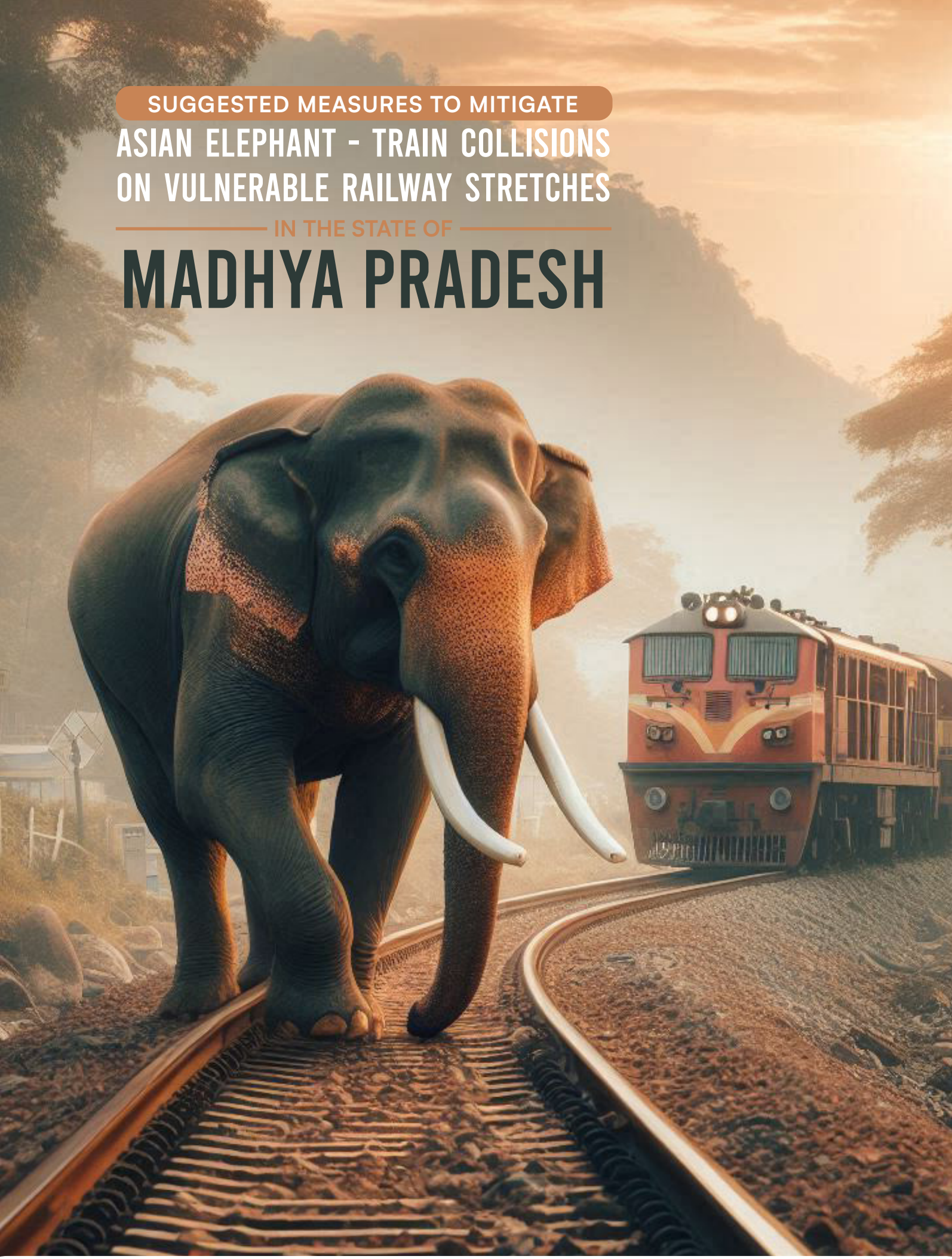
SUGGESTED MEASURES TO MITIGATE

ASIAN ELEPHANT - TRAIN COLLISIONS ON VULNERABLE RAILWAY STRETCHES

IN THE STATE OF

MADHYA PRADESH



सत्यमेव जयते

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

AUGUST 2024

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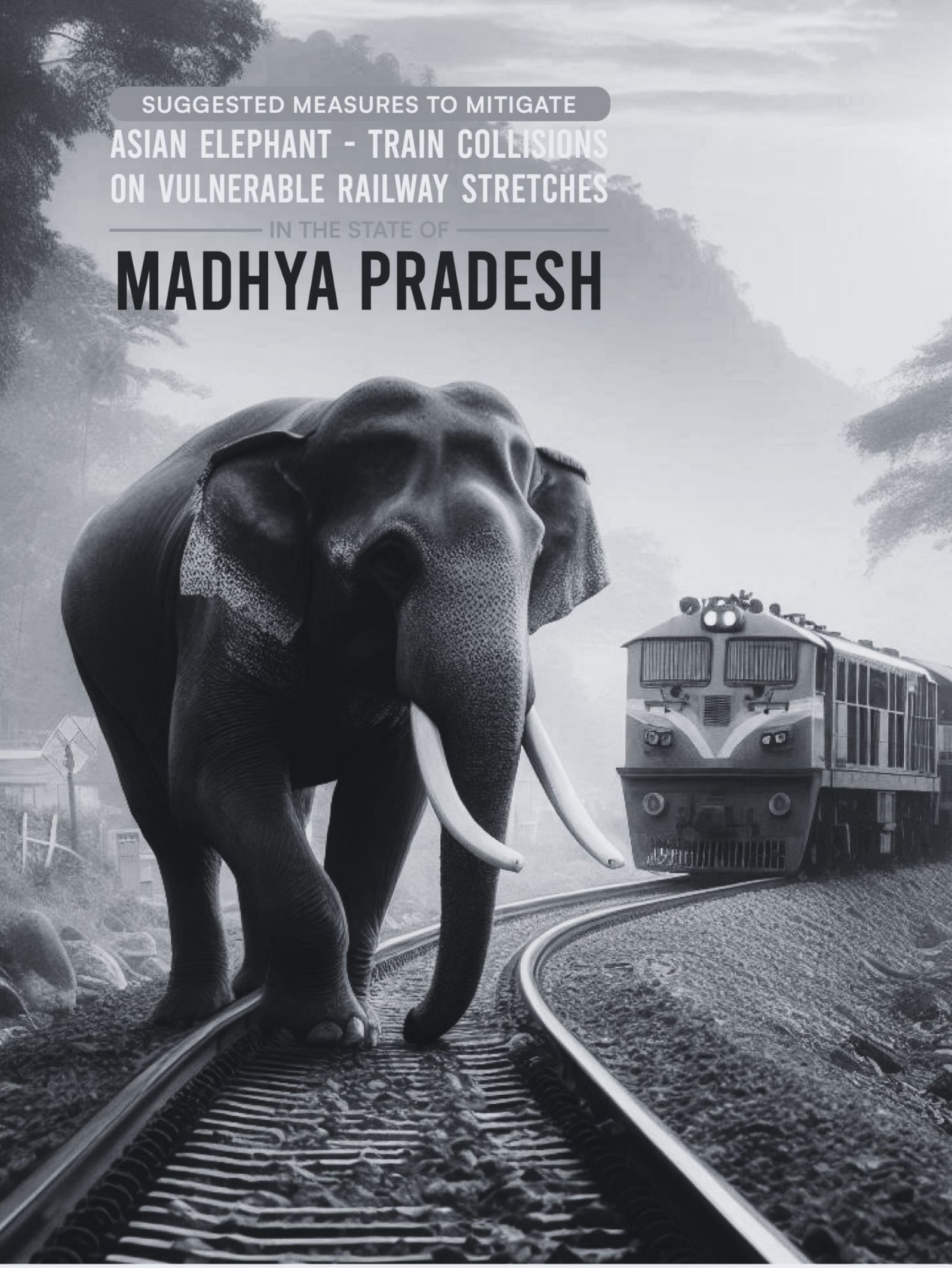

