Government of India
Ministry of Road Transport and Highways

PREPARATORY STUDY
FOR
ROAD NETWORK IMPROVEMENT
IN
NORTH-EAST STATES OF INDIA

FINAL REPORT

(Volume 3: Supplementary Technical Assistance for Additional Engineering Surveys and Design Modification / Application of Contract Mode and Preparation of Technical Specifications)

June 2018

Japan International Cooperation Agency (JICA)

Study Team constituted by

NIPPON KOEI CO., LTD.

NIPPON KOEI INDIA PVT. LTD.

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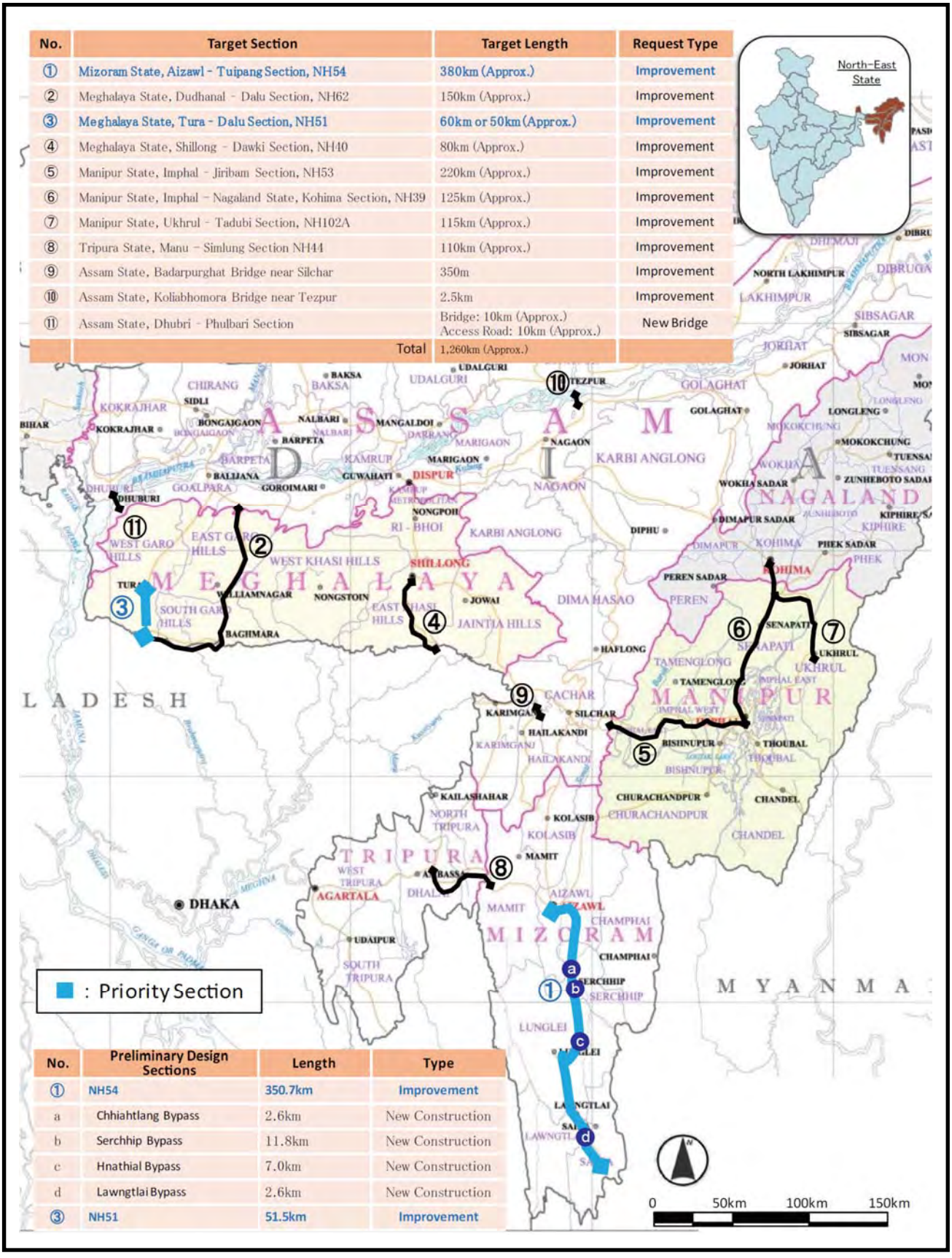

Source: JICA Study Team

LOCATION MAP

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Abbreviations

CRR	- Core Recovery Ratio
DPR	- Detailed Project Report
F/S	- Feasibility Study
GOI	- Government of India
GOJ	- Government of Japan
GPS	- Global Positioning System
GTS	- Great Trigonometrical Survey
JICA	- Japan International Cooperation Agency
LIDAR	- Light Imaging Detection and Ranging
MORTH	- Ministry of Road Transport and Highways
NE	- North East
NH	- National Highway
NHIDCL	- National Highways and Infrastructure Development Corporation
PVC	- Polyvinyl chloride
PWD	- Public Works Department
RQD	- Rock Quality Designation
SH	- State Highway
SPT	- Standard Penetration Test
TOR	- Terms of Reference
WGS	- World Geodetic System

1. Introduction

In the North-Eastern States only 28.5% of the roads are paved (63.4% is the average in the whole country), and only 53% of national highways have more than two lanes; the lack of infrastructure is apparent. The GDP per capita of the target area is INR. 34,405 (2010-2011), only about 60% of the GDP per capita of the country which is INR. 59,606, and the development of the highway network that could be the foundation for economic acitivity is essential. Government of India (hereinafter referred to as "GOI") raised the "Special Accelerated Road Development Programme for North East", which was committed in the "Twelfth Five Year Plan (from April 2012 to March, 2017)", to cope with the abovementioned problems through the improvement of national highways connecting major cities within the North-Eastern States.

Based on such background, GOI requested the Government of Japan (hereinafter referred to as "GOJ") to provide loan assistance in carrying out the improvement of existing roads in eight sections, repair of two existing bridges, and construction of one new bridge within the six states of the North-East States in India.

Two existing road sections of NH54 and NH51 are selected as part of the phase-1 Japanese Yen Loan project based on project prioritization by the "Preparatory Study for Road Network Improvement in North-East States of India" and project appraisal for Japanese Yen Loan by Japan International Cooperation Agency (JICA). To ensure the quality of the project, necessity of supplemental natural engineering surveys and design modification for NH54 and NH51 were confirmed during project appraisal stage between JICA and the National Highways and Infrastructure Development Corporation (NHIDCL), implementation of supplemental natural engineering surveys and design modification for NH54 and NH51 by NHIDCL and provision of technical assistance for the survey and the design modification by JICA are mutually agreed upon.

The major objectives of this study are:

- To analyze the existing data/reports and review of existing feasibility study reports (hereinafter referred to as "F/S");
- To examine the procurement and construction method, implementation schedule, project organization, capability of operation and maintenance, social and environmental conditions and evaluate project cost and feasibility of target sections; and
- To examine the procurement and construction method, implementation schedule, social and environmental conditions, project cost, and feasibility of four bypass routes plan on NH54.

Above objectives have been achieved as Interim Report 4 which was submitted in August 2016. Besides, additional objectives are discussed and concluded between NHIDCL and JICA as below:

- To review and monitor the entire process of additional engineering survey and modification of engineering design of NH54 mainline and NH51.
- To assist preparations of technical specifications, and procedures for application of EPC contract mode.

Target section for the scope is shown in Table 1-1.

Table 1-1 Target Section of Additional Technical Assistance in NH54 and NH51

No.	Name		Section（Kilo-post）	Length	
1-1	NH54	Section 1	Start near 8.000 km, End near 116.945 km	108.95 km	350.68 km
1-2		Section 2	Start near 125.000 km, End near 243.320 km	118.32 km	
1-3		Section 3	Start near 431.000 km, End near 554+410 km	123.41 km	
2	NH51		Start near 85.000 km, End near 143.280 km	51.51 km	
Total				402.19 km	

Source: JICA Study Team

2. Plan for the Technical Assistance

(1) Background of the Technical Assistance

For the target section of NH54 and NH51, topographical surveys have been conducted during DPR by implementation of NHIDCL in 2009. Also, some geological/geotechnical surveys have been conducted by a JICA preparatory study in 2014.

However, it was confirmed by the JICA study that some additional engineering surveys are required in order to supplement previous surveys. Because, topographical map made up by the survey does not provide necessary accuracy for the use of hill road design. In addition, the amount of geological /geotechnical survey already conducted is limited. The necessity of the additional engineering survey is detailed in Table 2-1.

Table 2-1 Necessity of Additional Engineering Surveys

Item	Reason
Topographical Survey	Topographic data of DPR does not fully cover ground surface on valley and hill side, and X-Y coordinates of designed road alignment in DPR is not harmonized with the actual road alignment.
	Several sections of the road ground surface data are different from the actual one.
Geological/ Geotechnical Survey	Due to the limitation of survey schedule and budget in the JICA Preparatory Survey, the slope inventory survey was carried out with an interval of 100 m to 200 m.
	Under the JICA Preparatory Survey, the JICA Study Team identified 864 locations of slope failure section on the target route of NH-54, and the critical 99 locations out of 864 locations were examined with countermeasures against slope failure. The slope design in the bidding documents is recommended to be updated with the collected up to date late slope condition.
	Under the JICA Preparatory Survey, the boring investigation was conducted only in three locations out of the total 99 critical sections in terms of slope stability.

Source: JICA Study Team

The additional engineering surveys are implemented by NHIDCL with order to local consulting company in India. Therefore, it is required for the JICA Study Team to perform the monitoring and provide necessary technical guidance for the survey.

Moreover, the detailed project report (DPR) design shall be revised in accordance with the result of the additional engineering surveys. The design requires technical know-how for hill road design and slope protection design which are not familiar in India. Therefore, the JICA Study Team should also conduct the technical assistance for the design modification.

In addition to this, about the contract terms and conditions applicable to construction contracts of the project, the JICA Study Team provides necessary technical assistance to compile appropriate contents using the EPC contract provisions of MORTH.

(2) Additional Engineering Surveys Implemented by NHIDCL

1) Overview of the Additional Surveys

(a) Overview of Additional Survey for NH54

i) Scope of Works

The scope of the works for additional survey of NH54 conducted by the additional survey consultant is as shown in Table 2-2.

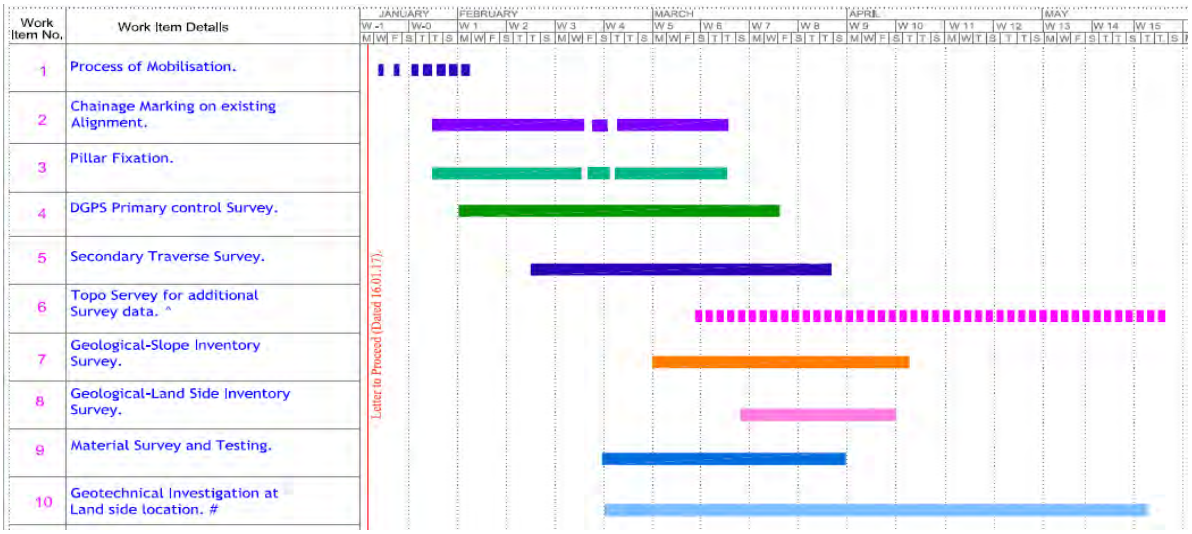
Table 2-2 Scope of Works for Additional Survey of NH54

Sl No.	Item	Unit	Quantity
A.	Topographical Survey		
1	Survey for Additional Data	Km	372
B.	Control Point Survey		
1	Primary Control Survey @ 2.5 km	Nos	71
2	Establishing GPS Monument @ 5km	Nos	71
3	Establishing Secondary Traverse @ 0.5 Km	Km	372
4	Traverse Survey	Km	372
C.	Geological/Geotechnical Survey and Investigation		
1	Detailed Slope Inventory Survey @ 40 m interval.	Km	372
2.	Geological Survey at Critical Section / Landslide Location	Km	372
3.	Bore Hole Investigation at Landslide / Critical Location	Nos	38 locations
D.	Material Source Survey of Quarry		
	Material Survey and Quarry Location.	Nos	8 locations

Source：Request for Proposal

ii) Work Schedule

The work schedule for additional survey of NH54 conducted by the additional survey consultant is as shown in Figure 2-1.



Source：Inception Report by BPC

Figure 2-1 Work Schedule for Additional Survey of NH54

iii) Work Organization

The work organization for additional survey of NH54 conducted by the additional survey consultant is as shown in Table 2-3.

Table 2-3 Work Organization for Additional Survey of NH54

SI. No.	Name	Task
1	Mr. Sourav Dasgupta	Team Leader
2	Mr. Siladitya Haldar	Senior Highway/Survey Engineer
3	Mr. Sardendu Mukherjee	Senior Geologist
4	Mr. Kaushik Pal	Highway Engineer
5	Ms. Beena Shaw	Geologist
6	Mr. Sumanta Pakhira	Geo-technical cum Materials Engineer

Source：Inception Report by BPC

(b) Overview of Additional Survey for NH51

i) Scope of Works

The scope of works for additional survey of NH51 conducted by the additional survey consultant is as shown in Table 2-4.

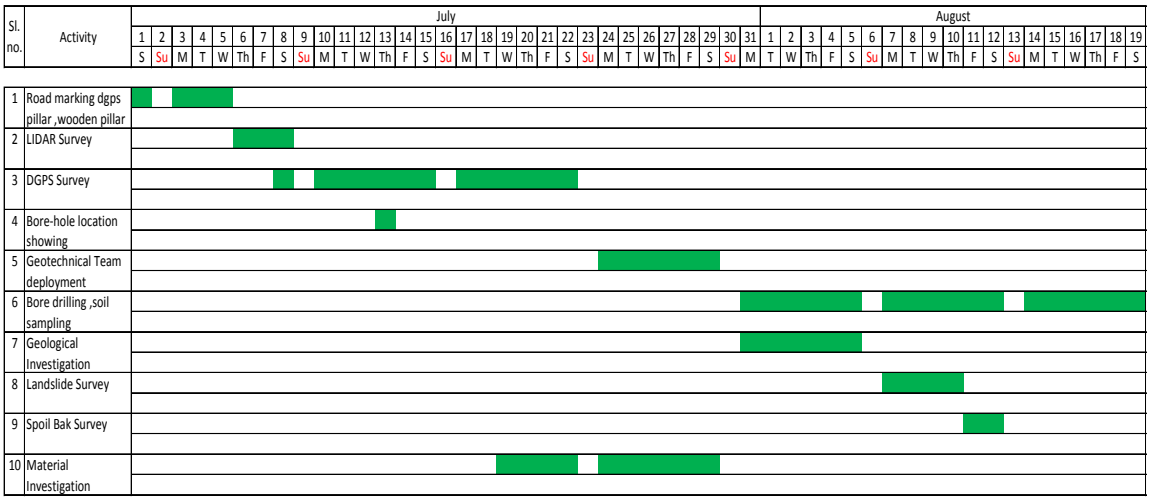
Table 2-4 Scope of Works for Additional Survey of NH51

Sl No.	Item	Unit	Quantity
A.	Topographical Survey		
1	Survey for Additional Data	Km	55
B.	Control Point Survey		
1	Primary Control Survey @ 2.5 km	Nos	11
2	Establishing GPS Monument @ 5 km	Nos	11
3	Establishing Secondary Traverse @ 0.5 km	Nos	1,236
4	Traverse Survey	Km	30.2
C.	Geological/Geotechnical Survey and Investigation		
1	Detailed Slope Inventory Survey @ 40 m interval.	Km	55
2.	Geological Survey at Critical Section / Landslide Location	Km	55
3.	Bore Hole investigation at Landslide / Critical Location	Nos	6 locations
D.	Material Source Survey of Quarry		
	Material Survey and Quarry Location.	Nos	(as obtained)

Source：Request for Proposal

ii) Work Schedule

The work schedule for the additional survey of NH51 conducted by the additional survey consultant is as shown in Figure 2-2.



Source：Inception Report by BPC

Figure 2-2 Work Schedule for Additional Survey of NH51

3. Technical Assistance for Additional Surveys and Design Modifications of NH54

(1) Additional Topographic Survey

1) Progress Monitoring of the Survey

(a) Mobilization

A survey team was mobilized in January 2017 and site work commenced from 26 January.

(b) Chainage Marking on Existing Alignment

Road marking work is carried out for descriptive purposes of land acquisition; therefore, the work progress is uncorrelated to other topo survey work. The field work for the full section was finished

at the end of March, 20 days behind of the initial plan, however, only section-1 (109 km) needed repainting due to the instruction of the NHIDCL. All works were completed at the end of April.

(c) Pillar Fixation

All works were completed at the end of March, 20 days behind the original plan.

(d) DGPS Primary Control Survey

GPS measurement for full section was completed in the middle of April, 25 days behind the plan. Only several pillars have an error in GPS accuracy due to the obstacle caused by the nearby object, therefore, the survey team carried out a re-survey at the failed pillar position while doing the topo survey.

(e) Secondary Traverse Survey

Work schedule was far behind than the initial plan because of the lack in number of the mobilized team, and because of the prediction errors with site works difficulty. All site works took long as twice to complete than the initial plan, and were only finished at the beginning of June.

(f) Topo Survey for Additional Data

Due to the delay of the Secondary Traverse Survey, the following topo survey works commenced at the end of May, two months behind the initial schedule. In the topo survey using a total station, it was predicted that the work speed is only about 2 km/day, which is much slower than the initially assumed speed, and it will take six months if the same pace is continued. To catch up with the schedule, the additional survey consultant proposed the Light Imaging Detection and Ranging (LIDAR) survey as an alternate to the total station survey. Immediately, NHIDCL approved it, the surveyor commenced mobilization of the new measurement equipment and operators at the end of June. Field work using the LIDAR equipment has completed a full section of 351 km by the beginning of July.

(g) Data Processing

Observed raw data was carried to the surveyor's office in Bangalore, and processing work was commenced immediately to deduct unnecessary point and to generate topo drawings. BPC began to submit the first topo drawing from the priority package at the end of August. Finally, all processing works for NH54 have been completed at the end of October, five months behind the initial schedule.

2) Technical Guidance by the JICA Study Team

(a) Adjustment of the Additional Survey Scope

The JICA Study Team explained to NHIDCL and the additional survey consultant about the survey contents and discussed about the scope of works that should be adjusted. Required survey works are not only items listed in the terms of reference (TOR), supplement survey for sections with poor accuracy in DPR topo survey and items missing in TOR (features requiring re-survey) are to be mentioned.

In order to specify the range required for additional survey, the difference of the drawings with coordinate system based on the previous survey and coordinate system based on the additional survey were compared, respectively. The JICA Study Team defined utilizable range and insufficient range of DPR to explain to the survey consultant.

(b) Comments on Proposal of LIDAR Survey

After commencement of site work, the survey consultant suggested to NHIDCL to introduce LIDAR survey instead of total station survey as progress was slow. The JICA Study Team made comments on the consultant's suggestion to NHIDCL that although LIDAR survey will be able to shorten the site work period, the following design modification works will take much time than the conventional method. In addition to this, the fact that the survey consultant has no experience

in conducting a LIDAR survey is also risky. Nevertheless, as a result, NHIDCL decided to approve the consultant's suggestion to accelerate the survey process.

(c) Advise for Data Processing

Comparing with the initially planned total station survey, the LIDAR survey can collect vast number of 3D point geographic information and the processing work needs a longer time. Therefore, it is difficult for the consultant to proceed and complete all packages at the same time and it needs to fill in the manpower resources into the package one by one. Under the condition, the JICA Study Team advised the consultant to proceed their work in a proper schedule for early completion of the priority packages.

(2) Additional Geological / Geotechnical Survey

1) Progress Monitoring for the Survey

(a) Mobilization

Mobilization for the geological / geotechnical survey was started in February 2017, and slope inventory survey and borehole survey were started on 20 February and 1 March, respectively.

(b) Slope Inventory Survey

The site survey along all the alignments was completed until 9 April. A part of the survey result was shared with the JICA Study Team on 24 May.

The team also surveyed all the slopes along the road and recorded critical slopes which need landslide countermeasures on critical slope inventory sheets (Appendix-III).

(c) Borehole Survey

Planned entire length of the borehole survey was 1,510 m. It is greatly behind the schedule that the BPC planned, which was supposed to be completed by the middle of May as stated in the inception report, and was only completed in late August.

2) Technical Guidance by the JICA Study Team

(a) Technical Guidance on Slope Inventory Survey Methods

On 13 January 2017, the JICA Study Team instructed BPC about the slope inventory survey methods along with the "Manual for Slope Inventory Survey" prepared by the team.

(b) Technical Guidance for Quality Improvement of Slope Inventory Survey

The JICA Study Team reviewed the slope inventory survey results received from BPC and sent comments in writing on June 1. The comments are (1) a clear mismatch between the survey points and the site condition, (2) imprecise description about dip slope, and the team requested to correct these two points.

(c) Joint Verification on Borehole Survey Location

On 13 to 14 January and 12 to 16 May, the JICA Study Team jointly verified the borehole survey locations with the BPC site engineers.

(d) Technical Guidance for Quality Improvement of Borehole Survey

The JICA Study Team provided guidance to improve the survey quality as shown below through the joint site verification on 12 to 16 May, and review on the survey results.

- Location of Boring Survey: Despite the joint site verification mentioned in (3) above, some boreholes were conducted at distinct locations from where the team instructed. The team notified BPC that the survey results at such points cannot be utilized for analysis and design, and reconfirmed BPC the purpose of the survey and request to prevent recurrence.
- Appropriate Collection of Core Sample: Since the core sampling rate is low, the team has requested measures for improving core recovery rate such as adjustment of water flow rate,

bit rotation speed, and drilling load since the beginning of the survey. In addition, because core collection was not done between standard penetration tests (SPT), the team requested BPC to collect samples properly.

- Description of Borehole Column: The team reviewed the format of the borehole column submitted by BPC, and instructed to describe from the geological and geotechnical point of view as well as adding depths of slip plane of the landslide and groundwater level.

3) Technical Guidance on Landslide Stability Analysis and Countermeasure Selection

Regarding landslide stability analysis and countermeasure design specified in the scope of work in the TOR, the JICA Study Team shared to BPC the manual presenting landslide stability analysis and countermeasure selection on 7 March.

(3) Modification of Preliminary Design

1) Basic Policy of Modification

The additional topographic survey was carried out as an entirely regenerated survey which has no element from the previous DPR survey. Basic policy of modification of preliminary design is to optimize road proposed center line corresponding to new topo data and accompanied design modification of road structure design with applying the same design policy and criteria in the previous stage.

2) Major Modification in Preliminary Design

In the middle of August 2017, a new fact was found that the construction of shortcut road in Chhingchhip, located near the existing bailey bridge of NH54 was newly commenced by PWD.

For the subject, the JICA Study Team had a meeting with NHIDCL. The modification plan of the route was proposed and it was agreed by NHIDCL.

Therefore, a planning route in the section was modified to the location along the newly built-up shortcut road. In addition, the new bridge plan of steel arch in Chhingchhip initially proposed by the JICA Study Team was canceled.

3) Modification of Landslide Countermeasure Design

Due to the changes in the base data and some considerations stated below, the plan for landslide countermeasure design of NH54 was revised during the design modification.

I. Update of topographical drawing: Accompany with update of topographical drawing by additional survey, geographical descriptions of natural terrains as valleys and hills are changed from the previous data.

II. Modification of road alignment design: Road alignment design was modified in order to ease a risk of landslide as much as possible. Accompany with centerline modification, proposed countermeasure location and range have been changed accordingly.

(4) Construction Cost Estimate

For the assistance of preparing tender document, the construction cost estimate is updated.

4. Technical Assistance for Additional Surveys and Design Modifications of NH51

(1) Additional Topographic Survey

1) Progress Monitoring for the Survey

(a) Mobilization

A survey team was mobilized at the end of June 2017 and site work was commenced.

(b) Chainage Marking on Existing Alignment

As scheduled, all works were completed in the beginning of July.

(c) Pillar Fixation

As scheduled, all works were completed in the beginning of July.

(d) DGPS Primary Control Survey

Site works were completed in the beginning of August which were slightly delayed from the schedule.

(e) Secondary Traverse Survey

Site works were completed in the middle of September which were rather delayed from the schedule.

(f)Topo Survey for Additional Data

As scheduled, the LIDAR survey at site was completed in the beginning of July.

(g) Data Processing

Observed raw data was carried to the surveyor's office in Bangalore, and processing work was commenced immediately to deduct unnecessary points and to generate topo drawings. Since BPC's manpower was flung into NH54 until its completion, processing work for NH51 was commenced only after the NH54 work. Therefore, topographic drawing was completed in the beginning of November being greatly behind the initial schedule. However, the JICA Study Team found lack of drawing area for the 1 km road stretch and requested BPC to revised it through NHIDCL. Finally, the entire topographic drawing was completed in the beginning of December.

