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Source: The Metro Railways Act (Construction of Works) ACT, 1978

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Source: The Metro Railways Act (Operation and Maintenance) Act, 2002

Attachment 3. New Metro Rail Policy

METRO RAIL POLICY-2017

A. Background and Context

i. Indian cities are growing rapidly. There is a need to direct growth in a planned manner with adequate attention to the transport system at early stages in their development. Cities are witnessing fast growth in the number of personal motor vehicles, with severe congestion and pollution being the most visible manifestation of the growth in the number of motor vehicles. Efforts at remedying the situation will need to focus on improving the public transport system. In several cities this would require implementation of Mass Transit systems such as metro rail, bus rapid transit, light rail, etc.

ii. Urban Rail, popularly referred to as Metro Rail, has seen substantial growth in India in the recent years. More cities are experiencing the need for metro rail to meet their day-to-day mobility requirements. Most of the metro rail projects have been financed by the central government in partnership with the state governments, while some have been funded by the state governments either on their own or with private partnership. Metro rail projects provide high capacity public transit and are capital intensive. However, considering the rapid urbanization and the imminent need for enhancing mobility in cities through metro rail, it is imperative to explore alternative and innovative sources of funds to supplement the budgetary resources. At the same time, it is also important to ensure that the proposals are prepared and appraised in a comprehensive manner to enhance urban mobility as well as the speed and quality of implementation of metro projects. It is in this context that the need for a policy on metro rail has been felt necessary to ensure that such systems are decided upon and implemented in the most sustainable manner from the social, economic and environmental perspectives.

iii. The following are the prevalent broad models of financing metro rail in India:

a. The existing 50:50 Joint Venture model that is predominantly the major model available for the financing and organization structure was started with Delhi Metro Rail Corporation and later followed in other metros like Mumbai Line-3, Chennai, Bangalore, Nagpur, Lucknow, Kochi and Ahmedabad.

b. The second model is that of full funding by the central government. Examples of this model are the first metro in the city of Calcutta (now Kolkata) by Indian Railways, followed by East-West corridor in Kolkata being implemented on a 74:26 equity sharing between Ministry of Railways and Ministry of Housing and Urban Affairs respectively.

c. The third model is that of complete funding by state government; examples are Metro rail in Jaipur and Monorail in Mumbai.

d. The other model is the Public Private Partnership (PPP). Mumbai Metro Line-1 and Hyderabad metro rail have been taken up with Viability Gap Funding (VGF) from Government of India. The Rapid Metro in Gurugram is an initiative of Government of Haryana where full funding is by the private concessionaire.

B. Benefits of Mass Rapid Transit Systems

i. Mass Rapid Transit Systems in urban areas not only facilitate easy and quick movement of people but also have a positive impact on the economic growth and quality of life. This result in increased income and various benefits to the society like reduced external cost due to reduction in traffic congestion, road and parking cost, transport cost and per-capita traffic accidents. Mass Rapid Transit Systems tend to reduce per capita vehicle ownership and usage and encourage more compact & walkable development pattern which provide developmental benefits to the society. Reduction in cost and time of travel lowers the cost of production of goods and services which significantly improves city's competitiveness. One of the significant contributions is substantial reduction in per capita pollution emission bringing down various chronic diseases; hence, results in huge public health benefits.

C. Options of Mass Rapid Transit Systems(MRTS)

i. The mass transit systems in cities/ urban agglomeration can be broadly classified into the following 5 categories:

a. **Busways and Bus Rapid Transit System (BRTS)**: Busways are physically demarcated bus lanes along the main carriageway with a segregated corridor for movement of buses only. At the intersections, the buses may be given priority over other modes through a signalling system. BRTS, is an enhanced form of a busway which incorporates features such as facilities for pedestrians, Non-Motorised Vehicles (NMV) and many other associated infrastructures including operations and control mechanism.
b. **Light Rail Transit (LRT)**: LRT is generally at-grade rail based mass transit system, which is generally segregated from the main carriageway.
c. **Tramways:** These are at-grade rail based system that are not segregated and often move in mixed traffic conditions.
d. **Metro Rail:** Metro rail is a fully segregated rail based mass transit system, which could be at grade, elevated or underground. Due to its physical segregation and system technology, metro rail can have a very high capacity of 40,000 – 80,000 passengers per hour per direction (PPHPD). Metro systems also include monorails, which, however, has lower capacities and higher maintenance cost.
e. **Regional Rail**: Regional rail caters to passenger services within a larger urban agglomerate or metropolitan area connecting the

outskirts to the center of the city. The services have greater number of halts at smaller distances compared to long distance railways but fewer halts and higher speeds compared to metro rail. Regional rail are common in large metropolitan cities and help in decongesting the city center by providing safe, and speedy access to the city center for commuters residing in less congested suburbs.

ii. Choice of Metro Rail as a Mode of Mass Transit: The choice of a particular MRTS will depend on a variety of factors like demand, capacity, cost and ease of implementation. A BRT or LRT systems at grade may require linear pathway to be carved out of existing land if additional space cannot be made available on the sideways and will reduce the space for other traffic depending on the width of existing roads. LRTs and Tramways without horizontal separation will have reduced speed and hence reduced capacity. The capacity of MRTS is generally denoted by passengers per hour per direction (PPHPD). A BRTS typically has a capacity of 10,000-15,000 PPHPD on a single lane but can be enhanced with additional lanes. Comparatively metro rail systems are able to carry much higher passenger volumes of 60,000 PPHPD and can go up to 80,000. Such rail based systems also generally provide rapid service, a higher quality ride and service regularity due to grade separation.

iii. It is pertinent to observe that the above mentioned capacities of different systems can be at best, a guidance parameter and choice of mode will depend on the overall feasibility of the transport system.

D. Planning and Implementation of Metro Rail Projects

i. Metro Rail: A mode of Urban Transport

Due to the very nature of urban transport and its inseparable and intricate connect with the issues of urban development, it is essential that those who have overall perspective and feel of the city formulate the plans for urban transport for that city. Therefore, the proposals for central assistance for an identified metro rail project will have to be mooted by the State Government; also as the "Urban development" is a State subject in the Constitution.

ii. System Approach

a. There should be a comprehensive approach to planning for urban land use and transport infrastructure. A system approach should be applied in the planning of multi-modal transport systems in a city. For, this, a city can be represented by land use zones superimposed with a matching transport networks. By treating the urban area as a system, and recognizing the interactions between land use, traffic and transport, it is possible to predict future requirements and accordingly evaluate alternative modes for the most optimum mobility plan for the city.

Therefore, a Comprehensive Mobility Plan (CMP), is a mandatory prerequisite for planning metro rail in any city. Cities having a population of two million and more may start planning for mass transit systems including metro rail based on the CMP.

b. Integration between various modes like roadway, railways, non-motorized transport, and other modes of transport enhances the mobility of the citizens and encourages public transport. Existing railway suburban services or circular rail systems, if any, should be integrated with the metro rail and other transport modes. It is imperative that the various service providers collaborate through signing of a Memorandum of Understanding (MoU), to provide seamless integration between the various modes.

c. For integrated approach in planning and management of urban transport, State Governments should constitute Unified Metropolitan Transport Authority (UMTA) as a statutory body. This Authority would prepare Comprehensive Mobility Plan for the city, organize investments in urban transport infrastructure, establish effective coordination among various urban transport agencies, manage the Urban Transport Fund (UTF) etc.

d. As metro rail systems operate in the urban arena, it would be worthwhile considering a stake of the local body like municipal corporations or city development authorities in the agency implementing and/or operating the metro rail system in a city.

e. For metro projects in metropolitan region, which transcend state boundaries, there is a need for the governments to synergize their efforts in providing a comprehensive transport system which can be formalized through a Memorandum of Understanding between the States.

iii. **Alternatives Analysis**

a. Metro rail, though being capital intensive, provides the much needed high capacity rapid transit in the cities. Though they have a life of 100 years and beyond, due to the nature of construction, the flexibility in design changes after the construction is very limited. Hence, they should be planned and executed with a longer future perspective. Being a high capacity transport system, they are most suited for growing cities having prospective increase in population over several years. Therefore, the metro rail systems are best suited for cities with teeming population and favorable future growth prospects. Further, they should be decided upon with due care and after a systematic and unbiased analysis of different alternatives. In this context, the spatial pattern of a city is important. Cities with a well spread out spatial pattern, even if they have a high population, may not have sufficient number of corridors with adequate density to

justify investments in a metro. Yet cities with a linear spatial pattern may justify a metro even at lower population levels as they have fewer corridors and each would have a high traffic density. A comparative analysis of alternate modes should be an essential requirement for the transit mode selection. The mode which matches the demand projections over the project life cycle and has the least cost should be chosen.

b. The alternative analysis report will have to be necessarily incorporated in the project report while seeking central assistance. To make the analysis comparable among various alternatives, a horizon of 30 years or more may be taken for forecasting the cost and revenue variables.

iv. **Project Report**

a. The project report will be the key document for assessing the feasibility of a metro project and the issue of central assistance. The report should examine the techno – economic feasibility and include provision of infrastructure for integration of various modes of transport, last mile connectivity, seamless transfer between various modes through common payment instrument and universally accessible infrastructure. Pricing of urban transport is a public policy issue and should be aimed at encouraging public transport. Therefore, it should be determined in a manner that it may incentivize modal shift from private vehicles. Pricing of metro rail should not be seen as a mere tool for enhancing financial viability as this will defeat the very purpose of having a high capacity mass transit system which brings in greater economic, social and environmental benefits to the city. Financial support of state government/ city authorities to ensure good financial health of the agency implementing/ operating the metro rail project will be essential and will need to be provided within a well-defined framework.

b. As per global practice, urban transport projects, including urban rail, are treated as public projects which deliver public good. Therefore, appraisal of metro rail projects should entail economic and social cost benefit analysis. Metro rail projects provide larger economic and social benefits to the society in terms of reduction in cost and time of travel, substantial reduction in per capita pollution emissions resulting in reduction in chronic diseases, reduction in road accidents, bringing down noise pollution etc. Enhancing mobility catalyzes the economic development and improves the livability of a city. Hence, while appraising such project proposals the economic and social viability may be assessed. The economic internal rate of return for any metro rail project proposal should be 14% and above for consideration of its approval.

c. For all metro rail projects taken up with central assistance it will be mandatory for the State Governments to give commitment to set up and

operationalise UMTA in the city within a year. Further, cities, where metro projects are under implementation, may consider setting up of UMTA within a year.

d. The State Governments shall commit to provide required support to metro rail companies/agencies to ensure financial sustainability during operations.

e. Proposals for additional metro lines in a city, or new metro in a State already having a metro rail in one of its cities, would be appraised keeping in view the state governments efforts in ensuring financial viability of the existing lines.

v. **Requirement of Allied Investments**

a. Metro Rail systems need to be seen not merely as a transportation project, but as urban transformation projects that help a city move from sprawled development to greater compactness leading to sustainable cities. Lower travel distances, vastly reducing energy consumption and significantly lowering emissions should be the objective of such investments, along with faster mode of travel. Towards this end, allied investments in expanding utility capacity to densify areas around metro stations should be a requirement and this should be adequately covered in the project proposal report/ Detailed Project Report (DPR).

b. As metro rail systems are high capacity systems with large congregations of people during the peak hours, it is essential that the security and safety of the system is planned accordingly. As security is a function of the State, it needs to be provided by the State.

vi. **Enhancing the Viability of Metro Rail Projects**

a. Because of the well acknowledged role of metro rail in reducing urban transport-related problems, such as congestion, air and noise pollution, accidents and at the same time providing faster and safer mode of mass transport, more and more cities world over are providing rail based urban transport systems for their commuters. Public mass transport systems serve the economic and social requirements of a growing city and therefore need to be appraised using a socio-economic framework. Nevertheless, all efforts should be made to reduce costs and enhance revenues through various innovative means.

vii. **Enhancing Revenues**

a. Feeder System to Metro Rail: Every proposal for Metro Rail should necessarily include proposals for feeder systems that help to enlarge the catchment area of each metro station atleast to 5 kms. Last mile connectivity through pedestrian pathways, Non-Motorized Transport (NMT) infrastructure, and induction of facilities for para transit modes will be essential requirements for availing any central assistance for the proposed metro rail projects. State governments will be required to commit provisioning of feeder systems for the metro rail proposed for availing central financing assistance.

b. Transit Oriented Development (TOD) and Value Capture Finance (VCF): The project proposal should mandatorily contain a chapter on the "Transit Oriented Development (TOD)" with proposed intermodal integration, universal accessibility, adequate walkways and pathways for Non-Motorized Transport (NMT), stations for public bike sharing, commensurate parking lots for cycles and personal vehicles, as well as adequate arrangement for receiving and dispatch of feeder buses at all metro stations. The commitment by the State Government to adhere the guidelines issued by the central government w.r.t. TOD and adoption of VCF framework should be an integral part of the project proposal. The commitment should inter alia include commitment of transfer of the financial benefits accruing in the influence zone of the metro alignment on account of the TOD policies and VCF framework directly to the Special Purpose Vehicle (SPV)/agency implementing the metro rail project. The project report should specify the proposed quantum of such benefits being transferred to the project. This requirement would form a mandatory part of all metro rail project proposals.

c. Commercial/property development at stations and on other urban land has been used as a key instrument for maximizing revenues in metro rail/ railway systems in cities around the world. Notable examples are Hong Kong and Tokyo. Metro rail implementing agencies should endeavor to maximize revenue through commercial development at stations and on land allocated for this purpose.

d. The DPR should also mandatorily contain a chapter on enhancing non-fare box revenue through conventional as well as innovative means. The State Government shall ex-ante commit the enabling policy and regulatory framework and provision of requisite permissions, clearances & licenses etc. for all avenues of exploiting non-fare box revenue such as advertisements, leasing of space, fire clearances etc. under the state statute and rules through a single window facility to the SPV/agency implementing the metro rail project.

viii. **Reducing Costs: Standardization, Indigenization and Inducing Competition**

a. All efforts should be made to reduce the cost of construction and operation. Substantial efforts have been made since the advent of metro rail systems in India in standardizing the various components of Metro Rail Systems like track-gauge, civil

structure and components of rolling stock. These should be further consolidated progressively from time to time by the government to take care of the emerging technologies with the increase in the number of projects and increase in the quantum of rolling stock required so as to reduce costs on account of economies of scale by the manufacturers. Government will progressively take requisite steps to further standardize the sub-systems and components of the Metro Rail Systems without hampering the flexibility required for the varying urban texture and differing new emerging needs of rapidly urbanizing agglomerations in the country. The standards so evolved will have to be mandatorily adhered to for the metro projects taken up with central assistance.

b. Government and metro rail implementing agencies shall take adequate steps for progressively indigenizing the metro rail systems through incentivizing and encouraging indigenous development and manufacture of the components that are being presently imported. Such steps will include compulsory indigenization and progressive increase in local content in the conditions of procurement, encouraging bulk tendering for similar components duly aggregating the requirements of various agencies within a state, among other initiatives.

ix. Legal Cover

All the metro rail projects will have to be governed by the Central Metro Acts.

x. Fare Fixation

The fixation of the fare will be as per the extant provisions of the Act governing the metro rail projects.

xi. Issuance of Bonds by Metro Rail Companies

The financial health of metro rail projects hinges, among other things, on the cost of capital used for funding the project. It is, therefore, imperative that the avenues of mobilizing capital at reasonable cost should be facilitated for metro rail project. State Governments should enable metro rail implementing agencies to raise cheaper long term debt by allowing them to issue corporate debt bonds or earmarking revenue from VCF modes like betterment levies etc. The provision of such security to support corporate debt bonds issued by metro rail companies will enable such bonds to obtain appropriate credit rating thereby making them attractive debt investment options for investors.

xii. Appraisal

The project reports, which entail financial assistance from the Government of India, will be appraised by an independent agency/ agencies identified by the Government. These agencies like the national Institute of Urban Transport, other 'centers of excellence' etc. will be identified on the basis of the domain

knowledge and expertise in the field of urban transport and metro rail available with them. Government will come up with a rigorous appraisal framework for appraisal of metro rail proposals. The identified independent agency/ agencies will appraise the projects on the basis of an appraisal framework.

xiii. Monitoring of Performance

Performance of metro rail projects during construction and implementation shall be monitored regularly against established Key Performance Indicators to ensure high standards of service delivery. The metro rail implementing agencies shall put in place an appropriate monitoring mechanism for this and the same should be indicated in the project report.

xiv. Private participation and Public Private Partnership (PPP)

Private participation either for complete provisioning of metro rail or for some unbundled components will form an essential requirement for all metro rail project proposals seeking central financial assistance.

a. More cities are now leveraging on the private partnership for development and implementation of metro rail projects by way of unbundling the various activities and components to capitalize on the private resources, expertise and entrepreneurship.
b. Government will encourage Public Private Partnership (PPP) for implementation of the metro rail projects in the country. State Government desirous of availing central financial assistance for metro rail system in a city should mandatorily explore the possibility of having a PPP arrangement.
c. Forms of Public Private Partnership-All forms of PPP will be encouraged by the Government. As an indicative menu, the following broad models of PPP are some of the options for a way forward for PPP in Metro Rail:

    i. Construction of new Metro Rail systems through DBFOTs (Design-Build-Finance-Operate- Transfer);
    ii. Award of Concessions for operational services which could include supply of rolling stock;
    iii. Award of Concessions for maintenance and upgrading of infrastructure.

d. Private Participation in Operation and Maintenance (O&M)- With the increase of metro rail systems in the country coupled with the steady development of the expertise for managing the services in the private sector, metro rail agencies may explore the possibility of provisioning of rolling stock, signaling systems etc. and also maintenance and operation by a private entity. This would also bring in the managerial efficiencies, and entrepreneurial spirit of the private sector in the delivery of service.

Also, it is important to define the exact nature of private participation in the early stage of planning.

Some indicative models of O&M are:

Cost + Fee Contract: The authority/ owner pays the operator a monthly/ annual payment for operations and maintenance of the system. The remuneration given could comprise of a fixed fee and a variable component, which would depend on the quality of service provided. The operating and revenue risk are borne by the authority.

Gross Cost Contract: The operator is paid an agreed fixed sum for the duration of the contract. All risks related to operation and maintenance is borne by the operator and the revenue risk is assumed by the authority.

Net Cost Contract: The operator collects the complete revenue generated from the services provided. In case, the revenue generated is lower than O&M cost, the Authority may agree to compensate the difference in cost to the operator while finalizing the agreement. However, the operating and revenue risk are borne by the operator for the tenure of the contract.

e. Private Participation in non-core activities: Some metro companies have been successful in involving private participation in the Automatic Fare Collection System leading to higher efficiencies and sharing of the cost by the private partner. Other such non-core activates should be explored for unbundling on PPP mode.

E. Options of Central Assistance for Metro Rail Projects

The various options for central financial assistance for metro projects are as below:

i. **Public Private Partnership (PPP)**: Central financing for this model will be governed by the Viability Gap Funding (VGF) Scheme of Government of India or by any other guidelines issued or revised by Government of India from time to time.

ii. **Grant by the Central Government :** Central Government will consider providing a grant of 10% of project cost, excluding private investment, cost of land, rehabilitation & resettlement and tax, to the state government for the construction of a metro rail project. The release of the grant may be indexed with the progress of the project. However, public private partnership in some form for implementation, operation & maintenance, fare collection or any other unbundled activities of the proposed metro rail project, wherever feasible, will be required.

iii. **Equity Sharing Model:**

a. In this model, projects will be taken up under equal ownership of Central and State Government concerned through **equal sharing of equity**. The formation of a jointly owned Special Purpose Vehicle (SPV) will be an essential feature of this model. As is the prevalent structure, the SPV will be managed by a Board of Directors. The Managing Director of the SPV will be a nominee of the State Government so appointed with the prior approval of the Central Government. The ex-officio chairman of the SPV will be nominee of Government of India.

b. In this model, public private partnership (PPP) in some form for implementation, operation & maintenance, fare collection or any other unbundled activities of the proposed metro rail project, wherever feasible, will be required.

c. Government of India will provide financial support to metro rail projects in the form of equity and subordinate debt (for part of taxes), subject to an overall ceiling of 20% of the cost of the project excluding private investment, cost of land, rehabilitation and resettlement, after evaluating various parameters and as per extant practice and policies.

iv. Government of India on its own may take up, after due consultation with the concerned state government(s), in the existing equity sharing model or any other funding pattern and institutional arrangement, those projects which are necessary for a city or metropolitan region development.

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Attachment 4. Appraisal Guidelines

September 2017

Appraisal Guidelines for Metro Rail Project Proposals

Ministry of Housing & Urban Affairs
Government of India

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1. METRO RAIL POLICY, 2017

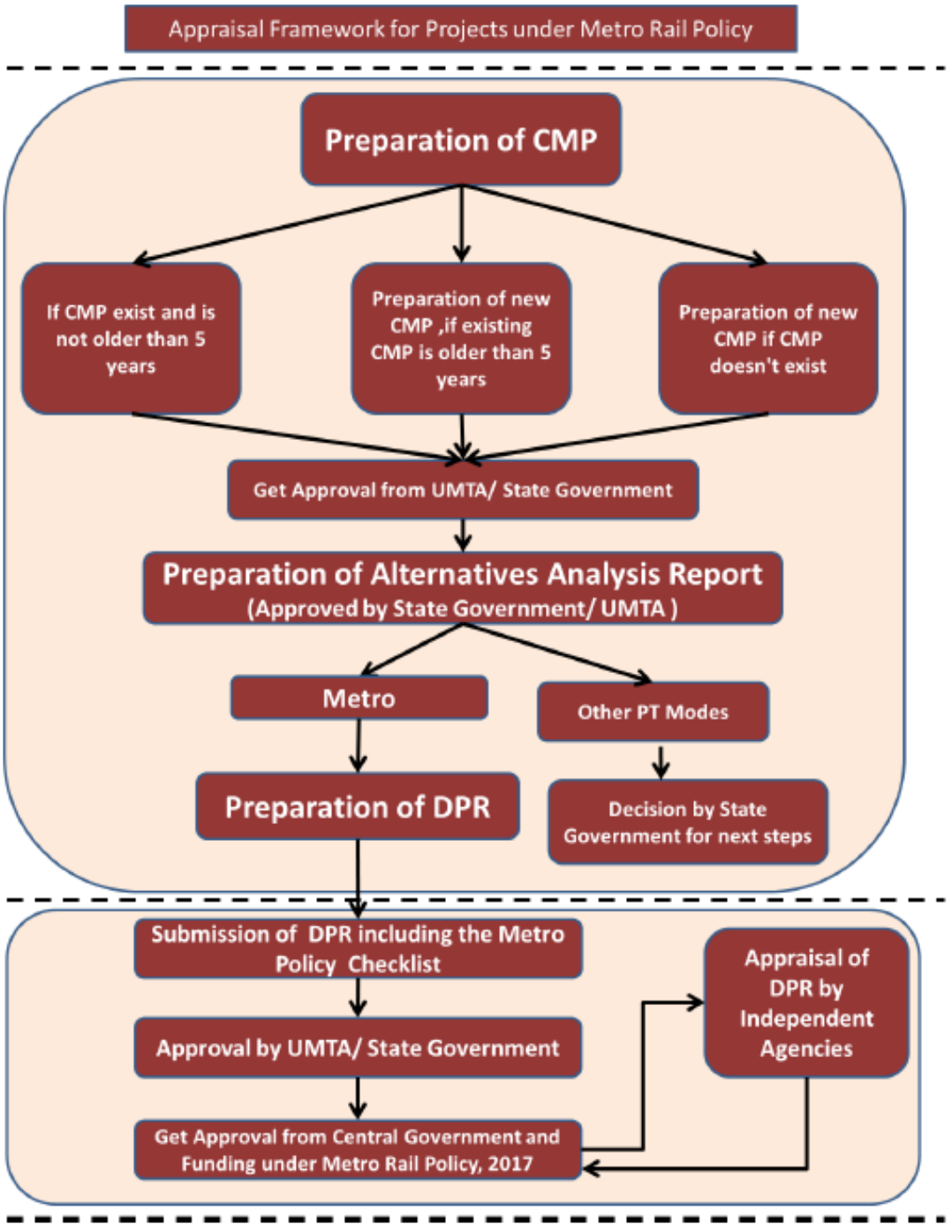
The Union Cabinet approved the Metro Rail Policy in August 2017. The following are some of the salient features of the 2017 policy:

- Recognition of the fast-growing need for improvements in the public transport system in a large number of cities
- Evaluation of various options of Mass Rapid Transit Systems (MRTS), along with a comparative analysis of alternate modes of transport to be a vital part
- Metro Rail system is often considered the most suitable urban transport system due to high capacity and speed, along with comfort
- Comprehensive Mobility Plan (CMP) a pre-requisite for planning metro rail systems in any city
- Integration of suburban systems with the proposed metro rail
- The Economic Internal Rate of Return (EIRR) of 14% and above essential requirement for sanctioning of metro rail, since metro rail projects have significant economic and social benefits
- Feeder systems up to a catchment area of 5 km of each metro station, and last mile connectivity to be included in metro rail project proposals
- Increased focus on maximizing non-fare box revenue and revenue through commercial development at stations and allocated land
- Efforts to be made towards reducing costs of construction and operations, with the aim to standardize sub-systems and components
- Exploration of various PPP models and encouragement for all forms of PPP, whether for full provisioning or for unbundled components
- Appraisal by an independent agency as identified by the Ministry of Housing and Urban Affairs(MoHUA).

2. NEW APPRAISAL FRAMEWORK

A new appraisal framework is required as per the Metro Rail Policy, 2017 for appraisal of the Metro Rail project proposals received for approval by the Central Government. This new appraisal framework is for internal use by the Ministry of Housing and Urban Affairs (MoHUA) for appraisal of project proposals. The guidelines for approval of proposed metro rail projects by other departments of Government of India would prevail. The new appraisal framework is given in the following sections as also represented in Figure 1.

Figure 1: Appraisal Framework for Projects under Metro Rail Policy, 2017



3. PREPARATION OF PROJECT REPORTS

The Project Reports will be the basis of evaluation, sanction or refusal of a Metro Rail project proposal. The methodology and guidelines for preparation of the Project Reports are discussed in detail in the subsequent sections. As urban transport is a state subject, State Governments would prepare the following reports.

(a) Comprehensive Mobility Plan (CMP)
(b) Alternatives Analysis Report (AA)
(c) Detailed Project Report (DPR)

3.1. COMPREHENSIVE MOBILITY PLAN

A Comprehensive Mobility Plan (CMP) is a long-term vision for movement of people and goods for a city and provides a strategy and investment program to meet the vision. The methodology for the preparation of a CMP is given below:

3.2. METHODOLOGY FOR PREPARATION OF CMP

3.2.1. Stage I: Define objectives of Mobility Plan and delineate Planning Area and Horizon of Mobility Plan

Task 1: Define Objectives and Vision of the Mobility Plan

- Define Objectives and Vision of the Mobility Plan. These objectives would aim at addressing the following aspects:
  - Develop a long-term strategy for the desirable city mobility pattern that recognizes all modes of transport and avoids a piecemeal and reactive approach to existing problems and those expected to arise in future.
  - Improve and promote public transport, non-motorized vehicles (NMVs) and facilities for pedestrians as important transportation modes.
  - Promote integrated land use and transport planning.
  - Develop an urban transport strategy that is in line with the current National Urban Transport Policy (NUTP).
  - Ensure that the most appropriate, sustainable and cost-effective investments are made in the transport sector.

Task 2: Delineation of the Planning area and planning horizon

- Delineation of planning boundary for Mobility Plan based on existing Planning and Municipal area boundary and in discussions with relevant agencies. The CMP should be made for a horizon period of 30 years and should to be reviewed after every 5 years and revised, if required.

3.2.2. Stage II: Data Collection and Analysis of the existing Urban Transport Environment

Task 3: Review of City profile, delineation of Traffic Analysis Zones and review of Land Use pattern and Population density

- Data on existing land use and land use plans should be collected and presented after a detailed review of existing development plans, including the Master Plan and/or the City

Development Plan (CDP). In particular, new development areas that will affect transport demand in the planning area should be highlighted.

- The secondary data collected should be utilized in studying the past and existing growth pattern, land use plan of the city and its suburbs. The data to be used in projecting future growth patterns, land use patterns and possible growth directions.
- In case, there are data gaps or the survey data is more than 2 years old, fresh primary surveys to be conducted, if considered necessary.

Task 4: Review of the Existing Transport Systems

A review of existing transport infrastructure and facilities should be done for each transport mode, including walking, bicycle, cycle rickshaw, shared auto-rickshaw, public transport and any other prevailing modes. The review will include all types of facilities and amenities including pavement description, intersection treatments, lighting, parking space, parking cost and operation-related parameters.

Task 5: Data Collection Approach - Methodology and Sources

- Relevant data should be collected from secondary sources like published reports (CDP, CMP or CTTS), city authorities or primary surveys.
- The. primary surveys to be carried out for the analysis of the existing urban transport systems are as follows:
  - Road Network Inventory Surveys (within city limits- All major arterials and important sub-arterials and local streets)
  - Classified Traffic Volume Count Surveys - 16 hours (Outer and Inner Cordon)
  - Speed and Delay Surveys – Peak hour and off peak hour
  - Pedestrian Count Surveys - 8 hours (peak hours)
  - Parking Surveys - 12 hours (peak hours)
  - Public Transport - Boarding and Alighting Survey (based on city travel characteristics)
  - NMT Opinion Surveys
  - Junction Turning Volume Counts - 12 hours

Task 6: Study of Existing Travel Behavior

Two important considerations that should be taken into account while collecting data on travel patterns are; the collected data should be representative and cover the travel behavior of all individuals within a household; and the data to be segregated by social group and trip purpose. The household surveys should be designed to assess different social groups effectively and to represent people's perceptions towards different modes of transport in terms of time, cost, comfort, safety and security. For understanding and analyzing the existing travel behavior and characteristics, the following additional primary surveys need to be conducted:

- Screen Line Classified Volume Count Surveys - 16 hours
- Household Interview Surveys (sample size should be between 1-2% depending on the size of the city)
- Road Side Interview Surveys - 8 hours (peak hours)

Task 7: Review of Energy and Environment

Quantifying energy consumption for transport is important for estimating the CO_2 and local air pollution emissions from transport-related activities. In order to create a complete picture, both top down and bottom-up approaches for estimating energy consumptions will be adopted.

Task 8: Analysis and Indicators

The impact of the projects in terms of service level benchmarks should be evaluated. Service level performance benchmarks identified as per the Ministry of Housing and Urban Affairs (MoHUA) guidelines are for the following areas of intervention:

- Public transport facilities
- Pedestrian infrastructure facilities
- Non-Motorized Transport (NMT)facilities
- Level of usage of Intelligent Transport System (ITS) facilities
- Travel speed (Motorized and Mass Transit) along major corridors
- Availability of parking spaces
- Road safety
- Pollution levels
- Integrated land use transport system
- Financial sustainability of public transport

As part of the study, the impact of the projects proposed should be evaluated in terms of improvement in the Service Level Benchmark (SLB) of each indicator and overall improvement in SLB.

3.2.3. Stage III: Development of Business as Usual (BAU) Scenario

Task 9: Framework for Scenarios

BAU Scenario represents the future based on the continuation of past trends, and is used as a counter factual reference or benchmark for assessing policy interventions. In terms of passenger transport, the BAU scenario predicts the increased car ownership and a higher demand for motorization. In terms of technologies, the scenario foresees continued reliance on fossil fuel cars, with improved efficiency and a greater share of electric and hybrid cars.

Task 10: Socio-economic Projections

City's future economic transitions depends on the current economic transitions taking place across the country. Demographic projections, Employment projections and Industrial growth projections will be done using the model and other parameters.

Task 11: Land Use Transitions

The land use type should be disaggregated into residential, commercial, retail, recreational, industrial, educational, religious, and other categories. Land use projections and allocations for the horizon years should be done in three steps. The first step includes the projection of socio demographics and the per capita space requirements for each activity in the city. The second step involves the allotment of activities based on connectivity and distances, as well as the availability of space. The third step includes the scope of the land use transition.

Task 12: Transport Demand Analysis

Demand for passenger transport should be estimated using a four-step model. The four-step model is based on an understanding of existing travel behavior obtained from the household survey, and provisioning existing transport infrastructure and service quality. The transport model to be developed must be a peak-hour model and not a daily model. After set up for the base year, the transport traffic flows on different road links should be compared with the actual traffic volume counts observed at various locations observed across the city.

Task 13: Technology Transitions

An understanding of vehicles, fuels and CO_2 emissions from electricity use in transportation system is essential to understanding the implications of travel demand on CO_2 emissions and air quality.

Task 14: Model Framework

The framework for sustainable urban mobility should utilize the four strategic levers: Urban form, Non-Motorized Transport (NMT), Public Transport and Technology. The framework should study the impacts of alternative strategies using key indicators for mobility, safety, and local environment, as well as more aggregate indicators like CO_2 and energy use.

3.2.4. Stage IV: Development of Sustainable Urban Transport Scenarios

Task 15: Framework for Scenarios

Review of Green House Gas Emission indicators for the BAU scenario as well as sustainable scenarios should be done, however, technological transitions for various scenarios should also be discussed in detail.

Task 16: Strategies for Sustainable Urban Transport Scenario

Various scenarios should be developed describing the plans and policies aimed at limiting private vehicle ownership and use. The scenarios also assume an increase in motorized transport to some extent, which is inevitable given the low level of vehicle use on a per capita basis. Therefore, emphasis should be placed on improving technology in terms of efficiency and emissions.

Task 17: Transport Demand Analysis of Alternative Strategies for Sustainable Urban Transport

Strategies on Urban Structure, Non-Motorized Transport infrastructure, Public Transport, Improving Public Transport, NMT and Urban structure, Technology options, Regulatory and financial measures should aim to improve transport infrastructure and increase the cost of using personal motorized vehicles. The transport model to be developed must be a peak-hour model and not a daily model.

Task 18: Technology Transitions under a Low Carbon Scenario

In the low carbon scenario, the fuel mix is expected to diversify further from BAU scenario towards bio-fuels, electricity and natural gas. With advanced technologies, vehicle efficiency will also improve, and thus the overall demand for fuels will be lower in the low carbon scenario.

Task 19: CO_2 Emissions and Air Quality

The model framework is same as the BAU scenario for estimating CO_2 Emissions and Air Quality. The indicators for the sustainable urban transport scenario are similar to those estimated for the base year.

3.2.5. Stage V: Development of Urban Mobility Plan

Task 20: Integrated Land Use and Urban Mobility Plan

Integrating land use with the urban mobility plan would entail a two-way interaction between the two plans. High density residential areas intertwined with high-density employment areas, along with increased travel costs and an efficient public transport system would encourage people to use NMT for shorter trips and public transport for longer ones, thus encouraging low-carbon mobility. To summarize, the land use plan should locate activities in a manner that encourages low-carbon mobility and the urban mobility plan, in turn, should facilitate access to activities.

Task 21: Formulation of Public Transport Improvement Plan

CMP details the Public Transport Improvement Plans into a number of sections, including service improvements for buses, trams and para-transit, appropriate MRT options and development plans, trunk and feeder network systems and intermodal facility plans. Formulating a public transport improvement plan in small sized Indian city can involve several challenges. These range from assessing transport demand to service provision and its alignment with land use.

Task 22: Preparation of Road Network Development Plan and NMT Facility Improvement Plan

A set of specific projects and policy measures would need be identified that the city authorities need to implement as part of the Mobility Plan. These projects and policy measures could be categorized as follows:

- Road network development Plan
- NMT facilities

Task 23: Preparation of Mobility Management Measures

In CMP, traffic management plans cover parking plans, traffic control measures, intermodal facilities, demand management measures, traffic safety plan and ITS.
Mobility management measures suggested in the CMP should enable use of public transit and NMT modes. Additional measures should be added to increase the cost and discourage the use of motorized travel, including the taxation of cars and fuel, land use planning that encourages shorter travel distances and traffic management by reallocating space on the roads.

Task 24: Preparation of Regulatory and Institutional Measures

Effective development of urban land use and transport systems often requires regulatory and institutional changes. Such requirements should be worked out in detail and documented in the CMP. These measures can be developed region-wide/ city wide or be project specific. The regulatory and institutional plan should include the following:
Regulatory measures in relation to:

- Bus service improvement (concession, privatization, and lease contract);
- Traffic safety improvement (traffic regulation, mandatory road user education, enforcement systems);
- Introduction of Transport Demand Management (TDM) measures;
- Vehicle emissions (focus on non-fuel based vehicles and compressed natural gas/CNG vehicles);
- Public-Private Partnerships (PPPs).

Institutional measures in relation to:

- Coordination mechanism to integrate public transport operation and to integrate fares;
- Establishment of Unified Metropolitan Transport Authorities (UMTA); if not in place earlier
- Establishment of SPVs for the implementation of proposed projects; and other changes necessary to promote PPPs.

Task 25: Development of Fiscal Measures

Fiscal measures should be considered to achieve a balanced modal split, and to secure the budget necessary to implement urban transport projects. As fiscal measures usually correspond to institutional and regulatory measures, the following aspects may have to be examined in the CMP document:

- Fare policy for public transportation, and parking;
- Subsidy policy for public transport operators;
- Taxation on private vehicles and public transport vehicles; and
- Potential for road congestion charging.

Task 26: Mobility Improvement Measures and NUTP Objectives

The land use and transport measures proposed in the CMP should improve mobility in the metropolitan area and cover the critical issues addressed in the NUTP. A table can be prepared summarizing the relationship between the NUTP objectives and the measures proposed in the CMP, together with a classification of the measures according to their implementation time frame (short, medium and long term).

3.2.6. Stage VI : Implementation Plan

Task 27: Preparation of Implementation Programs

The necessary interventions for public transport improvement plans, road development plans, NMT facility improvement plans and mobility management measures are listed next into a set of actionable projects to be implemented in the city and prioritized into the following categories

- Short term (next 2-5 years)
- Medium term (5-10 years)
- Long term (more than 10 years)

All the projects should be presented to the city stakeholders and the suggested implementing agencies identified for each project.

Task 28: Identification and Prioritization of Projects

- Short-term measures are aimed at improving the safety and accessibility of pedestrians, cyclists and public transport users through area level traffic circulation plans and measures like implementing traffic signals.
- Medium-term measures typically involve corridor-level projects like implementing cycle tracks and mass-transit corridors, city level initiatives like public transport fleet improvement and efficient scheduling, developing area level cycle networks and Public Bicycle Sharing (PBS) schemes, parking policy development and implementation in the city. They are primarily aimed at restricting the decrease in the city's public transport and non-motorized transport mode shares.
- Long-term measures include implementing the overall vision of the CMP. These project ideas are presented to the stakeholders in order to get their feedback on both the projects and their prioritization. The final list of identified projects should include the implementation framework, cost estimates and the likely funding options.

Task 29: Funding of Projects

The various project-funding options would be assessed, identifying the projects amenable to PPP and those that can be implemented based on the government sources of funding from the city, State Government and Central Government schemes. Alternative and innovative sources of funding should be identified to reduce the investment by various Government agencies.

Task 30: Monitoring of CMP Implementation

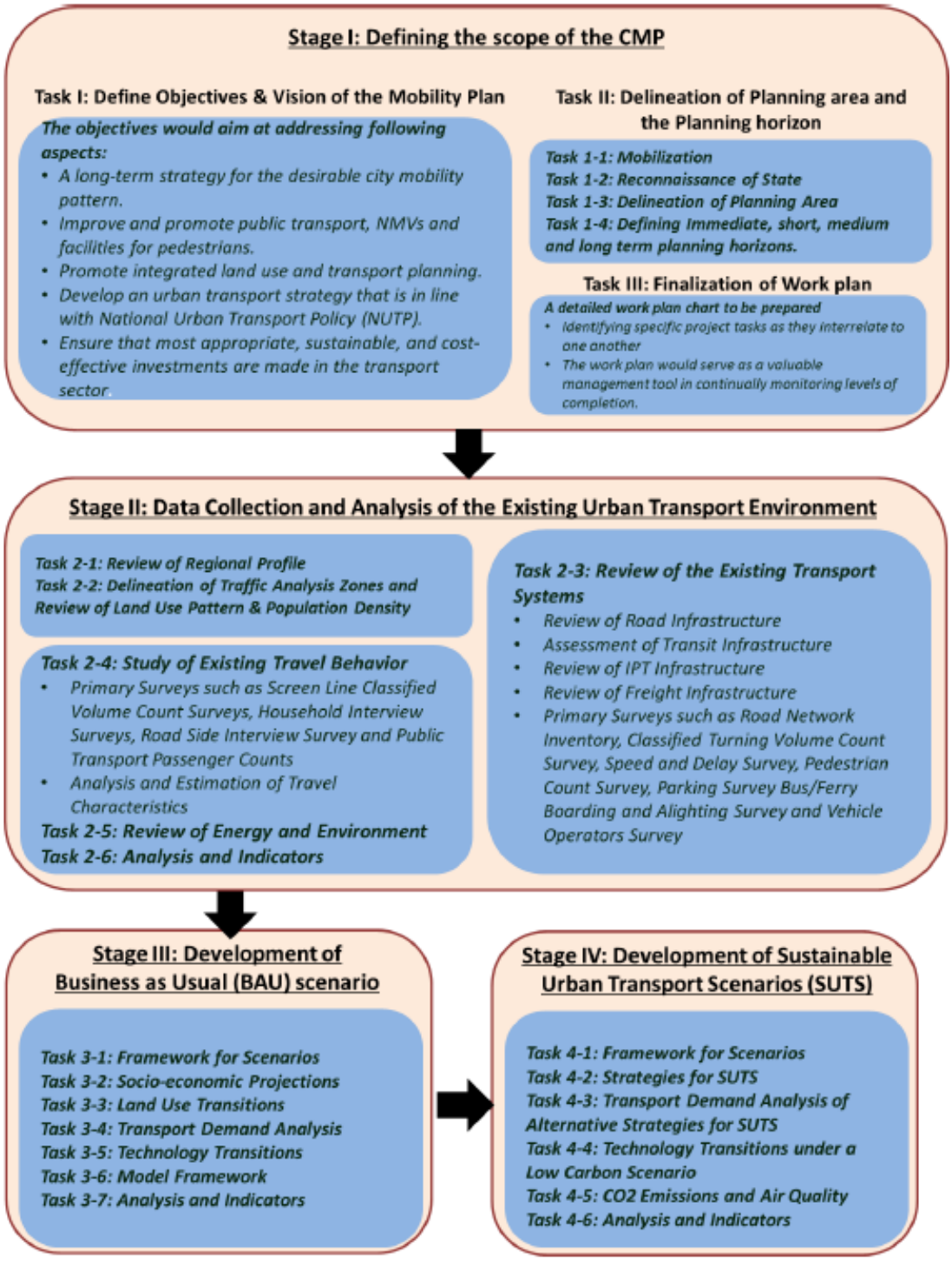
CMP is the basis for approving projects, plans and various regulatory measures within the city related to transport and it is therefore important to monitor and measure the impact of interventions. Agencies responsible for implementation of the projects and monitoring the progress of implementation of urban transport projects should be identified.

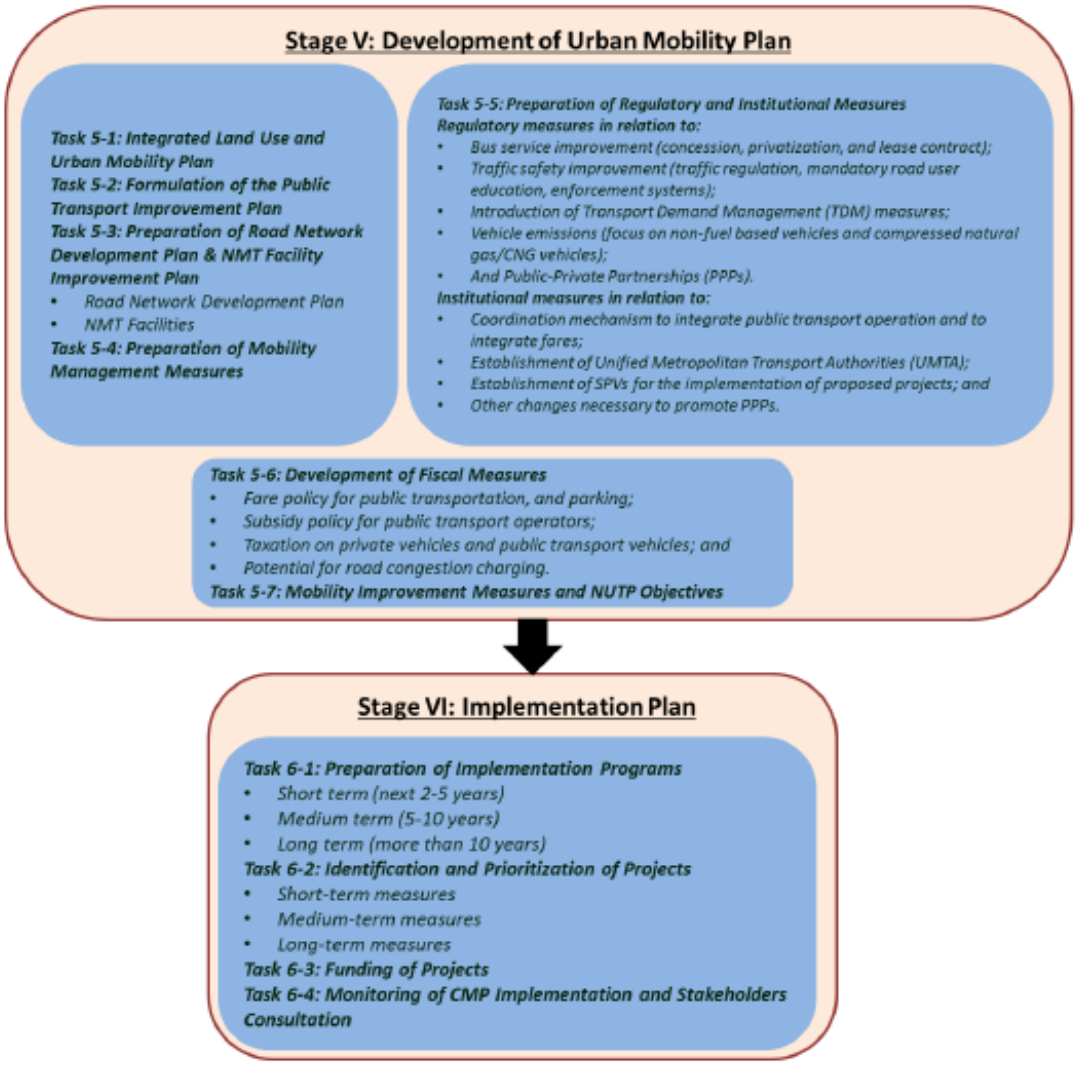
Task 31: Stakeholders Consultation

Stakeholders' consultation should be done after each major stage of the CMP such as the draft stage to ascertain their feedback and comments on the proposals and projects for improving urban transport.

The methodology flow chart for preparation of CMP is given in Figure 2:

Figure 2: Methodology flow chart for preparation of CMP





The Table of Contents for preparation of CMP is given in the **Annexure I**.

3.3. ALTERNATIVES ANALYSIS REPORT

3.3.1. Introduction

Alternatives Analysis (AA) is about finding the best alternative to solve transport related problems mainly in a particular corridor or sometimes in a sub-area. Based on inputs from the CMP, evaluate all the feasible alternatives across all modes of transportation and recommend the most feasible transport system(s) for the city that would alleviate the traffic and transportation problems of the city.

3.3.2. Objectives of Alternatives Analysis

The key objective of conducting an Alternative Analysis is mainly to:

- Ensure that reasonable transportation alternatives are considered
- Evaluate all impacts due to the project
- Consider opinion of Stakeholders
- Select the locally preferred alternative

3.4. METHODOLOGY FOR ALTERNATIVES ANALYSIS REPORT

The Methodology for preparation of Alternatives Analysis Report is given below:

3.4.1. Stage I: Develop Screening Criteria for the identified Alternative Options

Task 1: Develop screening criteria to identify the most reasonable and feasible alternatives based on the options suggested in CMP

The screening criteria may include the broad criteria of

- **Mobility Effects**: These criteria relate to travel demand forecasting and facility capacity, presence/absence of different modes, access, connectivity and circulation.
- **Conceptual Engineering effect**: These criteria relate to developing all civil aspects of the system
- **Financial and Economic Effects**: To identify and quantify the benefits and costs associated with the project to help in identification of the optimum solution along with the economic viability in terms of its likely investment return potential.
- **Environmental and Social Effects**: Screening criteria assessing environmental impacts related to land-use and natural environment like water, air etc. The social impact of the alternatives is evaluated to see potential social costs and benefits.
- **Cost Effectiveness and Affordability**: The capital and annual costs associated with each of the alternatives would be evaluated. It also assesses the cost-effectiveness and affordability of the alternatives.
- **Other Factors**: How each of the alternatives comply with the local policies and priorities are assessed.

Task 2: Qualitative Evaluation of Screening Criteria

First-level screening criteria will be developed to quickly and efficiently identify the alternatives considering all available modes of transportation that most warrant

further consideration and evaluation, which will include preliminary qualitative evaluations to narrow the number of alternatives.

Task 3 : Quantitative Evaluation of Screening Criteria

With the first screening of alternatives considering all available modes of transportation completed, the second level of evaluation involves quantitative screening, wherein various parameters will be screened based on quantitative assessment.

3.4.2. Stage II : Evaluation parameters of various Alternatives

Task 4: Mobility Effect

Travel Demand Forecasting: The primary purpose of this task is to assess the most current version of the City/regional travel demand model (from CMP) for base year data, with available future year networks and land use data, and model documentation. While preparing the travel demand analysis, following tasks need to be completed:

a. Identify available transport system, right of way of roads in city and along corridor
b. Prepare road and transit networks for each alternative and a no-project scenario (without project).
c. Summarize the travel demand results for existing and all future year alternatives, including corridor and region-wide travel demand, peak period volumes and congestion levels, and person trips by mode for the corridor and the region.
d. Analyze the differences among the alternatives to provide information to Environmental Assessment (in Task 6).
e. Opportunity for intermodal integration at various levels
f. Similar analysis to be conducted for the future horizon year to assess how conditions would change over time.

Task 5: Conceptual Engineering Effect

Further to refine the range of alternatives to a sufficient level of detail to compare the relative differences between alternatives, conceptual engineering report must be prepared for all feasible alternatives, including those specified in the Comprehensive Mobility Plan (CMP) and any other viable/practical "alternative" (or combination of features that are not identified in the CMP).

(a) Geotechnical
- Prepare preliminary foundation reports, soil investigations, water data and other information that are necessary to allow preliminary evaluation of alternatives.
- Develop other information concerning adjacent structures impacted by the project, water treatment considerations and information concerning wetlands.
- Perform investigations and analysis necessary to assess aspects of soil and foundations behaviors based on the suitability of each alternative system

(b) Civil Structures
- Provide preliminary design of bridges, retaining structures and other permanent or temporary structures associated with alternatives selected for evaluation.

- Develop sufficient detail concerning the structures to allow preparation of preliminary cost estimates.
- Identify the road space to be occupied by civil structure and the project permanently/temporarily

(c) Station Planning (Bus Stations/Rail Stations etc.)

- Provide preliminary design including geometrics, structural design, shoring and architectural design. Identify the road space to be occupied by station (either underground or elevated) and the project permanently/temporarily.

(d) Utilities

- Identify the existing utility available and how many will be required to be shifted.

(e) Right-of-ways

- Research and report on the status of current right-of-ways and other properties potentially affected by the project.
- Prepare estimates of the valuation of any property to be permanently acquired or needed for temporary construction easements, as also how the project will the social effect for the city

(f) Other Planning Parameters like impacts on parking, inter-modal connectivity, etc.

Task 6: Environmental Effect: Environmental Assessment

The purpose of the preliminary environmental analysis is to identify environmentally sensitive areas early on, so that these areas can be avoided if possible during design. The preliminary environmental analysis will also assist in determining the level of additional environmental documentation that will be required in subsequent project phases. A screening-level analysis or environmental scan will be conducted to determine the potential environmental impacts of each alternative identified.

Task 7: Social Effect: Social Assessment

- Preliminary screening of the social impacts for each alternative including Social Impact Mitigation including R&R impacts. A detailed assessment would be done at the DPR stage. Stakeholders Consultations to be carried out at important stages.

Task 8: Cost Effectiveness and Affordability

- Project cost estimates: Provide preliminary cost estimates based upon conceptual engineering completed for alternatives selected for evaluation. Detail items of work, estimates of quantities and costs shall be included at DPR stage.
- Provide estimates of costs for all project elements including right-of-ways, easements, relocations, environmental mitigation, protection of facilities and any other elements affecting project cost.

Task 9: Financial and Economic Effect

- Prepare a preliminary project financial plan, which outlines a realistic strategy for implementing the project alternatives.
- Public and private funding options should be considered in developing the plan.
- To identify and quantify the benefits and costs associated with the project to help in identification of the optimum solution along with the economic viability in terms of its likely investment return potential.

The plan should also identify any appropriate phasing of corridor segments, and include

a financial strategy for implementation of phased independent segments with the goal of providing a complete project corridor.

3.4.3. Stage III: Alternatives Evaluation

The objective is to conduct an evaluation that would lead to the identification of those alternatives that is most likely to be implemented. The goal is to conduct an evaluation that would lead to the identification of those alternatives that are most likely to:

a. Meet the purpose and need identified for the project.
b. Concurrently avoid or minimize environmental and community impacts.
c. Allow for effective and feasible project phasing and constructability.
d. Provide a cost-effective transportation investment.
e. The evaluation of alternatives should include a No-Build Alternative (without project).

A Draft Alternatives Report describing reasonable and feasible alternative(s) that are recommended should include the analysis supporting the recommendation. The scoring can be done for each of the alternatives which shall be the basis for comparing alternatives. The option with highest score may be considered for further preparation of DPR.

3.4.4. Stage IV: Implementation Options for the most viable Alternative

The implementation options should be identified for best suitable alternative. If metro system is identified as the most viable alternative, then implementation options needs to be explored for those projects seeking Central Financial Assistance (CFA) as mentioned in the Metro Rail Policy, 2017. The various options for CFA for these metro projects are as below:

I. Public Private Partnership (PPP): Central Government financing to be governed by the Viability Gap Funding (VGF) Scheme of Government of India or any other Guidelines issued by Government of India from time to time.
II. Grant by the Central Government: Central Government will consider providing a grant upto 10% of project cost excluding items as mentioned in the Metro Policy 2017, which do not seek project funding as per the VGF Scheme of GoI or under the Equity Sharing Model.
III. Equity Sharing Model: Central Government will provide financial support to Metro Rail projects upto 20%of the project cost excluding items as per the Metro Policy 2017.

PPP models should be explored for implementation as per the Metro Rail Policy, 2017. Private participation either for complete provisioning of metro rail project or for some unbundled components will form an essential requirement for all metro rail project proposals seeking Central Financial Assistance. The PPP model options as per the Metro Rail Policy, 2017 that could be taken up for implementation are:

- Construction of new Metro Rail systems through DBFOTs (Design-Build-Finance-Operate- Transfer);
- Award of Concessions for operational services which could include supply of rolling stock;
- Award of Concessions for maintenance and upgrading of infrastructure.

