SECTION 5: SOILS AND GEOLOGY

5.1 INTRODUCTION

5.1.1 Purpose of Study

This study presents available information on the soils and geology within and immediately beyond the site of the inert waste recovery facility to be operated by Roadstone Dublin Ltd, at Fassaroe, Co. Wicklow, together with an interpretation of the existing local geological environment at the site. It will identify how the geological environment will be impacted by the waste recovery facility and, where possible, will identify how these impacts may be mitigated.

5.1.2 Difficulties Encountered in Compilation

This impact assessment is based on a visual inspection of the site, published geological maps and available ground investigation data which includes a trial pit survey and borehole survey at the applications site. No particular difficulties were encountered in preparing this report.

5.1.3 Personnel

This study of soils and geology was undertaken and prepared by:

Peter Glanville, B.A., M.Sc. Ph.D., Geomorphologist, SLR Consulting Ireland
Mike Kelley, B.Sc., M.Sc., M.I.E.I., Geotechnical Engineer, SLR Consulting Ireland

5.1.4 Consultations

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

- Teagasc
- 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

5.2 RECEIVING ENVIRONMENT

5.2.1 Outline of the Baseline Study

This study was prepared using previously published regional geological and geomorphological data, together with site-specific ground investigation information from the trial pit and borehole surveys across the application site. The application site lies entirely within Roadstone Dublin's existing landholding at Fassaroe, Co. Wicklow. Existing in-situ soil exposures were also visually inspected to assist in the interpretation of ground conditions occurring across and immediately beyond the application site.

5.2.2 Soil

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.

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.

The soils surrounding the application site at Fassaroe are classified as Grey Brown Podzolics, a mineral soil which formed on fluvio-glacial limestone gravels and sands (An ForasTaluntais,

1980). These soils are described as having a wide use range of agricultural uses, including tillage and pasture (An ForasTaluntais, 1980).

Topsoil (the upper layer of soil capable of sustaining vegetation and crop growth) and subsoil was previously stripped from the application site in order to facilitate the development of the sand and gravel quarry. It is currently stockpiled as hummocky mounds along the eastern side of the former quarry void.

5.2.3 Quaternary Geological and Geomorphological Setting

Quaternary geology comprises the study of the soils deposited or formed during the last 2 million years. Such soils are termed quaternary subsoils. The two main types of quaternary subsoil in Ireland are glacial till, deposited at the base or margins of ice sheets, and sand and gravel deposits, whose deposition is generally associated with the melting of ice sheets, at the end of periods of glaciation. Other extensive quaternary subsoils in Ireland include basin and blanket peat, river alluvium and estuarine deposits.

Sand and gravel deposits are broadly categorised as glacio-fluvial outwash deposits, and can consist of esker, outwash and deltaic soils deposited beneath, or at the edge of, the melting ice sheets. The majority of quaternary sub-soils in Ireland were formed or deposited during, or at the end of, the last glaciation, termed the 'Midlandian Glaciation'. In Ireland, the peak (maximum) extent of this glaciation occurred approximately 24,000 to 20,000 years ago. However, by around approximately 11,000 years ago, the associated ice sheets had largely retreated and melted from the island of Ireland.

During the maximum of the last glaciation, the Midlandian ice sheet covered most of central Ireland while another ice sheet pushed down the Irish Sea basin from Scotland. The Irish Sea basin ice sheet pushed up onto the eastern side of the Dublin and Wicklow mountains and deposited large quantities of glacio-fluvial material along the eastern side of the mountains in a series of deltas. The sands and gravels which occur in the vicinity of the application site at Fassaroe are interpreted to be glacio-fluvial deltaic outwash deposits which were transported in glacial meltwaters and laid down in lakes between the edge of the ice sheet and the mountains. The application site at Fassaroe is located within the larger Fassaroe delta deposit.

5.2.4 Regional Quaternary Geology

The historical geological map for the North Wicklow (Bray) area published by the Geological Survey of Ireland (GSI), Sheet 121 (1855), indicates that the quaternary subsoils in the vicinity of the application site are described as comprising '*Drift principally Marl with Sand and Gravel*'.