2) Technical Guidance by the JICA Study Team

(a) Datum Level Check

Datum level installed at NH51 site and managed by N.H. is required for the topographical survey, but it had not been obtained by BPC. Therefore, the JICA Study Team jointly visited the N.H. Office at Tura and asked about the information of the datum level installed at the site. After, the JICA Study Team jointly visited the site and confirmed the datum level.

(b) Others

Work method and work procedure are almost the same for the survey for NH54. Therefore, it can be followed as a technical guidance conducted for the survey of NH54.

(2) Additional Geological / Geotechnical Survey

1) Progress Monitoring for the Survey

(a) Mobilization

A survey team was mobilized at the end of June 2017 and site work was commenced immediately.

(b) Slope Inventory Survey

As scheduled, site works were completed in the middle of September.

(c) Borehole Survey

As scheduled, site works were completed at the end of August.

2) Technical Guidance by the JICA Study Team

(a) Joint Verification on Borehole Survey Location

The JICA Study Team jointly verified the borehole survey location with BPC. The team instructed the detailed location of the six boreholes in the three sections at the site.

(b) Others

Work method and work procedure are almost the same for the survey for NH54. Therefore, it can be followed as a technical guidance conducted for the survey of NH54.

3) Modification of Preliminary Design

(a) Basic Policy of Modification

Basic policy of modification of preliminary design is same as NH54.

(b) Major Modification in the Preliminary Design

Detailed topographic information on both sides of the existing road were obtained by conducting additional topographic survey. Submitted map data contains 50 m width along the existing road. Based on the updated terrain data, road centerline design was optimized while considering the construction cost reduction and road safety. The centerline change involves design modification for earthwork, retaining wall and miscellaneous structures and that resulted to quantity calculations being changed as well.

4) Construction Cost Estimate

For the assistance of preparing tender documents, the construction cost estimate was updated.

5. Technical Assistance for Application of Contract Mode and Preparation of Technical Specifications

(1) Technical Assistance for Preparation of Application of Contract Mode

1) Discussion Progress about Modification of General Contract Condition

The study team reviewed the items which is assumed as a risk of smooth implementation of the project under EPC contract conditions. Based on the discussions among the government of India and JICA, a draft of proposal for the conditions was summarized with referring application examples on ADB projects.

2) Draft for Schedules

The necessary assistance by JICA Study Team for the "Schedules" which is composed in Tender Documents in range of Phase-1 of the project are as shown in Table 5-1.

Table 5-1 Components of Schedules, and Assistance Target

Schedule	Note
Schedule – A: Site of the Project	
[Annex -I] 1. The Site 2. Chainage References (Existing vs Design) 3. Land 4. Carriageway 5. Major Bridge 6. Road over-bridges (ROB) 7. Grade separators 8. Minor bridges 9. Railway level crossings / Railway Track 10. Underpasses (Vehicular, Non Vehicular) 11. Culverts 12. Bus bays 13. Truck Lay byes 14. Road side drains 15. Major junctions 16. Minor junctions 17. Bypass 18. Other structures / Details	
[Annex -II] **Dates for providing Right of Way**	
[Annex -III] **Alignment Plans**	**The Survey Team assistance is required.**
[Annex -IV] **Environment Clearances**	

Schedule	Note
Schedule – B: Development of the Project Highway [Annex -I] Description of Two-Laning 1. Widening of the Existing Highway 2. Geometric Design and General Features 3. Intersections and Grade Separators 4. Road Embankment and Cut Section 5. Pavement Design 6. Roadside Drainage 7. Design of Structures 8. Traffic Control Devices and Road Safety Works 9. Roadside Furniture 10. Compulsory Afforestation 11. Hazardous Locations 12. Special Requirements for Hill Roads 13. Utilities 14. Change of Scope	**The Survey Team assistance is required.**
Schedule – C: Project Facilities 1. Project Facilities 2. Description of Project Facilities	**The Survey Team assistance is required.**
Schedule – D: Specifications and Standards 1. Construction 2. Design Standards	**The Survey Team assistance is required.**
Schedule – E: Maintenance Requirement [Annex -I] Repair/rectification of Defects and deficiencies	
Schedule – F: Applicable Permits	
Schedule – G: Form of Bank Guarantee	
[Annex -I] Performance Security	
[Annex -II] Form for Guarantee for Withdrawal of Retention Money	
[Annex -III] Form for Guarantee for Advance Payment	
Schedule – H: Contract Price Weightages	**The Survey Team assistance is required.**
Schedule – I: Drawings [Annex -I] List of Drawings	**The Survey Team assistance is required.**
Schedule – J: Project Completion Schedule	
Schedule – K: Test of Completion	
Schedule – L: Provisional Certificate	
Schedule – M: Payment Reduction for Non-Complaisance	
Schedule – N: Selection of Authority Engineer [Annex -I] Terms of Reference for Authority Engineer	
Schedule – O: Forms of Payment Statements	
Schedule – P: Insurance	

Source: JICA Study Team

(2) Technical Assistance for Preparation of Technical Specifications

1) Slope Protection Works

Indian Design Standards / Guidelines / Manuals related to design or construction of the slope protection works published by Indian Roads Congress contains little explanation for the mechanism of slope failures development and its countermeasures. However, the description is not sufficient for the project due to lack of detailed explanation / understanding for mechanism of slope failure or mass movement.

It is necessary for design standards to specify appropriate design method and technical specification with detailed design values used for design. However, such description is not sufficient for anchor works and rock bolt works specially.

Non-frame works is slope protection works like rock bolt works, but particular method developed in Japan, which features the remain of natural plants on the slope.

Rockfall prevention fence /retaining wall shall be designed in accordingly to mechanism of rock falling. Detailed design theory and design conditions such as fence type or working forces are to be specified.

Because these works have been experienced and developed well in Japan, technical standards provided in Japan Road Association, etc. contains enough description for these particular works. Therefore, it is planned that "Schedule-D" is made up by description of important points from Japanese related standards.

2) Steel Arch Bridge

The design standards / guideline / manual for design or construction of general steel bridge works such as girder or truss bridge are provided well including design theory, the design values to be used for design, notification for fabrication and erection. However, some structural types such as arch bridge are not covered by these standards. For example, verification for steel arch stability and erection method for steel arch bridge are not described by these standards. In addition, Knuckle bearing which is applied to bottom of arch rib generally is not included.

Hence, it is necessary that whole description shall be consistent well by applying Indian standards for the part which is covered enough by Indian standards and applying overseas standards / guidelines / manuals such as Japanese standard or EUROCODE, etc. for the part which is particular for steel arch bridge.

6. Conclusion

(1) Wrap-up of the Technical Assistance Activities

1) Activities of Monitoring and Technical Assistance for the Entire Process of the Additional Survey and Modification of the Preliminary Design for NH54 and NH51

(a) Additional Topographic Survey

To verify accuracy of the topographic mapping in DPR, The JICA Study Team compared the coordinate values of the same kilo-post block located along NH-54 which are observed in the map of DPR, and the secondary traverse by the additional survey by BPC, respectively. As results, it was found that both coordinates are widely different from each other. This means reliability of DPR survey is significantly-low, therefore, the JICA Study Team advised to NHIDCL to carry out detail survey for the entire stretch of the target road.

The detail survey was planned to be done with total station at the beginning, however, the work progress was significantly delayed and it was expected that completion of the survey will be later than planned. To catch up with the schedule, the additional survey consultant proposed the LIDAR survey as an alternate to the total station survey and NHIDCL approved it. Because of the method change, the survey progress improved to a certain extent, however, in the meantime, it was confirmed that there was widely different between the topographic map in DPR and the terrain observed by LIDAR survey, again.

(b) Additional Geological / Geotechnical Survey

The additional survey consultant carried out the slope inventory survey and the boring survey at critical slope locations. The slope inventory survey completed according to plan, while the boring survey took seven months as against three months and half of the initial plan due to insufficient input and of boring equipment and worker of the consultant.

(c) Modification of Preliminary Design

Because of changing method to LIDAR survey, topographic maps being a basis of following design works are fully regenerated from one in DPR. Basic policy of modification of preliminary design is to optimize road proposed center line corresponding to new topo data and accompanied design modification of road structure design with applying the same design policy and criteria in the previous stage. The JICA Study Team carried out technical assistance for updating of preliminary design of eight packages in NH54 and one package in NH51.

About the slope protection design works which is taken as a significant element of updating preliminary design, the landslide stability analysis and the countermeasure design are specified in the scope of work in the consultant's TOR. The JICA Study Team shared to BPC the manual presenting landslide stability analysis and countermeasure selection.

2) Technical Assistance for Application of Contract Mode and Preparation of Technical Specifications

(a) Application of Contract Mode

The study team reviewed the items which are assumed as a risk of smooth implementation of the project under EPC contract conditions. Based on the discussions among the government of India and JICA, a draft of proposal for the conditions was summarized with referring application examples on ADB projects. After perpetual discussions among GOI (MORTH and NHIDCL), JICA, and the Study Team, a letter (JFY2017,4R-0372) was issued for NHIDCL as a final proposal of addendum request for EPC of India by JICA.

(b) Preparation of Technical Specifications

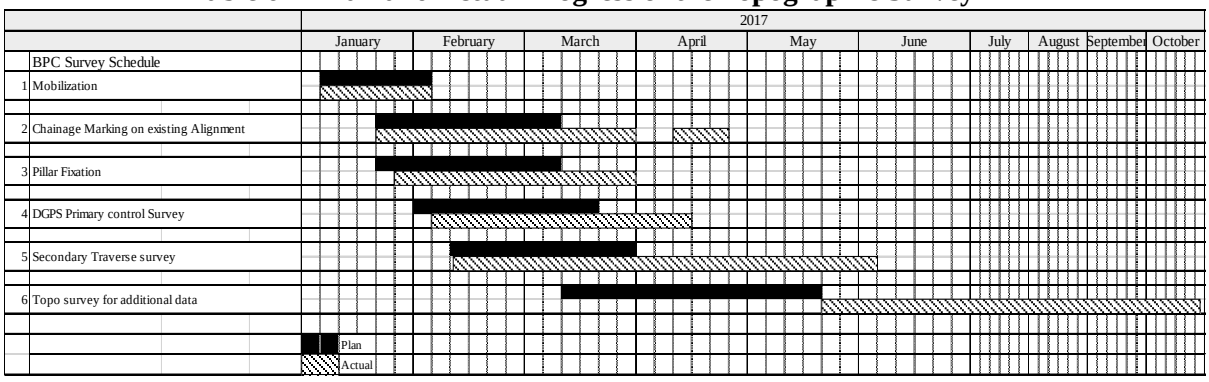
A road of NH54 is located in a quite hilly terrain, therefore, the JICA Study Team established a design policy aiming to a disaster-resistant road with considering reductions of large scale cut slope and spoil soil. India has laid down technical standards about design and construction works of road structures, however, it does not include technical specifications of some kind of slope protection works and steel arch bridge works. The JICA Study Team arranged drafts for the technical specifications and submitted to NHIDCL.

3) Conclusions of Technical Assistance

On a basis of above activities through the monitoring and the technical assistance for additional survey and modification of preliminary design, and the technical assistance for application of contract mode and preparation of technical specifications, the study team arranged reference documents for the preparation of tender documents for each package in NH54 and NH51.

In the progress of the topographic survey by the additional survey consultant, site works and digital mapping works took another five months from the initial plan, as shown in Table 6-1. Due to this, the commencement of modification of preliminary design was significantly delay accordingly.

Table 6-1 Plan and Actual Progress of the Topographic Survey



Source: JICA Study Team

Nevertheless, whenever topographic map submission is delayed, the study team re-considered work schedule for each package for catching up the demanded deadline. After all, the technical assistance works were completed in four months and half as promised initially**.**

(2) Points to Note

1) Note on Reference Documents prepared by This Study

In this technical assistance, the JICA Study Team prepared the reference documents for arranging tender documents for NH54 and NH51 carried out by NHIDCL and the additional survey consultant.
While NHIDCL and the additional survey consultant ought to arrange official tender documents with reference to the above reference documents at the bidding of NH54 and NH51, it is important to note that the documents prepared through this technical assistance shall be treated as only reference.

2) Concern for Project Implementation and Proposed Supporting Measures

NHIDCL has started land acquisition and contractor procurement for this project. For the smooth implementation of this project and implementation of high-quality construction based on the design concept proposed in this survey, supporting measures for concerned matters in the project implementation stage is proposed as shown in Table 6-3.

Table 6-3 Concern for Project Implementation and Proposed Supporting Measures

Concern Items	Contents of Concern and Proposed Supporting Measures	Responsible by	Timing
Delay of land acquisition	Contents of concern: In order for contractor to begin construction work, over 90% of construction area needed to be handed over to the contractor, and submission of performance guarantee also needed to be confirmed. Land for acquisition is fixed by Mizoram Province, but the conventional land fixing method based on the offset from the existing road center is applied regardless of the control point survey, so there is concern about securing accuracy and prolonging the work. Proposed Supporting Measure: Land acquisition will be implemented based on DPR design results finalized by DPR consultants employed by NHIDCL. However, it is necessary to measure and provide offset data from the existing road center to the boundary of land acquisition etc. for Mizoram state. Since the DPR consultant does not have the technology to accurately and quickly measure the above data, supporting by JICA study team for the above data is desirable.	・Mizoram State ・NHIDCL ・DPR consultant ・JICA Study Team	・On going (by end of May, 2018)
Reflecting the design concept on construction	Contents of concern: The responsibility and authority of the construction supervision consult (Authority's Engineer) is prescribed as follows in the 18th term of the contract agreement between NHIDCL and Contractor. Prior approval from the NHIDCL is required before AE instructions and guidance concerning the following are notified to the contractor. 1. Extension of construction period, 2. Additional payment to the contractor, 3. Contract termination payment, and 4. When either the NHIDCL or the contractor incurs an obligation / responsibility to exceed 0.2% of the aggregate contract (lump sum contract price). However, since the schedule N (Annex - I) attached to	・JICA	From the beginning of construction

Concern Items	Contents of Concern and Proposed Supporting Measures	Responsible by	Timing
	the agreement specifies Rs. 5,000,000 as the limit, the amount of money is given priority. Since the authority of AE is limited as described above, NHIDCL's discretion largely determines whether the design concept proposed in this survey is sufficiently reflected in construction. Proposed Supporting Measure: Through technical assistance in this survey, since it was decided to include a schematic design drawing, a structure list, etc. as a reference in bidding documents. By implementing the " Special Assistance for Project Implementation: SAPI", monitoring and guiding based on the bidding documents is considered as effective support.		
Quality Assurance for Construction	Contents of concern: The types of inspections and tests conducted by AE before handover are detailed in Schedule-K of the bidding documents. Although it is possible for AE to entrust the actual inspection / test to an external organization, the internal consent of NHIDCL is necessary. Also, it is AE's job to audit whether the site meets Indian environmental standards and safety standards. Assistance plan: When concluding an AE consulting contract, instruct NHIDCL from JICA to clarify who is responsible for the examination expenses and who is responsible for the audit of the environmental and safety standards.	・NHIDCL ・JICA	At bidding of AE

Source: JICA Study Team

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The remarkable economic growth of India, located in South Asia, is widely known to the world today. Good progress of development of infrastructures in the transport sector, including strengthening of the connection between major cities, has made this economic growth possible. Especially, road is one of the most important modes to deal with mostly for domestic transportation activities along with railway, because road transportation constitutes 85% of the total passengers while railway serves 60% of the total freight. However, strengthening of traffic infrastructures in mountainous areas has not progressed smoothly due to financial and technical issues, while the reinforcement of the main highways in the plain areas has been undertaken with the acceleration of economic growth of India.

Particularly, only 28.5% (63.4% is the average in the whole country) of the roads in the North-East States are paved and only 53% of the national highways have more than two lanes. This is because the North-East States are located far from the mainland of India as well as the access road to reach the borders with neighboring countries is undeveloped, considering that the Government of India (hereinafter referred to as "GOI") does not approve the agreement to make transportation with neighboring countries available except for particular countries to avoid security risk. Furthermore, the North-East States area has severe natural conditions such as steep mountainous geography (most of the state is located in hilly area) and high rainfall area (more than 10,000 mm rainfall per year was recorded, particularly in Mizoram). Therefore, it is a key issue how to prevent or reduce road closure caused by natural disasters to achieve the economic growth in these states.

The GOI raised the "Special Accelerated Road Development Programme for North East", which was committed in the "Twelfth Five-Year Plan (from April 2012 to March 2017)", to cope with the abovementioned problems through the improvement of national highways connecting major cities within the North-East States.

Based on such background, GOI requested the Government of Japan (hereinafter referred to as "GOJ") to provide loan assistance in carrying out the improvement of existing roads in eight sections, repair of two existing bridges, and construction of one new bridge within the six states of the North-East States in India.

Two existing road sections of NH54 and NH51 are selected as part of the phase-1 Japanese Yen Loan project based on project prioritization by the "Preparatory Study for Road Network Improvement in North-East States of India" and project appraisal for Japanese Yen Loan by Japan International Cooperation Agency (JICA). To ensure the quality of the project, necessity of supplemental natural engineering surveys and design modification for NH54 and NH51 were confirmed during project appraisal stage between JICA and the National Highways and Infrastructure Development Corporation (NHIDCL), implementation of supplemental natural engineering surveys and design modification for NH54 and NH51 by NHIDCL and provision of technical assistance for the survey and the design modification by JICA are mutually agreed upon.

1.2 Objectives of the Study

The major objectives of this study are:

- To analyze the existing data/reports and review of existing feasibility study reports (hereinafter referred to as "F/S");
- To examine the procurement and construction method, implementation schedule, project organization, capability of operation and maintenance, social and environmental conditions and evaluate project cost and feasibility of target sections; and
- To examine the procurement and construction method, implementation schedule, social and environmental conditions, project cost, and feasibility of four bypass routes plan on NH54.

Above objectives have been achieved as Interim Report 4 which was submitted in August 2016. Besides, additional objectives are discussed and concluded between NHIDCL and JICA as below:

- To review and monitor the entire process of additional engineering survey and modification of engineering design of NH54 mainline and NH51.
- To assist preparations of technical specifications, and procedures for application of EPC contract mode.

1.3 Study Area

Target section for the scope is shown in Table 1.3-1.

Table 1.3-1 Target Section of Additional Technical Assistance in NH54 and NH51

No.	Name		Section（Kilo-post）	Length	
1-1	NH54	Section 1	Start near 8.000 km, End near 116.945 km	108.95 km	350.68 km
1-2		Section 2	Start near 125.000 km, End near 243.320 km	118.32 km	
1-3		Section 3	Start near 431.000 km, End near 554+410 km	123.41 km	
2	NH51		Start near 85.000 km, End near 143.280 km	51.51 km	
Total				402.19 km	

Source: JICA Study Team

CHAPTER 2 PLAN FOR THE TECHNICAL ASSISTANCE

2.1 Background of the Technical Assistance

For the target section of NH54 and NH51, topographical surveys have been conducted during DPR by implementation of NHIDCL in 2009. Also, some geological/geotechnical surveys have been conducted by a JICA preparatory study in 2014.

However, it was confirmed by the JICA study that some additional engineering surveys are required in order to supplement previous surveys. Because, topographical map made up by the survey does not provide necessary accuracy for the use of hill road design. In addition, the amount of geological /geotechnical survey already conducted is limited. The necessity of the additional engineering survey is detailed in Table 2.1-1.

The additional engineering surveys are implemented by NHIDCL with order to local consulting company in India. Therefore, it is required for the JICA Study Team to perform the monitoring and provide necessary technical guidance for the survey.

Moreover, the detailed project report (DPR) design shall be revised in accordance with the result of the additional engineering surveys. The design requires technical know-how for hill road design and slope protection design which are not familiar in India. Therefore, the JICA Study Team should also conduct the technical assistance for the design modification.

Table 2.1-1 Necessity of Additional Engineering Surveys

Item	Reason
Topographical Survey	Topographic data of DPR does not fully cover ground surface on valley and hill side, and X-Y coordinates of designed road alignment in DPR is not harmonized with the actual road alignment.
	Several sections of the road ground surface data are different from the actual one.
Geological/ Geotechnical Survey	Due to the limitation of survey schedule and budget in the JICA Preparatory Survey, the slope inventory survey was carried out with an interval of 100 m to 200 m.
	Under the JICA Preparatory Survey, the JICA Study Team identified 864 locations of slope failure section on the target route of NH-54, and the critical 99 locations out of 864 locations were examined with countermeasures against slope failure. The slope design in the bidding documents is recommended to be updated with the collected up to date late slope condition.
	Under the JICA Preparatory Survey, the boring investigation was conducted only in three locations out of the total 99 critical sections in terms of slope stability.

Source: JICA Study Team

In addition to this, about the contract terms and conditions applicable to construction contracts of the project, the JICA Study Team provides necessary technical assistance to compile appropriate contents using the EPC contract provisions of MORTH.

2.2 Additional Engineering Surveys Implemented by NHIDCL

2.2.1 Consultant for the Additional Surveys

Additional engineering surveys for NH54 and for NH51 were packaged in separate contract. However, the same consultant company has been selected to both packages. The consultant for the surveys is selected by the company as indicated in Table 2.2-1.

Table 2.2-1 Consultant for the Additional Surveys

Package	Items	Description
Additional survey for NH54	Consultant	BPC CONSULTANT INDIA PVT LTD.
	Address	Concept Building, Prince Park 514/ A/1, Kalikapur Road, Kolkata-700099
	Selected date	December 2016
Additional survey for NH51	Consultant	BPC CONSULTANT INDIA PVT LTD.
	Address	Same as above
	Selected date	May 2017

Source: JICA Study Team

2.2.2 Overview of the Additional Surveys

(1) Overview of Additional Survey for NH54

1) Scope of the Works

The scope of the works for additional survey of NH54 conducted by the additional survey consultant is as shown in Table 2.2-2.

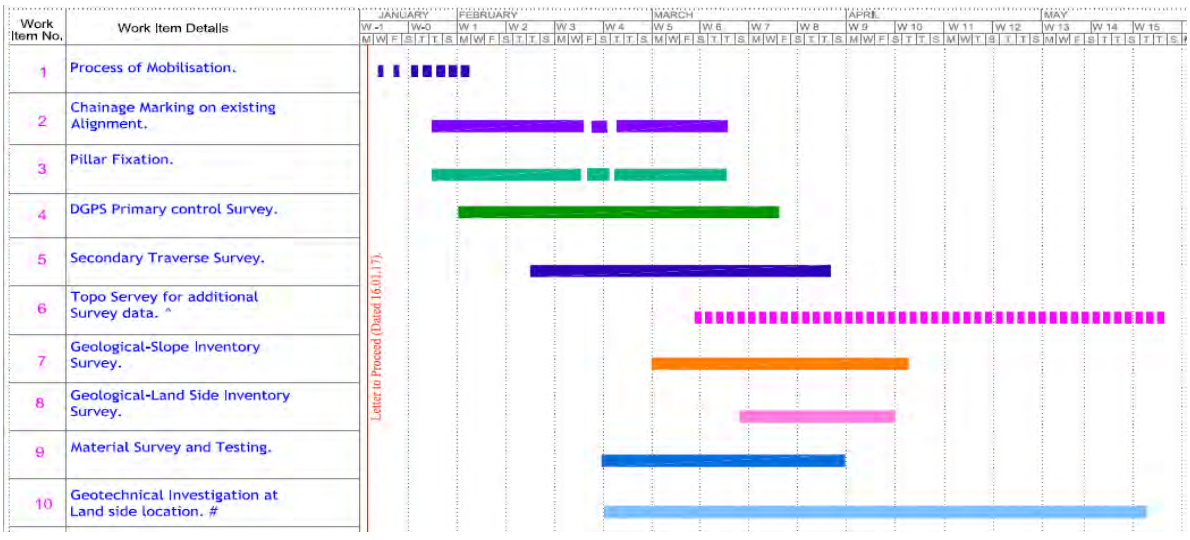
Table 2.2-2 Scope of Works for Additional Survey of NH54

Sl No.	Item	Unit	Quantity
A.	Topographical Survey		
1	Survey for Additional Data	Km	372
B.	Control Point Survey		
1	Primary Control Survey @ 2.5 km	Nos	71
2	Establishing GPS Monument @ 5km	Nos	71
3	Establishing Secondary Traverse @ 0.5 Km	Km	372
4	Traverse Survey	Km	372
C.	Geological/Geotechnical Survey and Investigation		
1	Detailed Slope Inventory Survey @ 40 m interval.	Km	372
2.	Geological Survey at Critical Section / Landslide Location	Km	372
3.	Bore Hole Investigation at Landslide / Critical Location	Nos	38 locations
D.	Material Source Survey of Quarry		
	Material Survey and Quarry Location.	Nos	8 locations

Source：Request for Proposal

2) Work Schedule

The work schedule for additional survey of NH54 conducted by the additional survey consultant is as shown in Figure 2.2-1.



Source：Inception Report by BPC

Figure 2.2-1 Work Schedule for Additional Survey of NH54

3) Work Organization

The work organization for additional survey of NH54 conducted by the additional survey consultant is as shown in Table 2.2-3.

Table 2.2-3 Work Organization for Additional Survey of NH54

SI. No.	Name	Task
1	Mr. Sourav Dasgupta	Team Leader
2	Mr. Siladitya Haldar	Senior Highway/Survey Engineer
3	Mr. Sardendu Mukherjee	Senior Geologist
4	Mr. Kaushik Pal	Highway Engineer
5	Ms. Beena Shaw	Geologist
6	Mr. Sumanta Pakhira	Geo-technical cum Materials Engineer

Source：Inception Report by BPC

(2) Overview of Additional Survey for NH51

1) Scope of Works

The scope of works for additional survey of NH51 conducted by the additional survey consultant is as shown in Table 2.2-4.

