forms – they may be direct and indirect; cumulative, temporary and permanent, reversible or irreversible, visual, physical, social and cultural, even economic. Impacts may arise as a consequence of construction or operation of the proposed development. Each needs to be considered for its relevance to the HIA.

5-3 Direct impacts are those that arise as a primary consequence of the proposed development or change of use. Direct impacts can result in the physical loss of part or all of an attribute, and/or changes to its setting - the surroundings in which a place is experienced, its local context, embracing present and past relationships to the adjacent landscape. In the process of identifying direct impacts care must be taken of the development technique of gaining approvals by just avoiding direct impact - impacts which just "miss" physical resources can be just as negative to a single resource, a pattern, ensemble, setting, spirit of place etc.

5-4 Direct impacts resulting in physical loss are usually permanent and irreversible; they normally occur as a consequence of construction and are usually confined within the development footprint. The scale or magnitude of these impacts will depend on the proportion of the attribute affected, and whether its key characteristics or relation to OUV would be affected.

5-5 Direct impacts that affect the setting of an attribute may occur as a consequence of construction or operation of the development scheme and may have an effect some distance from the development. Assessment of impacts on setting refers to perceptible visual and aural (noise) effects that can be appreciated at a given time. Such impacts may be temporary or permanent, reversible or irreversible depending on the extent to which the cause of the impact can be removed. Impacts may also be transient where occurrence is sporadic or of limited duration, for example, related to hours of operation or the frequency of passage of vehicles.

5-6 Indirect impacts occur as a secondary consequence of construction or operation of the development, and can result in physical loss or changes to the setting of an asset beyond the development footprint. For example, construction of related infrastructure such as roads or powerlines that are required to support the development. Facilitated impacts should also be considered which may be further actions (including by third parties) which are made possible or facilitated by the development.

5-7 Scale or severity of impacts or changes can be judged taking into account their direct and indirect effects and whether they are temporary or permanent, reversible or irreversible. The cumulative effect of separate impacts should also be considered. The scale or severity of impact can be ranked without regard to the value of the asset as:

- No change
- Negligible change
- Minor change
- Moderate change
- Major change

5-8 The significance of the effect of change – i.e. the overall impact - on an attribute is a function of the importance of the attribute and the scale of change. This can be summarized for each attribute described using the following descriptors. As change or impacts may be adverse or beneficial, there is a nine-point scale with “neutral” as its centre point:

- Major beneficial
- Moderate beneficial
- Minor beneficial
- Negligible beneficial
- Neutral
- Negligible adverse
- Minor adverse
- Moderate adverse
- Major adverse

<table>
<tr><th rowspan="2">VALUE OF HERITAGE ASSET</th><th colspan="5">SCALE & SEVERITY OF CHANGE/IMPACT</th></tr>
<tr><th>No Change</th><th>Negligible change</th><th>Minor change</th><th>Moderate change</th><th>Major change</th></tr>
<tr><td rowspan="2">For WH properties Very High – attributes which convey OUV</td><td colspan="5">SIGNIFICANCE OF EFFECT OR OVERALL IMPACT (EITHER ADVERSE OR BENEFICIAL)</td></tr>
<tr><td>Neutral</td><td>Slight</td><td>Moderate/ Large</td><td>Large/very Large</td><td>Very Large</td></tr>
</table>

For other heritage assets or attributes	**SIGNIFICANCE OF IMPACT (EITHER ADVERSE OR BENEFICIAL)**				
Very High	Neutral	Slight	Moderate/ Large	Large/very Large	Very Large
High	Neutral	Slight	Moderate/ Slight	Moderate/ Large	Large/Very Large
Medium	Neutral	Neutral/Slight	Slight	Moderate	Moderate/ Large
Low	Neutral	Neutral/Slight	Neutral/Slight	Slight	Slight/ Moderate
Negligible	Neutral	Neutral	Neutral/Slight	Neutral/Slight	Slight

5-9 For example:

- Total demolition of a key building which is the main conveyance of OUV for a WH property to make way for a new road would be a major adverse effect or overall major adverse impact.
- Removal of a later road from the immediate vicinity of a key building which conveys OUV and which is not directly related to its OUV attributes would be a major beneficial effect or overall impact.

5-10 The table above is a summary to aid assessment of impact. The HIA Report will need to show the assessment for each OUV attribute – for example in a simple table - and demonstrate how the results for each individual or collective heritage attribute have been obtained. This should include qualitative as well as quantitative evaluation.

5-11 Proposals should be tested against existing policy frameworks and the management plan for the property and surrounding area. The compatibility of the scale, pattern, use, etc should be tested according to the attributes of the property that convey OUV and other assets. Issues such as sight lines, architectural type, volumes and surface appearances, settlement form, functional uses and persistence through time etc might be relevant. In all this, it is necessary to match the attributes of the development to the attributes of the site, so that development is complementary and even enhancing to the property.

5-12 Changes arising from developments must also be assessed for their impact on integrity and authenticity. The property should have baseline statements regarding integrity and authenticity at the time of inscription, or at the time the retrospective SoOUV was undertaken [paragraphs 79-88 in *Operational Guidelines*]. The relationship between attributes of OUV, authenticity and integrity needs to be understood and needs to be shown to be understood in the HIA report. Authenticity relates to the way attributes convey OUV and integrity relates to whether all the attributes that convey OUV are extant within the property and not eroded or under threat.

5-13 Benefits and dis-benefits – or adverse effects - must be very carefully considered. There are a range of benefits and dis-benefits, and the question of who receives the benefits (or misses out through the benefits) is important. Often the property itself and the associated communities do not receive the benefits flowing from development. Financial consequences of the assessment are also important and often directly influence decisions. The analysis must reveal rather than disguise these complexities. The conservation of the property should be counted within the benefits of a project, so that projects that are supportive of conservation can be weighted more than those that do not.

6 Can impacts be avoided, reduced, rehabilitated or compensated – mitigation?

6-1 Impact assessment is an iterative process. Results of data collection and evaluation should be fed back into the design process for the development, or proposals for change or for archaeological investigation.

6-2 Conservation is about managing sustainable change. Every reasonable effort should be made to avoid, eliminate or minimise adverse impacts on attributes that convey OUV and other significant places. Ultimately, however, it may be necessary to balance the public benefit of the proposed change against the harm to the place. In the case of WH properties this balance is crucial.

6-3 HIA should include proposed principles and where possible proposed methods to mitigate or offset the effects of a development proposal or other agent of change. This should include consideration of other options for the development including site selection/location, timing, duration and design. The HIA should indicate fully how the mitigation is acceptable in the context of sustaining OUV, including the authenticity and integrity of the WH property. Available guidance in the *Operational Guidelines* on periodic reporting should be consulted to help this process.

6-4 It may be appropriate to undertake further consultation at this stage before finalising the HIA.

7 Deliver an evaluation that is helpful to States Parties, the Advisory Bodies and the World Heritage Committee, and relevant to the World Heritage context in general and specific properties in particular

7-1 Appendix 4 sets out a guide to the contents of an HIA report. It is a matter of expert judgement, following suitable consultation and scoping to define exact requirements.

7-2 The HIA report should provide the evidence on which decisions can be made in a clear, transparent and practicable way. The level of detail needed will depend on the site and proposed changes. The Statement of OUV will be central to the evaluation of the impacts and risk to the property.

7-3 The HIA report will need to show

- A comprehensive understanding of the WH property and its OUV, authenticity and integrity, condition, context (including other heritage attributes) and inter-relationships;
- An understanding of the range of impacts arising from the development or other proposal for change;

- An objective evaluation of those impacts (beneficial and adverse) on the heritage elements and in particular on the site's OUV, integrity and authenticity;
- An assessment of the risk posed to the retention of OUV and the likelihood that the property may be in potential or actual danger;
- A statement of heritage benefits which may arise from proposals including better knowledge and understanding and awareness-raising;
- Clear guidelines as to how impact can be mitigated or avoided;
- Supporting evidence in the form of a suitably detailed inventory of attributes of OUV and other heritage assets, impacts, survey or scientific studies, illustrations and photographs.

