ENVIRONMENTAL BALANCE IN DESIGN AND CONSTRUCTION

THORNTONS RECYCLING

ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED DEVELOPMENT AT MILLENNIUM BUSINESS PARK

VOLUME 2 – MAIN EIS

CHAPTER 11 – SOILS, GEOLOGY AND HYDROGEOLOGY

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FEHILY TIMONEY & COMPANY

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11. SOILS, GEOLOGY & HYDROGEOLOGY

11.1 Introduction

This chapter was prepared having regard to the publication "Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters in Environmental Impact Statements" by the Institute of Geologists of Ireland (1). It was prepared using available published literature and included a walkover survey of the site and consideration of results of previous ground investigations.

This chapter has been prepared to examine the potential impacts of the proposed materials processing & transfer facility, which includes for solid recovered fuel production and residual MSW, bio-waste, wood and green waste transfer facilities, on the soils, geology and hydrogeology in the local environment. The effects of the proposed development are considered, taking account of mitigation measures to reduce or eliminate any residual impacts on the soils and geology.

11.2 Methodology

11.2.1 Study Area

It is proposed to redevelop a site in the Millennium Business Park, Cappagh Road, Dublin 11 as a materials transfer and processing facility. The site is a 2.4 hectares area and currently comprises a large undeveloped grass-covered area in the western portion of the site, while a gravelled hardstanding area with two disused buildings are located in the eastern portion of the site.

The location of the proposed materials processing and transfer facility is shown in Figure 1.1. The hydrogeological study area is shown in the figures associated with this chapter.

Historic mapping for the site shows no evidence of any industrial use for the site. Historically, the site has remained an agricultural site, likely to have been utilised for tillage or pasture uses.

A review of historic aerial photographs indicates that prior to 1995 the majority of eastern portion of the site remained undeveloped. Three buildings and hardstanding were identified in the east portion of the site. It is likely that these buildings were developed in association with the quarry activities to the east and northeast of the site. Aerial photographs from 2000 suggest a number of residential developments associated with agriculture in the surrounding area, while the quarrying activity to the east of the site has become more prominent. The aerial photograph from 2005 identifies the quarry adjacent to the site, suggesting that the quarrying activities had intensified.

Historical imagery suggests that the Millennium Business Park developed in the surrounding area from 2002 with one large commercial building was identified 260 m to the north of the site. Several additional commercial properties were developed prior to 2006 with large buildings developed 130 m to the north and 210 m to the northwest. Two commercial buildings were constructed adjacent to the western and northern boundary in 2008, while another large building was noted 40 m to the southwest.

11.2.2 Relevant Guidance

This section presents the methodology used in assessing the baseline soil and geological environment. As well as considering the relevant EPA guidance (EPA, 2003) (EPA, 2002) with respect to the preparation of an EIS, the scope and methodology for the baseline assessment has been devised in consideration of the following guidelines and sources of information:

- Geology in Environmental Impact Statements (IGI, 2013)
- Geology of Kildare-Wicklow (B. McConnell, M.E. Philcox., 1995)
- General Soil Map of Ireland (Taluntais, 1980)
- Groundwater Protection Scheme for County Dublin (on GSI website) (Geological Survey of Ireland & Kildare Co. Council, 2004)
- Online historic OSI mapping and aerial photographs (OSI, 2013)
- Online landslide database (GSI, Online Landslide Viewer, 2013)
- Online heritage database (GSI, Online Heritage Database, 2014)
- Online Aggregate Potential Mapping database (GSI, Online Aggregate Potential Mapping Database, 2014)
- EPA Envision Map Viewer (Environmental Protection Agency, 2015)
- Prior site investigation data from the site
- Groundwater data derived from the EIS associated with a soils recovery licence application for the adjacent Huntstown Quarry

11.2.3 Consultation

Statutory consultees, bodies with environmental responsibility and other interested parties were informed with regards the proposed development, with the responses summarised in Chapter 5 of the EIS.

FT consulted the Geological Survey of Ireland (GSI) with regards any potential impacts from the development, however no formal response was received.

Consultation with Fingal County Council did not raise any issues with regards the potential impacts of the development to the underlying soils, geology and hydrogeology.

11.2.4 Field Assessment

A site walkover was undertaken in May 2016 which incorporated the proposed site for development. The information obtained is also referenced in this chapter.

11.2.5 Evaluation Criteria

During each phase (construction, operation, maintenance and decommissioning) of the proposed waste management facility, a number of activities will take place on site, some of which will have the potential to cause impacts on the geological regime at the site and the associated soils, geology and hydrogeology. These impacts are discussed in detail in Section 11.5.

11.3 Existing Soils and Geology

11.3.1 Overburden Geology

The GSI Spatial resources website indicates that the soils underlying the site mainly comprise deposits of grey brown podzolic and brown earths, with surface water gleys and ground water gleys identified in the north-eastern portion of the site. The GSI Quaternary Geology website shows the area of the site to be covered with deposits of glacial till derived from limestone bedrock. Approximately 100 m to 200 m east and west of the site, bedrock is shown to be present at, or close to the ground surface.

The Quaternary Geology of the site and its surrounds is presented in Figure 11.1.

11.3.2 Bedrock Geology

The survey "*Geology of Kildare-Wicklow*" (GSI, 1994) is the reference source for the description of the bedrock geology of the region. The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock geology map (Sheet 16) shows that Carboniferous (Dinantian) limestone underlies the majority of the site and the surrounding area, while a small portion to the south of the site is underlain by the Boston Hill Formation. The surrounding formations in the area includes the Waulsortian Limestone Formation, the Boston Hill Formation and the Tober Colleen (Calp) Formation.

The majority of the site is underlain by Walulsortian Limestone Formation, comprising fine grained, pale grey, massive, unbedded, biomicrite (limestone containing skeletal debris and carbonate mud). The sediments commonly form depositional mounds or "reefs" with depositional dips of 30-40° or more and with relief typically of several tens of metres. The Waulsortian passes laterally into the Boston Hill, and Tober Colleen Formations along with other Carboniferous limestones. The Waulsortian is commonly dolomitised, making it difficult to distinguish from other limestones.

A small portion of the southern portion of the site is underlain by the Boston Hill Formation. This formation consists predominantly of uniform thick successions of nodular and diffusely bedded, argillaceous (muddy), fossiliferous limestones (often dolomitised) with subordinate thin shales. The thickness of the formation in the Haberton Bridge area is more than 600m.