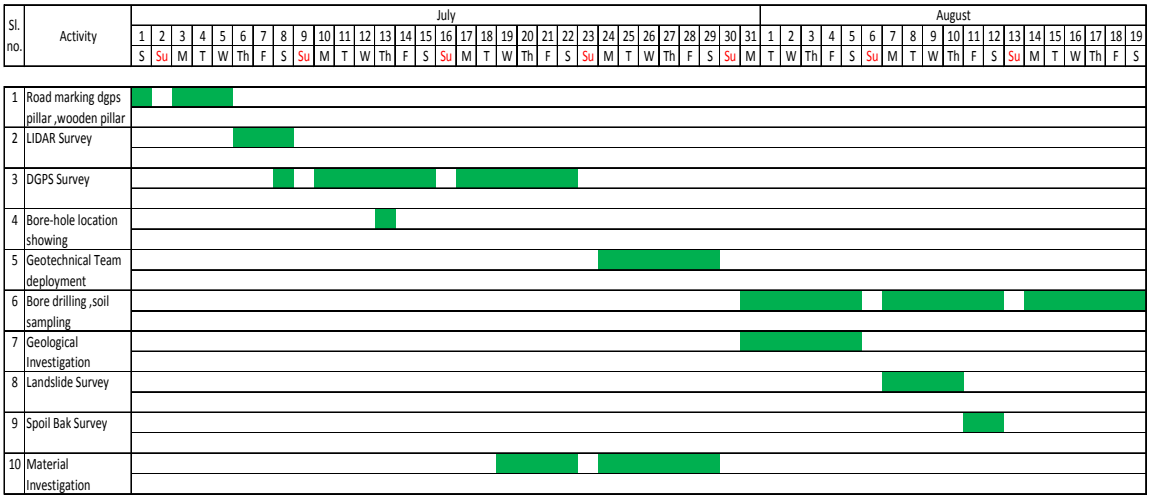
Table 2.2-4 Scope of Works for Additional Survey of NH51

Sl No.	Item	Unit	Quantity
A.	Topographical Survey		
1	Survey for Additional Data	Km	55
B.	Control Point Survey		
1	Primary Control Survey @ 2.5 km	Nos	11
2	Establishing GPS Monument @ 5 km	Nos	11
3	Establishing Secondary Traverse @ 0.5 km	Nos	1,236
4	Traverse Survey	Km	30.2
C.	Geological/Geotechnical Survey and Investigation		
1	Detailed Slope Inventory Survey @ 40 m interval.	Km	55
2.	Geological Survey at Critical Section / Landslide Location	Km	55
3.	Bore Hole investigation at Landslide / Critical Location	Nos	6 locations
D.	Material Source Survey of Quarry		
	Material Survey and Quarry Location.	Nos	(as obtained)

Source：Request for Proposal

2) Work Schedule

The work schedule for the additional survey of NH51 conducted by the additional survey consultant is as shown in Figure 2.2-2.



Source：Inception Report by BPC

Figure 2.2-2 Work Schedule for Additional Survey of NH51

3) Work Organization

The work organization for the additional survey of NH51 conducted by the additional survey consultant is as shown in Table 2.2-5.

Table 2.2-5 Work Organization for Additional Survey of NH51

SI. No.	Name	Task
1	Mr. Siladitya Haldar	Project Manager
2	Mr. Dipak Baishya	Highway/Survey Engineer
3	Mr. Dinesh Bind	Geological/Geotechnical Engineer
4	Ms. Ramkrishna Santra	Geological/Geotechnical cum Materials Engineer

Source：Inception Report by BPC

2.3 Policy of Technical Assistance

2.3.1 Assignment Schedule of the JICA Study Team

Assignment schedule of the JICA Study Team in addition to the scope for "Supplementary Technical Assistance for Additional Engineering Survey and Design Modification" is shown in Table 2.3-1 and Table 2.3-2**.**

As described in the section of "Progress Monitoring for the Survey" later on, the additional survey progress was significantly delayed from the initial schedule by BPC due to the lack of sufficient mobilization of survey workers and equipment, and misreading of difficulty of site work. This delay affects the JICA Study Team's assignment schedule for the supplementary technical assistance as well. As a result, time of preparation for the Final Report is to be delayed approximately 7 months from the initial plan. Table 2.3-3 shows the assignment schedule which was revised to correspond the delay.

Table 2.3-1 Assignment Schedule of the Study Team (Term Before the Supplementary Technical Assistance)

	Position	Name	FY 2014 12	1	2	3	FY 2015 4	5	6	7	8	9	10	11	12	1	2	3	FY 2016 4	5	6	7	8	9	10
Works in India	**Project Management Group**																								
	TL / Traffic Planning	Hisatoshi Naito																							
	DTL / Road Planning & Design 1	Takayasu Nagai																							
	Experts																								
	Road Planning & Design 2	STHAPIT NARESH																							
	Road Planning & Design 3	Ippei Iwamoto																							
	Road Planning & Design 4	Motoki Iwamaru																							
	Bridge Planning & Design	Yasuhiro Takaoka																							
	Slope Protection Planning & Design 1	Hideo Katagiri																							
	Slope Protection Planning & Design 2	Naoki Kawahara																							
	Slope Protection Planning & Design 3 / Tunnel	Hiroyuki Katsuro																							
	Construction Planning & Cost estimate	Masahiro Toriu																							
	Construction Planning & Cost estimate 2	Fumiyasu Nakata																							
	Economic and Financial Analysis	R. K. Khanka																							
	Contract Management Specialist	Kenji Nomoto																							
	Social Environmental Specialist	Hayato Kobayashi																							
	Social Environmental Specialist 2	Hiroaki Nakagawara																							
Works in Japan	**Project Management Group**																								
	TL / Traffic Planning	Hisatoshi Naito																							
	DTL / Road Planning & Design 1	Takayasu Nagai																							
	Experts																								
	Road Planning & Design 2	STHAPIT NARESH																							
	Road Planning & Design 3	Ippei Iwamoto																							
	Contract Management Specialist	Kenji Nomoto																							
	Social Environmental Specialist	Hayato Kobayashi																							
	Economic and Financial Analysis	R. K. Khanka																							
	Submission Legend			IC/ R				IT/ R1						IT/ R2								IT/ R3			IT/ R4

: Assignment in India
: Assignment in India (Indian Nationality)
: Assignment in Japan
△ : WG for Environmental & Social Consideration

Source：JICA Study Team

Table 2.3-2 Assignment Schedule of the JICA Study Team (Supplementary Technical Assistance / Plan)

	Position	Name	FY 2016 11	12	1	2	3	FY 2017 4	5	6	7	8	9	10	M/M Total India	Japan
Works in India	**Project Management Group**															
	TL / Traffic Planning	Hisatoshi Naito													7.10	
	DTL / Road Planning & Design 1	Takayasu Nagai													10.53	
	Experts															
	Road Planning & Design 2	STHAPIT NARESH													0.77	
	Road Planning & Design 3	Ippei Iwamoto													0.90	
	Road Planning & Design 4	Motoki Iwamaru													2.50	
	Bridge Planning & Design	Yasuhiro Takaoka													4.70	
	Slope Protection Planning & Design 1	Hideo Katagiri													8.93	
	Slope Protection Planning & Design 2	Naoki Kawahara													7.00	
	Slope Protection Planning & Design 3 / Tunnel	Hiroyuki Katsuro													3.50	
	Construction Planning & Cost estimate	Masahiro Toriu													2.20	
	Construction Planning & Cost estimate 2	Fumiyasu Nakata													1.00	
	Economic and Financial Analysis	R. K. Khanka													0.13	
	Contract Management Specialist	Kenji Nomoto													2.23	
	Social Environmental Specialist	Hayato Kobayashi													7.40	
	Social Environmental Specialist 2	Hiroaki Nakagawara													2.00	
															Sub-Total in India	**60.89**
Works in Japan	**Project Management Group**															
	TL / Traffic Planning	Hisatoshi Naito														0.67
	DTL / Road Planning & Design 1	Takayasu Nagai														0.87
	Experts															
	Road Planning & Design 2	STHAPIT NARESH														11.90
	Road Planning & Design 3	Ippei Iwamoto														0.60
	Contract Management Specialist	Kenji Nomoto														1.10
	Social Environmental Specialist	Hayato Kobayashi														1.90
	Economic and Financial Analysis	R. K. Khanka														3.70
																Sub-Total in Japan	**20.74**
	Submission Legend			△				IT/R5				DF/ R		F/ R		
															Total	**81.63**

: Assignment in India
: Assignment in India (Indian Nationality)
: Assignment in Japan
△ : WG for Environmental & Social Consideration

Source: JICA Study Team

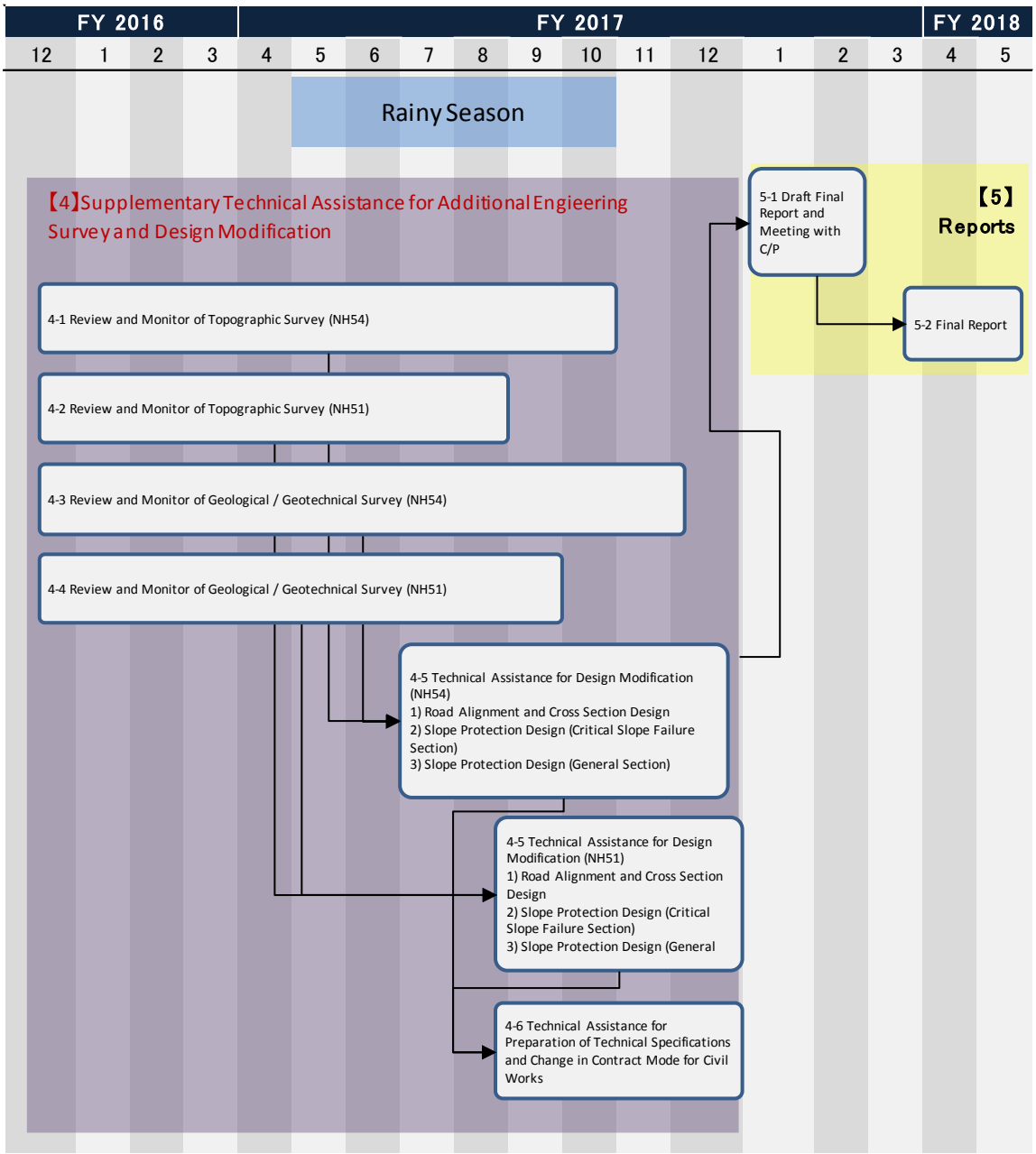
Table 2.3-3 Assignment Schedule of the JICA Study Team
(Supplementary Technical Assistance / Modified Due to the Delay of the Survey)

	Position	Name	FY 2016 11	12	FY 2017 1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	M/M Total India	M/M Total Japan
Works in India	**Project Management Group**																						
	TL / Traffic Planning	Hisatoshi Naito																				7.70	
	DTL / Road Planning & Design 1	Takayasu Nagai																				11.73	
	Experts																						
	Road Planning & Design 2	STHAPIT NARESH																				1.40	
	Road Planning & Design 3	Ippei Iwamoto																				0.90	
	Road Planning & Design 4	Motoki Iwamaru																				4.00	
	Bridge Planning & Design	Yasuhiro Takaoka																				7.20	
	Slope Protection Planning & Design 1	Hideo Katagiri																				8.93	
	Slope Protection Planning & Design 2	Naoki Kawahara																				7.00	
	Slope Protection Planning & Design 3 / Tunnel	Hiroyuki Katsuro																				5.50	
	Construction Planning & Cost estimate	Masahiro Toriu																				2.20	
	Construction Planning & Cost estimate 2	Fumiyasu Nakata																				3.00	
	Economic and Financial Analysis	R. K. Khanka																				0.13	
	Contract Management Specialist	Kenji Nomoto																				4.43	
	Tender Document Specialist	J.R.Montano Michel																				2.50	
	Social Environmental Specialist	Hayato Kobayashi																				7.40	
	Social Environmental Specialist 2	Hiroaki Nakagawara																				2.00	
																						Sub-Total in India	**76.02**
Works in Japan	**Project Management Group**																						
	TL / Traffic Planning	Hisatoshi Naito																					0.67
	DTL / Road Planning & Design 1	Takayasu Nagai																					0.87
	Experts																						
	Road Planning & Design 2	STHAPIT NARESH																					11.25
	Road Planning & Design 3	Ippei Iwamoto																					0.60
	Contract Management Specialist	Kenji Nomoto																					1.25
	Tender Document Specialist	J.R.Montano Michel																					0.15
	Social Environmental Specialist	Hayato Kobayashi																					1.70
	Social Environmental Specialist 2	Hiroaki Nakagawara																					0.20
	Economic and Financial Analysis	R. K. Khanka																					3.70
																						Sub-Total in Japan	**20.39**
	Submission			▲							▲							▲		▲			
	Legend			IT/ RS							IT/ RS							DF/ R		F/ R			
	: Assignment in India			△																			
	: Assignment in India (Indian Nationality)																						
	: Assignment in Japan																						
	△ : WG for Environmental & Social Consideration																					**Total**	**96.41**

Source: JICA Study Team

2.3.2 Work Flow Chart

The work flow chart of the JICA Study Team regarding the scope for "Supplementary Technical Assistance for Additional Engineering Survey and Design Modification" is shown in Figure 2.3-1.



Source: JICA Study Team

Figure 2.3-1 Work Flow Chart

2.3.3 Technical Assistance Plan for Additional Surveys

(1) Additional Topographical Survey

The JICA Study Team reviewed and monitored all the activities of the additional topographic survey work with attention to the following:

i. Carrying out the plan for topographic survey with an average 25 m in total (average 15 m outside from the most lateral survey point of hill side in DPR design, and average 10 m outside from the most lateral survey point of valley side in DPR design). Survey accuracy shall be in the ensured scale of 1:1,000, and center of existing road, edge of slope and edge of existing pavement shall be continuously surveyed.

ii. If reference survey points by DPR are not confirmed at site and/or related documents to verify accuracy of the reference survey points by DPR are not confirmed, necessary control point survey to supplement above inadequacy shall be implemented.

iii. Establishing Global Positioning System (GPS) Control Point with an interval of 5.0 km with elevation survey from Great Trigonometrical Survey (GTS) Bench Mark (national bench mark).

iv. Work items and notes for the topographic survey (if full scale is required) are shown in Table 2.3-4.

Table 2.3-4 Work Items and Notes for Topographic Survey

Item	Note
Plan Mapping Survey (S = 1:1,000)	
1) Survey for Additional Data	- To cover an average 15 m outside from the most lateral survey point of hill side in DPR design, and average 10 m outside from the most lateral survey point of valley side in DPR design - Survey accuracy shall be in an ensured scale of 1:1,000, and center of existing road, edge of slope, and edge of existing pavement shall be continuously surveyed. - Existing utilities, road structures, house structures, and social / religious objects shall be covered.
A. Control Point Survey (if reference survey points by DPR are not confirmed at site and/or related documents to verify accuracy of the reference survey points by DPR are not confirmed)	
1) Primary Control Survey (if required)	- To use the Global Positioning System (GPS) and to integrate to the World Geographic System (WGS) 1984. - Elevation of GPS point shall relate to the GTS Bench Mark (national bench mark).
2) Establishing GPS Monument (if required)	- To install concrete square monument with a dimension of 30 cm x 30 cm x 60 cm with a 10 mm diameter, 60 cm long steel bar embedded at the center of the monument with i) Date Established, ii) GPS No., iii) Coordinates, iv) Elevation, v) Name of Project.
3) Establishing Secondary Traverse (if required)	- Secondary traverse is to be established using Total Station instrument and tied to at least 2 GPS control points. - To be spaced not greater than 500 m in interval. - To be marked with a wooden hub of a dimension of 5 cm x 5 cm x 50 cm with a common wire nail embedded at the center of the wooden hub.
4) Traverse Survey (if required)	- Secondary traverse is to be observed and measured in accordance with the following manners; • Horizontal angles are to be observed by two rounds of angle on two different zero settings. • The allowable linear error of closure should not exceed 0.0002 Ps, where Ps is the perimeter of the control. • The angular error of closure (Azimuth) should not exceed 10" $\sqrt{}$S where S is the number of station. • Number of stations between azimuth check should not exceed 35. • Relative error after azimuth adjustment should not be less than 1:10,000.

Source: JICA Study Team

v. The above survey data shall be incorporated to the digital three-dimensional mapping for the updating of the road alignment design.

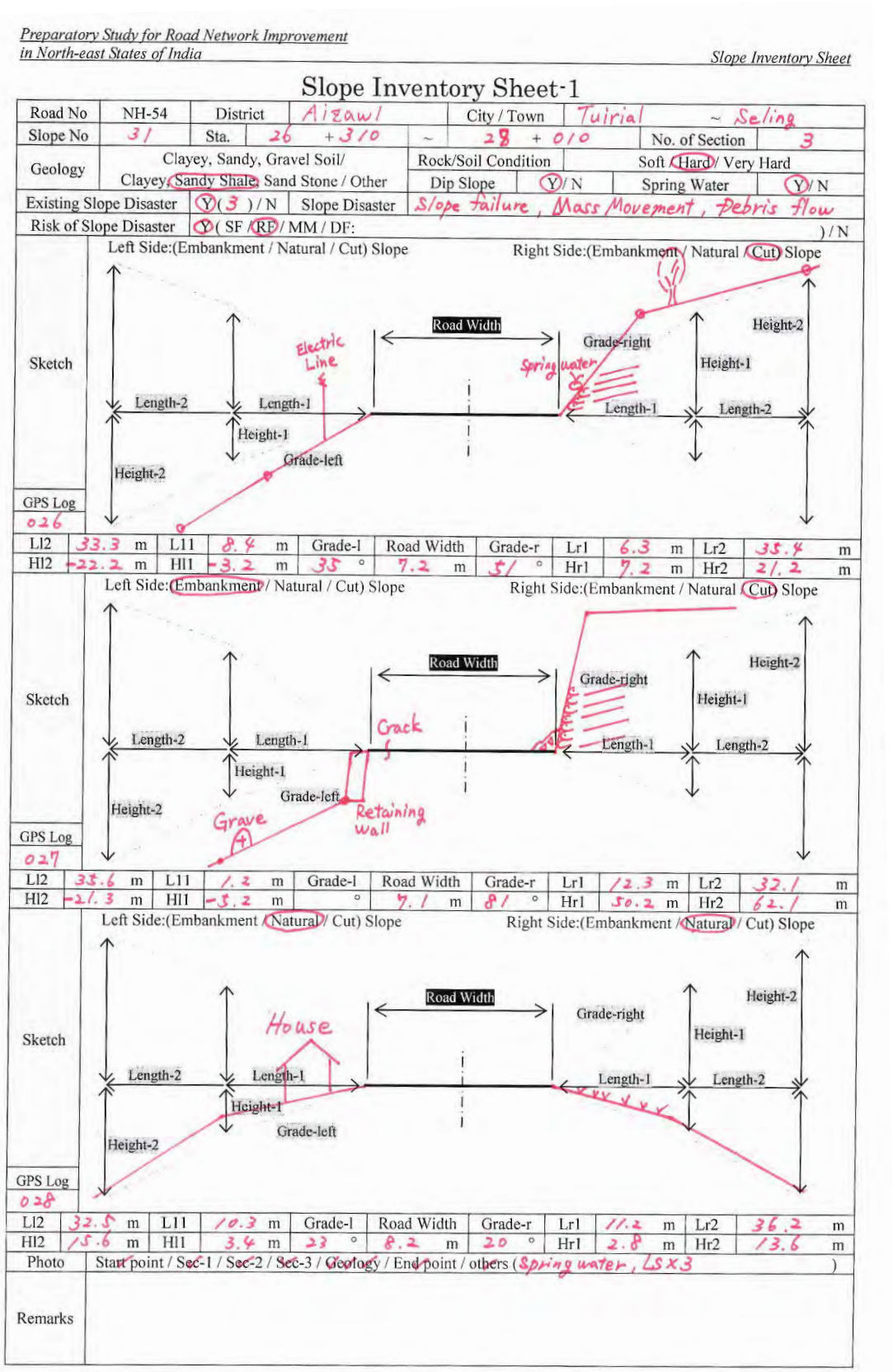
(2) Additional Geological / Geotechnical Survey

The JICA Study Team reviewed and monitored all the activities of the additional geological / geotechnical survey work with attention to the following:

(3) Detailed Slope Inventory Survey

- Preparing slope inventory sheets for both sides of the road with an interval of 40 m for survey to identify; i) type of rock / soil, ii) degree of weathering, iii) classification of rock, iv) slope angel, v) strike and dip, vi) dislocation / landslide /spring, and vii) to take photograph and sketch.
- Type of Rock / Soil: to identify by visual inspection

- Degree of Weathering: to identify by visual inspection or to confirm by using Schmidt Hammer
- Rock Classification: to classify as per Indian Standard in Rocky Stretch
- Slope Angle: to measure by using survey tool (portable clinometer)
- Strike and Dip: to measure by using survey tool (portable clinometer)
- Dislocation / Landslide / Spring: to identify by visual inspection
- A sample of an inventory sheet for geological survey of slope surface (general section) is enclosed in Figure 2.3-2, and the inventory sheet for critical section is in the same format used in this Study.



Source: JICA Study Team

Figure 2.3-2 Sample of Slope Inventory Sheet (General Section)

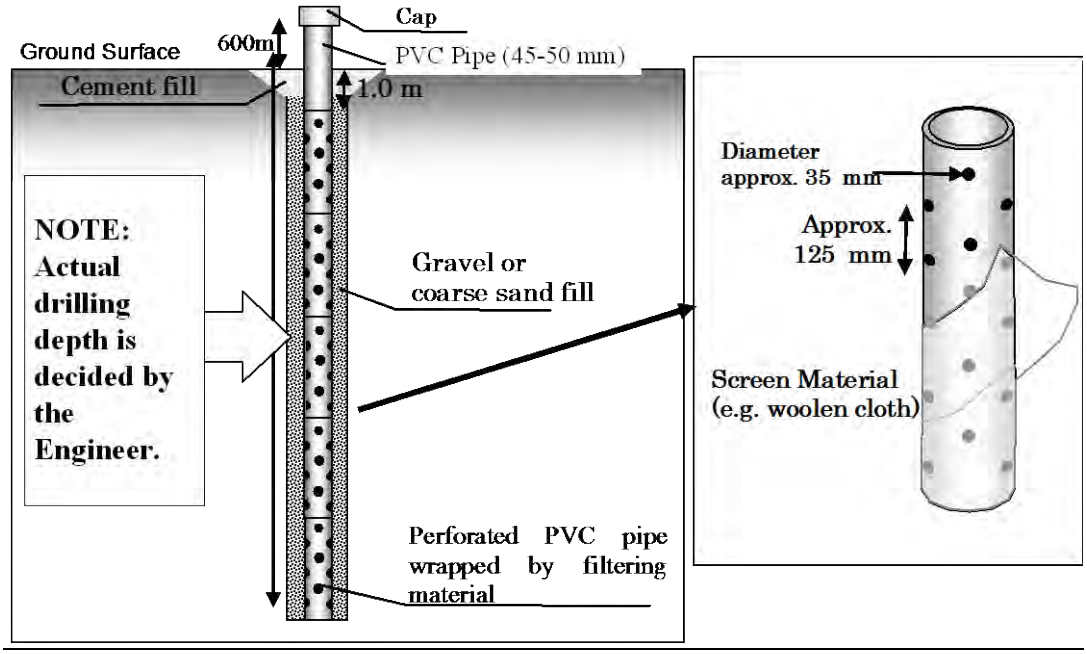
- Among the 99 locations of critical failure section identified in the JICA Preparatory Survey, there were three locations of countermeasure against debris flow disaster. The JICA Preparatory Survey has recommended considering potential flow capacity of debris in the culvert design. In a detailed inventory survey, the potential scale of debris flow should be updated for the design review.

