

**GOVERNMENT OF MEGHALAYA
OFFICE OF THE CHIEF ENGINEER, P. W. D. (ROADS)
NATIONAL HIGHWAY, SHILLONG**

**REQUEST FOR EXPRESSIONS OF INTEREST
(Consulting Services – Consultant Qualification based Selection (CQS))**

INDIA

MEGHALAYA INTEGRATED TRANSPORT PROJECT

Project ID: P-168097

Assignment Title: Preparation of designs and detailed project reports (DPRs) of Major and Minor Bridges to be constructed as a replacement of existing Semi Permanent Timber Bridges (SPT) on the PWD roads in the State of Meghalaya under the World Bank Meghalaya Integrated Transport Project.

Reference No: PW/CE/NH/WB/4/2019/Pt.

The Government of Meghalaya has applied for financing from the World Bank toward the cost of the Meghalaya Integrated Transport Project and intends to apply part of the proceeds for consulting services.

The consulting services (“the Services”) include

- (i) to finalize the selection of the most viable/ feasible/ economical site for the construction of bridge on the existing road or on a new road to be constructed by studying the course of the stream, its meandering tendency, existence of firm banks, confluence with other streams, alternative sites, Hydraulic survey, Design Discharge, H.F.L, L.W.L, Scour depth, type of foundation, length of the structure by studying the existing bridges on the river in the vicinity (Upstream & Downstream) and span arrangements.
- (ii) to undertake detailed Hydraulic survey of the finally selected site to decide the design discharge, linear waterway, scour depth, afflux and vertical clearance above H.F.L., including sub-soil investigation etc.
- (iii) to develop cost effective keeping in mind both the options i.e. Steel bridges & RCC bridges, Innovative and Aesthetically pleasing structure with due considerations given to the site conditions & Environment friendly, climate resilient keeping in consideration the hilly terrain and construction friendly designs of Bridges with latest innovative technology. The design shall conform to the specifications & design parameters contained in relevant Indian Roads Congress Codes / Ministry of Road Transport & Highways specifications/ guidelines and circulars (latest versions).
- (iv) to design appropriate river training works including slope pitching, Toe wall, Guide Bunds, apron, launching apron etc, if any required with full justification, keeping in consideration the hilly terrain, and
- (v) Preparation of the General Arrangement Drawing (GAD) and methodology (philosophy) of the design
- (vi) Design of different parts of the Bridge (Structure)

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- (vii) Preparation of technical specifications of all the works involved in construction of the bridge project in totality including quality assurance plan for the same
- (viii) Preparation of cost estimate including details of measurements, Bill of Quantities and analysis of rates; and
- (ix) to transfer the technology and develop skill of PWD engineers in design of major/minor bridges.

The Meghalaya Public Works Department (R&B), Government of Meghalaya (PWD) now invites eligible consulting firms (“Consultants”) to indicate their interest in providing the Services. Interested Consultants should provide information demonstrating that they have the required qualifications and relevant experience to perform the Services. The short listing criteria are:

- Experience of the consulting firm of last 7 years.
- Turn-over of the existing firm of last 5 consecutive financial year, from the year of REOI.
- Experience of the firm of last 7 years in preparing the cost-effective designs and cost estimates of bridges over river/roads in hill areas specifically in North-Eastern States of the India.
- Qualifications and Experience of the key personnel of the consultancy firm.

The TOR for the activity is also enclosed.

The employer intends to engage the services of a consultant for the aforementioned works.

The attention of interested Consultants is drawn to paragraph 3.17 of the World Bank’s *Procurement Regulations for IPF Borrowers, July 2016* as amended from time to time [under *IBRD Loans and IDA Credits & Grants*] by the World Bank Borrowers, setting forth the World Bank’s policy on conflict of interest.

Consultants may associate with other firms in the form of a joint venture or a sub consultancy to enhance their qualifications.

A Consultant will be selected in accordance with the Consultant’s Qualification based Selection (CQS) method set out in the Consultant Guidelines of the World Bank.

Further information can be obtained at the address below during office hours i.e., 11:00 am to 03:00 pm.