Some 500m north of the site, the area is underlain by the Tober Colleen Formation which is the lowest part of the Calp Formation. It typically comprises gradationally interbedded calcareous mudstone and very argillaceous micrite. The formation overlies the Waulsortian reef mounds in the Dublin Basin. The thickness of the formation is very variable because it drapes mounds and fills depressions between them.

Structurally, the Carboniferous rocks of the area are crossed by a series of northeast-southwest trending faults which are in turn dissected by a series of northwest-southeast trending faults. One of these latter faults is shown on the geological map of the area, bisecting the eastern portion of the site.

The Bedrock Geology of the site and its surrounds is presented in Figure 11.2.

11.3.3 Geological Heritage

The GSI Online Irish Geological Heritage database (GSI, Online Heritage Database, 2014) indicates that the development site is not located in an area of specific geological heritage interest. The nearest site of significant geological heritage feature is Huntstown Quarry, located adjacent to the eastern boundary of the site. The proposed development will have no perceivable impact on this or any other areas of geological heritage.

11.3.4 Economic Geology

The GSI online Aggregate Potential Mapping database (GSI, Online Aggregate Potential Mapping Database, 2014) shows that the nearest listed active quarry is located adjacent to the eastern boundary of the site at Huntstown Quarry. The site is located within an area of very high potential for crushed rock aggregate. Several other disused pits, quarries and mineral exploration localities are also shown within 1 km of the site on the GSI database.

11.3.5 Site Investigation

As part of a previous planning application (Planning Ref: 230770) for the site, which related to a smaller portion (1.26 ha) of the currently proposed site area, an intrusive investigation was undertaken in September 2007. The investigation comprised the supervised excavation of three trial pits across the site to a maximum depth of 3.7 m below ground level (bgl).

The site investigation generally confirmed the geological succession of the overburden geology. Topsoil was revealed across the site to depths ranging from 0.3 m to 0.6 m bgl. A layer of sandy silt / sandy silty clay was encountered at TP1 and TP2 to depths ranging to 0.8 to 1.4 m bgl. This was generally underlain by firm to stiff gravelly clay at each location with minor quantities of limestone cobbles and boulders. Bedrock was not encountered during the site investigation. No visual or olfactory evidence of contamination was noted during the site investigation.

The planning application to which this EIS relates includes an extension of the previous development site of c.1.2 hectare to the east of the site. The information obtained from the original site investigation is therefore considered an accurate representation of the underlying ground conditions for the entire site given the limited operations on site and the geology.

The locations of the trial pits are shown in Figure 11.3. The trial pit logs are presented in Appendix 18 of Volume 3 of this EIS.

11.3.6 Soils Analysis

In 2007 a total of nine soil samples were recovered from TP1 to TP3 at depths ranging from 0.4 to 3.4 m bgl. These samples were dispatched to an accredited laboratory and tested for a range of determinants which included heavy metals, cyanide, solvents and phenols in order to provide a baseline for possible contamination on the site.

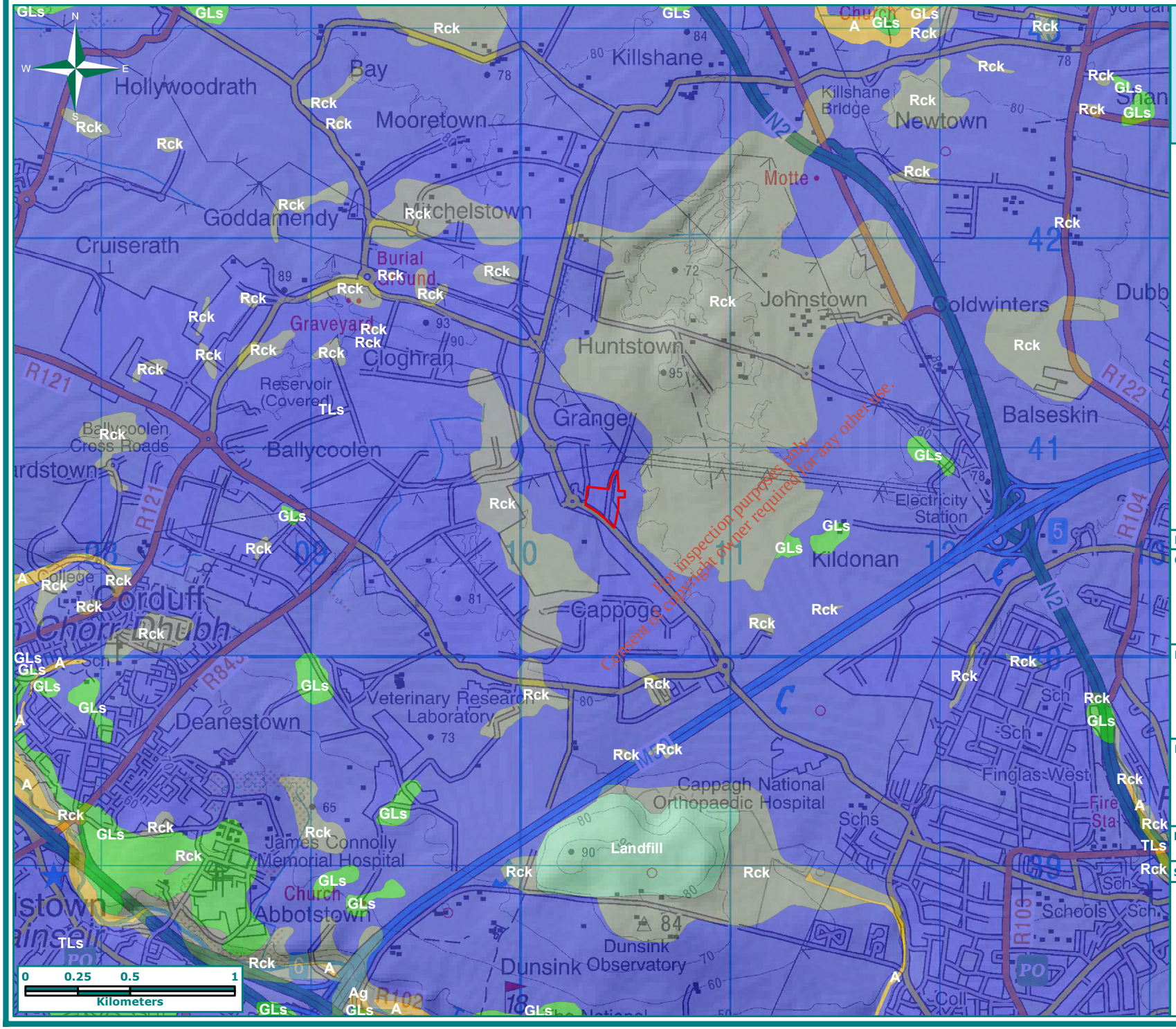
The results from this site investigations have been screened against current *Suitable for Use Levels* (S4ULs) assessment criteria published in 2015 by LQM/CIEH. These precautionary screening levels are designed to be representative of minimal risk to human health in a number of land use scenarios. Given the proposed development, S4ULs have been selected for commercial land-use and also residential land use to provide a more conservative assessment.