(4) Borehole Investigation at Landslide Section

- Carry out boring investigation at critical section of landslide of NH-54 and sinking section to be identified in the JICA Preparatory Survey. NHIDCL plans to conduct in 38 holes of the investigation along the NH-54. The exact location of the boreholes shall be instructed by the JICA Study Team.
- NH-51: Three locations: as decided during the joint survey taken by DPR consultant, JICA Study Team, and NHIDCL,
- NH-54: to be decided based on the history of frequent occurrence of landslide based on visual inspection of site and historical data of soil failure
- The drilling machine shall have the drilling capacity sufficient to drill the required depth and hole diameter of more than 66 mm. The drill bit shall be selected deliberately to meet the geological conditions for the best core recovery and efficiency.
  - For Cohesive Soil:

    Thin-walled tube (φ76) should be used to obtain undisturbed samples.
  - For Rock Core:

    Type: Built-in rotary sleeve double tube sampler
    Outer diameter of the inner tube: φ68 (φ86)
    Inner diameter of the inner tube: φ48 (φ66)
- The Sub-consultant shall use rock coring techniques to explore and sample bedrock, and to confirm bedrock locations beneath proposed foundations. It is recommended to use double or triple tube core barrels to minimize disturbance of samples. Measure and record percent core recovery ratio (CRR) and rock quality designation (RQD) as soon as the cores are recovered, and classify the rock. Cored rock samples are retrieved by rotary drilling with hollow core barrels equipped with diamond or carbide embedded bits. The core is commonly retrieved in 1.50 m lengths.
- The drilling shall aim at 100% core recovery in both rock and unconsolidated deposits. Drilling slime shall not be regarded as recovery of core samples. The recovery rate of samples in each five-meter section of the hole shall not be less than 70% without acceptable reason.
- Monitoring Groundwater Level
- Perforated PVC pipes with a diameter 45-50 mm shall be prepared. The perforated PVC pipes shall be installed into each borehole. Details of the perforated PVC pipe are shown in Figure 4.6. The inside diameter of the pipes shall not be less than 40 mm.



Source: JICA Study Team

Figure 2.3-3 Details of Perforated PVC Pipe for Each Borehole

- After the installation of the perforated PVC pipe into each borehole, the groundwater level shall be measured twice a week for five weeks from installation of drilling. Groundwater levels shall be measured by using a battery-operated electrical indicator (tester).
- The results of the measurement of the groundwater levels shall be recorded with the rainfall in graphs and tables. The rainfall data shall be obtained from authorized meteorological agency by the consultant.

(5) Material Source Survey of Quarry

- DPR of NH-54 has identified the following eight locations of the existing quarry sites;

Table 2.3-5 Location of Existing Quarry along NH-54 as per DPR

No.	Quarry Name	Location
Section-1		
1	PC Stone Quarry	Km 13+135
2	Keifang Quarry	Km 35+000
3	Airport Quarry	Km110+000
Section-2		
4	Maudrh Quarry	Km194+000
5	Lungpuzawl Quarry	Km223+300
Section-3		
6	Liapha Quarry	Km473+300
7	Rulkual Quarry	Km486+900
8	Kawlchaw Quarry	Km506+650

Source: JICA Study Team

- Three samples of rock material shall be taken from each quarry, and the following laboratory material tests shall be conducted to confirm the quality as aggregate.

Table 2.3-6 Required Material Test for Existing Quarry

Laboratory Material Test	Number Test
Specific Gravity	24 samples
Water Absorption	24 samples
Soundness	24 samples
Loss Angels Abrasion	24 samples

Source: JICA Study Team

- Besides the above existing quarry identified in DPR, the potential location of quarry development should be surveyed, and shall carry out laboratory material tests in the same manner above.

2.3.4 Technical Assistance Plan for the Modification of Preliminary Design

(1) Basic Policy

The JICA Study Team reviews the topographic map data and geological survey data obtained by the additional surveys and confirms these validities. Based on the topographical and geological information, technical guidance is to be given to NHIDCL to optimize the design elements of roads and road structures.

(2) Design Criteria

The design modification based on the additional surveys is to follow the design criteria which has been established in the previous preliminary design by the JICA Study Team.

2.3.5 Technical Assistance Plan for the Application of Contract Mode

Cabinet decision was made in 2012 to change from the conventional contract method paying by checking bill of quantity to EPC method for Indian National Highway Development Project. On the other hand, considering the characteristics of the project which locates mountainous terrain requires huge volume of earth works and slope countermeasure works, contents of conditions (bidding period, risk allocation, payment method, maintenance, consulting position, design approval process etc.) in the EPC contract are considered to be important risk items concerning the quality assurance intended by this survey. Therefore, in order to propose to avoid the above-mentioned risks in this project, consideration, analysis and necessary advice are given on the contract clause contents.

In addition, JICA Study Team conduct necessary assistance for the “Schedules” which is composed in Tender Documents in range of Phase-1 of the project such as main line of NH54 and NH51, totally 9 packages.

2.3.6 Technical Assistance Plan for the Preparation of Technical Specifications

For the project implemented by NHIDCL with EPC contract style, technical specifications for both of design and construction works are described of in “Schedule-D : Specification and Standards” among Tender Document of the project.

As far as Design/Construction technics have experienced well in India are applied, to refer existing Indian specifications would be enough to specify technical specification for the project. Because, several Standards / Guidelines / Manuals such as series of IRC, ISO and construction specification of SPECIFICATION FOR ROAD AND BRIDGE WORKS are provided in India.

However, the project of road improvement for NH54 and NH51 does include Design / Construction works particular to hill road such as slope protection method including anchor works and rock bolt works. (Table 2.3-7) Because, existing Indian standard does not describe well for such design / construction works, the contents described in Schedule-D shall be considered well.

In order to make “Schedule-D” responsible by NHIDCL as appropriately, JICA Study Team conduct a necessary assistance.

Table 2.3-7 Particular works applied for the project

Category	Items	Applied for
Slope Protection Works	Anchor Works	NH54
	Rock Bolt Works	NH54
	Crib Works	NH54
	Non-Frame Works	NH54
	Sub-surface Drain	NH54
	Rockfall Prevention Fence /Retaining Wall	NH54
Bridge Works for hill road	Steel Arch Bridge	- (Planned firstly for Chhingchhip in NH54, but finally canceled)

Source: JICA Study Team

CHAPTER 3 TECHNICAL ASSISTANCE FOR ADDITIONAL SURVEYS AND DESIGN MODIFICATIONS OF NH 54

3.1 Record of the Monitoring Activities

The record of the monitoring activities by the JICA Study Team is as shown in the table below.

Table 3.1-1 Record of the Monitoring Activities

Date / Duration	Section / Location	Activity / Site visit purpose	Remarks
13-Jan '17 - 15-Jan '17	Aizawl~Keitum (km 8 - km 125)	Instruction on Slope Inventory Survey, and Joint Site Verification for Borehole location	Appendix-IV.1
16-Jan '17	Aizawl	Kick-off Meeting together with NHIDCL	
25-Feb '17	Aizawl	Provision of ICR, confirmation of progress	
28-Feb '17	Seling (km 8 - km 380)	Survey progress (Topo) and discussion	
2-Mar '17	Aizawl	Comments on ICR, improve of progress	Appendix-II.1
9-Mar '17 - 10-Mar '17	Aizawl~Lunglei (km 8 - km 201)	Survey progress (Topo and Geotechnical) and discussion	Appendix-I.1
15-Mar '17 - 17-Mar '17	Aizawl~Lawngtlai (km 8 - km 297)	Survey progress (Topo and Geotechnical) and discussion	Appendix-I.2
10-Apr '17 - 13-Apr '17	Aizawl~Tuipang (km 8 - km 380)	Survey progress (Topo and Geotechnical) and discussion	
18-Apr '17	Aizawl	Survey progress (Topo and Geotechnical)	Appendix-II.2
26-Apr '17 - 29-Apr '17	Aizawl~Tuipang (km 8 - km 380)	Survey progress (Topo and Geotechnical) and discussion	
12-May '17 - 16-May '17	Keitum~Tuipang (km 125 - km 380)	Joint Site Verification for Borehole location	Appendix-IV.3
29-May '17	Aizawl	Discussion on Borehole Survey Result	Appendix-IV.4
1-Jun '17	Aizawl	Discussion on Slope Inventory Result	Appendix-IV.2
6-Jun '17	Aizawl	Discussion about survey progress	
8-Jun '17	Aizawl	Discussion about survey method	LIDAR survey Appendix-II.3
14-Jun '17	Turial	Land failure situation	
17-Jun '17	Turial	Land failure situation	
20-Jun '17 - 25-Jun '17	Aizawl~Lunglei (km 8 - km 380)	Survey progress (Geotechnical) and discussion	
29-Jun '17 - 2-Jul '17	Aizawl~Lunglei (km 8 - km 380)	LIDAR survey method and progress	Appendix-II.4
6-Jul '17 - 10-Jul '17	Aizawl~Lunglei (km 8 - km 380)	Survey progress (Geotechnical) and discussion	
19-Jul '17 - 22-Jul '17	Aizawl~Lunglei (km 8 - km 380)	Survey progress (Geotechnical) and discussion	
22-Aug '17	Kolkata	Data processing progress and discussion	

Source: JICA Study Team

3.2 Additional Topographic Survey

3.2.1 Progress Monitoring of the Survey

(1) Mobilization

A survey team was mobilized in January 2017 and site work commenced from 26 January.

(2) Chainage Marking on Existing Alignment

Road marking work is carried out for descriptive purposes of land acquisition; therefore, the work progress is uncorrelated to other topo survey work. The field work for the full section was finished at the end of March, 20 days behind of the initial plan, however, only section-1 (109 km) needed repainting due to the instruction of the NHIDCL. All works were completed at the end of April.

(3) Pillar Fixation

All works were completed at the end of March, 20 days behind the original plan.

(4) DGPS Primary Control Survey

GPS measurement for full section was completed in the middle of April, 25 days behind the plan. Only several pillars have an error in GPS accuracy due to the obstacle caused by the nearby object, therefore, the survey team carried out a re-survey at the failed pillar position while doing the topo survey.

(5) Secondary Traverse Survey

Work schedule was far behind than the initial plan because of the lack in number of the mobilized team, and because of the prediction errors with site works difficulty. All site works took long as twice to complete than the initial plan, and were only finished at the beginning of June.

(6) Topo Survey for Additional Data

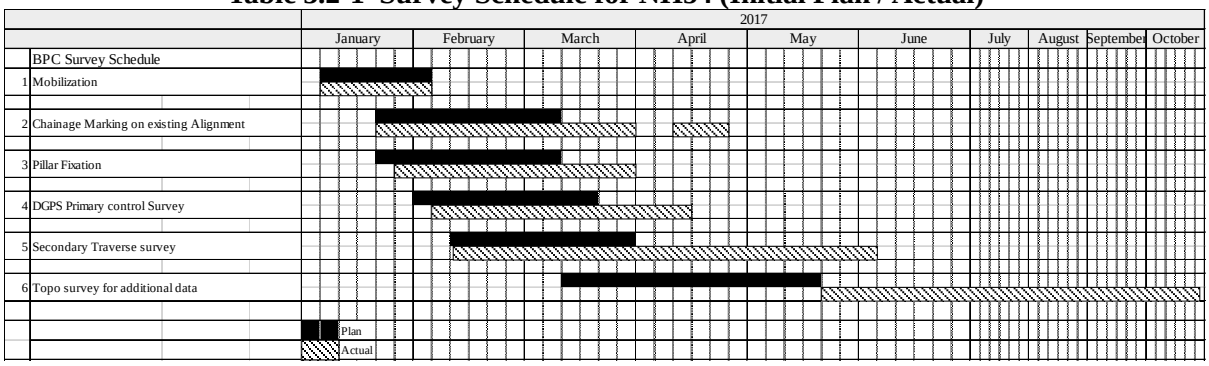
Due to the delay of the Secondary Traverse Survey, the following topo survey works commenced at the end of May, two months behind the initial schedule. In the topo survey using a total station, it was predicted that the work speed is only about 2 km/day, which is much slower than the initially assumed speed, and it will take six months if the same pace is continued. To catch up with the schedule, the additional survey consultant proposed the Light Imaging Detection and Ranging (LIDAR) survey as an alternate to the total station survey. Immediately, NHIDCL approved it, the surveyor commenced mobilization of the new measurement equipment and operators at the end of June. Field work using the LIDAR equipment has completed a full section of 351 km by the beginning of July.

(7) Data Processing

Observed raw data was carried to the surveyor's office in Bangalore, and processing work was commenced immediately to deduct unnecessary point and to generate topo drawings.

BPC began to submit the first topo drawing from the priority package at the end of August. Finally, all processing works for NH54 have been completed at the end of October, five months behind the initial schedule.

Table 3.2-1 Survey Schedule for NH54 (Initial Plan / Actual)



Source: JICA Study Team

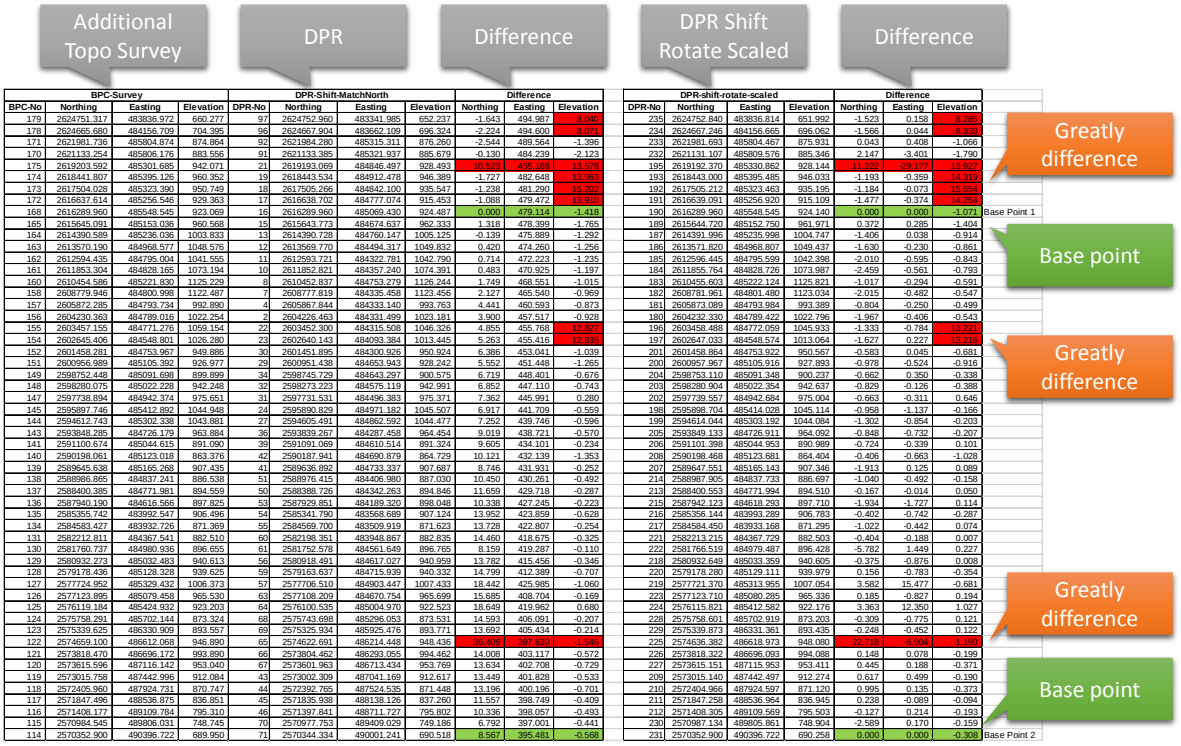
Source: JICA Study Team

Figure 3.2-1 View of Topographical Survey (Traverse Survey)

3.2.2 Technical Guidance by the JICA Study Team

(1) Adjustment of the Additional Survey Scope

The JICA Study Team explained to NHIDCL and the additional survey consultant about the survey contents and discussed about the scope of works that should be adjusted. Required survey works are not only items listed in the terms of reference (TOR), supplement survey for sections with poor accuracy in DPR topo survey and items missing in TOR (features requiring re-survey) are to be mentioned. In order to specify the range required for additional survey, the difference of the drawings with coordinate system based on the previous survey and coordinate system based on the additional survey were compared, respectively. The JICA Study Team defined utilizable range and insufficient range of DPR to explain to the survey consultant. As a specific procedure, the coordinate position of the existing kilo-post was also measured at the time of traverse survey of the additional survey, and the positional relationship with the kilo-post in DPR topo survey was compared to know their positional difference. To match these gaps, adjustments were made so that the previous survey was adjusted to kilo-post of the additional survey. By doing this, position difference can be visualized in the drawing and the coordinate list as well.



BPC-Survey				DPR-Shift-MatchNorth				Difference		
BPC-No	Northing	Easting	Elevation	DPR-No	Northing	Easting	Elevation	Northing	Easting	Elevation
179	2624751.317	483836.972	660.277	97	2624752.960	483341.985	652.237	-1.643	494.987	8.040
178	2624665.680	484156.709	704.395	96	2624667.904	483662.109	696.324	-2.224	494.600	8.071
171	2621981.736	485804.874	874.864	92	2621984.280	485315.311	876.260	-2.544	489.564	-1.396
170	2621133.254	485806.176	883.556	91	2621133.385	485321.937	885.679	-0.130	484.239	-2.123
175	2619203.592	485301.685	942.071	21	2619193.069	484846.497	928.493	10.523	455.188	13.578
174	2618441.807	485395.126	960.352	19	2618443.534	484912.478	946.389	-1.727	482.648	13.963
173	2617504.028	485323.390	950.749	18	2617505.266	484842.100	935.547	-1.238	481.290	15.202
172	2616637.614	485256.546	929.363	17	2616638.702	484777.074	915.453	-1.088	479.472	13.910
168	2616289.960	485548.545	923.069	16	2616289.960	485069.430	924.487	0.000	479.114	-1.418
165	2615645.091	485153.036	960.568	15	2615643.773	484674.637	962.333	1.318	478.399	-1.765
164	2614390.589	485236.036	1003.833	13	2614390.728	484760.147	1005.125	-0.139	475.889	-1.292
163	2613570.190	484968.577	1048.576	12	2613569.770	484494.317	1049.832	0.420	474.260	-1.256
162	2612594.435	484795.004	1041.555	11	2612593.721	484322.781	1042.790	0.714	472.223	-1.235
161	2611853.304	484828.165	1073.194	10	2611852.821	484357.240	1074.391	0.483	470.925	-1.197
160	2610454.586	485221.830	1125.229	8	2610452.837	484753.279	1126.244	1.749	468.551	-1.015
158	2608779.946	484800.998	1122.487	7	2608777.819	484335.458	1123.456	2.127	465.540	-0.969
157	2608472.285	484793.734	992.890	4	2608467.844	484333.140	993.763	4.441	460.593	-0.873
156	2604230.363	484789.016	1022.254	2	2604226.463	484331.499	1023.181	3.900	457.517	-0.928
155	2603457.155	484771.276	1059.154	22	2603452.300	484315.508	1046.326	4.855	455.768	12.827
154	2602645.406	484548.801	1026.280	23	2602640.143	484093.384	1013.445	5.263	455.416	12.835
152	2601458.281	484753.967	949.886	30	2601451.895	484300.926	950.924	6.386	453.041	-1.039
151	2600956.989	485105.392	926.977	29	2600951.438	484653.943	928.242	5.552	451.448	-1.265
149	2598752.448	485091.698	899.899	34	2598745.729	484643.297	900.575	6.719	448.401	-0.676
148	2598280.075	485022.228	942.248	32	2598273.223	484575.119	942.991	6.852	447.110	-0.743
147	2597738.894	484942.374	975.651	31	2597731.531	484496.383	975.371	7.362	445.991	0.280
145	2595897.746	485412.892	1044.948	24	2595890.829	484971.182	1045.507	6.917	441.709	-0.559
144	2594612.743	485302.338	1043.881	27	2594605.491	484862.592	1044.477	7.252	439.746	-0.596
143	2593848.285	484726.179	963.884	36	2593839.267	484287.458	964.454	9.019	438.721	-0.570
141	2591100.674	485044.615	891.090	39	2591091.069	484610.514	891.324	9.605	434.101	-0.234
140	2590198.061	485123.018	863.376	42	2590187.941	484690.879	864.729	10.121	432.139	-1.353
139	2589645.638	485165.268	907.435	41	2589636.892	484733.337	907.687	8.746	431.931	-0.252
138	2588986.865	484837.241	886.538	51	2588976.415	484406.980	887.030	10.450	430.261	-0.492
137	2588400.385	484771.981	894.559	50	2588388.726	484342.263	894.846	11.659	429.718	-0.287
136	2587940.190	484616.566	897.825	53	2587929.851	484189.320	898.048	10.338	427.245	-0.223
135	2585355.742	483992.547	906.496	54	2585341.790	483568.689	907.124	13.952	423.859	-0.628
134	2584583.427	483932.726	871.369	55	2584569.700	483509.919	871.623	13.728	422.807	-0.254
131	2582212.811	484367.541	882.510	60	2582198.351	483948.867	882.835	14.460	418.675	-0.325
130	2581760.737	484980.936	896.655	61	2581752.578	484561.649	896.765	8.159	419.287	-0.110
129	2580932.273	485032.483	940.613	56	2580918.491	484617.027	940.959	13.782	415.456	-0.346
128	2579178.436	485128.328	939.625	59	2579163.637	484715.939	940.332	14.799	412.389	-0.707
127	2577724.952	485329.432	1006.373	57	2577706.510	484903.447	1007.433	18.442	425.985	-1.060
126	2577123.895	485079.458	965.530	63	2577108.209	484670.754	965.699	15.685	408.704	-0.169
125	2576119.184	485424.932	923.203	64	2576100.535	485004.970	922.523	18.649	419.962	0.680
124	2575758.291	485702.144	873.324	68	2575743.698	485296.053	873.531	14.593	406.091	-0.207
123	2575339.625	486330.909	893.557	69	2575325.934	485925.476	893.771	13.692	405.434	-0.214
122	2574659.100	486612.068	946.890	65	2574622.691	486214.448	948.436	36.409	397.620	-1.546
121	2573818.470	486696.172	993.890	66	2573804.462	486293.055	994.462	14.008	403.117	-0.572
120	2573615.596	487116.142	953.040	67	2573601.963	486713.434	953.769	13.634	402.708	-0.729
119	2573015.758	487442.996	912.084	43	2573002.309	487041.169	912.617	13.449	401.828	-0.533
118	2572405.960	487924.731	870.747	44	2572392.765	487524.535	871.448	13.196	400.196	-0.701
117	2571847.496	488536.875	836.851	45	2571835.938	488138.126	837.260	11.557	398.749	-0.409
116	2571408.177	489109.784	795.310	46	2571397.841	488711.727	795.802	10.336	398.057	-0.493
115	2570984.545	489806.031	748.745	70	2570977.753	489409.029	749.186	6.792	397.001	-0.441
114	2570352.900	490396.722	689.950	71	2570344.334	490001.241	690.518	8.567	395.481	-0.568

DPR-shift-rotate-scaled				Difference			
DPR-No	Northing	Easting	Elevation	Northing	Easting	Elevation	
235	2624752.840	483836.814	651.992	-1.523	0.158	8.285	
234	2624667.246	484156.665	696.062	-1.566	0.044	8.331	
233	2621981.693	485804.467	875.931	0.043	0.408	-1.066	
232	2621131.107	485809.576	885.346	2.147	-3.401	-1.790	
195	2619192.370	485330.852	928.144	11.223	-29.177	13.927	
193	2618443.000	485395.485	946.033	-1.193	-0.359	14.310	
192	2617505.212	485323.463	935.195	-1.184	-0.073	15.554	
191	2616639.091	485256.920	915.109	-1.477	-0.374	14.254	
190	2616289.960	485548.545	924.140	0.000	0.000	-1.071	Base Point 1
189	2615644.720	485152.750	961.971	0.372	0.285	-1.404	
187	2614391.996	485235.996	1004.747	-1.406	0.038	-0.914	
186	2613571.820	484968.807	1049.437	-1.630	-0.230	-0.861	
185	2612596.445	484795.599	1042.398	-2.010	-0.595	-0.843	
184	2611855.764	484828.726	1073.987	-2.459	-0.561	-0.793	
183	2610455.603	485222.124	1125.821	-1.017	-0.294	-0.591	
182	2608781.961	484801.480	1123.034	-2.015	-0.482	-0.547	
181	2608473.089	484793.984	993.389	-0.804	-0.250	-0.499	
180	2604232.330	484789.422	1022.796	-1.967	-0.406	-0.543	
196	2603458.488	484772.059	1045.933	-1.333	-0.784	13.221	
197	2602647.033	484548.574	1013.064	-1.627	0.227	13.216	
201	2601458.864	484753.922	950.567	-0.583	0.045	-0.681	
200	2600957.967	485105.916	927.893	-0.978	-0.524	-0.916	
204	2598753.110	485091.348	900.237	-0.662	0.350	-0.338	
203	2598280.904	485022.354	942.637	-0.829	-0.126	-0.388	
202	2597739.557	484942.684	975.004	-0.663	-0.311	0.646	
198	2595898.704	485414.028	1045.114	-0.958	-1.137	-0.166	
199	2594614.044	485303.192	1044.084	-1.302	-0.854	-0.203	
205	2593849.133	484726.911	964.092	-0.848	-0.732	-0.207	
206	2591101.398	485044.953	890.989	-0.724	-0.339	0.101	
208	2590198.468	485123.681	864.404	-0.406	-0.663	-1.028	
207	2589647.551	485165.143	907.346	-1.913	0.125	0.089	
214	2588987.905	484837.733	886.697	-1.040	-0.492	-0.158	
213	2588400.553	484771.994	894.510	-0.167	-0.014	0.050	
215	2587942.123	484618.293	897.710	-1.934	-1.727	0.114	
216	2585356.144	483993.288	906.783	-0.402	-0.742	-0.287	
217	2584584.450	483933.168	871.295	-1.022	-0.442	0.074	
221	2582213.215	484367.729	882.503	-0.404	-0.188	0.007	
222	2581766.519	484979.487	896.428	-5.782	1.449	0.227	
218	2580932.649	485033.359	940.605	-0.375	-0.876	0.008	
220	2579178.280	485129.111	939.979	0.156	-0.783	-0.354	
219	2577721.370	485313.955	1007.054	3.582	15.477	-0.681	
223	2577123.710	485080.285	965.336	0.185	-0.827	0.194	
224	2576115.821	485412.582	922.176	3.363	12.350	1.027	
228	2575758.601	485702.919	873.203	-0.309	-0.775	0.121	
229	2575339.873	486331.361	893.435	-0.248	-0.452	0.122	
225	2574636.382	486618.973	948.080	-27.718	-6.904	-1.190	
226	2573818.322	486696.093	994.088	0.148	0.078	-0.199	
227	2573615.151	487115.953	953.411	0.445	0.188	-0.371	
209	2573015.140	487442.497	912.274	0.617	0.499	-0.190	
210	2572404.966	487924.597	871.120	0.995	0.135	-0.373	
211	2571847.258	488536.964	836.945	0.238	-0.089	-0.094	
212	2571408.305	489109.569	795.503	-0.127	0.214	-0.193	
230	2570987.134	489805.861	748.904	-2.589	0.170	-0.159	
231	2570352.900	490396.722	690.258	0.000	0.000	-0.308	Base Point 2

Source: JICA Study Team

Figure 3.2-2 Comparison of Kilo-post Position of Additional Survey and DPR

(2) Advise for Priority Section

As shown in (1), the JICA Study Team superposed the old and new drawings to adjust it to the correct coordination. The survey consultant can utilize the results to know the range of additional survey. However, there is no any referable feature in Sec-2, so the above procedure was possible only in Sec-1 and Sec-3. Therefore, the JICA Study Team suggested to commence a topo survey from Sec-2 which does not require the above adjustment procedure, in order to begin the following design works as soon as possible. This instruction was made to the additional survey consultant via NHIDCL. It is noted that decision of priority section was changed in response to the situation change as described at (5) in this section.