7-4 The HIA Report will need to have a non-technical summary clearly setting out all relevant matters, a detailed text description and analysis and a text summary of the results of the evaluation of impact accompanied by tables to assist the reader.

Appendix 1: Heritage Impact Assessment Process

Stages of HIA
Initial development and design
Early consultation
Identify and recruit suitable organisations to undertake works
Establish study area
Establish scope of work
Collect data
Collate data
Characterise the heritage resource, especially in identifying attributes that convey OUV
Model and assess impacts, direct and indirect
Draft mitigation – avoid, reduce, rehabilitate or compensate
Draft report
Consultation
Moderate the assessment results and mitigation
Final reporting and illustration – to inform decisions
Mitigation
Dissemination of results and knowledge gained

Appendix 2: Scoping Report Contents

At the outset of any proposed impact assessment it is desirable to agree the scope of the work needed so that the work is ‘fit-for-purpose’ and will enable decision to be made. Early consultation is essential.

The scope should be agreed with all relevant parties, including the State Party, regional or local government or its agencies, any statutory consultees and local community representatives and the public. In some cases it may be also desirable to consult with the WHC or its advisors, ICOMOS or IUCN.

The “developer” is responsible for producing the scoping report. Its contents should include

- An outline description of the proposed change or development, providing as much detail as is available at the time of writing;
- A summary of the conditions present on the site and its environs, based on information collated to that point in time;
- The Statement of Outstanding Universal Value
- Details of how alternatives to changes are being considered;
- Outline methodology and terms of reference for the HIA as a whole;
- The organisations/people consulted and to be consulted further;
- A topic by topic assessment of the key impacts of the development; this should include:
    - details (as known) of the baseline conditions;
    - consideration of the potential effects of the development where overall impacts or effects are not considered to be significant, a justification of why they should be “scoped out” of the HIA;
    - where overall impacts are considered to be potentially significant, details of the baseline information to be collected (including methods and appropriate study areas), likely sensitive heritage receptors in particular those related to attributes of OUV and proposed survey and assessment methodology.
- A negotiated calendar covering the whole process, including deadlines for reporting and consultation.

Appendix 3A: Example Guide for Assessing Value of Heritage Assets

HIAs for WH properties will need to consider their international heritage value and also other local or national values, and priorities or recommendations set out in national research agendas. They may also need to consider other international values which are reflected in, for example, international natural heritage designations.

Professional judgement is used to determine the importance of the resource. The value of the asset may be defined using the following grading scale:

- Very High
- High
- Medium
- Low
- Negligible
- Unknown potential.

The following table is not intended to be exhaustive.

Grading	Archaeology	Built heritage or Historic Urban Landscape	Historic landscape	Intangible Cultural Heritage or Associations
Very High	Sites of acknowledged international importance inscribed as WH property. Individual attributes that convey OUV of the WH property. Assets that can contribute significantly to acknowledged international research objectives.	Sites or structures of acknowledged international importance inscribed as of universal importance as WH property. Individual attributes that convey OUV of the WH property. Other buildings or urban landscapes of recognised international importance.	Landscapes of acknowledged international importance inscribed as WH property. Individual attributes that convey OUV of the WH property. Historic landscapes of international value, whether designated or not. Extremely well-preserved historic landscapes with exceptional coherence, time-depth, or other critical factors.	Areas associated with Intangible Cultural heritage activities as evidenced by the national register. Associations with particular innovations, technical or scientific developments or movements of global significance. Associations with particular individuals of global importance

High	Nationally-designated Archaeological Monuments protected by the State Party's laws Undesignated sites of the quality and importance to be designated. Assets that can contribute significantly to acknowledged national research objectives.	Nationally-designated structures with standing remains. Other buildings that can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the listing grade. Conservation Areas containing very Important buildings. Undesignated structures of clear national importance.	Nationally-designated historic landscape of outstanding interest. Undesignated landscapes of outstanding interest. Undesignated landscapes of high quality and importance, and of demonstrable national value. Well preserved historic landscapes, exhibiting considerable coherence, time-depth or other critical factors.	Nationally-designated areas or activities associated with globally-important Intangible Cultural Heritage activities . Associations with particular innovations, technical or scientific developments or movements of national significance Associations with particular individuals of national importance
Medium	Designated or undesignated assets that can contribute significantly to regional research objectives.	Designated buildings. Historic (unlisted) buildings that can be shown to have exceptional qualities or historical associations. Conservation Areas containing buildings that contribute significantly to its historic character. Historic townscapes or built-up areas with important historic integrity in their buildings, or built settings.	Designated special historic landscapes. Undesignated historic landscapes that would justify special historic landscape designation. Landscapes of regional value. Averagely well preserved historic landscapes with reasonable coherence, time-depth or other critical factors.	Areas associated with Intangible Cultural heritage activities as evidenced by local registers. Associations with particular innovations or developments of regional or local significance. Associations with particular individuals of regional importance

Low	Designated or undesignated assets of local importance. Assets compromised by poor preservation and/or poor survival of contextual associations. Assets of limited value, but with potential to contribute to local research objectives.	"Locally Listed" buildings. Historic (unlisted) buildings of modest quality in their fabric or historical associations. Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings.	Robust undesignated historic landscapes. Historic landscapes with importance to local interest groups. Historic landscapes whose value is limited by poor preservation and/or poor survival of contextual associations.	Intangible Cultural heritage activities of local significance Associations with particular individuals of local importance Poor survival of physical areas in which activities occur or are associated
Negligible	Assets with little or no surviving archaeological interest.	Buildings or urban landscapes of no architectural or historical merit; buildings of an intrusive character.	Landscapes little or no significant historical interest.	Few associations or ICH vestiges surviving
Unknown potential	The importance of the asset has not been ascertained.	Buildings with some hidden (i.e. inaccessible) potential for historic significance.	n/a	Little is known or recorded about ICH of the area

Appendix 3B: Example Guide for assessing magnitude of impact

Impact Grading	Archaeological attributes	Built heritage or Historic Urban Landscape attributes	Historic landscape attributes	Intangible Cultural Heritage attributes or Associations
Major	Changes to attributes that convey OUV of WH properties Most or all key archaeological materials, including those that contribute to OUV such that the resource is totally altered. Comprehensive changes to setting.	Change to key historic building elements that contribute to OUV,, such that the resource is totally altered. Comprehensive changes to the setting.	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit and loss of OUV.	Major changes to area that affect the ICH activities or associations or visual links and cultural appreciation.

Moderate	Changes to many key archaeological materials, such that the resource is clearly modified. Considerable changes to setting that affect the character of the asset.	Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.	Change to many key historic landscape elements, parcels or components; visual change to many key aspects of the historic landscape; noticeable differences in noise or sound quality; considerable changes to use or access; resulting in moderate changes to historic landscape character.	Considerable changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Minor	Changes to key archaeological materials, such that the resource is slightly altered. Slight changes to setting.	Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.	Change to few key historic landscape elements, parcels or components; slight visual changes to few key aspects of historic landscape; limited changes to noise levels or sound quality; slight changes to use or access; resulting in limited change to historic landscape character.	Changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Negligible	Very minor changes to key archaeological materials, or setting.	Slight changes to historic building elements or setting that hardly affect it.	Very minor changes to key historic landscape elements, parcels or components; virtually unchanged visual effects; very slight changes in noise levels or sound quality; very slight changes to use or access; resulting in a very small change to historic landscape character.	Very minor changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
No change	No change.	No change to fabric or setting.	No change to elements, parcels or components; no visual or audible changes; no changes in amenity or community factors.	No change

Appendix 3C: Example Inventory Entry

The following list gives a suggested set of data fields which could be used in supporting tables or inventories which collate information on an individual or group of heritage assets.