An additional set of phytotoxin screening levels have been adopted from 'The Code of Agricultural Practice for the Protection of Soil' Ministry of Agriculture, Fisheries and Food (MAFF), 1993, which are protective of healthy plant growth.

All of the samples returned concentrations below their relevant screening criteria. A summary of the laboratory results is shown in Table 11.3 below, while the laboratory reports are presented in Appendix 19 of Volume 3 of this EIS.

Table 11-1: Laboratory Results from 2007 Baseline Site Investigation

CONTAMINANT	UNITS	MAX	No of Tests	SL1 Commercial	SL2 Residential	No > SL
HUMAN HEALTH RISK ASSESSMENT						
pH	-	8.45	9	5 – 9		0
Arsenic	$mg.kg^{-1}$	<1	9	640	37	0
Boron	$mg.kg^{-1}$	1	9	192,000	290	0
Cadmium	$mg.kg^{-1}$	3	9	190	11	0
Chromium (total)	$mg.kg^{-1}$	34	9	8,600	910	0
Copper	$mg.kg^{-1}$	64	9	68,000	2400	0
Lead	$mg.kg^{-1}$	120	9	2,300	200	0
Mercury	$mg.kg^{-1}$	<1	9	1,100	40	0
Nickel	$mg.kg^{-1}$	69	9	980	180	0
Selenium	$mg.kg^{-1}$	<1	9	12,000	250	0
Zinc	$mg.kg^{-1}$	163	9	730,000	3700	0
Phenol	$mg.kg^{-1}$	<1.0	9	1500	760	0
Cyanide	$mg.kg^{-1}$	<2.5	9	-	-	-
Sulphate (SO4)	$mg.kg^{-1}$	770	9	-	-	-
Solvents	$mg.kg^{-1}$	18	9	-	-	-
PHYTOTOXICITY RISK ASSESSMENT						
	Units	**Max**	**No of Test**	**Screening Level (SL)**		**No > SL**
Copper	$mg.kg^{-1}$	64	9	200		0
Nickel	$mg.kg^{-1}$	69	9	110		0
Zinc	$mg.kg^{-1}$	163	9	300		0



Date	13/10/2016
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Project Title	EIS for Proposed Development at Millennium Park
Figure Title	Quaternary Geology
Figure No.	11.1
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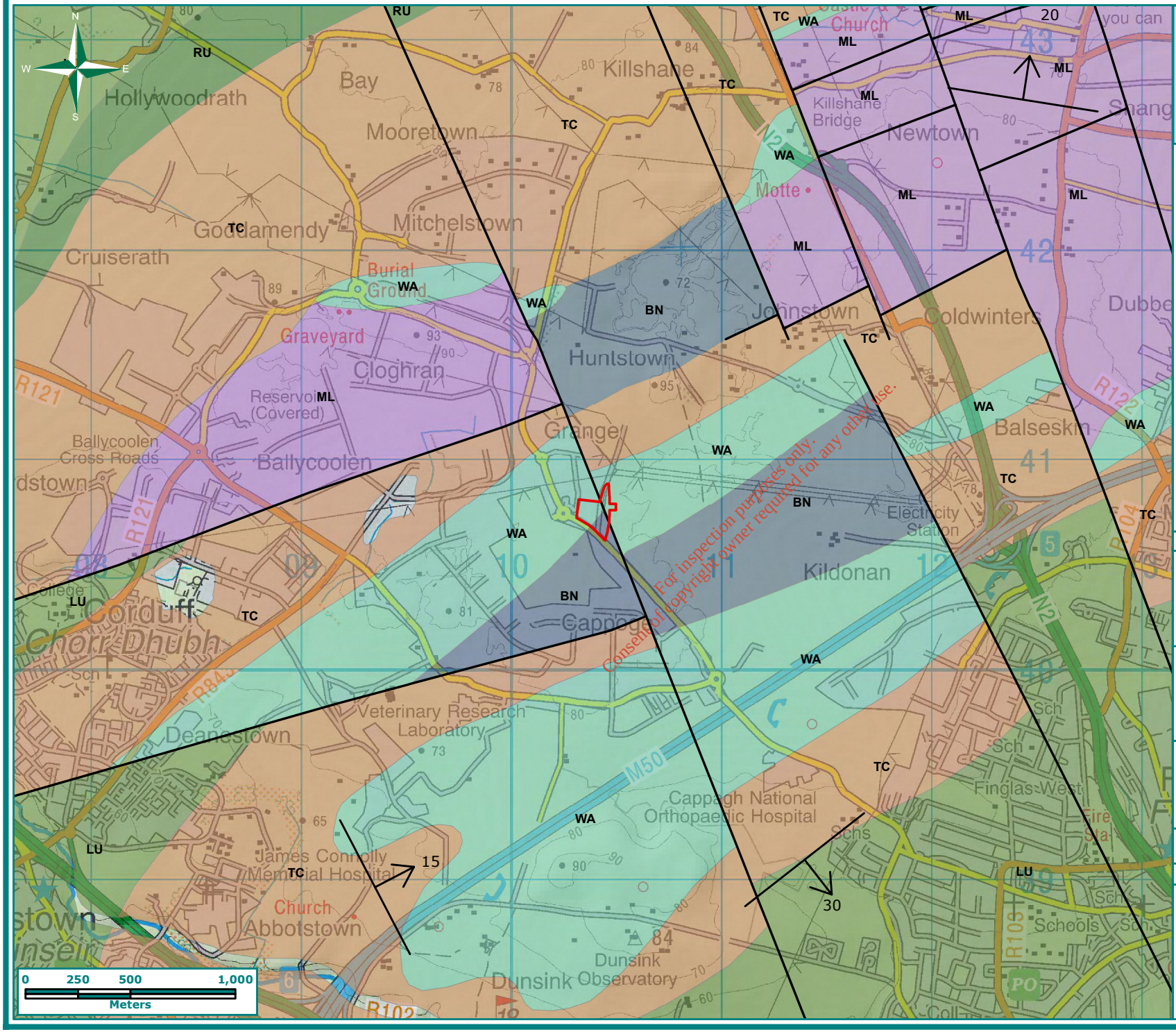

