PDH Project

TECHNICAL SPECIFICATION FOR GROUND INVESTIGATION

2017.11.08

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Dokument do zatwierdzenia przez osobę posiadającą wymagane uprawnienia zgodnie z obowiązującym prawem budowlanym - z ramienia Wykonawcy
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APPENDICES

Appendix 1.1 Soil Investigation Plan Site I Stage 3 & V
Appendix 1.2 Soil Investigation Plan Site VI
1 SCOPE AND OBJECTIVES

The present document details the programme and the technical specifications for the (supplementary) ground investigation to be carried for the site preparation and foundations design of the structures to be constructed for the facility of PDH and PP units located in the western part of Grupa Azoty Zaklady Chemiczne Police S.A. Plant.

Previous ground investigation has been carried out in the area of interest in 2015-2016. The ground investigation specified hereafter is intended to provide information about ground conditions, with particular reference to the new PDH Unit, PP Unit, Harbour facilities and OSBL (Outside Battery Limits) utilities i.e. auxiliary units, utilities and infrastructures.

UXO survey shall be carried out prior to execution of soil tests – to be agreed between the COMPANY and the SUBCONTRACTOR.

Figure 1 Soil tests locations

In particular, the ground investigation to be carried out shall provide the following information:

- Presence of existing underground services/foundation close to the location of the investigation points – for the safety reasons;
- Identify and characterize all possible geohazards;
- Determine/confirm soil profile and present variability within the Project area;
- Determine/confirm geotechnical parameters for design;
- Determine/confirm permeability of foundation soils;
- Determine groundwater levels;
- Determine groundwater regime and permeability;
• Determine the dynamic properties of foundation soils;
• Determine chemical characteristics of soils and groundwater to evaluate aggressiveness on buried structures and possible special requirements for handling and disposal of excavated material;
• Present potential contamination of soils and groundwater;
• Determine electrical resistivity of foundation soils at the site, for the design of earthing and as an additional measure of aggressiveness on buried structures;
• Determine thermal conductivity of foundation soils at the site (if requested) for the design of buried electrical cables;
• Characterize possible swelling behaviour of the clays.

Other issues regarding a final or more extensive evaluation of the environmental conditions of the site, including possible existing pollution of ground and groundwater, are beyond the scope of this document, except in so far as they need to be considered for the health and safety of personnel involved in performing the ground investigation.

The number, type and depths of field tests, as well as the technical requirements, are described in detail in this specification and drawings (the Appendices 1.1, 1.2 “Soil investigation plans”).

2 SITE PLANT DESCRIPTION

The site is located within the existing Grupa Azoty Zaklady Chemiczne Police S.A. and in harbour area. Map of the investigation area is in Appendices 1.1 & 1.2 – Soil Investigation Plans.

3 DEFINITIONS

The following definitions are applied in the present document:

COMPANY: PDH Polska S.A.

COMPANY representative: the Firm acting as technical supervisor of investigation at site.

SUBCONTRACTOR: the specialized firm Contracted by the Company, which will carry out the investigation specified herein.

PROJECT: PDH Project consisting of the new PDH Unit, PP Unit, Harbour facilities and OSBL (Outside Battery Limits) utilities i.e. auxiliary units, utilities and infrastructures.
Any reference in this Specification to COMPANY shall be deemed to include reference to any nominated representative for the purposes of the ground investigation, whose qualification to this effect shall be notified in writing to the other parties.

Occasional reference in the Specification or omission thereof to SUBCONTRACTOR’s Site Representative shall not be construed to limit the generality of the above.

4 REFERENCE DOCUMENTS

4.1 Previous investigation

1. Extract from the Geotechnical Documentation for the new Propane Dehydrogentaion Plant (wyciąg z Opinii Geotechnicznej wraz z Dokumentacją Badań Podłoża Gruntowego dla inwestycji polegającej na budowie instalacji do produkcji propylene metodą PDH).

4.2 Reference standards – geotechnical

The ground investigations shall be carried out in accordance with the technical specifications written in the following paragraphs, relevant EN (EN 1997-2), ISO Standards and with the technical specifications written in the following paragraphs and applicable Laws and National Regulations and Technical Standards for environmental research. Where particular reference is not available, an alternative internationally accepted standard (BSI and ASTM standards) shall be adopted to the approval of the Company representative. In the following paragraph 4.2 a list of International Standard is provided for easy reference.

[2] PN-EN-206 Beton - Wymagania, właściwości, produkcja i zgodność
[4] ASTM D 421 Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
[5] ASTM D 422 Particle Size Analysis of Soils
[11] ASTM D1140-00 Standard Test Methods For Amount Of Material In Soils Finer Than The No. 200 (75-Um) Sieve
[14] BS 1377:1990 “Methods of test for soils for civil engineering purposes”
[15] ASTM D 1556 Density of Soil in Place by Sand Cone Method
[16] ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
[17] ASTM D 1586 Standard Penetration Test and Split Barrel Sampling of Soils
[18] ASTM D 1587 Thin Walled Tube Sampling of Soils for Geotechnical Purposes
[19] ASTM D 2166 Unconfined Compressive Strength of Cohesive Soil
[20] ASTM D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock by Mass
[21] ASTM D2217-85 Standard Practice For Wet Preparation Of Soil Samples For Particle-Size Analysis And Determination Of Soil Constants
[22] ASTM D 2435 One Dimensional Consolidation Properties of Soils Using Incremental Loading
[23] ASTM D 2487 Classification of Soils for Engineering Purposes
[25] ASTM D2573-94 Field Vane Shear Test in Cohesive Soils
[26] ASTM D 2850 Unconsolidated, Undrained Triaxial Compression Test on Cohesive Soils
[27] ASTM D 3080 Direct Shear Test of Soils Under Consolidated Drained Conditions
[28] ASTM D 3370 Sampling Water from Closed Conduits
[29] ASTM D 3550 Thick wall, ring-Lined, Split Barrel, Drive Sampling of Soils
[31] ASTM D 4186 One Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading
[33] ASTM D 4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
[34] ASTM D 4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
[37] ASTM D 4373 Rapid Determination of Carbonate Content of Soils
[38] ASTM D 4429 Standard Test Method for CBR (California Bearing Ratio) of Soils in Place
[39] ASTM D 4546 One Dimensional Swell or Settlement Potential of Cohesive Soils
[40] ASTM D 4767 Consolidated Undrained Triaxial Compression Test for Cohesive Soils
[41] ASTM D4829-95 Expansion Index Test
[42] ASTM D4972-95 Standard Test Method For Ph Of Soils
[43] ASTM D5030-89 Standard Test Method For Density Of Soil And Rock In Place By The Water Replacement Method In A Test Pit
According to the Polish regulations:

Acts of the law and executive regulations in the field of Geological and Mining law:

- Ustawa z dnia 9 czerwca 2011 r. Prawo geologiczne i górnicze (tekst jednolity Dz.U. z 2015 r. poz. 196)
- Rozporządzenie Ministra Środowiska w sprawie szczegółowych wymagań dotyczących projektów robót geologicznych, w tym robót, których wykonywanie wymaga uzyskania koncesji z dnia 20 grudnia 2011r. (Dz.U. Nr 288, poz.1696) wraz z późniejszymi zmianami.
- Rozporządzenie Ministra Transportu i Gospodarki Morskiej z dnia 25 kwietnia 2012r „w sprawie ustalania geotechnicznych warunków posadowienia obiektów budowlanych” (Dz.U.poz.463).
- Rozporządzenie Ministra Środowiska w sprawie dokumentacji hydrogeologicznej i dokumentacji geologiczno-inżynierskiej z dnia 8 maja 2014r. (Dz.U. z 2014r. poz.596).

5 **SUBCONTRACTOR DUTIES**

5.1 **General**

All investigation activities and tests shall be carried out and reported in accordance with the agreed time schedule and the technical requirements given in this Specification and in relevant Reference standards. Other international standards may be used as reference standards, subject to the approval of COMPANY, where the particular activity or test is not covered by PN, EN, ASTM or BS standards. Any changes, due to operational difficulties of the SUBCONTRACTOR, must be previously discussed and authorized in writing by the COMPANY representative.

Where conflict may arise between the technical requirements detailed in this Specification and the relevant standard, well in advance of performing the specified activity this will be brought to the attention of the COMPANY representative whose decision on the matter will be binding for the SUBCONTRACTOR.

All investigation activities and tests shall be carried out in full compliance of all applicable National and Local laws, rules and regulations including but not limited to provisions related to Health and Safety, Environment and control of pollution.
5.2 **Healthy safety and environment**

Full care and precaution shall be taken by the SUBCONTRACTOR for health and safety of the workmen in the field and in the laboratory to prevent accidents during the execution of the works, according to applicable Laws and COMPANY safety plans.

5.3 **Company requirements and underground utilities**

The SUBCONTRACTOR shall ascertain in advance of the investigation and abide by any special requirement of the COMPANY in relation to working on the COMPANY’s property, including but not limited to obtaining from the COMPANY all applicable permits (e.g.: confined space, excavation; hot works, etc.).

In any case, the SUBCONTRACTOR shall check for underground utilities at every location to be investigated by using underground detection equipment and/or excavating test pits up to 2.0 m depth.

The SUBCONTRACTOR shall perform all work at a sufficient distance from underground and above ground utilities and/or shall adopt every necessary precaution in order to protect personnel and equipment, according to the National, Local and Site-specific safety regulation.

5.4 **Setting-out and survey of „as built“ location**

The SUBCONTRACTOR shall be responsible for the correct staking out of investigation points and for measuring their coordinates and elevation relative to official survey and/or COMPANY benchmarks. Coordinates and elevations shall be measured to 10cm and 5cm precision respectively. Coordinates and elevations shall be reported on logs.

5.5 **Disposal of surplus material and restoring the site to the original condition**

The restoration of the site shall be carried out in accordance with the requirements of National legislation and regulations.

5.6 **Detailed planning of laboratory tests**

All undisturbed and remoulded samples shall be delivered to an approved geotechnical laboratory without delay. A copy of the preliminary borehole or exploratory pit log and of the sample list will be sent to the laboratory together with the samples to be analysed. A copy of the same will be sent to the COMPANY representative at the same time.

As the investigation progresses, within the overall framework described in these Specifications, the SUBCONTRACTOR shall prepare detailed laboratory testing schedules for samples from each borehole or exploratory pit. A copy of this document will be given or sent to COMPANY representative for approval, which approval shall be deemed to have been granted unless otherwise communicated within three working days. Irrespective of any express or tacit approval to said laboratory testing schedules, tests carried out in excess of the presumed quantities stated in this Specification shall not be paid unless previously specifically approved in writing to that effect.
Once approved, the detailed testing schedules will be sent to the laboratory, for timely implementation. It shall be the responsibility of the SUBCONTRACTOR immediately to notify the COMPANY representative if samples are unsuitable for the testing specified in the testing schedule and/or if samples differ significantly from the descriptions in the preliminary borehole or exploratory pit logs and to propose revised testing schedules accordingly.

5.7 Documents

All documents, reports, correspondence, mapping and drawings shall be in both Polish and English; dimensions, elevations and units shall be according to The International System of Units (SI). Documents submitted to Authorities for approval (Geological works design, Geological-engineering documentation, Soil investigation report, Geotechnical project) shall be prepared in Polish language as well in accordance with Authorities requirements.

All documents, reports, correspondence, mapping and drawings shall bear a unique reference number, revision index and date of issue. If requested, reports and drawings shall also bear a reference number and revision index indicated by COMPANY representative in accordance with his own document management system.

Drawings shall be prepared using AutoCAD program and delivered in the form of AutoCAD format that also matches with COMPANY drafting requirements. Other documents using MS Word/Excel programs. All documentation shall be delivered in the form of a hard copy and electronic files (pdf and editable).

Drawings and reports shall also include such translations, certificates, signature and/or stamps by qualified professionals and/or such other formalities as may be applicable for the reports to be submitted officially as part of applications for permits in accordance with national and local regulations.

Within the time specified in the Order, the SUBCONTRACTOR will submit to the COMPANY the Geological-engineering documentation, Soil investigation report and Geotechnical project, in accordance with the requirements detailed in this Specification. Initially this report will be submitted in draft, for approval. The Final Geological-engineering documentation, Soil investigation report and Geotechnical project will be submitted taking into account any given comments.
6 PROGRAMME OF GROUND INVESTIGATION

The program detailed below may be modified during the site investigation, at the instruction or subject to the approval of the COMPANY representative, to suit the geotechnical conditions actually encountered and/or due to existing underground facilities which force the program and/or the location of tests to be modified.

6.1 Field tests

Field tests to be carried out are:
- geotechnical boreholes,
- environmental boreholes,
- piezometers,
- exploratory pits,
- in-situ density tests,
- electrical resistivity tests (if requested),
- thermal resistivity tests (if requested),
- CPTU tests (if requested),
- SCPTU tests (if requested),
- DMT (if requested),
- MASW tests (if requested),
- seismic wave refraction tests.

Manner of performance of particular tests is detailed in item 8 of this Specification.

Location, typologies and quantities of field tests listed below are provided in Appendices 1.1 & 1.2 – Soil Investigation Plans.

6.2 Geotechnical laboratory tests

Geotechnical laboratory tests shall be carried out on selected samples of soil and groundwater in accordance with the following guidelines:
- Opening and geotechnical description of all undisturbed and SPT soil samples;
- Determination of natural water content, bulk unit weight and Atterberg’s Limits on all undisturbed samples collected in cohesive soil;
- Sieve analysis on selected undisturbed and disturbed or remoulded soil samples, including those obtained by SPT tests, supplemented by hydrometer analyses and Atterberg’s Limits if fines content exceed 15%;
- Determination of specific gravity on selected soil samples;
- Minimum and maximum dry density;
• Modified Proctor Compaction test;
• Incremental Loading edometer tests to 20% strain or to 3200 kPa vertical stress, whichever occurs first, including unloading steps, on selected undisturbed samples;
• Edometer tests carried out according to procedures Method B and Method C fo ASTM D 4546 for wetting-induced swell measurements. Alternatively Huder-Amberg swelling test procedure can be proposed;
• Unconsolidated undrained triaxial (Tx-UU);
• Triaxial undrained (Tx-ICU) single stage tests with pore pressure measurement on selected undisturbed or reconstituted samples consolidated isotropically to the field vertical effective pressure;
• Triaxial drained (Tx-ICD) single stage tests on selected undisturbed or reconstituted samples consolidated isotropically to the field vertical effective pressure;
• Triaxial drained (Tx-ICD) with small displacement measurements and wave velocity measurements;
• Direct shear tests on selected soil samples;
• Incremental loading (IL) consolidation tests, including determination of compression index and of coefficient of consolidation: up to and including a maximum load of 3.2 N/mm2;
• Determination of organic content on selected soil samples;
• Chemical tests on selected soil samples;
• Chemical tests on groundwater sample.

In accordance with the duties and procedures and subject to the conditions specified in the relevant section of these specifications, the SUBCONTRACTOR shall be responsible for defining the detailed programme of laboratory tests in relation to the ground conditions actually encountered in boreholes. The above program shall be sent to Company representative for approval.

6.3 Chemical laboratory tests

6.3.1 Soil and groundwater chemical test

Soil and groundwater samples shall be analyzed for the parameters listed below:

• Aggressiveness towards concrete and steel;
• Heavy metals;
• Total Petroleum Hydrocarbons;
• BTEX;
• Polyaromatic hydrocarbons;
• Nitrate;
• Pesticides.

Groundwater samples taken from piezometers shall be additionally tested for:

• sulphate ion content;
• chloride ion content;
• total salt content;
• pH.

6.3.2 Environmental chemical test

Final scope of chemical analysis, if requested, shall be confirmed by Party responsible for Environmental Impact Assessment.

7 TIME SCHEDULE

The SUBCONTRACTOR shall complete the requested investigations within the agreed time schedule.

8 GEOTECHNICAL FIELDWORK – TECHNICAL SPECIFICATIONS

8.1 Boreholes

Boreholes shall be carried out by rotary drilling with full core recovery or with flight auger drilling (According to the SOIL INVESTIGATION PLAN). If fine to medium dense granular soils are encountered, SPT tests shall be carried out every 1.0m in the top 10m, every 1.5m up to 25m and every 3.0m thereafter. If soft cohesive or cemented soils are encountered, alternate undisturbed sampling and SPT tests shall be carried out, every 1.0m in the top 10m, every 1.5m up to 25m and every 3.0m thereafter, starting with undisturbed sampling. On site testing on cores will include test with pocket penetrometer (calibrated to measure resistance up to 2 MPa) and undrained shear resistance by pocket vane.

Ground water measurements shall be made inside each borehole after stabilization of the water table, recording both the depth at which groundwater is encountered and the stabilized level and recorded on the borehole log.

Falling head or constant head permeability tests shall be performed as appropriate (depending on soil type) at 1.0m and 3.0m depth below equilibrium groundwater level in boreholes where piezometers are foreseen. The drilling equipment shall be capable of installing temporary steel casing, in order to assure borehole wall stability at any stage of the drilling through soil or weathered rock.

Boreholes shall be carried out with equipment suitable to comply with the following requirements, including but not limited to advancing the borehole and casing to the specified depth and by the specified method.

Full-length temporary steel casing is recommended for the entire depth of the hole. Provided that the borehole walls remain stable and the bottom remains clean from debris and subject to the approval of the COMPANY representative, polymer mud can be used as an alternative.

In particular it is recommended to avoid the use of bentonite mud in order to prevent possible alterations in the chemical characteristics of the samples for the first 3 m of depth, where environmental sampling is planned.
When advancing the borehole in cohesionless strata below groundwater level, the hole shall be kept full of fluid at all times to prevent piping.

All necessary steps will be taken to ensure that total core recovery is not less than 70% of sampled length (after discounting the section disturbed by the SPT test or undisturbed sampling).

Minimum core diameter shall be 100mm. The diameter of drilling tools shall not exceed 160mm. The actual diameter used shall be reported on the logs.

Diamond bits shall be used, if necessary. Fluid discharge holes or passages on rotary tools are to be located to avoid disturbance at the hole bottom.

Recovered cores shall be placed in core boxes of stout construction, lined with polythene. Depth of start and end of each core section will be shown using indelible markers. A zenithal colour photograph of each core box taken immediately after sampling shall be included in the Factual Report with a suitable colour reference chart. Soil cores shall be cleaned on the upper face before visual description.

Core boxes shall be stored protected from direct sunlight, for minimum 12 months, on site or at SUBCONTRACTOR’s facilities at the discretion of COMPANY representative.

The absence of debris on the hole bottom shall be checked before performing each SPT and undisturbed sampling.

When encountering groundwater, drilling shall be suspended and the equilibrium level shall be measured and reported on the borehole log.

Groundwater levels in boreholes at the start and at the end of drilling every day will be measured and reported on the borehole log, together with the daily progress of drilling and casing installation.

Boreholes not used to install instrumentation shall be grouted from the bottom of the hole up, using a grout mixture of clean fresh water, bentonite and Portland cement, 100-6-40 parts by weight, respectively. Water shall be from a source approved by COMPANY representative.

Soil and rock samples and cores shall be classified in the field using relevant EN ISO 14668 as a reference to write the field log of boring.

Pocket penetrometer and undrained shear resistance by pocket vane readings measured in the field at the bottom of all cohesive undisturbed samples shall be recorded on log.

Different methods of drilling and coring, proposed by the SUBCONTRACTOR, shall be submitted in advance for approval.

8.2 Sampling boreholes

8.2.1 General

All samples will be clearly labelled and stored in a fresh suitable place before dispatch to the laboratory. Samples shall be protected from direct sunlight at all times. Storage and transport of undisturbed samples shall be in accordance with relevant standard EN-1997-2(ISO -22475-1).
8.2.2 Undisturbed sampling

If fine grained (silt and clay) materials are encountered during drilling, undisturbed sampling shall be performed using suitable samplers, chosen accordingly to the consistency of the soil to be sampled as follows:

- In soft to firm soils: thin wall piston sampler having minimum 100mm inner diameter;
- In stiff soils: open thin wall sampler (i.e. Shelby) having minimum 76mm inner diameter;
- In very stiff to hard soils and dense and/or cemented granular soils: double tube rotational sampler with the cutting shoe of the sample tube protruding ahead of the core bit (i.e. Improved Denison sampler or similar), having minimum 100mm inner diameter.

All types of samplers shall have working length not less than 600mm.

Before each sampling operation the bottom of the hole shall be checked; in presence of more than 50mm of unexpected materials (debris, piping), the hole shall be cleaned before inserting the sampler in the borehole.

Undisturbed sampling requires the sampler to penetrate into the soil in a single continuous stroke.

Both ends of each undisturbed sample shall be cleaned disposing of debris and remoulded-wetted materials and sealed with molten wax.

Undisturbed samples shall be clearly labelled indicating details of job site, borehole, serial number, depth, top/bottom and stored in a fresh suitable place before dispatch to the laboratory.

8.2.3 Disturbed sampling

Semi-disturbed samples shall be extracted on site, described, sealed in strong plastic bags, clearly labelled indicating details of job site, borehole, serial number, depth and stored in a fresh suitable place before dispatch to the laboratory.

8.2.4 Environmental sampling

These BH shall be carried out by rotary drilling with continuous coring and record of the soil stratigraphy to 6 m depth. In each borehole, pairs of remoulded samples suitable for chemical analysis shall be collected at 0.0 to 0.5 m; 1.0 to 1.5 m and 2.0 to 2.5 m, 3.0 to 3.5 m, 4.0 to 4.5, 5.0 to 5.5 m. If encountered, groundwater entry level and equilibrium levels shall be observed and recorded on the borehole log. Environmental and geotechnical boreholes shall be carried out at minimum distance of 2.0m from each other.

The extrusion of the samples from the core barrels shall be carried out without the use of fluids; in particular, for this purpose, it is recommended the use of a piston extruder at site. Soil samples shall be stored in core boxes, examined and described in the field following ASTM D2488 as a reference, reporting, in addition, all evidences of potential contaminations (visual or olfactory evidences). Soil samples shall be taken from core boxes (in case of use of simple, double or triple core barrels) at depths indicated in the soil investigation programmes and delivered to the laboratory to be subjected to the chemical analyses listed in the laboratory programme. Soil shall be taken from core boxes by field technicians with nitrile gloves and carefully put into clean glass jars, with hermetic seal and
wrapped up with tinfoil. Each sample shall be labelled with borehole ID, sample ID, collection depth, date and time of sampling, project and client references. In case of use of percussion methods, samples shall be directly delivered to the environmental chemical laboratory.

In case that contamination evidences are observed at different depths from those listed in the soil investigation programme, additional samples shall be collected, even in stiff cohesive soils.

In case that contaminants in free phase are observed during drilling, the thickness of the free phase shall be measured by means of an interface probe.

Different methods of drilling proposed by the SUBCONTRACTOR, shall be submitted in advance to the COMPANY for approval.

Decontamination procedures

At the end of every sampling phase (both during boreholes perforation, and during exploratory pits excavation) all the equipment employed shall be carefully decontaminated with high pressure clean water before the execution of a new sampling phase.

Samples quantities, handling and transport

Samples shall be composed of soil quantities agreed by COMPANY with the laboratory charged for the analyses. All equipment used for soil sampling shall be in adequate conditions to avoid possible cross-contaminations of samples.

After sampling soil samples shall be temporary stored in refrigerators (temp. 4°C), and transported to the laboratory maintaining a constant temperature. Samples shall be delivered to laboratory without delay and in any case within the times specified by the reference procedures, if applicable, as indicated by the chemical laboratory.

8.3 Standard penetration test (SPT) and associated samples

SPT tests shall be carried out according to the relevant standard EN 1997-2(ISO 22476-3).

A split spoon sampler shall be used with 35mm inner diameter. All inner parts of the sampler shall have the same diameter.

An automatic trip free fall hammer shall be used.

Before each test is carried out, the bottom of the hole shall be checked. In the presence of more than 70mm of unexpected materials (debris, piping), the hole shall be cleaned before inserting the SPT equipment in the borehole.

The number of blows necessary to achieve the penetration of each of three successive 150mm sections shall be recorded. The total length of penetration shall be 450mm unless a greater depth of penetration is achieved by self-weight or a single blow. In each section, refusal shall be defined as 50 blows failing to achieve a penetration of 150 mm.

In the case of refusal, the penetration obtained with the last 50 blows will be measured and recorded on the log.
The length of the recovered sample shall be measured, disposing of any debris in the upper part and in the cutting shoe. The sample shall be described and closed in a plastic bag.

The test results shall be recorded on the borehole log even if no sample is recovered in the sampling tubes.

SPT samples shall be clearly labelled indicating details of job site, borehole, serial number, depth and stored in a fresh suitable place before dispatch to the laboratory.

8.4 CPTU Test

CPTU shall be carried out for identification of soil type and soil stratification and to determine soil properties.

CPTU tests, shall be carried out to a maximum depth of 20 m from G.L. if refusal is reached in the first 2,5m, predrilling shall be carried out to continue the tests.

Static cone penetration tests with measurement of piezometric pressures shall be carried out in accordance with the ASTM D5778-12. Tests shall be carried out with a penetrometer having thrust not less than 20 tons. An enlarging ring can be installed at the bottom of the pushing rods in order to reduce total lateral friction.

Preborings shall be drilled to overcome obstacles in case of refusal within the top 2,5 m below existing g.l. Optionally, obstructions within 2,5 m depth may be excavated and replaced with compacted sand.

The cone shall be standard and equipped to measure both point resistance (full scale 5 t) local lateral friction and piezometric pressures. Electrical instrumented cone will be used. Penetration will be carried out at a constant penetration rate of 20 mm/s. Point resistance, lateral friction, pore water pressure and deviation from the verticality will be measured continuously during penetration; all the readings will be recorded at intervals not higher than 50 mm.

The relevant certificate of calibration shall be available on site. Calibration shall cover the full reading range, with special attention to low values of resistance.

The calibration curve must always be used in determining the actual values of point resistance and side friction.

The graphs showing the various parameters being measured must be available at the surface at the time of testing. They must be made available to the COMPANY at the end of the test as hard copy of preliminary results. The Factual Report shall include all tests results both as hard copy and as electronic files in a modifiable format (ASCII, xls or other to be agreed).

It is important to assure complete saturation of the filter ring of the porewater (piezo) element. If necessary, a preboring shall be drilled down to the watertable, and a PVC tube installed filled with water. The cone shall then be lowered into the tube.
8.5 Dilatometer Test (DMT)

DMT shall be carried out for identification of soil type and soil stratification and to determine soil properties.

These tests will be carried out only if CPTU tests will be able to reach not less than 15 m from G.L.

Dilatometer tests shall be carried out in accordance with the ASTM D6635-15. Tests shall be carried out with a penetrometer rig having thrust not less than 20 tons. The test will stop at 20 m or at refusal, if shallower. An enlarging ring can be installed at the bottom of the pushing rods in order to reduce total lateral friction. Penetration will be carried out at a constant pace of 20 mm/s.

Pressure readings shall be taken every 20cm.

The graphs showing the various parameters being measured must be available at the surface at the time of testing. They must be made available to the COMPANY at the end of the test as hard copy of preliminary results. The Factual Report shall include all tests results both as hard copy and as electronic files in a modifiable format (ASCII, xls or other to be agreed).

8.6 Seismic Static Cone Penetration Test (SCPT)

The reference standard for the execution of the SCPTs to which the SUBCONTRACTOR is referred, for what here not specified is ASTM D7400-14. The survey will be conducted by making direct measurement of S (shear) and P (pressure) wave velocities. An appropriate seismic source will be used to generate a seismic wave train at ground level; downhole receiving units, mounted on the SCPT apparatus will be used to detect wave arrival. Both the source mounted sensor (trigger signal) and receivers (high precision accelerometers or geophones) will be connected to an acquisition system, in order to measure the travel time of the generated wave, from the source to the receiving units.

Separate measurement of P and S waves shall be carried out, using an appropriate source for each case. Seismic measurements shall be made at every rod change and in any case at a vertical spacing not greater than 1m.

When measuring S waves, the source will be rich in the type of energy required by the generation of identifiable S waves. The source shall be repeatable, in order to allow for the implementation of the procedure of signal stacking to increase the signal to noise ratio, with particular reference to the measurements carried out at shallower depths (i.e. within the first 5 m) or in the presence of high noise levels. The source shall be reversible; the generation of reversely polarized shear wave trains and their interpretation will be considered as mandatory.

The received units shall have appropriate frequency response and sensitivity characteristics in order to determine the seismic wave arrival. When measuring S and P waves, the geophones in the receiving unit shall be accurately oriented in the polarization plane of the generated waves, in order to maximize the signal to noise ratio of incoming SH-waves.
The use of a two receiving units bar (each of those composed by 3-5 sensors) as per par. 6.1.2.1 of ASTM D7400-14 (preferred method), although not mandatory, is strongly suggested.

The acquisition system will be based on digital filters to allow for a real time visualization of the recorded seismograms and verification during testing.

The data reduction and interpretation according to the best standards and literature indications (see ASTM D7400-14) will allow for the definition of a soil profile in terms of S and P wave velocities, which constitutes the main result of the test. In the presence of layered soils, with significant variation of stiffness between different strata, and consequent generation of refraction phenomena, the travel path of a single wave could not be a straight line. In this case, Sneel’s law will be considered during data reduction.

8.7 Permeability test

Where foreseen in the programme of investigation, permeability Lefranc tests shall be performed. ASTM D 6391 shall be taken as the reference standard, in so far as it is applicable, otherwise reference may also be made to BS 5930:1999 – Section 4. Field test – Permeability. Constant head method or Variable head test methods will be adopted on the basis of the encountered soil condition.

At each specified depth the hole shall be filled for not less than 0.75m with clean fine gravel and the casing withdrawn 0.5m.

Care shall be made during the creation of the test section to avoid collapse of the hole wall and to avoid changes of the characteristics of the natural soil around the test section.

The same attention shall be adopted to avoid passage of water during the test from the test section to the upper layers throughout the gap between casing and hole wall; a double casing shall be employed if necessary.

Values of the permeability coefficient “k” will be calculated and test layout, readings, method of calculation and obtained values shall be reported on the final documentation.

8.8 Supply and installation of standpipe piezometres and groundwater sampling

Where foreseen in the drawings and/or instructed by COMPANY representative, a standpipe piezometer shall be installed inside the borehole at the end of the drilling and testing activities.

Piezometers shall be installed in or near boreholes, as indicated in the soil Investigation plan. Unless directed otherwise, the filter section shall extend from 2.0 m below existing ground level to 5.0 m below the groundwater level encountered at the time of the investigation or to the base of the borehole, whichever is the lesser. Piezometric levels shall be monitored daily for a minimum period of 15 days. A groundwater sample shall be obtained from the piezometer after purging, for chemical testing in the laboratory.
Piezometers shall be formed by the connection of rigid PVC or metallic pipes, to the depths specified in the programme of the investigation, or as directed by the COMPANY representative.

Inner nominal diameter of the pipes shall be the minimum necessary to insert a pump for piezometer purging and for groundwater sampling as detailed below.

In the filter section the pipe shall be micro fissured, from the base to 0.5m below the top of the filter section. The bottom of the pipe shall be plugged. The upper portion of the piezometer pipe above the filter section shall be solid. It shall extend at least 0.5m above the surrounding ground and it shall be protected by a steel tube with a lockable cover as directed or approved by the COMPANY representative.

The portion of the borehole below the base of the filter section shall be filled from the bottom of the hole up using bentonite pellets or a grout mixture of clean fresh water, bentonite and Portland cement, 100-6-40 parts by weight, respectively. Water shall be from a source approved by COMPANY representative. If present, the temporary casing will be progressively pulled out to the base of the filter section as filling or grouting proceeds, topping up the bentonite pellets or grout as necessary.

After setting of the grout in the lower portion of the borehole, the standpipe piezometer will be lowered in the borehole. Clean saturated coarse sand / fine gravel will be poured till the top of the filter section. If present, the temporary casing will be progressively pulled out without rotation as placement of the filter material proceeds, to just below the top of the filter section.

After formation of the filter section is complete to the correct level, the gap between pipe and hole walls above the filter section will be filled to the ground surface with impervious material such as bentonite pellets to form a seal. If present, the temporary casing will be progressively pulled out without rotation as placement of the seal material proceeds.

Levels shall be checked regularly during all stages of piezometer construction. Details of the piezometer “as built” shall be attached to the borehole log.

Completed piezometers shall be protected by posts and/or fencing and warning signs to the approval of COMPANY representative.

Completed piezometers shall be monitored daily for the duration of the investigation fieldwork or for the minimum duration indicated in the Programme of Investigation, whichever is the lesser. The measurements shall be included in the factual report.

Before groundwater sampling is carried out, the piezometer shall be purged. Purging shall be carried out by pumping (submerged pump is required), taking into account that the volume of water extracted shall be at least three times the volume of the filter section. Once the purging operation is completed, water samples shall be collected and delivered to a chemical laboratory for the following analysis:

- sulphate ion content;
- chloride ion content;
- total salt content;
- pH.
8.8.1 Groundwater Sampling

Water sampling for chemical analysis shall be carried out only after the complete piezometer installation.

The following activities shall be carried out:

1. Measurement of groundwater level. Prior to purging and sampling, groundwater level inside the piezometer shall be measured by means of a conventional water level measuring device (dipmeter). The head of the PVC pipe, or alternatively the locked head of the piezometer, shall be used as reference for level measures. Measured data and the reference used for taking measures shall be included in the factual report.

2. Purging the well of standing water is required to ensure that the sample water will be withdrawn directly from the aquifer. Purging operations shall be carried out till three or more well volumes have been removed and discharged water has reached clarification.

3. Groundwater samples shall be collected by means of submersible pumps. Groundwater shall be transferred into sample containers in such a manner that agitation and aeration are minimized.

Once a sample is obtained, it shall be clearly and uniquely labelled using adhesive labels. The labels adopted shall be resistant to external influences at the site (e.g. rain) and to future treatment (e.g. abrasion, handling, etc.).

The labels shall be large enough to contain all the following relevant information clearly written:
- Sample Identification (site name, piezometer ID)
- Date and time of sampling
- Sampling personnel identification

8.9 Exploratory pits

Detailed soil profile description will be carried out inside each trial pit, with particular reference to the detection of the anthropogenic layer (if any). One sample of the natural water shall be taken for chemical analyses, if encountered.

The pits shall be filled at the end of inspection with excavated material reinstating the pre-existing finish to its original condition.

On exploratory pits, maintained load Plate Load tests with and without inundation shall be carried out at 1,5 and 3,0 m depth thereafter using a 500mm diameter plate, as detailed in the relevant section of the specification.

The pit excavation shall be carried out using a back-hoe excavator down to the specified depth (3,0m), or to the groundwater level if shallower, keeping topsoil, if any, separate from other excavated material. The position and depths of the pits will be determined by the COMPANY representative in agreement with COMPANY to investigate the whole area.
with particular reference to the possibility of encountering rock or cemented materials in excavations. The excavation shall be carried out in stages, to carry out sampling and in situ density tests at the depths specified, before the pit is excavated further.

The cross section of pits shall be 0.8~1.0m x 3.0~5.0m at the bottom of excavation; slopes and/or temporary support of pit walls shall be chosen according to the soil nature and consistency so as to allow pit inspection and set up and execution of the in situ tests in conditions of absolute safety.

If water table is encountered the excavation will be immediately stopped and both dynamic and static water levels will be measured and recorded.

Oxygen content shall be evaluated before entering in confined spaces/pits, according to National/Site regulation.

The SUBCONTRACTOR shall be personally responsible to confirm the adequacy of the excavation and of any temporary supports to guarantee the safety of workers entry into the pit and the stability of the surrounding ground and structures.

Referring to the part of the pit above the water level the following activities shall be carried out:

- In situ density tests (sand-cone method) shall be carried out in each pit at 1.5 and 3.0 depth. In each pit bulk samples shall be taken in each significant layer (at least at 2.0m from G.L.), sufficient to perform also a Modified Proctor compaction test. Cohesive layers shall be tested directly on the pit wall by pocket instruments (penetrometer and vane).

- Large disturbed sample (about 50 kg) for laboratory tests (one for each depth at which in situ density tests are carried out). Additional standard disturbed samples shall be collected as necessary, if the soil stratigraphy varies within the depth of the exploratory pit. Samples of topsoil are not required. Topsoil contamination of samples shall be avoided. Samples will be placed and sealed in suitable double bags, labelled and stored in a fresh suitable place before dispatch to the laboratory;

- Cohesive layers shall be tested directly on the pit wall by pocket instruments (penetrometer and vane), recording the average representative value for each stratum;

- A log of the exploratory pit shall be prepared, including a detailed stratigraphic description, records of sampling and in situ tests, notes on wall stability and groundwater if encountered (dynamic and stabilized levels).

Each pit shall be filled at the end of inspection with excavated material reinstating the top soil or other pre-existing finish to its original condition. During this operation, backfill material shall be compacted in layers maximum 150mm thick using mechanical equipment to not less than 95% of the maximum dry density as determined in modified compaction tests (in case of doubt, density tests shall be carried out on the backfill, at the discretion of COMPANY representative).

8.10 Plate load tests

Plate Load Tests shall be carried out generally at 2.5 m; in case of appearance of groundwater level in the pits the tests will be carried out at 1.0m depth.
Particular prescriptions only are given below. For details of the general arrangement of the test, general prescriptions, the type and format of information to be provided, reference shall be made to EN 1997-2 (ISO 22476-13). Plate diameter shall be 500mm.

Plate load tests shall be carried out in shallow (say 5cm deep) pits of diameter a few centimetres larger than the plate diameter, carefully excavated by hand below the current base of the exploratory pit, to minimize disturbance to the soil below. The test surface shall be levelled accurately, using a thin bed of damp clean fine sand if necessary. Filter paper shall be placed below the plate and over the base of the shallow pit where tests are to be carried out with inundation, to facilitate infiltration.

Once the plate is positioned, the kenteledge, loading and measuring equipment shall be assembled. Reference beams for displacement measurement shall be horizontal with at least one simply supported end.

Displacements shall be measured by four dial gauges with precision 0.01mm and minimum range 0 – 50mm. Load shall be measured with a load cell or proving ring with precision 0.1 kN and minimum range 0 – 150 kN. Measurement of load based on oil pressure in the loading jack is not acceptable.

Calibration certificates (maximum 6 months old) for all measuring equipment shall be presented to COMPANY representative before carrying out the tests.

The loading programme for each test shall be as directed by COMPANY and may be varied in relation to the results being obtained. It is anticipated, however, that the loading programme will be as indicated in Table 1 and in Table 2 for tests without and with inundation respectively.

Plate displacement and applied load shall be measured at the times shown in Table 1 and in Table 2. Unless a servo-assisted system is used to maintain load constant throughout the test, load will be adjusted manually only in so far as necessary to keep it to within +/- 2% of the nominal value. All load adjustments shall be recorded alongside the result, noting the load measured immediately before and immediately after the adjustment is carried out.

Table 1: Loading programme for plate load tests without inundation.

<table>
<thead>
<tr>
<th>Step</th>
<th>Pressure (kN/m²)</th>
<th>Duration (min)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>10</td>
<td>Read at t = 5; 10</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>5</td>
<td>Read at t = 5. Set gauges = 0</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>5</td>
<td>250</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>6</td>
<td>200</td>
<td>15</td>
<td>Read at t = 1; 2; 4; 8; 15</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>15</td>
<td>Read at t = 1; 2; 4; 8; 15</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>15</td>
<td>Read at t = 1; 2; 4; 8; 15</td>
</tr>
<tr>
<td>9</td>
<td>50</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
</tbody>
</table>
### Table 2 Loading programme for plate load tests with inundation.

<table>
<thead>
<tr>
<th>Step</th>
<th>Pressure (kN/m²)</th>
<th>Duration (min)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>10</td>
<td>Read at t = 5; 10</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>5</td>
<td>Read at t = 5. Set gauges = 0</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>30</td>
<td>Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>720</td>
<td>Inundation* - Read at t = 1; 2; 4; 8; 15; 30, 60, and every 60 thereafter</td>
</tr>
<tr>
<td>7</td>
<td>250</td>
<td>60</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30, 45, 60</td>
</tr>
<tr>
<td>8</td>
<td>350</td>
<td>60</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30, 45, 60</td>
</tr>
<tr>
<td>9</td>
<td>250</td>
<td>30</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>10</td>
<td>150</td>
<td>30</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>11</td>
<td>50</td>
<td>30</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>60</td>
<td>*Read at t = 1; 2; 4; 8; 15; 30, 45, 60</td>
</tr>
</tbody>
</table>

#### 8.11 Electrical resistivity measurement

At given locations soil electrical resistivity shall be measured down to 1, 2, 4, 8 and 16 m below G.L. The SUBCONTRACTOR shall operate in order to reach this goal by choosing the adequate electrodes spacing. Wenner configuration methods will be adopted according to the ASTM Designation G 57 – 06 (reapproved in 2012).

#### 8.12 Thermal conductivity measurements

Thermal conductivity measurements shall be carried out at the bottom of dedicated pits excavated to 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 m depth by means of the Thermal Needle Probe Procedure in accordance with ASTM 5334. Natural soil temperature shall be also measured and reported as part of these tests.
8.13 S-WAVE SEISMIC REFRACTION TESTS

S-wave seismic refraction profiles shall be carried out by energizing the soil in a predetermined pattern and measuring the arrival time of refracted shear (S) waves at horizontally polarized geophones set out at a uniform spacing along the survey alignment, to determine the depth profile of seismic refractors. The spacing of the geophones and the length of each alignment shall be commensurate with the required resolution and depth of investigation (ASTM D 5777).

The test equipment consists of:

- A recording unit (minimum 24 channels), having the possibility of stacking seismic signals, programmable digital filters (active high pass, band pass and band reject filters), signal amplitude gain control, sensitivity 6 to 92 dB and minimum 16 bit digital data recording for subsequent analysis;
- Minimum 24 horizontally polarized geophones with natural frequency between 8 and 14 Hz;
- Energizing system adequate for the required depth of investigation.

The layout of energization will be adequate to provide the maximum resolution and penetration specified in the Programme of Investigation. It shall be the responsibility of the SUBCONTRACTOR to increase the number of energizations and/or to repeat energizations as required in accordance with local conditions, for example in areas with high background noise.

Data reduction and interpretation shall be carried out with a dedicated software of proven validity, capable of providing the values of wave velocity for each formation identified by refractors (for example using the Generalized Reciprocal Method, Palmer 1980). The software shall allow “real time” analysis of the signal acquired after each energization and a preliminary post-processing, to improve survey effectiveness.

The data reduction phase will include the determination, by the application of iterative curvilinear ray tracing techniques and tomographic algorithms (for example using Algebraic Reconstruction Technique, simultaneous Iterative Reconstruction Technique or Iterative Least Square Technique) of an anisotropic ground model defined in terms of a field of wave velocities with a high density of information.

8.14 Multichannel Analysis of Surface Waves (MASW)

MASW tests shall be carried out in case that DMT, SCPTU tests could not achieve at least 15 m from G.L.

The MASW technique (Multi Channel Analysis Surface Waves) is an indirect method aimed at the determination of the S-shear wave profiles based on the inversion of the velocity phase of surface waves (Rayleigh and/or Love waves). The method consists of recording, with an array of vertical geophones, the vibrations artificially induced in the soil. The source used to generate vibrations may consist of a hammer, a falling mass or a seismic gun depending on the characteristic of the investigated ground, the level of environmental noise and the specific experience of SUBCONTRACTOR.
The theory developed for data reduction and processing of the recorded signals provides a theoretical model of the subsurface that is not necessarily unique. Therefore, it is important to compare and calibrate the data model with the geological knowledge of the site (e.g., geological surveys, penetration tests, existing stratigraphy, seismic surveys in refraction, cross-hole, down-hole) in order to identify from the beginning of the test a representative soil profile at the site.

The test will be carried out in order to investigate the soil properties (S-waves velocity profile) up to 30 m below actual ground level.

On the basis of the characteristics of ground and instrumentation, the SUBCONTRACTOR will identify the more appropriate source of vibration (impact mass or hammer), the number of channels of the acquisition system (at least 24) and spacing between geophones for the purposes of the survey.

It is recommended to perform the test by moving the source at both ends of the alignment, performing 2/5 energizations at each side. In any case, it will be responsibility of the SUBCONTRACTOR to increase the number of energizations and/or to repeat energizations as required in accordance to local conditions, for example in areas characterized by high background noise (records of background noise will be saved for further analyses by the COMPANY). Particular attention will be posed to the condition of the ground surface by removing, prior to the installation of the geophones, any paved layer that may affect data recording.

Data reduction and interpretation shall be carried out with a dedicated software of proven validity. The dispersion algorithm implemented will be fully documented by the SUBCONTRACTOR in the factual report.

9 TECHNICAL REPORTS

According to the local law (Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki morskiej z dnia 25 kwietnia w sprawie ustalania geotechnicznych warunków posadowienia obiektów budowlanych”) designed project - Propane Dehydrogenation plant (PDH) was qualified to the third geotechnical category. In that point of view it is obligatory to prepare the following elaborations:

- Geotechnical opinion,
- Geological works design,
- Geological-engineering documentation,
- Soil investigation report,
- Geotechnical project.

Each of the above documentations will be issued initially as DRAFT FOR REVIEW, then as FINAL ISSUE taking into account given comments. Both the DRAFT and the FINAL issue will be provided as follows:

- 4 no. signed hard copies (3 bound and 1 unbound suitable for reproduction),
• 1 no. copy as electronic file in pdf format,
• 1 no. copy of all data and tables as electronic file in a modifiable format (ASCII, xls or other to be agreed),
• 1 no. copy of all drawings as electronic file in dwg format.

The final elaborations will include all certificates, stamps, signatures and whatever is necessary under the national laws and regulations to validate the report for future official use in connection with the Project.

The final documentations shall be submitted in orderly bound volumes, with complete index for ease of reference. If the Report is produced in more than one volume, each volume will include a complete index to all volumes, highlighting the contents of each volume.

9.1 Geotechnical opinion

Geotechnical opinion has to be prepared in pursuance of „Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki morskiej z dnia 25 kwietnia w sprawie ustalania geotechnicznych warunków posadowienia obiektów budowlanych”.

It has to specify geotechnical category of investigation and complexity of soil and groundwater conditions.

9.2 Geological works design

Geological works design has to be compatible with appropriate ordinations of Environmental Minister.

The responsibility of the Subcontractor is to obtain the positive decision for the Geological works design approved by the competent authority.

9.3 Geological-engineering documentation and soil investigation report

Geological-engineering documentation has to be compatible with appropriate ordinations of Environment Minister.

Soil investigation report has to be prepared in pursuance of „Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki morskiej z dnia 25 kwietnia w sprawie ustalania geotechnicznych warunków posadowienia obiektów budowlanych”.

The responsibility of the Subcontractor is to obtain the positive decision for the Geological-engineering documentation approved by the competent authority.

Both documentations should contain but not limited:

• Introduction, indicating purpose and scope of investigation. Abstract of findings and recommendations;
• Detailed description of the field investigation, including photos and main characteristics of the equipment, methods, personnel, comments;
- Description of site conditions, local geology, topography, above-ground and underground obstructions (if any);
- Vicinity map, showing location of investigation area;
- “As built” Plan showing location of all investigated points;
- Determine the value of geotechnical parameters (derived);
- Table with coordinates (in both UTM and Plant Systems) of all investigated points including elevation referenced to MSL-mean sea level (this data will also appear on each log);
- Logs of boreholes and exploratory pits, with date and time and with a detailed geotechnical description of each stratum, including details and results of samples, in situ tests, groundwater observations, type of equipment used, instrumentation or backfilling;
- Installation certificates for piezometers, including details of piezometer pipe; extent of filter section, type and quantity of materials used for backfilling filter section, type and quantity of materials used for sealing and final backfilling, by depth; details of cover;
- Records of piezometers readings;
- Results and interpretation of the Static Cone penetration tests (CPTU) (if available);
- Results and interpretation of the Dilatometer tests (DMT) (if available);
- Results and interpretation of Seismic Static Cone penetration tests (SCPT) or MASW (if available);
- Results and interpretation of the electrical resistivity tests (if available);
- Results and interpretation of the thermal conductivity tests (if available);
- Detailed description of the laboratory tests, including photos and main characteristics of the equipment, methods, personnel.
- Presence of existing underground services/foundation;
- Identification and characterization all possible geohazards;
- Presenting of soil profile and present variability within the Project area;
- Presenting groundwater levels, groundwater regime and permeability;
- Presenting dynamic properties of foundation soils;
- Result of chemical characteristics of soils and groundwater to evaluate aggressiveness on buried structures and possible special requirements for handling and disposal of excavated material;
- Presenting potential contamination of soils and groundwater;
- Presenting electrical resistivity of foundation soils at the site, for the design of earthing and as an additional measure of aggressiveness on buried structures;
- Presenting thermal conductivity of foundation soils at the site, for the design of buried electrical cables;
• Characterization of possible swelling behaviour of the clays.

The report will include all in situ and laboratory collected data as electronic file in a editable format (ASCII, xls or other to be agreed).

The responsibility of the Subcontractor is to obtain the positive decision for the Geological works design approved by the competent authority.

9.4 Geotechnical project

Geotechnical project has to be prepared in pursuance of „Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki morskiej z dnia 25 kwietnia w sprawie ustalania geotechnicznych warunków posadowienia obiektów budowlanych”.

Especially it should (but not limited to):

• Determine the value of geotechnical parameters (characteristic and design);
• Determine geotechnical model of bedding;
• Calculations of load bearing capacity and subsidence
• Recommendations for choice appropriate level of foundation