Appendix F

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PROPOSED DIMENSIONAL STONE QUARRY AT BANNAGAGOLE, OLD LEIGHLIN, CO. CARLOW

STAGE I - FLOOD RISK ASSESSMENT

FINAL REPORT

Prepared for:
MILFORD QUARRIES LIMITED

Prepared by:
Hydro-Environmental Services

DOCUMENT INFORMATION

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1. INTRODUCTION

1.1 BACKGROUND

Hydro-Environmental Services (HES) were requested by Milford Quarries Limited to undertake a site specific, Stage I Flood Risk Assessment (FRA) for a proposed dimensional stone quarry at Bannagagole, Old Leighlin, Co. Carlow.

This FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009).

1.2 STATEMENT OF EXPERIENCE

Hydro-Environmental Services ("HES") are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core area of expertise and experience is hydrology and hydrogeology, including flooding assessment and surface water modelling. We routinely work on surface water monitoring and modelling and prepare flood risk assessment reports.

This report was prepared by Michael Gill and Conor McGettigan.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with 22 years ofenvironmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological assessments for various developments across Ireland. Michael has significant experience in surface water drainage issues, SUDs design, and flood risk assessment.

Conor McGettigan (BSc, MSc) is an Environmetal Scientist with 3 years experience in the environmental consultancy sector in Ireland. Conor holds an MSc in Applied Environmental Science and a BSc in Geology. Conor has completed flood risk assessments for numerous proposed wind farm and quarry developments in Ireland.

1.3 REPORT LAYOUT & METHODOLOGY

This Stage I FRA report has the following format:

- Section 2 describes the proposed site setting and details of the proposed development;
- Section 3 outlines the hydrological and geological characteristics of the local surface water catchments in the vicinity of the proposed development site;
- Section 4 deals with a site-specific flood risk assessment (FRA); and,
- Section 5 presents the FRA report conclusions.

As stated above this FRA is carried out in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' (DoEHLG, 2009). The assessment methodology involves researching and collating flood related information from the following data sources and field surveys:

- Base maps – Ordnance Survey of Ireland;
- OPW Flood Hazard Maps and flooding information for Ireland (www.floodmaps.ie);
- Geological Survey of Ireland databases (www.gsi.ie);

- EPA hydrology maps (www.catchment.ie); and,
- Site Walkover, drainage mapping and flow monitoring.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

This section provides details on the topographical setting of the Proposed Development site along with a description of the proposed development.

2.2 SITE LOCATION AND TOPOGRAPHY

The proposed development site at Bannagagole, Old Leighlin Co. Carlow (the 'site'), occupies a total area of ~9.34hectares (ha) and forms part of the applicant's wider landholding of ~26ha. The site is located ~1.5km south of the village of Old Leighlin, ~5km southwest of Leighlinbridge and immediately south of the existing Old Leighlin Quarry. A site location map is included as **Figure A**.

The M9 motorway is located to the east of the site with the closest access point being located ~7km to the south at Junction 7. Junction 6 of the M9 motorway at Powerstown is located ~10km to the northeast.

The lands surrounding the site are largely agricultural in nature with several one-off houses located within a 1km radius. There is an equestrian centre located ~2km to the east. The site lies immediately to the south of an existing limestone bedrock quarry at Bannagagole (Old Leighlin Quarry) which is operated by Kilkenny Limestone Quarries Ltd. Rock extraction, processing, and surplus rock storage is carried out at that site.

The River Barrow is located ~4km to the east of the site while the Madlin River, a tributary of the Barrow runs in a west to east direction ~1.5km north of the site.

The site is located to the east of the Castlecomer Plateau, with ground elevations within the site sloping to the east. Natural ground levels within the site range from ~75mOD in the east, adjacent a local road (L3036), to a high of ~130mOD in the west. Topography to the west of the site rises steeply.

The site is accessed from the L3036 which connects to the village of Old Leighlin to the north and the R448 to the east. A small laneway extends westwards into the site from this local road. This laneway connects the road with a derelict farmhouse and associated farm outbuildings (5 no.) which are located within the site.

