GOVERNMENT OF MEGHALAYA

PUBLIC WORKS DEPARTMENT(ROADS)

**Terms of Reference for Consultancy Services to establish**
"Meghalaya Road Asset Management System"
**On the Meghalaya State Road network**

**Terms of Reference**

## 1. SHORT DESCRIPTION:

These services cover technical assistance to establish and operationalize a Road AssetManagement System (RAMS) for the state road network in the state of Meghalaya.

## 2. BACKGROUND

The Meghalaya Infrastructure Development and Financing Corporation (MIDFC), Department of Planning, Government of Meghalaya, Shillong is the implementing agency for the Meghalaya Integrated Transport Project (MITP). A dedicated Project Management Unit (PMU) has been established in MIDFC at Shillong, headed by a Project Director and supported by other staff responsible to implement the project with the support of various line department's PIUs (Project Implementation Units) of Government of Meghalaya. The major stakeholder is Directorate of Tourism.

MIDFC strives to provide efficient, affordable, customer-focused, environmentally sustainable integrated transportation solutions, connecting villages, towns, cities and centres of industry, commerce, tourism, and pilgrimage across the State.

**3.** Meghalaya is a relatively small hilly state situated in the North-East region of the country. It is lagging in development as compared to rest of the country due to its poor transport infrastructure, difficult hilly terrain and climatic conditions, tenuous communication, poor market access, low agriculture productivity, and low level of industrialization. About 80 percent of the population is rural and mainly depends on agriculture which contributes only 17 percent to the state GDP. Meghalaya is famous for its natural scenic beauty and has big potential for development of tourism in addition to agriculture, forestry, handicraft, and minerals. Meghalaya is a matrilineal society and adequate livelihood opportunities for women are a key priority. As part of its development policies, Government of Meghalaya is implementing various programs for development of tourism, agriculture, handicrafts, rural livelihood, employment generation, and women empowerment. It is perceived that adequate transport infrastructure and efficient transport services (focus of the proposed project) are essential for successful implementation of these programs. **Road Network in Meghalaya State:**

Meghalaya's road network of over 14,000 km consists of National Highways, State Highways, Major District Roads, Rural Roads, and Urban Roads, in addition to many unclassified tracks and footbridges. The Core Road Network comprises of:

| Road Type | Length (KM) |
|---|---|
| National Highway (NH) | 1,204 |
| State Highway (SH) | 751 |
| Major District Road (MDR) | 1,200 |
| Rural Road (RR) | 10,618 |
| Urban Roads (UR) | 350 |
| **Total** | **14,123** |

The existing road network of over 14,000 km has been developed in bits and pieces rather than according to a well-designed plan: consequently, it is non-coherent and has many deficiencies like missing links, bridges, drainage and protection structures, and road safety engineering measures; and inadequate pavements and poor riding quality. There is practically no effective air, rail, or waterway connectivity. Its road density is 0.48 km/sq. km against 1.7 km/sq. km for all-India. Large part of the network has failed due to poor quality of initial construction, lack of maintenance, and extreme climate events (high rainfall). There are about 800 semi-permanent timber bridges in failed condition – posing a serious safety issue and need immediate replacement. Particularly, the road network towards Bangladesh Border is relatively underdeveloped and the population living in that part is deprived of even the basic facilities like access to health and education.About half of the 5,362 habitations lack all-weather road access, out of these 1,700 not covered under PMGSY as their population (of individual habitation) is below 250. Due to hilly and difficult terrain conditions, road construction is not always possible in many areas. In such situations, alternate solutions such as ropeways, foot bridges and foot paths are to be considered.

The absence of last mile connectivity and transport services impact the transport costs which are about 25 percent higher compared to other places in India reducing the competitiveness of agriculture and businesses.

**3.1.Due to limited road space, traffic management and parking issues, Shillong and other urbanized locations experience long traffic congestions, especially during peak working hours. The reasons for the under-developed transport network are inadequate funds, their inefficient utilization, and low institutional capacities and knowledge base of the transport agencies. Need for establishing a comprehensive computerized RAMS:**

The MIDFC wish to establish a Road Asset Management System (RAMS) to significantly improve state road network planning for both capital and maintenance (Plan and Non-Plan) budgets. The RAMS is envisaged as a system which will eventually serve all levels in the PWD (Roads) department, i.e. headquarters, Circle and Division offices, in planning and managing the state road network.

**3.2.Required features of the RAMS:**

The core of the system will be a Road Information System (RIS) that will include road inventory, condition, and traffic data, around which several applications will be developed/configured to address the various requirements of road planning, management, and monitoring.

**The RAMS will:**

i   identify the needs for road widening, pavement strengthening, bridges, and maintenance;

ii  prioritize these needs using a prioritization criterion, based on economic and other factors; and

iii prepare a multiyear rolling program for network improvement and an Annual Maintenance Plan (AMP) each year containing the identified needs based on the budget allocation.

The system shall be user-friendly and adaptable to produce reliable outputs with minimum level of data inputs and more accurate outputs with better data.

### 3.3.RAMS Project Team:

To establish the RAMS, the MIDFC now intends to commission a team of highly qualified and experienced consultants having proven track record in developing and operationalizing at practical level such systems in road agencies, to undertake the following terms of reference. Concurrent with these services, the MIDFC is proposing to undertake a comprehensive program of investment in its Information Technology and Management Information Systems.

## 4.  OBJECTIVES

The overall objective of the proposed services is to ensure that PWD (Roads) is able to effectively plan and prioritize their capital and maintenance works for 14,123KMs of road network for efficient use of resources. This will help to improve the quality and delivery of department's services in the provision and management of the road system.

**Specific objectives include:**

• Establish and implement, a web enabled GIS based Road Asset Management System (RAMS) that will provide readily accessible, relevant, and valid information on the core and non-core road network, along with analytical tools for use in PWD (Roads) headquarters and all divisional field offices.

• Generate multi-year rolling program for both road improvements and maintenance, linked to the plan and non-plan budgets through the system;

• Institutionalize the RAMS and build capacity within PWD (Roads) to sustain its use.

