

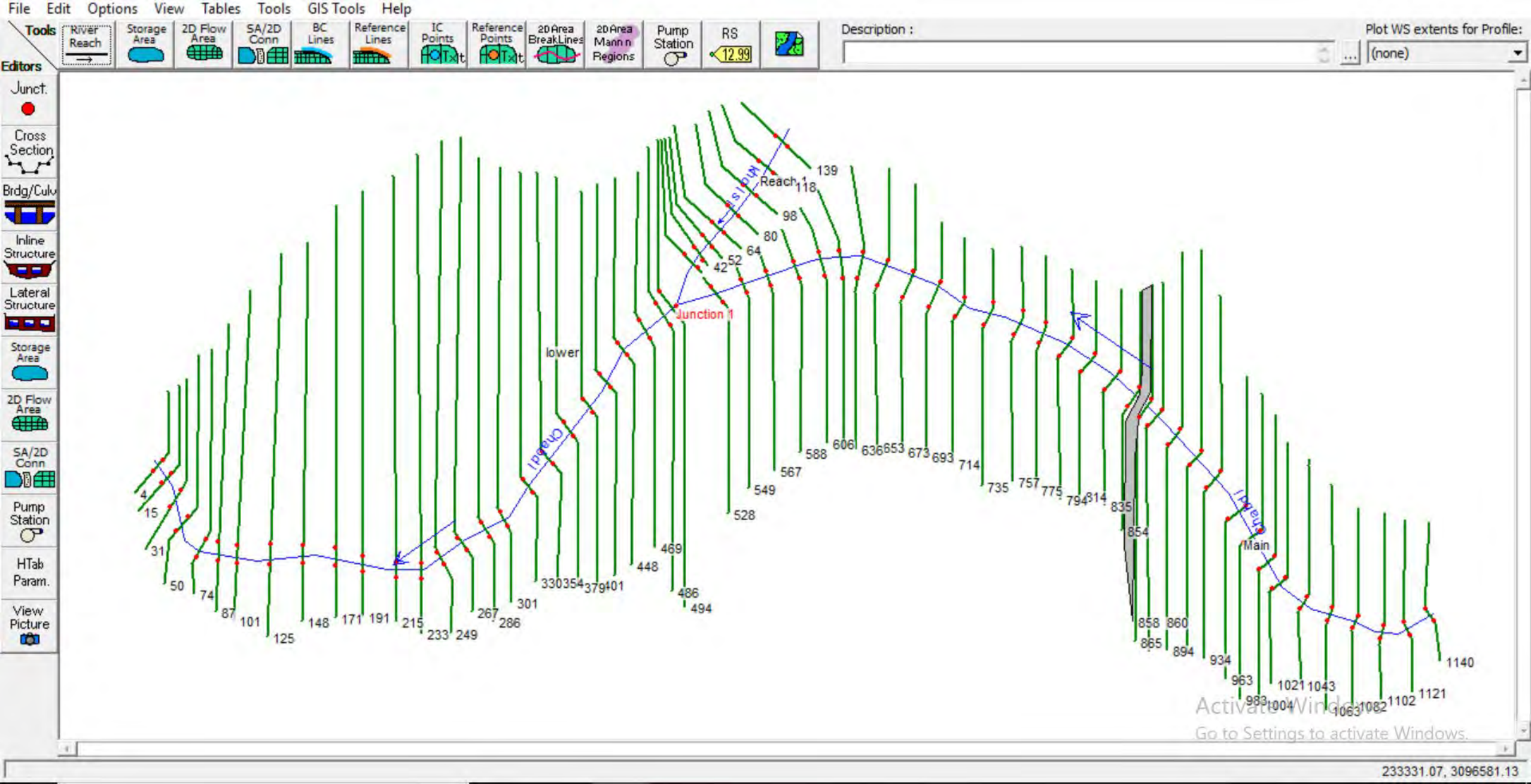


# Annex D5-16

Chabdi River Hydrological Analysis  
Report (NEA)

## Annex D5-16 Geological Study Final result from NEA

| Inputs   |                         |                                  |  |
|--|-------------------------|----------------------------------|--|
| Description  | Values                  | Units                            | Remarks  |
| Geometric Data   | Digital Elevation Model | 0.5mx0.5m size raster resolution | Generated from 1 m contour   |
| Mannings "n" for channel                                   | 0.035                   | Unit less                        | Considered for Clean, straight, full stage, no rifts or deep pools but more stones and weeds |
| Mannings "n" for Flood plains                              | 0.035                   | Unit less                        | Considered for Mature row crops, scattered brush, heavy weeds                                |
| 200 year return period flood of Chabdi River (Main reach)  | 71.57                   | m <sup>3</sup> /sec              | Estimated from Catchment Co-relation   |
| 200 year return period flood of Kholsi (reach 1)           | 1.5                     | m <sup>3</sup> /sec              | Estimated from Catchment Co-relation   |
| 200 year return period flood of Chabdi River (Lower reach) | 73.07                   | m <sup>3</sup> /sec              | Summation of both discharges at junction   |
| Top level of Bridge  | 340                     | m                                |  |
| Bottom level of Bridge                                     | 338.6                   | m                                |  |
| Clear span of Bridge                                       | 15                      | m                                |  |
| River Training wall offset distance from River's thalweg   | 20                      | m                                |  |
| River Training wall offset distance from River's left edge | 15                      | m                                |  |



River: Chabdi

Apply Data



Plot Options

☐ Keep Prev XS Plots

Clear Prev

☒ Plot Terrain (if available)

Cut from Terrain

Reach: Main

River Sta.: 1140

Description

Del Row

Ins Row

## Cross Section Coordinates

|    | Station | Elevation | n Val |
|----|---------|-----------|-------|
| 1  | 0       | 351.57    | 0.035 |
| 2  | 0.7     | 351.05    |       |
| 3  | 1.2     | 350.64    |       |
| 4  | 1.7     | 350.2     |       |
| 5  | 2.3     | 349.68    |       |
| 6  | 2.7     | 349.23    |       |
| 7  | 4.1     | 347.74    |       |
| 8  | 4.7     | 346.98    |       |
| 9  | 7.7     | 343.33    |       |
| 10 | 8.2     | 342.74    |       |
| 11 | 8.7     | 342.22    |       |
| 12 | 9.3     | 341.74    |       |
| 13 | 9.8     | 341.36    |       |
| 14 | 10.3    | 341.06    |       |
| 15 | 10.8    | 340.83    |       |
| 16 | 11.3    | 340.65    |       |
| 17 | 12.2    | 340.41    |       |
| 18 | 13.3    | 340.17    |       |
| 19 | 14.8    | 339.86    |       |
| 20 | 16.8    | 339.51    |       |
| 21 | 18.1    | 339.33    |       |
| 22 | 19      | 339.22    |       |
| 23 | 19.8    | 339.14    |       |
| 24 | 20.3    | 339.1     |       |
| 25 | 21.3    | 339.05    |       |
| 26 | 22.8    | 339.01    |       |
| 27 | 26.7    | 338.98    |       |
| 28 | 28.6    | 338.9483  |       |

## Downstream Reach Lengths

| LOB  | Channel | ROB  |
|------|---------|------|
| 18.7 | 18.7    | 18.7 |

## Manning's n Values

| LOB | Channel | ROB |
|-----|---------|-----|
| N/A | N/A     | N/A |

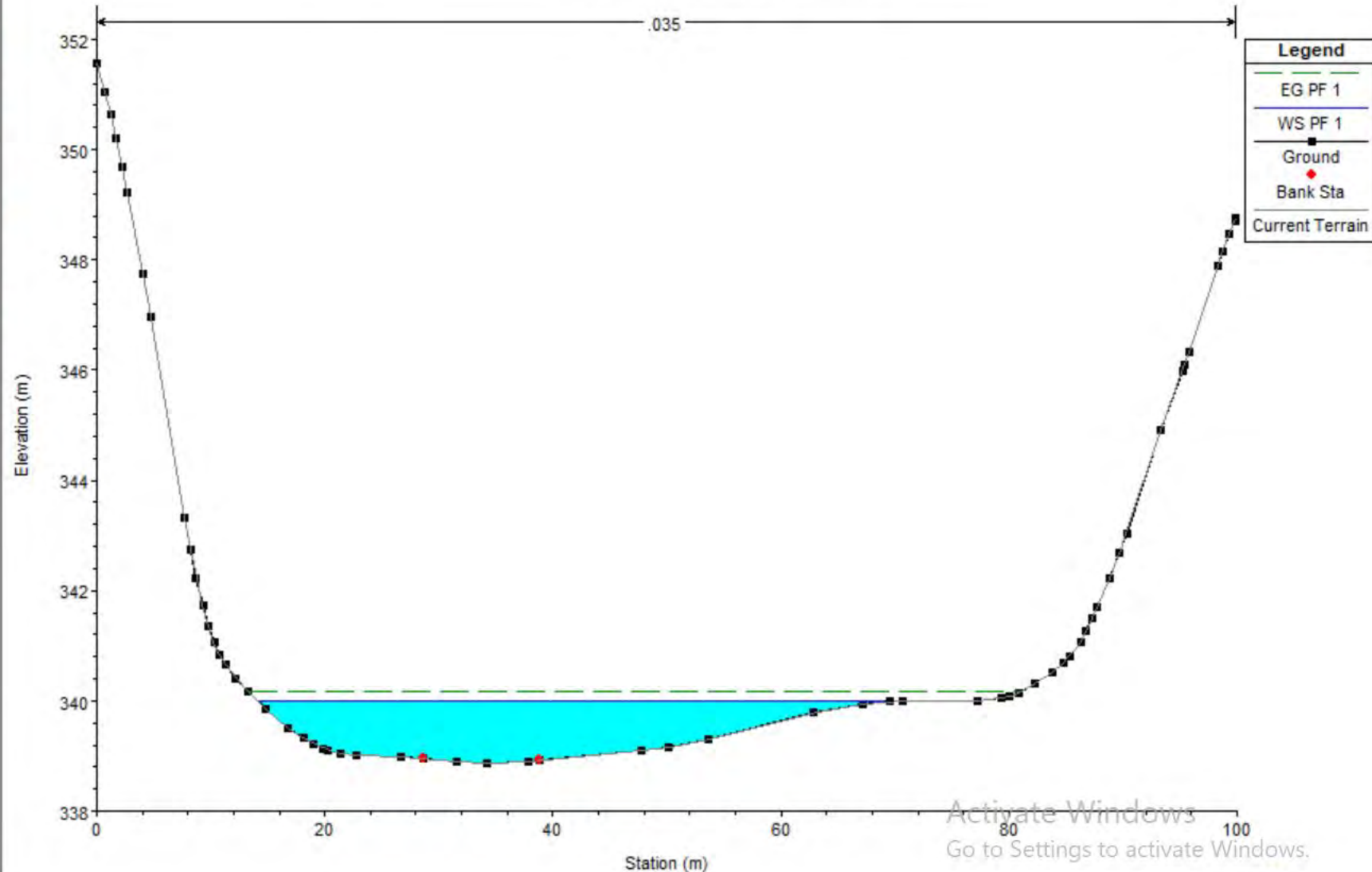
## Main Channel Bank Stations

| Left Bank | Right Bank |
|-----------|------------|
| 28.6      | 38.8       |

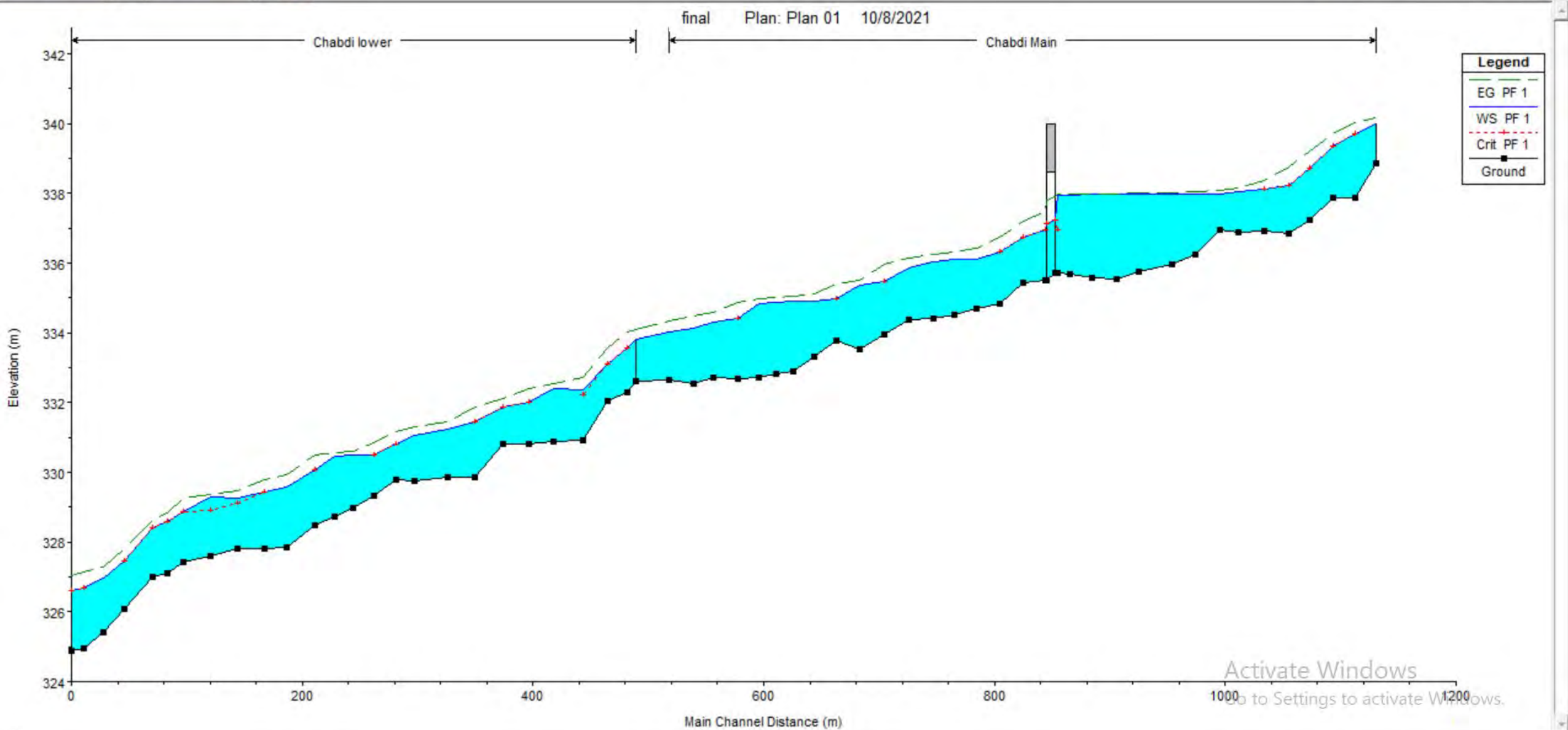
## Cont'Exp Coefficient (Steady

| Contraction | Expansion |
|-------------|-----------|
| 0.1         | 0.3       |

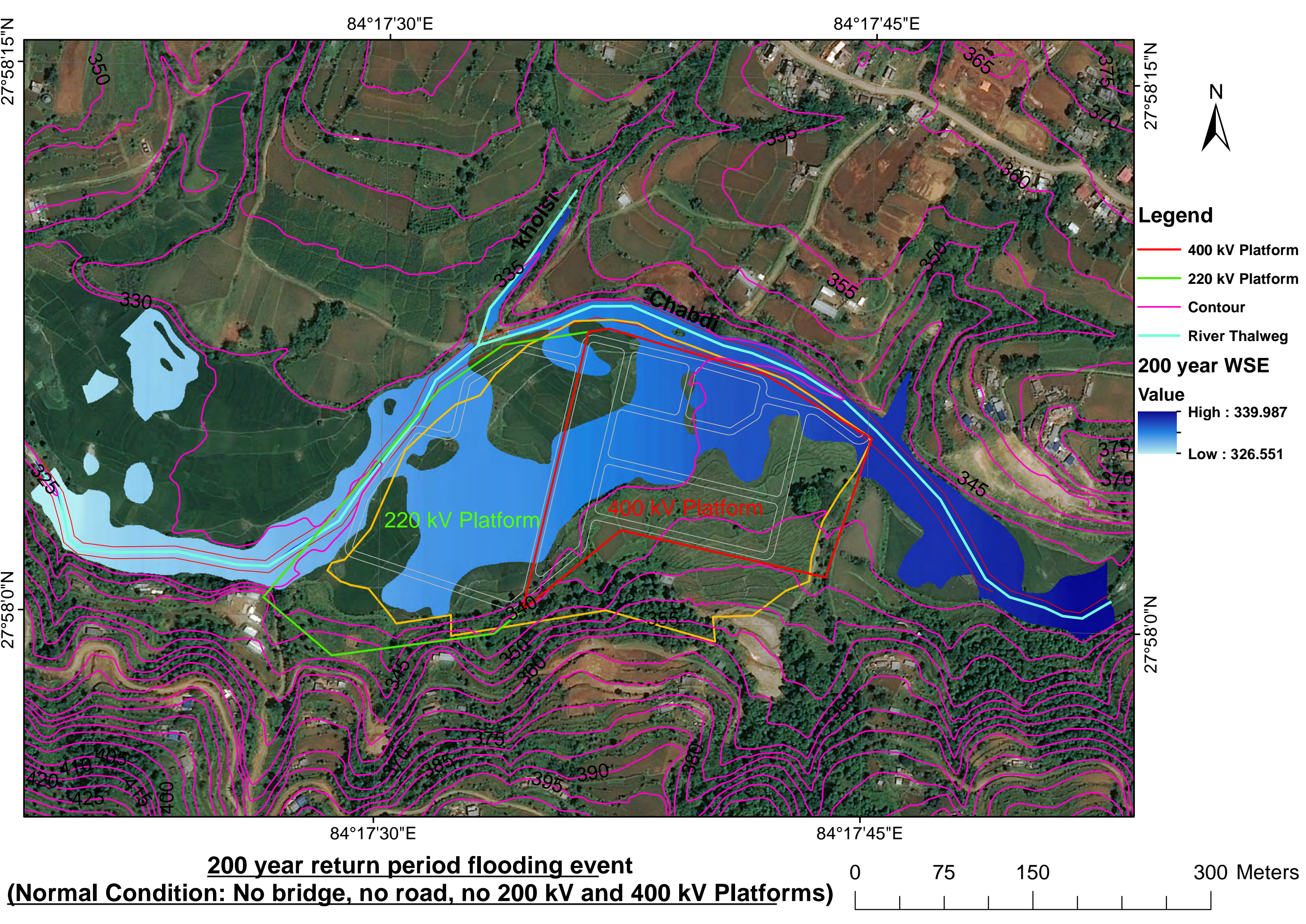
final Plan: Plan 01 10/8/2021



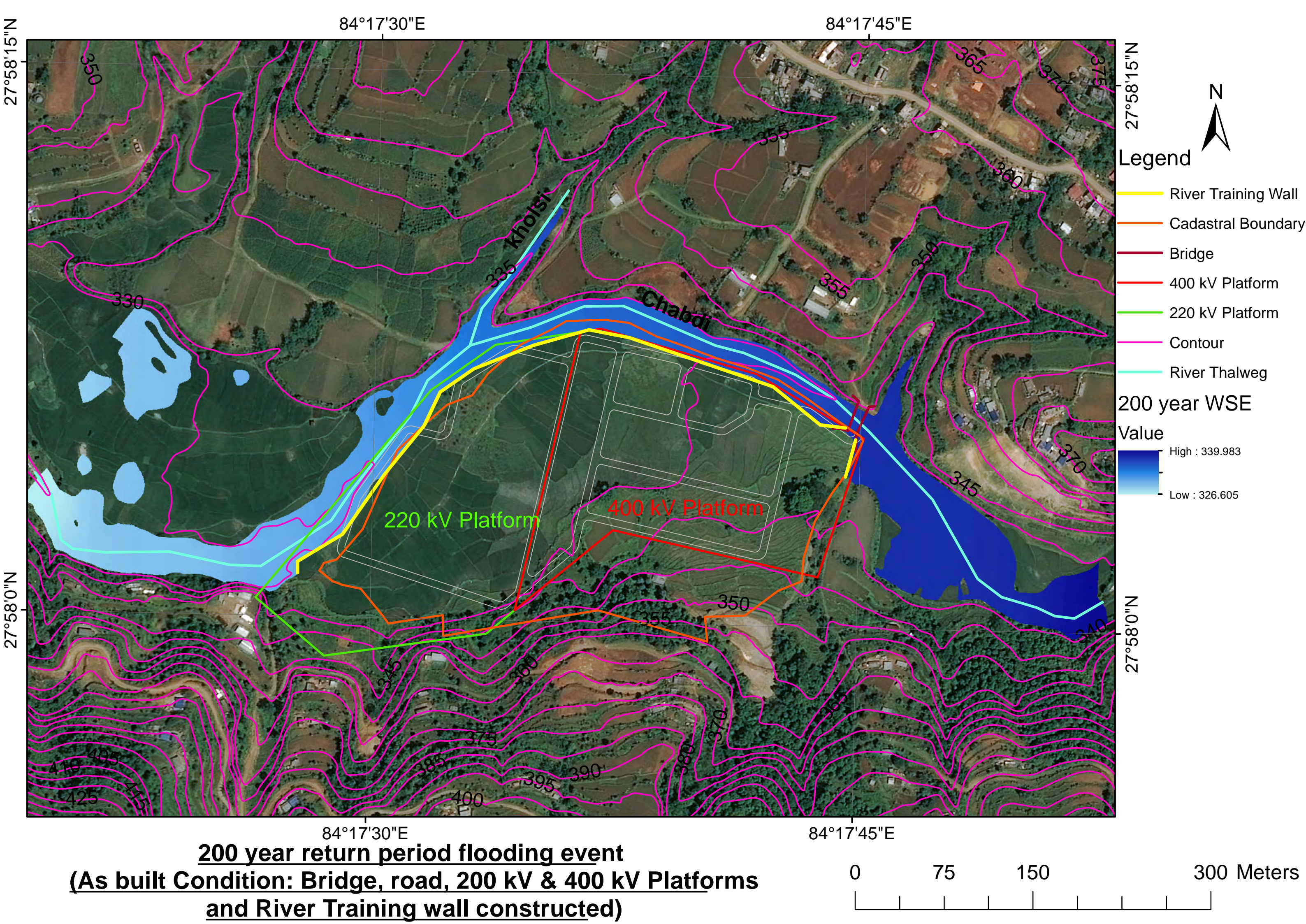
Activate Windows  
Go to Settings to activate Windows.