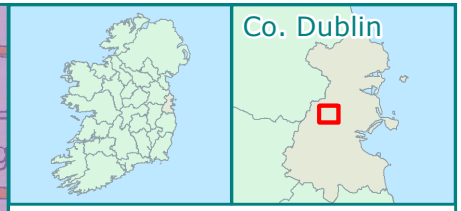

Legend

- Proposed Site Boundary

Bedrock Geology

- BN: Boston Hill Formation
- LU: Lucan Formation
- ML: Malahide Formation
- RU: Rush Conglomerate Formation
- TC: Tober Colleen Formation
- WA: Waulsortian Limestones
- Structural Linework
- Dip of Bedding in Degrees

Date	13/10/2016
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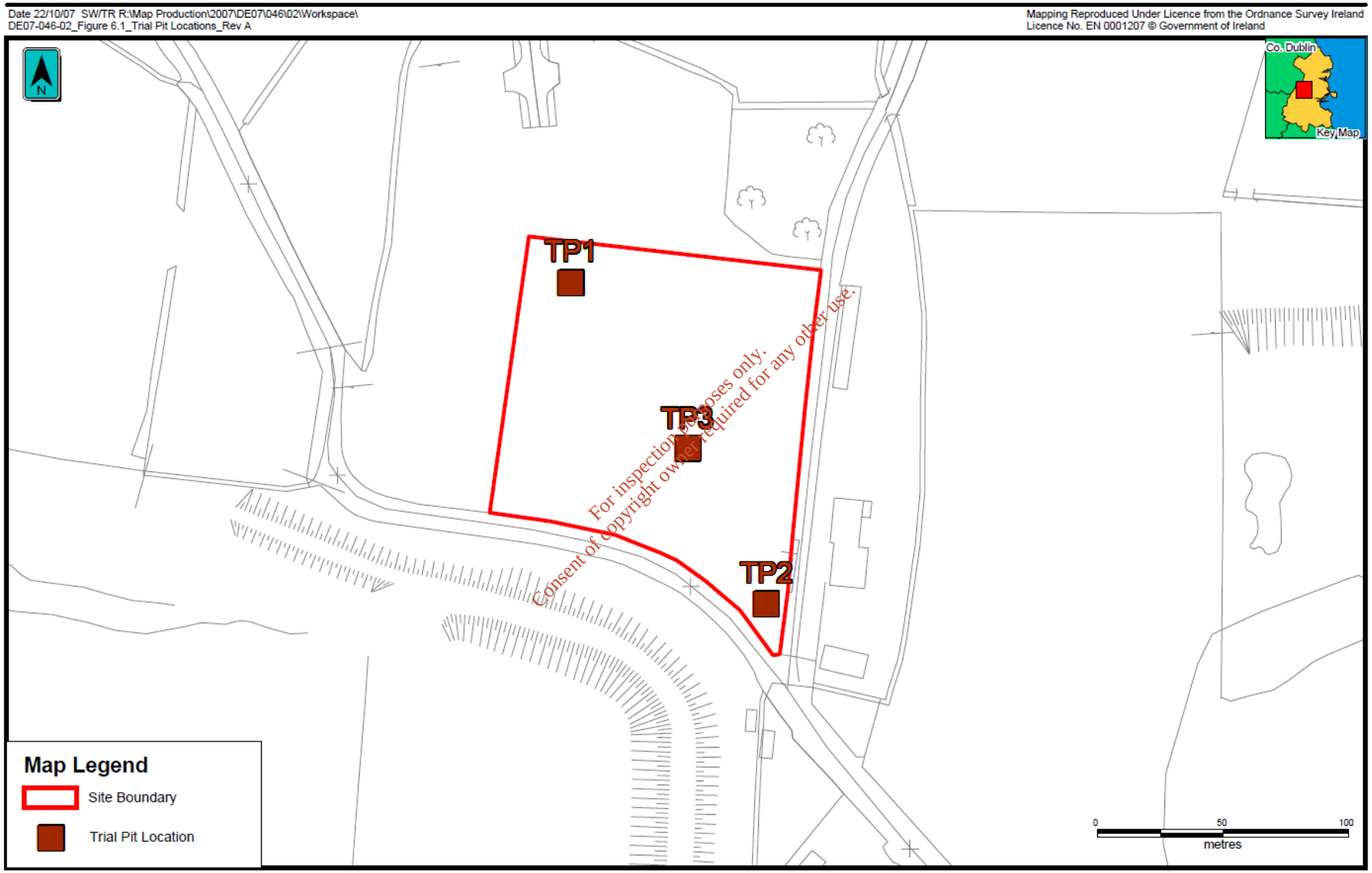


Figure 11.3: Location of trial pits dug as part of previous site investigation

11.4 Hydrogeology

The groundwater section of the GSI website classifies the Waulsortian Limestones and Boston Hill Formation underlying the site as Locally Important Aquifers. A Locally Important Aquifer would normally be capable of yielding moderate quantities of water in localised zones only, sufficient to supply wells or small irrigation schemes. The aquifer classification for the site is shown in Figure 11.4.

