3 ENVIRONMENTAL CONSIDERATIONS

The following sub-sections are intended to assess and describe specific areas of the existing baseline environment, to identify potentially significant impacts of the proposed development in respect of these areas, and to detail any proposed mitigation measures and on-going monitoring programmes, where appropriate.

3.1 HUMAN BEINGS

3.1.1 INTRODUCTION

All projects and developments that require an EIS *by virtue of their nature, size and location*, have the potential to have an impact on the environment. The impact on human's beings forms one of the most important aspects to be considered in an EIS. Any likely significant impact on human beings, including their community and activities, must therefore be comprehensively addressed. The principal concern in respect to this proposed development is that human beings should experience no significant unacceptable diminution in an aspect, or aspects of 'quality of life' as a consequence of the construction and operation of the proposed development.

This section of the EIS has been prepared in order to establish the human environment in the vicinity, and to assess the potential impact, if any, arising from the continued operation of a Waste Recovery Facility (MRF) at Clashford quarry, on the existing environment in respect of human beings. Matters related to water, air quality, noise, landscape and other such environmental impacts are not considered here, as these are more appropriately dealt with in their respective sections of the EIS. Thus, the impacts of the proposed continuation of operations at the MRF on human beings in relation to particular issues are addressed in the following sections:

- Water – Section 3.4
- Air Quality – Section 3.6
- Noise – Section 3.7
- The Landscape – Section 3.8
- Cultural Heritage – Section 3.9
- Material Assets – Sections 3.10
- Traffic – 3.11

The issues considered here include, land use, population, economy & employment, social infrastructure, amenity, tourism and recreation and health and safety. The potential impact on human beings resulting from the proposed development is assessed, and possible mitigation measures proposed to reduce any significant impacts.

3.1.2 STUDY METHOD

The human environment was assessed by undertaking a desktop study and conducting visits to the site and the area. The desktop study was undertaken to compile, review and interpret available information and data pertaining to the human environment of the site and area.

The desktop study involved the assessment of all relevant demographic and socio-economic data for the area, much of which was sourced from the Central Statistics Office (CSO). The Meath County Development Plan (2013 – 2019) and the Fingal County Development Plan (2011 - 2017) were also reviewed, whilst there are no plans for towns, villages or local areas relevant to the proposed development site. In addition, the desktop study used: (a) maps and site layout plans of the existing quarry development; (b) a copy of the conditions imposed on the quarry development under (P.Ref. QY36 QC 17.QC2085); (c) copy of the waste management permit for the MRF (WMP 2005/25); (d) Greater Dublin Area Regional Planning Guidelines 2010-2022 (Dublin Regional Authority & Mid-East Regional Authority 2010); (e) the National Spatial Strategy 2002-2020 (DOELG 2002); and (f) the National Development Plan 2007-2013 (DOT 2004).

In preparing this section, regard was given to the relevant guidelines and recommendations set out in 'Guidelines on Information to be contained in Environmental Impact Statements' (EPA 2003). It is considered that there is a wealth of available data and information, which is sufficient to adequately assess the local environment with respect to human beings.

The assessment of impacts on the human environment were considered using criteria such as: (a) location of nearest sensitive receptors; (b) disturbance to the general amenity of the local environment; and (c) pre-existing use of the land and area. The construction and operational phases of the proposal were both considered. In carrying out the assessment both positive and negative impacts were considered in each case, and the significance of the impacts are rated as being either: imperceptible; slight; moderate; significant; or profound (See Table 3.1.3).

3.1.3 PROPOSED CONTINUATION OF WRF OPERATIONS

This EIS pertains to a proposal to continue operation of a WRF at Clashford quarry in the Townland of Naul, Co. Meath. The quarry and WRF currently operate under the terms and conditions imposed under P.A. Reg. Ref.QY36, QC 17.QC2085 and P.A. Reg. Ref. 85/512, PL.17/5/72181 granted by Meath County Council. Since 2001, the quarry site is being progressively restored in accordance with a phased restoration scheme using imported soil and stone subject to successive Waste Management Permits granted by Meath County Council (e.g., Waste Permit Reg. No. WMP 2005/25).

Changes in Waste Management legislation which came into effect in June 2008 (S.I. No. 821 of 2007), now require a Waste Management Licence issued by the Environmental Protection Agency (EPA) in order to operate a WRF with a lifetime total intake volume in excess of 100,000 tonnes. An application for a Waste Management Licence was originally submitted in February 2009 (EPA Reg. No. W0265-01). Pursuant to Article 3(4) of the 2007 Regulations, the WRF has continued to operate under the existing Waste Permit (Reg. No. WMP 2005/25), until such time as a decision is rendered in respect of the application for a Waste Management Licence.

The application area refers an area of c 22.3 ha located centrally within the larger landholding of c. 33.4 ha, which is being progressively restored. Ultimately, the entire quarry site at Clashford will be fully restored to agricultural and some silvicultural use on closure of the quarry and WRF. The objective underpinning the proposal for continued operation of the existing WRF, is to recover up to 90,000 cubic metres per annum of inert Construction and Demolition (C&D) waste, principally soil and stone, for backfilling and restoration of the quarry in accordance with P.A.Reg. Ref. No. QY36, QC 17.QC2085. Any small quantities of timber, plastic, paper and steel will be separated for recovery and/or disposal offsite. Once licenced, it is proposed that the operation will continue to use the existing site infrastructure, and to operate to the current standards for such facilities. No new facilities or infrastructure are planned, nor are any new waste streams or processes envisaged.

3.1.4 RECEIVING ENVIRONMENT

In this section, land use, recent demographic trends, employment characteristics, social infrastructure and amenity and tourism are examined.

3.1.4.1 LAND USE

The Clashford site is located on the east side of Regional Road R108 in the Townland of Naul, County Meath, c. 300m north of the village of Naul, across the Delvin River in County Dublin (Refer to Figure A1.0, *EIS Section 2 Figures*). The R108 connects with the R122 in village of Naul, which connects with the M1 (Dublin-Drogheda-Dundalk) motorway at junction 6 c. 5km to the east, and to the town of Balbriggan c. 7km to the east. Dublin lies c. 25km to the south, whereas Drogheda lies c. 15 km to the north. The Delvin River flows roughly SW-NE and flanks the southern boundary of the site, whilst an unnamed tributary stream of the Delvin River flanks the northern boundary of the site, and joins the river at the northeastern terminus of the quarry site. The western boundary of the quarry site is defined by the R108 and the party boundary with several residential properties on the east side of the R108.

The surrounding landscape is defined by the valley of the Delvin River, known as Roche Valley (elev. c. 60-90m OAD), separating two sets of hills to the northwest (max. elev. 159m) and southeast (max. elev. 176m). The quarry has been developed on a c. 1km long mound of sand and gravel within a southwest-northeast oriented ribbon of glacial deposits that extends from the Townland of Tobeen (i.e., c. 2km further up valley) down the river valley to the coastal plain. The predominant land use within the application site, which is co-located within the quarry site, is by definition that of quarrying activities related to the extraction of sand and gravel and associated operations such as placement of soil and stone in quarry restoration. Prior to the commencement of quarrying in the 1980s, the lands had been kept in medium intensity agriculture. The land-use in the area consists of a patchwork of agricultural fields that are designated as non-irrigated arable land and pasture, reflecting medium-high intensity agricultural, with very low levels of forest cover, restricted largely to river valleys and hedgerows. Outside of the immediate environs of the village of Naul, the settlement pattern can be described as low-intensity rural settlement.

The applicants land holding is shown edged blue, whilst the existing quarry site, which covers an area of c. 33.4 hectares, is shown edged green on EIS Figure B2.2 - Rev A, *EIS Section 2 Figures*. The site of the WRF occupies a subordinate footprint of c. 22.3 ha, located west centrally within the larger quarry site. The northeastern (Restored Lands) and the south central (P1) sectors of the quarry site have been restored to agricultural use, and are currently supporting livestock, while a plantation of broadleaf forest fringes much of the eastern half of the quarry site. The sector designated as P2 is currently being restored, whilst the sector designated P3 houses all of the site infrastructure and is yet to be restored (Refer to EIS Figure B 2.1 – Rev A, *EIS Section 2 Figures*).

The development will also continue to use the established quarry infrastructure including internal roads, crushing and screening plant, site office, wheelwash, and other ancillaries (Refer to EIS Figure B 2.1 – Rev A, *EIS Section 2 Figures*).

There are numerous established individual residences within a 500m radius of the site, particularly in the village of Naul, as shown on EIS Figures B 2.1 – Rev A and B 2.2 – Rev A. There are no dwellings on the site or landholding, although several dwellings are located to the immediate west of the site on the R108, and across the Delvin River on the R122.

3.1.4.2 POPULATION AND SETTLEMENT

Analysis of the 2011 Census indicated that in the 2006–2011 period, Meath experienced one of the highest population increases amongst the 26 counties (i.e., 13.1%), and for the first time the population eclipsed the pre-Famine population of 183,828 in 1841. Meath is the third most populace county in Leinster after Dublin (i.e., 1,273,069) and Kildare (i.e., 210,312). A population of 109,732 was recorded in 1996, 134,005 in 2002, 162,831 in 2006, and 184,135 in 2011, representing increases of 22.1%, 21.5% and 13.1% for the three inter-censal periods. The average inter-censal increase in population is 18.9%, whilst annual rate of population growth in the period was 3.78%. Births far outpace deaths, which for example were 3,474 versus 823 in 2009, adding c. 2,500 annually to the population. Thus, the increase in the population of Meath between 2006 and 2011 (i.e., 21,304) is comprised of comparable components due to natural increase (births over deaths) and net migration (i.e., both approximately 2,500).

Since 2006, the population of Leinster increased by 9.14%, while the population of the State increased by 8.22%. Thus, despite this significant population growth in both the Province and State, the population growth of Meath (13.1%) was only exceeded by that of Longford (i.e., 13.4%) and Laois (i.e., 20.1%). Nonetheless, Meath's share of the provincial population (i.e., 2,295,123) grew from 7.09% in 2006 to 7.35% in 2011. Meath, along with Dublin, Louth, Kildare and Wicklow, comprise the "Functional Area of the Dublin City Region" (FADCR), and with a population of c. 1.8 million, accounts for 42% of the population of the State (Walsh & McNicholas 2009). The latter authors noted a contrast between areas of population decline in the inner suburbs of Dublin and various rural parts, compared to areas of high increase in southeast Meath, northeast Kildare and Fingal. This is reflected in County Dublin having the lowest population growth rate (i.e., 7.24%) in Leinster for the 2006-2011 inter-censal period, whilst the population of the FADCR increased by 8.64% in the same period. Meath's population represents an increasing proportion of the population of the FADCR from 9.18% in 2006 to 9.56% in 2011. Similarly, Meath's population as a percentage of the population of the Greater Dublin Area (GDA – includes Dublin, Meath, Kildare and Wicklow, but excludes Louth), also increased to 10.2% in 2011.

There are numerous large to medium towns with legally defined boundaries in Co. Meath, namely Navan (pop. 28,158), Ashbourne (pop. 11,338), Ratoath (pop. 9,043), Dunboyne (pop. 6,959), Dunshaughlin (pop. 3,903), Kells (pop. 2,208) and Trim (pop. 1,441). There are other significant urban areas, including the *census towns* of Drogheda Environs (i.e., 5,983), Laytown-Bettystown-Mornington (pop. 10,889), Maynooth Environs, Kilcock Environs, and a host of smaller towns and villages, including Duleek, Stamullen, Oldcastle, Athboy, Slane, etc. Although Drogheda is in Co. Louth, and hence the Border Region, its development is strongly influenced by its relative proximity to Dublin, and it along with Balbriggan are proximate to Clashford, and are thus also considered here. Notably, the nearest town to the Clashford site is Balbriggan, Co. Dublin (pop. 19,932), and the Dublin Regional and Mid-East Regional Authorities (2010) designate it a Large Growth Town II in their settlement hierarchy (Greater Dublin Area Regional Planning Guidelines 2010).

The Dublin Regional and Mid-East Regional Authorities designate Navan and Dunboyne as Large Growth Towns I and II, respectively, whilst Ashbourne, Dunshaughlin, Kells and Trim are designated as Moderate Sustainable Growth Towns. Because of differences in the way boundaries between urban and rural areas are incorporated into the 2006 and 2011 censuses, it is difficult to give a consistent statement on the population growth of these towns. However, by including both urban and rural components in the comparisons, it is apparent that the population growth in the 2006-2011 period for Navan was 14.9% (i.e., 24,851 versus 28,559), compared to Dunboyne at 22.8%, Ashbourne at 33.0%, Dunshaughlin at 15.3%, Kells at 12.2%, and Trim at 20.4%. It is apparent from the data that the population growth of the towns generally increased with proximity to Dublin.

The National Spatial Strategy (NSS) recognises the strong functional interrelationships between the Dublin and the Mid-East regions as the GDA (DOELG 2002). There are a large number of towns in the GDA, and these are largely located on the main transport corridors radiating out from Dublin, such as the M1 (Swords, Balbriggan, Laytown-Bettystown-Mornington and Drogheda), N2 (Ashbourne, Ratoath, Duleek and Slane), and the M3 (Dunboyne, Dunshaughlin, Navan and Kells).

The NSS also identifies Dublin as the only Gateway within the Dublin and Mid-East Region or GDA, and does not identify any Hubs. Within the north central sector, which includes all of Meath and the wider area around Clashford and Naul, there are three Primary Development Centres identified, namely Drogheda and Balbriggan on the M1, and Navan on the M3, and the County Town of Meath. These centres are strategically placed, strong and dynamic urban centres, located on major transport corridors, where development in the hinterland of Dublin should be concentrated. However, because of proximity and the anisotropic connectivity of the transport network in the area, Clashford only falls within the natural catchment of Balbriggan and Drogheda. Clashford falls within the large swathe of southeastern Meath that is designated as a *Rural Area under Strong Urban Influence* (Meath County Council 2013), and represents an unsustainable trend away from the principle of building critical mass in the Primary Development Centres and larger towns in order to facilitate balanced regional development.

The proposed development is located in the townland of Naul within the civil parish of Clonalvy, and the Electoral Division (ED) of Stamullin, (Refer to Figure 3.1.1). The surrounding electoral divisions include Julianstown, Ardcath, Garristown, Hollywood, Balscadden and Balbriggan Rural. Although, the Clashford area is located in a relatively sparsely populated rural area of south Meath, it includes the town of Stamullin (pop. 3130). Thus, the Stamullin ED, an area of 37.68 km^2, has a population of 4,696 persons, which translates into a relatively high population density of 124.6 persons per km^2. This compares to the population densities of 78.6 and 67 persons per km^2 for County Meath and the State, respectively, which themselves constitute low population densities relative to those in neighbouring UK and Europe (i.e., 255 and 112 persons per km^2, respectively).

Although the sex ratio for Meath is 0.997 (i.e., more females than males), the sex ratio for the Stamullin ED is 1.07 (i.e., 2,424 males versus 2,272 females), with females preferentially migrating to the towns, resulting in this characteristic pattern for rural areas throughout Ireland. The average age of the population in Meath is 33.8, which is significantly below the national average of 36.1, and is the second youngest in the State after Kildare (i.e., 33.5), albeit Fingal local authority has the youngest population (i.e., 32.9). The average age in the Stamullin ED in 2011 is approximately 32 (See Figure 3.1.2), and is thus markedly younger than Meath in general. This reflects Stamullin's high population growth rate of 21.8% in the 2006-2011 inter-censal period.

Age dependency shows the ratio of the old and young segments of the population to that of working age. Notably, the total age dependency ratio in the State increased by 3.5% from 45.8% in 2006 to 49.3% in 2011, whilst the ratio in Meath increased by 5.9% from 45.8% to 51.7% in the same period. The young dependency ratio is the number of young people aged 0-14 as a percentage of the population of working age. In 2011, the ratio was 31.9% for the State overall, whilst Meath had the highest ratio at 38.3%, reflecting its very young and fast growing population. In contrast, the old dependency ratio is the number of people aged 65 and older as a percentage of the population of working age. In 2011, the old dependency ratio in the State was 17.4%, whilst the ratio in Meath was 13.5%, which is the second lowest county after Kildare (11.7%), albeit the local authorities of Fingal (10.6%), Galway City (12.6%), and South Dublin (12.7%) had even lower ratios. Thus, while Meath has a moderately high total age dependency ratio, it reflects a very young, growing population versus an ageing population.

Table 3.1.1 gives population data for the electoral divisions in the vicinity of Clashford, as well as for County Meath, the GDA, and the State from 2002-2011 (CSO 2013). Notably, the populations of the seven electoral divisions that comprise the local area showed widely differing growth rates between 2002-2011, although together the population has more than doubled in the decade. Much of this growth is related to the burgeoning population on Balbriggan and urban sprawl into rural Balbriggan, where the population of the latter electoral division accounts for half of the local area. In contrast, the strongly rural electoral divisions of Ardcath and Balscadden exhibit populations that are comparatively stagnant, with growth rates of 0.2% and 15.6%, respectively. Meath's population grew at the rate of 37.4% between 2002-2011, significantly higher than the more modest growth rates of 17.5% and 17.1% for the GDA and the State, respectively. It is noteworthy, that the population of the GDA did not grow at a substantially more accelerated pace than that of the State (17.5% versus 17.1%).

There are several large residential settlements close to the site, with the village of Naul c. 300m to the south, Stamullin c. 5km to the northeast, Balbriggan c. 7km to the east, Ashbourne c. 11km to the southwest, Lusk c. 11km to the southeast, and Skerries C. 11km to the east. There are numerous residences in the immediate area. Notably, there is a suburban style graig or hamlet on Moonlone Lane off the R122, c. 1.5km east of Naul. However, residential development predominantly consists of isolated farm dwellings and of owner occupied bungalow/houses along public roads (Refer to EIS Figures B 2.1 – Rev A and B 2.2 – Rev A, *EIS Section 2 Figures*).

Table 3.1.1 Population in the Local Area 2002-2011

District	2002	2006	2011	%Change 2002-2011
Julianstown	5,806	8,289	9,606	+65.4
Ardcath	1,907	1,873	1,911	+0.2
Garristown	1,162	1,182	1,438	+23.8
Hollywood	952	998	1,259	+32.2
Balscadden	577	653	667	+15.6
Balbriggan Rural	4,501	9,615	15,140	+236.4
Stamullin	779	2,487	3,130	+301.8
Total Local Area	15,684	25,097	33,151	111.4
County Meath	134,005	162,831	184,135	+37.4
Dublin & Mid-East Region	1,535,446	1,662,536	1,804,156	+17.5
State	3,917,203	4,239,848	4,588,252	+17.1

Note: Data from CSO (2013).

3.1.4.3 ECONOMY & EMPLOYMENT

Historically, Meath's location within the Pale, access to the ports of Dublin and Drogheda, and abundance of productive agricultural land bestowed great advantage on Meath. Today Meath's strategic advantage is its proximity to Dublin and location within the capital city region or GDA, which is the most economically dynamic and progressive area of the country. Meath benefits from this proximity to Ireland's primary economic hub and National Gateway, and the largest market in the State. Meath also benefits from its strategic location on the Dublin-Belfast international corridor linking both capital cities and international airports. The excellent, multi-modal transport infrastructure which provides ready access to Dublin Airport and Dublin Port also delivers strong connectivity throughout the county with four national primary routes, three of which are motorway (i.e., M1, M3 and M4). The fertile soils of Meath also provide the basis for a thriving agricultural and food sector that can support the rural economy and communities.

With its rich array of cultural and heritage assets, such as the World Heritage Site of *Bru Na Boinne*, *Hill of Tara*, the seat of the High Kings, *Loughcrew Cairns*, the *Battle of the Boyne* site, *King John's Castle,* Trim, *Bective Abbey*, and the *Kells Crosses*, Meath has positioned itself as the *'The Heritage Capital'* of Ireland. Cultural tourism has been identified as a potentially significant driver of the county's modern economy. Meath County Council (2013) recognises that the sustainable development of green infrastructure and natural heritage and the maintenance and improvement of the unique rural and urban built heritage present strong attractions.

Meath is the second most affluent local authority area in the Mid-East Region, and sixth most in the State, and in general is not characterised by particular extremes of affluence or deprivation (Haase 2007). The most affluent areas are situated in the South East of the county, including Clashford, which lie within easy commuting distance to Dublin.

Although urban areas of Meath are home to a greater fraction of the population of Meath (i.e., 105,018 or 57% in 2011), rural areas are home to a substantial population (i.e., 97,117 or 43% in 2011). This urban/rural split of near-parity in Meath (i.e., 1.33) contrasts with that in the State, Mid-East Region and the GDA (i.e., 1.64, 1.74 and 43.6, respectively). Although rural areas account for 43% of the population, only 6% are employed in agriculture, forestry and fishing in 2011. Nonetheless, agriculture is the primary land-use in the county and the economy benefits significantly from the sector. The rural areas are also the location of major natural resources as well as major recreational, amenity, tourist and archaeological resources.

From Table 3.1.2, it is apparent that the dominant employment sectors in Meath are commerce and trade (23%), transport and communications (18%), manufacturing (13%) and professional services (12%).

Examination of the Central Statistics Office (CSO) Live Register figures for County Meath during the recession shows that unemployment levels rose dramatically from the end of 2007 to 2010 and remained a factor of about 3 times the pre-recession levels at c. 12,000 during 2010 and 2011 (See Figure 3.1.3). In the 2011 census, unemployment stood at 18% in Meath compared to 19% nationally. The unemployment level in Meath began to fall gradually from early 2012, and fell below the 10,000 mark in late 2013. In May 2014, the figure stood at 9,775, which equates to an unemployment rate of 9.9%, whereas the national rate was 11.8%. Thus, the unemployment rate in County Meath is approximately two percentage points lower than in the State. The dramatic increase in unemployment has been largely associated with the collapse of the construction industry and the associated service industries. The recent improvement in unemployment figures probably reflects stabilisation in job losses and an improving economic outlook, combined with the historical pressure valve of emigration.

Commerce and trade, which includes wholesale and retail trade, banking and financial services, real estate, renting and business activities, is the single largest employer in the Stamullin ED. Given that approximately half the workforce in Meath work outside of Meath, and given the proximity of the Stamullin ED to Dublin, it is probable that the dominance of commerce and trade reflects the large fraction of the workforce in the Stamullin ED that works outside both the electoral division and county, in Dublin City. Transport and communications, followed by manufacturing are the next largest employers for the population of the Stamullin ED, although similarly these are probably located in Dublin City. Although a largely rural electoral district, agriculture, forestry and fishing represents the smallest employment category for the workforce in Stamullin ED (See Table 3.1.2).

Table 3.1.2 Employment by Industry in County Meath and Stamullin ED in 2011

Industry	County Meath		Stamullin ED	
Agriculture, forestry and fishing	2,862	7.37%	62	6.00%
Building and construction	1,719	4.43%	106	10.3%
Manufacturing	5,514	14.2%	131	12.7%
Commerce and trade	10,137	26.1%	240	23.2%
Transport and communications	1,832	4.72%	188	18.2%
Public administration	2,398	6.18%	64	6.19%
Professional services	9,376	24.2%	128	12.4%
Other	4,984	12.8%	115	11.1%
Total	38,822	100.0%	1,034	100.0%

Note: Excludes 32,942 workers who work outside Meath. Data from CSO (2013).

Historically, agriculture and businesses supporting agricultural production would have been the main source of employment in Naul village and its environs. Employment in the village is very limited, focused on small scale/family run local commercial businesses, mostly retail shops, a sales/service garage and the Seamus Ennis Cultural Centre. Naul and Stamullin offer few employment opportunities, with the nearest major commercial and industrial centre being the Stephenstown industrial estate in Balbriggan. There are some employment opportunities related to the M1, including the M1 business park at junction 5, near Balrothery, and at the City North hotel and business park at junction 7, near Stamullin. However, the major employment opportunities for the workforce resident in the Stamullin ED are in Dublin. Despite proximity to the Dublin-Belfast M1 road and rail corridor, east Meath, including the Stamullin ED, recorded very high transport energy consumption (Walsh & McNicholas 2009), and is most probably related to commuting to work in Dublin. This is consistent with the average journey times to work, school or college of c. 35 minutes for the Stamullin ED in 2011.

Clashford Recovery Facility Ltd is an established small family run business based in Naul, Co Meath. Clashford Recovery Facility Ltd employs four people directly and a number of others indirectly, with the majority of the employees being local people. An additional two temporary staff are hired occasionally. The WRF will help sustain employment in the local area while beneficially restoring the quarry back to agricultural use.

3.1.4.4 SOCIAL INFRASTRUCTURE

Clashford and Naul are located in a rural area, which is under strong development pressure for residential and economic uses associated with its proximity to Dublin. Residential development consists of isolated farm dwellings and of owner occupied bungalow/houses along public roads (Refer to EIS Figures B 2.1 – Rev A and B 2.2 – Rev A, *EIS Section 2 Figures*). The picturesque village of Naul lies c. 300m to the south of Clashford, and acts as a local centre servicing the agricultural hinterland. The Square and Main Street provide the focus of the built form of the village. The Square contains a range of 19th and early 20th century buildings, including the re-thatched Seamus Ennis Cultural Centre, which is an important focal point for the community in the in the village and wider area. The village has a population of c. 200.

Beyond the village of Naul, there are no large residential settlements close to the site with Stamullin c. 5km to the northeast, Balbriggan c. 7km to the east, Garristown C. 7km to the west, Oldtown c. 7.5 km to the south southwest, Ballyboughal c. 7.5km to the south, Ashbourne c. 11km to the southwest, Lusk c. 11km to the southeast, and Skerries C. 11km to the east. With exception of the N-S oriented R108 and the E-W oriented R122 Secondary National Road, the roads in the area are of a local character and typical of a rural location. The M1 motorway lies c. 5km to the east, whilst the Dublin-Belfast mainline railway runs along the coast at Balbriggan c. 7.5km to the east.

The nearest Post Office is in the town of Balbriggan or Garristown (i.e., both c. 7km), where the former also has a large range of shops available. A Postpoint electronic payment service is available in Reilly's Daybreak shop in Naul. The nearest bank is also located in Balbriggan.

The Naul National School caters for the primary education of over a 100 pupils, whilst secondary schools are available in Balbriggan (i.e., Ardgillan Community College, Balbriggan Community College, Coláiste Chlor na Mara and Loreto Secondary School), Swords (i.e., Fingal Community College, St. Finnians Community College, Loreto College Swords, and Coláiste Choilm C.B.S.), and Ashbourne (i.e., Ashbourne community school, and the new Meath VEC Secondary School is scheduled to open in September 2014).

The nearest third level Institutions are located in Blanchardstown (i.e., Blanchardstown Institute of Technology or BIT), Tallaght (i.e., Institute Technology Tallaght or ITT), Dublin (i.e., Dublin Institute of Technology or DIT), and Dun Laoghaire (i.e., Dun Laoghaire Institute of Art, Design & Technology or IADT), whereas the nearest universities are Dublin City University (DCU) in Glasnevin, University College Dublin (UCD) in Belfield, and Trinity College Dublin (TCD) in the city centre.

The nearest church to Clashford is the Nativity of Our Lady in the village of Naul. Other churches in the region include: St. Peter and St. Paul, Balbriggan; Church of the Assumption, Garristown; St. Mary's Church, Ardcath; St. John the Baptist, Clonalvy; St. Patrick's Church, Stamullin; Assumption of Our Lady, Ballyboughal; and St. Mary's Church, Oldtown. The nearest houses of worship of other major denominations are: Church of Ireland: St. Georges, Balbriggan; Presbyterian: Donabate Presbyterian Church; Baptist: the Balbriggan Baptist Church; and Pentecostal: the Redeemed Christian Church of God, Balbriggan.

The Health Centre in Naul has closed, and the Health Centre at Clonmethan, Oldtown has been designated as the Primary Care Centre for the villages in north county Dublin (or Fingal), including Naul, Garristown and Ballyboughal. The nearest hospital is Highfield Private Hospital, Swords, whereas the nearest public hospital is Our Lady of Lourdes Hospital, Drogheda, followed by Beaumont Hospital, Beaumont, Dublin 9, and Connolly Hospital, Blanchardstown, Dublin 15.

The nearest Fire Station is located in Balbriggan, with next closest located in Ashbourne, Skerries and Swords, all but the last of which are retained services. The Dublin Fire Brigade is headquartered at Townsend Street, Dublin 2, whilst the Meath Fire Brigade is headquartered in Navan. The nearest Garda Station to Clashford is located in Balbriggan and falls within the Dublin Metropolitan Region of An Garda Síochána, whereas the Garda Station at Ashbourne falls within the Meath Region.

Other facilities in the wider area, include the Community Centre and Seamus Ennis Cultural Centre in Naul, and community centres in Balbriggan, Garristown, Stamullin, Skerries, Oldtown, Ballyboughal and Lusk.

Power to local residences is provided by over-head lines. The mains water supply for Naul and its surroundings is served by a 4 inch concrete water main from the Hollywood Reservoir. There are also houses in the area served by bored wells. Most rural houses are serviced by septic tank systems and proprietary effluent treatment systems.

3.1.4.5 AMENITY, TOURISM AND RECREATION

Meath is named after the ancient Kingdom of Meath, and is also known colloquially as the “Royal County”, because of its history as the seat of the High King of Ireland. It was also part of the area known as “The Pale”, which was under the direct control of the English establishment during the Middle Ages. The area of County Meath is very much defined by the Boyne River Catchment, and it is the Boyne Valley which is home to the megalithic tumuluses of Dowth, Knowth and Newgrange at Brú na Bóinne, the Hill of Tara, and the source of the ABradan Feasa@ or ASalmon of Knowledge@ of Cú Chulainn mythology. With its numerous ancient monuments, ruins, castles, battlefields and Landed Estates (or Demesnes) with their Great Houses, Meath is a county steeped in history.