Further, Private Participation in Operation and Maintenance also to be explored for

implementation. It is also important to define the exact nature of private participation as per the Metro Rail Policy, 2017. The indicative models of O&M mentioned in the Policy are:

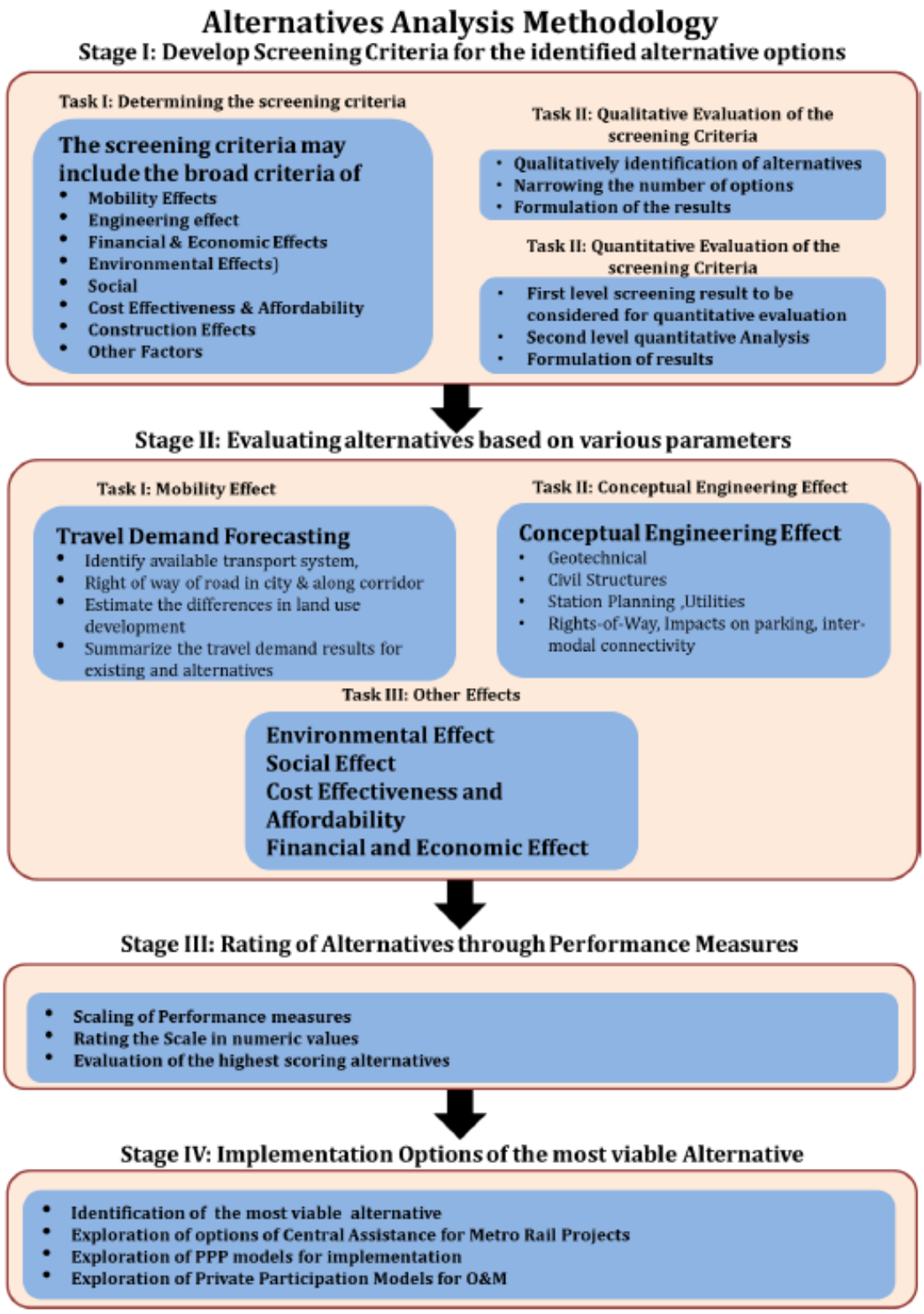
- Cost + Fee Contract
- Gross Cost Contract
- Net Cost Contract

Thus, based on the above available alternatives, the State Government needs to decide the Metro Project Implementation options

(a) Whether the project should be implemented on a PPP framework eligible under the VGF Guidelines of Government of India; or
(b) Whether the project should be implemented on a PPP framework with some component of the project being implemented on PPP model; or
(c) Whether the project should be implemented on an Equity Sharing Model with some form of PPP for any component of the project , wherever feasible.

The Methodology flowchart for preparation of Alternatives Analysis Report is given in Figure 3.

Figure 3: Methodology flow chart for preparation of Alternatives Analysis Report



The Table of Contents for Alternatives Analysis Report is given in Annexure II.

3.5. DETAILED PROJECT REPORT

The DPR along with the checklist for compliance with Metro Rail Policy 2017, as given in **Annexure V** needs to be submitted to the Central Government for approval. The DPR should be prepared in conformity to the Standards and Specifications for Metro Rail projects that have been issued/ being issued by MoHUA from time to time.

3.6. METHODOLOGY FOR PREPARATION OF DETAILED PROJECT REPORT

The Methodology for preparation of DPR is given below:

3.6.1. Assessment of existing city profile with existing transport characteristics

Task 1: A brief overview of the city in terms of its growth, economy, spatial structure and trends, perspectives on the future growth. Overview of study areas and existing plans with land use distribution, review of zoning Regulations, employment distribution by Traffic Zones, land use plan proposals should be done.

Task 2: Brief review of previous transport studies like City Master Plan, Comprehensive Mobility Plan and proposed Metro Rail plan and other urban transport proposals. A brief showing interconnection among City Master Plan, Comprehensive Mobility Plan and proposed Metro Rail plan should be given.

3.6.2. Travel characteristics and demand estimates

Task 3: Describes the components of urban transport system in terms of status, trends and gaps based on primary survey data, present travel patterns and forecast for the future travel demand.

Task 4: Based on primary survey data and various traffic and transportation studies undertaken for the city, the present travel patterns and forecast for future travel demand should be done.

Task 5: Travel demand analysis, model framework, model calibration, summary of travel demand patterns and ridership assessment for horizon year.

3.6.3. System and Technology Selection

Task 6: Identification of suitable transit technology and the system specification to be adopted for the corridor including the rationale for choosing a particular technology as per the prescribed specification as issued by MoHUA from time to time. The technology chosen should not be a proprietary technology of any vendor.

3.6.4. Corridor alignment description

Task 7: Alignment description of approved alignment, with detail about site conditions specifying road geometrics, utilities available along the corridor

Task 8: Detailed analysis of corridor options with grade selection for construction. Design norms for track geometry, fixed structure clearance, geotechnical details with new innovative techniques to be used for implementation in civil works, track system etc.

Task 9: Identification of existing services/utilities, if any

Task 10: Detailed estimation regarding land requirement for the corridor, depots, stations, parking, multi modal stations etc. with land ownership

3.6.5. Station Planning

Task 11: Station planning with preparation of general layouts based on type of station and site specific conditions focusing on:

- Station Area planning for non-motorized vehicles and pedestrians' facilities, multi modal integration with existing modes, feeder service planning.
- Accessibility for differently abled persons including specifying parking at stations for private and para transit facilities.
- Platform widths based on Station loadings and the minimum width to be provided.

3.6.6. Intermodal Integration

Task 12: Prepare an Intermodal Integration Plan focusing on how the Metro Rail will integrate with the existing transportation systems/proposed transit system and introduction of a feeder system, integrated with the proposed Metro Rail project for improving last mile connectivity. This will include not only preparation of an operational plan for feeder system but also infrastructure that need to be upgraded/ improved or introduced for improving the intermodal integration with other modes of public transport to improve the viability of the project. Recommendations for institutional integration, physical integration, fare integration, operational integration and technology integration would also need to be elaborated in the report.

3.6.7. Train Operation Plan

Task 13: System operation approach, station yard planning, trains operation plan including system frequency, timetabling, rolling stock requirement, stabling details.

3.6.8. Signaling and Telecommunication

Task 14: Identification of Signaling and System control, Operation Control Centre (OCC), maintenance requirement, technology selection and choice of automation

Task 15: Identification of Telecommunication System, System Traffic Control, maintenance and emergency communication, Passenger Information System (PIS)

3.6.9. Fare Collection System

Task 16: Detailing the specifications for Automatic fare collection system, Ticketing and pass system, Fare System integrated with other transport Systems including integration of fares of all available modes with the Metro system planned as per the guidelines issued by MoHUA (such as National Common Mobility Card).

3.6.10. Rolling Stock

Task 17: Technology selection, identification of rolling stock adopted as per Guidelines laid by MoHUA. Rationale for deviations, if any in choice of rolling stock parameters from the prescribed specifications and standards prevailing and Rolling stock requirement for various horizon years should be specified.

3.6.11. Power Supply and Traction System

Task 18: Choice of electric traction system. Projected power demand, Source of power supply, Traction and Auxiliary Supply and supervisory control and data acquisition system. No. of tractions and their locations.

3.6.12. Ventilation and Air Conditioning System

Task 19: Need for Ventilation and Air Conditioning, design parameters and design concepts for VAC System with details on tunnel ventilation, station ventilation and air conditioning of ancillary spaces including specifications for control and monitoring facilities.

3.6.13. Depots

Task 20: Identification of Depot locations. Approach to maintenance of depot facilities and workshop along with detailed designs and layout plans.

3.6.14. Environment and Social Impact Assessment

Task 21: Existing scenario, with analysis on water quality, noise level, land environment, biological environment etc.

Task 22: Environmental norms and Regulations, Detailed Environment Impact Assessment (EIA), Environment Management Plan (EMP), formation of an Environmental Management System (EMS) and costs estimates for Environment Impact mitigation measures.

Task 23: Detailed Social Impact Assessment (SIA) including R&R assessment, Resettlement Impacts, Resettlement Assistance Plan (RAP) and Monitoring and Evaluation Framework.

3.6.15. Disaster Management and Security Measures

Task 24: Disaster Management, Disaster Management imperatives, Objectives of Disaster Management Plan, Systems to cater for disasters and Security Systems recommended for MRTS and Safety and Security Measures.

3.6.16. Cost Estimation

Task 25: Detailed project cost estimates

- Capital cost estimates including taxes and duties
- Innovations proposed to reduce the cost of system
- Estimation of Operations and Maintenance Cost and the assumptions made thereof

3.6.17. Transit Oriented Development Plan

Task 26: The potential for Transit Oriented Development along the metro corridors based on the guidelines issued by MoHUA to be developed including densification of corridor by increasing FSI and land value capture as per the guidelines issued by MoHUA. Guiding list of lands/areas amenable for change in near future e.g. vacant land, low rise development relocation etc., use type.

3.6.18. Financial Analysis and Non Fare Box Revenue Assessment

Task 27: Estimations and inputs for the corridor, estimation for O & M, overheads, phasing of construction and lease of Built up Area (BUA), Operational viability of the project

Task 28: Means of finance, revenue from different sources, fare box revenue, non-fare box revenue, like advertisement, taxes and property development etc, possible ways of funding the project using different approaches. Alternative means of funding the project using different approaches Like PPP, BOT, DBFOT, DFBOT, Developer Finance Model Etc. and need to identify the proposed funding /implementation model in line with the Metro Policy 2017.

Task 29: Financial Returns: FIRR with 30 year time horizon, Sensitivity analysis should be done based on scenario building with variation in ridership estimates scenarios, costs estimates and Time overrun. Alternative scenarios based on the different options for funding /implementation of the project should be evaluated. A project should be able to meet its financial requirement for cost recovery and under a set of plausible assumptions be able to self-finance its activities. The State Governments will have to ensure the financial sustainability of the project through financial assistance.

3.6.19. Economic Analysis

Task 30: The Economic analysis should include economic cost and benefit analysis of the project and estimation of the EIRR for a period of 30 years as per the methodology for economic cost and benefit analysis as given in **Annexure IV**.

3.6.20. Implementation Plan

Task 31: Project implementation structure, if proposed to be implemented under various alternatives such as public or PPP model, role, responsibility and involvement (including financial stake) of the city government along with other government agencies in metro rail project, needs to be elaborated in the report.

3.6.21. Institutional Arrangement and Stakeholders Consultation

Task 32: Legal and Institutional Framework for implementation of the project based on the identified implementation plan should be included in the report. Stakeholders' consultation should be held at each major stage of the project such as the Corridor Alignment Report and the Draft DPR stage.

The Table of Contents for preparation of DPR is given in **Annexure III.**

4. ANNEXURES

4.1. ANNEXURE I: TABLE OF CONTENTS FOR COMPREHENSIVE MOBILITY PLANS

The following are the Table of Contents for Comprehensive Mobility Plan:

S.No Chapters

Executive Summary

1. **Introduction**
   - 1.1. Define sustainable mobility principles
   - 1.2. Impact of regional/national framework
   - 1.3. National Urban Transport Policy
   - 1.4. Delineation of Planning Area
   - 1.5. Define objectives and vision of Mobility Plan
   - 1.6. Review availability of resources
   - 1.7. Stakeholder's identification
   - 1.8. Approach and Methodology

2. **Review of City Profile**
   - 2.1. Review of existing Transport system
   - 2.2. Transport demand surveys
   - 2.3. Review of existing land use pattern
   - 2.4. Analysis of existing Traffic/Transport conditions
   - 2.5. Traffic volume count
   - 2.6. Road network Inventory
   - 2.7. Modal share
   - 2.8. Speed and delays surveys
   - 2.9. Parking surveys
   - 2.10. Non-motorized transport surveys
   - 2.11. Future land use developments plan
   - 2.12. Review of Energy and Environment
   - 2.13. Analysis and Indicators

3. **Transport Demand Assessment**
   - 3.1. Development of Business as Usual (BAU) scenario
   - 3.2. Development of Sustainable Urban Transport Scenario
     - Framework for scenarios
     - Strategies and plans for Sustainable Urban Transport
     - Transport Demand analysis of Alternative strategies for Sustainable Urban Transport
     - Technology transitions under a Low carbon scenario
     - CO_2 emissions and Air quality
     - Analysis and Indicators (Comparison with benchmarks)
   - 3.3. Conclusions

4. **Development of Comprehensive Mobility Plan**
   - 4.1. Integrated land use and Urban mobility plan

4.2. Formulation of Public Transport Improvement plan
4.3. Preparation of Road Network Development Plan
4.4. Preparation of NMT (Non-Motorised Transport) Facility Improvement Plan
4.5. "Inter-modality" -Integrated development of all modes including non-motorised transport
4.6. Freight Movement Plan
4.7. Plans for Intelligent Transport System
4.8. Traffic management measures
4.9. Action plan and budget plan
4.10. Monitoring and evaluation plan
4.11. Inform and engage stakeholders including citizens
4.12. Development of Fiscal measures
4.13. Mobility improvement measures and NUTP Objectives
4.14. Impact of the proposed measures on Service Level Benchmark

5. Implementation Plan

5.1 Preparation of implementation programs
5.2 Prioritization of sub-projects
5.3 Funding of projects
5.4 Monitoring of CMP
5.5 Stakeholders Consultation

4.2. ANNEXURE II: TABLE OF CONTENTS FOR ALTERNATIVES ANALYSIS

S.No. Chapters

Executive Summary

1. Need of Study
1.1 Background
1.2 Guidelines for Alternatives Analysis
1.3 Overview of Study Area
1.4 Regional Goals and Objectives
1.5 Project Purpose
1.6 Need for Proposed Project

2. Study Area and Existing Conditions
2.1 Study Area Description
2.2 Existing Roadway Network
2.3 Existing Transit Service
2.4 Other Transportation Corridors
2.5 Existing Land Use and Zoning

3. Conceptual Transportation Alternatives as per CMP
3.1 Planning Considerations
3.2 Description of Alternatives
3.3 Constraints

4. Screening Criteria for the identified Alternative Options
4.1 Screening Parameters
4.2 Evaluation Parameters of various Alternatives
4.2.1 Mobility Effect with Travel Demand Forecasting for each alternative mode considered
4.2.2 Conceptual Engineering effect with details Geotechnical investigation, Civil Structures, Station Planning (Bus Stations/Rail Stations etc.), Utilities, Rights-of-Way, Other Planning Parameters like impacts on parking, inter-modal connectivity
4.2.3 Financial and Economic Effects
4.2.4 Environmental Effects
4.2.5 Social Effects
4.2.6 Cost Effectiveness and Affordability
4.2.7 Other Factors

5. Screening and Alternatives Evaluation based on grading for each mode
5.1 Evaluating based on scoring criteria
5.2 Screening Results
5.3 Alternatives Evaluation

6. Implementation Options for viable Alternative
6.1 Implementation Options
6.2 Pros and cons of each Option
6.3 Most suitable option for Implementation

4.3. ANNEXURE III: TABLE OF CONTENTS FOR PREPARATION OF DETAILED PROJECT REPORT (DPR)

Chapter	Content
	Executive Summary
1.	**A Profile of the City**
	A brief overview of the city in terms of its growth, economy, spatial structure and trends are analysed and perspectives on the future growth are presented.
1.1.	General/historical background
1.2.	Location, climate, physical setting, regional linkages
1.3.	Demographic and socio economic profile: population growth, density, migration patterns, spatial patterns of growth, projections for next 20 years
1.4.	Urban Land Use Structure / Activity Distribution Planning study areas and existing plans, existing land use distribution, review of zoning regulations (zoning and FSI pattern and its appropriateness), employment distribution by Traffic Zones, activity locations (Business areas, University, Hospitals, Transport Terminals), land use plan proposals (Master Plan and CDP strategy), road network pattern (Add compliance checklist)
2.	**Existing Transportation System in the City**
	Describe the components of urban transport system in terms of status, trends and gaps.
2.1.	Introduction
2.2.	Vehicular growth and composition
2.3.	Road network characteristics, Network inventory including length, width, Bridges, RoBs, flyovers, network pattern, missing links etc.
2.4.	Major transport nodes e.g. Railway. Station, ISBT, Airport and Traffic handled
2.5.	Pedestrian and NMV facilities
2.6.	Traffic Management Including parking management
2.7.	Traffic Characteristics, Volume, traffic composition, speed and delays, pedestrian and NMV movement
2.8.	Traffic safety
2.9.	Intermediate Public Transit (IPT)System : Composition, status and role
2.10.	Public Transportation System Type, status and trends in terms size, service, routing, fare, patronage, financial performance, institutional framework, responsible agency and Act, constraints
2.11.	Past proposals from CMP/CTTS/Transport Master Plan Based on Transport Master Plan/CMP, it should focus on moving people and not vehicles. It should integrate land use with transport plan including mass transit systems connectivity to all new/ future satellite townships/emerging activity centres (SEZ's), main network and feeder network including pedestrian and NMVs, phasing of implementation
2.12.	A brief showing interconnections among city Master Plans/Development plans, Comprehensive Mobility Plan and proposed Metro Rail Plan
2.13.	Issues and Prospects
3.	**Travel Characteristics and Demand Estimates**
	Based on primary survey data, present travel patterns and forecast the future travel demand

3.1. Details of various traffic and transportation studies undertaken for the city
Study area, Zoning, Land use surveys, Transportation surveys: Classified volume counts, road side interviews, OD Surveys, willingness to pay/use Surveys, Traffic surveys, Speed-Delay surveys, Parking surveys

3.2. Socio-Economic Characteristics
- Age wise distribution of Population, Activity status (Work, Education), Income distribution, Vehicle ownership
- Travel characteristics, trip rate, trip purpose, mode choice, trip length, monthly expenditure on travel, spatial pattern of passenger movement, mobility patterns and needs of women, old aged, physically challenged

3.3. Travel demand analysis
model framework, model calibration, summary of travel demand patterns

3.4. Future travel demand scenarios

3.5. Ridership assessment for horizon year

4. System and Technology Selection

4.1. Technology

4.2. System specification to be adopted for the corridor

5. Civil Engineering , Alignment details

5.1. Alignment description of approved alignment, availability of road space

5.2. Analysis of corridor options to be Elevated, Underground or At Grade

5.3. Design norms-Track geometry, Fixed structure clearance, Geo-technical details with new innovative techniques to be used for implementation in civil works, track system etc.

5.4. Geometric design of Corridor including plan/profile.

5.5. Identification of existing services/utilities, if any

5.6. Land requirement for the corridor, depots, stations, parking ,multi modal stations etc.

5.7. Ownership details of the land required for the corridor

6. Station Planning

6.1. Station planning-elevated/underground based on site specific

6.2. Station area planning for Non-Motorized Vehicle and pedestrians facilities

6.3. Accessibility for differently-abled

6.4. Parking on stations for public bike sharing, commensurate parking lots for cycles and personal vehicles, as well as adequate arrangement for receiving and dispatch of feeder buses at all metro stations and for IPT system

7. Intermodal Integration

7.1. Inter modal integration with existing modes

7.2. Feeder service planning from stations, fleet requirement, route planning,

7.3. Physical infrastructure requirement for integration with other modes

7.4. Recommendations for Institutional integration, Physical integration, Fare integration, Operational integration and Technology integration

8. Train Operations Plan

8.1. System operation approach, Station yard planning, Train operations plan

8.2. System frequency, Time-tabling

8.3. Rolling Stock requirement, stabling details

9. Signaling and Telecommunication

9.1. Signaling and System Control, Planning for Operation Control Centre(OCC) with System communication system, Electronic interlocking in stations and Depots , Maintenance requirement for maintaining and running an efficient system, Technology selection and choice of automation

9.2. Telecommunication, System shall cater to the needs of System traffic control, features to supplement signaling system, maintenance and emergency communication, passenger information system, etc.

10. Fare Collection System

10.1. Ticketing and access control

10.2. Automatic fare collection system options available, Ticketing and Pass System

10.3. Fare System integrated with other Transport System

11. Rolling Stock

11.1. Referring to system adopted ,type of rolling stock adopted as per guidelines issued by MoHUA from time to time

11.2. Rationale for deviation, if any in choice of rolling stock parameters from the prescribed specifications and standards prevailing

11.3. Rolling stock requirement for various horizon years for identified system

12. Power Supply and Traction

12.1. Choice of electric traction system

12.2. Power supply, total projected power demand

12.3. Source of power supply

12.4. Traction Power Supply and traction overhead equipment, if applicable

12.5. Auxiliary power supply network

12.6. Supervisory control and data acquisition system

13. Ventilation and Air Conditioning System for Rail based System

13.1. Alignment Analysis, need for Ventilation and Air Conditioning

13.2. Internal design conditions in Underground stations, if provided

13.3. Design parameters and design concepts for VAC System

13.4. Station ventilation and Air Conditioning of ancillary spaces

13.5. Tunnel ventilation system, in case the same is provided

13.6. Control and monitoring facilities

14. Depots

14.1. Depot location and number, approach to maintenance

14.2. Design of depot facilities and workshop with layout plans

15. Environment and Social Impact Assessment

15.1. Existing scenario, water quality, noise level, land environment, biological environment, socio economic survey, archeological sites, if any

15.2. Environmental norms and Regulations

15.3. Detailed Environment Impact Assessment, discussing Impacts due to project location, project design, project construction, project operation, depot etc.

15.4. Positive & Negative Environmental Impacts

15.5. Environment Management Plans

15.6. Environmental Monitoring Plan, discussing Pre-construction phase, Construction phase, Operations phase, Implementation of Environmental Management Plan, Formation of an Environmental Management System (EMS)

15.7. Summary of Costs

15.8. Social Impact Assessment (SIA), potential resettlement impacts, baseline socio economic study, eligibility and entitlements, institutional framework, public consultation, resettlement assistance plan and cost, monitoring and evaluation

16. Disaster Management & Security Measures

16.1. Disaster Management, Disaster Management imperatives

16.2. Need for Disaster Management

16.3. Type of Disasters in MRTS

16.4. Objectives of Disaster Management Plan, Systems to cater for disasters

16.5. Preparedness of staff for disasters, preparedness for Disaster Management, Authorities to be coordinated with in case of disaster, Command & Control at the National, State & District Level

16.6. Security measures, essentials of security management, Security system design parameters, Door frame metal detectors, X-ray scanning etc.

16.7. Security systems recommended for MRTS

17. Detailed Project Cost Estimates

17.1. Capital cost estimate of complete system with details of civil engineering works , permanent way ,utility diversions, environmental protection, miscellaneous other works ,rehabilitation and resettlement ,traction and power supply ,signaling and telecommunication works, rolling stock ,general charges and contingencies

17.2. Innovations proposed to reduce the unit cost of Civil works, Track system, Rolling stock etc.

17.3. Costing of entire project and for each of the phases

17.4. Summary of Capital Cost

17.5. Estimations of Operations and Maintenance Cost

18. Transit Oriented Development Plan

18.1. Assessment of development Potential
List Land/Buildings amenable for change in near future e.g. vacant land, low rise development relocation etc., use type, densification of corridor by increasing FSI, land value capture as per the guidelines issued by MoHUA

19. Financial Analysis and Non Fare Box Revenue Assessment

19.1. Estimations and inputs for the corridor, phasing of construction and lease of BUA

19.2. Estimations for operations and maintenance cost ,overheads, compare the proposed costs with existing domestic and international benchmarks (including manpower/km), and measures to be taken for improvement in operations and maintenance cost, Innovations to ensure profitability at O&M level

19.3. Operational viability

19.4. Means of finance
Revenue From Different Sources
- Fare box revenue
- Non fare box revenue, like advertisement, taxes and property development etc.

19.5. Financial Returns , FIRR for 30 years time horizon

19.6. Alternative sources for Means of Finance, exploring all possible ways of funding the project using different approaches Like PPP, BOT, DFBOT, DBFOT, Developer Finance Model Etc. and proposed funding model/implementation model.

19.7. Sensitivity Analysis
i. Expected Ridership
ii. Costs
iii. Time overrun

20. Economic Analysis

20.1. Approach and Methodology for Economic Analysis

20.2. Estimation of Economic Project cost of MRTS

20.3. Economic Benefits of MRTS

20.4. EIRR for 30 Years

20.5. Outcome on Economic viability

21. Implementation Plan

21.1. Project Implementation Plan

21.2. Project implementation structure if implemented on PPP model

21.3. Legal and institutional Framework for implementing the project

21.4. Role, responsibility and involvement (including financial stake) the city government shall have in the Metro Rail project

4.4. ANNEXURE IV: FRAMEWORK FOR ECONOMIC COST BENEFIT ANALYSIS

As per global practice, urban transport projects including urban rail, are considered and seen as public projects, with the objective to deliver public good. Therefore, it is imperative that the appraisal of metro rail project proposals should entail economic cost and benefit analysis. Metro rail projects provide larger economic and social benefits to the society in terms of reduction in cost and time of travel, substantial reduction in per capita pollution emissions resulting in reduction in chronic diseases, reduction in road accidents, bringing down noise pollution etc. Enhancing mobility catalyses the economic development and improves the quality of life in a city. Hence, while appraising such project proposals, the economic viability must be considered. As per the Metro Rail Policy 2017, the Economic Internal Rate of Return (EIRR) for any metro rail project proposal should be 14% and above for consideration of its approval.

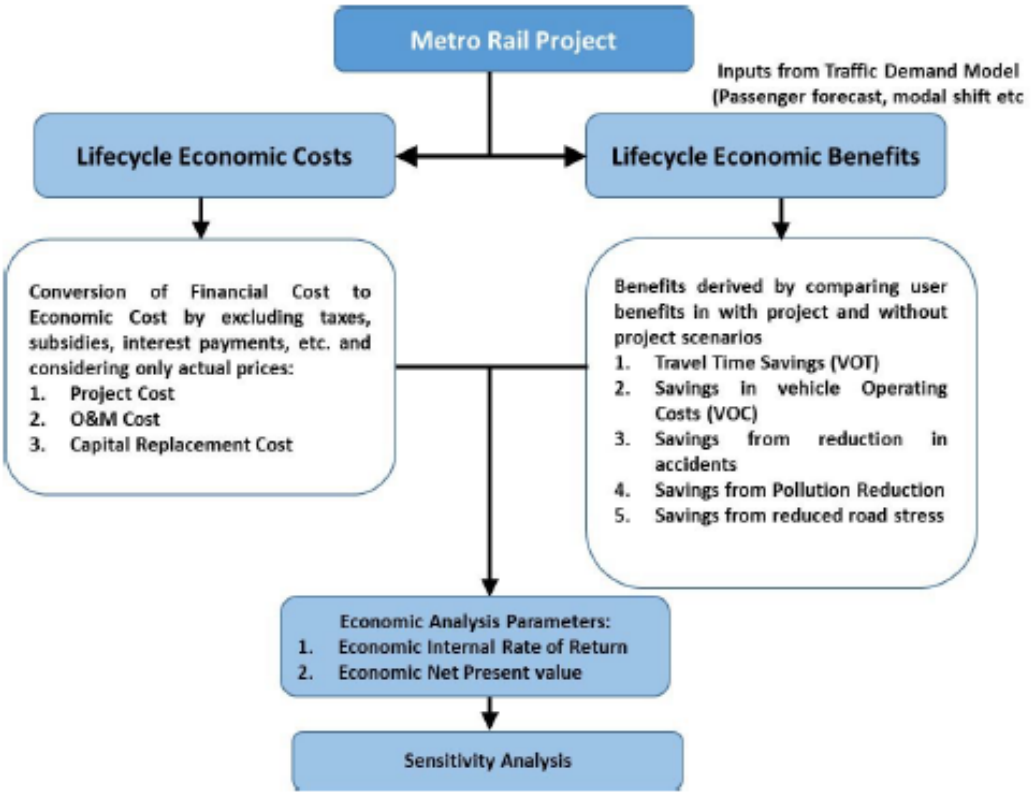
4.4.1. Basis adopted for Economic Cost Benefit Analysis

For the purpose of appraisal of a metro rail project proposal, the Economic Cost Benefit Analysis should be done based on the various parameters such as project's economic benefits, economic costs, sensitivity analysis, and distribution analysis to achieve economic rationale and economic viability at every stage of the project life cycle:

4.4.2. Economic analysis framework

The pictorial representation of framework for Economic analysis is provided in Figure 4.

Figure 4: Framework for Economic Analysis



4.4.3. Steps for economic analysis

The steps in economic analysis are as described below.

Step 1: Define Project Horizon

Project horizon comprises of the construction and operation period of the metro rail project. During the project horizon, the cost and benefits associated with project should be estimated. The horizon period for the purpose of economic analysis should be taken as 30 years.

Step 2: Develop Alternative Scenarios

This involves development of alternative project scenarios or base case to which comparison with the project case that is undertaken is to be made. For example, economic cost and benefits of undertaking metro project ("With Project") is to be compared with the base case i.e. "Without Project" or Do Nothing scenario or any other alternative project in order to arrive at incremental costs and benefits.

Step 3: Determine Economic Cost of the Project

The steps involved in determining the Economic Cost of the project are specified in Table 1.

Table 1: Steps for estimating Economic Cost of Project

Determination of the Economic Cost of the Project	The economic costs of the capital works and annual operation and maintenance costs are calculated from the financial cost estimates based on: 1. **Price contingencies/price escalations** are excluded but physical contingencies are included because they represent real consumption of resources; 2. **Import duties and taxes** are excluded because they represent transfer payments. For this the shadow exchange rate factor is used; i) The existence of unemployment and under-employment for unskilled workers within the Indian economy means that the opportunity costs if unskilled labour can be considered to be lower than its wage rate; ii) The market wage rate for skilled labour and the acquisition cost of land are considered to represent opportunity costs, as both factors are in demand 3. **Sunk costs** –these are the costs which are already committed or irretrievably made. It does not have any prospective cost benefit analysis. Thus, it is excluded. 4. **Interest payment, principal payment and interest during construction period** are excluded – these are the financial costs and are hence not included as part of economic costs. The conversion factors to be used for economic analysis are given in Table 6.

Source: Toolkit on Finance and Financial Analysis, 2013

Table 2: Steps for Estimating Lifecycle Cost of the Project

Determination of Lifecycle Cost	Develop lifecycle cost during the analysis period converting the Financial Cost of the following to Economic Cost 1. Capital Cost 2. Maintenance Cost 3. Capital Replacement Cost Only real prices shall be considered in determining the economic costs. Thus any price escalations should be removed using the conversion factors.

Source: Toolkit on Finance and Financial Analysis, 2013

The two parameters[1] of economic analysis are:

- Economic Net Present Value (ENPV)– ENPV is the sum of differences between the discounted benefits and cost flows and is calculated using the following formula:

$$\sum_{t=1}^{n} \frac{(Bt - Ct)}{(1+r)^t}$$

- Economic Internal Rate of Return (EIRR)– EIRR is the discount rate at which the ENPV becomes zero. It is represented by the following formula

$$\sum_{t=1}^{n} \frac{Bt}{(1+r)^t} - \sum_{t=1}^{n} \frac{Ct}{(1+r)^t} = 0$$

Where,

B_t – Benefits at time 't'

C_t – Costs at time 't'

r – Economic Internal Rate of Return

n - Number of years

Step 4: Estimation of Project Benefits

Year wise project benefits should be estimated during the project operation period. The "With project" scenario should be compared with the option of "Without project scenario" to determine the incremental economic benefits.

Quantifiable Economic Benefits accrue to Society

The following quantifiable benefits are accrued to the society owing to implementation of the metro rail project.

1. Travel Time Savings
2. Savings in Vehicle Operating Cost
3. Savings from Accident Reduction
4. Savings from Pollution Reduction
5. Savings due to Reduced Road stress

[1] Source – ADB Report, 2016 for the above formulae

The components and the steps to be undertaken to estimate the above benefits are discussed herein.

1. **Travel Time Savings (VOT Savings)**

Metro rail projects significantly contribute to modal shift owing to higher speeds and comfort to passengers. This leads to travel time savings for passengers travelling on metro rail system due to the following:

- Travel Time Savings due to higher speed of metro rail project as compared to do nothing or alternative scenario.
- Congestion reduction due to modal shift leads to fewer vehicles on roads. This also contributes to time savings of passengers travelling on other modes.

The formula for calculation of travel time savings is presented below.

Passenger Time Savings = Time Savings of Modal Shift passenger + Time savings of passenger travelling on other mode.

Time Savings of Modal Shift Passengers = (Time spent by Modal shift Passengers on Metro Rail Project - Time spent by Modal Shift diverted passenger on alternate transport mode in do nothing/alternative scenario) X Value of Passenger time.

Time Savings of Passengers travelling on other modes = (Time spent by Passengers Travelling on other mode in With Project Scenario - Time spent by passengers travelling on other mode in do nothing/alternative scenario) X Value of Passenger time.

The steps involved in calculation of travel time savings are presented below.

Steps 1: Estimation of Time Savings in terms of passenger hours

i) Mode wise Passenger trips are estimated based on traffic demand studies during project horizon period.
ii) Mode wise modal shift passengers' trips are also estimated based on traffic demand studies.
iii) Calculate the time of travel for each vehicle type including modal shift of passengers along the project corridor in each direction both for 'without' and 'with' project scenarios.
iv) By working out the difference, the time savings for each transport mode (i.e. bus, two-wheeler, four- wheeler etc.) from daily to annual is estimated.

Step 2: Estimation of Value of Time

i) Passengers trips are divided into working and nonworking trips based on traffic demand studies/ surveys
ii) The value of time for working trips is valued in relation to either the specific wage of the workers involved if such information is available or national per capita income/regional per capita income where the project is implemented. These are converted into hourly wages/per capita income.
iii) The value of time for non-working trips is calculated based on assumption where adult passenger non-working time at 30% of household income per capita and a child's non-working time at 15% of household income per capita.

iv) Using the unit rates, estimate the annual time savings for the project operation period.

2. Savings in Vehicle Operating Cost (VOC)

Savings in Vehicle Operating Cost arise owing to following;

- Absence of vehicles of modal shift passengers.
- Smoother operations of passenger trips of other mode vehicles owing to congestion reduction.

VOC is a function of speed, road roughness, carriageway, width/capacity, rise and fall per unit. VOCs is calculated from the sum of distance related (i.e. fuel, tyre, maintenance, labour, oil consumption cost) and time related VOCs (i.e. opportunity cost of capital, depreciation cost).

The first step is to calculate the value of vehicle operating cost per km for different vehicle types. The VOC for future years is to be calculated by multiplying it with the annual CPI or WPI, which may be taken as flat 5% annually.

The VOC unit cost can be calculated using the equations and guidelines given in the "Manual on Economic Evaluation of Highway Projects in India, 2009" by the Indian Road Congress (IRC). These national level guidelines provide a reliable source for estimating the VOCs. The VOC has to be adjusted for different cities according to the traffic, road conditions, fuel cost in the state as recommended in the manual. The VOC is based on the following parameters as per the manual:

- Cost of Fuel Consumption
- Spare parts Costs
- Maintenance labour
- Tyre Life
- Engine oil/Other oil/Grease
- Speed considerations
- Utilization
- Fixed cost
- Depreciation of vehicle costs

The VOC savings are calculated by multiplying the unit VOC cost with the number of vehicle trips and with the average lead distance for the particular vehicle category.

VOC savings = VOC [Rs. /km] x Average Lead [km][2] x no. of vehicle trips[2]

The VOC savings will be calculated for the vehicle types (2-wheelers, 3-wheelers, cars, bus, any other prevalent mode) and then added. The difference of cost in "with" and "without" project can be taken in to calculate savings in Vehicle Operating Cost.

3. Accident Reduction Benefits

The reduction in traffic volumes on roads due to modal shift to metro rail project is expected to reduce the accidents on the project corridor owing to following:

[2] Inputs from Comprehensive Mobility Plan

- Lower number of vehicles on roads due to reduction of vehicles of modal shift passengers.
- Lower accidents from vehicles due to decongested roads / other modes.

Further reduction in accidents will also lead to savings from damages to vehicle and savings towards medical, insurance expense, administrative expense on police and the intangible psychosomatic cost of pain to personal involved in the accidents. This also leads to savings because of reduction of productivity to the economy by the personnel involved in the accident.

The steps involved in estimating the accidents benefits are specified below.

Step 1: Projection of accidents in with and without project scenario

i) Collection of past accident data along the project corridor, for the development of a reasonably accurate accident prediction model.
ii) Developing a reasonably accurate accident prediction model is relevant for the project under consideration based on past data as specified above (i). This model could allow an examination of the relationships between traffic volume, vehicle speed, design standards, terrain, no motorized traffic, and accidents. Based on this relationship, probability of accidents in without project scenario can also be estimated.
iii) The accidents will have varying degrees of severity and the projections must be dis-aggregated to reflect this. A common distinction is between fatalities, serious injury, slight injury, and damage only where no injuries are involved.
iv) A prediction model may not be detailed enough to distinguish between these and if it is not then past trends on the respective share of accidents in the various categories can be applied.

Step 2: Estimation of unit cost of accidents.

An accident cost can be classified in following three categories and calculation steps for each category is specified in Table 3.

Table 3: Classification of Accident Cost

Cost Category	Details	Calculation Steps
Direct Costs	Medical treatment cost, property damage vehicle damage, and administrative costs like legal, police and insurance fees	Direct costs require basic data like average length of hospital stay and average costs per patient day, and average damage and administrative cost, with the average relating to whatever accident categories are used in the prediction model. Average medical treatment costs must distinguish between in-patient care allowing for average length of stay and out-patient costs including

Cost Category	Details	Calculation Steps
		average number of visits and average associated costs.
Indirect Costs	Loss of future earnings for the individuals affected which can be considered as loss to economy.	Indirect costs are normally estimated as earnings foregone over the period the individual cannot work due to the accident; with fatalities, this is lifetime earnings. Normally for simplicity, earnings foregone will be based on national average wages.

As per the study undertaken by MoHUA (Toolkit on Finance and Financial Analysis, 2013) the costs of accidents (at 2004 prices) under different heads are provided in the Table 4. The cost of accidents for future years is to be calculated by multiplying it with the annual CPI or WPI, which may be taken as flat 5% annually.

Table 4: Cost of Accidents (at 2004 prices)

Particular	Accident Cost (Rs)
Cost of fatal accident (person killed)	4,37,342
Cost of major accident (person Injured)	64256
Cost of damage to Two wheelers	2286
Cost of damage to Car	9763
Cost of damage to buses in road accidents	32818

Source: Toolkit on Finance and Financial Analysis, 2013 by MoHUA

4. Pollution Reduction Benefits

Metro rail projects significantly contribute to pollution reduction and are thus a pre requisite for sustainable development. The metro rail projects lead to modal shift and hence fewer vehicles on road. This leads to reduction in the use of fuel. Thus, absence of Green House Gas emission (GHG) from the vehicles of modal shift passengers' and lower emission due to decongested roads contributes in reduction in GHG emissions in the region.

The major environmental savings come from the reduction in air pollution. Due to the modal shift from the existing modes of transport to metro rail, the air pollutants released are significantly reduced.

According to the Central Pollution Control Board (CPCB), the emission factors vary with vehicle type and age of vehicle. Table 5 provides the emission factors for pollutants commonly emitted by vehicles, along with the treatment cost per ton of the respective pollutants.

Table 5: Volume of pollutants emitted (gram per km) for different modes

Vehicle Type/ Pollutant	CO	HC	NOX	PM	CO_2
2-wheeler	1.4	0.7	0.3	0.05	28.58
3-wheeler	2.45	0.75	0.12	0.08	77.89
Cars (incl. cabs)	1.39	0.15	0.12	0.02	139.52
Bus (incl. BRT)	3.72	0.16	6.53	0.24	787.72
Treatment Cost (Rs. /ton)	1,00,000	1,00,000	1,00,000	1,00,000	500

The first step is to calculate the daily vehicle kilometers saved by passengers' due to a shift to metro. This is to be derived from the number of vehicle trips and the average lead distance of that vehicle category obtained from CMP or other relevant studies for the specific city.

Vehicle Km saved = [No. of Trips shift to Metro from other mode] x [Average Lead of the mode]

The second step is to calculate the emission volume of each of the pollutants released every year. This will be a summation of the all the vehicle types emitting that pollutant. Daily vehicle kilometer saved could be obtained from relevant data in CMP or other relevant studies done earlier for the specific city.

Total Volume of Pollutant= [Volume of Pollutant released per km] x [Daily vehicle km saved]

The final step is to calculate the savings by calculating the Annual Treatment cost. This is to be calculated separately for different types of pollutants and then summed to get the final cost.

Annual Treatment Cost = [Volume of pollutant] x [Treatment cost/ton]

5. **Reduced Road Infrastructure Costs**

This benefit arises due to a reduced need for road maintenance owing to reduced traffic on account of modal shift. The savings will accrue due to two reasons:

i) Maintenance of the existing road infrastructure – As the traffic congestion on the roads will be lesser due to a modal shift to the metro rail, the wear and tear of the road will reduce.
ii) Upgrading existing road infrastructure – To solve the congestion problem, an alternative could be to expand the existing roads to accommodate for traffic. Due to the construction of metro rail, this cost will now be saved.

The road infrastructure development cost per km can be calculated using the city specific data regarding the cost of road construction. If such data is unavailable, then the state or national level data may be used, after adjusting them for local prices.

4.4.4. Distribution Analysis

A qualitative distribution analysis should be done amongst the various cities within a state to ensure equitable distribution.

4.4.5. Economic Conversion Factors

When the financial values are converted into economic values, they need to be adjusted for taxes, subsidies, inefficient land or wage markets, and other transfer payments, before performing the economic analysis. The conversion factors for different categories to be used are given in Table 6.

Conversion Factor = Economic Price/Financial Price

Table 6: Conversion Factors

S.No.	Component	Economic Factor
1	Capital Cost	83%
2	Operating Cost	87%
3	Time cost savings	100%
4	Vehicle Operating cost savings	90%
5	Emission saving cost	100%
6	Accident reduction saving	90%
7	Infrastructure Maintenance cost savings	87%

4.4.6. Sensitivity Analysis

The range of sensitivity can be in the range of 5% to 15% of the critical factors such as

(a) Cost overruns due to delay or other factors

(b) Increase in Maintenance Cost

(c) Reduction in Ridership

(d) Reduction in benefits

(e) Combination of reduction in benefits and increase in cost.

Step 5: Outputs of Economic Analysis

The outputs of economic analysis are as given below.

i) Estimated Economic Cost and Benefits stream
ii) Estimated EIRR and ENPV

4.5. ANNEXURE V: CHECK LIST

A checklist has been made, which is to be attached by the State Governments/Project Proponents along with the proposal and the DPR being submitted to the central government for the sanction of the Metro Rail projects. The Checklist needs to be submitted to the MoHUA along with the DPR. The State Governments/Project Proponents simply have to write Yes/No against items in the checklist as given in Table 7.

Table 7: Check List

S.No.	Items	Yes/No
	CMP/ Master Plan	
1.	Does the city have a Master Plan for the horizon year?	
2.	Does the city have a Comprehensive Urban Mobility Plan/Integrated Mobility Plan (IMP); and have the recommendations of the same been incorporated in the City Master Plan/Development Plan?	
3.	Has the Comprehensive Urban Mobility Plan been notified as per the State Town and Country Planning Act, if not, will it be notified in next six months?	
	Alternatives Analysis	
4.	Has the Alternatives Analysis Report been prepared as per the framework issued by MoHUA and with justifications for the construction of a Metro Rail?	
	Detailed Project Report	
5.	As part of the DPR, has Techno Economic Feasibility of the Metro System been examined or not?	
6.	Does the proposal include Economic cost and benefit analysis?	
7.	Does the proposal contain the status report on prevailing pre-metro urban transport infrastructure in the city?	
8.	Is the DPR prepared strictly in accordance with the standards and specifications of Metro rail system issued by MoHUA from time to time?	
	Public Transport System	
9.	Does the city have an existing Public Transport System? (please tick)	
	a) Upto 50 buses	
	b) 50 to 100 buses	
	c) 100 to 200 buses	
	d) More than 200 buses	
10.	Does the proposal include a report on how the Metro Rail will integrate with the existing transportation systems/proposed transit system?	
11.	Does the proposal include a status report on the existing status and financial viability or socio- economic benefits of an existing Metro Rail System, if any in the city and the support being extended by the State Government to improve its financial viability?	
12.	Does the proposal contain a report on making a feeder system integrated with the proposed Metro Rail project?	
13.	Does the report ensure last mile connectivity/NMT infrastructure?	
	Transit Oriented Development (TOD) and Non Fare Box Revenue	
14.	Does the proposal contain distinct proposal for development of commercial property at and around stations to supplement fare-box revenue?	

S.No.	Items	Yes/No
15.	Are the recommendations of the Transit Oriented Development Plan incorporated in the Master Plan?	
16.	Has TOD plan and Value capture financing framework been prepared as per guidelines issued by MoHUA?	
17.	Does the proposal include expanding utility capacity to densify areas around metro station as per notified TOD policy?	
18.	Does the proposal include measures that will be taken for maximization of non-fare box non-property revenue?	
19.	Does the proposal contain a detailed Environmental and Social Impact Analysis?	
	Economic Analysis	
20.	Does the proposal contain measures for optimization of O&M costs?	
21.	Does the proposal contain an Economic Analysis of the project along with the calculated values of EIRR and ENPV as per approved framework of MoHUA?	
	Implementation Framework	
22.	Does the proposal include the exploration of PPP models for implementing the project? Does proposal contain implementation of at least one component of Metro Rail Project through PPP?	
23.	Does the proposal include the exploration of PPP models for Operations and/or maintenance of the project?	
24.	Does the project clearly bring out key performance indicators and robust monitoring mechanism?	
25.	Is the methodology devised for integrating fares of all available modes with Metro system planned (including National Common Mobility Card)?	
26.	Does the proposal contain an MOU in between various service providers to provide seamless integration between the various modes?	
27.	Does the proposal include any monitoring mechanism to monitor the project during construction & implementation?	
28.	In case the project is for a metropolitan region, is there an MOU between the participating states?	
29.	Is there an involvement of municipal corporation/city development authority in implementing and/or operating the project?	
	Role of State Government and UMTA	
30.	Has State Government committed in maintaining the financial viability of metro line?	
31.	Has the State Government committed for providing & financing security provision for Metro System?	
32.	Has the State Government firmed up funding of the project, with exploration of various methods?	
33.	Has the State Government committed financial support to the project including O&M to ensure financial sustainability during the project life cycle including the operations stage?	
34.	Has the State Government set up or firmed up the plan for setting up of UMTA for the city?	
35.	Is the UMTA notified?	
36.	If UMTA is not notified, is there a commitment for notifying it within a year?	
37.	Is there a role, responsibility and involvement (including financial stake) of the	

S.No.	Items	Yes/No
	city government in the Metro Rail project, both during construction and the operations phase.	
38.	Has the State Government committed for enabling policy & regulatory framework required for enhancing non fare box revenue	
39.	Has the State Government devised any option to enable metro rail implementing agencies to issue corporate bonds	

The list contains information that needs to be attached. The Project Proponents simply have to write Yes/No against items in the checklist.

Attachment 5. Route Plan and Alignment

(1) Index

Drawing Index No.1

Sheet No.	Line	Drawing name	Scale
01 /120	Corridor 1	Track Alignment (-0km013m - 0km300m) UP Track	1/1000
02 /120	Corridor 1	Track Alignment (0km300m - 0km600m) UP Track	1/1000
03 /120	Corridor 1	Track Alignment (0km600m - 0km900m) UP Track	1/1000
04 /120	Corridor 1	Track Alignment (0km900m - 1km200m) UP Track	1/1000
05 /120	Corridor 1	Track Alignment (1km200m - 1km500m) UP Track	1/1000
06 /120	Corridor 1	Track Alignment (1km500m - 1km800m) UP Track	1/1000
07 /120	Corridor 1	Track Alignment (1km800m - 2km100m) UP Track	1/1000
08 /120	Corridor 1	Track Alignment (2km100m - 2km400m) UP Track	1/1000
09 /120	Corridor 1	Track Alignment (2km400m - 2km700m) UP Track	1/1000
10 /120	Corridor 1	Track Alignment (2km700m - 3km000m) UP Track	1/1000
11 /120	Corridor 1	Track Alignment (3km000m - 3km300m) UP Track	1/1000
12 /120	Corridor 1	Track Alignment (3km300m - 3km600m) UP Track	1/1000
13 /120	Corridor 1	Track Alignment (3km600m - 3km900m) UP Track	1/1000
14 /120	Corridor 1	Track Alignment (3km900m - 4km200m) UP Track	1/1000
15 /120	Corridor 1	Track Alignment (4km200m - 4km500m) UP Track	1/1000
16 /120	Corridor 1	Track Alignment (4km500m - 4km800m) UP Track	1/1000
17 /120	Corridor 1	Track Alignment (4km800m - 5km100m) UP Track	1/1000
18 /120	Corridor 1	Track Alignment (5km100m - 5km400m) UP Track	1/1000
19 /120	Corridor 1	Track Alignment (5km400m - 5km700m) UP Track	1/1000
20 /120	Corridor 1	Track Alignment (5km700m - 6km000m) UP Track	1/1000
21 /120	Corridor 1	Track Alignment (6km000m - 6km300m) UP Track	1/1000
22 /120	Corridor 1	Track Alignment (6km300m - 6km600m) UP Track	1/1000
23 /120	Corridor 1	Track Alignment (6km600m - 6km900m) UP Track	1/1000
24 /120	Corridor 1	Track Alignment (6km900m - 7km200m) UP Track	1/1000
25 /120	Corridor 1	Track Alignment (7km200m - 7km500m) UP Track	1/1000
26 /120	Corridor 1	Track Alignment (7km500m - 7km800m) UP Track	1/1000
27 /120	Corridor 1	Track Alignment (7km800m - 8km100m) UP Track	1/1000
28 /120	Corridor 1	Track Alignment (8km100m - 8km400m) UP Track	1/1000
29 /120	Corridor 1	Track Alignment (8km400m - 8km700m) UP Track	1/1000
30 /120	Corridor 1	Track Alignment (8km700m - 9km000m) UP Track	1/1000
31 /120	Corridor 1	Track Alignment (9km000m - 9km300m) UP Track	1/1000
32 /120	Corridor 1	Track Alignment (9km300m - 9km600m) UP Track	1/1000
33 /120	Corridor 1	Track Alignment (9km600m - 9km900m) UP Track	1/1000
34 /120	Corridor 1	Track Alignment (9km900m - 10km200m) UP Track	1/1000
35 /120	Corridor 1	Track Alignment (10km200m - 10km500m) UP Track	1/1000
36 /120	Corridor 1	Track Alignment (10km500m - 10km800m) UP Track	1/1000
37 /120	Corridor 1	Track Alignment (10km800m - 11km100m) UP Track	1/1000
38 /120	Corridor 1	Track Alignment (11km100m - 11km400m) UP Track	1/1000
39 /120	Corridor 1	Track Alignment (11km400m - 11km700m) UP Track	1/1000
40 /120	Corridor 1	Track Alignment (11km700m - 12km000m) UP Track	1/1000

Sheet No.	Line	Drawing name	Scale
41 /120	Corridor 1	Track Alignment (12km000m - 12km300m) UP Track	1/1000
42 /120	Corridor 1	Track Alignment (12km300m - 12km600m) UP Track	1/1000
43 /120	Corridor 1	Track Alignment (12km600m - 12km900m) UP Track	1/1000
44 /120	Corridor 1	Track Alignment (12km900m - 13km200m) UP Track	1/1000
45 /120	Corridor 1	Track Alignment (13km200m - 13km500m) UP Track	1/1000
46 /120	Corridor 1	Track Alignment (13km500m - 13km800m) UP Track	1/1000
47 /120	Corridor 1	Track Alignment (13km800m - 14km100m) UP Track	1/1000
48 /120	Corridor 1	Track Alignment (14km100m - 14km400m) UP Track	1/1000
49 /120	Corridor 1	Track Alignment (14km400m - 14km700m) UP Track	1/1000
50 /120	Corridor 1	Track Alignment (14km700m - 15km000m) UP Track	1/1000
51 /120	Corridor 1	Track Alignment (15km000m - 15km300m) UP Track	1/1000
52 /120	Corridor 1	Track Alignment (15km300m - 15km600m) UP Track	1/1000
53 /120	Corridor 1	Track Alignment (15km600m - 15km900m) UP Track	1/1000
54 /120	Corridor 1	Track Alignment (15km900m - 16km200m) UP Track	1/1000
55 /120	Corridor 1	Track Alignment (16km200m - 16km500m) UP Track	1/1000
56 /120	Corridor 1	Track Alignment (16km500m - 16km800m) UP Track	1/1000
57 /120	Corridor 1	Track Alignment (16km800m - 17km100m) UP Track	1/1000
58 /120	Corridor 1	Track Alignment (17km100m - 17km400m) UP Track	1/1000
59 /120	Corridor 1	Track Alignment (17km400m - 17km700m) UP Track	1/1000
60 /120	Corridor 1	Track Alignment (17km700m - 17km825m) UP Track	1/1000
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63 /120	Corridor 1	Track Alignment (0km600m - 0km900m) DN Track	1/1000
64 /120	Corridor 1	Track Alignment (0km900m - 1km200m) DN Track	1/1000
65 /120	Corridor 1	Track Alignment (1km200m - 1km500m) DN Track	1/1000
66 /120	Corridor 1	Track Alignment (1km500m - 1km800m) DN Track	1/1000
67 /120	Corridor 1	Track Alignment (1km800m - 2km100m) DN Track	1/1000
68 /120	Corridor 1	Track Alignment (2km100m - 2km400m) DN Track	1/1000
69 /120	Corridor 1	Track Alignment (2km400m - 2km700m) DN Track	1/1000
70 /120	Corridor 1	Track Alignment (2km700m - 3km000m) DN Track	1/1000
71 /120	Corridor 1	Track Alignment (3km000m - 3km300m) DN Track	1/1000
72 /120	Corridor 1	Track Alignment (3km300m - 3km600m) DN Track	1/1000
73 /120	Corridor 1	Track Alignment (3km600m - 3km900m) DN Track	1/1000
74 /120	Corridor 1	Track Alignment (3km900m - 4km200m) DN Track	1/1000
75 /120	Corridor 1	Track Alignment (4km200m - 4km500m) DN Track	1/1000
76 /120	Corridor 1	Track Alignment (4km500m - 4km800m) DN Track	1/1000
77 /120	Corridor 1	Track Alignment (4km800m - 5km100m) DN Track	1/1000
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79 /120	Corridor 1	Track Alignment (5km400m - 5km700m) DN Track	1/1000
80 /120	Corridor 1	Track Alignment (5km700m - 6km000m) DN Track	1/1000

Drawing Index No.2

Sheet No.	Line	Drawing name	Scale
81 /120	Corridor 1	Track Alignment (6km000m - 6km300m) DN Track	1/1000
82 /120	Corridor 1	Track Alignment (6km300m - 6km600m) DN Track	1/1000
83 /120	Corridor 1	Track Alignment (6km600m - 6km900m) DN Track	1/1000
84 /120	Corridor 1	Track Alignment (6km900m - 7km200m) DN Track	1/1000
85 /120	Corridor 1	Track Alignment (7km200m - 7km500m) DN Track	1/1000
86 /120	Corridor 1	Track Alignment (7km500m - 7km800m) DN Track	1/1000
87 /120	Corridor 1	Track Alignment (7km800m - 8km100m) DN Track	1/1000
88 /120	Corridor 1	Track Alignment (8km100m - 8km400m) DN Track	1/1000
89 /120	Corridor 1	Track Alignment (8km400m - 8km700m) DN Track	1/1000
90 /120	Corridor 1	Track Alignment (8km700m - 9km000m) DN Track	1/1000
91 /120	Corridor 1	Track Alignment (9km000m - 9km300m) DN Track	1/1000
92 /120	Corridor 1	Track Alignment (9km300m - 9km600m) DN Track	1/1000
93 /120	Corridor 1	Track Alignment (9km600m - 9km900m) DN Track	1/1000
94 /120	Corridor 1	Track Alignment (9km900m - 10km200m) DN Track	1/1000
95 /120	Corridor 1	Track Alignment (10km200m - 10km500m) DN Track	1/1000
96 /120	Corridor 1	Track Alignment (10km500m - 10km800m) DN Track	1/1000
97 /120	Corridor 1	Track Alignment (10km800m - 11km100m) DN Track	1/1000
98 /120	Corridor 1	Track Alignment (11km100m - 11km400m) DN Track	1/1000
99 /120	Corridor 1	Track Alignment (11km400m - 11km700m) DN Track	1/1000
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101 /120	Corridor 1	Track Alignment (12km000m - 12km300m) DN Track	1/1000
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103 /120	Corridor 1	Track Alignment (12km600m - 12km900m) DN Track	1/1000
104 /120	Corridor 1	Track Alignment (12km900m - 13km200m) DN Track	1/1000
105 /120	Corridor 1	Track Alignment (13km200m - 13km500m) DN Track	1/1000
106 /120	Corridor 1	Track Alignment (13km500m - 13km800m) DN Track	1/1000
107 /120	Corridor 1	Track Alignment (13km800m - 14km100m) DN Track	1/1000
108 /120	Corridor 1	Track Alignment (14km100m - 14km400m) DN Track	1/1000
109 /120	Corridor 1	Track Alignment (14km400m - 14km700m) DN Track	1/1000
110 /120	Corridor 1	Track Alignment (14km700m - 15km000m) DN Track	1/1000
111 /120	Corridor 1	Track Alignment (15km000m - 15km300m) DN Track	1/1000
112 /120	Corridor 1	Track Alignment (15km300m - 15km600m) DN Track	1/1000
113 /120	Corridor 1	Track Alignment (15km600m - 15km900m) DN Track	1/1000
114 /120	Corridor 1	Track Alignment (15km900m - 16km200m) DN Track	1/1000
115 /120	Corridor 1	Track Alignment (16km200m - 16km500m) DN Track	1/1000
116 /120	Corridor 1	Track Alignment (16km500m - 16km800m) DN Track	1/1000
117 /120	Corridor 1	Track Alignment (16km800m - 17km100m) DN Track	1/1000
118 /120	Corridor 1	Track Alignment (17km100m - 17km400m) DN Track	1/1000
119 /120	Corridor 1	Track Alignment (17km400m - 17km700m) DN Track	1/1000
120 /120	Corridor 1	Track Alignment (17km700m - 17km777m) DN Track	1/1000