The Teagasc Subsoil map (2004) for the area, an extract of which is re-produced in Figure 5.1, indicates that the site lies within an area of sand and gravel deposits which are predominantly comprised of Carboniferous limestone materials. Figure 5.1 also indicates that alluvium occurs along the Cookstown and Dargle Rivers to the south and east of the site.

5.2.5 Regional Solid Geology

The 1:100,000 scale solid geology map (*Geology of Kildare – Wicklow, Sheet 16)* published by the Geological Survey of Ireland indicates that the regional bedrock geology at the site comprises slates, phyllites and schists of the Maulin Formation and tuffs and greywacke of the Glencullen River formation. An extract from the GSI bedrock map is reproduced as Figure 5.2.

The Maulin and Glencullen River formations are members of the Ribband Group which were deposited in a deep marine environment setting and now outcrop on either side of the Leinster Granite batholiths. Both formations are believed to be of Lower Ordovician Age (490 to 470million years old). A contact or fault line between the Glencullen and Maulin Formations is inferred to run beneath the site in east-west direction, refer to Figure 5.2. However, there is no surface evidence of this fault as bedrock is buried at depth across the site, overlain by significant thickness of Quarternary subsoils.

5.2.6 Available Ground Investigation Information

A ground investigation at the site undertaken in November and December 2008 comprised a series of trial pits and boreholes to investigate the nature of the soils and subsoils at the site.

A total of five trial pits were excavated at Fassaroe, specifically trial pits FTP1, FTP2, FTP3, FTP6 and FTP7. The locations of these excavations are indicated in Figure 5.3. Excavation depths extended to between 2.8m and 4.3m below ground level. A further two trial pits, FTP4 and FTP5, were attempted in the existing silt lagoons, shown in Figure 5.3, however it was not possible to excavate them due to the saturated and softened nature of the silt materials. The trial pit logs and photographs of this excavation are provided in a ground investigation report in Appendix 5.1.

Two trial pits, FTP1 and FTP2, were excavated at the existing (permitted) construction and demolition (C&D) waste recovery facility. Trial pit FTP1 encountered 1.9m of Made Ground comprising crushed concrete / rock overlying glacial till, while trial pit FTP2 encountered 0.3m of Made Ground comprising crushed concrete / rock overlying sand. Trial pit FTP3 was excavated on the floor of the worked out quarry and encountered 4.3m of glacial till material.

Trial pits FTP6 and FTP7 were excavated in undisturbed ground to the east of the worked out quarry area, refer to Figure 5.3. Trial pit FTP6 encountered 3.2m of glacial till material, while trial pit FTP7 encountered 2.7m of glacial till material overlying sand, refer to Appendix 5.1.

Two subsoil samples were taken at the site for baseline chemical analysis, one sample was taken from trial pit FTP2 at the existing waste recovery facility, while the other was taken from trial pit FTP6, located immediately to the east of the quarry, see Figure 5.3

Three groundwater monitoring wells (BH1, BH2 and BH3) were subsequently installed across the application site in December 2008, at locations indicated in Figure 5.3. The monitoring wells were drilled using rotary techniques, and as a result, it was only possible to obtain general descriptions of the quarternary subsoil deposits encountered during well drilling. In general, the monitoring wells encountered an upper sand layer overlying clayey sand and gravel. The boreholes were drilled to a depth of between 24m (BH1 and BH2) and 30m (BH3). Subsoils encountered during drilling are described as follows:

- MADE GROUND (sandy gravelly clay);
- Fine to medium to coarse brown to brown SAND;
- Slightly sandy, silty CLAY; and,
- Brown clayey slightly gravelly medium SAND.

The clay bands were recorded at a thickness of between 0.5m to 3m. Monitoring well construction records are presented in the groundwater well installation report, reproduced as Appendix 6.1.

5.2.7 Geological Interpretation: Ground Conditions

An interpretation of the general subsoil profile across the application site at Fassaroe has been inferred on the basis of the available ground investigation information.