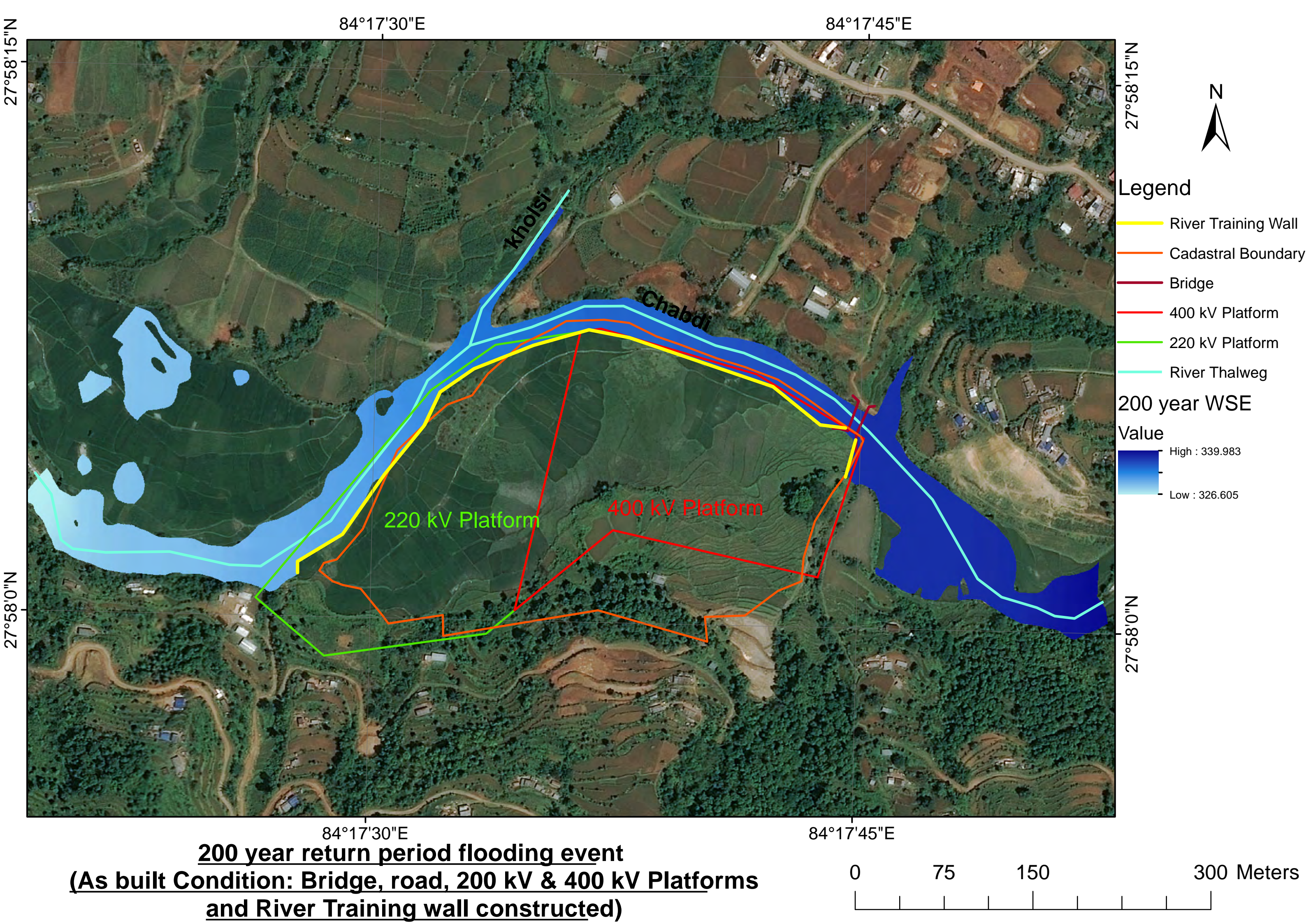




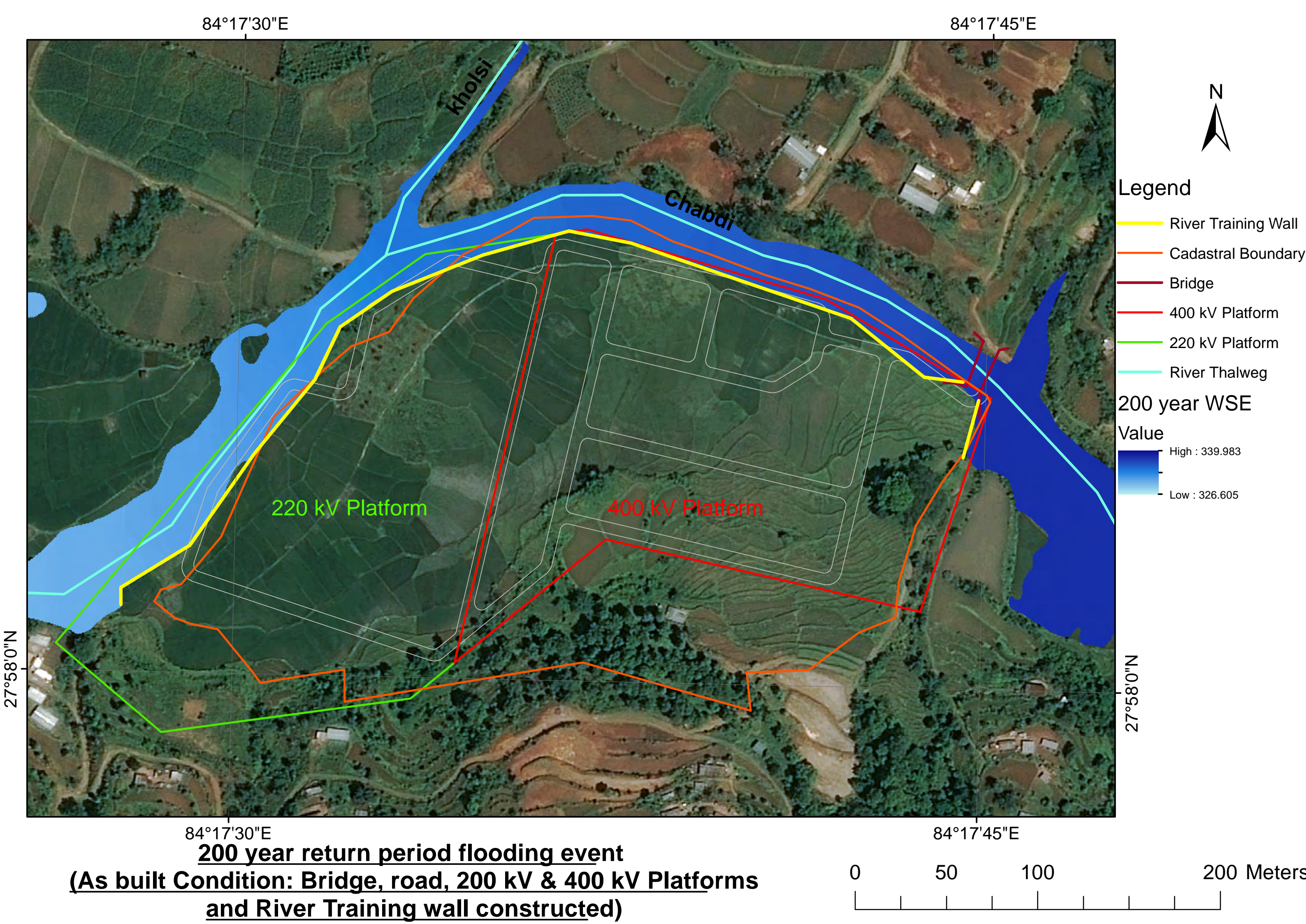


**200 year return period flooding event**  
**(As built Condition: Bridge, road, 200 kV & 400 kV Platforms**  
**and River Training wall constructed)**

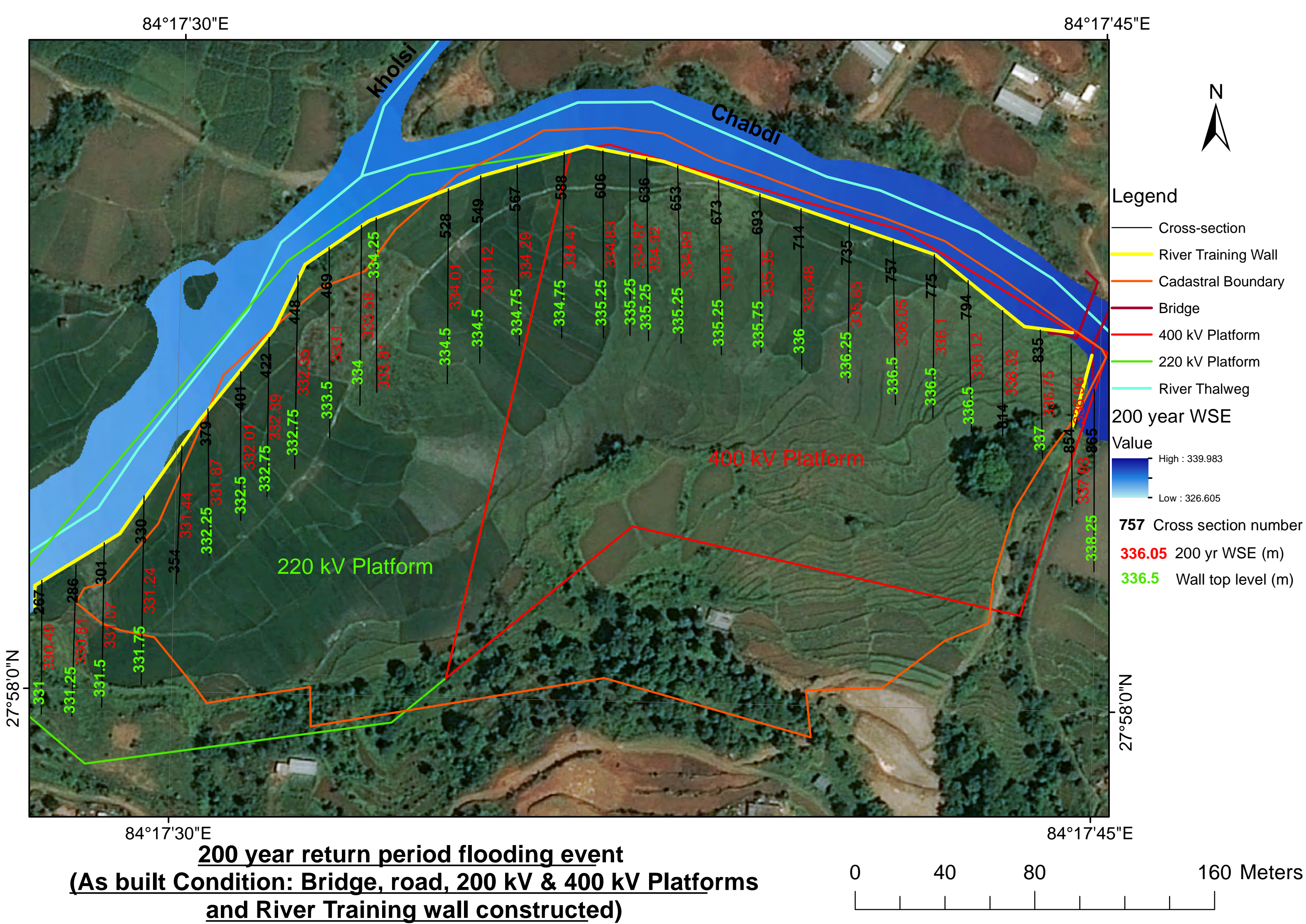














| Results                                   |         |                   |                                 |          |                          |  |                    |
|---|---------|-------------------|---------------------------------|----------|--------------------------|--|--------------------|
| River Station/<br>Cross section<br>Number | Q Total | Min<br>Ch<br>Elev | 200 yr<br>flood<br>W.S.<br>Elev | Vel Chnl | Froude<br>number<br>Chnl | River<br>Training<br>Wall Top<br>level | Remarks            |
|   | (m3/s)  | (m)               | (m)                             | (m/s)    |                          | (m)                                    |                    |
| 875                                       | 71.57   | 335.67            | 337.95                          | 0.83     | 0.18                     |  |                    |
| 865                                       | 71.57   | 335.7             | 337.93                          | 1.03     | 0.23                     | 338.25                                 |                    |
| 860                                       | 71.57   | 335.6             | 337.24                          |          |                          |  | U/s edge of bridge |
| 852.5                                     | 71.57   | 335.6             | 337.13                          |          |                          |  | D/s edge of bridge |
| 854                                       | 71.57   | 335.5             | 336.96                          | 3.32     | 0.99                     | 337.25                                 |                    |
| 835                                       | 71.57   | 335.43            | 336.75                          | 3.12     | 0.97                     | 337                                    |                    |
| 814                                       | 71.57   | 334.82            | 336.32                          | 3.02     | 0.87                     | 336.75                                 |                    |
| 794                                       | 71.57   | 334.7             | 336.12                          | 2.67     | 0.78                     | 336.5                                  |                    |
| 775                                       | 71.57   | 334.52            | 336.1                           | 2.14     | 0.59                     | 336.5                                  |                    |
| 757                                       | 71.57   | 334.42            | 336.05                          | 2.03     | 0.56                     | 336.5                                  |                    |
| 735                                       | 71.57   | 334.36            | 335.85                          | 2.49     | 0.71                     | 336.25                                 |                    |
| 714                                       | 71.57   | 333.94            | 335.48                          | 3.25     | 0.93                     | 336                                    |                    |
| 693                                       | 71.57   | 333.54            | 335.35                          | 1.82     | 0.48                     | 335.75                                 |                    |
| 673                                       | 71.57   | 333.77            | 334.96                          | 2.8      | 1                        | 335.25                                 |                    |
| 653                                       | 71.57   | 333.33            | 334.89                          | 2.13     | 0.59                     | 335.25                                 |                    |
| 636                                       | 71.57   | 332.88            | 334.92                          | 1.56     | 0.37                     | 335.25                                 |                    |
| 620                                       | 71.57   | 332.81            | 334.87                          | 1.7      | 0.42                     | 335.25                                 |                    |
| 606                                       | 71.57   | 332.7             | 334.83                          | 1.79     | 0.43                     | 335.25                                 |                    |
| 588                                       | 71.57   | 332.68            | 334.41                          | 3.26     | 0.89                     | 334.75                                 |                    |
| 567                                       | 71.57   | 332.72            | 334.29                          | 2.47     | 0.68                     | 334.75                                 |                    |
| 549                                       | 71.57   | 332.54            | 334.12                          | 2.84     | 0.76                     | 334.5                                  |                    |
| 528                                       | 71.57   | 332.64            | 334.01                          | 2.67     | 0.77                     | 334.5                                  |                    |
| 494                                       | 73.07   | 332.62            | 333.81                          | 2.49     | 0.83                     | 334.25                                 |                    |
| 486                                       | 73.07   | 332.28            | 333.58                          | 3.09     | 0.97                     | 334                                    |                    |
| 469                                       | 73.07   | 332.04            | 333.1                           | 3        | 1.01                     | 333.5                                  |                    |
| 448                                       | 73.07   | 330.91            | 332.35                          | 2.95     | 0.85                     | 332.75                                 |                    |
| 422                                       | 73.07   | 330.88            | 332.39                          | 2.02     | 0.54                     | 332.75                                 |                    |
| 401                                       | 73.07   | 330.81            | 332.01                          | 3.26     | 0.98                     | 332.5                                  |                    |
| 379                                       | 73.07   | 330.81            | 331.87                          | 2.66     | 0.84                     | 332.25                                 |                    |
| 354                                       | 73.07   | 329.85            | 331.44                          | 3.28     | 0.87                     | 331.75                                 |                    |
| 330                                       | 73.07   | 329.86            | 331.24                          | 2.43     | 0.67                     | 331.75                                 |                    |
| 301                                       | 73.07   | 329.75            | 331.07                          | 2.45     | 0.7                      | 331.5                                  |                    |
| 286                                       | 73.07   | 329.8             | 330.81                          | 2.97     | 0.99                     | 331.25                                 |                    |
| 267                                       | 73.07   | 329.33            | 330.49                          | 3.06     | 0.95                     | 331                                    |                    |
| 249                                       | 73.07   | 328.98            | 330.51                          | 1.63     | 0.43                     |  |                    |
| 233                                       | 73.07   | 328.74            | 330.47                          | 1.69     | 0.43                     |  |                    |
| 215                                       | 73.07   | 328.47            | 330.07                          | 3.19     | 0.84                     |  |                    |



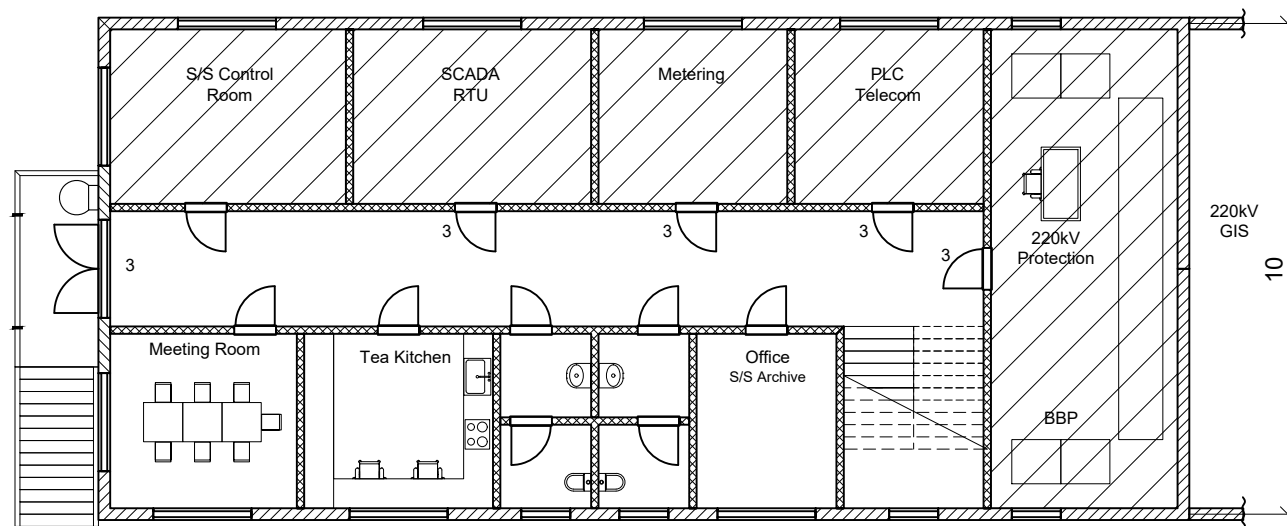


# Annex D5-18

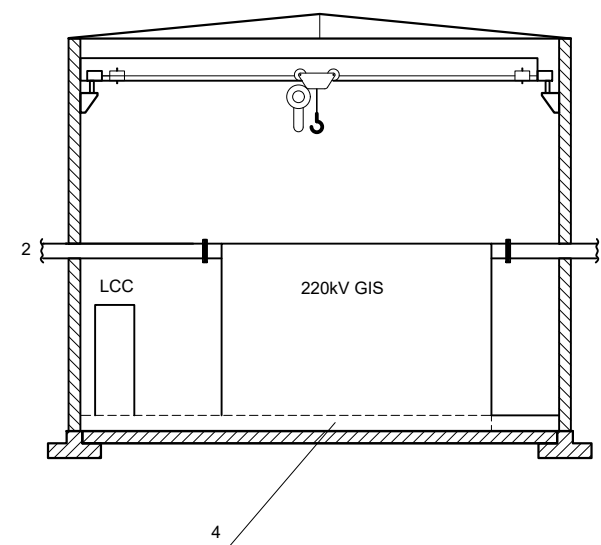
Lekhnath 220/33 kV Substation 220 kV  
Building Layout



1st Floor



Section A-A

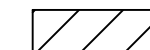


Legend

1. Roller door for GIS transport
2. 220kV bus ducts
3. Doors for equipment/panel transport
4. Cable channel

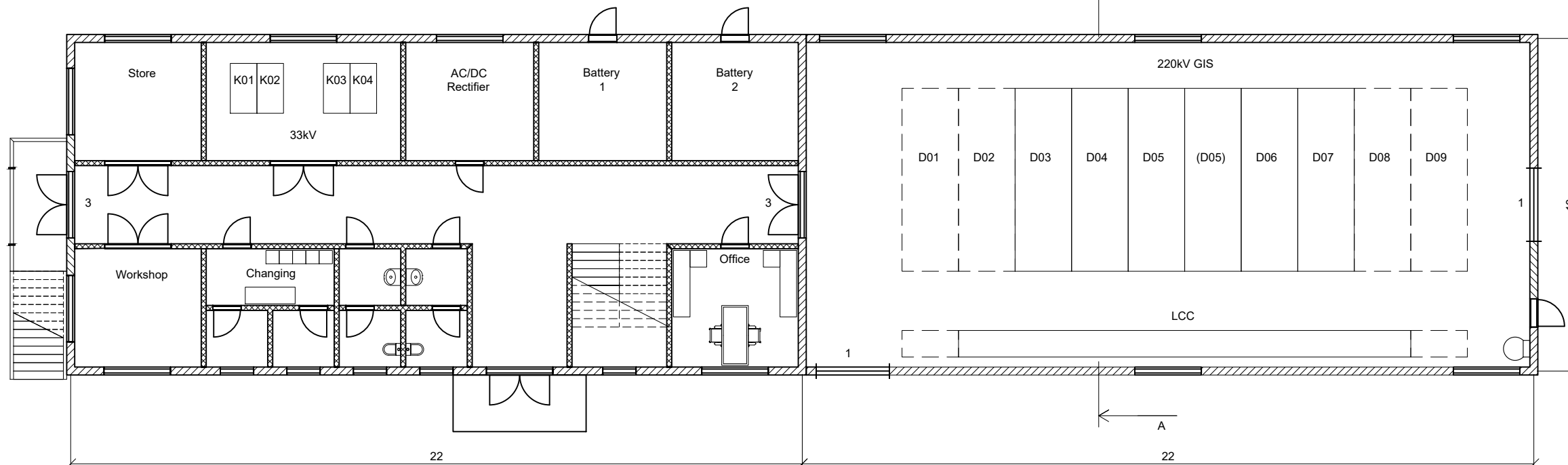


Ladder with safety cage



Raised floor (aseismic)

Ground Floor



Note:  
The Layout and dimensions are tentative and represent minimum requirements subject to design by Contractor during design phase.