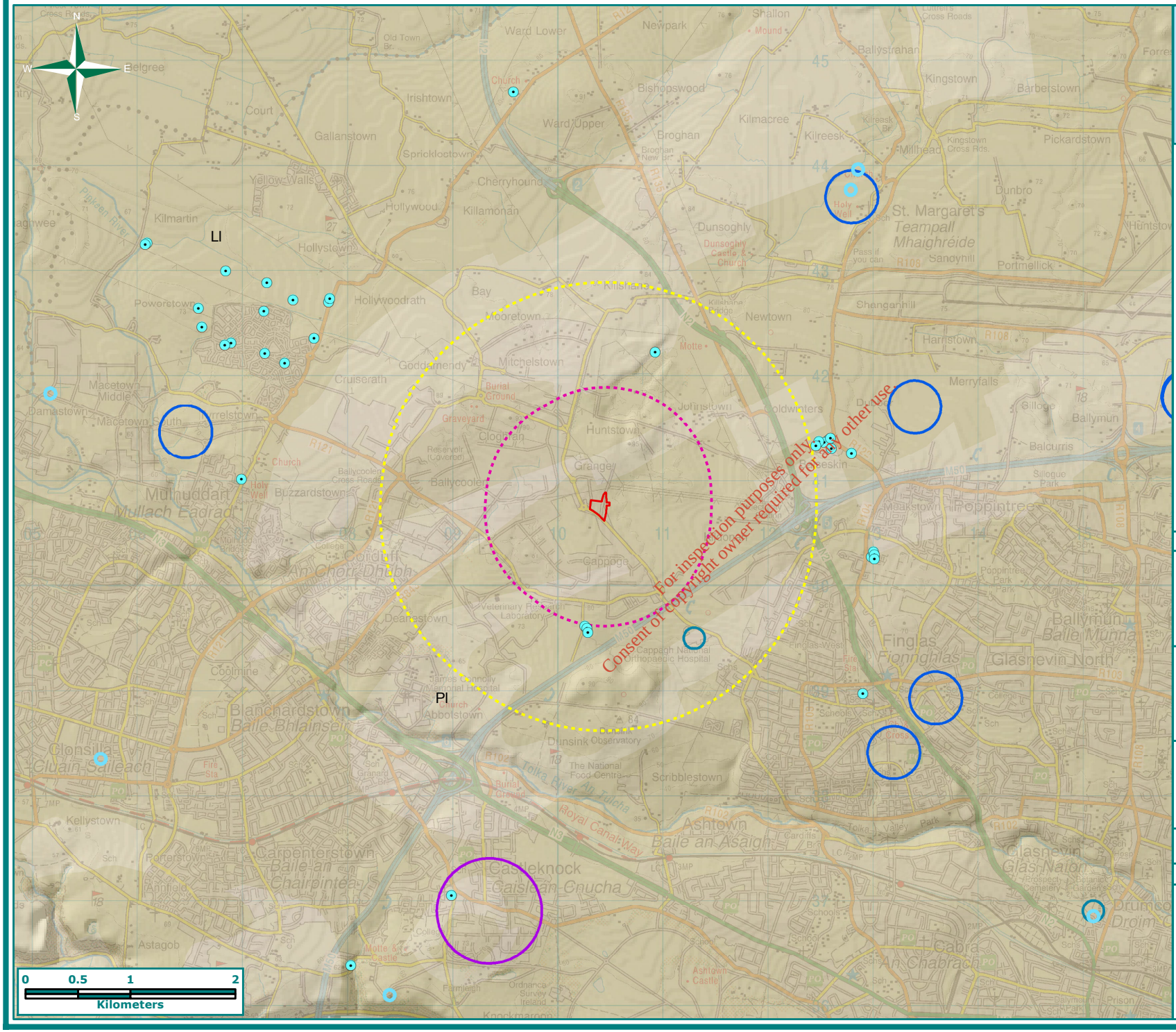
The Waulsortian Limestones to the southwest of Dublin are extensively dolomitised and act as a major aquifer with typical well yields of between 300 and 1,500 m^3/day. However within the proposed development site area, the Waulsortian is discontinuous and less extensive, hence well yields may be less.

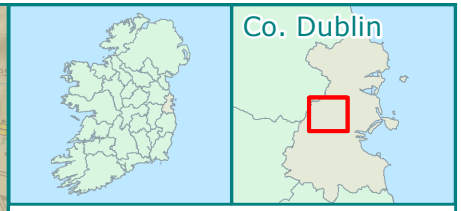
The surrounding Calp Formation which covers most of the Dublin Basin represents a basinal facies. The Formation is very variable but is dominated by low permeability, fine grained argillaceous limestones and shales which are generally unproductive although there are more permeable strata within the unit which may be the result of fracturing, faulting or deep karstification due to the proximity of the coast. Typical well yields for the Calp are in the range 40 to 1000 m^3/day.

To the north of the site (approximately 500m north), the Tober Colleen (Calp) Formation is classified as a Poor Aquifer which is generally unproductive except in localised zones.

The GSI does not list any wells within 1km of the site boundary. The closest wells, as shown in 4, are located approximately 1.05 km to the south of the site with a potential yield of 40 to 100 m^3 per day.

No groundwater was encountered during the 2007 site investigation.





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- Proposed Site Boundary
- 1km Buffer from Site
- 2km Buffer from Site
- GW Wells (10m-50m
- GW Well (50m-100m
- GW Well (100m-200m
- GW Well (200m-500
- GW Well (500m-1km

Aquifer Classification

- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- PI: Poor Aquifer Bedrock Generally Unproductive Except Locally

Date 13/10/2016

Client Name

Thorntons Recycling

Project Title

EIS for Proposed Development at Millennium Park

Figure Title

Aquifer Classification and Groundwater Wells in the Vicinity of the Proposed Development

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11.4.1 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The vulnerability of an aquifer to contamination is influenced by the leaching characteristics of the topsoil, the permeability and thickness of the subsoil, the presence of an unsaturated zone, the type of aquifer, and the amount and form of recharge (the hydrologic process where water moves downward from surface water to groundwater). Groundwater vulnerability is determined mainly according to the thickness and permeability of the subsoil that underlies the topsoil, as these properties strongly influence the travel times and attenuation processes of contaminants that could be released into the subsurface from below the topsoil (as in the case of contaminants from landfills, septic tank systems and underground storage tanks). The type of recharge is also considered where indirect recharge (termed 'point recharge' in Ireland) can occur through swallow holes or sinking streams.

The GSI Groundwater Data viewer classifies the area where the site is located is predominantly '*Extreme*' due to shallow bedrock in the area. The shallow nature of the overburden is evident in the surrounding land which is being extensively quarried for limestone. The aquifer vulnerability of the site and surrounding area are shown in Figure 11.5.

