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Western Balkans Investment Framework Infrastructure Project Facility Technical Assistance 10 (IPF10)

AA-010071-001

WB24-SRB-TRA-02

**Reconstruction and Modernization of railway line
Lapovo- Kraljevo-Lesak-Kosovo Polje- Đeneral
Janković – state border – (Volkovo), section
Kraljevo – Rudnica,**

**Feasibility Study, ESIA, Preliminary Design and
Tender Documents**

ToR – Geological and Geotechnical Surveys

March 2023



The Infrastructure Project Facility (IPF) is a technical assistance instrument of the Western Balkans Investment Framework (WBIF) which is a joint initiative of the European Union, International Financial institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic infrastructure investments. This technical assistance operation is financed with EU funds.

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NAME OF SUBPROJECT	Orient/East-Med Corridor, Kraljevo – Rudnica Route 10 Railway Section: Feasibility Study, ESIA, Preliminary Design, Tender Documents
SUBPROJECT REF	WB24-SRB-TRA-02
WBIF SC APPROVAL DATE	June 2021
BENEFICIARY/PROMOTER	Ministry of Construction, Transport and Infrastructure of Serbia (MCTI), JSC Serbian Railways Infrastructure (SRI)
SECTOR	Transport
COUNTRY	Serbia
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DATE	March 2023
REPORT TITLE	ToR – Geological and Geotechnical Surveys

TERMS OF REFERENCE

Geological and Geotechnical Surveys

WB24-SRB-TRA-02 Orient/East-Med Corridor, Kraljevo – Rudnica Route 10 Railway Section:
Feasibility Study, ESIA, Preliminary Design, Tender Documents

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1. BACKGROUND INFORMATION

1.1. Project Background

Railway line Kraljevo-Rudnica is a single-track railway line route the length of approx. 77km, with a current permitted operational speed up to 60km/h. The Railway line starts at the exit of Kraljevo railway station passengers’ building and ends after the Rudnica railway station. Along the railway section there are 9 main Stations, several halts, 65 structures (bridges) and many level crossings. Currently the trains travel at a low speed due to the condition of the infrastructure and the superstructure. The objective of this assignment is to upgrade the railway line to meet European standards, improve safety and increase the speed.

