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APPENDIX 8-1

GEOTECHNICAL AND PEAT STABILITY ASSESSMENT REPORT

Seskin Wind Farm

Geotechnical Investigation Report

MKO

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1. EXECUTIVE SUMMARY

AFRY Ireland ("AFRY") has been commissioned by MKO on behalf of EDF Renewables Ireland Ltd ('the Applicant') to complete a Geotechnical and Peat Stability Assessment Report as part of an application for planning permission for the proposed Seskin Wind Farm in Co. Carlow (the 'Proposed Project'). In accordance with the planning guidelines compiled by the Department of the Environment, Heritage and Local Government (Draft Revised Wind Energy Development Guidelines, DoEHLG, 2019 (Draft DoEHLG 2019 Guidelines)), where peat >0.5m thickness is present on a proposed wind farm development, a peat stability assessment is required.

As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Project', 'Proposed Wind Farm', 'Proposed Grid Connection Route' and the 'site'.

The objective of this report is to identify the risk of peat slide failure by assessing the geological, geotechnical, and peat-related characteristics of the Proposed Project site.

The site slopes from the northeast to the southwest, ranging in elevation from 271m OD to 230mOD, with drainage channels running typically east to west. The land use within the Proposed Wind Farm site comprises commercial forestry and open farmlands.

The slope inclinations at the main infrastructure locations vary between 2 and 6.2 degrees. The uniform topography on site reflects the low risk of peat failure, as determined by this peat stability risk assessment. Ground conditions predominantly consist of blanket peat overlying clay, silt, sand, and gravel overlying bedrock.

Various site walkovers were carried out by AFRY Ireland Limited between July 2023 and January 2024. Peat probing was carried out by MKO between June 2023 and August 2023. Site investigation works were carried out by Causeway Geotech Limited in November 2023 which included trial pits, heavy dynamic probes and hand shear vanes. Peat depths recorded on site range from 0 to 2.7 meters, with an average depth of 0.23m. Overall, 83.4% of recorded peat depths were under 0.5m, and 96.5% were under 1m. Peat exceeding 1m in depth was recorded near T3 and the maximum peat depth recorded was 2.7m near the T5 blade finger area.

Based on the findings from desk study, site walkovers and site investigations, both qualitative and quantitative risk assessments were carried out to evaluate the potential for peat slide failure. The risk assessment methodology was adopted from *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006).

This methodology defines the risk of peat slide failure as the product of the probability and its adverse consequences, as elaborated in Section 3 and Section 8. The consequence is assessed in terms of the scale of damage inflicted by the geotechnical failure on the surrounding area. The probability is evaluated based on the results of the quantitative and qualitative assessments. In the quantitative analysis, the Factors of Safety (FoS) for undrained and drained conditions are calculated. A FoS of less than 1.0 indicates that a slope is unstable (high risk); a FoS between 1.0 and 1.3 indicates that a slope is stable but not safe (medium risk), and an acceptable FoS for slopes is 1.3 or greater (low risk). The methodology for the qualitative assessment has been adopted from *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) in which risk due to eight principal factors is assessed.

The quantitative analysis for the Proposed Wind Farm analysed the turbine locations, access roads and related infrastructure where peat is greater than 0.5m in thickness. The analysis resulted in FoS above the minimum acceptable value of 1.3, and hence LOW probability of peat slide failure.

In summary, the results of the peat stability risk assessment showed that the site has an acceptable margin of safety and LOW risk of peat failure, making it suitable for the Proposed Wind Farm. The findings include recommendations and control measures for construction work in peat lands to ensure that all works adhere to an acceptable standard of safety.

2. INTRODUCTION

2.1 AFRY Ireland Limited

AFRY Ireland (formerly Ionic Consulting) is a leading renewable energy consultancy firm in Ireland, with offices in Dublin and Edinburgh. At the beginning of July 2022, the business was acquired by AFRY – a Swedish-based international consultancy business who is a European leader in engineering, design, and advisory services across multiple industries, including infrastructure, energy, and construction. The former Ionic business has now been rebranded as AFRY Ireland, but the fundamental skills and ethos have not changed. However, this change provides access to a range of technical experts in other AFRY offices whose skills and experience can be utilised by our clients in Ireland.

The AFRY Ireland team currently has over 30 members of staff across various technical and management specialities with plans to further increase those numbers in both countries in 2023 and beyond.

AFRY Ireland is a technology agnostic renewable energy company, offering a complete range of specialist services and technical advice throughout project lifecycles providing technical and project management services to support the development, preconstruction and construction of complimentary renewable technologies including solar PV, onshore wind, energy storage and offshore wind, throughout Ireland, the UK, and Europe.

Our clients tell us that our service is different. We have strong corporate credentials, a first-class in-house team, supported by our new colleagues from the wider AFRY family, allowing us to adapt our offering to each geography and the specifics of every project, on a case-by-case basis.

This report has been prepared by Liam Power (AFRY Senior Project Manager) and Manasvi Srivastava (AFRY Civil Engineer, M.E. Structural Engineering, BTech. Civil Engineering). Liam Power is the head of AFRY Ireland Civil Team and has over 25 years construction experience in all aspects of large civil engineering projects, with latter years focusing on project managing large scale renewable projects. Manasvi Srivastava is a Civil Engineer with AFRY Ireland and has five years' experience in civil, structural, and geotechnical engineering.

2.2 Project Background and Description

AFRY has been commissioned by MKO on behalf of the Applicant to prepare a Geotechnical and Peat Stability Assessment Report as part of an application for planning permission for the Proposed Project.

The Proposed Wind Farm is located in Co. Carlow, approximately 3.1km northwest of the village of Oldleighlin. Co. Carlow. The townlands in which the Proposed Project is located is listed in Table 1-1 in Chapter 1 of this EIAR: Introduction.

The Proposed Project will comprise 7 no. wind turbines, and associated foundations and hardstanding areas, access roads, underground cabling, permanent meteorological mast, temporary construction compounds, carriageway strengthening works, junction accommodation works, peat and spoil management, tree felling, site drainage, operational stage signage, battery energy storage system, 38kV onsite substation and associated underground 38kV cabling connecting to the existing Kilkenny 110kV Substation, and all ancillary works and apparatus.

A full description of the Proposed Project is included in Chapter 4 of the EIAR: Description of the Proposed Project.

This report presents the geotechnical and peat stability risk assessment carried out for the Proposed Wind Farm site located within the site boundary as defined in Chapter 4 of this EIAR.

This report has been prepared using information obtained from findings of the site walkovers, preliminary site investigation carried out by Causeway Geotech Limited in November 2023 and supplemented by information available from the Geological Survey Ireland.

The turbine delivery route and the Proposed Grid Connection Route are not examined in further detail in this report as the Geological Survey of Ireland (GSI) mapping and the peat probe survey indicate minimal to no presence of peat in these areas. As a result, the risk of peat slides along these routes is deemed to be negligible.

2.3 Purpose

The objective of this report is to present a Geotechnical and Peat Stability Assessment for the Proposed Wind Farm site. This assessment aims to investigate the geological, geotechnical, and peat-related characteristics of the site based on the published geology and data obtained from walkovers and site investigations. It includes an analysis of the ground conditions to evaluate the stability of the peat layers, with a focus on assessing the risk of a peat slide occurrence. The outcome of this peat stability risk assessment is presented in mapping and tabular form, identifying areas assessed as having a 'high', 'moderate', 'low' or 'negligible' baseline risk. Furthermore, this report outlines proposed mitigation measures to eliminate or reduce the identified risk levels.

This report presents AFRY's methodology for Geotechnical and Peat Stability Risk Assessment, the analyses performed, and results obtained. This methodology considers the impacts of imposed infrastructure and considers both quantitative and qualitative assessments, using both desk study and site investigation to gather assessment data.

This peat stability assessment has been undertaken taking into account peat failures that have occurred on peatland sites (such as recent failures at Shass Mountain 2020, Co. Leitrim and Meenbog 2020, Co. Donegal). The lessons learned from both peat slide events have been incorporated into the design of the Proposed Project and the construction methodologies to be implemented. The Meenbog failure occurred during the construction of a section of floating road on sidelong ground in an area of weak peat. This construction technique is not proposed on sidelong ground on the Proposed Wind Farm site. It is important that the existing site drainage is maintained during construction to avoid a similar failure to that on Shass Mountain, which occurred following heavy rainfall, and this is referenced in the Risk Assessments for the turbines/access roads (AFRY, 2024).

This report has been developed for the purposes of planning. A detailed site investigation will be carried out prior to construction and further geotechnical assessments undertaken prior to detailed design and construction.

2.4 Overview of Peat Slide Failure

2.4.1 Peat Definition and Classification

The *Developments on Peat and Off-Site Uses of Waste Peat* (SEPA, 2017) defines peat as a sedimentary material, commonly exhibiting a dark brown or black colour, comprised of partially decomposed plant and organic matter that is preserved under anaerobic conditions within waterlogged environments. This classification delineates peat into two primary strata:

- **Acrotelm:** Identified as the upper layer, the acrotelm is characterized by its fibrous structure and the presence of plant roots. Acrotelmic peat is noted for its relatively low moisture content and has some tensile strength.
- **Catotelm:** Identified as the lower layer, the catotelm is highly amorphous and contains a notably higher water content. Catotelmic peat typically demonstrates very low tensile strength and structure of catotelmic peat tends to disrupt completely on excavation and handling.

This classification is based on peat composition, physical characteristics, and strength properties. The *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) categorizes peat according to depth and organic content as follows:

- **Peaty (or organo-mineral) soil**: a soil with a surface organic layer less than 0.5 m deep;
- **Peat:** a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60%;
- **Deep Peat**: a peat soil with a surface organic layer greater than 1.0 m deep.

2.4.2 Peat Landslide

A peat landslide is defined as large-scale mass movement of peat deposits, which typically occurs naturally under extreme weather conditions but has been observed to occur in association with construction and other land management practices (*Carbon-rich soils, deep peat and priority peatland habitat: Expert views on project level assessment, 2021).*

The two main classifications of a peat landslide as mentioned in the guidance literature are:

- **Peat Slide**: The term 'peat slide' refers to shallow slab-like failures, often with shear occurring at the peat-substrate interface or within the peat body. These slides involve the breaking up of the peat surface into rafts and blocks, which move downslope mainly through sliding. They resemble translational landslides and typically occur in shallow peat, up to 2m, on moderate slopes of 5 to 15 degrees. Peat slides are the most common type of recorded landslides in Scotland, England, and Wales.
- **Bog Burst**: The term 'bog burst' describes highly fluid failures where the peat blanket ruptures due to subsurface creep or swelling, expelling liquefied material through tears on the surface, followed by settling of the overlying mass. These events result in pear-shaped areas of disturbed blanket bog, often with concentric tears and rafts, and little substrate exposure and lacking a clear scar margin. A block and slurry runout zone is typically observed downslope, resembling features associated with peat slides. Bog bursts resemble spreading failures and tend to occur in deep peat, exceeding 1.5 meters, on shallow slopes ranging from 2 to 10 degrees, where deeper peat deposits are common. They are most frequently reported in the Republic of Ireland and Northern Ireland.

2.4.3 Types and Controlling Parameters

Peat landslides are influenced by two main factors: *preparatory factors*, which gradually increase susceptibility to failure without directly causing landslides, and *triggering factors*, which initiate instability and lead to failure. Additionally, certain inherent characteristics (*preconditions*) of peat-covered slopes can predispose them to failure.

Preparatory Factors include the gradual increase in peat mass through vertical accumulation, changes in water content, afforestation activities, reductions in shear strength from creeping and fracturing, loss of vegetation, formation of sub-surface pools or water-filled pipe networks, and afforestation-induced desiccation cracks.

Triggering factors involve both natural triggers and human activities that can initiate peat landslides. Natural triggers include intense rainfall, snow melt, rapid ground accelerations such as earthquakes, fluvial incision reducing support to upslope material, and loading by landslide debris increasing shear stress. Human activity-related triggers include alterations to drainage patterns leading to high pore-water pressures, rapid ground accelerations from blasting or mechanical vibrations, cutting of peat reducing support to upslope material, loading by heavy plant or structures increasing shear stress, and digging and tipping associated with building, engineering, farming, or mining, including subsidence.

The factors that may act as preconditions to slope instability in peatlands include impeded drainage from a peat layer overlying an impervious base, convex slopes or breaks in slope concentrating subsurface flow, proximity to local drainage sources, and connectivity between surface drainage and the peat or impervious interface, facilitating excess pore pressure generation.

2.4.4 Pre-failure Indicators

Ground conditions indicating preparatory or preconditioning factors before failure are often detectable through mapping, remote measurement, or site visits. In many cases, sites experiencing landslides without prior warning could have been identified as susceptible to failure by experienced personnel or through basic monitoring methods.

Certain critical features are indicative of potential failure in peat environments:

- Presence of historical and recent failure scars and debris;
- Presence of features indicative of tension (e.g. cracks);
- Presence of features indicative of compression (e.g. ridges, thrusts, extrusion features);
- Evidence of peat creep (typically associated with tension and compression features);
- Presence of subsurface drainage networks or water bodies;
- Presence of seeps and springs;
- Presence of artificial drains or cuts down to substrate;
- Presence of drying and cracking features;
- The concentration of surface drainage networks;
- Presence of soft clay with organic staining at the peat and (weathered) bedrock interface; and
- Presence of iron pans or similar hardened layers in the upper part of the mineral substrate

2.4.5 Peat conditions on site

The Proposed Wind Farm site is overlain by peaty/non-peaty poorly drained mineral soils with blanket peat at some locations. Peat depths recorded on site range from 0 to 2.7 meters, with an average depth of 0.23m.

The slope angles within the Proposed Wind Farm site range from 2° to 6.2°.

Site walkovers and site investigations did not reveal any evidence of peat failure or bog bursts within the Proposed Wind Farm site.

According to the GSI landslide mapping, no previous landslides have been recorded within the Proposed Wind Farm site. The nearest recorded landslide (Event ID: GSI_LS06-0300) occurred west of N80 in Maidenhead, County Laois, located off the N80 national road, approximately 10.5km northwest of Carlow Town by road. However, there is no available information regarding the date or cause of the event.

The Proposed Wind Farm site is approximately 14.3km south of this recorded landslide event. Therefore, it is assumed that the site-specific causes of that previous landslide are deemed to not be pertinent to this site.

3. PEAT STABILITY RISK ASSESSMENT METHODOLOGY

The methodology for the risk assessment is to undertake a broad assessment of the site in such a way that the risk for the whole site can be visually interpreted on a map overlaid on the Proposed Wind Farm layout. Infrastructure overlying any potential high-risk areas can therefore be easily identified and further assessments of these areas can be undertaken to better evaluate the risk. This will allow better quantification of the risk to be made and determine whether any mitigation measures can be installed to reduce the risk to an acceptable level or whether the layout needs to be altered.

Figure 1 shows a workflow diagram showing the general methodology for the Geotechnical and Peat Stability Assessment which has been adopted from *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017).

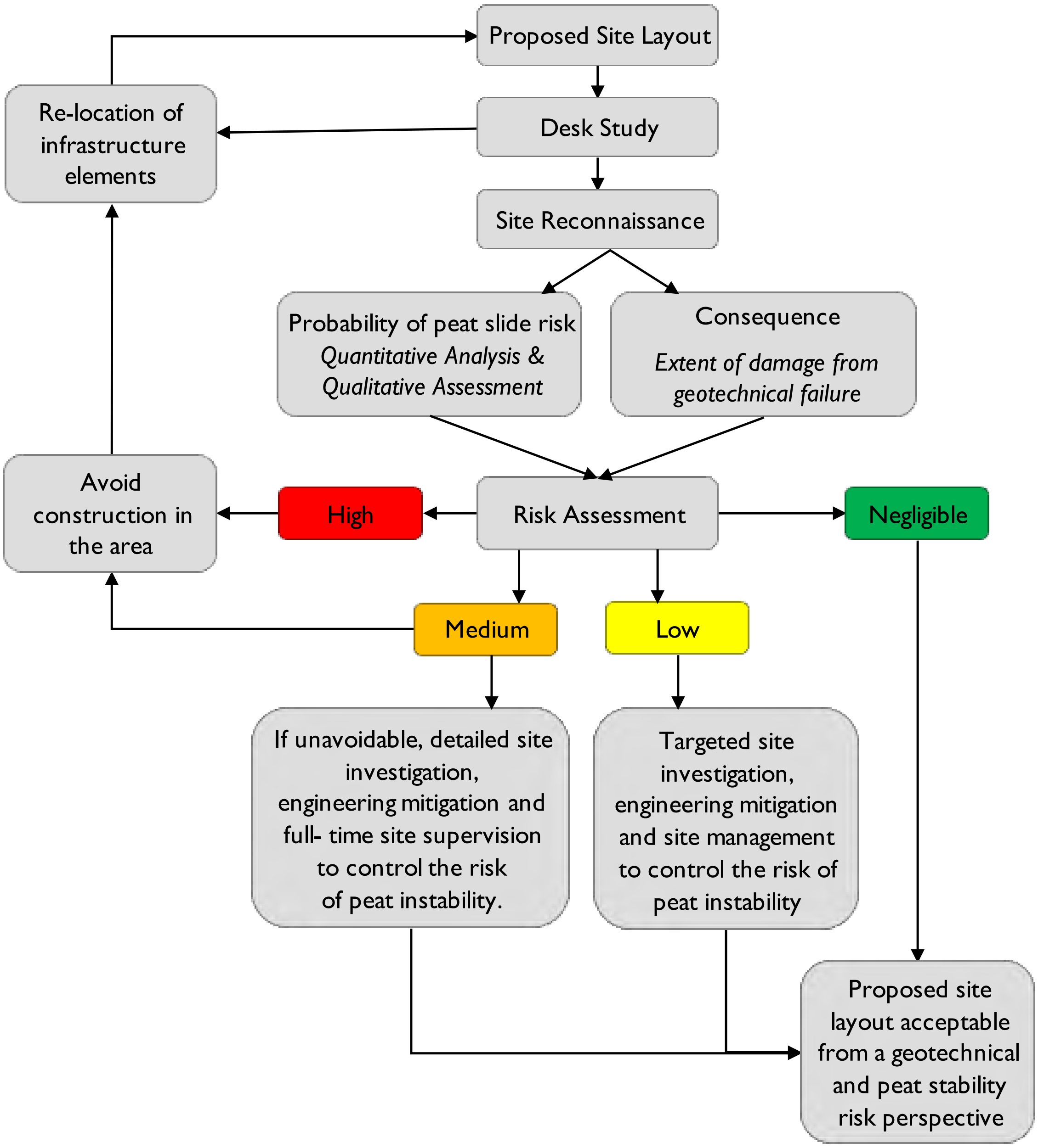

Figure 1: Peat Stability Risk Assessment Methodology

The methodology implemented for the risk assessment is outlined in the subsequent sections.

3.1 Desk Study

The desktop study was undertaken to collate and review published geological information to inform the site investigation. A desk study utilising existing maps, geological data/memoirs of the site is undertaken as an initial step to identify risks and "obstacles". The following data sources were examined during the desk study:

- Aerial/Satellite imagery
- Quaternary sediments
- Bedrock geology
- Geological faults
- Landslide inventory and susceptibility
- Hydrogeology
- Hydrology
- Topography
- Mining and active quarries
- Radon risk

3.2 Preliminary Walkover

A preliminary walkover of the site builds upon information from the desk study identifying areas of significant geotechnical risk and existing geotechnical failures which are immediately identifiable without any level of detailed/penetrative site investigation. These may include existing landslips, areas of peat bog, areas of cracked peat, etc. Other features such as engineered drainage, manmade or natural features are also easily identified and mapped during a site walkover.

A site walkover is also useful to identify where the true site condition or layout differs from existing map-based data of a site or information gathered from other sources.

3.3 Preliminary Fieldworks

Whilst traversing the site on the preliminary walkover it is relatively easy to undertake some fieldworks such as preliminary peat probing. This initial field work allows factual data to be added to existing site layouts/maps. The outcome of Preliminary Walkover/Fieldworks also allow future site investigation works to be better focused on areas beyond the reach of Preliminary walkover/fieldworks and away from areas identified as being of low risk.

3.4 Terrain Assessment

A terrain assessment of the site is carried out allowing analysis of slope angles, directions of slope and run off analysis. Assessing slope angles across the site is key in assessing the risk of peat slides.

The assessment of terrain and determination of sliding angles at the site are carried out using Digital Terrain Models (DTMs) obtained from Bluesky, alongside site walkovers.

3.5 Site Investigation

Further Site Investigation (SI) is required to better understand the subterranean geological conditions. SI generally includes trial pits, dynamic probes, dynamic cone penetrometers, and hand shear vane testing. These works give a better understanding of the soils ability to support loads and also gives a clearer picture of soil depths.

3.6 Risk Assessment Process

This report follows the risk assessment process as detailed in *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006). The methodology follows the well-established principle that,

RISK = PROBABILITY x CONSEQUENCE

1. Consequence Assessment: Evaluates the potential severity of damage caused by geotechnical failure, considering factors such as displacement scale, infrastructure impact, and environmental consequences.
2. Probability Assessment: Determines the likelihood of peat slide failure through a combination of two separate analyses:
    a. Quantitative approach based on geotechnical data.
    b. Qualitative approach based on best practice guidelines.

By integrating these quantitative and qualitative assessments, the risk assessment process provides a comprehensive understanding of the potential for peat slide failure and informs mitigation strategies to minimize risks.

3.7 Mitigation Measures

Where the Risk Assessment Process has identified infrastructure overlying areas of geotechnical risk, mitigation measures are recommended to reduce the risk level in those areas.

3.8 Summary

The outcome of the risk assessment and other findings are drawn together in a series of conclusions and recommendations at the end of the report.

4. DESKTOP STUDY

4.1 Site Description

The site covers approximately 370 hectares, extending approximately 2.5km from north to south, with varying widths between 300 meters to 1650 meters. The area is currently accessed through an existing agricultural track off the eastern edge of the L3037.

The ground contours obtained from Bluesky shows the site to be moderately flat with the gradients ranging between 230m OD in the southwest to 271m OD in the northeast.

The aerial imagery indicates that the Proposed Wind Farm site is mostly forested, with the remainder used as open farmland.

Site layout plans for the Proposed Wind Farm site are included in Appendix 4-1 of the EIAR: Site Layout Planning Drawings. The coordinates and elevations of turbine bases are given in the table below.

Turbine Location	Turbine Coordinates (ITM)		Elevation
	Easting	Northing	
T1	663467	669637	252m OD
T2	663996	669653	269m OD
T3	664205	669229	260m OD
T4	663569	669075	252m OD
T5	664134	668661	254m OD
T6	663450	668611	242m OD
T7	663626	668143	252m OD

Table 1 Coordinates and Elevation of Turbine Bases

4.2 Published Geology

The following section is compiled from information provided by the Geological Survey Ireland (GSI) and indicates the conditions across the site.

4.2.1 Quaternary Sediments

GSI Quaternary Sediments mapping indicates that the subsoil mainly consists of till derived from Namurian sandstones and shales and blanket peat, with a tiny patch of alluvium in the western part of the site.

The mapping suggests the possible presence of peat at turbine locations T2, T3, T5 and T7, as well as along the associated spur roads. It is noted that no infrastructure has been proposed over the area of alluvium.

4.2.2 Bedrock Geology

The GSI Bedrock Geology 100k Map indicates that the western part of the site, which includes T1, T4, T6, T7, the temporary construction compound, and the met mast, is underlain by feldspathic quartzitic sandstone of the Clay Gall Sandstone Formation.

T2, T3 and T5 are underlain by thick flaggy sandstone and siltstone of Bregaun Flagstone Formation.

A thin band of shale, siltstone and minor sandstone of Moyadd Coal Formation exists between the aforementioned bedrock types. This layer underlies the onsite 38kV substation, battery storage compound, and adjacent temporary construction compound.

4.2.3 Geological Faults

Fault lines derived from GSI Bedrock Geology 100k Map indicate that a north south orientated fault traverses through the existing access road to T5. However, there are no faults within the footprint of any turbine foundation or hardstand.

4.2.4 Landslide Inventory and Susceptibility

Previous landslide records of the Geological Survey Ireland events within the vicinity of the Proposed Project site were examined. It is noted that the nearest recorded landslide (Event ID: GSI_LS06-0300) occurred west off N80 in Maidenhead in County Laois. The land use at this location has been categorized as 231 Pastures, with the Quaternary sediment identified as Bedrock at Surface. Aerial imagery and Street View indicate that this location is densely vegetated, with a mix of trees covering the hilly terrain. However, there is no available information regarding the date or cause of the event.

The Proposed Wind Farm is located approximately 14.3km south of this recorded landslide event. Therefore, it is assumed that the site-specific causes of that previous landslide are deemed to not be pertinent to this site.

GSI Landslide Susceptibility mapping indicates that the site is classified as Moderately Low to Low Susceptibility.

4.2.5 Hydrogeology

1. Aquifer

GSI Groundwater Resources (Aquifer) mapping indicates that almost half of the site is underlain by Locally Important Aquifer (bedrock which is generally moderately productive) while the remainder of the site is characterised by Poor Aquifer (bedrock which is generally unproductive except for local zones) and Poor Aquifer (bedrock which is generally unproductive). The study area is located within the Castlecomer and Shanragh groundwater bodies.

2. *Groundwater Vulnerability*

As per the GSI Groundwater Vulnerability mapping, the vulnerability of the aquifer underlying the majority of the site is classified as predominantly Low. However, for the area from the site entrance to the met mast location, the vulnerability is classified as High.

3. Subsoil Permeability

As per the GSI Groundwater Subsoil Permeability mapping, the subsoil at the Proposed Wind Farm is classified as having Low permeability.

4.2.6 Hydrology

As per the GSI Surface Water Features mapping, it's noted that three existing watercourses from the Seskinrea River Network traverse the Proposed Wind Farm site. Two of these water courses run from northeast to southwest, with one crossing the proposed access road to T1. The third water course runs from southeast to northwest, intersecting the access road to the met mast.

4.2.7 Topography

In order to characterise the slope conditions over the Proposed Wind Farm site, slopes were analysed from a DTM derived from Bluesky (2018) orthophoto data. The slopes have been collated in the table below.

Location Reference	Slope of Sliding Plane (%)
T1-01	4.3
T1-02	4.8
T1-03	3.4
T1-04	3.6
T2-01	3.3
T2-02	3.3
T2-03	2.5
T2-04	3.0
T3-01	3.7
T3-02	3.6
T3-03	3.7
T3-04	2.1
T5-01	2.7
T5-02	2.7
T5-03	2.7
T5-04	3.4
T5-05	3.5
T5-06	3.8
T7-01	3.2
T7-02	2.3
T7-03	2.5
T7-04	2.1
T7-05	2.0
T7-06	2.9
T7-07	2.6
T7-08	2.9
T7-09	2.6

Table 2: Summary of Slopes on Site

4.2.8 Mining and Active Quarries

GSI mining mapping indicates that the Proposed Wind Farm site layout is surrounded by a number of "non-metallic" mineral markers to the west of the met mast and turbine location T1.

There are no active mines or quarries within the Proposed Wind Farm site. The nearest quarry, Clongrennane Quarry, is located at approximately 5km northeast of T2.

