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Western Balkans Investment Framework Infrastructure Project Facility Technical Assistance 8 (IPF 8)

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WB19-SRB-TRA-03
Terms of Reference for the Geotechnical investigation program for preparation of the Preliminary Design reconstruction of single-track railway Niš - Preševo - State border, section Brestovac - Preševo - State border

May 2023 revised July 2023

*) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

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Western Balkans Investment Framework (WBIF)

Infrastructure Project Facility Technical Assistance 8 (IPF 8)

Infrastructures: Energy, Environment, Social, Transport and Digital Economy

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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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1 INTRODUCTION

1.1 Objective of project creation and purpose of the Investigation program

The railway line Niš - Preševo - State border plays a significant role in the internal and international traffic of the Republic of Serbia. The wider importance of this railway comes from the fact that it is part of the main railway line E 85 (Budapest - Kelebija - Subotica - Belgrade - Niš - Preševo - Skopje - Đevđelija - Thessaloniki - Athens), which according to the AGC Agreement from 1985 (ratified in 1989 year) classified among the most important international railways, and according to the AGTC Agreement from 1991, also among the most important railways for international combined transport.

According to the decision from Helsinki in 1997, the Niš - Preševo - State border line is part of Priority Pan-European Railway Corridor X.

According to the conclusions of the Southeast UIC Group from 2001 and the Agreement of the countries of Southeast Europe from 2006 (SEECP), the lines of Corridor X are the priority routes of Southeast Europe.

According to these documents, the railway Niš - Preševo - State border should be reconstructed and modernized into a railway for mixed traffic for train speeds up to 160 km/h.

Planned services on the existing railway (Niš) - Brestovac - Preševo - State border, include the reconstruction of the open railway, station tracks and stops, road crossings, contact network and power supply, SS and TT installations, bridges and culverts and drainage on the open railway and in stations, as well as water protection, which is also the subject of this Project Assignment.

This has the following effects:

- increasing the safety and reliability of railway traffic,
- increasing the driving speed to 160 km/h,
- shortening travel time,
- increasing bandwidth and bandwidth,
- creating conditions for the development of combined transport,
- reduction of noise and vibration levels.

The objective of the geotechnical, hydrological and hydro-geological investigations is to investigate the geomorphological, lithological, tectonic, hydrogeological and geotechnical characteristic of the formations along the study zone.

The geological and geotechnical surveys will be executed by the Service Provider and they shall identify all potential problems along the proposed route in correspondence of civil works – bridges, tunnels, passenger station, underpasses, overpasses, embankments, etc.

The geological and geotechnical investigations shall be carried out to the level of the Preliminary Design.

1.2 Preliminaries

The Service Provider is the entity with whom the Consultant enters into a Service Agreement.

Prior to commencement, the Service Provider will submit for approval an implementation methodology and time schedule and will be responsible for ensuring submission of deliverables in accordance with the approved schedule.

The Consultant will provide the Service Provider with an electronic version of the outputs from all relevant previous studies, if available.

1.3 Health and Safety

Access and services conditions to site will influence basically all types of investigations Safety measures adequate for these access conditions have to be considered and provided by the Service Provider for all the duration of the investigation services.

The Service Provider is responsible for satisfying all requirements of affected stakeholders including Serbian Railways "Infrastruktura železnice Srbije" a.d. prior to commencement of the services. Obtaining permissions, permits, trainings etc shall be foreseen in the Service Provider's schedule of the services.

1.4 Schedule of the services

Before starting the services (mobilization), the Service Provider must request from the Serbian Railways the conditions for execution of investigative services on the railway route.

The Service Provider shall be required to satisfy all necessary health and safety requirements necessary for working within the existing boundaries of a fully operational rail line under traffic conditions. This includes obtaining the necessary permissions and trainings required from the rail operator(s) / Owner(s).

The Service Provider shall be responsible for the programming, coordination, quality and timely execution of the foreseen services. It is critical that the site investigation programme will be completed within the shortest time from the signing of the Service agreement.

Consultant requires that a detailed Geotechnical investigation be carried out at various locations to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site.

The Consultant will review the Service Provider's drilling and investigation schedule which should comply with this requirement.

The Service Provider will take all contingencies into consideration (e.g. mobilization, time to move rigs, in-situ testing, progress rates, maintenance, breakdowns, spare parts, weather and any other factors that could delay progress) to finally define the number and type of rigs to be mobilized on site to comply with the time schedule.

Service Provider's Programme

The Service Provider is expected to submit, as part of his Proposal, a detailed schedule of activities, identifying especially:

- Mobilization period,
- Preparatory/access works,
- Schedule of on-site activities (geophysical investigations and drilling boreholes),
- Schedule of laboratory activities,
- Submission of Deliverables.

The Service Provider's programme should avoid any delay to the start of laboratory testing activities.

1.5 Contract Quantities

Indicative Quantities of services to be performed are summarized in **Annex 2** and may be subject to variations following instructions from the Consultant.

Payments shall be made as a lump sum basis in accordance with the Payment terms defined in the Service Provision Agreement (part D of the tender dossier) and the Financial Offer.

The price shall include all the Service Provider's obligations as described here. They shall cover all costs (including preparation and maintenance during the contract period of accesses), expenses, duties and taxes linked to the services.

For the preparation of the prices, the Service Provider is deemed to be fully aware of site conditions and no claim will be accepted during the investigation services, related to the position of the investigation points, access, etc.

The Consultant reserves the right to modify the locations and/or quantities of the Investigation Services before or during the execution of the Investigation Services to cope with eventual unexpected events encountered before or during the operations.

Prices shall be deemed to cover:

- Labour and all costs in connection therewith
- Plant and all costs in connection therewith
- Materials and consumable supplies
- Transport
- On-site and off-site supervision
- Overhead charges and profit
- Construction and maintenance of accesses and associated administrative costs

1.6 Commencement of the Service

A kick off meeting shall be organised with the Consultant.

The Service Provider shall consider in his Schedule that the on-site activities for Sections A and B will start by a collaborative Walk Over with the Consultant. This Walk Over will aim at confirming the exact location of each investigation to be performed.

Section C walk over shall be undertaken once the programme has been confirmed.

1.7 Submission of Deliverables

The Service Provider is expected to submit the following deliverables:

- Monthly progress report, presenting the general progress of activities and who will present the updated results of the information collected (core logs with pictures, laboratory results, raw data and interpretation report of the geophysical investigations).
- Preliminary Parameters and lithological profiles for each section.
- Geotechnical investigation report (An approved elaborate in compliance with Law on planning and Construction and subsequent bylaws) for each sub-section; and
- one Final report which will be cumulative report all sections combined for submittal to the State Revision Committee.

2 PERSONNEL AND EQUIPMENT REQUIREMENT & SCOPE OF SERVICES & TECHNICAL SPECIFICATIONS

2.1 Personnel and equipment requirements

Field services shall be supervised on full time basis by a suitably and experienced expert.

The Service Provider shall position on a full-time basis a qualified and experienced Engineering Geologist at site throughout the duration of the services (Head of Investigations). This engineer shall be in charge of the entire field and laboratory work and shall be responsible to the Consultant about all day-to-day matters of the investigation services. Head of investigation must possess relevant license recognised in Serbia.

The Service Provider shall also provide a competent foreman, experienced in recognized site investigations techniques, full time on site.

The Service Provider shall show in his O&M that he possesses (or has access to) the following staff members:

- 5 geological engineers with license 391 or 491 (or recognised equivalent acceptable by the Review Committee)
- 1 geotechnical engineer with license 492 (or recognised equivalent acceptable by the Review Committee)
- 1 geotechnical engineer with license 493 (or recognised equivalent acceptable by the Review Committee)

The Service Provider must carry out the services and meet the quality requirements specified in this document. In case these requirements are not fulfilled, the Service Provider will have to perform again the faulty tasks so as to meet the criteria.

The Service Provider shall provide the sites with recent drilling rig (rigs) fitted with conventional systems, and equipped with all the necessary accessories, tools, rods, casings, in order to meet the technical specifications described below.

2.2 Scope of services

The services are subdivided into three sections:

- Section A: Brestovac – Grdelica, from km 267+942.00 to km 301+514.60
- Section B: Grdelica – Suva Morava, from km 301+514.60 to km 333+730.50
- Section C: Suva Morava – Border with North Macedonia (Tabanovce), from km 333+730.50 to km 396+025.04

Services for Sections A and C will commence upon commencement of the Contract. Section B services will be given once the Consultant has received confirmation from the Beneficiary to proceed with investigations for this section.

Chainages and locations are indicatively given for sections A, B and C and shall be confirmed by the Client before commencement of site services.

Before commencing each section, the Service Provider shall be required to satisfy all health and safety requirements necessary for working within the existing boundaries of a fully operational rail line under traffic conditions. This includes obtaining the necessary permissions and trainings required from the rail operator(s) / Owner(s).

The indicative locations of the Investigation Services are provided as shown on Annex 1 and shall be confirmed by the Client before commencement of site services.

For the purposes of developing the Preliminary Design, it is necessary to carry out engineering-geological and geotechnical investigations and tests, in order to obtain detailed and reliable geotechnical conditions and parameters for:

- geological structure, engineering geological and hydrogeological properties of the terrain, modern geodynamic processes and phenomena (unstable and potentially unstable parts of the terrain, landslides, zones of weak soil bearing capacity and similar),
- foundation of structures (bridges, viaducts, underpasses, culverts, overpasses, buildings),
- construction and slopes of the railway embankment,
- locations, reserves and material properties of potential borrowers.
- Investigation must be performed according to the current legislation in Serbia:
  - Geotechnical Design Standards SRPS EN 1997-2;
  - "The law on mining and geological surveys" Official Gazette of the RS number 101/2015, 95/2018 – other law and 40/2021;
  - "The Rulebook on the content of geological investigation design and studies on the results of geological surveys" Official Gazette of the RS number 51/1996, 45/2019 – other law);
  - And all other relevant standards.