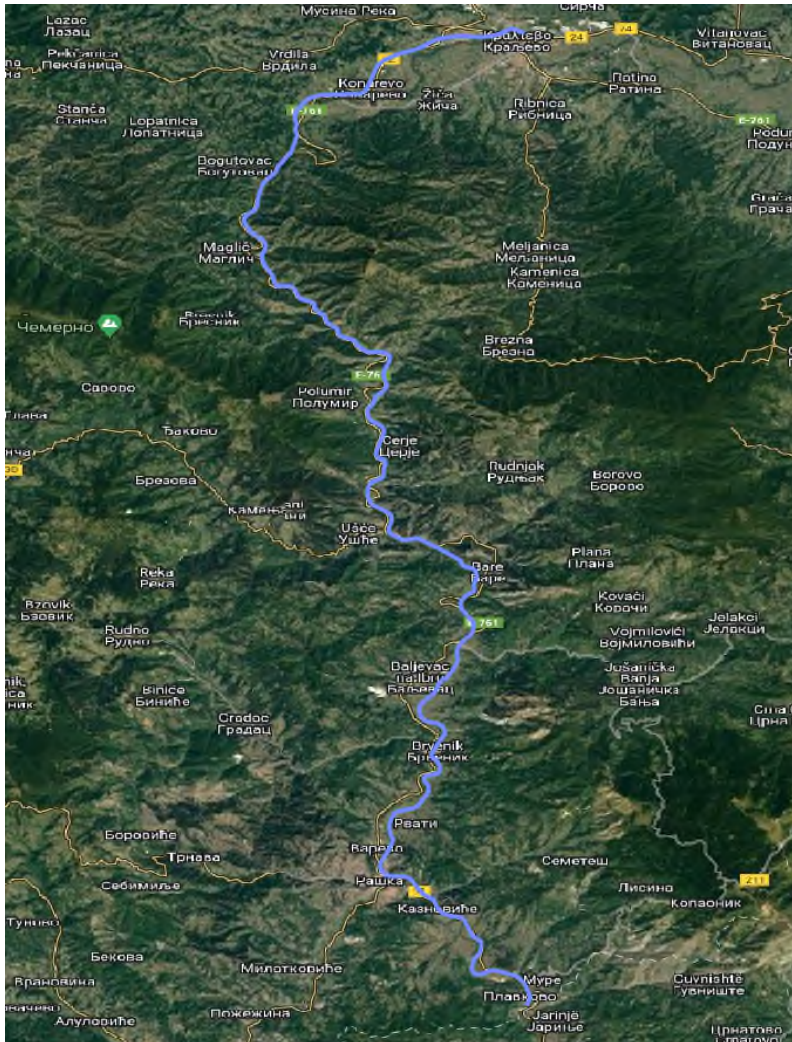


Figure 1: Area of the project, railway line Kraljevo-Rudnica

The grant WB24-SRB-TRA-02 was approved at the 23rd meeting of the WBIF Steering Committee in December 2020 with a total amount for TA of €3,700,000. The expected duration of the assignment is 26 months. A Pre-Feasibility Study with a General Design for the Reconstruction and Modernization of Stalać – Kraljevo-Rudnica railway line was prepared in 2019 under WBIF Grant WB14-SRB-TRA-01 by IPF5 and approved by State Review Commission in October 2020.

1.2. Objectives of Terms of Reference (ToR)

This document forms the Terms of Reference (ToR) for the Geological and Geotechnical Survey and Investigation required for the implementation of the TA Project Western Balkans Investment Framework (WBIF) “Orient/East-Med Corridor, Kraljevo – Rudnica Route 10 Railway Section: Feasibility Study, ESIA, Preliminary Design, Tender Documents”.

SUBPROJECT REF. **WB24-SRB-TRA-02**

This document has been prepared for procurement in compliance with EIB Procurement rules.

The Technical Assistance Contract for the preparation of the Feasibility, Preliminary Design and Tender Documents has started officially with the Kick off Meeting held on 13 May 2022 in Belgrade, Serbia.

This document has been prepared for procurement in compliance with EIB Procurement rules.

The Technical Assistance Contract for the preparation of the Preliminary Design and Tender Dossier has started officially with the Kick off Meeting held on 13 May 2022 in Belgrade, Serbia. A Pre-Feasibility Study (PFS) with a General Design for the Reconstruction and Modernization of Stalać – Kraljevo-Rudnica railway line was prepared in 2019 under WBIF Grant WB14-SRB-TRA-01 by IPF5 and approved by State Review Commission in October 2020.

2. SCOPE OF WORK

The objective of this assignment is to conduct Geological and Geotechnical surveys / investigations along the existing rail line undertake laboratory testing and prepare the finalized factual report to the satisfaction of the Beneficiary.

A geological survey shall be conducted to investigate the geomorphological, lithological, tectonic, hydrogeological, geological, and geotechnical characteristics of the formations along the study zone.

In order to achieve the scope, comprehensive geological and geotechnical investigations and testing should be performed, as follows:

- Collection and evaluation of bibliographic data; it includes collection, database recording, and evaluation of all available bibliographic reports;
- Review of previous geological/geotechnical investigations and reports performed during the previous Conceptual Design phase of the project, existing geological maps and all other kind of available information;
- Study of aerial and satellite images;
- Engineering-geological prospecting of the terrain along the alignment;
- Geological survey / investigation along the railway line;
- Drilling of boreholes with standard penetrations tests (SPT);
- Excavation of trial pits;
- Laboratory tests on soils/rocks;
- Preparing the Factual Report from all investigations and testing.
- Geological survey report, which will include:
 - reconnaissance on satellite images, followed by ground geological survey, identification of problematic zones;

- description of stratigraphy and geological structures in plan and sections at appropriate scale;
- analysis of hydrogeological conditions;
- geological mapping at scale 1:2,000
- survey report;
- Proposed for borrow pits and waste deposits.