4.2.9 Radon Risk

The Environmental Protection Agency radon risk map indicates that the Proposed Project site infrastructure does not fall under the High Radon Area.[1]

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[1] https://gis.epa.ie/EPAMaps/default?easting=?&northing=?&lid=EPA:RadonMapForUseWithTechnicalGuidanceDocumentC

5. FIELDWORKS

5.1 Preliminary Walkover

A series of walkover surveys were conducted between July 2023 and January 2024 by AFRY. The walkover surveys consisted of a review of all infrastructure areas.

During the first walkover in July 2023, it was observed that turbines T1, T6, the met mast, the substation and battery storage compound, and the temporary construction compounds are located within open farmlands, which exhibit good ground conditions. The remaining turbines are located within active commercial forestry lands. It was noted that the areas of T2, T3, T5 and T7 had recently been felled and the area of T4 was being felled. The recently felled forest area included tree roots and stumps being left in-situ. It was also observed that some areas of the site were overlain by shallow and dry peat.

During a follow-up site walkover in November 2023, it was observed that the areas adjacent to T4, T5, and T7 were vegetated with forestry and waterlogged, considering the time of the year. No evidence of any previous landslides or peat instability indicators as described in Section 2.4.4 were identified during the walkovers.

Overall, the Proposed Project site appeared relatively flat, and indicated favourable ground conditions.

Photos from the November site walkover have been included within Appendix A of this report.

5.2 Preliminary Fieldworks

289 peat probes were carried out by MKO between June 2023 and August 2023 across the Proposed Project site. The peat probing results indicate that the depth of peat across the site is generally shallow, with localised deeper peat pockets identified around T3 and T5.

The peat depths across the site range from 0 to 2.7 meters, with an average depth of 0.23m. Overall, 83.4% of recorded peat depths were under 0.5m, and 96.5% were under 1m. Peat exceeding 1m in depth was recorded near T3 and the maximum peat depth recorded was 2.7m near the T5 blade finger area.

Results of the peat probe survey are included within Appendix B.

A Peat Depth Map for the Proposed Wind Farm site is shown in Figure 2.

5.3 Further Site Investigation

Site investigation works were carried out by Causeway Geotech Limited in November 2023 which included 8no. trial pits, 5no. heavy dynamic probes and 28no. hand shear vanes. Testing was carried out at turbine bases, hardstands, met mast, substation and battery storage compound, temporary construction compounds, and access roads. Laboratory tests were carried out on soil samples taken from trial pits. The ground investigation factual report is included within Appendix C.

6. GROUND CONDITIONS

6.1 Superficial Deposits

The Proposed Wind Farm site is overlain by peaty/non-peaty poorly drained mineral soils with blanket peat at some locations. A Peat Depth Map, as shown in Figure 2, has been developed based on the findings of the peat probing and site investigation. The peat depths at main infrastructure locations and across the access roads are listed in Table 3 and Table 4.

Site Location	Peat Depths
T1	0.1m - 0.6m
T2	0.1m - 0.5m
T3	0m - 1.3m
T4	0.1m
T5	0m - 2.1m
T6	0m - 0.4m
T7	0.2m - 0.6m
Met Mast	0m
Substation and BESS Compound	0m - 0.1m
Temporary Construction Compounds	0m - 0.5m

Table 3: Estimated Peat Depths at Proposed Wind Farm Infrastructure Locations

Site Location	Peat Depths
Spur to T1	0m - 0.5m
Spur to T2	0m - 0.2m
T4 – T1/T2 junction	0m - 0.4m
T3-T4	0m - 0.1m
T3 - T5	0m - 0.5m
T5-T6	0m - 0.4m
Spur to T6	0m - 0.1m
Spur to T7	0.3m - 0.6m
Road to Met Mast	0m

Table 4: Estimated Peat Depths across Proposed Wind Farm Access Roads

The depth of organic strata each trial pit location is listed in Table 5.

Site Location	Trial Pit Coordinates		Subsoil Material	Organic Strata Depth
	Easting	Northing		
T1	663468.39	669638.21	Clay	0.30m
T2	663994.20	669652.07	Clay	0.30m
T3	664203.86	669225.26	Clay	0.40m
T4	663610.77	669042.36	Clay	0.40m

T5	664146.21	668712.68	Sand	0.30m
T6	663454.01	668611.05	Clay	0.40m
T7	663554.86	668199.34	Clay	0.50m
Substation and BESS Compound	663744.72	669345.41	Clay	0.30m

Table 5: Overburden Material, Organic Strata Depth at each Trial Pit Location

6.2 Groundwater and Hydrogeology

Groundwater levels at each trial pit location are listed in Table 6.

Infrastructure Location	Groundwater Level m (bgl)
T1	Did not encounter GW
T2	Seepage at 2.3m
T3	Light seepage at 2.2m
T4	Did not encounter GW
T5	Light flow at 2.1m
T6	Strong flow from 0.0m
T7	Did not encounter GW
Substation and BESS Compound	Slight seepage at 0.3m

Table 6: Groundwater Levels

6.3 Shear Strength

The shear strength of peat recorded during the hand vane testing is summarised in the table below.

Location Ref.	Easting	Northing	Peat Strength (kPa)
T1-01	663635.1	669551.6	23.0
T1-02	663603.2	669551.7	24.7
T1-03	663471.3	669640.8	77.0
T1-04	663441.2	669672.1	71.0
T2-01	663897.3	669582.3	25.3
T2-02	663933.3	669630.5	33.0
T2-03	663988.8	669590.7	14.7
T2-04	664006.3	669641.9	36.7
T3-01	664211.4	669158.3	27.0
T3-02	664171.5	669181.0	22.3
T3-03	664198.8	669195.2	32.3

T3-04	664214.3	669229.7	81.0
T5-01	664068.7	668848.9	20.7
T5-02	664016.4	668766.1	13.7
T5-03	664062.9	668751.4	11.0
T5-04	664107.3	668736.4	12.0
T5-05	664104.2	668704.3	17.3
T5-06	664142.8	668661.0	14.0
T7-01	663351.8	668360.0	20.7
T7-02	663399.5	668316.7	24.7
T7-03	663446.0	668264.6	25.3
T7-04	663479.5	668229.9	18.0
T7-05	663517.6	668212.3	19.7
T7-06	663548.8	668148.6	23.7
T7-07	663581.3	668171.9	25.0
T7-08	663593.6	668103.4	16.7
T7-09	663630.0	668133.0	24.7

Table 7: Summary of Shear Strengths

6.4 Laboratory Testing Results

All geotechnical tests were carried out in accordance with IS EN 1997 (Eurocode 7) and BS 5930. The following geotechnical testing was scheduled by AFRY:

- pH and SO4 Testing

6.4.1 Geochemical Testing

Samples were tested to determine the chemical characteristics of the soil and groundwater, including the level of acidity (pH value).

The results from the chemical analysis are used primarily to determine the concrete exposure classification for chemical attack, which is in turn required to establish an appropriate concrete mix design in accordance with the requirements of IS EN 206-1.

The following data in Table 8 and Table 9 summarise the geochemical testing results conducted on soil samples.

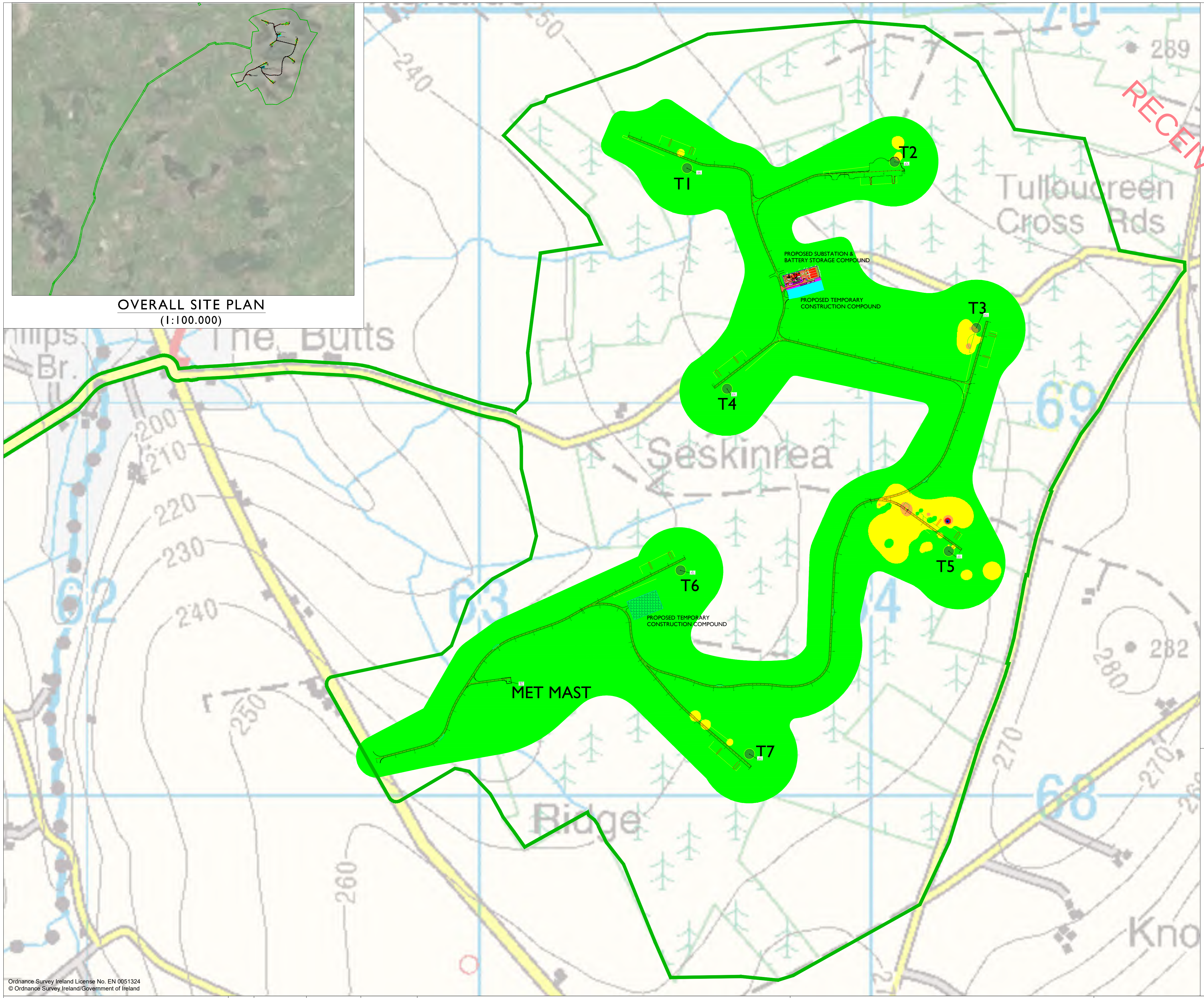
Infrastructure Location	Sample Depth m (bgl)	Moisture Content Ratio (%)
T1	1.2	13
T2	N/A	N/A
T3	0.5	24
T4	N/A	N/A

T5	N/A	N/A
T6	1.0	22
T7	N/A	N/A
Substation and BESS Compound	0.6	20

Table 8: Summary of Moisture Content Results

Infrastructure Location	Sample Depth BGL m (bgl)	pH (pH Units)	Sulphate Aqueous Extract as SO_4 (2:1) (mg/l)
T1	N/A	N/A	N/A
T2	0.4	7.2	24
T3	N/A	N/A	N/A
T4	1.0	6.6	14
T5	1.5	6.7	<10
T6	N/A	N/A	N/A
T7	0.7	5.8	11
Substation and BESS Compound	N/A	N/A	N/A

Table 9: Summary of Chemical Laboratory Test Results



N
W E
S

LEGEND

🟩 EIAR SITE BOUNDARY

● TURBINE LOCATION

PEAT DEPTHS

NUMBER	MINIMUM LEVEL	MAXIMUM LEVEL	COLOUR
1	0.0	0.5	🟩
2	0.5	1.0	🟨
3	1.0	1.5	🟧
4	1.5	2.0	🟥
5	2.0	2.5	🟦
6	2.5	3.0	⬛

NOTES

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
F	02.05.2024	M.S.	L.P.	EIAR SITE BOUNDARY UPDATED
E	01.05.2024	M.S.	L.P.	EIAR SITE BOUNDARY UPDATED
D	01.05.2024	M.S.	L.P.	EIAR REDLINE BOUNDARY UPDATED
C	19.01.2024	M.S.	L.P.	GENERAL REVISION
B	18.01.2024	M.B.	M.S.	GENERAL REVISION
A	08.12.2023	M.S.	L.P.	FIRST ISSUE

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MKO

PROJECT
SESKIN WIND FARM
CO. CARLOW

TITLE
PEAT DEPTH MAP

REVISION
F

DRAWN BY: M. SRIVASTAVA
DATE: 08.12.2023
PAPER SIZE: A3
SCALE: 1:10000
CHECKED AND APPROVED: L. POWER
DATE: 08.12.2023
STATUS: FINAL
DRAWING NUMBER: FIGURE 2

Plotted - 02/05/2024 17:59:35
Z:\Projects\Ireland\Seskin SESK\Drawings\d011 Peat Management\d011.2 Peat Depth Map

7. PEAT STABILITY ASSESSMENT

The peat stability assessment is undertaken to evaluate the PROBABILITY or likelihood of a peat slide failure, utilizing a combination of quantitative and qualitative analyses detailed within this section.

The turbine delivery route and the Proposed Grid Connection Route are not included in this assessment.

7.1 Methodology

The report follows two methods for analysing peat stability assessment, as follows:

7.1.1 Quantitative Assessment (FoS approach)

The following analysis uses a quantitative approach to determine factors of safety to quantify the risks of peat slides and local rotational failure or engulfment of excavations occurring. This includes assessing the peat for undrained (short-term stability) and drained (long-term stability) conditions:

- The undrained loading condition is relevant in the short-term, specifically during construction and until any pore water pressures induced by construction activities subside.
- The drained loading condition pertains to the long-term scenario. This condition assesses the impact of groundwater level changes due to rainfall on the stability of existing natural peat slopes.

7.1.2 Qualitative Assessment

The qualitative peat stability assessment or the likelihood of peat slip outlines several contributory factors affecting the peat stability which include slope angle, peat depth, peat strength, moisture content, cracking, underground hydrology, surface hydrology, historical peat slips, and weather. This assessment has been covered in further detail in the Section 7.3.

7.1.3 Geotechnical Parameters of Peat

To complete a drained Factor of Safety (FoS) analysis, the values of effective cohesion (c') and effective friction angle (ø') are required. However, obtaining these values can be difficult due to the disturbance experienced during peat sampling and the difficulties in interpreting test results caused by the excessive strain induced within the peat. For the purposes of a conservative FoS calculation, these values have been derived as averages from the published literature, as summarized in Table 10.

The values for c' and ø' for drained analysis in this report are as follows:

$$c' = 4\ kPa$$

$$ø' = 25°$$

Reference	Cohesion, c' (kPa)	Friction Angle, ø' (degrees)
Hanrahan et al. (1967)	5 to 7	36 to 43
Rowe and Mylleville (1996)	2.5	28
Landva (1980)	2 to 4	27.1 to 32.5
Landva (1980)	5 to 6	-

Carling (1986)	6.5	0
Farrell and Hebib (1998)	0	38
Farrell and Hebib (1998)	0.61	31
Rowe, Maclean and Soderman (1984)	3	27
McGreever and Farrel (1988)	6	38
McGreever and Farrel (1988)	6	31
Hungr and Evans (1985)	3.3	-
Madison et al. (1996)	10	23
Dykes and Kirk (2006)	3.2	30.4
Dykes and Kirk (2006)	4	28.8
Warburton et al. (2003)	5	23.9
Warburton et al. (2003)	8.74	21
Entec (2008)	3.8	36.8
Komatsu et al. (2011)	8	34
Zhang and O'Kelly (2014)	0	28.9 to 30.3

Table 10: Effective Cohesion and Friction Angle Values for Peat from Published Literature

7.1.4 Assumptions

The assumptions incorporated in the peat stability analysis are as follows:

1. Peat depths were determined based on the maximum depths recorded in each probe during the walkover surveys.
2. Slope angles are analysed from the Digital Terrain Model (DTM) (Bluesky) which are assumed to accurately represent slope angles on site.
3. The surface of failure is assumed to be parallel to the ground surface.
4. Three surcharging conditions were considered for the stability analysis:
    i. No surcharge load
    ii. Surcharge load of 10 kPa, equivalent to 1m of stockpiled or side-cast peat.
    iii. Surcharge load of 20 kPa, equivalent to 2m of stockpiled or side-cast peat.

7.2 Quantitative Assessment

The methodology for quantitative peat slide risk assessment is derived from the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006), which includes Infinite Slope Analysis and Stability of Excavation in peat. In Infinite Slope Analysis, the Factors of Safety (FoS) for undrained and drained conditions are calculated, which helps in assessing the likelihood of a peat slide.

The analysis is based on a theoretical infinite slope which considers the resistance to failure (dependent on shear strength) and the active gravitational force (dependent on peat depth, weight and slope).

The purpose of this analysis is to determine the Factor of Safety (FoS) against failure of peat slopes across the site. The analysis was carried out for each section and provides an indication of the stability of peat slopes at each location.

The minimum required FoS for stable slopes is 1.3, as specified in BS6031:1981: Code of Practice for Earthworks (BSI, 1981). Therefore, on the basis of FoS values, the risk can be deemed as "low", "medium" or "high". The following table lists the risk level based on FoS values.

Factor of Safety (FoS)	Risk Level
> 1.3	Low
1.0 – 1.3	Medium
< 1.0	High

Table 11: Risk Level based on Factor of Safety Values

The detailed FoS calculations for both the cases are outlined in this section. The shear vane site testing was carried out in the areas of higher perceived risk primarily in the general vicinity of T1, T2, T3, T5 and T7, where the peat depth exceeds 0.5m. The quantitative analysis is therefore focused on these areas.

7.2.1 Undrained Condition

Undrained analysis is used to assess the short-term stability of the peat. The formula used to determine the FoS for the undrained condition for a given slope, weight and strength of material (Bromhead, 1986) is as follows:

$$FoS = \frac{C_u}{\gamma z \, Sin\alpha \, Cos\alpha}$$

where

FoS= Factor of Safety
C_u= Peak undrained shear strength (kPa)
γ= Bulk Unit Weight of Material (kN/m$^{3)}$
z=Depth to failure plane (Assumed depth of peat) (m)
α= Slope angle (deg)

The results are summarised in the table below:

LOCATION			DATA				ANALYSIS		
Location Reference	Easting	Northing	Peat Depth [z (m)]	Peat Strength (kPa)	Angle of Sliding Plane [α (deg)]	Unit Weight Peat [γ (kN/m3)]	No Load FoS	+1m Peat FoS	+2m Peat FoS
T1-01	663635	669552	0.4	23.0	2.46	10	134.0	38.3	22.3
T1-02	663603	669552	0.4	24.7	2.75	10	128.5	36.7	21.4
T1-03	663471	669641	0.4	77.0	1.92	10	575.3	164.4	95.9
T1-04	663441	669672	0.6	71.0	2.03	10	333.8	125.2	77.0
T2-01	663897	669582	0.4	25.3	1.89	10	192.1	54.9	32.0
T2-02	663933	669631	0.1	33.0	1.89	10	1001.1	91.0	47.7
T2-03	663989	669591	0.5	14.7	1.43	10	117.4	39.1	23.5
T2-04	664006	669642	0.7	36.7	1.72	10	174.8	72.0	45.3

T3-01	664211	669158	0.3	27.0	2.12	10	243.6	56.2	31.8
T3-02	664171	669181	1.3	22.3	2.06	10	47.8	27.0	18.8
T3-03	664199	669195	0.9	32.3	2.12	10	97.2	46.1	30.2
T3-04	664214	669230	1.2	81.0	1.20	10	321.6	175.4	120.6
T5-01	664069	668849	0.5	20.7	1.55	10	153.2	51.1	30.6
T5-02	664016	668766	2.1	13.7	1.55	10	24.1	16.3	12.4
T5-03	664063	668751	1.2	11.0	1.55	10	34.0	18.5	12.7
T5-04	664107	668736	2.7	12.0	1.95	10	13.1	9.5	7.5
T5-05	664104	668704	0.8	17.3	2.00	10	62.0	27.5	17.7
T5-06	664143	668661	0.6	14.0	2.18	10	61.5	23.1	14.2
T7-01	663352	668360	0.4	20.7	1.83	10	161.6	46.2	26.9
T7-02	663400	668317	0.5	24.7	1.32	10	214.6	71.5	42.9
T7-03	663446	668265	0.3	25.3	1.43	10	338.0	78.0	44.1
T7-04	663480	668230	0.6	18.0	1.20	10	142.9	53.6	33.0
T7-05	663518	668212	0.6	19.7	1.15	10	164.0	61.5	37.8
T7-06	663549	668149	0.3	23.7	1.66	10	272.3	62.8	35.5
T7-07	663581	668172	0.6	25.0	1.49	10	160.4	60.1	37.0
T7-08	663594	668103	0.5	16.7	1.66	10	115.0	38.3	23.0
T7-09	663630	668133	0.5	24.7	1.49	10	189.9	63.3	38.0

Table 12: Factor of Safety against Sliding for Undrained Condition

The FoS for undrained condition is greater than 3 at all locations where shear vane testing was carried out. This indicates that the short-term risk of peat instability is LOW under surcharge loadings of +1m peat and +2m peat.

7.2.2 Drained Condition

Drained analysis is used to assess the long-term stability of the peat. The formula used to determine the FoS for the drained condition for a given slope, weight and strength of material (Bromhead, 1986) is as follows:

$$FoS = \frac{c' + (\gamma z - \gamma_w h_w) Cos^2\alpha \, Tan\phi'}{\gamma z \, Sin\alpha \, Cos\alpha}$$

where

FoS= Factor of Safety
c'= Effective cohesion (kPa)
γ= Bulk Unit Weight of Material (kN/m$^{3)}$
z= Depth to failure plane (Assumed depth of peat) (m)
h_w= Height of water table
α= Slope angle (deg)

For estimation of FoS in case of drained condition, the unit weight of water (γ_w) and peat (γ) have been taken as 10 kNm^{-3} and 10 kNm^{-3}, respectively. The results are summarised in the table below;

LOCATION			**DATA**								**ANALYSIS**		
Probe No.	Easting	Northing	Peat Depth [z (m)]	Height of Water Table [h_w (m)]	Effective Cohesion [c' (kPa)]	Friction Angle [ø' (deg)]	Slope of Sliding Plane (%)	Angle of Sliding Plane [α (deg)]	Unit Weight Peat [γ (kN/m3)]	Unit Weight Water [γ_w (kN/m^3)]	No Load FoS	+1m Peat FoS	+2m Peat FoS
T1-01	663635	669552	0.4	0.4	4.0	25.0	4.3	2.46	10.0	10.0	23.3	6.7	3.9
T1-02	663603	669552	0.4	0.4	4.0	25.0	4.8	2.75	10.0	10.0	20.8	6.0	3.5
T1-03	663471	669641	0.4	0.4	4.0	25.0	3.4	1.92	10.0	10.0	29.9	8.5	5.0
T1-04	663441	669672	0.6	0.6	4.0	25.0	3.6	2.03	10.0	10.0	18.8	7.1	4.3
T2-01	663897	669582	0.4	0.4	4.0	25.0	3.3	1.89	10.0	10.0	30.3	8.7	5.1
T2-02	663933	669631	0.1	0.1	4.0	25.0	3.3	1.89	10.0	10.0	121.3	11.0	5.8
T2-03	663989	669591	0.5	0.5	4.0	25.0	2.5	1.43	10.0	10.0	32.0	10.7	6.4
T2-04	664006	669642	0.7	0.7	4.0	25.0	3.0	1.72	10.0	10.0	19.1	7.9	4.9
T3-01	664211	669158	0.3	0.3	4.0	25.0	3.7	2.12	10.0	10.0	36.1	8.3	4.7
T3-02	664171	669181	1.3	1.3	4.0	25.0	3.6	2.06	10.0	10.0	8.6	4.8	3.4
T3-03	664199	669195	0.9	0.9	4.0	25.0	3.7	2.12	10.0	10.0	12.0	5.7	3.7
T3-04	664214	669230	1.2	1.2	4.0	25.0	6.2	3.55	10.0	10.0	5.4	2.9	2.0
T5-01	664069	668849	0.5	0.5	4.0	25.0	2.7	1.55	10.0	10.0	29.7	9.9	5.9
T5-02	664016	668766	2.1	2.1	4.0	25.0	2.7	1.55	10.0	10.0	7.1	4.8	3.6
T5-03	664063	668751	1.2	1.2	4.0	25.0	2.7	1.55	10.0	10.0	12.4	6.7	4.6
T5-04	664107	668736	2.7	2.7	4.0	25.0	3.4	1.95	10.0	10.0	4.4	3.2	2.5

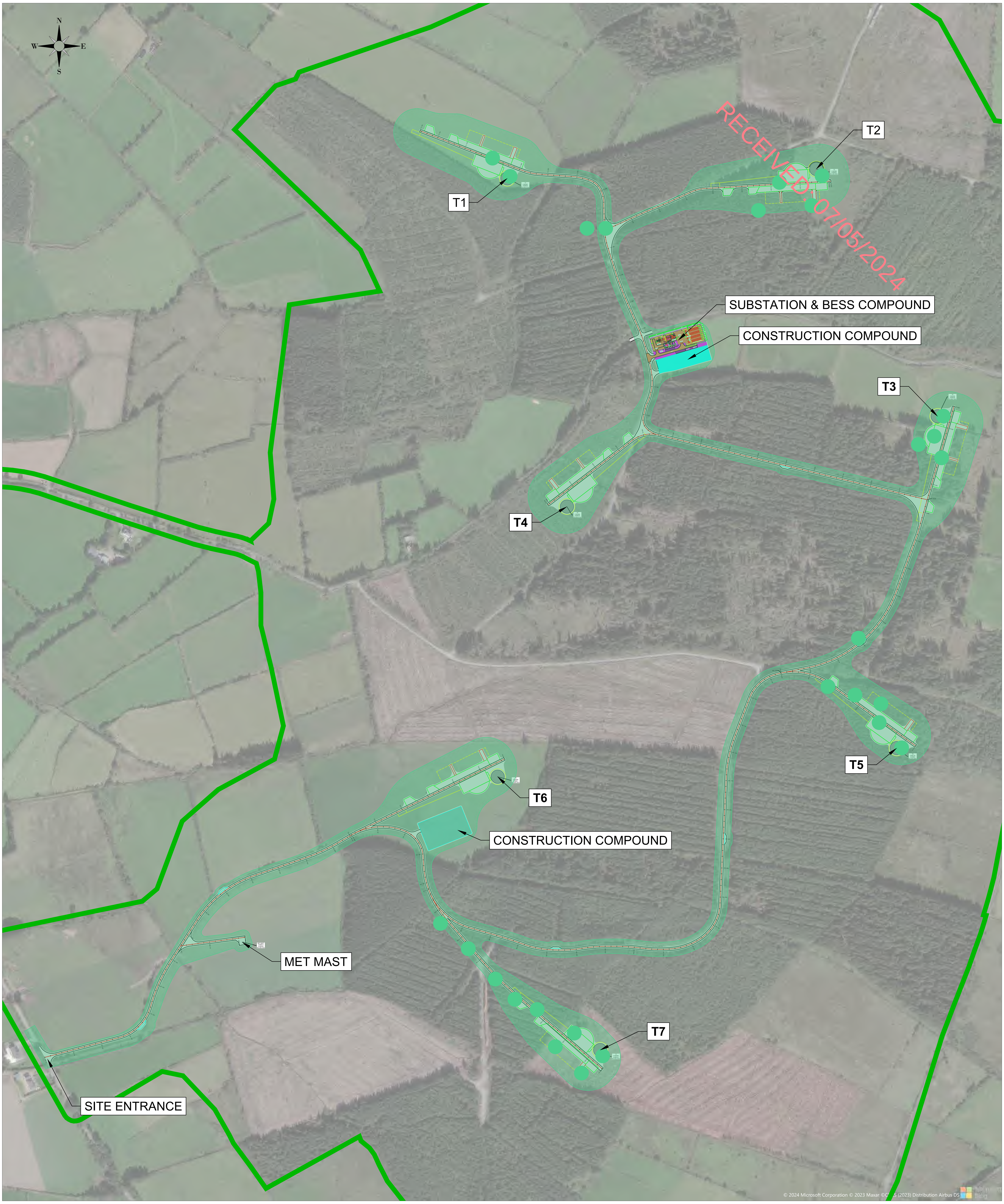
T5-05	664104	668704	0.8	0.8	4.0	25.0	3.5	2.00	10.0	10.0	14.3	6.4	4.1
T5-06	664143	668661	0.6	0.6	4.0	25.0	3.8	2.18	10.0	10.0	17.6	6.6	4.1
T7-01	663352	668360	0.4	0.4	4.0	25.0	3.2	1.83	10.0	10.0	31.3	8.9	5.2
T7-02	663400	668317	0.5	0.5	4.0	25.0	2.3	1.32	10.0	10.0	34.8	11.6	7.0
T7-03	663446	668265	0.3	0.3	4.0	25.0	2.5	1.43	10.0	10.0	53.4	12.3	7.0
T7-04	663480	668230	0.6	0.6	4.0	25.0	2.1	1.20	10.0	10.0	31.8	11.9	7.3
T7-05	663518	668212	0.6	0.6	4.0	25.0	2.0	1.15	10.0	10.0	33.3	12.5	7.7
T7-06	663549	668149	0.3	0.3	4.0	25.0	2.9	1.66	10.0	10.0	46.0	10.6	6.0
T7-07	663581	668172	0.6	0.6	4.0	25.0	2.6	1.49	10.0	10.0	25.7	9.6	5.9
T7-08	663594	668103	0.5	0.5	4.0	25.0	2.9	1.66	10.0	10.0	27.6	9.2	5.5
T7-09	663630	668133	0.5	0.5	4.0	25.0	2.6	1.49	10.0	10.0	30.8	10.3	6.2

Table 13: Factor of Safety against Sliding for Drained Condition

The FoS for drained condition is greater than 3 at all locations where shear vane testing was carried out. This indicates that the long-term risk of peat instability is LOW under surcharge loadings of +1m peat and +2m peat.