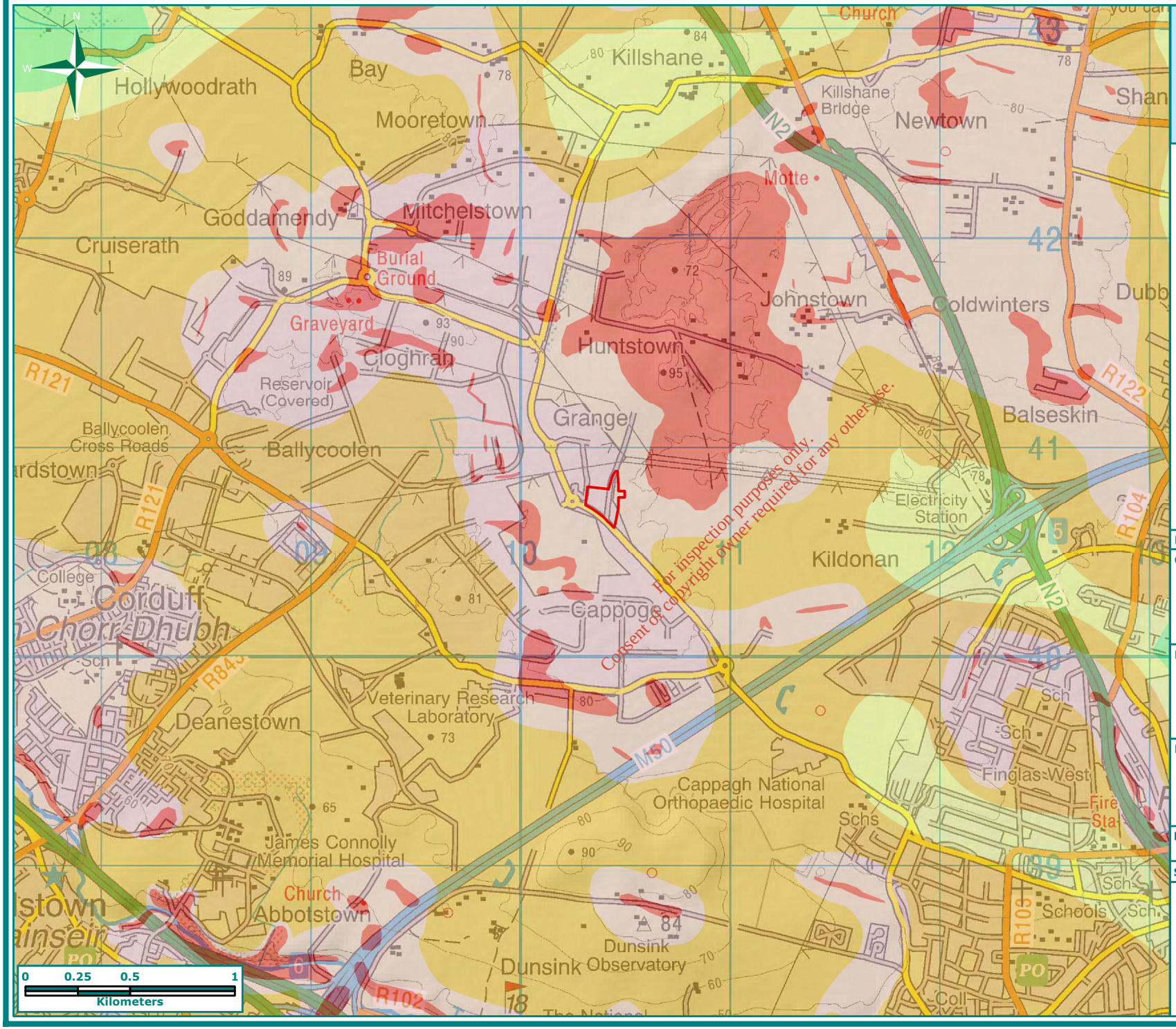
The assessed vulnerability for the majority of the site is shown in Table 11.2. The table illustrates the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the ground investigations.

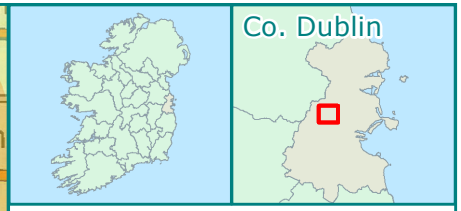
Table 11-2: Groundwater Vulnerability

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (Sand/gravel)	Moderate Permeability (e.g., Sandy soil)	Low Permeability (e.g., Clayey subsoil, clay, peat)
Extreme (E)	**0 - 3.0 m**	**0 - 3.0 m**	0 - 3.0 m
High (H)	**> 3.0 m**	**3.0 -10.0 m**	3.0 - 5.0 m
Moderate (M)	Not applicable	>10.0 m	5.0 - 10.0 m
Low (L)	Not applicable	Not applicable	>10 m

Based on the findings of the trial pit investigations, greater than 3m of low-permeability overburden was encountered over the bedrock. As bedrock is very shallow to the east and west of the site, an overburden thickness of 3-5m is assumed, and therefore the assessed vulnerability for the site would be determined as 'High'.

The overburden deposits of glacial till are derived from the limestones and have generally low permeability and where they are of sufficient thickness, act as confining aquitards to the underlying aquifer within the bedrock.





Legend

Proposed Site Boundary

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Medium
- L - Low
- Water
- X (Rock Near Surface or Karst)

Date	13/10/2016
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11.4.2 Groundwater monitoring

As noted, no groundwater was encountered during the site investigations. Published geological reports indicate that groundwater is generally within 10m of the surface across the eastern region of Ireland and has an annual fluctuation of less than 5m.

A review of the pertinent groundwater information presented in an EIS undertaken in relation to the adjacent Huntstown Quarry was carried out[1]. Six boreholes (GW01 to GW06) were advanced across the quarry complex to depths ranging from 49m to 80.5m bgl. Groundwater monitoring wells were installed at each location for subsequent monitoring. Groundwater was gauged at 74.52 mAOD (GW05) to 42.32 mAOD (GW06), generally flowing in a south to southeast direction. The closest monitoring point to the site were GW05 and GW06, located 540m to the northwest and 440 m to the southeast of the proposed development site respectively.

FT undertook groundwater monitoring at two of the boreholes at the adjacent Huntstown Quarry in June 2016 to provide a baseline assessment of the underlying groundwater quality.

Samples were retrieved from GW05 located 540 m northeast of the site (up gradient) and GW06 located 440 m southeast of the site (down gradient). The samples were submitted to an accredited laboratory and analysed for a broad range of determinants which included heavy metals, hydrocarbons, ammonical nitrogen, chloride, hardness (as CaCO2), total alkalinity, sulphate, nitrate, nitrite and phosphate. The results are summarised below and presented in Appendix 20 of Volume 3 of this EIS.

