

Rajasthan State Highways Development Program II
(A World Bank Funded Project)

Environment Management Framework

June 29, 2018

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Executive Summary

The Rajasthan State Highway Development Program II is designed to build capacity for better management of state highways and to improve traffic flows and safety on selected state highways in the state of Rajasthan. The project has five components

- **Component 1: Operationalisation of the Rajasthan State Highways Authority :** The Project will support operationalisation of the Rajasthan State Highway Authority (RSHA), in accordance with the provisions of the Rajasthan State Highways Act, 2014. The goal is to transform the management of the strategic road network through operationalising a i State Highways Agency
- **Component 2: Highway Improvements:** This includes
 - **Subcomponent 2A: State highways improvements.** The project will support construction/upgrading/improvement of 766 km of state highways and major district roads through two contract approaches explained below:
 - **Upgrading and Maintenance through EPC Contracts:** This subcomponent will support civil works under EPC contracts for widening/ upgrading/ improvement of approximately 472 km of existing state highways and major district roads to two-lane/four-lane with granular/ paved shoulders, including formation, realignment, new structures and pavement strengthening, plus maintenance for a five-year period after the construction. The services of one or more firms as “authority engineers” for supervision of EPC contracts would also be used in the project.
 - **Upgrading and Maintenance through PPP – Hybrid Annuity Mode:** This subcomponent will support civil works under PPP-Hybrid Annuity Mode (HAM) contracts for widening/ upgrading/ improvement of approximately 294 km of existing state highways and major district roads to two-lane/four-lane with paved shoulders, including formation, realignment, new structures and pavement strengthening, plus and maintenance during the concession period of ten years. The services of one or more firms as “independent engineers” for supervision of HAM contracts would also be used
 - **Subcomponent 2B: Piloting Green Highways:** This subcomponent will finance demonstration projects of the concept of green highways, incorporating resource efficiency and sustainability measures from a menu of options such as pavement recycling, use of local materials, recycled aggregates, use of innovative materials, plantations along the corridor, bio-engineering, soil and water conservation, new technologies, and energy-efficient lighting through solar.
 - **Subcomponent 2C: Climate-Resilient Highways** This sub component will support implementation of a resilient design of the project roads located in flood prone zones, a design that ensures the use of appropriate wearing course binder resilient enough to withstand the adverse effect of extreme heat.
 - **Subcomponent 2D: Piloting Digital Highways** With the aim of making state

highways safer and smarter, this subcomponent will finance the piloting and demonstration of the concept of Digital Highways through design and implementation of Intelligent Transportation System (ITS) applications in selected project highways

The other subcomponents include:

- **Component 3: Institutional Strengthening:** This includes the following sub-components a) Strengthening Business Processes and Systems b) Road Asset Management System and Network Planning Tool c) Citizen Engagement and Accountability d) Capacity Building.
- **Component 4: Road Safety:** The road safety component will take a multi-sectoral approach to building the state's capacity for road safety management, using both proactive and preventive methods.
- **Component 5: Project Management Support:** This would include Project management for operationalizing RSHA and also hiring of Project management consultants among other.
- **Climate Change Mitigation and Adaptation.** Rajasthan is located in the hottest climatic zone of India, with two thirds of its area comprising the Thar desert, which is exposed to intense solar radiation and high wind velocity. The state has the maximum vulnerability and lowest adaptive capacity to climate change challenges. A climate screening related to the proposed highway investments will be carried out, and adaptation and resilience measures will be incorporated into both the built infrastructure and the capacity-building programs. The impact of the proposed investment on the GHG emission will also be assessed through a widely used tools.

The environment management process and tools for the program has been designed keeping in mind the varied scope of work. It includes upgrading of about 766 km of state highways, road safety and ITS interventions, development of green and climate resilient highways. The EMF focuses on all the components associated with the planning, construction and operation of the road upgradation and maintenance of the roads under RHSDP II. Given that the sub-project roads can be from anywhere in the districts in western Rajasthan namely Jaisalmer, Jodhpur, Sri Ganganagar, Barmer, Bikaner, Hanumangarh, Churu, Nagaur and Pali Jalore, this guiding framework is prepared to ensure that subsequent project activities have a common understanding of the environmental and social issues involved, and a harmonised approach to handling these issues is followed. This Environmental Management Framework (EMF) will be used to identify the environmental and social impacts of each sub-project and help design commensurate mitigation/enhancement measures as well as to assign the responsibility for implementation of these measures.

The EMF for Rajasthan State Roads Development Program has been informed by (i) a) the results of an environment screening exercise; ii) rapid assessment of a few sample sub-project corridors; iii) experiences from the Bank-funded road projects in the state, particularly the completed Rural Roads Project I, on-going PMGSY – RRP II and Rajasthan Road Sector Modernization project iv) review of secondary data on different environmental components including regulatory frameworks, (v) experiences from similar state road projects implemented/under implementation elsewhere in the country.

The adverse impacts are likely to be fairly limited in the local context, the exact nature and magnitude of impacts will vary in accordance to the location and type of proposed engineering intervention. In view of the project's potential impacts on the environment, the Bank's OP 4.01 on Environmental Assessment and OP 4.11 on Physical Cultural Resources have been triggered, and the project is designated as Category B. As per the EIA Notification 2006 and the subsequent amendment, all State Highway with exceptions are classified as Category B2 and are exempted from the process of Environmental Clearance in India. Thus the projects under RHSDP II does not have to obtain environmental clearance However, the Project, has to obtain statutory permits relating to discharges and emission to air and water and also generation of hazardous waste. The contractor also need to abide by the other statutory provisions applicable e.g. Fly Ash Notifications 2016. For abstraction of groundwater for construction the Contractor needs to apply to the Central Groundwater Board for permits. Some of the project roads would cross the Aravalli range but would not attract the provisions of the Aravalli Notification.

The screening studies carried out under the RHSDP indicated that the projects under RHSDP II does not pass through any protected areas e.g. National Park, Sanctuaries etc. However, there are other sensitivities e.g. wildlife in modified habitats. In addition, due the physiographic location the western part are faced with scarcity of surface water resources (due to scanty rainfall) and also groundwater (due to over exploitation for domestic, agricultural and industrial purpose). The region also experiences extremes of temperature with highs >47°C (beyond the softening point of VG10/VG20 grade of bitumen normally used for road construction, resulting in bleeding of road). Parts of the project districts e.g. Jodhpur, Pali and Barmer in the basins of River Luni and its tributaries are prone to flooding. The district of Jaisalmer have sandy soil and also experiences high wind speed and thus are prone to erosion by wind .

Key issues which have been identified include:

Protection and Preservation of Surface water resources: Due to the scarcity of the water resource and also supply of drinking water surface water bodies have been developed by communities to harvest rainwater and use them for drinking purpose. The catchment and the water bodies are protected from any pollution: The project road would pass through settlements though in few cases due to technical and resettlement considerations realignment/bypasses have been proposed. However, in most cases the road would pass through settlement. During the construction phases health and safety of the community in these settlements would be a great concern. Additionally, during the operations the increased speed of the vehicle would also be a cause of concern. Similarly, sensitive receptors e.g. educational institutions, hospitals adjoining the highway would also have serious health and safety concern during the operations. Encroachment into the waterbodies or their catchment or discharge of run-off from the pavement into these waterbodies would have serious impacts on the scarce water resources. Also, utilisations of the surface water for construction purpose would cause scarcity of drinking water

Usage of Groundwater: The scarcity of groundwater has led to the overexploitation of groundwater in all the districts. Even some tehsil of the project districts has been notified i.e. extraction of groundwater is only permitted for drinking purpose. Thus, extraction of water for construction from groundwater would also have severe impacts on the already stressed resource.

Interactions with Wildlife: Even though the project road does not interfere with any presence of sensitive natural habitats (Biosphere Reserve, National Parks, Sanctuaries, Wetlands, Reserved and Protected Forests); eco sensitive zone but there are modified habitats in the projects districts. These modified habitats have considerable population of Black bucks , Chinkaras, Nilgai's. These animals cross the road in search of food and water. There are reports of road kills especially in the districts of Jodhpur, Pali and Nagaur.

Occupational Health and Safety: The workers involved in the operations of the machinery, and plants are also at risk. In addition, since most of the work of the expansion of the highway would be carried out when the traffic is in operations the chances of accidents are increased.

The other concerns though minor in nature would be due to the felling of roadside plantation; water logging, flooding and drainage issues especially in flood prone area; physiographic conditions; soil resources including erosion prone areas; material sources and their requirement (earth, sand, aggregates); management and disposal of spoil materials, debris and scarified bitumen and cultural heritage sites; religious properties. Broad mitigation measures have been defined for each of them. Mitigation measures include provision of rainwater harvesting for sourcing construction water, use of saline ground water after treatment in construction, use of alternative technologies include water conservation measures e.g. used of plasticizers, compensatory plantation in line with the local laws. Further, an attempt has been made to estimate the magnitude of the climate related impacts – of the proposed improvement to roads and on the roads considering currently known trends for the future. Based on this, the required adaptation and mitigation options are being evaluated. These would further be elaborated in the EA and EMP studies carried out for each of the project roads.

Preparation of Environmental Impact Assessment (EIAs) along with preparation of corridor specific Environment Management Plans (EMPs) for roads under Component 2 in line with Bank policies and applicable environmental laws and regulations of GoI and GoR would be carried out.. The project design and implementation planning have been informed by the EA process and outputs, which are integrated in documents such as bidding/contract documents for works and ToR for Authority/ Independent Engineer.

The specific mitigation measure suggested in the EMP would further be analysed during the detailed design by the EPC Contractor or Concessional (in case of HAM contracts) and included in the final designs.

The overall program including the construction activities would be headed by the Secretary of the Works Department and he would have oversight into the preparation and implementation of the program including the environmental safeguards. At the Public Works the Engineer- in -Chief responsible for the PPP division would not only oversee the program but will also supervise the program

The construction activities of RHSDP II would be headed by the Chief Engineer of the PPP cell who will be responsible for the successful implementation of the Project. The Chief Engineer would be assisted by an Environmental Officer and Health Safety officer equivalent to the rank of an Executive Engineer. The team at the PMU would be assisted by the Environmental Officer Project Management Consultant (PMC).

At the PIU the Project Director an officer of the rank of Executive Engineer who is the Project Director would also be responsible for the environmental health safety performance of the project road. He would be assisted by an EHS Engineer of the rank of Assistant Engineer who would be responsible for ensure that the provisions of the environmental management plan

are implemented. The Authority/ Independent Engineer associated with the PIU would also have an Environmental Engineer. He would assist the PIU in ensuring that the provisions in the EMP are implemented. The actual responsibility of implementation of the EMP would be with the Contractor. An Environmental Engineer and Health Safety Officer would be responsible for the implementation of the environmental safeguards. The roles and responsibilities of each of these officials have also been detailed out in the EMP

Training and capacity building would be required especially for the PMU and PIU staff associated with the project as the Environmental Safeguards would be a relatively new area which staff are required to handle. The training and capacity building would not only be project specific but would target and developing long term capacities in the PPP Division. The training program would include

- **Sensitisation Training:** primarily aimed at introducing the EHS safeguards to the officers and also make them aware of the responsibilities and benefits of implanting the environmental safeguards.
- **Orientation Training:** introducing the Environmental safeguards to the PIU staff and making them aware of the key principles of environmental safeguards
- **Detailed Training:** aimed at the PIU staff and the Authority/ Independent Engineer to make them aware of the detailed activities which needs to be implemented and enforced during the EMP Implementation
- **Refresher Training:** this would be a need-based training organised to rectify the shortcomings identified during the Monitoring and Auditing.
- **Specialised Training:** These would include training on developing Climate resilient highways, green highways. These trainings would also include only an overview of road safety as the detailed training on road safety are being separately envisaged

An Environmental Monitoring Program has been drawn up to essentially monitor the day to day activities in order to ensure that the environmental quality is not adversely affected during the implementation. The monitoring programme consists of Performance Indicators and Process Indicators. The performance indicators would identify the components which have to be monitored and reported on a continuous basis during the stage of the implementation. These would help identify the level of environmental performance of the project. In addition, there would be Process Indicators which would help in assessing the effectiveness of the system which has been instituted for the program.

For reporting of environmental performance, a reporting framework has been defined. This includes:

- **Daily Monitoring Report:** by the contractor to the Authority/Independent Engineer on the environmental actions which has been implemented.
- **Fortnightly Monitoring Report:** by the Authority/Independent Engineer to the PIU and PMC
- **Monthly Monitoring** by the PMC and reporting to the PMU
- **Quarterly Auditing** by the PMU to the Management

- **Annual Audit** by an External Agency of the entire process of EMP Implementation and reporting to the PMU for onward reporting to the World Bank

The Environmental Performance and Process Monitoring Tool (EPPMT) would be developed in sync with the project management component envisaged in RHSDP II. The tool would help in reporting of the environmental performance of the individual corridors. This would also help the PMU analyse the information and help them in making strategic decisions. The PMC would help the PMU in design the tool and also develop the Terms of reference for developing a web-based tool.

The information collated by the EPPMT would be analysed by the PMU and PMC. This information would be helpful in defining the procedures for operationalisation of the RSHA. It would further help in defining the procedures for the RSHA and integration of the environmental concerns into the operations of RSHA

1 Project Overview

1.1 Project Background

The Rajasthan State Highway Development Program II is to build capacity for better management of state highways and to improve traffic flows and safety on selected state highways in the state of Rajasthan.

1.2 Project Components

The project will have five components:

Component 1: Operationalisation of the Rajasthan State Highways Authority

The Project will support operationalisation of the Rajasthan State Highway Authority (RSHA), in accordance with the provisions of the Rajasthan State Highways Act, 2014. The goal is to transform the management of the strategic road network through operationalising a i State Highways Agency. To help design this component, an institutional capacity assessment was undertaken by the Bank team in collaboration with the client, based on the “Institutional Development Route map” (IDR) tool developed to promote a more programmatic, outcome-based approach to institutional development across WB financed transport projects.

Component 2: Highway Improvements

Subcomponent 2A: State highways improvements (Total cost US\$ 373 million, including IBRD financing of XX million). The project will support the Rajasthan State Highway Development Program, announced in FY 2014-15, an ambitious plan of developing 20,000 km of state highways and major district roads through PPPs, requiring US\$3 billion investment for the entire development. In the first phase of the program, 139 priority road corridors with a length of 9,038 km—selected on the basis of traffic levels and viability for private capital investments—are to be developed. To support this huge investment requirement, state government has sought assistance from multiple development partners such as World Bank, Asian Development Bank, and Malaysia to be implemented under multiple phases. Financial feasibility studies for all these roads have already been completed. These revealed that the traditional BOT-Toll PPP model would not be commercially viable and amenable for these corridors due to low traffic densities. However, there is potential to harness private investment and operational efficiencies in developing and operating such corridors through innovative options such as the hybrid-annuity PPP model. For World Bank support, 22 priority road corridors (state highways and major district roads) totalling about 2,100 km were initially identified for inclusion based on traffic levels, socio-economic importance, and the existing level of service/condition of the roads. Out of this group of roads, the project will support construction/upgrading/improvement of 766 km of state highways and major district roads at an estimated cost of US\$ 373 million through two contract approaches explained below:

Subcomponent 2A.1 Upgrading and Maintenance through EPC Contracts This subcomponent will support civil works under EPC contracts for widening/ upgrading/ improvement of approximately 472 km of existing state highways and major district roads to two-lane/four-lane with granular/ paved shoulders, including formation, realignment, new structures and pavement strengthening, plus maintenance for a five-year period after the construction. The contracts will include (i) the design and deployment of ducting for fiber optic cables along the state highways, and

in some cases possibly the laying of the cables as well; (ii) application of social and environment safeguard measures; (iii) safety improvements; and (iv) intelligent transport system infrastructure.

Subcomponent 2A.2 Supervision of EPC Contracts This subcomponent will finance the services of one or more firms as “authority engineers” for supervision of EPC contracts.

Subcomponent 2A.3 Upgrading and Maintenance through PPP – Hybrid Annuity Mode This subcomponent will support civil works under PPP-Hybrid Annuity Mode (HAM) contracts for widening/ upgrading/ improvement of approximately 294 km of existing state highways and major district roads to two-lane/four-lane with paved shoulders, including formation, realignment, new structures and pavement strengthening, plus and maintenance during the concession period of ten years. The concession will leverage an estimated private financing equivalent to \$80 million in capital investment and O&M costs. All these roads will have toll plazas managed by a separate contractor. The annuity payment to the concessionaire is not dependent on the toll revenues since the traffic risk under this model is not borne by the concessionaire. The contracts will include (i) the design and deployment of ducting for fibre optic cables along the state highways, and in some cases possibly the laying of the cables as well; (ii) application of social and environment safeguard measures; (iii) safety improvements; and (iv) intelligent transport system infrastructure.

Subcomponent 2A.4: Supervision of HAM Contracts This subcomponent will finance the services of one or more firms as “independent engineers” for supervision of HAM contracts.

Subcomponent 2B: Piloting Green Highways: This subcomponent will finance demonstration projects of the concept of green highways, incorporating resource efficiency and sustainability measures from a menu of options such as pavement recycling, use of local materials, recycled aggregates, use of innovative materials, plantations along the corridor, bio-engineering, soil and water conservation, new technologies, and energy-efficient lighting through solar.

Subcomponent 2C: Climate-Resilient Highways This sub component will support implementation of a resilient design of the project roads located in flood prone zones, a design that ensures the use of appropriate wearing course binder resilient enough to withstand the adverse effect of extreme heat.

Subcomponent 2D: Piloting Digital Highways With the aim of making state highways safer and smarter, this subcomponent will finance the piloting and demonstration of the concept of Digital Highways through design and implementation of Intelligent Transportation System (ITS) applications in selected project highways. The ITS applications to be considered under the scope of this project include Toll Management Systems and Control Center, Incident Detection and Management Systems using CCTV cameras, Variable Message Signs, Speed Management Systems using ANPR (license plate recognition) Speed Cameras, and Solar-powered Animal Crossing Warning System, among others.

Component 3: Institutional Strengthening

Subcomponent 3A: Strengthening Business Processes and Systems

- The development of an online project management system (e-PMS), together with a companion smartphone application, to handle contract management, data reporting, quality control, invoicing, payments, and financial reporting electronically on a web-based platform.
- The development of an online management information system for the implementation of Resettlement Action Plans (e-RAP), with the aim to enhance

the transparency and accountability of the process. The geo-referenced MIS and a companion mobile app will be designed to track the progress of resettlement on a real-time basis and help project authorities to make informed decisions based on in-time evidence from the field.

- Provision of training for PIU and PMU staff on these tools.

Subcomponent 3B: Road Asset Management System and Network Planning Tool The project will finance (i) the implementation of the road asset management system (RAMS) in RSHA and PWD being developed under the ongoing Bank-financed Rural Road Sector Modernization Project (RRSMP); (ii) the development of a linked system for future highway network expansion/upgrading and corresponding investment plans based on transport demand modelling; and (iii) strengthening the existing asset management cell in PWD and RSHA, including training, communication, and knowledge exchanges with other states and countries.

Subcomponent 3C: Citizen Engagement and Accountability Mechanisms The project will finance the following mechanisms for citizen engagement and accountability:

- A comprehensive communications strategy for all project beneficiaries and affected persons to be kept informed of activities and issues that concern them.
- A Grievance Redressal Mechanism (GRM) to deal with problems raised by affected persons and serve as a conduit for soliciting inquiries, inviting suggestions, and increasing community participation.
- User Satisfaction Surveys to obtain feedback on citizens' perceptions of the adequacy and efficiency of services provided under the project. The surveys will be administered three times during the life of the project: in year one to establish baseline, in year 3 to feed in to the mid-term review, and in the last year of the project to generate end-line data.

Subcomponent 3D: Capacity Building The project will finance a program of training and capacity building for PWD and RSHA staff including international and domestic training course, study tours, workshops, international exposure visit, and knowledge exchanges.

Component 4: Road Safety

The road safety component will take a multi-sectoral approach to building the state's capacity for road safety management, using both proactive and preventive methods.

Subcomponent 4A: Road Accident Database Management System (RADMS). This sub-component will provide support to the Government of Rajasthan in developing and operationalizing a Road Accident Database Management System (RADMS) anchored at the Police Department with the capability of crowdsourcing crash data. The following activities will be financed under this sub-component: (i) preparation of an improved crash/injury database system by systematically investigating current data collection and analysis systems, and analyzing options for better combined use of Police and Health data; (ii) development of specifications for a major initiative to reform crash data business processes, formalize agency roles and responsibilities, and prepare for new capital and operational investment; (iii) implementation of the crash data initiative, combining software and related hardware investments for a new crash data system, with additional operational investment in collecting, collating and analyzing crash data; and (iv) deployment of community-based road accident reporting for local residents to report to police and emergency services on crashes using a smartphone application to be developed by the project.

Subcomponent 4B: Speed Management Program This sub-component will support the piloting of a speed management program along selected high-risk corridors (approx. 100 kms in length). This will include the following activities: (i) Identification of high risk corridors (each approx. 100 kms in length); (ii) Undertaking speed management study to prepare recommendations and support policy and investment decisions regarding setting and enforcing speed limits, professional capacity building, public information and awareness, monitoring and evaluation; (iii) recommendation to Rajasthan on investment in automated enforcement, including mapping priority enforcement sites and establishing a highway patrol (within the Police Department); (iv) develop a program of professional capacity building, publicity and communications activities; and (v) Developing and implementing monitoring and evaluation systems for the program.

Subcomponent 4C: Road Safety Performance Survey). The project will support a road safety performance survey for selected state highway network (about 500 km), or at least for the strategic network, to establish the road safety level in each road segment. This is a proactive/preventive approach to help the PWD/RSHA, and the road safety lead agency to understand the safety risks involved in each road corridor and the required investment to bring the risk to an acceptable level. The following activities will be financed: (i) Conduct a comprehensive iRAP survey for high risk state highways (about 500 km); (ii) Prepare a Safer Roads Investment Program (SRIP) to estimate future infrastructure safety needs and plan a significant multi-year investment allocation to upgrade the safety star rating of the core road; and (iii) Undertake iRAP training for senior PWD staff. This subcomponent will be a pilot on a small scale, with a view to help the state scale it up to the state road network as appropriate and feasible.

Subcomponent 4D: Road Safety Strategy Building upon the work previously done under the RRSMP, this sub-component will provide support to the Government of Rajasthan in developing an ambitious long-term road safety strategy based on the safe systems approach, incorporating: (i) an ultimate vision for road safety in Rajasthan; (ii) interim targets for final and intermediate outcomes; (iii) strategic directions for a full range of interventions; (iv) management and implementation arrangements including funding requirements; and (v) related monitoring and evaluation tools. The project will finance technical assistance to (i) prepare the long-term road safety strategy and identify one or more funding mechanisms and (ii) prepare a multi-year action plan to implement the new strategy.

Subcomponent 4E: Review of Approach to Black Spots. For many years, Rajasthan and other states have been treating black spots by signage, guard rails, speed calming measures, speed restrictions, improving sightlines, straightening bends, and the like. More recently, a debate has arisen over the effectiveness of such measures, in terms of how black spots are defined, identified, and remediated. This sub-component will support an exercise to re-assess existing approaches to black spot improvements and to disseminate and discuss the results. This may also result in the development of new training program for PWD staff and police officers.

Component 5: Project Management Support

Subcomponent 5A: Project management for operationalizing RSHA. The project will finance consultants, studies, and incremental operating costs for the Project Management Unit that will implement the activities related to Component 1, operationalization of the RSHA. This will include (i) financial management, procurement, and safeguards; (ii) data collection and reporting for monitoring and evaluation; and (iii) financial audits.

Subcomponent 5B: Project Management for PWD. The project will finance consultants, studies, and incremental operating costs for the PPP Division of PWD to implement Components 2, 3 and 4

of the project, including (i) financial management, procurement, and safeguards; (ii) data collection and reporting for monitoring and evaluation; and (iii) financial audits.

Subcomponent 5C: Project Management Consultant This subcomponent also will finance the services of a Project Management Consultant (PMC) to provide technical advice and implementation support to PWD, including inter alia, (i) monitoring components 2, 3 and 4 with periodic site visits; (ii) reminding the client of any major actions it would need to take as per the contracts or in response to the loan covenants of the Bank; (iii) assessing the progress of project outputs and outcomes per the project's M&E framework; (iv) act as PWD's technical agent during its site visits and bring to the notice of PWD any significant quality aberrations or cost variations; (v) support the client on all environmental and social management activities/ requirements of the project; and (vi) prepare monthly and quarterly project reports for PWD and the Bank.

Subcomponent 5D: Independent Technical Audits and DLI Verification The project will finance the services of an independent Technical Audit Consultant (TAC) to perform an annual Integrated Performance Audit covering, inter alia, engineering designs, management of social and environmental issues, procurement, quality assurance, contract management, compliance with loan and contract conditions, works supervision, and verification of the achievement of DLIs to trigger disbursements. DLI verification will cover all DLIs with targets to be achieved in a given year. The TAC will normally review a sample of the civil works and other contracts under the project. The TAC may also review any contracts having sensitive environmental or social impacts or which require special oversight as determined by the client and the Bank.

Subcomponent 5E: User Satisfaction Surveys The project will finance user satisfaction surveys covering samples of beneficiaries of the project's road users and others to be identified.

Mainstreaming gender equality and the needs of differently abled persons. Potential gender-related interventions are under discussion; for example, gender audits for road designs and security enhancements for women and girls at bus stops and other locations. The project will also launch a study to explore the linkages between the rampant human trafficking in Rajasthan, in which women and girls are highly vulnerable, to inform future designs of future transport projects, and retrofit any possibilities to include interventions in the proposed project as appropriate. With regard to differently abled persons, designs adjacent to built-up areas as well include facilities such as access to and from the road proper ramps at bus stops, etc.

Maximising Finance for Development (MFD): The project addresses MFD in two areas: (i) mobilising private capital through a hybrid annuity PPP model on selected highway upgrading subprojects and (ii) operationalising a corporatised highway agency with a mandate to mobilise commercial capital leveraging public resources at its disposal.

Climate Change Mitigation and Adaptation. Rajasthan is located in the hottest climatic zone of India, with two thirds of its area comprising the Thar desert, which is exposed to intense solar radiation and high wind velocity. The state has the maximum vulnerability and lowest adaptive capacity to climate change challenges. A climate screening related to the proposed highway investments will be carried out, and adaptation and resilience measures will be incorporated into both the built infrastructure and the capacity-building programs. The impact of the proposed investment on the GHG emission will also be assessed through a widely used tools.

1.3 Project Activities

The environment management process and tools for the program has been designed keeping in mind the varied scope of work. It includes upgrading of about 766 km of state highways, road safety and ITS interventions, development of green and climate resilient highways. The EMF focuses on all the

components associated with the planning, construction and operation of upgradation and maintenance of the roads under RHSDP II. The road sector project can be classified into four stages which would make up the lifecycle of the project. Each of the stages would have several activities and sub-activities. The four stages are

- Feasibility Stage
- Pre-Construction Stage
- Construction Stage
- Post-Construction, Operations & Maintenance Stage

The sub-activities and activities which would be undertaken in each of the four stages are detailed in Figure 1-1.

1.4 Requirement of the EMF

The state highways proposed for upgrading, under the World Bank Supported project are distributed across the districts in the western part of the Rajasthan¹ namely Jaisalmer, Jodhpur, Sri Ganganagar, Barmer, Bikaner, Hanumangarh, Churu, Nagaur and Pali Jalore. The proposed development envisaged in project would pertain mostly to improvement / strengthening / widening / maintenance of existing State Highways (SH). The proposed road improvement work would be concentrated along the existing alignments; however, there may be some roads which require some realignment for geometric improvement/constriction on the Right of Way. Some of the alignment/ realignment may pass through or would be adjacent to the environmentally sensitive areas.

Given that the sub-project roads can be from anywhere in the above-mentioned districts, this guiding framework is prepared to ensure that subsequent project activities have a common understanding of the environmental and social issues involved, and a harmonised approach to handling these issues is followed. This Environmental Management Framework (EMF) will be used to identify the environmental and social impacts of each sub-project and help design commensurate mitigation/enhancement measures as well as to assign the responsibility for implementation of these measures.

The EMF would ensure that decision making in subsequent stages of the project is informed and influenced by environmental and social considerations for each of the sub-projects, many of which may not have been identified at this stage of the project. The EMF aims to integrate environmental concerns into the project's design and implementation and would thus help PPP Division, Public Works Department (PWD), Government of Rajasthan integrate environmental concerns into the process of planning, designing, construction and operations.

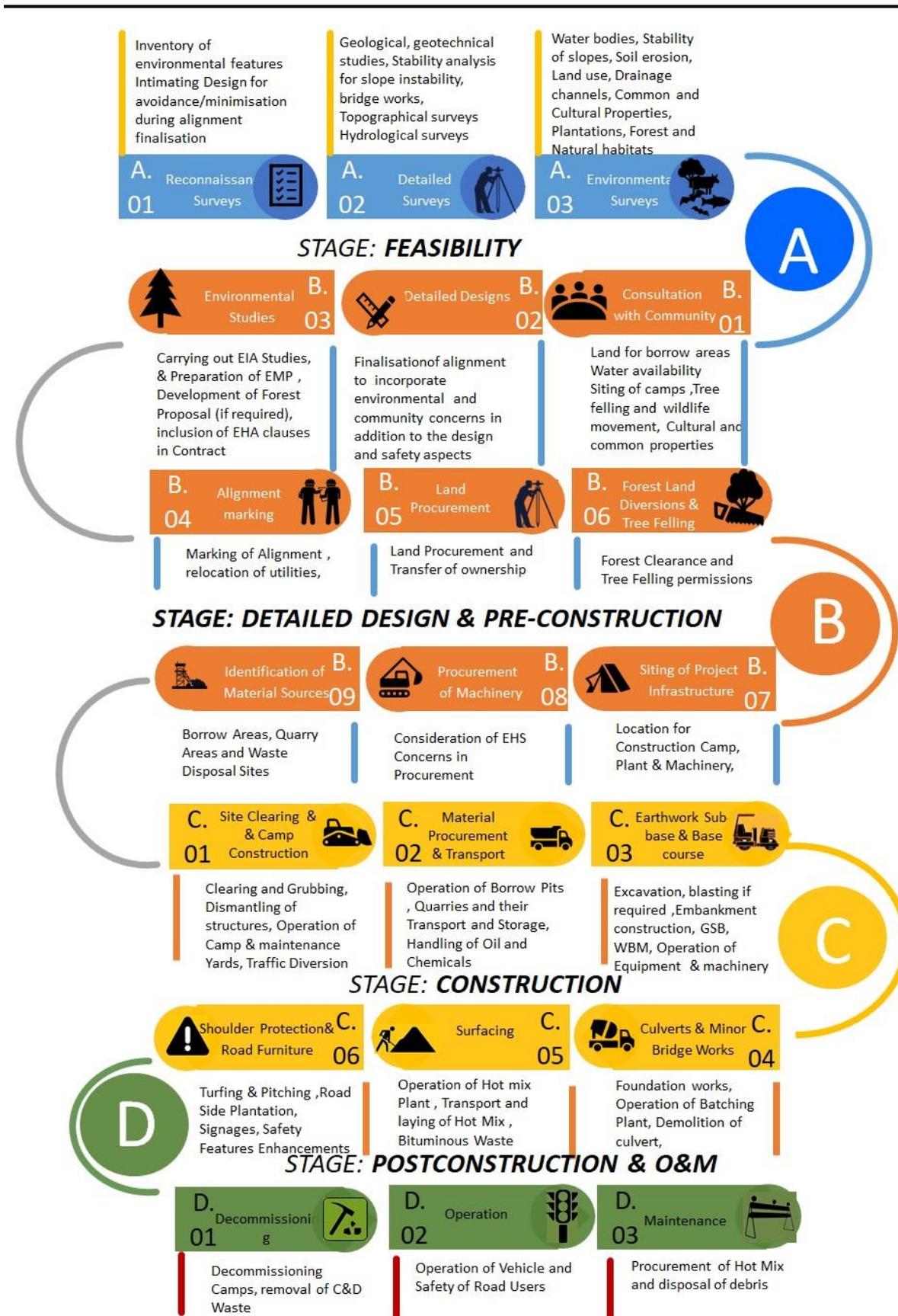
The EMF has been developed to provide:

- Clear procedures and methodologies for the environmental and social planning, review, approval of sub-projects to be financed under the Program;
- Define contractual obligations of the Contractor for environmental protection during the construction and operations phases;
- Specify appropriate roles and responsibilities, and outline the necessary reporting procedures, for managing and monitoring environmental and social concerns related to

¹ The State can be divided into two major divisions structurally along the Aravalli range into east and west Rajasthan and presents contrasting environmental setting..

subprojects;

Figure 1-1: Stages in the Road Construction along with the Activities and Sub Activities



- Determine the training, capacity building and technical assistance needed to successfully

- implement the provisions of the EMF;
- Establish the Project funding required to implement the EMF requirements; and
- Provide practical information resources for implementing the EMF.

The EMF would be an overarching tool developed at the macro level to provide guidance to the PMU for executing the project. The EMF in addition to the components mentioned above, would provide technical guidance in form of Guidance Notes.

1.5 Methodology of EMF Preparation

The EMF for Rajasthan State Roads Development Program has been informed by (i) a) the results of an environment screening exercise; ii) rapid assessment of a few sample sub-project corridors; iii) experiences from the Bank-funded road projects in the state, particularly the completed Rural Roads Project I, on-going PMGSY – RRP II and Rajasthan Road Sector Modernisation project iv) review of secondary data on different environmental components including regulatory frameworks, (v) experiences from similar state road projects implemented/under implementation elsewhere in the country.

1.6 Usage of the EMF

The recommended approach for the end users of the EMF i.e. the PMU is detailed, as follows:

- Use guidance provided in the document to assess localised impacts and determine mitigation measures based on the guidance provided in the document and the annexes
- Follow the technical guidance in the Environmental Code of Practices and the Environmental Conditions of Contract to ensure that the safeguards planned are duly implemented;
- Ensure that the guidance on personnel and community safety is not only integrated in to the planning but is also implemented by the contractor.

1.7 Structure of the EMF

The Management frameworks has been organised as follows:

Chapter 2: The Policy and Legal framework

Chapter 3: Environmental Sensitivities issues and Mitigation Measures

Chapter 4; Environmental Management Framework for Project Implementation

Chapter 5: Implementation Arrangement

Chapter 6: Consultation Disclosures and Grievances

2 The Policy & Legal Framework

The policy framework which would be guiding the projects and the legal compliance which the project has to comply, are summarised in the section below. It also provides a guidance on the responsibilities for the implementation and a timeframe in the project lifecycle when it would be applicable.

2.1 Applicable Environmental Policies Regulations and Guidelines

2.1.1 Legislations

The laws, legislation and policies applicable to the project has been reviewed and the actions which would be required has also been defined. The summary also provides the responsibilities for the implementation along with the statutory agency responsible for its enforcement. A summary of environmental legislations / regulations relevant to RHSDP II is furnished in Table 2-1

Table 2-1: Summary of the Legal and Policy requirement in the Project

Policy/Acts/Rules	Applicable /Project Relevant policies	Responsible Agency	Implications for RHSDP II
The Environment Protection Act 1986	The Environment (Protection) Act is an umbrella legislation seeking to supplement the existing laws on the control of pollution (the Water Act and the Air Act) by enacting a general legislation for environment protection and to fill the gaps in regulation of major environmental hazards. The act empowers central government to make rules to regulate environmental pollution, such as- The standards of quality of air, water, soil for various areas and purposes etc. Prohibits carrying out of any industry, operation or process which discharges or emits environmental pollution more than the standards Regulates handling of hazardous substances States, the persons responsible for discharges, bound to prevent or mitigate environmental pollution and intimate the	MoEFCC	The Act and the Rules framed under the act defines the standards for emission and discharges. All the equipment machinery which would be used in the project has to comply with the emission and or discharge standards specified. If The wastes which would be generated gets classified under any of the said category (municipal, plastic, construction and demolition, hazardous, e-waste etc) would also have to meet the requirements of the rules framed under the provisions of the act.

<i>Policy/Acts/Rules</i>	<i>Applicable /Project Relevant policies</i>	<i>Responsible Agency</i>	<i>Implications for RHSDP II</i>
	any accidents due to any occurrences.		
EIA Notification 2006 and amendments thereafter	<p>The notification specifies that prior Environmental Clearance is required for the projects listed in the schedule of the notification before any construction work, or preparation of land by the project management except for securing the land, is started on the project or activity.</p> <ul style="list-style-type: none"> The Schedule of the notification lists eight broad categories of projects that require prior environmental clearance. These are sub categorised into to Category 'A' and category 'B' based on the magnitude and environmental impacts of the project. <p>A category Projects require Clearance to be obtained from the Ministry of Environment, Forests while Category 'B' projects, require clearance from the State Environment Impact Assessment Authority (SEIAA). . Category 'B' projects will be further classified in to category 'B1' and category 'B2'.</p>	EAC (MoEF&CC) / SEIAA & SEAC (Rajasthan))	<p>All State Highway are classified² as Category B2 and are exempted from the process of Environmental Clearance.</p> <p>However New highway alignment (greenfield Projects) and expansion of existing state highway outside hilly terrain above 1000 m above mean sea level and or ecologically sensitive areas would require prior environmental clearance from the State Level Environmental Impact Assessment Authority (SEIAA). However, in case such sub-projects fall within (i) Protected Areas notified under the Wild Life (Protection) Act, 1972; (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time; (iii) Notified Eco-sensitive areas; and (iv) 5 kilometres from interstate boundaries and international boundaries would be treated as a Category A project and would require prior Environmental Clearance from the Expert Appraisal Committee of MoEFCC.</p>
	Sand borrow soil and aggregate used for road construction has been classified as a minor	District Level Expert Appraisal Committee/	The quarry sites borrow areas and the sand mines would require a prior environmental clearance

² The notification specifies that prior Environmental Clearance is required for the projects listed in the schedule of the notification. The Schedule of the notification lists eight broad categories of projects that require prior environmental clearance. These are sub categorised into to Category 'A' and category 'B' based on the magnitude and environmental impacts of the project. A category Projects require Clearance to be obtained from the Ministry of Environment, Forests while Category 'B' projects, require clearance from the State Environment Impact Assessment Authority (SEIAA). . Category 'B' projects will be further classified in to category 'B1' and category 'B2'

<i>Policy/Acts/Rules</i>	<i>Applicable /Project Relevant policies</i>	<i>Responsible Agency</i>	<i>Implications for RHSDP II</i>
	mineral as per The Rajasthan Minor Mineral Concession Rules, 2017.	District Level Impact Assessment Authority	under the EIA Notification 2006.
The Forest Conservation Act 1980 and The Forest Conservation Rules 1981	The central government enacted The Forest (Conservation) Act in 1980 to stop largescale diversion of forestland for non-forest use.	The Forest Department, Government of Rajasthan and MoEF&CC	Highways /sub-projects passing through any protected area (e.g. National Park, Reserve Forest, Protected Forest Wildlife Sanctuaries) or requiring use of any forest land for construction would need to obtain prior clearance ³ under the provisions of the Act
The Wildlife Protection Act 1972 ⁴ and the Supreme Court Ruling thereto	The act was enacted to protect wild animals and birds	Wildlife Division, Government of Rajasthan/ MoEF&CC	Sub-projects involving diversion of land within any National Parks, Wild Life Sanctuaries etc. will require permission of Standing Committee of National Board of Wild Life (NBWL) as per the W.P and associated Court rulings
Notification of Eco-Sensitive Zones	Non-forest activities in the eco-sensitive zone around a Wildlife Sanctuary or National Park would require recommendation ⁵ of the National Board of Wildlife	Wildlife Division, Government of Rajasthan/ MoEF&CC	Sub -projects near the wildlife would require to obtain prior recommendation of the National Board of Wildlife
The Water (Prevention and Control of Pollution) Act 1972	The Act vests regulatory authority on the State Pollution Control Board and empowers them to establish and enforce	Rajasthan State Pollution Control Board	All the discharges from the project activities especially construction camps/Labour Camps need to meet the standards specified.

³ As per the Forest Conservation Rules (1981, amended 2003) a Forest Clearance from Department of Forests is required for diversion of forest land for non-forest purpose. Processing of the forestry clearance entails two stages: stage I and stage II. Amongst other requirements stage I clearance requires the

applicant to make payments for compensation of forestry land that will be acquired and trees that will be cut under the project. Accordingly timely allocation of budget for this purpose by the applicant is necessary to expedite the clearance process.

⁴ Hon'ble Supreme Court though a number of order has made it essential to seek the recommendations of the National Board of Wild Life for regulating activities in the adjoining areas to the Protected Areas. Protection

⁵ In pursuance to the order of Hon'ble Supreme Court dated 4th December 2006 in Writ Petition (Civil) No. 460/2004, all non-forest activities in the Ecosensitive Zone would be under the jurisdiction of the notification. The Hon'ble Supreme Court vide its order dated 4th December 2006 had further directed that in case the Eco-Sensitive Zones are not declared by the respective states an area of 10km adjoining the sanctuary or national park would be declared as an Eco-Sensitive Zone

Policy/Acts/Rules	Applicable /Project Relevant policies	Responsible Agency	Implications for RHSDP II
(Amended 1988) and Rules 1974	effluent standards for industries and local authorities discharging effluents.		
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	An Act to provide for the prevention, control and abatement of air pollution The Act vests regulatory authority on the State Pollution Control Board and empowers them to establish and enforce emission standards for industries, other activities including local authorities carrying out emissions.	Rajasthan State Pollution Control Board	Applicable for equipment and machineries potential to emit air pollution e.g. hot mix plant, rock crusher, diesel generator and construction vehicles need to adhere to the norms specified in the rules. Consent for Establishment (CFE) and Consent for Operation (CFO) would be required for the plants from RSPCB prior to the establishment
Ancient Monuments & Archaeological Sites and Remains Act, 1958; Indian Treasure Trove Act, 1878; The Orissa Ancient Monuments Preservation Act, 1956	This Act provides for the preservation of ancient and historical monuments, Archaeological sites, remains of national importance, sculptures, carvings, etc. According to this Act, areas within the radii of 100m and 300m from the 'protected property' are designated as 'protected areas' and 'controlled areas' respectively. No development is permitted in such areas without prior permission from the Archaeological Survey of India (ASI).	Rajasthan Archaeological Dept. & Archaeological Survey of India	All sub-projects would try to avoid such areas in case a subproject is located within the 'protected areas' or 'controlled area' necessary permissions would be obtained
Solid Waste Management Rules 2016	Source segregation of degradable, nondegradable and hazardous wastes to be ensured.		The municipal solid waste generated from the labour camps would have to comply with the provisions of segregation of waste and its treatment & disposal.
Construction and Demolition Wastes (Management) Rules 2016	Every waste generator shall prima-facie be responsible for collection, segregation and storage of construction and demolition (C & D) waste generated, as directed or notified by the concerned	Rajasthan State Pollution Control Board	Sub-projects would generate construction waste during the dismantling of the old pavement or cross drainage structures. These wastes must be segregated, stored and disposed of separately as

<i>Policy/Acts/Rules</i>	<i>Applicable /Project Relevant policies</i>	<i>Responsible Agency</i>	<i>Implications for RHSDP II</i>
	<p>local authority in consonance with these rules.</p> <ul style="list-style-type: none"> • The generator shall ensure that other waste (such as solid waste) does not get mixed with this waste and is stored and disposed separately. • Any activity that generates 20 tonnes per day or 300 tonnes per project in a month must prepare a Waste Management Plan. • Waste generator either must store the waste within the premises or must supply to the city level collection centre and should avoid all kinds of obstruction to traffic/public or in drains. 		per the provision of these rules. A Waste Management Plan would also be developed for the project.
Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009),	The rules regulate the management and handling of Hazardous Waste generated from any activity. The rules make a distinction between hazardous waste and other waste (Waste tyre, paper waste, metal scrap, used electronic items, etc) and recognise them as resource for recycling and reuse.	Rajasthan State Pollution Control Board	The hazardous waste generated from the construction e.g. waste oils, lubricants, and bitumen would have to comply with the provisions of the rules with regards to storage and disposal. The rules also make it mandatory for maintaining records and reporting the same to the RSPCB.
Central Motor Vehicle Act (1988) Central Motor Vehicle Rules (1988)	The act and the rules formulated thereunder have provisions for control of vehicular air and noise pollution. They regulate development of the transport sector, check and control vehicular air and noise pollution.	Transport Department, Government of Rajasthan	The vehicles must obtain a Pollution Under Control Certificate under the provisions of the Act.
Mount Abu Eco-Sensitive Zone Notification, 2009	The notification prohibits or restricts certain activities There shall be no felling of trees whether on Forest, Government, Revenue or private lands within the Eco-Sensitive Zone without the prior		The Zonal Master Plan for Mount Abu 2030 lay down the provisions for the design of roads (State Highways and MDR). The sub-projects in the Mount Abu eco-sensitive zone

<i>Policy/Acts/Rules</i>	<i>Applicable /Project Relevant policies</i>	<i>Responsible Agency</i>	<i>Implications for RHSDP II</i>
	permission as per existing procedures. The Zonal Master Plan shall develop guidelines for the development of Hill roads.		should be designed as per the guidelines.
Wetland (Conservation and Management) Rules, 2016	Encroachment or construction activities within the wetland is prohibited	State Wetland Authority	The construction of roads in the vicinity of the wetland areas would need to ensure that it does not encroach into the area of the wetland denoted by the “Wetland Authority”
The Rajasthan Lakes (Protection and Development) Authority Act, 2015	The Act makes provisions for protection of lakes except for private properties located in such lakes. The Act empowers the state to declare the boundaries of the lake and also the area around the lake as a protected area.		No road construction can be undertaken in the protected area without obtaining prior permission of the Authority constituted under the Act
Rajasthan Land Revenue Act, 1956 and its amendments	No forest produce shall be moved into or from or within any area in the State of Rajasthan without a pass issued by a Forest Officer and as per the conditions specified in the pass	Forest Department, Government of Rajasthan	The removal of trees from forest land and those within the RoW would require authorisation from the Forest Department. For trees on private land regulatory processes as applicable shall be dealt in the Resettlement Action Plan
Fly Ash Notification 2016	The Notification mandates road construction projects within an area of 300 Km to mandatorily use fly ash for construction of the embankment.	Ministry of Environment Forest and Climate Change	The Contractor has to use the fly ash from within 300 km of the project site
Abstraction of Ground water u/s 5 of the Environment (Protection) Act, 1986	Ground water abstracted for construction purpose shall require the prior permission of the authority. The permission would be required for sinking the bore well and wells and the quantum of water that can be extracted and the dept from which it can be extracted.	Central Ground Water Board.	In case the Contractor withdraws ground water for the construction purpose he shall have to obtain a permission from the Central Ground Water Board.
Aravalli Notification 2006	The Aravalli Notification states that identified	District Level Committee (Alwar)	Only sub-project roads in Gurgaon and Alwar districts

<i>Policy/Acts/Rules</i>	<i>Applicable /Project Relevant policies</i>	<i>Responsible Agency</i>	<i>Implications for RHSDP II</i>
	activities ⁶ in the notification in reserve forest, protected forest or designated as forest in land records or all land designated as Gair Mumkin Pahar, Gair Mumkin Rada, Gair Mumkin Behed, Banjad Beed, Rundh as per land records in Gurgaon district of Haryana and Alwar districts of Rajasthan would be covered under the Notification and would require a clearance from the District Expert Committee in the Gurgaon and Alwar.		would be covered under this notification

2.1.2 Policies

Projects financed with World Bank assistance should comply with World Bank Operational Policies. These safeguard policies have been designed to reduce or eliminate the adverse effects of development projects. The World Bank Environmental Safeguard Policies which would be triggered due to the project and are presented in Table 2-2

Table 2-2:Applicable World Bank Policies in the Project

<i>World Bank Safe Guard Policies</i>	<i>Objective</i>	<i>Applicability</i>	<i>Safeguard Requirements</i>
OP 4.01: Environmental Assessment	The policy requires environmental assessment (EA) of projects under Bank financing to help ensure that they are environmentally sound and sustainable. EA considers the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples, and	The environmental issues in all projects need to be addressed adequately in advance. An integrated Environmental Screening and Environmental Assessment (EA) with Environmental Management Plan (EMP) needs to be	For each of the sub project an Environmental Assessment and Environmental Management Plan would be carried out covering all the phases of the project

⁶ (i) Location of any new industry including expansion modernisation; (ii) (a) All new mining operations including renewals of mining leases, (b) Existing mining leases in sanctuaries/national Park and areas covered under Project Tiger and/or (c) Mining is being done without permission of the competent authority, (iii) Cutting of trees;

(iv) Construction of any clusters of dwelling units, farms houses, sheds, community centres, information centres and any other activity connected with such construction (including roads a part of any infrastructure relating thereto); (v) Electrification (laying of new transmission lines).

<i>World Bank Safe Guard Policies</i>	<i>Objective</i>	<i>Applicability</i>	<i>Safeguard Requirements</i>
	physical cultural resources); and transboundary and global environmental aspects.	developed to manage environmental risks and maximise environmental benefits	
OP 4.04 Natural Habitats	The policy recognises that the conservation of natural habitats is essential for long-term sustainable development. This policy provides for the conservation of natural habitats, which is essential for long-term sustainable development. The Bank supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue.	This policy may be triggered by the sub-projects where improvement activity of road would require forest/ sanctuaries, locating close to the natural habitats. Additionally, conservations areas which are not legally protected but have significant wildlife may also be called a modified habitat and would also trigger this policy	Efforts would be made in this project to avoid such natural habitats through careful planning. However, if unavoidable sub-projects/subprojects in natural habitats, a separate Biodiversity Assessment would be carried out and management plan would be developed
OP 4.36: Forest	This policy focuses on the management, conservation, and sustainable development of forest ecosystems and resources. It applies to project that may have impacts on (a) health and quality of forests; (b) affect the rights and level of dependence upon forests and projects that aim to bring about changes in the management, protection or utilisation of natural forests or plantations, whether they are publicly, privately or community owned. The Bank does not support the significant conversion or degradation of critical forest areas or related critical natural habitats.	Efforts would be made to ensure that the widening /construction of sub-projects do not infringe upon Forest lands However in case it becomes essential, diversion of forest land would be applicable.	Forest land diversion Application would be prepared for all sub-projects requiring forestland and would be submitted to the Forest Department for approval. In case of felling of trees requisite permissions would be obtained from the Forest Department before felling.

The Operational Policy (OP) 4.01 classifies projects into:

- Category A- requires a full Environmental Assessment (EA).
- Category B- projects require a lesser level of environmental investigation.

- Category C- projects require no environmental analysis.

The Rajasthan State Highway Development Program II (RHSDP II) does not interfere with any natural habitat or sensitive environmental areas. Further the impacts are mostly during the construction activities and are predictable local and thus mitigation measures can be clearly defined. The exact nature and magnitude of impacts will vary in accordance to the location and type of proposed engineering intervention. In view of the project's potential impacts on the environment, the Bank's OP 4.01 on Environmental Assessment and OP 4.11 on Physical Cultural Resources have been triggered, and the project is designated as Category B.

2.1.3 Guidelines

The Ministry of Surface Road Transport & Highways (MOSRT&H) specifications that govern road and bridges construction in India also cover environmental aspects of the works. In addition, the Indian Roads Congress also have environmental Codes which have integrated environmental considerations in them. These sections and codes which specifically related to the environmental safeguards are presented in Box 2.1

Box 2-1: Codes and Guidelines applicable

MOSRT&H Code:

- Section 111: Protecting the Environment, and Annexure A to Clause 501 which covers pollution aspects directly address environmental issues
- Clause 301 and 305: Stipulation of topsoil conservation
- Clause 302: Safety during construction for blasting
- Clause 304: Excavation and safety for operation stage
- Section 810: Maintenance of existing amenities and facilities
- Clause 201: Clearing and grubbing
- Clause 2501, Precautions during river training works
- Clause 305: Location of borrow areas, soil erosion and control measures
- Clause 701: Provision of geotextiles under
- Section 517 Recycle and reuse of existing pavement
- Clause 407: provision of turning
- Guidelines for Design of High Embankment
- Guidelines on Utilisation of Fly ash

IRC Codes:

- **Survey & Design:**
 - IRC SP 19 2001: Manual for Survey Investigation and Preparation of Road Project
 - IRC SP 54 - 2000: Manual for bridge Projects Geometric Design:
 - IRC SP 73 - 2007 Two-lining of Highways through Public Private Partnership Manual of Specifications & Standards,
-

- IRC: 86, Guidelines for Selection, Operation and Maintenance of Pavers
- IRC 38 - 1988 Design of Horizontal Curves for Highways
- IRC SP 23 - 1983 Vertical curves on Highways
- Embankment:
 - IRC 75 - 1979 Design of High Embankments
 - IRC 88 - 1984 Lime Fly-ash stabilised soil
 - IRC SP 58 - 2001 Guidelines for Use of Fly Ash in Road Embankment Structures
- Drainage

IRC SP 42 - 2004 Guidelines of Road Drainage

- Signage
 - IRC 67: Codes of Practice for Road Signs
- Plantation & Landscaping
 - IRC SP 21 2009: Landscaping and Tree plantation

2.2 Clearance and Permit Requirements in the Project

Based on the discussion above the clearance and permit requirement which would be likely for sub-projects are presented in Table 2-3

Table 2-3: Clearance and Permit requirement in project

<i>Sl. No</i>	<i>Clearance /Permits</i>	<i>Applicability</i>	<i>Project Stage</i>	<i>Responsibility</i>	<i>Approximate Time Requirement⁷</i>
1.	Environmental Clearance	Prior Environmental Clearance for State Highways Located at 1000 m above mean sea level and/or located in eco-sensitive zone. This would be applicable to projects located in	Prior to Construction (Pre-Construction Stage)	PMU	12-18 months

⁷ Approximate time requirement is based on the discussion with the respective department and assuming an ideal situations. These timelines are likely to change depending on the external environment which prevails at that point of time.

<i>Sl. No</i>	<i>Clearance /Permits</i>	<i>Applicability</i>	<i>Project Stage</i>	<i>Responsibility</i>	<i>Approximate Time Requirement⁷</i>
		Mount Abut Eco-Sensitive Zone			
2.	Forest Clearance for diversion of land under Forest Department	For diversion of any land under the possession of the Forest Department including Forest and Protected Forest	Prior to Construction (Pre-Construction Stage)	PIU	18 -24 months
3.	Tree Felling Permits	Or felling of any tree	Prior to Construction (Pre-Construction Stage)	Contractor/PIU	3-4 months
4.	NOC (Consent to Establish and Consent to Operate) under Air and Water Act from RSPCB	For siting and erection of stone crusher and Hot Max Plants, WMM and Batching plants etc.	(Prior to erection and operation of Plants (Construction Stage)	Contractor	2-4 months
5.	Explosive License from Chief Controller of Explosives	For storing fuel oil, lubricants, diesel etc.	Construction stage (Prior to storing fuel, lubricants and Diesel, etc.)	Contractor	2-4 months
6.	Permission for storage of hazardous Waste from RSPCB	Storage and disposal of spent oil and lubricant	Construction stage (Prior to storing used oil etc.)	Contractor	2-4 months
7.	Quarry Lease Deed and Quarry License from State Department of Mines and Geology	In case of new quarry for the project. In case an existing quarry is used the same must be collected from the owner/Lessee before operations	Construction stage (Prior to initiation of Quarrying)	Contractor	4-6 months

<i>Sl. No</i>	<i>Clearance /Permits</i>	<i>Applicability</i>	<i>Project Stage</i>	<i>Responsibility</i>	<i>Approximate Time Requirement⁷</i>
8.	Environmental Clearance for the Quarry Operations	In case of new quarry for the project. In case an existing quarry is used the same must be collected from the Owner before operations	Construction stage (Prior to any offtake of material from the quarry)	Contractor	8-12 months
9.	Environmental Clearance for Borrow area Operations	Prior environmental clearance from District level committees	Construction stage (Prior to initiation of Borrowing)	Contractor	8-12 months
10.	Permission for extraction of ground water for use in road construction activities from State Water Resource Department/ Central Groundwater Board	Extraction of Ground water including saline ground water	Construction stage (Prior to initiation of installation of Bore wells and abstraction of water from such source)	Contractor/PIU (operation Stage borewell)	2-4 months
11.	Permission for use of water for construction purpose from irrigation department or dispose of water into any surface channel	Use of surface water for Construction or disposal of construction water into any channel	Construction stage (Prior to initiation of Abstraction/ discharge of water from such source)	Contractor	4-6 months

The list stated above is not exhaustive, additional permits/clearances may be required. These have been discussed in the guidance notes above.