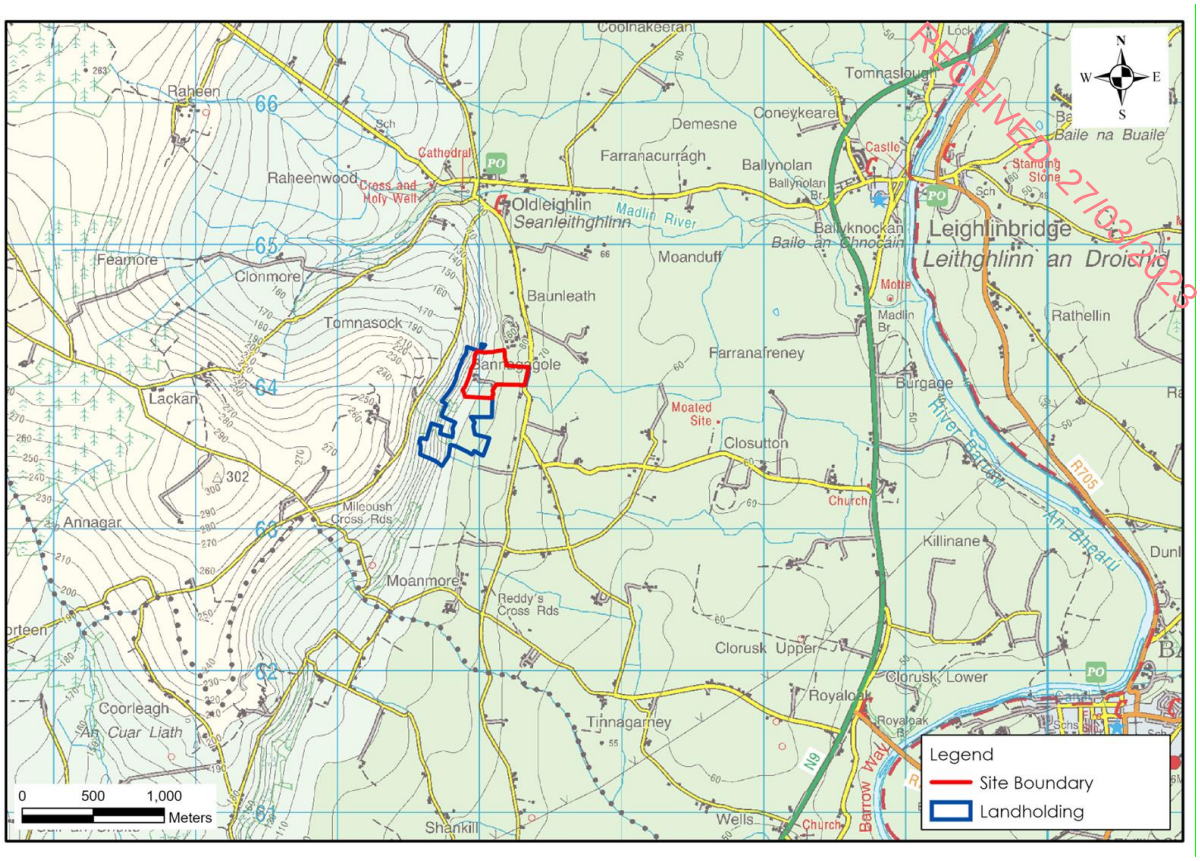

Figure A: Site Location Map

2.3 PROPOSED DEVELOPMENT DETAILS

The proposed development comprises the development of a bedrock quarry. Extraction is proposed over a total area of 2.44ha and will involve the extraction of ~84,000tonnes (30,000m^3) of material annually from the site. The proposed quarry void will be extracted to a depth of 2 no. benches of ~10m each from the top of the bedrock, with a final floor level of ~56.5mOD.

Extraction will be preceded by site preparation which will involve stripping soils and subsoils from the proposed extraction area. The volume of overburden to be removed is estimated to be ~122,345m^3. The stripped overburden will be utilised in the construction of berms surrounding the extraction area while it is proposed to store the remainder in a soil storage area (~3.1ha) which will have an average fill depth of ~4m.

Site investigations have revealed that the usable dimension limestone at the site is at a depth of ~10m and a layer of unusable stone will require extraction prior to reaching the quality limestone bedrock. The proposed development includes a working area (~1.2ha) to the south of the extraction area which will provide for the crushing and processing of the unusable stone and storage of the dimension stone. The working area will also include parking, a staff canteen, a weighbridge and a stockpile area.

Once the quality dimension stone is exposed in the extraction area, the stone will be cut into blocks using a diamond tipped chain or diamond wire saws. The blocks of dimension stone will be lifted by an excavator and immediately transported offsite for processing elsewhere.

Access to the site will be facilitated by a HGV site entrance from the local road to the east of the site.

The proposed development will also include a wheel wash facility, storage shed (240m^3), the installation of surface water attenuation and settlement ponds on the quarry floor and all other associated siteworks including the final quarry restoration.

Drainage controls within the proposed development will include the following:

- A series of land drains are proposed below the soil storage area, and these drain to an open drain on the eastern edge of the soil storage area. Any drainage water and runoff arising from this area will be directed into the quarry void, and managed via the quarry water management system.
- The setdown area will have a hardcore surface. Part of the setdown area also drains into the quarry void. The southern half of the setdown has bounding collection drains, and these will be filled with drainage stone (i.e. french drains), and any excess surface water arising from these French drains will discharge to ground via a proposed soakaway.
- Within the quarry void surface water and groundwater will be collected and pumped from temporary sumps to the main settlement pond. Water within the settlement pond will drain via gravity and flow through a hydrocarbon interceptor and then discharge to a drain at the northeastern corner of the proposed site. The drain flows via a culvert under the L3036 towards the Baunleath Stream which in turn flows into the Madlin River further downstream. A discharge licence will be required for this proposed discharge.
- Drainage water from the main site access road will be collected in a roadside filter drain. Excess water from the filter drain will flow through a hydrocarbon interceptor and recharge to groundwater in a soakaway at the southeast of the site.
- Aco drains are proposed across the site entrance. The Aco drain closest to the entrance gate will drain into the filter drain/hydrocarbon interceptor/soakaway arrangement outlined in the previous paragraph. The second Aco drain prevents runoff from the site entrance area onto the public road. This Aco drain direct water to the south into a french drain/linear soakaway located inside the site boundary.
- Wastewater/greywater arising at the welfare units (during the construction and operational phases) will be collected and stored in a sealed tank, and this tank will be emptied by vacuum tanker and the contents transferred to a suitably licenced wastewater facility for treatment and disposal.

3. EXISTING ENVIRONMENT AND CATCHMENT CHARACTERISTICS

3.1 INTRODUCTION

This section gives an overview of the hydrological and geological characteristics in the area of the proposed quarry.

3.2 BASELINE HYDROLOGY

3.2.1 Regional and Local Hydrology

The site is located within the Barrow River surface water catchment and Hydrometric Area 14 of the South Eastern River Basin District. This catchment includes the area drained by the River Barrow upstream of the River Nore confluence and all streams entering tidal water between the Barrow railway bridge at Great Island and Ringwood, Co. Kilkenny, draining a total area of 3,025km². The Barrow catchment comprises 20 sub-catchments.