## 5.  SCOPE OF WORK

The broad scope of this Consultancy services is to:

• Review existing PWD (Roads) business processes and identify the improvements required for developing a state-of-the-artRAMS;

• Supply, configure and host web-enabled state-of-the-art RAMS on the Cloud, and enable transition of the system to the Meghalaya state cloud/any other platform as and when decided by the GOM;

• Review available data with PWD (Roads), collect any missing/required data and migrate all data into the proposed RAMS;

- Determine annual maintenance needs including prioritisation for roads and bridges;
- Define an institutional framework for the RAMS to ensure its sustainability, acceptability of generated plans and development over the long term;
- Impart technology transfer and training to PWD (Roads) staff in operation of the RAMS.

## 6. Description of Services

While performing the following services, the consultants are advised to adhere to Indian Road Congress' recent Guidelines for Road Asset Management System – i.e. IRC: 130-2020.

### 6.1. Task 1: Review Existing Business processes

The Consultant will make a comprehensive review of the existing processes, particularly in terms of preparation of annual maintenance needs and planning budgets for the road network being managed by PWD (Roads)/CRN. The review shall include, but not limited to, road referencing system, data collection and compilation, maintenance needs analysis and preparation of annual works programme. The review shall also identify the availability of current resources, gap analysis and roadmap for RAMS implementation.

### 6.2. Task 2: Development of Road Asset Management System (RAMS)

The broad scope is to configure, install and host a web-enabled system with the following components or modules:

- Road Information System (RIS),
- Location Reference Management System (LRMS);
- Pavement Management System (PMS) with HDM4 software and Engineering Decision Tree process,
- Lifecycle Management System -Asset Management Plan Module
- Traffic Information System (TIS),
- Routine Maintenance Management System (RMMS),
- Bridge Information System (BIS),
- Web-GIS Interface
- Accident Information System (AIS)/ Road safety Analysis System
- Works Monitoring System (WMS).
- Right of Way Feature Information System (RoWFIS) -Environment and Social Information System (ESIS) -
- Rural Accessibility Index Module (RAI)
- Economic Corridor Information System (ECIS)
- Green and Resilient Right of Way module
- Mobile Asset Management System (MAMS)
- Project and Program Development Effectiveness
- System Security and User Management

### 6.2.1. Road Information System (RIS)

The Consultant shall establish a Road Information System (RIS) as the main repository of road assets for the RAMS. The RIS shall:

- be designed around accepted international practices (e.g. common user interface, proper location referencing system, data import/export standards, truth-in-data standards);
- be capable of handling data of different spatial attributes ranging from point data (e.g. km stones) to continuous or interval data (e.g. roughness), and should handle overlapping sections;
- be capable of checking data accuracy and inconsistencies, and enable import and export of data to Excel and/or any other spreadsheet software;
- allow PWD (Roads) staff to add or delete data without needing to access/edit any source code of the application;
- be a GIS based web enabled system, including facilities for data input, mapping, display and information dissemination;
- have a reliable but flexible security system for access and data processing;
- have sufficient flexibility to cater to systemic changes over time

### 6.2.2. Location Reference Management System (LRMS)

The Location Reference Management System (LRMS) will have GIS based interface to create, and store centre-line GIS representation of the road and calibrated with the supplied road length, start/end points, jurisdiction and direction. It must have facility to copy externally prepared GIS representation. It will also allow referencing of road, bridge, culvert and other linear and point assets using linear measurement or GPS location. It should allow for re-classification, re-alignment, re-location, change in jurisdiction, length and chainage of roads using in-built tools.

The Consultant shall establish a comprehensive Geo-referenced Location Reference Management System (LRMS) with the following functionalities:

- Store and manage GIS based location referencing data, such as road, link, node, LRP and section etc,
- Split/merge or edit links and roads,
- Maintain historical changes in the road network, such as new bypasses, road category changes etc,
- Changes in identifiers, alignment and edit of network etc,
- Updates to relevant attribute data due to changes in the location reference data,
- Any other relevant features as per PWD (Roads)'s requirements.

### 6.2.3. Pavement Management System (PMS)

The Consultant shall establish an appropriate Pavement Management System (PMS) based on sound engineering and economic priority principles, capable of undertaking both strategic and project level analysis including program maintenance and rehabilitation of pavements, as well as expansion covering multi-Laning or capacity increase. The software should make use of standard acceptable tools and models for the analysis using HDM-4 as primary knowledge engine. At a minimum, it shall be capable of performing the following types of analysis:

- Strategic budgeting studies: To establish necessary funding levels in general budget categories to achieve a defined level of performance. The analysis should be based on

a life cycle cost approach. The RAMS should be able to establish a medium-term budget framework including budget forecasts.

- Multi-year Rolling Plans and Annual Maintenance Plans for the budget allocation forthe year: To allow for yearly programs for road maintenance covering works such as periodic renewals (based on detailed data provided), routine maintenance (based on norms to be developed using age of surface, type of road and overall condition index), emergency maintenance (based on norms), and special repairs based on the indicative budget to be provided by PWD (Roads)/CRN.

- Project level technical analyses: To allow for specific sections of road to be evaluated for different technically feasible options such as periodic maintenance, resurfacing, rehabilitation, reconstruction, capacity improvement, and other improvement and betterment works.

- Projection of network condition under various budget scenarios.

The Consultant will estimate the average unit cost of road works from historical data and/or engineering estimates through a desktop study. These could come out of recently completed road projects or projects being prepared for bidding. The calibration of the PMS should be based on the available data following guidelines given in Volume 5 of HDM-4 manual or equivalent.

The RAMS should be capable of producing unconstrained budget requirements for multi-year rolling plans for road improvements and periodic maintenance and annual maintenance plans. These should then be prioritized into three years rolling plan considering budget forecasts from the government and other sources. The prioritized road sections for the investments under various plans should be capable of being exported to GIS to be accessible to senior managers to enable decision making.