The geological and geotechnical investigation will include the following sections:

- The whole alignment of the railway section Stalac- Kraljevo incl. Station areas, any local deviations;
- The major structures bridges along the alignment;
- Potential landslides areas (if any).

2.1. Description of investigation work

Preparatory works

The services to be provided by the Contractor will include, but not be limited to the following:

- Providing the survey equipment and drilling machines and tools, materials, labour, qualified geologists, transport, insurances for the working staff and all the incidental items as may be necessary for the successful completion of the surveying, drilling and laboratory testing, etc.;
- Mobilization to the site of the drilling equipment and personnel;
- Obtaining necessary permits and permissions to access the working area for all equipment and personnel;
- Preparation of accesses to each site, setting up at each location and moving between boreholes. Construct access paths for the transport of drills, on inaccessible parts of the route, accessories and water for drilling to the microlocations of investigation points These works must be performed with working machines that correspond to the description of this job. In addition to the access paths, these machines should also make a working plateau for drilling equipment. Construction of access roads is deemed to be included within the rate for of mobilisation.
- Storage and handling of samples;
- Transfer of samples and core boxes to the testing laboratory;
- Participation in meetings regarding the geotechnical investigations;
- Restoration and cleaning of affected areas;

Engineering-geological prospecting of the terrain

The aim of this activity is to gain insight into the current terrain conditions along the whole alignment, as well as to perceive the basic geological, geomorphological, engineering-geological and hydrogeological characteristics of the terrain (processes of rapid erosion, unstable areas, zones with low bearing capacity, swamps, wet zones, etc.). All data from the performed engineering-geological prospecting should be drawn on a updated map.

Geological investigations Boreholes

Drilling of investigation boreholes will provide information of the subsurface conditions, types of lithological layers, groundwater level, depth of bedrock if any, as well as to collect representative soil/rock samples for laboratory testing and analysis.

Equipment and drilling modes should be adapted to the subsurface conditions in which the drilling is carried out (drill bit, rotation speed, application of casing, etc.). The ultimate goal is to extract a quality core that will allow obtaining confidential and reliable geotechnical data, as well as quality samples for laboratory tests.

The extracted core from the drilling should be placed in wooden / metal / plastic core boxes with standard length of 1 m and 3 – 5 sections. The core shall be photographed and mapped. In cohesive soils, undisturbed samples shall be taken with Shelby tubes and in non-cohesive soils, disturbed samples shall be taken with split-spoon sampler (while performing SPT).

The drilling will be performed under the supervision of a qualified geologist / geotechnical engineer, whose task is to prepare borehole logs, sampling, as well as preparing soil / rock samples for transport to an accredited laboratory. After the drilling, the position of each borehole shall be geodetically defined.

For each borehole, shall be applied:

- Carry out permeability tests (Lefranc or Luegon test), depending on the nature of the soil encountered;
- Take disturbed samples of core material (at least 1 sample every 3 m) and undisturbed samples (at least 1 sample every 5 m), depending on the nature of the soil encountered, for geotechnical laboratory testing and provide a detailed mapping of the borehole;
- Install piezometer instrumentation for water table monitoring.

During the drilling of each borehole, shall be executed:

- Standard Penetration Test (SPT) every 3 m of drilling (minimum); and

The exact number, distribution, and depth of SPT will depend on the soil encountered and the local geological settings

Geological investigations excavation of Trial Pits

Excavation of trial pits will provide information of the subsurface conditions, types of lithological layers, groundwater level, as well as to collect bulk and jar samples for laboratory testing, especially for Proctor and CBR tests. That data, in correlation with other geotechnical investigations, will be used to obtain precise and accurate input of the soil parameters, in order to give appropriate recommendations from a geotechnical point of view on the type of foundation of the underpasses (shallow or deep), as well as for eventually improvement of the ground on which the railway corridor is placed/ or will be build.

