Section 5.

Terms of Reference

FOR

Survey & Design and Provision of Engineering Supports during Construction for the rehabilitation of two roads in Anbar Governorate

3 km road from the Anbar International road to entrance of Saqra village in Ana district under LIRA I project &

3 km road from the steel bridge in Zagareed village to the technical institute in Fallujah district under LIRA II

Anbar Governorate

February- 2023

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1.0 Background

1. The LIRA project aims to address critical problems related to living standards of conflict-affected people with acute needs by expanding access to services. The project outcome is improved living conditions of the population in the targeted peri-urban and rural areas of the Anbar governorate. The project objective and outcome are in line with all relevant reconstruction and development frameworks for Iraq. The United Nations Office for Project Services UNOPS proposes the adoption of an integrated approach to municipal services delivery that provides coordinated, multi-sectoral support to the returnees in Anbar. According to that, the rehabilitated housing units' component, held by UNOPS, will be connected to the restored decentralized services taking into consideration the whole neighborhood or village. This component will entail the provision of Solar Street Lighting for enhanced community safety, the rehabilitation of selected community roads and of water and sanitation networks and/or stations.

According to the Iraq Reconstruction and Investment-2018, the road sector has also incurred widespread damage, with the destruction of some major road links and bridges. The damage to the roads has rendered segments of the road network inaccessible with negative impacts on mobility and access.

The locations of the both proposed roads to be rehabilitated are shown in the below table, both of the selected roads are existing roads:

Road	Point	GPS Coordinates		Length
Zagareet Road	Starting Point	33.412783	43.682227	3 km
Saqra Road	Starting Point	34.198272	42.127654	3 km

2. The United Nations Office for Project Services UNOPS is the Executing Agency for the Project, responsible for overall project implementation including management of civil works contracts for quality and quantity, civil works contract administration, supervision of supply, and benefit monitoring and evaluation.

2.0 Objectives of the assignment

The primary objectives of the services are to:

a. Conducting geotechnical investigation, topographic survey, traffic survey, hydrological assessment and any other surveys and assessments required for the development of detailed design.

b. Conducting Environmental & Social Assessment and preparation of required reports and Environmental and Social Management Plan, ESMP, in line with the project's Environmental and Social Management Framework, ESMF and the UNOPS HSE requirements..

c. Conducting technical studies, preparation of analysis and design, generating related reports and preparing detailed design/construction drawings, design calculations, technical specifications, construction methodology and the works implementation work program.

d. Provide engineering support on all matters concerning implementation of the contract aspects such as modification of the designs, drawings, documentation and or report, preparation of shop drawings where required, and solving any other survey and design related that may arise during the implementation of the civil works contracts.

A. Detailed Engineering Design

3.0 Duration of the Services:

Duration of the Services is to be started from the date of effectiveness of the Contract for a period of [16 Calendar weeks/considered as completion period of Designs, with the understanding that the design of 3 km road of the LIRA I project shall be completed within the first 12 weeks.]

Whilst the engineering design supports (modification of the design, preparation of shop drawings, corrections where required, etc) shall be provided for the entire duration of the implementation contract throughout 30 June 2024.

4.0 Scope of Work for Topographic Survey

4.1.1 Horizontal and Vertical Controls

All site plans shall be geo-referenced using the WGS 1984 coordinate system, specifically the following: WGS 1984 UTM with country specific zone. If the designer is not able to use the stated coordinate system, the coordinate system used shall be correlated to the stated coordinate system.
A survey data file for all features should show latitude/longitude as well as UTM coordinates. Basic project control surveys will be performed using precise Differential GPS measurement procedures. The Consultant shall submit the Differential GPS survey report.
All control points established at the site shall be identified by name or number, and elevations. Permanent survey monuments shall be established at approximately one (1) kilometer intervals. The horizontal and vertical control points established on site shall be a closed loop with acceptable degree of accuracy and standard procedures. The location of the project site, as determined by the surveyor, shall be submitted in writing to UNOPS. The site location shall be identified by temporary markers, approved by UNOPS before proceeding with the surveying work.

4.1.2 Primary Control Points

Prior to the commencement of topographic survey, primary control point monuments shall be established along the full length of the section at approximately 1 km spacing. A primary control survey shall then be carried out to determine coordinates and elevation of the primary control points by traversing or by a Differential GPS.
A description sheet showing reference number of each primary control point shall be prepared as part of the report.

4.1.3 Secondary Control Points

The Consultant shall establish secondary control points to provide a suitable basis for the topographic survey of the site. The secondary control survey shall then be carried out to determine the elevation and coordinates of secondary control points by traversing reference to the primary control points.
The secondary control points shall be spaced at maximum intervals of 500m and located so that a minimum of two adjacent points are inter-visible. The secondary control points shall be located to fully enclose the required area of topographic survey for the roads, and shall be at sufficient distance from the proposed works so as not to be disturbed during construction. The location of points shall also be suitable for use in setting out.
A description sheet showing reference number of each secondary control point shall be prepared as part of the report.

4.1.4 Topographic Survey Technical Requirements

The contours shall accurately express the relief detail and topographic shapes. In addition, 90 percent of the elevations or profiles interpolated from the contours shall be correct to within one-half of the contour interval and spot elevations shall be correct within plus or minus 20 millimeters.
Spot elevation shall be taken at intervals not exceeding 50 m and at change of slope along the road corridor covering 100m from the road centerline where no stationary objects. All spot elevations affecting design of facilities shall be provided. Specifically, break points or control points in grades of terrain such as tops of existing bridges, tops of existing road surface in rolling terrain, and bottoms of ditches and gullies, etc.
All surface and subsurface structures features within the area, including existing structure, buildings and property lines, drainage crossings, etc., to be surveyed shall be shown and identified on the topographic maps. In addition, these features shall be

located by sufficient distance ties and labeled on the topographic sheets to permit accurate scaling and identification.
The location and sizes of potable, sanitary, electrical and mechanical utilities within the survey site shall be shown on the survey map. Sanitary manholes and appurtenances shall show top elevations and invert elevations.
Digital mapping on standard sheets A1 size at scale 1:1000 which shall be used as base maps for the road design shall be generated.

4.1.5 Topographic Maps

The consultant shall prepare a topographic map of the property/roadway right-of-way including boundary. The survey shall show the property boundary along the alignment of the proposed roadway consisting of identifying all property corners, establishing horizontal and vertical control, listing all bearing and distances of property lines, and curve data.
The topographic maps shall be in no less than 1:1000 scale and shall include topographic information for up to 100 meters from the roadway centerline. Drainage lines intersecting and affecting the roadway shall be surveyed with topographic information for up to 100m from the roadway.
The topographic maps shall show the locations of all on-site and nearby offsite existing features including but not limited to buildings, structures, streams, rivers, major trees, road pavements and connecting road pavements and right of ways, names of roads, widths of roads, and existing underground and aboveground utilities etc.
The topographic contour interval shall be no greater than 0.5 meter difference in elevation. In the event the terrain is so steep that contour lines with a 0.5 meters interval are illegible, the contour interval shall be increased to show topographic data clearly. Intermediate elevations shall be provided as necessary to show breaks in grade and changes in terrain.

4.1.6 Topographic Survey Drawings

All survey drawings shall be prepared on A1 size drawing sheets. Names and annotations shall be aligned parallel to the gridlines except for names relating to linear features which shall be aligned parallel with those features. The overlap of adjacent drawings shall give a minimum overlap of 75mm of detail common to each drawing and match lines shall be included on each drawing. Coordinates and heights of all primary and secondary control points shall be shown on the drawings.

The topographic survey report shall also be prepared by the consultant and shall present the following information:

- Travers data
- Existing structure information
- Coordinates of BMs
- Location map for BMs
- Site photos with changes

The consultant engineer may add any additional information in the survey report which will then be required for the design engineers during preparation of the detailed design.

5.0 Scope of Work for Geotechnical Investigation

5.1.1 Objectives of the Geotechnical Investigations

The primary objective of this service is to provide a comprehensive geotechnical investigation report through the identification of any site-specific geotechnical data required to develop pavement structure design (flexible/rigid), slope stability analysis, drainage and retaining structures foundations, construction materials, earthwork, and other geotechnical related design and construction activities for the targeted roads. The Consultant shall develop all pertinent geotechnical design and construction parameters by appropriate field and laboratory investigations, testing and analyses.

6.0 Scope of Service for Geotechnical Investigation

The scope of this service is to produce a detailed geotechnical report containing field exploration and testing results, laboratory testing results (tests and assessments required for physical, mechanical and thermo-hydraulic properties of soil and project site).

Information in the report shall include, but not limited to: existing geotechnical (e.g. surface and subsurface) conditions, location of subsurface exploration logs on site plan, exploration point, allowable soil bearing capacity and foundations recommendations, bearing capacity, pavement design criteria (e.g. CBR values, K values), ground-water levels, and construction materials (e.g. concrete cement, asphalt, and aggregates), that are required for the design and construction of the targeted roads. All geotechnical laboratory and field work shall be based on standards set forth in the AASHTO and ASTM latest versions.

7.0 Geotechnical Assessment

For the design and analysis of pavement structure (flexible/rigid), slope stability, drainage and retaining structures' foundations, construction materials, earthwork, and other geotechnical and construction related activities the following properties of soil and geotechnical assessments shall be assessed:

- Physical Properties
- Mechanical Properties
- Thermo-hydraulic Properties
- Climatic and Environmental Inputs
- Chemical Properties of Soil

Laboratory and field methods that are appropriate for determining the physical properties of unbound materials and roadbed soil in pavement systems and other structures shall be conducted with the consideration of volumetric properties (moisture content, specific gravity, unit weight), compaction properties (proctor compaction), gradation properties (mechanical sieve analysis and hydrometer analysis) and plasticity properties (Atterberg limits) of soil samples.

Laboratory and field methods that are appropriate for determining of stiffness and other relevant mechanical properties of unbound materials and roadbed soil in pavement systems shall conduct with the consideration of index properties (California Bearing Ratio, Structural Layers Coefficients), Stiffness properties

(Resilient Modulus, Poisson Ratio and Modulus of Subgrade Reaction) and other mechanical properties such as Interface friction, coefficient of lateral pressure, allowable bearing capacity, permanent deformation (settlement) and etc. May the correlation method shall be used for the identification of those mechanical properties that are not applicable in Iraq or project sites.

A proper assessment shall be performed for the identification of accurate thermo-hydraulic properties of soil that are required for the design and analysis of pavement structures and foundations with the consideration of drainage properties (drainage coefficients for drainage, base and sub-base layers), swelling potential of roadbed soil, frost heave and spring thawing parameters for roadbed soil, collapse potential, liquefaction, high compressibility properties for roadbed soil, ground water table and so on.

A comprehensive climatic and environmental assessment shall be performed for the project site with the consideration of ambient temperature, precipitation, wind speed, relative humidity, sunshine, frost depth, snow fall, number of frost days per year and so on.

A number of tests shall be conducted to identify the project site exposure class based on the salphate/chloride content and PH of soil/water that to be considered for the selection of minimum compressive and tensile strength of Portland Cement Concrete for the drainage and retaining structures at project site.

8.0 Geological/Seismological Assessments

Comprehensive geological and seismological assessments shall be performed for the project site based on the latest version of USGS and USACE proposed maps for Iraq. The assessment shall give geological and seismological recommendations for the pavement structure design, drainage/retaining structures design, cutting/filling slopes, high embankment analysis/design and so on.

9.0 Geographical Assessment

The Consultant is responsible to identify the alignment of roads based on the coordinates that will be provided by the UNOPS technical team. The Consultant shall identify the required location of test pits and boreholes based on the project site geological and geotechnical aspects. All the test pits and boreholes shall be dug exactly within the pavement and structures foundation area. Before starting the work at the project site, the Consultant is required to submit test pit and borehole layout plan to the UNOPS technical team for approval. After approval, the Consultant can start work at the project site.

10.0 Field Work

The field work shall be performed based on the AASHTO, ASTM and other accepted standards with the consideration of this TOR for the geotechnical investigation. The field work includes borehole drilling, bore-logging, test pit digging, pit logging, soil sampling, in situ testing, site photos, etc.

10.1.1 Boreholes

A number of boreholes shall be drilled using a rotary drilling machine facilitated with disturbed and undisturbed soil sampling tools for laboratory testing required to assess and analyze the rock slope stability, high embankment and deep excavation analysis, major retaining (height more than 2m) and drainage structure (size more than 2mx2m) foundation design.

10.1.2 Borehole Size

All boring shall be done through a rotary drilling machine with minimum inner diameter of 100mm.

10.1.3 Borehole depth

The boring depth shall be determined based on the structures size and cutting/embankment height with respect to the recommendations of AASHTO Subsurface Investigation Manual, recent edition.

High Embankment Borings: for embankments greater than 5m in height, the test borings should penetrate to approximately two (2) to four (4) times the height of the proposed embankment, depending on the width of the proposed roadway, unless rock is encountered above that depth. The depth may be decreased to approximately the height of the embankment if very suitable bearing material is encountered, such as dense sand/gravel soils.

Deep Excavation Borings: In areas where excavations exceed then 5m, the test borings should penetrate to approximately twice the depth of the excavation. If bedrock or refusal is encountered within the proposed excavation depth, the boreholes should be cored a minimum of 3m to determine the quality of the rock or the nature of the refusal. If there is a possibility of artesian aquifers; soft, highly cohesive soil; or loose, liquefiable granular soils, the exploration depths should be increased to penetrate these deposits.

Structures Borings: The boring depth for structures shall follow the “rule-of thumb” guidelines for depths of borings, where the explorations should be advanced to the depth where the net increase in soil stress due to structure load is less than 10 percent of the existing effective stress in the soil at that depth. In case of bedrock, it is desirable that all explorations penetrate to rock with selected explorations penetrating 3 to 6m into the rock. To simplicity the boring procedure and depth may be as below:

Extend borings to depth below final ground line (retaining walls foundation bed level) 1.5 times the height of the retaining or protection wall. Where stratification indicates possible deep stability or settlement problems, borings should be extended to hard stratum.

Extend borings to depth below final ground line (culverts or canal foundation bed level) equal to twice the culverts height unless a hard stratum is encountered above this depth. Where soft strata are encountered which may present stability or settlement concerns the borings should extend to hard material.

Slope Stability Boring: In areas where slope stability analysis is required, the test borings should penetrate to approximately equal to the depth of the side cutting. If bedrock or refusal is encountered within the proposed side cutting depth, the boreholes should be cored to determine the quality of the rock.

For shallow test boring, may excavator machine or hand digging procedure used in the project site.

10.1.4 Borehole Spacing or Intervals

The borehole spacing or internal shall be determined based on the structures size and cutting/embankment height with respect to the recommendations of AASHTO Subsurface Investigation Manual.

High Embankment Borings: The average maximum boring interval or spacing for high roadway embankments (height greater than 5m) is approximately 100m. If erratic foundation conditions or compressible materials are encountered, this spacing may be decreased to 60m or less. At least one boring shall be located at the maximum height of the proposed embankment.

Deep Excavation Borings: The average maximum boring interval or spacing for deep roadway cutting (cutting deeper than 5m) is approximately 100m. At least one bore may be located at the maximum depth of the proposed cut.

Structures Borings: The number and spacing of structure borings is highly variable depending on the complexity of the surface conditions. To simplify the procedure, boring space or interval may be as below:

A minimum of one boring should be performed for each retaining/protection wall. For retaining/protection walls more than 30 m in length, the spacing between borings should be not greater than 60m. Additional borings inboard and outboard of the wall line defining conditions at the toe of the wall and in the zone behind the wall to estimate lateral loads and anchorage capacities should be considered.

A minimum of one boring at each major culvert (size more than 2mx2m). Additional borings should be provided for long culverts (length more than 30m) or in areas of erratic subsurface conditions.

For irrigation or storm water canals, the spacing between borings should not be greater than 200m. In case of material change property, the boring spacing may be decreased as per site requirements.

Slope stability Boring: In areas where slope stability analysis is required, a minimum of one boring should be performed for each cut slope. For cuts more than 60 m in length, the spacing between borings along the length of the cut should generally be between 60 and 120 m. At critical locations and high cuts, provide a minimum of three borings in the transverse direction to define the existing geological conditions for stability analyses. For an active slide, place at least one boring upslope of the sliding area.

10.1.5 Soil Sampling from Boreholes

The undisturbed soil sample shall be obtained by thin-wall-tube or any other accepted method from the boreholes for determination of soil mechanical properties to be used for the design of slope stability analysis, high embankment, deep excavation and drainage/retaining structures. The undisturbed soil sampling shall be performed based on the soil property change method but at least one sample in each 5m depth.

Disturbed soil samples shall be obtained from boring based on material change property aspects but at least one sample from each meter depth of test pit. Disturbed, representative samples of soil are satisfactory for certain laboratory tests including classification, water content determination, index properties, gradation, specific gravity, and so on.

In rock boring, e.g. when SPT refusal is encountered, the borehole shall be advanced by means of continuous coring with double tube barrels. The cores shall not be less than 75 mm in diameter. The two provisions above will ensure relatively sound samples. Cores shall be properly wrapped and labeled, stored and photographed in wooden boxes on site. A competent geotechnical engineer/geologist shall log the borehole on site according to standards and specifications. Values of TCR, SCR, RQD and FI (Fracturing Index) shall be computed for the recovered cores at the end of every run. Photographs of the cumulative boxed recovered core from every borehole shall be taken.

The water level in all boreholes shall be reported at the beginning and end of each working day and monitored throughout the investigation period.

The sample shall have enough weight or size for performing soil physical and mechanical properties as required for design. All soil samples shall be properly transferred to the laboratory for required testing.

Each borehole will have an informative board that represents borehole number, drilling date, boring depth, location, etc.

10.1.6 Standard Penetration Test (SPT)

The Consultant shall execute the SPT in compliance with the ASTM and AASHTO standards. SPT testing shall be done on every borehole at 1.0 m intervals of soil depth up to 10 meters, and at 1.5m intervals of soil depth beyond 10 meter and at every identifiable change of soil strata.

The test shall be conducted after driving the casing to the bottom of the borehole and after cleaning with drill bits and other tools, to ensure the stability of tested soil at targeted depth. The SPT test shall be terminated when the SPT value is more than 50 in three consecutive layers.

In case of rock material, the SPT will change by CPT and record its blows as SPT.

The N-values as observed shall be reported in the bore logs without any correction for overburden or water table. The disturbed samples shall be taken from the SPT tube and air tight containers, labeled with the following details.

- Boring name
- Dates of test performing in bore
- Location of borehole
- Depth of SPT test
- Number of SPT blows

10.1.7 Borehole Logs

Standard log forms shall be filled based on the field sampling, exploration and observations. The log's material shall be visually described based on the ASTM D 2488.

10.2.1 Test Pits

A number of test pits shall be also dug for collection of laboratory testing samples to identify the physical, mechanical, chemical and thermo-hydraulic properties of roadbed and light structures foundations soil.

10.2.2 Test Pits depth

Subgrade Test Pits: In areas where the preliminary alignment profile indicates that minor cuts or embankments are anticipated, the explorations should be extended from 2-3m below the existing ground level. If soft cohesive soils are encountered, this depth is increased as required to fully evaluate the stratum. Shallow refusals encountered within the limits of the proposed cut should be cored a minimum of 3m to determine the presence of bedrock.

Structures Test Pits: The below criteria will apply for all light drainage (size less than 2mx2m) and retaining/protection (height less than 2m) structures.

Extend pit digging to depth below final ground line (retaining walls foundation bed level) equal to 3m unless a hard stratum is encountered above this depth. Where stratification indicates possible deep stability or settlement problems, pit digging should be extended to hard stratum as much as possible.

Extend pit digging to depth below final ground line (culverts foundation bed level) equal to 3m unless a hard stratum is encountered above this depth. Where soft strata are encountered which may present stability or settlement concerns the pit digging should be extended to stratum as much as possible.

Extend pit digging to depth below final ground line (small canal foundation bed level) equal to 3m unless a hard stratum is encountered above this depth. Where soft strata are encountered which may present stability or settlement concerns the pit digging should be extended to stratum as much as possible.

10.2.3 Test Pits Spacing or Intervals

Subgrade Test Pits: In areas where relatively uniform subsurface conditions are anticipated and deep cuts or high embankments are not being expected, an average spacing of 200m is recommended. Where highly erratic and critical foundation

conditions exist, it may be necessary to further decrease the spacing to an adequate distance with respect to the AASHTO Subsurface Investigation Manual.

Structures Test Pits: The below criteria is recommended for all light drainage (size less than 2mx2m) and retaining/protection (height less than 2m) structures test pits intervals.

A minimum of one test pit should be performed for each light retaining/protection wall. For retaining/protection walls more than 30 m in length, the spacing between test pits should not be greater than 60m. Additional test pits inboard and outboard of the wall line defining conditions at the toe of the wall and in the zone behind the wall to estimate lateral loads and anchorage capacities should be considered.

A minimum of one test pit at each minor culvert (size less than 2mx2m). Additional test pits should be conducted for long culverts (length more than 30m) or in areas of erratic subsurface conditions.

For small irrigation or storm water canals (size less than 2mx2m), the spacing between test pits should not be greater than 200m. In case of material change property, the test pits spacing may be decreased as per site requirements.

10.2.4 Soil Sampling from Test Pits

The undisturbed soil sample shall be obtained either by cube or thin-wall-tube method if required, from the test pits for determination of soil mechanical properties to be used for the design of drainage/retaining structures. The undisturbed soil sampling shall be performed based on the soil property change method. For certain soils such as very soft clays or gravelly soils, undisturbed samples may be impossible to obtain. The provided unit weight and moisture content of the soil in place can be estimated or are known, it may be permissible to perform certain laboratory tests on specimens remolded from samples of disturbed material. The sample should properly be sealed to avoid moisture loss. Each sample shall have a proper record format that represents the location, depth, date and type of sample.

Disturbed samples shall be obtained from test pits based on material change property aspects but at least one sample from each meter depth of test pit. Disturbed, representative samples of soil are satisfactory for certain laboratory tests including classification, water content determination, index properties, gradation, specific gravity, MDD, OMC, CBR and other tests.

Additional soil samples will be taken from the borrow pits that may be used for the production of subgrade, embankment and sub-base borrow material. The geotechnical engineer will insure himself from the amount of material that satisfies the construction requirements. It is superseded if more than one borrow area is selected for material production.

10.2.5 Test Pit Logs

Standard log forms shall be filled based on the field sampling, exploration and observations. The log's material shall be visually described based on the ASTM D 2488.

10.2.6 In-situ Testing and its Frequencies

For determination and assessment of thermo-hydraulic, climatic, environmental and some mechanical properties of soil, the field density test is required to be performed. The field density test shall be performed based on the ASTM D 1556 or AASHTO T191. At least one test will be performed in each 500 m length of road in the test pits (where subgrade is proposed to be constructed). One percolation test shall be conducted in each 1000m distance of the road and canal to identify the percolation rate of subsurface strata that can be used in the sub-surface drainage design of road and hydraulic analysis of wastewater collection canal. The exact locations of the test shall be identified based on the site geological and geotechnical aspects and requirements.

10.3.1 Site Photo Log

Required photos shall be taken from the site during drilling/digging of boreholes/test pits and soil sampling. The photos shall be taken in the manner that each photo will represent required information regarding boring/test pit locations, boring/test pit number, soil sampling and its date, sample depth, soil type and soil strata's physical view in the test pits. Each photo will have an informative label in the lower left corner that represents the above-mentioned information. The site photo log will be part of the geotechnical investigation.

11.0 Laboratory Work

Laboratory tests shall be performed based on the AASHTO or ASTM standards with the consideration of TOR's recommendations. The laboratory work includes those tests that are required for determination of physical, mechanical and thermo-hydraulic properties.

11.1 Tests for Physical Properties

The following tests shall be performed for the determination of physical properties of soil at laboratory:

- Moisture Content
- Mechanical Sieve Analysis
- Atterberg Limits
- Hydrometer Analysis
- Proctor Compaction
- Specific Gravity

The tests required for determination of physical properties of soil shall be conducted on each sample that has been collected from the test pits except hydrometer, proctor compaction and specific gravity tests. The hydrometer test will be performed on the samples that were obtained from natural strata especially on fine grain soil and its frequency will be based on the project site geologic and frost susceptibility classification, but nor apart than 500m. The proctor compaction testing frequency will be as per CBR frequency. The specific gravity will be conducted in the same frequency of field density.

11.2 Tests for Mechanical Properties

The following tests are required for determination of mechanical properties of soil:

- California Bearing Ratio (CBR)
- Shear Strength
- Elastic Modulus
- Unconfined Compressive Strength (soil and rock)
- Bulk Density (rock)
- Point Load Index (rock)

The California bearing ratio test shall be performed at laboratory on disturbed samples. The samples shall be compacted in optimum moisture content and soaked for 96 hours. The CBR values shall be calculated in 95% and 97% compactions based on laboratory maximum dry density. As the CBR and Proctor testing are time consuming, it is not required to conduct these tests on each sample that obtains from the pits. Based on the proper justification and physical properties testing results, the test pits will be divided into approximately uniform soil properties and then the CBR and Proctor tests will be performed on the 50% test pits (from each meter depth).

The MR and K-value may be derived based on the more accurate and acceptable correlation from the CBR tests results.

The direct shear and unconfined compressive strength tests shall be performed for the mechanical properties assessment of foundation soil for drainage/retaining structures, slope stability analysis, high embankment and deep excavation. A required number of tests will be performed that satisfy the design requirements and design needs.

The point load index, unconfined compressive strength, bulk density and any other required test will be performed for rock coring samples to identify its mechanical properties required for slope stability analysis and foundation design. A required number of tests will be performed that satisfy the design requirements and design needs.

11.3 Tests for Chemical Properties

The following tests are required for determination of chemical properties of soil and water if encountered in the test pits:

- Sulphate Content
- Chloride Content
- pH
- Organic Content

The above-mentioned tests shall be performed in the same frequency of field density to classify the project site based on the exposure of severity.

11.4 Tests for Thermo-Hydraulic Properties

The following tests are required for determination of drainage properties of subsurface soil sample collecting from the boring or test pits.

- Permeability
- Collapse Potential
- Liquefaction

The above-mentioned tests shall be performed one in each 1000m distance of the road to be used for related geotechnical analysis.

Note: The Consultant is required to conduct any other tests that are not mentioned above for provision of geotechnical aspects and properties of subsurface strata.

12.0 Geotechnical Plan

The Consultant is required to conduct a geotechnical reconnaissance survey and desk study before start of the actual geotechnical work in the project site to identify the exact number, depth, spacing and location of boreholes and test pits. The Consultant is required to prepare a geotechnical plan that consists of boring/pitting coordinates, location, depth, spacing and required number of tests for each borehole and test pit. The Consultant shall submit the plan to the UNOPS for approval. After approval, the Consultant is required to stakeout the defined location with the help of a total station machine and start working as per given time schedule.

13.0 Geotechnical Report

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

13.1 Executive Summary

- Total number of boring and test pits conducted in the project site.
- The results of in-situ and laboratory testing
- Recommended design parameters for pavement structure design, slope stability analysis, embankment analysis and design and drainage/retaining structure design.

The above information shall be in tabulated format.

13.2 Main Body:

- Summary of the geotechnical finding that shall be required for the design of pavement structure and other road features.
- Project background, objectives/scope of investigation, methodology of investigation, geographical location and structure of the report.
- Information about the geological formation, climatic/environmental condition and seismological assessment of the project site along with suitable design recommendations.
- Comprehensive information about the stereographical formation, assessment and required recommendation for the project site.
- Information regarding the field and laboratory work, assessment, evaluation and recommendations along with the testing results in the text form.
- Classification of project site based on the frost susceptibility, spring thawing, swelling, collapse potential, liquefaction and severity exposure.

- Classification of project site strata based on the material type hardness like soft, boulder and rock.
- Determination of waste and structure disposal material pockets dumped by the community in the project site and specific recommendations for its removal and treatment.
- The result of existing geotechnical (e.g. surface and subsurface) conditions of the project site.
- A summary of design parameters required for the design of flexible/rigid pavement, drainage/retaining structures design, slope stability analysis, embankment design and analysis.
- Analysis and calculation required for the slope stability of side slopes (natural or after cutting).
- Information regarding borrow area and available material along with a summary of physical/mechanical properties of borrow material.
- Information regarding the ground water table.
- Geotechnical recommendations for the design and construction of pavement, drainage/retaining structures, slope stability and etc.
- Geotechnical recommendations for construction material that shall be used in the pavement and drainage/retaining structures.
- Geotechnical recommendations for cut and fill slopes that use in the roadway transverse sections.
- Geotechnical recommendations regarding the structures treatment against chemical, climatic and environmental aspects.
- Geotechnical recommendations for the design of pavement and other structures with the consideration of frost heave, spring thawing, swelling potential, collapse potential, high compressibility and liquefaction aspects of the project site.

13.3 Appendixes

- Project site general, boring and test pit layout plan with stations and coordinates.
- Summary of test results in tabulated form (for roadway, structures, slope stability and borrow pits).
- Site subsurface exploration logs (boreholes and test pits) with a proper visual and laboratory description of soil based on the ASTM D 2488.
- Site photo log with informative labels for each photo that present the location, depth, size, and date of exploration.
- Test results.

All geotechnical engineering design parameters shall be developed by an expert geotechnical engineer or geotechnical firm that will have at least 10 years work experience in similar projects.

14.0 Deliverables

The Consultant shall develop the geotechnical investigation services in the following deliverables:

- **Borehole and Test Pits Layout Plan:** The Consultant or consultant shall submit a borehole and test pits layout plan within one week after receipt of letter of access to the site. The layout plan shall be included but not limited to project site geotechnical/geological reconnaissance, field and laboratory work methodology, boring/test pit location map and depths, required tests numbers, staff list used for field and laboratory work, etc.
- **Draft Final Geotechnical Report:** The Consultant or consultant shall submit the draft final geotechnical report after 30 days after approval of the inception report to UNOPS for review. The UNOPS technical team will review the geotechnical report and will give comments to the consultant for incorporation and rectification.
- **Final Geotechnical Report:** The Consultant will submit the 2 full sets of report as hard copies along with CDs with all support documents of geotechnical report within one week after UNOPS technical team review.

15.0 Consultant's Personnel

The services shall be carried out by National Engineers, reviewed and approved by a senior geotechnical specialist. The Consultant's staff should have extensive experience in geotechnical survey and design of similar civil infrastructure projects. Geotechnical Engineers must have a verifiable engineering degree and professional background.

Minimum requirements to the composition of Consultant's project team and their staff qualification are provided in the below table:

Consultant's Geotechnical Team

Description of Staff	Level of Qualification	Years of professional experience (minimum)
Chief Geotechnical Engineer	Min. Master degree in Civil Engineering (transportation or geotechnical engineering)	10 years' experience as a design team leader, and overall 5 years of experience in transportation related projects' geotechnical investigation.
Office Geotechnical Engineer	Min. Bachelor Degree in Geotechnical or Civil Engineering, Master degree is preferable.	7 years experience in geotechnical and material engineering, 5 years in general design and construction engineering.

Field Geotechnical Engineer	Min. Bachelor Degree in Geotechnical or Civil Engineering, Master degree is preferable.	5 year experience in geotechnical and material engineering, 3 year in general design and construction engineering.

Good knowledge of spoken and written English by the consultant's key staff is essential.

16.0 Facilities to be provided by the Consultant

The Consultant shall ensure that the project staff are adequately supported and equipped. In particular the Consultant shall ensure that there is sufficient administrative, secretarial and interpreting assistance to enable the experts to concentrate on their primary responsibilities.

17.0 Quality Assurance

UNOPS technical team will perform a quality assurance review of the Consultant's work to confirm that proper criteria, regulations, laws, codes, principles and professional procedures have been used. UNOPS will review the work of the Consultant during each phase of geotechnical and return comments in writing.

18.0 Detailed Engineering Design

18.1.1 Technical Standards and Regulations

All design products shall be in compliance with the local design standards for highways and streets and in line with the following codes and standards and those referenced throughout the design procedure. If there is conflict in the criteria the most stringent requirement shall be applied, and also modified only where needed to suit local conditions. This list is not exclusive and is not necessarily complete. The publications to be taken into consideration shall be those of the most recent editions, except where specific publication years are noted.

- UNOPS design planning manual for transport infrastructure
- UNOPS guidelines for Environmental, Health and Safety
- Iraqi Standard for Highways and Streets Geometric Design Standards
- Iraqi Standard for Highways and Streets Pavement Design
- NACTO Standards/Guidelines where applicable
- A Policy on Geometric Design of Highways and Streets , AASHTO.
- AASHTO Guide for Design of Pavement Structures 1993 , AASHTO.
- AASHTO LRFD Bridge Design Specifications
- AASHTO Highway Safety Manual (HSM)
- ACI 301M Specifications for Structural Concrete
- ACI 318M-08 Building Code Requirements for Structural Concrete,

- ACI 360R-06 Design of Slabs-on-Ground,
- ACI 530/ASCE 5/TMS 402, Building Code Requirements for Masonry Structures
- ASTM - American Society for Testing and Materials (ASTM)
- LRFD STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS
- Manual on Uniform Traffic Control Devices (MUTCD), By Federal Highway Administration (FHWA).
- NRCS (SCS)

18.1.2 Geometric Design

18.1.3 Roadway Plan and Profile

Based on the Topographic Maps a separate Roadway Plan & Profile shall be prepared in plan and profile sheet format at a scale no larger than 1:1000 showing the property boundary and all proposed surface features including but not limited to the road, shoulder, culverts, retaining walls, guard rails, location of signage, pavement markings etc. Any feature that cannot be legibly seen on the Roadway Plan shall have a detail made of that particular area. Proposed contour lines shall be shown on the Roadway Plan. The contour interval shall be no greater than 0.5 meters difference in elevation.

The Roadway Plan shall be properly stationed and show complete geometric design of the road with tables showing curve data. Centerline stationing shall be set at intervals of 50m at tangents and 20m at curves. The Roadway Plan shall be drawn in the Universal Transverse Mercator Grid Zone (Iraqi National Grid 37,38, 39 depending on the area), World Geodetic System (WGS84) projection.

18.1.4 Cross Sections and Key Map

Based on the survey, Topographic Map and Roadway Plan & Profile, cross sections shall be generated at 20m intervals throughout the project according to local, to AASHTO's Policy on Geometric Design of Highways and Streets and NACTO standards where applicable. Additional cross sections shall be provided through any existing and proposed drainage structures and road features. These cross sections shall be obtained through the flow line of the drainage system. Cross section shall also be provided at the beginning, middle, and end of each super elevation. Cross Sections drawings shall show the location and height of retaining structures as well.

A typical cross-section shall include:

1) Pavement thickness, base thickness, subbase thickness, and drainage criteria;
2) Cross slope;
3) Roadway widths showing carriageway, shoulders, drainage systems, cycle facilities and another road furniture;
4) Slopes tying into existing grades, and etc.

An overall site key map that depicts project design area with respect to the project shall be provided.

18.1.5 Traffic Analysis

The Consultant shall conduct a traffic study and determine the average daily traffic (ADT) and separately calculate the percentage of truck traffic passing the proposed roadway. Prior to performing the study, the Consultant shall seek UNOPS and the local authorities' advice for historical traffic data if available.

The Consultant shall identify the design vehicle in accordance with Local Standard and or AASHTO's Policy on Geometric Design of Highways and Streets. The design speed recommended shall conform to AASHTO and MUTCD guidelines. The road shall be designed to carry the average daily traffic volume and shall correspond to the AASHTO design vehicle and recommended design speed as well in compliance with local codes.

18.1.6 Horizontal Alignment

The Consultant shall design the horizontal alignment according to AASHTO's policy on geometric design requirements. The plans shall show the horizontal alignment for the finished road, to include the edge of the proposed road surface, proposed edge of shoulder, cycle and pedestrian paths, drainage criteria, and etc. All intersecting roads, paths, and driveways are required to have a smooth transition to the new road alignment. For horizontal curves, the super elevation shall be designed to comply with the AASHTO policy on geometric design and shall correspond to the design speed.
The horizontal alignment shall be labeled with the following at a minimum:

- Curves - Point of Curve (PC) station
- Tangents-Bearing and distance on each segment
- Point of Tangent (PT) station
- Point of Intersection (PI)
- PI Station
- Deflection Angle
- Tangent (T)
- Length (L)
- Deflection Angle (Delta)
- Degree of Curve (Dc)
- Radius (R)
- Begin of Curve (BC)
- End Curve (EC)

18.1.7 Vertical Alignment

Based on the topographic survey, centerline profile drawings of the existing and proposed alignment shall be provided. Plan and profile views of project segments shall be shown on the same plan sheet. The profiles shall show the vertical alignment for the finished road with the existing grade along this vertical alignment. The plan and profile drawings shall be developed at 1:1000 horizontal scale and 1:100 vertical scale or as graphically required.
The vertical profile shall be labeled with the following at a minimum:

- Tangents- Percent of slope (Shall meet AASHTO minimums)
- Curves - Point of Vertical Intersection Station (PVI-S) - At an even meter station
- Point of Vertical Intersection Elevation (PVI-E)
- Algebraic Difference (AD)
- Rate of Curvature (K) (Shall meet AASHTO minimums)
- Curve Length (L) - In even meter increments
- Begin Vertical Curve Station (BVC-S)
- Begin Vertical Curve Elevation (BVC-E)
- End Vertical Curve Station (EVC-S)

- End Vertical Curve Elevation (EVC-E)
- Crest (high point) or Sag (low point) station & elevation

18.1.8 Intersection Design

The consultant shall identify all locations where intersections are required to be analyzed and designed. Intersection design shall address all mobility and safety goals as well as opportunities to enhance the public realm. The design shall address traffic signals (if warrant), required channelization, turning bays, corner radii, crosswalks, pedestrian safety islands, visibility/sight distance, and etc. All required signage and pavement marking to facilitate movements and safety shall be considered according to MUTCD and NACTO guidelines. The Consultant shall prepare detailed geometric design drawings of each intersection on 1:500 scale.

18.1.9 Traffic and safety Analysis and Design

The Consultant shall conduct a traffic study to examine the existing traffic condition at the corridor. In addition, basic traffic data shall be collected in order to be used for analysis and design. The Consultant shall conduct traffic count studies for at least four days, Saturday, Monday, Wednesday and Friday in locations where necessary. The Traffic volumes shall be recorded in AM, 6:30am to 9:30am, and PM, 4:00pm to 7:00pm, peak hours. The data shall be recorded for each 15 mins increment. Before data collection, the Consultant is required to submit a Traffic Data Collection Plan to the UNOPS Engineers, have their approval, and also seek their advice for historical traffic data at the corridor. The Consultant shall have close coordination with local authorities during the process.

The Consultant shall conduct a comprehensive analysis of different safety countermeasures in order to enhance the safety of the roadway. The Consultant shall address safety design considerations in accordance with the AASHTO Highway Safety Manual (HSM) for design of roadway sections and junctions. All road signs, pavement marking, etc. shall be designed in accordance with local and international standards.

Special safety countermeasures shall be proposed along the roadway especially in areas with high filling and cutting to ensure safety due to sliding and stone downfall.

The Consultant shall submit a report on traffic and safety studies which shall include the following as a minimum:

- Traffic counts: Traffic volumes for AM and PM peak hours.
- Existing condition: Road classification, existing condition diagram of intersections, right-of-way, previous traffic studies, and existing land use, as applicable.
- Future condition: Future land uses and developments, future road network in the vicinity, and future traffic projections, applicable.
- Traffic safety study report including all proposed safety countermeasures.
- Improvement plans for pedestrian crossings, underpasses and skywalks, cycle lanes, and bus stop relocation.

18.1.10 Pavement Structure Design

The structure of the roadway is considered to be flexible pavement with asphalt concrete surface course. The Consultant shall design the pavement structure

according to the AASHTO Guide for Design of Pavement Structures and make structure response models according to the Asphalt Institute Method.
The Consultant shall modify the baseline structure design with the consideration of frost heave, spring thawing and swelling aspects of the project's site roadbed soil properties. The required asphalt layers thickness shall be determined based on the fatigue cracking, thermal cracking and rutting criteria for the proposed design for performance life introduced by AASHTO 2002 or Asphalt Institute method to avoid cracking and permanent deformation during performance. For making of structure response model, the consultant can use KENPAVE or any other accepted computer program. If it is realized that the pavement structure con not response for thermal/fatigue cracking in winter seasons and permanent deformation in summer season, the asphalt wearing course layer may be modified with a proper polymer modifier such as Styrene-Butadiene-Styrene (SBS) and one of the granular layers with bitumen, Portland cement, geogrid and geonet.

18.1.11 Design Life

A design life of 20 years and construction period of 1year are recommended for the design of pavement structure and ESAL analysis.

18.1.12 Level of Reliability

A 90% level of reliability is recommended for the design of pavement structure.

18.1.13 Pavement Serviceability Indexes

An initial serviceability index of 4.2 shall be considered for the main lane and service roads if any. A terminal serviceability index of 2.5 shall be considered for the main lanes and 2.0 for the service roads if any. The baseline ΔPSI shall be modified with the consideration of serviceability loss due to roadbed soil frost heave, spring thawing and swelling as per AASHTO design manual; unless otherwise specified in the consultant's design criteria and to be approved by UNOPS.

18.1.14 Traffic Loading

The Consultant shall estimate the design traffic loading based on the basis of 18,000 lb equivalent single axle load (ESAL) for 20-year design period and 2 years construction period. All design parameters, i.e. directional distribution factor, lane distribution factor, load equivalency factor (LEF) and traffic growth rate shall be selected and used according to the AASHTO 1993 guideline.

18.1.15 Traffic Growth Rate

A traffic growth rate of 2.5 % is recommended for the calculation of design ESALs. Unless otherwise to be determined according to the actual situation and local traffic conditions.

18.1.16 Pavement Material Stability

The minimum pavement granular material (base and subbase courses) stability is recommended in terms of California Bearing Ratio (CBR) and shall be converted to the Resilient Modules (MR) as per AASHTO guideline. A minimum CBR value of 80% and 30% are recommended for base and sub base course material respectively when tested after 96 hours soaking at 2.54mm penetration. A Dense Graded Asphalt Concrete is recommended for the construction of proposed road with a minimum marshal stability of 10000N and maximum flow of 14.

18.1.17 Embankment Material Stability

The minimum stability for embankment material is also recommended in term of California Bearing Ratio (CBR) and shall be converted to the Resilient Modules (MR) as per AASHTO guideline. A minimum CBR value of 18% is recommended for embankment layers when tested after hours soaking at 2.54mm penetration.

18.1.18 Drainage Coefficients (mi)

The drainage coefficients of granular layers (base and sub base courses) shall be determined based on sub-surface drainage quality recommended by AASHTO guideline for pavement structure design. The time required for 50% drainage shall be calculated based on the FHWA subsurface drainage guidelines for highways or may the DRIP 2.0 computer program be used. Based on the result of removal time, the mi values will be selected from AASHTO related manuals.

18.1.19 Subsurface Drainage Design

The consultant team shall visit the road alignment and study the geotechnical report in order to confirm whether it is a wetland area where the road alignment passes through, it is recommended that the consultant shall conduct a proper analysis and design for subsurface drainage layer and treatments. If required, may the subgrade layer be modified with geotextile or geogrid as required.

18.1.20 Traffic Survey for ESAL Calculation

The traffic data must include the current average daily traffic (ADT) and the 24-hour truck percentage. The Consultant shall conduct a traffic count study for at least 4 week days, Saturday, Monday, Wednesday and Friday; each day for 24 hours. Considering the fact that the pavement thickness is a function of traffic loading that corresponds to heavy trucks, efforts shall be made to capture an accurate number of trucks passing the roadway. Sometimes the heavy trucks are not traveling during the daylight due to weather conditions; therefore, it's necessary that special attention shall be taken in night shift traffic count.

The traffic shall be classified as per AASHTO/FHWA recommendations (13 classes) and the load equivalency factor of each vehicle shall be determined based on the AASHTO guide procedure but in consideration of Iraq local vehicles and loadings conditions. Consultant has to calculate the LEF for Iraq vehicles and loads.

Before data collection, the Consultant is required to submit a Traffic Data Collection Plan to UNOPS, have their approval, and also seek their advice for historical traffic data at the corridor.

18.1.21 Hydrological Analysis and Drainage Design

The finishing level of the roadway shall be above existing grade for storm water drainage and protected where necessary. Drainage of the area should be compatible with the existing terrain. The consultant shall use satellite images, or topographic maps if available, to delineate all watersheds and verify that all drainage areas are accounted for. The site shall be designed to provide a positive and effective drainage system and minimize the requirement for major structures in a cost-effective manner.

Rainfall data shall be based on data obtained from Iraqi Meteorological Authority records. In the absence of site-specific data, intensity-duration frequency curves contained in the US Army Corps of Engineers publications, Design Requirements—Hydrology can be used by extrapolating the rainfall intensity

information from the closest proximity to the project. Otherwise the consultant shall come with an alternative solution to be applicable with local conditions.
Drainage ditches are required on both sides of the road and ditches shall terminate in areas where water can drain away from road structure. Hydrological analysis of the region shall be used to determine drainage ditch and other cross drainage structure sizes.
Types, locations, size, and invert levels of proposed drainage structures shall be in conformity with the geometry of the roadway and connecting ditches. Drainage structures, and all relevant details, shall be shown on the plan and profile drawings.

18.1.22 Street Lighting Design

The Consultant shall carry out the design related to the electrical works, installations, and lighting. The layout of the street lighting works shall be presented on the plan and profile drawings supported by necessary details of pole foundation, cabling, feeder pillars, etc. the source of the street lighting shall be considered solar.

18.1.23 Road Signage and Pavement Marking

The Consultant shall prepare a scheme for road safety comprising road signage, pavement marking, and safety barriers; climate resilience measures shall be considered while developing the design and specifications . The signage and road safety devices shall be shown on the plan and profile drawings. Typical details shall be prepared for all signs (regulatory, warning, and guide signs) and sign posts including their sizes and types using current local standards. In the absence of local standards for specific details, the Consultant proposed design shall comply with MUTCD requirements. Similarly, details shall be prepared for pavement marking showing dimensions, types and patterns and symbols. Also, details of road safety barriers shall be prepared. The signage plan shall be coordinated with the local department of roads for their approval.

18.1.24 Utilities Relocation and Future Crossings

Utility data collected from site surveys and from the relevant authorities shall be reviewed, and measures for the relocation and/or protection of underground and overhead lines shall be discussed and agreed in principle with each concerned authority.
Standard drawings for relocations and protection of utilities shall be obtained from the utility authorities along with specifications and method statements.
Moreover, the Consultant shall coordinate with various utility authorities to obtain information concerning their future plans for extension of utilities in order to provide the required utility crossings and underground utility works along the alignment of the proposed and existing roads. Future crossings shall be considered every 500 to 1000 m and at junction locations in order to be used by different stakeholders in future projects.

18.1.25 Drainage Structure Design

Following the hydrological assessment and site requirements, the consultant shall develop the list of both existing and proposed drainage structures, the consultant shall assess the capacity of the condition of the existing drainage structures and accordingly propose new drainage structures where required. The consultant shall prepare structural details, design and calculations for each of the proposed drainage structures. Some of the existing drainage structures may require extensions, the

consultant shall assess the existing structures in terms of structural stability and hydraulic designs, in case if the existing structure is found insufficient a new drainage structure shall be designed as a substitute of the existing. The list of structures shall include the chinages, locations GPS, type of structures and the identification of whether it is an existing or newly proposed structure. Structural design, drawings and details must be prepared according to the industry's best practice.
The consultant shall produce construction technical specifications for road and drainage structure works.

19.0 Design Submittals Requirements

19.1.1 Design Submittals

The Consultant shall clearly label and date all Survey and Design Submittals to reflect the current design stage and date of submission to UNOPS to avoid confusion between current and previous submittals. The consultant's design submittals will be initially reviewed by the UNOPS project team in terms of package content and availability of all required documents and details, after this initial clearance, the design submittal will be shared with UNOPS design review teams for technical review and certifications. The consultant shall check the quality of the design before submission to UNOPS.
As a minimum, survey and design submittals shall be submitted in the following packages:

- Preliminary (30%) Design Submittal
- Detailed (65%) Design Submittal
- Final (100%) Design Submittal

19.1.2 Preliminary (30%) Design Submittal

As a minimum the following shall be submitted eight (4) weeks after NTP:

a. A comprehensive design brief, design criteria for geometric design, pavement design and drainage structures.

b. Key Location Maps.

c. Complete Topographic Survey Report and Topographic Maps.

d. Complete Geotechnical Investigation Report.

e. Environmental and social safeguard assessment, plans, mitigation measures all inline with UNOPS guidelines and Environmental and Social Management Framework.

f. Traffic survey/reports

g. Development of geometric design criteria for horizontal and vertical alignment, super-elevation, sight distances, sight triangles, stopping distances, etc.

h. Preliminary geometric design.

i. Hydrology report/ hydraulic calculations for drainage structures.

j. Design Drawings of the Roadway Plan; all roadway plan and profile geometry. Curves shall be numbered and curve information shall be displayed on the drawings. Slope stability measures shall be shown on the drawings.

k. List of drainage structures and necessary structural drawings at this stage.

l. Pavement Design and roadway typical cross section

19.1.3 Detailed (65%) Design Submittal

As a minimum the following shall be submitted eight (8) weeks after NTP:
In this stage of the design, the consultant shall rectify the comments given on the 30% submission, provide detailed designs, drawings, calculations and reports:

a. Complete Topographic Survey Report and Topographic Maps with consideration of the 30% design comments.
b. Complete Geotechnical Investigation Report, with consideration of the 30% design comment
c. Detailed geometric design and drawings for horizontal and vertical alignment, super-elevation, sight distances, sight triangles, stopping distances, etc.
d. Detailed design of drainage structures, design drawings, details, calculations, analysis and reports.
e. Complete design analysis showing calculations for cut/fill, hydrologic calculations for all watersheds including watershed maps, hydrologic and hydraulic calculations for all drainage structures, all roadway plan and profile calculations, super-elevation, and pavement structure.
f. Design drawings of the roadway Plan; all roadway plan and profile geometry. Curves shall be numbered and curve information shall be displayed on the drawings. Slope stability measures shall be shown on the drawings.
g. Road signage plans shall be submitted according to the agreed criteria.
h. Solar Street Lights drawings and designs,
i. Cross Sections.
j. Bill of Quantities and details cost estimation at this stage.
k. Construction Schedule
l. Draft Technical Specifications for construction
m. All other necessary detail drawings, details, calculator and design analysis report required at this stage.

19.1.4 Final (95-100%) Design Submittal- Cleared for Construction

The objective of this submission is to ensure that the detailed drawings, documents and design analysis are at the state of completion and that the comments given at 65% design review state are rectified, contract requirements and design criteria are being correctly met and adhered to. The submittal shall consist of the followings and shall be submitted in 12 (LIRA I Road) -16 (LIRA II Road) weeks after NTP:

a. Complete Topographic Survey Report and Topographic Map incorporating revisions/additions from comments from the 65% Design Submittal.
b. Geotechnical Report incorporating revisions/additions from comments from the 65% Design Submittal.
c. Complete design analysis, calculations, plans and reports for any contract feature(s) with all prior comments incorporated.
d. Complete package of Construction Specifications.
e. Complete and accurate BOQ with detailed calculation breakdowns of quantities.
f. Complete cost estimates
g. Complete and final construction schedule
h. Construction drawings complete with all prior comments incorporated. The Consultant is expected to have a comprehensive quality check of all drawings, documents, details, reports in coordination with each other, and ensure that the package is ready for final submission and issuance for tender. The drawings shall contain all the details necessary to assure a clear understanding of the works throughout construction implementation.

i. Construction methodology for road pavement works in line with the local context.

j. The final submission shall be a clear for construction package of all drawings, documents, and reports, signed and stamped by the consultant.

19.1.5 Drawings

The drawings shall comprise the following but not limited to:

- Plans and profiles of the road at 1:1000 horizontal and 1:100 vertical scale. Drawings shall include all design data for construction such as earthwork slopes, drainage structures, retaining walls, safety barriers, relocation of existing utilities and utility crossings.
- Road cross sections at 25 meters interval at scale 1:100.
- Detailed plans of junctions at 1:500 scale.
- Typical road cross-sections and pavement structures.
- Drainage details and detailed structural drawings
- Traffic Safety device details (signals, concrete barriers, guardrails, etc.)
- Pavement marking and signage plans details.
- Street Lighting plans and details.
- Utilities plans
- Miscellaneous details.

19.1.6 Language

All specifications, drawings, design analysis, design calculations, catalog data, and materials list submitted shall be in the English language.

19.1.7 Units of Measurement

Design drawings shall be prepared by metric measurements. The metric units used are the International System of Units (SI) developed and maintained by the General Conference on Weights and Measures (CGPM).

19.1.8 Drawing Scale

Every drawing submitted shall have a properly graphic and numeric scale of 1:1000, unless otherwise required, that is properly dimensioned.

19.1.9 Geo-Reference

All site plans shall be geo-referenced using the WGS 1984 coordinate system, specifically the following: WGS 1984 UTM local Iraq zone. If the designer is not able to use the stated coordinate system, the coordinate system used shall be correlated to the stated coordinate system. A table shall be provided within the site drawing set cross referencing the WGS84 system to that utilized.

19.1.10 Drawing Layers

Standard drawing layers shall be used and follow the guidelines of CADD standards. For AutoCAD, .dwt (drawing template files) shall be used to import the proper layers that will be inclusive of the correct line type, color, and line thickness of the respective layer.

19.1.11 Legends

For each submittal, legends of symbols and lists of abbreviations shall be placed on the drawings. They shall include all of the symbols and abbreviations used in the drawing set, but shall exclude any symbols and abbreviations not used. Since many symbols are limited to certain design disciplines, there is a definite advantage to the use of separate legends on the initial sheet of each design discipline.

19.1.12 Binding

All volumes of drawing prints shall be firmly bound and shall have covers of heavier bond than the drawing sheets.

19.1.13 Independent Design Review

The Consultant shall have someone other than the Designer or Design Team to perform an Independent Technical Review of all drawings, design analysis, calculations, and other required data prior to submission to UNOPS. This review shall ensure the professional quality, technical accuracy, and the coordination of all design analysis, drawings and specifications, and other services furnished under this contract have been accomplished. Work must be organized in a manner that will assure thorough coordination between various details on drawings, between the various sections of the specifications, and between the drawings and specifications. Upon completion of this review, the Consultant shall certify that each design submission is complete, accurate, and is in strict conformance with all contract requirements.

Design submittals Cleared for Construction by UNOPS shall not relieve the Consultant from responsibility for any design errors or omissions and any liability associated with such errors, nor from responsibility for complying with the requirements of this contract.

19.1.14 Procedure for Design Submittals

Uniform covers shall be used by the Consultant on all design submittals and shall have the following as a minimum:

- Consultant (Firm Name)
- Contract Number
- Contract Name

- POC (Full Name and Contact Information)

- UNOPS will provide the drawings and title block templates

For all submittals the following must be included in the submittal package to be considered acceptable.
Submittal package will include one (3) A3 size hard copy and 3 (3) soft copies on CD-ROM (electronic version of all documents and drawings, drawings shall be both in Autocad and PDF). Submittal cover sheet is required for all design drawings, topographic survey report, all specifications, design analysis, geotechnical investigation report, and all other documentation required in the contract. All hard copies and soft copies should be arranged in identical format. If Submittal is deemed unacceptable at pick up, submittal will be pushed back and a new arrangement for drop off and will be coordinated at a future time and date.
An editable CADD/Civil 3D and other design software format of drawings and design files shall be submitted to UNOPS for references.

19.1.15 UNOPS Review of Consultant Prepared Design

The work under contract will be subject to continuous review by representatives of UNOPS project teams and the UNOPS design review team which will be appointed for this particular design review. The Consultant shall furnish copies of all drawings and related documents to be reviewed at the review meeting on or before the date indicated by UNOPS. Additional meetings pertaining to specific problems may be requested by the Consultant or may be directed by UNOPS as necessary to progress the work. The Consultant shall prepare minutes of all meetings and shall furnish a copy to UNOPS within three (3) days after the meeting via email.

a. After receipt of a Design Submittal, UNOPS will be allowed seven (7) full days to review and comment on 30% design and 14 days to to review and comment on the 65% and 7 days on the final detailed design Submittals. This time period starts on the next full day after delivery of the Design Submittal to UNOPS.
b. Upon completion of the review the Consultant will be notified by the UNOPS Representative about requests to respond to UNOPS comments.

19.1.16 Incorporation of UNOPS Review Comments

a. The Consultant shall review each comment and furnish a complete response via email within three (3) days as to how the comment will be addressed in the Design Submittal. The Consultant will then incorporate each comment into the design submittal along with other work required at the next Design Submittal stage.
b. If the Consultant disagrees technically with any comment or comments and does not intend to comply with the comment, he must clearly outline, with ample justification, the reasons for noncompliance within five (5) days after the close of review period.
c. Consultant is cautioned that if he believes the action required by any comment exceeds the requirements of this contract, he should notify UNOPS in writing within five (5) days.

20.0 Design Quality Requirements

The Consultant shall provide and maintain a Design Quality Control (QC) Plan to ensure that all services required by this contract including topographic survey, geotechnical investigation, and design are performed and provided in a manner that meets professional and engineering quality standards. The Consultant shall submit the QC Plan to UNOPS for approval within two (2) weeks after Contract Award.

All site activities of topographic survey, site and lab activities of geotechnical investigation, documents, drawings, and reports shall be monitored and technically reviewed by the Project Manager. The QC Plan shall cover the following at a minimum:

- General quality control procedures
- Procedures of sampling and testing of materials as part of geotechnical investigation
- Type, procedure, and frequency of materials testing as part of geotechnical investigation
- Structure of the Design Quality Control procedures
- Geometrical designs quality control procedures
- Procedures of topographic survey and generation of topographic map
- Procedures of producing design submittals
- Procedures of reviewing design submittals
- Procedures of submission of design submittals
- Procedure rectification of of UNOPS design review comments
- Any other, specified by the contractor according to this ToR and contract requirements.

All errors and deficiencies in the design documents shall be corrected prior to submission to UNOPS.

The QC Plan shall be implemented by the Project Manager who has the responsibility of being cognizant of and assuring that all documents on the project have been coordinated. This individual shall be a person who has a verifiable engineering degree in transportation engineering and has proven road design management experience. The Consultant shall notify UNOPS, in writing, of the name of the individual assigned as the Project Manager and stating that he shall be in charge of QC Plan implementation.

UNOPS will notify the Consultant in writing of the acceptance of the QC Plan. After acceptance, any changes proposed by the Consultant are subject to the acceptance of UNOPS.

21.0 Key Experts' requirements:

The project team of the consultants would include but not limited to, the following key and non-key staff.

S. No.	Staff Position	Number	Estimated Person Month
A-Key Experts			
K-1	Team Leader/Senior Highway Engineer	1	as per contract
K-2	Resident Engineer/Structural Design	1	as per contract

K-3	Pavement and Material Engineer	1	as per contract
K-4	Highway Design Engineer	2	as per contract
K-5	Chief Geotechnical Engineer	1	as per contract
K-6	Chief Topographic Survey Engineer	1	as per contract
K-7	Chief Hydrological Engineer	1	as per contract
B-Support to Experts			
K-8	Assistant Highways Engineer/CADD	2	as per contract
K-9	Quantity Engineer	1	as per contract
K-10	Structure Engineer	1	as per contract
K-11	Road Traffic and Safety Engineer	1	as per contract
K-12	Environmental and Social Safeguard Specialist	1	as per contract
K-13	Survey Engineer	2	as per contract

Note:

- The consultant may propose alternate team composition in order to fulfill the contact requirements.

21.1 KEY STAFF'S MINIMUM QUALIFICATIONS

The job descriptions and minimum qualification of the key/other professionals for the core Team of the Consultants shall be as given below:

SL	Positions	Minimum Qualification
K-1	**Team Leader/ Senior Highway Engineer**	**Education**: Master Degree in civil engineering/Road Construction. **Experience** (10) years' general technical works (7) years' Experience in similar road projects and position as Team Leader or Senior Highway Engineer, he shall be involved in reviewing designs, supervision and contract administration in flexible pavement construction.

K-2	**Resident Engineer**	**Education: Bachelor's** Degree in Civil engineering or equivalent, preferably Master in Road Construction/ highways **Experience: (**10 years' experience on road construction projects, with a minimum of (7)-years' experience in similar capacity /assignment as Resident Engineer/ Project Manager.
K-3	**Pavement and Material Engineer**	**Education;** BSc civil engineering is required, Master's degree preferred in Transportation/Material Engineering or equivalent, specialized in pavement design and material engineering of road projects. **Experience**; Overall minimum professional experience (7) years in design and construction of road/highways pavement projects and material. At least (5) years as Pavement/ Materials Engineer for similar road projects. He should have supervision experience of at least 5 highway projects with similar size.
K-4	**Highway Design Engineer**	**Education**: Bachelor's Degree in Civil or equivalent, preferably Master degree in transportation or civil engineering. **Experience:** should have overall experience of (7) years as a road design engineer. (5) Years' experience must have major transportation infrastructure/ road highways projects in a similar position and he should be fully familiar with preparation and implementation of highway design. .
K-5	**Chief Geotechnical Engineer**	**Education**: Bachelor's Degree in Geotechnical or Civil Engineering, preferably Master degree in geotechnical or transportation engineering. **Experience:** should have overall experience of (7) years as a geotechnical engineer. (5) Years' experience must include major transportation infrastructure/ road highways projects, geotechnical investigations and design.
K-6	**Chief Topographic Survey Engineer**	**Education**: Bachelor's Degree in Civil Engineering, preferably Master degree in civil or transportation engineering. **Experience:** should have overall experience of (7) years as a survey engineer. (5) Years'

		experience must include major transportation infrastructure, road and highways projects, topographic survey and generating of related maps.
K-7	**Chief Hydrological Engineer**	**Education**: Bachelor's Degree in Hydrological or Hydraulic Engineering, preferably Master degree in Hydrological or Hydraulic Engineering. **Experience:** should have overall experience of (7) years as a hydrologist or hydraulic engineer. (5) Years' experience must include major transportation infrastructure, road and highways projects, hydrological assessment, hydraulic design of drainage structures and generating or related reports.
K-10	**Structures Engineer**	**Education:** Bachelor Degree in Civil Engineering with post-graduation in structural engineering. **Experience**: (7) years' experience in design and construction of structures of road projects. Experience in design and construction of culverts, retaining/protection structure, side drain, irrigation canals etc.
K-11	**Road Traffic and Safety Engineer**	**Education:** Bachelor's Degree in Civil engineering, preferably in traffic or transportation engineering. **Experience**: (7) years' general technical experience for road projects. Minimum (5) years' similar experience as traffic engineer with having experience in traffic analysis and forecasting and road safety analysis during and after construction works, and working on similar traffic or road safety improvement assignments.

21.2 Payment Schedule

Report	Payment (% of total)	Expected submission time from Commencement Date
Installment 1 – Submission of Preliminary Design (30%)	20%	According to the submissions
Installment 2 – Submission and approval (by UNOPS) of 65% design	60%	
Installment 3 – Submission and approval (by UNOPS) of final 100 designs and reports.	85%	
Installment 4 – Providing Engineering Supports during implementation of civil works contracts	100%	

B. Engineering Supports to be provided during implementation of the civil works contract:

The consultant shall provide engineering support during the implementation of the civil works contract. This includes:

- Design modifications when required during construction
- Correction of drawings when required required during construction
- Providing feedback on the contractor's construction methodology
- Providing construction oversight advisory support by conducting at least 4 site visits during the implementation of the civil works in coordination and upon request of the UNOPS project manager. Check the conformity of the implemented works with the design and specifications developed by the consultant.
- Provide necessary quality management advisory support especially on the material inspections and mix designs.
- Reply to technical queries issued by UNOPS related any required verification or clarifications on the design and documents during tendering and execution stages of civil works contracts.
- Answering bidders' technical queries during the tendering process.
- Attend at least 4 project meetings during procurement and executions of the civil works upon request from UNOPS.