7.2.3 Summary

The FoS obtained from both undrained and drained analyses is greater than 3 at all locations where peat depth exceeded 0.5m during peat probing. This indicates that the PROBABILITY or the likelihood of peat slide occurrence within the Proposed Wind Farm site is deemed as LOW. The result of the quantitative analysis for the most critical load case (+2m peat loading) is shown on Figure 3.



Factor of Safety	Risk Level
● > 1.3	Low
● 1.0 - 1.3	Medium
● < 1.0	High

LEGEND

— EIAR SITE BOUNDARY

REV	DATE	DRAWN BY	CHECKED BY	DETAILS
C	01.05.2024	M.S.	L.P.	EIAR SITE BOUNDARY UPDATED
B	08/03/2024	M.S.	L.P.	LEGEND UPDATED
A	07/02/2024	M.B.	L.P.	FIRST ISSUE

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CLIENT

PROJECT
SESKIN WIND FARM

TITLE
PEAT FACTOR OF SAFETY MAP

REVISION
C

DRAWN BY
M. BROWNE

DATE
07/02/2024

PAPER SIZE
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SCALE
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CHECKED AND APPROVED
L. POWER

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DRAWING NUMBER
FIGURE 3

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Z:\Projects\Ireland\Seskin SESK\Drawings\d011 Peat Management\d011.4 Peat Factor Of Safety Map

7.3 Qualitative Assessment

The qualitative peat slide risk assessment or the likelihood of peat slip is based on the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) that outlines several contributory factors affecting the peat stability. The contributory factors and the methodology for qualitative assessment is described in the following sections.

7.3.1 Controlling Principal Factors

The key parameters which influence the LIKELIHOOD or PROBABILITY of occurrence of a peat slide are:-

- Slope angle
- Peat depth
- Peat strength/ Moisture Content
- Cracking
- Underground Hydrology
- Surface Hydrology
- Historical Peat Slips
- Weather

By focusing on these eight factors it is possible to ensure a consistent site based approach to the likelihood of a geotechnical failure occurring. The qualitative risk assessment process is not necessarily limited to the above eight factors and, potentially, other parameters such as the existing harvesting techniques, water level, pore pressures and especially the nature of the interface between the superficial geology and underlying solid geology may also be significant.

However, some of these factors are variable and transient (resulting from prolonged heavy rainfall) and cannot be determined in a systematic manner and without extensive site investigations and considerable expense. This level of investigation is deemed beyond the scope of a risk assessment unless there are persuasive counter-indications.

The data within these eight principal factors, some of which is not numeric, is used to derive a single representative value for individual areas of the site. The methodology has been adopted from *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) in which the measured value of the principal factors is linked to the likelihood of contributing to a peat slide.

The following tables define the method of assessment, value and the probability of contributing to peat slide for each of the principal factors.

1. Moisture Content

Table 6 of the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) has been adopted to assess the likelihood of peat slips based on mositure content of the soil. The table links the moisture content to shear strength, values of which were obtained for soils at different locations of the site. The table below shows the probability of contributing to peat slides for different shear strength values.

Shear Strength (kPa)	Probability
≤5kPa	Very Likely
5kPa - 10kPa	Likely
10kPa - 12.5kPa	Probable

12.5kPa - 15kPa	Unlikely
≥15kPa	Negligible

Table 14: Probability of peat slide occurrence based on shear strength values

2. Peat Depth

Peat depth at the site location is measured using peat probes, trial pits and GPR surveys. The table below shows the probability of contributing to peat slides based on peat depths values.

Peat Depth (m)	Probability
0 - 0.5m	Negligible
0.5m - 1.0m	Unlikely
1.0m - 1.5m	Probable
1.5m - 2.0m	Likely
≥ 2m	Very Likely

Table 15: Probability of peat slide occurrence based on peat depth values

3. Slope Angle

Slope angle at the site location is indicative from probing, GPR surveys, and LIDAR and can also be measured when peat is excavated. The table below shows the probability of contributing to peat slides based on slope angle values.

Slope Angle (°)	Probability
0 - 3°	Unlikely
4 - 9°	Probable
10 - 15°	Likely
16 - 20°	Very Likely
≥ 20°	High Risk

Table 16: Probability of peat slide occurrence based on slope angle values

4. Cracking

Cracking at the site location can be observed visually. The table below shows the probability of contributing to peat slides based on cracks observed.

Cracking	Probability
No Evidence	Negligible
0 - 5% Road Length	Unlikely
5 - 10% Road Length	Probable
10 - 15% Road Length	Likely
15 - 20% Road Length	Very Likely

Table 17: Probability of peat slide occurrence based on percentage of cracks in the road

5. Underground Hydrology

Underground hydrology is observed visually. Although it is very difficult to evaluate, it can exist in the form of exit/entrances to underground channels. Collapsed ceilings of pipes are quite evident. The table below shows the probability of contributing to peat slides based on underground hydrology of the site location.

Underground Hydrology	Probability
None Evident	Negligible
Few	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 18: Probability of peat slide occurrence based on underground hydrology

6. Surface Hydrology

Surface Hydrology is also observed visually. Interpretation may be necessary due to weather conditions at the time of survey. The table below shows the probability of contributing to peat slides based on surface hydrology observed at the site location.

Surface Hydrology	Probability
None Evident	Negligible
Few	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 19: Probability of peat slide occurrence based on surface hydrology

7. Historical Peat Slips

Evidence of historical peat slips found using Geological Survey Ireland Spatial Resources Map Viewer. Details on historical peat slips and other geotechnical failures are included in Section 4 and Section 5 of this report. The table below shows the probability of contributing to peat slides based on evidence of previous peat landslide events.

Historical Peat Slips	Probability
No Evidence	Negligible
Little	Unlikely
Frequent	Probable
Many	Likely
Continuous/Significant	Very Likely

Table 20: Probability of peat slide occurrence based on evidence of historical peat slips

8. Weather

This can be evaluated from the weather records of the site area. The table below shows the probability of contributing to peat slides based on weather conditions.

Weather	Probability
Previous Very Dry Period in excess of 5 years	Negligible
Previous Very Dry Period within 4-5 years	Unlikely
Previous Very Dry Period within 3-4 years	Probable
Previous Very Dry Period within 2-3 years	Likely
Previous Very Dry Period within 1-2 years	Very Likely

Table 21: Probability of peat slide occurrence based on weather conditions

7.3.2 Peat Slip Assessment

The likelihood of occurrence of peat slide based on each of the eight contributory factors has been assessed based on the information available.

Infrastructure Location	Peat Strength (kPa)		
	Shear Strength	Probability	Probability (%)
T1	≥15kPa	Negligible	10
T2	12.5kPa - 15kPa	Unlikely	20
T3	≥15kPa	Negligible	10
T5	12.5kPa - 15kPa	Unlikely	20
T7	≥15kPa	Negligible	10
Spur to T1	≥15kPa	Negligible	10
Spur to T2	≥15kPa	Negligible	10
Spur to T3	≥15kPa	Negligible	10
Spur to T5	10kPa - 12.5kPa	Probable	40
Spur to T7	≥15kPa	Negligible	10

Table 22: Probability of occurrence of peat slide based on peat strength values

Infrastructure Location	Peat Depth (m)		
	Average Peat Depth	Probability	Probability (%)
T1	0.36	Negligible	10
T2	0.37	Negligible	10
T3	0.53	Unlikely	20
T5	0.38	Negligible	10
T7	0.45	Negligible	10
Spur to T1	0.15	Negligible	10
Spur to T2	0.19	Negligible	10
Spur to T3	0.34	Negligible	10
Spur to T5	0.73	Unlikely	20
Spur to T7	0.40	Negligible	10

Table 23: Probability of occurrence of peat slide based on peat depth values

Infrastructure Location	Slope Angle (°)		
	Recorded Value	Probability	Probability (%)
T1	2.8	Unlikely	20
T2	1.9	Unlikely	20
T3	2.9	Unlikely	40
T5	2.2	Unlikely	20
T7	1.5	Unlikely	20
Spur to T1	2.8	Unlikely	20
Spur to T2	1.9	Unlikely	20
Spur to T3	2.1	Unlikely	20
Spur to T5	2.0	Unlikely	20

Spur to T7	1.8	Unlikely	20

Table 24: Probability of occurrence of peat slide based on slope angle values

Infrastructure Location	**Cracking**		
	Recorded Value	**Probability**	**Probability (%)**
T1	No Evidence	Negligible	10
T2	No Evidence	Negligible	10
T3	No Evidence	Negligible	10
T5	No Evidence	Negligible	10
T7	No Evidence	Negligible	10
Spur to T1	No Evidence	Negligible	10
Spur to T2	No Evidence	Negligible	10
Spur to T3	No Evidence	Negligible	10
Spur to T5	No Evidence	Negligible	10
Spur to T7	No Evidence	Negligible	10

Table 25: Probability of occurrence of peat slide based on cracking observed

Infrastructure Location	**Underground Hydrology**		
	Recorded Value	**Probability**	**Probability (%)**
T1	None Evident	Negligible	10
T2	None Evident	Negligible	10
T3	None Evident	Negligible	10
T5	None Evident	Negligible	10
T7	None Evident	Negligible	10
Spur to T1	None Evident	Negligible	10
Spur to T2	None Evident	Negligible	10
Spur to T3	None Evident	Negligible	10
Spur to T5	None Evident	Negligible	10
Spur to T7	None Evident	Negligible	10

Table 26: Probability of occurrence of peat slide based on underground hydrology

Infrastructure Location	**Surface Hydrology**		
	Recorded Value	**Probability**	**Probability (%)**
T1	Few	Unlikely	20
T2	Few	Unlikely	20
T3	Few	Unlikely	20
T5	Few	Unlikely	20
T7	Few	Unlikely	20
Spur to T1	Few	Unlikely	20
Spur to T2	Few	Unlikely	20
Spur to T3	Few	Unlikely	20
Spur to T5	Few	Unlikely	20

Spur to T7	Few	Unlikely	20

Table 27: Probability of occurrence of peat slide based on surface hydrology

Infrastructure Location	**Historical Slips**		
	Recorded Value	**Probability**	**Probability (%)**
T1	No Evidence	Negligible	10
T2	No Evidence	Negligible	10
T3	No Evidence	Negligible	10
T5	No Evidence	Negligible	10
T7	No Evidence	Negligible	10
Spur to T1	No Evidence	Negligible	10
Spur to T2	No Evidence	Negligible	10
Spur to T3	No Evidence	Negligible	10
Spur to T5	No Evidence	Negligible	10
Spur to T7	No Evidence	Negligible	10

Table 28: Probability of occurrence of peat slide based on historical slips

Infrastructure Location	**Weather (Previous Dry Period)**		
	Recorded Value	**Probability**	**Probability (%)**
T1	1-2 years	Very Likely	90
T2	1-2 years	Very Likely	90
T3	1-2 years	Very Likely	90
T5	1-2 years	Very Likely	90
T7	1-2 years	Very Likely	90
Spur to T1	1-2 years	Very Likely	90
Spur to T2	1-2 years	Very Likely	90
Spur to T3	1-2 years	Very Likely	90
Spur to T5	1-2 years	Very Likely	90
Spur to T7	1-2 years	Very Likely	90

Table 29: Probability of occurrence of peat slide based on weather (previous dry period)

Table 8 of the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006) has been adopted to assess the the likelihood of occurrence of a peat slide.

Probability (P) Value	
Very Likely	>75%
Likely	50-75%
Probable	25-50%
Unlikely	10-25%
Negligible	<10%

Table 30: Probability Values for Likelihood of Peat Slip Occurring

In order to maintain consistent results across the varying methods of analysis used in this report, AFRY has taken the approach to summarise the above table as follows.

Probability (P) Value	
High	>75%
Medium	25-75%
Low	10-25%
Negligible	<10%

Table 31: Probability Values for Likelihood of Peat Slip Occurring Developed by AFRY

After taking into account all eight contributory factors, probability has been assessed and is outlined in the table below.

	Probability (%)	Probability
T1	23	Low
T2	24	Low
T3	24	Low
T5	24	Low
T7	23	Low
Spur to T1	23	Low
Spur to T2	23	Low
Spur to T3	23	Low
Spur to T5	28	Medium
Spur to T7	23	Low

Table 32: Result of Qualitative Risk Assessment

7.3.3 Summary

Based on the above qualitative assessment, the PROBABILITY or the likelihood of peat slide occurrence at all locations is deemed as LOW, except along the spur road to T5, where it has been assessed as MEDIUM.

8. PEAT STABILITY RISK ASSESSMENT

Risk assessment is a screening process at the end of which it may be necessary to undertake more detailed studies or identify the residual risks associated with the Proposed Project after the implementation of the mitigation measures. The Peat Slide Risk Assessment for the Proposed Project involved a number of steps identified within this document – please refer to the risk assessment process map which follows.

The Peat Slide Risk Assessment methodology is adopted from *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) and The Geotechnical Risk Assessment methodology devised by AFRY. This methodology utilises the well-defined principal that,

RISK = PROBABILITY x CONSEQUENCE

where PROBABILITY and CONSEQUENCE have been defined as:-

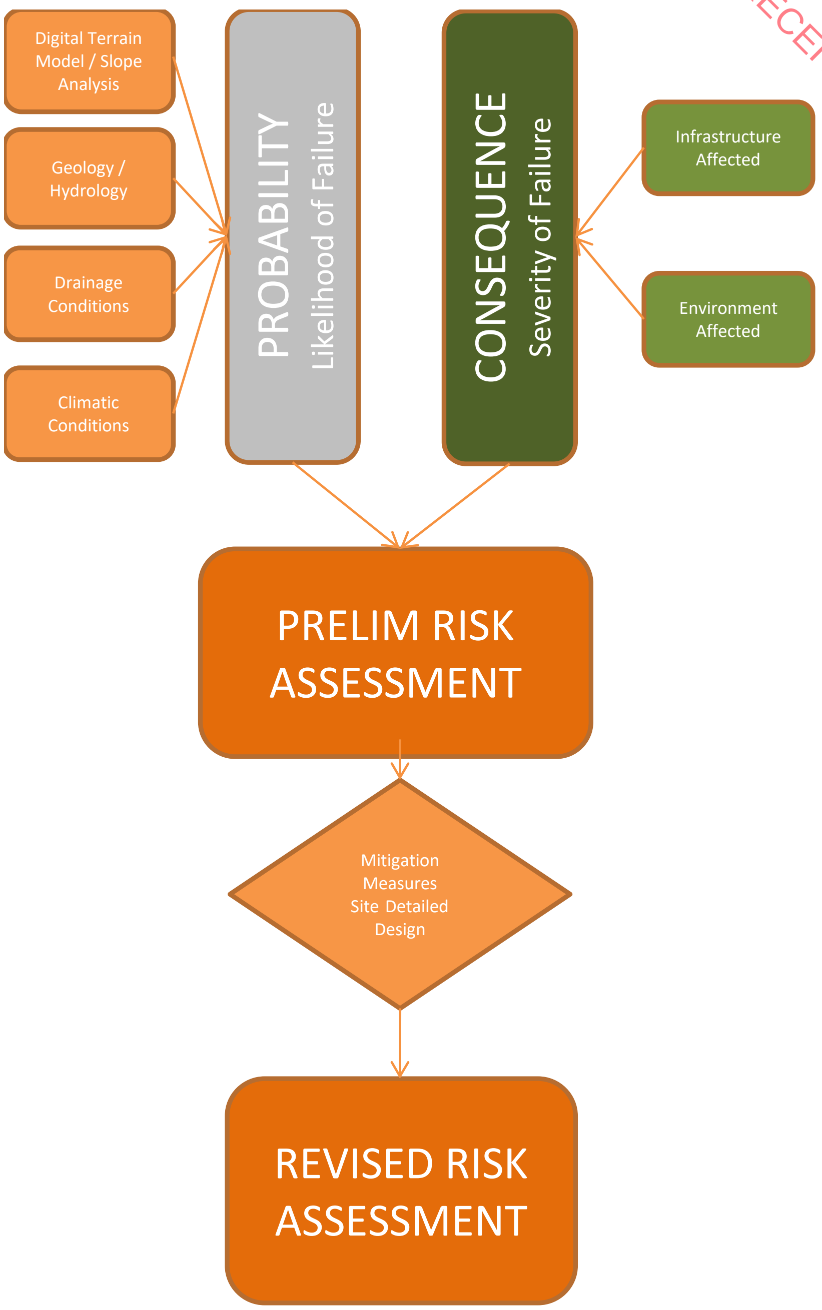
PROBABILITY = Likelihood of a peat landslide occurring

CONSEQUENCE = Severity of a peat landslide

The risk assessment matrix developed by AFRY to represent how risk varies with probability and consequence is displayed below.

		CONSEQUENCE			
		NEGLIGIBLE	LOW	MEDIUM	HIGH
PROBABILITY or LIKELIHOOD	NEGLIGIBLE	Negligible	Negligible	Low	Low
	LOW	Negligible	Low	Medium	Medium
	MEDIUM	Low	Medium	Medium	High
	HIGH	Low	Medium	High	High

It is proposed that Proposed Project site infrastructure identified with a Negligible or Low risk from a landslide (or other geotechnical failure) would not have any further consideration within this report. However, Proposed Project site infrastructure in areas identified with a Medium or High risk of a peat slide may require additional consideration and implementation of specific mitigation or control measures. This process is summarised below.



The following paragraphs describe how PROBABILITY and CONSEQUENCE have been identified and what processes are involved in establishing these values.

8.1 Probability

Based on the quantitative and qualitative risk assessments carried out in Chapter 7 of this report, the probability of risk is shown in the table below.

SUMMARY OF QUANTITATIVE AND QUALITATIVE RISK ASSESSMENTS		
	Quantitative Risk Assessment	Qualitative Risk Assessment
Infrastructure Location	Infinite Slope Analysis	Peat Slide Risk
T1	LOW	LOW

T2	LOW	LOW
T3	LOW	LOW
T5	LOW	LOW
T7	LOW	LOW
Spur to T1	LOW	LOW
Spur to T2	LOW	LOW
Spur to T3	LOW	LOW
Spur to T5	LOW	MEDIUM
Spur to T7	LOW	LOW

Table 33: Summary of Quantitative and Qualitative Risk Assessments

8.2 Consequence

In this report, the consequence of a geotechnical failure is considered to be the scale of the damage inflicted by the geotechnical failure on the surrounding area. The rising scale of consequence is considered as follows:-

CONSEQUENCE		
	WIND FARM INFRASTRUCTURE	**LOCAL ECOLOGY/ENVIRONMENT**
Negligible	Little or no effect on the wind farm infrastructure. No works are required in the site area.	Little or no effect on local wildlife habitat
Low	A land/peat slide does not directly affect any site infrastructure. The wind farm is not shut down. Works are required to stabilise/reinstate the slide area.	A land/peat slide destroys/affects wildlife habitat within the site boundary.
Medium	A land/peat slide deposits debris over and against site infrastructure without causing structural damage. The wind farm is not shut down. Works are required to stabilise/reinstate the slide area. Works are required to clear areas affected by slide debris.	A land/peat slide destroys/pollutes wildlife habitat within and beyond the site, deposits debris over and against transport links and property without causing structural damage. Works are required to stabilise/reinstate the slide area. Works required to clear areas affected by slide debris.
High	A land/peat slide de-stabilises site foundations / site roads / local pylons / substation. The wind farm is shut down. Works are required to stabilise/reinstate the slide area. Works are required to rebuild roads/buildings/site infrastructure damaged by slide debris	A land/peat slide destroys/pollutes wildlife habitat within and beyond the site, damages transport links and damages surrounding property. Works are required to stabilise/reinstate the slide area. Works are required to clear debris, rebuild damaged transport links and buildings.

Analysing the site layout in conjunction with the 1:25,000 OSI map of the area, available aerial photography and gathered site data will allow AFRY to consider the likely consequence of potential geotechnical failures within the site.

The table below indicates the consequence of a peat slide in the proposed site location.

Infrastructure Location	Consequence
T1	LOW
T2	LOW
T3	LOW
T5	LOW
T7	LOW
Spur to T1	LOW
Spur to T2	LOW
Spur to T3	LOW
Spur to T5	LOW
Spur to T7	LOW

Table 34: Summary of Consequence

8.3 Overall Risk Assessment

The following table summarises the probability and consequence of failure and highlights higher risk areas across the site.

LOCATION	PROBABILITY			CONSEQUENCE	SUMMARY
	QUANTITATIVE ASSESSMENT	QUALITATIVE ASSESSMENT	PROBABILITY	CONSEQUENCE	OVERALL RISK
T1	LOW	LOW	LOW	LOW	LOW
T2	LOW	LOW	LOW	LOW	LOW
T3	LOW	LOW	LOW	LOW	LOW
T5	LOW	LOW	LOW	LOW	LOW
T7	LOW	LOW	LOW	LOW	LOW
Spur to T1	LOW	LOW	LOW	LOW	LOW
Spur to T2	LOW	LOW	LOW	LOW	LOW
Spur to T3	LOW	LOW	LOW	LOW	LOW
Spur to T5	LOW	MEDIUM	MEDIUM	LOW	MEDIUM
Spur to T7	LOW	LOW	LOW	LOW	LOW

Table 35: Overall Risk Assessment

8.4 Discussion

While qualitative assessments can provide valuable insights, quantitative analyses offer a more comprehensive and precise evaluation of risks across various locations. At the Proposed Wind Farm site, a significant 96.5% of recorded peat depths were under 1m. AFRY's extensive experience demonstrates that quantitative analyses better capture site conditions by leveraging numerical data. This approach enables a deeper understanding of potential risks and would result in a more informed and data-driven risk evaluation, which holds true for the current site as well.

9. MITIGATION MEASURES AND REVISED RISK ASSESSMENT

9.1 Avoidance

If the risk of peat slide failure is assessed to be high, avoidance is suggested as a mitigation measure. This scenario does not apply at the Proposed Project.

9.2 Micrositing Infrastructure

Not deemed necessary. Mitigation by avoidance has been a key aspect of the Proposed Project's evolution through the selection and design process. The Proposed Project layout takes account of the results of all site investigations and baseline assessments that have been carried out during the EIAR process.

9.3 Spur to T5 and T5 Blade Finger Area

Due to relatively deep and weak peat at this location, additional construction measures such as the following will be required:

- excavation side walls to be supported (e.g. boulders, sheet piles) or excavation face battered to a shallow angle;
- temporary works designer may be required to provide excavation support design
- full time supervision during construction and daily detailed inspection of excavation faces;
- potential for greater water inflow into excavation requiring removal of water using pumping; and
- increased exclusion zone around excavation to avoid accidental loading of crest of slope.

9.4 Engineered Solution

9.4.1 Installation of Drainage Measures

Installation of targeted drainage measures would aim to isolate areas of susceptible peat from upslope water supply, re-routing surface (flushes/gullies) and subsurface (pipes) drainage around critical areas. Surface water drainage plans will be considered as a useful way of accounting for modified flows created by construction, which in turn may affect peat stability, pollution and wildlife interests. Drainage measures will be carefully planned to minimise any negative impacts.

9.4.2 Leaving the Peat in Place

This mitigation measure has been adopted from the *Guidelines for the Risk Management of Peat Slips* (MacCulloch 2006). When dealing with peat depths in excess of 2 metres, it normally becomes more cost effective to leave the peat in place and utilise the strength of the in-situ peat. The most commonly used methods in low volume/low cost roads are:

- Placing an embankment over a layer of timber/timber brash as recommended by the Forestry Commission. This method involves laying a raft of timber directly onto the peat surface and then constructing an embankment on top of the raft. In the short and medium term this provides a reinforcement effect to the base of the embankment, aids stability, and can reduce differential settlements and lateral stresses on the peatland surface.
- Constructing an embankment using geotextiles and geogrids. Geotextiles act as a separator and filter and are placed directly onto the peat surface. However, it is

the geogrid layers that provide reinforcement to the base of the embankment. Geogrids also aid stability and can reduce differential settlements and lateral stresses on the peatland surface.

Both the above methods have the benefit of reducing the amount of material required to build the embankment, and a combination of the two methods can be used, involving brash below a geogrid reinforced road. When using geogrids an appropriately sized and graded engineering fill is required to provide the necessary interlocking effect.

In the "Leaving the Peat in Place" construction method, a loading rate is to be determined prior to the construction process and amended during construction. A "loading rate" is the time for materials to be delivered at the embankment head of the road under construction. During construction, the following elements will be monitored:

- Increased rate of sinking or tilting
- Rising of adjacent peat
- Cracking on peat surface
- Rise in water levels

If visual monitoring shows deterioration in the four elements listed above, the time interval between loading will be increased in order to decrease the risk.

