Garrane Green Energy Project, Charleville, Co. Limerick

Desktop Study and Walkover Survey for Preliminary Determination of Ground Conditions

Report No: 2177-22A

17th June 2025

This document has been prepared by Whiteford Geoservices Ltd on behalf of

Garrane Green Energy Ltd

and

Jennings O'Donovan Ltd

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Desktop Study and Walkover Survey – Garrane Green Energy Project, near Charleville, County Limerick, Ireland

Client: **Garrane Green Energy Ltd**
Jennings O'Donovan Ltd

Date: **14th October 2022**

Report No. 2177-22A

Statement of Authority

John Whiteford BSc (Hons) Geophys AMIOSH MEAGE FGS has more than 20 years of experience in the field of earth sciences, geotechnical engineering and management. His academic qualifications are a BSc with Honours in Geophysics from Edinburgh University, with memberships of The European Association of Geoscientists and Engineers and The Institute of Safety and Health.

Commencing work with Kirk McClure Morton (Consulting Engineers) in Belfast, he has been engaged in full-time consultancy for the past 20 years and since 1996 trading as Whiteford Geoservices Ltd. The company and its staff of professional and technical personnel and has completed in excess 2000 contracts for clients within the construction and mineral exploration sectors where they have built up a recognised level of specialist experience, particularly in the field of Wind Energy. Working at home, in Europe and worldwide the company has been involved in more than 100 wind power projects where our services have been sought in relation to foundation design, peat slide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

The following report contains an analysis of the soils and geology present at the target site and also assesses the risk presented by organic soils.

Assessment of the former draws from, 'Design Manual for Roads and Bridges ("DMRB") Volume 11, Section 3 (Environmental Assessment), Part 11: Geology and Soils, but also references, the current best practice guidance presented in the English Nature publication 'Geological conservation – a guide to good practice'.

Assessment of the latter employs guidance contained within the Scottish Executive's "*Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*", published as a Second Edition April 2017 (referred to as "the Scottish Guidance").

This Best Practice Guide was updated, in part, in April 2017, and for the purpose of clarity the protocols adopted to determine Peat Slide Hazard Ranking are consistent with the version of the report, as published in 2017. Unless otherwise stated, all assessments and conclusions contained within this report are made with reference to either the 2006 or 2017 publication. Where variations from the guidance occur the reason for this is provided, either within the text or as a footnote.

This report details the works undertaken by Whiteford Geoservices Ltd at the site of the proposed Garrane Green Energy Project near Charleville, Co. Limerick

Dated: 14th October 2022

1.0 INTRODUCTION

1.1 Background and Purpose of Desk Study and Walkover Survey

This report relates to the first stage of an assessment into the stability of Peat soils at Garrane Green Energy Project near Charleville, Co. Limerick.

In July 2022 Whiteford Geoservices Ltd was commissioned by Jennings O'Donovan Ltd to undertake an assessment of the Soils and Geology at Garrane Green Energy Project.

Reporting for the purposes of this Soils and Geology Assessment has been split into three (3) distinct elements, as follows:

1. Desktop Study and Walkover Survey Report 2177-22A. This report details the findings of desktop analysis and site scoping of the general area within which the proposed wind farm is to be constructed. This report identifies the existing site conditions, potential sensitive receptors, potential preconditions that increase the risk of peat instability and pre-failure indicators present at the site. The report includes with a preliminary screening assessment of the Hazard of Peat Slide occurrence.
2. Preliminary Site Investigation Works Report 2177-22B. This report presents the findings of further field work undertaken after optimisation of the turbine layout plan, following on from the preliminary assessment of hazard. Further investigations to determine ground composition, gouge coring, shear strength analysis and slope analysis have undertaken within the proposed construction zone. The information contained in this report provides the further detail required for the final assessment of peat stability.
3. Soils and Geology Report 2177-22C. This report takes the preliminary findings from Item 1 above and reviews the information in light of both the development layout plan and the site investigation works carried out and reported as Item 2. In this particular case the "Peat Stability and Hazard Assessment" element of this report. normally included in Report 2177-21C, is not required.

The purpose of this reporting is to determine the existing soils and geology environment directly attributable to the construction of new proposed turbines, tracks and infrastructure throughout the proposed lifetime of the scheme.

This portion of the soils and geology assessment consists of both a desktop review of available ground information and a walkover survey conducted at the proposed development site. Where organic or peat soils are present the report would also contain an assessment of peat stability (not applicable in this case).

The findings of the desktop study and walkover survey have been employed to obtain a baseline overview with respect to the soils and solid geology present within the boundary of the proposed development site.

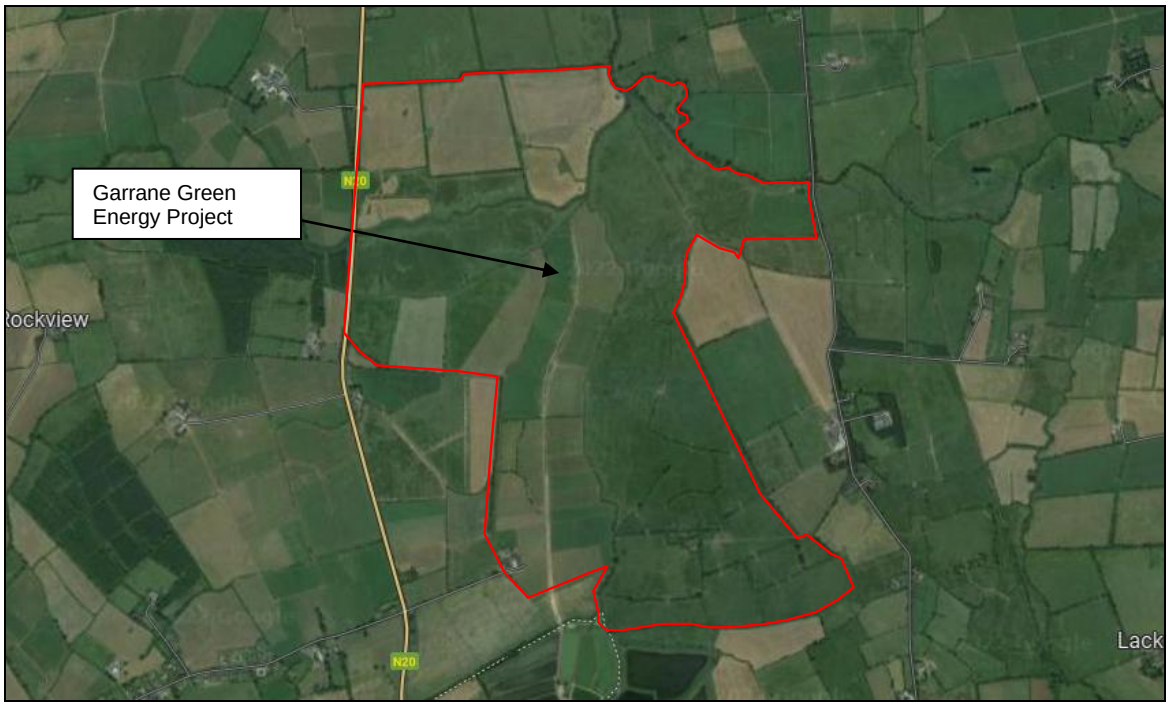


Figure 1 – General Site Location
(Reproduced courtesy of Google maps)

The purpose of this stage of the assessment is as follows:

- Undertake an initial study of the existing geology, topography, ground stability and hydrology surrounding the site.
- Identify the potential impacting factors upon the site, such as contamination, seismic activity etc.
- Identify all soils and geology related factors likely to impact upon either the construction and / or operation of the approved wind energy development.

Environmental legislation that is relevant to the hydrological aspects of this study is as follows:

- Quality of Water Intended for Human Consumption (80/778/EEC) and Quality of Water Intended for Human Consumption Directives (98/83/EC).

The Water Framework Directive (WFD) which was passed by the European Union (EU) in 2000 is a wide-reaching legislation that will eventually replace a number of the previous water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive.

1.2 Timescale

Desktop based research and the initial walkover surveys were carried out during September 2022 by Mr John Whiteford of Whiteford Geoservices Ltd.

Assisting in these preliminary works were Mr Jaime Stothers, who collected stage 1 soils and peat depth data along with other site-specific data.

2.0 EXISTING ENVIRONMENT

2.1 Topography

Analysis of coarse topographic information indicates that Garrane Green Energy Project occupies relatively flat lands, which slope generally in a northerly direction.

Ground surface level elevations vary between approximately 59m to 67m above Ordnance Datum (Malin Head).

2.2 Land Usage

2.2.1 Current

Land usage does not appear to vary significantly across the various land holdings which make up the Garrane Green Energy Project development; these being typified typically by pastureland for grazing sheep and cattle.

The closest active quarrying operations to the site, are at Ballinruane and Killmeedy Quarrys, which are approximately 15km to the west.

Surface water flowing from Garrane Green Energy Project can ultimately be expected to drain towards the east and north east.

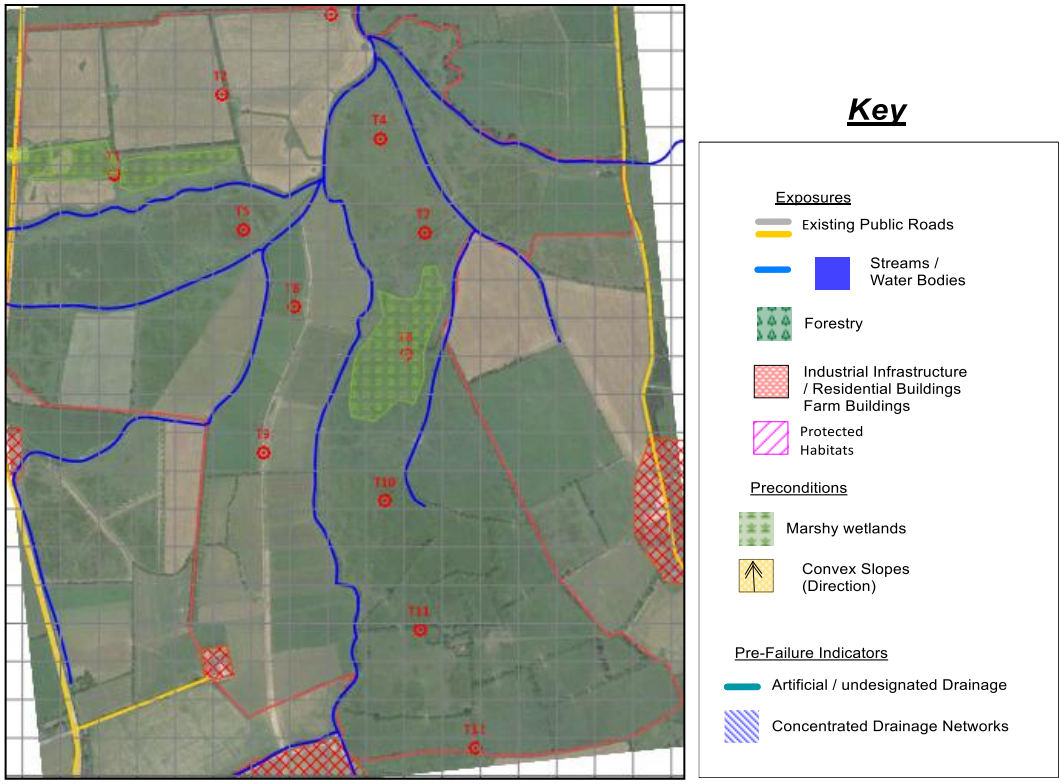


Figure 1A – General Site Location Annotated with Local Features
Reproduced courtesy of www.maps.google.co.uk

There are no residential dwellings located within the site boundary, with the closest inhabited buildings being approximately 350m east of the wind farm boundary. However, there are some buildings associated with an agricultural land use present within the site boundary

2.2.2 Historic

A review of historical mapping, courtesy of OSI, suggests that the site of Garrane Green Energy Project has not changed in land use from that recorded on the 6" Second Edition Mapping, dated 1842.

