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INTRODUCTION

5.1 SLR Consulting Ireland (SLR) has been appointed by Roadstone Ltd. to prepare a soils and geology impact assessment for the proposed restoration of Calary Quarry at Killough Upper, Kilmacanogue, County Wicklow by backfilling it to former ground level using imported inert soil and stone and re-establishing a heathland / grassland habitat, similar to that which existed prior to quarrying.

5.2 This EIS chapter presents data on the local geology of the application site and the surrounding area (up to 5km radius around the site boundary) and identifies potential geological impacts arising from the proposed development.

5.3 Roadstone Ltd. has operated Calary Quarry since 1973. Quarry operations were suspended in 2010 in response to the sharp downturn in activity in the construction sector at that time.

5.4 The proposed development provides for the backfilling and restoration of the existing void at Calary Quarry using imported soil and stone and minor quantities of virgin aggregate for temporary haul road construction. The final ground profile of the backfilled quarry will mirror the gradient on adjoining sloping lands and fall from approximately 290mOD on the eastern side of the quarry to approximately 250mOD on the western side. The total volume of soil required is estimated to be of the order of 1,820,000m^3 (1.82 million cubic metres), equivalent to approximately 3,280,000 tonnes.

5.5 The nature and description of the proposed development is outlined in more detail in Chapter 2 of this EIS.

Scope of Work

5.6 This study presents available information on the soils and geology within and immediately beyond the site of the existing quarry, together with an interpretation of the existing local geological environment at the site. It identifies the baseline geological environment, how the geological environment will be impacted by the proposed development, and where possible, will identify how these impacts may be mitigated.

Legislative Framework / Planning Policy and Guidance

5.7 This chapter was prepared in accordance with the following guidance:

- Guidelines on the information to be contained in Environmental Impact Statements (2002) Environmental Protection Agency; and
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (2003) Environmental Protection Agency and
- Geology in Environmental Impact Statements : A Guide (2013). 2nd Edition, Institute of Geologists of Ireland.

Consultations

5.8 In undertaking this study / assessment, informal consultations were held with the Geological Survey of Ireland (GSI) Geological Heritage Programme. Publically accessible datasets were also consulted via the GSI website (www.gsi.ie) and that of the Environmental Protection Agency (www.epa.ie).

RECEIVING ENVIRONMENT

Baseline Study Methodology

5.9 The baseline study was prepared using published and publically accessible regional geological and geomorphological data.

Study Area

5.10 The study area for this assessment comprises the site of the proposed development (the application site) and the area immediately surrounding it (up to a distance of 250m). The soils and geology for this area is described below and describes the regional and local geological context for the proposed development.

Sources of Information

5.11 In undertaking this study, documentation and information was obtained from the following bodies:

- The Environmental Protection Agency, Johnstown Castle, Co. Wexford;
- Teagasc, Kinsealy, Co. Dublin;
- Soil Associations of Ireland and their Land Use Potential, National Soil survey of Ireland / An Foras Talúntais;
- The Quaternary Section, Geological Survey of Ireland, Haddington Road, Dublin 4;
- The Quaternary Section, Geological Survey of Ireland, Haddington Road, Dublin 4;
- Bedrock Geology Section, Geological Survey of Ireland, Haddington Road, Dublin 4;
- Groundwater Section, Geological Survey of Ireland, Haddington Road, Dublin 4;
- Irish Geological Heritage Programme, Geological Survey of Ireland, Haddington Road, Dublin 4 and
- Ordnance Survey Ireland (OSi).

Field Monitoring / Inspection

5.12 In-situ soil and geological (subsoil) exposures revealed by quarrying activity over the past number of years were visually inspected by SLR staff during site visits undertaken in late 2014 and the first half of 2015.

5.13 Details of previous ground investigation work and earlier site visits undertaken in respect of previous development proposals and planning applications were also reviewed.

Receiving Environment - Baseline

Soils

5.14 Soil is the top layer of the earth's crust. It is formed by mineral particles, organic matter, water, air and living organisms. It is an extremely complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

5.15 Soil can take thousands of years to evolve and is essentially a non-renewable resource. Soil performs many vital functions. It supports food and other biomass production (forestry, biofuels etc.) by providing anchorage for vegetation and storing water and nutrients long enough for plants to absorb them. Soil also stores, filters and transforms others substances including carbon and nitrogen. It also has a role supporting habitats and serves as a platform for human activity, landscape and archaeology.

5.16 The soils across Ireland were mapped as part of the Teagasc Irish Forestry Soils (IFS) mapping project. The soils in the area around Calary are typical of those found in this mountainous area of Co. Wicklow.

5.17 Much of the soil which occurred across the application site has previously been removed / excavated by quarrying activities. Three soil types are identified around the application site on the IFS map, namely shallow well drained mineral soils (AminSW), shallow / rocky / peaty soils (AminSRPT) and deep, well drained mineral soils (AminDW). Each of these soil types are classified as acidic (ie. derived from mainly non-calcareous parent materials).

5.18 The shallow well drained soils are indicated to occur at agricultural fields immediately downslope (west) and upslope (east) of the application site, while shallow / rocky / peaty soils occur immediately to the north and south-east of it and a short distance further east and upslope on the western flank of the Great Sugar Loaf. A small area of deep well drained soil occurs towards the extreme southern end of the application site and further west, along the lower reaches of the Killough River valley.

5.19 In the publication Soil Associations of Ireland (Gardiner and Radford, 1980), the soils in the area are also indicated to comprise mainly well-drained Brown Podzolics of mainly loam to clay loam texture (80%), with minor proportions of Gleys (15%) and Podzol (5%). They are indicated to occur in an area underlain by Palaeozoic shales and mica schist and as being formed from bedrock or from glacial drift of similar composition.

Quaternary (Subsoil) Geology and Geomorphology

5.20 Quaternary (subsoil) deposits were deposited during the last 2 million years. The two principal types of quaternary subsoils in Ireland are glacial till, deposited at the base of ice sheets, and sand and gravel deposits associated with the melting of the ice sheets, which are generally termed glaciofluvial outwash sands and gravels. Other extensive quaternary subsoils in Ireland include peat and river alluvium. Most Quaternary deposits in Ireland were deposited since the maximum of the last glaciation, the Midlandian, which occurred approximately 17,000 years ago.