2.2.1 Preparatory services

These services should include the following:

- Development of the final program and project for geological and geotechnical exploration and investigations of terrain along the railway route,

- Overview and analysis of existing documentation.
- Obtaining necessary maps and data from relevant national and municipal authorities
- Construction works for the execution of access roads and all other works required for carrying out geological investigations. Maintenance during the Services.
- Obtaining necessary permits and payment of compensations

2.2.2 Geotechnical field investigation

These services will be performed by the Service Provider to define the geotechnical conditions of the alignment of the railway with stations and structures along the alignment and should include the following:

- Detailed engineering - geological (geotechnical) and hydrogeological surveying (mapping)
- Required number of boreholes to be foreseen drilled along the railway alignment, bridges, tunnels, engineering structures, all other objects, etc.
- Detailed structural geological and hydrogeological mapping of the borehole cores photographing the drilling cores, taking soil samples, etc.
- Excavation and mapping of trial pits,
- Compaction, bearing capacity, CBR, Field Vane, in-situ tests in trial pits
- Collecting of soil, rock, water and other samples for the laboratory tests
- Field tests SPT with laboratory classification test, CPT or CPTu tests
- Installation and monitoring of piezometric construction in boreholes
- Execution of geophysical investigations and geoelectrical investigations
- Execution of seismic refraction surveying.

2.2.3 Investigation boreholes and trial pits

- The Service Provider will execute boreholes and trial pits along proposed railway.
  - Each borehole must reach minimum depth of 6m (for instance, in low embankment) up to 40m or more (for example, at new bridge or tunnel structure).
  - Trial pits must be form 2.0m up to 2.5m depth.

- For the alignment, the trial pits and boreholes shall be executed at maximal distances of 300-500m along the railway route.
- For new bridge structures at least one borehole per 2 piers foundation must be execute.
- For new tunnel at least 2-3 boreholes (2 at portals and 1 at the middle if it is possible).
- For new retaining walls, foreseen number of boreholes depending on the length is as a minimum as follows:
  - 1 borehole to the required depth for the length of the wall up to 50m,
  - 2 boreholes to the required depth for the length of the wall of 50-100m,
  - 3 boreholes to the required depth for the length of the wall of 100-200m,
  - 4 boreholes to the required depth of 200-300m length of the wall.
- At the location of box culvert, at least 1 borehole to the required depth is foreseen.
- For each borehole the following activities must be conducted:
  - detailed engineering- geological mapping of the core;
  - measuring the existence and level of groundwater;
  - carry out permeability test, depending on the nature of the soil encountered.
  - sampling of soil for geotechnical laboratory testing, such as: disturbed samples of the base material (at least 1 sample every 3m) and undisturbed samples (at least 1 sample every 5m), depending on the characteristics of the terrain under investigation;
  - Install piezometer instrumentation for water table monitoring.

2.2.4 On-site testing

During the drilling of each borehole, the Consultant will execute:

- Standard Penetration Test (SPT) minimum every 3-5m of drilling in each borehole.
- Cone Penetration Test (CPT) at the foundation of new bridges.

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

2.2.5 Geoelectrical and seismic refraction investigation

Consultant will conduct Vertical Electrical Sounding (VES) and seismic refraction surveying along the alignment and in adjacent areas. These investigations need to be perform on tunnels and other inaccessible locations which will be prescribed in layout.

2.2.6 Existing tunnels

There are three tunnels on the railway: "Grdelički" (L= 170m), "Letoviški" (L= 483m) and "Hanski" (L= 402m). For tunnel rehabilitation/reconstruction, geotechnical investigations should be carried out which are related to determining the thickness and strength properties of the tunnel lining, as well as the composition and properties of the rock mass (soil) in the immediate damage zone:

- at the defined locations of damage to the tunnel, carry out research and testing of the concrete lining and rock mass by carrying out exploratory boreholes both laterally through the tunnel lining and vertically in the axis of the tracks. In the course of drilling, detailed geotechnical mapping will be carried out and samples will be taken from the lining and rock - soil for laboratory tests.

- laboratory geomechanically tests on rock or soil samples (uniaxial strength, tensile strength, volumetric mass, dynamic modulus of elasticity - for rocks; granulation, humidity, plasticity, compressibility, direct shear - for soil)

- carry out mapping, i.e. creation of a developed profile of the tunnel where all locations where the tunnel lining has leaked, the appearance of cracks and degradation of the tunnel will be mapped.

2.2.7 Laboratory activities

In order to define the physical and mechanical characteristic of soil in and on which the railway will be built (with structures along the railway), samples taken during the investigation boreholes and investigation excavation trial pits (disturbed and undisturbed) will be analysed and tested by the Consultant through geotechnical testing. These services shall include the following:

- Classification and identification investigations test of soil (volume, density, humidity, plasticity and consistency, granulometry, organic and combustible substances, permeability, etc.)

- Investigation of Aggressiveness and Water Chemistry

- Unconfined compressive strength of soil

- Direct shear test (CD - slow test) with five loads levels

- Direct shear test, residual strength investigations (R test)

- Oedometer stiffness test, with permeability and consolidation coefficient determination

- Compaction and bearing capacity investigations, Proctor and CBR tests

- Uniaxial compressive load test
- Investigations on solid rock samples (w, γd, sc, Vp, Vs, E, D, v)
- Determination of rock tensile strength - indirect method (Brazilian test)
- Determination of the rock point strength of (point load test)

Standards according to which laboratory activities will be done: accreditation of SRPS EN 22475-1 or equivalent. The Service Provider's responsibility is to perform the laboratory activities in the manner which will ensure Positive report from State Revision Committee for the Geotechnical report (Elaborate).

In case the Service Provider does not possess such accreditation, they must in the Organization and Methodology include a statement confirming that they will apply for accreditation SRPS EN 22475-1 within 7 days after the Notification of Intention to Award. The receipt of the accreditation is the obligation and responsibility of the awarded Tenderer. All cost for obtaining such accreditation will be borne by the Tenderer.

2.2.8 Accreditation and certification

All testing shall be carried out at laboratories that are experienced and accredited in performing such tests. Copies of laboratory registration or certification to perform certain tests shall be provided to the Consultant where applicable.

The laboratory must be accredited to perform tests according to the following standards:

- Visual and engineering classification (SRPS EN ISO 14688-1:2018, SRPS EN ISO 14688-2:2018)
- Moisture content (SRPS EN ISO 17892-1:2015)
- Saturated volume and density (SRPS EN ISO 17892-2:2015, SRPS EN ISO 17892-3:2016)
- Particle size distribution, Sieve analysis and hydrometric analysis (SRPS EN ISO 17892-4:2017)
- Organic and combustible substances (SRPS U.B1.024:1968)
- Liquid limit, plastic limit and plasticity index (SRPS EN ISO 17892-12:2018/A1:2022)
- Proctor compaction test (SRPS EN 13286-2:2012)
- Permeability tests (SRPS EN ISO 17892-11:2019)
- Unconfined compression test (SRPS EN ISO 17892-7:2018)

- Direct shear test (SRPS EN ISO 17892-10:2019) with 5 level of stress levels
- Direct shear test including residual strength (SRPS EN ISO 17892-10:2019)
- Oedometer stiffness test with permeability and consolidation coefficient determination (SRPS EN ISO 17892-5:2017)
- CBR laboratory tests (SRPS EN 13286-47:2022)
- Uniaxial compressive load test (SRPS B.B7.126:2020)
- Investigations on solid rock samples (w, γd, sc, Vp, Vs, E, D, v) - SRPS B.B8.121:1990, SRPS B.B7.113:1993
- Determination of rock tensile strength - indirect method (Brazilian test) - SRPS B.B7.127:2020
- Determination of the rock point strength of (point load test) - ASTM D 5731
- Investigation of Aggressiveness and Water Chemistry (Concrete - Specification, performance, production and conformity - Aggressiveness of natural soil and groundwater on concrete - SRPS EN 206:2021)

2.3 Technical Specifications

2.3.1 Mobilization and demobilization

The Service Provider will have to bring drilling and excavation plant to the site, including all drilling and operational plants, water pumps for providing water to the drills form the river, equipment and vehicles, demobilization and leaving the site in a clean and tidy condition.

The mobilization price includes clearing and preparation of construction site, maintenance and final reinstatement, in particular bush cleaning on projected working area when necessary.

The mobilization price will be paid upon submission of the Mobilization Report including photo documentation and relevant proofs of completion.

2.3.2 Accessibility to the investigation points

The Service Provider shall construct and maintain the temporary access roads off the public road network to the site that he deems necessary for the field investigations. The access is dedicated for his field activities and the Consultant’s use.

The Service Provider will secure access to all investigation points locations irrelevant on the ownership of it. In case of difficulties Service Provider will timely inform Consultant to propose alternative solutions.

All costs associated with the construction of accesses including obtaining permits, payment of compensations, construction, maintenance and final reinstatement are deemed to be included within unit rates of the field services and will not be subject to separate payment.

2.3.3 Boreholes

All drilling operations shall be performed on field in a manner complying with accepted practice by skilled staff, conversant with such specific investigation services. The Service Provider shall provide the sites, with recent drilling rig (rigs) fitted with conventional systems, and equipped with all the necessary accessories, tools, rods, casings, in order to meet all requirements.

Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15 cm above the borehole bottom.

In case of cohesionless soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.

The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned b using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

In each borehole a SPT test must be execute (see chapter 2.3.10 Standard Penetration Tests (SPT))

The Consultant will decide the termination criteria for each borehole. The Service Provider may be required to terminate a borehole earlier than the depth given at the commencement of the hole, or extend the borehole beyond that depth if, in the opinion of the Consultant, geological conditions warrant this.

On completion of the drilling, Service Provider shall backfill all boreholes as directed by the Consultant.

If requested by the Consultant the logged image and borehole size (or trial pits) shall be available in preliminary form within 72 hours from test execution.