2.3 Services & Utilities

Overhead services were not identified within or immediately adjacent to the site boundary.

Underground services are present within the site boundary; those being both telecom and an outflow pipe associated with the adjacent Kerry Group facility. Minor water services are also present and feed cow troughs within the site boundary.

Services are also anticipated to be present surrounding farm infrastructure and along the N20 and within other minor road verges, which are adjacent to the site boundary and site entrance.

2.4 Geology

2.4.1 Soils and Sub-soils

A study was made of available geological information for the area (GSI Online Database). This study indicated that the following natural geology is present across the site of Garrane Green Energy Project;

- Lacustrine deposits
- Boulder Clay (Glacial Till derived from Sandstone and Limestone)
- River Deposits

2.4.2 Solid Geology

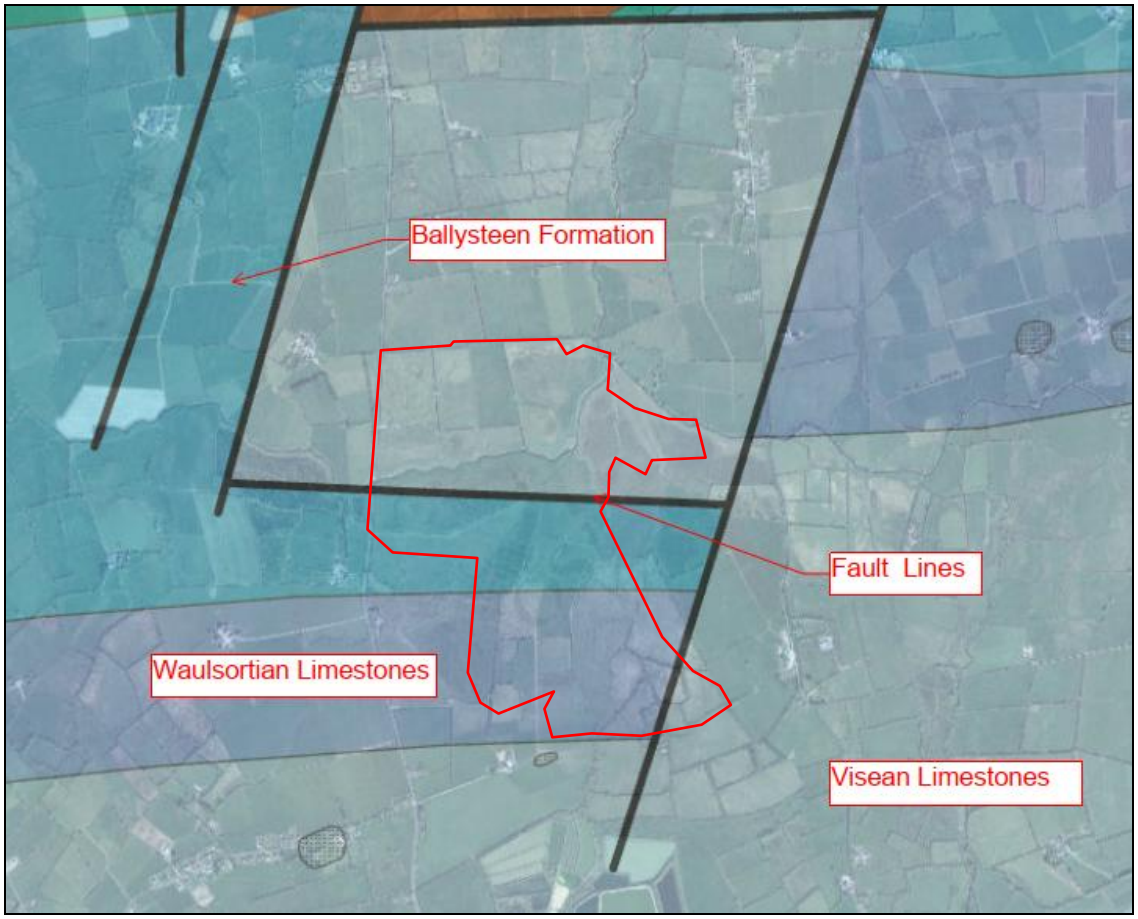


Figure 2A – Bedrock Solid Geology
Reproduced courtesy of GSI Datasets Public Viewer

According to the GSI online database, Garrane Green Energy Project is underlain by a succession of Limestone formations. Those being; Visean Limestones, the Ballysteen Formation and Waulsortian Limestones.

Visean Limestones are typically undifferentiated limestones
The Ballysteen Formation is typically a dark muddy limestone and shale
Waulsortian Limestones are again undifferentiated limestones

2.4.3 Superficial Geology

Figure 2B – Superficial Geology
Reproduced courtesy of GSI Datasets Public Viewer

Superficial soils present within the wind farm boundary largely consist of lacustrine (granular) and river deposits (alluvium) with the northern and southern extents underlain by Glacial Till

To the south west a small area of gravel deposits is also shown to be present.

2.5 Regional Hydrogeology

2.5.1 Aquifer Classification

A review of site hydrogeology was undertaken with respect to the Geological Survey of Ireland (GSI) Database's Aquifer Bedrock Potential, Superficial Aquifers and Groundwater Vulnerability Mapping.

Surface water is anticipated to enter the subsurface where the surface is permeable and can be expected to continue vertically downwards until it comes in contact with either an impermeable stratum or the water table. At this point the surface water will migrate in the same direction as the groundwater or according to the gradient of the impermeable stratum.

GSI database mapping indicates that the site is underlain largely by locally Important bedrock aquifers which are moderately productive. Some of these bedrock aquifers are also highly karstified.

Potential superficial aquifers have not been identified within the site boundary.

2.5.2 Groundwater Vulnerability

The groundwater vulnerability within the site boundary of the development is predominantly low where bedrock is covered by thick weakly permeable alluvium or tills. However, close to the southern and northern boundaries the groundwater vulnerability becomes moderate to extreme which suggests that rock my be close to the surface or that karst features are present which offer a potential groundwater pathway.

2.5.3 Well Database

The GSI database records 1nr water well within the site boundary along with a large number of groundwater abstraction wells 2km distant from the northern and southern site boundaries.

Both the water well within the site boundary and immediately south of the wind farm have been drilled within the Visean Limestones aquifer.

The potential for adverse impact to these abstraction wells, caused by the wind farm construction, is considered low.

A number of "springs" and "rises" are also indicated on mapping external to the site boundary and tends to indicate that groundwater is readily accessible in the locality.

2.6 Local Hydrology

2.6.1 Site Drainage

Across the proposed development site, a number of drainage channels are evident. Most are generally less than 1m in width and depth and situated adjacent to field boundaries, access tracks or to effect removal of significant volumes of groundwater from fields.

A low impact on the current "natural hydrology", as a result of the development, is anticipated following application of mitigation.

Please refer to the site walkover and reconnaissance section (Section 3.0) and Appendix A, for details of site drainage features identified within the site boundary.

2.6.2 Local Watercourses

For the purpose of defining watercourses as sensitive receptors these are deemed to fulfil the following criteria: -

1. Consistently contain flowing water / not ephemeral.
2. Be a natural watercourse with either a designated name or be a smaller tributary of a designated watercourse. i.e. Not man made in origin.

The development site for Garrane Green Energy Project straddles the Charleville stream which flows northwards to join the Maigue River to the north of the site, close to where the Loobagh River also joins the Maigue River. Both the Maigue and Loobagh rivers form the northern boundary of the wind farm site.

2.6.3 Palaeo-Karst Features

Karst topography is defined as "An assemblage of topographic forms resulting from dissolution of the bedrock and consisting primarily of closely spaced sinkholes." Karst topography can form in regions of exceptionally soluble rocks, including Limestone.

Soluble rocks generally mean the presence of limestone, chalk or evaporite deposits such as gypsum that contain carbonates which are particular susceptible to dissolution under the action of rainfall.

The presence of such features has, in some cases, resulted in structural instability. The walkover survey did confirm that landforms / features consistent with a "karst" landscape are present at Garrane Green Energy Project.

In order to provide confirmatory evidence in relation to karst, further sampling and assessment of the solid geology is recommended to be undertaken during the Site Investigation phase of the Soils and Geology study.

GSI records do not record the presence of "karst" features within the site boundary and no landforms consistent with "karst" topography were identified during the walk over survey. However, GSI do record "karst" features on lands adjacent to the site and it is the author's opinion that the surface of the rock formation underlying Garrane Green Energy Project is likely to exhibit "karst" landscape characteristics.

In summary, the potential for "karstified rock" to affect the stability of installed structures and infrastructure is considered to be moderate. Specific, supplementary ground investigation is proposed prior to construction.

2.7 Mining or Active Quarry Operations

Review of the GSI Online Database data indicates that there are no quarries within 4km of the site. The closest quarries / pits are as follows:

1. Shane Foley Plant Hire Ltd (Quarry products, sand and gravel, contract crushing) 7km to the south.

2. Ballyhea Ready mix (Concrete, gravel) 7.1km to the south.

3. Costello Quarry (Basalt aggregate) 9km to the north west.

4. Ballyorgan Quarry (Limestone aggregate) 14km to the east.

5. Kilmeedy Sandstone Building Stone Quarry (Building stones, crushed stones and decorative stones) 16.5km to the north west.

No records of shafts or adits associated with mineral exploration were observed within 10km of the site.

2.8 Peat Disturbance and Soil Removal

At the site of Garrane Green Energy Project no areas of peat nor past peat cutting where recorded during the walk over survey.

2.8.1 Historic Landslides and Landslide Susceptibility

Records indicate no significant historic soils and rock movement within the site boundary or within 7.5km of the site. GSI landslide susceptibility mapping also indicates that the site has a low to moderately low landslide susceptibility.

The Geological Survey of Ireland (GSI) records show the closest landslide events are approximately 7.50km, north west, 32km to the south west, 34km to the north east of the site and 36km to the east of the site.

Please refer to Appendix 1 for further details.

2.9 Potential Contamination

2.9.1 Land Contamination

The site has not been subject to the action of industrial activities that would have the potential to contaminate the soils at the site.

There is potential for moderate negative impact on natural soils as a result of exposure to unknown historic contamination at the site, which should be investigated by a land contamination specialist prior to the construction phase.

2.9.2 Contaminated Watercourses

There is no visual or olfactory evidence to suggest that any potential contaminants have significantly affected existing watercourses at the Garrane Green Energy Project site.

An assessment of baseline surface and groundwater should be included within the contaminated land investigations.

2.10 Analysis of Existing SI Information

A search for existing site investigation information within the immediate vicinity of the proposed new development did not yield any previous relevant reporting:

3.0 SUMMARY OF DESK STUDY

The following section summarises the findings of the desktop study carried out to determine local conditions at the site of Garrane Green Energy Project.

- The lands are classed as agricultural with no recorded significant industrial heritage associated with the site. Apart from the construction of small sections of metalled tracks, the proposed development of the wind farm will take place on natural soils and rock formations. For the purpose of construction these lands would be mainly classified as "greenfield".
- Geological studies indicate that the uppermost rock formation applicable to the majority of the site is limestone pertaining to the Ballysteen Formation, which is in turn mantled by superficial soils consisting of river deposits, lacustrine deposits and glacial till.
- Limestone rock pertaining to the Visean and Waulsortian Limestones and the Ballysteen Formation not appear to be exposed within the site. Where limestone formations are present typical "karst" features, such as sinkholes and subterranean chambers can potentially be present. Such features are associated with ground instability and are a recognised geo-hazard when encountered close to the surface.
- The apparent absence of peat and presence of low slope gradients suggests that a peat stability assessment may not be required. Preliminary / scoping assessment of peat stability hazard carried out at Walkover Phase has confirmed this to be the case. No further detailed peat assessment is required.
- Records indicate that the closest active quarrying operations are as listed in Section 2.7
- Although, hard rock aggregate quarries often have a requirement for rock blasting, resulting in the transmission of sonic and vibrational energy, any such negative impacts at 7km are anticipated to be negligible.
- Minor tributaries of the Maigue River, are present within the site boundary (refer to appendix for relevant mapping) and care should be taken to ensure that any possible environmental impact caused by the construction process is minimised by implementing effective mitigation controls. Further fieldwork may be required to assess these features on site. Other sensitive receptors in the immediate and wider vicinity, such as SAC sites, bridge structures, etc. have been considered.
- Direct impact by peat debris flow on other more significant receptors, by either construction works or operations has been ruled out. The risk of soil debris flow, given the shallow ground slopes is very low. In the event of a debris flow reaching

a watercourse, there is potential for the wider environment to be impacted. The mechanisms for this impact would be by:

- siltation pollution of watercourses and those into which they flow.
- deterioration in river water quality and that of waterways into which they flow.
- impact to water borne flora and fauna.
- damage to highways and third-party structures.
- damage to overhead and underground services.
- damage to bridge or culvert structure crossing the affected watercourse.