Unique Identity number
Asset name
Location (map reference)
Type of asset (burial mound, church, fort, landscape, ICH etc)
Date
Statutory designation (e.g. on national or local register, WHS)
Brief description
Condition
Authenticity
Integrity
Inter-relationships (list)
Sensitivity
Importance (Very high, high,
Development magnitude of impact – construction (Major, Moderate, Minor, Negligible, No change)
Development significance of effect – construction (Major beneficial, Moderate beneficial, Minor beneficial, Negligible beneficial; No Change, Negligible adverse, Minor adverse, Moderate adverse, Major adverse)
Operational magnitude of impact (as above)
Operational significance of effect

Appendix 4: Heritage Impact Report Contents

The HIA Report should provide the evidence on which decisions can be made in a clear, transparent and practicable way. The level of detail needed will depend on the site and proposed changes. The Statement of OUV will be central to the evaluation of the impacts and risk to the site.

The report should include:

- the proper name of the WH property,
- its geographical coordinates,
- the date of inscription,
- the date of the HIA report,
- the name of the organization or entities responsible for preparing the HIA report,
- for whom it was prepared, and
- a statement on whether the report has been externally assessed or peer-reviewed.

Outline report contents

1 Non-technical summary – must contain all key points and be useable alone.

2 Contents

3 Introduction

4 Methodology
- Data sources
- Published works
- Unpublished reports
- Databases
- Field Surveys
- Impact Assessment Methodology
- Scope of Assessment
- Evaluation of Heritage Resource

- Assessment of Scale of Specific Impact and Change
- Evaluation of Overall Impact
- Definition of the Assessment Area

5 Site history and description –
Key in this section will be the Statement of OUV, and a description of the attributes which convey OUV and which contribute to the Statements of authenticity and integrity.

This section should also include any nationally or locally designated sites, monuments or structures as well as non-designated sites. t should set out the historical development of the study area, and describe its character, such as the historic landscape, including field patterns, boundaries and extant historic elements of the landscape and cultural heritage. It should describe the condition of the whole and of individual attributes and components, physical characteristics, sensitive viewpoints and intangible associations which may relate to attributes. This should focus on areas affected in particular but must include a description of the whole.

6 Description of changes or developments proposed

7 Assessment and evaluation of overall impact of the proposed changes

This part should set out an assessment of specific changes and impacts on the attributes of OUV and other heritage assets. It should include a description and assessment of the direct or indirect impacts, including physical impacts, visual, or noise, on individual heritage attributes, assets or elements and associations, and on the whole. Impact on OUV should be evaluated through assessment of impact on the attributes which convey the OUV of the site. It should consider all impacts on all attributes; professional judgement is required in presenting the information in an appropriate form to assist decision-making.

It should also include an evaluation of the overall significance of effect – overall impact - of the proposals for development or change on individual attributes and the whole WH property. This may also need to include an assessment of how the changes may impact on the perception of the site locally, nationally and internationally. I

8 Measures to avoid, to reduce or to compensate for impacts - Mitigation Measures
Such measures include both general and site or asset-specific measures and cover

- those needed before the development or change proceeds (such as archaeological excavation),
- those needed during construction or change (such as a watching brief or physical protection of assets) and
- any post-construction measures during the operation of any proposed change or development (such as interpretation or access measures, awareness-building, education, reconstruction proposals),
- proposals to disseminate information, knowledge or understanding gained by the HIA and any detailed desk, field or scientific studies.

9 Summary and Conclusions, including

- A clear statement on effects on the Outstanding Universal Value of the WHS, its integrity and authenticity,
- The risk to the Inscription of the site as a WH property,
- Any beneficial effects, including better knowledge and understanding and awareness-raising.

10 Bibliography

11 Glossary of terms used

12 Acknowledgements and authorship

13 Illustrations and photographs showing for example
- Location and extent of sites, including buffer zones
- Any study area defined
- Development or proposals for change
- Visual or inter-visibility analyses
- Mitigation measures
- Key sites and views

14 Appendices with detailed data, for example
- Tables of individual sites or elements, summary description and summary of impacts
- Desk studies
- Field study reports (such as geophysical survey, trial evaluation, excavation)
- Scientific studies
- List of consultees and consultation responses
- The scoping statement or project brief.

Annexure-VII

VISUAL CONNECTIONS STUDY

A study of the visual connections was conducted by team of architects all identified heritage resources of the study area. This survey was done during the months of September and October in 2019. This study focused on visual impacts of elevated sections of proposed Metro corridor-I since the in case underground sections of the proposed Metro visual impacts would be low to negligible.

Taj Mahal

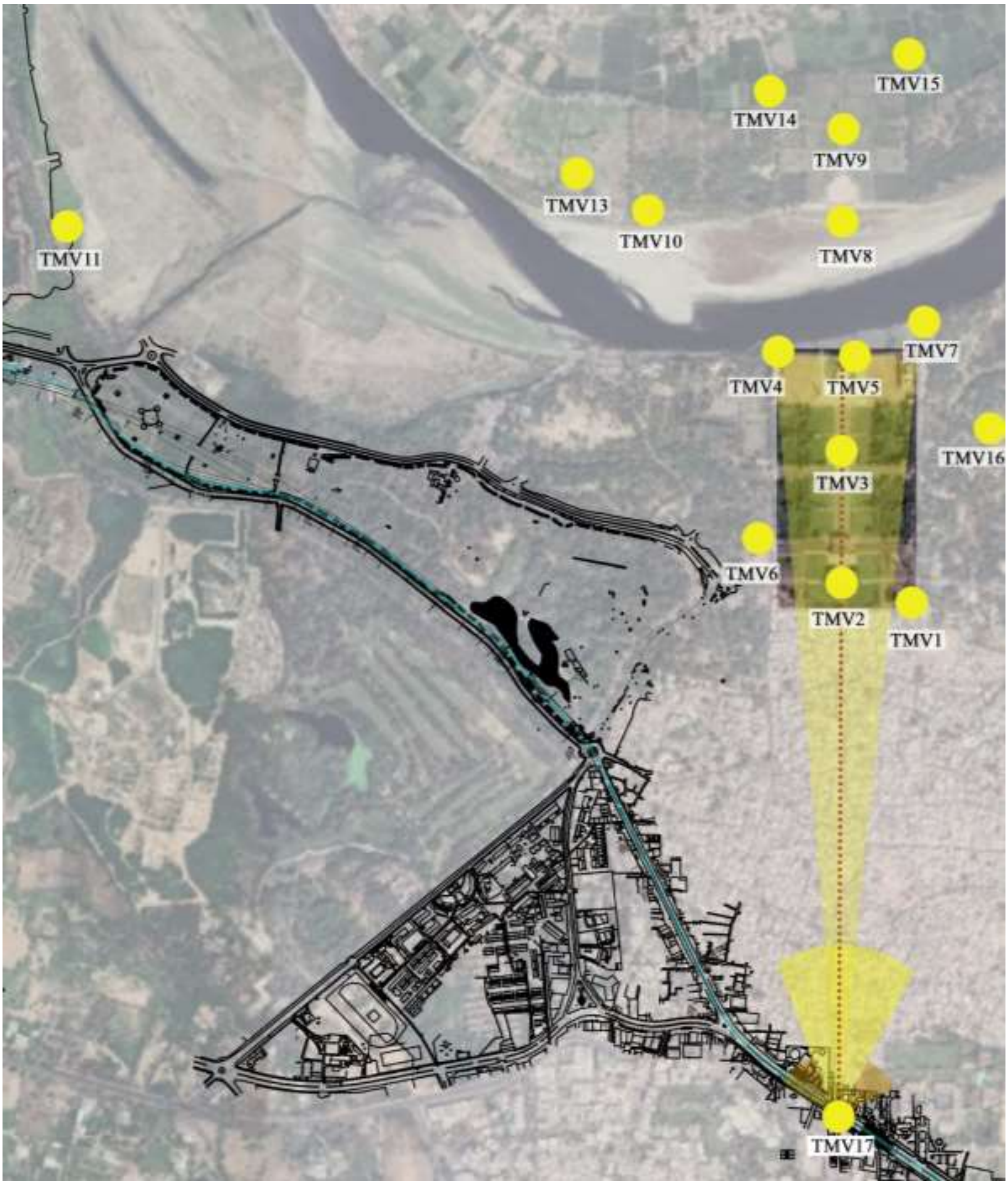

Fig: VII/TM/01 Study of viewpoints of Taj Mahal

All important viewpoints of Taj Mahal were identified from previous study of 16 viewpoints of Taj[1], as marked in Figure: VII/TM/01 were analysed for visual impact of proposed Metro corridor. It has been observed from the study that the alignment of corridor-1 Metro alignment in no way causes any visual impact on these 16 viewpoints (TMV1-TMV16)

Another viewpoint was identified (TMV17) on Fatehabad Road. At present the dome and a part of Taj Mahal is partially visible from this point. With construction of the proposed elevated section from elevated Fatehabad Road Metro station to Taj East Gate Metro station there will be a visual barrier from the viewpoint across the road to the Taj Mahal. This proposed change will note only negative impact. But a new viewpoint will be created.