Drilling in soil

Boring in soil strata shall be carried out by shell and auger, or percussion tools or by method approved by the Consultant. In any case the method for boring used shall be such as to bring to the notice of the field operator, any change in stratum, within the accuracy of 100 mm. Also rigs shall be capable of boring to required depth. The Service Provider shall indicate with his bid the method of boring to be adopted by him, if the Contract is awarded to him. Casing and/or Bentonite/ mud slurry may be used to avoid caving. However, for those boreholes where water samples are to be collected for chemical analysis or field permeability tests are to be conducted, bentonite/ mud slurry shall not be used or shall be restricted as directed by the Consultant.

In boring particularly through cohesion less and dry soft to medium stiff clay strata, the Service Provider shall take every precaution to avoid unnecessary disturbance to the soil including ensuring that:

- the net hydraulic head at the bottom of borehole is zero or slightly on positive side within the borehole;
- close-fitting tools such as bailer shall be withdrawn slowly to avoid suction pressure.

The diameter of the boreholes shall be such as to permit collection of undisturbed samples of 90 to 100 mm diameter. In order to meet these requirements, rotation exploratory drilling should be executed with the diameters Ø 116 - 146 mm. Borehole diameter shall not exceed 150 mm unless approved by the Consultant prior to commencement of such services.

Where a borehole is being cased, the bottom of the casing shall always be maintained within 150 mm of the bottom of the borehole, till a stratum is reached where a casing is not required. However, the casing shall never be in advance of the bottom of the borehole during undisturbed sampling, standard penetration tests, and other in-situ test.

If any obstruction to normal boring is encountered in any borehole, this obstruction shall be overcome by drilling and/or by chiselling. Chiselling will normally be paid at the contract rate for boring in soil at appropriate depths, unless a separate rate has been provided for in the Contract.

Drilling in rock

In rock strata, boring shall be done by using a rotary cutting tool tipped with diamonds and equipped to recover cores. All rock drillings should be used double tube core barrel and diamond bits. Minimum diameter of the sample depends on the condition and composition of the rock and should not be less than 76 mm in rock with discontinuities unless otherwise instructed by the Consultant.

Core barrels shall normally be double-tube ball-bearing, swivel type, with the core lifter located in the lower end of the inner barrel.

Drilling shall be carried out in such a manner that maximum core is recovered. Drilling in soil or rock will be carried out with the aim of approaching 95 - 100 % of core recovery. This requires close surveillance of wash water, drilling pressures, lengths of runs etc.

The drill bit shall be withdrawn and the core removed as often as may be necessary to secure the maximum possible amount of core. The Service Provider shall ensure that drilling is carried out with necessary skill and expertise.

Coring runs shall be limited to a maximum length of 3.0m. When less than 50% of the core is recovered from a run or when a geological feature is to be accurately determined, the length of the run shall be reduced to 0.3 - 0.50 m unless directed otherwise by the Consultant.

If core recovery is less than 20 per cent, the payment for drilling shall be same as that for boring in soil at appropriate depths.

The core shall be removed from the drillhole immediately if blocking of the bit or grinding of the core is apparent, regardless of the length of run which has been made.

The Service Provider shall not use drilling mud or any lubricant in the drillhole other than water.

The ease or difficulty of drilling at different depths shall be carefully noted and recorded during drilling. The returning drill water shall be kept constantly under observation and its character, such as, its clarity or its turbidity, its colour, etc. shall be recorded.

For each run, Core Recovery and Rock Quality Designation (RQD) shall be noted carefully, immediately after cores are taken out of the barrel.

Each and every core piece shall be serially and sequentially numbered from top downwards as soon as the core pieces are removed from the core barrel. The serial number shall be painted with good quality enamel paint.

Geological mapping should be performed immediately after each drilling maneuver to record the rock mass properties in their natural state. Important geotechnical properties of certain rock are: condition (cracking or crushing and weathering), composition (texture), hardness, and deformation properties. These characteristics can be determined by examination and laboratory tests of the appropriate samples.

Parts of the core for undisturbed samples shall be tightly sealed and so handled as to prevent changes in the sample.

All core pieces shall be placed in core boxes in serial order in correct sequence from top downwards.

The sample shall be handled so that damage to soil or rock is preventative. with no vibrations and no significant temperature changes

Colour photographs of the cores on putting in core boxes shall be take. Cost of these shall be included in drilling rate.

Expert documentation on the borehole for tests of the soil includes documents on:

- Drilling
- Visual inspection
- Tests in the borehole
- Laboratory tests for identification and classification and
- Geotechnical profile of the borehole

Documentation on drilling is kept by the implementer of drilling. Documentation must contain data on: Location: facility, marking, coordinates of the borehole, Drilling machinery and tools, drilling liquid: type, composition, density, and viscosity, Borehole: diameters, depths, protective tubes, Core: sampling interval, % of the core, Samples: marking, depth, sampling method, Measurements in the borehole: type and point of measurements, Drilling parameters, Findings during drilling: loss of drilling liquid, caverns, layer fluids occurrence and, Ground water level if the drilling technology enables it. Drilling parameters depend on the drilling method. In rotation drilling these is: weighing of the drilling tool, Rotation speed, Pressure and flow of drilling liquid and Drilling advancement

Visual examination of the core, fragments, and samples shall be performed by suitably trained workers having appropriate knowledge in geology.

When preparing the geological geotechnical profile of the borehole, data from all specified documents shall be taken into account.

Groundwater observations

The observation of ground water level for all types of boreholes shall be made with a tape, rod, rule or diameter that permits measurements with an accuracy of plus or minus 25 mm. The groundwater levels shall be reported in the borehole logs. The groundwater level shall be recorded as the last operation of the day and the first operation on the following day's boring. The duration of rainfall for the last 12 hours should be recorded. The recordings shall be repeated daily while boring for that particular borehole is in progress.

For boreholes advanced without use of drilling fluid and when water is first encountered, the depth from ground level to point of entry shall be recorded and exploratory hole operations stopped. The depth from ground to water shall then be recorded at 5-minute intervals until no further rise is observed. However, if at the end of the period of 20 minutes the water level is still rising, unless otherwise instructed by the Consultant, this shall be recorded together with the depth to water below ground level and the exploratory hole shall be continued.

If casing is used and this forms a seal against the entry of groundwater, the Service Provider shall record the depth at which no further entry or only insignificant infiltration of water occurred. Where applicable every effort shall be made to seal off each water strike.

Where ground water occurs as a slow seepage into the exploratory hole, the point of entry of the seepage shall be recorded and water levels monitored as specified above.

Weather Record

The Service Provider shall keep a weather record of the site for the whole duration of the field services.

2.3.4 Trial pits

Trial pits shall be excavated for visual examination of sub-surface strata and for use as test pits for conducting plate load test. Trial pits must be from 2.0m up to 2.5 m deep and excavation shall be done such that side slopes are safe.

As the excavation proceeds, the Service Provider shall generously conduct pocket penetrometer tests in cohesive strata, covering the entire depth of pit. These test values shall be recorded.

All four walls of the pit shall be logged in detail. Level of each strata interface shall be recorded at each pit corner. Any non-uniform interface change along the wall shall be noted. Each wall shall be identified with respect to compass direction of the wall face.

On conducting all the required tests within the test pits and after making and noting all the required observations the pit shall be backfilled using the excavated material. Backfilling shall be done in layers not exceeding 200mm.

The inspection pits and trial pits shall be backfilled as soon as practicable after they have been completed. The Service Provider shall backfill and compact the pits with the excavated materials in such a manner that no subsequent depression is formed at the ground surface due to settlement of the backfill.

2.3.5 Geological surveying of boreholes and trial pits

During borehole drilling and trial pits excavation, detailed structural geological and hydro-geological mapping is also required, with photo shooting of the cores and pits.

The interpretation of the logged data is also required which consists in the full analysis of the images with the identification of the discontinuities or voids position, and measurement of their orientation, width and filling condition. The final log will include:

- Continuous mapping of the boreholes and trial pits with indication of the discontinuities or layer position;
- Columns with discontinuities frequency, depth, orientation and characteristics, soil plasticity, consistency, etc.;
- Stereographic plot of the discontinuity planes on a Schmidt net;
- Borehole direction and inclination.

The log will be delivered in hard and digital copy of each log.

2.3.6 Sampling

Method and frequency of sampling shall depend on the purpose or nature of structure for which the borehole is required. The purpose of each borehole shall fall into the following main categories:

- Road Alignment
- Cuttings
- Embankments and shallow structural foundations
- Major Structures (bridges, tunnels, culverts, walls, etc.)
- Cut/fill interface
- Landfills/ borrow pits

In addition, at any major change of soil type or consistency a small disturbed sample shall be taken followed immediately by an undisturbed, bulk disturbed or split spoon sample as appropriate.

Core barrels shall be held horizontally whilst cores are extruded, which shall normally be by applying a constant pressure, without vibration or hammering and in a manner to prevent disturbance of the core.

Selected lengths of soil core shall be coated in suitable paraffin wax so as to preserve the natural moisture content of the soil samples and shall be wrapped in plastic to protect the coating. The selected samples, dispatched to the laboratory for testing, shall be recorded on the borehole log. The cores shall be secured in the correct order in stout wooden boxes (hole number, box number), clearly marked, with lids and suitable partitions. They shall be stored on the site in a weatherproof shed.

The Service Provider will be responsible for the safe keeping of all cores until the end of the Project.

Disturbed Sampling

Small disturbed samples may be obtained by any means provided that the soil sample obtained is representative and unchanged in its constituent components. Samplers with flap retainer or basket retainer or other attachment may be necessary for cohesionless soils. Small disturbed samples shall be not less than 1.0 kg. They shall be placed immediately in a wide-mouth, air-tight screw-top clear plastic jar which they should sensibly fill and sealed with a masking tape and non-shrink wax.

