Morell River
Flood Management Scheme
Volume III: Environmental Impact Assessment Report - Appendices

July 2017

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LIST OF APPENDICES

RPS

Appendix A

Feasibility Report

Appendix A

Kildare County Council
Comhairle Chontae Chill Dara

OPW
The Office of Public Works
Oifig na nOibreacha Poiblí

Morrell Flood Management Scheme

Feasibility Report

Version F01 - July 2016

RPS

Morrell Flood Management Scheme

Feasibility Report

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ABBREVIATIONS

AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
BCR	Benefit Cost Ratio
CFRAM	Catchment Flood Risk Assessment and Management
CPI	Consumer Price Index
DEHLG	Department of Environment, Community and Local Government (previously known as the Department of Environment, Heritage and Local Government)
FCERM	Flood or Coastal Erosion Risk Management
FRA	Flood Risk Assessment
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
HA	Hydrometric Area
HEFS	High End Future Scenario
HPW	High Priority Watercourse
IRR	Individual Risk Receptor
MCM	Multi Coloured Manual
MRFS	Mid Range Future Scenario
OPW	Office of Public Works
pvD	Present Value Damage
RBD	River Basin District
RMP	Record of Monuments and Places
SAC	Special Area of Conservation
SMR	Sites and Monuments Record

SI	Statutory Instrument
SoP	Standard of Protection
SPA	Special Protection Area
SSA	Spatial Scale of Assessment
UoM	Unit of Management

1 INTRODUCTION

The Morrell catchment in County Kildare is situated within the Eastern River Basin District (ERBD) and Hydrometric Area (HA) 9 (Figure 1.1). The main rivers in the catchment are the Morrell River (itself a tributary of the River Liffey) and its tributaries the Painstown, Slane and Kill rivers. The Grand Canal flows through the catchment from northeast to southwest. Fluvial flooding on the Morrell River has been an issue for decades and is caused by intense rainfall events, or prolonged and heavy rainfall with antecedent wet conditions.

1.1 EASTERN CFRAM STUDY

In 2011 the Morrell catchment, extending from Johnston and Kill to the confluence of the Morrell and the Liffey, and was designated as an Area for Further Assessment (AFA) under the Eastern Catchment-based Flood Risk Assessment and Management (CFRAM) Study. For the purposes of the CFRAM study it was referred to as Turnings/Killeenmore AFA. The geographical extents of the individual AFAs were determined based on the zoned development limits of towns, villages and areas of cities but gave consideration to the river network and hydraulic connectivity, to ensure that a catchment based solution to flooding was possible. Historically in Ireland flood risk management has been undertaken by developing local solutions often in reaction to recent flooding but the CFRAM programme will enable catchment scale plans to be developed to ensure the cumulative effect of such measures can be assessed.

The Office of Public Works (OPW) commissioned RPS to undertake the Eastern CFRAM Study in June 2011.

The main objectives of the Eastern CFRAM Study are to:

- Develop flood mapping for each AFA in the ERBD at a catchment scale (2014);
- Identify viable structural and non-structural flood risk management options (2015);
- Prepare a set of Flood Risk Management Plans (FRMPs) outlining the flood risk management options (2016).

1.2 MORRELL FAS STUDY

Due to the significant flooding that has taken place in the Morrell catchment, and concern amongst residents, the Morrell catchment was prioritised within the Eastern CFRAM Study programme and an advance project was carried out during 2013 to accelerate the development of flood mapping for this AFA.

The flood mapping developed is being taken forward by the Morrell Flood Alleviation Scheme (FAS) Study being undertaken by RPS on behalf of Kildare County Council. The Morrell FAS Study, which is being funded by OPW, will include flood risk assessment and the development of flood risk management options for the Morrell catchment. The Turnings/Kileenmore AFA will continue to be part of the Eastern CFRAM Study and the options developed as part of this study will feed into the plan for Hydrometric Area 09.

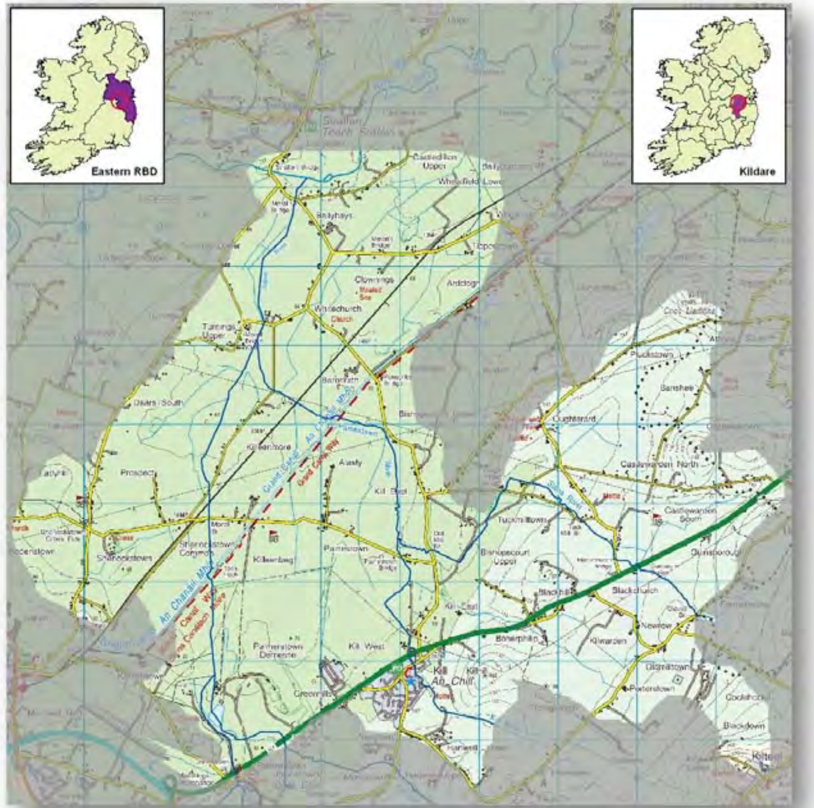


Figure 1.1: Morrell catchment

1.3 PROPERTY FLOODING

There is a history of flooding in the catchment since the early 1990s. In recent years, the severity and frequency of the flood events have resulted in severe hardship for residents of approximately 60 households as well as for five enterprises (excluding farms) in the area. Figure 1.2 illustrates the properties at risk of flooding that are included in the damage assessment outlined in Chapter 4 of this report.

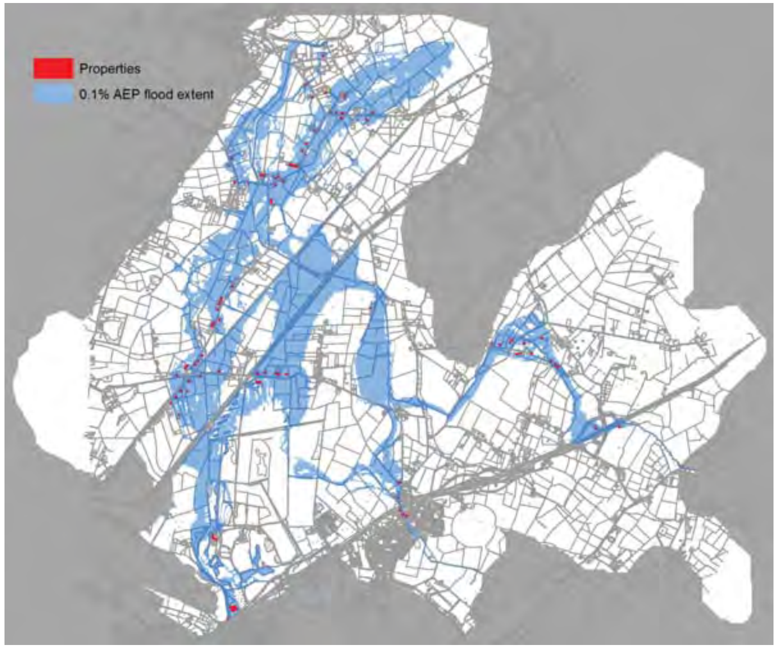


Figure 1.2: Properties at risk of flooding in a 0.1% AEP flood event

1.4 ROAD FLOODING

The river systems in the Morrell catchment cross the N7 national roadway between Maudlins Interchange, south of Junction 9, and at Castlewarden Junction 6. The latter of these two crossings poses a serious flood risk for the N7, as illustrated in Figure 1.3.

Severe extensive flooding incidents have been documented from April 1998 in the 'Hydraulic Model & Flood Alleviation Measures Report' for the N7 Naas Road Interchange Scheme, prepared by J.B. Barry's & Partners Limited in 2002. At the time of this report, it was noted that the Morrell river channel

was under capacity between the N7 and the canal. Substantial works have been carried out to address the insufficient capacity and problematic flooding issue of the N7 by the National Roads Authority (NRA) in 2011 – 2012 in line with the 'Castlewarden – Flood Mitigation – Minor Works' detailed design completed by J.B. Barry & Partners in June 2011. However the improvement works outlined in this design document were subsequently amended to reflect the previous hydraulic capacity in this area. This amendment was a result of concerns that the improvement works at the N7 - Castlewarden Junction 6 would exacerbate flooding of residential properties in the downstream catchment of the Turnings / Kileenmore AFA, and at that time there was an absence of a hydraulic model for the catchment. Consequently the improvement works designed by J.B. Barry & Partners have not been fully implemented and a severe flood risk still exists at Castlewarden Junction 6 on the N7. These works, along with flood risk management measures undertaken previously in Johnstown, are indicative of the lack of a catchment approach in addressing the flood risk in the Morell catchment historically and the need to manage the identified issue as a whole.

Figure 1.3: N7 Hydraulic model analysis for Castlewarden junction 6 in 1% AEP event

1.5 PURPOSE OF THE OPTIONS REPORT

The main objectives of this Morrell FAS Study options report is to undertake a flood risk assessment of the entire catchment and develop a range of Flood Risk Management (FRM) Options which best manages the identified risk.

The flood risk to the study area will be defined based on the following four main groups of receptors:

- Society (including risk to people);
- The environment;
- Cultural heritage; and
- The economy.

The option development section of the report details the decision-making process in identifying the most appropriate FRM options for the catchment and provides details of the options to be taken forward to public consultation.

1.6 INTRODUCTION TO THE OPTIONEERING PROCESS

'Optioneering' is a process where the flood risk to an area is identified and quantified to inform the choice of the most appropriate FRM options. This is carried out through a series of activities as summarised in Figure 1.4.

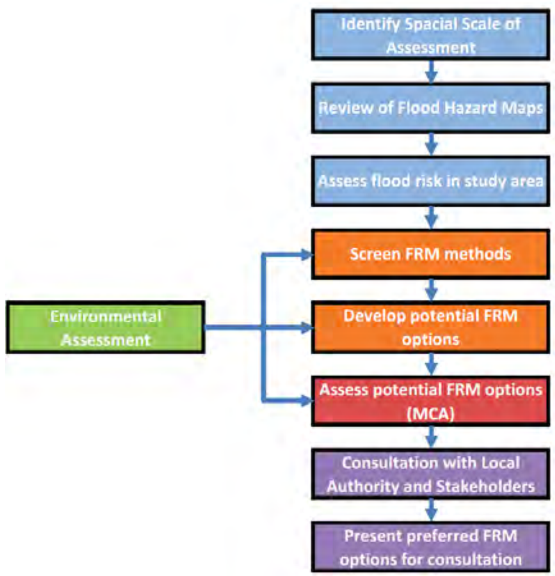


Figure 1.4: Optioneering process

Morrell FMS Morrell Feasibility Report

The activities listed in the blue boxes are activities that aim to identify and assess flood risk. This is undertaken by the establishment of the baseline flooding situation through hydrological and hydraulic analysis to produce a series of flood hazard maps. The flood hazard maps are then used to identify which receptors are at risk and and flood risk maps are subsequently produced incorporating receptor information. The flood risk receptors, as defined in Section 1.5, are assessed in order to ascertain where, and to what extent, flood risk management is required. These activities are detailed in chapter 4 of this report.

On quantifying the flood risk, the FRM methods go through an initial screening to rule out unacceptable methods at an early stage of the process. The remaining methods are then assessed and developed further and combined into potential FRM options. This process is described further in Chapter 7 and illustrated in the orange boxes.

The FRM options that emerge from the initial screening undergo multi-criteria analysis in relation to technical criteria and the criteria outlined in Section 1.1. They are scored according to their success in achieving the criteria's objectives in order to identify the preferred options (maroon box). These preferred options are then presented for consultation with relevant study stakeholders (study steering group) and the preferred options are taken forward to public consultation, thereby allowing the public the opportunity to influence the choice of options (purple box). Comments from the public consultation are then considered, and appropriate choices or amendments made, to produce updated preferred options which become the FRM Measures to be presented in the draft Flood Risk Management Plans (FRMPs).

2 DATA COLLECTION

This section details the data used in the optioneering process. The data was received primarily from the OPW and Kildare County Council. Data was also produced by RPS through hydrological and hydraulic analysis activities, both under the Morrell FAS Study and the Eastern CFRAM Study. Supplementary data was also received from stakeholders and members of the public through consultation and engagement activities. The following sections list the data used for the various activities in the optioneering process.

2.1 BACKGROUND MAPPING

Mapping was used throughout to aid the various tasks. This included assessing the flood risk in the study area and identifying the receptors at risk. The maps were used to locate and inform the alignment of proposed FRM options and to reference the options being displayed in the various maps produced. The table below summarises the mapping that was used.

Table 2.1: Background mapping data

Data	Use
OSi 210,000 scale raster map	Various tasks
OSi 50,000 scale raster map	Various tasks
OSi 10,000 scale Digi-City map	Various tasks
OSi 6 inch scale map	Historical review
OSi Ortho Photography	Various tasks
OSi 5,000, scale vector map	Various tasks
OSi 2,500, scale vector map	Various tasks
OSi 1,000, scale vector map	Various tasks
Google maps	Identification of receptors and location of FRM measures
Bing maps	Identification of receptors and location of FRM measures
LiDAR	Various tasks

2.2 RECEPTORS

The following data was used to identify and assess the social, environmental, cultural heritage and economic receptors at flood risk within the study area.

Table 2.2: Receptor data

Data	Use
Primary Schools, Post Primary Schools, Third Level	Flood Risk Assessment
Fire Stations	Flood Risk Assessment
Garda Stations	Flood Risk Assessment
Civil Defence	Flood Risk Assessment
OPW buildings	Flood Risk Assessment
Nursing Homes, Hospitals, Health Centres	Flood Risk Assessment
Geo-Directory (2013)	Flood Risk Assessment and Damage Assessment
ESB Power Stations, ESB HV Substations, Bord Gáis assets, Eircom assets, Eirgrid assets	Flood Risk Assessment
Road	Flood Risk Assessment
Rail	Flood Risk Assessment
Architectural Heritage	Flood Risk Assessment
National Monuments	Flood Risk Assessment
National Heritage Area	Flood Risk Assessment
Proposed National Heritage Area	Flood Risk Assessment
Special Area of Conservation	Flood Risk Assessment
Special Protected Area	Flood Risk Assessment
Pollution Sources	Flood Risk Assessment
Development and Local Area Plans	Assessment of FRM methods
Historical Flood Data	Flood Risk Assessment
OPW Channels	Assessment of FRM methods
OPW Embankments	Assessment of FRM methods

Data	Use
OPW Benefiting Land	Assessment of FRM methods
River Centrelines	Various tasks

2.3 FLOOD HAZARD

The output of the hydraulic analysis provides details on the flood extent, depth, velocity, risk to life and flood zones. This was used to inform the flood risk assessment, the screening of FRM methods, and developing and assessing potential FRM options. The following datasets were used.

Table 2.3: Flood hazard data

Data	Use
Morrell flood extent raster (50%, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.1% AEP flood events)	Establish flood extent and depth for Flood Risk Assessment and developing FRM options
Morrell MRFS (50%, 20%, 10%, 5%, 2%, 1%, 0.5%, 0.1% AEP flood events)	Developing FRM options
Morrell HEFS (10%, 1%, 0.1% AEP flood events)	Developing FRM options

2.4 SURVEY DATA

Surveys were carried out by Murphy Surveys Ltd and the information collected is listed in Table 2.4

Table 2.4: Survey data

Data	Use
Channel and Structure survey	Model Construction and developing FRM options
Property threshold survey	Flood Risk Assessment
Floodplain survey	Model Construction and option development

2.5 ECONOMIC ASSESSMENT

The following data was used during the economic assessment. This involved assigning damage to receptors during different flood events and providing costs to FRM options.

Table 2.5: Economic assessment data

Data	Use
Cost Database	Costing FRM options
Depth Damage Database	Damage assessment
Consumer Price Index data	Damage assessment and costing FRM options
Market value of house data	Damage assessment
Purchasing Power Parity	Damage assessment and costing FRM options
OSi Building polygons	Damage assessment
Traffic Count Data (NRA)	N7 Damage assessment
Parameter Values from Guidelines for a Common Appraisal Framework for Transport Projects & Programmes (Dept. of Transport)	N7 Damage assessment
Parameter Values from Project Appraisal Guidelines - Unit 6.11 National Parameter Values Sheet (NRA)	N7 Damage assessment

3 FLOOD RISK ASSSESSMENT

The aim of the Flood Risk Assessment is to assess and map the potential adverse consequences (risk) associated with flooding events of varying frequency to the four receptor groups as listed in the table below. The level of flood risk to a receptor can be affected by the location of the receptor within the flood extent or the proportion of the receptor within the flood extent, the depth to which it floods, the velocity of the water adjacent to the receptor, and the receptors' innate vulnerability to flooding.

Table 3.1: Flood risk receptor groups

Flood Risk Receptor Group	Receptor Dataset	Indicator
Social	Residential Properties	Location and number of residential properties
	Residential Homes (children, disabled, elderly)	Location, type and number
	Prisons, Schools (primary, post-primary, third level education), fire stations, garda stations, civil defence, ambulance stations, hospitals, health centres, OPW buildings, government buildings, local authority buildings.	Location, type and number
	Social amenity sites	Location and extent
Environment	Special Area of Conservation, Special Protected Area, Groundwater Abstraction for Drinking Water, Pollution Sources, Recreational water including bathing water	Location, extent and nature
Cultural Heritage	Architectural Heritage, National Monuments, National Heritage Area, Proposed National Heritage Area, Sites and Monument Records, Record of Monuments and Places	Location, type and number
Economic	Residential and commercial properties	Location, type, number and depth-damage data
	ESB power stations, ESB HV substations, Bord Gáis assets,	Location, type and number

Flood Risk Receptor Group	Receptor Dataset	Indicator
	Eircom assets, water supply, data centres	
	Road networks, rail networks & stations, ports and harbours	Location, type, number and length

3.1 FLOOD RISK MAPS

The clearest way to present the flood risk within a study area is through a series of flood risk maps. These maps illustrate the source of the risk and the receptors at risk. The following flood risk maps have been produced in relation to the Morrell FAS Study:

- Social, environmental and cultural heritage risk map;
- Economic activity map;
- Economic risk density map;
- Number of Inhabitants map.

The economic activity map presents the receptors with a monetary damage according to their type as listed in Table 3.1.

The economic risk density maps present the annual average damage (AAD) calculated from the damage assessment, for further details on the damage assessment see chapter 4. The AAD is represented by the total damage occurring from all receptors in a square grid.

The full set of flood risk maps are presented in the Morrell Options Report Maps Booklet.

3.2 FLOOD RISK WITHIN THE MORRELL CATCHMENT

The following table summarises the flood risk associated with the study area.

Table 3.2: Flood risk within the Morrell Catchment

Flood Risk Receptor Group	Receptor	Risk
Social	Residential Properties	61 residential properties are a risk from the 0.1% AEP flood event. 30 residential properties are a risk from the 1% AEP flood event.

Flood Risk Receptor Group	Receptor	Risk
		15 residential properties are a risk from the 10% AEP flood event.
	Residential Homes (children, disabled, elderly)	None at risk within a 0.1% AEP flood event.
	Prisons, Schools (primary, post-primary, third level education), fire stations, garda stations, civil defence, ambulance stations, hospitals, health centres, OPW buildings, government buildings, local authority buildings.	None at risk within the 0.1% AEP flood event.
	Social amenity sites	There are no parks or open amenity spaces at risk from a 10%, 1% and 0.1% AEP flood events.
Environment	Special Area of Conservation, Special Protected Area, Groundwater Abstraction for Drinking Water, Pollution Sources, Recreational water including bathing water	None at risk within the 0.1% AEP flood event.
Cultural Heritage	Architectural Heritage, National Monuments, National Heritage Area, Proposed National Heritage Area (pNHA), Sites and Monument Records, Record of Monuments and Places, UNESCO sites	A section of the Grand Canal, a pNHA, is at risk from a 1% and 0.1% AEP event.
Economic	Residential and Commercial Properties	The total AAD from residential and commercial properties is €4,296,094.92
	ESB power stations, ESB HV substations, Bord Gáis assets, Eircom assets, Water supply, Data centres	None at risk within a 0.1% AEP flood event.
	Road networks, Rail networks & Stations, Ports and Harbours	The N7 at Castlewarden (Junction 6) is at risk from a 10%, 1% and 0.1% AEP flood event.

4 DAMAGE ASSESSMENT

As part of the economic risk assessment, a monetary damage is assigned to certain receptors at risk. This damage represents the costs to the nation if the flood events being considered were to occur. A monetary damage value was assigned to the following three receptor groups:

- Properties:
    - Residential properties;
    - Non-residential (commercial) properties;
- Utility infrastructure, emergency services and intangibles;
- National road network (N7).

The total damage to the study area is used to quantify the economic risk and provide the amount of potential benefit that would occur if an FRM option is put in place which would prevent the damage from occurring.

The damage assessment methodology follows the guidance in 'Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal' (Flood Hazard Research Centre, Middlesex University, UK, 2013). This document is often referred to as the Multi Coloured Manual (MCM). It is also informed by the 'Flood and Coastal Erosion Risk Management: Handbook and Data for Economic Appraisal' (Flood Hazard Research Centre, Middlesex University, UK, 2014), an online companion volume to the 2013 MCM.

The MCM is a result of research carried out by Middlesex University Flood Hazard Research Centre and provides data and techniques for assessing the benefits of flood risk management in the form of flood alleviation. The MCM has focused on the benefits that arise from protecting residential property, commercial property and road disruption, amongst other areas, as experience has shown that these sectors constitute the vast majority of the potential benefits of capital investment.

4.1 PROPERTY DAMAGE ASSESSMENT

Based on the model outputs and the threshold survey of each property, a flood depth has been assigned to each property for the range of return periods listed in Table 2.3. A type has also been assigned to each property based on the codes contained within the MCM this is explain in more detailed in section 4.1.1. In order to do this efficiently, RPS has created a geo-referenced economic risk shapefile "MorrellDamageAssessment_DoNothing_Long_removeblds_cap", with the relevant depth data for each return period recorded in its attribute table. The damage data for residential properties, commercial properties and utility infrastructure have been grouped into a single polygon. The following sections detail how the damage assessment was carried out and the data that is recorded during various processes within the shapefile attribute tables. Figure 4.1 shows an example of the shapefile and associated attribute table. The full set of attribute tables containing all damage information for each property in the catchment are contained in Appendix D.

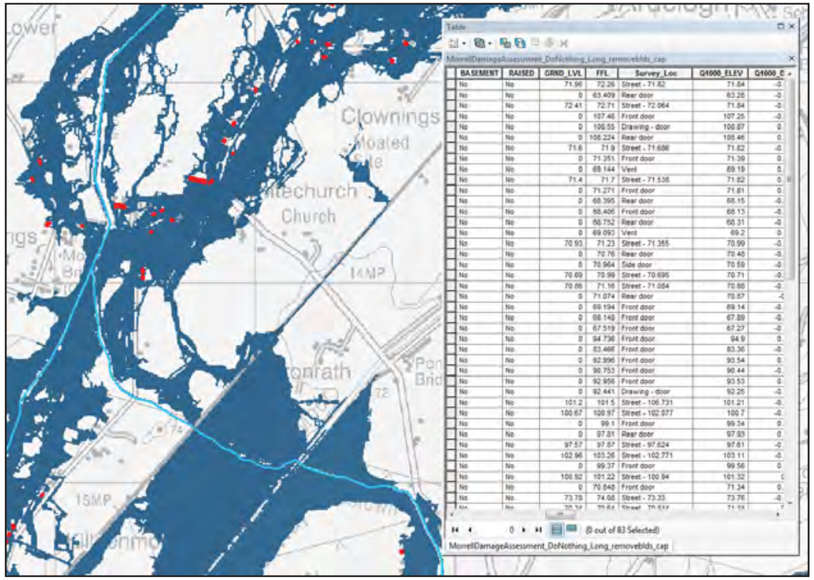


Figure 4.1: Example shapefile with attribute table showing damage assessment data

4.1.1 Categorisation of properties

The first task in this process is to identify the property use. This was carried out according to MCM guidelines, Table 4.1 details the various property types. The MCM assigns a code to each property type to aid the damage calculations where a number can more readily be used in calculations rather than a description in text format.

Table 4.1: MCM property types

Property Type	MCM code	Property Type	MCM code
Detached House	11	Leisure	51
Semi Detached House	12	Playing Field	521
Terrace House	13	Sports Centre	523
Bungalow	14	Sports Stadium	525
Flat	15	Marina	526
Retail	2	Public Buildings	6
Offices	3	Industry	8
Warehouses	4	Car Park	910
Warehouse (frozen goods)	413	Electricity sub-station	960

For the Morrell catchment, all of the properties within the OSi building polygon layer that intersected the 0.1% AEP flood extent were included were selected. Sheds and garages, which have no corresponding depth damage data in the MCM guidelines, were removed.

The properties were then categorised. This was carried out using data gained from site visits, surveys, OSi mapping, An Post's geo-directory, orthophotography and online mapping and orthophotography.

Several residential properties were identified by the surveyors, and during site visits by the study team, that were not included in the OSi building polygon layer. These were digitised into the layer using a floor area of $186m^2$, the average of all of the residential properties in the layer.

The following details were recorded within the economic risk shapefile attribute tables:

Table 4.2: Categorisation of properties data

Data type	Attribute name	Data details
Property ID	geodb_oid	An Post geo-directory database ID
Location	"X" and "Y"	X Y coordinates to Irish National Grid
Floor Area	"AREA"	Floor area of the property
Property Use	Use	"R" for residential and "C" for commercial
MCM code	MCM_CODE	As per MCM guidelines
Property type	PROP_TYPE	As per MCM guidelines
Local Business	Local_Biz	'L' for local business. This attribute is left blank for properties that do not fall under this category.

Within the Morrell catchment 0.1% AEP flood extent, 83 residential and commercial properties were categorised. Of the commercial properties identified, six were categorised as local business premises.

4.1.2 Property threshold level

The damage assigned to a property relates to the depth of water above floor level. As such the threshold level of all properties is required as part of the damage assessment. RPS commissioned Murphy Surveys Ltd to undertake a property threshold survey for all properties within the 0.1% flood extent plus those within a 50m buffer.

Not all properties were accessible by the surveyors. Where this was the case, the surveyors took levels at the street but it was decided that it would be more accurate in these instances to estimate the finished floor levels (FFLs) of these properties by adding 300mm to the ground level around the property as per the LiDAR survey data. The LiDAR data captures the ground level to an accuracy of 0.2m. This data was extracted at the centre point of each property using the spatial analysis tool within ArcMap.

The following details were recorded within the economic risk shapefile attribute table.

Table 4.3: Property threshold data

Data type	Attribute name	Data details
Basement present?	BASEMENT	"Yes" basement present, "No" no basement.
Is ground floor raised	RAISED	"Yes" ground floor is raised, "No" ground floor is not raised.
Ground level	GRND_LVL	LiDAR data extracted at each property where there is no survey data at the property itself, measured in mOD.
Finished Floor Level	FFL	Survey data where available. Where survey data is not available - ground level plus 300mm for properties without basement, ground level minus 2.5m for properties with basement.
Survey location	Survey_Loc	Location of surveyed finished floor level e.g. front door, back door etc.

4.1.3 Flood depth to properties

To estimate the damage to a property, an estimation of the predicted flood depths is required for a wide range of flood events. The Morrell FAS Study requires the depths to which the properties flood during the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP flood events to be calculated. The

depth of flooding is calculated by finding the difference between the maximum flood water elevation and the measured or estimated threshold levels. It is recognised that as flood water passes around a building the water levels will vary, therefore the maximum flood level adjacent to the property was extracted in ArcMap (zonal statistics) for each flood event and recorded in the attribute table of the economic risk shapefile detailed in Table 4.4.

Table 4.4: Flood depth of properties data

Data type	Attribute name	Data details
Flood level for all flood events	Q1000_ELEV, Q200_ELEV, Q100_ELEV, Q50_ELEV, Q20_ELEV, Q10_ELEV, Q5_ELEV, Q2_ELEV,	The maximum flood level adjacent to the building (mOD)
Flood depth for all flood events	Q1000_Dp, Q200_Dp, Q100_Dp, Q50_Dp, Q20_Dp, Q10_Dp, Q5_Dp, Q2_Dp,	Difference between the flood level and FFL (m)

4.1.4 Contents Value

Once the depths of flooding are known the damage to each property can be calculated using the MCM depth damage data. For each property type, a typical damage in pounds sterling (2013-2014 price base) was assigned to a calculated depth of flooding based on historical data. These direct damage figures are based on the floor area of the building in square meters. A GIS tool has been developed which provides the direct damage in each flood event for each building in pounds sterling 2013-2014 prices per square metre by interpolating between the depth damage figures provided in the MCM guidance. This damage figure is then multiplied by the floor area of the property to give the total damage. This figure is then converted to euro, as described in Section 4.1.3.

Table 4.5 details the information and calculations described above which were recorded within the economic risk shapefile attribute tables:

Table 4.5: Flood damage to properties data

Data type	Attribute name	Data details
Direct damage per meter square	Q1000_M2Dm, Q200_M2Dm, Q100_M2Dm, Q50_M2Dm, Q20_M2Dm, Q10_M2Dm, Q5_M2Dm, Q2_M2Dm	Damage per meter square to each property according to the depth of flooding from each flood event as per MCM data. Values in pounds sterling at 2013 – 2014 costs.
Damage to property over full floor area	1000_Dm£13, Q200_Dm£13 Q100_Dm£13 Q50_Dm£13 Q20_Dm£13 Q10_Dm£13 Q5_Dm£13 Q2_Dm£13	Damage per meter square multiplied by floor area of building.
Present Direct Damage	1000_PDD Q200_PDD Q100_PDD Q50_PDD Q20_PDD Q10_PDD Q5_PDD Q2_PDD	Euro conversion rate applied to damage to property over full floor area to give the present direct damage

4.1.5 Property market value

Property market values were calculated for residential and non-residential properties. It is recognised that for certain properties the overall damage associated with flooding can far exceed the market value of the property. Calculating the market value for each property will be used to cap certain damages calculated at a later stage in the damage assessment.

For the purpose of this report, Purchasing Power Parity (PPP) rates are used as the conversion mechanism from pounds sterling to euro. This conversion is required as MCM depth damage data, used both in this section and later in Section 4.4, is given in pounds sterling (£). PPPs are currency conversion rates that both convert to a common currency and equalise the purchasing power of different currencies. In other words, they eliminate the differences in price levels between countries in the process of conversion.

PPPs are calculated on an annual basis by Eurostat through the European Comparison Programme, which involves National Statistical Institutes in the collection of data for the calculations. On a wider basis, the OECD undertakes the International Comparison Programme involving the OECD member states. Once all data has been submitted, Eurostat can perform its calculations and produce the parities for the given year. The most recent PPP value is for 2013[1]. Therefore the PPP value used to convert from sterling (£) to euro (€) is 1.162.

Table 4.6: Converting pound sterling to euro using the PPP 2013 values from OECD website

	PPP (2013)
US - UK	0.694
US - Ire	0.806
UK - Ire	**1.162**

4.1.6 Rate value

The market values for non-residential properties were derived using regional valuations of each type of property. Current rateable values (CRV) were found in Annual Rates of Evaluations data, sourced from the Valuations Office. In accordance with OPW guidance (OPW, 2013), the rate value for capping non-residential properties can be calculated as the CRV of the property multiplied by 10.

4.1.7 Market value

The market value of residential properties was calculated at a regional level with the market value data sourced from the Department of Environment, Community and Local Government's latest house price statistics database available online at http://www.environ.ie/en/Publications/StatisticsandRegularPublications/HousingStatistics/. This database provides house prices for new and second hand houses per area. The average of the regional market values of second hand and new properties for areas outside of the main urban centres were taken during the fourth quarter of 2013, as this is the most recent data available.

[1] http://stats.oecd.org/#

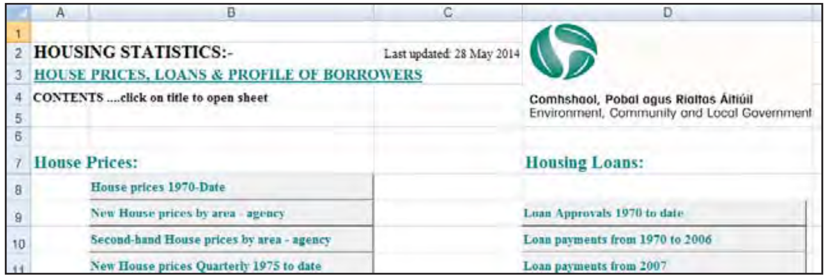


Figure 4.2: House price statistics database

Once the rates values, market values and content values for the all properties have been established the total market value for each property can be established. The data type, attribute names and details recorded within the economic risk shapefile attribute tables are summarised in the table below.

Table 4.7: Property market value

Data type	Attribute name	Data details
Rate Value	Rate_Value	Current rateable value of each non-residential property multiplied by 10.
Market Value	Market_Value	Average of regional market values of second hand and new residential properties.
Contents Value	ContentVal	Damage to each property according to the depth of flooding from each flood event as per MCM data. Values in pound sterling are converted to euro 2013 – 2014 costs.
Total Value	Total_Val	Sum of rate value, market value and contents value for each property.

4.1.8 Annual Average Damage and present value damage

In order to gain an appreciation of the economic risk, the overall damage needs to be calculated. This is represented by assessing the likelihood of each of these flood events occurring in any given year and applying this as a percentage to the damage, this is known as the Annual Average Damage (AAD). This can then be taken over the lifetime of the study (which has been set at 50 years) and discounted back to present day costs, this is known as Present Value Damage (pvD). For computation purposes, it is assumed that the residual value of the works at the end of this 50 year period is nil. This may be regarded as somewhat conservative since the works on this scheme typically have a design life of 100 years. However, it is in accordance with standard methodology for economic appraisal of flood relief schemes developed in other countries.

The AAD can best be described by considering the graph shown in Figure 4.3. The points shown represent the various design flood events where the damage has been calculated. Their position on the graph is dictated by the damage caused and the frequency of the flood event occurring in any given year. These points are joined together to create a damage curve. The area under the curve is a function of the damage and the frequency and gives the AAD. The events that were considered for this study were the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% AEP flood events.

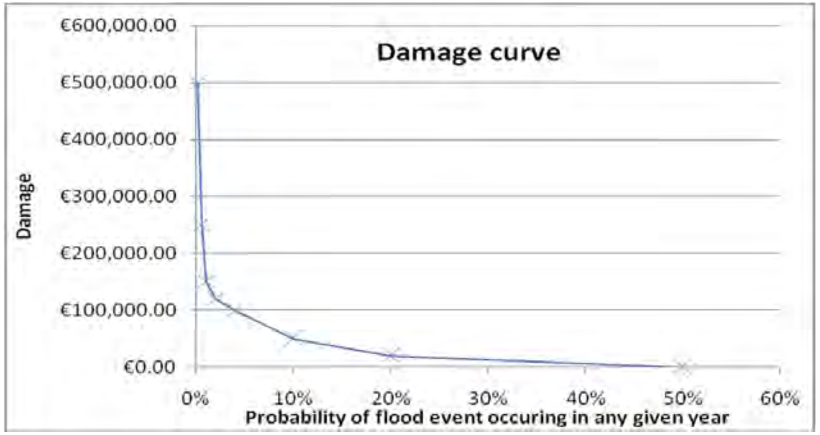


Figure 4.3: Example damage curve

Once the AAD has been established, the pvD is calculated. The pvD calculation sums the AAD that is expected to occur for each of the 50 years being considered in this study. However, in order for the damage value in each year to be comparable with each other, they are discounted to represent the equivalent pvD. Discounting damage values in the future is based on the principle that people generally prefer to receive goods or services now rather than later. This is known as ‘social time preference’. This social time preference can be measured by an appropriate discount rate (STPDR) and is taken as the compound rate of interest r (% per annum) by which y euros in x years' time is equal to one euro now. The cost therefore of providing a FRM option will also be discounted to present day values. The OPW has set this discount rate at 4% for the CFRAM studies, this reflects the Department of Finance's test discount rate for public investment of 4%, and has been used for the Morrell FAS Study. Over the 50 years being considered, this amounted to factoring the AAD by 21.482. The AAD and pvD are calculated for the direct damages, intangible damages and the emergency costs separately and totalled to give the overall damage incurred.

The AAD calculations consider damages up to the 0.1% AEP flood event. However, when considering the FRM options to alleviate this risk, the standard of protection will usually be the 1% AEP flood event. An assessment of the AAD up to the 1% AEP flood event is also calculated as this enables a good indicator of residual risk. Chapter 5 provides more information in this regard. Table 4.8 details which were recorded within the economic risk shapefile attribute tables:

Table 4.3: AAD and pvD data

Data type	Attribute name	Data details
Annual Average Damage for direct damages	AAD	The equation to calculate the AAD is as follows: (([Q2_PDD]+[Q5_PDD])/2*(0.5-0.2)+([Q5_PDD]+[Q10_PDD])/2*(0.2-0.1)+([Q10_PDD]+[Q20_PDD])/2*(0.1-0.05)+([Q20_PDD]+[Q50_PDD])/2*(0.05-0.02)+([Q50_PDD]+[Q100_PDD])/2*(0.02-0.01)+([Q100_PDD]+[Q200_PDD])/2*(0.01-0.005)+([Q200_PDD]+[1000_PDD])/2*(0.005-0.001))
Present Value Damage	pvD	The AAD factored by 21.482

4.1.9 Capping property damages

It is recognised that for certain properties the overall damage associated with it can far exceed the market value of the property. This can be due to either the depth to which it floods or the frequency with which it floods or more likely a combination of both. Where such a situation occurs, it is necessary to cap the damages at the total market value.

Residential properties in the Morrell catchment were assigned a market value of €190,797 which is the average of regional market value of second hand and new properties for areas outside of the main urban centres taken during the fourth quarter of 2013. The approach taken in this study is to cap the direct damages and the intangible damages separately before totalling up the overall damages with

the emergency costs. Table 4.9 shows the details which were recorded within the economic risk shapefile attribute tables:

Table 4.4: Capping property damages data

Data type	Attribute name	Data details
Capped damages for direct and intangibles	Total_Val	The sum of Market_Val and ContentsVal for residential properties, where Market_Val damages over €190,797 are capped at this value
Capped damages for direct and intangibles*	Total_Val	Equal to Rate_Value of non-residential properties.

*Intangibles only relate to local businesses for non-residential properties

The capped pvD (pvD_cap) was then calculated, using the pvD evaluated in Section 4.1.8 and the total market value (Total_Val). This was achieved using a GIS tool which simply let pvD_cap equal the pvD, where pvD was less that the total market value. Where pvD was greater than the market value, pvD_cap was set equal to the total market value.

4.2 UTILITY INFRASTRUCTURE, EMERGENCY AND INTANGIBLE DAMAGES

Economic damages to infrastructure utility assets (e.g. electrical sub-stations, gas installations and pipe-work, telecommunications assets etc) should be calculated at 20% of the total principal direct damage, in accordance with OPW guidance (OPW, 2013). The MCM manual notes there is often little data from which to make an assessment of the potential losses due to flooding and therefore these methodologies draw on experiences from previous flood events (in particular 2007 and 2012) to underpin the approaches identified. It was in this manner that the 20% figure was derived - from the analysis of damages of past floods in the UK.

As well as the material damages to the building structure and the goods inside the property, it is recognised that there are monetary damages associated with clean-up costs, temporary accommodation, stress, etc. To account for this, intangible damages are assigned to all residential properties equal to its direct damages. This is in line with OPW guidance (OPW, 2013). No intangible damages are assigned to commercial properties as these costs do not apply at the same level with the exception of small family run businesses. To achieve this, a survey is carried out identifying these small businesses and an intangible damage equal to the direct damage is assigned to the property.

The cost associated with emergency services dealing with the flood events was calculated as part of the damage assessment. Following the UK Environmental Agency's (EA) Flood or Coastal Erosion Risk Management (FCERM) appraisal guidance, which the MCM guidance has been adapted to comply with, a value of 8.1% of the residential damages has been assigned to the emergency services costs. This percentage of the residential damages has been applied in the Morrell Catchment damage assessment. The details in Table 4.5 were recorded within the economic risk shapefile attribute tables.

Table 4.5: Utility, intangible damages and emergency cost data

Data type	Attribute name	Data details
Utility Damages	Utility	Equal to 20% of the capped residential and non-residential damages (PvD_cap)
Emergency costs	Emergency	Equal to 8.1% of the capped residential and non-residential damages (PvD_cap)
Intangible Damage	Intangible	Set equal to the capped direct damage of residential properties and small family run businesses.

4.3 SUMMARY OF PROPERTY DAMAGES IN THE MORRELL CATCHMENT

Table 4.11 summarises the property damages associated with the Morrell catchment. The total pvD has been calculated by summing the capped present value direct damages, the present value utility damages, the present value emergency costs and the capped present value intangible damages.

Following OPW guidance note 27 of the CFRAM studies the residual damage can be calculated by assuming that damages are avoided up to and including the standard of protection of the option with no benefit offered for events greater than the standard of protection. For full details of the current scenario damage to all properties and the residual damage see appendix D.

Table 4.6: Summary of property damages for the Morrell catchment

Scenario	Total AAD	Total PvD
Current Scenario Damage	€177,698	€4,738,400
Residual Damage	€14,648	€717,749
Benefit	**€163,051**	**€4,020,650**

4.4 NATIONAL ROAD NETWORK (N7) DAMAGE ASSESSMENT

Benefit-cost analysis has been carried out using the guidelines in the 2013 MCM and accompanying online handbook.

4.4.1 Approach

The N7 damage assessment was approached in the following way:

The assessment approach was based on 'Method 3: The Speed-Time Method' from the online MCM handbook entitled "The Benefits of Flood and Coastal Defence: A Manual of Assessment Techniques". The speed and cost calculation in 'Step Five' of Method 3 were substituted with design speed assumptions from the NRA and costs from publications by the NRA and the Irish Department of Transportation.

For the economic appraisal of damages due to potential time loss and potential accident and casualty, costs were calculated using the NRA traffic data, assumed design speeds, and values published by the NRA in "Project Appraisal Guidelines – Unit 6.11 National Parameter Values Sheet" in July 2011. The operating cost associated with diverting traffic from the Castlewarden Junction on the N7 were calculated using the Irish Department of Transportation document entitled "Guidelines on a Common Appraisal Framework for Transport Projects and Programmes" from June 2009, with figures from this report converted to 2014 figures using the consumer price index (CPI) values for "Transport".

4.4.2 Damages to be assessed from flood events on the N7

The following table summarises the key damages and associated losses to be considered in a flood event on the N7.

Table 4.7: Key damages arising from flooding on the N7 roadway

Tangible
Disruption of road traffic avoided on one of Ireland's busiest roadways *Direct damage to roads averted
Intangible
Avoidance of anxiety, inconvenience and ill health Avoidance of the inconvenience of post flood recovery

Tangibles losses are addressed as follows;

- The *disruption of road traffic on the N7* has been investigated and a detailed economic appraisal is presented in Section 4.3.3 and Section 4.3.4 of this report.
- The *direct damage to roads* has been excluded in this report as it is addressed in the property damage assessment in Section 4.1 of this report. This is in accordance with the MCM which

allocates the economic appraisal of damage to road infrastructure and emergency services that may be associated with this, as a percentage of the cost of residential property losses.

Intangibles losses were either excluded and / or addressed as follows;

- The avoidance of anxiety, inconvenience and ill health for residents in the area is addressed in the property damage assessment, and the effect of time inconvenience on motorists on the N7 has been encompassed in the evaluation of Economic Values of Time and Operation Costs, Section 4.3.4.
- The avoidance of the inconvenience of post flood recovery for residents in the area is addressed in the property damage assessment in Section 4.1 of this report, and the effect of post flood recovery for the roadways in the Junction 6 area on the N7 shall be encompassed in the existing maintenance road costs.

4.4.3 N7 damages calculation

4.4.3.1 Traffic disruption due to flooding of the Morrell catchment

Hydraulic model analysis show that rainfall events of 5 to 1000 year return period (20% - 0.1% AEP) result in a number of road closures within the study area. According to the MCM, a road should be assumed closed when the middle of the lane is inundated; and while this may be considered cautious, it is consistent with UK Environment Agency advice which attempts to prevent the public from driving through flood waters.

The hydraulic model has shown that a flooding event of 2 year return period (50% AEP) and higher would result in standing water on the N7 roadway. The model shows that in a 2 year event this standing water does not fully inundate the entire span of the N7 and for the basis of the damage assessment it has been conservatively assumed that the N7 will remain open in a 2 year return period. For a 5 year return period, and all flood events of greater magnitude up to the model capacity of a 1000 year return period, the model shows that the entire N7 is inundated at Junction 6 – Castlewarden exit. Based on safety precautions outlined by the UK Environment Agency for flooding of roadways, and to prevent the risk of accidents from vehicles aquaplaning, it is assumed that it is necessary to close the N7 at Junction 6 for a 5 year return period event and above.

The locations that would be rendered impassable in a flood event of magnitude varying from 5 to 1000 years (20% - 0.1% AEP) include the following;

- N7 main route and the roadway at Junction 6 – Castlewarden exit;
- Straffan Road (where the Slane River crosses the road, just after the Barberstown Rd junction);
- Straffan Road (in Bishopscourt Lower where the Painestown River runs adjacent to the road);

- Straffan Demesne, (in the area near the K Club, where the road crosses the River Liffey).

It will be necessary to circumvent the detour route around Straffan Road, the locally suggested diversion route, as in a 100 year flood event (1% AEP) the hydraulic model shows that these roads in the lower Morrell catchment would be inaccessible.

Flood durations for inundation of the N7 at Junction 6 were calculated using three approaches A, B and C, through two methods - the MCM, FHRC (2013) publication and the hydraulic model for the catchment – to provide a sensitivity analysis for traffic disruption and potential cost of delays.

Approach A applied flood duration figures from ‘indicative delay durations at different return periods’ from Table 6.17 in the MCM, FHRC 2013 publication and reduced the calculated time delays at different return periods by approximately half to more accurately reflect the catchment. Table 4.13 below presents the calculated flood durations for Approach A.

Approach B uses the hydraulic model to calculate the duration of standing water on the N7 at Junction 6 for the range of flood event and takes account of time to divert traffic pre and post total roadway inundation – i.e. time to close the N7, re-route traffic and then post flood re-opening of the road – by assuming one hour before and after the total roadway inundation time at each flood event. Table 4.14 below presents the calculated flood durations for Approach B.

Approach C uses the duration of standing water on the N7 at Junction 6 calculated by the hydraulic model for the range of flood events to denote the traffic delay, but does not make any allowance for time to divert traffic pre and post total roadway inundation. Table 4.15 below presents the calculated flood durations for Approach C.

Table 4.8: Approach A - flooding durations on the N7 at junction 6 using MCM Handbook

Flood Return Period (Year)	2	5	10	20	50	100	200	1000
Flood Duration (Days) - 'Do Nothing' Scenario	-	0.25	0.25	0.5	0.5	1	2	4
Flood Duration (Days) - 'Do Minimum' Scenario	0	0	0	0	0	0	0	0
Net Flood Duration (Days) - For Benefit Purposes	0.25	0.25	0.25	0.5	0.5	1	2	4

Table 4.9: Approach B - flooding durations on the N7 at junction 6 using hydraulic model

Flood Return Period (Year)	2	5	10	20	50	100	200	1000
Flood Duration (hrs) - 'Do Nothing' Scenario	0	4	4	5	6	8	8.5	9
Time for Diverting Traffic Pre & Post Flood Event (hrs)	-	2	2	2	2	2	2	2
Flood Duration (Days) - 'Do Nothing' Scenario	0	0.25	0.25	0.29	0.33	0.42	0.44	0.46
Flood Duration (Days) - 'Do Minimum' Scenario	0	0	0	0	0	0	0	0
Net Flood Duration (Days) - For Benefit Purposes	0	0.25	0.25	0.29	0.33	0.42	0.44	0.46

Table 4.10: Approach C - flooding durations on the N7 at junction 6 using hydraulic model

Flood Return Period (Year)	2	5	10	20	50	100	200	1000
Flood Duration (hrs) - 'Do Nothing' Scenario	0	4	4	5	6	8	8.5	9
Time for Diverting Traffic Pre & Post Flood Event (hrs)	-	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Flood Duration (Days) - 'Do Nothing' Scenario	0.00	0.17	0.17	0.21	0.25	0.33	0.35	0.38
Flood Duration (Days) - 'Do Minimum' Scenario	0	0	0	0	0	0	0	0
Net Flood Duration (Days) - For Benefit Purposes	0.00	0.17	0.17	0.21	0.25	0.33	0.35	0.38

To provide a broad range for sensitivity analysis of the estimated traffic disruption and potential cost of delays for inundation at Junction 6 on the N7, the net flood durations calculated using Approach A, B and C reflect worst case delay, conservative delay and minimum delay scenarios, respectively.

Use of these three approaches for estimating flood durations have been used to assess the sensitivity of the associated potential cost for traffic disruption due to time delays on the N7. Section 4.5 presents these potential costs of road closure calculated for each the flood duration approaches.

4.4.3.2 Diversion route selection for flooding of N7 at Junction 6

Hydraulic analysis indicates that for the 5-year flood or greater, vehicular access on the N7 at Junction 6 – Castlewarden is cut off due to flooding. When this happens, traffic wishing to travel north or south

on the N7 through Junction No. 6, is forced to divert. For the purpose of this analysis, it is assumed that the traffic travels to the north and south along the diversion routes detailed in Figure 4.5.

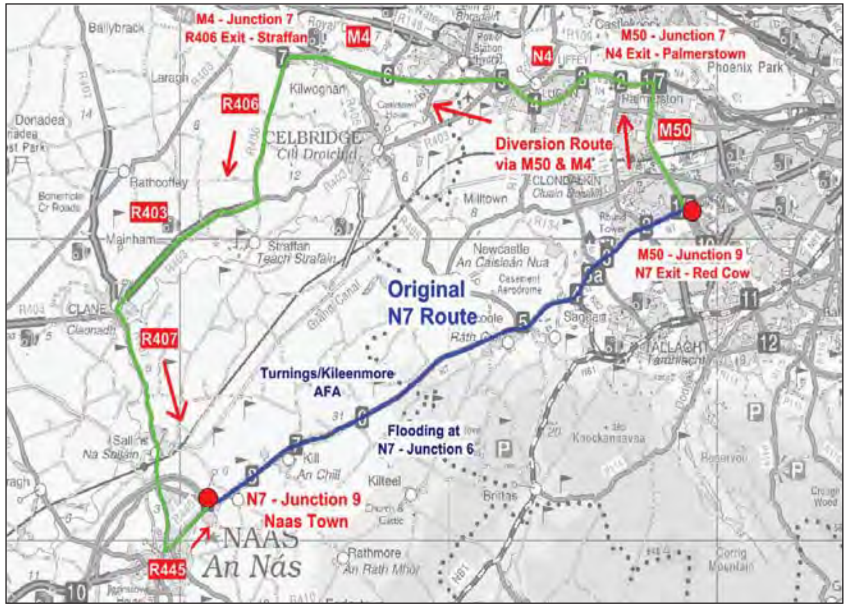


Figure 4.4: Assumed diversion route for N7 traffic, M50 Dublin – N7 Naas town

The selection of the diversion route in the event of the Morrell River flooding in the Turnings/Kileenmore AFA has been based on the results from the hydraulic model, and has diverted around Straffan Road where flooding would also occur. The diversion route also adheres to best practice outlined in the MCM, FHRC 2013 publication which recommends diversion routes concentrate primarily on major rather than minor roads. Due to the high volume of HGVs travelling on the N7 (approximately 6,116 HGVs daily) the diversion route has avoided local roads, and uses motorways, national primary roads and regional roads only. The Steering Group for the Morrell River Flood Alleviation Scheme identified this diversion route as the preferred detour route, and concluded that the traffic disruption would be of similar magnitude on any alternative route.

For the purposes of this traffic disruption analysis, it is assumed that all traffic originates at the N7 Exit, at Junction 9 on the M50, it is assumed that traffic heading southbound as far as Naas Town, at Junction 9 on the N7, or a location further south on the N7. This assumption reflects 94.3% of the average annual daily traffic (AADT) figure for traffic volumes travelling the N7 between Junction 1 and Junction 7 – 8. It is assumed that diversion from/to other destinations will be of similar duration.

In the event of a Morrell River flood incident resulting in the closing of the N7 at Junction 6 - Castlewarden, a vehicle intending to head southbound on the N7 would be diverted at the start of the N7, at Junction 9 on the M50. The vehicle would be diverted northbound on the M50 to Junction 7, at the N4 Exit – Palmerstown. The vehicle would then travel along the N4 until it changed into the M4. The vehicle would continue on the M4 as far as Junction 7, R406 Exit – Straffan Road. The diversion route would track along the R406 as far as Barberstown Castle, and then turn right onto the R403 as far as Clane. The vehicle would then turn left in Clane town and take the R407 through Sallins to Naas Town where the diversion route would turn left onto the R445, taking the vehicle back to the N7 at Junction 9. It is assumed that a similar diversion route would be used for the opposite flow of traffic heading north from Naas Town to the Red Cow interchange.

4.4.3.3 Traffic data analysis for diversion route in flood event

Traffic Count Data for 2013-14 obtained from the NRA estimates that the average annual daily traffic (AADT) on the N7 between Junction 1 - 2 and Junction 7 - 8 is 78,407, and 73,938, respectively. There is no traffic count information available for Junction 6 specifically; however, an NRA official has advised that the AADT at Junction 6 is approximately 85,000 vehicles. Based on the advice from the NRA, and as a safety precaution to ensure the total traffic has been accounted for, the higher and more conservative value of 78,407 AADT has been used for traffic disruption analysis. Of this AADT, 7.8% of these were HGVs.

The AADT in 2014 for the M50 between Junction 9 – N7 Exit at the Red Cow, and Junction 7 – N4 Exit at Palmerstown, was estimated to be 120,005 vehicles per day; and of these vehicles, 6.6% were HGVs. For the N4 at Junction 7 – Palmerstown, the AADT was estimated to be 96,047 vehicles per day; and of these vehicles, 3.7% were HGVs. The AADT in 2013 for the M4 at Junction 7 was estimated to be 51,175 vehicles per day; and of these vehicles, 4.7% were HGVs.

There is no Traffic Count Data available from the NRA for the regional roads (R406, R403, R407 and R445) on the diversion route. However it has been noted by Kildare County Council that the Clane, Sallins and the Monread Roads all have very heavy traffic regardless of flooding problems at Junction 6 on the N7. In the absence of Traffic Count Information for the Regional Roads, a conservative estimate of 6,000 AADT with 4.0% vehicles assumed to be HGVs has been applied for these routes.

The hydraulic analysis indicated that for flood with a 2-year return period, the N7 at Junction 6 would not be entirely inundated and it is assumed full road closure of the N7 would not be necessary for this flood. For flood of 5-year return period and greater (20% - 0.1% AEP), the hydraulic model shows that the N7 will be fully inundated and closure of the N7 at Castlewarden Junction 6 will be required. This is in compliance with the FHRC 2013 and UK Environmental Agency guidelines, and to prevent unsafe conditions where vehicles could aquaplane. As such further analysis of traffic disruption due to flooding has been applied to floods with a return period of 5 years and greater.

The assessment of the traffic disruption occurring when the roads become impassable was carried out based on the assumptions for traffic data as summarised and presented below in Table 4.16. It is

worth noting that the number of cars and number of LGVs are summarised in one figure as no specific AADT data is available for these respective vehicle types.

Table 4.11: NRA traffic data assumed for diversion route

Road Route	AADT	% HGV	No. Cars /LGVs	No. HGVs
N7 - Junction 1	78,407	7.8	72,291	6,116
N7 - Junction 8 (No Data for No 9)	73,938	7	68,762	5,176
M50 - Junction 7-9	120,005	6.6	112,085	7,920
M4 - Junction 7	51,175	4.7	48,770	2,405
N4 - Junction 1	96,047	3.7	92,493	3,554
R406,R403,R407,R445 *(estimate)*	6,000	4.0	5,760	240

For the purposes of this analysis it is assumed that the traffic speed depends on the quality of the road being used. Roads speeds are detailed in Table 4.17.

Table 4.12: Design speeds for HGVs and Cars/LGVs

Road Category Design Speed	National Motorway (M4)	National Motorway (M50 -Jctn 7-9)	National Primary Roads (N7, N4)	Regional Roads (R406, R403, R407, R445)
HGV km/h	80	80	80	80
Cars /LGVs km/h	120	100	100	80

The distance of the diversion route is compared to the original route in Table 4.18.

Table 4.13: Original route and diversion route distances

Route	National Motorway (M4)	National Motorway (M50 -Jctn 7-9)	National Primary Roads (N7, N4)	Regional Roads (R406, R403, R407, R445)
Original Route Distance (km)	0	0	20.5	0
Diversion Route Distance (km)	8	4.3	6.3	23.3
Difference (km)	-8	-4.3	14.2	-23.3

The detour route above represents net additional travel distances of 21.4km on motorways, national primary roads and regional roads. The associated travel times have been calculated based on these diversion route distances, together with a percentage of the design speed for the respective roads. The standard NRA practice for calculating travel time is to apply the 85th percentile to a road's design speed.

In addition, considering the high volume of traffic being diverted from the N7 onto the already congested M50 and N4/M4; and also then onto the regional roads which would not be accustomed or designed for the increased capacity of traffic, the 50th and 20th percentile of the design speed has been used to calculate an amended travel time for the diversion route. Travel times associated with the diversion route distance and the 85th, 50th and 20th percentile of the respective road's design speed are included in Table 4.19.

Table 4.14: Diversion route travel times

Vehicle Type	Road Description	National Motorway (M4 - Approx 8.0km)	National Motorway (M50 - Approx 4.3km)	National Primary Roads (N7, N4)	Regional Roads (R406, R403, R407, R445)	Total Travel Time for Diversion Route (h)
HGV	Design Speed (DS)(km/h)	**80**	**80**	**80**	**80**	-
	Travel Time (h) (85%ile DS-68km/h)	0.118	0.063	0.093	0.343	**0.62**
	Travel Time (h) (50%ile DS-40km/h)	0.200	0.108	0.158	0.583	**1.05**
	Travel Time (h) (20%ile DS-16km/h)	0.500	0.269	0.394	1.456	**2.62**
Car / LGV	Design Speed (DS)(km/h)	**120**	**100**	**100**	**80**	**-**
	Travel Time (h) (85%ile DS)	0.078	0.051	0.074	0.343	**0.55**
	Travel Time (h) (50%ile DS)	0.133	0.086	0.126	0.583	**0.93**
	Travel Time (h) (20%ile DS)	0.333	0.215	0.315	1.456	**2.32**

It is should be noted that an important consideration to be accounted for in calculation of travel time is the additional time for navigating through junctions, as it causes traffic to back-up and extends delays.

To account for the time delay due to junction turnings on the diversion route, the following travel time assumptions have been made: right turn from the R403 to the R406 at Barberstown Castle = 10 minutes, left turn from the R403 to the R407 in Clane = 20 minutes, left turn from the R407 to the R445 in Naas Town = 20 minutes. This equates to a total of 50 minutes (0.833 hr) of junction delay time.

Furthermore, as noted by Kildare County Council, Clane, Sallins and Naas Town are prone to traffic congestion. In a flooding event, the traffic flow on the diversion route via the regional roads (R406, R403, R407 and R445) is assumed to be very slow, particularly due to the higher volume of vehicles on roads designed as minor routes, as such the 20th percentile of the design speed has been applied to the regional roads.

Taking into consideration the increased volume of diverted traffic (78,407) from the N7 re-routed via the M4, N4 and M50, which commonly suffer from traffic congestion problems; it has been assumed that in a flooding event associated with the Morrell River, the traffic flow would be the 50th percentile of the design speeds of the respective roads. Based on these assumptions for traffic flow, and the junction turning delays, the amended version of the diversion travel times as calculated in Table 4.19 are displayed in Table 4.20.

Table 4.15: Amended diversion route travel times

Vehicle Type	National Motorway (M4) 50%ile - DS	National Motorway (M50) 50%ile - DS	National Primary Roads 50%ile - DS	Regional Roads 20%ile - DS	Travel Delay at Junctions (h)	Total Travel Time for Diversion Route (h)
HGV Travel Time (h)	0.200	0.108	0.158	1.45625	0.833	**2.754**
Car / LGV Travel Time (h)	0.133	0.086	0.126	1.456	0.833	**2.635**

4.4.3.4 Economic values of time and operation costs

In accordance with the recommendations set out by the Department of Transport to conduct an economic appraisal of a transport project, in this case the diversion route; the values of time, vehicle operating costs and accident costs should be considered. The economic values of time and vehicle operating costs are taken from a Department of Transportation document entitled "Guidelines on a Common Appraisal Framework for Transport Projects and Programmes" from June 2009 (Department of Transportation, 2009). The parameter values (which are those values recommended for economic appraisal) in these guidelines are at 2002 prices in order to facilitate project appraisals and comparisons of the economic return across transport projects generally. The Department of Transport may issue updates of these parameter values from time to time; but for the purpose of this Cost Benefit analysis, the consumer price index (CPI) was applied to bring the 2002 costs to 2014.

The guidelines recommend Market Cost Values for working and non-working time of €26.50 and €8.10 per hour respectively.

- Estimate of working time at 2014 value = €26.50 x 1.3972 = € 37.03 / hour.
- Estimate of non-working time at 2014 value = €8.10 x 1. 3972 = € 11.32 / hour.

The "Project Appraisal Guidelines – Unit 6.11 National Parameter Values Sheet" published by the NRA in July 2011 were used to estimate the 'occupancy/vehicle' and the 'proportion working' for the various vehicles types, and the peak hour 'Flow Group 4' values were assumed.

Cars and LGVs are combined in the analysis to reflect the AADT data. The average value in 'work' and 'commuting' time modes was calculated for cars and LGVs and values applied for the 'occupancy/vehicle' and the 'proportion working' for these vehicles. For cars/LGVs and HGVs, the 'proportion working' was calculated as the sum of 'work' and 'commuting', and the 'proportion non-working' was calculated as the 'other non-work' value from the guidelines. The contributing parameters and calculations are presented in Appendix B.

The potential time loss is displayed in Table 4.21 as follows:

Table 4.16: Potential time loss

Vehicle Category		Cars / LGVs	HGVs
No./day		72,291	6,116
Occupancy/vehicle		1.33	1.17
Passengers/day		96147	7155
Proportion Working	%	70.1	92.6
No. working		67,399	6,626
No. non-working		28748	530
Time/loss/vehicle	(hr)	2.63	2.75
Working time loss/day	(hrs)	177,569.09	18,249.44
Non-working time loss/day	(hrs)	75,739.17	1,458.38
Working time	(€/hr)	€37.03	€37.03
Non working time	(€/hr)	€11.32	€11.32
Working time loss	(€/hr)	€6,574,637.44	€675,700.28
Non working time loss	(€/hr)	€857,164.40	€16,504.94
Sub total	€	€7,431,801.83	€692,205.22
Total time loss/day	€	**€8,124,007.05**	

Operating costs for cars/LGVs and HGVs, which comprise of 'fuel costs' & 'non-fuel costs' have been calculated at Market Cost Value as per the recommendations in the 2009 Department of Transport guidelines. The costs presented pertain to 2002 estimate and have been factored up accordingly to 2014 costs using the CPI index. The estimates for the total operating costs due to traffic diversions were calculated and are shown in Table 4.22.

It should be noted that the AADT Traffic Count from the NRA does not give a breakdown of percentage of cars to LGVs, as such it has been assumed that all vehicles not HGVs are cars. This will reduce the operating costs incurred for the diversion route but, in the absence of further specific information, this conservative assumption has been made. It is assumed that HGVs fall under the category of OGV(1) (vehicles >3.5tonnes, with 2-3 axles), which is approximately half the operating costs of OGV(2) (vehicles with 4 axles, or articulated vehicles with 3 axles). Again this assumption is conservative as in the absence of further information it may underestimate the actual operating cost incurred by HGVs.

Table 4.17: Operating costs due to traffic diversion

Vehicle Type	No. of Vehicles	Fuel Costs (cents/km)	Non-Fuel Costs (cents/km)	Operating Costs (€/km)	Diversion Route	Distance (km)	Costs (€/day)
Car / LGVs	121,061	7.768	9.375	0.171	M4 @ 60 km/hr	8.3	€172,260
	184,376	8.579	9.515	0.181	M50 @ 50 km/hr	4.3	€143,450
	164,785	8.579	9.515	0.181	N4 @ 50 km/hr	6.3	€187,839
	78,051	14.643	11.443	0.261	Regional @ 16 km/hr	23.3	€474,393
HGVs	8,521	26.673	33.980	0.607	M4 @ 40 km/hr	8.3	€42,896
	14,036	26.673	33.980	0.607	M50 @ 40 km/hr	4.3	€36,607
	9,669	26.673	33.980	0.607	N4 @ 40 km/hr	6.3	€36,948
	6,356	38.046	48.301	0.863	Regional @ 16 km/hr	23.3	€127,870
Total Vehicle Operating Cost on Diversion Route / day							**€1,222,264**

4.4.3.5 Economic value of accidents

Statistically, accident frequency is related to the distance travelled on different classes of road and is given in terms of accidents per million vehicle kilometres. Using the accident rates and costs abstracted from the "Project Appraisal Guidelines – Unit 6.11 National Parameter Values Sheet" published by the NRA in July 2011; the accident rates, accident proportions and severity, casualty severity, number of casualties per accident, and the associated costs were calculated for each road type and number of vehicles on the detour route. The stretch of the N4 road on the detour route between the M50 and start of the M4 at Leixlip has three lanes and a bus lane in each direction. Within the guidelines there is no classification for this specific road type. For the purpose of accident cost calculation, this stretch of road has been assumed to be a dual-carriageway. Table 4.23 presents the summary of the potential accident cost calculation. The detailed breakdown of the Potential Accident Cost calculation parameters is provided in Appendix B.

Table 4.18: Potential accident costs per day

Road Type	Vehicles / Day	Distance (km)	Vehicles km / Day	Accident Rate PIA/mvkm	Total Potential Accident & Casualty Costs / Day - per road type	Total Potential Accident & Casualty Costs / Day
					€	€
Motorway - M4 & M50 ≤ 60 km/hr	249,587	12.6	3,144,796	0.026	€25,447	**€126,568**
Dual Carriageway - N4 ≤ 60 km/hr	174,454	6.3	1,099,060	0.144	€18,732	
2 Lane Single Carriageway - Regional Roads ≤ 60 km/hr	84,407	23.3	1,966,683	0.202	€82,390	

4.4.3.6 Summary of potential costs for N7

A summary of the economic appraisal of the loss per day incurred in relation to the values of time, vehicle operating costs and accident costs due to the closure of the N7 at Junction 6 – Castlewarden is outlined in Table 4.24.

Table 4.19: Summary of potential costs per day for N7 damages

Category	Loss (€ / day)
Time	€8,124,007.05
Vehicle Operating Costs	€1,222,263.97
Accidents	€126,568.42
Total Cost per Day	**€9,472,839.44**

A sensitivity analysis was carried out for the total losses for the various flood return periods using the potential cost per day calculated for road closure of the N7 at Junction 6, and a range of delay times calculated using Approach A, Approach B, and Approach C to estimate flood duration of the roadway. Table 4.25, Table 4.26 and Table 4.27 present the total losses for the various flood return periods calculated using Approach A, Approach B and Approach C respectively.

Table 4.20: Potential road closure costs of the N7 at junction 6 - using Approach A

Flood Return Period	Flood Duration (Days) - 'Do Nothing' Scenario	Flood Duration (Days) - 'Do Minimum' Scenario	Net Flood Duration (Days)	Potential Costs €
2 year	0.00	0	0.00	**€0**
5 year	0.25	0	0.25	**€2,368,210**
10 year	0.25	0	0.25	**€2,368,210**
20 year	0.5	0	0.5	**€4,736,420**
50 year	0.5	0	0.5	**€4,736,420**
100 year	1	0	1	**€9,472,839**
200 year	2	0	2	**€18,945,679**
1000 year	4	0	4	**€37,891,358**

Table 4.21: Potential road closure costs of the N7 at junction 6 - using Approach B

Flood Return Period	Flood Duration (Days) - 'Do Nothing' Scenario	Flood Duration (Days) - 'Do Minimum' Scenario	Net Flood Duration (Days)	Potential Costs €
2 year	0.00	0	0.00	**€0**
5 year	0.25	0	0.25	**€2,368,210**
10 year	0.25	0	0.25	**€2,368,210**
20 year	0.29	0	0.29	**€2,762,912**
50 year	0.33	0	0.33	**€3,157,613**
100 year	0.42	0	0.42	**€3,947,016**
200 year	0.44	0	0.44	**€4,144,367**
1000 year	0.46	0	0.46	**€4,341,718**

Table 4.22: Potential road closure costs of the N7 at junction 6 – using Approach C

Flood Return Period	Flood Duration (Days) - 'Do Nothing' Scenario	Flood Duration (Days) - 'Do Minimum' Scenario	Net Flood Duration (Days)	Potential Costs €
2 year	0.00	0	0.00	**€0**
5 year	0.17	0	0.17	**€1,578,807**
10 year	0.17	0	0.17	**€1,578,807**
20 year	0.21	0	0.21	**€1,973,508**
50 year	0.25	0	0.25	**€2,368,210**
100 year	0.33	0	0.33	**€3,157,613**
200 year	0.35	0	0.35	**€3,354,964**
1000 year	0.38	0	0.38	**€3,552,315**

The potential costs calculated for the various flood events in the Tables 4.25, 4.26 and 4.27 demonstrate the cost sensitivity to the various approaches taken to calculate traffic delay from flood durations. It is evident that there is a large discrepancy between using the MCM Handbook reduced figures in Approach A, to the results from the hydraulic model in Approach B and Approach C. The MCM Handbook recommends that local knowledge be used to refine the estimations made for indicative delay durations presented in the document. The hydraulic model results show that flood events in the Morrell system at Junction 6 on the N7 are experienced as relatively flashy and do not cause excessively prolonged flooding in the longer return periods, (i.e. 1%, 0.5% and 0.1% AEP). From these results, the time delays and potential costs using Approach A, the worst case scenario, are considered excessive and unlikely. It is clear that Approach B and Approach C, based on the hydraulic model, are more conservative and of similar magnitude in potential cost of delay, with Approach C resulting in a lower potential cost as it makes no provision for delays in re-routing traffic pre and post total roadway inundation.

The NRA and the Steering Group for the Morrell River Flood Alleviation Scheme have agreed that an allowance of 1 hour either side of a flood event at Junction 6 on the N7 is a valid assumption for delays in re-routing traffic to and from diversion routes. As such it has been concluded that Approach B is the most accurate and applicable for calculating traffic delays and associated costs for the traffic disruption.

4.4.3.7 Potential cost for other routes

An alternative detour route that could be utilised in a Morrell River flooding event would be to divert traffic at Junction 3 – City West on the N7, and direct it south on the N82 as far as the N81, traffic would continue south on the N81 as far as Blessington Village, where it would turn north on the R410 as far as Naas Town, then take the R445 back to the N7 at Junction 9. This alternative detour route is illustrated below in Figure 4.6.

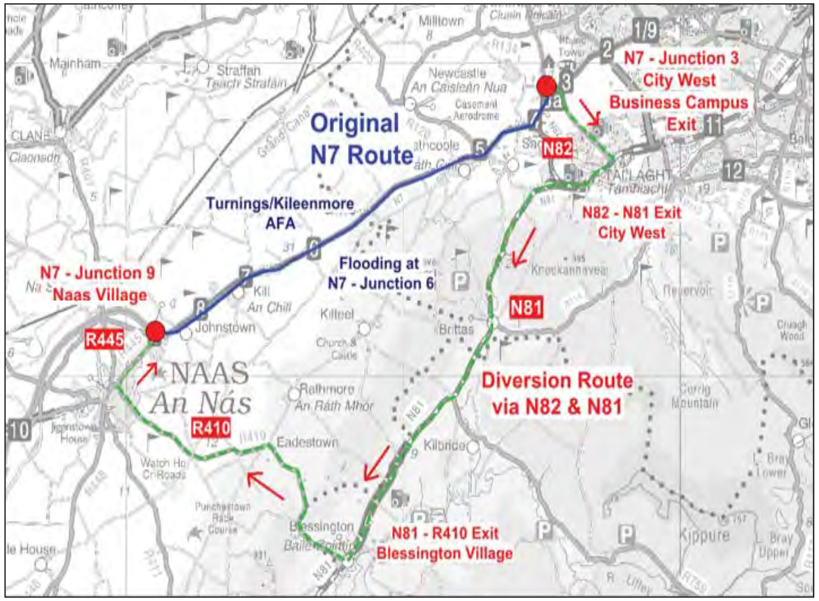


Figure 4.5: Alternative diversion route for N7 traffic via N82, N81, R410 and R445

This detour route has not been applied in the N7 damage assessment as the Steering Group for the Morrell River Flood Alleviation Scheme identified the diversion route via M50, N4, M4, R406, R403 & R407 as the preferred detour route, and concluded that the traffic disruption would be of similar magnitude on any alternative route.

4.5 SUMMARY OF N7 DAMAGES

The discounted total present value of the damages for flooding of the N7 at Junction 6 is calculated for Approach A, Approach B and Approach C using a discount rate of 4% over 50 years as per the recommendations of the Department of Finances and the National CFRAM Programme Guidance Note No. 29. Table 4.28 presents a summary of the discounted present value for N7 damages for the various approaches, with the details of these calculations shown in Appendix A**.** As discussed, it has been concluded that Approach B is the most accurate and applicable for calculating traffic delays and associated costs for the traffic disruption.

Table 4.23: Discounted pvD for flooding of the N7

N7 Damage Assessment Method of Time Delay Calculation	Discounted Net Present Value of Damages for 50 year period (€)
Approach A	€25,080,825
Approach B	**€15,984,998**
Approach C	€13,025,834

4.6 SUMMARY OF TOTAL DAMAGES

The overall total of the damages arising for flooding of the Lower Morrell catchment, which includes the combined damages of flooding of the residential and non-residential properties, and the N7, are summated and shown below in Table 4.29.

Table 4.24: Total Damages due to flooding of the Morrell Catchment

Description	Discounted Net Present Value of Damages (€)
Property Damages	€4,020,650
N7 Damages	€15,984,998
Total Damages	**€20,005,648**

5 FLOOD RISK MANAGEMENT MEASURES

There are various measures to manage the flood risk within any study area. These can be grouped into 4 areas.

- Protect measures - reduce the likelihood of flooding. Measures include flood walls, flow diversion and upstream storage.
- Prepare measures - reduce the impact of flooding. Measures include individual property protection, flood forecasting and public awareness campaigns.
- Prevent measures - avoids future flood risk. Measures include planning and development control.
- Permit measures - accepts that flooding will occur. Measures include maintaining the existing regime and doing a minimal amount of maintenance.

The Morrell FAS study has set an objective to identify viable structural and non-structural options and measures for the effective and sustainable management of flood risk within the study area. With this being said it is an aspiration of the study to provide the highest standard of flood risk management to protect all receptors at risk from the design event. This would, in general, entail providing 'protect' methods over 'prepare' methods and avoiding 'permit' methods where possible. Prevent methods should always be included to ensure flood risk is continually managed into the future.

5.1 STANDARD OF PROTECTION

The standard of flood risk management is dependent on the design standard being applied i.e. the maximum level of protection that the FRM measures provide. The preferred design standard for this study is the 1% AEP event for fluvial flood risk. The FRM measures achieving the design standard must also have provision for adaptability to the mid-range future scenario (MRFS) flood risk, as recommended by the CFRAM process.

Where there is a clear technical, economic, social or environmental case as to why the preferred standards would not be appropriate or acceptable; or where the adoption of alternative standards would provide significant additional benefit in relation to costs and impacts, this is also considered.

5.1.1.1 Residual risk

For any FRM option, the flood risk to a study area can never be totally eliminated as a flood event greater than the design standard can occur, this is referred to as residual risk. The design standard for the Morrell catchment is the 1% AEP event. It can therefore be assumed there will be residual damage for the 0.5% and 0.1% AEP flood events.

For the purposes of this study it is assumed that for FRM methods that contain the flow within the river channel, such as flood walls, the residual damage for flood events greater that the design standard will be the same as the present day current damages. For FRM measures that reduce the flow, such as upstream storage, a benefit will be provided during flood events greater than the design standard event and therefore will be calculated.

5.2 LIST OF FRM MEASURES

It is required under National Policy that certain non-structural FRM measures be applied regardless of other proposed measures; these include:

- Application of the Guidelines on the Planning System and Flood Risk Management (DoELG & OPW, November 2009);
- Preparation of emergency response plans for severe weather events, including flood events (A Framework for Emergency Management, DoELG).

As these measures will be applied regardless of the outcome of the Multi-Criteria Analysis (MCA) process, they will not be subject to MCA appraisal, but should be assumed to be included in all proposed FRM options.

Table 5.1 presents a long list of structural and non-structural FRM measures and a descriptions of what flood risk management function which they perform. RPS have considered all of these measures initially for the Morrell catchment.

Table 5.1: Long list of FRM measures

FRM Method	Method type	Description
Do Nothing	Permit	Implement no new flood risk management measures and abandon any existing practices.
Maintain Existing Regime	Permit	Continue any existing flood risk management practices, such as reactive maintenance.
Do Minimum	Permit	A measure that can be used as a baseline for testing other options, as it assumes no active intervention but recognises on-going maintenance activities.
Planning and Development Control	Prevent	Zoning of land for flood risk appropriate development, prevention of inappropriate incremental development, review of existing Local Authority policies in relation to planning and development and of inter-jurisdictional co-operation within the catchment.

FRM Method	Method type	Description
Building Regulations	Prevent	Regulation relating to floor levels, flood proofing, flood resilience, sustainable drainage systems, prevention of reconstruction, or redevelopment in flood risk areas.
Catchment Wide SuDS	Prevent	Implement attenuating infrastructure to the existing drainage system in order to reduce the flow entering the river network. This may consist of swales, french drains, soak aways, larger culverts, underground storage tanks, ponds, green roofs, etc.
Land Use Management	Protect	Changing how the land is used in order to store or slow surface water runoff and slow in channel and out of bank flow along the river in order to store flood water in suitable locations. This may consist of the creation of wetlands, restoring river meanders, increasing the amount of boulders and vegetation in channel, perpendicular hedges or ditches in the floodplain, tree rows and planting in floodplain to either slow flow or direct flow, planting along banks parallel to flow, fencing off livestock from riparian strip, changing agricultural practices to decrease soil compaction and increase water infiltration.
Strategic Development Management	Prevent	Management of necessary floodplain development (proactive integration of structural measures into development designs and zoning, regulation on developer-funded communal retention, drainage and/or protection systems).
Maintenance Programme	Protect	Increased frequency of routine maintenance, targeting of problem culverts, bridges or other control structures, removal of debris and rubbish tipping, desilting of sedimentation prone areas.
Upstream Storage/Storage	Protect	Large scale dam and reservoir, offline washlands (embanked areas of floodplain to store water during larger flood events).
Tidal Barrage	Protect	A fixed or moveable barrier across the river to prevent tidal water progressing upstream.

FRM Method	Method type	Description
Improvement of Channel Conveyance	Protect	Deepening of channel bed, widening of channel, realigning long section profile, removal of constraints, lining or smoothing channel.
Hard Defences	Protect	Reinforced concrete walls, earth embankments, demountable barriers.
Relocation of Properties	Protect	Abandoning flood risk area and properties within and providing alternative properties in suitable area.
Culverting	Protect	Routing the watercourse underground through culverts to prevent out of bank flooding along a specific stretch.
Diversion of Flow	Protect	Removing flow from the watercourse via a diversion and discharging to a suitable river or coastline or reintroducing the flow further downstream. This may consist of a culvert or an open channel.
Overland Floodways	Protect	Using topographical features of the floodplain to convey out of bank flow and discharge to other suitable rivers, the coast line, further downstream on the same river or to an open area for storage. This may consist of fields, park land, roads, etc.
Sealing Manholes	Prevent	Preventing pressurised culverts from surcharging through manholes and flooding the surrounding area.
Rehabilitation of Existing Defences	Protect	Improvement of existing flood defences.
Localised Protection Works	Protect	Minor raising of existing defences/levels, infilling gaps in defences, etc.
Flood Warning/Forecasting	Prepare	Installation of flood forecasting and warning system and development of emergency flood response procedures.
Public Awareness Campaign	Prepare	Informing public who live, work or use a flood risk area on risks of flooding and how to prepare for flooding.

FRM Method	Method type	Description
Individual Property Protection	Prepare	Flood protection and resilience measures such as flood gates, vent covers, use of flood resilient materials, raising electrical power points, etc.

5.3 BASELINE CONDITION

The existing flood risk management measures in the Morrell catchment include some hard defences, culverts and very basic individual property protection. The existing hard defences are embankments that have been built by the local landholders in a number of fields adjacent to tributaries of Morrell river system.

The existing culverts along the channel are old and in varying condition; some of the larger culverts / bridges are showing signs of disrepair, with the structural supports being undermined by scour erosion, a number of the smaller culverts are screened and require debris to be cleared, and the culvert near Castlewarden at the N7 is under capacity. In 2002 there were works completed, whereby box culvert sections were constructed beside a number of the older bridges in the catchment for overflow requirements. The design standard of these works was to convey a 2% AEP flood event, as was in accordance with recommendations at that time. In the past six years Kildare County Council has undertaken some light maintenance work, specifically removing silt from these overflow culverts to restore them to full capacity, however Kildare County Council have noted that the silt builds and blocks the culvert quite quickly after maintenance works has been completed. It should be noted that no silts or gravels have been removed from the river channel itself, in compliance with the Inland Fisheries Ireland (IFI) restrictions.