For these reasons, impact on designated watercourses is considered critical and directly related to the potential for impact of other sensitive receptors downstream. Once a debris flow reaches a water body its impact can be transmitted far from its initial point of entry. Consideration of designated watercourses as sensitive receptors thus includes for the potential impacts detailed above. Refer to the Preliminary Risk Plot[1] for an initial screening assessment of the Hazard of Peat Instability with respect to all receptors.

- The majority of the site is of low groundwater vulnerability, however some areas of moderate to extreme groundwater vulnerability are recorded in GSI mapping. Care must therefore be taken when carrying out works in these areas to avoid any possible contamination entering the groundwater aquifer.

[1] Finalised following walk over survey fieldwork and testing

4.0 SITE WALKOVER SURVEY

4.1 Introduction

A reconnaissance / walk over survey was undertaken by Whiteford Geoservices Ltd at the proposed site of Garrane Green Energy Project following completion of the desk-based study. This had the general objective of identifying and assessing on-site features, which could affect both the construction and / or operation of the wind energy development.

This walkover survey (see section 4.0) has taken into account the findings of the initial desktop study and includes a preliminary investigation of the potential receptors, preconditions and failure mechanisms. Following the walkover survey further ground investigations have also been recommended (see follow on Report, 2177-22B); specified in order to aid further understanding of the subsurface in order to determine preliminary geotechnical parameters ahead of final design. The final report 2177-22C, will contain an amalgamated of the desktop study, walkover and site investigation phases.

4.2 Survey Date

The site walkover survey was carried out by Jaime Stothers of Whiteford Geoservices Ltd on 5th and 6th September 2022.

Weather conditions consisting of generally mild temperatures with periods of heavy rainfall conditions were experienced during the site walkover survey.

4.3 Survey Strategy

The site walkover survey was carried out in order to determine the following general on-site features, and act as a confirmatory method to the desk-based study:

- "Spot" checks on peat depth
- Nature of superficial deposits
- Existing bedrock geology (where exposed)
- Presence of significant landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note.
- Topography – significant slopes
- Location of potential receptors such as building, roads, etc.
- Location of any services / utilities
- Identification of any other forms of receptor or sensitive ground

In order to do this an assessment was made at a series of positions in the vicinity of the proposed turbine infrastructure, in order to gain a preliminary geotechnical understanding of

ground conditions that may affect the stability of lands at and surrounding the wind energy development.

5.0 PREVAILING SITE CONDITIONS

The following section details the soils and geology characteristics encountered across the proposed site of Garrane Green Energy Project during the walkover survey.

5.1 Superficial Deposits

The majority of the proposed development site is confirmed to consists of grazing land and semi improved grass land.

Desk study analysis indicates that the soils consist of superficial lake and river deposits with areas of glacial tills all mantled by organic topsoils. The walkover survey generally confirms this to be the case.

5.2 Solid Geology

During the site reconnaissance survey, it was not possible to determine the depth that bedrock will be encountered across the development site, nor the rock type, as exploratory hole data collected on site terminated without reaching the bedrock level.

No regions of outcropping rock were encountered within the proposed development site during the walkover survey. Only Peat soils or thin organic topsoils were identified.

The Author believes that the solid geology of the site is not dissimilar to what has been published by the GSI.

No further information with respect to the solid geology was added following the walkover.

5.3 Existing Slopes

A preliminary analysis of OSNI topographic data was undertaken to identify the variation in gradient applicable to the existing slopes within the vicinity of the proposed wind farm development.

Both Evans and Warburton (2007) and Boylan et al. (2008) found from their analysis of recorded failures in blanket bog, that these were often recorded for slopes of typically 4 – 8 degrees to the horizontal. However, it is not wise to suggest that the slope angle, as represented by the top of the bog, is of significance in the hierarchy of preconditioning when it comes to bog failure. In such cases the mechanism of failure is almost certainly, exclusively, by "bog burst" (i.e. peat, on average, greater than 2.5m thick) where the cause is a build-up of excessive hydrostatic pressure in the peat mass.

Often the peat failure mechanism is internal and not due to a detaching of the peat soils from the underlying mineral substrate or as a result of activation along on surface tear. A common mechanism for internal failure is increased hydrostatic pressure which occurs when significant rainfall falls on peat soils. This both increases the weight of the peat bog and can cause any minor weaknesses in the bog structure to be activated as the system attempts to reduce the internal pressure. Such internal failure is then likely to cause detachment to occur below the failure point, resulting in the peat mass moving under gravity along the water-lubricated basal plane; where the peat – mineral soil friction may never have been exceeded.

Of course, friction at the base of the peat is nonetheless important and thus it is important to consider the existing slope gradient as a potential trigger and precondition for a peat slide. This is especially the case where thinner peat thicknesses are present for which "bog burst" is much less likely to occur.

For this reason, a banded factor-based approach is advocated for the purpose of apportioning risk. The following bands are used for this purpose, based on our experience with accidently triggered peat slides at over 100 different wind farm sites.

Existing Slope Angle (*Measured at Surface of Peat, Angle to Horizontal)*	**Risk Factor Assigned *(Using Factor Based Probabilistic Analysis)***	**Remarks**
0 - ≤5	0	Negligible influence
5 - ≤ 10	1	Low
10 - ≤ 22.5	2	Medium
>22.5	3	High

This additional risk of internal failure relating to "bog burst", is allowed for by apportioning an additional risk factor to the peat soils in excess of 2.5m thick.

5.4 Observations

The following is an appraisal of ground conditions at the site of the approved Garrane Green Energy Project. Mapping is provided which indicates the point survey locations which have informed this assessment.

Point 1 - Turbine 1

Nature of Assessment	Observations
Position (ITM)	553640, 627475
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping rock
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage network within vicinity of the Turbine, Surface recorded as saturated.
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer
Utilities: Underground or overhead	None evident within 100m
Any other observations	Trial pit carried out within the vicinity of the turbine

Point 2 - Turbine 2

Nature of Assessment	Observations
Position (ITM)	553923, 627695
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer
Utilities: Underground or overhead	None evident within 100m
Any other observations	Trial pit carried out within the vicinity of the turbine

Point 3 - Turbine 3

Nature of Assessment	Observations
Position (ITM)	554215, 627881
Peat Depth	No Peat was encountered
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	None

Point 4 - Turbine 4

Nature of Assessment	Observations
Position (ITM)	554337, 627570
Peat Depth	No Peat was encountered
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	None

Point 5 - Turbine 5

Nature of Assessment	Observations
Position (ITM)	553979, 627330
Peat Depth	No Peat was encountered
Superficial Soils	sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	None

Point 6 - Turbine 6

Nature of Assessment	Observations
Position (ITM)	554110, 627128
Peat Depth	No Peat was encountered
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No Outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	Underground services within 50m of Turbine. Minor stream within 100m
Utilities: Underground or overhead	Main sewer within 50m of Turbine
Any other observations	None

Point 7 - Turbine 7

Nature of Assessment	Observations
Position (ITM)	554453, 627324
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	Trial pit carried out within the vicinity of the turbine

Point 8 - Turbine 8

Nature of Assessment	Observations
Position (ITM)	554406, 627002
Peat Depth	No Peat was encountered
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	None

Point 9 - Turbine 9

Nature of Assessment	Observations
Position (ITM)	554031, 626747
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None
Topography	<5 degrees to horizontal
Sensitive Receptors	Underground services within 50m of Turbine
Utilities: Underground or overhead	Main sewer < 50m to the east of Turbine. Underground telecom service < 50m from Turbine.
Any other observations	Trial pit carried out within the vicinity of the turbine

Point 10 - Turbine 10

Nature of Assessment	Observations
Position (ITM)	554351, 626620
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage network present in the vicinity of the turbine. Surface recorded as saturated.
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer. Minor stream within 100m
Utilities: Underground or overhead	None evident within 100m
Any other observations	Trial pit carried out within the vicinity of the turbine

Point 11- Turbine 11

Nature of Assessment	Observations
Position (ITM)	554441, 626283
Peat Depth	No Peat was encountered
Superficial Soils	Assumed slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Surface was saturated within the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer
Utilities: Underground or overhead	None evident within 100m
Any other observations	None

Point 12- Turbine 12

Nature of Assessment	Observations
Position (ITM)	554587, 625973
Peat Depth	No Peat was encountered
Superficial Soils	Slightly sandy, slightly gravelly SILT / CLAY
Solid Geology	No outcropping
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Drainage ditches in the vicinity of the turbine
Topography	<5 degrees to horizontal
Sensitive Receptors	None evident within relevant buffer
Utilities: Underground or overhead	None evident within 100m
Any other observations	Trial pit carried out within the vicinity of the turbine

5.5 Existing Mining Activities

The walkover survey confirms that there are no current quarrying operations evident within the site boundary

5.6 Existing Services / Utilities

No further evidence of existing services / utilities was recorded during the walkover survey. However, given the area the site covers, underground services should be expected in the vicinity of local and regional roads

Redundant utilities are potentially present at any location within the site.

5.7 Potential Sensitive Receptors

Analysis of desk study resources and follow up walkover survey have identified the following receptors with the potential to be susceptible to peat instability generated by activity related to the proposed wind farm construction and / or operation.

Receptor	**Minimum distance to Development Boundary**	**Exposure Factor Assigned** ***(Using Factor Based Probabilistic Analysis)***	**Remarks**
Peatlands / Bog	None evident	1	
Agricultural Lands	0m (within site)	1	
Minor Utilities	0m (within site	2	Water / Telecom within site boundary and assumed in the vicinity of roads traversing the site
Designated Minor Watercourses / Water Bodies	0m (within site)	2	Tributaries of the Maigue River
Designated Major Watercourses / Water Bodies	c. 0 (within site)	3	Maigue River
Undesignated Watercourses / Drainage	0m (within site)	1	e.g. ditches and man-made watercourses, ephemeral run-off channels
Minor Public Roads	c. 500m	3	Minor road present east site boundary
Moderately to highly trafficked Public Road	c. 600m	4	N20 west of site
Dwellings	c. 500m	4	
Commercial Property	0m (within site)	3	Cow shed withing site boundary
Significant Utilities (Overhead) / Underground	>200m	3	
Population centre / Urban area	c.1km	5	Charleville – population 3919 (2016)[2]

[2] Source: Wikipedia: https://en.wikipedia.org/wiki/Charleville,_County_Cork

5.8 Potential Preconditions Identified within the immediate vicinity of the proposed development

Analysis of desk study resources and follow up walkover survey have identified the following static or inherited factors that could potentially act as preconditions to slope instability, especially in organic soils and bogland habitats.

Precondition	Minimum distance to Development (m)	Remarks
Concentrated drainage network / presence of standing water / area of flush / springs, or rises	Identified within wind farm	
Significant slopes	Not at assessed infrastructure	
Significant peat thickness	No Peat encountered	Soils assessed to be organic topsoils only
Very highly decomposed Peat	N/A	
Very weak Peat and underlying mineral soils	No very weak underlying mineral soils encountered.	
Potential sonic vibration or ground accelerations	No piling works anticipated during construction that might adversely affect peat stability. Potential for blasting at a Quarry is considered low.	Vibrationally induced energy, e.g. from quarry blasting >10km away is deemed negligible at the site.