Annex 5-18

|                                    |          |           |          |                                   |
|------------------------------------|----------|-----------|----------|-----------------------------------|
| 3                                  | 14.06.22 | AKHALADZE | GATTI    | Revised according NEA comments    |
| 2                                  | 11.02.22 | AKHALADZE | KUITUNEN | For Tender Documents              |
| 1                                  | 15.11.21 | AKHALADZE | KUITUNEN | First Issue                       |
| 0                                  |          |           |          |                                   |
| REV                                | DATE     | NAME      | CHECKED  | NOTE                              |
| FICHTNER                           |          |           |          | NEPAL ELECTRICITY AUTHORITY (NEA) |
| PROJECT NO.: 4899A81               |          |           |          | Lekhnath Damauli 220kV            |
| FILE: DS-18 LEK.220-11 Cont. Build |          |           |          | Transmission Line Project         |
| SYSTEM: ACAD 2022                  |          |           |          | Lekhnath Substation               |
| SCALE:                             |          |           |          | 220/33 kV Building Layout         |
| SHEET: 1 / 1                       |          |           |          | SIZE: A3                          |
|                                    |          |           |          | DRAWING NO.:                      |

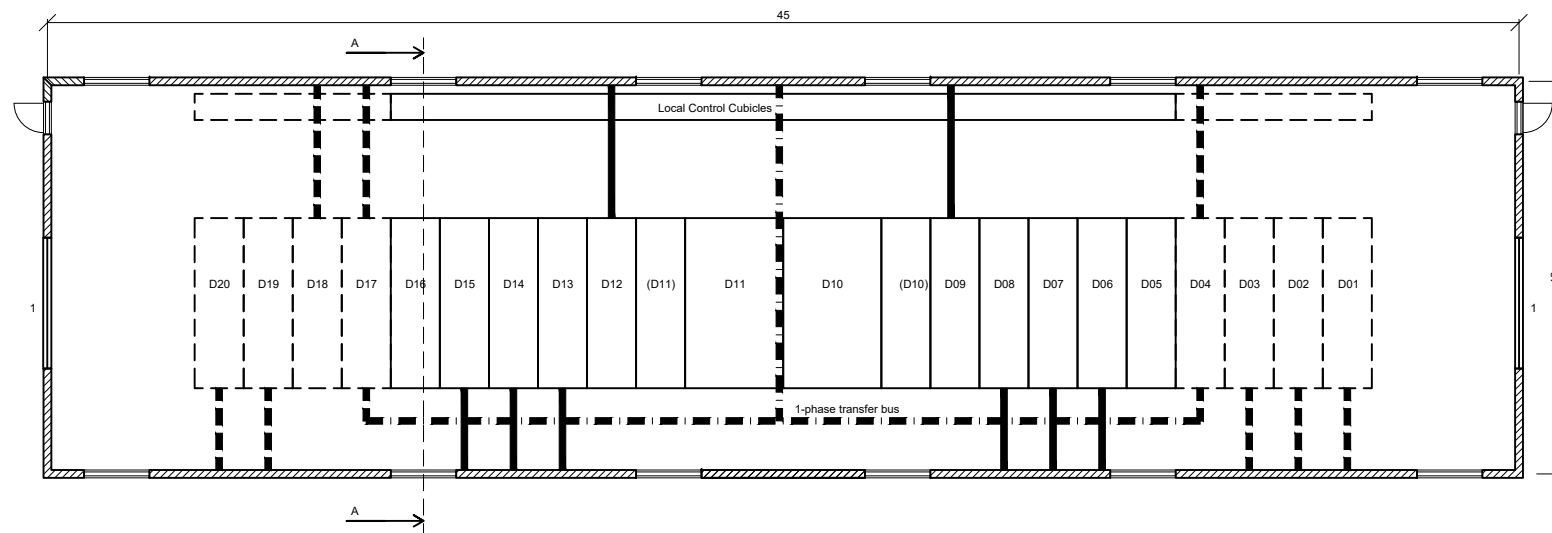
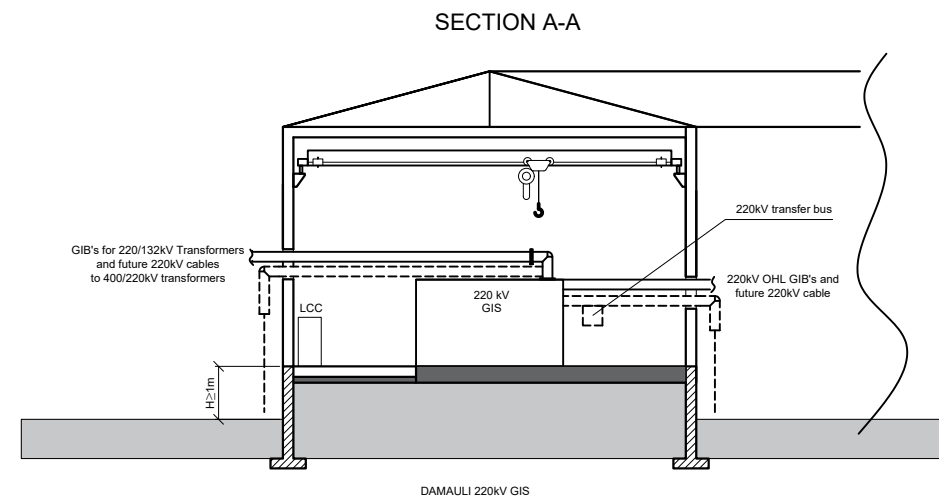
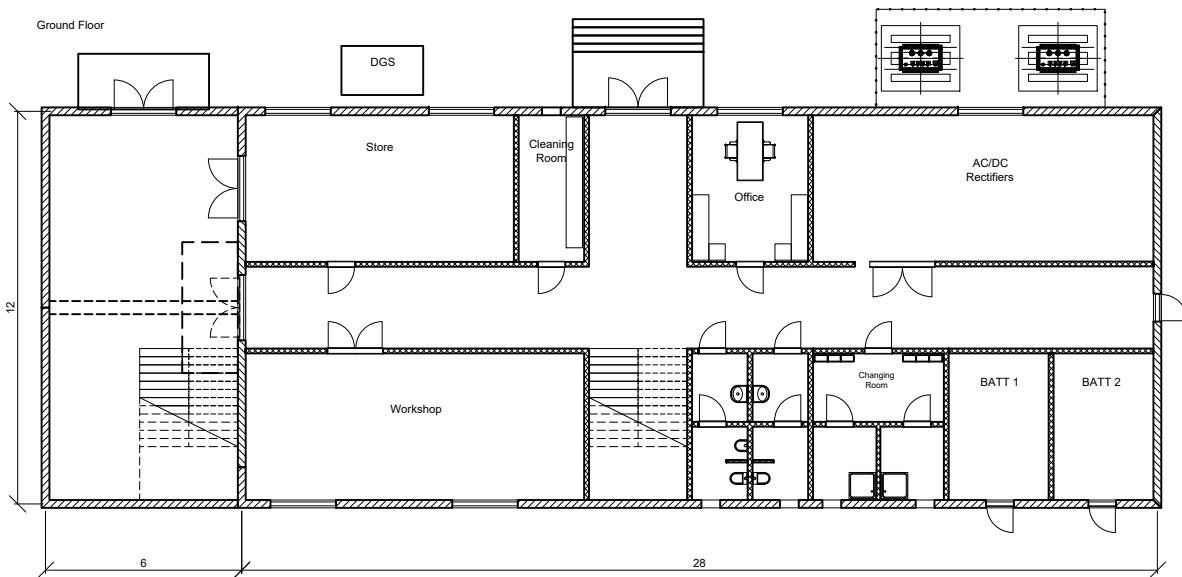
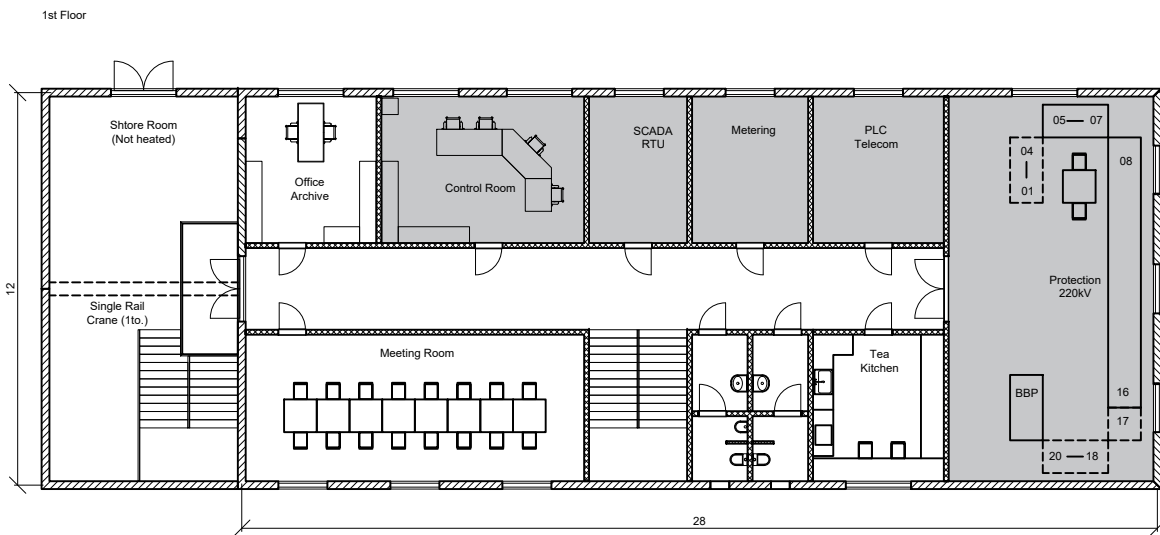




# Annex D5-19

New Damauli Substation 220 kV GIS  
and Control Building Layout





- Legend
- 1-phase Gas Insulated Transfer Bus
  - 220kV Gas Insulated Bus (GIB)
  - 220kV Cable
  - Roller Door for GIS Transport
  - Raise Floor

Note:  
The Layout and dimensions are tentative and represent minimum requirements subject to design by Contractor during design phase.

Annex D5-19

| REV                              | DATE     | NAME      | CHECKED  | NOTE   |
|----------------------------------|----------|-----------|----------|--|
| 3                                | 17.06.22 | AKHALADZE | GATTI    | Revised according NEA comments                   |
| 2                                | 31.01.22 | AKHALADZE | KUITUNEN | For Tender Documents                             |
| 1                                | 28.10.21 | AKHALADZE | KUITUNEN | FIRST ISSUE                                      |
| 0                                |          |           |          |  |
| FICHTNER                         |          |           |          | NEPAL ELECTRICITY AUTHORITY (NEA)                |
| PROJECT NO.: 4899A81             |          |           |          | Lekhnath Damauli 220kV Transmission Line Project |
| FILED5-19 DAM.220kV Cont. Build. |          |           |          | New Damauli Substation                           |
| SYSTEM: ACAD 2018                |          |           |          | 220kV GIS and Control Building Layout            |
| SCALE:                           |          |           |          |  |
| SHEET: 1 / 1                     |          |           |          | SIZE: A3 DRAWING NO.:                            |

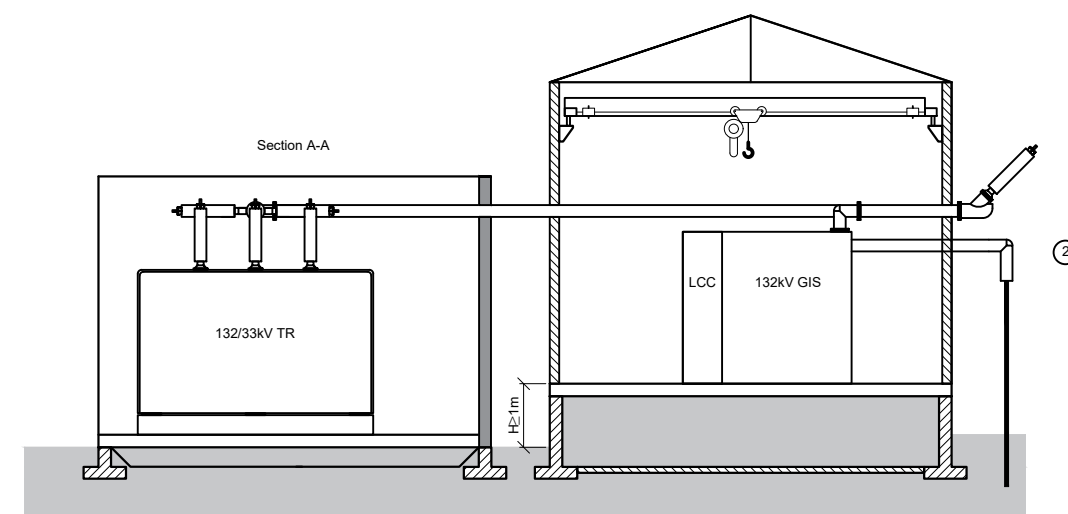
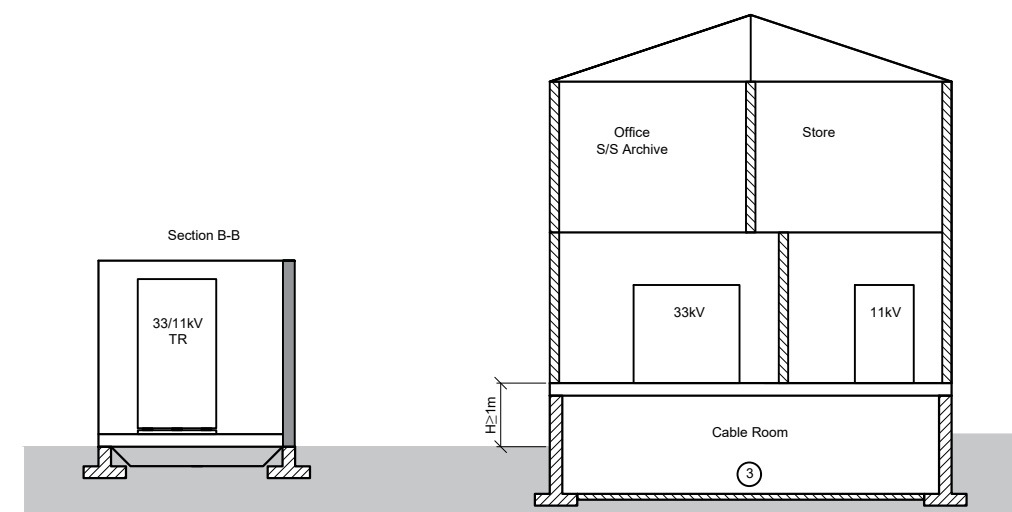
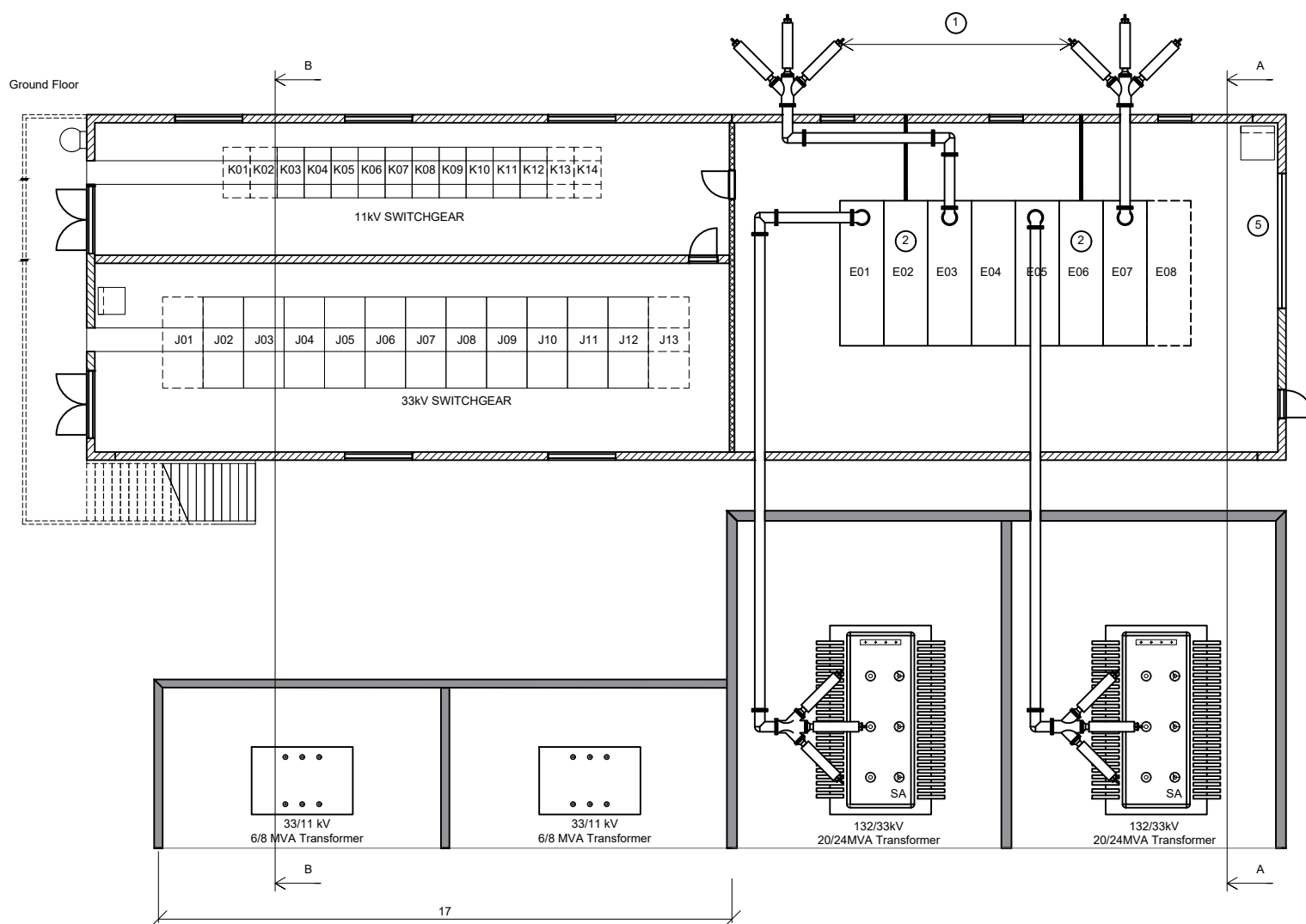
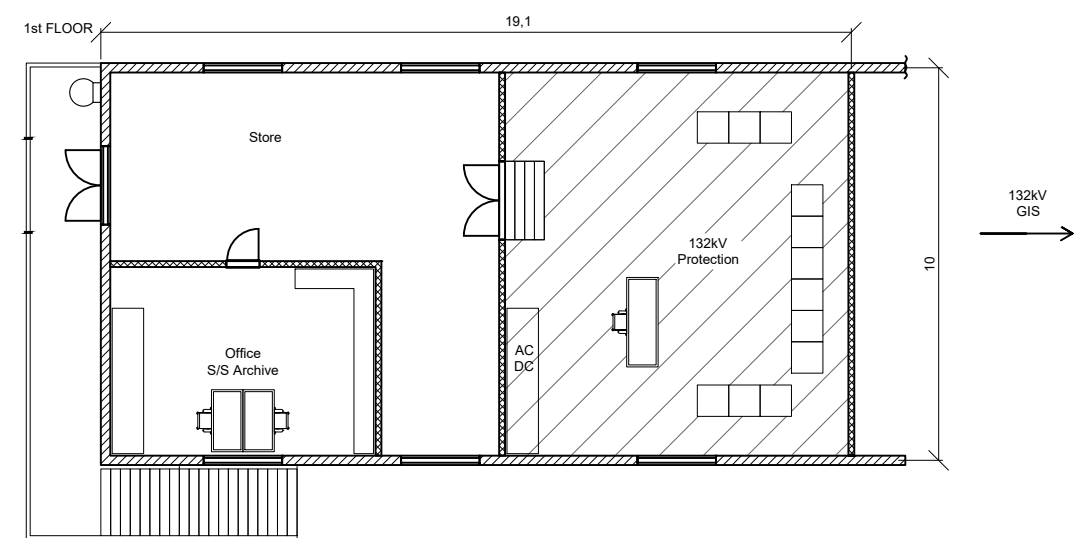




# Annex D5-20

Damauli 220/132/33/11 kV Substation  
132/33/11 kV Building Layout

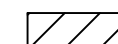




#### Legend

- Distance to be considered
- Cable feeders
- Cable room under 33kV and 11kV switchgear
- Roller door for GIS transport
- Transformer connection with GIB
- Protection fence

Remark: Common control & battery room in 220kV GIS SWG building.



Raised floor (aseismic)



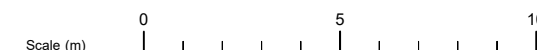
Fire wall



Ladder with safety cage



Vertical cat ladder



Note:  
The Layout and dimensions are tentative and represent minimum requirements subject to design by Contractor during design phase.

|                                |          |  |           |
|--------------------------------|----------|--|-----------|
| Annex D5-20                    |          |  |           |
| 3                              | 17.06.22 | AKHALADZE  | GRIESBAUM |
| 2                              | 17.06.22 | AKHALADZE  | GRIESBAUM |
| 1                              | 31.01.22 | AKHALADZE  | KUITUNEN  |
| 0                              | 30.10.21 | AKHALADZE  | KUITUNEN  |
| REV                            | DATE     | NAME   | CHECKED   |
| NOTE                           |          |  |           |
| FICHTNER                       |          | NEPAL ELECTRICITY AUTHORITY (NEA)                |           |
| PROJECT NO.: 4899A81           |          | Lekhnath Damauli 220kV Transmission Line Project |           |
| FILED5-20 DAM.132kV Cont.Buid. |          | Damauli 220/132/33/11 kV Substation              |           |
| SYSTEM: ACAD 2022              |          | 132/33/11kV Building Layout                      |           |
| SCALE:                         |          | SIZE: A3   |           |
| SHEET: 1 / 1                   |          | DRAWING NO.:                                     |           |





# Annex D5-21

## Telecommunications System



## **CHAPTER 19: Fiber Optic Based Communication Equipments**

### **1. Introduction, General Information and General Requirement**

This document describes the technical specifications for Communication Equipment which includes Fiber Optic Terminal Equipment for Establishment of Fiber Optic Communication System under the contract. This specification describes the functional and performance requirements of the system.

#### **1.1 Scope and General Requirements**

The broad scope of the procurement of this part include the survey, planning, design, engineering, supply, transportation, insurance, delivery at site, unloading, handling, storage, installation, termination, testing, training, and demonstration for acceptance, commissioning and documentation for:

- (i) The communication equipments shall have SDH features with STM - 4 MADM upto 4 MSP Protected directions as well as MPLS - TP functionality with 10G capacity 4 MSP Protected directions along suitable optical line interfaces & tributary cards.
- (ii) Local Craft Terminal (Laptop) with full operational programming software and data cables.
- (iii) All cabling, wiring, Digital Distribution Frame patch facilities, equipment MDF's and interconnections to the supplied equipment at the defined interfaces.
- (iv) MDF & DDF cross connects required to route and activate circuits.
- (v) System integration of the supplied subsystems and also integration with existing communication equipment such as SDH, MPLS - TP, MUX etc.
- (vi) System integration of the supplied equipments (termination equipment system) with existing equipments for seamless transmission of communication channel
- (vii) Integration of supplied system with the User equipments such as RTU/SASs, SCADA system, PLC equipment etc.
- (viii) Maintenance of the supplied system

All other associated works/items described in the technical specifications for a viable and fully functional communication network.

#### **1.2 General Requirements**

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

It should be noted that preliminary design information and bill of quantity (BOQ) specified in this specifications are indicative only. The Contractor shall verify the design data during the site surveys & detail engineering and finalise the BOQ as required for ultimate design & system performance.



The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

An analysis of the functional and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items and services such that a viable and fully functional communication equipment system is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials and services shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items and services in their proposal.

All equipment provided shall be designed to interface with existing equipment and shall be capable of supporting all present requirements and spare capacity requirement identified in this specification.

The communication equipment shall be designed and provisioned for expansions and reconfigurations without impairing normal operation, including adding and removing circuits. The offered items shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

The Bidders are advised to visit sites (at their own expense), prior to the submission of a proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site survey schedule to the Employer well in advance. The site survey schedule shall be finalised in consultation with the Employer. The Employer may be associated with the Contractor during their site survey activities.

After the site survey, the Contractor shall submit to the Employer a survey report on each link and site. This report shall include at least the following items:

- (a) Proposed layout of Equipment in the existing rooms and buildings.
- (b) Proposed routing of power, earthing, signal cables and patch cords etc.
- (c) Confirmation of adequacy of Space and AC/DC Power supply requirements
- (d) Identification of facility modifications if required
- (e) Identify all additional items required for integration for each site/location.

### **1.2.1 Synchronization of the Communication Network**

The Contractor shall be responsible for synchronization of new communication equipment with existing network utilizing the existing clock (if available). The Contractor shall make an assessment of additional clock requirement for synchronization of the communication equipment.



### 1.2.2 Contractor's Responsibilities and Obligations

The Contractor shall be responsible for all cables and wiring associated with the equipment provided, both inside and outside buildings in accordance with technical specifications. The Contractor shall also be responsible for determining the adequacy of the local power source for the equipment and for wiring to it, with adequate circuit protective breakers. In addition, the Contractor shall be responsible for shielding equipment and cabling to eliminate potential interference to or from the equipment, and for earthing all cabinets and shields.