The bare surfaces across the existing waste recovery and aggregate processing facilities comprise varying depths of Made Ground, principally processed concrete / rock, overlying natural ground comprising glacial till and/or sand. The silt lagoon is underlain by silt and clay materials derived from on-site aggregate washing activities, while any remaining undisturbed ground is underlain by glacial till.

5.2.8 Geohazards

The Fassaroe site is underlain by the Maulin and Glencullen River formations, comprising Lower Ordovician Age slate, schist, tuff and greywacke. There are no Carboniferous age limestones or other solution prone bedrock within the study area, and therefore no karst solution features occur within the area.

The presence of relatively flat to slightly undulating topography and surrounding quaternary geology predominantly comprising glacial tills, suggest the application site is unlikely to be susceptible to natural geological hazards such as landslides. There are no raised bogs in the

vicinity of the site and no historical landslides were identified area around the site by the Irish Landslides Working Group (GSI, July 2006).

The site is unlikely to flood given its elevated location above the Cookstown and Dargle rivers. The OPW flood database (www.floodmaps.ie) does not indicate any recurring flood points in the vicinity of the site (within 1km). A few flood points identified in the general area (within 2km to 3km) of the site are associated with the Dargle River in Bray town.

5.2.9 Geological Heritage

The Geological Survey of Ireland has confirmed that there are no proposed geological National Heritage (pNHA) sites in the vicinity of the application site.

Schedule 10.9 of the Wicklow County Development Plan identifies a number of sites of geological and geomorphological interest in the vicinity of the application site. The listed sites include

(i) the Fassaroe Delta which is located immediately beyond the north-west arm of the Fassaroe Junction on the N11 National Primary Road
(ii) a sub-glacial channel, known as the Scalp, along the channel of the Glenmunder River to the north of the application site and
(iii) the Dargle River Valley to the south of the application site.

The extent of the Fassaroe Delta deemed to be of geological and/or geomorphological interest is not defined in the Wicklow County Development Plan. Visual inspection of the side slopes in the former sand and gravel quarry indicate that existing exposures are inaccessible, of relatively poor quality and of little geological heritage interest. The existing side slopes are also partially obscured by end tipping of inert waste (principally soil and stone) and/or by vegetation growth.

5.2.10 Economic Geology

The location of naturally occurring sand and gravel deposits beside local population centres at Greystones and Bray, Co. Wicklow and Shankill, Co. Dublin, coupled with its proximity to a large population centre in the Greater Dublin Area, has meant that this site has historically supported sand and gravel extraction activity and related value added industry. Extracted sand and gravel is generally processed and supplied to the construction industry as drainage stone or mortar sand. It is also used in the production of construction materials such as blocks, paving blocks or ready-mixed concrete.

Sand and gravel extraction activity ceased at the Fassaroe site in the mid-1990's when the existing sand and gravel resource had largely been worked out. Although extraction activity has ceased at the site, sand and gravel continues to be imported to the site for screening and washing and use in production of readymix concrete.

5.2.11 Made Ground

Construction and demolition waste materials have been recovered at the northern end of the application site since 2004, in accordance with the terms of a waste recovery permit issued by Wicklow Co. Council. Trial pits excavated across site confirm that Made Ground, comprising inert C&D waste (stones, crushed concrete etc) lies across the existing waste permit area.

Elsewhere, within the waste licence application area, the silt lagoons formed by hydraulic deposition of excess silt and clay sized particles from the aggregate washing process also comprise Made Ground.

5.3 IMPACT OF THE SCHEME

5.3.1 Evaluation of Impacts

The evaluation of impacts on the soil and geology environment at and in the vicinity of the inert waste recovery site at Fassaroe, Co. Wicklow is generally based on a methodology similar to that outlined in the soon to be published 'Guidelines for the Assessment of Geology, Hydrology and Hydrogeology for National Road Schemes' (2009).