Bulk disturbed samples shall be obtained from the cutting tools during percussion boring. The samples shall be collected over a depth interval of 1. 0m or less and shall weigh not less than 30 kg.

Undisturbed Sampling

Before taking an "undisturbed" sample the bottom of the exploratory hole shall be carefully cleared of loose material and where a casing is being used the sample shall be taken below the bottom of this casing. The depth to the bottom of the casing shall be recorded on the borehole logs. When an uncompleted hole is left overnight or for any other substantial period of time, no samples shall be taken until the hole has been advanced by a minimum of 300 mm from the previous depth.

All tubes used for undisturbed sampling shall be of light alloy, stainless steel or with an equivalent surface plating for corrosion protection and shall be clear and free of all surface irregularities including p weld seams, dents, and rust and should be properly greased. Sample tubes that are corroded or susceptible to corrosion shall not be used.

The following tubes for undisturbed sampling could be used: open – tube drive samples, thin-walled samples, piston sampling, etc.

Open-tube drive samples shall generally be taken in stiff to hard cohesive soils in cable percussion borings using open-tube sampler. The sampler shall be suitable to obtain samples having minimum diameter of 70 mm and a minimum length of 450 mm.

Thin-walled samples shall generally be taken in soft to firm soils. The tube shall be suitable to obtain samples minimum diameter of 70 mm and nominal length of the tube shall be 1000 mm.

Piston Sampling is used for detailed investigation of soft cohesive soils. The minimum inside diameter of the tube shall be 70 mm and the nominal length of the tube shall be 1000 mm. Wall thickness shall be between 1.5 mm and 2.0 mm.

A waiting period of at least 5 minutes shall elapse before the complete sampler is removed from the borehole. The sampler shall be lifted without rotation.

After withdrawal of the sampler from the borehole the sample and tube shall be removed from the sampler. The air vent screws shall be removed to ensure that there is not any vacuum created as the sampler head and sample tube are separated.

Until the samples are removed from the site they shall be placed in protective boxes in a dry place.

Where an attempt to take an undisturbed sample fails, the boring shall be cleaned out for the full depth to which the sampling tube has been driven and the recovered soil saved as a disturbed sample. A fresh attempt shall then be made from the level of the base of the failed attempt.

Approximately 1.0 litre of water should be collected and stored in a clear inert plastic bottle, rinsing the bottle three times with the water being sampled before filling. The ground water sample shall sensibly fill the bottle which shall be sealed with a watertight screw cap. Water samples should be collected at least 24 h after end of standpipe drilling, i.e., after settling down of groundwater level.

Water samples shall be also taken from streams, ditches or standing water as directed by the Consultant. The samples taken shall be representative of the water in the source.

Sampling from Trial Pits

From the trial pits small disturbed samples of not less than 1 kg shall be taken at each change in soil type, change in consistency or as instructed by the Consultant. They shall be placed immediately in air- tight containers which they should sensibly fill.

Bulk disturbed samples of not less than 30kg shall be collected over a depth interval of 0.5 m at specified depths or as instructed by the Consultant. The samples collected shall be representee of the zone from which they have been taken.

In association with the bulk sampling, two separate samples of not less than 0.2 kg each shall be taken for natural moisture content determination and shall be collected, preserved and stored as disturbed samples in accordance with Clause 2.2.6.

Labelling of Samples

All samples shall be labelled immediately after being taken. The label shall be clearly and indelibly marked and shall show all the necessary information about the sample, including the following: contract title and reference number, date of sampling, borehole or trial pit reference number (for surface water, give relevant details), sample reference number, depth of sample (including top and bottom of sample), type of boring, core sampling, type of sample taken (disturbed or undisturbed), etc.

The label shall be securely fixed onto the outside of the sample tube, jar or bag. The outside of the sample tube, jar or bag shall also be clearly and indelibly marked with the same information as the label.

The Service Provider shall store all samples in an orderly fashion at site in protective boxes in a dry place until they are despatched to the designated laboratories or as directed by the Consultant.

The thin-walled, stationary piston and Mazier type undisturbed samples shall be stored, protected and transported with utmost care to avoid disturbance to the samples. They shall be placed and transported in approved shipping containers.

The shipping container shall be constructed such that they are padded throughout with rubber foam and contain partitions to stop the sampler tubes from moving in any direction during transporting to the laboratory. The rubber foam lining shall have a minimum uncompressed thickness of 100mm.

The container shall be capable of accommodating a minimum of three undisturbed samples and shall be of strong construction with carrying handles. Prior to the commencement of site services, the Service Provider shall submit a sample of the shipping container for approval.

During transportation all undisturbed samples shall be protected in the same manner as during storage on site.

2.3.7 In- situ California Bearing Ratio (CBR)

The in-situ California bearing ratio (CBR) test is typically used for road, runways or car park pavement design to assess the strength of the sub-grade. The test involves driving a cylindrical plunger of a defined area into the soil at a uniform rate. This requires the use of a reaction load, (for example, a four-wheel drive vehicle or mechanical excavator), to provide the force.

In-situ CBR Test Apparatus is used to determine quickly and efficiently the bearing capacity of soils on road constructions, foundations, road subgrades.

The test is carried out by one technician using small, hand-operated, vehicle-mounted equipment. A hardened steel plunger is inserted into the test surface at a constant rate of penetration and the applied stress is measured. Load is applied through a mechanical jack and handwheel. Upper beam can be adjusted in height.

The set consists usually of:

- mechanical jack with ball seating
- load ring
- Analog penetration dial gauge
- Adjustable dial gauge holder
- CBR Penetration piston
- Set of extension rods
- Datum bar assembly with two stands
- 4.5 kg annular surcharge disc
- 4.5 kg slotted surcharge discs (2 pcs.)
- 9 kg slotted surcharge discs (2 pcs.)
- Vehicle bracket
- Wooden carrying case

The test should be performed according to SRPS EN 13286-47:2022. Alternatively, a profile of equivalent in-situ CBR can be measured using the dynamic cone penetrometer (DCP).

2.3.8 Plate bearing test

Plate bearing test shall be conducted in trial pits at location designated. This test is used to investigate and test the load-settlement characteristics of a soil.

The test plate shall be square of size not less than 300 x 300 mm or 600 x 600 mm. Size of the pit shall be at least 5 times the plate size.

Initially the pit shall be excavated to a depth of about 300 mm above proposed depth of testing. The final 300mm shall be excavated only after all kentledge has been placed in position and the Service Provider is about to set up the plate and jack assembly.

It is carried out by one technician using a steel plate and a hydraulic jack. The jack pushes against a kentledge such as the underside of a mechanical excavator. The vertical deformation of the ground under load is assessed by measuring the settlement of the plate over time under different applied loads.

The test should be performed according to SRPS U.B1.046:1969 Determination of compression modulus by circular slab method.

2.3.9 Penetration Field Vane Test

The vane shear test is an in-situ testing methods used to estimate the undrained shear strength of fully saturated clays without disturbance. The test is relatively simple, quick, and provides a cost-effective way of estimating the soil shear strength; therefore, it is widely used in geotechnical investigations.

The vane shear test apparatus consists of a four-blade stainless steel vane attached to a steel rod that will be pushed into the ground. The height of vane is usually twice its overall widths and is often equal to 10 cm or 15 cm.

A typical vane shear test kit usually contains the following items:

- Torque wrench
- Drive head
- Extension rods,
- Spanner for extension rod
- or 3 Vane sizes.
- Transport Case

The test can be conducted either from the ground surface or from the bottom of a borehole or a trial pit. If conducted from the bottom of a bore hole, the test area should be should be at the

depth of least three times the borehole diameter lower that the borehole bottom in order to avoid the borehole disturbance effects.

The test starts by pushing the vane and the rod vertically into the soft soil. The vane is then rotated at a slow rate of 6° to 12° per minute. The torque is measured at regular time intervals and the test continues until a maximum torque is reached and the vane rotates rapidly for several revolutions.

At this time, the soil fails in shear on a cylindrical surface around the vane. The rotation is usually continued after shearing and the torque is measured to estimate the remoulded shear strength.

The penetration field vane test shall be carried out at locations and suitable intervals or as instructed by the Consultant in accordance with SRPS EN ISO 22476-9:2020 and shall comprise the measurement of peak and residual vane shear strength without the use of a borehole. The apparatus shall be calibrated immediately before use on site.

2.3.10 Standard Penetration Tests (SPT)

This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil satisfaction by correlating with the number of blows required for unit penetration of a standard penetrometer. SPT test is performed in each borehole at every 3-5m of drilling.

Structure sensitive engineering properties of cohesive soils and silt such as strength and compressibility shall not be inferred based on SPT values.

The spacing between the levels of standard penetration testing and next undisturbed sampling shall not be less than 1.5 – 2.0 m (1.0 m), equipment's, accessories and procedures for conducting the test and for the collection of the disturbed soil samples shall conform to SRPS EN ISO 22476-3:2011/A1:2014 Standard penetration test - Amendment 1.

The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of a 650 N hammer having a free fall of 0.75m. The sample shall be driven using the hammer for 450mm recording the number of blows for every 150mm. The number of blows for the last 300mm drive shall be reported as N value.

This test shall be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labeled.

2.3.11 Cone penetration test (CPT/CPTu)

CPT shall be carried out at the indicative locations provided along with this Technical Requirements as shown on Annex 3, using a mechanical friction cone in accordance with SRPS EN ISO 22476-1:2014 Part 1: Electrical cone and piezocone penetration test, SRPS EN ISO 22476-12:2011 - Part 12: Mechanical cone penetration test (CPTM) and shall comprise the measurement of cone resistance and local friction.

The equipment shall follow the requirements of SRPS EN ISO 22476-1:2014 Part 1: Electrical cone and piezocone penetration test, SRPS EN ISO 22476-12:2011 - Part 12: Mechanical cone penetration test (CPTM), with the additional requirement that the cone shall have a tapered mantle similar to the mantle cone. A friction reducer shall be used for all tests.

