3.4.1 SOILS AND GEOLOGY

3.4.2 Introduction

This section of the EIS describes the geological setting in both a local and regional context. It provides an assessment of the impact of the proposed restoration of a quarry on the geological features of the area. IE Consulting were engaged by Kildare Architects and Design Ltd., to assess the geological impacts relating to the retention of the existing quarry and proposed infilling and restoration of a sand and gravel pit using inert Construction and Demolition (C&D) waste (mainly soil and stone) at Boherkill Quarry, Rathangan, Co Kildare. The proposal to restore the quarry in this fashion is technically classified as recovery of waste through deposition on land. The large volume of imported inert soil and stone required to complete this task (>100,000 tonnes) requires a Waste Licence Application to be submitted to the Environmental Protection Agency, together with a supporting Environmental impact Statement. IE Consulting has prepared this geological impact assessment in accordance with guidelines on Geology in Environmental Impact Statements issued by the Institute of Geologists in Ireland (2013).

Both the geology and soils play an important part in determining the environmental characteristics of a region. The underlying geology has a major influence on landform and rocks providing the parent material from which soils are created. The nature of the rock determines not only the nature and chemistry of the soil formed, but also the rate at which it forms. This in turn strongly affects the natural vegetation and the type of agriculture or horticulture that can be sustained. The geological materials also have a strong influence on the physio- chemical characteristics of both surface water and groundwater

An assessment of the hydrological and hydrogeological impacts relating to the proposed quarry is detailed in *Section 3.5* of the EIS. As this section also includes details regarding the geological setting e.g. bedrock geology, soils and subsoils. Section 3.5 should be consulted with reference to the detailed geology of the site.

3.4.3 Site Location

Kildare Sand & Gravel is located at Boherkill on the R4011 Kildare/Rathangan road (*Drawing No. IE1105-001-A, Appendix A*). The site is approximately 3 km south west of the small town of Rathangan. Operations at the facility involve the extraction of sand and gravel for supply to the construction market. The process involves the extraction of material from the western boundary of the facility. The material is then transported to the screening and washing plant, at the southern boundary of the facility, close to the entrance gate (*Drawing No. IE1105-001-A, Appendix A*). The screening plant is positioned at a lower elevation relative to the road, neighbouring lands and local dwellings. The strategic positioning of the plant helps dampen dust and noise levels by utilising the quarry embankments. Land usage around the facility is mainly agricultural tillage land. All materials washed and segregated are stored within and around the processing area.

The site is surrounded by lands which are primarily used for agricultural activities. According to the EPA Corine Land use Map 2012, land use in the area has been classified as ‘Pastures and non-irrigated land`.

There are three residences located within a 500 m radius of the site along the public roads; as one-off rural dwellings and also associated with farm holdings. The closest residential property is located along the public road immediately north west of the site.

3.4.2 Baseline Environmental Study

3.4.2.1 Outline of the Baseline Study

Available geological maps, surveys, literature and reports relating to the site and the locality were examined as part of the baseline desk study (Refer also to EIS Section 3.5).

3.4.3 Baseline Study Methodology

3.4.4 Geological Study

No fieldwork other than a site walkover was undertaken as part of this geological assessment. The initial evaluation consisted of examination of relevant geological data from the Geological Survey of Ireland and geological references for the area.

An area of 7.8 ha has previously been excavated at the site. This excavation has not been backfilled. The extraction scenario proposed for the site comprises 2 years workings of about 100 tonnes per day (approximately five loads per day).

3.4.5 Bedrock Geology

Kildare's land surface topography is characterised by glacial deposition. It is mostly underlain by Carboniferous bedrock, which only occasionally reaches the surface (e.g. Carbery Castle), but older rocks underlie the hills on the eastern edge of the county, and the distinctive high ground in a fault bound inlier (older rocks surrounded by younger rocks) to the north of Kildare town.

Reference to the 1:100,000 scale map of the Geology of Kildare/Wicklow (Sheet 16) (Geological Survey of Ireland, 1994) indicates that the entire quarry site is underlain by the Carboniferous Boston Hill Formation described as a rather uniform, thick successions of nodular diffusely bedded, argillaceous fossiliferous limestones (and their dolomitised equivalents) and subordinate thin shales (*Figure 1, Appendix B*).

According to the GSI online maps, the nearest mapped fault is located approximately 810 m southeast of the site. It is a north-east/south-west trending fault (*Figure 1, Appendix B*).

3.4.6 Soils and Subsoils

The Teagasc/EPA soils map (2006) describes the soils underlying the site as deep and shallow well-drained mineral soil derived mainly from calcareous parent material (**BminSW**).

The Subsoil Map describes the overburden material at the site as glacial till, Carboniferous Limestone sand and gravels (**GLs**) (*Figure 2, Appendix B*); the majority of this subsoil cover on the site has now been excavated.