5.21 The application site is shown on the 1:50,000 scale GSI quaternary / subsoil map of the area reproduced in Figure 5.1. This map indicates that the valley to the west of the existing quarry (downslope, on the opposite side of the R755 Regional Rod) is underlain by glacial till, with quartzite as the dominant clast type. It is likely that this material extends upslope, gradually thinning out as it nears the R755. The subsoil map also indicates outcrop or subcrop occurring everywhere around the application site, which is consistent with exposures which are visible in adjoining fields.

5.22 During the Pleistocene period, the Great Sugar Loaf "*stood as a nunatak* (or glacial 'island') *which was scoured by the Ivernian, Midland and Mountain ice sheets"*, resulting in a rocky, conical peak. This contrasts with the flat peaks of both Bray Head and Howth which were overridden by ice sheets, and the rounded granite mountains to the west.

Regional Solid Geology

5.23 The regional geological map of the area published by the Geological Survey of Ireland (GSI) indicates that the bedrock underlying much of the application site comprises of a sequence of greywackes, sandstones and shales overlain by indurated quartzites from the Bray Head Formation. The quartzites form the higher ground in the area, typified by the Great Sugar Loaf. These units structurally overlie the surrounding dark shales and siltstones of the Ribband Group. An extract from the GSI 1:100,000 bedrock geological map of the area, reproduced in Figure 5-2, identifies the regional geological formations around the application site at Calary Quarry.

5.24 The peak of the Great Sugar Loaf is formed from the Bray Head Formation, a sub-unit of the Bray Group. This formation is composed of feldspathic and lithic-greywackes (clayey sandstone), quartz-wackes and quartzite (metamorphosed sandstone). The quartzites form basin wide sandstone bodies, as opposed to the associated greywackes, which show marked lateral variation from north to south. The quartzite of the Great Sugar Loaf forms the core of a megascopic isoclinal slump fold and has a very distinctive grainsize and texture.

5.25 The GSI describes the structure of the area as *"The structure of the Bray Group as a whole consists of D2 deformation involving F2 folding and westward directed thrusting, particularly in the north-west. The Sugar Loaf syncline is an F2 megascopic fold cross-folding both F1 folds and the pre-cleavage isoclinally folded Sugar Loaf quartzites"*[1].

Local Geology

5.26 Examination of existing faces and outcrop shows Calary Quarry to be developed in a sequence of Pre-Cambrian rocks belonging to the Bray Group. Rocks in the quarry are identified as greywackes (sandstones) underlain by green and red shales. The red shales are taken to be the transition units from the underlying Devil's Glen Formation to the overlying Bray Head Formation. Fine- to medium-grained green and red sandstones and mudstones are currently exposed in the working quarry. The sandstones have been interpreted by the Geological Survey of Ireland as greywackes.

5.27 Weathering of the rock shows a consistent pattern, with a zone of weathered bedrock present beneath the overburden. This zone of weathered rockhead is underlain by slightly weathered bedrock characterised by a higher fracture incidence (loosely termed "broken rock"), which is, in turn, underlain by fresh, unweathered rock. These zones are clearly visible in the face at the northern end of the quarry.

5.28 At the southern end of the quarry, the sequence dips gently to the north. Towards the centre of the quarry the sequence is monoclinally folded with increased dips to the north. The steeper dips present in the central portion of the workings reduce to a gentler dip at the northern end.

5.29 Rotary drilling carried out as part of an earlier assessment for a proposed quarry extension (in 2008) indicated that the surrounding lands were underlain by green and red quartzitic sandstones, with subordinate siltstones and mudstones. This sequence is overlain to the north and north-west by pale buff to off white quartzitic sandstones.

Economic Geology

5.30 A review of the minerals database held by the GSI indicated that there are two mineral workings within 2km of the application site. A quarry at Ballybawn Lower, approximately 1.8km to the north-west of the application site, is identified as a slate quarry, extracting rock from the Maulin Formation (described by GSI as blue grey slate, phyllite and schist). Another quarry at Kilmurry South, approximately 2km to the east, is identified as a shale quarry, producing materials for road aggregate.

5.31 A review of historical 6 inch Ordnance Survey mapping indicates that no historical mineral workings took place in the area surrounding the quarry.

Geohazards

5.32 The application site is underlain by the Bray Head Formation. No karst dissolution features or hazards are associated with this or any other rock formation surrounding the application site.

5.33 The presence of bedrock at or close to the surface means that the application site will not be susceptible to natural geological hazards such as landslides. There is no blanket bog in the immediate vicinity of the application site and no historical landslides have been identified around it by the Irish Landslides Working Group.

Geological Heritage

5.34 The Irish Geological Heritage (IGH) Programme of the GSI has confirmed that there are no proposed geological Natural Heritage Areas (pNHA) or County Geological Sites (CGS) within the application site. There are 11 proposed geological pNHA or CGS sites located within a 5km radius of the quarry.

5.35 The Great Sugar Loaf, immediately east and upslope of the application site, is a designated pNHA under two IGH themes, for its physical weathering features under Quaternary Geology (IGH 7) and scree slopes under Fluvial and Lacustrine Geomorphology (IGH 14). The western boundary of the pNHA effectively extends along the eastern boundary of the existing quarry and application site.

5.36 Rocky Valley, located approximately 1.5km to the north of the application site, is a designated pNHA for its important fossilised stratigraphy under Precambrian – Devonian Palaeontology (IGH 2).

5.37 The Glen of the Downs, located approximately 3.5km to the southeast of the site, is a designated pNHA as the largest example of a glacial overflow channel in the country (under Quaternary Geology theme, IGH7).

5.38 Powerscourt Waterfall, located approximately 2.8km to the west of the application site, is designated a CGS under two themes, Igneous Intrusions (IGH 11) and Fluvial Lacustrine (IGH 14).

5.39 Powerscourt Deerpark Cave, located approximately 2.8km to the south-west of the application site is designated a CGS for is pseudokarst development in a breccia / conglomerate of fluvial gravels under the Mesozoic and Cenozoic theme (IGH 12).