3 Environmental Sensitives Issues and Mitigation Measures

Considering the activities envisaged under the Rajasthan State Highways Development Program II and the environmental and social setting of Rajasthan, the potential environmental and social issues are discussed in the sections below. The potential mitigation measures to manage these issues/impacts are also discussed.

3.1 Environmental Sensitivities in Project Area

This section describes natural resources, social and climatic conditions as well as land form, land use and related characteristics that have relevance or some implications for road development and the road sector generally. This compendium of the bio-physical and social sensitivities in the State of Rajasthan would provide an understanding of scale and magnitude of sensitivity/ vulnerability of ecological, physical and social environment.

3.1.1 Physical Environment related sensitivities

The climate of the state is also largely influenced by its topography. Large parts of the state are covered by deserts and thus the climate varied from arid to sub-humid types.

Temperature

The climate of Rajasthan state is categorised as arid to semi-arid. It is characterised by average temperatures ranging from 25° to 46° C in summers and 8° to 28° C in winters. The extreme temperature in summer and winter, at times, touch 49° C and -2° C, respectively. The past trends indicate increasing trends for averaged annual mean maximum, averaged annual mean minimum and annual mean temperatures. The trends for temperature for the state of Rajasthan for the period 1951 to 2010 are indicated in Table 3-1

Table 3-1: State level annual and seasonal temperature trends for Rajasthan for 1951-2010.

		<i>Temperature Trends in 0 C per year</i>			
		<i>Annual</i>	<i>Winter</i>	<i>Summer</i>	<i>Monsoon</i>
Mean	Max	(+) 0.01	No trend	(+) 0.02	(+) 0.01
Temp					
Mean	Min	(+) 0.01	(+) 0.02	(+) 0.02	No trend
Temp					
Mean	Temp	(+) 0.01	(+) 0.01	(+) 0.02	(+) 0.01
Mean	Max	(+) 0.01	No trend	(+) 0.02	(+) 0.01
Temp					

Note: Increasing (+) and decreasing (-) trends significant at 95% level of significance shown in bold.

Source: IMD (2013)ⁱ

The increasing trends in temperatures in Rajasthan are accompanied with increasing frequency of extreme weather (temperature) events. A study by De et al. (2005), as cited in the Rajasthan State Action Plan on Climate Change (RSAPCC) indicates that Rajasthan is the second state after Jammu & Kashmir where maximum number of cold waves have occurred (table 2) while on the other extreme, the state also witnesses temperatures as high as 49° C in summers.

Table 3-2: Frequencies of the occurrence of cold waves and hot waves in Rajasthan for different periods.

<i>Period</i>	<i>Cold waves</i>	<i>Heat waves</i>
1901-10	11	
1911-67	124	43
1968-77	7	1
1978-99	53	7

Source: De et al. (2005) cited in GoR (2014)ii

Future projections for state

- As per the RSAPCC, projections for 2071-2100 indicate that the annual mean surface temperature for the state of Rajasthan will increase by 2 to 40 C.
- Projections for the the near-term period i.e. 2021-2050 predict an increase in temperature by about 2 to 2.50 C.
- RSAPCC indicates that the average increase in temperature by 2035 will be in the range of 1.80 C to 2.10 C. Importantly, minimum temperature increase is predicted to be higher than the maximum temperature increase.

Rainfall

In the western part of the Aravalli Mountains the climate is marked by low rainfall, extreme diurnal and annual temperature while in the eastern part there is some increase in precipitation. The average rainfall of Rajasthan is 531 mm compared to the all-India average of 1,200 mmⁱⁱⁱ and a significant variation is seen across different regions. The variation is seen both in the amount of precipitation as well as in the spread of the rainy days. In the western Rajasthan, the average annual rainfall ranges from less than 100 mm to over 400 mm. The north-western part of Jaisalmer have the lowest rainfall while the districts of Sikar, Jhunjhunu, Pali region and along the western periphery of the Aravalli range have relatively higher rainfall. On the eastern side of the Aravalli the rainfall ranges from 550 mm to 1020 mm in Jhalawar. The highest rainfall (1638 mm) is received at Mount Abu (Sirohi district) in the southwest region of the state. In addition to the variation in the spatial distribution the rainfall is most erratic in the western region with frequent dry spells, punctuated occasionally by heavy downpour in some years associated with the passing low-pressure systems over the region. The number of rainy days during the South west monsoon period from June end to mid-September ranges from 10 in Jaisalmer to 40 in Jhalawar and to 48 in Mount Abu^{iv}.

3.1.2 Precipitation and Flooding

Due to the spatial and temporal variation of the rainfall in some of the locations the state is prone to flooding. In the flood prone-areas the design of cross drainage structure and the finished road levels should take these into climatic variability into considerations.

The past trends (1951-2010) indicate increasing trends for averaged annual rainfall with increase for summer season being highest. Interestingly, the rainfall trends for monsoon and post-monsoon are decreasing. The trends for rainfall for the state of Rajasthan for the period 1951 to 2010 are indicated in

Table 3-3: State level annual and seasonal rainfall trends for Rajasthan for 1951-2010.

	Rainfall Trends in mm per year				
	Annual	Winter	Summer	Monsoon	Post-monsoon
Rainfall	(+) 0.04	(+) 0.02	(+) 0.17	(-) 0.09	(-) 0.04

Floods and inundations are common in Rajasthan, primarily along the basins of rivers like Luni and Chambal. Past events of major floods include:

- July 2017 – Flash floods in Jalore district (Pali and Sirhi district also affected)
- August 2006 – Flash floods in Barmer
- August 1982 – Floods in Dholpur
- July 1981 - Flooding in Jaipur, Tonk, Nagaur and Sawai Madhopur
- July 1943 - Flooding in Mewar and Merwar

Flood prone areas in the state include major parts of the basins and sub basins of River Luni in Barmer, Pali, Sirohi and Jalore; the basins and sub basins of River Chambal in Baran, Kota and Bundi districts; major portions of Bharatpur districts falling under the basin of River Banganga; and the basins of River Ghaggar in Sriganganagar

Land Environment related sensitivities

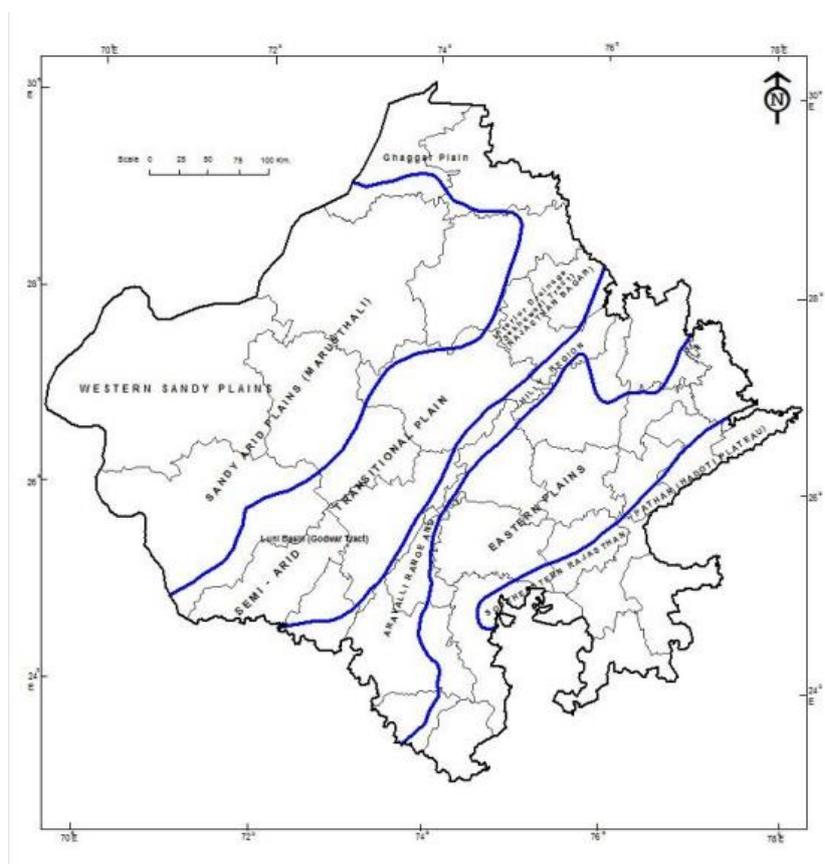
Physiography

The state of Rajasthan covers an area of 3.42 lakhs sq. m. and extends between 23° 03' 54" N to 30° 11' 54" N and 69° 29' 05' E to 78° 16' 24" E. The Aravalli Hills runs across the state from North Gujarat to the Delhi Ridge. The range is confined in the state between Mount Abu (1158m) in the south west and Khatri in north east. The areas around the Aravalli are the highest points of the topography of the State. The Aravalli divides the state into distinct physiographic regions. The Physiographic region of the state are presented in

Figure 3-1

The sand dunes occur in the Western Sandy Plains and in the Shekhawati Region of the Semi-Arid Plains in the districts of Bikaner, Barmer, Jaisalmer, Jodhpur, Nagaur, Churu. These areas are part of the Thar Desert. The shifting sand dunes pose threat to infrastructure which has been developed in the region. The Luni Basin covering parts of Barmer, Jalore, Jodhpur and Nagaur districts and Bharatpur Plains in Bharatpur District are prone to flooding especially during heavy rains. Thus, road design in this area must take care of the High Flood levels and the cross drainages. The physiographic regions, extent, characteristics and implications for the project are described in Annexure 1.

Figure 3-1: Physiographic Division of Rajasthan



Soil

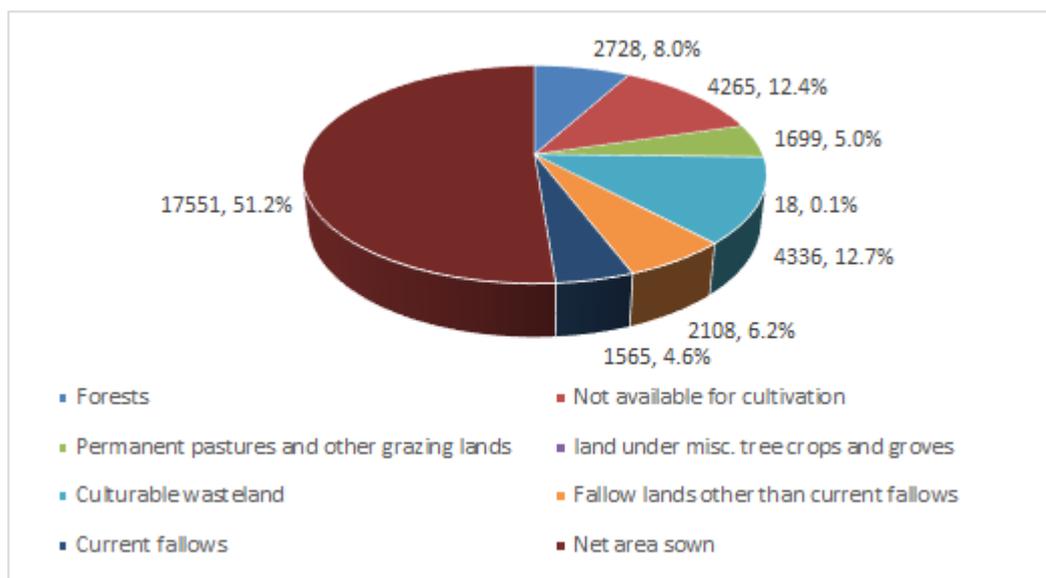
The soil in the state is primarily divided into 7 distinct classes as described in Annexure 1. The soil west of the Aravalli where most of the sub-projects are located is Desert Soil. These soils have high nitrate content. The precipitation in these areas are low and thus these soil remain unproductive. However, these soils are very productive if some irrigation facility is available. Thus, sub-projects in the area should avoid uptake of irrigated land parcels either for road or any other infrastructure. The Grey Brown (Desert) Soil which occurs in the areas adjacent to the Desert Soil occurs in the districts of Barmer, Jalor, Jodhpur, Sirohi, Pali, Nagaur, Sikar and Jhunjhunu. These soils also have high nitrate concentration. There is a presence of nitrogen in the form of nitrates which enhance the soil fertility. The nitrogen, organic carbon concentrations varies in the other remaining soil types namely Red and Yellow Soil, Ferrogenous Red Soil, Mixed Red and Black Soil and Medium Black Soil. In addition, the alluvial Soil which is present in the district of districts of Alwar, Bharatpur, Jaipur and Sawai Madhopur and the central part of Ganganagar district. As described above, fertile, irrigated agricultural lands in the state are a scarce resource and thus should be avoided for use in the project.

Land use

In the state of Rajasthan, even though large areas are covered by desert and are subject to extreme climates the net sown area accounts for 51% of the land use of the state. The districts of Alwar, Jaipur, Bharatpur, Tonk in eastern Rajasthan and Churu, Jalore, Sikar, Jhunjhunu, Nagaur Ganganagar Hanumangarh in Western Rajasthan primarily account for such land. The Culturable waste land and the area not available for cultivation are the other two major landuse. In the sub

project districts land available for cultivation varies from 17% in Jaisalmer district to 84% in Jodhpur district. Bikaner and Barmer districts have 60% and 77% area, respectively, under the category. Jaisalmer district has 67.2% of its area under cultivable waste, followed by Bikaner (25.6%), Barmer (7.7%) and Jodhpur (0.5%) districts. Even though these region are arid, the presence of the Indira Gandhi Canal Network and the irrigation facilities made available using groundwater have converted some of the cultivable wasteland into agricultural land.

Figure 3-2: Landuse Patterns in the State of Rajasthan (Area is in thousands Hectares (ha), percentage)



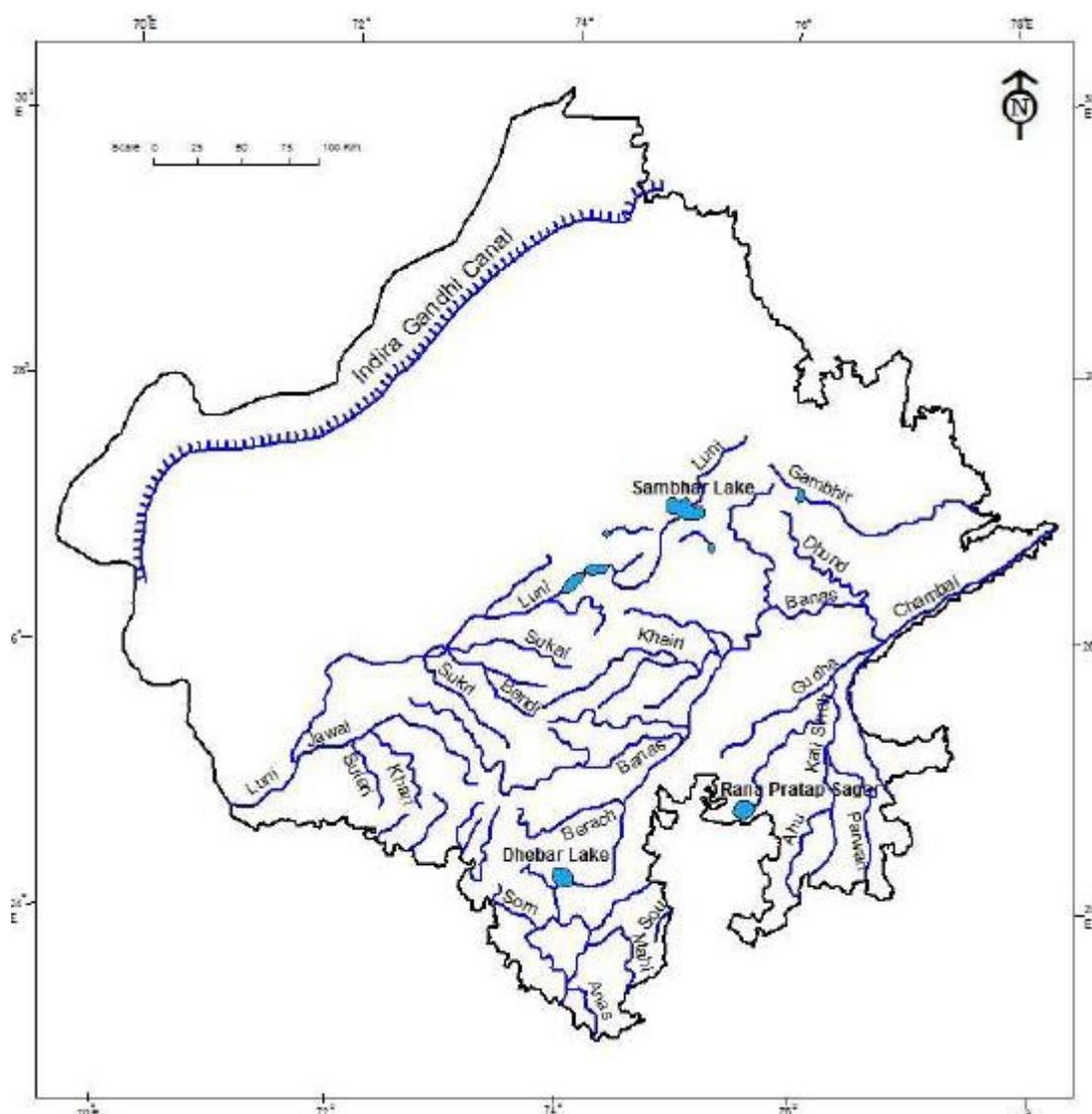
Source: India State of Forest Report, 2011; **Land Use Statistics, Ministry of Agriculture, GOI, 2008-09;

The forest areas only occupy only 8% of the total land use and is concentrated in the areas along the Aravalli Region. The forests are spread in the districts of Ajmer, Banswara, Bundi, Chittorgarh, Pali, Sawai Madhopur, Sirohi, Udaipur and Kota. Due to the low rainfall the forest areas are scanty in the western districts of Barmer, Bikaner, Jaisalmer, Sri Ganganagar, Churu, Jalore and Jodhpur. The state also has considerable area which is designated as grazing land or permanent pastures. The irrigated north western plains have negligible grazing land while sub-humid southern plains have pastures and grazing areas which are one-tenth of the reporting area. The districts of Barmer, Jodhpur and Bhilwara have large tracts of areas designated for pastures.

3.1.3 Water Environment Related Sensitivities

The drainage pattern of Rajasthan is also greatly influenced by the Aravalli Ranges. All the rivers except for the River Luni and its tributaries flows eastwards and form the part of the Chambal River System. The River Luni flows westwards into the Arabian Sea and passes through the districts of Barmer, Jodhpur and Nagaur Districts. There are no defined river systems in Districts of Jaisalmer, Bikaner, Sir Ganganagar, Jhunjhunu and Churu. The Indira Gandhi Canal however passes through these districts. The Drainage Map of Rajasthan is presented in Figure 3.3 The River Banas and Chambal along with its tributaries drain the eastern districts of the state The River Luni and Banas along with their tributaries are prone to flooding. The districts that are prone to flooding by the Luni and its tributaries parts of Jodhpur, Pali and Barmer

Figure 3-3: Drainage System in Rajasthan



The State's water resources are categorised in following terms:

- SW: Surface water (stream flows) generated from within Rajasthan boundaries;
- ISW: Imported water delivered to Rajasthan from other states by means of several projects under relevant inter-state agreements;
- GW: Groundwater, in terms of Dynamic and Static availability (fresh as well as saline), while for planning purposes only fresh Dynamic groundwater has been considered for utilisation.

The surface water resources are limited as well as variable because of the scarcity of the rain and its fluctuations in the monsoon. The surface water resources are thus limited and artificial tank and water retaining structures have been constructed at several places. These are used primarily for domestic needs and for irrigation purpose. These water-retaining structures have great importance for the community and thus are protected by the community.

Ground water in the western districts mainly those in the Sandy Western Plain is scarce as well as saline. Additionally, in other areas the ground water availability largely varies with rainfall condition during in the year. Limited surface water availability coupled with population explosion and increased per capita consumption of water tremendous pressure is being created on the ground water resources. Resultant, the ground water resources are rapidly depleting and at places with deterioration in quality, thus availability of safe drinking water is regularly becoming a cause of concern. The stage of ground water exploitation, which was just 35% in the year 1984 has attained a level of 134.53% in the year 2009⁸. Out of 239 blocks of the State presently only 31 blocks have been categorised in “Safe Category”, 16 blocks in “Semi Critical” and 191 blocks in “Critical and Over Exploited category”. The block categorised as safe or semi critical are generally located in areas having saline ground water or low development activities in western part of Rajasthan. Thus, using surface water or groundwater for construction purpose would cause further stress on the already stressed natural resources. The Central Ground water board has notified some of these block in the state as notified areas⁹ where ground water abstractions for purpose other than drinking is not allowed.

The groundwater quality is also very poor in number of districts. The water is saline in number of districts (Salinity (EC > 3000 µS/cm at 25 ° C)) including the districts of Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer where some of the sub-projects maybe located. In addition, the ground water has been reported to have high concentration of Iron, Fluoride, Nitrate in the sub-projects districts. Heavy metals contaminations (Lead, Cadmium, Chromium, Nickel and Copper) have also been reported from the districts which have either industrial or mining activity. Since the groundwater is reported to have contamination it would not be fit for consumptions of the labour who would be working during the construction as also during the operations phase.

The area west of the Aravalli especially in Barmer, Jaisalmer and Jalore remains dry throughout the year except few days rain during July to September. To sustain in the region, people have adopted various traditional methods of rainwater harvesting. To meet the day-to-day need of drinking water rainwater is stored in Kachha Tanka, Kui, Khadeen, small ponds. However, a few villages in Barmer receive water from the Indira Gandhi Canal.

3.1.4 Ecological Sensitivities in Rajasthan

The ecological profile in the state is also to a large extent influenced by the physiography. The scrub jungle is located towards the western districts of the state. The natural vegetation is classed as Northern Desert Thorn Forest (Champion 1936). This scrub vegetation occurs in small clumps scattered in more or less open form. The North-western thorn scrub forests lie in a band around the Thar Desert, between the desert and the Aravalli.

Density and size of patches increase from west to east following the increase in rainfall. The Aravalli and the south-eastern region is home to the dry deciduous forests, with tropical dry broadleaf forests that include teak, Acacia, and other trees. The hilly ‘Vagad’ region lies in southernmost Rajasthan, on the border with Gujarat. With the exception of Mount Abu, Vagad is the wettest region in

⁸ Rajasthan Ground Water, Vision – 2025, Rajasthan Ground Water Department, Jodhpur January 2010

⁹ Notified areas are those blocks / talukas / mandals / areas which have been notified under Environment (Protection) Act, 1986 by Central Ground Water Authority for regulation of ground water development and management. In notified areas abstraction of ground water is not permissible for any purpose other than drinking and domestic use.

Rajasthan, and the most heavily forested. The eastern part of the state is divided into number of regions¹⁰ all these regions have varied flora and fauna distinct to the region.

The sub-project districts are mostly desert terrain. The Tropical thorn forests and grasslands are found in arid and semi-arid regions of western Rajasthan. The main species found in this kind of forests are *Acacia nilotica*, *Acacia leucophloea*, *Prosopis cineraria*, *Capparis aphylla*, *Zizyphus* spp., *Flacourtia* spp. etc. These forests are basically found in western part of Rajasthan namely Jodhpur, Pali, Jalore, Barmer, Nagaur, Churu, Bikaner etc. The grasses in the region have classified into four habitats comprising: (i) perennial drought resisting plants, (ii) perennial drought evading plants, (iii) ephemeral drought evading plant as, and (iv) sand binders and sand dwellers. Some of the important grasses in Rajasthan which have been cited by Bhandari include *Aristida funiculata*, *A. adscensionis*, *A. mutabilis*, *Brachiaria ramosa*, *Cenchrus ciliaris*, *C. biflorus*, *C. setigerus*, *Chloris virgata*, *Cymbopogon jwarncusa*, *Dactyloctenium indicum*, *D. aegyptium*, *Dichanthium annulatum*, *Eragrostis ciliaris*, *E. tremula*, *Eleusine compressa*, *Lasiurus indicus*, *Panicum antidotale*, *P. turgidum*, *Sporobolus marginatus*, *S. helvolus*, *Tetrapogon tenellus* and *Tragus racemosus*.

A total of 2304 plant species and 792 animal species¹¹ have been reported of which there are two red data species of Plant and 14 Red Data Species of Birds. There are 15 mammals, 5 reptiles and 6 birds which have been provided Schedule I Protections Status under the Wildlife Conservation Act.

In the subproject districts the Blackbuck (*Antelope cervicapra*), Indian Gazelle, (*Gazella bennetti*) and the Schedule I mammals while the Great Indian bustard (*Ardeotis nigriceps*), Pea Fowl (*Pavo cristatus*) are the Scheduled I protected species. The list of such species is presented in Annexure 1.

Forest

The forests of Rajasthan cover an area of 32,638.74 sq. km which is 9.54% of the total geographical area of the state. They are spread unequally in northern, southern, eastern and south-eastern parts of the state. Chittorgarh, Karauli, Sirohi and Udaipur districts have more than 25% of the geographical area under the district covered by forest.

Protected areas

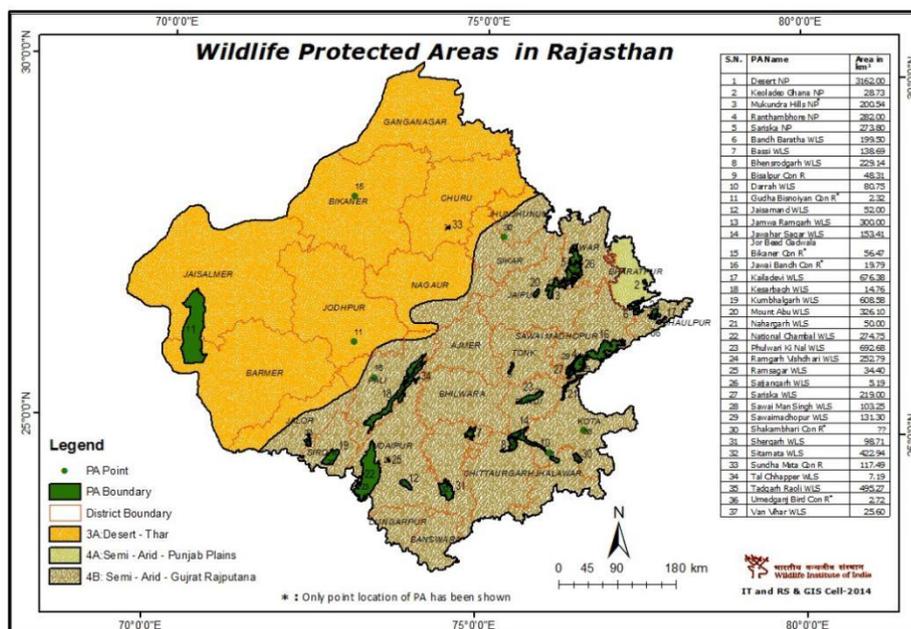
To provide protection to the wildlife the state has also declared protected areas under the Wild Life Protection Act 1972 and the Forest Conservation Act 1980. There are three national parks viz. the Keoladeo National Park of Bharatpur, Ranthambore National Park of Sawai Madhopur, and Mukundara Hills National Park of Kota. In addition there are 26 wildlife sanctuaries and 10 conservation reserve. Prominent among the wildlife sanctuaries are Mount Abu Sanctuary, Bhainsrod Garh Sanctuary, Jaisamand Sanctuary, Kumbhalgarh Wildlife Sanctuary, Jawahar Sagar sanctuary and Sita Mata Wildlife Sanctuary. A list of these protected areas is presented in Annexure 1. In addition to these legally protected areas there are Community Based Conservation

¹⁰ North of 'Vagad' lies the Mewar region, home to the cities of Udaipur and Chittaurgarh. The Hadoti region lies to the southeast, on the border with Madhya Pradesh. North of 'Hadoti' and 'Mewar' lies the 'Dhundhar' region, home to the state capital of Jaipur. Mewar, the easternmost region of Rajasthan, borders Haryana and Uttar Pradesh.

¹¹ Fishes (114), Amphibians(14), Reptiles(67), Mammals(87), Birds (510)Source: <http://environment.rajasthan.gov.in/content/environment/en/rajasthan-state-biodiversity-board/about-rajasthan/biodiversity-of-rajasthan.html>

Initiatives¹² commonly known as mandir vans (dev vans) or banis¹³, Kakad bani¹⁴ Orans¹⁵, Kesar chhanta¹⁶, Radi¹⁷.

Figure 3-4: Wildlife Protected areas of Rajasthan



The expansion of State Highways should avoid the legally protected forest areas but avoid these community conservation reserves as well.

Wetlands

In Rajasthan, area under wetland is estimated at 7,82,314 ha that is around 2.29 per cent of the geographic area of the state. Total of 12625 wetlands above 2.25 ha and 34123 small wetlands (< 2.25 ha) have also been identified. River/ Stream contributed 39.95% to the total wetland area and reservoir/barrage with 190600 ha (24.36% area) is the second major wetland category.

In the 32 districts of the state, the wetlands occupy as high as 6.94% of geographic area in Bhilwara, and as low as 0.08% in Churu. Reservoir/Barrage and tank/pond are the dominant wetland types in

¹² <http://kalpavriksh.org/images/CCA/Directory/M-19%20Rajasthan.pdf>

¹³ A large patch of land downstream of the talab was also demarcated as part of the dev van to compensate for any losses of tree growth to submergence. Only local tree species were planted in these vans. These are common in Kota, Bundi, Jhalawar and Tonk, Districts of Rajasthan

¹⁴ Kakad is the name applied to areas located on the boundary of two villages. This common land between villages was developed as community forests known as kakad banis.

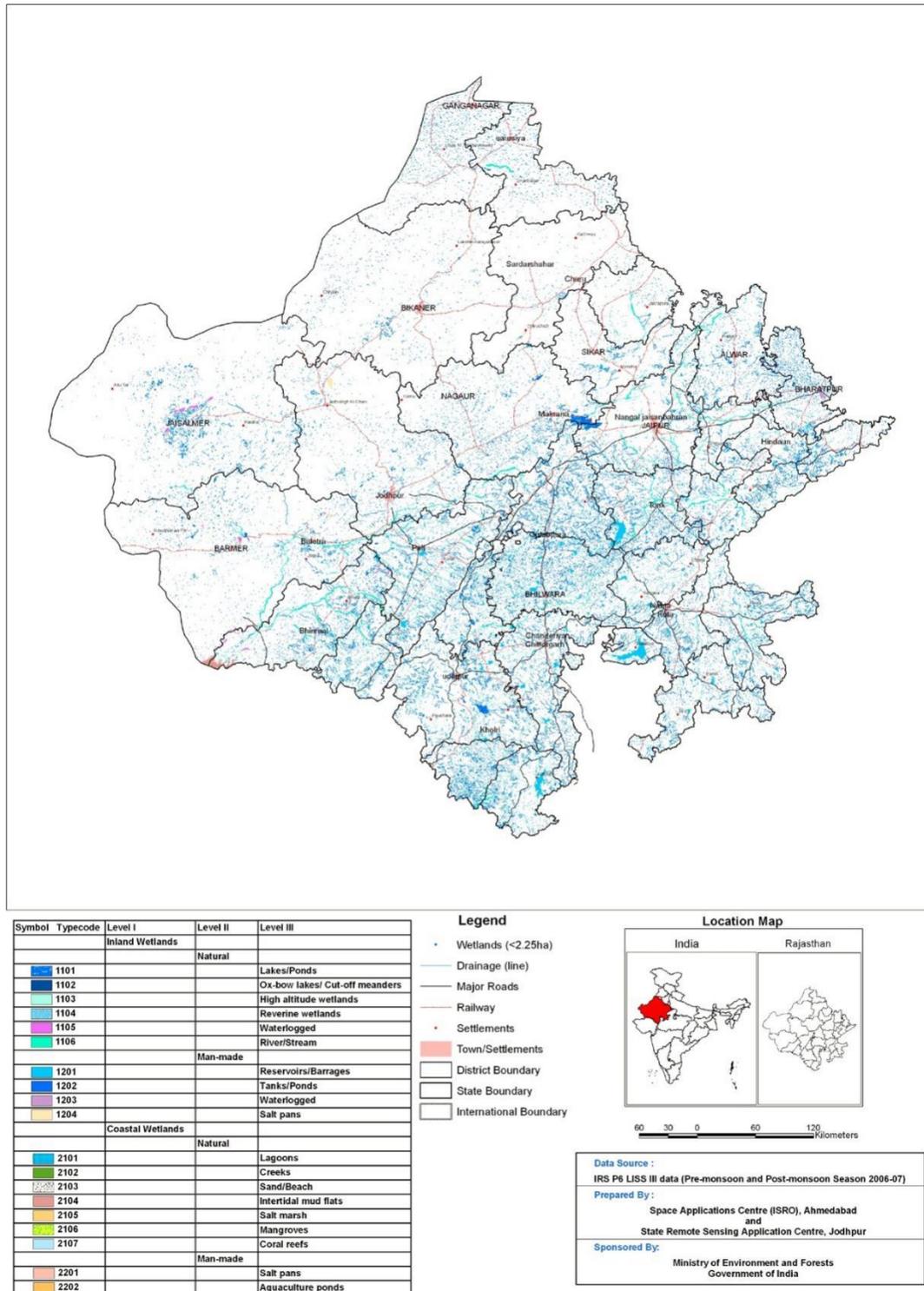
¹⁵ Orans are sacred patches of pastureland, devoted to a god or temple.

¹⁶ In southern Rajasthan people sprinkle saffron on the boundary of the forest area to indicate that the area would henceforth be protected and felling of trees would no longer be permitted

¹⁷ Close to village settlements, amidst cultivable areas, are remarkable woodlands, known as radis, which are found in Bundi, Kota, Baran and Jhalawar districts of Rajasthan. Radis are most frequent in Kota.

almost all districts. Jalore is the only district containing coastal wetlands, which includes mudflats. The spatial distribution of wetland in Rajasthan is presented in Figure 3-5.

Figure 3-5: Wetland Map of Rajasthan



The Sambhar lake is Ramsar Site. The lake is an extensive saline wetland. The lake straddles Nagaur and Jaipur districts and borders on the Ajmer district. It occupies an area of 190 to 230 square

kilometres based on the season. The lake is elliptically shaped with a length of approximately 35.5 km and a breadth varying between 3 km and 11 km.

3.1.5 Environmental Quality Sensitivities

The Air quality was not measured along the sub-project corridors. However, Rajasthan Pollution Control Board (RSPCB) had carried out Ambient Air Quality Monitoring at 21 locations in 5 cities under the National Air Quality Monitoring program. The results for the time 2010-2015 for the pollutants PM 2.5, SOX and NOx was provided to the National Green Tribunal through an affidavit. The data indicates that the SoX levels are much lower at all the 21 locations. However, NOx levels in Jaipur are higher at some locations. The PM 2.5 levels are at least 1.5 times the standards and at places in Jaipur and Jodhpur at some locations they are 3.5 times the standards.

A no source apportionment study was carried out and RSPCB had indicated to the NGT that other than the natural sources of PM2.5 i.e. dust restrained due to the arid conditions, the vehicular, industrial pollution sources is responsible for this high ambient pollutant concentrations. Since the air quality especially PM 2.5 and NOx levels are much higher indicating the stress air quality. The project operations thus should minimise the generation of PM2.5 and NOx likely to be generated from it.

The surface water quality is also monitored by CPCB as part of the National Water Quality Monitoring Program. There are approximately 190 stations monitoring both ground water and surface water bodies, of which approximately 40 locations covering the rivers, lakes and other surface water bodies. The Biological Oxygen Demand (BoD 5 days and 20 °C) and the Dissolved oxygen levels are being analysed monthly at these water bodies along with other parameters. The data for the year 2016- 2018 was analysed for the 11 surface water locations which are within the sub-project area. It was observed at all the locations the DO values are more than the CPCB Surface Water Class B while the BoD values are less than 3mg/l. Some stress is however observed in the DO in the water bodies during the summer season. This may be either due to the additional loading or concentrations of organic matter during the dry months. These water bodies thus fit the water quality criteria for outdoor Bathing i.e. domestic use. Since the water bodies are fit for domestic use the construction activities should not use these water bodies

3.1.6 Natural Hazards

Due to the extreme weather climate along with the variability in rainfall patterns, the entire state is prone to droughts. These events are prolonged over years and affect large regions affecting water availability in those regions. In addition, the western part of the state mainly the districts of Jaisalmer, Barmer, are vulnerable to moderate earthquake while the parts of Alwar, Jalore and Barmer are identified as High Damage Risk Zones. The spatial disposition is presented in Figure 0-7 of the Annexure 1.

Even though the state has scanty rainfall and had no history of floods due to the variability of the climate there has been some incidence of flash flood and water logging. The floods occur mostly along the basins of rivers like Luni and Chambal. These include major parts of the basins and sub basins of River Luni in Barmer, Pali, Sirohi and Jalore; and the basins and sub basins of River Chambal in Baran, Kota and Bundi districts. Also, major portions of Bharatpur districts falling under the basin of River Banganga, and the basins of River Ghaggar in Sriganganagar are also prone to floods. A map of the flood prone area of the stat is presented in Figure 8 of Annexure 1

3.2 Environmental Issues & Mitigation Measures

The key environmental issues associated with the different stages of the road sector project especially with reference to the environmental sensitivities described in the sub-project districts are discussed. The corresponding preventive and/ or mitigation measures are designed applying the principle of mitigation hierarchy: “Avoid, Minimise, Mitigate and Offset”.

3.2.1 Issues related to Soil

Impact on Soil

The impacts on the soil are expected along the alignment especially in case of expansion of carriageway, realignment as well as in the borrow areas and construction camp. The impact on the soil is primarily due to the:

- Loss of topsoil. The topsoil on the land parcels which is either used for short term (e.g. borrow areas, construction camps etc) or permanent use (expansion of the road alignment) would be lost unless the same has been preserved.
- Soil Erosion: The western part of the state is covered with sand which are eroded by wind. These shifting sand dunes would cause threat to the road infrastructure unless the road is protected.
- Compaction: The movement of vehicle over the agricultural land to access the construction site would also cause compactions of soil and affect soil fertility.

In case of construction of minor bridge or culvert, the excavated material along with construction and demolition waste, is expected to be generated during the dismantling of the existing cross drainage structure. Bituminous waste would also be generated during dismantling of pavement, off-spec hot-mix as well as from the regular operations of the machinery e.g. layers and bitumen sprayers during the surfacing of the roads. The concrete wastes from the batching plant and transit mixer wash water would also be generated.

The labour camps would be setup for the construction would generate municipal solid waste and hazardous waste (waste oil from the maintenance and operation of machinery). These wastes have potential to contaminate the soil around the site if it is not properly stored, handles and disposed.

If these excess excavated material, construction and demolition wastes are disposed on agricultural land it may result in loss of productivity of land. The impacts may get further aggravated because of the scarcity of good agricultural land in the state.

Mitigation Measures

Mitigation measures which would be considered to reduce impacts on soil during road and bridge construction are given below:

- Excess excavated material should not be dumped by the contractor on any adjoining property. The excess excavated material may be reused where ever possible or used for strengthening of shoulders of village roads;
- Surface Stabilisation to prevent erosion of loose sand from a dune or sand sheet. In sub-projects which are prone to shifting sand the following methods can be considered for sand stabilisation:
 - Sand fencing can be erected along the road corridor. Sand fences are high

density polyethylene mesh material with holes distributed to provide 50% porosity to maximise sand deposit. This is a temporary measure which can be adopted till the plantation is established on sand dunes for long term stabilisation.

- Planting local vegetation along the highways can be the only method which can be applied as a long-term solution. The local grass species¹⁸ and plant species¹⁹ which have good foliage cover and low water consumption should be planted.
- All demolition debris especially from cross drainage structures and pavement should be utilised in the backfilling where ever possible. No virgin material shall be utilised unless the demolition debris are certified by the Engineer as “not fit for use”. Detailed guidance on use of alternative material for construction is presented in Guidance Note 14: Use of Alternate Material. All construction debris which cannot be reused should be disposed at pre-designated sites. The Contractor should identify site for temporary storage of the construction debris during the pre-construction stages as per the Guidance Note 11 Waste Management
- Vehicular movement should be restricted over the open fields or agricultural land.
- The handling of both Municipal Solid Waste and Hazardous Waste would be carried out as per the Guidance Note 11: Waste management And Debris Management

3.2.2 Issues related to Land use

Impacts on Land Use

Since the road strengthening would follow the existing alignment the change in land use would be limited only to areas where realignment is proposed or improvement of geometrics is required or widening is undertaken. Some temporary changes in land use might occur due to setting up of construction camp, material storage yards and plant and machinery. Even though the state has 51% of the area under net sown area large tracts of land are unproductive and cannot be used for agriculture. The sub-project districts also have large tracts of grazing land. Agricultural land or grazing land used either permanently or temporarily for road construction purpose would thus cause adverse impacts.

With the development of the road there is a likelihood of induced ribbon development along the sub-project roads. The agricultural or other land use would change to commercial and or residential use.

Mitigation Measures

To prevent any adverse impacts on land-use the following measures need to be adopted:

- For realignments agricultural lands, grazing land would best be avoided if possible. In case the same is not feasible least amount of agricultural land would be used for road construction;

¹⁸ *Cenchrus ciliaris, C. setigerus, Dichanthium annulatum, Lasiurus indicus, and Panicum antidotale*

¹⁹ *Acacia nilotica, Acacia leucophloea, Prosopis cineraria, Capparis aphylla, Zizyphus spp., Flacourtia spp*

- No agricultural land, fallow land (current or temporary), grazing land should be used for setting up of construction camps, material storage or staging of plant and machinery.

3.2.3 Issues related to Air Environment

The impact on the air environment are likely both during the construction as well as the operations phases.

Impacts Due to Construction

In the construction phases the activities related to the earthwork is likely to generate large number of particulates. The possible sources of generation of such particulates are borrow area operations, transport of material, storage of construction material, carrying out of earthwork, movement of vehicles on unpaved road. Vehicular movement due to the project would also add to PM 2.5 and SOx and NOx emissions. The PM 2.5 is identified as a major source of pollutant in large parts of Rajasthan (as reported by RSPCB).

The operations of the Hot-mix plant, quarry and the handling of cement in batching plants is also likely to generate the air pollutant. The generation of PM2.5 due to the construction activities would add on the already stressed air environment.

Mitigation Measures During Construction

To prevent the generation of dust during the construction activity the following measures may be considered:

- The speed limit of project vehicle movement over unpaved surface should be limited to 15 kmph;
- All vehicles carrying construction material should be covered;
- The construction material should be stored against wind breaks so that they are not carried away by wind. The length of the windbreak wall shall be twice the height for it to effectively work. The stockpiling of material should be carried out considering the prevailing wind direction;
- Water sprinkling should be carried out but in areas where there is scarcity of water dust suppressant should be applied on the surface of the unpaved earthwork;
- Vehicular movement on the unpaved pavement should be strictly restricted. The access roads within the construction camp should be paved using the waste concrete or batching plant and concrete mixer wash;
- All project related vehicles and equipment should have valid Pollution Control Certificates.
- The pollution control equipment in the Hot-mix plant shall be kept in working condition at all times. The plant shall not be operated if the pollution control equipment is not functional;
- Requisite permits shall be obtained from the RSPCB for operation of the Hot Mix Plant and Quarry (in case of new Quarry);
- For grievances related to the air pollution or air polluting sources associated to the project or its activities the citizens can use the grievance mechanism

developed under RHSDP II to redress their complaints.

Impacts During Operation

The strengthening of the carriageway would improve vehicular movement, congestion is likely to get reduced and speed to vehicles are likely to improve. Even though there would be a decrease in vehicular emission due to the reduction in congestion the increased vehicular traffic on the state highways would increase the pollution load.

Mitigation During the Operations

To mitigate the impacts of vehicular pollution during the operations phase:

- Green belt shall be developed along the corridors. Local species which can arrest both gaseous and particulates shall be planted.

3.2.4 Issues related to Water Environment

Impacts Due to Construction

Both surface water and groundwater are scarce in most parts of the sub-project districts. The construction activities e.g. earthwork, concreting of structure and labour camps, would require large quantities of water and may result in conflicting situations with local communities. In addition, the construction activities would also witness influx of skilled labour who would be housed in the construction camps. Water would also be required for domestic requirement and the ground water at places also does not meet the required standards of IS 10500: 2012.

The sub-projects districts are affected by water crisis during the summer months. Additional water requirement for construction would not only put stress on the resource but also lead to conflict with the local community.

Other than the scarcity of resource the construction camp and the construction activities would generate waste water. These would include domestic wastewater from the construction camp and the wash water from the machinery e.g. batching plant concrete transit mixers would cause deterioration of the water quality These liquid wastes have potential to contaminate the water bodies around the site if it is not properly handled.

In addition to usage of water the encroachment of the road on any surface waterbody or well or irrigation structure would reduce the water holding capacity. As rainfall is erratic in most of the western districts and rainwater being stored by locals for domestic purpose. Any encroachment on the surface water body would also impact the surface water resources. In some cases the surface water bodies are used by the local community for storage of water . Runoff from the pavement or discharge of the longitudinal drain into these waterbodies or the catchment of these water bodies would pollute the water body and adversely affect the drinking water resources.

Mitigation Measures

- Water for construction should not be sourced from any waterbody used for drinking purpose.
- Construction water would not be procured from any unauthorised wells. The permission of CGWB would be obtained in case new wells are sunk. In case existing wells are used for procurement of water valid permission of CGWB shall be obtained;

- In Notified areas, freshwater shall not be used for construction activity. The saline water should preferably be used for the construction activities after treatment. The feasibility of using the saline water for construction and the treatment technologies shall be identified during the project design and pre-construction;
- The Contractor with support from the project, shall consider development of new surface water bodies or renovation of existing surface water bodies with prior permission of the village panchayat for harvesting of water. This water can be used for construction purpose and on completion of the construction the same can be handed over to the community for maintenance and use. To facilitate the selection of the site for location of the surface water bodies a Digital Elevation Model for the study area may be created.
- The water from the longitudinal drains should not be allowed to drain into any water body used for drinking water. In case the drinking water body is the lowest point in the topography the Contractor shall identify a separate location and use it for storage of water as described above
- None of the project components i.e. existing alignment, realignment or toll plaza shall encroach into any waterbody. During construction, no construction and demolition debris shall be left in the catchment of the water body.
- The Contractor should notify the PIU its source for procurement of water. It should provide monthly reports of water consumed and its source.
- The Contractor should notify the PIU its source for procurement of water. It should provide monthly reports of water consumed and its source.
- The water consumption for concrete mixing can be reduced by use of plasticizers/ super plasticizers as mentioned in IRC 015:2011
- Enhancement measures may be considered in all the ponds along the corridor. These could include the strengthening of the embankment, excavation of the pond to increase its holding capacity, construction of the silt traps at the end of the pond so that the siltation reduces. In water scarce areas dust suppressant /dust binders shall be used to reduce water consumptions. The acceptable dust suppressants include: Acrylic polymers, Solid recycled asphalt, Chloride compounds (calcium chloride and magnesium chloride), Lignin compounds (lignin sulphate and lignin sulfonate powders), Natural oil resins (soybean oil) and Organic resin emulsions.

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Impacts Due to Operations

The water requirement during the operations of the highways would be primarily due to the maintenance of the plantation. Small quantities of water would also be required for the personnel operating the toll plaza. Considerable quantity of water would be required for landscaping and plantation. Sub-projects in water scarce area would thus put pressure on the water resources.

Mitigation Measures

- During the operation of the highway efforts would be made for harvesting rain water. The harvested water would be used for plantation purposes
- For construction of bore well at toll plaza permission from CGWA would be obtained. Each of these bore wells would be fitted with water meter to monitor ground water abstraction.
- Only brackish groundwater would be used for plantation purposes.

3.2.5 Impact of Flooding

Parts of some of the project corridor may be prone to flooding by the River Luni and River Bandi. The finished level may be raised over the existing ground level to maintain serviceability of the road. The raising of the embankment might impede the flow of water especially during the flood and also cause water logging in areas adjoining the alignment.

3.2.6 Mitigation Measure

The following mitigation measures can be adopted:

- Detailed hydrological modelling should be carried out for the flood event during the detailed design. Based on the results of the hydrological modelling the following options can be carried out:
- In case the road is submerged during the high flood event the embankment road may be raised further to maintain the serviceability of the road
- The number of cross drainage structures can be increased to facilitate the movement of water

3.3 Potential Impact on Surface Water Quality

3.3.1 Impacts Due to Construction

In addition to competition over the scarce resource, the construction camp and the construction activities would generate waste water. These would include domestic wastewater from the construction camp and the wash water from the machinery e.g. batching plant concrete transit mixers would cause deterioration of the water quality. These liquid wastes have potential to contaminate the water bodies around the site if it is not properly handled.

3.3.2 Mitigation Measures

No wastewater should be discharged from construction camps. Runoff from the camp shall be passed through an oil-water separator. All peripheral drains shall be linked to the oil water separator.. The contractor shall undertake the following measures specified below:

Box 3-1: Facilities in Contractors Camps

Security:

- The contractor shall put in place the following security measures to ensure the safety of the workers. The following measures shall be incorporated:
- The contractor/sub-contractor shall provide Identity cards to all the employees/workers;
- Access to the campsite shall be limited to the residing workforce;
- The contractor shall be responsible for deploying adequate number of guards;
- Adequate, day-time night-time lighting shall be provided;

- The security personnel shall be provided with training to respect the community traditions and in dealing with, use of force etc.; and
- The rental accommodation shall be provided with firefighting equipment and portable fire extinguishers.

Provision of Drinking Water:

- Access to an adequate and convenient supply of free potable water is necessity for workers. The domestic water supply shall be made available by the contractor.
- Safe drinking water conforming to the IS 10500:2012 for drinking water shall be provided;
- Bottled Potable drinking water would be provided to all the employee/workers both at the worksite and at the construction camps;
- Every water supply or storage shall be at a distance not less than 15m from any wastewater / sewage drain or other source of pollution. Water sources within 15m proximity of toilet, drain or any source of pollution will not be used for any consumption purpose in the project
- The Contractor should regularly monitor (every quarter) the quality of drinking water available. In case of non-compliance with the Drinking Water Specifications, additional treatment shall be provided, or alternative sources of water supply shall be arranged; and
- All tanks used for the storage of drinking water shall covered as to prevent water stored therein from becoming polluted or contaminated.
- The tanks shall be cleaned at regular interval (minimum every 3 months) to ensure hygiene conditions are maintained.

Cooking Arrangement:

- The construction phase will involve engagement of large number of migrant people in the project area for a limited time. Hence, there shall be requirement of provision of cooking facilities (kitchen) as listed below:
- The cooking area shall be separate from the Living quarters;
- Places for food preparation are designed to permit good hygiene practices, including protection against contamination between and during food preparation;
- The cooking area should be provided with water connections which is fit for consumption;
- Adequate personal hygiene including designated areas for cleaning hands and cleaning of utensils; and
- All kitchen floors, ceiling and wall surfaces adjacent to or above food preparation and cooking areas are built using durable, non-absorbent, easily cleanable, non-toxic materials;
- Food preparation area to be durable, easily cleanable, non-corrosive surface made of non-toxic materials.
- To ensure that the fuel need of labourers in the project area does not interfere with the local requirements, necessary arrangements for supply of cooking fuel to the labourers shall be done by the contractor. Clean fuels shall be used in no circumstance fuel wood shall be used for cooking or heating.

Washing and Bathing Facilities

- In every site, adequate and suitable facilities for washing clothes and utensils shall be provided and maintained for the use of contract labour employed therein. Separate and adequate bathing shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic conditions.

Toilets Facilities

- Sanitary arrangements, latrines and urinals shall be provided in every work place separately for male and female workers. The arrangements shall include:
- A latrine for every 15 females or part thereof (where female workers are employed).
- A latrine for every 10 males.
- Every latrine shall be under cover and so partitioned as to secure privacy and shall have a proper door and fastenings.
- Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by most of the workers —” For Men Only” or —” For Women Only” as the case may be. Pictographic signages can also be used
- The latrines and urinals shall be adequately lighted and shall be maintained in a clean sanitary condition at all times and should have a proper drainage system;
- Water shall be provided in (preferably) or near the latrines and urinals by storage in suitable containers

Waste Water Generation:

- There will of generation of wastewater from the campsite. About 80% of water used shall be generated as sewage/wastewater. Contractor shall ensure that the campsite/s is/are equipped with:

- Septic tank and soak pit for disposal of sewage or with mobile bio-toilets. The toilets and the septic tank and soak pit should not be located near any drinking water sources either within or outside the camp.
- The storm water and sewage system should be separate. The surface water drainage shall include all necessary gutters, down pipes, gullies, traps, catch pits, manholes etc. An Oil water separator should be in the drains leading out of the maintenance area. Water passing out of the camp should be passed through a sedimentation tank of at-least 3hrs holding capacity.
- Sanitary and toilet facilities are constructed of materials that are easily cleanable. Sanitary and toilet facilities are required to be cleaned frequently and kept in working condition.

Solid Waste Management:

- The solid waste generated from campsite will mostly comprise of compostable wastes like vegetable residues (kitchen waste) and combustible waste like paper, cans, plastic and some non-degradable waste like glass/glass bottles. Improper disposal of solid waste will lead to environmental degradation and health hazards to labour as well as nearby community.
- The following measures shall be adopted by contractors for ensuring effective management of solid waste:
- The solid wastes of domestic nature (especially food waste, waste from canteen) shall be collected and stored separately in appropriate containers with proper covers on them so that they are not littered;
- Separate bins with proper markings in terms of recyclable or non-recyclable waste shall be provided in the houses and kitchen premises in sufficient numbers for collection of garbage;
- Food waste and other refuse are to be removed from the kitchen frequently to avoid accumulation; and
- The contractor shall ensure that the all food waste generated is composed within the camp premises. All recyclables except for the waste which are covered by any other act/rules other than the Municipal Solid Waste Rules 2016.