On a more local scale the site is located in the Barrow_110 sub-catchment (Barrow_SC_110) and the Old Leighlin Stream_020 river sub-basin. Further to the south, the southern section of the overall landholding is located in the Barrow_190 river sub-basin.

Within the Old Leighlin Stream_020 river sub-basin, the Baunleath stream (EPA Code: 14B95) originates to the southeast of the site along the L3036. This stream flows to the east before veering northwards and discharging into the Old Leighlin stream (EPA Code: 14O02) (also known as the Madlin River) ~2km northeast of the site. The Old Leighlin stream then flows to the southeast, discharging into the Barrow River (EPA Code: 14B01) to the south of Leighlinbridge.

Site walkover surveys have also revealed the presence of a second drain and culvert which enters a small ditch and flows eastwards along a hedgerow northeast of the northern corner of the proposed site. This drainage pathway cross the L3036 via a culvert and flows to the east before discharging into the Baunleath stream.

Within the Barrow_190 river sub-basin, the Burgage stream (EPA Code: 14B96) flows eastwards to the south of the overall landholding and discharges into the Barrow River ~3.5km east of the site.

A local hydrology map is shown as **Figure B** below.

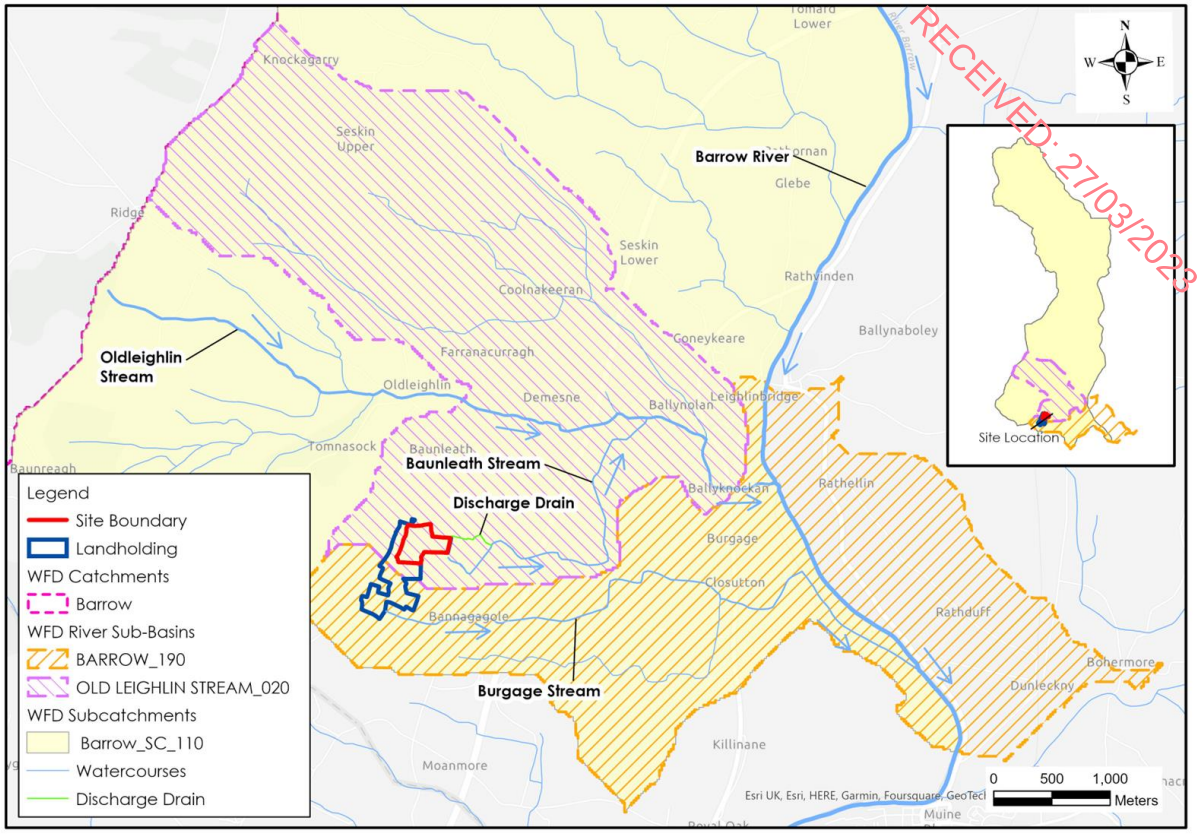

Figure B: Local Hydrology Map

3.2.2 Rainfall and Evaporation

The SAAR (Standard Average Annual Rainfall) recorded at Paulstown Castle, located ~6km southeast of the site is 818.9mm (www.met.ie).

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, approximately 17.5km southwest of the site. The long-term average PE for this station is 458.8mm/yr. This value is used as the best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 435.9mm/yr (which is 0.95 × PE). Therefore the effective rainfall at the site is estimated to be 383mm/yr.

In addition to average rainfall data, extreme value rainfall depths are available from Met Eireann. Error! Reference source not found. below presents return period rainfall depths for the area of the proposed quarry site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 5-year, 30-year, 100-year).

Table A: Bannagagole - Return Period Rainfall Depths (mm)

	Return Period (Years)			
Duration	**1**	**5**	**30**	**100**
5 mins	3.4	5.6	9.3	12.6
15 mins	5.6	9.2	15.2	20.7
30 mins	7.3	11.7	19.0	25.6
1 hours	9.6	15.0	23.8	31.6
6 hours	19.0	28.3	42.5	54.8
12 hours	24.8	36.2	53.3	67.7
24 hours	32.4	46.3	66.7	83.7
2 days	39.1	54.6	76.9	95.1

3.3 GEOLOGY

The EPA soils map for the local area (www.epa.ie) shows that the soils overlying are site are predominantly acid poorly drained mineral soils (AminPD). The EPA map some acid deep well drained mineral soil (AminDW) and basic shallow well drained mineral soils (BminSW) in the west of the site.