Firstly, existing grass and vegetation will be cut and removed, as well as the topsoil will be removed and kept separate from the soil that is the subject of investigation and testing. The soil piles will be deposited at a suitable distance from the pit edge, to ensure that the weight of the soil piles does not endanger the stability of the pit sides. Because the depth of the trial pits, samples will be taken directly from the pit only if it is considered safe to do so, otherwise, the samples will be taken from the excavator bucket.

The trial pit will remain open only for the duration of excavation to the predicted depth and during descriptions of the geological layers and collecting disturbed samples. Backfilling will be carried out immediately after finishing with the mapping, photographing and sampling. On completion, the pit and surrounding area will be left in a condition that is acceptable to the engineer and their position shall be also geodetically defined. Any remains of consumables, waste and excess materials associated with the excavation (e.g. litter, plastic) will be bagged and removed from the trial pit location.

The excavations will be performed under the supervision of a qualified geologist / geotechnical engineer, whose task is to prepare trial pit logs, as well as preparing samples for transport to an accredited laboratory.

2.2. Geophysical and Seismic Surveys

The seismicity of the project area will be assessed in detail. Geophysical investigations for seismic micro regionalization of the subject area will include seismic and geoelectrical investigations for bridges and tunnels.

2.3. Geo-electrical investigations

In addition to boreholes and CPT investigations, the Consultant will conduct Vertical Electrical Sounding (VES) geo-electrical investigations, based on the nature of soil encountered and the local geological settings.

The programme of work under this ToR is detailed in par.2.6

2.4. Reports

After the completion of all investigation works, both in the field and in the laboratory, the Contractor shall prepare Geotechnical Elaborate of Investigation Works, which consists of a report, textural part, tables, graphic attachments and photo documentation. In particular:

Geology Report

The Service Provider shall produce a detailed geological and geotechnical report containing the field exploration data, laboratory testing results, evaluations, recommendations, calculations and descriptive supporting text. Information in the report shall include, but not be limited to:

- Existing geological and geotechnical (e.g. surface and subsurface) conditions of the site;
- Subsurface (substrata) exploration logs, location of exploration points, etc
- Conducting all field and laboratory tests for determining the strength and compressibility characteristics of the soil;
- Geophysical exploration, if necessary;
- Preparation of drawings and charts; and
- Brief description of the project for which this report is prepared, with information about the location of the project, structures, etc.;
- Time frame in which site investigations and laboratory tests were conducted;
- Descriptions of methodology, equipment, standards, etc. used in the site and laboratory;
- Procedure used for sampling, transport of the samples and their storage;
- The geology, geotechnical, and hydrogeological characteristics of the terrain at the locations investigated;
- Information on seismic activity in the area;
- Longitudinal engineering-geological profile along alignment and characteristic engineering-geological cross sections.
- Borehole and test pit logs with description of subsurface geological layers, underground water level, SPT data and laboratory test results, including photographs of cores and pits;
- Laboratory data sheets;
- Engineering-geological maps;

Engineering – Geological mapping along the railway axis up to 50 m alongside it (i.e. 100 m zone). Mapping shall cover the following at minimum: a) Identification of different lithological units or/and soil formations b) Tectonic diagrams (where possible) at the areas of the bridges, tunnels and retaining structures c) Geological map at 1:2000 for the alignment and 1:500 for the portals of the tunnels (if any) d) Geological section along the alignment e) Cross sections at the locations of the tunnels, bridges and retaining structures f) Classification of rockmass/soil g) Identification of unstable zones along the alignment, evaluated towards the direction of deriving a conceptual geological model for the whole area of investigation with conclusions and recommendations regarding any geological risks / hazards that could arise

1:5,000 for the wider area;

2,000 for adjacent areas;

1:200 for the geotechnical profile of the railway and structures.