Clashford is located in County Meath c. 300m north of the village of Naul. There are community and recreational facilities in the village of Naul, which include the Nativity of Our Lady Church, Community Centre, Seamus Ennis Cultural Centre, Naul National School, and the Clann Mhuire GGA club. Sports are actively pursued in the wider area and include soccer, golfing, hillwalking, fishing, horse riding and swimming. The Delvin River is popular with anglers. The Square in the village is used for the Fingal Traditional Music Festival held annually in October.

Naul village and its environs are steeped in history and have a wealth of historical and archaeological sites. In particular, the passage graves at Four Knocks c. 2km northeast of

Naul date back 5,000 years. Within the village, there are also the ruins of a stone tower known as Black Castle on the cliff overlooking the Delvin River; the ruins of the Church of Ireland Chapel with Cross; the restored Mill House, and the distinctive estate houses on Main Street, reflecting the village origins as a manorial village.

Naul sits on the border of Meath and north County Dublin (or Fingal), and is c. 7km from Balbriggan, c. 20km from Dublin Airport, and c. 25 km from Dublin Port. Naul benefits from the myriad amenities and attractions located within both of these local authority areas, as well as being within easy reach of the vibrant Capital City of Dublin.

Heritage attractions in Fingal include: castles at Ardgillan, Malahide, Swords and Howth; a Round Tower at Swords; the 12th Century St. Doulagh's Church, Kinsealy; Newbridge House, and numerous Martello Towers along the coastline. Parks and gardens are available at Ardgillan Castle Demesne, Malahide Castle Demesne, Howth Castle Demesne, Newbridge House Demesne, and Ward River Valley. Other visitor attractions include: the National Transport Museum, Howth; Dunsink Observatory; Draoícht Arts Centre, Blanchardstown; National Aquatic Centre, Blanchardstown; Newbridge Farm Museum, Donabate; and the Skerries Mill, a complex of water and wind powered mills.

There are numerous walking and cycling trails, including several on Howth Head, and "Slí na Sláinte" in Swords, whilst boat trips and cruises of Fingal coastline and islands are available. There are also many prime locations for sea angling along the coast from Howth to Balbriggan and around Dublin Bay, whilst fresh water angling is concentrated on the Liffey and Tolka Rivers and the Royal Canal. Courtlough Shooting Grounds, Balbriggan is Ireland's premier shooting grounds, and provides all weather facilities where several shooting disciplines, such as Clay Pigeon and Target, as well as archery, can be enjoyed.

Heritage attractions in east Meath include: the World Heritage Site and visitor centre at Bru na Boinne; Hill of Tara; Loughcrew Cairns; Kells Round Tower and High Crosses; King John's Castle, Trim; Battle of the Boyne Site, Oldbridge; Slane Castle; Ardbraccan House; and many more. Meath also offers many other tourist attractions, including: Tower of Lloyd, Kells; 8 heritage trails; numerous walking and hiking trails; water sports at Rathbeggan Lakes and on the miles of sandy beaches at Bettystown-Laytown; adventure centre at Loughcrew, Oldcastle; angling on the famous Boyne and Blackwater Rivers; golfing; horse racing; and numerous festivals such as Moynalty Steam Threshing; Tattersalls International Horse Trials and County Fair; and the Slane Castle Music Festival.

The main local GAA clubs in the area are: Clann Mhuire GAA, Naul; St. Patrick's Stamullin; St. Vincent's Ardcath; Garristown GAA, Garristown; O'Dwyer's GGA, Balbriggan; Wild Geese GAA, Oldtown; and Man O'War GAA, Lusk. Additional sports facilities are scattered around the region, such as outdoor soccer pitches at Balbriggan, Balrothery, Skerries, Ashbourne, and indoor soccer at Santry, Dublin 9. Rugby clubs are located at Balbriggan, Skerries, Swords, Malahide and Sutton.

Golf enthusiasts visiting the area can enjoy a wide choice of excellent golf courses within short driving distance, including numerous links and heathland courses. Golf courses abound in the region, with twenty six courses within Fingal alone. The nearest course is at Hollywood (c. 4km to the south), whilst others are located in Balbriggan, Ballyboughal, Gormanstown, Ashbourne, Bellewstown, Skerries, Swords, Rush, Donabate, Malahide, Howth, and the fabled Championship Course at Portmarnock. Slightly further afield is the championship links course at County Louth Golf Club, Baltray, just north of the mouth of the Boyne River.

Located c. 7.5 km from the east coast, water sports are also popular in the region, such as swimming, windsurfing and sailing, where the latter is served by several yacht / sailing clubs in Skerries, Malahide, Sutton and Clontarf. Horse racing is also popular at the annual Laytown Beach Races in September, at the Bellewstown racecourse, and at Fairyhouse, the home of the Irish Grand National. There are equestrian activities at nearby equestrian centres at: Broadmeadows and Curragha, Ashbourne; Thornton Park, Kilsallaghan; Kilronan, Swords; Castlehill, Julianstown; Copperfield, Skerries; and Broadmeadow, Donabate.

3.1.4.6 HEALTH & SAFETY

Operations within the quarry site, which includes the WRF, are carried out in accordance with all relevant legislation / regulations and with the best work practices for the industry. The policy of the operator is to ensure the health and welfare of its employees by maintaining a safe, clean and tidy working environment, and employing safe working procedures. The policy has been extended to include the WRF, and is in accordance with the requirements of employment legislation, including the provisions of the "Safety, Health and Welfare at Work Act, 2005", and the relevant Regulations.

The wearing of protective clothing such as footwear, helmets and high visibility clothing is mandatory in operational areas. Careful attention is paid to safe practices when carrying out machinery maintenance and ensuring appropriate guarding of moving parts.

Adequate fencing, signage and other barriers have been erected around the quarry site, which will also encloses the WRF, for the safety of the general public and to prevent livestock straying into the development. Large lockable gates are in place to guard against unauthorised and unsupervised entry to the site outside of working hours.

3.1.5 ASSESSMENT OF IMPACTS

3.1.5.1 INTRODUCTION

The proposed continued operation of the WRF at Clashford arises from: (1) the continued demand of human beings to have their buildings, roads and structures, modified and improved, resulting in the generation of large volumes of inert C&D waste, including soil and stone; and (2) the requirement to restore land, previously disturbed and degraded by sand and gravel extraction at the Clashford quarry, through backfilling with recovered inert soil and stone. The recycling and recovery of C&D waste is essential to reduce resource utilisation and divert reusable inert waste from landfill.

The strategic location of Clashford with access directly onto regional road R108, and c. 5km from junction 6 on the M1, and c. 7km from Balbriggan, via the R122, renders the WRF well positioned to deliver recovery of inert soil and stone from a large catchment area. This will contribute to the diversion of greater volumes of waste from disposal in landfill, as required under the Waste Framework Directive 2008 (2008/98/EC), and the European Communities (Waste Directive) Regulations, 2011 (S.I. 126 of 2011). There is also a preference for the deposition of soil and stone to be underpinned by a beneficial use in order to be considered waste recovery. Consequently, co-location of a waste recovery facility at Clashford quarry has significant positive impacts, and is thus environmentally preferred.

The impact on human beings resulting from the proposed continued use of the WRF is assessed here, and possible mitigation measures proposed to reduce any significant impacts. Table 3.1.3 identifies the levels of impacts which are used here in order to evaluate the significance of potential impacts resulting from the proposed continuation of the WRF. These impact ratings are in accordance with impact assessment criteria provided in EPA's "Advice Notes on Current Practice in the Preparation of Environmental Impact Statements" (2003).

It is expected that the potential negative impacts on human beings and amenity of the area arising from the WRF, above those already arising from the quarry, relate mainly to nuisance from noise, dust and traffic.

There are a number of potential environmental impacts associated with the WRF that may directly, or indirectly, affect the local "human" environment. These potential impacts and the mitigation measures proposed are described in the following sections of this report under the headings detailed below:

- Flora & Fauna – Section 3.2
- Water – Section 3.4
- Air Quality – Section 3.6
- Noise– Section 3.7
- Landscape – Section 3.8
- Cultural Heritage – Section 3.9
- Material Assets – Sections 3.10
- Traffic – 3.11

Table 3.1.3. Glossary of Impacts following EPA Guidance Documents.

Impact Characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment
	Neutral	A change which does not affect the quality of the environment
	Negative	A change which reduces the quality of the environment
Significance	Imperceptible	An impact capable of measurement but without noticeable consequences
	Slight	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
	Moderate	An impact that alters the character of the environment in a manner consistent with existing and emerging trends
	Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
	Profound	An impact which obliterates sensitive characteristics
Duration	Short-term	Impact lasting one to seven years
	Medium-term	Impact lasting seven to fifteen years
	Long-term	Impact lasting fifteen to sixty years
	Permanent	Impact lasting over sixty years
	Temporary	Impact lasting for one year or less
Type	Cumulative	The addition of many small impacts to create one larger, more significant impact
	'Do Nothing'	The environment as it would be in the future should no development of any kind be carried out
	Indeterminable	When the full consequences of a change in the environment cannot be described
	Irreversible	When the character, distinctiveness, diversity, or reproductive capacity of an environment is permanently lost
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect
	Synergistic	Where the resultant impact is of greater significance than the sum of its constituents
	'Worst Case'	The impacts arising from a development in the case where the mitigation measures may substantially fail

3.1.5.2 LAND USE

The existing quarry development has been undergoing progressive reinstatement to agricultural/woodland using imported material for at least 15 years. A waste licence is now required to complete the final stages of the restoration programme. The impact of the restoration works to date has had a positive impact on the environment in returning these lands to beneficial use including establishing new woodland habitat along the Delvin River valley. The visual amenity of the locality has also benefited from the restoration works being undertaken.

The quarry has put in place a number of mitigation measures with respect to environmental management and monitoring to ensure that operations do not result in significant impacts on the surroundings, including the human environment.

The area has an established history of sand and gravel working, and these activities have co-existed with other land uses in the area, particularly medium to high intensity agriculture. On completion of site activities, the site of the quarry and WRF will be decommissioned and left safe and secure. Furthermore, the site will be reinstated in accordance with the phased restoration scheme for the quarry, and thus integrated back into the surrounding landscape with the attendant improvement to the visual amenity of the area.

3.1.5.3 POPULATION AND SETTLEMENT

It is not anticipated that the proposed continuation of WRF operations will result in any change in population. However, by supporting and maintaining the workforce living in the area, it is considered that the WRF will have a positive impact on sustaining the population.

3.1.5.4 ECONOMY & EMPLOYMENT

Clashford Recovery Facility Ltd is an established small family run business based in Naul, Co Meath. Clashford Recovery Facility Ltd employs four people directly and a number of others indirectly, with the majority of the employees being local people. An additional two temporary staff are hired occasionally. The WRF will help sustain employment in the local area while beneficially restoring the quarry back to agricultural use.

The quarry has contributed indirectly to sustaining and developing the local and regional economy through the supply of building products, recovery of inert C&D waste, and has provided employment for local people, both directly and indirectly. The number of employees at the quarry and WRF is 4, whilst an additional two temporary staff are hired occasionally.

The WRF will require one person operating a bull-dozer/back-hoe excavator, one general foreman to monitor and inspect the quality and suitability of imported materials being brought to the site for recovery and two other general site operatives. It is expected that the existing staff will continue in these roles, if and when the WRF is licensed.

3.1.5.5 SOCIAL INFRASTRUCTURE

The proposed continuation of the WRF would provide a valuable and necessary resource to the county and wider region, providing a beneficial use for the recovery of inert soil and stone as an alternative to landfill. The WRF already exists and has an established record of meeting its regulatory obligations and current environmental standards.

There are no community facilities within close proximity of the WRF. The church, national school and community and cultural centres are located in Naul village, greater than 300m from the site, which constitutes a significant standoff distance. Thus, it is expected that there will be imperceptible impact on local community facilities as a result of the continued use of the WRF at Clashford.

3.1.5.6 AMENITY, TOURISM AND RECREATION

There are no major tourism attractions in the immediate vicinity of the WRF, with the exception of Seamus Ennis Cultural Centre and the annual Fingal Traditional Music Festival, in Naul village. Given the history of quarrying and waste material recovery at this location it is expected that there will be imperceptible impact on local tourism as a result of the continued use of the WRF at Clashford. There are numerous other attractions in east Meath and Fingal, however all of these are relatively remote to the WRF and therefore will be not be impacted upon.

Tourists visiting the Four Knocks Passage Graves, may pass the site location while travelling on the R108, and may notice some site activity, but this will be both limited and transient. Existing landscaping to the front of the site already acts as a buffer, such that the impact of the WRF on the landscape will be minimal. It is considered that adequate screening is provided by berms, hedgerows and intervening topography, coupled with the positive impact associated with the respect to the restoration completed to date including woodland.

Traffic entering and leaving the site will use the existing established quarry site access. The road servicing the site is generally in good condition. The site entrance has been adequately set-back and splayed in accordance with P. Reg. 86/349 to the satisfaction of the Planning Authority. Further details with respect to the impact and mitigation of traffic are contained within this report (Refer to Section 3.11).

As the WRF is co-located within the existing quarry, there is negligible additional visual intrusion. Nonetheless, there is a Protected View and Prospect, designated as 71, on a county road off the R108 at Snowtown north of the site (Meath County Council 2013). The view is to the South East and is described as “at gate along hedgerow of extensive tillage landscape, visible settlement and infrastructure”. The visual impact of the WRF is discussed in more detail in Section 3.8 - Landscape. Upon decommissioning, the site will be restored in accordance with the approved restoration scheme for the quarry. Therefore in the long term, the site will be assimilated back into the landscape in a planned manner.

3.1.5.7 CONSTRUCTION

As the WRF is already in operation under an existing Waste Permit (Reg. No. WMP 2005/25), there are no future impacts on human beings arising from the construction and establishment of the WRF. There are however potential impacts arising from the operational phase of the WRF, and these include dust, noise, and traffic (Refer to EIS Sections 3.6, 3.7 & 3.11

respectively). No additional construction related to the WRF is envisaged, and thus construction will have an imperceptible impact on the human environment.

3.1.5.8 OTHER

The site of an unclassified megalithic tomb (RMP ME034-012) is recorded within the proposed development area. This monument or possible associated archaeological features no longer survives above or below ground. There are no Protected Structures, Architectural Conservation Areas, NIAH structures or NIAH historic gardens or designed landscapes within the proposed development area. As a result there will be no direct or indirect construction impact on the recorded or unrecorded archaeological, architectural or cultural heritage resource.

There will be no construction or operational visual impact on the archaeological, architectural or cultural heritage resource. There will be no construction noise impact on the archaeological, architectural or cultural heritage resource. There will be a negligible operational noise impact on the archaeological and architectural resource.

The impact of inert waste recovery on this site will be considerable in local terms but will not result in any loss of heritage values in the locality. The changes will be both positive (gain of woodland) and negative (loss of open habitats).

The surrounding habitat has a low level of ecological interest except in the valley of the Delvin River and the continuance of infill and re-afforestation will have a significant positive impact on it. Sediment control measures will prevent any impact on the nearby river.

3.1.5.9 'DO-NOTHING' IMPACTS

If the proposed continuation of the WRF did not proceed, the recovery of inert soil and stone at the WRF would not occur, and result in the failure to divert these volumes from disposal in landfill, as required under the Waste Framework Directive 2008. Furthermore, the Clashford site would be unable to complete the phased restoration of the quarry void and the reinstatement of the land to its former topographic profile. Additionally, the existing WRF would be forced to cease operations resulting in the loss of employment. This would have a significant and direct negative impact on the local human environment.

3.1.6 MITIGATION & MONITORING

Proposed mitigation measures with regard to environmental issues such as air quality, noise, traffic and visual impacts are provided for and are described in detail under the relevant sections (See above list in Section 3.1.5.1). Any impact on the natural environment will be mitigated against to the greatest degree practical, thereby minimising any associated impact on the “human” environment.

The Clashford Recovery Facility has established an on-going environmental monitoring programme for the quarry and WRF site. The programme will allow on-going monitoring of environmental emissions (e.g., noise, dust, water) from the site, thereby assisting in ensuring compliance with any future requirements or regulations. The results of this monitoring will be made available to the EPA and the Local Authority on a regular basis, where members of the public may examine it. The future monitoring programme will be revised accordingly, subject to compliance with any conditions attached to a decision to grant a Waste Management License.

The development can be controlled and regularised in accordance with the scheme as outlined in this document, through continued environmental monitoring and by conditions imposed by the EPA. The proposal will have no major and/or long-term effect on the human environment.

3.1.7 RESIDUAL IMPACTS

Once the proposed continued operation of the WRF is authorised with a Waste Management License, and mitigation measures provided for, there are no significant residual impacts envisaged in terms of community and other socio-economic issues.

3.1.8 REFERENCES

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3.1.9 FIGURES

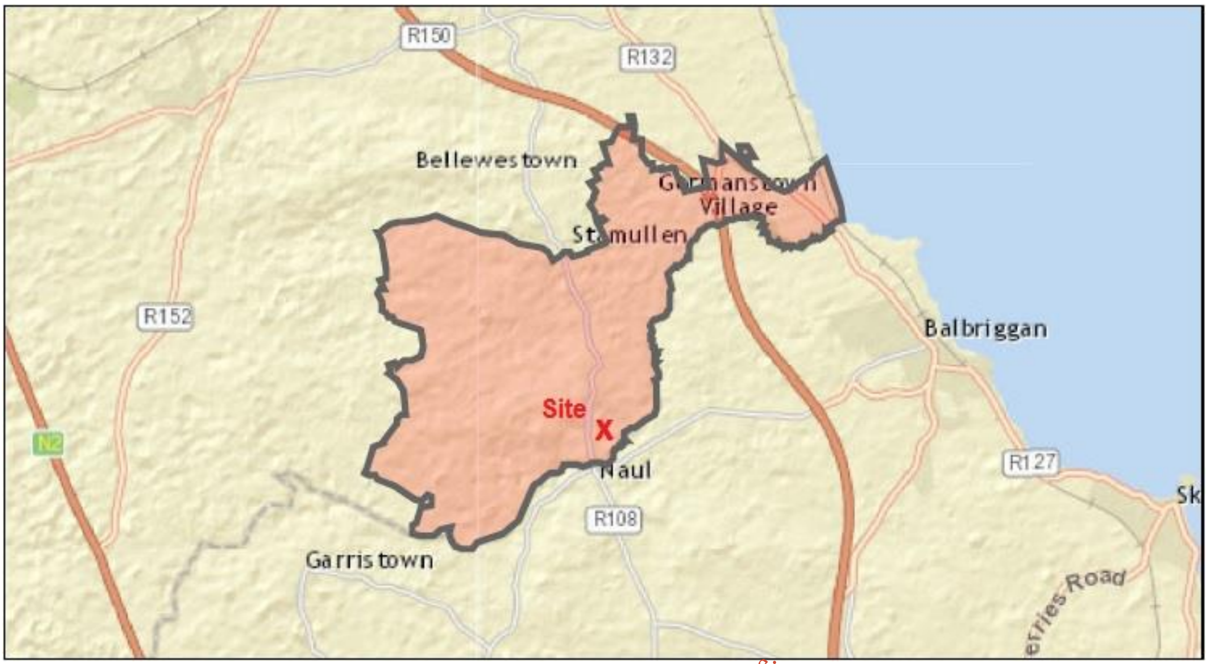

Figure 3.1.1. Electoral Division of Stamullin, showing Clashford site (marked X), immediately north of Naul and c. 7km west of Balbriggan. Redrawn from CSO Census 2011 SAPMAP Viewer (CSO 2014).

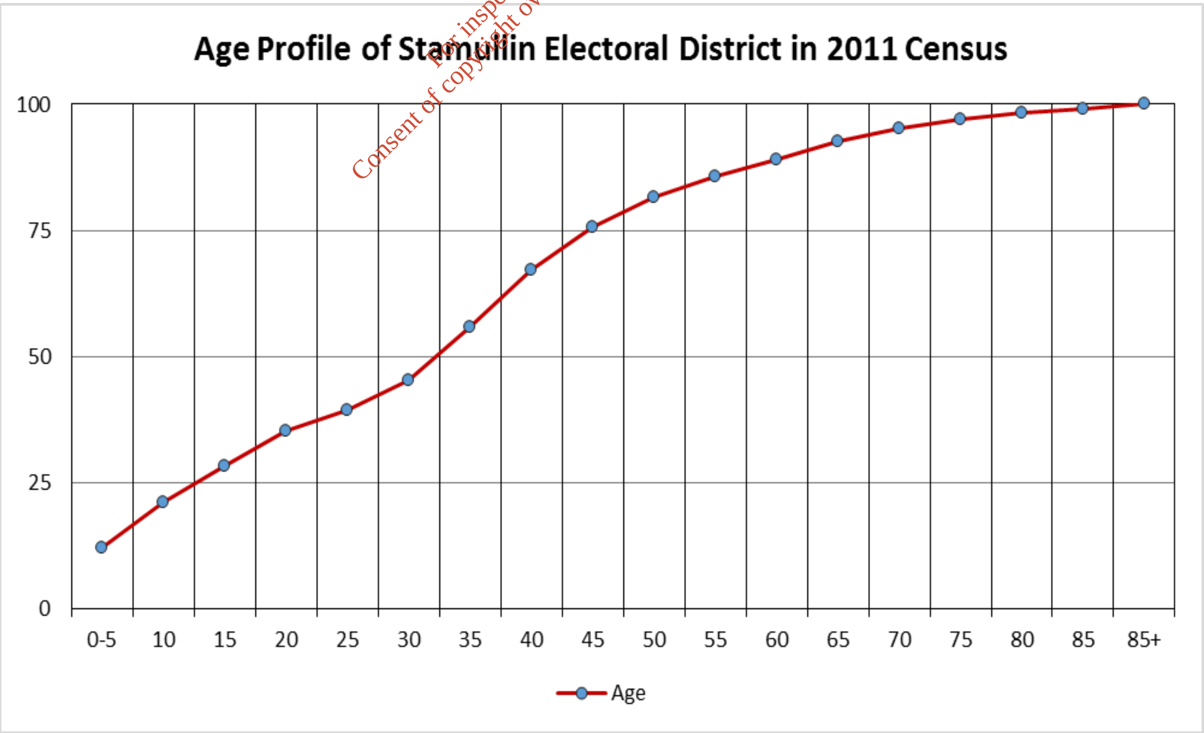

Figure 3.1.2. Age profile of population in the Stamullin Electoral Division in 2011. Note average age is approximately 32 years. The Census 2011 data was sourced from the CSO (2014).

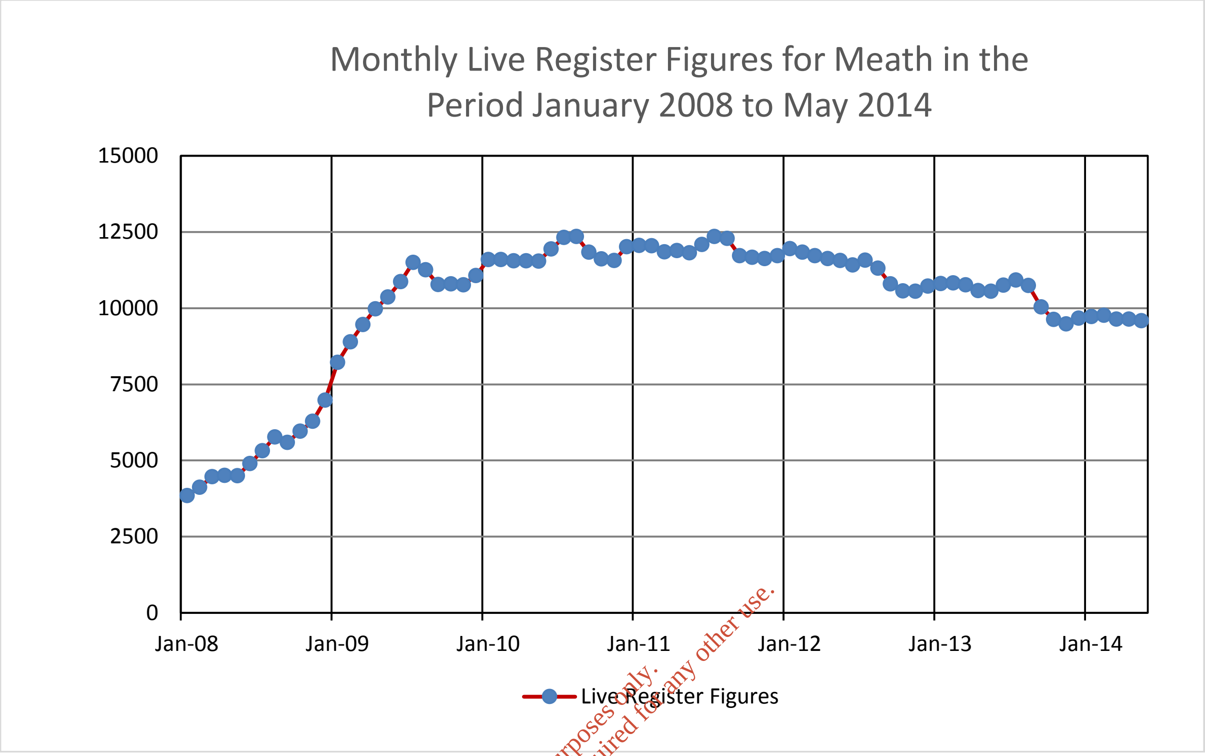

Figure 3.1.3. Live Register figures for Meath in the period from January 2008 to May 2014. Data from CSO (2014).

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3.2 FLORA & FAUNA

3.2.1 INTRODUCTION & METHODOLOGY

The purpose of this section is to assess the ecological effects of the development and to describe the mitigation measures that have or will be undertaken.

It is based on a site visit in April 2014 and a study of existing aerial photographs. The field investigation followed the methodology of the Heritage Council guidelines (Smith et al 2011). Mapping was not digitized in the field and depends partly on the air photos. Habitats are classified as in Fossitt (2000). Signs of mammals and birds were searched for at all times.

3.2.2 EXISTING ENVIRONMENT

3.2.2.1 HABITATS & VEGETATION

The site is an extensive sand and gravel quarry dug in glacial material on the northern side of the Delvin River, northeast of Naul village. It is partly reclaimed to agricultural or forestry land so has some improved agricultural grassland (GA1 in Fossitt 2000) and broad-leaved woodland (WD1) as well as the more typical quarry habitats of spoil and bare ground (ED2) and recolonising bare ground (ED3). To the south the land falls into the Delvin valley which carries an eroding upland river (FW1) with artificial margins. The slope above supports dry meadows and grassy verges (GS2) with incipient scrub while the fields are edged by young treelines/hedgerows of planted alder and hawthorn. An older treeline defines the northern boundary which is a small tributary of the Delvin River.

The grassland occurs in the NW and SE corner of the site, almost meeting in the middle. Much of it is level and sown with a mix of ryegrass *Lolium perenne*, meadowgrass Poa sp and crested dogstail *Cynosurus cristatus* but on the SE slope it is damper and more mossy with the frequent mosses *Brachythecium rutabulum* and *Calliergonella cuspidata* and a little red fescue *Festuca rubra*. There are also a few small plants of hard rush *Juncus inflexus* and dandelion *Taraxacum* agg. here.

Woodland has been planted in the NE corner. It is all ash *Fraxinus excelsior* and the trees are 12-15m tall and growing well. Underneath is some grass *Poa* sp. as well as scattered figwort *Scrophularia nodosa* and hogweed *Heracleum sphondylium*.

The following Figure 3.2.1 shows the habitats and vegetation relating to the site.