Contractor's obligations include, but are not limited to, the following:

- (1) Site visits, and surveys, necessary to identify and provide all equipment needed to implement the network.
- (2) Equipment Engineering and design specific to each location including review of, and conformance with local environmental and earthing considerations.
- (3) Overall integration of communication equipments/subsystem procured in present and existing network.
- (4) All cabling, wiring including supply, laying and termination etc of the cables, and distribution frame at wideband nodes required for full interconnectivity and proper operation of the telecommunications network including equipment supplied under this package and the connectivity and interfacing of user equipment.
- (5) Installation and integration of network management software, hardware and firmware (as applicable).
- (6) Project management, project scheduling, including periodic project reports documenting progress, review meeting during the contract period.
- (7) Engineering and technical assistance during the contract and warranty period.
- (8) Implement all minor civil works and identify any major civil works i.e. expansion or construction of rooms, trenches necessary for installation of proposed equipment and provide the details of such work to the Employer.
- (9) Factory and site testing of all hardware, software, and firmware provided.
- (10) Provide documented evidence of satisfactory Type Test performance to the Employer and if required by The Employer, conduct type test.
- (11) Provide a Quality Assurance Plan, ensuring the Employer access to the manufacturing process.



- (12) Training of the Employer personnel.
- (13) Hardware, software, and firmware maintenance, debugging, and support of the equipment through final acceptance, and maintenance on all new equipment through out the warranty period.
- (14) Availability of service, spare and expansion parts for the supplied items for the designed life of the equipment or seven (7) years after the declaration of withdrawal of equipment from production, whichever is earlier? However, the termination of production shall not occur prior to Operational Acceptance of the system by the Employer.

Detailed descriptions of the Contractor's obligations, in relation to individual items and services offered, are delineated in other sections of this specification.

### **1.2.3 The Employer Responsibilities and Obligations**

The Employer will provide the following items and services as part of this Project:

- (1) Overall project management of the project
- (2) Review and approval of the Contractor's designs, drawings, and recommendations.
- (3) Communication network configuration data, including:
  - (a) Channel assignments for voice and data
  - (b) Interconnection drawings for existing equipment
- (4) Review and approval of test procedures.
- (5) Participation in and approval of "Type", factory and site acceptance tests where testing is required.
- (6) Review and approval of training plans.
- (7) Providing support and access to facilities at the sites.
- (8) Implement the major civil works such as expansions or construction of rooms, trenches etc. as required for the equipment to be provided by the Contractor.
- (9) Coordination of the Contractor's activities with the Employer's and constituents' concerned departments.
- (10) Provide to the extent possible drawings for existing sites and facilities for which equipment installations are planned.
- (11) Approval of the key personnel for the project

### **1.3 Applicable Standards**

The following standards and codes shall be generally applicable to the equipment and works supplied under this Contract:

- (i) IEEE 802.3
- (ii) ITU-T/CCITT Recommendations, G.652, G.701, G.702, G.703, G.711/ 12/ 14/ 35/ 36, G.721, G.742, G.811 and G.823
- (iii) ITU-T/CCITT Recommendations, G.801, G.821, G.822, G.823, G.826.



- (iv) ITU-T/CCITT Recommendations of the V Series
- (v) ITU-T/CCITT Recommendations R35, R37, and R38A (or R38B)
- (vi) ITU-T/CCITT Recommendations M3010, G771
- (vii) Internet Activities Board, RFC-1157 (SNMP)
- (viii) International Electrotechnical Commission standards, IEC801-2/3/4/5, IEC-255-4, IEC-255-5, IEC-870-2-1, IEC-721-3-3, IEC-529.
- (ix) International Electrotechnical Commission standards, IEC 1000-4-xx series.
- (x) IEC publication 68, 68-2-2, 68-2-3, 68-2-14, 68-2-27, 68-2-32.
- (xi) ITU-T/CCITT Recommendations K.11, K.17, K.20.
- (xii) International CISPR standards

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such, provided that no additional expenses are charged to the Employer without Employer's written consent.

In the event the Contractor offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Contractor shall include with their proposal, full salient characteristics of the new standard for comparison.

In case values indicated for certain parameters in the specifications are more stringent than those specified by the standards, the specification shall override the standards.

## **2. Network Configuration and Equipment Characteristics**

### **2.1 Introduction**

This section describes the Fiber Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

- (1) Fiber Optic Transmission System (FOTS)
- (2) Termination Equipment Subsystems
- (3) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network requirements. The equipment supplied shall support existing network for Power system operational requirements.

The security related requirements of the equipment shall be as per relevant agency and shall be followed/complied by the vendor.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing, facility and supply chain and subject all software to a security/threat check any time during the supplies of equipment.



The contractor shall ensure that the supplied equipments have been got tested as per relevant contemporary International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27000 series Standards, Telecom and Telecom related elements against 3GPP security standards, 3GPP2 security standards etc. from any international agency/ labs of the standards e.g. Common Criteria Labs in case of ISO/IEC 15408 standards. The certification shall be got done from authorized and certified agency.

The Contractor shall also ensure that the equipment supplied has all the contemporary security related features and features related to communication security as prescribed under relevant security standards. A list of features, equipments, software etc. supplied and implemented in the project shall be given for use by the Employer.

In case of any deliberate attempt for a security breach at the time of procurement or at a later stage after deployment/installation of the equipment or during maintenance, liability and criminal proceedings can be initiated against the Contractor as per guidelines of Government department.

## **2.2 General Network Characteristics**

### **2.2.1 Description**

The fiber optic network shall be based on Hybrid technology which has the functionality of both Synchronous Digital Hierarchy (SDH) as well as Multiprotocol Label Switching - Transport Profile (MPLS - TP) technology. The network shall consist of overhead fiber optic links with a minimum bit rate for SDH shall be STM-4 (622 Mbps) and 10G for MPLS - TP as indentified in the Price Schedule (BOQ). The Contractor can propose a system based on higher bit rate systems and SFPs, if required, so as to meet the link budget requirements or any other specification requirement. The detailed Price Schedule (BOQ) is described in appendices. The Contractor can propose as mentioned above Hybrid technology which can be accommodated in a single sub - rack or a multiple sub - racks but the total nos. of MSP protected direction (1+1) for SDH and MPLS - TP must be fulfilled. It is clearly mentioned in Price Schedule (BOQ) that the Fiber Optic based communication equipments shall have 4 MSP protected direction for SDH at STM - 4 level as well as same 4 MSP (1 +1) protected direction for MPLS -TP at 10G level. If the contractor proposed multiple sub - rack, then the interconnection between such sub - racks in any bit rate (not less than above mentioned level) will not be considered as separate MSP protected directions.

### **2.2.2 Functional Requirement**

The primary function of the communication network is to provide a highly reliable voice and data communication system for grid operation in support of the SCADA/EMS/RTU/SASs/PMUs. The communications support requirement for SCADA/EMS/RTU/SASs/PMUs system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

- (a) High speed E1 channel support
- (b) Data transport supporting Network Management channels
- (c) The connectivity envisaged between RTU/SASs and Control Centre over TCP-IP using Ethernet interface.
- (d) Voice communication between different substations through IP based PABX system.

### **2.2.3 General Systems Requirements**

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level.

#### **2.2.3.1 System Synchronization**

The Contractor shall synchronize the existing equipments and all the new equipments under the contract using existing Master clock. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. The contractor shall submit the synchronisation plan as per standard ITU-T G.811. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of slave clock, if any, shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipments new & existing. The Contractor shall submit the synchronization plan for the entire network meeting the requirement of ITU-T G.803. The synchronization plan shall clearly indicate the requirement of additional clocks with full justification.

The system equipment requiring "clock" shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission & termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

#### **2.2.3.2 System Maintainability**

To facilitate performance trending, efficient diagnosis and corrective resolution, the system shall permit in-service diagnostic testing to be executed both locally and from remote locations, manually and/or initiated under TMN control (if provided). Such testing shall not affect the functional operation of the system.

#### **2.2.3.3 System Upgradeability and Expandability**

Equipment supplied shall be sized (though not necessarily equipped) to support system/subsystem expansion to full capacity as provided by specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching



facilities or termination blocks. Power supplies shall be sized for maximum equipped system capacity.

#### **2.2.3.4 Equipment Availability**

The calculated availability of each fiber optic link (EI to EI) shall be at least 99.999%. The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the FOTS. For this analysis, an MTTR of at least 4 hours shall be assumed. The down time of the fiber optic cable shall not be considered in the aforesaid availability calculations. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided by the Contractor during detailed engineering.

#### **2.2.3.5 Revision Levels and Modifications**

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most of current revision level. All modifications and changes necessary to meet this requirement shall be completed prior to the start of the factory tests or under special circumstances, on written approval by Employer, prior to the completion of SAT.

#### **2.2.3.6 Equipment Capacities**

Equipment supplied shall be sized and equipped with sufficient capacity to support BoQ and configuration requirements as identified in the appendices. Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

#### **2.2.3.7 Software Upgrades**

The Contractor shall provide antivirus software along with all the computer hardware/software which shall be upgraded periodically till the maintenance services contract in the bid. Further, to meet all the specifications requirements during implementation and maintenance, if upgrade in the hardware/software of supplied item is required, the same shall be done by the contractor without any additional cost to the Employer.

#### **2.2.3.8 General Site Considerations**

All fiber optic links up to 175 kms transmission line length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipments only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/subrack to meet the maximum distance limit. All the provided equipments shall be monitored/managed by Craft Terminal.

### 2.23.9 Proposed Optical Fiber Characteristics

The link budget calculations and equipment design shall be based on the specified fiber parameters. The optical cables shall have Dual Window Single Mode (DWSM) fibers conforming to ITU-T Recommendations G.652D and the major parameters of these optical fiber(s) are defined in Table below.

| Optical Fiber Characteristics   |   |
|---|---|
| <b>Fiber Description:</b>   | Dual-Window Single-Mode (DWSM)  |
| <b>Mode Field Diameter:</b>   | 8.6 to 9.5 $\mu\text{m}$ ( $\pm 0.6 \mu\text{m}$ )  |
| <b>Cladding Diameter:</b>   | 125.0 $\mu\text{m}$ + 1 $\mu\text{m}$   |
| <b>Mode field Concentricity Error:</b>  | < 0.6 $\mu\text{m}$   |
| <b>Core-Clad concentricity error:</b>   | < 1.0 $\mu\text{m}$   |
| <b>Cladding non-circularity</b>   | $\leq 1\%$  |
| <b>Cable Cut off Wavelength:</b>  | $\leq 1260 \text{ nm}$  |
| <b>1550 loss performance</b>  | As per G.652D   |
| <b>Proof Test Level</b>   | > 0.69 Gpa  |
| <b>Attenuation coefficient</b>  | @ 1310nm < 0.35 dB/Km<br>@ 1550nm < 0.21 dB/Km  |
| <b>Attenuation variation with wavelength</b><br><b>1285 nm - 1330 nm</b><br><b>1525 nm - 1575 nm</b>          | Attenuation coefficient @ 1310 $\pm 0.05 \text{ dB}$<br>Attenuation coefficient @ 1550 $\pm 0.05 \text{ dB}$  |
| <b>Point discontinuities</b>  | < 0.1 dB  |
| <b>Chromatic Dispersion; Max.:</b><br><br><b>Zero Dispersion Wavelength:</b><br><b>Zero Dispersion Slope:</b> | 18.0 ps/(nm x km) @ 1550 nm<br>3.5 ps/(nm x km) @ 1288-1339nm<br>5.3 ps/(nm x km) @ 1271-1360nm<br><br>1300 to 1324nm<br>0.092 ps/(nm <sup>2</sup> xkm) maximum |
| <b>Polarization mode dispersion coefficient</b>   | < 0.2 ps/km <sup>A1/2</sup>   |
| <b>Temperature Dependence:</b>  | Induced attenuation < 0.05 dB (-60 deg C - +85 deg C)   |
| <b>Bend performance:</b>  | @ 1310nm (75+2 mm dia Mandrel), 100 turns;<br>Attenuation rise < 0.05 dB<br>@ 1550nm (30+1 mm dia Mandrel), 100 turns;  |



| Optical Fiber Characteristics |   |
|-------------------------------|---|
|                               | Attenuation rise < 0.10 dB              |
|                               | @1550nm (32+0.5 mm dia Mandrel), Iturn; |
|                               | Attenuation rise < 0.50 dB              |

### 2.2.5 Fiber Optic Link Lengths

The fiber optic route lengths are as specified. The lengths specified are the transmission line route lengths; however, the actual fiber cable length shall exceed the route lengths on account of extra cable requirement due to sag, jointing & splicing, approach cabling etc. For bidding purposes, the Contractor may assume an additional cable length of 5% of given route length + 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Contractor during the survey. The same shall be used by the Contractor for final link design during the detailed engineering of the project.

## 2.3 Fiber Optic Transmission System

The Fiber Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on Hybrid technology described in section 2.2.1. Minimum aggregate bit rate of SDH shall be STM-4 and MPLS-TP shall be 10G equipped with 2 nos. of minimum 8 port EI interface card, 3 nos. of minimum 8 ports Gigabit Fast Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service. Protection scheme for Ethernet traffic should be ERPS based (Ethernet ring protection scheme) as per ITU-T G.8032. Such vendors which have no separate EI and Fast Ethernet tributaries card, they shall offer sufficient nos. of ports mentioned in attached Price Schedule (BOQ). The VOIP Telephone instrument (Set) shall be operated through LAN cable only with the support POE+ switch and no additional power supply for VOIP telephone set is accepted.

The Contractor shall provide (supply and install) connectorised jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. Two number spare jumpers shall be provided for each equipment connection. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

The contractor shall provide Fiber Optic based Communication Equipment which has full functionality mentioned above at Sitalpati 400kV Substation as per scope of works.

It is the responsibility of contractor to design, supply and install the above mentioned optical equipment in the respective places and integrate with existing communication equipments in that regions. The adjoint Substation of Sitalpati 400kV substation is Tumlingtar 220 kV substation. The ABB make FOX615 hybrid equipment is installed at Tumlingtar 220 kV Substation. The Communication Equipment has both SDH STM -4 level and 10G MPLS-TP functionality. As per the

present scope of works, the contractor can propose such communication equipment which shall be integrated to existing ABB make FOX615 at Tumlingtar 220kV substation through optical fiber in SDH STM - 4 level as well as 10G MPLS - TP. All the required SFP are mentioned in the Price Schedule (BOQ). If there is not license of 10 G MPLS - TP SFP in the ABB make FOX615 equipment at Tumlingtar 220kV Substation, the Price of 10G MPLS - TP license is also covered in the current scope of works.

### **2.3.1 SDH / MPLS - TP Equipment**

#### **2.3.1.1 Functional Requirement**

There is a requirement for different types of equipment under this project which are described in this section. The Drawing if required is provided in the appendices. For the purpose of BOQ, the Hybrid type of communication Equipment is considered to be divided in three parts i.e. Optical interface/SFP, Tributary Cards (Electrical tributaries such as EI & Fast Ethernet 10/100 Mbps) and Base Equipment (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards).

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications.

The equipment shall be configurable either as Terminal Multiplexer (TM) as well as ADM with software settings only.

#### **2.3.1.2 Redundancy and Protection**

Two fiber rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibers shall be implemented.

#### **2.3.1.3 Service Channel**

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldem's that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

#### **2.3.1.4 Supervision and Alarms**



ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local craftsman terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

#### 2.3.1.5 Synchronisation

The equipment shall provide synchronization as per Table given above. One 2 MHz synchronization output from each equipment shall be provided.

#### 2.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

Table below provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

| Electrical and Optical I/O Characteristics and General Parameters |                                      |
|---|--------------------------------------|
| <b>Optical Wavelength</b>   | 1310/1550nm                          |
| <b>Optical Source</b>   | Laser                                |
| <b>Optical Source Lifespan</b>                                    | Better than 5 X10 <sup>5</sup> hours |
| <b>Optical Fiber Type</b>   | G.652 D                              |
| <b>Optical Connectors</b>   | Type FC-PC                           |
| <b>Transmission Quality</b>                                       | Per ITU-T G.821, G.823, G.826        |
| <b>Source Primary Power</b>                                       | -48 Vdc                              |
| <b>Equipment Specifications</b>                                   | Per ITU-T G.783                      |
| <b>Tributary, Electrical Interface</b>                            | Per ITU-T G.703, 75 Q                |
| <b>Ethernet Interface</b>   | 10/100/1000 Mbps                     |
| <b>SDH Bit Rates</b>  | Per ITU-T G.703                      |
| <b>Optical Interfaces</b>   | Per ITU-T G.957, G.958               |
|   |                                      |

|   |                               |
|---|-------------------------------|
| <b>Frame and Multiplexing Structure for SDH</b> | Per ITU-T G.707               |
| <b>Synchronization</b>                          | Per ITU-T G.813               |
| <b>Management Functions</b>                     | Per ITU-T G.774, G.784        |
| <b>Protection Architectures</b>                 | Per ITU-T G.841               |
| <b>Built In Testing and Alarms</b>              | Per ITU-T G.774, G.783, G.784 |

Optical wavelength shall be selected considering the characteristics of the optical fiber and the link budget.

**Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.

### 2.3.2 Optical Link Performance Requirements

The optical fiber link performance requirements are specified as follows:

#### 2.3.2.1 Link Budget Calculations

The fiber optic link budget calculations shall be calculated based upon the following criteria:

- (1) Fiber attenuation: The fiber attenuation shall be taken to be the guaranteed maximum fiber attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.
- (2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.
- (3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.
- (4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.
- (5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.



(6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fiber dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @ 1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM fibers.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of  $10^{-10}$ .

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each category of fiber optic link during detailed engineering.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fiber attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

#### **2.3.2.2 Link Performance**

The Link performance for ES, SES and BER for the fiber optic links shall correspond to National Network as defined in ITU-T G.826.

#### **2.3.2.3 FODP to Fiber Optic Communication Equipment**

The Contractor shall be responsible for connectivity between the FODP and the Communication equipment. The Contractor shall provide FC PC, SC PC or LC coupled patch cords as per site conditions. The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

### **2.4 Termination Equipment Subsystem**

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fiber Optic Transmission System (FOTS). Functional descriptions of these equipments are as follows:

#### **2.5 MDF, DDF and Cabling**

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and

material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

#### **2.5.1 Digital Distribution Frame Functional Requirements**

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality (better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

- (i) "Normally thru" circuit routing
- (ii) Circuit rerouting via patch cord assemblies
- (iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.

### **2.6 Patch Cords**

The Contractor has to supply FC, SC or LC Coupled Patch cords as per condition as described in BOQ. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB.

### **2.7 Telecommunication Management Network / Network Management System (If Applicable)**

If the contractor proposed those equipments which NMS is already available at Nepal LDC to monitor such Fiber optic communication equipments; it will be contractor's responsibility to integrate such communication equipments with existing NMS and any license issues for NMS without any cost implication under the scope of works. Otherwise, the Contractor shall provide a Telecommunications Management Network System (TMN/NMS) for operational support to the FOTS and associated Termination equipment subsystems without additional costs mentioned in Price Schedule as per following specifications. This TMN shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location and at each node of the network where equipment is located with at least 15 nodes license. This TMN system shall assist Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.



The contractor shall supply preferably a single TMN for all the NEs (Network Elements) such as MPLS - TP, SDH equipment, Mux, Drop-Insert, DACSetc. In case a single TMN can not be provided for all the NEs, the contractor may supply separate TMNs. Each of the offered TMN shall meet the requirements indicated in this section. The bidder shall provide details of the offered TMN in the bid.

### **2.7.1 Applicable Standards**

The TMN design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010. The offered TMN system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through North bound interfaces. The north bound interface in the EMS shall be CORBA/TMF-814 compliant.

### **2.7.2 TMN Architecture**

The TMN shall provide

- a. Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.
- b. Processing of above management data by using processor(s) located at control Centre and additional intermediate station processor(s), wherever required.
- c. Monitoring and control of the NEs as defined below:
  - I) TMN system at LDC (including local operator console, if applicable) shall support management of all equipments supplied and monitoring of the entire regional network supplied under this package. At minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITTM3010. The detailed functions are listed in TS.
  - II) Monitoring and control of NEs using Craft Terminals as defined in this Section.
- d. Supervisory monitoring and control of the following station associated devices:
  - I) Intrusion Detection Alarms
  - II) Power Failure

- III) Fire and Smoke Detection
- IV) Environmental Control (Temperature, Humidity etc.)

- e. Communication channel support for TMN System as specified in Technical Specifications (TS).

The supplied TMN system shall be capable of handling all management functions for at least 150% of the final network elements. Further, the centralised TMN system shall also have provision for addition of at least two remote operator consoles. The TMN hardware shall be so designed that failure of a single processor/component (router, switch, converter etc.) shall not inhibit any of the functionality of the TMN at control centre. The Contractor shall submit for Employer's approval the TMN architecture describing in detail the following subsystems/features:

- a. Database used in TMN
- b. Master Processor, server/workstation, LAN, Peripherals and hardware
- c. Software and operating system
- d. Local Consoles/remote consoles
- e. Craft Terminals
- f. Data communication between NEs, Remote/Local Consoles and TMN Processor(s)
- g. Routers/Bridges
- h. Expansion Capabilities

### **2.7.3 Management Functions**

The TMN shall support following Management functions:

#### **2.7.3.1 Configuration Management**

Configuration management is concerned with management, display, and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

- a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.
- b. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.
- c. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to equipment failures, planned upgrades, and operator requests to take equipment offline for testing.
- d. Provide verification testing to support new equipment installation.

#### **2.7.3.2 Fault Management**



Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment, systems, and links. Minimum specific requirements that shall be satisfied include the following:

- a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of colours on links and nodes as well as through text.
- b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events, and periodic testing for connectivity.
- c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a log of all received alarms. The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single, common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colours.
- d. Provide the capability to diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.
- e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator-initiated actions where automatic fail over is not possible. The status of fail over shall be reported to the NMS.
- f. Track network equipment failure history.

### **2.7.3.3 Performance Management**

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

- a. Provide support for an operator to initiate, collect, and terminate performance metrics under both normal and degraded conditions. For example, BER of each link, together with other data measured at each node, shall be available on operator request (atleast for MPLS -TP and SDH).
- b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources (atleast for MPLS - TP and SDH). Specifically provide displays to permit the operator to:
  - 1. Select/deselect network equipments, events, and threshold parameters to monitor

2. Set monitoring start time and duration or end time
3. Set monitoring sampling frequency
4. Set/change threshold values on selected performance parameters
5. Generate alarm events when thresholds are exceeded.
6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.
7. Calculate selected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.
8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.
9. Generate reports on a daily, weekly, monthly, and yearly basis containing system statistics.

#### **2.7.3.4 Security Management**

The TMN shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN system. With "read only" access level, network parameters should only be viewed. Access to database maintenance, command control and test functions shall be available with "write" access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network. It shall be possible to define multiple domains for purposes of monitoring and control.

Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

#### **2.7.3.5 Hardware Requirements**

- **Master Processor, Server/Workstation**

The server/workstation shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification. Only reputed make like Dell, IBM, HP, Compaq make shall be supplied.

The server shall have minimum configuration of 3GHz for CISCbased processor, 8GB RAM, DVD-ROM drive, redundant 500 GB internal Hard Disk Drive, 101-Enhanced style keyboards, mouse, parallel, serial, USB(3.0) ports and hot swap redundant power supply. The operating system shall be latest Genuine Microsoft Windows Version. VDUs shall be minimum of 19 inch, LED Display Monitor, 2-Ethernet Cables, 2-HDMI Cables and accessories. Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN software shall support data mirroring on redundant disk drives.