(3) Guidance for Catch-up Schedule

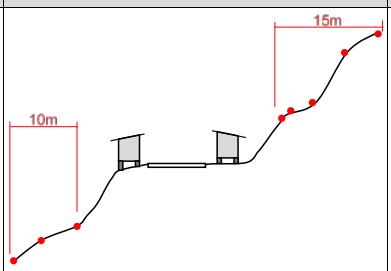
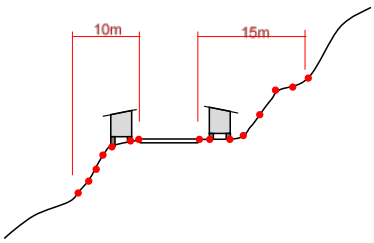
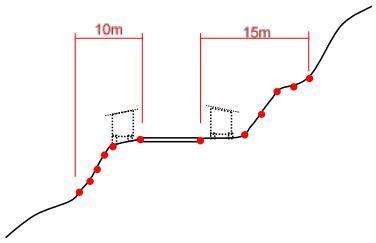
The JICA Study Team requested to the survey consultant to prepare and submit substantial work schedule considering the goal to catch up with the initial schedule. At the process of site work, the JICA Study Team confirmed a progress situation and suggested to mobilize more surveyors/team by each work item. Progress is properly reported to NHIDCL to urge that the additional survey consultant makes necessary countermeasure to catch up with the schedule.

(4) Comments on Proposal of LIDAR Survey

After commencement of site work, the survey consultant suggested to NHIDCL to introduce LIDAR survey instead of total station survey. The JICA Study Team made comments on the consultant's suggestion to NHIDCL that although LIDAR survey will be able to shorten the site work period, the following design modification works will take much time than the conventional method. In addition to this, the fact that the survey consultant has no experience in conducting a LIDAR survey is also risky. Nevertheless, as a result, NHIDCL decided to approve the consultant's suggestion to accelerate the survey process. It is noted that if significant difference is found between the terrain data using the LIDAR survey and those of the previous topo survey, it will be necessary to re-work the road alignment design by the JICA Study Team. This means that significant extension of the design period will happen as a consequence of the shortened survey period.

On a basis of the above decision, the JICA Study Team discussed and shared the detailed method and work schedule of the LIDAR survey with the survey consultants. It is confirmed that all site works have been completed without any problem in the beginning of July.

Table 3.2-2 Comparison of the Survey Method

	Type-1 : Applicable to Section-1	Type-2 : Applicable to Section-2	Type-3 : Applicable to Section-3
Total Station			
	- Only for acceptable precision of DPR topo - Particular sections (missing section for updated design only) -Terrain survey only - Without object drawing	- For unacceptable precision of DPR topo - All section -Terrain and objects survey from edge of pavement -Objects drawing	- For unacceptable precision of DPR topo - All section -Terrain survey from edge of pavement only -Without object drawing
	- Almost-use DPR design in updated design	**- No-use DPR design in updated design**	**- Partially-use DPR design in updated design**
Lidar Survey	**- Time for field survey can be shorten from Total Station** **- This is test case for BPC** **- No-use DPR design in updated design and take longer time than above method**		

Source: JICA Study Team

(5) Advise for Modification of Priority Section

By the decision of adopting the LIDAR survey, the priority section described in (2) was changed from Sec-2 to Sec-3 due to the advanced progress of land acquisition. However, further progress situation change was informed at the joint meeting with NHIDCL and BPC on 8 August 2017. NHIDCL indicated their intention to commence tender procedures promptly in the other order. In response, the JICA Study Team considered comprehensively from the previous design condition and the difficulty of design update based on the additional survey, and proposed the precedence implementation that is expected to be completed the earliest. After a discussion between the NHIDCL and the JICA Study Team, a mutual understanding was made.

(6) Advise for Data Processing

Comparing with the initially planned total station survey, the LIDAR survey can collect vast number of 3D point geographic information and the processing work needs a longer time. Therefore, it is difficult for the consultant to proceed and complete all packages at the same time and it needs to fill in the manpower resources into the package one by one. Under the condition, the JICA Study Team advised the consultant to proceed their work in a proper schedule for early completion of the priority packages.

The additional survey consultant planned to divide the topographic information by tendering package and to provide topographic drawing to the JICA Study Team in the order of the priority package. During the discussion, the JICA Study Team found a mismatch between the boundary plotted by the consultant and one of the package defined for tender. The distance of the gap of each boundary position is around 6 km at the maximum. To settle this issue, the JICA Study Team instructed that every topographic drawing shall include proper road stretch for each package.

Source: JICA Study Team

Figure 3.2-3 View of Technical Guidance for Topographical Survey (At Site)

Source: JICA Study Team

Figure 3.2-4 View of Technical Guidance for Topographical Survey (In Meeting)

3.3 Additional Geological / Geotechnical Survey

3.3.1 Progress Monitoring for the Survey

(1) Mobilization

Mobilization for the geological / geotechnical survey was started in February 2017, and slope inventory survey and borehole survey were started on 20 February and 1 March, respectively.

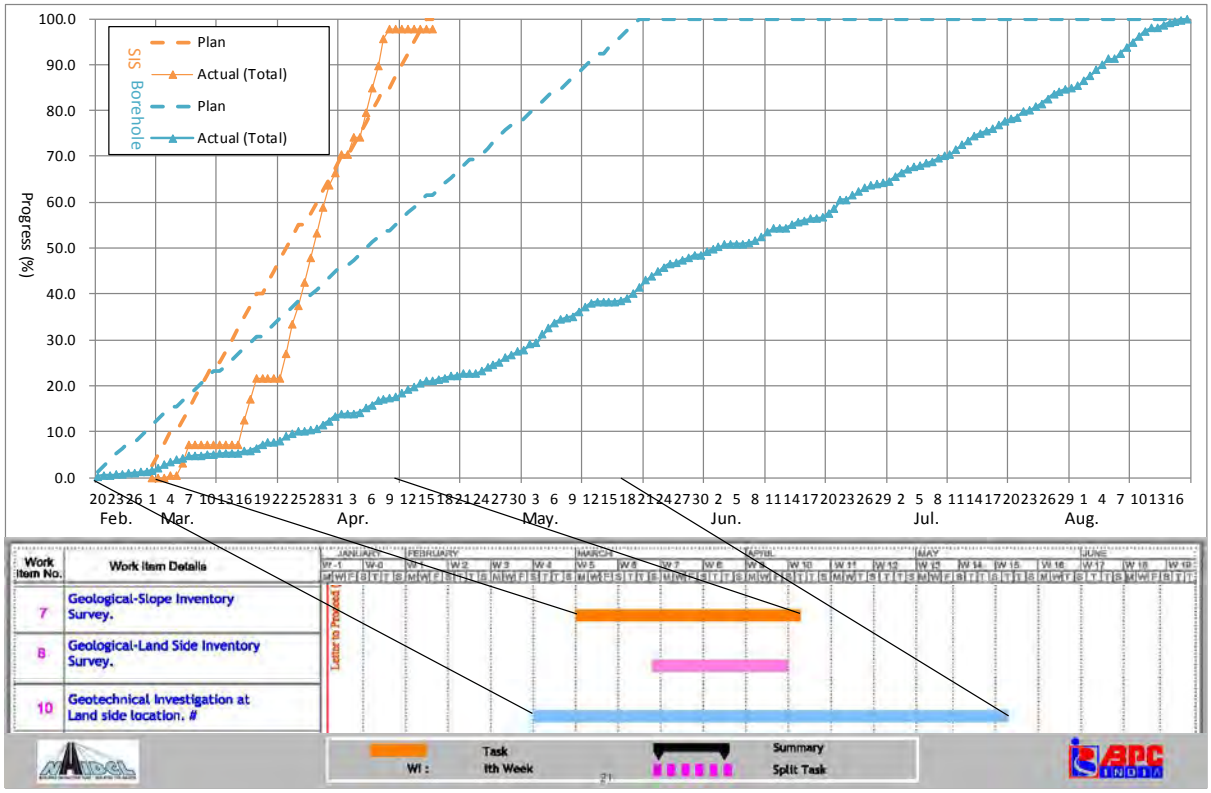
(2) Slope Inventory Survey

The site survey along all the alignments was completed until 9 April (see Figure 3.3-1). A part of the survey result was shared with the JICA Study Team on 24 May.

The team also surveyed all the slopes along the road and recorded critical slopes which need landslide countermeasures on critical slope inventory sheets (Appendix-III).

(3) Borehole Survey

Planned entire length of the borehole survey was 1,510 m. It is greatly behind the schedule that the BPC planned, which was supposed to be completed by the middle of May as stated in the inception report, and was only completed in late August. (see Figure 3.3-1).



Source: JICA Study Team

Figure 3.3-1 Comparison Between BPC's Initial Work Schedule and Progress of Geological/Geotechnical Survey

Source: JICA Study Team

Figure 3.3-2 View of Borehole Survey (Drilling Work)

Source: JICA Study Team

Figure 3.3-3 View of Borehole Survey (Installation of PVC Pipe)

3.3.2 Technical Guidance by the JICA Study Team

(1) Technical Guidance on Slope Inventory Survey Methods

On 13 January 2017, the JICA Study Team instructed BPC about the slope inventory survey methods along with the "Manual for Slope Inventory Survey" prepared by the team. The team confirmed the survey procedure and tools with BPC and shared format of slope inventory sheet. The memo of meeting is shown in Appendix-IV.1.

(2) Technical Guidance for Quality Improvement of Slope Inventory Survey

The JICA Study Team reviewed the slope inventory survey results received from BPC and sent comments in writing on June 1 (Appendix-IV.2). The comments are (1) a clear mismatch between the survey points and the site condition, (2) imprecise description about dip slope, and the team requested to correct these two points.

(3) Joint Verification on Borehole Survey Location

On 13 to 14 January and 12 to 16 May, the JICA Study Team jointly verified the borehole survey locations with the BPC site engineers. The team instructed the location of borehole and survey line, quantity and drilling depth at the site from the viewpoint of landslide analysis and countermeasure design. The meeting report showed the instructions were handed over to BPC (see Appendix-IV.1 and IV.3).

(4) Technical Guidance for Quality Improvement of Borehole Survey

The JICA Study Team provided guidance to improve the survey quality as shown below through the joint site verification on 12 to 16 May, and review on the survey results. The content of the instruction was compiled into the above Appendix-IV.3 and IV.4, and handed over to BPC. Also, local engineers hired by the team have monitored BPC's works.

- Location of Boring Survey: Despite the joint site verification mentioned in (3) above, some boreholes were conducted at distinct locations from where the team instructed. The team notified BPC that the survey results at such points cannot be utilized for analysis and design, and reconfirmed BPC the purpose of the survey and request to prevent recurrence.
- Conservation of Groundwater Monitoring Borehole: Since some PVC pipes inserted to the boreholes for groundwater monitoring were broken or clogged by local people, the team requested BPC to explain to the local people and add lockable instruments.
- Appropriate Collection of Core Sample: Since the core sampling rate is low, the team has requested measures for improving core recovery rate such as adjustment of water flow rate, bit rotation speed, and drilling load since the beginning of the survey. In addition, because core collection was not done between standard penetration tests (SPT), the team requested BPC to collect samples properly.
- Interval of Standard Penetration Test (SPT): BPC had conducted SPT every 1.5 m due to the specifications of sampler equipment of BPC, while every 1 m is a global standard. The team requested BPC to carry out every 1 m. And, as specified in the TOR, the team instructed to conduct SPT until more than 3 m with N value of 50 or more is confirmed.
- Proper Storage of Boring Core Samples: In the site verification, the team confirmed that boring core samples were not properly stored in sample boxes. Because the reliability of the survey was compromised, the team strictly requested for an improvement.
- Description of Borehole Column: The team reviewed the format of the borehole column submitted by BPC, and instructed to describe from the geological and geotechnical point of view as well as adding depths of slip plane of the landslide and groundwater level.
- Recording Photograph of Boring Core Samples: The team instructed BPC to take photographs of boring core samples after taking out the core sample from the plastic bag so that their condition can be understood finely.

- Interval and Frequency of Groundwater Monitoring: The team instructed BPC to properly monitor the groundwater level twice a week for five weeks as specified in the TOR.

(5) Technical Guidance on Landslide Stability Analysis and Countermeasure Selection

Regarding landslide stability analysis and countermeasure design specified in the scope of work in the TOR, the JICA Study Team shared to BPC the manual presenting landslide stability analysis and countermeasure selection on 7 March (Appendix-IV.5).

Source: JICA Study Team

Figure 3.3-4 View of Technical Guidance on Slope Inventory Survey

3.4 Modification of Preliminary Design

3.4.1 Basic Policy of Modification

The additional topographic survey was carried out as an entirely regenerated survey which has no element from the previous DPR survey. Basic policy of modification of preliminary design is to optimize road proposed center line corresponding to new topo data and accompanied design modification of road structure design with applying the same design policy and criteria in the previous stage.

3.4.2 Division of EPC Contract Package

Design modification was planned by the package division.

It is noted that there are four bypass plan around major built-up area of Chhiahtlang, Serchhip, Hnahthial, and Lawngtlai along the project main road of NH54, which was planned in this study (described in Volume 2 of the report). The construction of these bypass routes will be implemented in the near future, separately from the road improvement of NH54 main road.

It was decided in the meeting with NHIDCL that the widening and improvement of existing road are not applied to the main road in range of these bypass planned section. Instead, replacement or rehabilitation of pavement of the existing road for these sections is included to the scope.

3.4.3 Major Modification in Preliminary Design

(1) Modification of Road Centerline

Detailed topographic information on both sides of the existing road were obtained by conducting additional topographic survey. Submitted map data contains 50 m width along the existing road. Based on the updated terrain data, road centerline design was optimized considering the construction cost reduction, and road safety. The centerline change involves design modification for earthwork, retaining wall, and miscellaneous structures and that results quantity calculations changed as well.

(2) Modification of Route Plan in Chhingchhip

In the middle of August 2017, a new fact was found that the construction of shortcut road in Chhingchhip, located near the existing bailey bridge of NH54 was newly commenced by PWD (Refer to Figure 3.4-1, Figure 3.4-2). By a construction of shortcut road, NH54 can be connected without passing over the curved gully section where bailey bridge is placed at present. Hence, it is required for the design modification that route plan is revised by taking account of the existence of the shortcut road.

The modification of the route from the previous plan to the new location, which is along the newly built-up shortcut road can have several advantages.

I. The shortcut road is almost a straight route. It shortens the road length so that trip time is reduced compared with the existing NH54 or previous route plan.

II. It does not require a new bridge construction as previously proposed with the steel arch bridge. It can greatly reduce the construction cost.

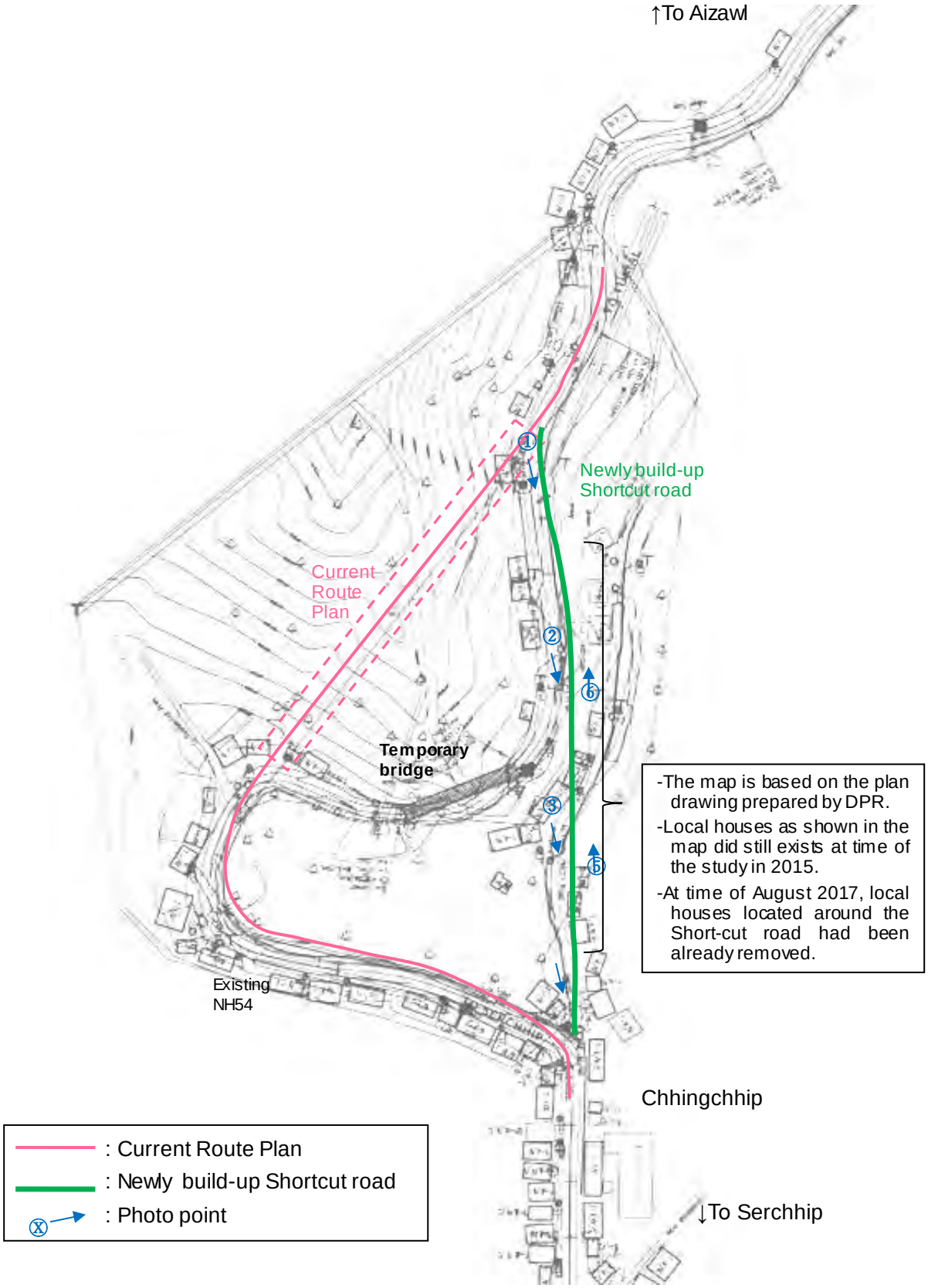
III. Because shortcut road has been built-up in advance, some extent of earthworks along the shortcut road has been already completed.

IV. Local houses previously existed at the area has been already removed along the shortcut road.

V. Because of the shortcut road construction, local people already have a consensus for passage of traffic in this location.

For the subject, the JICA Study Team had a meeting with NHIDCL. The modification plan of the route was proposed and it was agreed by NHIDCL.

Therefore, a planning route in the section was modified to the location along the newly built-up shortcut road. In addition, the new bridge plan of steel arch in Chhingchhip initially proposed by the JICA Study Team was canceled.



Source: JICA Study Team

Figure 3.4-1 Location Map Around the Modified Route Plan in Chhingchhip

Photo - ①

Photo - ②

Photo - ③

Photo - ④

Photo - ⑤

Photo - ⑥

Source: JICA Study Team

Figure 3.4-2 Short-cut Road in Chhingchhip

(3) Modification of Bridge Plan

Bridge plan for NH54 was majorly modified in the following points.

1) Cancellation of Plan for Steel Arch Bridge in Chhingchhip

As mentioned in (2) of this section, the route was modified to the location along the newly build-up shortcut road in which the route can be connected without passing over the curved gully section. Therefore, the plan of the new bridge construction of steel arch L=130 m as proposed near the 75 km of NH54 was canceled.

2) Additional Rehabilitation Works for the Tuirial Bridge

It was determined through a discussion with NHIDCL that an existing bridge of Tuirial, 24 km away from NH54 is to be rehabilitated as proposed by DPR. The rehabilitation shall include any repairing works such as wearing coat, handrails/parapet, bearings, expansion joints, drainage spouts, and spalling of concrete.

(4) Modification of Cross Drainage Arrangement

Due to the changes in the base data and some considerations below, the plan for cross drainage arrangement of NH54 was revised during the design modification.

I. Update of topographical drawing: An update of the topographical drawing by additional survey, geographical descriptions of natural terrains as valleys and hills were changed from the previous data. Also, some objectives shown in the drawing such as the existing culverts were renewed.

II. Modification of road alignment design: Accompany with modification of road alignment design, crossing points of water flown from the hill are changed. Its chainage is also revised.

III. Adjustment with bypass plans: For the section where bypass route is planned in NH54, it was decided that improvement of the main road is basically not included. Hence, the plan of culverts arrangement in these sections were excluded.

IV. Adjustment with package borders: The quantity of culverts was estimated by taking account of decided package borders.

(5) Modification of Landslide Countermeasure Design

Due to the changes in the base data and some considerations stated below, the plan for landslide countermeasure design of NH54 was revised during the design modification.

I. Update of topographical drawing: Accompany with update of topographical drawing by additional survey, geographical descriptions of natural terrains as valleys and hills are changed from the previous data.

II. Modification of road alignment design: Road alignment design was modified in order to ease a risk of landslide as much as possible. Accompany with centerline modification, proposed countermeasure location and range have been changed accordingly.

3.4.4 Construction Cost Estimate

For the assistance of preparing tender document, the construction cost estimate is updated as follows:

(1) Condition of Cost Estimate

Unit costs set out based on the SOR 2014 were applied to most work items, as described in Volume 1 of this report. Besides, unit costs derived from experience in foreign countries were employed for some specific items considering the possibility of participation of international contractors. Those items are:

I. Crib Work (F300)

II. Crib Work (F500)

III. Non-frame

IV. Anchor Work

V. Rock-bolt Work

As per instruction by NHIDCL, price escalation from 2014 up to the time of bidding was estimated to be 5% and was added to the construction cost.

(2) Abstract of Cost Estimate

Abstracts of construction cost estimate per package are estimated.

CHAPTER 4 TECHNICAL ASSISTANCE FOR ADDITIONAL SURVEYS AND DESIGN MODIFICATIONS OF NH51

4.1 Record of the Monitoring Activities

The record of the monitoring activities by the JICA Study Team is as shown in the table below.

Table 4.1-1 Record of the Monitoring of Activities

Date / Duration	Section / Location	Activity / Site Visit Purpose	Remarks
12-Jul '17 – 15-Jul '17	Tura ~ Dalu (km 85 - km 95, km 101 - km 145)	Survey Progress (Topo and Geotechnical) and discussion Joint Site Verification for Borehole location	-

Source: JICA Study Team

4.2 Additional Topographic Survey

4.2.1 Progress Monitoring for the Survey

(1) Mobilization

A survey team was mobilized at the end of June 2017 and site work was commenced.

(2) Chainage Marking on Existing Alignment

As scheduled, all works were completed in the beginning of July.

(3) Pillar Fixation

As scheduled, all works were completed in the beginning of July.

(4) DGPS Primary Control Survey

Site works were completed in the beginning of August which were slightly delayed from the schedule.

(5) Secondary Traverse Survey

Site works were completed in the middle of September which were rather delayed from the schedule.

(6) Topo Survey for Additional Data

As scheduled, the LIDAR survey at site was completed in the beginning of July.