In addition, the Consultant shall develop an alternative application for medium term programming of road preservation and development works that would not entail life-cycle cost (LCC) analysis for each homogeneous road section. Instead, it should use a different process (such as through decision-tree) to identify immediate needs for renewal, rehabilitation and capacity enhancement with prioritization using multi-criteria analysis (MCA). This tool should be simple, transparent, and user-friendly and capable of producing 2-year programmes of road works under annual budgetary constraints.

### 6.2.4. Lifecycle Management System- Asset Management Plan Module:

This module should be able to link to HDM-4 output and prepare multiple forward budget scenarios/plans for evaluation, including fixed budgets and variable budgets, and budgets aimed at achieving a defined level of service over time including:

- Multiple year works programming and budgeting
- Condition projection
- Lifecycle planning
- Management of performance-based PPP/PFI contracts
- Economic prioritisation
- Whole-life costing

- Long-term modelling of the impacts (on condition, serviceability, asset value and cost) of alternative budgetary scenarios
- Forward investment planning and scenario modelling

### 6.2.5. Traffic Information System (TIS)

The Consultant shall review the existing practices of collecting, storing, and using traffic data and through suitable modifications, develop a Traffic Information System (TIS) linked to the RIS. TIS shall be capable of storing regular and special traffic counts as well as the outcome from specific studies. It shall have the following attributes:

- continuous counts from permanent traffic count stations;
- 3 day or 7 day classified traffic counts;
- seasonal factors and traffic growth rates, if available;
- traffic class (based on subjective assessment) such as high, medium, low for section of roads which are not explicitly covered using regular counts;
- vehicle fleet characteristics including road user costs, vehicle operating costs, travel time and costs, accident and other -related costs;
- sample hourly flow data;
- processed axle load survey data (i.e. aggregated statistics), if available.

The TIS should be able to analyse the above data to produce the following reports:

- <u>Traffic volume and flow characteristics:</u> Average Daily Traffic (ADT), Average Annual Daily Traffic (AADT), seasonal factors, K-factors, hourly distribution of annual traffic;
- <u>Traffic growth forecasts:</u> predicted traffic patterns on road network using supplied traffic growth rates using socio-economic factors;
- <u>Vehicle loading characteristics:</u> average axle loadings and equivalent standard axles;
- <u>Historical and forecast data</u> in a graphical format by vehicle class and/or road class including but not limited to network utilization, traffic volume and loadings, annual vehicle km of travel, annual tonne km of freight by vehicle class and/or road class.

### 6.2.6. Routine Maintenance Management System (RMMS)

The Consultant will establish a RMMS to allocate routine maintenance funding for roads not receiving periodic maintenance or improvement. The RMMS shall enable the PWD (Roads) to define or edit the routine and periodic maintenance activities for all categories of roads and their standards and prepare reports and charts for a business plan. These activities shall have quantity and performance standards, unit rates, and intervention frequencies. It should enable calculation of budget requirements based on the desirable intervention frequency and the work quantity. The criteria for the prioritised work programme shall be developed in consultation with PWD (Roads).The Consultant shall build the system such that an additional monitoring module can be built into it at a later date.

### 6.2.7. Bridge Information System (BIS)

The RAMS shall also contain a cross-drainage/bridge information system with sufficient information on inventory of minor and major bridges including information collected from

routine and special inspections. BIS shall be able to define bridge condition, identify the broad maintenance needs in terms of reconstruction, rehabilitation, periodic maintenance, routine maintenance along with planning and prioritization of bridge works on condition index including prioritized list and cost of repairs. The sub-database will initially be an inventory of all bridges (minor and major), the results of bridge inspections with an option to specify the repair cost. The referencing system of BIS should be compatible with the other modules of RAMS including integration with RIS for network referencing and road data. The system should be able to store bridge inspection photographs, design drawings etc. it should assign condition index to the bridge depending on the rating of elements and overall condition. The system should enable import and export of data from/to common file formats/standards data formats. The Consultant shall design the system such that it can be expanded into a more comprehensive bridge management system at a later date.

### 6.2.8. Web-GIS Interface:

The Web-based GIS Interface (web-GIS) will allow a GIS-map based representation of road data. This application will have road and bridge information organized in different layers to prepare thematic representation of layers using dynamic segmentation. It will also allow overlay of external layers published using ArcGIS services, open source, online satellite map services, and other layers provided by the State, as well as filtering and display of road segments matching a user defined criteria for road/bridge data from surveys or those processed using PMS or AMT.

The system will allow to view/download/report data through a browser based web-GIS interface and will support representation of any linear/point data items using spatial dynamic segmentation of the road network. It will also have the ability to generate maps/reports based on query of selected attribute(s).

It should provide an intelligent dashboard reporting interface using appropriate visual and analytics for instant viewing of the road network characteristics using dynamic charting/tables with drill-down capability.

The reporting will include a 'strip chart' popularly used by PWD for representing location of road assets on a linear diagram of a road, and to present road inventory/condition/structure values in varying width, colour, trend line and cross sectional graphs.

The software will have GIS capability to display the attribute data of roads in a user-configurable thematic map interface. It should have the following capabilities:

- Integration with road, culvert, bridge, R-o-W features and related data
- GPS data integration (an interface to transfer data from external source/ equipment) and show on the GIS
- GIS map plotting/ thematic map preparation capability for the attributes of the road section and bridges as well as viewed in the GIS.
- The GIS interface should be able to display data along the length in a dynamically segmented section
- The GIS interface should be able to view background GIS data held in the client's GIS database
- The GIS interface should enable viewing of video/image data as stored or referenced, by the direction and chainage of the video lookup tables stored in the database

- The GIS-based interface must have facility to overlay open source map layers, and/or satellite imageries, and shared layers provided by the State. There shall be no restriction on the number of layers that can be overlaid. The addition of layers must be user configurable and with appropriate access control
- The software should use ArcGIS Server for integration of map data to publish and display GIS thematic maps.