The GSI subsoil map for the local area (www.gsi.ie) shows that the site is predominantly underlain by till derived from Namurian sandstones and shales (TNSSs). A small area bedrock outcrop or subcrop (Rck) is located on the higher ground in the northwest of the site. The GSI also map a small area of till derived from limestones (TLs) in the east of the site, adjacent the L3036. A local subsoils map is included as **Figure C**.

Intrusive site investigations have shown the subsoils at the site to comprise of Boulder Clay consisting of stiff, brown gravelly silty CLAY with angular and subangular gravels and cobbles of siltstone and mudstone. Subsoil thickness at the site range from 4.1 to 15.7m (refer to EIAR Chapter 7 for details).

The bedrock geology map for the local area (www.gsi.ie) shows that the site is underlain by 2 no. bedrock geological formations.

A small area in the east of the site, adjacent the L3036, is underlain by the Ballyadams Formation. The Ballyadams Formation comprises of medium to dark-grey thick-bedded to massive crinoidal calcarenite wackestones and packstones. Meanwhile, the remainder of the site is underlain by the Clongrenan Formation. The GSI state that this formation is characterised by typically medium-coarse grained thick limestones beds with variable presence of shales.

Intrusive site investigations have revealed that the bedrock underlying the site is comprised of dark blue laminated and fossiliferous limestone which has been heavily dolomitised in places. Based on site-specific data the depth to bedrock at the site ranges from 4.1 to 15.7m with an average depth to rock of 9.2m (refer to EIAR Chapter 7).

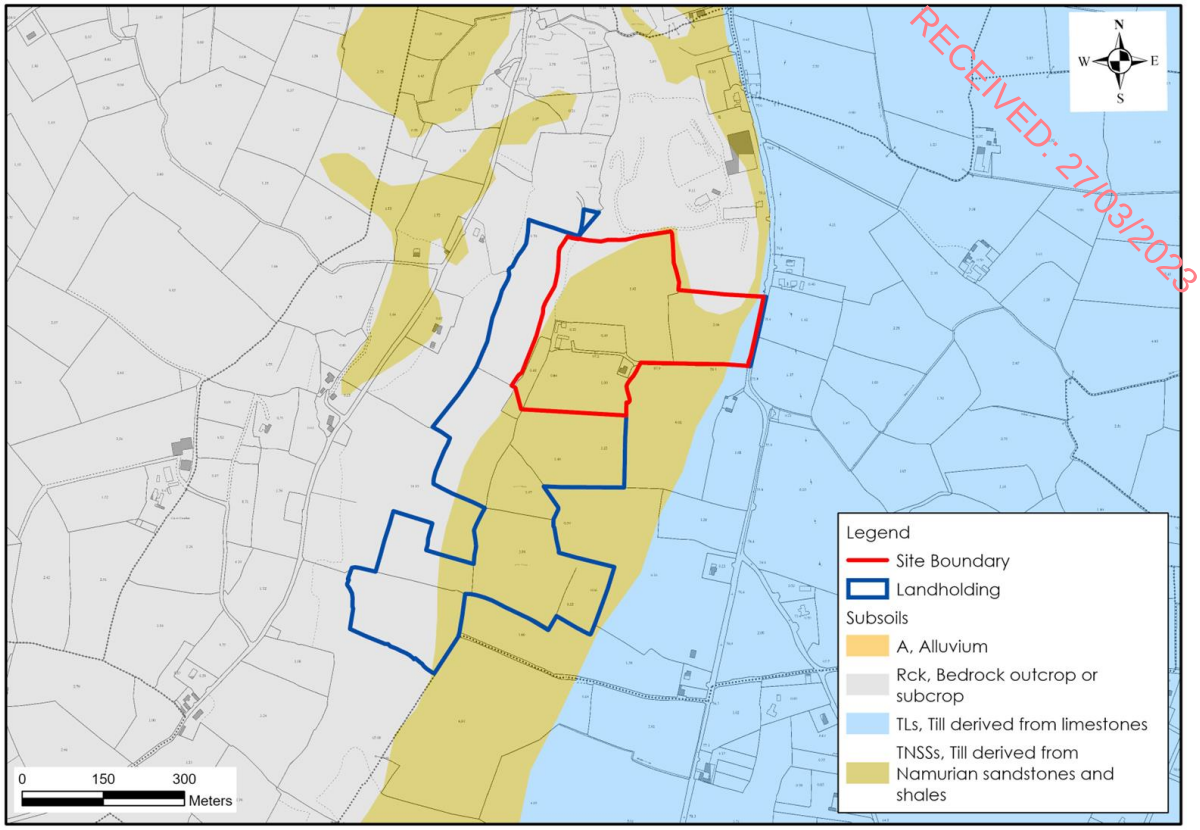

Figure C: Local subsoils map

3.4 HYDROGEOLOGY

The site is underlain by Dinantian Pure Bedded Limestones of the Clongrenan and Ballyadams Formations. These are classified by the GSI as being a Regionally Important Aquifer – Karstified (diffuse) (www.gsi.ie).