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To minimize the risk of collisions between elephants and trains, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways in India have jointly undertaken several measures. These include the construction of underpasses and overpasses for safe elephant passage, setting up of signage boards to warn locomotive drivers, and speed regulations in elephant corridors. Further, efforts have also been made to sensitize train drivers and railway staff about elephant movements and using technology to track and predict elephant movements near railway tracks .These collaborative efforts aims to safeguard elephant populations while ensuring the smooth operation of railway services, and are part of a comprehensive strategy to reduce train-elephant collisions.

By implementing early warning systems like DAS, underpasses, overpasses, level crossings and installing barriers at vulnerable points along railway tracks, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways aim to create a safer environment for elephants while maintaining efficient rail operations.

The collaboration between the Ministry of Environment, Forest and Climate Change and the Ministry of Railways underscores the importance of inter-departmental cooperation in wildlife conservation. By aligning their efforts, these ministries are working towards a sustainable solution to mitigate the risk of elephant-train collisions.

A combination of technological innovations, such as the use of thermal imaging cameras and automated alert systems, & traditional methods, like patrolling and community involvement, are being employed by the Ministry of Environment, Forest and Climate Change and the Ministry of Railways to protect elephants from train accidents.

ACKNOWLEDGEMENT

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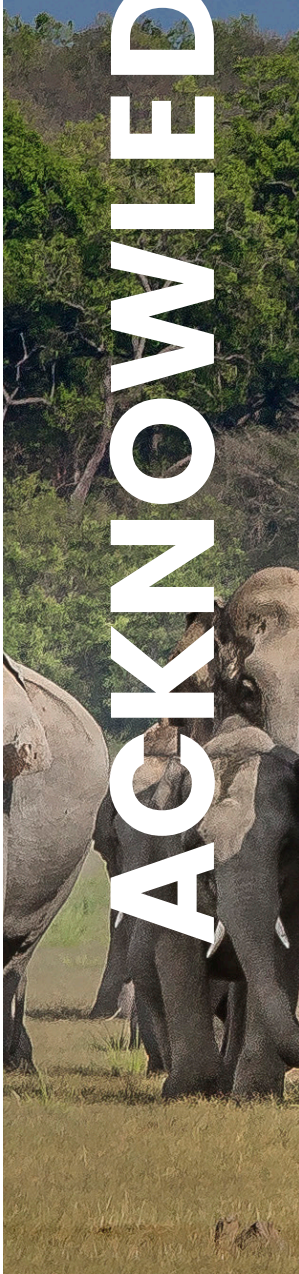

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CONTENTS

01. Introduction

The habitat of elephants in central India includes Madhya Pradesh but very rarely elephants used to enter the area. There are roughly 3128 elephants living in the habitat, which covers more than 21,000 sq.km. across the states of Odisha, Jharkhand, Chhattisgarh, and southern West Bengal. Nowadays, the elephants are regularly entering into Madhya Pradesh creating a state of panic for both the residents and the Forest department. Residents and forest officials in Madhya Pradesh are especially concerned when elephants wander into the eastern districts of Singrauli and Anuppur from the neighboring northern Chhattisgarh due to abundant standing crops, water, and bamboo. Chhattisgarh has a small elephant population that originally migrated from Jharkhand and Odisha in the 1980s and 90s. Illegal felling, encroachment, industrialization, and mining have all contributed to the degradation of these two states' forested areas during the recent past. The degradation of habitat quality has forced elephants to engage in long-distance disoriented movements, using smaller forest patches to move to larger forest regions. This is one of the key causes of elephant migration into Chhattisgarh extending into Madhya Pradesh. This landscape supports a sizeable elephant population that has increasingly come into conflict with humans because of habitat fragmentation. Linear infrastructure such as roads and railway lines has further fragmented elephant movement pathways, leading to elephant mortalities especially through collisions with trains. Elephant and wildlife movement within the landscape is hampered because of the aforementioned railway lines, leading to several wildlife mortalities.

Based on a meeting on 17th August 2022, the Hon'ble Minister of Railways, Government of India, instructed the Ministry of Environment, Forest and Climate Change (MoEF&CC) to provide at least 100 locations of existing railway segments across sensitive elephant and tiger landscapes in the country for construction of permanent mitigation measures in view of wildlife-train collisions (Proceedings under Ministry of Railways letter No. 2022/CE- IV/ Elephant Pass dated 30th September 2022). Consequently, details of sensitive stretches for constructing permanent and temporary mitigation measures were provided by the MoEF&CC (vide OM F.No. 12-1/2019-PE (Part-I), dated 30th August 2022).

Further, meeting to review the progress of the survey and finalization of the mitigation measures to mitigate wildlife- rail collisions across identified sensitive stretches on railway lines passing through sensitive elephant habitats across India was held on 22nd November, 2023 under the Chairmanship of Shri Ramesh Kumar Pandey Inspector General of Forests, Project Tiger and Elephant and Director, Project Elephant, MoEF&CC through virtual mode (OM F.No. 1-32/2017-PE). Based on the discussion during the meeting, a team from Elephant Cell conducted the survey in Madhya Pradesh between 16th and 26th February, 2024.

02. Field Survey

The survey was conducted in the critical stretches in Sidhi and Umaria districts of Madhya Pradesh and with an objective to identify specific elephant crossing zones to suggest site-specific mitigation measures based on the location and the extent of these crossing zones to mitigate train elephant collisions.