### 6.2.9. Accident Information System (AIS)/Road Safety Analysis System

Road safety is a growing problem in India and in Meghalaya. Most often the problems of safety are largely a result of inappropriate and excessive speeds, inadequate facilities or consideration for pedestrians, poor design of road geometrics or bad condition of the roads. PWD (Roads) feels that some of this information is extremely useful for road maintenance planning. As such, PWD (Roads) requires an appropriate Accident Information System (AIS) to be developed with required functionality. Such a system should enable required information, such as on black spots to be shared with other stakeholders of road safety in PWD (Roads) through a web based, access controlled interface. The system should include features such as input of accident data, location of road safety hazards (black-spots), data collected from inspections, propose standard engineering safety countermeasures for a defect already stored.

The road safety analysis tool should have capabilities for comprehensive road safety management and advanced analysis and monitoring and evaluation. These may include, inter alia features such as cluster analysis, grid density analysis, stick analysis, blackspot analysis, comprehensive blackspot management capabilities, road safety countermeasure library, cost benefit analysis, heat map analysis.

The consultant should be in close interaction with other consultants responsible for Road Accident Data Management system while designing this module and integrate the systems as necessary.

### 6.2.10. Works Monitoring System (WMS)

RAMS shall also have a facility to track or monitor projects progress at a higher management level. It should enable input of broad progress of the projects along with observations and comments on the progress from the project/site offices. It should contain macro details such as project details, start date, estimated completion, current progress – both physical and financial, major issues and suggested measures etc. The system should have facility to upload geo-tagged photos from the site for each project, which should be linked and displayed on a GIS map to facilitate timely decision making by the senior management of PWD (Roads).

### 6.2.11. Right of Way Feature Information System (RoWFIS) -Environment and Social Information System (ESIS) -

This system will allow input and storage of information about structures, utility services (both above and below ground), and main features of the Environmental and Social components such as by each road and chainage (Linear) within the right-of-way (ROW) and may extend beyond in case of large waterbodies, forests etc. It will facilitate reporting of location of features in a GIS and strip map showing these features along with road features and bridge locations. It should be able to identify features with a given offset from

Centreline or edge of the carriageway. Further, it should be able to store environment and social information as available by Area (District) and as link to external internet resources.

The RoWFIS supports the following core right-of-way business areas of appraisal (land valuation), acquisition, relocation, and property management for the Ministry or Road Authority. An integrated Right-of-Way Feature Information System (RoWFIS) primary functions must include the following capabilities:

- Manage transportation project information relevant to the right-of-way (land) acquisition process;
- Manage all information using GIS-enabled data including on individual parcelsthat are candidates for acquisition
- Support all aspects of the right-of-way acquisition lifecycle, including appraisal (land valuation), negotiation, and relocation (RAP);
- Support land ownership management activities, including tracking of land parcels cataloguing, gazetting of land parcels, lease/rental for advertising or utilities, etc.
- Capture the appraisal (land valuation), the review appraisal, and the finding of just compensation within the system
- Support residential and business relocation services, including either calculations of relocation eligibility within the system or linkages to external tools/calculators;

- Manage and track utility/facilities relocations, including managing the details of required agreements with utilities. This includes managing resettlement action plans (RAPs), community (affected persons) consultations, social impacts management, etc.


### 6.2.12. Rural Accessibility Index Module (RAI):

The tool shall aid in measuring proportion of the rural population who live within 1-2 km of an all-season (supported by field verification). For this purpose, an open RAI Toolkit may be referred to (https://github.com/developmentseed/rai-toolkit)or the Consultant use a web-based geo referenced toolkit. The data should be represented in Web-GIS maps and integrated in RAMS.


### 6.2.13. Economic Corridor Information System (ECIS):
The module shall help to identify centres for economic growth, major service delivery locations such as SMEs, markets, warehouses, cold storage, packhouses, processing facilities, employment centres;bus and truck stops, logistics parks,social services (hospitals schools), airports, railway stations, River Ports, congestion level (expressed in actual average driving speed),Air Quality Index (AQI), major national / regional investment initiatives using GIS-enabled shapefiles. Corridors shall be identified through the modules based on their economic importance and map various parameters.


### 6.2.14. Green and Climate Resilient Right of Way Module:
The module shall help identify disaster prone sections (landslide/ landslip, flood) etc. along Right of Way in the field. The module shall also enable mapping bioengineering solution for protecting landslide, vegetated dumping areas, etc. as well as PWD owned rehabilitated quarry sites, etc.The process shall include verification of existing right-of-way (RoW) by

obtaining relevant revenue records for the 14,123 km roads(National Highways, State Highways, MDRs, Rural Roads and Urban Roads).

The data shall be appropriately geo-referenced and integrated in Web-GIS and strip-charts.

### 6.2.15. Mobile Asset Management and Accident Data Capture System (MAMADS))

The system should include mobile application software that can be used by PWD (Roads) engineers and contractors for asset management related data collection. The Consultant should provide 35 licences of this software which should link with the COTS RAMS solution hosted by the Consultant. The mobile application software should be platform independent and should work in all mobile phone and tablet devices including Android, IOS and Windows platforms. The application should work with or without internet connection. It should assist with visual inspections of the road assets and to automatically upload data to the RAMS database.

It should, allow monitoring of the performance of the network, at a minimum cover the following surveys:

- Routine maintenance
- PMS visual surveys
- Detailed inspections
- Asset inspections
- Risk surveys
- Value Management surveys
- Inventory surveys
- Accident data collection – The accident data collected via this Mobile app shall be integrated into the Accident Information System ( AIS)

It should also allow community participation to disseminate, and upload photographs and information related to road condition, traffic, emergency, works etc.

### 6.2.16. Project and Program Development Effectiveness

The RAMS should enable analysis of data for improved prioritization based on understanding of multiple complex factors, improved project scoping based on understanding of root causes, budget provisions, road condition and ongoing maintenance costs.The Consultant shall develop procedures for monitoring the implementation of forward work programs being produced by the RAMS, and for feeding back relevant information to the RAMS to enable future planning to be more accurate and effective. The feedback must include location, type, and cost of actual works in the field. The consultant shall also provide training in these procedures.