The Service Provider shall use the load cell and gauges most suitable for the soils penetrated. If necessary, during a test the load cells shall be changed to suit the type of material penetrated.

The capacity of the jacking equipment and the amount of available reaction shall be sufficient to fully utilise the full capacity of the specified cone.

Calibration of the load cells shall be carried out no more than 6 months before the start of site services.

Permitted tolerances on equipment dimensions shall be as given in standards. Permitted tolerances on load cells shall be plus or minus 5% of the measured value.

2.3.12 Standalone pipe

In order to measure ground water level oscillations, in some investigation boreholes, standard standpipes are to be installed. The standpipes is made of PVC tubes with slotted perforation, filter mesh, granular material and bentonite seal, protective concrete block and removable cap.

Standpipes shall consist of a minimum 25mm internal diameter UPVC tube with minimum thickness of 2mm with an end cap and slotted or perforated over its lower end. The slots or perforations shall be at least 1.5mm wide, and evenly distributed over the slotted or perforated part of the tube to provide a minimum open area of 30% of the total circumferential surface by the Consultant. The slotted part of the tube shall be wrapped with filter fabric as approved by the Consultant. The length of the slotted portion shall be 3m minimum.

The standpipe shall be placed in the borehole, backfilled with graded filter sand (600 to 2000 micron) up to 1.0m below ground level. The top 0.5m (min.) of the borehole shall be sealed with a concrete plug and subsequent 0.5m (min.) depth sealed with bentonite pellets or with an approved bentonite cement grout. The top of the standpipe shall be covered by a plastic cap or similar as approved by the Consultant.

Before taking initial readings, the Service Provider shall stabilise the standpipe by alternately baling and filling at least five (5) times unless otherwise directed by the Consultant. The Service

Provider shall then carry out a simple falling head test by topping up the riser tube with clean water and measure and record the fall in the head of water for a period not exceeding 30 minutes.

Depth from the top of the riser tube to water in the standpipe shall be measured using a dipmeter. The dipmeter shall be of the electric type, but simple metal probes attached to nylon cord may be used for shallow depths. Where piezometer buckets are installed, water levels in the piezometer buckets shall also be recorded.

The piezometer tip shall consist of a porous ceramic element or other element not less than 150mm long with a diameter not less than 40mm, and shall be protected at each end by unplasticized polyvinylchloride (UPVC) fittings.

A grout of cement and bentonite shall be used. Unless otherwise approved by the Consultant, the grout shall consist of 4 parts of bentonite mixed with 10 parts of water to which is then added 1 part of Ordinary Portland Cement.

The ground water level shall be recorded immediately before and after installation of the piezometer. Before readings are commenced the piezometer shall be filled with water and its correct functioning demonstrated to the Consultant. Each piezometer shall be clearly and permanently labelled with a metal stamp or tag giving the exploratory hole number.

The Service Provider shall be responsible for the correct installation, and proper functioning and maintenance of all standpipe's installation throughout the duration of the services.

The Service Provider shall monitor the water levels in the installed standpipes at least once daily.

2.3.13 Geophysical survey

The extent of the geophysical investigation and the choice of equipment should take account of the type, size and area of the development, the range of foundation options and the uniformity and type of rock and shallow soils conditions likely to be encountered.

The geophysical investigation should provide relevant information on all geohazards, water depths and the shallow soils and geology over the area to be surveyed to a depth below which the underlying conditions will not influence the safety or performance of the structures being considered. In interpreting the results, existing insights into the composition and structure of the terrain were taken into account.

The data obtained from geophysical surveying tests are very reliable if verified by borehole drilling and if the results of the measurements are interpreted by an experienced staff.

Geoelectric surveying

The principle of the geoelectric method is based on an electrical resistivity survey which operates as follows: an electric current is induced in the structure by means of contact metal electrodes into the ground, regularly arranged along a linear profile (current electrodes A and B located outside), and the apparent resistance of the soil is determined from the resulting potential difference at the measuring voltage electrodes (voltage electrodes M and N). The current strength between the current electrodes is measured, so that the apparent resistance is determined by the difference of potentials between the potential electrodes, by the constant of the geometric relationships of all the electrodes. The interpretation determines the thicknesses and specific electrical resistances of particular geoelectric environments. In practice, this method is most commonly used to determine changes in resistance with depth.

This current invokes an electric field. Consequently, using other contact electrodes, the electric potential is measured in the neighbourhood of the actual path of electric streamlines. The current as well as the electric potential data are recorded and stored. Whenever there are inhomogeneities or changes in transmission of electric current beyond the surface, there will be a change of the electric streamline distribution. This causes an alteration of the electric potential distribution, which delivers information on the inhomogeneous state of the medium.

Geoelectric sounding is required to be performed using the standard Schlumberger symmetrical arrangement of A MN B electrodes. The maximum distance of current electrodes was AB/2 =100, 200 or 300 m, which allowed reliable interpretation to depths of about 100 m.

Seismic Refraction Surveying

Seismic refraction surveys shall be conducted in order to determine the elastic characteristics of lithologic terrain members, the thickness of the overburden and the depth to weathered and sound rock horizons, by measuring the propagation velocities of refractive sound elastic waves. The seismic survey shall be capable of extending to depths of up to 50 – 100 m. P-waves and S-waves should be recorded.

The test is usually performed with suitable number of ignition points (elastic wave sources, usually five). A mechanical device was used as the source of the elastic waves. The advantage of this apparatus is the fact that signals can be collected on the screen, and the operator has the ability to select and record on the disk more secure wave findings, which later allow them to be read and processed with appropriate processing software (programs). The shot sourse is connected to an apparatus - a seismograph, which amplifies and captures oscillations. During recoding of oscillation, times of occurrence of longitudinal and transverse waves relative to the beginning of the measurement 0 (ms) is denoted in (ms) milliseconds.

The ignition points - shot source could be explosives, hammer or falling weight; the recorder stacks the first arrivals.

In case of national restriction regarding the use of explosives, a weight drop of heavy hammer is supposed acceptable for the refraction profiles. To avoid any doubts, the Service Provider shall be responsible to obtain the authorization from the local and relevant authorities for handling, operating, and storage of the explosive materials for the Seismic refraction surveys. The handling, operation, and storage of explosive materials shall be under full responsibility of the Service Provider.

The interpretation report contains all raw data acquired during the field services, the body wave's velocity profiles and the interpreted profiles. Automatic interpretation is allowed, but only in addition to prior manual body waves velocity profiles interpretation. Raw data will be furnished is soft copy annexed to the final report.

2.3.14 Laboratory tests

Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the services.

The Service Provider will select a laboratory to carry out the analysis and tests of soil and rock samples from the project area. It shall be checked that the apparatus is in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory.

All laboratory testing shall be carried out at laboratories that are experienced and accredited in performing such tests. Copies of laboratory registration or certification to perform certain tests shall be provided to the Consultant where applicable. The standards the laboratory intends to use will be submitted to the Consultant in advance for approval prior any laboratory testing. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant SRPS, EN ISO, or relevant codes. One copy of all laboratory test data records shall be submitted to Consultant progressively every week. A schedule of laboratory tests shall be established by Service Provider to the satisfaction of the Consultant within one week of completion of the first bore hole.

It may be necessary to specify additional testing after the results of the original testing are available. The Service Provider shall therefore ensure that the portions of samples remaining after extraction of test specimens are properly resealed and stored.

All test samples taken from the project site will remain the property of the Consultant and shall be handed over to the Consultant after testing, together with suitable identification and protection.

All samples, whether undisturbed or disturbed shall be extracted, prepared and examined by competent personnel properly trained and experienced in soil sampling, examination, testing and in using the apparatus in conformance with the specified standards.

While extracting a sample from a liner or tube, care shall be taken to assure that during sampling stress reversal is avoided, breaking, or any other disturbance.

Independent laboratory testing may be carried out by the Consultant and for this purpose the Consultant reserves the right to instruct the Service Provider to send samples to an independent laboratory for testing

The Service Provider will provide prices for the total estimated quantities of services according to the unit rates given in his offer, which shall be paid on actual basis.

The prices for laboratory tests shall include sampling, transport to the laboratory, testing follow-up and reporting. The unit rates for the tests will also be given by the Service Provider to cover the need for extra services. These rates for additional tests shall cover all possible efforts and expenditures by the Service Provider in the procurement of the test results. The Service Provider shall plan and coordinate the tests in an efficient and effective manner that will not negatively impact the progress of the services resulting in delays for the overall schedule of the services

Service Provider shall execute investigation tests on undisturbed, disturbed and rock samples and water samples also. All test must be performed regarding the relevant standards (see chapter 2.2.8 Accreditation and certification)

3 REPORT ON GEOTECHNICAL INVESTIGATIONS

Service Provider shall prepare separate Geotechnical investigation reports (Elaborate in compliance with Law on planning and Construction and subsequent bylaws) for each sub-section (A, B and C), and one Final report which will be cumulative report of all sections for submission to the State Revision Committee.

Geotechnical report (Elaborate) will be considered approved upon issuing Positive report from State Revision Committee.

Geotechnical documentation should include:

- Layout of all performed investigations and tests, and the results of all performed investigations and testing in accordance with approved standards;
- Geological structure of the terrain along the alignment, location and distribution of lithological elements showing their physical and mechanical parameters;
- Geotechnical characteristics of the terrain and lithological elements in the terrain;
- Features of hydrogeological terrain (showing the groundwater level);
- Geoelectric conductivity of the soil in the natural and the most adverse ground conditions along the alignment of the railway;
- Presentation of the current state of the track substructure (and depending on its findings define geotechnical conditions for the reconstruction of the substructure of the railway or conclude that the substructure does not meet the quality and geometry requirements and that it should be removed and replaced);
- Definition of geotechnical conditions and recommendations for the design and construction of the substructure and all the structures along the alignment;
- Relevant geostatic calculations for the railway and structures;
- General layout of the area showing geological structure, existing and newly designed railway and the location of all the performed investigations and testing;
- Geotechnical longitudinal section along the alignment of the railway;
- Cross-sections through the substructure of the railway;
- Geotechnical cross-sections of the terrain in the area of the structures and graphical representation of all performed investigations and testing (boreholes, trial pits, CPT and SPT tests and geophysical measurements), as well as all the certificates of the performed laboratory geomechanically tests.