Expressions of interest must be delivered in a written form to the address below (by e-mail) by **05.01.2020 before 4.00 PM.**

Attn: B.P. Marak, CE(NH)
O/o The Chief Engineer PWD (R&B), Meghalaya Shillong.
Lower Lachumiere, Shillong-793001, Meghalaya.
Tel: 8787375062
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Meghalaya Integrated Transport Project (MITP)

Design of Small and Medium Bridges

TERMS OF REFERENCE

1. Introduction

The Public Works Department (PWD) is the implementing agency for improvement/rehabilitation of roads and construction of bridges under the World Bank funded Meghalaya Integrated Transport Project (MITP) which has the objective of improving transport connectivity and efficiency, and enhancing transport sector management in Meghalaya. MITP includes rehabilitation and improvement of about 300 km roads including replacement of existing semi-permanent timber bridges using innovative, climate resilient and nature-based solutions. There are about 800 semi-permanent timber bridges in Meghalaya and most of these are in depilated condition and need immediate replacement. PWD has decided to introduce innovative, climate resilient and nature-based design solutions to replace these bridges. The design solutions should be able to withstand the extreme climatic events and high rainfall in the hilly state of Meghalaya, in addition to demonstrating use of innovative bridge design practices. With this background, PWD wishes to engage a reputed and experienced consultant (having proven experience in design of innovative bridges) to prepare such designs for the eight number existing timber bridges given in **Table-1, Annexure-I**.

2. Main objectives of the consultancy services

The main objective of this consultancy is to prepare innovative, climate resilient and nature-based designs to replace existing semi-permanent timber bridges keeping in view the climatic conditions, availability of materials and local manpower and capabilities of the local construction agencies in Meghalaya. The governing factors for innovations would include use of new materials and technologies, value for money, resource efficiency –focusing on material conservation – saving on total quantities of the material used and reducing carbon foot prints, minimizing time of construction considering limited availability of working session in Meghalaya, safety, and enhanced performance during floods and seismic conditions, improved durability and design life, and aesthetics.

The Designs including all surveys and investigations shall confirm to the latest Indian standards (IRC/MoRTH/BIS) and/or other International Standards (i.e.Euro codes/AASHTO etc.) used in the developed countries if these are applicable to the conditions prevailing in Meghalaya. The consultant is encouraged to use integral, continuous, and pre-cast and other innovative bridge designs as well as high strength/improved concrete depending on the site condition and above considerations. The consultancy services shall primarily include the following:

- Collection of the data from the site and those available with PWD that are needed for fixing the alignment (plan as well as elevation), formation level, span arrangements, total length and type of bridge.
- Selection of the sites and fixing alignment (plan and elevation), formation level, span arrangements, total length and type of bridge with due consideration to the merits and demerits of various feasible alignments and bridge types (to be finalized with the approval of PWD).

- All the relevant surveys and site investigations including topographic surveys, hydrological studies and sub-surface soil investigations.
- Analysis, design and preparation of working drawings of all components of the bridges and river training and floor/bank protection works (if provided).
- Detailed cost estimates, technical specifications for construction, and use of maintenance approach for future maintenance of the bridges.

3. Scope of consultancy services:

The scope of services shall primarily include the following and shall be completed under three tasks/stages i.e. Pre-feasibility Report, Feasibility Report or Preliminary Project Report (PPR) and Detailed Project Report (i.e. DPR). Various submissions made by the consultant shall be reviewed and proof checked by PWD, if required using separate consultants. However, the consultant must proof-check all the designs before submission using an independent bridge expert (who would not be part of the design team). S/he must take full responsibility for the correctness of the designs and certify the same in writing. The consultant shall make power point presentations to PWD to explain the submissions made by them. Any under prepared, incomplete/inadequate or part submittal shall be deemed as shortfall in the services and may attract a penalty upto 4 percent of the cost of this assignment.

3.1 Task-1: Pre-feasibility Report consisting of site selection report for bridges: This shall primarily include suggestions regarding possible alignments (existing or new) along with recommended alignment with due consideration given to the following:

- Environmental impacts.
- Geometry (plan and elevation) of the bridge and approach roads. Requirements of skew angle or plan curvature and longitudinal gradient (to improve the geometrics in plan/elevation) shall be considered.
- Narrowness of the channel at the proposed bridge site which affects the economy.
- Characteristics and hydraulics of the river i.e. straight or meandering portions of the river, high flood level (HFL), ordinary flow level (OFL), low water level (LWL), discharge in the river, linear waterway requirements, scour depths, presence of any obstructions in the river (e.g. islands, big boulders, plantations etc.), uniformity of the depth of flow etc. These have considerable impact on the soundness and cost of the bridge. The consultant is required to account for climate change impacts by using the available climate change prediction models.
- Confluence of the river with other streams.
- Existence of high and stable/firm riverbanks.
- Requirement of any river training and floor/bank protection works.
- Presence of debris, boulders, wooden logs, vegetation etc. in the floods.
- Characteristics of the sub-surface soil/rock and presence of sound or erodible riverbed.
- Climatic resilience, sustainability and other considerations defined in above section.
- Land acquisitions requirements.
- Length of the approach roads on either side of the bridge.
- Performance of the existing and other bridges on the same river/stream on the upstream and downstream sides.
- Presence of underground/overhead utilities and cost of temporary/permanent shifting of the same.

- Any requirements and cost of traffic diversions during construction of the bridge.
- Any possibility of mining within 5 km of the bridge site.
- Availability of materials, local manpower, expertise of local construction agencies and working season for the construction of the bridge.

Comparisons shall be made between alternative alignments along with their merits and demerits for easy understanding and finalization of the alignment. Pre-feasibility Report (site selection report) shall primarily include the following:

- Collection of data from the site and those available with PWD which is needed to finalize the alignment, formation level, span arrangement and total length of the bridge, type of the bridge and foundations, requirement of river training works and floor/bank/approach road protection works.
- Details of the existing bridges (i.e. span arrangement and total length, formation level, lowest bed level, highest flood level and type of the bridge and foundations) on the same stream/river which are located within 10 km on the upstream and downstream side of the proposed alignment.
- Reconnaissance/preliminary survey of alternate sites consisting of available ROW, plan (including various features affecting the alignment) and section along the proposed alignment. Alternate alignments of the bridge shall be marked on the survey sheets as well as on Google maps for better understanding while making comparisons of various alignments.
- Preliminary hydraulic studies which are needed to decide the span arrangements, total bridge length, formation level and type of bridge and foundations. These are needed as they have considerable impact on the cost of the bridge and hence on the proposed alignment.
- Preliminary sub-surface investigations which are needed to decide the foundation type i.e. open or deep (piles or wells) foundations. This is needed as the foundation type has considerable impact on the cost of the bridge and hence on the proposed alignment.
- Comparisons(along with justifications) of various alignments in tabular format with due attention paid to climatic resilience, sustainability, geometry of the alignment (plan and elevation), safety and performance of the bridge, cost, durability, time of construction, maintenance requirements, aesthetics and riding quality. While making comparisons, long descriptions and justifications may be given separately or included in the form of notes below the table.
- Photographs of the sites of alternate alignments and existing bridges(from different angles) on the same stream as mentioned above.
- Any other information which is relevant for finalizing the alignment.

Any comments on the Pre-feasibility Report shall be communicated to the consultant for incorporation and final submission of the report.

3.2 Task-2: Feasibility Report or Preliminary Project Report (PPR):The prime purpose of the **Feasibility Report** is to finalize the general arrangement drawing (GAD) of the bridge. It shall primarily include the following:

- Detailed topographic survey of the finally selected site. This shall include contour plans, longitudinal section along the selected alignment, longitudinal section of the river and cross sections of the approach roads, and river bed at suitable intervals. The plan shall

include all the relevant features of the site (i.e. available ROW, existing roads and structures, other streams, drains, utilities, trees etc.) which may affect the proposed alignment and the bridge.

- The bridge along with approach roads shall be marked on the survey sheets as well as on Google maps for better understanding.
- Detailed hydraulic calculations using different methods as per the IRC codal provisions to ensure correctness of the design discharge, linear waterway, vertical clearance above HFL, scour depths etc., river training and floor/bank/approach road protection works (if provided).
- Sub-surface investigation report to ensure correctness of the foundation type and founding level.
- Design philosophy report clearly describing the methodology for analysis and design of various components of the bridge, list of the software and codes used, description of the loads and load combinations considered, moment of inertia of the members considered, properties (i.e. grade, modulus of elasticity, coefficient of thermal expansion etc.) of the materials (concrete and steel), cover to reinforcement etc.
- General arrangement drawings(GAD) of the bridge for alternate bridge types consisting of levels and profile of the river bed, high flood level (HFL), ordinary flow level (OFL), low water level (LWL), formation level, design discharge, scour levels, information related to sub-surface soil (bore log), span arrangement and total length of the bridge, type of foundations (along with founding level), type of substructure (abutments and piers), type of superstructure, type of bearings (if provided) and expansion joints, details of wearing coat, loads to be considered for bridge design, grade of concrete/steel, details of river training and floor/bank protection works(if provided) and any other relevant details.
- Comparisons (along with justifications) of various bridge types in tabular format with due attention paid to climatic resilience, sustainability, geometry (plan and elevation), safety and performance of the bridge under different loads, cost, durability, time of construction, maintenance requirements, aesthetics and riding quality. While making comparisons, long descriptions and justifications may be given separately or included in the form of notes below the table.