The area surveyed comprised of the Dubri, Sehdol and Bihari range of Sanjay- Dubri Tiger Reserve (Figure 1 & 2), and a railway segment near Bandhavgarh Tiger Reserve (Figure 3). There have been regular incidents of wild animal mortality on the Katni- Singhrauli Railway track recently and in the past.

Prior to the survey, the survey team was provided with locations points along railway lines that were considered priority wildlife crossing zones by the Forest Department. Thereafter, the team walked along the railway lines with Railway officials and Forest Department personnel, and collected data on animal signs on and near the railway tracks, information of previous railway line crossings and use of trails near railway lines by elephants and other wildlife. The GPS coordinates of these sites were noted down. Records of previous wild animal mortality and wildlife sightings on the railway track from the Department and Railways were also collected.

The aforementioned information was collated in the GIS-domain to determine priority high-use railway segments. Mitigation measures were then suggested based on width of crossing zone, track height of the railway line, presence of drainage structure and human infrastructure (potential for conflict) in that segment.

* The objective of the field survey was to minimise elephant-train collisions either by constructing underpasses and overpasses wherever possible, by reducing the time taken by elephants to cross the railway tracks by easing movement across the track through construction of ramps and level crossings, and by implementation of technology for early detection and warning systems.

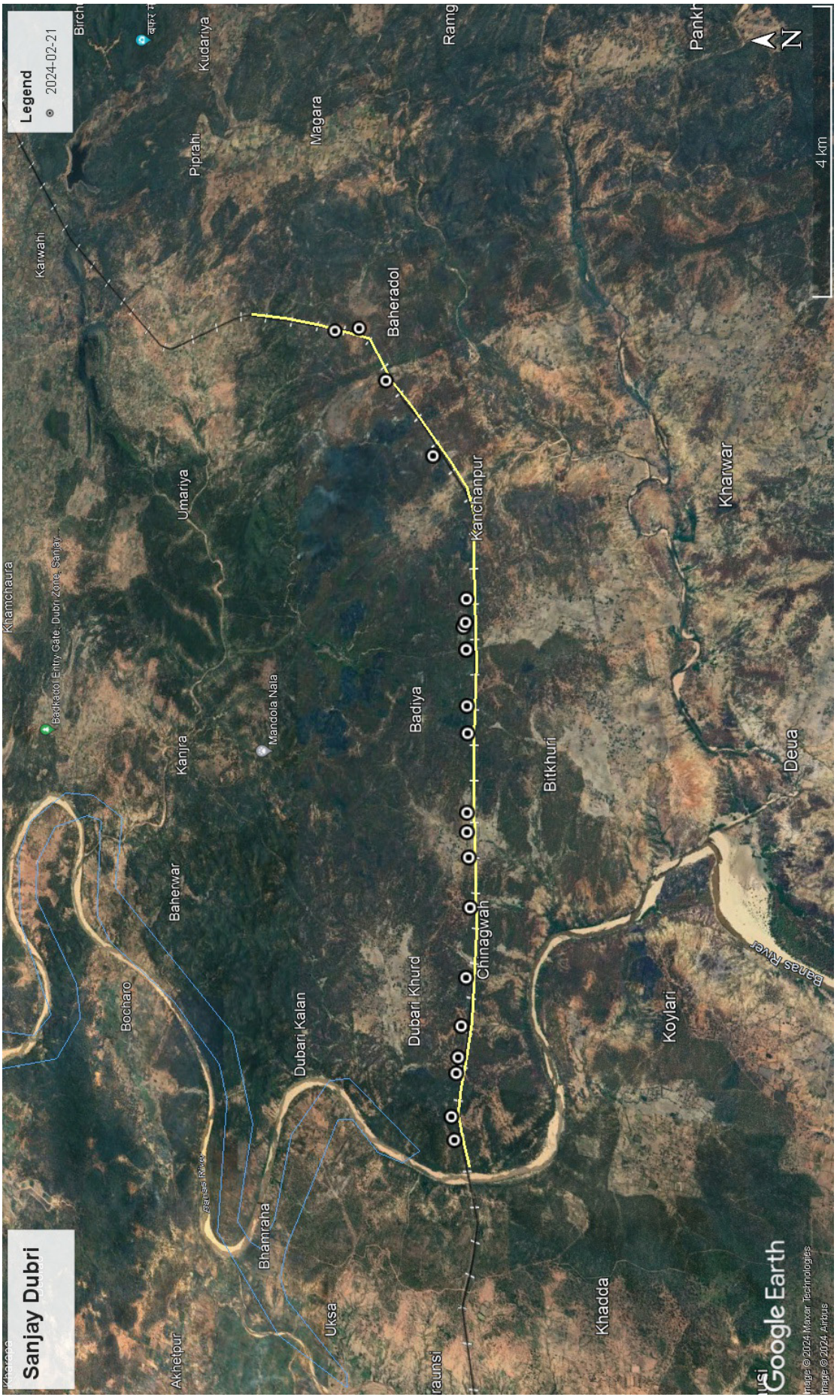


Figure 1: Railway segment inspected inside Sanjay- Dubri Tiger Reserve during the field visit.