5.40 Powerscourt, located approximately 3.5km to the north of the application site is designated a CGS for its moraines under the Quaternary Geology theme (IGH 7).

5.41 The River Dargle, located 3.3km to the north of the application site, is designated a CGS under the Fluvial and Lacustrine Geomorphology theme (IGH 14).

5.42 Greystones, located 5km to the west of the application site, is a designated CGS on account of a coarse grained glacial morainal bank under the Quaternary theme (IGH 7).

5.43 The Glasnamullen haematite breccia locality, approximately 4.5km to the south-west of the application site, is designated a CGS under the Mesozoic and Cenozoic theme (IGH 12).

5.44 The Wicklow County Development Plan (2010-2016) states that geology is now recognized as an intrinsic component of natural heritage and that it is appropriate that due regard is given to the conservation of geological heritage features in planning development and control. The CDP records that the GSI's IGH Programme has identified 88 County Geological Sites of interest in County Wicklow, some of which merit designation as NHAs.

5.45 Objective SG2 in the current County Development Plan states that '*Sites of Geological Importance' will be protected from inappropriate development at or in the vicinity of the site, such that would adversely affect their existence or interpretation*'. Extracts from Volume 2 of the CDP (which identifies the IGH / CGS sites) are provided in Appendix 5-A.

Made Ground

5.46 Some limited progressive restoration of the southern quarry slopes was undertaken by Roadstone in the years 2007 to 2009 using imported inert soil and stone, at a time when the quarry was still operational. These activities were controlled by a waste facility permit (Ref No. ESS/15/8/12) issued by Wicklow County Council which subsequently expired in 2010.

Licensed Sites

5.47 No IPPC Licensed sites are located in the immediate vicinity of the application site. A licensed waste disposal / landfill facility, operated by Marrakesh Ltd. (Waste Licence Ref. No W0048-01) is located at Kilmurry South approximately 2km to the east.

Difficulties Encountered

5.48 There were no particular difficulties encountered in accessing published geological data in the preparation of this chapter of the EIS.

IMPACT ASSESSMENT

Evaluation Methodology

5.49 The following sections of this assessment identify the potential impacts of the proposed development on the existing geological environment. It also assesses the likelihood of occurrence of each identified impact. The assessment of likely impacts is based on the baseline description of the local geology at the application site presented above.

5.50 The methodology applied in this assessment is a qualitative risk assessment methodology, in which the probability of an impact occurring and the magnitude of the impact (if it were to occur) are considered.

5.51 This approach provides a mechanism for identifying the areas where mitigation measures are required, and for identifying mitigation measures appropriate to the risk presented by the development. This approach allows effort to be focused on reducing risk where the greatest benefit may result. The assessment of risk is outlined in Table 5-1 below.

Table 5-1
Matrix used to Estimate Risk to the Receiving Environment

Probability of Occurrence	Significance of Potential Impacts			
	Significant / Profound	Moderate	Slight	Imperceptible
High	High	High	Medium	Low
Medium	High	Medium	Low	Near zero
Low	Medium	Low	Low	Near zero
Negligible	Low	Near zero	Near zero	Near zero

5.52 The definition of degree of significance and nature of potential impacts in terms of geology are detailed in Table 5-2 overleaf:

Table 5-2
Significance of Potential Geological Impacts

Significance	Description of Potential Impact	Nature of Potential Geological Impact
Imperceptible Impact	An impact capable of measurement but without noticeable consequences	No impact or alteration to existing geological environs.
Slight Impact	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities	Some loss of rock or soils with no long term impact.
Moderate Impact	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends.	Slope failure or instability which may cause foundation problems; Loss of extensive areas of peat or agricultural soil; Damage to geological structures / features.
Significant Impact	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment	Slope failure or instability which causes significant damage to property; Permanent degradation of locally or regionally important geological feature.
Profound Impact	An impact which obliterates sensitive characteristics	Slope failure or instability which causes loss of life; Permanent degradation and loss of nationally important geological feature.

5.53 The physical works associated with the proposed development will involve some very limited disturbance to in-situ soils and subsoils at the application site. They will not require the excavation of bedrock material at the site.

5.54 Any direct impacts on the soils and geology at the application site will principally be associated with the final backfilling phases of the proposed development. The proposed development will have no direct or indirect impact on any geological or physical features for which the adjoining lands on the western flank of the Great Sugar Loaf were designated a pNHA. No related activity or emission will adversely affect the existence, presentation or interpretation of these features. In the long-term, the infilling of an open void and associated reduction of ground disturbance within a scenic landscape, may enhance in a minor way the presentation of the Great Sugar Loaf.

5.55 The potential impacts of the proposed development on the geological environment, was assessed and the likelihood of occurrence of each potential impact identified has been assessed. The results of this assessment are summarised in Table 5-3 overleaf. The significance of the potential impacts assessed has been described in Table 5-1 and Table 5-2 above.

Table 5-3
Summary of Unmitigated Potential Impacts

Potential Impact	Spatial and Temporal Impact	Probability of Occurrence	Significance of Impact	Risk from Impact	Mitigation Required?
Backfilling / Operational Phase					
Leakage of fuel to soil, subsoil and/or bedrock	Local and long term	Medium	Moderate	Medium	Yes - see text below
Rogue load of contaminated material	Local and long term	Medium	Moderate	Medium	Yes – see text below
Instability of temporary slopes	Local and short term	Medium	Slight	Low	Yes – see text below
Post Restoration Phase					
Instability of final slopes	Local and short term	Low	Slight	Low	Yes – see text below

Backfilling / Operational Phase Impacts

5.56 The principal potential impacts on soils and subsoils associated with the construction / operational phase will be from fuels / oils from plant and machinery used at the application site or a rogue load of contaminated material being delivered to the site.

5.57 Without mitigation, the probability of a leak or spillage of fuels/oils is considered to be **Medium**, the scale of this impact on the receiving environment is considered to be **Moderate** and therefore, by reference to the matrix in Table 5-1, the significance of this impact is deemed to be **Medium**. The potential impact of hydrocarbons is considered to be local and long term. It is considered that mitigation measures are required in respect of this impact.