### 6.2.17. System Security and User Management

- Authentication - The system will adopt Single Sign On (SSO) security system for authentication in place in MIDFC Server with appropriate encryption level for user data. DoIT& C currently uses 'Windows Active Directory' based SSO.

- Authorization - Following levels of user security management features must be present in the RAMS application.

    a. User Management – RAMSwill request list of users through the SSO from Meghalaya State portal, the modality of which will be discussed with DoIT& C as the inception by the SPC. These lists of users will always be dynamically synced and a copy of the same will be store within RAMS database to assign role and jurisdiction. The supplier will make alternate arrangements to build own security module to create/manage users if the SSO facility is not available from DoIT& C.

    b. Role Management – Thesystem will define levels of system use (roles). This will allow grouping of select functions available in a module(s) and create roles for users. The functions must include separate mode for view only, and/or editing for all such functions and allow for assignment of role(s) to users.

    c. Jurisdiction management–Thesystem will define (or add new) hierarchical jurisdiction of PWD (sub-division, division, circle, districts, zone), political jurisdictions (block, district, constituency etc.) or any other jurisdiction type as desired by PWD (Roads) in the future. Further, the system will allow to assign jurisdiction to a road or a part of the road for data reporting.

### 6.2.18. RAMS Software Requirements

The Consultant shall supply Commercial Off the Shelf (COTS) RAMS, customize it for use at PWD (Roads), populate it with the required data and provide managed services for a period of two years as follows:

i) Software and customization: The Consultant shall provide 35  licenses of the customized RAMS, one license for HDM4, 35  licenses for MAMDS and licenses for appropriate GIS base maps for two years. COTS which is already in use in India or Indian sub-continent shall be preferred for further customization. All supporting and 3$^{rd}$ party software like backend database such as MS SQL Server, Oracle or any equivalent RDBMS, GIS platform such ArcGIS etc., should be included as part of COTS RAMS, for the full functioning of the asset management software.  It is to be noted that the Client will not pay for any third-party software after the contract is signed. After successful use of the COTs solution, the client may decide to go for local, on site implementation with unlimited licenses under a separate contract.  As such, the solution should be fully web-based and mobile enabled, with all core applications functional on all popular mobile platforms.The Consultant shall establish and implement a RAMS through customisation of their COTS software or by developing one for unlimited Users. The buyer will retain the IPR for only those modules, sub-systems, or applications that have been custom-developed for this project. All the standard IPR clauses will apply to only these          bespoke          parts          of          the          offered          solution.

6.2.18.1.          Hardware: The Consultant should provide 10 Personal computers (i.e. Intel® 6th Gen Core™ i5, Windows 10, 8GB RAM, up to 500GB HDD, 25-inch LCD

monitor from reputed brands such as Dell, HP, or Lenovo) for end users for accessing and using the cloud hosted RAMS.

6.2.18.2.     Calibration of HDM-4: The consultant shall undertake Level 1 calibration. In addition, the approach, methodology and data requirements shall be identified for levels 2 and 3. Calibration of levels 2 and 3 will be in a phased manner and identified road sections will be included as part of this calibration.

6.2.18.3.     Software Hosting Services: The Consultant shall host, configured RAMS with the necessary infrastructure, platform and RAMS application software purchased above for use by 35  concurrent users. At a minimum, the consultant will provide the following for hosting the RAMS:

- Storage capacity: 5 TB
- Bandwidth: 4 Mbps dedicated
- Data transfer limit: Unlimited
- Operating System: preferably Windows
- Video streaming facility:  The Consultant will capture videos of roads for hosting as per the needs of PWD (Roads) during the duration of the contract.

6.2.18.4.     Handover: PWD (Roads) initially intends to acquire hosting services for two years, with an option of extending the services for another two-year period. In case PWD (Roads)/CRN decides to take over the operation and hosting of the RAMS at the end of initial two years, the Consultant shall extend all necessary support and training to PWD (Roads)/CRN or their appointed Consultant in hosting RAMS. The support shall include, but not limited to transfer of fully configured RAMS (including source codes) with all software components, underlying algorithms and documentation required for the full operation of the system to PWD (Roads), support for installation on the designated platform/state cloud, and training to the appointed consultant or PWD (Roads) staff.

6.2.18.5.     Additional Requirements:  Keeping in mind that PWD may intend to have complete technical ownership of the system after end of contract, the Consultant should be prepared to transfer the entire system (including any setup software/hardware for installation, licenses, documentation, all source codes, and all libraries) to the PWD. As such, consultants should include separate costs for such handover and cite the same; Consultants who are not proposing open-source software should also include costs for customizing their application to an open source environment. The consultants should also give costs for hosting, maintenance, and support services beyond the two-year period for information.

### 6.2.19. Compliance Testing

The Consultant shall undertake compliance testing of all components of RAMS before hosting the system for PWD (Roads).

### 6.3.   Task 3: Data Collection and Input

### 6.3.1.   Review Available Data

The data available with the PWD will be provided to Consultant in electronic format. The Consultant shall undertake a comprehensive review of this data and business

processesincluding but not limited to data collection, data recording, input/coding, and output formats from the perspective of ensuring full compatibility with the design of the proposed RAMS including organisational aspects and business process. Based on this, the Consultant will collect any additional/missing data, identify solutions that can be achievedfor RAMS requirements and prepare recommendations for implementation of RAMS including collecting data for the remaining road network for input into the RAMS.

The Consultant shall prepare a comprehensive data collection strategy for the complete state road network entrusted to PWD (Roads) from the perspective of annual maintenance needs. The strategy shall include, but not limited to location reference method, type of data to be collected over the entire network on the basis of functional classification, method, and frequency of data collection etc. The Consultant shall consider capability and resources available with PWD (Roads) while formulating the strategy, as it will be presented to the senior management of PWD (Roads) /CRN and Meghalaya state government for their endorsement and eventual adoption.

The Consultant shall collect comprehensive inventory and condition data for all roads (State highways, MDRs, District Roads, Rural Roads, PMGSY roads, etc with a total length of **14,123**km .) under the jurisdiction of PWD..