Table VII/TM : Views points of Taj Mahal		
View Point Number	**Visual Impact**	**Remarks**
TMV1	No predicted Visual Impact	
TMV2	No predicted Visual Impact	
TMV3	No predicted Visual Impact	
TMV4	No predicted Visual Impact	
TMV5	No predicted Visual Impact	
TMV6	No predicted Visual Impact	
TMV7	No predicted Visual Impact	
TMV8	No predicted Visual Impact	
TMV9	No predicted Visual Impact	
TMV10	No predicted Visual Impact	
TMV12	No predicted Visual Impact	
TMV13	No predicted Visual Impact	
TMV14	No predicted Visual Impact	
TMV15	No predicted Visual Impact	
TMV16	No predicted Visual Impact	
TMV17	Predicted Visual Impact to this present point of view.	Very poor view of Taj Mahal from this view point presently. All historic context has been already compromised due to modern construction. Proposed elevated corridor will provide an excellent view additionally to Taj Mahal complex from this station.

[1] Sinha, Amita (2001) Taj Mahal Cultural Heritage District Development Plan, Directorate of Tourism Uttar Pradesh India

Image: TMV8| View of Taj Mahal from other side of river

Image: TMV9| View of Taj Mahal from Mehtab Bagh

Image: TMV10 |View of Taj Mahal from other side of river

Image: TMV13 |View of Taj Mahal from other side of river

Image: TMV14 |View of Taj Mahal from other side of river

Image: TMV17 |View of Taj Mahal from Fatehabad Road

Agra Fort

Fig: VII/AF/01 Study of viewpoints of Agra Fort

An underground Metro line is proposed along the moat of the Agra Fort. This avoids any visual obstruction of Agra Fort due to Metro construction. There are two proposed Metro stations in close vicinity to the fort. After visual analysis it can be said that the location of these two proposed underground Metro stations do not pose any major visual obstruction to the monument.

Akbar's Tomb

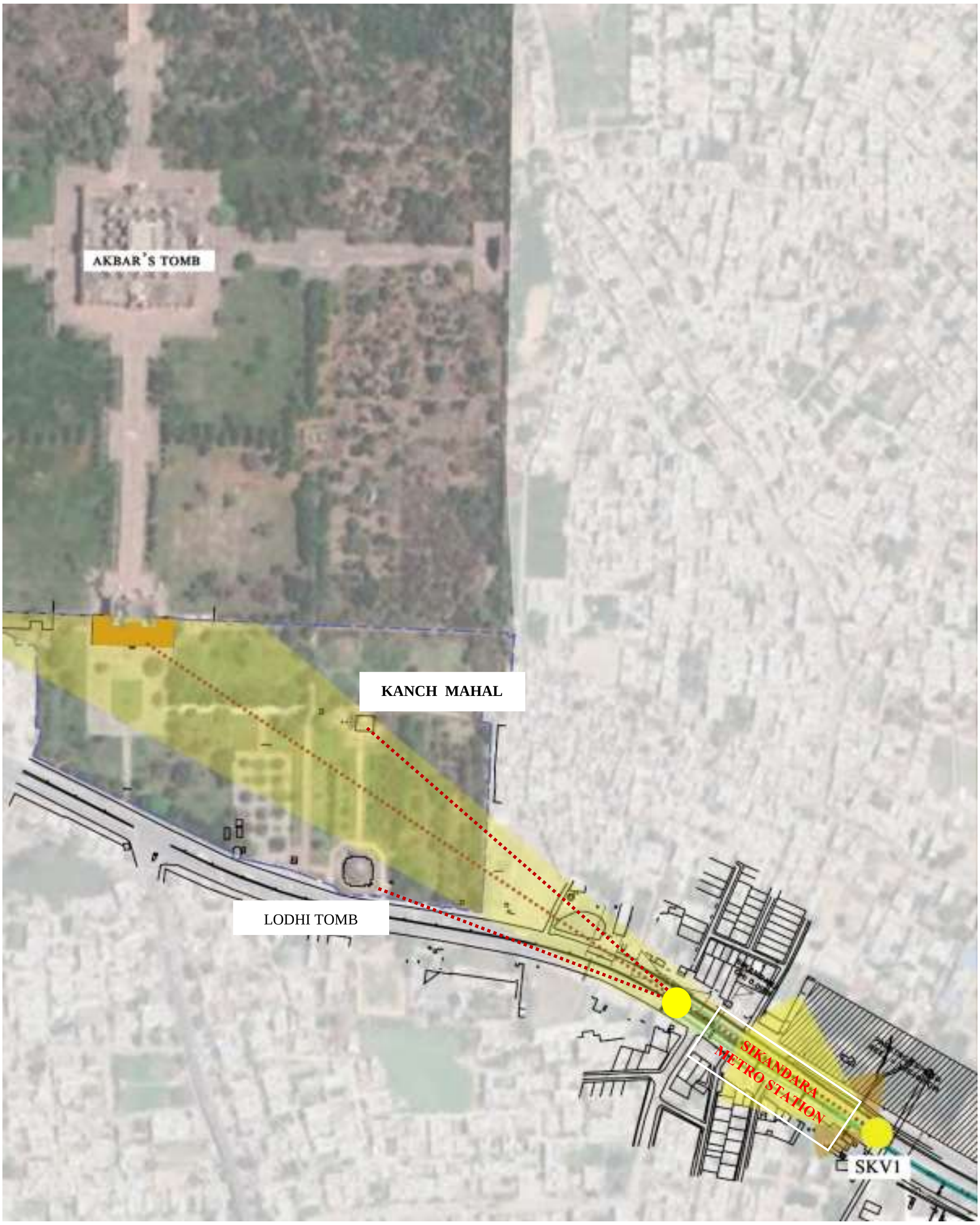

Fig: VII/SK/01 Study of viewpoints of Abkar's Tomb, Kanch Mahal and Lodhi Tomb

The minarets of the complex is visible from NH19 along the proposed elevated station of Sikandara. Construction of proposed elevated Metro station and viaducts on piers might have an impact from the view point.