5.58 Without mitigation, the probability of a contaminated load causing contamination is considered to be **Medium**, the scale of this impact on the receiving environment is considered to be **Moderate** and therefore the significance of this impact deemed to be **Medium**. The potential impact of a contaminated load being delivered to the site is considered to be local and long term. It is considered that mitigation measures are required in respect of this impact.

5.59 There is potential for instability of temporary working slopes in backfilled soils during the construction / operational phase. Without mitigation, the potential risk of instability in temporary slopes is considered to be **Medium**, the scale of this impact on the receiving environment is however considered to be **Slight** and therefore the significance of this impact is **Low**. It is considered that some mitigation measures could be beneficial in further reducing the significance of this impact.

Indirect Impacts

5.60 There are no indirect impacts associated with the backfilling / operational phase of the proposed development on soils, subsoils or solid geology.

Post Restoration Phase

5.61 The proposed development will result in the loss of any remaining aggregate resource at the application site as a result of backfilling the quarry void. The potential impact of sterilising any remaining aggregate resource is considered to be local and long term. The probability of sterilising some resources is considered to be **High**. However, given the availability of replacement aggregate resources from other locations, the scale of this impact is considered to be **Slight.** By reference to the matrix in Table 5-1, the significance of this impact is deemed to be **Medium**.

Interaction with Other Impacts

5.62 The potential impacts considered here interact with the local hydrological and hydrogeological environment and are addressed in more detail in Chapter 6 of this EIS.

5.63 During the quarry backfilling and restoration works, the presence of exposed, unvegetated soil surfaces could give rise to dust blows during dry windy weather. These issues are discussed in more detail in Chapter 8 of the EIS (Air Quality).

Do-nothing Scenario

5.64 If the application site is not restored completely to its former ground level as proposed, and it remains essentially unchanged from its existing layout, the continued absence of soil cover at the site will mean that there is limited, or no protection provided for groundwater quality. Left unmanaged over time, there is also a small risk that slope or face instability could occur around the quarry, most likely in the form of localised soil slope instability or rock fall.

MITIGATION MEASURES

5.65 Mitigation measures to further reduce and avoid potential adverse impacts of soil, subsoil and bedrock during the construction and operational phases (detailed above) are described in subsequent sections.

5.66 The principal aims of the mitigation measures are to avoid any potential adverse impacts in the first instance, and where this is not possible, to then reduce the probability or scale of the potential impact and its significance for the receiving environment.

Backfilling / Operation Phase

5.67 Measures will be implemented at the application site to mitigate against any potential adverse impacts on the receiving soil and subsoil environment which could arise during the backfilling / operational phase. These mitigation measures will include the following:

- Fuel will be stored at a proposed new auto diesel fuel storage tank to be erected at the site infrastructure area. This tank will be constructed over a

sealed concrete pavement and with a perimeter bund sized to provide a storage / retention capacity of 110% of tank storage volume.

- Oils, greases and hydraulic fluids will be stored under cover in bunded containers in a container shed placed over a drained concrete slab;
- Refuelling and routine servicing of plant and machinery used in the construction phase will take place on paved hardstanding areas;
- Good site management practices will be implemented to reduce risks of spills, including regular monitoring and inspection of storage vessels and regular maintenance and servicing of construction plant and equipment;
- A construction stage contingency plan will also be developed to deal with potential leaks and spills and an emergency spill response kit will be held on site.

5.68 Visual inspection, in-situ monitoring and chemical testing of imported waste materials will be undertaken by the Applicant's site staff as inert waste materials are end tipped at the active restoration area. If there is any concern about the nature of the imported materials, they will be redirected to the quarantine facility for further examination and/or testing. The quarantine area will consist of a new covered structure constructed over a sealed concrete slab, see Chapter 2 of this EIS for more details.

5.69 Temporary side slopes in backfilled soils will be graded at an angle no steeper than 35° (approximately 1v:1.5h), sufficient to ensure no large scale instability arises over the short-term. Ongoing assessment of slope stability will be undertaken at the application site as backfilling progresses and where necessary, slopes will be re-graded having due regard to safe systems of work.

Post Restoration Phase

5.70 Once the proposed backfilling and restoration works are complete, there will be no risk of instability, as the final ground surface will be graded to a relatively flat, shallow slope. Permanent restored slopes on completion of the site backfilling and restoration activities will generally be shallower than 1v:5h (11°) and everywhere shallower than 1v:2h (26°).

5.71 It will not be possible to mitigate the potential loss of aggregate resource associated with any prospective backfilling and restoration of the former quarry. It is however considered that this impact, although assessed to be of medium significance, is acceptable when balanced against other potentially beneficial impacts of the proposed development.

RESIDUAL IMPACT ASSESSMENT

5.72 The geology at the proposed development site has been assessed with reference to information held by the Geological Survey of Ireland, Teagasc and the Office of Public Works. This information has been supplemented with observations made during site visits.

5.73 The potential impacts of the proposed development upon the soils and geology have been identified and assessed, and where appropriate, mitigation measures have been identified which mitigate potential environmental impacts arising from the proposed development.

5.74 It is recommended that all aspects of the proposed backfilling / operation phase works should be undertaken in accordance with best practice environmental guidance similar to that implemented at active quarries.

Backfilling / Operational Phase

5.75 Measures have been identified which will ensure that there will be no significant impact on the soils, subsoils and bedrock at the application site during the backfilling / operational phase of the project.

Post Restoration Phase

5.76 Measures have been identified which will ensure that there will be no significant impact on the soils, subsoils and bedrock at and beyond the application site after the quarry void has been backfilled.

5.77 Backfilling and reinstatement of the existing quarry void will improve the visual appearance of the local landscape and facilitate re-establishment of the heathland / grassland habitat which originally existed at the application site.

5.78 The restored site will ultimately merge into the surrounding local landscape, thereby improving the overall visual quality, amenity and presentation of the landscape around the Great Sugar Loaf, a prominent geological feature of local historical and cultural significance (and a designated pNHA).

Summary of Residual Impacts

5.79 Overall, the implementation of the identified mitigation measures and establishment of an Environmental Management System at the application site means that the residual significance of the impacts on the underlying soils, subsoils and bedrock at the application site are, with one exception, largely determined to be 'Low' or better (refer to Table 5-4 overleaf).