3.4.7 Material requirements

The only material requirements in respect of the proposed restoration scheme are the inert soil, stone and rock to be used in backfilling the existing void and construction site site-won secondary aggregates. Clean, inert soil and stone is likely to be sourced from green field development sites. Intermixed soil, stones EWC Code 170504 and inert construction waste (concrete, tiles block and brick) WC code 170107 will be sourced from re-development sites. An estimate of the material quantities required to complete backfilling of the application site is provided below: -

Table 3.4.1 – Material requirement summary

Material	Quantity (t)	Source
Inert Soil, Rock Stones / Subsoil and inert C&D material	1,408,624	Imported
Topsoil	91,376	Onsite relocated / stored
Total	1,500,000	

3.4.8 Geohazards

The Boherkill site is underlain by Carboniferous limestones and thin shales. Karst topography is a landscape formed from the dissolution of soluble rocks such as limestone, dolomite, and gypsum. It is characterized by underground drainage systems with sinkholes, dolines, and caves. Reference to the Geological Survey of Ireland karst database indicates that there are no karst landforms located within the site perimeter and in the vicinity of the site. Nevertheless the bedrock underlying the site is limestone and therefore groundwater flow may be karstic to some degree and more so in local zones where purer limestones exist.

Based on the relatively flat to slightly undulating topography and surrounding quaternary geology predominantly comprising glacial tills, the 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 are identified in the GSI Geohive Geohazard web map.

The OPW flood database (www.floodmaps.ie) indicates two recurring flood points in the vicinity (within 5 km) of the proposed site both of which correspond to the River Slate. Given the sloping nature of the ground immediately beyond of the site towards the river, the risk of flooding locally is considered low.

The exposed slopes along the former extraction areas within the application site, being relatively steep, are prone to erosion and localised slope instability. The lack of established vegetation covering these slopes may be any indication of on-going erosion. Minor tension cracking, consistent with onset of slope instability, was observed along the perimeter of the site at the time of the site visit.

3.4.9 Geological Heritage

The Irish Geological Heritage (IGH) Programme identifies and selects a complete range of sites that represent Ireland's geological heritage under sixteen themes ranging from Karst features to Hydrogeology. The IGH Programme is a partnership between the GSI and the National Parks and Wildlife Service (NPWS) and sites identified as important for conservation are conserved as Natural Heritage Areas (NHA). Datasets are now available online detailing sites of geological heritage. Reference to this database confirms there are no sites of geological heritage within the perimeter of the site boundaries.

According to the GSI, there are two sites of interest located within a 5 km radius of the proposed development. The closest geological heritage site, Dunmurray Hill IGH 2, is located approximately 1.3 km to the southeast of the site (*Figure 5, Appendix B*). This site is designated under the Precambrian to Devonian Palaeontology theme and consists of a forested hillside which is the site of the discovery of Silurian dated graptolite fossils. The Chair of Kildare is located approximately 1.7 km to the southeast of the proposed site (*Figure 5, Appendix B*). This site is also designated under the Precambrian to Devonian theme and consists of an artificial mound on the edge of Grange Hill which is an inlier of Ordovician Rocks. The proposed development is not expected to impact on either of these geological heritage sites.

3.4.10 Existing Site Activities

The nature of the existing development is the continued extraction of sand and gravel. The extraction scenario proposed for the site is for 2 years workings of remaining stocks of 100 tonnes per day (approximately five loads).

Currently the excavated area of the site is 7.8 hectares. This existing sand and gravel pit is proposed to be restored on a phased basis, from north to south over 10 years, using imported inert construction and demolition (C&D) waste, mainly soil and stone. The proposed restoration area is proposed to extend to 10.7 hectares.

As shown in *IE Drawing 1105 -002-A*, *Appendix A*, the ancillary site infrastructure includes an office, a toilet, a wheel wash, and a bunded fuel tank. Wastewater from the toilet is discharged to a septic tank (*Drawing No*. *IE1105-002-A, Appendix A*).

The washwater from the wheel wash facility percolates to ground.

Run-off from the aggregate washing area is pumped to the silt lagoon, where it currently overflows to the natural sump in the northern extent of the site and percolates to ground. The lagoons are cleaned periodically and the settled silt is used as part of the site restoration. The lagoons required dredging at the time of the site visit on 18th November 2015.

There is no surface water run-off or discharge from the site.

3.4.11 Assessment of Impacts

3.4.12 Direct Impacts

Past and future quarrying activities

The nature of the development has involved the removal, storage and placement of soils and subsoils. The impact on the soils is considered to be of a temporary nature as they are stored for reuse directly within the worked out areas as a fundamental part of the proposed site rehabilitation.

By its nature, quarrying of the underlying sand and gravel deposits will involve removal of an identified aggregate resource. This has and will result in an *irreversible negative significant impact* on the sand and gravel resource.