Image: SKV1 | View towards main gate of Akbar's Tomb from NH19

Image: SKV1 | View towards main gate of Akbar's Tomb from NH19 with visualisation of proposed Metro work

Guru Ka Taal

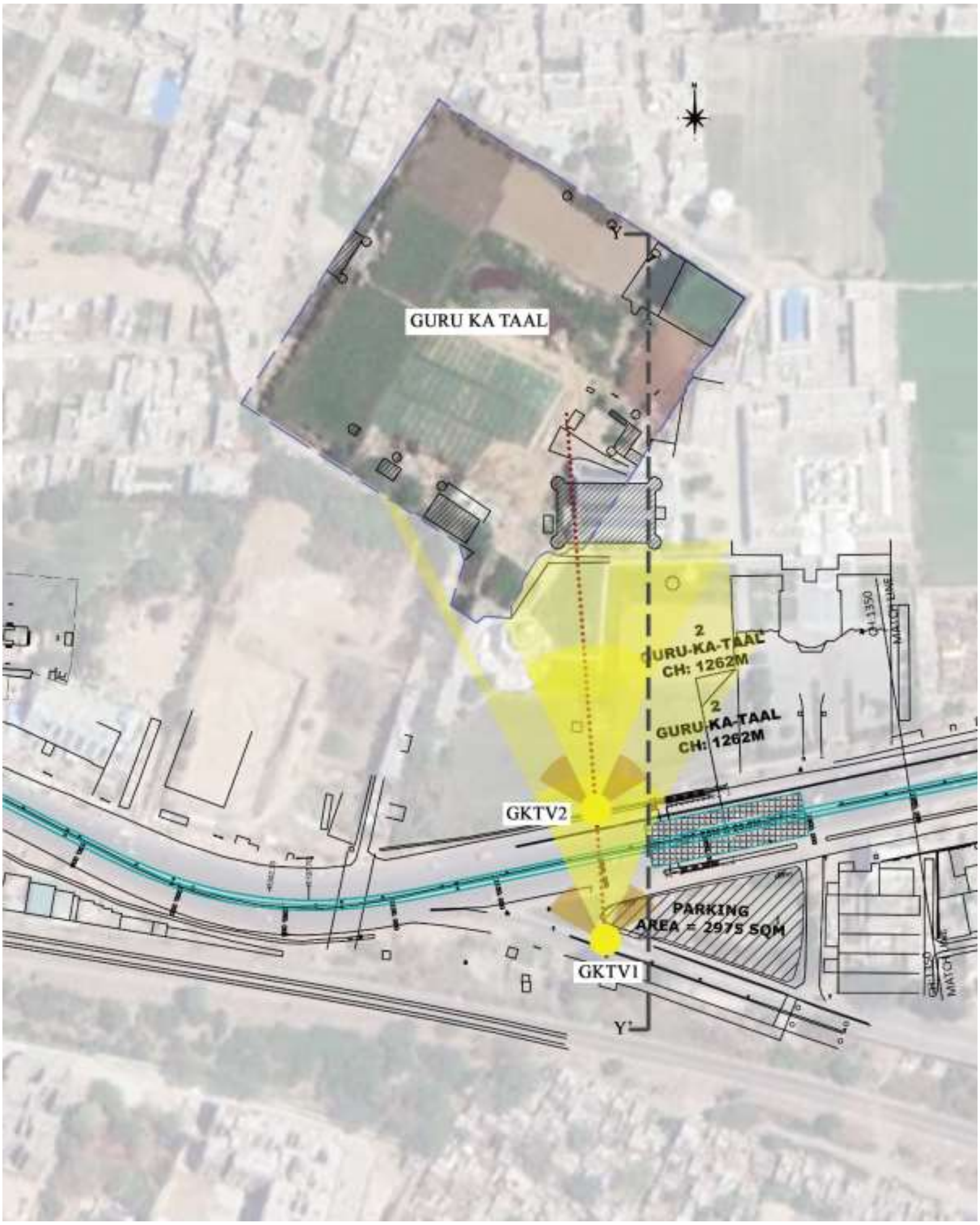

Fig: VII/GK/01 Study of viewpoints of Guru Ka Taal

At present, a newly constructed Gurudwara obstructs the view of Guru ka Taal. It is not visible from the road. Thus, alignment of proposed Metro tracks will have not major negative impact on current view.

Instead, proposed elevated Metro route has the potential to provide a new visual connection of Guru ka Taal from the Metro.

Image: GKV1 | View towards Guru Ka Taal from Pathar ka Ghoda

Image: GKV1 | View towards Guru ka Taal from median of the road

Fig: VII/GK/02 Study of viewpoints of Guru ka Taal

Jama Masjid

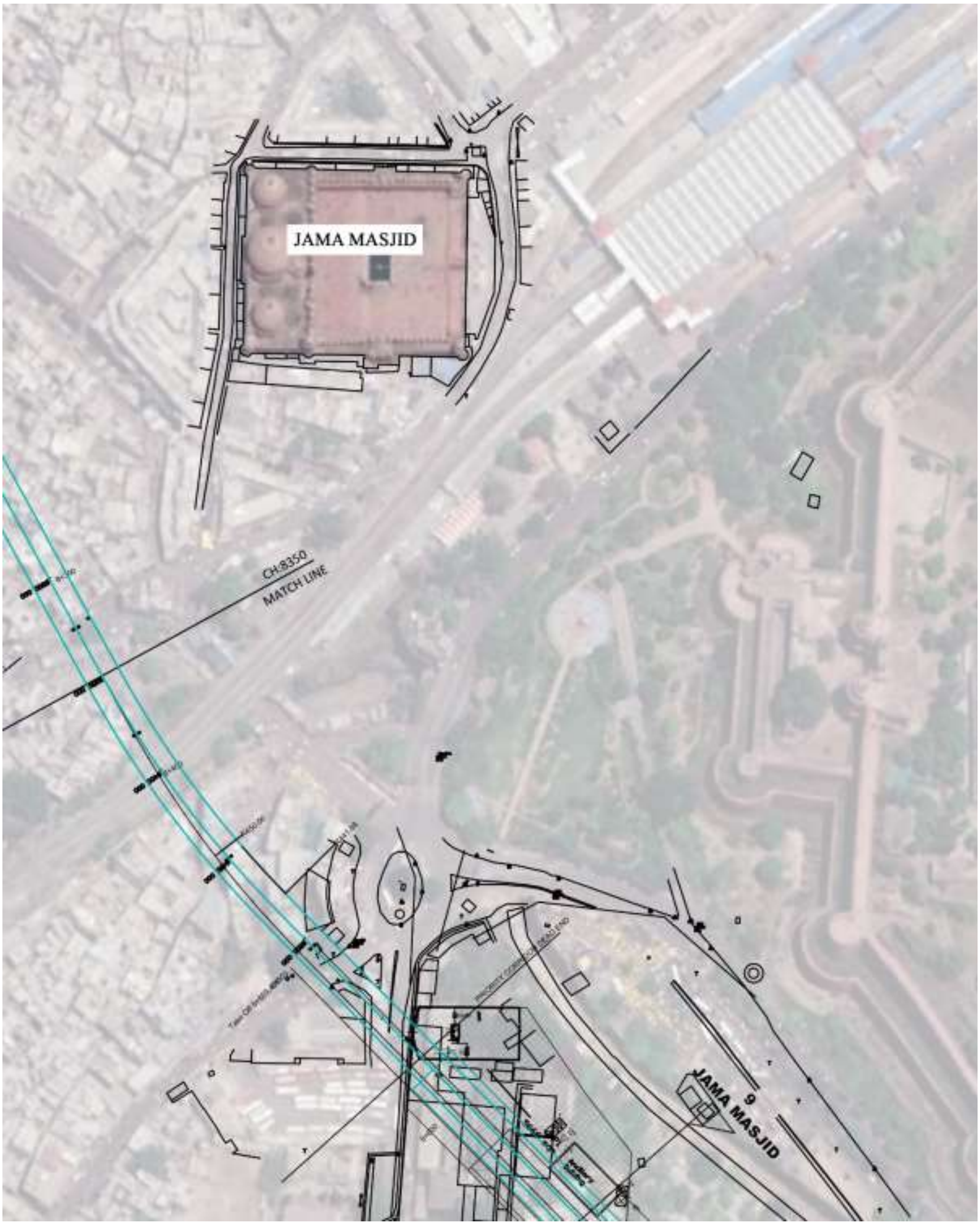

Fig: VII/JM/02 Study of viewpoints of Jama Masjid

At present multiple tall structures obstruct view of Jama Masjid along the proposed route, leaving no clear view points. In addition to this, the proposed corridor 1 Metro line continues to be underground along this stretch. Therefore, visually there won't be any negative impact of proposed Metro line and station on Jama Masjid.