Table 5-4
Summary of Residual Effects with Proposed Mitigation

Potential Impact	Spatial and Temporal Impact	Probability of Occurrence	Magnitude of Impact	Risk from Impact	Proposed Mitigation Measures	Mitigated Probability of Occurrence	Mitigated Magnitude of Impact	Residual Significance of Impact
Soils, Subsoils and Geology – Construction / Operational Phase								
Leakage of fuels etc. to soils and subsoils	Local and long term	Medium	Moderate	Medium	Bunded Fuel Storage. Hard stand for refuelling and repairs. Oils and lubricants stored under cover. Emergency Spill Kit.	Low	Moderate	**Low**
Rogue load of contaminated material	Local and long term	Medium	Moderate	Medium	Visual & chemical inspection of all imported waste. Covered and sealed concrete quarantine area.	Low	Moderate	**Low**
Instability of temporary slopes	Local and short term	Medium	Slight	Low	Slope graded at an angle no steeper than 35°. Continuous assessment of the slope stability as backfilling progresses.	Low	Slight	**Low**
Soils, Subsoils and Geology – Post Restoration Phase								
Instability of final slopes	Local and long term	Low	Slight	Low	Graded to a relatively flat shallow slope - everywhere shallower than 11° (and no steeper than 26°).	Near Zero	Slight	**Negligible**
Potential loss of aggregate reserves	Regional and long term	High	Slight	Medium	No mitigation possible at application site. Increased output from other facilities	High	Slight	**Medium**

REFERENCES

Gardner and Radford (1980) Soil Associations of Ireland and Their Land Use Potential, An Foras Taluntais / National Soil Survey of Ireland.

Geological Survey of Ireland (2000) Database of Active Quarries, Mines and Pits

Geological Survey of Ireland 1:100,000 Digital Geology Map of Ireland.

Geological Survey of Ireland (2004) 'Geology of Kildare-Wicklow (Sheet 16)'

Geological Survey of Ireland Irish Landslides Working Group (2006) 'Landslides in Ireland'

Geological Survey of Ireland (2010) Minerals Database

Geological Survey of Ireland (2010) Karst Database

Office of Public Works (www.floodmaps.ie).

Ordnance Survey Ireland (www.smartmaps.ie).

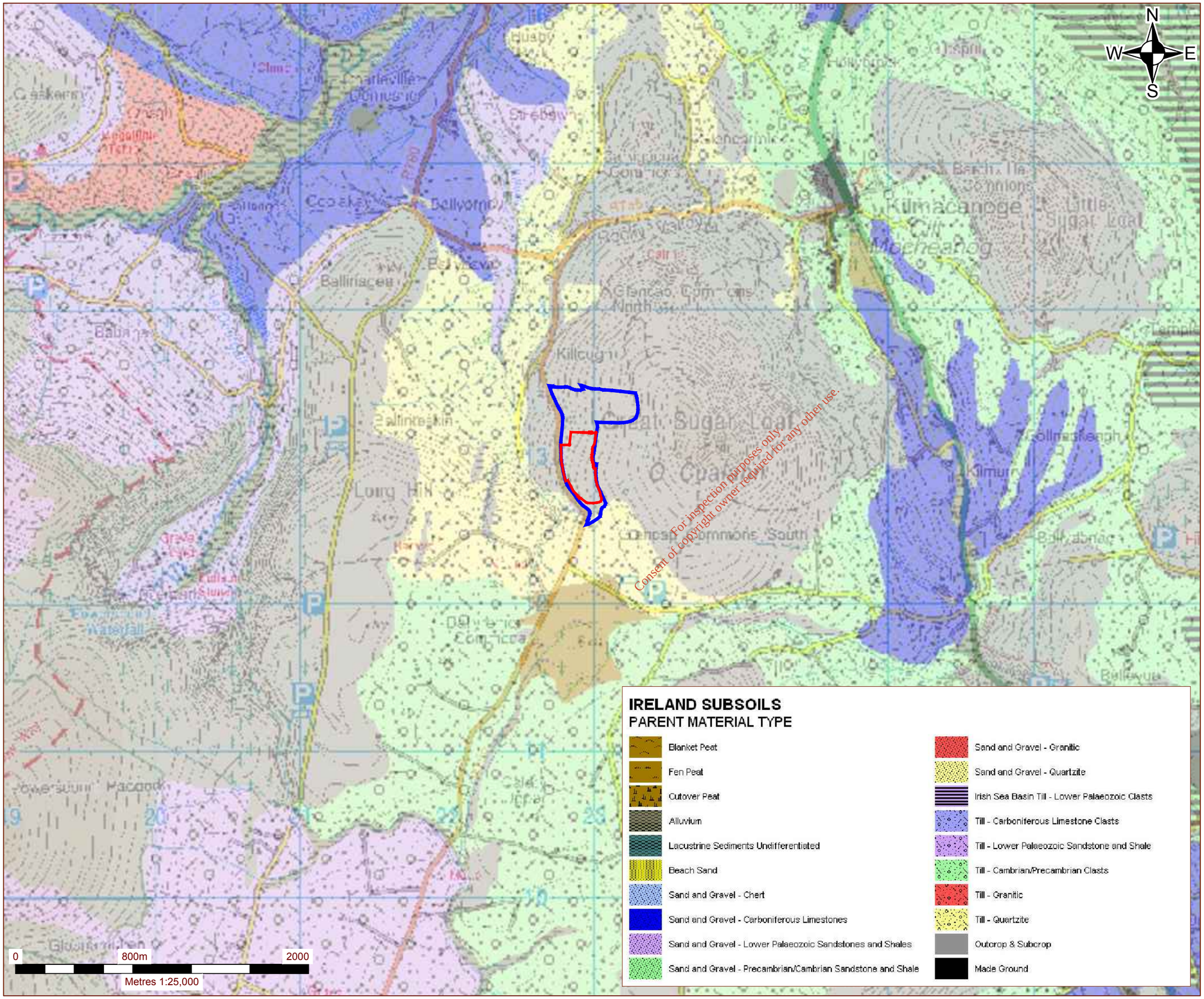
Teagasc (2004) 'Subsoil Map of Ireland' Digital Copy.