Roads

- All the internal roads shall be paved. The concrete slurry from the batching plant shall be used for paving the roads

Medical Facility:

- Effective health management is necessary for preventing spread of communicable diseases among labour and within the adjoining community. The following medical facilities shall be provided by contractors for the construction workers:
- A first aid centre shall be provided for the labour within the construction site equipped with medicines and other basic facilities;
- Adequate first aid kits shall be provided in the campsite in accessible place. The kit shall contain all type of medicines and dressing material;
- Contractor shall identify and train an adequate number of workers to provide first aid during medical emergencies;
- Regular health check-ups shall be carried out for the construction labourers every six month and health records shall be maintained;
- Labours should have easy access to medical facilities and first aid; where possible, nurses should be available for female workers;
- First Aid Box will be provided at every construction campsite and under the charge of a responsible person who shall always be readily available during working hours. He shall be adequately trained in administering first aid-treatment. Formal arrangement shall be prescribed to carry injured person or person suddenly taken ill to the nearest hospital. The first aid box shall contain the following.
 - small sterilized dressings
 - 3 medium size sterilized dressings
 - 3 large size sterilized dressings
 - 3 large sterilized burns dressings
 - 1 (30 ml) bottle containing 2 % alcoholic solution of iodine
 - 1 (30 ml) bottle containing Sal volatile
 - 1 snakebite lancet
 - 1 (30 gms) bottle of potassium permanganate crystals
 - 1 pair scissors
 - Ointment for burns
 - A bottle of suitable surgical antiseptic solution
- In case, the number of labour exceeds 50, the items in the first aid box shall be doubled. All the vehicles and

<p>equipment shall be provided with a fir-aid box with all the above. The medicines should be regularly checked for the expiry of the medicines.</p> <ul style="list-style-type: none"> ○ Information and awareness of communicable diseases, AIDS etc. shall be provided to workers. ○ Basic collective social/rest spaces are provided to workers.; <p>Fire-fighting arrangement</p> <ul style="list-style-type: none"> ○ The contractor shall carry out demarcation of area susceptible to fires and put in precautionary signages as specified in IS 9457 ○ Portable fire extinguishers and/or sand baskets shall be provided at easily accessible locations in the event of fire as per the provisions of IS 2190 ○ The contractor shall carry out fire safety drill every quarter and Workers shall be trained on the usage of such equipment/s <p>Fuel and Chemical Storage</p> <ul style="list-style-type: none"> ○ Licence is required for storage and transport of any such product (i.e. petroleum class B) if the total quantity in in possession does exceed 2500 litres in non-bulk (i.e. drums) or 1000litres in a receptacle / tank (i.e. bulk). ○ All fuel and chemical storage area should be made impermeable either by concrete flooring or by placing an HDPE liner. ○ The storage area shall be provided with a bund. The capacity of the bund shall be 110% of the volume of the maximum storage tank ○ The area shall be covered and secured under lock and key. ○ In no condition shall the fuel be decanted by tilting of drums. An approved fuel pump manual or energy driven shall be used. ○ .
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3.3.3 Issue Related to Noise Environment

Impact due to Construction

The principal source of noise during construction of highway would be from operation of equipment, machinery and vehicles. Earth moving machineries e.g. excavators, graders and vibratory rollers has potential to generate high noise levels. These machineries produce noise level of more than 70 dB (A). This can cause disturbance to the settlement, adjacent to the carriageway or at 500 m from the worksite. The vibration produced by rollers can be transmitted along the ground. This may cause damage to kutcha structure located along the alignment. The extent of damage would be dependent on the type of soil, the age and construction of the structure.

The operation of the quarry and stone crusher can, produce noise levels higher than 100 dB(A). These noise levels can thus cause inconvenience to settlement located close to the quarry site. During quarry operations blasting carried out would also generate vibration. The quantum of vibrations i.e. Peak Particle Velocity would be dependent on the quantum and type of charge and the type of rock.

The noise generated during the construction would cause inconvenience to the population adjoining the highways especially within 500 m of the alignment after which it would be attenuated to acceptable levels Since, the settlement along the road alignment would be sparse the severity of the impact would be low. The impact on the workers however would be dealt with in the section 3.3.5.

Mitigation Measures

- Regular maintenance of the machinery, equipment and vehicle would be carried out to prevent excessive noise. A maintenance schedule would be prepared and maintained by the contractor.
- Night time construction activity would be prohibited in case settlement/habitation is located within 500 m of the construction site.
- In case of blasting the quantum of charge would be decided based on the DGMS

These measures as discussed above would also be made part of the Standard bidding document of Contractor involved in sub-projects.

3.3.4 Issues Related to Ecological Environment

Impact on Flora

The area under forest in the state is just 9.0 % of the total geographical area. As a result, major habitat alteration is not expected due to the expansion of the highways since most of the road alignment would avoid forest or natural habitats. Similar is the case with wetlands which cover 2.29% of the state. Since forest areas would be avoided the impact on trees would be primarily from felling of trees. The plantation along the roadside have to be felled to accommodate the expansion of the highway. The construction activities would cause disturbance of RoW soils and vegetation along the alignment due grubbing and clearing of the land. Even though there would be a conscious effort to avoid mature tree the number of trees to be felled would be considerable. The impact on the flora would thus be limited to felling of trees.

Mitigation Measures

Following measures would be adopted during planning and construction of highways.

- Wherever possible, efforts would be made not to fell the mature tree by selecting the alignment on the side where the number of trees to be felled can be reduced.
- In case mature trees come within the proposed alignment the option of transplantation of the trees would be worked out;
- Contract document for the Contractor would include specific clauses to prevent felling of trees by selecting design alternative unless it becomes absolutely necessary;
- Only those trees for which tree felling permission has been obtained from the Forest Department under The Rajasthan Forest (Produce Transit) rules, 1957 would be felled;
- Additional plantation would be carried out in places along the alignment as per the provisions of the IRC SP 021: Guidelines for Landscaping and Tree Plantation or as suggested by the regulatory agency;
- Only local tree species which are less water consuming should be used for plantation especially in water scarce districts.

Impact on Fauna

The alignment would avoid all the National park, Wildlife Sanctuaries and Community reserves. However, there are considerable wildlife outside the National Parks and Wildlife Sanctuaries in the community conserved areas e.g. Orans, Gochars. Any encroachment into the natural habitats whether legally protected or by community would have impact on the scarce ecological resources.

During the construction of the culvert, excavation have to be carried out for developing the foundation. In areas where there is wildlife movement the wildlife is at risk primarily due to falling of the animal into the excavation carried out for foundation.

Movement of wildlife in the desert areas occur especially in search of water and resting areas. Large number of road kills especially reptiles and mammals have been reported in the highways in the sub-project areas. Due high day temperature in the subproject districts most of the wildlife movement occurs at night. Without any interventions planned in the design, there would be impact on the wildlife.

Mitigation Measures

- During the design of the sub-project it would be ensured that intrusions in the conservation areas irrespective of its conservation status would be avoided through optimisation of route alignment. Modern tools like GIS alternative route analysts would be used for the avoidance exercise.
- A survey of the vulnerable stretches of the road especially with respect to road kill would be carried out. Information may be sought from the Forest Department or from the local people about the road kill. Based on the information available during the design the areas with known road kills and wildlife movement would be identified. Modern techniques e.g. camera traps may be used for identification of the wildlife movement.
- For the vulnerable stretches of the road especially with respect to road kill the following measures would be taken:
 - Reflectors should be installed along the highway in these areas to prevent wildlife from approaching the road
 - Display boards (as per IRC 30 - 1968 - Numerals of Different Height for Use on Highway Signs and IRC 67 - 2012: Code practice for Road Signs) should be placed ahead of the stretch to warn drives of the approaching wildlife crossing areas
- During the construction areas which have proven wildlife movement temporary woven wire mesh guards of about 2.4 m (8 ft.) high will be put around the excavated areas to prevent small wild animal from falling. No harm would be done to the animal if they are trapped in the excavated area. The contractor in association with Employer and Forest Department would ensure safe release of the animal.

3.3.5 Issues related to Occupational Health and Safety

Highway workers are at risk of injury from i) passing traffic vehicles, ii) Construction equipment operating within the work zone and in ancillary areas which support the work zone e.g. batching plant, hot-mix plants iii) construction vehicles entering and leaving the work zone. The statistical information²⁰ indicate that the worker on foot are the most vulnerable in the Highway Construction work zone. Similarly, there are occupational risks during operation of the highway is from traffic. Accidents primarily occur due to collisions with passing vehicle.

The sub-project districts experience extreme weather conditions especially during summers. This can cause fatigue and lead to issues of dehydration and heat-stroke.

²⁰ Building Safer Highway Work Zones: DHHS (NIOSH) PUBLICATION No. 2001-128, April 2011, <https://www.cdc.gov/niosh/docs/2001-128/pdfs/2001-128.pdf>

Mitigation Measures

The following mitigation measures need to be adopted to protect the workers:

- Temporary traffic control devices such as signages, warning devices, concrete barriers can be used to segregate the highway traffic from the work zone. These control devices should be setup at a distance ahead of the work zone to control traffic. Cover or remove the precautionary signages when the workers are not present;
- Flaggers should be placed with high reflective jackets and other devices so that they can slow down the traffic;
- No equipment or vehicle should enter the work zone without the flaggers being present;
- All vehicle should be fitted with reverse siren. Rotating equipment should also be fitted with siren which should come on when the equipment rotates to the reverse;
- To prevent the workers from getting dehydrated or being affected by heat stroke the following measures may be considered:
 - All workplace to have adequate provisions of drinking water,
 - The workplace should be provided with temporary shelters where the workers can rest during prolonged exposure to sun
 - In case of extreme temperatures, the working hours may be regulated. Night time working can be considered especially in areas outside settlement with the permission of the Employer/Engineer.

3.3.6 Issues related to Community Health Safety

Impacts during Construction

The construction activities would be carried out without hampering the siting traffic since there is no alternate corridor for diversions of traffic. The construction activities would also remove the additional spaces i.e. shoulder to accommodate the construction of the additional carriageway or strengthening of the carriageway and shoulders. Since the local slow-moving traffic including pedestrians and the through highway traffic would be using a reduced road space the congestions on the highway would increase. This situation would be further aggravated by the vehicle used in the construction activity.

The local slow-moving traffic and pedestrians are thus prone to collision with the through highway traffic and the construction vehicle. Also, at times the excavations are carried out close to a village access road or settlement. These work sites would also cause potential injuries to the public.

Mitigation measures

- All worksites should be barricaded, and the integrity of the workspace segregations maintained at all times;
- In settlement area the workplace should be segregated by the erecting barriers. Separate walkway should be identified in the settlement areas. Crossover points should be provided at the worksite locations in settlement areas so that people can easily crossover.

- At the point of entry or exit from the work site flagman should be provided. The entry and exit vehicle shall be regulated by the flagman to prevent collision;
- All worksite shall be provided with reflective stickers so that it can be easily identified during night
- Precautionary signages should be put-up well in advance to warn diver of impending construction works
- Flashers should be provided near excavation to warn the traffic of the excavations
- The worksite within the settlement shall be properly illuminated as a safety precaution.
- The construction debris should not be placed on the road as it would further constrict the space available for the public.

Impacts During Operations

During the operations phase of the highway the traffic volumes and vehicular speeds are both likely to increase. This can potentially be risky both for pedestrian as well as slow -moving traffic. In addition, as traffic speeds increase the chances of vehicular collisions are also expected to increase.

Mitigation Measures

- During the design activity a traffic hotspot study should be carried out to identify the location of accident or areas of conflicting traffic. Design interventions should be carried out at these locations
- During the operations of the highway traffic hotspot studies should be carried out every year as per the MoRTH's Circular detailed in Guidance Note 13: Community Health Safety

3.4 Environment Management Plan

A Management plan has been developed based on the issues which are likely to occur due to the project activities and also on the mitigation measures which have been identified.. The management plan further elaborates these mitigation measures through detailed guidance placed in the Guidance Notes.

A set of 12 Guidance Notes have been developed for the project considering the environmental setting, type of activities and the possible impacts. The guidance notes in addition to providing technical guidance on mitigation measures also provide guidance on regulatory requirements related to the activity. The guidance Notes which have been developed include:

Box 3-2:Guidance Notes developed for the Project

Guidance Note (GN) 1: Planning and Design: Discusses on the environmental considerations which can be included in the design to reduce the EHS impacts;

Guidance Note (GN) 2: Slope Stability and Erosion Control: lists out mitigations which can be included in the planning and design to reduce impacts;

Guidance Note (GN) 3: Forest and Other Natural habitats: measures to be undertaken during blacktopping / widening of road sections passing through natural habitats;

Guidance Note (GN) 4: Wildlife Management: planning, operations and maintenance, and monitoring wildlife, ecological systems with respect to transportation systems;

Guidance Note (GN) 5: Drainage and Waterbodies: reduce impacts on the road construction activities on the drainage and water bodies;

Guidance Note (GN) 6: Construction Camp Management: provides guidance on siting, planning and operation of construction camps and construction yards;

Guidance Note (GN) 7: Construction Equipment and Machinery: guidance for selection and procurement, operations and maintenance of machinery

Guidance Note (GN) 8: Borrow Area Management: guidance for selection, operation and closure of borrow areas including the regulatory requirements

Guidance Note (GN) 9: Quarry Management: guidance for procurement of quarry material including the regulatory requirements

Guidance Note (GN) 10: Construction Water Management: due to the scarcity of the water in the sub-project districts it provides guidance on water conservation also provide some management actions for reducing water consumption

Guidance Note (GN) 11: Waste Management: provides guidance for reuse and disposal of different types of waste arising out of the Contractor's operations

Guidance Note (GN) 12: Occupational Health and Safety: Occupational Health Safety Guidance during the contractor's operations

Guidance Note (GN) 13: Community Health and Safety: Details out the community health and safety aspects both during the construction and operation

Guidance Note (GN) 14: Use of Alternate Material and Construction methodologies.: The alternate materials and construction methodologies which may be used in construction of the sub-project roads.

The Environment Management Plan would also detail out the responsibility for implementation and overview of the activities. The Environment Management Plan is presented in Table 3-4

Table 3-4: Potential Impacts and Mitigation Measures during -Construction Stage

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
A. Feasibility Stage						
A 01. Reconnaissance Surveys	Potential impacts on sensitive environment / Natural habitats which might be impacted directly or indirectly due to expansion/ widening or strengthening	Walk-over surveys / strip mapping should be conducted to identify the following: Forest areas, Sanctuaries, Community Reserves, Conservation areas, plantations, Grazing land, agricultural land, Sand dunes, Cultural properties, Water bodies, Wetlands, River crossing, flood prone areas, erosion prone areas (including sand dunes) utilities including underground pipeline.	Along all the project road	Guidance Notes 1: Project Planning and Design The environmental hotspots to be marked on the strip plan and provided to the design team		
A 02. Detailed Surveys: Geo-technical Surveys	Increasing of instability of unstable slopes	Slope Stability analysis to be carried out and design to define slope stabilisation measures. Bio-engineering techniques to be adopted	Along sub-project roads in the Aravalli hill and in the Mount Abu	Guidance Note: GN-2 Slope Stability and Erosion Control (on Bio-engineering techniques)		
	Potential aggravation of erosion prone areas	Measures to be taken to control erosion, special focus to be provided on the wind erosion in the sub-project located in the desert districts. Also potential for erosion in areas prone to flooding, flash floods to be identified	Specially on the project roads in Dry Sandy Areas	Guidance Notes GN-2 Wind Erosion Control in Deserts.		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	Potential impacts on soil environment in terms of loss of productive land due to disposal, soil erosions etc	Identify the areas requiring excavations and assessment of the quantity of excavation Prevent excessive excavation leading to unnecessarily large volumes of earthworks, and generation of waste material. Develop management plans for erosion control in dumping areas	Especially in sub-projects in Mount Abu or in Aravalli region. Also, in sharp curves where geometric adjustment is required	Guidance Notes GN-2: Water related Erosion & Control.		
A 02. Detailed Surveys: Topographical & Hydrological surveys	Poor drainage caused by poorly designed/ specified drainage structures would cause water logging and damage to drainage structure and road. Inadequacy for cross drainage structure would cause water logging and damage to road	Identify the areas prone to floods/ flash floods Drainage structures designed in accordance with anticipated levels of water flows (flash floods, sheet flows to be considered). The culverts should be designed as per the provisions of IRC: SP:13-2004 so that there is adequate passage for water to pass.	In bridges and culverts in all the sub-projects			
A 03. Environmental Surveys including Wildlife surveys	To prevent adverse impacts on the wildlife especially those outside protected areas.	Mitigation measures would include reflectors, underpasses for use by wildlife etc	Along the stretched of the sub-project which have identified wildlife habitat	Guidance Note 10 Wildlife Management. Location of natural habitats should be identified and avoided.		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
				Location of wildlife movement should be identified, and mitigation suggested		
Detailed Design and Pre-construction						
B.02 Detailed Design: Finalisation of RoW: Non -forest areas	Widening or geometric improvements leading to loss of agricultural land and or destruction of trees,	Cross sections for the sub-project road shall be worked out to minimise uptake of agricultural land or irrigation structure. The proposed designs shall minimise the number of trees to be felled.	Along all the sub-project roads	Guidance Note 1: Planning and Design		
B 02. Detailed Design Finalisation of alignment -Natural Habitats (forest, wetlands)	Potential impact to the ecosystem (Both biotic and abiotic) and wildlife and migratory birds.	Avoidance of the alignment through any environmentally sensitive habitats (National Parks, sanctuaries, Reserve Forest, Community forest). Promoting good practices such as wildlife crossings, erosion control measures, signage etc Have provisions in the contract to temporarily suspend noise generating activities during the migratory season. Construction activities near these sensitive habitats shall be	Sub-projects along natural habitats.	Guidance notes 3 Forests and Other Natural Habitats).		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
		controlled. No construction waste shall be disposed in any forest area				
B 04: Marking of the Alignment	Unnecessary widening leading to additional geometric cuts, soil erosion, destruction of plant and water resources	Cross sections for the sub-project road shall be worked out to minimize impacts on water bodies/courses, plantation, unstable areas.	Along the either length of the sub-projects	Guidance Notes 1: Planning and Design		
B 06. Forest Land Diversion and Tree Felling	Loss of Natural Habitat with diversion of forest land or felling of trees	Alignment would not encroach into any legally protected forest land or into any community conservation reserve				
		Feasibility of transplantation of trees should be worked out. In case the same is unfeasible the permission for felling of tree shall be obtained from the Forest Department.				
B 07: Siting of Project Infrastructure: Construction camps and contractor facilities	Inappropriate location such (near settlements or eco-sensitive zones, biodiversity hotspots and human settlements) can lead to conflicts with community or potential impacts on natural habitats	Location of construction camps at least 500m away from Settlements, /religious structures, and away from drinking water sources The construction camps shall be located at least 1000m (1km) away from eco-sensitive zones (the boundaries of the National Parks Wildlife sanctuaries and 500m away from the community reserve or community conservation areas		GN – 3 Construction and Labour Camps) Provide siting guidelines and norms for construction GN-4 Siting Guidelines for Hot-Mix Plants		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
		The camps must be located such that the drainage from and through the camps shall not affect any domestic or public water supply of flow into any of the areas mentioned above The location of the hot mix plant, stone crushers should also be selected considering the guidelines set by the state pollution control board.		and Crushers.: Provide siting guidelines and norms for construction		
B 07: Siting of Project Infrastructure: Crushers, Hot-mix Plants & Batching Plants	Potential impact from air pollution on natural habitats and resources located in sensitive areas legally and otherwise	The location of the hot mix plant should also be selected considering the guidelines set by the state pollution control board. Processing of clearances/permits on a timely basis and keeping in mind the time requirements for these clearances		Guidance Notes GN-7 Construction Plants & Equipment Management) \ Time requirement: (Refer Table 2-3)		
B 08 Procurement of Machinery	Potential sources of impacts on air and noise environment	Procure/ Hire machinery which comply with the Emission Standards suggested by CPCB. All diesel generators procured or hired for the project to comply with the standards prescribed by CPCB		Guidance Notes: GN 7: Construction Plants & Equipment Management		
B 09. Identification of Material Sources: Location of quarry sites	Potential impacts on natural habitats and resources located in	Only existing or new approved sites (having necessary Environmental Clearance) may be considered for procurement of quarry material		Guidance Note – GN 3:Quarry Management		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	sensitive areas legally and otherwise	Crushers to have valid Consent to establish and Consent to Operate from RSPCB Only waste land to be used for dumping of debris, no agricultural land shall be used even for temporary dumping				
B 09. Identification of Material Sources: Location of borrow areas	Potential impacts on unstable areas or on agricultural land	Location in area with stable soil and preferably away from agricultural land The Employer/Engineer shall inspect every borrow area location prior to issuing approval for use of such sites.		Guidance Notes GN-2 Borrow Areas)		
C. Construction						
C 01. Site Clearance and Construction Activities: Clearing and Grubbing	Impact on Roadside Vegetation	No tree shall be felled without the permission of the forest department		Guidance Note 4: Forest and Natural Habitats		
	Dumping of debris can affect the quality of the soil if dumped on agricultural land	Debris should not be placed on agricultural land even temporarily. Debris to be placed on designated disposal sites only Debris should be used for backfilling The root stump shall not be place on the edge of the carriageway as it would pose hazard for both the local community and the traffic.		Guidance Note 11: Waste Management & Debris Disposal		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
C 01. Site Clearance and Construction Activities: Dismantling of existing culverts and structures, if any	Dumping of debris can affect existing drainage causing flooding Diversion of drainage channel can affect the normal flow The quality of the soil would degrade if debris dumped on agricultural land	None of the debris should be placed inside any drainage channel Provision of diversion channels and/or scheduling construction of culverts preferably in dry months The debris shall be dumped only at specified dumping area		Guidance Note 5: Drainage and Water bodies Guidance Note 11: Waste Management and Debris Management		
C 01. Site Clearance and Construction Activities: Traffic diversion	Loss of vegetation Loss of topsoil	No trees would be cutdown for the creation of diversions without appropriate permissions. The topsoil shall be removed and stored separately for reclamation of the diversion road.		Guidance Note 3 : Forest and Natural Habitat		
C 01. Site Clearance and Construction Activities: Operation of Construction Camp	Wastewater from Camp deteriorating quality of receiving waterbody Runoff from camp contaminating surface water body Contamination of soil and ground water from oil	Water pollution control measures to be provided: i.) adequate number of toilets and bathrooms to be provided ii) soak pits and septic tank to be provided; iii) no wastewater to flow out of the camp Runoff from camp routed through i) peripheral drain ii) sedimentation tank All oil and bitumen to be stored i) on impervious platform ii) storage	All Construction camps, laydown areas, material storage yards etc	Guidance Note (GN)9: Construction Camp Management		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	Conflict with community	areas to be bunded and iii) runoff from the areas to be routed through oil-water separator The i) Camp shall be fenced; ii) Access to Camp to be restricted				
C 02. Material Procurement & Transport: Borrow Areas Operation	Illegal Procurement of Soil Loss of topsoil Formation of stagnant water pools due to borrowing/quarrying Particulate emission from excavation Safety of the adjoining private or Public Property	The Borrow Areas to obtain requisite licenses and permission and environmental Clearance The topsoil shall be removed and stored separately for reclamation of the diversion road. The borrow area to be adequately drained Excavation operations to adopt measures: i) consider the wind direction during operation ii) reducing drop height during loading iii) water sprinkling depending on water availability Adequate Safety distance and slope to be maintained to prevent the damage to the adjoining property	All Borrow areas in the project	Guidance Note 8: Borrow Area Management		
C 03. Material Procurement & Transport: Quarry Operation (Stone and Sand) including stone crusher	Illegal Procurement of Stones	The Quarry to obtain requisite licenses and permission and environmental Clearance. In case of exiting quarry, the same must be obtained from the owners.	All new and existing quarry	Guidance Notes 9: Quarry Operations		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	Noise and Vibrations from Blasting resulting in damages Air pollution from Stone crushers Erosion of sediments from the Stacked material	The charge of the blasting to be decided in conformity with DGMS circular. Dry and Wet method of dust suppression Erosion control measures to prevent sediment being washed to nearby properties				
C 02. Material Procurement & Transport: Material Transport	Deterioration of Air Quality due to: i) Dust emission from Haul roads ii) Fugitive emission from trucks	Water sprinkling on haul roads (in case of water scarcity dust suppressant may be used) Speed of the truck on haul roads not to exceed 15 kmph All truck carrying a) excavated soil, b) sand c) cement shall be covered with tarpaulin cover	All Borrow areas and during procurement of material	Guidance Notes 8: Borrow Area management		
C 02. Material Procurement & Transport: Material Handling (Soil, Aggregates Bitumen, Oils)	Fugitive emission from loose material deteriorating air quality Erosion from stockpiling causing sedimentation Contamination of surface and ground water from oil and bitumen	Storage against wind break and windrow in the direction of the wind Wetting / covering of surface Cement to be stored in closed area All stockpile to have garland drains along with sedimentation tank All oil and bitumen to be stored i) on impervious platform ii) storage areas to be bunded and iii) runoff	All Borrow areas and during procurement of material	Guidance Notes (GN) 11: Borrow Area Management		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	Health & Safety concerns of workers Risk of injury from vehicle and equipment	from the areas to be routed through oil-water separator Workers involved in material procurement to be provided with PPE's				
C 03. Earthwork Subbase and Base Course: Operation of Equipment and Machinery	Compaction of the agricultural land Emission resulting in air quality deteriorations Noise emissions Risk of Injury to workers Safety of the public	Restrict the equipment and machinery within the designated work site All vehicle to have "Pollution Under Control" Certificates; Regular Maintenance of Equipment and Vehicle; Safety measures for workers e.g. i) posting of flagman ii) reverse alarm on vehicles iii) reflective jackets and high reflective material to be work by workmen Safety Measures e.g. i) Traffic Marshals (Flagman) to control traffic		Guidance Note (GN) 7: Construction Equipment and Machinery		
C 03. Earthwork Subbase and Base Course: Excavation	Discharge of water from excavation increasing sediment	Water to be routed through sedimentation tank before discharge,		Guidance Notes (GN) 2: Slope Stability and Erosion Control		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	load in receiving water body Erosion of Cut Slopes Safety of the public	Feasibility of reusing the water for construction Slope stabilization measures as seeding, mulching & bio-engineering techniques Safety Measures e.g. i) barricading of worksites ii) dedicated walkways and crossover points ii) illumination of work area in settlement				
C 03. Earthwork Subbase and Base Course: Embankment Construction	Erosion causing impact on embankment/slope stability Contamination of water bodies/ water courses	Encroachment into any surface water body is discouraged. Slope stabilization measures as seeding, mulching & bio-engineering techniques, Construction of temporary erosion control structures as per requirements Control measures as silt fencing, vegetative barriers etc Avoiding disposal of liquid wastes into natural water courses		Guidance Notes (GN) 2: Slope Stability and Erosion Control Guidance Notes (GN) 5: Drainage and Waterbodies		
C 04. Culvert and Minor Bridge Works:	Interruption of flows Pollution of water channel during construction	Diversion channels to prevent stoppage of the flow of water Construction wastewater or water in excavation to be disposed through sedimentation tank		Guidance Note (GN) 5: Drainage and Water Body		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
	<p>Debris contaminating the soil and water</p> <p>Occupational Health and safety of workers</p> <p>Community Health and safety</p>	<p>Batching plant and Transit mixer wash waste i) not to be disposed on agricultural land ii) to be reused in paving of roads</p> <p>PPE to be provided to workers involved in bar bending and casting operations</p> <p>Traffic Marshall to guide traffic during the movement of transit mixers in and out of the casting site.</p>		<p>Guidance Notes (GN) 11: Waste Management and Debris Disposal</p> <p>Guidance Notes (GN) 12: Occupational Health & Safety</p> <p>Guidance Notes (GN) 13: Community Health and Safety</p>		
C 05. Surfacing: Bituminous Surfacing	<p>Deterioration of air quality</p> <p>Contamination of Soil from Bituminous Waste</p> <p>Worker's safety</p> <p>Community Safety</p>	<p>Air Pollution Control Measures: i) No open burning of wood / burned for bitumen works; ii) Hot- mix plants to have air pollution control</p> <p>Bitumen waste and off-spec material not to be thrown on agricultural land</p> <p>PPE's to be provided to workers</p> <p>Traffic Marshall to guide traffic during the movement of vehicle carrying hot-mix to and from the surfacing site</p>		<p>Guidance Notes (GN) 7: Construction Equipment and Machinery</p> <p>Guidance Note (GN) 12: Occupational Health and Safety</p>		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
C 05. Surfacing: Concrete Surfacing	Contamination of soil and water from concrete Stress on water resources in water scarce areas	Batching plant and Transit mixer wash waste i) not to be disposed on agricultural land ii) to be reused in paving of roads Construction wastewater to be used for curing Admixture to be used for reducing water requirement in curing		Guidance Notes (GN) 11 Waste Management & Debris Disposal Guidance Notes (GN) 10: Construction Water Management		
C 06. Shoulder Protection and Road Furniture: Shoulder Protection	Erosion of adjoining areas leading sedimentation of water bodies	Erosion control measures of shoulders especially in areas with higher slopes.		Guidance Notes (GN) 2: Slope Stability and Erosion Control		
C 06. Shoulder Protection and Road Furniture: Plantation	Shifting sand dunes affecting infrastructure Impact on Species Diversity	Stabilisation of Sand Dunes using vegetative cover (grasses and Trees) Selection of local species drought resistant species		Guidance Notes (GN) 2: Slope Stability and Erosion Control Guidance Notes: Plantation Guidance Notes (GN) 10: Construction Water Management		

<i>Project Activity</i>	<i>Potential Issues /Impacts</i>	<i>Mitigation Measures</i>	<i>Location in the project</i>	<i>Tools</i>	<i>Responsible Agency</i>	
					<i>Implementation</i>	<i>Supervision</i>
C 06. Shoulder Protection and Road Furniture: Signages	Safety of local population and traffic Collision with Wildlife	Safety Features to be included as per Traffic Hot Spot Study findings Road Signages to be provided as per IRC Code Safety features to be included considering the outcomes of the Wildlife Surveys		Guidance Notes (GN) 13: Community Health and Safety Guidance Note (GN) 4: Wildlife Management		
D. Post Construction Decommissioning						
D 01. Decommissioning: Clearing of Construction Camps	Debris Contaminating the Soil and Water Loss of productive land	All Debris to be removed and disposed at designated sites Reutilisation of debris for strengthening of the shoulder of approach roads Restoration of Topsoil		Guidance No (GN) 11: Waste Management & Debris Disposal Guidance Note (GN) 6; Construction Camp Management		

4 Environmental Management Framework for Project Implementation

The environmental mitigation measures and management plan discussed above have to be integrated into the work flow of the Rajasthan State Highway Development Program. The sections below describe the areas where synergies can be built between the environmental safeguards and the project activities.

4.1 E&S Activities in Feasibility Phase

During the Feasibility stage it would be extremely necessary that the environmental sensitivities along the alignment are identified. The environmental studies carried out during this stage must ensure that the design is informed adequately about the environmental sensitive receptors during the finalisation of the alignment. Further the basic design parameters should also integrate these environmental concerns. The activities which are to be undertaken during this phase of the project and the environmental safeguard activities and their expected outcomes are briefly discussed below

4.1.1 Reconnaissance Surveys

The reconnaissance surveys are to be carried out on all the sub-project roads to identify the environmental sensitivities along them and mark them on a strip plan. The spatial extent of the environmental sensitivity i.e. distance along the corridor and within the proposed Right of Way would be demarcated on the strip map. The importance of the sensitive environmental areas /receptors would be obtained through both consultation with the various respective interested department, local populations and desktop studies. The implication of the sensitivities, probable impact on the environment and project time lines must be discussed and presented in the Reconnaissance visit report. Some of the sensitivity which must be identified the reconnaissance visits are presented in Box 4-.

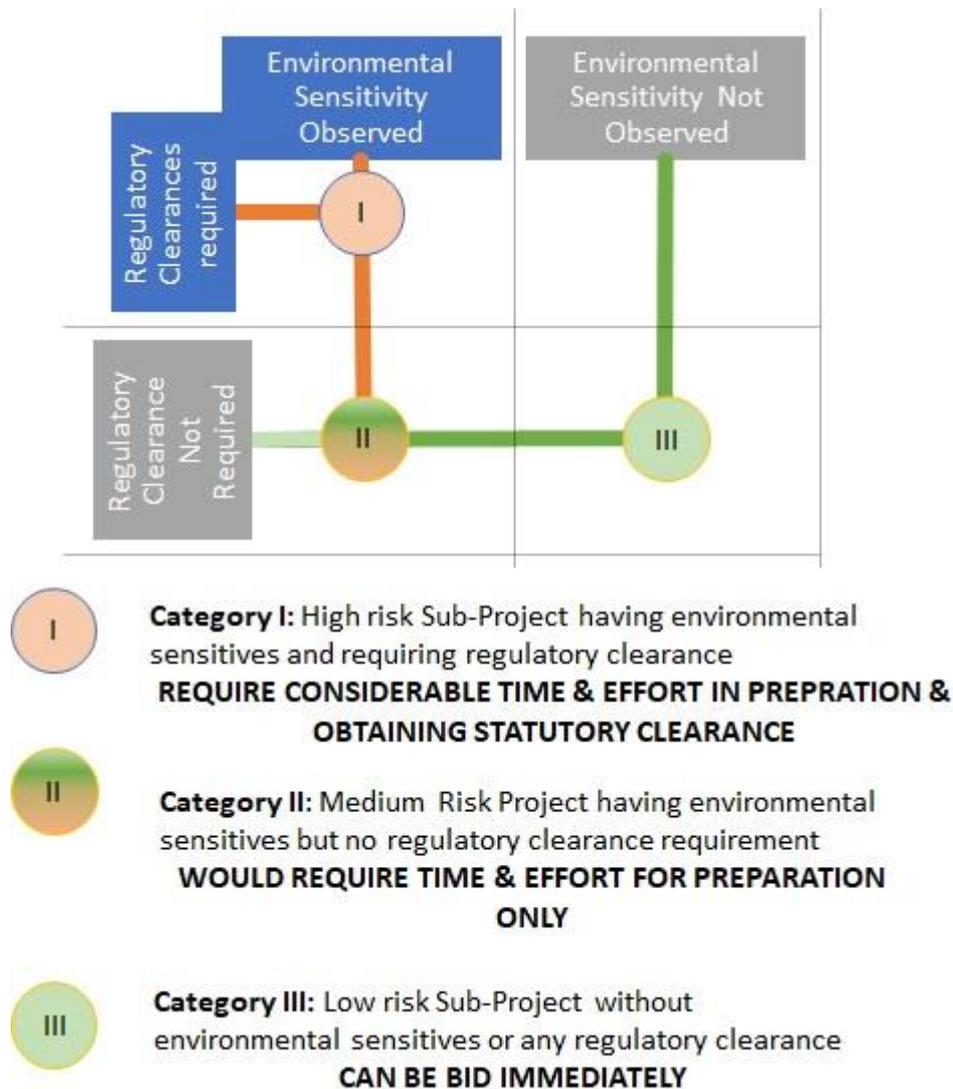
Box 4-1: Environmental sensitivities which need to be identified during the Feasibility stage

- **Forest areas** Including National Parks Sanctuaries, Protected and Reserve Forest all of which have legally protection. status. The legal boundary of these protected areas has to be obtained from the Forest Department to ensure that the alignment do not infringe on it. In case of ESZ the boundary of the ESZ also have to be obtained so that the alignment (if allowed) can be undertaken after obtaining requisite permissions.
- **Eco Sensitive Area:** The boundaries of the Eco-Sensitive Area of Mount Abu has to be obtained so that sub-projects in that area are in compliance to the Master Plan and the Mount Abu Eco-sensitive area Notifications
- **Community Reserves and Conservation areas:** These areas include conservation areas, plantations, Grazing land. Even though these do not have any protection status these provided habitats for wildlife.
- **Productive lands:** Agricultural land are scarce in Rajasthan and thus irrigated agricultural land stretched have to be identified and protected (so that the final alignment does not infringe);
- **Erosion prone Areas:** Areas are either prone to erosion by runoff or wind must be identified for developing measures to prevent erosion. Sand dunes, caused due to shifting sands by wind also threaten the road infrastructure and this needs to be identified
- **Other Sensitivities** The other sensitive areas which needs to be identified include Cultural properties, Water bodies, Wetlands ,River crossing, flood prone area utilities including underground pipeline

4.1.2 Screening of Sub-projects

Based on the information collected during the reconnaissance visit the sub-projects would be screened into three Categories i.e. Category I- III. The classification of these three categories and their implication in the future design and implementation is Figure 4-1.

Figure 4-1: Screening Mechanism for Sub-projects



Based on the above screening the subprojects would be prioritised and taken up for detailed design and bidding.

4.1.3 Detailed Surveys

The detailed surveys would include the following:

- **Geo-technical Surveys:** The areas of instability which have been identified would be further investigated and suitable protection measures suggested. Both erosion caused by run-off and wind would be studied based on the location of the sub-project. The erosion control measures are elaborated in Guidance Note 2: Slope Stability & Erosion Control.
- **Topographical and Hydrological Surveys:** to prevent impact on the natural flow of water and damage to the road the hydrological studies have be carried out along with the study of the contours. Since the state receives low rainfall, it is also important to protect any surface water body. The detailed surveys should also integrate protection of these surface drainage and water bodies into the

design. The cross drainage and longitudinal drainage have to be designed in accordance with Guidance Note 5: Drainage and Water Bodies

- **Environment & Wildlife studies:** These studies would be carried out with other environmental studies. Since in principle, the legally protected areas would not be infringed upon it has been decided that the focus of the study would be on identifying the wildlife habitats along the alignment outside the protected areas. The areas of animal crossing also need to be identified so that protection measures suggested in Guidance Note 4: Wildlife Management can be implemented.
- **Road Safety:** A road safety study would be conducted for the project road as per the Guidance Note 13: Community Health and Safety. The Traffic hotspots would be provided a unique identification as per the directive of MoRTH. The design team also needs to be made aware of these blackspots so that engineering interventions can be included in the design.

4.1.4 Environmental Studies

Environmental assessment for each of the project roads would be carried out simultaneously with the detailed design. During this period for category I and II subproject EIA study would be carried out as per the Standard Terms of Reference²¹ for Highway projects developed by Ministry of Environment Forest & Climate Change. Sub-project specific Environmental Management Plans shall be developed. This would be appended to the bidding documents. For Category III sub-projects the standard EMP presented in Table 3-4 would be considered and included in the bid -document.

Sub-projects which have additional sensitivities related to the wildlife, ecology, water resources, erosion (especially wind-borne erosion) specialised studies would be conducted primarily using secondary information or discussion with institutional stakeholders and the local people. One season field surveys may be considered if it extremely important. Specific Management Plan would be developed along with design drawing, developed. The management plans would be useful document which shall help in planning of environmental safeguards and included in the Operations Manual.

Addressing Climate Resilience

In areas which are prone to water scarcity the design should identify the mitigation measures as discussed above. Rainwater harvesting for construction purpose should be actively pursued as it would not only reduce the stress on the scare water resource during the construction but also help in augmenting water resources in the area over a period of time. Since most of the roads would be concentrated in the western parts of Rajasthan which is prone to extreme temperatures above the softening point of bitumen used for road construction i.e. VG10/VG 20. Thus, in extreme temperature conditions of western Rajasthan in May and June there would be bleeding of asphalt resulting in damage to the pavement. To prevent such damages in this project and making the project resilient to climate changes, VG 30 with a softening point of 47°C is being recommended. Some of the projects located in the basin of the Luni river are prone to flooding. The finished level of the road may have to be raised to maintain serviceability of the road during the extreme weather events. Cross drainage structures need to be designed to prevent water logging in the adjoining areas.

Greening of Highways

²¹ <http://www.moef.gov.in/sites/default/files/final%20Booklet.pdf>

Since construction material are getting scarce and costlier because of the competition from different other users, use of alternative material and waste in constructions gains importance. Road construction also accounts for a large quantities of greenhouse gas emissions, pollutants and energy consumption. For greening of the Highways alternate construction methodologies and alternate construction materials also need to be adopted. Indian road Congress (IRC) has already formulated guidelines for these. The alternate material and methodologies are all included in the Guidance Note 14: Use of Alternate Material and Methodologies

Road Safety

The preliminary design should also analyse traffic safety issues (identify black spots along the corridor and develop engineering design or traffic calming measures), EHS issue in construction and operations of the road and also include them into the project documents.

The findings of these studies would be included in the Environmental Assessment Study which would be prepared along with the Feasibility Report. Sub-project specific Environmental Management Plans shall be developed for Category I and Category II sub-project to address the sensitivities. This management would be appended to the bidding documents to guide the bidders to estimate the nature and extent of mitigation measures required. For Category III sub-projects the standard EMP presented in Table 3 2 would be considered and included in the bid -document.

The mitigation measures and environment management plans which had been identified would be included in the Bill of Quantities (BoQ) so that it can be integrated into the detailed design. It would also be important to ensure that based on the detailed design EHS requirements are integrated into the Bidding Documents of the respective sub-project. This would be in addition to the standard provisions that are already there in the standard bid document.

4.2 E&S Activities in Detailed Design and Pre-Construction Phase

The phase would essentially include the detailed designing by the contractor and the preparatory activities for construction. The activities which would be carried out by the contractor and their environmental responsibilities are described below.

4.2.1 Detailed Design

During the detailed design stage, the inputs from the above Feasibility studies and the EIA and EMP would be integrated into the design. Inclusion of the different mitigation measures suggested in the different guidance notes would ensure that the proposed roads are environmentally sustainable. The mitigation measures which might be adopted is included in:

- Guidance Notes 1: Planning and Design;
- Guidance Note 2: Erosion Control and Slope Stability
- Guidance Note 3: Forest and other Natural areas;
- Guidance Note 4: Wildlife Management
- Guidance Note 5: Drainage and Water bodies

The specific actions which would be undertaken during the detailed design would include:

Box 4-2: Actions to be taken by the Contractor during the Detailed Design to integrate Environmental Safeguards

Protection of the water resources

This would gain considerable significance in case of alignment passing through water scarce regions. The mitigation measures suggested in section 3.2.4 need to be suitably considered in the design. In addition, the contractor shall carry preferably identify local depression along the alignment in consultation with the local panchayat to be developed as water storage areas. To facilitate the selection of the site for location of the surface water bodies a Digital Elevation Model for the study area may be created. The PIU can enter into an agreement with the panchayat for development of this water body and using the water stored on it for construction purpose. The runoff of from the surrounding area and or pavement can also be channelized into them depending on feasibility. As part of the development it is envisaged that the water body would be excavated to a depth of 2-3 m and the excavated material may be used for earthwork of used for creating bunds of the waterbody. Since the project area has sand and sandy loam soil it is proposed to use HDPE line 1.5mm thick on the for lining the water body so that the water does not perchlorate. This waterbody would be handed over to the community for use and maintenance after the completion of construction

Wildlife Sensitivity

In project roads passing through the Jodhpur, Nagaur and Barmer district there is presence of wildlife especially chinkaras, blackbuck and Nigai in areas outside the protected areas. In such areas as mentioned in Section 3.3.4 the contractor should identify the areas of road kills or wildlife crossing . Based on the finding the mitigation measures as suggested should be included in the design

Road Safety

Identify and define black spots which are already identified as per the Guidance Note 13: Community Health and Safety. In addition to accident prone areas along the highway , settlement along the highway sensitive receptors e.g. schools, hospitals and market would also be considered for traffic safety . The traffic safety intervention in terms of design intervention e.g. elevation of the road, or traffic calming measures The following traffic calming measures can be considered in settlements:

- i) circular humps : this is capable of reducing the speed of vehicle by 5kmph below the desired speed.;
- ii) trapezoidal humps raised flat areas with two ramps;
- iii) zebra crossing on top of a trapezoidal hump with two pair of jingle strip on both side. This can be used in settlement areas where there is pedestrian crossover points;
- iv) rumble strips cased by asphalt and thermoplastic would increase noise and but reduce speed
- v) jingle strips
- vi) traffic islands

Flooding and Water Logging

Certain areas in Jodhpur, Barmer, Pali in the basin of the River Luni and its tributaries are prone to flooding . For roads in such district the Contract shall identify the flood prone areas and carry out detailed hydrological modelling. Based on the outcome of the modelling the finished level of the road shall be decided the cross drainage structures shall also be defined based on the modelling so that the water logging does not occur.

Based on the specific inputs of these studies the Contractor shall finalise the design . He shall also refine on the EMP which has been prepared during the EA.

4.2.2 Marking of the Alignment

The final staking on the ground is carried out by the Contractor at this time of the project. During this activity, if any environmental sensitivities are found the same would be adjusted in the design with minimum or minor modifications. The possibility of modifying the alignment would be to avoid certain environmental sensitive receptor and can also be worked out.

4.2.3 Diversion of Forest Land

Efforts would be made through the Feasibility and Detailed design stages to avoid use of forest and natural habitats. Again, if there is still possibility of exclusion of forest land /any natural habitat the same would be carried out during the marking of the alignment. The residual forest land (if any), would be identified on a GIS map with ground truthing points and the Forest Diversion Plan prepared. The Forest Diversion proposal of the residual forest land would be submitted online to the Nodal Officer of the State Forest Department for processing.

4.2.4 Siting of Project Infrastructure

Siting project infrastructure e.g. Construction camps, hot mix plants and batching plant are important so that there is least interference with and from the local population. Additionally, the facilities in the construction camp must be planned in such a way that the living conditions for workers and employees are not compromised. There would also be no competition with local population over natural resources. The discharges and emissions from the camp must also be controlled through design interventions so that the receiving environment is not polluted. The Guidance Note 6: Construction Camp Management details out the measures which need to be taken to prevent the above.

4.2.5 Identification of Material Sources

this activity would not only be limited to identification of the resource but would initiate the process permitting and clearance because some of these natural resources required for construction activities are regulated and require statutory permissions and clearances. The necessary permits under The Rajasthan Minor Mineral Concession Rules, 2017 and the prior Environmental Clearance for the minor minerals must be obtained from the District Level Environmental Appraisal Committees as per the EIA Notification 2006. The Guidance Notes 8 Borrow Areas and Guidance Notes 9: Quarry details out the process and safeguard measures which must be incorporated in the project. The planning of procurement of the material should include these and the safeguards to be implemented during the operations included in the Operations Manual.

4.2.6 Procurement of Machinery

The machinery mobilised for the project need to be in conformation with the standards for emission and discharges. The guidance on the procurement of machinery is provided in Guidance Note 7: Construction Equipment and Machinery.

4.2.7 Organisation Development for Environmental Safeguards

To ensure that the above-mentioned safeguards are implemented a system for managing the environmental aspects have to be developed by the EPC Contractor/ Concessionaire. The Operations Manual would detail out the environmental safeguard systems which have to be followed. The measures presented in the Guidance Notes along with the roles and responsibilities would be detailed out in the Manual. Taking cue from the EMF an arrangement to report environmental performance complete with indicators, format and frequency would be developed as part of the activities during this activity an included in the manual.

To ensure that the professionals are aware and equipped to implement the environmental safeguards The Training and Capacity Building Plan shall be prepared. The plan would include provisions for Orientation Training, Detailed Job Related Safeguards Training, and Refresher Training.

4.3 E&S Activities in Construction Phase

The construction stage would witness most of the activities on the ground. As a result, most of the impacts which have been identified in the EMF except for the ones which are linked to the planning and design stage e.g. encroachment into forest areas etc, are likely to occur during the period. At this stage of the project the major focus would thus be on ensuring that the environmental safeguards which have been planned during the earlier two stages are implemented. Capacity building of the staff and empowering them to ensure safeguards would be crucial to the success of the safeguards implementation. At the same time close supervision needs to be carried out by the Employer/Engineer to ensure so that the safeguards are properly implemented by the EPC Contractor/ Concessionaire. The training and supervision would continue through this phase and

would provide feedback to the EPC Contractor’s / Concessionaire’s management to develop corrective action for continual improvement.

The major project activities during this stage include i) clearing and grubbing, ii) Material procurement and transport (including soil, sand and quarry material) iii) Earthwork iv) Construction of Structure (culverts and bridges) v) surfacing and vi) shoulder protection and road furniture. However, from an environmental safeguards perspective the activities are described in section below.

4.3.1 Establishment of the System to ensure safeguards Implementation

To ensure the implementation of the environment safeguards including Occupational Health Safety (OHS) and Community Health Safety Safeguard provision an appropriate organisational mechanism developed during the pre-construction stage has to be adequately staffed with clear responsibilities. Even though all the employees/sub-contractors associated with the project would be responsible for ensuring implementation of the environmental safeguards, safety of the workers and the community the EPC Contractor/ Concessionaire would deploy exclusive manpower for environment safeguard and occupational, community health and safety at the supervisory level. The roles and responsibilities of each of the employees related to Environment, Health and Safety (EHS) would be detailed out and included in the job profile. The organisational structure is described in detail in Section 5.1 and would be detailed in the Operational Manual along with the detailed job profile

4.3.2 Training of the Workers

The training to be imparted to the workers would comprise of four different types at different phases of the project lifecycle. These are presented in Figure 4-2.

The details of the training i.e. aspects to be covered in each training, target groups, training duration etc would be described in Section 5.2.

Figure 4-2: The Training Cycle



4.3.3 Monitoring and Auditing of Implementation

To ensure that the effective implementation of the environmental safeguards and the activity is carried in a safe manner from both the community and the workers perspective, regular supervision monitoring shall be carried out. While the regular and intensive supervision (on job supervision and

regular monitoring) would be the responsibility of the EPC Contractor/ Concessionaire personnel deployed on site, the EPC Contractor's / Concessionaire's Management would carry out quarterly Audits to keep a tab on the environmental performance. The Engineer/Employer would carry out periodic checks (monthly monitoring and half yearly audits) to ensure that the on-ground performance is as per the expectations of the Project. The Engineer/Employer would collate the documents and send a report of the environmental performance to the Board (of PWD) for review and onward reporting to the Bank every six months. The overall scheme of the supervision monitoring and auditing in Rajasthan State Highways Program is presented in Figure 4-3 and discussed in detailed in Section 5.3

Figure 4-3: The Overall framework for supervision monitoring and auditing



4.3.4 Review of the Performance and Corrective Actions

A review of the environmental performance of the project would be carried out by the Line management based on the regular monitoring report carried out by the EPC Contractor/ Concessionaire Supervisors and Corrective Action Plan would be prepared and implemented. The EPC Contractor's/ Concessionaire's Management would deploy additional resources if required.

For repeated offence or violations of the environmental safeguards or Occupational health and safety provisions the EPC Contractor's/ Concessionaire's management can also impose a penalty on an individual/group of individuals and at all levels.

4.4 E&S Safeguards during Post-Construction and O&M

This phase contains both the post-construction or the decommissioning and the operations and maintenance phase. Since the decommissioning is very short period and some of the assets of the EPC Contractor/ Concessionaire would be retained no separate phasing has been done. Rather, post-construction/decommissioning and operation and maintenance has been considered as part of one phase. The immediate activity at the time of the decommissioning of the EPC Contractor/ Concessionaire would include a closeout-audit, followed by a continuous activities maintenance and efforts to recycle material during the maintenance Improvement of the Road safety would be another effort which has to be undertaken during this period.

4.4.1 Close-out Audit

The closeout audit would be carried out by the Employer/Engineer during the decommissioning of the facilities. The facilities which would be completely vacated and handed over to the

Owner/Employer would be audited to ascertain any pending environmental issues. The due diligence would also include the agreement reached between the owner and the EPC Contractor/ Concessionaire for final handover of the property to ensure that the conditions of the agreement are fulfilled. Any deviations to the agreed terms and conditions would also be pointed out. Similarly, any pending issues/actions from the construction stage which might still be relevant at the time of decommissioning would also need to be addressed by the EPC Contractor/ Concessionaire before the closure.

For assets which would be either fully or partially retained by the EPC Contractor/ Concessionaire for the operations stage the audit would point out key environmental issues pertaining waste and debris disposal, waste water, disposal of hazardous waste etc. An action plan would be drawn up for the redressal of these problems before the closure of the construction phase. On successful closure of all the relevant issues the Employer would provide a No-Objection Certificate,

4.4.2 Road (Traffic and Community) Safety

During the operation of the road the road safety including both community health safety and the traffic safety gains importance. The improvement of road safety has to be a continual process through augmenting road safety infrastructure as well as awareness of the local people on road safety. The Guidance Notes 13: Community Health Safety discusses on the issues.

4.4.3 Recycling of Material

During the maintenance stage greater stress has to be laid on recycling of existing construction material. This would not only reduce the consumption of the natural resources but also provide large scope for savings in the project. Similarly, alternate methods for use of bitumen can be adopted to reduce emission load as well as reduce the energy cost related to the heating of bitumen. The possible mechanism has been discussed in Guidance Notes 14: Use of Alternate Material and Methodologies.

4.4.4 Occupational Health Safety

The Occupational Health and Safety of the workers during the operations phase is important because some of the maintenance works has to be carried out when the traffic is flowing the Operations Manual should detail out the procedures for ensuring the safety of the workers during the maintenance however a brief outline has been provided in Guidance Note 12: occupational Health and Safety.

5 Implementation Arrangements

Subsequent to the detailing of safeguards measures and process which would be followed for environmental and social safeguards implementation it is necessary to define the structural mechanism for its successful implementation. The organisational structure for E&S safeguards implementation at Rajasthan State Highways Program including the mechanism for monitoring, supervision and reporting of the E&S safeguards implementation is described in the subsequent sections.

5.1 Institutional Arrangement

The institution which has been envisaged for the implementing the program especially the environmental safeguards are discussed have been elaborated below along with the roles and responsibilities of each of the position .

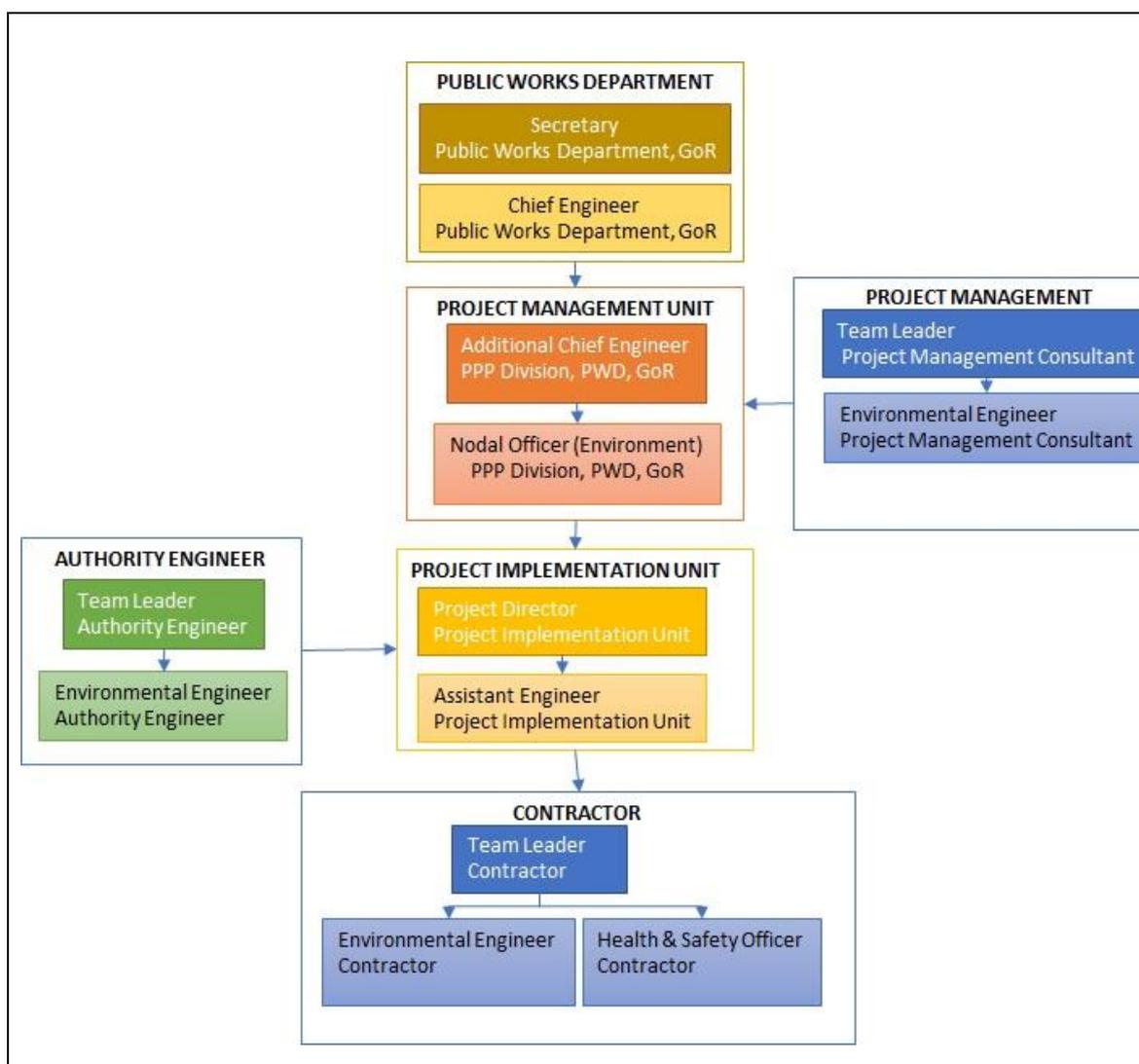
The overall program including the construction activities would be headed by the Secretary of the Works Department and he would have oversight into the preparation and implementation of the program including the environmental safeguards. At the Public Works the Engineer- in -Chief responsible for the PPP division would not only oversee the program but will also supervise the program

The construction activities of RHSDP II would be headed by the Chief Engineer of the PPP cell who will be responsible for the successful implementation of the Project. The Chief Engineer is also responsible for the Environment Health Safety performance of the project. The Chief Engineer would be assisted by an Nodal Environmental Officer and Health Safety officer equivalent to the rank of an Executive Engineer and form the Project management Unit. The team at the PMU would be assisted by the Project Management Consultant (PMC). The PMC also would have a Environmental Officer who would assist the Nodal Environmental Officer at the PMU in ensuring environmental safeguards are implemented.