Dinantian Pure Bedded Limestones are also mapped to the north, south and east of the site. Meanwhile, Namurian Shales of the Killeshin Siltstone Formation and the Luggacurren Shale Formation are mapped to the west of the site and underlie the southwest of the overall landholding. These bedrock geology formations are classified by the GSI as being Poor Aquifer -Bedrock which is Generally Unproductive except for Local Zones (Pl) and a Poor Aquifer – Bedrock which is Generally Unproductive (Pu) respectively (www.gsi.ie).

The majority of the site is underlain by the Bagenalstown Lower Groundwater Body (GWB) which is characterised by a karstic flow regime. This GWB includes a Regionally Important Karstified Aquifer which is considered a major aquifer comprising of water-bearing units of pure limestone and dolomitised limestone. Meanwhile, a small area in the southwest of the site is underlain by the Shanragh GWB which is characterised by poorly productive bedrock. This GWB consists of the Westphalian Shales of the Castlecomer Plateau and is not considered to be an important aquifer.

3.5 DESIGNATED SITES & HABITATS

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

The site is not located within any designated conservation site, however there are designated sites in close proximity to the proposed development.

The Madlin River downstream of the site has been designated as part of the River Barrow and River Nore SAC (Site Code: 002162). This designated site consist of the freshwater stretches of the Barrow and Note River catchments upstream as far as the Slieve Bloom Mountains. The site is a SAC due to the presence of several habitats and species which are listed on Annex I/II of the E.U. Habitats Directive.

Whitehall quarries pNHA (Site Code: 000858) is located ~2.2km southwest of the site.

4. SITE SPECIFIC FLOOD RISK ASSESSMENT

4.1 INTRODUCTION

The following assessment is carried out in accordance with '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*' (DoEHLG, 2009). The basic objectives of these guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders; and,
- Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

A stage 1 assessment of flood risk requires an understanding of where the water comes from (*i.e.* the source), how and where it flows (*i.e.* the pathways) and the people and assets affected by it (*i.e.* the receptors). It is necessary to identify whether there may be any flooding or surface water management issues related to the proposed site that may warrant further detailed investigation.

As per the guidance (DOEHLG, 2009), the stage 1 of a flood risk assessment comprises:

- *Flood risk identification* – identify whether there are surface water flooding issues at a site; and,
- *Initial flood risk assessment* - confirm sources of flooding that may affect a proposed development.

4.2 FLOOD ZONE MAPPING

Flood zones are geographical areas within which the likelihood of flooding is in a particular range. There are three types or levels of flood zones defined for these purposes according to OPW guidelines:

- Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);
- Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding); and,
- Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

4.3 FLOOD RISK IDENTIFICATION

4.3.1 Soils Maps – Fluvial Maps

A review of the soil types in the vicinity of the site was undertaken as soils can be a good indicator of past flooding in an area. Due to past flooding of rivers deposits of transported silts/clays referred to as alluvium build up within the floodplain and hence the presence of these soils is a good indicator of potentially flood-prone areas.

Based on the EPA soil map (www.epa.ie) for the area it appears that there are no areas of mineral alluvium within the site or in the surrounding lands. The closest mapped area of mineral alluvium soils (fluvial deposits) is mapped along the Madlin river ~1.7km northeast of the site. Further to the east, mineral alluvium is also mapped along the length of the Barrow River.

Based on the EPA soil map for the area (www.epa.ie), soils at the site comprise of acid poorly drained mineral soils (AminPD), acid deep well drained mineral soil (AminDW) and basic shallow well drained mineral soils (BminSW). These soils are not indicative of areas prone of fluvial flooding.

4.3.2 Historical Mapping

To identify those areas as being at risk of flooding, historical mapping (*i.e.* 6" and 25" base maps) were consulted. There was no identifiable map text on local available historical 6" or 25" mapping for the study area that would identify lands that are "liable to flood" within or in the vicinity of the site.

4.3.3 OPW National Flood Hazard Mapping

No recurring or historic flood incidents were identified within the site boundary from OPW's Flood Hazard Mapping (refer to **Figure D** below).

The nearest flood incident (Flood ID:2958) is a recurring flood event located at the village of Old Leighlin, ~1.2km north of the site. Here the Johnsduffswood road is noted to be periodically impassable however the OPW do not state the source of the flooding (www.floodinfo.ie).

A recurring flood event (Flood ID: 2959) is also located 2.28km west of the site at Lacken where a road is periodically impassable (www.floodinfo.ie).

Meanwhile, further to the east and downstream of the site, several recurring flood incidients are mapped along the Barrow River. Upstream of the confluence of the Maldin and Barrow rivers, a recurring flood event (Flood ID: 255) is recorded on the Barrow River at Leighlinbridge. Several historic flood events are also mapped in this area dating from 1995, 1999, 2000 and 2015.

Downstream of the confluence of the Madlin and Barrow rivers, recurring flood events are recorded to the north (Flood ID: 2952) and west (Flood ID: 2951 and 2950) of Bagenalstown. These recurring flood events are noted to occur due to overbank flood along the Barrow River (www.floodinfo.ie).

Further downstream flood events are also recorded on the Barrow River at Goresbridge, Graiguenamanagh and Inishtioge.