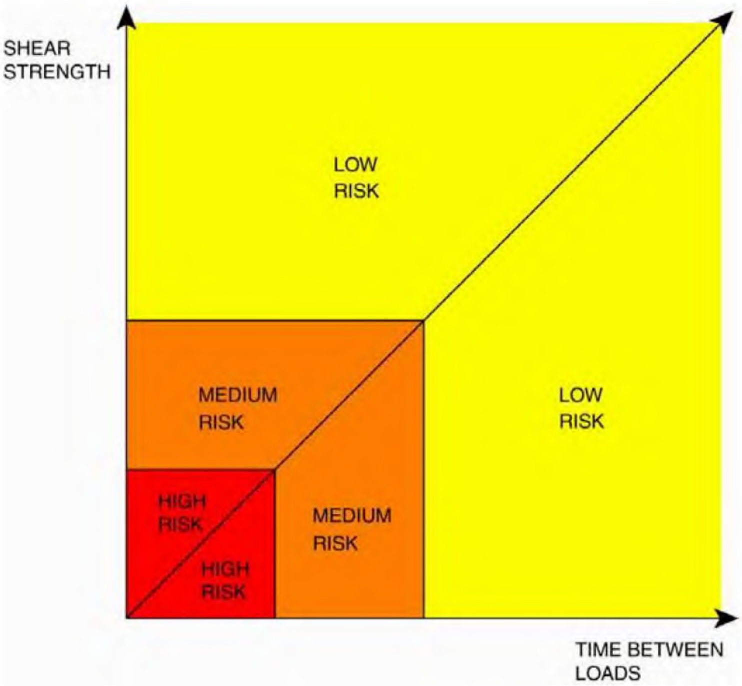


Figure 4: Graph showing relationship between shear strength and time between loads (MacCulloch 2006)

The graph shown in Figure 4 above indicates that reducing the time between deliveries would increase the risk of peat failure. However, increasing the time between the loads allows the pore water pressure to dissipate into the adjoining peat, thus reducing the risk.

In general, if the period of recovery for sinking or tilting, rising of adjacent peat, cracking or rise of water level is too slow due to excessively poor shear strength in the peat, the Excavation and Replacement shall be adopted as a mitigation measure.

9.4.3 Excavation and Replacement

In this method the peat is removed, usually side cast, and the mineral sub soil exposed, shaped, and an embankment constructed on it. This method is, in construction terms, almost fail-safe, and is restricted only by the depth of peat. In low-cost roads, the economic depth, is approximately 2 metres. The risk is thus moved to the adjacent peat, and to the placement method used for the excavated peat spoil.

In this method of construction, the designer and contractor have several design features to address;

- Shallower excavated faces can be left nearly vertical in the short term. This is an unusual feature of peat, particularly considering the water content. As the peat is excavated, the phreatic surface drops with a consequent reduction in the hydrostatic pressure.
- Localised failures can occur on the edges of the excavation. These may be as a result of encountering peat areas of high water content. Such failures are usually minor but can trigger retrogressive failure.
- The collapse of an excavated face can lead to the siltation, or more significantly damming of a ditch, watercourse or pipe. This could, in turn, trigger a slide event.
- Alteration of water flows will increase the slide risk by increasing the flow or pressure within the pipe system.
- The drainage of the road and the surrounding peatland area must be carefully planned to ensure water flows away from the road.
- The position of the road on a side slope is critical. This is particularly true on convex slopes where the excavation could remove toe support thus triggering a slip.
- The placement of excavated peat requires careful attention. Until the pore water dissipates, the stability of the peat is at its most vulnerable.

9.5 General Mitigation Measures

The following are mitigation measures to be adopted at all locations where peat depths are ≥ 1.0m.

- Upslope cut-off drains will be installed in advance of construction activities to prevent water build up in excavations.
- The sides within excavated peat will be sloped back at an angle of 30 degrees to the horizontal to prevent slippage.
- No excavations shall take place unless fill material is available for filling at the point of excavation. Excavation will be limited to the reach of the excavator sitting on the constructed road surface.
- Any excavations will be immediately backfilled with suitable material when available.
- Excavation for access track to be backfilled as soon as practicable in intact peat. Excavation and filling operations will be co-ordinated to minimise the time an excavation remains unfilled.
- Deposition of excavated material must not occur outside designated areas; temporary stock piling would take place within the development footprint of

turbine hardstands before reinstatement and disposal at proposed deposition areas.

- Temporary deposition of excavated soils will only be allowed in areas with peat depth less than 0.5m.
- Excavated spoil will not be deposited on the downslope or upslope edges of adjacent peat.
- Existing drainage patterns in peat will be maintained whenever possible, and any uncontrolled discharges of water onto peat will be prevented.
- Engineered drainage to prevent concentrated flow onto slopes or into excavations. Pumping to be used as required until a permanent solution is in place.
- As per *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Energy Consents Unit Scottish Government, 2017) catch wall fences shall be positioned downslope of the suspected or known landslide prone area to slow or halt runout. Similarly, catch ditches may also be used to slow or halt runout, although it is preferable that they are cut in non-peat material.
- Machinery use on peat surfaces would be minimized, and dependant on site topography the use of vibrating rollers may not be permitted.
- Materials must not be stockpiled, and heavy machinery must not be parked on peat surfaces.
- The use of low ground bearing pressure machines to be used on areas of peat exceeding 1m depth.
- No operatives other than the excavator driver to be allowed in close proximity to open excavations.
- Monitoring posts to be installed in vicinity of risk areas and to be inspected prior to and following works each day by a competent person.
- A qualified geotechnical and/or environmental engineer will conduct regular site visits and assessments to monitor the potential for a peat slide regularly during construction.
- Upon commencement of the reinstatement works, guidance from a suitably qualified environmental professional will be sought to confirm the methodology and programme.
- Exclusion zones delineating the working corridor will be established around all working areas using post and rope fences. No activity will be permitted past this fence.
- The environmental manager or other designated person will conduct induction training and toolbox talks with site staff to explain the risks associated with working on peat, the procedures for reducing the risk of peat slides, and the location of exclusion zones.
- Strict adherence to method statements is required at all times, and any deviation from the agreed work methodology must be approved by a suitably qualified environmental professional or the site geotechnical engineer.
- Particular attention will be paid to conditions during and after heavy rainstorms, especially following extended dry periods when the likelihood of peat movement is higher. The site supervisor would suspend work if either work practices or weather conditions are deemed unsafe.

- After reinstatement is completed, the disposal sites will be re-vegetated using the topsoil, sod or harvested peat.

The above mitigation measures are proposed to reduce the existing risks to acceptable levels.

9.6 Revised Peat Slide Risk Assessment

A LOW risk rating is indicated where the risk can be managed through the mitigation measures indicated. The risk rating at all areas on the site is reduced to LOW provided all mitigation measured are adhered to. The following table summarises the revised risk rating.

LOCATION	PRE-MITIGATION RISK ASSESSMENT	POST-MITIGATION RISK ASSESSMENT
T1	LOW	LOW
T2	LOW	LOW
T3	LOW	LOW
T5	LOW	LOW
T7	LOW	LOW
Spur to T1	LOW	LOW
Spur to T2	LOW	LOW
Spur to T3	LOW	LOW
Spur to T5	MEDIUM	LOW (Construction measures outlined in Section 9.3 to be implemented)
Spur to T7	LOW	LOW

Table 36: Revised Risk Assessment

Regular checking of peat monitoring posts shall be carried out and if there are any signs of peat instability works in the vicinity will be ceased immediately and a construction method statement will be developed before proceeding further.

10. PRELIMINARY CONSTRUCTION DETAILS

10.1 Turbine Foundations

From a review of the available information associated with the ground conditions present across the site, the following commentary is supplied in relation to the turbine locations. The purpose of the following sections is to define the design approach and present details for the proposed foundations and associated site infrastructure including site roads and hardstands.

Reinforced concrete buoyant gravity foundations are currently proposed at all the turbine locations. Table 29 below presents a summary of the ground conditions encountered during the geotechnical investigation and the likely foundation type. It is to be noted that these are subject to confirmation during the detailed design stage.

Turbine Location	Relevant GI	Geology Encountered	Foundation Type
T1	TP-T1-01	0 - 0.3m Topsoil 0.3m - 2.5m Clay	Gravity Buoyant
T2	TP-T2-01	0 - 0.3m Topsoil 0.3m - 1.9m Clay 1.9m - 2.7m Gravel	Gravity Buoyant
T3	TP-T3-01	0 - 0.4m Topsoil 0.4m - 1.6m Clay 1.6m - 2.2m Gravel	Gravity Buoyant
T4	TP-T4-01	0 - 0.4m Topsoil 0.4m - 1.1m Clay 1.1m - 1.9m Silt	Gravity Buoyant
T5	TP-T5-01	0 - 0.3m Topsoil 0.3m - 2.3m Sand	Gravity Buoyant
T6	TP-T6-01	0 - 0.4m Topsoil 0.3m - 1.3m Clay	Gravity Buoyant
T7	TP-T7-01	0 - 0.5m Topsoil 0.5m - 1.3m Clay	Gravity Buoyant

Table 37 : Summary of Indicative Turbine Foundation Type

Further ground investigation will be carried out at the detailed design stage at each turbine location in the form of a borehole with in-situ SPT testing at 1m intervals in the overburden and follow-on rotary core through bedrock to confirm the foundation types and formation strata.

For gravity type turbine foundations, where the depth of excavation exceeds the required formation depth for the proposed turbine base, engineered fill (6N or equivalent) shall be used to backfill the excavation to the required formation depth.

10.2 Concrete Specification

Based on the presence of peat at the Proposed Wind Farm site, it is anticipated that XA1 classification will be required at a minimum at this location.

The pH of the samples taken from the trial pits at turbine locations to date averages 6.6, ranging from 5.8 to 7.2 indicating an acidic to neutral environment, as tabulated in Table 9 above.

The aggressive chemical environments classified below are based on natural soil and ground water at water/-soil temperatures between 5 °C and 25 °C and a water velocity sufficiently slow to approximate to static conditions.

The most onerous value for any single chemical characteristic determines the class.

Where two or more aggressive characteristics lead to the same class, the environment shall be classified into the next higher class, unless a special study for this specific case proves that it is not necessary.

Chemical characteristic	Reference test method	XA1	XA2	XA3
Ground water				
SO_4^{2-} mg/l	EN 196-2	≥ 200 and ≤ 600	> 600 and ≤ 3000	> 3000 and ≤ 6000
pH	ISO 4316	≤ 6,5 and ≥ 5,5	< 5,5 and ≥ 4,5	< 4,5 and ≥ 4,0
CO_2 mg/l aggressive	prEN 13577:1999	≥ 15 and ≤ 40	> 40 and ≤ 100	> 100 up to saturation
NH_4^+ mg/l	ISO 7150-1 or ISO 7150-2	≥ 15 and ≤ 30	> 30 and ≤ 60	> 60 and ≤ 100
Mg^{2+} mg/l	ISO 7980	≥ 300 and ≤ 1000	> 1000 and ≤ 3000	> 3000 up to saturation
Soil				
SO_4^{2-} mg/kg^a total	EN 196-2^b	≥ 2000 and ≤ $3000^{3)}$	> 3000^c and ≤ 12000	> 12000 and ≤ 24000
Acidity ml/kg	DIN 4030-2	> 200 Baumann Gully	Not encountered in practice	

[a] Clay soils with a permeability below 10^{-5} m/s may be moved into a lower class.

[b] The test method prescribes the extraction of SO_4^{2-} by hydrochloric acid; alternatively, water extraction may be used, if experience is available in the place of use of the concrete.

[c] The 3000 mg/kg limit shall be reduced to 2000 mg/kg, where there is a risk of accumulation of sulfate ions in the concrete due to drying and wetting cycles or capillary suction.

Table 38: Limiting Values for Exposure Classes for Chemical Attack (I.S. EN 206.1)

2 Corrosion induced by carbonation		
Where concrete containing reinforcement or other embedded metal is exposed to air and moisture, the exposure shall be classified as follows: NOTE The moisture condition relates to that in the concrete cover to reinforcement or other embedded metal, but in many cases, conditions in the concrete cover can be taken as reflecting that in the surrounding environment. In these cases classification of the surrounding environment may be adequate. This may not be the case if there is a barrier between the concrete and its environment.		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2

Table 39: Exposure Classes related to Environmental Actions (I.S. EN 206.1)

11. SUMMARY AND RECOMMENDATIONS

No evidence or indications of any previous landslides or past geological failures within the Proposed Wind Farm site were identified during the site walkovers and site investigation. Additionally, the review of published GSI geological data and analysis of aerial/satellite imagery also did not indicate any such failures.

Observations from site walkovers indicate that the topography of the site is predominantly flat. This observation is supported by the terrain assessment of the Bluesky's DTM, which shows the slope angles on site range from 2° to 6.2°. The findings of the site investigation data suggest favourable subsoil conditions and shallow peat depths across the site.

The peat depths across the site range from 0 to 2.7m, with an average of 0.23m. It is to be noted that the peat thickness within the proposed infrastructure footprint is generally less than 1.3m, with a localised deeper deposit of up to 2.7m near the T5 blade finger area. Hand shear vane testing conducted by Causeway Geotech Limited showed peat shear strengths ranging from 11kPa to 81kPa.

When a quantitative assessment for undrained condition was carried out, FoS ranged from 7.5 to 95.9 for 2m peat surcharge. The drained analysis resulted in FoS values between 2.0 to 7.7 for 2m peat surcharge. FoS values higher than 1.3 are deemed to have a negligible probability of instability once mitigation/control measures are implemented.

A qualitative assessment of the peat stability returned a LOW risk at all locations, except along the spur road to T5, where it was assessed as MEDIUM. This was based on peat depths, lower shear strength, shallow slope and previous dry periods. However, this risk is reduced to LOW following the implementation of the specific control measures outlined in Section 9.3 of this report.

In summary, the findings of the geotechnical and peat stability assessment indicate that the Proposed Wind Farm site has an acceptable margin of safety and is suitable for a wind farm development. The report also includes recommendations and mitigation measures for construction work in peatlands to ensure that all works adhere to an acceptable standard of safety.

The recommendations and guidelines outlined within Appendix 4-2: Peat and Spoil Management Plan prepared by AFRY should be taken into consideration during the detailed design and construction stage of the Proposed Wind Farm.

To minimise the risk of construction activity causing potential peat instability it is recommended that the Construction Method Statements for the project take into account, but not be limited to, the recommendations above. This will ensure that best practice guidance regarding the management of peat stability is integrated into the construction phase.

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APPENDIX A – PHOTOS FROM SITE WALKOVER

Photo 1: Access to T5 covered with brash, with uneven and soft to very soft ground surface

Photo 2: Access to T5 covered with tree stumps, with uneven and soft to very soft ground surface

Photo 3: Ongoing tree felling near T5

Photo 4: Access to T5 showing soft and wet ground conditions

Photo 5: Area around T7 shows replanted fir and hardwood trees, with soft, uneven ground and tree stumps

APPENDIX B – PEAT PROBING DATA

X(ITM)	Y(ITM)	Peat Depth (m)
663616.44	669061.00	0.5
663616.23	669066.67	0.2
663573.34	669017.48	0.1
664002.69	669700.91	0.7
664004.05	669664.43	0.7
663969.87	669682.67	0.2
663630.12	669577.06	0.1
663586.48	669637.24	0.1
663531.34	669601.91	0.2
664243.33	668610.35	0.6
664178.97	668597.25	0.6
664175.60	668566.61	0.2
663959.54	668734.68	0.9
664024.48	668688.58	0.9
664132.93	668653.95	0.5
664145.66	668671.26	0.6
664149.69	668718.83	0.4
664131.44	668736.17	2.7
664082.24	668858.37	0.5
664129.60	668916.41	0.0
664142.33	668943.84	0.0
664177.38	669075.17	0.3
664187.96	669106.91	0.0
664217.93	669111.87	0.0
664190.94	669131.43	0.1
664185.47	669183.21	1.3
664167.19	669187.31	0.5
664219.87	669174.43	0.3
664253.68	669190.01	0.0
664207.80	669198.98	0.9
664217.91	669184.64	0.1
664211.07	669212.26	0.4
664205.46	669228.10	0.5
664224.34	669223.90	0.5
664259.25	669217.91	0.0
664204.22	669240.21	0.1
664192.30	669228.15	1.2
663676.46	669404.18	0.1
663668.50	669444.47	0.0

663642.89	669483.42	0.0
663632.28	669546.37	0.4
663619.75	669626.89	0.1
663551.14	669635.67	0.4
663703.40	669588.37	0.2
663790.74	669617.89	0.0
663847.73	669610.41	0.1
663882.47	669647.03	0.1
663911.11	669588.98	0.4
663952.39	669610.89	0.2
663996.91	669586.66	0.5
664004.18	669608.90	0.2
664003.65	669622.92	0.1
663938.49	669631.18	0.0
663979.02	669648.52	0.1
664029.63	668763.53	2.0
664053.75	668756.40	0.4
664085.80	668742.35	0.3
664076.64	668699.72	0.3
664084.09	668672.23	0.7
664112.19	668670.82	0.4
664134.13	668675.33	0.6
664130.51	668683.63	0.4
664115.59	668699.35	0.8
664116.27	668724.84	0.5
664099.08	668743.08	0.3
664083.08	668753.89	1.2
664063.78	668763.98	0.4
664029.54	668765.54	2.1
664022.99	668770.68	2.0
663984.07	668774.17	0.3
663957.88	668778.95	1.1
663934.29	668791.88	0.1
663876.20	668738.81	0.1
663853.69	668685.10	0.2
663855.25	668597.21	0.1
663828.83	668532.55	0.2
663854.22	668454.77	0.2
663822.46	668370.11	0.0
663773.49	668325.63	0.0
663704.97	668326.51	0.0
663610.31	668317.48	0.0

663537.40	668318.53	0.0
663456.62	668331.82	0.0
663446.09	668358.28	0.2
663419.79	668355.82	0.3
663385.09	668371.51	0.2
663363.24	668380.90	0.3
663353.22	668403.36	0.3
663331.52	668442.14	0.2
663326.97	668454.65	0.1
663333.18	668491.12	0.0
663314.03	668530.60	0.5
663384.96	668547.32	0.4
663423.47	668524.12	0.4
663425.71	668584.80	0.1
663449.25	668616.93	0.3
663453.52	668610.87	0.2
663439.67	668626.93	0.2
663393.90	668612.54	0.1
663371.41	668597.67	0.3
663344.27	668614.00	0.4
663330.58	668556.07	0.0
663270.84	668556.07	0.2
663245.43	668522.36	0.1
663187.25	668506.02	0.0
663350.53	668392.53	0.2
663356.45	668383.82	0.4
663400.01	668330.64	0.5
663446.54	668271.94	0.3
663487.11	668240.98	0.6
663516.32	668216.65	0.6
663548.55	668193.15	0.2
663548.35	668177.90	0.2
663547.84	668144.85	0.3
663573.85	668132.39	0.3
663615.41	668134.83	0.5
663620.10	668147.13	0.4
663603.39	668165.61	0.4
663574.94	668172.91	0.6
663619.01	669560.11	0.0
663610.52	669594.83	0.0
663605.76	669628.71	0.1
662690.42	668121.69	0.0

662818.79	668160.29	0.0
662866.09	668250.26	0.0
662892.08	668297.00	0.0
662948.81	668315.54	0.0
663016.18	668331.10	0.0
663033.18	668306.17	0.0
663055.70	668261.17	0.0
663141.67	668299.90	0.0
663156.70	668369.09	0.0
663149.45	668448.78	0.0
663073.14	668451.35	0.0
663020.21	668431.74	0.0
662965.90	668424.03	0.0
663015.24	668455.49	0.0
663050.97	668469.31	0.0
663112.91	668492.48	0.1
663091.22	668556.41	0.1
663018.38	668541.33	0.0
662979.57	668504.55	0.1
663905.55	668796.28	0.0
663938.07	668761.44	0.0
663963.78	668725.72	0.6
663973.57	668725.52	0.9
663982.66	668685.91	0.5
663984.94	668682.16	0.4
664018.61	668672.47	1.0
664044.01	668671.36	0.0
664072.49	668661.61	0.9
664074.51	668656.74	0.4
664075.24	668652.08	0.2
664073.21	668637.25	0.1
664120.30	668674.71	0.3
664126.17	668675.01	0.1
664127.64	668676.36	0.2
664122.54	668668.73	0.3
664121.27	668683.51	0.0
664133.78	668681.67	0.2
664126.64	668700.72	0.4
664127.55	668708.74	0.0
664125.66	668719.29	0.1
664108.49	668736.53	0.8
664030.37	668763.43	0.5

664026.27	668767.27	0.0
664023.32	668771.13	0.0
664022.83	668772.23	1.9
663991.87	668771.16	0.6
663973.59	668769.81	0.5
663964.76	668769.02	0.2
663945.77	668781.46	0.1
663918.98	668790.79	0.2
663910.25	668787.67	0.1
664074.09	668831.67	0.1
664066.82	668830.01	0.0
664067.47	668827.02	0.0
664067.61	668826.68	0.3
664055.78	668817.63	0.0
664066.89	668829.79	0.5
664110.73	668883.56	0.0
664125.49	668920.70	0.0
664142.44	668956.20	0.0
664150.14	668991.57	0.0
664166.58	669034.08	0.0
664176.78	669074.72	0.0
664190.24	669072.00	0.0
664188.52	669085.33	0.0
664156.45	669095.92	0.0
664132.76	669106.74	0.0
664101.28	669108.33	0.0
664081.54	669116.41	0.0
664047.56	669123.31	0.0
664021.59	669132.87	0.0
663976.90	669143.63	0.0
663946.59	669149.46	0.1
663907.96	669156.85	0.0
663866.41	669169.77	0.0
663822.72	669182.33	0.1
663796.94	669192.34	0.1
663754.04	669195.89	0.1
663720.86	669208.81	0.1
663697.87	669206.95	0.1
663688.17	669215.84	0.0
663699.51	669225.89	0.1
663682.44	669195.28	0.0
663680.43	669173.00	0.0

663667.04	669149.46	0.1
663666.50	669154.90	0.0
663672.62	669172.12	0.0
663671.20	669171.77	0.0
663678.73	669194.90	0.1
663683.48	669208.21	0.0
663641.02	669085.36	0.1
663628.54	669079.96	0.0
663625.98	669079.48	0.3
663621.61	669077.87	0.0
663625.45	669073.47	0.0
663611.30	669097.32	0.0
663612.73	669102.01	0.1
663768.97	669389.82	0.0
663755.66	669380.52	0.0
663738.90	669372.07	0.0
663716.41	669363.20	0.0
663711.40	669348.45	0.1
663716.68	669331.83	0.1
663724.91	669301.89	0.1
663758.26	669300.44	0.1
663787.47	669307.05	0.2
663813.17	669308.06	0.1
663828.77	669306.93	0.1
663852.44	669313.69	0.3
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663860.10	669393.35	0.1
663852.53	669398.93	0.1
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663798.90	669392.22	0.0
663784.40	669386.68	0.0
663777.19	669385.70	0.0
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663711.73	669298.04	0.0
663705.98	669273.27	0.0
663706.59	669247.57	0.0
663640.12	669509.09	0.1

663608.63	669569.10	0.4
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662818.49	668162.51	0.0
662843.75	668177.42	0.0
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662866.03	668249.48	0.0
662883.51	668286.43	0.0
663011.32	668331.26	0.0
663094.97	668272.92	0.0
663124.14	668288.21	0.0
663150.13	668344.97	0.0
663159.18	668406.95	0.0
663149.37	668449.78	0.0
663130.44	668473.35	0.0
663049.98	668442.15	0.0
662970.22	668434.32	0.0
663046.21	668467.13	0.0
663038.92	668472.27	0.0
663072.28	668481.49	0.0
663105.74	668493.28	0.0
663091.83	668556.08	0.1
663025.55	668540.31	0.1
662993.30	668518.52	0.1
663320.13	669719.56	0.1
663346.71	669693.75	0.2
663403.14	669666.89	0.1
663459.11	669634.46	0.4
663461.07	669633.71	0.2
663465.23	669640.89	0.4
663463.34	669650.99	0.3
663451.22	669674.98	0.6
663495.71	669653.19	0.5
663525.06	669632.88	0.5
664200.64	669228.26	0.5
663940.67	669639.89	0.1
663955.70	669660.12	0.2
663994.18	669650.80	0.3

APPENDIX C – PEAT STABILITY RISK REGISTER

Seskin Wind Farm - Peat Stability Risk Register

Location:	**Spur to T5 and T5 Blade Finger Area**
Grid Reference (Eastings, Northings):	**Varies**
Distance to Watercourse (m)	**> 150**
Min & Max Measured Peat Depth (m):	**0.3 - 2.7**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory/Qualitative Factors to Potential Peat Failure	Prob (Note 1)	Impact (Note 2)	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob (Note 1)	Impact (Note 2)	Risk	Risk Rating
1	Factor of Safety for undrained condition = 7.5	1	3	3	Negligible	No	See Below	1	3	3	Negligible
2	Factor of Safety for drained condition = 2.5	1	3	3	Negligible	No		1	3	3	Negligible
3	Evidence of sub peat water flow	1	3	3	Negligible	No		1	3	3	Negligible
4	Evidence of surface water flow	2	3	6	Low	No		1	3	3	Negligible
5	Evidence of previous failures/slips	1	3	3	Negligible	No		1	3	3	Negligible
6	Type of vegetation	2	3	6	Low	No		2	3	6	Low
7	General slope characteristics upslope/downslope from location	2	3	6	Low	No		1	3	3	Negligible
8	Evidence of very soft/soft clay at base of peat	0	3	0	Not Applicable	No		0	3	0	Not Applicable
9	Evidence of mechanically cut peat	0	3	0	Not Applicable	No		0	3	0	Not Applicable
10	Evidence of quaking or buoyant peat	0	3	0	Not Applicable	No		0	3	0	Not Applicable
11	Evidence of bog pools	0	3	0	Not Applicable	No		0	3	0	Not Applicable
12	Relatively deep peat	4	3	12	Medium	No		2	3	6	Low

	Control Measures to be Implemented Prior to/and During Construction for **Spur to T5 and T5 Blade Finger Area**
i	Due to relatively deep peat at this location, additional construction measures such as the following will be required: - excavation side walls to be supported (e.g. boulders, sheet piles) or excavation face battered to a shallow angle - temporary works designer may be required to provide excavation support design -daily detailed inspection of excavation faces -potential for greater water inflow into excavation requiring removal of water using pumping -increased exclusion zone around excavation to avoid accidental loading of crest of slope
ii	Maintain hydrology of area as far as possible;
iii	Use of experienced geotechnical staff for site investigation;
iv	Use of experienced contractors and trained operators to carry out the work;
v	Detailed ground investigation to confirm peat, mineral soil and bedrock condition and properties.

Notes:

(1) Probability assessed as per Guidelines for the Risk Management of Peat Slips (MacCulloch 2006).

(2) Impact based on distance of infrastructure element to nearest watercourse.