RPS also identified during walkover surveys of the catchment that some existing individual property protection is provided through use of sand bags placed on the periphery of properties as a temporary barrier in flood events.

In terms of a baseline maintenance program, there is no formal regime in place by Kildare County Council or the OPW for the Morrell River System. Therefore the baseline condition is such that the ‘Do Nothing’ measure is assumed to be equivalent to the ‘Maintain Existing Regime’ measure. At present any maintenance works are reactionary, and in the event of emergency works being required, i.e. resulting from severe weather events, fallen trees, large specific blockages, etc., Kildare County Council on behalf of the OPW would manage such a situation.

In terms of flood risk approximately 30 properties and one commercial businesses (excluding farms), in addition to flooding the N7, and local roadways, fields and golf courses in the catchment are inundated during the 1% AEP event. In order to provide a baseline scenario against which the proposed FRM options can be assessed, a ‘Do Nothing’ option will provide this comparative function with the existing condition. A plan drawing showing the existing Baseline Scenario for 1% AEP flood events in the catchment is provided in Appendix B.

6 ASSESSMENT OF FRM MEASURES

The development of FRM options for the Morrell catchment follows the flow chart in Figure 6.1. This process has been developed to demonstrate that all feasible measures have been considered and that suitable justification has been provided by those measures which have been included and also those which have been rejected.

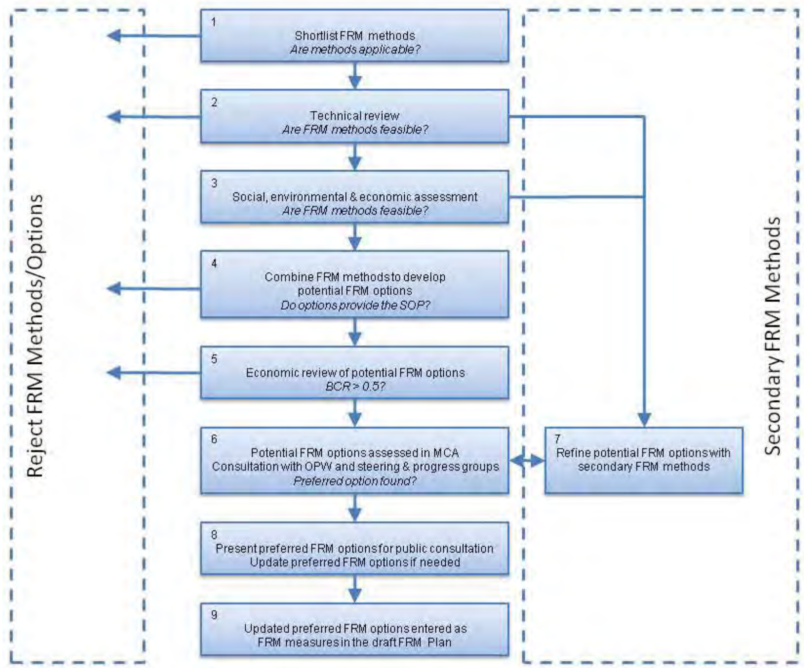


Figure 6.1: Flood risk option development flow chart

The flow chart summarises in boxes 1 to 3 how the screening of FRM measures is carried out. Boxes 4 and 5 describe how the feasible FRM measures that come through the screening are developed into potential FRM options and box 6 shows how the potential FRM options are assessed to identify the preferred FRM options. If however no preferred FRM option is identified, box 7 shows how the options can be refined with additional or other FRM measures and reassessed. The preferred FRM options are then taken forward to public consultation and, if required, updated to reflect the comments and issues raised before presenting the final FRM measure in the FRM Plan as shown in boxes 8 and 9.

6.1 SCREENING OF FRM MEASURES

The aim of the screening process is to ensure the widest possible range of FRM measures are considered in the assessment process while the rejection of any methods is robust and with clear and transparent reasoning. The long list of measures in Table 5.1 is consistent with those being proposed by the OPW CFRAM Studies.

6.1.1 Applicability review

As a first step in the screening process each of the long list of measures has been reviewed against its applicability for the Morrell catchment and those which are obviously unsuitable have been removed. Table 6.1 summarises this review.

Table 6.1: Applicability review

Measure	Review comment	Applicable?
Do nothing	Baseline condition. Consider further	✓
Maintain existing regime	Equivalent to 'Do Nothing' measure as no maintenance program in place. Not applicable.	×
Do minimum	Equivalent to 'Do Nothing' measure as no maintenance program in place. Not applicable.	×
Planning and development control	Consider Further	✓
Building regulations	Considered further	✓
Catchment wide SuDS	Consider further	✓
Land use management	Consider further	✓
Strategic development management	Consider further	✓
Maintenance programme	Consider further	✓
Upstream storage/storage	Consider further	✓
Tidal barrage / flap valve	Not applicable due to the Morrell catchment's inland location	×
Improvement of channel	Consider further	✓

Measure	Review comment	Applicable?
conveyance		
Hard defences	Consider further	✓
Relocation of properties	Consider further	✓
Culverting	Consider further	✓
Diversion of flow	Consider further	✓
Overland floodways	Consider further	✓
Rehabilitation of existing defences	Consider further	✓
Localised protection works	Consider further	✓
Flood warning / forecasting	Consider further	✓
Public awareness campaign	Consider further	✓
Individual property protection	Consider further	✓
Sealing manholes	Not applicable as there are no manholes	×

6.1.2 Technical review

All remaining measures were then reviewed on their technical merits and their ability to alleviate the specific mechanisms of flooding that exist in the Morrell catchment. This is based on engineering judgement, information from local engineers, feedback from stakeholders, flood mapping, and review of the model output.

Table 6.2 provides the technical review of the applicable measures indicating:

- those that have a reasonable likelihood of providing the required standard of protection to the majority of properties at risk from a 1% AEP event;
- those that have some technical merit and could solve some localised flooding issues but will only address flooding to a small number of properties at risk during the 1% AEP event; and
- those which have been excluded from the option development process at this stage.

The symbol "►" indicates the measure will be retained but not assessed as part of the MCA. This is usually because generally it is a national or regional policy that will be applied regardless of the options proposed for the Morrell. The "✓" symbol indicates the measure has technical merit and will be considered as part of the MCA and the symbol "×" indicates the measure has been rejected.

Table 6.2: Technical review of applicable measures

Measure	Review comment	Technically feasible?
Do Nothing	Baseline Condition. This measure is to be kept in for comparative purposes.	✓
Planning and development control	This measure is to be kept in order to manage future flood risk. It does not require assessment through MCA as it is required under National Policy as part of Planning and ensure consistency with National Planning Guidelines for Flood Risk Management.	►
Building regulations	This measure is to be kept in order to manage future flood risk and could inform a recommendation to a nationwide approach to flood resilience. This measure will not require assessment through the MCA process but will provide recommendations in the plan.	►
Retro-fitted SuDS	This measure will have negligible impact as the majority of the Morrell catchment is rural so it is not technically possible to introduce across all of catchment but may solve very localised flooding issues. This measure will not require assessment through the MCA process but will provide recommendations in the plan.	►
Land use management	This measure may have some influence on certain areas of the Morrell catchment but will not resolve all flooding issues. Measure can continue through screening process.	✓
Strategic development management	No Strategic Development is envisaged for the Morrell catchment that would require this measure but it will be kept to address future flood risk. This measure will not require assessment through the MCA process but will provide recommendations in the plan.	►

Measure	Review comment	Technically feasible?
Maintenance programme	Existing maintenance programme has been influenced by recent flood events and is important to minimise risk from smaller rainfall events. Will be required regardless of the chosen option. As such, this measure will not require assessment through the MCA process but will provide recommendations in the plan.	►
Upstream storage / Storage	Measure can continue through screening process as viable measure.	✓
Improvement of channel conveyance	Measure can continue through screening process as viable measure.	✓
Hard defences	Measure can continue through screening process as a viable measure.	✓
Relocation of properties	There are approximately 60 properties at risk in a 1% AEP flood event (Q100). It is considered that it would be an excessively socially complex measure to relocate all properties, and while it is technically feasible it should be considered further if other measures are found to be unsuitable.	►
Culverting	May have some influence on certain areas in Morrell catchment but will not resolve all flooding issues. Measure can continue through screening process.	✓
Diversion of flow	The Morrell river system consists of several tributaries, the diversion of which may have some influence on certain areas in Morrell catchment but will not resolve all flooding issues. Measure can continue through screening process.	✓
Overland floodways	Overland floodways currently exist in the flooding areas at risk within the Morrell catchment. May have some influence on certain areas in Morrell catchment but will not resolve all flooding issues. Measure can continue through screening process.	✓
Rehabilitation of existing	Existing defences may have been influenced by recent	✓

Measure	Review comment	Technically feasible?
defences	flood events and is important to minimise risk from smaller rainfall events. Will be required regardless of the chosen option. Measure can continue through screening process.	
Localised protection works	Along certain reaches of the Morrell river system there is potential to provide localised defence infrastructure but will not resolve all flooding issues. Measure can continue through screening process.	✓
Flood warning/forecasting	Flood warning/forecasting would not be effective in reducing the impact of flooding but could be effective as possible management scale measure that could minimalize residual flood risk. This measure should be kept as part of the National Policy for preparation of emergency response plans for severe weather events, including flood events (A Framework for Emergency Management, DoELG) and will not require assessment through the MCA process but will provide recommendations in the plan.	►
Public awareness campaign	A public awareness campaign could be effective in reducing the impact of flooding but will not reduce the flood risk itself. This measure should be kept as part of the National Policy for Preparation of emergency response plans for severe weather events, including flood events (A Framework for Emergency Management, DoELG) and will not require assessment through the MCA process but will provide recommendations in the plan.	►
Individual property protection	Along certain reaches of the Morrell river system there is potential to provide very localised defence infrastructure but will not resolve all flooding issues or the overall flood risk. Measure can continue through screening process, while it is technically feasible it should be considered further if other measures are found to be unsuitable.	✓

Table 6.3 provides a summary of the FRM measures for the Morrell catchment that have passed through the screening process and are to be considered for the proposed FRM options. Table 6.4 provides a summary of the FRM measures that will not be screened through the MCA, but will be considered within the FRM Plan.

Table 6.3: Summary of FRM Measures

FRM Measures to be Considered in Proposed Options
Do Nothing
Land use management
Upstream Storage / Storage
Improvement of Channel Conveyance
Hard defences
Relocation of Properties
Culverting
Diversion of flow
Overland floodways
Rehabilitation of existing defences
Localised protection works
Individual property protection

Table 6.4: Summary of FRM Measures to be considered in FRM Plan

FRM Measures not included in MCA but to be Considered in FRM Plan
Planning and development control
Building regulations
Retro-fitted SuDS
Strategic Development Management
Maintenance Regime
Flood warning/forecasting
Public awareness campaign

6.1.3 Environmental and social review

It is important to ensure that methods being brought through the assessment process will not have significant detrimental environmental, social/cultural or economic impacts. To this end each measure that has come through the technical review is screened in terms of potential environmental and social/cultural impacts.

The following issues were considered when developing the methodology for screening methods in relation to their potential to impact on environmental, social and cultural receptors:

- The methodology must be robust and defendable;
- The methodology must be rapid and replicable;
- The methodology must be precautionary to avoid rejecting measures at an early stage which might prove to be the best available measures to manage flood risk;
- The methodology must not overlap the multi-criteria analysis and environmental assessment processes.

In order to fulfil these aims, the methodology considers whether the measures are likely to have a direct or indirect negative effect on Special Areas of Conservation (SACs), Special Protection Areas (SPAs) or Unesco sites.

- If there are no SACs, SPAs or Unesco sites within the footprint of the proposed measure, directly adjacent to the proposed measure, or directly upstream or downstream of the proposed measure, then the measure can continue through the screening process as a primary measure.
- If an SAC, SPA or Unesco site is within the footprint of the proposed measure, directly adjacent to the proposed measure or directly upstream or downstream of the proposed measure, then the measure cannot be considered as a standalone measure at this stage and is classed as a secondary measure.

This methodology ensures that when a measure has been flagged as potentially having a negative impact on an SAC, SPA or Unesco site, the optioneering team will put the measure aside and consider other measures which have not been flagged in terms of environmental, social or cultural impacts first.

All of the measures pass through this review to the next stage of the screening process.

6.1.4 Economic review

The economic review aims to ensure that only measures likely to be cost beneficial will progress to the more detailed assessment. This was carried out by calculating the benefit available and comparing that to the cost of implementing the measure.

The benefit available was quantified through the present value damage (pvD), as described in the damage assessment in chapter 4. Benefit is a monetary measurement and considers the reduction in damage between the baseline condition (Option 4 – Do Nothing) and the FRM measure or option being considered. In practice the benefit usually equates to the baseline condition damage up to the design standard of the FRM measure/option being considered plus the reduction in residual risk beyond the design standard.

In adherence with the OPW National CFRAM Programme Guidance Notes (OPW, 2013), in order to ensure that the screening process is conservative, only the construction cost associated with the FRM measure in question was considered. Costs associated with other works such as design and maintenance of the FRM measure were excluded at this stage. This allows more FRM measures to pass through the economic review to be assessed in more detail. A ratio between the benefit and construction cost provides the basis for screening out measures. FRM measures achieving a benefit cost ratio (BCR) of 0.5 or greater were considered further. Setting the minimum BCR at 0.5 recognises that when FRM measures are developed into FRM options, the quantities (i.e. length of flood wall etc) of any given FRM measure can change and therefore so too can the BCR. A BCR of 0.5 is therefore a conservative approach while still identifying excessively expensive measures.

The cost of constructing FRM measures has been calculated using data from OPW, local authorities, the Environment Agency and RPS. This data is based on previous similar schemes using real costs.

This data is presented as rates to be applied to the FRM measures depending on the quantities involved.

The ratio between the benefit and the cost is calculated and where a ratio of less than 0.5 is achieved then those measures are classed as secondary measures as they are unlikely to produce a cost beneficial scheme. All other measures achieving a ratio over 0.5 are progressed to the more detailed study.

6.2 DEVELOPING PROPOSED FRM OPTIONS

The FRM measures which have progressed through the technical, environmental, social and economic screening are combined to create potential FRM options. This is required because although most measures provide significant reductions in flood risk, they will not individually provide the required standard of protection. Measures are therefore required to be combined into options so that they will manage the flood risk and achieve the objectives set by the study. All possible combinations of FRM measures are considered as potential FRM options; however, only options that can provide the required design standard are progressed further. All options must, as minimum criteria, meet the objective of protecting all assets within the Morrell Catchment for in a 1% AEP event; otherwise they should be rejected.

6.2.1 Proposed FRM Options

The proposed FRM Options developed for the Morrell River FAS are outlined in Table 6.5.

Table 6.5: Summary of proposed FRM options to be assessed

Proposed FRM Options			
1.	**Improved Conveyance / Hard Defences**	Storage adjacent to channel	Hard Defences
		Localised protection works	Culverting
2.	**Upstream Storage (Offline) & Hard Defences**	Retention Ponds	Hard Defences
		Culverting	Localised protection works
3.	**Maximising Channel Conveyance**	Hard Defences	Culverting
4.	**Do Nothing**	-	-

A brief description of what each FRM option will encompass is detailed below a full drawing of each option is provided in Appendix B

FRM Option 1 –Option 1 proposes to address the flood risk in the Morrell river catchment by maintaining as far as possible the existing storage adjacent to the river but using hard defences, including flood walls and embankments, to protect properties and key assets which are currently at risk. This will maintain the existing natural flood management benefits and habitats that much of the agricultural land currently provides.

Approximately 6.5km of hard defences will be required in total for FRM Option 1.

Option 1 also proposes the upgrade of existing culverts to improve channel conveyance of the 1% AEP flows. This will include increasing the capacity of the culvert conveying the Slane River under the N7 at Junction 6 Castlewarden exit, and improvement works on culverts at various other locations, including the Dublin-Cork Railway crossings.

FRM Option 2 – To reduce the flood risk to the downstream Morrell catchment, Option 2 proposes to create offline storage areas for all major tributaries of the Morrell river system, including the rivers Slane, Kill, Hartwell, Haynestown, and the Morrell. The tributaries originate in the foothills of the Wicklow Mountains flowing north-east towards the N7. The retention storage areas, to be created offline, adjacent to each of the tributaries, are proposed to throttle the 1% AEP peak flow to 50% AEP (Q100 back to Q2). For the Haynestown and Morrell, the storage areas will be located south of Kill and Johnstown respectively. The storage volume is calculated for the 1% AEP and the proposed area is calculated in hectares at 1m depth. Earth embankments will be created with adequate freeboard to prevent overtopping and maintain flood water within the storage area, protecting nearby roads and properties, before releasing the flood water in a controlled manner during and after the rainfall event. Each retention pond will have an overflow weir that will divert flows from flood events greater than the 1% AEP back to the river tributary. This option will require major land acquisition to provide for the upstream storage areas, and significant landholder liaison. These retention ponds will require engineered embankments to retain the water as the topography does not lend itself to providing this naturally.

In addition to the storage areas, hard defences will still be required along the Morrell and Painestown rivers downstream of the N7 to alleviate flooding of properties in a 1% AEP flood event due to the localised rainfall within the lower catchment. These works will consist of embankments and flood walls in similar locations to those for Option 1.

Approximately 3.3km of hard defences will be required in total for FRM Option 2. This quantity is in addition to the engineered works required to create the upstream storage areas.

Option 2 also proposes the upgrade of existing culverts to improve channel conveyance of the 1% AEP flows. This will include increasing the capacity of the culvert conveying the Slane River under the N7 at Junction 6 Castlewarden exit, and improvement works on culverts at various other locations, including the Dublin-Cork Railway crossings.

A plan drawing of Option 2, showing storage areas and hard defence sites, is provided in Appendix B.

FRM Option 3 – Option 3 proposes to convey of all flows from the Morrell river system to the River Liffey, to protect protect properties and avoid flooding local roads, fields, the Grand Canal embankments and the Dublin-Cork Railway crossings. This option proposes that hard defences, including flood walls and embankments, be used to convey all 1% AEP flood flows to the River Liffey.

This will include increasing the capacity of the culvert for the Slane River under the N7 at Junction 6 Castlewarden exit, upgrading and upsizing culverts under the railway and canal embankments, and upgrading and increasing capacity at all other culverts to convey 1% AEP flows to the Liffey. This option eliminates all flooding in the downstream Morrell catchment floodplain for a 1% AEP flood event, providing protection to all properties in the lower catchment, the N7, agricultural lands, the Grand Canal embankments and the Dublin-Cork Railway line.

Approximately 35.3km of hard defences will be required in total for Option 3.

A plan drawing of Option 3 is provided in Appendix B.

FRM Option 4 – This option is to 'Do Nothing', which is equivalent to the 'Maintain the Existing Regime' and 'Do Minimum' scenarios as at present Kildare County Council and the OPW have no formal maintenance regime for the Morrell River system. Option 4 provides a baseline scenario to enable a comparative analysis against which benefits of a proposed option will be established.

The plan drawing for the Existing Baseline Scenario for flood events in the catchment reflects Option 4 and is provided in Appendix B.

6.3 ASSESSMENT OF PROPOSED FRM OPTIONS

6.3.1 Further feasibility analysis of potential FRM options

As a preliminary assessment, prior to progression to the full MCA, the 3 potential options, excluding Option 4 – Do Nothing scenario, were further analysed to ensure they were to be technically, socially, environmentally and economically feasible. It was determined through a review of the hydraulic model for the River Liffey from the CFRAM study, that Option 3 – Full flow conveyance of the Morrell river system channelled to the River Liffey - would be unfeasible. The peak flow in the River Liffey in a 1% AEP flood event at the point of confluence with the Morrell River is estimated to be 145m³/s. The hydraulic model for the Option 3 scenario shows that the peak flow in Morrell River at the point of confluence with the River Liffey has increased from 28 m³/s in the existing scenario to 73m³/s for the 1% AEP event. The 45 m³/s flow increase results in the total peak flow in a 1% AEP event from the Morrell River being greater than 50% of the River Liffey peak flow at the point of confluence. This substantial peak flow increase is unacceptable as it will create a substantial increase in flood risk to the downstream catchment of the Liffey, particularly nearby Celbridge, and will have significant socio-economic and technical consequences. Figure 6.2 shows the Morrell River hydrograph for Option 3 – Full flow conveyance and the peak flow for this scenario at the point of confluence with the River Liffey.

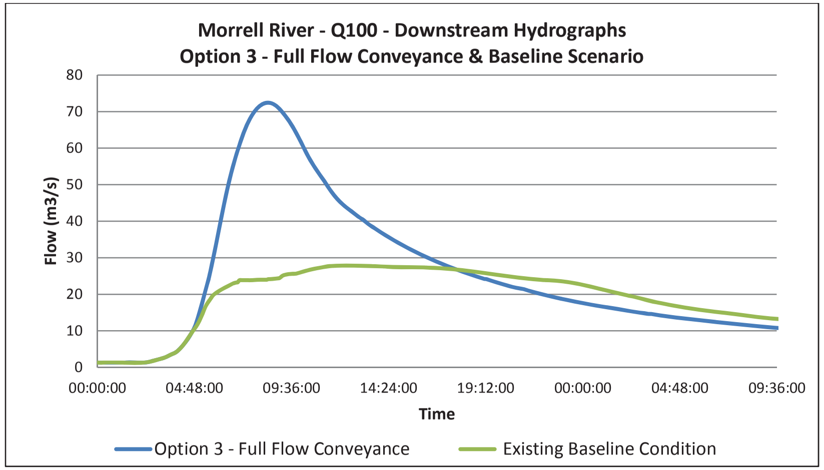


Figure 6.2: Option 3 – Hydrograph of Morrell River peak flow at confluence with River Liffey

Upon review of this issue, it was decided to eliminate Option 3 and focus on Options 1 and 2, with Option 4 as a baseline condition comparison, as these remaining options provide varying amounts of storage and flood retention along the river system and hence reduce the peak at the confluence with the River Liffey, which is preferential.

6.3.2 FRM Options Assessment Criteria

The FRM Option 1 and Option 2 that have progressed to this stage have been found to be technically, socially, environmentally and economically feasible. In order to ascertain the preferred option for the Morrell catchment, each option must be considered against a range of criteria and objectives to determine the optimum solution. As part of this process the Option 4 – 'Do Nothing' provides a scenario against which the technical, social, environmental and economic feasibility can be compared. The comparative analysis is undertaken by scoring each option against the following three criteria to provide an overall score for each:

- Economic Benefit Cost Ratio (BCR) - The ratio between the monetary benefit of adopting a FRM option and the overall cost of constructing, operating and maintaining the option. A ratio of one or greater must be achieved for an option to be considered further.
- MCA Benefit Score - The sum weighted score of all of the objectives set in the MCA. This score represents the non-monetary benefit of adopting the FRM option.
- Overall Net MCA BCR - This is a ratio between the non-monetary benefit of adopting a FRM option and the overall cost of constructing, operating and maintaining the option.

6.3.3 Benefit Cost Ratio

Economic review of proposed FRM options

A further economic review is carried out to ensure that a BCR of greater than 0.5 is still being achieved as it is possible that combining FRM measures can lead to an excessively costly option being created that is unlikely to be cost beneficial.

To quantify the FRM options the individual rates for the FRM measures (as described in Section 6.1.4) are applied and summated for each option, and additional costs are included to those specific for construction to give a more accurate estimate of the overall cost of the option. Costing of the individual FRM measures in an option was carried out by hydraulic modelling and using the GIS software ESRI ArcMap to provide wall lengths and heights, lengths of culvert, volume of embankments, etc. The location and extent of FRM measures were delineated in GIS using OSi mapping with consideration of the flood risk receptors. Once finalised, the design standard 1% AEP flood event was simulated with the FRM measures for each FRM Option in place in a hydraulic model and the heights required were calculated, and the construction rates applied to estimate the cost. Drawings of these options have been included in Appendix B a and breakdown of the costing for each has been included in Appendix E.

Costs additional to those for construction were included to give a complete estimate of the overall cost of the options. Table 6.6 lists the additional provisions that were included, as per the standard percentages set out by the OPW for assessment of a feasibility study.

Table 6.6: Additional costs of FRM Options

Item	% of construction cost
Preliminaries and bond	6
Provision for unmeasured items	10
Contingencies	10
Construction site supervision	5
Detailed design (design fees)	6
NVP maintenance costs	1% p.a. Capital costs over design life
Cost of land acquisition/compensation	12.5
Environmental monitoring and mitigation	6
Allowance for archaeology	6

6.3.4 Estimation of BCR Ratio

Based on the methodology set out in Section 6.3.3, costs for the 2 potential options have been calculated and compared to the damage avoided from the existing baseline condition (Option 4 – 'Do Nothing') to determine the BCR Ratio. This is been summarised in Table 6.7.

Table 6.7: Economic Review of Potential FRM Options

Option	Description	Benefit	Whole Life Cost	BCR*
1	**Improved Channel Conveyance**	**€20,005,648**	**€11,659,156**	**1.72**
2	**Upstream Storage (Offline)**	**€20,005,648**	**€89,265,507**	**0.22**

*BCR is the ratio between the benefit and the whole life cost of each option

6.3.5 The Multi-Criteria Analysis (MCA) Methodology

The assessment of FRM options in the past has been primarily based on economic costs and benefits, with an EIA undertaken to minimise negative impacts on the environment, and public consultation undertaken to ensure social acceptability. The National Flood Policy Review (OPW, 2004) set a broader range of objectives for flood risk management in Ireland, which was subsequently reinforced by the EU 'Floods' Directive [2006/60/EC]. As part of the National CFRAM Programme, the OPW produced Guidance Notes (No. 27 & 28) to set a standard methodological approach for 'Economic Damage and benefit Calculation and Cost-Benefit Analysis' and 'Option Appraisal and Multi-Criteria Analysis Framework' (OPW, 2013).

The MCA framework has been developed to broaden the range of potential impacts associated with flooding and the implementation of FRM options considered in the development and selection of FRM options and strategies, and their subsequent prioritisation. It is based on the numeric, but non-monetarised, assessment of options against a range of objectives. Indicators are used to assign scores for each objective on the basis of the degree to which the option being appraised goes beyond a specified basic requirement for that objective towards meeting a specified aspirational target for that objective. Weightings are applied globally for each objective, with local weightings applied to reflect the local importance of that objective, and these weightings are applied to the scores derived as described above.

The sums of the weighted scores, set against the total costs of their achievement, represent the preference for a given option (using all criteria) or the net benefits of an option (using only the economic, social and environmental criteria). These total scores can be used to inform the decision on the selection of (a) preferred option(s) for a given location and the prioritisation of potential schemes between locations.

Table 6.8 lists the criteria, objectives and sub-objectives used to undertake the MCA of the potential FRM options for the Morrell catchment.

Table 6.8: Criteria and Objectives of the MCA

	CRITERIA		OBJECTIVE		SUB-OBJECTIVE
1	Technical	a	Ensure flood risk management options are operationally robust	i)	Ensure flood risk management options are operationally robust
		b	Minimise health and safety risks associated with the construction and operation of flood risk management options	i)	Minimise health and safety risks associated with the construction and operation of flood risk management options
		c	Ensure flood risk management options are adaptable to future flood risk	i)	Ensure flood risk management options are adaptable to future flood risk i.e. can be managed effectively and sustainably into the future
2	Economic	a	Minimise economic risk / reduce economic damages	i)	Minimise economic risk / reduce economic damages
		b	Minimise risk to transport infrastructure	i)	Minimise risk to transport infrastructure
		c	Minimise risk to utility infrastructure	i)	Minimise risk to utility infrastructure
		d	Minimise risk to agriculture	i)	Minimise risk to agriculture
3	Social	a	Minimise risk to human health and life	i)	Minimise risk to human health and life – residents
				ii)	Minimise risk to human health ad life - high vulnerability properties
		b	Minimise risk to community	i)	Minimise risk to community - social infrastructure
				ii)	Minimise risk to community - local employment
		c	Minimise risk to, and where possible enhance, social amenity sites	i)	Minimise risk to, and where possible enhance, social amenity sites

	CRITERIA		OBJECTIVE		SUB-OBJECTIVE
4	Environmental	a	Support the objectives of the WFD	i)	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives
		b	Support the objectives of the Habitats and Birds Directives	i)	Avoid detrimental effects to, and where possible enhance, the Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and corridors
		c	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	i)	Avoid damage to or loss of, and where possible enhance, legally protected sites / habitsts of national, regional and local nature conservation importance
		d	Protect, and where possible enhance, fisheries resource within the catchment	i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species
		e	Protect, and where possible enhance, landscape character and visual amenity within the zone of influence	i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the zone of influence
		f	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods	i)	Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial
				ii)	Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where it is beneficial

6.3.6 Scoring options

The CFRAM OPW Guidance Note No. 28 (OPW, 2013) has devised a scoring system for the MCA to assess each option in a robust, clear and transparent way. A score is given for how well an option achieves an objective but also accounts for the importance of the objective relative to other objectives and how important the receptors within the study area are relative to the receptor group being considered.

To enable the scoring of the objectives, indicators have been set. Indicators are parameters, measurable and numeric where possible, by which the success of the option in meeting a particular objective can be gauged. For example a social objective is to "minimise risk to human health and life of residents" and the indicator is "the number of residential properties at risk from flooding during the 0.1% AEP event". The difference that the option being assessed makes to the number of residential properties at risk can be calculated as a percentage and applied to the maximum score value to give the score.

The success of the option in achieving the objective in question is quantified by how much it goes beyond a specified basic requirement and achieves a specified aspirational target. As such basic requirements and aspirational targets have been set in terms of the defined indicator.

The basic requirement represents a neutral status or 'no change', whereby an option has no impact on the matter the objective relates to, or meets what might be termed for some objectives as minimum requirements for acceptability. If an option performs less well than than the basic requirement, i.e. has a negative impact (a dis-benefit) or does not meet the minimum requirements for acceptability, it will score a negative-value score for that objective, but might still be considered further, depending on the degree of the dis-benefit or failure to meet the requirements. The basic requirement is therefore not an absolute minimum requirement for acceptability, but a benchmark to define positive versus negative impacts or performance.

The aim of an objective is defined by the aspirational target, whereby an option would be deemed as performing optimally with respect to the given objective if it were to meet the aspirational target. Typically this will represent complete removal of a risk, or the full achievement of another benefit, and it will be rare that any option will meet such aspirational targets for even one, let alone all, objectives. The aspirational targets are therefore not requirements that must be met, and it should be noted that very effective options may still fail to meet the aspirational targets.

The following rules have been applied to the MCA scoring:

- An option achieving the basic requirement is given a score of zero;
- An option meeting the aspirational target is given a score of five. Options achieving more than the aspirational target still score a maximum of five;
- An option achieving somewhere in between the basic requirement and the aspirational target is given a score proportional to the degree to which it achieves the objective beyond the basic requirement towards meeting the aspirational target;
- An option failing to meet the basic requirement is given a negative score of -1 to -5 depending on the impacts associated with the options;
- Where the performance or impact of the option becomes unacceptable a score of -999 is given and the option is rejected from further consideration;

Justification for each objective score has been included within the MCA tables providing the rationale for each score.

6.3.7 Weighting objectives

It is appreciated that some objectives are more important that others and to give them all equal importance would not reflect the real benefit, or lack thereof, achieved. For example, an objective considering risk to life is more important that one considering social amenity sites. To reflect this in the scoring a global weighting has been applied. This gives an objective more or less weight in the overall assessment of the suitability or value of the option. Global weightings will remain constant nationally and were derived following consultation carried out on previous pilot studies and with OPW and a number of environmental stakeholders.

It is further appreciated that for any given objective its importance will depend on the scale of the assessment and the type of receptor it is considering. For example, an objective considering the impact to environmentally designated sites may have more significance if the site is of international importance than of local importance. To account for this a local weighting is applied to the objective. The local weighting has is some cases been determined numerically according to the degree of risk (e.g. annual average damage, number of properties, etc.) and it other instances have been set by professional judgment. Details of the local weighting rationale have been included within the MCA tables.

6.3.8 Summary of MCA scores of potential FRM options

Based on the methodology set out in Section 6.3.3, the results of the MCA are presented in Table **6.9**. The MCA evaluation sheets providing the breakdown of scoring for each option are provided in **Appendix** C.

Table 6.9: FRM options MCA score breakdown

Criteria	Option 1	Option 2
Technical score	1200	900
Economic score	1066	1106
Social score	880	880
Environmental score	-240	-210
Overall score	**2906**	**2676**

6.3.9 Overall net benefit score methodology

The overall net benefit is a ratio used to demonstrate the relevant overall benefits of each option. It is accepted that for an option to proceed, it must be cost-beneficial in its own right; but it is a method by which a numerical score can be assigned to give an indication of the overall or net benefit of each option. To calculate the net benefit the MCA score is divided by the whole life cost of the scheme.

Based on the methodology described in Section 6.3.3, the overall net benefit scores are outlined in Table 6.10.

Table 6.10: Net benefit scores

FRM Options	Whole Life Cost (€Ms)	MCA Score	Net Benefit	Overall Ranking
Option 1	€11,659,156	2906	249.25	1
Option 2	€89,265,507	2676	29.98	2

It is clear from the above tables 6.9 and 6.10 that Options 2 is not as economically viable or as technically robust as Option 1. Therefore Option 1 is considered to be the preferred primary option.

6.4 SENSITIVITY AND UNCERTAINTY ANALYSIS

6.4.1 Land Acquisition uncertainty

At this stage of the preliminary design process for any flood alleviation scheme there is a degree of uncertainty in the construction costs associated within the preferred option. For the Morrell FAS the major uncertainty is the cost and ability to acquire the land where the FRM defences are to be sited. For all options this will be important, however Option 2 which will require 1.306km² of land to be developed into storage ponds presents the greatest degree of uncertainty in land acquisition. While the cost of land acquisition has been factored as 12.5% of non-construction costs, as per OPW guidance, in the case of Option 2 being selected as the preferred option it is anticipated that this could be significantly more considering the proximity of urban / sub-urban areas. For Option 1, land acquisition will only be required at the land / field peripheries where the FRM defences are located adjacent to the river (this will also be required in Option 2).

6.4.2 Damage Assessment (Benefit uncertainty)

Many of the predicted flood depths within Morrell are low and there is relatively little historical flooding information of sufficient accuracy to provide good calibration data. Relying on just hydraulic modelling results in this circumstance would not be recommended and therefore it is essential that comprehensive sensitivity testing is undertaken in detailed design stage to ensure the estimated BCR is robust.

7 CONSULTATION AND UPDATING PREFERRED FRM OPTIONS

Note: This Chapter to follow public consultation of Draft Options Report

8 SUMMARY OF PREFERRED FRM OPTIONS FOR THE RIVER MORRELL

Note: This Chapter to follow public consultation of Draft Options Report

References

OPW (2013) National CFRAM Programme Guidance Note No. 27 – Economic Damage and Benefit Calculation and Cost-Benefit Analysis

OPW (2013) National CFRAM Programme Guidance Note No. 28 – Option Appraisal and the Multi-Criteria Framework

Appendix A

N7 Damage Assessment Cost Estimates

Vehicle Occupancy Rates & Proportion by Time Mode – For Calculation of Cost Estimate for Time Loss / Day

		Flow Group 4			
Vehicle Type	**Time Mode**	**Vehicle Occupancy Rate**	**Vehicle Proportions time mode**	**Avg Vehicle Occupancy Rate**	**Avg Vehicle Proportions time**
Car	Work	1.26	12.0%	1.33	70.1%
	Commuting	1.23	42.9%		
LGV	Work	1.38	40.2%		
	Commuting	1.4	45.1%		
HGV	Work	1.09	75.6%	1.17	92.6%
	Commuting	1.24	17.0%		

The parameters for Vehicle Occupancy Rate & Vehicle Proportions Time Mode are taken from Flow Group 4 – Peak Hour, in Table 27 & Table 28 of Unit 6.11 National Parameter Values Sheet, NRA Project Appraisal Guidelines, July 2011.

Potential Accident & Casualty Cost Parameters & Calculation

Road	Accident Rate PIA/mvkm	Accident Proportions ≤ 60 km/hr			Avg No. of Casualties per Accident ≤ 60 km/hr			Accident Costs (Market Costs, 2014)			Accident Costs (Market Costs, 2014)		
		Casualty Severity			Casualty Severity			Cost per Accident €			Cost per Casualty €		
		Fatal	Serious	Minor	Fatal	Serious	Minor	Fatal	Serious	Minor	Fatal	Serious	Minor
Motorway - M4 & M50 ≤ 60 km/hr	0.026	0.091	0.091	0.819	0.099	0.116	1.194	€8,990	€4,994	€2,652	€2,514,917	€282,576	€21,791
Dual Carriageway - N4 ≤ 60 km/hr	0.144	0.022	0.081	0.896	0.025	0.098	1.196	€7,071	€2,345	€1,548			
2 Lane Single Carriageway - Regional Roads ≤ 60 km/hr	0.202	0.049	0.101	0.849	0.057	0.132	1.140	€7,071	€2,345	€1,548			

Road	Vehicles / Day	Distance (km)	Vehicles km / Day	Accident Rate PIA/mvkm	Potential Accident Costs			Potential Casuality Costs from Accidents			Total Potential Accident & Casuality Costs - per road type	Total Potential Accident & Casuality Costs
					€			€				
					Fatal	Serious	Minor	Fatal	Serious	Minor	€	€
Motorway - M4 & M50 ≤ 60 km/hr	249,587	12.6	3,144,796	0.026	€67	€37	€178	€20,358	€2,680	€2,127	€25,447	**€126,568**
Dual Carriageway - N4 ≤ 60 km/hr	174,454	6.3	1,099,060	0.144	€25	€30	€220	€9,951	€4,383	€4,125	€18,732	
2 Lane Single Carriageway - Regional Roads ≤ 60 km/hr	84,407	23.3	1,966,683	0.202	€138	€94	€522	€56,949	€14,818	€9,869	€82,390	

Overall Damage – Based on Approach A – Flood Duration calculation based on reduced figures from MCM Handbook

Design Flood Return Period (Years)	Annual Exceeding Probability (AEP) (%)	Damage (€)	Average Damage Interval	Probability of Flood Interval	Annual Damage for Interval (€)	Culmulative Average Damage (€)	Discounted Net Present Value of 50 year Scheme (€)	Design Return Period (Years)
1	1	€0.00						
2	0.5	€0.00	€0.00	50.0%	€0.00	€0.00	€0.00	2
5	0.2	€2,368,209.86	€1,184,104.93	30.0%	€355,231.48	€355,231.48	€7,631,082.64	5
10	0.1	€2,368,209.86	€2,368,209.86	10.0%	€236,820.99	€592,052.47	€12,718,471.06	10
20	0.05	€4,736,419.72	€3,552,314.79	5.0%	€177,615.74	€769,668.20	€16,534,012.38	25
50	0.02	€4,736,419.72	€4,736,419.72	3.0%	€142,092.59	€911,760.80	€19,586,445.43	50
100	0.01	€9,472,839.44	€7,104,629.58	1.0%	€71,046.30	€982,807.09	€21,112,661.96	100
200	0.005	€18,945,678.89	€14,209,259.17	0.5%	€71,046.30	€1,053,853.39	€22,638,878.49	200
1000	0.001	€37,891,357.78	€28,418,518.33	0.4%	€113,674.07	€1,167,527.46	€25,080,824.93	1000

Net Present Value = $\frac{x}{r}\left((1+r) - \left[\frac{1}{(1+r)}\right]^{n} \right)$

x - Cumulative average damage (€)

r – 0.04 (Irish Treasury's Test Discount Rate, Dept. of Finance)

n – 49 (The projected life of the asset / scheme – 50 years from Year 1 to Year 50)

Overall Damage – Based on Approach B – Flood Duration calculation based on road inundation in Hydraulic Model with time allowance re-routing traffic

Design Flood Return Period (Years)	Annual Exceeding Probability (AEP) (%)	Damage (€)	Average Damage Interval	Probability of Flood Interval	Annual Damage for Interval (€)	Culmulative Average Damage (€)	Discounted Net Present Value of 50 year Scheme (€)	Design Return Period (Years)
1	1	€0.00						
2	0.5	€0.00	€0.00	50.0%	€0.00	€0.00	€0.00	2
5	0.2	€1,973,508.22	€986,754.11	30.0%	€296,026.23	€296,026.23	€6,359,235.53	5
10	0.1	€1,973,508.22	€1,973,508.22	10.0%	€197,350.82	€493,377.05	€10,598,725.88	10
20	0.05	€2,368,209.86	€2,170,859.04	5.0%	€108,542.95	€601,920.01	€12,930,445.58	25
50	0.02	€2,762,911.50	€2,565,560.68	3.0%	€76,966.82	€678,886.83	€14,583,846.81	50
100	0.01	€3,552,314.79	€3,157,613.15	1.0%	€31,576.13	€710,462.96	€15,262,165.27	100
200	0.005	€3,749,665.61	€3,650,990.20	0.5%	€18,254.95	€728,717.91	€15,654,318.13	200
1000	0.001	€3,947,016.44	€3,848,341.02	0.4%	€15,393.36	€744,111.27	€15,984,998.38	1000

Net Present Value = $\frac{x}{r}\left((1+r) - \left[\frac{1}{(1+r)}\right]^{n} \right)$

x - Cumulative average damage (€)

r – 0.04 (Irish Treasury's Test Discount Rate, Dept. of Finance)

n – 49 (The projected life of the asset / scheme – 50 years from Year 1 to Year 50)

Overall Damage – Based on Approach C – Flood Duration calculation based on road inundation in Hydraulic Model with No time allowance re-routing traffic

Design Flood Return Period (Years)	Annual Exceeding Probability (AEP) (%)	Damage (€)	Average Damage Interval	Probability of Flood Interval	Annual Damage for Interval (€)	Culmulative Average Damage (€)	Discounted Net Present Value of 50 year Scheme (€)	Design Return Period (Years)
1	1	€0.00	€0.00	50.0%	€0.00	€0.00	€0.00	2
2	0.5	€0.00	€789,403.29	30.0%	€236,820.99	€236,820.99	€5,087,388.42	5
5	0.2	€1,578,806.57	€1,578,806.57	10.0%	€157,880.66	€394,701.64	€8,478,980.71	10
10	0.1	€1,578,806.57	€1,776,157.40	5.0%	€88,807.87	€483,509.51	€10,386,751.37	25
20	0.05	€1,973,508.22	€2,170,859.04	3.0%	€65,125.77	€548,635.28	€11,785,783.18	50
50	0.02	€2,368,209.86	€2,762,911.50	1.0%	€27,629.12	€576,264.40	€12,379,311.83	100
100	0.01	€3,157,613.15	€3,256,288.56	0.5%	€16,281.44	€592,545.84	€12,729,069.79	200
200	0.005	€3,354,963.97	€3,453,639.38	0.4%	€13,814.56	€606,360.40	€13,025,834.11	1000
1000	0.001	€3,552,314.79						

Net Present Value = $\frac{x}{r}\left((1+r) - \left[\frac{1}{(1+r)}\right]^{n} \right)$

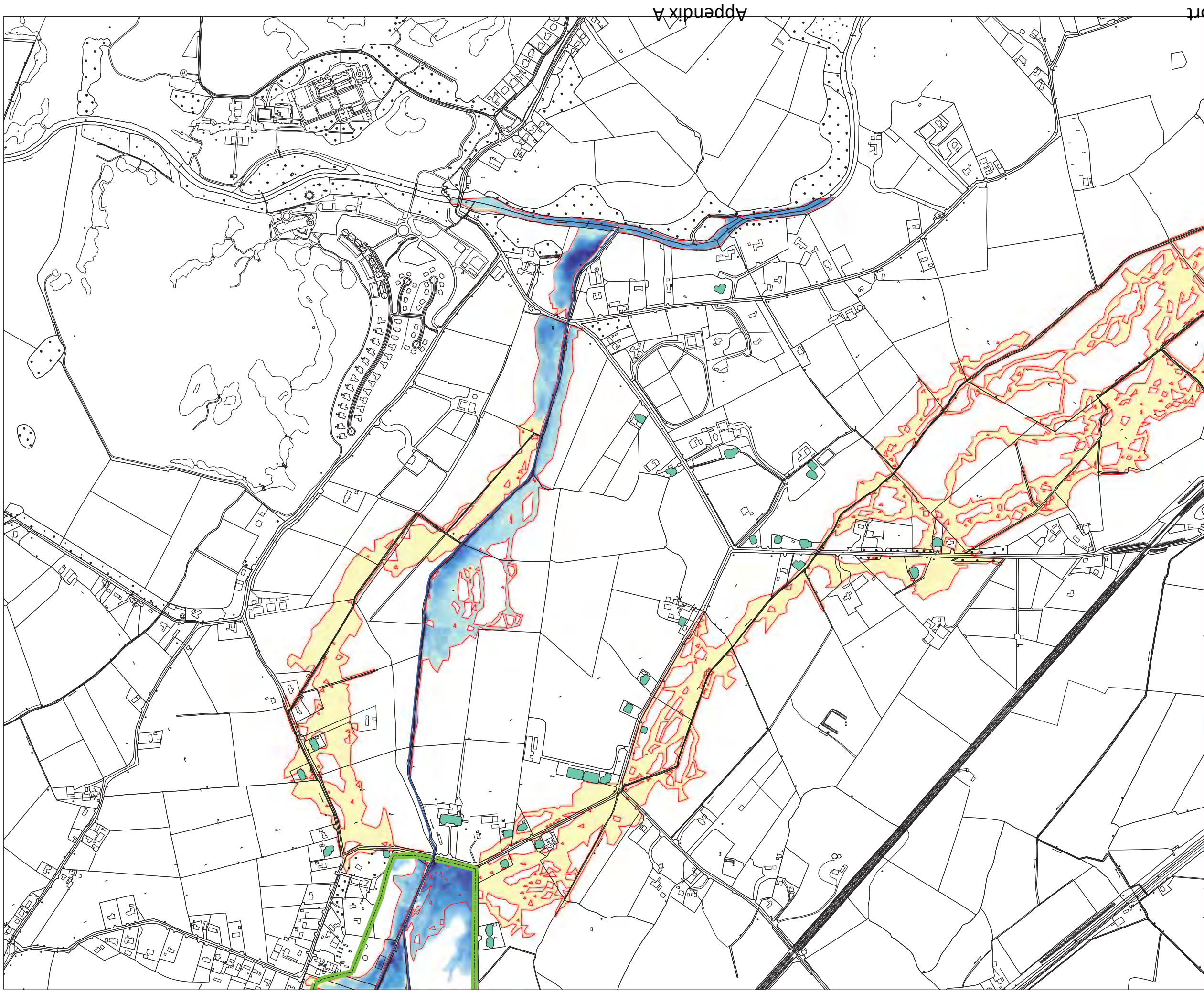
x - Cumulative average damage (€)

r – 0.04 (Irish Treasury's Test Discount Rate, Dept. of Finance)

n – 49 (The projected life of the asset / scheme – 50 years from Year 1 to Year 50)

Appendix B

Plan view Maps of FRM Options



Legend

- Embankment
- Morrell River
- KS Classified Buildings (5m buffer)
- Q100 Existing

Q100 Option 1

Depth (m)
1.95
0.0001

Client: OPW

River Morrell FAS

Q100 Option 1

(Map 1 of 7)

RPS West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland. T +353 (0) 1 4882900 F +353 (0) 1 4620814 E ireland@rpsgroup.com W rpsgroup.com/ireland

Issue Details

Drawn By:	S. Khan	Project No.	MDW0575
Checked By:	C. Delaney	File Ref:	MDW0575Arc0009D01
Approved By:	J. Hobbs		
Scale:	1:10,000 @ A3	Map Projection:	
Date:	15/08/2014		TM65_Irish_Grid

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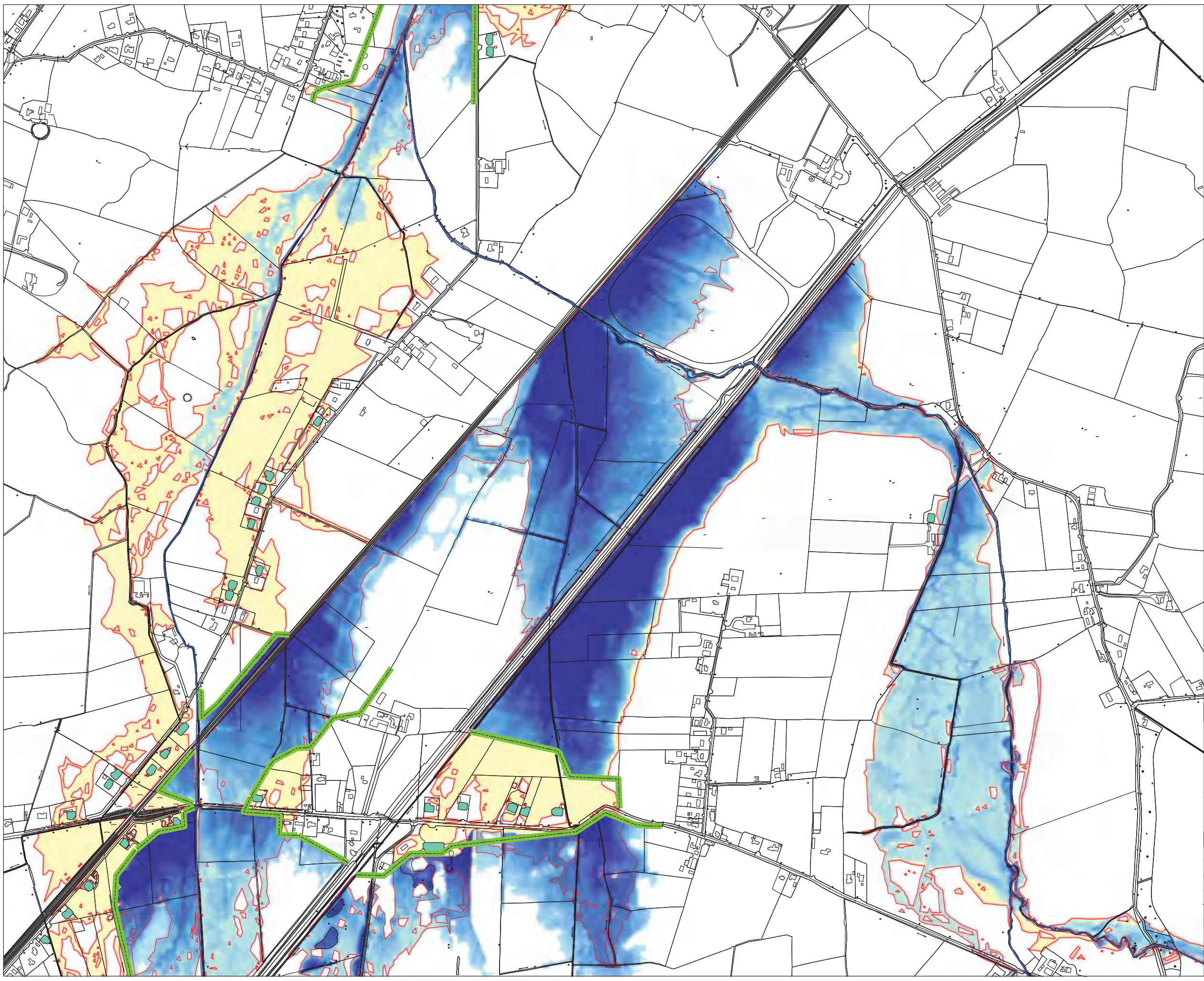

Legend

- Embankment
- Morrell River
- KS Classified Buildings (5m buffer)
- Q100 Existing

Q100 Option 1

Depth (m)
1.95
0.0001

Client: OPW

River Morrell FAS

Q100 Option 1

(Map 2 of 7)

RPS West Pier Business Campus, Dun Laoghaire, Co Dublin, Ireland. T +353 (0) 1 4882900 F +353 (0) 1 4620814 E ireland@rpsgroup.com W rpsgroup.com/ireland

Issue Details

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Scale:	1:10,000 @ A3	Map Projection:	
Date:	15/08/2014		TM65_Irish_Grid

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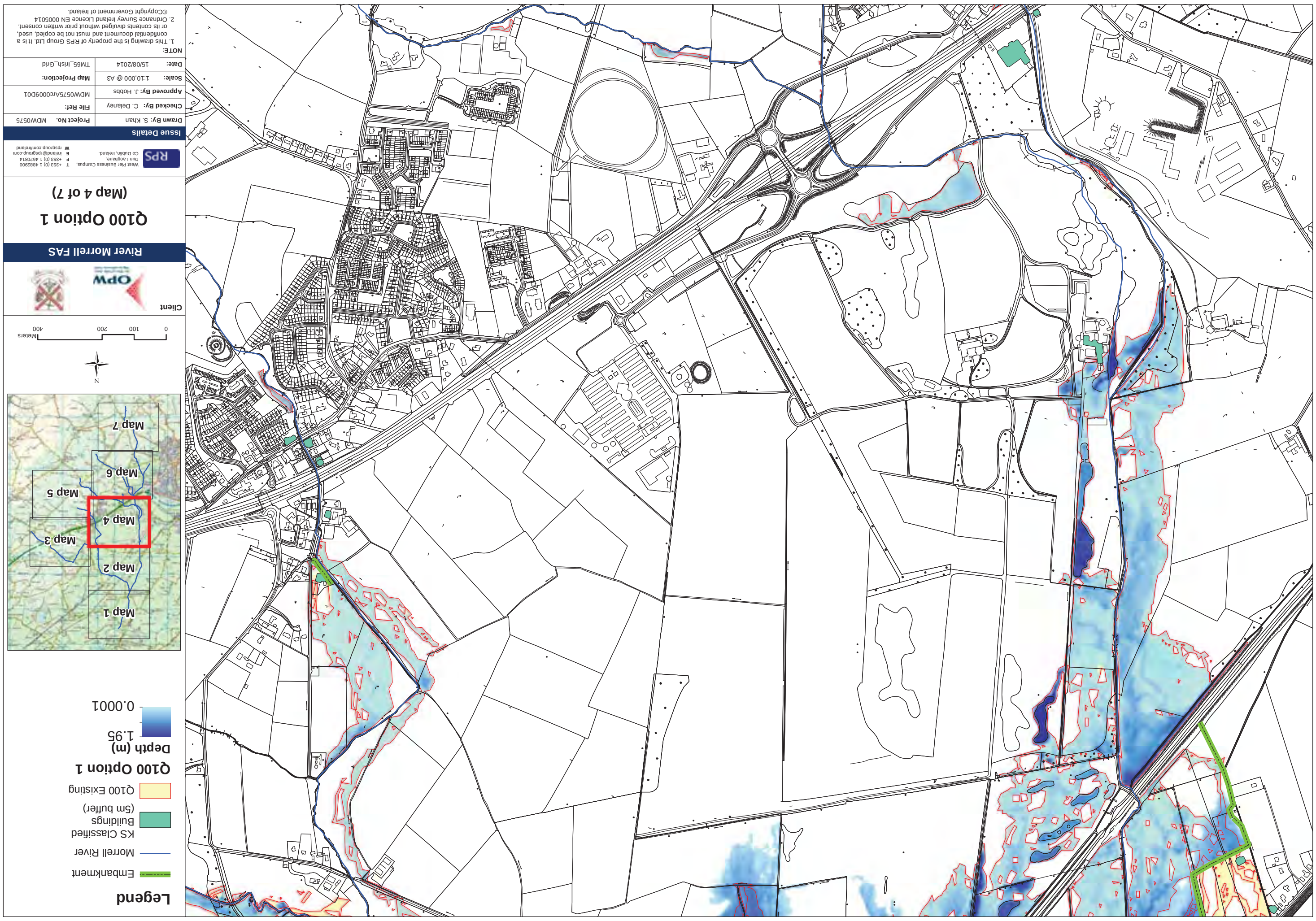
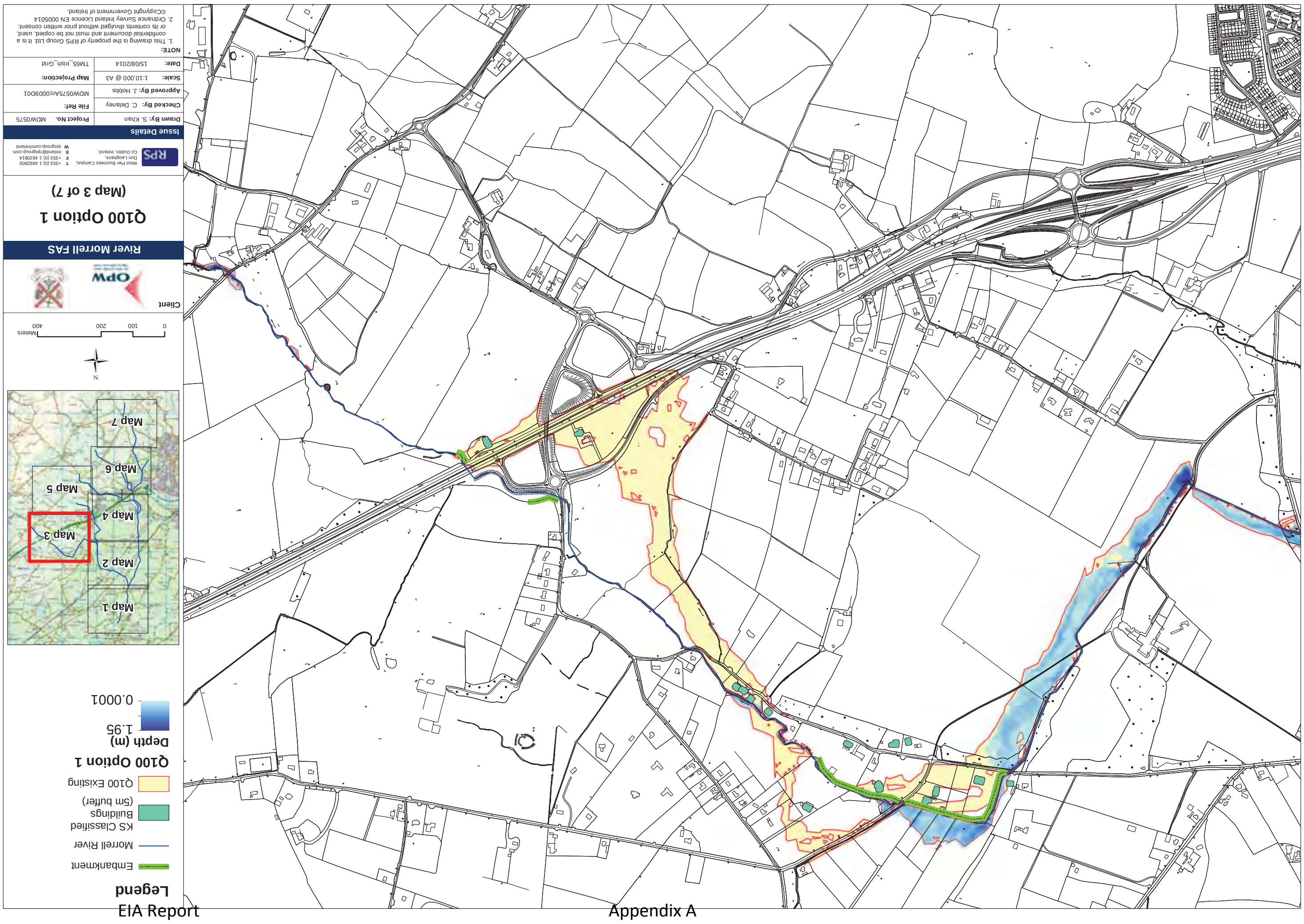
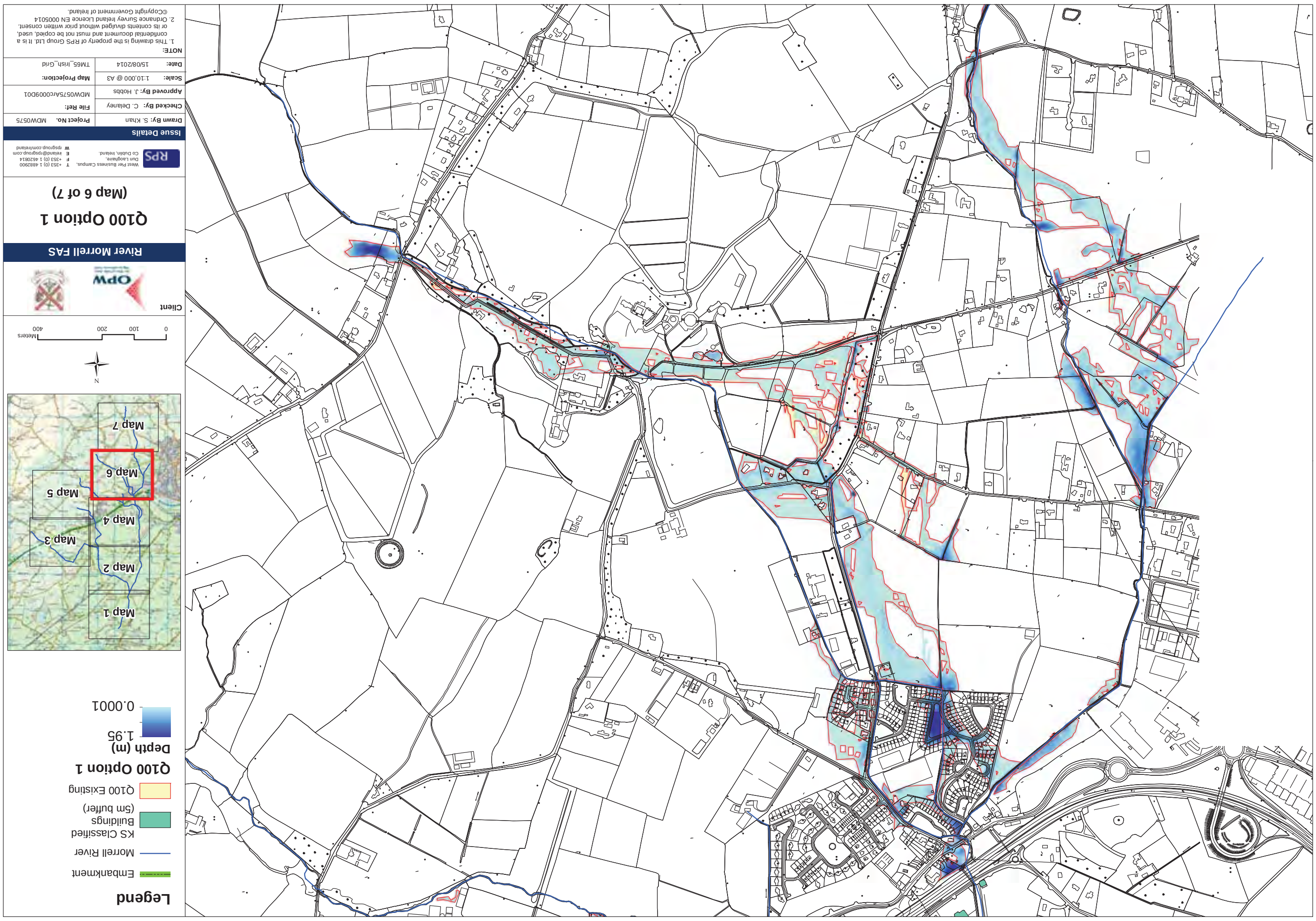

Legend
Embankment
Morrell River
KS Classified Buildings (5m buffer)
Q100 Existing
Q100 Option 1
Depth (m)
1.95
0.0001
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
0 100 200 400
Meters
Client
River Morrell FAS
Q100 Option 1
(Map 4 of 7)
Issue Details
Drawn By: S. Khan
Project No. MDW0575
Checked By: C. Delaney
File Ref: MDW0575Ar0009D01
Approved By: J. Hobbs
Scale: 1:10,000 @ A3
Map Projection: TM65_Irish_Grid
Date: 15/08/2014
NOTE:


Legend
Embankment
Morrell River
KS Classified Buildings (5m buffer)
Q100 Existing
Q100 Option 1
Depth (m)
1.95
0.0001
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
0 100 200 400
Meters
Client
River Morrell FAS
Q100 Option 1
(Map 3 of 7)
Issue Details
Drawn By: S. Khan
Project No. MDW0575
Checked By: C. Delaney
File Ref: MDW0575Ar0009D01
Approved By: J. Hobbs
Scale: 1:10,000 @ A3
Map Projection: TM65_Irish_Grid
Date: 15/08/2014
NOTE:


Legend
Embankment
Morrell River
KS Classified Buildings (5m buffer)
Q100 Existing
Q100 Option 1
Depth (m)
1.95
0.0001
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Client
OPW
River Morrell FAS
Q100 Option 1
(Map 6 of 7)
RPS
Issue Details
Drawn By: S. Khan
Project No.: MDW0575
Checked By: C. Delaney
File Ref: MDW0575Arc0009D01
Approved By: J. Hobbs
Scale: 1:10,000 @ A3
Map Projection: TM65_Irish_Grid
Date: 15/08/2014
NOTE:


Legend
Embankment
Morrell River
KS Classified Buildings (5m buffer)
Q100 Existing
Q100 Option 1
Depth (m)
1.95
0.0001
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Client
OPW
River Morrell FAS
Q100 Option 1
(Map 5 of 7)
RPS
Issue Details
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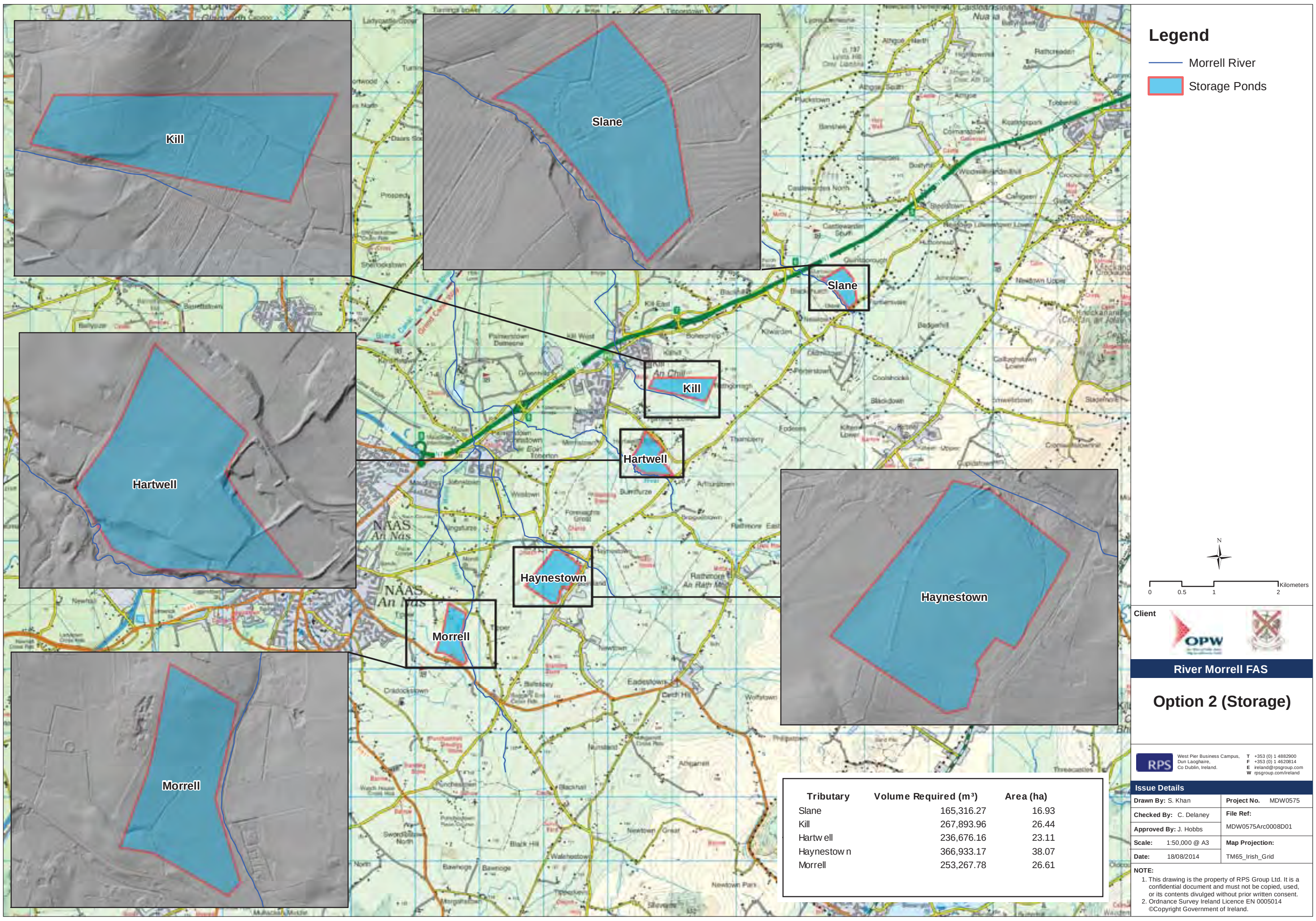
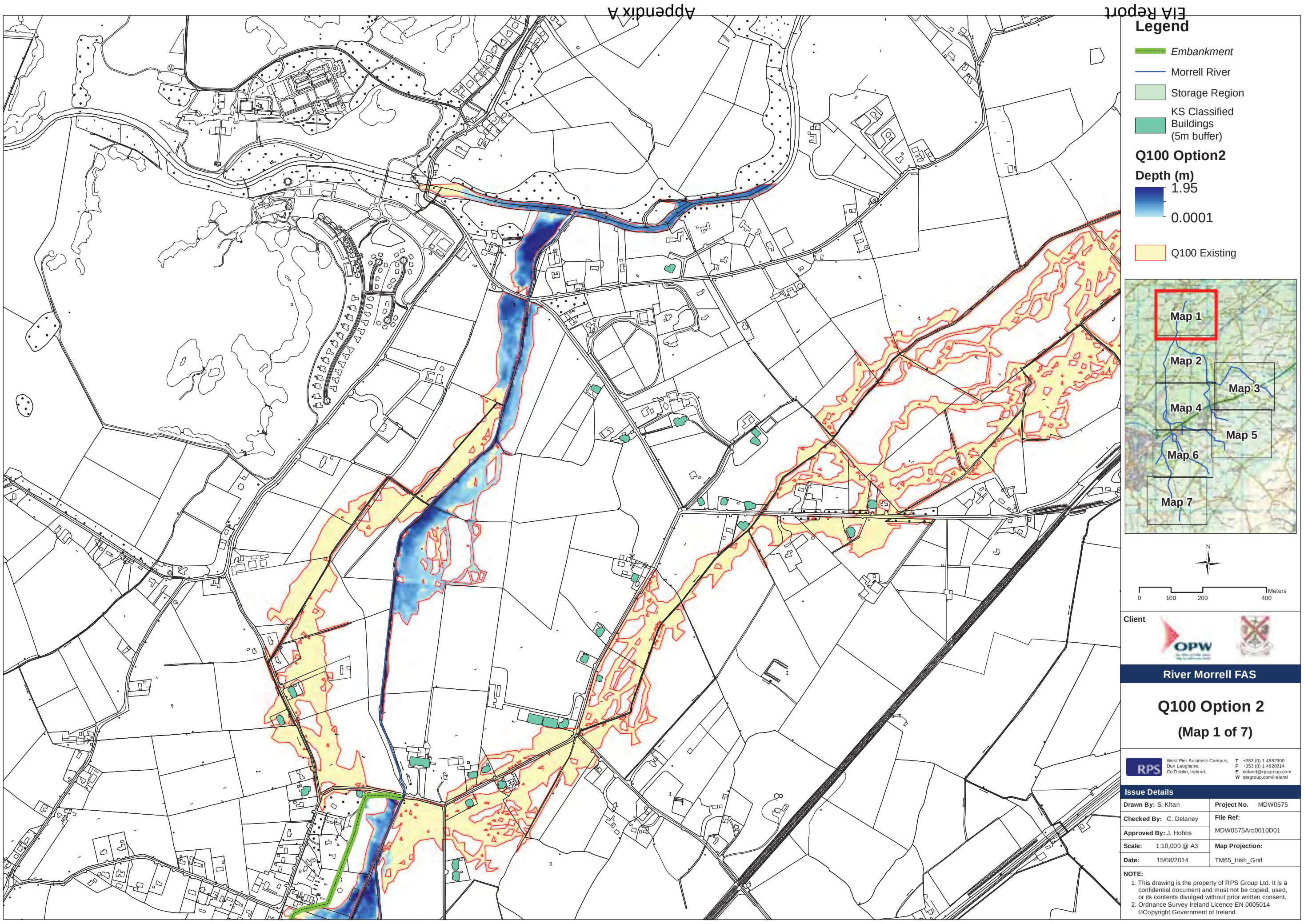
Scale: 1:10,000 @ A3
Map Projection: TM65_Irish_Grid
Date: 15/08/2014
NOTE:



Tributary	Volume Required (m^3)	Area (ha)
Slane	165,316.27	16.93
Kill	267,893.96	26.44
Hartwell	236,676.16	23.11
Haynestown	366,933.17	38.07
Morrell	253,267.78	26.61


Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
N
0 100 200 400 Meters
Client
OPW
River Morrell FAS
Q100 Option 2
(Map 1 of 7)
RPS
Issue Details
Drawn By: S. Khan
Project No. MDW0575
Checked By: C. Delaney
File Ref:
Approved By: J. Hobbs
MDW0575Arc0010D01
Scale: 1:10,000 @ A3
Map Projection:
Date: 15/08/2014
TM65_Irish_Grid
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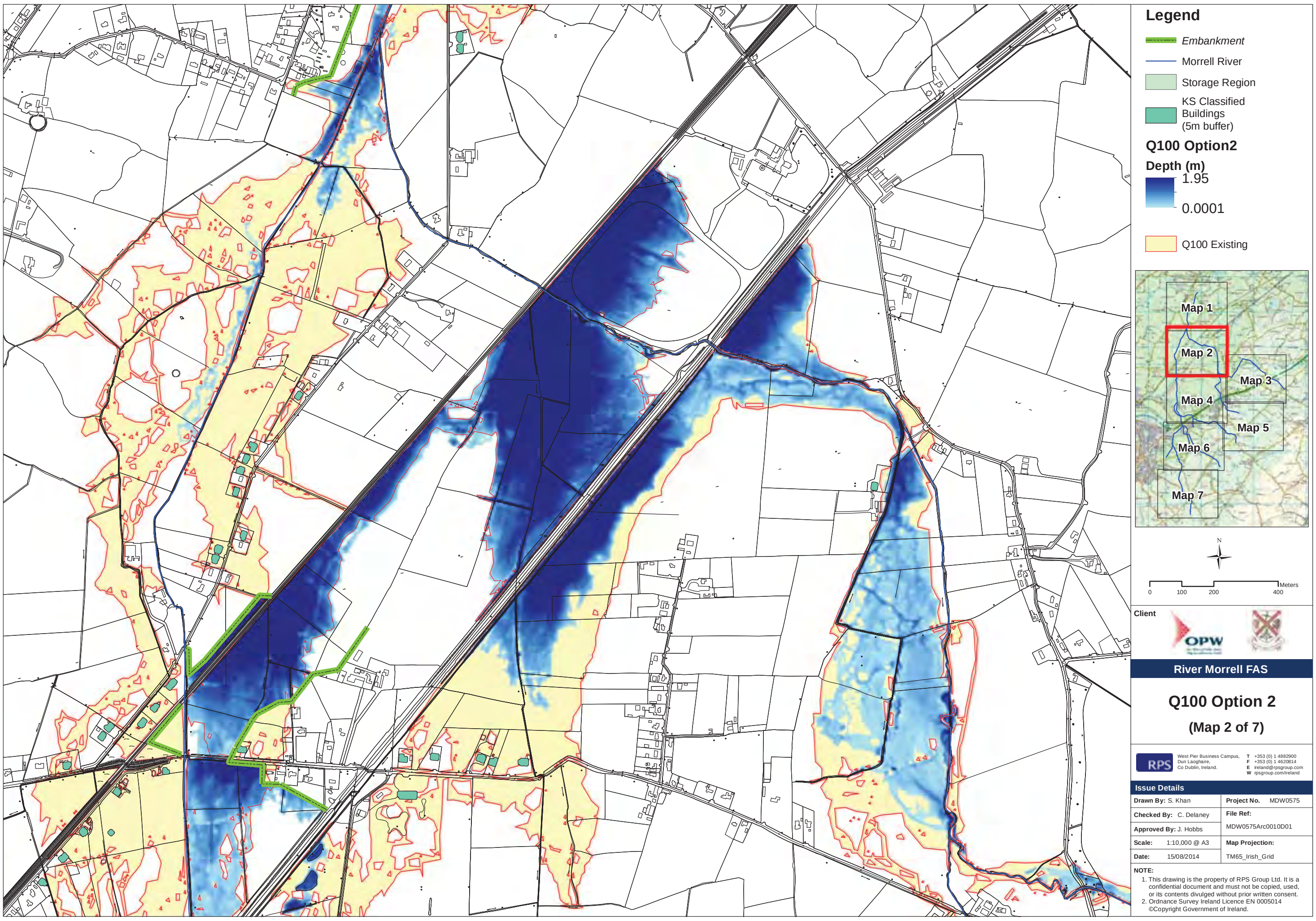
Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
N
0 100 200 400 Meters
Client
OPW
River Morrell FAS
Q100 Option 2
(Map 2 of 7)
RPS
Issue Details
Drawn By: S. Khan
Project No. MDW0575
Checked By: C. Delaney
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Scale: 1:10,000 @ A3
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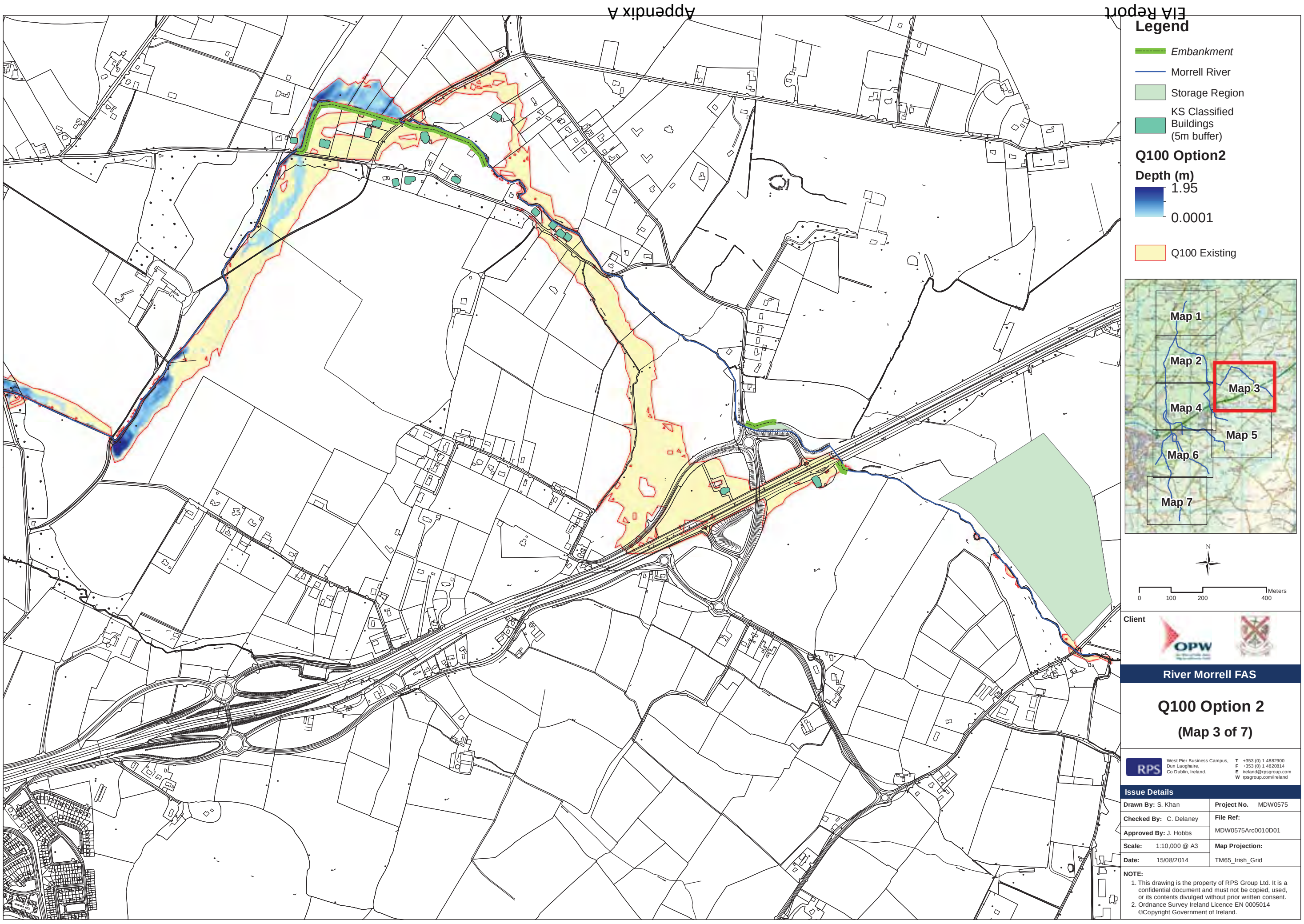
Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
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Map 4
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N
0 100 200 400 Meters
Client
OPW
River Morrell FAS
Q100 Option 2
(Map 3 of 7)
RPS
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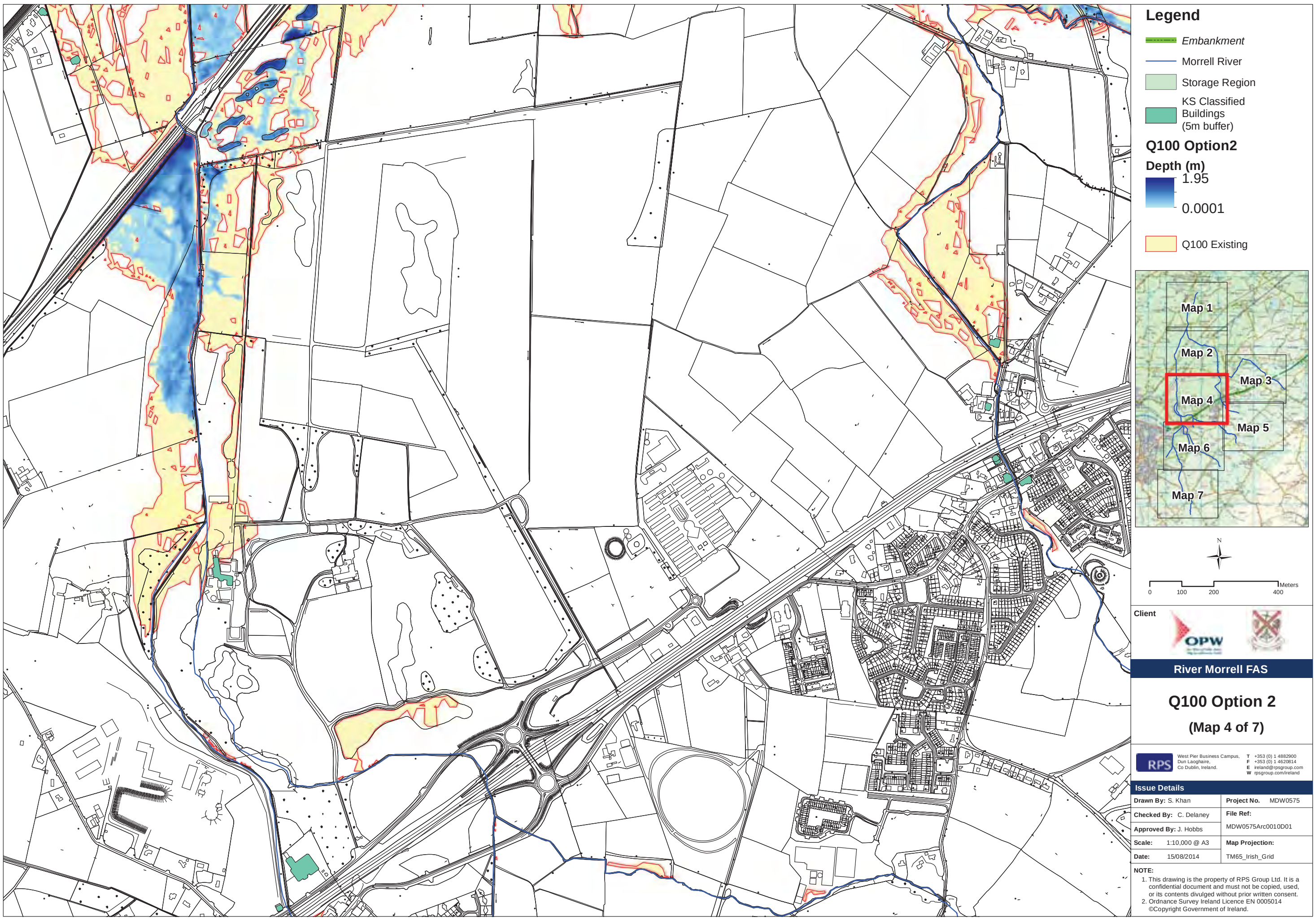
Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
N
0 100 200 400 Meters
Client
OPW
River Morrell FAS
Q100 Option 2
(Map 4 of 7)
RPS
Issue Details
Drawn By: S. Khan
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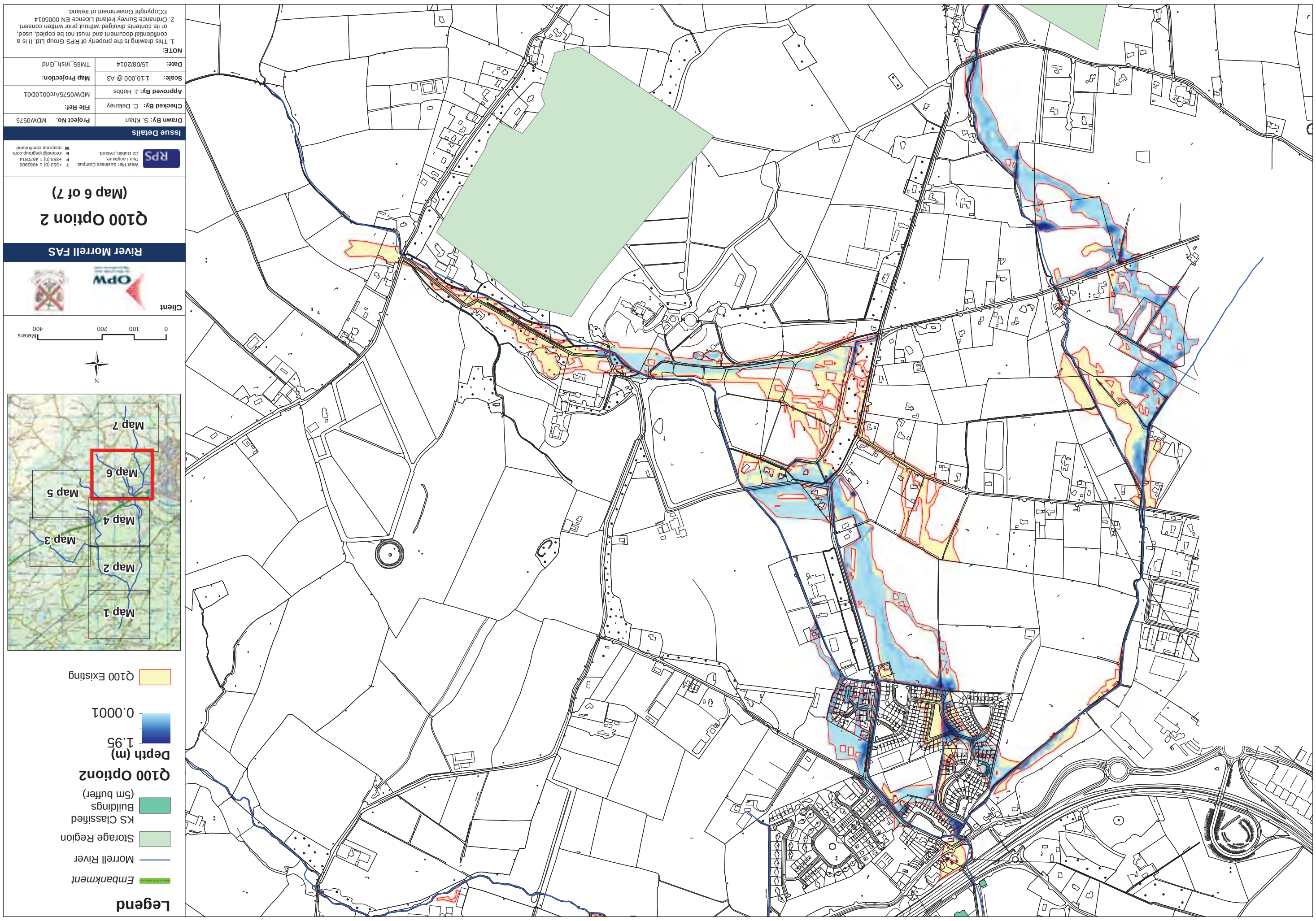
Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Client
River Morrell FAS
Q100 Option 2
(Map 6 of 7)
Issue Details


Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
Client
River Morrell FAS
Q100 Option 2
(Map 5 of 7)
Issue Details


Legend
Embankment
Morrell River
Storage Region
KS Classified Buildings (5m buffer)
Q100 Option2
Depth (m)
1.95
0.0001
Q100 Existing
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Map 7
N
0 100 200 400 Meters
Client
OPW
River Morrell FAS
Q100 Option 2
(Map 7 of 7)
RPS
Issue Details
Drawn By: S. Khan
Project No. MDW0575
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Appendix C

Multi Criteria Analysis of Proposed FRM Options

CRITERIA	OBJECTIVE	SUB-OBJECTIVE	INDICATOR	BASIC REQUIREMENT	ASPIRATIONAL TARGET	GLOBAL WEIGHTING	LOCAL WEIGHTING	LOCAL WEIGHTING COMMENT	SCORE	SCORE COMMENT	WEIGHTED SCORE
1 Technical	a Ensure flood risk management options are operationally robust	i Ensure flood risk management options are operationally robust	Level of operational risk of option - Degree of reliance on mechanical, electrical or electronic systems or on human intervention, action or decision, for the option to operate or perform successfully	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	b Minimise health and safety risks associated with the construction and operation of flood risk management options	i Minimise health and safety risks associated with the construction and operation of flood risk management options	Degree of health and safety risk during construction and operation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	c Ensure flood risk management options are adaptable to future flood risk	i Ensure flood risk management options are adaptable to future flood risk i.e. can be managed effectively and sustainably into the future	Sustainability and adaptability of the option in the face of potential future changes, including the potential impacts of climate change	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 Economic	a Minimise economic risk / reduce economic damages	i Minimise economic risk / reduce economic damages	Annual Average Damage (AAD) expressed in euro / year calculated in accordance with the economic risk assessment methods, but with no allowance for social / intangible benefits	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	b Minimise risk to transport infrastructure	i Minimise risk to transport infrastructure	Number and type of transport routes at risk from flooding	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	c Minimise risk to utility infrastructure	i Minimise risk to utility infrastructure	Number and type of infrastructure assets at risk from flooding	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	d Minimise risk to agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3 Social	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4 Environmental	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CRITERIA	OBJECTIVE	SUB-OBJECTIVE	INDICATOR	BASIC REQUIREMENT	ASPIRATIONAL TARGET	GLOBAL WEIGHTING	LOCAL WEIGHTING	LOCAL WEIGHTING COMMENT	SCORE	SCORE COMMENT	WEIGHTED SCORE
1 Technical	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 Economic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3 Social	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4 Environmental	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Appendix D

Damage Assessment of Properties

geodb_oid	NAME	X	Y	AREA	Use	MCM_CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
9704		291349.4	224579	62	R	11
9706		292889.2	227647	62	R	11
27040828		291211.7	224788	177.69	R	11
35410432		296662.1	224091	137.87	R	14
35411535	ROSALEAN	292358.5	224815	200.39	R	11
35411703		291752.7	225708	183.66	R	14
35411704		291771	225745	162.49	R	14
36518778	ROSSAN	294083.8	223192	106.41	R	11
36690475		292540.8	224799	206.03	R	11
36690478		291343.5	224908	220.76	R	11
36690483		291762.7	225506	150.65	R	11
36912231	ASHMORE HOUSE	291885.9	227516	151.93	R	11
36912301		292533	227363	137.78	R	11
36912304		292734.8	227509	681.28	C	4
36912330		292687.4	227519	695.86	C	4
36915590		295670	225070	229.33	R	11
36915593		295305.5	225195	105.36	R	14
36915599		295568.1	225249	207.36	R	14
36915601		295538.9	225219	196.41	R	11
37805846		291237.8	224273	215.27	R	11
37805849		292635.5	224799	264.58	R	11
37805854		291321.3	224879	171.2	R	11
37805858		291446.7	224921	220.67	R	14
37805859		291485.7	224968	158.03	R	11
37805862		291538	225041	275.21	R	14
37810090		291694.3	222675	867.86	C	51
37810433		291945.9	221754	3376.5	C	2
37884370		293382.5	228421	113.2	C	4

Morrell FAS Property Damage Assessment
Do Nothing Scenario

geodb_oid	NAME	X	Y	AREA	Use	MCM_CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
37885222	THORN HILL LODGE	291923.2	227605	211.76	R	14
37885392		292135	227284	90.06	R	14
37885397		292436.3	227061	224.56	R	11
37885403		292438	227025	185.39	R	11
37885491		296165.7	224891	175.6	R	14
38505977		295626.1	225063	147.06	R	11
38506008		296066.3	224969	142.37	R	11
38506012		296121.3	224929	162.57	C	4
40053434		292480.3	227256	136.86	R	11
40182045		295402.5	225185	309.23	R	11
40182047		295943.4	225270	215.67	R	14
60053887		293001.1	227964	142.33	R	14
60076792		291200.9	224500	220.97	R	11
60077044	KILASTY HOUSE	292503.4	224810	255.5	R	14
60215906		295718.3	225204	322.5	R	11
60215908		295815.3	225071	150.48	C	4
80446021	ALASTY HOUSE	293730	225659	169.63	R	11
80446099		296145.3	224902	192.62	R	14
80446142	DUNBUAIN LODGE	296951.4	224121	283.06	R	14
80446167	DEVON VILLA	292259.9	224810	215.19	R	14
80549147	ACORN LODGE	291934.6	225942	143.9	R	11
80549148		291792.1	225782	198.92	R	14
80549149	DERRYARD	291738.9	225642	152.36	R	14
80549150	PINE VALE	291674.8	225433	195.87	R	11
80549164		293281.5	228204	104.2	R	14
80549165		293209.1	228204	116.23	R	11
80549167		293112.2	228938	202.99	R	11
80549173	BALLYHAYS LODGE	292878.3	228558	202.37	R	11

geodb_oid	NAME	X	Y	AREA	Use	MCM_ CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
80549174		292969.8	228403	163.19	R	14
80549175	WHITECHURCH LODG	293144	228457	326.23	R	11
80549176		292892	227794	194.76	R	14
80549177		292843.2	227710	175.02	R	14
80549178		292777.6	227505	231.36	R	14
80549179		292491.3	227344	170.91	R	11
80549197		291757.5	224838	179.87	R	14
80549311		293362.5	228192	256.07	R	11
80549312		293342.1	228128	240.78	R	11
80549313	WHITECHURCH COTT	293380.4	228394	177.3	R	11
80549318		292583.5	227313	163.78	R	14
80549319		292323.9	227385	784.2	C	8
80549322		291965.3	227293	225.76	R	14
80549331	DOMARIST	291684.3	225463	228.19	R	14
80549332		291520.2	224770	97.89	R	14
80549333		291368	224706	154.02	R	14
80549335		291262.9	224581	199.67	R	11
80549337		291135.9	224424	141.86	R	11
80549370	OAKVALE	293748.7	228195	263.99	R	11
80549371	TYMEN LODGE	293680.4	228108	248.2	R	11
80556278		292273.2	224696	793.69	C	51
80556312	GATE LODGE	291874.1	221627	72.65	R	14
80556344	DOOEGA	294105.1	223391	284.32	R	11
80556658	RIVERSIDE	294107.7	223031	81.36	R	12
80556659	BRAE COTTAGE	294111.9	223023	83.97	R	12
80556838		294201.9	222961	251.08	R	11
80556852		294144.5	222969	240.44	C	2

Morrell FAS Property Damage Assessment
Do Nothing Scenario

geodb_oid	PROP_TYPE	Local_ Biz	Rate_Value	Market_Val	ContentVal
An Post geodirectory ID	Property Type	Local Business	Rateable Value of Commercial Property	Market Value of Residential Property	Contents Value of Residential Property
9704	Detached House		0	190797	0
9706	Detached House		0	190797	0
27040828	Detached House		0	190797	1604.8
35410432	Bungalow		0	190797	7755.8
35411535	Detached House		0	190797	0
35411703	Bungalow		0	190797	0
35411704	Bungalow		0	190797	0
36518778	Detached House		0	190797	0
36690475	Detached House		0	190797	0
36690478	Detached House		0	190797	0
36690483	Detached House		0	190797	0
36912231	Detached House		0	190797	0
36912301	Detached House		0	190797	0
36912304	Warehouses	L	39991	0	0
36912330	Warehouses	L	45507	0	0
36915590	Detached House		0	190797	0
36915593	Bungalow		0	190797	0
36915599	Bungalow		0	190797	6155.2
36915601	Detached House		0	190797	6777.6
37805846	Detached House		0	190797	0
37805849	Detached House		0	190797	8677.83
37805854	Detached House		0	190797	0
37805858	Bungalow		0	190797	0
37805859	Detached House		0	190797	0
37805862	Bungalow		0	190797	0
37810090	Club House		597797	0	0
37810433	Garden Centre		482650	0	0
37884370	Warehouses	L	6645	0	0

geodb_oid An Post geodirectory ID	PROP_TYPE Property Type	Local_ Biz Local Business	Rate_Value Rateable Value of Commercial Property	Market_Val Market Value of Residential Property	ContentVal Contents Value of Residential Property
37885222	Bungalow		0	190797	0
37885392	Bungalow		0	190797	0
37885397	Detached House		0	190797	0
37885403	Detached House		0	190797	0
37885491	Bungalow		0	190797	7682.87
38505977	Detached House		0	190797	0
38506008	Detached House		0	190797	0
38506012	Warehouses	L	9543	0	0
40053434	Detached House		0	190797	0
40182045	Detached House		0	190797	3624.8
40182047	Bungalow		0	190797	0
60053887	Bungalow		0	190797	0
60076792	Detached House		0	190797	0
60077044	Bungalow		0	190797	10201.33
60215906	Detached House		0	190797	2986
60215908	Warehouses	L	8833	0	0
80446021	Detached House		0	190797	0
80446099	Bungalow		0	190797	6873.4
80446142	Bungalow		0	190797	8558.07
80446167	Bungalow		0	190797	1051.6
80549147	Detached House		0	190797	0
80549148	Bungalow		0	190797	0
80549149	Bungalow		0	190797	0
80549150	Bungalow		0	190797	3305.4
80549164	Bungalow		0	190797	0
80549165	Detached House		0	190797	0
80549167	Detached House		0	190797	0
80549173	Detached House		0	190797	0

geodb_oid An Post geodirectory ID	PROP_TYPE Property Type	Local_ Biz Local Business	Rate_Value Rateable Value of Commercial Property	Market_Val Market Value of Residential Property	ContentVal Contents Value of Residential Property
80549174	Bungalow		0	190797	1051.6
80549175	Detached House		0	190797	0
80549176	Bungalow		0	190797	0
80549177	Bungalow		0	190797	0
80549178	Bungalow		0	190797	0
80549179	Detached House		0	190797	0
80549197	Bungalow		0	190797	0
80549311	Detached House		0	190797	0
80549312	Detached House		0	190797	0
80549313	Detached House		0	190797	0
80549318	Bungalow		0	190797	0
80549319	Industry		46032	0	0
80549322	Bungalow		0	190797	0
80549331	Bungalow		0	190797	2629
80549332	Bungalow		0	190797	9287.4
80549333	Bungalow		0	190797	4224.6
80549335	Detached House		0	190797	0
80549337	Detached House		0	190797	0
80549370	Detached House		0	190797	0
80549371	Detached House		0	190797	0
80556278	Club House		43776	0	0
80556312	Bungalow		0	190797	0
80556344	Detached House		0	190797	0
80556658	Semi Detached		0	190797	5894.3
80556659	Semi Detached		0	190797	5776.6
80556838	Detached House		0	190797	4902.4
80556852	Licensed House	L	26242	0	0

geodb_oid An Post geodirectory ID	Total_Val Total Value of Property	BASEMENT Property has a Basement?	RAISED	GRND_LVL Ground Level	FFL Finished Floor Level	Survey_Loc Threshold Survey Location
9704	190797	No	No	71.53	71.828	Front door
9706	190797	No	No	62.26	62.56	
27040828	192401.8	No	No	71.05	71.351	Front door
35410432	198552.8	No	No	120.1	120.4	Street - 119.595
35411535	190797	No	No	71.16	71.461	Front door
35411703	190797	No	No	68.09	68.395	Rear door
35411704	190797	No	No	68.11	68.406	Front door
36518778	190797	No	No	92.14	92.441	Drawing - door
36690475	190797	No	No	71.07	71.369	Front door
36690478	190797	No	No	70.77	71.074	Rear door
36690483	190797	No	No	68.89	69.194	Front door
36912231	190797	No	No	63.77	64.07	Front door
36912301	190797	No	No	63.68	63.98	Street - 63.653
36912304	39991	No	No	63.13	63.432	Front door
36912330	45507	No	No	63.07	63.368	Front door
36915590	190797	No	No	101.2	101.5	Street - 106.731
36915593	190797	No	No	97.57	97.87	Street - 97.624
36915599	196952.2	No	No	99.07	99.37	Front door
36915601	197574.6	No	No	98.8	99.1	Front door
37805846	190797	No	No	71.89	72.188	Rear door
37805849	199474.83	No	No	70.55	70.848	Front door
37805854	190797	No	No	70.86	71.16	Street - 71.084
37805858	190797	No	No	70.69	70.99	Street - 70.695
37805859	190797	No	No	70.66	70.964	Side door
37805862	190797	No	No	70.46	70.76	Rear door
37810090	597797	No	No	79.77	80.07	Drawing - door
37810433	482650	No	No	82.49	82.787	Front door
37884370	6645	No	No	60.3	60.6	Street - 60.395

geodb_oid An Post geodirectory ID	Total_Val Total Value of Property	BASEMENT Property has a Basement?	RAISED	GRND_LVL Ground Level	FFL Finished Floor Level	Survey_Loc Threshold Survey Location
37885222	190797	No	No	63.64	63.94	Front door
37885392	190797	No	No	64.5	64.8	Front door
37885397	190797	No	No	64.15	64.453	Front door
37885403	190797	No	No	64.34	64.635	Front door
37885491	198479.87	No	No	108.25	108.55	Drawing - door
38505977	190797	No	No	100.67	100.97	Street - 102.077
38506008	190797	No	No	107.16	107.46	Front door
38506012	9543	No	No	107.82	108.119	Front door
40053434	190797	No	No	63.85	64.15	Street - 64.264
40182045	194421.8	No	No	97.51	97.81	Rear door
40182047	190797	No	No	102.96	103.26	Street - 102.771
60053887	190797	No	No	62.08	62.378	Front door
60076792	190797	No	No	71.96	72.26	Street - 71.82
60077044	200998.33	No	No	70.34	70.64	Street - 70.844
60215906	193783	No	No	100.92	101.22	Street - 100.94
60215908	8833	No	No	102.88	103.184	Rear door
80446021	190797	No	No	73.78	74.08	Street - 73.33
80446099	197670.4	No	No	107.92	108.224	Rear door
80446142	199355.07	No	No	123.23	123.53	Street - 123.833
80446167	191848.6	No	No	71.03	71.325	Front door
80549147	190797	No	No	67.22	67.519	Front door
80549148	190797	No	No	67.85	68.148	Front door
80549149	190797	No	No	68.45	68.752	Rear door
80549150	194102.4	No	No	68.79	69.093	Vent
80549164	190797	No	No	60.9	61.2	Front door
80549165	190797	No	No	61.18	61.482	Rear door
80549167	190797	No	No	58.83	59.13	Street - 58.561
80549173	190797	No	No	60.39	60.686	Front door

geodb_oid An Post geodirectory ID	Total_Val Total Value of Property	BASEMENT Property has a Basement?	RAISED	GRND_LVL Ground Level	FFL Finished Floor Level	Survey_Loc Threshold Survey Location
80549174	191848.6	No	No	60.66	60.964	Rear door
80549175	190797	No	No	60.8	61.1	Street - 61.078
80549176	190797	No	No	62.38	62.68	Front door
80549177	190797	No	No	62.76	63.06	Street - 62.84
80549178	190797	No	No	63.11	63.409	Rear door
80549179	190797	No	No	63.85	64.15	Street - 64.082
80549197	190797	No	No	70.93	71.23	Street - 71.355
80549311	190797	No	No	60.79	61.093	Front door
80549312	190797	No	No	60.95	61.248	Front door
80549313	190797	No	No	60.68	60.977	Front door
80549318	190797	No	No	63.61	63.91	Front door
80549319	46032	No	No	64.01	64.31	Rear door
80549322	190797	No	No	64.71	65.01	Drawing - door
80549331	193426	No	No	68.84	69.144	Vent
80549332	200084.4	No	No	70.97	71.271	Front door
80549333	195021.6	No	No	71.4	71.7	Street - 71.538
80549335	190797	No	No	71.6	71.9	Street - 71.686
80549337	190797	No	No	72.41	72.71	Street - 72.064
80549370	190797	No	No	59.82	60.123	Front door
80549371	190797	No	No	60.18	60.484	Front door
80556278	43776	No	No	71.05	71.353	Rear door
80556312	190797	No	No	83.17	83.466	Front door
80556344	190797	No	No	90.45	90.753	Front door
80556658	196691.3	No	No	92.66	92.956	Front door
80556659	196573.6	No	No	92.7	92.996	Front door
80556838	195699.4	No	No	94.44	94.736	Front door
80556852	26242	No	No	93.79	94.092	Front door

geodb_oid An Post geodirectory ID	Q1000_ELEV Maximum water elevation at Property during a 0.1%AEP event	Q1000_Dp Maximum water depth at Property during a 0.1%AEP event	Q1000_M2Dm Damage to Property per m2 during a 0.1%AEP event	1000_Dm£13 Damage to property in £ in the year 2013 during a 0.1%AEP event	1000_PDD Damage to property in € in the year 2013 during a 0.1%AEP event
9704	71.82	-0.01	55.76	3457.12	4017.63
9706	62.56	0	57.04	3536.48	4109.85
27040828	71.39	0.04	199.91	35522.01	41281.23
35410432	120.73	0.33	494.9	68231.86	79294.37
35411535	71.34	-0.12	41.64	8344.24	9697.1
35411703	68.15	-0.24	22.36	4106.64	4772.45
35411704	68.13	-0.28	18.43	2994.69	3480.22
36518778	92.25	-0.19	32.66	3475.35	4038.81
36690475	71.34	-0.03	53.19	10958.74	12735.49
36690478	70.87	-0.2	31.38	6927.45	8050.61
36690483	69.14	-0.05	50.63	7627.41	8864.05
36912231	63.84	-0.23	27.53	4182.63	4860.76
36912301	63.8	-0.18	33.95	4677.63	5436.02
36912304	63.3	-0.13	0	0	0
36912330	63.31	-0.06	0	0	0
36915590	101.21	-0.29	19.83	4547.61	5284.92
36915593	97.61	-0.26	20.4	2149.34	2497.81
36915599	99.56	0.19	398.61	82655.77	96056.84
36915601	99.34	0.24	539.95	106051.58	123245.84
37805846	72.07	-0.12	41.64	8963.84	10417.16
37805849	71.34	0.49	648.47	171572.19	199389.38
37805854	70.88	-0.28	21.12	3615.74	4201.96
37805858	70.71	-0.28	18.43	4066.95	4726.33
37805859	70.59	-0.37	0	0	0
37805862	70.48	-0.28	18.43	5072.12	5894.47
37810090	78.66	-1.41	0	0	0
37810433	83.03	0.24	338.48	1142870.95	1328165.88
37884370	60.53	-0.07	0	0	0

geodb_oid An Post geodirectory ID	Q1000_ELEV Maximum water elevation at Property during a 0.1%AEP event	Q1000_Dp Maximum water depth at Property during a 0.1%AEP event	Q1000_M2Dm Damage to Property per m2 during a 0.1%AEP event	1000_Dm£13 Damage to property in £ in the year 2013 during a 0.1%AEP event	1000_PDD Damage to property in € in the year 2013 during a 0.1%AEP event
37885222	63.78	-0.16	30.21	6397.27	7434.47
37885392	64.79	-0.01	44.93	4046.4	4702.45
37885397	64.42	-0.03	53.19	11944.35	13880.9
37885403	64.44	-0.2	31.38	5817.54	6760.74
37885491	108.87	0.32	493.06	86581.34	100618.87
38505977	100.7	-0.27	22.4	3294.14	3828.22
38506008	107.25	-0.21	30.1	4285.34	4980.13
38506012	108.24	0.12	211	34302.27	39863.73
40053434	64.1	-0.05	50.63	6929.22	8052.66
40182045	97.93	0.12	383.03	118444.37	137647.89
40182047	103.11	-0.15	31.19	6726.75	7817.37
60053887	62.16	-0.22	24.32	3461.47	4022.68
60076792	71.84	-0.42	0	0	0
60077044	71.34	0.7	559.51	142954.8	166132.22
60215906	101.32	0.1	355.09	114516.52	133083.21
60215908	103.2	0.02	61	9179.28	10667.53
80446021	73.76	-0.32	0	0	0
80446099	108.46	0.24	441.4	85022.47	98807.26
80446142	123.97	0.44	515.1	145804.21	169443.61
80446167	71.35	0.02	106.57	22932.8	26650.92
80549147	67.27	-0.25	24.96	3591.74	4174.07
80549148	67.89	-0.26	20.4	4057.97	4715.89
80549149	68.31	-0.44	0	0	0
80549150	69.2	0.11	369.06	72287.78	84007.88
80549164	61.08	-0.12	34.13	3556.35	4132.94
80549165	61.12	-0.36	0	0	0
80549167	59.1	-0.03	53.19	10797.04	12547.58
80549173	60.52	-0.17	35.23	7129.5	8285.41

geodb_oid An Post geodirectory ID	Q1000_ELEV Maximum water elevation at Property during a 0.1%AEP event	Q1000_Dp Maximum water depth at Property during a 0.1%AEP event	Q1000_M2Dm Damage to Property per m2 during a 0.1%AEP event	1000_Dm£13 Damage to property in £ in the year 2013 during a 0.1%AEP event	1000_PDD Damage to property in € in the year 2013 during a 0.1%AEP event
80549174	60.98	0.02	106.57	17391.16	20210.81
80549175	60.74	-0.36	0	0	0
80549176	62.45	-0.23	23.34	4545.7	5282.7
80549177	62.69	-0.37	0	0	0
80549178	63.28	-0.13	33.15	7669.58	8913.06
80549179	63.99	-0.16	36.51	6239.92	7251.61
80549197	70.99	-0.24	22.36	4021.89	4673.96
80549311	61.03	-0.06	49.34	12634.49	14682.93
80549312	61.24	-0.01	55.76	13425.89	15602.64
80549313	60.53	-0.45	0	0	0
80549318	63.77	-0.14	32.17	5268.8	6123.04
80549319	64.19	-0.12	0	0	0
80549322	64.56	-0.45	0	0	0
80549331	69.19	0.05	197.57	45083.5	52392.94
80549332	71.81	0.54	533.46	52220.4	60686.95
80549333	71.82	0.12	322.99	49746.92	57812.44
80549335	71.82	-0.08	46.78	9340.56	10854.96
80549337	71.84	-0.87	0	0	0
80549370	59.93	-0.19	32.66	8621.91	10019.79
80549371	60.17	-0.31	0	0	0
80556278	71.52	0.17	453.32	359795.55	418129.6
80556312	83.36	-0.11	35.12	2551.47	2965.14
80556344	90.44	-0.31	0	0	0
80556658	93.53	0.57	742.61	60418.75	70214.51
80556659	93.54	0.54	736.11	61811.16	71832.67
80556838	94.9	0.16	438.91	110201.52	128068.61
80556852	93.59	-0.5	0	0	0

geodb_oid An Post geodirectory ID	Q200_ELEV See Q1000_ELEV	Q200_Dp See Q1000_Dp	Q200_M2Dm See Q1000_M2Dm	Q200_Dm£13 See Q1000_Dm£13	Q200_PDD See Q1000_PDD
9704	71.69	-0.14	39.08	2422.96	2815.8
9706	62.56	0	57.04	3536.48	4109.85
27040828	71.37	0.02	128.48	22829.61	26531
35410432	120.59	0.19	398.61	54956.36	63866.5
35411535	-999	-999	0	0	0
35411703	68.14	-0.25	21.38	3926.65	4563.28
35411704	68.12	-0.29	17.45	2835.45	3295.16
36518778	92.12	-0.32	0	0	0
36690475	70.73	-0.64	0	0	0
36690478	70.82	-0.25	24.96	5510.17	6403.54
36690483	69.13	-0.06	49.34	7433.07	8638.2
36912231	63.75	-0.32	0	0	0
36912301	63.76	-0.22	28.81	3969.44	4613.01
36912304	63.17	-0.26	0	0	0
36912330	-999	-999	0	0	0
36915590	101.19	-0.31	0	0	0
36915593	-999	-999	0	0	0
36915599	99.5	0.13	333.79	69214.69	80436.54
36915601	99.24	0.14	410.97	80718.62	93805.62
37805846	72	-0.19	32.66	7030.72	8170.62
37805849	70.73	-0.12	41.64	11017.11	12803.33
37805854	70.82	-0.34	0	0	0
37805858	70.69	-0.3	16.47	3634.43	4223.68
37805859	70.57	-0.39	0	0	0
37805862	70.46	-0.3	16.47	4532.71	5267.6
37810090	78.51	-1.56	0	0	0
37810433	82.74	-0.05	0	0	0
37884370	60.38	-0.22	0	0	0

geodb_oid An Post geodirectory ID	Q200_ELEV See Q1000_ELEV	Q200_Dp See Q1000_Dp	Q200_M2Dm See Q1000_M2Dm	Q200_Dm£13 See Q1000_Dm£13	Q200_PDD See Q1000_PDD
37885222	63.74	-0.2	26.28	5565.05	6467.32
37885392	-999	-999	0	0	0
37885397	64.24	-0.21	30.1	6759.26	7855.15
37885403	-999	-999	0	0	0
37885491	108.72	0.17	377	66201.2	76934.47
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	108.03	-0.09	0	0	0
40053434	64.06	-0.09	45.49	6225.76	7235.15
40182045	97.83	0.02	128.48	39729.87	46171.32
40182047	103	-0.26	20.4	4399.67	5112.99
60053887	62.12	-0.26	20.4	2903.53	3374.28
60076792	71.69	-0.57	0	0	0
60077044	70.73	0.09	280.62	71698.41	83322.95
60215906	101.23	0.01	92.76	29915.1	34765.27
60215908	103.16	-0.02	0	0	0
80446021	-999	-999	0	0	0
80446099	108.39	0.17	377	72617.74	84391.33
80446142	123.78	0.25	449.4	127207.16	147831.4
80446167	-999	-999	0	0	0
80549147	67.26	-0.26	23.68	3407.55	3960.02
80549148	67.88	-0.27	19.41	3861.04	4487.03
80549149	68.31	-0.44	0	0	0
80549150	69.19	0.1	355.09	69551.48	80827.94
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q200_ELEV	Q200_Dp	Q200_M2Dm	Q200_Dm£13	Q200_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	60.97	0.01	76.24	12441.61	14458.78
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	62.61	-0.45	0	0	0
80549178	63.17	-0.24	22.36	5173.21	6011.95
80549179	63.94	-0.21	30.1	5144.39	5978.46
80549197	70.98	-0.25	21.38	3845.62	4469.11
80549311	60.94	-0.15	37.8	9679.45	11248.79
80549312	61.14	-0.11	42.93	10336.69	12012.59
80549313	60.38	-0.6	0	0	0
80549318	63.72	-0.19	27.26	4464.64	5188.5
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.18	0.04	167.24	38162.5	44349.83
80549332	71.68	0.41	509.59	49883.77	57971.48
80549333	71.69	-0.01	44.93	6920.12	8042.09
80549335	71.69	-0.21	30.1	6010.07	6984.49
80549337	71.73	-0.98	0	0	0
80549370	59.86	-0.26	23.68	6251.28	7264.81
80549371	60.1	-0.38	0	0	0
80556278	71.41	0.06	288.76	229185.92	266344.09
80556312	83.19	-0.28	18.43	1338.94	1556.02
80556344	90.46	-0.31	0	0	0
80556658	93.17	0.21	570.05	46379.27	53898.79
80556659	93.17	0.17	511.35	42938.06	49899.66
80556838	-999	-999	0	0	0
80556852	93.52	-0.57	0	0	0

geodb_oid	Q100_ELEV	Q100_Dp	Q100_M2Dm	Q100_Dm£13	Q100_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	71.61	-0.22	28.81	1786.22	2075.82
9706	-999	-999	0	0	0
27040828	71.35	0	57.04	10135.44	11778.71
35410432	120.52	0.12	322.99	44530.63	51750.43
35411535	-999	-999	0	0	0
35411703	68.14	-0.25	21.38	3926.65	4563.28
35411704	68.12	-0.29	17.45	2835.45	3295.16
36518778	-999	-999	0	0	0
36690475	70.49	-0.88	0	0	0
36690478	-999	-999	0	0	0
36690483	69.13	-0.06	49.34	7433.07	8638.2
36912231	63.7	-0.37	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.46	0.09	280.62	58189.36	67623.67
36915601	99.19	0.09	331.2	65050.99	75597.78
37805846	71.97	-0.22	28.81	6201.93	7207.46
37805849	70.49	-0.36	0	0	0
37805854	-999	-999	0	0	0
37805858	70.69	-0.3	16.47	3634.43	4223.68
37805859	70.56	-0.4	0	0	0
37805862	70.45	-0.31	0	0	0
37810090	78.46	-1.61	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q100_ELEV See Q1000_ELEV	Q100_Dp See Q1000_Dp	Q100_M2Dm See Q1000_M2Dm	Q100_Dm£13 See Q1000_Dm£13	Q100_PDD See Q1000_PDD
37885222	63.7	-0.24	22.36	4734.95	5502.63
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.67	0.12	322.99	56717.04	65912.64
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.94	-0.18	0	0	0
40053434	64	-0.15	37.8	5173.31	6012.06
40182045	97.78	-0.03	53.19	16447.94	19114.66
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	71.61	-0.65	0	0	0
60077044	70.49	-0.15	31.19	7969.05	9261.08
60215906	101.18	-0.04	51.91	16740.97	19455.2
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.37	0.15	355.39	68455.22	79553.94
80446142	123.7	0.17	377	106713.62	124015.22
80446167	-999	-999	0	0	0
80549147	67.25	-0.27	22.4	3223.36	3745.97
80549148	67.88	-0.27	19.41	3861.04	4487.03
80549149	68.3	-0.45	0	0	0
80549150	69.19	0.1	355.09	69551.48	80827.94
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q100_ELEV See Q1000_ELEV	Q100_Dp See Q1000_Dp	Q100_M2Dm See Q1000_M2Dm	Q100_Dm£13 See Q1000_Dm£13	Q100_PDD See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.98	-0.25	21.38	3845.62	4469.11
80549311	-999	-999	0	0	0
80549312	60.97	-0.28	21.12	5085.27	5909.75
80549313	-999	-999	0	0	0
80549318	63.62	-0.29	17.45	2857.96	3321.32
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.17	0.03	136.91	31241.49	36306.71
80549332	71.61	0.34	496.74	48625.88	56509.65
80549333	71.61	-0.09	37.08	5711.06	6637
80549335	71.61	-0.29	19.83	3959.46	4601.41
80549337	71.71	-1	0	0	0
80549370	59.79	-0.33	0	0	0
80549371	-999	-999	0	0	0
80556278	71.37	0.02	228.92	181691.51	211149.36
80556312	-999	-999	0	0	0
80556344	90.44	-0.31	0	0	0
80556658	93.07	0.11	419.3	34114.25	39645.23
80556659	93.07	0.07	315.05	26454.75	30743.89
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q50_ELEV	Q50_Dp	Q50_M2Dm	Q50_Dm£13	Q50_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	71.55	-0.28	21.12	1309.44	1521.74
9706	-999	-999	0	0	0
27040828	71.25	-0.1	44.21	7855.67	9129.32
35410432	120.47	0.07	239.09	32963.34	38307.72
35411535	-999	-999	0	0	0
35411703	68.14	-0.25	21.38	3926.65	4563.28
35411704	68.11	-0.3	16.47	2676.21	3110.11
36518778	-999	-999	0	0	0
36690475	70.32	-1.05	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.69	-0.38	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.42	0.05	197.57	40968.12	47610.33
36915601	99.1	0	57.04	11203.23	13019.62
37805846	71.94	-0.25	24.96	5373.14	6244.29
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	70.68	-0.31	0	0	0
37805859	70.56	-0.4	0	0	0
37805862	70.44	-0.32	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q50_ELEV	Q50_Dp	Q50_M2Dm	Q50_Dm£13	Q50_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.69	-0.25	21.38	4527.43	5261.47
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.63	0.08	259.86	45631.42	53029.69
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.88	-0.24	0	0	0
40053434	64	-0.15	37.8	5173.31	6012.06
40182045	97.71	-0.1	44.21	13671.06	15887.56
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	71.53	-0.73	0	0	0
60077044	-999	-999	0	0	0
60215906	101.05	-0.17	35.23	11361.67	13203.75
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	0.13	333.79	64294.63	74718.79
80446142	123.66	0.13	333.79	94482.6	109801.17
80446167	-999	-999	0	0	0
80549147	67.25	-0.27	22.4	3223.36	3745.97
80549148	67.88	-0.27	19.41	3861.04	4487.03
80549149	68.3	-0.45	0	0	0
80549150	69.18	0.09	331.2	64872.14	75389.93
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q50_ELEV See Q1000_ELEV	Q50_Dp See Q1000_Dp	Q50_M2Dm See Q1000_M2Dm	Q50_Dm£13 See Q1000_Dm£13	Q50_PDD See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.98	-0.25	21.38	3845.62	4469.11
80549311	-999	-999	0	0	0
80549312	60.87	-0.38	0	0	0
80549313	-999	-999	0	0	0
80549318	63.61	-0.3	16.47	2697.46	3134.8
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.17	0.03	136.91	31241.49	36306.71
80549332	71.55	0.28	473.39	46340.15	53853.33
80549333	71.55	-0.15	31.19	4803.88	5582.74
80549335	71.55	-0.35	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	71.29	-0.06	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q20_ELEV See Q1000_ELEV	Q20_Dp See Q1000_Dp	Q20_M2Dm See Q1000_M2Dm	Q20_Dm£13 See Q1000_Dm£13	Q20_PDD See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.51	0.07	239.09	32963.34	38307.72
35411535	-999	-999	0	0	0
35411703	68.13	-0.27	19.41	3564.84	4142.81
35411704	68.11	-0.3	16.47	2676.21	3110.11
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-0.39	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.41	0.04	167.24	34678.89	40301.42
36915601	99.09	-0.01	55.76	10951.82	12727.45
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q20_ELEV	Q20_Dp	Q20_M2Dm	Q20_Dm£13	Q20_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.68	-0.26	20.4	4319.9	5020.29
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.63	0.08	259.86	45631.42	53029.69
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.86	-0.26	0	0	0
40053434	63.94	-0.21	30.1	4119.49	4787.39
40182045	97.69	-0.12	41.64	12876.34	14964
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	101.05	-0.17	35.23	11361.67	13203.75
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	0.13	333.79	64294.63	74718.79
80446142	123.67	0.13	333.79	94482.6	109801.17
80446167	-999	-999	0	0	0
80549147	67.25	-0.27	22.4	3223.36	3745.97
80549148	67.88	-0.27	19.41	3861.04	4487.03
80549149	68.29	-0.46	0	0	0
80549150	69.18	0.09	331.2	64872.14	75389.93
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q20_ELEV	Q20_Dp	Q20_M2Dm	Q20_Dm£13	Q20_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.97	-0.26	20.4	3669.35	4264.27
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.16	0.02	106.57	24318.21	28260.95
80549332	71.19	-0.08	38.06	3725.69	4329.74
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.47	0.07	239.09	32963.34	38307.72
35411535	-999	-999	0	0	0
35411703	68.09	-0.3	16.47	3024.88	3515.31
35411704	68.1	-0.31	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-0.39	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.4	0.03	136.91	28389.66	32992.51
36915601	99.06	-0.04	51.91	10195.64	11848.67
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

Morrell FAS Property Damage Assessment
Do Nothing Scenario

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.68	-0.26	20.4	4319.9	5020.29
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.62	0.07	239.09	41984.2	48791.14
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.84	-0.28	0	0	0
40053434	-999	-999	0	0	0
40182045	97.67	-0.14	39.08	12084.71	14044.02
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	101.01	-0.21	30.1	9707.25	11281.1
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	0.13	333.79	64294.63	74718.79
80446142	123.66	0.13	333.79	94482.6	109801.17
80446167	-999	-999	0	0	0
80549147	67.24	-0.28	21.12	3039.17	3531.91
80549148	67.87	-0.28	18.43	3666.1	4260.49
80549149	68.28	-0.47	0	0	0
80549150	69.16	0.07	283.41	55511.52	64511.66
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.95	-0.28	18.43	3315	3852.46
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.15	0.01	76.24	17397.21	20217.84
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q5_ELEV	Q5_Dp	Q5_M2Dm	Q5_Dm£13	Q5_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.47	0.07	239.09	32963.34	38307.72
35411535	-999	-999	0	0	0
35411703	68.07	-0.33	0	0	0
35411704	68.09	-0.32	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-0.39	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.39	0.02	106.57	22098.36	25681.19
36915601	99.04	-0.06	49.34	9690.87	11262.06
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q5_ELEV See Q1000_ELEV	Q5_Dp See Q1000_Dp	Q5_M2Dm See Q1000_M2Dm	Q5_Dm£13 See Q1000_Dm£13	Q5_PDD See Q1000_PDD
37885222	63.68	-0.26	20.4	4319.9	5020.29
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.62	0.07	239.09	41984.2	48791.14
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.84	-0.28	0	0	0
40053434	-999	-999	0	0	0
40182045	97.66	-0.15	37.8	11688.89	13584.02
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	100.97	-0.25	24.96	8049.6	9354.69
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	0.13	333.79	64294.63	74718.79
80446142	123.66	0.13	333.79	94482.6	109801.17
80446167	-999	-999	0	0	0
80549147	67.22	-0.3	18.55	2669.35	3102.13
80549148	67.86	-0.29	17.45	3471.15	4033.93
80549149	68.27	-0.48	0	0	0
80549150	69.15	0.06	259.52	50832.18	59073.66
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q5_ELEV See Q1000_ELEV	Q5_Dp See Q1000_Dp	Q5_M2Dm See Q1000_M2Dm	Q5_Dm£13 See Q1000_Dm£13	Q5_PDD See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.94	-0.29	17.45	3138.73	3647.62
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.13	-0.01	44.93	10252.58	11914.84
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q2_ELEV	Q2_Dp	Q2_M2Dm	Q2_Dm£13	Q2_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	-999	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	-999	-999	0	0	0
35411704	-999	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	-999	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	-999	-999	0	0	0
36915601	-999	-999	0	0	0
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q2_ELEV	Q2_Dp	Q2_M2Dm	Q2_Dm£13	Q2_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	-999	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	-999	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	-999	-999	0	0	0
40053434	-999	-999	0	0	0
40182045	-999	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	-999	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	-999	-999	0	0	0
80446142	123.4	-0.13	33.15	9383.44	10904.79
80446167	-999	-999	0	0	0
80549147	-999	-999	0	0	0
80549148	-999	-999	0	0	0
80549149	-999	-999	0	0	0
80549150	69.1	0.01	92.76	18168.9	21114.64
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid An Post geodirectory ID	Q2_ELEV See Q1000_ELEV	Q2_Dp See Q1000_Dp	Q2_M2Dm See Q1000_M2Dm	Q2_Dm£13 See Q1000_Dm£13	Q2_PDD See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.56	-0.67	0	0	0
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.09	-0.05	41	9355.79	10872.65
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

Morrell FAS Property Damage Assessment
Do Nothing Scenario

geodb_oid An Post geodirectory ID	AAD Annual Average Damage	PvD Present Value Damage	PvD_cap Capped Present Value Damage
9704	66.71	1433.06	1433.06
9706	26.714	573.87	573.87
27040828	472.879	10158.39	10158.39
35410432	13667.202	293598.83	198552.8
35411535	19.394	416.62	416.62
35411703	584.931	12565.49	12565.49
35411704	233.109	5007.65	5007.65
36518778	8.078	173.53	173.53
36690475	25.471	547.17	547.17
36690478	44.917	964.91	964.91
36690483	121.387	2607.64	2607.64
36912231	9.722	208.85	208.85
36912301	31.631	679.5	679.5
36912304	0	0	0
36912330	0	0	0
36915590	10.57	227.06	227.06
36915593	4.996	107.32	107.32
36915599	11236.195	241375.94	196952.2
36915601	5146.153	110549.66	110549.66
37805846	236.544	5081.44	5081.44
37805849	456.394	9804.26	9804.26
37805854	8.404	180.53	180.53
37805858	60.137	1291.86	1291.86
37805859	0	0	0
37805862	35.493	762.46	762.46
37810090	0	0	0
37810433	2656.332	57063.32	57063.32
37884370	0	0	0

geodb_oid An Post geodirectory ID	AAD Annual Average Damage	PvD Present Value Damage	PvD_cap Capped Present Value Damage
37885222	1771.862	38063.14	38063.14
37885392	9.405	202.04	202.04
37885397	63.11	1355.73	1355.73
37885403	13.521	290.46	290.46
37885491	17641.133	378966.82	198479.87
38505977	7.656	164.47	164.47
38506008	9.96	213.96	213.96
38506012	79.727	1712.7	1712.7
40053434	405.491	8710.76	8710.76
40182045	5312.843	114130.49	114130.49
40182047	38.643	830.13	830.13
60053887	23.23	499.03	499.03
60076792	0	0	0
60077044	776.676	16684.55	16684.55
60215906	4077.77	87598.66	87598.66
60215908	21.335	458.32	458.32
80446021	0	0	0
80446099	26204.825	562932.05	197670.4
80446142	40353.353	866870.73	199355.07
80446167	53.302	1145.03	1145.03
80549147	1164.34	25012.35	25012.35
80549148	1458.821	31338.39	31338.39
80549149	0	0	0
80549150	25481.649	547396.78	194102.4
80549164	8.266	177.57	177.57
80549165	0	0	0
80549167	25.095	539.09	539.09
80549173	16.571	355.98	355.98

Morrell FAS Property Damage Assessment
Do Nothing Scenario

geodb_oid An Post geodirectory ID	AAD Annual Average Damage	PvD Present Value Damage	PvD_cap Capped Present Value Damage
80549174	105.486	2266.05	2266.05
80549175	0	0	0
80549176	10.565	226.96	226.96
80549177	0	0	0
80549178	44.88	964.11	964.11
80549179	41.406	889.48	889.48
80549197	1341.389	28815.72	28815.72
80549311	79.985	1718.24	1718.24
80549312	129.585	2783.74	2783.74
80549313	0	0	0
80549318	123.2	2646.58	2646.58
80549319	0	0	0
80549322	0	0	0
80549331	7963.436	171070.53	171070.53
80549332	2056.324	44173.95	44173.95
80549333	313.247	6729.17	6729.17
80549335	87.651	1882.92	1882.92
80549337	0	0	0
80549370	52.731	1132.77	1132.77
80549371	0	0	0
80556278	3618.428	77731.07	43776
80556312	12.932	277.81	277.81
80556344	0	0	0
80556658	680.313	14614.48	14614.48
80556659	598.793	12863.27	12863.27
80556838	256.137	5502.34	5502.34
80556852	0	0	0

geodb_oid An Post geodirectory ID	Utility Damage to Utility	Emergency Cost to Emergency Service	Intangible Intangible Costs	Total_PvD Total Present Value Damage
9704	286.61	116.08	1433.06	3268.81
9706	114.77	46.48	573.87	1308.99
27040828	2031.68	822.83	10158.39	23171.29
35410432	39710.56	16082.78	198552.8	452898.94
35411535	83.32	33.75	416.62	950.31
35411703	2513.1	1017.8	12565.49	28661.88
35411704	1001.53	405.62	5007.65	11422.45
36518778	34.71	14.06	173.53	395.83
36690475	109.43	44.32	547.17	1248.09
36690478	192.98	78.16	964.91	2200.96
36690483	521.53	211.22	2607.64	5948.03
36912231	41.77	16.92	208.85	476.39
36912301	135.9	55.04	679.5	1549.94
36912304	0	0	0	0
36912330	0	0	0	0
36915590	45.41	18.39	227.06	517.92
36915593	21.46	8.69	107.32	244.79
36915599	39390.44	15953.13	196952.2	449247.97
36915601	22109.93	8954.52	110549.66	252163.77
37805846	1016.29	411.6	5081.44	11590.77
37805849	1960.85	794.15	9804.26	22363.52
37805854	36.11	14.62	180.53	411.79
37805858	258.37	104.64	1291.86	2946.73
37805859	0	0	0	0
37805862	152.49	61.76	762.46	1739.17
37810090	0	0	0	0
37810433	11412.66	4622.13	57063.32	130161.43
37884370	0	0	0	0

geodb_oid An Post geodirectory ID	Utility Damage to Utility	Emergency Cost to Emergency Service	Intangible Intangible Costs	Total_PvD Total Present Value Damage
37885222	7612.63	3083.11	38063.14	86822.02
37885392	40.41	16.37	202.04	460.86
37885397	271.15	109.81	1355.73	3092.42
37885403	58.09	23.53	290.46	662.54
37885491	39695.97	16076.87	198479.87	452732.58
38505977	32.89	13.32	164.47	375.15
38506008	42.79	17.33	213.96	488.04
38506012	342.54	138.73	1712.7	3906.67
40053434	1742.15	705.57	8710.76	19869.24
40182045	22826.1	9244.57	114130.49	260331.65
40182047	166.03	67.24	830.13	1893.53
60053887	99.81	40.42	499.03	1138.29
60076792	0	0	0	0
60077044	3336.91	1351.45	16684.55	38057.46
60215906	17519.73	7095.49	87598.66	199812.54
60215908	91.66	37.12	458.32	1045.42
80446021	0	0	0	0
80446099	39534.08	16011.3	197670.4	450886.18
80446142	39871.01	16147.76	199355.07	454728.91
80446167	229.01	92.75	1145.03	2611.82
80549147	5002.47	2026	25012.35	57053.17
80549148	6267.68	2538.41	31338.39	71482.87
80549149	0	0	0	0
80549150	38820.48	15722.29	194102.4	442747.57
80549164	35.51	14.38	177.57	405.03
80549165	0	0	0	0
80549167	107.82	43.67	539.09	1229.67
80549173	71.2	28.83	355.98	811.99

geodb_oid An Post geodirectory ID	Utility Damage to Utility	Emergency Cost to Emergency Service	Intangible Intangible Costs	Total_PvD Total Present Value Damage
80549174	453.21	183.55	2266.05	5168.86
80549175	0	0	0	0
80549176	45.39	18.38	226.96	517.69
80549177	0	0	0	0
80549178	192.82	78.09	964.11	2199.13
80549179	177.9	72.05	889.48	2028.91
80549197	5763.14	2334.07	28815.72	65728.65
80549311	343.65	139.18	1718.24	3919.31
80549312	556.75	225.48	2783.74	6349.71
80549313	0	0	0	0
80549318	529.32	214.37	2646.58	6036.85
80549319	0	0	0	0
80549322	0	0	0	0
80549331	34214.11	13856.71	171070.53	390211.88
80549332	8834.79	3578.09	44173.95	100760.78
80549333	1345.83	545.06	6729.17	15349.23
80549335	376.58	152.52	1882.92	4294.94
80549337	0	0	0	0
80549370	226.55	91.75	1132.77	2583.84
80549371	0	0	0	0
80556278	8755.2	3545.86	43776	99853.06
80556312	55.56	22.5	277.81	633.68
80556344	0	0	0	0
80556658	2922.9	1183.77	14614.48	33335.63
80556659	2572.65	1041.92	12863.27	29341.11
80556838	1100.47	445.69	5502.34	12550.84
80556852	0	0	0	0

geodb_oid	NAME	X	Y	AREA	Use	MCM_ CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
9704		291349.4	224579	62	R	11
9706		292889.2	227647	62	R	11
27040828		291211.7	224788	177.69	R	11
35410432		296662.1	224091	137.87	R	14
35411535	ROSALEAN	292358.5	224815	200.39	R	11
35411703		291752.7	225708	183.66	R	14
35411704		291771	225745	162.49	R	14
36518778	ROSSAN	294083.8	223192	106.41	R	11
36690475		292540.8	224799	206.03	R	11
36690478		291343.5	224908	220.76	R	11
36690483		291762.7	225506	150.65	R	11
36912231	ASHMORE HOUSE	291885.9	227516	151.93	R	11
36912301		292533	227363	137.78	R	11
36912304		292734.8	227509	681.28	C	4
36912330		292687.4	227519	695.86	C	4
36915590		295670	225070	229.33	R	11
36915593		295305.5	225195	105.36	R	14
36915599		295568.1	225249	207.36	R	14
36915601		295538.9	225219	196.41	R	11
37805846		291237.8	224273	215.27	R	11
37805849		292635.5	224799	264.58	R	11
37805854		291321.3	224879	171.2	R	11
37805858		291446.7	224921	220.67	R	14
37805859		291485.7	224968	158.03	R	11
37805862		291538	225041	275.21	R	14
37810090		291694.3	222675	867.86	C	51
37810433		291945.9	221754	3376.5	C	2
37884370		293382.5	228421	113.2	C	4

geodb_oid	NAME	X	Y	AREA	Use	MCM_ CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
37885222	THORN HILL LODGE	291923.2	227605	211.76	R	14
37885392		292135	227284	90.06	R	14
37885397		292436.3	227061	224.56	R	11
37885403		292438	227025	185.39	R	11
37885491		296165.7	224891	175.6	R	14
38505977		295626.1	225063	147.06	R	11
38506008		296066.3	224969	142.37	R	11
38506012		296121.3	224929	162.57	C	4
40053434		292480.3	227256	136.86	R	11
40182045		295402.5	225185	309.23	R	11
40182047		295943.4	225270	215.67	R	14
60053887		293001.1	227964	142.33	R	14
60076792		291200.9	224500	220.97	R	11
60077044	KILASTY HOUSE	292503.4	224810	255.5	R	14
60215906		295718.3	225204	322.5	R	11
60215908		295815.3	225071	150.48	C	4
80446021	ALASTY HOUSE	293730	225659	169.63	R	11
80446099		296145.3	224902	192.62	R	14
80446142	DUNBUAIN LODGE	296951.4	224121	283.06	R	14
80446167	DEVON VILLA	292259.9	224810	215.19	R	14
80549147	ACORN LODGE	291934.6	225942	143.9	R	11
80549148		291792.1	225782	198.92	R	14
80549149	DERRYARD	291738.9	225642	152.36	R	14
80549150	PINE VALE	291674.8	225433	195.87	R	11
80549164		293281.5	228204	104.2	R	14
80549165		293209.1	228204	116.23	R	11
80549167		293112.2	228938	202.99	R	11
80549173	BALLYHAYS LODGE	292878.3	228558	202.37	R	11

geodb_oid	NAME	X	Y	AREA	Use	MCM_ CODE
An Post geodirectory ID				Floor area m2	R = Residential C = Commercial	Multi Coloured Manual
80549174		292969.8	228403	163.19	R	14
80549175	WHITECHURCH LODG	293144	228457	326.23	R	11
80549176		292892	227794	194.76	R	14
80549177		292843.2	227710	175.02	R	14
80549178		292777.6	227505	231.36	R	14
80549179		292491.3	227344	170.91	R	11
80549197		291757.5	224838	179.87	R	14
80549311		293362.5	228192	256.07	R	11
80549312		293342.1	228128	240.78	R	11
80549313	WHITECHURCH COTT.	293380.4	228394	177.3	R	11
80549318		292583.5	227313	163.78	R	14
80549319		292323.9	227385	784.2	C	8
80549322		291965.3	227293	225.76	R	14
80549331	DOMARIST	291684.3	225463	228.19	R	14
80549332		291520.2	224770	97.89	R	14
80549333		291368	224706	154.02	R	14
80549335		291262.9	224581	199.67	R	11
80549337		291135.9	224424	141.86	R	11
80549370	OAKVALE	293748.7	228195	263.99	R	11
80549371	TYMEN LODGE	293680.4	228108	248.2	R	11
80556278		292273.2	224696	793.69	C	51
80556312	GATE LODGE	291874.1	221627	72.65	R	14
80556344	DOOEGA	294105.1	223391	284.32	R	11
80556658	RIVERSIDE	294107.7	223031	81.36	R	12
80556659	BRAE COTTAGE	294111.9	223023	83.97	R	12
80556838		294201.9	222961	251.08	R	11
80556852		294144.5	222969	240.44	C	2

geodb_oid	PROP_TYPE	Local_ Biz	Rate_Value	Market_Val	ContentVal
An Post geodirectory ID	Property Type	Local Business	Rateable Value of Commercial Property	Market Value of Residential Property	Contents Value of Residential Property
9704	Detached House		0	190797	0
9706	Detached House		0	190797	0
27040828	Detached House		0	190797	1604.8
35410432	Bungalow		0	190797	7755.8
35411535	Detached House		0	190797	0
35411703	Bungalow		0	190797	0
35411704	Bungalow		0	190797	0
36518778	Detached House		0	190797	0
36690475	Detached House		0	190797	0
36690478	Detached House		0	190797	0
36690483	Detached House		0	190797	0
36912231	Detached House		0	190797	0
36912301	Detached House		0	190797	0
36912304	Warehouses	L	39991	0	0
36912330	Warehouses	L	45507	0	0
36915590	Detached House		0	190797	0
36915593	Bungalow		0	190797	0
36915599	Bungalow		0	190797	6155.2
36915601	Detached House		0	190797	6777.6
37805846	Detached House		0	190797	0
37805849	Detached House		0	190797	8677.83
37805854	Detached House		0	190797	0
37805858	Bungalow		0	190797	0
37805859	Detached House		0	190797	0
37805862	Bungalow		0	190797	0
37810090	Club House		597797	0	0
37810433	Garden Centre		482650	0	0
37884370	Warehouses	L	6645	0	0

geodb_oid	PROP_TYPE	Local_ Biz	Rate_Value	Market_Val	ContentVal
An Post geodirectory ID	Property Type	Local Business	Rateable Value of Commercial Property	Market Value of Residential Property	Contents Value of Residential Property
37885222	Bungalow		0	190797	0
37885392	Bungalow		0	190797	0
37885397	Detached House		0	190797	0
37885403	Detached House		0	190797	0
37885491	Bungalow		0	190797	7682.87
38505977	Detached House		0	190797	0
38506008	Detached House		0	190797	0
38506012	Warehouses	L	9543	0	0
40053434	Detached House		0	190797	0
40182045	Detached House		0	190797	3624.8
40182047	Bungalow		0	190797	0
60053887	Bungalow		0	190797	0
60076792	Detached House		0	190797	0
60077044	Bungalow		0	190797	10201.33
60215906	Detached House		0	190797	2986
60215908	Warehouses	L	8833	0	0
80446021	Detached House		0	190797	0
80446099	Bungalow		0	190797	6873.4
80446142	Bungalow		0	190797	8558.07
80446167	Bungalow		0	190797	1051.6
80549147	Detached House		0	190797	0
80549148	Bungalow		0	190797	0
80549149	Bungalow		0	190797	0
80549150	Bungalow		0	190797	3305.4
80549164	Bungalow		0	190797	0
80549165	Detached House		0	190797	0
80549167	Detached House		0	190797	0
80549173	Detached House		0	190797	0

geodb_oid	PROP_TYPE	Local_ Biz	Rate_Value	Market_Val	ContentVal
An Post geodirectory ID	Property Type	Local Business	Rateable Value of Commercial Property	Market Value of Residential Property	Contents Value of Residential Property
80549174	Bungalow		0	190797	1051.6
80549175	Detached House		0	190797	0
80549176	Bungalow		0	190797	0
80549177	Bungalow		0	190797	0
80549178	Bungalow		0	190797	0
80549179	Detached House		0	190797	0
80549197	Bungalow		0	190797	0
80549311	Detached House		0	190797	0
80549312	Detached House		0	190797	0
80549313	Detached House		0	190797	0
80549318	Bungalow		0	190797	0
80549319	Industry		46032	0	0
80549322	Bungalow		0	190797	0
80549331	Bungalow		0	190797	2629
80549332	Bungalow		0	190797	9287.4
80549333	Bungalow		0	190797	4224.6
80549335	Detached House		0	190797	0
80549337	Detached House		0	190797	0
80549370	Detached House		0	190797	0
80549371	Detached House		0	190797	0
80556278	Club House		43776	0	0
80556312	Bungalow		0	190797	0
80556344	Detached House		0	190797	0
80556658	Semi Detached House		0	190797	5894.3
80556659	Semi Detached House		0	190797	5776.6
80556838	Detached House		0	190797	4902.4
80556852	Licensed House	L	26242	0	0

geodb_oid	Total_Val	BASEMENT	RAISED	GRND_LVL	FFL	Survey_Loc
An Post geodirectory ID	Total Value of Property	Property has a Basement?		Ground Level	Finished Floor Level	Threshold Survey Location
9704	190797	No	No	71.53	71.828	Front door
9706	190797	No	No	62.26	62.56	
27040828	192401.8	No	No	71.05	71.351	Front door
35410432	198552.8	No	No	120.1	120.4	Street - 119.595
35411535	190797	No	No	71.16	71.461	Front door
35411703	190797	No	No	68.09	68.395	Rear door
35411704	190797	No	No	68.11	68.406	Front door
36518778	190797	No	No	92.14	92.441	Drawing - door
36690475	190797	No	No	71.07	71.369	Front door
36690478	190797	No	No	70.77	71.074	Rear door
36690483	190797	No	No	68.89	69.194	Front door
36912231	190797	No	No	63.77	64.07	Front door
36912301	190797	No	No	63.68	63.98	Street - 63.653
36912304	39991	No	No	63.13	63.432	Front door
36912330	45507	No	No	63.07	63.368	Front door
36915590	190797	No	No	101.2	101.5	Street - 106.731
36915593	190797	No	No	97.57	97.87	Street - 97.624
36915599	196952.2	No	No	99.07	99.37	Front door
36915601	197574.6	No	No	98.8	99.1	Front door
37805846	190797	No	No	71.89	72.188	Rear door
37805849	199474.83	No	No	70.55	70.848	Front door
37805854	190797	No	No	70.86	71.16	Street - 71.084
37805858	190797	No	No	70.69	70.99	Street - 70.695
37805859	190797	No	No	70.66	70.964	Side door
37805862	190797	No	No	70.46	70.76	Rear door
37810090	597797	No	No	79.77	80.07	Drawing - door
37810433	482650	No	No	82.49	82.787	Front door
37884370	6645	No	No	60.3	60.6	Street - 60.395

Morrell FAS Property Damage Assessment
Design SoP scenario

geodb_oid	Total_Val	BASEMENT	RAISED	GRND_LVL	FFL	Survey_Loc
An Post geodirectory ID	Total Value of Property	Property has a Basement?		Ground Level	Finished Floor Level	Threshold Survey Location
37885222	190797	No	No	63.64	63.94	Front door
37885392	190797	No	No	64.5	64.8	Front door
37885397	190797	No	No	64.15	64.453	Front door
37885403	190797	No	No	64.34	64.635	Front door
37885491	198479.87	No	No	108.25	108.55	Drawing - door
38505977	190797	No	No	100.67	100.97	Street - 102.077
38506008	190797	No	No	107.16	107.46	Front door
38506012	9543	No	No	107.82	108.119	Front door
40053434	190797	No	No	63.85	64.15	Street - 64.264
40182045	194421.8	No	No	97.51	97.81	Rear door
40182047	190797	No	No	102.96	103.26	Street - 102.771
60053887	190797	No	No	62.08	62.378	Front door
60076792	190797	No	No	71.96	72.26	Street - 71.82
60077044	200998.33	No	No	70.34	70.64	Street - 70.844
60215906	193783	No	No	100.92	101.22	Street - 100.94
60215908	8833	No	No	102.88	103.184	Rear door
80446021	190797	No	No	73.78	74.08	Street - 73.33
80446099	197670.4	No	No	107.92	108.224	Rear door
80446142	199355.07	No	No	123.23	123.53	Street - 123.833
80446167	191848.6	No	No	71.03	71.325	Front door
80549147	190797	No	No	67.22	67.519	Front door
80549148	190797	No	No	67.85	68.148	Front door
80549149	190797	No	No	68.45	68.752	Rear door
80549150	194102.4	No	No	68.79	69.093	Vent
80549164	190797	No	No	60.9	61.2	Front door
80549165	190797	No	No	61.18	61.482	Rear door
80549167	190797	No	No	58.83	59.13	Street - 58.561
80549173	190797	No	No	60.39	60.686	Front door

geodb_oid	Total_Val	BASEMENT	RAISED	GRND_LVL	FFL	Survey_Loc
An Post geodirectory ID	Total Value of Property	Property has a Basement?		Ground Level	Finished Floor Level	Threshold Survey Location
80549174	191848.6	No	No	60.66	60.964	Rear door
80549175	190797	No	No	60.8	61.1	Street - 61.078
80549176	190797	No	No	62.38	62.68	Front door
80549177	190797	No	No	62.76	63.06	Street - 62.84
80549178	190797	No	No	63.11	63.409	Rear door
80549179	190797	No	No	63.85	64.15	Street - 64.082
80549197	190797	No	No	70.93	71.23	Street - 71.355
80549311	190797	No	No	60.79	61.093	Front door
80549312	190797	No	No	60.95	61.248	Front door
80549313	190797	No	No	60.68	60.977	Front door
80549318	190797	No	No	63.61	63.91	Front door
80549319	46032	No	No	64.01	64.31	Rear door
80549322	190797	No	No	64.71	65.01	Drawing - door
80549331	193426	No	No	68.84	69.144	Vent
80549332	200084.4	No	No	70.97	71.271	Front door
80549333	195021.6	No	No	71.4	71.7	Street - 71.538
80549335	190797	No	No	71.6	71.9	Street - 71.686
80549337	190797	No	No	72.41	72.71	Street - 72.064
80549370	190797	No	No	59.82	60.123	Front door
80549371	190797	No	No	60.18	60.484	Front door
80556278	43776	No	No	71.05	71.353	Rear door
80556312	190797	No	No	83.17	83.466	Front door
80556344	190797	No	No	90.45	90.753	Front door
80556658	196691.3	No	No	92.66	92.956	Front door
80556659	196573.6	No	No	92.7	92.996	Front door
80556838	195699.4	No	No	94.44	94.736	Front door
80556852	26242	No	No	93.79	94.092	Front door

geodb_oid	Q1000_ELEV	Q1000_Dp	Q1000_M2Dm	1000_Dm£13	1000_PDD
An Post geodirectory ID	Maximum water elevation at Property during a 0.1%AEP event	Maximum water depth at Property during a 0.1%AEP event	Damage to Property per m2 during a 0.1%AEP event	Damage to property in £ in the year 2013 during a 0.1%AEP event	Damage to property in € in the year 2013 during a 0.1%AEP event
9704	71.82	-0.01	55.76	3457.12	4017.63
9706	62.56	0	57.04	3536.48	4109.85
27040828	71.39	0.04	199.91	35522.01	41281.23
35410432	120.73	0.33	494.9	68231.86	79294.37
35411535	71.34	-0.12	41.64	8344.24	9697.1
35411703	68.15	-0.24	22.36	4106.64	4772.45
35411704	68.13	-0.28	18.43	2994.69	3480.22
36518778	92.25	-0.19	32.66	3475.35	4038.81
36690475	71.34	-0.03	53.19	10958.74	12735.49
36690478	70.87	-0.2	31.38	6927.45	8050.61
36690483	69.14	-0.05	50.63	7627.41	8864.05
36912231	63.84	-0.23	27.53	4182.63	4860.76
36912301	63.8	-0.18	33.95	4677.63	5436.02
36912304	63.3	-0.13	0	0	0
36912330	63.31	-0.06	0	0	0
36915590	101.21	-0.29	19.83	4547.61	5284.92
36915593	97.61	-0.26	20.4	2149.34	2497.81
36915599	99.56	0.19	398.61	82655.77	96056.84
36915601	99.34	0.24	539.95	106051.58	123245.84
37805846	72.07	-0.12	41.64	8963.84	10417.16
37805849	71.34	0.49	648.47	171572.19	199389.38
37805854	70.88	-0.28	21.12	3615.74	4201.96
37805858	70.71	-0.28	18.43	4066.95	4726.33
37805859	70.59	-0.37	0	0	0
37805862	70.48	-0.28	18.43	5072.12	5894.47
37810090	78.66	-1.41	0	0	0
37810433	83.03	0.24	338.48	1142870.95	1328165.88
37884370	60.53	-0.07	0	0	0

geodb_oid	Q1000_ELEV	Q1000_Dp	Q1000_M2Dm	1000_Dm£13	1000_PDD
An Post geodirectory ID	Maximum water elevation at Property during a 0.1%AEP event	Maximum water depth at Property during a 0.1%AEP event	Damage to Property per m2 during a 0.1%AEP event	Damage to property in £ in the year 2013 during a 0.1%AEP event	Damage to property in € in the year 2013 during a 0.1%AEP event
37885222	63.78	-0.16	30.21	6397.27	7434.47
37885392	64.79	-0.01	44.93	4046.4	4702.45
37885397	64.42	-0.03	53.19	11944.35	13880.9
37885403	64.44	-0.2	31.38	5817.54	6760.74
37885491	108.87	0.32	493.06	86581.34	100618.87
38505977	100.7	-0.27	22.4	3294.14	3828.22
38506008	107.25	-0.21	30.1	4285.34	4980.13
38506012	108.24	0.12	211	34302.27	39863.73
40053434	64.1	-0.05	50.63	6929.22	8052.66
40182045	97.93	0.12	383.03	118444.37	137647.89
40182047	103.11	-0.15	31.19	6726.75	7817.37
60053887	62.16	-0.22	24.32	3461.47	4022.68
60076792	71.84	-0.42	0	0	0
60077044	71.34	0.7	559.51	142954.8	166132.22
60215906	101.32	0.1	355.09	114516.52	133083.21
60215908	103.2	0.02	61	9179.28	10667.53
80446021	73.76	-0.32	0	0	0
80446099	108.46	0.24	441.4	85022.47	98807.26
80446142	123.97	0.44	515.1	145804.21	169443.61
80446167	71.35	0.02	106.57	22932.8	26650.92
80549147	67.27	-0.25	24.96	3591.74	4174.07
80549148	67.89	-0.26	20.4	4057.97	4715.89
80549149	68.31	-0.44	0	0	0
80549150	69.2	0.11	369.06	72287.78	84007.88
80549164	61.08	-0.12	34.13	3556.35	4132.94
80549165	61.12	-0.36	0	0	0
80549167	59.1	-0.03	53.19	10797.04	12547.58
80549173	60.52	-0.17	35.23	7129.5	8285.41

geodb_oid	Q1000_ELEV	Q1000_Dp	Q1000_M2Dm	1000_Dm£13	1000_PDD
An Post geodirectory ID	Maximum water elevation at Property during a 0.1%AEP event	Maximum water depth at Property during a 0.1%AEP event	Damage to Property per m2 during a 0.1%AEP event	Damage to property in £ in the year 2013 during a 0.1%AEP event	Damage to property in € in the year 2013 during a 0.1%AEP event
80549174	60.98	0.02	106.57	17391.16	20210.81
80549175	60.74	-0.36	0	0	0
80549176	62.45	-0.23	23.34	4545.7	5282.7
80549177	62.69	-0.37	0	0	0
80549178	63.28	-0.13	33.15	7669.58	8913.06
80549179	63.99	-0.16	36.51	6239.92	7251.61
80549197	70.99	-0.24	22.36	4021.89	4673.96
80549311	61.03	-0.06	49.34	12634.49	14682.93
80549312	61.24	-0.01	55.76	13425.89	15602.64
80549313	60.53	-0.45	0	0	0
80549318	63.77	-0.14	32.17	5268.8	6123.04
80549319	64.19	-0.12	0	0	0
80549322	64.56	-0.45	0	0	0
80549331	69.19	0.05	197.57	45083.5	52392.94
80549332	71.81	0.54	533.46	52220.4	60686.95
80549333	71.82	0.12	322.99	49746.92	57812.44
80549335	71.82	-0.08	46.78	9340.56	10854.96
80549337	71.84	-0.87	0	0	0
80549370	59.93	-0.19	32.66	8621.91	10019.79
80549371	60.17	-0.31	0	0	0
80556278	71.52	0.17	453.32	359795.55	418129.6
80556312	83.36	-0.11	35.12	2551.47	2965.14
80556344	90.44	-0.31	0	0	0
80556658	93.53	0.57	742.61	60418.75	70214.51
80556659	93.54	0.54	736.11	61811.16	71832.67
80556838	94.9	0.16	438.91	110201.52	128068.61
80556852	93.59	-0.5	0	0	0

geodb_oid	Q200_ELEV	Q200_Dp	Q200_M2Dm	Q200_Dm£13	Q200_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	71.69	-0.14	39.08	2422.96	2815.8
9706	62.56	0	57.04	3536.48	4109.85
27040828	71.37	0.02	128.48	22829.61	26531
35410432	120.59	0.19	398.61	54956.36	63866.5
35411535	-999	-999	0	0	0
35411703	68.14	-0.25	21.38	3926.65	4563.28
35411704	68.12	-0.29	17.45	2835.45	3295.16
36518778	92.12	-0.32	0	0	0
36690475	70.73	-0.64	0	0	0
36690478	70.82	-0.25	24.96	5510.17	6403.54
36690483	69.13	-0.06	49.34	7433.07	8638.2
36912231	63.75	-0.32	0	0	0
36912301	63.76	-0.22	28.81	3969.44	4613.01
36912304	63.17	-0.26	0	0	0
36912330	-999	-999	0	0	0
36915590	101.19	-0.31	0	0	0
36915593	-999	-999	0	0	0
36915599	99.5	0.13	333.79	69214.69	80436.54
36915601	99.24	0.14	410.97	80718.62	93805.62
37805846	72	-0.19	32.66	7030.72	8170.62
37805849	70.73	-0.12	41.64	11017.11	12803.33
37805854	70.82	-0.34	0	0	0
37805858	70.69	-0.3	16.47	3634.43	4223.68
37805859	70.57	-0.39	0	0	0
37805862	70.46	-0.3	16.47	4532.71	5267.6
37810090	78.51	-1.56	0	0	0
37810433	82.74	-0.05	0	0	0
37884370	60.38	-0.22	0	0	0

geodb_oid	Q200_ELEV	Q200_Dp	Q200_M2Dm	Q200_Dm£13	Q200_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.74	-0.2	26.28	5565.05	6467.32
37885392	-999	-999	0	0	0
37885397	64.24	-0.21	30.1	6759.26	7855.15
37885403	-999	-999	0	0	0
37885491	108.72	0.17	377	66201.2	76934.47
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	108.03	-0.09	0	0	0
40053434	64.06	-0.09	45.49	6225.76	7235.15
40182045	97.83	0.02	128.48	39729.87	46171.32
40182047	103	-0.26	20.4	4399.67	5112.99
60053887	62.12	-0.26	20.4	2903.53	3374.28
60076792	71.69	-0.57	0	0	0
60077044	70.73	0.09	280.62	71698.41	83322.95
60215906	101.23	0.01	92.76	29915.1	34765.27
60215908	103.16	-0.02	0	0	0
80446021	-999	-999	0	0	0
80446099	108.39	0.17	377	72617.74	84391.33
80446142	123.78	0.25	449.4	127207.16	147831.4
80446167	-999	-999	0	0	0
80549147	67.26	-0.26	23.68	3407.55	3960.02
80549148	67.88	-0.27	19.41	3861.04	4487.03
80549149	68.31	-0.44	0	0	0
80549150	69.19	0.1	355.09	69551.48	80827.94
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q200_ELEV	Q200_Dp	Q200_M2Dm	Q200_Dm£13	Q200_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	60.97	0.01	76.24	12441.61	14458.78
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	62.61	-0.45	0	0	0
80549178	63.17	-0.24	22.36	5173.21	6011.95
80549179	63.94	-0.21	30.1	5144.39	5978.46
80549197	70.98	-0.25	21.38	3845.62	4469.11
80549311	60.94	-0.15	37.8	9679.45	11248.79
80549312	61.14	-0.11	42.93	10336.69	12012.59
80549313	60.38	-0.6	0	0	0
80549318	63.72	-0.19	27.26	4464.64	5188.5
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.18	0.04	167.24	38162.5	44349.83
80549332	71.68	0.41	509.59	49883.77	57971.48
80549333	71.69	-0.01	44.93	6920.12	8042.09
80549335	71.69	-0.21	30.1	6010.07	6984.49
80549337	71.73	-0.98	0	0	0
80549370	59.86	-0.26	23.68	6251.28	7264.81
80549371	60.1	-0.38	0	0	0
80556278	71.41	0.06	288.76	229185.92	266344.09
80556312	83.19	-0.28	18.43	1338.94	1556.02
80556344	90.46	-0.31	0	0	0
80556658	93.17	0.21	570.05	46379.27	53898.79
80556659	93.17	0.17	511.35	42938.06	49899.66
80556838	-999	-999	0	0	0
80556852	93.52	-0.57	0	0	0

geodb_oid	Q100_ELEV	Q100_Dp	Q100_M2Dm	Q100_Dm£13	Q100_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	71.61	-999	0	0	0
9706	-999	-999	0	0	0
27040828	71.35	-999	0	0	0
35410432	120.52	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	68.14	-999	0	0	0
35411704	68.12	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	70.49	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	69.13	-999	0	0	0
36912231	63.7	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.46	-999	0	0	0
36915601	99.19	-999	0	0	0
37805846	71.97	-999	0	0	0
37805849	70.49	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	70.69	-999	0	0	0
37805859	70.56	-999	0	0	0
37805862	70.45	-999	0	0	0
37810090	78.46	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q100_ELEV	Q100_Dp	Q100_M2Dm	Q100_Dm£13	Q100_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.7	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.67	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.94	-999	0	0	0
40053434	64	-999	0	0	0
40182045	97.78	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	71.61	-999	0	0	0
60077044	70.49	-999	0	0	0
60215906	101.18	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.37	-999	0	0	0
80446142	123.7	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	67.25	-999	0	0	0
80549148	67.88	-999	0	0	0
80549149	68.3	-999	0	0	0
80549150	69.19	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q100_ELEV	Q100_Dp	Q100_M2Dm	Q100_Dm£13	Q100_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.98	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	60.97	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	63.62	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.17	-999	0	0	0
80549332	71.61	-999	0	0	0
80549333	71.61	-999	0	0	0
80549335	71.61	-999	0	0	0
80549337	71.71	-999	0	0	0
80549370	59.79	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	71.37	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	90.44	-999	0	0	0
80556658	93.07	-999	0	0	0
80556659	93.07	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q50_ELEV	Q50_Dp	Q50_M2Dm	Q50_Dm£13	Q50_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	71.55	-999	0	0	0
9706	-999	-999	0	0	0
27040828	71.25	-999	0	0	0
35410432	120.47	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	68.14	-999	0	0	0
35411704	68.11	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	70.32	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.69	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.42	-999	0	0	0
36915601	99.1	-999	0	0	0
37805846	71.94	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	70.68	-999	0	0	0
37805859	70.56	-999	0	0	0
37805862	70.44	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q50_ELEV	Q50_Dp	Q50_M2Dm	Q50_Dm£13	Q50_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.69	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.63	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.88	-999	0	0	0
40053434	64	-999	0	0	0
40182045	97.71	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	71.53	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	101.05	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	-999	0	0	0
80446142	123.66	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	67.25	-999	0	0	0
80549148	67.88	-999	0	0	0
80549149	68.3	-999	0	0	0
80549150	69.18	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q50_ELEV	Q50_Dp	Q50_M2Dm	Q50_Dm£13	Q50_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.98	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	60.87	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	63.61	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.17	-999	0	0	0
80549332	71.55	-999	0	0	0
80549333	71.55	-999	0	0	0
80549335	71.55	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	71.29	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