Any comments on the Feasibility Report shall be communicated to the consultant for incorporation and final submission of the report.

3.3 Task-3: Detailed Project Report (DPR):Detailed Project Report shall primarily include the following:

- Detailed topographic surveys as done in previous stages.
- Detailed hydraulic calculations as done in previous stages.
- Design philosophy report as prepared in previous stages.
- General arrangement drawings (GAD) of the bridge finalized in previous stages.
- Detailed sub-surface investigations at the location of every abutment/pier foundation which will comprise boring, collection of soil/rock samples, laboratory testing and preparation of sub-surface investigation report as per the provisions of relevant IRC/BIS codes. Results of the sub-surface investigation reports shall be presented in the format given in the relevant IRC/BIS codes. Depth of the bore hole (for open/deep foundations) shall be decided based on the provisions given in relevant IRC/BIS codes. At places where rock is present, studies shall also include geological investigations for the rock.
- Analysis and design of different components of the bridge using reliable and commonly adopted software in the country and as per the latest Indian/International standards. All the input data, design parameters, assumptions made, and relevant codes used shall be clearly mentioned in the design reports for better understanding and appreciation. Also, wherever needed/feasible, correctness of software outputs shall be cross checked with simple and/or manual calculations.
- Design of various elements of river training and floor/bank/approach road protection works (if provided).
- Preparation of detailed working drawings of each component of the bridge along with river training and floor/bank/approach road protection works (if provided). While preparing working drawings it shall be ensured that each component of the bridge is detailed properly so that details are clear and easily understandable by the site engineers. Drawings shall also include suggested methodology and sequence of construction of the bridge. Computer aided drafting is mandatory for preparation of all the drawings.
- Design and drawings of the approach roads.
- Preparation of land acquisition, utility shifting, and traffic diversion plans wherever needed.
- Preparation of cost estimate including bill of quantity (BOQ), details of measurement and analysis of rates. The cost estimate shall also include cost of land acquisition, utility shifting and traffic diversion wherever applicable.
- Preparation of technical specifications and quality assurance plan to ensure quality of work during execution. This shall also include requirements and frequency of site and outside laboratory tests and checklists for each activity of construction during execution.
- Maintenance approach to ensure regular maintenance and hence desired performance of the bridge in future.

Any comments on the Detailed Project Report shall be communicated to the consultant for incorporation and final submission of the report.

4. Consultant's Team

- 4.1 The consultants are required to produce timely and high-quality work and are encouraged to propose a staffing and mobilization plan that best suits the needs of the project. About 18

person-months of key professionals are anticipated to be required for this assignment over a period of eight(8) months. Consultants shall make the provision accordingly in their financial proposals.

4.2 The core team of key personnel will primarily consist of:

- a) Senior Bridge/Structural Design Engineer (Team Leader)
- b) Highway Engineer
- c) Hydrologist cum Drainage Engineer
- d) Geotechnical Engineer
- e) Quantity Surveyor

Required qualifications and experience of the key personnel are listed in **Table-2,Annexure-II** given on the following pages.

4.3 During implementation of the project, the design team shall be supplemented with support staff and associated specialists/advisers from time to time to provide support in accomplishment of various assignments indicated above. Provision for the same should be made in the financial proposals. The consultant shall at their own cost establish a site office at Shillong. The consultant shall interact with the local PWD engineers during field studies, and keep them informed about all surveys and investigations to be carried out.