Sheet No.	Line	Drawing name	Scale
01 /120	Corridor 2	Track Alignment (0km000m - 0km300m) UP Track	1/1000
02 /120	Corridor 2	Track Alignment (0km300m - 0km600m) UP Track	1/1000
03 /120	Corridor 2	Track Alignment (0km600m - 0km900m) UP Track	1/1000
04 /120	Corridor 2	Track Alignment (0km900m - 1km200m) UP Track	1/1000
05 /120	Corridor 2	Track Alignment (1km200m - 1km500m) UP Track	1/1000
06 /120	Corridor 2	Track Alignment (1km500m - 1km800m) UP Track	1/1000
07 /120	Corridor 2	Track Alignment (1km800m - 2km100m) UP Track	1/1000
08 /120	Corridor 2	Track Alignment (2km100m - 2km400m) UP Track	1/1000
09 /120	Corridor 2	Track Alignment (2km400m - 2km700m) UP Track	1/1000
10 /120	Corridor 2	Track Alignment (2km700m - 3km000m) UP Track	1/1000
11 /120	Corridor 2	Track Alignment (3km000m - 3km300m) UP Track	1/1000
12 /120	Corridor 2	Track Alignment (3km300m - 3km600m) UP Track	1/1000
13 /120	Corridor 2	Track Alignment (3km600m - 3km900m) UP Track	1/1000
14 /120	Corridor 2	Track Alignment (3km900m - 4km200m) UP Track	1/1000
15 /120	Corridor 2	Track Alignment (4km200m - 4km500m) UP Track	1/1000
16 /120	Corridor 2	Track Alignment (4km500m - 4km800m) UP Track	1/1000
17 /120	Corridor 2	Track Alignment (4km800m - 5km100m) UP Track	1/1000
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20 /120	Corridor 2	Track Alignment (5km700m - 6km000m) UP Track	1/1000
21 /120	Corridor 2	Track Alignment (6km000m - 6km300m) UP Track	1/1000
22 /120	Corridor 2	Track Alignment (6km300m - 6km600m) UP Track	1/1000
23 /120	Corridor 2	Track Alignment (6km600m - 6km900m) UP Track	1/1000
24 /120	Corridor 2	Track Alignment (6km900m - 7km200m) UP Track	1/1000
25 /120	Corridor 2	Track Alignment (7km200m - 7km500m) UP Track	1/1000
26 /120	Corridor 2	Track Alignment (7km500m - 7km800m) UP Track	1/1000
27 /120	Corridor 2	Track Alignment (7km800m - 8km100m) UP Track	1/1000
28 /120	Corridor 2	Track Alignment (8km100m - 8km400m) UP Track	1/1000
29 /120	Corridor 2	Track Alignment (8km400m - 8km700m) UP Track	1/1000
30 /120	Corridor 2	Track Alignment (8km700m - 9km000m) UP Track	1/1000
31 /120	Corridor 2	Track Alignment (9km000m - 9km300m) UP Track	1/1000
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35 /120	Corridor 2	Track Alignment (10km200m - 10km500m) UP Track	1/1000
36 /120	Corridor 2	Track Alignment (10km500m - 10km800m) UP Track	1/1000
37 /120	Corridor 2	Track Alignment (10km800m - 11km100m) UP Track	1/1000
38 /120	Corridor 2	Track Alignment (11km100m - 11km400m) UP Track	1/1000
39 /120	Corridor 2	Track Alignment (11km400m - 11km700m) UP Track	1/1000
40 /120	Corridor 2	Track Alignment (11km700m - 12km000m) UP Track	1/1000

Drawing Index No.3

Sheet No.	Line	Drawing name	Scale
41 /120	Corridor 2	Track Alignment (12km000m - 12km300m) UP Track	1/1000
42 /120	Corridor 2	Track Alignment (12km300m - 12km600m) UP Track	1/1000
43 /120	Corridor 2	Track Alignment (12km600m - 12km900m) UP Track	1/1000
44 /120	Corridor 2	Track Alignment (12km900m - 13km200m) UP Track	1/1000
45 /120	Corridor 2	Track Alignment (13km200m - 13km500m) UP Track	1/1000
46 /120	Corridor 2	Track Alignment (13km500m - 13km800m) UP Track	1/1000
47 /120	Corridor 2	Track Alignment (13km800m - 14km100m) UP Track	1/1000
48 /120	Corridor 2	Track Alignment (14km100m - 14km200m) UP Track	1/1000
49 /120	Corridor 2	Track Alignment (0km000m - 0km300m) DN Track	1/1000
50 /120	Corridor 2	Track Alignment (0km300m - 0km600m) DN Track	1/1000
51 /120	Corridor 2	Track Alignment (0km600m - 0km900m) DN Track	1/1000
52 /120	Corridor 2	Track Alignment (0km900m - 1km200m) DN Track	1/1000
53 /120	Corridor 2	Track Alignment (1km200m - 1km500m) DN Track	1/1000
54 /120	Corridor 2	Track Alignment (0km1500m - 1km800m) DN Track	1/1000
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57 /120	Corridor 2	Track Alignment (2km400m - 2km700m) DN Track	1/1000
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62 /120	Corridor 2	Track Alignment (0km3900m - 4km200m) UP Track	1/1000
63 /120	Corridor 2	Track Alignment (0km4200m - 4km500m) UP Track	1/1000
64 /120	Corridor 2	Track Alignment (0km4500m - 4km800m) UP Track	1/1000
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74 /120	Corridor 2	Track Alignment (0km7500m - 7km800m) UP Track	1/1000
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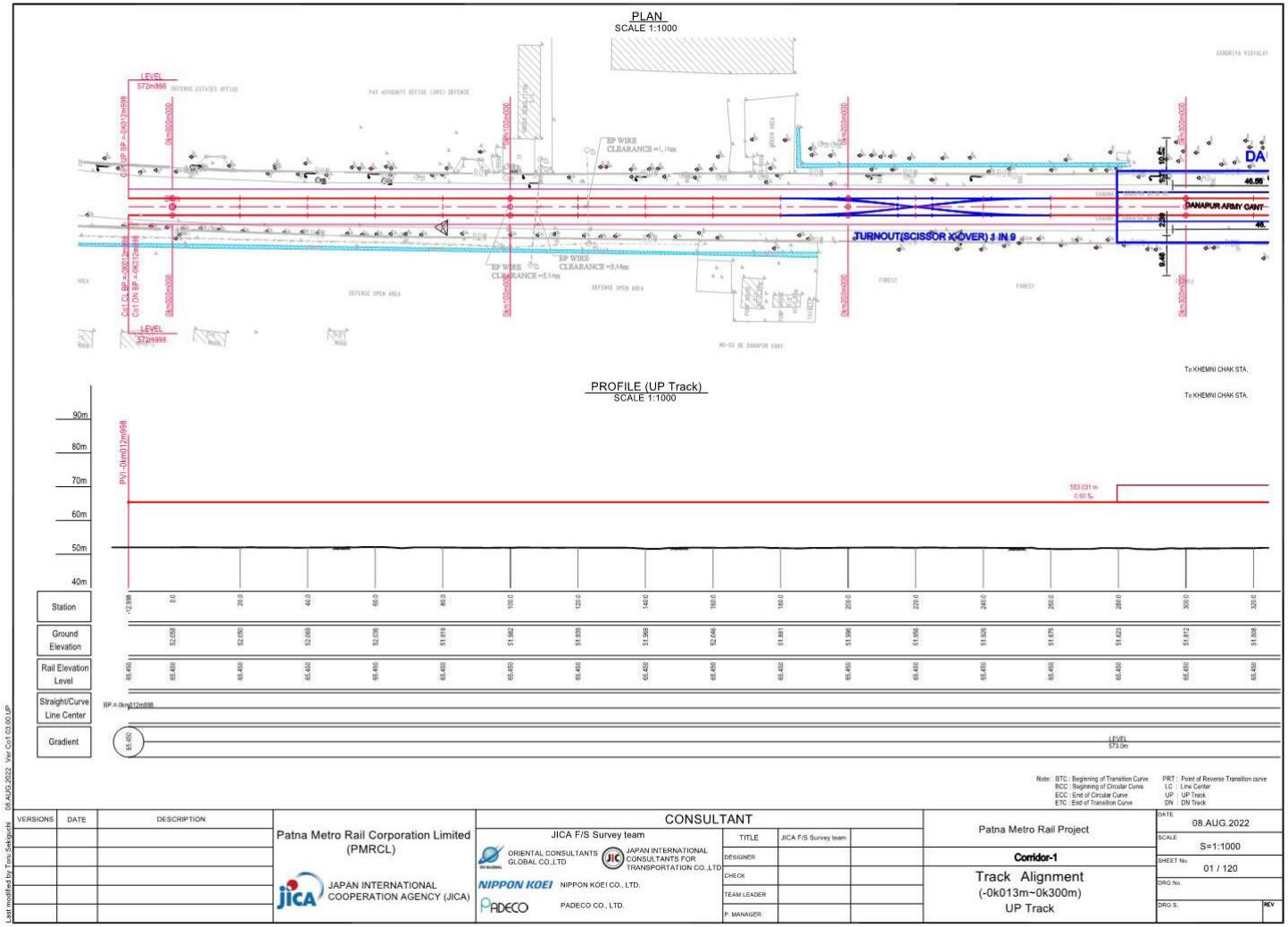
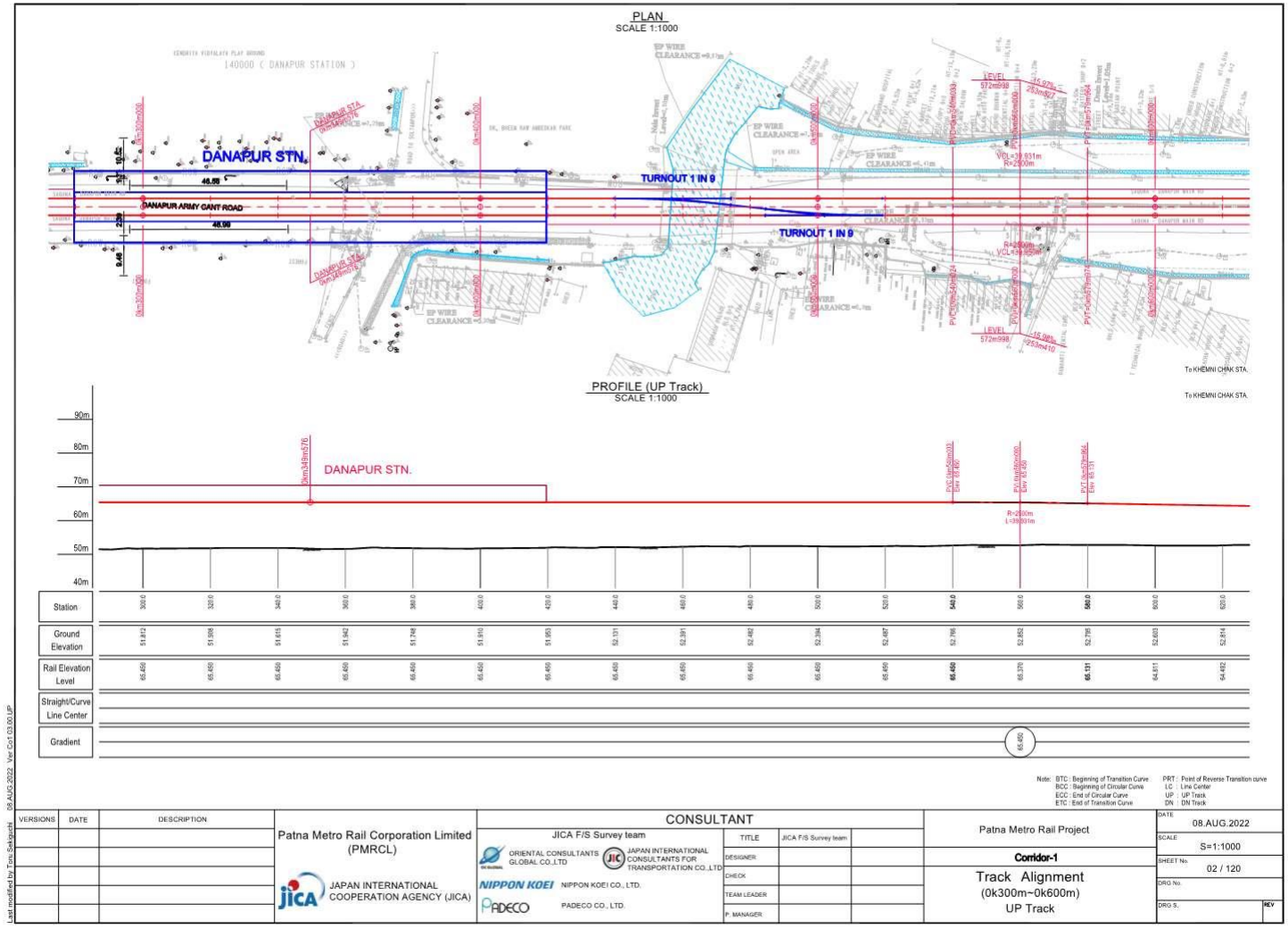
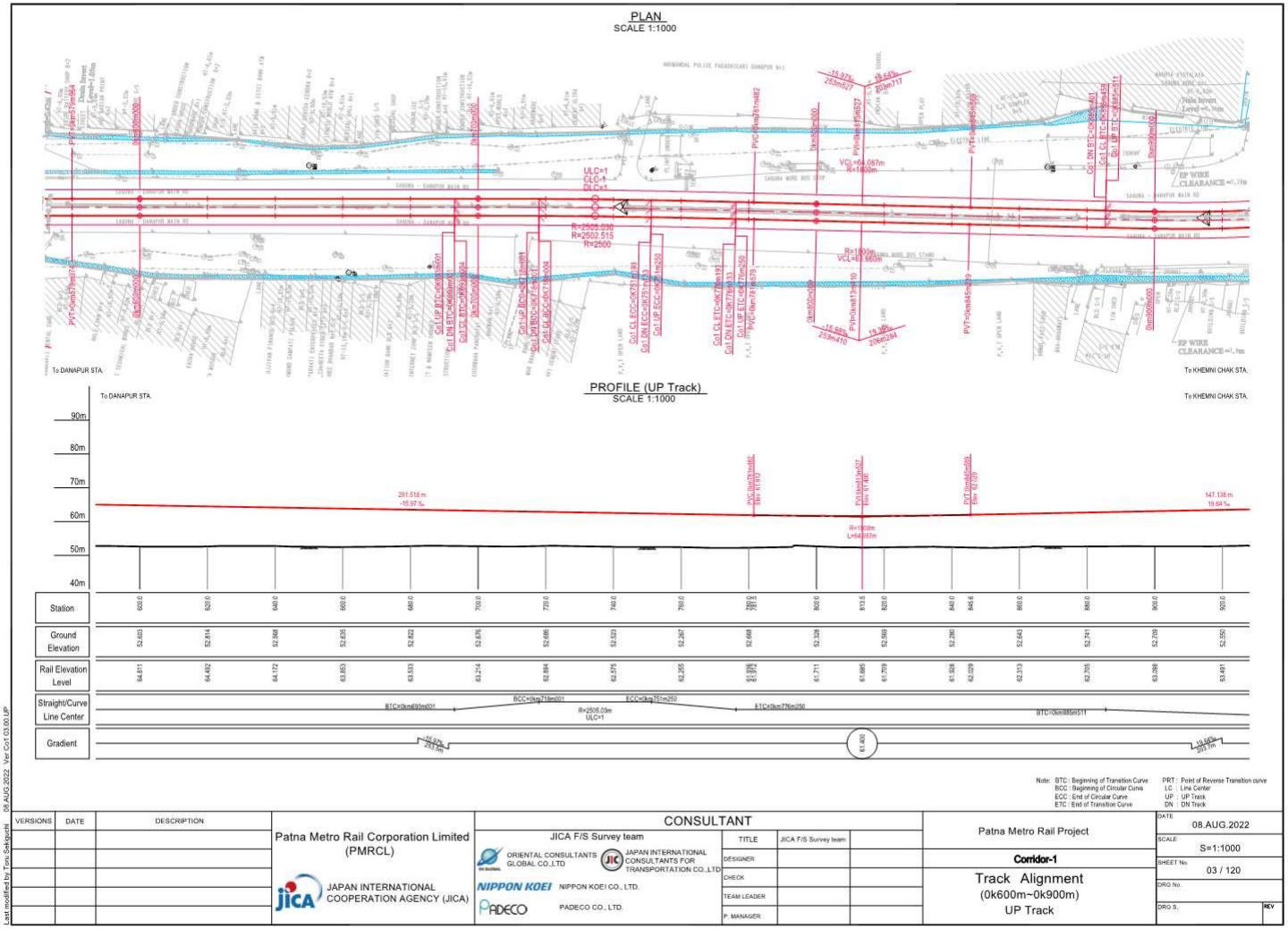
77 /120	Corridor 2	Track Alignment (8km400m - 8km700m) UP Track	1/1000
78 /120	Corridor 2	Track Alignment (0km8700m - 9km000m) UP Track	1/1000
79 /120	Corridor 2	Track Alignment (0km9000m - 9km300m) UP Track	1/1000
80 /120	Corridor 2	Track Alignment (9km300m - 9km600m) UP Track	1/1000

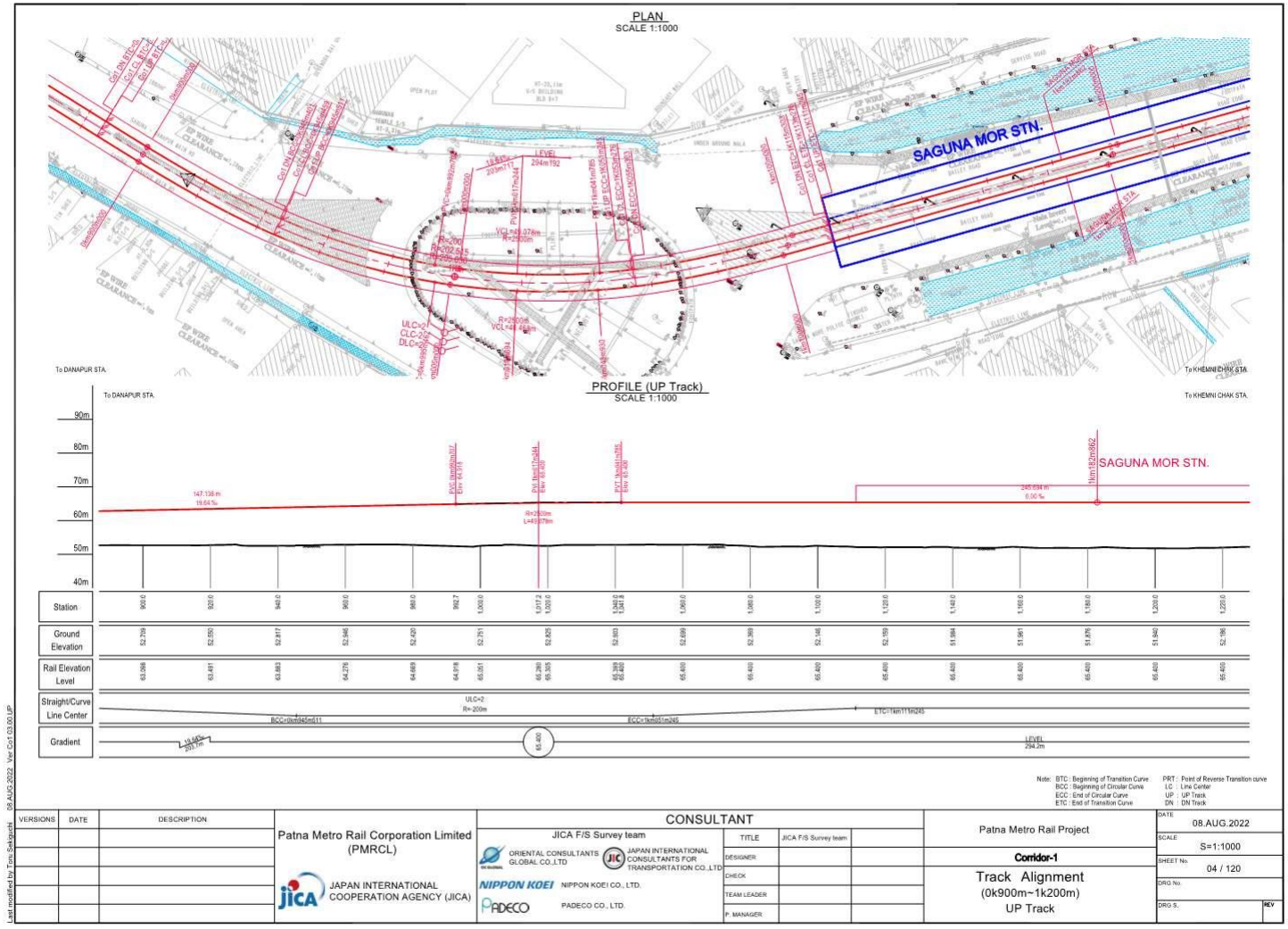
Sheet No.	Line	Drawing name	Scale
81 /120	Corridor 2	Track Alignment (9km600m - 9km900m) DN Track	1/1000
82 /120	Corridor 2	Track Alignment (9km900m - 10km200m) DN Track	1/1000
83 /120	Corridor 2	Track Alignment (10km200m - 10km500m) DN Track	1/1000
84 /120	Corridor 2	Track Alignment (10km500m - 10km800m) DN Track	1/1000
85 /120	Corridor 2	Track Alignment (10km800m - 11km100m) DN Track	1/1000
86 /120	Corridor 2	Track Alignment (11km100m - 11km400m) DN Track	1/1000
87 /120	Corridor 2	Track Alignment (11km400m - 11km700m) DN Track	1/1000
88 /120	Corridor 2	Track Alignment (11km700m - 12km000m) DN Track	1/1000
89 /120	Corridor 2	Track Alignment (12km000m - 12km300m) DN Track	1/1000
90 /120	Corridor 2	Track Alignment (12km300m - 12km600m) DN Track	1/1000
91 /120	Corridor 2	Track Alignment (12km600m - 12km900m) DN Track	1/1000
92 /120	Corridor 2	Track Alignment (12km900m - 13km200m) DN Track	1/1000
93 /120	Corridor 2	Track Alignment (13km200m - 13km500m) DN Track	1/1000
94 /120	Corridor 2	Track Alignment (13km500m - 13km800m) DN Track	1/1000
95 /120	Corridor 2	Track Alignment (13km800m - 14km100m) DN Track	1/1000
96 /120	Corridor 2	Track Alignment (14km100m - 14km200m) DN Track	1/1000
1 / 2	Corridor 2	Track Alignment DEPOT Access Track No.1	1/1000
2 / 2	Corridor 2	Track Alignment DEPOT Access Track No.2	1/1000
1 / 3	Corridor 2	Track Alignment NEW ISBT DEPOT Overall plan	1/3000
2 / 3	Corridor 2	Track Alignment NEW ISBT DEPOT No.1	1/2000
3 / 3	Corridor 2	Track Alignment NEW ISBT DEPOT No.2	1/2000

(2) Corridor1 Alignment 03 00 UP




PLAN
SCALE 1:1000
DANAPUR STN.
DANAPUR ARMY CANT ROAD
TURNOUT 1 IN 9
TURNOUT 1 IN 9
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
DANAPUR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k300m~0k600m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
02 / 120
DRG.No.
DRG.S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k600m~0k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
03 / 120
DRG.No.
DRG.S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 UP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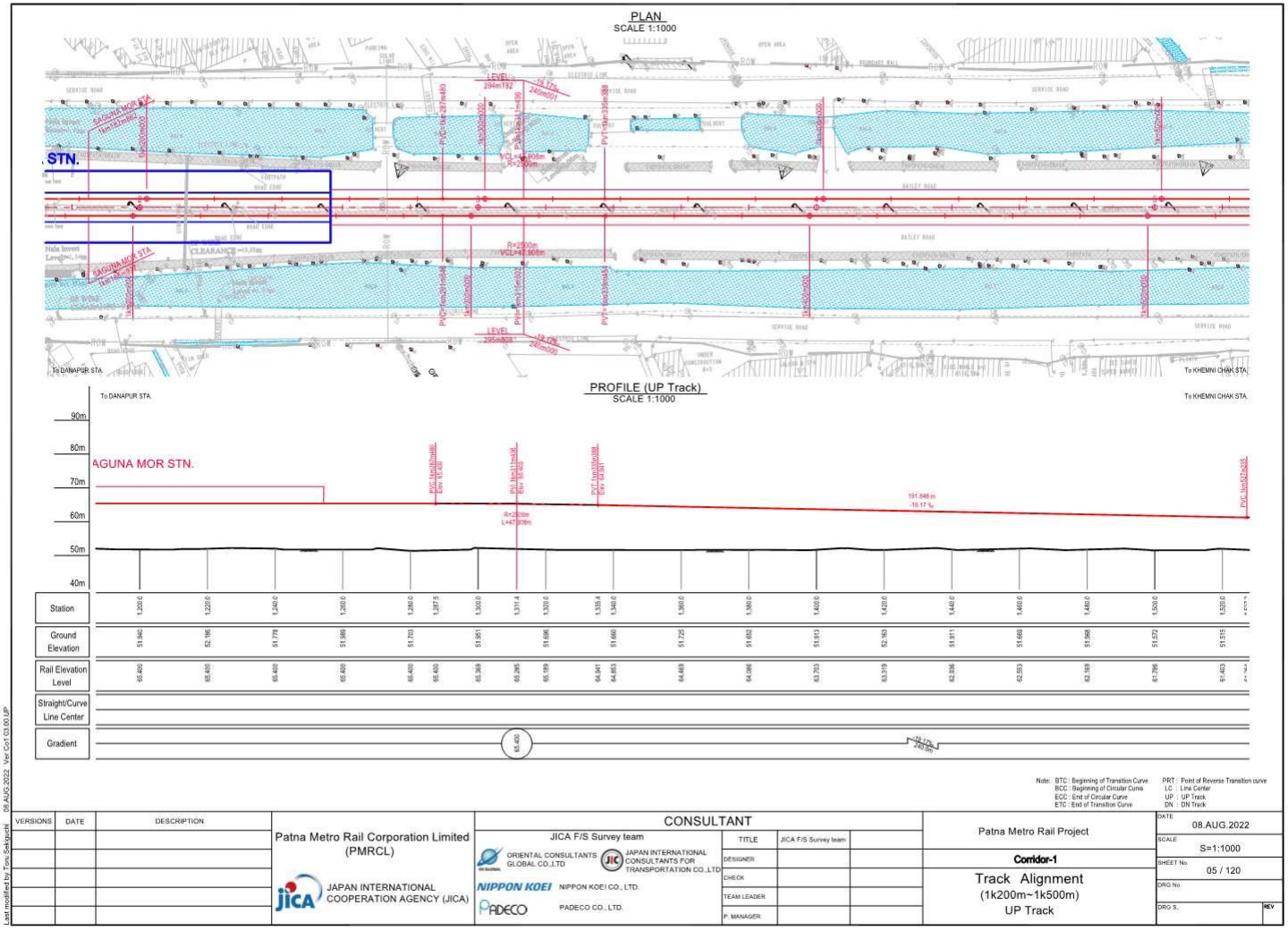
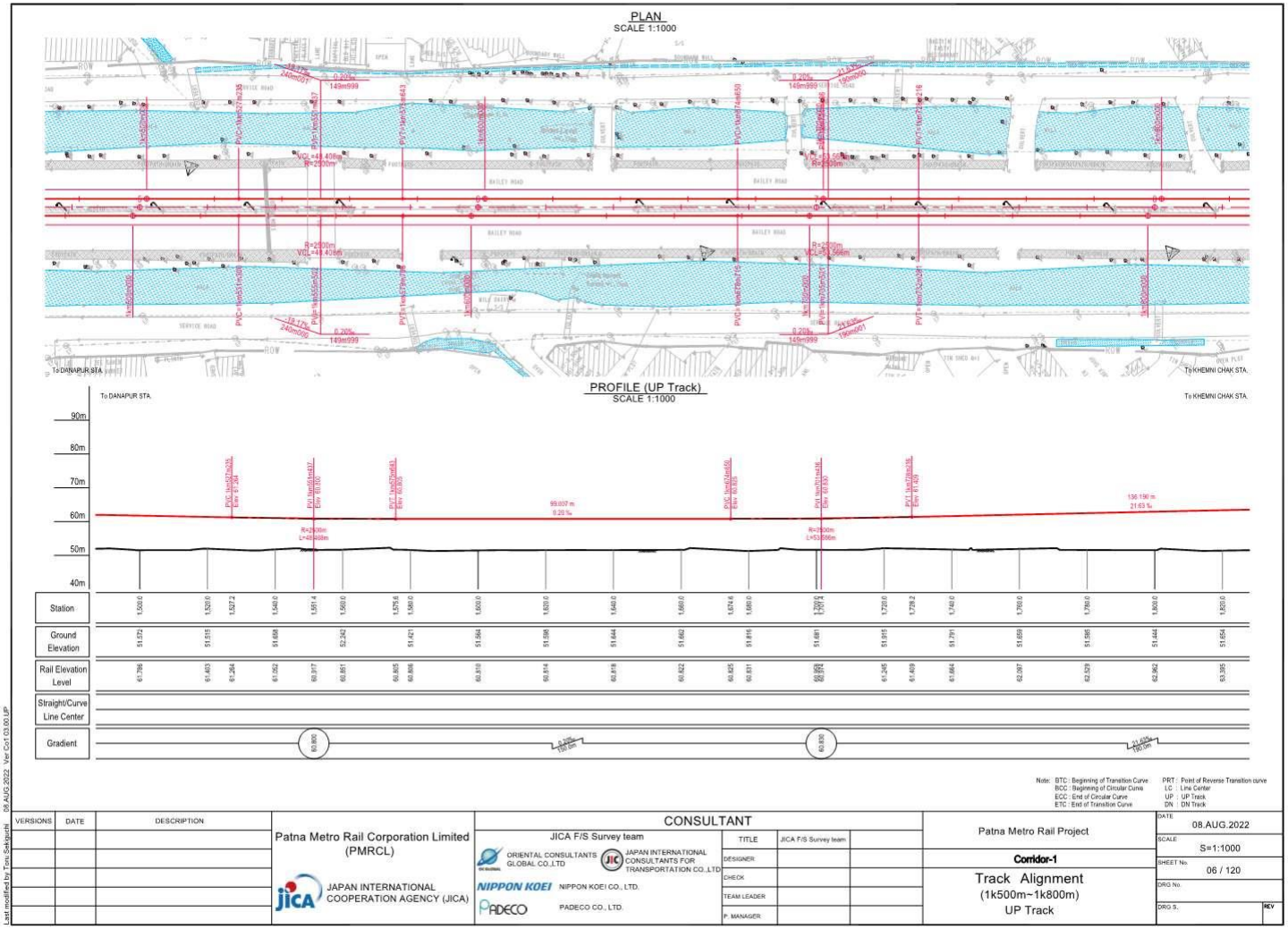
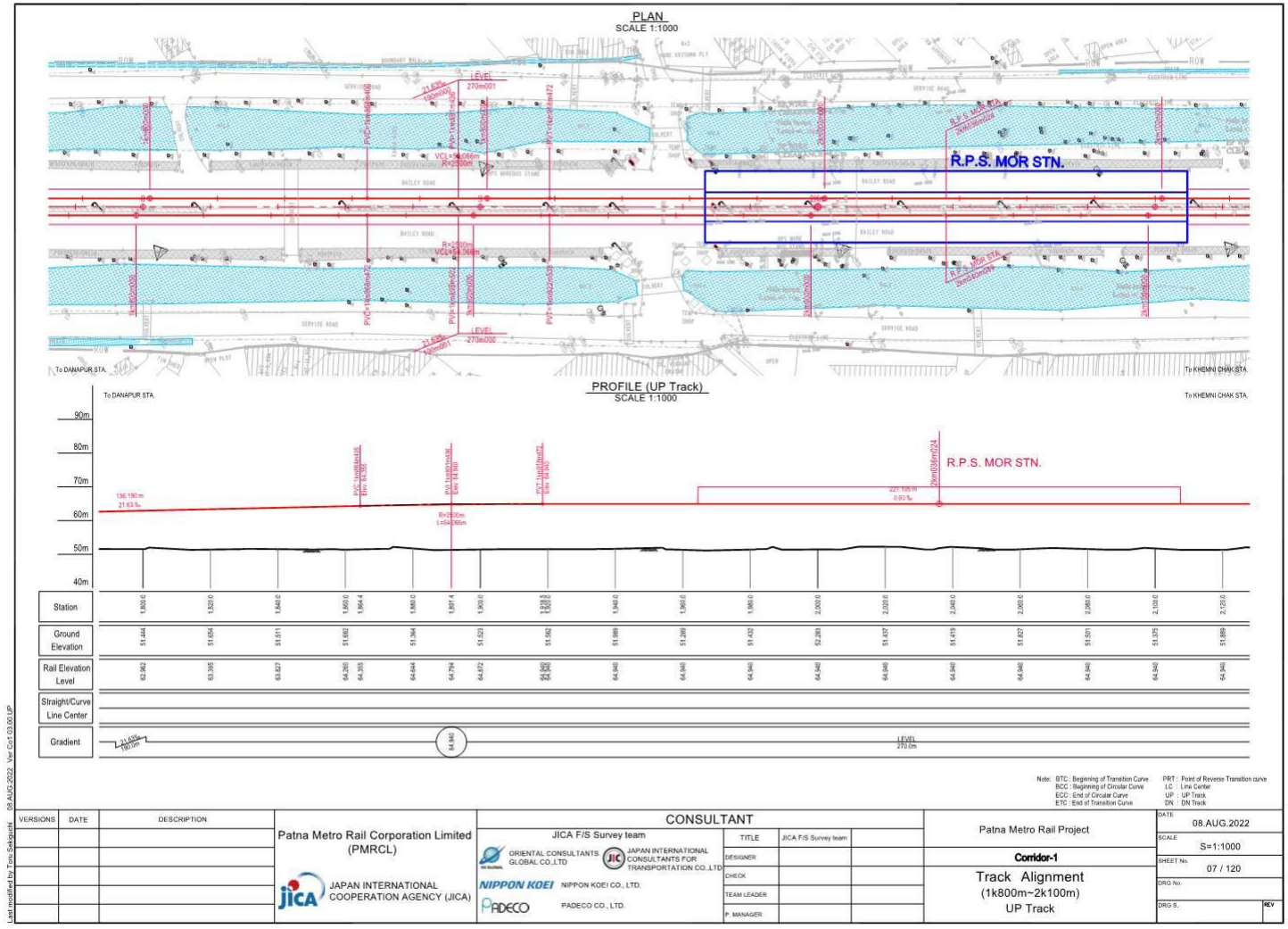
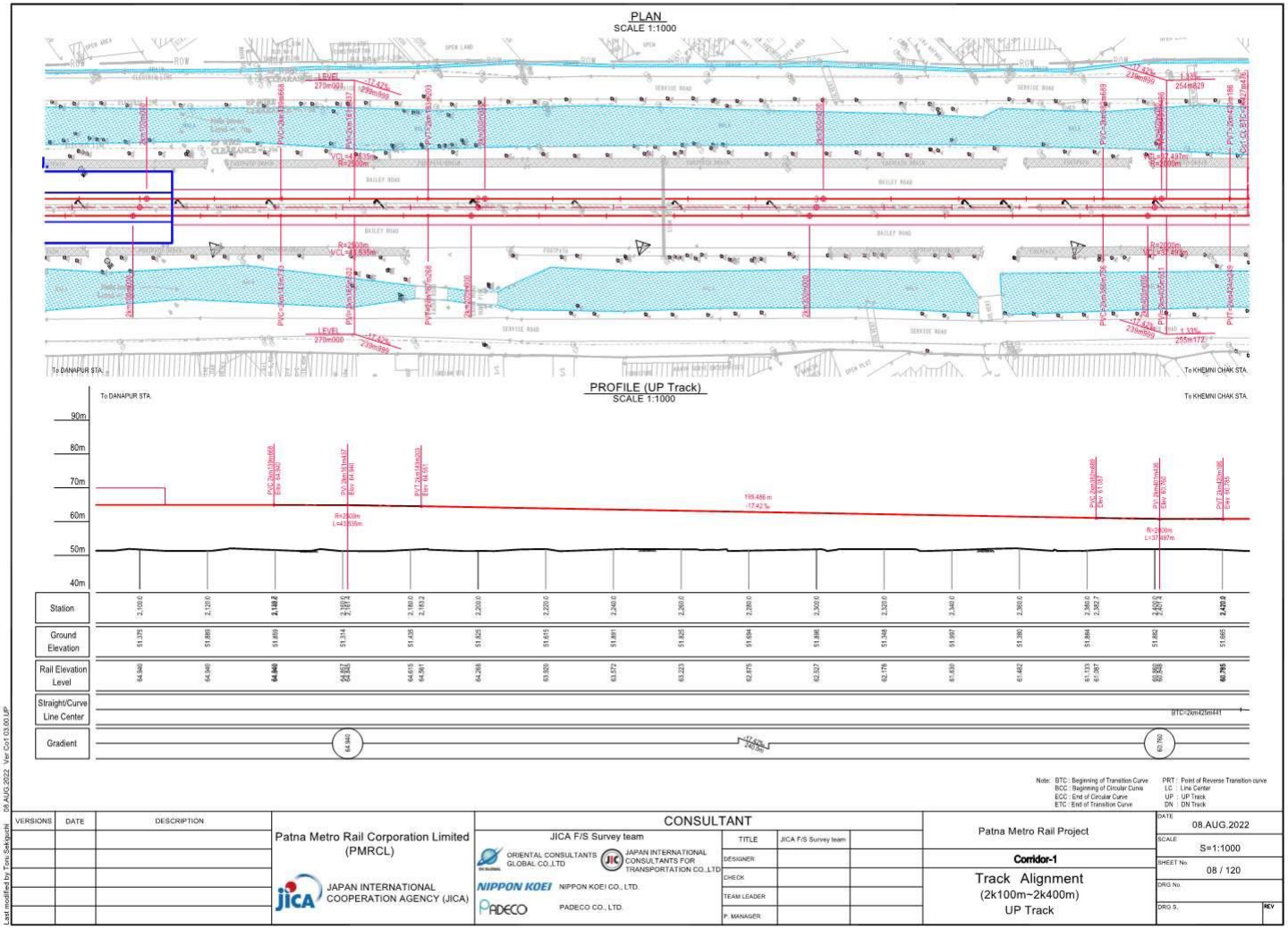
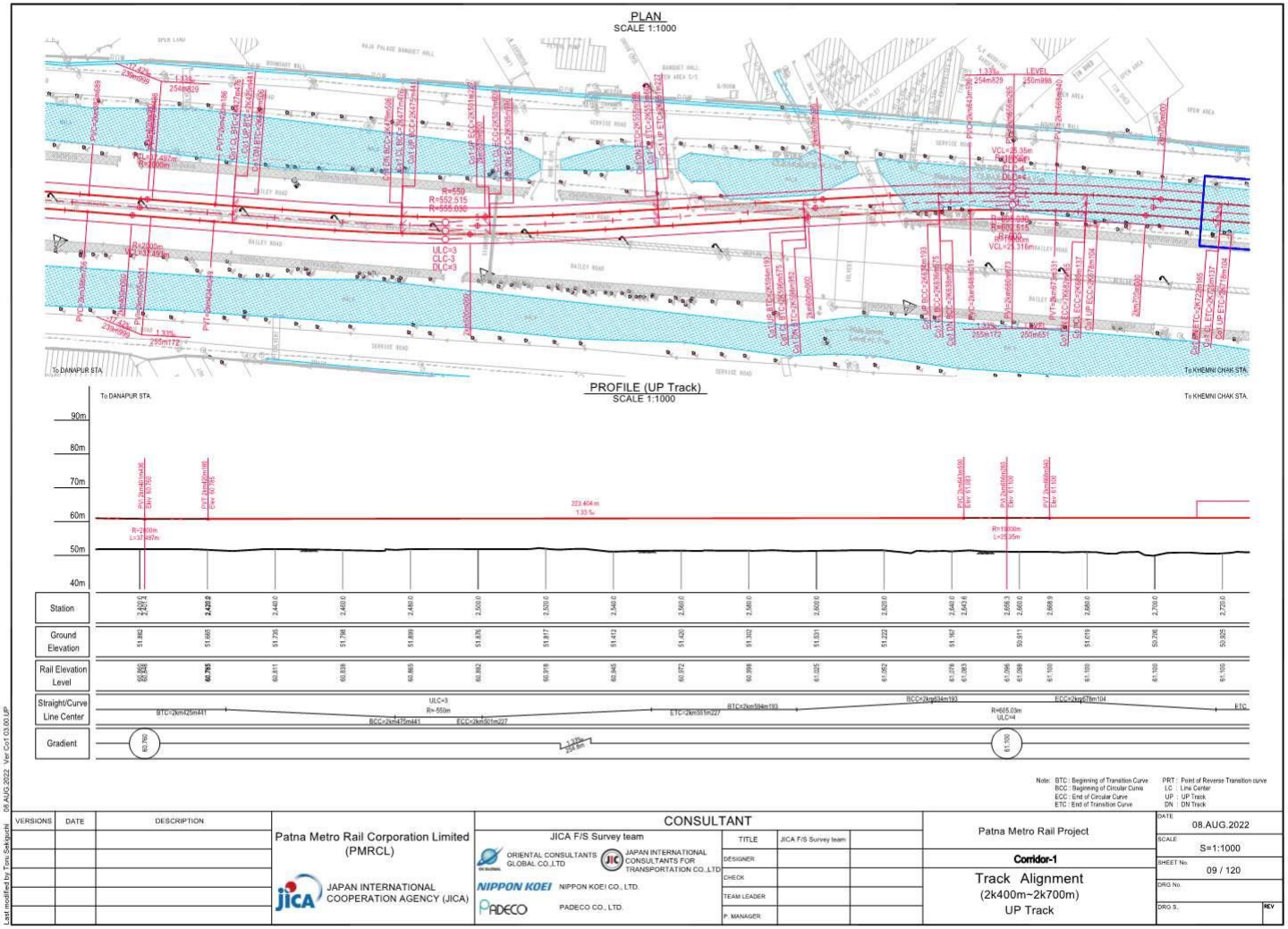
SCALE 1:1000
SAGUNA MOR STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
SAGUNA MOR STN.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k900m~1k200m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
04 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00 UP


PLAN
SCALE 1:1000
STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
AGUNA MOR STN.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k200m~1k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
05 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k500m~1k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
06 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00.UP


PLAN
SCALE 1:1000
R.P.S. MOR STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
R.P.S. MOR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k800m~2k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
07 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k100m~2k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
08 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP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SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
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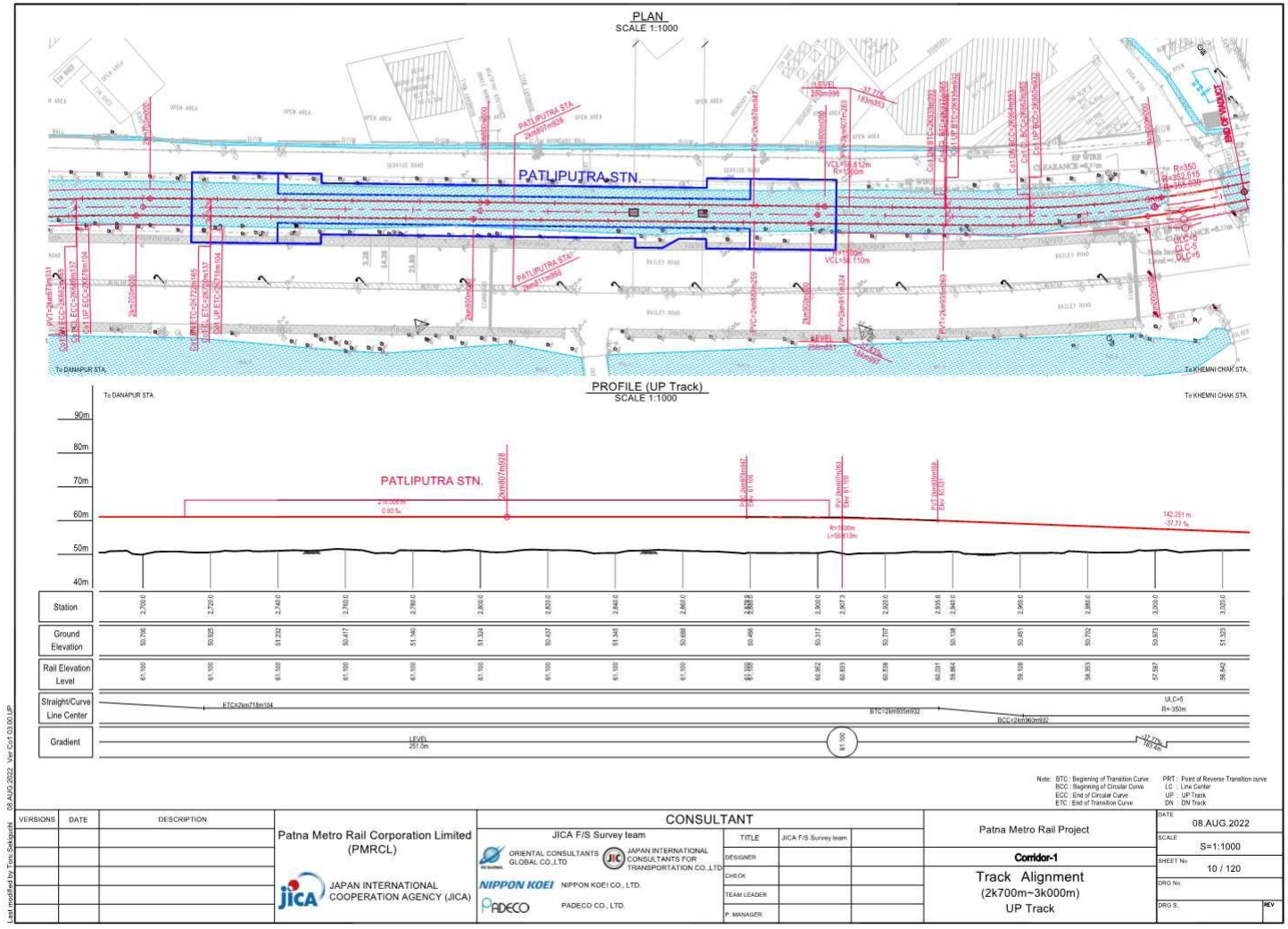
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k400m~2k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
09 / 120
DRG No.
DRG S.
REV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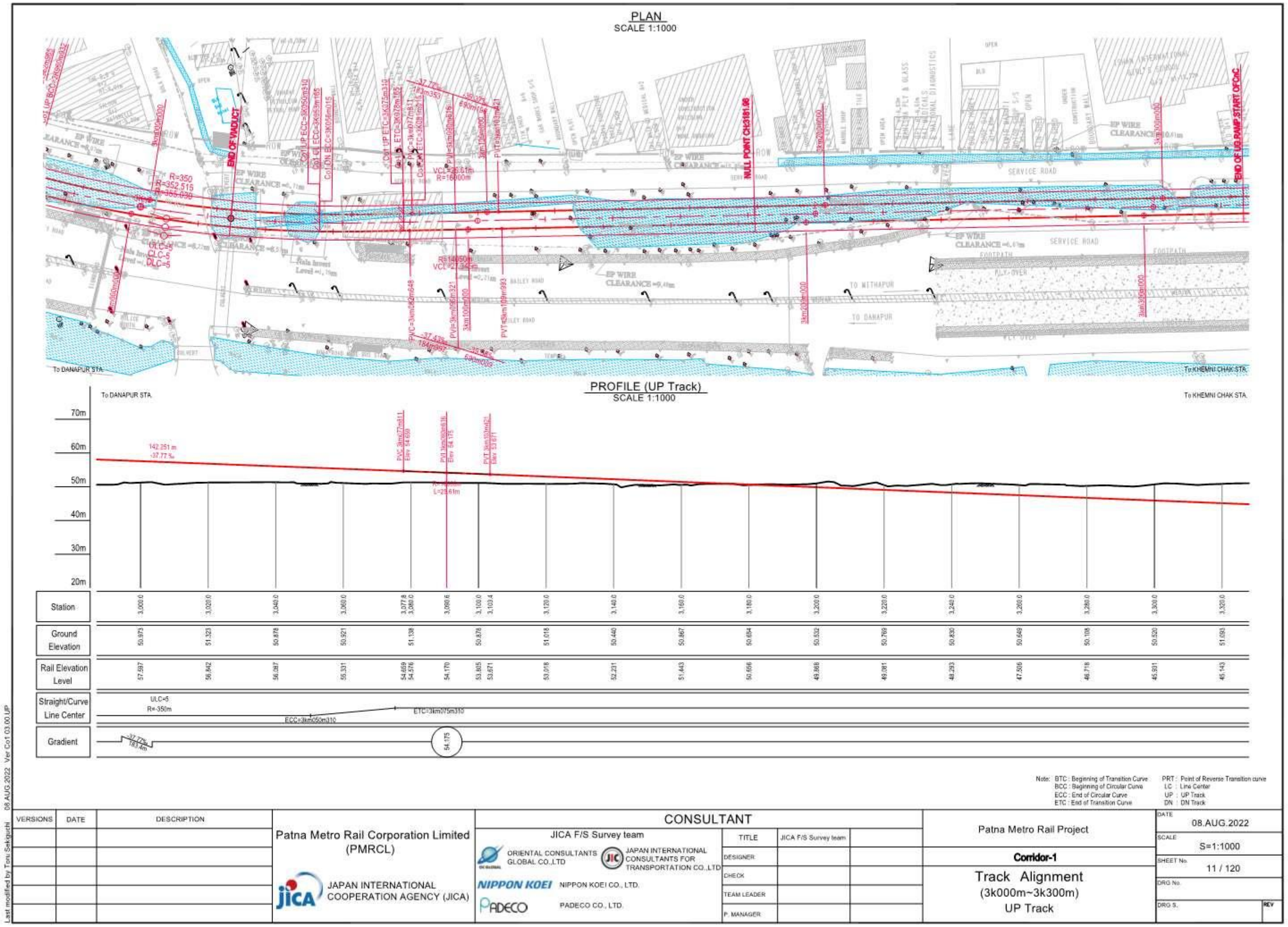
SCALE 1:1000
PATLIPUTRA STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
PATLIPUTRA STN.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k700m~3k000m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
10 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03 00 UP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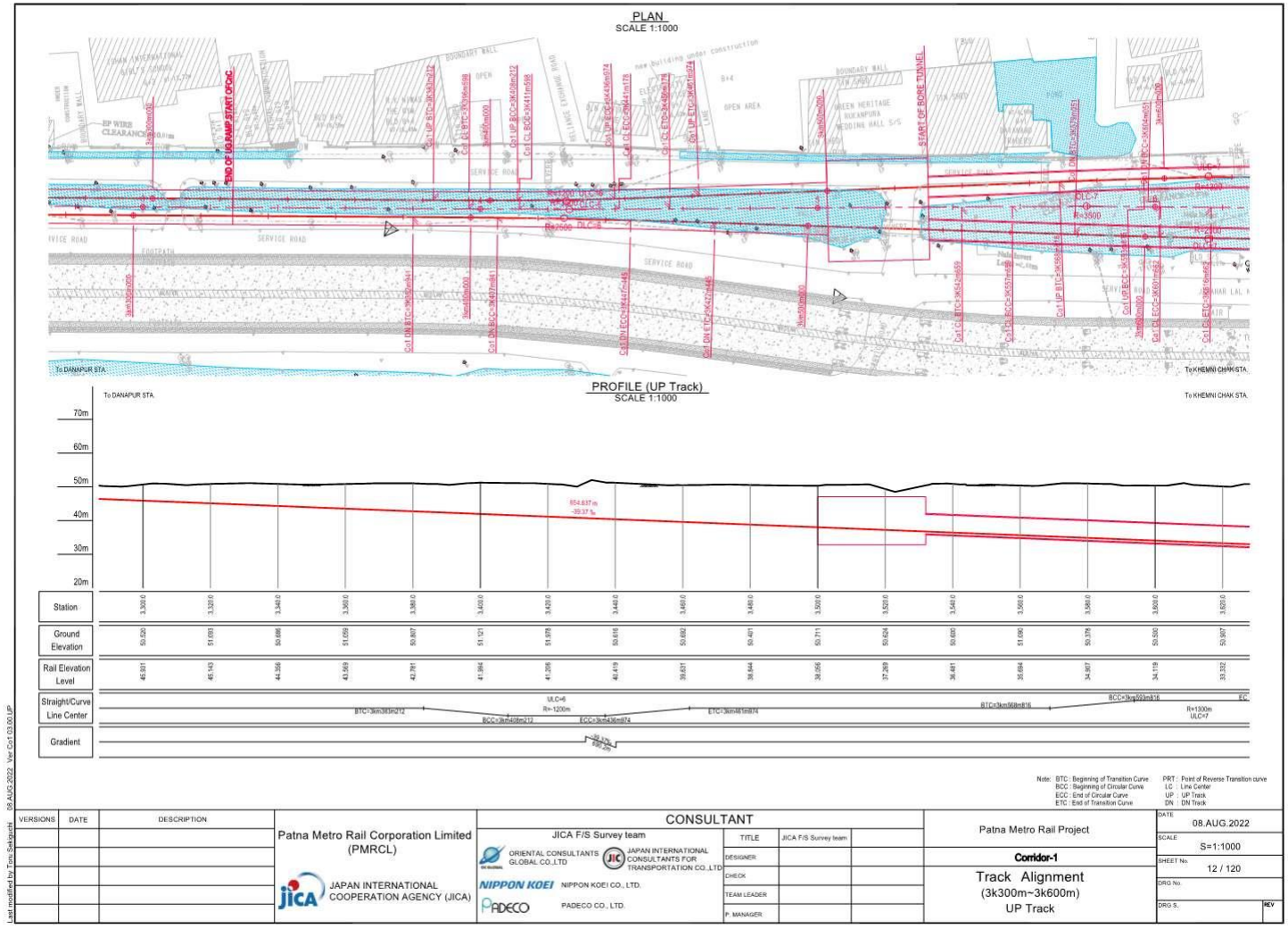
END OF VIADUCT
NULL POINT
END OF U/G RAMP START OFC&C
To DANAPUR STA.
To KHEMNI CHAK STA.
TO MITHAPUR
TO DANAPUR
SERVICE ROAD
FOOTPATH
PROFILE (UP Track)
SCALE 1:1000
70m
60m
50m
40m
30m
20m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k000m~3k300m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
11 / 120
DRG No.
DRG S.
REV