(7) Data Processing

Observed raw data was carried to the surveyor's office in Bangalore, and processing work was commenced immediately to deduct unnecessary points and to generate topo drawings. Since BPC's manpower was flung into NH54 until its completion, processing work for NH51 was commenced only after the NH54 work. Therefore, topographic drawing was completed in the beginning of November being greatly behind the initial schedule. However, the JICA Study Team found lack of drawing area for the 1 km road stretch and requested BPC to revised it through NHIDCL. Finally, the entire topographic drawing was completed in the beginning of December.

4.2.2 Technical Guidance by the JICA Study Team

(1) Datum Level Check

Datum level installed at NH51 site and managed by N.H. is required for the topographical survey, but it had not been obtained by BPC. Therefore, the JICA Study Team jointly visited the N.H. Office at Tura and asked about the information of the datum level installed at the site. After, the JICA Study Team jointly visited the site and confirmed the datum level.

(2) Others

Work method and work procedure are almost the same for the survey for NH54. Therefore, it can be followed as a technical guidance conducted for the survey of NH54.

Source: JICA Study Team

Figure 4.2-1 View of Topographical Survey (Datum Level Check)

4.3 Additional Geological / Geotechnical Survey

4.3.1 Progress Monitoring for the Survey

(1) Mobilization

A survey team was mobilized at the end of June 2017 and site work was commenced immediately.

(2) Slope Inventory Survey

As scheduled, site works were completed in the middle of September.

(3) Borehole Survey

As scheduled, site works were completed at the end of August.

4.3.2 Technical Guidance by the JICA Study Team

(1) Joint Verification on Borehole Survey Location

The JICA Study Team jointly verified the borehole survey location with BPC. The team instructed the detailed location of the six boreholes in the three sections at the site.

(2) Others

Work method and work procedure are almost the same for the survey for NH54. Therefore, it can be followed as a technical guidance conducted for the survey of NH54.

Source: JICA Study Team

Figure 4.3-1 View of Geological/ Geotechnical Survey (Wooden Peg Installation)

4.4 Modification of Preliminary Design

4.4.1 Basic Policy of Modification

Basic policy of modification of preliminary design is same as NH54.

4.4.2 Division of EPC Contract Package

The construction package of NH51 is examined based on project scale.

4.4.3 Major Modification in the Preliminary Design

(1) Modification of Road Centerline

Detailed topographic information on both sides of the existing road were obtained by conducting additional topographic survey. Submitted map data contains 50 m width along the existing road. Based on the updated terrain data, road centerline design was optimized while considering the construction cost reduction and road safety. The centerline change involves design modification for earthwork, retaining wall and miscellaneous structures and that resulted to quantity calculations being changed as well.

(2) Modification of Cross Drainage Arrangement

Due to the changes in the base data and some considerations shown below, the plan for cross drainage arrangement of NH51 was revised during the design modification.

I. Update of topographical drawing: Accompany with update of topographical drawing by additional survey, geographical descriptions of natural terrains as valleys and hills are changed from previous data. Also, some objectives shown in the drawing such as existing culverts are renewed.

II. Modification of road alignment design: Accompany with modification of road alignment design, crossing points of water flown from hill are changed. Its chainage is also revised.

The quantities of culverts revised in the design modification are summarized as shown in the table below.

Table 4.4-1 Quantities of Culvert for NH51 (Revised in the Design Modification)

	NH51
Pipe culvert dia 1.2m	293
(Re-construction)	190
(New)	103
BOX culvert 2x2m	11
BOX culvert 3x3m	0
BOX culvert 4x4m	0
BOX culvert 4x6m	0
Total	304

Source: JICA Study Team

4.4.4 Construction Cost Estimate

For the assistance of preparing tender documents, the construction cost estimate was updated as follows.

(1) Condition of Cost Estimate

Unit costs set out based on the SOR 2014 were applied to most of the work items, as described in Volume 1 of this report. As per the instruction by NHIDCL, price escalation from 2014 up to the time of bidding was estimated to be 5% and was added to the construction cost.

(2) Abstract of Cost Estimate

Abstract of construction cost estimate per package is estimated.

CHAPTER 5 TECHNICAL ASSISTANCE FOR APPLICATION OF CONTRACT MODE AND PREPARATION OF TECHNICAL SPECIFICATIONS

5.1 Technical Assistance for Preparation of Application of Contract Mode

5.1.1 Discussion Progress about Modification of General Contract Condition

The study team reviewed the items which is assumed as a risk of smooth implementation of the project under EPC contract conditions. Based on the discussions among the government of India and JICA, a draft of proposal for the conditions was summarized with referring application examples on ADB projects. The record of discussions and explanations is shown below.

15-18 February 2016	Official meeting was held among GOI (MORTH, NHIDCL), JICA and the Study Team regarding JICA's proposal for the modifications of contract mode.
21 May 2016	The JICA Study Team received a response from NHIDCL via JICA India Office. The answer was acceptance for 44 items and rejection for 28 items in total 72 items of proposal by JICA and the JICA Study Team.
30 June 2016	It was considered that there are some items that can be compromised in the 28 items rejected by NHIDCL, but there were deviations in understanding of subcontract, BOQ payment, Defect Liability Period and Maintenance Period. The JICA Study Team submitted explanatory materials to JICA against one-sided conditions.
29 September 2016	Based on the above materials, the JICA Study Team explained to NHIDCL (Mr. Sanjeev Malik / Executive Director and Mr. Ashok Kumar / General Manager) about understanding of subcontract, BOQ payment, Defect Liability Period and Maintenance Period. GOI has rejected the proposals on Defect Liability Period and Maintenance Period, however, positive outlook has been felt about the issues on subcontract mode and BOQ payment. NHIDCL showed signs of having decisions of high places in 4 to 6 weeks.
November 2016	The JICA Study Team asked NHIDCL and confirmed that the decision was not yet made about the above.
17 March 2017	Answer from NHIDCL was delivered to JICA by the official letter. Main topics of the letter were about Advance Payment and Dispute Resolution. The JICA Study Team started to prepare responding to their opinions and demands aside from the mentioned topics.
23 August 2017	JICA issued a letter (JFY2017,4R-0372) to NHIDCL as a final proposal of addendum request for EPC of India.
4 September 2017	It was found that there is still minor modification in the final draft attached in the above letter. The JICA Study Team submitted a revision to JICA India Office.

5.1.2 Draft for Schedules

(1) Objected Schedules for Assistance

The necessary assistance by JICA Study Team for the "Schedules" which is composed in Tender Documents in range of Phase-1 of the project are as shown in Table below.

Table 5.1-1 Components of Schedules, and Assistance Target

Schedule	Note
Schedule – A: Site of the Project	
[Annex -I] 1. The Site 2. Chainage References (Existing vs Design) 3. Land 4. Carriageway 5. Major Bridge 6. Road over-bridges (ROB) 7. Grade separators 8. Minor bridges 9. Railway level crossings / Railway Track 10. Underpasses (Vehicular, Non Vehicular) 11. Culverts 12. Bus bays 13. Truck Lay byes 14. Road side drains 15. Major junctions 16. Minor junctions 17. Bypass 18. Other structures / Details	
[Annex -II] **Dates for providing Right of Way**	
[Annex -III] **Alignment Plans**	**The Survey Team assistance is required.**
[Annex -IV] **Environment Clearances**	
Schedule – B: Development of the Project Highway [Annex -I] Description of Two-Laning 1. Widening of the Existing Highway 2. Geometric Design and General Features 3. Intersections and Grade Separators 4. Road Embankment and Cut Section 5. Pavement Design 6. Roadside Drainage 7. Design of Structures 8. Traffic Control Devices and Road Safety Works 9. Roadside Furniture 10. Compulsory Afforestation 11. Hazardous Locations 12. Special Requirements for Hill Roads 13. Utilities 14. Change of Scope	**The Survey Team assistance is required.**
Schedule – C: Project Facilities 1. Project Facilities 2. Description of Project Facilities	**The Survey Team assistance is required.**
Schedule – D: Specifications and Standards 1. Construction 2. Design Standards	**The Survey Team assistance is required.**
Schedule – E: Maintenance Requirement [Annex -I] Repair/rectification of Defects and deficiencies	
Schedule – F: Applicable Permits	
Schedule – G: Form of Bank Guarantee	
[Annex -I] Performance Security	
[Annex -II] Form for Guarantee for Withdrawal of Retention Money	

Schedule	Note
[Annex -III] Form for Guarantee for Advance Payment	
Schedule – H: Contract Price Weightages	**The Survey Team assistance is required.**
Schedule – I: Drawings [Annex -I] List of Drawings	**The Survey Team assistance is required.**
Schedule – J: Project Completion Schedule	
Schedule – K: Test of Completion	
Schedule – L: Provisional Certificate	
Schedule – M: Payment Reduction for Non-Complaisance	
Schedule – N: Selection of Authority Engineer [Annex -I] Terms of Reference for Authority Engineer	
Schedule – O: Forms of Payment Statements	
Schedule – P: Insurance	

Source: JICA Study Team

(2) Outline of Each Schedule

1) Schedule – A: Site of the Project: Annex III. Alignment Plans
Drawings including Plan and Profile.

2) Schedule – B: Development of the Project Highway: Annex I. Description of Two-Laning
Basic conditions for Two-laning, road work quantities and structure's arrangement plan are described in this Schedule.

3) Schedule – C: Project Facilities
The facilities to be provided for the Authority and the Authority's Engineer are described in this Schedule.

4) Schedule – D: Specifications and Standards
Technical specifications for design and construction works applied to the project including slope prevention works.

5) Schedule – H: Contract Price Weightages
Based on quantity calculation and the cost estimate as per the proposed design, work items weightage is described as proportions of the contract price for construction of the Project Highway.

6) Schedule – I: Drawings
Drawings including Typical Cross Section, Drainage Work, Retaining Wall Work, Slope Protection Work, Traffic Safety Facilities Work, Road Appurtenances are bound in this Schedule.

5.2 Technical Assistance for Preparation of Technical Specifications

5.2.1 Slope Protection Works

(1) Review of Indian Design standards / Guidelines / Manuals

Indian Design Standards / Guidelines / Manuals related to design or construction of the slope protection works published by Indian Roads Congress are summarized in Table 5.2-1 below.

Table 5.2-1 Indian Design Standards / Guidelines / Manuals related to Slope Protection Works

Category	Title	Remarks
Design	IRC: SP: 48-1998, Hill Road Manual	Manual of road design which is targeted for hill road including some slope measures.
	IRC: SP: 106-2015, Engineering Guidelines on Landslide Mitigation Measures for Indian Roads	Introduction of landslide mitigation measures for design and construction
	HRB SR No.15, State-of-the-Art-Report: Landslide Correction Techniques	Introduction of Slope disasters, investigation and idea of slope measures
	HRB SR No.23, State-of-the-Art-Report: Design and Construction of Rockfall Mitigation Systems	Introduction of rockfall mitigation measures for design and construction
Construction	MORTH SPECIFICATION FOR ROAD AND BRIDGE WORKS (Fifth Revision)	Standard for construction works including reinforced soil wall and soil nail method

Source: JICA Study Team

The design standards / guidelines / manuals as mentioned above contains little explanation for the mechanism of slope failures development and its countermeasures. However, the description is not sufficient for the project due to lack of detailed explanation / understanding for mechanism of slope failure or mass movement.

It is necessary for design standards to specify appropriate design method and technical specification with detailed design values used for design. However, such description is not sufficient for anchor works and rock bolt works specially.

Non-frame works is slope protection works like rock bolt works, but particular method developed in Japan, which features the remain of natural plants on the slope.

Rockfall prevention fence /retaining wall shall be designed in accordingly to mechanism of rock falling. Detailed design theory and design conditions such as fence type or working forces are to be specified.

Because these works have been experienced and developed well in Japan, technical standards provided in Japan Road Association, etc. contains enough description for these particular works. Therefore, it is planned that “Schedule-D” is made up by description of important points from Japanese related standards.

(2) Proposed description

The proposed description to be included in “Schedule-D” for slop protection works are summarized in Table 5.2-2 below.

Table 5.2-2 Proposed Description for Slope Protection Works

Items	Contents	Remarks
Anchor Works	a. Design Investigation, Material (Grout, Tendon, Fixture, Other materials), Corrosion protection, Design method (Anchor arrangement, Anchor length, Anchor body, Anchor head, Anchor force, Tension force at fixing time, Basic investigation test) b. Construction Construction plan, Construction and construction management (Material storage, Drilling, Assembling and processing tendons, Tendon handling, Insertion and retaining of tendon, Injection, Curing, Tension and fixing, Heat treatment), Record, Acceptance inspection, Maintenance and management	Prepared based on 「Ground anchor design and construction standard (Japan Society of Civil Engineering)」

Items	Contents	Remarks
Rock Bolt Works	a. Design Material (Reinforced material, Bearing pressure plate, Injection material), Design method (Fixing length, Installation angle of reinforcing material, length of reinforcing material) b. Construction Construction plan, Construction and construction management (Drilling, Insertion of reinforcing material, Injection, Curing, Acceptance inspection, Heat treatment)	Prepared based on「Guideline for excavation and stabilization method for slope (Japan Road Association）」
Crib Works	a. Design Material (Cement, Aggregate, Admixture, Reinforcing steel, Wire mesh and formwork), Design (Load) b. Construction Construction plan, Construction and construction management (Assembling the formwork, People who handles nozzle, Spraying and surface treatment), Record	Prepared based on「Guideline for excavation and stabilization method for slope (Japan Road Association）」
Non-Frame Works	a. Design Material (Reinforcing material, bearing pressure plate, Head coupling material, Injection material), Design method (Arrangement of reinforcement, Fixing length, Installation angle / length of reinforcing material, bearing pressure plate and head connecting material) b. Construction Construction plan, Construction and construction management (Positioning, Scaffolding), Drilling, Insertion of reinforcing material, Injection, Curing, Acceptance inspection, Record	Prepared based on「Guideline for excavation and stabilization method for slope (Japan Road Association）」
Sub-surface drainage	Planning, Investigation, Save record, Material, Design and construction, Maintenance	Prepared based on「Guideline for excavation and stabilization method for slope (Japan Road Association）」
Rockfall prevention fence and rockfall prevention retaining wall	Design concept, Load	Prepared based on「Manual for rockfall measures (Japan Road Association）」

Source: JICA Study Team

5.2.2 Steel Arch Bridge

(1) Review of Indian Design Standards / Guidelines / Manuals

Indian Design Standards / Guidelines / Manuals related to design or construction of the steel bridge published by Indian Roads Congress are summarized in Table 5.2-3 below.

Table 5.2-3 Indian Design Standards / Guidelines / Manuals related to Steel Bridge

Category	Title	Remarks
Design	IRC: 5-2015, Standard Specification & Code of practice for Road Bridges. Section – I General Features of Design (Seventh Revision)	General requirements for bridge design
	IRC: 6-2014, Standard Specification & Code of practice for Road Bridges. Section – II Loads & Stresses (Revised Edition)	Design standard for design loads to be applied for road bridge
	IRC: 24-2010, Standard Specification & Code of practice for Road Bridges, Steel Road Bridges (Limit State Method) (Third Revision)	Design standard for steel bridge
	IRC: 78-2014, Standard Specification & Code of practice for Road Bridges. Section – VII Foundation & Substructure (Revised Edition)	Design standard for foundation and sub-structures

Category	Title	Remarks
	IRC: 83, Standard Specification & Code of practice for Road Bridges. Section – IX Bearings	Design standard for bearings
	IRC: 112-2011, Code of Practice for Concrete Road Bridge	Design standard for concrete bridge
	IS 800:2007, General Construction in Steel – Code of Practice (CED:7 Structural Engineering and Structural Sections)	Design standard for steel structures
Construction	MORTH SPECIFICATION FOR ROAD AND BRIDGE WORKS (Fifth Revision)	Standard specification for the construction including general steel bridge works
	IRC: SP: 104-2015, GUIDLINES FOR FUBRICATION AND ERECTION OF STEEL BRIDGES	Guideline for fabrication and erection of steel bridge

Source: JICA Study Team

The design standards / guideline / manual for design or construction of general steel bridge works such as girder or truss bridge are provided well including design theory, the design values to be used for design, notification for fabrication and erection. However, some structural types such as arch bridge are not covered by these standards. For example, verification for steel arch stability and erection method for steel arch bridge are not described by these standards. In addition, Knuckle bearing which is applied to bottom of arch rib generally is not included.

Hence, it is necessary that whole description shall be consistent well by applying Indian standards for the part which is covered enough by Indian standards and applying overseas standards / guidelines / manuals such as Japanese standard or EUROCODE, etc. for the part which is particular for steel arch bridge.

(2) Proposed description

The proposed description for steel arch bridge are summarized in Table 5.2-4 below. As mentioned in Chapter 3.4.3, the plan of new bridge construction of steel arch L=130m as proposed near 75km of NH54 is canceled. Therefore, this description is not included in Schedule-D.

Table 5.2-4 Proposed Description for Steel Arch Bridge (Canceled)

Item	Contents	Remarks
Design of Steel Arch Bridge	・Basic requirement for the design	
	・Foundation design	Refer IRC:78-2014 For notification for foundation placed on slope, added description prepared based on Japanese Standard.
	・Steel super-structure design - Basis of Design - Analysis and Design - Considerations for the Fatigue - Corrosion Protection	Refer IRC:24-2010 For stability of overall structure of steel arch, standards in overseas are referred.
	・Design of bearing - Bearing for bottom of arch rib - Bearing for main girders or stiffening girders	For bearing at bottom of arch rib, Road Bridge Bearing Manual in Japan or BS5400-9.1 is referred. For bearing at main girders, IRC:83(Part II, Part III) are referred.
	・Design of erection stage - General - Considerations for the Design	Prepared based on Guideline for the design and construction of steel structures' erection (Japan Society of Civil Engineers)
	Others - Load Condition - Geotechnical Investigation - Sub-structure Design - Concrete Super-Structure Design - Seismic Design	Refer IRC:6-2014, IRC:78-2014, IRC:24-2010, IRC:112-2011, IRC:5-2015 and any other related codes

Item	Contents	Remarks
	- Design of Auxiliary Components	
Construction of Steel Arch Bridge	・Steel Super-structure - Material, Fabrication, Transportation - Erection (Surveying for Erection Work, Preparation of Temporary Work, Cantilever Erection Work, Assembling Steel) - Painting, Tests and Standards of Acceptance	For general matter, SPECFICATION FOR ROAD AND BRIDGE WORKS of Section1900, IRC: SP:104-2015 is referred. For the erection, prepared based on Guideline for the design and construction of steel structures' erection (Japan Society of Civil Engineers)
	・Bearings - Bearing for bottom of arch rib - Bearing for main girders or stiffening girders	For bearing at bottom of arch rib, Road Bridge Bearing Manual in Japan or BS5400-9.2 is referred. For bearing at main girders, SPECFI CATION FOR ROAD AND BRIDGE WORKS of Section 2000 is referred.
	Others - Geotechnical Investigation - Foundation - Sub-structure - Concrete Super-structure - Expansion Joints - Wearing Coat and Appurtenances	Refer Section2400, 1100, 1200, 2100, 2200, 2300, 2600, 2700 of SPECFI CATION FOR ROAD AND BRIDGE WORKS and any other related Section.

Source: JICA Study Team

CHAPTER 6 CONCLUSIONS

6.1 Wrap-up of the Technical Assistance Activities

(1) Activities of Monitoring and Technical Assistance for the Entire Process of the Additional Survey and Modification of the Preliminary Design for NH54 and NH51

1) Additional Topographic Survey

To verify accuracy of the topographic mapping in DPR, The JICA Study Team compared the coordinate values of the same kilo-post block located along NH-54 which are observed in the map of DPR, and the secondary traverse by the additional survey by BPC, respectively. As results, it was found that both coordinates are widely different from each other. This means reliability of DPR survey is significantly-low, therefore, the JICA Study Team advised to NHIDCL to carry out detail survey for the entire stretch of the target road.

The detail survey was planned to be done with total station at the beginning, however, the work progress was significantly delayed and it was expected that completion of the survey will be later than planned. To catch up with the schedule, the additional survey consultant proposed the LIDAR survey as an alternate to the total station survey and NHIDCL approved it. Because of the method change, the survey progress improved to a certain extent, however, in the meantime, it was confirmed that there was widely different between the topographic map in DPR and the terrain observed by LIDAR survey, again.

2) Additional Geological / Geotechnical Survey

The additional survey consultant carried out the slope inventory survey and the boring survey at critical slope locations. The slope inventory survey completed according to plan, while the boring survey took seven months as against three months and half of the initial plan due to insufficient input and of boring equipment and worker of the consultant.

3) Modification of Preliminary Design

Because of changing method to LIDAR survey, topographic maps being a basis of following design works are fully regenerated from one in DPR. Basic policy of modification of preliminary design is to optimize road proposed center line corresponding to new topo data and accompanied design modification of road structure design with applying the same design policy and criteria in the previous stage. The JICA Study Team carried out technical assistance for updating of preliminary design of eight packages in NH54 and one package in NH51.

About the slope protection design works which is taken as a significant element of updating preliminary design, the landslide stability analysis and the countermeasure design are specified in the scope of work in the consultant's TOR. The JICA Study Team shared to BPC the manual presenting landslide stability analysis and countermeasure selection.

(2) Technical Assistance for Application of Contract Mode and Preparation of Technical Specifications

1) Application of Contract Mode

The study team reviewed the items which are assumed as a risk of smooth implementation of the project under EPC contract conditions. Based on the discussions among the government of India and JICA, a draft of proposal for the conditions was summarized with referring application examples on ADB projects. After perpetual discussions among GOI (MORTH and NHIDCL), JICA, and the Study Team, a letter (JFY2017,4R-0372) was issued for NHIDCL as a final proposal of addendum request for EPC of India by JICA.

2) Preparation of Technical Specifications

A road of NH54 is located in a quite hilly terrain, therefore, the JICA Study Team established a design policy aiming to a disaster-resistant road with considering reductions of large scale cut slope and spoil soil. India has laid down technical standards about design and construction works of road structures, however, it does not include technical specifications of some kind of slope protection works and steel

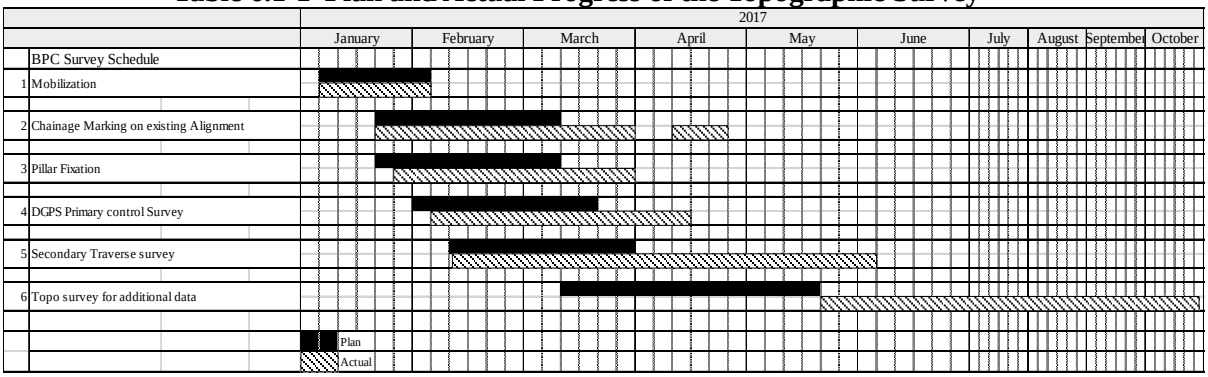
arch bridge works. The JICA Study Team arranged drafts for the technical specifications and submitted to NHIDCL.

(3) Conclusions of Technical Assistance

On a basis of above activities through the monitoring and the technical assistance for additional survey and modification of preliminary design, and the technical assistance for application of contract mode and preparation of technical specifications, the study team arranged reference documents for the preparation of tender documents for each package in NH54 and NH51.

In the progress of the topographic survey by the additional survey consultant, site works and digital mapping works took another five months from the initial plan, as shown in Table 6.1-1. Due to this, the commencement of modification of preliminary design was significantly delay accordingly.

Table 6.1-1 Plan and Actual Progress of the Topographic Survey



Source: JICA Study Team

Nevertheless, whenever topographic map submission is delayed, the study team re-considered work schedule for each package for catching up the demanded deadline. After all, the technical assistance works were completed in four months and half as promised initially**.**

6.2 Points to Note

(1) Note on Reference Documents prepared by This Study

In this technical assistance, the JICA Study Team prepared the reference documents for arranging tender documents for NH54 and NH51 carried out by NHIDCL and the additional survey consultant.

While NHIDCL and the additional survey consultant ought to arrange official tender documents with reference to the above reference documents at the bidding of NH54 and NH51, it is important to note that the documents prepared through this technical assistance shall be treated as only reference.

(2) Concern for Project Implementation and Proposed Supporting Measures

NHIDCL has started land acquisition and contractor procurement for this project. For the smooth implementation of this project and implementation of high-quality construction based on the design concept proposed in this survey, supporting measures for concerned matters in the project implementation stage is proposed as shown in Table 6.2-1.