The importance of existing soil and geology attributes discussed previously is assessed in Table 5.1 below:

Attribute	Status / Occurrence	Importance
Geohazards	Ongoing, localised erosion and instability in exposed soils on existing quarry side slopes.	Low
Geological Heritage	Fassaroe Delta : Area designated by Local Authority as being of Geological and Geomorphological interest.	High
Economic Geology	Economic extraction complete at application site.	Low
Soils	Productive soils previously removed / degraded across application site. Undisturbed soils in the vicinity of site used for wide range of agricultural activities.	Medium
Made Ground	Crushed, recycled inert construction and demolition waste is generally of low economic value and is as general fill material. No evidence of soil/subsoil contamination at application site.	Low

Table 5.1 Importance of Geological Attributes in vicinity of Application Site

The significance of the impacts on the soil and geology attributes is assessed in Table 5.2:

Attribute	Impact of Proposal on Attribute	Magnitude
Geohazards	Elimination of localised erosion over slope faces. Elimination of risk of slope instability.	Small
Geological Heritage	Fassaroe Delta : Reinstatement of quarry will mean the loss of some limited subsoil exposure of possible geological interest. The reinstatement will also result in the restoration of the former delta landform.	Small (negative)
Economic Geology	No further extraction at the site or sterilisation of potential aggregate resource	Neglible
Agricultural Soils	Restoration of former landform and placement of topsoil / subsoil on completion of backfilling will restore lands to agricultural use.	Small
Made Ground	Importation of soil, stones and inert construction and demolition waste introduces a risk of potential soil contamination	Small

Table 5.2 Magnitude of Impacts on Soil and Geology

The backfilling and restoration of the application site to former ground level will eliminate ongoing erosion and the risk of potential slope instability within the worked out area of the application site.

Although the loss of subsoil exposures within a site, which are considered to be of potential significant regional geological interest, may be deemed to be of moderate negative impact, this is lessened to some degree by the potential enhancement of the original landform arising from backfilling and restoration of the void (albeit with different geological materials). The backfilling and quarry restoration works at the site will result in a small negative impact overall.

As this proposal constitutes a small impact on a feature of high value; the overall significance of the quarry restoration works on geological heritage is deemed to be moderate and negative.

The proposed quarry restoration works will provide for the re-establishment of agricultural soils across the application site and result in its return to agricultural use. As it constitutes a small improvement for soils considered to be of moderate importance, the significance of this impact is considered to be minor and positive.

In the absence of any controls, the importation of soil, stones and inert C&D waste could introduce a risk of potential soil contamination at the application site. The recent ground investigation did not identify any soil contamination at the existing C&D waste recovery facility. Assuming continued good management of the facility in accordance with best waste management practice, this risk is likely to remain small. Given that the risk of introducing contamination into existing relatively degraded, low value subsoils is small, the significance of this potential impact is considered to be minor and negative.

5.3.2 Interaction with Other Environmental Receptors

The potential risks associated with the introduction of contaminated soil when backfilling and restoring the former quarry could have implications for groundwater quality, were infiltrating rainfall to percolate down through contaminated backfill materials. This aspect is discussed in more detail in Section 6 of the EIS.

When successfully completed however, the proposed quarry restoration works will provide an increased thickness of soil and subsoil cover above the existing groundwater table, thereby reducing the potential risk of future groundwater contamination.

During the quarry restoration works, the presence of exposed, unvegetated soil surfaces could give rise to fugitive dust during dry windy weather. These issues are discussed in more detail in Section 7 of the EIS (Air Quality).

5.3.3 Do-nothing Scenario

If the application site is not restored completely to former ground level as proposed, and it remains essentially unchanged from its existing layout, it will have the following implications for soil and geology:

(i) the limited soil cover overlying the groundwater will provide for reduced groundwater protection for groundwater quality; and
(ii) there is the potential for continued degradation of existing side slopes, leading to possible slope failures;

5.4 MITIGATION MEASURES

The loss of the existing soil exposures at the application site will be permanent and irreversible. No mitigation measures to retain any exposures are considered feasible, particularly considering the future long-term land-use for mixed residential and commercial development, identified for the site by the Bray Draft Environs Local Area Plan 2009-2015.