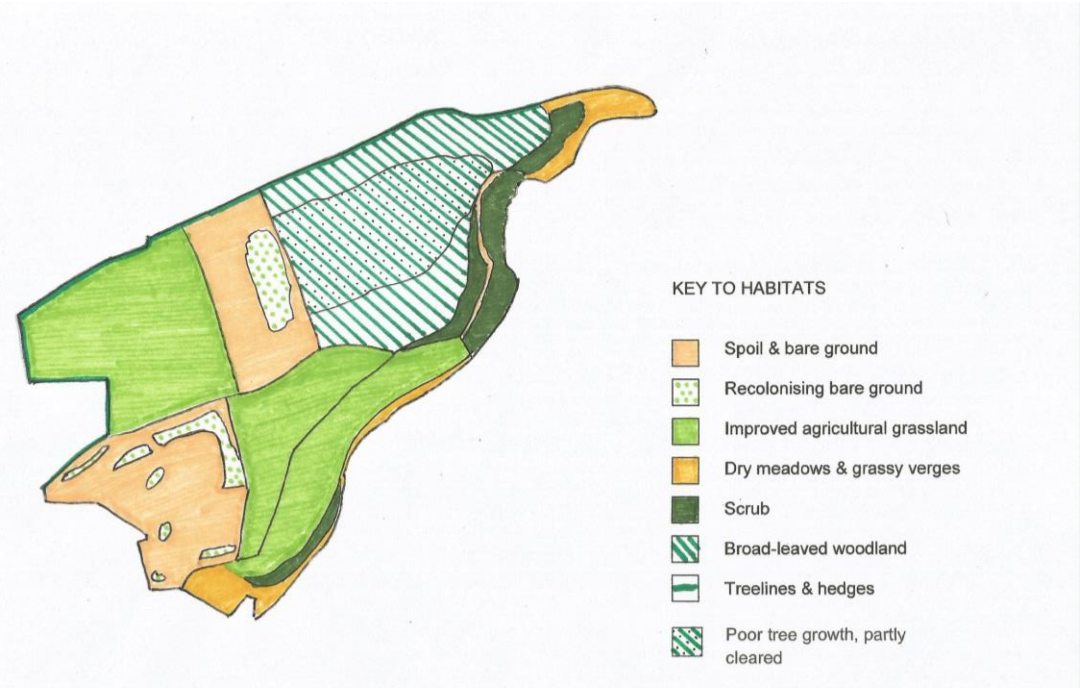

Figure 3.2.1 Habitats & Vegetation

The habitats of disturbed ground support many more species, if not a complete cover of vegetation. The plants that first appearare widespread grasses such as annual meadowgrass *Poa annua* and common bent *Agrostis capillaris* and broad-leaved plants with windblown seeds – coltsfoot *Tussilago farfara*, American willowherb *Epilobium ciliatum*, sow-thistle *Sonchus oleraceus* and fleabane *Conyza* sp. Other species include

Medicago lupulina	black medick
Veronica persica	field speedwell
Senecio vulgaris	groundsel
S.jacobaea	ragwort
Geranium dissectum	cut-leaved cranesbill
Euphorbia peplus	petty spurge
Galium aparine	goosegrass
Cerastium glomeratum	sticky mouse-ear
Malva sylvestris	common mallow
Sisymbrium officinale	hedge mustard

Given time and stability, as on piles of material away from roadsides, grasses become taller, especially false oat *Arrhenatherum elatius*, Yorkshire fog *Holcus lanatus* and scutch *Elytrigia repens* as well as

Chamerion angustifolium	rose-bay
Cirsium arvense	creeping thistle
Urtica dioica	nettle
Centranthus ruber	wall valerian
Achillea millefolium	yarrow

Buddleja davidii	butterfly bush
Artemisia vulgare	mugwort
Tripleurospermum inodorum	scentless mayweed
Lapsana communis	nipplewort
Raphanus raphanistrum	wild radish
Papaver somniferum	opium poppy
Silene latifolia	white campion

This list suggests some content of agricultural or garden soil and a similar pile of soil at the southern point adds the deadnettles *Lamium purpureum*, *L.hybridum*, self-heal *Prunella vulgaris* and the small nettle *Urtica urens*.

Water accumulates at the base of the quarry void and flows towards the NE corner from where it is piped to the stream. Ponding and general dampness creates marshy communities on the base, most of them close to the northern and eastern sides. Jointed rush *Juncus articulatus* and hard rush *J.inflexus* and obvious species along with creeping bent *Agrostis stolonifera* and a little sweet grass *Glyceria fluitans*. In addition there is

Epilobium parviflorum	hoary willowherb
E.hirsutum	great willowherb
Carex pendula	pendulous sedge
C.flacca	glaucous sedge
Typha latifolia	bulrush
Rumex crispus	curled dock
Ranunculus repens	creeping buttercup
Scrophularia auriculata	water figwort
Bellis perennis	daisy
Salix cinerea	grey willow
Calliergonella cuspidata	a moss
Warnstorfia cf *exannulatus*	a moss

The last habitat to be described is the valley side between the Delvin River and the sheep-grazed pastures above. Although partly sown as part of the reclamation, red fescue *Festuca rubra* is an important grass along with cocksfoot *Dactylis glomerata*, ryegrass *Lolium perenne* and scutch *Elytrigia repens*. Salad burnet *Sanguisorba minor* is a feature of this area along with

Potentilla reptans	creeping cinquefoil
Plantago lanceolata	ribwort plantain
Vicia sepium	bush vetch

Vicia sativa	early vetch
Lathyrus pratensis	meadow vetchling
Odontites vernus	red bartsia
Crepis vesicaria	beaked hawksbeard
Origanum vulgare	marjoram
Daucus carota	wild carrot
Echium vulgare (on path)	viper's bugloss

Parts of this valley side carry blackthorn *Prunus spinosa* and gorse *Ulex europaeus* scrub with scattered trees of sycamore *Acer pseudoplatanus* and also, close to the river, grey willow *Salix cinerea* and goat willow *S.caprea*. This sort of scrub is also found at the eastern end of the site, adjoining the ash woodland.

A damp section of the valley supports abundant great horsetail *Equisetum telmateia* along with pendulous sedge *Carex pendula*, osier *Salix viminalis* and winter heliotrope *Petasites fragrans*. There is also a patch of teasel *Dipsacus fullonum* and one plant of Japanese knotweed *Fallopia japonica*.

3.2.2.2 FAUNA

There were few signs of wild mammals present in the quarry area and only rabbit tracks were at all common. Otherwise the site is probably visited by scavenging foxes and occasionally badgers though there were no overt signs of this species. Bats are likely to be seen along the river valley as there is good habitat on the southern side. A few would be found in the ash woodlands but these would develop more significant populations as they mature.

The birds seen were those of open habitats, in particular pied wagtail and linnet, both of which would feed within the quarry to some extent. Other species in the surrounding area which could make some use of the habitat were woodpigeon, magpie, hooded crow, rook, jackdaw and pheasant. The gorse areas are likely to hold stonechat while chiffchaffs were heard in the river area. Grey wagtail and dipper would also be expected here also. There were no sand martin burrows in the side walls and this species does not seem to occur.

The vegetation is diverse enough to support a good range of insects and there were a number of bumble bees (*Bombus terrestris*) flying during the site visit. The common blue is a likely butterfly as there are records in Nash *et al* (2012) for this 10km square. The more frequent species such as small tortoiseshell, small white and meadow brown are also probable.

3.2.2.3 EVALUATION

The overall site is relatively diverse having typical quarry habitats as well as restored land. The species list is similarly varied, though it is much longer in the disturbed ground than in the newly-created habitats, both grassland and woodland. A few unusual plants occur in the grassy bank above the river (Preston *et al* 2002) – salad burnet *Sanguisorba minor*, viper's bugloss *Echium vulgare* and marjoram *Origanum vulgare* – but may have been derived from a wildflower sowing. Elsewhere the plants and animals are typical of gravel and sand quarries in the Dublin/Meath area.

There is no feature of the fauna that is of significant interest as far as is known (e.g. Balmer *et al* 2012, Nash *et al*; 2012).

3.2.2.4 DESIGNATIONS

The only Natura 2000 sites within 15km of Naul are the Laytown Dunes/Nanny Estuary cSAC (Site Code 0554), the River Nanny and Shore SPA (Site Code 4158) and the Skerries Island SPA (Site Code 4122).

The nearest pNHA site is the Bog of the Ring (Site Code 001204), Ring Commons, Co. Dublin at c. 3km, whilst Cromwell's Bush Fen pNHA (Side Code 001576), Greenanstown, Co. Meath is c. 4.5 km.

3.2.3 IMPACT OF DEVELOPMENT

3.2.3.1 COUNCIL POLICY & POSSIBLE IMPACTS

The Meath County Development Plan (2013-2019) contains policies and objectives concerning conservation. For European sites (Natura 2000) and Natural Heritage Areas:

It is the policy of Meath County Council:

NH POL 5	To permit development on or adjacent to designated Special Areas of Conservation, Special Protection Areas, National Heritage Area or those proposed to be designated over the period of the plan, only where an assessment carried out to the satisfaction of the Meath County Council, in consultation with National Parks and Wildlife Service, indicates that it will have no significant adverse effect on the integrity of the site.

NH POL 6	To have regard to the views and guidance of the National Parks and Wildlife Service in respect of proposed development where there is a possibility that such development may have an impact on a designated European or National site or a site proposed for such designation.

It is an objective of Meath County Council:

NH OBJ 2	To ensure an Appropriate Assessment in accordance with Article 6(3) and Article 6(4) of the Habitats Directive, and in accordance with the Department of Environment, Heritage and Local Government Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities, 2009 and relevant EPA and European Commission guidance documents, is carried out in respect of any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect on a Natura 2000 site(s), either individually or in combination with other plans or projects, in view of the site's conservation objectives.

NH OBJ 3	To protect and conserve the conservation value of candidate Special Areas of Conservation, Special Protection Areas, National Heritage Areas and proposed Natural Heritage Areas as identified by the Minister for the Department of Arts, Heritage and the Gaeltacht and any other sites that may be proposed for designation during the lifetime of this Plan.

The quarry site at Clashford, which includes the application site, is not included in any area with an ecological designation (NHA, cSAC or SPA).

Screening for Appropriate Assessment was carried out with respect to the proposed development and a copy of this report is included with the planning application. The findings of the assessment, were, in view of best scientific knowledge, it is concluded that the activity, individually or in combination with other plans or projects is not likely to have a significant effect on the Natura 2000 network, and the conservation objectives of the sites. A Stage 2 Appropriate Assessment is therefore not required.

The nearest pNHA site is the Bog of the Ring (Site Code 001204), Ring Commons, Co. Dublin at c. 3km, whilst Cromwell's Bush Fen pNHA (Side Code 001576), Greenanstown, Co. Meath is c. 4.5 km. There will no direct or indirect impact on these sites as a result of the continued operation of the WRF at Clashford. The Delvin River discharges to the sea south of the Laytown Dunes, below Julianstown.

3.2.3.2 ACTUAL IMPACTS

The impact of the continued recovery of inert waste in the quarry is considerable in local terms as it will lead to the disappearance of a good part of the existing flora (with its dependant insects) – those species that require open soils and disturbance to grow. However the development of woodland elsewhere on site will tend to diversify the larger fauna such as birds and mammals so that there will be gains as well as losses. At a landscape scale the restoration will be beneficial as it is creating a nucleus of woodland with links to the existing similar habitat in the Delvin River valley.

There will be no disruption to animal pathways or ecological corridors from the proposals.

As well as the physical impacts there is the potential for sediment and/or chemical loss to surface waters but this will be minimised by the existing and planned control measures, by the local drainage gradient and by the distance to surface waters.

3.2.3.3 MITIGATION MEASURES

The existing quarry includes several mitigation measures which will remove or reduce the impact of its use for waste recovery in the future. There is a wheel wash facility in which all waters are recycled through a system of silt lagoons which overflow to surface waters. The lagoons are cleaned on a periodic basis, with the silt used within the restoration of the site.

This surplus and site run-off currently pass through a temporary settlement area and sump before discharge northwards to the tributary of the Delvin. The reclamation scheme has been designed to drain surface water run-off in a similar direction to the northern boundary of the site. A little ground drainage is currently discharged from the eastern end of the site into the Delvin River.

Restoration will include the removal of all machinery and structures and the smoothing of the contours to facilitate the establishment of grassland and grazing animals.

3.2.4 CONCLUSION

The impact of inert waste recovery on this site will be considerable in local terms but will not result in any loss of heritage values in the locality. The changes will be both positive (gain of woodland) and negative (loss of open habitats).

The surrounding habitat has a low level of ecological interest except in the valley of the Delvin River and the continuance of infill and re-afforestation will have a significant positive impact on it.

Sediment control measures and the materials to be disposed of will prevent an impact on the nearby river.

3.2.5 REFERENCES

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3.3 SOIL & GEOLOGY

3.3.1 INTRODUCTION

All projects and developments that require an EIS *by virtue of their nature, size and location*, have the potential to have an impact on the environment. This section of the EIS has been compiled in order to establish both the regional and local geological setting of the Waste Recovery Facility (WRF) at Clashford with respect to the soil, subsoil and geological bedrock environment. Furthermore, this section also assesses the potential impact, if any, of the WRF on this existing baseline geological environment.

The section was prepared following a desktop study, which included research of relevant maps and data on the Geological Survey of Ireland online mapping website (GSI 2014), and on the Environmental Protection Agency Envision geoportal website (EPA 2014). Additional documents that were researched comprised geological maps and bulletins published by the GSI (GSI 2001), the Geology of Ireland monograph edited by Holland & Sanders (2009), as well as other miscellaneous publications. The available information is considered sufficient to adequately characterise the geological environment of the site and its environs.

The potential impact on the geological environment resulting from the proposed development is assessed and possible mitigation measures proposed to reduce any significant impacts.

3.3.2 STUDY METHOD

No fieldwork other than a site walkover was undertaken as part of this geological assessment. The desktop study was undertaken to compile, review and interpret available information, data and literature pertaining to the natural environment of the site, its immediate environs and regional setting. The desktop study included the following:

- Examination of physiographic and other maps, and aerial photography (e.g., Google Images (Google 2014), and EPA Ortho Photos 1995-2005 (EPA 2014));
- Examination of the GSI datasets and maps pertaining to geological bedrock, soil and subsoil maps (GSI 2014);
- Examination of EPA soil and subsoil maps (EPA 2014);
- Observations made during the site walkover;

In the preparation of this geological assessment, all available regional and site specific information was compiled, assessed and interpreted. The geological maps and literature provide the regional geological context of the site, whilst the prior environmental report provided the site-specific information. The geological assessment of the site is considered sufficiently detailed to adequately characterise the geological setting of the site. This section was prepared with consideration to the guidelines and recommendations set out in 'Guidelines on Information to be contained in Environmental Impact Statements' (EPA 2003), and the Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements, published by the Institute of Geologists of Ireland (IGI 2013).

3.3.3 TOPOGRAPHY

The site of Clashford quarry and WRF is located in a rural area of the townland of Naul, c. 300m north of the village of Naul, across the Delvin River. It covers an area of 22.3 ha on a larger landholding of 33.4 ha, and has been actively quarried since the 1980's. The shape of the landholding is broadly triangular (Opposite: R108; Hypotenuse: Delvin River; and Adjacent: tributary stream). It has an approximate length of c. 800m along a SW-NE axis, and a maximum width of c. 550m along a NW-SE axis.

Both the soils and bedrock geology have an important role in determining the environmental characteristics of an area. The underlying bedrock has a major influence on the landform that develops, and the constituent rocks provide the parent material from which the soils are derived. The natural characteristics of the rock help determine the nature of the derived soil, as well as the rate at which it forms, whilst the soil strongly affects both the natural vegetation that emerges, and the type of agriculture that can be sustained.

As stated above, the topography is partly a reflection of the underlying geology, which is described in the succeeding subsections. The Clashford and Naul area lies in the valley of the Delvin River, known as Roche Valley, which features steep rocky outcrops carved by glacial meltwaters (Fingal County Council 2011, GSI 2001). The area occurs in the Roche Valley, but is classified as occurring in the Coastal Plains (Meath County Council 2007). However, the area appears to have greater affinity to the adjacent Bellewstown Hills to the west and northwest. The Delvin River rises to the southwest of Naul and flows northeastwards in the area, descending onto the coastal plain and draining into the Irish Sea near Balbriggan. The valley of the Delvin River separates two sets of hills to the southeast on Late Visean siliciclastics and limestones of the Walshestown Formation (max. elev. 176m), and to the northwest on an Ordovician volcanic arc sequence of the Balbriggan inlier (max. elev. 159m). Indeed, the terrain of southeast County Meath is characterised by limestone lowlands with Ordovician volcanics and Late Visean siliciclastics forming the hills.

The wider local landscape around Clashford is generally of steeply rolling hills with intensively managed agricultural lands with well wooded hedgerows, creating a closed landscape. The landscape changes to the northeast to the flat topography of the coastal plain, but with dense hedgerows also creating a closed landscape.

Forest cover is very limited, with copses and larger stands and woods of trees in river valleys and estuaries. The land use in the area is classed as roughly evenly divided between pasture and non-irrigated arable land, with a few minor areas of complex cultivation patterns. This pattern transitions to significantly less pasture with an increase in complex cultivation patterns to the east in north County Dublin.

The sand and gravel extraction at Clashford exploited a glacial feature that consists of glaciofluvial outwash. The topography of the site is slightly elevated (≤ 80m AOD) above the valley floor (elev. c. 60-70m), as a consequence of a c. 1km long mound of the sand and gravel within a SW-NE oriented ribbon of glacial deposits that extends from c. 2km further up valley, down the river valley to the coastal plain. The land of the quarry site had been previously used for pasture and arable production, according to the 1990 Corine Map (See EPA 2014), given the superior drainage of the underlying sand and gravel (See EIS Figure 3.3.1). The existing topographical contours are shown in EIS Figure B 2.1 Rev A - Site Plan.

3.3.4 SOIL

Soil is an essential natural resource and is intrinsically valuable to the environment, and all life within it. Soil encompasses topsoil and subsoil, which together provide for several important functions, including:

- Contributes to the hydrological cycle in the filtration/recharge, storage and discharge of rainwater;
- Supports all terrestrial ecology, including all flora and fauna;
- Protects and enhances biodiversity;

Topsoil and subsoil may derive from parent geological material and organic matter under the influence of numerous processes, including weathering and erosion. In terms of subsoil, the profound influence of glaciation in Ireland is seen in the glacial till, which blankets much of the underlying rocks.

3.3.4.1 TOPSOIL

The 2nd Edition of the General Soil Map of Ireland with accompanying Soil Survey Bulletin No. 36 was published by Gardiner & Radford (1980). The map has a publication scale of 1:575,000, which results in generalised features that provide inadequate geographic reference to allow useful spatial data on the scale of the property. The soil map of Co. Meath with accompanying Soil Survey Bulletin No. 37 was published by Finch et al . (1983), and was similarly compiled by surveying and mapping using direct visual inspection, profile pits and laboratory analysis. The soil map was developed on a nominal working scale of 1:10,560, condensed down to a publication scale of 1:126,720, and maps the distribution of soil types based on the classification of the Great Soil Groups of Ireland.

Teagasc and the EPA initiated a nationwide Soil and Subsoil Mapping Project, the final report for which was published by Fealy & Green (2009). The soil map of every county in Ireland were compiled by a remote sensing and GIS-based methodology. Soil type was predicted using key soil factors (e.g., vegetation) and geology (e.g., parent material) and topography (e.g., slope), and using a qualitative, expert-based classification system. In order to map all the soil variants in a single national soil map, the classification system of soil types had to be simplified relative to previous soil surveys, but retain a close relationship to the Great Soil Groups in Ireland. Although the maps have a maximum online scale of 1:2,000 (See EPA 2014), the nominal working scale of 1:100,000-150,000 was used during map preparation. Although the Teagasc/EPA Soil Maps are categorically simplified, they are cartographically detailed, and thus offer superior spatial definition. The distribution of the soil types at Clashford is assessed by reference to Teagasc/EPA Soil/Subsoil Maps, with supplementary interpretation based on the Soil Map of Meath (Finch et al. 1983).

The general soil map of Ireland by Gardiner & Radford (1980) shows that the predominant topsoil or soil type across the Clashford site is Grey Brown Podzolics (38), which has associated soils of Gleys (25). The soil map of County Meath by Finch et al. (1983) also indicates the predominant soil type is Grey Brown Podzolics of the Dunboyne Shaley Phase soil series (i.e., 218sy) derived from limestone and shale, and possibly also Dunboyne-Ashbourne Shaley Phase (i.e., 224sy).

The soil types occurring at the site and in the wider area were also assessed by reference to the Teagasc/EPA subsoil map (EPA 2014). The dominant subsoil occurring at the Clashford quarry site are designated as:

1. AminSW - Lithosol / Regosol derived mainly from non-calcareous parent material, dominates the quarry site (i.e., c. 75%)
2. AminSP - Surface water Gleys / Ground water Gleys derived mainly from non-calcareous parent material
3. BminSW - Rendzinas / lithosols derived mainly from calcareous parent material
4. AlluvMIN - Mineral Alluvium

where the latter two subsoils only occur on the banks of the river. Other subsoils in the wider area are:

1. AminPD - Surface water Gleys / Ground water Gleys derived mainly from non-calcareous parent material, in the wider Delvin River valley, lowlands and coastal plain
2. AminDW - Acid Brown Earths and Brown Podzolics derived mainly from non-calcareous parent material, mainly on medium elevated ground in hills over Balbriggan Inlier to NW and Namurian sediments to SE
3. AminSRPT – Podzols (Peaty) / Lithososls / Peats derived from non-calcareous parent material
4. Lac - Lacustrine-type deposits, immediately west of the site
5. Made - Made/built ground, in the village of Naul

Grey Brown Podzolics are usually derived from a calcareous parent material, which counteracts the effects of leaching. These contrast with Podzols, which are heavily eluviated by heavy rainfall leaching through the organic layer in a process known as podzolisation. Lithosols are predominantly shallow soils derived from calcareous rocks or gravels with/without peaty surface horizons, and tend to be stony mineral soils. These soils are usually overlying solid or broken bedrock, and are in the early stages of being formed. Regosols show no distinct layer development, and the texture may vary between sands and clays, and be acid or alkaline.

It is considered that the lithosols / regosols designated in the Teasgasc/EPA maps correspond to the Grey Brown Podzolic soils of Finch et al. (1983). In that Finch et al. (1983) determined soil type at a finer working scale, and by mapping using direct visual inspection, profile pits and laboratory analysis, it is considered that the designation of the soil as Grey Brown Podzolics as the dominant soil type on site prior to quarrying operations is valid. There were also occurrence of minor amounts of Gleys, and of Redzinas / Lithosols and Alluvium on site. The soil map of the area including the site is shown in Figure 3.3.1 Soil Map of Clashford Area.

The quarry resource has been worked-out, and the quarry void is in the process of being backfilled with imported soil and stone, capped with topsoil, as per the phased restoration scheme. Most of the original topsoil has already been utilised together with imported topsoil to restore previous sections of the site.

3.3.4.2 SUBSOIL

The subsoil types occurring at the site and in the wider area were determined by reference to the EPA subsoil map (EPA 2014). The dominant subsoil occurring at the Clashford quarry site is described as Lower Palaeozoic sandstone and shale sands and gravels (i.e., designated GLPSsS), and prior to quarrying operations covered the entire application site. Within the wider quarry site, there are also minor occurrences of undifferentiated gravelly alluvium (i.e., A) and exposed rock (i.e., Rck), including karstified rock (i.e., KaRck), outcropping along the banks of the Delvin River. Other subsoil types in the wider area include: (1) till from Devonian/ Carboniferous sandstone and shale (TLPSsS) covering much of the elevated area overlying the Ordovician sediments and volcanics of the Balbriggan Inlier to the NW; (2) Irish Sea till from Palaeozoic sandstone and shale (IrSTLPSsS) covering ground with medium elevations in the wider Delvin River valley and extending across the coastal plain around Balbriggan; (3) till from Namurian sandstone and shale (TNSSs) covering Namurian sediments to the SE; and (4) made ground (i.e., Made) in village of Naul.

The last Ice Age, known as the Late Midlandian or Devensian, peaked at approximately 20-25,000 years ago with total deglaciation of Ireland around 13,000 years ago. The origin of the subsoil is associated with deposition related to ice movement, specifically glacial retreat and melting during deglaciation. Soils would have begun to develop after deglaciation, around the beginning of Holocene epoch at 12,000 years ago.

Sands and gravel dominate the subsoil of the Clashford quarry site, and represent unconsolidated glacial sediments deposited during the retreat of the ice sheet that once covered Ireland. Ice sheets grind and pulverise the underlying bedrock, reducing it to fragments ranging from boulders to clay particles. Sediments and features formed during the glaciation are commonly treated under the general term Quaternary Geology. The subsoil map of the area including the site is shown in Figure 3.3.2 Subsoil Map of Clashford Area.

This area of County Meath was completely overlain by a thick ice sheet (up to 1 km thick), which moved in a general south-easterly direction. The powerful erosive force of the ice sheet is considered to have sculpted the landscape in the region, as evidenced by many preserved glacial features. As the ice sheet melted, the meltwaters sorted and deposited sands and gravels in the form of characteristic glacial features. As stated earlier, the valley of the Delvin River features rocky outcrops on the steep sided channels carved by the glacial meltwaters (Fingal County Council 2011, GSI 2001). The Clashford quarry is situated on, and extracts sand and gravel from a deposit of well sorted, fluvioglacial sand and gravel, which was deposited by these glacial meltwaters.

The GSI Groundwater Protection Scheme maps for Co. Meath and the borehole database GSI (2014) indicate subsoil depths of up to 18 m (200 m to the east of the site) and up to 42.5 m (100 m to the southeast of the site). Observations from site visits and information obtained from the facility operators, indicate that there is approximately 8 m of boulder clay overlying the bedrock in the quarry site. The quarry pit excavations extend to approximately 10m to 15m below the surrounding ground level, and thus indicate substantial thickness of subsoils/soils, sand and gravel, and boulder clay overlying the bedrock in the quarry site. The following approximate thicknesses of the overburden on the quarry site prior to operations are indicated: 0.5-1m of topsoil, 10-15m of sand and gravel, and 8m of boulder clay at the base.

3.3.5 BEDROCK GEOLOGY

This subsection is based largely on GSI (2001), Graham & Stillman (2009) and Sevastopulo & Wyse Jackson (2009), but without explicit individual references in the text. The 1:100,000 scale map of the Geology of Meath: Sheet 13 (GSI 2001) and online mapping (GSI 2014) indicates all of the rock units within c.1km of the site, which are given in approximate chronological order in Table 3.1.

Table 3.1 Bedrock Units of the Clashford Area

North Dublin Basin	**Thickness (m)**	**Mississippian Substage**
Walshestown Formation (WL)	>200m	Pendleian-Arnsbergian
Balrickard Formation (BC)	75-100m	Pendleian
Mudbank Limestone Lithology (Mk)	Not Available (na)	Asbian (Probable)
Loughshinny Formation (LO)	<150m	Brigantian
Naul Formation (NA)	<100m	Asbian
Holmpatrick Formation (HO)	90-200m	Arundian to Holkerian
Northern Sector of the Balbriggan Inlier	**Thickness (m)**	**Silurian Substage**
Denhamstown Formation (DD)	na	Wenlock
Southern Sector of the Balbriggan Inlier	**Thickness (m)**	**Ordovician Substage**
Clashford House Formation (CF)	100m	Mid-Caradoc
Herbertsown Formation (HB)	250-430m	Caradoc
Snowtown Formation (SW)	200m	Arenig
Fournocks Formation (FK)	na	Arenig-Llanvirn

During the Ordovician and Silurian Periods (c. 490-415Ma), the Iapetus Ocean closed bringing Laurentia (including northwest Ireland) and Avalonia (including southwest Ireland) into collision and culminating in the Caledonian Orogeny c. 425-395Ma. During the Devonian Period (c. 417-354Ma) Ireland was part of the Laurasian super continent, also known as the Old Red Sandstone continent. The latter underwent extensive subaerial erosion, whilst laying in arid southern subtropical latitudes, giving rise to the characteristic red coloured, continental facies sandstones. During the early Carboniferous (c. 354-327Ma), a marine transgression advanced northward across the eroded and flat-lying continent (i.e., peneplain), and deposited a sequence of carbonate rocks that cover much of the Irish Midlands.

The rocks of the Clashford area belong to: (1) the Lower Palaeozoics of the Balbriggan Inlier; or (2) the Mississippian (Lr. Carboniferous) marine sequence of the North Dublin Basin. The Balbriggan inlier is composed of the northern sector representing the Bellewstown Arc Terrane, and the southern sector representing the Avalonia Terrane, and are separated by the Lowther Lodge Fault. The two terranes were accreted to one another at the end of the Ordovician, prior to the final closure of the Iapetus Ocean at the end of the Silurian. Silurian rocks then formed an overstep sequence on the Ordovician rocks of both the northern and southern sectors. The rocks of the North Dublin Basin are dated from the Tournaisian, Visean and earliest Namurian of the Mississipian Epoch (c. 358-318Ma), and were laid down as a retrograding sequence due to a northward advancing marine transgression.

Numerous faults have been identified within 1km of the site, and many of the contacts between the major stratigraphic units are faulted contacts. These would have been initiated during the Caledonian Orogeny, and reactivated during the crustal extension associated with subsidence and 'block and basin' development during the Carboniferous. Crustal compression during the Variscan Orogeny around the end of the Carboniferous (c. 299Ma) also reactivated the faults, and was associated with uplift and gentle folding of Carboniferous rocks.

Palaeozic Rocks of the Balbriggan Inlier

The base of the Ordovician sequence in the area is the Fournocks Fm. (FK), which consists of red and green banded mudstones and siltstones. This is conformably overlain by the Snowtown Fm. (SW), which consists of a 200m thick unit of banded grey mudstones and siltstones. These are unconformably overlain by the Herbertsown Fm. (HB), a unit of andesitic volcanics and mudstones.

The Herbertstown Fm. is conformably overlain by the Clashford House Fm. (CF), which underlies much of the site. It consists of 100m thick sequence of micaceous green- to brown-grey mudstones and siltstones with interfingering sheets of andesite. The unit is fossiliferous, containing a shelly fauna of Avalonian affinities, consistent with a position on the northernmost margin of the Leinster Terrane. The Clashford House Fm. represents marine sedimentary rocks associated with a fore arc / volcanic arc on the continental margin of Avalonia on the southern side of the Iapetus Ocean. The Denhamstown Fm. forms the base of the Silurian overstep sequence, which was deposited over the accreted Bellewstown-Arc and Avalonia Terranes. The Lowther Lodge Fault has brought the Denhamstown Fm. into contact with the Clashford House Fm. c. 750m north of the site.

Carboniferous Rocks of the North Dublin Basin

By the start of the Visean, basin development was more advanced, and strata are identifiable as forming in shelf/platform (e.g., pale grey limestones), shelf edge (e.g., Waulsortian) or basin (e.g., dark micritic limestones and black shales). The base of the Carboniferous sequence in the area is marked by the Holmpatrick Fm. (HO), which consists of a 90-200m thick sequence limestones. The formation belongs to the Milverton Group, which includes all shelf/platform formations in the northeast.