Wicklow County Council (2010-2016) Wicklow County Development Plan

FIGURES

Figure 5-1
Regional Subsoils

Figure 5-2
Regional Bedrock Geology



IRELAND SUBSOILS
PARENT MATERIAL TYPE

- Blanket Peat
- Fen Peat
- Cutover Peat
- Alluvium
- Lacustrine Sediments Undifferentiated
- Beach Sand
- Sand and Gravel - Chert
- Sand and Gravel - Carboniferous Limestones
- Sand and Gravel - Lower Palaeozoic Sandstones and Shales
- Sand and Gravel - Precambrian/Cambrian Sandstone and Shale
- Sand and Gravel - Granitic
- Sand and Gravel - Quartzite
- Irish Sea Basin Till - Lower Palaeozoic Clasts
- Till - Carboniferous Limestone Clasts
- Till - Lower Palaeozoic Sandstone and Shale
- Till - Cambrian/Precambrian Clasts
- Till - Granitic
- Till - Quartzite
- Outcrop & Subcrop
- Made Ground

NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. **SU 0000716 (C)** ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

2. MAPPING FROM ORDNANCE SURVEY DISCOVERY SERIES MAPPING - MAP NO'S **68, 69, 76 & 77**

LEGEND

- ROADSTONE LIMITED LAND INTEREST (c.25.4 Hectares)
- PLANNING APPLICATION AREA (c.9.1 Hectares)

SLR CONSULTING IRELAND
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ROADSTONE LIMITED
ENVIRONMENTAL IMPACT STATEMENT

INERT SOIL WASTE RECOVERY FACILITY
CALARY QUARRY,
KILMACANOGE, CO. WICKLOW

SUBSOILS MAP

FIGURE 5-1

Scale	Date
1:25,000 @ A3	MAY 2016

00180.00109.0.FIG_5-1.Subsoils Map.dwg

N
W E
S

0 800m 2000
Metres 1:25,000

Bedrock Type

- BR: Bray Head Fm. (Greywacke & quartzite)
- DG: Devils Glen Fm. (Greywacke & shale)
- MN: Maulin Fm. (Dk. blue-grey slate, phyllite & schist)
- Nt1: Type 1 Granite (granodiorite)
- Nt2e: Type 2 Granite (equigranular)
- Nt2p: Type 2 Granite (microcline porphyritic)
- Nt3: Type 3 Granite (muscovite porphyritic)
- Nt4: Type 4 Granite (muscovite-microcline porphyritic)
- BRqz: Quartzite in Bray Head Formation

Structures

- Fault
- Anticlinal axis
- Synclinal axis

NOTES

1. ORDNANCE SURVEY IRELAND LICENCE NO. **SU 0000716 (C)** ORDNANCE SURVEY IRELAND & GOVERNMENT OF IRELAND

2. MAPPING FROM ORDNANCE SURVEY DISCOVERY SERIES MAPPING - MAP NO'S **68, 69, 76 & 77**

LEGEND

ROADSTONE LIMITED LAND INTEREST (c.25.4 Hectares)

PLANNING APPLICATION AREA (c.9.1 Hectares)

SLR CONSULTING IRELAND
7 DUNDRUM BUSINESS PARK
WINDY ARBOUR
DUBLIN 14
T: +353-1-2964667
F: +353-1-2964676
www.slrconsulting.com

ROADSTONE LIMITED
ENVIRONMENTAL IMPACT STATEMENT

INERT SOIL WASTE RECOVERY FACILITY
CALARY QUARRY,
KILMACANOGE, CO. WICKLOW

BEDROCK MAP

FIGURE 5-2

Scale	Date
1:25,000 @ A3	MAY 2016

00180.00109.0.FIG_5-2.Bedrock Map.dwg

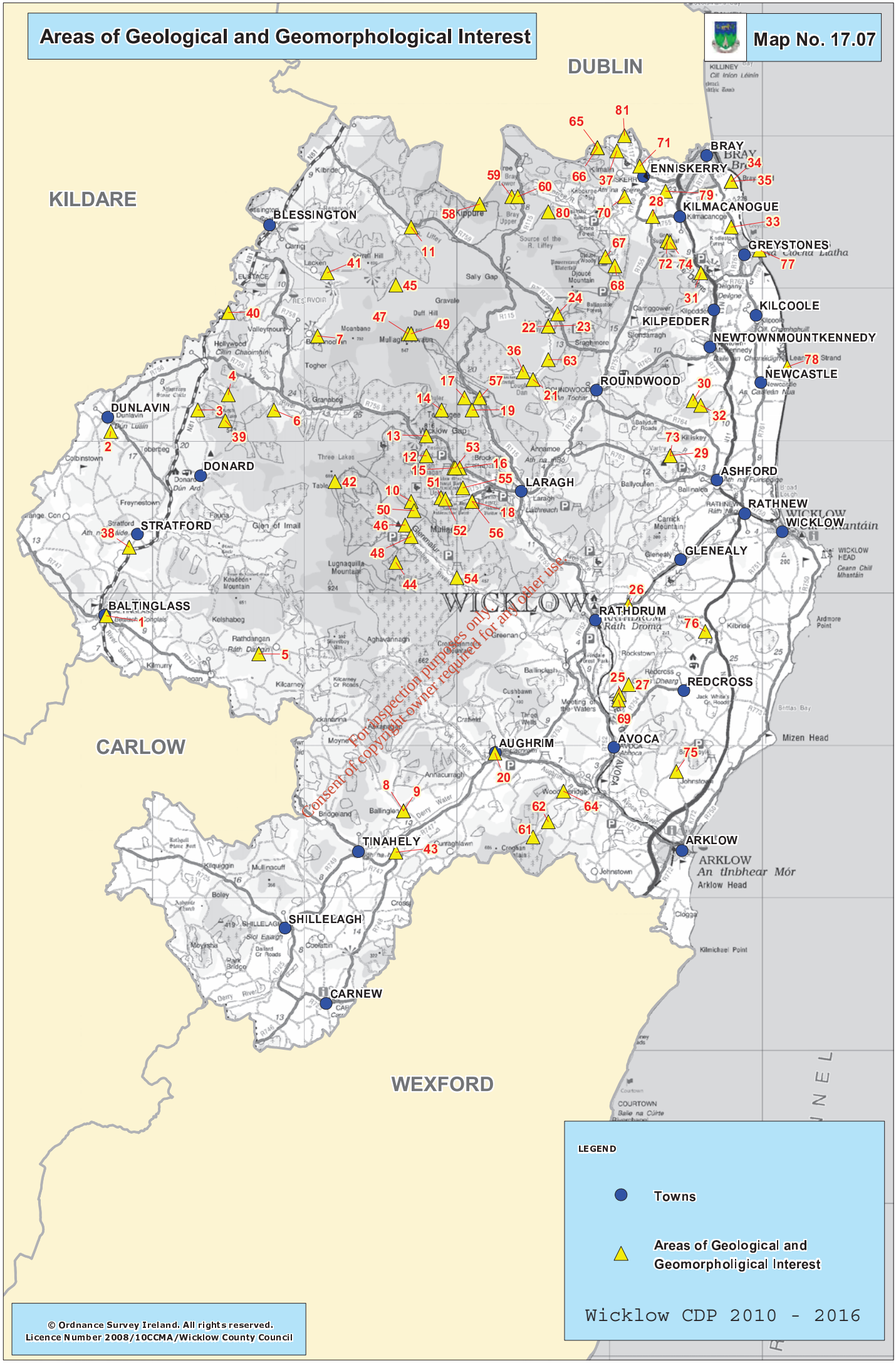
APPENDIX 5-A
GEOLOGICAL HERITAGE SITES IN CO. WICKLOW