Tomb of Salabat Khan and Tomb of Sadiq Khan

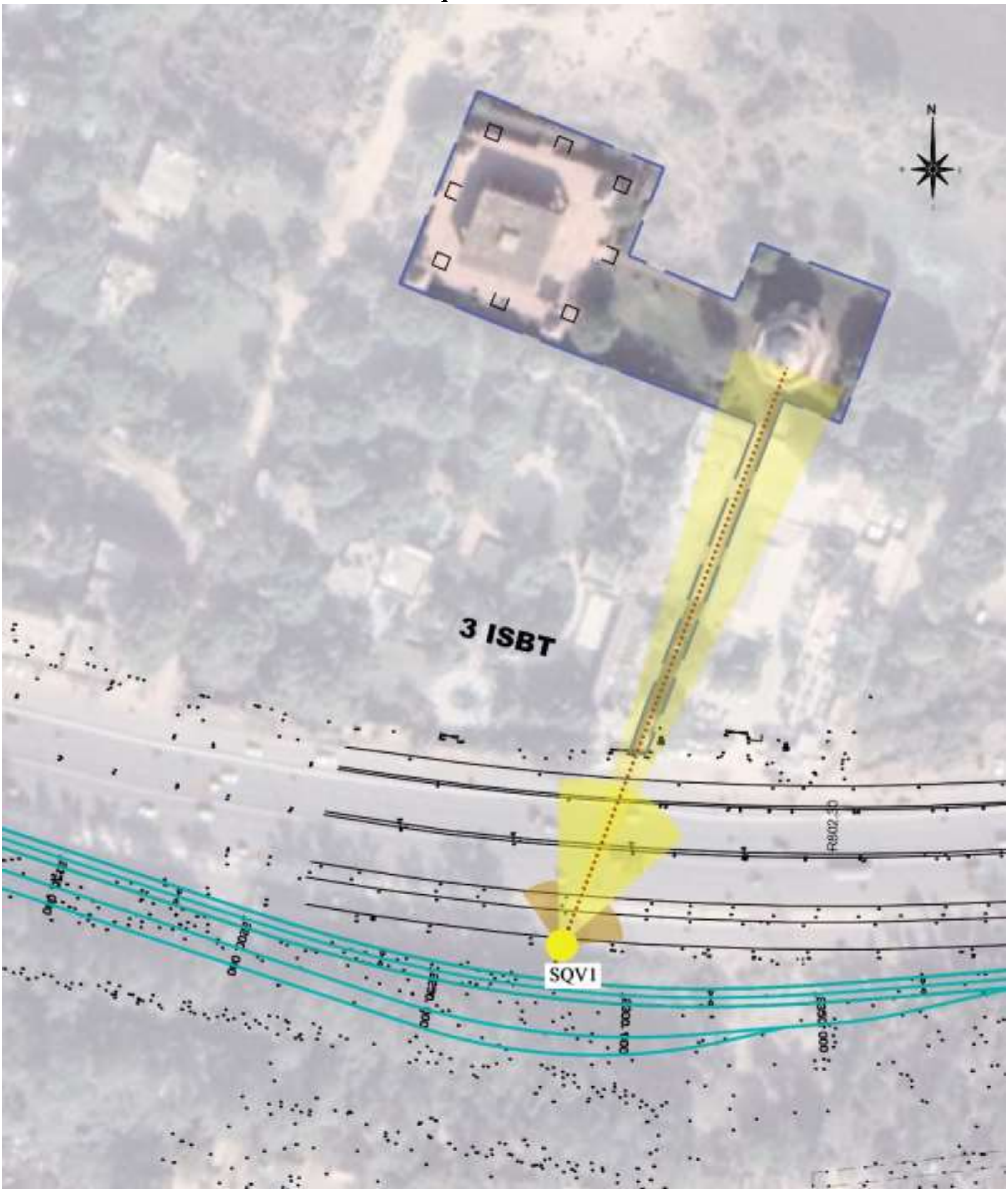

Fig: VII/SQ/01 Study of viewpoints of Tomb of Salabat Khan and Tomb of Sadiq Khan

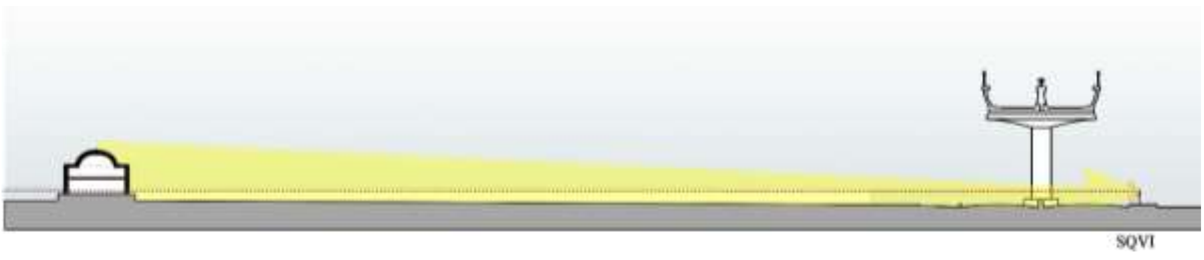

Fig: VII/SQ/02 Study of viewpoints of Tomb of Salabat Khan and Tomb of Sadiq Khan

Image: SQV1 | View of Tomb of Sadiq Khan from the road.

Tomb of Salabat Khan is not visible from the road. At present, the dome of tomb of Sadiq Khan is visible from the road. From visual analysis of the area it can be said that the proposed elevated Metro line might obstruct that view. Visual analysis of the area it can be concluded that the proposed elevated Metro line would impact the context of the complex Elevated Metro line would provide complete view of the complex

Annexure-VIII

1. **SUPREME COURT ORDERS**

SR. NO.	ORDER	EXCERPTS OF THE JUDGMENT
01	Judgment dated 30.12.1996	• The industries would apply to GAIL for gas. The industries which fail to get the gas for operation were ordered to close. • Green belt around the Taj • Suggested planning commission for separate funds to the Taj and the creation of separate cell under the control of Central Government to safeguard the Taj, the city of Agra and other monuments in the TTZ. • The GoI should decide the issue pertaining to declaration of Agra as heritage city within two months.
02	Judgment dated 20.11.2017	• Any comprehensive action plan being developed by TTZA? • Why is the TTZA not meeting every two months as recommended?
03	Judgment dated 08.12.2017	• Detailed vision document to preserve Taj and its environs to be developed with six districts of UP and Bharatpur in Rajasthan for few hundred years. • The expertise of all stakeholders to be considered.
04	Judgment dated 08.02.2018	• State to identify land for forestation. • The state should inform how many trees were planted and their mortality rate
05	Judgment dated 22.03.2018	• SPA would be preparing the vision document. Draft to be prepared within four months. • There would be a status quo in the TTZ. • MC Mehta informs that the order of 1996 is not complied with and has to submit the application.
06	Judgment dated 11.07.2018	• It is alleged that the status quo has been violated. The court orders the TTZA to present all applications of industries which have been received and granted (expansion or reopening). • The court is presented by the report of PSC on Science and Technology and Environment and Forests (262 Report) • As actions to the report, the Government had sited the SC orders and a new study by IIT-Kanpur. The court is critical on the need for a new study. • An affidavit is filed by MoEFCC highlighting the actions taken for the report. • The court is critical siting there are only steps. It recommends timelines for implementation, responsibilities and accountabilit

SR. NO.	ORDER	EXCERPTS OF THE JUDGEMENT
		• The courts also sites that the MoM on 11.04.2018 introduced ad hoc moratorium which is sought by the GoI to be dispensed with. • The court is critical and wants the GoI to file an affidavit.
07	Judgment dated 26.07.2018	• The court observed that ASI was not consulted for the draft vision document. • The court ordered consultation with ASI and the report to be shared with panel of experts and Mr. MC Mehta. • The court wanted to know who would be the responsible person for preservation of TTZ. • ASI would be responsible for preservation of Taj and the monuments within the TTZ. • The court also asked the GoI whether a management plan has been submitted to the WHC of UNESCO.
08	Judgment dated 30.07.2018	• The GoI response to the responsible authority • Commissioner Agra Division maintenance and issues concerning the TTZ • JS, MoEFCC in charge of TTZ from GoI • Director General, ASI for preservation of Taj • Mr. MC Mehta suggested the TTZ needs major revamping.
09	Judgment dated 28.08.2018	• Court asked if Ms. Minakshi Dhote is facing any obstacles or hurdles in preparation of Vision Document. • AG committed that ASI would submit a management plan to WHC of UNESCO within three months.
10	Judgment dated 25.09.2018	• Prof. Dhote requested more time till 15.11.2018 • AG informed that a study is being done by CEPT for declaration of Agra as heritage city.