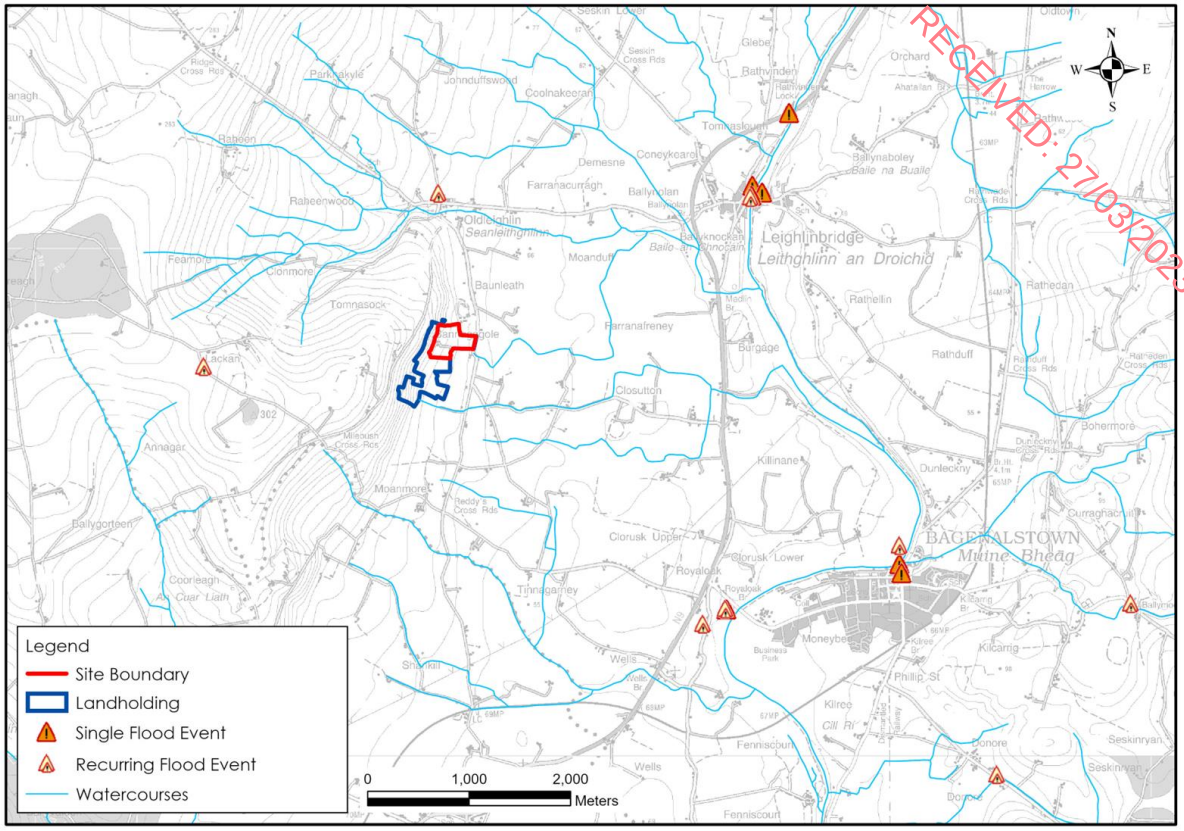

Figure D: OPW Flood Hazard Mapping (www.floodinfo.ie)

4.3.4 CFRAM Maps – Fluvial and Pluvial Flooding

Catchment Flood Risk Assessment and Management (CFRAM)1 OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the previous PFRA maps.

CFRAM mapping has not been completed for the area of the proposed development site. The closest CFRAM mapping to the site has been completed at Leighlinbridge, with fluvial flood zones mapped along the Madlin River to the west of the town.

The modelled fluvial flood extents are located approximately 1.9km downstream of the site and in the vicinity of the confluence between the Madlin River and the Baunleath stream. CFRAM modelling has been completed at 2 no. nodes in this area. One node is located on the Madlin River ~1.94km northeast of the site, with a second located further downstream and 2.2km from the site. CFRAM modelling shows flood levels of 47.46mOD and 48.00mOD for the 100-year and 1,000-year flood events respectively at the node closest to the site (**Table B**).

We note that these flood levels are significantly below the lowest ground elevation within the site (~75mOD) and the final proposed quarry floor level (56.5mOD).

[1] ***CFRAM is Catchment Flood Risk Assessment and Management. The national CFRAM programme commenced in Ireland in 2011 and is managed by the OPW. The CFRAM Programme is central to the medium to long-term strategy for the reduction and management of flood risk in Ireland.***

Table B: CFRAM Modelled Fluvial Flood Levels (www.floodmaps.ie)

Fluvial Flooding				
Node	**Location Description**	**10% AEP WL (mOD)**	**1% AEP WL (mOD)**	**0.1% AEP WL (mOD)**
14MADL00158	Madlin River ~1.97km northeast of site	47.05	47.46	48.00
14MADL00118D	Madlin River ~2.2km northeast of site	44.40	44.71	45.17

4.3.5 National Indicative Fluvial Flood Mapping

The National Indicative Fluvial Flood Mapping (www.floodinfo.ie) shows probabilistic fluvial flood zones for catchments greater than 5km^2 for which flood maps were not produced under the CFRAM Programme.

The Present Day Scenario has been generated using methodologies based on historic flood data and does not take into account the potential changes due to climate change. The potential effects of climate change on flooding have been separately modelled (see **Section** Error! Reference source not found. below.)

For the Present Day Scenario medium (1 in 100-year) and low probability (1 in 1,000-year) fluvial flood zones have been mapped along the Madlin River between the village of Old Leighlin and Leighlinbridge to the northeast of the site. The closest mapped flood zones occur ~1km northeast of the site with extensive flooding modelled along the Madlin River and some flooding also extending along the Baunleath stream. However, no fluvial flood zones encroach upon the site.

A fluvial map showing the National Indicative Fluvial Flood Mapping for the present day is included as **Figure E** below.

Furthermore, the GSI Winter (2015/2016) Surface Water Flooding Map[2] shows areas of fluvial and pluvial flood extents during the Winter 2015/2016 flood event, which was the largest recorded flood event in many areas. This map does not record any surface water flooding along the Madlin River or Baunleath stream. The closest mapped surface water flood zones for this flood event are mapped along the Barrow River.