Morrell FAS Property Damage Assessment
Design SoP scenario

geodb_oid	Q20_ELEV	Q20_Dp	Q20_M2Dm	Q20_Dm£13	Q20_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.51	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	68.13	-999	0	0	0
35411704	68.11	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.41	-999	0	0	0
36915601	99.09	-999	0	0	0
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q20_ELEV	Q20_Dp	Q20_M2Dm	Q20_Dm£13	Q20_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.68	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.63	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.86	-999	0	0	0
40053434	63.94	-999	0	0	0
40182045	97.69	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	101.05	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	-999	0	0	0
80446142	123.67	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	67.25	-999	0	0	0
80549148	67.88	-999	0	0	0
80549149	68.29	-999	0	0	0
80549150	69.18	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q20_ELEV	Q20_Dp	Q20_M2Dm	Q20_Dm£13	Q20_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.97	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.16	-999	0	0	0
80549332	71.19	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.47	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	68.09	-999	0	0	0
35411704	68.1	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.4	-999	0	0	0
36915601	99.06	-999	0	0	0
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.68	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.62	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.84	-999	0	0	0
40053434	-999	-999	0	0	0
40182045	97.67	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	101.01	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	-999	0	0	0
80446142	123.66	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	67.24	-999	0	0	0
80549148	67.87	-999	0	0	0
80549149	68.28	-999	0	0	0
80549150	69.16	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q10_ELEV	Q10_Dp	Q10_M2Dm	Q10_Dm£13	Q10_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.95	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.15	-999	0	0	0
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q5_ELEV	Q5_Dp	Q5_M2Dm	Q5_Dm£13	Q5_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	120.47	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	68.07	-999	0	0	0
35411704	68.09	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	63.68	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	99.39	-999	0	0	0
36915601	99.04	-999	0	0	0
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q5_ELEV	Q5_Dp	Q5_M2Dm	Q5_Dm£13	Q5_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	63.68	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	108.62	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	107.84	-999	0	0	0
40053434	-999	-999	0	0	0
40182045	97.66	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	100.97	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	108.35	-999	0	0	0
80446142	123.66	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	67.22	-999	0	0	0
80549148	67.86	-999	0	0	0
80549149	68.27	-999	0	0	0
80549150	69.15	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

Morrell FAS Property Damage Assessment
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geodb_oid	Q5_ELEV	Q5_Dp	Q5_M2Dm	Q5_Dm£13	Q5_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.94	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.13	-999	0	0	0
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	Q2_ELEV	Q2_Dp	Q2_M2Dm	Q2_Dm£13	Q2_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
9704	-999	-999	0	0	0
9706	-999	-999	0	0	0
27040828	-999	-999	0	0	0
35410432	-999	-999	0	0	0
35411535	-999	-999	0	0	0
35411703	-999	-999	0	0	0
35411704	-999	-999	0	0	0
36518778	-999	-999	0	0	0
36690475	-999	-999	0	0	0
36690478	-999	-999	0	0	0
36690483	-999	-999	0	0	0
36912231	-999	-999	0	0	0
36912301	-999	-999	0	0	0
36912304	-999	-999	0	0	0
36912330	-999	-999	0	0	0
36915590	-999	-999	0	0	0
36915593	-999	-999	0	0	0
36915599	-999	-999	0	0	0
36915601	-999	-999	0	0	0
37805846	-999	-999	0	0	0
37805849	-999	-999	0	0	0
37805854	-999	-999	0	0	0
37805858	-999	-999	0	0	0
37805859	-999	-999	0	0	0
37805862	-999	-999	0	0	0
37810090	-999	-999	0	0	0
37810433	-999	-999	0	0	0
37884370	-999	-999	0	0	0

geodb_oid	Q2_ELEV	Q2_Dp	Q2_M2Dm	Q2_Dm£13	Q2_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
37885222	-999	-999	0	0	0
37885392	-999	-999	0	0	0
37885397	-999	-999	0	0	0
37885403	-999	-999	0	0	0
37885491	-999	-999	0	0	0
38505977	-999	-999	0	0	0
38506008	-999	-999	0	0	0
38506012	-999	-999	0	0	0
40053434	-999	-999	0	0	0
40182045	-999	-999	0	0	0
40182047	-999	-999	0	0	0
60053887	-999	-999	0	0	0
60076792	-999	-999	0	0	0
60077044	-999	-999	0	0	0
60215906	-999	-999	0	0	0
60215908	-999	-999	0	0	0
80446021	-999	-999	0	0	0
80446099	-999	-999	0	0	0
80446142	123.4	-999	0	0	0
80446167	-999	-999	0	0	0
80549147	-999	-999	0	0	0
80549148	-999	-999	0	0	0
80549149	-999	-999	0	0	0
80549150	69.1	-999	0	0	0
80549164	-999	-999	0	0	0
80549165	-999	-999	0	0	0
80549167	-999	-999	0	0	0
80549173	-999	-999	0	0	0

geodb_oid	Q2_ELEV	Q2_Dp	Q2_M2Dm	Q2_Dm£13	Q2_PDD
An Post geodirectory ID	See Q1000_ELEV	See Q1000_Dp	See Q1000_M2Dm	See Q1000_Dm£13	See Q1000_PDD
80549174	-999	-999	0	0	0
80549175	-999	-999	0	0	0
80549176	-999	-999	0	0	0
80549177	-999	-999	0	0	0
80549178	-999	-999	0	0	0
80549179	-999	-999	0	0	0
80549197	70.56	-999	0	0	0
80549311	-999	-999	0	0	0
80549312	-999	-999	0	0	0
80549313	-999	-999	0	0	0
80549318	-999	-999	0	0	0
80549319	-999	-999	0	0	0
80549322	-999	-999	0	0	0
80549331	69.09	-999	0	0	0
80549332	-999	-999	0	0	0
80549333	-999	-999	0	0	0
80549335	-999	-999	0	0	0
80549337	-999	-999	0	0	0
80549370	-999	-999	0	0	0
80549371	-999	-999	0	0	0
80556278	-999	-999	0	0	0
80556312	-999	-999	0	0	0
80556344	-999	-999	0	0	0
80556658	-999	-999	0	0	0
80556659	-999	-999	0	0	0
80556838	-999	-999	0	0	0
80556852	-999	-999	0	0	0

geodb_oid	AAD	PvD	PvD_cap
An Post geodirectory ID	Annual Average Damage	Present Value Damage	Capped Present Value Damage
9704	20.706	444.81	444.81
9706	26.714	573.87	573.87
27040828	201.952	4338.33	4338.33
35410432	445.988	9580.71	9580.71
35411535	19.394	416.62	416.62
35411703	30.08	646.18	646.18
35411704	21.789	468.07	468.07
36518778	8.078	173.53	173.53
36690475	25.471	547.17	547.17
36690478	44.917	964.91	964.91
36690483	56.6	1215.88	1215.88
36912231	9.722	208.85	208.85
36912301	31.631	679.5	679.5
36912304	0	0	0
36912330	0	0	0
36915590	10.57	227.06	227.06
36915593	4.996	107.32	107.32
36915599	554.078	11902.7	11902.7
36915601	668.617	14363.23	14363.23
37805846	57.602	1237.41	1237.41
37805849	456.394	9804.26	9804.26
37805854	8.404	180.53	180.53
37805858	28.459	611.36	611.36
37805859	0	0	0
37805862	35.493	762.46	762.46
37810090	0	0	0
37810433	2656.332	57063.32	57063.32
37884370	0	0	0

geodb_oid	AAD	PvD	PvD_cap
An Post geodirectory ID	Annual Average Damage	Present Value Damage	Capped Present Value Damage
37885222	43.972	944.61	944.61
37885392	9.405	202.04	202.04
37885397	63.11	1355.73	1355.73
37885403	13.521	290.46	290.46
37885491	547.443	11760.17	11760.17
38505977	7.656	164.47	164.47
38506008	9.96	213.96	213.96
38506012	79.727	1712.7	1712.7
40053434	48.663	1045.38	1045.38
40182045	483.067	10377.25	10377.25
40182047	38.643	830.13	830.13
60053887	23.23	499.03	499.03
60076792	0	0	0
60077044	707.218	15192.46	15192.46
60215906	422.61	9078.51	9078.51
60215908	21.335	458.32	458.32
80446021	0	0	0
80446099	577.376	12403.19	12403.19
80446142	1004.129	21570.7	21570.7
80446167	53.302	1145.03	1145.03
80549147	26.168	562.14	562.14
80549148	29.623	636.36	636.36
80549149	0	0	0
80549150	531.741	11422.86	11422.86
80549164	8.266	177.57	177.57
80549165	0	0	0
80549167	25.095	539.09	539.09
80549173	16.571	355.98	355.98

geodb_oid	AAD	PvD	PvD_cap
An Post geodirectory ID	Annual Average Damage	Present Value Damage	Capped Present Value Damage
80549174	105.486	2266.05	2266.05
80549175	0	0	0
80549176	10.565	226.96	226.96
80549177	0	0	0
80549178	44.88	964.11	964.11
80549179	41.406	889.48	889.48
80549197	29.459	632.84	632.84
80549311	79.985	1718.24	1718.24
80549312	85.262	1831.6	1831.6
80549313	0	0	0
80549318	35.594	764.63	764.63
80549319	0	0	0
80549322	0	0	0
80549331	304.36	6538.26	6538.26
80549332	382.246	8211.41	8211.41
80549333	151.814	3261.27	3261.27
80549335	53.14	1141.55	1141.55
80549337	0	0	0
80549370	52.731	1132.77	1132.77
80549371	0	0	0
80556278	2034.808	43711.75	43711.75
80556312	12.932	277.81	277.81
80556344	0	0	0
80556658	382.974	8227.05	8227.05
80556659	368.214	7909.97	7909.97
80556838	256.137	5502.34	5502.34
80556852	0	0	0

geodb_oid	Utility	Emergency	Intangible	Total_PvD
An Post geodirectory ID	Damage to Utility	Cost to Emergency Service	Intangible Costs	Total Present Value Damage
9704	88.96	36.03	444.81	1014.61
9706	114.77	46.48	573.87	1308.99
27040828	867.67	351.4	4338.33	9895.73
35410432	1916.14	776.04	9580.71	21853.6
35411535	83.32	33.75	416.62	950.31
35411703	129.24	52.34	646.18	1473.94
35411704	93.61	37.91	468.07	1067.66
36518778	34.71	14.06	173.53	395.83
36690475	109.43	44.32	547.17	1248.09
36690478	192.98	78.16	964.91	2200.96
36690483	243.18	98.49	1215.88	2773.43
36912231	41.77	16.92	208.85	476.39
36912301	135.9	55.04	679.5	1549.94
36912304	0	0	0	0
36912330	0	0	0	0
36915590	45.41	18.39	227.06	517.92
36915593	21.46	8.69	107.32	244.79
36915599	2380.54	964.12	11902.7	27150.06
36915601	2872.65	1163.42	14363.23	32762.53
37805846	247.48	100.23	1237.41	2822.53
37805849	1960.85	794.15	9804.26	22363.52
37805854	36.11	14.62	180.53	411.79
37805858	122.27	49.52	611.36	1394.51
37805859	0	0	0	0
37805862	152.49	61.76	762.46	1739.17
37810090	0	0	0	0
37810433	11412.66	4622.13	57063.32	130161.43
37884370	0	0	0	0

geodb_oid	Utility	Emergency	Intangible	Total_PvD
An Post geodirectory ID	Damage to Utility	Cost to Emergency Service	Intangible Costs	Total Present Value Damage
37885222	188.92	76.51	944.61	2154.65
37885392	40.41	16.37	202.04	460.86
37885397	271.15	109.81	1355.73	3092.42
37885403	58.09	23.53	290.46	662.54
37885491	2352.03	952.57	11760.17	26824.94
38505977	32.89	13.32	164.47	375.15
38506008	42.79	17.33	213.96	488.04
38506012	342.54	138.73	1712.7	3906.67
40053434	209.08	84.68	1045.38	2384.52
40182045	2075.45	840.56	10377.25	23670.51
40182047	166.03	67.24	830.13	1893.53
60053887	99.81	40.42	499.03	1138.29
60076792	0	0	0	0
60077044	3038.49	1230.59	15192.46	34654
60215906	1815.7	735.36	9078.51	20708.08
60215908	91.66	37.12	458.32	1045.42
80446021	0	0	0	0
80446099	2480.64	1004.66	12403.19	28291.68
80446142	4314.14	1747.23	21570.7	49202.77
80446167	229.01	92.75	1145.03	2611.82
80549147	112.43	45.53	562.14	1282.24
80549148	127.27	51.55	636.36	1451.54
80549149	0	0	0	0
80549150	2284.57	925.25	11422.86	26055.54
80549164	35.51	14.38	177.57	405.03
80549165	0	0	0	0
80549167	107.82	43.67	539.09	1229.67
80549173	71.2	28.83	355.98	811.99

geodb_oid	Utility	Emergency	Intangible	Total_PvD
An Post geodirectory ID	Damage to Utility	Cost to Emergency Service	Intangible Costs	Total Present Value Damage
80549174	453.21	183.55	2266.05	5168.86
80549175	0	0	0	0
80549176	45.39	18.38	226.96	517.69
80549177	0	0	0	0
80549178	192.82	78.09	964.11	2199.13
80549179	177.9	72.05	889.48	2028.91
80549197	126.57	51.26	632.84	1443.51
80549311	343.65	139.18	1718.24	3919.31
80549312	366.32	148.36	1831.6	4177.88
80549313	0	0	0	0
80549318	152.93	61.94	764.63	1744.13
80549319	0	0	0	0
80549322	0	0	0	0
80549331	1307.65	529.6	6538.26	14913.77
80549332	1642.28	665.12	8211.41	18730.22
80549333	652.25	264.16	3261.27	7438.95
80549335	228.31	92.47	1141.55	2603.88
80549337	0	0	0	0
80549370	226.55	91.75	1132.77	2583.84
80549371	0	0	0	0
80556278	8742.35	3540.65	43711.75	99706.5
80556312	55.56	22.5	277.81	633.68
80556344	0	0	0	0
80556658	1645.41	666.39	8227.05	18765.9
80556659	1581.99	640.71	7909.97	18042.64
80556838	1100.47	445.69	5502.34	12550.84
80556852	0	0	0	0

Appendix E

Costing of FRM Options

Costing of: Option 1 Hard Defences

Construction Costs

Costing of walls and embankments
Cost of walls and embankments based on previous schemes in association with RPS

Shapefile ID: Option1	Type	Length / Volume	Height	Freeboard	Height with FB	Cost €/m 2013
1	Embankment	1260.26 m	1.26 m	0.60 m	1.86 m	1,059,369.36
2	Embankment	259.71 m	0.71 m	0.60 m	1.31 m	158,378.14
3	Embankment	455.02 m	1.75 m	0.60 m	2.35 m	476,037.40
4	Embankment	1027.87 m	0.77 m	0.60 m	1.37 m	652,699.19
5	Embankment	953.46 m	1.21 m	0.60 m	1.81 m	781,471.91
6	Embankment	573.58 m	0.90 m	0.60 m	1.50 m	395,510.42
7	Embankment	617.59 m	0.50 m	0.60 m	1.10 m	322,206.03
8	Embankment	491.07 m	0.85 m	0.60 m	1.45 m	328,313.73
9	Wall	433.46 m	1.00 m	0.50 m	1.50 m	1,168,629.69
10	Wall	305.18 m	0.80 m	0.50 m	1.30 m	764,498.83
11	Embankment	99.28 m	0.60 m	0.60 m	1.20 m	55,961.47
12	Embankment	47.35 m	0.60 m	0.60 m	1.20 m	26,689.92
13	Gabion Wall	28.84 m	1.50 m	0.50 m	2.00 m	91,523.34
14	Excavation	1875.00 m^2	-	-	-	32,171.03
15	Culvert	2.5 m	-	-	-	58,289.69
						€6,371,750

Project Whole Life Cost

Basic construction cost	**€6,371,750.15**
Preliminaries and bond (6%)	€382,305.01
Provision for unmeasured items (10%)	€637,175.02
Contingencies (10%)	€637,175.02
Construction site supervision (5%)	€318,587.51
Detailed design (design fees) (6%)	€382,305.01
NVP maintenance costs (1% p.a. Capital costs)	€1,368,779.37
Cost of land acquisition/compensation (12.5%)	€796,468.77
Environmental monitoring and mitigation (6%)	€382,305.01
Allowance for archaeolgy (6%)	382,305.01
Allowance for art (NA)	€0.00
Project Whole Life Cost	**€11,659,155.86**

Summary

Total Damage/Benefit	**€20,645,191.00**
Total Construction Cost	**€6,371,750.15**
Project Whole Life Cost	**€11,659,155.86**
BCR	**1.77**
MCA score	**2906.00**
MCA BCR	**249.25**

Costing of: Option 2 Defences

Construction Costs

Costing of walls and embankments

Cost of walls and embankments based on previous schemes in association with RPS

Shapefile ID: Option2	Type	Length / Volume	Height	Freeboard	Height with FB	Cost €/m 2013
1	Embankment	459.45 m	3.40 m	0.60 m	4.00 m	869,463.53
2	Embankment	449.43 m	3.40 m	0.60 m	4.00 m	850,501.67
3	Embankment	274.42 m	3.40 m	0.60 m	4.00 m	519,312.62
4	Embankment	309.23 m	3.40 m	0.60 m	4.00 m	585,187.09
5	Embankment	507.68 m	3.40 m	0.60 m	4.00 m	960,734.02
6	Embankment	259.10 m	0.71 m	0.60 m	1.31 m	160,160.22
7	Embankment	454.10 m	1.75 m	0.60 m	2.35 m	496,391.98
8	Embankment	1022.20 m	0.77 m	0.60 m	1.37 m	659,875.10
9	Embankment	950.60 m	1.21 m	0.60 m	1.81 m	804,685.39
10	Embankment	572.10 m	0.90 m	0.60 m	1.50 m	403,283.68
11	Embankment	622.56 m	0.50 m	0.60 m	1.10 m	325,118.59
12	Wall	433.46 m	1.00 m	0.50 m	1.50 m	1,272,084.87
13	Wall	305.18 m	0.80 m	0.50 m	1.30 m	832,177.56
14	Gabion Wall	29.00 m	2.00 m	0.00 m	2.00 m	100,178.32
15	Excavation	1875.00 m^2	-	-	-	32,171.03
16	Culvert	2.50 m	-	-	-	58,289.69
17	Excavation	179400 m^2	-	-	-	2,963,096.38
18	Excavation	536600 m^2	-	-	-	8,789,482.96
19	Excavation	635600 m^2	-	-	-	10,384,981.66
20	Excavation	816000 m^2	-	-	-	13,352,942.16
21	Excavation	264000 m^2	-	-	-	4,363,645.68
						€48,783,764

Project Whole Life Cost

Basic construction cost	**€48,783,764.18**
Preliminaries and bond (6%)	€2,927,025.85
Provision for unmeasured items (10%)	€4,878,376.42
Contingencies (10%)	€4,878,376.42
Construction site supervision (5%)	€2,439,188.21
Detailed design (design fees) (6%)	€2,927,025.85
NVP maintenance costs (1% p.a. Capital costs)	€10,479,728.22
Cost of land acquisition/compensation (12.5%)	€6,097,970.52
Environmental monitoring and mitigation (6%)	€2,927,025.85
Allowance for archaeolgy (6%)	2,927,025.85
Allowance for art (NA)	€0.00
Project Whole Life Cost	**€89,265,507.38**

Summary

Total Damage/Benefit	**€20,645,191.00**
Total Construction Cost	**€48,783,764.18**
Project Whole Life Cost	**€89,265,507.38**
BCR	**0.23**
MCA score	**2676.00**
MCA BCR	**29.98**

RPS

Appendix B

Outline CEMP

Appendix B

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1 INTRODUCTION

This document comprises a high-level outline Construction Environmental Management Plan (CEMP) for the Morell River Flood Management Scheme for which Kildare County Council (KCC) is the developer. KCC will seek to achieve the highest possible standards of environmental management during both the construction and operation of the proposed scheme.

The purpose of a CEMP is to ensure the contractor maintains an approved environmental and construction management plan for the construction works. No statements in this document shall supersede those or be taken to replace the terms of the contract, or the design description issued with the contract tender. Similarly the items covered within this document may be amended or added to by the contractor.

The main aims of the outline CEMP are to:

- Provide a mechanism for ensuring that measures to mitigate potentially adverse impacts identified in the Environmental Impact Assessment Report are implemented;
- Ensure that best construction practices are adopted throughout the construction of the proposed development;
- Provide a framework for mitigating unexpected impacts during construction;
- Provide assurance to third parties that their requirements with respect to minimising project impacts will be met;
- Provide a mechanism for ensuring compliance with environmental legislation and statutory consents;
- Provide a framework for compliance auditing and inspection to enable KCC to meet their environmental performance objectives.

The potential environmental impacts of the project are documented in the Environmental Impact Assessment Report (EIAR) for the Morell Flood Management Scheme. The Outline CEMP does not aim to re-assess those impacts, but to develop and outline controls to manage them during construction and operation.

This outline plan will be developed and updated by the appointed Contractor as required into the full CEMP in advance of the construction phase. The final CEMP can only be produced after planning permission is received, in order to be able to address any conditions imposed by the planning authority.

It is intended that revisions to this document will be circulated and agreed with Kildare County Council, the Office of Public Works (OPW) and any other relevant consultees, such as Inland Fisheries Ireland (IFI) and the National Parks and Wildlife Service (NPWS), as additional details are incorporated.

1.1 PROJECT SUMMARY

The Morell River Flood Management Scheme involves the construction of approximately 7,423 metres of new flood embankments and approximately 474 metres of flood walls in the catchment of the Morell River and its tributaries the Slane, Kill and Painestown rivers. The scheme also involves structural examination and potential remediation/restoration of up to 1,842 metres of existing embankments along the Morell, Painestown and Slane Rivers. Figure 1 overleaf shows the locations of the proposed works.

The scheme also includes works at several existing culverts. One culvert (C22), beneath the N7 which is currently throttled to reduce flow, will have its throttle opened to increase flows. Two culverts which cross beneath the Dublin-Cork railway line (C4, C4a) will be throttled to reduce flows.

Two culverts have been identified as requiring in-stream works for the installation of scour protection measures (C5 & C10). One culvert (C9) is in a poor state of repair and will require remediation.

A further five culverts (C1, C2, C7, C18 & C19) will have tie-ins with embankments. These culverts will be structurally assessed at the detailed design stage to determine if they require scour protection measures or underpinning. Where such works are found to be required, the same mitigation protocols as per culverts C5, C10 and C9 will be adhered to.

In order to accommodate seasonal constraints, including the requirement for low river flows for instream works and spawning/migration periods for aquatic species, the project is expected to be constructed predominantly during summer months and will thus take place in phases over a total period of up to four years. However, it should be recognised that other constraints, including the bird nesting season and restrictions on the disturbance of mammals such as bats, badgers and otters will be applicable during summer months.

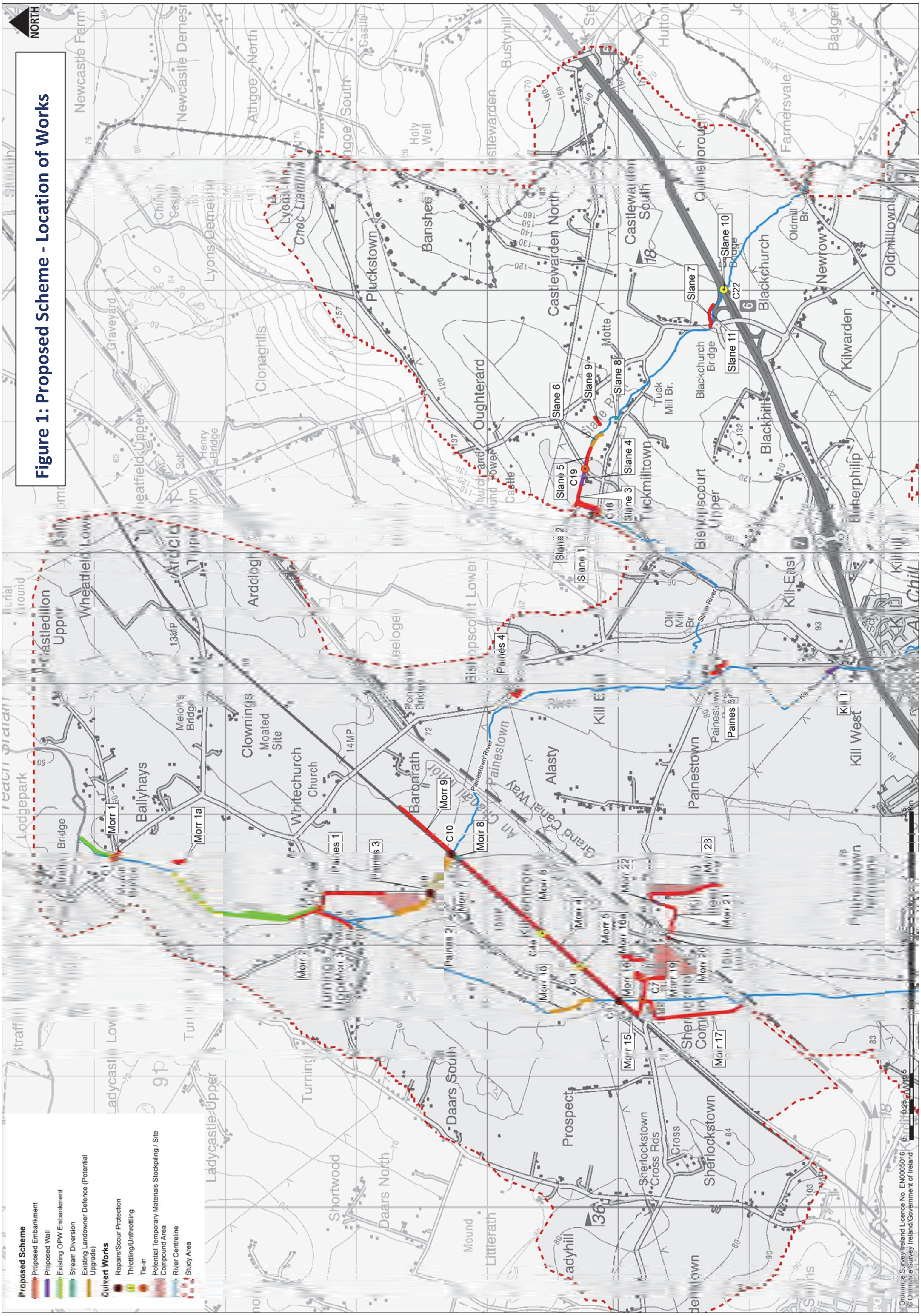

Figure 1: Proposed Scheme - Location of Works

2 ENVIRONMENTAL MANAGEMENT PLAN

As the proposed development is an EIA project and is being advanced by a local authority that is a planning authority, the application for planning approval has been made to An Board Pleanála in accordance with Part X of the Planning and Development Act, 2000, as amended.

This Outline Construction Environmental Management Plan (Outline CEMP) specifies the environmental management controls to be employed to mitigate potential environmental impacts during the construction of the proposed development. The Outline CEMP has collated the mitigation measures specified in the EIAR and also the specific requirements of the various statutory and non-statutory bodies that made submissions during the pre-planning stage of the project.

The requirements detailed are binding between the scheme's developer and the appointed contractor. It shall be the responsibility of the contractor to ensure that the requirements of this specification are met by themselves and by any approved sub-contractors on the site.

The CEMP, which will be developed from this Outline CEMP, will be available to all personnel working on this project. All personnel working on the project are responsible for the environmental control of their own work and should perform their duties in accordance with the requirements of the outline CEMP and in compliance with the procedures referenced within.

The Outline Construction Environmental Management Plan is set out as follows:

Chapter 1 Provides a general project summary and introduction to the Outline CEMP

Chapter 2 Gives an overview of the planning regime and those that will be responsible for administering the final CEMP.

Chapter 3 Provides a summary of the relevant environmental legislation which applies to a project of this type.

Chapter 4 Describes the proposed project team and their responsibilities

Chapter 5 Provides information on the construction methodology

Chapter 6 Describes the mitigation measures and safeguards which will be implemented to provide environmental protection. This section will also cover how wastes arising from the site will be dealt with.

Chapter 7 Provides a summary of site safety

3 ENVIRONMENTAL ASPECTS AND RELEVANT LEGISLATION

3.1 INTRODUCTION

It is expected that the Client's Representative, Principal Contractor and all Sub-contractors and other parties involved in the development will comply with the requirements of this Outline CEMP, associated documentation and all applicable environmental, health and safety legislation as a minimum standard.

3.2 ENVIRONMENTAL ASPECTS

'Environmental Aspect' is defined as an element of an organisation's activities, products or services that can interact with the environment. Environmental Aspects are activities on site which can lead to an Environmental Impact.

At the outset of this project the Client's Representative and Principal Contractor will need to identify the Environmental Aspects associated with the construction of the proposed development.

3.3 ENVIRONMENTAL LEGISLATION

The CEMP and associated sub-plans (e.g. Water Quality Monitoring Plan, Dust Minimisation Plan) will be prepared in compliance with the relevant environmental quality standards and will be agreed with relevant authorities, including Kildare County Council and the NPWS.

The CEMP will be based on mitigation measures presented in the EIAR (summarised in Chapter 15 thereof). The monitoring programme will include requirements for best practice and adherence to relevant legislation and guidelines including (but not limited to) the following:

Title	Relevance to Project
Flora (Protection) Order 2015 (S.I. No. 356/2015)	Enforces the protection of rare and endangered plants. Derived from Section 21 of the Wildlife Act, objectives include it being illegal to alter, damage or interfere in any way with named flora species or their habitats. This protection applies wherever the plants are found and is not confined to sites designated for nature conservation.
The Wildlife Act 1976 (S.I. No. 39/1976) and The Wildlife (Amendment) Act 2000 (S.I. No. 38/2000) (as amended)	The principal national legislation for the protection of wildlife species and habitats in Ireland.
European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011) as amended 2015	Transposes the EU Habitats Directive into Irish national law. Consolidates the European Communities (Natural Habitats) Regulations 1997 to 2005 and the European Communities (Birds and Natural Habitats)(Control of Recreational Activities) Regulations 2010, as well as addressing transposition failures identified in judgments of the Court of Justice of the European Union (CJEU).
The Fisheries Acts, 1959 to 2007 (S.I. No. 14 of 1959 and No. 17 of 2007) and the Inland Fisheries Act 2010 (No. 10 of 2010) Local Government Water Pollution Acts 1977 (S.I. No. 1/1977) & 1990 (S.I. No. 21/1990)	Provide for the efficient and effective management, conservation, protection, development and improvement of fisheries, hatcheries and fish farms. The species protected include all freshwater fish, sea bass and certain molluscs. IFI is empowered to enforce the Water Pollution Acts 1977 & 1990, and at fisheries sensitive locations where industrial, local authority and agricultural discharges have resulted in a serious deterioration in water quality, including fish kills, successful prosecutions have been taken.
Local Government (Water Pollution) Act 1977 (S.I. No. 1/1977) as amended 2010	Aims to manage and protect water at catchment based level in cases where Integrated Pollution Prevention Control (IPPC) is not applicable; the control of water pollution is exercised through the Local Government (Water Pollution) Acts 1977-1990 and Water Services Act 2007-2013. Local authorities are responsible for the issuing of effluent discharge licences for effluents discharged

European Communities Environmental Objectives (Groundwater) Regulations 2010 S.I. No. 9 of 2010 as amended European Communities Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009 as amended	Give effect to the measures needed to achieve the environmental objectives established for groundwater and surface water by the EU Water Framework Directive.
S.I. No. 684 of 2007 Waste Water Discharge (Authorisation) Regulations, 2007, as amended (S.I 231 of 2010).	These Regulations implement Community legislation aiming at preventing and reducing the pollution of waters by waste water discharges
S.I. No. 278 of 2007 European Communities (Drinking Water) (No.2) Regulations.	Basic standards governing the quality of drinking water intended for human consumption.
European Communities (Renewable Energy) Regulations 2011 (S.I. No. 147/2011)	Sets renewable energy targets which the FMS should have regard for achieving.
European Communities (Environmental Liability) Regulations S.I. No. 457 of 2008 as amended	Establishes a framework of environmental liability based on the 'polluter-pays' principle, to prevent and remedy environmental damage.
The National Monuments Acts (1930 to 2004) (S.I. No. 2/1930 & No. 22/2004) The Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act 1999 (S.I. No. 119/1999)	Establishes measures for the protection of monuments of national importance by virtue of the historical, architectural, traditional, artistic or archaeological interest attaching to them. Includes the site of the monument, the means of access to it and any land required to preserve the monument from injury or to preserve its amenities. Includes requirements for licensing of excavations and guidelines for licensees on strategies and method statements, reports and publications.
Arterial Drainage Act, 1945 (S.I No 3/1945) as amended and extended 1995 (S.I. No. 14/1995)	Sets out the roles and responsibilities of the OPW in maintaining all rivers, embankments and urban flood de fences on which it has executed works since the 1945 Act in “proper repair and effective condition”.
Safety, Health and Welfare at Work Act 2005 Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013)	Prescribe the main requirements for the protection of the safety, health and welfare of persons working on construction sites.
Environmental Protection Agency Act 1992 (S.I. No. 7 of 1992), Waste Management Act 1996 (S.I. No. 10 of 1996), (as amended) Protection of the Environment Act 2003 (S.I. No. 27 of 2003)	Forbids the handling, transportation, recovery or disposal of waste when it is done in a manner which causes environmental pollution. The Waste Acts also require that, when waste is to be transferred, the waste passes to a body that falls within the legal concept of an “appropriate person”. There is a duty to inform a local authority if there is any loss, spillage or accident involving non-hazardous waste that may cause environmental pollution to arise. Where hazardous waste is involved, both the local authority and the EPA must be informed.
BS 5228-1: 2009: Code of Practice for Noise and Vibration Control	Guidance on the control of noise and vibration from demolition and construction activities
TA Luft (German Government ‘Technical Instructions on Air Quality’)	Guidelines for limits of 350 mg/m²/day for the deposition of non-hazardous dusts from construction activities.

3.4 ENVIRONMENTAL RISK

Each of the elements of the construction works will be evaluated for risks by the Contractor in advance of any works commencing on site and will be incorporated into the CEMP. The Contractor will be expected to undertake an individual risk assessment of all the construction elements and propose mitigation measures based on the control measures highlighted in Tables 6.1-6.12 below and included in the EIAR. The risk assessment should include the severity of impact which can be derived from the impact assessments included in the EIAR and the risk of occurrence.

The Contractor will be required to evaluate aspects of the construction and impacts on a continual basis and these will be deemed significant if:

- They breach legislative or contractual compliance;
- The impact could cause a prolonged or long term nuisance or environmental impact during the contract period;
- The impact could have a long term effect to the environment outside of the footprint of the works; or

- The impact could adversely impact the flora and fauna within the footprint of the proposed works and adjacent areas.

3.4.1 Construction Phase Environmental Management Plans

A suite of Construction Phase Environmental Management Plans will be prepared in association with the Contractor. These Management Plans will reflect any conditions imposed by the Planning Authority and will be agreed with Kildare County Council, the OPW and the relevant competent authorities in advance of works commencing.

These will include:

- Dust Minimisation Plan (outline example provided in Appendix A)
- Fuelling Procedure (prepared by contractor in accordance with mitigation measures in Tables 6.7, 6.8 and 6.9)
- Water Quality Monitoring Plan (outline example provided in Appendix B)
- Emergency Response Plan (outline example provided in Appendix C)
- Construction Traffic Management Plan (CTMP)
- Waste Management Plan (WMP) (an outline Plan has been provided as Appendix M to the EIAR)

4 ENVIRONMENTAL ROLES AND RESPONSIBILITIES

4.1 POLICY STATEMENT

Kildare County Council recognises that environmental impacts relating to nature conservation may be created as a result of the activities associated with the construction of this scheme and that it has a responsibility to mitigate and manage these impacts appropriately. This involves consultation with both statutory and non-statutory organisations, detailed desk studies, ecological assessments and the production of a CEMP. The baseline information contained within the EIAR for the Morell River FMS has been used to develop site-specific mitigation to minimise damage to the nature conservation value of the site and disturbance to key habitats and species.

4.2 PROJECT TEAM STRUCTURE

The proposed team structure for the construction of the proposed scheme is shown in Figure 2 below.

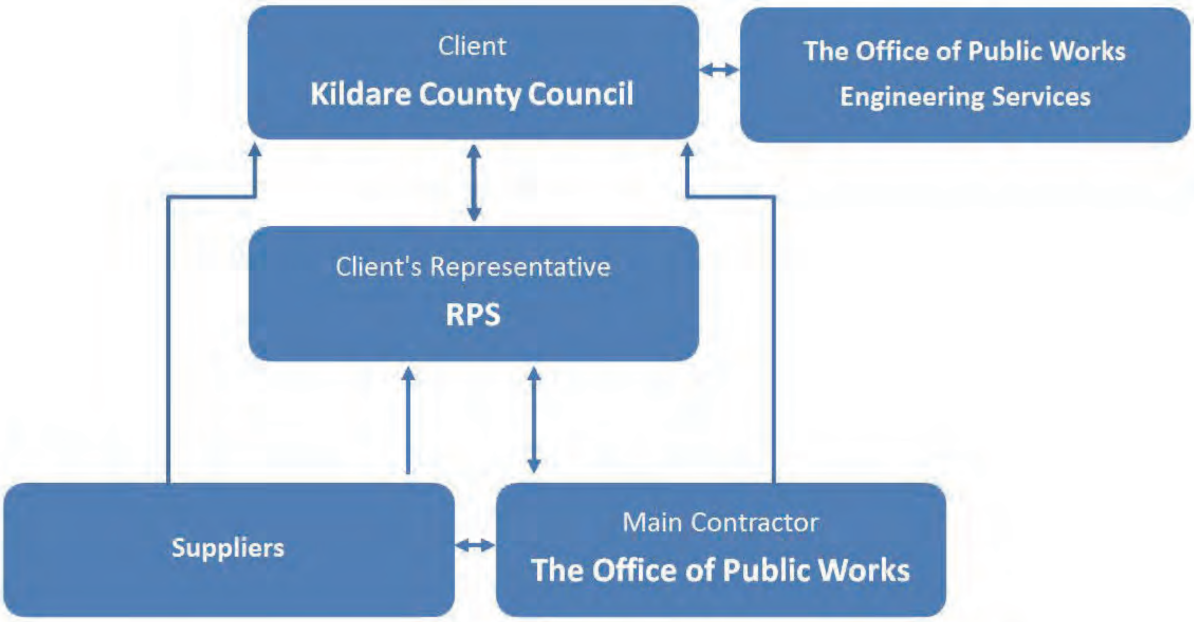

Figure 2: Team Structure

The outline CEMP will be developed by the Client's Representative and the Contractor to fulfil all relevant planning conditions.

It is currently anticipated that the OPW will undertake the role of Contractor via direct labour. The contract between KCC and the OPW will allocate the responsibility for compliance with the terms of the CEMP during the construction phase of the scheme.

A suitably qualified person, or persons, will be appointed to the role of Environmental Manager, to oversee the environmental aspects of the construction works. The Environmental Manager will monitor activities and ensure that all relevant environmental legislation is complied with and that the requirements of the CEMP are implemented. The Environmental Manager will have the responsibility for reviewing method statements, overseeing works and instructing actions, as appropriate, including the authority to require the temporary cessation of works, where necessary.

The CEMP (having been developed into a full CEMP by the Contractor and agreed by the relevant authorities) will be made available along with other Plans (Noise, Dust and Traffic Management, etc.) to all relevant personnel in their place of work to direct, guide and assist in their activities. All personnel working on the project will be responsible for the environmental control of their own work and will perform their duties in accordance with the requirements of the CEMP and in compliance with the controls referenced therein. No deviations will be permitted without the written authority of the Construction Manager and the relevant consenting authorities.

The Construction Manager is responsible for ensuring that the contents of the outline CEMP are satisfactorily circulated and explained to site supervisory staff for implementation during construction. Any problems or disputes arising from such will be brought to the attention of the Construction Manager and the Client Representative.

5 CONSTRUCTION AND SITE OPERATION DETAILS

5.1 PHASING AND TIMESCALES

The nature of the works dictates that they should be undertaken in settled weather, without flood risk. As such, the construction of the scheme may take 61 weeks, phased over three years (but potentially taking up to four years dependent on weather conditions).

The "best case" scenario, based on completing all works within three years, considers the following groupings of works:

- **Group One**: The section from the confluence of the River Morell/River Liffey to Killeenmore (Morr 1 to 3 and Paines 1 to 3) which should hopefully be completed as a single phase.
- **Group Two**: The second phase consists of the embankments, walls, culverts and stream diversions from Morr 4 to 23 and may be divided across two years, depending on construction delivery time, if this is the case Morr 4 to Morr 19 would most likely be completed as phase 2A in year one and Morr 20 to 23 as phase 2B in year two.
- **Group Three:** encompasses Paines 4 & 5, Kill 1 and Slane 1 to 11.

The construction works are proposed to commence at the confluence of the Rivers Morell and Liffey and from there the works will progress upstream, subject to the availability of suitable construction material. Within the works, the main artery of the scheme will be prioritised from embankments and associated tie-ins and culverts.

5.2 HOURS OF WORKING

The normal working hours for the construction of this scheme will be 7.30am – 4:30pm Monday to Friday. On occasion, working hours may be extended to 7.00am - 7.00pm Monday to Friday; and 9.00am and 4.00pm on Saturdays. There will be no activity on Sundays or Bank Holidays.

Where additional or alternative working hours outside those stated above are required, these will require notification to Kildare County Council and to be agreed in advance.

5.3 SITE ESTABLISHMENT

A central base construction compound will be established for of the construction of the project. Each embankment, wall and culvert upgrade will be a small satellite site for the project.

The base compound will be centrally located for the phase of the works being undertaken, it will be secure with controlled access and egress and will provide the following amenities for the Contractor's staff and agents;

- Adequate materials drop-off and storage area
- Canteen complete with tables, chairs, sink, fridge, kettle etc.
- Drying area
- Toilets and washing facilities

- Adequate Parking
- Offices
- First aid room (stocked)
- Bunded fuel storage

Perimeter hoarding or fencing will be provided around the base compound to provide a barrier against unauthorised access from the public. Controlled access points to the compound, in the form of gates or doors, will be kept locked for any time that these areas are not monitored (e.g. outside working hours). All hoarding or fencing will be kept well maintained.

A satellite site will be established for each embankment, wall or culvert; this will consist of the temporary working area adjacent to the works (15m approx.) and will include the following amenities;

- Staff welfare facilities, i.e. portable toilets
- Adequate materials drop-off and storage area for new construction material
- Stock piling area for excavated material
- Internal turning area for trucks

Where appropriate, fencing and barriers will be provided within the central base site and within satellite sites as a safety barrier around areas where the public may have access, or to prevent livestock from entering the site. The locations of the temporary fencing will change during the course of the project, but will generally be surrounding excavations.

As the works are progressive, satellite amenities will be transferred from the first site to the second and so on, with the central base providing all other required amenities. Landscaping, such as the removal of scrub and trees that are not being retained, will be completed as part of the establishment of each satellite site, having regard for relevant seasonal constraints (see bullet points below). Prior to the commencement of vegetation clearance the services of a qualified aboriculturist will be sought to perform a tree survey of the proposed scheme. The trees should be assessed to quantify their age, condition and amenity value and existing trees which are to be retained tagged with metal tags. Trees which are to be retained will be protected by erection of timber post and wire fence to ensure no works are carried out under reach of their canopies. Unstable trees should be removed under direction of the aboriculturist.

At each site, the proposed works area will be clearly marked out with temporary fencing or a suitable alternative method to ensure that plant and vehicles remain within the working area and do not extend the site footprint unnecessarily.

Prior to undertaking any works along the scheme measures or setting up central base compounds, the Contractor shall engage a suitably qualified ecologist (or surveyor) to carry out the following surveys:

- badger survey of the proposed scheme measure areas, temporary compounds and all access routes;
- otter survey of the proposed scheme measure areas, temporary compounds and all access routes;

- visual inspection by a suitably qualified and licenced bat surveyor of any trees requiring removal to facilitate construction works, to identify potential bat roosts;
- invasive plant species survey, in the appropriate botanical season (April through to September) of the proposed scheme measure areas, temporary compounds and all access routes;
- if vegetation removal/trimming is required during the bird nesting season (1st March to 31st August inclusive) a suitably qualified ecologist with experience in nest-finding will be required to check all vegetation for nests (under licence from NPWS to permit potential disturbance to nesting birds) prior to removal/trimming.

Where excavation or embankments are occurring on or adjacent to a riverbank (within a distance of 10 metres), the river will be protected by the installation of a sediment barrier which will extend beyond the ends of the feature being worked on. This sediment barrier will function to prevent silt run-off into the river and will run the length of the embankment or flood wall where it is adjacent to the watercourse. The sediment barrier construction will be a priority during site setup and will remain in situ until the works have been completed.

During construction, the Construction Manager and Project Ecologist shall also maintain a watching brief for frog spawn and frogs.

5.3.1 Temporary Crossings

For the majority of the construction activity, the working areas will be accessed via existing farm tracks and it will not be necessary for plant machinery to cross any rivers or streams within the temporary working areas.

The measures at Morr 4 - Morr 8 will require temporary bridging to allow vehicles travelling along the temporary working area to cross the watercourse at Culvert 4 and the Painestown tributary stream at Morr 8. The works at Culvert 10 and Morr 9 are also likely to require a temporary crossing over the Painestown River, upstream of Culvert 10, to facilitate their construction. At the conclusion of stream diversion works at Slane 8, plant will be required to cross the newly-diverted Slane River to exit the working area.

Each temporary crossing will be included in the Method Statement for its associated works area agreed in advance with IFI personnel in advance of construction works. The design of each crossing will take into account the recommendations on temporary crossing structures in '*Guidelines on Protection of Fisheries during Construction works in or adjacent to Waters*' (IFI, 2016). Clear-span bridges, such as Bailey bridges are IFI's preferred approach for crossing rivers with fisheries and fish habitat (e.g. the Painestown River) but the use of a piped ford/causeway may be proposed for the smaller watercourses.

If instream works are required for the installation of a temporary crossing at the Painestown River or Slane river, these will be subject to the same timing restrictions for aquatic protected species of the Morell Catchment (Table 7.1) as other instream works.

A key issue of the temporary crossing will be preventing silty or sediment laden run-off from the temporary crossing and the adjacent haul route from entering the watercourse.

Any piped temporary crossing will be designed and constructed so that:

- It is perpendicular to the river/watercourse, ensuring the crossing is as short as possible;
- The pipes are adequately sized to convey the expected range of flows for the period of use, including flood flows, without overtopping;
- The pipe invert should be level with the watercourse bed to allow the passage of water during low flows;
- Pipes should extend 1.0 to 2.0 metres beyond the running track and should be covered with clean inert material such as to allow the safe crossing of the widest items of plant and equipment without cover material being dislodged and falling into the watercourse;
- The deck should have an edge upstand (e.g. steel plate, timber, straw bales, sandbags, geotextile);
- The crossing's surface should be on a slight gradient/graded to ensure that surface water is not shed into the watercourse, and is instead routed beyond the top of the river bank into site drainage which has the appropriate form of treatment.

5.4 EMBANKMENTS

The construction of each embankment will commence at the downstream end, the site will be cleared during establishment and the height and extents of the sediment barrier (where applicable, see 5.3 above) verified before ground is broken.

Made ground will be encountered during the construction of new embankments and restoration of existing embankments. Site investigations carried out in accordance with BS5930:2015 and BS10175:2011+A1:2013 during detailed design will inform the final CEMP. An outline Waste Management Plan has been prepared and is attached to the EIAR as Appendix M.

- Access routes will be agreed with landowners and stabilised where required by laying down a track of compacted granular material.
- Scrub and debris will be stripped from the work area and disposed of correctly.
- The entire length of the embankment and temporary work area (TWA) will be clearly marked out.
- There will be two teams involved in the works. Team 1 will commence the excavation for the embankment at the downstream end
- Embankment works will be undertaken using tracked vehicles which, for those measures sited adjacent to watercourses, will only travel along the temporary works area on the side of the embankment furthest away from the watercourse, or on top of the embankment itself.
- Where a requirement for restoration / remediation of an existing embankment is identified, existing embankment materials will require to be tested for contaminants and to Waste Acceptance Criteria. Excavated made ground which is unsuitable for reuse onsite and/or has evidence of contamination is required to be correctly classified as inert, non-hazardous or hazardous for offsite disposal in accordance with '*Establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC)*'.

- Should evidence of potential contamination be encountered, investigations will be carried out to delineate the contamination. Mitigation as outlined in Table 6.11 below and in the accompanying outline WMP will be applied in the event of potential contamination.
- The excavated material will be sorted into types (Topsoil, Subsoil Unsuitable for re-use) and stockpiled in the TWA for re-use or removal. Stockpiling locations will be away from the river or watercourse. Specific measures for handling potentially contaminated soils are included in section 4.1.1.3 of the outline WMP. Stockpiling of any potentially contaminated made ground onsite should be avoided.
- As Team 1 progresses down the site Team 2 will fall in behind, Team 2 will install the clay core and re-fill the area forming the embankment with the required slopes
- This will continue down the length of the embankment, once the embankment is complete the fencing will be removed but the sediment barrier (where required, see 5.3 above) will be left in-situ to allow the embankment to settle in. The sediment barrier will be removed only after inspection of the embankment confirms that the topsoil is stable.

5.5 WALLS

The construction of the wall will commence at the downstream end, the site will be cleared during establishment and the height and extents of the sediment barrier verified before ground is broken.

- Access routes will be agreed with landowners and stabilised where required by laying down a track of compacted granular material.
- Where walls are being constructed on or adjacent to the river bank (i.e. within a distance of 10m), the length of the proposed wall in proximity to the watercourse will have a sediment barrier installed on the river side.
- Scrub and debris will be stripped from the work area and disposed of correctly.
- The entire length of the wall and temporary work area (TWA) will be clearly marked out.
- There will be two teams involved in these works, works Team 1 will commence the excavation for the footing and foundations of the wall at the downstream end
- For those measures sited adjacent to watercourses, construction vehicles will only travel along the temporary works area on the side of the wall furthest away from the watercourse.
- Excavated material will be sorted into types (Topsoil, Subsoil Unsuitable for re-use) stockpiled in the TWA for re-use or removal
- As Team 1 progresses down the site Team 2 will fall in behind, Team 2 will construct the wall and reinstate the site as they progress upstream
- Wall construction will adopt best practice in bulk-liquid concrete management, in respect of pouring and handling, secure shuttering / form-work and allowing adequate curing times
- Where shuttering is used, measures should be put in place to prevent against shutter failure and to control storage, handling and disposal of shutter oils
- Construction will progress down the length of the wall. Once the wall has been completed, the site markings will be removed but the sediment barrier (where applicable) will be left in-situ to allow the reinstated ground around the wall to settle in. The sediment barrier will be removed only after inspection of the reinstated ground confirms that it is stable.

5.6 STREAM RE-ALIGNMENT

The plant required will operate from the river bank without need to enter the stream. The new channels will be open cut through the existing bends, the streams will be diverted through this new channel and the old channel will be filled in. The opening of the new channels will be completed from the field, it will start at the centre point and move progressively in both directions until it reaches the stream banks. Once it reaches the banks, both banks will be opened and the upstream section of the stream diverted in a controlled manner by restricting flow down the old channel, the down stream section will also have flow restiction to minimise backflow, this will allow the old section to drain slowly. The old channel will be backfilled from the upstream side starting with the new upstream bank around the bend to the downstream section where the second new bank will be created.

The filling in of the old channels will be from the temporary island that the new channel will have created. During re-alignment the temporary work areas will be set up in the field, this is where the excavated material will be stock piled for use when backfilling the old channel. The machinery will traverse the stream twice, once to access the island to fill in the old channel and the second time to exit the works area upon completion.

There is the potential for significant sediment disturbance and run-off during this operation. A detailed design and Method Statement will be drawn up by the contractor for each of the diversions and agreed in advance with IFI personnel in advance of construction works.

- Access routes will be agreed with landowners and stabilised where required by laying down a track of compacted granular material;
- Stream realignments shall be carried out in accordance with the recommendations within the IFI document '*Requirements for the protection of Fisheries Habitat during construction and Development Works at River Sites*' (ERFB, 2003). Method Statements will be prepared by the Contractor and approved;
- Scrub and debris will be stripped from the route of the realignment and disposed of correctly;
- The entire length of the re-alignment will be clearly marked out, including the Temporary work area (TWA);
- Excavation works to construct the new channel alignment will be carried out in dry conditions, without connection to the existing watercourse;
- The banks and bed of the new channel will be lined with a biodegradable geotextile;
- Effective silt management measures should be placed in stages downstream of the new channel in advance of opening the channel. These will be specified by the Contractor in the Method Statement and agreed with IFI, but the currently proposed measure would be triple silt curtains derived from Terram or other similar material, to first filter out the heaviest of materials and subsequently the finer material. These would need to be checked on a regular basis with the heavy material removed from the first silt curtain thereby keeping it functional. A procedure will need to be included in the Method Statement for the removal of the silt fences on a staged basis, as even these preventative measures will lead to a build up behind the curtain. The curtain nearest to the point of works should be removed first followed by the others;
- The connection of the new stream channel to the existing watercourse shall only be made during a timing window agreed with IFI for in-stream works;

- Fish will need to be removed from the impacted section of the existing channel in advance. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended);
- During realignment works on the Slane River, contractor SOPs will be applied to respond in the case white-clawed crayfish are present and emerge from refuges at the times of stream realignment. In the event that significant populations of white clawed crayfish emerge, advice will be sought from IFI and NPWS to facilitate any necessary rescue and relocation;
- During the diversion operation, bungs should be fixed at both ends of the channel and removed in a controlled manner at IFI's direction ensuring the river flow remains uninterrupted from above to below the works. As the ends of the new channel are opened, flow will be restricted down the old channel; the downstream section will also have flow restriction to minimise backflow, this will allow the old section to drain slowly;
- To assist with reinstatement of the river bed in the new channel, if suitable, the existing bed material from the original channel should be removed and kept clean, then placed on the bed of the new channel at the conclusion of the diversion works.
- Once the diversion is complete the old channel will be backfilled from the upstream side;
- At Slane 08 filling in of the old channel will be from the temporary island that the new channel will have created;
- During re-alignment, a temporary work area will be set up, this is where the excavated material will be stock piled for use when backfilling the old channel. Stockpiles will be kept away from both the old and new river alignments;
- At Slane 08 the excavator will be required to cross the newly diverted stream to exit the works area upon completion of backfilling. The Method Statement for Slane 08 will incorporate mitigation measures to protect the newly constructed river bank during the crossing and prevent the entrainment of sediment into the watercourse.

5.7 CULVERT WORKS

In-channel works for upgrades on Culverts 6, 9, 10 and 22 and, where relevant, at Culverts 1, 2, 4, 4a 7, 18 & 19 will use cofferdam-type construction whereby flow can be restricted, allowing the civil engineering works to be undertaken in dry conditions. A cofferdam is a temporary watertight enclosure that is pumped dry to expose the bottom of a body of water so that construction can occur. A Method Statement will be prepared for each site of culvert alterations and will be agreed in advance with IFI personnel ahead of commencing the culvert alteration.

All instream works should adhere to timing restrictions for aquatic protected species of the Morell Catchment (Table 6.1).

- Any culvert alterations must be designed to ensure the unimpeded passage of fish at all times;
- Morell River (Cul 5) and Painestown River (Cul 9 & 10) should be electro fished downstream of the proposed works area in advance of any works to assess whether there are any fish or lamprey ammocoetes in the affected channels, as advised by IFI. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended);
- Headwalls for Cul 5, Cul 9 and Cul 10 should be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete;

- For proposed works on Cul 5, Cul 9 and Cul 10, and, where relevant, at Culverts 1, 2, 4, 4a 7, 18 & 19 effective silt management measures should be placed in stages downstream of the new channel in advance of commencing culvert alterations. These will be specified by the Contractor in the Method Statement and agreed with IFI, but the currently proposed measure would be triple silt curtains derived from Terram or other similar material, to first filter out the heaviest of materials and subsequently the finer material. These would need to be checked on a regular basis with the heavy material removed from the first silt curtain thereby keeping it functional. A procedure will need to be included in the Method Statement for the removal of the silt fences on a staged basis, as even these preventative measures will lead to a build up behind the curtain. The curtain nearest to the point of works should be removed first followed by the others.

If there is significant water ingress into the cofferdam (dependant on river levels), an approved pumping and settlement system will be set up. Pumps will transfer accumulated standing water into a settlement tank, or tanks, which in turn will discharge into a 'silt buster' or 'dirt bag' prior to being returned to the watercourse, to minimise the discharge of suspended solids into the watercourse. Measures for transferring water during instream works will be subject to approval within the Contractor's Method Statement.

5.8 CONSTRUCTION TRAFFIC

5.8.1 Site Access

As outlined previously all construction traffic will enter and leave the satellite sites via access routes agreed with landowners.

The entrances to the satellite sites will be kept free from obstruction to ensure construction traffic can drive straight into the site. Special consideration will have to be given to deliveries to ensure no vehicles are left waiting outside of the site causing potential obstructions.

5.8.2 Construction Traffic Routing

Construction traffic will be confined to designated and planned haul routes in the vicinity each of the satellite sites. The heavy goods vehicles (HGVs) routes to and from the site will be planned and provided with the designated haul route for delivery and egress from each site.

Proposed Haul routes and expected truck numbers are described in Chapter 6 of the EIAR. A Traffic Management Plan will be prepared in advance of the proposed works to minimise any impacts on other road users and to maximise road safety along the haulage route.

5.8.3 Construction Parking

Staff Parking will be in the central base site, staff will carpool from here to the satellite sites to ensure minimum traffic impact on the satellite site. Plant and delivery trucks will have sufficient parking within the temporary work area.

6 ENVIRONMENTAL MITIGATION MEASURES

Chapters 5 to 14 of the EIAR assess the likely significant impacts arising from the proposed development. Tables 6.2 to 6.11 below summarise the potential impacts identified and the mitigation measures required, where necessary.

A Method Statement will be prepared by the Contractor for each works area (e.g. Morr 1, Morr 2, Paines 1, etc.). This Method Statement is to be strictly adhered to by staff and contractors involved in the works and will be overseen by the contractor's representative/foreman. The Environmental Management Protocols and Standard Operating Procedures (SOPs) will form the backbone of the Method Statements, which will incorporate the mitigation measures proposed below.

A robust mechanism for reporting of pollution incidents will be agreed in advance between the OPW, Kildare County Council, the IFI and other relevant statutory agencies. An outline emergency spill response plan is included in Appendix C.

6.1 GENERAL ENVIRONMENTAL PROTECTION

6.1.1 Flood Warnings

The works are proposed to take place during settled weather which should reduce the risk of a flood event occurring during construction. However, should a flood warning be raised during the construction phase, every effort will be made to make any active working areas safe, e.g. removal of plant machinery and all stores of fuels, oils and wastes from areas within range of flood waters. Open excavations will be backfilled and compacted to replicate the original condition insofar as is possible. Measures to be taken in the event of a flood warning for each of the works area will be described within the Method Statement.

Table 6.1: In-Stream Works Restriction Periods for Aquatic Protected Species of the Morell Catchment

Species	Period of no instream disturbance (inclusive)	Likelihood of presence in the affected areas and comments	Period instream works allowed (inclusive)
Salmon (*Salmo salar*)	October to April - spawning, nursery (IFI).	Distributed throughout study area.	May to September
Brook (*Lampetra planeri)* and River Lamprey (*Lampetra fluviatilis*)	March to May - spawning / hatching	Distributed throughout study area, depending on localised habitat, i.e. spawning in riffles, nursery in silty deposits.	June to February.
Sea Lamprey (*Petromyzon marinus*)	Mid June – July	Distributed throughout study area, depending on localised habitat i.e. Spawning and juvenile nursery habitat abundant throughout the study area, depending on localised habitat, i.e. spawning in riffles, nursery in silty deposits.	August to April.

Species	Period of no instream disturbance (inclusive)	Likelihood of presence in the affected areas and comments	Period instream works allowed (inclusive)
White Clawed Crayfish (*Austropotamobius pallipes*)	November to late June (breeding / berried females + hatching).	Distributed throughout study area but populations particularly abundant on Slane River.	July - October
Trout (*Salmo Trutta*)	October to May - spawning, nursery (IFI).	Distributed throughout study area.	June to September
Combined/ overall timing restrictions.	No instream works allowed between October and July.	-	Instream works allowed August to September.

6.1.2 Summary Tables of Mitigation Measures

Table 6.2: Standard Pollution Prevention Control Measures

Potential Impact	Mitigation Measure
General	▪ Prior to any works, all construction personnel will receive an on-site induction relating to operations within and adjacent to watercourses and the environmentally sensitive nature of working within and in proximity to the watercourses within the Morell catchment and re-emphasise the precautions that are required as well as the mitigation measures to be implemented. ▪ The Contractor will ensure that the engineer setting out the works is fully aware of the ecological constraints and mitigation requirements. Kildare County Council will ensure that a Corrective Action procedure is put in place in the event of an incident onsite. ▪ The amount of bare ground created by excavation and vegetation removal will be minimised, to prevent run-off. ▪ Direct instream works such as culvert upgrades and proposed measures along the riverbank have the greatest potential for negative impacts during spawning / breeding and early nursery periods for aquatic protected species in the study area. No instream works or out-of-river works with potential for significant damage should occur during restricted periods for relevant species (see Table 6.1). Consultation should be undertaken with the IFI in this regard. ▪ Storage areas will be clearly identified, ensuring that similar items are stored together to prevent wastage ▪ Perishable materials will be stored inside, under cover or in containers ▪ Where possible, materials will be stored off the ground by using pallets or racking ▪ Materials will be used within their shelf life ▪ Materials will be stored in accordance with manufacturer's guidelines to prevent damage. ▪ Regular housekeeping checks will be made to ensure the site remains safe (in terms of reducing slip, trip and fall hazards) and environmentally sound. ▪ The amount of materials actually stored on site should be kept to a minimum to help instil the concept of the law of diminishing returns amongst operatives (i.e. resources will be used more wisely when less abundant).
Pollution of Watercourses	**<u>General</u>** ▪ To prevent the spread of invasive aquatic / riparian species, all plant and equipment employed on the construction site (e.g. excavator, footwear, etc.) must be thoroughly cleaned down using a power washer unit and washed into a dedicated and contained area, prior to arrival on site. A sign off sheet must be maintained by the contractor to confirm cleaning. ▪ Tools and equipment are not to be cleaned in rivers. ▪ Chemicals/fuels used shall be stored in sealed containers in the site lockup prior to use. ▪ The chemicals shall be applied in such a way as to avoid any spillage or leakage. Any and all excavated material is not to be temporarily stored adjacent to watercourses ▪ Storage areas will be identified in advance of any deliveries and will be located in the area of least risk to environmental receptors. For example, should there be any storm water drainage systems on site, raw materials and hazardous liquids will be stored away from this area.

Potential Impact	Mitigation Measure

	▪ Any spoil will be stored a minimum of 10 metres from watercourses, covered if practicable and sandbagged or other suitable measures employed to prevent silt run-off.
	▪ Materials such as cement will be covered from the weather to prevent spoiling and caustic runoff.
	▪ All hazardous liquids below 200 litres in capacity will be stored in drip trays, under cover and larger volumes divided into smaller containers e.g. 20 litre cans in preference to 190 litre drums.
	▪ All hazardous liquids above 200 litres will be fully bunded to 110% of their capacity. Steel drums should be avoided in favour of bunded, bulk stores with integral dispensing systems e.g. fuel cube mounted in a refuelling bay.
	
	Fuelling and Lubrication
	▪ The Contractor shall provide designated areas for fuel transfer away from any watercourses or drainage channels. The refuelling of mobile plant in the working area will be undertaken well away (minimum 10m) from any drains or water bodies. Oil contaminated water will be disposed of at an appropriate oil recovery plant or licensed tip site.
	▪ Vehicles will not be left unattended during refuelling. All machinery will be checked regularly for any leaks or signs of wear and tear. The Contractor will ensure that personnel are nominated as being responsible for the supervision of the filling of vehicles. Any standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution.
	▪ Adequately sized spill kits will be available on site in a designated area, with additional material available for restocking. Emergency spill control training will be provided for all operatives working on site including emergency communication. When crossing rivers, floating booms and silt traps will also be held onsite.
	▪ All fuels, lubricants and hydraulic fluids will be kept in secure bunded areas at a minimum of 10m from the river.
	▪ The bunded area will accommodate 110% of the total capacity of the containers within it. Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner.
	▪ All plant shall be well maintained with any fuel or oil drips attended to on an ongoing basis.
	▪ Any minor spillage during this process will be cleaned up immediately. Should any incident occur, the situation will be dealt with and coordinated by the nearest supervisor who will be responsible for instructions by Kildare County Council.
	▪ Disposal of unused liquids will be via a specialist, licensed contractor fully complying with relevant legislation. This will include run off from drip trays.
	
	Cement/Concrete Runoff
	▪ Measures relating to concrete/cement management will apply to the construction of the flood walls Morr7, Morr22, Slane1, Slane 4 and Kill 1.
	  □ Disposal of raw or uncured waste concrete will be controlled to ensure that the watercourse will not be impacted;
	  □ Best practice in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times;
	  □ Where shuttering is used, measures should be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils;
	  □ All working materials and excavated material should be stockpiled on the land side of the works within the assigned temporary working area;
	  □ For works within 10m of river banks, the river side of the flood wall excavation will be separated from the river by a sediment barrier. Once the flood wall is complete the sediment barrier should be left in-situ to allow the reinstated ground around the wall to settle in. The sediment barrier should only be removed after inspection of the reinstated ground confirms that it is stable;
	  □ Wash water from cleaning ready mix concrete lorries and mixers may be contaminated with cement and is therefore highly alkaline. Due to the size of the site and the proximity of sensitive watercourses, it is recommended that lorries and mixers are washed out offsite.
	▪ The following activities associated with the construction of flood defence walls should be noted:
	  □ Bank Protection – Refer to OPW's Environmental Management Protocols and Standard Operating Procedures (OPW, 2011).

Potential Impact	Mitigation Measure
	▫ Bush Cutting / Branch Trimming - Refer to OPW's Environmental Management Protocols and Standard Operating Procedures (OPW, 2011). **Silt Runoff** Measures relating to management of silt runoff will mostly apply to the construction of the embankments. ▪ The following measures should be employed during proposed works: ▫ Works should be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle; ▫ Embankment material should be selected that has low silt content; ▫ All working materials and excavated material should be stockpiled on the land side of the works within the temporary working area; and ▫ For works within 10m of river banks, the river side of the embankment excavation will be separated from the river by a sediment barrier. Once the embankment is complete the sediment barrier should be left in-situ to allow the reinstated ground around the wall to settle in. The sediment barrier should only be removed after inspection of the reinstated ground confirms that it is stable. ▫ A silt trap will be located downstream of works. ▪ The following activities associated with the construction of embankments should be noted: ▫ Bank Protection – Refer to the OPW's Environmental Management Protocols and Standard Operating Procedures (OPW, 2011). ▫ Bush Cutting / Branch Trimming - Refer to the OPW's Environmental Management Protocols and Standard Operating Procedures (OPW, 2011).

Table 6.3: Human Beings: Summary of Mitigation Measures

Potential Impact (Human Beings)	Summary of Proposed Mitigation
Construction Potential impacts include construction noise, and temporary dust and vibration arising from the construction works and associated construction traffic.	Mitigation measures for traffic, noise, & vibration and dust are presented in their respective chapters.
There is potential for some disruption to the residential/ working population and economic activity within the study area during the construction phase of the flood management scheme. Some disruption to residents and businesses may arise during the construction period, from works occurring close to commercial premises, road restrictions, etc.	Impacts will also be mitigated by the adoption of good construction and traffic management measures and by the dissemination of information to owners and operators of places of work. Such measures should be identified in a formal Construction and Environmental Management Plan (CEMP) and Construction Traffic Management Plan (CTMP). ▪ The CEMP will be implemented by the contractor to mitigate against adverse impacts during construction. The CEMP will incorporate mitigation measures to avoid nuisance from construction activities including dust and noise. ▪ The CTMP will also be prepared in advance of the proposed works to minimise any impacts on other road users and to maximise road safety along the haul routes. The aim of a CTMP is to put in place procedures to manage construction traffic effectively. The plan will consider construction traffic accessing the site via the public road network as well as traffic circulation within the construction site. ▪ The working and resident community would also benefit from an organised information campaign on temporary access arrangements and proposed construction detail.
During construction, potential impacts in respect of education and health are not expected to be significantly	▪ Construction phase impacts in respect of education and

Potential Impact (Human Beings)	Summary of Proposed Mitigation
different from the existing situation. There will be a temporary increase in the number of HGVs on routes within the works areas during construction and the resultant temporary traffic management procedures may result in some minor disruption to local traffic which may include increases to typical journey times.	health will be mitigated in the same way as for the resident/working population in the section above, by the adoption of good construction and traffic management measures and by the dissemination of information to schools and healthcare providers. Such measures should be identified in the CEMP and CTMP plan as previously outlined, and an organised information campaign on temporary access arrangements and proposed construction detail as previously identified.
Site investigations have established the presence of made ground in a number of works areas. If contaminated ground is encountered during construction, the excavation and handling of contaminated ground has the potential to result in the increased mobilisation of contaminants. Dependant on the contaminant of concern; these impacts could include: ▪ Leaching of any contaminants from the made ground to the surrounding area could lead to further areas of soils within the vicinity becoming impacted and the impacting of groundwater and surface water; ▪ Risk from gas production; and, ▪ Human health risk, as excavation of made ground could expose construction works to potential contaminants. If contaminant levels exceed soil guideline values (SGVs) this could present a risk to human health from direct contact and from volatile or semi-volatile vapours.	▪ Additional Site Investigations will be carried out in accordance with BS5930:2015 and BS10175:2011+A1:2013 during detailed design. ▪ Should evidence of contamination be encountered in the identified areas of made ground or other excavated areas, appropriate health and safety measures shall be implemented, as discussed in Table 15.9 below. A site specific Waste Management Plan shall be implemented onsite to mitigate any potential impacts from potentially contaminated made ground. An outline example has been appended to the EIA report (Appendix M). The plan will include steps for the excavation, handling, storage and disposal of potentially contaminated material in accordance with industry best practices and waste management regulations. ▪ Mitigation measures for the preservation of water quality are set out in Tables 15.7 and 15.9 below.
Whilst the proposed works will have little impact on many sectors of the tourism industry within the catchment, there is potential for an impact to angling activity. The proposed scheme will have a localised temporary adverse impact on the angling amenity during any in-stream works.	Construction phase impacts in respect of tourism and leisure will be mitigated in the same way as for the resident/working population above. ▪ Phasing of works around peak user times of other uses such as specific sports facilities, in particular Killeen Golf Club, and seasonal tourist facilities should be considered. ▪ Local angling clubs and IFI have been included in the consultation process and will be kept informed throughout the construction process. Mitigation and control measures to address the impact from suspended sediments associated with construction activities should follow good work practices and sound design principles (see also Table 15.7, Aquatic Ecology). Contractors shall establish contact with the relevant authorities, e.g. IFI before works commence, with ongoing liaison throughout the construction. ▪ Regular updates and consultation with all sports clubs/schools affected by construction works will be required. Ongoing consultation with other land users specifically affected by proposed construction works will be required.
Construction works may affect land uses within the study area through temporary landtake for construction purposes. Particular land areas may temporarily severed from access to facilitate construction works and/or have temporary access restrictions (short term access to land may be affected immediately adjacent to the works) causing a short term adverse impact.	▪ Extensive landowner consultation has been carried out during the development of the proposed scheme. ▪ Consultation with landowners will continue throughout detailed design and construction of the scheme to ensure that appropriate mitigation for individual landowners is agreed between the landowner and the Contractor and will be implemented. ▪ Existing accesses to property or severed areas, including homes and farms will, where practicable, be maintained during construction; otherwise reasonable temporary access will be provided. Discussions have taken place

Potential Impact (Human Beings)	Summary of Proposed Mitigation
	with landowners in this regard and these discussions will continue throughout the construction period. ▪ All lands, temporarily acquired, will be re-instated to pre-construction conditions, subject to the agreement of the landowners.
Construction works may affect safety within the study area.	The works will be subject to the Safety, Health and Welfare at Work Act 2005 (S.I. No. 10 of 2005) and at a minimum the Safety, Health and Welfare at Work (Construction) Regulations, 2013 (S.I. No. 291 of 2013). All aspects of design construction will be reviewed with regard to health and safety and risk assessments will be carried out. ▪ A project supervisor design process (PSDP) has been appointed. As part of their duties they will be required to produce a Preliminary Safety and Health Plan for the project. The main contractor will be appointed as project supervisor construction stage (PSCS) and will be responsible for the control and co-ordination of health and safety during the construction phase of the works. ▪ A CTMP will be prepared in advance of the proposed works to minimise any impacts on other road users and to maximise road safety along the haul routes.
Potential impacts to agricultural activities within the proposed works areas.	▪ Mitigation measures regarding construction traffic, dust and noise are outlined in Tables 15.2, 15.3 & 15.4 below. ▪ Any disruption to water supply will be reinstated immediately by the Contractor or an alternative source supplied until the original source is reinstated, unless otherwise agreed with the landowner. Discussions have taken place with landowners in this regard and these discussions will continue throughout the construction period. ▪ Existing accesses to all properties will, where practicable, be maintained during construction otherwise reasonable temporary access will be provided. ▪ Where necessary, suitable stock proof temporary fencing will be erected for the duration of construction. ▪ Where any fences, walls or hedges are damaged they will be made stock proof immediately, where necessary. Any necessary permanent restoration of fences, walls, drains or land will be completed as soon as practicable after work has concluded ▪ During the construction stage the contractor will be instructed that any gates used by them are closed so as to prevent animals from straying. ▪ All machines will be treated with appropriate disinfectant prior to arrival on site. The contractor will verify to the construction manager engineer that this has been done. ▪ The construction manager will liaise with the local District Veterinary Office (DVO) to establish the location of any restricted herds along the proposed scheme. The liaison will continue on a regular basis throughout the construction period. ▪ Where the construction manager has been informed of a restricted herd along the scheme, all machinery and personnel will be disinfected appropriately before leaving the land concerned. The contractor will arrange for disinfectant mats/baths to be replenished with disinfectants, as required. ▪ In the event of an outbreak of a serious Class A Disease,

Potential Impact (Human Beings)	Summary of Proposed Mitigation
	the project will be subject to such operational restrictions as are imposed by the Department of Agriculture, Food and Marine.
Operation Impacts will arise particularly to the residential amenity of the occupants of specific residential properties within the study area where some of the proposed flood defences are to be constructed adjacent to residential properties (i.e. embankments constructed close to residence boundaries).	▪ The proposed scheme will alleviate intermittent flooding to the residential properties in the catchment area. This is a significant positive and long term impact. ▪ For the resident and working community, no mitigation is required; provided plans to reinstate areas damaged or disturbed during the construction phase are implemented in a timely manner following the carrying out of the works and that the necessary maintenance to ensure the continued effectiveness of the scheme is carried out.
During the operation phase, significant areas of land and a wide range of land uses such as residential and agricultural will benefit from reduced flood risk, though some agricultural areas will be included in the post scheme floodplain.	▪ There are no mitigation measures to off-set significantly reduced land usage due to embankment locations. There are also no mitigation measures to off-set significantly increased flooding of certain land parcels due to the proposed scheme. ▪ Extensive landowner consultation has been carried out during the development of the proposed scheme. Where possible, adversely affected landowners have been accommodated by protecting adjacent land parcels.

Table 6.4: Traffic, Transport and Infrastructure: Summary of Mitigation Measures

Potential Impact (Traffic, Transport and Infrastructure)	Summary of Proposed Mitigation
Construction Phase Increase in HGV movements along roads that may not normally be used for HGV journeys.	Statutory Undertakers are required to agree temporary traffic management procedures with the local authority to carry out their works. The traffic management proposals will be carried out using the following industry recognised standards: ▪ Traffic Signs Manual 2010 Chapter 8 – temporary Traffic Measures and Signs for Roadworks (Department of Transport, Tourism and Sport). Chapter 8 assists with planning all works activities and temporary closures to optimise safety, road space and work efficiency, whilst minimising road user congestion, delay and inconvenience. Safe and efficient traffic management is founded upon the following simple principles: □ Provision of clear and early warning of obstructions in the highway; □ Optimisation of road space and the provision of adequate safety zones and working space at works locations; □ Clear directions relating to decisions/actions required from the road users; □ Minimisation of potential conflict between road users, and between road users and road workers and their operations; □ Credibility of traffic signs and temporary requirements; □ Speed limits and restrictions appropriate for the temporary highway geometry and safety features. The underlying design of traffic management arrangements should be to produce a safety performance no worse than the rate for non-works conditions, whilst

Potential Impact (Traffic, Transport and Infrastructure)	Summary of Proposed Mitigation
	minimising delays for traffic passing the works. Therefore the use of these measures will mitigate the potential temporary, localised traffic delays that may be caused by the construction of the scheme. A Construction Traffic Management Plan (CTMP) will be prepared in advance of the proposed works to minimise any impacts on other road users and to maximise road safety along the haul routes. It should also outline measures to enhance the efficient transportation of construction materials and machinery whilst minimising delay and disruption to the general traffic. The Traffic Management Plan will address the following issues:- ▪ Consultation with Kildare County Council / TII to minimise road works on the N7 during the construction programme; ▪ Maintenance of the haul route – ensuring that it is adequately swept to avoid the safety hazard of mud building up on the road, and pavement condition monitored so that developing potholes are dealt with promptly; ▪ Ensuring that Emergency Response Systems are in place to deal with incidents, written notification of the commencement of the delivery periods shall be given to the Gardaí, Fire and Ambulance services, and TII to allow the coordination of the work and the mobilisation of the safety procedures; ▪ Local residents in the area would also be notified prior to the commencement of works; ▪ Systems to encourage HGV drivers not to exceed the speed limit, not to over-rev engines etc. and to drive with consideration for other road users; ▪ Application of maintenance standards to minimise emissions by ensuring all HGVs are well-maintained; ▪ Systems to ensure that roles and responsibilities of all parties are clearly appreciated; ▪ Reuse of materials on site where possible to reduce HGV movements; and ▪ Backloading - removing waste material from site using the return journeys of HGVs that bring material to site - would reduce the amount of empty running associated with the transport of materials. Backloading options will be explored at the project progresses to detailed design. The proposed mitigation measures for the above and provision of a CTMP may include, but not limited to, the following: ▪ Signage and temporary traffic control measures and devices at specific locations; ▪ Plan drawings providing the details of the proposed traffic management measures including the text and location of the proposed temporary signage:- advisory, warning and Variable Message Signage (VMS); ▪ Details of times that the heavy vehicles are permitted on the public roads; ▪ Details of speed limits for the heavy vehicles; ▪ Details of the Public information Strategies; and ▪ Details of the Traffic Incident Management. The traffic management mechanisms described above will ensure that the works will be co-ordinated and controlled.

Potential Impact (Traffic, Transport and Infrastructure)	Summary of Proposed Mitigation
	The detailed CTMP will be agreed with the local authority post consent.
Ground investigations undertaken to date have identified made ground in the vicinity of works areas Morr 2 & 3, Paines 1, 2, 3 and 5, Morr 10 and 23, Slane 5, 6, 7 and 11 totalling approximately 17,391m³. Excavated made ground which is unsuitable for reuse onsite and / or which has evidence of contamination will have to be classified and taken away for offsite disposal.	An outline Waste Management Plan has been prepared to support the proposed development. It is anticipated that dedicated HGVs should be used for the transport of any contaminated soils identified as unsuitable for onsite use. Any additional traffic associated with removal of unsuitable waste material will not exceed the maximum 60 vehicles per day threshold; however, the construction programme might extend slightly as a result of the necessity to remove any contaminated soils. A dedicated waste management company which holds a valid Waste Collection Permit will be used for the transport of any contaminated material identified as unsuitable for onsite use. The outline Waste Management Plan states that any waste removed from the site shall be taken to facilities which hold either a valid Waste Facility Permit issued by KCC or a Waste Licence issued by the EPA.
Potential impact of excavation work on underground utilities. Potential impact of construction plant on overhead utilities	Precautions will be necessary during construction of the works in order to ensure there is no damage to any of this infrastructure. These precautions will be determined at detailed design stage in consultation with the Service Providers.
Operation Phase Only minor traffic requirements will be associated with scheme maintenance. These are not predicted to present significant residual impacts for the operational phase of the development. The scheme will result in protection from flooding for events up to the 1% AEP for a number of roads including the N7, the L6016, the L2010, the L6021 and the Killeenmore Road which will represent a very substantial improvement over the existing situation.	No mitigation measures are required.