Annexure-IX

कार्यालय सक्षम प्राधिकारी/आयुक्त, आगरा मण्डल, आगरा।

संख्या 2849/2/353/356/19—सीए दिनांकः अगस्त, 26 ,2019

सदस्य सचिव,
संस्कृति मंत्रालय, भारत सरकार,
राष्ट्रीय स्मारक प्राधिकरण,
24 तिलक मार्ग,
नई दिल्ली—110001

विषयः— गुरू का ताल व पत्थर का घोड़ा के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण—पत्र निर्गत करने के सम्बन्ध में।

महोदय,

कृपया उपर्युक्त विषयक प्रबन्ध निदेशक, लखनऊ मैट्रो रेल कॉरपोरेशन लि0, लखनऊ के पत्र दिनांक 21.06.2019 जो इस कार्यालय में दिनांक 25.06.2019 को निर्धारित प्रारूप (प्रपत्र—1) सहित प्राप्त हुआ। उक्त आवेदन पत्र में गुरू का ताल व पत्थर का घोडा के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण—पत्र निर्गत किये जाने का अनुरोध किया गया है।

2. तद्क्रम में इस कार्यालय के पत्र संख्या—2813/2/361/19—सीए दिनांक 02.07.2019 के द्वारा उप जिलाधिकारी,सदर,जनपद आगरा से स्थल निरीक्षण कर समिति की रिपोर्ट स्पष्ट संस्तुति सहित निर्धारित प्रारूप पर उपलब्ध कराये जाने हेतु निर्देशित किया गया। उप जिलाधिकारी, सदर, जनपद आगरा द्वारा अपने कार्यालय पत्र संख्या—3866/एस0टी0 दिनांक 30.07.2019 के साथ संलग्न कर प्रश्नगत प्रकरण की निर्धारित प्रारूप पर संयुक्त स्थलीय निरीक्षण आख्या दिनांक 18.07.2019 प्राप्त करायी गयी है, जिसमें अंकित किया गया है कि गुरू का ताल के समीप मैट्रो रेल कारपोरेशन की संरक्षित स्मारक से 109 मीटर, पत्थर का घोड़ा से 58.50 मीटर तथा गुरू का ताल से ट्रैक की दूरी 111मीटर, पत्थर का घोड़ा से 25 मीटर है, जो प्रतिनिषिद्ध/विनियमित क्षेत्र के अन्तर्गत है।

3. भारतीय पुरातत्व सर्वेक्षण की अधिसूचना दिनांक 23.8.2011 के नियम 10 के अन्तर्गत सक्षम प्राधिकारी द्वारा संरक्षित संस्मारक या संरक्षित क्षेत्र के प्रतिषिद्व या विनियमित क्षेत्र में निर्माण, पुनर्निर्माण, मरम्मत, पुनरूद्वार के लिए प्रारूप—2 के अनुसार आवेदन पत्र प्राधिकरण (राष्ट्रीय संस्मारक प्राधिकरण) के पास अग्रसारित किया जायेगा।

4. अतः उपर्युक्त तथ्यों के आलोक में प्रश्नगत आवेदन—पत्र, उप जिलाधिकारी,सदर, जनपद आगरा के पत्र संख्या—3866/एस0टी0 दिनांक 30.07.2019 के साथ उपलब्ध कराई गयी संयुक्त निरीक्षण आख्या दिनांक 18.07.2019 की छायाप्रति तथा प्रारूप—2 की तीन प्रतियां इस पत्र के साथ संलग्न कर नियमानुसार आवश्यक कार्यवाही हेतु प्रेषित हैं।

संलग्नकः—यथोक्त।

भवदीय

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

संख्या व दिनांक उपरोक्तानुसार

प्रतिलिपिः—प्रबन्ध निदेशक, लखनऊ मैट्रो रेल कॉरपोरेशन लि0, प्रशासनिक भवन, बिल्डिंग विपिन खण्ड, गोमती नगर, लखनऊ को सूचनार्थ प्रेषित।

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

कार्यालय सक्षम प्राधिकारी/आयुक्त, आगरा मण्डल, आगरा।

संख्या 2849/2/355/357/19–सीए दिनांकः अगस्त, 26 ,2019

सदस्य सचिव,
संस्कृति मंत्रालय, भारत सरकार,
राष्ट्रीय स्मारक प्राधिकरण,
24 तिलक मार्ग,
नई दिल्ली–110001

विषयः– सद्दीक खॉ टोम्ब व सलामत खॉ टोम्ब के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण–पत्र निर्गत करने के सम्बन्ध में।

महोदय,

कृपया उपर्युक्त विषयक प्रबन्ध निदेशक, लखनऊ मैट्रो रेल कॉरपोरेशन लि0, लखनऊ के पत्र दिनांक 21.06.2019 जो इस कार्यालय में दिनांक 25.06.2019 को निर्धारित प्रारूप (प्रपत्र–1) सहित प्राप्त हुआ। उक्त आवेदन पत्र में सद्दीक खॉ टोम्ब व सलामत खॉ टोम्ब के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण–पत्र निर्गत किये जाने का अनुरोध किया गया है।

2. तद्क्रम में इस कार्यालय के पत्र संख्या–2810/2/361/19–सीए दिनांक 02.07.2019 के द्वारा उप जिलाधिकारी,सदर,जनपद आगरा से स्थल निरीक्षण कर समिति की रिपोर्ट स्पष्ट संस्तुति सहित निर्धारित प्रारूप पर उपलब्ध कराये जाने हेतु निर्देशित किया गया। उप जिलाधिकारी, सदर, जनपद आगरा द्वारा अपने कार्यालय पत्र संख्या–3867/एस0टी0 दिनांक 30.07.2019 के साथ संलग्न कर प्रश्नगत प्रकरण की निर्धारित प्रारूप पर संयुक्त स्थलीय निरीक्षण आख्या दिनांक 16.07.2019/18.07.2019 प्राप्त करायी गयी है, जिसमें अंकित किया गया है कि आई0एस0बी0टी0 के समीप मैट्रो रेल कारपोरेशन की संरक्षित स्मांरक सद्दीक खॉ टोम्ब व टोम्ब ऑफ सलामत खॉ से प्रस्तावित कार्यस्थल की दूरी 160 मीटर एवं ट्रैक की 60 मीटर दूरी है,जो प्रतिनिषिद्ध/विनियमित क्षेत्र के अन्तर्गतहै।

3. भारतीय पुरातत्व सर्वेक्षण की अधिसूचना दिनांक 23.8.2011 के नियम 10 के अन्तर्गत सक्षम प्राधिकारी द्वारा संरक्षित संस्मारक या संरक्षित क्षेत्र के प्रतिषिद्व या विनियमित क्षेत्र में निर्माण, पुनर्निर्माण, मरम्मत, पुनरूद्वार के लिए प्रारूप–2 के अनुसार आवेदन पत्र प्राधिकरण (राष्ट्रीय संस्मारक प्राधिकरण) के पास अग्रसारित किया जायेगा।

4. अतः उपर्युक्त तथ्यों के आलोक में प्रश्नगत आवेदन–पत्र, उप जिलाधिकारी,सदर, जनपद आगरा के पत्र संख्या–3867/एस0टी0 दिनांक 30.07.2019 के साथ उपलब्ध कराई गयी संयुक्त निरीक्षण आख्या दिनांक 16.07.2019/18.07.2019 की छायाप्रति तथा प्रारूप–2 की तीन प्रतियां इस पत्र के साथ संलग्न कर नियमानुसार आवश्यक कार्यवाही हेतु प्रेषित हैं।