An officer of the rank of Executive Engineer who is the Project Director of the Project implementation unit under the PMU will be implementing the project and also be responsible for the environmental health safety performance of the project road. He would be assisted by an EHS Engineer of the rank of Assistant Engineer who would be responsible for ensuring that the provisions of the environmental management plan are implemented. The Authority / Independent Engineer associated with the PIU would also have an Environmental Engineer. He would assist the PIU in ensuring that the provisions in the EMP are implemented.

The actual responsibility of implementation of the EMP would be with the EPC Contractor/ Concessionaire. An Environmental Engineer and Health Safety Officer would be responsible for the implementation of the environmental safeguards. The organisation structure for environmental safeguards is presented in Figure 5-1

Figure 5-1: Implementation Arrangement of RHSDP II



Roles and Responsibilities

The roles and responsibilities of the different officers and professionals involved in the implementation of the environmental safeguards are presented in Table 5-1.

Table 5-1: Roles and Responsibilities for implementation of Environmental Safeguards

SL. No	Position	Responsibilities
1.	Secretary (PWD)	Oversight of the Program and also the Safeguard Requirement Overview of the Annual Safeguards review
2	Engineer in Chief (PWD)	Overview of the Program and also the Safeguard Requirement Carrying out annual safeguards review
3.	Chief Engineer (PMU)	<ul style="list-style-type: none"> Overview of the RHSDP II's compliance to Bank's and national laws and regulations Oversight of the EHS requirements to be integrated in the Project formulation, implementation and formulation

<i>SL. No</i>	<i>Position</i>	<i>Responsibilities</i>
		<p>e.g. bid documents and contract of all involved in the planning, construction, and operations of the roads</p> <ul style="list-style-type: none"> • Ensure that sufficient funds are available for implementation of all agreed Environmental safeguards measures. • Review of environment monitoring and audit findings, grievance associated with environment during each of the project review • Submit annual safeguards monitoring reports to the Bank and its closure. • Review of the annual environmental audit and approve of the mitigation of the EMP if any new or unanticipated environmental impacts occur during project implementation due to design change or other reasons • In case of significant new or unforeseen impacts, immediately inform Bank to make a decision on the same besides updating relevant project reports.
4.	Environmental Officer (PMU)	<ul style="list-style-type: none"> • Ensure that RHSDP II meets the statutory requirement and Bank's requirement; • Recommend for approval to PMU all document and ensure that design and documents include all relevant EHS Safeguards; • Recommend for approval to PMU the EPC Contractor's/ Concessionaire's Implementation Plan after approval of the Environmental Engineer of the PMC; • Review the environmental performance of the project through Monthly Reports and Monthly Environmental Audits reports submitted by the Project Management Consultants and report to the Management; • Carry out quarterly environmental audits and report back to the management • Review Corrective Action Plan for closure of the Environmental Audit Findings • Overall coordination and management through PIU supported by PMC and Authority/ Independent Engineer for implementation of Environment Safeguards. • Review and action on all grievance related to environment through the Grievance Redress Mechanism.
5.	Environmental Engineer (PMC)	<ul style="list-style-type: none"> • Preparation of all application including documentation required for statutory clearance. Assisting PWD in obtaining requisite clearances. • Review of all document and ensure that design and documents include all relevant EHS Safeguards; • Compile and analyse all Fortnightly and Monthly Audits reports submitted by the Authority/ Independent Engineer for review by the Environmental Officer; • Review the EPC Contractor's/ Concessionaire's Implementation Plan after approval of the Authority/ Independent Engineer for the environmental measures as per the EMP;

<i>SL. No</i>	<i>Position</i>	<i>Responsibilities</i>
		<ul style="list-style-type: none"> • Carry out monthly environmental audits of all the project roads; • Preparation of the Corrective Action Plan for closure of the Environmental Audit Findings along with the PIU the Authority/ Independent Engineer and the EPC Contractor's/ Concessionaire's; • Assisting the Environment Officer of the PMU in the discharge of their duties; • Carry out any specialised studies which would be required for the environmental safeguards e.g. rainwater harvesting, environmental enhancements • Assist the PMU to implement the process and procedures described in the Project Management Manual; • Capacity building of PIUs for effective implementation of EMP; • Updating of checklists and reporting formats prepared by Authority/ Independent Engineer for EMP implementation.
6.	Project Director (PIU)	<ul style="list-style-type: none"> • Overview of that the Project Road is in compliance to Bank's and national laws and regulations • Oversight of the EHS requirements are integrated in the Project design and documents e.g. detailed drawing • Ensure that sufficient funds are available for implementation of all agreed Environmental safeguards measures. • Review of environment monitoring and audit findings, grievance associated with environment during each of the project review • Ensure timely submission of the reports to Nodal Officer of PMU.
7.	Assistant Engineer (PIU)	<ul style="list-style-type: none"> • Review the EPC Contractor/ Concessionaire compliance with all the statutory requirement and the Safeguard requirement mentioned in the EMP. • Approve the EPC Contractor's/ Concessionaire's EMP Implementation Plan after the same has been approved by the Authority / Independent Engineer; • Review the weekly environmental reports submitted by the Authority / Independent Engineer and submission to the PMU for review; • Review the grievances in the Grievance Management System and ensure its closure. If required interact with the district authorities and ensure its closure; • Coordinate with the Environmental Officer of the PMU for the Implementation of the EMP and environmental Safeguards • Oversight of the package specific EMP's and make necessary modifications if required. • Review the Environmental Performance during the project review meeting.

<i>SL. No</i>	<i>Position</i>	<i>Responsibilities</i>
		<ul style="list-style-type: none"> • Ensure monthly, quarterly and annual environmental monitoring reports are prepared by Authority / Independent Engineer and submitted to PMU . • Review the Corrective Action Plan for closure of the Environmental Audit findings
8.	Environmental Engineer (Authority / Independent Engineer)	<ul style="list-style-type: none"> • Ensure that EPC Contractor/ Concessionaire is in compliance with all the statutory requirement and the Safeguard requirement mentioned in the EMP. • Review and approve the EPC Contractor's/ Concessionaire's EMP Implementation Plan; • Ensure that the weekly environmental reports are compiled by Contractor, reviewed and submitted to PMC; • Carry out any specialised designs which would be required for the environmental safeguards; • Facilitating the EPC Contractor/ Concessionaire to obtain necessary permissions/ approvals and its submission to PMC • Directly interact with aggrieved persons and record their views and grievances in the Grievance Management System. • Work with the EPC Contractor/ Concessionaire to ensure grievances if any at field level is resolved • Review and approve the package specific EMP's and make necessary modifications if required. • Ensure that all mitigation measures as given in the EMP are implemented properly by the EPC Contractor/ Concessionaire during the study.
9.	Environmental Engineer (EPC Contractor/ Concessionaire)	<ul style="list-style-type: none"> • Responsible for ensuring integration of the mitigation measures proposed in the Environmental Management Plans (EMP) associated with the construction activities into the construction processes. • Responsible for daily monitoring of the environmental compliance and submission of the information to the Authority/ Independent Engineer. • Preparation of Contract Specific management and submission of the same to the Authority / Independent Engineer for approval. • Ensure that adequate budget provisions are made for implementing all mitigation measures specified in the Contract specific EMP. • Participate in induction training on EMP provisions and requirements delivered by the PMU and carry out the same for all contract staff. • Carry out liaison with the regulatory agencies for necessary environmental license(s), permits etc. • Assist the PIU with support required for obtaining necessary environmental permits • Participate in resolving issues as a member of the Grievance Redressal Cell. • Respond promptly to grievances raised by the local community or and implement corrective actions.

<i>SL. No</i>	<i>Position</i>	<i>Responsibilities</i>
10.	Health and Safety Office (Contractor EPC Contractor/ Concessionaire)	<ul style="list-style-type: none"> • Responsible for ensuring integration of the health and safety in the work processes associated with the construction activities ;. • Responsible for day -to day monitoring of the occupational health and safety performance and submission of the information to the Authority/ Independent Engineer. • Preparation of a Safety Plan and submission of the same to the Authority/ Independent Engineer for approval. • Participate in induction training on EMP provisions and requirements delivered by the PMU and carry out the same for all contract staff. • Carry out Construction safety Audits and report it to the Team Leader of the Contractor. • Assist the PIU with the health safety performance of the project • Respond promptly to grievances raised by the local community for the safety and implement corrective actions.

5.2 Capacity Building

The capacity building of the PMU and the PIU would be through both training program and on-job training.

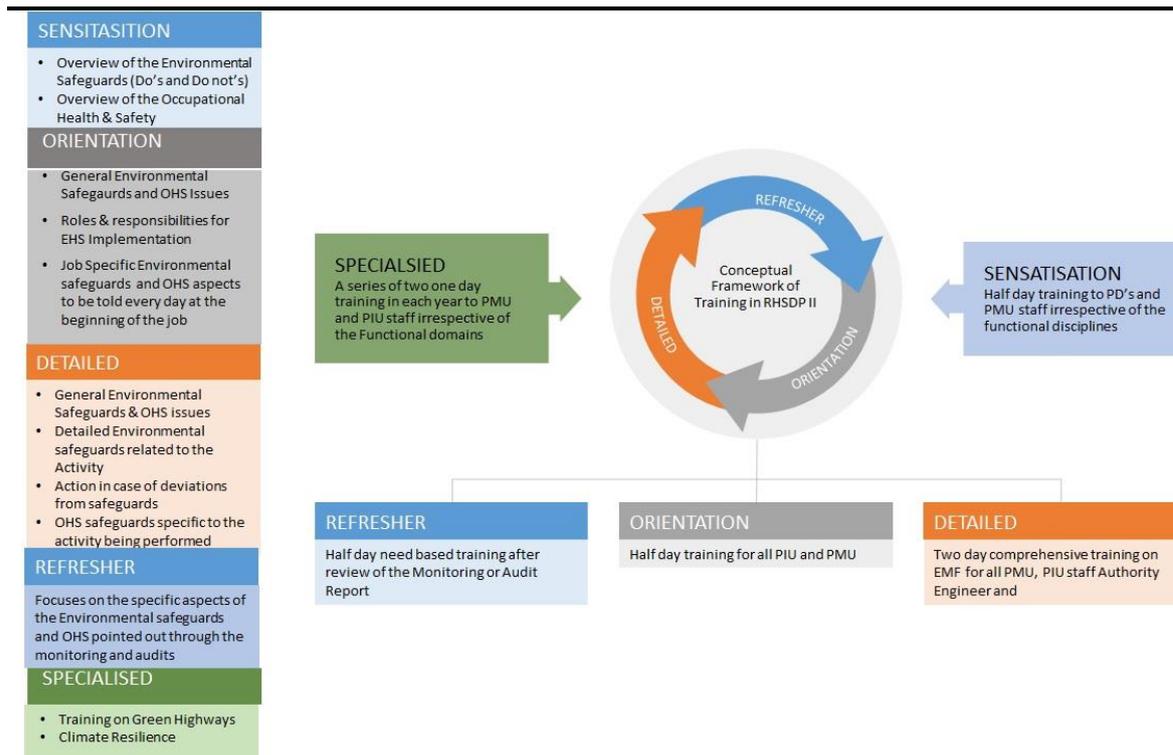
5.2.1 Training

Training would be required especially for the PMU and PIU staff associated with the project as the Environmental Safeguards would be a relatively new area which the staff are required to handle. The training and capacity building would not only be project specific but would also target and develop long term capacities in the PPP Division. The training program would include:

- **Sensitisation Training:** primarily aimed at introducing the EHS safeguards to the officers and also make them aware of the responsibilities.
- **Orientation Training :** introducing the Environmental safeguards to the PIU staff and making them aware of the key principles of environmental safeguards
- **Detailed Training :** aimed at the PIU staff and the Authority/ Independent Engineer to make them aware of the detailed activities which needs to be implemented and enforced during the EMP Implementations
- **Refresher Training:** this would be a need-based training organised to rectify the shortcomings identified during the Monitoring and Auditing.
- **Specialised Training:** These would include training on developing Climate resilient highways, green highways . These training would also include only an overview of road safety as the detailed training on road safety are being separately envisaged

The modalities of the training are presented in Figure 5-2.

Figure 5-2: The training to be carried out as part of Capacity Building



5.2.2 On-Job Capacity Building

The capacity building of the PMU and the PIU official would also be through on-job facilitations. The Environmental Engineer of the PMC would assist the Environmental Officer at the PMU in discharging the duties related to environmental safeguards implementation. He would also provide hand-holding support to other officers especially with relate to integration of the Environmental safeguards into the planning, designing, construction and supervision activities of the PMU .

Similar role would be played by the Authority/ Independent Engineer. The Environmental Engineer would support the PD and the PIU with respect to the implementation of the Environmental safeguards. He would also help him in understanding the nuances of the safeguards especially when to comes to verification of the design and the implementation of the works.

5.3 Monitoring & Auditing Plan

Reporting system for the suggested monitoring and auditing plan, operating at two levels are as follows:

- Reporting for environmental management (EM) indicators to assess the progress of the EMP Implementations
- Auditing of the Environmental management implementation to assess the effectiveness of the implementation

The monitoring and auditing responsibilities and their reporting authority over the period of one year is presented in Figure 5-3 This cycle would be replicated over the tenure of the project

Figure 5-3: Monitoring and Auditing Protocol

	<u>Reporting Responsibility</u>	<u>Reporting Authority</u>
Daily Reports	<ul style="list-style-type: none"> • Contractor • Summary of all environmental issues and activities 	<ul style="list-style-type: none"> • Authority Engineer – Review the report and suggest Corrective Action
Bi-Monthly Monitoring	<ul style="list-style-type: none"> • Authority Engineer – Carry out independent Monitoring of Env Safeguards – Compilation of issue reported, action taken and status 	<ul style="list-style-type: none"> • PIU and PMC – Review the actions taken and issue Directions to the Contractor
Monthly Monitoring	<ul style="list-style-type: none"> • PMC – Monitoring of all the subprojects – Compilation and review of all corrective action 	<ul style="list-style-type: none"> • PMU – Review the Action taken report and develop new strategies
Quarterly Internal Auditing	<ul style="list-style-type: none"> • PMU – Review of the Corrective Action – Auditing of the process of implementation 	<ul style="list-style-type: none"> • Management – Review of the progress and process of implementation – Approve of the Corrective Action Plan
Annual External Auditing	<ul style="list-style-type: none"> • External Agency – Review the progress of the EMP Implementation – Review of the process of Implementations 	<ul style="list-style-type: none"> • Management /World Bank – Review of the finding and approve of the Corrective Action Plan – Report to the World bank

5.3.1 Monitoring

Periodic Monitoring of the EMP is required for assessing the progress of the implementation of the EMP. The monitoring would include regular activities related to the activities proposed in the EMP. The following Monitoring reports would be submitted as per the protocol described earlier:

- **Daily Monitoring Report:** by the Contractor to the Authority/ Independent Engineer on the environmental actions which has been implemented on site on a daily basis. The complains received from the community, observations at site for EHS issues, daily site audit, unsafe acts etc would also recorded ;
- **Fortnightly Monitoring Report:** by the Authority/ Independent Engineer to the PIU and PMC . This would review the Action Taken Report submitted by the Contractor and certify for the completion. In addition, an independent monitoring would be carried out by the Authority/ Independent Engineer and observations include in the report. The Action Plan agreed with the Contractor shall also be appended to the report.
- **Monthly Monitoring:** by the PMC for reporting to the PMU, would include a monitoring of all the packages and report the observations. The Completed Action would also be assessed for its effectiveness and sustainability.

5.3.2 Auditing

The Internal Audit will be conducted once every quarter by the Nodal Officer of the PMU and annually by an External Agency. The audit team would conduct document review of earlier issues and their closure and also make visits for verification and auditing of the works being carried out.

It has been envisaged that auditing shall be carried out for

- assessing the process and the effectiveness of the measures suggested. In addition, an external
- compliance audit shall be conducted every before the annual review to assess the effectiveness of the management system and compliance of the environmental safeguards
- .

5.3.3 Monitoring Tool

The Environmental Performance and Process Monitoring Tool (EPPMT) would be developed in sync with the project management component envisaged in RHSDP II. The tool would help in reporting of the environmental performance of the individual corridors. This would also help the PMU analyse the information and help them in making strategic decisions. The PMC would help the PMU in design the tool and also develop the Terms of reference for developing a web-based tool.

The information collated by the EPPMT would be analysed by the PMU and PMC. This information would be helpful in defining the procedures for operationalisation of the RSHA. It would further help in defining the procedures for the RSHA and integration of the environmental concerns into the operations of RSHA.

5.4 Review and Corrective Action Plan

5.4.1 Formats and Checklists

To facilitate monitoring and auditing of the EMP implementation formats and checklist would be developed by the PMU . The EMP matrix presented in Table 3-4 and the corresponding Guidance Notes would act as a guidance for the development of the monitoring format.

5.4.2 Records

All monitoring and auditing records would be transmitted and maintained electronically. No hard copies of the documents would be used for circulation. Each of the documents would be uniquely numbered by the Package, Project Corridor Nomenclature of the Report and Date. The records of the project would be stored in a Central repository at the PMU.

5.4.3 Review and Corrective Action

An annual review shall be conducted by Additional Chief Engineer at the time of the Project Review meeting and after the completion of the Quarterly and Annual audit. The Project Directors and the Assistant Engineer of the respective projects shall deliberate on the findings and recommendation of Environment Audit and agree on a Corrective Action Plan including budgetary support if required. The Corrective Action Plan shall be implemented in a time bound manner and reported back to the PMU. The PMU would prepare a closure report which would form a part of the Annual Report submitted to the Bank

5.5 Operational Procedure

The operational procedures would be developed separately by the PMU as part of the project . An outline of the operational procedures are envisaged is presented in

Box 5-1: Outline of the Operational Procedure

- **Procedures during the Project Conceptualisation**
- Scoping of Project
- Reconnaissance Surveys
- **Procedure during the Planning and Design**
- Carrying out of Environmental Studies
- Integration in the Design
- **Safeguards during the Pre-Construction**
- Staffing Arrangement
- Capacity Building
- **Mobilising of Contractor**
- Detailed designing
- **Procedure During Construction Supervision**
- Concurrent Supervision
- Audits and Reviews
- **Procedure During Operation of the Road**

6 Consultation Disclosure and Grievance Redressal

6.1 Consultations

Through the process of consultation and disclosures, RHSDP II would envisage to build participation of stakeholders' at each stage of project planning and implementation. RHSDP II would be responsible not only for ensuring participation of the community in the consultation process but to make it effective ensure integration of the feedback received from stakeholder into the project plans where it deems fit.

A Consultation Framework has been prepared to ensure involvement of stakeholders at each stage of project planning and implementation. To ensure community participation at different stages of the project the Consultation framework for RHSDP II has been proposed in Table 6-1

Table 6-1: Framework for Consultation in RHSDP II

<i>Project Phase</i>	<i>Activity</i>	<i>Details</i>	<i>Responsible Agency</i>	<i>Target Stakeholders</i>
Feasibility and Preliminary Design	Reconnaissance Surveys	Identification of the Environmental and Social Sensitive Areas which needs to be excluded	PMU & Feasibility Consultant	PIU/ PWD Divisional Officers, Forest Department, District Land Revenue Office.
	Stakeholder Mapping	Cross-section of stakeholders to be identified in order to facilitate their participation in the subproject	PMU & Feasibility Consultant	PIU/ PWD Divisional Officers, Forest Department, District Land Revenue Office.
Pre-Construction	Detailed Designs	Integration of Mitigation measures to avoid Environmental and Social Sensitivities	PIU & Contractor, Authority / Independent Engineer	Local Land Revenue officer, Village Panchayat, Local Community people
	Stakeholder meetings	Stakeholder meetings for determining land compensation value	PIU & Contractor, Authority / Independent Engineer	
Construction	Clearing and Earthwork	Identification of sensitivities along RoW	Contractor along with the Authority / Independent Engineer and PIU	Community People especially the Land Owners, Local Land Revenue officer , Village Panchayat

6.2 Ongoing Consultation Mechanism

The consultation stated above are not limiting in nature. The consultation for the project would be an ongoing process and would include the active involvement of the PIU. The PMU would also be responsible for overseeing the process of consultation. The office from both the PIU and PMU would get actively involved in the consultation process and ensure that the concerns of the citizens are adequately addressed.

6.3 Disclosure

The information disclosure would provide citizen centric information on the policies and the details of subprojects along with its implementation process of JPSIP. It would be carried out in accordance to the provision of the Right to Information Act 2005 and World Bank Policies on Information Disclosure. The JPSIP Information Disclosure Procedure would ensure that information concerning the JPSIP's activities is made available to the public in the absence of a compelling reason for confidentiality.

6.4 Grievance Mechanism

The feedback of the project affected persons/citizens would be captured through the PIU and conveyed to the PMU for necessary action. The Grievance Redresses Mechanism for RHSDP II would be used.

Annexure 1: Environmental Features

Climate

Like its varying topography, Rajasthan has varying climate. The average temperature in winter ranges from 8° to 28° C (46° to 82° F) and in summer the average temperature ranges from 25° to 46° C (77° to 115° F). The average rainfall varies throughout the state. The western part that consists of the desert receives an annual rainfall of 100 mm (about 4 inches). The south-eastern part of Rajasthan receives annually 650 mm (26 inches). Like most parts of India, the state receives a maximum rainfall during the monsoon season during the months of July to September.

In the western Rajasthan, the average annual rainfall ranges from less than 100 mm in north-western part of Jaisalmer (lowest in the state) to over 400 mm in Sikar, Jhunjhunu, Pali region and along the western periphery of the Aravalli range. In the eastern region, the rainfall ranges from 550 mm in Ajmer to 1020 mm in Jhalawar. In plains, Banswara (92.0cm) and Jhalawar (95cm) districts receive the maximum annual rain. The highest rainfall (1638 mm) is received at Mount Abu (Sirohi district) in the southwest region of the state. The annual spatially averaged rainfall is highly variable and it is most erratic in the western region with frequent dry spells, punctuated occasionally by heavy downpour in some years associated with the passing low pressure systems over the region. The number of rainy days during the South west monsoon period from June end to mid-September over Rajasthan varies from 10 in Jaisalmer to 40 in Jhalawar and to 48 in Mount Abu. The number of rainfall days during the rest of the year in different parts of Rajasthan range from 2.1 cm at Jaisalmer to 7.2 cm at Jaipur, distributed over 2.5 to 6 rainy days (Khan, 1988). The district wise information on rainfall is presented in table below

Table : District wise rainfall in Rajasthan

Sl. No	District	No of yrs.	Abnormal Rainfall		Excess Rainfall		Normal Rainfall		Deficit Rainfall		Scanty Rainfall	
			No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of years
1	Ajmer	30	3	10	4	13.3	16	53.3	5	16.7	2	6.7
2	Alwar	30	4	13.	3	10	14	46.7	7	23.3	2	6.7
3	Banswara	30	2	6.7	4	13.3	14	46.7	10	33.3	0	0
4	Baran	30	0	0	4	13.3	23	76.7	2	6.7	1	3.3
5	Barmer	30	4	13.3	3	10	10	33.3	9	30.0	4	13.3
6	Bharatpur	30	2	6.7	5	16.6	14	46.7	9	30.0	0	0
7	Bhilwara	30	0	0	7	23.3	15	50	8	26.7	0	0
8	Bikaner	30	1	3.3	8	26.7	12	40	8	26.7	1	3.3
9	Bundi	30	0	0	6	20	20	66.7	4	13.3	0	0
10	Chittorgarh	30	1	3.3	6	20	15	50	8	26.7	0	0

Sl. No	District	No of yrs.	Abnormal Rainfall		Excess Rainfall		Normal Rainfall		Deficit Rainfall		Scanty Rainfall	
			No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of yrs.	No. of yrs.	% of years
11	Churu	30	1	3.3	7	23.3	13	43.3	9	30.0	0	0
12	Dausa	29	2	6.9	4	13.8	11	37.9	11	37.9	1	3.4
13	Dholpur	29	1	3.4	4	13.8	17	58.6	7	24.1	0	0
14	Dungarpur	30	2	6.7	3	10	18	60	7	23.3	0	0
15	Ganganagar	30	5	16.7	6	20	4	13.3	7	23.3	8	26.7
16	Hanumangarh	28	1	3.6	7	25	12	42.8	8	28.6	0	0
17	Jaipur	30	2	6.7	6	20	11	36.6	11	36.7	0	0
18	Jaisalmer	30	1	3.3	10	33.3	11	36.6	6	20.0	2	6.7
19	Jalore	30	5	16.6	2	6.7	11	36.6	10	33.3	2	6.7
20	Jhalawar	30	1	3.3	4	13.3	20	66.7	5	16.7	0	0
21	Jhunjhunu	30	1	3.3	7	23.	12	40	9	30.0	1	3.33
22	Jodhpur	28	1	3.6	6	21.4	13	46.4	7	25.0	1	3.6
23	Karauli	23	1	4.3	5	21.7	12	52.2	5	21.7	0	0
24	Kota	30	1 2	40	1	3.33	5	16.7	10	33.3	1	3.33
25	Nagaur	30	2	6.7	6	20	12	40	10	33.3	0	0
26	Pali	30	6	20	5	16.6	5	16.7	6	20	8	26.6 6
27	Pratapgarh	26	1	3.8	4	15.4	15	57.7	6	23.1	0	0
28	Rajsamand	27	0	0	8	29.6	11	40.7	8	29.6	0	0
29	Sawai Madhopur	29	2	6.9	7	24.1	10	34.5	9	31.0	1	3.4
30	Sikar	28	2	7.1	7	25	11	39.3	8	28.6	0 0	0
31	Sirohi	30	4	13.3	8	26.7	4	13.3	7	23.3	7	23.3
32	Tonk	30	1	3.3	5	16.7	17	56.7	7	23.3	0	0
33	Udaipur	28	2	7.1	9	32.1	7	25	9	32.1	1	3.6

Source: http://waterresources.rajasthan.gov.in/Daily_Rainfall_Data/Rainfall_Index.htm

Physiography

The Physiographic division sub-divisions in the state along which their Characteristics and implications for the project is presented in Table -0-1.

Table -0-1: Physiographic Divisions, Regions and Sub-Regions in Rajasthan , their Characteristics and Implications for the project.

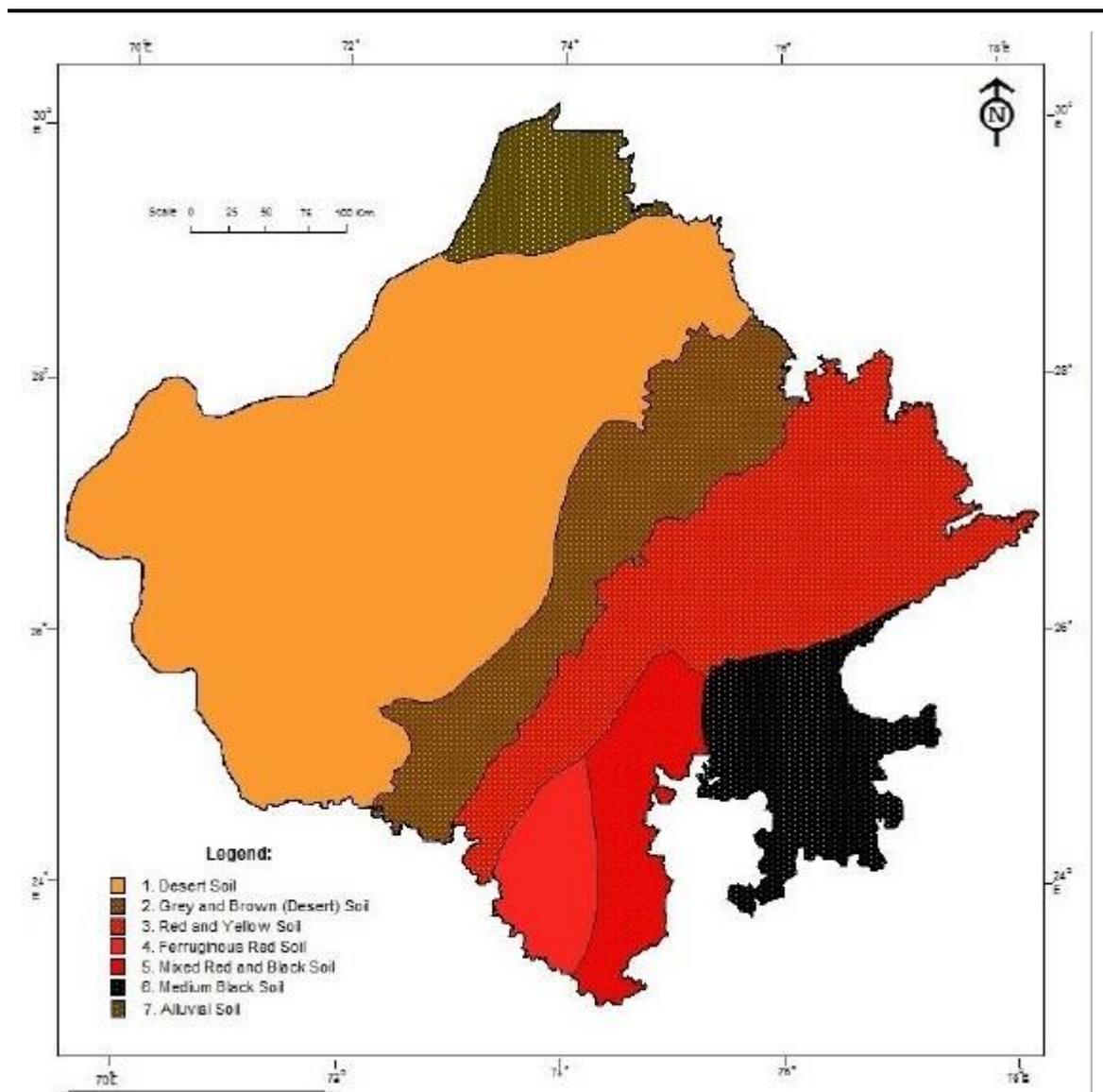
<i>Physiographic Division</i>	<i>Regions</i>	<i>Sub-region</i>	<i>Districts</i>	<i>Characteristics</i>	<i>Implications for the project</i>
Western Sandy Plain	Sandy Arid Plain	Marusthali	Bikaner, Barmer, Jaisalmer, Jodhpur, Nagaur, Churu	Known as Thar Desert towards the west, characterised by shifting sand dunes is locally terms as Dharians.	The road has to be protected from shifting sand dunes
		Dune Free Tract	Bikaner, Jaisalmer, Phalodi & Pokhran	Limestone & Sandstone rocks exposes (to lay open) here belong to Jurassic & Eocene formations. It is rocky but dune free tract. Small hills are found within a circle of 64 Km of Jaisalmer town. Grid conglomerate, gneiss, schist & granite rocks are also exposed at places.	The limestone can cause geo-technical problems which needs to be investigated during planning of the project
	Semi-Arid Plain/Ban gar region	Luni Basin	Barmer, Jalore, Jodhpur, Nagaur	Luni is a seasonal river and floods occur during the rains. Topography is marked by hills with steep slopes & extensive alluvial plains (locally known as (Naid (Rel)) & is one of best alluvial plains.	Since the area is prone to floods the road in the Luni Basin must plan for adequate cross drainage structure and the HFL while designing of the pavement
		Shekhawati Region	Churu, Sikar, Jhunjhunu & Nagaur	Characterised by an undulating sandy terrain traversed by longitudinal sand dunes.	The road must be protected from shifting sand dunes
		Nagauri upland	Nagaur	This region is full of sand hills & low depressions. The temperature in the area is high, the evaporation of the saline flood water results in the deposits of the salt & soda in these depressions	Since there is a natural tendency for conversion of land into wasteland, the prime agricultural lands have to be avoided.
		Ghaggar Plain	Hanumangarh & Sriganganagar	This plain of the River Ghaggar is sandy and interspersed with sand-dunes & small sand-hills.	The road has to be protected from sand dunes

<i>Physiographic Division</i>	<i>Regions</i>	<i>Sub-region</i>	<i>Districts</i>	<i>Characteristics</i>	<i>Implications for the project</i>
				A large part of it is (dreary &) full of sand dunes.	
Aravalli Range and Hilly Region	Aravalli Range and Borat Plateau		East Sirohi, nearly whole of Udaipur except a narrow belt in the east and whole of Dungarpur district	The average elevation of this plateau is 1,225 metres.	The sub-projects in this area may require and Environmental Clearance and design needs to consider special protection as in hill roads
	North East Hill tracts		Primarily Alwar and Northern parts of Jaipur	Elevation varies between 670m and 306 m. However, the relative level is about 60 m to 90 m above the surrounding plain.	
Eastern Plains	Banas Basin		Eastern Part of Udaipur, Western Chittorgarh, Bhilwara, Tonk, Jaipur, Western Sawai Madhopur, Southern Alwar	Slopes gradually from east and north-east, Drained by River Banas and the alluvial deposits are scanty to the west and thick in the east	Some good agricultural land is expected to be present and these have to be avoided in case of realignments.
	Bharatpur Plain		Bharatpur	This is an alluvial flat plain and deeply silted. Due to the low topography in case the rain persists for 3-4 days the lower parts of the plain are flooded. Large number of tanks and water retaining structures have been built	Since the area is prone to flooding the HFL needs to be considered during the design. The alignments near water retaining structure and tanks also natural drainage and thus adequate cross drainage structures and retaining structures have to be planned
	Chappan Plains		South-eastern Udaipur, Banswara, Southern Chittorgarh	Characterised by the steep gradients of genesis	

Soil

The Aravalli's also has a great influence on the soil characteristics. The soil improves in fertility from west and northwest towards east and northeast. In many parts of the state the soils are saline or alkaline. The soils of the State have been divided into the 7 groups based on their occurrence, chief characteristics and suitability for cultivation. The spatial distribution of the soil classes is presented in Figure 0-1.

Figure 0-1 Soil Map of Rajasthan



The different soil types are described in the sections below

6.4.1 Desert Soil

They cover the largest area in Rajasthan the area west of the Aravalli's up to the Pakistan border is covered by this soil type. They cover large parts of Jaisalmer, Jodhpur, Barmer and Bikaner. The entire tract is ill watered and unproductive and characterised with sand dunes, hillocks and rock

outcrops. This windblown sand is partly derived from the surface rocks and partly from sand blown in from the coastal regions. The soil has the presence of high nitrogen content in the form of nitrates. The phosphates and nitrates together make the desert sands fertile for agricultural crops and plants at places where water supply is regular.

6.4.2 Grey Brown (Desert) Soil

This group of soil occurs in the districts of Barmer, Jalor, Jodhpur, Sirohi, Pali, Nagaur, Sikar and Jhunjhunu. The fertility of this soil increases towards the east and northeast. There is a presence of nitrogen in the form of nitrates which enhance the soil fertility.

6.4.3 Red and Yellow Soil

The western part of the districts of Udaipur, Bhilwara and Ajmer has this soil type. Silty-loams to silty-clay loams are common in the region. Both the nitrogen content and the Carbon content varies significantly.

6.4.4 Ferrogenous Red Soil

The red soil which had been formed from ancient crystalline and metamorphic rocks occupies the central and southern part of Udaipur district and the entire Dungarpur district. In different areas the red soil greatly differs in depth and fertility, the characteristics of lighter texture, porous and friable structure. On an average this soil is poorer in nitrogen, phosphorus and humus.

6.4.5 Mixed Red and Black Soil

This soil with neutral to alkaline pH is found in the eastern parts of the districts of Udaipur, Chittorgarh, Dungarpur, Banswara and Bhilwara.

6.4.6 Medium Black Soil

Soil of this type is most commonly found in the districts of Kota, Bundi, and Jhalawar in the south-eastern part of the State. The internal drainage is good due to the presence of vertical cracks of varying sizes. In most of the above soils the presence of organic carbon and nitrogen are low to medium.

6.4.7 Alluvial Soils

Alluvial soil is found in the north eastern part of the state in the districts of Alwar, Bharatpur, Jaipur and Sawai Madhopur and the central part of Ganganagar district. The soil is deficient in lime, phosphoric acid and humus. It varies from clayey to sandy loam in texture. The top soil contains 'kankar' which lie either on sands or sandy clays. The soil supports a wide variety of crops namely wheat, rice, cotton and tobacco.

Surface Water

There are 13 river basins in the state viz.: Shekhawati, Ruparail, Banganga, Gambhiri, Parbati, Sabi, Banas, Chambal, Mahi, Sabarmati, Luni, West Banas, and Sukli. Out of these, Luni, Banas, and Chambal basins are the largest and are divided into several sub basins. While the Luni river flows through parts of Ajmer, Barmer, Jalore, and Jodhpur, its sub basins of Bhund Hemawas, Sukri, Jawai and Bendi cover parts of Pali, Jalore, and Sirohi. Similarly, the Banas basin falls in Udaipur and Bundi districts and its sub basins of Berach, Morel and Mashi cover parts of Chittorgarh and Jaipur districts. Chambal is the largest basin of the State. Along with its sub basins of Kali Sindh and Parwati, it covers parts of Bundi, Kota, Jhalawar and Baran districts.

Ground Water

The State can be divided into three hydrogeological units namely, unconsolidated sediments, semi-consolidated sediments and consolidated rocks. The unconsolidated sediments are of two types- alluvial sediments and aeolian deposits. The Alluvial deposits are confined to Barmer, Jalore and Jodhpur district, consisting of sand, clay, gravel and cobbles. Valley fills have been reported from Jhunjhunu, Ajmer, Bhilwara and Udaipur district. The Aeolian sediments constitute one of the major aquifers east of major fault, east of Bikaner. The aquifer thickness is 40 to 80 m. The yield of wells ranges from 100 to 150 m³/hr. Semi-consolidated formations include sandstones, limestones and Aur beds, covering Jaisalmer and Barmer districts. The dug-wells in Jaisalmer limestones yield 13 to 68 m³/day. The yield of wells in Lathi sandstone varies from 50-150 m³/hr. The consolidated rocks include gneiss, granites, schist, phyllites, marble and Vindhyan sandstones, limestone, quartzite and basaltic flows, mostly restricted to eastern part of the State. The yield prospect is limited unless the well is located near major lineaments or any other weak planes. Thus, the eastern districts of the states have better yields compared to the western districts.

The ground water quality is in general poor (brackish to saline) at deeper levels. The areas with ground water quality problems both natural and anthropogenic is presented in Table 0-2.

Table 0-2: Areas with Groundwater Quality issues

<i>SSL No</i>	<i>Parameter (Permissible Limits)</i>	<i>Acceptable Limits (IS: 10400:2011)</i>	<i>Districts Affected (in part) Bold indicate districts with subprojects</i>
1.	Salinity (EC > 3000 μ S/cm at 25 ° C)	————	Ajmer, Alwar, Barmer, Bharatpur, Bhilwara, Bundi, Bikaner, Churu, Chittorgarh, Dholpur, Dausa, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhunjhunu, Karoli, Nagaur, Neemuch, Raja Samand, Sirohi, Sikar, Sawai Madhopur, Tonk, Udaipur
2.	Fluoride (>1.5 mg/l)	1.0 mg/l	Ajmer, Alwar, Banswara, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dausa, Dholpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajsamand, Sirohi, Sikar, Sawai Madhopur, Tonk, Udaipur
3.	Chloride (>1000 mg/l)	250 mg/l	Barmer, Bharatpur, Bikaner, Churu, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhunjhunu, Jodhpur Nagaur, Sirohi, Sikar, Tonk
4.	Iron (>1.0 mg/l)	0.3 mg/l	Ajmer, Alwar, Banswara, Baran, Bharatpur, Bhilwara, Bikaner, Chittorgarh, Churu, Dausa, Dholpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Rajsamand, Sikar, Sawai Madhopur, Tonk, Udaipur
5.	Nitrate(>45mg/l)	45.0 mg/l	Ajmer, Alwar, Banswara, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Chittorgarh, Churu, Dausa, Dholpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhalawar, Jhunjhunu, Jodhpur, Karauli,

<i>SSL No</i>	<i>Parameter (Permissible Limits)</i>	<i>Acceptable Limits (IS: 10400:2011)</i>	<i>Districts Affected (in part) Bold indicate districts with subprojects</i>
			Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sirohi, Sikar, Sawai Madhopur, Tonk, Udaipur
Heavy Metals			
	Lead (>0.01mg/l)	0.01 mg/l	Khetri Copper area in Jhunjhunu District; Pali urban area in Pali district; Sambhar Lake and Sanganer area of Jaipur district; Bhiwandi industrial area of Alwar district; Basni & Mandore areas of Jodhpur Urban Bhiwandi industrial area of Alwar district; Pali urban area
	Cadmium (>0.003 mg/l)	0.003 mg/l	in Pali district; Sanganer area of Jaipur
	Chromium (>0.05 mg/l)	0.05mg/l	Bhiwandi industrial area of Alwar district; Pali urban area in Pali district
	Nickel (>0.02mg/l)	0.02 mg/l	Bhiwandi industrial area of Alwar district
	Copper (>1.5 mg/l)	0.05 mg/l	Basni & Mandore industrial areas of Jodhpur Urban

Even though there are quality issues with the groundwater in various districts of the state as described above, the same is exploited by the people both for meeting the domestic needs as well as irrigation requirements. The ground water resources have thus rapidly depleted and at places with deterioration in quality, availability of safe drinking water is regularly reducing. The stage of ground water exploitation, which was just 35% in the year 1984 has attained a level of 134.53% in the year 2009. Out of 239 blocks of the State presently only 31 blocks have been categorized in “Safe Category”, 16 blocks in “Semi Critical” and 191 blocks in “Critical and Over Exploited category”. The block which has been notified for regulation of ground water regulation is listed in Table 0-3 below.

Table 0-3:List of Block declared as Notified Areas by CGWB

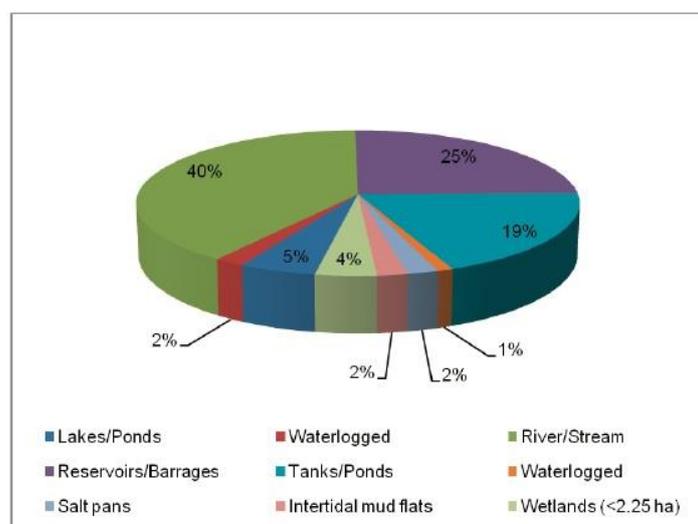
<i>SL. NO</i>	<i>State</i>	<i>District</i>	<i>Block / Taluka / MC Area etc</i>	<i>Administrative Unit</i>
1	Rajasthan	Ajmer	Peesangan	Block
2	Rajasthan	Alwar	Behror	Block
3	Rajasthan	Barmer	Baytoo	Block
4	Rajasthan	Chittorgarh	Chittorgarh	Block
5	Rajasthan	Chittorgarh	Nimbahera	Block
6	Rajasthan	Churu	Rajgarh	Block
7	Rajasthan	Jaipur	Amber	Block
8	Rajasthan	Jaipur	Bassi	Block
9	Rajasthan	Jaipur	Govindgarh	Block
10	Rajasthan	Jaipur	Jhotwara	Block
11	Rajasthan	Jaipur	Sambhar	Block
12	Rajasthan	Jaipur	Sanganer	Block
13	Rajasthan	Jaipur	Shahpura	Block
14	Rajasthan	Jalor	Bhinmal	Block
15	Rajasthan	Jalor	Jalor	Block
16	Rajasthan	Jalor	Raniwara	Block
17	Rajasthan	Jalor	Sanchoe	Block

<i>SL. NO</i>	<i>State</i>	<i>District</i>	<i>Block / Taluka / MC Area etc</i>	<i>Administrative Unit</i>
18	Rajasthan	Jalor	Sayla	Block
19	Rajasthan	Jhunjhunu	Buhana	Block
20	Rajasthan	Jhunjhunu	Chirawa	Block
21	Rajasthan	Jhunjhunu	Jhunjhunu	Block
22	Rajasthan	Jhunjhunu	Nawalgarh	Block
23	Rajasthan	Jhunjhunu	Surajgarh	Block
24	Rajasthan	Jhunjhunu	Udaipurwati	Block
25	Rajasthan	Jodhpur	Bhopalgarh	Block
26	Rajasthan	Jodhpur	Bilara	Block
27	Rajasthan	Jodhpur	Mandor	Block
28	Rajasthan	Jodhpur	Osian	Block
29	Rajasthan	Karauli	Todabhim	Block
30	Rajasthan	Nagaur	Kuchaman City	Block
31	Rajasthan	Nagaur	Merta	Block
32	Rajasthan	Nagaur	Mundwa	Block
33	Rajasthan	Sikar	Dhond	Block
34	Rajasthan	Sikar	Srimadhapur	Block

6.5 Wetlands

In Rajasthan, area under wetland is estimated at 782314 ha that is around 2.29 per cent of the geographic area of the state. Total 12625 wetlands above 2.25 ha have been mapped at 1: 50,000 scales in the state. In addition, 34123 small wetlands (< 2.25 ha) have also been identified. River/Stream contributed 39.95% to the total wetland area. The reservoir/barrage with 190600 ha (24.36% area) is the second major wetland category. Area under tank/pond is 151027 ha (19.31%). Open water spread is more during in post-monsoon (368129 ha) than during pre-monsoon (158696 ha). Aquatic vegetation is slightly more during pre-monsoon (5166 ha) than in post-monsoon (4102 ha). The qualitative turbidity of water is low in both the seasons.

Figure 0-2: Type wise distribution of wetlands in Rajasthan



In the 32 districts of the state, the wetlands occupy as high as 6.94% of geographic area in Bhilwara, and as low as 0.08% in Churu. Reservoir/Barrage and tank/pond are the dominate wetland types in almost all districts. Jalore is the only district containing coastal wetlands, which includes mudflats. District-wise and type wise distribution of wetland area estimates is given in Figure 0-2.

The district wise area of the wetlands is presented in Table 0-4.

Table 0-4: District wise distribution of wetland

<i>Sl. No</i>	<i>District</i>	<i>Geographic Area (Sq.km)</i>	<i>Wetland Area (ha)</i>	<i>% of total Wetland areas of state</i>	<i>% of the total Geographic area of the state</i>
1	Ganganagar	7984	1708	0.22	0.21
2	Hanumangarh	12645	6549	0.84	0.52
3	Bikaner	27244	2666	0.34	0.10
4	Churu	16830	1368	0.17	0.08
5	Jhunjhunu	5928	5319	0.68	0.90
6	Alwar	8380	12774	1.63	1.52
7	Bharatpur	5066	10415	1.33	2.06
8	Dholpur	3084	9370	1.20	3.04
9	Karauli	5530	10042	1.28	1.82
10	Sawai Madhopur	4500	22606	2.89	5.02
11	Dausa	3429	11720	1.50	3.42
12	Jaipur	11152	41352	5.29	3.71
13	Sikar	7732	5388	0.69	0.70
14	Nagaur	17718	30876	3.95	1.74
15	Jodhpur	22850	17032	2.18	0.75
16	Jaisalmer	38401	24876	3.18	0.65
17	Barmer	28387	44638	5.71	1.57
18	Jalore	10640	54440	6.96	5.12
19	Sirohi	5136	19259	2.46	3.75
20	Pali	12387	50304	6.43	4.06
21	Ajmer	8481	32167	4.11	3.79
22	Tonk	7194	46875	5.99	6.52
23	Bundi	5550	21238	2.71	3.83
24	Bhilwara	10455	72563	9.27	6.94
25	Rajsamand	3853	20435	2.61	5.30
26	Udaipur	13430	42292	5.41	3.15
27	Dungarpur	3770	21278	2.72	5.64
28	Banswara	5037	32468	4.15	6.45
29	Chittorgarh	10856	55537	7.10	5.12
30	Kota	5446	16316	2.09	3.00
31	Baran	6955	22602	2.89	3.25
32	Jhalawar	6219	15911	2.03	2.56
	Total	342269	782384	3.13	3.01

Source: National Wetland Atlas, Space Applications Centre, Indian Space Research Organisation, Ahmedabad –380 015, Sponsored By: Ministry of Environment and Forests, Government of India, March 2011

In the state the Sambhar lake and the Keoladeo National Park are the only wetland which is protected under the Ramsar convention. The details of the Sambhar Lake are presented in Box 0-1.

Box 0-1: The Sambhar Lake (Ramsar Site)

Location: 26°52'31" to 27°01'57" N Latitude and 74°53'47" to 75°13'41" E Longitude

Area: 24294 ha (Wetland Area)

Description

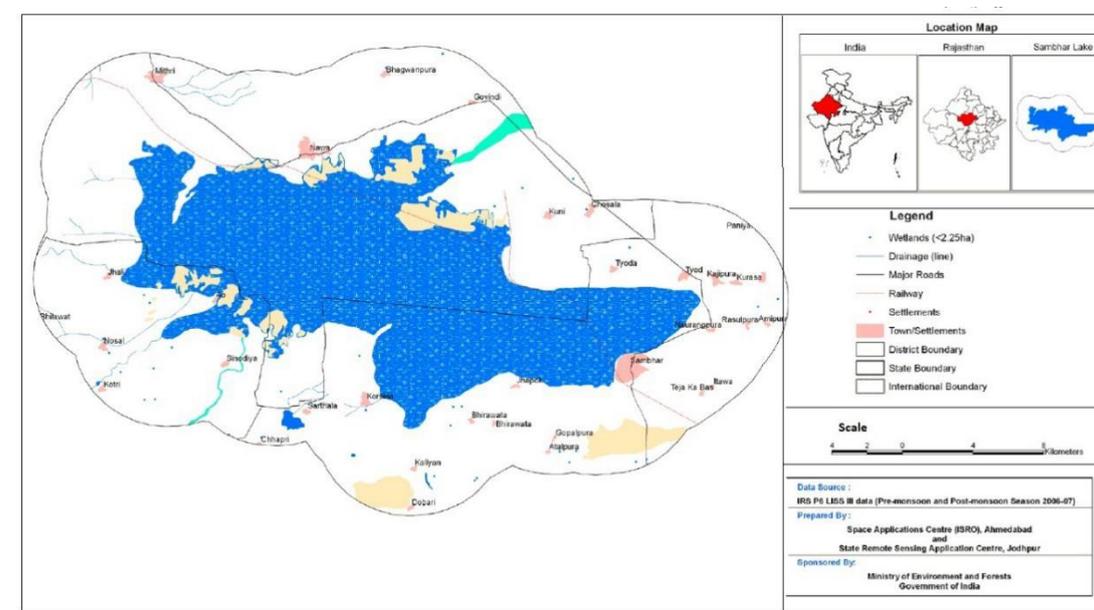
Sambhar lake is a Ramsar site and it is a typical shallow saline wetland of Rajasthan located near Sambhar village. The average depth is 3 meters in the monsoon while in pre-monsoon it becomes very shallow (< 100 cm). During monsoon season it receives rain water from its catchments. The flora and fauna mainly represent of fresh water during monsoon season while season proceeds the water becomes saline. Fresh water flora of monsoon season will be replaced by fresh water flora and fauna mainly plankton population. A large part of the lake dries up during summer to accelerate mining activity of ground water for manufacturing of salt. There are thousands of salts plan constructed at the periphery of the Sambar Lake.

Vegetation

The vegetation present in the catchment area in mostly xerophytic type. Shoreline vegetation includes the halophytes *Suaeda fruticosa*, *Salsola baryosma* and *Cressa cretica*. The most dominant algae in Sambhar lake and the salt pans are *Dunaliella salina* (dominant saline algae of the lake), *Chlmydomonas sp.*, *Anabaena sp.*, and *Aphanothece halophytica*.

Fauna

Zooplankton studies are limited. In depth studies were made to record avifauna of the lake. Every year thousands of migratory birds visit the lake and feed on plankton and fish fry. Some of the common birds recorded are: lesser flamingo, greater flamingo, tufted duck, pochard, white pelican, brown-headed gull, black-headed gull, herring gull, redshank, greenshank, common sandpiper, blackwinged stilt, pintail, shoveler, dabchick, purple moorhen, demoiselle crane, large Indian pratincole, and avocet



6.6 Ecology

Rajasthan state is largely arid for the most part. Only 9.5 % of the state's total geographical area is recorded as forest. The forests of Rajasthan are spread unequally in the northern, southern, eastern and south-eastern parts. The total reserved and protected forest areas are 12,453.92 and 17,415.00

sq. Km respectively and the unclassified forest constitutes about 2,768.86 sq.km. The extent of Natural Forests in Rajasthan is not only one of the lowest in the country but also low in terms of forest productivity. On the contrary, the State is endowed with the largest expanse of wasteland, which is about 20% of the total wastelands of the country.

Flora

The floral wealth of Rajasthan is rich and varied. The western half is desert terrain, most of the area under forests is restricted to eastern and southern parts of the state. The forests are unevenly distributed in the various districts. Most of the forests are over the hilly areas i.e. in Udaipur, Rajsamand, Kota, Baran Sawai Madhopur, Chittorgarh, Sirohi, Bundi, Alwar, Jhalawar and Banswara districts, which make up for about 50 per cent of the forests of the state. The flora and fauna in Rajasthan are specifically endemic to the dry region and they are adapted to survive in Rajasthan's water-scarce and arid regions. The forest vegetation includes the grasses, shrubs and thorny trees. The commonly found tree species in Rajasthan are bamboo, khejri, teak and varied species of acacia. Some of the national parks have several species of plants and herbs, having great medicinal value. Dense natural forests are in protected patches, mostly confined to various national parks and wild-life sanctuaries. Most of the remaining forests of state are in various stages of plant growth. The forests of state can be divided into four broad forest types.