Table 6.5: Air Quality: Summary of Mitigation Measures

Potential Impact (Air Quality)	Summary of Proposed Mitigation
Construction Phase The movement of machinery will generate exhaust fumes and subsequently contribute to potential emissions of the following compounds; oxides of nitrogen, carbon monoxide, sulphur dioxide, particulate matter (including $PM_{10}/PM_{2.5}$), volatile organic compounds (VOCs) and polyaromatic hydrocarbons (PAHs).	While concentrations of these pollutants are expected to increase in the immediate vicinity of the machines during site works it is not anticipated that they will have any impact on the air quality of the region or in turn on the sensitive receptors in the area considering the size and nature of the proposed scheme and the number of machines proposed. Proposed measures to reduce construction vehicle emissions are given below in the third section of this table.
Construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive receptors locations and whether the wind can carry the dust to these locations. Site investigations carried out have also indicated that the made ground (in the vicinity of work areas Morr 2, 3 10 and 23, Paines 1, 2, 3 and 5, and Slane 5, 6, 7 and 11) totalling approximately 17,391m³ to be excavated is comprised of re-worked gravelly clays with rare inclusions of glass, concrete fragments, timber, brick and other potentially contaminated materials. The excavation, handling, processing and transport of this material therefore have the potential to give rise to contaminated dust. The contractor may employ a mobile screen on site to sift out the larger elements of the excavated made ground material and this could also give rise to construction dust.	In order to mitigate construction dust emissions during the construction phase, a dust minimisation plan will be prepared as part of the Construction Environmental Management Plan (CEMP). The dust minimisation plan will be based upon the industry guidelines in the Building Research Establishment document entitled 'Control of Dust from Construction and Demolition Activities'. The implementation of a dust minimisation plan during the construction phase of the project will include measures such as: ▪ Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only; ▪ Any site roads with the potential to give rise to dust will be regularly watered, as appropriate, during dry and/or windy conditions (also applies to vehicles delivering material with dust potential); ▪ All vehicles exiting the site shall make use of a wheel wash facility prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Wheel washes should be self-contained systems that do not require discharge of the wastewater to water bodies; ▪ Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary; ▪ Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind; ▪ Water misting or sprays shall be used as required if particularly dusty activities, or activities generating potentially contaminated dust (associated with the excavation of made ground), are necessary during dry or windy periods; ▪ All vehicles which present a risk of spillage of materials, while either delivering or removing materials, will be loaded in such a way as to prevent spillage on to the public road; ▪ Vehicles delivering material with dust potential shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust; ▪ The Contractor will be required to ensure that all vehicles are suitably maintained to ensure that emissions of engine generated pollutants is kept to a minimum; ▪ The contractor will be required to put a mobile screen on site in areas where made ground is to be excavated, to sift out the larger elements of the spoil. This will

Potential Impact (Air Quality)	Summary of Proposed Mitigation
	minimise the generation of construction dust; ▪ Due to the transient nature of the works, it is recommended that regular inspections are carried out by the construction contractor to monitor the potential for dust deposition. Where the duration of works are estimated to be longer than 4 weeks, it is recommended that the construction Contractor monitors monthly dust deposition levels for the duration of construction using –the Berger Hoff method (German Standard VD 2119, 1972). Results should be compared to the TA Luft guidelines of 350mg/m²/day (for non-hazardous dusts). This will be applicable for works at Paines 1, Morr 4, Morr 17 and Morr 23. The monitoring is only deemed necessary where residential receptors are located within 1km of the proposed works locations. In this instance, monitoring should take place along the boundary of the location of works or at the nearest residential location. ▪ In order to minimise the likelihood of complaints, the Council and affected residents should be kept informed of the works to be carried out. A complaints procedure should be operated by the Contractor throughout the construction phase.
Construction activities will require energy resources and will generate vehicle emissions such as CO_2 which have potential to influence climate change.	A Traffic Management Plan will be prepared in advance of the construction works. This will form part of the specification for the construction works. The CTMP will outline measures to minimise congestion and queuing, reduce distances of deliveries and eliminate unnecessary loads; ▪ Reducing the idle times by providing an efficient material handling plan that minimises the waiting time for loads and unloads. Reducing idle times could save up to 10% of total emissions during construction phase; ▪ Turning off vehicular engines when not in use for more than five minutes. This restriction will be enforced strictly unless the idle function is necessary for security or functionality reasons; and ▪ Regular maintenance of plant and equipment. Technical inspection of vehicles to ensure they will perform the most efficiently. As part of the Construction Environmental Management Plan, the Contractor will be required to implement an Energy Management System for the duration of the works. This Energy Management system may include such measures as:- ▪ The use of thermostatic controls on all space heating systems in site buildings to maintain optimum comfort at minimum energy use; ▪ The use of sensors on light fittings in all site buildings and low energy lighting systems; ▪ The use of adequately insulated temporary building structures for the construction compound fitted with suitable vents; ▪ The use of low energy equipment and "power saving" functions on all PCs and monitors in the site offices; ▪ The use of low flow showers and tap fittings; and ▪ The use of solar/thermal power to heat water for the on-site welfare facilities and contamination unit (sinks and showers). ▪

Potential Impact (Air Quality)	Summary of Proposed Mitigation
Operational Phase No energy requirements will be associated with the proposed scheme post construction and as such there are no scheduled emissions planned for the scheme. Therefore it is not envisaged that the proposed scheme's operation will have any significant impacts on air or climate.	There will be no operational phase impacts on air quality/climate as a result of the proposed scheme.

Table 6.6: Noise: Summary of Mitigation Measures

Potential Impact (Noise)	Summary of Proposed Mitigation
Construction Phase The most noticeable noise impact will occur during general construction activities associated with the proposed scheme. During the construction phase the majority of works to be undertaken will comprise of site preparation works, involving use of earth moving and excavation equipment. There are a number of noise sensitive receptors located adjacent to the proposed work areas where embankments and new walls will be constructed. Site investigations have indicated that the made ground present in the vicinity of the following work areas (Morr 2, 3, 10 and 23, Paines 1, 2, 3 and 5 and Slane 5, 6, 7 and 11) totalling approximately 17,391m³ to be excavated is mainly comprised of re-worked gravelly clays with rare inclusions of glass, concrete fragments, timber, brick, and other potentially contaminated material. For this reason, the contractor may employ a mobile screen on site to sift out the larger elements of the spoil. There will also be additional traffic noise generated by construction site traffic, which will include HGV movements associated with the delivery of the earthworks, which would have potential for a noise impact along the haul routes to the site.	Reference will be made to BS 5228-1: 2009: *Code of Practice for Noise and Vibration Control on Construction and Open Sites: Noise*, which offers detailed guidance on the control of noise and vibration from demolition and construction activities. The following proposed practices will be adopted during construction and will be outlined in the Construction Management Plan, including: ▪ The normal working hours for the construction of this scheme will be 7.30am – 4:30pm Monday to Friday. Working hours may be extended to 7.00am - 7.00pm Monday to Friday; and 9.00am and 4.00pm on Saturdays on occasion. There will be no activity on Sundays or Bank Holidays. Where additional or alternative working hours outside those stated above are required, these will require notification to Kildare County Council and to be agreed in advance;; ▪ All construction related traffic should only use the designated and approved haul routes; ▪ Provision of a 2.4m high hoarding should be provided around constractor's compound; ▪ A mobile system of screens or temporary hoarding should be placed close to the noisy construction works within embankment areas to provide acoustic screening in locations with residential properties in close proximity to construction works; ▪ The contractor will be required to put a mobile screen on site in areas where made ground is to be excavated to sift out the larger elements of the spoil. This will minimise the generation of construction dust and noise. ▪ Establishing channels of communication between the client/ contractor, Kildare County Council and residents through implementation of a communications procedure for noise and vibration related issues; ▪ Appointing a site representative responsible for matters relating to noise and vibration; and ▪ Monitoring typical levels of noise and vibration during critical periods and at sensitive locations. Furthermore, it is envisaged that a variety of practicable noise control measures will be employed. These may include: ▪ Selection of plant with low inherent potential for generation of noise and/ or vibration; ▪ Erection of enclosures as necessary around noisy processes and items such as generators, heavy mechanical plant or high duty compressors; and ▪ Placing of noisy/ vibratory plant as far away from

Potential Impact (Noise)	Summary of Proposed Mitigation
	sensitive properties as permitted by site constraints and the use of vibration isolated support structures where necessary. It is also recommended that periodic noise monitoring be undertaken during the initial construction phase to determine noise levels at noise sensitive receptors, in particular during 'noisy' activities. If the recommended noise exposure levels are exceeded, further mitigation measures will be employed including temporary enclosures or screens around particularly 'noisy' plant.
Potential sources of vibration during typical construction projects include rock-breaking equipment, sheet piling machinery, excavators, dump trucks and HGVs.	▪ It has been identified that sheet-piling will not be used during the construction works. If this changes during detailed design and sheet piling is undertaken of the flood defence walls as part of the proposed scheme, vibration measurements will need to be carried out at any requisite monitoring points in the vicinity of residential properties. The chosen locations will be agreed in advance with Kildare County Council. This would help to ensure that any vibration generated by the construction of the proposed scheme would not give rise to nuisance in the vicinity of the proposed scheme. If vibration-monitoring results were to indicate that levels were approaching the standard limits, appropriate mitigation measures will need to be put in place to ensure that vibration levels were reduced to acceptable levels. ▪ It is proposed that vibration monitoring will be carried out for all properties in close proximity to construction works and haul routes. Precondition surveys will be carried out at residential properties in close proximity to the construction works and haul routes. Survey and monitoring locations will be identified during detailed design and agreed with residents/owners as part of the CEMP in advance of the construction works. The vibration limits for the duration of the construction works are set out in Table 8.3 and represent the allowable vibration in order to minimise the risk of building damage. Specifically, Noise & Vibration levels shall be kept below those levels specified in Table 8.3, or if further limits are imposed by the Local Authority. ▪ A programme of noise monitoring and vibration (if required) at sensitive receptors will be detailed by the Contractor prior to works beginning. This will allow for a constant review of noise and vibration (if required) levels generated by the construction of the proposed scheme and will highlight the need for further mitigation measures should they be required
Operational Phase There is no significant noise impact predicted to be emitted from the operational phase of the proposed scheme. Maintenance requirements will consist of clearing the overgrowth from the river banks and embankments in addition to removing debris from the rivers, embanked areas and culverts and will be completed on an annual basis, as required.	No mitigation measures are necessary.

Table 6.7: Landscape and Visual: Summary of Mitigation Measures

Potential Impact (Landscape and Visual)	Summary of Proposed Mitigation
Construction Phase Potential construction stage impacts relate to the following: (i) Obstruction of views; (ii) Change in landscape character; (iii) Machinery for site preparation/enabling works and operations; and (iv) Site access and vehicular and plant movements. The proposed scheme has lengths of both flood walls and embankments extending to approximately 2.00m in height. The construction of flood walls will be required at certain locations particularly in proximity to properties. The proposed scheme will result in loss of riverside vegetation at some locations.	The impact of the proposed scheme should be ameliorated through a landscape rehabilitation plan, prepared in conjunction with the engineering design which would, in time, go some way to insuring integration of the proposals into the broader environment. Given the nature of the proposals, particular mitigation measures shall be incorporated as part of the proposed scheme. A list of objectives in terms of mitigation for visual quality and landscape character shall include the following for the construction and operational stage. ▪ Materials chosen for flood wall construction to be of similar colour, size and scale to existing flood walls within the locality. Walls where visible at roadsides will be masonry stone faced and where appropriate stone capped; ▪ Temporary storage heaps associated with infill materials and soil not to exceed 1m height; ▪ Storage compound areas will be reinstated to former agricultural use upon completion of the works. ▪ Vehicles exiting compound areas will be subject to wheel wash facilities or road sweepers shall be used in order to maintain clean roads; ▪ Any lighting used will be kept to a minimum, providing for site safety only and shall be directed into the compound and away from adjacent residential properties. Lighting shall be shielded to avoid light spill onto adjacent properties and roads. ▪ Fencing used around site offices, welfare units and parking within the compound areas shall be painted green in order to merge with surrounding landscape. ▪ Construction of Embankments. The embankments will be planted with grass; ▪ Protection of existing trees. The services of a qualified aboriculturist will be sought to perform a tree survey of the proposed scheme. The trees should be assessed to quantify their age, condition and amenity value and tagged with metal tags. Prior to commencement of construction, existing trees which are to be retained will be protected by erection of timber post and wire fence to ensure no works are carried out under reach of their canopies. Unstable trees should be removed under direction of the aboriculturist; ▪ Ensuring landscape framework remains dominant by cleaning up of debris on river banks and providing a landscape management programme to protect and reinforce bank side vegetation.
Operational Phase The key potential direct impact on the landscape is from the positioning of new vertical flood walls and embankments and loss of any vegetation as permanent features in this landscape. There are existing flood embankments at locations within the wider Morell floodplain and therefore such features are not uncharacteristic of this landscape. The permanent loss of vegetation will have localised but significant impacts at locations, particularly at Morr 2; Morr	▪ Ensuring the landscape management programme identified previously is implemented during the lifetime of the proposed scheme to protect and reinforce bank side vegetation with the aim of ensuring landscape framework remains dominant; and ▪ Ongoing landscape maintenance and debris cleaning from the river channel.

Potential Impact (Landscape and Visual)	Summary of Proposed Mitigation
7; Morr 20-23; and Slane 1-4. The new flood walls and embankments will read as part of the wider landscape from most locations.	

Table 6.8: Terrestrial Ecology: Summary of Mitigation Measures

<table>
<tr><th>Potential Impact (Terrestrial Ecology)</th><th>Summary of Proposed Mitigation</th></tr>
<tr><td>Construction Phase</td><td>It is recommended that a Construction Manager with appropriate experience and expertise be employed for the duration of the construction phase to ensure that all the mitigation measures outlined in relation to the environment are implemented. This manager will be awarded a level of authority and will be allowed to stop construction activity if there is potential for adverse environmental effects other that those predicted in the EIAR. In addition a Project Ecologist will be appointed to assist with potential ecology queries as they may arise during the course of the project.</td></tr>
<tr><td>There is potential for indirect impacts as a result of run-off from construction areas, eutrophication and sedimentation decreasing water quality in the Grand Canal pNHA.</td><td>The effective protection of water quality within the proposed scheme during the construction and operation phases will minimise the risk to the ecological interests of this site and other water bodies within the Morell catchment. The measures outlined in Table 15.7 below to ensure protection of water quality during operation, along with the requirement to implement current best practice for works at the time of maintenance will ensure the protection of waterbodies.</td></tr>
<tr><td>The proposed scheme will involve the construction of c. 7683m of new embankments, potential restoration works to c. 1843m of existing embankments, construction of c.544m of new flood walls, c. 100m of stream alignment (over two areas) and a number of culvert upgrades. Construction activities and site clearance could lead to direct loss of habitats and disturbance through trampling or damage by machinery. There will be a permanent loss of habitat in the footprint of any new flood alleviation measures, although impacts arising from disturbance to habitats would last longer than the construction period, it is likely to be reversible in time once construction ceases allowing the habitat to re-establish in the vicinity of the proposed scheme.</td><td>General mitigation will involve implementation of best practice, such as the OPW's Standard Operating Procedures for Arterial Drainage Maintenance Service (OPW, 2011).
Works shall be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle. Effective measures to prevent silt runoff will be in place at the foot of each embankment as it develops and for a settling period following completion.</td></tr>
<tr><td>Wet Grassland and Marsh
Scheme measures Morr 4, Morr 7, Morr 8, Morr 15 and Morr 17 will involve c. 400m of walls and embankment to be built on Wet Grassland and Marsh habitat, and a stream diversion adjoining the habitat, constituting direct habitat removal.</td><td rowspan="3">Where construction activity takes place in habitat types that are identified as sensitive ecological receptors it is important that construction activity is restricted to the footprint required for development of the proposed scheme measures. Therefore, the proposed works area must be clearly demarcated with temporary fencing or another suitable method to restrict access to areas outside the necessary working area. When establishing central base compounds and access tracks, vegetation should only be removed where absolutely essential.
The implementation of the proposed scheme will not result in the drying out of wet grassland and marsh habitat. Therefore, no indirect impacts are anticipated. The embankments will be positioned in relatively species poor areas of wet grassland. Therefore the loss of wet grassland habitat is not deemed to be significant.</td></tr>
<tr><td>Riparian Woodland
Scheme measures Slane 8 will involve the realignment of a small section of the stream to remove a sharp bend. Although this will largely involve the direct removal of improved agricultural grassland to dig the realignment channel, there may be a very small portion of riparian woodland removed at either end of the new channel.</td></tr>
<tr><td>Mixed Broadleaved Woodland
Scheme measure Morr 3 will likely involve the removal of a small area of Mixed Broadleaved Woodland habitat c.</td></tr>
</table>

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
<30m in length, immediately adjoining the south side of Turnings Upper road on western bank of River Morell.	No further mitigation is required. ▪ The stream realignment at Slane 8 will encourage the establishment of riparian woodland within in the old stream alignment lands. Therefore the loss of a very small section of riparian woodland is not deemed to be significant. No further mitigation is required ▪ The *Mixed Broadleaved Woodland* habitat at Morr 3 was not classified as semi-natural habitat and the loss of a very small portion is not deemed to be significant. No further mitigation is required.
Treelines, Hedgerows and Scrub Scheme measures Morr 1-6, Morr 8 - 10, Morr 15-23, Paines 1, 2, 4 & 5, Kill 1, Slane 1-6 and Slane 9 will necessitate removal of small sections of treelines, hedgerows and scrub where the proposed scheme embankments, walls and stream realignments will cross field boundaries. Some scrub/ tree removal may also be required at the junction of Killeenmore Road and the L2010 for haulage routes accessibility. In the absence of mitigation, the loss of these habitats could result in a permanent, irreversible, negative impact significant at the local level.	▪ Trees, hedgerows, treelines, woodland and scrub shall be retained intact where possible. Trees located adjoining/adjacent to the construction/compound areas shall be protected from root damage by machinery by an exclusion zone of at least seven metres or equivalent to canopy height. Such protected trees shall be fenced off by adequate temporary fencing prior to other works commencing. NRA guidelines on the protection of trees and hedges prior to and during construction should be followed (NRA, 2006d). No soil, spoil, construction materials or rubbish will be stored or tipped and no construction plant or vehicles will be parked within the spread of existing trees, shrubs or hedges. ▪ Where treeline, hedgerow or scrub removal as part of the proposed scheme was unavoidable, a new native planting scheme should be implemented to function as replacement habitat for that removed.
Invasive Species Invasive species can be introduced into a location or spread from a location by contaminated vehicles and equipment, in particular tracked vehicles which have been used previously in locations that contained invasive alien plant species. They can also be spread to a location via vector materials such as soil. Therefore, construction works for the scheme measures have the potential to introduce invasive alien plant species into the proposed scheme area. In the absence of mitigation this could result in a long term reversible negative impact significant at the local level.	The introduction of invasive alien plant species (including Japanese Knotweed (*Fallopia japonica*)) will be avoided during the construction and operation phase of the proposed scheme by ensuring that appropriate precautionary measures are in place. ▪ Prior to undertaking any construction works of the various scheme measures, or establishing central base compounds and access tracks, the OPW shall engage a suitably qualified ecologist to carry out an invasive plant species survey, in the appropriate botanical season (April through to September). This should entail a walkover of each location of the proposed scheme measures due for construction in that phase, to identify any stands of invasive plants species that may have become established in the intervening period between the EIA surveys and construction. Particular attention should be given to identifying those invasive plant species listed on the Third Schedule of the Birds and Natural Habitats Regulations 2011 (as amended). If any invasive alien plant species are identified then the suitably qualified ecologist shall outline the appropriate course of action to be taken with regard to treatment during construction works. ▪ All plant and equipment employed on the construction/compound sites (e.g. excavator, footwear, etc.) must be thoroughly cleaned down using a power washer unit and washed into a dedicated and contained area prior to arrival on site to prevent the spread of invasive aquatic / riparian species such as Japanese Knotweed *(Fallopia japonica)* and Himalayan Balsam *(Impatiens glandulifera).* A sign off sheet must be maintained by the contractor to confirm cleaning. ▪ The treatment and control of invasive alien species will follow *Guidelines for the Management of Noxious*

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
	Weeds and Non-Native Invasive Plant Species on National Roads (NRA 2010), and any other best practice guidance which may become available in the interim. ▪ For any material entering the site, including all fill material, the supplier must provide an assurance that it is free of non-native invasive species. ▪ Should any invasive plant species be encountered, the infested areas will be clearly demarcated accounting for potential underground rhizome spread, creating an exclusion zone. ▪ Ensure all site users are aware of invasive species management plan and treatment methodologies. This can be achieved through "toolbox talks "before works begin on the site. ▪ Adequate site hygiene signage should be erected in relation to the management of non-native invasive material.
Badger Potential badger setts/mammal burrows were identified in the vicinity of scheme measures Morr 1a, Morr 3, Morr 4, Morr 6, Morr 18 and Slane 9. The construction of the proposed scheme could result in direct destruction of setts via excavation for embankment/wall construction or via machinery driving over setts en route to the construction area.	Precise mitigation measures for badger will be informed by a badger survey prior to construction works commencing on each phase of the development (including establishing central base compounds, satellite sites and access tracks) to identify setts and confirm the level of activity and breeding status of setts/mammal burrows at that time. The following measure is proposed: ▪ Prior to construction works commencing on each phase of the development (including establishing central base compounds, satellite sites and access tracks) the Contractor will engage the services of a suitably qualified ecologist to conduct a badger survey of the proposed scheme measure areas and all access routes. This shall be undertaken to NRA (2006a) specifications, and no more than 10 months in advance of construction; ▪ If an active sett is encountered, mitigation measures as outlined in national guidelines *Guidelines for the Treatment of Badgers Prior to the Construction of National Road Schemes* (NRA, 2006a) will apply. In brief these are, but are not limited to: ◻ During the breeding season (December to June inclusive) a clearly marked exclusion zone of 50m should be established around the active sett and no works should take place within this exclusion zone; ◻ Outside of the breeding season (July – November inclusive) a clearly marked exclusion zone of 30m should be established around the active sett and no heavy machinery used within this exclusion zone. Lighter machinery (wheeled vehicles) should not be used within 20m of a sett entrance and light work such as digging by hand should not take place within 10m of a sett entrance; ◻ Any works in and around setts must be supervised/carried out by a suitably qualified and experienced ecologist; ◻ If the above detailed exclusion zones cannot be adhered to and disturbance to setts is deemed likely during construction works then the local NPWS Ranger will be contacted. This may require an application for a derogation licence from the NPWS to exclude the sett. If required, any further mitigation measures required will follow those outlined in NRA (2006a) and will be agreed with the NPWS at the time

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
	of licence application.
Bat A number of trees and treelines were identified as having low to moderate bat roost potential, which could be affected by scheme measures Morr 1, Morr 1a, Morr 16, Morr 16a, Morr 17, Morr 18, Morr 20-23, Paines 1, Paines 5, Kill 1 and Slane 9. One building near Killeenmore was identified as having low bat roost potential, located near Morr 16-16a. In the absence of mitigation, if any of these trees/treelines and buildings supported bat roosts and had to be removed as a result of the construction works, there would be potential for bat mortality. This could result in a short term negative impact, significant at a local level. Hedgerows, treelines and rivers act as commuting corridors for bats in the landscape. The proposed scheme requires the removal of some hedgerows and treelines for creation of the scheme measures. Temporary negative impacts are likely but are not expected to be significant at a local level.	As no bats have so far been identified as roosting within the study area no specific mitigation in relation to roost loss is recommended. In the unlikely event that bats are found on the site during construction works, works will immediately cease in that area and the local NPWS Conservation Ranger will be contacted. The bats will be removed by hand by a suitably qualified and licenced bat surveyor. A number of trees/treelines, buildings and bridges in the proposed scheme area were identified as potential bat roots and the following mitigation applies. ▪ Where possible, trees, treelines and woodland shall be retained. Any existing trees adjacent to the works, construction sites or compounds to be retained shall be protected from root damage by machinery by an exclusion zone of at least seven metres or equivalent to canopy height. Such protected trees shall be fenced off by adequate temporary fencing prior to other works commencing. ▪ Any trees requiring removal to facilitate construction works, establishment of compounds or access tracks, must be subject to a visual inspection by a suitably qualified and licenced bat surveyor to identify bat roosts potential and advise on additional surveys required. If potential bat roosts are identified then bat activity surveys at such trees will be required. If bats are found, the suitably qualified and licenced bat surveyor will advise on the appropriate course of action, including the need for application for a derogation licence from the NPWS. ▪ All trees requiring removal in the proposed scheme area should be felled and left in place on the ground for 24 hours prior to removal/disposal to allow any bats beneath foliage to escape overnight. ▪ Should the removal of mature broadleaved trees be unavoidable, it is recommended that two bat boxes, of Schwegler Type 1FF flat box, for each felled mature broadleaved tree shall be attached to suitable alternative trees in order to compensate for the loss of potential roosting space. The bat box locations and supervision of installation of same shall be carried out by a suitably qualified ecologist in line with best practice measures. ▪ One abandoned cottage and associated outhouses was identified in Killeenmore adjacent to scheme measures Morr 16 and Morr 16a. Although not identified as requiring removal for construction for the proposed scheme, adopting a precautionary approach, in the event that demolition or other construction works on the abandoned cottage and associated outhouses are required, the Contractor will refer to the mitigation outlined in section 10.5.1 of the EIAR. ▪ No construction or upgrade works to bridges have been identified for the proposed scheme, rather the works identified are either in relation to culverts but that may be associated with bridges, or embankment/wall tie ins to bridges which will not affect the underside of the bridge structure. However, adopting a precautionary approach, mitigation has been specified for any works to culverts or bridges adjoining or adjacent to culverts

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
	to ensure that any potential disturbance to potential roosting bats is considered prior to construction activities commencing and in the event that any works to bridges becomes apparent during construction. ▪ The bridge must be subject to a visual inspection by a suitably qualified and licenced bat surveyor to identify bat roost potential and advise on additional surveys required. If potential bat roosts are identified then bat activity surveys will be required. If bats are found, the suitably qualified and licenced bat surveyor will advise on the appropriate course of action, including the need for application for a derogation licence from the NPWS. ▪ Lighting should be avoided where possible. If any external lighting is required to facilitate night time working, security lighting in the proposed works areas or within the central base compounds, it must be sensitive to the presence of bats in the area. Directional lighting shall be used to prevent overspill. Lighting levels should be the minimum required for health and safety requirements, and vertical light spill at light sources should be below 3m to avoid potential bat flight paths. ▪ Existing hedgerows and treelines, semi-natural scrub or semi-natural grasslands should be retained where possible and incorporated into the landscaping programme. Where hedgerow or treeline removal is unavoidable, the severed linear features should, where possible, be reconnected using native hedgerow or tree species to compensate for the loss of hedgerows that are currently used by bats. The exact locations of such planting will be designed at detailed landscaping stage. Treelines are of far greater benefit to bats than single, free-standing trees or shrubs as they provide corridors for movement, avoidance of light and predators, a better shelter belt for the clustering of insects and provide greater substrate for insect breeding and feeding (bats food source). Native species of broadleaved trees are generally more beneficial to bats.
Other Mammals It is likely that Pygmy shrew and Hedgehog occur in hedgerows, woodlands and grasslands. The proposed scheme will involve the removal of sections of these habitats in a number of locations. In the absence of mitigation, if the species were present then negative impacts could arise via direct mortality or disturbance. As a relatively widespread mobile species, it is considered likely that both Pygmy shrew and Hedgehog could re-establish in adjacent habitats and that the proposed scheme is extremely unlikely to negatively affect the conservation status of the species locally. Therefore it is unlikely that a significant impact would arise.	No mitigation measures are necessary
Amphibians In the absence of mitigation, there could be a negative impact on amphibians through direct mortality during construction works. It is considered likely that this short term impact could negatively affect the conservation status of frogs locally.	▪ The Construction Manager and Project Ecologist shall maintain a watching brief for frog spawn and frogs throughout construction works. If frog spawn is identified, this should be translocated to an alternative suitable habitat under derogation licence from the NPWS.
Birds If vegetation clearance and/or building demolition is carried out during the breeding bird season (i.e. from the 1st March to the 31st August), there is the potential for significant negative impacts to local breeding bird	▪ To limit the potential impact of construction on breeding birds, vegetation removal/trimming (including trees, treelines, hedgerow, woodland and) will not be permitted during the breeding bird season (1st March to 31st August inclusive). If this seasonal restriction cannot

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
populations. During the breeding season noise, vibration, increased human presence and movement of construction vehicles associated with the construction phase of the proposed scheme has the potential to result in a disturbance to local breeding bird populations. This could result in reduced breeding success of birds in habitats adjacent to the construction zone and could potentially impact on the conservation status of bird species locally. Therefore a significant effect at a local level is concluded. The construction of the proposed scheme will require the removal of hedgerows, trees, treelines, scrub and some woodland. It may also involve the removal of some buildings/structures. These habitats have the potential to provide breeding habitat for birds. Removal of these areas of habitat during the breeding bird season could potentially impact on the conservation status of bird species locally.	be accommodated, a suitably qualified ecologist with experience in nest-finding will be required to check all vegetation for nests (under licence from NPWS to permit potential disturbance to nesting birds) prior to removal/trimming.
Operational Phase During the operational phase of the proposed scheme there will be considerably less site activity than during the construction phase. Maintenance will be carried out to maintain the completed flood relief scheme in proper repair and effective condition. This may mean, inter alia: ▪ Clearing obstructions to flows from time to time e.g., fallen trees, significant weed growth, build-up of materials likely to impact on the performance of the scheme; ▪ Repairing and rebuilding structures (walls and embankments); and ▪ Prevention of erosion/undermining of the completed works of the proposed scheme.	▪ General mitigation will involve implementation of current best practice for riparian works at the time of maintenance, e.g. the OPW's Standard Operating Procedures for Arterial Drainage Maintenance Service (OPW, 2011) or any subsequent updates. ▪ No additional mitigation measures are required.
Maintenance works for the proposed scheme located in the vicinity of the Grand Canal may be hydrologically connected to the Grand Canal via wet field drains and/or wet ditches. There is potential for indirect impacts as a result of run-off from construction areas, eutrophication and sedimentation decreasing water quality in the Grand Canal. This may in turn impact on the aquatic species therein. In the absence of mitigation this could result in a temporary, reversible negative impact.	▪ The effective protection of water quality within the proposed scheme during the construction and operation phases will minimise the risk to the ecological interests of this site and other water bodies within the Morell catchment. The water quality mitigation measures for avoidance, reduction and remediation of impacts outlined in Table 17.7 below and the he requirement to implement current best practice for works at the time of maintenance will ensure the protection of waterbodies.
Once completed, areas from which vegetation was removed will gradually re-vegetate through succession. Some smaller areas of arable land, amenity grassland and broadleaved woodland will also be subject to reduced flooding. This is unlikely to result in any significant changes in species composition as these areas will still be subject to periodic flooding, albeit reduced. New flooding areas and the 1% AEP floodplain are also mainly located in areas of agricultural grasslands (and associated hedgerows and treelines) and buildings and artificial surfaces (mainly associated with residential dwellings). Some smaller areas of habitat located within the flood area include arable land, amenity grassland, wet grassland, scrub, broadleaved and riparian woodland will also be subject to reduced flooding. This is unlikely to result in any significant changes in species composition as much of these areas will only be subject to periodic flooding.	No mitigation measures are necessary
Maintenance work poses a potential risk of introducing invasive species, via contaminated vehicles and equipment. In the absence of mitigation this could result	▪ Prior to undertaking any maintenance works along the scheme measures, the OPW shall engage a suitable

Potential Impact (Terrestrial Ecology)	Summary of Proposed Mitigation
in a long term reversible negative impact, significant at the local level.	qualified ecologist to carry out an invasive plant species survey, in the appropriate botanical season (April through to September) and in advance of any maintenance works. This should entail a walkover of the scheme measures due for maintenance works to identify any stands of invasive plants species that may have become established in the intervening period between construction and maintenance. Particular attention should be given to identifying those invasive plant species listed on the Third Schedule of the Birds and Natural Habitats Regulations 2011 (as amended). If any invasive alien plant species are identified then the suitably qualified ecologist shall outline the appropriate course of action to be taken with regard to treatment during maintenance works. ▪ Specific mitigation measures in respect of invasive species are as per those stated for the construction phase above.
In the absence of mitigation, there could be a negative impact on badger through direct destruction or disturbance to badger setts during maintenance works. It is considered likely that this short term impact could negatively affect the conservation status of badger locally.	▪ Prior to undertaking any maintenance works along the scheme measures, the OPW shall engage a suitably qualified ecologist to assess the potential ecological impact of the maintenance works (including but not limited to badgers, bats, otters, bird, water quality and invasive species) and identify potential constraints. Dependent on the extent of the works, this may require a survey of the scheme measures due for maintenance works to confirm presence/absence of species and to identify potential impact pathways that may exist between the maintenance works, access routes and flora and fauna. ▪ The ecologist should be engaged in advance of works to allow adequate time for survey, monitoring if required, and developing measures to avoid ecological impacts where possible, and to propose mitigation measures for those impacts that cannot be avoided. Where appropriate, construction methodology for maintenance works should detail how water quality will be maintained throughout the maintenance works. All mitigation measures outlined should be in line with current best practice and national guidelines
In the absence of mitigation, there could be a negative impact on bats through direct destruction or disturbance to bat roosts in trees or works to bridges during maintenance works. Maintenance works could result in a short term negative impact on the conservation status of bats locally.	
In the absence of mitigation, there could be a negative impact on amphibians through direct mortality during maintenance works. Wet areas that host frogs and frog spawn could be directly trampled by machinery. Removal of bank side vegetation also has the potential to result in direct mortality of frogs that utilise this habitat. It is considered likely that this short term impact could negatively affect the conservation status of frogs locally.	
Maintenance works requiring the removal of vegetation such as scrub and trees during the breeding bird season (i.e. from the 1st March to the 31st August), have the potential for significant negative impacts to local breeding bird populations. During the breeding season noise, vibration, increased human presence and movement of vehicles associated with the maintenance of the proposed scheme has the potential to result in a disturbance to local breeding bird populations. This could result in reduced breeding success of birds in habitats adjacent to the maintenance area and could potentially impact on the conservation status of bird species locally. Therefore a significant effect at a local level is concluded.	

Table 6.9: Aquatic Ecology and Environment: Summary of Mitigation Measures

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
Construction Phase The proposed scheme has been identified as potentially giving rise to adverse effects on aquatic ecology and other natural resources such as water quality and substrate condition of the Morell River catchment and therefore the overall biodiversity of the area.	▪ Standard pollution control and mitigation measures, as outlined in Table 11.21 of the EIAR, will be employed where relevant when working in and near the watercourses affected by the proposed works, to prevent the transport of deleterious substances to the Morell River Catchment and its associated water-dependent habitats and species. The CEMP and Method Statements will include how these mitigation measures will be monitored for effectiveness. An outline water quality monitoring plan has been included in the draft CEMP but this will be developed by the contractor and a detailed programme of water quality monitoring, will be agreed with the IFI. ▪ Direct instream works such as stream alignment, culvert upgrades or proposed measures along the riverbank have the greatest potential for negative impacts during spawning / breeding and early nursery periods for aquatic protected species in the study area. **No instream or potentially significantly damaging out of river works should occur during restricted periods for relevant species in relation to individual measures (Table 11.22 of the EIAR).**
Haul routes, access roads and parking areas can generate significant quantities of water polluted with sediment. During heavy rainfall surface run-off can erode the surface of the haul route. The tracking of plant and machinery across wet or saturated soil can also loosen and mobilise additional sediment.	▪ Surface water should be directed away from haul routes to prevent uncontaminated run-off flowing onto the road. Excess water should be prevented from running along haul routes by installing small earth bunds (like speed bumps) or cut-off ditches at regular spacing to direct water into roadside ditches. ▪ Where haul routes cross watercourses, adopt measures to prevent sediment-laden run-off from entering them, e.g. ensuring crossing structures have edge upstands or bunds eg straw bales, sandbags or earth; and making sure bridge decks are sealed. ▪ Water polluted by sediment should not be allowed to leave the site untreated; polluted run off should be routed for treatment by filtration, settlement or specialist techniques. ▪ Where inlets to existing surface water drainage are present on- site (eg road gullies or yard drains), they should be protected them from run-off polluted with sediment. Water should be diverted away from the inlet to treatment facilities. Where this is not possible, a bund should be created around the surface water drain to prevent contaminated water entering.
There is potential for the release of sediment during the construction phase. The potential for sediment loss would primarily arise as a result of earth movement and excavation associated with the placement of embankments and defence walls, particularly those proposed along riverbanks. Such an impact would be more likely during very heavy rain giving to slumping of the bank edges or run-off of silt-laden water.	▪ Works should be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle. ▪ Embankment material should be selected that has low silt content. ▪ All working materials and excavated material should be stockpiled on the land side of the works within the assigned 15m temporary working area. ▪ Where embankments which are within 10 metres of a river, sediment barriers, e.g. silt fencing, should be used on the river side to minimise the potential for sediment transport. Once the embankment is complete the

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
	sediment should be left in-situ to allow the reinstated ground around the wall to settle in. The sediment barriers should only be removed after inspection of the reinstated ground confirms that it is stable.
There is potential for the release of sediment during instream works and in particular stream realignments. Sediment loss can give rise to increased bottom sedimentation, which, in turn, can adversely impact macroinvertebrates and aquatic habitat quality. Elevated suspended solids levels within the water column can impact on the the gills of salmonid fish, white-clawed crayfish and benthic macroinvertebrates and can smother fish spawning areas when deposited. Plumes of silt could result in a reduced food supply for otters- i.e. where reductions in water quality affect macro-invertebrate diversity and abundance and fisheries production or temporarily displace fish from sections of channel.	▪ All instream works should adhere to timing restrictions for aquatic protected species of the Morell Catchment (Table 11.22 in Chapter 11). ▪ Operation of machinery instream should be kept to an absolute minimum. ▪ All construction machinery operating instream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. ▪ In-stream works will be carried out outside of the salmonid spawning season and the times that early life stages of salmonid fish will be present. In-stream work within the period 1st October to 1st May (inclusive) will only be undertaken with the advanced approval of Inland Fisheries Ireland. ▪ Stream realignments shall be carried out in accordance with the recommendations within the document '*Requirements for the protection of Fisheries Habitat during construction and Development Works at River Sites'* (ERFB, 2003). Method Statements will be prepared by the Contractor and approved; ▪ Stream diversions will be excavated in the dry to an agreed specification. Fish will need to be removed from the impacted section of the existing channel being diverted at Slane 8 in advance. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended). ▪ During realignment works on the Slane River, contractor SOPs will be applied to respond in the case white-clawed crayfish are present and emerge from refuges at the times of stream realignment. In the event that significant populations of white clawed crayfish emerge, advice will be sought from IFI and NPWS to facilitate any necessary rescue and relocation. ▪ The banks and bed of the new channel will be lined with a biodegradable geotextile; ▪ The stream diversions will have a natural stream bed and will replicate insofar as practicable the stream bed material characteristics of the watercourse. ▪ Bungs will be fixed at both ends of the existing channel and removed in a controlled manner at IFI's direction ensuring the river flow remains uninterrupted from above to below the works. ▪ Effective silt management measures should be placed in stages downstream of the new channel in advance of opening the channel. These will be specified by the Contractor in the Method Statement and agreed with IFI, but the currently proposed measure would be triple silt curtains derived from Terram or other similar material, which would be placed in stages downstream of the confluence with the new channel to first filter out the heaviest of materials and subsequently the finer material. These would need to be checked on a regular basis with the heavy material removed from the first silt curtain thereby keeping it functional. A procedure will need to be included in the Method

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
	Statement for the removal of the silt barrier on a staged basis, as even these preventative measures will lead to a build up behind the curtain. The curtain nearest to the point of works should be removed first followed by the others; ▪ The design and construction of new channel with natural habitat characteristics will where possible replicate the existing and will incorporate riparian vegetation and other natural features such as meanders. This will require importation of various grades of stone and gravel to construct habitat features e.g. riffles, pools and gravel areas. Materials from original channel may be re-used to minimise quantities of new material required.
There is potential for the release of sediment and other pollutants during culvert alteration works.	▪ All instream works should adhere to timing restrictions for aquatic protected species of the Morell Catchment. ▪ Works should be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle. ▪ In-channel works for upgrades on Culverts 5, 9, 10 and 22 and, where relevant, 1, 2, 4, 4a, 7, 18 & 19 will use cofferdam type construction whereby flow can be restricted allowing the civil engineering works to be undertaken in the dry. Method statements for the construction of cofferdam structures should be agreed in advance with IFI personnel in advance of construction works. ▪ The Morell River (Cul 5) and Painestown River (Cul 9 & 10) should be electro fished downstream of the proposed works in advance of any works to assess whether there are any fish or lamprey ammocoetes in the affected channels as advised by IFI. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended); ▪ If there is significant water ingress into the cofferdam (dependant on river levels), an approved pumping and settlement system will be set up. Pumps will transfer accumulated standing water into a settlement tank, or tanks, which in turn will discharge into a 'silt buster' or 'dirt bag' prior to being returned to the watercourse, to minimise the discharge of suspended solids into the watercourse. Water quality monitoring will be carried out to monitor the effectiveness of the mitigation measures. ▪ Headwalls for Cul 5, Cul 9 and Cul 10 should be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete; ▪ For proposed works on Cul 5, Cul 9 and Cul 10, and, where relevant Culverts 1, 2, 4, 4a, 7, 18 & 19 effective silt management measures should be placed in stages down-stream of the new channel, in advance of commencing culvert alterations. The proposed measures are as per the mitigation for stream realignment above and will bewill be specified by the Contractor in the Method Statement and agreed with IFI. A procedure will also need to be included in the Method Statement for the removal of the silt management measures.
There exists the risk of sediment loss from stockpiled	▪ The compounds have been selected to be located away

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
construction materials held within the temporary working areas associated with each of the various measures and also stored at the larger stockpiling/compound areas that will be established for the project beside Paines 3, Morr 19 and Morr 23 as illustrated in Figure 11.1. Haul routes, access roads and parking areas can generate significant quantities of water polluted with sediment. Being temporary in nature, they are often formed by simply stripping topsoil and grading the subsoil to suit. This means that during heavy rainfall surface run-off can erode the surface. The tracking of plant and machinery across wet or saturated soil can also loosen and mobilise additional sediment.	from vulnerable watercourses (or, in the case of Paines 3, separated from them by existing embankments) and outside the flood plain to reduce the risk of sediment mobilisation. ▪ Stockpile run-off must be prevented from entering drains, ditches and watercourses. ▪ Surface water should be directed away from exposed soils. ▪ Diversion drains should be implemented on the upstream/upslope side of the stockpile area. Drains should be lined with a non-erodible material such as turf/geotextiles. ▪ Bunds should be placed around exposed soils. This will prevent clean water entering the area and dirty water from leaving the area. Bunds should be made of non-erodible material such as straw bales/geotextiles. ▪ Water polluted by sediment should not be allowed to leave the site untreated; polluted run off should be routed for treatment by filtration, settlement or specialist techniques.
There is a potential for the loss of cement or hydrocarbons such as diesel and hydraulic fluids during the construction phase particularly at locations proposed for defence walls along select riverbanks of the Slane and Kill (EIAR REF: Slane 1, Slane 4 & Kill 1) as well as construction of head walls within the Morell River Lower and Painestown River (EIAR REF: Cul 5 & Cul 10) respectively and culvert upgrading at Cul 9, also on the Painestown River. Cement is highly alkaline and can give rise to very serious fish kills with similar effects on invertebrates, including white-clawed crayfish. Wash off from poorly cured cement can also be highly alkaline and potentially dangerous to fish.	▪ Operation of machinery instream should be kept to an absolute minimum. ▪ All construction machinery operating instream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. ▪ Concreting works will only occur 'in the dry' ▪ Headwalls for Cul 5, Cul 9 and Cul 10 should be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete. ▪ Disposal of raw or uncured waste concrete will be controlled to ensure that the watercourse will not be impacted; ▪ Best practice will be adopted in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times and management of spills; ▪ Where shuttering is used, measures should be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils; ▪ Wash water from cleaning ready mix concrete lorries and mixers may be contaminated with cement and is therefore highly alkaline. Due to the size of the site and the proximity of sensitive watercourses, it is recommended that lorries and mixers are washed out offsite.
Invasive species can be introduced into a location or spread from a location by contaminated vehicles and equipment.	▪ Refer to mitigation in Table 6.8 above.
Otter Loss of habitat/vegetation cover (scrub clearance) could result in reduced habitat quality and cover for otter utilising the various rivers throughout the catchment. Plumes of silt could result in a reduced food supply - i.e. where reductions in water quality affect macro-invertebrate diversity and abundance and fisheries production or temporarily displace fish from sections of channel.	▪ Where possible, flood measures will be set back from the river bank, leaving a buffer zone of natural riparian vegetation. The removal of natural riparian vegetation should be minimised. ▪ Where possible, bank slopes should be protected - minimise scraping of bank slope on working bank. This will ensure that riparian habitat is permanently available for otters, thus providing potential breeding and sheltering opportunities; ▪ Prior to construction works commencing, the Contractor will engage the services of a suitably

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
	qualified ecologist to conduct an otter survey of the proposed scheme measures, construction compounds and all access routes to identify whether the species occurs or not at the site of the proposed measure to be constructed and whether there is a breeding or resting place present. ▪ The OPW Environmental Management Protocols and SOPs (for Otter) should be followed: ▪ Operational Staff will walkover the works area one week in advance in conjunction with the Health & Safety assessment noting dense cover with access directly to the water that is to be avoided where feasible. ▪ Any recognisable signs of Otter presence observed such as Spraints, Footprints or suspected Holts, will be recorded on the Weekly Record Cards. ▪ While holts are usually well concealed, where Operational Staff observe a suspected holt such as a burrow opening, in consultation with Management Staff, subject to flood risk management functions, no works are to occur within a 50m buffer each side. ▪ It is important that any otter holts identified during survey work are dealt with appropriately, to stay within the obligations of relevant legislation. Where a holt is identified by a suitably trained ground staff member, work should not commence until NPWS have been consulted for advice and on the requirement for a licence to proceed. Where construction activities are required within 150m of a breeding Otter holt, a derogation licence will be required from NPWS. In relation to nonbreeding holts, no wheeled or tracked vehicles should be permitted within 20m of active holts or scrub clearance by hand within 15m (NRA, 2008). ▪ Where possible, mature trees within the river corridor should be retained. Similarly, large in-stream boulders and substrate should be retained where possible. Where in-stream works are required, the replacement of in-stream boulders will also ensure that features are available for otters to use as territorial sign posts, and substrate is available for fish spawning/hiding places. Steps to enhance fisheries (loosen bed gravels and if channel bed is composed of suitable material, excavate pools and create riffles) should also be undertaken. This will ensure that fisheries habitat, fish populations and food availability for otters are improved (Envirocentre, 2006).
The excavation and handling of potentially contaminated made ground could result in the increased mobilisation of contaminants which could increase the potential impacts on the surrounding areas. Dependant on the contaminant of concern; these impacts could include: ▪ Surface run off from exposed contaminated made ground; and ▪ Migration of contaminants through the subsurface could result in the impacting of groundwater (and surface water). In the absence of mitigation, the excavation of potentially contaminated made ground would have a temporary negative effect on the water quality with associated	The outline Waste Management Plan in Appendix M has included a number of measures to prevent environmental risks associated with contaminated water arising from leaching of contaminated made ground, surface runoff and exposure of the aquatic environment to contaminants. These include the avoidance of onsite stockpiling of any potentially contaminated soils / made ground and direct loading of potentially contaminated soils / made ground into designated trucks for removal offsite. If temporary stockpiling is necessary, stockpile management will include the following measures to prevent leaching and surface runoff of potential contaminants to the aquatic environment: ▪ Stockpiling should be limited to a specific area of the

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
impacts on aquatic ecology and therefore biodiversity within the study area.	site and not within 50m of any water course; ▪ Stockpiled made ground should be placed on impermeable plastic liners and covered to minimise rainfall infiltration; and, ▪ Berms should be constructed around the stockpiles.
Operational Phase Maintenance works for the proposed scheme may potentially give rise to adverse effects on water quality. The effective protection of water quality within the proposed scheme during operational (maintenance) phase will minimise the risk to the ecological interests of this site and other water bodies within the Morell catchment.	▪ General mitigation will involve implementation of current best practice for riparian works at the time of maintenance e.g. the OPW's Standard Operating Procedures for Arterial Drainage Maintenance Service (OPW, 2011) or any subsequent updates. ▪ Maintenance works to be carried out will be subject to the relevant environmental assessment requirements, including Screening for Appropriate Assessment and surveys for protected species.
Culvert Alterations can result in potential impacts on aquatic ecology during the operation of the proposed scheme. Culvert works, particularly if incorrectly designed, may prevent fish from migrating through them due to the flow pattern in the culvert or behavioural changes resulting from the imposition of a new structure i.e. increased shade, etc. if not appropriately designed. This can lead to a net loss of large areas of habitat and a reduction in biodiversity as fish are unable to colonise or spawn within aquatic habitats upstream of an inappropriately designed culvert.	▪ The design of any alteration to a culvert will ensure the unimpeded passage of fish at all times.
Instream structures may change flow patterns resulting in loss of gravel substrate, increased siltation and may remove meanders and natural riffle-pool sequences, which are important for fish populations during different stages of their life cycle.	▪ Alterations to the channel will be designed such that they display hydraulic and morphological characteristics fulfilling the requirements of salmonid habitats.
Stream diversions - Certain proposed works at the Slane River (Slane 8) will involve realigning the stream channel to alleviate bank erosion (See Section 4.3.4 in Chapter 4 for complete description of works). At Morr 8, a short section (70 metres) of a small tributary of the Painestown River running adjacent to the railway embankment will be diverted to allow construction of the flood defence at this location. If poorly designed, stream diversions can result in changes to the hydraulic and morphological characteristics of the channel, making them less desirable for fish populations. Permanent diversions of watercourses can result in permanent loss of aquatic and established riparian habitat and therefore biodiversity if the new channel is significantly shorter than the original or if it is not reinstated to a standard at least equivalent to the original in terms of fish habitat type and quality.	▪ The design and construction of new channel with natural habitat characteristics will where possible replicate the existing and will incorporate riparian vegetation and other natural features such as meanders. This will require importation of various grades of stone and gravel to construct habitat features e.g. riffles, pools and gravel areas. Materials from original channel may be re-used to minimise quantities of new material required. ▪ The design of the realigned channel shall be carried out in accordance with best practice, i.e. Crossing of Watercourses during the Construction of National Roads Scheme (NRA, 2005), 'Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites' (ERFB, 2003) and CIRIA Technical Guidance C648 (CIRIA 2006).
Loss of bank riparian cover as a result of installation of walls and embankments will result in increased light incidence to the channel and may encourage greater in-stream productivity, i.e. increased algal growth and benthic macroinvertebrate density. A decrease in channel shading can also impact negatively on fish and crayfish distribution. Riparian tree cover plays an important role in regulating stream ecology, e.g. stream temperature, carbon inputs and in-stream vegetation cover. Recent IFI research, for example, shows the importance of channel shading in avoiding lethal stream temperatures for salmonids in Irish rivers (Gretta Hannigan, IFI, *pers comm*). Lack of shade has been shown to be correlated with absence of crayfish in habitat that would otherwise be	▪ Vegetation removal will be kept to a minimum. Mature trees will be retained, where possible (see also mitigation in Table 6.7). A landscape management programme will be implemented during the lifetime of the proposed scheme to protect and reinforce natural bank side vegetation.

Potential Impact (Aquatic Ecology and Water Environment)	Summary of Proposed Mitigation
optimal for the species (Besson et al., 2007). Whilst it is not proposed for any removal of canopy cover along the riparian zone for operational purposes, there may be some incidental requirement for removal of individual canopy stands during proposed construction works.	

Table 6.10: Hydrology and Drainage: Summary of Mitigation Measures

Potential Impact (Hydrology and Drainage)	Summary of Proposed Mitigation
Construction Phase During the construction phase of the works, the potential causes of flooding could include: Blockage to the river flows due to collapsing of unstable river banks or temporary or permanent stockpiles during construction; Flooding of adjacent lands and properties caused by any reduction of channel conveyancing capacity during the construction of flood defences.	▪ An examination of historical flood records shows the worst of the fluvial flooding in this catchment occurs during the winter months, as would be expected. It is therefore recommended that the works be undertaken in summer months when flooding risks are lower.
The existing land drainage system in the study area could be affected during the construction period of the works. Potential impacts on the existing drainage systems include: The pattern of runoff could change with some existing drains and ditches receiving significantly more or less flow than they receive currently; rainfall on elevated areas could wash peat and silt into the surrounding watercourses. Localised erosion and scouring could occur while reduced flow may result in stagnation in some drains and ditches; and Obstruction of flow paths could cause localised water logging in the vicinity of the proposed flood protection embankments.	▪ To avoid any water logging in the lands adjacent to the river banks, it is proposed to maintain the existing drainage ditches that are crossed over by the proposed flood defences and similarly for any temporary or permanent stockpiles to ensure overland surface water flow is not restricted.
Operational Phase *Morell River (Turnings Lower to Ballyhays)* As a result of the installation of flood defences in these areas, there are increases in water level ranging from 0.035 m to 0.210 m between the abattoir bridge and the bridge under the R406. This increase results in a slight increase in flood extents to pastureland in these areas.	▪ No mitigation measures are necessary
Morell River (Killeenmore to Turnings Lower) In areas along this stretch of river, there are increases in water level ranging from 0.025 m to 0.376 m. These increased water levels result in an additional flooding to pastureland adjacent to the proposed defences Morr 3 and Paines 1.	▪ The affected landowner has been accommodated by ensuring an adjacent land parcel is protected.
Morell River (Sherlockstown to Killeenmore) There are increases in water level ranging from 0.002m to 0.637 m. Increased water levels adjacent to Morr 4, Morr 15, Morr 17 and Morr 19 are the result of flood defences being put in place to protect properties at risk in these areas. Increased water levels result in an additional flooding to pastureland adjacent to Morr 17. However this is the result of a reduction in the floodplain in the surrounding areas which helps to protect a minimum of 8 properties.	▪ Affected landowners have been accommodated by ensuring adjacent land parcels are protected.
Slane River The Slane River has a combination of reduced and increased water levels upstream and downstream of the N7 due to the opening of culvert under the road. Upstream of the N7 and surrounding lands there is a significant reduction in the floodplain; Downstream of the N7 there are increased water levels within the retention pond at Blackchurch. In the townland of Tuckmilltown adjacent to the proposed defences there is an increase of water levels.	▪ It is proposed to increase the height of the retention pond embankments at Blackchurch to maintain freeboard. ▪ At Tuckmilltown defences are proposed to protect a minimum of 4 properties from flooding. As a result of these defences, there is an overall reduction in the floodplain in this area.
The drainage pattern of the overland flows to the river	▪ Toe drains will be included at the base of the

channel along the embankments may be changed slightly. Construction of the embankments in the floodplain will change the slope of the existing lands in some areas which consequently may have an impact on the existing surface water drainage pattern. For example, the existing permeability of the soil could be reduced and the time of concentration to surface water flow could increase if the existing slope reduces. Some existing land drainage culverts under the railway will be fully or partially blocked to prevent flood waters bypassing the defences.	embankments, where required, in order to ensure that adjacent fields can continue to drain. ▪ Existing field drains that intersect the proposed embankments will be dealt with, by diverting them to adjacent field drains or by maintaining a limited flow path through the proposed defence.

Table 6.11: Soils, Geology and Hydrogeology: Summary of Mitigation Measures

Potential Impact (Soils, Geology and Hydrogeology)	Summary of Proposed Mitigation
Construction Phase General construction activities present a risk to water quality.	▪ All construction works should be completed in line with the following best practice guidelines to ensure the potential for accidental soil and groundwater contamination is minimised: ▪ CIRIA (Construction Industry Research and Information Association) guidance on 'Control of Water Pollution from Construction Sites' (CIRIA Report No C532, 2001) ▪ CIRIA (Construction Industry Research and Information Association) guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006)
Construction activities relating to the import and placement of fill material would be considered to constitute a temporary negative impact on the soils, geology and hydrogeology of the area. Over-compaction of soil and subsoil due to plant activities and potential for sediment run-off to the adjacent watercourses are particular risks that need careful management.	▪ Ensuring that a Construction & Environmental Management Plan is in place will mitigate any risks associated with embankment construction activities, thus reducing these impacts to an imperceptible level.
Where the nature of the soil cannot be returned to a similar pre-construction quality due to soil spreading activities, this would constitute a permanent negative impact on the soils and geology of the area. The attribute importance of the soils is considered to be medium as they are considered in general moderately drained with moderate fertility. A permanent impact on a significant proportion of the soil in the area would constitute a moderate impact on the soils and geology.	▪ Land used as the temporary working area will be restored to its original condition.
The proposed scheme will necessitate the requirement to store soil along the length of works areas. In the absence of mitigation, soil storage may present a risk of instability.	▪ A maximum height of 1 metre will apply for all temporary spoil heaps, with maximum side slopes of 1V:3H, to ensure that risk of instability is reduced. This will be subject to stability analysis by a suitably qualified geotechnical engineer at design stage.
In the absence of mitigation, construction of new embankments and river banks may present a risk of slope instability.	▪ The construction of the embankments should be completed to ensure slope stability based on the mixture of rock and soil type used in the construction. The final design of these features should be approved by a geotechnical engineer to ensure slope failure will not occur. ▪ The construction of new river banks at the stream realignment should be completed to ensure slope stability based on in-situ material. The final design of these features should be approved by a geotechnical engineer to ensure slope failure will not occur.
The import and pouring of concrete material for the foundations and walls could result in spillage and contamination of adjacent watercourses and soils.	▪ Refer to Table 15.7 above for proposed mitigation measures in respect of concrete management.
It is proposed to use surface dewatering pumps to dewater the section of the channel where works are taking place. It is possible that during such works slight to moderate groundwater inflows from the channel bed could occur where fractured limestone is exposed. Inflows can be expected laterally though the weathered bedrock and also vertically where discrete fissures are intercepted in the riverbed. Stream realignment works are also proposed at Slane 8 in Tuckmilltown and Morr 8 at Killeenmore. It is proposed	▪ Effective silt management measures such as the use of silt curtains will be placed in stages down-stream of the new channel, in advance of commencing stream realignments. These will be specified by the Contractor in the Method Statement and agreed with IFI. A procedure will also need to be included in the Method Statement for the removal of the silt management measures. ▪ An approved pumping and settlement system will be established to deal with dewatering activities.

Potential Impact (Soils, Geology and Hydrogeology)	Summary of Proposed Mitigation
that the plant required can operate from the river bank without need to enter the stream. However, works have the potential for significant sediment disturbance and run-off during this operation. Where water management controls may be required, this may involve dewatering within the channel in the vicinity of the works. Dewatering would constitute a temporary, slight negative impact on the groundwater flow regime. In-channel works can lead to river sediment disturbance with subsequent siltation and deposition downstream of the location which is considered a slight impact on soils and geology.	▪ Pumps will transfer accumulated standing water into a settlement tank, or tanks, which in turn will discharge into a 'silt buster' or 'dirt bag' prior to being returned to the watercourse, to minimise the discharge of suspended solids into the watercourse. ▪ Water quality monitoring will be carried out to monitor the effectiveness of the mitigation measures.
There is the potential for accidental soil and groundwater contamination due to spills and leaks of oils and other contaminants during the construction stage of the proposed works.	▪ Refer to Table 15.7 above for proposed mitigation measures in respect of fuels and oils.
There is the potential to hydrogeological impact on local water features such as ground water wells where dewatering may be required e.g. at culvert upgrades. However, the extent of dewatering required over a short timeframe is not expected to result in any significant impact.	▪ No mitigation measures are necessary.
Made ground will be encountered at locations during the construction works. There is the potential that pockets or larger tracts of made ground are contaminated and the excavation and handling of any potentially contaminated made ground could increase the mobilisation of any contaminants present. This presents a risk from leaching, surface run, migration through the subsurface and direct contact (human health).	▪ Further site investigations will be carried out during detailed design to identify and, if necessary, delineate any potential contamination within the made ground. ▪ Identified contaminated made ground will require Waste Acceptance Criteria (WAC) testing to classify the made ground as either: inert, non-hazardous or hazardous. ▪ The made ground should be disposed of at the appropriate licenced or permitted waste facility. ▪ The testing, excavation, handling and disposal of any contaminated made ground should be implemented in accordance with the methodology detailed in the outline Waste Management Plan (WMP) Appendix M of the EIAR.
Operational Phase Maintenance activities during operational stage will involve periodic inspection of flood defence measures at most (likely to be annual). This is expected to be carried out as visual walkover inspections and general landscaping activities. As a result, there are no expected impacts due to spillages or leaks.	▪ No mitigation measures are necessary.
The existing land drainage system in the study area could be affected during the construction period of the works (see also Table 15.8).	▪ Permanent cut-off ditches are proposed on the land side of all embankments to direct overland flow away from the embankments.

Table 6.12: Cultural Heritage: Summary of Mitigation Measures

Potential Impact (Cultural Heritage)	Summary of Proposed Mitigation
Construction Phase Ground disturbances, such as topsoil stripping, have the potential to have a direct and negative impact on previously unrecorded archaeological features or deposits that may survive beneath the current ground level with no surface expression.	▪ All topsoil stripping associated with the proposed scheme should be subject to full time archaeological monitoring. This will be carried out by a suitably qualified archaeologist under licence by the National Monuments Service. Full provision will be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed. ▪ A wade survey will be carried out within the section of Slane River to be realigned prior to any construction works going ahead. This will be carried out by a suitably qualified archaeologist, under licence by the National Monuments Service. Full provision will be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed. ▪ It is recommended that topsoil stripping within Morr 19 and 23 stock pile areas is monitored by a suitably qualified archaeologist. It is recommended that the area at Paines 3 only be used as a last resort. If it is required, it is recommended that the site be subject to archaeological testing in the first instance. This should be undertaken by an archaeologist under licence to the DoAHRRGA. Full provision should be made available for the resolution of any archaeological features that may be discovered, should that be deemed an appropriate manner in which to proceed.
Ground disturbances associated with the construction of embankments adjacent to a number of bridge structures: 'Old Morell Bridge', 'Morell Bridge', 'Painestown Bridge', 'Finger-post Bridge' and an un-named bridge in Tuckmilltown, have the potential to directly and negatively impact on these structures. This may occur through inadvertent damage from plant, or burying of portions of the structures from the construction of embankments.	▪ A written and photographic record will be carried out of 'Finger-post Bridge' prior to construction and any direct impact on the structural remains of the bridge will be avoided. Furthermore a sufficient buffer (minimum of 1m) will be maintained between the embankment and bridge during construction. ▪ Any direct impact to the remaining three bridges 'Old Morell Bridge', 'Morell Bridge' and 'Painestown Bridge' will be avoided during use of the haulage and due care will be taken by all vehicles during the construction phase
Three potential stock pile areas may be required as part of the proposed scheme. Topsoil stripping within these sites has the potential to have a direct and negative impact on archaeological features that have the potential to survive within these areas, especially in the site at Turnings North.	▪ It is recommended that topsoil stripping within Morr 19 and 23 stock pile areas is monitored by a suitably qualified archaeologist. It is recommended that the area at Paines 3 only be used as a last resort. To avoid the need for topsoil stripping at this site, the contractor will instead temporarily stockpile fill material on top of a geotextile layer at this location, if it required for material storage.
Operational Phase No operational phase impacts are predicted to occur.	▪ No mitigation measures are necessary.

6.2 CONSTRUCTION WASTE MANAGEMENT PLAN

Contractors working on site during the works will be responsible for the collection, control and disposal of all wastes generated by the works.

An outline Waste Management Plan is attached as Appendix M, in Volume III of the EIAR. The Contractor will be responsible for developing and updating the Waste Management Plan as required in advance of the construction phase. The Waste Management Plan will identify likely waste arisings, approximate quantities and appropriate handling and disposal methods of potentially contaminated material in accordance with industry best practices and waste management regulations. An important aspect of the Waste Management Plan will be to collect and control waste on site.

As a minimum the following measures will be taken to ensure that the central base sites and surroundings are kept clean and tidy:

- A regular program of site tidying will be established to ensure a safe and orderly site.
- Food waste will be strictly controlled on all parts of the site.
- Mud spillages on roads and footpaths outside the site will be cleaned regularly and will not be allowed to accumulate.

6.3 AIR AND DUST MANAGEMENT

A dust minimisation plan will be based upon industry guidelines in the Building Research Establishment document entitled 'Control of Dust from Construction and Demolition Activities'. An outline dust minimisation plan is included in Appendix A.

6.4 WATER QUALITY MONITORING

6.4.1 Water Quality Monitoring Plan

A Water Quality Monitoring Plan will be prepared in compliance with the relevant environmental quality standards. It will be agreed with relevant authorities, including Kildare County Council, the IFI, EPA and the NPWS.

The monitoring programme will take a multi faceted approach to ensure a robust system is in place capable of policing construction activities. The contractor's Environmental Manager will be responsible for drawing up a schedule of the environmental monitoring programme required as part of the Water Quality Monitoring Plan and this will be based on the requirements of all monitoring recommended in this draft CEMP, conditions imposed as part of any consents, mitigation measures presented in Chapter 6 and Tables 6.7, 6.8 and 6.9, requirements for best practice and adherence to relevant legislation and guidelines as described in Section 3.3.

Monitoring will be required prior to, during and post construction. The monitoring programme will be the responsibility of the contractor's Environmental Manager and reporting will be made to the Engineer, IFI, NPWS and Kildare County Council. Baseline sampling shall start in advance of the works and will continue for a period after the works have been complete, these timeframes will be agreed in advance of construction with the relevant authorities outlined above. As a minimum requirement sampling will be carried out downstream of the main work areas that are progressing at any one time during the construction programme.

Monitoring will include regular inspection of silt management measures and all interceptors, sumps and ancillary elements associated with water collection or transfer systems. This will ensure no significant pollution incidents occur on site in particular in relation to water quality where suspended solids and turbidity may lead to deterioration in water quality.

An outline Water Quality Monitoring Plan is provided in Appendix B.

6.4.2 Emergency Spill Response Plan

An Emergency Response Plan will be prepared, detailing actions to be taken in the event of an accidental spillage of fuel, chemicals or other hazardous material. It will detail procedures to be followed if there is an accidental spillage. The Environmental Manager for the site should be notified of all incidents where there has been a breach in agreed environmental management procedures.

The contingency plan may take in to consideration the recommendations published within the UK's '*Pollution Prevention Guidelines Incident Response Planning: PPG 21*' and '*Pollution Prevention Guidelines Dealing with Spills: PPG 22*' (UK Environment Agency, 2009) and will be prepared in collaboration with the Contractor(s).

Staff should be trained so that they know where there is a copy of the Emergency Response Plan; what they should do if there is a spill; and where pollution control and personal protective equipment is.

An outline Emergency Response plan is included in Appendix C. If the main contractor already has a standard spill response procedure in operation then this should instead be amended to reflect the local conditions on site.

7 SITE SAFETY

Safety will be of prime importance during the construction works. The works will be subject to the Safety, Health and Welfare at Work Act 2005 (S.I. No. 10 of 2005) and at a minimum the Safety, Health and Welfare at Work (Construction) Regulations, 2013 (S.I. No. 291 of 2013). All aspects of design construction will be reviewed with regard to health and safety and risk assessments will be carried out.

A project supervisor design process (PSDP) has been appointed. As part of their duties they will be required to produce a Preliminary Safety and Health Plan for the project. The main contractor will be appointed as project supervisor construction stage (PSCS) and will be responsible for the control and co-ordination of health and safety during the construction phase of the works. All individuals working on the Project will be required to undertake induction procedures. Such will be designed to make individuals aware of all the issues associated with the Project and will include, but not be limited to:

- The terms of the CEMP;
- Working Hours;
- Access arrangements;
- Health, Safety and environmental policy and procedures;
- Code of Conduct within the site and surrounding environs;
- Statutory obligations of individuals on site;
- Traffic Management;
- Site parking;
- Public Access;
- Lighting requirements;
- Complaints and disciplinary procedures;
- Protection of the water environment;
- Protection of wildlife and habitats;
- Dust and air quality;
- Noise and vibration; and
- Emergency procedures.

Visitors will not be allowed onto the site unless they have received formal induction or are accompanied by an authorised person who has completed the induction. All visitors will be required to sign a visitor’s book.

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APPENDIX A

OUTLINE DUST MANAGEMENT PLAN

OUTLINE DUST MANAGEMENT PLAN

In order to ensure that any dust nuisance is minimised, a series of mitigation measures are prescribed below:

- Display name and contact details of responsible person for dust issues at relevant in addition to site office contact.
- Record all dust and air quality complaints and record outcomes.
- Consult with and advise any landowners with the potential to be impacted by temporary construction dust emission prior to staring of those activities.
- Make the complaints log available to the local authority when asked.
- Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.
- Where required, use solid screens as an interface between closest residential receptors and working area.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Carry out regular inspections to ensure compliance with the CEMP/Dust Management Plan (DMP) and record results in the site log book. Increase the frequency of inspections during activities with a high potential to create dust or in prolonged dry weather.
- Undertake daily on and off site visual inspections where there are nearby receptors ensuring that no excessive dust emissions and/or deposition during pipeline installation.
- Ensure all vehicles switch off engines when stationary - no idling vehicles.
- Enforce an on-site speed limit of 15 mph on surfaced roads and 10 mph on unsurfaced areas. Have sign posts indicating these speed limits.
- Vehicles and machinery to be fitted with appropriate exhaust systems and emission controls. The devices will be maintained in good working order.
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression /mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes, conveyors and covered skips. Minimise drop heights of materials.
- Ensure aggregates are stored in bunded areas and are not allowed to dry out.
- Ensure vehicles entering and leaving the site are appropriately covered.
- Use water-assisted dust sweepers to clean access and local roads. Avoid dry sweeping of large areas.
- No bonfires and burning of waste materials on site
- Ensure use of covered skips as appropriate

APPENDIX B

OUTLINE WATER QUALITY MONITORING PLAN

INTRODUCTION

The Water Quality Monitoring Plan (WQMP) shall be adhered to throughout the construction phase to include preventive and precautionary methods of working and if necessary a mechanism through which abnormal or emergency situations are managed and addressed. The Water Quality Monitoring Plan outlines how the construction activities are to be monitored and will ensure the mitigation measures included to ensure water quality is protected and managed appropriately are effective and preventative of environmental damage.

PROCEDURES

The plan shall be enacted on all occasions, whatever the source of information.

- However, the main mechanisms for identifying issues pertaining to the water environment e.g. potential pollution incidents are as follows:
- Surface Water Drainage and proposed temporary discharge points will be mapped on a site plan, tracked on a schedule and agreed with relevant authorities
- The Environmental Manager shall undertake a site walkover on a weekly basis and make notes. These notes shall form the primary source of environmental checks of the works
- Temporary drainage and sedimentation features will be visually inspected on a daily basis and any abnormalities reported to the Environmental Manager
- Water quality monitoring to alert of any detrimental effects that particular construction activities may be having on water quality and provide evidence of the effectiveness of management procedures on site
- All site workers shall be given tool-box talks to enable them to understand the mechanism for reporting environmental incidents, including spillages, and how to respond to emergency or abnormal situation with regards to the water environment
- Site Supervisors shall be encouraged to identify potential pollution or hydrological problems or concerns and report them to the Environmental Manager.

Should the source of the pollution be attributable to a construction activity associated with the Works then measures will be undertaken immediately to mitigate the release of pollutants or the activity will cease until this can be achieved. The root cause of any pollution incident will be investigated and measures or corrective actions put in place in order to prevent its reoccurrence.

Roles and Responsibilities

Staff roles and responsibilities will be defined on appointment of the Main Works Contractor during the preparation of the detailed contractor CEMP.

MONITORING PROGRAMME

Pre-Construction Baseline Survey

A pre-construction baseline survey will be required to assess background concentrations of relevant parameters in the Morell River and tributaries affected by the proposed works. This is essential in order to be able to assess any impact from the works against the existing conditions. The baseline survey will require consultation with the Contractor and relevant authorities to determine;

- Relevant parameters deemed necessary for analysis;
- Frequency and timeframe of monitoring;
- Threshold concentration levels which must not be exceeded; and
- Actions to be taken if threshold levels are breached.

This will help determine the threshold concentrations for certain parameters which the construction activities will be required to adhere to, and as such it is suggested that a suite of physico-chemical and chemical analyses are undertaken. A possible list of parameters is provided below, giving consideration to the potential impacts and pressures associated with the construction of the slipway, piers and ferry terminals.

- Total Suspended solids
- Visible oil and grease
- Turbidity (as a surrogate for TSS)
- Dissolved oxygen
- Temperature
- pH
- Conductivity

As suspended solids and sediment transport pose significant potential impact to water quality and aquatic ecology during construction, turbidity readings shall be used as a surrogate in the field. This will require a rating relationship curve drawn up from the results of the baseline survey to allow a turbidity/suspended solid threshold limit to be calculated. Real time measurement of turbidity using field instrumentation can then be used to assess the potential impact from the construction activities.

Once a pre-construction baseline survey is complete and has been processed it will further inform the water quality monitoring programme to be carried out under the CEMP. Until then, this preliminary proposal for the monitoring programme will outline recommended monitoring locations, parameters for analysis and other mitigation measures which may have an impact on water quality.

CONSTRUCTION PHASE MONITORING

During the construction phase, monitoring of water quality will continue to enable any pollution incidents to be identified and the effectiveness of pollution mitigation measures to be evaluated.

Consultation will continue with the OPW, Kildare County Council, Inland Fisheries and the NPWS regarding the water quality monitoring to be undertaken for watercourses that will be affected by construction works or discharge of surface water run-off.

The parameters to be tested, frequency of sampling and sampling locations will be agreed with the above bodies prior to construction commencing.

Monitoring is required during the construction period in order to:

- Alert the contractor to any detrimental effects that particular construction activities may be having on water quality (based on the baseline thresholds set) in order that appropriate remedial action can be taken as quickly as possible; and
- Provide evidence that management procedures on site (for example sediment run-off control) are adequate and working correctly, consistent with the CEMP control measures, and are being adhered to.

The proposed construction phase monitoring regime will be agreed with the relevant authorities but should include the information below:

- Daily visual monitoring of surface waters crossed by the scheme, at a point upstream and downstream, for colouration, oil sheens, and flow. Measurement of pH, temperature, conductivity, DO and turbidity (NTU) (other parameters may be included depending on activities and circumstances). Downstream monitoring for any temporary discharges required from settlement systems, will be undertaken at a location that allows sufficient mixing of discharge waters and receiving waters;
- Daily visual inspections of water discharge at all outfalls or watercourses whilst high risk activities are occurring along the associated working areas. Such activities would include earthworks and drainage works;
- The streambed below each construction phase will also be inspected during daily monitoring in order to assess the degree of siltation and any appropriate remedial action. Water quality monitoring points will be located immediately upstream and downstream of crossing construction points
- Daily visual inspection of surface water courses and ponds adjacent to any compounds; and
- In-situ monitoring of turbidity should be undertaken at critical nodes in the surface water network downstream of construction activities to ensure pre-determined threshold turbidity levels, derived with due consideration of the pre-construction baseline, are not breached. In the event of a breach an agreed and proportionate response and remedial action protocol shall be included in the CEMP and agreed with the relevant authorities.

REPORTING AND RECORDING

Construction Period Reporting

The results of the water quality monitoring will be routinely reported to the responsible parties in the CEMP, unless baseline threshold levels are breached where immediate contact and/or meetings with the statutory bodies will be required.

Exceedances of Baseline Threshold Values Reporting

Where any exceedances of defined baseline threshold values occur, this will be reported within 30 minutes to the Client Project Manager and Engineer. At this point, the actions proposed will also be notified to parties affected, including relevant statutory authorities.

All reports shall be reviewed and signed off by the Environmental Manager.

APPENDIX C

OUTLINE EMERGENCY POLLUTION SPILL RESPONSE PLAN

OUTLINE EMERGENCY SPILL RESPONSE PLAN

An emergency response plan shall be prepared to inform the procedures to be taken in the event of a spillage that has the potential to cause pollution.

The contractor will be responsible for the preparation and implementation of the spillage response procedure. The key issues to consider for the spillage response procedure include:

1. If the main contractor already has a standard spill response procedure in operation then this should be amended to reflect the local conditions on site. Where a spill response plan is not in place a project specific plan will be developed;

2. The Plan should also detail the procedures to be followed if there is any accidental spillage or discharge of contaminated water. It will be important to ensure that the Environmental Manager is notified of all incidents where there has been a breach in agreed environmental management procedures;

3. As a general rule the following principles should apply In the event of an environmental emergency:

    a. If SAFE, stop the source of the spill and raise the alarm to alert people working in the vicinity of any potential dangers. Inform Engineer immediately

    b. IF SAFE (USE PPE), contain the spill using the absorbent spill material provided. Do not spread or flush away the spill. Cover or bund off any vulnerable areas where appropriate.

    c. If possible, clean up as much as possible using the absorbent spills materials. Do not hose the spillage down or use any detergents.

    d. Contain any used absorbent material so that future contamination is limited.

    e. Notify the Construction Manager or the Engineer and environmental officer so that used absorbent material can be disposed of using a specialist contractor.

4. The Construction Manager, in conjunction with the contractor's environmental manager, will develop and test, through exercises, the Emergency Spillage Procedure to ensure that appropriate measures to prevent and mitigate damage due to accidents and spillages are in place.

5. Testing of the Emergency Spillage Procedure shall be recorded on the relevant environmental control form.

6. Inform all personnel about the spill response procedure through toolbox talks and/or induction training. Consider the need for refresher training on long-term construction projects.

7. Use reminder posters, identifying the key essential elements of the spill response procedure, located in appropriate areas such as fuel storage areas, mess cabins, security points or on the back of toilet doors.

8. Example control containment measures for different pollutants are given below:

Control/Containment Measure	Pollutants				
Spill on ground	**Concrete / cement**	**Paints**	**Oils**	**Silt**	**Detergents**
Sand	✓	✓	✓	×	✓
Straw bales	×	×	✓	✓	×
Absorbent granules	×	×	✓	×	×
Geotextile fence	✓	×	×	✓	×
Drip trays	×	✓	✓	×	×
Pads/rolls	×	×	✓	×	×
Drain seal	✓	✓	✓	✓	✓
Earth bunds	✓	✓	✓	✓	✓
Spill in water					
Straw bales	×	×	✓	✓	×
Pads/rolls	×	×	✓	×	×
Booms	×	×	✓	×	×
Stop further spill contain and inform appropriate personnel immediately	✓	✓	✓	✓	✓

In the event of a significant spill contact the relevant Emergency Response Agencies:

EPA, Local Authority, Fire Service, Health Service Executive, Gardaí, Health and Safety Authority, Fisheries Board, Sanitary Authority, Food Safety Authority

It will be important to incorporate the names and telephone numbers of others you need to inform (includes alerting people out of hours) and who should contact them within the spillage response plan.

Further issues to be considered when the main contractor is preparing an emergency spill response plan include:

- Details of a professional 24 hour call-out clean-up service
- Ensure sufficient types and quantities of spill response equipment are available on site. Keep spill kits where spills may occur, e.g. at refuelling points or on plant working near a watercourse.
- Material safety data sheets and CLP assessments will assist in identifying appropriate spill measures for dealing with hazardous materials.
- Dispose of used spill response material appropriately, e.g. oily granules or pads should be bagged up and placed in the designated waste skip.

IMPORTANT TELEPHONE NUMBERS

Emergency Contact Details	
Emergency Services	112 or 999
Nearest hospital – Accident & Emergency Dept.	
Environmental Incident Reporting	

Contractor Contacts: (Out of Hours)	
Engineer	TBC
Construction manager	TBC
Environmental Manager	TBC
Foreman	TBC

The flow chart in Figure C.1 summarises the action to be taken in the event of a spillage and will be used to inform the development of the contractor's emergency spill response plan.

What to do if you find a spillage of any substance on site

STOP - CONTAIN - NOTIFY

STOP work immediately and prevent any more material spilling, e.g. right an oil drum, close valves.

Eliminate any sources of ignition, e.g. switch off plant, extinguish cigarettes.

CONTAIN the spillage using bunds of earth or sand, drip tray etc. immediately.

Check the spill has not reached any nearby drains / manholes, watercourses, ponds and other sensitive areas. Bund drains / manholes to stop the substance entering the drainage system

NOTIFY your foreman / supervisor immediately giving the following information:

- whether material has entered the drain / watercourse or is affecting the environment
- material involved
- location
- reason for the incident
- quantity involved.

SPILLAGE TYPE	
MAJOR	Cannot be controlled; pollution has entered, or could enter a drain or watercourse. Report to foreman / supervisor immediately.
MINOR	Can be controlled; pollution has not entered, and cannot enter a drain or watercourse.

FOREMAN/SUPERVISORS INSTRUCTIONS	
MAJOR	Contain and report immediately to contact detailed below.
MINOR	Clean up immediately using appropriate materials (granules, pads etc.)

Contact Names and Numbers	
EPA	Tel
Health Service Executive (HSE)	Tel
Eastern Regional Fisheries Board	Tel
Kildare County Council	Tel
Clean up contractor	**(tbc)**

Figure C1 Emergency Spillage Response Flow Chart

Appendix C

Consultations

APPENDIX C – CONSULTATION CORRESPONDENCE

Date 13th October 2014

Re: Morrell Flood Alleviation Scheme (FAS) Study
Public Consultation Day on the Preferred Flood Risk Management Options Study

Dear Householder

Following representations from Kildare County Council in response to concerns voiced by residents and landowners, the OPW's Catchment-based Flood Risk Assessment and Management (CFRAM) Programme prioritised work to prepare a **Flood Risk Management Options Study** and in turn followed by a **Flood Risk Management Plan** for the Morrell catchment.

In 2013, an assessment of flood risk in the Morrell catchment was undertaken, which included

- topographical surveys of river channels and floodplains,
- hydrological analysis of river flows and water levels,
- hydraulic modelling to predict how and where flooding is likely to occur.
- Verification of the hydraulic model against past flood events

Draft flood maps were prepared, showing the likely extent of flooding under a range of scenarios, and presentations were made to Elected Members of Kildare County Council on 9th April 2013, and at a Public Consultation day on 16th April 2013. Comments were invited and in turn revised mapping was prepared in October 2013 and a brief was prepared for the procurement of a Consultant.

In late 2013, RPS Consulting Engineers were procured and appointed to carry out the **Flood Risk Management Options Study,** the aim of the Options Study being to identify a number of solution proposals that would alleviate identified flood risk to all properties and essential infrastructure affected by a 1 in 100 year event (1% event), that included anticipated impacts of future climate change events. Having identified and analysed a number of options the Consultants then identified a solution (preferred option) that in their view is cost beneficial, i.e. where the financial benefit outweighs the cost of installing and maintaining the preferred option, delivers the best technical, social and environmental solution, and by retaining existing flood storage areas where possible, ensures that flood risk is not increased elsewhere in the Morrell catchment or in the neighbouring Liffey catchment

The Preferred Option identified by the Consultant includes the construction of embankments alongside the river channel at several locations to restrict the pathways of floodwaters. Crucially, the cooperation and support of residents and landowners within the catchment for the Preferred Option Solution is essential as a precursor to effecting the works.

A **Public Consultation**, to inform and seek the views of all stakeholders, will take place at **Aras Chill Dara in Naas, County Kildare on Thursday 23rd October 2014 from 3pm to 8pm.** You are invited to attend the Public Consultation event to meet with the Consultants and gain insight into their work to date to identify and analyze the Options considered and to identify the Preferred Option. In turn the Consultants will welcome your views, comments and opinions, and following the consultation will review their work to take account of your input before finalizing a **Flood Risk Management Plan for the Morrell River.**

In addition to the information presented on the Public Consultation Day, details of the **Flood Risk Management Options Study** will be available to view on Kildare County Council's website, and submissions and observations can be submitted to Ms Katie Smart of RPS Consulting Engineers before Friday 28th November at 5pm. (Submission address details below). The relevant information will be on the website after the Public Consultation event.