संलग्नकः–यथोक्त।

भवदीय

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

संख्या व दिनांक उपरोक्तानुसार

प्रतिलिपिः–प्रबन्ध निदेशक, लखनऊ मैट्रो रेल कॉरपोरेशन लि0, प्रशासनिक भवन, बिल्डिंग विपिन खण्ड, गोमती नगर, लखनऊ को सूचनार्थ प्रेषित।

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

कार्यालय सक्षम प्राधिकारी/आयुक्त, आगरा मण्डल, आगरा।

संख्या 2847/2/360/19–सीए दिनांकः अगस्त, 26,2019

सदस्य सचिव,
संस्कृति मंत्रालय, भारत सरकार,
राष्ट्रीय स्मारक प्राधिकरण,
24 तिलक मार्ग,
नई दिल्ली–110001

विषयः– अकबर टाम्ब सिकन्दरा के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण–पत्र निर्गत करने के सम्बन्ध में।

महोदय,

कृपया उपर्युक्त विषयक प्रबन्ध निदेशक, लखनऊ मैट्रो रेल कॉरपोरेशन लि0, लखनऊ के पत्र दिनांक 21.06.2019 जो इस कार्यालय में दिनांक 25.06.2019 को निर्धारित प्रारूप (प्रपत्र–1) सहित प्राप्त हुआ। उक्त आवेदन पत्र में अकबर टाम्ब सिकन्दरा के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण–पत्र निर्गत किये जाने का अनुरोध किया गया है।

2. तद्क्रम में इस कार्यालय के पत्र संख्या–2817/2/361/19–सीए दिनांक 03.07.2019 के द्वारा उप जिलाधिकारी,सदर,जनपद आगरा से स्थल निरीक्षण कर समिति की रिपोर्ट स्पष्ट संस्तुति सहित निर्धारित प्रारूप पर उपलब्ध कराये जाने हेतु निर्देशित किया गया। उप जिलाधिकारी, सदर, जनपद आगरा द्वारा अपने कार्यालय पत्र संख्या–3864/एस0टी0 दिनांक 30.07.2019 के साथ संलग्न कर प्रश्नगत प्रकरण की निर्धारित प्रारूप पर संयुक्त स्थलीय निरीक्षण आख्या दिनांक 19.07.2019 प्राप्त करायी गयी है, जिसमें अंकित किया गया है कि सिकन्दरा के समीप मैट्रो रेल कारपोरेशन की संरक्षित स्मांरक अकबर का मकबरा से प्रस्तावित कार्यस्थल की दूरी 343 मीटर एवं ट्रैक की 152 मीटर दूरी है,जो विनियमित क्षेत्र के अन्तर्गतहै।

3. भारतीय पुरातत्व सर्वेक्षण की अधिसूचना दिनांक 23.8.2011 के नियम 10 के अन्तर्गत सक्षम प्राधिकारी द्वारा संरक्षित संस्मारक या संरक्षित क्षेत्र के प्रतिषिद्व या विनियमित क्षेत्र में निर्माण, पुनर्निर्माण, मरम्मत, पुनरूद्वार के लिए प्रारूप–2 के अनुसार आवेदन पत्र प्राधिकरण (राष्ट्रीय संस्मारक प्राधिकरण) के पास अग्रसारित किया जायेगा।

4. अतः उपर्युक्त तथ्यों के आलोक में प्रश्नगत आवेदन–पत्र, उप जिलाधिकारी,सदर, जनपद आगरा के पत्र संख्या–3864/एस0टी0 दिनांक 30.07.2019 के साथ उपलब्ध कराई गयी संयुक्त निरीक्षण आख्या दिनांक 19.07.2019 की छायाप्रति तथा प्रारूप–2 की तीन प्रतियां इस पत्र के साथ संलग्न कर नियमानुसार आवश्यक कार्यवाही हेतु प्रेषित हैं।

संलग्नकः–यथोक्त। भवदीय

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

संख्या व दिनांक उपरोक्तानुसार

प्रतिलिपिः–प्रबन्ध निदेशक, लखनऊ मैट्रो रेल पॉरपोरेशन लि0, प्रशासनिक भवन, बिल्डिंग विपिन खण्ड, गोमती नगर, लखनऊ को सूचनार्थ प्रेषित।

(अनिल कुमार)
सक्षम प्राधिकारी/आयुक्त,
आगरा मण्डल,आगरा।

C.7.8.1L... A.C.
2/5/8/19

कार्यालय सक्षम प्राधिकारी/आयुक्त, आगरा मण्डल, आगरा।

संख्या 2832/2/354/19-सीए दिनांक: जुलाई, 31 2019

विषय:- ताज महल के समीप मैट्रो रेल कॉरपोरेशन के कार्यो हेतु अनापत्ति प्रमाण-पत्र निर्गत करने के सम्बन्ध में।

प्रबन्ध निदेशक,
लखनऊ मैट्रो रेल कॉरपोरेशन लि0
लखनऊ।

महोदय,

कृपया उपर्युक्त विषयक मैट्रो रेल कॉरपोरेशन लि0 लखनऊ के आवेदन पत्र दिनांक 21.06.2019 का सन्दर्भ ग्रहण करने का कष्ट करें, जिसके द्वारा ताज महल के समीप मैट्रो रेल कॉरपोरेशन के कार्य हेतु अनापत्ति प्रमाण-पत्र निर्गत किये जाने का अनुरोध किया गया है।

2. आपके आवेदन पत्र (प्रपत्र-1) के कम में इस कार्यालय के पत्र संख्या-2814/2/354/19-सीए दिनांक 02.07.2019 के द्वारा उप जिलाधिकारी,सदर,आगरा से निर्धारित प्रारूप पर आख्या मांगी गयी। उप जिलाधिकारी, सदर, आगरा के कार्यालय पत्र संख्या-3742/एस.टी. दिनांक 25.07.2019 के साथ संलग्न निर्धारित प्रारूप-2 पर आख्या दिनांक 11.07.2019 उपलब्ध करायी गयी है। उक्त आख्या में प्रस्तावित मैट्रो स्टेशन की संरक्षित स्मारक ताज महल के दक्षिण पश्चिम कोने से 535 मीटर और ट्रैक की दूरी 310 मीटर दूरी अंकित की गयी है।

3. उल्लेखनीय है कि संस्कृति मंत्रालय,भारत सरकार,नई दिल्ली से निर्गत तत्संबंधी दिशा-निर्देश (गाइड-लाइन्स) के अनुसार संरक्षित स्मारक से 300 मीटर की दूरी तक बिना अनुमति के नवनिर्माण/मरम्मतीकरण कार्य नही किया जा सकता है। उप जिलाधिकारी, सदर, आगरा की आख्यानुसार प्रस्तावित मैट्रो स्टेशन की संरक्षित स्मारक ताज महल के दक्षिण पश्चिम कोने से 535 मीटर और ट्रैक की दूरी 310 मीटर दूरी पर स्थित है।

4. अतः उपर्युक्त तथ्यों के दृष्टिगत अनापत्ति प्रमाण-पत्र हेतु प्राप्त प्रश्नगत आवेदन पत्र पर अधोहस्ताक्षरी के स्तर से कोई अग्रेत्तर कार्यवाही किया जाना नियमसंगत नही है।

भवदीय

Pl. discuss

Discussed. 07.08.19
Dir(WAI)
CPM-2

MD.
6/8
06.08.19.

(अनिल कुमार)
आयुक्त/सक्षम प्राधिकारी,
आगरा मण्डल, आगरा

संख्या एवं दिनांक उपरोक्तानुसार।

प्रतिलिपिःसदस्य सचिव, राष्ट्रीय स्मारक प्राधिकरण, संस्कृति मंत्रालय, भारत सरकार, नई दिल्ली को सूचनार्थ प्रेषित।

DyCE/C
Please put up status as per joint survey.
07.08.19
CPM-2

(अनिल कुमार)
आयुक्त/सक्षम प्राधिकारी,
आगरा मण्डल, आगरा