In order to minimise the risk of importing and introducing contaminated soil to the site, management systems will be introduced at the application site to establish the source of imported materials in advance and to confirm that they are inert. Multiple level soil testing regimes will be established at the site and will include

(i) basic characterisation testing covering a wide range of parameters to determine the leaching behaviour of soils and inert C+D waste materials imported to site;
(ii) frequent, compliance testing covering a limited range of key soil parameters; and
(iii) comprehensive on-site verification, comprising visual inspection and record of all imported soil and CD waste materials unloading at the site

During backfilling of the former quarry, all temporary surfaces will be graded to facilitate overground run-off of surface water, thereby minimising the volume of rainfall percolating through and potentially eroding the backfilled soil. This will further reduce any residual risk of potential contaminants within the imported wastes leaching into the underlying in-situ soil and groundwater.

In order to confirm that there are no residual risks to soil or groundwater, monitoring of groundwater should continue for the duration of quarry backfilling operations for a short aftercare period.

In order to reduce the risk of localised soil erosion and potential dust emissions during the quarry backfilling works, the area of bare or exposed soils should, insofar as practicable, be kept to a minimum. Consideration could be given to establishing temporary vegetation cover over exposed soil surfaces pending final backfilling and restoration to original ground level.

In order to maximise the future agricultural potential of the restored land, a minimum 150mm thick layer of topsoil and approximately 300mm thick layer of subsoil should be placed over the backfilled material. The final landform should also be graded so as to facilitate overground run-off of surface water and avoid ponding of surface water in closed depressions.

REFERENCES

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

GSI (2004) 'Geology of Kildare - Wicklow (Sheet 16)

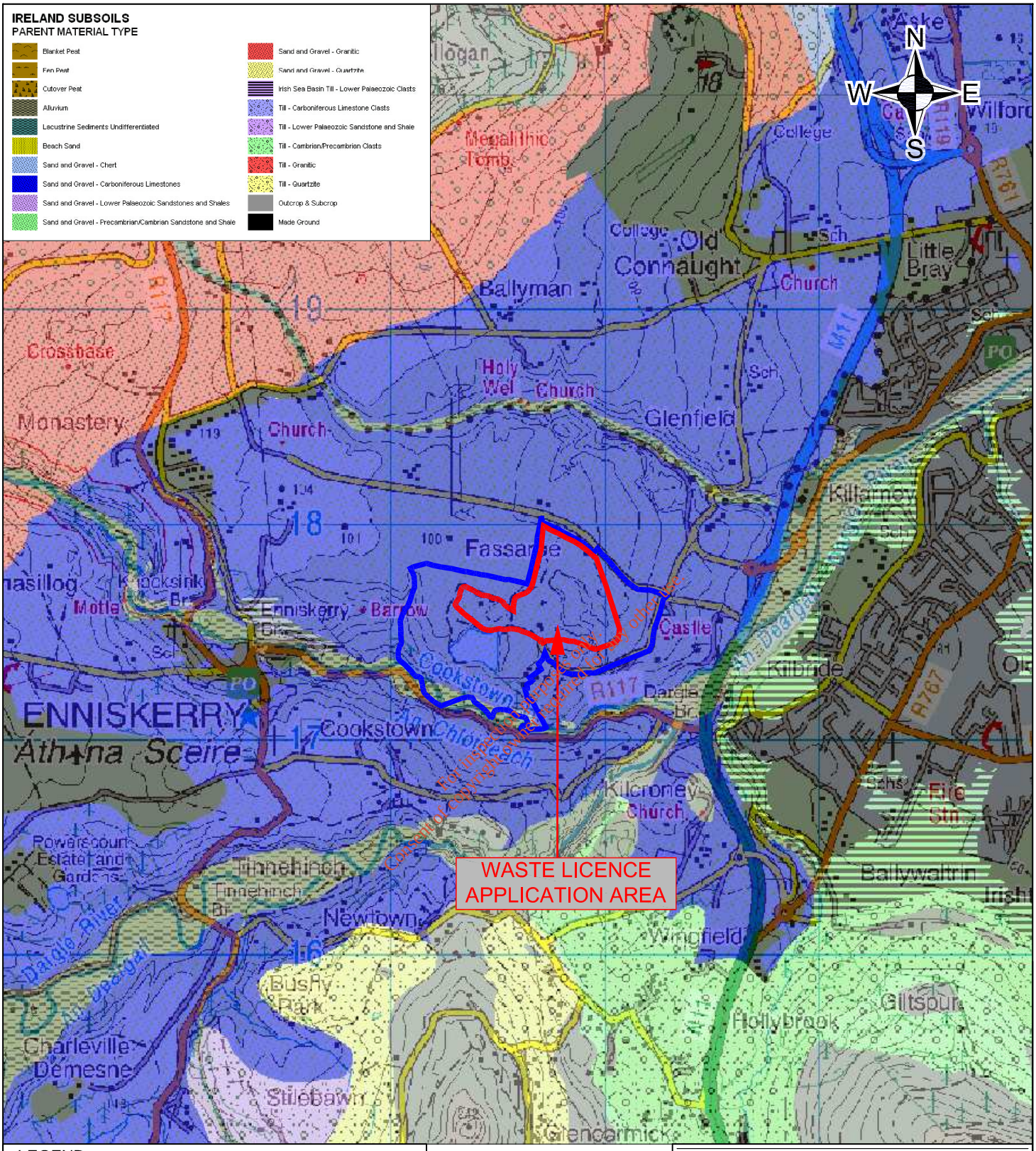
Wicklow County Development Plan (2004 - 2010)