APPENDIX D – SI FACTUAL REPORT

Seskin Wind Farm – Ground Investigation

Client:	MKO
Client's Representative:	AFRY
Report No.:	23-1591
Date:	January 2024
Status:	Final for Issue

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

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Appendix A	Site and exploratory hole location plans
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Appendix C	Trial pit photographs
Appendix D	Dynamic Probe test results
Appendix D	Groundwater and ground gas monitoring
Appendix E	Geotechnical laboratory test results

Document Control Sheet

<table>
<tr><td>Report No.:</td><td colspan="5">23-1591</td></tr>
<tr><td>Project Title:</td><td colspan="5">Seskin Wind Farm</td></tr>
<tr><td>Client:</td><td colspan="5">MKO</td></tr>
<tr><td>Client’s Representative:</td><td colspan="5">AFRY</td></tr>
<tr><td>Revision:</td><td>A00</td><td>Status:</td><td>Final for Issue</td><td>Issue Date:</td><td>12 January 2024</td></tr>
<tr><td colspan="2">Prepared by:</td><td colspan="2">Reviewed by:</td><td colspan="2">Approved by:</td></tr>
<tr><td colspan="2">N. Webb
Niamh Webb
MICE</td><td colspan="2">Carin Cornwall
BSc MSc PhD</td><td colspan="2">Matthew Gilbert
MEarthSci PGeo FGS</td></tr>
</table>

The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2015) BS 5930:2015+A1:2020, Code of practice for ground investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015+A1:2020, The Code of Practice for Ground Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler).
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler).
P	Nominal 100mm diameter undisturbed piston sample.
B	Bulk disturbed sample.
LB	Large bulk disturbed sample.
SB	Sonic bulk disturbed sample.
D	Small disturbed sample.
C	Core sub-sample (displayed in the Field Records column on the logs).
L	Liner sample from dynamic sampled borehole.
W	Water sample.
ES / EW	Soil sample for environmental testing / Water sample for environmental testing.
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained).
SPT (c)	Standard penetration test using 60 degree solid cone.
(x,x/x,x,x,x)	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015+A1:2020	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Seskin Wind Farm

1 AUTHORITY

On the instructions of AFRY, ("the Client's Representative"), acting on the behalf of MKO ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information for input to the design and construction of a proposed wind farm and associated infrastructure.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the ground investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included trial pits, soil sampling, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on the proposed site of Seskin Wind Farm (WF) located in the townlands of Seskinrea and Ridge in County Carlow. The site consists of forestry and farmland, and was accessed by public roads, farm tracks, and forestry lanes.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 1st and 28th November 2023, comprised:

- Eight machine dug trial pits
- Six standalone dynamic probes
- Hand vane tests at twenty-seven standalone locations

The exploratory holes and in-situ tests were located as instructed by the Client's Representative, and as shown on the exploratory hole location plan in Appendix A.

4.2 Dynamic probes

Six dynamic probes were conducted using the DPSHB method as described in BS EN ISO 22476-3:2005+A1:2011. The method entails a 63.5kg hammer falling 0.75m onto a 50.5mm diameter cone with an apex angle of 90°.

Appendix D provides the dynamic probe logs in the form of plots, against depth, of the number of blows per 100mm penetration.

4.3 Trial pits

Eight trial pits (TP–SS-01, TP-T1-01- TP-T7-07) were excavated using 8.5t tracked and 13t tracked excavators, to depths of 1.30-2.50m.

Disturbed (small jar and bulk bag) samples were taken at standard depth intervals and at change of strata.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix C presents the trial pit logs with photographs of the pits and arising provided in Appendix D.

Hand vane tests were carried out in all pits where soils were suitable at depths indicated on the trial pit logs provided in appendix B.

4.4 Hand vane tests

In addition to the hand vanes conducted in the trial pits, a series of hand vanes were also carried out at twenty-seven standalone locations.

Appendix E provides the results of the standalone hand vane tests.

4.5 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R10 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish Transverse Mercator) and ground elevation (mOD Malin) at each location are recorded on the individual exploratory hole logs. The exploratory hole location plan presented in Appendix A shows these as-built positions.

The monitoring records are presented in Appendix F.

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described, and their descriptions incorporated into the borehole logs.

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.

- **soil chemistry:** pH and water soluble sulphate content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute: *BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).*

The test results are presented in Appendix F.

6 GROUND CONDITIONS

6.1 General geology of the area

GSI Quaternary mapping indicates that the superficial deposits underlying the site comprise glacial till, peat, and occasional alluvium in the western portion of the site. These deposits are underlain by shale, sandstone, and siltstone of the Sherwood Sandstone Formation.

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Topsoil:** encountered in all trial pits, in 300mm-500mm thickness across the site.
- **Glacial Till:** sandy gravelly clay or silty clay, frequently with low to medium cobble content, typically firm or stiff. TP-T5-01 consisted of silty sand deposits.
- **Possible Bedrock:** TP-T2-01 and TP-T3-01 encountered sandy silty angular gravel deposits at the bottom of the trial pit. Additional ground investigation is needed to verify the presence of bedrock.

6.3 Groundwater

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.

Groundwater was encountered as seepage in trial pits TP-SS-01, TP-T2-01, TP-T3-01, and TP-T5-01 between 0.30-2.30m. Surface water also infiltrated TP-T3-01 and TP-T6-01 during excavation.

Seasonal variation in groundwater levels should also be factored into design considerations.

7 REFERENCES

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland.

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. National Standards Authority of Ireland.

BS 5930: 2015+A1:2020: Code of practice for ground investigations. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description.

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

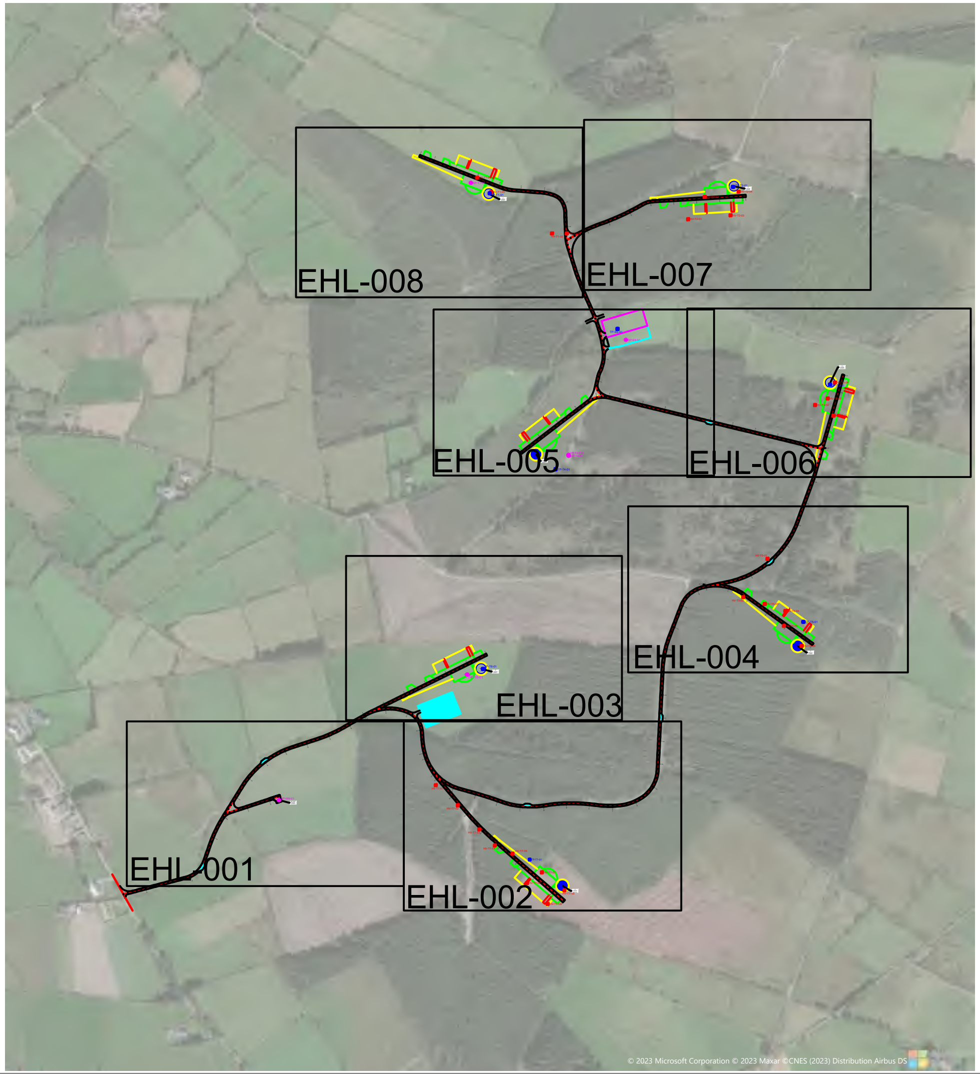
BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

CAUSEWAY
GEOTECH

APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLANS



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PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan Overview

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- ▣ Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

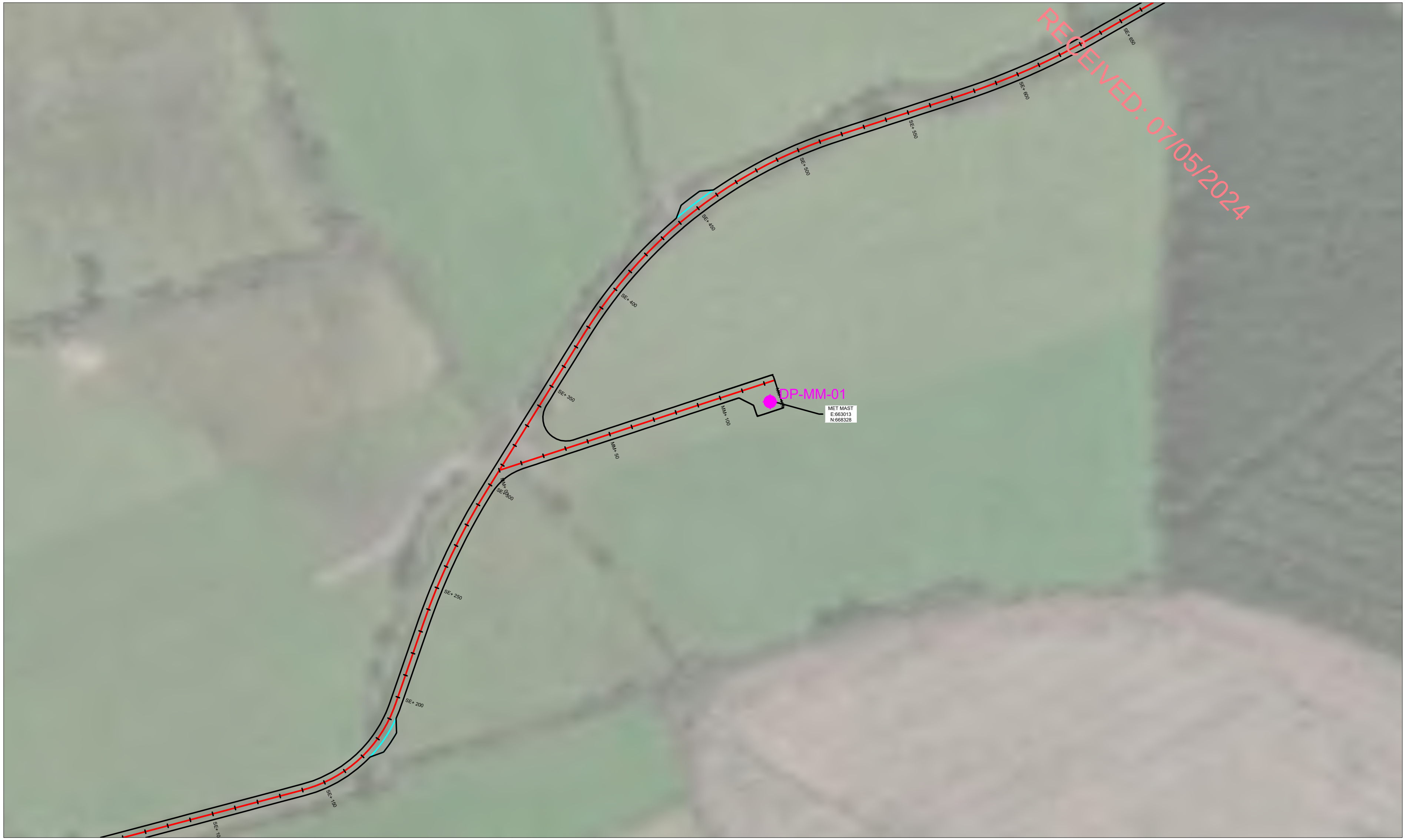
DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 1 of 1

DWG NO: 23-1591-EHL-OW-001



PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- ▨ Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 1 of 8

DWG No: 23-1591-EHL-001

PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- 🟦 Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 2 of 8

DWG No: 23-1591-EHL-002

PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- ▨ Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

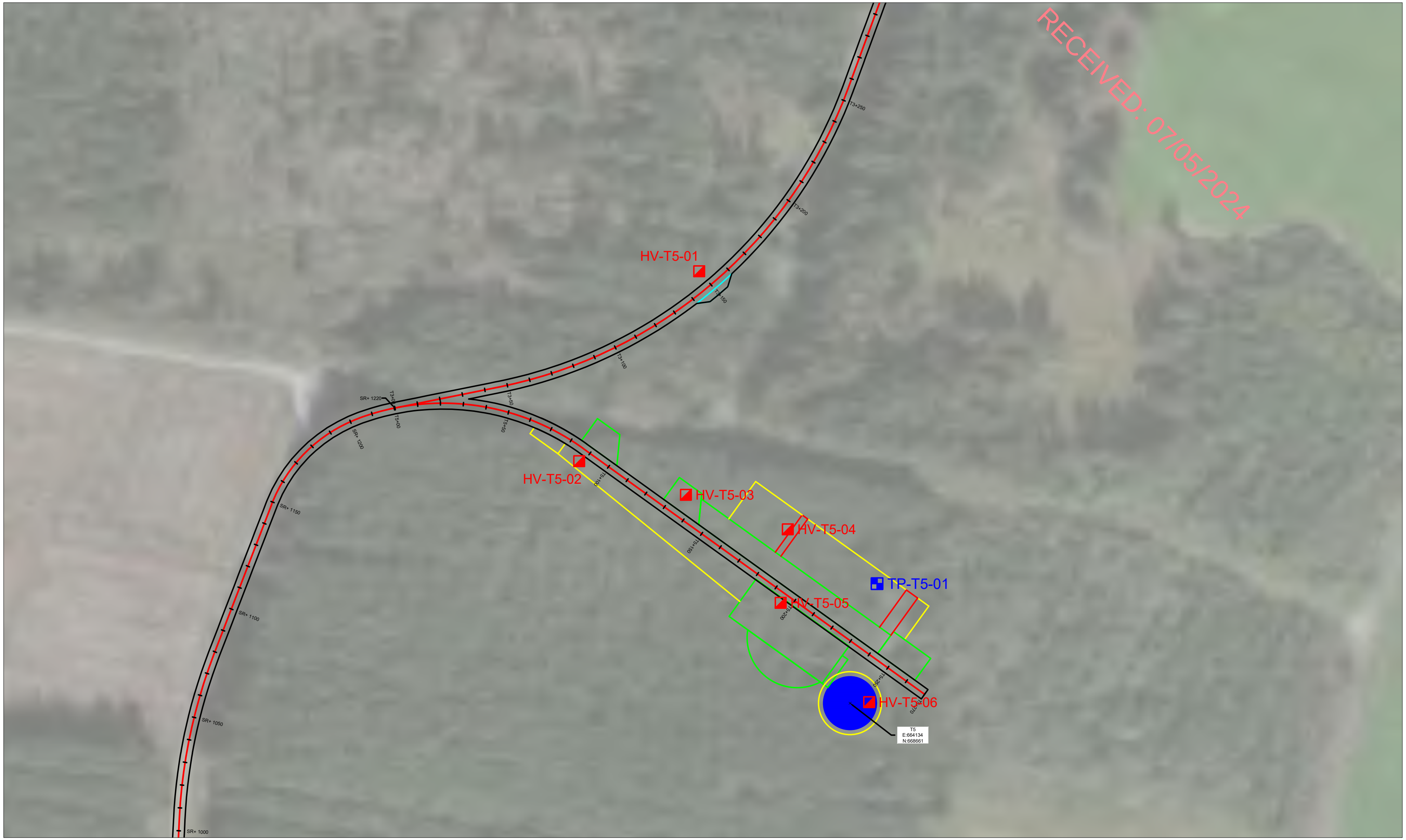
DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 3 of 8

DWG No: 23-1591-EHL-003



PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- 🟦 Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

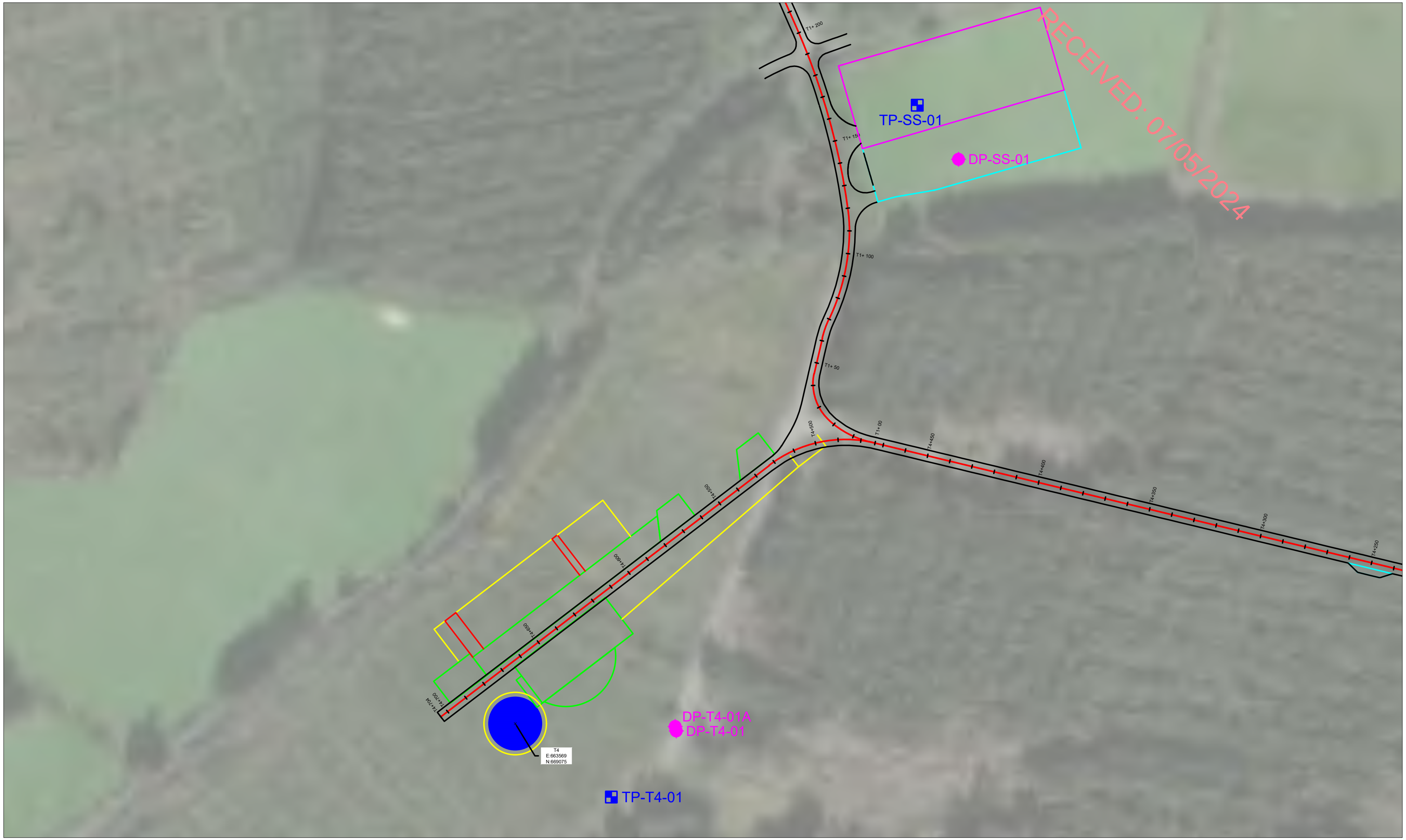
DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 4 of 8

DWG NO: 23-1591-EHL-004



PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- ▨ Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3		DATE: 12/01/2024	
DRWN:	BS	SERIES: 5 of 8	DWG NO: 23-1591-EHL-005
CHCK:	MFG		

PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

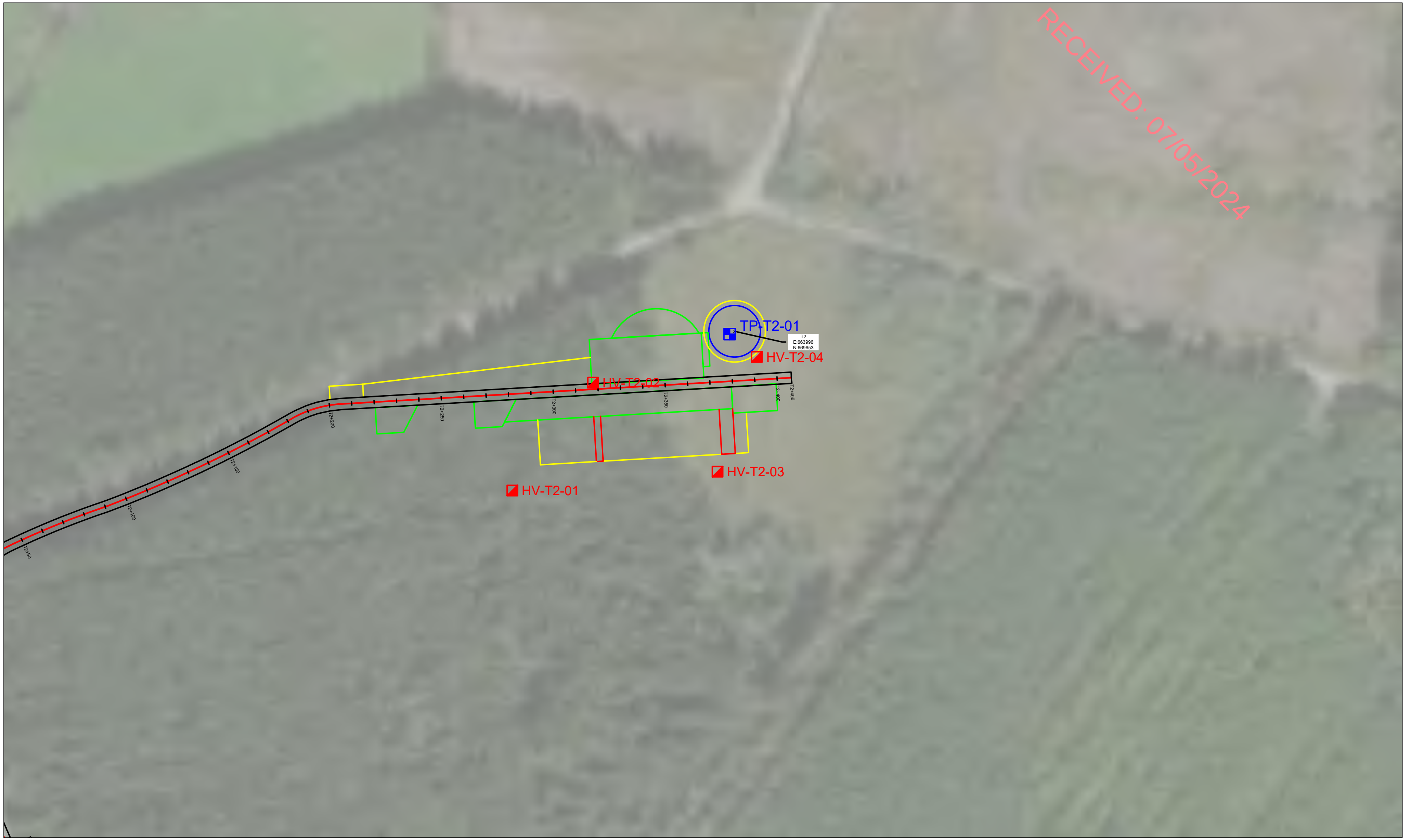
CLIENT: MKO

ENGINEER: AFRY

KEY:
- 🟥 Hand Vane
- 🟦 Trial Pit
- ● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3		DATE: 12/01/2024	
DRWN:	BS	SERIES: 6 of 8	DWG NO: 23-1591-EHL-006
CHCK:	MFG		



PROJECT: Seskin Wind Farm

TITLE: Exploratory hole location plan

CLIENT: MKO

ENGINEER: AFRY

KEY:
🟥 Hand Vane
🟦 Trial Pit
● Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 12/01/2024

DRWN: BS

CHCK: MFG

SERIES: 7 of 8

DWG No: 23-1591-EHL-007

PROJECT: Seskin Wind Farm		TITLE: Exploratory hole location plan	
CLIENT: MKO	KEY: 🟥 Hand Vane 🟦 Trial Pit ● Dynamic Probe	SCALE: NTS@A3	DATE: 12/01/2024
ENGINEER: AFRY		DRWN: BS CHCK: MFG	SERIES: 8 of 8
			DWG No: 23-1591-EHL-008

CAUSEWAY
GEOTECH

APPENDIX B

TRIAL PIT LOGS

CAUSEWAY GEOTECH

	Project No. 23-1591	**Project Name:** Seskin Wind Farm	**Trial Pit ID** **TP-SS-01**
	Coordinates 663744.72 E 669345.41 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 256.04 mOD	**Date:** 01/11/2023 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
		Slight seepage at 0.30m	255.74	0.30	▨	Firm light brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	▼
0.60	B1						
0.60		HVP=104, HVR=69					
0.60		HVP=87, HVR=62					
0.60		HVP=95, HVR=36					
1.20		HVP=102, HVR=65					
1.20		HVP=125, HVR=54					
1.20		HVP=71, HVR=66					
1.40	B2						
			254.14	1.90		End of trial pit at 1.90m	

0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

Water Strikes			
Struck at (m)	Remarks	**Depth:** 1.90	**Remarks:**
0.30	Slight seepage at 0.30m	**Width:** 0.70	
		Length: 2.90	

Stability:	**Termination Reason**	**Last Updated**
Stable	Terminated at refusal on boulders / possible bedrock.	10/01/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1591	**Project Name:** Seskin Wind Farm		**Trial Pit ID** **TP-T1-01**
Coordinates 663468.39 E 669638.21 N	**Client:** MKO		
Method: Trial Pitting	**Client's Representative:** AFRY		Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 251.45 mOD	**Date:** 01/11/2023	**Logger:** JAC
			FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
						TOPSOIL	
			251.15	0.30		Stiff light brown sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
0.50	B1						
0.50		HVP=125, HVR=62					
0.50		HVP=138, HVR=69					
0.50		HVP=144, HVR=72					
			250.65	0.80		Stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
1.00		HVP=131, HVR=74					
1.00		HVP=143, HVR=77					
1.20	B2						
			249.65	1.80		Firm to stiff light brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
2.00	B3						
			248.95	2.50		End of trial pit at 2.50m	

Water Strikes

Struck at (m)	Remarks

Depth: 2.50
Width: 0.80
Length: 3.20

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1591	**Project Name:** Seskin Wind Farm	**Trial Pit ID**
	Coordinates 663994.20 E 669652.07 N	**Client:** MKO	**TP-T2-01**
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 8.5T Tracked Excavator	**Elevation** 268.29 mOD	**Date:** 28/11/2023 — **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
						TOPSOIL with roots and rootlets	
			267.99	0.30		Firm orangish brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
0.40	B1						
0.40	D2						
0.50		HVP=45, HVR=23					
0.50		HVP=50, HVR=21					
0.50		HVP=59, HVR=14					
			267.49	0.80		Firm to stiff grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.	
1.00		HVP=62, HVR=29					
1.00		HVP=69, HVR=33					
1.00		HVP=74, HVR=30					
1.50	B3						
1.50	D4						
			266.39	1.90		Brown slightly sandy angular to subangular fine to coarse GRAVEL with medium cobble content. Sand is fine to coarse. (Possibly highly weathered bedrock)	
2.20	B5						
2.20	D6						
		Seepage at 2.30m					▼
			265.59	2.70		End of trial pit at 2.70m	

Water Strikes

Struck at (m)	Remarks
2.30	Seepage at 2.30m

Depth: 2.70
Width: 1.00
Length: 2.90

Remarks:

Stability: Stable

Termination Reason: Terminated at refusal on boulders / possible bedrock.