PLAN
SCALE 1:1000
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
70m
60m
50m
40m
30m
20m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
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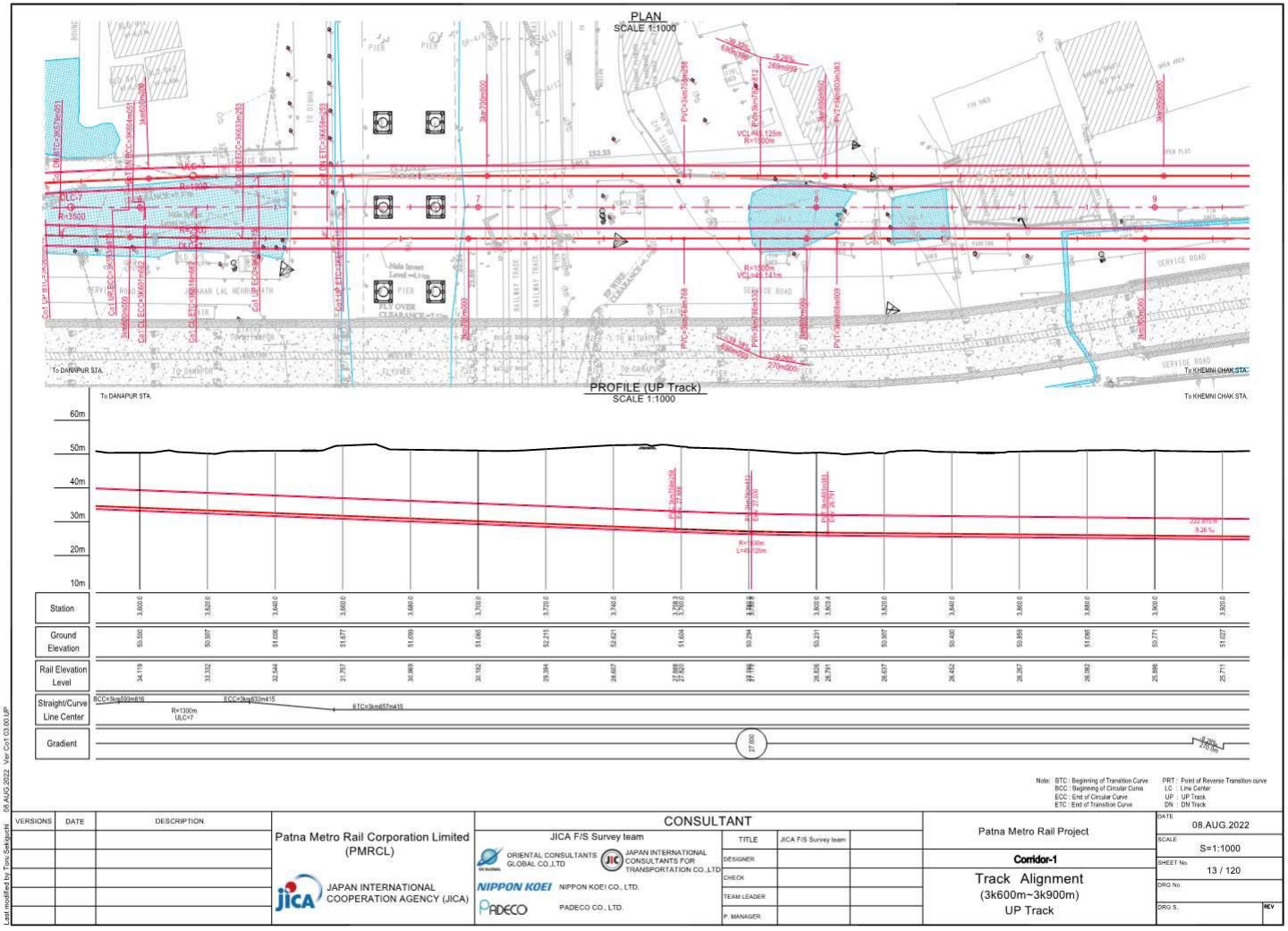
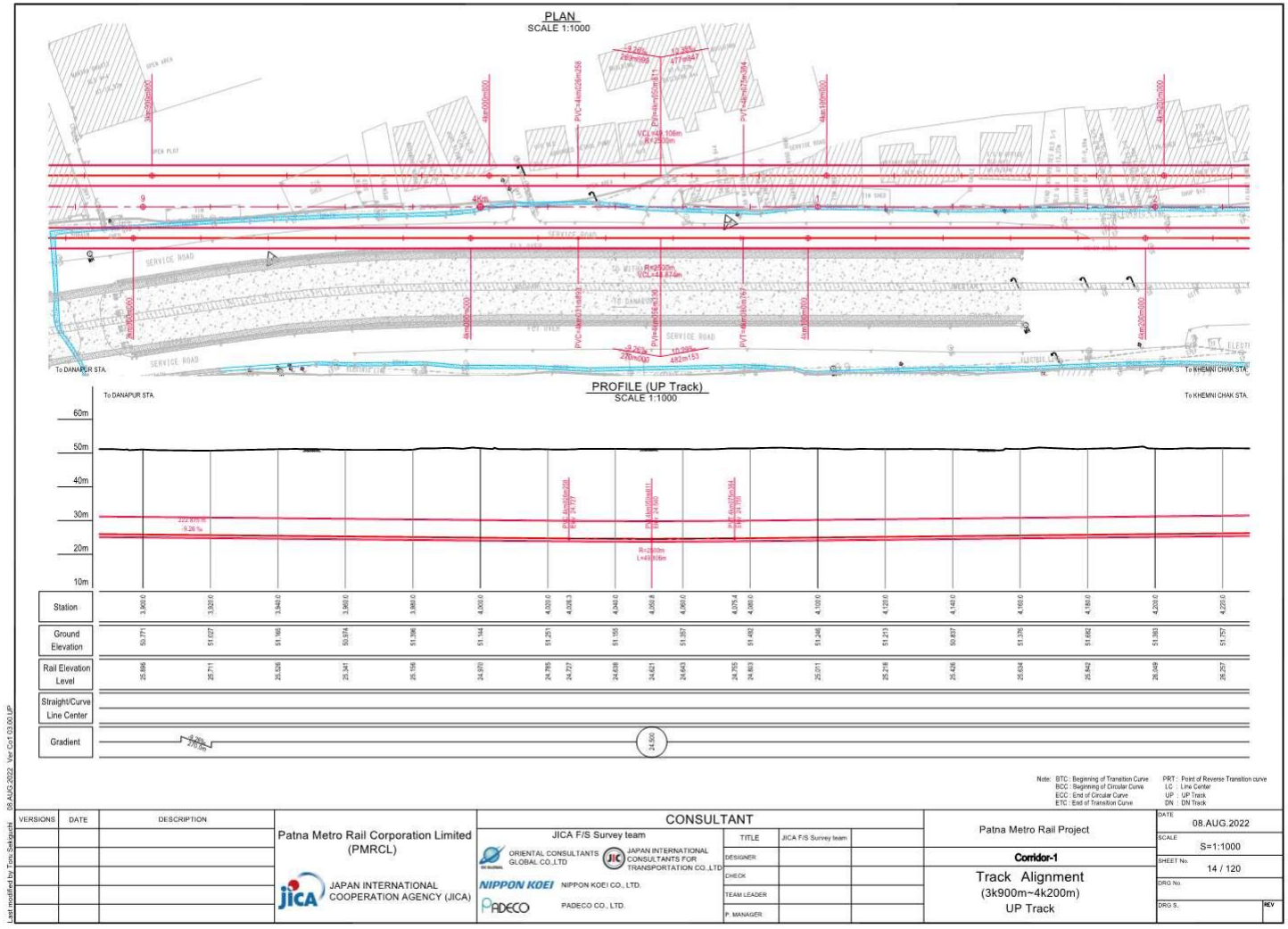
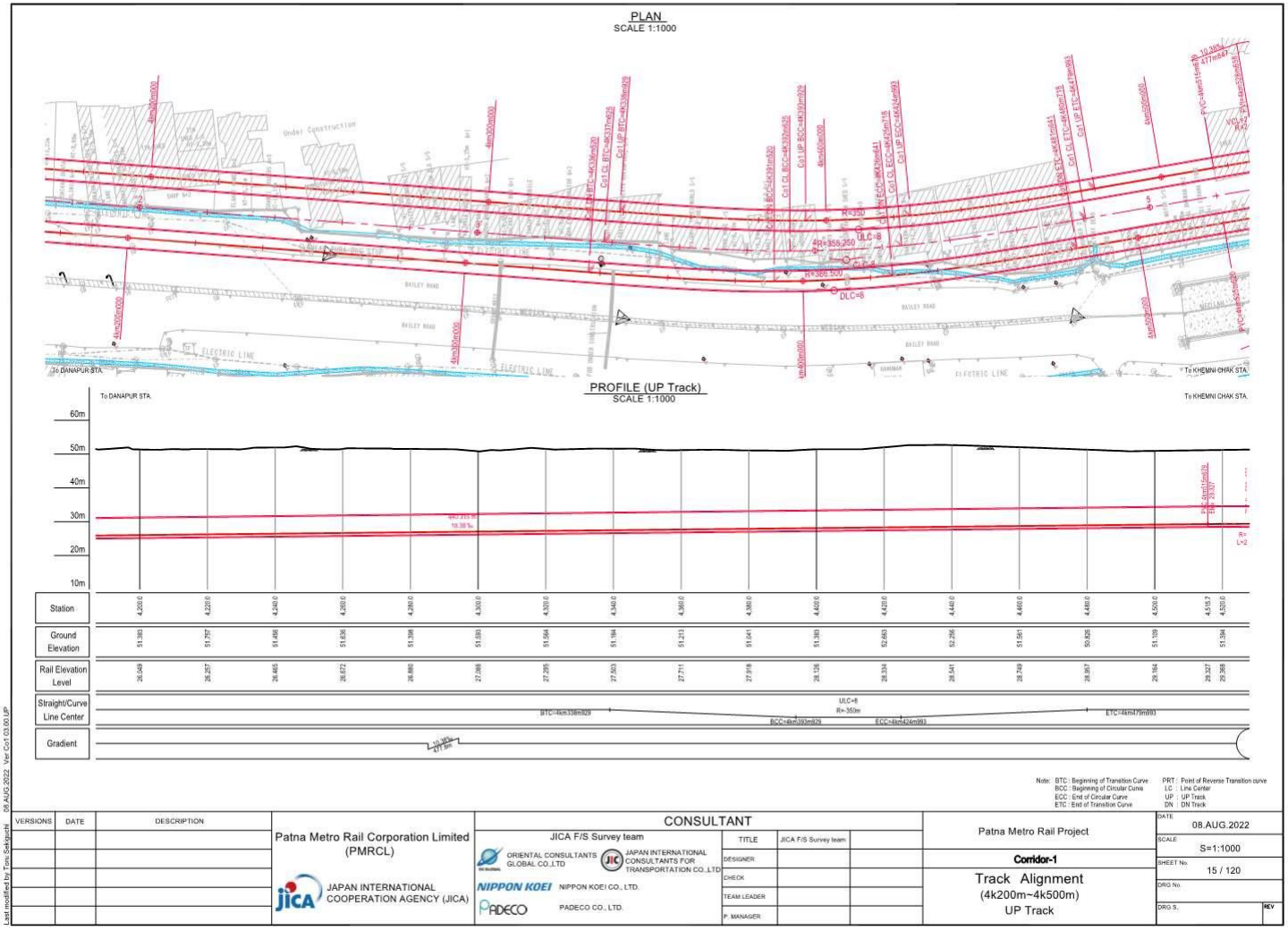
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k300m~3k600m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
12 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cs1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k600m~3k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
13 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k900m~4k200m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
14 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
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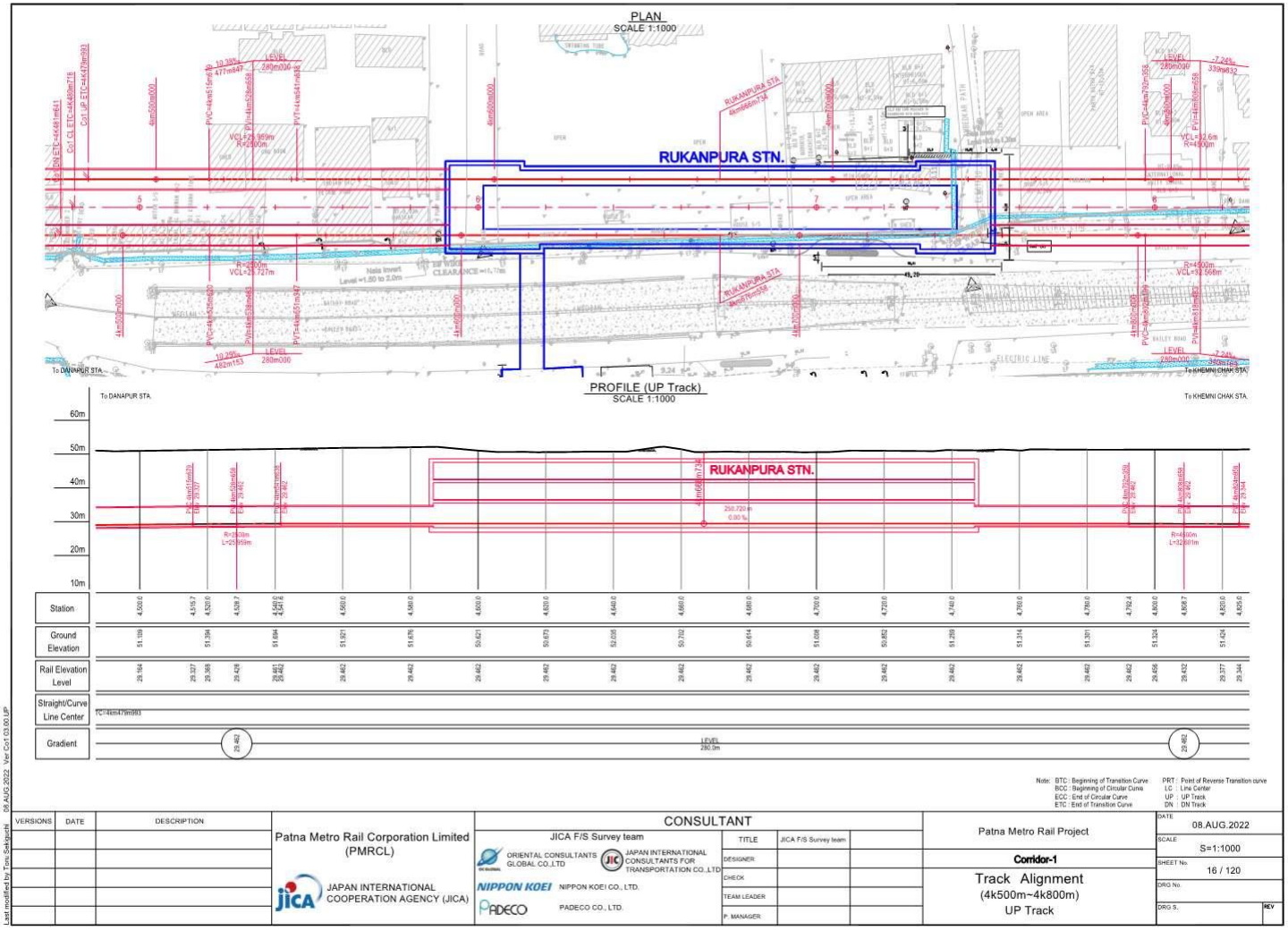
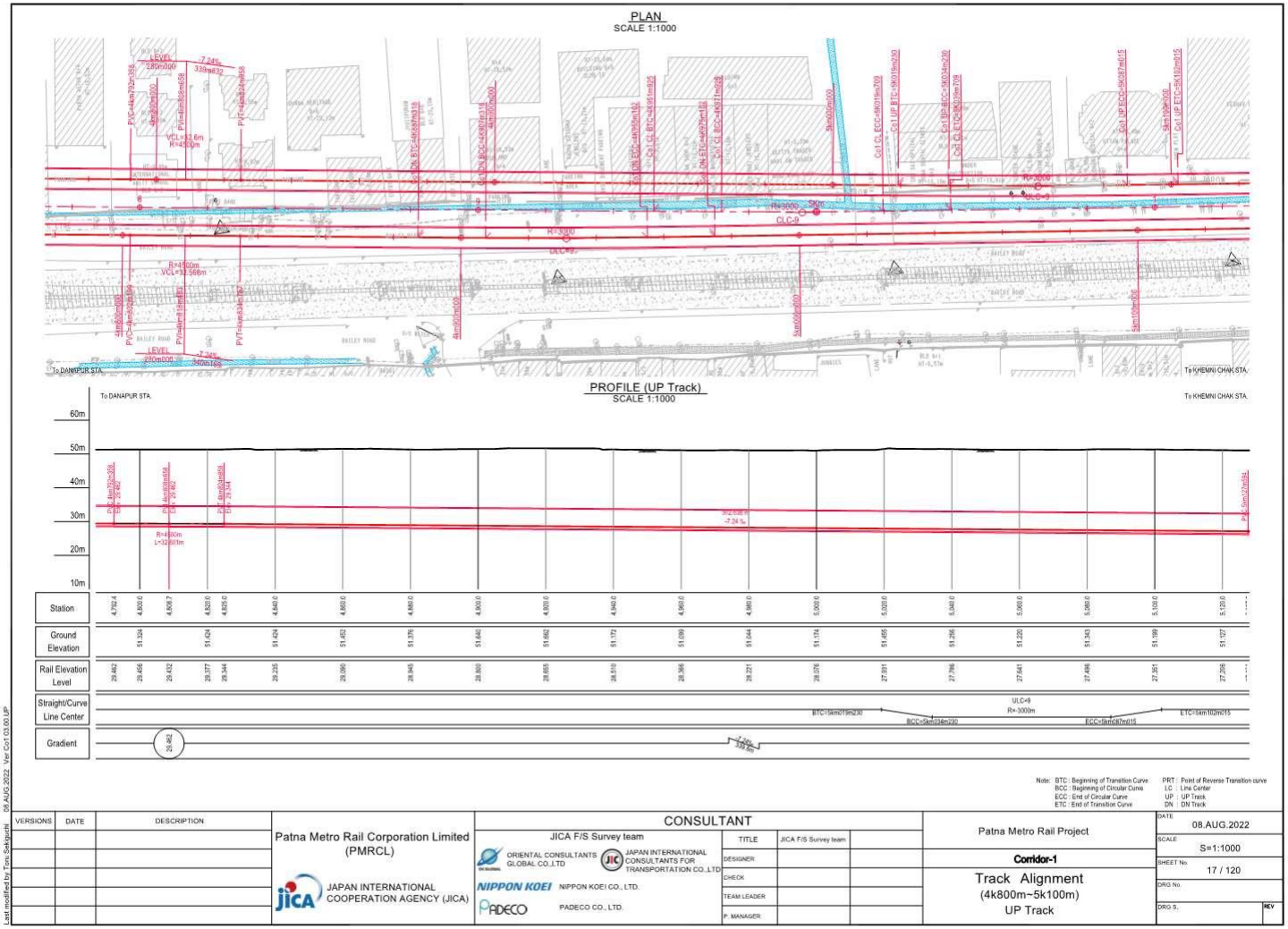
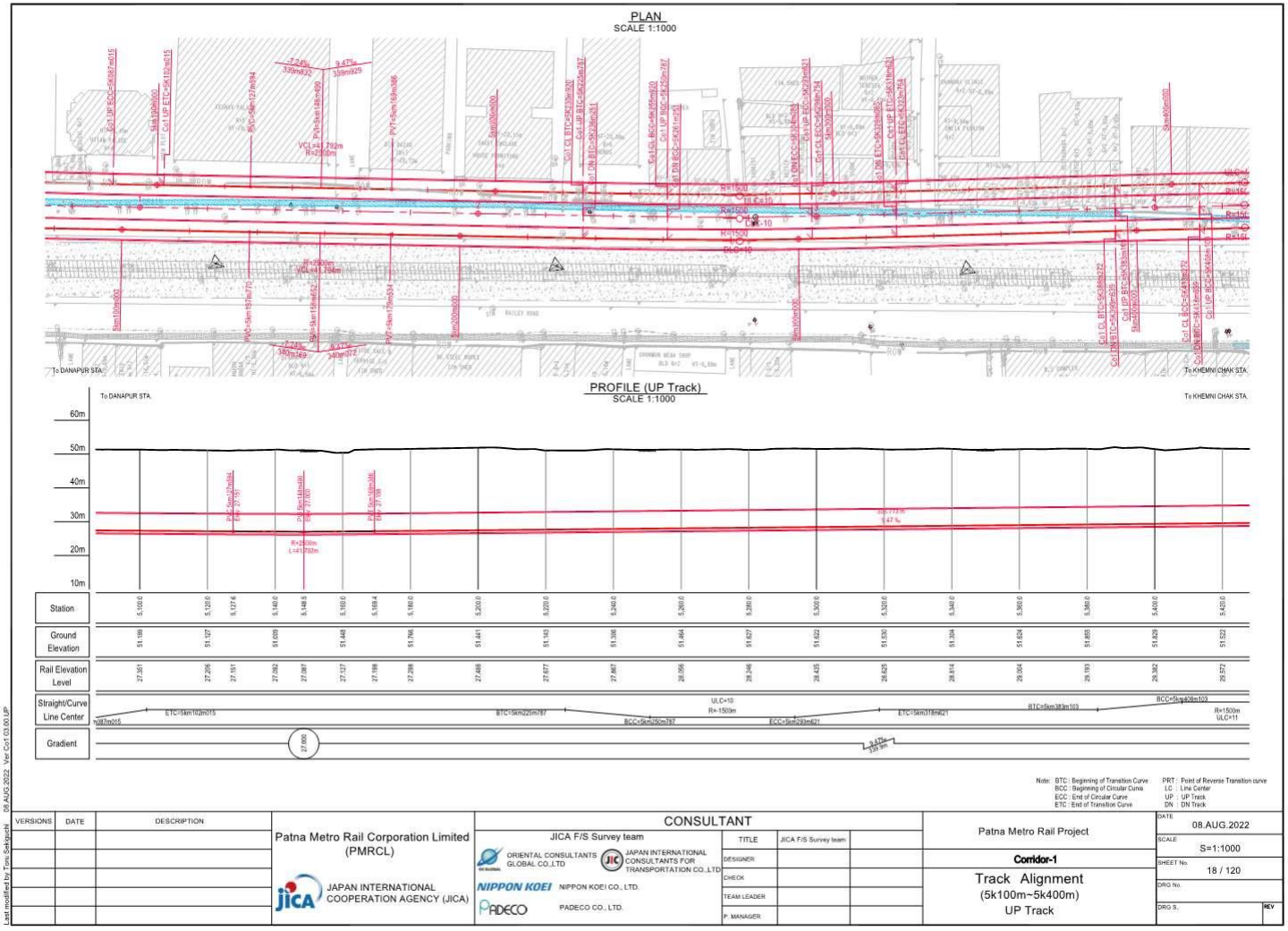
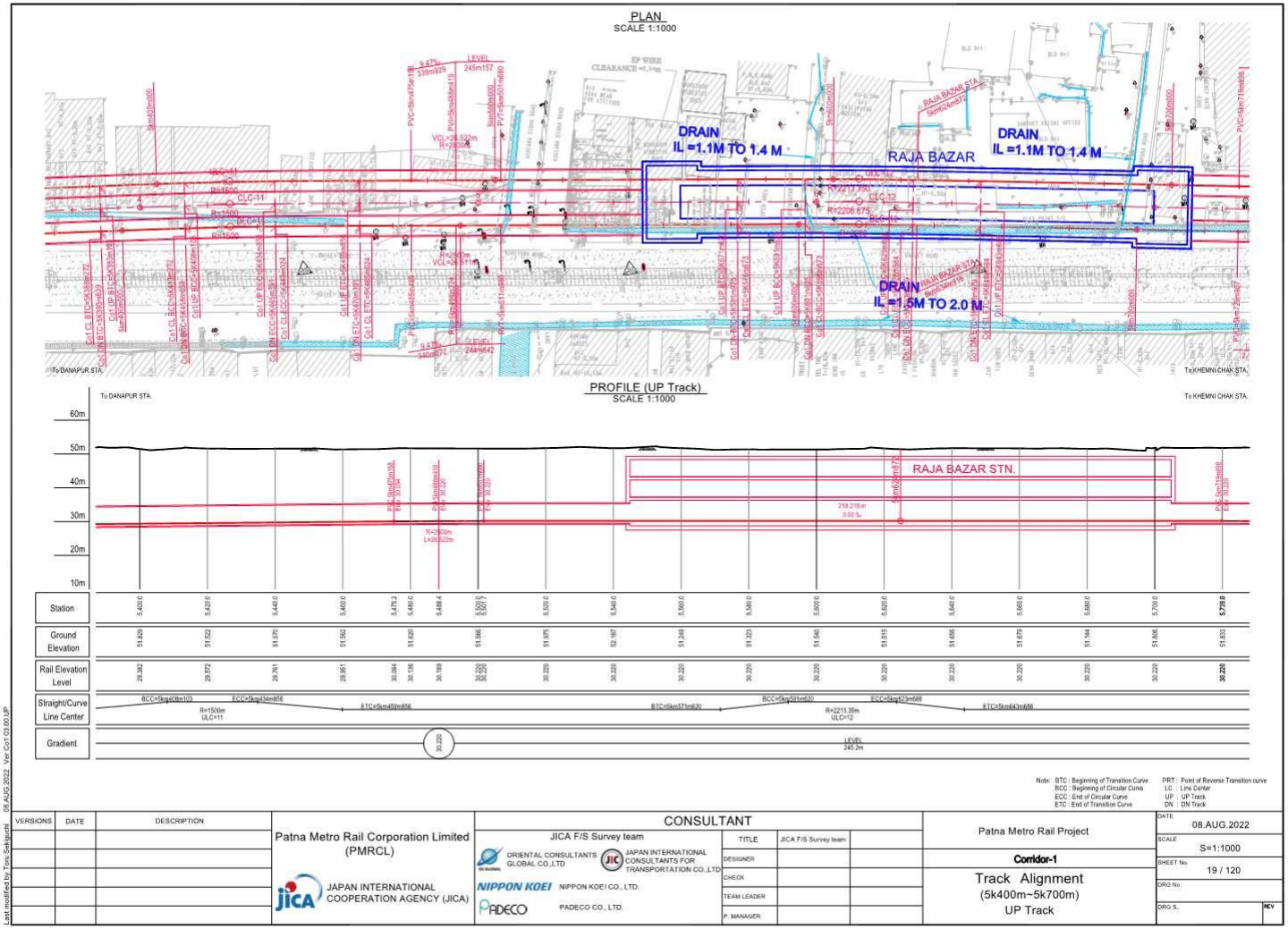
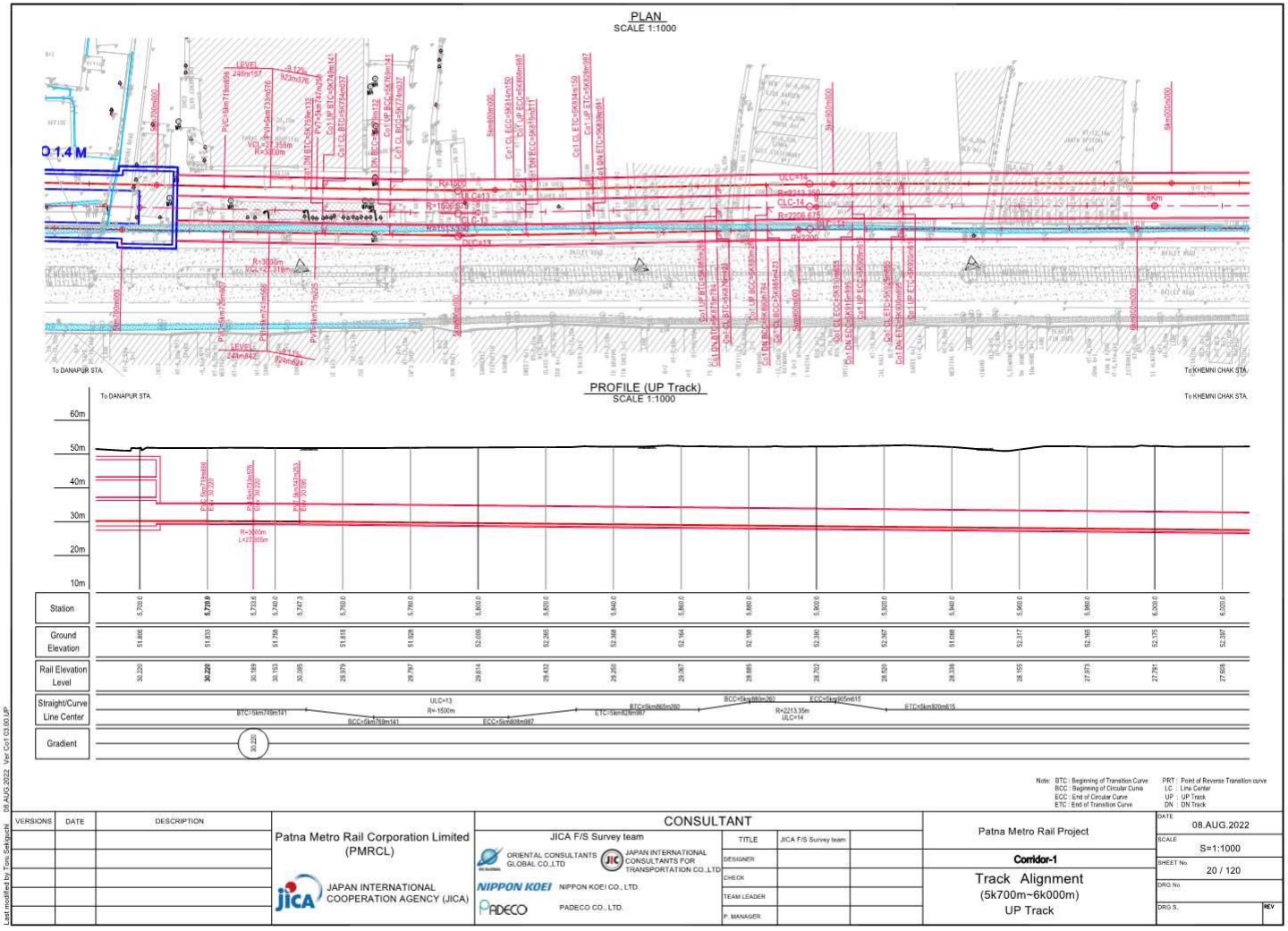
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k200m~4k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
15 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP

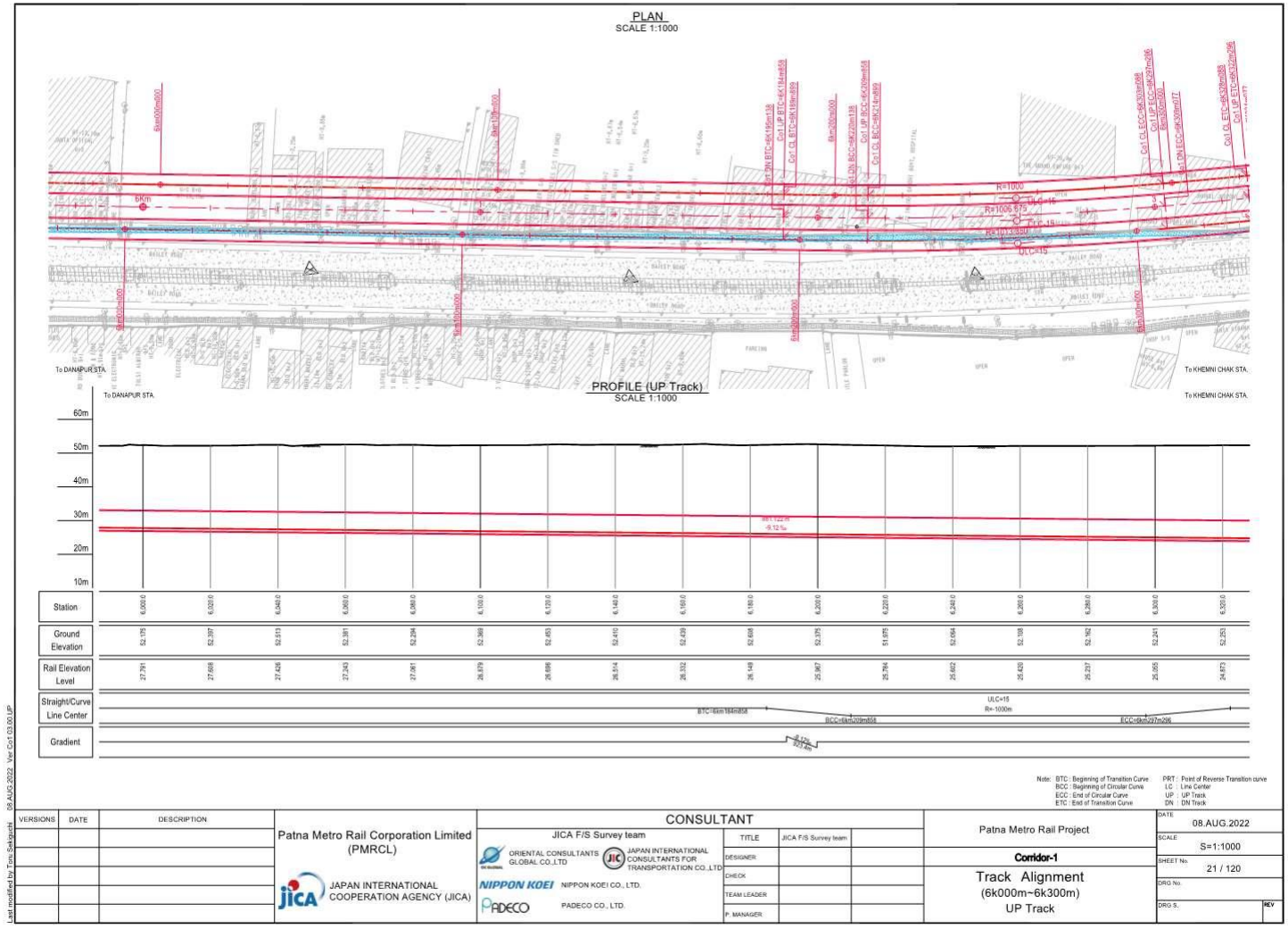

PLAN
SCALE 1:1000
RUKANPURA STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
RUKANPURA STN.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k500m~4k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
16 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 UP

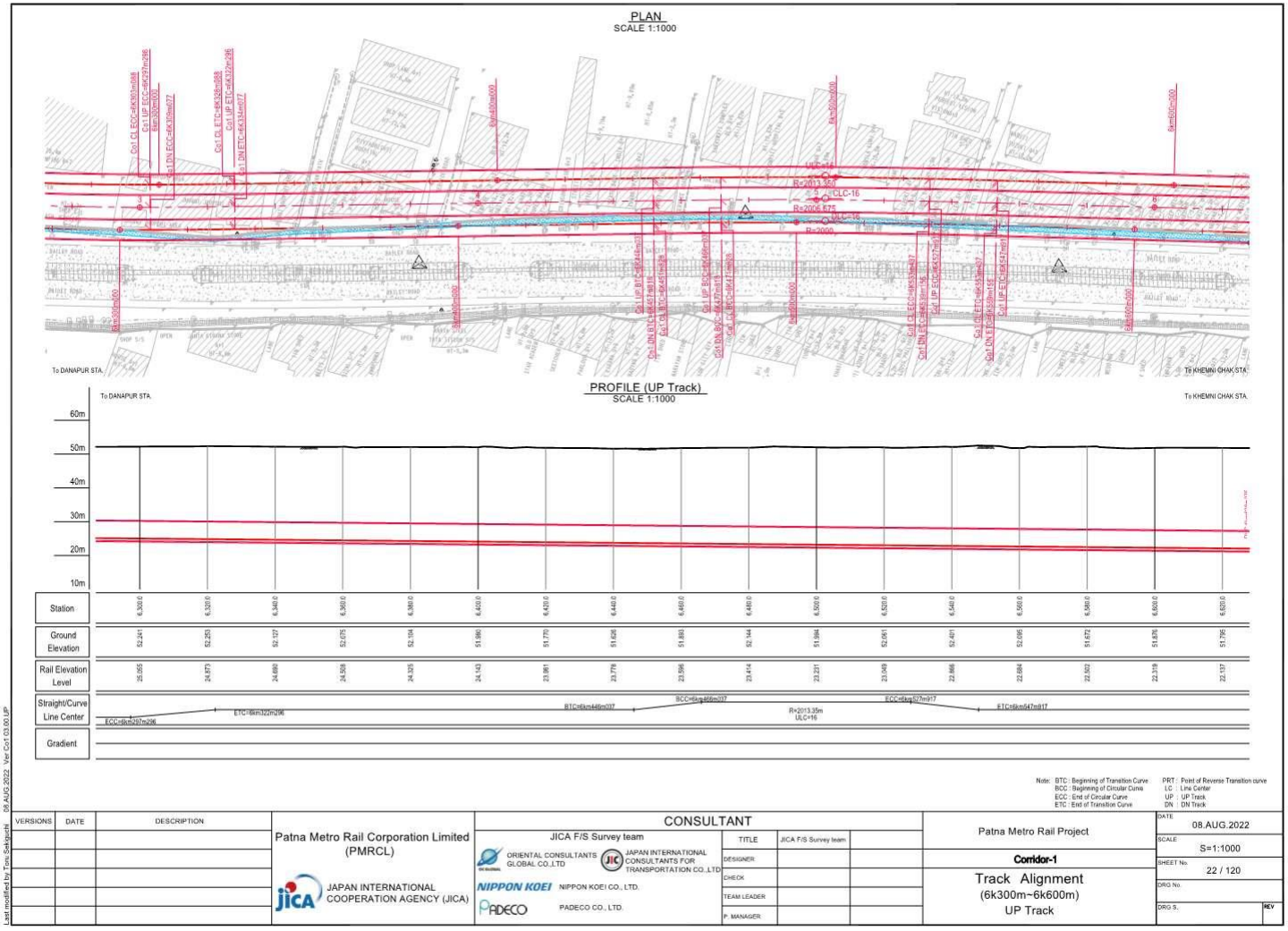

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k800m~5k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
17 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cor1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k100m~5k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
18 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sakiyachi 08.AUG.2022 Ver Cor1.03.00 UP


PLAN
SCALE 1:1000
DRAIN
IL =1.1M TO 1.4 M
RAJA BAZAR
DRAIN
IL =1.1M TO 1.4 M
DRAIN
IL =1.5M TO 2.0 M
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
RAJA BAZAR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k400m~5k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
19 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k700m~6k000m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
20 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyachi 08.AUG.2022 Ver Cv1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
ULC=15
R=-1000m
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k000m~6k300m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
21 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Co1 03 00 UP



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VERSIONS	DATE	DESCRIPTION

Patna Metro Rail Corporation Limited (PMRCL)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA F/S Survey team

ORIENTAL CONSULTANTS GLOBAL CO.,LTD

JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD

NIPPON KOEI CO., LTD.

PADECO CO., LTD.

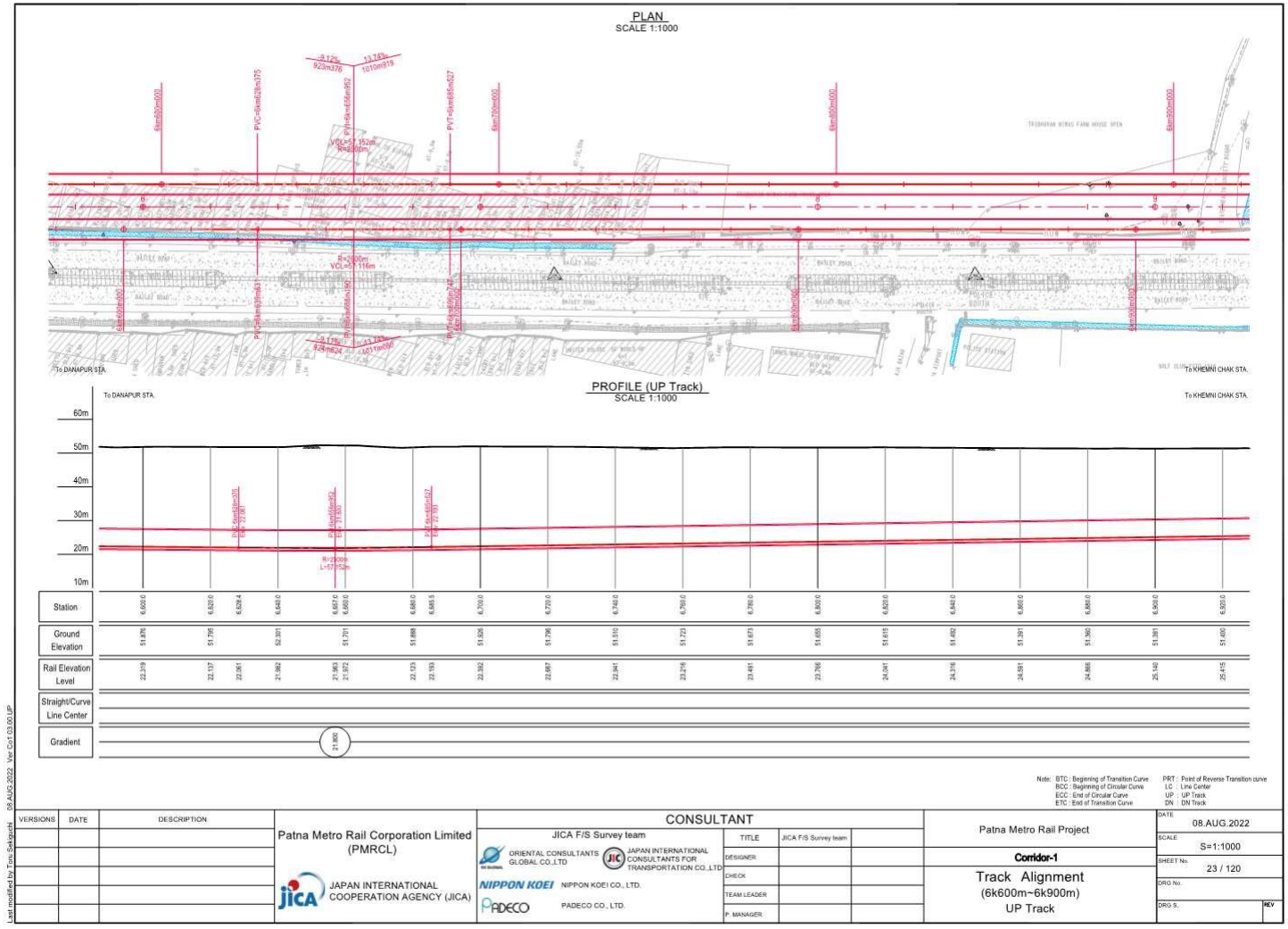
TITLE	JICA F/S Survey team	
DESIGNER		
CHECK		
TEAM LEADER		
P. MANAGER		

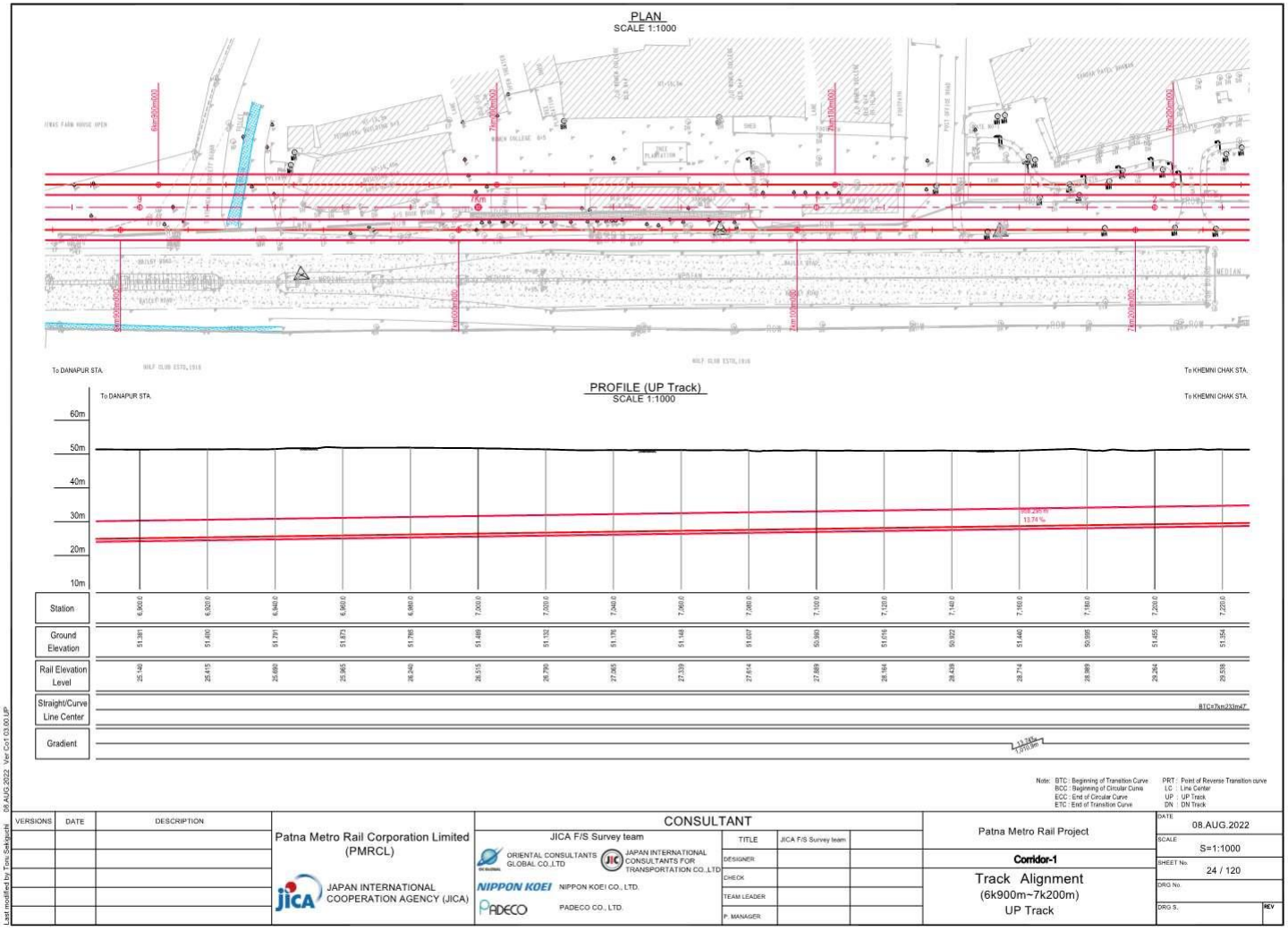
Patna Metro Rail Project

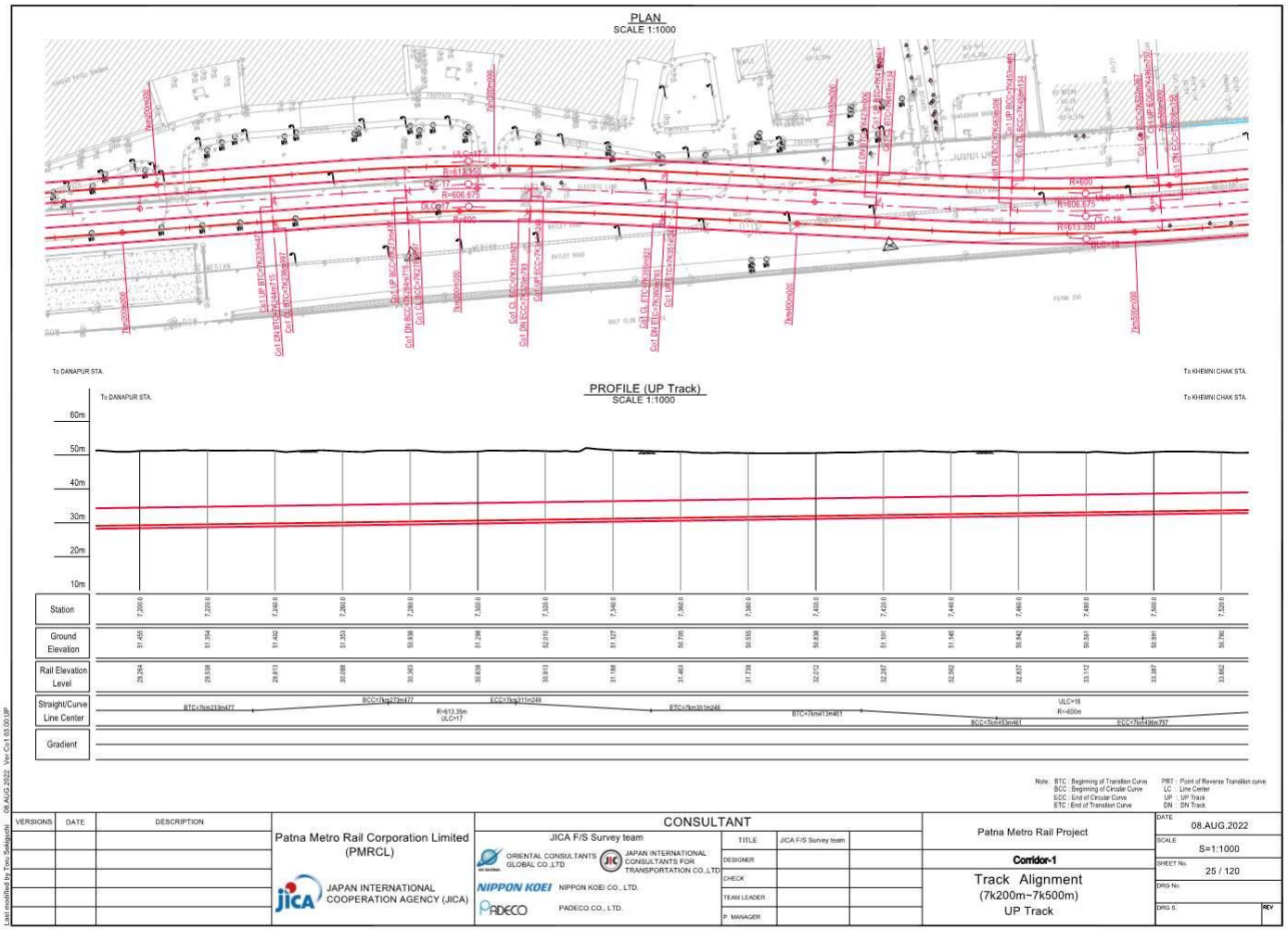
Corridor-1

Track Alignment
(6k300m~6k600m)
UP Track

DATE	08.AUG.2022
SCALE	S=1:1000
SHEET No.	22 / 120
DRG.No.	
DRG.S.	REV


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k600m~6k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
23 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k900m~7k200m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
24 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP


PLAN
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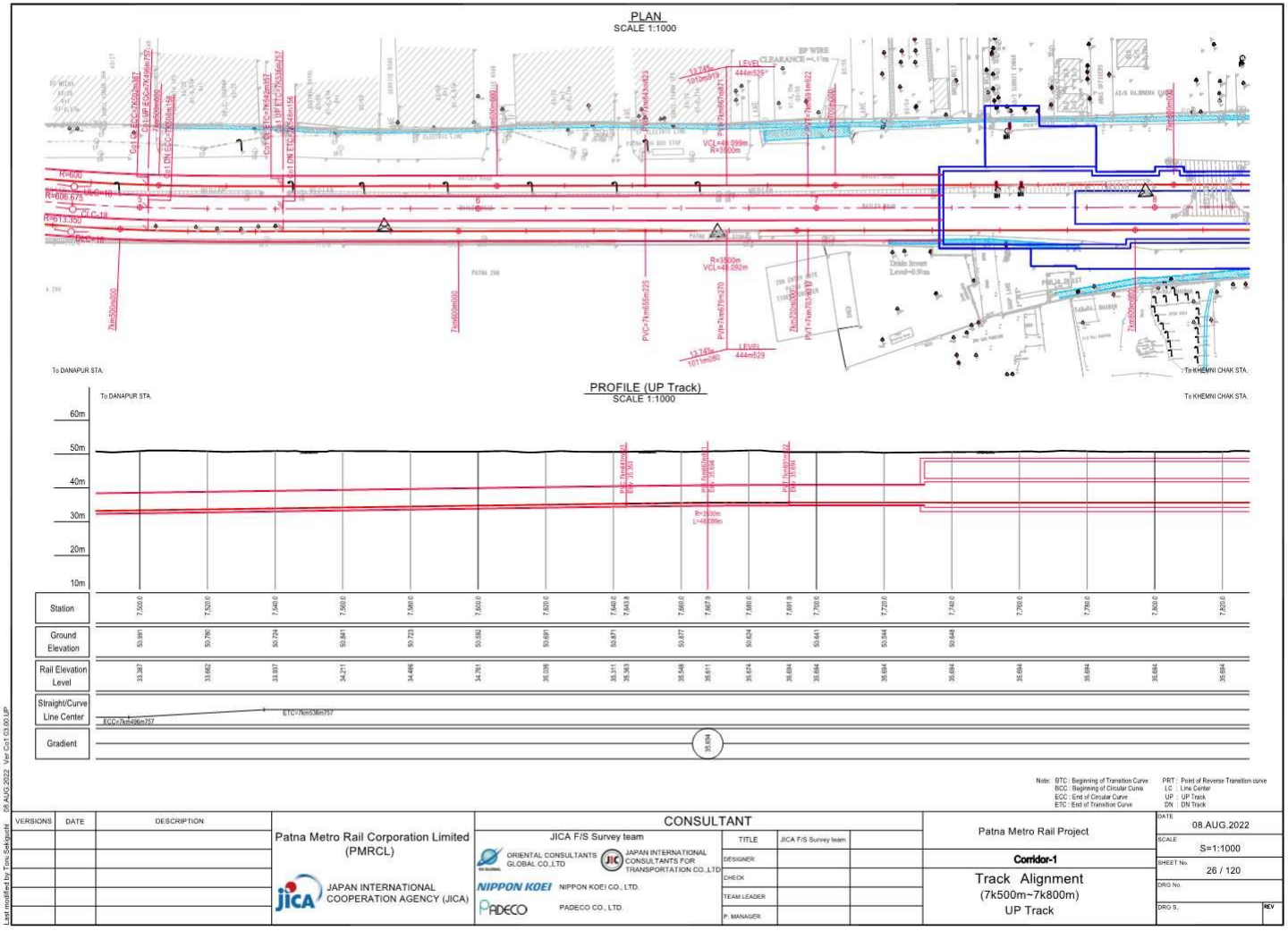
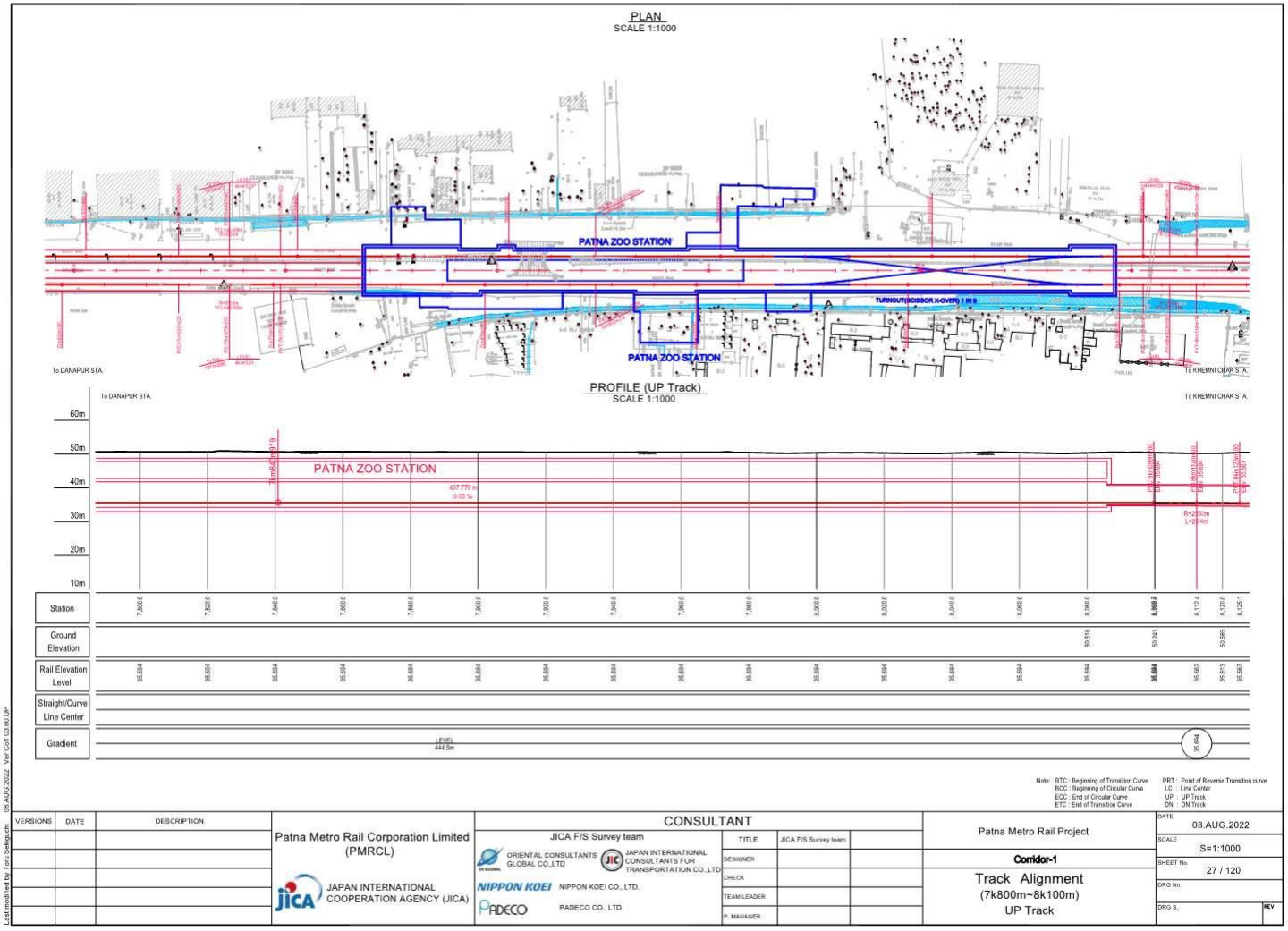
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD.
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD.
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(7k200m~7k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
25 / 120
DRG No.
DRG S.
REV
Last modified by Tomi Sekiguchi 08.AUG.2022 Ver-Cp1.03.00.UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(7k500m~7k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
26 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP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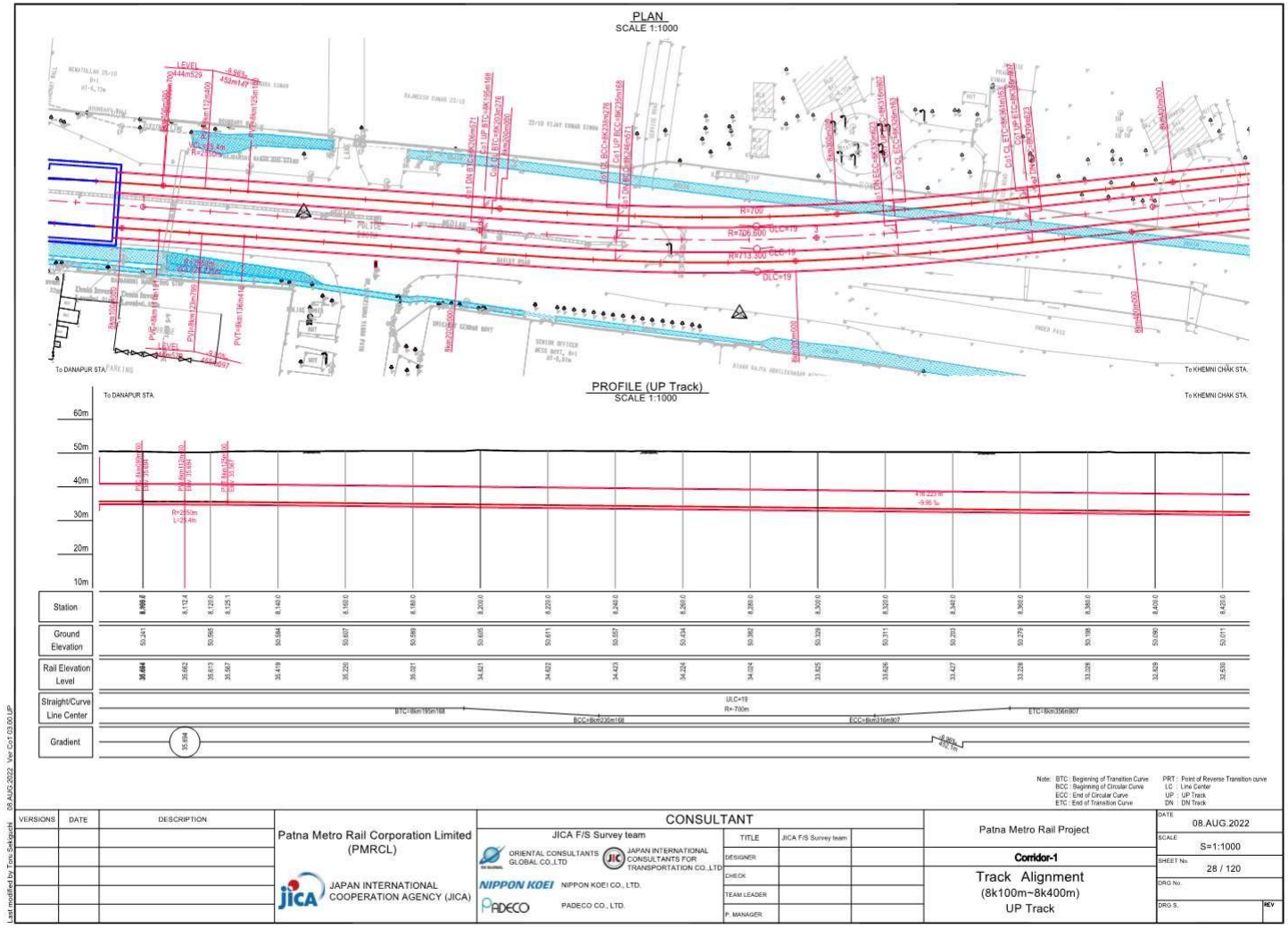
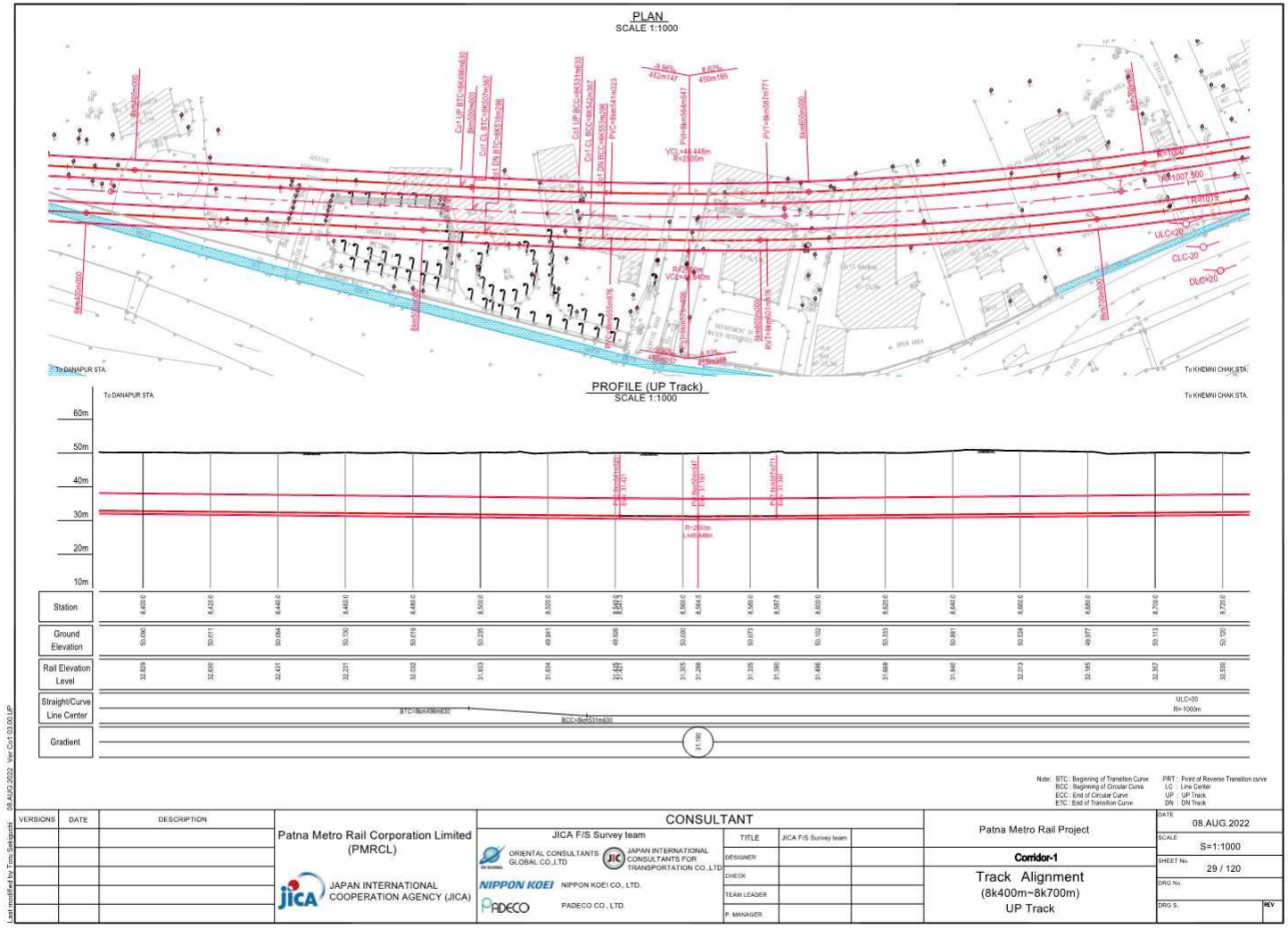
SCALE 1:1000
PATNA ZOO STATION
PATNA ZOO STATION
TURNOUT(SCISSOR X-OVER) 1 IN 8
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
PATNA ZOO STATION
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(7k800m~8k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
27 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(8k100m~8k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
28 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP


PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
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Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
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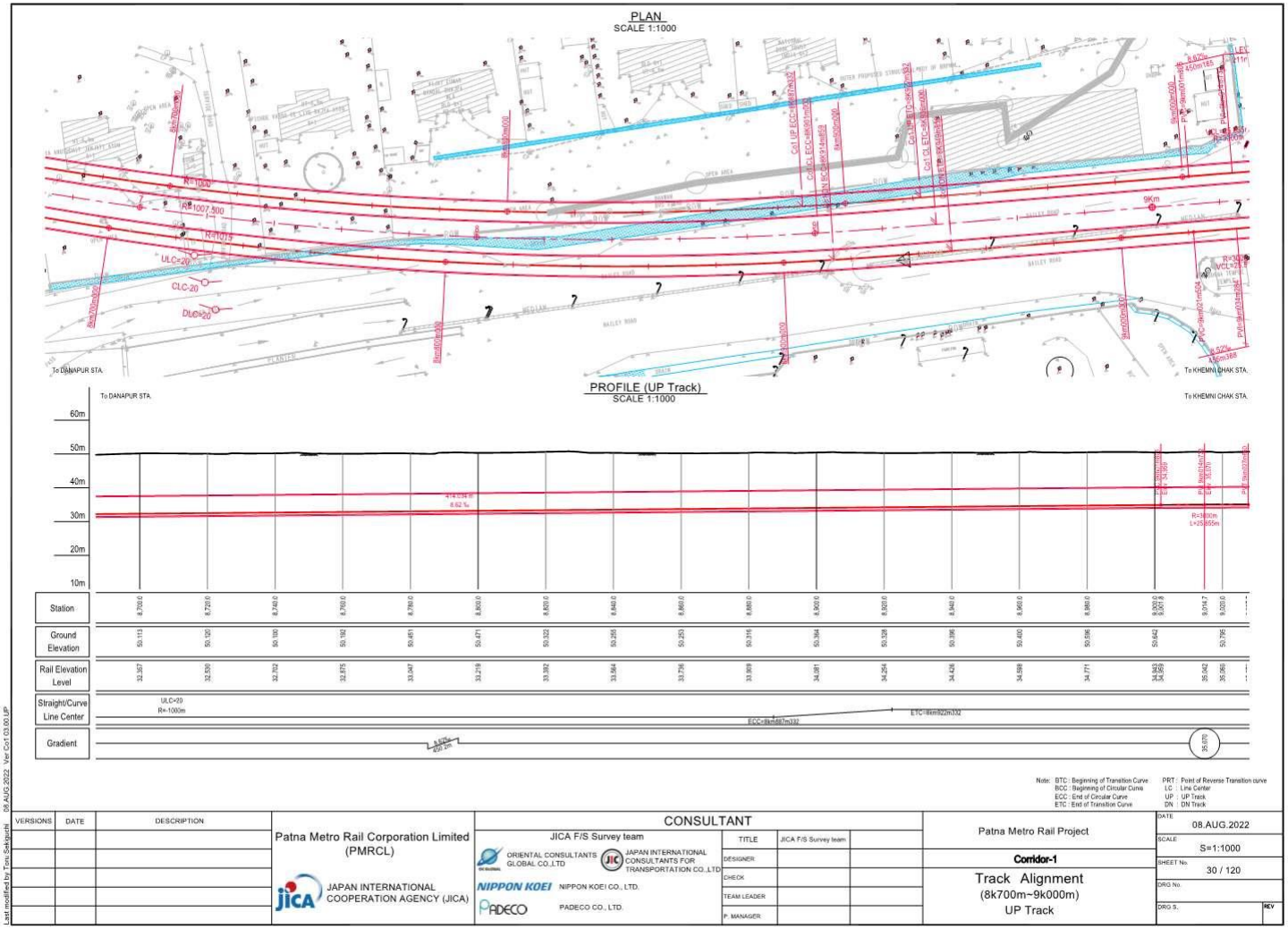
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(8k400m~8k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
29 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Cv1.03.00 UP



VERSIONS	DATE	DESCRIPTION

Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP

Patna Metro Rail Corporation Limited (PMRCL)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANT

JICA F/S Survey team

ORIENTAL CONSULTANTS GLOBAL CO.,LTD

JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD

NIPPON KOEI CO., LTD.

PADECO CO., LTD.

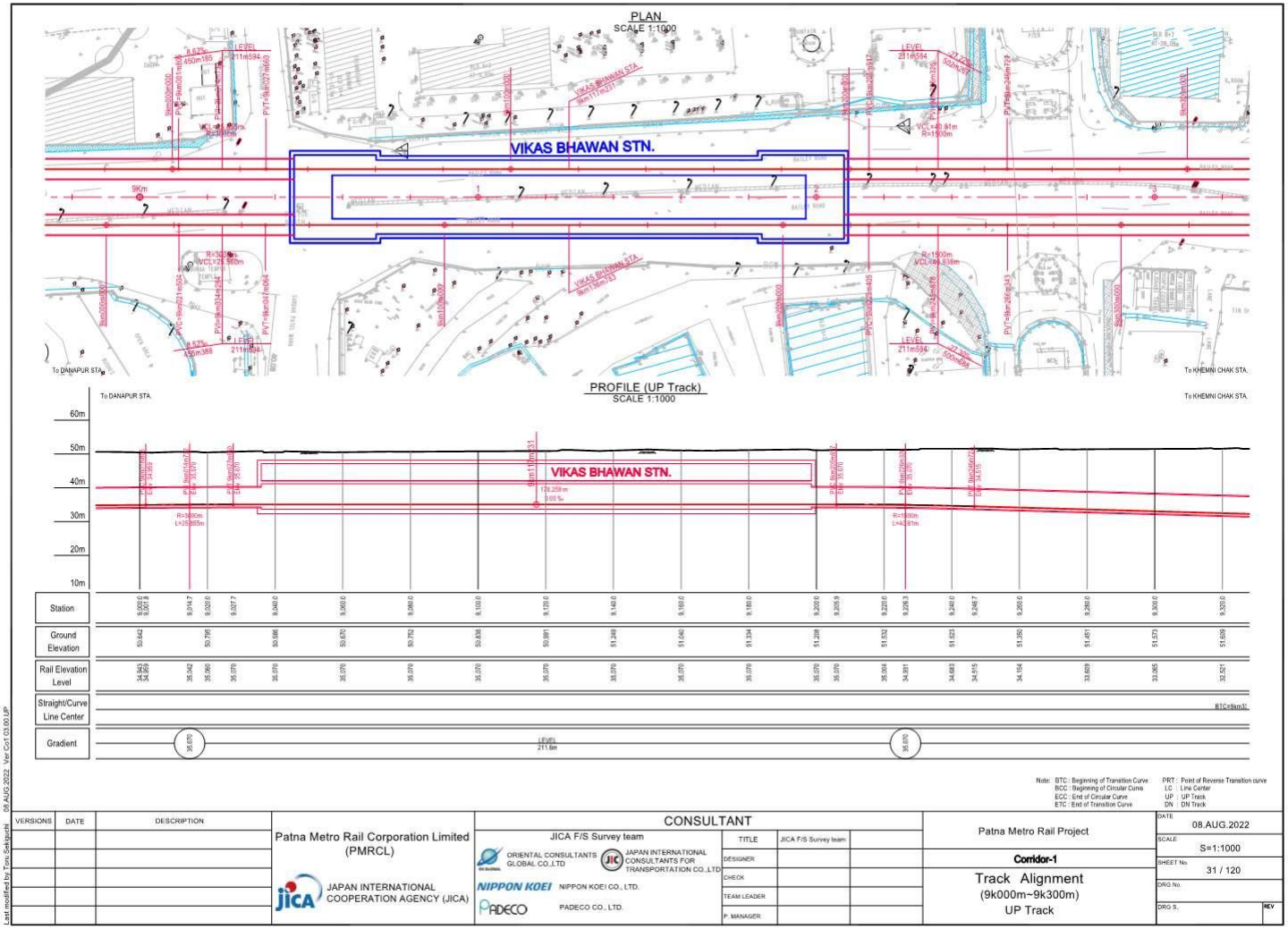
TITLE	JICA F/S Survey team	
DESIGNER		
CHECK		
TEAM LEADER		
P. MANAGER		

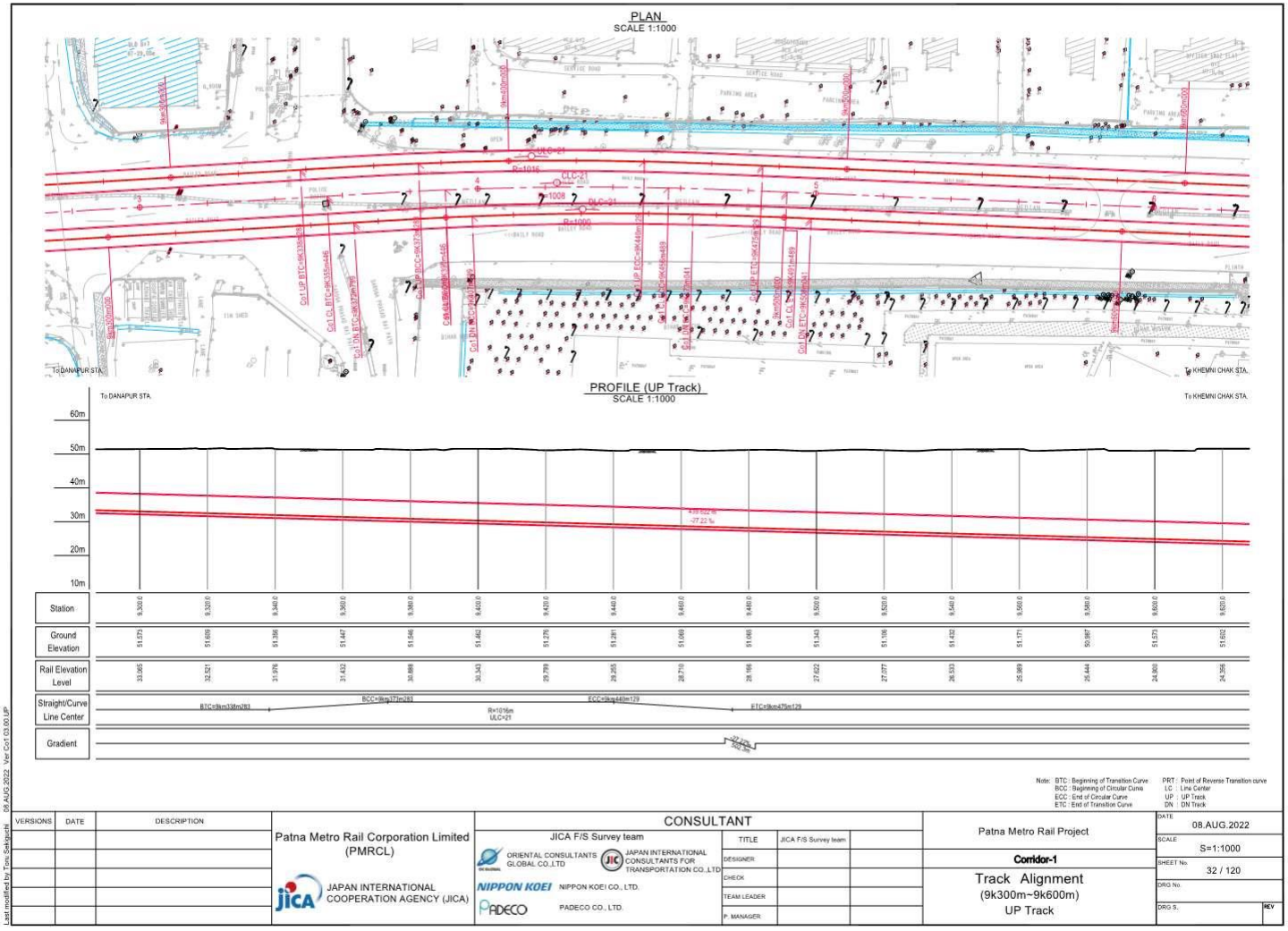
Patna Metro Rail Project

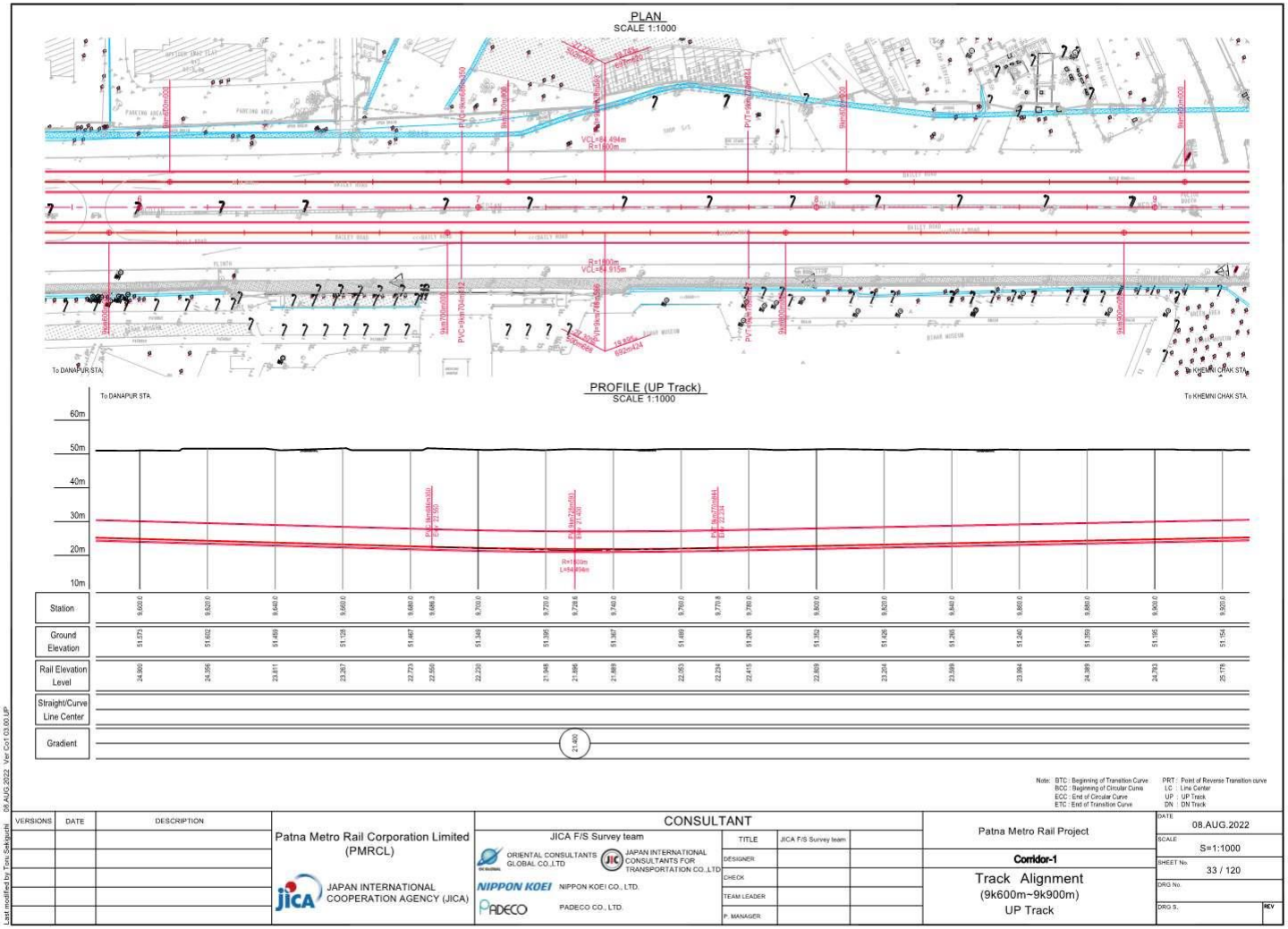
Corridor-1

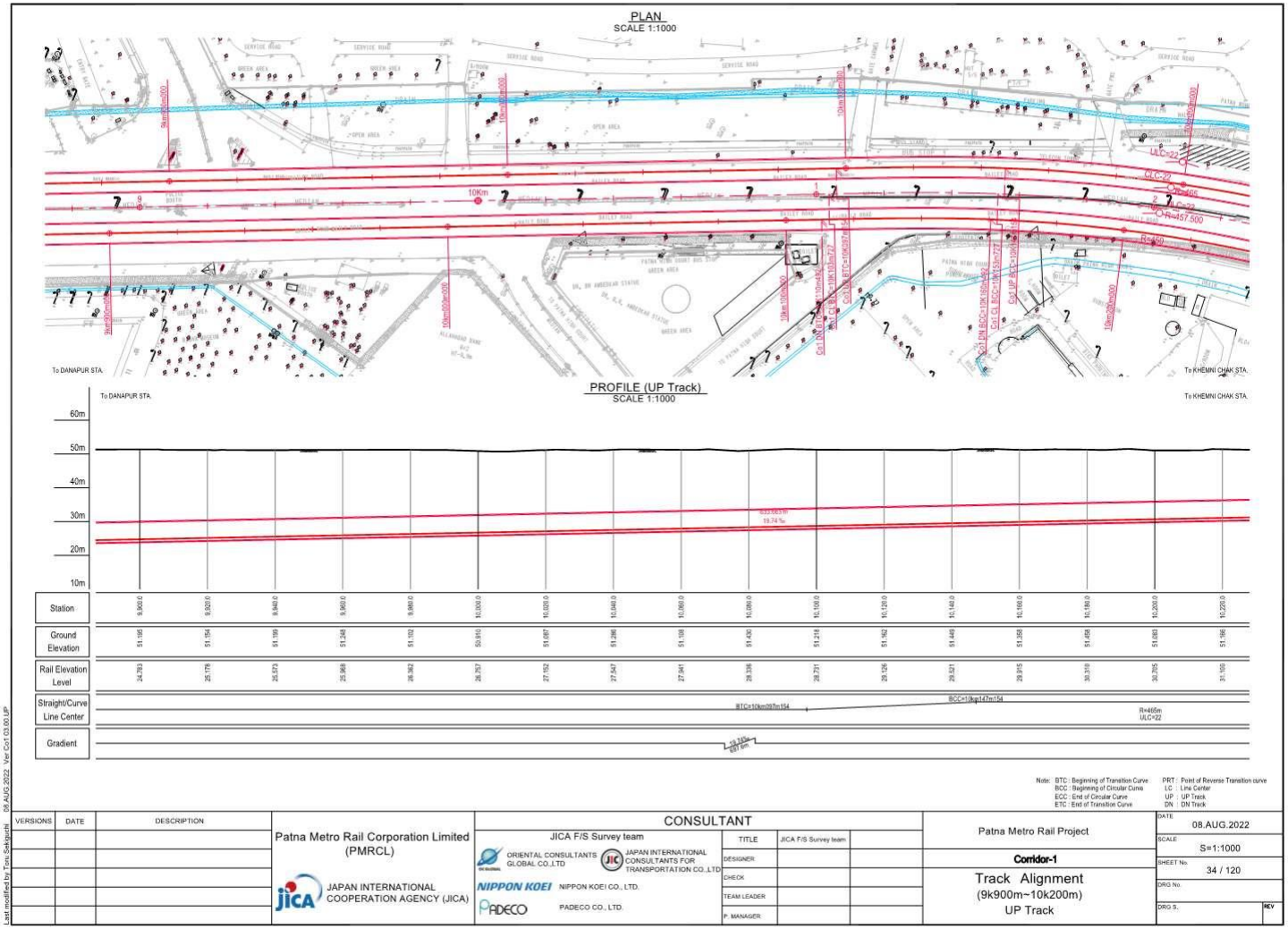
Track Alignment
(8k700m~9k000m)
UP Track

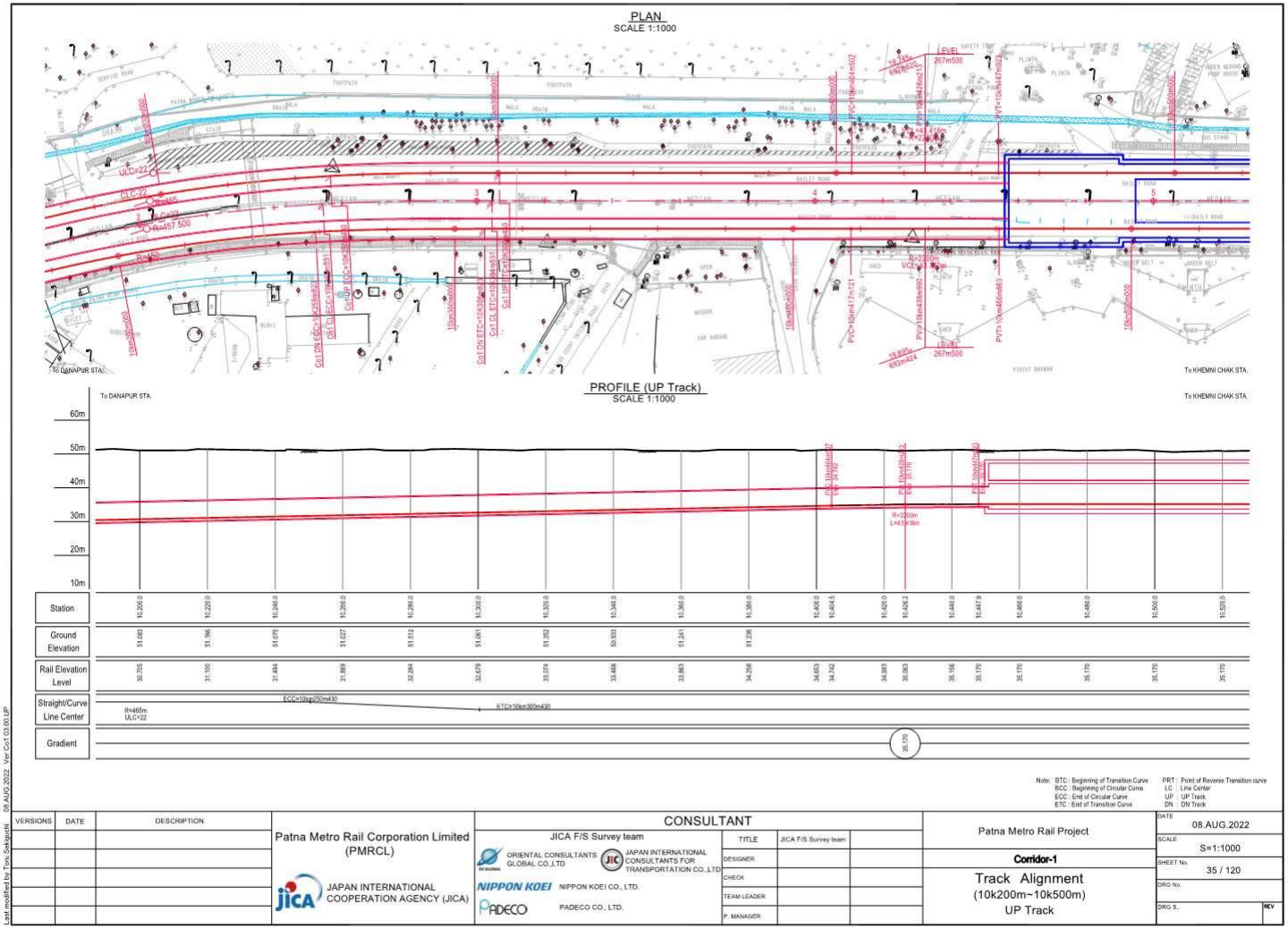
DATE	08.AUG.2022
SCALE	S=1:1000
SHEET No.	30 / 120
DRG No.	
DRG S.	REV

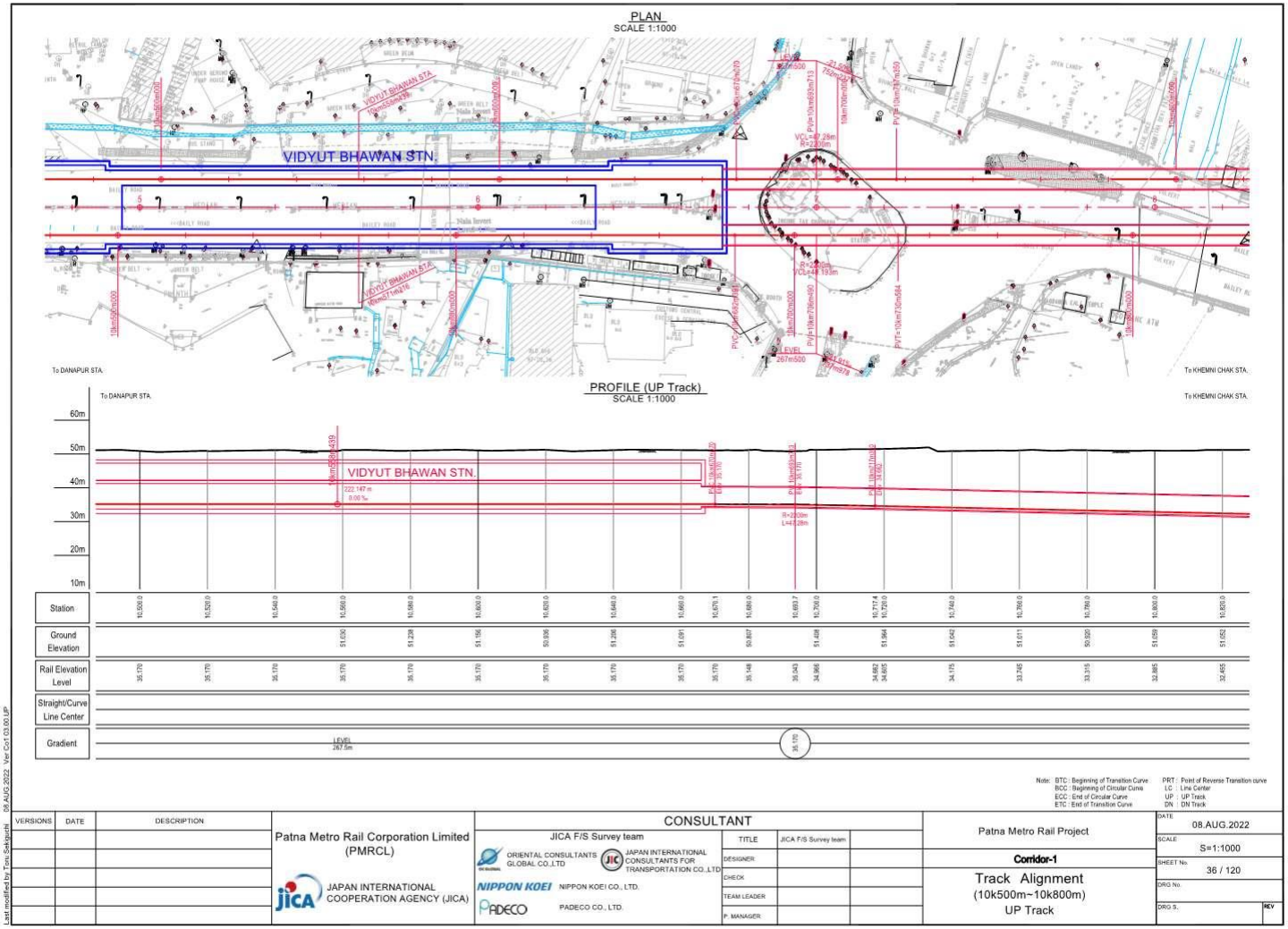

PLAN
SCALE 1:1000
VIKAS BHAWAN STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
VIKAS BHAWAN STN.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(9k000m~9k300m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
31 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00 UP

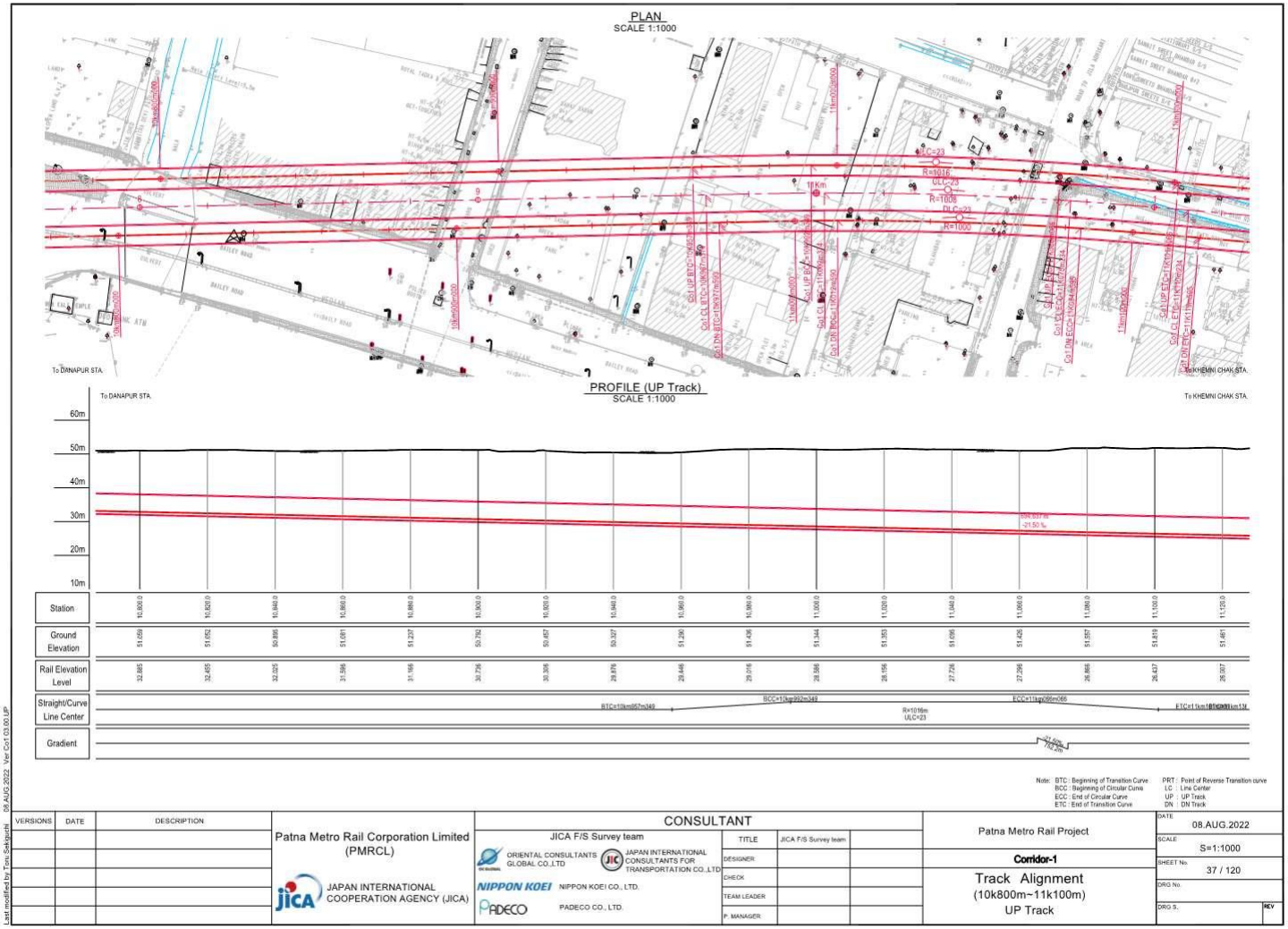

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(9k300m~9k600m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
32 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP

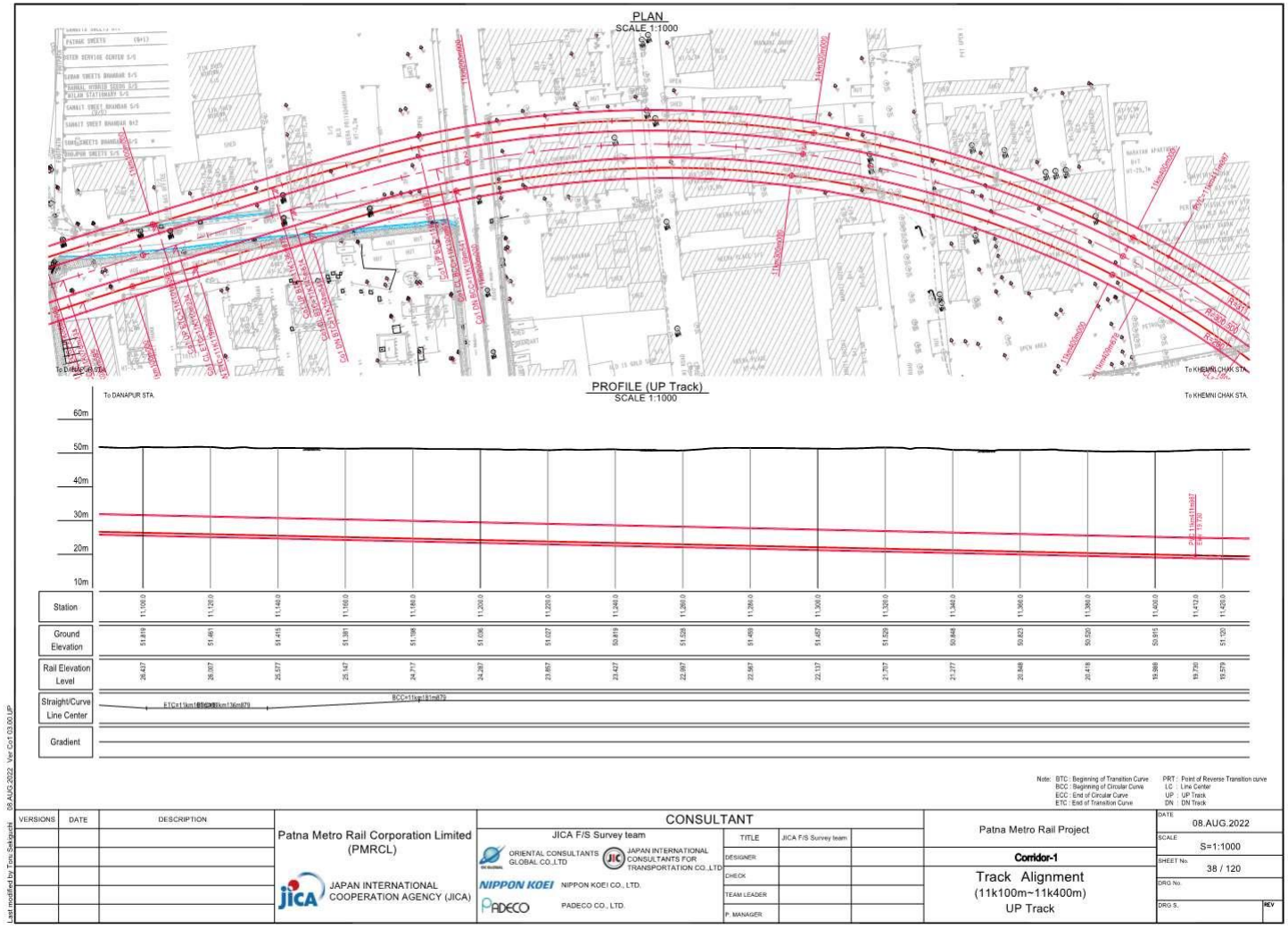

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(9k600m~9k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
33 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.UP

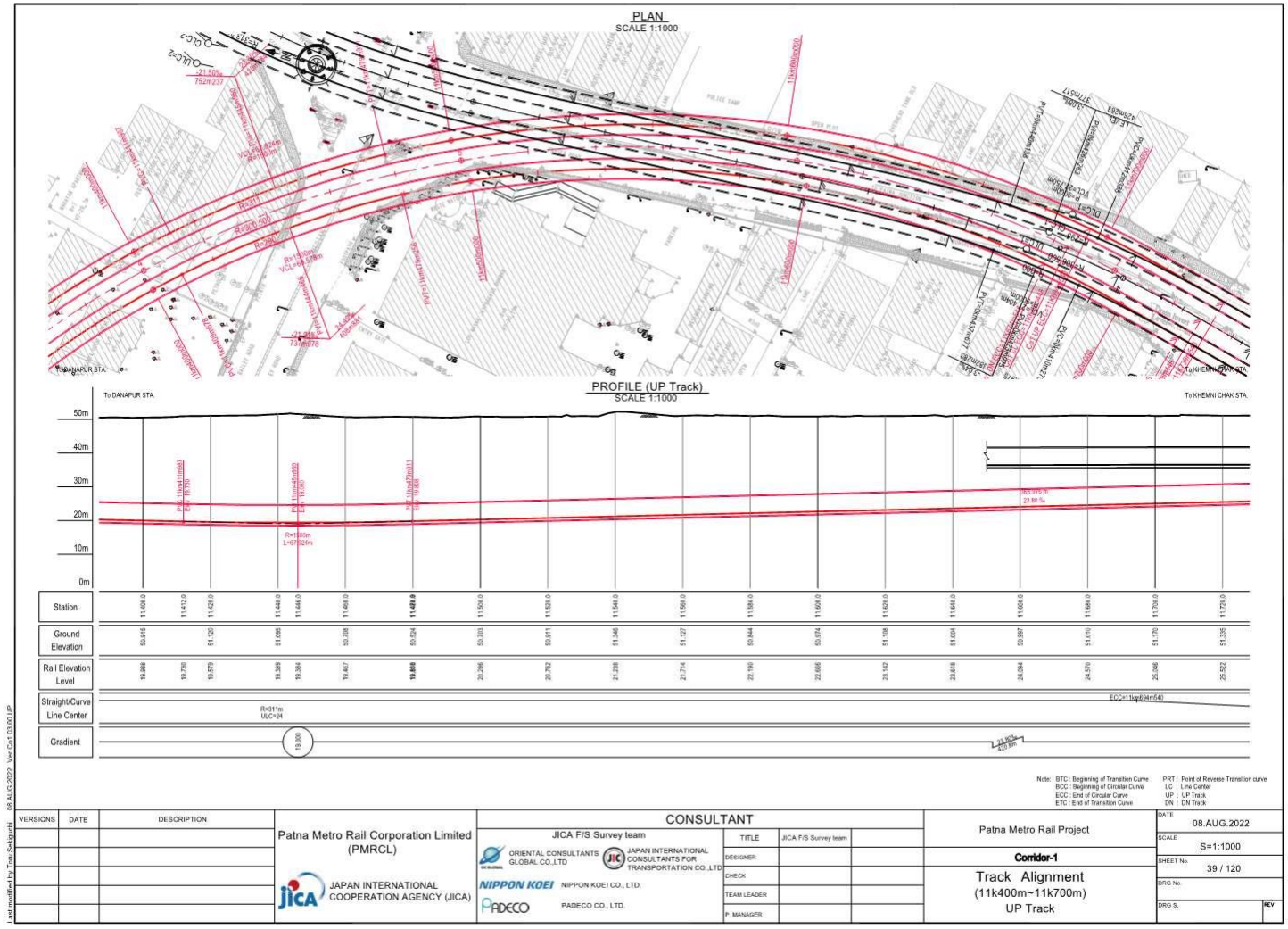

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(9k900m~10k200m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
34 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00 UP

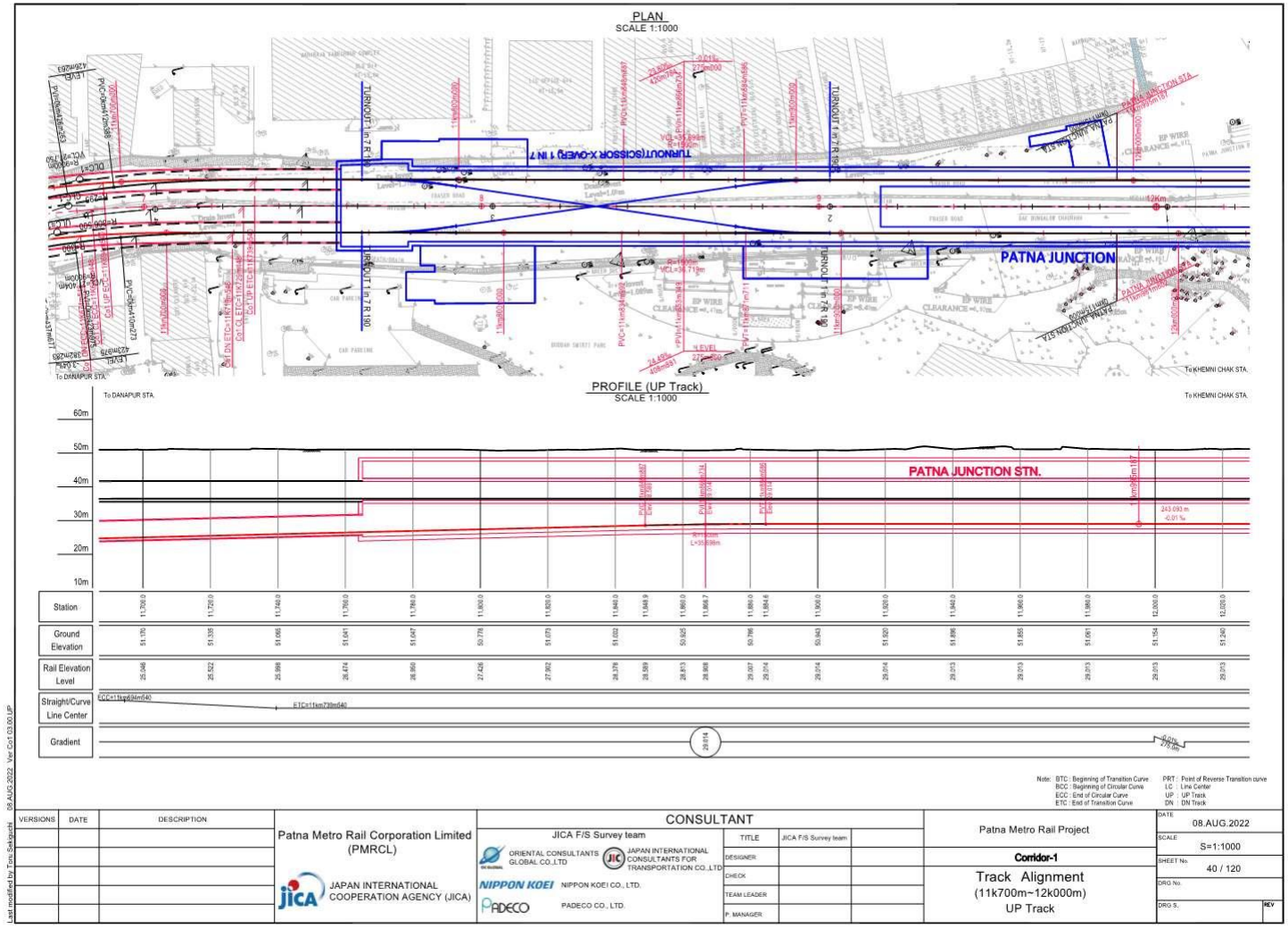

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
R=465m
ULC=22
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(10k200m~10k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
35 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cs1.03.00.UP

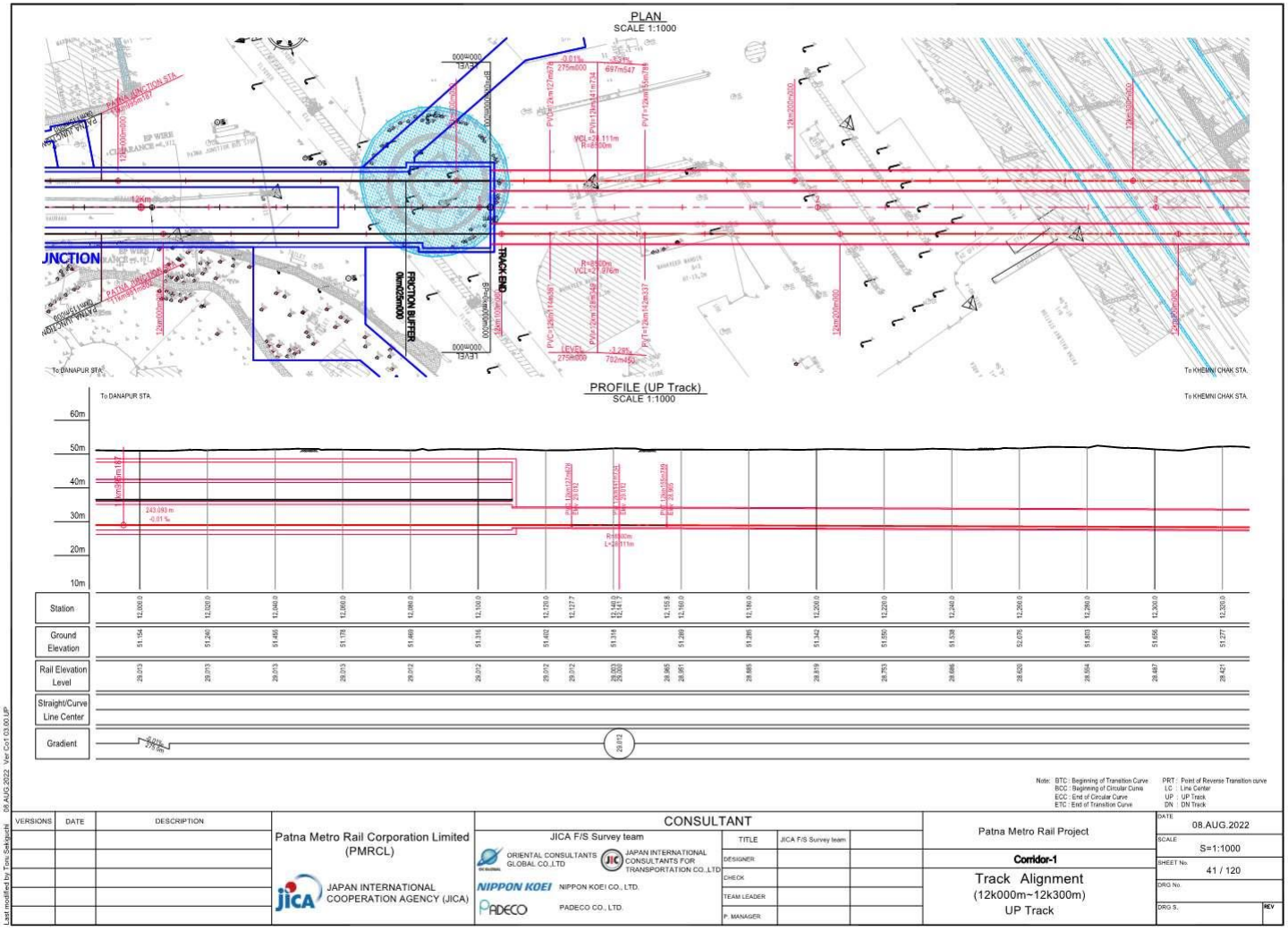

PLAN
SCALE 1:1000
VIDYUT BHAWAN STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(10k500m~10k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
36 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00.UP