4.4 The consultant shall give a detailed program of completion of each activity for which s/he is responsible. The program may be prepared in the form of bar charts/CPM charts /PERT charts or any other latest technique which can be updated with the help of available computer packages. For monitoring the progress, the consultant would submit Monthly Progress Reports in 6(six) copies by the 7th day of each month.

5. Deliverables:

The consultant shall submit six sets (hard copies) of monthly progress reports and other submissions as mentioned above. All the submissions shall be made in English and supplied in soft copies also in PDF and/or MS word format as desired by PWD.

6. Schedule of submissions and completion of project:

The project would be considered to be completed within eight months as per the schedule defined in **Table-3, Annexure-III** on the following pages.

7. Inputs by the PWD

PWD shall provide and assist in obtaining the following information for the consultant:

- Available traffic census data, lead chart showing location of quarries and copy of the Schedule of Rates of Meghalaya.
- Help in procuring required data about rivers from the concerned Departments of Government of Meghalaya.
- Details of available right of way (ROW) of the road.

The Bridge Design Cell of PWD will work as the nodal agency for the consultant. Two (2) PWD engineers from the Design Cell will work with the consultant team for counterpart training as well as to provide necessary assistance from the Department.

Financial proposal:

The Consultant shall give lump sum proposal for preparation of Detailed Project Report for eight number of bridges listed in **Annexure-I** and for the scope of work defined in above sections. The lump sum consultancy fee shall include cost of making 25m deep bore hole (for the purpose of sub-surface investigations which includes laboratory testing and preparation of sub-surface investigation report) as per the relevant IRC/BIS provisions at the location of each abutment/pier foundations.

In addition to the lump sum consultancy fee, the Consultant shall also quote rate for carrying out sub-surface investigations for unit (1m) length of boring which shall be used in making necessary adjustments (addition or deductions) in case of any variations in the actual length of bore holes with respect to specified 25m length of bore hole at each foundation.

Note: At any intermediate stages when submission is made for some of the bridges, the payment shall be made in the ratio of length of the bridge(s) for which submission is made to total length of all the bridges i.e. 375m. For example, if submission is made for 60m long bridge, the payment made at this stage shall be in the ratio of 60 and 375 i.e. 60/375. It may be noted here that individual and overall length of the bridges given in **Annexure-I** is for guidance purpose and actual bridge length shall be decided based on the studies and submissions made by the Consultant. Furthermore, in case of variations in the individual and overall bridge lengths the payment shall be made in the ratio of actual lengths and not the lengths specified in **Annexure-I**.

Payment shall be made as per the schedule of payment defined in **Table-4, Annexure-IV**.

Table-1: List of bridges:

It may be noted that length of the bridges mentioned below is for general information, actual length shall be finalized by the consultant based on his design.

Sl. No.	Name of the road	Length of the bridge (m)	Division
1	Umling-Patharkmah road	60.00	Nongpoh
2	Laitkor-Pomlakrai-Laitlyngkot road	30.00	NH Bye Pass
3	Pasyih-Garampani road	60.00	North Jowai
4	Parallel road (Br. No. 2/1)	74.25	Barengapara
5	Parallel road (Br. No. 21/3)	49.5	Barengapara
6	Rongram-Rongrenggre-Darugre road (Br. No. 52/11)	43.50	Williamnagar
7	Rongjeng-Mansang-Adokgre (Br. No. 54/3)	33.00	Resubelpara
8	AMPT road (15/3)	24.75	NEC Division
9	Bridge over River Umiurem	40.00	North Jowai
	TOTAL	415.00	

Table-2: Experience and qualifications of the key personnel

Sl. No	Position	Professional Experience	Educational Qualification	Specific Expertise
1	Senior Bridge/Structural Design Engineer (Team Leader)	Minimum of 20 years' experience in structural design out of which at least 10 years should have been in the design of major river bridges (length more than 60 m).	Essential: (i) Graduate in Civil Engineering (ii) Post Graduate in Structural Engineering Both the above degrees should be from recognized institute(s) of repute and should have been done as regular full time courses. Degrees obtained by distance learning or through part time facility shall not be considered.	<ul style="list-style-type: none"> - Proven record of project management of infrastructure projects especially roads/highways involving major bridges. - Thorough knowledge of specifications/ Codes (national and international) related to design of major structures especially river bridges. - Experience of design (on own i.e. independently) of at least five nos. standalone river major bridges (more than 60m long) during the last five years. - Experience in design of bridges with the help of latest acceptable computer aided methods/software. - Experience of design of at least five nos. major (more than 90 m long) steel and composite bridges.
2	Highway Engineers	Minimum of 15 years' experience in an engineering related field, out of which at least 7 years should have been on highway/road design.	Essential: (i) Graduate in Civil Engineering (ii) Post Graduate in Highway/Transportation Engineering*	<ul style="list-style-type: none"> - At least 5 years' experience years in highway projects. - Fully familiar with the acceptable study methods in different situations. - Experience in determining geometric design of roads as well as design of road crusts (flexible/rigid).