The groundwater quality retrieved from GW05 and GW05 indicated that the underlying groundwater can be considered to be of good quality with the majority of the determinants analysed returning concentrations below the EPA's Interim Guideline Values (IGVs). A slightly elevated concentration for zinc (0.17 mg/l) was detected in the sample retrieved from GW05, marginally exceeding the screening criteria of 0.1 mg/l, however, this is not considered significant. A marginally elevated concentration of chloride was detected in the sample retrieved from GW06, however, this is likely to be due the slightly higher concentration of chloride in rainfall due to the sites close proximity to the coast. Both samples exceeded the guidance for hardness (as $CaCO_3$) which is typical of the underlying Limestone Aquifer. Both of the samples exceeded the criteria for manganese (0.05 mg/l) returning concentrations of 0.21 mg/l and 0.165 mg/l respectively. The IGV guidelines outline that elevated concentrations of manganese can be an indicator of organic contamination (i.e. silage) however, it is also naturally occurring. Additionally, the IGV for manganese is set because of aesthetic and taste reasons, not for health reasons and therefore the exceedances are not considered significant.

On the basis of the above information, the groundwater underlying the site was considered to be of good quality and therefore additional site specific groundwater monitoring was not considered necessary for the proposed development.

11.4.3 Hydrochemistry

The aquifers of the region contain mainly calcium magnesium bicarbonate type waters with Total Dissolved Solids of less than 500 mg/l. The Total Hardness of limestone and dolomite generally range from 300 mg/l (as $CaCO_3$) to over 400 mg/l (as $CaCO_3$). The chemistry of the overlying aquitard groundwaters will generally be similar as the glacial till is also derived from the limestones. Many of the groundwaters in Dublin City are of poor quality as a result of numerous activities associated with urban centres.

[1] http://www.epa.ie/terminalfour/waste/waste-view-filter.jsp?regno=W0277-01&filter=b&docfilter=go

11.5 Potential Impacts

The proposed development comprises the construction of a waste processing building, a bale storage building and ancillary infrastructure. A detailed description of the proposed development is provided in Chapter 2. The potential impacts of the development on the soils, geology and hydrogeology and of the site are assessed below.

11.5.1 Impact Appraisal Methodology

The following elements of the development were examined in order to determine the potential impacts on the soils, geology and hydrogeology aspects of the proposed development:

- characterisation of the soils, geology and hydrogeology of the site
- evaluation of the risks and potential impacts of the proposed development

The following sections detail the potential impacts that have been identified from the appraisal methodology presented above. Appropriate mitigation measures are then proposed to avoid or adequately mitigate these impacts.

11.5.2 Assessment of Significance of Geological Impact on the Receiving Environment

An impact rating has been developed for each phase of the development of the site based on guidance as recommended by the Institute of Geologists of Ireland (IGI). The importance (sensitivity) of the receiving environment was first identified. Then the magnitude of the potential hydrological impact was estimated. This determines the significance of the impact prior to the application of mitigation measures.

The criteria for rating site importance of the geological features is set out in Table 11.3.

Table 11-3: Criteria for Rating Site Importance of Geological / Hydrogeological Features

Importance	Criteria	Typical Example
Extremely High (Hydrogeology only)	Attribute has a high quality or value on an international scale.	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status.
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale.	Geological feature on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource. Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation e.g. NHA status. Regionally important potable water source supplying >2500 homes.

Importance	Criteria	Typical Example
		Inner source protection area for regionally important water source.
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying the site is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or high fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource. Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub- economic extractable mineral resource. Locally important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying the site is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomic extractable mineral resource. Poor bedrock aquifer. Potable water source supplying <50 homes.

Generally, the site geology and hydrogeology ranks as *Medium* importance as the site is underlain by Waulsortian Limestones and the Boston Hill Formation, both characterised as Locally Important Aquifers. Additionally, the site is located within an area of *Very High* potential for crushed rock aggregate with a limestone quarry is located adjacent to the eastern boundary of the site.

11.5.3 Assessment of Magnitude of the Impact on Geology Attribute

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for geological impacts are defined as set out in Table 11.4.

Table 11-4: Estimation of Magnitude of Impact on Geological & Hydrogeological Features

Magnitude	Criterion	Description and Example
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	• Loss of high proportion of future quarry or pit reserves • Irreversible loss of high proportion of local high fertility soils • Removal of entirety of geological heritage feature • Requirement to excavate / remediate entire waste site • Requirement to excavate and replace high proportion of peat • organic soils and/or soft mineral soils beneath alignment • Removal of large proportion of aquifer • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems • Potential high risk of pollution to groundwater from routine run-off. • Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves • Removal of part of geological heritage feature • Irreversible loss of moderate proportion of local high fertility soils • Requirement to excavate / remediate significant proportion of waste site • Requirement to excavate and replace moderate proportion of peat, • organic soils and/or soft mineral soils beneath alignment. • Removal of moderate proportion of aquifer. • Changes to aquifer or unsaturated zone resulting in moderate changes to existing water supply of springs and wells, river baseflow or ecosystems. • Potential medium risk of pollution to groundwater from routine run-off • Calculated risk of serious pollution >1% annually
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves • Removal of small part of geological heritage feature

Magnitude	Criterion	Description and Example
		• Irreversible loss of small proportion of local high fertility soils and/or • high proportion of local low fertility soils • Requirement to excavate / remediate small proportion of waste site • Requirement to excavate and replace small proportion of peat. • organic soils and/or soft mineral soils beneath alignment. • Removal of small proportion of aquifer. • Changes to aquifer or unsaturated zone resulting in minor change to water supply of springs and wells, river baseflow or ecosystems. • Potential low risk of pollution to groundwater from routine run-off. • Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes. Calculated risk of serious pollution incident <0.5% annually.
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Generally the unmitigated impact on the geological environment is considered to be a *Small Adverse* effect based on the impact and attributes given in Table 11.4. This is due to the potential loss of a small proportion of crushed aggregate potential underlying the site and perceived low risk of pollution to the aquifer which may be caused as a result of contamination caused by leaks and spills from construction plant or materials.

11.6 Assessment of Significance of Geological Impacts

The matrix in Table 11.5 determines the significance of the impacts based on the importance and magnitude of the impacts as determined by Tables 11.3 and 11.4 over.

Table 11-5: Ratings of Significant Environmental Impacts for Geology & Hydrogeology

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/Significant
Medium	Imperceptible	**Slight**	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

The determination of the significance of each impact for this site is presented below.