5.9 Pre-Failure Indicators within the immediate vicinity of the proposed development

Pre-failure indicators are physical landforms that are "tell-tale" signs of stress within the soils and peatland environment.

The following pre-failure indicators have been considered for the proposed development at Garrane Green Energy Project: -

- Historical evidence of previous movement / Peat cutting
- Tension or compression features
- Soil creep
- Cracking / desiccation

- Other[3]

The following pre-failure indicators are present within the immediate vicinity of the proposed development.

Pre-Failure Indicator	**Minimum distance to Development (m)**	**Remarks**
Historic peat cutting	0m (within site)	None evident
Evidence of historical peat / soil movement	Not at assessed infrastructure	
Evidence of tension cracking or compression features	Not at assessed infrastructure	
Evidence of soil creep	Not at assessed infrastructure	
Cracking / desiccation	Not at assessed infrastructure	

5.10 Summary of Prevailing Site Conditions

Analysis of Desk Study and Walkover Survey data allows the following preliminary geotechnical appraisal for the Garrane Green Energy Project site: -

1. Superficial soils consisting of alluvium, tills and granular lake deposits mantle the site
2. Rock does not outcrop at the surface and the author believes that surface of the underlying rock formation is probably >3m below the existing ground surface.
3. The underlying rock formations are limestone and potentially exhibit karst landscape features such as sinkholes, cavities or subterranean drainage networks. "Karst" landscape features have the ability to affect the stability of turbine infrastructure. No such features, expressed at the surface, have been observed during the walkover surface. However, it is possible that the buried rock surface could be highly variable in both its depth of burial and competence. The hazard that this represents to construction of wind turbine foundations is considered to be Medium.
4. Further supplementary SI is recommended prior to construction to assess the nature of the rock formation present at each turbine base.
5. Given the shallow ground slopes and proximity to a number of watercourses and open water bodies the potential for a high water table and flooding is of Medium Hazard to the proposed development. The presence of a high water table will have an effect of the

[3] The Scottish Guidance notes other potential pre failure indicators such as artificial drainage, concentrated drainage networks, seeps, springs, soft clays and iron pans. The author considers these to be preconditions and not pre failure indicators.

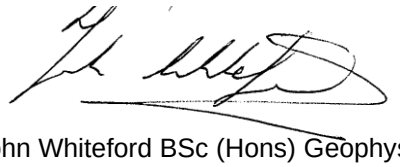
construction methods used, particularly for the construction of turbine foundations, and may also give rise to a need for regular maintenance within the lifetime of the scheme.

6. Peat soils were not recorded either from desk study analysis or at walkover survey stage. Therefore, the opinion of the author is that a peat stability hazard assessment is not required.

This report has been prepared on behalf of Garrane Green Energy Ltd and Jennings O'Donovan Ltd.

by

Whiteford Geoservices Ltd



John Whiteford BSc (Hons) Geophys AMIOSH MEAGE FGS

Technical Director

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Appendices

Appendix 1

General Site Location Plans – P1 / P2
Proposed Layout Plan

Priority Habitat Mapping – Local (EPA Online Environment Viewer)

Plot Depicting location of sensitive receptors, as well as identified preconditions and pre-failure indicators in the immediate vicinity of the wind farm development [2177-22-PE]

Geological Survey of Ireland Public Viewer Data – Solid and Structural Geology
Geological Survey of Ireland Public Viewer Data – Superficial Soils and Landforms
Geological Survey of Ireland Public Viewer Data – Groundwater Vulnerability, Springs and Karst
Geological Survey of Ireland Public Viewer Data – Landslide Susceptibility

Historic Landslide Events (GSI Data Viewer Analysis) 2177-22A-LE1

Appendix 2

Preliminary Peat Depth Data

Appendix 3

Preliminary Plot of Ground Elevation

(10mx 10m data compiled using OSI DTM elevation data)

Appendix 4

Preliminary Plot of Ground Slopes

(Calculus applied to determine Gradient of 10m x 10m Data used to compile Ground elevation Plot – Appendix 3

Appendix 5

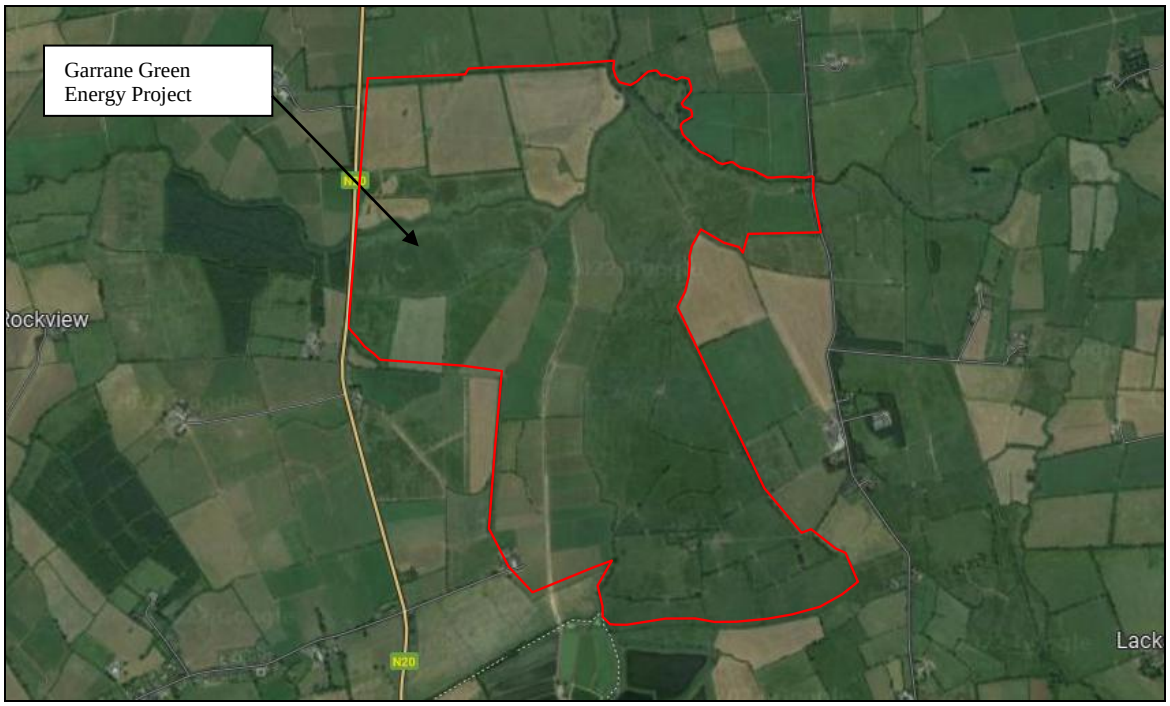
Preliminary Assessment of Peat Stability Hazard

(Compiled following analysis of site conditions and potential receptors)

Appendix 6

Walkover Survey Photographic Record

P1 - General Location Plan (Aerial view)
(© google maps 2021)



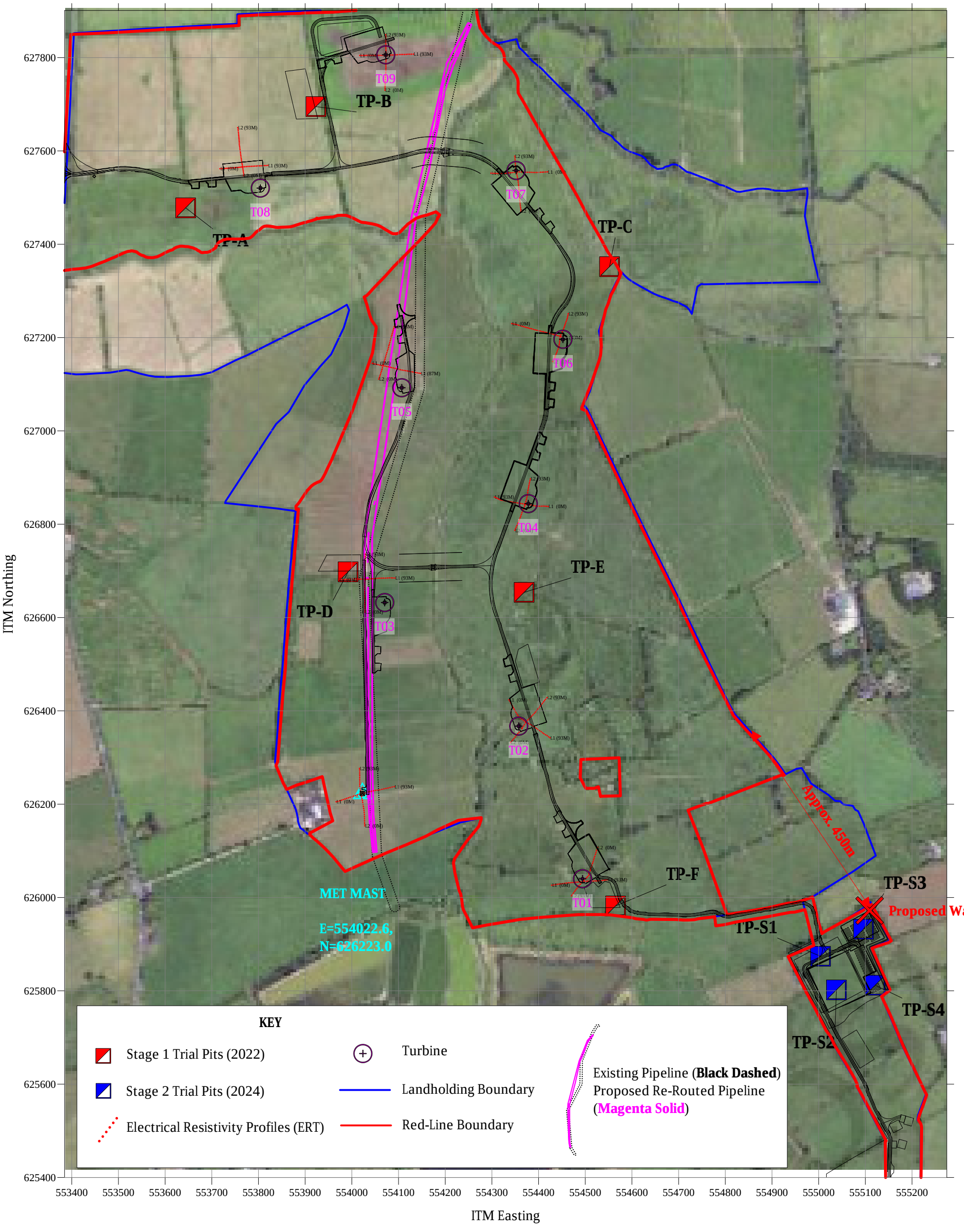
P2 - Local Location Plan (Aerial view)
(© google maps 2021)

2177-22 Garrane Green Energy Project

Site Layout Plan - Garrane Green Energy Project Updated with SI Exploratory Works

Includes:
Trial Holes within Wind Farm Landholding
Trial Holes at Substation and Battery Storage Site
ERT Resistivity Profiles (all Turbines and Met Mast)

17th June 2025



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head
4. Do not scale from drawing; not to be used for measurement.
5. Relates to Stage 2 SI Works undertaken between 17 July and 17 August 2024.