Proposed Site Restoration

The nature of the proposed restoration of the site involves the importation and placement of inert soil and stone as backfill in the quarry void. The application site occupies the existing worked-out quarry, from which sands and gravels have been stripped, and as such will have no impact on virgin soils, sands and gravels. As a result of backfilling using inert soils and stones, the reinstatement of the quarry will progress to land suitable for agricultural and forestry, and thus will have a *positive impact*.

Consideration had been given to soil and overburden management. For the placement of subsoil and topsoil, the machinery will work from the haulage track or the exposed subsoil surface and away from the reinstated part of the site.

Soils will only be handled in dry weather conditions. Soils will not be placed when the moisture content is high, such as after heavy rainfall. Soils will not be moved in unusually dry and windy weather conditions. All temporary storage mounds will have slope angles not greater than 1:1.5 and will be re-vegetated as quickly as possible to avoid soil erosion by air and water.

3.4.13 Indirect Impacts

Past and future quarrying activities

The previous quarry workings have not had an indirect impact on the local or regional geology other than within the area of extraction. There is no evidence that the working of the limestone released contaminants and uncontrolled dust onto the lands.

Proposed Site Restoration

The available site investigation data indicates that the area to be backfilled is underlain by relatively competent sand and gravel strata. The increase in loading applied to these soils (below existing formation level) will not exceed that which existed prior to extraction of sand and gravel. As a consequence, no deep seated failure of temporary slopes is anticipated.

Temporary slopes in backfilled soils (above formation level) will be graded at an angle no steeper than 35^0, sufficient to ensure no instability arises. It is envisaged that a stability assessment of side slopes at the application site will be undertaken on an annual basis. In the longer-term, there will be no risk of instability as the restored site will be graded to a relatively flat, shallow slope.

Therefore, restoration of the quarry will have no indirect impact on the local or regional geology, as placement of the inert soil and stone will not instigate slope instability, release contaminants onto the lands and dust from the restoration will be tightly controlled.

3.4.14 'Do Nothing' Scenario

The proposal involves the recovery of significant quantities of inert soil and stone through backfilling in the quarry void.

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:

- Failure to recover soil and stone for beneficial use of land improvement, specifically reinstatement of a quarry, could result in unnecessary extraction of natural resources and exhaustion of landfill space;
- the reduced soil cover overlying the sand and gravel aquifer will result in a potential risk to groundwater quality;
- there is the potential for continued degradation of existing slopes, leading to possible slope failures;
- the site may be a target for unauthorised disposal / fly-tipping of waste by unscrupulous operators.

Given that a locally important aquifer underlies the site, and the important role soils and subsoil plays in the protection of aquifers, leaving the quarry void unrestored would cause the increased vulnerability of the aquifers caused by the quarry operations to remain.

3.4.15 Interaction with other Impacts

There are no negative cumulative impacts on the geological environment identified. The previous quarry development did not involve excavation below the water table and, as such, there is no evidence of a significant physical impact on surface and groundwater.

3.4.16 Mitigation Measures

3.4.17 Soils

Past and future quarrying activities

Consideration has been given to soil and subsoil management. Topsoil and subsoil stripped to obtain access to the sand and gravel resource under the current operating scenario will either be utilised directly for construction of peripheral screening berms, for progressive restoration, or placed in temporary overburden storage areas for use in future restoration. The storage areas and restoration areas will be vegetated as soon as is possible, to reduce both visual impact and erosion.

Stripping will be carried out in accordance with the principles of good soil handling. These principles are aimed at reducing possible adverse effects such as smearing and compaction of the soil. Measures which are to be incorporated to achieve this aim include:

- Storage of soils within perimeter security / screening embankment of the site. This is to allow the vegetation of these screening embankments as soon as possible.
- Placement of soils directly on completed sections of the quarry face as part of the final quarry face restoration.
- Placement of soils within designated soils and subsoils storage areas. Subsoil material will be placed first and then covered with topsoil. When the mounds have been completed, they will be graded and blended with the existing topography. Vegetation of these mounds will begin as quickly as possible to reduce any erosional effects and to facilitate the transformation into an amenity area.
- Within soil stripping areas, topsoil will be stripped with back-actors (excavators) and dumper trucks working from the haulage track.
- For the replacement of subsoil and topsoil, the machinery will work from the haulage track or the exposed subsoil surface and away from the reinstated part of the site.
- Soils will not be handled be handled in wet weather conditions. This decision will be made by experienced personnel.
- Soils will not be stripped or placed when the moisture content is high, i.e. after heavy rainfall. This decision will be made by experienced personnel.
- Soils will not be moved in unusually dry and windy weather conditions.
- All temporary storage mounds will have slope angles not greater than 1:1.5 and will be re-vegetated as quickly as possible to avoid soil erosion by air and water.
- Topsoil shall be stored to a height not exceeding 3 metres to preserve organic constituents.