The next youngest unit is the Naul Fm. (NA), which has been brought into contact with the Balbriggan Inlier through faulting. The Naul Fm. is similar to the Lucan Fm., except the limestones are paler and less argillaceous, and consist largely of calcarenite and calcsiltite with minor chert and shale (i.e., higher on ramp - less basinal). It outcrops on the banks of the Delvin River at Naul, and has been interpreted as the lateral equivalent of the upper part of the Lucan Fm., which is widespread in north County Dublin. The formation varies widely in thickness up to 100m.

Overlying the Naul Fm., is the Loughshinny Formation (LO), which has been brought into contact with the Naul Fm. in the Naul area by a major SW-NE fault. The formation consists of up to 150m of laminated to thinly bedded, argillaceous, pyritic, locally cherty limestones, interbedded with dark grey to black shales. The Naul and Loughshinny Fms. are lithologically very similar, and were formerly grouped together as the Calp Limestone, but have been divided into separate formations within the Fingal Group of predominantly basinal facies.

The Loughshinny is conformably overlain by the Balrickard Fm. (BC), which is Namurian in age, and consists of 75-100m deltaic sandstone interbedded with shale and argillaceous micrite. This is conformably overlain by the Walshestown Fm. (WL), which is also Namurian in age, and consists of >200m of black shales, with siltstone, fine sandstone, and calcareous mudstone. The Balrickard and Walshestown formations belong to the Knockbrack Group, which straddles the Visean-Namurian boundary. It heralds an abrupt change in depositional environments from that of limestones and shales in shallow tropical seas during the Tournaisian-Visean to sandstones and shales in quiescent, deep waters during the Namurian.

An additional lithology known as the Mudbank Limestone Lithology (Mk) is also recognised, and occurs in several fault blocks adjacent to the Balbriggan Inlier. The lithology consists of massive, unbedded, grey micritic (fine-grained) limestones and represent a complex lime mud mound facies rich in bryozoa and brachiopods, similar to the Waulsortian, which interdigitates with the Asbian shelf limestones (MEIL 2004). These limestones pass laterally into calcarenites and calcsilicates with shale partings, probably indicating local basin development.

The quarry site straddles the faulted contact between the Balbriggan Inlier and the North Dublin Basin, and is predominantly underlain by the Clashford House Fm. (70%), with minor Mudbank Limestone (20%) and Naul Fm. (10%) in the southwest corner. Two faults traverse the site: (1) a roughly ENE-WSW oriented fault brings a triangular sliver of the Mudbank Limestone lithology into contact with the Clashford House Fm.; and (2) an E-W oriented fault brings the Mudbank Limestone into contact with the Naul Fm. Whilst the area is heavily faulted, a major NE-SW oriented fault with substantial vertical displacement, traverses c. 500m east of the site. The bedrock of the area including the site, is shown in Figure 3.3.3: Bedrock Geological Map of Clashford Area.

Bedrock was not encountered in the application site due to the advanced state of the phased restoration of the quarry (i.e., restored lands in northeast section, and Phases 1 and 2 are complete or near-complete, respectively), as well as the presence of deep overlying subsoil deposits in, the unrestored, worked-out area (i.e., Phase 3).

3.3.6 GEOLOGICAL HERITAGE

The Irish Geological Heritage (IGH) programme identifies and selects a complete range of sites that represent Ireland's geological heritage. The programme is operated by the GSI and the National Parks and Wildlife Service (NPWS). Some of these sites may be designated in due course, as Natural Heritage Areas (NHAs) because of their geological interest from a national perspective.

In its 2013-2019 County Development Plan (CPD), Meath County Council recognises areas of conservation value, which include twenty eight geological sites. A search of the GSI Geological Heritage Database indicates that there are no sites of geological heritage within or near the site of the WRF.

The nearest site occurs c. 3.5km to the NNE at Laytown-Gormanstown:

1. Laytown-Gormanstown (Site Code: MH008; Theme: IGH 7)

Irish National Grid: 316500, 269300

Location: County: Meath; Area: Laytown to Gormanstown

Critical Feature: Flat to gently undulating glacial outwash plain of sand or gravel

There is a cluster of three sites occurs c. 4 to 4.5km to the SE:

2. Nag's Head Quarry (Site Code: DF016; Theme: IGH 8)

Irish National Grid: 315500, 257910

Location: County: Fingal; Townland: Hollywood Great

Critical Feature: Exposed faces of limestone, shale and sandstone displaying structural deformation (chevron folds)

3. Balrickard Quarry (Site Code: DF017; Theme: IGH 9)

Irish National Grid: 317720, 259690

Location: County: Fingal; Townland: Balrickard

Critical Feature: Exposed faces of Upper Carboniferous sandstone and shale

4. Walshestown Stream Section (Site Code: DF018; Theme: IGH 9)

Irish National Grid: 317300, 258300

Location: County: Fingal; Townland: Walshestown

Critical Feature: Exposure Upper Carboniferous (Namurian) shale, sandstone and limestone

An additional, sites is located c. 7km to the NW:

5. Bellewstown (Site Code: MH003; Theme: IGH 2)

Irish National Grid: 307870, 267130

Location: County: Meath; Townland: Bellewstown

Critical Feature: Fossiliferous exposures of volcanic and sedimentary rocks

3.3.7 ASSESSMENT OF IMPACTS

3.3.7.1 DIRECT IMPACTS

The nature of the WRF involves the importation and placement of inert soil and stone as backfill in the quarry void. The application site for the WRF occupies the unrestored areas, or areas containing failed forestry within the worked-out quarry area, and as such will have no impact on virgin soils, sands and gravels, which have already been stripped, disturbed or extracted. As a result of backfilling using inert soils and stones, the WRF will continue to progress the reinstatement of the quarry back to land suitable for agricultural and silviculture, and thus will have a positive impact.

Consideration has 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. Further details with respect to the management of topsoil and overburden soils are outlined in EIS Section 2.4.3.1.

3.3.7.2 INDIRECT IMPACTS

The WRF will have no indirect impact on the local or regional geology, as placement of the inert soil and stone will not release contaminants onto the lands, whilst dust from the WRF will be tightly controlled (Refer to EIS Section 3.6).

3.3.7.3 'DO NOTHING' IMPACTS

The WRF recovers significant quantities of inert soil and stone through backfilling in the quarry void. Failure to recover soil and stone for the beneficial use of land improvement, specifically reinstatement of a quarry, could result in unnecessary exhaustion of landfill space. Thus, it is considered that the proposed continuation of the WRF will have a positive impact.

3.3.7.4 INTERACTION WITH OTHER IMPACTS

The interaction of the quarry and proposed WRF is seen as 'symbiotic' and positive, with no negative cumulative impacts on the geological environment identified.

3.3.8 MITIGATIONS & MONITORING

There is no bedrock exposed within the quarry or the site of the WRF, and as such no impact on bedrock geology as a result of the WRF is expected. The WRF is also not expected to have any significant negative impact on the surficial geology of the site or surrounding area, and thus no mitigation measures are proposed. Ultimately, after final land reclamation of the quarry site, with the land restored principally to agricultural use and forestry, there will be no residual impact on the surrounding environment from the WRF.

3.3.9 REFERENCES

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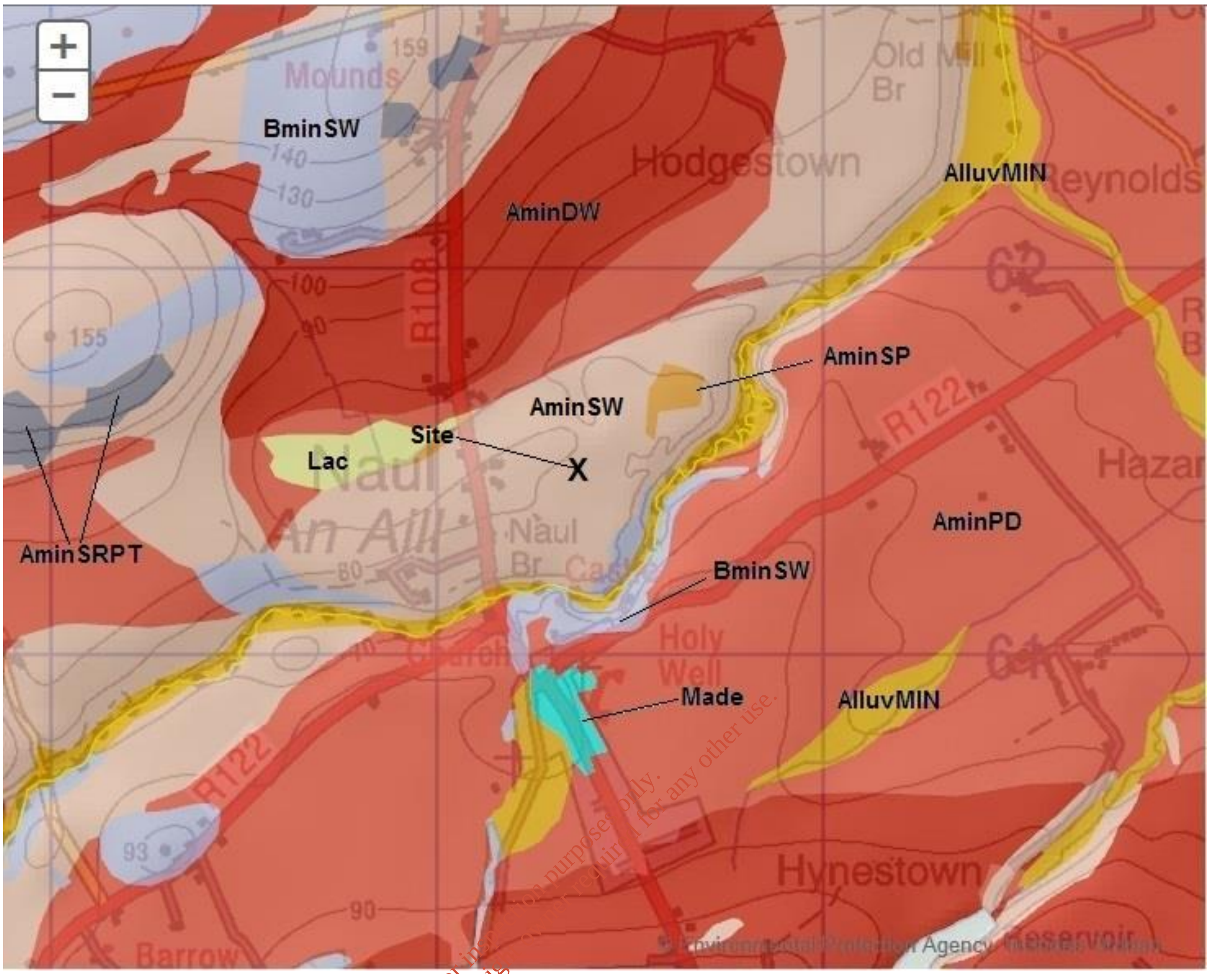

Figure 3.3.1. **Soil Map of Clashford Area.**

Redrawn extracts from EPA Envision online mapping website at http://gis.epa.ie/Envision. Scale: Grid Spacing = 1km.

Soil Map Legend:

Pink: AminSW - Lithosol / Regosol derived mainly from non-calcareous parent material, dominates the quarry (i.e., c. 75%)

Orange: AminSP - Surface water Gleys / Ground water Gleys (Shallow) derived mainly from non-calcareous parent material

Blue: BminSW - Rendzinas / lithosols derived mainly from calcareous parent material

Light Orange: AlluvMIN - Mineral Alluvium

Light Red: AminPD - Surface water Gleys / Ground water Gleys (Deep) derived mainly from non-calcareous parent material, in the wider Delvin River valley, lowlands and coastal plain

Dark Red: AminDW - Acid Brown Earths and Brown Podzolics derived mainly from non-calcareous parent material, mainly on medium elevated ground in hills over Balbriggan Inlier to NW and Namurian sediments to SE

Yellow: Lac - Lacustrine-type deposits, immediately west of the site

Grey Blue – AminSRPT – Podzols (Peaty) / Lithososls/ Peats derived from non-calcareous parent material

Turquoise: Made - Made/built ground, in the village of Naul

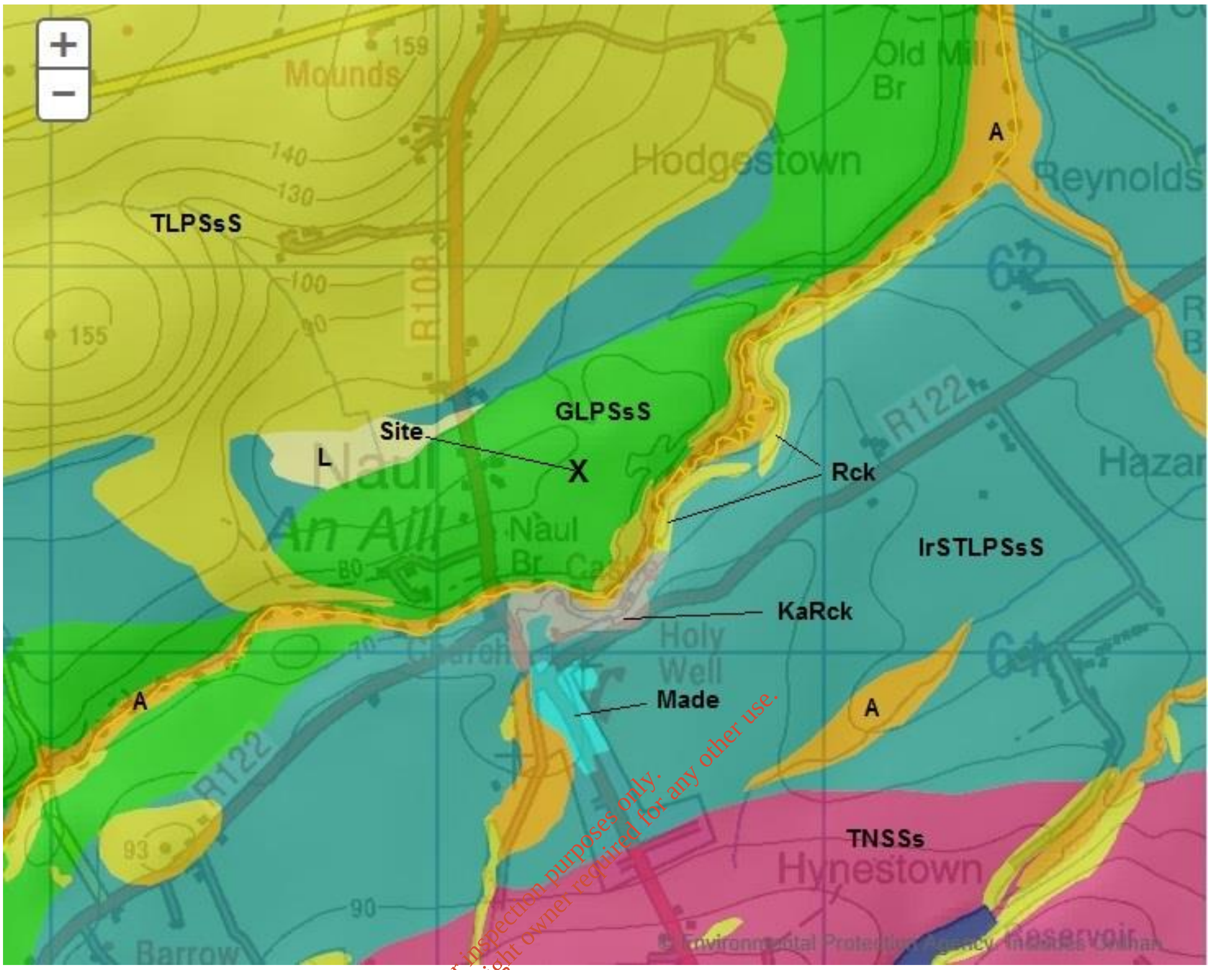

Figure 3.3.2. Subsoil Map of Clashford Area.

Redrawn extracts from EPA Envision online mapping website at http://gis.epa.ie/Envision. Scale: Grid Spacing = 1km.

Subsoil Map Legend:

Green: GLPSsS - Lower Palaeozoic sandstone and shale sands and gravels

Orange: A – Alluvium (gravelly)

Yellow: Rck – Exposed Rock

Mauve: KaRck – Karstified Rock

Blue: IrSTLPSsS - Irish Sea Till derived from Palaeozoic sandstone and shale, surrounding the site

Beige/Yellow: TLPSsS - Till derived from Devonian/ Carboniferous sandstone and shale, northwest of site

Purple: TNSSs - Till derived from Namurian sandstone and shale, southeast of site

Light Beige: L – Lake Sedimemnts – undifferentiated, west of site

Turquoise: Made - Made Ground in village of Naul, south of site

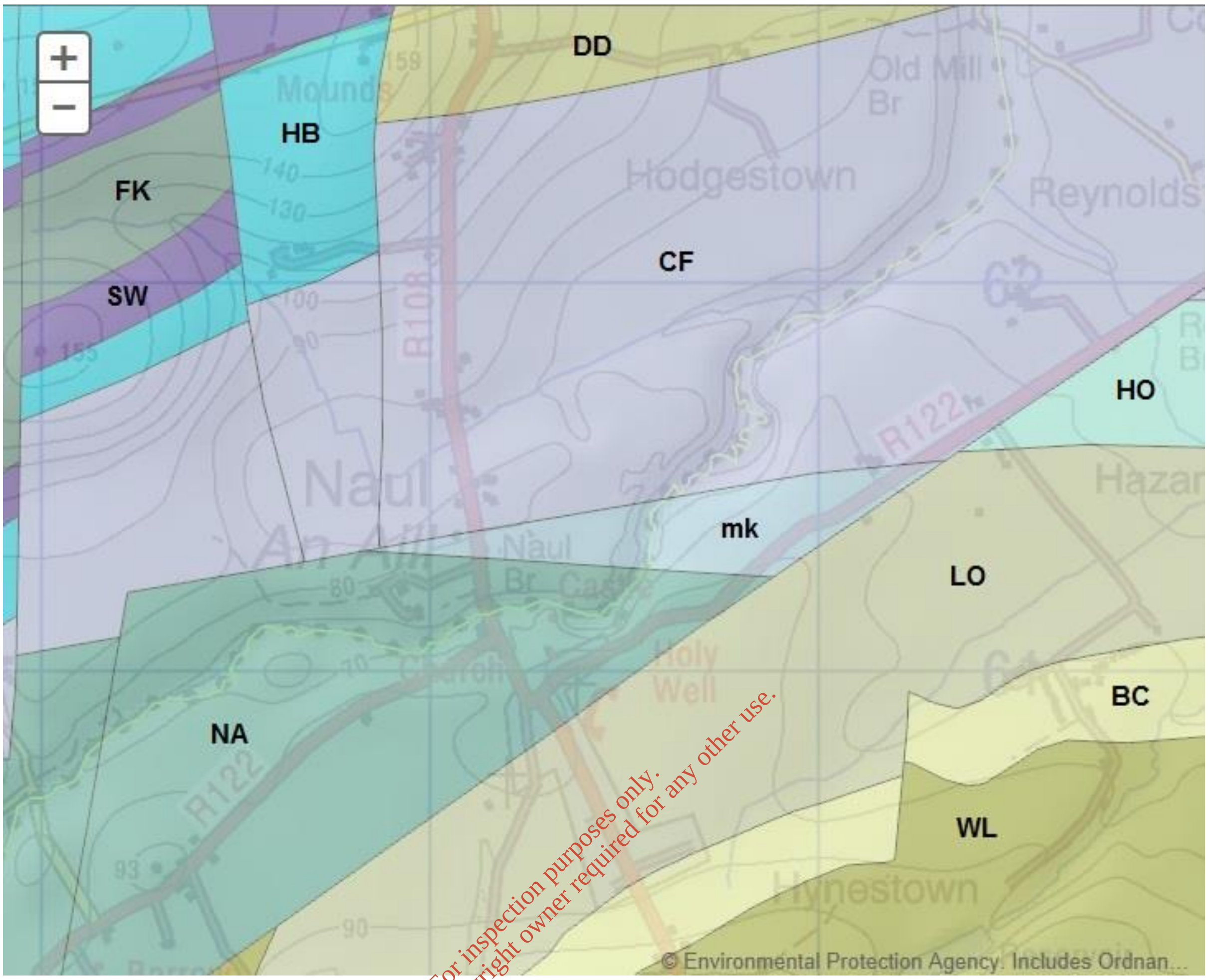

Figure 3.3.3. Geological Bedrock Map of the Clashford Area.

Redrawn extracts from EPA Envision online mapping website at http://gis.epa.ie/Envision. Scale: Grid Spacing = 1km.

The Clashford quarry site straddles the Clashford House Fm. (CF), Mudbank Limestone Lithology (mk), and Naul Fm. (NA). Other bedrock units in the wider area include the Lower Palaeozoic Fournocks Fm. (FK), Snowtown Fm. (SW), Herbertstown Fm. (HB) and the Denhamstown Fm. (DD), as well as the Mississippian Holmpatrick Fm. (HO), Loughshinny Fm. (LO), Balrickard Fm. (BC), and Walshestown Fm. (WL).

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3.4 WATER

3.4.1 INTRODUCTION

IE Consulting were engaged by J Sheils Planning & Environmental Ltd., on behalf of Clashford Recovery Facility Ltd., to assess hydrological and hydrogeological impacts relating to the on-going infilling and restoration of a sand and gravel pit using inert Construction and Demolition (C&D) waste, mainly soil and stone, at Naul townland, Naul, Co Meath.

This assessment has been undertaken as part of the Water Section of an Environmental Impact Statement (EIS), which will be submitted with a waste licence application and incorporates available background information and site-specific information.

3.4.2 SCOPE OF WORKS

The scope of works for the assessment undertaken comprised the following:

- Desk Study
    - Collation of existing regional information regarding the geology, hydrology and hydrogeology of the site and surrounding area;
    - Review of available site information.
- Field Work
    - Site walkover conducted by IE Consulting on 01st July 2014 to review site water management practices;
    - Supervision of downgradient monitoring well (2.No) drilling, on the 28th and 29th July 2014;
    - Groundwater monitoring of existing boreholes (GW1 and GW2) and the two new downgradient monitoring wells (GW3 and GW4) on the 05th and 11th August 2014;
    - Surface water sampling of the river and tributary stream near the quarry site on 05th August 2014.
- Reporting
    - Preparation of a hydrogeological report.

Reference was made to the following documents:

- Department of the Environment, Heritage and Local Government (2004) "*Quarries and Ancillary Activities – Guidelines for Planning Authorities*".
- Environmental Protection Agency (2006) "*Environmental Management in the Extractive Industry (Non-scheduled minerals)*".
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- Institute of Geologists of Ireland (2007) "*Recommended Collection, Presentation and Interpretation of Geological Hydrogeological Information for Quarry Development*".
- Waste Management (Facility and Registration) Regulations 2007 (S.I. No. 821 of 2007).
- Waste Management (Facility and Registration) Amendment Regulations 2008 (S.I. No. 86 of 2008).
- Institute of Geologists of Ireland (2013) "*Guidelines in the Preparation of the Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements"*.

As part of the desk study assessment, the following organisations were consulted for information pertaining to the site hydrology and hydrogeology e.g., databases, studies, etc.:

- Geological Survey of Ireland;
- National Parks and Wildlife Service;
- Environmental Protection Agency;
- Met Éireann;
- Teagasc.

The primary objective of the hydrogeological assessment is to assess the impact posed to surface water and groundwater by the on-going waste recovery of inert material and by the infilling and restoration of an area of the existing quarry using inert waste. Where appropriate, mitigation measures are recommended.

3.4.3 SITE LOCATION

The existing sand and gravel pit is located in the townland of Naul, County Meath, approximately 0.3 km north of Naul village, at an elevation of approximately 60-80 mAOD. The regional R108 road between Ballyboghill and Drogheda passes near the western boundary of the site (Drawing 1, Appendix 3.4.1). The site includes an area of restored agricultural lands, reclaimed agricultural grassland used for grazing sheep Phase 1 (P1), an area currently (2014) being restored Phase 2 (P2), the existing pit area Phase 3 (P3), and an area of reclaimed forestry along the northwestern boundaries of site (Drawing 1, Appendix 3.4.2).

The site is surrounded by lands which are primarily used for agricultural activities. According to the EPA Corine Land use Map 2006, land use in the area has been classified as 'Pastures and Non-irrigated land`.

There are a number of residences in the vicinity of the site located 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 west of the site.

Kilsaran concrete batching plant is located to the southwest of the site, and is outside the boundary of the site (Drawing 1, Appendix 3.4.2).

The Fingal Waste Water Treatment Plant (WWTP) is located on the southern flanks of the Delvin River approximately (Drawing 1, Appendix 3.4.1).

3.4.4 EXISTING SITE ACTIVITIES

The nature of the development is the continued phased restoration of a sand and gravel pit using imported inert construction and demolition (C&D) waste, mainly soil and stone.

As shown in Appendix 3.4.2, the site infrastructure includes an office, a toilet, a wheel wash, and a bunded fuel tank. Wastewater from the toilet is discharged to an adjacent site (Kilsaran Concrete) and is not treated within the site boundary.

The washwater from the wheel wash facility is recycled through a system of two silt lagoons which overflow to a surface water outlet. The lagoons are cleaned periodically and the settled silt is used as part of the site restoration. The lagoons were dry at the time of the site visit on 01^{st} July 2014.

The only other discharge from the site area is surface water run-off. The reclamation scheme has been designed to drain surface water run-off to the northern boundary area of the site. Currently all surface water runoff from the pit/recovery area of the site passes through two settlement lagoons prior to discharge to the tributary of the Delvin River. The settlement lagoons were dry during the site walkover.

Surface water drainage from the restored farmland to the south of the site is discharged to the Delvin River through an underground stormwater drain at three locations as shown in Appendix 3.4.3.

3.4.5 TOPOGRAPHY

In a regional setting, the village of Naul is located approximately 7 km east of the Irish Sea in a valley area associated with the River Delvin. According to the 1 in 50,000 Discovery Series Map, the nearest topographical high is located approximately 1.61 km to the south at Cabinhill (i.e., elevation of 143 mAOD), whilst the next nearest is located approximately 1.87 km northwest to the site at Fourknocks Hill (i.e., elevation of 156 mAOD Drawing 1, Appendix 3.4.1).

Based on a site survey undertaken by J Sheils Planning & Environmental Ltd in August 2014, the highest elevation recorded on-site is 79.91 mAOD located inside the site entrance. The site area consists of a central elevated east-west aligned ridge (with the exception of the existing pit area). The land slopes to the north and south from this ridge. The land slopes gently northwards towards Tributary 1 (approximately 65 mAOD) and steeper towards the southeast, north of the Delvin embankment (to approximately 50 mAOD). The approximate topographic gradient across the site is 0.03-0.05 in the direction of the Delvin River (Appendix 3.4.2).

3.4.6 METEOROLOGY AND WATER BALANCE

Rainfall data for the area was obtained from Met Eireann. The closest rainfall gauging station to the site is at Dunshaughlin, approximately 6km east of the site. The average annual rainfall (AAR), based on mean monthly rainfall data during the period 1942-1991, was calculated at 853 mm/yr.

Long term Potential Evaporation (P.E.) data was obtained for the closest synoptic station at Dublin Airport, 14km south of the quarry. The average P.E. for this synoptic station (based on 1961-1990 average monthly data) is 560 mm/year. The Actual Evaporation (A.E.) is taken to be 0.82 of P.E. Therefore, the A.E. at the quarry is estimated at 459.2mm/yr.

The effective precipitation (EP) is the amount of precipitation that is available to form recharge or runoff. The effective precipitation in the vicinity of the site boundary is estimated as follows:

EP = AAR – AE.

= 853 mm/yr – 459mm/yr

EP = 394mm/yr

An average surface water balance for the total application area of 22.3ha (excavation and restored area) is presented in *Table 3.4.1* below. This calculation assumes that site area is bunded so that water ingress from outside of the existing quarry footprint does not enter the quarry area.

Existing Quarry Area (m^2)	Average Annual Rainfall (mm)	Mean Annual Potential Evaporation (mm)	Actual Evaporation (mm)	Effective Annual Precipitation (mm)	Annual Volume of Water Available for Recharge or Runoff (m^3)	Annual Volume of Water Available for Recharge or Runoff (m^3/day)
223,000	853	560	459	394	87,862	240

Table 3.4.1 Mean Water Balance for the Existing Excavation Area and Ancillary Activities Area

All effective precipitation formed within the quarry area recharges into the ground, is discharged to the surface water drain which discharges to Tributary 1 or is discharged via stormwater drains to the Delvin River. The existing site water management is discussed in further detail in *Section 3.4.13*.

The GSI National Recharge maps indicate the average recharge beneath the unit and surrounding area is 474 mm/yr. This figure is greater than the calculated effective rainfall for the site.

The hydrogeological controls determining the rate of groundwater recharge as indicated by the Geological Survey of Ireland (GSI) are provided in Tables 3.4.2 and 3.4.3 below.

Hydrogeological Controls	
Hydrogeological Setting:	2.ii *(source: GWWG, 2005)*
Hydrogeological Setting Description:	Sand & gravels subsoil overlain by well drained soil
Soil Drainage:	DRY
Subsoil Type:	GLPSsS
Subsoil Description:	Sandstone and shale sands and gravels Lower Palaeozoic
Subsoil Permeability:	H
Subsoil Permeability Description:	High
GW Vulnerability:	H
GW Vulnerability Description:	High
Aquifer Category:	Pl
Aquifer Category Description:	Poor Aquifer – Bedrock that is generally unproductive except for local zones
Recharge Coefficient (%):	85
Maximum Recharge Capacity (mm/yr):	100
Average Recharge (mm/yr):	474 (This is higher than the calculated effective rainfall for the site)

Table 3.4.2 - Hydrogeological Control Determining Groundwater Recharge for the north of the Site

Hydrogeological Controls	
Hydrogeological Setting:	2.iii *(source: GWWG, 2005)*
Hydrogeological Setting Description:	Sand & gravels subsoil overlain by well drained soil
Soil Drainage:	DRY
Subsoil Type:	GLPSsS
Subsoil Description:	Sandstone and shale sands and gravels Lower Palaeozoic
Subsoil Permeability:	H
Subsoil Permeability Description:	High
GW Vulnerability:	H

Hydrogeological Controls	
GW Vulnerability Description:	High
Aquifer Category:	LI
Aquifer Category Description:	Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
Recharge Coefficient (%):	85
Maximum Recharge Capacity (mm/yr):	200
Average Recharge (mm/yr):	474 (This is higher than the calculated effective rainfall figure for the site).