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.W.	J.W.	J.M - 17/06/2025	2177/22 - L1	17/06/2025	1 : 7500

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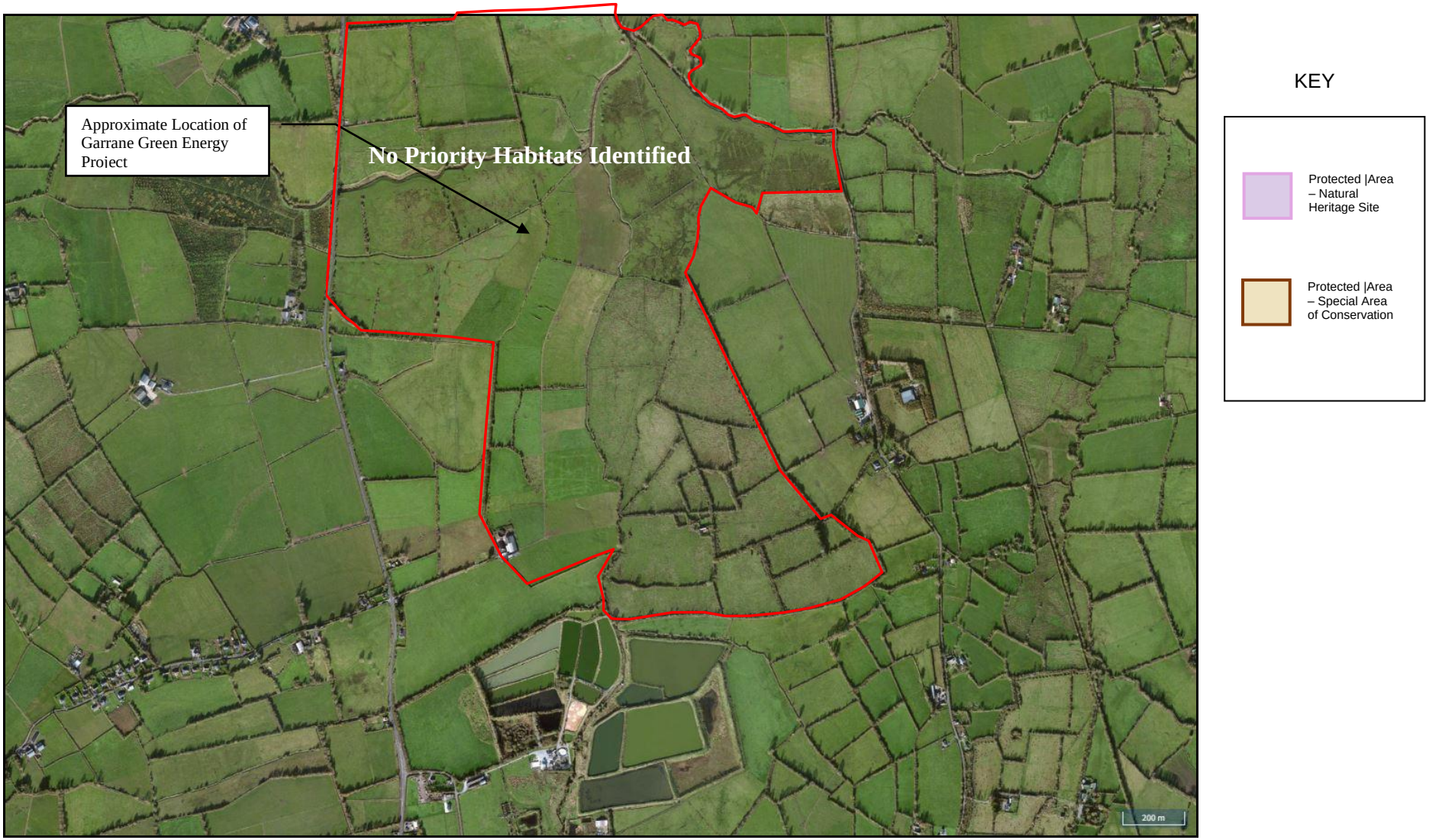
Site Layout Plan - Phases 1 & 2 (SI Works - Sept 22 / Aug 24)	Edition	Sheet
	2	A3

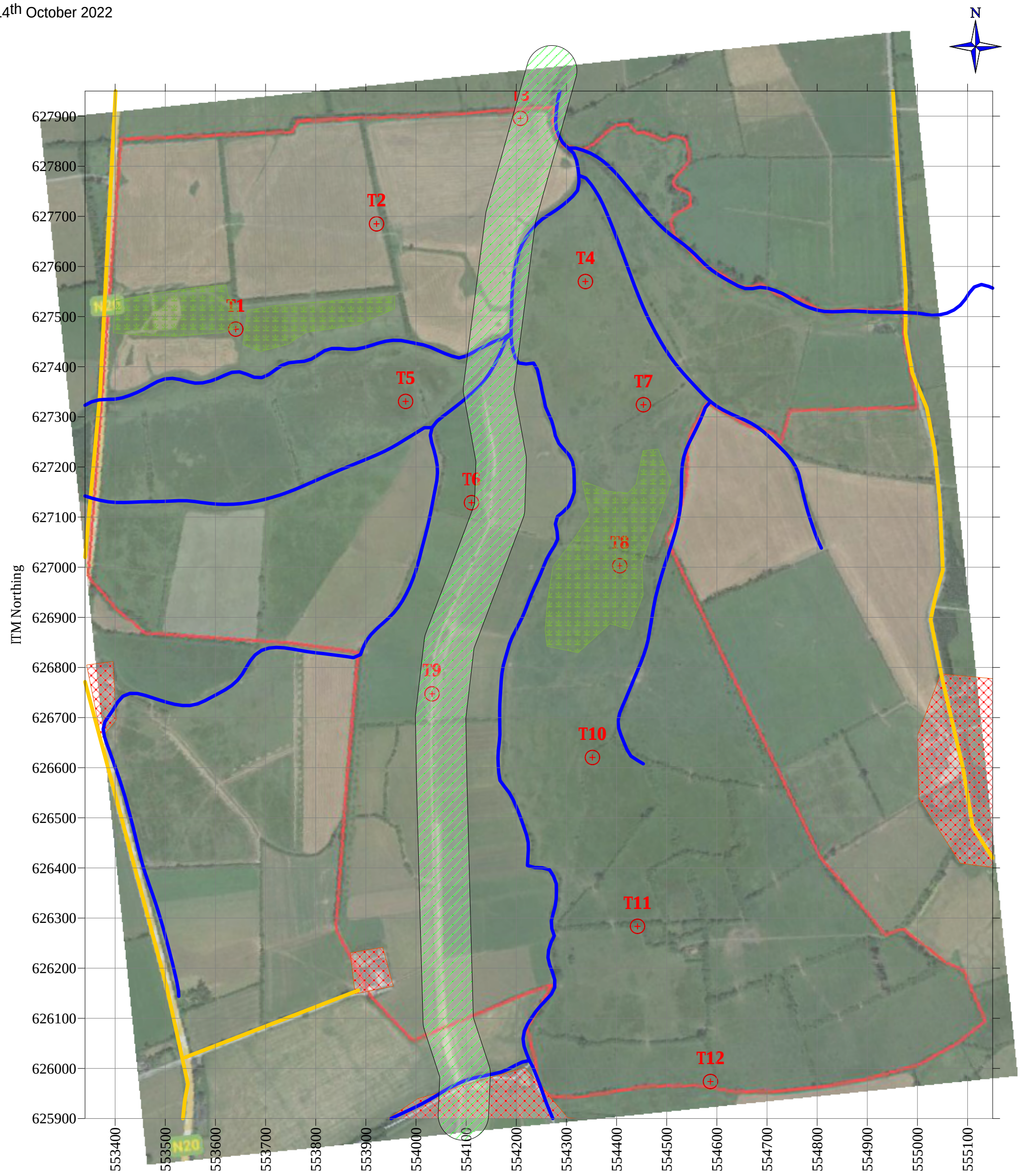


E1 – SAC and Natural Heritage Sites
(© EPA Maps - OSi)

2177-22 Garrane Green Energy Project

Plot of Potential Local Exposures, Pre-conditions and Pre-failure indicators of slope instability
Preliminary Assessment

14th October 2022



Exposures

- Existing Public Roads
- Streams / Water Bodies
- Forestry
- Industrial Infrastructure / Residential Buildings Farm Buildings
- Protected Habitats
- Kerry Group Overflow Pipeline

Preconditions

- Marshy wetlands
- Convex Slopes (Direction)
- Potential Peat Landforms / Historical Peat Cutting and associated drainage

Pre-Failure Indicators

- Artificial / undesignated Drainage
- Concentrated Drainage Networks

Notes:

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2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head
4. Do not scale from drawing; not to be used for measurement.

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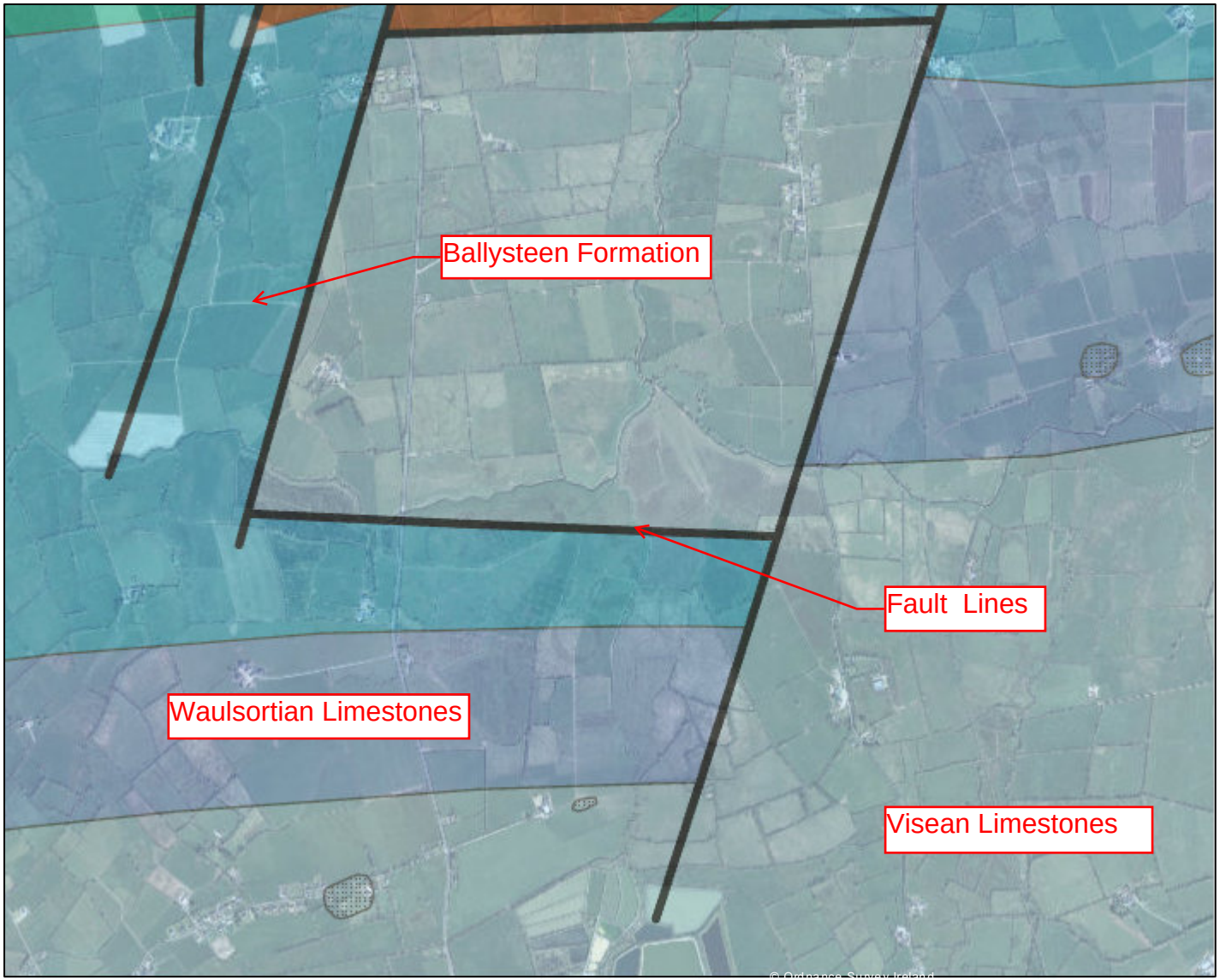
Exposure Plot | Edition 0 | Sheet A3