As such, the proposed development site is located in Fluvial Flood Zone C, where the probability of fluvial flooding is low (less than 0.1%).

[2] GSI ***Historical flood mapping principally developed using Sentinel-1 Satellite Imagery from the European Space Agency Copernicus Programme as well as any available historic records (from winter 2015/2016 or otherwise)***

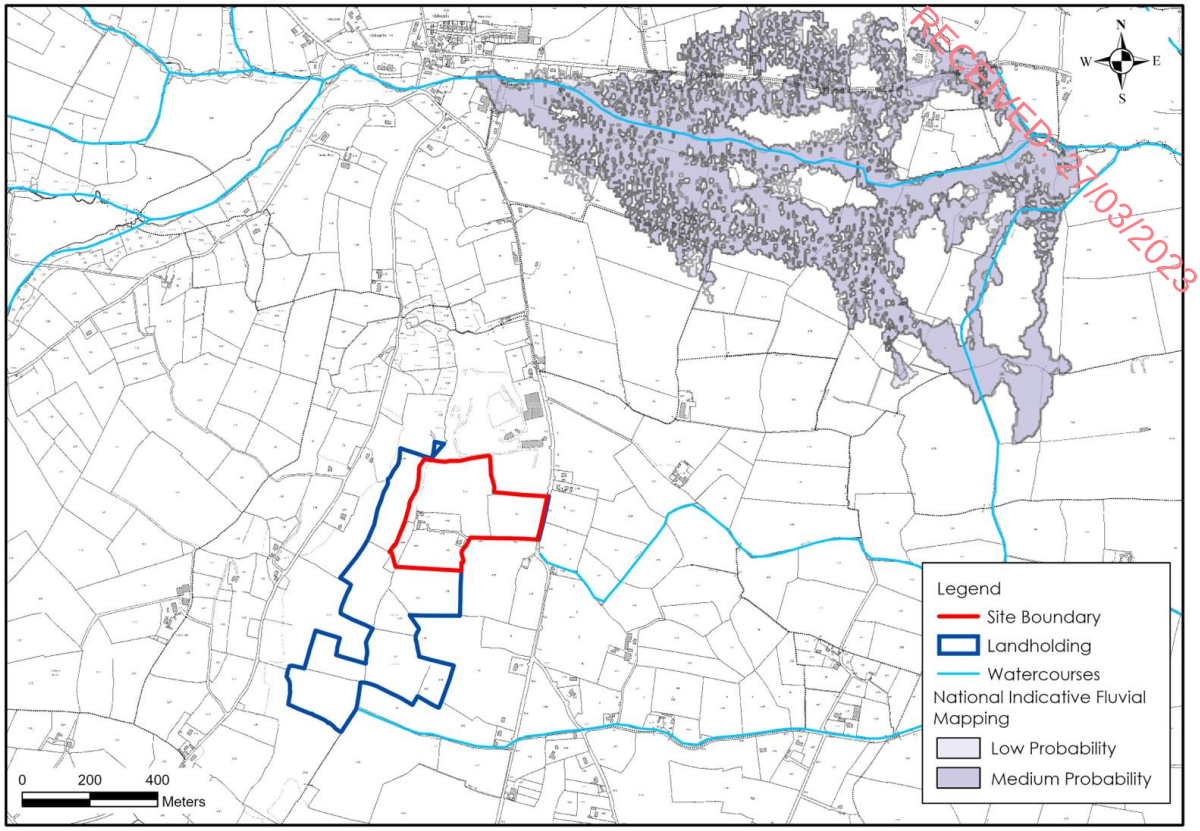

Figure E: OPW National Indicative Flood Mapping (Present-Day Scenario)

4.3.6 Groundwater Flooding

The GSI Historical Groundwater flood map and the modelled groundwater flood extents map (www.floodinfo.ie) do not show the occurrence of any groundwater flooding within the site.

In terms of historic groundwater flooding, the GSI's Maximum Historic Groundwater Flood Map (www.gsi.ie) shows groundwater flooding in Old Leighlin Quarry to the north of the site. This quarry is operating below the groundwater table and the quarry void fills with groundwater when pumps are turned off.

No modelled high, medium or low probability groundwater flood zones are mapped in the site or in the surrounding lands.

4.3.7 Climate Change

Fluvial flood modelling has also been completed to consider future climate scenarios where the potential effects of climate change can increase rainfall.

The National Indicative Fluvial Flood Mapping Mid-Range Future Scenario models flood extents based on a 20% increase in rainfall. Similarly, the National Indicative Fluvial Flood Mapping High-End Future Scenario models flood etens based on a 30% increase in rainfall. Both of these modelled flood extents show similar flood zones along the Madlin River to the Present Day Scenario discussed above in **Section** Error! Reference source not found.. Therefore, fluvial flood zones at the site are unlikely to be significantly impacted by future climate change.

4.3.8 Coastal Flooding

The site is located ~27km upstream of the where the Barrow becomes tidal near Inistioge. Therefore the site is not at risk of coastal / tidal flooding.

4.3.8 Summary – Flood Risk Identification

Based on the information gained through the flood identification process, no parts of the site are mapped within any fluvial flood zones (Flood Zones A - B). The site is located above the mapped 1,000-year flood level and therefore all infrastructure is located in Flood Zone C (Low Risk).

4.4 INITIAL FLOOD RISK ASSESSMENT

4.4.1 Site Survey

Detailed walkover surveys of the site were undertaken by HES on 10th March, 15th August, 17th August, 23rd August, 13th September, 10th October and 15th November 2022.