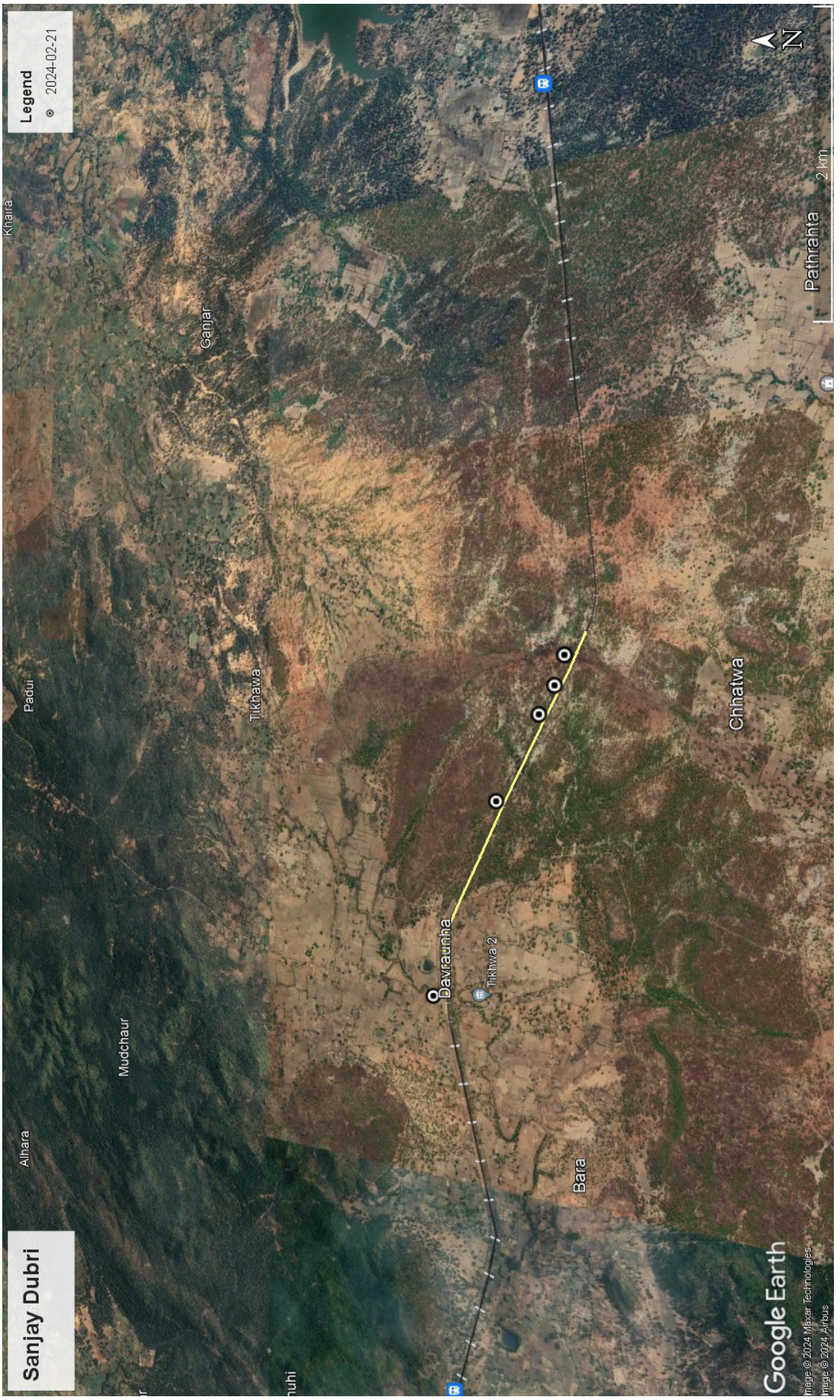


Figure 2: Railway segment inspected inside Sanjay- Dubri Tiger Reserve during the field visit.

Figure 3: Railway segment inspected near Bandhavgarh Tiger Reserve during the field visit

03. Site-Specific Findings & Mitigation Measures

3.1 Katni- Singhrauli railway line railway line passing through Sanjay- Dubri Tiger Reserve

The railway track along this segment is relatively flat with regard to the surrounding terrain. Based on the field survey, discussions and data obtained from the Forest Department and Railways, majority of this segment was found suitable for wildlife movement, since most of the crossing sites have similar characteristics in terms of track height and adjacent vegetation. Multiple sites of elephants crossing the track were reported by the railways (Table 1), FD ground staff and observed on field. Wildlife mortality sites were also reported and duly GPS marked (Table 2).

However, same issue had already been discussed and worked upon with the railway department and the process of removing the railway line completely from within the Sanjay-Dubri Tiger Reserve has already started.

Table 1: Major crossing points and underpasses for wildlife on the Katni- Singhrauli railway line

S. No.	Latitude	Longitude	Animal Movement details
1	23.302	81.244	Narrow underpass, tiger crossing line
2	23.36	81.137	Major animal crossing used by leopards
3	23.301	81.246	Tiger crossing
4	23.308	81.236	Non-functional underpass, functional track at mouth of underpass
5	23.31	81.234	Underpass used by tigers
6	23.364	81.144	Naon- functional underpass
7	23.318	81.226	New underpass under construction
8	23.365	81.15	New underpass under construction
9	23.364	81.154	Underpass seldom used by wildlife for crossing
10	24.002	81.213	Underpass used by elephants
11	23.997	81.227	Old elephant crossing point on railway track which is now blocked due to construction on new railway track
12	23.994	81.234	New crossing point of elephants
13	23.993	81.236	Underpass besides the new crossing point
14	23.994	81.508	Tiger crossing
15	23.993	81.519	Tiger crossing
16	23.991	81.545	Underpass used by tigers
17	23.991	81.572	Underpass
18	23.991	81.576	Underpass used by tigers

19	23.992	81.585	Underpass used by tigers
20	23.992	81.589	Underpass
21	23.014	81.638	Tiger crossing
22	23.009	81.638	Underpass used by tigers

Table 2: Mortality of different animal species on the Katni- Singhrauli railway line passing through forests of the Sanjay- Dubri Tiger Reserve as reported by the railways and forest department.

S.no.	Month	Year	Latitude	Longitude	Details of incidence
1	March	2022	24.005N	81.629	Death of tigress while crossing
2	February	2020	23.308	81.236	Leopard death
3	December	2023	23.308	81.236	Wild pig death
4	December	2023	23.363	81.16	Leopard cup death while chasing chital
5		2021	23.994	81.512	Chital death
6	April	2015	23.993	81.521	Wild pig death
7	January	2021	23.992	81.526	Chital death
8	April	2021	23.992	81.534	Chital death
9	December	2014	23.991	81.553	Wild pig death
10		2014	23.991	81.557	Hyena death
11		2014	23.991	81.56	Sloth bear death
12	October	2019	23.992	81.589	Sloth bear death
13	December	2022	23.991	81.593	Sloth bear death
14		2010	23.997	81.616	2 Hyenas death
15		2010	23.997	81.616	Nilgai death
16		2021	23.997	81.616	Hyena death
17	March	2022	24.005	81.629	Tigress death

3.2 Burhar to Shahdol

The railway track along this segment is approximately 30 km in length and the stretch is being renovated with additional lines being developed near the old lines. The railway track along this segment is relatively flat with regard to the surrounding terrain. Based on the field survey, discussions and data obtained from the Forest Department, majority of segment was found suitable for wildlife movement, since most of the crossing sites have similar characteristics in terms of track height and adjacent vegetation. Consequently, given the importance of almost entire stretch for wildlife movement, and the relatively flat track, we recommend construction of ramps with level crossings that would help wild animals, especially elephants, quickly cross the railway track.

These stretches are indicative of the aggregations of signs and sightings of elephants and other wildlife as observed and reported, and ramps may be constructed on other suitable sites along this track as well. One ramp with rubberised level crossing is to be constructed every 250 m within these segments wherever the maximum slope gradient can be maintained (Fig. 4). The width of the crossing should be 25 m (at the top).