Last Updated: 10/01/2024

AGS

CAUSEWAY GEOTECH

Project No.
23-1591

Project Name:
Seskin Wind Farm

Trial Pit ID

TP-T3-01

Coordinates
664203.86 E
669225.26 N

Client:
MKO

Method:
Trial Pitting

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:25

Plant:
13t Tracked Excavator

Elevation
259.72 mOD

Date:
01/11/2023

Logger:
JAC

FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
		Strong flow at ground level				TOPSOIL	
			259.32	0.40		Firm grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.	
0.50	B1						
0.50		HVP=69, HVR=36					
0.50		HVP=89, HVR=48					
0.50		HVP=92, HVR=45					
1.00		HVP=104, HVR=68					
1.00		HVP=122, HVR=71					
1.00		HVP=95, HVR=47					
			258.42	1.30		Firm to stiff grey slightly sandy very gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
1.50	B2						
			258.12	1.60		Grey sandy slightly silty angular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse. (Possibly highly weathered bedrock)	
1.80	B3						
		Light seepage at 2.20m	257.52	2.20		End of trial pit at 2.20m	▼

0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

Water Strikes

Struck at (m)	Remarks
0.00	Strong flow at ground level
2.20	Light seepage at 2.20m

Depth: 2.20
Width: 0.70
Length: 3.30

Remarks:

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
10/01/2024

AGS

	Project No. 23-1591	**Project Name:** Seskin Wind Farm	**Trial Pit ID** **TP-T4-01**
	Coordinates 663610.77 E 669042.36 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 8.5T Tracked Excavator	**Elevation** 250.65 mOD	**Date:** 28/11/2023 — **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records
0.50		HVP=50, HVR=15
0.50		HVP=63, HVR=26
0.50		HVP=71, HVR=23
1.00	B1	
1.00	D2	
1.00	D4	
1.00		HVP=63, HVR=21
1.00		HVP=71, HVR=27
1.00		HVP=84, HVR=32
1.50	B3	

Level (mOD)	Depth (m)	Legend	Description	Water
			TOPSOIL with roots and rootlets	
250.25	0.40		Firm light grey slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
249.55	1.10		Firm to stiff grey sandy gravelly SILT with medium cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
248.75	1.90		End of trial pit at 1.90m	

Water Strikes	
Struck at (m)	Remarks

Depth: 1.90

Width: 1.10

Length: 3.10

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH	**Project No.** 23-1591	**Project Name:** Seskin Wind Farm	**Trial Pit ID** **TP-T5-01**
	Coordinates 664146.21 E 668712.68 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 8.5T Tracked Excavator	**Elevation** 252.75 mOD	**Date:** 28/11/2023 **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
					▨	TOPSOIL	
			252.45	0.30	▒	Grey very silty fine to coarse SAND.	
0.70 0.70	B1 D2						
1.50 1.50	B3 D4						
		Light flow at 2.10m					▼
			250.45	2.30		End of trial pit at 2.30m	

Water Strikes	
Struck at (m)	Remarks
2.10	Light flow at 2.10m

Depth: 2.30
Width:
Length:

Remarks:

Stability:
Unstable

Termination Reason
Terminated due to pit walls collapsing

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH

	Project No. 23-1591	**Project Name:** Seskin Wind Farm	**Trial Pit ID** **TP-T6-01**
	Coordinates 663454.01 E 668611.05 N	**Client:** MKO	
Method: Trial Pitting		**Client's Representative:** AFRY	Sheet 1 of 1 Scale: 1:25
Plant: 13t Tracked Excavator	**Elevation** 241.64 mOD	**Date:** 01/11/2023 — **Logger:** JAC	FINAL

Depth (m)	Sample / Tests	Field Records	Level (mOD)	Depth (m)	Legend	Description	Water
		Strong flow from surface				TOPSOIL	
			241.24	0.40		Firm to stiff light brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
0.50	B1						
0.50		HVP=65, HVR=32	241.04	0.60		Stiff light grey slightly sandy slightly gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
0.50		HVP=71, HVR=14					
0.50		HVP=87, HVR=33					
1.00	B2						
1.00		HVP=108, HVR=39					
1.00		HVP=114, HVR=30					
1.00		HVP=122, HVR=44					
			240.34	1.30		End of trial pit at 1.30m	

Water Strikes

Struck at (m)	Remarks
0.00	Strong flow from surface

Depth: 1.30
Width: 0.70
Length: 3.20

Remarks:

Stability: Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1591

Project Name: Seskin Wind Farm

Trial Pit ID **TP-T7-01**

Coordinates 663554.86 E 668199.34 N

Client: MKO

Method: Trial Pitting

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:25

Plant: 8.5T Tracked Excavator

Elevation 250.56 mOD

Date: 28/11/2023

Logger: JAC

FINAL

Depth (m)	Sample / Tests	Field Records
0.70	B1	
0.70	D2	
0.70		HVP=50, HVR=17
0.70		HVP=63, HVR=20
0.70		HVP=74, HVR=27
1.00		HVP=63, HVR=15
1.00		HVP=71, HVR=21
1.00		HVP=80, HVR=24
1.20	B3	
1.20	D4	

Level (mOD)	Depth (m)	Description	Water
		TOPSOIL with roots and rootlets.	
250.06	0.50	Firm light grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine.	
249.46	1.10	Stiff blackish grey sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.	
249.26	1.30	End of trial pit at 1.30m	

Water Strikes

Struck at (m)	Remarks

Depth: 1.30

Width: 1.00

Length: 2.50

Remarks:
No groundwater encountered

Stability:
Stable

Termination Reason
Terminated at refusal on boulders / possible bedrock.

Last Updated
10/01/2024

AGS

APPENDIX C

TRIAL PIT PHOTOGRAPHS

Trial Pit: TP-SS-01

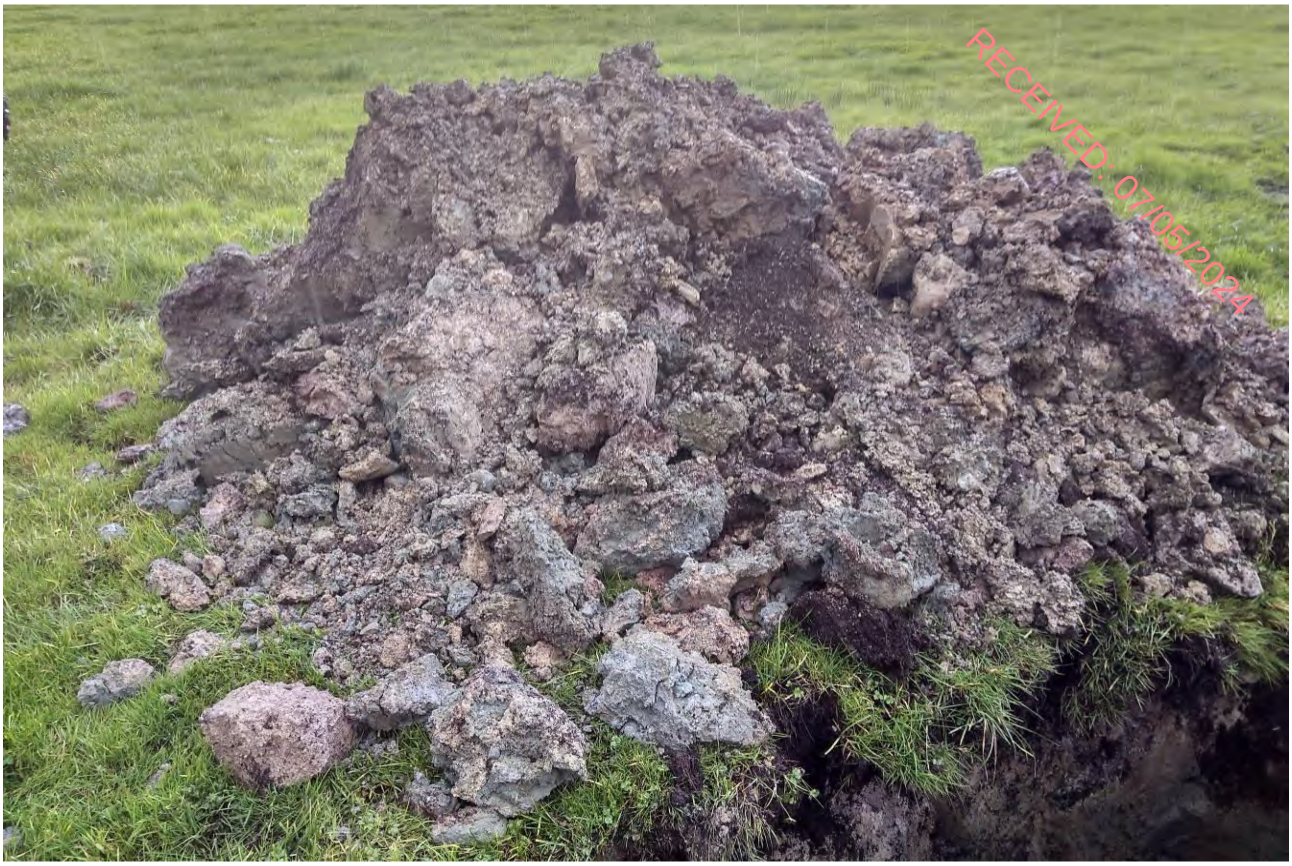
Trial Pit: TP-SS-01

Trial Pit: TP-SS-01

Trial Pit: TP-SS-01

Trial Pit: TP-T1-01

Trial Pit: TP-T1-01



Trial Pit: TP-T1-01

Trial Pit: TP-T2-01

Trial Pit: TP-T2-01

Trial Pit: TP-T2-01

Trial Pit: TP-T2-01

Trial Pit: TP-T2-01

Trial Pit: TP-T2-01

Trial Pit: TP-T3-01

Trial Pit: TP-T3-01

Trial Pit: TP-T3-01

Trial Pit: TP-T3-01

Trial Pit: TP-T3-01

Trial Pit: TP-T3-01

Trial Pit: TP-T4-01

Trial Pit: TP-T4-01

Trial Pit: TP-T4-01

Trial Pit: TP-T4-01

Trial Pit: TP-T4-01

Trial Pit: TP-T4-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T5-01

Trial Pit: TP-T6-01

Trial Pit: TP-T6-01

Trial Pit: TP-T6-01

Trial Pit: TP-T6-01

Trial Pit: TP-T7-01

Trial Pit: TP-T7-01

Trial Pit: TP-T7-01

Trial Pit: TP-T7-01

APPENDIX D

DYNAMIC PROBE LOGS

CAUSEWAY GEOTECH

Project No. 23-1591

Project Name: Seskin Wind Farm

Probe ID DP-MM-01

Coordinates 663013.37 E 668327.52 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

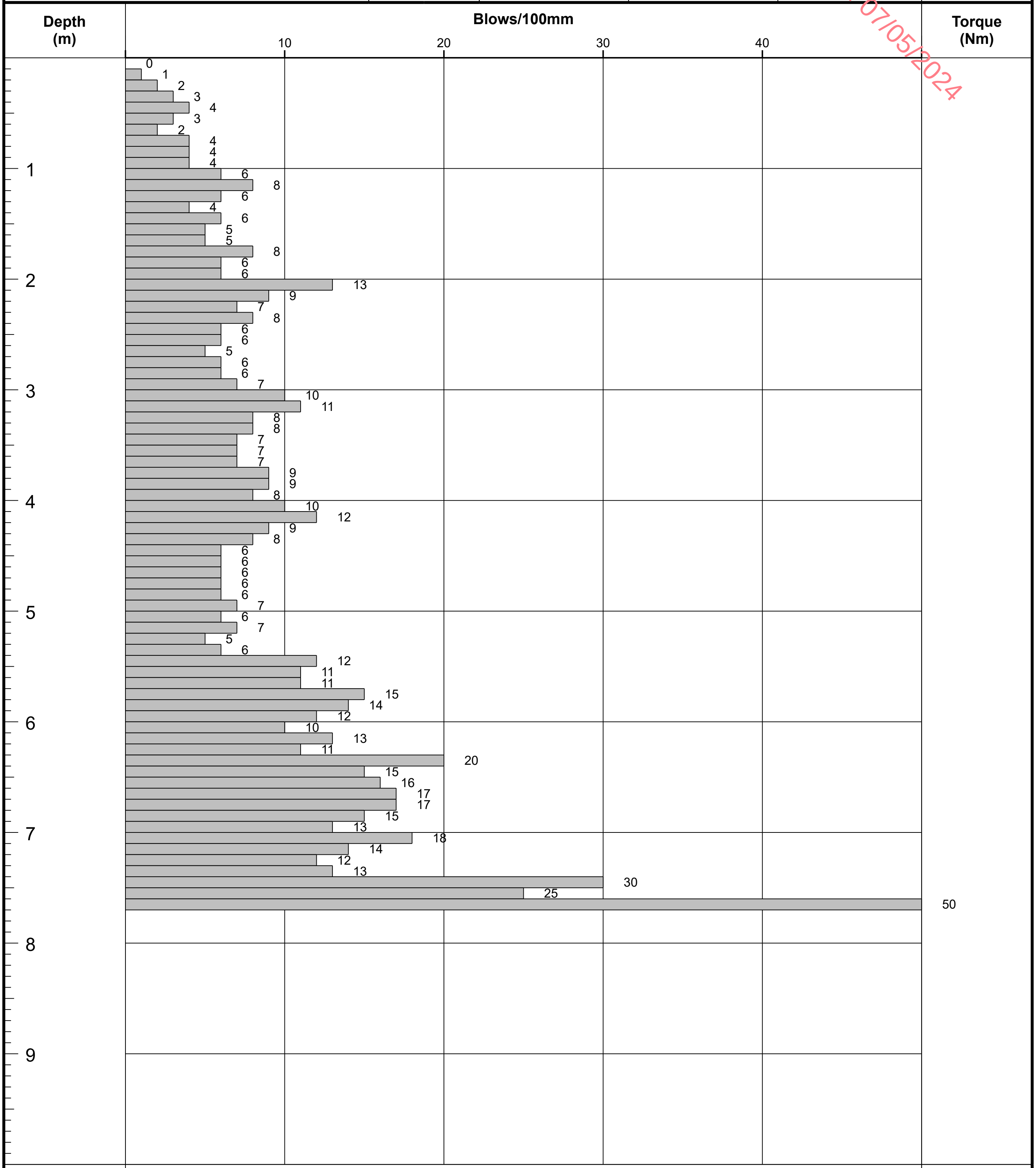
Elevation 235.58 mOD

Final Depth: 7.68

Date: 01/11/2023

Operator: JFSC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated at refusal on boulder / possible bedrock.

Last Updated 10/01/2024

AGS

Project No.
23-1591

Project Name:
Seskin Wind Farm

Probe ID
DP-SS-01

Coordinates
663762.82 E
669321.74 N

Client:
MKO

Client's Representative:
AFRY

Method:
Dynamic Probing

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

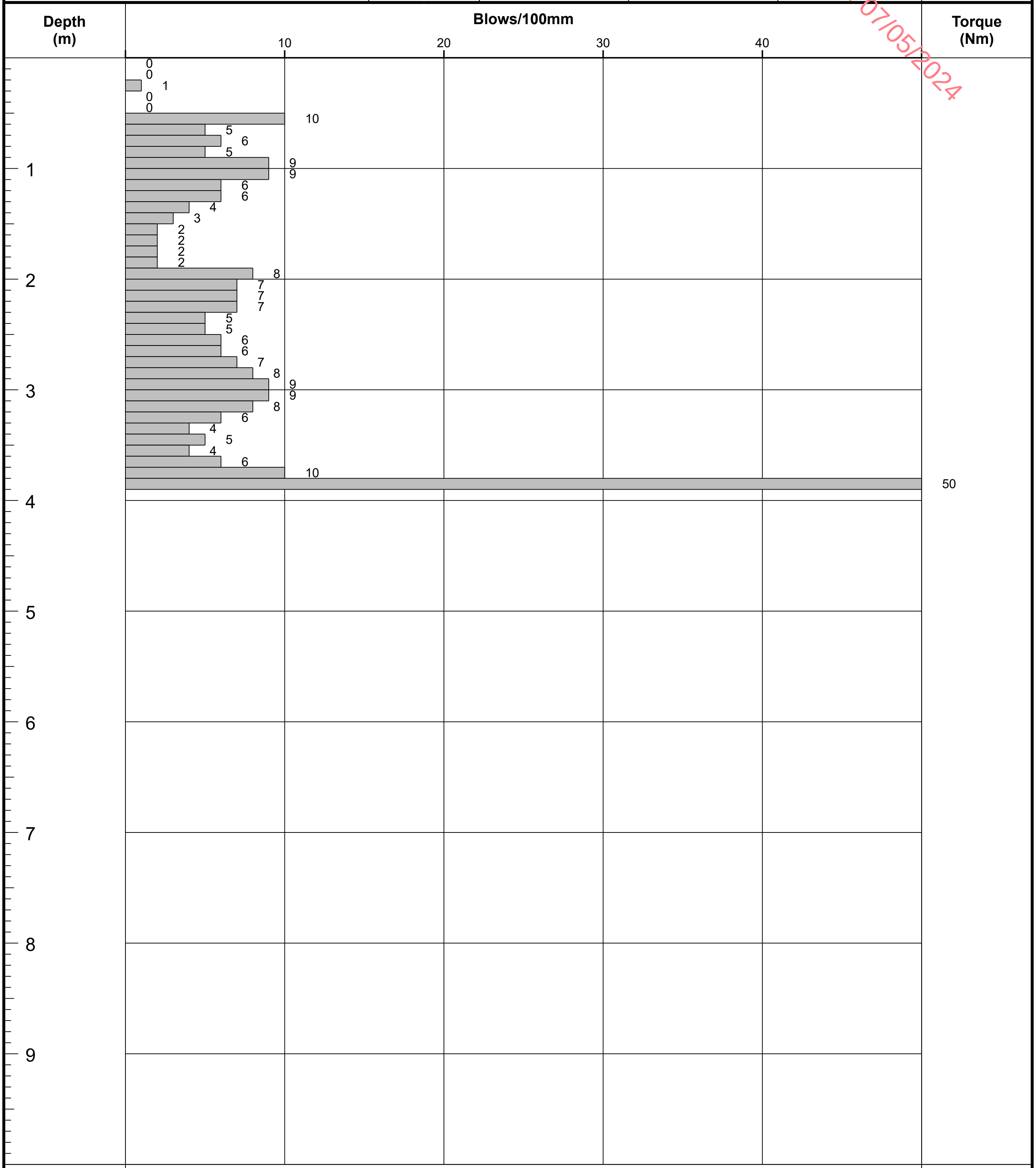
Elevation
255.84 mOD

Final Depth:
3.90

Date:
01/11/2023

Operator:
JFSC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

Termination Reason
Terminated at refusal on boulder / possible bedrock.

Last Updated
10/01/2024

CAUSEWAY GEOTECH

Project No.
23-1591

Project Name:
Seskin Wind Farm

Probe ID
DP-T1-01

Coordinates
663428.07 E
669660.66 N

Client:
MKO

Method:
Dynamic Probing

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

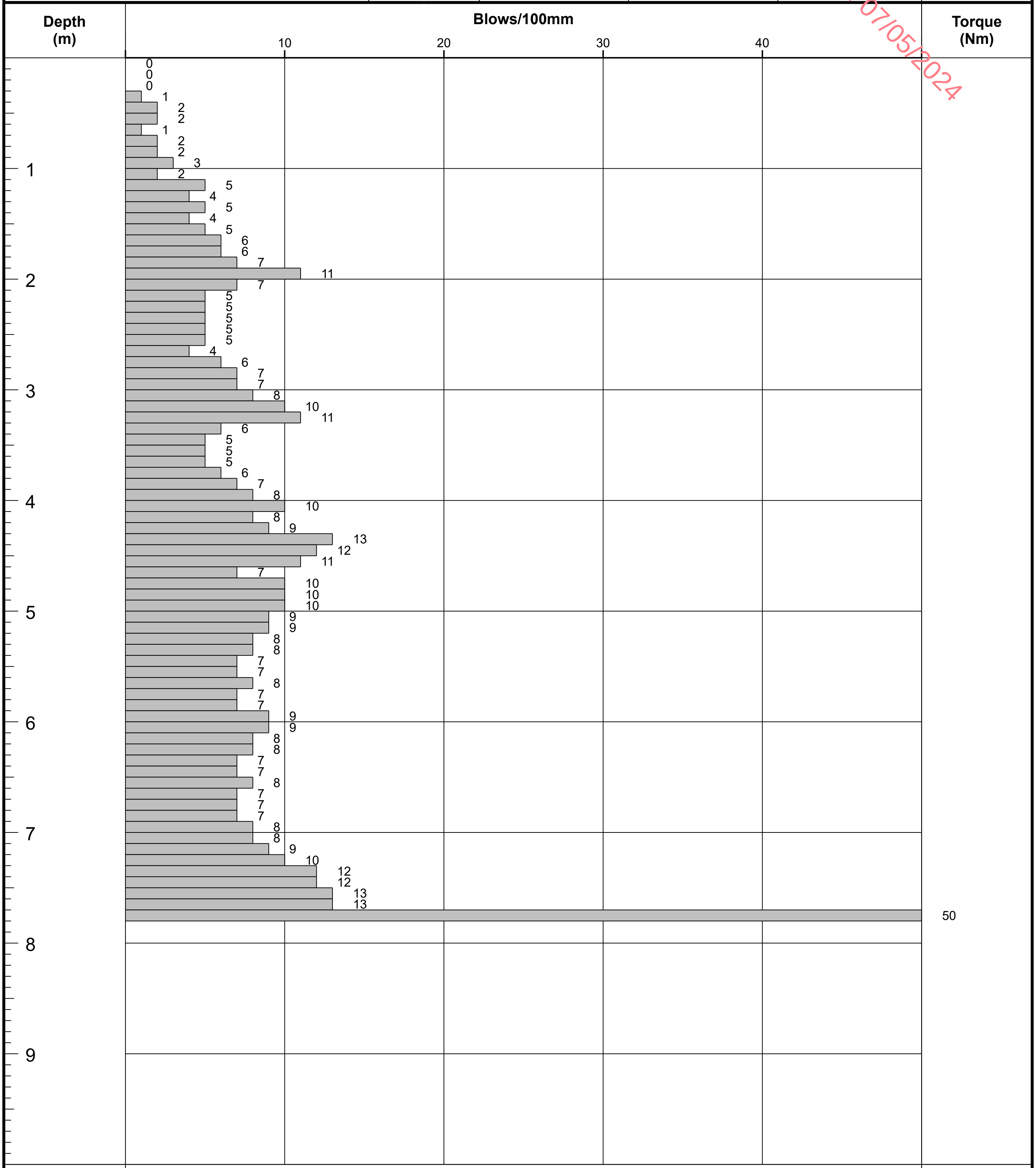
Elevation
250.66 mOD

Final Depth:
7.79

Date:
01/11/2023

Operator:
JFSC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

Termination Reason
Terminated at refusal on boulder / possible bedrock.