- (1) Tropical Thorn Forests interspersed with grasslands
- (2) Tropical Dry Deciduous Forests;
- (3) Central India Sub-tropical hill forests;
- (4) Mixed Miscellaneous Forests

Tropical Thorn Forests

Tropical thorn forests are found in arid and semi-arid regions of western Rajasthan. These extend from western Indo -Park border and gradually merge with the dry deciduous mixed forests of the Aravalli hills and the south-eastern plateau. The main species found in this kind of forests are *Acacia nilotica*, *Acacia leucophloea*, *Prosopis cineraria*, *Capparis aphylla*, *Zizyphus spp.*, *Flacourtia spp.* etc. These forests are basically found in western part of Rajasthan namely Jodhpur, Pali, Jalore, Barmer, Nagaur, Churu, Bikaner etc.

Grassland

Along with the Tropical Thorn Forest the grasslands cover a large part of the Thar deserts. Dadadghao and Shankarnarayan in their research ²² have classified the grasses of Rajasthan into four habitats comprising: (i) perennial drought resisting plants, (ii) perennial drought evading plants, (iii) ephemeral drought evading plant as, and (iv) sand binders and sand dwellers. Some of the important grasses in Rajasthan which have been cited by Bhandari²³ include *Aristida funiculata*, *A. adscensionis*, *A. mutabilis*, *Brachiaria ramosa*, *Cenchrus ciliaris*, *C. biflorus*, *C. setigerus*, *Chloris virgata*, *Cymbopogon jwarncusa*, *Dactyloctenium indicum*, *D. aegyptium*, *Dichanthium annulatum*, *Eragrostis ciliaris*, *E. tremula*, *Eleusine compressa*, *Lasiurus indicus*, *Panicum antidotale*, *P. turgidum*, *Sporobolus marginatus*, *S. helvolus*, *Tetrapogon tenellus* and *Tragus racemosus*. The most important grasses in these grasslands are *Cenchrus ciliaris*, *C. setigerus*, *Dichanthium annulatum*, *Lasiurus indicus*, and *Panicum antidotale* (Dauley 1980) for livestock production and find their significance in range management to improve the production. Gupta (1971) described the distribution of main grassland types with regards to climate, soil type and ecology in western

²² . Dadadghao and Shankarnarayan 1973.

²³ Bhandari 1990

Rajasthan (Table 4). Tree 11 species like *Prosopis cineraria*, *Zizyphus nummularia*, *Salvadora oleoides* and *Acacia senegal*, which provides top feed to the livestock are associated with these grass species in isolated conditions.

Tropical Dry Deciduous Forests

These forests are mostly found in small patches in few parts of the state. the northern and eastern slopes of Aravalli Ranges, mostly in Alwar, Bharatpur and Dholpur districts, are covered with this type of forests. Sporadic growth of certain species of dry deciduous forests is found along the dry river beds of Jalore, Nagaur, Ganganagar and Bikaner, districts. The main species found in this kind of forests are *Anogeissus pendula*, *Anogeissus latifolia*, *Acacia catechu*, *Terminalia tomentosa*, *Terminalia balerica*, *Terminalia arjuna*, *Boswellia serrata*, *Dendrocalamus strictus*, *Lanea grandis*.

Central Indian Sub - tropical Hill Forests

These forests which are most abundant in central India, as in Madhya Pradesh, parts of Gujarat and Maharashtra, are found in Sirohi district of Rajasthan also, mostly on the hills girding Mt. Abu. These forests have semi-evergreen and some evergreen species of trees. The vegetation of Mt. Abu consists of many plants which are like the sub - tropical region of Himalayas. Around Mt. Abu, they are well represented between 700 to 800 m altitudes.

Mixed Miscellaneous Forests

These forests are mostly found in south eastern and eastern part of Rajasthan comprising Chittorgarh, Kota, Udaipur, Sirohi, Banswara, Dungarpur, Baran and Jhalawar districts. These Forests mainly have *Anogeissus pendula*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Terminalia arjuna*, *Terminalia chebula*, *Albizia lebbek*, *Dalbergia paniculata* etc. and its associates.

Distribution of forest

The extent of Natural Forests in Rajasthan is not only one of the lowest in the country but also in terms of productivity of forest, it is the lowest. The district wise distribution of forest areas in India is presented in Table 14

Table 0-5: District wise distribution of Forest area in Rajasthan

<i>Sl. No:</i>	<i>Name of District</i>	<i>% of Forest Area</i>	<i>Reserve Forest (sq. km)</i>	<i>Protected Forest (sq. Km)</i>	<i>Unclassed Forest (sq. km)</i>
1.	Ajmer	7.32	194.99	418.09	0.02
2.	Alwar	21.29	1006.06	636.83	141.25
3.	Banswara	24.55	0	1236.67	0
4.	Baran	32.2	0	2226.74	12.58
5.	Barmer	2.15	0	568.33	44.77
6.	Bharatpur	7.55	0	369.57	12.82
7.	Bhilwara	7.6	437.8	289.62	66.77
8.	Bikaner	4.58	0	234.29	1014.45
9.	Bundi	28.11	837.29	706.65	16.04
10.	Chittorgarh	25.48	1584.7	1181.36	0.56
11.	Churu	0.42	7.2	10.84	53.18
12.	Dausa	9.58	133.37	148.69	0.57
13.	Dholpur	21.04	7.92	597.78	32.75
14.	Dungarpur	18.39	251.29	433.25	8.71
15.	Ganganagar	7.97	0	50.65	582.79
16.	Hanumangarh	1.89	0	113.25	126.21

17.	Jaipur	8.19	679.34	263.1	5.63
18.	Jaisalmer	1.51	0	199.77	383.52
19.	Jalore	4.24	122.24	298.05	30.4
20.	Jhalawar	21.7	413.45	930.62	5.73
21.	Jhunjhunu	6.84	6.02	392.57	6.77
22.	Jodhpur	1.06	4.68	175.52	62.7
23.	Karauli	35.69	62.99	1675.55	64.27
24.	Kota	23.9	874.83	412.58	22.63
25.	Nagaur	1.36	0.8	206.23	33.89
26.	Pali	7.78	819.45	141.62	2.51
27.	Rajsamand	8.32	277.44	119.14	0
28.	Sawai Madhopur	19.06	792.88	154.16	6.67
29.	Sikar	8.25	9.92	619.18	8.59
30.	Sirohi	31.91	866.6	749.75	22.3
31.	Tonk	4.67	101.42	230.75	3.8
32.	Udaipur	39.67	2961.25	1626.17	0

6.6.1 Fauna

Mammals

The fauna of Rajasthan contains about 25 species of serpents and 23 species of lizards. The wildlife in Rajasthan includes species like Indian gazelles or chinkaras, antelopes, black bucks, silver foxes, great Indian bustards, the Nilgai, and wild cats.

Species of wild animals that can adapt to these harsh climatic and environmental conditions flourish in the sub-project districts. About 390 species of animal have been recognized in Thar Desert of Indian. Amongst the mammals, chinkara (*Gazella bennetti*), Indian fox (*Vulpes bengalensis*), desert fox (*Vulpes vulpes pussila*), jackal (*Canis aureus*), desert cat (*Felis chaus*), jungle cat (*Felis lybia*), desert hare (*Lepus nigricollis dayanas*), nilgai (*Boselaphus tragocamelus*), wolf (*Canis lepus pallips*), black buck (*Antelope cervicaps*) and spotted deer (*Axis axis*) wild boar (*Sus scrfa*) are the animals of the region. The habits and Habitats of some of the mammals in the sub-project district are

Bo x 0-2: Habits and Habitats of Mammalian species in Project Area

Blackbuck (*Antelope cervicapra*)

The animal is provided Schedule I status as per the provisions of the Wildlife Conservation Act 1972. The Blackbuck is an animal of short grass plains where surface water is easily available, as it has to drink frequently. In the Thar Desert, it is confined to comparatively mesic areas of the Luni river basin, and Vishnoi dominated agriculture areas near Guda Malani (Dhorimanna) in Barmer district. In all these areas, surface water is available, in isolated natural / artificial storages, throughout the year. Both the division i.e., Jalor and Barmer indicated



Blackbuck population

Chinkara or Indian Gazelle (*Gazella bennetti*)

sssssssssss It can be seen easily in parts of Barmer and Jalore districts It is usually seen in small herds rarely more than 7-8, except in extreme northwest of Thar. The Chinkara density was very high in Vishnoi areas where the animal is protected by the community



Indian Desert Cat

This animal is spotted in western part of the state in Barmer, Jaisalmer and Jalore district. The length of head and body measures about 40-45 cm and tail 25-28 cm. This cat is about the size of domestic cat, fur soft, tapering tail, ears well developed and pointed, having pale sandy ground colour with small black rounded spots on the body, with smaller elongated spots on the crown and nape running into longitudinal bands). When chased the cat escapes by climbing up a nearby tree or hiding under the thick bushes. The jackal, wolves and stray dogs are main natural enemies of the desert cat.

Grey Wolf (*Canis lupus pallipes*)

The Indian Wolf, like the Blackbuck, is not found in very dry and sandy areas of the Thar desert. Therefore, it has totally disappeared from flat, sandy areas where it can be followed by its footprints. It survives only in rocky, undulating areas in Barmer district or in Vishnoi areas

Caracal (*Felis caracal*):

Caracal habitat is present in the extreme northwest of Jaisalmer, bordering the Thar Parker district of Pakistan. However, it may migrate to the local areas.

Desert Fox (*Vulpes vulpes pussila*)

Like the previous species, common in remote areas. The Desert Fox is more adapted to the undulating, sandy areas, which form the natural features of the Thar Desert. It appears to avoid cultivated areas where the Indian fox and Jackal thrive.

Avian Fauna

Over 350 bird species including partridges, quails, sand grouses, Great Indian bustard, shrikes, bayas, sparrows, munias, crows, mynas, starlings, parakeets, kites, hawks, shikras, vultures, doves, bee eaters, bulbuls, babblers, larks, ducks, pea fowls, finches, hoopoe, lapwings, coursers, teals, woodpeckers, pigeons and cranes etc are recorded from the Thar Desert (Rana et al. 1996). In forest and planted areas common species of birds are Owl (*Bubo bubo*), drongo, minivet, hornbill, bulbul, peacock (*Pavo cristatus*), flycatcher, woodpecker, bee eater, kingfisher, mynas (*Sturmia malabarica*), swallow, swift, partridge, quail, sand grouse, pigeon, doves, parakeet, night jar, roller, barbet, shrike, tree pie, warbler, chat robin etc are spotted.

Box 0-3: Endangered Avian Fauna In sub-project area

Great Indian bustard (*Ardeotis nigriceps*)

The Great Indian bustard, a large and heavy bird, is found in small numbers in the Rajasthan desert. The species is listed in Schedule I of the Indian Wildlife (Protection) Act, 1972. It is found in the busy scrub grassland. During monsoon period, it migrates locally. However, in the remote areas of the desert where they are free from disturbances large number of these birds are observed in appreciable numbers. It feeds upon grasshoppers, beetles, small snakes, lizards, grass seeds and food grains.

Pea Fowl (*Pavo cristatus*)

Peafowl inhabits piedmont zones and village complexes Being the national bird of India, it is well protected by the people.

Some of the migratory birds like Lesser floricans (*Supheotides indica*) are found in the south-eastern desert of Rajasthan. It arrives only in the monsoon season. It is believed that this bird migrates from Narmada and Tapti valleys to southern part of this region. The common crane (*Grus grus*) is a palaeartic breeding species that spends winters in the Mediterranean North Africa and China but sub species *G. gurus* subspecies *lilfordi* migrates in winter to the Indian desert also. Flocks of 20-50

may be observed near lakes or water holes in the rocky habitat, from the third week of October to March. The Imperial sand grouse (*Pterocles orientalis*) is a palaeotropical bird and a winter visitor to the desert region. It arrives in the Western Rajasthan desert in flocks of 20-500. The important areas of congregation of these species are presented in the later sections.

Herpetofauna

Herpetofauna includes both, amphibians and reptiles. These two classes of animals are blessed with unique adaptations to cope with the varying climatic conditions and the environmental niche

The area provides suitable conditions for survival of a few species of lizards, gerbils and snakes. The spiny tailed lizards with their prehistoric looks are quite common in many areas of the Barmer and Jalore. Among the snakes the saw scaled viper, the large rat snake and sand boa are noteworthy

Ecologically sensitive areas

National Parks

The state has 3 National Parks and 26 Wildlife Sanctuaries. The three national parks viz. the Keoladeo National Park of Bharatpur, Ranthambore National Park of Sawai Madhopur, and Mukundara Hills National Park of Kota.

Wild Life Sanctuaries

The wildlife Sanctuaries are presented in Table -0-6.

Table -0-6: Wildlife Sanctuaries in Rajasthan

Sl. No:	Protected Areas	District	Area (sq.km)	Wildlife present
1.	Damp-baretha	Bharatpur	199.24	Resident and migratory Birds
2.	Sariska	Alwar	492.29	Tiger, Panther, Chital, Sambhar, Porcupine
3.	Sariska 'A'	Alwar	3.01	Sambhar, Chital, Panther
4.	Desert National Park	Jaisalmer, Barmer	3162	Chinkara, Desert Cat, Fox, Great Indian Bustard
5.	Ramgarh-Vishdhari	Bundi	307	Panther, hyena, Sloth Bear, jackal, Fox, Chital
6.	Kesar Bagh	Dholpur	14.76	Wolf, hyena, Fox, Chital
7.	Ram Sagar	Dholpur	34.40	Wolf, hyena, Fox, Chital
8.	Van Vihar	Dholpur	25.60	Bear, Wolf, Chital, hyena, Fox, Wild Cat
9.	Keoladevi	Karauli, Sawai Madhopur	676.82	Panther, Chital, Chinkara, Sambhar, Bear, hyena, Wild Boar, Wolf
10.	Sitamata	Chittorgarh, Udaipur	422.94	Flying Squirrel, Panther, Wild Cat, Sambhar, hyena, Civet
11.	Besrodgarh	Chittorgarh	201.4	Panther, Sloth Bear, Four horned antelope, Chinkara, hyena, Fox
12.	Shergarh	Baran	81.67	Panther, Chital, Chinkara, Wild Boar
13.	Darrah	Kota, Jhalawar	239.76	Panther, Wolf, Jackal, Chital, Fox, Sambhar, Sloth Bear, Porcupine

Sl. No:	Protected Areas	District	Area (sq.km)	Wildlife present
14.	Jawahar Sagar	Kota, Bundi, Chittorgarh	220.09	Panther, Bear, Wolf, Gharial, Crocodile, Chital, Hyena, Fox, Jackal
15.	National Chambal Gharial	S. Madhopur, Bundi, Karauli, Dholpur, Kota,	280	Gharial, Crocodile, Tortoise, Dolphin, Bear, Chinkara, Otter
16.	Bassi	Chittorgarh	138.69	Chital, Chinkara, Panther, Hyena, Wild Cat
17.	Tal-Chhapar	Churu	7.19	Black Buck, Resident birds,
18.	Nahar-garh	Jaipur	52.4	Hyena, Jackal, Fox, Hare
19.	Jamwa-Ramgarh	Jaipur	300	Panther, Chital, Wild Boar, Hyena, Jackal
20.	Sajjan-garh	Udaipur	5.19	Panther, Hyena, Wild Cat, Jackal, Fox
21.	Phulwari-ki-naal	Udaipur	511.4	Panther, Hyena, Wild Cat, Jackal, Fox
22.	Tatgarh Ravli	Rajsamand, Pali, Ajmer	475.23	Panther, Hyena, Wolf, Green Pigeon, Jungle fowl
23.	Jaisamand	Udaipur	52.34	Resident Birds, Hyena, Jackal, Chinkara
24.	Kumbhalgarh	Udaipur, Pali, Rajsamand	610.528	Panther, Sloth Bear, Hyena, wild boar, Four Horned antelope, Sambhar
25.	Mount Abu	Sirohi	326.1	Panther, Bear, Hyena, Wolf, Porcupine
26.	Sawai Man Singh	Sawai Madhopur	113.07	Tiger, Panther, Hyena, Fox, Bear, Chital, Sambhar

Source: <http://environment.rajasthan.gov.in/content/environment/en/rajasthan-state-biodiversity-board/about-rajasthan/wild-life-protection-areas.html>

Conservation Reserve

In addition, the National Parks and Wild Life Sanctuaries which are protected the Central Acts i.e. The Forest Conservation Act 1980 and the Wildlife Protection Act 1982 the state government can also declare some of the areas as Conservation Reserve. Conservation Reserves are declared for protecting landscapes, flora and fauna and their habitat. The rights of people living inside a Conservation Reserve are not affected. The areas declared as conservation reserves in the State of Rajasthan are presented in Table 0-7

Table 0-7: Conservation reserves in Rajasthan

SL. No	Protected Area	District (s)	Area (sq.km)	Main Wildlife
1.	Bisalpur Reserve	Tonk	48.31	Black Buck, Wolf, jackal, Hyena,
2.	Jod Beed Gaadwala	Bikaner	56.46	Black Buck, Wild Cat, wild boar

<i>SL. No</i>	<i>Protected Area</i>	<i>District (s)</i>	<i>Area (sq.km)</i>	<i>Main Wildlife</i>
3.	Sundha Mata	Jalore, Sirohi	117.49	Panther, Bear, Wolf, Hyena, Chinkara
4.	Gudha Vishnoiyan	Jodhpur	2.31	Chinkara, Black Buck, Wild boar
5.	Shakambhari	Sikar	131	Sambhar, Porcupine, Fox, wild Cat, Hyena
6.	Gogelao	Nagaur	3.58	Chinkara, Hare, Black Buck
7.	Bir Jhunjhunu	Jhunjhunu	10.47	Hare, Hedge-hog, Resident and Migratory Birds
8.	Rotu	Nagaur	0.73	Chinkara, Hare, Black Buck
9.	Ranthambore/Sariska (Critical Tiger Habitat Area)			
10.	Ranthambore/Sariska (Tiger Project Buffer Area)			

Community Based Conservation

Across the State, there are number of areas which are not designated as protected areas as per the existing Act and Rules, yet the communities have volunteered to conserve wild life and its habitat in these areas.

IBA Sites

In the state there are several water bodies which habitats for water-birds are. Large number of avian species congregate every year at these locations. The Important Bird Areas which have been declared as IBA Sites are presented in Table 0-8.

Table 0-8:IBA Sites in Rajasthan

<i>Name of IBA</i>	<i>Districts</i>	<i>Area (sq.km)</i>	<i>Status</i>	<i>Habitat Type</i>
Alniya Dam	Kota	20143	Non-Officially Protected	Freshwater Swamp
Bardha Dam Reservoir	Bundi	300 sq. km.	Non-Officially Protected	Freshwater Swamp
Desert	Jaisalmer and Barmer	316200 sq. km	National Park	Tropical Arid Zone
Diyatra	Bikaner	5019 sq. km.	Non-Officially Protected	Tropical Arid Zone, Tropical Secondary Scrub, Tropical Grassland
Gagwana Arain, Mangliyawas, Ramsar	Ajmer	Not Defined	Non-Officially Protected	Tropical Grasslands
Jaisamand Lake	Udaipur	7300 sq. km	Wildlife Sanctuary	Freshwater Swamp, Tropical Dry Deciduous
Keoladeo	Bharatpur	2873 sq. km.	National Park	Freshwater Swamp, Tropical Dry Deciduous Forest

<i>Name of IBA</i>	<i>Districts</i>	<i>Area (sq.km)</i>	<i>Status</i>	<i>Habitat Type</i>
Khichan	Jodhpur	Not Officially Protected	Not Defined	Freshwater Swamp, Tropical Thorn Forest, Tropical Arid Zone
Kumbhalgarh	Udaipur, Pali, Rajsamand	57825 sq. km.	Wildlife Sanctuary	Tropical Dry Deciduous Forest
Mount Abu	Sirohi	28884 sq. km.	Wildlife Sanctuary	Tropical Semi Evergreen Forest, Tropical Dry Deciduous Forest
National Chambal	Kota, Bundi	5200 sq. km.	Wildlife Sanctuary	Freshwater Swamp, Riverine Vegetation
Phulwari - Ki – Naal	Udaipur	51114 sq. km.	Wildlife Sanctuary	Tropical Dry Deciduous Forest
Ram Sagar Bandh	Bundi	400 sq. km.	Non-Officially Protected	Freshwater Swamp
Ranthambore	Sawai Madhopur	39200 sq. km.	Tiger Reserve	Tropical Dry Deciduous Forest
Sajjan Garh	Udaipur	519 sq. km.	Wildlife Sanctuary	Tropical Dry Deciduous Forest
Sambhar Lake	Nagaur, Jaipur, Ajmer	19000 sq. km.	Non-Officially Protected	Freshwater Swamp
Sareri Bandh	Bhilwara	300 sq. km.	Non-Officially Protected	Freshwater Swamp
Sariska	Alwar	86600 sq. km.	Tiger Reserve	Tropical Dry Deciduous Forest, Tropical Thorn Forests
Sei Dam Globally threatened species (A1)	Udaipur	300 sq. km.	Non-Officially Protected	Freshwater Swamp, Tropical Moist Deciduous Forest
Sitamata	Chittorgarh, Udaipur	42294 sq. km.	Wildlife Sanctuary	Tropical Dry Deciduous Forest
Sonkhilya Globally threatened species (A1)	Ajmer	17134 sq. km.	Non-Officially Protected	Tropical Secondary Scrub
Talchapar	Churu	790 sq. km.	Wildlife Sanctuary	Tropical Arid Zone
Udaipur Lake Complex	Udaipur	3030 sq. km.	Non-Officially Protected	Freshwater Swamp
Baghdarrah	Udaipur	342 sq. km.	Non-Officially Protected	Freshwater Swamp, Tropical Dry Deciduous Forest

6.7 Environment Quality

Ambient Air Quality

The Ambient Air Quality was monitored at five locations in the state under the National Ambient Air Quality Monitoring Program. The Rajasthan State Pollution Control Board had carried out these results. The monitoring was carried out at 21 locations of these 5 cities i.e. Jaipur (6 locations), Alwar (3 locations), Kota (3 locations), and Udaipur (3 locations). The average yearly concentration of the Sox, NOx and PM_{2.5} was reported by RSPCB to the National Green Tribunal²⁴. The data for a period of 2010- 2015 was analysed. Location-wise timeseries values were plotted for each of these pollutants namely SO_x, NO_x and PM_{2.5} in Figure 0-3, Figure 0-4, Figure 0-5 respectively

It is observed that the NO_x concentrations at all the locations are well below the standards except in the case of Jaipur. Even though no source apportionment has been carried out by RSPCB a plausible reason can be the large number of vehicles in the city. The number of vehicle in the city is presented in Table 0-9.

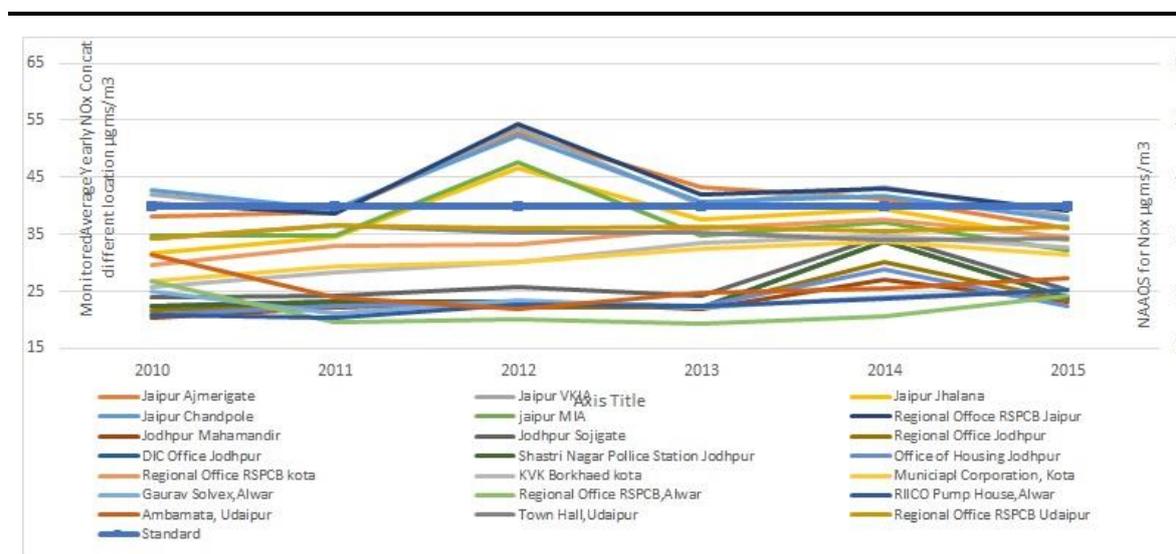
*Table 0-9: Registration of Vehicles in City wise up to 2016
(in two cities with highest Vehicle Population)*

City	Two- Wheeler	Three Wheeler	Light Motor Vehicle	Heavy Motor Vehicle	Total
Jaipur	1910739	27744	546191	129736	2614410
Jodhpur	727677	12974	207376	90870	1038897

Source: Transport Department in Affidavit filed by Government of Rajasthan

During the period between 2010 and 2016; 9.75 and 4.13 lakhs vehicles were added in Jaipur and Jodhpur respectively.

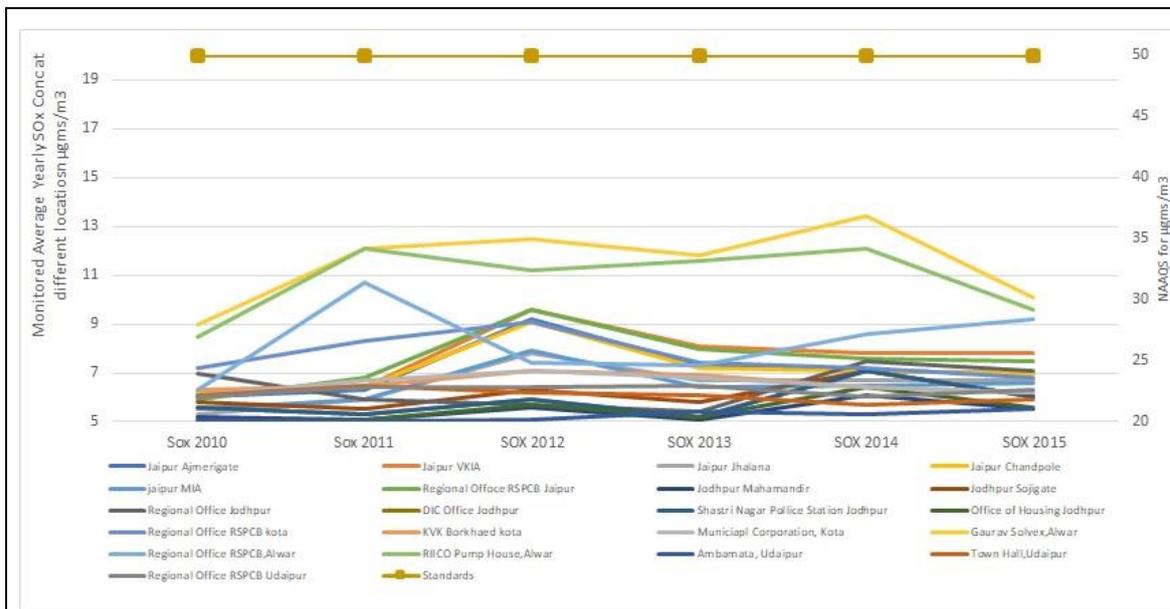
Figure 0-3: Monitored NO_x Concentration between 2010-2015 at different locations in 5 cities



²⁴ P.10(281)(2)Env/PD/2010/SP-1, dated 29/07/2016 : Affidavit filed the Government of Rajasthan to the National Green Tribunal in matter of Vardhaman Kaushik vs Union of India in OA No 21of 2014, OA No 95 of 2014 and OA No 303 of 2015.

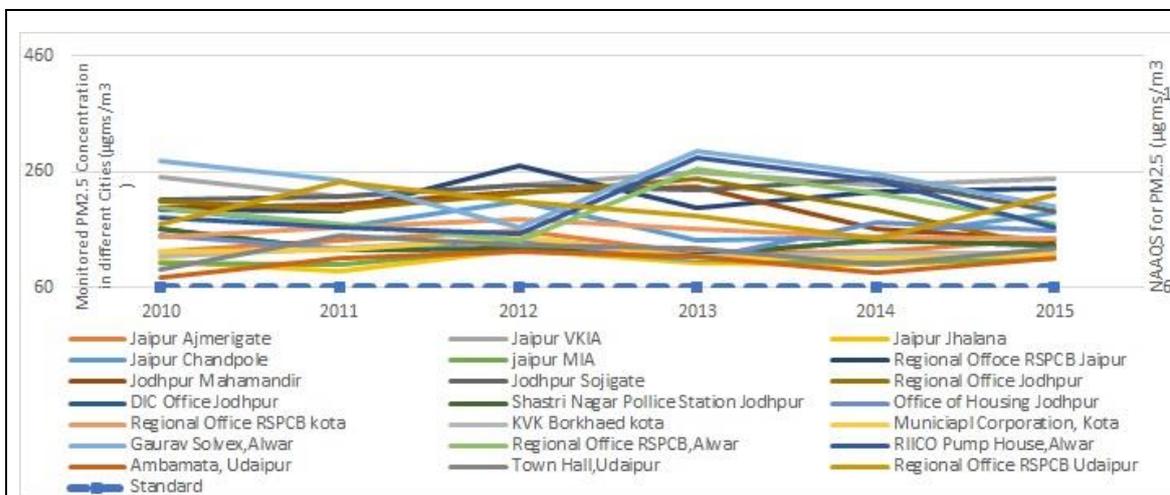
The level of Sox monitored at the 21 locations in 5 different cities show that the levels are well below the standards specified in NAAQS. The monitored NOx, SOx and PM 2.5 concentration in these 21 locations between 2010 and 2015 is presented in Figure 0-3, Figure 0-4 and Figure 0-5 respectively.

Figure 0-4: Monitored SOx Concentration between 2010-2015 at different locations in 5 cities



The PM_{2.5} results across all the cities in all these cities indicates that it is above the PM_{2.5} standards. At some locations in Jaipur and Jodhpur the PM_{2.5} values recorded was almost 3.5 times the limits specified in the NAAQS.

Figure 0-5: Monitored PM_{2.5} Concentration between 2010-2015 at different locations in 5 cities



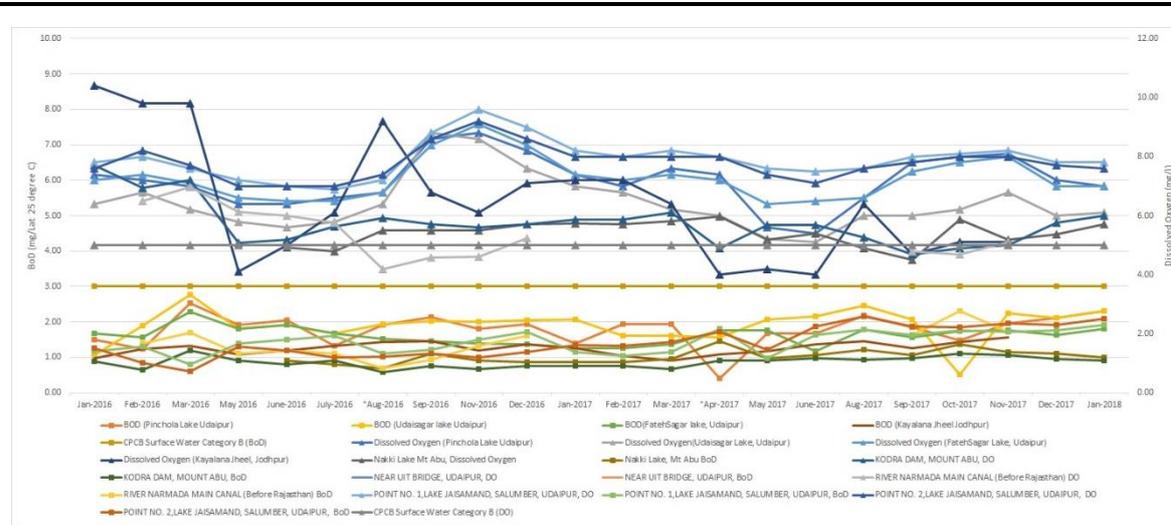
Since no source apportionment study was carried out definitive sources of the pollutants cannot be identified but the RSPCB had stated the arid climate coupled with the soil types contribute to the high level of PM_{2.5} in the ambient air. The other sources of PM_{2.5}, SOX and NO_x include pollution from vehicles, industrial units and residential sources.

Surface Water Quality

The Surface Water was monitored at approximately 40 locations covering the rivers, lakes and other surface water bodies. These sampling and analysis is carried out by the Rajasthan State Pollution Control Board as part of the National Water Quality Monitoring Program. In the districts where the sub-projects are expected to be located the Biological Oxygen Demand (BoD 5 days at 20°C) and

Dissolved Oxygen levels were analysed. The two basic parameters help in determining the suitability of water for different purpose. The DO and BoD values are presented in Figure 0-6.

Figure 0-6: Monitored BoD and Do values at different waterbodies in the Sub-Project Districts



Source: CPCB, National Water Quality Monitoring Program

Analysis of the results indicated that DO levels in water are more than 5.0 mg/l and the BoD (5 days 20 °C) is less than 3.0 mg/l. However, the DO level in the water bodies dips during the summer season. Considering the above results these surface water bodies can be Classified as Category B (CPCB Surface Water Class) and is only fit for bathing.

Natural Hazards

The Hazard Vulnerability Risk Assessment (HRVA) was carried out for the state as part of the State Disaster Management Plan.²⁵ The natural hazards which have been identified are primarily due to the extreme climatic conditions and the variability in the precipitations. These include:

Droughts

Low rainfall coupled with erratic behaviour of the monsoon in the state makes Rajasthan the most vulnerable to drought. These events are prolonged and the impacts are spread over a large area. Due to the sparse rainfall there is always scarcity of water over a region. Construction activities would require water which can lead to potential sources of conflict with the local people.

Earthquakes

As per the BMPTC²⁶ Vulnerability Atlas²⁷, various parts of the State of Rajasthan fall under earthquake zones II, III, and IV. The areas under the different earthquake zone are presented in Figure 0-7 and Table 0-10.

²⁵State Disaster Management Plan (SDMP), Disaster Management & Relief Department Jaipur, Rajasthan , Government of Rajasthan,2014 <http://www.dmrelief.rajasthan.gov.in/documents/sdmp-eng.pdf>

²⁶ Building Material and Technology Promotion Council, Ministry of Housing and Urban Affairs , Government of India

²⁷ The Atlas gives information on all vulnerable areas that have been mapped indicating the expected intensities of natural events like earthquakes, cyclones and floods that can occur in different areas. Beside containing a

Figure 0-7: Earthquake Zones of Rajasthan

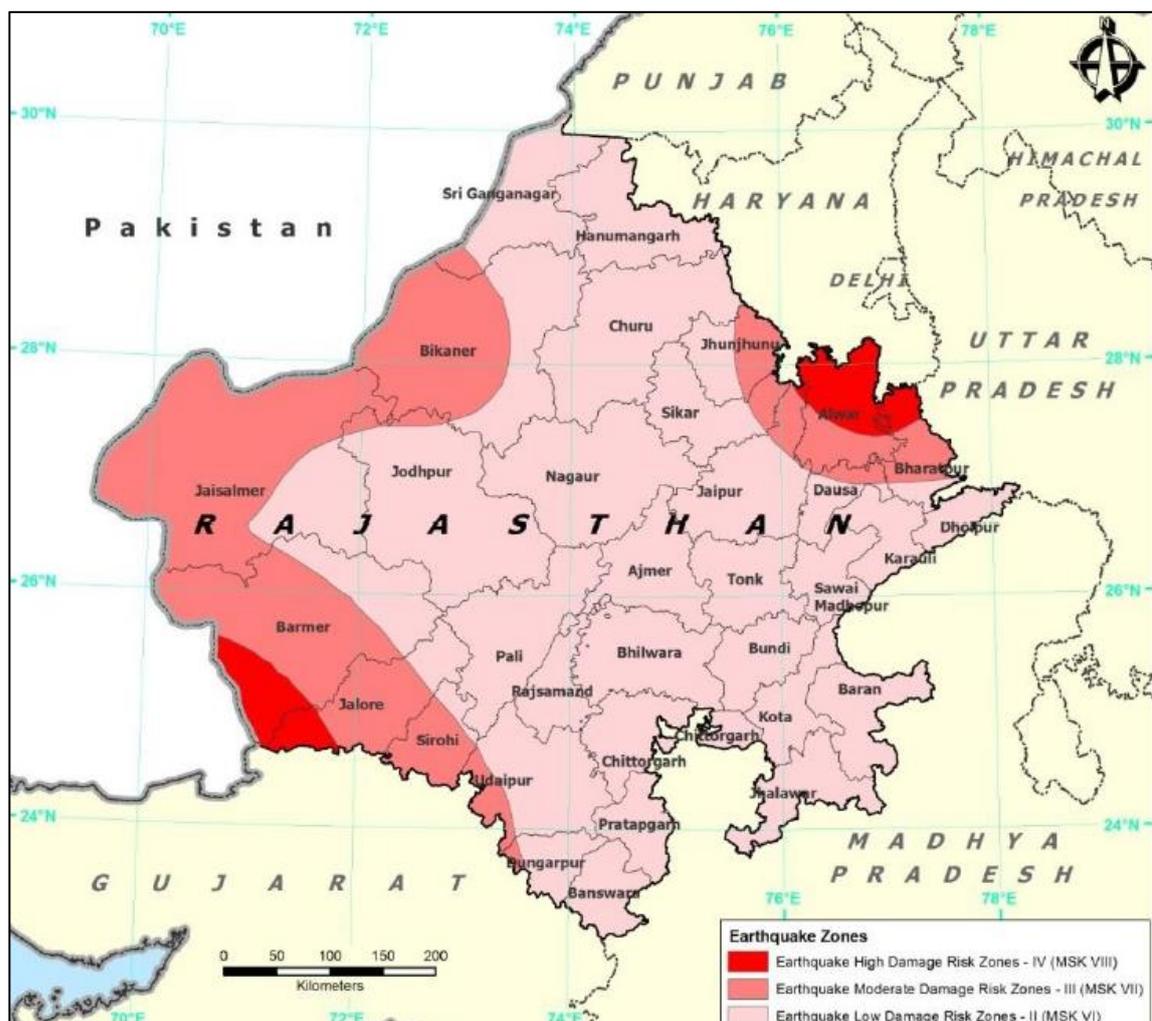


Table 0-10: Classification of districts according to seismic zones

Sl. No	Seismic Zone	Magnitude	Districts
1.	IV [High Damage Risk Zone]	6.0 - 6.9	Some parts of Barmer Chohtan Block], Jalore [Sanchore Block] Alwar [Tijara Block], and Bharatpur [Block Nagar, Pahari]
2.	III [Moderate Damage Risk Zone]	5.0 - 5.9	Some parts of Udaipur, Dungarpur, Sirohi, Barmer, Jaisalmer, Bikaner, Jhunjhunu, Parts of Sikar, Jaipur, Dausa, and Bharatpur.
	II [Low damage Risk Zone]	4.0-4.0	Ganganagar, Hanumangarh, Churu, Jodhpur, Pali, Rajsamand, Chittorgarh, Jhalawar, Baran, Kota, Bundi, Sawai Madhopur, Karauli, Dholpur, Banswara, some areas of Bikaner, Udaipur, Jhunjhunu, Sikar, and Jaipur.

hazard maps of India, the atlas also includes the maps for each State and Union Territory, thereby indicating the vulnerability upto district level.

Source: *Earthquake Manual, Government of Rajasthan*

Though the state of Rajasthan has not had a major earthquake in recent years, small to moderate earthquake have been felt in the state. On 9 April 2009, an earthquake of 5.3 intensity on the Richter scale struck Jaisalmer and surrounding districts.

Floods

Even though most parts of Rajasthan receive scanty rainfall and have historically not been prone to flood. However, recent floods and inundations have occurred, mostly along the basins of rivers like Luni and Chambal. These include major parts of the basins and sub basins of River Luni in Barmer, Pali, Sirohi and Jalore; and the basins and sub basins of River Chambal in Baran, Kota and Bundi districts. Also, major portions of Bharatpur districts falling under the basin of River Banganga, and the basins of River Ghaggar in Sriganganagar are prone to floods.

The reasons for flooding in these regions include:

- Excess rain in the catchment
- Sudden release of large quantities of water from Dams/ water reservoirs
- Breach/ damage in major reservoirs/ dams
- Limited holding capacity

Figure 8: Flood Prone Zones of Rajasthan



Besides the floods in these natural drainage systems, there are other reasons for inundation. Changes in rainfall patterns have also increased the risk of flash floods in many areas that were not flood prone historically. The flood map of the area is presented in Figure 8

Annexure 2: Guidance Notes

Guidance Note 1: Planning and Design

General Principle

This code of practice details the factors to be considered during project planning and design stages to avoid/address environmental concerns through modifications in project design and incorporation of mitigation measures.

Environmental Issues/Concerns

The planning and designing of highways need to take the following issues into consideration.

- Unnecessary widening leading to unnecessary geometric cuts, soil erosion, and destruction of plant and water resources
- Alignment through:
 - sensitive habitats would have potential impacts on wildlife;
 - agricultural land would have impact on the productive resources
 - near or along water bodies would have impact on the water resource and quality
-

Legislations & Standards

Guidelines specified in IRC: SP-84:2009 (four-lane highways), IRC SP 73 :2007 (two lane highways) and IRC SP-48 and the specifications for Road and Bridge Works issued by the Ministry of Road Transport & Highways (MORTH) for project preparation are to be followed in conjunction with the measures suggested as part of this Guidance Notes.

Detailed Guidance

Feasibility Stage

Finalisation of the Alignment

All requirements of Section 4 and 9 of IRC: SP-19: 2001 in selection of alignment should be met with. The ecological, aesthetics and social considerations should also be considered in addition to the Engineering Costs. To the extent possible especially in rolling topography and in hill roads (in Aravalli hill area), natural topography as far as possible to avoid excessive cut and fill. In case of sub projects in hill areas (in Aravalli hill area), alignment selection should incorporate provisions of IRC: SP-48:1998, “Hill Road Manual”. Due attention to geo-technical, environmental aspects of hill roads and take appropriate measures to ensure the following:

- Stability against geological disturbances.
- Prevention of soil erosion.
- Provision of efficient drainage and preservation of natural drainage system

An inventory of all environmental features along the proposed road is to be prepared and marked on a strip chart during the reconnaissance visit. The sensitive environmental features which needs to be identified include:

- Trees;
- Forests (including National Parks, Wild Life Sanctuaries, Reserve Forest) if any;

- Community Reserve, Community Conservation Areas, Gochars etc;
- Rivers/Streams/Water crossings;
- Sand Dunes;
- Flood prone and water-logged areas, Areas prone to flash floods;
- Water bodies (Ponds/Reservoirs);
- Irrigation channels;
- Cultural/Religious properties;
- Social Infrastructure: Schools, Hospitals/Health Centres;
- Common Property Resources/Community Facilities;
- Wildlife crossing Areas;
- Location for Ramps, Cattle Crossing and Bus-bays;
- Seasonal markets or cultural congregations;
- Major/minor junctions;
- Location for ducts for threading agricultural/utility pipes;
- Location for disposal of debris.

The spatial extent of the features would be marked on the strip map and would be included in the Feasibility Report.

Consultations with the local communities are to be conducted during the reconnaissance to identify the features which may not be identifiable on ground or visible. These consultations would be carried out at settlement along the alignment or at regular interval of 5 km to identify the local concerns to address the potential environmental issues. The information should be collected from:

- Review of published literature (maps, reports, publications)
- Consultation with the concerned line departments (e.g. Forest Department, Water Resource Department etc)
- Discussion with the local panchayats/key informants in the village
- In addition, accident records and discussion with the local population would help in identifying the Accident Hotspots.

Suggestions of the community and other stakeholders during the reconnaissance visit should also be incorporated appropriately into the findings of the Reconnaissance Visit Report.

The Reconnaissance Visit Report shall be shared with the design team so that they can be incorporated, to the extent possible, while finalising the alignment.

Design Considerations

All the road designs should conform to the specifications of IRC: SP-84:2009 (four-lane highways), IRC SP 73 :2007 (two lane highways). Additional measures suggested for minimisation of environmental impacts, safety of road users and for enhancement of community benefits are indicated in this Guidance Note may be followed. Where it is necessary to deviate from the IRC specifications the following design considerations shall be the absolute minimum.

Design Speed

Ruling design speed may be reduced²⁸ to 80 km/hr from 100 km/hr in plain and 60 km/hr in rolling terrain and 40 km/hr in hills. The speed may however be relaxed (on case to case basis) in case of existing alignment where realignment of the road through the environmentally sensitive areas would have excessive impacts on the sensitive environment.

Road Land Width

If larger widths are available, the existing standards of Section 6 of IRC 73 (non-urban) and IRC 86 (Urban areas) should be followed. The minimum standard road land width may be reduced to 12 m in plains in areas where it is difficult to obtain 15 m, keeping local conditions in view and after assigning reasons of keeping reduced width. The requirement may be further reduced to 9 m in areas under intensive irrigation and where traffic is less than 100 vehicles/day. But in such cases, the roadway width shall also be reduced to 6 m. Normally a land width of 12m shall be attempted in case of hill roads. It may be reduced to 9m only in exceptional cases.

Carriageway Width

Standard carriageway width of 3.75 m is to be adopted on all roads. It may be however be reduced to 3.0 m in exceptional cases such as hilly terrain or as per provisions of IRC: SP-48:1998, "Hill Road Manual". Hard shoulders of 1 m width may be provided on either side only in case longer routes or "through" village roads connecting many habitations to cater for the expected increase in traffic intensity.

Embankment height

Lower embankment height of 0.3–0.4m to be provided in case of arid and sandy areas. In case of desert areas, the embankment height could be reduced since no overtopping is anticipated. In flood prone areas, height of embankment shall not be reduced and shall be a minimum of 0.6m above expected highest water level (based on data of last five years).

Geometric Design

Geometric design shall conform to IRC 73 - 1980 Geometric Design of Highways Rural , however, in case of areas where adherence to the standards would result in adverse impacts on any of the environmental sensitive areas listed above the design speed may be reduced to accommodate in the design.

(i) In plain and rolling terrain the alignment should be designed for maximum possible radius of curves. Minimum absolute curve radius of 90m @ 60 km/hr and 45m @ 35 km/hr should be adopted without further relaxation due to safety reasons. (ii) Junction design of access road with collector road should be in conformity with IRC: SP-84:2009 (four-lane highways), IRC SP 73 :2007 (two lane highways) for both sight distance and flaring requirements. Generally, a minimum radius of 14m shall be provide in case of design of hill roads but in exceptional cases it may be reduced to 12m to reduce excessive cutting or uptake of agricultural land.

Special care should be taken to align the roads along the hill side which is stable and where cutting on hill side causes least disturbance. The geologist/ engineer shall investigate the disturbance likely to be caused keeping the geology of hill slope in view.

²⁸ Short stretches (say less than 1 km) of varying terrain met with on the road stretch shall not be taken into consideration while deciding the terrain classification for a given section of Project Highway

Drainage

For large catchment areas with low ground slope, the accumulation of water causes flooding on the up-stream of the road. The increased velocity of water passing through the culverts causes scour on the down-stream and alters natural ground levels and scour of land. Hydrological studies are to be conducted in large catchment areas to limit the afflux and provide adequate waterway for cross-drainage structures. The drainage must be designed in conformance with IRC SP 42 - 2004 Guidelines of Road Drainage, IRC SP 50 - 1999 - Guidelines for Urban Drains and Clause 309 of MORTH Specifications.

The design of drainage should prevent that:

- Flooding of the road and ponding on the road surface;
- Protect the bearing capacity of the pavement and the subgrade material;
- Avoid the erosion of side slopes.

The alignment shall be away from drainage channel. In case any natural drainage channel is flows along the alignment the embankment should be protected against erosion (Refer Guidance Note 2: Erosion and Slope Stability). Similarly, in case of high embankment the same should be protected against erosion by providing chute drains.

The drainage in built-up areas should be developed as per the provisions of IRC SP 50 1999. It should be ensured that after the development of the highway through the built-up area does not lead to water logging or pointing. Adequate, cross drainage structure and longitudinal drains are constructed. The longitudinal; drains should be linked to the, aim drainage channel of the urban area.

All CD works shall have steps constructed for inspection, repair and maintenance purpose

Underpass

In urban / built up areas, pedestrian / cattle crossing facility shall be provided such that pedestrians do not have to walk more than 0.5 km to reach the underpass for crossing the sub-project highway. Wherever a cross road is proposed to be taken below the Project Highway, minimum clearances at underpasses shall be:

- Vehicular underpass: 5.5. m
- Cattle and Pedestrian underpass: 3.0 m (to be increased to 4.5m, in case certain categories of animals such as elephant/camel are expected to cross the sub-project Highway.
- Full roadway width at the approaches shall be carried through the underpass

Wherever existing slab culverts and minor bridges allow a vertical clearance of more than 2 m, these can be used in dry season for pedestrian and cattle crossing by providing necessary flooring and approach road. In additions, underpass may also be considered for wild animals as discussed in Guidance Note 10 Wildlife Management.

Ingress & Egress

Ingress/egress to/from commercial and industrial properties including retail outlets shall be provided through acceleration/deceleration lane in accordance with MOSRTH guidelines²⁹. However, in no case the access to residential property shall be blocked except for safety reason. In case the of same, alternate access shall be created by the sub-project.

Ramps for access to and from the settlement and agriculture lands shall be constructed. The junctions shall be designed with adequate visibility so that it does not lead to accidents. The ramps would also avoid damage to embankment and roadside drain for cross traffic.

Facilities

Sub-projects which has regular movement of busses (public or private) bus bays should be constructed to avoid traffic obstruction and to provide for turning radius wherever feasible. The

On hill roads, passing places are required to facilitate crossing of vehicles. These shall be provided at a rate of at least two per kilometre and exact location to be based on sight condition. The length of passing places shall be about 15-20m with carriageway of 5m.

Road Signs

The mandatory, regulatory and cautionary/warning signs and informatory signs as provided in IRC:67 and section 802 of MORTH specifications shall be worked out. Proper signs shall be provided for left in and left out at service roads for safe guidance of traffic. Clustering and proliferation of road signs shall be avoided for enhancing their effectiveness.

Road Side Safety Barriers

Detailed Road Safety audits must be conducted during the Feasibility and design stages as per the MOSRTH circular³⁰. Traffic Hotspots/Accident Hotspots on Highways are to be identified based on fatality data furnished by traffic police/ Police authorities for three preceding calendar years. In case of lack of date the or information is very inadequate information may be obtained from the local people

For bridges without foot paths, concrete crash barriers shall be provided at the edge of the carriageway on all new bridges. The longitudinal roadside barriers are basically meant to shield two types of roadside hazards i.e. embankments and roadside obstacles and also for preventing the vehicles veering off the sharp curves. Appropriate road barriers shall be designed and include in the designs.

Detailed Environmental Studies During this state the detailed environmental studies must be conducted. The following studies would be undertaken however, this is not limiting and may be increased based on the outcomes of the reconnaissance visits:

- Geological, geotechnical studies in hill areas
- Assessment of angle of hill slopes
- Assessment of angle of hill slopes
- Location of soil erosion and slope stability
- Ecological surveys to establish the presence of wildlife along the sub-project stretches;

²⁹ Guidelines on access permission to Fuel Stations, Service Stations; Rest Areas etc. vide Circular No. RW/NH-33023/19/99-DO-III dated 25.09.2003/17.10.2003, & access permission to Private Properties etc. along National Highways vide Circular No. RW/NH-33023/19/99-DO-III dated 31.08.2000

³⁰ RW/NH/29011/2/2015/-P&M (RSCE) dated 20th April 2017

- Surface water resources and water availability along the subproject stretches

In addition to the above topographic and geo-technical surveys the location of borrow and quarry material would also be identified.

Inclusion of Environmental Considerations into Detailed Design

The design and environmental considerations discussed above must be incorporated suitably in the Feasibility Report, Bill of Quantities and the bid document to ensure this is integrated into the bidding process. Towards this end, the Employer/Engineer should ensure that all the measures mentioned above have been studied appropriately by the Contractor and include in the design drawings.

The preliminary drawings should also include spatial location for the mitigation measures. The bill of quantities in the bid document would also include clear direction for use of alternate material and methods of construction. Cost implications of environmental measures suggested in the Guidance Notes must be included in the estimates for the sub-project. In case there is additional, but the state government are expected to make land available free of all encumbrance. Cost of restoration of common property resources, as detailed in social management plan, are expected to be met by the state government.

During the Construction Period

Scheduling of the Construction

The construction schedule needs to be prepped by the contractor keeping into consideration climatic conditions and resource availability:

- In areas where water resource is scarce the earthworks must be carried out just before the monsoon so that so that water requirement for subsequent construction works such as granular sub-base and water bound macadam are met in monsoon and post monsoon season. Carrying out these activities even during the monsoon is possible as the rainfall may not be high enough to disrupt construction.
- In areas where there are very high temperatures the working time must be modified to ensure that the heat stress on the workers do not adversely affect their health
- The mitigation measures suggested in Table 3 1 should also be implemented in addition to the above guidance.

Guidance Note 2: Slope Stability & Erosion Control

General Principle

The scope of this Guidance Note is to include in the design measures to minimize the adverse environmental impacts of slope stability and soil erosion due to the construction of roads. Unstable slopes developed due to construction activity is not only an environmental concern but also a concern for the maintenance of the infrastructure itself. The concern mainly arises at locations where there is cutting of slopes in hill areas and at locations of high embankment. In cases of high embankment, water retention at the embankment base initially causes toe failure and subsequently failure of the whole embankment.

Soil erosion is consequent to high runoff on hill slopes. Erosion control measures are provided to prevent soil damage done by moving water, wind either by displacement of soil by water or air in motion or deposit of soil by sedimentation/accumulation at points of low velocity. Erosion in hilly areas occurs when the natural slopes are affected due to cutting or due to ingress of water in the rock mass and leaching/ weakening of jointing compounds. High wind velocities cause erosion of embankments made up of cohesion-less sandy soils. Embankments made up of silty and sandy soils are eroded, in the absence of vegetative cover, when the slopes are steep, say more than 20 degrees.

Environmental Issues/Concerns

The adverse environmental impact can be: (i) damage to adjacent land, (ii) silting of ponds and lakes disturbing the aquatic habitat (iii) erosion of rich and top fertile top layer of soil (iv) contamination of surface water bodies and (v) reduction in road formation width due to erosion of shoulders/berms.

Legislations & Standards

The principles of the IRC 56-1974: Recommended Practice for Treatment of Embankment Slopes for Erosions Control would be followed for erosion control measures.

Detailed Guidance

Planning during the Pre-Construction

During the detailed project preparation phase, the following investigations shall be carried out prior to finalisation of alignment.

- Topographical: location of the sand dunes and the landslide prone areas
- Hydrological: Interruption and disruption due to existing drainage system
- Geo-technical: type of rock
- Geological Investigation (particularly, slide prone areas of hill roads) and
- Aesthetic consideration.

The rock profile, other information and geologically critical sections are identified based on surveys carried out by Geological Survey of India. Map of the critical areas shall be used as a base for further investigation.

Slope stability analysis for retaining / breast walls of height greater than 5m shall be carried out in hilly areas. The stability analysis shall be as per IRC: SP-48: 1998. Based on these investigations slope stabilisation measures are to be incorporated for finalising the alignment design.