Ramps should be made of compressed soil, and cement wherever feasible. Ramps should be at least 25 m wide at the top, and the slope of the ramps should not be more than 25°. Adequate land may be acquired to ensure that a gradual incline is provided at both ends of the overpass. The ramps should be maintained regularly to check for erosion and breakage. Ramps should be revegetated using native grass species, and landscaping should be done in such a way so as to make the overpass appear contiguous with the surrounding landscape. The orientation (direction) of the ramp can be perpendicular or oblique with respect to the railway track considering the land and slope available to flatten the ramp to a navigable slope.

Though underpasses are being constructed keeping in mind the suggested width and height (30 m and 6 m), water logging is to be avoided under these passages by avoiding excavation of ground for achieving minimum height of underpass.

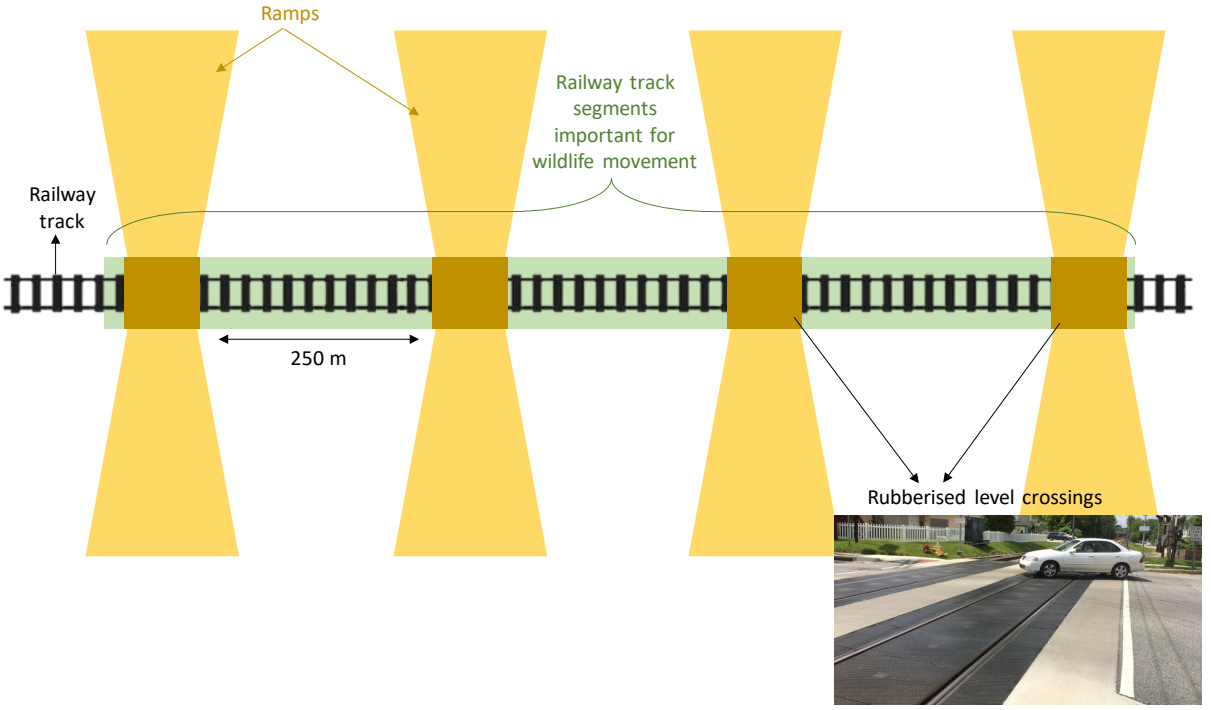


Figure 4: Diagrammatic representation of layout of ramps, spaced 250 m apart, on elephant movement stretches

Table 3: Approximate start and end GPS coordinates of stretches of the railway line segment considered sensitive with respect to presence and movement of elephant and other wildlife.

S. No.	Start GPS	End GPS	Length (m)
1	23° 21' 48.26"N 81° 9' 37.66"E	23°21'41.18"N 81°10'0.50"E	700
2	23° 17' 59.65"N 81° 15' 3.48"E	23°17'30.42"N 81°15'38.69"E	1300

Figure 5: Underpasses being constructed on the Railway segment from Burhar to Shahdol Railway segment

Figure 6: Construction of new railway line on Shahdol Railway segment

04. General recommendations for all sites

The following blanket recommendations are to be implemented across all sites:

1. Distributed Acoustic Sensing (DAS) – based Intrusion Detection Systems (IDS) are to be implemented on all sensitive stretches on priority. Further all level crossings and ramps should incorporate the DAS IDS system as well.

2. Sign boards on the sensitive stretches should be erected to alert loco pilots, along with indications of specific wildlife-crossing zones.

3. Goods trains should be scheduled for the daytime as much as possible or during the time period when the activity of the wildlife species especially elephants is at its minimum.

4. For construction of structural mitigation measures (underpasses, overpasses, level crossings and ramps), the WII report on specifications of mitigation measures should be referred.

5. Regular clearing of vegetation till at least 30 m on either side of the railway tracks is to be done to increase visibility for both loco pilots and elephants. The frequency and responsibility of carrying out pruning may be decided mutually by both parties.

6. Strict restriction and fines on disposal of garbage, especially food items, from operating trains on railway tracks in sensitive stretches and railway stations near them should be imposed.

7. Joint teams of railways and forest department personnel should be formed for all critical stretches. The team would be responsible for joint patrolling on the track of elephant presence, coordination and information sharing, and regular cleaning of railway tracks. This can be achieved by creating WhatsApp groups for each region comprising of senior officials and frontline staff of the railways and forest department.

8. There should be regular cooperation and exchange of information between forest department and railways staff. Regular sensitization workshops for railway staff, especially loco pilots and ground staff should be conducted.

9. Most railway tracks in the surveyed areas are in the process of getting electrified. Adequate measures (insulation and proofing of all electric infrastructure) should be taken to avoid incidents of electrocution of wildlife because of the railway electric infrastructure.

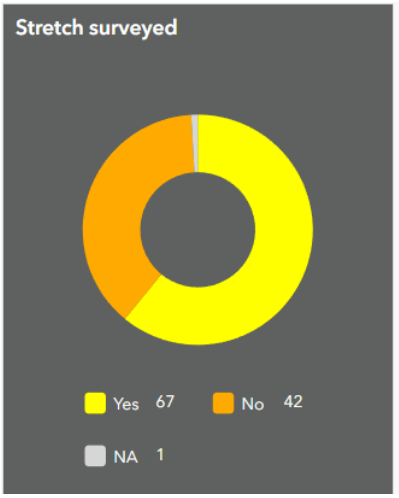
10. To discourage use of wildlife-friendly ramps and level crossings by people and vehicles, concrete barrier poles and/or other barriers should be built that are high enough to block passage of 2 and 4-wheelers, but low enough to allow elephants to pass.