11.6.1 Potential Impacts on Soil and Geology – Direct & Indirect

The following on-site activities have been identified as the sources of potential risks to the soils and geology from the development:

- The removal of topsoil and subsoil during the construction phase will expose the subsoil to erosion. Some element of cut and fill will occur on site, however, this will be limited given the relatively flat-lying nature of the site. Further impact on the soils will occur during excavation for foundations and service trenches.
- A significant proportion of the glacial till may also be removed from site during the development. The impact on the geology and hydrogeology will be to reduce the overburden cover to the aquifer and therefore increase the vulnerability of the aquifer to contamination for a temporary period during construction.
- Soil compaction may occur due to movement of construction and maintenance traffic. This will occur particularly within areas of topsoil which are highly compressible. This could lead to an increase in runoff and subsequently to an increase in erosion.

The magnitude of these potential direct impacts, prior to mitigation, is considered to be of slight significance.

11.6.2 Potential Impact on Groundwater – Direct & Indirect

The following on-site activities have been identified as the sources of potential risks to groundwater from the development:

- Removal of topsoil and subsoil during construction phase may result in the exposure of the underlying limestone bedrock to sources of contamination and may temporarily increase the vulnerability of the aquifer whether or not the rock is exposed.

- Chemical pollution may occur as a result of spillage or leakage of chemicals, runoff from vehicle washing facilities, unset concrete, storage of fuels or refuelling activities etc.

- It is likely that site derived material will be used in the formation of sub-base material and landscaped areas, however, some materials may be required to be imported to site. If not properly regulated or controlled, this may result in an increased risk of contamination to the underlying groundwater from contaminants within the imported materials.

- The construction of additional drainage channels and other infrastructure may result in localised drawdown of the water table and, where gravel is used during construction, may also result in localised preferential drainage pathways. The changes in the drainage regime may also result in changes to the moisture content of the soils which may have implications for ecology (described in Chapter 10 Flora & Fauna), sediment transport, flooding and erosion (described in Chapter 8 Hydrology and Water Quality).

The magnitude of these potential direct impacts, prior to mitigation, is considered to be of slight significance.

11.6.3 Potential Cumulative Impacts on Geology and Hydrogeology – Direct & Indirect

The site is located within a heavy industry zone with numerous industrial and commercial developments located within the area, as identified in Chapter 1. Huntstown Quarry is also located 100m to the east of the site. However, given the resultant slight significance impact of the potential development, it is not considered that there would be any cumulative impact on the geology and hydrogeology of the site.

11.7 Mitigation Measures for Soils, Geology and Hydrogeology

The following sections outline appropriate mitigation measures to avoid or reduce the potential impacts of the proposed development on soils, geology and hydrogeology.

11.7.1 Mitigation by Design and Best Practice

With regard to the proposed development, detailed design best practice will be implemented as follows:

- The works will be designed and checked by a suitably qualified and experienced geotechnical engineer.
- Any excavation and construction related works will see the carrying out of a design risk assessment to evaluate risk levels for the construction, operation and maintenance of the works. Identified risks will be minimised by the application of principles of avoidance, prevention and protection. Information on residual risks will be recorded and relayed to appropriate parties
- A method statement for each element of the works will be prepared prior to any element of the work being carried out.
- Details of the relevant assumptions, relating to methods and sequencing of work will be provided to the contractor.
- Given the current site layout and the scale of the proposed development, it is not envisaged that a significant programme of earthworks will be required. However, any potential earthworks undertaken will be monitored by suitably qualified and experienced geotechnical personnel.
- The programming of the works will be such that earthworks are not scheduled to be carried out during severe weather conditions. Where such weather is forecast, suitable measures will be taken to secure the works.

- Details of all appropriate assumptions, relating to methods and sequencing of any works, will be provided to the contractor.
- No amendments to any designed works will be carried out without the prior approval of the designers.

11.7.2 Mitigation Measures for Soils and Geology

To mitigate against erosion of the exposed soil or rock, all excavations will be constructed and backfilled as quickly as possible. Excavations will not be left open overnight where possible and excavation will stop during or immediately after heavy rainfall.

To mitigate against possible contamination of the exposed bedrock/aquifer, refueling of machinery and plant will only occur offsite or in specially designated areas such as site compounds, using designated refueling bowsers.

Imported soils will be chemically validated and imported from a verified source. It will be placed and levelled as quickly as possible after unloading on the site. Any temporary stockpiles will be covered overnight to prevent erosion and sedimentation.

All temporary cuts / excavations will be carried out such that they are stable or adequately supported. Unstable temporary cuts / excavations will not be left unsupported. Temporary cuts and excavations will be protected against the ingress of water or erosion. Temporary works will be such that they do not adversely interfere with any existing drainage channels.

11.7.3 Mitigation Measures for Groundwater

The effects of groundwater control, if required during excavation, are likely to be localised, temporary and reversible. To reduce the impact on groundwater flow, controls such as dewatering or physical cut-offs will be avoided where possible.

The nature of the proposed materials-processing & transfer facility poses a low risk to groundwater, with no significant quantities of potentially contaminating material stored on the site. All materials brought on site will be stored in designated impermeable concrete hardstanding areas breaking any potential pathway.

Diesel for any site based equipment will be stored in a bunded area to prevent run-off, with a designated hard-standing fill area for re-fueling operation.

11.8 Residual Impacts

Residual impacts on the soils, geology and hydrogeology after implementation of the mitigation measures listed are predicted to be imperceptible.

11.9 Conclusions

The following conclusions can be drawn, in relation to soils, geology and hydrogeology:

- the site geology typically consists of a thin layer of topsoil, overburden predominantly comprising cohesive gravelly clay overlying limestone bedrock
- the majority of the site is grass covered, with the eastern portion of the site covered in gravelled hardstanding with 3 no. buildings in the southeastern portion of the site

A site walkover was undertaken and prior intrusive investigations were used to inform the assessment of the potential impacts on the soils, geology and hydrogeology.

Mitigation measures have been proposed with regard to the design and construction of the proposed development. Provided that these mitigation measures are carefully implemented, the residual risks to the soils, geology and hydrogeology associated with the construction, operation and decommissioning of the site are considered to be imperceptible.

11.10 References

EPA Envision Map Viewer
http://gis.epa.ie/Envision

Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters in Environmental Impact Statements, IGI;
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Groundwater Protection Scheme for County Dublin (on GSI website) (Geological Survey of Ireland & Kildare Co. Council, 2004)

Online Landslide Viewer:
http://spatial.dcenr.gov.ie/GeologicalSurveys/LandslidesViewer/index.html

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https://www.gsi.ie/Mapping.htm

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