Fort East WF - Solid Geology



Legend

Structural Symbols 100K ITM 2018

- Dip of bedding or main foliation, old GSI data
- First foliation parallel to bedding
- Foliation trend, Thorr and Rosses Granites
- Horizontal Bedding
- Strike and dip of bedding, right way up
- Strike and dip of bedding, way up unknown
- Strike and dip of first foliation
- Strike and dip of overturned bedding
- Strike and dip of second foliation
- Strike and dip of third foliation
- Strike and plunge of first generation fold axis
- Strike and plunge of second generation fold axis
- Strike and plunge of third generation fold axis
- Strike of vertical bedding/foliation
- Strike of vertical first foliation
- <all other values>

- Bedrock Outcrops 100 ITM 2018

Bedrock Linework 100k ITM 2018

- Anticlinal Axis
- Antiformal axis
- Aquifer Boundary
- Area
- Coal seam
- Dyke
- Fault
- Ghost Line
- Goniatite marine band (R1-R4)
- Lithological boundary offshore
- Metadolerite sheet, mainly sills
- Paleogene/ Tertiary Dyke
- Synclinal Axis
- Synformal axis
- Tectonic Slide, barbs on hanging-wall
- Thin stratigraphical unit, diagrammatic
- Thrust, barbs on hanging-wall side
- Tuff band
- Unconformity, dots on younger side
- X-Section

Scale: 1:25,000

Geological Survey Ireland

N W E S

0 0.175 0.35 0.7 mi

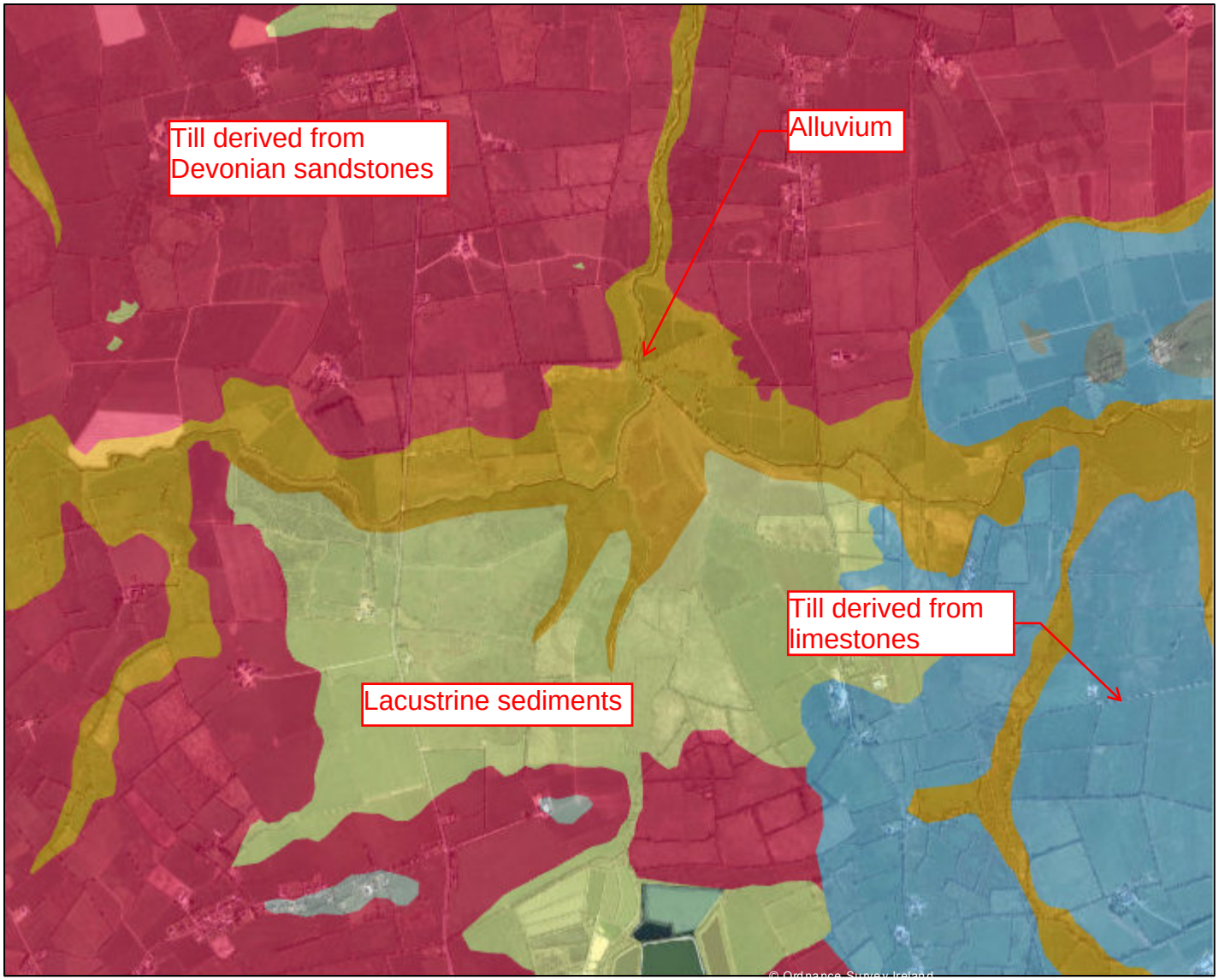
0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 554,167 627,408

13/10/2022, 16:41:17

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Fort East WF -Superficial Geology



Legend

Scale: 1:25,000

Geological Survey Ireland

N W E S

0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

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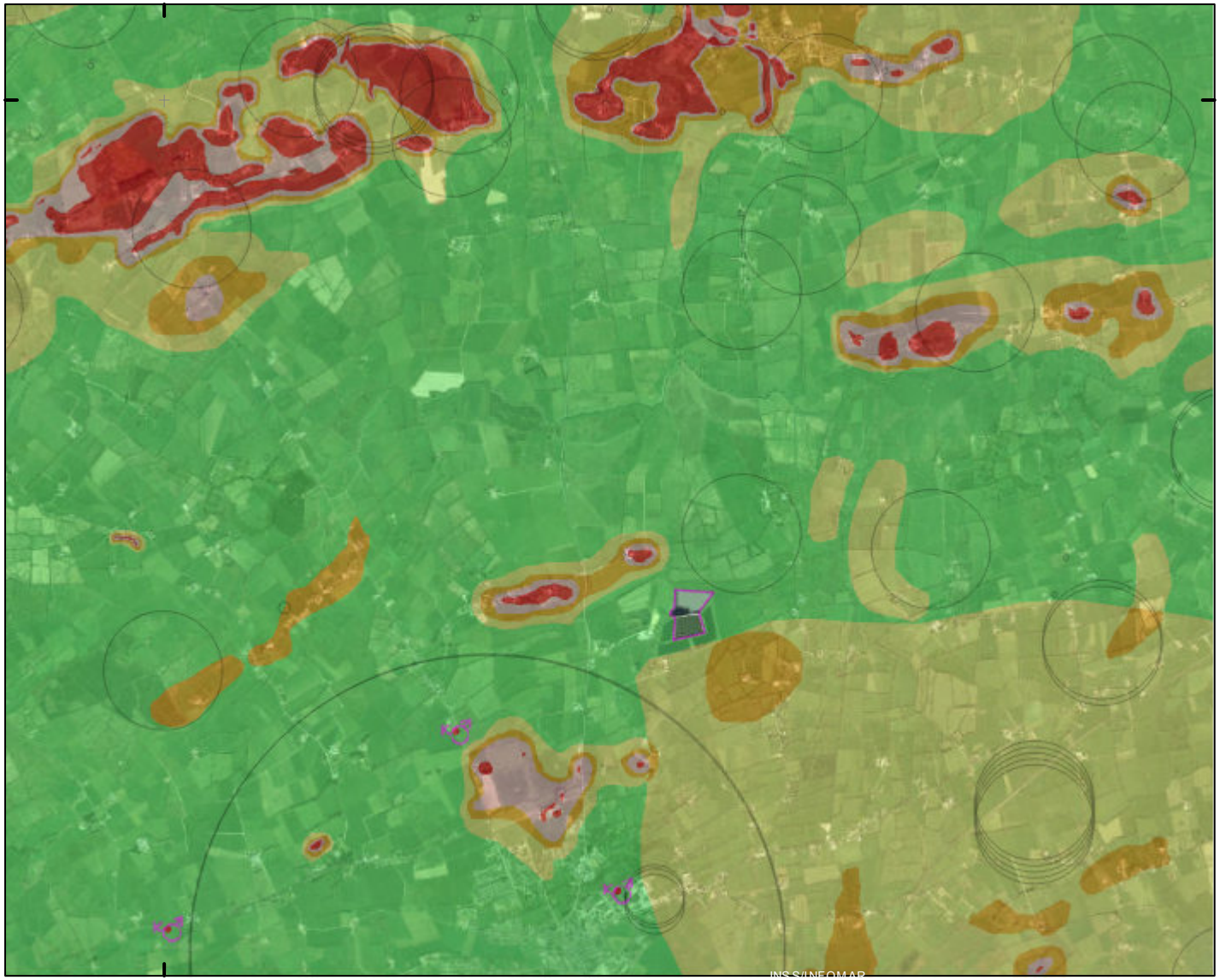
GSI - Groundwater Vulnerability, Springs & Karst Features



Legend

Karst Landforms

- Borehole
- Cave
- Dry Valley
- Enclosed Depression
- Spring
- Superficial Solution Features
- Swallow Hole
- Turlough

- Traced Underground Connections
- Groundwater Wells and Springs

Groundwater Vulnerability

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

Scale: 1:54,308

Geological Survey Ireland

N W E S

0 0.375 0.75 1.5 mi

0 0.5 1 2 km

Map Centre Coordinates (ITM) 553,745 626,725

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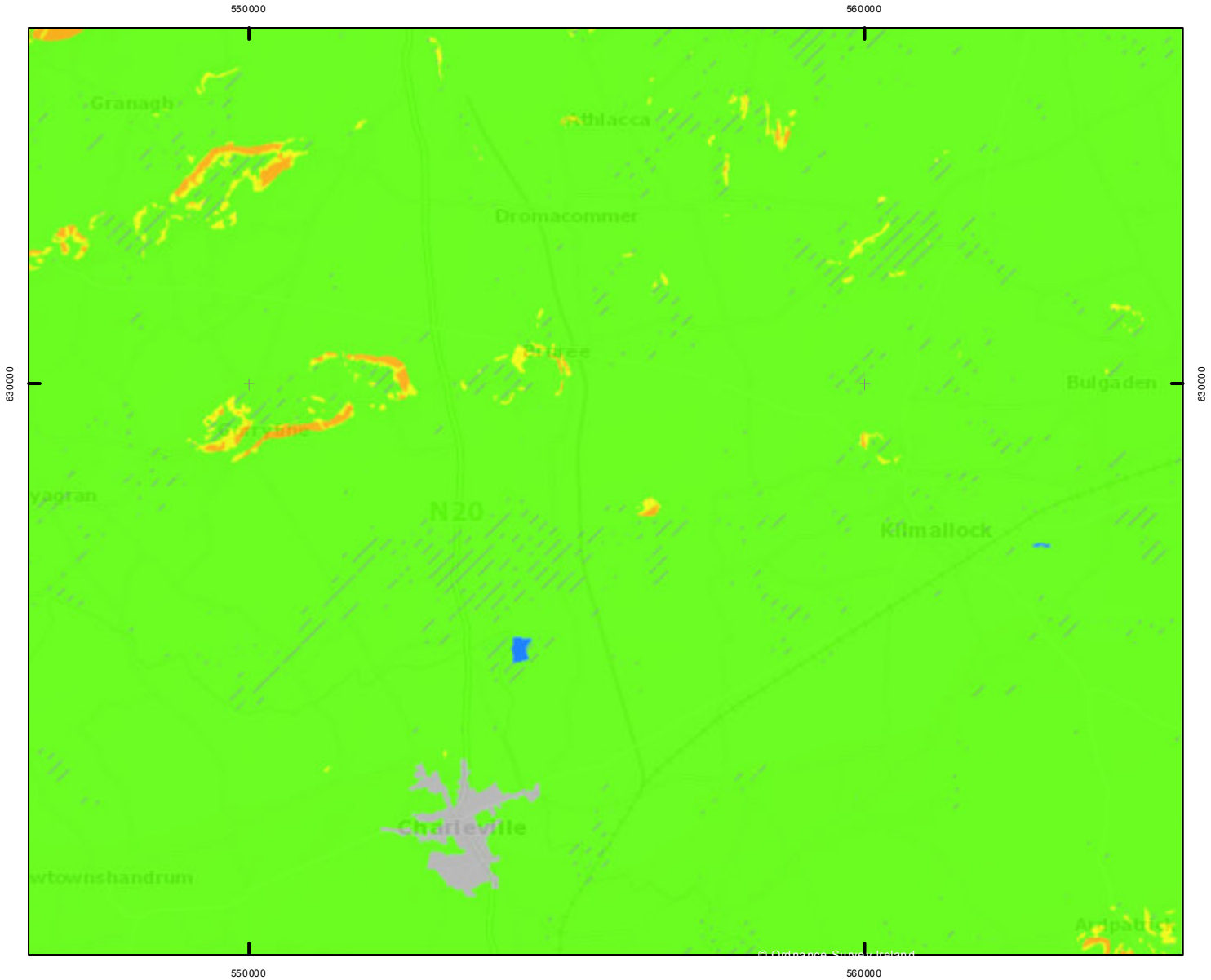
Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Landslide Susceptibility Map