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH

Project No.
23-1591

Project Name:
Seskin Wind Farm

Probe ID
DP-T4-01

Coordinates
663639.21 E
669071.30 N

Client:
MKO

Method:
Dynamic Probing

Client's Representative:
AFRY

Sheet 1 of 1
Scale: 1:50

Probe Type:
DPSH-B

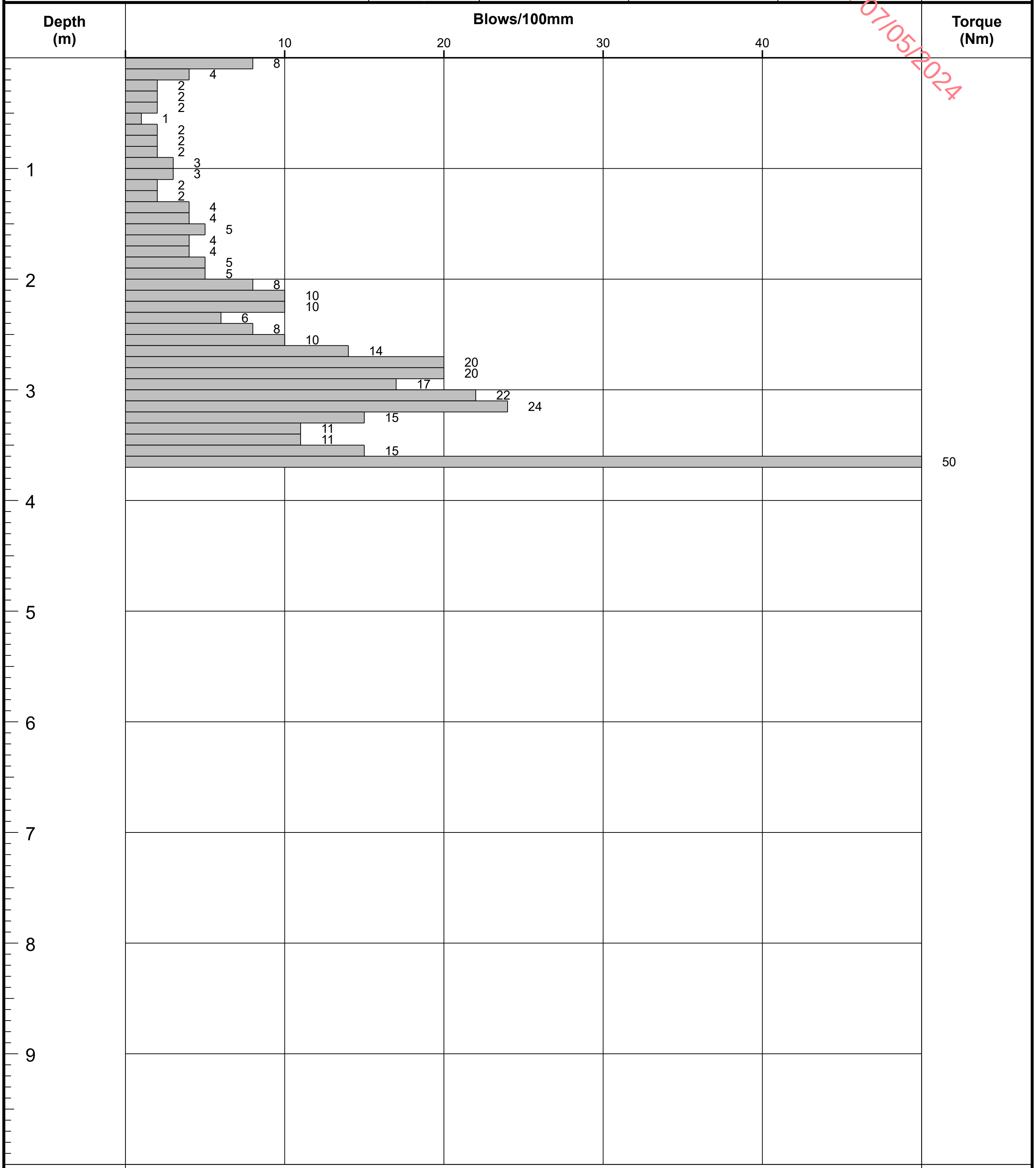
Elevation
250.58 mOD

Final Depth:
3.60

Date:
27/11/2023

Operator:
IC

FINAL



Fall Height:
750 mm

Hammer Mass:
63.5 kg

Cone Diameter:
50.5 mm

Remarks

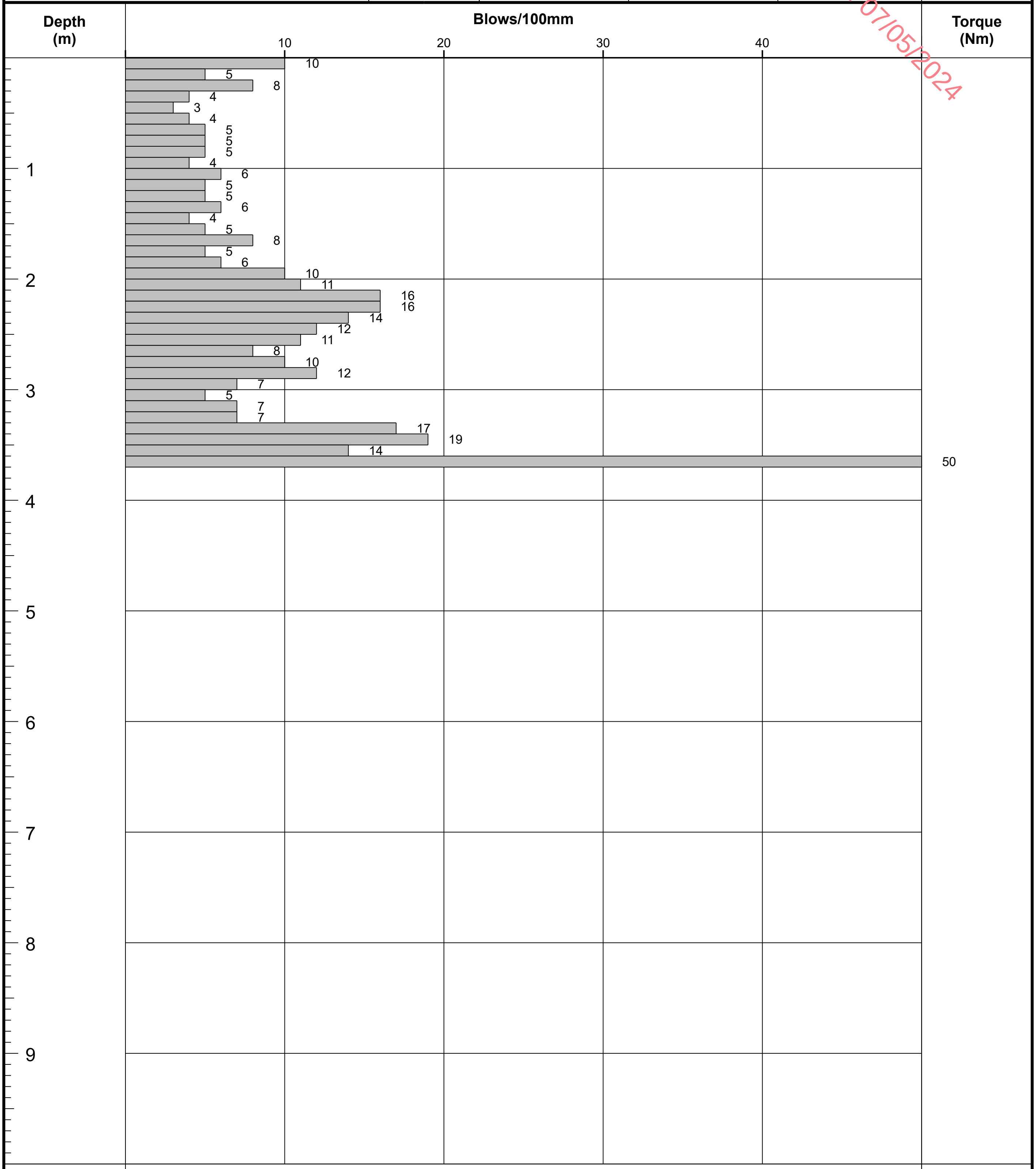
Termination Reason
Terminated at refusal on boulder / possible bedrock.

Last Updated
10/01/2024

AGS

CAUSEWAY GEOTECH

Project No. 23-1591	**Project Name:** Seskin Wind Farm		**Probe ID** **DP-T4-01A**
Coordinates 663638.76 E 669073.22 N	**Client:** MKO		
Method: Dynamic Probing	**Client's Representative:** AFRY		Sheet 1 of 1 Scale: 1:50
Probe Type: DPSH-B	**Elevation** 250.49 mOD	**Final Depth:** 3.60 | **Date:** 27/11/2023 | **Operator:** IC	FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated at refusal on boulder / possible bedrock.

Last Updated

10/01/2024

AGS

Project No.: 23-1591

Project Name: Seskin Wind Farm

Probe ID: DP-T6-01

Coordinates: 663420.00 E
668598.53 N

Client: MKO

Method: Dynamic Probing

Client's Representative: AFRY

Sheet 1 of 1

Scale: 1:50

Probe Type: DPSH-B

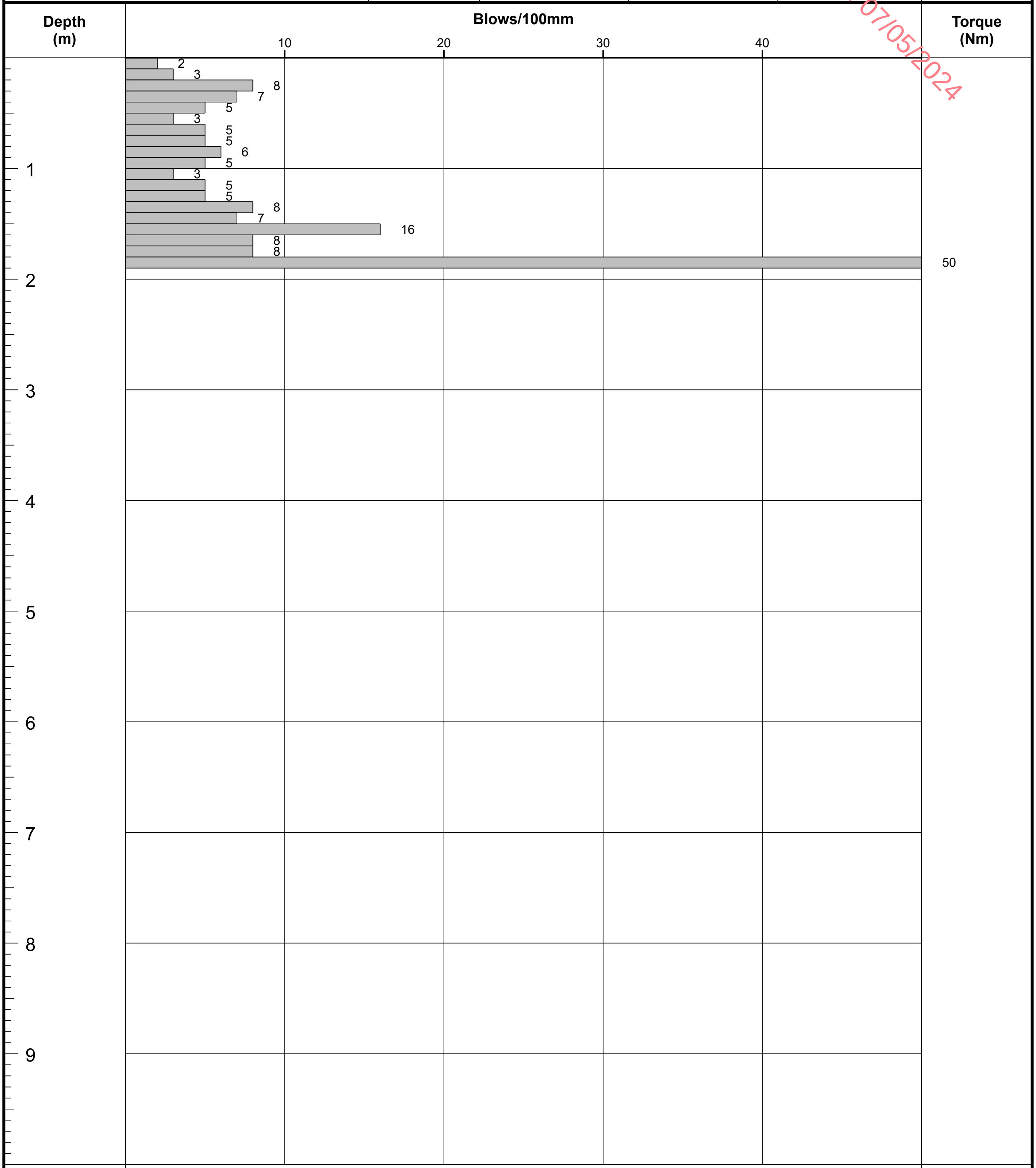
Elevation: 240.12 mOD

Final Depth: 1.88

Date: 01/11/2023

Operator: JFSC

FINAL



Fall Height: 750 mm

Hammer Mass: 63.5 kg

Cone Diameter: 50.5 mm

Remarks

Termination Reason

Terminated at refusal on boulder / possible bedrock.

Last Updated 10/01/2024

APPENDIX E

HAND VANE TEST RESULTS

HAND VANE TEST RESULTS

Project No.
23-1591

Project Name
Seskin Wind Farm

Location ID	Depth (m)	Test Number	Vane Type	Result (kPa)	Residual result (kPa)
HV-T1-01	0.40	1	FIELD	59	21
HV-T1-01	0.40	2	FIELD	81	27
HV-T1-01	0.40	3	FIELD	69	21
HV-T1-02	0.40	1	FIELD	77	24
HV-T1-02	0.40	2	FIELD	89	33
HV-T1-02	0.40	3	FIELD	63	17
HV-T1-03	0.40	1	FIELD	90	77
HV-T1-03	0.40	2	FIELD	119	83
HV-T1-03	0.40	3	FIELD	111	71
HV-T1-04	0.40	1	FIELD	99	60
HV-T1-04	0.40	2	FIELD	144	75
HV-T1-04	0.40	3	FIELD	153	78
HV-T2-01	0.40	1	FIELD	56	17
HV-T2-01	0.40	2	FIELD	80	32
HV-T2-01	0.40	3	FIELD	66	27
HV-T2-02	0.40	1	FIELD	71	33
HV-T2-03	0.40	1	FIELD	27	9
HV-T2-03	0.40	2	FIELD	44	17
HV-T2-03	0.40	3	FIELD	47	18
HV-T2-04	0.40	1	FIELD	51	18
HV-T2-04	0.40	2	FIELD	84	50
HV-T2-04	0.40	3	FIELD	90	42
HV-T3-01	0.40	1	FIELD	95	32
HV-T3-01	0.40	2	FIELD	63	20
HV-T3-01	0.40	3	FIELD	84	29
HV-T3-02	0.40	1	FIELD	71	23
HV-T3-02	0.40	2	FIELD	89	27
HV-T3-02	0.40	3	FIELD	66	17
HV-T3-03	0.40	1	FIELD	87	33
HV-T3-03	0.40	2	FIELD	101	35
HV-T3-03	0.40	3	FIELD	71	29
HV-T3-04	0.40	1	FIELD	>165	N/A
HV-T3-04	0.40	2	FIELD	147	81
HV-T3-04	0.40	4	FIELD	>165	N/A
HV-T5-01	0.40	1	FIELD	66	27
HV-T5-01	0.40	2	FIELD	60	20
HV-T5-01	0.40	3	FIELD	44	15
HV-T5-02	0.40	1	FIELD	62	21
HV-T5-02	0.40	2	FIELD	45	17
HV-T5-02	0.40	3	FIELD	27	3
HV-T5-03	0.40	1	FIELD	45	14
HV-T5-03	0.40	2	FIELD	32	8
HV-T5-03	0.40	3	FIELD	42	11
HV-T5-04	0.40	1	FIELD	27	9
HV-T5-04	0.40	2	FIELD	23	12
HV-T5-04	0.40	3	FIELD	44	15
HV-T5-05	0.40	1	FIELD	51	21
HV-T5-05	0.40	2	FIELD	33	8
HV-T5-05	0.40	3	FIELD	59	23
HV-T5-06	0.40	1	FIELD	41	14
HV-T5-06	0.40	2	FIELD	35	11
HV-T5-06	0.40	3	FIELD	50	17
HV-T7-01	0.40	1	FIELD	53	18
HV-T7-01	0.40	2	FIELD	59	20
HV-T7-01	0.40	3	FIELD	74	24
HV-T7-02	0.40	1	FIELD	68	27
HV-T7-02	0.40	2	FIELD	72	27
HV-T7-02	0.40	3	FIELD	56	20
HV-T7-03	0.40	1	FIELD	56	20
HV-T7-03	0.40	2	FIELD	74	26
HV-T7-03	0.40	3	FIELD	80	30

HAND VANE TEST RESULTS

Project No. 23-1591

Project Name Seskin Wind Farm

Location ID	Depth (m)	Test Number	Vane Type	Result (kPa)	Residual result (kPa)
HV-T7-04	0.40	1	FIELD	42	12
HV-T7-04	0.40	2	FIELD	54	21
HV-T7-04	0.40	3	FIELD	62	21
HV-T7-05	0.40	1	FIELD	72	24
HV-T7-05	0.40	2	FIELD	50	17
HV-T7-05	0.40	3	FIELD	68	18
HV-T7-06	0.40	1	FIELD	69	29
HV-T7-06	0.40	2	FIELD	41	12
HV-T7-06	0.40	3	FIELD	80	30
HV-T7-07	0.40	1	FIELD	56	21
HV-T7-07	0.40	2	FIELD	66	27
HV-T7-07	0.40	3	FIELD	77	27
HV-T7-08	0.40	1	FIELD	54	18
HV-T7-08	0.40	2	FIELD	41	12
HV-T7-08	0.40	3	FIELD	63	20
HV-T7-09	0.40	1	FIELD	83	33
HV-T7-09	0.40	2	FIELD	56	24
HV-T7-09	0.40	3	FIELD	45	17

APPENDIX F

GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

HEAD OFFICE
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Registered in Northern Ireland.
Company Number: NI610766

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ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

RECEIVED: 07/05/2024

SOIL AND ROCK SAMPLE ANALYSIS LABORATORY TEST REPORT

29 November 2023

Project Name:	Seskin Wind Farm
Project No.:	23-1591
Client:	MKO
Engineer:	AFRY

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s). This testing was performed between 09/11/2023 and 29/11/2023.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Seskin Wind Farm

Report Reference: Schedule 1

The table below details the tests carried out, the specifications used, and the number of tests included in this report. The results contained in this report relate to the sample(s) as received.

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	4
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	4
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	4
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	4

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Derwentside Environmental Testing Services Limited *(UKAS 2139)*	BRE Test - Suite A		4

Summary of Classification Test Results

Project No.	Project Name
23-1591	Seskin Wind Farm

Hole No.	Sample				Specimen Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type										
TP-SS-01	1	0.60		B	Brown sandy slightly gravelly silty CLAY.			20	85	33 -1pt	20	13		CL
TP-T1-01	2	1.20		B	Greyish brown sandy slightly gravelly silty CLAY.			13	74	32 -1pt	18	14		CL
TP-T3-01	1	0.50		B	Greyish brown sandy slightly gravelly silty CLAY.			24	94	27 -1pt	18	9		CL
TP-T6-01	2	1.00		B	Greyish brown sandy slightly gravelly silty CLAY.			22	89	34 -1pt	19	15		CL

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 6

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed

29/11/2023

Approved By

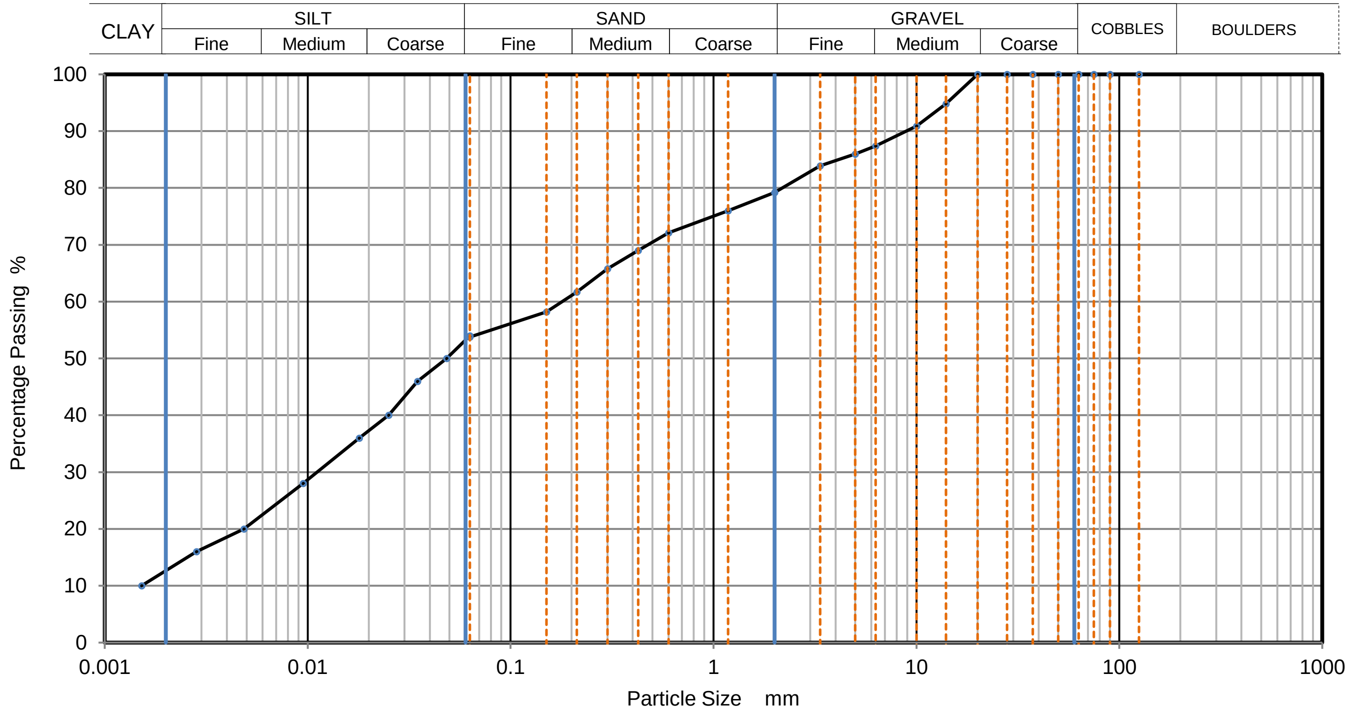
Stephen Watson

10122

CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1591**
				Borehole/Pit No.	TP-SS-01
Site Name	Seskin Wind Farm			Sample No.	1
Specimen Description	Brown sandy slightly gravelly silty CLAY.			Sample Depth (m) Top	0.60
				Base	
Specimen Reference	6	Specimen Depth	0.6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus202310956



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	54
90	100	0.04846	50
75	100	0.03473	46
63	100	0.02505	40
50	100	0.01794	36
37.5	100	0.00949	28
28	100	0.00486	20
20	100	0.00284	16
14	95	0.00152	10
10	91		
6.3	87		
5	86		
3.35	84		
2	79		
1.18	76		
0.6	72	Particle density	(assumed)
0.425	69	2.65	Mg/m3
0.3	66		
0.212	62		
0.15	58		
0.063	54		

Dry Mass of sample, g	530

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	20.8
Sand	25.5
Silt	41.1
Clay	12.6

Grading Analysis	
D100 mm	
D60 mm	0.18
D30 mm	0.0112
D10 mm	0.00152
Uniformity Coefficient	120
Curvature Coefficient	0.46

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

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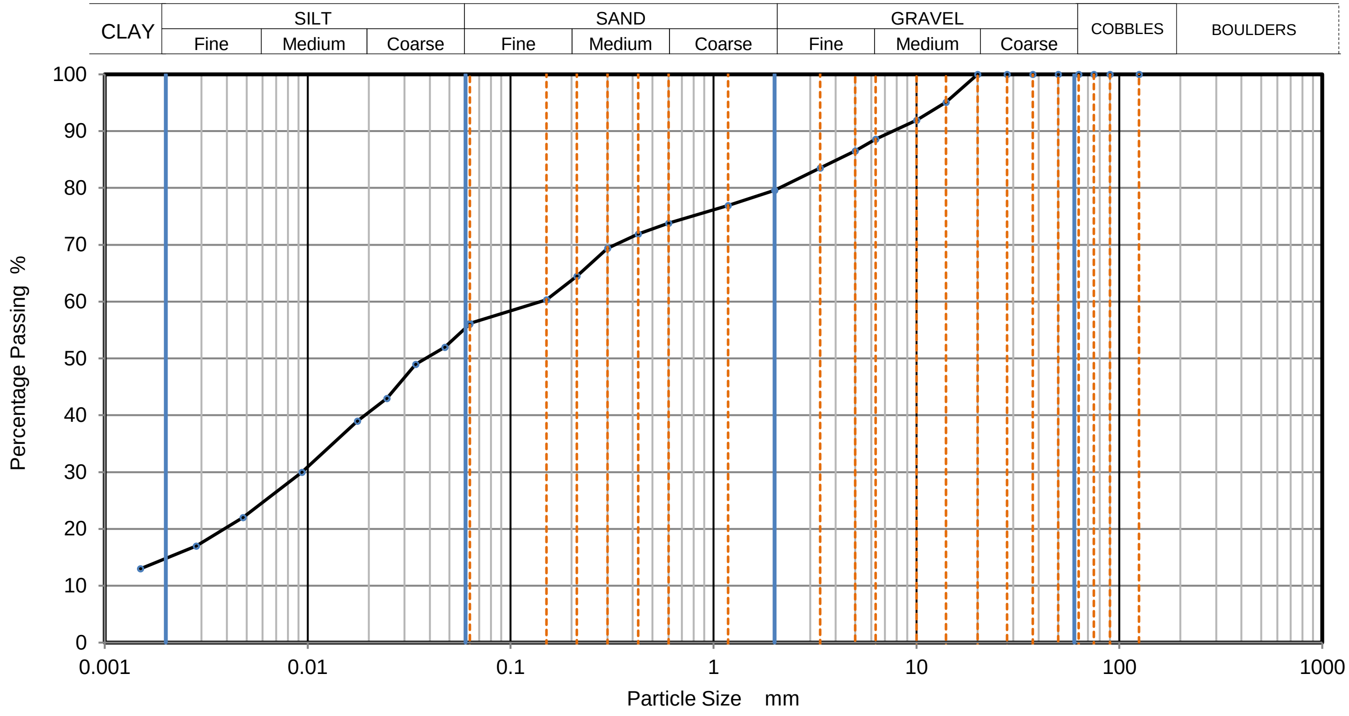
UKAS TESTING
10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref		**23-1591**
				Borehole/Pit No.		TP-T1-01
Site Name	Seskin Wind Farm			Sample No.		2
Specimen Description	Greyish brown sandy slightly gravelly silty CLAY.			Sample Depth (m)	Top	1.20
					Base	
Specimen Reference	6	Specimen Depth	1.2 m	Sample Type		B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID		Caus202310958



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06289	56
90	100	0.04745	52
75	100	0.03403	49
63	100	0.02456	43
50	100	0.01760	39
37.5	100	0.00938	30
28	100	0.00480	22
20	100	0.00282	17
14	95	0.00150	13
10	92		
6.3	89		
5	87		
3.35	84		
2	80		
1.18	77		
0.6	74	Particle density	(assumed)
0.425	72	2.65	Mg/m3
0.3	69		
0.212	65		
0.15	60		
0.063	56		

Dry Mass of sample, g	521

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	20.4
Sand	23.4
Silt	41.4
Clay	14.8

Grading Analysis		
D100	mm	
D60	mm	0.142
D30	mm	0.0094
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

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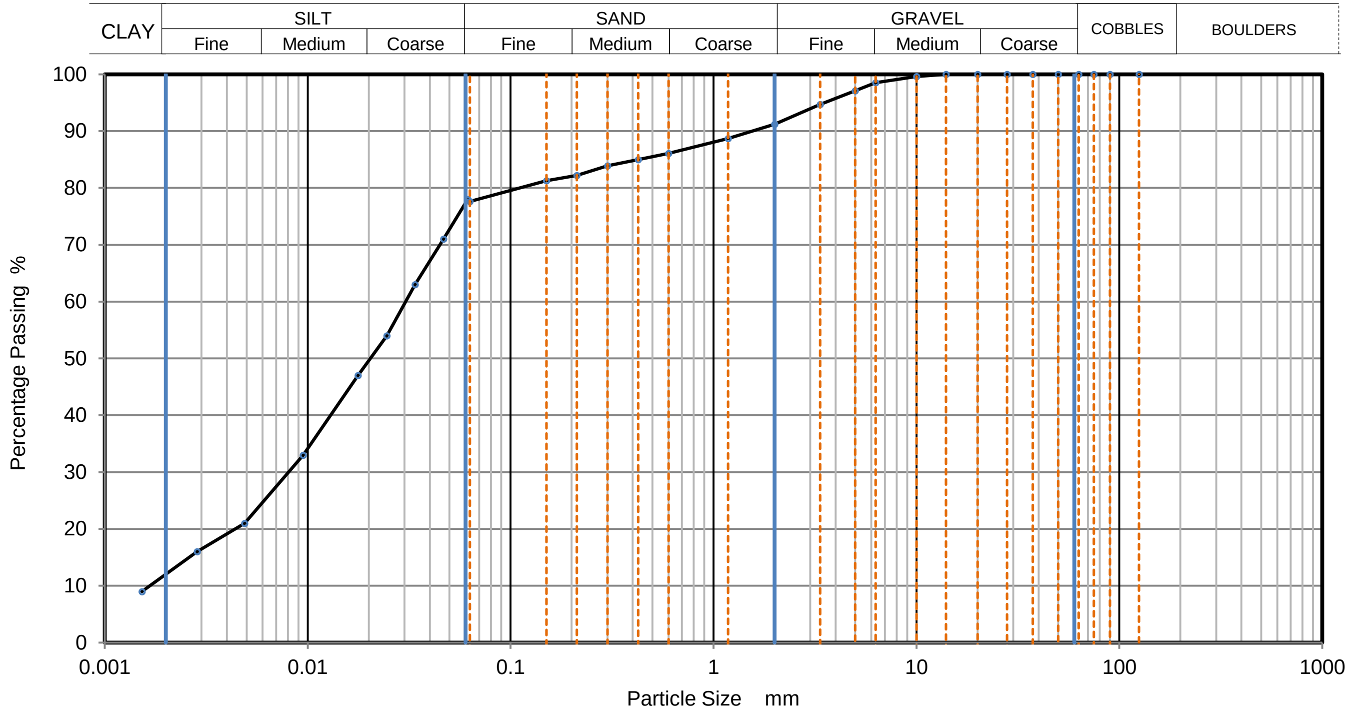
UKAS TESTING
10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**23-1591**
				Borehole/Pit No.	TP-T3-01
Site Name	Seskin Wind Farm			Sample No.	1
Specimen Description	Greyish brown sandy slightly gravelly silty CLAY.			Sample Depth (m) Top	0.50
				Base	
Specimen Reference	6	Specimen Depth	0.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2023110960