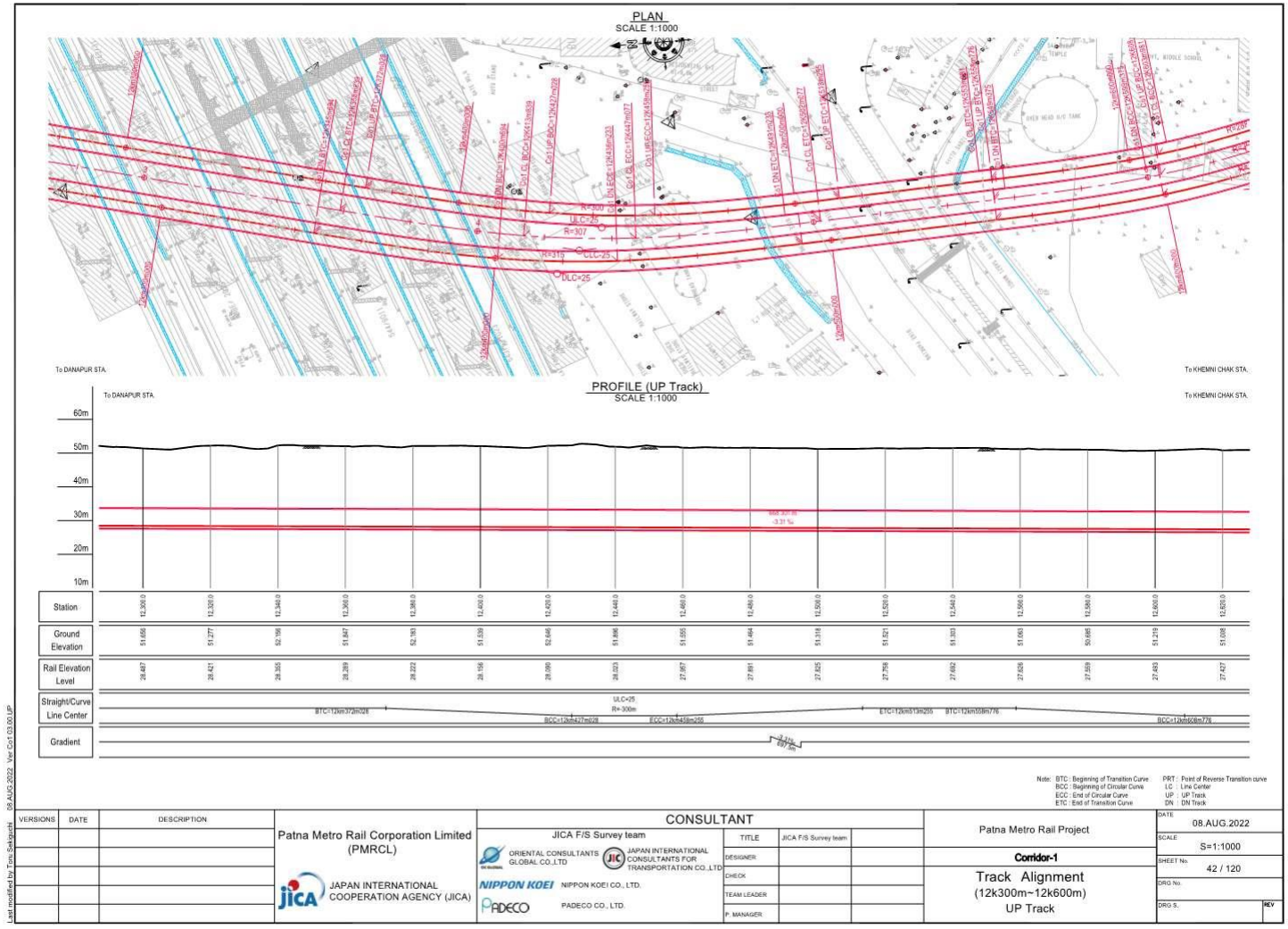

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
R=1016m
ULC=23
-21.50 ‰
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cnt 03.00 UP
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(10k800m~11k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
37 / 120
DRG No.
DRG S.
REV

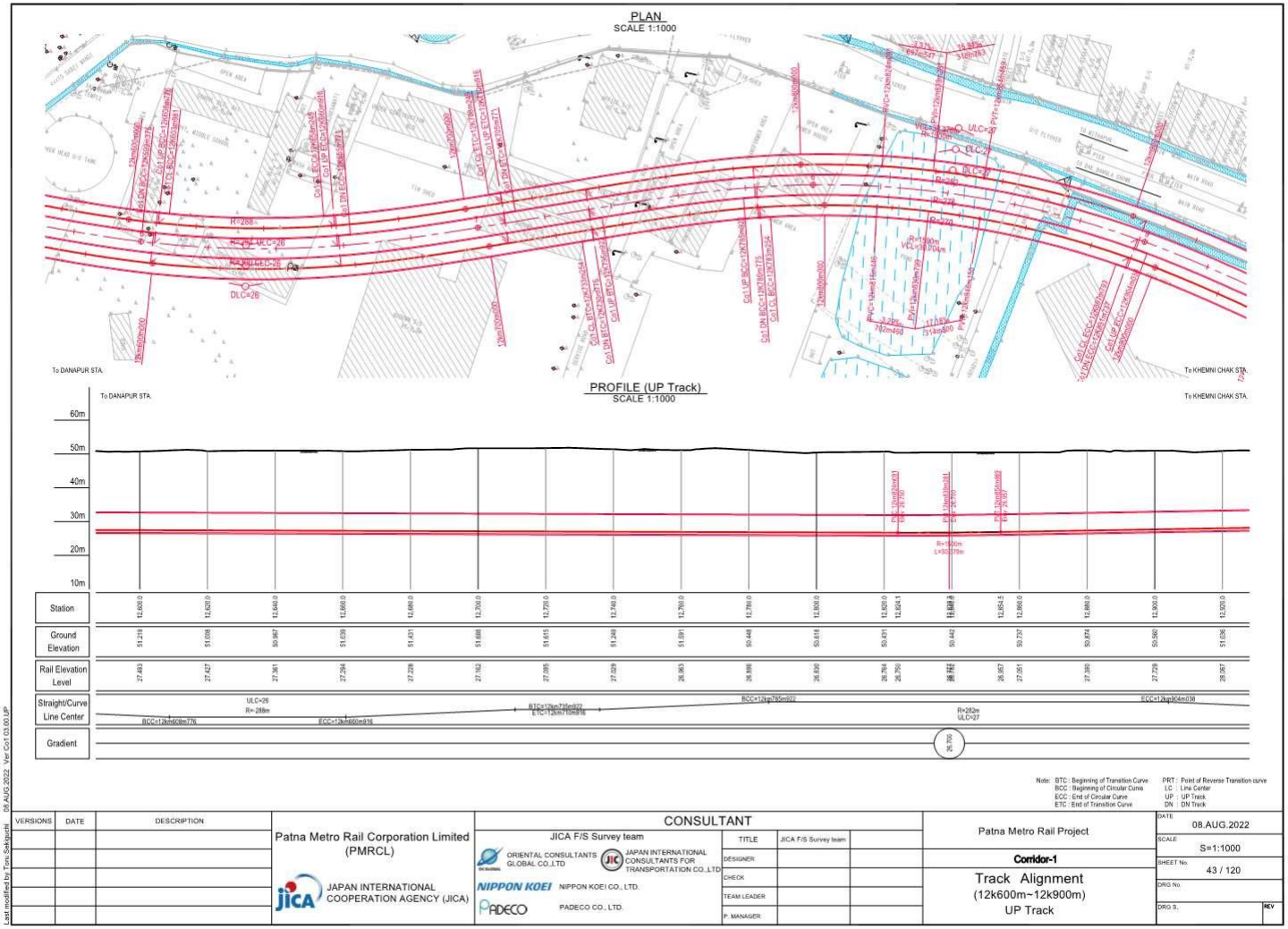

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(11k100m~11k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
38 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1.03.00 UP

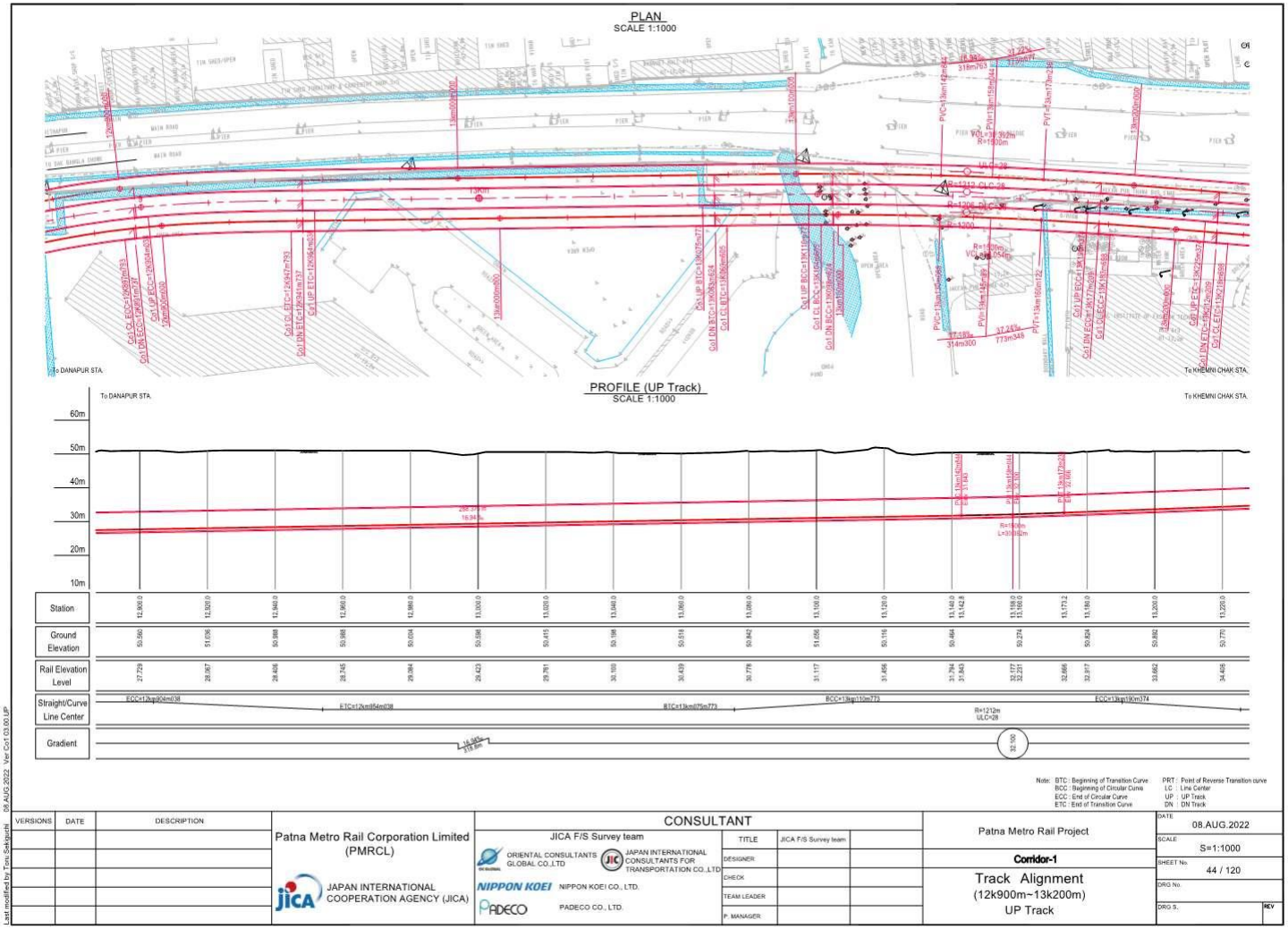

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
50m
40m
30m
20m
10m
0m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(11k400m~11k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
39 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00.UP

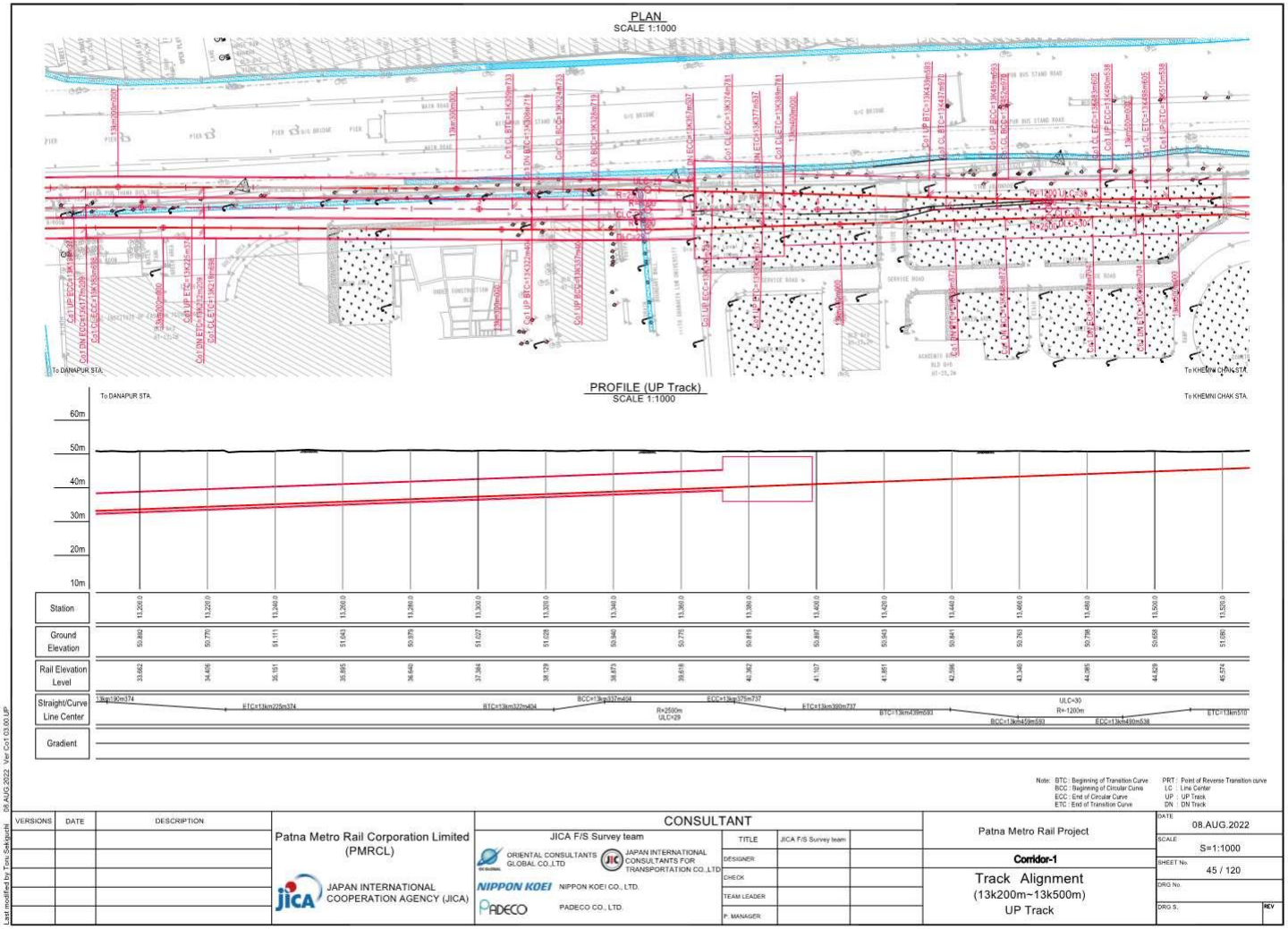

PLAN
SCALE 1:1000
PATNA JUNCTION
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
PATNA JUNCTION STN.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(11k700m~12k000m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
40 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cs1.03.00.UP

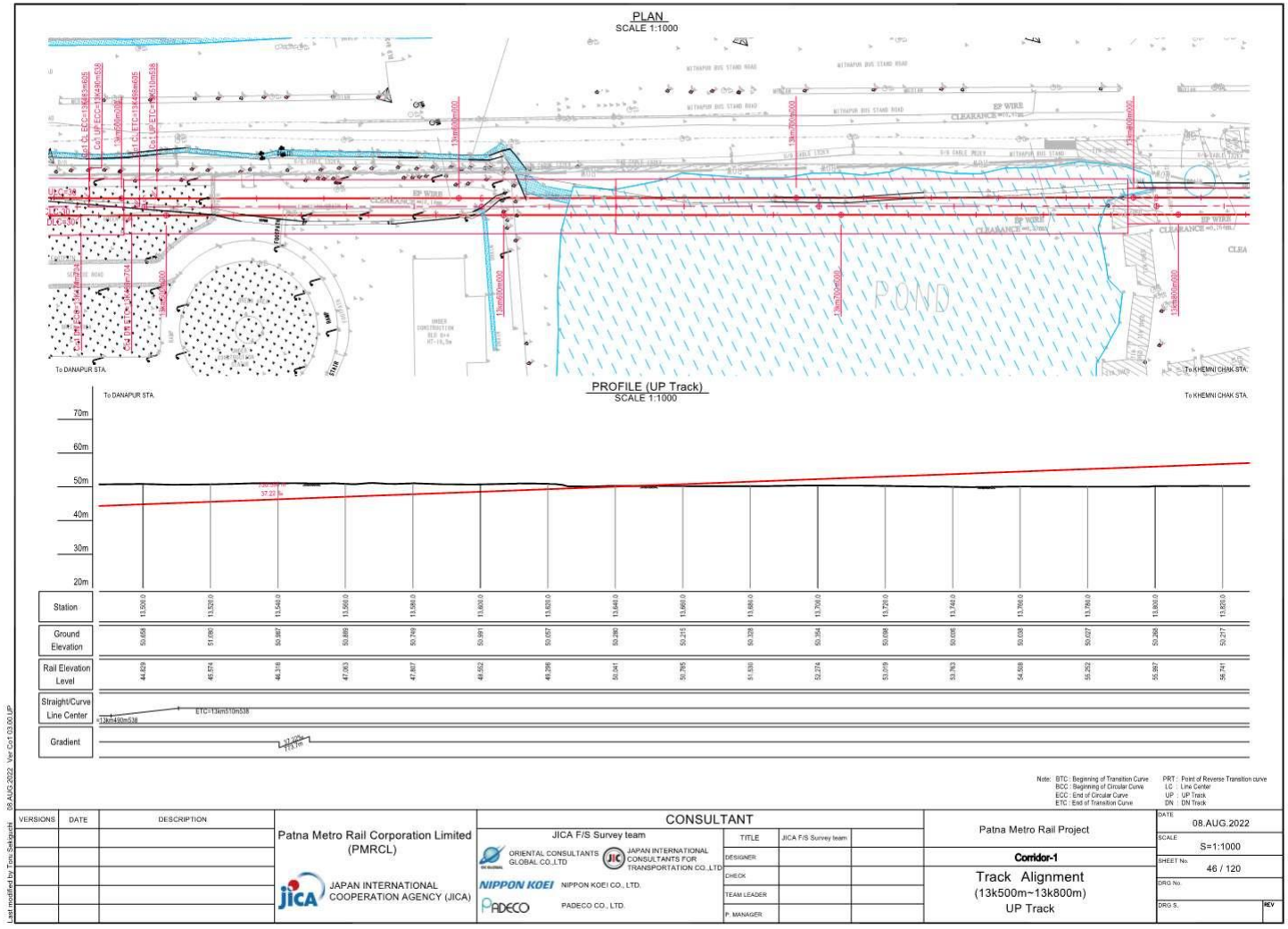

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(12k000m~12k300m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
41 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00.UP

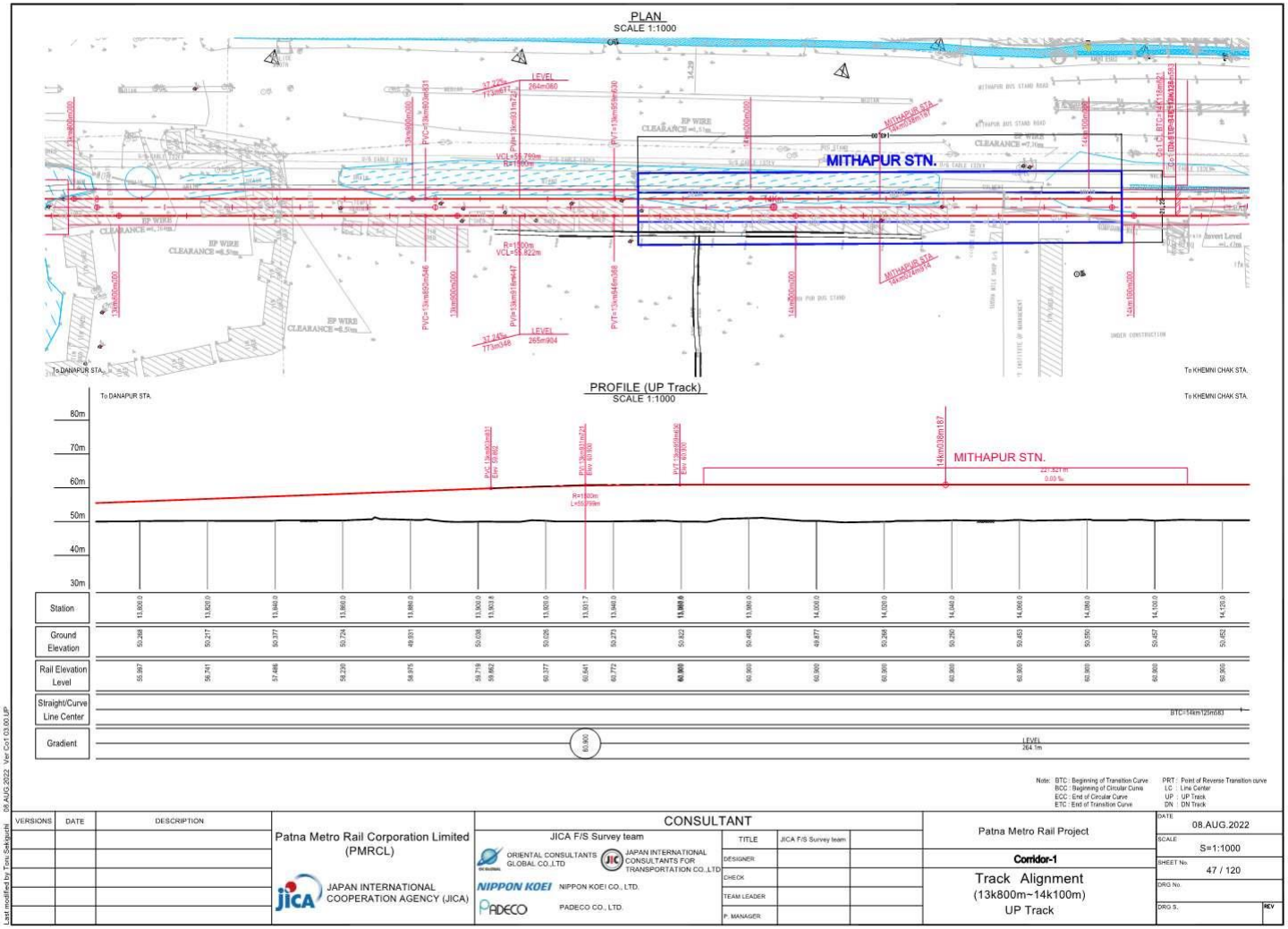

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(12k300m~12k600m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
42 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP

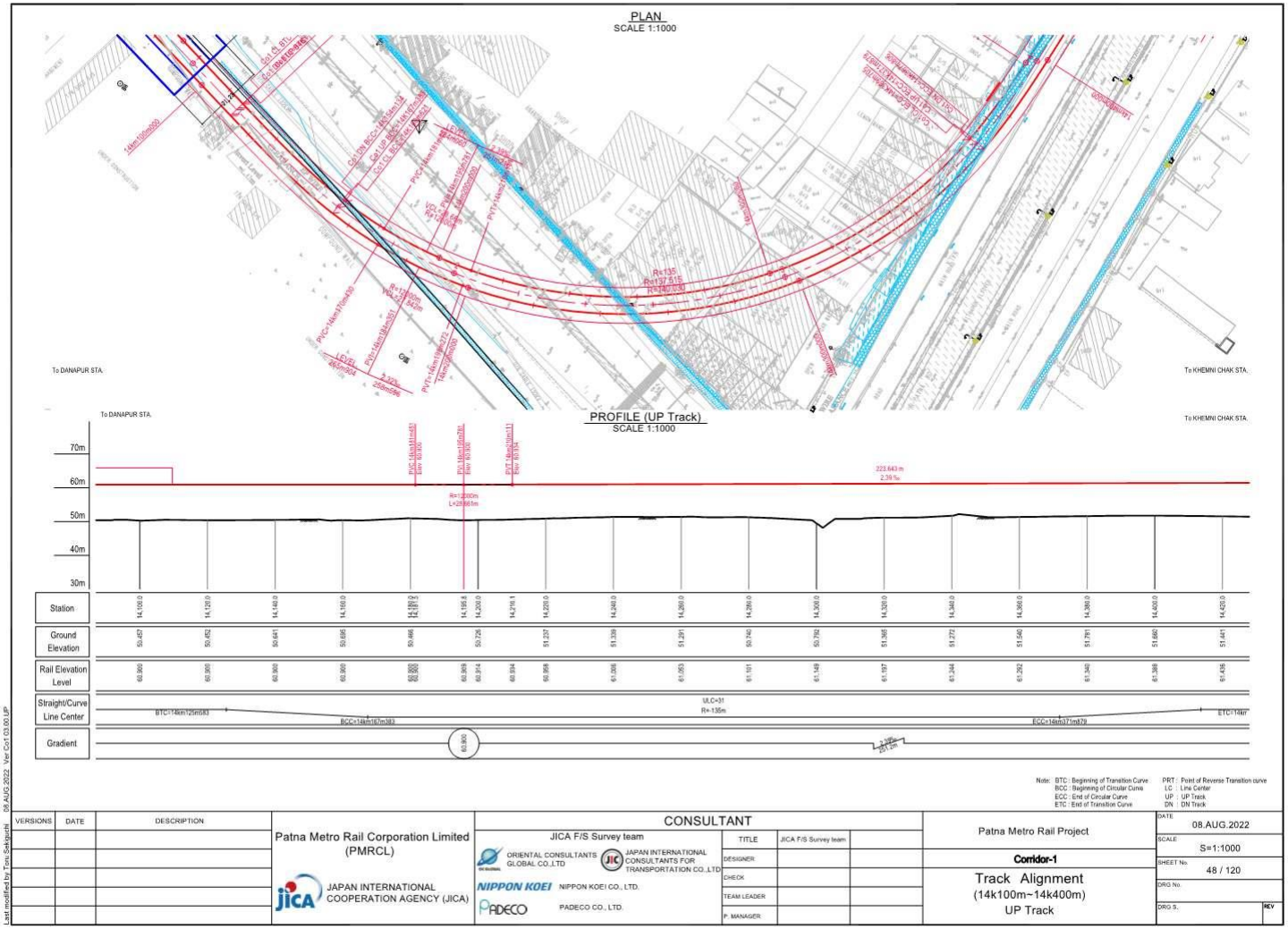

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(12k600m~12k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
43 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Cor1.03.00 UP

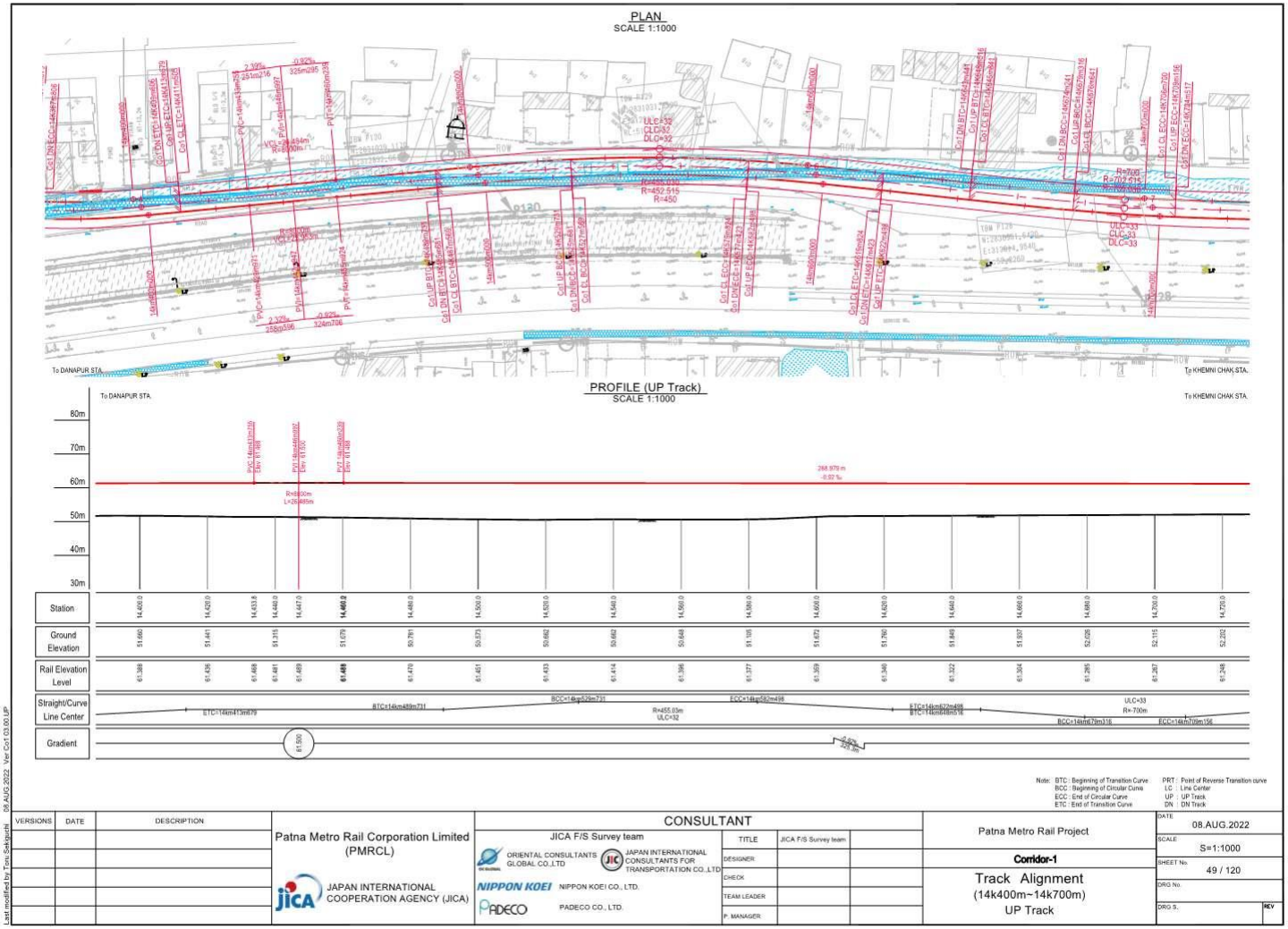

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(12k900m~13k200m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
44 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sekiguchi 08 AUG 2022 Ver Co1.03.00 UP

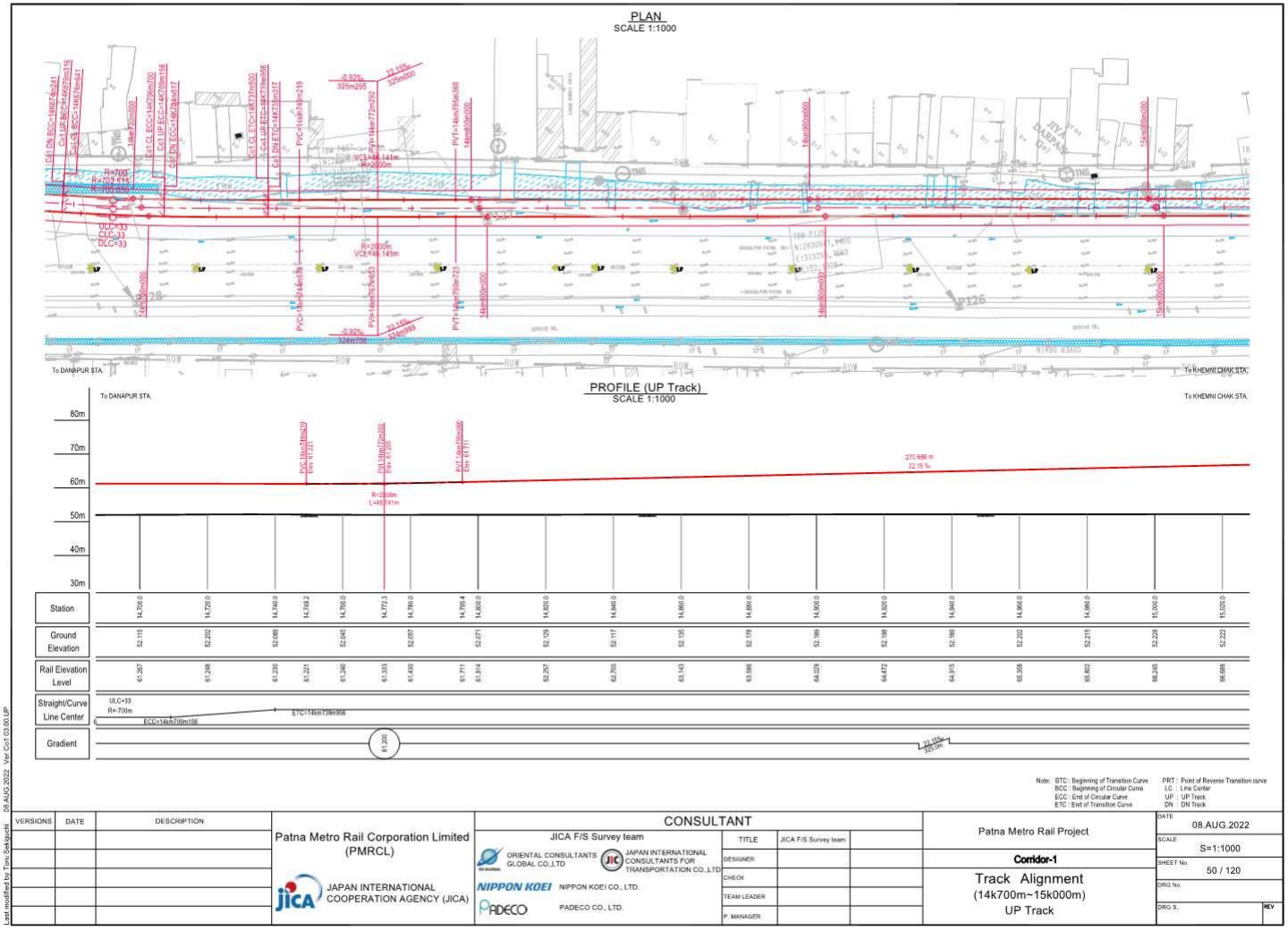

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(13k200m~13k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
45 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1.03.00 UP

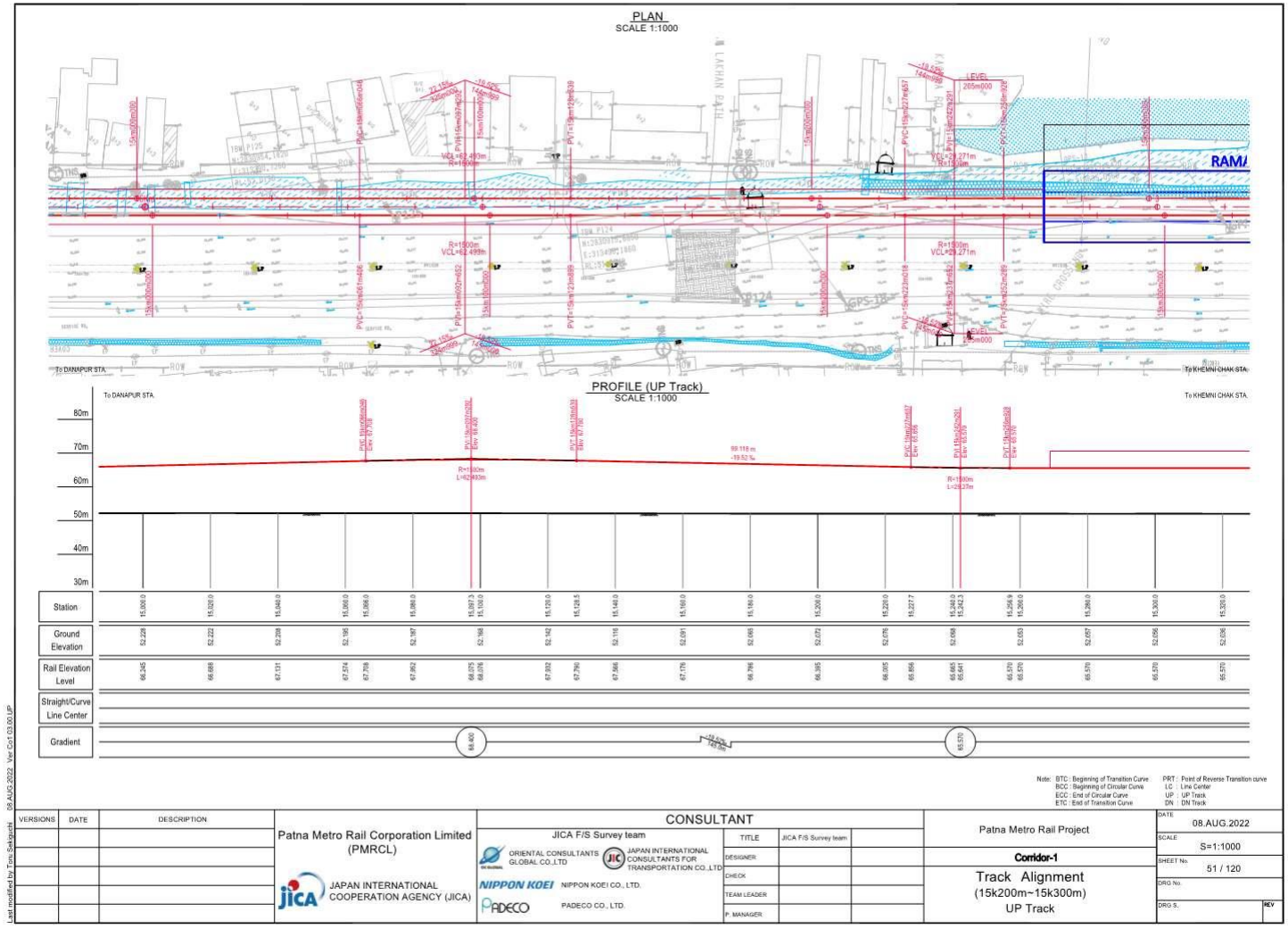

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
70m
60m
50m
40m
30m
20m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(13k500m~13k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
46 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00 UP

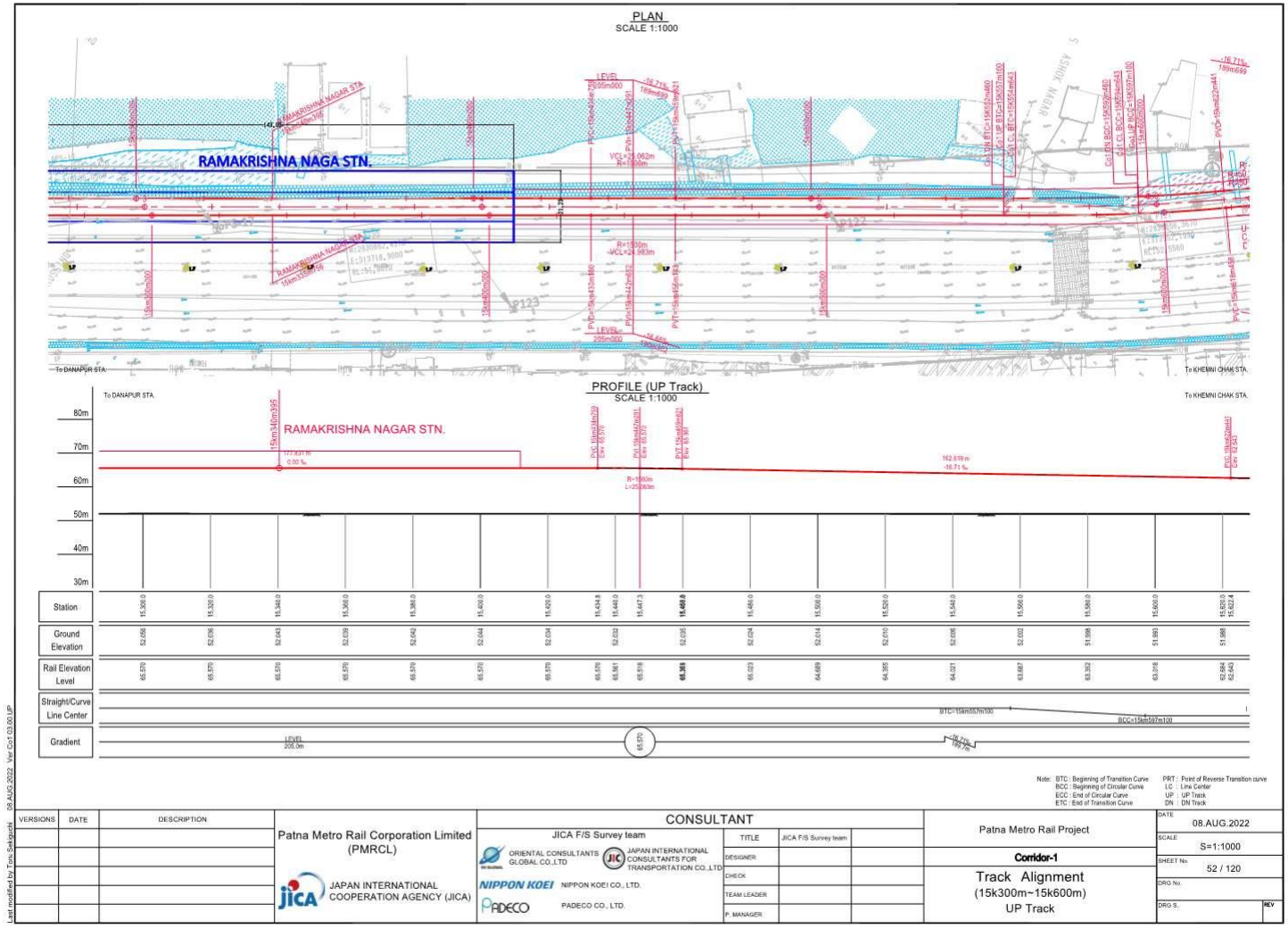

PLAN
SCALE 1:1000
MITHAPUR STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
MITHAPUR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(13k800m~14k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
47 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1.03.00 UP

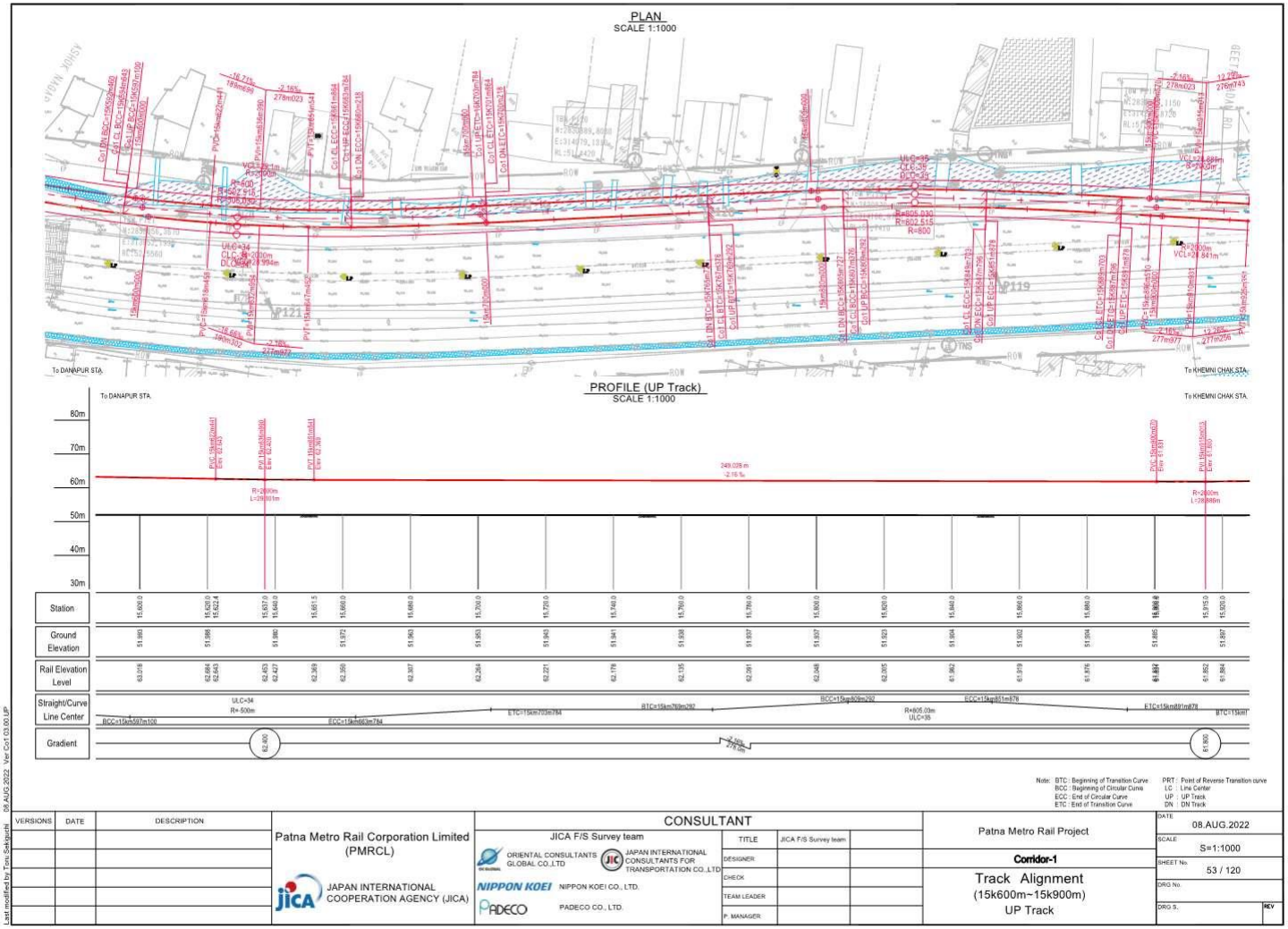

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(14k100m~14k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
48 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP

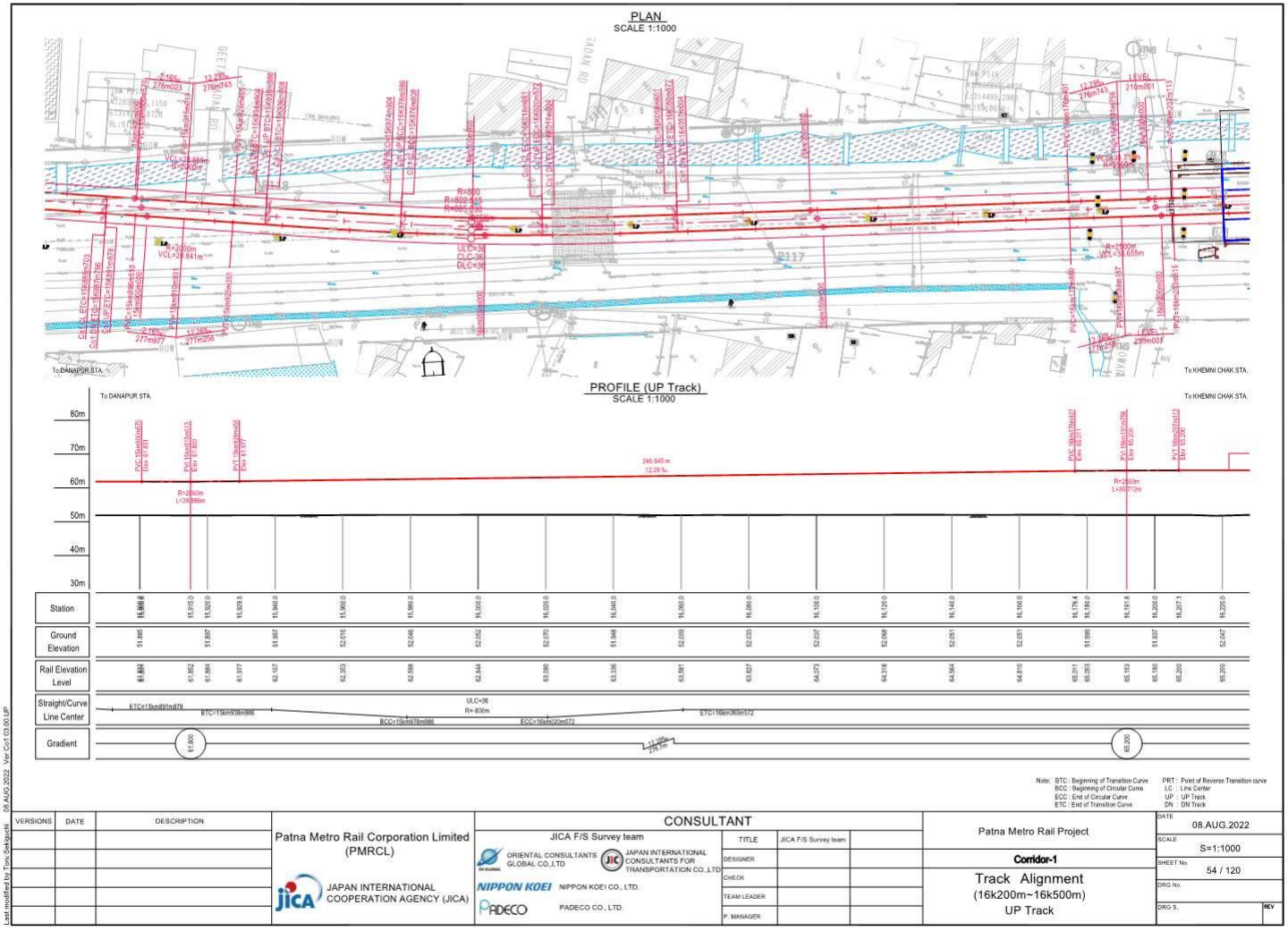

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(14k400m~14k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
49 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Co1.03.00 UP

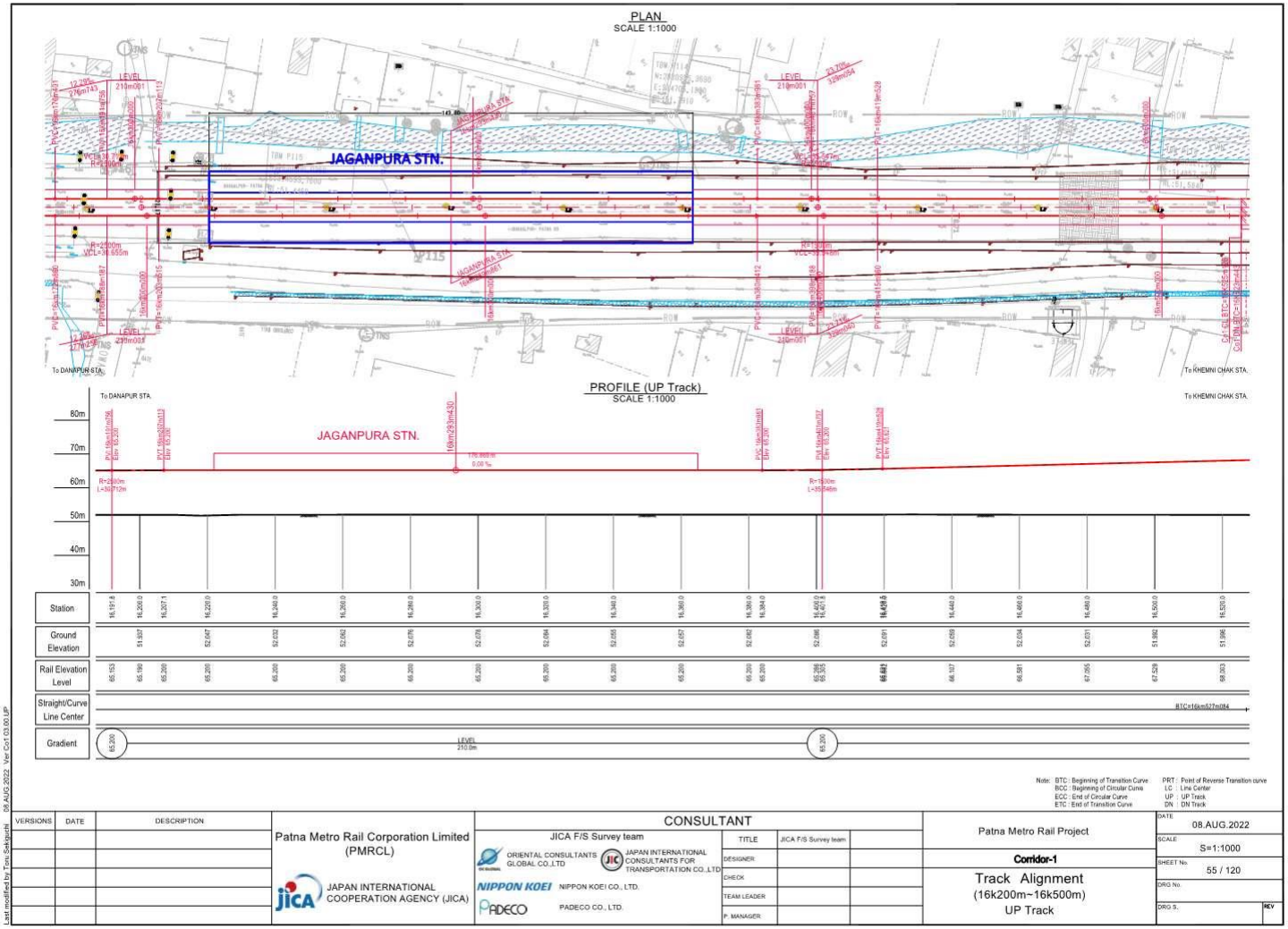

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
270.686 m
22.15 %
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Co1.03.00 UP
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(14k700m~15k000m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
50 / 120
DRG No.
DRG S.
REV

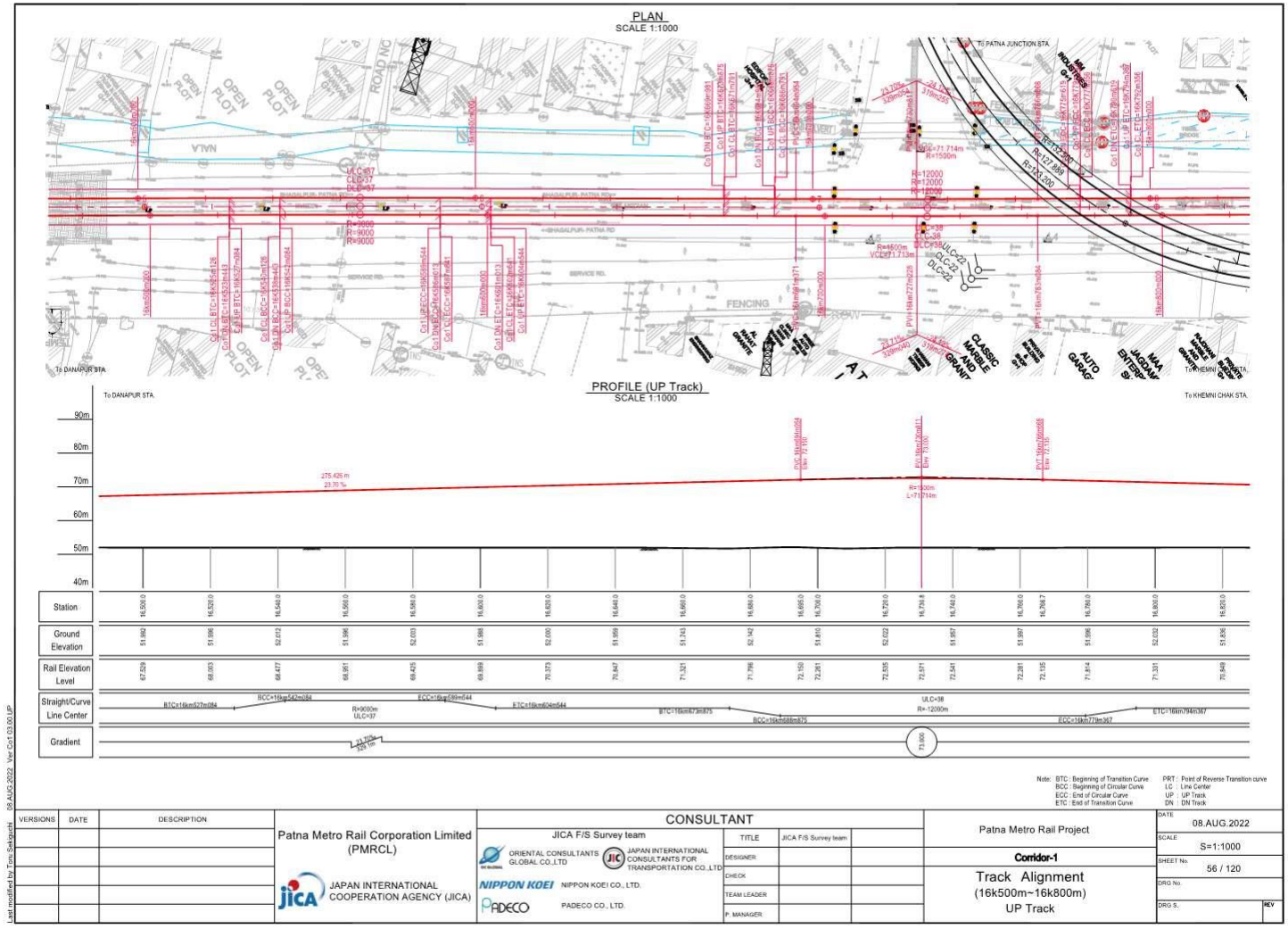

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(15k200m~15k300m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
51 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00 UP