CPU enclosures shall be desktop type and shall include available expansion slots.

## **2.8 Communication Channel Requirement and Integration**

Communication requirements for TMN system have not been considered in Appendices and the Contractor shall provide these as a part of TMN system. The Contractor shall provide all required interface cards/ devices, LAN, routers/bridges, channel routing, cabling, wiring etc. and interfacing required for full TMN data transport.

The TMN data transport shall utilize the wideband communications transmission system service channel in the overhead whenever possible. This will provide inherent critical path protection.

Should the configuration requirements dictate multiple TMN station processors, the TMN Master Station shall require bidirectional data transport with its station processor(s). This communications interfacing shall be via critically protected data channels. It shall be the Contractor's responsibility to provide for and equip all necessary critically protected TMN data channel support.

In case supervisory channels are not available, the Contractor shall provide suitable interfaces in their supplied equipment for transport of TMN data. The Contractor shall also be responsible for providing suitable channels with appropriate interfaces to transport the TMN data.

The NMS information of existing PDH & SDH system shall be transported through the new communication network, wherever required, up to the NMS location. The NMS information of the new MPLS-TP, SDH & PDH system being procured under the package shall be transported through the existing communication network using 64 kbps/2Mbps (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

The bidders shall describe in the proposal the TMN data transport proposed to be used by the bidder in detail including capacity requirements and various components/equipment proposed to be used.



## **2.9 Craft Terminal**

The communication equipment on the fiber optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

- a. Change the configuration of the station & the connected NEs.
- b. Perform tests
- c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the employer. The cost of such craft terminals is included in overall Price Schedule (BOM).

### **2.9.1 Hardware Requirements**

The laptop shall have minimum configuration of Intel 8th Generation i7 processor, 8 GB RAM, 2GB Graphics, DVD RW drive, 256 GB SSD, 1TB Hard Disk Drive, keyboard, mouse/trackball etc., parallel, serial/USB (3.0) ports to accommodate printers, and Internal/external Data/Fax modem and a battery back-up of at least 180 minutes. VDUs shall be minimum 14" FHD. Operating System shall be Genuine Windows with installation DVD.

## **2.10 Power Supplies**

The TMN system shall use 220 volts 50 Hz A.C or -48 volt D.C as available at site for its operation as available at site.

## **2.11 General Software/Firmware Requirements**

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable and meets both hardware systems requirements and the customer's operational requirements.

### **2.11.1 Operating System Software**

Operating system software shall be provided to control the execution of system programs, application programs, management devices, to allocate system resources, and manage communications among the system processors. The contractor shall make no modifications to the OEM's operating system, except as provided as USER installation parameters.

### **2.11.2 Applications Software**

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

### **2.11.3 Software Utilities**

A utility shall be provided to convert all reports into standard PC application formats such as excel.

### **2.11.4 Revisions, Upgrades, Maintainability**

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

All software shall be easily user expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

### **2.11.5 Database(s)**

The contractor shall develop all the databases for final wideband network following the global acronyms for all stations. Database(s) to be provided shall contain all structure definitions and data for the integrated functional requirements of TMN system.

TMN operator Groups shall share the same virtual database. This means that they shall share the same database and database manager, whether or not physically separate databases are maintained.

## **3.1 Inspection**

Access to the Contractor's facilities during system manufacturing and testing and to any facility where systems/ equipment are being produced/ tested/ integrated for the fiber optic communication network, shall be available to the Employer. At all times the Employer shall have full facilities for unrestricted inspection of such materials or equipments. To facilitate this, the Contractor shall submit for the Employer approval, a comprehensive Quality Assurance Plan using ISO 9000 as a general guideline. In addition, the Quality Assurance Plan shall satisfy the following:

- (a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.
- (b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings and labeling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.
- (c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.
- (d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representatives prior to shipping this equipment to the Contractor's facility or directly to the Employer.
- (e) The above inspection rights shall also apply to sub Contractors supplying assemblies, subassemblies and components. However, such items will normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

#### **4.1 Test Plans and Procedures**

Test plans and test procedures for both factory and site acceptance tests shall be provided by the Contractor. Test plans and test procedures shall ensure that each factory and site test is comprehensive and verify all the features of the equipment to be tested. Test plans and test procedures shall be modular to allow individual test segments to be repeated upon request.

The Contractor shall submit a Test Schedule for the Employer's approval within one (1) week after the award of contract for Type Tests and three (3) months after the award of contract for all other tests. The test schedule shall list the tests to be carried out, and the approximate test duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall give the Employer twenty one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer's opinion, are not compliant to the specification. The Contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

##### **4.1.1 Factory and Site Test Plans**

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests,



documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table below.

| Item: | Description:   |
|-------|--|
| 1.    | Test schedule  |
| 2.    | Record-keeping assignments, procedures and forms   |
| 3.    | Procedures for monitoring, correcting and retesting variances  |
| 4.    | Procedures for controlling and documenting all changes made to the communications equipment after the start of testing |

#### 4.1.2 Test Procedures

Test procedures for factory and site testing shall be submitted for the Employer approval at least four (4) weeks before each individual test. Fully approved test procedures shall be submitted to the Employer at least four weeks prior to the commencement of testing. Testing shall not commence without approved test procedures. At a minimum, test procedures shall include the items listed in Table below.

All test equipment and/or instruments shall bear calibration stickers indicating valid calibration on and beyond the testing date. The time lapsed since last calibration shall not exceed the test equipment/ jig manufacturer recommended calibration interval or the interval recommended in the test lab's internal quality procedures.

The Contractor shall ensure that all testing will be performed by qualified testing personnel well experienced in performing such tests.

| <b>Item:</b> | <b>Description:</b>  |
|--------------|--|
| <b>1.</b>    | Test Title and Revision Level, if applicable   |
| <b>2.</b>    | List of Standard(s) complied with  |
| <b>3.</b>    | Function(s) / parameter(s) to be tested  |
| <b>4.</b>    | Purpose of each test segment   |
| <b>5.</b>    | List of required test equipment  |
| <b>6.</b>    | Description of any special test conditions or special actions required. This includes complete descriptions, listings and user interface procedures for all special hardware and software tools and/or display formats to be used during the test. |
| <b>7.</b>    | Test setup including test configuration block diagrams and/or illustrations.   |
| <b>8.</b>    | Test procedures to be followed.  |
| <b>9.</b>    | Required inputs and expected outputs for each test segment   |
| <b>10.</b>   | Acceptance criteria for each test segment.   |
| <b>11.</b>   | List of test data to be supplied by the Contractor(s) and copies of any certified data to be used  |
| <b>12.</b>   | Format of test reports.  |

#### 4.1.3 Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table below.

| <b>Item:</b> | <b>Description:</b>   |
|--------------|---|
| <b>1.</b>    | Test Title and Revision Level, if applicable; contract references   |
| <b>2.</b>    | Date and time for test start and test completed   |
| <b>3.</b>    | Test title and reference to the appropriate section of the test procedures                                    |
| <b>4.</b>    | Description of any special test conditions or special actions taken (Includes test-case data).                |
| <b>5.</b>    | Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed. |
| <b>6.</b>    | Test procedure modifications made during testing.   |
| <b>7.</b>    | Variance Report(s) tracking information and copies (if variance(s) was detected).                             |
| <b>8.</b>    | Contractor's test engineer(s) identification, signature and remarks   |
| <b>9.</b>    | Employer's test witness identification, signature and remarks   |
| <b>10.</b>   | List of all attachments   |
| <b>11.</b>   | Attachments (including system logs, printouts, variances, hard copies of visual test result displays, etc.)   |

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test.

These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

#### **4.1.4 Rejection of Elements**

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the Employer either in whole or part as considered necessary.

Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the Employer for further inspection and/or tests.

#### **4.1.5 Test Periods Defined**

The terminology used in Volume I, General Conditions of Contract and their correlation with the tests requirements described within this section is as follows:

Pre-Commissioning & Commissioning Period - The Site Acceptance Test (SAT)

Operational Acceptance - Successful completion of SAT

### **4.2 Type Testing**

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with specified the conditions.

#### **4.2.1 List of Type Tests**

The type testing shall be conducted on the following equipment

- (a) SDH Equipment with all types of cards (optical card, Tributary card or any other equipment as part of repeater less links)

##### **4.2.1.1 List of type test to be conducted on Telecom equipment**

The type tests for SDH Equipment with all types of cards, Primary Multiplexer & Drop - Insert Mux with subscriber interface card are described below:



#### 4.2.1.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

**(a) Low Temperature Test: Operation to Specifications**

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.
- (2) Degree of Severity: Test shall be done at 0°C
- (3) Acceptance Criteria: No degradation of performance during and after the test.

**(b) Low Temperature Test: Operation without Damage**

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).
- (2) Degree of Severity: Test shall be done at -10°C
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

**(c) Dry Heat Test: Operation to Specifications**

Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.
- (2) Degree of Severity: As per operation to specification range.
- (3) Acceptance Criteria: No degradation of performance during and after the test.

**(d) Dry Heat Test: Operation without Damage**

Dry heat tests shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).

- (2) Degree of Severity: Test shall be done at 55 C.
- (3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

**(e) Damp Heat Test**

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

- (1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.
- (2) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

**(f) Temperature Variation Test**

Temperature variation testing shall be as per IEC Publication 60068-2-14 (Gradual Variations, Method Nb). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

- (1) Number of cycles required is five (5)
- (2) The degree of severity: temperature TL:0°C, TH: As per operation to specification range
- (3) Cycle duration for each temperature is three (3) hours.
- (4) Ramp: 1 °C/minute.
- (5) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

**4.2.1.1.2 Power Supply and EMI/EMC tests**

The test procedure and acceptance criteria shall be as defined in IEC 60870-2-1.

**(a) Immunity Tests**

The list of Immunity tests are specified below in Table below.

### Recommended Immunity Tests

| s. No. | Immunity Test                                       | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres                                    |
|--------|---|-----------------|-----------------|------------------|--------------|--|
| 1      | Voltage Fluctuations                                | Yes             | Yes             | N/A              | N/A          | Table 11 of IEC 60870-2-1: 1995<br>- Level : 1 |
| 2      | Voltage dips and Interruptions                      | Yes             | Yes             | N/A              | N/A          |  |
| 3      | 1.2/50 - 8/20 pis surges                            | Yes             | Yes             | Yes              | N/A          | Table 12 of IEC 60870-2-1: 1995<br>- Level : 4 |
| 4      | Fast transient bursts                               | Yes             | Yes             | Yes              | Yes          |  |
| 5      | Damped oscillatory waves                            | Yes             | Yes             | Yes              | Yes          |  |
| 6      | 10/700 ps surges                                    | N/A             | N/A             | N/A              | Yes          |  |
| 7      | Electrostatic discharge                             | Yes             |                 |                  |              | Table 13 of IEC 60870-2-1: 1995<br>- Level : 4 |
| 8      | Power frequency magnetic field                      | Yes             |                 |                  |              | Table 14 of IEC 60870-2-1: 1995<br>- Level : 4 |
| 9      | Damped oscillatory magnetic field                   | Yes             |                 |                  |              |  |
| 10     | Radiated electromagnetic field                      | Yes             |                 |                  |              | Table 15 of IEC 60870-2-1: 1995<br>- Level : 4 |
| 11     | Power Frequency voltage on control and signal lines | N/A             | N/A             | Yes              | Yes          | IEC 61000-4-16 : 2002-07 Level: 4              |
| 12     | DC voltage on control and signal lines              | N/A             | N/A             | Yes              | N/A          | IEC 61000-4-16 : 2002-07 Level :4              |

### (b) Emission Tests

The list of Emission tests are specified below in Table.



| S. NO. | Emission test  | AC Power Supply | DC Power Supply | Control & Signal | Telecom Line | Para-metres                                      |
|--------|--|-----------------|-----------------|------------------|--------------|--|
| 1      | LF disturbance voltages<br>CCITT recommendation P.53 | N/A             | Yes             | N/A              | N/A          | Table 17 of IEC 60870-2-1: 1995- Class: <b>B</b> |
| 2      | RF disturbance voltages<br>CISPR22                   | Yes             | Yes             | N/A              | N/A          |  |
| 3      | RF disturbance currents<br>CISPR22                   | N/A             | N/A             | N/A              | Yes          |  |
| 4      | RF radiated fields<br>CISPR22                        | Yes             |                 |                  |              |  |

**(c) Insulation Withstand Voltages**

As per section 6 of IEC 870-2-1. Recommended class: VW1 of Table 18.

**4.2.1.1. 3 Mechanical Tests**

**(a) Mechanical Vibration Test**

The procedure for this test is described in IEC Publication 60068-2-6. The testing procedure shall be carried out in the sequence 8.1 + 8.2.1 + 8.1 as described in document 60068-2-6.

For the vibration response investigation (clause 8.1 of 60068-2-6), the test shall be carried out over a sweep cycle under the same conditions as for the endurance test (described later), but the vibration amplitude and the sweep rate may be decreased below these conditions so that the determination of the response characteristics can be obtained.

The endurance test conditions are selected according to the vibration withstand requirements.

Transportation tests shall be performed with the equipment packed according to the Contractor's specifications.

**(b) Shock Test**

The procedure of this test is defined in IEC Publication 60068-2-27 (each test) with a semi-sinusoidal shape (clause 3.1.1. 2).

The recommended severity shall be  $A = 294 \text{ m/s}^2$ ,  $D = 18 \text{ ms}$ . Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

#### **Or      Free Fall Test**

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC68-2-32. The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

#### **Or      Bump Test**

This test could be performed as an alternative to Shock test or Free Fall test. The procedure is defined in IEC 60068-2-29.

### **4.3      Factory Acceptance Tests**

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on SDH Equipments, associated line & tributary cards, Optical Approach Cable Termination Equipments (Primary Mux, Drop/Insert, associated Subscriber Line Interface Cards etc) and all other items for which price has been identified separately in the Bid Price Schedules.

Equipment shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (MICC). Successful completion of the factory tests and the Employer approval to ship shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waiver for witnessing by Employer's representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. List of factory acceptance tests for Fiber Optic Transmission system, Termination Equipment Sub-system and NMS are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

For Test equipment & clock, FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

#### **Factory Acceptance Testing Requirements for Termination Equipment (MUX)**

| <b>Item</b> | <b>Description:</b>  |
|-------------|--|
| <b>1.</b>   | Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment  |
| <b>2.</b>   | Performance of supervision, alarm, control and switching systems, diagnostics, loopbacks, Craftsperson interface etc.  |
| <b>3.</b>   | Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for the channel banks/low-level multiplexers |
| <b>4.</b>   | Framing, signaling, and operational and maintenance tests consistent with applicable ITU-T requirements  |
| <b>5.</b>   | Simulation of failure conditions and failover of each redundant unit   |
| <b>6.</b>   | Test of spare card slots and test of spare parts/modules/cards as per applicable tests   |
| <b>7.</b>   | Checks of power supply/converter voltage margins and short circuit and overvoltage protection  |
| <b>8.</b>   | Random inspections to verify the accuracy of documentation   |

| <b>FAT on Craft Terminal</b> |   |
|------------------------------|---|
| 1                            | Physical inspection of Craft Terminal hardware for conformance to approved BoQ, DRS & drawing |
| 2                            | Testing of Craft Terminal to demonstrate proper operation of all functions                    |

#### **4.4 Site Acceptance Tests**

The Contractor shall be responsible for the submission of all equipment & test equipment supplied in this contract for site tests and inspection as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for Telecom equipment, is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

##### **4.4.1 Phases for Site Acceptance Testing**

The SAT shall be completed in following phases:



#### **4.4.1.1 Installation Testing**

The field installation test shall be performed for all equipment at each location. If any equipment has been damaged or for any reason does not comply with this Specification, the Contractor shall provide and install replacement parts at its own cost and expense.

In the installation test report, the Contractor shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

The minimal installation testing requirements for fiber optic transmission subsystem, Termination equipment sub-system are provided in respective Tables in this section.

#### **4.4.1.2 Link Commissioning Tests**

The commissioning tests shall verify that communication can be performed over the fiber optic link under test. Delay measurement, Bit Error measurements & service channel performance monitoring shall be made on the fiber optic links to verify compliance with designed link performance.

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

- a) Ping test
- b) Throughput test
- c) Latency test
- d) Packet Loss

10% of the total links (Chosen by the Employer, generally to cover links from all configurations used) shall be tested for duration of 12 Hours. Rest of the links shall be tested for 1 Hour. In case a link does not meet the performance requirements during 1 hour, then the duration of the test shall be increased to 12 hours.

In case any link does not meet the performance requirements during 12 hour, then the cause of failure shall be investigated and the test shall be repeated after rectifying the defects.

This phase of testing shall be conducted by the Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

#### **4.4.1.3 Integrated Testing**

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect the various User's interfaces. The integrated testing for a batch shall include end-to-end testing of back-bone network included in that batch. Integrated testing for last batch shall include testing of the entire back-bone. The intent of integrated testing is to demonstrate that the equipment is operational end to end under

actual conditions, that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment at all locations. The Integrated System Test shall include all fiber optic transmission equipment, termination equipment, the network management subsystem and other components.

At a minimum the following tests shall be included in the integrated testing:

- (1) Equipment configuration shall be checked to establish that it supports the channel routing.
- (2) End to end testing of all individual voice circuits
- (3) End-to-end testing of all individual Data Circuits.
- (4) Demonstration of Protection switching and synchronization of equipment as per synchronization plan.

#### **Fiber Optic Transmission system Installation Testing**

| <b>Item:</b> | <b>Description:</b>  |
|--------------|--|
| <b>1.</b>    | Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling         |
| <b>2.</b>    | Station power supply input and equipment power supply (DC-DC converter) output voltage measurements              |
| <b>3.</b>    | Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.) |
| <b>4.</b>    | Service channel performance  |
| <b>5.</b>    | Craftsperson interface, alarm and control functional performance   |
| <b>6.</b>    | Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional          |
| <b>7.</b>    | Network management interface and supervision performance   |
| <b>8.</b>    | Correct configuration, level setting & adjustments and termination of Input/output interfaces                    |
| <b>9.</b>    | Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.            |
| <b>10.</b>   | Simulation of failure conditions and failover of protected components.   |

#### **Termination Equipment Sub-system Installation Testing**

| <b>Item:</b> | <b>Description:</b>  |
|--------------|--|
| <b>1,</b>    | Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |
| <b>2.</b>    | Power supply/converter voltage measurements  |
| <b>3.</b>    | Muldem performance testing   |
| <b>4.</b>    | Craftsperson interface, alarm and control functional performance   |
| <b>5.</b>    | Rack and Local alarms  |
| <b>6.</b>    | Network management interface and supervision performance   |
| <b>7.</b>    | Channel performance  |

|           |  |
|-----------|--|
| <b>8.</b> | Safety and signalling earthing system                                  |
| <b>9.</b> | Simulation of failure conditions and failover of protected components. |

**NMS Installation Testing (if Applicable)**

| <b>Item:</b> | <b>Description:</b>  |
|--------------|--|
| 1.           | Physical inspection for conformance to drawings, rack elevations and appearance of equipment and cabling |
| 2.           | Workstation hardware inventory, configuration and characteristics  |
| 3.           | Demonstration of proper operation of all hardware, including workstations peripherals                    |





# Annex D5-22

## New Damauli Substation Site Development and Project Phasing



## Annex D5-22

### Damauli Substation Boundary Features and Project Phasing

Consulting Services for "*Lekhnath Damauli 220 kV Transmission Line Project*"

BMZ No. 2016 67 773

NEPAL ELECTRICITY AUTHORITY (NEA)

Tender No. NEA/LD220kVTLP/075-76/EOI-01

## Contact



Fichtner GmbH & Co. KG  
Sarweystrasse 3  
70191 Stuttgart  
Germany

[www.fichtner.de](http://www.fichtner.de)

**Mr. Giacomo Fugazza**

+49 711 8995 641

+49 178 8995 641

[giacomo.fugazza@fichtner.de](mailto:giacomo.fugazza@fichtner.de)

Fichtner GmbH & Co. KG

## Document approval

|              | Name              | Signature | Position          | Date       |
|--------------|-------------------|-----------|-------------------|------------|
| Prepared by: | Joachim Griesbaum |           | Substation Expert | 12.07.2024 |
| Checked by:  | Giacomo Fugazza   |           | Project Manager   | 12.07.2024 |
| Approved     | Elmar Neubauer    |           | Projects Director | 12.07.2024 |

## Document revision record

| Rev. | Date       | Details of revision       | Fichtner Doc Ref.            | Prepared by | Checked by | Approved by |
|------|------------|---------------------------|------------------------------|-------------|------------|-------------|
| 2    | 12.07.2024 | Final update for retender | RNWS7JUM2C5X-1730981799-9953 | Griesbaum   | Fugazza    | Neubauer    |
| 1    | 10.06.2024 | Updated for re-tender     | RNWS7JUM2C5X-1730981799-9953 | Griesbaum   | Fugazza    | Neubauer    |
| 0    | 21.06.2022 | First release             | RNWS7JUM2C5X-1730981799-5832 | Fugazza     | Dr Gatti   | Neubauer    |

## Disclaimer

The content of this document is intended for the exclusive use of Fichtner's client and other contractually agreed recipients. It may only be made available in whole or in part to third parties with the client's consent and on a non-reliance basis. Fichtner is not liable to third parties for the completeness and accuracy of the information provided therein.



# Table of Contents

- 1 Document Purpose..... 5
- 2 Site Boundary Features ..... 6
  - 2.1 Site Fencing ..... 6
  - 2.2 220kV Substation Platform..... 6
  - 2.3 Flood Retaining Wall..... 7
  - 2.4 External Drainage Collector..... 8
- 3 Project Phasing ..... 9

# 1 Document Purpose

This document aims to describe the project site boundary features (fencing, 220kV substation platform, flood retaining wall, external drainage systems), as well as the different phases envisaged for the development of the 220kV substation and site area.

## 2 Site Boundary Features

### 2.1 Site Fencing

The 220kV site shall be protected from intrusion by two lines of chain link fence, equipped with barbed wire (see Figure 2-1):

- The first fence line shall surround the 220kV site area (external fence), partially sitting on top of the flood retaining wall (see §2.3)
- The second fence line shall surround the 220kV substation area (inner fence)

The chain link fence lines shall be provided with a suitable number of gates/entrances for personnel and vehicles, to allow access to the site area and to the substation area (see Annex D-24 to Bidding Documents, Part 2 Section VII).

Depending on the MCA project timeline, the fence towards the future 400kV site (dotted line in Figure 2-1) may or not be constructed.