Sl. No	Position	Professional Experience	Educational Qualification	Specific Expertise
3	Hydrologist cum Drainage Engineer	Minimum of 15 years' experience in an engineering related field, out of which at least 7 years should have been on hydraulic studies of bridges.	Essential: (i) Graduate in Civil Engineering (ii) Post Graduate in Hydraulics/Hydrology Engineering*	<ul style="list-style-type: none"> - At least 5 years' experience in highway bridge (river) projects. - Fully familiar with acceptable study methods in different situations. - Experience in determining flood levels, discharge calculations using different methods, linear water ways, scour depths, model studies, preparing schemes for proper cross drainage and determining the regime/ waterway widths for bridge projects.
4	Geotechnical Engineer	Minimum of 15 years' experience in an engineering related field, out of which at least 5 years should have been in the field of sub-surface investigations for soil/rock for the design of bridge foundations.	(i) Graduate in Civil Engineering (ii) Post Graduate in Geotechnical Engineering/Soil Mechanics and Foundation Engineering.*	<ul style="list-style-type: none"> - Experience in conducting and evaluation of sub-surface investigations for soil and rock. - Experience of designing foundation of major structures especially river bridges. - In depth knowledge of various types of foundations i.e. shallow foundations and deep foundations (wells and pile foundations) .
5	Quantity Surveyor	Minimum 15 years' of experience out of which at least five years as Quantity Surveyor in bridge and road projects.	Graduate in Civil Engineering from a recognized institute of repute as a regular candidate. Degree obtained as Part Time or through distance learning will not be accepted.	<ul style="list-style-type: none"> At least 5 years' experience in major bridge and highway projects including preparation of detailed cost estimate as Quantity Surveyor. Should be well versed with computers.

*Both the above degrees should be from recognized institute(s) of repute and should have been done as regular full-time courses. Degrees obtained by distance learning or through part time facility shall not be considered.

Annexure-III

Table-3: Schedule of submissions

Task No	Description of submission	Time period
1	Pre-feasibility Report	60 days from the date of commencement of the consultancy services. Acceptance and/or any comments on the submitted report shall be communicated in 10 days, and final report (incorporating comments, if any) shall be submitted in 10 days of receiving the comments. Final approval of the report shall be communicated in 5 days.
2	Feasibility Report i.e. Preliminary Project Report	120 days from the date of commencement.
3	Detailed Project Report	180 days from the date of commencement after final approval of the Feasibility Report (PPR). Acceptance and/or any comments on the submitted report shall be communicated in 30 days and final report (incorporating comments, if any) shall be submitted in 30 days of receiving the comments. Final approval of the report shall be communicated in 10 days.

Annexure-VI

Table-4: Schedule of payments

Sr. No.	Description of submission	Payment schedule
1	Task-1: Pre-feasibility Report	- 10(ten)percent after submission of the report - 10 (ten) percent after approval of the report
2	Task-2: Feasibility Report i.e. Preliminary Project Report	- 15 (ten) percent after submission of the report - 15 (ten) percent after approval of the report
3	Task-3: Detailed Project Report	- 25 (ten) percent after submission of the report - 25 (ten) percent after approval of the report
4	Total	100% (i.e. 10+10+10+10+30+30)
5	Adjustment for actual length of boring done for sub-surface investigations (with respect to 25m length of boring at each abutment/pier foundations which is considered in lump sum consultancy fee)	Adjustments (additions or deductions) shall be made in the lump sum consultancy fee based on the actual length of boring and rate quoted by the consultant for unit (1m) length of sub-surface investigations.
6	Payment at intermediate stages when reports are submitted for some of the bridges	Payment shall be made in the ratio of length of the bridge(s) to total length of all the bridges as explained in above sections.