Schedule 17.7 Areas & sites of geological and geomorphological interest - map 17.07

	Site Name	Location		Summary description
1	Baltinglass	287000	188500	Tourmaline.
2	Tober, Dunlavin	287300	200600	Spring in gravels.
3	Hollywood Glen	293000	202000	Meltwater, channels, flood tracks.
4	Toor Channel	295000	203000	Glacial spillway.
5	Rathdangan End Moraine	297000	186000	Moraine, fan, kettle holes.
6	Upper Lockstown Delta	298000	202000	Glacial meltwater delta, fans.
7	Ballyknockan Quarries	300852	206854	Granite quarries.
8	Ballinglen	306500	175700	Mineralogy in microgranite.
9	Ballinglen	306500	175700	Tungsten and other minerals.
10	Van Diemen's Mine	307000	196000	Pyromorphite mineral.
11	Athdown Moraine	307000	214000	Moraine, gravels.
12	Lough Nahanagan	308000	199000	Corrie.
13	Wicklow Gap	308000	200300	Granite pillars.
14	Lough Ouler	309000	202000	Corrie.
15	Glendasan	309800	198200	Pyromorphite, wolfenite, other minerals.
16	Glendasan [Pb]	310187	198204	Lead-Zinc veins in Leinster Granite; mine workings.
17	Glenmacnass Waterfall	310500	202800	Leinster Granite contact with Ordovician sediments.
18	Glendalough Valley	311000	196000	Delta, hanging valley, U-shaped valley.
19	Glenmacnass	311000	202000	Granite, schists, moraines, U-shaped valley, upland morainic landscape.
20	Aughrim Quarry	312500	179500	Microgranites earlier than Leinster Granite.
21	Lough Dan	315000	204000	Ribbon lakes.
22	L. Tay/ Luggala	316000	207500	Coticule/garnetiferous quartzites with intricate folds.
23	Lough Tay	316000	207500	Ribbon lakes.
24	Luggala	316600	208300	Coticule (garnet quartzite).
25	The Mottee Stone	320650	183350	Large erratic boulder.
26	Slieveroe lane and rail cutting	321250	189200	Ordovician shelly fossils.
27	Kilmacoo	321278	183990	Pyrite Mine with metallic minerals.
28	Rocky valley	322850	214700	Cambrian microfossils.
29	Devils Glen	324000	199000	meltwater channel.
30	Callow Hill Upr.	325500	202600	Eskolalite - green mineral coating on quartz pebbles.
31	Glen of the Downs	326000	111000	Glacial overflow channels, glacial meltwaters.
32	Dunran	326000	202300	Meltwater channel.
33	Greystones	328000	214000	Glacial morainal bank, coarse grained diamict.
34	Bray Head	328000	217000	Cambrian trace fossils, Oldhamia.
35	Bray Head	328000	217000	Type locality of the Cambrian Bray Head Formation.
36	Lough Dan, north end	~314350	~204500	Leinster Granite contact with Ordovician sediments.
37	Glencullen River - Enniskerry	~320500	~219000	Gorge.
38	Manger - Saundersgrove	288500	193000	Palaeo-deltas.
39	Church Mountain	294800	201300	Chemical weathering, mass wasting.
40	Brittonstown	295000	208400	Glacial channel.