During these walkover surveys the site was noted to comprise of agricultural pastures and areas of coniferous forestry. No areas of surface water ponding were encountered during any of the site visits.

Drinage mapping was completed with the site and in the surrounding lands. characterised by a general lack of surface water features. However, a small drain was noted to flow along the northeastern boundary of the site, between the site and Old Leighlin Quarry to the north. These stream cross the L3036 via a culvert and continues to the east before it discharges into the Baunleath stream.

During the walkover surveys there was no evidence of past out of bank flow and no flooding was encountered.

4.4.2 Hydrological Flood Conceptual Model

Potential flooding in the vicinity of the site can be described using the Source – Pathway – Receptor Model ("S-P-R"). Given the elevated and sloping nature of the site the potential for pluvial flooding is low. The primary potential source of fluvial flooding in this area, would be overbank flooding of the Baunleath stream to the east of the site during significant flood events. The potential receptors in the area are infrastructure and land as outlined below.

4.4.3 Summary – Initial Flood Risk Assessment

Based on the information gained through the flood identification process and Initial Flood Risk Assessment process it has been determined that flooding is unlikely to be problematic in the area of the site proposed for development. The potential sources of flood risk for the site are outlined and assessed in **Table C.**

Table C: S-P-R Assessment of Flood Sources for the Site

Source	Pathway	Receptor	Comment
Tidal	Not applicable	Land and infrastructure.	The site is ~27km from the the upper reaches of the Barrow Estuary near Inistioge and stands at an elevation of 75 to 130mOD. Therefore, there is no risk of coastal or tidal flooding at the site.
Fluvial	Overbank flooding of the Baunleath stream which drains the local area.	Land and infrastructure	There are no mapped fluvial flood zones within the site or in the surrounding lands. The closest mapped fluvial flood zones are from the OPWs' National Indicative Flood Maps and are located ~1km from the site. Furthermore, the site stands at a significant elevation above the CFRAM modelled flood levels on the Madlin River. The site is located in Fluvial Flood Zone C.
Pluvial	Ponding of rainwater on site	Land and infrastructure.	The topography of the site is sloping with any surface water quickly making its way into nearby drainage ditches which in turn discharge to the Baunleath stream. Pluvial flooding is not likely to be a risk at the site.
Surface water	Surface ponding/ Overflow	Land and infrastructure	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land and infrastructure.	Based on local hydrogeological regime and GSI mapping, there is no apparent risk from groundwater flooding at the site.

4.5 REQUIREMENT FOR A JUSTIFICATION TEST

The matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test[3] is shown in **Table D** below.

The proposed development site can be categorised as "Less Vulnerable Development". However, as stated above, the site, including any proposed infrastructure is not located in a mapped Flood Zone and therefore the proposed development is appropriate from a flood risk perspective.

[3] *A 'Justification Test' is an assessment process designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk, (DoEHLG, 2009).*

Table D: Matrix of Vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification test	Justification test	Appropriate
Less vulnerable development	Justification test	Appropriate	**Appropriate**
Water Compatible development	Appropriate	Appropriate	Appropriate

Note: Taken from Table 3.2 (DoEHLG, 2009)
Bold: *Applies to this project*

4.6 FLOOD IMPACT PREVENTION

The proposed development has the potential to increase volumes of water being discharged from the site to the Baunleath stream, which in turn discharges into the Madlin River. This increase in surface water discharge will be as a consequence of the increased volumes of surface and groundwater being generated within the proposed quarry void.

Any unmitigated and uncontrolled increases in discharge has the potential to adversely impact local hydromorphology, water quality and increase flood risk downstream of the site.

However, the proposed water management system will direct surface water and any minor groundwater inflows in the site towards suitably designed settlement lagoons on the quarry floor. These lagoons will serve to attenuate discharge from the site and will ensure that discharge rates to the Baunleath stream do not exceed the existing greenfield runoff rates or the maximum permitted daily discharge volume as per the discharge licence.

The proposed infrastructure will attenuate storm water so that any increase in discharge volumes during storm events are gradual and controlled, preventing an increase in the flood risk downstream of the site.

5. REPORT CONCLUSIONS

5.1 CONCLUSIONS

- A flood risk identification study was undertaken to identify existing potential flood risks associated with the proposed dimensional stone quarry at Bannagagole, Old Leighlin, Co. Carlow. From this study:
  - No instances of historical flooding were identified in historic OS maps;
  - No instances of recurring flooding were identified on OPW maps within the site;
  - The GSI Histocial 2015/2016 Surface Water Flood Map does not record any areas of surface water flooding within the site;
  - The GSI Groundwater Flood Mapping does not record any historic or predictive groundwater flood zones within the site; and,
  - No areas of the site were identified within the OPW/CFRAM Flood Zones.
- The OPW National Indicative Flood mapping indicates that fluvial flooding does occur along the Madlin River ~1km northeast of the site;
- Much of the site is located on sloping ground with little risk of pluvial flooding;
- The Justification Test concluded that the site is located within a low-risk area (Flood Zone C), and as such is appropriate from a flood risk perspective. Therefore, the site is not susceptible to coastal, fluvial or pluvial flooding;
- Flood risks associated with potential fluvial flooding downstream of the site can be managed by way of standard drainage measures and the implementation of on site surface water attenuation; and,
- The overall risk of flooding within the site is estimated to be low.

* *

6. REFERENCES

AGMET	1996	Agroclimatic Atlas of Ireland.
DOEHLG	2009	The Planning System and Flood Risk Management.
Met Eireann	1996	Monthly and Annual Averages of Rainfall for Ireland 1961-1990.

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