Factual report

Factual report for bridges, tunnels, open line and material construction including external control, Documentation of site and laboratory tests. The following should be included at minimum a) Cumulative tables and graphs of laboratory testing results, b) Presentation of field test results in tables and graphs, c) GWL monitoring during drilling and subsequently (if available), d) Plan view with the points of investigation, e) Borehole logs with the description of the encountered formations, the SPT results, the laboratory testing results, the permeability testing results, the TCR, SCR and RQD (if applicable) of the drilling process and any other informations relevant to the current borehole each time, f) The laboratory sheets for every test conducted, g) Photo documentation of the boreholes, h) Classification (GSI, RMR) of the rockmass/soil samples.

Waste deposits and borrow pits Report

A survey report for waste deposits and borrow pits will be drafted separately unless otherwise requested by the Beneficiary. This report will include an appraisal of the cost-effectiveness of transporting the land material for construction works to and from the construction sites, in addition to the results of field investigations, laboratory tests and quantities of executed works.

2.5. Deliverables

The reports shall be submitted to the Consultant in English and Serbian for review and approval. All charts, pictures and drawings should be bi-lingual (English – Serbian).

All final deliverables shall be submitted electronically and in paper and in 6 copies. Electronic deliverables must be submitted in a suitable format for update and use in future work by the Beneficiary.

2.6. Program of investigation work

The program was made based on geodetic layouts drawings from the PFS and with a draw of the railway alignment on a conceptual design level. The program focuses on the sections/structures where the alignment is considered as fixed and no further options/alternatives of the railway line will be investigated. Prior the commencement of the field works the Project Manager, and the Geotechnical/Geologist expert shall confirm the program of works while the Contractor shall inform of any changes to the program of works and any issues

with respect to access for the location. Any changes shall be proposed for approval by IPF10 during the execution of the works. Such changes shall not affect the rates of the contract.

Investigation works

Investigation works are presented in detail in the layout drawings in Annex 1. Qualitative and quantitative characteristics of individual investigation work are given in. The execution of the planned investigation works will depend on the situation on the ground, i.e. the detailed positioning of the micro-locations of the investigation works will be performed depending on the technical possibility of access to the working machines. Also, since the conceptual design at this stage is not approved, positioning of the investigation works could be different during execution of field works. Detailed positions of all locations will be determined by the Supervision during execution phase. The supervisor will report any changes the IPF10 management and the Project Manager.

The following table shows the program investigations works:

Item	Description of the Activities	Unit	Quantity
1. PREPARATORY WORKS AND TRANSPORTATION COSTS			
1.1.	Mobilization and Demobilization, including coordination and obtaining permits from Serbian Railways Infrastructure (SRI) and eventual H&S training etc	Lump Sum	1
2. SITE INVESTIGATION WORKS			
2.1.	Setting up and dismantling of the drilling rig,	Lump Sum	1
2.2.	Engineering - Geological mapping along the railway axis up to 50m alongside it (i.e. 100m-wide zone). Mapping shall cover the following <i>at minimum</i> : a) Identification of different lithological units or/and soil formations b) Tectonic diagrams (where possible) at the areas of the bridges, tunnels and retaining structures c) Geological map at 1:2000 for the alignment and 1:500 for the portals of the tunnels d) Geological section along the alignment e) Cross sections at the locations of the tunnels, bridges and retaining structures f) Classification of rockmass g) Identification of unstable zones along the alignment. See Article 4.2	km2	7,7
2.3.	Rotary core drilling of boreholes including water provision and casing (were necessary). (Vertical drilling)	ml	551
2.4	Rotary core drilling of boreholes including water provision and casing (were necessary). (Vertical drilling)-Tunnels	ml	578
2.5	Rotary core drilling of boreholes including water provision and casing (were necessary). Inclined - horizontal drilling-Tunnels where the access is not possible	ml	70
2.6	Non sampling Borehole (m) In locations where there is no road access close to abutments and the drilling will be executed from the track bed level .	ml	130