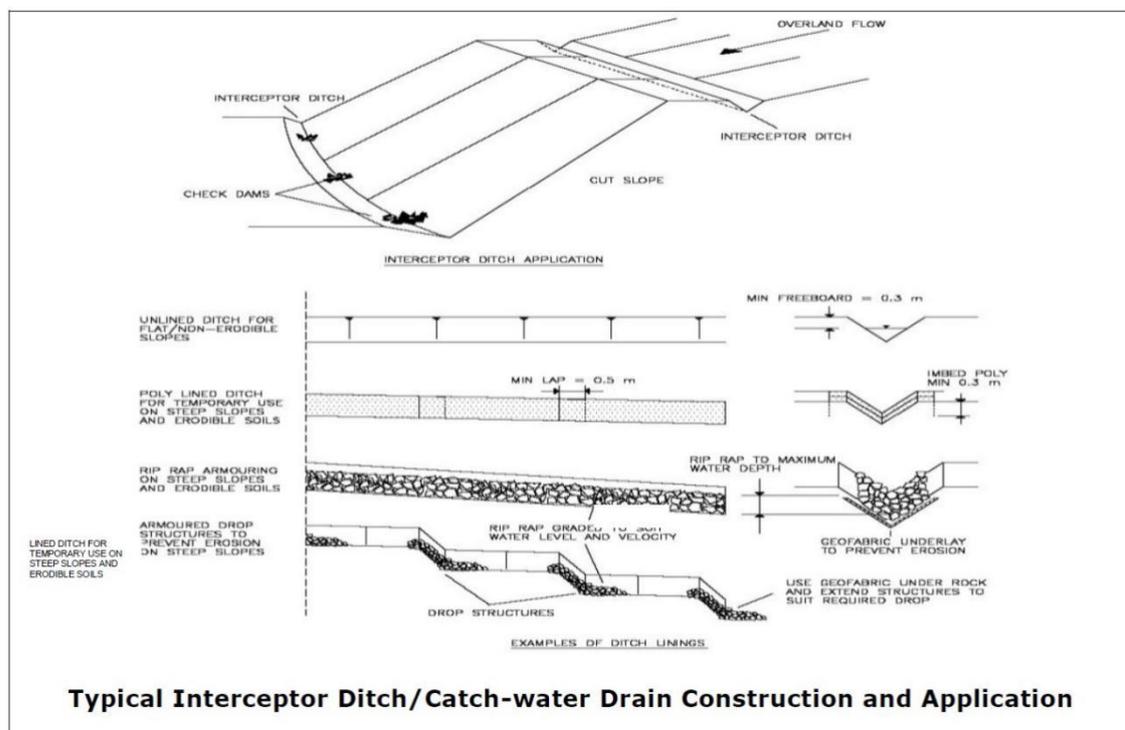
In addition to the slope stability analysis the alignment should be such that (i) Steep as well as heavy cuts are avoided, (ii) Flora and fauna of the area are disturbed to a minimum possible extent and (iii) Natural drainage pattern is not obstructed.

For high embankments, geo-technical investigations to determine the density of the available material need to be conducted to check its suitability as fill material.

Construction stage

Interceptor ditches are constructed in hill areas to protect the road bench and hillside slope from erosion due to heavy rainfall and runoff. Interceptor ditches are very effective in the areas of high intensity rainfall and where the slopes are exposed. These are the structures designed to intercept and carry surface run-off away from erodible areas and slopes, thus reducing the potential surface erosion. Figure 0-1 shows typical installation of interceptor ditch structure as well as ditch lining types.

Figure 0-1: Typical Interceptor Ditch/Catch -Water Construction & Application



The Contractor must ensure that the layout and siting of ditches is as per IRC: SP-42:2004 and the Guidance Note (GN) 5: Drainage and Waterbodies are developed before the constructions activities are carried out in the slopes.

When alternative material such as fly ash is used for embankment formation, it needs to be ensured that sufficient filter bed is provided along with the top cap. All tests as per IS: 2720 (Parts: 4, 5, 8 & 40) and IRC: SP-84:2009 (four-lane highways), IRC SP 73 :2007 (two lane highways) are to be conducted on the embankment to keep a check on the compaction achieved.

Slope stabilisation techniques and erosion control measures as mentioned below are to be undertaken in hill areas.

Vegetation Cover

On side slopes in hills, immediately after cutting is completed and debris is removed, vegetative growth must be initiated by planting fast growing species of grass. This would prevent high velocities of runoff and resultant gully formation as well as pounding of water on the road bench.

Box 0-1: Specification for Vegetation Control

Description

The vegetative cover should be planted in the region where the soil has the capacity to support the plantation and at locations where meteorological conditions favours vegetative growth.

Site Preparation

- To prevent the seeds from being washed away after sowing, the area should be protected with surface roughening and diversions.
- Soil samples should be taken from the site and analysed for fertilizer and lime requirements.

Seed Application

- The seed should be sown uniformly as soon as preparation of the seedbed has been completed.
- No seed should be sown during windy weather, or when the ground surface is wet, or when not tillable.

Maintenance

During first six weeks, the planting should be inspected by the PIU, to check if the growth is uniform and dense. Appropriate moisture levels shall be maintained. There may be requirement of watering the plantings regularly during the dry seasons. Fertilizer and pest control applications may also be needed from time to time.

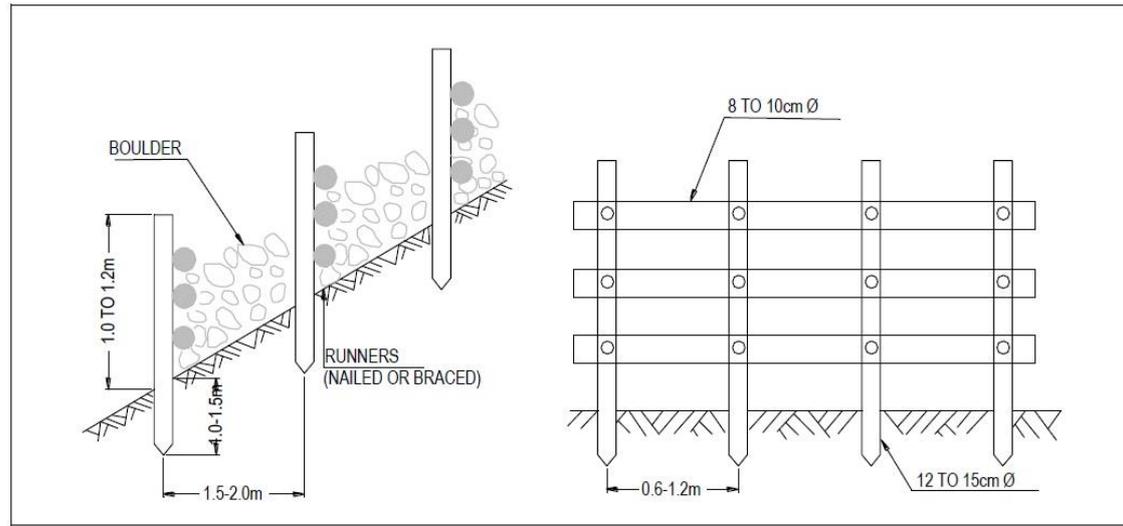
Sausage Walls / Gabions:

Sausage wall (commonly termed as Gabions) are being used extensively in hilly areas. The sausage wall is made by forming sausages of galvanized iron or steel wire netting of 4 mm dia having 10 cm square or hexagonal opening and filling the sausages with hard local boulders / stones and wrapping the wire net at the top. The sausage walls can withstand large deformation without cracking and are flexible. Further, due to the open structure, they allow free drainage of water. Sausage Walls shall be constructed in-situ as per IRC: SP: 48-1998. The stone used for the pitching shall only be obtained from licensed quarries. The Contractor should submit to the Employer/Engineer valid certificates of procurement of stones. The Employer/Engineer shall certify that all the stones which has been used for the sub-project has been procured from quarries having valid environmental clearances and other licences. All payments for the pitching shall only be allowed by the after receiving such certificates

Bally Benching

To control the erosion on slopes as well as for arresting the shallow movement of top mantle slid mass at the construction location; the Contractor should provide Bally Benching. This method is also very effective in preventing gully erosion. Bally benching shall be installed as per IRC: SP: 48-1998. The layout and design specification for Bally benching is provided in Figure below.

Figure 0-2: Layout and Design Specification for Bally Benching



Silt Fencing

Silt fence is a temporary sediment barrier of entrenched permeable geotextile fabric designed intercept and slow the flow of sediment-laden sheet flow runoff from small areas of disturbed soil. The purpose of this practice is to reduce slope length of the disturbed area and to intercept and retain transported sediment from disturbed areas. This silt fencing is applicable in the following situations:

- Erosion occurs in the form of sheet and rill erosion³¹. There is no concentration of water flowing to the barrier (channel erosion).
- Where adjacent areas need protection from sediment-laden runoff.
- Where effectiveness is required for one year or less.
- Where conditions allow for silt fence to be properly entrenched and staked.

Under no circumstance shall silt fence be used in the following applications:

- Below the ordinary high watermark or placed perpendicular to flow in streams, wales, ditches or any place where flow is concentrated.
- Where the maximum gradient upslope of the fence is greater than 50% (2:1).

The Design Criteria for silt fencing is presented below

Box 0-2: Design Criteria for Sedimentation Control

Description

Silt fencing is a temporary sediment barrier made of woven, synthetic filter fabric supported by steel or wood post. The purpose of the silt fence is to prevent sediment carried by sheet flow from leaving the site and entering to natural drainage or any other water body located near the construction site. Silt fencing encourages the sheet flow and reduces the potential for development of rills and gullies. Care should be taken that silt fences are not installed across streams, ditches, waterways or other concentrated flow areas. All silt fencing should be installed along the contour,

³¹ Sheet and rill erosion is the removal of soil by the action of rainfall and shallow overland runoff. It is the first stage in water erosion. As flow becomes more concentrated rills occur. As soil detachment continues or flow increases, rills will become wider and deeper forming gullies.

never up or down a slope. Where all the sheet flow run off is to be stored behind the silt fence, maximum slope length should not exceed as shown in the table below.

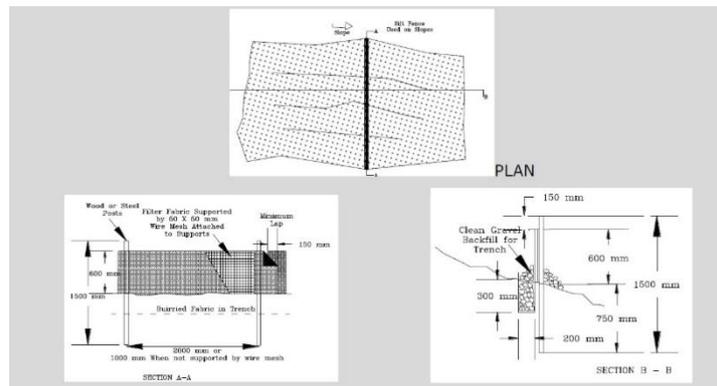
Criteria for Silt Fence Placement

• Land Slope (%)	• Maximum Slope Length (Above the fence in m)
<2	30.0
2 to 5	22.5
5 to 10	15.0
10-20	7.5
>20*	4.5

*In areas where slope is greater than 20 %, a flat area length of 3.0 m between the toe of the slope and the fence should be provided

Construction Specification

Silt fencing consists of 1.0 m wide filter fabric and should be placed on the contour. In case runoff flow or velocities are very high or where slope exceed vertical height of 3.0 m, silt fencing should be wire reinforced as shown in the illustration below. The contractor should purchase silt fencing in a continuous roll to the length of the barrier to avoid the use of joint. In case of joints, filter cloth should be spliced together only at supporting post, with minimum 15 cm overlap and securely sealed. The pile is to be driven to a depth of 300 mm into the ground by pressing from the top. The frame will be installed at the edge of stockpiles and at the water bodies along which construction is in progress.



Inspection

The Employer/Engineer will inspect location as well as efficiency of silt fencing. The inspection should be done after every 15 days and in case of storm water, within 24 hours after the end of rain.

Maintenance

The contractor should remove sediments, once they have accumulated to one-half the original height of the fence. Filter fabric should be replaced whenever it has deteriorated to such an extent that the efficacy of the fabric is reduced. Silt fence should remain in place until disturbed areas have been permanently stabilized. All the sediments accumulated should be properly disposed of before the fence is removed. The operation of removing and disposing must be monitored by the Engineer/Employer.

Check Dams

Sheet and channel erosion on hill slopes gentler than 1(V):12(H) can be prevented effectively through construction of check dams.

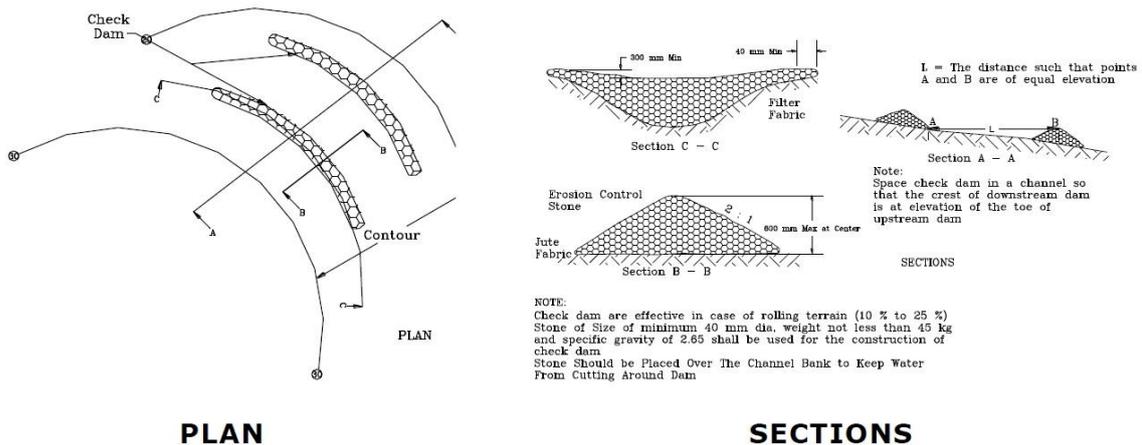
Box0-3: Conceptual Design and Specification of Check Dams

General

A check dam is a small dam constructed in a drainage way to mitigate sheet and channel erosion by restricting the flow velocity. On steeper slopes greater than 1: 12 (H: V), check dams are not effective.

Basic Design Criteria

- Check dams are usually constructed of riprap, logs, sandbags, and/or straw bales.
- The maximum check dam height should be 0.6 m.
- The centre of the check dam should be a minimum of 25 cm lower than the ends to act as a spillway for runoff, as illustrated in Figure 9.3
- Overflow areas should be stabilized to resist erosion.
- Stone check dams should use 7.5 cm or larger stone with side slopes of 2:1 (H: V) or flatter and should be keyed into the sides and bottom of the channel for a minimum depth of 0.6 m. The drainage area for a stone check dam should not exceed 0.2 Sq. Km



Check Dam Specification

Multiple check dams should be spaced so that the bottom elevation of the upper dam is the same as the top elevation of the next dam downstream, as illustrated above.

Erosion Control Matting

This type of erosion protection measures is used to protect the channel from erosion or act as turf reinforcement during and after the establishment of grass or other vegetation in a channel. This practice applies to both Erosion Control Re-Vegetative Mats (ECRM1) and Turf-Reinforcement Mats (TRM). The design specification is presented in Box below

Box 0-4: Erosion Control Matting

Description

The design specifications as well as locations should be finalised during the Project Preparation Phase. During the execution period in post-construction stage, PIU must ensure that all the guidelines are to be followed as per specifications during the site preparation and installation of erosion control matting.

To aid in the selection based on the requirement the different types of mats these have been classified.

- Class I: A short-term duration (minimum of 6 months), light duty, organic Erosion Control Re-vegetative Mats (ECRM) with plastic or biodegradable netting.
 - Type A – Only suitable for slope applications, not channel applications.
 - 2. Type B – Double netted product for use in channels where the calculated (design) shear stress is 1.5 lbs/ft² or less.
- Class II: A long-term duration (three years or greater), organic ECRM.
 - Type A – Jute fibre only for use in channels to reinforce sod.
 - Type B – For use in channels where the calculated (design) shear stress is 2.0 lbs/ft² or less. Made with plastic or biodegradable mat.
 - Type C – A woven mat of 100% organic material for use in channels where the calculated (design) shear stress is 2.0 lbs/ft² or less. Applicable
- C. Class III: A permanent 100% synthetic ECRM or Turf-Reinforcement Mats (TRM). Class I, Type B erosion mat or Class II, Type B or C erosion mat must be placed over a soil filled TRM.
 - 1. Type A – An ECRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft² or less.
 - 2. Type B – A TRM for use in channels where the calculated (design) shear stress of 2.0 lbs/ft² or less.
 - 3. Type C – A TRM for use in channels where the calculated (design) shear stress of 3.5 lbs/ft² or less.
 - 4. Type D – A TRM for use in channels where the calculated (design) shear stress of 5.0 lbs/ft² or less.

Following are the steps need to be followed for the placing erosion control matting:

Site Preparation

- The areas should be fertilized and seeded.
- A smooth surface free of depressions that allows water to collect or flow under matting is required.
- The soil should be left with loose surface after seeding.
- The material should be steel wire formed into “U” shape and should be 15 cm to 25 cm long.

Installation

- Filter fabric made of ECRM should be placed horizontally on the slope less than 2:1
- Prior to netting, a 10 cm anchor trench should be dug at the top and toe of the slope with the top trench placed 30 cm back from the crown, or a berm over which the fabric can be carried.
- For horizontal application, work must proceed from the bottom towards the top of the slope with a 10 cm overlap. Cutting material should be folded less than 7.5 cm to 10 cm at the end, stapled and covered.
- Staples should be placed at a spacing of 22.5 cm to 30 cm apart in the trenches along the horizontal lap joints.

Sand Fencing

Sand fencing can be erected along the road corridor. Sand fences are high density polyethylene mesh material with holes distributed to provide 50% porosity to maximize sand deposit. This is a temporary measure which can be adopted.

Box -0-5:Specification for Sand Fencing

Standard fencing used in dune restoration projects consists of wooden slats wired together with space between the slats; however, the use of woven fabric type fencing has also been successfully. It is important that whatever material is used, the fencing must contain a 40% to 60% open space to closed space ratio. It should also be noted that fabric-type fences might not perform as well as the wooden slats and that many fabric-type fences are susceptible to ultraviolet degradation that causes the material to become brittle and deteriorate and may sag and lose the original shape, thus reducing performance. To maximize the benefits of sand fencing, it is recommended that the fence be lifted and repositioned prior to the fence becoming 50% buried. If the sand is allowed to accumulate, the fence will not only become difficult to remove but will also lose its ability to collect sand.

Sand fences are usually designed as follows:

- 2 to 4 feet high. Sand fencing located windward of the crest of the primary dune
- It shall be designed and installed as follows, a maximum of ten (10) foot long spurs of sand fencing spaced at a minimum of seven (7) feet on a diagonal alignment (facing the predominate wind direction)

Vegetative Covering

Planting local vegetation along the highways can be the only method which can be applied. The local plant species should have good foliage cover and low water consumption.

The development or degradation of plant communities on sand dunes are encountered in the Thar desert in various stages³².

- Initially, a largescale coverage by *Crotalaria*, *Aerva* and *Cypenls sps.* brings about the stabilization of sand .
- This makes the substratum more suitable for succession of under shrubs, shrubs

³² Sand Dune Stabilization in the Thar Desert of India: A Synthesis R.N. Kaul: <http://www.cazri.res.in/annals/1996/1996S-4.pdf>

and perennial grasses, e.g., *Sericostemma pauciflorum*, *Leptadenia pyrotechnica*, *Clerodendron phlomoides*, *Calligonum polygonoides*, *Calotropis procera*, *Panicum turgidum*, *P. antidotale*, *Lasiacis sindensis* and *Cenchrus ciliaris*.

- Subsequent stabilization and undisturbed conditions bring about *Acacia jacquemontii*, *Lycium barbarum*, *Balanites aegyptiaca* and *Mesquite emarginata*. The last three species form the penultimate stage for the climax community of *Prosopis cineraria*.

Guidance Note 3: Forest and Other Natural Habitats

General Principle

This guideline envisages measures to be undertaken during blacktopping / widening of road sections passing through natural habitats³³ which are not protected under the provisions of the Forest Conservation Act 1982 or are part of the Eco-Sensitive Zone of any Wildlife Sanctuary or have any conservation status e.g. The Ramsar Convention. These measures suggested in the guidance shall be considered as the bare minimum and any measure suggested by stakeholders regulatory or otherwise shall be undertaken in addition to the measures laid down in the guidelines.

Issues

Development of road through/ along natural habitat can cause fragmentation of habitats, Reduction in species diversity and result in the deterioration of the habitat quality. In case of road either restricting the water-body or causing water logging due to poorly designed drainage can result in Algal bloom and pollution

Legislations & Standards

For natural Habitats which have been provided protection status under the Forest Conservation Act 1980 or Wildlife Protection Act 1972 the procedure stipulated in the said act shall be followed. All activities of the road constructions would be governed by the procedures laid down in the act. This guidance note shall only be implemented in conjunction with such acts.

Detailed Guidance

Project Planning and Design

The alignment shall avoid all legally protected forest areas i.e. National Parks, Wildlife Sanctuaries, Reserve Forest and Protected Forest.

The alignment shall be routed through natural habitats (Gochars, wetlands, mandir vans (dev vans) or banis, Kakad bani, Orans, Kesar chhanta, Radi, stream) only when there are no other alternatives which can be feasible.

To minimize the adverse impact on the ecology of the natural habitats, selection of alignment should be carried out so that these minimise the impacts on such natural habitats. An ecologist has to be deputed for carrying out a detailed inventory of ecological features along the road. The nature and type of impact on natural habitats due to road construction shall be identified. Magnitude of the impact to the extent feasible on the ecological features shall also be assessed. The views of the Forest Department shall also be considered during the assessment and preparation of the mitigation measures.

Box 0-1: Issues which need to be assessed during the ecological assessment

- | |
|--|
| <ul style="list-style-type: none">• Area of diversion of Natural Habitat• Number and Species of trees which need to be felled |
|--|

³³ Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. (IFC Performance Standard 6)

- Migration of animal or birds (if any)
- Animal Crossing (locations, time of the day)
- Breeding, spawning season
- Nesting Season (in case of avian species)
- Loss of breeding ground
- Chances of pollution of the water either due to the construction activity of operation

Impacts identified on the natural habitats shall be minimized to the extent required through modification of the design and relaxations in geometrics mentioned in the IRC Guidelines. In case the minimisation is not possible the appropriate mitigation measures would be designed.

- Constricting the road width, embankment height etc shall be carried out as per the relaxation available in the IRC Codes To the extent possible encroachment on the natural habitat, felling of trees shall be avoided.
- Drainage Structures shall be designed strictly in accordance with guideline on Guidance Note 4: Drainage & Water Bodies.
- Rumble strips shall be provided at every kilometre along the length of the natural habitat and invariably at the start and end of the natural habitat
- Signage (viz. speed limit, animal crossing, switch of headlight etc) shall be provided as per IRC: 67- 2001 Code of Practice for road sign (first revision).
- Display boards (as per IRC 30 - 1968 - Numerals of Different Height for Use on Highway Signs and IRC 67 - 2012: Code practice for Road Signs) should be placed ahead of the stretch to warn drivers of the approaching wildlife crossing areas

In addition to the above measures, specific mitigation measures suggested for the site by the Forest Department shall be implemented.

In case proposed alignment falls within the catchments of a water body or a stream, a flush causeway shall be constructed without impacting the drainage system. The length of the causeway shall be as per the existing water spread. The causeway shall be strictly in compliance with IRC: SP-84:2009 (four-lane highways), IRC SP 73 :2007 (two lane highways) . In no circumstances a water body within the natural habitat shall be cut across or filled for laying the road.

Underpasses: well-designed tunnels, culverts, pipes, and other structures can function as underpasses below roads and bridges, for a wide-range of terrestrial and aquatic species, especially frogs, turtles, fish etc shall be included in the design to facilitate the crossing over of the wildlife. Detailed guidance on this is provided in Guidance Note 4: Wildlife Management.

In case of roadside plantation design efforts must be made to ensure that the minimum number of mature trees are felled.

Pre-Construction Period

No Construction Camps, Stockyards, Concrete Batching or Hot Mix Plants shall be located within the natural habitat or within 500m from its boundary.

Contractor in consultation with Ranger of the local area or any other concerned authority shall prepare a schedule of construction within the natural habitat. All construction in protected areas shall

only be carried out after the required statutory clearances have been obtained. Due consideration shall be given to the time of migration, time of crossing, breeding habits and any other special phenomena taking place in the area for the concerned flora or fauna.

Contractor must ensure that there will be no parking of vehicles machine and equipment within the natural habitat.

The contractor shall also ensure that the construction material or debris stored at any locations is not carried by elements of nature into the natural habitats. Storage of any material near or within the natural habitat is also prohibited. Disposal of construction waste within the natural habitat shall be strictly prohibited

Procurement of any kind of construction material (as quarry or borrow material) from within the natural habitat shall be strictly prohibited. No water resources within the natural habitat shall be tapped for road construction. Use of mechanized equipment shall be kept minimum within the natural habitat.

Feasibility of the transplantation of the trees should be worked out.

Operation phase

Compensatory tree plantation within the available Right of Way shall be done as per the existing rules or as directed by the forest department

Procurement of any kind of construction material (as quarry or borrow material) from within the natural habitat shall be strictly prohibited. No water resources within the natural habitat shall be tapped for road construction. Use of mechanized equipment shall be kept minimum within the natural habitat.

Storage of any material near or within the natural habitat is also prohibited.

Disposal of construction waste from resurfacing within the natural habitat shall be strictly prohibited

Signages as indicated in the mitigation measures shall be implemented.

The contractor shall also ensure that the construction material or debris stored at any locations is not carried by elements of nature into the natural habitats

Guidance Note 4: Wildlife Management

General Principle

This guidance will be used for planning, operations and maintenance, and monitoring wildlife, ecological systems with respect to transportation systems. The Practices described in this guide should be included in the evaluation, design, construction, operations, maintenance, and monitoring of transportation projects and facilities

Issues

Wildlife need to move. Ecosystems need interactions to be resilient. Highway systems must prevent wildlife- vehicle collisions. Also, the planning and designing of the highways need to ensure that the entire, interacting ecosystems bisected by roads and highways.

Legislations & Standards

Within the protected area the highways must ensure compliance to The Wildlife (Protection) Act, 1972, however with the Eco-Sensitive Zone of Wildlife Sanctuaries compliance the gazette notification of the respective sanctuaries must be ensured.

For Wildlife located outside these areas the provisions of these guidance notes would be used for planning, designing, construction, operations of the highway

Detailed Guidance

Planning during the Design

During the design stage specific wildlife studies should be conducted to:

- Identify species and species movement groups in the region of the project corridors to ensure that the project do not impede the wildlife movement.
- Identify segments of highway where collisions with many species, or certain species, has been measured to be significantly greater than other areas.
- Identify segments of highway wildlife movement/collision may not be apparent, but wildlife is present on either side of rights-of-way.

Action during the Pre-Construction Period

- Establish working partnerships with state wildlife board, local bodies, and community conservation organizations to establish the veracity of the wildlife corridors;
- Focus on existing structures. Maintain openings and enhance culverts and bridge-underpasses to facilitate wildlife movement;
- When designing or cross drainage structure or structural improvement
 - identify the co-benefits that can be achieved for wildlife movement through simple and inexpensive design features e.g. larger passages, vegetation maintenance, and more frequent structures.
 - make sure the structure provides light and line-of-sight to encourage wildlife passage.
 - Placement and size of new wildlife crossings should be tied to information

about the adequacy of existing structures in providing opportunistic wildlife crossing.

- The placement, frequency and size of wildlife crossing are closely tied together. Crossings for smaller animals are needed at more frequent intervals along highways than for larger animals; similarly, smaller animals need more accessible and smaller structures than larger animals.
- The wildlife crossing structures should usually be accompanied by fencing that directs animals to the structure to be effective.
- Associated fencing (through the vegetative fencing, berms) should be created to maintain effectiveness of the wildlife corridor.
- Wildlife should be able to see the other end of a crossing structure for it to be generally effective. For very long crossings (> 10 m), lighting at mid-way will tend to improve wildlife passage.
- In addition, the following measures would be taken:
 - Reflectors should be installed along the highway in these areas to prevent wildlife from approaching the road
 - Display boards (as per IRC 30 - 1968 - Numerals of Different Height for Use on Highway Signs and IRC 67 - 2012: Code practice for Road Signs) should be placed ahead of the stretch to warn drivers of the approaching wildlife crossing areas
- No Construction Camps, Stockyards, Concrete Batching or Hot Mix Plants shall be located within the natural habitat or within 500m from the boundary of such wildlife habitats,
- Contractor in consultation with forest ranger or any other concerned officials prepare a schedule of construction considering the time of migration, time of crossing, breeding habits and any other special phenomena taking place in the area for the concerned fauna.

During the Construction phase

- During the construction areas which have proven wildlife movement temporary woven wire mesh guards of about 2.4 m (8 ft.) high will be put around the excavated areas to prevent small wild animal from falling.
- No harm would be done to the animal if they are trapped in the excavated area. The contractor in association with Employer and Forest Department would ensure safe release of the animal.

During the Operation Phases

- Signs warning of wildlife crossing should include flashing lights and be periodically moved to garner attention.
- Establish a long-term program to educate existing and new drivers about the importance of watching out for wildlife and reducing speed in wildlife movement areas.

Guidance Note 5: Drainage and Water bodies

General Principle

Water bodies and drainage channels may be impacted when the road construction is adjacent to it or the runoff to the water body is affected by change of drainage pattern due to construction of embankment. Drainage is designed on roads to direct surface or subsurface flow away from structural elements of a roadway and then to convey it to a safe outfall without damage to the road structure, adjoining property or agricultural fields

In the state since water resources are scarce, water retaining structure have greater significance. The water retaining structures can be in the form of ponds, wells etc.

Issues

The following activities are likely to have an adverse impact on the drainage and water bodies of the area:

- Clearing and grubbing
- Earthwork
- Vehicle/Machine operation and maintenance
- Handling and laying of asphalt and
- Waste disposal from construction camps

Inadequate and faulty drainage arrangements result in obstruction to natural drainage pattern. The problem is further aggravated in the low-lying areas and flood plains receiving high intensity rainfall, which can lead to the instability of embankment, damage to pavement, sinking of foundation, soil erosion, safety hazards and disruption in traffic.

Any encroachment on the water retaining structures or contamination of the water would also have impact on the water resources. Construction near water bodies may also impact on the catchment area of the water body, drainage system, flood level and water logging and can increase or decrease the runoff. The flora and fauna dependent on the water body would also be affected.

Legislations & Standards

The Rajasthan Lakes (Protection and Development) Authority Act, 2015 makes provisions for protection of lakes except for private properties located in such lakes. The Act empowers the state to declare the boundaries of the lake and the area around the lake as a protected area. However, construction can be undertaken in the protected area after obtaining prior permission of the Authority constituted under the Act

Similarly, wetlands are protected by the Wetland (Conservation and Management) Rules, 2016 The rules prohibit encroachment or construction activities within the wetland. The construction of roads near the wetland areas would need to ensure that it does not encroach into the area of the wetland denoted by the State Wetland Authority

Detailed Guidance

During the Design Phase

A profile of the water bodies, and cross-drainage structures should be carried out. All drains, water bodies either crossing or adjacent to the alignment shall be identified on site and marked on map. The hydrology of the area is to be studied before finalizing the alignment. While undertaking reconnaissance visits basic information on the width of channel, frequency of traffic holdup and flow would provide inputs into screening of alternate alignments as well as fixing the alignment.

Consultations with the community shall provide information on the HFL in the area channels of movement of water. Additionally, sections along the alignment prone to flooding or scouring should be identified. In such sections, additional hydrological studies will need to be conducted and designs updated accordingly.

Planning during the Pre-Construction

- All efforts are to be taken to avoid the alignments passing adjacent or close to water bodies. Where possible, it should be realigned away from the water body without cutting its embankment, decreasing the storage area or impairing the catchment area. Adequate drainage arrangements as per IRC SP 42 - 2004 “Guidelines of Road Drainage” must be provided.
- In areas of high and medium intensity rainfall (>400 mm/year), flood prone areas and hilly areas design of CD structures shall be prepared to avoid scouring on the downstream side and afflux on the upstream side. In areas where the Detailed Surveys should identify likely incidences of flooding/scouring, additional hydrological studies will need to be conducted and designs updated accordingly. For bridges and other drainage structures the studies shall be conducted as per IRC SP 42 - 2004 “Guidelines of Road Drainage”, IRC: SP-13: 1973 “Guidelines for the Design of Small Bridges & Culverts” and IRC: SP-33:1989 “Design of cross-drainage structures”.
- While planning of the road and scheduling of the activities the Contractor shall assess the uses of the water bodies along the alignment. During the design efforts should be made to ensure that the water bodies are not encroached, or the local community is not restricted from using it during the construction. However, if the interruption to regular activities of villagers near water body due to construction or rehabilitation work is anticipated, the Contractor’s should:
 - Intimate the community in advance about the restriction on use of water during construction,
 - Provide alternate access to the water body in case there is interruption to use of exiting access. The access provided should be convenient for use of all the existing users whether community or cattle;
 - If the water body affected is a drinking water source for a habitation, alternate sources of water are to be provided to the users during the period for which its use is affected.
- The Design of cross drainage structure shall be such that:
 - Normal alignment of the road is followed even if it results in a skew construction of culverts. In such cases the stream bank protection shall be incorporated in the design;
 - Afflux generated is limited to 45 cm in plains with flat land slopes as it

may cause flooding of upstream areas

- The opening in the Cross drainage should be adequate along with adequate scour protection measures for stream bank, roadway fill as head walls, wing walls and aprons as per provisions of IRC guidelines.
- The opening should be sufficient to act as a wildlife passage as mentioned in Guidance Note 10: Wildlife Management
- Reinforced road bed (of concrete or rock) for protection against overflow in case of low water crossing (fords/causeways) is included
- Schedule of construction of C-D structures should preferably be carried out during dry months to avoid contamination of streams.
- Longitudinal drains are to be designed to drain runoff from highest anticipated rainfall as per IRC: SP-13: 1998, “Guidelines for the Design of Small Bridges and Culverts”
- In case of up-gradation of the existing CD Structures, temporary route / traffic control shall be made for the safe passage of the traffic, depending upon the nature of the stream and volume of traffic.
- In case of utilization of water from the stream, for the construction of the CD structures, the contractor must take the consent from the concerned department (refer ECoP-8.0, “Water for Construction”).

During the Construction Period

- All the safety/warning signs are to be installed by the contractor before start of construction either at the drainage structure or near a water body;
- Erosion and sediment control measures suggested in Guidance Notes 2: Slope Stability. Erosion control measures should be implemented if site conditions so warrant, prior to the start of the civil works;
- It should be ensured by the contractor that the runoff from construction site entering the water body is generally free from sediments. In case run-off from construction site or water is pumped from the excavation during construction the same should be passed through a sedimentation tank before it is discharged into any waterbody.
- In case of water scarce area the formation water from the excavation should not be drained out into a natural channel but should be stored for use in construction activities.
- Silt/sediment should be collected and stockpiled for possible reuse as surfacing of slopes where they must be re-vegetated.
- Interceptor drains to be dug prior to slope cutting to avoid high runoff from slopes entering construction sites in case of hill roads.
- Runoff from temporary drains and interceptor drains to be directed into natural drainage system in hill roads
- In hill areas sub-surface drains, if required, shall be provided immediately after cutting the slopes and forming the roadbed (sub grade).
- No debris shall be disposal into water bodies or drainage channels. In case any debris is disposed in the channel or water body or areas adjoining to it

the same shall be removed before the onset of monsoon.

- No oil/grease/other storage area (temporary / permanent) or waste storage area shall be constructed near the waterbody

Operations Phase

All debris, from construction, excavation, or temporary storage shall be removed before the contractor demobilises from the site

Before decommissioning the surrounding of the water body and drains must be left clean and tidy with the completion of construction. The Employer/Engineer will check if drainage channels of adequate capacity have been provided. The No-Objection Certificate would be provided once the Employer/Engineer is satisfied that the debris are removed.

During the operation phase all cross-drainage structure shall be maintained so that there is no accumulation of water or restriction to water flow.

During the operations it must be ensured that all the cross-drainage structures are operational so that no waterlogging takes place.

Guidance Note 6: Construction Camp Management

General Principle

During construction phase of the project, labourers would be required for various jobs. These labours would be hired through authorised manpower agencies. For skilled jobs the labours would be employed from outside the region. These migrant labour would be provided accommodation in the construction camps. .

Issues

The influx of migrant labour will have both negative and positive impacts on the nearby community and local environment. The labour will be accommodated in temporary campsite within the project boundary which can have significant interface with the nearby community. However, the influx of migrant workers would lead to a transient increase of population in the immediate vicinity of the project area for a limited time. This would put pressure on the local resources such as roads, fuel wood, water etc. Some local economic benefits is also envisaged due to the purchase of ration for these people from the local markets.

Legislations & Standards

There are no specific legislations or guidance on the labour camps or the living condition in the labour camps. This guidance note shall be followed for aspects pertaining to the siting, development, management and restoration of construction and labour camps to avoid or mitigate impacts on the environment. The provisions stated in the guidance notes shall be considered as binding on the contractor.

The contractor shall also develop an understanding of the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, The Factories Act 1948. The provision of these act shall be used for the Environment Management at construction campsite.

Detailed Guidance

6.7.1 Pre-Construction

Site Identification

Identification of site for construction and labour camps is the first task. The Contractor shall identify the site for construction camp in consultation with the individual owners in case of private lands and the concerned department in case of Government lands. The guidance for selection of suitable sites is presented in Box -0-1

Box -0-1:Guidance on Site Suitability

<ul style="list-style-type: none">• Sites /land types to be avoided:• Lands close to habitations	<ul style="list-style-type: none">• Irrigated agricultural lands
<ul style="list-style-type: none">• Lands belonging to small farmers	<ul style="list-style-type: none">• Lands under village forests
<ul style="list-style-type: none">• Lands within 100m of community water bodies and water sources as	<ul style="list-style-type: none">• Lands supporting dense vegetation and Forest with/without

rivers	conservations status
<ul style="list-style-type: none"> • Low lying lands 	<ul style="list-style-type: none"> • Lands within 100m of watercourses
<ul style="list-style-type: none"> • Grazing lands and lands with or without tenure rights 	<ul style="list-style-type: none"> • Lands where there is no willingness of the landowner to permit its use
<ul style="list-style-type: none"> • 2km from Class A and above towns 	<ul style="list-style-type: none"> • 500m from any villages
<ul style="list-style-type: none"> • Community land ((Gochars, mandir vans (dev vans) or banis, Kakad bani Orans, Kesar chhanta, Radi) which is traditionally used as conservation areas • Land Types Preferred • Waste lands. • Waste Lands belonging to owners who look upon the temporary use as a source of income. • Community lands or government land not used for beneficial purposes. • Private non-irrigated lands where the owner is willing. • Lands with an existing access road. 	

Site Approval

On identification of the land the Contractor shall submit to PIU the following:

- Copy of the land records duly signed by the local revenue official
- Written No-objection certificate of the owner
- Extent of land required and duration of the use
- Photograph of the site in original condition
- Activities to be carried out in the site;
- Environmental mitigation measures to be undertaken to prevent land, air, water and noise pollution;
- Facilities which would be provided in the camp should also be provided on the layout map;
- Detailed layout plan for development of the construction and labour camp that shall indicate the various structures to be constructed in the camp including temporary, drainage and other facilities
- Proposal of site redevelopment after completion

The Employer through the Engineer may get a site visit organised for further assessment. The Employer shall provide the contractor a No-Objection Certificate within 15 days of the submission of all these documents. In case the Employer has not raised any objection within this time it shall be considered as a “Deemed Consent”.

Facility Planning

The Facilities which are to be provided in the camp are as follows:

Box 0-2:Facilites in Contractors Camps

- **Security:**

The contractor shall put in place the following security measures to ensure the safety of the workers. The following measures shall be incorporated:

- The contractor/sub-contractor shall provide Identity cards to all the employees/workers;
- Access to the campsite shall be limited to the residing workforce;
- The contractor shall be responsible for deploying adequate number of guards;
- Adequate, day-time night-time lighting shall be provided;
- The security personnel shall be provided with training to respect the community traditions and in dealing with, use of force etc.; and
- The rental accommodation shall be provided with firefighting equipment and portable fire extinguishers.

- **Provision of Drinking Water:**

Access to an adequate and convenient supply of free potable water is necessity for workers. The domestic water supply shall be made available by the contractor.

Safe drinking water conforming to the IS 10500:2012 for drinking water shall be provided;

Bottled Potable drinking water would be provided to all the employee/workers both at the worksite and at the construction camps;

Every water supply or storage shall be at a distance not less than 15m from any wastewater / sewage drain or other source of pollution. Water sources within 15m proximity of toilet, drain or any source of pollution will not be used for any consumption purpose in the project

The Contractor should regularly monitor (every quarter) the quality of drinking water available. In case of non-compliance with the Drinking Water Specifications, additional treatment shall be provided, or alternative sources of water supply shall be arranged; and

All tanks used for the storage of drinking water shall covered as to prevent water stored therein from becoming polluted or contaminated.

The tanks shall be cleaned at regular interval (minimum every 3 months) to ensure hygiene conditions are maintained.

- **Cooking Arrangement:**

The construction phase will involve engagement of large number of migrant people in the project area for a limited time. Hence, there shall be requirement of provision of cooking facilities (kitchen) as listed below:

The cooking area shall be separate from the Living quarters;

Places for food preparation are designed to permit good hygiene practices, including protection against contamination between and during food preparation;

The cooking area should be provided with water connections which is fit for consumption;

Adequate personal hygiene including designated areas for cleaning hands and cleaning of utensils; and

All kitchen floors, ceiling and wall surfaces adjacent to or above food preparation and cooking areas are built using durable, non-absorbent, easily cleanable, non-toxic materials;

Food preparation area to be durable, easily cleanable, non-corrosive surface made of non-toxic materials.

To ensure that the fuel need of labourers in the project area does not interfere with the local requirements, necessary arrangements for supply of cooking fuel to the labourers shall be done by the contractor. Clean fuels shall be used in no circumstance fuel wood shall be used for cooking or heating.

- **Washing and Bathing Facilities**

In every site, adequate and suitable facilities for washing clothes and utensils shall be provided and maintained for the use of contract labour employed therein. Separate and adequate bathing shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic conditions.

- **Toilets Facilities**

Sanitary arrangements, latrines and urinals shall be provided in every work place separately for male and female workers. The arrangements shall include:

A latrine for every 15 females or part thereof (where female workers are employed).

A latrine for every 10 males.

Every latrine shall be under cover and so partitioned as to secure privacy, and shall have a proper door and fastenings.

Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by most of the workers —” For Men Only” or —” For Women Only” as the case may be. Pictographic signages can also be used

The latrines and urinals shall be adequately lighted and shall be maintained in a clean sanitary condition at all times and should have a proper drainage system;

Water shall be provided in (preferably) or near the latrines and urinals by storage in suitable containers

- **Waste Water Generation:**

There will of generation of wastewater from the campsite. About 80% of water used shall be generated as sewage/wastewater. Contractor shall ensure that the campsite/s is/are equipped with:

Septic tank and soak pit for disposal of sewage or with mobile bio-toilets. The toilets and the septic tank and soak pit should not be located near any drinking water sources either within or outside the camp.

The storm water and sewage system should be separate. The surface water drainage shall include all necessary gutters, down pipes, gullies, traps, catch pits, manholes etc. An Oil water separator should be in the drains leading out of the maintenance area. Water passing out of the camp should be passed through a sedimentation tank of at-least 3hrs holding capacity.

Sanitary and toilet facilities are constructed of materials that are easily cleanable. Sanitary and toilet facilities are required to be cleaned frequently and kept in working condition.

- **Solid Waste Management:**

The solid waste generated from campsite will mostly comprise of compostable wastes like vegetable residues (kitchen waste) and combustible waste like paper, cans, plastic and some non-degradable waste like glass/glass bottles. Improper disposal of solid waste will lead to environmental degradation and health hazards to labour as well as nearby community. The following measures shall be adopted by contractors for ensuring effective management of solid waste:

- The solid wastes of domestic nature (especially food waste, waste from canteen) shall be collected and stored separately in appropriate containers with proper covers on them so that they are not littered;
- Separate bins with proper markings in terms of recyclable or non-recyclable waste shall be provided in the houses and kitchen premises in sufficient numbers for collection of garbage;
- Food waste and other refuse are to be removed from the kitchen frequently to avoid accumulation; and
- The contractor shall ensure that the all food waste generated is composed within the camp premises. All recyclables except for the waste which are covered by any other act/rules other than the Municipal Solid Waste Rules 2016.

- **Roads**

All the internal roads shall be paved. The concrete slurry from the batching plant shall be used for paving the roads

- **Medical Facility:**

Effective health management is necessary for preventing spread of communicable diseases among labour and within the adjoining community. The following medical facilities shall be provided by contractors for the construction workers: A first aid centre shall be provided for the labour within the construction site equipped with medicines and other basic facilities;

Adequate first aid kits shall be provided in the campsite in accessible place. The kit shall contain all type of medicines and dressing material;

Contractor shall identify and train an adequate number of workers to provide first aid during medical emergencies;

Regular health check-ups shall be carried out for the construction labourers every six month and health records shall be maintained;

Labours should have easy access to medical facilities and first aid; where possible, nurses should be available for female workers;

First Aid Box will be provided at every construction campsite and under the charge of a responsible person who shall always be readily available during working hours. He shall be adequately trained in administering first aid-treatment. Formal arrangement shall be prescribed to carry injured person or person suddenly taken ill to the nearest hospital. The first aid box shall contain the following.

small sterilized dressings

3 medium size sterilized dressings

3 large size sterilized dressings

<p>3 large sterilized burns dressings 1 (30 ml) bottle containing 2 % alcoholic solution of iodine 1 (30 ml) bottle containing Sal volatile 1 snakebite lancet 1 (30 gms) bottle of potassium permanganate crystals 1 pair scissors Ointment for burns A bottle of suitable surgical antiseptic solution</p> <p>In case, the number of labour exceeds 50, the items in the first aid box shall be doubled. All the vehicles and equipment shall be provided with a fir-aid box with all the above. The medicines should be regularly checked for the expiry of the medicines.</p> <p>Information and awareness of communicable diseases, AIDS etc. shall be provided to workers.</p> <p>Basic collective social/rest spaces are provided to workers.;</p> <ul style="list-style-type: none"> • Fire-fighting arrangement <p>The contractor shall carry out demarcation of area susceptible to fires and put in precautionary signages as specified in IS 9457</p> <p>Portable fire extinguishers and/or sand baskets shall be provided at easily accessible locations in the event of fire as per the provisions of IS 2190</p> <p>The contractor shall carry out fire safety drill every quarter and Workers shall be trained on the usage of such equipment/s</p>
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Operation of the Camp during the Construction Period

Construction camps shall be maintained free from litter and in hygienic condition. It should be kept free from spillage of oil, grease or bitumen. Any spillage should be cleaned immediately to avoid pollution of soil, water stored or adjacent water bodies. The following precautions need to be taken in construction camps:

- Wastewater shall not be disposed into water bodies.
- Measures shall be taken to ensure that no leaching of oil and grease into water bodies or underground water takes place.
- Regular collection and safe disposal of solid wastes shall be undertaken.
- All consumables such as the first aid equipment, cleaning equipment for maintaining hygiene and sanitation should be recouped promptly.

Inspection of camp sites

The Employer/Engineer will monitor every month the cleanliness of construction campsites and ensure that the sites are properly maintained throughout the period of the contract in an acceptable and appropriate standard by the contractor. The key areas are:

- Daily sweeping of rooms and houses and campsite shall be undertaken;
- Regular cleaning of sanitary facilities shall be undertaken;
- The kitchen and canteen premises shall be established under good hygiene conditions;
- Daily meal times shall be fixed for the labour;
- Smoking and alcohol consumption shall be prohibited in the workplace;
- Water logging shall be prevented at areas near the accommodation facilities and adequate drainage is to be provided; and
- Checklists pertaining to the daily housekeeping schedule shall be maintained and

displayed at houses, toilets and kitchen.

- Security staff should have a clear mandate and instructions about their duties and responsibilities such as not to harass, intimidate, discipline or discriminate against workers;
- No individual carrying proper identify card shall be allowed to enter the premises of the construction camp.
- The access should be only through the gates. Any breach in the fence or boundary wall shall be immediately repaired to prevent access through these areas;
- Contractor should ensure that workers and members of the surrounding communities have specific means to raise concerns about security arrangement and staff;

Grievance Redress Mechanism:

The Grievance Redress Mechanism (GRM) of the project shall be formulated for the construction labourers (local and migrant) comprising of a review committee including representatives elected by labour and management representatives. The grievance mechanism developed for the project to the contractor also by the RPWD. A documented GRM shall have the following elements:

- Proper system for lodging grievances;
- Provision for raising anonymous complaints;
- Appropriate level of management for addressing concerns;
- Workers and members of the surrounding communities have specific means to raise concerns about security arrangement and staff;
- Provision for timely action and feedback;
- Monitoring and review of grievances raised, and action taken; and scope for continual improvement of the system.

Decommissioning of the Camp

At the completion of construction, all construction camp facilities shall be dismantled and removed from the site. The site shall be restored to a condition in no way inferior to the condition prior to commencement of the works. Various activities to be carried out for site restoration include the following:

- Oil and fuel contaminated soil shall be removed and transported and disposed of as per the provisions of the Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016.
- Soak pits and septic tanks shall be emptied using a gully sucker and covered and effectively sealed off.
- The contractor shall execute all works to restore the site and clear land of all debris. The contractor shall hand over to the community/land owner or lesser in clean condition without any encumbrance. Documentation (including photographs and certificate signed by the land owner) for site hand-over shall be submitted by the contractor. The site verification and written approval of this hand-over process must be done by the PIU at the end of the construction period prior to settling of the final bill (payments pertaining to construction and not the maintenance period activities).

Tools

Checklist for Inspection of Construction Camps

Guidance Note 7: Construction Equipment and Machinery

General Principle

The construction activities would require equipment and machinery which would be used for the construction purpose. Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers piling rigs, vibro hammers, mobile elevation work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, tankers and bowsers, trailers, hydraulic and mechanical breakers etc.

Issues

The impact can be due to the gaseous emissions, dust, noise and oil spills that concern the safety and health of the workers, surrounding settlements and environment.

Legislations & Standards

The standards for emission and discharges mentioned in the Environment Protection Act 1986 and the rules published thereunder shall apply. The Hot Mix plant, DG sets and Crushers needs to obtain a CTE as well as a CTO from the Rajasthan State Pollution Control Board under The Air (Prevention and Control of Pollution) Act, 1981. The noise generated from the construction sites shall conform to the provisions of the Noise Pollution (Regulation and Control) Act, 2000 and its amendments.

Detailed Guidance

6.7.2 Planning during the Pre-Construction

Siting Criteria for Hot Mix Plants

Selection criteria for setting up a plant area (except for hot-mix plant) and parking lot for equipment and vehicles shall be done as per siting criteria for construction camp specified in Guideline on —Construction and Labour Camps. The Hot-mix plant and the other air polluting equipment shall be sited as per the following guidelines:

The Hot Mix plant should follow the siting criteria as under:

Table -0-1:Siting Criteria for Hot Mix Plants

Sl. No	Distance from	Distance
1	Class A and above town and cities limit	2 Km
2	Other towns	1 Km
3	Village	500 meters
4	Wild Life Sanctuary zone declared for the same	5 Km or buffer
5	National Highway (From centre line)	200 meters *
6	State highway (From centre line)	200 meters *
7	Educational institute/ religious places	500 meters

Air Control Measures in Hot Mix Plants

- Adequate dust control system such as dry and wet scrubber for the Dryer and

mixer shall be provided.

- Hot Mix plant must have adequate stack height (at least 6 meter) for the discharge of its scrubbed flue gases
- Conveyor belts shall be fully covered from top and sides.
- The plant shall use only approved fuel such as diesel, LDO. In no case unauthorized fuel such as solvents, industrial waste shall be used.

Safe worthiness certificate

Every construction equipment which shall be procured shall be in sound mechanical working condition undertaken in the past. The contractor shall certify to the PIU that the equipment was not involved in any accident and shall also certify that safety parameters for the critical components and devices are in working condition and within manufacturer's specifications.

Reverse Horns:

All Vehicles procured for the project shall be fitted with audible reverse alarms and maintained in good working conditions.

Pollution control equipment

- The Contractor shall use construction equipment designed and equipped to minimize or control air pollution. The Contractor shall maintain evidence of such design and equipment and make these available for inspection by Employer.
- DG sets which meet the CPCB stipulated standards and have obtained the COP (Conformity of Product Verification) certification shall be procured.

6.7.3 Operation of the Camp during the Construction Period

Emissions

The air pollution during the construction activity can be from the following sources:

Material/ Debris Stockpile

The emissions from the material stock is primarily fugitive in nature. Small friable particles are usually carried out by strong winds causing dust pollution. The precautions which should be taken are as follows:

- The friable material like sand, GSB and soil should be stockpiled only against a wind break. Considering predominant wind direction, wind breaking wall shall be constructed. The walls of any store or any other building can be used as a wind break provided it is perpendicular to the direction of the prevailing wind. Windbreak walls that are at least six times longer than its height;
- The surface of the material shall be wetted at all time. However, if the wetting is not possible the surface shall be covered with tarpaulin sheets.
- The Contractor shall promptly transport all excavation disposal materials (non-hazardous) so as not cause pollution to the neighbouring areas. Stockpiling of materials will only be allowed at identified by the Contractor as per the site selection criteria and approved by the Employer.

Vehicular Movement

Dust generation also occurs during vehicular movement for transport of construction material. The following measures shall be adopted:

- The construction material shall not be carried above the tailboard of the vehicle. The tail board shall be properly closed and sealed to be spill proof,
- Fine Materials (soil, sand, GSB and cement) shall be Covered by Tarpaulin during transportation
- The speed of the truck shall not exceed 15 kmph on unpaved roads
- In regions which are water scarce water sprinkling shall only be carried out in settlement areas;
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high- pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. In Water Scarce areas the wheel washing facility is not recommended.
- All vehicle should have valid “Pollution Under Control Certificates”
- All vehicle used in the project should be maintained as per the manufacturer’s guidance. The Contractor/Subcontractor shall maintain a log of the maintenance operations;
- The vehicle carrying the construction material shall not be overloaded

Crushers

The dust generated at the crushers during Crushing, Screening, Conveyor transfer points, and stockpiling;

- The crushers should be provided with wet suppression system at the crushing screening and conveying transfer points.
- Minimize drop heights to storage piles;
- In case of areas where there is scarcity of water, dry collection system can be employed. A dry collection system involves hooding or enclosing dust producing points and exhausting emissions to a collection device. Completely enclosing process equipment is another very effective technique;
- The wet dust suppression and dry collection techniques can also be used in combination to control particulate emissions from stone crushers. The wet suppression is generally used to control emissions at the primary crushing stage and at subsequent screens, transfer points and crusher feeds. The dry collection is generally used to control emissions from the remaining points such as secondary and tertiary crusher discharges where new dry-stone surfaces and fine particulates are formed

Concrete Mix Plant

- The Cement and admixture handling shall be done in closed area and preferably through pneumatic systems.
- The sand and aggregate stored in bins shall be kept in wetted conditions
- The loading and unloading of the cement shall not be done in preferably covered

area

Hot Mix Plants

- Hot Mix plant must have adequate stack height (at least 6 meter) for the discharge of its scrubbed flue gases
- The conveyor belts shall be fully covered from top and sides. Any break/ opening in the conveyor belt or the covers shall be immediately covered.
- All roads/ vehicle movement areas at the site of Hot Mix Plant shall have be pucca/ stabilized with stone aggregated.
- Regular cleaning of the scrubbers and bag filters shall be carried out;
- Only approved fuel such as diesel, LDO shall be used. In no case unauthorized fuel such as solvents, industrial waste shall be used.