Provided that stripping, storage and restoration of the soils is carried out in an appropriate manner, the removal of the underlying deposits of sand and gravel should not interfere with the quality of the land for agricultural purposes.

Proposed Site Restoration

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. Inert materials shall be accepted at the site between 08.00 hours and 18.00 hours each workday and 08.00 hours to 14.00 hours on Saturdays. No materials shall be accepted at any other time.

Before waste is accepted at the site, all waste will be confirmed to meet the waste permit conditions, the waste acceptance procedures (WAP) and waste acceptance criteria (WAC as per *Council Decision 2003/33 of 19, December 2002 establishing criteria for the acceptance of waste at landfills*). WAC classification documentation will be produced and recorded for each load accepted. Characterisation testing will be required to undertaken in advance by Clients and/or Contractors forwarding soil to the application site. Any topsoil which is imported onto the site will have been chemically analysed and screened against generic screening values for a commercial end use to ensure that it does not pose a risk to human health. In addition multiple level soil testing regimes will be established at the site and will include;

- Frequent (1 in every 200 loads) compliance testing covering a limited range of key soil parameters and
- comprehensive on-site verification, comprising visual inspection and record of all imported soil unloading at the site by a competent person.

All inert soils imported to the site shall be unloaded from trucks at the active backfilling face. It will be visually inspected by site personnel at that point to ensure that there is no intermixed non-hazardous or hazardous waste placed within it. If any concern exists about the nature of the waste it will be segregated, re-loaded onto the truck and directed to the waste inspection and quarantine area for closer inspection and classification. A detailed record will be kept of all such inspections. In the event that inspections and/or subsequent testing indicate that the materials are non-inert and cannot be accepted and used for restoration purpose at this site, they will be placed in skips and covered pending removal off-site by permitted waste collectors to a suitably licenced/permitted waste disposal or recovery facility.

All waste tonnages will be recorded in daily report sheets and the reports will be completed on the waste acceptance. If the tonnage is not known by the haulier, the tonnage will be estimated based on the load capacity of the tipper truck. The tonnage may be verified by estimating the volume of the material and multiplying the volume by 1.5 specific gravity. Weighbridge dockets will be used when available depending on where the waste had been removed from. There must be a weighbridge at the point of waste generation or weighed at a weighbridge along the haulage route and annual returns will be made to the EPA by means of an Annual Environmental Report (AER).

During backfilling, all temporary surfaces will be graded to facilitate overground run-off of surface water, thereby minimising the volume of rainfall percolating through the backfilled soil. This will further reduce any residual risks of potential contaminants leaching into the soil and groundwater. In order to confirm that there are no residual risks to soil or groundwater, monitoring of groundwater should commence for the duration of the restoration works and for a short aftercare period.

On-going slope stability assessments will be undertaken on an annual basis during proposed site restoration activities and on-going quarrying activities.

The importation of soils and material can influence the chemical composition of underlying groundwater. This is primarily through potential changes to the pH - e.g. by importing base-rich mineral soil to a primarily acidic catchment. Any alteration of the chemical composition as a result of improper placement of soil would result in a direct *negative short-term moderate impact* on the underlying groundwater. This is unlikely to occur however as imported material will be from the Kildare hinterland and is likely to be similar in composition to the existing soil.

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

In order to maximise the future agricultural potential of the restored land, a minimum 150 mm thick layer of topsoil and 850 mm thick layer of subsoil will be placed over the backfilled clayey mineral soils. The final landform will also be graded so as to facilitate overground run-off of surface water and avoid ponding of surface water in closed depressions.

3.4.18 Quaternary Geology

The quarrying of sands and gravels to produce aggregates, by definition, has and will involve the excavation and removal of the Quaternary deposits. There is, therefore, an impact on the local geological environment that is confined to the Quaternary geology within the designated extraction area.

Whilst the material cannot be replaced, the extraction of these deposits will offer an opportunity for future geological study of these Quaternary deposits that may lead to a better understanding of past geological processes on a local and a regional scale.

The final land restoration scheme will ultimately allow the site to be returned to a condition whereby there will be negligible residual impact on the surrounding environment following the removal of sand and gravel within the pit. It is planned to minimise, eliminate or decrease long-term ecological and visual impacts on the environment through the implementation of the final restoration scheme.

3.4.19 Bedrock Geology

Rock quarrying has already occurred within the planning application area, and, as such, there has been an irreversible impact on the Carboniferous bedrock geology as a result of the development.

3.4.20 Conclusions

Any potential and existing risks to soils and geology from the proposed restoration works in this location will be minimised/prevented through the adherence to the proposed mitigation measures detailed in *Section 3.4.8.*