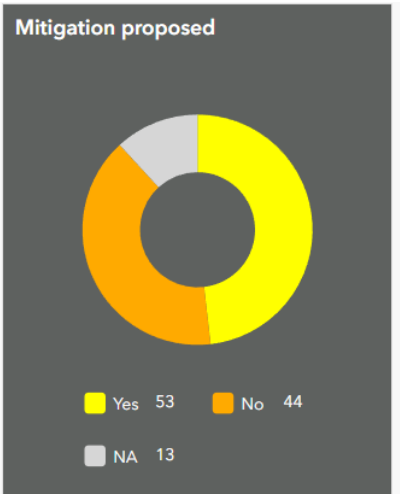
11. Incidences of elephant and wildlife injury and mortality should be documented by both parties, with complete details on GPS location, chainage, date and time of day.

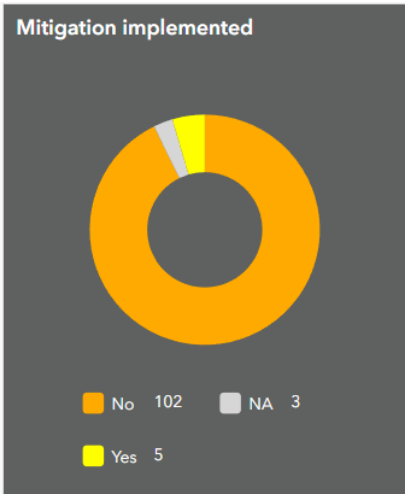
12. In the future, all metre-gauge to broad-gauge conversion projects in elephant landscapes should include comprehensive elephant mitigation plans.

13. In the future, railway stretches posing collision and barrier risks to wildlife should be identified that exist beyond elephant reserves and protected areas, such as corridors.

05. Dashboard for monitoring implementation of mitigation measures







Crossing zone details

Serial No	Name of area	State	Crossing zone width (m)	Stretch surveyed	Mitigation proposed	Mitigation implemented	Remarks	ReportLink
1	Elephant reserve	Uttarakhand	8.60	Yes	Yes	No		https://drive.google.com/file/d/1PZ2YCcHrQKnVcRywn7iyoOgDLiYQQkpe/view?usp=drive_link
2	Elephant reserve	Uttarakhand	14.30	Yes	Yes	No		-
3	Elephant reserve	Uttarakhand	28.90	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
4	Elephant reserve	Uttarakhand	4.50	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
5	Elephant reserve	Uttarakhand	21.30	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
6	Elephant distribution	Uttarakhand	5.90	Yes	No	No	Stretch falls within Kathgodam city limits	-
7	Elephant distribution	Uttarakhand	4.40	Yes	Yes	No	Surveyed by Forest Deparment	https://drive.google.com/file/d/1tFYaY4n5kYA9OhcBqeO5egHMzqTTJWlt/view?usp=sharing
8	Elephant distribution	Uttarakhand	39.80	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
9	Elephant distribution	Uttarakhand	30.70	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
10	Elephant reserve	Uttar Pradesh	7.60	No	No	No		
11	Elephant distribution	Uttar Pradesh	7.60	No	No	No		
12	Elephant distribution	Uttar Pradesh	3.30	No	No	No		
13	Elephant distribution	Uttar Pradesh	10.30	No	No	No		
14	Elephant distribution	Uttar Pradesh	49.80	No	No	No		
15	Elephant distribution	Uttar Pradesh	19.00	No	No	No		

India is a megadiverse country, with only 2.4% of the world's land area, but accounts for 7-8% of all recorded species of the world, including about 91,000 species of animals and 45,500 species of plants. India is also the second-most populous country in the world with a population of over 1.3 billion people! To transport and cater to the needs of such a large population, the Indian Railway is the main artery of inland transportation in India. In 2020, it carried a total of 808.6 crore passengers! Indian Railways is also the single largest employer in India and the eighth largest in the world, employing approximately 13 Lakh people. It is the country's lifeline for large-scale traffic movement – freight and passengers. Railways are at the core of India's economic development and make it possible to conduct many activities like business, sightseeing, and pilgrimage along with the transportation of goods over longer distances. In fact, the Indian Railways is among the world's largest rail networks and runs thousands of trains daily. To cater to India's fast-growing economy, the railway sector has envisaged Vision 2024 to achieve targets of 2024 MT freight loading by 2024. The railway also aims to electrify the entire network.

Recognized as economic, energy-efficient, and environment-friendly relative to other means of transport such as roads and air, the expansion and upgrading of railways is seen as an important measure in supporting development through large-scale movement of people and goods. However, railway construction and operation has its ecological effects, and a range of impacts on wildlife and habitats have also been documented. Several of India's passenger

and freight trains crisscross through some of the country's most sensitive wildlife habitats, particularly protected areas and corridors that are home to critically endangered tigers and elephants, amongst other animals. The extensive network of our Railways cuts through several of these forested landscapes, compromising the connectivity of the landscape and resulting in a barrier effect.

To reduce the impact of railways on our wildlife, it is important to come together and develop measures that can protect India's rich biodiversity and also help to develop a system that is more sustainable and effective in minimizing mortalities and reducing barrier effects across the railways tracks passing through sensitive habitats in India

Project Elephant Division of MoEF&CC in coordination with Ministry of Railways and Wildlife Institute of India has identified sensitive stretches which need prioritization for mitigation planning. The portal is developed to monitor the progress of implementation of mitigation measures from the beginning. The process involves joint surveys of the identified stretches by officials of the Forest Department, Railways and Wildlife Institute of India, recommendation of mitigation measures and implementation of the mitigation measures. The mitigation proposed on the stretches surveyed by various team has been upload on the dashboard. The dashboard can be accessed at Railway Crossing Zones Dashboard (arcgis.com)

The purpose of the dashboard is to monitor the implementation of the mitigation measures on the surveyed stretches. The officers are requested to update the information on the dashboard developed for the purpose. In case of any issues please reach us at projectelephant.moef@gmail.com or elephantcell@wii.gov.in

06. List of State Forest Department and Indian Railways officials consulted during the survey

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Indian Railways:

8. Shri Ashutosh Chourasia, *Sr. DEN/ Coordination/ Jhansi*

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APPENDIX 1

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

GENERAL GUIDELINES

FOR SUGGESTING MITIGATION MEASURES ON EXISTING RAILWAY TRACKS THROUGH ELEPHANT HABITATS IN INDIA

MAY 2023

General Guidelines for Suggesting Mitigation Mesaurs on Railways Tracks through Elephant Habitats in India

Railway lines passing through elephant habitats can alter movement patterns and cause collisions of elephants with trains. Considering the threats to both elephant and human life, WII in consultation with Project Elephant Division of MoEFCC and State Forest Departments has identified 105 stretches of railway lines cutting through elephant reserves and elephant distribution beyond elephant reserves. Subsequently, the Ministry of Environment, Forests and Climate Change (MoEF&CC) and the Ministry of Railways (MoR) in a joint meeting directed that surveys by the railway officials, respective state forest department officers, and WII should be conducted within these stretches. The objectives of the joint field surveys would be to identify specific elephant crossing zones on these stretches and to suggest site-specific mitigation measures based on the location and the extent of these crossing zones.