Table 3.4.3 Hydrogeological Control Determining Groundwater Recharge beneath the Centre of the Site

3.4.7 HYDROLOGY

In a regional context, the site is situated in the Eastern River Basin District (ERBD). The Delvin River, which forms the southern and south eastern boundaries of the site, flows in a north-easterly direction to its discharge point to the Irish Sea, approximately 7 km north-east of the site. An un-named tributary of the Delvin River forms the northern boundary of the site (referred to as Tributary 1). The source of this stream is a spring located approximately 1.2 km to the north-west. Tributary 1 discharges to the Delvin River at the most north eastern point of the site (Appendix 3.4.3).

Surface water runoff from the existing pit area is directed via the surface water management system to Tributary 1 to the north of the site. Surface water runoff from the current restoration area recharges to ground or runs off towards Tributary 1.

During the site walkover on the 01st August 2014, groundwater was observed to flow from a fracture in the outcrop exposed north of the Delvin River, outside the application area, within the applicant’s land ownership boundary. The flow was very minor and appeared to drain towards the nearby River Delvin (Appendix 3.4.3).

3.4.8 GEOLOGICAL SETTING

3.4.8.1 BEDROCK GEOLOGY

The rock units within c.1km of the site were identified from the 1:100,000 scale map of the Geology of Meath: Sheet 13 (GSI 2001) and online mapping (GSI 2014). The rocks belong to: (1) the Lower Palaeozoics of the Balbriggan Inlier; or (2) the Mississippian (Lr. Carboniferous) marine sequence of the North Dublin Basin.

The base of the Ordovician sequence in the area is the Fournocks Fm. (FK), which consists of red and green banded mudstones and siltstones. This is conformably overlain by the Snowtown Fm. (SW), which consists of a 200m thick unit of banded grey mudstones and siltstones. These are unconformably overlain by the Herbertsown Fm. (HB), a unit of andesitic volcanics and mudstones.

The Herbertstown Fm. is conformably overlain by the Clashford House Fm. (CF), which underlies much of the site. It consists of 100m thick sequence of micaceous green- to brown-grey mudstones and siltstones with interfingering sheets of andesite. The unit is fossiliferous, containing a shelly fauna of Avalonian affinities, consistent with a position on the northernmost margin of the Leinster Terrane. The Clashford House Fm. represents marine sedimentary rocks associated with a fore arc/volcanic arc on the continental margin of Avalonia on the southern side of the Iapetus Ocean, prior its closure culminating in the Caledonian Orogeny c. 425-394Ma.

The Denhamstown Fm. forms the base of the Silurian overstep sequence, which was deposited over the accreted Avalonia and Bellewstown-Arc Terranes of the Balbriggan Inlier. The Lowther Lodge Fault has brought the Denhamstown Fm. into contact with the Clashford House Fm. c. 750m north of the site.

The base of the Carboniferous sequence in the area is marked by the Holmpatrick Fm. (HO), which consists of a 90-200m thick sequence of platform limestones. The next youngest unit is the Naul Fm. (NA), which has been brought into contact with the Balbriggan Inlier through faulting. The Naul Fm. is similar to the Lucan Fm., except the limestones are paler and less argillaceous, and consist largely of calcarenite and calcsiltite with minor chert and shale (i.e., higher on ramp, and less basinal). It outcrops on the banks of the Delvin River at Naul, and has been interpreted as the lateral equivalent of the upper part of the Lucan Fm. The formation varies widely in thickness up to 100m.

Overlying the Naul Fm., is the Loughshinny Formation (LO), which has been brought into contact with the Naul Fm. in the Naul area by a major SW-NE fault. The formation consists of up to 150m of laminated to thinly bedded, argillaceous, pyritic, locally cherty limestones, interbedded with dark grey to black shales. The Naul and Loughshinny Fms. are lithologically very similar, and belong to the Fingal Group of predominantly basinal facies.

The Loughshinny is conformably overlain by the Balrickard Fm. (BC), and consists of 75-100m deltaic sandstone interbedded with shale and argillaceous micrite. This is conformably overlain by the Walshestown Fm. (WL), which consists of >200m of black shales, with siltstone, fine sandstone, and calcareous mudstone. The latter two units are Namurian in age and belong to the Knockbrack Group, which straddles the Visean-Namurian boundary. It heralds an abrupt change in depositional environments from that of limestones and shales in shallow tropical seas during the Visean to sandstones and shales in quiescent, deep waters during the Namurian.

An additional lithology known as the Mudbank Limestone Lithology (Mk) occurs in several fault blocks adjacent to the Balbriggan Inlier. The lithology consists of massive, unbedded, grey micritic (fine-grained) limestones and represent a complex lime mud mound facies rich in bryozoa and brachiopods, similar to the Waulsortian, which interdigitates with Asbian shelf limestones (MEIL 2004). These limestones pass laterally into calcarenites and calcsilicates with shale partings, probably indicating local basin development.

Numerous faults are located within 1km of the site, and many of the contacts between the major stratigraphic units are faulted contacts. The quarry site straddles the faulted contact between the Balbriggan Inlier and the North Dublin Basin, and is predominantly underlain by the Clashford House Fm. (70%), with minor Mudbank Limestone (20%) and Naul Fm. (10%) in the southwest corner. Two faults traverse the site: (1) a roughly ENE-WSW oriented fault brings a triangular sliver of the Mudbank Limestone lithology into contact with the Clashford House Fm.; and (2) an E-W oriented fault brings the Mudbank Limestone into contact with the Naul Fm. A major NE-SW oriented fault with substantial vertical displacement, traverses c. 500m east of the site. The bedrock of the Clashford area is shown in Figure 3.3.3: Bedrock Geological Map of Clashford Area. The bedrock geology is described in detail in Chapter 3.3.

3.4.8.2 SOILS AND SUBSOILS

3.4.8.2.1 Regional Data

The Teagasc/EPA soils map (2006) describes the soils underlying the majority of the site as AminSW, comprising Lithosols/Regosols. Two other types of soil are located along the Delvin River banks and are mapped on Figure 2 (Appendix 3.4.4). Mineral alluvium soil (AlluvMIN) is mapped along the Delvin River bank with a small mapped section of Renzinas/Lithosols mapped along the bank to the southeast of the site. Both the AlluvMIN and BminSW, Rendzinas/lithosols derived mainly from calcareous parent material, are outside the application area but within the applicant’s ownership (See Figure 3, Appendix 3.4.3).

The Teagasc/GSI ERBD Subsoil Map (Figure 2, Appendix 3.4.4) describes the natural subsoil material at the site as Glaciofluvial Sands and Gravels (GLPSsS); the majority of this subsoil cover has been excavated at the site to date. Karstified limestone bedrock outcrop is mapped along the Delvin river bed.

3.4.8.3 DEPTH TO BEDROCK

The groundwater vulnerability map (Figure 3, Appendix 3.4.3) suggest that the depth to bedrock within the area of investigation is >3m below ground level. This is based on a High (H) vulnerability classification and high permeability subsoil (DoELG/EPA/GSI 1999). Extreme vulnerability is mapped along the southern boundary of the site.

The borehole records from the monitoring well drilling works indicate that the depth to bedrock within the southern area of the site ranges from 6.8 m (GW4) to 14 m below ground level

(GW3) (See Appendix 3.4.5). The depth to bedrock is shallower at the base of the embankment beside the Delvin River with higher subsoil thicknesses associated with the elevated restored areas of the site.

3.4.8.4 BOREHOLE DRILLING

Two downgradient boreholes were installed on-site to serve as long-term groundwater monitoring points in addition to the existing site wells, GW1 and GW2. The additional boreholes are labelled GW3 and GW4 (Appendix 3.4.5). Borehole logs for GW1 and GW2 were not available.

The boreholes were drilled using compressed air boring methods: the drilling rig created a 150 mm diameter borehole to house a 50 mm diameter piezometer. The borehole drilling indicated significant subsoil and upper bedrock instability and it was necessary to install permanent steel casing in order to house the piezometers, otherwise borehole collapse would have necessitated re-drilling of the bore. Each borehole was covered at ground level with a lockable well cap set in a concrete plinth.

GW4 was drilled to a depth of 24.5 mbgl. A saturated weathered limestone bedrock zone was encountered at 6.8 mbgl. Competent limestone bedrock was encountered at 8.3 mbgl to the final drilled depth (end of hole). No significant water strikes were recorded in the competent limestone.

GW3 was drilled to a depth of 30.9 mbgl. A saturated weathered limestone bedrock zone was encountered from 14 -18 mbgl. Competent limestone bedrock was encountered to the final drilled depth (end of hole). The weathered bedrock zone was saturated and a minor water strike was recorded within the competent limestone at approximately 20.5 mbgl.

3.4.9 HYDROGEOLOGICAL SETTING

3.4.9.1 AQUIFER CLASSIFICATION

The rock underlying the northern and principal area of the site is mapped as part of the Duleek groundwater body (GWB) (EU_CD:IE_EA_G_012) and classified as a **poorly productive bedrock**. The southern tip of the site is mapped as part of the Lusk-Bog of the Ring (GWB EU_CD:IE_EA_G_014), which extends as far west as Garristown and is classified as a **productive fissured bedrock**. (A narrow strip of the extensive Lusk-Bog of the Ring GWB includes an area to the north of the Delvin River adjacent to the site).

The key characteristics of the Duleek groundwater body have been identified as follows:

- This aquifer is comprised of Lower Palaeozoic rocks, which are commonly considered to be poor aquifers, and transmissivities are presumed to be generally low (<10m^2/d).
- The majority of groundwater flow in this groundwater body is considered to take place in the upper weathered zone of the aquifer (~10 m). However, deep water strikes in more isolated faults/fractures can be encountered at 30-50 mbgl.
- Groundwater will flow from the recharge mounds in the north and south of the body towards the east and west of the area.

- This aquifer will discharge to the overlying rivers and streams in the area as baseflow.
- Flow paths are not considered to extend further than the nearest surface water feature and will generally not be greater than 500 m.

The key characteristics of the Lusk-Bog of the Ring groundwater body have been identified as follows:

- This groundwater body is composed of moderate permeability limestone which in some places is karstified.
- Transmissivity and storativity values in the aquifer appear to be better than is normal for the Calp limestone.
- Very small areas of low permeability impure limestones are incorporated with this GWB, however, since they are isolated and do not alter significantly the flow system.
- The aquifers within the GWB are generally unconfined, but may become locally confined where the subsoil is thicker and/or lower permeability and where the aquifer is overlain by Namurian Strata.
- In general, the majority of groundwater flow occurs in the upper 30 m, comprising a weathered zone of a few metres and a connected fractured zone below this.
- Flow path lengths are variable. From examining the drainage density it is clear that, in some instances, groundwater flow paths of up to a couple of kilometres may exist, although distances of a few hundred metres area more likely.
- The groundwater discharges directly to the Irish Sea in the east and also to the north and south via baseflow to rivers.

The majority of groundwater flow in this area is considered to take place in the upper weathered zone of the aquifer.

3.4.9.2 KARST FEATURES

Reference to the Geological Survey of Ireland karst database indicates that a cave is located approximately 152 m to the southwest from the southern boundary of the site. No karst features have been mapped within the site perimeter.

3.4.9.3 GROUNDWATER ABSTRACTIONS

There are two water wells at the southwestern part of the site, GW1 and GW2. Well GW1 is located near the western site boundary to the north side of the site entrance. Well GW2 is located in the southern part of the site. The two wells are approximately 273 m apart. GW1 supplies water for the office, canteen and toilet facilities. GW2 supplies the site sprinkler system and farmland areas and livestock. It is understood that that the average abstraction is approximately 450l/day.

Reference to the Geological Survey of Ireland (GSI) well database indicates the nearest recorded groundwater supply is in the Bog of the Ring (a public supply) approximately 2km to the south east of the site (*Figure 5, Appendix 3.4.4*). The database also indicates 3No.

groundwater supplies within a 2km radius of the site (public supplies, location accuracy 1km), the details of which are summarised in Table 3.4.4 below.

Well Type	Depth (m)	Usage	Yield	
Bored well	30.1	Public Supply Co.Co.		Approximately 2.2 km to SW
Bored well	7.3	Public Supply Co.Co.		Approximately 2.2 km to SW
Bored well		Public Supply CoCo		Approximately 2 km to SE

Table 3.4.4 – Groundwater Abstractions within a 2km radius

3.4.9.4 GROUNDWATER LEVELS, FLOW DIRECTION AND GRADIENT

Static (non-pumping) groundwater levels in all monitoring wells, were measured on the 11th August 2014 in order to establish groundwater flow direction, and are shown below.

Well ID	Static Water Level (mbtoc)*	Ground Elevation (mAOD)	Elevation Top of Casing (mAOD)	Static Water Level (mAOD)
GW1	9.39	76.661	76.661	67.271
GW2	22.38	76.571	76.571	54.250
GW3	20.49	75.625	76.175	55.685
GW4	5.42	49.334	49.974	44.554

Table 3.4.5 – Groundwater levels measured August 2014

A groundwater contour map for the site is shown in *Drawing 2, Appendix 3.4.3.* The contour map indicates that groundwater flow beneath the site is to the southeast towards the Delvin River.

The calculated groundwater flow gradient is 0.03 – 0.05.

3.4.9.5 GROUNDWATER VULNERABILITY

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. Where the subsoil thickness is <3m, the vulnerability is rated as Extreme (the highest risk situation). Where the subsoil thickness is >3m, the vulnerability is rated as High, Moderate or Low (depending on the nature and thickness of the subsoil).

The groundwater vulnerability map (*Figure 3, Appendix 3.4.4*) suggests that the depth within the area on investigation is >3m below ground level. This is based on a High (H) vulnerability classification and high permeability subsoil (DoELG/EPA/GSI, 1999).

The results of the site investigation indicate that the depth to bedrock within the southern area of investigation ranges from 14 m (GW3) to 6.8 m below ground level (GW4) (See Appendix 3.4.5). The depth to bedrock is shallower at the base of the embankment beside the Delvin River with higher subsoil thicknesses associated with the restored areas of the site.

Based on the site-specific information on depth to bedrock and subsoil type, the groundwater vulnerability is High beneath the southern section of the site.

3.4.10 WATER QUALITY

3.4.10.1 OVERVIEW

Under the Water Framework Directive (Directive 2000/60/EC) groundwater bodies and surface water bodies were assigned a status rating (Bad – Poor – Moderate – Good – High) based on chemical and ecological status.

In the context of the Eastern River Basin Management Plan the Delvin River has been assigned an overall “Poor” status result. On this basis, the surface water body has been assigned a score of 1a, indicating that the water body is at risk of failing to meet good status in 2015.

Surface water and groundwater quality data was obtained from 2No. rounds of sampling on 05th and 11th August 2014. The Certificates of Analysis are presented in *Appendix 3.4.6.* The sampling locations are presented in *Drawing 1, Appendix 3.4.3* and are summarised as follows:

- Groundwater quality
  - GW1, GW2, GW3 & GW4
- Surface water quality
  - Delvin River: upstream (SW1), downstream of Kilsaran Concrete Batching Plant (SW2) and downstream of the site (SW3);
  - Tributary 1: upstream (SW4) of site discharge point and downstream (SW5) of site.

The water quality results were compared with the following legislation/guidance (where relevant):

- Groundwater:
  - Groundwater Threshold Values (TVs) as set out in the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010) or in the absence,
  - Environmental Protection Agency (EPA) Interim Guideline Values (IGVs) (EPA 2003),
  - Parametric Values (MAC) in the Drinking Water Regulations 2007 (S.I. No. 278 of 2007).

- Surface Water:
    - Environmental Quality Standards (EQSs) in the European Communities Environmental Objectives (Surface Water) Regulations 2009 (S.I. No. 272 of 2009).

3.4.10.2 GROUNDWATER QUALITY

Samples were taken from GW1, GW2 and GW4 on the 05th August 2014 and from GW3 on the 11th August 2014, as GW3 was slow to recharge on the 05th August 2014. Groundwater samples were taken from each of the monitoring wells at the site using dedicated bailers. For the purposes of groundwater sampling, GW1 and GW2 are deemed to be upgradient boreholes. GW3 and GW4 were resampled on the 10th of September 2014 in order to confirm the results obtained on 5th and 11th August 2014.

In order to ensure extraction of samples which were representative of formation water, each well was purged prior to sample collection in accordance with standard best practice methods and using dedicated equipment.

After purging, the groundwater samples were decanted into labelled containers supplied by the laboratory. To avoid potential cross-contamination of samples, dedicated or disposable sampling equipment was used at each well. The sample containers were kept cool and in darkness and sent for analysis to a UKAS accredited laboratory. In order to maintain sample integrity, a chain of custody record was completed to track sample possession from time of collection to time of analysis.

Groundwater analytical results together with relevant assessment criteria are presented in Table 3.4.6 below. The certificates of analysis are included in *Appendix 3.4.6*.

Parameters	**Units**	**GW1**	**GW2**	**GW3**	**GW4**	**Groundwater Regulations (2010) (TV)**	**Drinking Water Regulations (2007)**	**EPA Interim Guideline Value (2003) (IGV)**
Ammoniacal Nitrogen as NH_4	mg/l	<0.03	0.08	<0.03 (<0.03)	1.4 (0.65)	0.083-0.225	0.30	0.15
Total Ammonia as N	mg/l	<0.03	0.06	<0.03 (<0.03)	1.09 (0.5)			
Chloride (Cl)	mg/l	18.9	25	110.1 (48.6)	120.4 (127.9)	24-187.5	250	30
Dissolved Calcium (Ca)	mg/l	65.6	90.7	119.1 (102.2)	109.3 (169.1)	-	200	200
Dissolved Magnesium (Mg)	mg/l	13.1	22.9	30.7 (23.6)	19.5 (22.0)	-	50	50
Dissolved Manganese (Mn)	mg/l	24	455	104 (50)	937 (2683)	-	0.05	0.05
Dissolved Iron (Fe)	mg/l	116	28	<20 (<20)	154 (1981)	-	0.2	0.2
Dissolved Potassium (K)	mg/l	2.1	1.9	9.9 (7.5)	75.2 (5.2)	5	-	5
Dissolved Sodium (Na)	mg/l	20.4	20.2	26.6 (21.3)	94.8 (70.1)	150	200	150
EPH (C8-C40)	µg/l	<10	<10	<10 (<10)	<10 (<10)	-	-	
C8-C40 Mineral Oil	µg/l	<10	<10	<10 (<10)	<10 (<10)	-	-	
Nitrate as NO_3	mg/l	0.6	0.7	0.2 (1.3)	0.4 (<0.2)	37.5	50	25
Nitrite as NO_2	mg/l	<0.02	<0.02	<0.2 (<0.2)	<0.02 (<0.2)	0.375	0.1	0.1
Ortho Phosphate as PO_4	mg/l	<0.06	<0.06	<0.06 (<0.06)	<0.06 (<0.06)	0.107	0.03	0.03
Total Phosphorus	µg/l	22	34	460 (315)	54 (97)	-	-	-
Sulphate (SO_4)	mg/l	22.75	73.97	90.82 (84.88)	138.27 (70.39)	187.5	250	200
Total Alkalinity as $CaCO_3$	mg/l	226	278	270 (0.9)	230 (0.5)	-	*No abnormal change*	*No abnormal change*
Turbidity	NTU	0.3	0.3	0.5 (0.9)	0.5 (0.1)	-	-	-
Electrical Conductivity (EC)	µS/cm	458	629	938 (755)	1140 (1245)	800-1875	2500	1000
pH	pH Units	7.82	7.72	7.62 (7.70)	10.64 (7.46)	-	≥6.5 and 9.5≤	≥6.5 and 9.5≤
Faecal Coliforms	CFU/100mls	0	0	>100 (10)	20 (30)	-	0	0
Total Coliforms	CFU/100mls	0	3	>100 (40)	600 (97)	-	0	0

Table 3.4.6 Summary of Groundwater Monitoring Results on 05th, 11th August and 10th September 2014 (in brackets).

The concentration of **Total Ammonia (as N)** in the samples taken from GW1 and GW3 in August was <0.03 mg/l. The concentration recorded in August was 0.06 mg/l at GW2 and 1.09 mg/l at GW4. Total Ammonia in the September at GW3 and GW4 was <0.03 mg/l and 0.50 mg/l, respectively.

The concentrations of **Ammoniacal Nitrogen** as **NH_4** in August at GW1 and GW3 was <0.03 mg/l. The concentration recorded in August was 0.08 mg/l at GW2 and 1.4 mg/l at GW4. Ammoniacal Nitrogen as NH_4 in September at GW3 and GW4 was <0.03 mg/l and 0.65mg/l, respectively. The results at GW4 for both sampling events exceeded the Groundwater TV, the Drinking Water Regulation limit and the IGV. The NH_4 ion can enter water systems on occasion even though the ion has a low mobility because it is usually tightly bound to soil particles. It is suggested that the presence of NH_4 in water at concentrations much above 0.1 mg/l indicates point source contamination (e.g. Flanagan 1992; Jarvis 1999). However, others acknowledge that vulnerable conditions may also be the cause of elevated NH_4 in groundwater (Kiely 1997). Concentrations greater than 0.15 mg/l is considered indicative of organic waste.

The **Total Phosphorous (P)** concentrations in August at GW1 and GW2 were 22 µg/l and 34 µg/l, respectively. The concentrations in August at GW3 and GW4 were 460 µg/l and 54 µg/l, respectively. Total Phosphorous in GW3 and GW4 in September were 315 µg/l and 97 µg/l respectively. The concentrations of 460 µg/l and 315 µg/l at GW3 are significantly elevated relative to the concentrations detected at the other sampling locations.

The concentrations of **Chloride (Cl)** in August at GW1 and GW2 were 18.9 mg/l and 25 mg/l, respectively. The chloride concentrations in August at GW3 and GW4 were 110.1 mg/l and 120.4 mg/l, respectively, whereas the Chloride concentrations in September at GW3 and GW4 were 48.6 mg/l and 127.9 mg/l, respectively. All of these results are below the limit of 250mg/l as set out in the Drinking Water Regulations 2007. Concentrations at GW2, GW3 and GW4 in both sampling events exceed the lower groundwater TV. The Chloride concentrations at GW3 and GW4 are significantly elevated compared with the upgradient chloride concentration at GW1 (18.9 mg/l). Chloride is a constituent of organic wastes and levels appreciably above background values are taken to indicate contamination by organic wastes.

The **Dissolved Potassium (K)** concentrations in August at GW1 (2.1 mg/l) and GW2 (1.9 mg/l) were both below the EPA IGV of 5 mg/l. However, the concentration of 75.2 mg/l recorded at GW4 was significantly elevated compared to the EPA IGV of 5mg/l. Dissolved Potassium in GW3 and GW4 in September were 7.5 mg/l and 5.2 mg/l, respectively.

The **Dissolved Sodium (Na)** concentrations in August at GW1 (20.4 mg/l), GW3 (9.9 mg/l), GW2 (20.2 mg/l) and GW4 (138.27 mg/l) were below the groundwater TV of 150 mg/l. Dissolved Sodium (Na) concentrations in September at GW3 and GW4 were 21.3 mg/l and 70.1 mg/l, respectively. All of the results in August and September are below the EPA IGV of 150 mg/l and the Drinking Water Regulations limit of 200 mg/l. Concentrations at GW4 are significantly higher than those recorded at GW1, GW2 and GW3. Sodium is not a harmful constituent, but it is used as an indicator of impact on groundwater quality (GSI 1999).

The **Petroleum Hydrocarbon and Mineral Oil** (Oil, Fat and Greases) concentrations were below the laboratory LOD of 10 µg/l for all samples taken in August and September 2014, which indicates that there has been no impact of hydrocarbon contamination from on-site activities.

The **Nitrate (NO_3)** concentrations recorded in August ranged between 0.2 mg/l to 0.7 mg/l, and in September were 1.3 mg/l and <0.2 mg/l at GW3 and GW4, respectively. These concentrations are below the Drinking Water Regulations limit of 50 mg/l, as well as the groundwater TV of 37.5 mg/l.

The **Nitrite (NO_2)** concentrations in all boreholes in August and September were lower than the detection limit used by the laboratory (<0.02 mg/l), and below the limits set out in the Groundwater Regulations and Drinking Water Regulations.

The **Ortho Phosphate** concentrations in all boreholes in August and September were below <0.06 mg/l, the detection limit used by the laboratory, which is also lower than the groundwater TV.

The **Sulphate (SO_4)** concentrations determined in August at GW1 (22.75 mg/l), GW2 (73.97 mg/l), GW3 (90.82 mg/l) and GW4 (138.27 mg/l), and in September at GW3 (84.88 mg/l) and GW4 (70.39 mg/l) were below the groundwater TV of 187.5 mg/l and the Drinking Water Regulations limit of 250 mg/l. The EPA (2003) acknowledges Sulphate as a significant indicator of groundwater contamination and labels its sources as agriculture and acid rain. Bohlke (2002) suggests that SO_4 is a useful tracer of agriculturally impacted groundwater. The data suggests that the Sulphate concentrations are elevated at the downgradient wells.

The **Total Alkalinity** in all boreholes in August and September ranged from 116 - 390 mg/l $CaCO_3$.

Total Coliforms were detected in GW2 (3 cfu/100mls) but were not detected in GW1**.** Total Coliforms were detected in August at GW3 (>100 cfu/100 mls) and at GW4 (600 cfu/100 mls). The Total Coliforms detected in September at GW3 were 40 cfu/100 mls and 97 cfu/100 mls at GW4.

Faecal Coliforms were not detected in GW1 or GW2. Faecal coliforms were detected in August at GW3 (>100 cfu/100mls) and at GW4 (20 cfu/100mls). Faecal coliforms detected in September in GW3 were 10 cfu/100 mls and 30 cfu/100mls in GW4. The results in GW3 and GW4 exceed the Drinking Water Limit of 0 cfu/100mls.

The **Electrical Conductivity (EC)** values determined in August at GW1 (458 µS/cm), GW2 (629 µS/cm), GW3 (938µS/cm) and GW4 (1140 µS/cm), and in September at GW3 (755 µS/cm) and GW4 (1245 µS/cm) were within the range for Dinantian pure, impure and dolomitised limestone bedrock aquifers (*Working Group on Groundwater, 2005*). The values for GW3 and GW4 in August and September are elevated relative to the lower groundwater TV (related to the elevated Chloride and Sodium concentration in these boreholes).

The **pH** values recorded at GW1, GW2 and GW3 were 7.82, 7.72 and 7.62 pH units, respectively. The pH value recorded at GW4 was 10.64, which is considered unusually high (basic). However, **pH** field measurements taken during purging and prior to sampling recorded pH values of 7.49 – 7.69 at this borehole. It is considered that the pH value of 10.64 may be the result of either a laboratory or sampling error. The **pH** values for GW3 and GW4 in September were 7.7 and 7.46 respectively.

The **K:Na** ratio in August was 0.37 at GW3 and 0.79 at GW4, whereas the K:Na ratio in September was 0.35 at GW3 and 0.07 at GW4. Daly and Daly (1982) point to the significance of a K:Na ratio greater than 0.3 as an indicator of contamination from dirty water, farmyard and other wastes derived from plant material. The K:Na ratio of soiled water and other wastes derived from plant organic matter is considerably greater than 0.4. Consequently, a K:Na ratio greater than 0.4 can be used to indicate contamination by organic wastes (Kiely 1997).

In summary, the K:Na ratio was greater than 0.4 for the downgradient borehole GW4 in August, and was 0.37 and 0.35 in the downgradient borehole GW3 in August and September, respectively. Hydrochemical results with a strong agricultural signature for these boreholes suggest that it may be impacted by point source contamination from farming activity on-site. The most likely source is manure spreading on the restored agricultural areas. Elevated EC, K, NH_4, Mn, Na, P, Total coliform and Faecal coliform levels in the downgradient boreholes, GW3 and GW4, indicate that the groundwater is vulnerable to contamination. Further monitoring is required to establish on-going trends in the groundwater monitoring boreholes.

3.4.10.3 SURFACE WATER QUALITY

Surface water quality sampling was undertaken in accordance with *BS6068:6.6 Guidance on sampling of rivers and streams*. Grab samples were obtained by IE Consulting on 05th August 2014 at two locations along Tributary 1, at (SW5) 20 m downstream of the point of discharge from the settlement lagoon to the tributary of the Delvin River, and at (SW4) 20 m upstream to the point of discharge. Grab samples were obtained from three locations at the Delvin River. SW1 is an upstream sample, SW2 is downstream of the WWTP (Drawing 1 – Appendix 3.4.1) and SW3 is downstream of the site.

Prior to obtaining the samples the outlet from the settlement lagoon had not been discharging to the stream (Drawing 1, Appendix 3.4.3).

A comparison of the surface water sampling results with the relevant legislation is presented in Table 3.4.7 below.