GSI Irish Landslides Working Group (2006) 'Landslides in Ireland'

Office of Public Works – www.floodmaps.ie

An Foras Taluntais (1980) 'Soil Associations of Ireland and Their Land use Potential National Soil Survey of Ireland,

FIGURES



LEGEND

Applicants Land Interest (c. 65.1 ha)

Waste Licence Application Area (c. 21.4 ha)

NOTES

1. Extract from Ordnance Survey Discovery Map No. 50

2. Ordnance Survey Ireland Licence No. SU 0000709 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres
1:25,000

0059.00017.18.FIG 5.2.0.SUBSOILS MAP

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

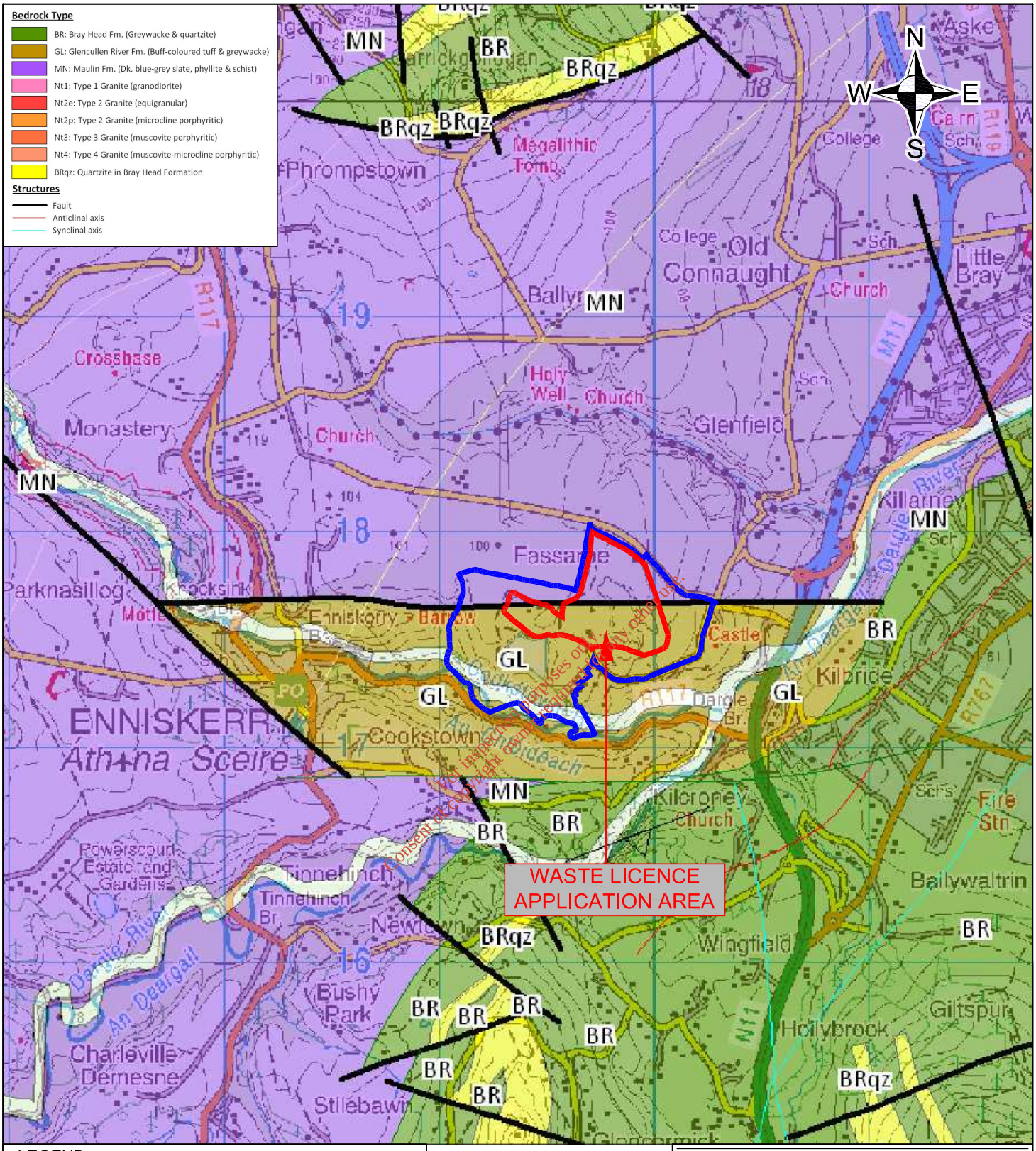
ROADSTONE DUBLIN LTD.
WASTE LICENCE APPLICATION