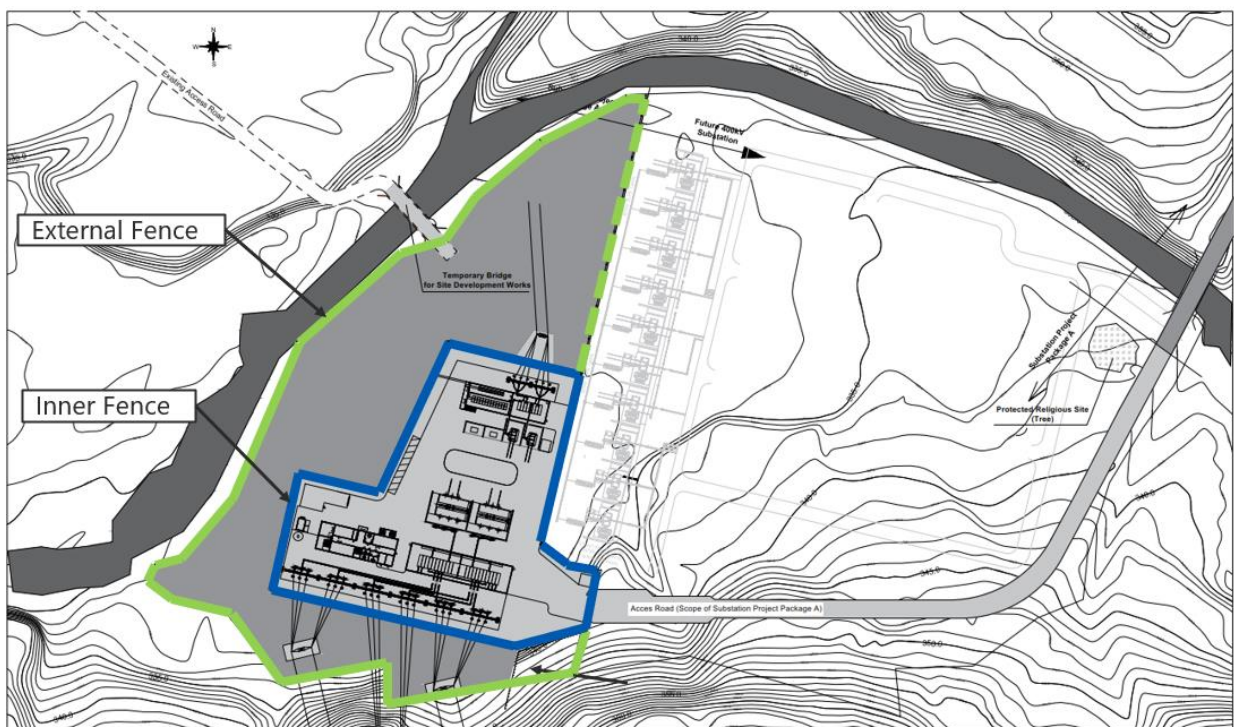


Figure 2-1 - Site fencing

### 2.2 220kV Substation Platform

The 220kV substation platform shall be filled to the 1 in 200 years flood level (indicatively 335m) and provided with suitable flood protection works (see Figure 2-2).

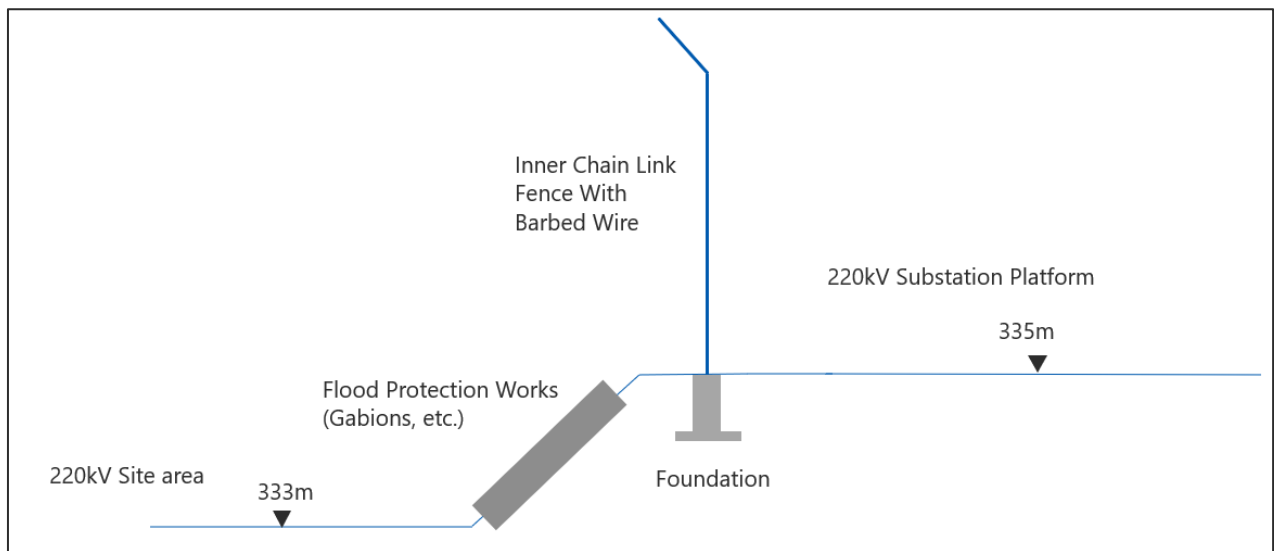


Figure 2-2 - Substation platform cross-section (sketch not to scale)

## 2.3 Flood Retaining Wall

To the north-west, adjacent to the riverbed, the site area shall be surrounded by a retaining wall, designed to prevent flooding of the substation area. As the site area is prone to soil liquefaction, suitable soil improvement methods shall be used (Figure 2-3). More details are given in Bidding Documents Part 2 Section VII-6 Technical Requirements - Civil Works.

The external chain link fence described in §2.1 shall be developed on top of the flood retaining wall. The approximate length of this section is 320m.

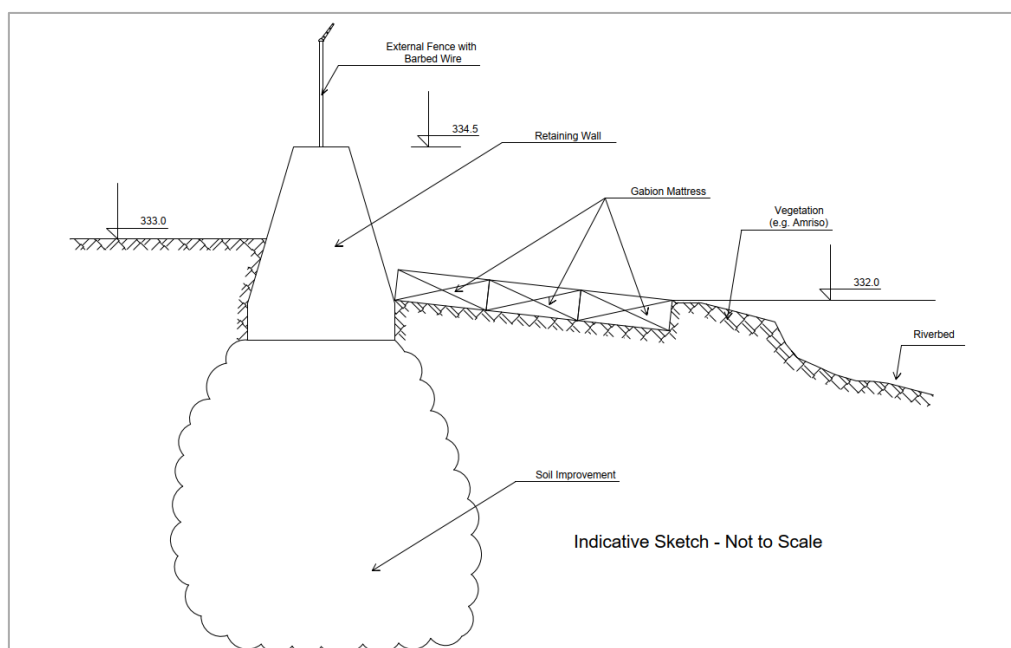


Figure 2-3 - Flood retaining wall cross section (sketch not to scale) see Annex D5-26



## 2.4 External Drainage Systems

Two independent external drainage systems of suitable characteristics and capacity shall be developed by the Contractor:

- to the east, towards the 400kV site (see Figure 2-4), to prevent water entering the 220kV site and substation area
- to the south, towards the hill side (see Figure 2-5), to prevent rainwater runoff entering the 220kV substation area

Additionally, a dedicated drainage system shall be developed as a protection to the external access road (see Annex D5-25 to Bidding Documents).

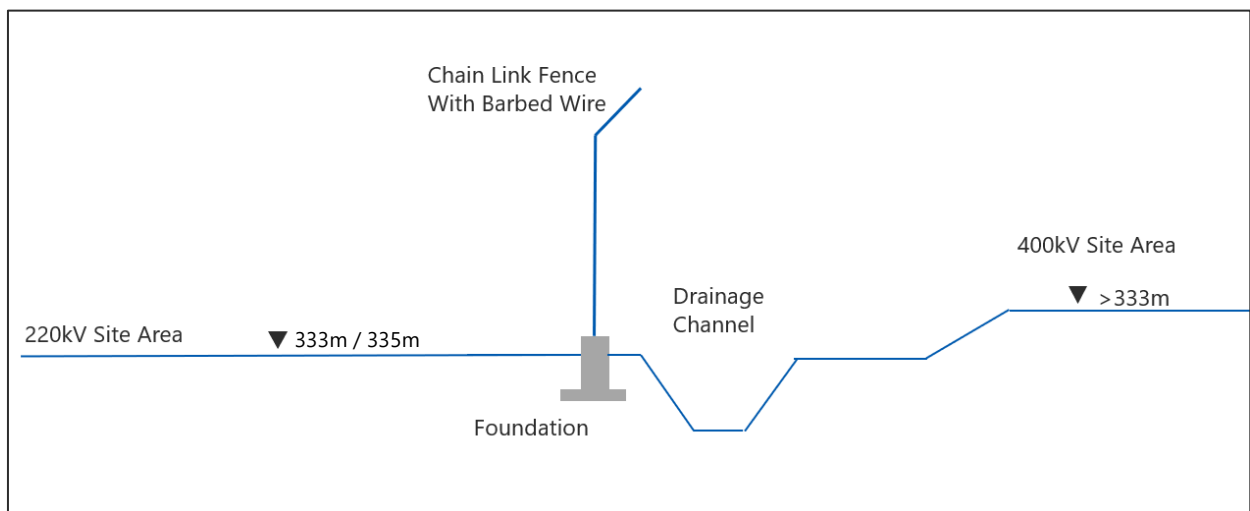


Figure 2-4 - External drainage collector (400kV site side) cross-section (sketch not to scale)

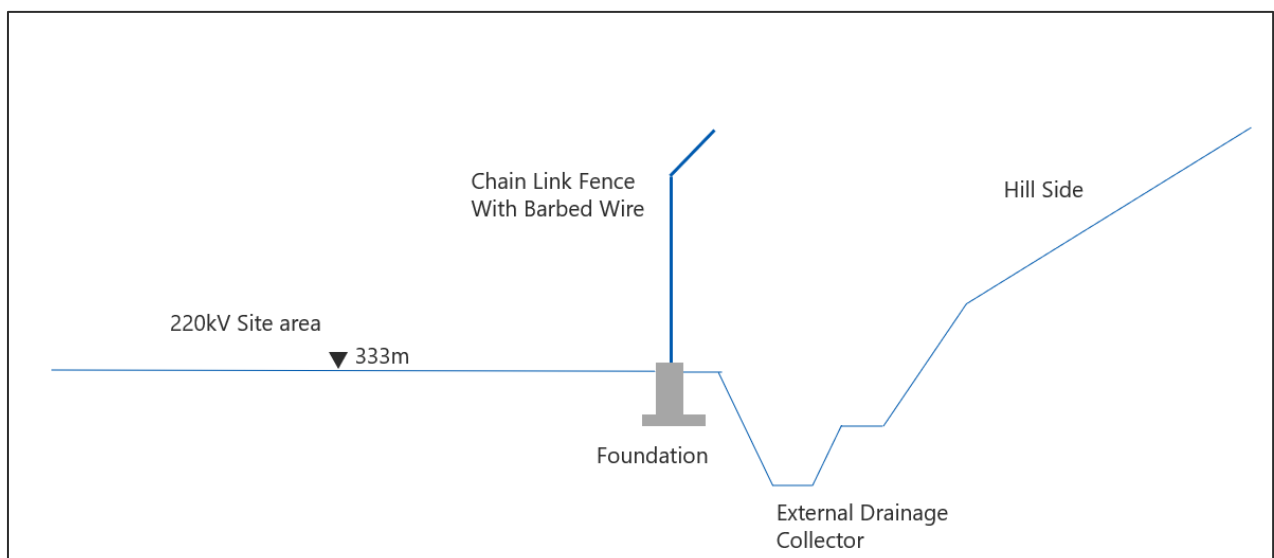


Figure 2-5 - External drainage collector (hill side) cross-section (sketch not to scale)

### 3 Project Phasing

The development of the project site shall encompass two phases.

Phase 1 shall comprise (Figure 3-1):

- Development of the external drainage collectors (hill side and 400kV site side)
- Development of the 220kV substation platform (excavation, filling and compaction)
- Permanent works, such as permanent access road (including dedicated drainage system), main gate, etc. and flood protection works for the substation platform (gabions, etc.)
- Substation's civil and electrical works
- Development of the inner chain link fence surrounding the substation area

Phase 2 shall comprise (Figure 3-2):

- Levelling of the area between the 220kV substation platform and the riverbed and development of a suitable drainage system to drain water from this area
- Development of the flood retaining wall and the external chain link fence surrounding the 220kV site area

The Price Schedule reflects the phases described above, allowing removal of price items.