		Delvin River			Tributary 1		
Parameters	**Units**	**SW1** Upstream	**SW2** Upstream	**SW3** Downstream	**SW4** Upstream	**SW5** Downstream	**Surface Water Regulations (2010)**
Ammoniacal Nitrogen as NH_4	mg/l	0.13	0.24	0.12	0.08	0.07	-
Total Ammonia as N	mg/l	0.1	0.19	0.09	0.06	0.05	≤065 *(mean)* or ≤0.140 *(95%ile)*.
Chloride (Cl)	mg/l	23.7	23.6	28.2	28.9	79.3	
Dissolved Calcium (Ca)	mg/l	95.9	94	93.1	81.3	94.3	-
Dissolved Magnesium (Mg)	mg/l	6.7	6.6	6.5	7.7	8.6	-
Total Dissolved Iron (Fe)	mg/l	77	81	72	39	21	-

		Delvin River			Tributary 1		
Parameters	**Units**	**SW1** Upstream	**SW2** Upstream	**SW3** Downstream	**SW4** Upstream	**SW5** Downstream	**Surface Water Regulations (2010)**
Dissolved Potassium (K)	mg/l	6.2	6.5	6.2	3.6	4.6	-
Dissolved Sodium (Na)	mg/l	11.2	11.5	11.9	14.5	50.2	-
EPH (C8-C40)	µg/l	<10	<10	<10	<10	<10	-
C8-C40 Mineral Oil	µg/l	<10	<10	<10	<10	<10	-
Nitrate as NO_3	mg/l	9.3	19.5	9.9	18.9	18.4	-
Nitrite as NO_2	mg/l	0.04	0.03	0.04	<0.02	<0.02	-
Ortho Phosphate as PO_4	mg/l	0.35	0.37	0.42	<0.06	<0.06	*≤0.035 (mean) or ≤0.075 (95%ile)*
Sulphate (SO_4)	mg/l	42.44	41.99	66.63	34.03	66.53	-
Total Alkalinity as $CaCO_3$	mg/l	230	220	220	190	204	≤0.065 (mean) or ≤0.140 (95%ile)
Electrical Conductivity (EC)	µS/cm	532	523	562	514	714	-
PH	pH Units	7.98	8.06	8.12	8.02	7.93	4.5 < pH < 9.0
Biological Oxygen Demand (Settled)	mg/l	11	13	9	8	6	≤1.5 (mean) ≤ 2.6(95%ile)
Total Suspended Solids	mg/l	<10	12	13	11	11	-

Table 3.4.7 Summary of Surface Water Monitoring Results on 05thAugust 2014

3.4.10.3.1 Delvin River

The discussion below refers to samples SW1 – SW3 taken from the Delvin River as shown in Drawing 1 (Appendix 3.4.3). SW1 is an upstream sample, SW2 is downstream of the WWTP (Drawing 1 – Appendix 3.4.1) and SW3 is downstream of the site.

Ammoniacal Nitrogen as NH_4 & **Total Ammonia as N** showed slight increases in downstream samples compared to upstream samples. This could be attributed to natural fluctuations in concentrations. Concentrations are highest at SW2 which could be attributed to the outfall from the sewage plant.

The **pH levels** were below the limits outlined in the Surface Water Regulations 2010. The results ranged from 7.93 to 8.12 pH.

The **Suspended Solids** concentrations ranged between <10 mg/l upstream of the site to 13 mg/l downstream of the site. There are no limits for suspended solids.

Orthophosphate concentrations were above the Surface Water TV of 0.035mg/l P at all locations. Orthophosphate concentrations are higher downstream of the site.

The concentrations of **EPH (C8-C-40)** and **C8-C40 Mineral Oil** were below the detection limit of the laboratory at the surface water monitoring points (<10µg/l).

The **Sulphate (SO_4)** concentrations at SW1 and SW2 are similar (42.44 mg/l and 41.99 mg/l, respectively). The concentration at SW3 is significantly higher at 66.53 mg/l/.

The **Electrical Conductivity (EC)** values in the three samples taken on the 05th August 2014 ranged from 523 µS/cm (SW2) to 562 µS/cm (SW3).

The **BOD** concentrations in all samples were above the limits set out in the Surface Water Regulations. The BOD in the upstream sample at SW1 was 11 mg/l, 13 mg/l at SW2 (downstream of the WWTP) and 9 mg/l at SW3 (downstream of the application site).

The **Nitrate (NO_3)** concentrations at SW1 and SW3 are similar (9.3 mg/l & 9.39 mg/l respectively). The concentration at SW2 is significantly higher at 19.5 mg/l.

Summary - The elevated BOD in all samples may be attributable to the agricultural nature of the catchment area. The elevated Ammonia and Nitrate in SW2 may be attributable to the discharge of waste water from the WWTP. It should also be noted that heavy rainfall preceded the August sampling event, which may have resulted in organic matter being washed in from the land and farmyards upstream of the site. Orthophosphate appears to be elevated in the upstream sample, but there appears to be evidence of additional contributions from the site. This may be attributable to run-off from the agricultural activity on-site.

3.4.10.3.2 Tributary 1

The discussion below refers to samples SW4 and SW5 taken from Tributary 1 as shown in Drawing 1 (Appendix 3.4.3). SW4 is an upstream sample and SW5 is a downstream sample of the surface water discharge point.

Ammoniacal Nitrogen as NH_4 & Total Ammonia as N showed no significant increases in concentrations in downstream samples compared to upstream samples. The slight increase observed could be attributed to natural fluctuations in concentrations.

The concentrations of **Ortho-Phosphate** were all below the LOD of <0.06 mg/l. The LOD is higher than the Surface Water Regulations 2010, so a comparison was not possible.

The **pH** levels were below the limits outlined in the Surface Water Regulations 2010. The results ranged from 7.93 to 8.12 pH.

The **Suspended Solids** concentrations are the same at both locations at 11 mg/l. There are no legislative limits for suspended solids.

The **Petroleum Hydrocarbon and Mineral Oil** (Oil, Fat and Greases) concentrations in the upstream and downstream are below the laboratory LOD of 10 µg/l, which indicates that there has been no impact of hydrocarbon contamination from upstream or on-site activities.

The **Dissolved Sodium (Na)** concentration is 14.5 mg/l at SW4 and is 50.2 mg/l at SW5. The concentration at SW5 is significantly higher than recorded at SW4. There is no Surface Water Regulations limit for this parameter.

The **Sulphate** concentration is 34.03 mg/l at SW4 and 66.53 mg/l at SW5. There is no Surface Water Regulations limit for this parameter.

The **Chloride** concentration is 28.9 mg/l at SW4 and 79.3 mg/l at SW5. There is no Surface Water Regulations limit for this parameter.

The **BOD** concentrations in the upstream (SW4) and downstream (SW5) samples were both above the limits set out in the Surface Water Regulations. The BOD concentration in the downstream sample (SW5) is lower than the upstream sample SW4.

The **Electrical Conductivity (EC)** value is 514 µS/cm in SW4 and 714 µS/cm in SW5. This is to be expected due to the elevated Sodium and Chloride concentrations recorded at SW5.

Summary - The increases in Sodium, Sulphate, Chloride and EC between SW4 and SW5 may be attributable to surface run-off from the currently worked restoration area. The hydrochemical signature is indicative of agricultural run-off.

3.4.11 CONCEPTUAL MODEL OF THE AQUIFER

The current understanding of the hydrogeological setting is described below.

An estimated 394 mm/yr effective rainfall is available for recharge or runoff in the vicinity of the site. However, Pl Aquifers, such as the aquifer beneath the majority of the site, are not considered to be capable of accepting all the recharge that may be available due to the limited capacity of the bedrock to both store and transmit the infiltrated water. Therefore, a maximum 25% of effective rainfall is considered to contribute to groundwater recharge in the bedrock (100 mm/yr).

The majority of groundwater is considered to flow in the upper 10 m – 15 m of the weathered and fractured bedrock, with groundwater flow through occasional interconnected fractures or faults at depths below this.

The groundwater contour map indicates that the groundwater flow direction is to the southeast, where it discharges to the Delvin River as baseflow. Shallow groundwater upflow also discharges in the southern section of the quarry. The borehole logs (for GW3 and GW4) show that the new boreholes draw in groundwater from the upper weathered bedrock zone, and wherever water-bearing fractures are encountered, through to the final drilled depth of the boreholes.

The vulnerability of groundwater beneath the site is classified as High (H) to Extreme and the subsoil permeability is also mapped as High. However, most of the natural subsoil has been excavated at the site and replaced with soil and stone, and other types of imported inert C&D waste used for construction of haul roads.

Groundwater level surveys and measurements made on the two on-site boreholes indicate a groundwater hydraulic gradient of 0.03-0.05.

3.4.12 SITE WATER MANAGEMENT

The locations of the site water management components are presented in Appendix 3.4.2. The water supply for the site is pumped from GW1 and GW2. This supplies washwater, in addition to recirculated water from the lagoons, where it is utilised for the wheel wash and for the dust suppression sprinkler system. All wheel washwater either evaporates from the surface or is returned to the lagoon system. The lagoons also act as sumps where silt is collected and allowed to settle. Water from the lagoons is discharged to Tributary 1 through an underground piped system. Surface water run-off from the P1 area of the site is collected in an underground stormwater line which discharges to the Delvin River at three separate locations, as shown in *Drawing 1, Appendix 3.4.3*.

There is an existing septic tank system off site for the treatment of wastewater.

Water management within the site can be divided into the components summarised in Table 3.4.8 below.

Component	Description
Direct Input	*Effective Precipitation falling onto the site within the site boundary. *Pumped supply from site boreholes.
Partial	*Groundwater throughput beneath the site, partially intercepted on-site as groundwater upflow.
Uses	*Toilet and canteen facilities. *Dust suppression. *Operation of restoration of site.
Outputs	*Evaporation from lagoons, existing pit floor and restored areas. *Surface water discharge. *Drainage discharge to the natural hollow north of GW4. *Seepage to ground through existing pit floor, restored and unrestored areas of site. *Seepage through base and sides of site lagoons. *Discharge to ground via off-site septic tank and percolation area.

Table 3.4.8 Summary of Site Water Management Components

3.4.13 SURFACE WATER RUNOFF – TREATMENT AND DISCHARGE

The silt and water from the wheel washing process flows by gravity into the settlement lagoons to the north of the site. The silt settles as the water flows across from Lagoon 1 to Lagoon 2, from where it is discharged to Tributary 1.

Wash water lost during the wheel washing process, and surface run off in the existing pit area (P3) will either evaporate from the surface, percolate to ground or flow over ground to the silt lagoons.

Surface water drainage is discharged to the Delvin River at three locations, as shown in *Appendix 3.4.3*

An Emergency Response Procedure for hydrocarbon spills and appropriate training of site staff in its implementation, are in place.

3.4.14 RISK ASSESSMENT

3.4.14.1 INTRODUCTION

The concepts of Risk, Risk Assessment and Risk Management have become important tools in the area of environmental protection. The philosophical basis and language of risk is useful in that it provides a logical framework for considering the impact of potentially polluting activities on the environment.

This framework enables a more rigorous systematic approach to decision making. In reality it is putting a recognised framework to what is done intuitively, but by being systematic. In addition, it is an aid in conceptualising the potential impact of the discharge of effluent on the wider environment.

A **hazard** (**source**) presents a risk when it is likely to affect something of value (the **target/receptor**), which in this case is groundwater and/or surface water, which in turn may impact on humans. It is the probability of the hazard occurring and its consequences that is the basis of Risk Assessment.

The conventional Source-Pathway-Receptor model for environmental management can be applied to identify potential sources, receptors and pathways, and hence potential pollutant linkages relating to the site.

For a particular contaminant to present a risk to receptors, three components must be present:

Source	An entity or action that releases contaminants into the environment
Pathway	A mechanism by which receptors can become exposed to contaminants
Receptors	The human or ecological component at risk of experiencing an adverse response following exposure to a contaminant

The qualitative risk assessment presented in *Tables 3.4.7-9* below is based on the hydrogeological and hydrological information collected to date in relation to the site, and incorporated into previous sections of this report.

3.4.14.2 SOURCES

The potential sources of groundwater/surface water contamination that are associated with the existing site activities are presented in Table 3.4.9 below.

Contaminant	Associated Activities
Hydrocarbons Diesel Fuel Oils	Refuelling of machinery. Accidental spillages. Machinery maintenance/repair.
Silt	Arising from backfill material placed into the quarry. Surface water runoff.
Farmyard Run-off	Organic manure spreading. Artificial fertiliser.
Nearby Organic Waste Source	Organic manure.
Low permeability inert backfill material	Infilling former high permeability material with low permeability inert fill material could create a low permeability zone altering groundwater recharge. Reduction in recharge due to the potentially low permeability inert infill material.

Table 3.4.9 Potential Site Contamination Sources

3.4.14.3 PATHWAY

The pathways into the groundwater and surface water and the likelihood of the occurrence of potential groundwater contamination associated with a particular pathway, are presented in Table 3.4.10 below.

Pathway	Description
Infiltration through quarry floor	Infiltration of rainfall in quarry excavation area through subsoils. Infiltration of rainfall through backfilled area. Infiltrations of rainfall through underlying bedrock.
Surface water drainage	After surface water has passed through lagoons, surface water run-off from the site is discharged to *Tributary 1* via the surface water drain. Runoff from agricultural area to the south of the site through drains into the Delvin River. Runoff from compacted hardcore areas. Runoff from stockpiled topsoil material. Through backfilled material into sub surface drainage system. Runoff from current restoration area into Tributary 1.

Table 3.4.10 Possible Site Pathways

3.4.14.4 RECEPTORS

The potential receptors to contamination sources from the quarry are presented in Table 3.4.11 below.

Receptor	Description
Groundwater	Groundwater flow directly beneath the site. Site water supply from GW1 and GW2.
On-Site Groundwater Seepage/Upflow	Groundwater upflow/seepage.
Surface water	Surface water run-off is discharged to Tributary 1. Stormwater drains from the southern P1 area of the site into the Delvin River.

Table 3.4.11 Potential Receptors to Site Contaminants

3.4.14.5 SOURCE-PATHWAY-RECEPTOR MODEL

A summary of the Source-Pathway-Receptor model for the site, in the absence of mitigation measures in place, is presented in Table 3.4.12 below.

Source	Pathway	Receptor	Risk
Hydrocarbons Diesel Fuel Oils	Infiltration to ground.	Groundwater beneath site Groundwater Seepage/Upflow	High due to groundwater vulnerability.
	Direct pathway from base of recovery/restoration areas.		High during periods of seasonally high water table where mitigation measured not adhered to.
	Discharge to drainage network.	Delvin River	High where adequate preventative, maintenance and control measures are not in place.
		Tributary 1	High where mitigation measures not adhered to.

Source	**Pathway**	**Receptor**	**Risk**
Nitrates Faecal Coliforms Chloride etc.	Manure spreading - Infiltration to ground.	Groundwater beneath the site Groundwater Seepage/Upflow	High where manure application is excessive or applied at inappropriate times of the year.
	Surface water runoff from the site.	Surface waters	Moderate where manure application is excessive or applied at inappropriate times of the year.
Silt	Surface water runoff from the site.	Surface water	High where no silt settlement measures are in place.
	Infiltration to ground.	Groundwater beneath site	High where unsuitable (low permeability) backfill material is placed as part of restoration works.
Unsuitable low permeability inert backfill material	Restoration area.	Groundwater Recharge	High where unsuitable (low permeability) inert backfill material is placed at base of restoration area.

Table 3.4.12 Qualitative Risk Assessment

3.4.14.6 DO NOTHING SCENARIO

The “do nothing scenario” will involve the restoration works without any mitigation measures in place.

3.4.15 POTENTIAL IMPACTS

3.4.15.1 SURFACE WATER

The site drainage is shown in *Drawing 1, Appendix 3.4.3*. Surface water runoff from the existing pit area (P3) of the site currently discharges via two settlement lagoons to the tributary of the Delvin River that runs along the northern boundary of the site.

Regular removal of sediment build-up and periodic maintenance of the drainage system is required in order to ensure optimum treatment of runoff before discharge off-site.

A stormwater drainage line runs along the road in the restored area P1 and discharges to the natural hollow area beside GW4. This area was dry during the site visits and the outfall was not observed. The depth to this drain varies from 0.8 m to 1.4 m along its length. This drainage line delivers attenuated water to the natural hollow beside the Delvin River (*see Drawing 1, Appendix 3.4.3*).

The land drain south of the stormwater line discharges to the Delvin River at three locations as shown in *Drawing 1, Appendix 3.4.3.* This drain collects runoff from the restored sloping agricultural land in P1.

The impact of releasing non-attenuated suspended solids from surface run-off at the Clashford Facility development site has the potential to be a *negative short-term moderate to significant impact* on Tributary No 1 that drains the north of the site and the Delvin River that flows along the southern boundary of the site. Any drainage not captured in this system will infiltrate into the ground and recharge to the underlying aquifer.

The implementation of mitigation measures, specified in Section 3.4.16, will reduce the overall risk of surface water contamination in Tributary 1 and the Delvin River during operation of the quarry restoration works.

Where adequate mitigation measures are not implemented during the on-going restoration phase activities in P2, and future activities scheduled for P3, the drainage network within the site may serve as rapid flow paths for uncontrolled runoff in the direction of the River.

3.4.15.2 GROUNDWATER

The continued operation of the recovery facility has the potential to impact on groundwater in terms of both the groundwater quality and the groundwater flow regime. Based on results obtained from the four on-site boreholes, there is evidence of potential agricultural contamination of the downgradient boreholes.

The implementation of mitigations measures specified in Section 3.4.16 will reduce the overall risk of groundwater contamination beneath, and downgradient of, the quarry in addition to reducing the risk of altering the groundwater recharge beneath the site during the restoration works at the quarry.

3.4.16 MITIGATION MEASURES

3.4.16.1 OVERVIEW

In order to reduce the impact of the ongoing restoration works on groundwater and surface water receptors, the following are proposed details of measures/procedures to be implemented at the site in order to ensure that the source and/or the pathway is removed. In this way, the potential risk for groundwater/surface water contamination and groundwater flow regime alteration at the site is minimised.

Many of these recommendations are in accordance with the publication "*Environmental Management Guidelines – Environmental Management in the Extractive Industry (Non-scheduled Minerals)*" (EPA, 2006).

The most effective means by which to implement the proposed measures is to condition the mitigation measures as part of a permission for the waste licence at the site. The most effective mitigations measures for the site are:

- Adequate containment of site fuels and oils, to prevent any accidental spillages which may migrate to the subsoils and underlying groundwater;
- A double skinned mobile fuel bowser is used to refuel plant and machinery. Spill trays and spill kits should be provided at all times;
- Adequate drainage network for the interception and treatment of runoff prior to entry into surface water drains, i.e., a drainage network that is not overwhelmed by runoff;
- Strict control measures to ensure only suitable material is allowed onto the site, i.e., thorough inspection of waste loads entering the site to confirm inert nature prior to deposition on-site;
- Only granular wastes should be deposited into areas immediately above the groundwater table to prevent the influx of suspended solids into groundwater;
- A Drainage channel has been provided along the Northwestern boundary of the P2 restored area, to intercept any surface run-off and direct it into the settlement lagoons before discharge to Tributary 1. This drainage channel needs to be extended northwards as restoration of Phase 2 progresses.
- The specific mitigation measures could be included in an Environmental Management Plan as part of the conditions for the site waste licence.

3.4.16.2 SURFACE WATER

It is proposed that Tributary 1 and the Delvin River should be monitored frequently during the on-going site works in Phase 2 and future site works planned in Phase 3 to ensure that the water quality is not adversely affected by on-site activities.

Discharge monitoring will continue to be undertaken at the discharge monitoring point to Tributary 1 on a quarterly basis for the following parameters: BOD, COD, Suspended Solids, Total Petroleum Hydrocarbons and Fats, Oils and Grease in order to ensure that the quarry discharge is not impacting negatively on the Tributary 1 and the Delvin River.

The drainage channel provided along the northern extent of the restoration works in the P2 area needs to be extended northwards to ensure that Tributary 1 is protected from untreated surface water run-off during the backfilling of the restoration area. Surface water runoff from this area should be directed into the settlement lagoons before discharging to Tributary 1.

It is proposed to install perimeter drains around the restoration area to capture and divert runoff to the current closed system for treatment.

3.4.16.3 GROUNDWATER

It is proposed that on-going groundwater monitoring is conducted at GW3 and GW4 to confirm possible contamination in these boreholes.

Only suitably permeable and inert material should be used in the restoration, thereby reducing the potential to create a low permeability zone which could hinder local/ regional groundwater recharge and/or creating an impermeable barrier to groundwater recharge.

Slurry spreading and organic fertiliser spreading on-site should adhere strictly to the Good Agricultural Regulations S.I. No. 31 of 2014. Appropriate buffer zones should be maintained from all watercourses as stipulated in the Regulations when applying fertiliser and other chemicals to the land.

3.4.16.4 STOCKPILING AREA

High absorbency mats, pig tails and drums are to be added/ maintained in the stock-piling areas of the site and in quarry vehicles to clean up any leaks from plant or machinery.

3.4.16.5 MACHINERY MAINTENANCE AND REPAIR

No servicing or maintenance of any plant or machinery takes place within the restoration areas. All plant and machinery is driven or tracked to the hardstanding area associated with the site entrance and between the entrance and the wheel wash for service or maintenance works (Refer to EIS *Section* 3.4.16.6 below).

High absorbency mats are provided to contain any spills that may occur.

3.4.16.6 STORAGE OF FUEL/CHEMICALS

A double skinned mobile fuel bowser is used to refuel plant and machinery on site. This is due to the fact that the bunded fuel storage tank has been subject to burglary.

Hydrocarbon spill kits and drip trays will be maintained on site. The operator has in place an Emergency Response Procedure for hydrocarbon spills and appropriate training of site staff in its implementation. All waste oils are collected and removed off-site by an approved licensed waste collection contractor in the area.

High absorbency mats are provided to contain any spills that may occur.

3.4.16.7 RESTORATION AREA

The area that is to be restored as part of Phase 2 is located in the northern area of the site. The Phase 3 restoration area is the pit area in the southwestern area of the site. All material to be used for the restoration should be thoroughly inspected to ensure only suitably permeable, inert material is deposited.

3.4.16.8 WATER QUALITY MONITORING

It is proposed that groundwater monitoring be carried out biannually. This is recommended to ensure that the restoration of the site is not impacting on the groundwater beneath the site and to establish on-going trends in the groundwater monitoring boreholes.

3.4.17 CONCLUSIONS

The evidence to date indicates that the existing excavation and restoration area has not impacted significantly on surface water quality downstream of the site.

It appears that groundwater quality has been indirectly affected as a result of the restoration of the site to agricultural land. This may be as a result of the agricultural practices applied to the restored P1 area of the site. Modification of the current agricultural practices is expected to improve the groundwater quality.

Any potential and existing risks to groundwater and surface water from the on-going restoration works in this location will be minimised/ prevented through the adherence to the proposed mitigation measures detailed in Section 3.4.16.

3.4.18 REFERENCES

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3.4.19 APPENDICES

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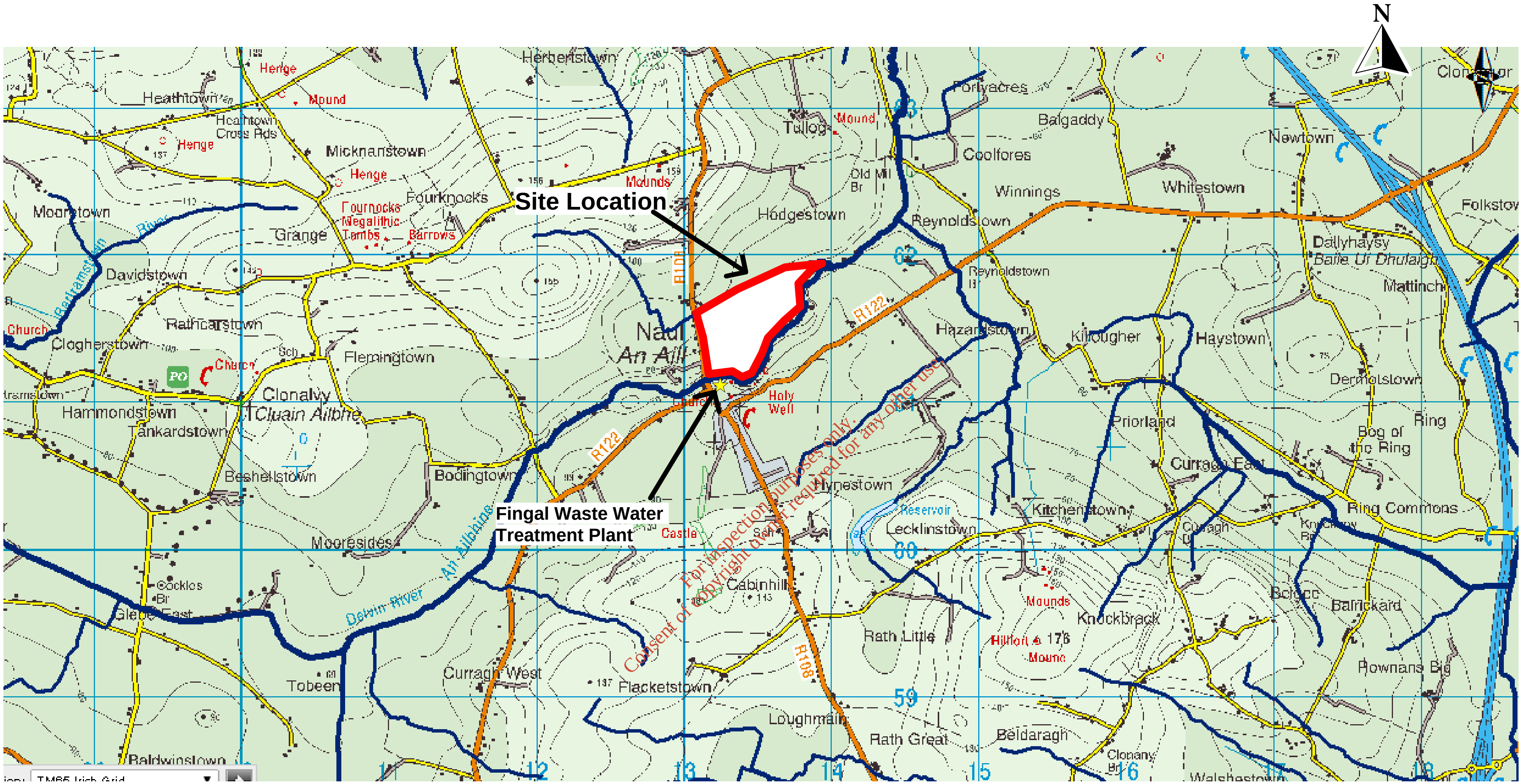
Appendix 3.4.1



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Project Title: Water Section - EIS

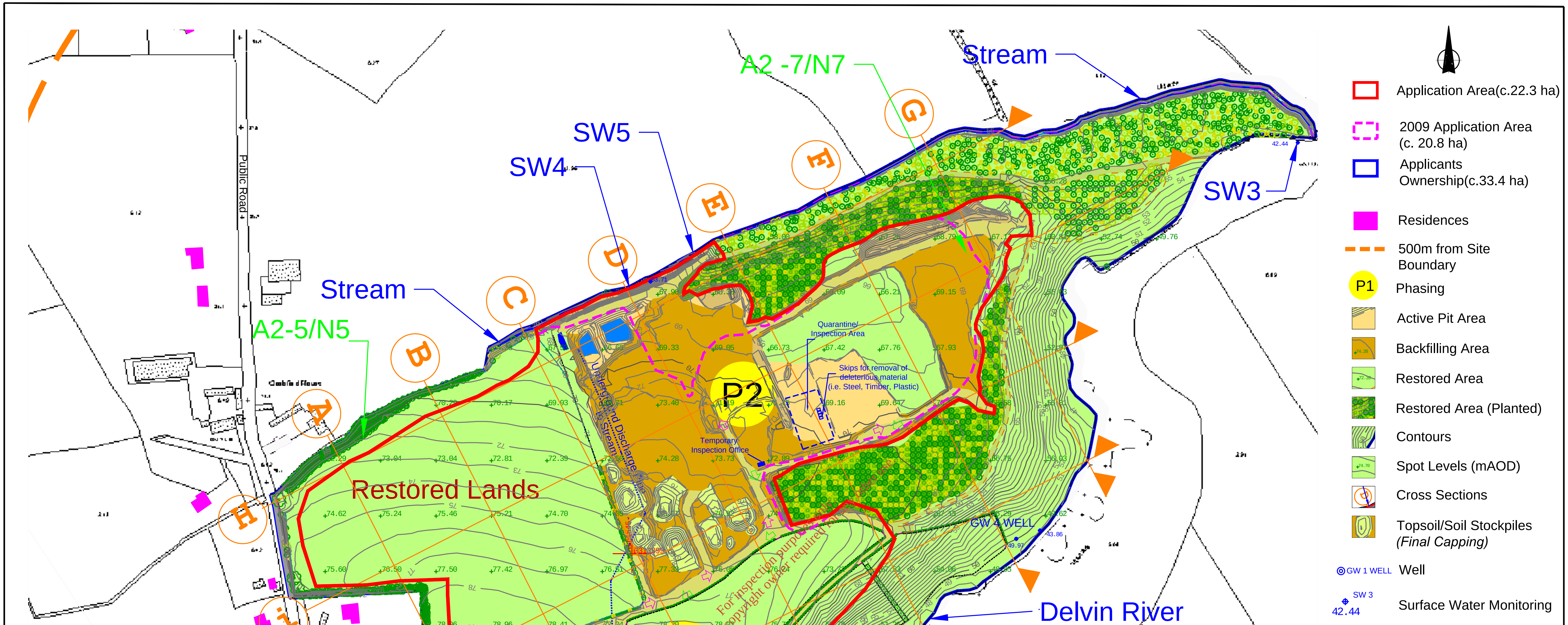
Project Address: Naul Townland, Naul, Co. Meath

Client: Clashford Recovery Facility Ltd.