In the case of existing railway lines, designing and locating structural mitigation measures for wildlife are confounded by several factors. Most critical among these is the limitation of the track height i.e., the height of the railway track with respect to surrounding terrain, making it difficult to allocate the minimum underpass height of 6 m required for animal underpasses in elephant landscapes. Additionally, excavating the ground under the track to achieve the prescribed height makes structures vulnerable to damage by rainwater, and also renders the structures unusable by wildlife. Thus, the choice of mitigation measures on existing railway lines has to be based on multiple factors that include wildlife, landscape as well as railway track design considerations. However, in the case of new railway lines, allocating adequate height to the railway tracks to incorporate wildlife mitigation measures along the line should be ensured.

In light of these factors, the following general pointers are prescribed to guide the Railway and Forest Officials in designing and choosing between different structural mitigation measures in the identified critical elephant zones intersected by railway lines. The choice of mitigation measures can be based on landscape, topography, railway track height, and other logistics.

1. Level crossings

The coarse ballast used on railway tracks is unsuitable for movement by wildlife, particularly elephants. For this reason, level crossings for elephants built using suitable material (soil, cement) and with smooth gradient can help ease movement across the railway track at grade. Level crossings are ideally located where the surrounding land is at level (flat) with the railway track and coincides with a known/identified elephant crossing area. Rubberized level crossings[1] (Fig. 1) may also be used in place of cement and soil.

[1] Functional Specification for Rubberised Surface at Level Crossings. 2019. Ministry of Railways, Govt of India. https://rdso.indianrailways.gov.in/

Figure 1. A level crossing with a rubberised surface that can be replicated on level crossings for wildlife.

2. Ramps

At most elephant crossing locations intersected by railway lines, the elevation in track height and the additional layer of ballast makes it difficult for a large-bodied hoofed animal like an elephant to make quick decisions and move away from a railway track in the event of an approaching train, leading to elephant-train collisions. At such locations, ramps using suitable material (soil, cement) may be constructed that flattens towards the top of the track, and allow for smooth and quick movement by elephants. It is important to include a level crossing instead of ballast at the top of the ramp (near the railway track) to ensure smooth movement by elephants. The sites for construction should be based on identified animal crossing zones and suitable terrain. Ramps should be levelled with the surrounding terrain by smoothening out the slope (Fig. 2). Additionally, in areas with human presence, the ramps may be fenced to funnel elephant movement across the railway track.

The orientation of the ramps with respect to the railway track may be oblique or perpendicular, depending on the land available for flattening the ramp to a navigable slope. The width of ramps and level crossings for elephants should be at least 50 m wide. Early warning systems or wildlife sensors may be provided at these places as additional measures to detect elephant movement and to avoid collision with trains.

Figure 2. An example of a ramp built for aiding elephant movement across a railway line near Coimbatore, Tamil Nadu, India (Top) and an elephant group using a ramp constructed for ease of movement in Deepor Bheel Assam, India (Bottom).

3. Wildlife underpasses

The term wildlife underpass can be used to describe different types of structures built below the railway track to facilitate wildlife movement. These can be box culverts, viaducts, or bridges with natural drainage of different heights and widths, depending on the target wild species or community. In elephant landscapes, the minimum height of an underpass should be 6 m, with adequate width (minimum 30 m) to allow for the movement of large elephant herds (Fig. 3). However, the actual size would depend on the width of the crossing zone and feasibility of construction of underpass considering track height and curvature. Nonetheless, all efforts should be made to maintain a minimum width of 30 m. At locations where the track height is suitable, the topography of the adjacent land should be such to avoid flooding of the underpass by rainwater. Additionally, light and sound barriers should be installed above the railway track to reduce the disturbance due to train traffic on animals using underpasses.

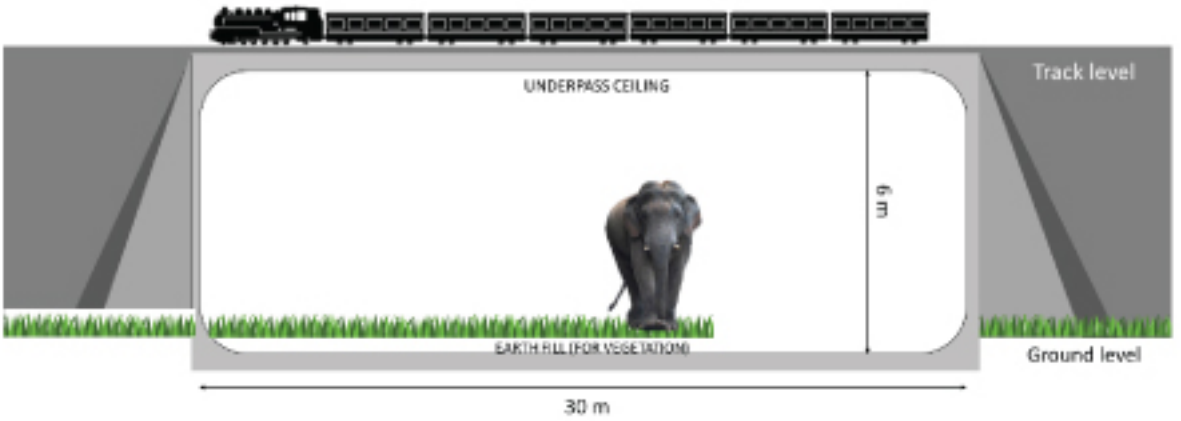

Figure 3. Graphic representation of an underpass for elephants below a railway track.

4. Wildlife overpasses

Wildlife overpasses are bridge-like structures built at a height across linear infrastructure (roads and railway lines) to allow wildlife to move across the gap in the habitat. Such structures are usually enhanced with natural habitat features such as native vegetation, rocks and logs. Wildlife overpasses are less confining, quieter and have ambient natural conditions of light and weather as compared to wildlife underpasses. Since wildlife overpasses are built at a height, construction of overpasses requires adequate height on either side of the road/railway line. Thus, overpasses should be built at locations with suitable height (> 7m) and topography on either side. A wildlife overpass should not be less than 30 m wide, and may be wider in case of double or triple parallel railway lines.