Legend

Landslides Susceptibility Classification

- Unclassified
- Low
- Low (inferred)
- Moderately Low
- Moderately Low (inferred)
- Moderately High
- Moderately High (inferred)
- High
- High (inferred)
- Made
- Water

Scale: 1:100,000

Geological Survey Ireland

0 0.5 1 2 mi

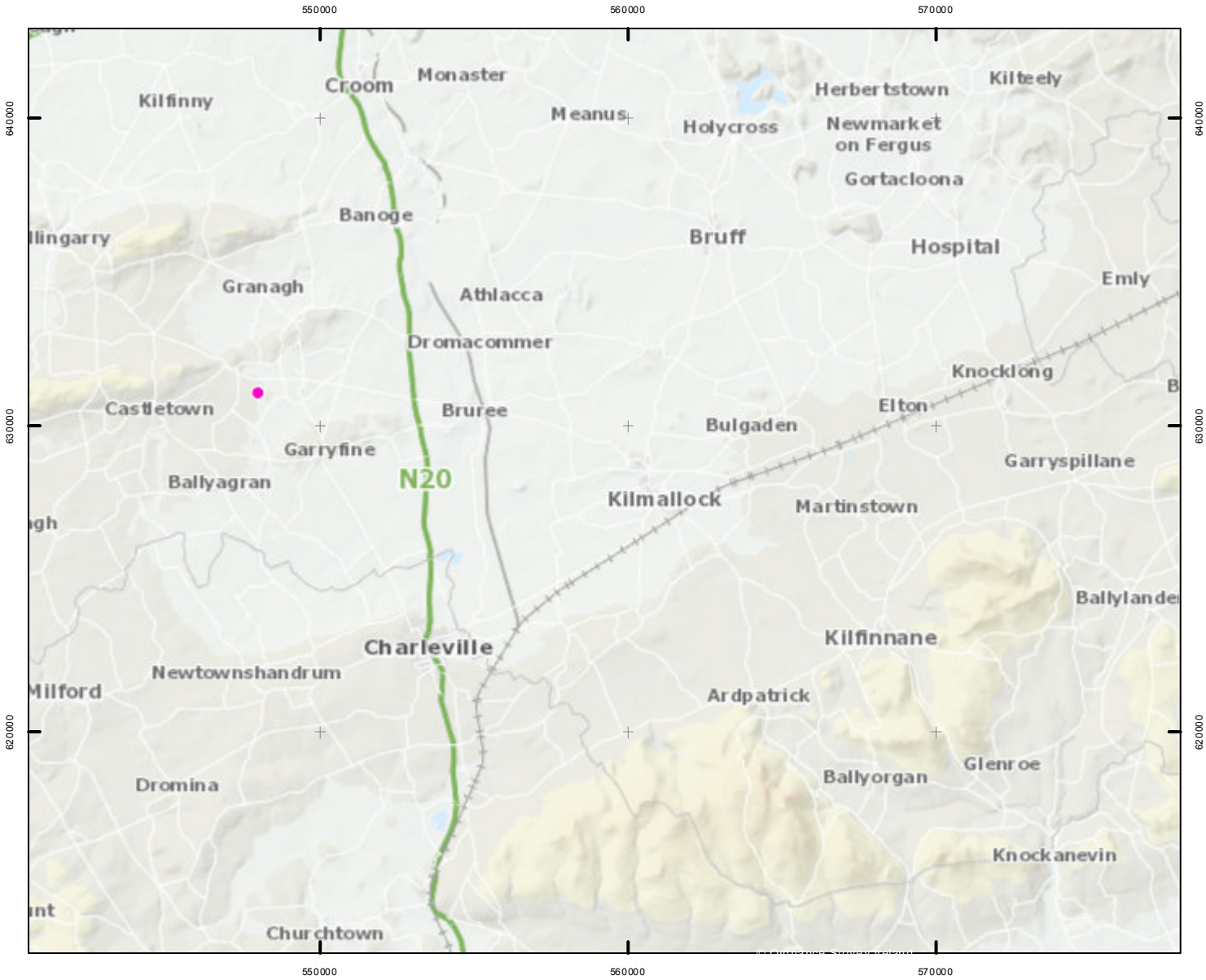
0 1 2 4 km

Map Centre Coordinates (ITM) 555,789 628,244

13/10/2022, 16:48:51

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Fort East WF - Landslide Events



Legend

- Landslide Locations Ireland ITM
- Landslide Extents Ireland ITM

Scale: 1:200,000

Geological Survey Ireland

N W E S

0 1.25 2.5 5 mi

0 2.25 4.5 9 km

Map Centre Coordinates (ITM) 559,207 627,861

13/10/2022, 16:46:18

2177-22 - Garrane Green Energy Project
Preliminary Data of Peat Depth at Turbines

Location	Easting	Northing	Depth
T1	553641	627475	0
T2	553921	627685	0
T3	554267	627779	0
T4	554338	627570	0
T5	553979	627331	0
T6	554111	627129	0
T7	554454	627324	0
T8	554406	627003	0
T9	554032	626747	0
T10	554352	626620	0
T11	554442	626284	0
T12	554587	625974	0

2177-22 Garrane Green Energy Project

Classed Plot of Peat Depth - Preliminary Data

10th October 2022

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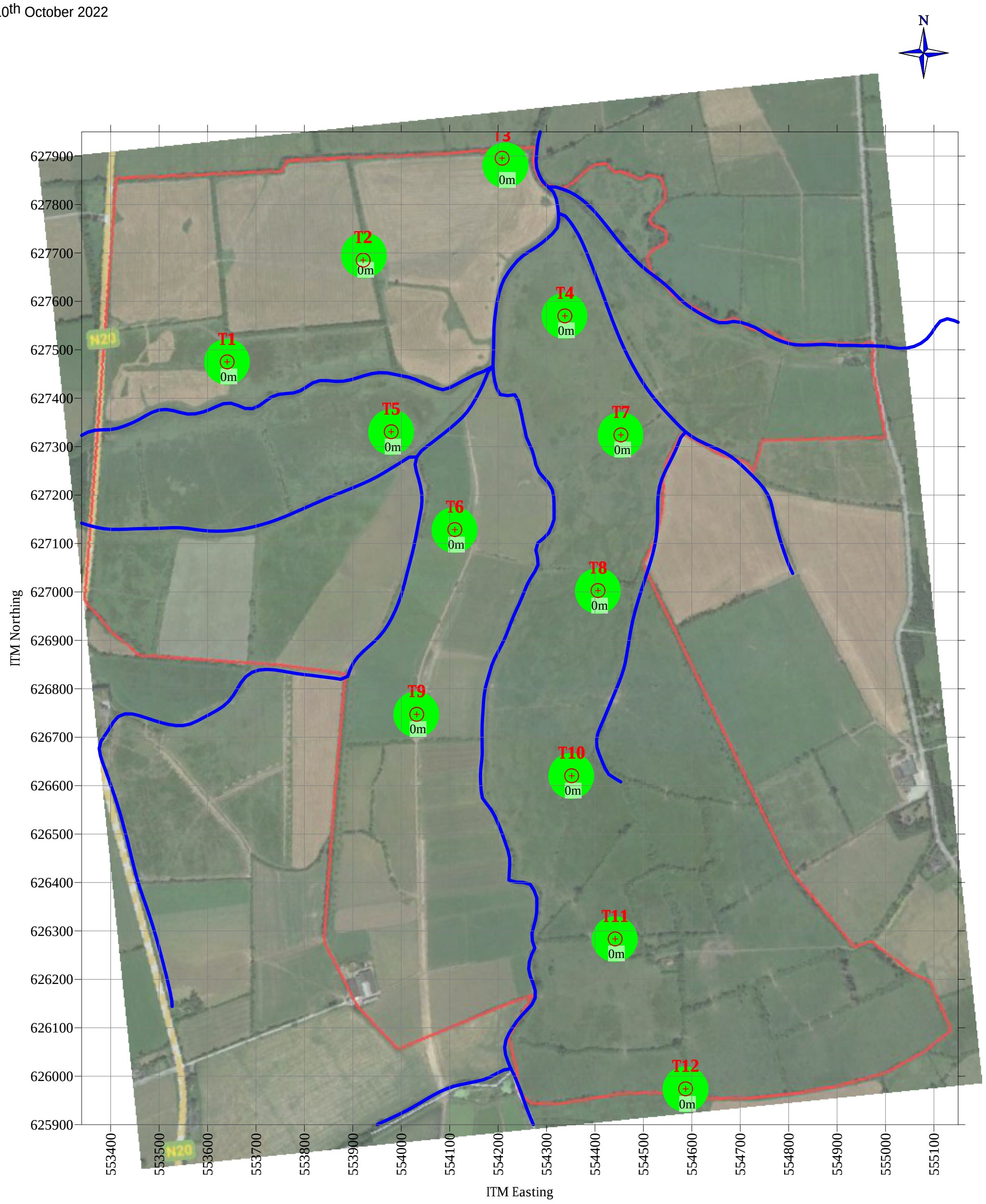
explore the possibilities



Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head
4. Do not scale from drawing; not to be used for measurement.
5. On certain slopes vegetation contained shrubs taller than low ground cover shrubs. This should be avoided generally and where present should be removed.