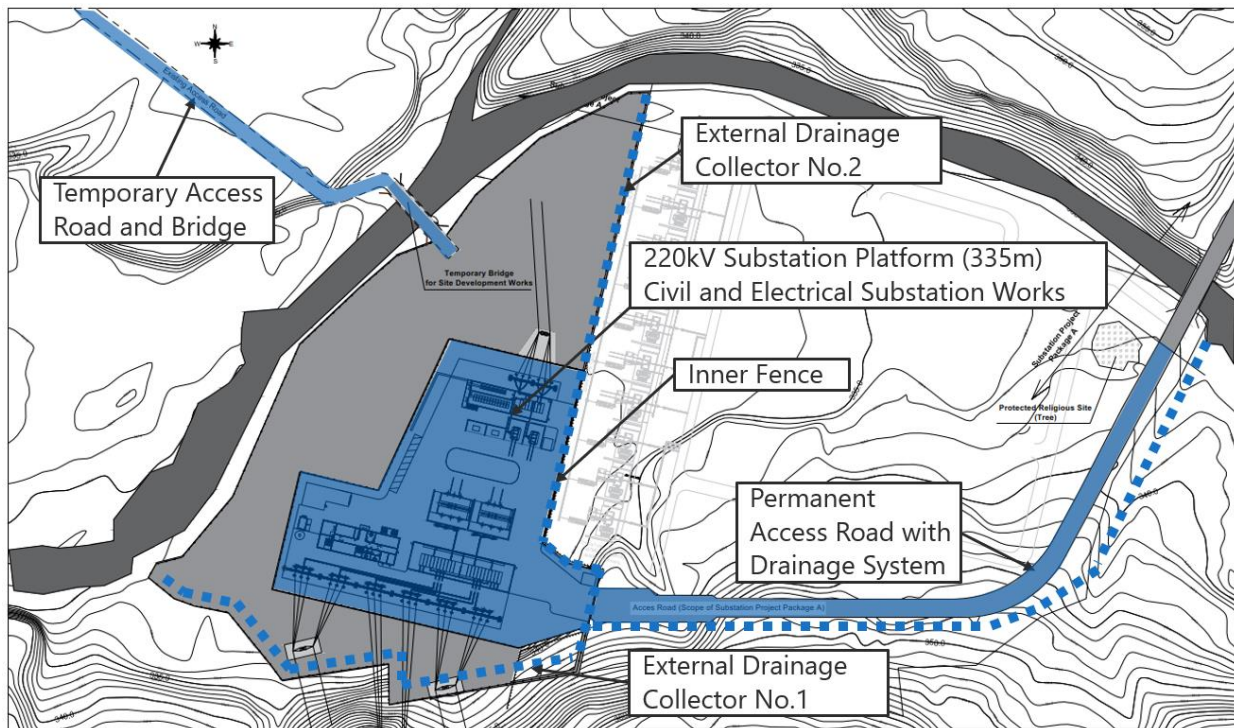


Figure 3-1 - Phase 1 main works

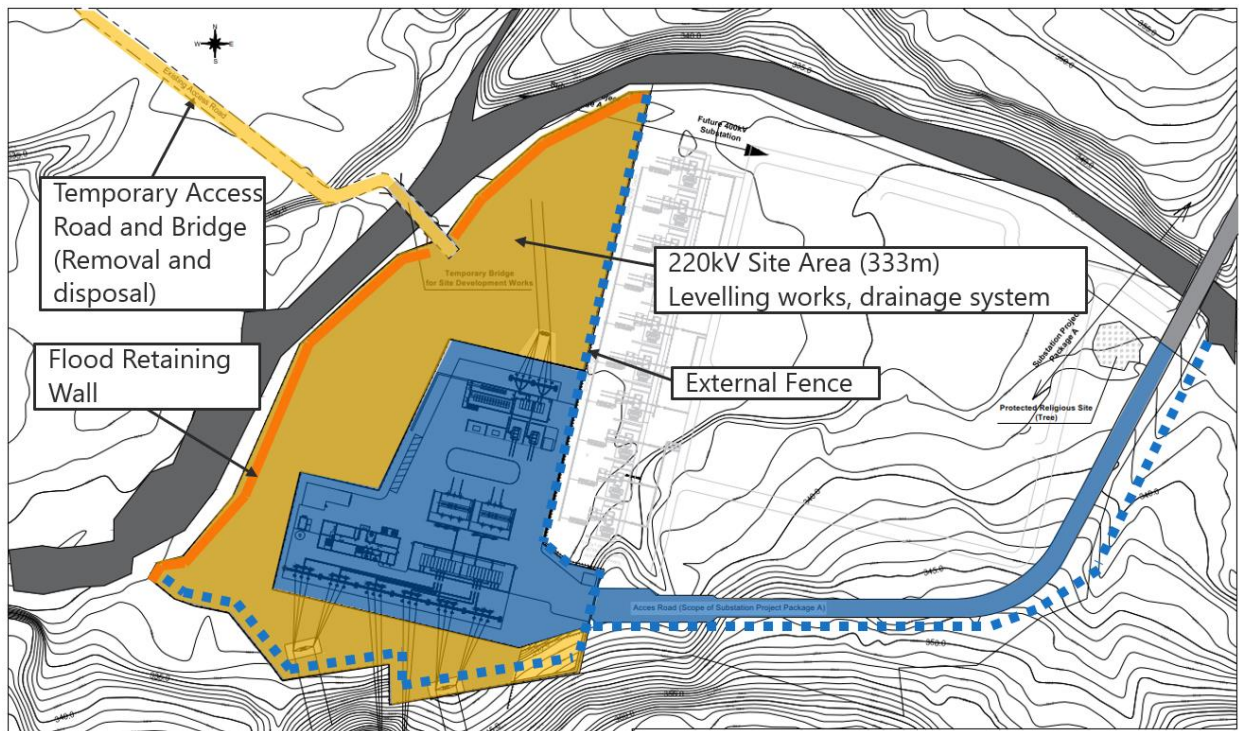


Figure 3-2 - Phase 2 main works



# Annex D5-23

## Principle Diagram for Spare Transformer Marshalling System

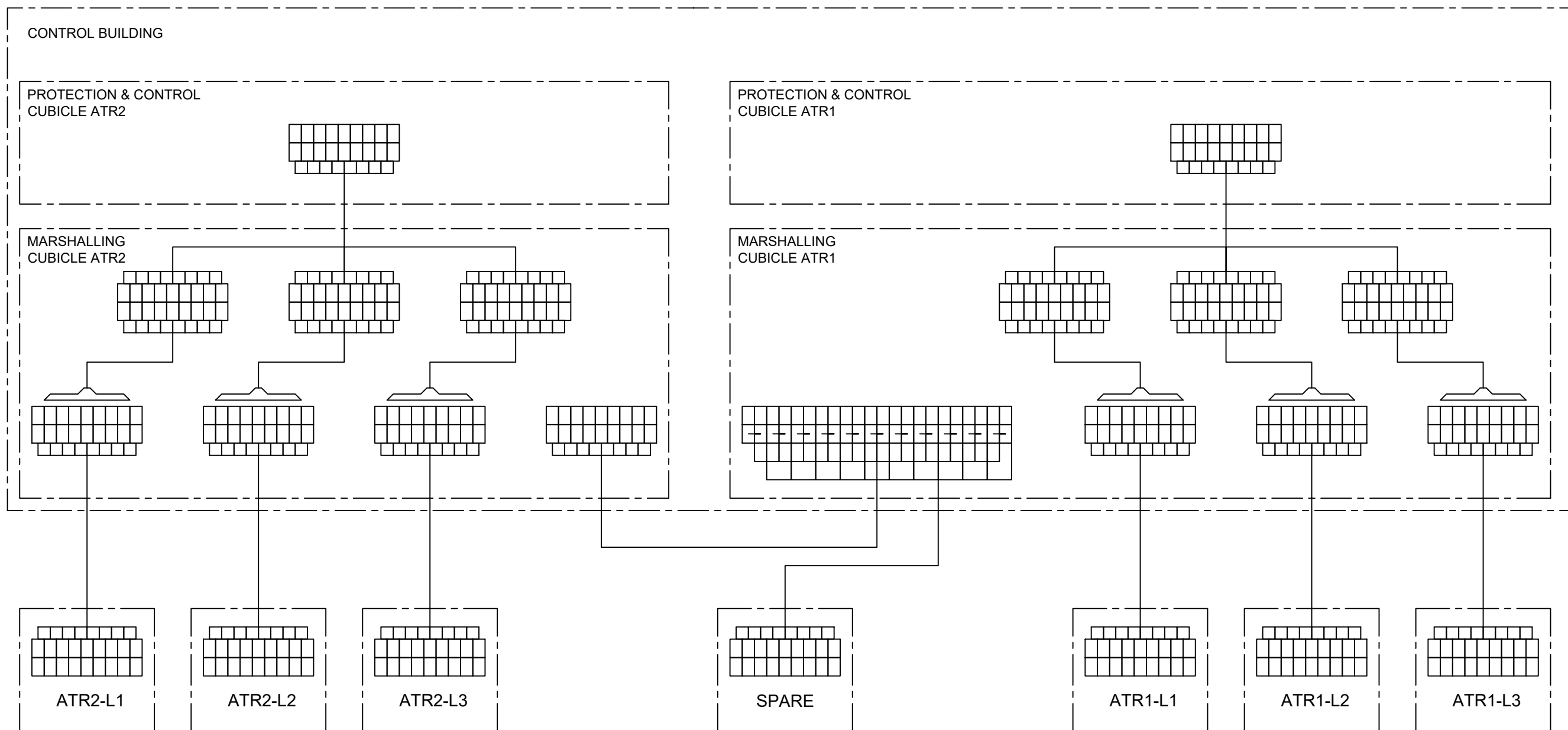


MARSHALLING WIRES  
WITH PLUG CONNECTOR  
RECONNECTABLE TO  
SPARE UNIT IN CASE OF  
FAULT

CONTROL  
BUILDING

FIELD  
CABLING

TRANSFORMER  
MARSHALLING  
CUBICLES  
MOUNTED ON  
TRANSFORMER  
TANK

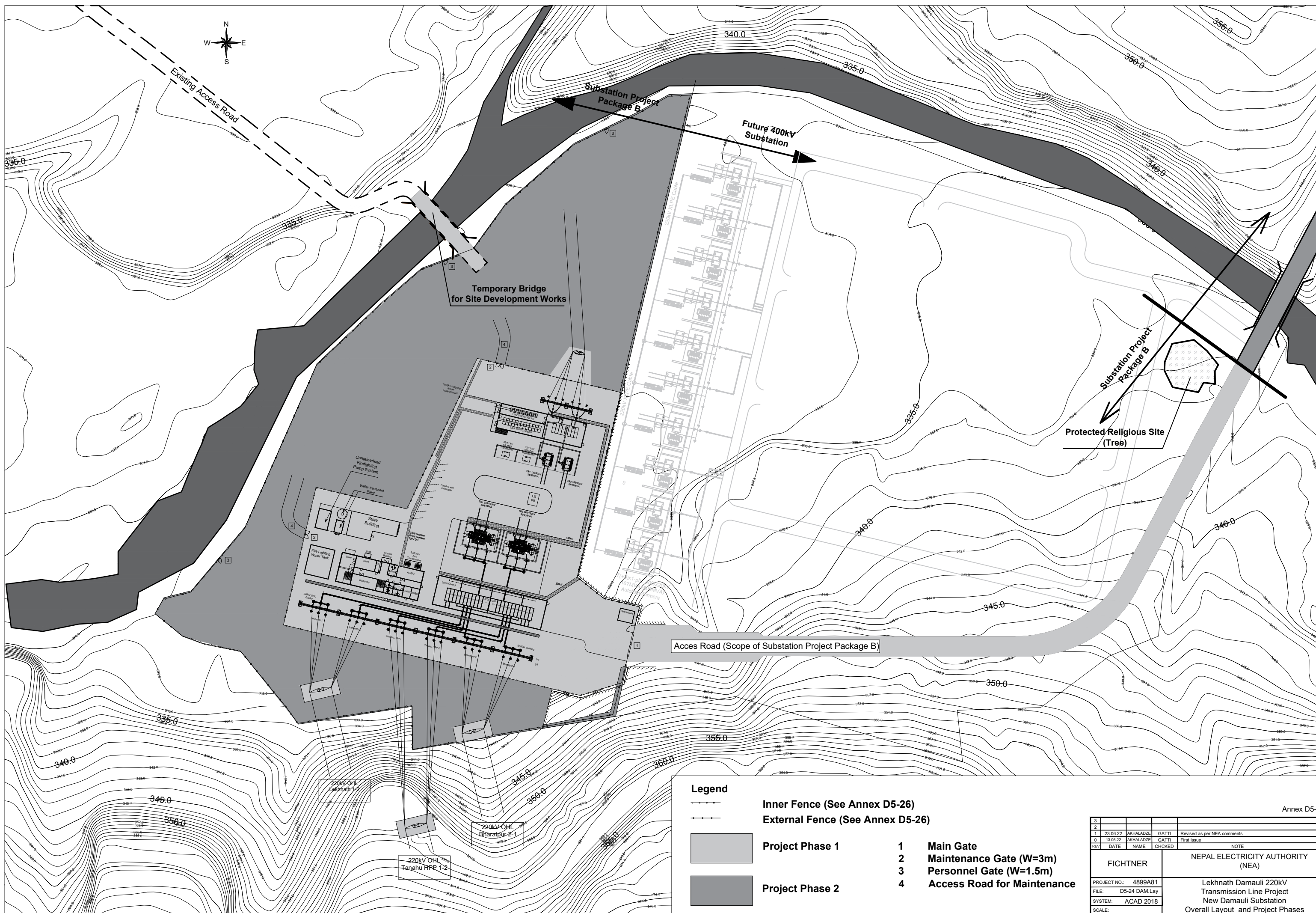


|                        |          |           |   |                |  |
|------------------------|----------|-----------|---|----------------|--|
| 3                      |          |           |   |                |  |
| 2                      |          |           |   |                |  |
| 1                      |          |           |   |                |  |
| 0                      | 25.05.22 | AKHILADZE | GRIEBBAUM                               | First Emission |  |
| REV                    | DATE     | NAME      | CHECKED                                 | NOTE           |  |
| FICHTNER               |          |           | NEPAL ELECTRICITY AUTHORITY (NEA)       |                |  |
| PROJECT NO.: 4899A81   |          |           | Lekhnaath Damauli 220kV                 |                |  |
| FILED5-23 SpTrMarshSys |          |           | Transmission Line Project               |                |  |
| SYSTEM: ACAD 2016      |          |           | Principle Diagram for Spare Transformer |                |  |
| SCALE:                 |          |           | Marshaling System                       |                |  |
| SHEET: 1 / 1           |          |           | DRAWING NO.:                            |                |  |



# Annex D5-24

## New Damauli Substation Overall Layout and Project Phases



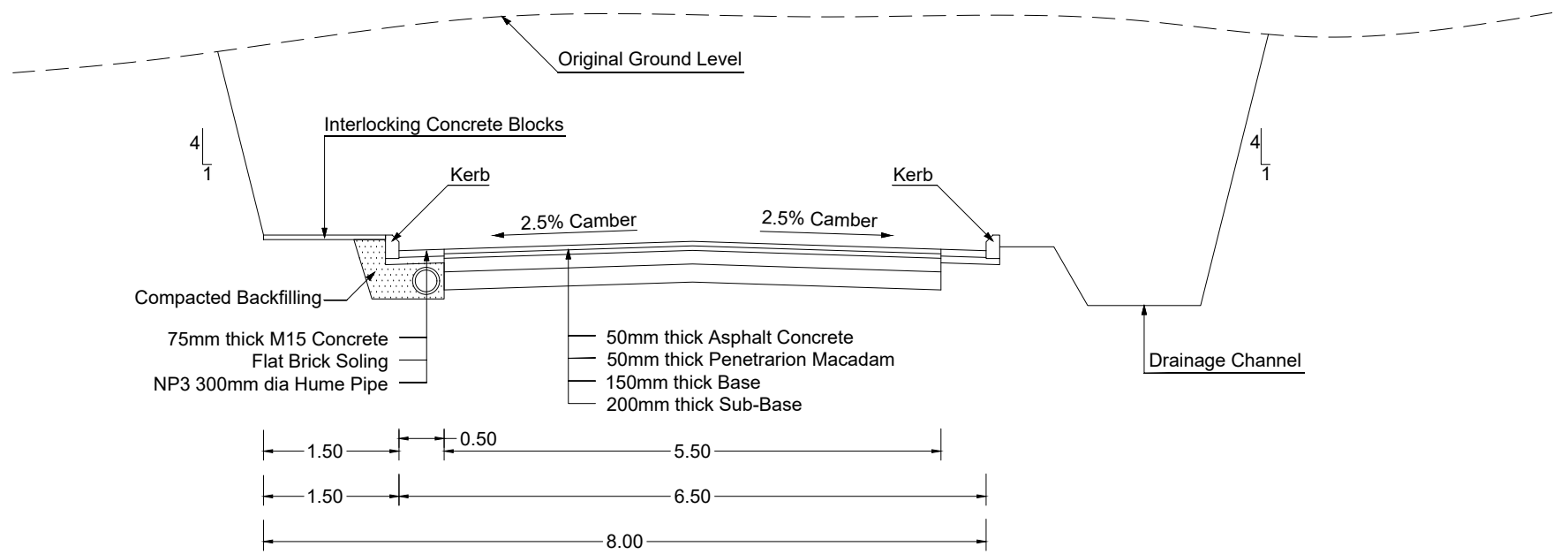
|                      |          |           |                                      |                             |
|----------------------|----------|-----------|--------------------------------------|-----------------------------|
| 3                    |          |           |                                      |                             |
| 2                    |          |           |                                      |                             |
| 1                    | 23.06.22 | AKHALADZE | GATTI                                | Revised as per NEA comments |
| 0                    | 13.05.22 | AKHALADZE | GATTI                                | First Issue                 |
| REV                  | DATE     | NAME      | CHECKED                              | NOTE                        |
| FICHTNER             |          |           | NEPAL ELECTRICITY AUTHORITY<br>(NEA) |                             |
| PROJECT NO.: 4899A81 |          |           | Lekhnamth Damauli 220kV              |                             |
| FILE: D5-24 DAM.Lay  |          |           | Transmission Line Project            |                             |
| SYSTEM: ACAD 2018    |          |           | New Damauli Substation               |                             |
| SCALE:               |          |           | Overall Layout and Project Phases    |                             |
| SHEET: 1 / 1         |          |           | SIZE: A1                             | DRAWING NO.:                |



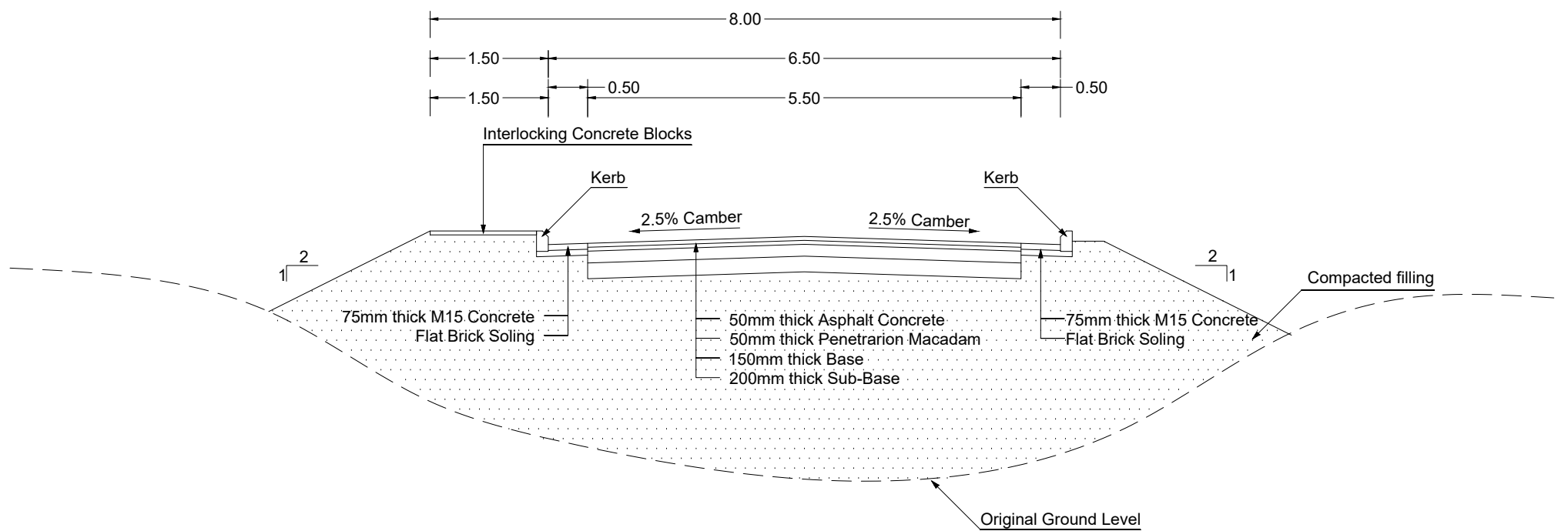
# Annex D5-25

## New Damauli Substation Access Road Typical Sections





TYPICAL CROSS - SECTION IN CUT



TYPICAL CROSS - SECTION IN FILLING

# NOTES:

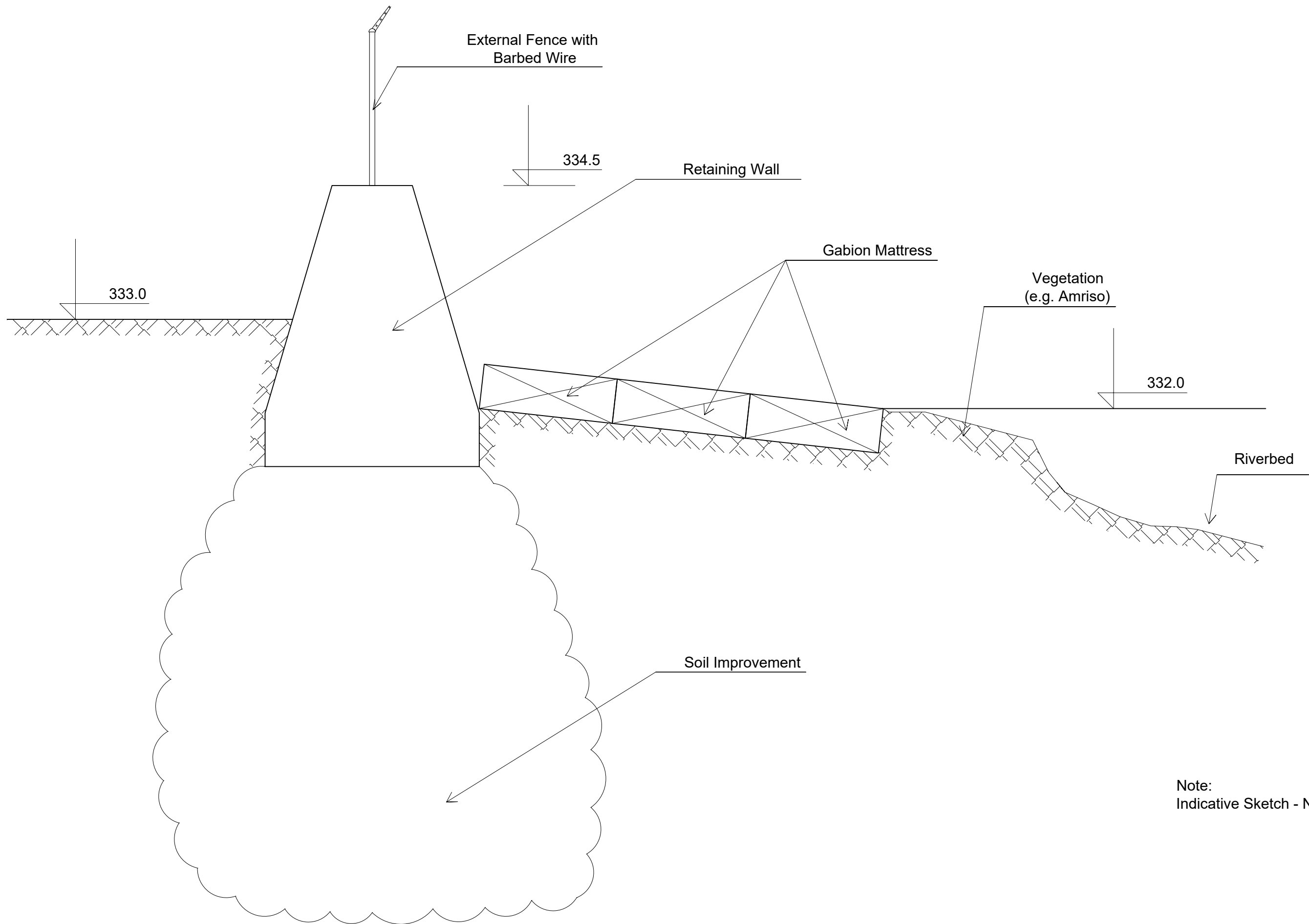
- This drawing shall be read in conjunction with Damauli Annex D5-24 Overall Layout;
- All dimensions are in meters;
- Excavation slope (1 horizontal to 4 vertical), Compacted Filling Slope (2 horizontal to 1 vertical);
- Base preparation, Compacted backfilling and Compacted filling shall be done to achieve 95% of modified proctor density in 15cm of layer as directed by the Engineer.

|                          |          |           |  |             |
|--------------------------|----------|-----------|--|-------------|
| 3                        |          |           |  |             |
| 2                        |          |           |  |             |
| 1                        |          |           |  |             |
| 0                        | 20.05.22 | AKHALADZI | GATTI  | First Issue |
| REV                      | DATE     | NAME      | CHECKED  | NOTE        |
| FICHTNER                 |          |           | NEPAL ELECTRICITY AUTHORITY (NEA)                |             |
| PROJECT NO.: 4899A81     |          |           | Lekhnath Damauli 220kV Transmission Line Project |             |
| FILE: D5-25 DAM.Acc.Road |          |           | New Damauli Substation                           |             |
| SYSTEM: ACAD 2022        |          |           | Access Road, Typical Cross-Section               |             |
| SCALE:                   |          |           | DRAWING NO.:                                     |             |
| SHEET: 1 / 1             |          |           | SIZE: A3   |             |




# Annex D5-26

## New Damauli Flood Retaining Wall



Note:  
Indicative Sketch - Not to Scale

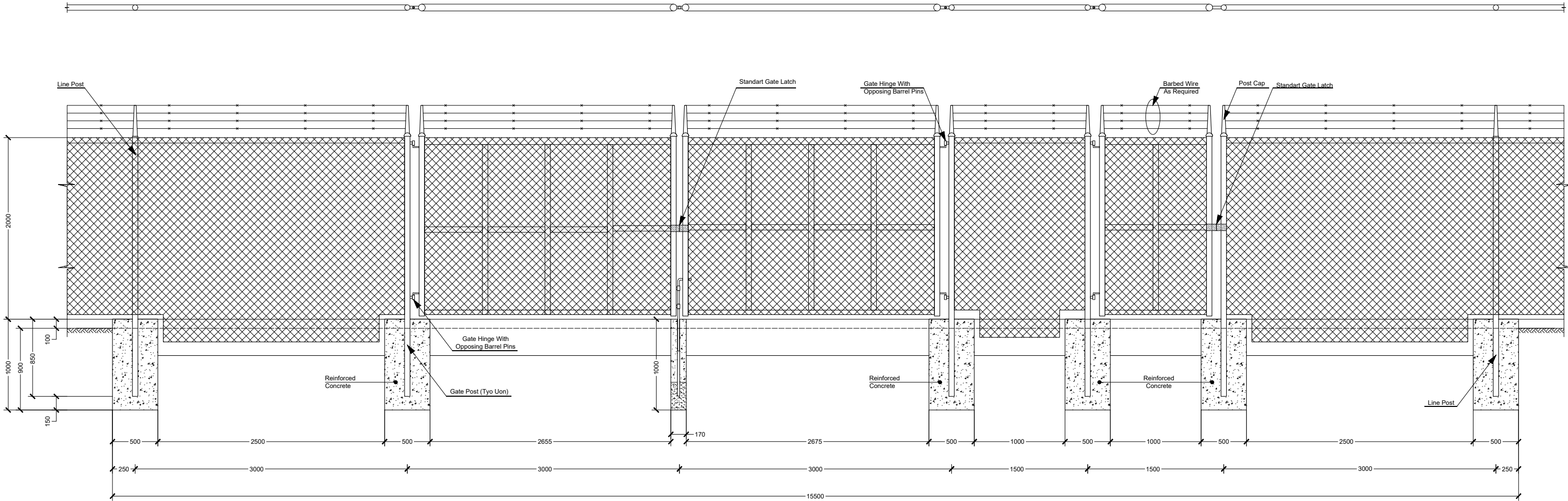
|                              |          |           |                                      |              |  |
|------------------------------|----------|-----------|--------------------------------------|--------------|--|
| 3                            |          |           |                                      |              |  |
| 2                            |          |           |                                      |              |  |
| 1                            |          |           |                                      |              |  |
| 0                            | 23.06.22 | AKHILADZE | FUGAZZA                              | First Issue  |  |
| REV                          | DATE     | NAME      | CHECKED                              | NOTE         |  |
| FICHTNER                     |          |           | NEPAL ELECTRICITY AUTHORITY<br>(NEA) |              |  |
| PROJECT NO.: 4899A81         |          |           | Lekhnath Damauli 220kV               |              |  |
| FILE: D5-26 DAM, FL Ret Wall |          |           | Transmission Line Project            |              |  |
| SYSTEM: ACAD 2020            |          |           | New Damauli Substation               |              |  |
| SCALE:                       |          |           | Flow Retaining Wall                  |              |  |
| SHEET: 1 / 1                 |          |           | SIZE: A3                             | DRAWING NO.: |  |



# Annex D5-27

## New Damauli Substation Inner Fence



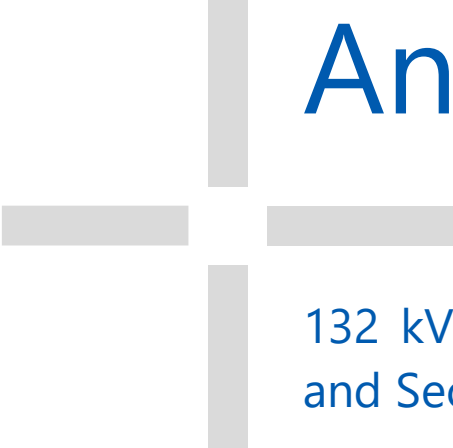


TYPICAL FENCE SWING GATE ELEVATION

NOTE:  
PROVIDE ONE DROP BAR FOR EACH LEAF (TYP).  
ASSOCIATED GALV SLEEVES TO DINSTALLED  
FLUSH WILL GRADE AT FULLY OPEN AND CLOSED POSITIONS.  
CONTRACTOR SHALL PROVIDE 6" LAYER OF #10  
STONE BELOW BOTTOM OF SLEEVE TO ALLOW FOR DRAINAGE.