### 6.3.2. Migrate Available Data

The Consultant shall reformat, if required all available data into the formats required by the RAMS, and then load the data into the proposed RAMS. The Consultant shall define and finalise location reference details from the available data. The data shall also be migrated to HDM4 codebase for location (geo-referenced) and road segment length. The data migration includes all the road data to be collected on all roads under the jurisdiction of PWD

### 6.3.3. Traffic Volume Data

Classified traffic volume count shall be carried out for 7 (seven) days (continuous, direction wise) at the selected 50 survey stations during normal period. The vehicle classification system, as given in IRC: SP 19-2001 shall be adopted for counting purpose. However, the Consultant shall review and suggest any changes in the format to include local vehicle characteristics.

The survey locations shall be presented in tabular form, discussed, and finalised prior to commencement of traffic counts. In general, the traffic count shall be carried in traffic homogeneous sections finalised based on traffic generation, dispersal locations and also considering PWD (Roads) census points, if any.

The Consultant may use manual or automated methods. If using automatic counters, they shall demonstrate that the equipment is capable of accurately classifying the vehicle types in IRC: SP 19-2001. In case of manual methods, PWD (Roads) may perform a parallel survey to validate Consultant survey. In case of the discrepancy between the two counts PWD (Roads) and Consultant) then PWD (Roads) may reject Consultant's data. In such a scenario, Consultant must redo the survey as suggested by PWD (Roads) at no extra cost.

The Consultant shall include 7 day counts at 50 locations and 1 day counts at another 50 locations in their proposal. The location of 7-day counts shall be proposed by the Consultant after thoroughly studying the road network.

It is expected that the Consultant shall use above information to extrapolate traffic volume on the remainder network where traffic data is not available or not collected.

### 6.3.4. Axle Load Data

Axle load surveys shall be carried out in both directions for duration of 48 hours at 10 locations. The location of axle load survey shall propose by the Consultant after thoroughly studying the road network.

Axle load survey may be performed using automated weigh-in-motion (WIM) apparatus which has the capability to assess the load on each axle, axle spacing and hence the type of vehicle, or stationary axle weigh pads. In their proposal, the Consultants shall describe the WIM equipment or Axle weigh pads proposed for use and description of the outputs, including the pros and cons of both methods.

### 6.3.5. Pavement Composition Data

Pavement layers thicknesses are to be measured using a non-destructive testing method such as Ground Penetrating Radar (GPR) or equivalent (Test Pits). As a minimum, the data shall be provided at the same sample points as the deflection basin measurements or 7 km interval. Pros and cons of GPR and Test Pits shall be described in the proposal and benefit of selecting GPR or Test Pits.

The data shall consist of the thickness expressed in cm, of asphalt, base, and sub-base and/or improved sub grade.

### 6.3.6. Pavement History Data

The Consultant shall acquire from office records the following as a minimum:

- Year of last surfacing,
- Thickness of last surfacing,
- Type of last surfacing,
- Year of pavement construction/reconstruction.

### 6.3.7. Cross Drainage Structure Data

The PWD (Roads) shall provide where available the required inventory and condition data for all bridges and culverts.

### 6.3.8. Road Accident Data

PWD (Roads) shall provide where available the required accident data.

### 6.4. Task 4: Maintenance Needs Analysis

**6.4.1.** The Consultant shall prepare annual maintenance needs report for road network using the proposed RAMS system. The maintenance analysis component shall have two options as, HDM-4 and Decision tree-based analysis. The PMS shall be interfaced with the current version of HDM-4 to enable project level, programme, and strategic analysis, while Decision tree analysis shall be developed for programme analysis. The logic to be used in the Decision tree shall be proposed by the Consultant specifically meeting the requirements of PWD (Roads). The logic of the decision tree shall be developed based on the data available the Client. The decision tree shall be discussed with the Client including but not limited to, current practices of PWD (Roads), analysis of existing data and logic developed specifically for PWD (Roads).

**6.4.2.** The Consultant shall produce maintenance needs analysis in year 1 The Consultant shall identify any deficiencies in the type and extent of data for performing industry standard maintenance needs analysis. The deficiencies if any shall be addressed in the data collection strategy.

**6.4.3.** The Consultant shall prepare maintenance needs plan for the entire road network in year 2 of the services. The Consultant shall analyse annual works plan derived from HDM-4 and Decision Tree and finalise the annual work plan that is most appropriate for the Project road network. In the process, the Consultant is expected to perform field validation of the final maintenance treatment proposed over at least 10% of the selected network for the respective year.

6.5. Task 5: Draft Asset Management Strategy to drive Institutionalisation of RAMS

The Consultants shall identify the necessary locus of dedicated 'core' responsibility PWD (Roads) for the Asset Management functions and RAMS operations, and the capacity building required to ensure sustainable competencies and knowledge. The institutional framework shall include, but not limited to the following:

- Who should maintain and operate RAMS? Where should it be ideally housed?
- What other institutional changes or measures required?
- How frequently should the RAMS be updated?
- How to source and collect data for updating?
- How to disseminate RAMS outputs to wider stakeholders?

The Consultant shall study the industry standard practices or best-case studies either in India or overseas for establishing a dedicated RAMS Cell within PWD (Roads). The staff mix and skills shall be identified, thoroughly discussed, and documented in the institutional strategy. The Consultant is expected to provide necessary support to PWD (Roads) in establishing the dedicated RAMS Cell.

Following strategies to implement the policy intent may also be considered:

- Allocate funds using economic and social rationale for overall betterment of network performance
- Undertake regular preventive and emergency maintenance of assets with long-term contracts supported by independent regular inspection and monitoring.
- Adopt centralised institutional framework, dedicated funding, improved process monitoring and regulatory mechanism to support activities related to asset

management. The Asset management strategy should clearly indicate the set-up and standard operating procedures of host unit within MIDFC to ensure sustainable operation of the system.

- Generating short, medium, and long-term maintenance and investment plan.