A geotechnical analysis of the geological formations along the route railway shall be performed, as well as report and analysis of eventual critical aspects related to the design activities. The Service Provider shall produce a geotechnical profile along the proposed route and a Geotechnical Report.

For the solving of each critical issues reported, such as slope stability, foundation design, soil settlements calculation, retaining walls, etc., single technical report shall be prepared, related to each specific earthworks/structure or to a typology of earthworks/structures.

Reports shall be provided in both Serbian and English languages.

4 TIMESCHEDULE OF THE SERVICES

The services are tentatively expected to be undertaken in the following time periods:

Field and Laboratory Services per section:

- Section A 5 months
- Section B 5 Months after receipt of instruction to commence.
- Section C 5 months

Submission of the following elaborates elaborate for Preliminary Design:

- Separate Geotechnical investigation report (Elaborate in compliance with Law on planning and Construction and subsequent bylaws) for each sub-section (A, B and C): two months after completion of Field and Laboratory Services for each section.

Final report which will be cumulative report all sections: one month after completion of the last section report. As part of his submission, Service Provider shall provide a services programme identifying the major tasks for each section, together with the key milestones.

Note: The time for execution of Investigative services on sectors A, B and C has been estimated based on the necessity that two drilling machines will be engaged in each section.

Annex 1- Indicative position of investigation services

All positions are approximate and may be adapted according to site access conditions and only after approval of the Consultant.

- Position of boreholes (Bo) along the railway are represented in the table 1.
- Position of boreholes (Bm) for bridge structure are represented in the table table 2.
- Position of boreholes (Bc) for culvert structures are represented in the table 3.
- Position of boreholes (Bt) for tunnel structures are represented in the table 4.
- Position of trial pits (TP) along the railway are represented in the table 5.
- Position of CPT test are represented in the table 6.
- Position of geoelectrical investigations is represented in the table 7.
- Position of seismic refractions are represented in the table 8.

Table 1Position and necessary depth of investigation services along the railway (perform SPT test in each borehole, at every 3-5m of drilling)

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bo-1	7571376.837	4778881.926	borehole	10	A
Bo-2	7576338.854	4773303.963	borehole	10	
Bo-3	7578520.927	4761820.911	borehole	10	
Bo-4	7583083.127	4754998.760	borehole	10	
Bo-5	7586804.967	4750647.654	borehole	10	B
Bo-6	7592714.623	4743780.756	borehole	6	
Bo-7	7592773.458	4743417.366	borehole	10	
Bo-8	7589881.364	4737814.292	borehole	10	
Bo-9	7589064.357	4734858.608	borehole	10	
Bo-10	7587445.633	4730098.140	borehole	10	
Bo-11	7586547.284	4726145.404	borehole	10	
Bo-12	7584333.912	4719451.094	borehole	10	C
Bo-13	7581017.515	4714184.568	borehole	10	
Bo-14	7576250.7	4710768.618	borehole	10	
Bo-15	7569789.606	4702868.649	borehole	10	
Bo-16	7561205.435	4698618.425	borehole	10	
Bo-17	7560814.929	4698169.49	borehole	26	
Bo-18	7560474.746	4697715.626	borehole	25	
Bo-19	7560127.742	4697252.969	borehole	10	
Bo-20	7559186.024	4693366.766	borehole	12	
Bo-21	7559181.355	4692816.578	borehole	11	
Bo-22	7559110.777	4691983.276	borehole	16	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bo-23	7558637.507	4689231.057	borehole	10	
Bo-24	7556659.364	4685816.046	borehole	10	
Bo-25	7556880.65	4684286.441	borehole	6	
Bo-26	7557737.339	4681801.568	borehole	10	
Bo-27	7557856.377	4680853.542	borehole	10	
Bo-28	7557845.225	4679682.961	borehole	12	
Bo-29	7557803.489	4679107.403	borehole	10	

Table 2 Position and necessary depth of investigation services for bridge structures (perform SPT test in each borehole, at every 3-5m of drilling)

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bm-1	7571595.71	4778651.84	borehole	25	A
Bm-2	7571971.68	4778152.13	borehole	15	
Bm-3	7573192.89	4776686.59	borehole	25	
Bm-4	7575020.18	4775227.57	borehole	25	
Bm-5	7575624.36	4774546.66	borehole	25	
Bm-6	7577334.52	4764010.3	borehole	20	
Bm-7	7577705.71	4763075.8	borehole	20	
Bm-8	7579557.17	4760121.69	borehole	15	
Bm-9	7582712.05	4755575.89	borehole	25	
Bm-10	7582757.17	4755469.86	borehole	20	
Bm-11	7583532.68	4754348.87	borehole	25	
Bm-12	7586081.14	4752010.5	borehole	25	
Bm-13	7587275.54	4750206.91	borehole	25	B
Bm-14	7588302.61	4749389.84	borehole	15	
Bm-15	7589105.56	4748720.87	borehole	25	
Bm-16	7590553.46	4748080.94	borehole	15	
Bm-17	7591829.57	4747128.77	borehole	15	
Bm-18	7592105.14	4746311.71	borehole	15	
Bm-19	7592252.08	4746235.79	borehole	25	
Bm-20	7592994.47	4744082.33	borehole	25	
Bm-21	7592812.88	4743336.54	borehole	15	
Bm-22	7591535.12	4741159.68	borehole	15	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bm-23	7591094.63	4740838.53	borehole	15	
Bm-24	7590596.86	4740442.92	borehole	15	
Bm-25	7589818.63	4739218.57	borehole	15	
Bm-26	7589956.01	4738097.93	borehole	15	
Bm-27	7589384.64	4736415.4	borehole	25	
Bm-28	7588774.68	4734510.35	borehole	20	
Bm-29	7587073.24	4732887.77	borehole	25	
Bm-30	7587193.17	4731578.91	borehole	20	
Bm-31	7587726.86	4730634.1	borehole	20	
Bm-32	7587284.87	4729863.88	borehole	15	
Bm-33	7587278.79	4728168.55	borehole	15	
Bm-34	7587212.67	4727383.35	borehole	15	
Bm-35	7586349.682	4724401.369	borehole	25	
Bm-36	7586078.741	4723917.56	borehole	15	
Bm-37	7585415.32	4721576.947	borehole	25	
Bm-38	7585126.501	4721042.77	borehole	25	
Bm-39	7584877.094	4720662.739	borehole	15	
Bm-40	7584141.806	4718745.666	borehole	15	
Bm-41	7583946.413	4718386.63	borehole	25	
Bm-42	7583455.993	4717862.447	borehole	25	
Bm-43	7583023.298	4716857.106	borehole	25	
Bm-44	7583021.65	4716644.396	borehole	25	
Bm-45	7583044.123	4716268.052	borehole	25	
Bm-46	7582933.296	4715679.603	borehole	25	
Bm-47	7582804.382	4715439.455	borehole	25	
Bm-48	7581702.496	4714683.75	borehole	25	C
Bm-49	7581316.086	4714486.481	borehole	25	
Bm-50	7580705.795	4713793.442	borehole	25	
Bm-51	7579166.094	4712738.229	borehole	25	
Bm-52	7578455.453	4712219.024	borehole	25	
Bm-53	7577214.576	4711441.153	borehole	25	
Bm-54	7575814.326	4710075.736	borehole	25	
Bm-55	7575713.773	4708615.954	borehole	25	
Bm-56	7575565.691	4708397.454	borehole	25	
Bm-57	7575079.539	4707928.818	borehole	25	
Bm-58	7573693.192	4707733.483	borehole	25	
Bm-59	7572603.383	4707088.025	borehole	25	
Bm-60	7571332.393	4705725.537	borehole	25	
Bm-61	7571089.986	4705347.193	borehole	25	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bm-62	7570613.403	4704341.027	borehole	15	
Bm-63	7570321.844	4703727.44	borehole	25	
Bm-64	7570025.467	4703228.274	borehole	25	
Bm-65	7569149.949	4702026.934	borehole	25	
Bm-66	7568610.045	4701636.77	borehole	15	
Bm-67	7566200.099	4701436.692	borehole	25	
Bm-68	7565632.837	4701247.226	borehole	25	
Bm-69	7564174.428	4700414.812	borehole	25	
Bm-70	7562815.563	4699721.936	borehole	25	
Bm-71	7562269.516	4699193.688	borehole	25	
Bm-72	7562147.95	4699123.231	borehole	25	
Bm-73	7559488.261	4696195.18	borehole	15	
Bm-74	7559280.397	4695763.17	borehole	15	
Bm-75	7559203.768	4694961.392	borehole	20	
Bm-76	7559201.546	4692566.324	borehole	25	
Bm-77	7559052.339	4691731.535	borehole	25	
Bm-78	7558695.246	4689484.599	borehole	25	
Bm-79	7558385.659	4687816.569	borehole	25	
Bm-80	7557793.26	4687071.489	borehole	20	
Bm-81	7556576.578	4685135.07	borehole	20	
Bm-82	7556670.503	4684827.284	borehole	25	
Bm-83	7557694.653	4682166.26	borehole	25	
Bm-84	7557791.181	4677705.834	borehole	25	

Table 3 Position and necessary depth of investigation services for culvert structures (perform SPT test in each borehole, at every 3-5m of drilling)

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bc-1	7576076.815	4773798.823	borehole	10	
Bc-2	7581748.261	4756887.780	borehole	10	**A**
Bc-3	7583851.692	4753937.674	borehole	10	
Bc-4	7592858.535	4745313.664	borehole	10	
Bc-5	7592319.432	4742461.432	borehole	10	**B**
Bc-6	7591757.701	4741373.447	borehole	10	