Table 6.2-1 Concern for Project Implementation and Proposed Supporting Measures

Concern Items	Contents of Concern and Proposed Supporting Measures	Responsible by	Timing
Delay of land acquisition	Contents of concern: In order for contractor to begin construction work, over 90% of construction area needed to be handed over to the contractor, and submission of performance guarantee also needed to be confirmed. Land for acquisition is fixed by Mizoram Province, but the conventional land fixing method based on the offset from the existing road center	・Mizoram State ・NHIDCL ・DPR consultant ・JICA Study Team	・On going (by end of May, 2018)

Concern Items	Contents of Concern and Proposed Supporting Measures	Responsible by	Timing
	is applied regardless of the control point survey, so there is concern about securing accuracy and prolonging the work . Proposed Supporting Measure: Land acquisition will be implemented based on DPR design results finalized by DPR consultants employed by NHIDCL. However, it is necessary to measure and provide offset data from the existing road center to the boundary of land acquisition etc. for Mizoram state. Since the DPR consultant does not have the technology to accurately and quickly measure the above data, supporting by JICA study team for the above data is desirable.		
Reflecting the design concept on construction	Contents of concern: The responsibility and authority of the construction supervision consult (Authority's Engineer) is prescribed as follows in the 18th term of the contract agreement between NHIDCL and Contractor. Prior approval from the NHIDCL is required before AE instructions and guidance concerning the following are notified to the contractor. 1. Extension of construction period, 2. Additional payment to the contractor, 3. Contract termination payment, and 4. When either the NHIDCL or the contractor incurs an obligation / responsibility to exceed 0.2% of the aggregate contract (lump sum contract price). However, since the schedule N (Annex - I) attached to the agreement specifies Rs. 5,000,000 as the limit, the amount of money is given priority. Since the authority of AE is limited as described above, NHIDCL's discretion largely determines whether the design concept proposed in this survey is sufficiently reflected in construction. Proposed Supporting Measure: Through technical assistance in this survey, since it was decided to include a schematic design drawing, a structure list, etc. as a reference in bidding documents. By implementing the " Special Assistance for Project Implementation: SAPI", monitoring and guiding based on the bidding documents is considered as effective support.	・JICA	From the beginning of construction
Quality Assurance for Construction	Contents of concern: The types of inspections and tests conducted by AE before handover are detailed in Schedule-K of the bidding documents. Although it is possible for AE to entrust the actual inspection / test to an external organization, the internal consent of NHIDCL is necessary. Also, it is AE's job to audit whether the site meets Indian environmental standards and safety standards.	・NHIDCL ・JICA	At bidding of AE

Concern Items	Contents of Concern and Proposed Supporting Measures	Responsible by	Timing
	Assistance plan: When concluding an AE consulting contract, instruct NHIDCL from JICA to clarify who is responsible for the examination expenses and who is responsible for the audit of the environmental and safety standards.		

Source: JICA Study Team

Appendix

Appendix -1.1: Progress Monitoring Report of NH54 Surveys (1)

Preparatory Study for Road Network Improvement in North-East States of India
Technical Assistance for the Additional Engineering Surveys
Progress Monitoring Report (1st)

14th March 2017

H.Katagiri, JICA Study Team

We informs that 1st Progress monitoring for the engineering surveys at site of NH54 was conducted as follows;

1. Abstract

(1) Date: 9th -10th March, Weather (9th): Fine, Weather (10th): Cloudy/Rain

(2) Participants : Mr.Hideo Katagiri, Mr.Michael Lalhmachhuana (Assistant)

(3) Inspected Section : CH8+450 – CH201+000 (See Fig-1)

(4) Inspected Works : Finding progress and issue for the works below

① Boreholes Investigation Works at Landslide Location

② Geological Slope Inventory Survey Works

③ Secondary Traverse Survey Works

④ DGPS Primary Control Survey Works

⑤ Pillar Fixation Works

⑥ Chainage Marking Works on Existing Alignment

2. Details

Refer to the Attachments

Fig.1 : Map of 1st Site Monitoring Point

Table-1 : List of Contact Person on the Site

Table-2 : Check Sheet on the Site Monitoring for Actual Progress

Graph-1 : Overall Progress Check Sheet (As of 7th March, 2017)

Photos : Photographs of Site Works Monitoring

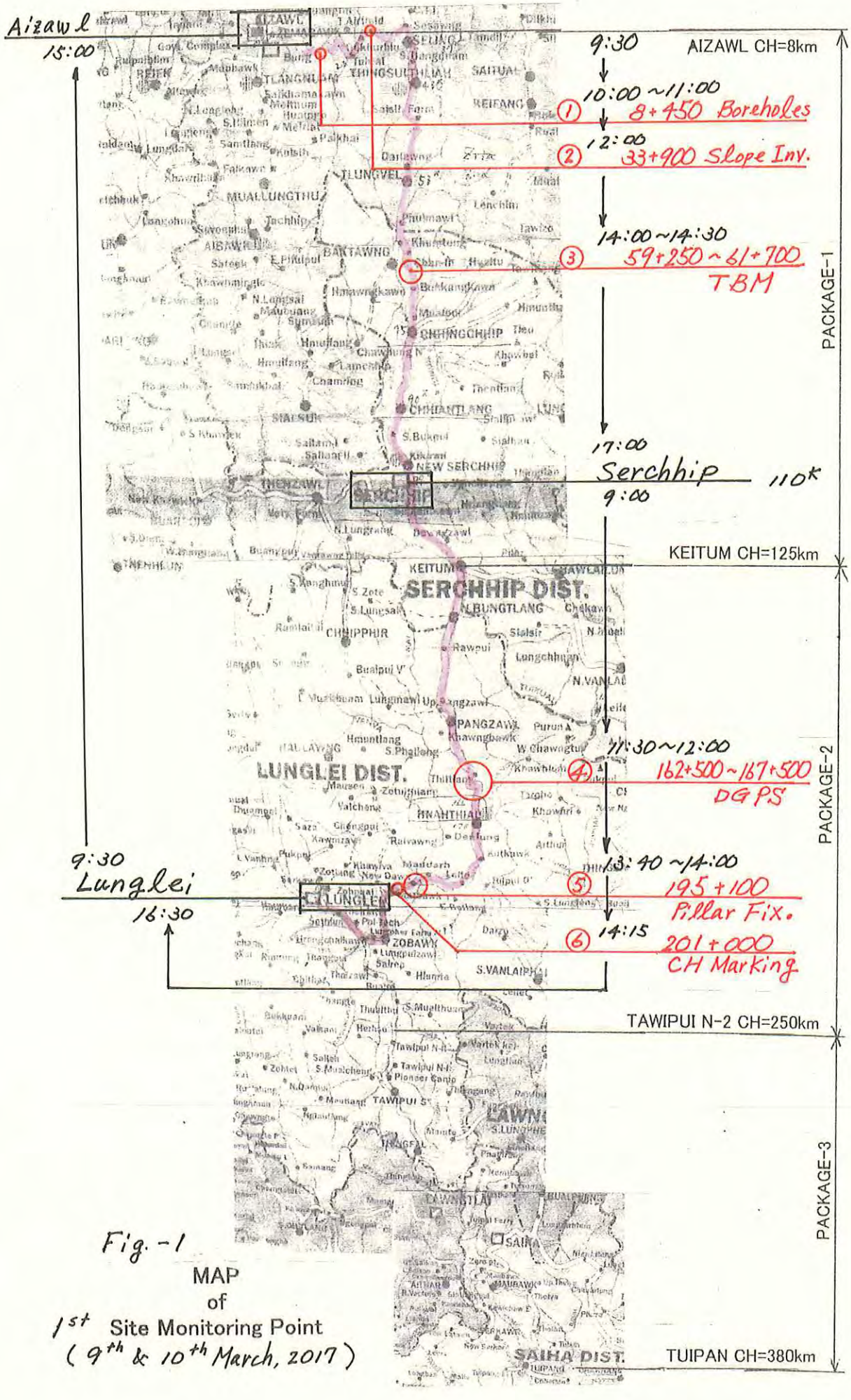


Fig.-1

MAP
of
1st Site Monitoring Point
(9th & 10th March, 2017)

Table-1 : List of Contact Person on the Site

Work Item No.	Work Item Details	Team	Name of Team Leader	Mobile No.
2	Chainage Marking	2-A	SATYAKINKAR PAKIRA	7679294761
		2-B	DEEPAK BAISYA	9612198700
3	Pillar Fixation	3-A	DWIJEN HALUI	8258978459
		3-B	DEEPAK BAISYA	9612198700
4	DGPS Survey	4-A	TANUMOY PARAMANIK	9775279890
5	Secondary Traverse Survey	5-A	BIPLAB MAITY	8116725775
		5-B	BISWARUP BHATACHARYA	8729901440
6	Topo Survey		none	
7	Slope Inventory Survey	7-A	SUMANTA PAKHIRA	8900707284
			SARADINDU MUKHERJEE	8250744560
8	Geological Landslide Inv. Survey	8-A	SUMANTA PAKHIRA	8900707284
			SARADINDU MUKHERJEE	8250744560
10	Boreholes at Landslide	10-A	SUMANTA PAKHIRA	8900707284
			SARADINDU MUKHERJEE	8250744560

Table-2: Check Sheet on the Site Monitoring for Actual Progress

Sheet No.1 Date : 9th March, 2017

Table 2-1: ① Boreholes Investigation Works at Landslide Location

Chainage	8+450 km	
Name of Team	Borehole Survey	
Work Item No.10	A03 BH-1 (20m completed)	8+450 (Team-A)
	A03 BH-2 (22 m currently)	8+450 (Team-A currently)
	A05 BH-1 (30m completed)	10+450 (Team-B Shift to 16+820)
Total No. of Team	3 (currently)	
Team Leader	Mr. Pakira	
Mobile Number	8900707284	
No. of Staff in aTeam	Team-A (7 members)	
	Team-B (7 members)	
Average Daily Progress	3-4m per day	
Problem	(1) Water loss (2)Mechanical 3 (3)Lack of Machine	
Start work & End Time	7:00 am to 5:00pm	22-26m (expected drill)
Remarks	NHIDCL instructed to drill with a minimum of 20m and maximum depth of 30m,Two machine available at the site,one machine currently working while the other one Machine not use due lack of man power as other staff/member went for Holi festival (nartional),3 more machine on th way from Dimapur ,nagaland and expected to reach at the site within 10 days	

Table 2-2: ② Geological Slope Inventory Survey Works

Chainage	33+900 km	
Name of Team	Slope Inventory Survey	
Work Item No.	7	33+900 (Team-A currently)
Total No. of Team	1(currently)	
Team Leader	Mr.Saradindu Mukherjee	
Mobile Number	8250744560	
No. of Staff in aTeam	Three Technical person are engage currently	
Average Daily Progress	One Team covered 6km per day	
Problem	No problen during Site survey	
Start work & End Time	8:00 Am to 5:30 Pm	No survey
Remarks	Survey stop due to physical problem, intend to recruit more of 2-3 geological staff fresher or Experience. Started survey from the inception point (I,e 8+292km) and completed with a total distance from 8 to 33+900km	

Table 2-3: ③ Secondary Traverse Survey Works

Chainage	59+250 km	
Name of Team	Secondary Traverse Survey	
Work Item No.	5	
Total No. of Team	2(currently)	
Team Leader	Mr.Biplap Maity	
Mobile Number	8116725775	
No. of Staff in a Team	Team-A (4 members)	
Average Daily Progress	2.5 km/Team	
Problem	No problen during Site survey	
Start work & End Time	8:00 Am to 5:00 Pm	57+000 to 60+000
Remarks	Started the work from 57+000 and will stop at 60+000 for the day	

Chainage	61+700 km	
Name of Team	Secondary Traverse Survey	
Work Item No.	5	
Total No. of Team	2(currently)	
Team Leader	Mr.Biswarup	
Mobile Number	9679885963	
No. of Staff in a Team	Team-B (4 members)	
Average Daily Progress	2.5 km/Team	
Problem	No problen during Site survey	
Start work & End Time	7:15 Am to 5:00 Pm	60+000 to 62+800
Remarks	Started the work from chainage 60+000 and plan to stop at chainage 62+800	

Sheet No.2 Date : 10th March, 2017

Table 2-4: ④ DGPS Primary Control Survey Works

Chainage	162+540	
Name of Team	DGPS survey	
Work Item No.4	Poin 62 A	162+540 (currently)
	Point 63 A & 63 B	165+000 (currently)
	Point 64 A	167+500 (currently)
Total No. of Team	-	
Team Leader	Mr.Tanumoy Paramanik	
Mobile Number	9775279890	
No. of Staff in aTeam	5 members	
Average Daily Progress	10-15km	
Problem	No problen during Site survey	
Start work & End Time	9:00 Am to 7:30 Pm	162+500 to 177+000
Remarks	From Chainage 162+500km started the work and plan to stop at Chainage 177+500.They completed data entry from 8+000 to 162+500 ,And intend to recruit two team for 4 member for each team	

Table 2-5: ⑤ Pillar Fixation Works

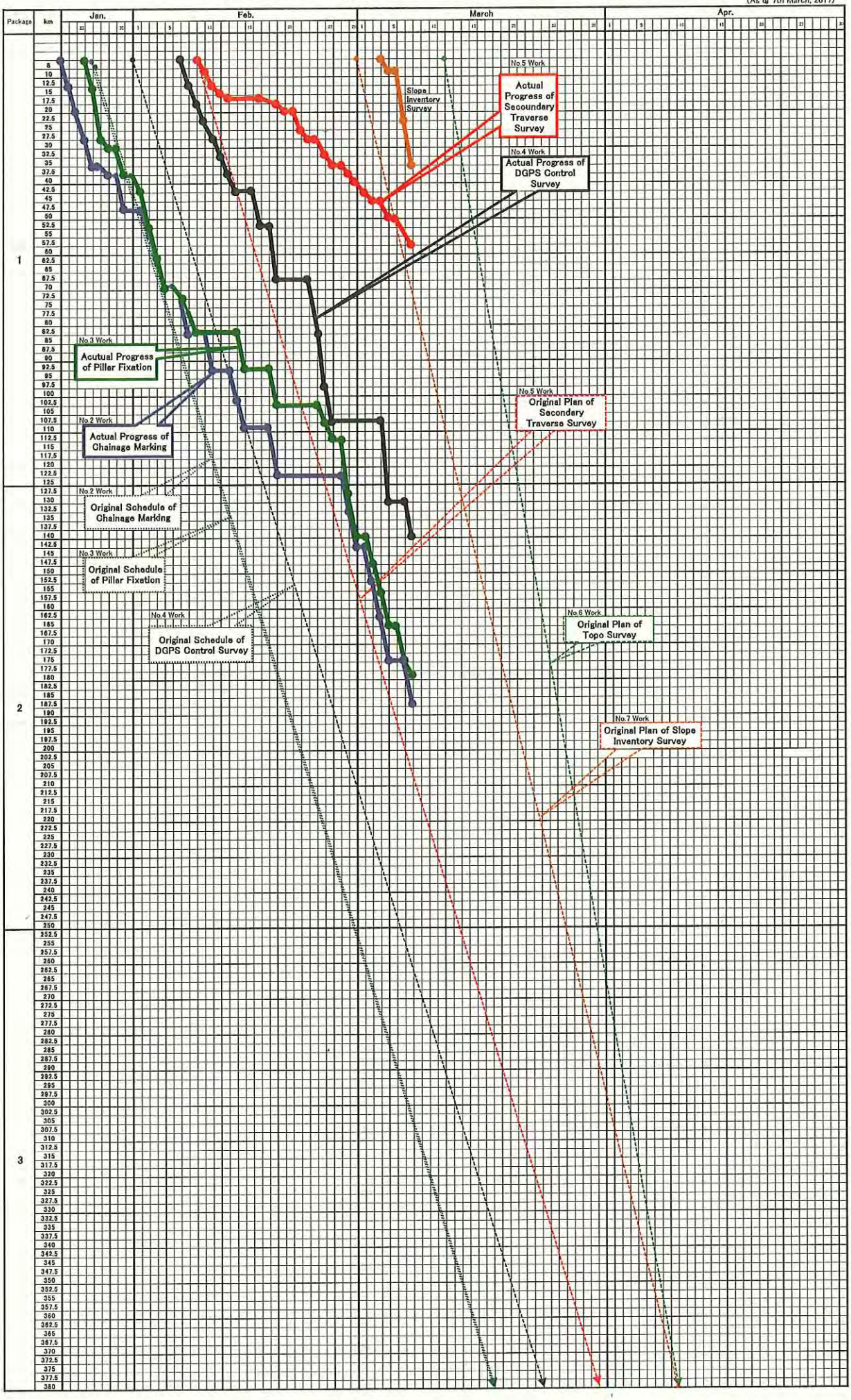
Chainage	195+000	
Name of Team	Pillar fixation (5km interval & 500m interval)	
Work Item No.	3	
Team Leader	Mr,Dwijen Halui	
Mobile Number	8258978459	
No. of Staff in aTeam	Team-A (4 members)	
Average Daily Progress	8-10km	
Problem	No problen during Site survey	
Start work & End Time	8:00 Am to 5:00 Pm	
Remarks	No plan of employing another staff for Team. Expected to complete pillar fixation within March in Section 2. Team-B are under working form 250km to 380km in Section 3.	

Table 2-6: ⑥ Chainage Marking Works on Existing Alignment

Chainage	201+000	
Name of Team	Chainage marking on the existing road	
Work Item No.	2	
Team Leader	Mr.Satyakinkar Pakira	
Mobile Number	7679294761	
No. of Staff in aTeam	Team-A (2members)	
Average Daily Progress	10km	
Problem	1)Bad Weather 2)Bad Road condition	
Start work & End Time	8:000 Am to 5:00 Pm	
Remarks	Team -A Work was Stop for Bad weathercoindition ,Chainage marking was completed upto 201+000 km. Team-A will continue from 125km and stop at 250km in Section 2, Team -B are under working from 250 km to 380km in Section 3.	

Graph-1 : Overall Progress Check Sheet (except Boreholes Works)

(As of 7th March, 2017)



PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 1

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-1
General View
with Geo-technical Engineers
Completed on 28th Feb.
Depth=20m

LOCATION:
Sta. 8+430～8+490

Photo No. 2

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-1
Core Box

Completed on 28th Feb.
Depth=20m

LOCATION:
Sta. 8+430～8+490

Photo No. 3

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-2
General View
Started on 2nd March

LOCATION:
Sta. 8+430～8+490

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 4

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-2
Core Box
Progress : As of 9th March
Depth=22m

LOCATION:
Sta. 8+430～8+490

Photo No. 5

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-2
Core Box
Label of Sample Record

LOCATION:
Sta. 8+430～8+490

Photo No. 6

DATE:
9-March-2017

DESCRIPTION:

Borehole Works
LS No. : A03
B No. : BH-2
Core Extraction

LOCATION:
Sta. 8+430～8+490

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 7
DATE: 9-March-2017
DESCRIPTION: **Borehole Works** LS No. : A03 B No. : BH-2 Drilling Mud Treatment
LOCATION: Sta. 8+430～8+490

Photo No. 8
DATE: 9-March-2017
DESCRIPTION: **Borehole Works** LS No. : A03 B No. : BH-2 Water Supply
LOCATION: Sta. 8+430～8+490

Photo No. 9
DATE: 9-March-2017
DESCRIPTION: **Borehole Works** LS No. : A03 B No. : BH-2 Water Stock Tanks
LOCATION: Sta. 8+430～8+490

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 10

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-B
Observation

LOCATION:
Sta. 59+250

Photo No. 11

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-B
Painting of Traverse Point

LOCATION:
Sta. 59+300

Photo No. 12

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-B
Setting of Mirror
with Team Leader

LOCATION:
Sta. 59+300

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 13

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-B
Nail hitting of
Traverse Point

LOCATION:
Sta. 59+350

Photo No. 14

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Concrete Pillar
of intermediate DGPS

LOCATION:
Sta. 59+500

Photo No. 15

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-A
Setting of Equipment

LOCATION:
Sta. 61+700

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 16

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-A
Observation toward
the Backsight

LOCATION:
Sta. 61+700

Photo No. 17

DATE:
9-March-2017

DESCRIPTION:

Secondary Control Point Survey (TBM) Works

Total Station Survey
Team-A
Observation toward
the Foresight

LOCATION:
Sta. 61+700

Photo No. 18

DATE:
9-March-2017

DESCRIPTION:

Kilo Post at Keitum
Border between
Section 1 & 2
End Point of Section-1
CH=122+023
Beginnig Point of Section-2
CH=125+000

LOCATION:
Sta. 125+000

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 19

DATE:
10-March-2017

DESCRIPTION:

DGPS Survey Works
on Reference Point Pillar
(GCP62A)
Receiving the Satellite Data

LOCATION:
Sta. 162+500

Photo No. 20

DATE:
10-March-2017

DESCRIPTION:

DGPS Survey Works
on Reference Point Pillar
(GCP63B)
Receiving the Satellite Data

LOCATION:
Sta. 165+000

Photo No. 21

DATE:
10-March-2017

DESCRIPTION:

DGPS Survey Works
on Main Point Pillar
(GCP63A)
Receiving the Satellite Data

LOCATION:
Sta. 165+000

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 22

DATE:
10-March-2017

DESCRIPTION:

DGPS Survey Works
on Reference Point Pillar
(GCP64B)
Receiving the Satellite Data

LOCATION:
Sta. 167+500

Photo No. 23

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works
(Main DGPS)
Excavation of Pillar

LOCATION:
Sta. 195+100

Photo No. 24

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works
(Main DGPS)
Setting of Form
(30cm × 30cm)

LOCATION:
Sta. 195+100

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 25
DATE: 10-March-2017
DESCRIPTION: **Pillar Fixation Works** (Main DGPS) Setting of Form (30cm × 30cm × 60cm)
LOCATION: Sta. 195+100

Photo No. 26
DATE: 10-March-2017
DESCRIPTION: **Pillar Fixation Works** (Main DGPS) Cement (Indian Cement)
LOCATION: Sta. 195+100

Photo No. 27
DATE: 10-March-2017
DESCRIPTION: **Pillar Fixation Works** (Main DGPS) Mixing by Manual
LOCATION: Sta. 195+100

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 28

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works
(Main DGPS)
Concrete Casting

LOCATION:
Sta. 195+100

Photo No. 29

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works
(Main DGPS)
Concrete Finishing

LOCATION:
Sta. 195+100

Photo No. 30

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works

Portable GPS Receiver
(GPS map 78s)

LOCATION:
Sta. 195+100

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 31

DATE:
10-March-2017

DESCRIPTION:

Pillar Fixation Works

Form for Reference Piont
Pillar
(Polyvinyl Chloride Pipe)

LOCATION:
Sta. 195+100

Photo No. 32

DATE:
10-March-2017

DESCRIPTION:

Site Works Monitoring

Query the Pillar Fixation
& Chainage Marking Works
to their Team Leaders
by JICA Team's Assitant,

LOCATION:
Sta. 195+100

Photo No. 33

DATE:
10-March-2017

DESCRIPTION:

Chainage Marking Works

Progress : up to 201km
No work, due to rainy day

LOCATION:
Sta. 201+000

Appendix -1.2: Progress Monitoring Report of NH54 Surveys (2)

Preparatory Study for Road Network Improvement in North-East States of India
Technical Assistance for the Additional Engineering Surveys
Progress Monitoring Report (2nd)

21th March 2017

H.Katagiri, JICA Study Team

We informs that 2nd Progress monitoring for the engineering surveys at site of NH54 was conducted as follows;

1. Abstract

(1) Date: 15th -17th March, Weather (15th-17th): Cloudy

(2) Participants : Mr.Hideo Katagiri, Mr.Michael Lalhmachhuana (Assistant)

(3) Inspected Section : CH8+450 – CH297+400 (See Fig-1)

(4) Inspected Works : Finding progress and issue for the works below

① Hearing at BPC's Site Office

② Boreholes Investigation Works at Landslide Location

③ Geological Slope Inventory Survey Works

④ Secondary Traverse Survey Works

⑤ DGPS Primary Control Survey Works

⑥ Pillar Fixation Works

⑦ Chainage Marking Works on Existing Alignment (Team-A)

⑧ Chainage Marking Works on Existing Alignment (Team-B)

⑨ Pillar Fixation Works (Team-B)

⑩ Border (CH250KM) between Section-2 and Section-3

2. Details

Refer to the Attachments

Fig.1 : Map of 2nd Site Monitoring Point

Table-1 : Revised List of Contact Person on the Site Works

Table-2 : Check Sheet on the Site Monitoring for Actual Progress

Graph-1 : Overall Progress Check Chart (except Borehole Works)