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 17/06/2025	2177-22 D1-P	17/06/2025	1 : 7500

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Classed Plot of Peat Depth | Edition **0** | Sheet **A3**

2177-22 Garrane Green Energy Project

Contoured Plot of Elevation

10th October 2022

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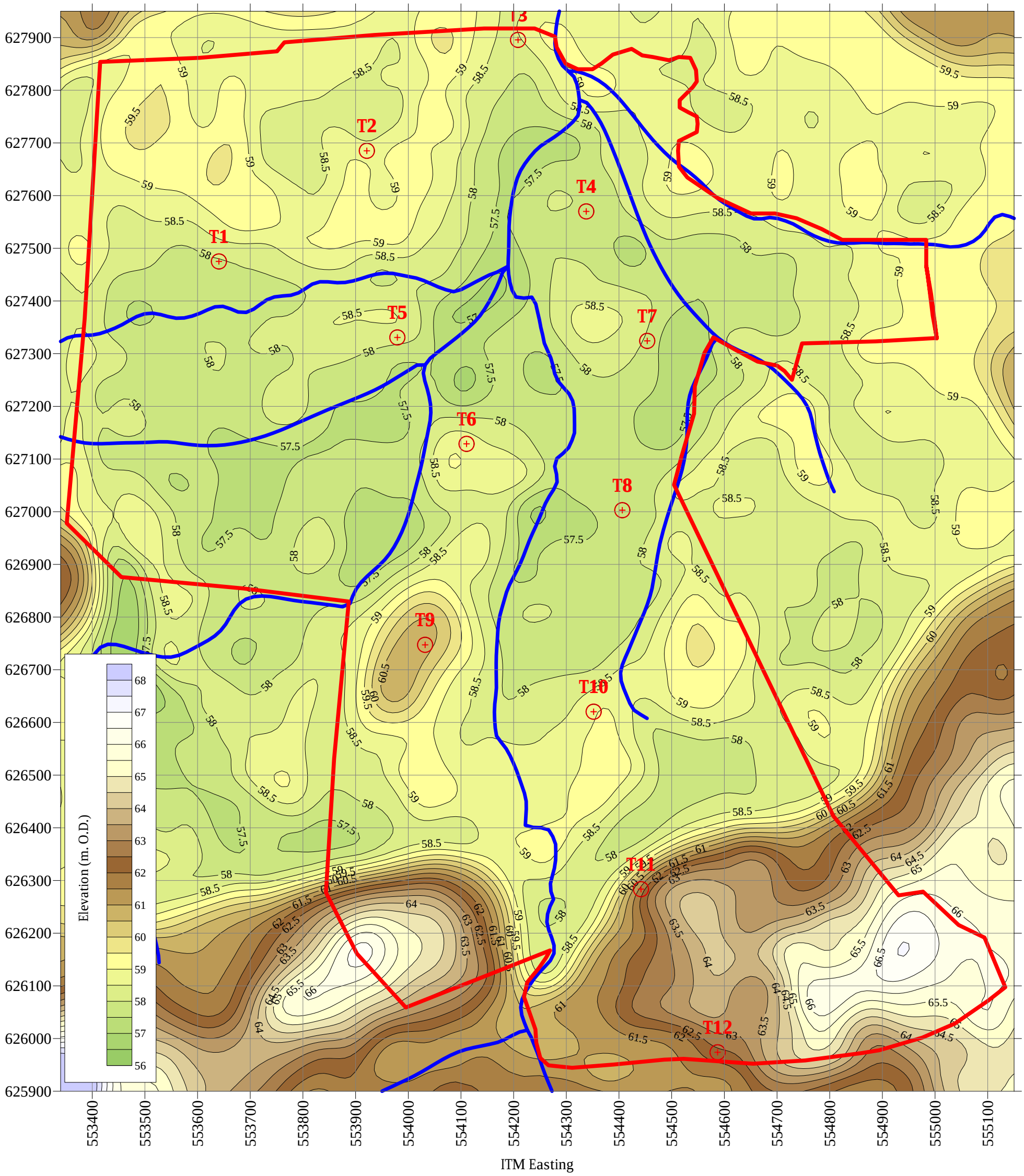
explore the possibilities



Notes:

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2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head
4. Do not scale from drawing; not to be used for measurement.
5. On certain slopes vegetation contained shrubs taller than low ground cover shrubs. This should be avoided generally and where present should be removed.

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Contoured Plot of Elevation | Edition **0** | Sheet **A3**

2177-22 Garrane Green Energy Project

Contoured Plot of Slope Angle

10th October 2022

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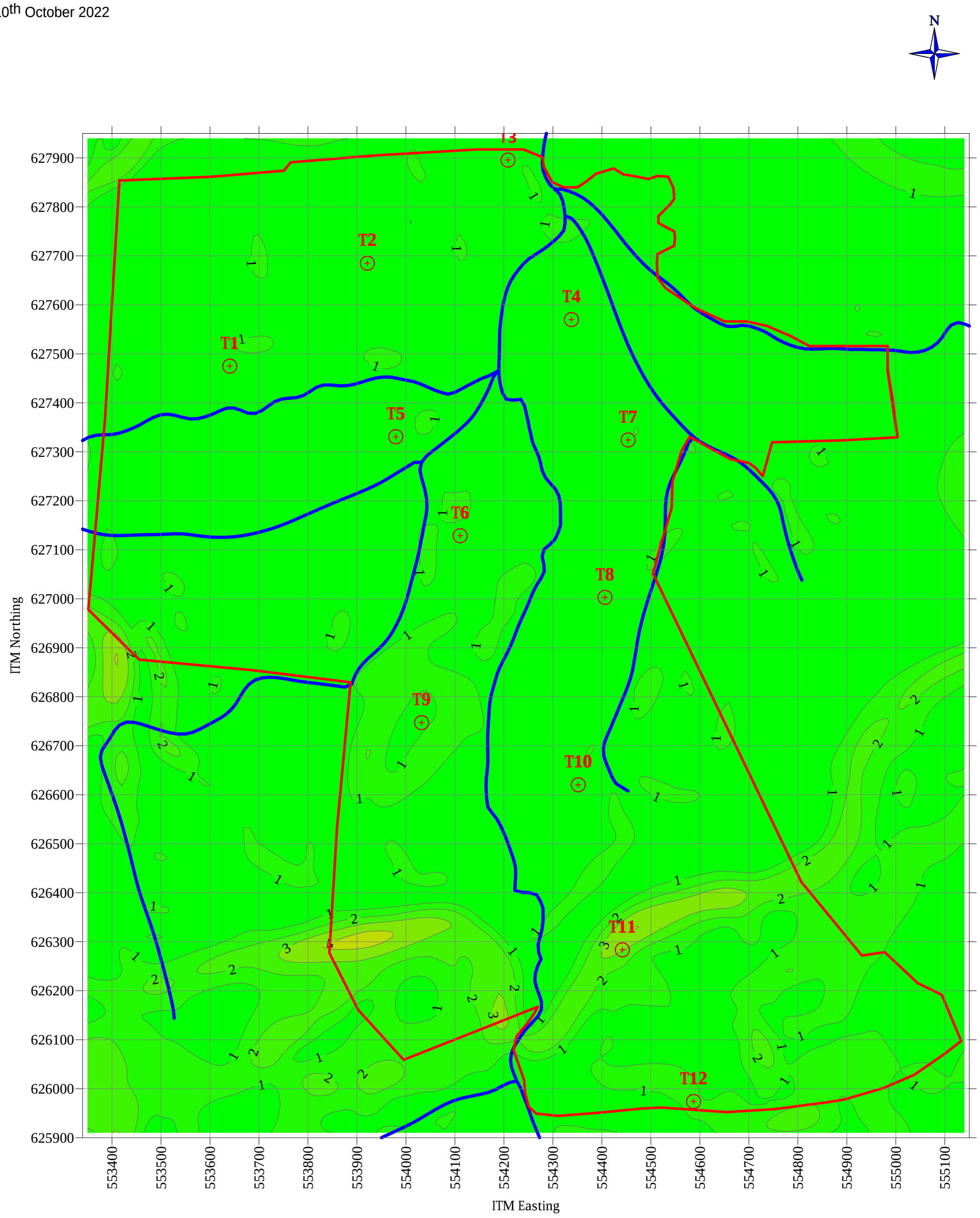

Notes:

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3. Any elevations are provided relative to Ordnance Datum Malin Head
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5. On certain slopes vegetation contained shrubs taller than low ground cover shrubs. This should be avoided generally and where present should be removed.

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
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Contoured Plot of Slope Angle | Edition 0 | Sheet A3

2177-22 Garrane Green Energy Project

Classed Plot of Peat Stability Hazard Ranking - Preliminary Data

10th October 2022

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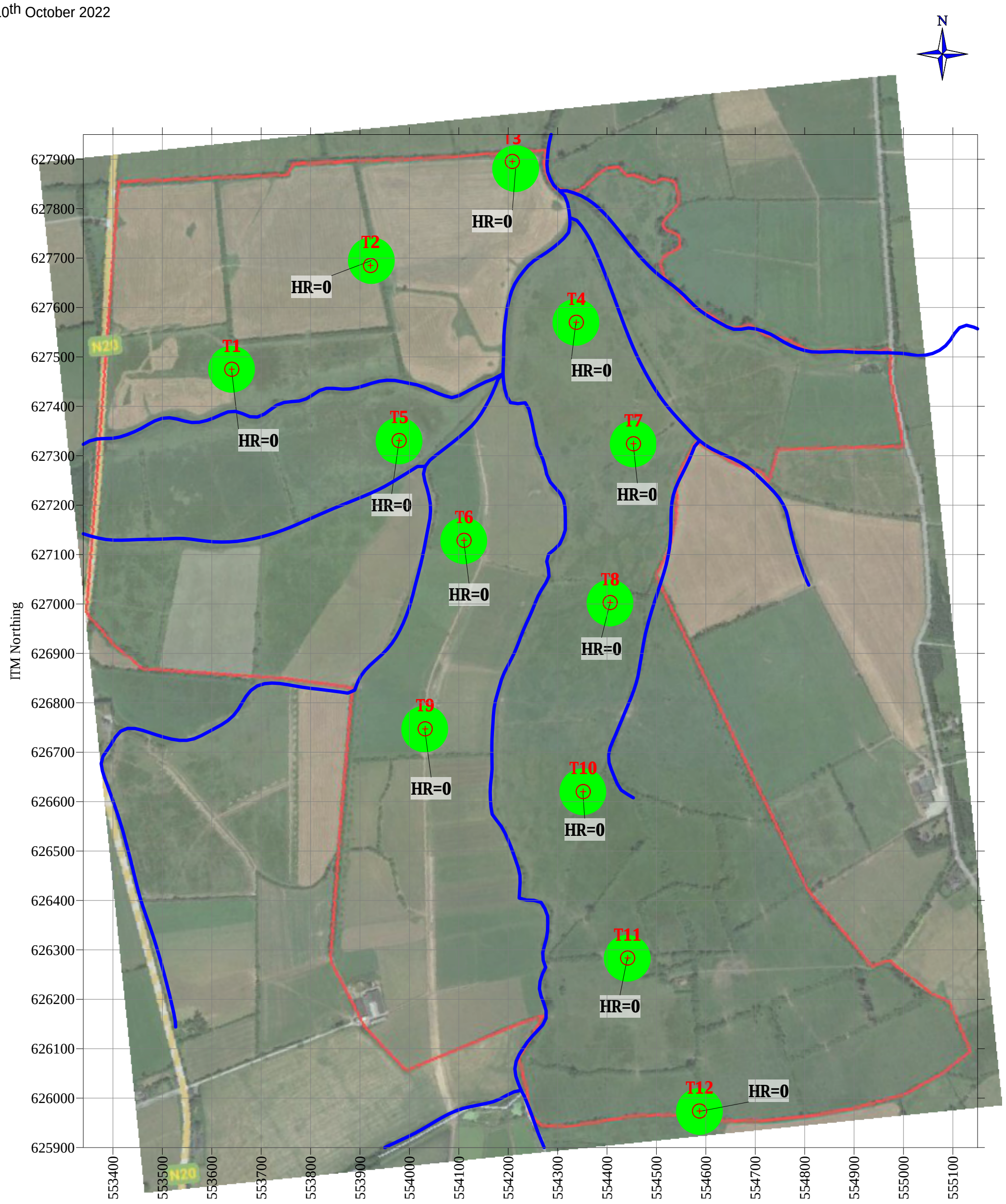

Notes:

1. All depths are relative to ground level existing at the time of the survey / investigation.
2. All positions relate to the ITM coordinate system.
3. Any elevations are provided relative to Ordnance Datum Malin Head
4. Do not scale from drawing; not to be used for measurement.
5. On certain slopes vegetation contained shrubs taller than low ground cover shrubs. This should be avoided generally and where present should be removed.

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
J.S.	J.W.	J.W - 17/06/2025	2177-22 D7-P	17/06/2025	1 : 7500

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Garrane Green Energy Project
Soils and Geology Assessment

Classed Plot of Peat Stability Hazard | Edition **1** | Sheet **A3**

Plate 1—Typical conditions around T-01

Plate 2—Typical conditions around T-02

Plate 3—Typical conditions around T-03

Plate 4—Typical conditions around T-04

Plate 5—Typical conditions around T-05

Plate 6—Typical conditions around T-06

Plate 7—Typical conditions around T-07

Plate 8—Typical conditions around T-08

Plate 9—Typical conditions around T-09

Plate 10—Typical conditions around T-10

Plate 11—Typical conditions around T-11

Plate 12—Typical conditions around T-12