Bc-7	7590305.771	4739852.431	borehole	10	
Bc-8	7590143.457	4739664.822	borehole	10	
Bc-9	7589844.168	4738367.280	borehole	10	
Bc-10	7589635.070	4737352.255	borehole	10	
Bc-11	7587042.691	4733125.917	borehole	10	
Bc-12	7587108.819	4727925.059	borehole	10	

Table 4 Position and necessary depth of investigation services for tunnel structures (perform SPT test in each borehole, at every 3-5m of drilling)

No.	X	Y	Type of investigation services	Depth of investigation services	Section
Bt-1	7591192.934	4747509.369	borehole	6	B
Bt-2	7587838.868	4734461.926	borehole	10	
Bt-3	7587452.864	4731129.544	borehole	6	
Bt-4	7587644.769	4730937.685	borehole	25	

Table 5 Position and necessary depth of trial pits along the railway

No.	X	Y	Type of investigation services	Depth of investigation services	Section
TP-1	7571798.816	4778363.903	trial pit	2.0 - 2.5	A
TP-2	7572287.514	4777764.771	trial pit	2.0 - 2.5	
TP-3	7572625.432	4777353.248	trial pit	2.0 - 2.5	
TP-4	7572923.280	4776992.058	trial pit	2.0 - 2.5	
TP-5	7573406.993	4776395.049	trial pit	2.0 - 2.5	
TP-6	7573761.634	4776045.094	trial pit	2.0 - 2.5	
TP-7	7574165.308	4775785.189	trial pit	2.0 - 2.5	
TP-8	7574619.783	4775505.206	trial pit	2.0 - 2.5	
TP-9	7575376.228	4774820.438	trial pit	2.0 - 2.5	
TP-10	7575894.949	4774130.812	trial pit	2.0 - 2.5	
TP-11	7576508.170	4772982.129	trial pit	2.0 - 2.5	
TP-12	7576687.574	4772554.026	trial pit	2.0 - 2.5	
TP-13	7576781.841	4772182.552	trial pit	2.0 - 2.5	
TP-14	7576883.762	4771777.088	trial pit	2.0 - 2.5	
TP-15	7576988.039	4771361.871	trial pit	2.0 - 2.5	
TP-16	7577062.377	4771028.881	trial pit	2.0 - 2.5	
TP-17	7577075.061	4770534.544	trial pit	2.0 - 2.5	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
TP-18	7577041.498	4770042.589	trial pit	2.0 - 2.5	
TP-19	7577011.885	4769589.803	trial pit	2.0 - 2.5	
TP-20	7576983.587	4769149.890	trial pit	2.0 - 2.5	
TP-21	7576949.565	4768652.455	trial pit	2.0 - 2.5	
TP-22	7576920.092	4768195.097	trial pit	2.0 - 2.5	
TP-23	7576893.073	4767801.716	trial pit	2.0 - 2.5	
TP-24	7576859.654	4767289.820	trial pit	2.0 - 2.5	
TP-25	7576835.238	4766931.503	trial pit	2.0 - 2.5	
TP-26	7576812.795	4766587.737	trial pit	2.0 - 2.5	
TP-27	7576801.333	4766081.774	trial pit	2.0 - 2.5	
TP-28	7576892.490	4765615.777	trial pit	2.0 - 2.5	
TP-29	7577024.069	4765136.988	trial pit	2.0 - 2.5	
TP-30	7577187.830	4764552.305	trial pit	2.0 - 2.5	
TP-31	7577278.982	4764211.928	trial pit	2.0 - 2.5	
TP-32	7577471.956	4763523.059	trial pit	2.0 - 2.5	
TP-33	7577973.120	4762628.728	trial pit	2.0 - 2.5	
TP-34	7578263.577	4762169.715	trial pit	2.0 - 2.5	
TP-35	7578724.981	4761438.906	trial pit	2.0 - 2.5	
TP-36	7578971.319	4761048.566	trial pit	2.0 - 2.5	
TP-37	7579226.770	4760644.561	trial pit	2.0 - 2.5	
TP-38	7579754.853	4759808.447	trial pit	2.0 - 2.5	
TP-39	7580006.025	4759412.625	trial pit	2.0 - 2.5	
TP-40	7580271.573	4758993.155	trial pit	2.0 - 2.5	
TP-41	7580596.202	4758500.026	trial pit	2.0 - 2.5	
TP-42	7581016.302	4757910.448	trial pit	2.0 - 2.5	
TP-43	7581296.046	4757517.061	trial pit	2.0 - 2.5	
TP-44	7581988.104	4756549.980	trial pit	2.0 - 2.5	
TP-45	7582266.585	4756159.942	trial pit	2.0 - 2.5	
TP-46	7583347.045	4754650.116	trial pit	2.0 - 2.5	
TP-47	7584092.480	4753602.092	trial pit	2.0 - 2.5	
TP-48	7584417.082	4753188.573	trial pit	2.0 - 2.5	
TP-49	7584851.676	4752897.468	trial pit	2.0 - 2.5	
TP-50	7585351.764	4752791.084	trial pit	2.0 - 2.5	
TP-51	7585801.444	4752701.982	trial pit	2.0 - 2.5	
TP-52	7585979.183	4752369.420	trial pit	2.0 - 2.5	
TP-53	7586251.247	4751427.310	trial pit	2.0 - 2.5	
TP-54	7586412.077	4750937.724	trial pit	2.0 - 2.5	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
TP-55	7587182.878	4750408.761	trial pit	2.0 - 2.5	
TP-56	7587528.721	4749798.331	trial pit	2.0 - 2.5	
TP-57	7587958.329	4749569.461	trial pit	2.0 - 2.5	
TP-58	7588763.376	4749094.024	trial pit	2.0 - 2.5	
TP-59	7589528.569	4748262.547	trial pit	2.0 - 2.5	
TP-60	7589979.722	4748137.892	trial pit	2.0 - 2.5	
TP-61	7590831.375	4747804.205	trial pit	2.0 - 2.5	
TP-62	7591617.417	4747328.974	trial pit	2.0 - 2.5	
TP-63	7591968.286	4746630.616	trial pit	2.0 - 2.5	
TP-64	7592525.980	4746008.106	trial pit	2.0 - 2.5	
TP-65	7592731.272	4745709.883	trial pit	2.0 - 2.5	
TP-66	7593153.289	4744880.632	trial pit	2.0 - 2.5	
TP-67	7593139.913	4744523.531	trial pit	2.0 - 2.5	
TP-68	7592740.120	4742857.314	trial pit	2.0 - 2.5	**B**
TP-69	7592142.679	4742157.835	trial pit	2.0 - 2.5	
TP-70	7591861.728	4741820.357	trial pit	2.0 - 2.5	
TP-71	7589459.593	4736903.628	trial pit	2.0 - 2.5	
TP-72	7589286.484	4735904.630	trial pit	2.0 - 2.5	
TP-73	7589210.402	4735427.383	trial pit	2.0 - 2.5	
TP-74	7588283.416	4734422.928	trial pit	2.0 - 2.5	
TP-75	7587373.754	4733659.117	trial pit	2.0 - 2.5	
TP-76	7587443.227	4732569.172	trial pit	2.0 - 2.5	
TP-77	7587565.852	4732122.765	trial pit	2.0 - 2.5	
TP-78	7587302.645	4729434.789	trial pit	2.0 - 2.5	
TP-79	7587520.751	4729002.175	trial pit	2.0 - 2.5	
TP-80	7587526.658	4728537.698	trial pit	2.0 - 2.5	
TP-81	7587027.838	4727044.293	trial pit	2.0 - 2.5	
TP-82	7586721.393	4726580.593	trial pit	2.0 - 2.5	
TP-83	7586404.47	4725680.018	trial pit	2.0 - 2.5	
TP-84	7586391.973	4725294.552	trial pit	2.0 - 2.5	
TP-85	7586375.294	4724819.798	trial pit	2.0 - 2.5	
TP-86	7585766.022	4723532.964	trial pit	2.0 - 2.5	
TP-87	7585572.23	4723130.253	trial pit	2.0 - 2.5	**C**
TP-88	7585497.933	4722488.905	trial pit	2.0 - 2.5	
TP-89	7585482.54	4722043.871	trial pit	2.0 - 2.5	
TP-90	7584655.043	4720250.707	trial pit	2.0 - 2.5	
TP-91	7584455.013	4719849.716	trial pit	2.0 - 2.5	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
TP-92	7583139.019	4717327.452	trial pit	2.0 - 2.5	
TP-93	7582497.089	4715081.857	trial pit	2.0 - 2.5	
TP-94	7582178.092	4714881.209	trial pit	2.0 - 2.5	
TP-95	7580356.941	4713419.604	trial pit	2.0 - 2.5	
TP-96	7580093.08	4713180.835	trial pit	2.0 - 2.5	
TP-97	7579568.507	4712933.284	trial pit	2.0 - 2.5	
TP-98	7578802.459	4712473.315	trial pit	2.0 - 2.5	
TP-99	7577889.635	4711804.148	trial pit	2.0 - 2.5	
TP-100	7576672.585	4711123.463	trial pit	2.0 - 2.5	
TP-101	7575827.499	4709598.986	trial pit	2.0 - 2.5	
TP-102	7575830.376	4709039.724	trial pit	2.0 - 2.5	
TP-103	7574556.557	4707736.699	trial pit	2.0 - 2.5	
TP-104	7574015.657	4707737.965	trial pit	2.0 - 2.5	
TP-105	7572884.285	4707369.546	trial pit	2.0 - 2.5	
TP-106	7572287.222	4706764.196	trial pit	2.0 - 2.5	
TP-107	7571938.763	4706388.21	trial pit	2.0 - 2.5	
TP-108	7571658.114	4706081.984	trial pit	2.0 - 2.5	
TP-109	7570841.599	4704824.239	trial pit	2.0 - 2.5	
TP-110	7569408.909	4702350.743	trial pit	2.0 - 2.5	
TP-111	7568083.96	4701525.838	trial pit	2.0 - 2.5	
TP-112	7567469.132	4701505.473	trial pit	2.0 - 2.5	
TP-113	7566865.395	4701484.481	trial pit	2.0 - 2.5	
TP-114	7564852.272	4700840.752	trial pit	2.0 - 2.5	
TP-115	7563704.387	4700190.405	trial pit	2.0 - 2.5	
TP-116	7563062.923	4699881.114	trial pit	2.0 - 2.5	
TP-117	7561600.17	4698850.252	trial pit	2.0 - 2.5	
TP-118	7559734.701	4696639.969	trial pit	2.0 - 2.5	
TP-119	7559208.088	4695343.778	trial pit	2.0 - 2.5	
TP-120	7559197.092	4694384.467	trial pit	2.0 - 2.5	
TP-121	7559192.145	4693915.16	trial pit	2.0 - 2.5	
TP-122	7558935.154	4690953.119	trial pit	2.0 - 2.5	
TP-123	7558848.415	4690440.473	trial pit	2.0 - 2.5	
TP-124	7558749.761	4689878.88	trial pit	2.0 - 2.5	
TP-125	7558569.292	4688836.961	trial pit	2.0 - 2.5	
TP-126	7558099.12	4687360.949	trial pit	2.0 - 2.5	
TP-127	7557451.017	4686762.42	trial pit	2.0 - 2.5	
TP-128	7556970.172	4686322.647	trial pit	2.0 - 2.5	
TP-129	7556999.206	4684022.849	trial pit	2.0 - 2.5	

No.	X	Y	Type of investigation services	Depth of investigation services	Section
TP-130	7557200.657	4683585.962	trial pit	2.0 - 2.5	
TP-131	7557473.301	4682985.477	trial pit	2.0 - 2.5	
TP-132	7557595.953	4682698.514	trial pit	2.0 - 2.5	
TP-133	7557794.617	4681347.873	trial pit	2.0 - 2.5	
TP-134	7557887.073	4680259.601	trial pit	2.0 - 2.5	
TP-135	7557773.433	4678674.917	trial pit	2.0 - 2.5	
TP-136	7557739.543	4678220.787	trial pit	2.0 - 2.5	
TP-137	7557942.526	4676979.277	trial pit	2.0 - 2.5	

Table 6 Position of CPT tests

No.	X	Y	Type of investigation services	Section
CPT-1	7571573.984	4778611.094	CPT	A
CPT-2	7573167.355	4776661.684	CPT	
CPT-3	7575020.292	4775181.822	CPT	
CPT-4	7575593.700	4774581.318	CPT	
CPT-5	7577346.021	4763966.623	CPT	
CPT-6	7577698.239	4763047.854	CPT	
CPT-7	7582668.559	4755559.607	CPT	
CPT-8	7582735.901	4755501.355	CPT	
CPT-9	7583569.987	4754367.087	CPT	
CPT-10	7586109.542	4751915.140	CPT	
CPT-11	7587288.214	4750144.727	CPT	B
CPT-12	7589198.923	4748617.657	CPT	
CPT-13	7592169.317	4746277.093	CPT	
CPT-14	7593035.792	4744213.103	CPT	
CPT-15	7589389.665	4736369.720	CPT	
CPT-16	7587113.786	4732777.932	CPT	
CPT-17	7587208.808	4727344.334	CPT	
CPT-18	7586294.623	4724415.85	CPT	C
CPT-19	7585423.954	4721603.497	CPT	
CPT-20	7583486.399	4717897.225	CPT	
CPT-21	7583041.852	4716304.767	CPT	
CPT-22	7582947.759	4715711.486	CPT	
CPT-23	7582850.316	4715489.637	CPT	
CPT-24	7581668.533	4714669.713	CPT	
CPT-25	7581253.399	4714413.604	CPT	

No.	X	Y	Type of investigation services	Section
CPT-26	7580641.727	4713781.232	CPT	
CPT-27	7577171.398	4711424.145	CPT	
CPT-28	7575737.862	4708671.175	CPT	
CPT-29	7575595.945	4708355.659	CPT	
CPT-30	7575058.796	4707884.961	CPT	
CPT-31	7573744.34	4707738.56	CPT	
CPT-32	7572559.896	4707051.394	CPT	
CPT-33	7571312.32	4705701.759	CPT	
CPT-34	7571055.799	4705273.177	CPT	
CPT-35	7570292.352	4703666.18	CPT	
CPT-36	7570061.124	4703198.728	CPT	
CPT-37	7569163.417	4701978.689	CPT	
CPT-38	7564130.38	4700394.81	CPT	
CPT-39	7562867.178	4699734.089	CPT	
CPT-40	7562135.473	4699077.076	CPT	
CPT-41	7559159.863	4692569.732	CPT	
CPT-42	7559090.283	4691772.168	CPT	
CPT-43	7558664.092	4689495.804	CPT	
CPT-44	7558350.805	4687803.59	CPT	
CPT-45	7556632.222	4684793.876	CPT	
CPT-46	7557752.338	4677698.981	CPT	

Table 7 Position of geoelectrical investigations

No.	X	Y	Type of investigation services	Section
VES-1	7587643.449	4734402.027	Vertical electrical sounding	B
VES-2	7587541.727	4731043.656	Vertical electrical sounding	
VES-3	7562534.442	4699442.049	Vertical electrical sounding	C

Table 8 Position of seismic refractions

No.	X	Y	Type of investigation services	Section
REF-1	7587511.624	4734154.892	Seismic refraction	B
REF-2	7587464.111	4731128.853	Seismic refraction	
REF-3	7562569.748	4699475.563	Seismic refraction	C

Annex 2 Indicative Investigation services quantities

1	***PREPARATORY WORKS***		**Section A**	**Section B**	**Section C**
1.1	Mobilization of equipment, transport and establishment at the site, issuing necessary permits at the local authorities, works on the execution of access roads and all other necessary works and activities required for carrying out complete geological investigations services	lump sum	1	1	1
2	**FIELD SERVICES**				
2.1	Detailed engineering - geological (geotechnical) and hydrogeological survaying (mapping) of the terrain in the narrow and wider zone of the road.	lump sum	1	1	1
2.2	Excecution of investigation boreholes for the purposes of defining the geotechnical conditions of the terrain. Drilling is requred to be carried out by continuous coring and measurement of groudnwater level. Driling is requred to be excecuted by double or triple thin-walls casing in order to obtain sufficient number of undisturbed or disturbed soil samples. The price include also detailed structural geological and hydrogeological mapping of the core log and photographing.				
	Bo investigation boreholes along railway	m^1	40.00	66.00	218.00
	Bm investigation boreholes for bridge structures	m^1	265.00	405.00	1165.00
	Bc investigation boreholes for culvert structures	m^1	30.00	90.00	0.00

	Bt investigation boreholes for tunnel structures	m^1	0.00	47.00	0.00
2.3	Excavation of trial pits in order to determine the thickness of the soil layers and defining the subsoil charateristics. The depth of the pit is from 2.0m up to 2.5 m.	pcs	54.00	28.00	55.00
2.4	Investigation of compaction and bearing capacity, identification and classification tests, Fiel Vane, Proctor,CBR tests in trial pits	pcs	54.00	28.00	55.00
2.5	Static cone investigations CPT (CPTu) with 20t penetrometer with piezocone and data processing.	pcs	10.00	7.00	29.00
2.6	Testing of the concrete lining and rock mass by carrying out investigation boreholes both laterally through the existing tunnel lining and vertically in the axis of the tracks. A detailed geotechnical mapping need to be carried out and samples need to be taken from the lining and rock (soil) for laboratory tests.	pcs	0.00	6.00	0.00
2.7	Undertaking and taking photos of the samples, packaging and labeling of samples and transport to laboratory for testing.	pcs	85.00	155.00	350.00
2.8	Standard penetration test (SPT) at every 3.0 - 5.0m depth, with labaratory classification tests	pcs	85.00	155.00	350.00

2.9	Installation of piezometric construction in boreholes with cover and monitoring.	pcs	0.00	2.00	3.00
2.10	Excecution of geophysical investigations with geoelectircal probing	pcs	0.00	2.00	1.00
2.11	Seismic refraction survaying	pcs	0.00	2.00	1.00
3	***LABORATORY INVESTIGATIONS***				
3.1	Laboratory investigations must consist the following items:- Classification and identification investigations of soil (volume, density, humidity, plasticity and consistency, granulometry, organic and combustible substances, permeability, etc.)- Investigation of Aggressiveness and Water Chemistry.- Unconfined compressive strength- Direct shear test (CD - slow test)- Direct shear test, residual strenght investigations (R test)- Investigations of uniaxial compressive strength of soil.- Oedometer stiffness test, with permeability and consolidation coefficient determination- Investigations on solid rock samples (w, γd, sc, Vp, Vs, E, D, v).- Compaction and vearing capacity investigations, Proctor and CBR tests - Determination of rock tensile strength - indirect method (Brazilian test)- Determination of the rock point strength of (point load test)	pcs	85.00	155.00	350.00
4	***PREPARING OF ENGINEERING - GEOLOGICAL AND GEOTECHNICAL BASES - TECHNICAL DOCUMENTS***				

4.1	Monthly progress report, presenting the general progress of activities and the presentation of the updated results of collected information (core logs with pictures, laboratory results, raw data and interpretation report of the geophysical investigations).An interim report at the completion of the on-site activities.	lump sum.	1	1	1
4.2	Final Geotechnical Report for rail alignment, structures and all other objects. Report must consist needed engineering - geological documentation, engineering - geological maps, longitudinal and cross sections, hidrology and seismic maps and all other documentation for defining the geotechnical conditions of the terrain	lump sum.	1		

Annex 3 Investigation services layout (see separate document)