Dwg. Title: Regional Location Map

Dwg. Scale:	Date:	Dwg. No.:	Job No.:	Revision:	Dwg. By:
NTS	02/07/2014	IE912-001	IE912	A	ÁMcE

Appendix 3.4.2



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OS Sheets 2649 - A & B, 2582 - C & D
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Scale 1:3500

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31 Athlumney Castle,
Navan, Co Meath
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Email: john.sheils@jspe.ie

JSPE
J SHEILS PLANNING & ENVIRONMENTAL LTD

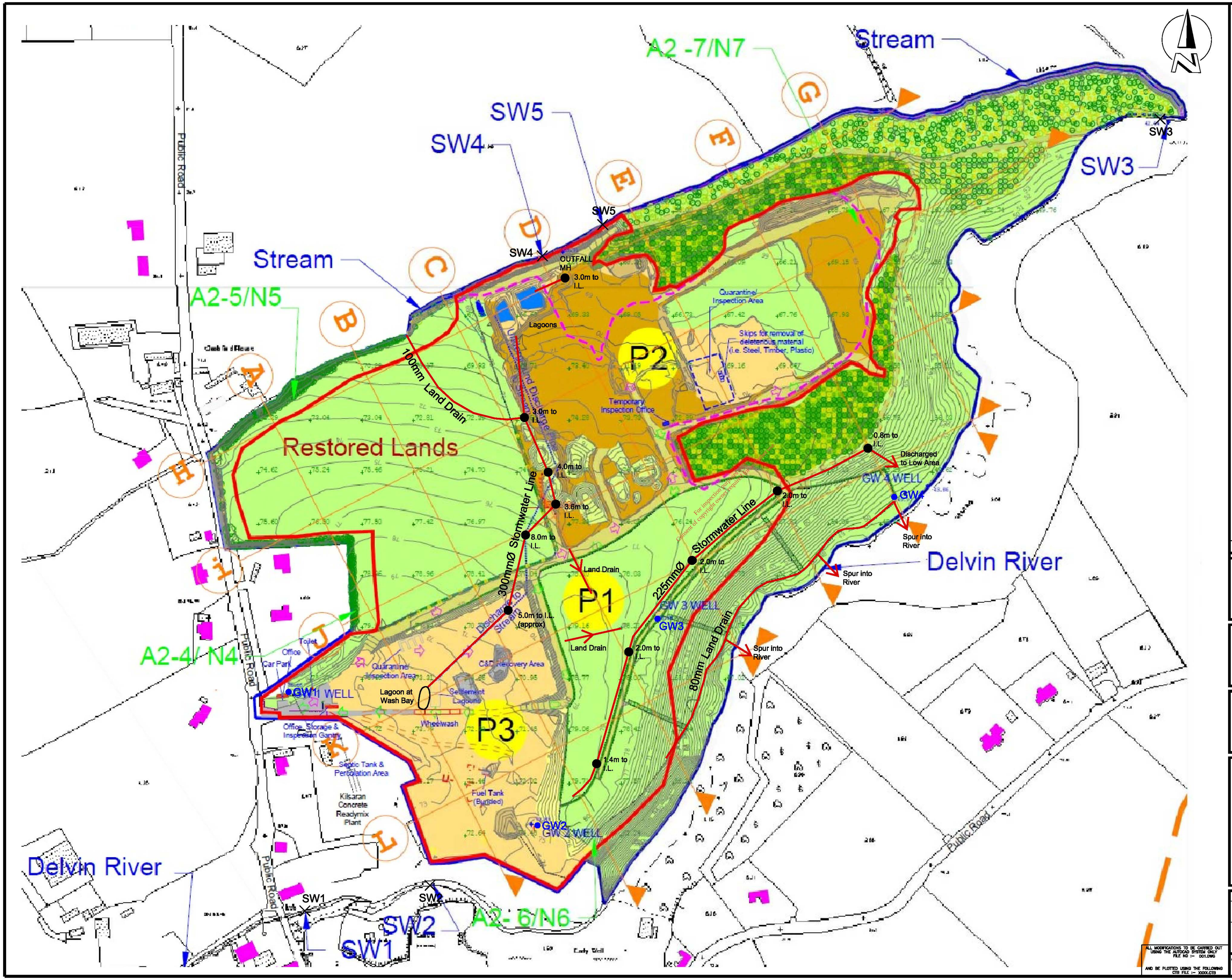
CLIENT **Clashford Recovery Facility Ltd**

DRAWING **SITE PLAN**

LOCATION **NAUL TOWNLAND**
Naul, Co. Meath.

Drawn by John Sheils	Scale 1 /3500	
Checked by John Sheils	Job No. JSPE 173	
Date 8/07/14	Figure No. B 2.1	Rev. A

Appendix 3.4.3



NOTES:–

1. DO NOT SCALE FROM THIS DRAWING. FOR INFORMATION ONLY

LEGEND

🟥	Application Area(c.22.3 ha)
▭	2009 Application Area (c. 20.8 ha)
🟦	Applicants Ownership(c.33.4 ha)
▨	Residences
- - -	500m from Site Boundary
P1	Phasing
▨	Active Pit Area
▨	Backfilling Area
▨	Restored Area
▨	Restored Area (Planted)
▨	Contours
▨	Spot Levels (mAOD)
▨	Cross Sections
▨	Topsoil/Soil Stockpiles *(Final Capping)*
◎ GW 1 WELL	Well
SW 3 ⌖ 42.44	Surface Water Monitoring

rev.	date	amendment	drn	ckd
C	03.10.14	SITE BOUNDARY AMMENDED	LM	PMS
B	26.09.14	SITE BOUNDARY AMMENDED	LM	PMS
A	05.08.14	ISSUED TO CLIENT	LM	PMS

CLASHFORD RECOVER FACILITY

HYDROGEOLOGICAL IMPACT ASSESSMENT
NAUL, CO. MEATH

SITE DRAINAGE MAP

ie
IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

INNOVATION CENTRE
GREEN ROAD
CARLOW

TELEPHONE: 059 91 33084
FAX: 059 91 40499
EMAIL: info@iece.ie

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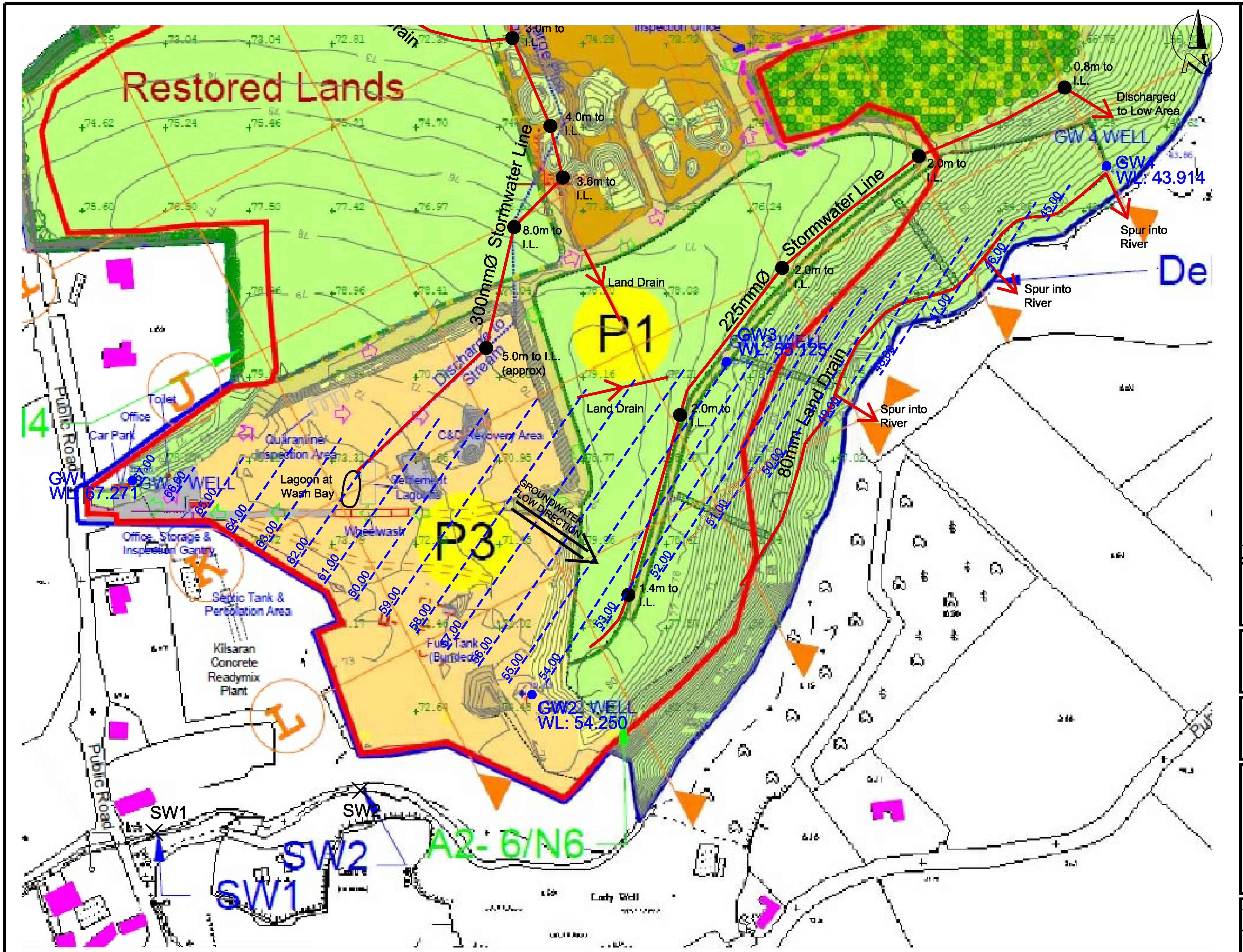

NOTES:-

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LEGEND

🟥	Application Area(c.22.3 ha)
▭	2009 Application Area (c. 20.8 ha)
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■	Residences
- - -	500m from Site Boundary
P1	Phasing
▨	Active Pit Area
▨	Backfilling Area
🟩	Restored Area
▨	Restored Area (Planted)
▨	Contours
▨	Spot Levels (mAOD)
⊕	Cross Sections
●	Manhole
▨	Topsoil/Soil Stockpiles *(Final Capping)*
◎ GW 1 WELL	Well
SW 3 ⊕ 42.44	Surface Water Monitoring

C	03.10.14	SITE BOUNDARY AMMENDED	LM	PMS
B	26.09.14	SITE BOUNDARY AMMENDED	LM	PMS
A	05.08.14	ISSUED TO CLIENT	LM	PMS
rev.	date	amendment	drn	ckd

CLASHFORD RECOVER FACILITY

HYDROGEOLOGICAL IMPACT ASSESSMENT
NAUL, CO. MEATH

GROUNDWATER CONTOUR MAP

ie
IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

INNOVATION CENTRE
GREEN ROAD
CARLOW

TELEPHONE: 059 91 33084
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		date: 27.08.14	

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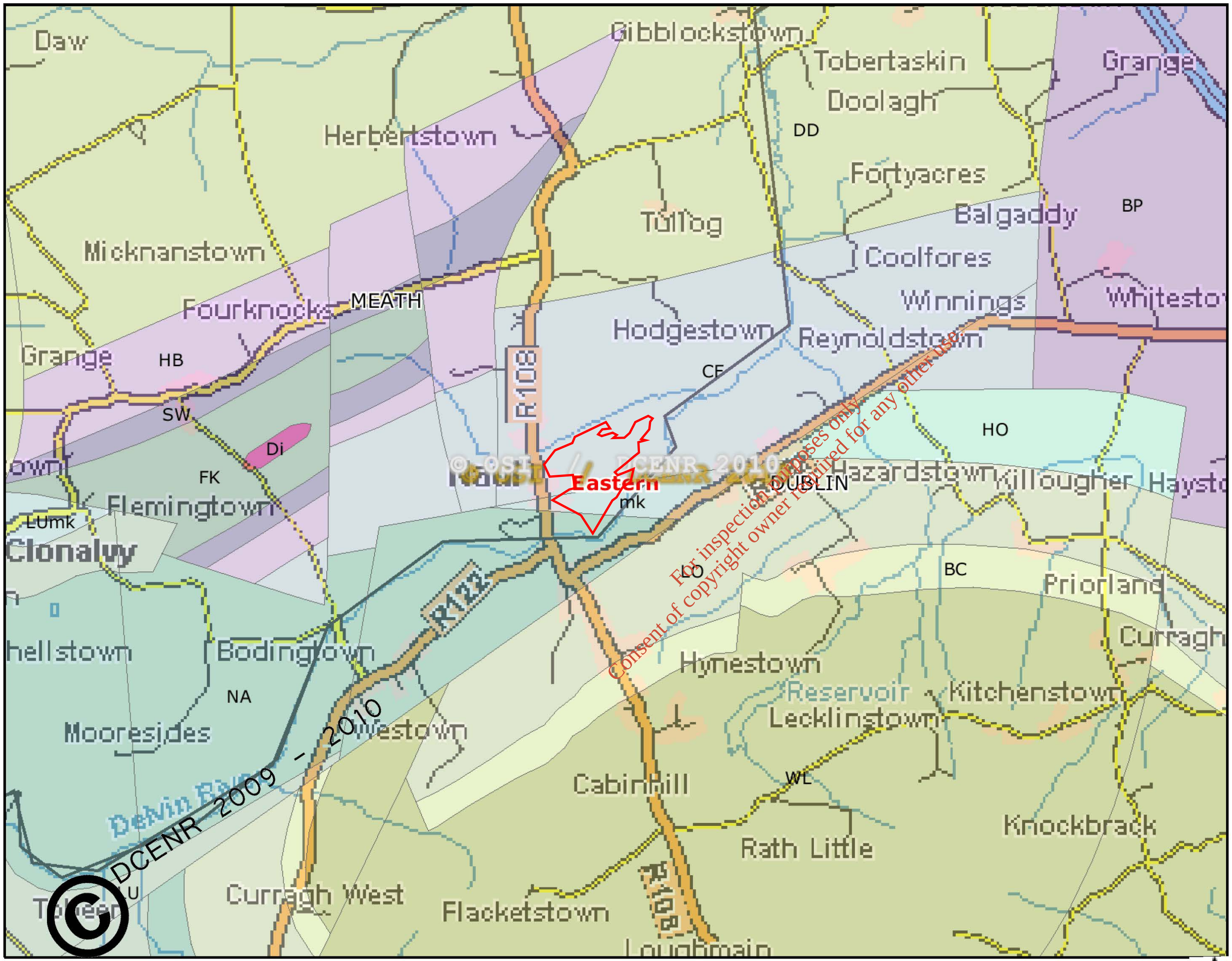
Appendix 3.4.4

Figure 1 100k Bedrock Geology



Legend

Bedrock 100k Solid Geology

- 🟦 AA - Aille and Barney Fms (undifferentiated)
- 🟩 AA - Allen Andesite Formation
- 🟩 AAwp - Westport Oolite
- 🟪 AB - South Achillbeg Formation
- ⬜ ABcg - Achillbeg Conglomerate Member
- ⬜ ABps - Achillbeg Lighthouse Psammite Member
- ⬜ ABsl - Achillbeg School Black Slate Member
- 🟪 AD - Aghaward Formation
- ⬜ AD - Ardagh Shale Formation
- 🟩 AD - Ardenagh Formation
- 🟦 AD - Ashleam Bridge Dolomitic Formation
- 🟩 AE - Aghamore Formation
- 🟫 AE - Ardane Formation
- 🟧 AG - Addergoole River Formation
- 🟪 AG - Aghfarrell Formation
- 🟦 AG - Aghmacart Formation
- 🟩 AGdh - Dowery Hill Member
- 🟦 AGdo - Aghmacart Formation
- 🟨 AH - Achill Head Formation
- 🟪 AH - Arklow Head Formation
- 🟨 AHfv - in Arklow Head Formation
- 🟦 AI - Aille Limestone Formation
- 🟪 AK - Askingarran Formation
- 🟦 AL - Altan Limestone Formation
- 🟪 AL - Annascaul Formation
- 🟦 AL - Argillaceous Limestones (Visean)
- 🟦 ALmk - in Argillaceous Limest (Visean)
- 🟨 AN - Anaffrin Formation
- 🟨 AN - Annabella Formation
- 🟧 ANgm - Glennamong Member
- 🟥 ANrd - Old Road Member
- ⬜ AP - Ards Pelite Formation
- 🟨 AP - Ashleam Head Formation
- 🟨 AQ - Ards Quartzite Formation
- 🟨 AQ - Ashleam Bridge Quartzite Formation
- ⬜ AQgr - Ashleam Bridge Graphitic Member
- 🟧 AR - Ardvarney Formation
- 🟧 AR - Ayle River Formation
- 🟦 ARM - Armagh Group
- ⬜ AS - Ardnasillagh Formation
- ⬜ AS - Ashleam Bay Formation

Scale: 1:35,094

Map center: 313532, 261456

N

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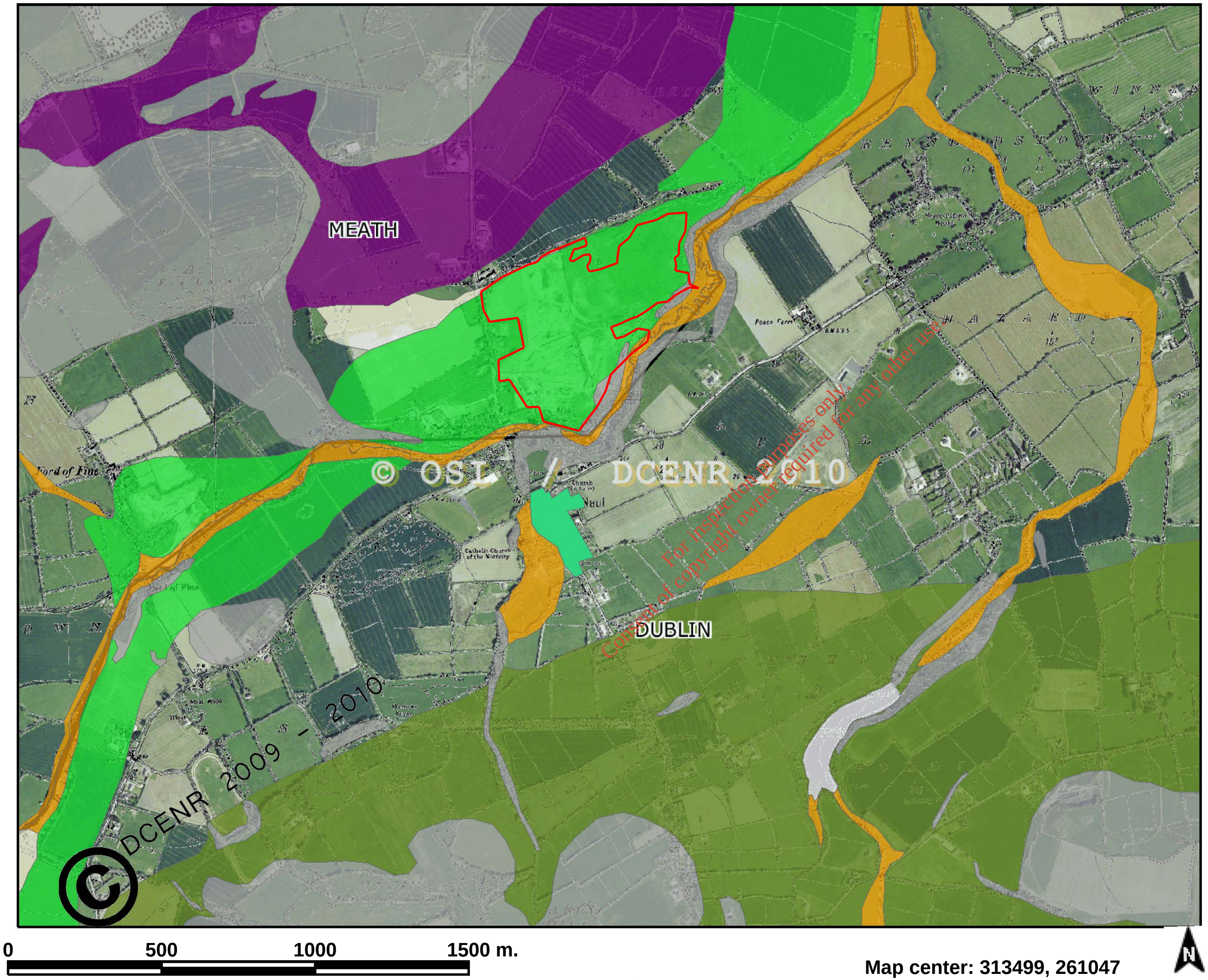
Snapshot Date: 18-Aug-2014

Figure 2 - Teagasc Subsoils Map



Map center: 313499, 261047

Legend

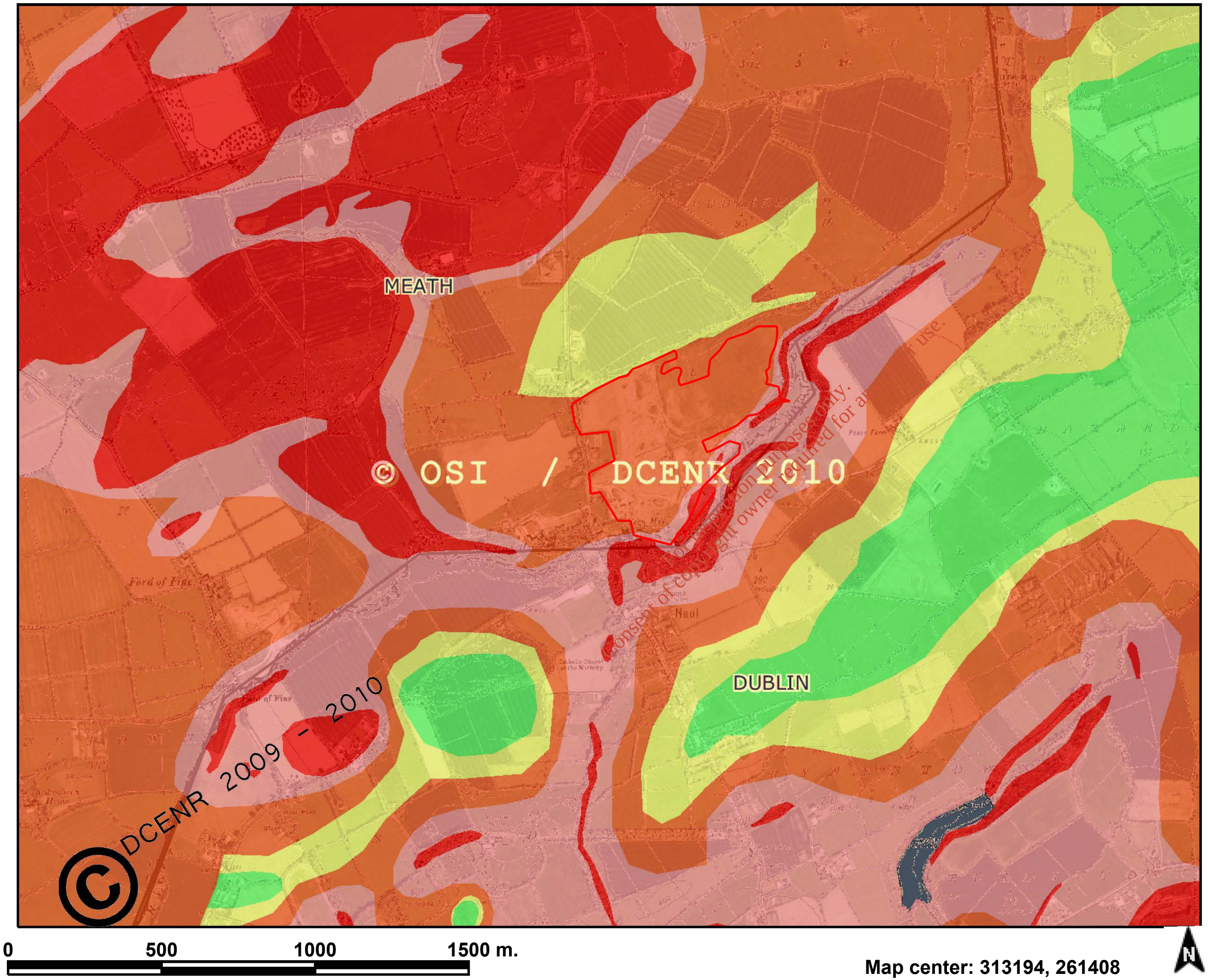
RBD Subsoils

- 🟧 Alluvium
- 🟨 Beach sands and gravels
- ⬜ Bedrock outcrop and subcrop
- 🟩 Esker sands and gravels
- 🟩 Glaciofluvial sands and gravels
- ⬜ Lake sediments
- ⬜ Made ground
- 🟦 Marine/estuarine silts and clays
- 🟩 Marsh
- 🟫 Peat
- ⬜ Scree
- 🟥 Till derived chiefly from Devonian sandstones
- 🟪 Till derived chiefly from Lower Palaeozoic rocks
- 🟩 Till derived chiefly from Namurian rocks
- 🟧 Till derived chiefly from granite
- 🟪 Till derived chiefly from limestone
- ⬜ Till derived chiefly from metamorphic rocks
- ⬜ Till derived from metamorphic rocks
- 🟪 Till derived from mixed Devonian and Carboniferous rocks
- ⬜ Water
- 🟨 Windblown sands
- ☐ County Boundaries
- Watermark

Scale: 1:20,000

Snapshot Date: 27-Jun-2014

Figure 3 - Groundwater Vulnerability



Map center: 313194, 261408

Legend

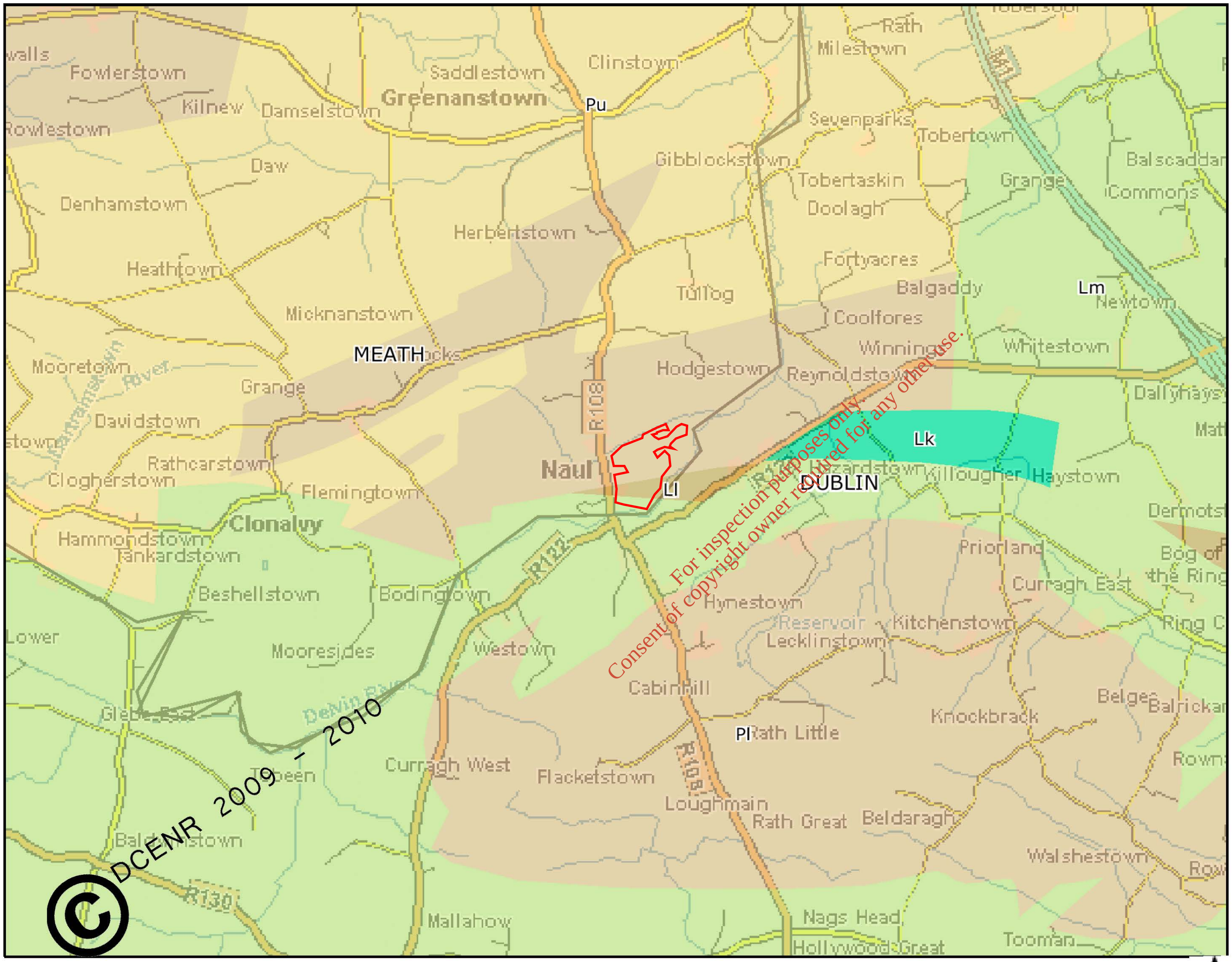
Vulnerability

- 🟥 X (Rock near Surface or Karst)
- 🟥 E - Extreme
- 🟧 H - High
- 🟨 M - Moderate
- 🟩 L - Low
- 🟦 Water
- ☐ County Boundaries
- Watermark

Scale: 1:20,000

Snapshot Date: 27-Jun-2014

Figure 4 - National Draft Aquifer Map



Legend

National Draft Bedrock Aquifer Map

- 🟩 Rf - Regionally Important Aquifer - Fissured bedrock
- 🟦 Rk - Regionally Important Aquifer - Karstified
- 🟩 Rkd - Regionally Important Aquifer - Karstified (diffuse)
- 🟦 Rkc - Regionally Important Aquifer - Karstified (conduit)
- 🟩 Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- 🟩 Lk - Locally Important Aquifer - Karstified
- 🟫 Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- 🟫 Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- 🟨 Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- ⬜ Unclassified
- ☐ County Boundaries

0 1250 2500 3750 m.