Generators

- Only Generator sets which are compliant to the CPCB guidelines on emission from DG sets should be installed. Single cylinder engines or engines which have not received COP Certificate from CPCB would not be allowed for any work or location in the project area.
- The DG sets shall be regularly maintained as per the manufacturer's specification. The Contractor shall maintain a log of the maintenance which can be audited by the Engineer/Employer if required;

In addition to the remedial measures listed above, the Contractor shall inspect and review all dust sources that may be contributing to air pollution. Remedial measures include use of additional/ alternative equipment by the Contractor or maintenance/ modification of existing equipment of the Contractor. If approved remedial measures are not being implemented and serious impacts persist, the Employer may direct the Contractor to suspend work until the measures are implemented, as required under the Contract.

Water Pollution Prevention

Construction Site

- Runoff from the construction site shall not be allowed to flow outside the camp unless it has passed through the settling tank providing adequate residence time
- No domestic waste water (sewage and kitchen waste water) shall be allowed to flow outside the camp.
- The Contractor shall provide adequate precautions to ensure that no spoil or debris of any kind is pushed, washed, falls or deposited on land adjacent to the site perimeter including public roads or existing stream courses and drains within or adjacent to the site. In the event of any spoil or debris from construction works being deposited or any silt washed down to any area, then all such spoil, debris or material and silt shall be immediately removed, and the affected land and areas restored to their natural state by the Contractor to the satisfaction of the Employer at his own cost.
- The Contractor shall take measures to prevent discharge of oil and grease during spillage from reaching drainage system or any water body. As indicated above

the oil removal/interceptors shall be provided to treat oil waste from workshop areas etc.

Excavation works

- The Contractor must comply with the requirements of the Central Ground Water Board for discharge of water arising from dewatering. Any water obtained from dewatering systems installed in the works must be used for construction purposes. This water may subsequently be discharged to the drainage system or, if not used, recharged to the ground water at suitable aquifer levels after obtaining required permissions.
- During dewatering, the contractor shall monitor ground water levels from wells to ensure that draw down levels do not exceed allowable limits. The Contractor will not be permitted to directly discharge, to the drainage system, unused ground water obtained from the excavation without obtaining approval of Employer or the Agency controlling the system.
- The Contractor shall ensure that earth, bentonite, chemicals and concrete agitator/mixer washings etc. are not deposited in the watercourses but are suitably collected and residue disposed of in a manner approved by Rajasthan State Pollution Control Boards or the Engineer/Employer.
- Any mud slurry from drilling, diaphragm wall construction or grouting etc. shall not be discharged into the drainage system unless treatment is carried out that will remove silt, mud particles, bentonite etc. The Contractor shall provide treatment facilities as necessary to prevent the discharge of contaminated ground water to the discharge standards specified by CPCB.

Batching Plant

- The batching plant and the concrete-mixer wash water shall be collected in a tank and the concrete slurry shall be used for the paving of the roads.
- The batching plant wash water can be reused for curing of concrete

Noise

Noise shall be generated from the DG sets and other construction works. The following measures would be taken:

- The Contractor shall construct acoustic screens or enclosures around any parts of the works from which excessive noise may be generated.
- The contractor shall, at his own expense, take all appropriate measures to ensure that work carried out by the Contractor and by his sub-contractors, whether on or off the Site, will not cause any unnecessary or excessive noise which may disturb the occupants of any nearby dwellings, schools, hospitals or premises with similar sensitivity to noise
- Diesel Generator sets which conform to the CPCB standards for Noise³⁴; and

³⁴ Noise Limit For Generator Sets Run With Diesel Were Notified By Environment (Protection) Second Amendment Rules Vide GSR 371(E), Dated 17th May 2002 At Serial No.94 And Its Amendments Vide GSR No 520(E) Dated 1st July 2003; GSR 448(E), Dated 12th July 2004; GSR 315(E) Dated 16th May 2005; GSR
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have obtained the COP certificate shall only be used for the project.

Wastes

The Contractor shall identify and shall keep inventory of different type of hazardous waste generated from its operation;

Box -0-1:Hazardous waste Likely from the Operations

-
- Used oil and waste oil
 - Empty barrels/containers contaminated with hazardous chemicals /wastes
 - Contaminated cotton rags or other cleaning materials
-

Source: Schedule I, Schedule III and IV of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

- The Contractor shall obtain authorization for generation and storage of hazardous waste from RSPCB. For this authorization, the contractor shall make an application to RSPCB in Form 1 (Appendix 4) as prescribed in the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. In case of renewal, the Contractor shall make the application to RSPCB in Form 1 (Appendix 4) along with conditions specified in the authorisation for hazardous waste.
- For storing of hazardous waste, following process would be adopted in the project:
 - The storage area should be provided with concrete floor;
 - The storage area floor should be provided with secondary containment;
 - Proper slopes as well as collection pit to be provided in the storage area to collect wash water and the leakages/spills etc.;
 - Storage area should be provided with the flameproof electrical fittings;
 - Automatic smoke, heat detection system should be provided in the sheds;
 - Adequate firefighting systems (ABC type fire extinguisher) should be provided for the storage area; and
 - The Storage area shall be designed in such a way that the floor level is at least 150 mm above the maximum flood level.
- In case of leakage/spills, following procedure should be followed:
 - At the foremost, to try and eliminate the source of the spill by adopting any of the following measures e.g. i) up-righting drums or other containers, ii) closing valves, or other similar actions;
 - Prevent the oil from spreading or entering drains by absorbing flowing oil or diking the area with sand bags, jute/cotton mats, or berms;
 - Spread absorbent material e.g., sawdust over the surface of the spill from

464(E) Dated 7th August 2006; GSR 566(E) Dated 29th August 2007 And GSR 752(E) Dated 24th October 2008; G.S.R. 215 (E), Dated 15th March, 2011 Under The Environment (Protection) Act, 1986; <http://cpcb.nic.in/displaypdf.php?id=Tm9pc2VfYW5kX0dlbnNldHMvbm9pc2VsaW1pdF9kaWVzZWdlbnNldC5wZGY=>

- the perimeter of the spill to its centre; and
- Contaminated absorbents containing diesel fuel etc., shall be stored in drums and disposed of as hazardous waste.

The Contractor shall maintain a record of hazardous waste in Form 3 of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and prepare and submit an annual return containing the details specified in Form 4 (Appendix 6) in this rule to the RSPCB, on or before the 30th day of June following the financial year to which that return relates.

The Contractor shall make an agreement with authorised common Hazardous and Other Waste Treatment Storage and Disposal Facility (TSDF) and handover hazardous waste to that TSDF, on or before 90 days last date of disposal or accumulated quantity of 10 ton whichever is earlier.

The Contractor shall provide the transporter of the hazardous waste with the relevant information e.g., nature of the wastes and measures to be taken in case of an emergency, in Form 9 and shall label the hazardous and other wastes containers as per Form 8.

While sending hazardous waste, the Contractor shall prepare and sign seven copies of the manifest in Form 10 comprising of colour code as indicated in box below:

Box 0-2: Colour code of Manifests to generated /maintained

-
- **Copy 1 (White)** To be forwarded by the sender (Contractor) to the State Pollution Control Board (RSPCB) after signing all the seven copies.
 - **Copy 2 (Yellow)** To be retained by the sender (Contractor) after taking signature on it from the transporter and the rest of the five signed copies to be carried by the transporter.
 - **Copy 3 (Pink)** To be retained by the receiver (actual user or treatment storage and disposal facility operator) after receiving the waste and the remaining four copies are to be duly signed by the receiver.
 - **Copy 4 (Orange)** To be handed over to the transporter by the receiver after accepting waste.
 - **Copy 5 (Green)** To be sent by the receiver to the State Pollution Control Board.
 - **Copy 6 (Blue)** To be sent by the receiver to the sender.
 - **Copy 7 (Grey)** To be sent by the receiver to the State Pollution Control Board of the sender in case the sender is in another State.
-

- When an accident occurs at the Construction Camp during handling of hazardous wastes, the contractor shall immediately intimate the RSPCB through telephone, e-mail about the accident and subsequently send a report in Form 11 of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- The Contractor shall maintain a register to record all accident /incident during handling hazardous waste.
- All the workers involved in handling hazardous waste should be equipped with personnel protective equipment (gloves and boots).

Inspection

The Employer /Engineer shall carry out periodic inspections to ensure that all the pollution control systems are appropriately installed and comply with existing emission and noise norms. The maintenance log of the equipment and vehicle maintained by the contractor shall also be verified during the inspection

6.7.4 Decommissioning of the Camp

- For decommissioning of a site or camp the following activities are essential:
- All waste or debris or construction before the decommissioning is carried out. The detailed procedure for management of waste and debris is presented in Guidance Note 11: Waste management and Debris Disposal.
- In case any haul road is damaged while transporting construction material or wastes, the contractor shall restore the road to its original condition. All temporary structures which have been developed for the purpose of construction would be dismantled unless otherwise given in writing by the Owner.
- The extraneous material which has been brought from outside shall be cleaned off so that the site can be restored back unless otherwise given in writing by the Owner. After the site has been restored the topsoil shall be re-laid so that the site can be reused;
- On successful completion of all these activities and the inspection of the Employer / Engineer the No Objection Certificate shall be issued

Guidance Note 8: Borrow Area Management

General Principle

Embankment fill material is to be procured from borrow areas designated for the purpose. The scope of this guideline is to include measures that are required during Feasibility Stage, design stage and pre-construction, construction stage and post construction stage. Borrow areas are related only to road construction activities. These guidelines would be in addition to the regulatory compliance requirements.

Issues

Borrow areas can cause significant adverse environmental impacts if appropriate mitigation measures are not taken. All ill designed borrow area would not only result in the loss of topsoil and agricultural land but can also alter surface flows, increase erosions of the soil and also pose safety risk to structure located adjacent the borrow area.

Legislations & Standards

The borrowing of soil has been considered as a minor mineral as per the provision of The Rajasthan Minor Mineral Concession Rules, 2017. Minor Minerals are included as an activity in the Schedule 1 of the EIA Notification 2006. This would thus require a prior environmental clearance under the EIA Notification 2006.

Detailed Guidance

6.7.5 Planning during the Feasibility Phase

Borrow area siting should be in compliance with IRC: 10-1961. The Feasibility Report shall contain (i) Guidelines for locating site of borrow areas and borrow material specifications. (ii) The arrangements to be worked out with the land owner/community for the site and (iii) Sample designs for redevelopment of borrow areas. Design optimisation must be carried out to reduce the quantity of material extracted and consequently decrease the borrow area requirement. Some of the measures are presented in Table 0-1.

Table 0-1: Generic Design Measures which can be used to reduce Borrow area requirement

• Measures:	Extent of reduction in earth requirement
Restriction of embankment height to 0.3-0.5 m in areas receiving annual rainfall less than 400mm or at locations where natural drainage is not obstructed and the finished level of the pavement is 0.6-0.8m above the adjoining ground	24%
Use of fly ash as an alternate fill material, within a radius of 300 km of Coal ³⁵ or Lignite ³⁶ based thermal power plant as per MoEFCC Notification, Part II, Section 3, Sub-section (ii), 2002, S.O. 1164(E)	15%

³⁵ Surtgarh Super Critical Thermal Power Plant located in Ganganagar district

³⁶ VS Lignite Power Plant, Barsingsar Thermal Power Station, Giral Lignite Power Plant are lignite based thermal power stations in Barmer District,

Industrial and quarry wastes will be utilized as fill material in embankments where suitable material is available.	Varies dependent upon the nature of material
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6.7.6 Preconstruction Stage

The contractor shall identify the borrow area locations in consultation with the individual owners in case of private lands and the concerned department in case of government lands, after assessing suitability of material. The contractor shall submit an application to the District Level Environmental Assessment Committee for Environmental Clearance with the required details. The Environmental clearance shall be submitted to the Employer before the borrowing operations can begin.

Borrowing are to be avoided in the following areas:

- Lands close to toe line of the existing or proposed road.
- Irrigated agricultural lands shall be avoided. (In case of necessity for borrowing from agricultural land, the topsoil shall be preserved in stockpiles. The subsequent Guidelines detail the conservation of topsoil.
- Grazing land or any community property e.g. Orans, Gochars etc.
- Lands within 0.8km of settlements.
- Environmental sensitive areas such as Reserve Forests, Protected Forests, Sanctuary, wetlands. distance of 1000 m should be maintained from such areas.
- Eco-sensitive areas around Mount Abu and Eco-Sensitive Zones of the Wild Life Sanctuaries
- Unstable side-hills.
- Water-bodies.
- Streams and seepage areas.
- Areas supporting rare plant/ animal species;

The Employer, Authority / Independent Engineer will have the right to stop work at any borrow location even after the required environmental clearance is received if it violates any of the above.

The Contractor shall ensure soft rock is not prominent within the proposed depth of excavation as it will render rehabilitation difficult. The following options for redevelopment of Borrow area might be considered in compliance to with MoRTH, clause 305.2.2.2.

Box 0-1: Options for Borrow Area redevelopment

<p>Borrow areas can be developed as:</p> <ul style="list-style-type: none"> • Ponds (various types) (e.g.: Drinking Water only; Washing and for other Domestic Chores; Only for Cattle; Mixed Uses etc.) (a large pond can be divided into two parts - each having a defined use) • Agricultural land • Water Recharging Zones (depending on the geology of the area) • Pastureland • Fish Ponds (pisciculture) • Plantation Zones
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- Recreational Zones (depending upon location, size, potential of the site, willingness of the local bodies to develop it)
- Wildlife Refuge and Drinking Area (applicable only in case of sensitive environs with appropriate planning and understanding including regulation of depth for safety of animals etc.)
- Waste disposal Sites (depending upon the location, distance from settlements, pollution risks, safety, associated environmental risks and hazards, regulations/ permissions of appropriate authority and other precautions e.g. HDPE Lining to prevent contamination of soil and groundwater)

The rehabilitation measures for the borrow areas shall be dependent on the following factors:

- Land use objectives and agreed post-borrowing activities with the owner of the land as per the agreement;
- Physical aspects (landform stability, erosion, re-establishment of drainage, geological profile);
- Biological aspects (species richness, plant density,) for areas of native re vegetation;
- Water quality and soil standards; and
- Public safety issues.

The method statement which can be adopted for different options is presented in the Appendix 1: Options for Rehabilitation of Borrow areas to the Guidance Notes

6.7.7 Operation of the Borrow Areas during the Construction Period

The Contractor will work out statutory requirement for borrowing with the land from the Department of Mining and Geology, Govt. of Rajasthan. The Contractor must also obtain the necessary environmental clearance as per the EIA Notification 2006.

The Contractor shall also work out an agreement for the borrowing of soil with the concerned land owner. The arrangements will include:

- commitment not to use the topsoil;
- redevelopment after completion of borrowing;
- Commercial terms and conditions as may be agreed between the two parties;

The contractor shall submit to the Employer/Engineer the following before beginning work on the borrow areas.

- Environmental Clearance Certificate of the borrow area
- Written No-objection certificate of the owner;
- Estimate extent of earth requires;
- Extent of land required and duration of the agreement;
- Photograph of the site in original condition; and
- Site redevelopment plan after completion.

The arrangements (except for the commercial terms and conditions) will be verified by the Employer/Engineer to enable redressal of grievances at a later stage of the project. The Employer/Engineer shall approve the borrow area with or without inspection of the site to verify the reclamation plan and its suitability with the contractor and landowner. The contractor shall commence borrowing soil only after the approval by the Employer/Engineer.

The depth of excavation should be decided based on natural ground level of the land and its surroundings, as well as based on the rehabilitation plan. In case of highland larger depths may be allowed but the final level of the borrowed land shall in no case be lower than the adjoining plots so that it gets water logged. In case higher depth of excavation is agreed by backfilling using unsuitable excavated soil (from roadway), in those cases filling should be adequately compacted except for topsoil, which must be spread on the top most layer (for at least 20m thick).

In case the borrow pit is on agricultural land, the depth of borrow pits shall not exceed 45 cm and may be dug out to a depth of not more than 30 cm after stripping the 15 cm top soil aside. In case of stripping and stockpiling of topsoil, provisions of Appendix 2: Topsoil Salvage, Storage and Replacement need to be followed.

The guidelines for location, depth, size and shape of the borrow areas are available in the following:

- Clause 305.2.2.2 of MoRTH specification for roads and bridge works of IRC;
- Guidelines for environmental impact assessment of highway projects, Indian Roads Congress, 1989: IRC: 104-1988);
- IRC: 10-1961-Recommended practice for borrow pits for road embankments constructed by manual operations, as revised in 1989;
- IRC SP: 58-2001 guideline for use of fly ash in road construction;
- Highways Sector EIA manual of MoEFCC, 2010 (http://envfor.nic.in/sites/default/files/highways-10_may_0.pdf);
- MoEFCC notification on utilisation of fly ash dated 25th March 2015 vide S.O. 1396 (E) mandating all road projects within a radial distance of 500 km to mandatorily use fly ash.

During the excavation the contractor must ensure that following database must be documented for each identified borrow areas that provide the basis of the redevelopment plan.

- Chainage along with offset distance;
- Area of the plot (Sq.);
- Geo-tagged Photograph of the borrow pit from all sides;
- Type of access/width/kutcha/pucca etc from the carriageway;
- Soil type;
- Slope/drainage characteristics;
- Water table of the area or identify from the nearest well, etc;
- Existing landuse, for example barren/agricultural/grazing land;
- Location/name/population of the nearest settlement from borrow area;
- Present usage of borrow area; and
- Community facility near borrow pit.

During the excavation of the borrow areas the Contractor should maintain the following precautions

Table 0-2: Mitigation Measures to be adopted in case of the Borrow Area excavation

Activity	Mitigation Measures
Access Road to Site	<ul style="list-style-type: none"> • Access road shall be used for hauling only after it is approved. In case of any of the infrastructure i.e. road or culvert is in poor conditions they may either be strengthened so that the conditions do not deteriorate after the activity is over • In case of Sensitive receptors on the access road e.g. school, hospitals flagman should be posted to control the traffic. These areas should also be maintained as a no-horn zone. The traffic movement should be planned to avoid the movement during the School timings.
Removal of natural vegetation	<ul style="list-style-type: none"> • The natural vegetation from the plot may be removed and stored separately. This may be used as a mulch to protect the topsoil heaps from wind erosion • No tree would be felled without the permission of the forest Department
Top Soil Preservation	<p>Before any excavation is carried out:</p> <ul style="list-style-type: none"> • In case of agricultural land, the topsoil (30 cm) shall be stripped and stored at corners of the plot. The topsoil shall be stored at location so that it is not disturbed during the process of excavation of the borrow area. Top soil should be reused / re-laid as per agreed plan.; • In case of riverside, borrow pit should be located not less than 15m from the toe of the bank, distance depending on the magnitude and duration of flood to be withstood. In no case shall borrow pit be within 1.5m from the Toe line of the proposed embankment. The topsoil shall however be stripped as indicated above <p>Subsoils and overburden may also need to be kept on site for future use in building final landforms or providing additional rooting medium over hard rock areas. However, subsoils and overburden materials are of lower value for revegetation than topsoil, and contamination of topsoil with these materials can reduce its value.</p>
Depth of Excavation	<ul style="list-style-type: none"> • For agricultural land, the total depth of excavation should be limited to 150cm including top 30 cm for top soil preservation; • For river side borrow area, the depth of excavation shall be regulated so that the inner edge of any borrow pit, should not be less than 15m from the toe of the

	<p>bank and bottom of the pit should not cut the imaginary line of 1:4 projected from the edge of the final section of the embankment. The distance may be increased depending on the magnitude and duration of flood to be withstood. In no case shall borrow pit be within 1.5m from the Toe line of the proposed embankment. To avoid any embankment slippage, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Engineer.</p> <ul style="list-style-type: none"> • For highland areas the depth of excavations may be increased but the final levels of the borrow area shall not be lower than the adjoining land top prevent the land from becoming a water- logged area
<p>Damage to Surrounding land and properties</p>	<p>Movement of man and machinery should be regulated to avoid damage to surrounding land. To prevent damages to adjacent properties,</p> <p>To prevent damages to adjacent properties, the Contractor shall ensure that an undisturbed buffer zone exists between the distributed borrow areas and adjacent land. Buffer zone shall be 3 m wide or equal to the depth of excavation whichever is greater.</p>
<p>Drainage Control</p>	<p>Most of the borrow work is likely to be carried out during the dry season. The contractor should ensure that the rehabilitation works is initiated at the onset of the monsoon.</p> <p>However, the Contractor shall maintain erosion and drainage control in the vicinity of all borrow pits and make sure that surface drains do not affect the adjacent land/ water body or future reclamation. In no case shall the topsoil be allowed to be washed away by the runoff. The protection measures mentioned in the “Guidance Notes 2: Slope Stability and Erosion Control” may be adopted. This needs to be rechecked by the Employer/Engineer.</p>
<p>Dust Suppression</p>	<ul style="list-style-type: none"> • Water should be sprayed on kutcha haul road twice a day or as may be required to avoid dust generation during transportation of material; Depending on moisture content, 0.5 to 1.5% water may be added to excavated soil before loading during dry weather to avoid fugitive dust emission. • However, in dry areas i.e. areas facing water scarcity the speed of the vehicle on Kutcha road may be controlled to 15 kmph to prevent re-entrainment of dust. • Consider the direction of prevailing winds when designing the work area, work faces and stockpile layouts to minimise dust nuisance • Loading of the excavated earth on to the tippers shall be done to minimise the dust

	<ul style="list-style-type: none"> • In case of extreme windy condition leading to dust emission stoppage of work may be considered.
Material transport	Material transport shall only be provided with tarpaulin cover
Decommissioning of Equipment	<ul style="list-style-type: none"> • All site should be cleaned of all contamination e.g. contamination from oil spillage. These contaminated areas should be scrapped and sent with the excavated material for use in embankment. • In case any adjoining area or property or area has become unstable the same shall be repaired before the decommissioning of the machinery • Any damage to road, culverts or any other common property shall be repaired immediately

6.7.8 Redevelopment of Borrow Areas

All reclamation shall begin within one month of decommissioning of borrow area, in accordance with the redevelopment plan. The site shall be inspected by the Employer/Engineer after implementation of the reclamation plan. Certificate of Completion of Reclamation is to be obtained by the Contractor from the landowner that —the land is restored to his satisfaction.

Inspection of the Redevelopment Works

Inspection needs to be carried out by the Employer/Engineer for overseeing the redevelopment of borrow areas as per the plan. The checklist for the inspection by the Employer/Engineer is given below (Box 0-2).

Box 0-2: Inspection Checkpoints for Borrow Area Operations

- Compliance of post-borrowing activities and land use with the restoration plan;
- Drainage measures taken for inflow and outflow in case borrow pit is developed as a detention pond;
- Levelling off the bottom of the borrow areas;
- In case the borrow area is on private property, the contractor shall procure written letter from landowner for satisfaction on rehabilitation. In case of no rehabilitation is desired by the landowner, the letter should include statement — “no responsibility of PWD or the contractor in the event of accident”.
- Condition of the reclaimed area in comparison with the pre-borrowing conditions.

Appendix 1: Options for Rehabilitation of Borrow Areas

6.7.9 Option I: Suitable in locations with high rainfall and productive areas

The sites which have relatively better rainfall is well suited for conversion to agricultural fields. The following process can be used for the rehabilitation of the borrow area into agricultural field:

- After the decommissioning of the machinery the entire area shall be graded so that the plot is level. A grader or even a Dozer may be used for the purpose.
- The subsoil soil if any which has been scrapped shall also be re-laid. Once the site is levelled no heavy machinery would enter the plot of land. To remove any compaction of the soil the deep ploughing would be applied;
- Once the site ash been levelled at the deep ploughed the topsoil shall be evenly re-laid. Topsoil must be placed, seeded, and mulched within 30 days of final grading if it is within a current growing season or within 30 days of the start of the next growing season.
- Vegetative material used in reclamation must consist of grasses, legumes, herbaceous, or woody plants or a combination thereof, useful to the community for the fuel and fodder needs.
- Plants must be planted during the first growing season following the reclamation phase. Selection and use of vegetative cover must consider soil and site characteristics such as drainage, pH, nutrient availability, and climate to ensure permanent growth. The vegetative cover is acceptable if within one growing season of seeding, the planting of trees and shrubs results in a permanent stand, or regeneration and succession rate, sufficient to assure a 75% survival rate.

6.7.10 Option II: In barren land, the borrow areas can be redeveloped into detention ponds.

The plots of land which cannot be put into agricultural or other productive use may be considered for such rehabilitation. These detention tanks will be doubled up as water bodies for rain-water harvesting and for removal of sediment from runoff flowing through the ponds. Design of the detention basin depends upon the particle size, settling characteristics, residence time and land area. A minimum of 0.02 mm size particle with a settling velocity of 0.02 cm/sec (assuming specific gravity of solids 2.65) can be settled in the detention basin.

The parameters are to be observed while setting up a detention pond:

Box 0-3: Design Parameters for the Detention Tank

- The plot in which the pond is being created should be located at the lowest point in the catchment area.
- Care should be taken that the horizontal velocity should be less than settling velocity to prevent suspension or erosion of deposited materials.
- Minimum Effective Flow Path: 5 times the effective width
- Minimum Free Board: 0.15 m
- Minimum Free Settling Depth: 0.5 m
- Minimum Sediments Storage Depth: 0.5 m
- Maximum interior slope: 2H: 1V

- Maximum exterior slope: 3H: 1V

The inlet structure should be such that incoming flow should be distributed across the width of the pond. A pre-treatment sump with a screen should be provided to remove detritus/debris. The settled sediments should get settled in the sedimentation tank.

Appendix 2: Topsoil Salvage, Storage and Replacement

Poor handling and stockpiling practices will result in a significant loss of viable seed and topsoil quality. Quality control procedures should be applied for the movement and handling, storage and re-spread of soil layers for use in revegetation

In case of hilly and desert areas, topsoil with humus wherever encountered while opening the site for construction shall be stripped and stockpiled (Refer MoRTH- Technical Specification no. 301.3.2 and 305.3.3³⁷ and for measurement for payment 301.8).

6.7.11 Location of Stockpile

The Topsoil stockpile shall be located within the agricultural plot. In case two or more plots are adjacent to each other the topsoil of the plots should not be mixed and stored separately. The location for storage of the topsoil shall have the following consideration (Box -0-4)

Box -0-4: Considerations for Storage of Topsoil

- The surface topsoil layer and the subsoil should not be mixed during the stripping and stockpiling process.
- A secure area away from:
 - Grade, Subsoil & Overburden materials;
 - Pit activities and Day-to-day operations.
 - Areas that do not interfere with future pit expansion
- Areas away from drainage paths and uphill of sediment barriers
- Areas away from the access roads
- Scalp good quality topsoil in windrow to each side of the earthworks to prevent erosion by wind.
- The stripping and handling of topsoil should occur when the field soil moisture content is optimum i.e. early morning for the soil texture class

6.7.12 Specifications for Stockpiles

The stockpiles for storing the topsoil shall be designed such that the slope does not exceed 1:2 (vertical to horizontal), and the height of the pile is restricted to 2m. A minimum distance of 1m is required between stockpiles of different materials.

6.7.13 Preservation of Stockpile

In cases where the topsoil must be preserved for more than a month, the stockpile is to be stabilized within 7 days. The stabilisation shall be carried out through temporary seeding. It consists of planting rapid-growing annual grasses or small grains, to provide initial, temporary cover for erosion control.

³⁷ November, 2000

Box -0-5: Vegetative material for stockpile stabilisation

- Must consist of grasses, legumes, herbaceous, or woody plants or a mixture thereof
- Selection & use of vegetative cover to take into account soil and site characteristics such as drainage, pH, nutrient availability, and climate to ensure permanent growth

The following precautions shall be considered for stockpile stabilisations:

- Stockpiles will not be surcharged, or otherwise loaded and multiple handling will be kept to a minimum to ensure that no compaction will occur.
- Divert runoff around stockpiles unavoidably located in drainage paths using a perimeter bank uphill.
- The stockpiles shall be covered with gunny bags or tarpaulin immediately in case they are not stored for periods longer than one month.

Guidance Note 9: Quarry Management

General Principle

The general practice adopted is to procure materials from existing quarries operating with the requisite permits. However, in some cases new quarries may be opened for the project. The Guidance note extends to management measures to both i.e. i.) in the event of the Contractor starting up new quarry for extraction of material for this project only ii) the contractor procures the material from an existing quarry.

Issues

The potential environmental impacts from the quarrying activities include the air pollution arising from the extraction of material, crushing of the rock and the transportation of the aggregates. In addition, noise and vibration related impacts occur in case of blasting. The crushing of the rock also produces very high sound levels. The quarry operations can also have impacts on surface and surface and ground water.

In addition to the environment issues the occupational health safety of worker working on quarries and crushers or handling of stone and aggregates are also of concern

Legislations & Standards

The quarrying of rocks for aggregates is covered under the Rajasthan Minor Mineral Concession Rules 2017. The operations of the quarry must comply to the said rules. Since the quarrying for metals (aggregates) is considered as a minor mineral it is also covered under the provisions of the EIA Notification 2006 and prior environmental clearance have to be obtained for the quarry operation

The Rajasthan Minor Mineral Concession Rules 2017 lays down environmental safeguards for sustainable mining operations (Chapter VI Rule 34). The quarry operations must comply to the said operations.

Detailed Guidance

The Contractor shall select an existing licensed quarry for procuring materials. However, the Contractor may establish a new quarry only in cases when: (i) Lead from existing quarries is uneconomical and (ii) Alternative material sources are not available or not suitable for the construction purposes. Considering the two scenarios discussed above i) The Contractor sets up a new quarry for the project operations and ii) The contractor procures material from any registered quarry. While Part A of the Guidance Notes deals with the former the Part B deals with Contractor's obligations in case of procurement of the material from other registered sources

PART A: New Quarry Operations

Planning during the Pre-Construction

The Contractor shall open a new quarry in accordance with Rajasthan Minor Mineral Concession Rules 1986 Necessary permission and licenses under the said rules would be obtained by the Contractor under these rules for the quarry operations.

The Contractor shall also obtain an environmental clearance under the EIA Notification 2006 before initiating quarry operations.

During the Quarry Operation

The guidance stipulated in this section would be over and above the conditions mentioned in the environmental clearance under the EIA Notification 2006 and any other permit and licence. The sustainable mining and the environmental safeguards mentioned in Rule 29 and 34 respectively of Rajasthan Minor Mineral Concession Rules 2017 would also apply.

Development of Quarry Area

To minimize the adverse impact during excavation of material following measures are to be undertaken:

- Ensure that no natural watercourse or water resources is obstructed due to any mining operation. Take adequate measures for protection of the older streams, if any, emanating or passing through the lease or licence area;
- Adequate drainage system shall be provided to prevent the flooding of the excavated area;
- Operator must establish a reliable source of water with adequate capacity and pressure to run all dust suppression systems at the quarry site;
- At the stockpiling locations, the Contractor shall construct sediment barriers to prevent the erosion of excavated material due to runoff. The contractor shall construct a garland drain around the entire mining operations areas. The collected water shall be led to a sedimentation tank providing for adequate residence time before it is discharged.
- Construction of offices, laboratory, workshop and rest places shall be done at least 100m the up-wind of the plant to minimize the adverse impact due to dust and noise.
- The access road to the plant shall be constructed taking into consideration location of units and slope of the ground to regulate the vehicle movement within the plant.
- In case of storage of blasting material, all precautions shall be taken as per The Explosive Rules, 1983.

Setting up of Crushers and other equipment

The following measures shall be undertaken for setting up of crushers and other equipment.

- The contractor shall obtain "No Objection Certificate (NoC)" from the Rajasthan State Pollution Control Board.
- Take effective safeguard, such as regular water sprinkling in critical areas prone to air pollution and having high levels of particulate matter such as around crushing and screening plant, loading and unloading point and all transfer points. The methods for wet suppression is presented in Appendix 1;
- Crushing, screening, and conveying operations must be enclosed with sheet metal or other rigid material. Do not use cloth or plastic enclosures. Roadways inside the crusher mill shall be metalled, paved. To suppress dust treatment with chemical suppressants may be considered. Dry dust extraction system can also be considered at these plant locations. The methods for dry suppression is presented

in Appendix 2;

- All vehicles must possess Pollution Under Control (PUC) Certificate and shall be renewed accordingly
- All machinery, equipment, and vehicles shall comply with existing CPCB noise and emission norms.
- The Employer/ Engineer must ensure that contractor shall submit the copy of NoC and PUC Certificate before the start of work.

Quarry operations

The followings precautions shall be undertaken during quarry operations.

- Keep the mine working restricted to above ground water level till approval of the Ground Water Department of the State is obtained;
- Temporarily store the top soil, at the place earmarked in the mine plan or scheme;
- Dump over burden generated during the mining operations at earmarked dump site shown in the mine plan or scheme;
- During excavation slopes shall be flatter than 20 degrees to prevent their sliding.
- In case of blasting, the procedure and safety measures shall be taken as per The Explosive Rules, 1983. The Contractor shall practice controlled blasting and implement mitigative measures for control of ground vibrations and to arrest fly rocks and boulders. Blasting shall be done only by a person holding blaster certificate from the Director General of Mines Safety. Deep hole blasting shall be carried out only after approval of the Director General of Mines Safety;
- The Contractor shall take all mitigative measures during the mining operations to ensure that the buildings or structures in the nearby areas shall not be affected due to blasting;
- The Contractor shall ensure that all workers related safety measures
 - Use drills either equipped with dust extractors or operated with water injection system for wet drilling to control the pneumoconiosis and silicosis;
 - Provide protective wears or respiratory devices to the personnel working in mining area and shall also provide adequate training and education on safety, environment and health aspects;
 - Organize regular health check-up camps for the workers engaged in mines and also periodically organize occupational health surveillance program for the workers to observe any contractions due to exposure to dust and take corrective measures, if needed;
- Provide insurance cover to all workers engaged in mines;
- The Contractor shall ensure maintenance of crushers regularly as per manufacturer's recommendation.
- Stockpiling of the excavated material shall be done. The drop height for the stockpile shall be lowered to reduce dust emissions
- Take measures for control of noise levels within permissible limit;

- The non-saleable mineral rejects at mine bottom shall regularly be collected and transported to the surface and the mine floor shall be kept reasonably clear of debris;
- During transportation of the material, the fall point of the loading shall be as low as possible to reduce the generation of dust. All truck carrying aggregate shall be covered;
- The Employer/Engineer shall review the performance of the environment management measures in addition to the regulatory authorities.

Occupational Health Safety in Quarry Operations

Prolonged exposure to excessive levels of respirable silica can affect chest health and result in pneumoconiosis or silicosis. The following Occupational Health Safety Measures shall be taken by the Contractor during the operation:

- Avoid generation of dust in the first place with the dry and wet suppression methods specified. Avoid exposure to dust. Maintain seals / filters etc for control rooms, vehicle cabs and other dust refuges.
- Where exposure to dust cannot be adequately controlled by other means, appropriate respiratory protective equipment should be used, and properly stored and maintained.
- For new and existing employees for whom exposure to respirable crystalline silica is foreseeable, pre-employment medical examination will be required. This should include a respiratory questionnaire and baseline lung function test. Chest X-rays should only be carried out if clinically required.

6.7.14 Decommissioning of the Quarry Operations

The Mine Closure plan as approved by the regulatory authority shall be implemented. The Mine Closure Certificate obtained from the regulatory authorities shall be provided to the Employer/Engineer for issue of the “No Objection Certificate”

PART B: Procuring Material from Existing Quarry

Planning during the Pre-Construction

The Contractor shall select an existing licensed quarry and shall carry out a legal due diligence of the operations. It shall obtain the copies of the licenses and permits provided under The Rajasthan Minor Mineral Concession Rules 2017. It shall also obtain a copy of the prior environmental clearance under the EIA Notification 2006. Due Diligence would also cover notices of violation against the said quarry by any regulatory authority. The contractor shall also assess the requirement vis-à-vis the present commitment of the quarry to supply aggregates and the permitted monthly production capacities. The said documents would be provided to the Employer /Engineer for approval. The material shall be procured only after the approval has been received from the Employer /Engineer.

Procurement of material during the Construction Period

The followings precautions shall be undertaken during quarry operations.

- The Contractor shall ensure that all workers are provided with personal protective equipment during the loading and unloading operations;

- During transportation of the material, the fall point of the loading shall be as low as possible to reduce the generation of dust. All truck carrying aggregate shall be covered;

The Employer/Engineer shall review the performance of the environment management measures in addition to the regulatory authorities.

Tools

References

Appendix 1: Wet Suppression System for Stone Crushing Mills

Details of system components for all stone crusher facilities:

- Minimum number and locations of pressure spray nozzles:
 - 1 nozzle on the top of the crusher
 - 2 nozzles at the delivery point of crushing material
 - 1 nozzle on the bottom of the vibrator screen or rotary screen
 - 2 nozzles within the storage hopper
 - 1 nozzle at the delivery point of raw materials
 - 1 nozzle at the bottom of the dust hopper
- No domestic showers, sprinklers, or other general water spray devices may be substituted for pressure misting nozzles. Nozzles may be hollow cone, solid cone or fan type. All water spray equipment shall be kept in good working condition and kept operational during all stone crushing operations at the site.
- A water pump with adequate motor horsepower and discharge pressure as required for optimal performance of spray nozzles. Centrifugal monoblock type self-priming pump capable of delivering 3 to 5 kg/cm² pressure and 72 litres per minute. The flow rate and operating pressure of the spraying liquid/solution shall be sufficient to suppress dust emissions from the corresponding sources. The spraying system shall be able to cover the areas of emission points concerned. 100 stainless steel mesh online water filter with two parallel cells. Parallel cells should be set up to allow connections to be reversed such that one cell undergoes backwash cleaning while the other cell is in operation. Only filtered water should be supplied to the spray nozzles.
- Chemical surfactants or wetting agents may be added to water used in the spraying systems.

Appendix 2: Dry Dust Extraction System for Stone Crusher Mills

The details of the dust collection system include the following:

- Minimum requirements for dry dust capture and collection systems:
 - Hood or enclosure to capture emissions;
 - Dust collector that separates particulates (e.g. centrifugal dust collectors); and

- Duct to transport particulates in air stream from dust collector to air pollution control device (e.g. baghouse).
- Capture hoods shall be installed over all crusher units and screens. Enclosures shall surround all sources of dust to the extent possible.
- Dust collector shall be connected in-line via an enclosed duct to a cyclone and baghouse for dust removal.
- Air handling system shall be a suitable size to prevent the escape of untreated airborne dust. Maintain minimum airflow as per design. A minimum draft velocity of 1 meter/second shall be maintained through all open hoods.
- Inspect bag filters routinely and at least once per month for damage and clean, repair or replace as needed.

Guidance Note 10: Construction Water Management

General Principle

Except bituminous works, water is required during all stages of road construction such as Embankment Sub- Grade; Granular sub-base (GSB) and Water Bound Macadam (WBM). Management of water in various stages of construction.

Issues

Some sub-districts in the project area have been declared as notified areas because of the scarcity of ground water resources. Using water for construction activity would put additional stress on the water resource. Additionally, as rainfall is scarce the surface water resources are limited. In places where surface water is available people depend on it for domestic purpose as well as drinking. Otherwise the population is dependent on the ground water resources.

While utilisation of a scarce resource for construction would put pressure on the resource the contamination of the scarce resource by construction activities would also cause inconvenience. Contamination of either ground water or surface water from construction activities, storage or material, oil, lubricant and bitumen would inconvenience the local populations and also degrade the environment

Legislations & Standards

Abstraction of ground water would require permission from Central Ground Water Board as per the CGWB Guidelines³⁸. The discharge from the construction camp would however be governed by the Discharge Standards specified in the Environment Protections Act 1986.

Detailed Guidance

For the project the sub-project districts/sub districts would be classified based on the ground water and surface water availability. While the status of groundwater is based on the CGWB's classification of district the surface water is decided based on the quantum of rainfall over the last 10 years. Based on this classification the strategies for water for construction would be decided. The criteria for classification and the strategies for water consumption is presented in Table -0-1

Table -0-1: Strategies for Water Sourcing and Use

<i>Status of Ground Water/Surface Water</i>	<i>Normal and Above Rainfall</i>	<i>Normal Rainfall</i>	<i>Deficit rainfall</i>	<i>Scanty rainfall</i>
:				
Notified Area	No Ground water abstraction other than saline water Primary dependence on Surface water for construction		No Ground water abstraction other than saline water Primary dependence on Surface water for construction	

³⁸ Guidelines/Criteria For Evaluation Of Proposals/ Requests For Ground Water Abstraction (With Effect From 15/11/ 2012), Central Ground Water Authority (Constituted under sub-section (3) of section 3 of the Environment (Protection) Act, 1986)

<i>Status of Ground Water/Surface Water</i>	<i>Normal and Above Rainfall</i>	<i>Normal Rainfall</i>	<i>Deficit `rainfall</i>	<i>Scanty rainfall</i>
:				
	Water conservation practiced for Construction purpose		Strict Water Conservation Practiced for Construction and Domestic purpose	
Semi-Critical Area	Abstraction of Ground water not preferred Primary dependence on Surface water for construction Water conservation practiced for Construction purpose		Abstraction of Ground water not preferred Dependence on Surface water for construction Strict Water Conservation Practiced for Construction and Domestic purpose	
Safe Area	Abstraction of Ground water allowed Surface water for construction preferred Water conservation practiced for Construction purpose		Abstraction of Ground water allowed Primary dependence on Surface water for construction Strict Water Conservation Practiced for Construction and Domestic purpose	

Planning During the Feasibility Stage

The Stage of the ground water development and eligibility for permission would be verified with Central Ground Water Authority (<http://cgwa-noc.gov.in/Sub/CheckEligibility/CheckEligibility.aspx>)

The status of the rainfall in the subdistrict would be checked with the Water Resources Department, Government of Rajasthan (http://waterresources.rajasthan.gov.in/Daily_Rainfall_Data/Rainfall_Index.htm)

The strategies for the water abstraction would be decided based on the above. The water conservation measures as also the costing for implementation of the water conservation measures would be carried out and included in the costing of the project.

Some of the strategies for water conservation and its use is presented in Box 0-1:

The Feasibility study should identify the sub-projects where there is likely to be scarcity of water and point out strategies which may be adopted. The Bill of Quantities prepared should reflect on the additional activities/works which is expected of the contractor. The same should also be reflected in the concession agreement.

No extra payment shall be generally made for these works and the Contractor has to include the cost of these items in his offer while quoting his tendered rate.

Box 0-1:Strategies for Reduction in water conservation and use

- Consider use of Dust suppressants for temporary haul roads, construction staging, material storage, and layout areas, compacted soil or aggregate base roads or driveways and paved surfaces
- Consider use of dust binders in Rough graded soils, Completed slopes and Soil stockpiles
- Facilities for extraction and treatment for saline ground-water: In some of the water scarce district brackish ground water is available the same may be used of construction after treatment.
- Water Harvesting techniques to be adopted to avoid extraction from existing community sources;
- Scheduling of construction activities: As part of the project preparation, the Employer/Engineer shall highlight that sub-projects which are located in water scarce areas and that there would be restriction on water availability. The Feasibility report shall indicate subprojects where such availability is a problem and shall indicate the need for modifying the schedule for construction

Planning during the Pre-Construction

Prior to the construction the contractor shall evaluate the possible sources of sourcing of water. The options which can be looked at include:

- Identify perineal water sources through interaction with user local panchayat, Government Departments and obtain necessary permissions
- In water scarce regions, water-harvesting structures are to be constructed, suitable locations and mechanism for siting these structures shall be identified. These could also be envisaged to be permanent water tanks for collection of stream water. Detailed drawings of water harvesting structures based on site conditions will need to be worked out and presented in the Detailed Design.
- Scheduling of Construction: For subprojects identified in water scarce region as far as possible, the schedule for construction shall be prepared such that earthwork for embankment is carried out just before monsoon, so that water requirement for subsequent construction works such as granular sub-base and water bound macadam are met in monsoon and post monsoon season. Carrying out these activities even during the monsoon is possible as the rainfall may not be high enough to disrupt construction.
- The feasibility of treatment system to treat saline ground water for construction and potable purpose shall also be worked out

The Contractor shall also work out strategies for reducing consumption of water:

- The feasibility of using dust suppressant and dust binders shall be worked out
- The feasibility of using additive in concrete to reduce water consumption shall be worked out
- The measures for reducing domestic consumption and also consumption in construction activities shall be worked out

In case of utilisation of any river or stream water for construction purpose the permission of the Irrigation Department / concerned authority should be obtained

6.7.15 Construction Period

During construction, the Contractor shall be responsible to monitor the following:

- Extraction of water is restricted to construction requirement and domestic use of construction workers;
- Water requirement for curing of concrete shall be minimized by pooling of water over the concrete or by covering with wet gunny bags; and
- Bottled Drinking water shall be procured for the construction workers
- As part of the regular audit the Employer/Engineer shall also carry out a water audit. This would essentially look into the sources from which water is extracted and also identify the consumption of water. Any violation identified in the water abstraction/sourcing would be reported and penalised as per the provisions of the Environment Management Framework.

Guidance Note 11: Waste Management & Debris Disposal

General Principle

The waste generated during the highways construction would include Construction and Demolition (C&D) Waste (excavated soil, bituminous waste, Concrete waste) and hazardous Waste (Oil waste, oil-soaked cotton). In addition, due to the operations of the construction camp Municipal Solid waste would be generated.

Issues

The C&D waste and municipal solid waste if disposed on agricultural land would reduce the productivity of the land. Similarly, if placed in low lying areas have potential to block the flow of water. Leaching of the waste and erosion by run-off can also cause deterioration of the water quality in surface water bodies. Hazardous waste, primarily waste oil and lubricants generated from operations and maintenance of the machinery has potential to contaminate the soil, ground and surface water.

Legislations & Standards

The Construction and Demolition Waste would be the major waste generated from the construction activities followed by the municipal waste which would be generated from the construction camps. The hazardous waste would be small in quantity and would be limited to the construction camps only.

The construction and demolition waste would be governed by Construction and Demolition Waste Management Rules, 2016 while the provisions of the Solid Waste Management Rules, 2015 would be followed in case of Municipal Solid Waste. The Hazardous waste would be governed by the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.

Detailed Guidance

The statutory requirements for the different types of waste applicable to the project is presented in sections below.

Procedure for Management of Hazardous Waste

- The Contractor shall identify and shall keep inventory of different type of hazardous waste generated from its operation. The types of hazardous wastes are presented in

Box 0-1: Type of Hazardous Waste

- | |
|---|
| <ul style="list-style-type: none">• Used oil and waste oil• Empty barrels/containers of oil, lubricant and grease• Contaminated cotton rags or other cleaning materials |
|---|

Source: Schedule I, Schedule III and IV of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

- The Contractor shall obtain authorization for generation and storage of hazardous waste from RSPCB. For this authorization, the Contractor shall make an application to RSPCB in **Form 1** as prescribed in the Hazardous and Other

Wastes (Management and Transboundary Movement) Rules, 2016. In case of renewal, the Contractor shall make the application to RSPCB in Form 1 along with conditions specified in the authorisation for hazardous waste.

- For storing of hazardous waste, the Contractor shall follow the guidelines while planning and designing the hazardous waste storage areas:
 - The storage area should be provided with concrete floor;
 - The storage area floor should be provided with secondary containment;
 - Proper slopes as well as collection pit to be provided in the storage area to collect wash water and the leakages/spills etc.;
 - Storage area should be provided with the flameproof electrical fittings;
 - Automatic smoke, heat detection system should be provided in the sheds;
 - Adequate firefighting systems (ABC type fire extinguisher) should be provided for the storage area; and
 - The Storage area shall be designed in such a way that the floor level is at least 150 mm above the maximum flood level.
- In case of leakage/spills, following procedure should be followed:
 - At the foremost, to try and eliminate the source of the spill by adopting any of the following measures e.g. i) up-righting drums or other containers, ii) closing valves, or other similar actions;
 - Prevent the oil from spreading or entering drains by absorbing flowing oil or diking the area with sand bags, jute/cotton mats, or berms;
 - Spread absorbent material e.g., sawdust over the surface of the spill from the perimeter of the spill to its centre; and
 - Contaminated absorbents containing diesel fuel etc., shall be stored in drums and disposed off as hazardous waste.
- The Contractor shall maintain a record of hazardous waste in Form 3 of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and prepare and submit an annual return containing the details specified in Form 4 in this rule to the JSPCB, on or before the 30th day of June following the financial year to which that return relates.
- The Contractor shall make an agreement with authorised Common Hazardous and Other Waste Treatment Storage and Disposal Facility (TSDF) and handover hazardous waste to that TSDF, on or before 90 days or accumulated quantity of 10 ton whichever is earlier.
- The Contractor shall provide the transporter of the hazardous waste with the relevant information e.g., nature of the wastes and measures to be taken in case of an emergency, in Form 9 and shall label the hazardous and other wastes containers as per Form 8.
- For sending hazardous waste, the Contractor shall prepare and sign seven copies of the manifest in Form 10 comprising of colour code as indicated in Table 0-1.

Table 0-1: Colour code of Manifests to generated /maintained

• Copy number with colour code:	• Purpose
Copy 1 (White)	To be forwarded by the sender (JUSNL) to the State Pollution Control Board (JSPCB) after signing all the seven copies
Copy 2 (Yellow)	To be retained by the sender (JUSNL) after taking signature on it from the transporter and the rest of the five signed copies to be carried by the transporter
Copy 3 (Pink)	To be retained by the receiver (actual user or treatment storage and disposal facility operator) after receiving the waste and the remaining four copies are to be duly signed by the receiver.
Copy 4 (Orange)	To be handed over to the transporter by the receiver after accepting waste.
Copy 5 (Green)	To be sent by the receiver to the State Pollution Control Board.
Copy 6 (Blue)	To be sent by the receiver to the sender.
Copy 7 (Grey)	To be sent by the receiver to the State Pollution Control Board of the sender in case the sender is in another State.

- When an accident occurs at the Construction Camp/ worksite / any facility owned/controlled by the Contractor during handling of hazardous wastes, the Contractor shall immediately intimate the RSPCB through telephone, e-mail about the accident and subsequently send a report in Form 11 of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- The Contractor shall maintain a register to record all accident /incident during handling hazardous waste.
- All the workers involved in handling hazardous waste should be equipped with personnel protective equipment (gloves and boots).

6.7.16 Procedure for Management of Municipal Waste

- At the point generation, the Contractor shall segregate and store bio-degradable³⁹ and non-biodegradable⁴⁰ municipal solid waste in two separate bins (primary collection point).
- At the end of every working day, bio-degradable and non-biodegradable waste shall be transferred from different primary collection points to the two secondary collection points (one for bio-degradable and another for non-biodegradable waste). For this purpose, The Contractor shall construct two (one for bio-degradable and another for non-biodegradable waste) waste collection pits within the hospital premises.
- The Contractor shall ensure that the bio-degradable waste shall be processed, treated and disposed of through composting or bio-methanation within the

³⁹ “biodegradable waste ” means any organic material that can be degraded by micro-organisms into simpler stable compounds.

⁴⁰ “non-biodegradable waste” means any waste that cannot be degraded by micro organisms into simpler stable Compounds.

premises as far as possible. The residual waste shall be given to the waste collectors or agency.

- All the workers involved in handling municipal waste should be equipped with personnel protective equipment (gloves and boots).

Procedure for managing Construction and Demolition waste

- All waste resulting from construction, re-modelling, repair and demolition of any civil structure would be considered under The Construction and Demolition Waste Management Rules, 2016.
- The Contractor shall be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated
- The contractor shall ensure that other waste (such as municipal solid waste) does not get mixed with this waste and is stored and disposed separately as indicted above;
- The Contractor shall prepare a waste management plan and get appropriate approvals from the Employer/Engineer before starting construction or demolition. The Contractor shall segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar and bituminous waste
- The Contractor shall keep the construction and demolition waste within the premise or at a designated place for the collection of the C&D waste. The designated place shall be decided in consultation with the local body. The agreement with the local body shall essentially mention the end-use of the designated location. The designated site shall be away from:
 - located at least 1000 m away from sensitive locations;
 - do not contaminate any water sources, rivers etc; and
 - total site has adequate capacity equal to the amount of debris generated;
 - Public perception about the location of debris disposal site has to be obtained before finalizing the
 - location;
 - Productive lands are avoided; and
 - Available waste lands shall be given preference, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest shall be avoided
- The designated place shall be developed ensure that there is no littering on adjoining properties or deposition of construction and demolition waste to prevent obstruction to the traffic or the public or drains.
- The Contractor shall construct a peripheral drain around the designated construction & demolition waste storage area. The drainage channel shall lead to the sedimentation tank with adequate residence time before it is discharged into any water channel.

Planning during the Design Phase

The contractor shall estimate the approximate quantity of the waste likely to be generated from different stretches and prepare a rough estimate of the size of the waste storage area required.

Planning during the Pre-Construction

For the disposal of excess cut and unsuitable (non-toxic) materials, the contractor shall identify the location for disposal in consultation with the community / concerned department. Prior to disposal of wastes onto private/community land, it shall be the responsibility of the Contractor to obtain a No-objection Certificate (NOC) from the land owner/community. No grazing land, community reserve shall be used for the dumping of waste. The NOC, along with the land document shall be submitted to the Employer/Engineer prior to commencement of disposal.

The Contractor shall construct a Hazardous waste and municipal waste collection and storage area as per the guidelines stated above.

Operation of the Camp during the Construction Period

The Contractor shall educate his workforce on issues related to disposal of waste, the location of disposal site as well as the specific requirement for the management of these sites during the Induction training itself as well as all the subsequent trainings

The Contractor shall either reuse or dispose the waste generated during construction for roads depending upon the nature of waste, as specified in

Table 0-2: Possible waste and the scope for reuse and disposal if required

<i>Stage</i>	<i>Activity</i>	<i>Type of Waste</i>	<i>Scope for Possible Reuse</i>	<i>Disposal of Waste</i>
B 03.	Tree Felling	Stumps of Trees		Stored in disposal yards
C 01.	Site Clearance and grubbing	Vegetative cover and top soil	Embankment stabilisation	
	Dismantling of exiting pavement	Bituminous waste	Road Sub-base,	
		Unsuitable excavated material	Stabilisation of shoulders of the villages road and haul roads	Disposal sites identified in consultation with local authorities
	Dismantling of existing Structures	Concrete Waste, Steel	Concrete waste used for backfilling or strengthening pavement	Steel to be sold off to the Recyclers
	Operation of the Construction Camp	Municipal Solid Waste	Bio-degradable waste composted used for roadside plantation	Recyclables sold off
	Maintenance of vehicle and equipment	Used Oil, lubricants and grease		Disposed of to authorised recyclers or at TSDF
C 02.	Operation of Borrow Areas and Quarry	Vegetation	Used as mulch over topsoil heaps to prevent erosion	
		Topsoil	Used for reclamation of borrow area/	

<i>Stage</i>	<i>Activity</i>	<i>Type of Waste</i>	<i>Scope for Possible Reuse</i>	<i>Disposal of Waste</i>
			stabilisation of overburden in quarried	
		Subsoil	Used for backfill/stabilisation of the slope in quarries	
C 04.	Culvert and Minor Bridge works	Waste concrete and batching plant and concrete transit mixer wash	Paving of internal roads	
		Water from excavation	Used for curing and construction activities other than concrete mix	
C 05.	Surfacing: Storage of Bitumen	Low grade Bitumen, Spilled bitumen	Low grade bitumen mix	Disposed of to recyclers
		Rejected Bitumen mix	Paving of approach roads	

The Contractor shall ensure reuse of waste only after carrying out the specific tests and ascertaining the material are not hazardous as per the provisions of the Act. The quantity of the waste materials reused and disposed of have to be reported to the Employer/Engineer.