Following Public Consultation as set out above, a **Flood Risk Management Plan for the Morrell River** will be published in late 2014. This will detail the works proposed to affect a **Flood Risk Alleviation Scheme**, and The Morrell FAS Study will then proceed to Environmental Impact Assessment and detailed design, and ultimately procurement of a works contractor to carry out works identified in the **Flood Risk Management Plan for the Morrell River**, and in turn set out in the construction project titled **Flood Risk Alleviation Scheme**.

It is possible that construction of the Flood Risk Alleviation Scheme could commence in the summer of 2015,subject to securing all Statutory Approvals and Landowner Consents in advance of procurement of a works contractor.

Comments and submissions on the prefered flood risk management option can be sent to Katie Smart at Katie.Smart@rpsgroup.com or posted to Ms Katie Smart at RPS Consulting Engineers Limited, West Pier Business Campus, Dun Laoghaire, Co. Dublin.

Closing date for submissionsFriday 28th November at 5pm

Yours sincerely

Gerry Halton

Gerry Halton,
Senior Executive Officer,
Water Services Section.

West Pier Business Campus, Dun Laoghaire, Co. Dublin, Ireland
T +353 (0)1 488 2900 **E** ireland@rpsgroup.com **W** rpsgroup.com/ireland

Insert Recipient's Name Here,
Address 1,
Address 2,
Address 3,
Address 4.

June 2nd 2015

Our Ref: Stakeholder EIA Letter
File Ref: MDW0575Lt0009 -Stakeholder EIA Letter

Re: River Morrell Flood Management Scheme – Environmental Impact Assessment

Dear Mr Smith,

I am writing to you to inform you that RPS has been appointed by Kildare County Council to provide the environmental consultancy services associated with the above mentioned scheme. The extent of the River Morrell catchment associated with this scheme is shown in Figure 1.

The Office of Public Works (OPW) commissioned RPS to undertake the Eastern CFRAM Study in June 2011. The Eastern CFRAM Study was the second RBD level CFRAM study to be commissioned in Ireland under the OPW's CFRAM Programme in accordance with national flood policy (2004).
Due to the significance of the flooding that has taken place in the Morrell Catchment and concern amongst residents, the Morrell catchment was prioritised within the Eastern CFRAM Study programme under which it was known as 'Turning/Killeenmore (AFA)'.

The Morrell catchment was prioritised and an advanced project was carried out during 2013 to accelerate the development of flood mapping for this Area for Further Assessment (AFA). This included topographical surveys of river channels and floodplains, hydrological analysis of river flows and water levels, and hydraulic modelling to predict how and where flooding is likely to occur.

Draft flood maps were prepared, showing the likely extent of flooding under a range of scenarios, and were presented to elected members on 9th April 2013 and at a public consultation day on 16th April 2013.

In 2014 a range of options for managing flood risk in the Morrell catchment were presented to Kildare County Council elected members on 2nd October 2014 and at a public consultation day on 23rd October 2014. Submissions received in reponse to those consultations have been reviewed and incorporated as appropriate.

Landowner liaisons have been ongoing throughout the preparation of the design options. Those design options have been assessed and the preferred option is progressing through the Environmental assessment process.

Dublin | Cork | Galway | Sligo

The following environmental stages form an integral part of this process;

Stage 1

- Environmental Constraints Report — Complete

Stage 2

- Environmental Assessment of Viable Options — Complete
- Screening for Appropriate Assessment — Complete

Stage 3

- Environmental Impact Assessment (EIA) — Current undertaking

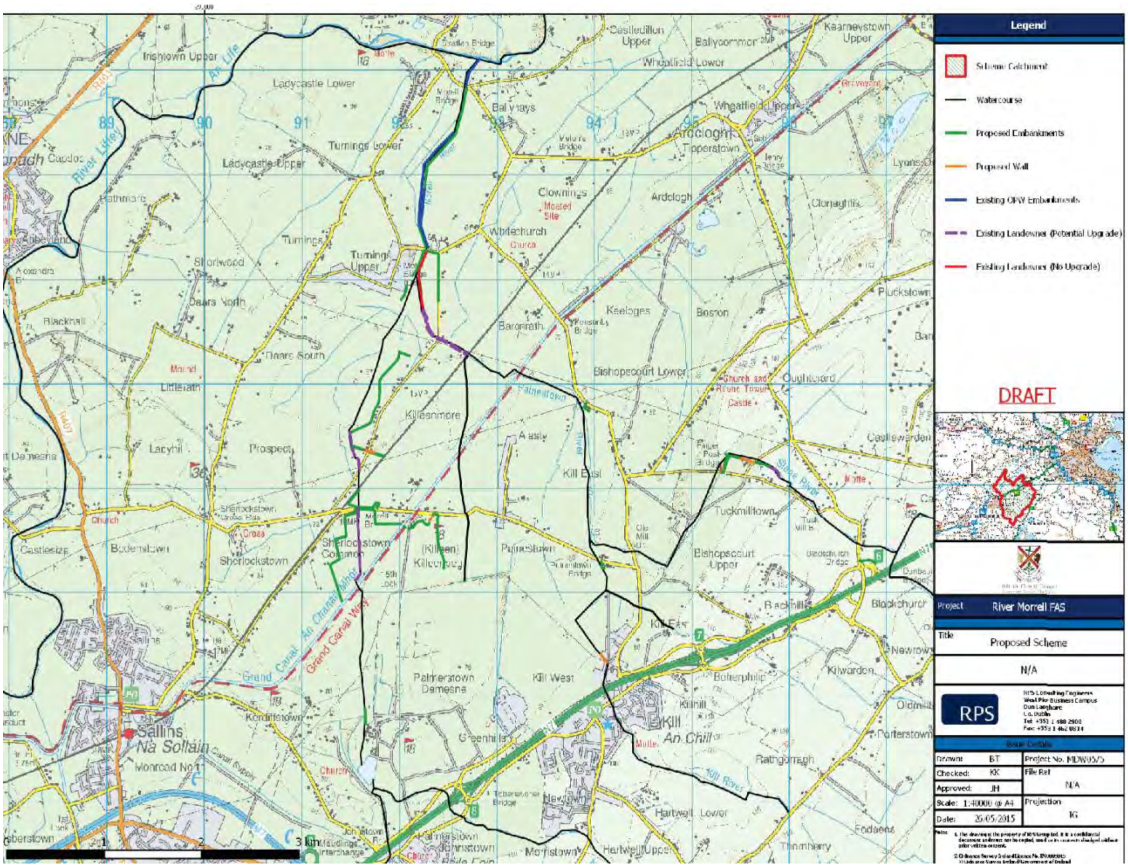


Figure 1 River Morrell Study Area

RPS has commenced Stage 3 of this process – Environmental Impact Assessment. If you would like to make a comment regarding Stage 3 of the scheme, please forward your correspondence for review to katherine.keogh@rpsgroup.com by Tuesday June 30th 2015.

The study recommends flood management works at a number of locations within the study area. The project is now being progressed through final design.

Yours sincerely,

Jean Hobbs,
Technical Director,
For and on behalf of RPS

KK/JFH

Morrell FAS Study

RPS

PREFERRED OPTION PCD — **COMMENT SHEET**

Áras Chill Dara, Naas, County Kildare — 23rd October 2014

NAME	
ADDRESS	
EMAIL	
TELEPHONE NO	
RECORDER	
REFERENCE	

1. Are you happy with the proposed Flood Risk Management Option? *Feedback can be provided overleaf*	Yes ☐ No ☐
2. Are you aware of any existing flood defences in the catchment? *Details can be provided overleaf*	Yes ☐ No ☐
3. Are there particular environmental features in the area that you value? *Details can be provided overleaf*	Yes ☐ No ☐
4. Are there particular cultural features in the area that you value? *Details can be provided overleaf*	Yes ☐ No ☐
5. Are there particular amenity features in the area that you value? *Details can be provided overleaf*	Yes ☐ No ☐

Any information provided will be subject to the provisions of the Freedom of Information Acts. Personal Information will be subject to the provisions of the Data Protection Acts.

FURTHER DETAILS AND FEEDBACK

Public Consultation Day on the Flood Risk Management Option for the River Morrell catchment

A Public Consultation Day will take place at Áras Chill Dara in Naas, County Kildare on Thursday 23rd October 2014 from 3pm to 8pm to consult with the public on a preferred option to reduce the risk of flooding in the River Morrell catchment between Kill and Straffan.

Following the identification and assessment of a number of flood risk management options, a preferred option for the area has been identified. The preferred option alleviates flood risk for more than 60 properties in the River Morrell catchment and the Castlewarden Junction of the N7 national roadway. It will involve the construction of embankments alongside the river channel at several locations to restrict the pathways of floodwaters.

Kildare County Manager, Mr. Michael Malone welcomed the publication of the Flood Risk Management Option stating, "This represents a significant step towards alleviating the risk of flooding for local residents in the affected areas between Kill and Straffan. Kildare County Council will continue to collaborate closely with the OPW and we look forward to the start of construction phase of the project envisaged to begin in mid-2015."

All interested parties are invited to attend the Public Consultation Day to discuss the project with the study team. The feedback received will be considered and incorporated into the Flood Risk Management Option where possible.

Details of the Flood Risk Management Option will be available to view on Kildare County Council's website for a period of four weeks after the Public Consultation Day. Details for sending submissions by email or post can be found on the website. The closing date for submissions is **Friday 28th November at 5pm**.

Following this public consultation, a Flood Risk Management Plan for the Morrell catchment will be published later in 2014. This will detail the works to affect a Flood Risk Alleviation Scheme. It is possible that construction of the Flood Risk Alleviation Scheme could commence as soon as the summer of 2015, subject to securing all statutory approvals and landowner consents in advance of procurement of a works contractor.

ENDS

Note to the Editor

The River Morrell Flood Alleviation Scheme is part of the national Catchment-based Flood Risk Assessment and Management (CFRAM) Programme which commenced in Ireland in 2011.

The CFRAM Programme is a medium to long-term strategy for the reduction and management of flood risk in Ireland. The Programme delivers on core components of the National Flood Policy, adopted in 2004, and on the requirements of the EU 'Floods'

Directive. The Irish CFRAM Programme is being carried out in parallel with similar programmes across the European Union.

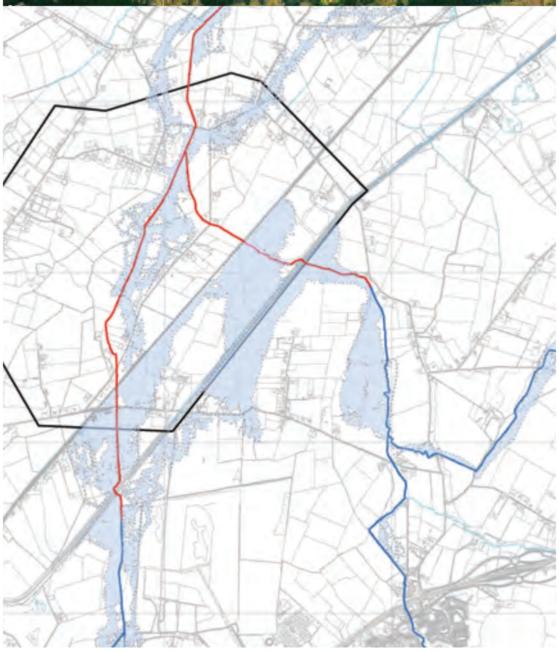
The OPW is the lead agency for flood risk management in Ireland and is the national competent authority for the EU Floods Directive. OPW works in close partnership with all Local Authorities in delivering the objectives of the CFRAM Programme.

Morrell FAS Study
Information Leaflet
September 2014

INSIDE | UPCOMING PUBLIC CONSULTATION DAY | DEVELOPMENT OF FLOOD RISK MANAGEMENT OPTIONS | NEXT STEPS

Public Consultation Day

"come and have your say on the preferred flood risk management option!"



There is a history of flooding in the Morrell catchment since the early 1990s. In recent years, the severity and frequency of the flood events have resulted in severe hardship for people in the area. The flooding also affects the N7 national roadway.

In 2013, flood mapping was prepared for the Morrell catchment by the Eastern Catchment-based Flood Risk Assessment and Management (CFRAM) Study. This flood mapping illustrated the extent of flooding under different conditions (i.e. differing amounts of rainfall) and illustrated the receptors (homes and businesses) at risk from the flooding.

In late 2013, Kildare County Council appointed RPS as consulting engineers to the Morrell Flood Alleviation Scheme (FAS) Study. The purpose of the study is to develop Flood Risk Management Options to deal with the identified flood risk.

A preferred Flood Risk Management Option has been identified by the Morrell FAS Study. The option is illustrated on the inside pages of this information leaflet and the process of developing the option is described on the back page.

A Public Consultation Day is taking place at Kildare County Council head office in Naas, County Kildare on Thursday 23rd October 2014 from 3pm to 8pm. All are invited to attend to discuss the option development process with the study team and to give feedback on the preferred option.

Details of the preferred flood risk management option will also be available to view on Kildare County Council's website for a period of four weeks after the Public Consultation Day. Submissions and observations on the preferred flood risk management option will be welcome during this time.

Your views and opinions are welcome at all times to Katie.Smart@rpsgroup.com.

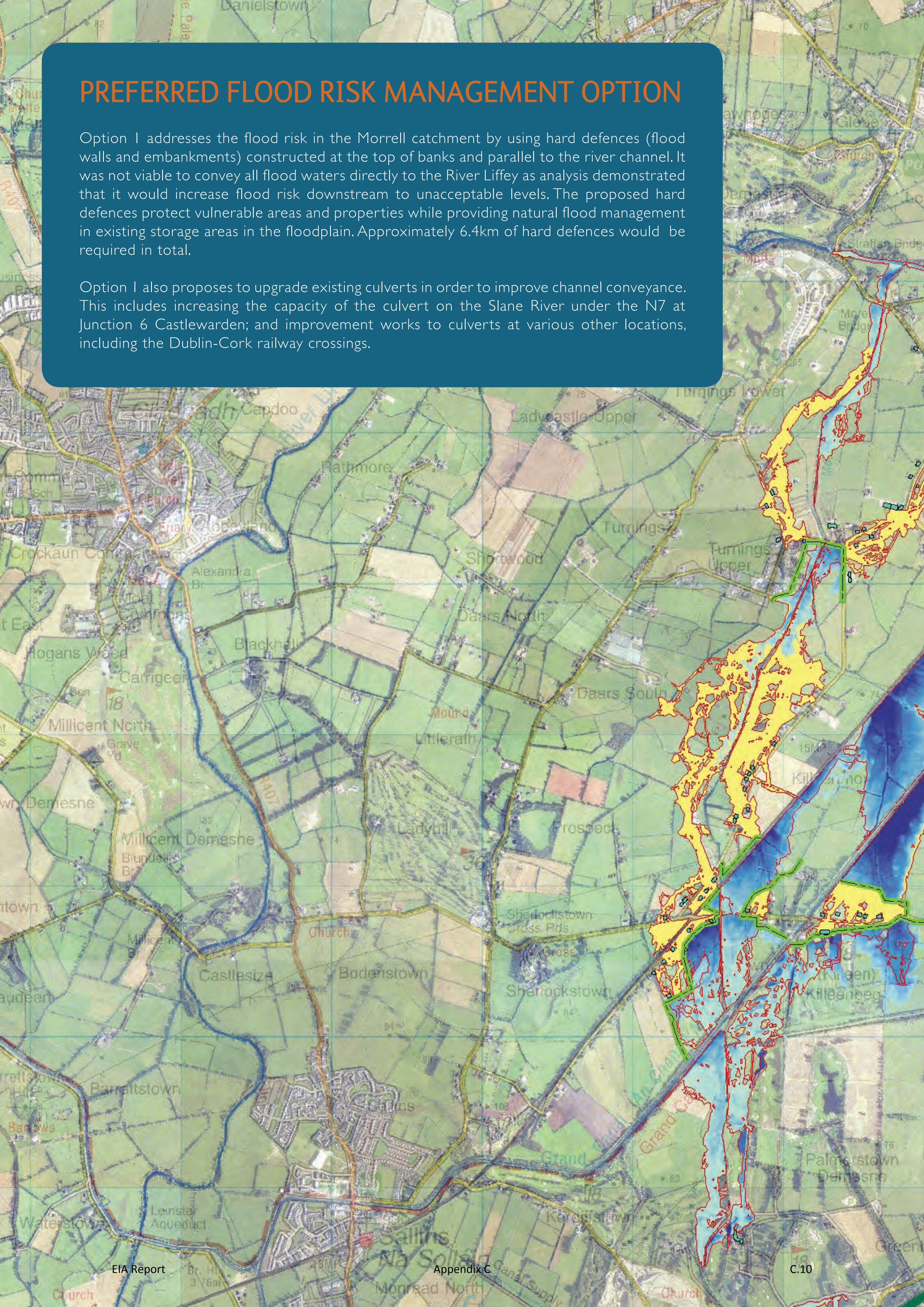
OPW The Office of Public Works Oifig na nOibreacha Poiblí

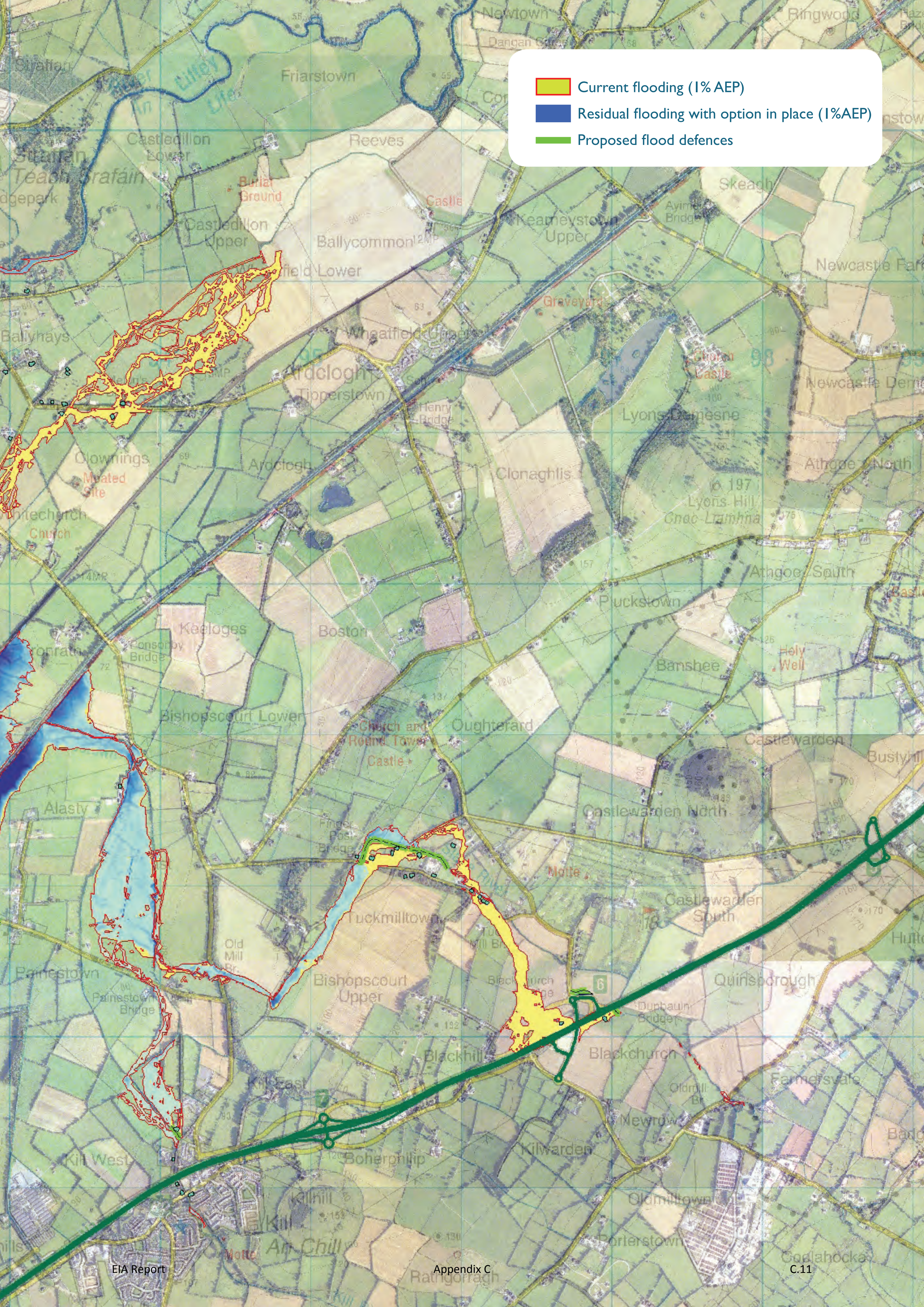
RPS

PREFERRED FLOOD RISK MANAGEMENT OPTION

Option 1 addresses the flood risk in the Morrell catchment by using hard defences (flood walls and embankments) constructed at the top of banks and parallel to the river channel. It was not viable to convey all flood waters directly to the River Liffey as analysis demonstrated that it would increase flood risk downstream to unacceptable levels. The proposed hard defences protect vulnerable areas and properties while providing natural flood management in existing storage areas in the floodplain. Approximately 6.4km of hard defences would be required in total.

Option 1 also proposes to upgrade existing culverts in order to improve channel conveyance. This includes increasing the capacity of the culvert on the Slane River under the N7 at Junction 6 Castlewarden; and improvement works to culverts at various other locations, including the Dublin-Cork railway crossings.




Current flooding (1% AEP)
Residual flooding with option in place (1%AEP)
Proposed flood defences
Newtown
Ringwood
Straffan
Friarstown
River Liffey
Castledillon Lower
Reeves
Burial Ground
Castle
Castledillon Upper
Ballycommon
Keameystown Upper
Skeagh
Newcastle Farm
Ballyhays
Graveyard
Wheatfield Upper
Ardclogh
Tipperstown
Henry Bridge
Newcastle Demesne
Lyons Demesne
Clownings
Moated Site
Ardclogh
Clonaghlis
Athgoe North
Lyons Hill
Cnoc Liamhna
Church
Athgoe South
Keeloges
Boston
Puckstown
Ponsonby Bridge
Banshee
Holy Well
Bishopscourt Lower
Church and Round Tower
Castle
Oughterard
Castlewarden
Bustyhill
Alasty
Castlewarden North
Motte
Castlewarden South
Tuckmilltown
Old Mill Br.
Palmerstown
Palmerstown Bridge
Bishopscourt Upper
Quinsborough
Dunbauin Bridge
Blackhill
Blackchurch
Farmersvale
Kill East
Oldmill Br.
Newrow
Boherphilip
Kilwarden
Kill West
Killhill
Oldmilltown
Kill
An Chill
Motte
Porterstown
Coolahocka
Rathgorragh

DEVELOPMENT OF FLOOD RISK MANAGEMENT OPTIONS

There are a series of steps involved in the development of flood risk management

Identify Flood Risk

Flood maps were produced to illustrate the extent of flooding as well as the receptors at risk from the flooding. This process was carried out by the Eastern CFRAM Study in 2013 and an example flood map is included on the front page of this information leaflet.

Develop Flood Risk Management Options

Once the flood risk was identified and quantified, a long list of potential measures to manage the flood risk was considered. A total of three Potential Flood Risk Management Options were identified for the Morrell catchment as follows.

1	Improved Conveyance	Storage adjacent to channel	Hard defences
		Localised protection works	Culverting
2	Upstream Storage	Retention ponds	Hard defences
		Culverting	Localised protection works
3	Full Conveyance	Hard defences	Culverting

Option 3 was, however, discounted when it was ascertained that it would increase flood risk in the Liffey catchment downstream, particularly at Celbridge.

Multi-Critera Analysis (MCA)

The two remaining potential Flood Risk Management Options then underwent multi-criteria analysis where each option was scored according to its success in achieving objectives under a range of criteria including technical, economic, social and environmental criteria. The maximum score that can be achieved is 4,575. Option 1 scored better overall than Option 2 in this exercise.

	Option 1	Option 2
MCA score	2,906	2,676

Cost-Benefit Analysis (CBA)

The cost of allowing the flooding to occur was then calculated. A monetary damage value was assigned to properties, utility infrastructure, emergency services and the national road network. The cost of the damages arising due to flooding in the Morrell catchment was calculated at €20,920,635.

This figure was compared to the cost of implementing the options to see if either of them is cost-beneficial. The higher the ratio of benefit to cost, the more cost-beneficial the option is. Option 1 was found to be significantly more cost-beneficial than Option 2.

	Option 1	Option 2
CBA score	1.74	1.00

At this point, Option 1 is the preferred option as it scored best in the multi-criteria analysis and is significantly more cost-beneficial. This option is now being taken forward to public consultation. All comments received in relation to Option 1 will be considered, and appropriate changes or amendments will be made, to produce an updated preferred option. The option will then proceed to detailed design and environmental impact assessment. It is the intention of Kildare County Council to begin construction of the flood alleviation scheme, provided all approvals and planning permission has been secured, in the summer of 2015.

RPS

West Pier Business Campus, Dun Laoghaire, Co. Dublin, Ireland
T +353 (0)1 488 2900 E ireland@rpsgroup.com W rpsgroup.com/ireland

Mr. Emmet Stagg
Straffan Anglers Association
736 Lodge Park
Straffan
Co. Kildare

June 15th 2015

Our Ref: Stakeholder EIA Letter
File Ref: MDW0575Lt0009 -Stakeholder EIA Letter Mail Merge

Re: River Morrell Flood Management Scheme – Environmental Impact Assessment

Dear Mr. Stagg,

I am writing to you to inform you that RPS has been appointed by Kildare County Council to provide the environmental consultancy services associated with the above mentioned scheme. The extent of the River Morrell catchment associated with this scheme is shown in Figure 1.

The Office of Public Works (OPW) commissioned RPS to undertake the Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study in June 2011. The Eastern CFRAM Study was the second RBD level CFRAM study to be commissioned in Ireland under the OPW's CFRAM Programme in accordance with national flood policy (2004).

Due to the significance of the flooding that has taken place in the Morrell Catchment and concern amongst residents, the Morrell catchment was prioritised within the Eastern CFRAM Study programme under which it was known as 'Turning/Killeenmore (AFA)'.

The Morrell catchment was prioritised and an advanced project was carried out during 2013 to accelerate the development of flood mapping for this Area for Further Assessment (AFA). This included topographical surveys of river channels and floodplains, hydrological analysis of river flows and water levels, and hydraulic modelling to predict how and where flooding is likely to occur.

Draft flood maps were prepared, showing the likely extent of flooding under a range of scenarios, and were presented to elected members on 9th April 2013 and at a public consultation day on 16th April 2013.

In 2014 a range of options for managing flood risk in the Morrell catchment were presented to Kildare County Council elected members on 2nd October 2014 and at a public consultation day on 23rd October 2014. Submissions received in reponse to those consultations have been reviewed and incorporated as appropriate.

Landowner liaisons have been ongoing throughout the preparation of the design options. Those design options have been assessed and the preferred option is progressing through the Environmental assessment process.

RPS

The following environmental stages form an integral part of this process;

Stage 1	
- Environmental Constraints Report	Complete
Stage 2	
- Environmental Assessment of Viable Options	Complete
- Screening for Appropriate Assessment	Current Undertaking
Stage 3	
- Environmental Impact Assessment (EIA)	Current undertaking

RPS has commenced Stage 3 of this process – Environmental Impact Assessment. If you would like to make a comment regarding Stage 3 of the scheme, please forward your correspondence for review to katherine.keogh@rpsgroup.com by Friday July 10th 2015.

The study recommends flood management works at a number of locations within the study area. The project is now being progressed through final design.

Yours sincerely,

Jean Hobbs.

Jean Hobbs,
Technical Director,
For and on behalf of RPS

KK/JFH

ENCL Figure 1 Study Area

Mr Ian Lumley

Heritage Officer
An Taisce,
Tailors Hall,
Back Lane,
Dublin 8.

Bat Conservation Ireland
Office 8, Unit 8D,
Dunshauglin Business Park,
Co. Meath .

Birdwatch Ireland
Unit 20, Block D
Bullford Business Campus
Kilcoole Co. Wicklow

The Minister

Department of the Environment, Community and
Local Government
Newtown Road,
Wexford

The Manager

Architecture Section
Deparment of Arts, Heritage and the Gaeltacht
Development Applications Unit,
Newtown Road,
Wexford

The Minister

Department of Agriculture, Food and the Marine
Agriculture House,
Kildare Street,
Dublin 2.

The Minister

Dept. of Communications, Energy and Natural Resources
29-31 Adelaide Road,
Dublin 2.

Mr Paddy Matthews

Failte Ireland
88-95 Amiens Street,
Dublin 1.

Dr Sarah Gatley

Senior Geoligist Irish Geological Heritage Section
Geological Survey of Ireland
Geological Survey of Ireland,
Beggars Bush,
Haddington Road, Dublin 5.

Health Service Executive
Oak House,
Millennium Park,
Naas, Co. Kildare

Ms Joanne Pender

Irish Wildlife Trust
Sigmund Business Centre,
93A Lagan Road,
Glasnevin, Dublin 11.

Ms Annamarie McNally

Programme Administrator
National Roads Authority
St. Martins Lane,
Waterloo Road,
Ballsbridge, Dublin 4.

The Arts Council
70 Merrion Square,
Dublin 2

Ms Alison Harvey

Planning Officer
The Heritage Council
Aras na hOidhreachta,
Church Lane,
Kilkenny.

Mr Seán Clerkin

National Federation of Group Water Schemes
24 Old Cross Square,
Monaghan

The Irish Farmers Association
Irish Farm Centre,
Bluebell,
Dublin 12.

Teagasc
Oak Park,
Carlow

NRA
St Martins House
Waterloo Rd,
Dublin 4

Railway Safety Commission
Trident House,
Blackrock,
County Dublin.

Irish Water
Colvill House,
24-26 Talbot Street,
Dublin 1

EPA
PO Box 3000
Johnstown Castle Estate
County Wexford

Mr Ray Earle

ERBD Coordinator
ERBD
Dublin City Council
4th Floor
68-70 Marrowbone Lane Dublin 8

The Manager

The Kildare Hotel, Spa & Country Club
Straffan
Co. Kildare

Conor Graham

The Clane Trout & Salmon Anglers Association
7 Lowtown Manor
Roberstown
Co. Kildare

J.R. Miley

Dublin Trout Anglers' Association
4 Dodder Park Road,
Dublin 14.

Mr Chris Hoban

National Roads Design Office
Aras Chill Dara
Devoy Park
Naas, Co. Kildare

Ms Gretta Hannigan

Senior Fisheries Environmental Officer
Inland Fisheries Ireland
15a Main Street
Blackrock,
Co. Dublin

Ms Ciara Flynn

National Parks and Wildlife

Mr John G. Murphy

Regional Engineer
Office of Public Works
Head Office
Jonathon Swift Street
Trim Co. Meath

Mr Mervyn Hamilton

Waterways Ireland
Eastern Regional Office
Floor 2, Ashtown Gate
Navan Road Dublin 15

25th January 2017

Environment Section
Edele O'Brien

Morrell Flood Management Scheme

Public Information Day

Dear Sir/Madam,

Following representations from Kildare County Council members and staff and in response to concerns voiced by residents and landowners, the development of a Flood Risk Management Plan for the Morrell catchment has been a priority of the council.

In 2013, a catchment-level assessment of flood risk in the Morrell catchment was undertaken. This included topographical surveys of river channels and floodplains, hydrological analysis of river flows and water levels, and hydraulic modelling to predict how and where flooding is likely to occur. Draft flood maps were prepared, showing the likely extent of flooding under a range of scenarios, and were presented to elected members on 9th April 2013 and at a public consultation day on 16th April 2013. Comments were invited on the maps which were subsequently finalised in October 2013.

In late 2013, RPS Consulting Engineers were appointed to undertake the preliminary design, environmental impact assessment and detailed design of a scheme to manage the identified flood risk. The scheme has been designed to perform technically, socially and environmentally. Crucially, the scheme is also cost-beneficial i.e. the financial benefit that accrues from the reduction of flooding in the area out-weighs the cost of installing and maintaining the option.

The scheme includes the construction of embankments at several locations within the river catchment to block and restrict the pathways of floodwaters.

It is now the intention of Kildare County Council to submit the Environmental Impact Statement for the scheme to An Bord Pleanala for it's approval. Construction of the flood managment scheme may commence, if all approvals and planning permission has been secured, in the summer of 2017.

A Public Information Day is taking place at Killeen Golf Club, Killeenmore, Kill, Co. Kildare on 1st February from 2pm to 7pm. You are invited to attend to view the proposed scheme.

Should you have any queries regarding the proposed scheme, you can contact the undersigned at 045 980588 or at eobrien@kildarecoco.ie

Yours sincerely,

Edele O'Brien,

Executive Engineer.

Appendix D

Screening for Appropriate Assessment

Appendix D

RPS

Morell River Flood Management Scheme

Screening for Appropriate Assessment

July 2017

rpsgroup.com/ireland

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

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1 INTRODUCTION

This report comprises information in support of screening for Appropriate Assessment in line with the requirements of the Planning and Development (Amendment) Act 2010-2015 and the European Union (Birds and Natural Habitats) Regulations 2011 as amended for the Morell Flood Management Scheme (FMS).

1.1 BACKGROUND

The Morell River catchment in County Kildare experiences significant flooding and the Morell Flood Management Scheme (FMS) Study was undertaken by RPS, on behalf of Kildare County Council, to identify flood risk management options to address flood risk in the catchment and prepare all of the relevant documentation in order to submit a FMS for planning application. Ecological surveys in respect of the earlier version of the EIS were conducted in 2014/2015. The EIS was not finalised at that time as the project was put on hold. More recently the documentation required for the planning process has been updated in terms of findings from consultations, additional ecological fieldwork and legislative changes.

1.2 LEGISLATIVE BACKGROUND FOR APPROPRIATE ASSESSMENT

The Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, better known as the "Habitats Directive" provides legal protection for habitats and species of European importance. Articles 3 to 9 provide the legislative means to protect habitats and species of Community Interest through the establishment and conservation of an EU-wide network of sites known as the Natura 2000 network. These are Special Areas of Conservation (SACs) designated under the Habitats Directive; and Special Protection Areas (SPAs) designated under the Conservation of Wild Birds Directive (79/409/ECC), as codified by Directive 2009/147/EC.

Articles 6(3) and 6(4) of the Habitats Directive set out the decision-making tests for plans and projects likely to affect European Sites (Annex 1.1). Article 6(3) establishes the requirement for AA:

> *Any plan or project not directly connected with or necessary to the management of the [European] site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.*

Article 6(4) states:

> *If, in spite of a negative assessment of the implications for the [European] site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, Member States shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.*

The Habitats Directive has been transposed into Irish law by the Planning and Development Act 2000 (as amended) and the European Union (Birds and Natural Habitats) Regulations 2011 as amended. The governing legislation is principally Part XAB (s. 177S) of the Planning and Development Act which requires that a Competent Authority (in this case Kildare County Council) *must take appropriate steps to avoid the deterioration of natural habitats and the habitats of species as well as the disturbance of species for which the site has been designated, in so far as such disturbance could be significant in relation to the objectives of the Habitats Directive*.

1.2.1 Role of the Competent Authority

Kildare County Council, in its role as the Competent Authority, is obliged to examine the likely significant effects individually or in combination, of the proposed development on European Sites in light of their specific qualifying interests and conservation objectives. If AA screening determines that there is likely to be significant effects on a European Site, then full AA must be carried out for the proposed works, including the compilation of a Natura Impact Statement to inform the decision making.

1.3 STAGES OF APPROPRIATE ASSESSMENT

The AA process progresses through four stages. If at any stage in the process it is determined that there will be no adverse effect on the integrity of a European Site in view of the sites conservation objectives, the process is effectively completed. The four stages are as follows:

- Stage 1 – Screening of the proposed plan or project for AA;
- Stage 2 – An AA of the proposed plan or project;
- Stage 3 – Assessment of alternative solutions; and
- Stage 4 – Imperative Reasons of Overriding Public Interest (IROPI)/ Derogation.

Stages 1 and 2 relate to Article 6(3) of the Habitats Directive; and Stages 3 and 4 to Article 6(4).

Stage 1: Screening for AA

The aim of screening is to assess firstly if the plan or project is directly connected with or necessary to the management of European Site(s); or in view of best scientific knowledge, if the plan or project, individually or in combination with other plans or projects, is likely to have a significant effect on a European Site. This is done by examining the proposed plan or project and the conservation objectives of any European Sites that might potentially be affected. If screening determines that there is potential for significant effects or there is uncertainty regarding the significance of effects then it will be recommended that the plan or project is brought forward to the next stage of the AA process.

Stage 2: Appropriate Assessment

The aim of stage 2 of the AA process is to identify any adverse impacts that the plan or project might have on the integrity of relevant European Sites. As part of the assessment, a key consideration is 'in combination' effects with other plans or projects. Where adverse impacts are identified, mitigation measures can be proposed that would avoid, reduce or remedy any such negative impacts and the plan or project should then be amended accordingly, thereby avoiding the need to progress to Stage 3.

Stage 3: Assessment of Alternative Solutions

If it is not possible during Stage 2 of the AA process to conclude that there will be no adverse effects on site integrity, Stage 3 of the process must be undertaken which is to objectively assess whether alternative solutions exist by which the objectives of the plan or project can be achieved. Explicitly, this means alternative solutions that do not have adverse impacts on the integrity of a European Site. It should also be noted that EU guidance on this stage of the process states that, '*other assessment criteria, such as economic criteria, cannot be seen as overruling ecological criteria'* (EC, 2001). In other words, if alternative solutions exist that do not have adverse impacts on European Sites; they should be adopted regardless of economic considerations. This stage of the AA process should result in the identification of the least damaging options for the plan or project.

Stage 4: Imperative Reasons of Overriding Public Interest (IROPI)/Derogation

This stage of the AA process is undertaken when it has been determined that a plan or project will have adverse effects on the integrity of a European Site, but that no alternatives exist. At this stage of the AA process, it is the characteristics of the plan or project itself that will determine whether or not the competent authority can allow it to progress. This is the determination of 'over-riding public interest'.

It is important to note that in the case of European Sites that include in their qualifying features 'priority' habitats or species, as defined in Annex I and II of the Directive, the demonstration of 'over-riding public interest' is not sufficient and it must be demonstrated that the plan or project is necessary for 'human health or safety considerations'. Where plans or projects meet these criteria, they can be allowed, provided adequate compensatory measures are proposed. Stage 4 of the process defines and describes these compensation measures.

2 METHODOLOGY

2.1 GUIDANCE DOCUMENTS ON APPROPRIATE ASSESSMENT

The AA requirements of Article 6 of the Habitats Directive 92/43/EEC (European Communities, 2001) follow a sequential approach as outlined in the following legislation and guidance documents/ Departmental Circulars, namely:

European and National Legislation

- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (also known as the 'Habitats Directive');
- Council Directive 2009/147/EC on the conservation of wild birds, codified version (also known as the 'Birds Directive');
- European Communities (Birds and Natural Habitats) Regulations 2011 as amended; and
- Planning and Development Act 2000 as amended.

Guidance

- *Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities.* Department of Environment, Heritage and Local Government, 2010 revision.
- *Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities.* Circular NPWS 1/10 and PSSP 2/10.
- *Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological Guidance on the provisions of Article 6(3) and 6(4) of the Habitats Directive 92/43/EEC* (European Commission Environment Directorate-General, 2001).
- *Managing Natura 2000 Sites: The provisions of Article 6 of the Habitat's Directive 92/43/EEC* (European Commission Environment Directorate-General, 2000)[1].
- *Guidance Document on Article 6(4) of the 'Habitat's Directive 92/43/EEC. Clarification of the Concepts of Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence.* Opinion of the European Commission (European Commission January 2007).
- *Communication from the Commission on the precautionary principle.* European Commission (2000).
- EC study on evaluating and improving permitting procedures related to Natura 2000 requirements under Article 6.3 of the Habitats Directive 92/43/EEC. (European Commission, 2013).

Department/NPWS Circulars

- *Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities.* Circular NPWS 1/10 and PSSP 2/10.
- *Appropriate Assessment of Land Use Plans*. Circular Letter SEA 1/08 & NPWS 1/08.
- *Water Services Investment and Rural Water Programmes – Protection of Natural Heritage and National Monuments*. Circular L8/08.
- *Guidance on Compliance with Regulation 23 of the Habitats Directive.* Circular Letter NPWS 2/07.

[1] The Commission has notified its intent to revise this guidance and a draft revised document was published in April 2015. It would appear that this has not been finalised to date, with no revised guidance document available on the Commissions website.

- *Compliance Conditions in respect of Developments requiring (1) Environmental Impact Assessment (EIA); or (2) having potential impacts on Natura 2000 sites*. Circular Letter PD 2/07 and NPWS 1/07.

2.2 GUIDING PRINCIPLES AND CASE LAW

Over time legal interpretation has been sought on the practical application of the legislation concerning AA as some terminology has been found to be unclear. European and National case law has clarified a number of issues and some aspects of the published guidance documents have been superseded by case law. Case law has been considered in the preparation of this document.

2.3 INFORMATION CONSULTED

The screening exercise is based on a desktop study, that has been informed by site visit as part of the ecological assessment and which utilised the following sources of information:

- Preliminary information on the location, nature and design of the proposed works supplied by the RPS design team;
- As yet unpublished results of the Ecological Impact Assessment studies 2015 and 2017 (RPS);
- Department of Housing, Planning, Community and Local Government – online land use mapping www.myplan.ie/en/index.html;
- National Parks and Wildlife Service – online European Site information www.npws.ie;
- National Parks and Wildlife Service – Information on the status of EU protected habitats and species in Ireland (NPWS, 2013a & 2013b);
- National Biodiversity Data Centre – www.biodiversityireland.ie;
- Ordnance Survey of Ireland – Mapping and aerial photography www.osi.ie;
- GeoHive online mapping - http://map.geohive.ie/mapviewer.html;
- Environmental Protection Agency – Water quality www.epa.ie;
- Geological Survey of Ireland – Geology, soils and hydrogeology www.gsi.ie;
- Information on the conservation status of birds in Ireland (Colhoun & Cummins 2013);
- Information on the Eastern River Basin District - www.erbd.ie;
- *Kildare County Development Plan 2011-2017*
- *Draft Kildare County Development Plan 2017 – 2023:* Chief Executive's Report*;*
- *Sallins Local Area Plan 2015-2021*; and
- Office of Public Works flood mapping – wwwfloodmaps.ie

2.4 SCREENING PROTOCOL

2.4.1 Screening Sequence

- Determine whether a project or plan is directly connected with or necessary to the conservation management of a European Site(s);
- Describe the project or plan;
- Identify the European Sites potentially affected by the project or plan;
- Identify and describing any potential effects of the project or plan on European Sites, alone, in-combination and cumulatively with other plans/projects; and
- Assess the likelihood of significant effects on European Sites.

3 SCREENING OF EUROPEAN SITES

3.1 BRIEF DESCRIPTION OF THE RECEIVING ENVIRONMENT

Located north-west of Sallins, the area is largely rural. Ecological survey of the entire scheme route was originally carried out in August 2014, with some additional survey work carried out in June 2015. Further surveys were undertaken on January 24th, 25th and 26th 2017 in light of further design modifications.

The proposed flood management scheme is applicable to the Morell catchment in County Kildare. It is situated within the Eastern River Basin District (ERBD) and Hydrometric Area (HA)/Unit of Management (UoM) 9 (**Figure 3-1**). The landscape is largely characterised by grassland habitats although hedgerow and patchily distributed woodland vegetation was also noted. Other obvious habitats (*sensu* Fossit, 2000) include roads, railway and canals as well as scattered dwellings/farmhouses.

A considerable percentage of the receiving lands are characterised by improved grasslands – largely agricultural but also including transitions to wet grassland and marsh, owing to the influence of waterlogged or flooded soils. There are some areas of drier grassland habitat notably associated with verges or amenity lands such as golf-courses.

Vegetation dominated by extensive woodland is not common although boundary delineation between most land parcels comprises hedgerows (in various degrees of upkeep). There are a number of treelines across the catchment. In terms of woodland vegetation a number of distinct habitats were noted. These include riparian woodland along the north eastern bank of the Slane River, a small parcel of Scot's pine (*Pinus sylvestris*) dominated mixed conifer woodland at Killeenmore and patchily distributed bands, typically small in nature, of mixed broadleaf woodland.

None of the terrestrial habitats surveyed in the study area correspond to Annex I habitats, and the ecological evaluation of most is ranked at the lower end of the 'local value' (as per the NRA scheme). This reflects their widespread nature and the lower floristic diversity. That is not to discount their inherent value as refuges or stepping stones for wildlife.

The main rivers in the catchment are the Morell River (itself a tributary of the River Liffey) and its tributaries the Painstown, Slane and Kill rivers. The Grand Canal flows through the catchment from north-east to south-west. Historically, sections of land within the Morell River Catchment have been prone to considerable waterlogging which has influenced the extent and composition of the habitats. The importance of these watercourses is recognised owing to the salmonid nursery habitat and potential presence of Otter (*Lutra lutra*).

In terms of overall ecological sensitivity, it is the watercourses and associated riparian vegetation including hedgerows that are the sensitive features within the study area. It is in these areas that the bulk of the disturbance/change will occur as a result of the proposed flood relief scheme.

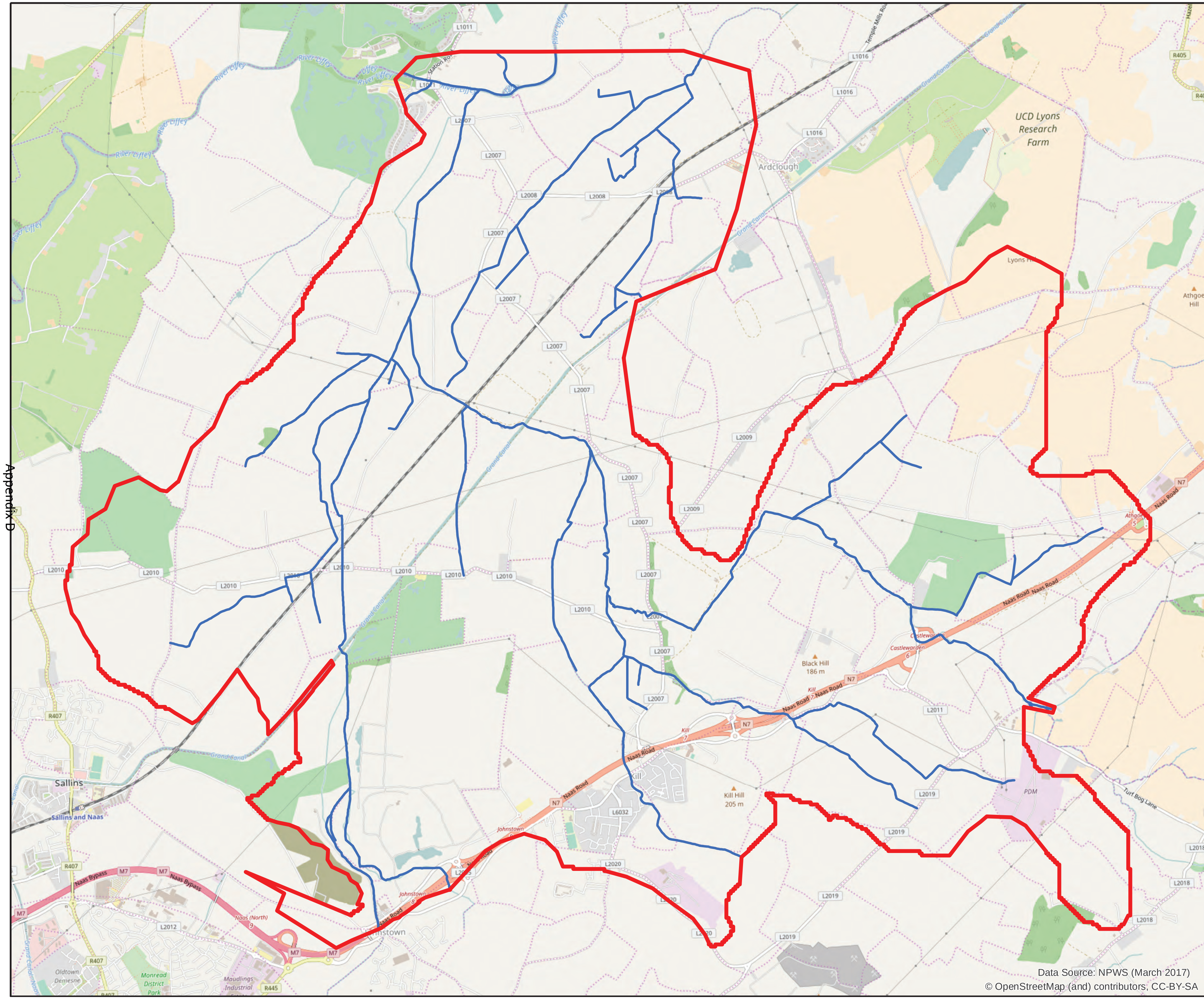
3.2 DESCRIPTION OF THE PROJECT

This section describes the basis of design for the proposed scheme and the main features of the proposed scheme. This description is based on the outline design of the scheme, which includes comprehensive information on all aspects of the works and which is considered sufficient to allow a robust impact assessment of the works to be undertaken.

The works proposed for the flood management scheme will include the construction of culverts, embankments, flood walls, stream realignment works and tie-ins to existing structures. A detailed description of the activities required to construct the proposed development, including temporary works, is provided in Chapter 4 of the EIS and a summary provided in **Section 3.3** of this document.

The basis of the scheme design was informed by the preferred design standards identified by the OPW (i.e. flood event probabilities that the Scheme and risk management measures and options should address), and that the scheme has been designed to alleviate flooding to properties for the 1% AEP (Annual Exceedance Probability), with provision for future adaptability to the Mid-Range Future Scenario for climate change.

The proposed scheme works will involve the construction of just over 7.4km of embankments that will have to be constructed or remediated in addition to 0.5km of wall for construction in order to redirect flood waters away from high risk areas. Several walls and embankments are also proposed to tie into existing culverts.



Legend

Morell catchment

Morell Catchment Rivers

N

0 0.25 0.5 1 Kilometers

Client

Kildare County Council

Morell River Flood Management Scheme

Figure 3.1

Morell Catchment

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Issue Details

Drawn By: LH	**File Ref:**
Checked By: TR	MDW0575Arc0050D01
Approved By: TR	**Scale:** 1:31,744 (A4)
Date: 24/03/2017	**Map Projection:** ITM

NOTE:

1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
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3.3 KEY CHARACTERISTICS OF THE PROPOSED SCHEME

A detailed description of the key characteristics of the proposed works is contained in Chapter 4 of the EIS report. Below is a brief summary of the extent of the works:-

- The proposed scheme involves the construction of approximately 7,423 metres of new embankments. These new embankments will consist of clay core with surrounding fill materials covered in topsoil. Once completed embankments will be seeded with grass.
- There are approximately 1,842m of existing embankments that may require restoration works to be carried out in order to meet the minimum standard of protection required under the scheme. These embankments will be/have been assessed for structural integrity prior to the scheme's detailed design. The report on this integrity will determine the level and extent of the restoration required.
- The scheme will require *c.* 474m of new flood walls, ranging in height from 1.0m to 2.0m. All walls will be constructed from reinforced concrete poured in situ.
- The scheme also includes works at several existing culverts. One culvert (C22), beneath the N7 which is currently throttled to reduce flow, will have its throttle opened to increase flows. Two culverts which cross beneath the Dublin-Cork railway line (C4, C4a) will be throttled to reduce flows.
- Two culverts have been identified as requiring in-stream works for the installation of scour protection measures (C5 & C10). One culvert (C9) is in a poor state of repair and will require remediation.
- A further five culverts (C1, C2, C7, C18 & C19) will have tie-ins with embankments. These culverts will be structurally assessed at the detailed design stage to determine if they require scour protection measures or underpinning. Where such works are found to be required, the same mitigation protocols are per culverts C5, C10 and C9 will be adhered to.
- Stream realignment works (approximately 100 metres) are also proposed at two locations, namely ***Slane 8*** and ***Morr 8*** in Tuckmilltown and Killeenmore.

A number of protective measures have been built into the design phase and construction methodology of the proposed project (see the outline Construction Environmental Management Plan included in **Appendix B** of this document).

It is also noted that Chapter 11 of the EIS on Biodiversity- Aquatic Ecology (Section 11.4.1.5.2) includes further details of protective measures which will be required for the proposed stream realignments. It is proposed that the plant required can operate from the river bank without need to enter the stream. Protective measures, described in more detail in Chapters 11 (Biodiversity- Aquatic Ecology), 12 (Hydrology & Drainage) and 13 (Soil, Geology and Hydrogeology) of the EIS report, include methods to prevent silt runoff. A detailed method statement for the realignment will be discussed and agreed with the relevant authorities in advance of the works commencing.

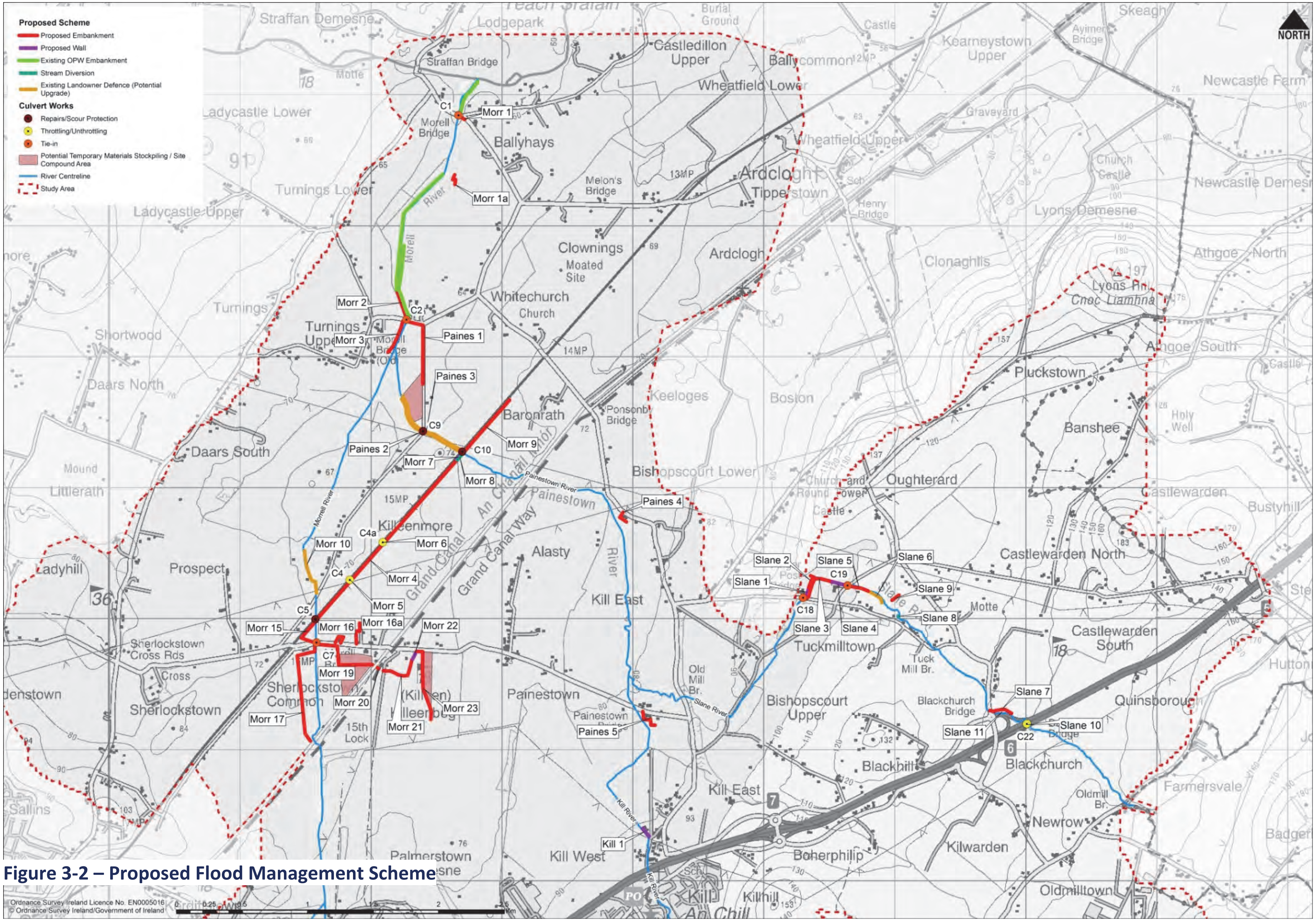


Figure 3-2 – Proposed Flood Management Scheme

3.4 CONSULTATION

In June 2015, a letter was issued by Kildare County Council to the following organisations informing them of the work of the Morell FMS and inviting submissions. Submissions and observations, via letter and over the phone, were received from several of the organisations.

- Department of Environment, Community and Local Government (DECLG)[2];
- Department of Communications, Energy and Natural Resources (DCENR)[3];
- Department of Agriculture, Food and the Marine (DAFM);
- Department of Arts, Heritage and the Gaeltacht (DAHG)[4];
- Environmental Protection Agency (EPA);
- National Parks and Wildlife Service (NPWS);
- Inland Fisheries Ireland (IFI);
- Waterways Ireland; and
- Irish Rail.

The results of consultation with IFI are detailed in Chapter 11 Biodiversity- Aquatic Ecology of the EIS, which assesses impacts on aquatic flora and fauna, including water quality and fisheries. Consultation with the NPWS was sought on 23rd June 2015 and they responded on 28th July 2015. A summary of the correspondence is contained in Chapter 2 of the EIS, along with further details of the consultations undertaken for the proposed scheme.

3.5 BRIEF DESCRIPTION OF THE EUROPEAN SITES

European Sites comprise (a) Special Areas of Conservation (SACs) that are designated under the Habitats Directive as requiring the conservation of important, rare or threatened habitats and species (other than birds) and (b) Special Protection Areas (SPAs), which are designated under the Birds Directive to conserve certain migratory or rare birds and their habitats. Collectively, these sites form the Natura 2000 network. In accordance with DEHLG Guidance (2009), the AA also takes into account transboundary impacts where it is identified that the proposed project has the potential to impact on European Sites in Northern Ireland.

A buffer of 15km is typically taken as the initial zone of influence (ZoI) extending beyond the reach of the footprint of a plan or project, as per Ministerial guidance (DoEHLG, 2010), although there may be scientifically appropriate reasons for extending this ZoI further afield depending on the pathway of potential impacts. Owing to the hydrological connectivity between the Morell catchment and the River Liffey system, consideration was given to European Sites within Dublin Bay (as the River Liffey discharges directly into Dublin Bay, at Dublin Port). Therefore, for clarity and comprehensiveness, an extension of the ZoI to include these sites is considered necessary in this case. It was decided that the ZoI would be taken as the Liffey Catchment area (see **Figure 3.3**) as this boundary is accurately delineated and encompasses the Morell and Liffey river systems.

The European Sites (twelve SACs and nine SPAs) that have been assessed are listed in **Table 3.2** and shown in **Figure 3.3**. The spatial boundary for the European Sites shown in this figure is the most recently issued by NPWS (March 2017).

[2] Since 2016 known as the Department of Housing, Planning and Local Government (DHPLG).
[3] Since 2016 known as the Department of Communications, Climate Action and Environment (DCCAE).
[4] Since 2016 known as the Department of Arts, Heritage, Regional Rural and Gaeltacht Affairs (DAHRRGA).

Table 3.1 – European Sites within the Zone of Influence.

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
Special Areas of Conservation (SACs)			
Red Bog, Kildare SAC (000397)	**Conservation Objectives Generic Version 5.0 (15/08/2016)** **Annex I Habitats** ▪ Transition mires and quaking bogs* [7140]	*ca.* 4 km	No. There is no connectivity between the proposed works and the European Site due to the distance and the lack of hydrological connectivity between them.
Rye Water Valley/Carton SAC (001398)	**Conservation Objectives Generic Version 5.0 (15/08/2016)** **Annex I Habitats** ▪ Petrifying springs with tufa formation (*Cratoneurion*)* [7220] **Annex II Species** ▪ Narrow-mouthed Whorl Snail (*Vertigo angustior)* [1014] ▪ Desmoulin's Whorl Snail *(Vertigo moulinsiana)* [1016]	*ca.* 8 km	No. There is no connectivity between the proposed works and the site due to the distance and the lack of hydrological connectivity between them. The Rye Water joins the Liffey near Leixlip, with the designated site immediately upstream of the confluence.
Glenasmole Valley SAC (001209)	**Conservation Objectives Generic Version 5.0 (15/08/2016)** **Annex I Habitats** ▪ Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6210] ▪ *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeluleae*) [6410] ▪ Petrifying springs with tufa formation (*Cratoneurion*)* [7220]	*ca.* 9.5 km	No. There is no connectivity between the proposed works and the European Site due to the distance and the lack of hydrological/hydrogeological connectivity between them. Petrifying springs with tufa formation are a groundwater dependent habitat; the European Site for which they are designated is not hydrogeologically connected to the proposed works and therefore the works are not likely to impact this habitat.
Wicklow Mountains SAC (002122)	**Conservation Objectives Generic Version 5.0 (15/08/2016)** **Annex I Habitats** ▪ Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3110]	*ca.* 11 km	No. There is no connectivity between the proposed works and the SAC owing to the distance and the lack of hydrological connectivity between them. Otter territory

[5] Distance measured 'as the crow flies'.

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
	▪ Natural dystrophic lakes and ponds [3160] ▪ Northern Atlantic wet heaths with *Erica tetralix* [4010] ▪ European dry heaths [4030] ▪ Alpine and Boreal heaths [4060] ▪ Calaminarian grasslands of the *Violetalia calaminariae* [6130] ▪ Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and sub-mountain areas, in Continental Europe)* [6230] ▪ Blanket bogs (*active only) [7130] ▪ Siliceous scree of the montane to snow levels (*Androsacetalia alpinae* and *Galeopsietalia ladani*) [8110] ▪ Calcareous rocky slopes with chasmophytic vegetation [8210] ▪ Siliceous rocky slopes with chasmophytic vegetation [8220] ▪ Old sessile oak woods with *Ilex* and *Blechnum* in British Isles [91A0] **Annex II Species** ▪ Otter (*Lutra lutra*) [1355]		can range between 1km and 40km (with about 18km being usual). As there is no aquatic corridor between the SAC and the Morell catchment for Otter to utilise, they will not be affected by the works in the Morell catchment.
Mouds Bog SAC (002331)	**Conservation Objectives Version 1.0 (20/11/15)** **Annex I Habitats** ▪ Active raised bogs* [7110] ▪ Degraded raised bogs still capable of natural regeneration [7120] ▪ Depressions on peat substrates of the Rhynchosporion [7150]	*ca.* 9 km	No. There is no connectivity between the proposed works and the European Site due to the distance and the lack of hydrological connectivity between them.
Howth Head SAC (000202)	**Conservation Objectives Version 1.0 (06/12/16)** **Annex I Habitats** ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	*ca.* 30km	Yes. There is hydrological connectivity between this European Site and the proposed works. The Morell River drains into the River Liffey system which drains into

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
	▪ European dry heaths [4030]		Dublin Bay, which this European Site is located within.
North Dublin Bay SAC (000206)	**Conservation Objectives Version 1.0 (06/11/13)** **Annex I Habitats** ▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ Annual vegetation of drift lines [1210] ▪ *Salicornia* and other annuals colonising mud and sand [1310] ▪ Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] ▪ Mediterranean salt meadows (*Juncetalia maritimi*) [1410] ▪ Embryonic shifting dunes [2110] ▪ Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120] ▪ Fixed coastal dunes with herbaceous vegetation (grey dunes)* [2130] ▪ Humid dune slacks [2190] **Annex II Species** ▪ Petalwort (*Petalophyllum ralfsii*) [1395]	*ca.* 26km	Yes. There is hydrological connectivity between this European Site and the proposed works. The Morell River drains into the River Liffey system which drains into Dublin Bay, which this European Site is located within.
South Dublin Bay SAC (000210)	**Conservation Objectives Version 1.0 (22/08/13)** **Annex I Habitats** ▪ Mudflats and sandflats not covered by seawater at low tide [1140]	*ca.* 21km	Yes. There is hydrological connectivity between this European Site and the proposed works. The Morell River drains into the River Liffey system which drains into Dublin Bay, which this European Site is located within.
Rockabill to Dalkey Island SAC (003000)	**Conservation Objectives Version 1.0 (07/05/13)** **Annex I Habitats** ▪ Reefs [1170] **Annex II Species**	*ca.* 28km	Yes. There is hydrological connectivity between the proposed works and this European Site. The Morell River drains into the River Liffey system which drains into Dublin Bay,

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
	▪ Harbour porpoise (*Phocoena phocoena*) [1351]		which this European Site is located within.
Baldoyle Bay SAC (000199)	**Conservation Objectives Version 1.0 (19/11/12)** **Annex I Habitats** ▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ *Salicornia* and other annuals colonizing mud and sand [1310] ▪ Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] ▪ Mediterranean salt meadows (*Juncetalia maritimi*) [1410]	*ca.* 29km	No. While the proposed works are contained within the Liffey catchment and this European Site shares a terrestrial boundary within the Liffey catchment there is no connectivity between the proposed works and the site due to the distance and marine open water buffer between them.
Malahide Estuary SAC (000205)	**Conservation Objectives Version 1.0 (27/05/13)** **Annex I Habitats** ▪ Mudflats and sandflats not covered by seawater at low tide [1140] ▪ *Salicornia* and other annuals colonizing mud and sand [1310] ▪ *Spartina* swards (*Spartinion maritimae*) [1320] ▪ Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] ▪ Mediterranean salt meadows (*Juncetalia maritimi*) [1410] ▪ Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120] ▪ Fixed coastal dunes with herbaceous vegetation (grey dunes)* [2130]	*ca.* 30km	No. There is no connectivity between the proposed works and the site due to the distance and marine open water buffer between them.
Ireland's Eye SAC (002193)	**Conservation Objectives Version 1.0 (27/01/17)** **Annex I Habitats** ▪ Perennial vegetation of stony banks [1220] ▪ Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]	*ca.* 34km	No. There is no connectivity between the proposed works and the site due to the distance and marine open water buffer between them.

Appendix D

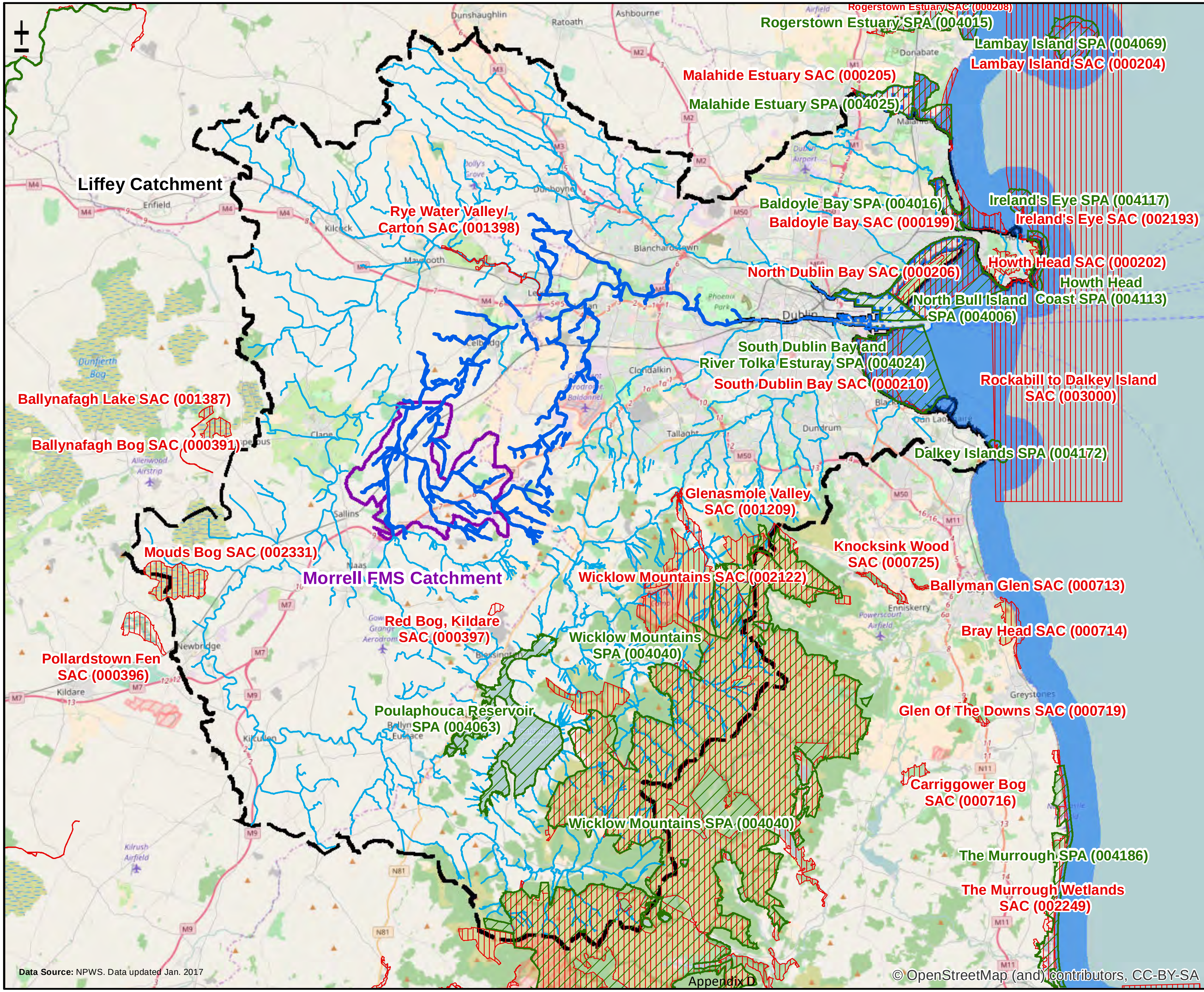
Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
Special Areas of Protection (SPAs)			
Poulaphouca Reservoir SPA (004063)	**Conservation Objectives Generic Version 5.0 (15/08/16)** ▪ Greylag Goose (*Anser anser*) [A043] ▪ Lesser Black-backed Gull (*Larus fuscus*) [A183]	*ca.* 5 km	No. There is no connectivity between the proposed works and the European Site due to the distance and the lack of hydrological connectivity between them. The Greylag Goose, a migratory bird, can be found in a varied range of habitats. Though it is mostly likely to be found in wetland habitats in Ireland, it can utilise lowland farmland during the non-breeding season. However, it is considered unlikely that the works in the Morell catchment will have any impact on the SCI birds associated with this site, due to the distance between this European Site and the proposed works. The Lesser Black-based Gull is predominantly a coastal species but can be associated with large lakes and rivers. This SCI species is unlikely to be found in the Morell catchment, an inland catchment without large rivers or lakes, and therefore this species would not be impacted by the proposed works.
Wicklow Mountains SPA (004040)	**Conservation Objectives Generic Version 5.0 (15/08/16)** ▪ Merlin (*Falco columbarius*) [A098] ▪ Peregrine (*Falco peregrinus*) [A103]	*ca.* 12 km	No. There is no connectivity between the proposed works and the European Site due to the distance and the lack of hydrological connectivity between them. Merlins typically breed in upland moorland but can favour coastal sites in winter. SCI species from this site are unlikely to be found in the Morell catchment due to the distance between this European Site and the proposed works and therefore would not be impacted by the proposed works. Peregrine falcons breed on coastal and inland cliffs and

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
			favour coastal sites in winter. SCI species from this site are unlikely to be found in the Morell catchment and therefore would not be impacted by the proposed works.
North Bull Island SPA (004006)	**Conservation Objectives Version 1.0 (09/03/15)** ▪ Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] ▪ Shelduck (*Tadorna tadorna*) [A048] ▪ Teal (*Anas crecca*) [A052] ▪ Pintail (*Anas acuta*) [A054] ▪ Shoveler (*Anas clypeata*) [A056] ▪ Oystercatcher (*Haematopus ostralegus*) [A130] ▪ Golden Plover (*Pluvialis apricaria*) [A140] ▪ Grey Plover (*Pluvialis squatarola*) [A141] ▪ Knot (*Calidris canutus*) [A143] ▪ Sanderling (*Calidris alba*) [A144] ▪ Dunlin (*Calidris alpina*) [A149] ▪ Black-tailed Godwit (*Limosa limosa*) [A156] ▪ Bar-tailed Godwit (*Limosa lapponica*) [A157] ▪ Curlew (*Numenius arquata*) [A160] ▪ Redshank (*Tringa totanus*) [A162] ▪ Turnstone (*Arenaria interpres*) [A169] ▪ Black-headed Gull (*Chroicocephalus ridibundus*) [A179]	*ca.* 26km	Yes. There is hydrological connectivity between this European Site and the proposed works. The Morell River drains into the River Liffey system which drains into Dublin Bay, which this European Site is located within.
South Dublin Bay and River Tolka SPA (004024)	**Conservation Objectives Version 1.0 (09/03/15)** ▪ Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] ▪ Oystercatcher (*Haematopus ostralegus*) [A130] ▪ Ringed Plover (*Charadrius hiaticula*) [A137]	*ca.* 21km	Yes. There is hydrological connectivity between this European Site and the proposed works. The Morell River drains into the River Liffey system which drains into

Appendix D

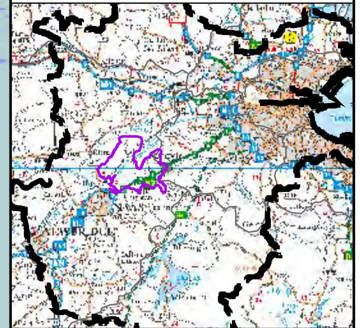
Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
	▪ Grey Plover (*Pluvialis squatarola*) [A141] ▪ Knot (*Calidris canutus*) [A143] ▪ Sanderling (*Calidris alba*) [A144] ▪ Dunlin (*Calidris alpina*) [A149] ▪ Bar-tailed Godwit (*Limosa lapponica*) [A157] ▪ Redshank (*Tringa totanus*) [A162] ▪ Black-headed Gull (*Chroicocephalus ridibundus*) [A179] ▪ Roseate Tern (*Sterna dougallii*) [A192] ▪ Common Tern (*Sterna hirundo*) [A193] ▪ Arctic Tern (*Sterna paradisaea*) [A194]		Dublin Bay, which this European Site is located within.
Baldoyle Bay SPA (004016)	**Conservation Objectives Version 1.0 (27/02/13)** ▪ Ringed Plover (*Charadrius hiaticula*) [A137] ▪ Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] ▪ Shelduck (*Tadorna tadorna*) [A048] ▪ Grey Plover (*Pluvialis squatarola*) [A141] ▪ Golden Plover (*Pluvialis apricaria*) [A140] ▪ Bar-tailed Godwit (*Limosa lapponica*) [A157]	*ca.* 29km	No. While the proposed works are contained within the Liffey catchment and this European Site shares a terrestrial boundary within the Liffey catchment there is no connectivity between the proposed works and the site due to the distance and marine open water buffer between them.
Dalkey Islands SPA (004172)	**Conservation Objectives Generic Version 5.0 (15/08/16)** ▪ Roseate Tern (*Sterna dougallii*) [A192] ▪ Common Tern (*Sterna hirundo*) [A193] ▪ Arctic Tern (*Sterna paradisaea*) [A194]	*ca.* 28km	No. There is no connectivity between the proposed works and the site due to the distance, marine open water buffer between them.
Howth Head Coast SPA (004113)	**Conservation Objectives Generic Version 5.0 (15/08/16)** ▪ Kittiwake (*Rissa tridactyla*) [A188]	*ca.* 33km	Yes. There is hydrological connectivity between this European Site and the proposed works. This European Site is located downstream of the proposed works in Dublin Bay.

Site Name	Qualifying Interest Habitats and Species (*=Priority Habitat)	Distance[5] from Proposed Works (km)	Connectivity
Malahide Estuary SPA (004025)	**Conservation Objectives Version 1.0 (16/08/13)** ▪ Great Crested Grebe (*Podiceps cristatus*) [A005] ▪ Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] ▪ Shelduck (*Tadorna tadorna*) [A048] ▪ Pintail (*Anas acuta*) [A054] ▪ Goldeneye (*Bucephala clangula*) [A067] ▪ Red-breasted Merganser (*Mergus serrator*) [A069] ▪ Grey Plover (*Pluvialis squatarola*) [A141] ▪ Golden Plover (*Pluvialis apricaria*) [A140] ▪ Oystercatcher (*Haematopus ostralegus*) [A130] ▪ Bar-tailed Godwit (*Limosa lapponica*) [A157] ▪ Dunlin (*Calidris alpina*) [A149] ▪ Knot (*Calidris canutus*) [A143] ▪ Black-tailed Godwit (*Limosa limosa*) [A156] ▪ Redshank (*Tringa totanus*) [A162]	*ca.* 30km	No. There is no connectivity between the proposed works and the site due to the distance, marine open water buffer between them.
Ireland's Eye SPA (004117)	**Conservation Objectives Version 1.0 (15/08/16)** ▪ Cormorant (*Phalacrocorax carbo*) [A017] ▪ Herring Gull (*Larus argentatus*) [A184] ▪ Kittiwake (*Rissa tridactyla*) [A188] ▪ Guillemot (*Uria aalge*) [A199] ▪ Razorbill (*Alca torda*) [A200]	*ca.* 34km	No. There is no connectivity between the proposed works and the site due to the distance and marine open water buffer between them.



Legend

- Liffey Catchment
- Morrell FMS Catchment
- Rivers Downstream of the FMS
- Transitional Waterbodies Downstream of FMS (Liffey Catchment)
- Coastal Waterbodies Downstream of FMS (Liffey Catchment)
- Rivers in the Liffey Catchment
- Special Protection Area
- Special Area of Conservation



Project
River Morrell FMS

Title
European Sites within the Liffey Catchment

Figure 3.3

RPS
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Issue Details

Drawn By:	NO'N	Project No.	MDW0575
Checked By:	TR	File Ref:	
Approved By:	TR		MDW0575Arc0047D01
Scale:	1:300,000 @ A4	Map Projection:	
Date:	21/03/2017		ITM (IRENET95)

4 ASSESSMENT CRITERIA

4.1 IS THE PROJECT NECESSARY TO THE MANAGEMENT OF EUROPEAN SITES?

The proposed project is not directly connected with or necessary to the management of any European Site.

4.2 DIRECT, INDIRECT OR SECONDARY IMPACTS

The potential impacts that could arise due to implementation of the proposed scheme and that could have a negative effect on the qualifying interests (QI)/special conservation interests (SCIs) of European Sites, in the absence of mitigation, include:-

- Habitat and species loss, disturbance or fragmentation;
- Water quality impacts (pollution, suspended solid release and sedimentation); and
- Hydromorphological impacts (changes to hydrological and morphological regime).

The likelihood of these impacts to significantly affect the QIs/SCIs and conservation objectives of the European Sites are considered in this Appropriate Assessment Screening report.

Table 3.1 lists the European Sites within and adjoining the ZoI of the proposed works (i.e. the Liffey catchment), whilst **Figure 3-3** illustrates the European Sites within and adjoining the ZoI of the proposed works. Whilst the Liffey catchment is considered the appropriate ZoI with regards to the proposed works, a number of proximal coastal European Sites have been included in the assessment owing to potential hydrological connectivity, for example some of the coastal sites of County Dublin. The proposed works do not lie within any European Site nor is it adjoining to or immediately contiguous with any European Sites. Therefore, no direct impacts are envisaged through land-take or fragmentation of habitats.

A source – pathway – receptor approach has been used as part of this assessment process. The pathway identified is the Morell River which drains into the River Liffey at the northern boundary of the Morell Catchment (see **Figure 3-1**). The Rye Water River also enters the River Liffey, at its confluence at Leixlip, Co. Kildare. The Rye Water River runs through the Rye Water Valley/Carton SAC. However, there is no connectivity between the Morell Catchment and this European Site as the European Site lies immediately upstream of the River Liffey and Rye Water River confluence. There is however hydrological connectivity to other European Sites, downstream of the proposed works within Dublin Bay.

As stated above, the Morell River drains into the River Liffey. Thereafter the Liffey discharges into the Liffey Estuary at Island Bridge weir (CFB, 2008). The Liffey Estuary extends downstream to coastal/open waters past both the Bull Wall and Great South Wall. The Liffey estuary is a transitional water body approximately 5km^2 in size and provides a dilution zone for inputs upstream of the estuary, before reaching Dublin Bay. Dublin Bay is located approximately 38km downstream of the confluence of the Morell River and the River Liffey, at Leixlip. Therefore, there is hydrological connectivity between the Morell Catchment and Dublin Bay by virtue of the fact that the Morell River flows into the River Liffey. There are fourteen European Sites within the greater Dublin coastal area with hydrological connectivity to the proposed scheme; 7 SACs and 7 SPAs.

Although there is hydrological connectivity between the proposed works and these European Sites in the Dublin Bay area, the potential effects are not considered significant. It is extremely unlikely that during the construction phase of the proposed works, a pollution incident would occur of such a magnitude as to have any negative effects on water quality or the Qualifying Interest/Special Conservation Interests of the European sites in Dublin Bay, due to:

- The protective measures built into the project design in accordance with best practice design and construction practice (see outline CEMP, **Appendix B**);
- the significant distance and volume of water separating the proposed works and Dublin Bay; and
- the potential for dilution within the Morell/Liffey system and the Liffey estuary, before entering Dublin Bay.

Therefore, any impacts to water quality are unlikely to have a significant effect on the European Sites.

4.3 CUMULATIVE AND IN-COMBINATION IMPACTS

This step aims to identify any likely significant in-combination or cumulative effects/impacts of the proposed scheme with other plans and projects on the identified European Sites.

4.3.1 Other Plans and Projects

The following plans and projects are specific to the relevant European Sites:

4.3.1.1 Catchment Flood Risk Assessment Management Plans

The National CFRAM project commenced in 2011. The programme delivers on the core components of 2004 National Flood Policy and on the later EU ‘Floods’ Directive (2010). The Office of Public Works is the lead agency working in conjunction with Local Authorities in delivering the objectives of the CFRAM Program and implementing it with regard to the requirements of the EU Water Framework Directive and the current River Basin Management Plans. As a final stage of the CFRAM project, draft flood risk management plans have being prepared detailing flood risk management measures. The statutory public consultation for these plans is currently closed.