### 6.6. Task 6: System Development, Testing

After the finalisation of the overall system, the architecture and the design reports of modules, system development, configuration and testing will be undertaken by the Consultant in accordance with the technical requirements. The consultant will use its own hardware and software for development of the application. However, testing should be conducted at the consultant's office at Shillong by its staff. The consultant will use the data collected on the project to load in the system and undertake all testing, including preparation of an annual maintenance plan for the first year. The system should incorporate all the procedures and maintenance strategies developed for this purpose.

The consultant is encouraged to split the design report schedule in order to initiate system development of some modules on a priority basis. the test cases should be finalised with the client before commencing under acceptance testing. Upon completion of user acceptance testing and the integration, the system will be released for client testing. The PWD (Roads) will provide comments/ suggestions related to the software for incorporation in the final release.

### 6.7. Task 7: Operational/ User Acceptance Testing

The tested system will undergo Operational/User Acceptance Testing in two phases. Phase I will use testing environment by the consultant and Phase 2 will use infrastructure (staging arrangement) at PWD before conducting cyber security audit. The consultant should ensure to submit copies of system user manuals for each application describing all the functional use cases and business scenarios before conducting Phase I testing. Upon completion of Phase I. identified deficiencies will be resolved by the consultant and necessary changes made.The system will then by deployed at the PWD (hosted on cloud) and comply will all the integration requirements as per given mandate and the same process of operational/user acceptance testing will be replicated.

The testing will be conducted by PWD and/or its appointed representative using the test cases and business scenarios in the design reports and user manuals. For the testing, it is mandatory to use the data collected on the project in a test environment.

### 6.8. Task 8: System Deployment and Cyber Security Audit

After successful conduct of operational/ user acceptance testing, at the staging arrangement at PWD, the system will comply with the security requirements as per the applicable policies of the Government of Meghalaya and/or Government of India in accordance with the technical requirements.

### 6.9. Task 8: Training

The Consultant shall provide comprehensive training to 35  departmental staff in operation of RAMS, including on all related software and their functionality. This will include training on level 1 calibration of HDM-4. The Consultant may also include training materials for the

management on applications/utilization of RAMS data for high-level decision-making – prioritization, institutional and sustainability measures, with real-life regional/global case studies. This will likely improve the adoption of the RAMS into regular Govt decision-making. The consultant shall prepare or otherwise provide all operational and training materials, which will be the property of the GOT for delivery of the program. Training venue, computers and other training facilities shall also be the responsibility of the Consultant.

## 7. Time frame

The duration of the Consultancy services is 2 years. Configured RAMS shall be made available for installation/hosting within 3 months from the start of the assignment. The hosting of RAMS including data processing, data loading, data collection (under provisional services), population of the system and maintenance needs analysis shall be completed within first 9 months. Successive 15 months shall be used for operation of RAMS, institutionalisation of RAMS within PWD (Roads), training, development of annual maintenance plans and multi-year rolling plans, potential handover of the system and maintenance needs analysis for year 2.

## 8. Deliverables

### 8.1. Inception Report

The purpose of the Inception Report is to: (a) fine-tune the proposed methodology specific to the project conditions which were not possible to identify and/or quantify at the time of the proposal and (b) jointly determine that the proposed methodology and its outputs will be fully aligned with the requirement of the Client. However, Consultant shall not reduce the scope of work and/or resources specified in their proposal. The extent of provisional services shall be identified and agreed with the Client. The revised schedule of the deliverables shall be included in the Inception Report.

### 8.2. Data Collection Requirement Report

This report shall include but not limited to requirement of data for each sub system of RAMS based on the overall requirements of PWD (Roads) from RAMS.

### 8.3. RAMS Design Report

This report includes but not limited to overall system architecture and functionality of each sub system of RAMS based on the requirements of PWD (Roads). The design report should contain flow model, data model and behaviour model which primarily cover data flow diagram, entity relationship diagram, functional use cases, actors, database dictionary, user interfaces and data/map reporting formats. If necessary based on the requirements, the consultant will be required to add few more functions in the modules, in discussion with PWD (Roads), to enhance the system functionality and reporting. The Consultant shall be responsible for providing entire functionality that is needed for PWD (Roads) at the time of initial                        hosting                        of                        RAMS.

### 8.4. User     Acceptance     Test     (UAT)     Plan     and     UAT     results
The UAT plan should cover at least the following areas: test hardware, application requirements, test data, accuracy, import/export of available data, backup and recovery, security, configuration management, documentation (including user manuals, system

documentation                               and                                     licenses).

## 8.5. Data migration report

This report shall outline all checks performed on the data, summary of data and findings, including reasons for why some data could not be loaded.

## 8.6. Data Collection Strategy Report

This report will include but not limited to annual data collection requirements, frequency, mode of data collection (in house or outsourced), budget requirements etc for the entire road network.

## 8.7. Institutional Framework/ Asset Management Strategy Report

This report will include but not limited to the establishment of dedicated RAMS cell, staff and skills requirements and training needs etc. This shall also include how best the outputs from RAMS could be used within PWD (Roads) on day-to-day basis. This will also elaborate upon the sources of financing for RAMS operations and maintenance, maintenance and the short, medium-term and long-term maintenance plan based on the data collected.

## 8.8. HDM-4 Calibration Report

This report shall include calibration performed for Level 1, and Strategy along with Approach and Methodology for Level 2 and Level 3 Calibration. The requirement of road section shall be elaborated with data requirement, engineers, experts and cost to complete Level 2 and Level 3 Calibration.

## 8.9. Maintenance Needs Report

This report shall include prioritised and/or optimised maintenance needs of roads and bridges for routine, periodic, rehabilitation, reconstruction and widening.

## 8.10.   Training Report

This report shall include training needs, training imparted and evaluation of training for 35 nominated staff.

## 8.11.   Final Report

This report shall include but not limited to the achievements, lessons learnt, way forward for recommendations for continued sustainability of RAMS.