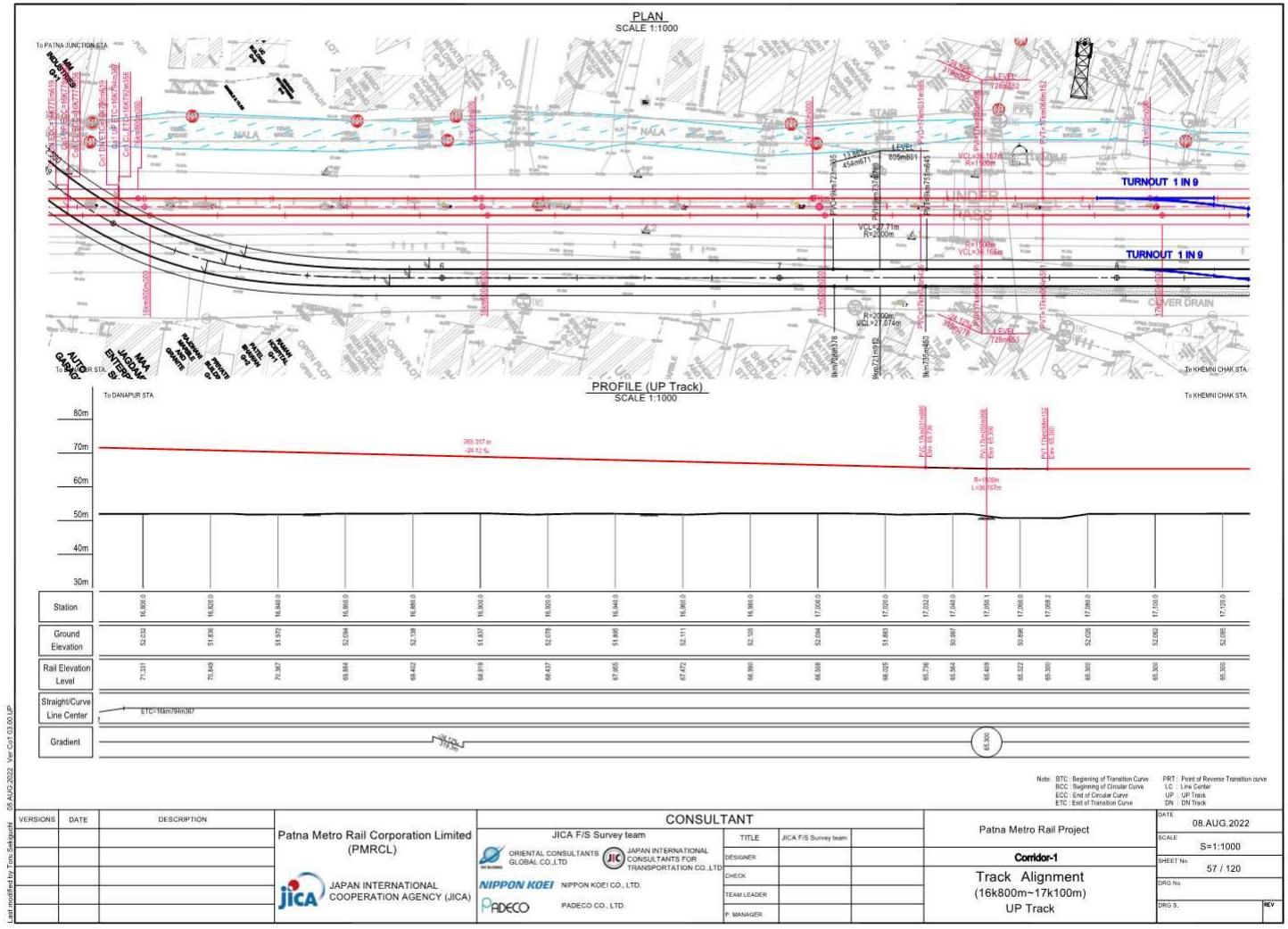

PLAN
SCALE 1:1000
RAMAKRISHNA NAGA STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
RAMAKRISHNA NAGAR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(15k300m~15k600m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
52 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cnt.03.00 UP

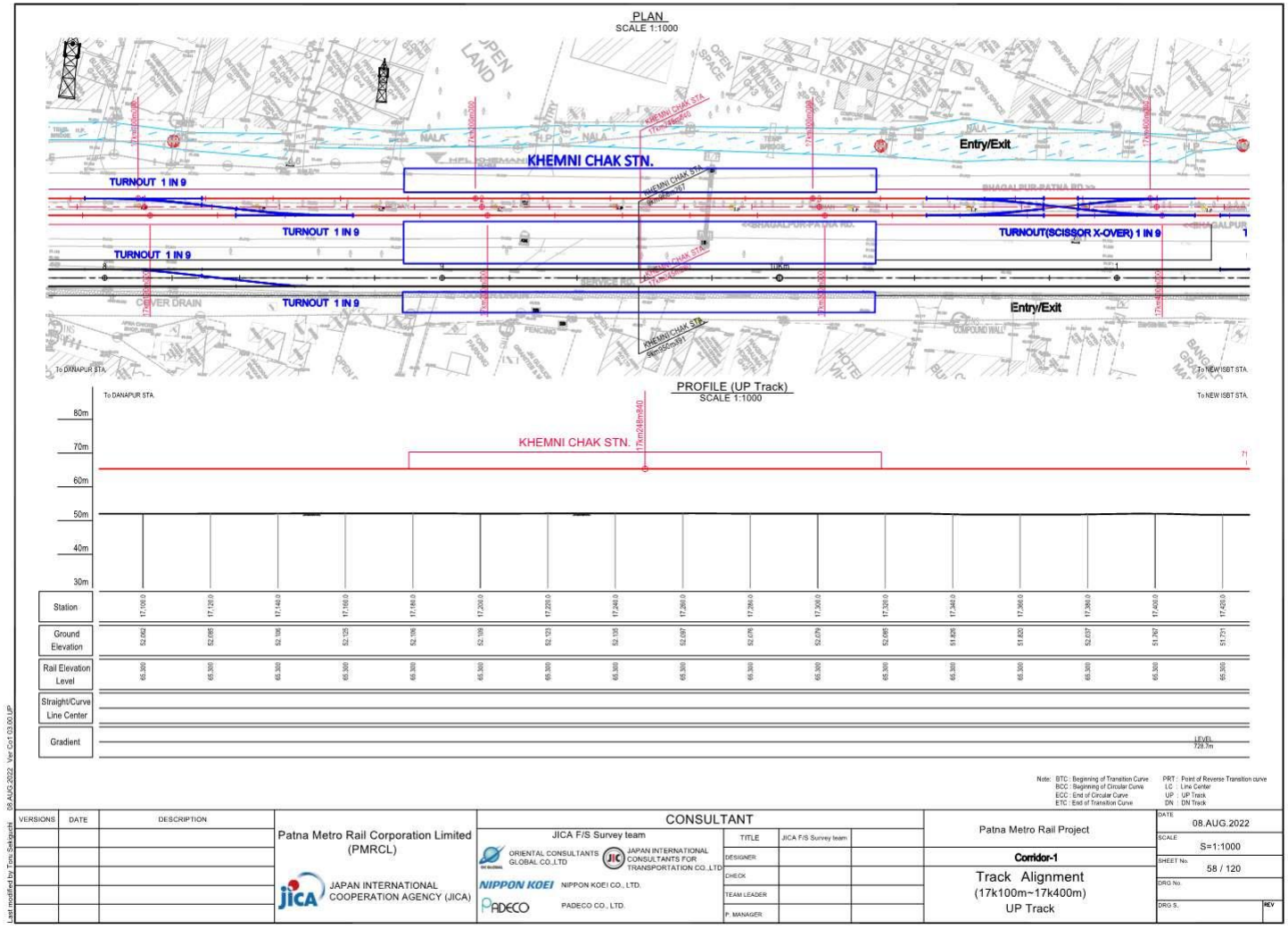

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(15k600m~15k900m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
53 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Cv1.03.00 UP

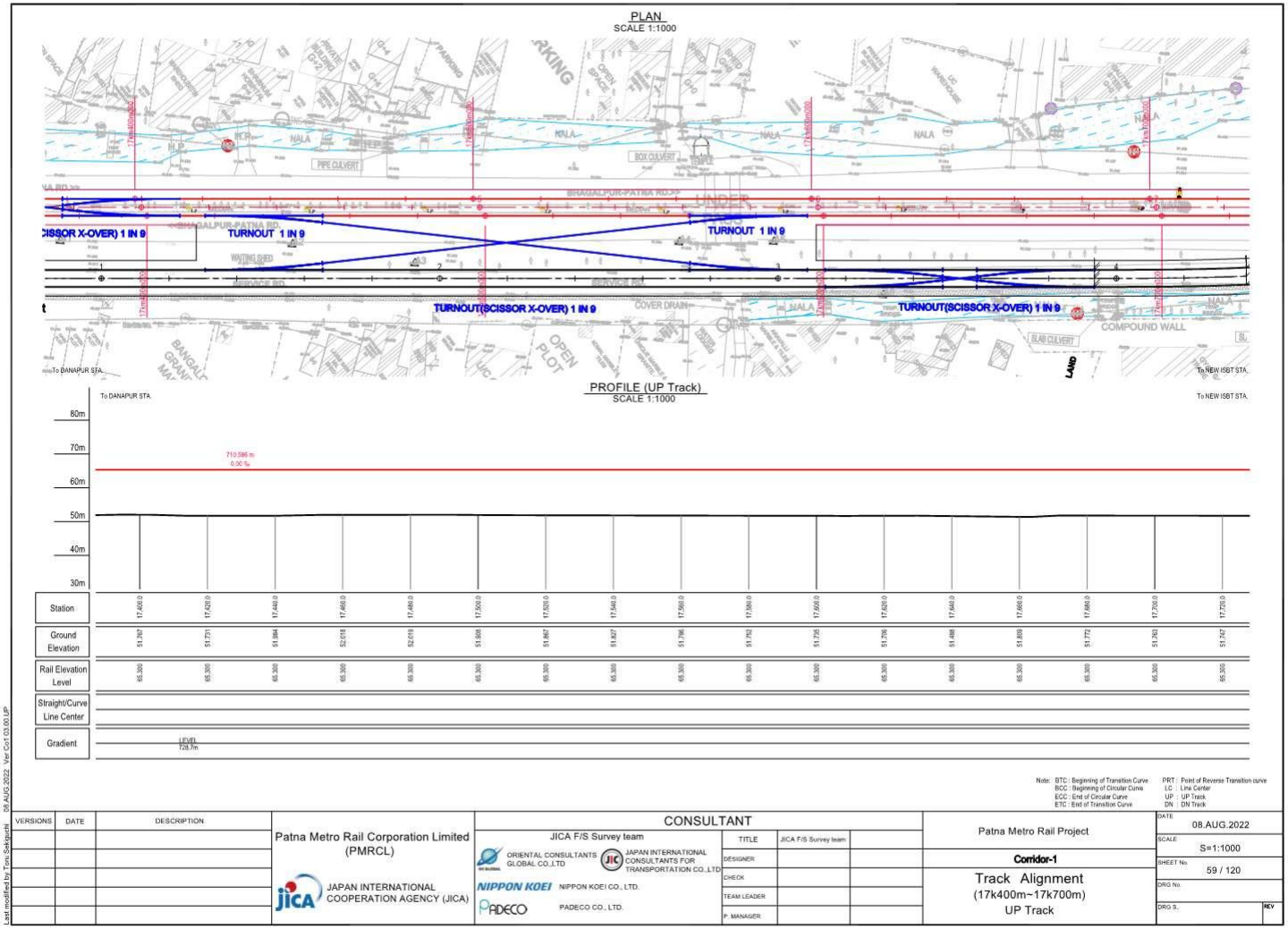

PLAN
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
246.945 m
12.29 %
R=2400m
L=280.886m
R=2400m
L=350.072m
ULC=36
R=800m
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cnt.03.00 UP
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(16k200m~16k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
54 / 120
DRG No.
DRG.S.
REV

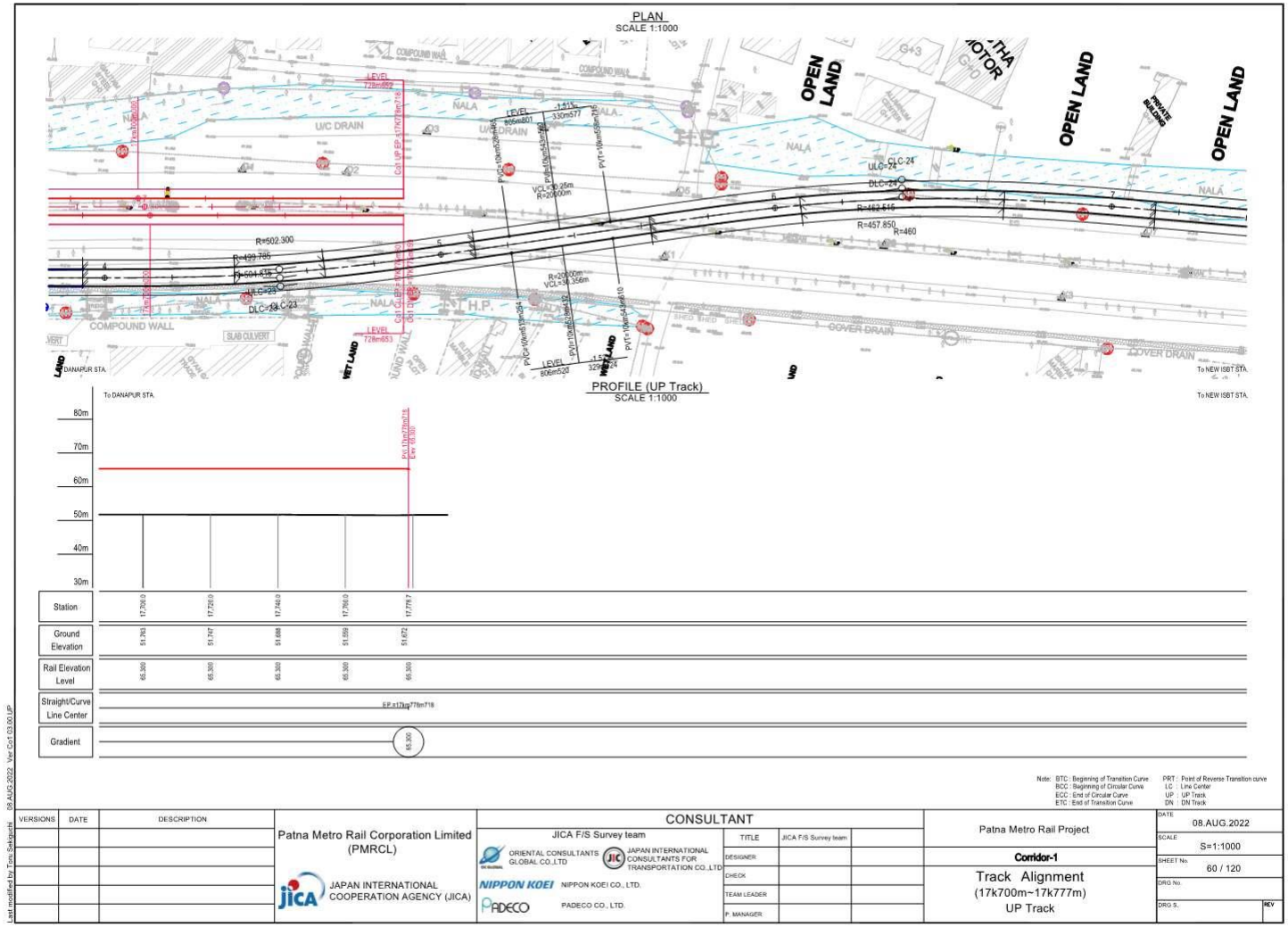

PLAN
SCALE 1:1000
JAGANPURA STN.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
JAGANPURA STN.
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(16k200m~16k500m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
55 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Cv1.03.00 UP


PLAN
SCALE 1:1000
To PATNA JUNCTION STA.
To DANAPUR STA.
To KHEMNI CHAK STA.
PROFILE (UP Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(16k500m~16k800m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
56 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cs1.03.00.UP

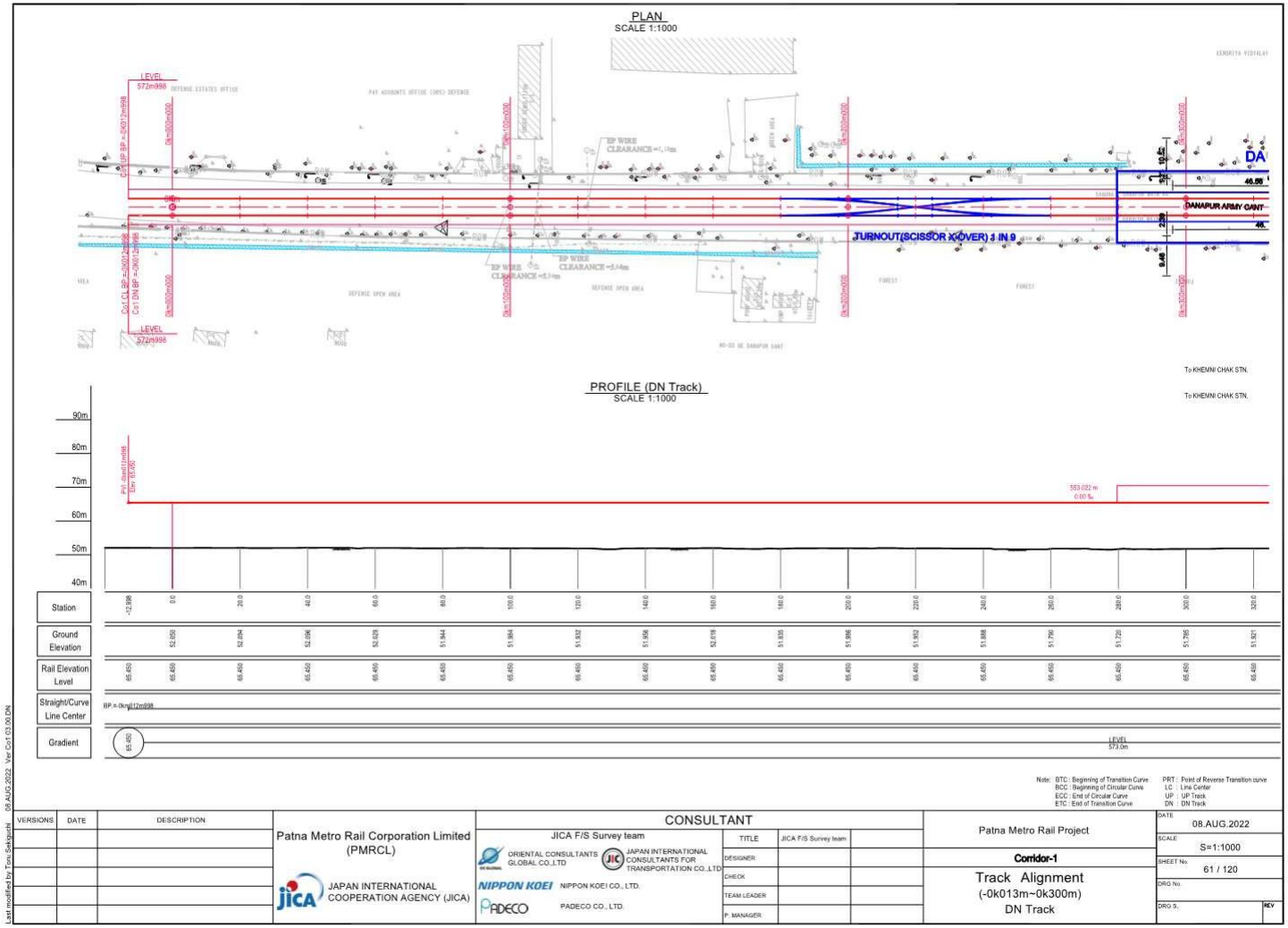

PLAN
SCALE 1:1000
To PATNA JUNCTION STA.
To KHEMNI CHAK STA.
TURNOUT 1 IN 9
TURNOUT 1 IN 9
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To KHEMNI CHAK STA.
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(16k800m~17k100m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
57 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver Cor1.03.00 UP

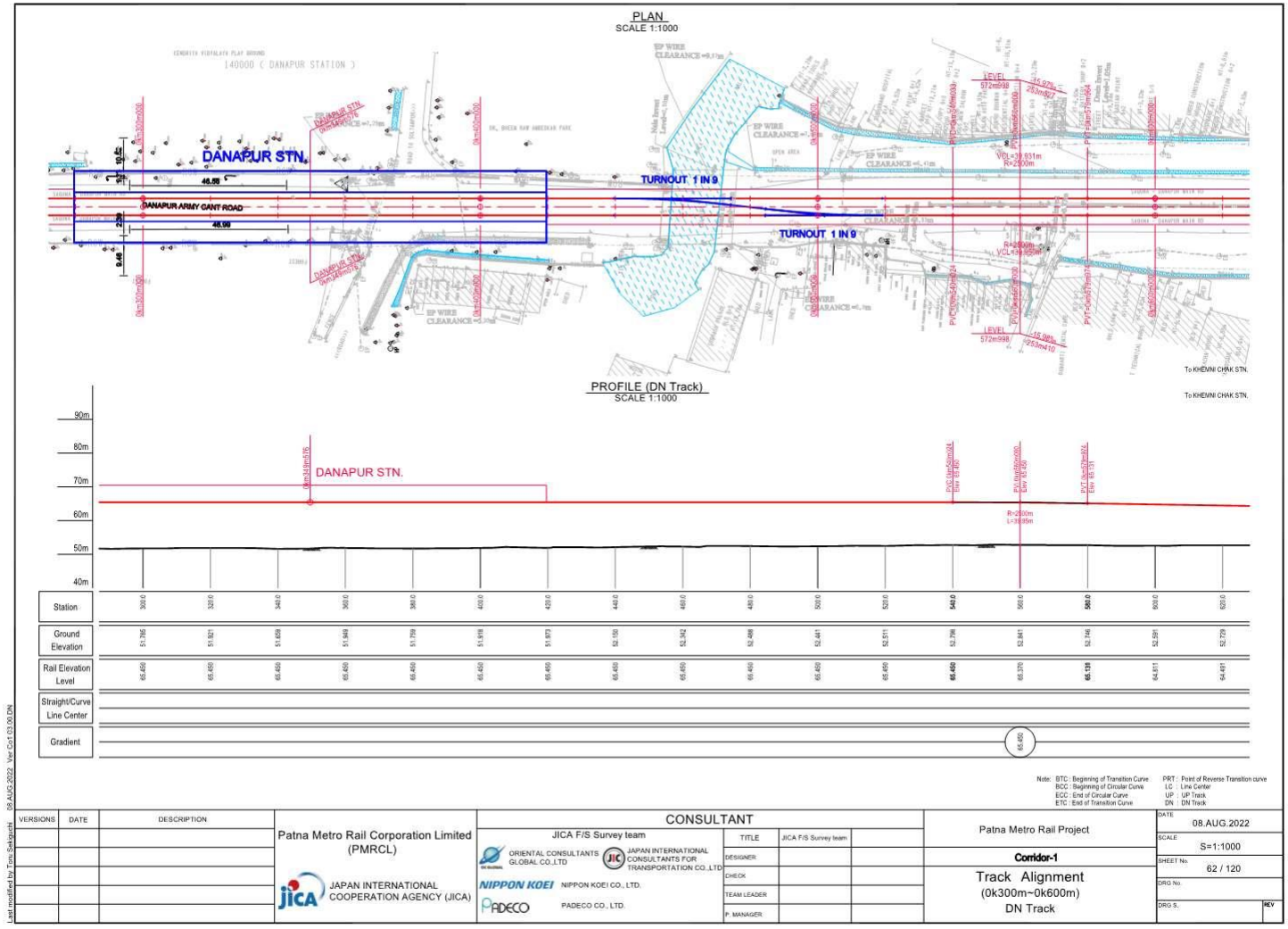

PLAN
SCALE 1:1000
KHEMNI CHAK STN.
TURNOUT 1 IN 9
TURNOUT 1 IN 9
TURNOUT 1 IN 9
TURNOUT 1 IN 9
TURNOUT(SCISSOR X-OVER) 1 IN 9
Entry/Exit
Entry/Exit
To DANAPUR STA.
To NEW ISBT STA.
PROFILE (UP Track)
SCALE 1:1000
To DANAPUR STA.
To NEW ISBT STA.
KHEMNI CHAK STN.
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
LEVEL
728.7m
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(17k100m~17k400m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
58 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cs1.03.00.UP

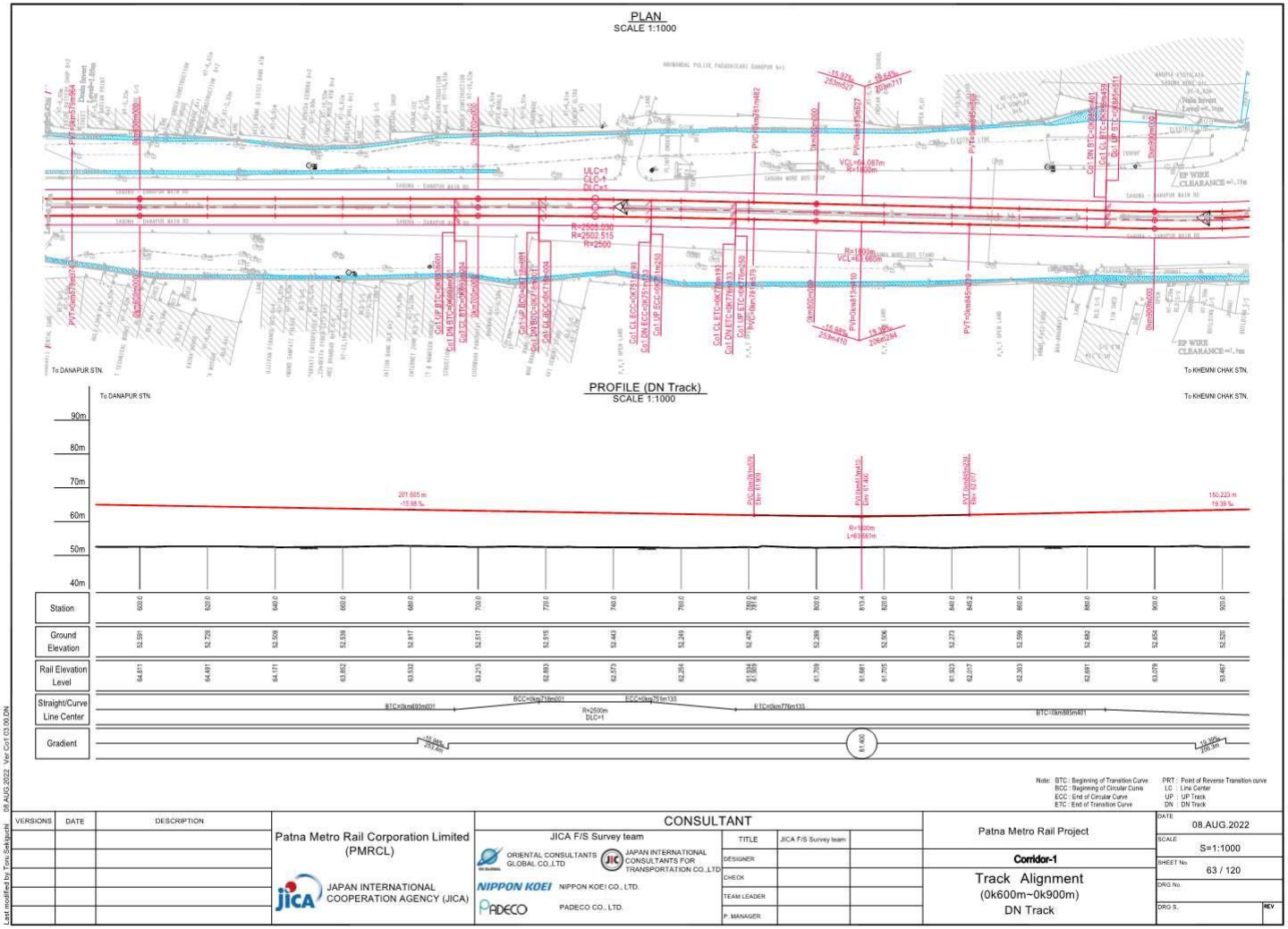

PLAN
SCALE 1:1000
TURNOUT 1 IN 9
TURNOUT 1 IN 9
TURNOUT(SCISSOR X-OVER) 1 IN 9
TURNOUT(SCISSOR X-OVER) 1 IN 9
BHAGALPUR-PATNA RD.
NALA
COMPOUND WALL
To DANAPUR STA.
To NEW ISBT STA.
PROFILE (UP Track)
SCALE 1:1000
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(17k400m~17k700m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
59 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1.03.00 UP

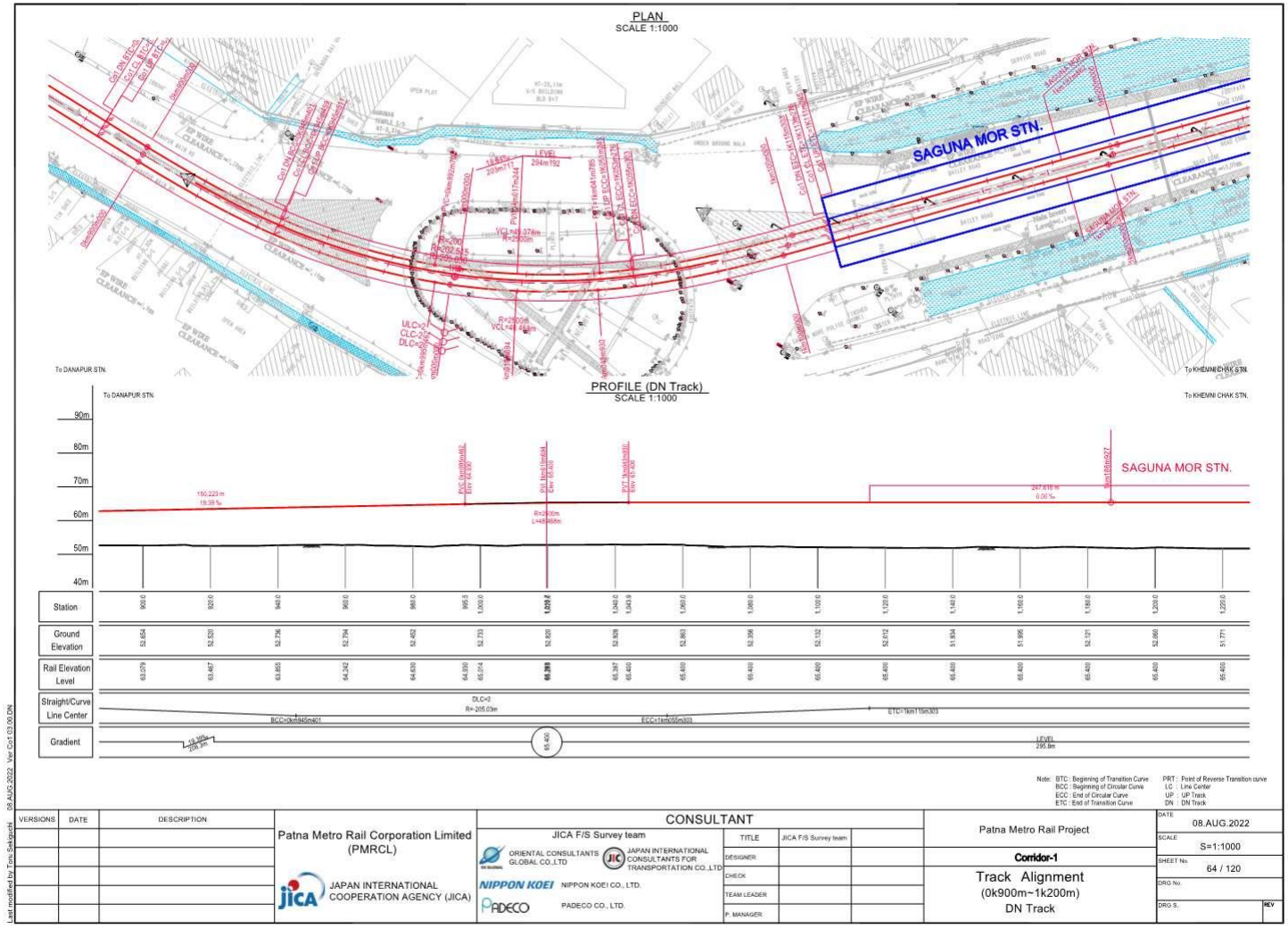

PLAN
SCALE 1:1000
OPEN LAND
OPEN LAND
OPEN LAND
PRIVATE BUNGLOW
U/C DRAIN
NALA
COMPOUND WALL
SLAB CULVERT
COVER DRAIN
R=502.300
R=499.785
R=504.615
R=462.515
R=457.850
R=460
ULC=23
DLC=23
ULC=24
DLC=24
To DANAPUR STA.
To NEW ISBT STA.
PROFILE (UP Track)
SCALE 1:1000
80m
70m
60m
50m
40m
30m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
17.700.0
17.720.0
17.740.0
17.760.0
17.778.7
51.763
51.747
51.688
51.659
51.672
65.300
EP.s17kp778m718
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00 UP
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(17k700m~17k777m)
UP Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
60 / 120
DRG No.
DRG S.
REV

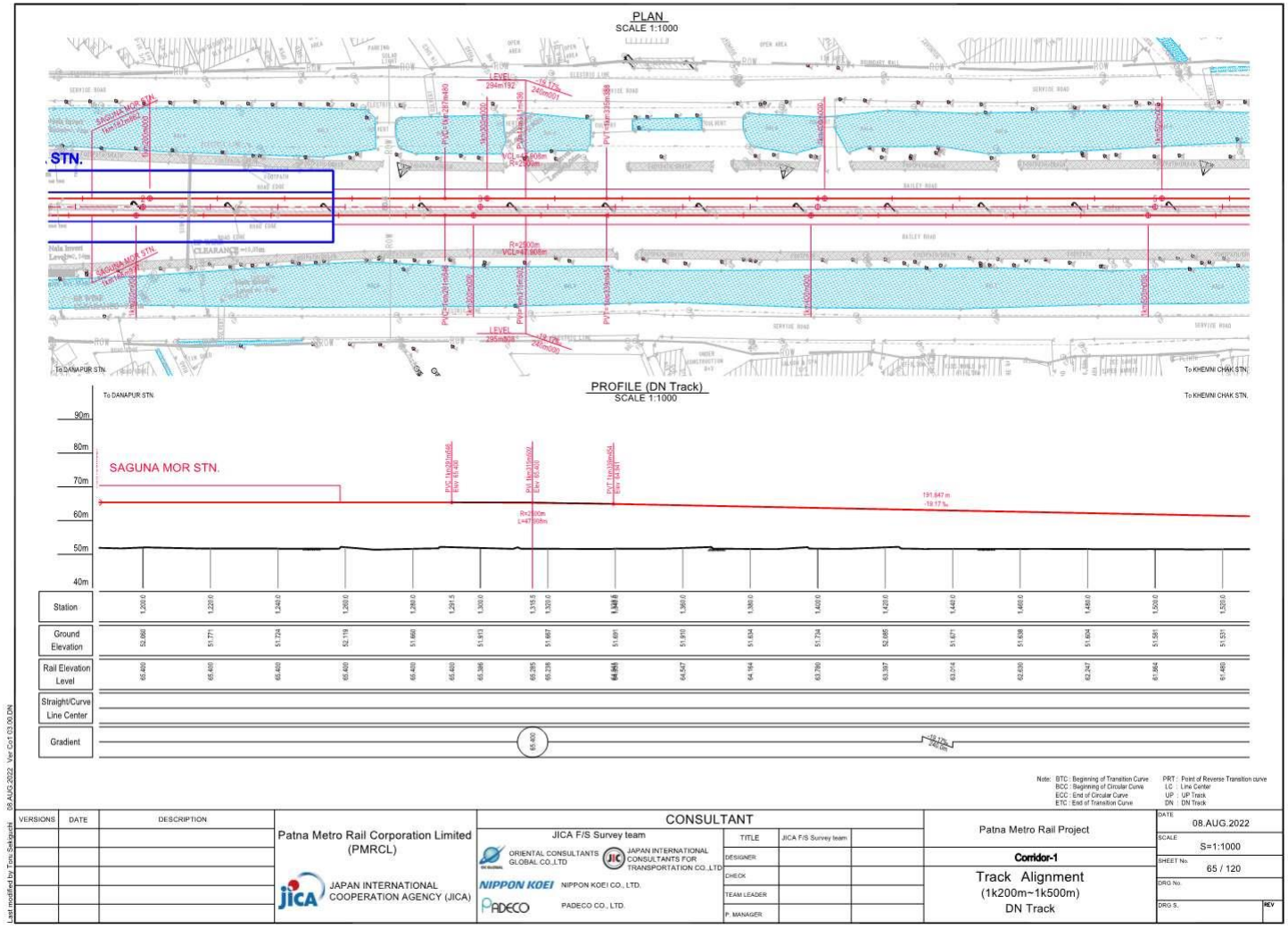
(3) Corridor1 Alignment 03 00 DN

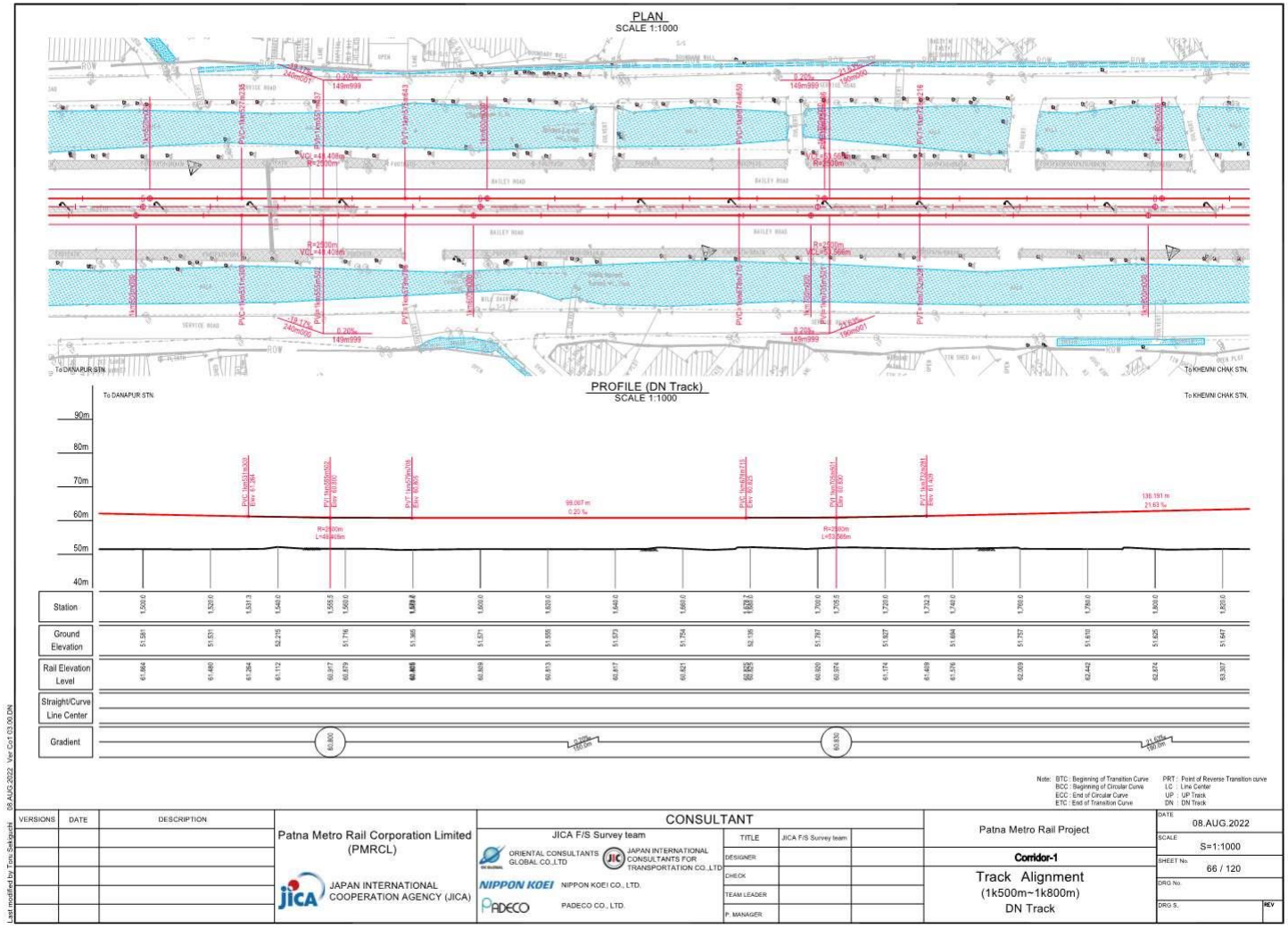


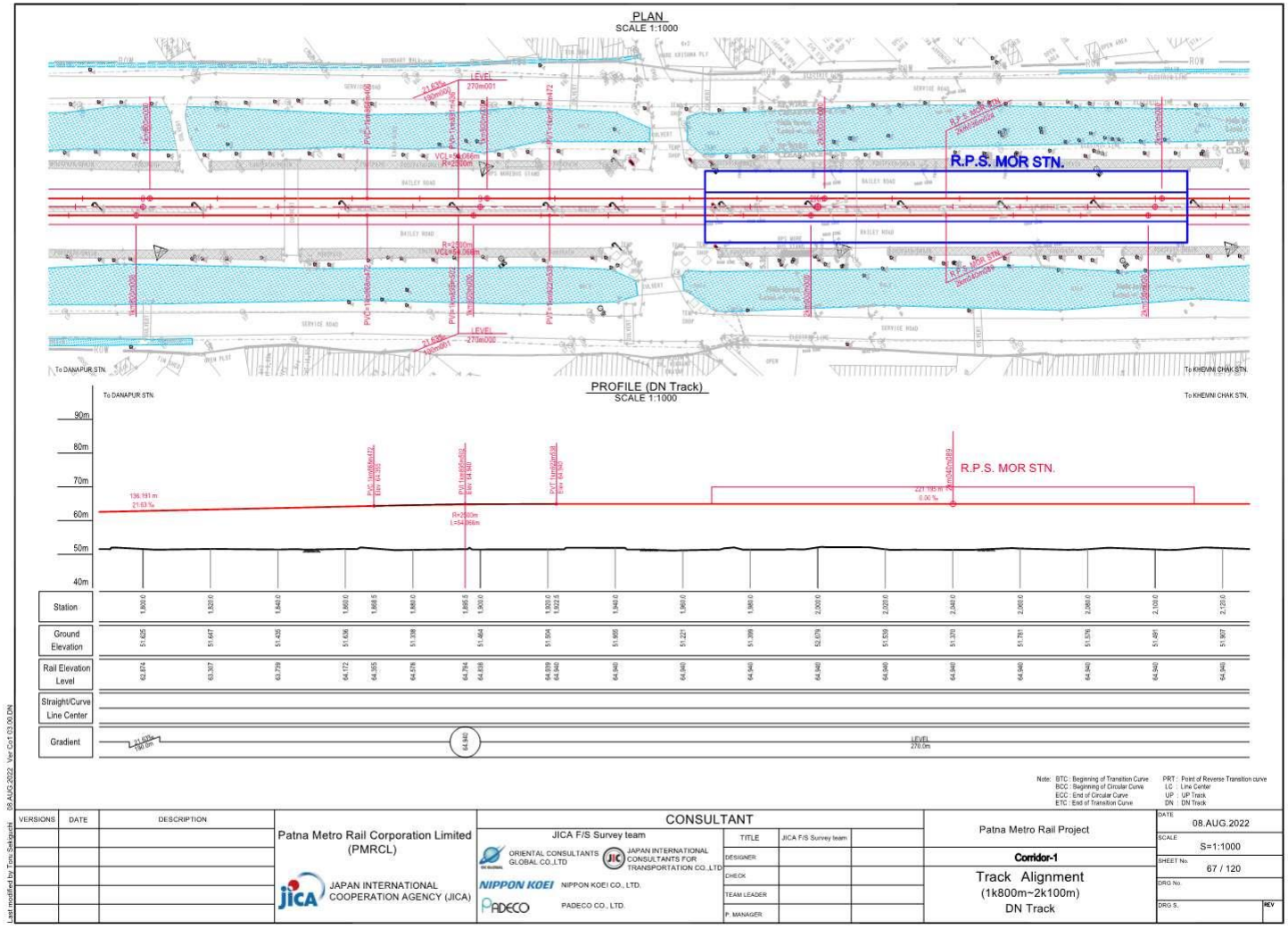

PLAN
SCALE 1:1000
DANAPUR STN.
DANAPUR ARMY CANT ROAD
TURNOUT 1 IN 9
TURNOUT 1 IN 9
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
DANAPUR STN.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k300m~0k600m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
62 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03:06 PM

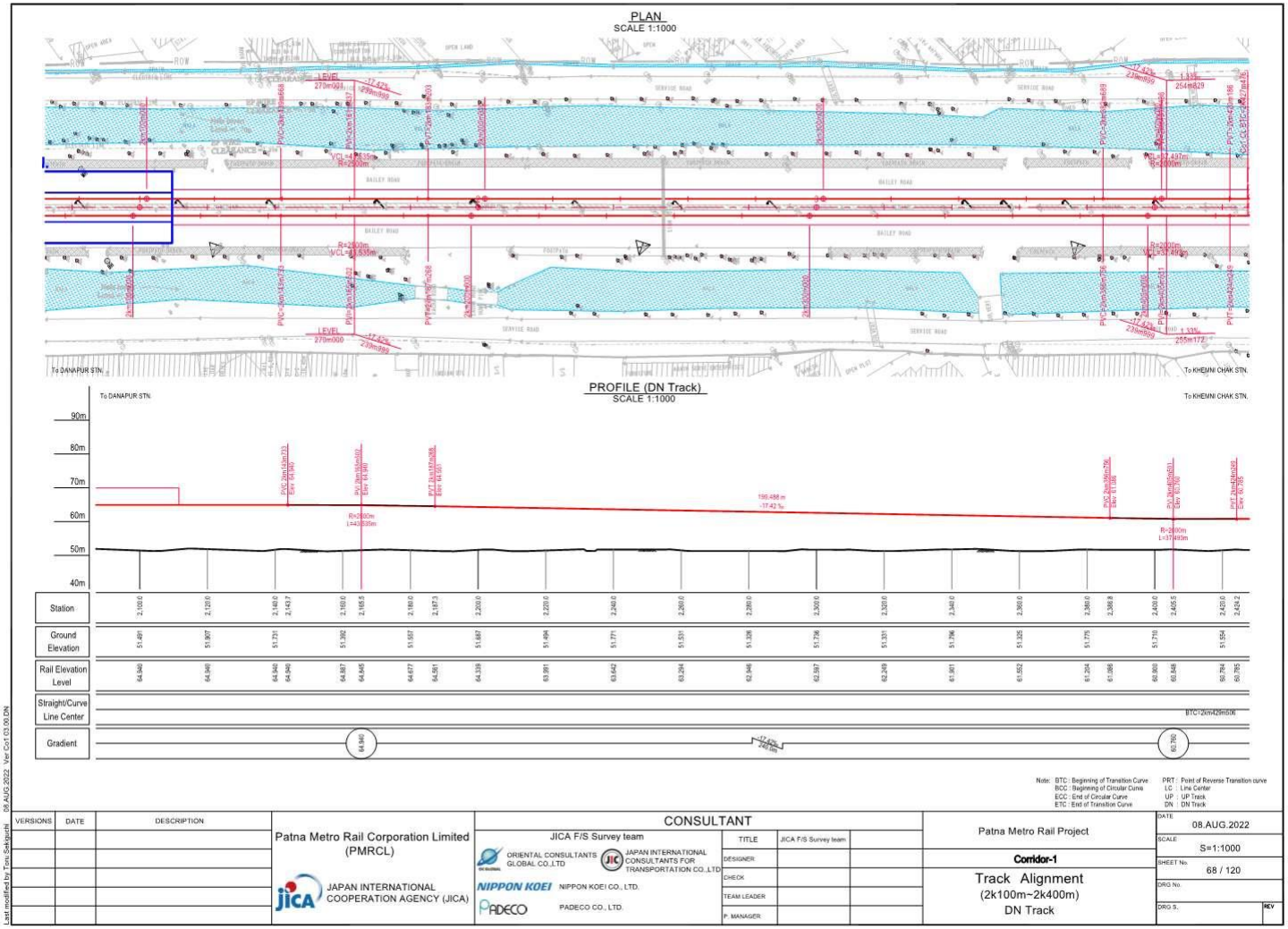

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k600m~0k900m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
63 / 120
DRG No.
DRG.S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Co1 03:06 DN

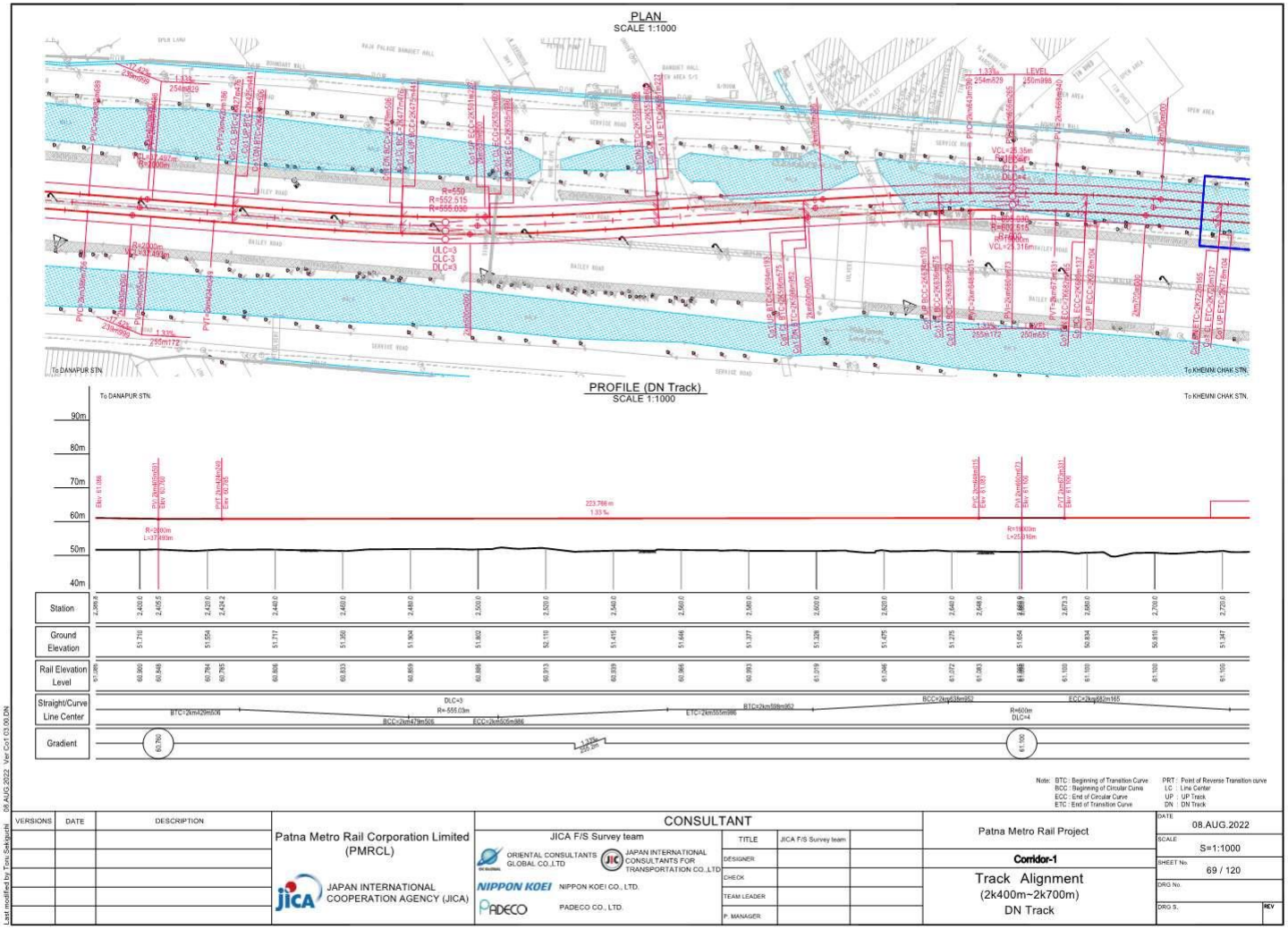

PLAN
SCALE 1:1000
SAGUNA MOR STN.
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(0k900m~1k200m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
64 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1.03.00 DN

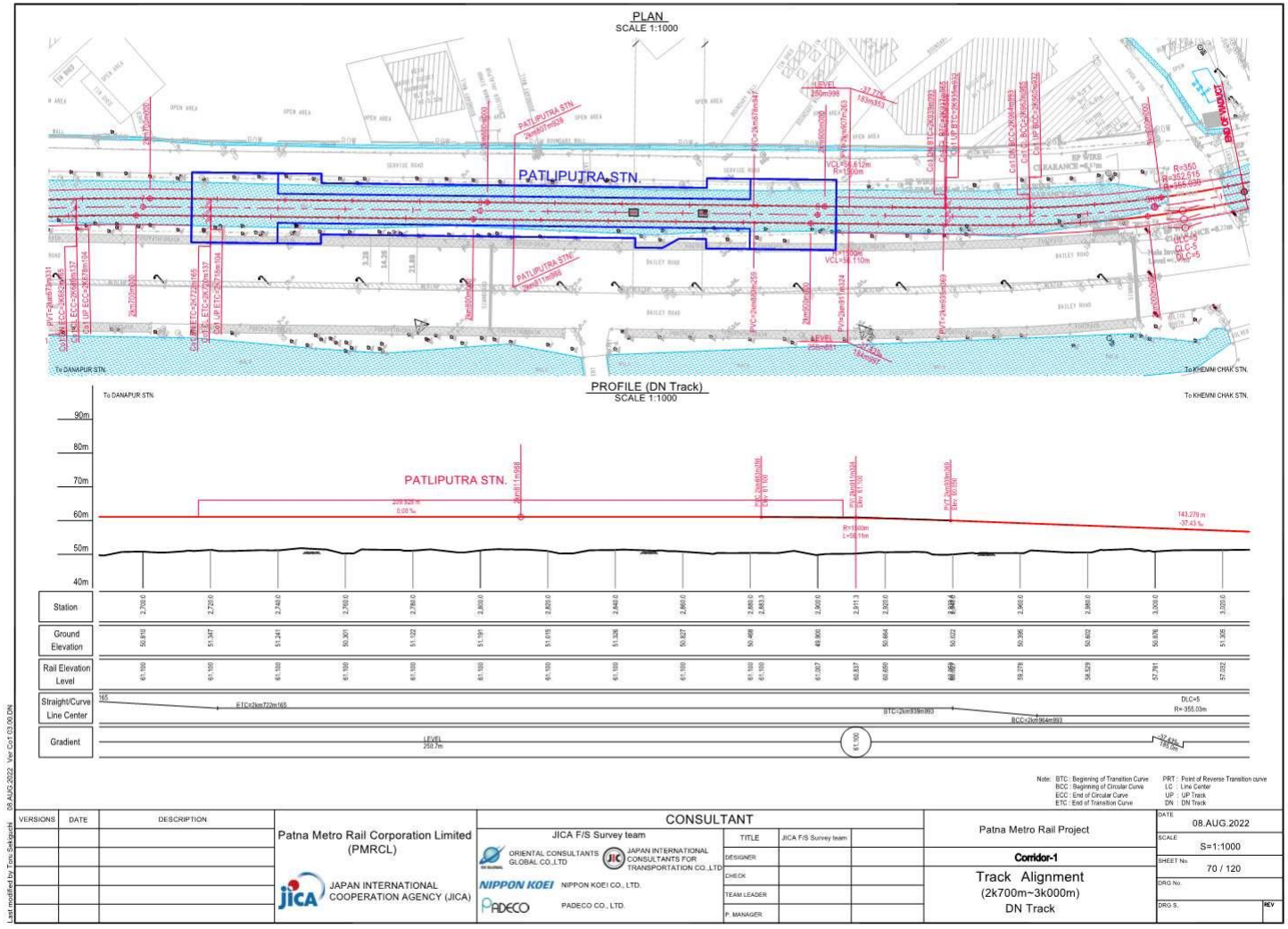

PLAN
SCALE 1:1000
STN.
SAGUNA MOR STN.
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
SAGUNA MOR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k200m~1k500m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
65 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cut 03:06 DN