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06148	78
90	100	0.04676	71
75	100	0.03379	63
63	100	0.02456	54
50	100	0.01771	47
37.5	100	0.00949	33
28	100	0.00489	21
20	100	0.00285	16
14	100	0.00153	9
10	100		
6.3	99		
5	97		
3.35	95		
2	91		
1.18	89		
0.6	86	Particle density	(assumed)
0.425	85	2.65	Mg/m3
0.3	84		
0.212	82		
0.15	81		
0.063	78		

Dry Mass of sample, g	371

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	8.8
Sand	13.7
Silt	65.0
Clay	12.5

Grading Analysis		
D100	mm	
D60	mm	0.03
D30	mm	0.00805
D10	mm	0.00161
Uniformity Coefficient		19
Curvature Coefficient		1.3

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

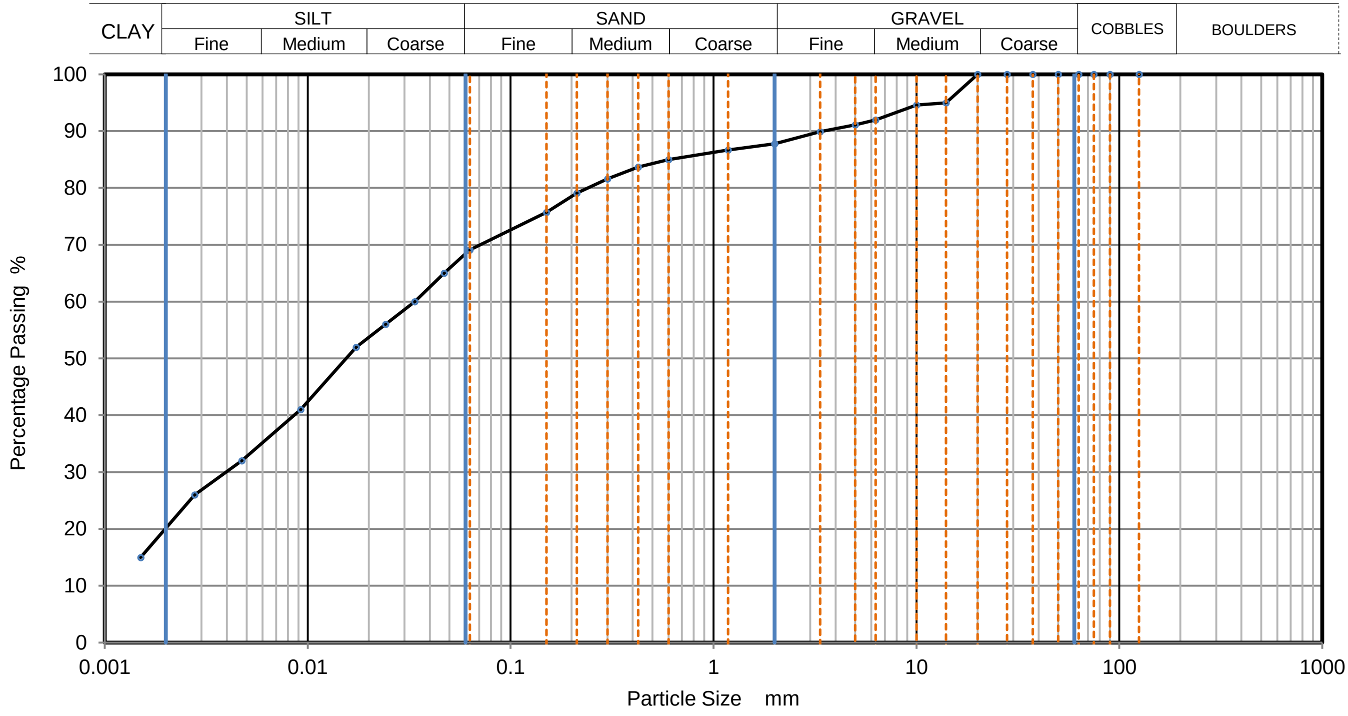
Approved
Stephen Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

			Job Ref	**23-1591**
			Borehole/Pit No.	TP-T6-01
Site Name	Seskin Wind Farm		Sample No.	2
Specimen Description	Greyish brown sandy slightly gravelly silty CLAY.		Sample Depth (m) Top	1.00
			Sample Depth (m) Base	
Specimen Reference	6	Specimen Depth 1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5		KeyLAB ID	Caus2023110963



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06236	69
90	100	0.04704	65
75	100	0.03373	60
63	100	0.02418	56
50	100	0.01733	52
37.5	100	0.00924	41
28	100	0.00473	32
20	100	0.00278	26
14	95	0.00150	15
10	95		
6.3	92		
5	91		
3.35	90		
2	88		
1.18	87		
0.6	85	Particle density	(assumed)
0.425	84	2.65	Mg/m3
0.3	82		
0.212	79		
0.15	76		
0.063	69		

Dry Mass of sample, g	510

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	12.2
Sand	18.7
Silt	49.0
Clay	20.1

Grading Analysis		
D100	mm	
D60	mm	0.0326
D30	mm	0.00389
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

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UKAS TESTING 10122

DETS

Certificate of Analysis

Certificate Number	23-27229	*Issued:*	23-Nov-23

Client Causeway Geotech
8 Drumahiskey Road
Ballymoney
County Antrim
BT53 7QL

Our Reference	23-27229
Client Reference	23-1591
Order No	(not supplied)
Contract Title	SESKIN WIND FARM
Description	4 Soil samples.
Date Received	18-Nov-23
Date Started	20-Nov-23
Date Completed	23-Nov-23
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Bridgewood

Kirk Bridgewood
General Manager

ilac-MRA UKAS TESTING 2139

Summary of Chemical Analysis

Soil Samples

Our Ref 23-27229
Client Ref 23-1591
Contract Title SESKIN WIND FARM

			Lab No	2264549	2264550	2264551	2264552
			.Sample ID	TP-SS-01	TP-T1-01	TP-T3-01	TP-T6-01
			Depth	1.40	2.00	1.50	0.50
			Other ID	2	3	2	1
			Sample Type	B	B	B	B
			Sampling Date	16/11/2023	16/11/2023	16/11/2023	16/11/2023
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Inorganics							
pH	DETSC 2008#		pH	5.9	6.9	5.7	5.9
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	< 10	< 10	17	14

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 23-27229
Client Ref 23-1591
Contract SESKIN WIND FARM

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2264549	TP-SS-01 1.40 SOIL	16/11/23	PT 500ml		
2264550	TP-T1-01 2.00 SOIL	16/11/23	PT 500ml		
2264551	TP-T3-01 1.50 SOIL	16/11/23	PT 500ml		
2264552	TP-T6-01 0.50 SOIL	16/11/23	PT 500ml		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

CAUSEWAY
GEOTECH

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ROI: +353 (0)1 526 7465

Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS LABORATORY TEST REPORT

20 December 2023

Project Name:	Seskin Wind Farm
Project No.:	23-1591
Client:	MKO
Engineer:	AFRY

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s). This testing was performed between 06/12/2023 and 20/12/2023.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Seskin Wind Farm

Report Reference: Schedule 2

The table below details the tests carried out, the specifications used, and the number of tests included in this report. The results contained in this report relate to the sample(s) as received.

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	4
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	4
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	4
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	4

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Derwentside Environmental Testing Services Limited *(UKAS 2139)*	BRE Test - Suite A		4

Summary of Classification Test Results

Project No.	Project Name
23-1591	Seskin Wind Farm

Hole No.	Sample				Specimen Description	Density		w	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		bulk	dry							
						Mg/m3		%	%	%	%	%	Mg/m3	
TP-T2-01	3	1.50		B	Greyish brown sandy slightly gravelly silty CLAY.			19	88	37 -1pt	21	16		CI
TP-T4-01	1	1.00		B	Brownish grey sandy slightly gravelly silty CLAY.			22	92	36 -1pt	25	11		MI/CI
TP-T7-01	1	0.70		B	Brownish grey sandy slightly gravelly silty CLAY.			29	93	42 -1pt	23	19		CI
TP-T7-01	4	1.20		D	Brownish grey sandy slightly gravelly silty CLAY.			13	73	25 -1pt	15	10		CL

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 6

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed

20/12/2023

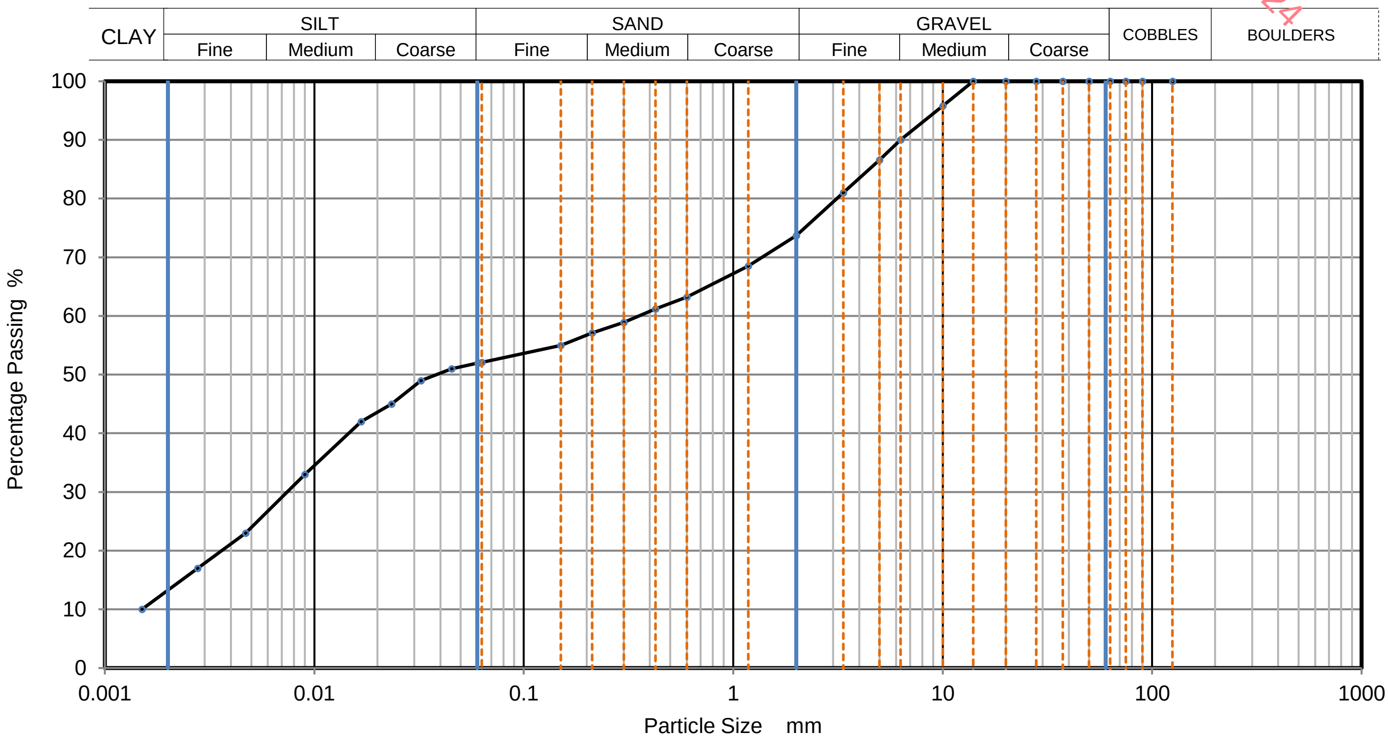
Approved By

Stephen Watson

10122

PARTICLE SIZE DISTRIBUTION

Job Ref						**23-1591**
Borehole/Pit No.						TP-T2-01
Site Name	Seskin Wind Farm			Sample No.		3
Specimen Description	Greyish brown sandy slightly gravelly silty CLAY.			Sample Depth (m)	Top	1.50
					Base	
Specimen Reference	6	Specimen Depth	1.5 m	Sample Type		B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID		Caus2023120612



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06050	52
90	100	0.04534	51
75	100	0.03230	49
63	100	0.02335	45
50	100	0.01675	42
37.5	100	0.00901	33
28	100	0.00470	23
20	100	0.00278	17
14	100	0.00150	10
10	96		
6.3	90		
5	87		
3.35	81		
2	74		
1.18	69		
0.6	63	Particle density	(assumed)
0.425	61	2.65	Mg/m3
0.3	59		
0.212	57		
0.15	55		
0.063	52		

Dry Mass of sample, g: 418

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	26.3
Sand	21.6
Silt	38.6
Clay	13.5

Grading Analysis	
D100 mm	
D60 mm	0.354
D30 mm	0.00729
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

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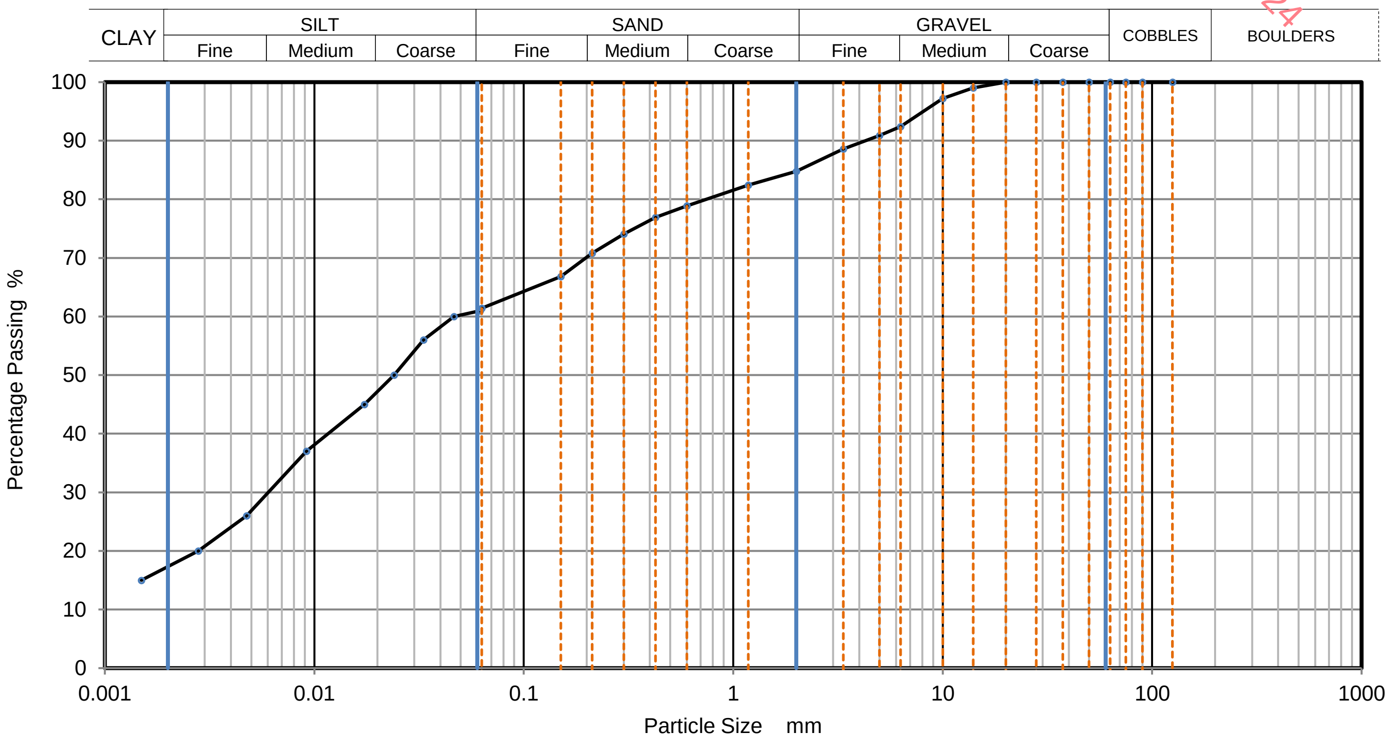
UKAS TESTING 10122

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1591**
				Borehole/Pit No.	TP-T4-01
Site Name	Seskin Wind Farm			Sample No.	1
Specimen Description	Brownish grey sandy slightly gravelly silty CLAY.			Sample Depth (m) Top	1.00
				Sample Depth (m) Base	
Specimen Reference	6	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2023120613



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06190	61
90	100	0.04637	60
75	100	0.03326	56
63	100	0.02402	50
50	100	0.01733	45
37.5	100	0.00918	37
28	100	0.00476	26
20	100	0.00279	20
14	99	0.00149	15
10	97		
6.3	92		
5	91		
3.35	89		
2	85		
1.18	82		
0.6	79	Particle density	(assumed)
0.425	77	2.65	Mg/m3
0.3	74		
0.212	71		
0.15	67		
0.063	61		

Dry Mass of sample, g	413

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	15.2
Sand	23.5
Silt	43.8
Clay	17.5

Grading Analysis	
D100 mm	
D60 mm	0.0498
D30 mm	0.006
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

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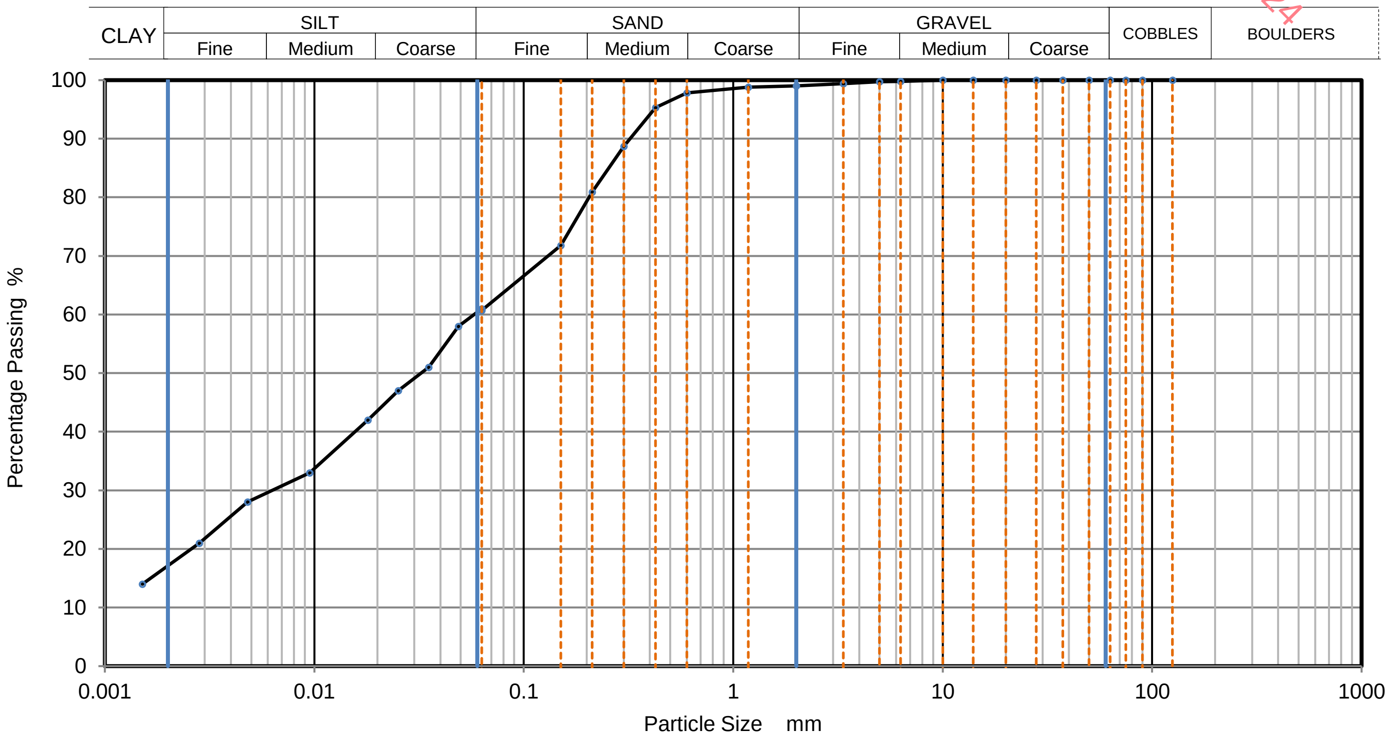
UKAS TESTING 10122

PARTICLE SIZE DISTRIBUTION

		Job Ref	**23-1591**
		Borehole/Pit No.	TP-T5-01
Site Name	Seskin Wind Farm	Sample No.	1
Specimen Description	Brownish grey sandy slightly gravelly silty CLAY.	Sample Depth (m) Top	0.70
		Base	
Specimen Reference	2 Specimen Depth 0.7 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2023120615



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	61
90	100	0.04869	58
75	100	0.03510	51
63	100	0.02514	47
50	100	0.01800	42
37.5	100	0.00952	33
28	100	0.00481	28
20	100	0.00283	21
14	100	0.00151	14
10	100		
6.3	100		
5	100		
3.35	99		
2	99		
1.18	99		
0.6	98	Particle density	(assumed)
0.425	95	2.65	Mg/m3
0.3	89		
0.212	81		
0.15	72		
0.063	61		

Dry Mass of sample, g	401

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	1.0
Sand	38.4
Silt	43.5
Clay	17.1

Grading Analysis	
D100 mm	
D60 mm	0.0585
D30 mm	0.00615
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

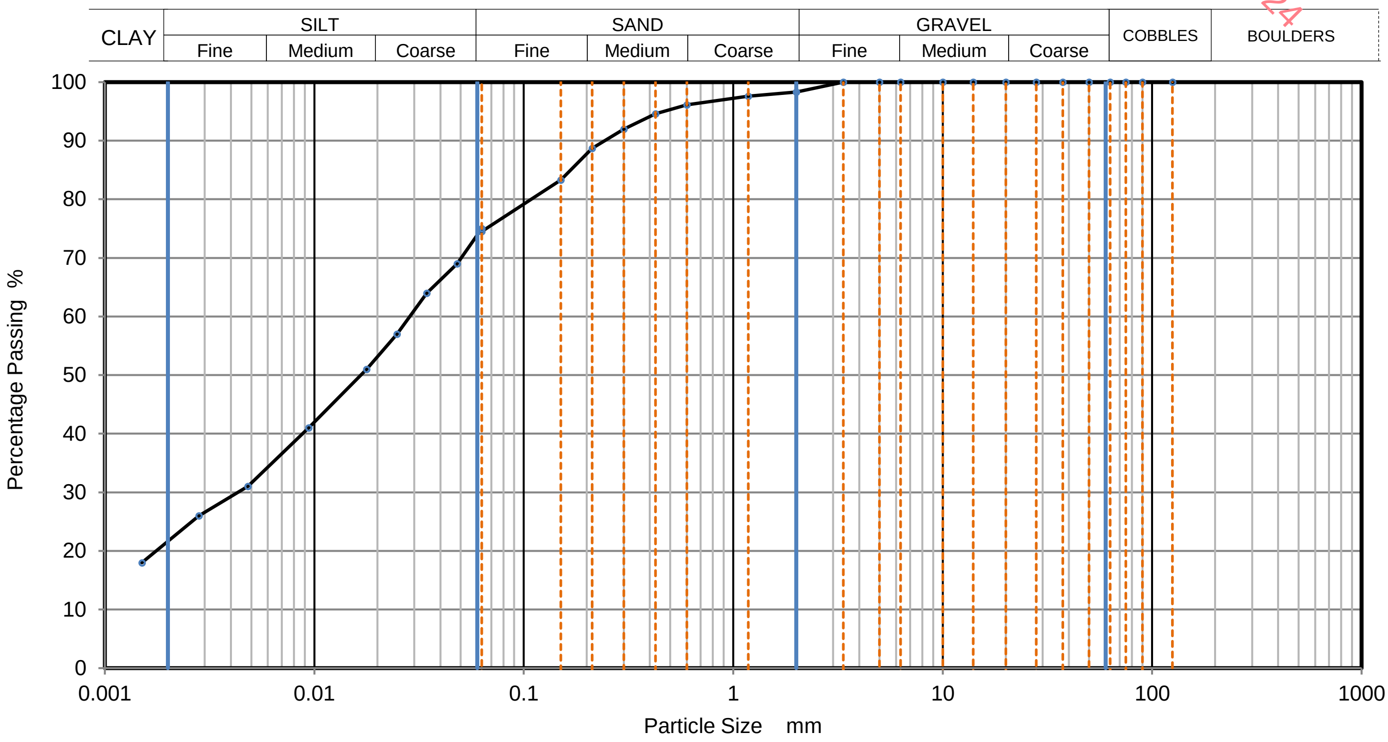
Approved
Stephen Watson

LAB 05R - Version 6

UKAS TESTING 10122

PARTICLE SIZE DISTRIBUTION

				Job Ref	**23-1591**
				Borehole/Pit No.	TP-T7-01
Site Name	Seskin Wind Farm			Sample No.	1
Specimen Description	Brownish grey sandy slightly gravelly silty CLAY.			Sample Depth (m) Top	0.70
				Base	
Specimen Reference	6	Specimen Depth	0.7 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2023120617



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	75
90	100	0.04803	69
75	100	0.03443	64
63	100	0.02482	57
50	100	0.01778	51
37.5	100	0.00940	41
28	100	0.00481	31
20	100	0.00281	26
14	100	0.00150	18
10	100		
6.3	100		
5	100		
3.35	100		
2	98		
1.18	98		
0.6	96	Particle density	(assumed)
0.425	95	2.65	Mg/m3
0.3	92		
0.212	89		
0.15	83		
0.063	75		

Dry Mass of sample, g	402

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	1.7
Sand	23.8
Silt	53.0
Clay	21.5

Grading Analysis		
D100	mm	
D60	mm	0.0288
D30	mm	0.00441
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen Watson

LAB 05R - Version 6

UKAS TESTING
10122

DETS

Certificate of Analysis

Certificate Number	23-29503	*Issued:*	19-Dec-23
Client	Causeway Geotech 8 Drumahiskey Road Ballymoney County Antrim BT53 7QL		
Our Reference	23-29503		
Client Reference	23-1591		
Order No	(not supplied)		
Contract Title	SESKIN WIND FARM		
Description	4 Soil samples.		
Date Received	14-Dec-23		
Date Started	14-Dec-23		
Date Completed	19-Dec-23		
Test Procedures	Identified by prefix DETSn (details on request).		
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.		

Approved By

Kirk Bridgewood
General Manager

UKAS TESTING 2139

Summary of Chemical Analysis
Soil Samples

Our Ref 23-29503
Client Ref 23-1591
Contract Title SESKIN WIND FARM

			Lab No	2277167	2277168	2277169	2277170
			.Sample ID	TP-T2-01	TP-T4-01	TP-T5-01	TP-T7-01
			Depth	0.40	1.00	1.50	0.70
			Other ID	1	2	4	2
			Sample Type	B	D	D	D
			Sampling Date	08/12/2023	08/12/2023	08/12/2023	08/12/2023
			Sampling Time	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**				
Inorganics							
pH	DETSC 2008#		pH	7.2	6.6	6.7	5.8
Sulphate Aqueous Extract as SO4 (2:1)	DETSC 2076#	10	mg/l	24	14	< 10	11

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 23-29503
Client Ref 23-1591
Contract SESKIN WIND FARM

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
2277167	TP-T2-01 0.40 SOIL	08/12/23	PT 500ml		
2277168	TP-T4-01 1.00 SOIL	08/12/23	PT 500ml		
2277169	TP-T5-01 1.50 SOIL	08/12/23	PT 1L		
2277170	TP-T7-01 0.70 SOIL	08/12/23	PT 500ml		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report