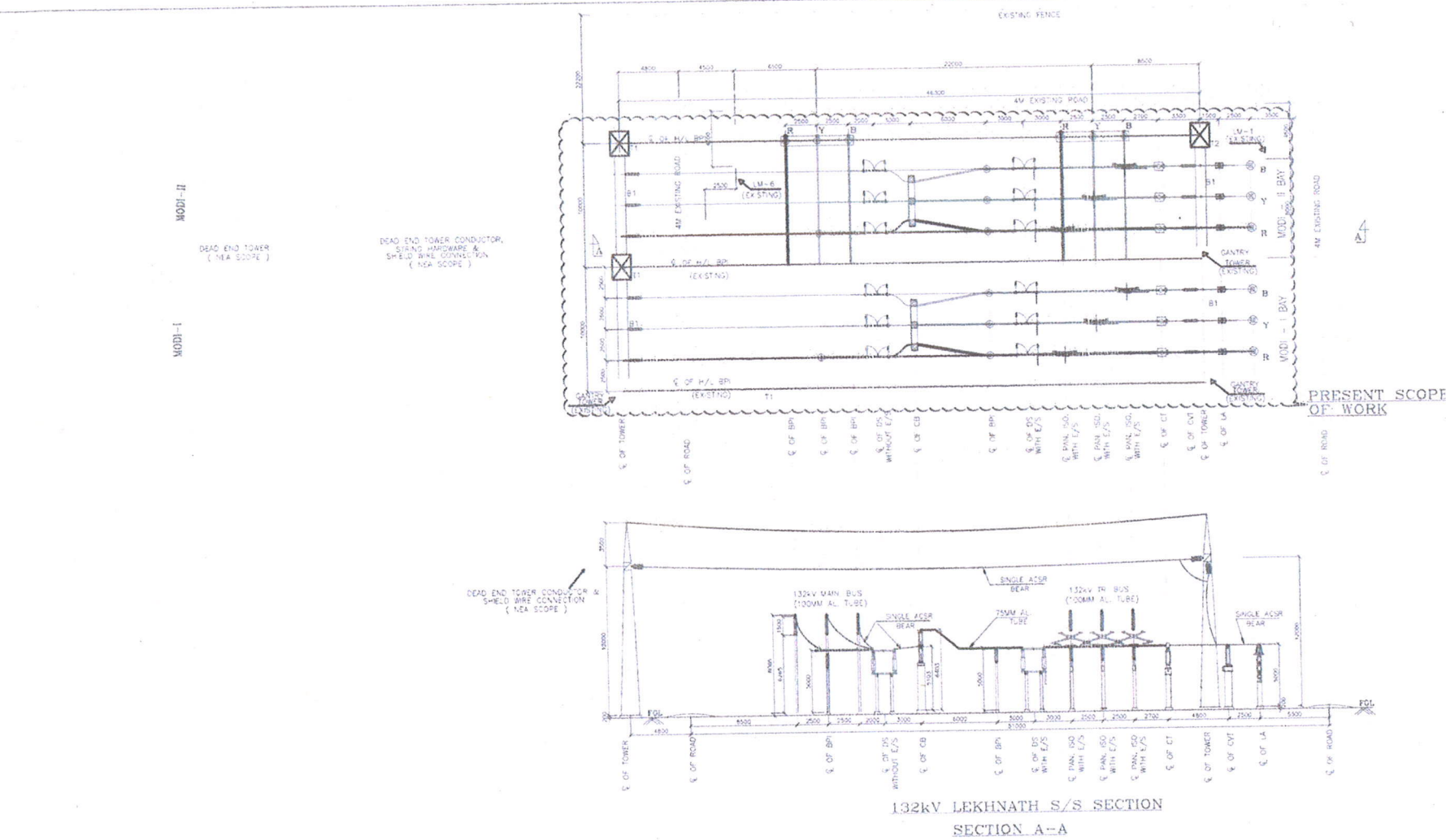
NOTE:  
-- FIXING DETAILS WILL BE DETERMINED  
BY MANUFACTURER;  
-- STEEL: S355;  
-- CONCRETE: C40 (XA2);

|                         |          |           |                                      |              |  |
|-------------------------|----------|-----------|--------------------------------------|--------------|--|
| 3                       |          |           |                                      |              |  |
| 2                       |          |           |                                      |              |  |
| 1                       |          |           |                                      |              |  |
| 0                       | 16.05.22 | AKHALADZE | GATTI                                | First Issue  |  |
| REV                     | DATE     | NAME      | CHECKED                              | NOTE         |  |
| FICHTNER                |          |           | NEPAL ELECTRICITY AUTHORITY<br>(NEA) |              |  |
| PROJECT NO.: 4899A81    |          |           | Lekhnath Damauli 220kV               |              |  |
| FILE: D5-27 Outer Fence |          |           | Transmission Line Project            |              |  |
| SYSTEM: ACAD 2022       |          |           | New Damauli Substation               |              |  |
| SCALE:                  |          |           | Substation inner Fence               |              |  |
| SHEET: 1 / 1            |          |           | SIZE: A3                             | DRAWING NO.: |  |



# Annex D5-28

## 132 kV AIS Lekhnath Existing Layout and Sections



**NOTES:-**  
 1- ALL DIMENSIONS ARE IN MM. AND CO-ORDINATES ARE IN MTR. UNLESS OTHERWISE SPECIFIED  
 2- MINIMUM CLEARANCE ARE AS PER EC61936-1:2002

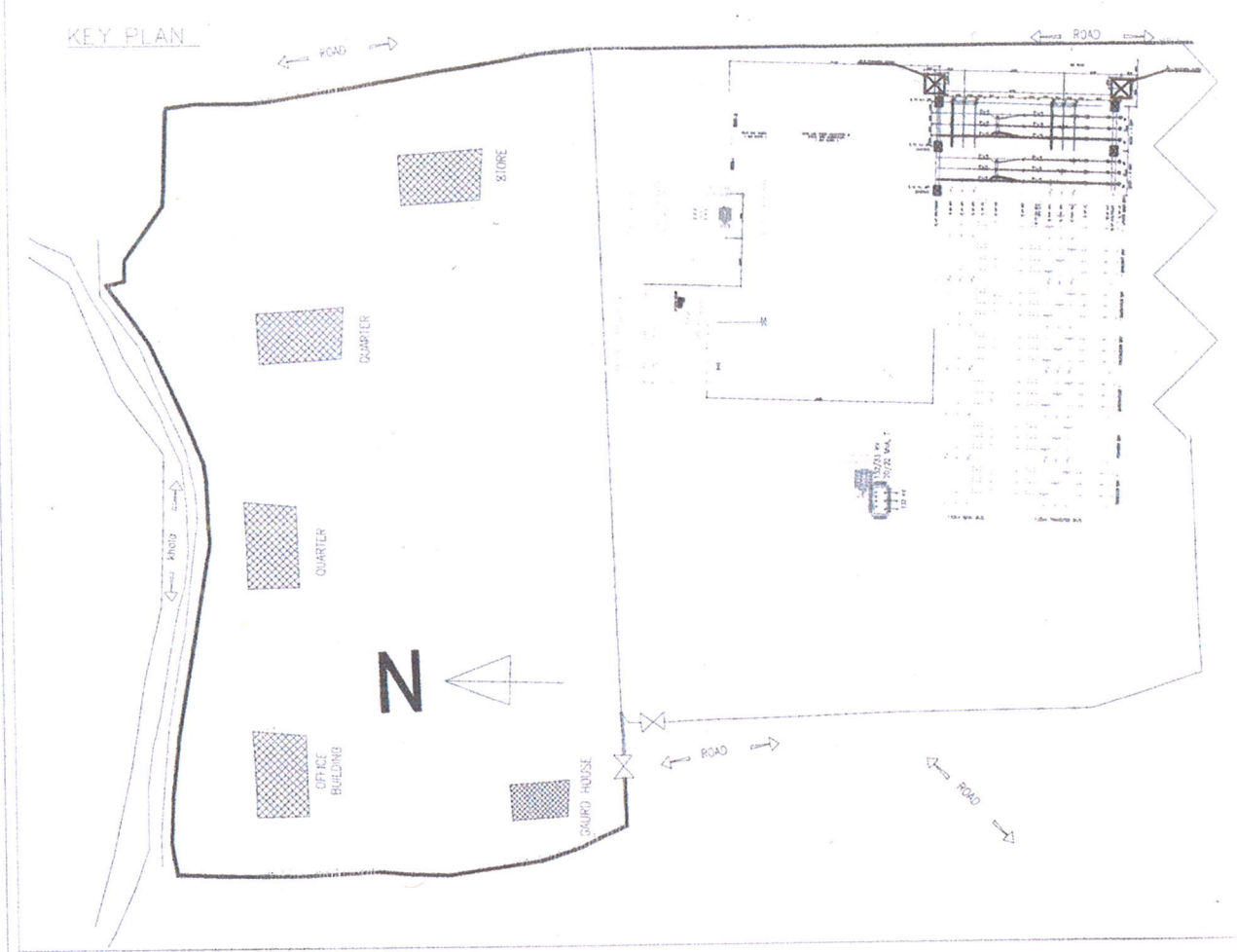
**4- CONNECTION TYPES**

| LEVEL FROM PLINTH TOP | 132KV SWGR | 132KV SWITCHYARD CONDUCTOR TYPE              |
|-----------------------|------------|--|
| a) MAIN BUS           | +805MM     | 100MM (NOMINAL SIZE) AL TUBE                 |
| b) JACK BUS           | +1200MM    | SINGLE ACSR BEAR                             |
| c) EQPT. TO EQPT.     | +5000MM    | 75MM (NOMINAL SIZE) AL TUBE/SINGLE ACSR BEAR |
| d) DROPPERS           | -          | SINGLE ACSR BEAR                             |
| e) EARTH WIRE         | +15500MM   | 7/3.35MM GS WIRE                             |

3- THE PARAMETERS FOR WHICH THE SYSTEM IS DESIGNED ARE:  
 a) NORMAL SYSTEM VOLTAGE 132KV  
 b) HIGHEST SYSTEM VOLTAGE 145KV  
 c) LIGHTNING IMPULSE WITHSTAND VOLTAGE (DRY & WET) ±650kVp  
 d) POWER FREQUENCY WITHSTAND VOLTAGE (DRY & WET) 275kV(rms)  
 e) NOMINAL CREEPAGE DISTANCE (25mm/kV) 3625MM  
 f) MAXIMUM FAULT LEVEL 31.5kA/1Sec

**LEGENDS:**  
 — EXISTING BAY EQUIPMENTS  
 — PRESENT SCOPE OF SUPPLY

**REFERENCE DRAWINGS:**  
 1- SINGLE LINE DIAGRAM FOR 132KV S/S AT LEKHNATH SS, DRG. NO.3VN1806520001\_RA  
 2- LAYOUT PLAN OF LEKHNATH SUBSTATION, VOLUME-II, DRG. NO. -6  
 3- 132KV LEKHNATH SUBSTATION CHINA INTERNATIONAL WATER AND ELECTRIC CORP. DRAWING NUMBER - SH500024-11-10-2\_RB  
 4- 132KV LEKHNATH SUBSTATION LAYOUT OF EQUIPMENT FOUNDATIONS - TPH/2033/5602/N/027 REV B (TATA INTERNATIONAL LTD)  
 5- 132KV LEKHNATH SUBSTATION EQUIPMENT FOUNDATIONS - TPH/2033/5602/N/025 REV C (TATA INTERNATIONAL LTD)



# BOQ ITEMS :

| SL                         | TYPE | PATICULAR   | BOQ ITEMS |
|----------------------------|------|---|-----------|
| LIST OF LATTICE STRUCTURES |      |   |           |
| 01                         | B1   | 132KV BEAM  | 03        |
| 02                         | T1   | 132KV TOWER WITH PEAK                               | 03        |
| 03                         | 1HPI | SUPPORT FOR HIGH LEVEL 132KV BPL FOR MAIN BUS       | 06        |
| 04                         | 1PI  | SUPPORT FOR LOW LEVEL 132KV BPL FOR EQUIPMENT BUS   | 08        |
| 05                         | 1CT  | SUPPORT FOR 132KV CT                                | 06        |
| 06                         | 1SA  | SUPPORT FOR 132KV LA                                | 06        |
| 07                         | 1VT  | SUPPORT FOR 132KV PT/CVT                            | 06        |
| 08                         | 3ISO | SUPPORT FOR 132KV ISO (WITH / WITHOUT EARTH SWITCH) | 04        |
| 09                         | 1PIS | SUPPORT FOR 132KV PANTO ISO (WITH EARTH SWITCH)     | 02        |
| OTHER ITEMS                |      |   |           |
| 10                         |      | STRING INSULATORS & HARDWARE                        | 12 SETS   |
| 11                         |      | SUSPENSION INSULATORS & HARDWARE                    | 06 SETS   |
| 12                         |      | STRING ACSR CONDUCTOR                               | 300MTRS   |

No of Sheets .....  
☒ Approved  
☐ Approved except As Noted  
☐ Returned For correction  
 Date: 19 June 2019 Sign: .....

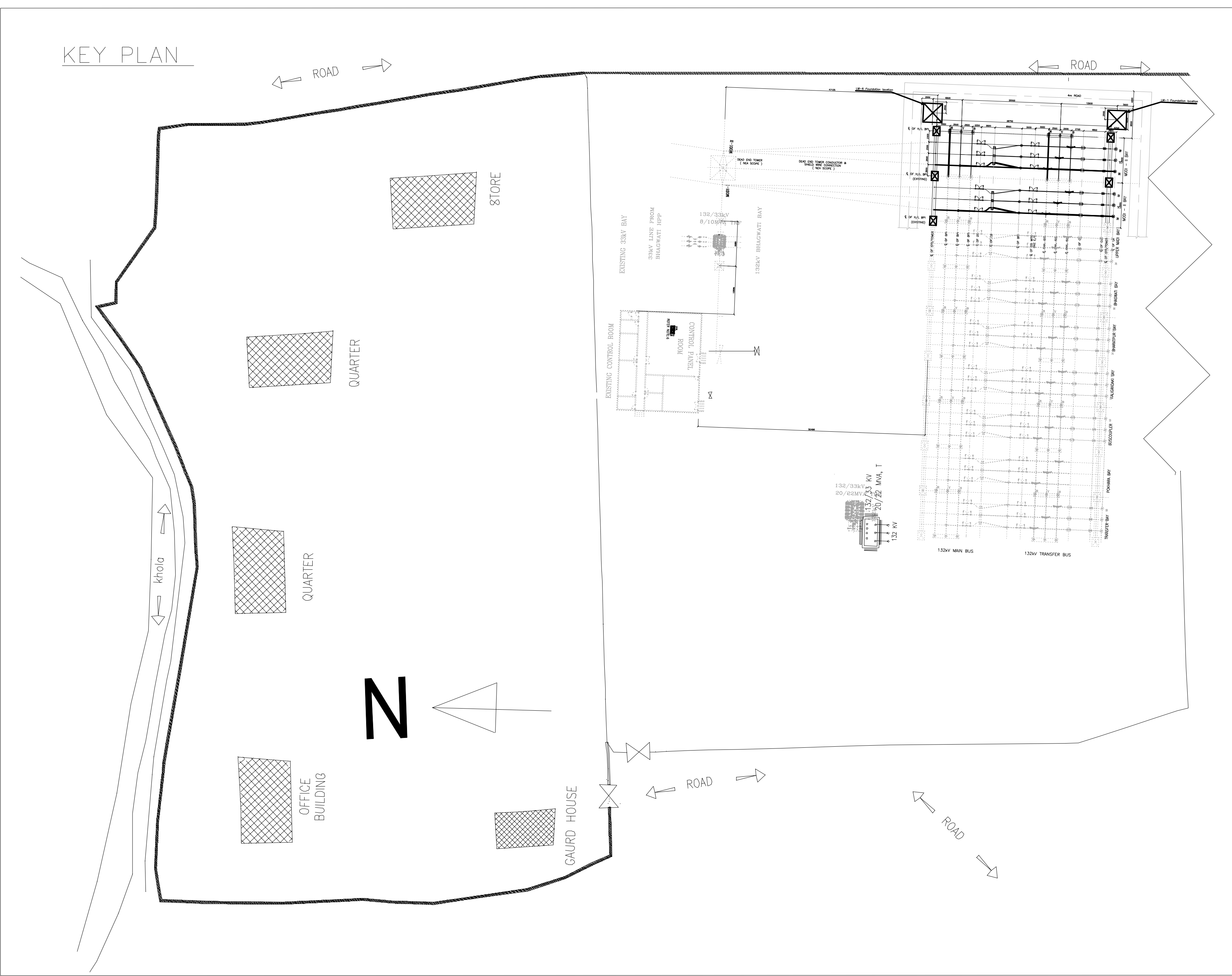


RELEASED FOR CONSTRUCTION  
**ABB**  
 SIGN \_\_\_\_\_ DATE \_\_\_\_\_



|   |             |  |  |              |   |
|---|-------------|--|--|--------------|---|
| RC  | 2019-06-12  | UPDATED AS PER THE CUSTOMER COMMENTS DATED ON 2019-04-22 | ✓                                      | ✓            | ✓   |
| RB  | 2018-12-17  | REVISED AS PER THE COMMENTS RECEIVED ON 2018-07-17       | ✓                                      | ✓            | ✓   |
| RA  | 2018-07-16  | FIRST SUBMISSION   | ✓                                      | ✓            | ✓   |
| REV   | DATE        | DESCRIPTION  | E.L.E. CIV. STR. C.M. P.M. REVIEWED BY |              |   |
| <p><b>CUSTOMER:</b><br/> <b>NEPAL ELECTRICITY AUTHORITY</b><br/>         (A Government of Nepal Undertaking)<br/>         Transmission Directorate<br/>         Grid Development Department</p> <p>NOA LETTER IFB NO : ML/SS/074/75-01.</p> |             |  |  |              |   |
| Prepared  | 2018-02-28  | SP   | Document Kind                          | FOR APPROVAL | Project   |
| Checked   | 2018-03-01  | PK   | DESIGN & ENGINEERING BY:               |              | NEW MODI LEKHNATH 132KV TRANSMISSION LINE PROJECT |
| Approved  | 2018-03-10  | PG   |  |              | Title   |
| Resp. (division/department)   | IN PGI-2882 |  |  |              | PLAN AND SECTION LAYOUT FOR 132KV LEKHATH SS      |
|   |             |  |  |              | Scale   |
|   |             |  |  |              | N'S   |
|   |             |  |  |              | Sheet   |
|   |             |  |  |              | 61/01   |
|   |             |  |  |              | Date  |
|   |             |  |  |              | 2018-07-03  |
|   |             |  |  |              | Rev.  |
|   |             |  |  |              | C   |





| SL. | TYPE | PATICULAR   | BOQ ITEMS |
|-----|------|---|-----------|
|     |      | LIST OF LATTICE STRUCTURES                          |           |
| 01  | B1   | 132KV BEAM  | 03        |
| 02  | T1   | 132KV TOWER WITH PEAK                               | 03        |
| 03  | 1HP1 | SUPPORT FOR HIGH LEVEL 132KV BPL FOR MAIN BUS       | 06        |
| 04  | 1PI  | SUPPORT FOR LOW LEVEL 132KV BPL FOR EQUIPMENT BUS   | 08        |
| 05  | 1CT  | SUPPORT FOR 132KV CT                                | 06        |
| 06  | 1SA  | SUPPORT FOR 132KV LA                                | 06        |
| 07  | 1VT  | SUPPORT FOR 132KV PT/CVT                            | 06        |
| 08  | 3ISO | SUPPORT FOR 132KV ISO (WITH / WITHOUT EARTH SWITCH) | 04        |
| 09  | 1PIS | SUPPORT FOR 132KV PANTO ISO (WITH EARTH SWITCH)     | 02        |
|     |      | OTHER ITEMS   |           |
| 10  |      | STRING INSULATORS & HARDWARE                        | 12 SETS   |
| 11  |      | SUSPENSION INSULATORS & HARDWARE                    | 06 SETS   |
| 12  |      | STRING ACSR CONDUCTOR                               | 300MTRS   |

**Annex D5-28**      **Page 2 of 2**




CUSTOMER:

**NEPAL ELECTRICITY AUTHORITY**  
(A Government of Nepal Undertaking)  
Transmission Directorate  
Grid Development Department

NOA LETTER IFB NO : ML/SS/074/75-01.

We reserve all rights in this document and in the information contained there in Reproduction, use or disclosure to third parties without express authority is strictly forbidden. © ABB.

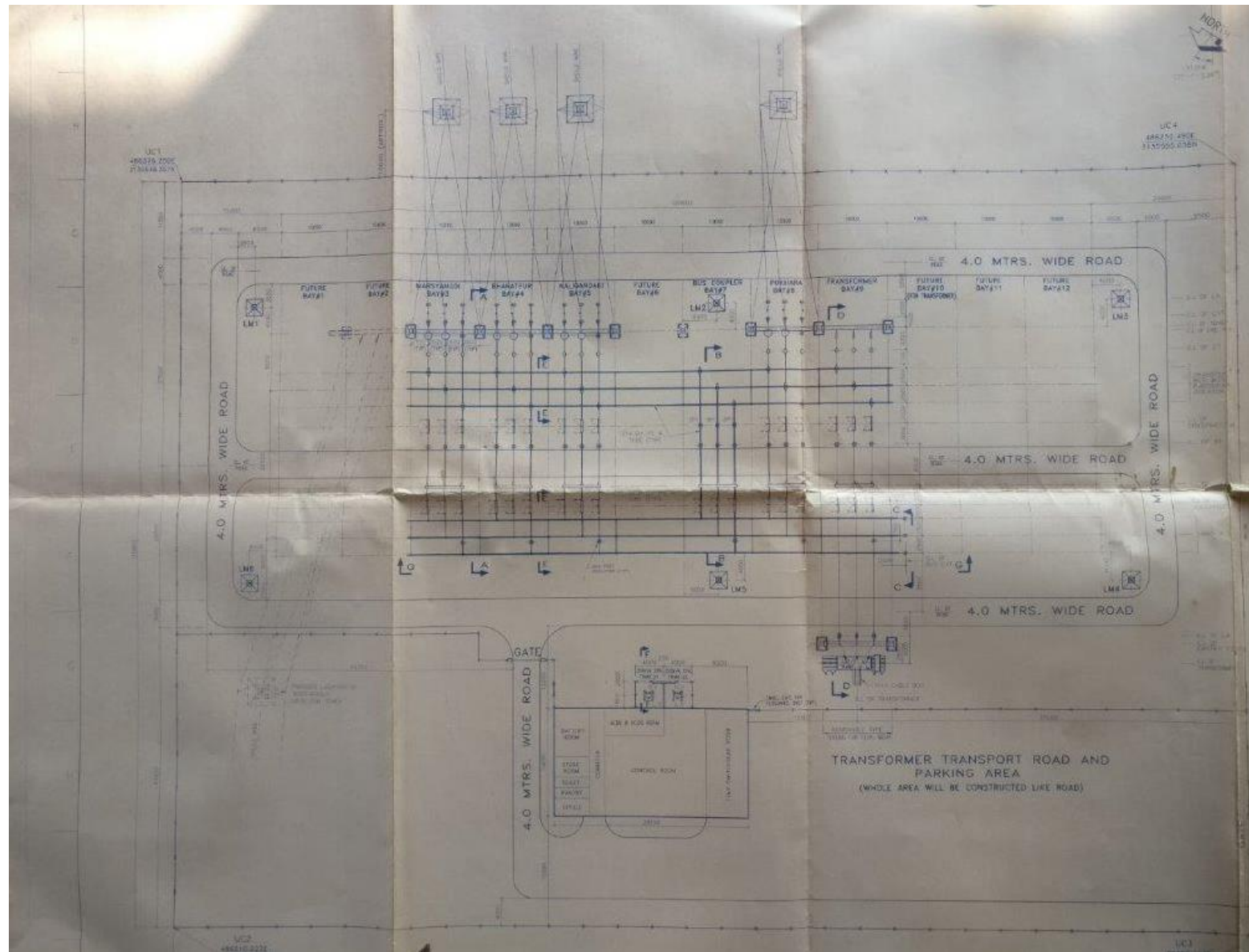


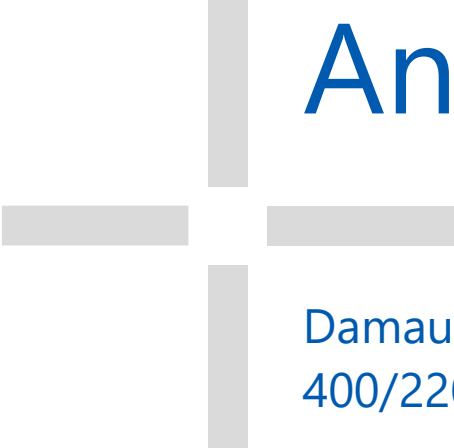


# Annex D5-29

## Lekhnath 132kV Substation Layout

## Lekhnath 132kV Substation Layout





# Annex D5-30

Damauli proposed substation  
400/220 kV boundaries adjusted





NOTES

SATELLITE IMAGERY © CNES 2019, DISTRIBUTION AIRBUS  
DEFENCE & SPACE / SPOT IMAGE S.A., FRANCE, ALL RIGHTS RESERVED  
SENSOR: PLEIADES  
RESOLUTION: 50 CM, RGB  
ACQ DATE: 2021/01/10, 2020/10/30, 2020/05/08

DRAWING REFERENCE

| TITLE                                  | DRG. No.  |
|--|-----------|
| NEW DAMALI 400/220/132kV<br>SUBSTATION | NDM-200-1 |

LEGEND

|                                 |  |
|---------------------------------|--|
| CADASTRAL BOUNDARY              |  |
| SUBSTATION 220kV-400kV BOUNDARY |  |

|      |            |      |       |       |                   |
|------|------------|------|-------|-------|-------------------|
| 1    | 2020/09/21 | SI   | AH    | PG    | ISSUED FOR TENDER |
| REV. | DATE       | DRN. | CH'D. | AP'D. | DESCRIPTION       |

TITLE: DAMAULI PROPOSED  
SUBSTATION 400/220kV  
BOUNDARIES ADJUSTED

SCALE: 1 : 2000  
GEOREF: UTM 45 N, WGS84

FICHTNER