Graph-2 : Overall Progress Check Chart for Boreholes Works

Photos : Photographs of Site Works Monitoring

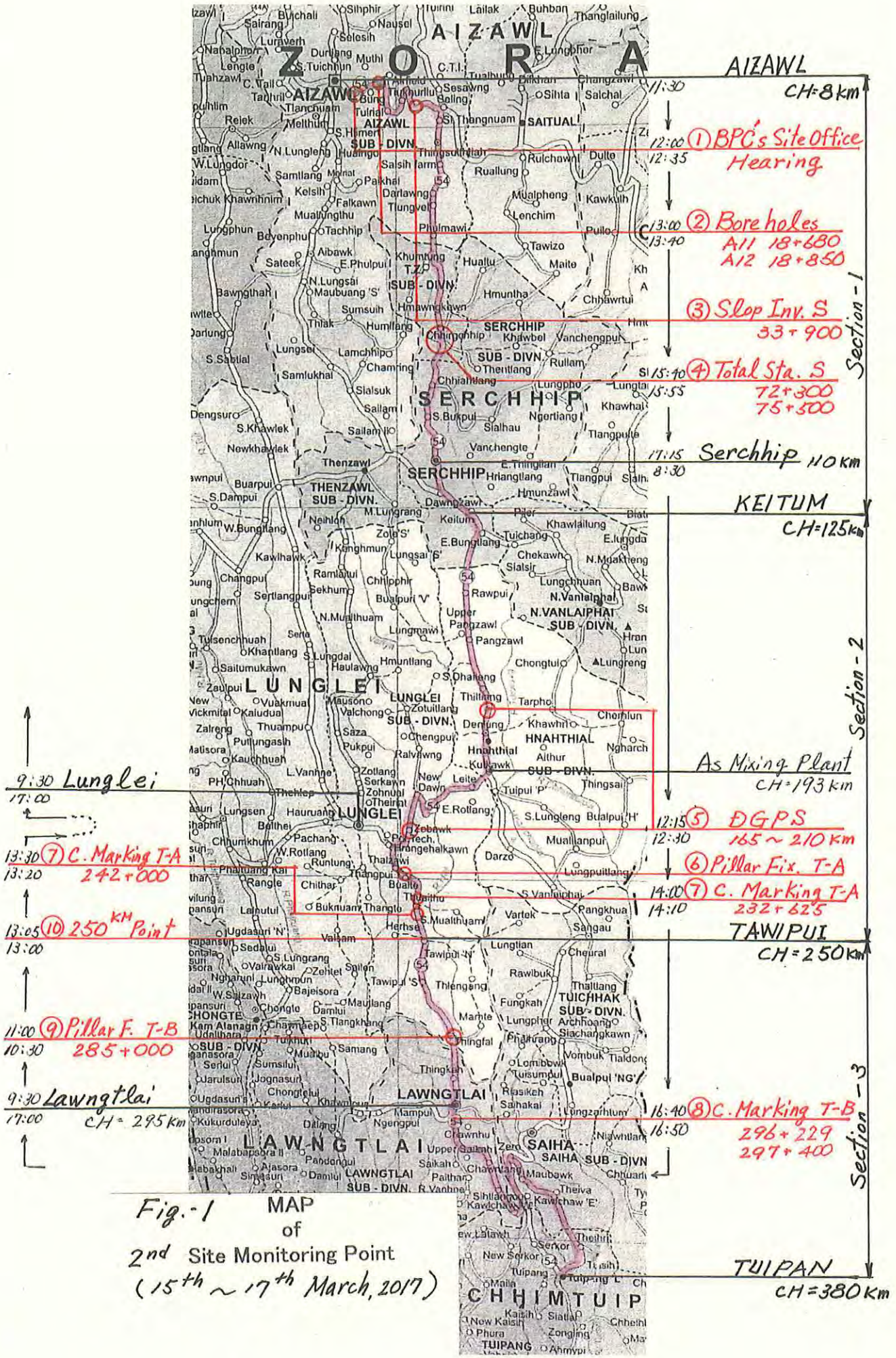


Fig.-1 MAP of 2nd Site Monitoring Point (15th ~ 17th March, 2017)

Table-1 : Revised List of Contact Person on the Site Works

Work Item No.	Work Item Details	Team	Name of Team Leader	Mobile No.
2	Chainage Marking	2-A	Completed	-
		2-B	DEEPAK BAISYA	9612198700
3	Pillar Fixation	3-A	Completed	-
		3-B	DEEPAK BAISYA	9612198700
4	DGPS Survey	4-A	TANUMOY PARAMANIK	9775279890
5	Secondary Traverse Survey	Head	MALAY MAHANTA	9433501054
		5-A	BIPLAB MAITY	8116725775
		5-B	BISWARUP BHATACHARYA	8729901440
6	Topo Survey	6-A	DWIJEN HALUI	8258978459
		6-B	SATYAKINKAR PAKIRA	7679294761
		6-C	not yet	-
7	Slope Inventory Survey	7-A	SARADINDU MUKHERJEE	8250744560
		7-B	SUMANTA PAKHIRA	8900707284
		7-C	ABHIKNAYAH	-
8	Geological Landslide Inv. Survey	8-A	SUMANTA PAKHIRA	8900707284
			SARADINDU MUKHERJEE	8250744560
10	Boreholes at Landslide	10-A	SUMANTA PAKHIRA	8900707284
			SARADINDU MUKHERJEE	8250744560

Site Office of BPC : Zemabawk, Aizawl, Mizoram, Pin-796001

Table-2 : Check Sheet on the Site Works Monitoring for Actual Progress

Sheet No.1　　Date : 15th march, 2017

Table 2-1 : ①Hearing at BPC's Site Office

Reason of no progress	Bore hole Survey and Slope survey could not work due to Inner Line Permit (ILP)Validation isssue

Table 2-2 : ②Boreholes Investigation Works at Landslide Location

Name of Team	Bore hole Survey	
Chainage	10+450, 18+680 & 18+850	
Work Item No.10	A11 BH-1 (1m currently)	18+680
	A12 BH-1 (under setting)	18+850
Total No. of Team	2 (currently)	
Team Leader	Mr Pakira	
Mobile Number	8900707284	
No. of Staff in aTeam	Team-A (7 members)	
	Team-B (7 members)	
Average Daily Progress	3-4m per day	
Problem	1) Water loss 2)Mechanical	
Start work & End Time	7:00 am to 5:00pm	
Remarks	Borehole A11 BH-1 started the work by Team -B at chainage of 18+680 , On the next day at a chainage of 18+850 Team -A will start the work, While the machine is under assemble	

Table 2-3 : ③Geological Slope Inventory Survey Works

Name of Team	Slope Inventory Survey	
Chainage	BPC Office ,Zemabawk,Aizawl	
Work Item No.	7	
Total No. of Team	3(currently)	
Team Leader	Mr.Saradindu Mukherjee	
Mobile Number	8250744560	
No. of Staff in aTeam	Three Technical person are engage currently	
Average Daily Progress	One person covered 6km per day	
Problem	No problen during Site survey	
Start work & End Time	8:00 Am to 5:30 Pm	No survey
Remarks	No prpgress due to the ILP (Inner Line Permit) validity. Some member need to renew the licence to increase the validity. And some member on the way after the celebration festival of holi (National holiday 13th March). The last point of the survey was 33+900. And plan to continue the slope survey on 16th March, One person coming to engage in the slope inventory Team And plan of the Survey not yet decided for each 3 Team, for Team-A (Mr Saradin Mukherjee-Leader), for Team -B (Mr .Pakira -Leader), for Team-C (MrAbhiknayah-Leader)	

Table 2-4-1 : ④Secondary Traverse Survey Works

Name of Team	Secondary Traverse Survey	
Chainage	72+300	Team-A
Work Item No.	5	
Total No. of Team	2(currently)	
Team Leader	Mr.Biplap maity	
Mobile Number	8116725775	
No. of Staff in aTeam	4 members	
Average Daily Progress	2.5 km	
Problem	No problen during Site survey	
Start work & End Time	8:00 Am to 5:00 Pm	
Remarks	Work continue as usual	

Sheet No.2

Table 2-4-2 : ④Secondary Traverse Survey Works

Chainage	75+500	
Work Item No.	5	Team-B
Total No. of Team	2(currently)	
Team Leader	Mr.Biswarup	
Mobile Number	9679885963	
No. of Staff in aTeam	4 members	
Average Daily Progress	2.5 km	
Problem	No problen during Site survey	
Start work & End Time	7:15 Am to 5:00 Pm	
Remarks	Work survey as usual	

Date: 16th & 17th March, 2017

Table 2-5 : ⑤DGPS Primary Control Survey Works

Name of Team	DGPS survey	
Chainage	210+000	
Work Item No.	4	
Total No. of Team	1	
Team Leader	Mr.Tanumoy Paramanik	
Mobile Number	9775279890	
No. of Staff in aTeam	5 members	
Average Daily Progress	10-15km	
Problem	No problen during Site survey	
Start work & End Time	9:00 Am to 7:30 Pm	
Remarks	Collect Data entry of Secondary traverse at the site (CH208+300), Work was continues as usual	

Table 2-6 : ⑦Chainage Marking Works on Existing Alignment

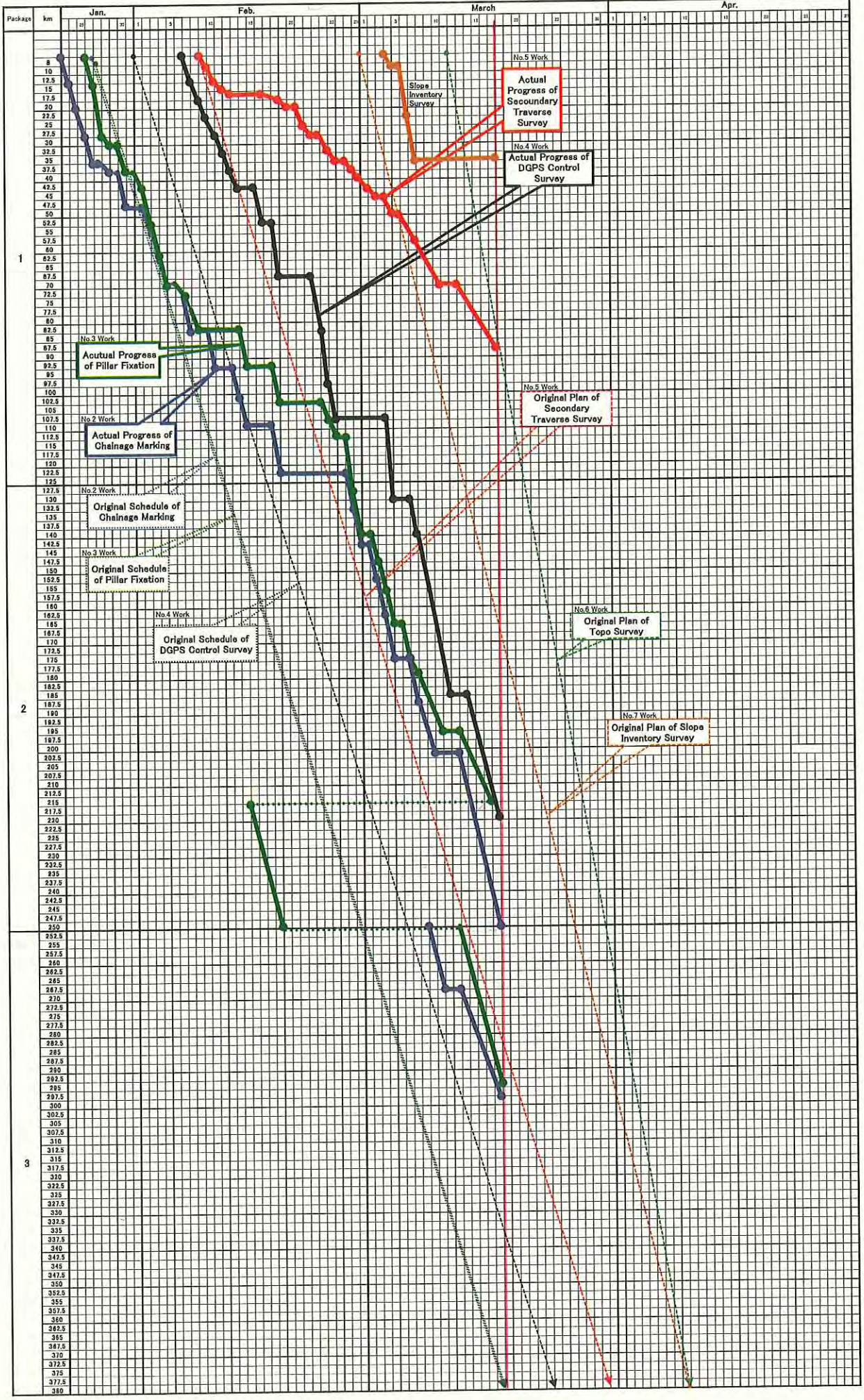
Name of Team	Chainage marking on the existing road	
Chainage	232+625 & 242+000	
Work Item No.	2	
Total No. of Team	2	Team-A
Team Leader	Mr.Satyakinkar Pakira	
Mobile Number	7679294761	
No. of Staff in aTeam	2 members	
Average Daily Progress	10km	
Problem	1)Bad Weather 2)Bad Road condition	
Start work & End Time	8:000 Am to 5:00 Pm	
Remarks	Chaingae marking completed of Section-2 (125+000 - 250+000) by 17th	

Table 2-6 : ⑧Chainage Marking Works on Existing Alignment

Name of Team	Chainage marking on the existing road	
Chainage	296+229 & 297+400	
Work Item No.	2	
Total No. of Team	2	Team-B
Team Leader	Mr.Biswajit	
Mobile Number	7628976027	
No. of Staff in aTeam	2 members	
Average Daily Progress	10km	
Problem	1)Bad Weather 2)Bad Road condition	
Start work & End Time	8:000 Am to 5:00 Pm	
Remarks	started the work from chainage 297+000 on 17th	

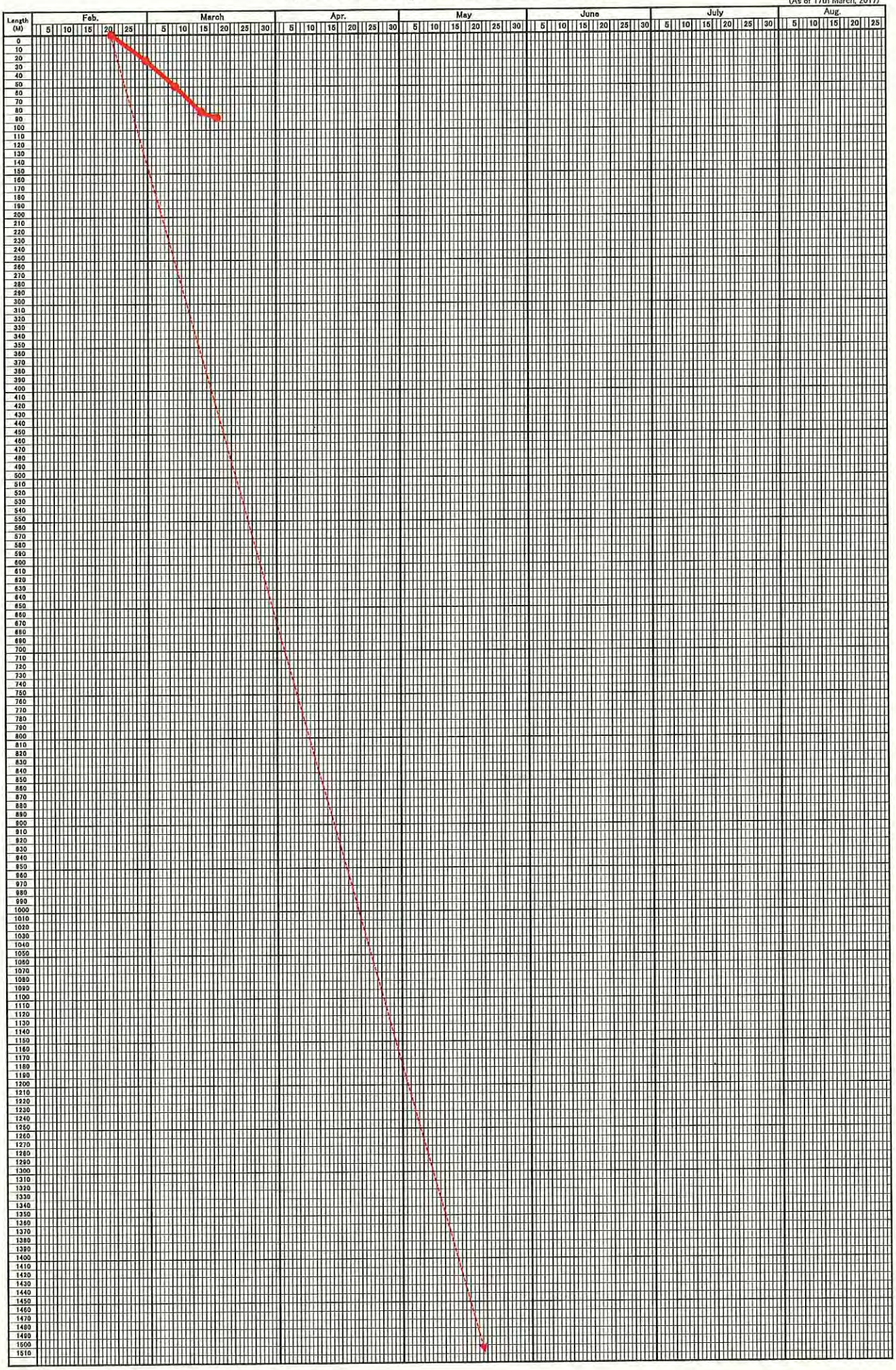
Graph-1 : Overall Progress Check Sheet (except Boreholes Works)

(As of 17th March, 2017)

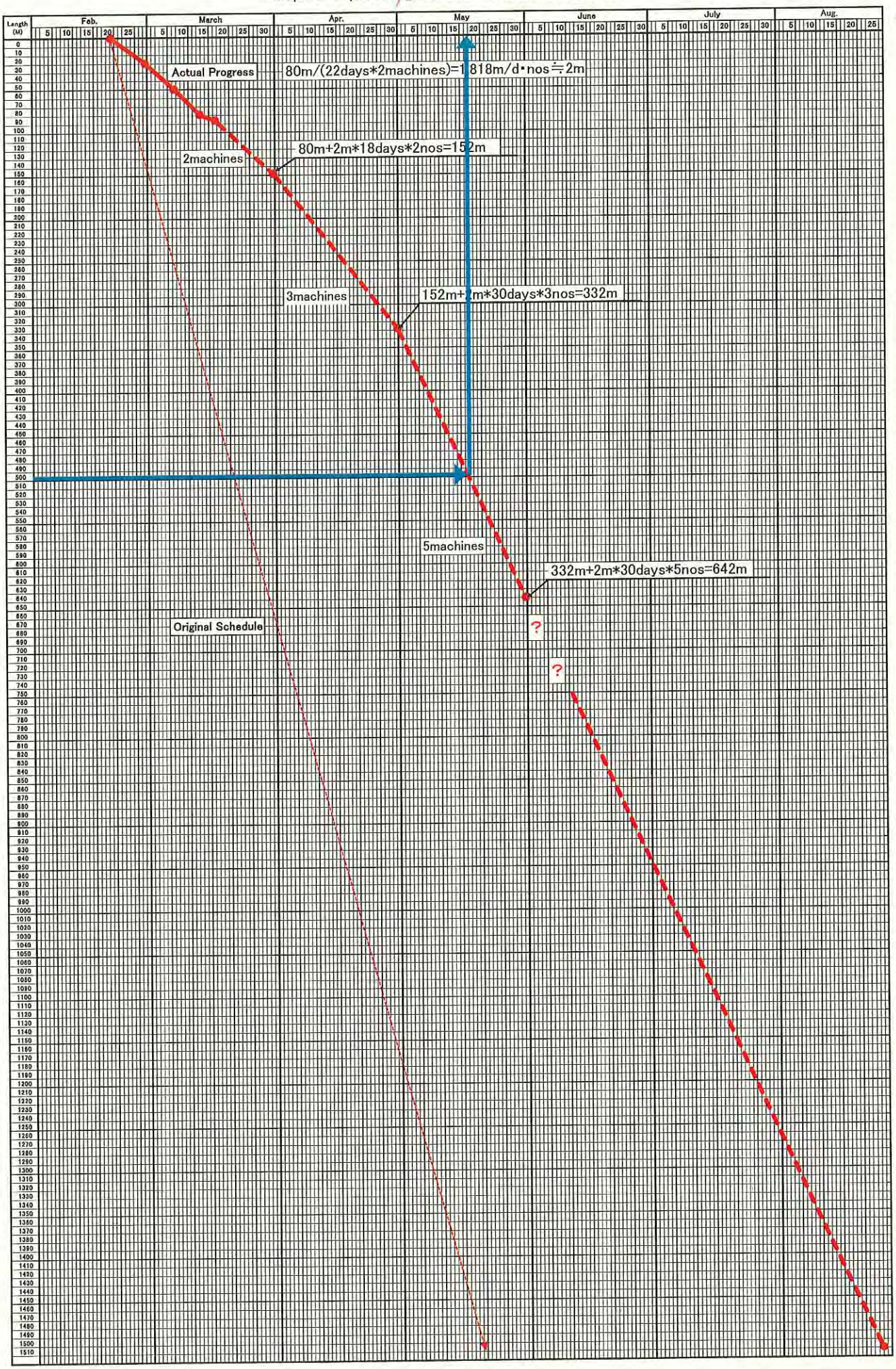


Graph-2 Overall Progress Chart for Boreholes Works

(As of 17th March, 2017)



Graph-2 Expect Progress Chart for Boreholes Works



PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 1

DATE:
15-March-2017

DESCRIPTION:

Hearing for Boreholes & Slope Inventory Survey Works Progress to BPC's Engineers at BPC's Site Office

LOCATION:
CH 8+200

Photo No. 2

DATE:
15-March-2017

DESCRIPTION:

Borehole Works
LS No. : A05
B No. : BH-1
Completed on 7th March
Depth=30m

LOCATION:
CH 10+450

Photo No. 3

DATE:
15-March-2017

DESCRIPTION:

Borehole Works
LS No. : A11
B No. : BH-1
General View
Started on 15th March

LOCATION:
CH 18+680

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 4

DATE:
15-March-2017

DESCRIPTION:

Borehole Works
LS No. : A12

Movement Work for assemble only

LOCATION:
CH 18+850

Photo No. 5

DATE:
15-March-2017

DESCRIPTION:

Landslide Site No. A12

Road has been repaired by PWD
(Covered by Sand & Gravel)

LOCATION:
CH 18+850

Photo No. 6

DATE:
15-March-2017

DESCRIPTION:

Total Station Survey Works

Hearing to Team-A

LOCATION:
CH 72+300

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 7

DATE:
15-March-2017

DESCRIPTION:

Total Station Survey Works

Hearing to Team-B

LOCATION:
CH 75+500

Photo No. 8

DATE:
16-March-2017

DESCRIPTION:

DGPS Works
(GCP81A)

Receiving the Satellite Data

LOCATION:
CH 210+000

Photo No. 9

DATE:
16-March-2017

DESCRIPTION:

DGPS Works

DGPS's Data collection from
BPC's Surveyor

LOCATION:
CH 208+300

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 10
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Hearing to Team-A
LOCATION: CH 232+625

Photo No. 11
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Distance Measuring Wheeler (Team-A)
LOCATION: CH 232+625

Photo No. 12
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Distance Meter (Team-A) 5km+625m from CH 227+000
LOCATION: CH 232+625

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 13
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Hearing to Team-B
LOCATION: CH 296+229

Photo No. 14
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Distance Meter (Team-B) 2km+229m from CH 294+000
LOCATION: CH 296+229

Photo No. 15
DATE: 16-March-2017
DESCRIPTION: **Chainage Marking Works on Existing Alignment** Painting & Distance Measuring (Team-B)
LOCATION: CH 297+400

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 16

DATE:
16-March-2017

DESCRIPTION:

Chainage Marking Works

Marking on the Guard Block
in case of rough surface road

LOCATION:
CH 287+000

Photo No. 17

DATE:
16-March-2017

DESCRIPTION:

Chainage Marking Works

Marking on the Rock
in case of rough surface road

LOCATION:
CH 284+575

Photo No. 18

DATE:
16-March-2017

DESCRIPTION:

Chainage Marking Works

Marking on a Tree
in case of rough surface road

LOCATION:
CH 283+782

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 19

DATE:
17-March-2017

DESCRIPTION:

Pillar Fixition Works
(Team-B)

Main Concrete Pillar
(30cm×30cm×60cm)

LOCATION:
CH 285+000

Photo No. 20

DATE:
17-March-2017

DESCRIPTION:

Pillar Fixition Works
(Team-B)

Reference Concrete Pillar
(φ15cm)

LOCATION:
CH 284+980

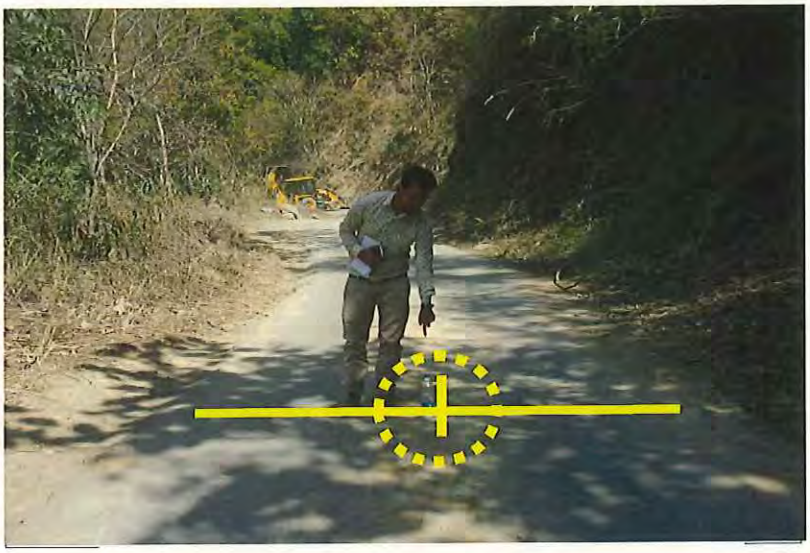


Photo No. 21

DATE:
17-March-2017

DESCRIPTION:

Chainage Marking Works
(Team-B)

Starting Point 250km of Section-3
toward Section-2
(instructed by NHIDCL)

LOCATION:
CH 250+000

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 22

DATE:
17-March-2017

DESCRIPTION:

Chainage Marking Works
(Team-B)

Starting Point 250km of Section-3
toward Section-3
(instructed by NHIDCL)

LOCATION:
CH 250+000

Photo No. 23

DATE:
17-March-2017

DESCRIPTION:

Road Repairing Works
by PWD

Asphalt Pavement Works
by Asphalt Finisher

LOCATION:
CH 150+000

Photo No. 24

DATE:
17-March-2017

DESCRIPTION:

Road Repairing Works
by PWD

Asphalt Pavement Works
by Tandem Loller

LOCATION:
CH 150+000

PHOTOGRAPHS OF SITE WORKS MONITORING

Photo No. 25
DATE: 17-March-2017
DESCRIPTION: **Road Repairing Works by PWD** Base Course Works
LOCATION: CH 200+000

Photo No. 26
DATE: 17-March-2017
DESCRIPTION: **Road Repairing Works by PWD** Portable Asphalt Mixing Plant
LOCATION: CH 193+000

DATE:
DESCRIPTION:
LOCATION: