NORDIC PILING SOLUTIONS

SOIL SURVEY AND METHOD OF ESTABLISHMENT STATEMENT ON THE PROJECT SITE OF THE SOLAR ENERGY PLANT

PIHLASSUO, JOUTSA

8.1.2024

Customer:
VAPO TERRA OY

PIHLASSUO, JOUTSA

Property codes:

172-417-95-3
172-417-98-1
172-417-6-16
172-417-6-12

Survey is carried out by:

NORDIC PILING SOLUTIONS OY, LAHTI
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Contents

1 Introduction

Vapo Terra Oy commissioned a study to assess the constructability of the soil in the designated project area for the construction of a solar power plant. The report includes a soil survey of the land area and outlines the method for establishing the project area located in Pihlassuo, Joutsa. The survey divides the area into northern and southern regions, as they are distinctly separated. The report objectively presents the current state and constructability characteristics of the area for the solar power plant project.

The total project area covers 165 hectares. The survey was conducted across the entire project area. Peat production has been phased out in this area, and peat extraction concluded in 2020.

The accuracy and comprehensiveness of the information in the report significantly impact the assessment of construction, influencing both investment decisions and construction methods.

Figure 1. Pihlassuo North and South

2 Conditions in the survey area

The fieldwork for the survey took place from November 13 to December 4, 2023. Throughout this period, the project area was covered with snow, and the average temperature hovered around -8 degrees Celsius. Despite a noticeable increase in snow accumulation as the survey progressed, it did not hinder the survey's implementation.

The surface of the peat bog was frozen in certain areas, and there was an abundance of surface water, making the mapping of the area challenging.

3 Soil survey

3.1 Mapping method

In the Pihlassuo area, trench mapping was selected as the method, involving the excavation of trenches approximately 1.5–3 meters deep. Peat thickness is measured during excavation, and soil characteristics relevant to the constructability of the solid soil beneath the peat are assessed. This method provides a precise understanding of soil conditions at the mapping points.

While there is no defined standard for the soil survey method in the project area, the objective is to offer a clear overview of the mechanical properties of the soil and the construction-related prerequisites. These should be considered in the planning of the area.

GPS point maps of the project area are created according to property identifiers and the agreed point network (e.g. 60x60m). The survey will be carried out with excavator equipment and excavations extending into the mineral soil. The depth of the excavations is determined by the soil, however, so that the excavation extends at least 1–1.5 m into the mineral soil. A clear soil layer can be seen from the wall of the trench, from which a topographic map of each soil layer can be created by measuring. Topographic maps provide a clear picture of soil layers, minerals, and differences in land surface level.

Survey equipment:
The soil survey in the project area utilized a wide-roller excavator equipped with a narrow bucket for precise excavations. Measurements were conducted using a Trimble TSC5 controller and a Trimble R12 GNSS GPS receiver. Data is stored on a terrain computer

located at the construction site, allowing retrieval in the form of topographic map data (see Annex 1)

3.2 Creation of base maps

A GPS map template (see Annex 2) was generated for the entire 165-hectare project area, with a total of 695 designated mapping points. GPS scoring was conducted using a 60x60 meter grid. Mapping points were strategically positioned at the boundaries of the property identifiers, as illustrated on the generated map. Due to the clear terrain, no additional points were required.

3.3 Map data

In the project area, a total of 304 excavations were conducted in the northern region and 348 in the southern region (refer to Annex 3). The data gathered from these excavations was used to generate the following map data.

Annex 2. Planned GPS points

Annex 3. Mapped GPS points

Annex 4. Surface height and area boundaries. Wooded areas and wetlands.

Annex 5. Peat cover thickness

Annex 6. Topographic map of the peat layer

Annex 7. Demarcation and levels of the bottom layer of soil

4 Overview of soil in the project area

4.1 Surface and bottom forms of the site

The overall topography of the area is predominantly flat. Peat extraction in the northern peat area ceased in 2016 when the peat deposit was depleted, resulting in shallow trenches with distinct edges. There is no evident plough area with a layer of peat significantly thicker than the rest of the region.

In the southern peat area, the terrain is visibly covered with thicker peat, displaying variations in shape (see Annex 5). Peat extraction in the southern region was concluded in 2020.

4.2 Watery soils and rocky areas

Most of the area was easily traversable, except for a 10-hectare portion in the northeast corner that was entirely submerged, preventing the survey from being conducted in that specific area. Surface water also posed challenges to the survey's implementation in other areas. Notably, there are very few rocky areas in the surveyed region.

Figure 2. A waterlogged area is in the eastern part of the northern section of the project site (11.8.2023)

5 Soil properties based on mapping

In soil surveys, the evaluation of soil properties relies on organoleptic assessment, which, in principle, is a sufficient method for gauging the constructability and characteristics of the soil. The organoleptic evaluation considers factors such as odor, color, hardness, toughness, structure, and the presence of plant remains in the soil.

For the project area, it can be confirmed that the soil beneath the peat throughout the entire region is sandy clay ('hiesusavi' in Finnish). Consequently, section 5 of this report solely assesses the properties of sandy clay and peat in the area.

5.1 Sandy clay (hiesusavi)

The entire project area consists of sandy clay or clay beneath the peat. The sandy clay observed during the survey was dry and hard in the region, with uniform characteristics of clay throughout the area. A distinct layer of peat and clay was clearly visible in the trenches.

Figure 3. Trench cutting (13.11.2023)

Figure 4. Soil sample/Sandy clay (13.12.2023)

5.2 Peat

In the northern area, the predominant feature is a thin layer of peat, with thickness varying between 0.10 and 3.0 meters. In the eastern part of the northern region, the peat thickness was above the average. In the southern region, the peat thickness ranges from 0.5 to 3.3 meters. The peat in the study area exhibited density and good load-bearing capacity. However, in terms of moisture content, the peat was consistently very wet (see Annex 7).

Figure 5. Peat cut photo from southern area (11.8.2023)

5.3 Acid sulphate

During the excavations, a strong rotten/sulfur odor was detected at certain points within the project area. The specific observation areas are marked on the map, provided as Annex 7. It is advisable to conduct soil sampling from the project area for laboratory testing.

6 Other conditions in the project area

6.1 Wind

Both areas are exposed to north and south winds. A road and a forest isthmus run between the two regions, serving as a natural separation. Strong forest borders the edges of both the northern and southern regions. The northern end has few trees, resulting in minimal wind protection effects.

6.2 Snow

On average, Joutsa receives approximately 20–30 cm of snow per year, according to the Finnish Meteorological Institute. When designing the power plant's panel structures, it is essential to consider the impact of wind and snow on the load-bearing capacity of the area. The distribution of snow within the site area depends on its construction and shape. The land beneath the panel rack area is often less covered with snow, making it more susceptible to frost.

Humidity and winds in the project field significantly influence snow loads and ice formation. Therefore, structural design should account for snow loads, quantities, and properties.

6.3 Surface water

The drainage of the project area and the maintenance of the site as a power plant necessitate a water management plan. While the condition of the ditches is reasonable, the overall drainage of the area requires restoration. Notably, a pumping station within the area plays a significant role in managing water supply. The station is still present, but there is no available information regarding its current functionality.

Figure 6. Wetland in the central area of the northern part of the project area (11.8.2023)

6.4 Vegetation

The southern region exhibits very scarce vegetation, a result of recent peat extraction activities that have concluded. In the northern area, low birch and alder trees are present along the margins of ditches and on the edges of the region.

6.5 Erosion

No erosion is evident in the project area. However, due to the limited vegetation in the southern region, there is hardly any solid topsoil present, which may result in the peat rising from the ground level under the influence of strong winds.

6.6 Ground frost

The peat in the project area experiences significant frostiness, influenced by factors such as peat thickness, moisture, and trampling caused by movement on the peat. Peat freezing occurs laterally and downward, necessitating consideration for the substrates of the panel racks to remain partially snow-free during the snow season. This intensifies the depth of frost at these points, requiring careful planning of the foundation method.

7 Method of establishment statement

7.1 Method of assessment of characteristics and requirements

The description of the method of establishment is based on map material created in the soil survey. The foundation method must always be dimensioned for the soil types of the object being built. The properties of soil materials determine the foundation methods suitable for the site.

7.2 Screw and drive piling

When the thickness of the peat aligns with the survey results, the piles must extend to the mineral soil and below the frost line. In cases where the length of screw and drive piles varies, the structural design must account for the loads on the panel racks. Dimensioning calculations and a foundation plan shall be prepared for the piling work.

7.3 Floating structure

A floating structure is considered a suitable construction method for roads and panel frames in the project area in question. The calculation and dimensioning of the floating structure must be carefully planned, and a comprehensive constructability study of the floating

structure must be conducted in the area. The study will provide insights into the amount of material needed in various parts of the project area. Different quantities of material are used in the foundations of roads and panel frames, ensuring a correctly dimensioned amount of material for each site.

7.4 Mass exchange

An excavation plan shall be developed for the mass exchange, supported by (HASU) acid sulphate concentration tests in the area. Laboratory tests will provide information on the acidity of the soil and the requirements for field structures in the construction of the project area. (see part 5.3 of this report)

8 Requirements for the construction of the area

8.1 Roads

Roads require special load-bearing capacity to withstand stresses during construction. Material storage areas should be constructed on georeinforced canvases and crushed stone layers. The planning of intermediate and service roads in the area must consider moisture control and structural layers. The existing road network in the region is strategically located. Logistically, the construction site is situated along good transport connections, and necessary site equipment can be easily sourced from the surroundings. Roads at the northern and southern ends of the area, as well as those crossing them, have been built on robust foundations, meeting the requirements for power plant construction.

8.2 Substations and transformer substations

The design and dimensioning of substation and transformer substation foundations shall consider the specific conditions present in the project area.

8.3 Water management in the project area

A water management and drainage plan shall be developed for the project area. The condition of existing ditches suggests that they can still be utilized to maintain the area's dryness. The current situation does not warrant any immediate action, as the pumping station was operational during the survey.

8.4 Panel racks

The panel racks must be designed to withstand Finnish conditions, with materials resistant to snow, water, and wind. Considering the planned service life of power plants, approximately

30–40 years, the materials used in the panel racks must meet the necessary technical requirements. To determine the specific requirements for the panel rack installation solution, a test field should be established in the project area. Additionally, dimensioning calculations and a foundation plan shall be prepared for the installation of panel racks.

9 Survey implementers

The following organisations have been involved in the implementation of the survey.

Producer organisation

Nordic Piling Solutions Oy (Business ID 3256053-9)

Persons:

Mikko Kyle, Management - survey reporting and administration

Tero Halonen, Projects - project planning and implementation supervision

The following subcontractors were used in the survey

Geops Oy (Business ID 3163131-5)

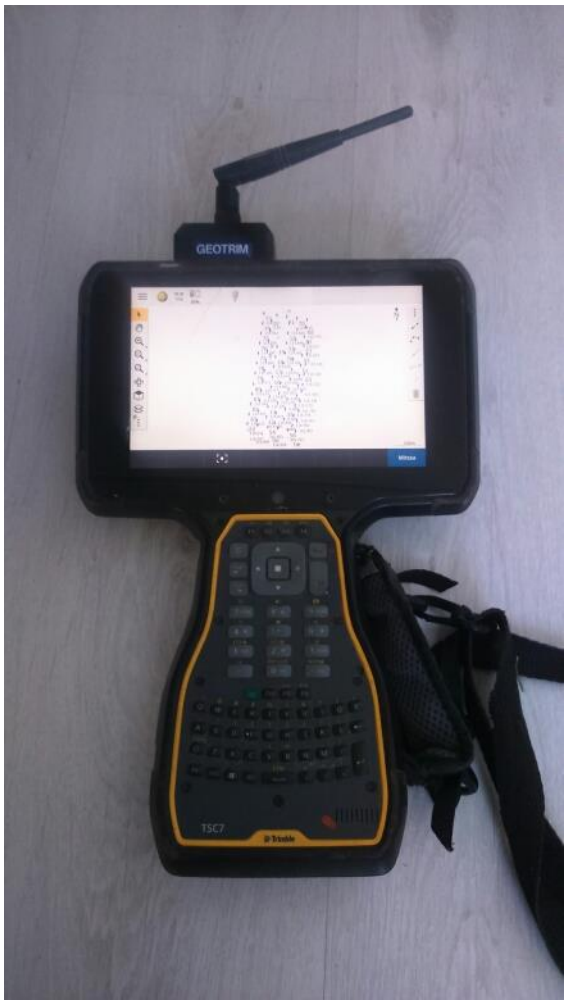
Lare Lautiainen, Land Surveying Engineer – project dimensioning and implementation supervision

Iina Pesonen, Land Surveying Engineer – field implementation of the project

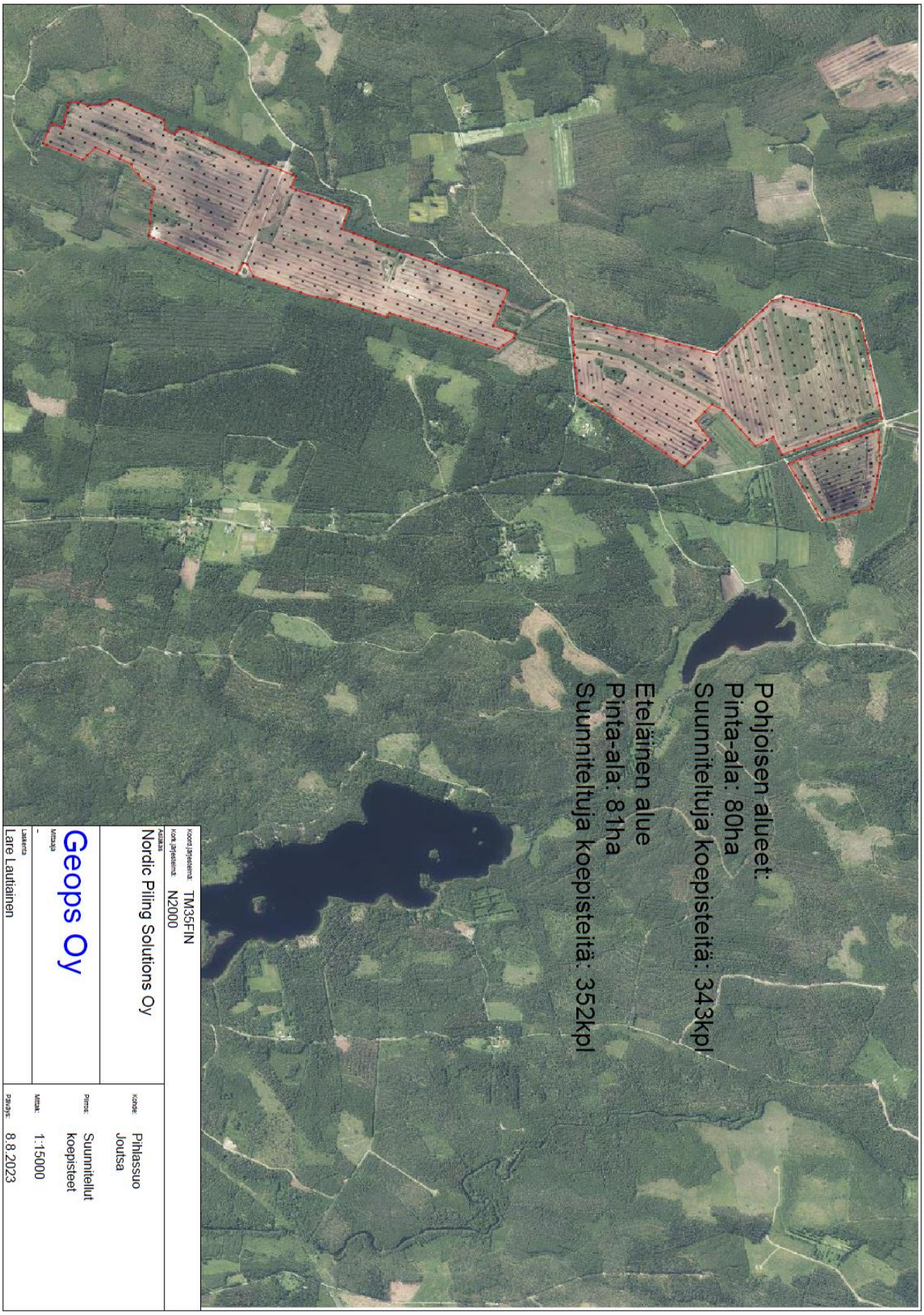
Koneurakointi Henry Laitinen Oy (Business ID 2841939-9)

Henry Laitinen – excavations and field implementation of tensile tests

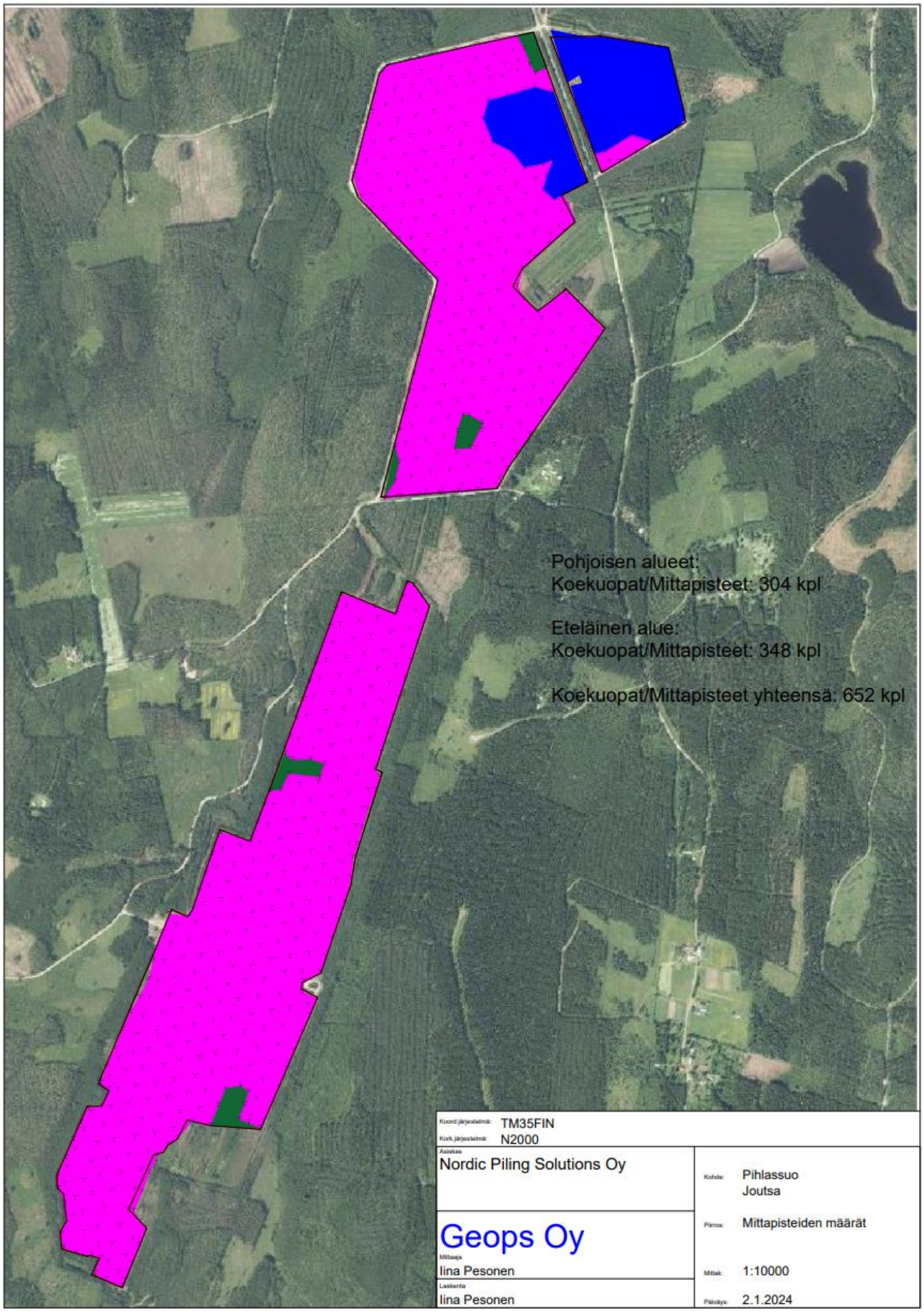
Annex 1. Soil mapping equipment



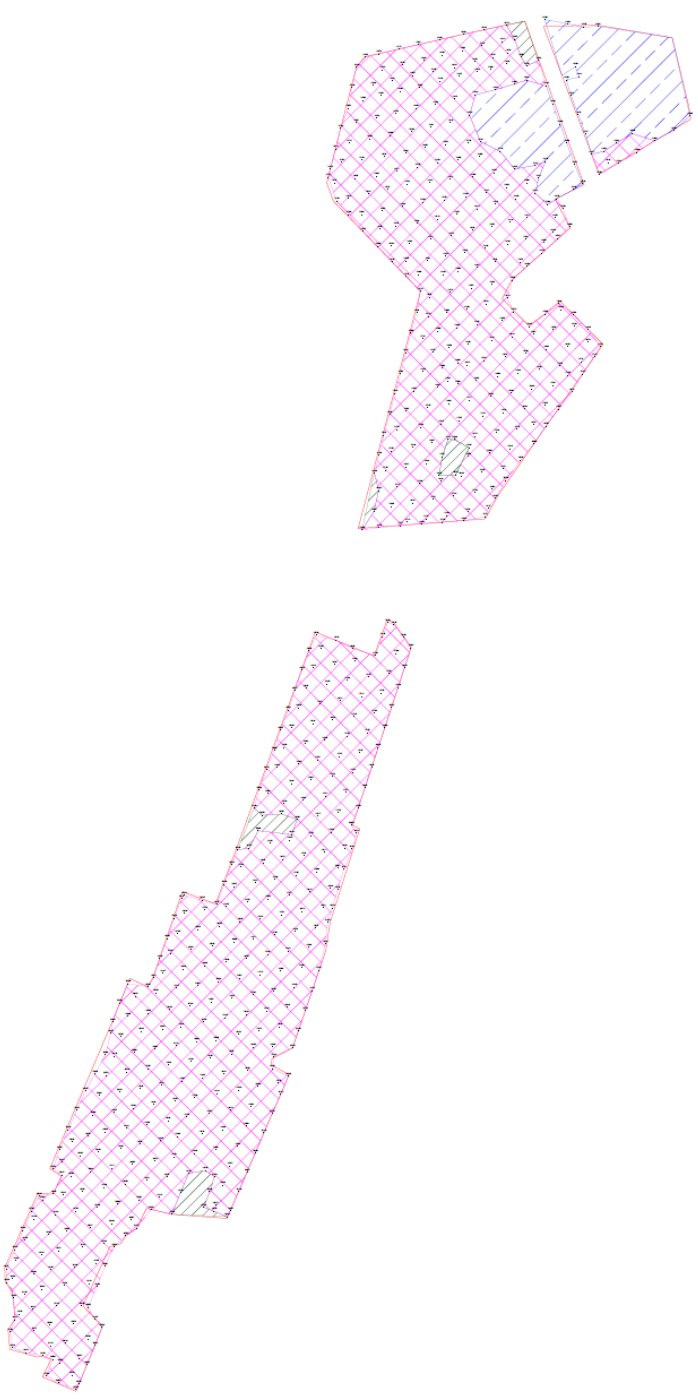
Annex 2. Planned GPS-points



Annex 3. Mapped GPS-points



Annex 4. Surface height and area boundaries. Wooded areas and wetlands.



METSÄINEN ALUE

VETINEN ALUE

TURVEKANSI

ETRS-TM35FIN

N2000

Nordic Piling Solutions OY

Pihlassuo,
Pajumäentie 791, Suonenjoki

Geops Oy

Maanpinnan korkopisteet ja alueet

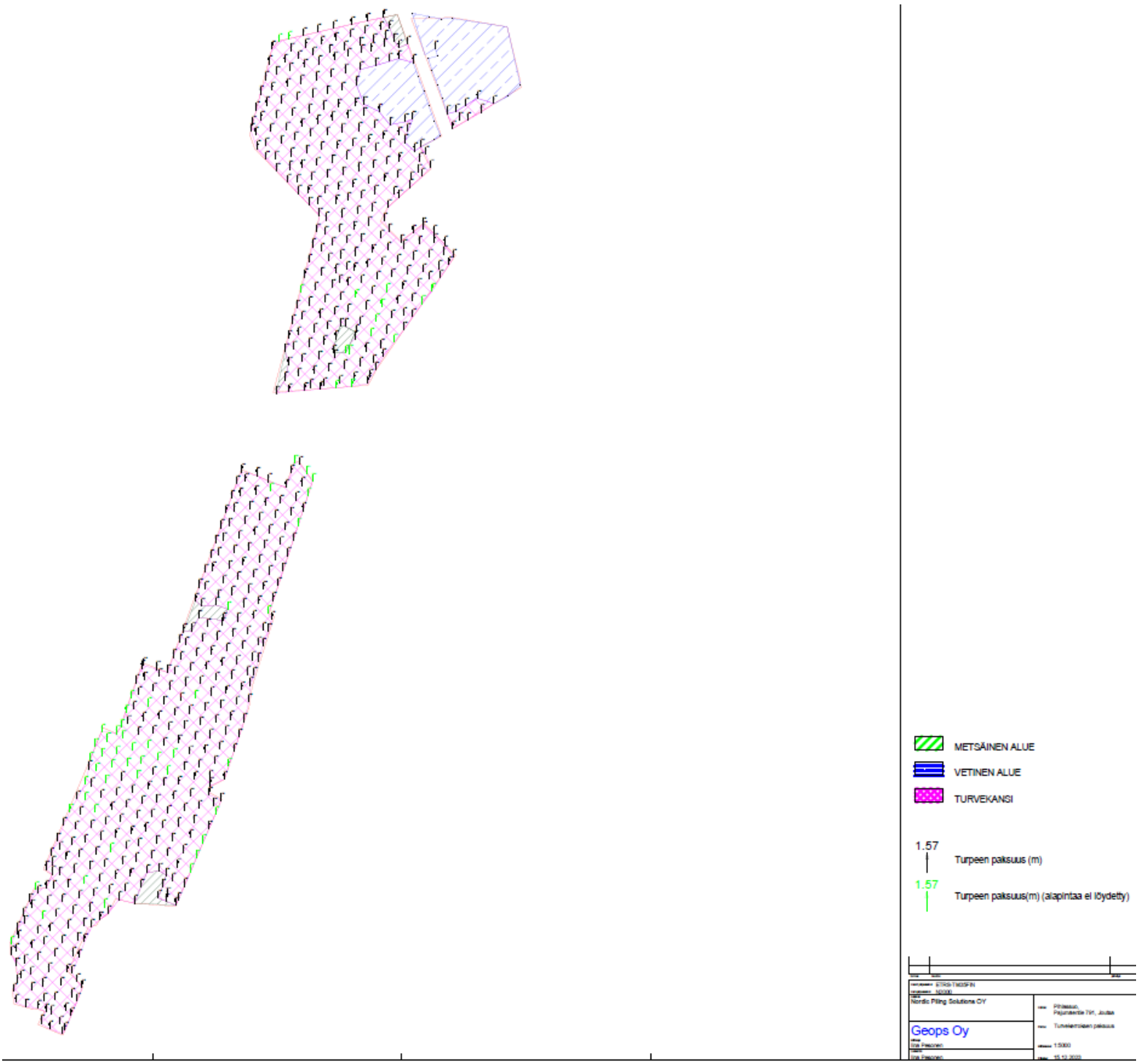
Ilmo Pesonen

1:5000

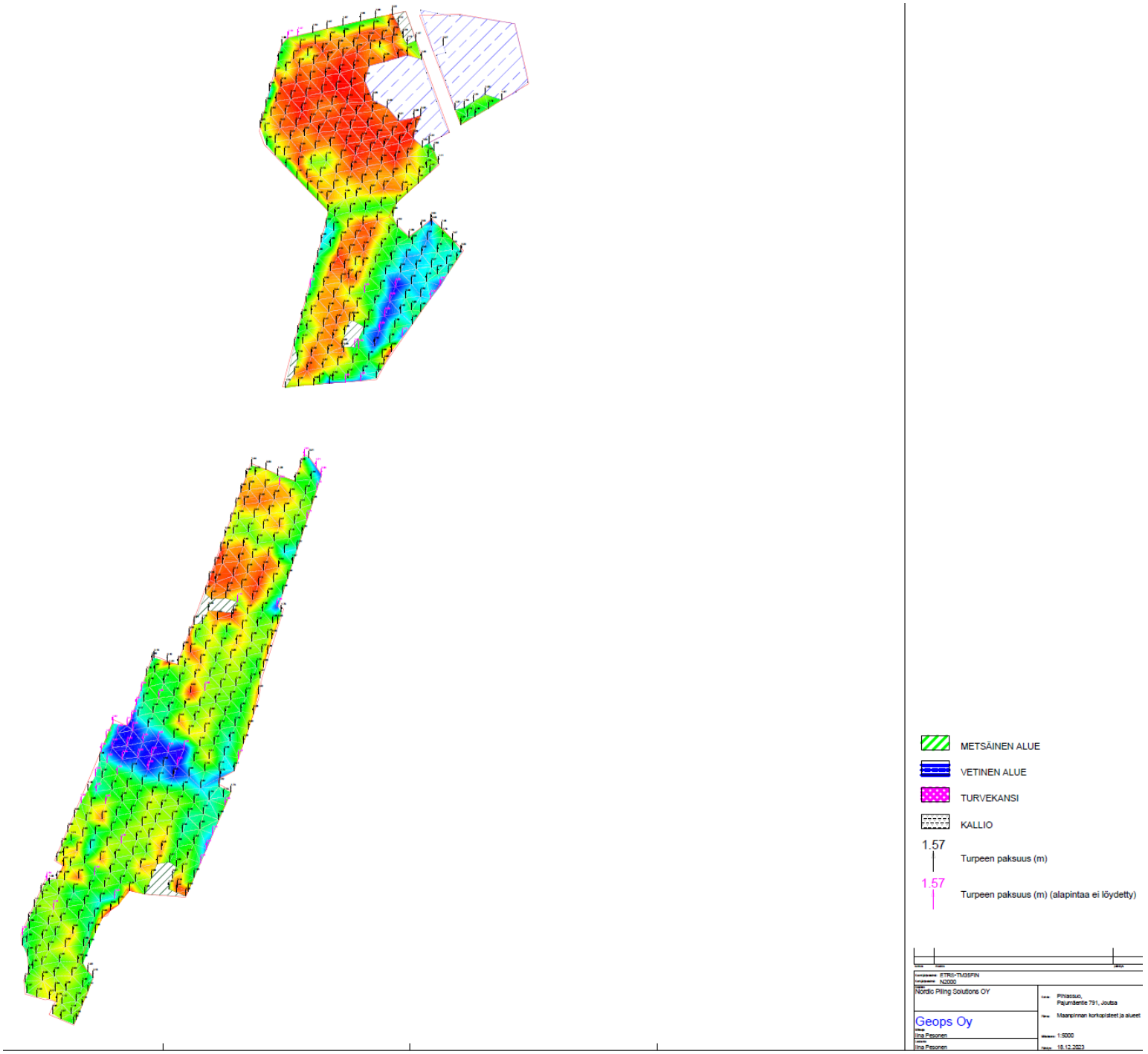
Ilmo Pesonen

11.12.2023

Annex 5. Peat cover thickness



Annex 6. Topographic map of the peat layer



Annex 7. Demarcation and levels of the bottom layer of soil