41	Lacken	301500	211000	Chemical weathering.
42	Table Mountain	302000	197300	Peat hags and erosion.
43	Derrywater & Derry River, Tinahely	306000	173000	Fluvial captures and diversions, palaeo-channels.
44	Lugnaquillia	306000	192000	Glacial features, e.g. nunataks.
45	Ballydonnell	306000	210200	Gravel bars, glacial mountain erosional inheritance.
46	Glenmalure (north side)	306600	194450	Leinster granite contact.
47	Mullacleevaun	306800	207000	Peat hags and erosion.
48	Glenmalure	307000	193700	Screes, fan, mass wasting.
49	Wicklow Mountains	307000	207000	Valley glacier landscapes.
50	Lugduff	307200	195400	Pseudokarst pipes.
51	Glendalough	308957	196248	Lead-zinc mineralization in Leinster Granite
52	Glendalough	309250	196150	Leinster Granite contact with Ordovician sediments.
53	Glendasan	309900	198200	Boulder beds, bedrock channel.
54	Glenmalure	310000	191000	Morainic landscape.
55	Camaderry Appinite	310400	196900	Appinite (igneous intrusion).
56	Glendalough	311000	196000	Pollanass waterfall, glacial mountain erosional inheritance.
57	Glenmacnass Upper	311500	202800	Meanders, waterfall, boulder beds, bedrock channel.
58	Kippure	311500	215500	Peat hags and erosion.
59	Lough Bray, Upper and Lower	313600	216000	Corrie lakes.
60	Lough Bray, Upper and Lower	314000	216000	Corries.
61	Ballinvally (Goldmine R.) [Au]	315000	174000	1790's gold workings.
62	Goldmines River	316000	175000	Straths, planation surface.
63	Cloghoge River and Lough Tay	316000	205300	Mass wasting, waterfall, boulder beds, delta.
64	Ballycoog [BIF]	317000	177000	Magnetite-siderite deposits in Avoca Volcanic Formation; old workings.
65	Ballybrew Quarry	319215	219205	Leinster granite quarry.
66	Ballybrew Quarry	319215	219205	Leinster granite quarry.
67	Powerscourt Waterfall	319750	212055	Steep 100m waterfall.
68	Powerscourt Deerpark Cave	320360	211465	Cave breccia of fluvial gravels.
69	Avoca Mine	320616	182986	Avoca Copper Mine.
70	Powerscourt	321000	216000	Morraines.
71	Enniskerry Delta	322000	218000	Delta.
72	The Sugarloaf	323800	213100	Physical weathering, screes.
73	Devils Glen	324000	199000	Waterfall, bedrock channel, gorge.
74	Great Sugarloaf	324000	213000	Scree slopes.
75	Snugborough	324400	178300	Fossil Pingos (glacial mound).
76	Ballard	326299	187484	Numerous Ballards In Wicklow.
77	Greystones	329850	212500	Appinite suites (igneous intrusions).
78	Wicklow - Greystones coast	332000 to 329000	194000 to 213000	Shingle coast with overwash features.
79	River Dargle, Enniskerry	~323700	~216350	Gorge.
80	Glen Ding	316000	215000	Glacial valley, overflow channel
81	The Scalp	321000	220000	Glacial outwash channel, block scree and spillway.
82	Crone forest outside Glencree	318300	214200	Pegmatite (igneous intrusions).
83	Haematite breccia locality	319825	209475	Haematite breccia.
84	Blessington	297500	215500	Glacial palaeo-deltas
85	Glencullen	320000	219200	Mass wasting (slumps)

86	Lockstown, Kings River	298050	203030	Meanders, oxbows, delta, palaeo-terraces, palaeo-deltas, glacifluvial sedimentary inheritance, glacial mountain erosional inheritance.
87	River Slaney, Baltinglass	286750	189400	Gorge
88	Upper River Liffey	309450	213230	Gravel bars (Sean's Bar), Bm, EB, palaeo-terraces, glacial mountain erosional inheritance, glacial sedimentary inheritance.



WICKLOW - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Great Sugar Loaf**
Other names used for site	Big Sugar Loaf, Little Sugar Loaf, *Ó Cualann*
IGH THEME	**IGH4 Cambrian-Silurian, IGH7 Quaternary**
TOWNLAND(S)	**Glencap Commons South, Glencap Commons Upper, Glencap Commons North**
NEAREST TOWN/VILLAGE	**Kilmacanoge**
SIX INCH MAP NUMBER	**7, 8**
ITM CO-ORDINATES	**723710E 713110N (summit)**
1:50,000 O.S. SHEET NUMBER	**56 GSI BEDROCK 1:100,000 SHEET NO. 16**

Outline Site Description
A prominent, scree covered, quartzite conical mountain peak standing out on the north Wicklow and Dublin skyline.

Geological System/Age and Primary Rock Type
Cambrian quartzite (Bray Head Formation) bedrock with greywacke/quartzite bedrock on the south/southwest slopes. The scree deposits (of quartzite) are Quaternary in age, having formed from freeze-thaw activity during the last glaciation.

Main Geological or Geomorphological Interest
Great Sugar Loaf (501m) is a prominent conical peak of pale-pink Cambrian quartzite, around 7km southwest of Bray. The conical shape contrasts with the rounded summits of the granite mountains to the west. The elevated terrain comprising Great Sugar Loaf, Little Sugar Loaf and Bray Head marks the northern margin of a tectonic slide (roughly along the course of the River Dargle) where Cambrian rocks were thrust up onto Ordovician rocks (found between Bray Head and Killiney Hill and southwest beyond Rathdrum). This NW directed thrusting occurred during a great mountain building event (Caledonian Orogeny), 475-400 million years ago, also during which the Late Caledonian Leinster granites were formed.

Great Sugar Loaf and Little Sugar Loaf (341m), 3km to the northeast, are separated by Kilmacanoge valley. This valley was part of a regional north-south subglacial meltwater drainage route that included the Scalp (north) and Glen of the Downs (southeast). The mountain summit affords wonderful views of these spectacular meltwater channels, which are incised into high topography of solid bedrock. The steep upper slopes of Great Sugar Loaf are blanketed with extensive patches of loose angular quartzite boulders (scree) that have physically weathered out, by freeze-thaw action, from the upper summit and rolled downwards to their present locations. Screes occur in virtually all upland areas throughout Ireland, particularly on quartzite mountains such as Great Sugar Loaf, Errigal (Co. Donegal) and the Twelve Bens (Co. Galway). Views even as far as Snowdonia, Wales are possible from the summit of Great Sugar Loaf on a clear day.

Site Importance - County Geological Site
Great Sugar Loaf is a prominent landmark on the Dublin and north Wicklow skyline. Great Sugar Loaf is a proposed NHA (001769). A Landscape Survey of the Great and Little Sugar Loaf Mountains conducted in 2010 considered the site to be of 'high amenity, cultural and natural heritage significance in a local and regional context'.

Management/promotion issues
A popular site for hiking, the southern 1km-long route to the summit is severely eroded down to the bedrock. Litter is a common problem along the well-trodden track and summit. A public information panel at the car park would help to inform visitors of the sensitive nature of the site, how to minimise damage, and promote the geological heritage of the mountain.

Great Sugar Loaf, viewed from the southern hiking route to the summit.

Hiking track through a scree slope-failure scar on the southern slopes of Great Sugar Loaf.

View of the north side of Great Sugar Loaf from Glencullen, looking southeast.

Scree on the southeast slopes of Great Sugar Loaf.