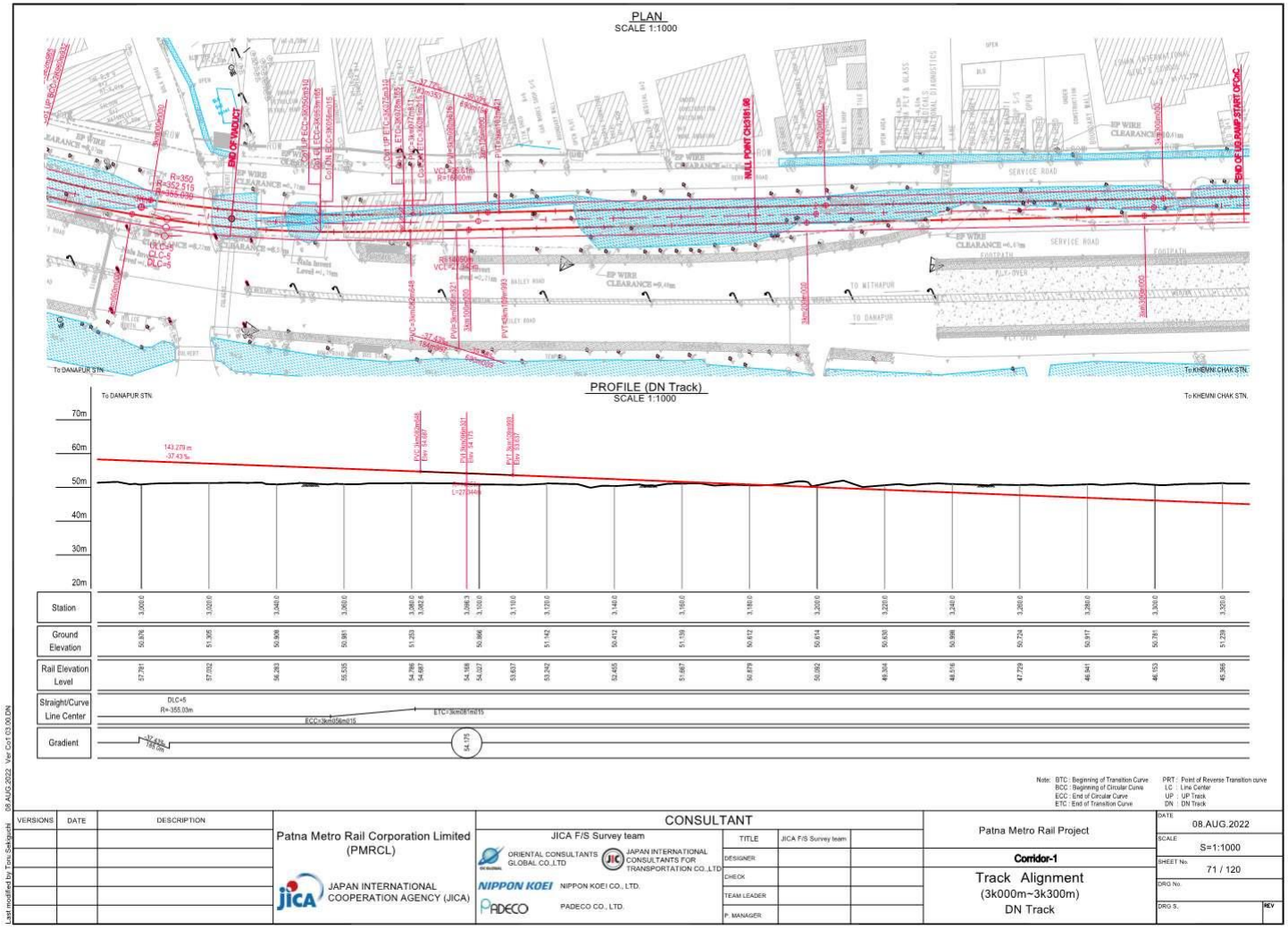

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k500m~1k800m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
66 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sekiguchi 08.AUG.2022 Ver.Cv1.03.00.DN

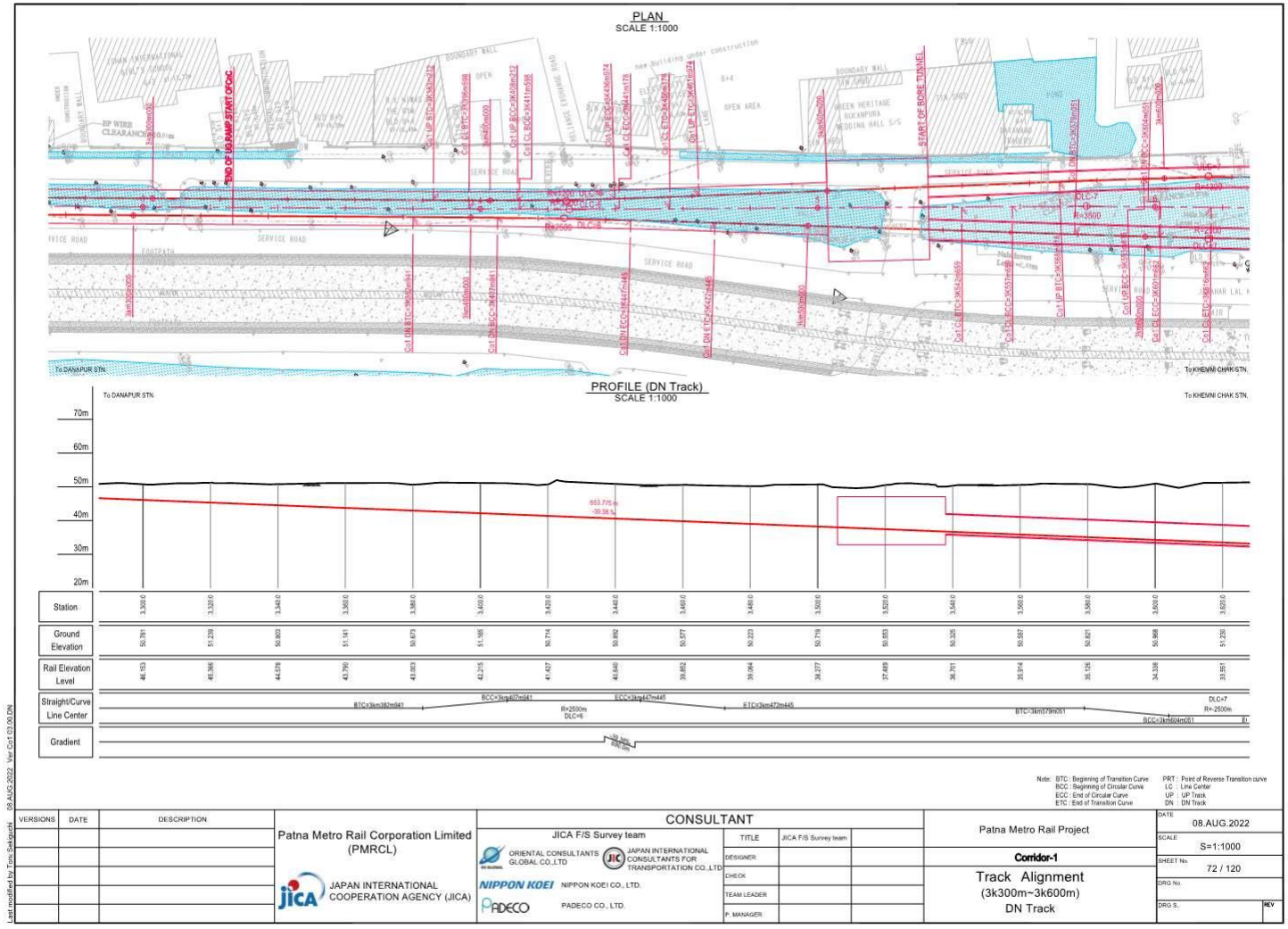

PLAN
SCALE 1:1000
R.P.S. MOR STN.
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
LEVEL 270.0m
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(1k800m~2k100m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
67 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 DN

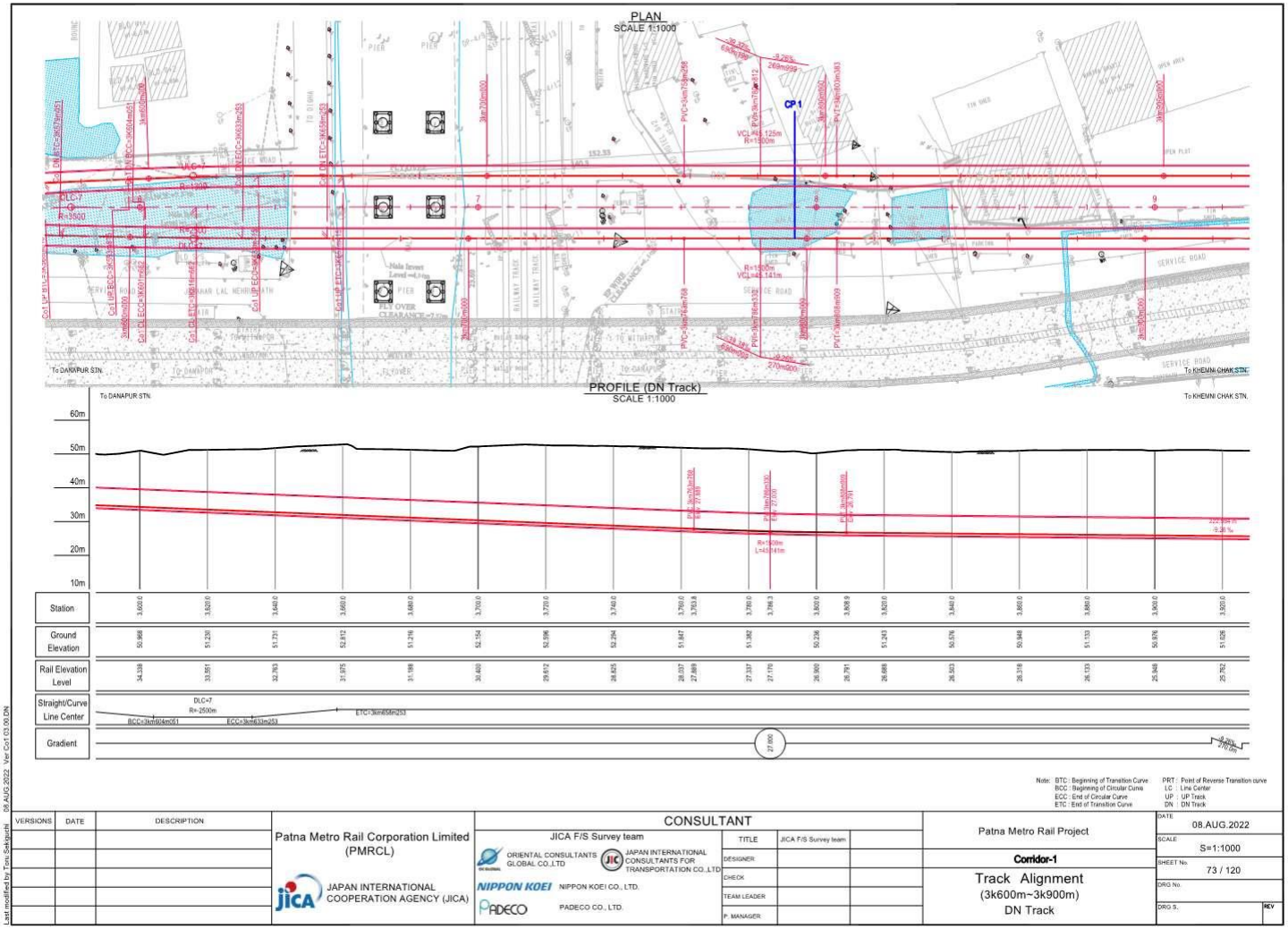

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k100m~2k400m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
68 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1 03:06 DN

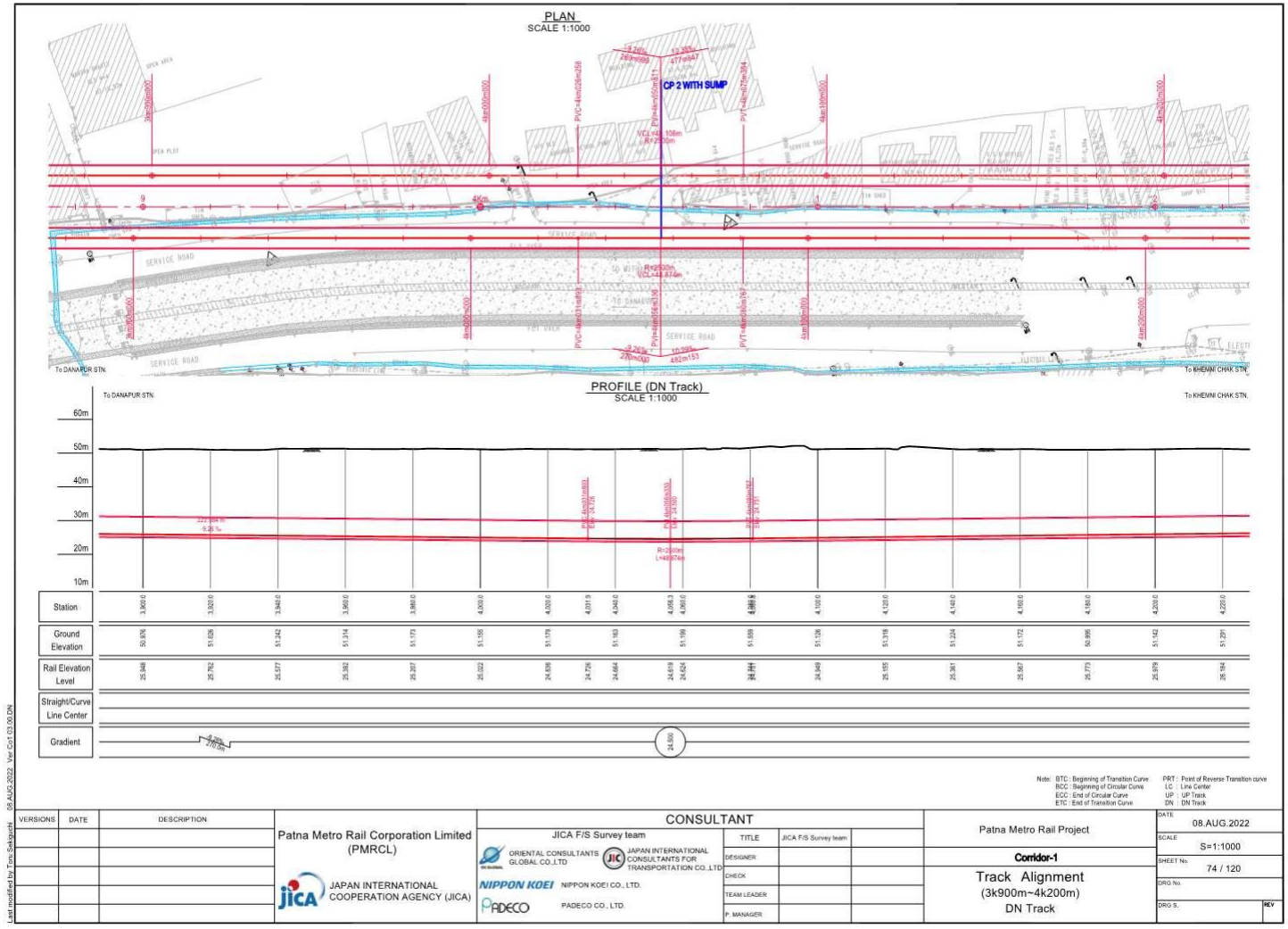

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k400m~2k700m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
69 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03 00 DN

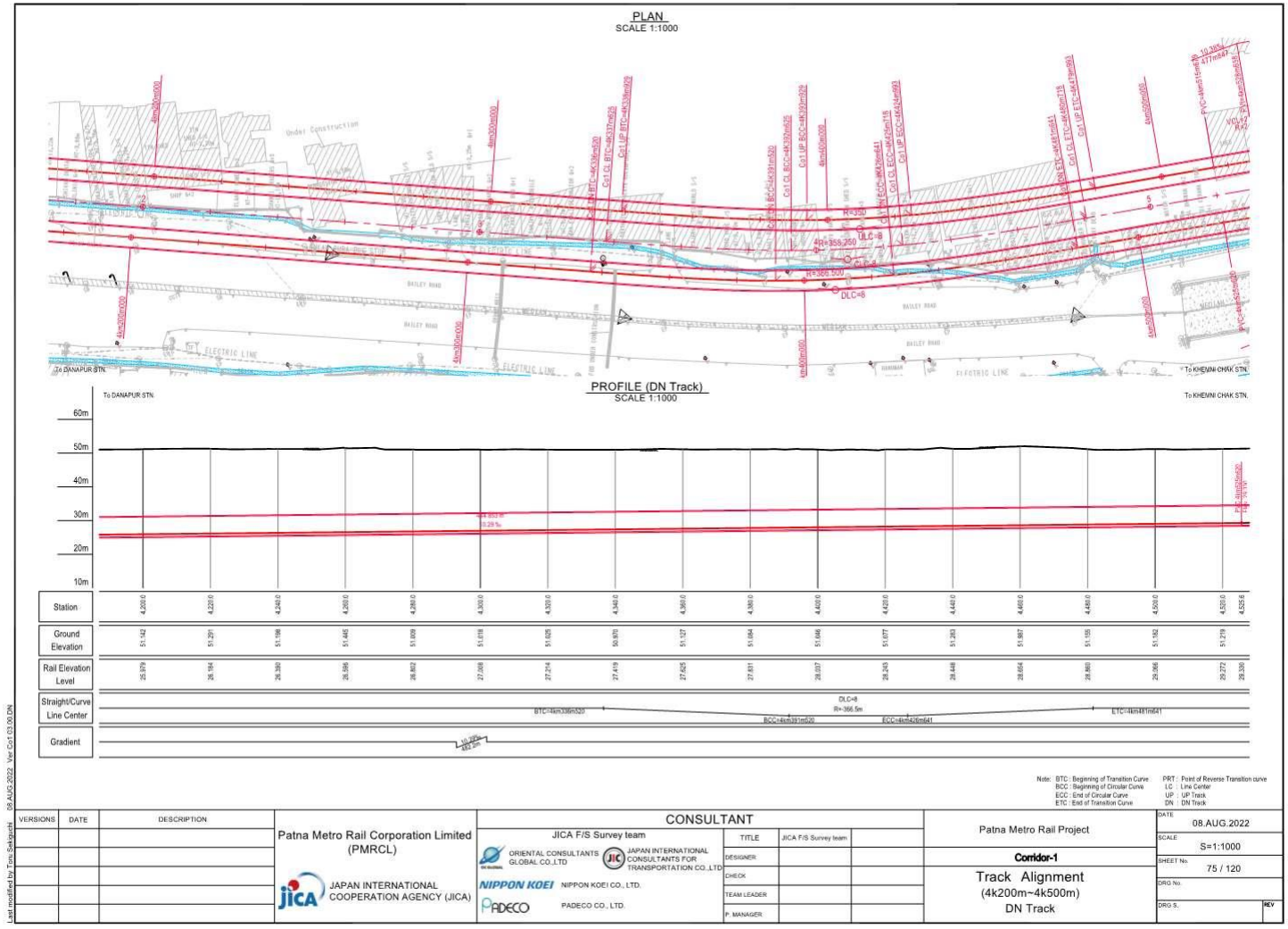

PLAN
SCALE 1:1000
PATLIPUTRA STN.
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
PATLIPUTRA STN.
90m
80m
70m
60m
50m
40m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(2k700m~3k000m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
70 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03:06 DN

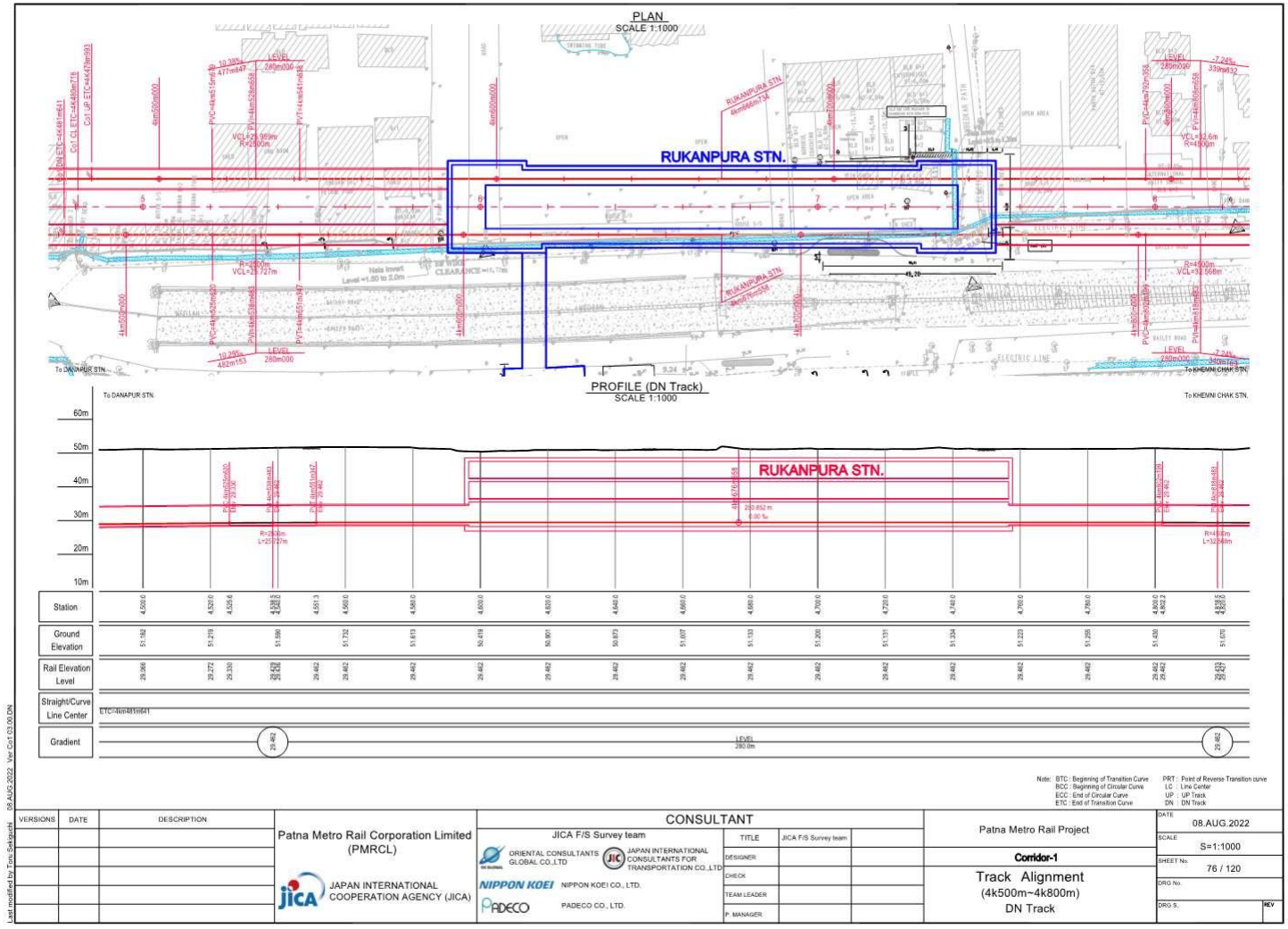

PLAN
SCALE 1:1000
END OF VIADUCT
NULL POINT CH:3+51.00
END OF UG RAMP START OF OC
SERVICE ROAD
FOOTPATH
FLY OVER
TO MITHAPUR
TO DANAPUR
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
70m
60m
50m
40m
30m
20m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k000m~3k300m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
71 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 DN

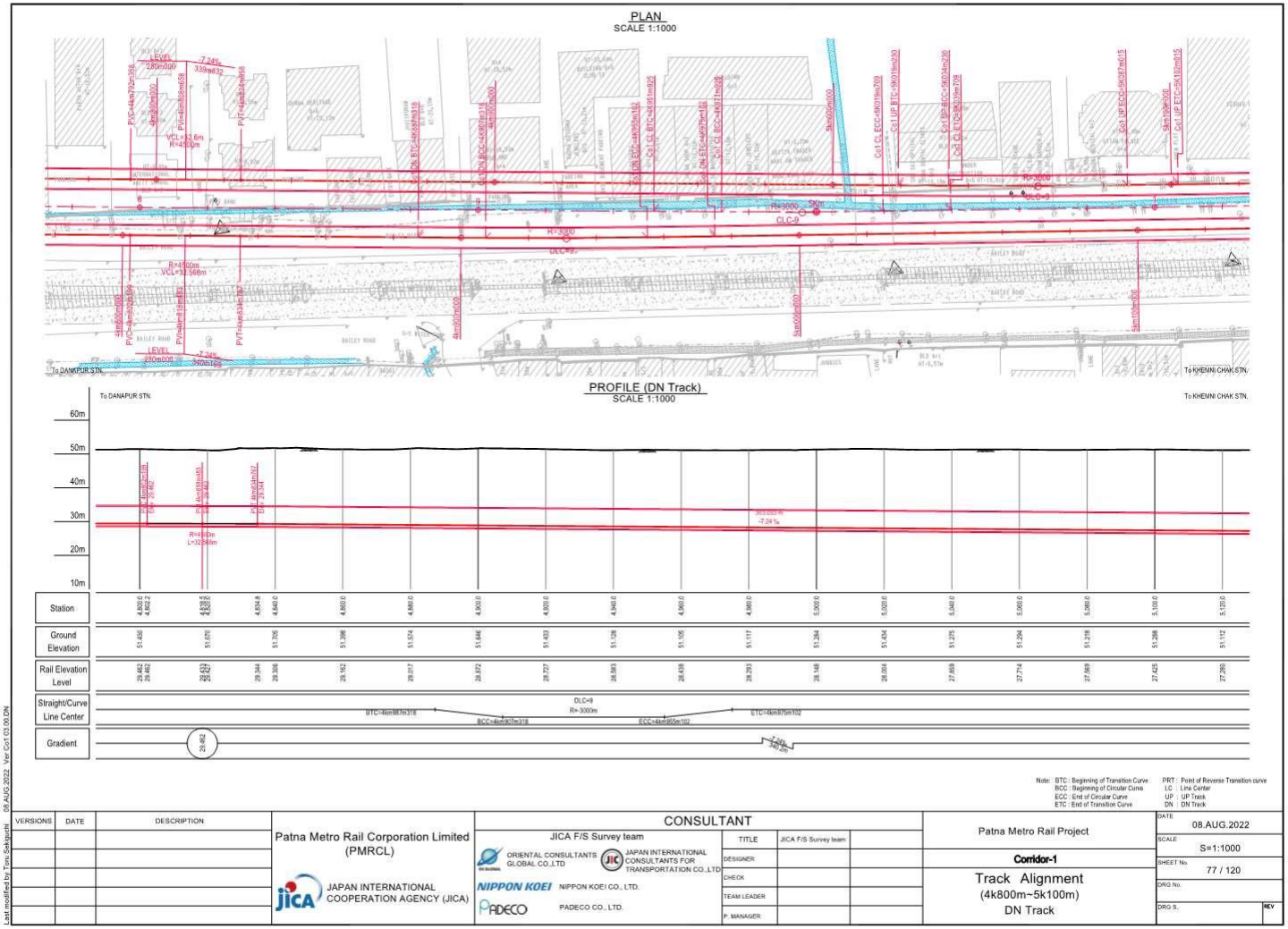

PLAN
SCALE 1:1000
PROFILE (DN Track)
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
70m
60m
50m
40m
30m
20m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k300m~3k600m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
72 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.DN

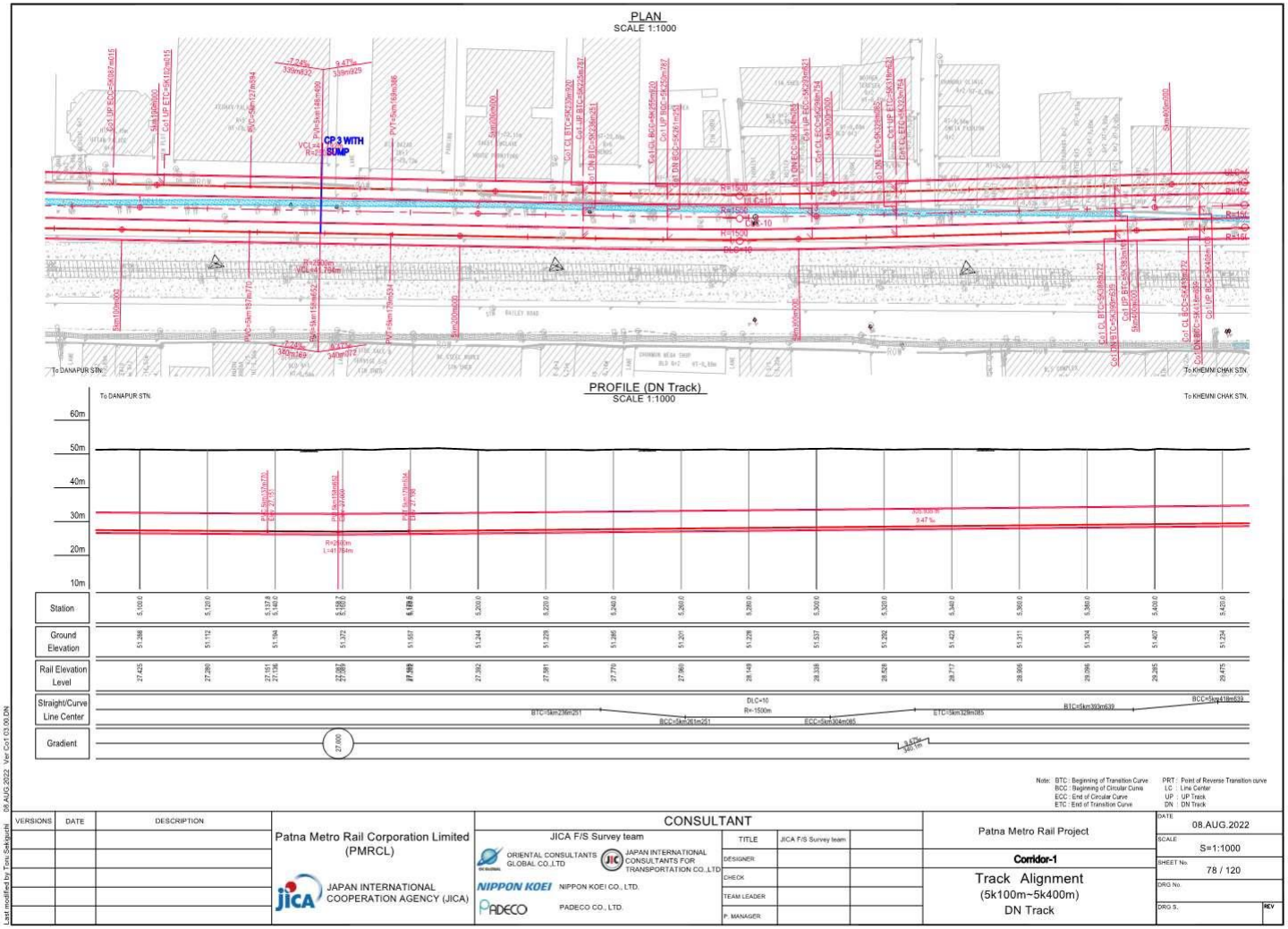

PLAN
SCALE 1:1000
CP 1
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k600m~3k900m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
73 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Co1 03 00 DN

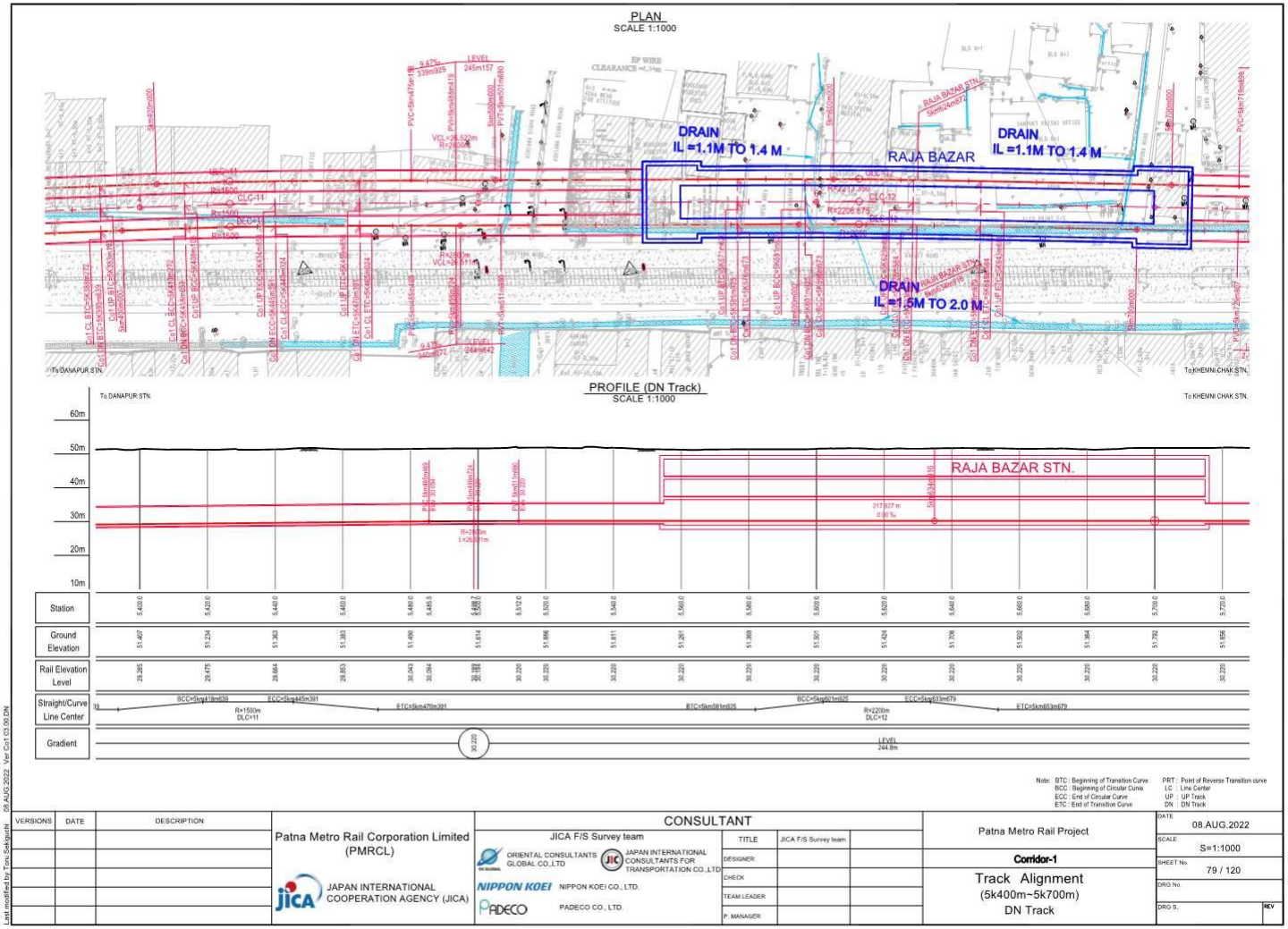

PLAN
SCALE 1:1000
CP 2 WITH SUMP
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(3k900m~4k200m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
74 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver.Cv1.03.00.DN

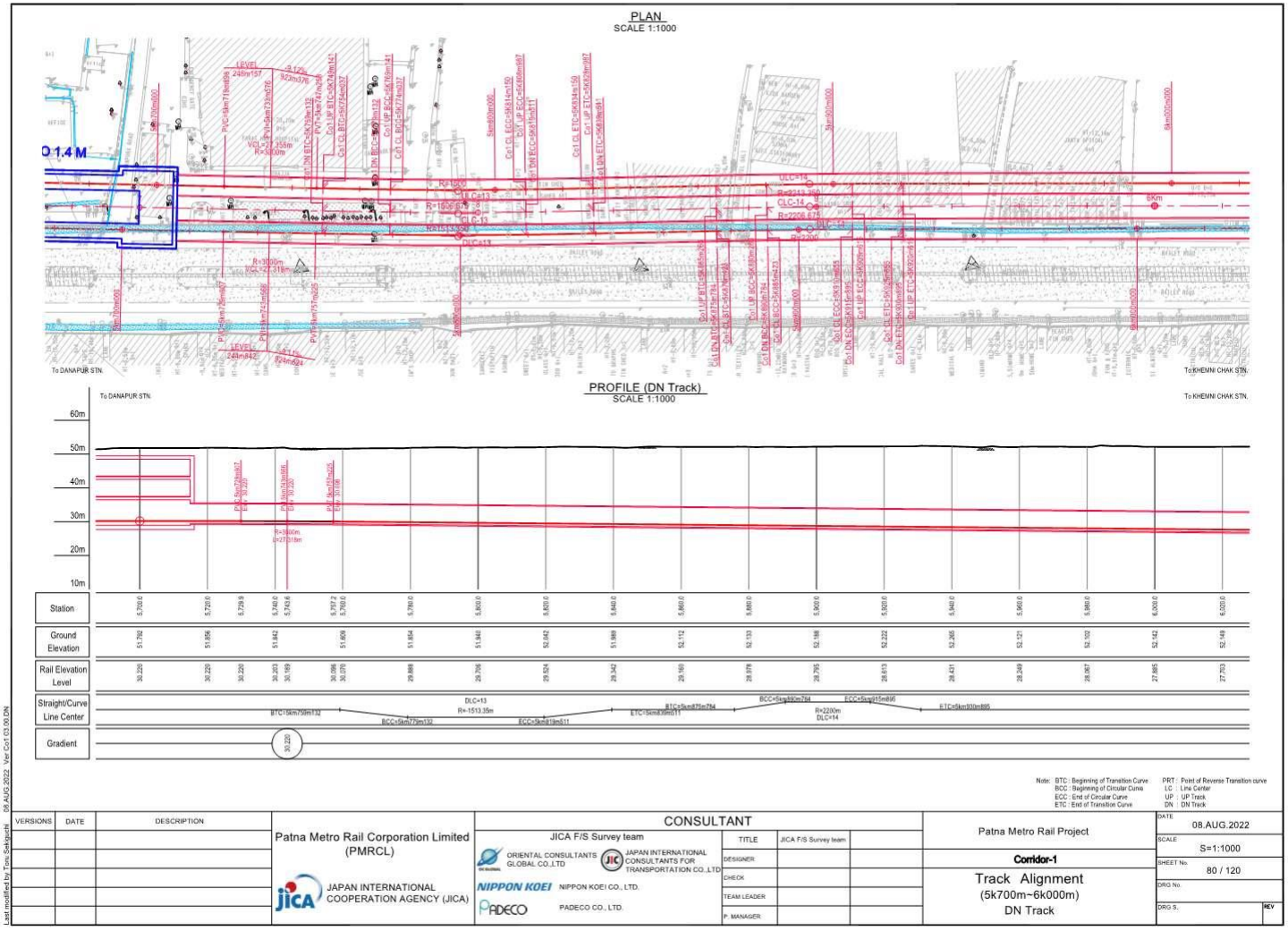

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k200m~4k500m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
75 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyachi 08.AUG.2022 Ver Co1.03.00 DN

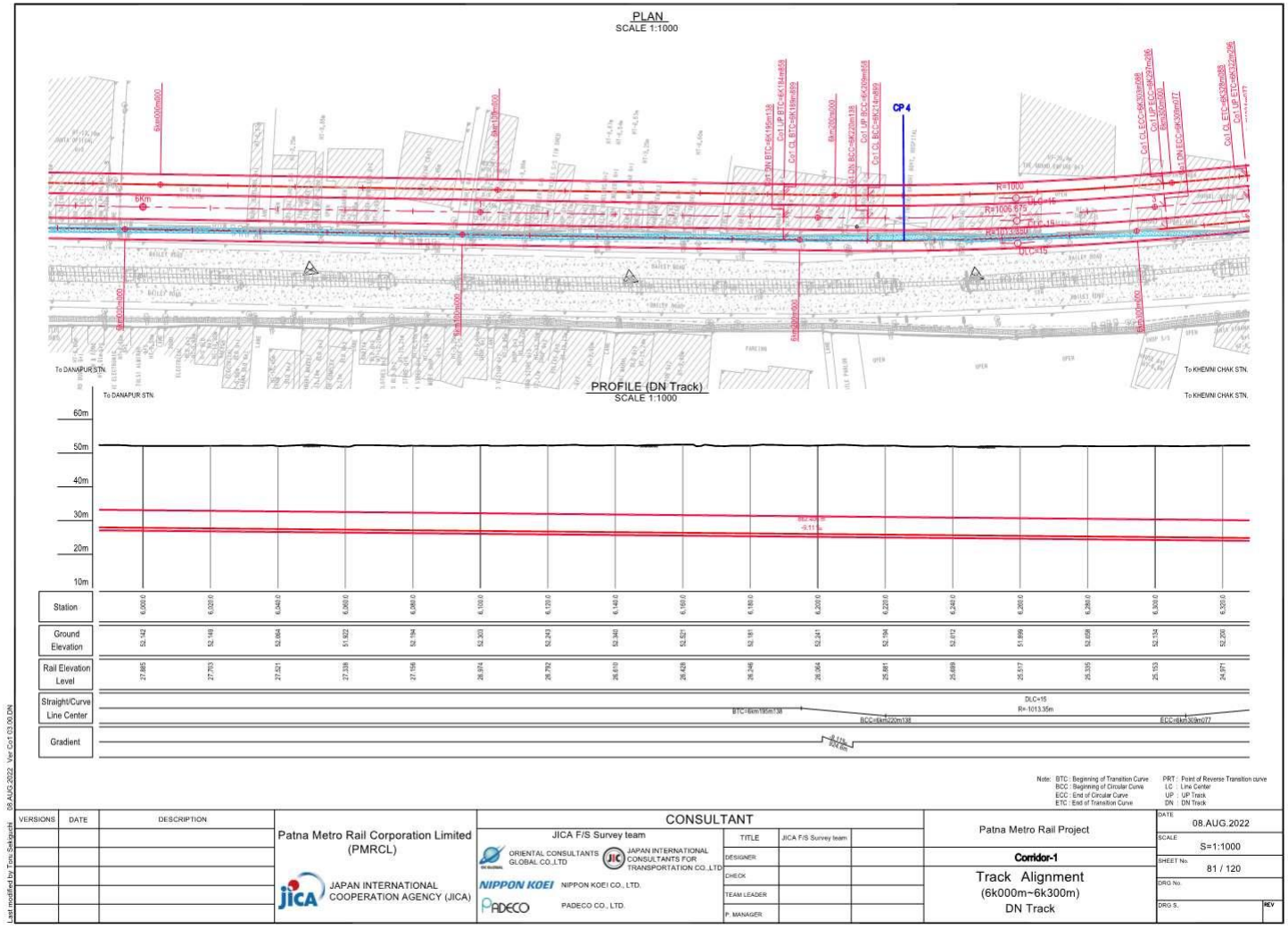

PLAN
SCALE 1:1000
RUKANPURA STN.
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
RUKANPURA STN.
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k500m~4k800m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
76 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Co1.03.00 DN

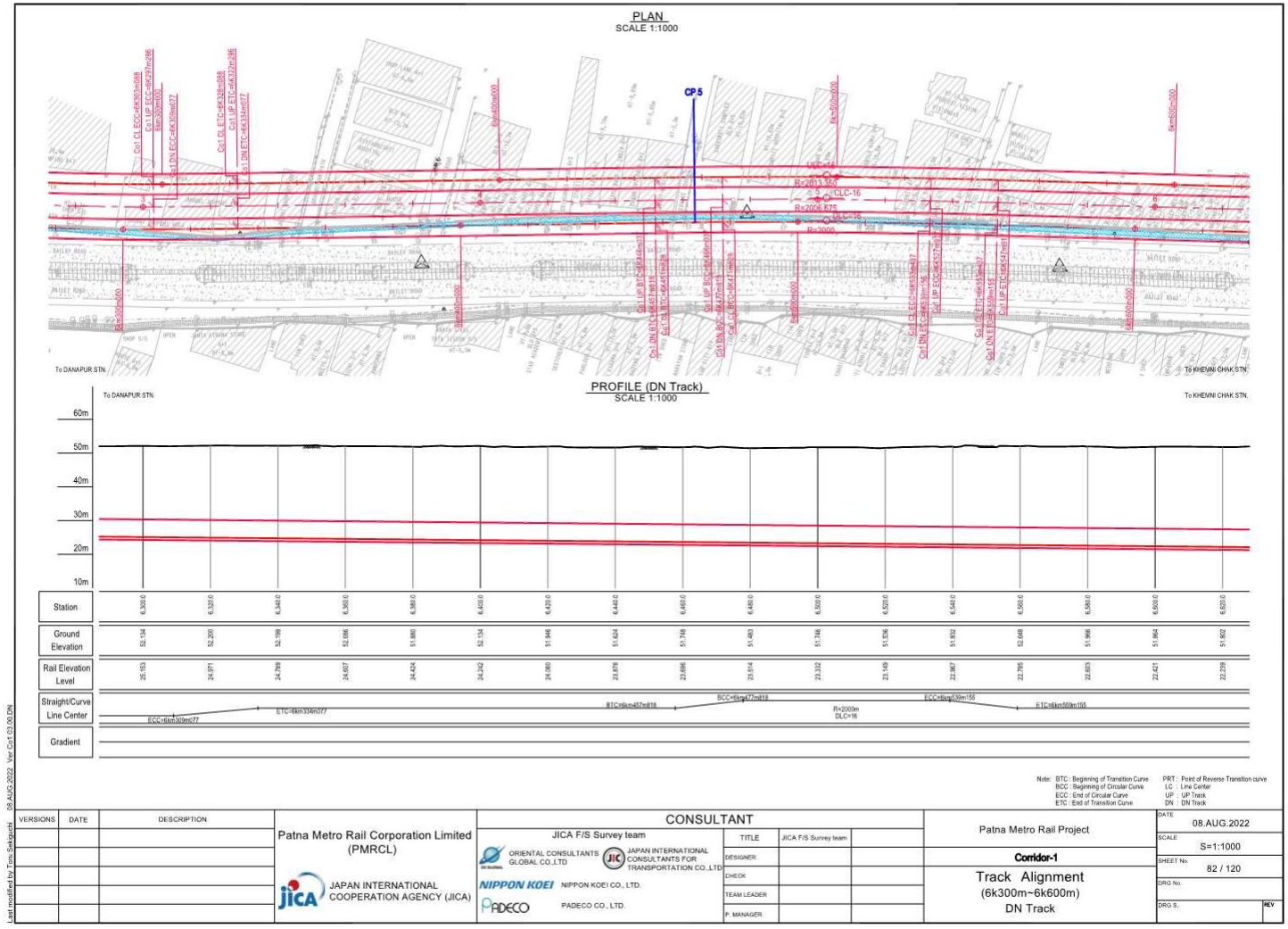

PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(4k800m~5k100m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
77 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyachi 08.AUG.2022 Ver.Cv1.03.00.DN

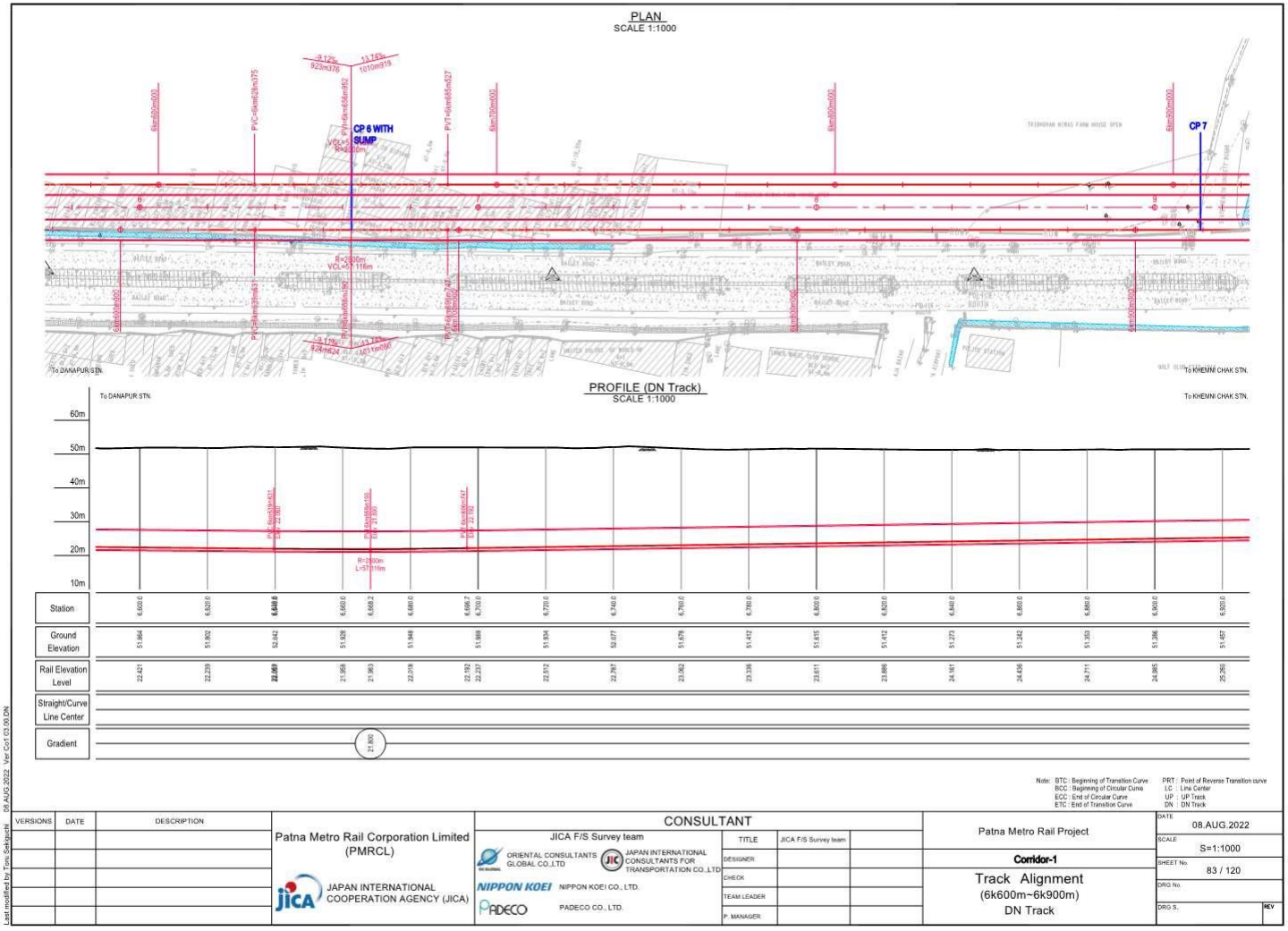

PLAN
SCALE 1:1000
CP 3 WITH SUMP
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k100m~5k400m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
78 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03 00 DN

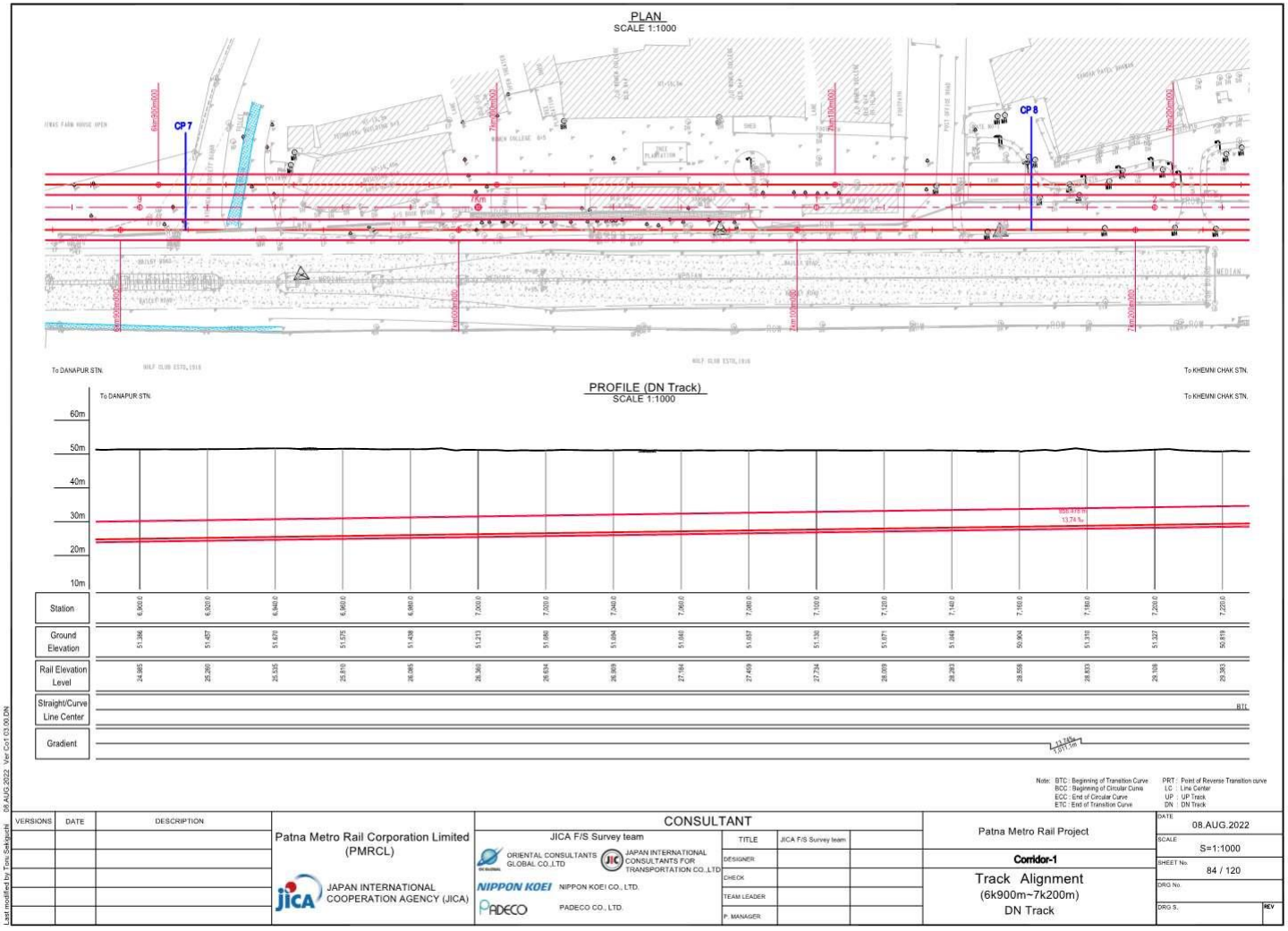

PLAN
SCALE 1:1000
DRAIN
IL =1.1M TO 1.4 M
RAJA BAZAR
DRAIN
IL =1.1M TO 1.4 M
DRAIN
IL =1.5M TO 2.0 M
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
RAJA BAZAR STN.
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k400m~5k700m)
DN Track
08.AUG.2022
S=1:1000
79 / 120


PLAN
SCALE 1:1000
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(5k700m~6k000m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
80 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyachi 08.AUG.2022 Ver Cv1.03.00 DN


PLAN
SCALE 1:1000
CP 4
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k000m~6k300m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
81 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03 00 DN


PLAN
SCALE 1:1000
CP 5
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k300m~6k600m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
82 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08.AUG.2022 Ver Cv1.03 DN


PLAN
SCALE 1:1000
CP 6 WITH SUMP
CP 7
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k600m~6k900m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
83 / 120
DRG No.
DRG S.
REV
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03:06 PM


PLAN
SCALE 1:1000
CP 7
CP 8
To DANAPUR STN.
To KHEMNI CHAK STN.
PROFILE (DN Track)
SCALE 1:1000
60m
50m
40m
30m
20m
10m
Station
Ground Elevation
Rail Elevation Level
Straight/Curve Line Center
Gradient
Note: BTC : Beginning of Transition Curve
BCC : Beginning of Circular Curve
ECC : End of Circular Curve
ETC : End of Transition Curve
PRT : Point of Reverse Transition curve
LC : Line Center
UP : UP Track
DN : DN Track
Last modified by Toru Sakiyama 08 AUG 2022 Ver Cv1 03:06 PM
VERSIONS
DATE
DESCRIPTION
Patna Metro Rail Corporation Limited (PMRCL)
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
CONSULTANT
JICA F/S Survey team
ORIENTAL CONSULTANTS GLOBAL CO.,LTD
JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO.,LTD
NIPPON KOEI CO., LTD.
PADECO CO., LTD.
TITLE
JICA F/S Survey team
DESIGNER
CHECK
TEAM LEADER
P. MANAGER
Patna Metro Rail Project
Corridor-1
Track Alignment
(6k900m~7k200m)
DN Track
DATE
08.AUG.2022
SCALE
S=1:1000
SHEET No.
84 / 120
DRG No.
DRG S.
REV