Item	Description of the Activities	Unit	Quantity
2.7	Standard Penetration Test ASTM D 1586. Performing the Standard Penetration Tests (SPT) – shall be carried out at 3 m interval in each borehole, exclusively in soil materials.	Nb	50
2.8	Engineering-geological mapping the core of the boreholes, together with photographing the core. The geologist on site shall provide the following: a. Field description of the core sample per AUSCS or/and BS5930, b. Wrapping and storing of samples in wooden core boxes, c. Photographing and labeling of core samples, d. Supervision of the flawless progression of the drilling process.	ml	1129
2.9	Excavation of trial pits with depth 2.5 – 4.0 m, together with mapping and sampling.	Nb	98
2.10	Geo Electrical measurement. Geo-electrical investigations in addition to boreholes will be conducted. Vertical Electrical Sounding (VES) geo-electrical investigations in the location of the new tunnels. Tunnel portals	Nb	4
2.11.	Lefranc test	Nb	10
2.12	Lugeon Test	Nb	90
2.13	Piezometer installation included PVC tube, for water table monitoring	ml	240
3. LABORATORY TESTS			
3.1	Particle size analysis – by sieving and / or hydrometer methods.		10
3.2	Atterberg limits ASTM D 4318 (plastic and liquid limits, plasticity index).		10
3.3	Determination of natural water content.		10
3.4	Determination of unit weight of soil – bulk and dry density.		0
3.5	Determination of soil strength parameters (direct shear test).		30
3.6	Unconsolidated-undrained / Consolidated-undrained triaxial test.		15
3.7	Unconfined compression test on soil.		10
3.8	Oedometer test.		5
3.9	Proctor test (dry density/moisture content relationship).	Nb	49
3.10	California Bearing Ratio (CBR) test.	Nb	49
3.11	Water Chemical analysis (SO ₄ , pH, CO ₂ , NH ₄ ⁺ , Mg ²⁺ , Cl ⁻)	Nb	20
3.12	Chemical analysis of ground (SO ₄ , (mg/kg), CaCO ₃ , Cl ⁻ , Acidity degree according to method Baumann Gully (ml/kg),	Nb	20
3.13	Uniaxial Compressive Strength (UCS) of intact rock core.	Nb	80
3.14	Point Load Test (PLT) on rock samples.	Nb	80
3.15	Direct shear on the discontinuity planes	Nb	60

Item	Description of the Activities	Unit	Quantity
4. Reports			
4.1.	Factual report	Lump Sum	1
4.2.	Geological Report incl. waste deposits and borrow pits report.	Lump Sum	1

Table 1: Program of work

Notes:

Quantities of investigation works may deviate from those given in the above program - bill of quantities (e.g Individual depths can be variable, depending on the conditions of each micro location as well as the depth of the projected level of the railway track in relation to the terrain surface), and need the prior written consent of the Supervising Engineer and in coordination /approval with the IPF10.

If the Contractor deviates from the contracted Bill of Quantities during the execution of works without the consent of the Supervising Engineer and the IPF10, all consequences shall be borne by the Contractor. The planned investigation works, due to the very difficult terrain, are arranged in such a way as to enable easier access to the execution of investigation works. The dynamics of the execution of the projected investigation work is classified by activities. Any issues with access to lands will be reported to IPF 10 who will subsequently inform the Beneficiary. This may result in a change of programme that will not lead to a modification of rates.

3. STANDARDS

For the performance of drilling, sampling, in situ testing and monitoring as described above, the following Standards will (but not be limited to) apply:

- Eurocode 7;
- EN1997;
- EN1998;
- EN ISO 22475-1, Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1: Technical principles for execution;
- EN ISO 22476-3, Geotechnical Investigation– Field testing –Part 3: Standard penetration test;
- Installation of piezometers will be carried out according to the specification EN 22475-1;
- Laboratory Testing according to relevant EN or ASTM Standards.

4. HEALTH AND SAFETY

The Contractor will follow and comply with all applicable national regulation concerning health and safety and pay especially attention if the railway is operational. In this respect, Contractor will have to comply with all the regulations of SRI, especially in regards with the safe access to the railways and will be fully responsible for establishing a Safe Work environment, both for his personnel and the trains using the railway line, while the surveying is ongoing.