Overpasses should ideally be built using pre-fabricated material and installed on-site. The overburden from the construction site or excavated from other sites may be used for filling. Further a suitably thick layer of soil should be laid on top of the pre-fabricated material. Revegetation should then be carried out using native grasses and shrubs on the substrate to provide a natural movement path. Either side of the top of the

overpasses should be fenced with light and sound barriers (Fig. 4). The slope/approach of the overpass should be not more than 30 degrees at any point. If the overpass is to be constructed across two or more railway tracks, a supporting pillar/post may be provided for structural support (Fig. 5).

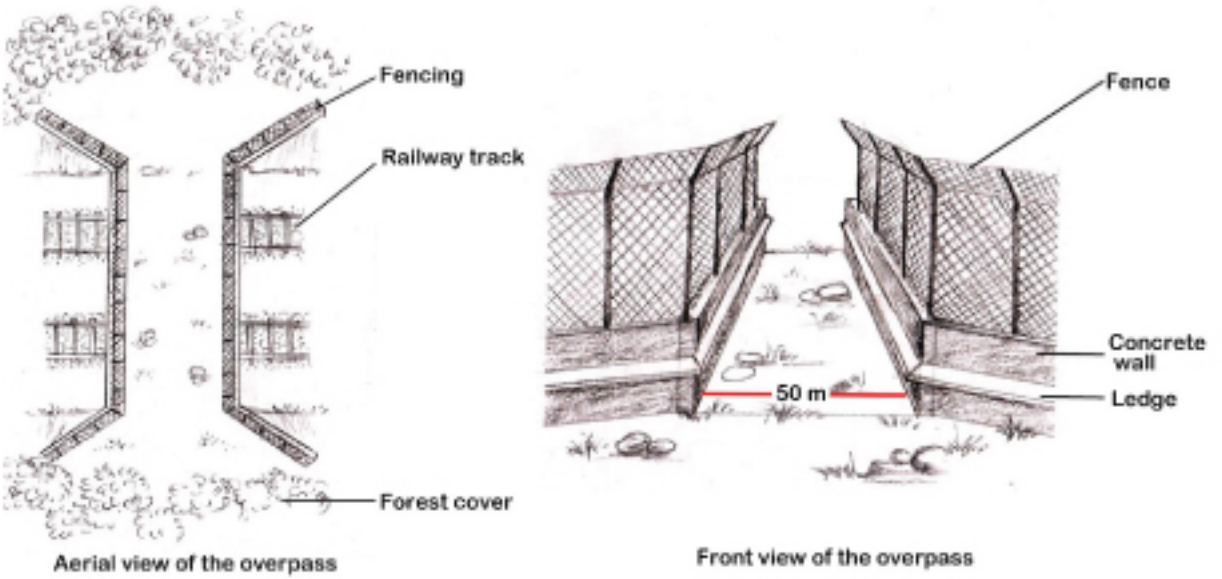

Figure 4. Aerial and front view of overpasses on railway tracks, with fencing/noise and sound barrier details.

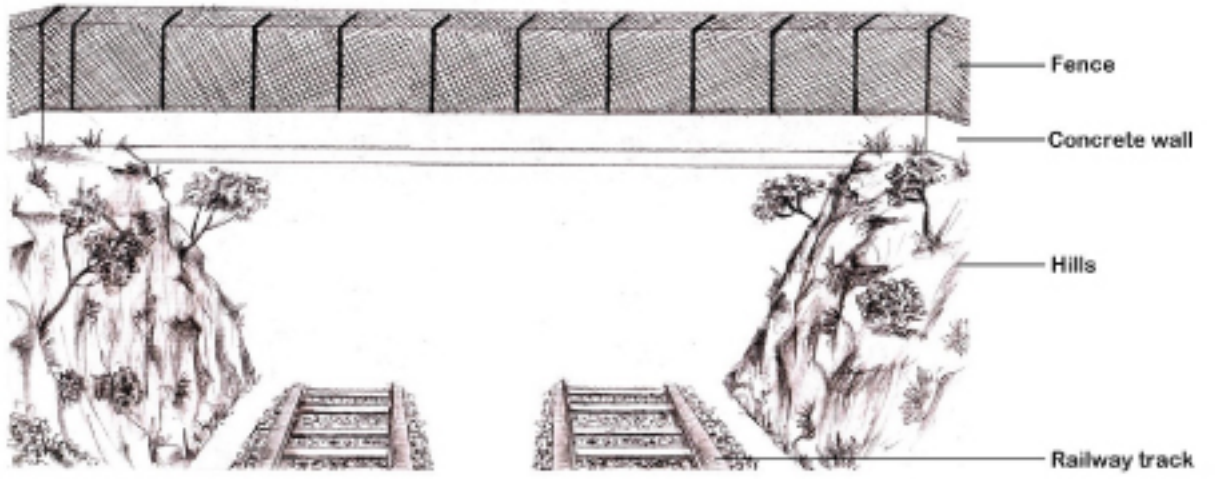

Figure 5. Lateral view of a wildlife overpass on a double-track railway line.

5. Installation of Distributed Acoustic Sensing (DAS) System

Irrespective of the type of mitigation measures to be employed across the sensitive railway stretches, all the sensitive stretches have to be installed with DAS. The system developed by railways to detect the presence and movement of the elephants along the railway tracks is basically an intrusion-based detection system based on Distributed Acoustic Sensing (DAS). A DAS monitoring interrogator converts a standard communications single-mode fiber into thousands of extremely sensitive

acoustic and vibration sensors. The Distributed Acoustic Sensor connected to one end of the fiber uses a laser to send thousands of short pulses of light along the fiber every second. A small portion of the light traveling in fiber is reflected by the process known as Rayleigh Backscatter. The concept of securing a network from malicious entities by capturing and monitoring data packets was first employed by James Anderson in 1980. Since then, researchers have developed various approaches to enhance the performance and accuracy of intrusion detection.

Vibrations from the surrounding environment will disturb the light in the fiber and will therefore be observed by the DAS interrogator. The events that are of concern are reported to the alarm server. As the data is processed in real-time, advanced algorithms can recognize the unique signatures of each type of event.

The system can show the precise location of the event, and information about what event has taken place, which means the laser pulse frequency, pulse width, and many other parameters. These parameters can be controlled, enabling the system to be tuned to the desired requirement. Integrated with machine learning and artificial intelligence, the system can differentiate even between minor variations in the scatter. The optic fiber cable running along infrastructure and other important assets can give uninterrupted and real-time feedback on activities occurring along and around them.

The recommendations of the MoEFCC committee constituted vide office order No. WL-8/28/2022-WL on 3rd January 2023 needs to be considered for the implementation of the DAS.

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