## 8.12.  Schedule of Deliverables
All deliverables shall be submitted in the electronic and paper format (5 copies) as mentioned below.

| Deliverables | Time from Commencement |
|---|---|
| Inception Report | 1 month |
| Data Collection Requirement Report | 2 months |
| RAMS Design Report | 3 months |
| RAMS Deployment with existing data | 4 months |
| Data Collection Strategy | 5 months |

| Deliverables | Time from Commencement |
|---|---|
| Data Collection Services<br>   1. Traffic Volume<br>   2. Axle Load<br>   3. Pavement Composition<br>   4. Bridge condition & inventory<br>   5. Culvert condition & inventory<br>   6. Pavement History | 9 months |
| Institutional Framework Report | 10 months |
| Acceptance Testing of RAMS and hosting with complete data | 10 months |
| Project and Program Development Effectiveness Report | 10 months |
| HDM-4 Calibration Report | 11 months |
| Maintenance Needs Report - Year 1 (1,500 km) | 12 months |
| Training on RAMS | 12 months |
| Maintenance Needs Report - Year 2 (entire network) | 22months |
| Final Report and Handing over of RAMS Software | 24 months |
| Quarterly progress report | Every 3 months |

## 8.13. Team Composition

The Consultant is expected to nominate a team of key technical and professional personnel, who between them should have at least the following experience:

- Development, implementation, and operation of large road asset data management systems
- Institutional strengthening of road asset management aspects
- Application of location referencing and road/traffic surveys

The following section provides an indicative guide to the make-up of and expertise requirements for the key professional staff. As per PWD (Roads)'s assessment, the assignment will require at-least 72 man-months of key professional staff. However, the Consultants shall use their own judgment regarding the team composition along with the time inputs that are most suitable for carrying out these services.

| Position | Minimum Qualifications & Experience |
|---|---|
| **Team Leader** | A graduate in Civil Engineering with post-graduation in Highway/Traffic/Pavement Engineering having at least 15 years of overall professional experience, 10 years in Road Asset Management and experience in at least 1 developed country. S/He should have expert knowledge in capacity building in road asset management for road authorities. S/He should be fully conversant with the local issues in India, should have successfully delivered at least one pavement/asset management capacity building project. S/He should have hands-on experience in road infrastructure related IT projects and proven working experience of HDM-4 and in calibration of HDM-4. S/He should be an expert in undertaking training needs assessments and in conducting training programs. S/He should be permanent employee of the lead firm. |

| Position | Minimum Qualifications & Experience |
|---|---|
| **Deputy Team Leader cum RAMS/RIMS Specialist** | A Graduate Degree in Computer Science/ IT Engineering or Systems Engineering. S/He must have minimum overall experience of 15 years in implementing large-scale, web-based IT/RAMS/Road Information Management Systems (RIMS) projects internationally and in India. S/He must have experience in implementing at least 3 RAMS/RIMS Projects. S/He should preferably have held positions of Team Leader or Deputy Team Leader in at least one international project and one Indian project of similar scale. S/He should have experience in knowledge transfer and training of counterpart staff. |
| **Bridge Management Systems Specialist** | A graduate in Civil Engineering with post-graduation Degree in structural engineering with 15 years' experience. S/He should be proficient in Bridges and structures maintenance management programmes and should have hands-on experience in bridge design and bridge maintenance management in India and overseas. |
| **Maintenance Management / Planning System Specialist** | A graduate in Civil Engineering with post-graduation in Highway/Traffic/Pavement discipline with 10 years' experience. S/He should have specific experience similar to this project and should be proficient in developing road maintenance needs plans using HDM-4 and Engineering Decision Tree. S/He should have successfully delivered minimum three road asset management system projects. S/He should have experience in knowledge transfer and training of counterpart staff. |
| **Highways / Pavement/Traffic Engineer** | A graduate in Civil Engineering with post-graduation in Highways or Transportation field or Traffic Discipline with 10 years' experience in traffic survey and analysis. S/He should have expert knowledge in Highway design, junction design, asset management system principles, good working knowledge of using WIM, Axle pads, asset management, road safety and crash data analysis. S/He should have experience of knowledge transfer and training of staff and local counterparts. |
| **IT Specialist** | A graduate in Computer Science & Engineering/Information Technology/MCA and with at least 8 years of experience in road information related database development and implementation. S/He should have minimum 5 years of proven hands-on experience in industrial RDBMS like MS SQL Server, Oracle, Postgres, .NET etc in India and internationally. |

| Position | Minimum Qualifications & Experience |
|---|---|
| **GIS Analyst** | A graduate in Civil Engineering/Science/Technology with post-graduation in Remote Sensing or GIS or equivalent qualifications. S/He should have in-depth knowledge of various GIS packages, including ESRI's products and should have mandatory experience in large scale, GIS enabled infrastructure projects. S/He should have experience in delivering the GIS portions of at least two, web-based, large-scale transport or road data systems. |
| **Transport Economist** | A graduate in Civil Engineering/Commerce/Science with post-graduation in Economics or equivalent with at least 15 years' experience as Transport Economist and Financial Expert. S/He should have experience as the Transport Economist in at least 20 projects in India/overseas. S/He must have thorough knowledge in calibrating and using HDM-4 economic model for road maintenance needs analysis. S/He should be an expert level HDM4 user and a hands-on trainer. |
| **RAMS on-site Engineer** | At least 10 years of professional experience with a postgraduation in Transportation and Highway Engineering. S/He should be proficient in highway design at both feasibility and detailed design stages. S/He should be proficient in use of various software used in highways and transportation sector to assist client in the operation and use of RAMS. |

## 7.12    Facilities to be provided by Client

Client will provide office facilities on MIDFC/PWD premises for this project. All Consultant activities and team members for this project should be based out of this office. Client will also make all available relevant data, maps, and other relevant information to the Consultant. Client will also provide internet bandwidth and internet connections required at client premises in PWD (Roads) for functioning of the asset management software.  It is expected that Consultants would make their own arrangements for transport, travel, accommodation, site expenses, visa, survey costs and any other costs related to this assignment.

## 7.13    Liaison
It is expected that Consultant will have a fully functional office in India for the duration of the services.