The CFRAM project is likely to result in future flood management plans, similar in nature to the Morell River FMS. These future developments may therefore result in potential impacts to water quality as a result of construction related activities, e.g. release of sediments, fuel spillages. Therefore, these plans have potential for cumulative impacts in relation to water quality, if both the Morell FMS and CFRAM projects resulted in impacts to same.

4.3.1.2 M7 Naas Newbridge Bypass Upgrade

This scheme was awarded to a Contractor by Kildare County Council (Q3 2016) to complete phase five services for the M7 Naas-Newbridge bypass upgrade. A review of the online project drawings suggests that a part of this scheme may occur within the southernmost section of the Morell catchment and that 2 sections of the Morell River (Upper River Morell and Hartwell River) may be impacted.

This proposed development could result in potential impacts to water quality as a result of construction related activities, e.g. release of sediments, fuel spillages and operation. Therefore, there is potential for cumulative impacts in relation to water quality, if both projects resulted in impacts to same. The road upgrade project will need to be cognisant of the measures included in the Morell FMS for the area to ensure no deterioration in water quality.

4.3.1.3 Local Authority Planning Register

Planning applications contained within the online planning register at Kildare County Council were examined for developments that are currently under way or for which planning has been granted but have not yet started. Without providing an exhaustive listing, the developments are typically small scale.

Such projects are relatively small in comparison to the level of works involved in the current proposal. There is potential for impacts to water quality as a result of construction and/or operation. Therefore, there is potential for cumulative impacts in relation to water quality, if such projects resulted in impacts to same. The projects would be subject to requirements of the planning authority. Therefore, there is no likelihood of significant in-combination effects as a result of the local developments.

4.3.2 In-combination Impacts Conclusion

There is potential for in-combination impacts to European Sites as a result of the Morell FMS and plans/projects listed above, mainly in relation to water quality, if both the Morell FMS and the plans/projects resulted in impacts to same. However, due to the measures incorporated into the outline CEMP for the Morell FMS to ensure protection of all waterbodies and water quality, it is not anticipated that the proposed works will result in any in-combination impacts on any SACs or SPAs.

As detailed in **Table 3.1** it is not anticipated that the proposed scheme will result in any likely significant effects on European Sites due to the distance between the proposed scheme area and any European Site (4km at closest point). No other pathway has been identified by which any plan or project could have a significant in-combination effect on any of the European Sites. There is therefore no potential for cumulative or in-combination impacts.

4.4 LIKELY CHANGES TO EUROPEAN SITES

The likely changes that could arise from the proposed Morell FMS have been examined in the context of a number of factors that could potentially lead to likely significant effects on European Sites. It is considered that the implementation of the proposed Morell FMS works will not lead to likely significant effects on any European Sites, see **Table 4.1**.

Table 4.1 – Likely Effects on European Sites

Site Name	Site Code	Reduction of Habitat Area	Disturbance to Key Species	Habitat or Species Fragmentation	Reduction in Species Density	Changes in Key Indicators of Conservation Value (Water Quality, etc.)	Climate Change
Special Area of Conservation (SACs)							
Red Bog, Kildare SAC	000397	None	None	None	None	None	None
Rye Water Valley/Carton SAC	001398	None	None	None	None	None	None
Glenasmole Valley SAC	001209	None	None	None	None	None	None
Wicklow Mountains SAC	002122	None	None	None	None	None	None
Mouds Bog SAC	002331	None	None	None	None	None	None
Howth Head SAC	000202	None	None	None	None	None	None
North Dublin Bay SAC	000206	None	None	None	None	None	None
South Dublin Bay SAC	000210	None	None	None	None	None	None
Rockabill to Dalkey Island SAC	003000	None	None	None	None	None	None
Baldoyle Bay SAC	000199	None	None	None	None	None	None
Ireland’s Eye SAC	002193	None	None	None	None	None	None
Malahide Estuary SAC	000205	None	None	None	None	None	None
Special Area of Protection (SPAs)							
Poulaphouca Reservoir SPA	004063	None	None	None	None	None	None
Wicklow Mountains SPA	004040	None	None	None	None	None	None
North Bull Island SPA	004006	None	None	None	None	None	None
South Dublin Bay and River Tolka SPA	004024	None	None	None	None	None	None
Baldoyle Bay SPA	004016	None	None	None	None	None	None
Dalkey Islands SPA	004172	None	None	None	None	None	None
Howth Head Coast SPA	004113	None	None	None	None	None	None
Malahide Estuary SPA	004025	None	None	None	None	None	None
Ireland’s Eye SPA	004117	None	None	None	None	None	None

5 SCREENING CONCLUSION AND STATEMENT

The proposed Morell Flood Management Scheme has been examined to identify any potential likely significant effects on European Sites, in the context of their qualifying interests and conservation objectives.

It is concluded that the proposed works associated with the Morell River Flood Management Scheme will have no likely significant effects on any European Sites, either alone or in combination with other plans and projects. For this reason, it is concluded that an Appropriate Assessment is not required.

6 REFERENCES

Central Fisheries Board (CFB) (2008). *Sampling Fish for the Water Framework Directive – Transitional Waters 2008*: Liffey Estuary. Accessed 24th March 2017 at: http://www.wfdfish.ie/wp-content/uploads/2009/09/Liffey.pdf

Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Council Directive 2009/147/EC on the Conservation of Wild Birds.

DEHLG (2009). *Appropriate Assessment of Plans and Projects in Ireland – Guidance for Planning Authorities*.

European Commission (2011). *Guidelines on the Implementation of the Birds and Habitats Directives in Estuaries and Coastal Zones with particular attention to port development and dredging*.

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European Commission (2001). *Assessment of Plans and Projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and 6(4) of the Habitats Directive 92/43/EEC* (European Commission Environment Directorate-General).

European Commission (2000). *Managing Natura 2000 sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*.

RPS (2017). Morell River Flood Management Scheme EIS.

APPENDIX A

European Sites Conservation Objectives

Site Name	Site Code	Conservation Objectives (Generic or Specific)	Version Number	Date of Issue
Baldoyle Bay SAC	000199	Specific	1.0	19/11/12
Howth Head SAC	000202	Specific	1.0	06/12/16
Malahide Estuary SAC	000205	Specific	1.0	27/05/13
North Dublin Bay SAC	000206	Specific	1.0	06/11/13
South Dublin Bay SAC	000210	Specific	1.0	22/08/13
Red Bog, Kildare SAC	000397	Generic	5.0	15/08/16
Glenasmole Valley SAC	001209	Generic	5.0	15/08/16
Rye Water Valley/Carton SAC	001398	Generic	5.0	15/08/16
Wicklow Mountains SAC	002122	Generic	5.0	15/08/16
Ireland's Eye SAC	002193	Specific	1.0	27/01/17
Mouds Bog SAC	002331	Generic	1.0	20/11/15
Rockabill to Dalkey Island SAC	003000	Specific	1.0	07/05/13
North Bull Island SPA	004006	Specific	1.0	09/03/15
Baldoyle Bay SPA	004016	Specific	1.0	27/02/13
South Dublin Bay and River Tolka SPA	004024	Specific	1.0	09/03/15
Malahide Estuary SPA	004025	Specific	1.0	16/08/13
Wicklow Mountains SPA	004040	Generic	5.0	15/08/16
Poulaphouca Reservoir SPA	004063	Generic	5.0	15/08/16
Howth Head Coast SPA	004113	Generic	5.0	15/08/16
Ireland's Eye SPA	004117	Generic	5.0	15/08/16
Dalkey Islands SPA	004172	Generic	5.0	15/08/16

APPENDIX B

Outline Construction and Environmental Management Plan

(This document has been included as a separate Appendix

to the EIA Report, Appendix B)

Appendix E

Aquatic Ecology

Appendix E

APPENDIX EI

Benthic Macroinvertebrate Assemblages

HABITAT 1 - MORRELL RIVER (LOWER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Rhithrogenia (Mayfly)	Common	Sensitive
Ecdyonurus (Mayfly)	Common	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	30%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 2 - MORRELL RIVER (LOWER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Polycentropidae (Uncased Caddis)	Common	Relatively tolerant – Slightly Sensitive
Rhithrogenia (Mayfly)	Few	Sensitive
Heptagenidia (Mayfly)	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Glossosomatidae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Common	Re. Tolerant but acid sensitive
Hydracarina (Freshwater Mite)	Few	Relatively tolerant
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	40%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 3 - MORRELL RIVER (LOWER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Common	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Caenis (Mayfly)	Few	Sensitive
Ecdyonurus (Mayfly)	Few	Sensitive
Limnephillidae (Cased Caddis)	Few	Less Sensitive
Glossosomatidae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	70%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 4 - MORRELL RIVER (LOWER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Rhithrogenia (Mayfly)	Few	Sensitive
Ecdyonurus	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Glossosomatidae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	Lemna 5%	
MACROALGAE	40%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 5 - MORRELL RIVER (LOWER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Rhithrogenia (Mayfly)	Few	Sensitive
Ecdyonurus (Mayfly)	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	10%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 6 - MORRELL RIVER (UPPER)

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Polycentropidae(Uncased Caddis)	Common	Relatively tolerant
Rhithrogenia (Mayfly)	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
Tubificidae (Worm)	Few	Very Tolerant
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	Nonw	
MACROALGAE	60%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 7 – PAINESTOWN RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Rhithrogenia (Mayfly)	Few	Sensitive
Sericostomatidae (Cased Caddis)	Few	Less Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	30%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 8 – PAINESTOWN RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Hydroptilidae (Uncased Caddis)	Few	Relatively tolerant
Ecdyonurus (Mayfly)	One individual	Sensitive
Limnephillidae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Common	Re. Tolerant but acid sensitive
Coleoptera (FW Beetle)	Few	Relatively tolerant
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	40%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 9 – SLANE RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Ephemerillidae (Mayfly)	Common	Sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Rhithrogenia (Mayfly)	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	5%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 10 – SLANE RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Polycentropidae (Uncased Caddis)	Few	Relatively tolerant
Rhithrogenia (Mayfly)	Fair Numbers	Sensitive
Ecdyonurus (Mayfly)	Few	Sensitive
Limnephillidae (Cased Caddis)	Common	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	40%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 11 – SLANE RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Fair Numbers	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Fair Numbers	Relatively tolerant
Rhithrogenia (Mayfly)	Few	Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Scarce	Re. Tolerant but acid sensitive
Hydracarina (FW Mite)	Few	Relatively tolerant
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	5%	
MOSSES AND LIVERWORTS	Not Observed	

HABITAT 12 - KILL RIVER

MACROINVERTEBRATE	RELATIVE ABUNDANCE	SENSITIVITY TO ORGANIC POLLUTION
Baetidae (Mayfly)	Dominant	Re. Tolerant but acid sensitive
Hydropsychidae (Uncased Caddis)	Common	Relatively tolerant
Ephemerella (Mayfly)	Few	Less Sensitive
Ecdyonurus (Mayfly)	Fair Numbers	Sensitive
Rhithrogenia (Mayfly)	Few	Sensitive
Goeridae (Cased Caddis)	Few	Less Sensitive
Glossosomatidae (Cased Caddis)	Few	Less Sensitive
Simulidae (Blackfly Larva)	Few	Relatively tolerant
Chironimid (Midge Larvae)	Few	Relatively tolerant
Gammaridae (Freshwater Shrimp)	Few	Re. Tolerant but acid sensitive
SEWAGE FUNGUS	Not Observed	
AQUATIC PLANTS	None	
MACROALGAE	5%	
MOSSES AND LIVERWORTS	Not Observed	

APPENDIX EII

HABITAT IMAGES

Plate 1: Habitat 1 Downstream (Morrell River – Lower)	**Plate 2**: Habitat 1 Upstream (Morrell River -Lower)

Plate 3: Habitat 2 Substrate (Morrell River-Lower)	**Plate 4**: Habitat 2 Downstream (Morrell River – Lower)

	
Plate 5: Habitat 3 Downstream. (Morrell River-Lower)	**Plate 6**: Habitat 3 Upstream. (Morrell River-Lower)
	
Plate 7: Habitat 4 Substrate (Morrell River-Lower)	**Plate 8**: Habitat 4 Upstream (Morrell River-Lower)

	
Plate 9: Habitat 5 (Morrell River Lower)	**Plate 10:** Habitat 5 Bridge (Morrell River Lower)
	
Plate 11: Habitat 6 (Morrell River Upper)	**Plate 12:** Habitat 6 (Morrell River Upper)

Plate 13: Habitat 7 (Painestown River)

Plate 14: Habitat 8 (Painestown River)

Plate 15: Habitat 9 (Slane River)

Plate 16: Habitat 10 (Slane River)

	
Plate 17: Habitat 11 (Slane River)	**Plate 18**: Habitat 12 (Kill River)

Appendix F

Socio-Economic / Land Use

Land Use (Agricultural and Non Agricultural)

Parcel ID	38	Parcel Area (ha)	6.7
PRAI Folio	KE23007F	Area Existing Flood	3.95
Building on Property		Area post Flood	3.83
Works on Property		Difference	0.12
Landuse	Agriculture	Impact Type	Positive
Crop Type	Cereals	Impact Significance	Positive

Parcel ID	156	Parcel Area (ha)	8.22
PRAI Folio	KE3620	Area Existing Flood	2.2
Building on Property		Area post Flood	0
Works on Property		Difference	2.20
Landuse	Agriculture	Impact Type	Positive
Crop Type	Cereals	Impact Significance	Positive

Parcel ID	157	Parcel Area (ha)	16.86
PRAI Folio	KE5168	Area Existing Flood	5.99
Building on Property		Area post Flood	0
Works on Property		Difference	5.99
Landuse	Agriculture	Impact Type	Positive
Crop Type	Cereals	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	159	Parcel Area (ha)	37.14
PRAI Folio	KE5168	Area Existing Flood	0.39
Building on Property		Area post Flood	0
Works on Property		Difference	0.39
Landuse	Agriculture	Impact Type	Positive
Crop Type	Cereals	Impact Significance	Positive

Parcel ID	208	Parcel Area (ha)	23.75
PRAI Folio	KE15767F	Area Existing Flood	5.4
Building on Property	No	Area post Flood	0
Works on Property		Difference	5.40
Landuse	Agriculture	Impact Type	Positive
Crop Type	Cereals	Impact Significance	Positive

Parcel ID	1	Parcel Area (ha)	5.67
PRAI Folio	KE52665F	Area Existing Flood	5.01
Building on Property	Yes	Area post Flood	0.95
Works on Property	Yes	Difference	4.06
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	3	Parcel Area (ha)	6.28
PRAI Folio	KE7471	Area Existing Flood	2.47
Building on Property		Area post Flood	0.62
Works on Property		Difference	1.85
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	4	Parcel Area (ha)	7.21
PRAI Folio	KE2435F	Area Existing Flood	4.69
Building on Property		Area post Flood	1.24
Works on Property	Yes	Difference	3.45
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	6	Parcel Area (ha)	9.51
PRAI Folio	KE2435F	Area Existing Flood	4.11
Building on Property		Area post Flood	5.19
Works on Property	Yes	Difference	-1.08
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Moderate

Land Use (Agricultural and Non Agricultural)

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Parcel ID	7	Parcel Area (ha)	1.11
PRAI Folio	KE2435F	Area Existing Flood	0.96
Building on Property		Area post Flood	0.89
Works on Property		Difference	0.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	8	Parcel Area (ha)	18.75
PRAI Folio	KE609F	Area Existing Flood	6.47
Building on Property	Yes	Area post Flood	10.83
Works on Property		Difference	-4.36
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Moderate

Parcel ID	10	Parcel Area (ha)	4.45
PRAI Folio	KE18932F	Area Existing Flood	2.51
Building on Property		Area post Flood	2.81
Works on Property		Difference	-0.30
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Land Use (Agricultural and Non Agricultural)

Parcel ID	11	Parcel Area (ha)	12.21
PRAI Folio	KE6210	Area Existing Flood	4.75
Building on Property		Area post Flood	0.77
Works on Property		Difference	3.98
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	12	Parcel Area (ha)	39.75
PRAI Folio	KE5974	Area Existing Flood	8.67
Building on Property	Yes	Area post Flood	4.74
Works on Property		Difference	3.93
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	13	Parcel Area (ha)	7.92
PRAI Folio	KE3808F	Area Existing Flood	2.85
Building on Property		Area post Flood	2.33
Works on Property		Difference	0.52
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

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Parcel ID	14	Parcel Area (ha)	14.21
PRAI Folio	KE2296F	Area Existing Flood	0
Building on Property	Yes	Area post Flood	0.22
Works on Property	Yes	Difference	-0.22
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	15	Parcel Area (ha)	1.07
PRAI Folio	KE15723F	Area Existing Flood	0.82
Building on Property		Area post Flood	0.86
Works on Property		Difference	-0.04
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	17	Parcel Area (ha)	3.35
PRAI Folio	KE609F	Area Existing Flood	0.01
Building on Property		Area post Flood	0.01
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Land Use (Agricultural and Non Agricultural)

Parcel ID	18	Parcel Area (ha)	3.76
PRAI Folio	KE609F	Area Existing Flood	0.27
Building on Property		Area post Flood	0.88
Works on Property		Difference	-0.61
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor
Parcel ID	19	Parcel Area (ha)	0.33
PRAI Folio	KE609F	Area Existing Flood	0.32
Building on Property		Area post Flood	0.33
Works on Property		Difference	-0.01
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Not significant
Parcel ID	20	Parcel Area (ha)	0.56
PRAI Folio	KE609F	Area Existing Flood	0.54
Building on Property		Area post Flood	0.54
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Land Use (Agricultural and Non Agricultural)

Parcel ID	21	Parcel Area (ha)	27.6
PRAI Folio	KE7471	Area Existing Flood	0.47
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.47
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive
Parcel ID	22	Parcel Area (ha)	10.19
PRAI Folio	KE4005F	Area Existing Flood	9.03
Building on Property		Area post Flood	8.85
Works on Property	Yes	Difference	0.18
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive
Parcel ID	23	Parcel Area (ha)	7.21
PRAI Folio	KE48433F	Area Existing Flood	1.79
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	1.79
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	24	Parcel Area (ha)	3.65
PRAI Folio	KE15965F	Area Existing Flood	0.17
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	0.17
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	25	Parcel Area (ha)	18.44
PRAI Folio	KE58046F	Area Existing Flood	5.04
Building on Property		Area post Flood	7.41
Works on Property	Yes	Difference	-2.37
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Moderate

Parcel ID	26	Parcel Area (ha)	12.99
PRAI Folio	KE58046F	Area Existing Flood	4.82
Building on Property		Area post Flood	0.4
Works on Property	Yes	Difference	4.42
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	27	Parcel Area (ha)	2.49
PRAI Folio	KE14787F	Area Existing Flood	1.22
Building on Property		Area post Flood	0
Works on Property		Difference	1.22
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	28	Parcel Area (ha)	2.71
PRAI Folio	KE14787F	Area Existing Flood	1.42
Building on Property		Area post Flood	0
Works on Property		Difference	1.42
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	30	Parcel Area (ha)	8.76
PRAI Folio	KE58824F	Area Existing Flood	3.65
Building on Property		Area post Flood	7.53
Works on Property	Yes	Difference	-3.88
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Moderate

Land Use (Agricultural and Non Agricultural)

Parcel ID	31	Parcel Area (ha)	1.58
PRAI Folio	KE14787F	Area Existing Flood	0.02
Building on Property		Area post Flood	0.02
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	32	Parcel Area (ha)	0.4
PRAI Folio	KE16599F	Area Existing Flood	0.39
Building on Property		Area post Flood	0.39
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	33	Parcel Area (ha)	6.13
PRAI Folio	KE16599F	Area Existing Flood	5.28
Building on Property		Area post Flood	5.32
Works on Property		Difference	-0.04
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Land Use (Agricultural and Non Agricultural)

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Parcel ID	34	Parcel Area (ha)	9.73
PRAI Folio	KE8189	Area Existing Flood	8.82
Building on Property	Yes	Area post Flood	8.72
Works on Property	Yes	Difference	0.10
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	35	Parcel Area (ha)	4.04
PRAI Folio	KE18691F	Area Existing Flood	1.36
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	1.36
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	36	Parcel Area (ha)	1.2
PRAI Folio	KE18691F	Area Existing Flood	0.04
Building on Property		Area post Flood	0
Works on Property		Difference	0.04
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	37	Parcel Area (ha)	7.4
PRAI Folio	KE23678F	Area Existing Flood	0.69
Building on Property		Area post Flood	0
Works on Property		Difference	0.69
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	40	Parcel Area (ha)	3.81
PRAI Folio	KE17376	Area Existing Flood	3.4
Building on Property		Area post Flood	3.33
Works on Property	Yes	Difference	0.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	41	Parcel Area (ha)	3.66
PRAI Folio	KE17132	Area Existing Flood	1.37
Building on Property		Area post Flood	0.31
Works on Property	Yes	Difference	1.06
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	42	Parcel Area (ha)	2.1
PRAI Folio	KE51893F	Area Existing Flood	1.89
Building on Property		Area post Flood	0.94
Works on Property		Difference	0.95
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	43	Parcel Area (ha)	4.52
PRAI Folio	KE51893F	Area Existing Flood	3.48
Building on Property		Area post Flood	2.38
Works on Property	Yes	Difference	1.10
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	44	Parcel Area (ha)	3.08
PRAI Folio	KE20328F	Area Existing Flood	0.99
Building on Property		Area post Flood	0
Works on Property		Difference	0.99
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	45	Parcel Area (ha)	2.43
PRAI Folio	KE46244F	Area Existing Flood	1.88
Building on Property		Area post Flood	0.81
Works on Property		Difference	1.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	46	Parcel Area (ha)	2.77
PRAI Folio	KE46244F	Area Existing Flood	2.34
Building on Property		Area post Flood	1.25
Works on Property		Difference	1.09
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	47	Parcel Area (ha)	0.55
PRAI Folio	KE57218F	Area Existing Flood	0.47
Building on Property		Area post Flood	0
Works on Property		Difference	0.47
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	57	Parcel Area (ha)	6.05
PRAI Folio	KE9738	Area Existing Flood	2.49
Building on Property		Area post Flood	2.55
Works on Property		Difference	-0.06
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	58	Parcel Area (ha)	13.06
PRAI Folio	KE9738	Area Existing Flood	2.24
Building on Property	Yes	Area post Flood	2.33
Works on Property		Difference	-0.09
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	59	Parcel Area (ha)	5.27
PRAI Folio	KE11235F	Area Existing Flood	1.7
Building on Property		Area post Flood	2.09
Works on Property	Yes	Difference	-0.39
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Land Use (Agricultural and Non Agricultural)

Parcel ID	60	Parcel Area (ha)	21.42
PRAI Folio	KE15805F	Area Existing Flood	4.97
Building on Property	Yes	Area post Flood	1.34
Works on Property	Yes	Difference	3.63
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	61	Parcel Area (ha)	15.56
PRAI Folio	KE59868F	Area Existing Flood	3.3
Building on Property	Yes	Area post Flood	1.76
Works on Property	Yes	Difference	1.54
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	62	Parcel Area (ha)	9.1
PRAI Folio	KE41557F	Area Existing Flood	1.85
Building on Property		Area post Flood	0
Works on Property		Difference	1.85
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

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Parcel ID	63	Parcel Area (ha)	7.38
PRAI Folio	KE10556F	Area Existing Flood	3.4
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	3.40
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	65	Parcel Area (ha)	0.4
PRAI Folio	KE55014F	Area Existing Flood	0.14
Building on Property		Area post Flood	0
Works on Property		Difference	0.14
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	66	Parcel Area (ha)	0.41
PRAI Folio	KE55013F	Area Existing Flood	0.02
Building on Property		Area post Flood	0
Works on Property		Difference	0.02
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	68	Parcel Area (ha)	15.19
PRAI Folio	KE51852F	Area Existing Flood	0.67
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.67
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	73	Parcel Area (ha)	12.95
PRAI Folio	KE7158F	Area Existing Flood	0.58
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.58
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	74	Parcel Area (ha)	3.72
PRAI Folio	KE7158F	Area Existing Flood	0.78
Building on Property		Area post Flood	0
Works on Property		Difference	0.78
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	75	Parcel Area (ha)	16.68
PRAI Folio	KE23229F	Area Existing Flood	4.98
Building on Property		Area post Flood	0
Works on Property		Difference	4.98
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	76	Parcel Area (ha)	0.51
PRAI Folio	KE57217F	Area Existing Flood	0.4
Building on Property		Area post Flood	0
Works on Property		Difference	0.40
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	79	Parcel Area (ha)	4.1
PRAI Folio	KE32016F	Area Existing Flood	1.65
Building on Property	Yes	Area post Flood	0.21
Works on Property	Yes	Difference	1.44
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	81	Parcel Area (ha)	10.89
PRAI Folio	KE23249F	Area Existing Flood	0.4
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.40
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	82	Parcel Area (ha)	11.4
PRAI Folio	KE15564F	Area Existing Flood	0.74
Building on Property		Area post Flood	0
Works on Property		Difference	0.74
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	83	Parcel Area (ha)	18.02
PRAI Folio	KE17334	Area Existing Flood	6.69
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	6.69
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	87	Parcel Area (ha)	7.58
PRAI Folio	KE20254F	Area Existing Flood	2.12
Building on Property		Area post Flood	0
Works on Property		Difference	2.12
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	88	Parcel Area (ha)	3.14
PRAI Folio	KE15805F	Area Existing Flood	2.72
Building on Property		Area post Flood	0
Works on Property		Difference	2.72
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	90	Parcel Area (ha)	3.23
PRAI Folio	KE15806F	Area Existing Flood	2.53
Building on Property		Area post Flood	0
Works on Property		Difference	2.53
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	91	Parcel Area (ha)	8.66
PRAI Folio	KE15979	Area Existing Flood	2.92
Building on Property		Area post Flood	0
Works on Property		Difference	2.92
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	92	Parcel Area (ha)	3.16
PRAI Folio	KE4819F	Area Existing Flood	1.88
Building on Property		Area post Flood	0
Works on Property		Difference	1.88
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	93	Parcel Area (ha)	6.85
PRAI Folio	KE5035F	Area Existing Flood	2.33
Building on Property		Area post Flood	0
Works on Property		Difference	2.33
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	94	Parcel Area (ha)	8.64
PRAI Folio	KE18834F	Area Existing Flood	1.3
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	1.30
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	96	Parcel Area (ha)	1.11
PRAI Folio	KE55796F	Area Existing Flood	0.85
Building on Property		Area post Flood	0
Works on Property		Difference	0.85
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	98	Parcel Area (ha)	4.3
PRAI Folio	KE17740	Area Existing Flood	1.46
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	1.46
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	100	Parcel Area (ha)	6.71
PRAI Folio	KE20621F	Area Existing Flood	2.92
Building on Property		Area post Flood	0
Works on Property		Difference	2.92
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	101	Parcel Area (ha)	4.2
PRAI Folio	KE12915F	Area Existing Flood	2
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	2.00
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	102	Parcel Area (ha)	0.54
PRAI Folio	KE15639F	Area Existing Flood	0.37
Building on Property		Area post Flood	0
Works on Property		Difference	0.37
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	103	Parcel Area (ha)	0.3
PRAI Folio	KE7184F	Area Existing Flood	0.27
Building on Property		Area post Flood	0
Works on Property		Difference	0.27
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	106	Parcel Area (ha)	13.45
PRAI Folio	KE3139	Area Existing Flood	2.9
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	2.90
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	107	Parcel Area (ha)	12.22
PRAI Folio	KE16062	Area Existing Flood	0.85
Building on Property		Area post Flood	0.01
Works on Property		Difference	0.84
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	110	Parcel Area (ha)	18.39
PRAI Folio	KE4079F	Area Existing Flood	8.28
Building on Property		Area post Flood	8.01
Works on Property		Difference	0.27
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	111	Parcel Area (ha)	11.71
PRAI Folio	KE8924	Area Existing Flood	2.72
Building on Property	Yes	Area post Flood	2.66
Works on Property		Difference	0.06
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	112	Parcel Area (ha)	19.32
PRAI Folio	KE6485	Area Existing Flood	5.88
Building on Property		Area post Flood	5.93
Works on Property		Difference	-0.05
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	113	Parcel Area (ha)	5.03
PRAI Folio	KE32961F	Area Existing Flood	2.92
Building on Property		Area post Flood	2.71
Works on Property		Difference	0.21
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	114	Parcel Area (ha)	2.68
PRAI Folio	KE32952F	Area Existing Flood	0.69
Building on Property		Area post Flood	0.49
Works on Property		Difference	0.20
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	115	Parcel Area (ha)	6.59
PRAI Folio	KE8601	Area Existing Flood	4.27
Building on Property		Area post Flood	0.37
Works on Property		Difference	3.90
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	117	Parcel Area (ha)	11.78
PRAI Folio	KE8925	Area Existing Flood	2.33
Building on Property	Yes	Area post Flood	1.89
Works on Property		Difference	0.44
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	118	Parcel Area (ha)	7.59
PRAI Folio	KE822F	Area Existing Flood	2.66
Building on Property		Area post Flood	1.71
Works on Property		Difference	0.95
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	123	Parcel Area (ha)	5.18
PRAI Folio	KE18931F	Area Existing Flood	0.94
Building on Property		Area post Flood	0.95
Works on Property		Difference	-0.01
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Not significant

Land Use (Agricultural and Non Agricultural)

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Parcel ID	124	Parcel Area (ha)	30.27
PRAI Folio	KE3089	Area Existing Flood	8.37
Building on Property		Area post Flood	7.72
Works on Property		Difference	0.65
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	126	Parcel Area (ha)	45.57
PRAI Folio	KE13965F	Area Existing Flood	15.06
Building on Property		Area post Flood	15.05
Works on Property		Difference	0.01
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	127	Parcel Area (ha)	19.77
PRAI Folio	KE23796F	Area Existing Flood	3.17
Building on Property		Area post Flood	3.23
Works on Property		Difference	-0.06
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Land Use (Agricultural and Non Agricultural)

Parcel ID	129	Parcel Area (ha)	2.43
PRAI Folio	KE27202F	Area Existing Flood	0.24
Building on Property	Yes	Area post Flood	0.17
Works on Property		Difference	0.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	130	Parcel Area (ha)	9.6
PRAI Folio	KE8130	Area Existing Flood	3.22
Building on Property	Yes	Area post Flood	3.09
Works on Property	Yes	Difference	0.13
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	131	Parcel Area (ha)	2.41
PRAI Folio	KE24891F	Area Existing Flood	2.02
Building on Property		Area post Flood	2.02
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Land Use (Agricultural and Non Agricultural)

Parcel ID	132	Parcel Area (ha)	9.26
PRAI Folio	KE8131	Area Existing Flood	5.42
Building on Property		Area post Flood	5.47
Works on Property		Difference	-0.05
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	133	Parcel Area (ha)	5.81
PRAI Folio	KE1833	Area Existing Flood	5.46
Building on Property		Area post Flood	5.34
Works on Property		Difference	0.12
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	134	Parcel Area (ha)	7.73
PRAI Folio	KE20360F	Area Existing Flood	5.34
Building on Property		Area post Flood	5.01
Works on Property		Difference	0.33
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	135	Parcel Area (ha)	25.82
PRAI Folio	KE24631F	Area Existing Flood	13.82
Building on Property		Area post Flood	12.43
Works on Property		Difference	1.39
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	136	Parcel Area (ha)	25.31
PRAI Folio	KE20360F	Area Existing Flood	0.88
Building on Property	Yes	Area post Flood	0.78
Works on Property		Difference	0.10
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	137	Parcel Area (ha)	29.91
PRAI Folio	KE20360F	Area Existing Flood	2.94
Building on Property	Yes	Area post Flood	4.64
Works on Property		Difference	-1.70
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Moderate

Land Use (Agricultural and Non Agricultural)

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Parcel ID	138	Parcel Area (ha)	3.3
PRAI Folio	KE1835	Area Existing Flood	0.01
Building on Property		Area post Flood	0.01
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	139	Parcel Area (ha)	81.12
PRAI Folio	KE1841	Area Existing Flood	6.77
Building on Property	Yes	Area post Flood	6.02
Works on Property		Difference	0.75
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	140	Parcel Area (ha)	3.25
PRAI Folio	KE19412F	Area Existing Flood	2.17
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	2.17
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	142	Parcel Area (ha)	8.58
PRAI Folio	KE8116	Area Existing Flood	0.72
Building on Property	Yes	Area post Flood	1.14
Works on Property		Difference	-0.42
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	143	Parcel Area (ha)	7.38
PRAI Folio	KE9365	Area Existing Flood	0.85
Building on Property		Area post Flood	0.9
Works on Property		Difference	-0.05
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	144	Parcel Area (ha)	0.43
PRAI Folio	KE37258F	Area Existing Flood	0.23
Building on Property		Area post Flood	0.57
Works on Property		Difference	-0.34
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	148	Parcel Area (ha)	6.43
PRAI Folio	KE668F	Area Existing Flood	1.22
Building on Property	Yes	Area post Flood	1.02
Works on Property		Difference	0.20
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	149	Parcel Area (ha)	1.99
PRAI Folio	KE11592	Area Existing Flood	0.22
Building on Property	Yes	Area post Flood	0.04
Works on Property		Difference	0.18
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	152	Parcel Area (ha)	1.23
PRAI Folio	KE23742F	Area Existing Flood	0.82
Building on Property		Area post Flood	0.06
Works on Property		Difference	0.76
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	153	Parcel Area (ha)	2.98
PRAI Folio	KE15840F	Area Existing Flood	0.35
Building on Property		Area post Flood	0
Works on Property		Difference	0.35
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	155	Parcel Area (ha)	6.82
PRAI Folio	KE57650F	Area Existing Flood	0.21
Building on Property		Area post Flood	0
Works on Property		Difference	0.21
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	158	Parcel Area (ha)	3.45
PRAI Folio	KE5168	Area Existing Flood	2.74
Building on Property		Area post Flood	0
Works on Property		Difference	2.74
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	161	Parcel Area (ha)	10.25
PRAI Folio	KE57545F	Area Existing Flood	0.59
Building on Property		Area post Flood	0
Works on Property		Difference	0.59
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	162	Parcel Area (ha)	37.8
PRAI Folio	KE47068F	Area Existing Flood	6.41
Building on Property		Area post Flood	6.37
Works on Property		Difference	0.04
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	163	Parcel Area (ha)	6.94
PRAI Folio	KE1678	Area Existing Flood	1.13
Building on Property		Area post Flood	1.12
Works on Property		Difference	0.01
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	164	Parcel Area (ha)	3.67
PRAI Folio	KE1679	Area Existing Flood	0.11
Building on Property		Area post Flood	0.13
Works on Property		Difference	-0.02
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	165	Parcel Area (ha)	13.39
PRAI Folio	KE11440F	Area Existing Flood	3.86
Building on Property		Area post Flood	3.22
Works on Property		Difference	0.64
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	168	Parcel Area (ha)	6.18
PRAI Folio	KE925F	Area Existing Flood	3.16
Building on Property	Yes	Area post Flood	3.15
Works on Property		Difference	0.01
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	169	Parcel Area (ha)	3.85
PRAI Folio	KE17570F	Area Existing Flood	0.53
Building on Property		Area post Flood	0.53
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	170	Parcel Area (ha)	16.37
PRAI Folio	KE11949	Area Existing Flood	0.3
Building on Property	Yes	Area post Flood	0.3
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	171	Parcel Area (ha)	3.68
PRAI Folio	KE52148F	Area Existing Flood	0.66
Building on Property		Area post Flood	0.66
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Land Use (Agricultural and Non Agricultural)

Parcel ID	172	Parcel Area (ha)	5.52
PRAI Folio	KE10611F	Area Existing Flood	1.63
Building on Property		Area post Flood	1.72
Works on Property		Difference	-0.09
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	173	Parcel Area (ha)	6.68
PRAI Folio	KE25135F	Area Existing Flood	1.72
Building on Property		Area post Flood	1.72
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	175	Parcel Area (ha)	4.16
PRAI Folio	KE14416F	Area Existing Flood	0.75
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.75
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	179	Parcel Area (ha)	1.5
PRAI Folio	Not Registered PRAI	Area Existing Flood	1.15
Building on Property		Area post Flood	0.01
Works on Property	Yes	Difference	1.14
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	184	Parcel Area (ha)	1.71
PRAI Folio	KE40887F	Area Existing Flood	0.1
Building on Property		Area post Flood	0.01
Works on Property		Difference	0.09
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	185	Parcel Area (ha)	5.52
PRAI Folio	KE822F	Area Existing Flood	2.23
Building on Property		Area post Flood	2.72
Works on Property		Difference	-0.49
Landuse	Agriculture	Impact Type	Negative
Crop Type	Grass	Impact Significance	Minor

Parcel ID	187	Parcel Area (ha)	1.21
PRAI Folio	KE34836F	Area Existing Flood	0.3
Building on Property		Area post Flood	0
Works on Property		Difference	0.30
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	188	Parcel Area (ha)	2.33
PRAI Folio	KE3141F	Area Existing Flood	0.27
Building on Property		Area post Flood	0
Works on Property		Difference	0.27
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	189	Parcel Area (ha)	4.45
PRAI Folio	KE30120F	Area Existing Flood	2.07
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	2.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	193	Parcel Area (ha)	0.69
PRAI Folio	KE15046F	Area Existing Flood	0.04
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	0.04
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	199	Parcel Area (ha)	14.81
PRAI Folio	Not Registered PRAI	Area Existing Flood	12.42
Building on Property		Area post Flood	10.28
Works on Property		Difference	2.14
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	200	Parcel Area (ha)	14.69
PRAI Folio	KE3088	Area Existing Flood	3.15
Building on Property		Area post Flood	3.15
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass	Impact Significance	No Impact

Parcel ID	201	Parcel Area (ha)	4.17
PRAI Folio	KE1834	Area Existing Flood	0.07
Building on Property		Area post Flood	0.04
Works on Property		Difference	0.03
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	204	Parcel Area (ha)	98.05
PRAI Folio	Not Registered PRAI	Area Existing Flood	3.51
Building on Property	Yes	Area post Flood	3.36
Works on Property	Yes	Difference	0.15
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	207	Parcel Area (ha)	74.53
PRAI Folio	KE911	Area Existing Flood	22
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	22.00
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	209	Parcel Area (ha)	34.75
PRAI Folio	Not Registered PRAI	Area Existing Flood	19.8
Building on Property	No	Area post Flood	0
Works on Property		Difference	19.80
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Parcel ID	205	Parcel Area (ha)	4.61
PRAI Folio	KE23007F	Area Existing Flood	1.45
Building on Property		Area post Flood	0.92
Works on Property	Yes	Difference	0.53
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass_Cereals	Impact Significance	Positive

Parcel ID	206	Parcel Area (ha)	168
PRAI Folio	Not Registered PRAI	Area Existing Flood	11.1
Building on Property	Yes	Area post Flood	11.1
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Grass_Cereals	Impact Significance	No Impact

Parcel ID	128	Parcel Area (ha)	23.17
PRAI Folio	KE959F	Area Existing Flood	4.4
Building on Property		Area post Flood	4.11
Works on Property		Difference	0.29
Landuse	Agriculture	Impact Type	Positive
Crop Type	Grass_Tillage	Impact Significance	Positive

Parcel ID	109	Parcel Area (ha)	18.84
PRAI Folio	KE3527	Area Existing Flood	7.14
Building on Property	Yes	Area post Flood	7.07
Works on Property		Difference	0.07
Landuse	Agriculture	Impact Type	Positive
Crop Type	OSR_Cereals	Impact Significance	Positive

Parcel ID	5	Parcel Area (ha)	6.58
PRAI Folio	KE3140F	Area Existing Flood	4.25
Building on Property		Area post Flood	4.54
Works on Property	Yes	Difference	-0.29
Landuse	Agriculture	Impact Type	Negative
Crop Type	Tillage	Impact Significance	Minor

Parcel ID	48	Parcel Area (ha)	3.15
PRAI Folio	KE3140F	Area Existing Flood	2.75
Building on Property		Area post Flood	0.67
Works on Property		Difference	2.08
Landuse	Agriculture	Impact Type	Positive
Crop Type	Tillage	Impact Significance	Positive

Parcel ID	203	Parcel Area (ha)	24.61
PRAI Folio	KE1854	Area Existing Flood	0.05
Building on Property		Area post Flood	0.05
Works on Property		Difference	0.00
Landuse	Agriculture	Impact Type	Neutral
Crop Type	Tillage	Impact Significance	No Impact

Parcel ID	108	Parcel Area (ha)	53
PRAI Folio	KE22162F	Area Existing Flood	11.43
Building on Property	Yes	Area post Flood	11.35
Works on Property		Difference	0.08
Landuse	Agriculture/Equine	Impact Type	Positive
Crop Type	Grass	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	210	Parcel Area (ha)	90.85
PRAI Folio		Area Existing Flood	9.4
Building on Property	No	Area post Flood	0
Works on Property		Difference	9.40
Landuse	Agriculture/Golf course	Impact Type	Positive
Crop Type	Golf course and Cereals	Impact Significance	Positive

Parcel ID	125	Parcel Area (ha)	47.45
PRAI Folio	KE21295F	Area Existing Flood	16.4
Building on Property	Yes	Area post Flood	24.24
Works on Property	Yes	Difference	-7.84
Landuse	Non_Agriculture	Impact Type	Negative
Crop Type	Golf course	Impact Significance	Moderate

Parcel ID	16	Parcel Area (ha)	2.53
PRAI Folio	KE15723F	Area Existing Flood	0.47
Building on Property	Yes	Area post Flood	0.5
Works on Property	Yes	Difference	-0.03
Landuse	Non_Agriculture	Impact Type	Negative
Crop Type	NA	Impact Significance	Minor

Land Use (Agricultural and Non Agricultural)

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Parcel ID	29	Parcel Area (ha)	4.37
PRAI Folio	KE58824F	Area Existing Flood	0.16
Building on Property	Yes	Area post Flood	0.38
Works on Property	Yes	Difference	-0.22
Landuse	Non_Agriculture	Impact Type	Negative
Crop Type	NA	Impact Significance	Minor

Parcel ID	39	Parcel Area (ha)	0.6
PRAI Folio	KE17376	Area Existing Flood	0.36
Building on Property	Yes	Area post Flood	0.36
Works on Property	Yes	Difference	0.00
Landuse	Non_Agriculture	Impact Type	Neutral
Crop Type	NA	Impact Significance	No Impact

Parcel ID	49	Parcel Area (ha)	0.21
PRAI Folio	KE8945F	Area Existing Flood	0.02
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.02
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	50	Parcel Area (ha)	0.43
PRAI Folio	KE49235F	Area Existing Flood	0.03
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.03
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	51	Parcel Area (ha)	0.75
PRAI Folio	KE16965F	Area Existing Flood	0.46
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.46
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	52	Parcel Area (ha)	0.34
PRAI Folio	KE36555F	Area Existing Flood	0.14
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.14
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	53	Parcel Area (ha)	0.22
PRAI Folio	KE16966F	Area Existing Flood	0.09
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.09
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	54	Parcel Area (ha)	0.21
PRAI Folio	KE8871F	Area Existing Flood	0.14
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.14
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	55	Parcel Area (ha)	0.2
PRAI Folio	KE30448F	Area Existing Flood	0.03
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.03
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	56	Parcel Area (ha)	0.19
PRAI Folio	KE59676F	Area Existing Flood	0.05
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.05
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	64	Parcel Area (ha)	0.52
PRAI Folio	KE1951F	Area Existing Flood	0.18
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.18
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	67	Parcel Area (ha)	0.26
PRAI Folio	KE36501F	Area Existing Flood	0.19
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.19
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

MDW0575
Morell River Flood Management Scheme

Land Use (Agricultural and Non Agricultural)

Parcel ID	69	Parcel Area (ha)	0.56
PRAI Folio	KE46324F	Area Existing Flood	0.11
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.11
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	70	Parcel Area (ha)	0.08
PRAI Folio	KE4722F	Area Existing Flood	0.02
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.02
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	71	Parcel Area (ha)	0.96
PRAI Folio	KE2260F	Area Existing Flood	0.15
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.15
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	72	Parcel Area (ha)	0.57
PRAI Folio	KE18692F	Area Existing Flood	0.23
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.23
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	77	Parcel Area (ha)	1.27
PRAI Folio	KE8190	Area Existing Flood	1.17
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	1.17
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	78	Parcel Area (ha)	2.58
PRAI Folio	KE28698F	Area Existing Flood	2.5
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	2.50
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	80	Parcel Area (ha)	0.29
PRAI Folio	KE52230F	Area Existing Flood	0.04
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.04
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	84	Parcel Area (ha)	0.48
PRAI Folio	KE50881F	Area Existing Flood	0.43
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.43
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	85	Parcel Area (ha)	0.34
PRAI Folio	KE6723F	Area Existing Flood	0.25
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.25
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	86	Parcel Area (ha)	0.55
PRAI Folio	KE5247F	Area Existing Flood	0.13
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.13
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	89	Parcel Area (ha)	0.27
PRAI Folio	KE3103F	Area Existing Flood	0.18
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.18
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	95	Parcel Area (ha)	0.31
PRAI Folio	KE13202F	Area Existing Flood	0.21
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.21
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	97	Parcel Area (ha)	0.38
PRAI Folio	KE21742F	Area Existing Flood	0.28
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.28
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	99	Parcel Area (ha)	0.13
PRAI Folio	KE6222	Area Existing Flood	0.02
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.02
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	104	Parcel Area (ha)	0.19
PRAI Folio	KE8673F	Area Existing Flood	0.09
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.09
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	105	Parcel Area (ha)	0.25
PRAI Folio	KE10892F	Area Existing Flood	0.17
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.17
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	116	Parcel Area (ha)	0.26
PRAI Folio	KE11991F	Area Existing Flood	0.07
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.07
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	119	Parcel Area (ha)	1.93
PRAI Folio	KE24784F	Area Existing Flood	0.7
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.70
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	120	Parcel Area (ha)	0.74
PRAI Folio	KE29926F	Area Existing Flood	0.08
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.08
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	121	Parcel Area (ha)	0.41
PRAI Folio	KE33912F	Area Existing Flood	0.01
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.01
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	122	Parcel Area (ha)	1.1
PRAI Folio	KE54845F	Area Existing Flood	0.1
Building on Property	Yes	Area post Flood	0.06
Works on Property		Difference	0.04
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	141	Parcel Area (ha)	0.24
PRAI Folio	KE14062F	Area Existing Flood	0.21
Building on Property	Yes	Area post Flood	0.04
Works on Property	Yes	Difference	0.17
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	146	Parcel Area (ha)	2.54
PRAI Folio	KE19351F	Area Existing Flood	0.96
Building on Property	Yes	Area post Flood	0.05
Works on Property	Yes	Difference	0.91
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	147	Parcel Area (ha)	3.13
PRAI Folio	KE8123	Area Existing Flood	0.11
Building on Property	Yes	Area post Flood	0.02
Works on Property	Yes	Difference	0.09
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	150	Parcel Area (ha)	0.87
PRAI Folio	KE19390F	Area Existing Flood	0.15
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.15
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	151	Parcel Area (ha)	0.51
PRAI Folio	KE19389F	Area Existing Flood	0.08
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.08
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	154	Parcel Area (ha)	1.64
PRAI Folio	KE15373F	Area Existing Flood	0.25
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.25
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	160	Parcel Area (ha)	0.36
PRAI Folio	KE11679	Area Existing Flood	0.26
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.26
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	166	Parcel Area (ha)	0.65
PRAI Folio	KE11441F	Area Existing Flood	0.59
Building on Property	Yes	Area post Flood	0.59
Works on Property		Difference	0.00
Landuse	Non_Agriculture	Impact Type	Neutral
Crop Type	NA	Impact Significance	No Impact

Parcel ID	167	Parcel Area (ha)	0.42
PRAI Folio	KE17191	Area Existing Flood	0.17
Building on Property	Yes	Area post Flood	0.16
Works on Property		Difference	0.01
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	174	Parcel Area (ha)	0.66
PRAI Folio	KE11700	Area Existing Flood	0.1
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.10
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	176	Parcel Area (ha)	0.24
PRAI Folio	KE50251F	Area Existing Flood	0.02
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.02
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	177	Parcel Area (ha)	0.44
PRAI Folio	Not Registered PRAI	Area Existing Flood	0.34
Building on Property	Yes	Area post Flood	0.02
Works on Property	Yes	Difference	0.32
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

Parcel ID	178	Parcel Area (ha)	1.41
PRAI Folio	Not Registered PRAI	Area Existing Flood	0.94
Building on Property	Yes	Area post Flood	0.08
Works on Property	Yes	Difference	0.86
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	180	Parcel Area (ha)	0.4
PRAI Folio	Not Registered PRAI	Area Existing Flood	0.22
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.22
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	181	Parcel Area (ha)	0.18
PRAI Folio	KE9012	Area Existing Flood	0.02
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.02
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Land Use (Agricultural and Non Agricultural)

MDW0575
Morell River Flood Management Scheme

Parcel ID	182	Parcel Area (ha)	0.2
PRAI Folio	KE1283F	Area Existing Flood	0.1
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.10
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	183	Parcel Area (ha)	0.19
PRAI Folio	KE3368F	Area Existing Flood	0.11
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.11
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	186	Parcel Area (ha)	0.23
PRAI Folio	KE4321F	Area Existing Flood	0.11
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.11
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	190	Parcel Area (ha)	0.2
PRAI Folio	KE6257F	Area Existing Flood	0.16
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.16
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	191	Parcel Area (ha)	0.21
PRAI Folio	KE6260F	Area Existing Flood	0.01
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.01
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	192	Parcel Area (ha)	0.38
PRAI Folio	KE52590F	Area Existing Flood	0.09
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.09
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	194	Parcel Area (ha)	0.25
PRAI Folio	KE6259F	Area Existing Flood	0.21
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.21
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	195	Parcel Area (ha)	0.21
PRAI Folio	KE8101F	Area Existing Flood	0.01
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.01
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	196	Parcel Area (ha)	0.43
PRAI Folio	KE62144F	Area Existing Flood	0.13
Building on Property	Yes	Area post Flood	0.03
Works on Property	Yes	Difference	0.10
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	197	Parcel Area (ha)	0.12
PRAI Folio	KE11450F	Area Existing Flood	0.04
Building on Property	Yes	Area post Flood	0
Works on Property	Yes	Difference	0.04
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	198	Parcel Area (ha)	0.36
PRAI Folio	KE47870F	Area Existing Flood	0.09
Building on Property	Yes	Area post Flood	0
Works on Property		Difference	0.09
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	NA	Impact Significance	Positive

Parcel ID	202	Parcel Area (ha)	0.38
PRAI Folio	KE60423F	Area Existing Flood	0.01
Building on Property	Yes	Area post Flood	0.02
Works on Property		Difference	-0.01
Landuse	Non_Agriculture	Impact Type	Negative
Crop Type	NA	Impact Significance	Not significant

Parcel ID	9	Parcel Area (ha)	1.18
PRAI Folio	KE13665F	Area Existing Flood	0.08
Building on Property		Area post Flood	0
Works on Property	Yes	Difference	0.08
Landuse	Non_Agriculture	Impact Type	Positive
Crop Type	Tennis court	Impact Significance	Positive

RPS

Appendix G

Archaeology & Cultural Heritage

Appendix G

APPENDIX G1. BASELINE DATA

1.1 RESULTS & ANALYSIS – ARCHAEOLOGY & CULTURAL HERITAGE

1.1.1 Archaeological and Historical Background

General

The proposed flood relief works run along sections of the Morrell River, Painestown River, Slane River and Kill River, to the north of the N7 within an area measuring c. 7.5km x 6km. The footprint of the proposed works, which consists of the construction of new embankments and walls, the upgrade of culverts and two stream diversions, are located within the following townlands:

Table 1 – List of townlands within the proposed scheme

Townland	Scheme Ref.:
Ballyhays	Morr 1
Ballyhays/ Turnings Lower	Morr 1a
Turnings Lower	Morr 2-3
Turnings Upper	Paines 1
Turnings Upper/ Killeenmore	Paines 2-3
Killeenmore	Morr 4-8
Baronrath	Morr 9
Killeenmore	Morr 10
Prospect	Morr 15
Killeenmore	Morr 16-16a
Sherlockstown Common	Morr 17,19
Killeenbeg	Morr 20-23
Alasty	Paines 4
Painestown	Paines 5
Tuckmilltown	Slane 1-6
Blackchurch	Slane 7

Townland	Scheme Ref.:
Tuckmilltown	Slane 8-9
Blackchurch	Slane 10-11
Kill East	Kill 1

There are seven groups or individual archaeological sites located within 250m of the proposed works. Of these, three represent sites that were have been excavated in the past. These include a *fulacht fiadh* located c. 25m east of Morr 2, which was excavated during the construction of flood embankments in 2003 (KD014-056). Of the four remaining sites, the closest is a ringfort (KD014-024), located c. 145m southeast of Paines 1.

Prehistoric Period

The earliest recorded activity in proximity to the proposed scheme can be dated to the Bronze Age (c. 2500–800BC). As with the earlier transition from Mesolithic to Neolithic, significant social change is associated with the early Bronze Age. This is reflected in the material culture of the time, but also in the excavated evidence for settlement and ritual. Large communal tombs were replaced in favour of individual, subterranean cist or pit burials that were either in isolation or in small cemeteries. A double-fosse ringditch (KD014-057) has been identified through aerial photography in the townland of Ballyhays, c. 160m south of the construction corridor Morr 1. Evidence for funerary activity has also been identified through excavation in advance of the N7 Naas Road Widening Scheme in the townland of Killhill (KD020-021 and KD020-022002), c. 750m–1km east of the proposed scheme. Records in the Topographical Files of the NMI note the discovery of cremated bone from a ‘sandy hill’ in Sherlockstown townland in 1983. It is likely that these remains represent a Neolithic or Bronze Age burial site.

Bronze Age activity is commonly identified in the landscape by the presence of *fulachta fiadh* or burnt mounds. Over 4,500 of these sites have been recorded in the country with the majority comprising of a mound of burnt stone, commonly in horseshoe shape, in low lying marshy areas or proximity to streams. These sites are generally uncovered in or near riverine and waterlogged environments which provide the ideal circumstances for the construction, use and ultimate preservation of the sites. One *fulacht fiadh* (KD014-056) was excavated c. 25m east of Morr 2 in the townland of Turnings Lower in 2003.

Early Medieval Period (AD 500–1100)

Kildare is strategically located on main route from Dublin to the west and south of Ireland. Roads were well established in early Ireland as indicated by the ability of the Vikings to land and make quick progress inland and, later, by the Anglo-Normans who had little difficulty in moving inland and did not need to build roads. From early medieval historical texts it is clear that the idea of a great road system existed and this was formalised in the tradition that five great roadways radiated from Tara. The *Slighe Dhála Meic Umhóir*, one of the five ancient highways traversing the country, made its way from the Hill of Tara in County Meath to the mouth of the River Shannon, passing through Naas and the Curragh. O’Lochlainn (1940) describes the route of the *Slighe Dhála Meic Umhóir*, meaning ‘The

Road of Dála, son of Umhóir', (or *Belach Muighe Dála*) as running along the northern boundary of Munster.

The territory of the *Uí Faeláin* was the tribal grouping who ruled the northern part of County Kildare up until the coming of the Normans. Naas, located c. 3km southwest of the proposed development, is regarded as the residence of the Kings of Leinster. Joyce records the name Naas as deriving from *Nás* meaning a fair or meeting place (www.booksulster.com).

During this period Ireland was not a united country but rather a patchwork of minor monarchies all scrambling for dominance. Borders were ever changing as alliances were formed and battles fought. Kingdoms were a conglomerate of clannish principalities with the basic territorial unit known as a *túath.* Byrne (1973) estimates that there were probably at least 150 kings in Ireland at any given time during this period, each ruling over his own *túath.* The assessment area is characterised by the remains of early medieval activity in the form of secular settlement and ecclesiastical activity.

The most common indicator of settlement during the early medieval period is the ringfort. Ringforts (raths and cashels) are also the most common monument type encountered within the surrounding region, with one example located within 250m of the proposed scheme. These sites represent a type of defended homestead comprising of a central area enclosed by a number of circular banks and ditches. The number of ditches can vary from one (univallate) to two or three (bivallate or multi-vallate) and is thought to reflect the status and affluence of the inhabitants. Another morphological variation consists of the platform or raised rath – the former resulting from the construction of the rath on a naturally raised area. Ringforts are most commonly located at sites with commanding views of the surrounding environs which provided an element of security. While raths, for the most part, avoid the extreme low and uplands, they also show a preference for the most productive soils (Stout 1997, 107). The most recent study of the ringfort (Stout 1997) has suggested that there is a total of 45,119 potential ringforts or enclosure sites throughout Ireland. One ringfort (KD014-024) is located c. 145m southeast of the proposed embankment at Paines 1.

There are a number of enclosure sites within the region; however only one is recorded within the vicinity of the proposed scheme at Ballyhays (KD014-058) c. 215m north for the embankment at Morr 1A. This belongs to a classification of monument whose precise nature is unclear. Often they may in fact represent ringforts, which have either been damaged to a point where they cannot be positively recognised, or which are smaller or more irregular in plan than the accepted range for a ringfort. An early medieval date is generally likely, though not a certainty.

Medieval Period (AD 1100–1600)

Little is known of the early process of Norman settlement in Kildare. The cantred of *Uí Faeláin* was granted to Adam de Hereford before 1176. It is likely that there was an influx of an immigrant farming population. By the end of the 12th century Norman settlement was effective over the whole county, as marked by the beginning of the rule of the Fitzgerald family as Earls of Kildare. Naas was granted by John, Earl of Morton, to William Fitzmaurice, together with the adjacent territory and various important privileges, with a market and a very extensive jurisdiction in all pleas except those of the crown (Lewis, 1837). It was at this time that Naas, fortified with an enclosing wall and several castles, rapidly rose into importance within the Pale. In 1569 Queen Elizabeth granted a charter declaring that Naas be a free and undoubted borough.

A medieval church and graveyard (KD019-014001, 2) are located c. 1.4km south of the proposed scheme in Palmerstown townland. The church may have been built originally by the Knights Hospitallers of St John of Jerusalem, from whom Johnstown village took its name (www.archaeology.ie). The church was dedicated to St. John the Baptist. The church is partially restored. The interior contains the 15th century 'Flatesbury Monument' (KD019-014003), a medieval font (KD019-014002) and a 19th century high cross marking the burials of the Bourke (Mayo) family. The Flatesbury Monument, comprising of a limestone slab carrying an eight-pointed cross of mixed floriated and pointed terminals on a stepped-base and two heraldic shields, possibly commemorates the marriage of Eleanor Wogan and James Flatesbury in 1564 (www.archaeology.ie). The site is not named as a graveyard on the first edition OS map (1837).

Buckley (2008, 29) noted that the word 'palmer' indicates a pilgrim during the medieval period who had been to the Holy Land (and brought back a palm leaf in token of the fact). She states that these pilgrims were frequently lepers and thus leper hospitals are associated with places named Palmerstown, Palmerston or Palmershill (*ibid*.). In addition some saints' names are associated with leper hospitals including St Stephen, St James, St Nicholas and St Mary Magdelene to name a few. Leper hospitals were frequently known as Maudlin houses; Maudlin being a corruption of Magdelene or Madeline. The site and grounds of a hospital or its endowed lands were often called 'The Maudlins' (Lee 1996, 19). The townland of Maudlings adjacent to Palmerstown may indicate the presence of a medieval leper hospital in the area. Lee (1996, 51) suggests that the Palmerstown Demesne lands may have been part of the endowment of the hospital of Naas. In 1606 the townland of Maudlings was recorded as belonging to the chantry priests of St. David's church (*ibid*.) associated with a 12th century priory and hospital at Stephenstown nearby.

Summary of Previous Archaeological Fieldwork

A review of the Excavations Bulletin (1970–2016) has shown that several programmes of archaeological investigation have been carried out within the vicinity of the proposed scheme. These are summarised below.

The SMR record for the site of a *fulacht fiadh* (KD014-056) states that it was one of three sites excavated in 2002 in advance of the construction of an embankment as part of flood alleviation measures undertaken on the Morell River, to the north of Morell Bridge (Old), by Kildare County Council (See Appendix G.2 for further detail). This site comprised a burnt mound, two oval pits and a roughly oval trough which contained burnt stone and charred timbers at the its base (Licence Ref.: 02E1539). This site was located c. 25m east of the proposed embankment at Morr 2.

Monitoring was carried out in 21 townlands, including Baronrath and Bishopscourt Lower, as part of the Kildare Water Strategy: Ballygoran to Castlewarden pipeline scheme in 2012/2013 (Walsh 2013, Licence Ref.: 13E0016). Nothing of archaeological significance was identified within proximity of the proposed scheme.

Archaeological testing was undertaken in advance of the improvements to Naas Dual Carriageway in the Naas, Johnstown and Kill area (O' Donnchadha 2003; Licence Ref.: 03E1257, 13E1606). A number of sites were identified and excavated under separate licence. Two of these sites have since been added to the SMR as habitation sites. These consist of KD015-014, located c. 175m to the south of the scheme at Slane 7 and KD015-015 located c. 175m to the west-southwest. Both sites contained evidence for medieval occupation although the excavated remains were ephemeral in nature.

Monitoring of the *Bord Gáis Éireann* pipeline through Johnstown Main Street revealed nothing of archaeological significance (O' Riordáin 1998; Licence Ref.: 98E0113). A small number of other programmes of work have been undertaken within or near the village of Johnstown; however nothing of archaeological significance was identified (McCabe 2002, Licence Ref.: 02E1820; O' Donovan 2002, Licence Ref.: 02E1838 and Larsson 2003, Licence Ref.: 03E0917).

1.1.2 Cartographic Analysis

Sir William Petty, Down Survey Maps: 1654–56, Barony of Naas North and South Salt

The Down Survey Map shows the parishes and townlands known within the baronies at this time. Naas town is shown as a fortified walled town with several castles and large houses within the settlement. A number of large houses are shown in the vicinity including Straffan and Castle Dillon to the north, Bishopscourt, Alasty Castle, Painestown Castle and Sherlockstown. The Liffey is shown to the north of the proposed development. The hill at Kill is also shown to the immediate south of the proposed development area within a circular enclosure. Large tracts of land are annotated as commonage belonging to adjacent townlands.

Noble and Keenan's Map of County Kildare, 1752 (Figure 14.4 in main body of ES)

Noble and Keenan's map provides a more detailed depiction of the surrounding landscape. The main infrastructural routes and topographical features are shown including many of the main houses. The Morrell River is shown leading flowing north into the River Liffey to the west of 'Ballyhaise'. Branches of river, including what appear to be the Painestown, Kill and Slane Rivers are shown as joining with the Morrell River to discharge into the Liffey. Palmerstown, Straffan and Bishopscourt Houses appear to be the more substantial residences in the area with large gardens while other houses of note are Turnings (KD014-023001), Baronsrath, Whitechurch, Darrs and Sherlockstown. Johnstown village comprises of six houses and a church (KD019-014001) bordered to the east and west by rivers. Further to the east Kill village is shown as comprising four houses, a church and a large house on the eastern banks of the Kill River. East of this again a mill is shown on the northern banks of the Slane River in an area annotated as Blackchurch. To the southeast of Palmerstown Demesne a water wheel is shown on the bank of the Morrell River with the fields to the north are annotated as 'Bleachy'.

Alex Taylor's Map of the County of Kildare, 1783 (Figure 14.4 in main body of ES)

Taylor's map shows a slightly more accurate account of the network or roads, rivers and topographical features of the area. The River Morrell is names for the first time running north through Johnstown, along the western boundary of Palmerstown Demesene, crossing at the 15th lock on the Grand Canal south of Sherlockstown, via Killeenmore, Turnings and Ballyhays to discharge into the River Liffey north of Beggars Lane. The demesne lands of Palmerstown appear heavily wooded and much of the course of the River Morrell is shown as tree-lined. A river course joins the Morrell River from the east at Turnings which is annotated as 'Little Morrell'. This represents the current Painestown and Kill Rivers. The Parish boundary is partially formed by a short section of the 'Little Morrell' (now Painestown River) along the southern boundary of Baronsrath townland at a junction with the Grand Canal. A number of mill races run south-east from the River Liffey and a mill and mill race are illustrated to the west of the River Morrell in Turnings Lower townland. Johnstown and Kill villages have developed along the main turnpike road from Dublin (now the N7). To the east the 'Slede River' is shown flowing north through Blackchurch townland, crossing the main road (N7), feeding a tuck mill before travelling west through Bishopscourt demesne join with the 'Little Morrell'.

First Edition Ordnance Survey Map, 1837–8, scale 1:10560 (Image 14.5)

The first edition OS mapping is the first accurate representation of the landscape in question. In general the landscape consists of undeveloped parkland associated with the big houses and agricultural land. The Morrell River flows north through Johnstown village, feeding a number of mill races associated with flour mills (Figure 14.5 [A]). The river is illustrated as running along the tree-lined western boundary of the Palmerstown Demesne, feeding a large pond feature. It crosses the line of the Grand Canal via an aquaduct at the 15th lock before passing beneath a road bridge ('Morrell Bridge' on the now Barberstown Road. North from here two short sections of the river in Daars South townland form the parish boundary between Sherlockstown/ Bodenstown and Bodenstown/ Whitechurch (Figure 14.5 [F]). The Morrell River continues to flow north along the eastern boundary of Turnings House (KD014-023001) and demesne (Figure 14.5 [F]). A weir is annotated to the immediate north of a road outside of the northeast corner of this demesne and a mill race extends from the river northwards. The mill race runs parallel and to the west of the Morrell River to power a flour mill located adjacent to Turnings Lower House, on the southern banks of the Liffey (Figure 14.5 [C]).

In the eastern limit of the proposed development the Slane River (unnamed on map) is shown crossing the Dublin Road (now N7) further south than the current course. It passes to the east of Blackchurch House, flowing north to feed a 'Tuck Mill' in the townland of that name (Figure 14.5 [D]). The river follows a meandering course through wooded areas, under-passing a couple of local access roads, before flowing south through the demesne parkland for Bishopscourt House. It joins with the Painestown River to the west of this demesne.

The Kill River flows north through the village of Kill, which by this time has expanded to include two schools, two churches, a glebe house and numerous houses along two main streets. The river, shown as a small meandering stream flows along the eastern side of the road leading north from the village, to the east of Kill House (Figure 14.5 [B]). The watercourse runs north along field boundaries to merge with the Slane River, forming the Painestown River.

The Painestown River flows north through undeveloped fields before turning west and running along the boundary between the townlands of Baronsrath and Alasty and the parishes of Whitechurch and Kill (Figure 14.5 [E]). It is at this point that it crosses the line of the Grand Canal, via three aquaducts. The river continues west where is merged with the Morrell River in Turnings Upper. A short field boundary to the east of the river at this merging point probably represents an old river course.

No previously unidentified features of archaeological potential were identified in this mapping.

Ordnance Survey Map, 1907–9, scale 1:2500

There are no changes of note within the landscape surrounding the proposed development by the time of the later 25-inch OS mapping. A number of footbridges are illustrated and annotated along the river courses. The mill at Turnings Lower is now annotated as 'Straffan Mill – disused' however the mill race continues to be outlined and annotated to the west of the Morrell River. The mill race on the Morrell River in Palmerstown continues to function, and it is now shown leading to a smithy. The line of the Great Southern & Western Railway is shown running parallel to, and west of, the Grand Canal. The Slane, Kill and Painestown Rivers are annotated as such for the first time. Painestown House is shown to the east of Painestown/ Kill River and south of the Slane River.

1.1.3 County Development Plan

The County Kildare Development Plan (2011–2017) identifies and acknowledges the statutory protection afforded to the RMPs within the vicinity of the proposed development area under the National Monuments Act. There are seven groups or individual archaeological sites located within 250m of the proposed works. Of these, three represent sites that were have been excavated in the past. These include a *fulacht fiadh* located c. 25m east of Morr 2, which was excavated during the construction of flood embankments in 2003 (KD014-056). Of the four remaining sites, the closest is a ringfort (KD014-024), located c. 145m southeast of Paines 1. These sites are detailed in Appendix G.2 and in Figures 14.1–3 in the main body of the ES.

Table 2 – SMR/ RMP sites located within 250m of proposed development

SMR	Classification	Townland	ITM	Statutory Protection?	Distance to scheme
KD014-057	Ring-ditch	Ballyhays	692634, 728691	Yes	c. 160m south Morr 1
KD014-058	Enclosure	Ballyhays	692629, 728623	Yes	c. 215m north Morr 1A
KD014-056	*Site of Fulacht fiadh* (fully excavated)	Turnings Upper	692167, 727499	No	c. 25m east Morr 2
KD014-023001–4	Architectural feature (x2), Inscribed stone (x2)	Turnings Upper	691971, 727228	Yes	c. 170m west Morr 3
KD014-024	Ringfort - unclassified	Turnings Upper	692431, 726760	Yes	c. 145m southeast Paines 1
KD015-015	Habitation site	Blackchurch	696530, 724254	No	c. 175m west-southwest Slane 7
KD015-014	Habitation site	Blackchurch	696684, 724151	No	c. 175m south Slane 7

1.1.4 Aerial Photographic Analysis

Inspection of the aerial photographic coverage of the proposed development area held by the Ordnance Survey (1995, 2000 and 2005) and Google Earth and Bing Maps resulted in the identification of one Area of Archaeological Potential (AAP 1), consisting of a rectangular enclosure located c. 10m west of the proposed embankment at Paines 1 (Image 1). This image, along with a large majority of the data sets, show numerous paleo-channels throughout the area as well as relic field boundaries that are not present within the historic mapping. This enclosure may relate to the post medieval landscape, but an earlier and more significant archaeological origin cannot be discounted. It has been designated as Area of Archaeological Potential 1.

Image 1 Google Earth 2010, showing Area of Archaeological Potential 1 (AAP 1)

1.1.5 Townland Boundaries

The townland is an Irish land unit of considerable longevity as many of the units are likely to represent much earlier land divisions. However, the term townland was not used to denote a unit of land until the Civil Survey of 1654. It bears no relation to the modern word 'town' but like the Irish word *baile* refers to a place. It is possible that the word is derived from the Old English *tun* land and meant 'the land forming an estate or manor' (Culleton 1999, 174).

Gaelic land ownership required a clear definition of the territories held by each sept and a need for strong, permanent fences around their territories. It is possible that boundaries following ridge tops, streams or bog are more likely to be older in date than those composed of straight lines (ibid. 179).

The vast majority of townlands are referred to in the 17th century, when land documentation records begin. Many of the townlands are mapped within the Down Survey of the 1650s, so called as all measurements were carefully 'laid downe' on paper at a scale of forty perches to one inch. Therefore most are in the context of pre-17th century landscape organisation (McErlean 1983, 315).

In the 19th century, some demesnes, deer parks or large farms were given townland status during the Ordnance Survey and some imprecise townland boundaries in areas such as bogs or lakes, were given more precise definition (*ibid*.). Larger tracks of land were divided into a number of townlands, and named Upper, Middle or Lower, as well as Beg and More (small and large) and north, east, south and west (Culleton 1999, 179). By the time the first Ordnance Survey had been completed 62,000 townlands were recorded in Ireland.

The Morrell River, Painestown River, Slane River and Kill River often partially form townland and parish boundaries. It is common for townland boundaries to follow topographical features such as rivers and streams.

1.1.6 Placename Analysis

The proposed scheme works will be undertaken in the townlands of Ballyhays, Turnings Lower, Turnings Upper, Killeenmore and Baronrath, which are located in the parish of Whitechurch and barony of Naas North. Sherlockstown Common and Prospect are located in the parish of Sherlockstown within the same barony. Killeenbeg, Painestown and Alasty are located in the parish of Kill and the barony of South Salt. Tuckmilltown and Kill East are in the parish of Oughterard and Blackchurch is in the parish of Kilteel. Both of these parishes are located within South Salt.

Townland and topographic names are an invaluable source of information on topography, land ownership and land use within the landscape. They also provide information on history; archaeological monuments and folklore of an area. A place name may refer to a long forgotten site, and may indicate the possibility that the remains of certain sites may still survive below the ground surface. The Ordnance Survey surveyors wrote down townland names in the 1830's and 1840's, when the entire country was mapped for the first time. Some of the townland names in the assessment area are of Irish origin and through time have been anglicised. The main reference used for the place name analysis is Irish Local Names Explained by P.W Joyce (1870). A description and possible explanation of each townland name within the footprint of the proposed development are provided below.

A number of these townland names refer to land ownership including Ballyhays, Sherlockstown Common, Painestown and Bishopscourt. Tuckmilltown refers to the tuck mill located on the banks of the Slane River within this townland.

Killeenmore and Killeenbeg may derive from *cillín* meaning little church, but it is more likely that they refer to woodland – *coillín*, a little wood. Turnings Upper and Lower may too have a reference to vegetation also – possibly deriving from *Ture* meaning the yew.

The settlement at Kill, including the townlands of Kill East and West refers to the ecclesiastic site (KD019-008) probably located within the vicinity of St. Johns Church.

1.1.7 Field Inspection

The field inspection sought to assess the proposed development area, its previous and current land use, the topography and whether any areas or sites of archaeological potential were present. During the course of the field investigation the proposed scheme locations and their surrounding environs were inspected for known or previously unknown archaeological sites. The field inspection was undertaken on 10th April 2015 and January 27th 2017 in dry conditions.

The landscape containing the proposed scheme largely comprises level pastureland and undeveloped parkland to the north of the N7. The area is traversed northeast–southwest by the line of the Grand Canal and the Dublin to Cork railway. The fields generally comprise large regular plots bound by tree-lined low earthen ditches and land drains.

Table 3 – Results of Archaeological Field Inspection

Scheme Ref.:	Field Inspection Results:
Morr 1	A short section of embankment is required to the immediate south of the L2007. This is a level field, under pasture. The embankment will be adjacent to the River Morrell. There are two recorded monuments over 160m south of the proposed embankment (KD014-057, 058), neither of which possess upstanding remains (Image 2). **Image 2: View southwest of ringditch and enclosure site in Ballyhays** 
Morr 1a	A short section of embankment is required as part of these proposed works, which will follow existing field boundaries. The northern boundary is formed by a modern fences, whilst the two boundaries to the south consist of mature hedgerows that separate level fields of pasture. The section of field boundary aligned east-west also forms the townland boundary between Ballyhays and Turnings Lower.
Morr 2-3	These section of embankment will run along the western banks of the River Morrell. Morr 2 will runs along the path of a former mill race, which is no longer

Scheme Ref.:	Field Inspection Results:
	in use. The path of the race is marked by an overgrown hedgerow and ditch (Image 3). The race formerly left the River Morrell adjacent to the Morrell Bridge (Old), via a weir. However, this has now been removed due to modern changes to the river channel at this location. **Image 3: Path of mill race, facing north**  Morr 3 will consist of the constriction of an embankment through the demesne associated with Turnings House, to the south of Morrell Bridge (Old). This section of the demesne is currently under pasture and a denuded embankment is located along by the eastern and western sides of the River Morrell (Image 4). **Image 4: Path of proposed embankment through Turnings House demesne** 
Paines 1	This section of the proposed works will consist of the construction of an embankment to the immediate south of a local road running east-west that forms the townland boundary between Turnings Lower and Turnings Upper and embankment to the immediate west of a local road that runs north-south through Turnings Upper. This field contains a number of former paleo-channels as well as several relic boundaries, which are visible on aerial photographs (see Image 1). A possible rectilinear enclosure is also visible on the aerial photographs, c. 20m west of the road. Whilst this feature may relate to the

Scheme Ref.:	Field Inspection Results:
	post medieval landscape, it has the potential to be archaeological and has been designated as AAP 1. The feature is not definitively identifiable on the ground, although the field does contain numerous undulations (Image 5). **Image 5: View north-northwest towards AAP 1** 
Paines 2-3	This section of the scheme consists of existing embankments, which may be upgrades. The embankment run parallel to the River Paines, through level fields of pasture (Image 6). **Image 6: Existing embankments at Paines 3, facing east-southeast** 
Morr 4-8	This section of the proposed scheme will consist of the constriction of an embankment immediate adjacent to the eastern side of the railway within the townland of Killeenmore. It will include the diversion of a section of stream, which was diverted originally when the railway was constructed. The eastern boundary of the railway is currently formed by a hedgerow that has become denuded in places. It crosses fields of level pasture and no specific features of archaeological potential were noted in the area. As noted above, the section of stream to be diverted was originally diverted when the railway was constructed and as such does not follow its original channel.

Scheme Ref.:	Field Inspection Results:
Morr 9	These works will consist of a continuation of the proposed embankment to the immediate southeast of the railway in the townland of Baron Rath. Here the boundary adjacent to the railway consists of a mature hedgerow. This screens a horse training facility from the adjacent train track.
Morr 10	This section of the proposed scheme is located to the immediate east of the River Morrell within the townland of Killeenmore. Here a new embankment will be constructed, although a partial embankment does already exist within the area. The embankment will cross two fields of level pasture, as well as the rear gardens of three properties. No specific features of archaeological potential were noted within this area.
Morr 15	This section of the scheme will see the construction of an embankment adjacent to the railway, which then turns to run towards the Morrell Bridge. Once again the works will cross level pasture, which appears to be water logged in places. No specific features of archaeological potential were noted within this area.
Morr 16-16a	These measures will consist of the construction of embankments around and adjacent to two existing residential plots. Both are located to the immediate north of a road and occupy level terrain under pasture. No specific features of archaeological potential were noted within these areas.
Morr 17,19	These measures will involve the construction of embankments across a number of fields of pasture in between the existing railway and the Grand Canal. The fields are level and bounded by mature hedgerows. However, nothing of archaeological potential was noted within the area.
Morr 20-23	This section of the proposed scheme will see embankments constricted across a golf course. The area has been heavily impacted upon by landscaping associated with the course and as such nothing of archaeological significance was noted.
Paines 4	A short section of embankment is proposed at Paines 4 to surround an existing residential plot. The plot is located within a level field of pasture to the immediate east of the Paines River.
Paines 5	A short section of embankment is required at this location to the west and south of several residential properties. The River Paines is located to the immediate southwest of these buildings. Here the embankment will travel through rough, level pasture (Image 7). **Image 7: Proposed Paines 5 location, facing southeast**

Scheme Ref.:	Field Inspection Results:
	
Slane 1-6	This area of proposed works will consist of the construction of proposed embankments and walls to the rear of a number of residential plots that are bounded by the River Slane within the townland of Tuckmilltown. For the most part of the river is relatively small and bounded in places by dense vegetation (Image 8). **Image 8: River Slane, facing west-northwest**  Attempts have already been made to construct small embankments adjacent to the River, presumably to try and resolve flooding. No specific areas of archaeological potential were noted in the vicinity of the proposed works, although there has been a large amount of ground disturbance to the south of the river as part of a commercial yard development.
Slane 7	This section of the proposed works in located within the footprint of a recently construction junction of the M7. As such, the water course through this area has been realigned and the whole area subject to large scale disturbance.
Slane 8-9	Slane 8 involves the realignment of a short section of stream in order to remove a pronounced curve within the channel. Slane 9 will involve the construction of a short section of embankment to the north of the river. The stream was not accessible for inspection during the January 2017 inspections. However, nothing of significance was noted within the area of Slane 9. Here the

Scheme Ref.:	Field Inspection Results:
	embankment will follow an existing mature hedgerow where it crosses level pasture.
Kill 1	This section of the scheme will consist of the constriction of an embankment to the immediate east of the Kill River in the townland of Kill East. The house is modern and the garden well planted with shrubs and trees. No specific features of archaeological potential were noted in the vicinity.

It should be noted that the overall landscape that contains the proposed scheme possesses a general archaeological potential due to the human activity that water courses have attracted since the prehistoric period. Sites such as burnt mounds/*fulachta fiadh* are regularly identified during the course of construction works in proximity to water courses.

Potential Stockpile Areas

As part of the proposed scheme, three possible areas that may be used for stock piling materials have been identified. These are areas located adjacent to Morr 23, Morr 19 and Paines 3. The main compound may be located at one of these identified stockpiling/compound areas and be established specifically for the project, or may alternatively use suitable existing premises, if one is available.

Morr 23

This area consists of a linear section of level pasture to the immediate east of a golf course within the townland of Killeenbeg. There are no recorded monuments within the site or its locale. No specific features or areas of archaeological potential were noted within the historic mapping, aerial photographs or field inspection. It appears that some landscaping and ground disturbances have taken place within the area that are associated with the golf course.

Morr 19

This area consists of a triangular section of level pasture to the immediate west of the canal within the townland of Sherlockstown Common. There are no recorded monuments within the site or its locale. No specific features or areas of archaeological potential were noted within the historic mapping, aerial photographs or field inspection.

Paines 3

This is a sub-triangular area located within the townland of Turnings Upper. The area is level and under pasture and is bordered to the east by a small local road and to the west by a stream. A recorded ringfort is located c. 80m to the east of the area (KD014-024). However, the first edition shows a large circular area, defined by a dashed line, surrounding the ringfort. The SMR file notes this feature, which has a diameter of 400m, but states it is of unknown significance. The very western section of the path of this feature extends into the proposed stock pile area. However, it possesses no surface expression and is not visible within the aerial photographic coverage. Due to the presence of the water course to the west of the site, this area possesses archaeological potential as it may contain burnt mounds or *fulachta fiadh*. The presence of the ringfort to the east and the possible associated enclosing feature that extends into the site increases the archaeological potential of this area.

1.2 RESULTS AND ANALYSIS – ARCHITECTURE

1.2.1 Built heritage background

Built heritage refers to all built features in the environment including buildings and other structures such as harbours, bridges, and wells. These sites have been identified through consultation with the County Development Plan (2011–2017), National Inventory of Architectural Heritage (NIAH) and through cartographic analysis and field inspection.

The built heritage within this area is typified by large country manors and associated demesne landscapes. The 18th century, a relatively peaceful period, saw the large-scale development of demesnes and country houses in Ireland. The houses generally form part of the larger demesne landscape. Demesnes were dominant features of the rural landscape throughout the 18th and 19th centuries. The large country house was only a small part of the overall estate of a large landowner and provided a base to manage often large areas of land that could be located nationwide. Lands associated with the large houses were generally turned over to formal gardens, which were much the style of continental Europe. Gradually this style of formal avenues and geometric gardens designs was replaced during the mid-18th century by the adoption of parkland landscapes – to be able to view a large house within a natural setting. Although the creation of a parkland landscape involved working with nature, rather than against it, considerable constructional effort went into their creation. Earth was moved, field boundaries disappeared, streams were diverted to form lakes and quite often roads were completely diverted to avoid travelling anywhere near the main house or across the estate.