Map center: 313194, 261408

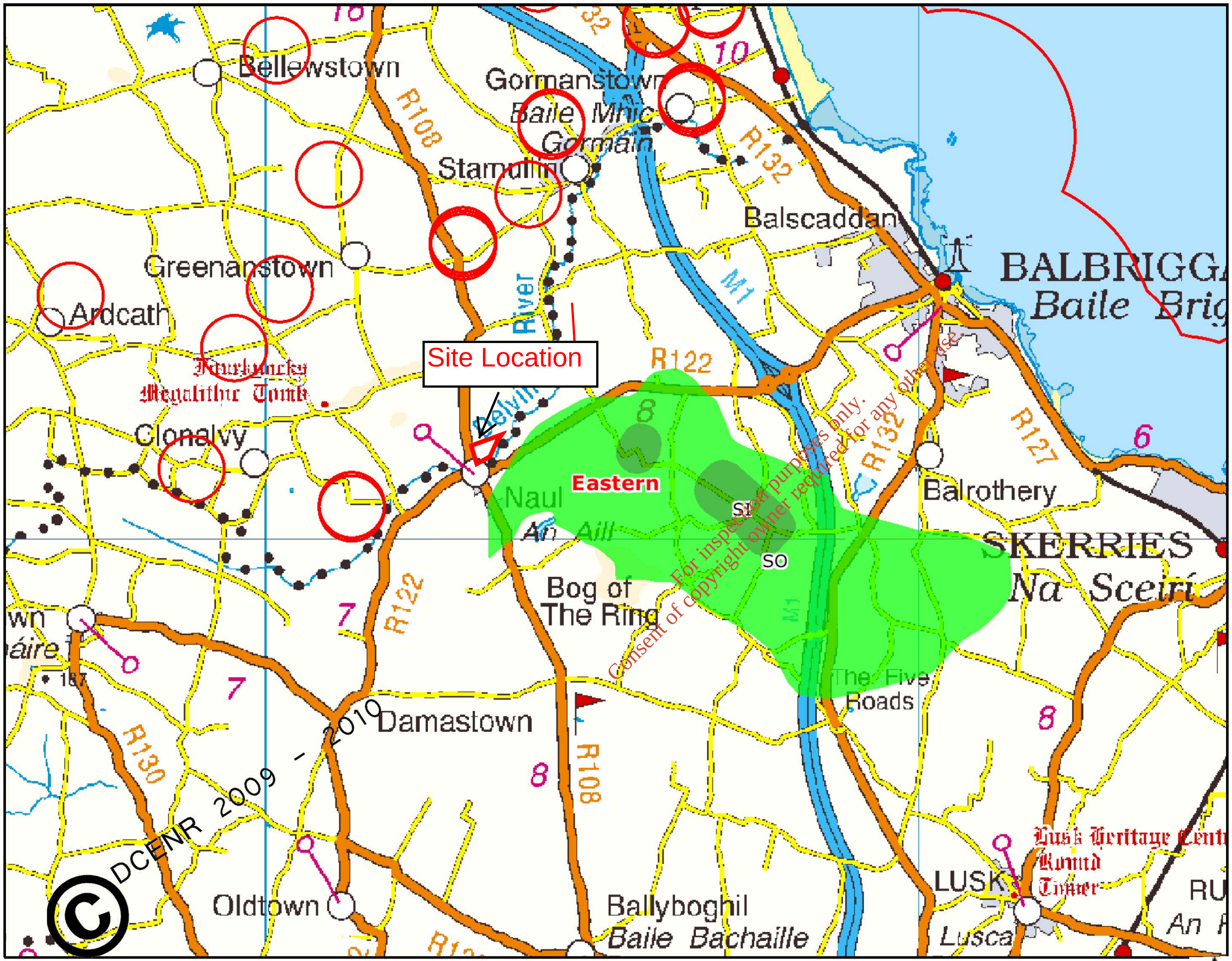
N

Scale: 1:50,000

This map and its data may not be used or reproduced for commercial purposes without the prior written permission of Ordnance Survey of Ireland. This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Snapshot Date: 27-Jun-2014

Figure 5 - Mapped Groundwater Abstractions



Legend

- 🟥 Wells Accuracy within 1km
- EPA Source Protection Area
- 🟩 SI - Inner Protection Area
- 🟩 SO - Outer Protection Area
- GSI Source Protection Area
- 🟩 SI - Inner Protection Area
- 🟩 SO - Outer Protection Area
- 🟥 RBD Boundaries

0 2.5 5 7.5 km.

Map center: 315390, 260871

Scale: 1:97,081

Snapshot Date: 23-Sep-2014

Appendix 3.4.5

IE CONSULTING

Innovation Centre,
Green Rd.,
Carlow.
Ph: 059-9133084
Fax: 059-9140499

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

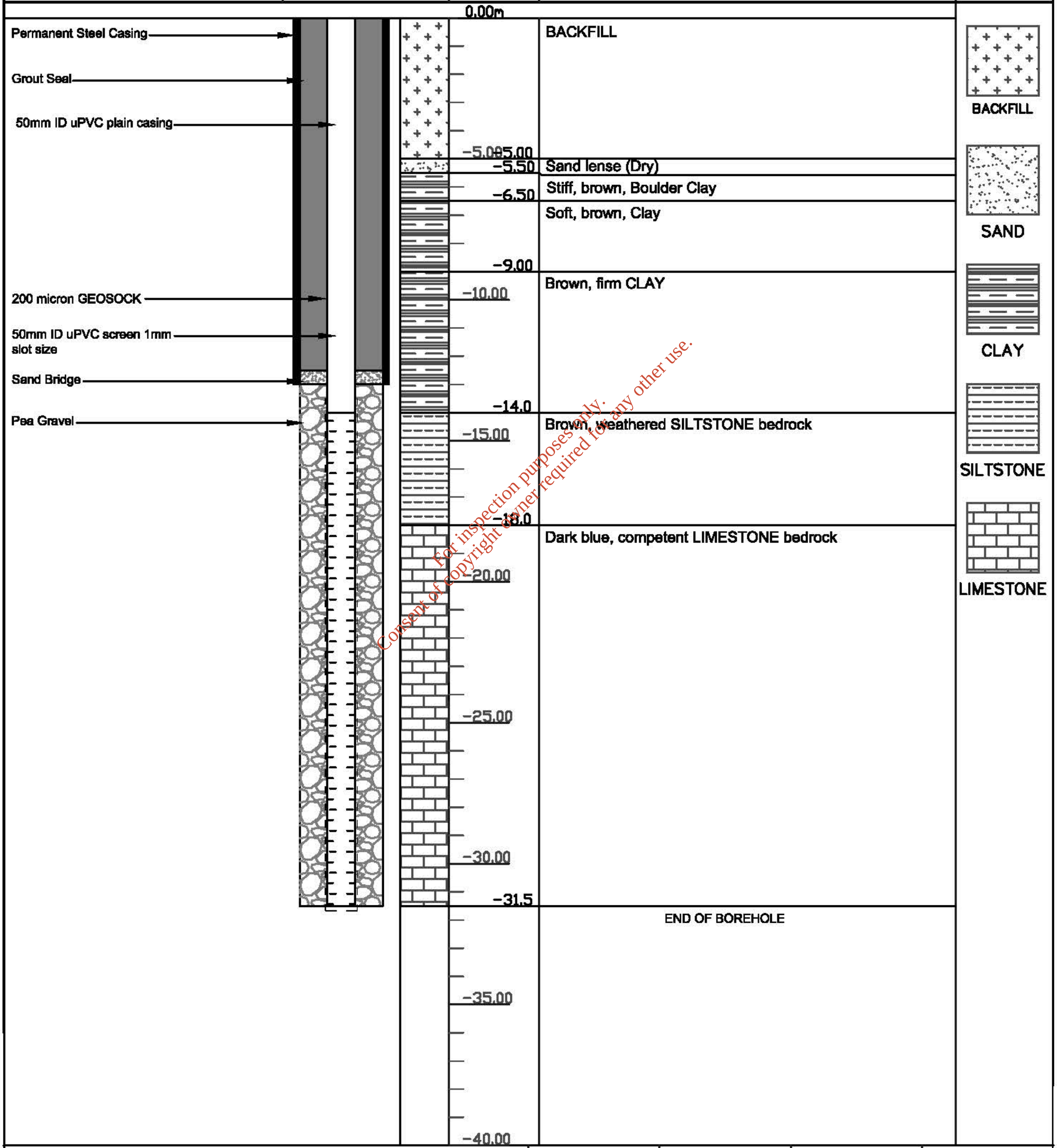
Borehole Log

GW3

Sheet 1 of 1

Method: Rotary	Date: 29/07/14	Site: Hydrogeological Assessment Naul, Co. Dublin	
Dia.mm: 100 OD	Coords: E313750:N261559	G.L.mO.D. 75.625mAOD	Client: John Sheils

Progress	Completion	Depth	Description of Strata	Legend



Depth	Description of Strata
0.00m	BACKFILL
-5.00	Sand lense (Dry)
-5.50	Stiff, brown, Boulder Clay
-6.50	Soft, brown, Clay
-9.00	Brown, firm CLAY
-14.0	Brown, weathered SILTSTONE bedrock
-18.0	Dark blue, competent LIMESTONE bedrock
-31.5	END OF BOREHOLE

Note/Remarks on Water Inflow:

- Permanent Steel Casing from 0.0m to 13.0m, 50mm ID uPVC plain casing from 0.0m to 10.0m, 50mm ID uPVC screen 1mm slot size from 14.0m to 31.5m below ground.
- 200 micron GEOSOCK from 13.5m to 31.5m below ground.
- Grout Seal from 0.0m to 12.5m, Sand Bridge from 12.5m to 13.0m, Pea Gravel from 13.0m to 31.5m.

Logged by:	Scale:	End Casing Depth:	Job No:
A.M.	1/200	31.5m	IE912

IE CONSULTING
WATER-ENVIRONMENTAL-CIVIL

IE CONSULTING

Innovation Centre,
Green Rd.,
Carlow.
Ph: 059-9133084
Fax: 059-9140499

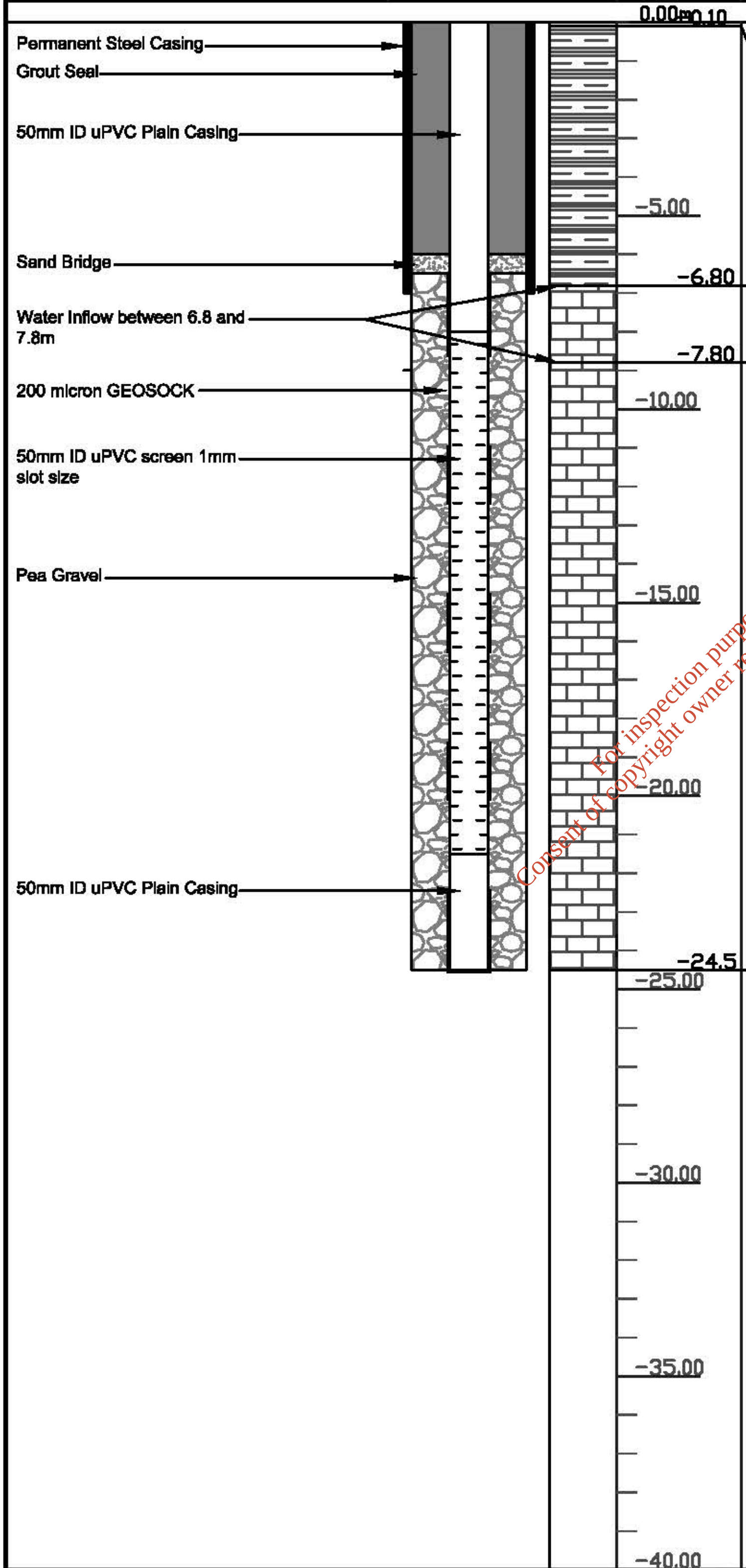
Borehole Log

GW4

Sheet 1 of 1

Method: Rotary	Date: 28/07/14	Site: Hydrogeological Assessment Naul, Co. Meath	
Dia.mm: 100 OD	Coords: E313506:N261440	G.L.mO.D. 49.334mAOD	Client: John Sheils

Progress	Completion	Depth	Description of Strata	Legend



Depth	Description of Strata
0.00 – 0.10	Topsoil
0.10 – -6.80	SILT/CLAY
-6.80 – -7.80	Dark blue/black fine grained weathered LIMESTONE bedrock
-7.80 – -24.5	Dark blue competent LIMESTONE bedrock
-24.5	END OF BOREHOLE

Note/Remarks on Water Inflow:

- Permanent Steel Casing from 0.0m to 7.0m,50mm ID uPVC plain casing from 0.0m to 7.0m, 50mm ID uPVC screen 1mm slot size from 7.0m to 21.5m, 50mm ID uPVC plain casing from 21.5m to 24.5m below ground.
- 200 micron GEOSOCK from 6.5m to 24.5m below ground.
- Grout Seal from 0.0m to 6.0m, Sand Bridge from 6.0m to 6.5m, Pea Gravel from 6.5m to 24.5m.
- Water Inflow between 6.8m to 7.8m below ground.

Logged by:	Scale:	End Casing Depth:	Job No:
A.M.	1/200	24.5m	IE912

Appendix 3.4.6

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

IE Consulting
Innovation Centre
Green Road
Carlow
Co. Carlow

UKAS TESTING 4225

Attention : Aine McElhinney

Date : 13th August, 2014

Your reference : IE912

Our reference : Test Report 14/8935 Batch 1

Location :

Date samples received : 7th August, 2014

Status : Final report

Issue : 1

Eight samples were received for analysis on 7th August, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Bruce Leslie
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Jones Environmental Laboratory

Client Name: IE Consulting
Reference: IE912
Location:
Contact: Aine McElhinney
JE Job No.: 14/8935

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40			LOD/LOR	Units	Method No.
Sample ID	LARRY KIERNAN IE912 GW1	LARRY KIERNAN IE912 GW2	LARRY KIERNAN IE912 GW4	LARRY KIERNAN IE912 SW1	LARRY KIERNAN IE912 SW2	LARRY KIERNAN IE912 SW3	LARRY KIERNAN IE912 SW4	LARRY KIERNAN IE912 SW5					
Depth													
COC No / misc													
Containers	H HN P G	H HN P G	H HN P G	H HN P BOD G	H HN P BOD G	H HN P BOD G	H HN P BOD G	H HN P BOD G					
Sample Date	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014					
Sample Type	Ground Water	Ground Water	Ground Water	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water					
Batch Number	1	1	1	1	1	1	1	1					
Date of Receipt	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014	07/08/2014					
Dissolved Calcium #	65.6	90.7	109.3	95.9	94.0	93.1	81.3	94.3			<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	116	28	154	77	81	72	39	21			<20	ug/l	TM30/PM14
Dissolved Magnesium #	13.1	22.9	19.5	6.7	6.6	6.5	7.7	8.6			<0.1	mg/l	TM30/PM14
Dissolved Manganese #	24	455	937	-	-	-	-	-			<2	ug/l	TM30/PM14
Dissolved Potassium #	2.1	1.9	75.2	6.2	6.5	6.2	3.6	4.6			<0.1	mg/l	TM30/PM14
Dissolved Sodium #	20.4	20.2	94.8	11.2	11.5	11.9	14.5	50.2			<0.1	mg/l	TM30/PM14
Total Phosphorus	22	34	54	222	178	165	93	67			<5	ug/l	TM30/PM14
EPH (C8-C40) #	<10	<10	<10	<10	<10	<10	<10	<10			<10	ug/l	TM5/PM30
C8-C40 Mineral Oil (Calculation)	<10	<10	<10	<10	<10	<10	<10	<10			<10	ug/l	TM5/PM30
Sulphate #	22.75	73.97	138.27	42.44	41.99	66.63	34.03	66.53			<0.05	mg/l	TM38/PM0
Chloride #	18.9	25.0	120.4	23.7	23.6	28.2	28.9	79.3			<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	0.6	0.7	0.4	9.3	19.5	9.9	18.9	18.4			<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02	<0.02	0.04	0.03	0.04	<0.02	<0.02			<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4 #	<0.06	<0.06	<0.06	0.35	0.37	0.42	<0.06	<0.06			<0.06	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4 #	<0.03	0.08	1.40	0.13	0.24	0.12	0.08	0.07			<0.03	mg/l	TM38/PM0
Total Ammonia as N #	<0.03	0.06	1.09	0.10	0.19	0.09	0.06	0.05			<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3 #	226	278	230	230	220	220	190	204			<1	mg/l	TM75/PM0
BOD (Settled) #	-	-	-	11	13	9	8	6			<1	mg/l	TM58/PM0
Electrical Conductivity @25C #	458	629	1140	532	523	562	514	714			<2	uS/cm	TM76/PM0
Faecal Coliforms*	0	0	20	-	-	-	-	-				CFU/100ml	Subcontracted
Free Ammonia as NH3	<0.07	<0.07	0.77	0.12	0.18	0.11	<0.07	<0.07			<0.07	mg/l	TM53/PM0
pH #	7.82	7.72	10.64	7.98	8.06	8.12	8.02	7.93			<0.01	pH units	TM73/PM0
Total Coliforms*	0	3	600	-	-	-	-	-				CFU/100ml	Subcontracted
Total Suspended Solids #	-	-	-	<10	12	13	11	11			<10	mg/l	TM37/PM0
Turbidity	0.3	0.3	0.5	-	-	-	-	-			<0.1	NTU	TM34/PM0

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Notification of Deviating Samples

Client Name: IE Consulting
Reference: IE912
Location:
Contact: Aine McElhinney

Matrix : Liquid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
14/8935	1					Samples were received at a temperature above 9°C.

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.

Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/8935

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
OC	Outside Calibration Range

JE Job No: 14/8935

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM5	In-House method based on USEPA 8015B. Determination of Extractable Petroleum Hydrocarbons (EPH) in the carbon chain length range of C8-40 by GC-FID. Accredited to ISO 17025 on soil and water samples and MCERTS (carbon banding only) on soils. All accreditation is matrix specific.	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM5	In-House method based on USEPA 8015B. Determination of Extractable Petroleum Hydrocarbons (EPH) in the carbon chain length range of C8-40 by GC-FID. Accredited to ISO 17025 on soil and water samples and MCERTS (carbon banding only) on soils. All accreditation is matrix specific.	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM37	Total Suspended Solids- gravimetric	PM0	No preparation is required.	Yes			
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM53	Ammonia by Colourimetric measurement	PM0	No preparation is required.				
TM58	In-house method based on USEPA 405.1 and BS 5667-3. Meausremnet of Biochemical Oxygen Demand by oxygen probe. ISO 17025 accredited. Accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM73	pH in by Metrohm	PM0	No preparation is required.	Yes			

JE Job No: 14/8935

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Air Dried (AD)	Reported on dry weight basis
TM75	Alkalinity by Metrohm	PM0	No preparation is required.	Yes			
TM76	Electrical Conductivity by Metrohm	PM0	No preparation is required.	Yes			
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

IE Consulting
Innovation Centre
Green Road
Carlow
Co. Carlow

Attention : Aine McElhinney

Date : 22nd August, 2014

Your reference : IE912

Our reference : Test Report 14/9172 Batch 1

Location : Naul

Date samples received : 14th August, 2014

Status : Final report

Issue : 1

One sample was received for analysis on 14th August, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Phil Sommerton BSc
Project Manager

Bob Millward BSc FRSC
Principal Chemist

Client Name:	IE Consulting	**Report :**	**Liquid**
Reference:	IE912		
Location:	Naul		
Contact:	Aine McElhinney	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	14/9172		$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

J E Sample No.	1-5												
Sample ID	GW3												
Depth													
COC No / misc													
Containers	H HN P G												
Sample Date	11/08/2014												
Sample Type	Ground Water												
Batch Number	1												
Date of Receipt	14/08/2014										LOD/LOR	Units	Method No.
Dissolved Calcium #	119.1										<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20										<20	ug/l	TM30/PM14
Dissolved Magnesium #	30.7										<0.1	mg/l	TM30/PM14
Dissolved Manganese #	104										<2	ug/l	TM30/PM14
Dissolved Potassium #	9.9										<0.1	mg/l	TM30/PM14
Dissolved Sodium #	26.6										<0.1	mg/l	TM30/PM14
Total Phosphorus	460										<5	ug/l	TM30/PM14
EPH (C8-C40) #	<10										<10	ug/l	TM5/PM30
C8-C40 Mineral Oil (Calculation)	<10										<10	ug/l	TM5/PM30
Sulphate #	90.82										<0.05	mg/l	TM38/PM0
Chloride #	110.1										<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	0.2										<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02										<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4 #	<0.06										<0.06	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4 #	<0.03										<0.03	mg/l	TM38/PM0
Total Ammonia as N #	<0.03										<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3 #	270										<1	mg/l	TM75/PM0
Electrical Conductivity @25C #	938										<2	uS/cm	TM76/PM0
Faecal Coliforms*	>100											CFU/100ml	Subcontracted
Free Ammonia as NH3	<0.07										<0.07	mg/l	TM53/PM0
pH #	7.62										<0.01	pH units	TM73/PM0
Total Coliforms*	>100											CFU/100ml	Subcontracted
Turbidity	0.5										<0.1	NTU	TM34/PM0

Please see attached notes for all abbreviations and acronyms

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Notification of Deviating Samples

Client Name: IE Consulting
Reference: IE912
Location: Naul
Contact: Aine McElhinney

Matrix : Liquid

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
14/9172						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/9172

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	UKAS accredited.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
OC	Outside Calibration Range

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

JE Job No: 14/9172

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM5	In-House method based on USEPA 8015B. Determination of Extractable Petroleum Hydrocarbons (EPH) in the carbon chain length range of C8-40 by GC-FID. Accredited to ISO 17025 on soil and water samples and MCERTS (carbon banding only) on soils. All accreditation is matrix specific.	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM5	In-House method based on USEPA 8015B. Determination of Extractable Petroleum Hydrocarbons (EPH) in the carbon chain length range of C8-40 by GC-FID. Accredited to ISO 17025 on soil and water samples and MCERTS (carbon banding only) on soils. All accreditation is matrix specific.	PM30	In-house method based on USEPA 3510. Liquid samples are mixed with solvent and agitated with an automatic magnetic stirrer with a stir bar for 15 minutes to extract organic molecules. ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific				
TM30	Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry) using Thermo iCAP 6000 series instrument. Accredited to ISO 17025 for soils and waters and MCERTS accredited for Soils. All accreditation is matrix specific.	PM14	In-house method based on USEPA 3005A. Acid digestion of water samples and analsyis by ICP-OES as per method TM030W.ISO 17025 accredited extraction method. All accreditation is matrix specific	Yes			
TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM53	Ammonia by Colourimetric measurement	PM0	No preparation is required.				
TM73	pH in by Metrohm	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.	Yes			
TM76	Electrical Conductivity by Metrohm	PM0	No preparation is required.	Yes			

JE Job No: 14/9172

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

IE Consulting
Innovation Centre
Green Road
Carlow
Co. Carlow

UKAS TESTING 4225

Attention :	Aine McElhinney
Date :	24th September, 2014
Your reference :	IE912
Our reference :	Test Report 14/10407 Batch 1
Location :	Naul
Date samples received :	12th September, 2014
Status :	Final report
Issue :	1

Two samples were received for analysis on 12th September, 2014. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

R Millward.

Bruce Leslie
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Client Name: IE Consulting
Reference: IE912
Location: Naul
Contact: Aine McElhinney
JE Job No.: 14/10407

Report : **Liquid**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-5	6-10											
Sample ID	GW3	GW4											
Depth													
COC No / misc													
Containers	H HN P G	H HN P G											
Sample Date	10/09/2014	10/09/2014											
Sample Type	Ground Water	Ground Water											
Batch Number	1	1											
Date of Receipt	12/09/2014	12/09/2014									LOD/LOR	Units	Method No.
Dissolved Calcium #	102.2	169.1									<0.2	mg/l	TM30/PM14
Total Dissolved Iron #	<20	1981									<20	ug/l	TM30/PM14
Dissolved Magnesium #	23.6	22.0									<0.1	mg/l	TM30/PM14
Dissolved Manganese #	50	2683									<2	ug/l	TM30/PM14
Dissolved Potassium #	7.5	5.2									<0.1	mg/l	TM30/PM14
Dissolved Sodium #	21.3	70.1									<0.1	mg/l	TM30/PM14
Total Phosphorus	315	97									<5	ug/l	TM30/PM14
EPH (C8-C40) #	<10	<10									<10	ug/l	TM5/PM30
C8-C40 Mineral Oil (Calculation)	<10	<10									<10	ug/l	TM5/PM30
Sulphate #	84.88	70.39									<0.05	mg/l	TM38/PM0
Chloride #	48.6	127.9									<0.3	mg/l	TM38/PM0
Nitrate as NO3 #	1.3	<0.2									<0.2	mg/l	TM38/PM0
Nitrite as NO2 #	<0.02	<0.02									<0.02	mg/l	TM38/PM0
Ortho Phosphate as PO4 #	<0.06	<0.06									<0.06	mg/l	TM38/PM0
Ammoniacal Nitrogen as NH4 #	<0.03	0.65									<0.03	mg/l	TM38/PM0
Total Ammonia as N #	<0.03	0.50									<0.03	mg/l	TM38/PM0
Total Alkalinity as CaCO3 #	280	398									<1	mg/l	TM75/PM0
Electrical Conductivity @25C #	755	1245									<2	uS/cm	TM76/PM0
Faecal Coliforms*	10	30										CFU/100ml	Subcontracted
Free Ammonia as NH3	<0.07	0.60									<0.07	mg/l	TM53/PM0
pH #	7.70	7.46									<0.01	pH units	TM73/PM0
Total Coliforms*	40	97										CFU/100ml	Subcontracted
Turbidity	0.9	1.1									<0.1	NTU	TM34/PM0

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Client Name: IE Consulting
Reference: IE912
Location: Naul
Contact: Aine McElhinney

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason

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NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 14/10407

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JE Job No: 14/10407

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
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TM34	Turbidity by Turbidimeter	PM0	No preparation is required.				
TM38	Ionic analysis using the Thermo Aquakem Photometric Automatic Analyser. Accredited to ISO17025 and MCERTS for most analytes. All accreditation is matrix specific.	PM0	No preparation is required.	Yes			
TM53	Ammonia by Colourimetric measurement	PM0	No preparation is required.				
TM73	pH in by Metrohm	PM0	No preparation is required.	Yes			
TM75	Alkalinity by Metrohm	PM0	No preparation is required.	Yes			
TM76	Electrical Conductivity by Metrohm	PM0	No preparation is required.	Yes			

JE Job No: 14/10407

Test Method No.	Description	Prep Method No. (if appropriate)	Description	UKAS	MCERTS (soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
Subcontracted	Subcontracted analysis, sent to an ISO 17025 accredited laboratory where possible.						