FASSAROE WASTE RECOVERY FACILITY
FASSAROE, BRAY, CO.WICKLOW

SUBSOILS MAP

FIGURE 5.1

Scale	Date
1:25,000 @ A4	APRIL 2009



LEGEND

Applicants Land Interest (c. 65.1 ha)

Waste Licence Application Area (c. 21.4 ha)

NOTES

1. Extract from Ordnance Survey Discovery Map No. 50

2. Ordnance Survey Ireland Licence No. SU 0000709 (c) Ordnance Survey Ireland / Government of Ireland

0 800m 2000

Metres
1:25,000

0059.00017.18.FIG 5.3.BEDROCK GEOLOGY

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

ROADSTONE DUBLIN LTD.
WASTE LICENCE APPLICATION

FASSAROE WASTE RECOVERY FACILITY
FASSAROE, BRAY, CO.WICKLOW

BEDROCK GEOLOGY

FIGURE 5.2

Scale	Date
1:25,000 @ A4	APRIL 2009

N
W E
S

FTP1
FTP2
FTP3
FTP4
FTP5
FTP6
FTP7
BH01
BH02
BH03

EXISTING POND
SILT AREA
CONCRETE YARD
BLOCK YARD
WEIGHBRIDGE
AGGREGATE PROCESSING PLANT & STOCKPILES
STORAGE YARD
RETAIL AREA & EMPLOYEE PARKING
EXISTING SITE OFFICE
SITE GATE
MAINTENANCE SHED
SILT POND / CLOSED DEPRESSION
EXISTING POND

0 80m 200
Metres
1:2500

NOTES

1. Based on OSi 6inch sheet no. 21

2. Ordnance Survey Ireland Licence no. SU 0000709 (c) Ordnance Survey of Ireland & Government of Ireland

LEGEND

- Applicant's Land Interest (c. 65.1 ha)
- Waste Licence Application Area (c. 21.4 ha)
- Borehole Location
- Trial Pit Locations
- Internal Unpaved Road
- Internal Paved Road
- Building
- Cross Sections

ROADSTONE DUBLIN LTD.
FORTUNESTOWN
TALLAGHT
DUBLIN 24

roadstone

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

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BH AND TP LOCATIONS

FIGURE 5.3

Scale	Date
1:2,500 @ A3	APRIL 2009

0059.00017.18.FIG 5.4.0.BH & TP LOCATIONS