Bituminous wastes shall be disposed of in 60mm thick clay lined pits and covered with 30cm good earth at top, so as to facilitate growth of vegetation in long run.

In case of filling of low-lying areas with wastes, it needs to be ensured that i) the low-lying area is not a drainage channel or a water retaining structure or iii) a rainwater harvesting structure; ii) the low-lying areas is the level matches with the surrounding areas.

Oil and grease are trapped for Oil & Grease Separator, should be located at the lowest end of the site and away from the residential areas.

The waste management practices adopted by the Contractor, including the management of wastes at construction camps etc. shall be reviewed by the Employer/ Engineer

The Contractor shall also carry out the stator reporting to the Rajasthan Pollution Control Board (RSPCB) during the progress of construction.

Decommissioning of the Camp

Guidance Note 12: Occupational Health & Safety

General Principle

The guidance notes defines the health safety requirements for works associated with the contractor / sub – contractor and any other agency to be engaged at construction worksites.

Issues

Absence of appropriate health and safety precaution can lead to unwanted incidents or accidents, occupational illness during construction. Occupational health concerns aren't an optional /extras. All employers have a legal duty of care to their employees. Improper occupational health practice would not only have impairment and fatalities but would also have adverse impacts on the business e.g. higher time loss, absenteeism, lower productivity, compensations and staff turnover.

Legislations & Standards

The construction works shall be undertaken in accordance with all applicable statutory requirements and codes listed below but not limiting to is presented in **Error! Reference source not found.Box1**.

Box1:Legislation codes and Guidelines relating to OHS in Road Construction

- IRC Codes
 - IRC: 67-2001' Code of practice for Road Signs'.
 - IRC: 35-1997' Code of practice for Road Markings'.
 - IRC: SP: 55-2001 'Guidelines on safety in Road Construction Zones.
 - IRC: 43- 1972, Recommended Practice for Tools, Equipment and Appliances for Concrete Pavement Construction
 - IRC: 72- 1978, Recommended Practice for Use and Upkeep of Equipment, Tools and Appliances for Bituminous Pavement Construction
 - IRC: 90- 1985, Guidelines of Selection, Operation and Maintenance of Bituminous Hot-Mix Plants
 - IRC: SP: 22- 1980, Recommendation for the Sizes for each Type of Road making machinery cater to the general demand of road works
 - IRC: SP: 25-1984, – Guidelines on Maintenance of Road Safety, Health & Environment
 - IRC: SP: 29-1994, directory of Indigenous Manufactures of Road/ Bridge Construction Machinery & Important Bridge Components
 - IRC: SP: 34-1989, General Guideline About the Equipment for Bituminous Surface Dressing
 - IRC: SP: 39-1992, Guidelines on Bulk Bitumen Transportation & Storage Equipment
 - MORT&H, Handbook on Road Construction Machinery
- Acts and Rules
- Indian Electricity Act 2003 and Rules 1956
 - National Building Code, 2005
 - Factories Act, 1948, Rajasthan Factories Rules 1951
 - The Petroleum Act, 1934 and Rules 1976
 - Gas Cylinder Rules, 2003
 - Indian Explosives Act, 1884,, Explosive substance Act 1908 and The Explosive Rules 1983
 - The Public Liability Insurance Act 1991 and Rules 1991
 - Minimum Wages Act, 1948 and 1950
 - Contract Labour Act, 1970 and 1971
 - Child Labour (Prohibitions & Regulations) Act, 1986 AND rules 1950
 - Workman Compensation Act, 1923 along with allied Rules
 - Building and other Construction workers Act and Rules,
 - Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules, 1989;

The Safety Plan of the Contractor shall not only ensure compliance to the above laws but also include safeguards for hazards which are identified for each activity.

The Contractor shall, based on the occupational health and safety hazards of work or if directed by the by the Employer/Engineer produce supplements to the Safety Plan to cover the site safety, occupational health obligations, responsibilities, relating to work on site.

Detailed Guidance

The guidance on the implementation of the Occupational Health and a safety is presented in Appendix 1

During the Feasibility Stage

During the feasibility study the environmental assessment should point the Occupational Health and safety risks in the project. The Common Causes of Accidents or unsafe conditions on Highway Construction worksites is presented in Box 2.

Box 2: Some Common Causes of Accidents or unsafe conditions on Highway Construction worksites

<p>Causes of Accident</p> <ul style="list-style-type: none">• Adopting short cuts and risky methods• Not using personnel protective equipment (PPE)• Careless in driving and overloading of trucks• Misuse of hoist• Lack of warning signs, protective barriers and facilities for the flow of traffic by the side of the road where the work in progress• Absence of barricade surrounding excavated pits• Unauthorised driving without proper license or safety certificate for equipment• Over speeding• Use of wrong tools• Employment of untrained or inexperienced workers for a skilled job like Bituminous work• Throwing of materials and tools from height• Lack of supervision during construction• Not following site rules <p>Unsafe Conditions</p> <ul style="list-style-type: none">• Standing under sling loads• Not using rope guys for heavy loads• Tampering/ meddling with electric connections• Repairing running machines• Climbing on staging by using bracing• Poorly maintained plant and equipment• Non-standard electrification and joints in cables, non-use of ELCB's etc.• Unprotected heights/ staging/ scaffolding• Lack of/ inadequate/ improper supervision• Improper I hazardous access to the worksite or part of it• Low level of safety awareness/ safety culture among workers due to lack of training at induction stage, not holding or irregular toolbox or safety meetings• Unskilled handling of materials like hot bituminous mixes and cement concrete• Not providing barricades around excavations• Work area not defined to the road users• Safety, Health & Environment Manual 12• Diversions not indicated or improperly indicated• Unsafe cranes/ lifting operations

- | |
|---|
| <ul style="list-style-type: none">• Welding/ cutting operations without proper safeguards• Hazardous storage of petrol, oil and lubricants |
|---|

- The Feasibility Report should also include provisions for inclusion of occupational health safety in the bidding documents. Even though the safety equipment shall not be part of the BoQ as no separate payment would be made for the safety. The cost of implementing the safety plan would be in-built in the operational cost of the Contractor. The Concession Agreement would however include all the safety aspects mentioned in Appendix 1.

Planning during the Pre-Construction

The first critical step in developing a comprehensive safety and health programme is to identify physical and health hazards in the workplace. This process is known as a "hazard assessment" or "worksite" analysis". During the pre-construction stage hazard analysis shall be carried out. However, the same activity would be repeated before initiating works at any new stretch of the highway to identify any new hazards which are either location specific or may arise due to the change in work methodology at that location. The hazard analysis process would help in locating and evaluating hazards that are most probable and have the severest consequences. This is information essential for establishing effective control measures and included in the Safety Plan.

- The Contractor shall analyse the training requirements for all the employees and initiate a training program to ensure all employee/worker, sub-contractor is suitably qualified, competent and fit to undertake the job in a safe manner. A matrix and schedule of training requirements, covering general, task-specific OHS related training, showing the training frequency and interval between refresher courses should be drawn up as part of the safety plan. The Safety Plan should be a separate document submitted along with the Method Statement.
- At this stage collaborations shall be worked out with Suitable transport to the nearest approachable hospital for treatment in case of emergencies.

During the Construction Period

Even though most of the common hazards at road worksites are well known and documented, as part of the Hazard analysis carried out during the pre-construction stage it is recommended that the exercise should be repeated whenever there is any change in work methodology (If any changes in conditions, equipment or operating procedures) or change in the worksite i.e. road stretch where work is being carried out. A periodic reassessment should also include a review of injury and illness records to spot any trends or areas of concern and taking appropriate corrective action. The suitability of existing PPE, including an evaluation of its condition and age, should be included in the reassessment.

During the progress of work, the following are the safety requirements that need to be undertaken by the contractor at the construction site;

- All transitions, ingress/ egress to and from the main highway, shall have proper and smooth geometry and traffic shall be guided by road signs, markings, delineation and other appropriate means as required for safe and efficient operation.;
- Personal safety equipment (such as footwear, gloves and eye protection devices, helmets etc.) for the workers. Some of the activity e.g. bar bending, bitumen spraying, welding would require additional PPE the same shall also be provided

by the Contractor.;

- First aid Kit needs to be placed at all worksites. The First-aid kit shall be distinctly marked with Red Cross on white background. In case, the number of labour exceeds 50 at any work-site, the items in the first aid box shall be doubled. All the vehicles and equipment shall be provided with a first-aid box with all the above. The medicines should be regularly checked for the expiry of the medicines. Adequate arrangement shall be made for immediate recoument of the equipment /consumables whenever necessary. A trained personnel in-charge of first aid treatment to be readily available during working hours at construction site
- Suitable transport to the nearest approachable hospital should be made available.
- All the cautionary signs as per IRC: 67-2001 and traffic control devices (such as barricades, etc as mentioned in Appendix 1) shall be placed as soon as construction activity get started and shall remain in place till the activities get completed.
- Following case specific measures need to be followed during the progress of the activity:
 - In case of blasting, the Contractor must follow The Explosives Rules, 1983.
 - If construction of road is within the settlement, the contractor must ensure there shall not be any unauthorized parking as well as storage of material, adjacent to road.
 - Approved methods to be used to prevent breeding of mosquitoes and other disease-causing organisms, at all the water logging areas.
- Plant and machinery and some of the activities have additions occupational health and safety risks. These risks are particularly important in:
 - Concrete and masonry Works Construction
 - Hot Mix Plant and Bituminous Works
 - Batching Plant
 - The risks related to these plant and equipment and the safety measures are indicated in Appendix 2.
- Internal and external monitoring and safety audits shall be carried out as mentioned in Appendix 1

6.7.17 Decommissioning of the Construction site

All the OHS measures mentioned in Appendix 1 shall also be followed during the decommissioning phase. The construction site shall be cleaned of all debris, scrap materials and machinery on completion of construction for the safety of public and road users, as per the Guidance Notes 4: “Construction Camp” and Guidance Notes 9: “Waste Management.”

6.7.18 Operation of the Road

During the operations the Highway workers would be provide with high reflective garments. It would be mandatory for any worker to wear the garment while working on the highway

In case of maintenance works being carried out by a worker or group of workers the following safety measures would be adopted:

- Warning drivers unambiguously and sufficiently in advance through Regulatory/mandatory/Prohibitive signs, warning/Cautionary signs. Guide Signs etc
- Provide clear demarcation/delineation for channelization of traffic to guide drives along the safe path
- Provide for devices e.g. safety signs, cones, barricades, lane closures and diversions
- Temporary/portable barricades to be provided in case of lane closures;
- Flagman should also be posted with signs and flag paddles to effectively guide traffic. The flag used for signalling should be 0.6 m. X 0.6 m made of good quality red cloth and shall be attached a staff of 1.0m in length. The sign paddles shall conform to IRC 67: 2001 and provide with rigid handle

Appendix 1: Guidance on General OHS Applications

General Safety procedure

- All workers entering the site should be trained and made aware of the environmental and safety practices. They should be made aware of the safety signages at the site;

Housekeeping

- Improper housekeeping is the primary hazard in any construction site. The Contractor shall ensure that a high degree of housekeeping is always maintained at the work sites. All site personnel, and line management shall demonstrate committed and continued efforts towards housekeeping.
- General Housekeeping shall be carried out by the contractor and ensured at all times at Work Site, Construction Depot, Batching Plant, Labour camp, Stores, Offices and toilets/urinals. In case public areas adjoining the worksites are soiled by construction debris, soil either spilled from worksite or carried by the vehicle moving out of the worksite it shall be the Contractor's responsibility to clean-up. Toward general house keeping the Contractor shall constitute a special group of housekeeping personnel. This group shall ensure daily cleaning at work site & surrounding areas and maintain a register.
- The contractor shall be responsible to provide segregated containers for disposal of debris at required places and regular cleaning of the same.

Safety During Clearing and grubbing

- If a tractor dozer is employed on clearing scrub or felling trees, it shall be provided with adequate driver protection.
- When two or more scrapers are working on the same job, a minimum distance of at least 25m or adequate shall be kept between them.
- In case of hydraulic breakers, hydraulic rams and hoses shall be in good working condition.

- During the clearing operations no material shall be dumped on public land so as to reduce the width of the carriageway;
- The stumps of trees shall not be dumped on the public land nor shall it encroach on the right of way.;

Construction within Settlements

- Full height fence, barriers, barricades, etc. shall be erected around the site in order to prevent the working area from the risk of accidents due to speedy vehicular movement. In the same way barricades protect the road users from the danger due to construction equipment and other temporary structures.
- Specific walkways should be demarcated by barricade for use by pedestrians;
- Cross-over sites would be provided at all worksites within settlements. At all cross over points flagman shall be posted to control the traffic and facilitate movement of the pedestrians,
- At night the worksite and adjoining areas within the settlement shall be well lit so that the people are not inconvenienced;
- Flasher should be provided at all cross over points to warn vehicular traffic of impending movement of pedestrians

Safety Measures for Vehicles

- Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.
- No passengers shall be carried, on any vehicle unless specific seating has been provided in accordance with the manufacturers recommendations;
- All Vehicles procured for the project shall be fitted with audible reverse alarms and maintained in good working conditions. Reversing shall be done only when there is adequate rear view visibility or under the directions of a Flagman.
- All vehicle drivers including Hydra operators shall be trained on defensive driving at recognized Institute for Driver Training. All vehicle drivers shall also undergo refresher training on defensive driving provided by recognized institutes for the purpose once in 6 months.
- No vehicle shall travel through the settlement at speed of more than 15 kmph
- Flagman shall be placed at the both ends of the settlement and at the cross-over point to facilitate movement of vehicle;

Safety measures at slopes

- Working on gradients beyond any equipment capability shall not be allowed. Prevention of dumper and dump truck accidents should be managed by providing wheel stops at a sufficient distance from the edges of excavations, spoil heaps, pits, etc.
- The manufacturer's recommended bucket size must not be exceeded in excavators.

- If excavators operating on a gradient, which cannot be avoided, it must be ensured that the working cycle is slowed down, that the bucket is not extended too far in the downhill direction, and that travel is undertaken with extreme caution. A large excavator must never be permitted to travel in a confined area, or around people, without a flagman to guide the driver, who should have the excavator attachment close in to the machine, with the bucket just clear of the ground. On wheeled excavators, it is essential that the tyres are in good condition and correctly inflated. If stabilizing devices are fitted, they should be employed when the machine is excavating.
- When the front shovel of the 180° backhoe loaders is being employed, the backhoe attachment shall be in its “travel” position, with the safety locking device in place.
- When operating the backhoe in poor ground conditions, the stabilizers tend to sink into the surface of the ground, reducing stability. Therefore, frequent checks shall be made for the stability of the machine. The loading shovel should always be lowered to the ground to stabilize the machine when the backhoe is employed.

Safety Measures During Bitumen Construction Work...

The Contractor shall ensure that bitumen storing, handling as well as mixing shall be done at hot-mix plant or designated areas to prevent contamination of soil and ground water.

- Skilled labour shall be used while hand placing the pre-mixed bitumen material.
- The hand placing of pre-mixed bituminous material shall be done only in following circumstances:
 - For laying profile corrective courses of irregular shape and varying thickness
 - In confined spaces where it is impracticable for a paver to operate and
 - For filling potholes
- The Contractor shall provide safety equipment i.e. gumboots and gloves to the workers while handling bitumen.
- While applying Tack Coat, spraying of bitumen shall be done in the wind direction. The labour shall wear jacket while spraying the bitumen.
- All the bituminous work shall be done as per IRC’s Manual for Construction and Supervision of Bituminous Works.

Dangerous Work Environment

As per BOCWR:

- When an internal combustion engine/s is/are used in a confined space or excavation or tunnel or any other workplace where either natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of workers shall be avoided unless suitable measures are taken and provided by the contractor.
- No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes/vapours or other impurities which is likely to be injurious or offensive, explosive or poisonous or noxious or

gaseous material or other harmful articles unless steps are carried out by the contractor and certified by the responsible person to be safe.

Danger areas

- The Contractor shall carry out a workplace safety assessment (not limited to the requirement of the any legislation) where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work
 - falling a distance; or
 - being struck by a falling object or moving vehicle and equipment which is liable to cause personal injury, and;
- Such area may be clearly indicated as a Danger area. The area shall be clearly demarcated by precautionary signages indicated in both pictorial and local language.
- In case of active worksite which are also dangerous, or dangerous worksite where there is heavy traffic or pedestrian movement flagman shall

Excavation

In case of excavation the safety plan should safeguard against the following::

- Collapse of the sides,
- Material falling on the people working in the excavation,
- People and vehicles falling into the excavation,
- People being stuck by plant and machinery,
- Access of both workers and local people to the excavation,
- Fumes/gas
- Underground utilities
- Accidents to members of the public.
- Make sure the necessary equipment needed such as trench sheets, props, etc. is available on site before work starts.

The following precautionary measures need to be considered:

- Before starting excavation; it shall be checked whether there are any underground utilities present like electrical power cables, pipe line or any other service line.
- If the excavation is deep more than 1.2 meters worker shall wear full body harness.
- For deep excavations appropriate preventive measure to be taken to avoid earth collapse like slope or bench providing to the walls of the pit or sheet piling etc. as per norms and design. The slope of excavation would not be steeper than the angle of repose of the particular soil. When the slope is less than the angle of repose, which cannot be achieved because of limited place or if it is uneconomical to provide such a slope then shoring should support the earth.
- Excavation area would be barricaded 1-meter away from the edge of excavation pit. Tube & coupler type hard barricades shall be used for the barricading.

- No materials would be stacked at edge of the excavation pit.
- There would not be any vehicle movement close to the edge of the excavation pit.
- Proper access would be made for workers, either by providing Stairways or cutting steps on the wall of the pit or by any appropriate means
- Proper ramp to be made if the excavated earth is to be moved by vehicles.
- Proper lighting shall be provided for working at night. Reflectors & caution boards are to be fixed to caution outsiders.
- Electrical cable routing would be laid such that it does not cause tripping hazard.
- Care would be taken that the persons working near by the excavation may not be hit by moving part of the machine.
- The Dump Truck that shifts the excavated material shall move only after lowering the hull to original position; after completion of dumping the material.
- Well trained two person are deployed for locking and unlocking backdoor of dumper.

Hand Tools & Power Tools

- Proper hand tools with insulated body shall be used.
- If duct dismantling is done at site, then the sheet handling shall be done carefully as it may cause cut injury. Proper gloves shall be used to prevent any injury.
- When not in use, sharp edged hand tools shall be provided with proper protection for the edges, Hand tools shall not be left unattended in the passageways, suitable cabinets or covers shall be provided for hand tools. (Especially metal bending and cutting tools).
- Power tools shall be connected through ELCB (Earth Leakage Circuit Breaker).
- Plug-top shall be provided with all power tools.

Temporary Electrical Supply Installation

- In case of layout of temporary cable and distribution board the layout shall displayed at the office and the main DB room.
- Cable markers shall be fixed to identify the route of the cables.
- The electrical installations shall be done in accordance with the regulation of the country
- All temporary electrical connection shall be done by authorized electrician, so deployed shall necessarily have the electrical license from the concerned Government authority.
- Earth Leakage Circuit Breaker (ELCB) shall be provided to all portable equipment supplies and a register to be maintained for its weekly check.

Setting up of Temporary Diesel Generator Set

- DG set shall be installed as per the electrical regulations;
- Fuel shall be stored away from the D.G Set and the area to be cordoned;

- CO2 fire extinguisher and two sand buckets shall be provided;
- All rotating parts of the equipment shall be adequately guarded;
- Fuelling shall be avoided while D.G is in operation;
- All cables shall be double insulated / armoured;
- Routing of cables shall be proper;
- Proper earthings shall be provided. Earth resistance shall be maintained as per norms in the Indian Electricity Act;
- Only authorized personnel shall be allowed to operate the generator;
- Smoking shall be strictly prohibited in the area around the generator and fuel storage area;
- The designated operator shall use earmuff in addition to other common PPEs.

Hydraulic Excavators /Lifts/Cranes

- Operator should have valid license;
- The equipment should also have a valid load test certificate;
- The driver should always carry his valid license and the certificate of the equipment he operates.
- No person would enter the radius of action of Earth-moving equipment when in operation.
- No Earth-moving equipment would be started up until all workers are away from the operating radius. The Flagman/traffic marshal/Signaller should assist the operator to ensure safety in operation. Similar precautions should be taken during lifting operations of cranes. The precautions mentioned in IS 13367: (Part 1): 1992 should be followed.
- The person directing the movement of the earth moving equipment/mobile crane (signaller) should be easily identifiable by the driver and should be wearing high visibility clothing. The Driver and the signaller should be providing with appropriate personnel protective equipment such as safety boots goggles gloves safety harness, safety spectacles and ear plugs as applicable.
- Earth-moving equipment would not travel on bridges, viaducts, embankments, etc. unless it has been found safe for it to do so.
- Adequate precautions shall be taken to prevent Earth-moving equipment being operated in dangerous proximity to live electrical conductors.
- On Earth-moving equipment motors, brakes, steering gear, chassis, blades, blade-holders, tracks, wire ropes, sheaves, hydraulic mechanisms, transmissions, bolts and other parts on which safety depends shall be inspected daily.
- Earth-moving equipment shall not be left on a slope with the engine running.
- No adjustments, maintenance work or repairs would be made on equipment in motion.
- Deck plates and steps shall be kept free from oil, grease, mud or other slippery substances.
- Permit to Work Procedures should ideally be followed.

Working at Night

- Arrangement shall be made for adequate lighting of the work area. Precautions for electrical safety should be considered during lighting
- Illumination shall be provided at working locations and passages the workers may use; Workers shall be instructed to use the passage;
- All workers would wear Hi-visibility jackets, Safety helmets with chin strip, Safety shoes and other PPEs.
- Availability of EHS person, safety personnel with beacons is essential during night work

Fall Protection

These safety precautions shall be applied when working at height especially in case of bridges or any place where the workers are working at heights more than 2m.

- Employee/ worker deployed for height work shall be selected persons who are experienced and screened by the site management.
- Proper access and working platform shall be provided to reach the work spot.
- Fall protection must be provided for each employee on a walking/working surface with an unprotected side or edge at the height. One of the following measures must be used when employees are exposed to a fall of 6 feet or more:
 - Guardrail: To an extent possible guard rails would be provided along the edges
 - Safety Net Systems: Safety Nets to be provide when workers are exposed to risks of fall from height.
 - Fall Arrest Systems: Workmen shall wear full body harness with double lanyards for work above 1.2 m height. The selection of safety Belts and harness would have done in accordance to the IS 3521: 1999.
 - On horizontal movements the lanyard of fall arrestor shall be hooked to the static line.
 - Life lines shall be used for easy movement during work of standard size as specified in IS Codes.
 - Cover or guard floor holes as soon as they are created. In case holes cannot be covered the holes / opening/ vacant spaces in the floor should be guarded (with isolation tapes or guard rails) or covered as soon as they are created.
- Height work permit to be followed on daily basis.
- Tool box talk shall be conducted on daily basis for height work.

Dropping Objects

These safety precautions shall be applied when working at height especially in case of bridges or any place where the workers are working at heights:

- Workers shall carry tools in a bag;
- No materials shall be dropped from height. The material would be lowered by a

headline. A workman shall be posted at ground level to clear and caution person from coming under the lowering material;

- In case where the work is carried out at height and the area below is used as a workspace or is a passage for worker the following additional precaution shall be undertaken:
 - The entire area shall be declared as a hard hat area and it shall be strictly enforced. No personnel shall be allowed inside that area with safety helmets.
 - Safety nets shall be provided below the work area

Slips & Trips

- The following are means to either prevent slips, trips, and falls or to minimize the consequences if they should happen:
 - Make the workers aware of the slipping and falling hazards when working on the ground or other platforms.
 - Keep all work areas clean and clear of oil, tools, and debris.
 - Provide guardrails and guards around work areas that are prone to slips, trips, and falls.
 - Instruct workers on proper procedures for using and installing ladders as per IS 3696-2 (1991):
 - Keep all cables and hoses orderly and clear of walking spaces.
 - Wear personal protective equipment (such as hard hats, work gloves, safety shoes, and eye protection).

Fire and Explosion Hazards

To prevent risks of fires from ignition of flammable or combustible materials in the space, and from leaks of flammable gas into the space, from hot work equipment during hot work such as welding, cutting, brazing, soldering, and grinding the following precautions would be undertaken:

- Perform hot work in a safe location, or with fire hazards removed or covered.
- Use guards to confine the heat, sparks, and slag, and to protect the immovable fire hazards

In addition, these basic safeguards have fire-extinguishing equipment readily available and be trained in its use. Make suitable fire-extinguishing equipment immediately available in a state or readiness.

Occupational Health and Safety Training

The contractor shall organize quality Occupational Health Safety training for all its employees/contractor and sub-contractors (including managers, supervisors, works (skilled/unskilled/ both temporary and permanent) and other personnel).

The contractor shall arrange behavioural-based training programmes for all the executives to identify, recognize and eliminate unsafe act and unsafe conditions. The contents of Occupational Health and Safety shall be discussed and assessed by Managers and Supervisors in all the regular and review meetings.

Based on the outcomes of the review meeting and the observations made during the different audits and inspections Refresher-Training programme shall be conducted once in six months.

Every day before start of work Toolbox talk shall be conducted by the supervisor during the morning meeting highlighting the safety precautions which needs to be taken and the rectifications in safety behaviour which has been pointed out.

In case of failure on the part of the contractor to provide all the above- mentioned training programs to all employees in time, the same shall be provided by the Employer through recognized & competent agencies if required by formulating a common scheme to all contractors. Any administrative expenses and training fee towards the same shall be at the cost of the contractor.

OHS Inspection & Audits

- The Contractor shall carry out the following OHS inspections to identify any variation in construction activities and operations, machineries, plant and equipment. The following OH inspections program shall be adopted.
 - Planned General Inspection
 - Routine Inspection
 - Specific Inspection
 - Other inspection
- In addition, the Employer/Engineer shall carry out periodic surprise inspection not less than once every month
- In addition, the Contractor shall carry out OHS Internal audit is to assess potential risk, liabilities and the degree of compliance of construction Occupational Health and Safety Plan. The Employer shall carry out annual OHS Audit of all sites every year. If required supplementary procedures and programs would be developed.

Accident Reporting and Investigation

- The accident reporting mentioned in this section would be over and above the statutory obligations
- All accidents and near misses/dangerous occurrences⁴¹ shall be immediately informed verbally to the Employer & Engineer, followed by a written communication giving brief about incident/ accident, date/ time of occurrence. This will enable the Employer/Engineer to reach to the scene of accident/near miss /dangerous occurrences to monitor/assist any rescue work and/ or start

⁴¹ The following classes of dangerous occurrences or near misses shall be reported to the Employer/Engineer, whether or not any disablement or death caused to the worker, namely: i) collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage or failure of rope, chain or loose gears; or overturning of cranes used in construction work; ii) falling of objects from height; iii). collapse or subsidence of soil, tunnel, pipe lines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork, iii) explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure, of any gas or gases or any liquid or solid used as building material; v) fire and explosion causing damage to any place on construction site where workers are employed; vi). spillage or leakage of any hazardous substance and damage to their container; vii) collapse, capsizing, toppling or collision of transport equipment; viii) leakage or release of harmful toxic gases at the construction site;

conducting the investigation process so that the evidences are not lost.

- Reports of all accidents (fatal/injury) and dangerous occurrences shall also be sent within 24 hours as per format provided in Appendix
- No incident or accident, near miss / dangerous occurrences is exempted from reporting to the Employer.
- Any wilful delay in verbal and written reporting to the Employer shall be penalized.

Emergency Preparedness Plan

The contractor shall ensure that an Emergency Response Plan is prepared to deal with emergencies arising out of:

- Fire and explosion
- Collapse of lifting appliances and transport equipment
- Collapse of building, sheds or structure etc.
- Gas leakage or spillage of dangerous goods or chemicals
- Drowning of workers.
- Landslides getting workers buried
- Natural Calamities like Dust storms, floods, Earthquake, storms etc.
- Collapse of excavated trench
- Collapse of temporary platform or scaffold

Appendix 2: Occupational Health Safety in Plant and Machinery

6.7.19 Construction Machinery

Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers piling figs, vibrio hammers, mobile elevation work platforms, cranes, tipper lorries, lorry loaders, 360° excavators, 180° backhoe loaders, crawler tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, vibratory rollers, tankers and bowsers, trailers, hydraulic and mechanical breakers etc.

A large number Construction machinery are deployed by the contractors for construction work, bridge rebuilding etc. It is therefore essential that adequate safety measures are taken for safety of trains as well the workforce. The following measures should invariably adopt:

The Vehicle and equipment shall not start any work without the presence of Contractor's Supervisor at site.

Since the vehicles and/or machinery are required to work in the close vicinity of active traffic on the highway, the work shall be so carried out in such a way that there is no infringement either to the movement of traffic or the slow-moving vehicle including pedestrian. For this purpose, the area where the vehicles and/or machinery are required to ply/operate, shall be clearly demarcated and acknowledged by the contractor. Special care shall be taken for turning / reversal of vehicles / machinery without infringing the road space available. Barricading shall be provided wherever justified and feasible as per site conditions.

The supervisor / workmen should be counselled about safety measures.

The Contractor shall provide a Safety Certificate to the Employer/Engineer. Every construction equipment shall be in sound mechanical working condition undertaken in the past, any accident to the equipment, visual examination details critical components safety check, devises and its working condition, manufacturer's maintenance checklist, past projects wherein the equipment were used etc as its minimum content.

6.7.20 Excavation & Trenching

Liaison with Utility Companies Prior to Excavation

Prior to any excavation the contractor is responsible for notification of all applicable utility companies, reasonably expected to be encountered during excavation work, -such as sewer, telephone, fuel, electric, water lines, or any other underground installations that excavation work is being performed.

It is expected that Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the commencement of actual excavation.

Contractor must verify the location of any marked utility or as-built information either prior to or during excavation.

Safety of Road Users and Workers

- During excavation, the contractor shall be responsible for ensuring a safe working environment for its employees and pedestrians. When excavation operations approach the estimated location of underground installations, the exact location of the installation will be determined by safe and acceptable means.
- Maintain a physical barrier around all excavations and machinery. Often times caution tape is insufficient, and barriers like properly supported fencing or temporary chain link fencing must be installed. All excavation sites are to be secured during off work hours to prevent unauthorized access.
- The contractor is responsible for providing the proper signage necessary to direct both vehicular and pedestrian traffic safely around or through the work area.
- The contractor is responsible for routine inspections of all excavation equipment. The inspection is to include safety features like back-up warning sounds and appropriate lighting.
- The contractor is responsible to ensure that equipment operators carry the required (valid) licenses and have the necessary training to operate the equipment on site.

Safe Practices for Excavation and Trenching

The contractor shall ensure that:

- Each employee in an excavation shall be protected from cave- ins by an adequate protective system.
- All excavation which is more than one 1.5 m or above, such excavation should be protected by adequate piling and bracing against such bank or side
- Where banks of an excavation are undercut, adequate shoring is provided to

support the material or article overhanging such bank.

- Excavated material is not stored at least 0.65 m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and the banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or fall upon a construction building worker working below such bank
- . Metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards.
- Trench and excavation is protected against falling of a person by suitable measures if the depth of such trench or excavation exceeds 1.5 m and such protection is an improved protection in accordance with the design and drawing of a professional engineer, where such depth exceeds 4m.

Concrete and Masonry Construction

Concrete Construction

- No construction loads shall be placed on portion of concrete structure unless the Supervisor determines, based on the information received from a person who is qualified in structural design, that the structures capable in supporting the loads.
- All protruding reinforced steel onto and into shall be guarded to eliminate the hazard.
- No employee shall be permitted to work under the concrete buckets while buckets are being elevated or lowered into the position. To the extent practical, elevated concrete buckets shall be routed so that no employee or the fewest number of employees are exposed to the hazards associated with buckets or concrete falling from it.
- Form work shall be designed, fabricated, erected, supported, braced and maintained so that it is capable of supporting without failure all vertical and lateral loads that may be reasonably be anticipated to be applied to form work.
- Forms (except those used for slabs on grade and slip forms) shall not be removed until it is determined that the concrete has gained sufficient strength to support its weight and superimposed loads. Such determination shall be based on one of the following:
 - The plans, specifications, and stipulated conditions for removal forms, or
 - The concrete has been properly tested with an appropriate standard test method designed to indicate the compressive strength, and the test results indicate that it has gained sufficient strength to support its weight and superimposed loads.

Reinforced Earth (RE) I Masonry Wall

- To the practically feasible extent at site, a limited access zone will be established whenever a RE Masonry wall is under construction. It shall be established prior to the start of the construction of the wall. The zone shall conform to the following as far as practical:

- It shall be equal to the height of the wall to be constructed plus 1.2 m and shall run the entire length of the wall.
- It shall be established on the side of the wall that will be un-scaffold or free standing.
- It shall be restricted to entry by the employees actively engaged in construction of the wall. No other employee shall be permitted to enter the zone.
- It shall remain in place until the wall is adequately supported to prevent overturning and to prevent collapse.
- All masonry walls more than 2.4 m in height shall be adequately braced to prevent overturning and to prevent collapse unless wall is adequately supported so that the wall will not overturn or collapse. The bracing shall remain in place until permanent supporting elements of the structure are in place.

Compaction of Backfill of Material

- Tracked equipment shall not be allowed to come into direct contact with reinforced strips.
- Heavy equipment shall not be allowed to come within 1.5 m of the retaining wall. The limited access zone shall be marked with the tape "No Heavy Equipment Beyond This Point".
- Tags shall be hung from the tape every 25m.
- Compaction of backfill close to the wall shall be done only with hand operated vibrating plate compactor or light weight rollers (< 500 kg). The compactor shall move only parallel to the wall.
- Props shall be placed on two layers for preventing outward movement before compaction is started.

To avoid kicking out, backfill shall not be placed against the initial row of panels until the first row of reinforcement has been connected.

Safety Measures for Handling Bituminous Materials

In cases of bitumen handling and application the following hazards

- Burn injuries if there is possibility of skin contact and if temperature is elevated
- exposure to bitumen fumes and solvent vapours
- In case of Hot-mix works and hot mix plants the hazard zones are as follows:

Box 0-3: Hazard Zones in Hot Mix Plant and at Worksites

In the Hot Mix Plant:

- Around the vents of the bitumen storage tanks.
- Near the asphalt mixer, asphalt conveyor -belt, skip, hot storage bins, during loading of trucks.
- Near the crusher of old asphalt.
- In the Plant laboratory
- Exposure in and around the mixing plant is in general of short duration.

On the Work Site

- During the application of hot asphalt, exposure to asphalt / bitumen fume: may be experienced by paver driver, screed man, rake man and roller driver since the work on and around the paving machine.

- Exposure to asphalt/ bitumen fume condensate via the skin may be considerable for people working on the paving machine.
- During spraying bitumen emulsions or cut back bitumen the sprayer may receive highest exposure to spray cloud or fume.

During milling or crushing, annihilated of and skin contact with bitumen.

The safety measures which are essential during the process of heating of paving bitumen are:

- Mercury-in-steel dial thermometer, with long stem, should be used for recording temperature of bitumen.
- The bitumen boiler should be filled with bitumen with sufficient space left for expansion of bitumen. It should be loaded with that much quantity of bitumen so as to avoid keeping hot bitumen continuously at high temperature for long periods.
- The heating process has to be controlled depending on the quantity of bitumen in the boiler, the outlet for bitumen should be leak-proof and the boiler should be covered when not in use.
- The boiler should have a chain pulley type of loading arrangement for lifting bitumen drums.
- **Hydrogen Sulphide Gas:** In view of the possible presence of hazardous concentrations of hydrogen sulphide gas in the vapour space in hot bitumen storage tanks or vessels appropriate precautions must be taken when opening or entering tanks, vessels or other containers to avoid inhalation of this acutely toxic gas. Gas detectors, available for rapid monitoring of hydrogen sulphide gas, should be used for suitability of atmospheres for safe entry into such storage spaces. Personal alarms for hydrogen sulphide could be used as a further safeguard. Advice on selection of suitable respiration and other protective devices could be obtained from a health and safety specialist.
- **Protective Clothing:** Labourers attending to the process of heating bitumen or its application should be provided with hand gloves, gumboots, face masks and goggles to ensure adequate personal safety and as a guard against any accidental contact with any bitumen or bitumen derivatives. They should wear full sleeve shirts and full-length trousers to ensure that they have the least exposure to bitumen.
- **Facilities:** Workers should be provided with adequate washing facilities viz. warm water mild soap, mild skin cleanser, and clean (preferably disposals) towels.
- Awareness about thorough washing of skin after handling bitumen materials should be encouraged through various educational means.
- **First Aid:**
 - In case of burn injury from hot bitumen falling on the body, first-aid may be done by thorough cooling of the affected part by cold running water up to 10 minutes or longer if layer is thick or by giving an ice pack. No attempt should be made to remove firmly adhering bitumen from the skin. It should either be allowed to fall off gradually or it may be removed when necessary by warm medicinal paraffin or a blend of paraffin and

kerosene oil, remembering that kerosene oil may cause skin irritation. This shall be followed by washing with soap and water and then applying a skin cleansing cream. The burnt area should not be bandaged. The casualty should be taken to hospital for treatment without delay.

- If bitumen is splashed into the eye it should be cooled immediately under cold running water for at least 5 minutes. Medical attention should be obtained.
- First aid treatment for inhalation is only to be required if hydrogen sulphide is involved. If this is suspected, all necessary precautions must be taken including the use of breathing apparatus to avoid exposing rescuers to a contaminated atmosphere.
- **Transportation:**
 - Closed systems should be used for the handling and transportation of hot and cut-back bitumen. Transfer from storage tanks to point of use should be by mechanical means in order to minimize the possibility of skin contact or fume inhalation. The bitumen boiler containing hot bitumen should be shifted from site to site carefully by towing at slow speed to avoid splashing of bitumen.
 - When hot bitumen is added in a hot mix plant for mixing with hot aggregates, care should be taken to avoid burn injuries. In the case of manual handling of hot bitumen, buckets should never be filled to the brim with hot bitumen. In mixing plants, which have no separate pug mill for mixing of aggregates and bitumen and where heating is done in the drum itself, the burner flame should be reduced after adding bitumen to avoid overheating of bituminous mix.
- **Spraying:** Care should be taken when spraying of bitumen from perforated can sprayer or from bar sprayer. The spraying nozzle and the hosepipe should be kept thoroughly clean for smooth and uniform spraying of hot bitumen. Under no circumstances, the hosepipe should be disconnected as any pressure developed in the pumping unit may result in hot bitumen splashing and thus injuring the operator.

Batching Plant & Casting Yard

Batching Plant and Casting Yard Layout

- The batching plant/casting yard shall be effectively planned for smooth flow of unloading and stacking the aggregates reinforcements and cement, batching plant, transport of concrete, casting the segment, stacking the segment and loading the segments to the trucks. As far as possible the conflicts should be avoided.
- The batching plant / casting yard shall be barricaded and made as a compulsory PPE zone
- If in case of material unloading area is not maintainable as PPE zone, the same shall be segregated properly and made as a non-PPE zone with appropriate barricading.

- Electrical system shall also be suitably planned so that location of diesel generator, if any, location of DBs, routing of cables and positioning of area lighting poles/masts does not infringe on any other utility and pose danger.
- Drainage shall be effectively provided, and waste water shall be disposed after proper treatment
- Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation.
- Manual handling of cement shall be avoided. Whenever it is absolutely necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.
- Access roads and internal circulation roads shall be well laid paved and maintained properly at all time.

Guidance Note 13: Community Health Safety

General Principle

Managing safety of road users both during construction and during the operation would be of very important. Considerable emphasis has been provided by the Ministry of Road Transport and Highways, Government of India on Road Safety. This would include safety of the vehicle as well as the pedestrians.

Issues

The scenario of road safety in the country described below clearly highlights the issues related to road safety and its importance:

The National Highways constitute about 2 per cent of the total road network of India, but they accounted for 29.6 per cent of total road accidents and 34.5 per cent of total number of persons killed. The State Highways accounted for 25.3 per cent of total accidents and 27.9 per cent of the total number of persons killed in road accident in 2016⁴². The following locations and road user have been found prone to accidents

- Traffic junctions are points of conflict and hence, are prone to road accidents. About 37 per cent of total accidents took place on junctions itself during the calendar year 2016. Within traffic junctions, uncontrolled ones contributed to a major portion of road accidents underscoring the importance of traffic control mechanism at junctions.
- Among the vehicle categories, two wheelers accounted for the highest share in total number of road accidents (33.8 per cent) in 2016, followed by cars, jeeps and taxis (23.6 per cent), trucks, tempos, tractors and other articulated vehicles (21.0 per cent), Buses (7.8 per cent), Auto-Rickshaws (6.5 per cent) and other motor vehicles (2.8 per cent).
- Road users on two-wheelers are the most vulnerable; constituting 34.8 per cent of total persons killed in 2016.

The above information highlights the requirement to develop road safety infrastructure, and improve driving quality as well as awareness among the population.

Legislations & Standards

The Rajasthan Road Safety Policy 2016 fixes a target of reducing the road accident fatalities in the state to 50% of the baseline figures in 2015 by 2020. To reduce the mortality and morbidity in the state the Government of Rajasthan has decided to undertake the following: Strengthening Institutional & Legal Environment

- Developing a mechanism for funding Road Safety Activities
- Improving Road Infrastructure
- Improving the quality of drivers
- Safety for vulnerable road users

⁴² <http://www.morth-roadsafety.nic.in//admnis/admin/showimg.aspx?ID=297>

- Road Safety Education and Training
- Emergency Care and medical service for road accident victims

Detailed Guidance

Planning during the Design stage

During the design stage a road safety audit shall be carried out as per the guidelines laid down by Ministry of Road Transport and Highways (MORTH). Black spots on the state highways would be identified based on fatality data furnished by traffic police/ Police authorities of states for the last three calendar years. In case such data is not available then the information may also be obtained in discussion with local police and local populations. Each black spot would be assigned a unique ID No which is an alphanumeric as per the guidance of MORTH⁴³. However, for the project, this may be modified to include the identification number of the state highway and the kilometre chainage and other parameters as appropriate.

During the Pre- Construction stage

To address the safety concerns to road user and traffic during operational phase, the Detailed Design shall contain the following:

- Traffic hotspot study indicating location where conflicting traffic and accidents occur. Design interventions should be suggested in such locations
- Selection and location of regulatory as well as informatory signs as per IRC: 67-2001, depending upon the geometry of the road.
- In case of hill roads, provision of passing places and parapet wall, crash barriers shall be included in road design

During the Construction Period

It would be the responsibility of the Contractor to execute construction work with least disturbance to the environment, adjoining road users and traffic. During the progress of work, the following are the safety requirements that need to be undertaken by the contractor at the construction site;

- All transitions, ingress/ egress to and from the main highway, shall have proper and smooth geometry and traffic shall be guided by road signs, markings, delineation and other appropriate means as required for safe and efficient operation.;
- All worksites should be barricaded, and the integrating of the workspace segregations maintained at all times;
- In settlement area the workplace should be segregated by the erecting barriers. Separate walkway should be identified in the settlement areas. Crossover points should be provided at the worksite locations in settlement areas so that people can easily crossover.
- At the point of entry or exit from the work site flagman should be provided. The entry and exit vehicle shall be regulated by the flagman to prevent collision;

⁴³ XX-YYY. XX is a alphabetical state/UT code. YYY is a numerical serial number of the spot in the state/UT. This ID is used for monitoring (i) actions for it's rectification and (ii) feed back on accidents after rectification.

- All worksite shall be provided with reflective stickers so that it can be easily identified during night
- The worksite within the settlement shall be properly illuminated as a safety precaution.

Decommissioning of the Camp

All the safety measures mentioned above shall also be followed during the decommissioning phase.

No debris shall be left of worksite or in the adjoining lands

Operation of the Road

Efficacy of the Road Safety Engineering measures proposed in the design phase is ensured only when road accidents / fatalities related to road and road environment are eliminated as reflected in feedback on accidents/ fatalities at the improved location for at least 3 years. Therefore, regular collection of the accident / fatality data at the improved locations from police authorities and processing the data is very important. This data shall also be forwarded to Road Safety Cell Engineering MORTH on quarterly basis.

Concerned field engineers should visit the Critical accident prone locations (identified out of the analysis of accident information- where there is history of repeated accidents) in their jurisdiction and should identify the broad additional features which would be required to improve the safety like improvement of junctions, improvement of geometry, provision of pedestrian facilities, provision of service roads, widening of any bottle neck portions etc.,. Availability of land for accommodating these additional features and any ongoing / upcoming projects at the identified sites should also be assessed. It should not be considered as a constraint in case of improving road safety.

Proposals should be prepared based on the outcome of the site visit for accommodating the remedial measures to the extent feasible. As discussed above land availability should not be considered as a constraint. If land is not available technological/ design or alternatives or in extreme cases procurement of land should also be considered. The draft proposal together with cost estimate, complete details of geometry, road signs, markings etc should be part of the annual Plan.

In case of sanction of the annual plan work relating to road safety shall be given priority.

Guidance Note 14: Use of Alternate Materials & Construction Methodologies

General Principle

Increasing demand for natural material for other construction activities e.g. building construction, urban development projects has put pressure on the existing natural resources e.g. aggregates, sand, soil. Procuring natural construction material for the road construction has thus not only become difficult due to increased competition from other sectors but also escalated both time and money required for procuring them. Increased regulatory compliance requirements have also made availability difficult. Added to this is the increase lead distance because at times these materials have to be procured from quarries away from the construction site thus not only increasing cartage cost but also increasing the carbon-footprint of the project.

The use of alternate materials for construction focuses on the management and reuse of alternate material including waste materials locally available in the project area or generated by the project itself.

Issues

As discussed above the pressures on the natural resources coupled with the increase regulatory requirement and the drive to make the construction of road sustainable the use of alternate or recycled material has been envisaged. This guidance note is not entirely obligatory on the Contractor. There are even regulatory directives e.g. fly ash usage in road and codal provision from Indian Road Congress (IRC) to use waste and recycled material.

Legislations & Standards

The IRC Codes relating to use of alternate material or environment friendly technology are:

- IRC SP 58 - 2001 Guidelines for Use of Fly Ash in Road Embankment Structures
- IRC: SP:63-2004 “Guidelines for the Use of Interlocking Concrete Block Pavement”
- IRC:44-2008 “Guidelines for Cement Concrete Mix Design for Pavement”
- IRC: SP:89-2010 “Guidelines for Soil and Granular Material Stabilization using Cement, Lime & Fly Ash”
- IRC:36-2010 “Recommended Practice for Construction of Earth Embankments and Subgrade for Works”
- IRC:37-2012: Tentative Guidelines for the Design of Flexible Pavements
- IRC: SP:70-2005: Guidelines for the Use of High Performance Concrete (HPC) in Bridges;
- IRC: SP:71-2006 Guidelines for Design and Construction of Pre-tensioned Girder of Bridges
- IRC: -2011 “Specifications and Code of Practice for Construction of Concrete Roads”
- IRC: -2011 “Code of Practice for Concrete Road Bridges”

- IRC:37-2012 “Tentative Guidelines for the Design of Flexible Pavements”
- IRC: SP:102-2014 “Guidelines for Design and Construction of Reinforced Soil Walls
- IRC:116-2014: Specifications for Readymade Bituminous Pothole Patching Mix Using Cut-Back Bitumen
- RC:120-2015: Recommended Practice for Recycling of Bituminous Pavements
- IRC: SP:107-2015: Guidelines for Gap Graded Wearing Course with Rubberised Bitumen-Rubber
- IRC 88 - 1984 Lime Fly-ash stabilised soil

In addition, MoEFCC notification on utilisation of fly ash dated 25th March 2015 mandating all road projects with 500 km to use fly ash for embankment purpose

Detailed Guidance

6.7.21 Planning during the Design Phase

The feasibility studies would identify the possible sources of use of alternate material as described in Appendix 1 Alternate methods of construction should also be identified. The Bid document and the bill of quantities prepared should have specific inclusion of both alternate material and alternate technology.

The feasibility of using saline water after treatment for use construction activities shall be carried out. Efforts should be made to treat the water to standards so that it can be used for consumption.

6.7.22 Planning during the Pre-Construction

During the design of the road the Contractor shall ensure that the consumption of natural resources is reduced. Alternate material and technologies should be used for road construction as per the provisions in the IRC Codes and the BoQ documents

6.7.23 During the Operation Phase

During this stage efforts would be made to reuse /recycle the material during the maintenance. Also, alternate techniques for construction shall be adopted so that the heating requirement for bitumen is reduced.

Appendix 1: Use of Alternate Recycled Material or Waste in Road Construction

Use of fly ash in construction

In tandem with the IRC Guidelines for promoting the use of fly ash in road embankments (IRC:SP:58-2001), MoEFCC issued an amendment to their fly ash notification which make it mandatory for road construction within a radius of hundred kilometres of thermal power plant to undertake construction or approve design for construction of roads or flyover embankment with fly ash as mentioned in the IRC specification No. SP:58.

Further, a number of guidelines been formulated by for promoting use of fly ash in different structural parts of road and bridge construction, these include:

- IRC: SP:63-2004 “Guidelines for the Use of Interlocking Concrete Block Pavement”
- IRC:44-2008 “Guidelines for Cement Concrete Mix Design for Pavement”

- IRC: SP:89-2010 “Guidelines for Soil and Granular Material Stabilization using Cement, Lime & Fly Ash”
- IRC:36-2010 “Recommended Practice for Construction of Earth Embankments and Subgrade for Works”
- IRC: -2011 “Specifications and Code of Practice for Construction of Concrete Roads”
- IRC: -2011 “Code of Practice for Concrete Road Bridges”
- IRC:37-2012 “Tentative Guidelines for the Design of Flexible Pavements”
- IRC: SP:102-2014 “Guidelines for Design and Construction of Reinforced Soil Walls”

Use of stabilised low-grade aggregate and soil to substitute crushed rock

To reduce the excessive dependence on the quarrying of rock for crushed rock in road construction new technology of stabilized low-grade aggregates and soils has been developed and tested. The same has been institutionalized in updated IRC:37-2012: Tentative Guidelines for the Design of Flexible Pavements. Besides, IRC:37-2012 provides for the modified design procedures based on the mechanistic empirical design which relies on the stresses and strains developed in various pavement layers and the strength of these layers in terms of elastic moduli and durability instead of the old design concept of strength of the pavement layers generated by inter-granular friction, which made the use of crushed rocks mandatory.

Use of Chemical in Cement Concrete

To reduce the consumption of aggregate and cement IRC has developed two codes namely

- IRC: SP:70-2005: Guidelines for the Use of High Performance Concrete (HPC) in Bridges;
- IRC: SP:71-2006 Guidelines for Design and Construction of Pre-tensioned Girder of Bridges

While the high performance concrete uses silica fume, (as a foaming agent and viscosity modifier; added @10% by weight in replacement of cement) in concrete mix. As a result, strength of concrete increases nearly 70%. This is technology has resulted in less consumption of stone aggregates and cement hence saving in time and energy.

The construction of pretensioned girders widely adopted for construction of structures, is safer (light structure); economical (less use of stone aggregates).

Use of Plastic Waste

Guidelines have already been developed by IRC for use of Plastic waste in bituminous waste. The IRC: SP-98-2013: Guidelines for the use of Waste Plastic not only legitimises the use of plastic waste in bituminous mixes it also helps in disposal of the plastic waste.

Keeping in view the non-bio-degradability character and toxic nature of the waste plastic, the provision for its use in road construction is recommended to be made “mandatory”. It also results in saving of 6-8 % in bitumen.

Use of Slag

The new IRC:112-2011: Code of Practice for Concrete Road Bridges provides for use of blast furnace slag up to 50% by weight in replacement of cement in construction of concrete piles in

coastal regions. This brings not only reduces the consumption of cement and steel in bridge construction but also reduce the greenhouse gas emission from both steel and cement. Additionally, it helps in disposal of blast furnace slag.

Use of Recycled Bitumen

The failed and damaged bituminous pavements have valuable aggregates and bitumen in them. Using the waste bituminous pavements by reclaiming and recycling the materials would not only saves natural resources i.e. aggregates, and land required for dumping of the failed bitumen but also reduce the consumption of bitumen. Use of such materials in a construction layer has been permitted in the IRC:37-2012 Pavement Design Guidelines (Revised).

In addition, using new environment friendly technology, reclaiming the damaged or unserviceable pavement materials is technically possible by milling, mixing fresh materials with reclaimed materials, and producing mixes (either in-situ or in plant). IRC has also drawn Guidelines namely IRC:120-2015: Recommended Practice for Recycling of Bituminous Pavements.

Use of Gap-graded bituminous mixes using crumb rubber

The technology involves converting the used and discarded rubber tyres of vehicles into crumbs and mixing them with aggregate and bitumen to produce a strong and durable mix. The grading (or packing of various sizes of aggregates) is not close but leaves gaps to accommodate the crumbs in the mix, which after absorbing oil in the bitumen expand and make the mix dense, durable and more flexible. IRC has developed standards and formulated the guidelines under the code named as “IRC: SP:107-2015: Guidelines for Gap Graded Wearing Course with Rubberised Bitumen-Rubber”. which will not only improve the pavement design but at the same time provide a way for utilize the rubber waste in construction rather than disposing it into landfills and use land resources or burning of rubber which itself is polluting., Use of these wastes in bituminous construction is extremely environment friendly and makes economic sense as well (because of higher performance, durability and less maintenance needs thus less emission from hot bitumen works.

Appendix 2: Use of Alternate Construction Methodologies

Use of warm mix asphalt technology

Most bituminous mixes are produced at a very high temperature (nearly 160°C), mainly because bitumen is very viscous at low temperatures and cannot coat the aggregates unless heated to high temperatures. This results in releasing large quantities of pollutant and GHG's in the atmosphere

Harnessing technologies available, which can facilitate the coating at low temperatures by:

- increasing the surface area of bitumen (foaming) or;
- by reducing the surface tension at the aggregate bitumen interface

with use of certain additives, thereby making the mixing possible at much lower temperature (typically 110°C), saving energy reducing GHG emission and hence earning carbon credit.

IRC has developed a code for using the environment friendly technology of using variety of patented products as additives which come in different forms such as solid, liquid and powder and use different processes for administering the additives and mixing namely IRC: SP-101-2014: Interim Guidelines for Warm Mix Asphalt.

Further, to reduce the emission during the maintenance IRC has also formulated guidelines

- IRC:116-2014: Specifications for Readymade Bituminous Pothole Patching Mix Using Cut-Back Bitumen, a mix capable of being stocked for at least six months without stripping

IRC: SP:100-2014: Use of Cold Mix Technology in Construction and Maintenance of Roads Using Bitumen Emulsion.

ⁱ Ibid.

ⁱⁱ Rajasthan State Action Plan on Climate Change (2014), Govt. of Rajasthan <http://www.moef.nic.in/sites/default/files/sapcc/Rajasthan.pdf>

ⁱⁱⁱ Rajasthan State Disaster Management Plan (2014), Disaster Management, Relief and Civil Defence Department, Government of Rajasthan <http://dmrelief.rajasthan.gov.in/documents/sdmp-eng.pdf>

^{iv} Rajasthan State Action Plan on Climate Change (2014), Govt. of Rajasthan <http://www.moef.nic.in/sites/default/files/sapcc/Rajasthan.pdf>