It is important to note that the Contractor shall undertake all necessary and required safety and healthy precautions during the execution of the field works.

5. EQUIPMENT AND PERSONNEL

The Contractor shall mobilize adequately qualified staff, and provide survey instruments, equipment, tools & plants, materials, and labours, to carry out the investigations. All the test needs to be performed in accreditive laboratories.

The methods in practice in Serbia or current internationally recognized standards shall be used in carrying out the investigations.

All equipment shall be properly maintained and calibrated. Certificates may be requested from the Contractor.

Equipment and materials that do not comply with the technical conditions, regulations and standards may not be used, and the Contractor is obliged to remove such equipment from the site free of charge.

The Contractor is required to provide internal supervision during investigation work to ensure responsibility for the quality of the work performed, this shall be done by qualified Geotechnical Engineer or Geologists who will be responsible for the execution of the works. In order to ensure the quality of work, the Contractor must ensure the following:

- schedule of works, and to ensure whether the work is carried out in full accordance with the program or adjustments are required.
- all the necessary equipment on the site,
- develop a way of keeping documentation and
- provide qualified staff for this type of work

6. LOGISTIC

The Contractor should provide all logistic equipment for surveying.

The Contractor must provide the necessary permits in agreement with the Consultant. Project Manager and Geology/Geotechnical Engineer should be informed about the surveying details on daily basis.

Drilling logs shall be provided for inspection to the IPF Expert on a weekly basis.

The Contractors head of investigation shall be in close collaboration with the Geotechnical/geologist expert and the Project Manager and provide any information or change is required during the investigations. All changes in surveying program should be discussed with the Consultant timely. The Contractor the designers, in cooperation with the Project Manager and the IPF 10, agrees on any changes or amendments to the program based on the local conditions.

The programme shall also be adapted to operational constraints set by the Beneficiary and other stakeholders responsible for the railways and adjacent infrastructures.

IPF experts and representatives of the Beneficiary may visit the site at any time in order to monitor and check the progress of the investigations.

The Contractor is responsible for respecting all applicable laws and regulations in the course of undertaking its services.

The Contractor is responsible for any possible damages to third parties as a result of surveying.

7. TIMING

Time for completion of all works described above is 180 days from the date of the Contract signing. The Consultant shall submit the deliverables in coordination with the Project Manager and the Lead Structural Engineer, in a way to provide all necessary geological and geotechnical data for the structural designs of the Bridges, Retaining Walls etc.

Additional surveys may also be performed, in accordance with the provisions of the overall scope of works of the entire project.

8. BUDGET

8.1 Payment schedule

The payment of the sub-contractor will be made in accordance with the progress of the works, as follows.

No	Payment	
1	Preparatory works, Mobilization	30% upon signature of contract
2	Interim payment	Up to 60% of the total amount based on agreed deliverables that will be defined after the inception period and based on the progress of work with actual APPROVED quantities undertaken on site and agreed by the SPM.
3	Balance payment	10% balance payment upon receipt and acceptance of the Final Deliverables.

Table 2: Payment schedule

8.2 Financial offer

The bidder is invited to provide unit rates and total prices for all items listed in the Bill of Quantity as per Annex 2 and submit it as part of a financial offer. The unit rates and total prices shall be without VAT as the procurement of goods and services in the current project are exempted from VAT.

In its offer, the Contractor shall consider all works like the cutting of vegetation, transport, supervision by competent engineers/surveyors, testing of materials, full insurance and all other incidental items as may be necessary for successful completion of the surveying, mapping, and development of reports, included.

The bidder is invited to visit the site prior to submitting his quotations to acquaint himself fully with the nature, type, scope of work and involvement therein. The rates quoted shall remain firm during the entire period of execution until the completion of the work and any additional claim for lack of knowledge shall not be entertained.

The overall offer shall not exceed the amount: 330,000.00 EUR.

ANNEX 1

(as a separate file)

- *Program of Boreholes and Trial pits (on main structures)*
- *Investigations drawings*

ANNEX 2

(as a separate file)

- *Bill of Quantity -Price Bid*