A number of large demesnes are shown on the first edition OS mapping within the vicinity of the proposed development area; including Straffan House, Lyons Demesne, Bishopscourt House, Palmerstown Demesne and Kerdiffstown House. Smaller demesnes within the area include Turnings Upper, Farmhill, Sherlockstown, Ladycastle, Littlerath and Wheatfield.

Turnings House is designated as a Protected Structure (Ref.: B14-33) in Turnings Upper townland. The house is located c. 115m west of the proposed Morr 3 works, which are located within the associated demesne landscape. Further to the north, Turnings Lower House is shown on the first edition OS map adjacent to a flour mill 200m northwest of the proposed embankment at Morr 1. This is now known as Millbrook House and is listed as a Protected Structure (Ref.: B14-32) and recorded in the NIAH Survey (NIAH 11809019).

Vernacular architecture is defined in James Steven Curl's Encyclopaedia of Architectural Terms as 'a term used to describe the local regional traditional building forms and types using indigenous materials, and without grand architectural pretensions', i.e. the homes and workplaces of the ordinary people built by local people using local materials. This is in contrast to formal architecture, such as the grand estate houses of the gentry, churches and public buildings, which were often designed by architects or engineers. The majority of vernacular buildings are domestic dwellings. Examples of other structures that may fall into this category include shops, outbuildings, mills, lime kilns, farmsteads, forges, gates and gate piers. A number of small farmyards are located within the general vicinity including a well preserved example of a late 19th century outbuilding at Ballyhays (NIAH 11809018), c. 145m east-northeast of the proposed embankment at Morr 1.

Numerous vernacular bridges cross the Morrell, Painestown and Slane Rivers within proximity to the proposed development. These include Morrell Bridge in Turnings Upper/Lower, Finger Post Bridge in Tuckmilltown and Painestown Bridge in Painestown. These bridges comprised narrow, single- and triple-arch masonry structures dating from the early to late 19th century. The majority of these are annotated for the first time on the early 20th century mapping.

Industrial development and rapid social and political change during the 19th century initiated a new phase of building throughout rural and urban areas. This included advances in infrastructure, with the construction of the Royal and Grand Canals and the railway network and associated bridges and railway stations, the erection of mills, distilleries and other industrial buildings. The commencement of the Grand Canal in 1756 and the Royal Canal in 1789 helped sustain urban and industrial growth in 18th century Kildare. The canal provided conveyance for corn, coal, culm, and turf for the supply of the surrounding neighbourhood.

The line of the Grand Canal passes through the landscape of the proposed development from northeast–southwest. All of the features associated with the canal, including locks, furniture and buildings should be considered to have built heritage significance. The Devonshire Bridge (RPS B14-17, NIAH 11901405), a single-arch stone hump back road bridge over the canal built in c. 1800, is located in the vicinity of the Morr 19-23 works. The proposed embankment runs to the line of the canal and continues on the opposite bank.

1.2.2 County Development Plan

County Kildare has a wealth of structures of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. Such features are contained in the Record of Protected Structures (RPS) and the Record of Monuments and Places (RMP). County Kildare boasts a large number of country houses and demesnes where the grounds and settings constitute an intrinsic element of their character.

A review of the 2011-2017 plan has shown that there are four structures/features recorded as Protected Structures within 250m of the proposed scheme. Architectural features at Turnings House are also listed in the Record of Monuments and Places (B14-33/ KD014-023).

Table 4 – RPS sites located within 250m of proposed development

RPS No.	Classification	Townland	Distance to proposed development
B14-33	Turning House and lodge/ entrance/ wall	Turnings Upper	c. 115m west of Morr 3
B14-32	Millbrook House	Turnings Lower	c. 200m northwest of Morr 1
B14-30	Painestown House	Painestown	c. 70m northeast of Paines 5
B14-17	Devonshire Bridge	Killeenbeg/ Killeenmore	c. 180m west and northeast of Morr 19-23

1.2.3 National Inventory of Architectural Heritage

A review of the architectural survey was undertaken as part of this assessment. An area up to 250m that surrounds the proposed development area was examined in order to identify any buildings or areas of architectural significance. The results of this survey are summarised below.

Three structures are recorded in the NIAH survey within 250m of proposed development area. The nearest of these is the vernacular outbuilding in Ballyhays located c. 200m northeast of the embankment at Morr 1. The remaining two structures are both protected structures, but the outbuilding is only listed in the NIAH survey.

Table 5 – NIAH sites located within 250m of proposed development

NIAH	Classification	Townland	Distance to proposed development
11901405	Devonshire Bridge	Killeenbeg/ Killeenmore	c. 180m west and northeast of Morr 19-23
11809018	Outbuilding	Ballyhays	c. 145m east-northeast of Morr 1
11809019	Millbrook House	Turnings Lower	c. 200m northeast of Morr 1

1.2.4 Field Inspection

The field inspection sought to assess the proposed development area, its previous and current land use, the topography and whether any structures of architectural heritage merit were present. The field inspection was undertaken on 10th April 2015 and January 27th 2017 in dry conditions.

Table 6 – Results of Architectural Field Inspection

Scheme Ref.:	Field Inspection Results:
Morr 1	Whilst the protected structure of Millbrook House (B14-32) is located c. 200m northwest of the proposed embankment at this location, it is not visible from the site. Neither is the outbuilding recorded in the NIAH survey c. 145m to the east-northeast (11809018). Morrell Bridge is located to the immediate west of the proposed embankment. Whilst it is marked on the historic OS maps and retains some rubble fabric, the bridge has been affected by modern works within the river channel itself.
Morr 1a	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Morr 2-3	The Morr 2 embankment will be located to the immediate north of Morrell Bridge (Old), which is present within the historic mapping. The structure has

Scheme Ref.:	Field Inspection Results:
	also been affected by modern works within the channel of the river (Image 15-9). The original single span segmental arched bridge has been added to on the western side with an additional span. The river bed has been widened, presumably to try and alleviate flooding. **Image 9: Morrell Bridge (old) in Turnings Upper/ Lower, facing north**  Morr 3 will consist of the construction of an embankment through the demesne associated with Turnings House, to the south of Morrell Bridge (Old) (see Image 15-4). The house is a protected structure, as is the derelict lodge and the existing entrance into the house and demesne (Image 10). The lodge is located c. 100m west of the proposed embankment. **Image 10: Gate Lodge associated with Turnings House (B14-33), facing southwest** 

Scheme Ref.:	Field Inspection Results:
Paines 1	Morrell Bridge (Old) is located to the immediate west of the Paines 1 embankment. No other structures were identified in the vicinity of the proposed works.
Paines 2-3	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Morr 4-8	The proposed embankment will be adjacent to the existing railway line and pass to the immediate southeast of two small bridges that carry the tracks over water courses.
Morr 9	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Morr 10	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Morr 15	This section of the scheme will see the construction of an embankment adjacent to the railway, which then turns to run towards the Morrell Bridge. The bridge is marked on the historic maps and consists of a single span structure of random rubble masonry.
Morr 16-16a	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Morr 17,19	These measures will involve the construction of embankments across a number of fields of pasture in between the existing railway and the Grand Canal. The Grand Canal is a well-defined feature flanked by banks topped by mature trees and boundaries. Morrell Bridge is located to the immediate north of the measures and the 14th Lock is located to the immediate east of Morr 19. A railway bridge, which carries the existing road across the railway tracks is located c. 65m northwest of the proposed embankments (Image 11) **Image 11: Railway Bridge, facing northwest** 
Morr 20-23	This section of the proposed scheme will see embankments constricted across a golf course. No architectural heritage sites are present within the vicinity of this

Scheme Ref.:	Field Inspection Results:
	section of the proposed works. The Devonshire Bridge (B14-17) is located c. 180m west of the northern section of the proposed embankments.
Paines 4	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Paines 5	A short section of embankment is required at this location to the west and south of several residential properties. The River Paines is located to the immediate southwest of these buildings. Paines Bridge is located c. 40m west-northwest of the proposed embankments (Image 12). The structure consists of a triple span random rubble bridge with a slight 'hump'. The bridge is marked on the historic OS maps. Painestown House (B14-30) is located c. 70m northeast of the proposed works. **Image 12: Painestown Bridge facing southeast** 
Slane 1-6	This area of proposed works will consist of the construction of proposed embankments and walls to the rear of a number of residential plots that are bounded by the River Slane within the townland of Tuckmilltown. Two bridges have been identified adjacent to the scheme at this location. The Finger Post Bridge is located to the immediate south of proposed embankments (Image 13). This structure is a double span bridge of random rubble masonry. It possesses similar characteristics to the Painestown Bridge. **Image 13: Finger Post Bridge, facing southwest**

Scheme Ref.:	Field Inspection Results:
	 A further bridge is located across the River Slane to the east-northeast of the Finger Post Bridge. This is a random rubble structure with a single span.
Slane 7	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Slane 8-9	No architectural heritage sites are present within the vicinity of this section of the proposed works.
Kill 1	No architectural heritage sites are present within the vicinity of this section of the proposed works.

Potential Stockpile Areas

As part of the proposed scheme, three possible areas that may be used for stock piling materials have been identified. These are areas located adjacent to Morr 23, Morr 19 and Paines 3. The main compound may be located at one of these identified stockpiling/compound areas and be established specifically for the project, or may alternatively use suitable existing premises, if one is available.

With the exception of the path of the canal to the immediate west of the proposed stock pile area at Morr 19, there are no sites of architectural heritage located within the immediate environs of the three stock pile areas.

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APPENDIX G2. SMR/ RMP SITES WITHIN THE SURROUNDING AREA

SMR No.	KD014-057
RMP	Yes
Townland	Ballyhays
Parish	Whitechurch
Barony	North Naas
ITM	692634, 728691
Classification	Ring-ditch
Distance from site	c. 160m south of Morr 1
Description	Aerial photograph (GB89.AF.11) shows the cropmark of a ring-ditch defined by two concentric fosses; located in close proximity to a curvilinear enclosure (KD014-058). Cropmarks of plough-levelled field boundaries located nearby; chronological relationship uncertain.
Reference	www.archaeology.ie
SMR No.	KD014-058
RMP	Yes
Townland	Ballyhays
Parish	Whitechurch
Barony	North Naas
ITM	692629, 728623
Classification	Enclosure
Distance from site	c. 215m north of Morr 1A
Description	Aerial photograph (GB89.AF.11) shows the cropmark of a curvilinear enclosure defined by a fosse; located in close proximity to a ring-ditch (KD014-057) Cropmarks of plough-levelled field boundaries located nearby; chronological relationship uncertain.
Reference	www.archaeology.ie
SMR No.	KD014-056
RMP	No
Townland	Turnings Upper
Parish	Whitechurch
Barony	North Naas
ITM	692167, 727499
Classification	*Fulacht fiadh*
Distance from site	c. 25m east of Morr
Description	In 2002, three small areas were archaeologically excavated (Kavanagh 2003 Excavation Licence Nos. 02E1537, 02E1539, 02E1540) in advance of the construction of an embankment as part of the flood alleviation measures undertaken on the Morell River, to the north of Morell Bridge (Old), by Kildare County Council. In 'Area 2' (22.5m NNW-SSE; 17.5m ENE-WSW), excavated under Licence No 02E1539, a large, roughly oval trough was discovered (diams. 3.4m; 2.72m; D 1.25m) and contained large quantities of burnt and partially burnt limestone. Large quantities of twigs, branches and charred timber at the base of the trough were interpreted as the remains of a lining. Four stakes were found embedded into the N and W sides of the trough, two with well-worked points. Two oval pits (diams. 1.42m; 0.92m; D 0.18m and diams. 0.42m; 0.33m; D 0.4m)

	were found, at a slight distance from the trough, and contained burnt limestone also, while a further two pits (diam. 0.92; D 0.3m and diam. 1.22m; D 0.32m) produced small quantities of burnt stone.
Reference	www.archaeology.ie
SMR No.	KD014-023001–4
RMP	Architectural features – Yes, Inscribed stones - No
Townland	Turnings Upper
Parish	Whitechurch
Barony	North Naas
ITM	691971, 727228
Classification	Architectural feature (x2), Inscribed stone (x2)
Distance from site	c. 170m west of Morr 3
Description	Turnings House is a heavily rendered, three storied, five-bayed structure, built in the early-18th century according to the owner. At ground-floor level it incorporates a fine, late-15th century ogival, twin-light window, the head of which is decorated with a knot pattern, a monkey, a bird and an unidentified animal. (Fitzgerald 1902, 482) The original location of the window is unknown. The house also contains a late-15th century ogival, single-light window (KD014-023002) and there are two small, early-18th century date stones (KD014-023003, KD014-023004) on the grounds. (Record number KD014-023005 has been created to cover the (unknown) Original location of the twin-light window (KD014-023001) and record number KD014-023006 covers the (unknown) original location of the single-light window (KD014-023002).
Reference	www.archaeology.ie
SMR No.	KD014-024
RMP	Yes
Townland	Turnings Upper
Parish	Whitechurch
Barony	North Naas
ITM	692431, 726760
Classification	Ringfort - unclassified
Distance from site	c. 145m southeast of Paines 1
Description	The monument is shown on the 1st ed. (1838) of the OS 6-inch map as circular area (est. max. diam. c. 70m) defined by a bank. (Also shown, as a dotted line, is a very large, outer enclosing feature (est. max. diam. c. 400m) concentric with the monument from E-N, which is of uncertain significance). On level, improved pasture. No visible surface trace of either feature survives, and a modern house with extensive outbuildings occupies part of the site.
Reference	www.archaeology.ie
SMR No.	KD015-015
RMP	No
Townland	Blackchurch
Parish	Kilteel
Barony	South Salt
ITM	696524, 724258

Classification	Habitation site
Distance from site	c. 175m southwest of Slane 7
Description	In 2003, a site was identified through archaeological testing (Licence no. 03E1606: www.excavations.ie) during pre-development road-widening of the existing N7 between the Maudlins Interchange and the Dublin/Kildare county boundary. It was subsequently excavated (Licence no. 03E1838: www.excavations.ie) as 'Site 14C. A square area (dims. L 50m; Wth 50m) located immediately north of the existing N7 and immediately east of the Castlewarden Road was excavated. Two main ditches identified were in the south-west corner and extended at right angles to one another. They did not, however, form part of an enclosure but appear to have an agricultural function - possibly drainage or land/property boundaries. The remaining features consisted of shallow, irregular-shaped pits and shallow gullies. It is thought that this activity may be associated with possible land clearance and subsequent agricultural activities, including drainage, ploughing and small field divisions/plots. All of the features produced medieval pottery dated to the 13th/14th centuries. Later post-medieval plough furrows show that the field has been cross-ploughed, but some stratigraphically earlier furrows running in different orientations may further indicate changes in boundaries.
Reference	www.archaeology.ie

SMR No.	KD015-014
RMP	No
Townland	Blackchurch
Parish	Kilteel
Barony	South Salt
ITM	696680, 724157
Classification	Habitation site
Distance from site	c. 175m south of Slane 7
Description	In 2003, a site was identified through archaeological testing (Licence no. 03E1606: www.excavations.ie) during pre-development road-widening of the existing N7 between the Maudlins Interchange and the Dublin/Kildare county boundary. It was subsequently excavated (Licence no. 03E1837: www.excavations.ie) as 'Site 14B'. A rectangular area (dims. L 40m; Wth 8m), located immediately north of the existing N7 and immediately west of the Castlewarden Road, was excavated and a number of linear ditches were identified extending both east-west and north-south. The stratigraphy suggested that the features represented multiple phases of activity. The linear features appeared to represent alterations in field boundaries and/or drains. Most of the fills contained medieval pottery. Some later, shallower recuts held post-medieval pottery. A number of irregularly shaped hollows filled with mixed organic soils that contained medieval pottery were identified within the natural subsoil and were interpreted as tree boles left after land clearance. All of the activity represented agricultural activity and the presence of the pottery in the dump fills suggests that there might be a medieval settlement in the vicinity.
Reference	www.archaeology.ie

APPENDIX G3. STRAY FINDS WITHIN THE SURROUNDING AREA

Information on artefact finds from the study area in County Cork has been recorded by the National Museum of Ireland since the late 18th century. Location information relating to these finds is important in establishing prehistoric and historic activity in the study area.

The following townlands were researched for stray finds: Alasty, Ballyhays, Baronrath, Bishopscourt Upper, Bishopscourt Lower, Blackchurch, Clownings, Daars South, Johnstown, Killeenmore, Killeenbeg, Killhill, Kill East, Kill West, Lodgepark, Maudlings, Oughterard, Painestown, Palmerstown / Demesne, Prospect, Sherlockstown, Sherlockstown Common, Straffan Demesne, Tuckmilltown, Turnings Upper, Turnings Lower and Whitechurch.

Museum Ref.	1980:130.1-20 and 1980:130.22-49
Townland	Oughterard
Parish	Oughterard
Barony	South Salt
Find	47 body sherds of Medieval Ceramic, Stone
Find Place	Exposed bank near Oughterard Church
Description	31 sherds of Leinster Cooking Ware, 3 sherds of soft fired orange fabric ceramic with glazed exterior (Dublin-type fineware?), 6 sherds of hard fired orange fabric with glazed exterior (Dublin-type ware?) and 7 sherds of miscellaneous glazed pottery
Museum Ref.	1980:129
Townland	Oughterard
Parish	Oughterard
Barony	South Salt
Find	Iron Knife
Find Place	Exposed bank near Oughterard Church
Description	Iron Knife fragment with wooden handle. Handle has two perforations and one rivet is still present
Museum Ref.	1983:44:1–3
Townland	Sherlockstown
Parish	Sherlockstown
Barony	Naas North
Find	Human remains, cremated remains
Find Place	Sandy Hill
Description	One box of bone and one skull, unburnt, Six small bags of cremated human remains, some of the fragments appear to be from a juvenile.
Museum Ref.	2013:202
Townland	Tuckmilltown
Parish	Oughterard
Barony	South Salt
Find	Pewter spoon

Find Place	Unknown
Description	Pewter spoon, lead-alloy. 18th or 19th century. Undecorated, handle broken. Found in a newly ploughed field

APPENDIX G4. RPS/ NIAH STRUCTURES WITHIN THE SURROUNDING AREA

RPS No.	B14-30
NIAH	n/a
Townland	Painestown
Parish	Kill
Barony	South Salt
ITM	694061, 724367
Classification	Painestown House
Distance from site	c. 70m northeast of Paines 5
Description	Late 19th century house. Two storey, three bay house with hipped slate roof set in well maintained grounds with farm buildings to the rear (west)
Categories of Special Interest:	Not specified
Rating	Not specified
Reference	Kildare County Development Plan, 2011-2017
RPS No.	B14-33
NIAH	n/a
Townland	Turnings Upper
Parish	Whitechurch
Barony	Naas North
ITM	691971, 727228
Classification	Turnings House and lodge/entrance/ walls
Distance from site	c. 115m west of Morr 3
Description	Turnings House is a heavily rendered, three storied, five-bayed structure, built in the early-18th century according to the owner. At ground-floor level it incorporates a fine, late-15th century ogival, twin-light window, the head of which is decorated with a knot pattern, a monkey, a bird and an unidentified animal. The original location of the window is unknown. The house also contains a late-15th century ogival, single-light window and there are two small, early-18th century date stones. Also Recorded Monument KD014-023.
Categories of Special Interest:	Not specified
Rating	Not specified
Reference	Kildare County Development Plan, 2011-2017, www.archaeology.ie
RPS No.	n/a
NIAH	11809018
Townland	Ballyhays
Parish	Whitechurch
Barony	North Naas
ITM	692768, 728903
Classification	Outbuilding

Distance from site	c. 145m east-northeast of Morr 1
Description	Detached two-bay two-storey outbuilding, c.1850, with square-headed integral carriageways to ground floor, flight of steps to first floor to side elevation to south-west and single-bay single-storey end bay to north-east. Reroofed, c.1930. Renovated, c.1975, with integral carriageways remodelled to ground floor. Gable-ended roofs. Replacement corrugated-iron, c.1930. Iron ridge tiles. Rendered coping to gables. Cast-iron rainwater goods. Roughcast walls. Painted. Square-headed openings (including door opening to first floor side (south-west) elevation approached by flight of steps). Stone sills. Replacement timber casement windows, c.1975. Square-headed integral carriageways to ground floor remodelled, c.1975. Replacement timber boarded doors, c.1975. Set back from road in grounds shared with further outbuildings to south-east and to south-west.
Categories of Special Interest:	Architectural, historical, social
Rating	Regional
Reference	NIAH survey
RPS No.	B14-17
NIAH	11901405
Townland	Killeenmore
Parish	Whitechurch
Barony	Naas North
ITM	692075, 724801
Classification	Devonshire Bridge
Distance from site	c. 180m west of Morr 20-23
Description	Single-arch dressed stone hump back road bridge over canal, c. 1800, with dressed stone voussoirs, keystone, cut-stone stringcourse and coursed stone parapet walls. Coursed dressed stone walls to abutments. Cut-stone advanced piers. Cut-stone stringcourse. Coursed dressed stone parapet walls. Rubble stone walls to wings. Single round arch. Dressed stone voussoirs with keystone. Rubble stone soffits with traces of render over. Sited spanning Grand Canal with tow path to east and grass banks to canal.
Categories of Special Interest:	Architectural, historical, social
Rating	Regional
Reference	NIAH survey, Kildare County Development Plan, 2011-2017
RPS No.	B14-32
NIAH	11809019
Townland	Turnings Lower
Parish	Whitechurch
Barony	Naas North
ITM	692456, 729022
Classification	Millbrook House
Distance from site	c. 200m northwest of Morr 1
Description	Detached three-bay two-storey Georgian house, c.1840, possibly over basement retaining early fenestration with five-bay two-storey lower return to rear to south-east having two-bay single-storey end bay. Renovated, c.1990. Hipped roof with slate (gable-ended to return to south-east). Clay ridge tiles. Rendered chimney stacks. Square rooflights, c.1990, to part of return. Rendered eaves course. Cast-iron rainwater goods.

	Roughcast walls. Unpainted. Square-headed window openings. Stone sills. 3/3, 3/6 and 6/6 timber sash windows. Elliptical-headed door opening approached by flight of steps. Timber pilaster doorcase with consoles and entablature. Timber panelled door. Overlight. Set back from road in own grounds. Gravel forecourt to front. Gateway, c.1840, to north-west comprising pair of cut-granite piers with stringcourses, pyramidal capping, cast-iron double gates having spear head finials and rubble stone flanking boundary wall.
Categories of Special Interest:	Architectural, historical, social
Rating	Regional
Reference	NIAH survey, Kildare County Development Plan, 2011-2017

APPENDIX G5. LEGISLATIVE FRAMEWORK PROTECTING THE ARCHAEOLOGICAL RESOURCE

Protection of Cultural Heritage

The cultural heritage in Ireland is safeguarded through national and international policy designed to secure the protection of the cultural heritage resource to the fullest possible extent (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the *European Convention on the Protection of the Archaeological Heritage* (Valletta Convention), ratified by Ireland in 1997.

The Archaeological Resource

The *National Monuments Act 1930 to 2004* and relevant provisions of the *National Cultural Institutions Act 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A National Monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act 1930 Section 2).

A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places, and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Ownership and Guardianship of National Monuments

The Minister may acquire national monuments by agreement or by compulsory order. The state or local authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

Register of Historic Monuments

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the register is illegal without the permission of the Minister. Two months notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Preservation Orders and Temporary Preservation Orders

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Record of Monuments and Places

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for the Environment, Heritage and Local Government) to establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994. All recorded monuments on the proposed development site are represented on the accompanying maps.

Section 12(3) of the 1994 Act provides that 'where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the work until two months after the giving of notice'.

Under the National Monuments (Amendment) Act 2004, anyone who demolishes or in any way interferes with a recorded site is liable to a fine not exceeding €3,000 or imprisonment for up to 6 months. On summary conviction and on conviction of indictment, a fine not exceeding €10,000 or imprisonment for up to 5 years is the penalty. In addition they are liable for costs for the repair of the damage caused.

In addition to this, under the *European Communities (Environmental Impact Assessment) Regulations 1989,* Environmental Impact Statements (EIS) are required for various classes and sizes of development project to assess the impact the proposed development will have on the existing environment, which includes the cultural, archaeological and built heritage resources. These document's recommendations are typically incorporated into the conditions under which the proposed development must proceed, and thus offer an additional layer of protection for monuments which have not been listed on the RMP.

The Planning and Development Act 2000

Under planning legislation, each local authority is obliged to draw up a Development Plan setting out their aims and policies with regard to the growth of the area over a five-year period. They cover a range of issues including archaeology and built heritage, setting out their policies and objectives with regard to the protection and enhancement of both. These policies can vary from county to county. The Planning and Development Act 2000 recognises that proper planning and sustainable development includes the protection of the archaeological heritage. Conditions relating to archaeology may be attached to individual planning permissions.

County Kildare Development Plan 2011–2017

AH 1: To have regard to the Record of Monuments and Places (RMP) and the Urban Archaeological Survey when assessing planning applications for development. No development shall be permitted in the vicinity of a recorded feature where it detracts from the setting of the feature or which is injurious to its cultural or educational value.

AH 2: To seek to protect and preserve archaeological sites which have been identified subsequent to the publication of the Record of Monuments and Places (RMP).

AH 3: To ensure that development in the vicinity of a site of archaeological interest is not detrimental to the character of the archaeological site or its setting by reason of its location, scale, bulk or detailing and to ensure that such proposed developments are subject to an archaeological assessment. Such an assessment will seek to ensure that the development can be designed in such a way as to avoid or minimise any potential effects on the archaeological heritage.

APPENDIX G6. LEGISLATIVE FRAMEWORK PROTECTING THE ARCHITECTURAL RESOURCE

The main laws protecting the built heritage are the Architectural Heritage (National Inventory) and National Monuments (Miscellaneous Provisions) Act 1999 and the Local Government (Planning and Development) Acts 1963-1999, which has now been superseded by the Planning and Development Act, 2000. The Architectural Heritage Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The background to this legislation derives from Article 2 of the 1985 Convention for the Protection of Architectural Heritage (Granada Convention). This states that:

For the purpose of precise identification of the monuments, groups of structures and sites to be protected, each member state will undertake to maintain inventories of that architectural heritage.

The National Inventory of Architectural Heritage (NIAH) was established in 1990 to fulfil Ireland's obligation under the Granada Convention, through the establishment and maintenance of a central record, documenting and evaluating the architecture of Ireland (NIAH Handbook 2005:2). As inclusion in the inventory does not provide statutory protection, the survey information is used in conjunction with the Architectural Heritage Protection Guidelines for Planning Authorities to advise local authorities on compilation of a Record of Protected Structures as required by the Planning and Development Act, 2000.

Protection under the Record of Protected Structures and County Development Plan

Structures of architectural, cultural, social, scientific, historical, technical or archaeological interest can be protected under the Planning and Development Act, 2000, where the conditions relating to the protection of the architectural heritage are set out in Part IV of the act. This act superseded the Local Government (Planning and Development) Act, 1999, and came into force on 1st January 2000.

The act provides for the inclusion of Protected Structures into the planning authorities' development plans and sets out statutory regulations regarding works affecting such structures. Under new legislation, no distinction is made between buildings formerly classified under development plans as List 1 and List 2. Such buildings are now all regarded as 'Protected Structures' and enjoy equal statutory protection. Under the act the entire structure is protected, including a structure's interior, exterior, attendant grounds and also any structures within the attendant grounds.

The act defines a Protected Structure as (a) a structure, or (b) a specified part of a structure which is included in a Record of Protected Structures (RPS), and, where that record so indicates, includes any specified feature which is in the attendant grounds of the structure and which would not otherwise be included in this definition. Protection of the structure, or part thereof, includes conservation, preservation, and improvement compatible with maintaining its character and interest. Part IV of the act deals with architectural heritage, and Section 57 deals specifically with works affecting the character of Protected Structures or proposed Protected Structures and states that no works should materially affect the character of the structure or any element of the structure that contributes to its special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. The act does not provide specific criteria for assigning a special interest to a structure. However, the National Inventory of Architectural Heritage (NIAH) offers guidelines to its field workers as to how to designate a building with a special interest, which are not mutually exclusive. This offers guidance by example rather than by definition:

Archaeological

It is to be noted that the NIAH is biased towards post-1700 structures. Structures that have archaeological features may be recorded, providing the archaeological features are incorporated within post-1700 elements. Industrial fabric is considered to have technical significance, and should only be attributed archaeological significance if the structure has pre-1700 features.

Architectural - A structure may be considered of special architectural interest under the following criteria:

- Good quality or well executed architectural design;
- The work of a known and distinguished architect, engineer, designer, craftsman;
- A structure that makes a positive contribution to a setting, such as a streetscape or rural setting;
- Modest or vernacular structures may be considered to be of architectural interest, as they are part of the history of the built heritage of Ireland;
- Well designed decorative features, externally and/or internally.

Historical - A structure may be considered of special historical interest under the following criteria:

- A significant historical event associated with the structure;
- An association with a significant historical figure;
- Has a known interesting and/or unusual change of use, e.g. a former workhouse now in use as a hotel;
- A memorial to a historical event.

Technical - A structure may be considered of special technical interest under the following criteria:

- Incorporates building materials of particular interest, i.e. the materials or the technology used for construction;
- It is the work of a known or distinguished engineer;
- Incorporates innovative engineering design, e.g. bridges, canals or mill weirs;
- A structure which has an architectural interest may also merit a technical interest due to the structural techniques used in its construction, e.g. a curvilinear glasshouse, early use of concrete, cast-iron prefabrication;
- Mechanical fixtures relating to a structure may be considered of technical significance.

Cultural - A structure may be considered of special cultural interest under the following criteria:

- An association with a known fictitious character or event, e.g. Sandycove Martello Tower, which featured in Ulysses.
- Other structure that illustrate the development of society, such as early schoolhouses, swimming baths or printworks.

Scientific - A structure may be considered of special scientific interest under the following criteria:

- A structure or place which is considered to be an extraordinary or pioneering scientific or technical achievement in the Irish context, e.g. Mizen Head Bridge, Birr Telescope.

Social - A structure may be considered of special social interest under the following criteria:

- A focal point of spiritual, political, national or other cultural sentiment to a group of people, e.g. a place of worship, a meeting point, assembly rooms;
- Developed or constructed by a community or organisation, e.g. the construction of the railways or the building of a church through the patronage of the local community;
- Illustrates a particular lifestyle, philosophy, or social condition of the past, e.g. the hierarchical accommodation in a country house, philanthropic housing, vernacular structures.

Artistic - A structure may be considered of special artistic interest under the following criteria:

- Work of a skilled craftsman or artist, e.g. plasterwork, wrought-iron work, carved elements or details, stained glass, stations of the cross;
- Well designed mass produced structures or elements may also be considered of artistic interest.

(From the NIAH Handbook 2003 & 2005 pages 15-20)

The Local Authority has the power to order conservation and restoration works to be undertaken by the owner of the protected structure if it considers the building to be in need of repair. Similarly, an owner or developer must make a written request to the Local Authority to carry out any works on a protected structure and its environs, which will be reviewed within three months of application. Failure to do so may result in prosecution.

County Kildare Development Plan 2011–2017

Protected Structures - It is the policy of the Council:

PS 1: To conserve and protect buildings, structures and sites contained on the Record of Protected Structures of special architectural, historic, archaeological, artistic, cultural, scientific, social or technical interest.

PS 2: To protect the curtilage of protected structures or proposed protected structures and to refuse planning permission for inappropriate development within the curtilage or attendant grounds of a protected structure which would adversely impact on the special character of the protected structure including cause loss of or damage to the special character of the protected structure including cause loss of or damage to, any structures of architectural heritage value merit within the curtilage of the protected structure. Any proposed development within the curtilage and/or attendant grounds must demonstrate that it is part of an overall strategy for the future conservation of the entire built heritage complex and contributes positively to that aim.

PS 16: To protect and retain important elements of the built heritage including historic gardens, stone walls, landscapes and demesnes, and curtilage feature

Vernacular Architecture - It is the policy of the Council:

VA 1: To encourage the protection, retention, appreciation and appropriate revitalisation of the vernacular heritage of the county.

VA 2: To resist the demolition of vernacular architecture, in particular thatched cottages and farmhouses and to encourage their sensitive reuse having regard to the intrinsic character of the structure

Architectural Conservation Areas (ACAs) - It is the policy of the Council:

ACA 1: To investigate the designation of further ACAs at appropriate locations throughout the county to include Celbridge, Kildare Town, Johnstown, Ballymore Eustace, Kilcullen, Brannockstown, Rathmore, Clane and Newbridge

ACA 2: To ensure that any development, modifications, alterations, or extensions within an ACA are sited and designed appropriately, and are not detrimental to the character of the structure or to its setting or the general character of the AC

Country Houses and Demesnes - It is the policy of the Council:

CH1: To promote appreciation of the landscape and historical importance of traditional and historic gardens, demesnes and parks within Kildare in general and particularly where they constitute an important setting to a protected structure.

CH 2: To have regard to the historic gardens and designed landscape sites in County Kildare identified in the National Inventory of Architectural Heritage.

CH 3: To encourage conservation, renewal and improvement which enhances the character and the setting of parks, gardens, and demesnes of historic interest within the county.

AAO 10: To identify and retain good examples of historic street furniture in situ e.g. cast-iron postboxes, water pumps, signage, street lighting, kerbing and traditional road and street surface coverings

APPENDIX G7. IMPACT ASSESSMENT AND THE CULTURAL HERITAGE RESOURCE

Potential Impacts on Archaeological and Historical Remains

Impacts are defined as 'the degree of change in an environment resulting from a development' (Environmental Protection Agency 2003: 31). They are described as profound, significant or slight impacts on archaeological remains. They may be negative, positive or neutral, direct, indirect or cumulative, temporary or permanent.

Impacts can be identified from detailed information about a project, the nature of the area affected and the range of archaeological and historical resources potentially affected. Development can affect the archaeological and historical resource of a given landscape in a number of ways.

- Permanent and temporary land-take, associated structures, landscape mounding, and their construction may result in damage to or loss of archaeological remains and deposits, or physical loss to the setting of historic monuments and to the physical coherence of the landscape.
- Archaeological sites can be affected adversely in a number of ways: disturbance by excavation, topsoil stripping and the passage of heavy machinery; disturbance by vehicles working in unsuitable conditions; or burial of sites, limiting accessibility for future archaeological investigation.
- Hydrological changes in groundwater or surface water levels can result from construction activities such as de-watering and spoil disposal, or longer-term changes in drainage patterns. These may desiccate archaeological remains and associated deposits.
- Visual impacts on the historic landscape sometimes arise from construction traffic and facilities, built earthworks and structures, landscape mounding and planting, noise, fences and associated works. These features can impinge directly on historic monuments and historic landscape elements as well as their visual amenity value.
- Landscape measures such as tree planting can damage sub-surface archaeological features, due to topsoil stripping and through the root action of trees and shrubs as they grow.
- Ground consolidation by construction activities or the weight of permanent embankments can cause damage to buried archaeological remains, especially in colluviums or peat deposits.
- Disruption due to construction also offers in general the potential for adversely affecting archaeological remains. This can include machinery, site offices, and service trenches.

Although not widely appreciated, positive impacts can accrue from developments. These can include positive resource management policies, improved maintenance and access to archaeological monuments, and the increased level of knowledge of a site or historic landscape as a result of archaeological assessment and fieldwork.

Predicted Impacts

The severity of a given level of land-take or visual intrusion varies with the type of monument, site or landscape features and its existing environment. Severity of impact can be judged taking the following into account:

- The proportion of the feature affected and how far physical characteristics fundamental to the understanding of the feature would be lost;
- Consideration of the type, date, survival/condition, fragility/vulnerability, rarity, potential and amenity value of the feature affected;
- Assessment of the levels of noise, visual and hydrological impacts, either in general or site specific terms, as may be provided by other specialists.

APPENDIX G8. MITIGATION MEASURES AND THE CULTURAL HERITAGE RESOURCE

Potential Mitigation Strategies for Cultural Heritage Remains

Mitigation is defined as features of the design or other measures of the proposed development that can be adopted to avoid, prevent, reduce or offset negative effects.

The best opportunities for avoiding damage to archaeological remains or intrusion on their setting and amenity arise when the site options for the development are being considered. Damage to the archaeological resource immediately adjacent to developments may be prevented by the selection of appropriate construction methods. Reducing adverse effects can be achieved by good design, for example by screening historic buildings or upstanding archaeological monuments or by burying archaeological sites undisturbed rather than destroying them. Offsetting adverse effects is probably best illustrated by the full investigation and recording of archaeological sites that cannot be preserved *in situ*.

Definition of Mitigation Strategies –

Archaeological Resource

The ideal mitigation for all archaeological sites is preservation in situ. This is not always a practical solution, however. Therefore a series of recommendations are offered to provide ameliorative measures where avoidance and preservation in situ are not possible.

Full Archaeological Excavation can be defined as 'a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site on land, inter-tidal zone or underwater. The records made and objects gathered during fieldwork are studied and the results of that study published in detail appropriate to the project design' (IFA 2008).

Archaeological Test Trenching can be defined as 'a limited programme of intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land, inter-tidal zone or underwater. If such archaeological remains are present field evaluation defines their character, extent, quality and preservation, and enables an assessment of their worth in a local, regional, national or international context as appropriate' (IFA 2009).

Archaeological Monitoring can be defined as 'a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive (IFA 2008).

Underwater Archaeological Assessment consists of a programme of works carried out by a specialist underwater archaeologist, which can involve wade surveys, metal detection surveys and the excavation of test pits within the sea or riverbed. These assessments are able to access and assess the potential of an underwater environment to a much higher degree than terrestrial based assessments.

Architectural Resource

The architectural resource is generally subject to a greater degree of change than archaeological sites, as structures may survive for many years but their usage may change continually. This can be reflected in the fabric of the building, with the addition and removal of doors, windows and extensions. Due to their often more visible presence within the landscape than archaeological sites, the removal of such structures can sometimes leave a discernible ‘gap’ with the cultural identity of a population. However, a number of mitigation measures are available to ensure a record is made of any structure that is deemed to be of special interest, which may be removed or altered as part of a proposed development.

Conservation Assessment consists of a detailed study of the history of a building and can include the surveying of elevations to define the exact condition of the structure. These assessments are carried out by historic building specialists and would commonly be carried out in association with proposed alterations or renovations on a protected structure.

Building Survey may involve making an accurate record of elevations (internal and external), internal floor plans and external sections. This is carried out using a EDM (Electronic Distance Measurer) and GPS technology to create scaled drawings that provide a full record of the appearance of a building at the time of the survey.

Historic Building Assessment is generally specific to one building, which may have historic significance, but is not a Protected Structure or listed within the NIAH. A full historical background for the structure is researched and the site is visited to assess the standing remains and make a record of any architectural features of special interest. These assessments can also be carried out in conjunction with a building survey.

Written and Photographic record provides a basic record of features such as stone walls, which may have a small amount of cultural heritage importance and are recorded for prosperity. Dimensions of the feature are recorded with a written description and photographs as well as some cartographic reference, which may help to date a feature.

Appendix H

NRA Ecological Valuation Criteria

Appendix H

Ecological Valuation Criteria

International Importance:
• 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation.
• Proposed Special Protection Area (pSPA).
• Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended).
• Features essential to maintaining the coherence of the Natura 2000 Network.[1]
• Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive.
• Resident or regularly occurring populations (assessed to be important at the national level)[2] of the following:
  o Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and / or
  o Species of animal and plants listed in Annex II and/or IV of the Habitats Directive.
• Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971).
• World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972).
• Biosphere Reserve (UNESCO Man & The Biosphere Programme).
• Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979).
• Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979).
• Biogenetic Reserve under the Council of Europe.
• European Diploma Site under the Council of Europe.
• Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988).[3]

National Importance:
• Site designated or proposed as a Natural Heritage Area (NHA).
• Statutory Nature Reserve.
• Refuge for Fauna and Flora protected under the Wildlife Acts.
• National Park.
• Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park.
• Resident or regularly occurring populations (assessed to be important at the national level)[4] of the following:
  o Species protected under the Wildlife Acts; and/or
  o Species listed on the relevant Red Data list.
• Site containing 'viable areas'[5] of the habitat types listed in Annex I of the Habitats Directive.

[1] See Articles 3 and 10 of the Habitats Directive.

[2] It is suggested that, in general, 1% of the national population of such species qualifies as an internationally important population. However, a smaller population may qualify as internationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[3] Note that such waters are designated based on these waters' capabilities of supporting salmon (*Salmo salar*), trout (*Salmo trutta*), char (*Salvelinus*) and whitefish (*Coregonus*).

[4] It is suggested that, in general, 1% of the national population of such species qualifies as a nationally important population. However, a smaller population may qualify as nationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

Ecological Valuation Criteria

County Importance:

- Area of Special Amenity.[6]
- Area subject to a Tree Preservation Order.
- Area of High Amenity, or equivalent, designated under the County Development Plan.
- Resident or regularly occurring populations (assessed to be important at the County level)[7] of the following:
    - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
    - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
    - Species protected under the Wildlife Acts; and/or
    - Species listed on the relevant Red Data list.
- Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance.
- County important populations of species, or viable areas of semi-natural habitats or natural heritage features identified in the National or Local Biodiversity Action Plan (BAP) if this has been prepared.
- Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county.
- Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.

Local Importance (higher value):

- Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared;
- Resident or regularly occurring populations (assessed to be important at the Local level)[8] of the following:
    - Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive;
    - Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;
    - Species protected under the Wildlife Acts; and/or
    - Species listed on the relevant Red Data list.
- Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality;
- Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.

Local Importance (lower value):

- Sites containing small areas of semi-natural habitat that are of some local importance for wildlife;
- Sites or features containing non-native species that are of some importance in maintaining habitat links.

Source: Guidelines for Assessment of Ecological Impacts in National Road Schemes (NRA, 2009)

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[5] A 'viable area' is defined as an area of a habitat that, given the particular characteristics of that habitat, was of a sufficient size and shape, such that its integrity (in terms of species composition, and ecological processes and function) would be maintained in the face of stochastic change (for example, as a result of climatic variation).

[6] It should be noted that whilst areas such as Areas of Special Amenity, areas subject to a Tree Preservation Order and Areas of High Amenity are often designated on the basis of their ecological value, they may also be designated for other reasons, such as their amenity or recreational value. Therefore, it should not be automatically assumed that such sites are of County importance from an ecological perspective.

[7] It is suggested that, in general, 1% of the County population of such species qualifies as a County important population. However, a smaller population may qualify as County importance where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

[8] It is suggested that, in general, 1%of the local population of such species qualifies as a locally important population. However, a smaller population may qualify as locally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.

Appendix I

WFD Assessment

Appendix I

SCHEDULE A: Water Framework Directive (WFD) Assessment - Surface Water Impact Scoping

Project Component Data Sheet

LOCATION	**Location**	NE of Naas, Co Kildare
	Map Reference	50k raster – Tile OS2822
	Waterbody Name	Morell_030
	WFD Waterbody ID	IE_EA_09M010150
	Stretches included	Morell Upper

WATER COURSE	**Designations (within 1 km of component)**	None
	WFD Status (Objective)	Moderate (Restore 2021)
	FFD Class. (Salmonid/Cyprinid)	N/A
	Abstractions in vicinity	No

	WFD Element	Current Status	Assessed Post Works Status
WFD ASSESSMENT	**Protected Area**	N/A	N/A
	Ecological Status	Moderate	Moderate
	Invertebrates	Moderate	Moderate
	Chemical Status	Pass	Pass
	pH	Pass	Pass
	Oxygen	High	High
	Total ammonium	High	High
	Total nitrogen	Moderate	Moderate
	MRP	High	High

LOCATION		
	Location	NNE of Naas, Co Kildare
	Map Reference	50k raster – Tile OS2822
	Waterbody Name	Morell_040
	WFD Waterbody ID	IE_EA_09M010300
	Stretches included	Morell Lower, Painestown River, Slane River

WATER COURSE		
	Designations (within 1 km of component)	None
	WFD Status (Objective)	Good (No deterioration)
	FFD Class. (Salmonid/Cyprinid)	N/A
	Abstractions in vicinity	No

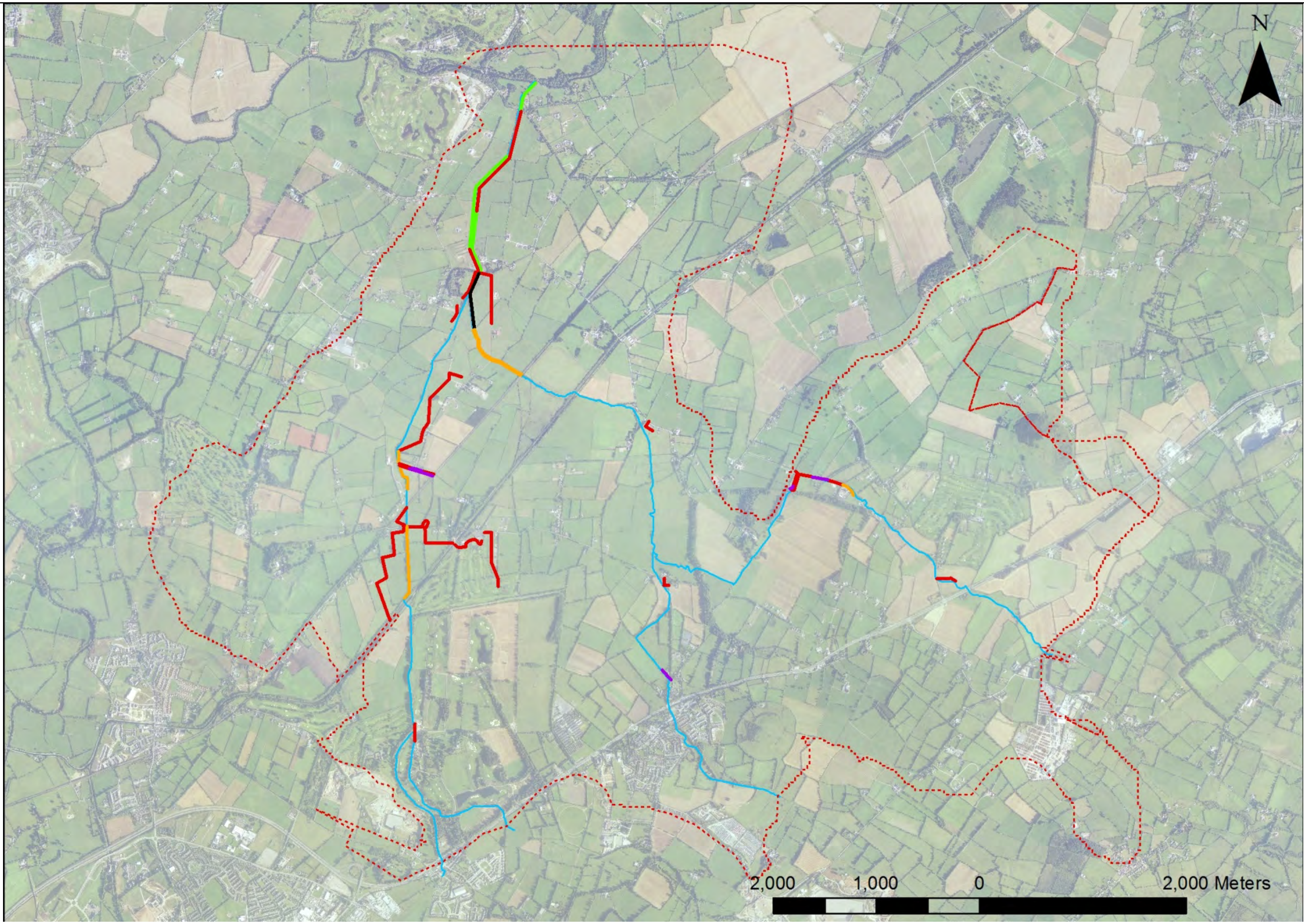
WFD ASSESSMENT	**WFD Element**	**Current Status**	**Assessed Post Works Status**
	Protected Area	N/A	N/A
	Ecological Status	Good	Good
	Invertebrates	Good	Good
	Chemical Status	No chemistry data available	
	pH		
	Oxygen		
	Total ammonium		
	Total nitrogen		
	MRP		

LOCATION		
	Location	Kill, Co Kildare
	Map Reference	50k raster – Tile OS2822
	Waterbody Name	Painestown_010
	WFD Waterbody ID	IE_EA_09P010400
	Stretches included	Kill River

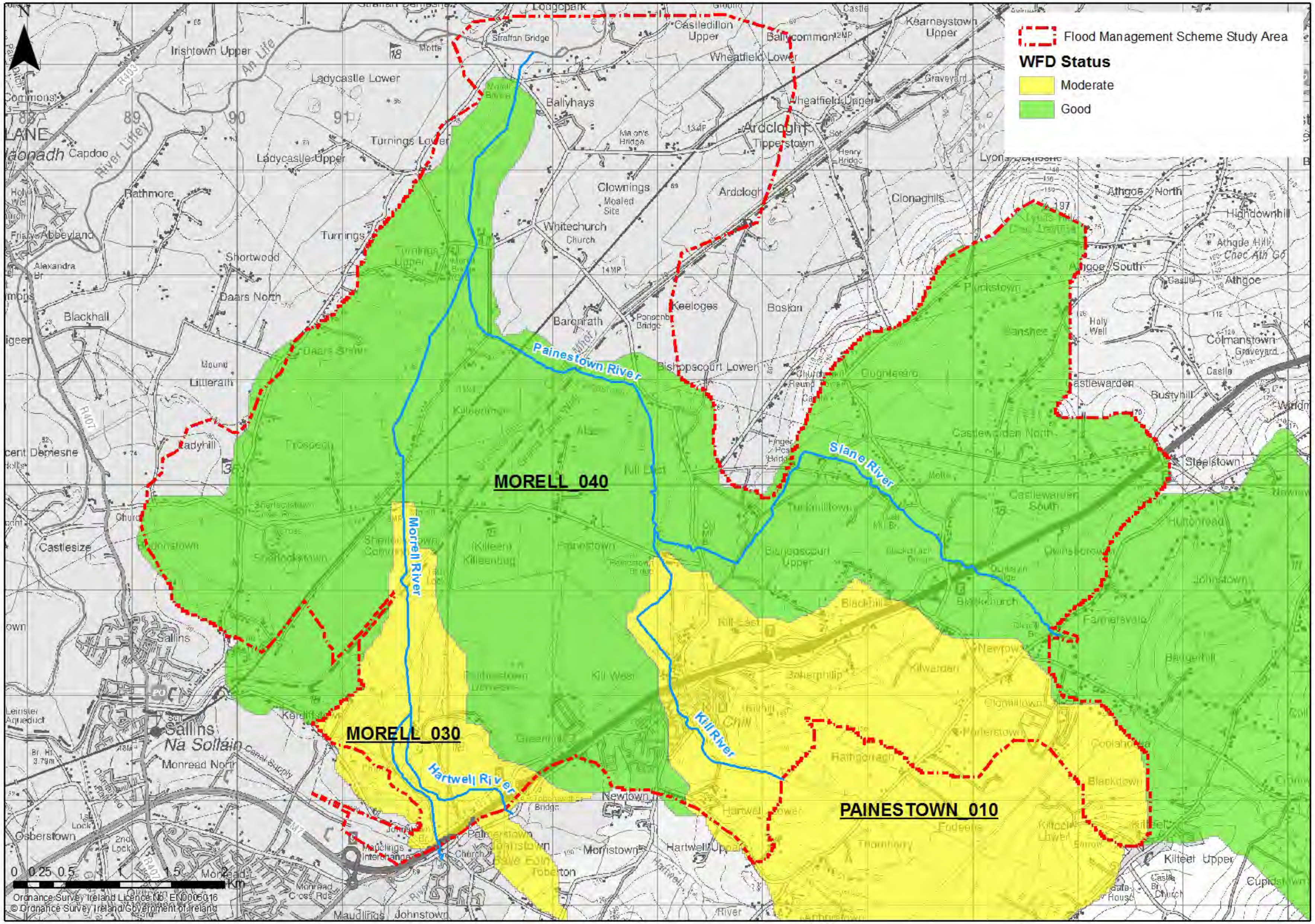
WATER COURSE		
	Designations (within 1 km of component)	None
	WFD Status (Objective)	Moderate (Restore 2021)
	FFD Class. (Salmonid/Cyprinid)	N/A
	Abstractions in vicinity	No

WFD ASSESSMENT	WFD Element	Current Status	Assessed Post Works Status
	Protected Area	N/A	N/A
	Ecological Status	Moderate	Moderate
	Invertebrates	Moderate	Moderate
	Chemical Status	Pass	Pass
	pH	Pass	Pass
	Oxygen	High	High
	Total ammonium	High	High
	Total nitrogen	Good	Good
	MRP	Good	Good

AERIAL SITE PHOTOGRAPHY



WFD STATUS


Flood Management Scheme Study Area
WFD Status
Moderate
Good
MORELL_040
MORELL_030
PAINESTOWN_010
Morell River
Painestown River
Slane River
Kill River
Hartwell River
0 0.25 0.5 1 1.5 2 Km
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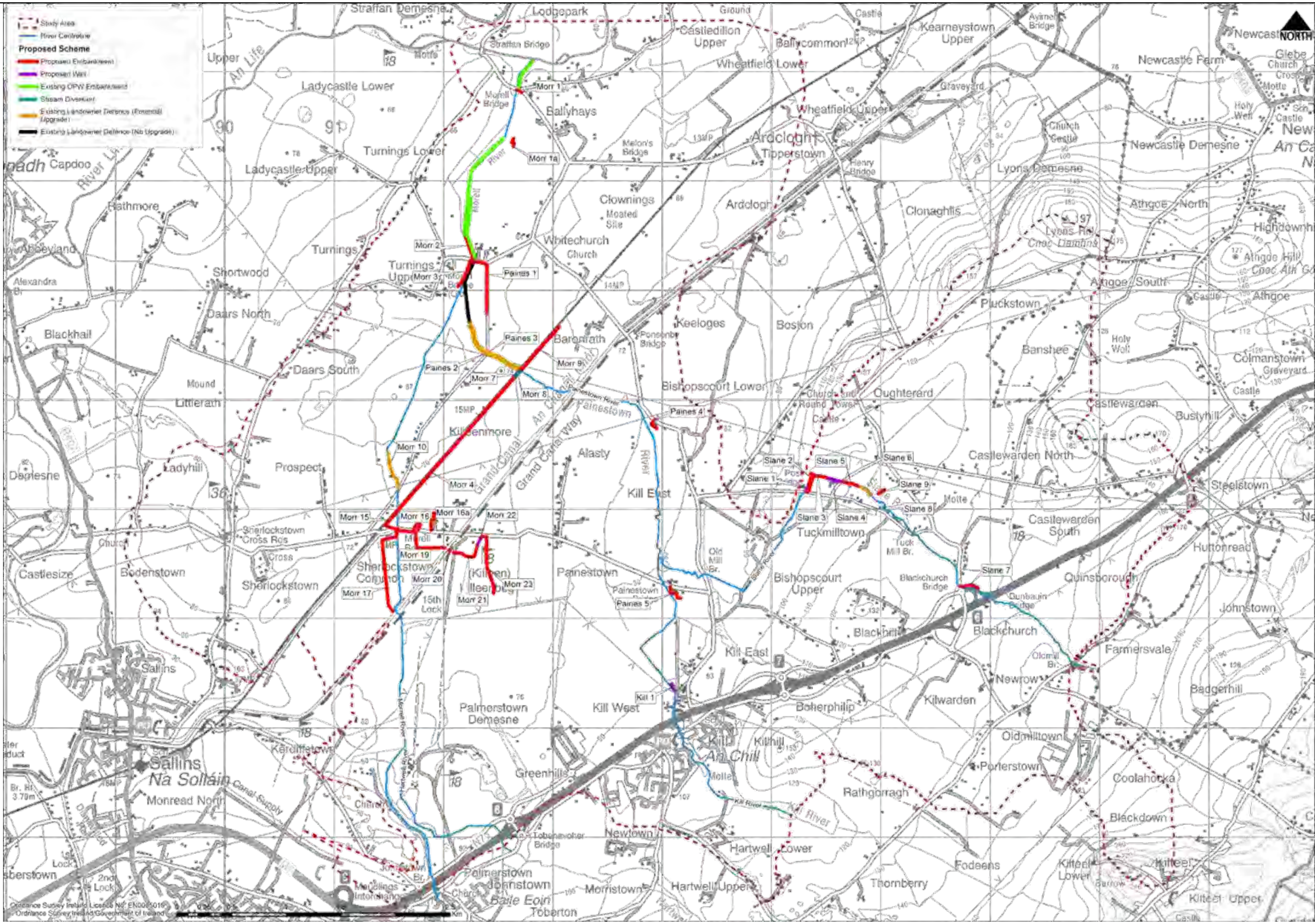
SITE OVERVIEW MAP



WFD ASSESSMENT	COMPONENT TYPE		Does the component comply with WFD Objectives 1, 2, 3 & 4?		
	Component ID:	MRFMS_1	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	General	**Yes (Justification provided)**		Proceed after stakeholder agreement.
	Component Description,	*Covers all General mitigation that should be considered in any development in or near water courses*	**Yes, with mitigation**	**X**	Complete schedule B.
	Component ID:	MRFMS_2	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	Stream Realignment	**Yes (Justification provided)**		Proceed after stakeholder agreement.
	Component Description,	*Certain proposed works at the Slane River (Slane 8) will involve realigning the stream channel to alleviate bank erosion (See Section 4.3.4 in Chapter 4 of the EIA Report for complete description of works).*	**Yes, with mitigation**	**X**	Complete schedule B.
	Component ID:	MRFMS_3	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	Flood Defence Walls	**Yes (Justification provided)**		Proceed after stakeholder agreement.
	Component Description,	*The scheme will require c. 474m of new flood walls, ranging in height from 1.0m to 2.0m. All walls will be constructed from reinforced concrete poured in situ.*	**Yes, with mitigation**	**X**	Complete schedule B.
	Component ID:	MRFMS_4	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	Embankments	**Yes (Justification provided)**		Proceed after stakeholder agreement.
	Component Description,	*The proposed scheme involves the construction or restoration of approximately 9000 metres of embankments. These embankments will consist of a hexagonal clay core with surrounding fill materials covered in topsoil. The required height*	**Yes, with mitigation**	**X**	Complete schedule B.

		of the embankment will determine the overall width, as the slope will have to be appropriate for the location. For example, some embankments will have low gradient slopes to allow vehicular access to the enclosed area and others will have steep slopes, to prevent access and act as a boundary for the site.			
	Component ID:	MRFMS_5	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	Upgrade of existing Walls	**Yes (Justification provided)**		Proceed after NIEA agreement.
	Component Description,	*This is proposed for existing boundary wall in Killeen Golf Club - Morr 22 (see Chapter 4 of the EIS)*	**Yes, with mitigation**	**X**	Complete schedule B.
	Component ID:	MRFMS_6	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	*Culvert Upgrades*	**Yes (Justification provided)**		Proceed after NIEA agreement.
	Component Description,	Upgrades are proposed for the following five existing culverts; Cul3, Cul4, Cul6, Cul10 and Cul22	**Yes, with mitigation**	**X**	Complete schedule B.
	Component ID:	MRFMS_7	**No**		Do not proceed or complete Article 4.7 assessment.
	Component Type:	*Operation & Maintenance*	**Yes (Justification provided)**		Proceed after NIEA agreement.
	Component Description,	All other works expected post construction and during the operational life of the project	**Yes, with mitigation**	**X**	Complete schedule B.

SCHEDULE B: Details of Mitigation Required to Comply with Water Framework Directive (WFD) Objectives

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_1 *General Mitigation*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. Prior to any works, all construction personnel will receive an on-site induction relating to operations within and adjacent to watercourses and the environmentally sensitive nature of working within and in proximity to the Morell River Catchment and re-emphasise the precautions that are required as well as the mitigation to be implemented. The contractor will ensure that their engineer setting out the works is fully aware of the ecological constraints and mitigation requirements. The OPW will ensure that a Corrective Action procedure is put in place in the event of an incident onsite. The amount of bare ground created by excavation and	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	vegetation removal will be minimised to prevent run-off. In-stream works will be carried out outside of the salmonid spawning season and the times that early life stages of salmonid fish will be present. In-stream work within the period 1st October to 1st May (inclusive) will only be undertaken with the advanced approval of Inland Fisheries Ireland. All footwear/ waders, etc used within watercourses must be steam cleaned prior to arrival on site to prevent the spread of invasive species such as Japanese knotweed in accordance with OPW Environmental SOPs. A sign off sheet must be maintained to confirm cleaning. Tools and equipment are not to be cleaned in rivers. Chemicals/fuels used shall be stored in sealed containers in the site lockup prior to use. The chemicals shall be applied in such a way as to avoid any spillage or leakage. Any and all excavated material is	measures detailed in Objective 1 are adhered to.		

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	NOT to be temporarily stored adjacent to watercourses ***Fuelling and lubrication*** Fuelling will not be conducted within 10m of the river. Spill kits will be made available close to the river and all staff will be properly trained on correct use. All fuels, lubricants and hydraulic fluids will be kept in secure bunded areas at a minimum of 10m from the river. The bunded area will accommodate 110% of the total capacity of the containers within it. Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner. All plant shall be well maintained with any fuel or oil drips attended to on an ongoing basis.			

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	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	Any minor spillage during this process will be cleaned up immediately. Should any incident occur, the situation will be dealt with and coordinated by the nearest supervisor who will be responsible for instructions by OPW. ***Timing of works*** Direct in-stream works such as stream alignment, culvert upgrades or proposed measures along the riverbank have the greatest potential for negative impacts during spawning / breeding and early nursery periods for aquatic protected species in the study area. No instream or potentially significantly damaging out of river works should occur during restricted periods for relevant species in relation to individual measures. (see table 11.22 of the EIA Report for detail of periods of no in stream disturbance)			

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_2 *Stream Realignment*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. The following measures will be put in place during proposed works: o Operation of machinery instream should be kept to an absolute minimum. o All construction machinery operating instream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc; o Machinery should be steam-cleaned and checked prior to commencement of instream works; o In-stream works will be carried out outside of the salmonid spawning season and the times that early life stages of salmonid fish will be present. In-stream work within the period 1st October to 1st May (inclusive) will only be undertaken with the advanced approval of Inland Fisheries Ireland; o During realignment works on the Slane River, contractor SOPs will be applied to respond in the case white-clawed crayfish are present and	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation measures detailed in Objective 1 are adhered	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	emerge from refuges at the times of stream realignment. In the event that significant populations of white clawed crayfish emerge, advice will be sought from IFI and NPWS to facilitate any necessary rescue and relocation; o The permanent diversion is excavated in the dry to an agreed specification; o Fish will need to be removed from the impacted section of the existing channel in advance. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended); o Bunds should be fixed at both ends of the existing channel and removed in a controlled manner at IFI's direction ensuring the river flow remains uninterrupted from above to below the works; The backfilling method to be agreed by method statement in advance with site contractor. Triple silt curtains derived from Terram or other similar material should be placed in stages downstream of the new channel to first filter out the heaviest of materials and subsequently the finer	to.		

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	material. These would need to be checked on a regular basis with the heavy material removed from the first silt curtain thereby keeping it functional. A procedure will need to be included for the removal of the silt fences on a staged basis, as even these preventative measures will lead to a build up behind the curtain. The curtain nearest to the point of works should be removed first followed by the others. IFI has advised that a detailed design be provided in relation to this proposal. The design of a new sinuous channel is deemed appropriate and must display hydraulic and morphological characteristics fulfilling the requirements of salmonid habitats as advised by IFI.			

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	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_3 *Flood Defence Walls*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. The following measures should be set in place during proposed works: o Disposal of raw or uncured waste concrete will be controlled to ensure that the watercourse will not be impacted; o Best practice in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times; o Where shuttering is used, measures should be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils; o All working materials and excavated material should be stockpiled on the land side of the works within the assigned 15m temporary working area; o Where embankments which are within 10 metres	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation measures detailed in	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	of a river, silt barriers should be used on the river side to minimise the potential for sediment transport. Once the wall is complete the silt barriers should be left in-situ to allow the reinstated ground around the wall to settle in. The silt barriers should only be removed after inspection of the reinstated ground confirms that it is stable; o Wash water from cleaning ready mix concrete lorries and mixers may be contaminated with cement and is therefore highly alkaline. Due to the size of the site and the proximity of sensitive watercourses, it is recommended that lorries and mixers are washed out offsite. o The following activities associated with the construction of flood defence walls should be noted: o Bank Protection – Refer to OPW's Environmental Management Protocols and Standard Operating Procedures. o Bush Cutting / Branch Trimming - Refer to OPW's Environmental Management Protocols and	Objective 1 are adhered to.		

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	Standard Operating Procedures. In addition to the above a detailed method statement will be drawn up by the contractor indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. These mitigation measures in combination with the considerable buffer area between the works and the river will to reduce the likelihood of silt mobilisation and cement runoff.			

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_4 *Embankments*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. The following measures should be employed during proposed works: o Works should be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle; o Embankment material should be selected that has low silt content; o All working materials and excavated material should be stockpiled on the land side of the works within the assigned 15m temporary working area; and o Where embankments which are within 10 metres of a river, silt barriers should be used on the river	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	side to minimise the potential for sediment transport. Once the wall is complete the silt barriers should be left in-situ to allow the reinstated ground around the wall to settle in. The silt barriers should only be removed after inspection of the reinstated ground confirms that it is stable. o The following activities associated with the construction of embankments should be noted: o Bank Protection – Refer to OPW's Environmental Management Protocols and Standard Operating Procedures. o Bush Cutting / Branch Trimming - Refer to OPW's Environmental Management Protocols and Standard Operating Procedures. In addition to the above a detailed method statement will be drawn up by the contractor indicating what measures will be taken to avoid sediment or soil loss associated with all aspects of the construction and how these will be monitored for effectiveness. These mitigation measures in combination with the considerable buffer area between	good status to the overall waterbody if mitigation measures detailed in Objective 1 are adhered to.		

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	the works and the river will to reduce the likelihood of silt mobilisation.			

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_5 *Upgrade of existing Walls*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. This is proposed for existing boundary wall in Killeen Golf Club - Morr 22 (see Chapter 4 of the EIA Report): o Address Best Practice OPW standards available for liquid and/or mortar management addressing batching on site pouring and handling, secure shuttering / form-work, adequate curing times and management of spills; o No washings should be allowed to enter nearby drains; and o Works should occur in the dry.	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation measures detailed in Objective 1 are adhered	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	Describe mitigation required to meet Objective 2:	Describe mitigation required to meet Objective 3:	Describe mitigation required to meet Objective 4:
		to.		

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	Describe mitigation required to meet Objective 2:	Describe mitigation required to meet Objective 3:	Describe mitigation required to meet Objective 4:
MRFMS_6 *Culvert Upgrades*	Mitigation has already been undertaken during the design phase of the scheme to minimise the potential impact of the project on the water environment. o All instream works should adhere to timing restrictions for aquatic protected species of the Morell Catchment (Table 11.22 of the EIA Report); o Any alteration to culverts must ensure the	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	unimpeded passage of fish at all times; o Morell River (Cul 6) and Painestown River (Cul 10) should be electro fished downstream of the proposed works in advance of any works to assess whether there are any fish or lamprey ammocoetes in the affected channels as advised by IFI. The fish removal must be completed by IFI or persons authorised under Section 14 of the Fisheries Consolidation Acts 1959 (as amended); o Headwalls for Cul 6 and Cul 10 should be pre-fabricated and inserted or assembled on site without the use of bulk liquid concrete; o In-channel works for upgrades on Culverts 3, 6, 10 and 22 will use cofferdam type construction whereby flow can be restricted allowing the civil engineering works to be undertaken in the dry conditions. A cofferdam is a temporary watertight enclosure using sheet piling that is pumped dry to expose the bottom of a body of water so that construction can occur. Method statements for the construction of cofferdam structures should be agreed in advance with IFI personnel in	and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation measures detailed in Objective 1 are adhered to.	Objectives.	furthermore will prevent any knock-on detriment to the water bodies downstream.

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
	advance of construction works; and o For proposed works on Cul 6 and Cul 10, triple silt curtains derived from Terram or other similar material should be placed in stages downstream of the river to first filter out the heaviest of materials and subsequently the finer material. These would need to be checked on a regular basis with the heavy material removed from the first silt curtain thereby keeping it functional. A procedure will need to be included for the removal of the silt fences on a staged basis as even these preventative measures will lead to a build up behind the curtain. The curtain nearest to the point of works should be removed first followed by the others. A detailed design and method statement should be drawn up by the contractor indicating how the above measures will be taken. IFI should be contacted prior to any works to review mitigation measures and offer additional advice on same.			

Scheme Component	Objective 1: To prevent deterioration in the ecological status of the water body.	Objective 2: To prevent the introduction of impediments to the attainment of Good WFD status for the water body.	Objective 3: To ensure that the attainment of the WFD objectives for the water body are not compromised.	Objective 4: To ensure the achievement of the WFD objectives in other water bodies within the same catchment are not permanently excluded or compromised.
	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
MRFMS_7 *Operation & maintenance*	It is considered highly unlikely that the operational phase will result in any significant negative impacts to the aquatic ecology of the Morell River along the proposed scheme catchment once General Mitigation measures for Pollution of Water contained in Table 11.21 of the EIA Report are followed during any repair or maintenance work on the proposed embankment and flood defence walls.	In the presence of Mitigation outlined in Objective 1 (detailed in the EIA Report) this development is unlikely to significantly contribute to nutrient / /pollutant loading to watercourses and the management of sediment release will ensure that sedimentation will be minimal, localised in nature and over the short term therefore the proposed development will not introduce impediments to achieving good status to the overall waterbody if mitigation measures detailed in Objective 1 are adhered	Mitigation detailed in objective 1 will ensure no qualifying features are directly impacted and the development will not compromise the attainment of the necessary WFD Objectives.	Mitigation measures implemented throughout the design, construction and operational phase of this project will ensure negligible residual impact from the proposal on this water body, and furthermore will prevent any knock-on detriment to the water bodies downstream.

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	Describe mitigation required to meet Objective 1:	**Describe mitigation required to meet Objective 2:**	**Describe mitigation required to meet Objective 3:**	**Describe mitigation required to meet Objective 4:**
		to.		

RPS

Appendix J

Vegetation Removal

All areas highlighted in yellow may require vegetation removal.

Morr 1:

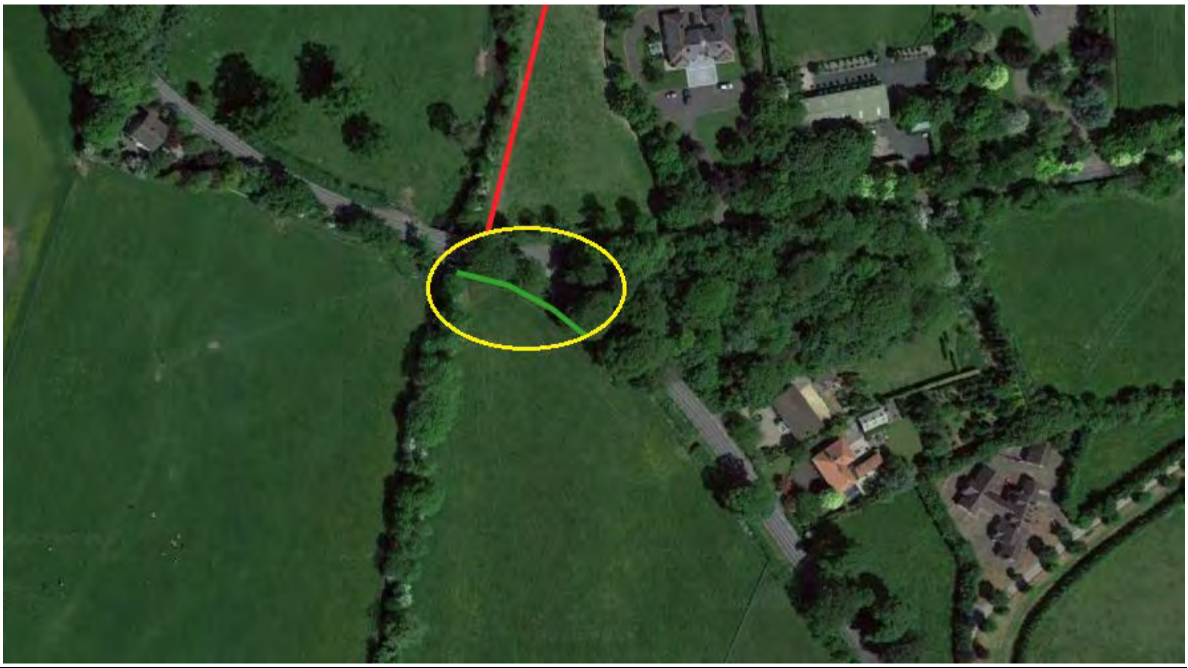

Figure 1 - Morr 1 plan view

Morr 1a:

Figure 2 - Morr 1a plan view

Morr 2:

Figure 3 - Morr 2 plan view

Morr 3:

Figure 4 - Morr 3 plan view

Morr 4:

Figure 5 - Morr 4 plan view

Morr 9:

Figure 6 - Morr 9 plan view

Morr 15:

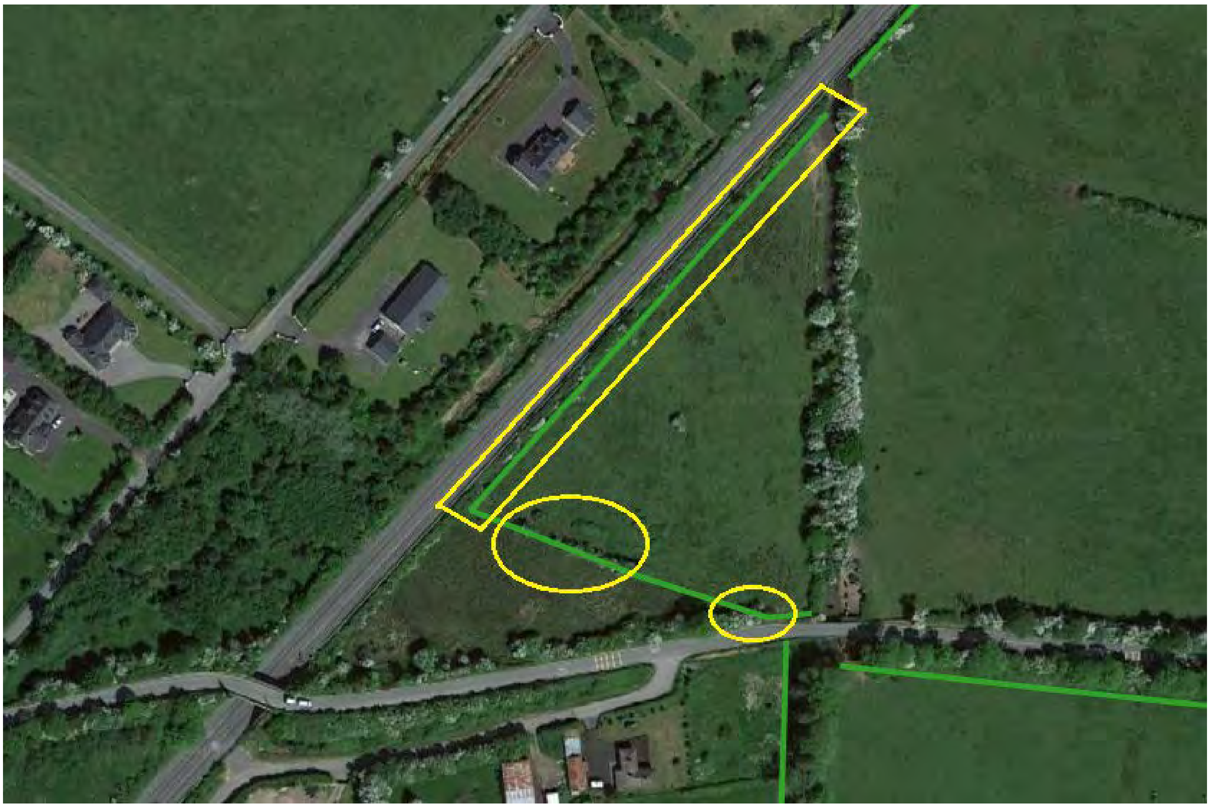

Figure 7 - Morr 15 plan view

Morr 16 & Morr 16a:

Figure 8 - Morr 16 & 16a plan view

Morr 17:

Figure 9 - Morr 17 plan view

Morr 19:

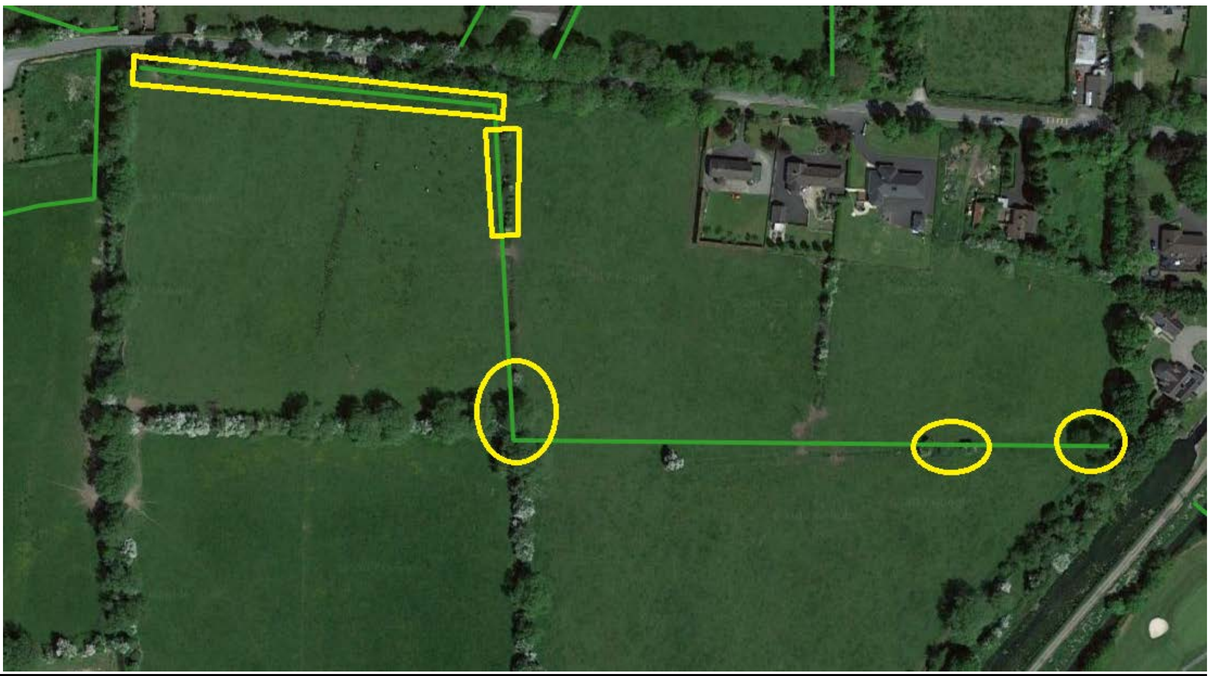

Figure 10 - Morr 19 plan view

Morr 20 – 23 (inclusive):

Figure 11 - Morr 20 -23 plan view

Paines 1:

Figure 12 - Paines 1 plan view

Paines 4:

Figure 13 - Paines 4 plan view

Paines 5:

Figure 14 - Paines 5 plan view

Slane 1 – 4 (inclusive):

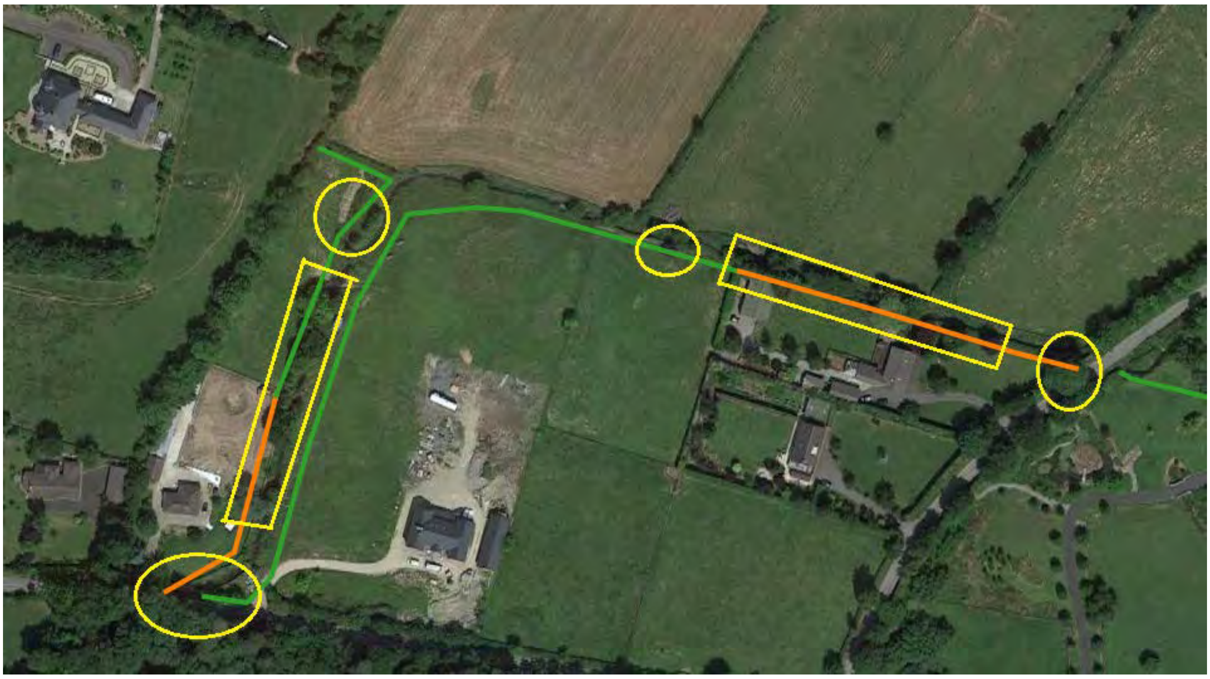

Figure 15 - Slane 1-4 plan view

Slane 5:

Figure 16 - Slane 5 plan view

Slane 9:

Figure 17 - Slane 9 plan view

Kill 1:

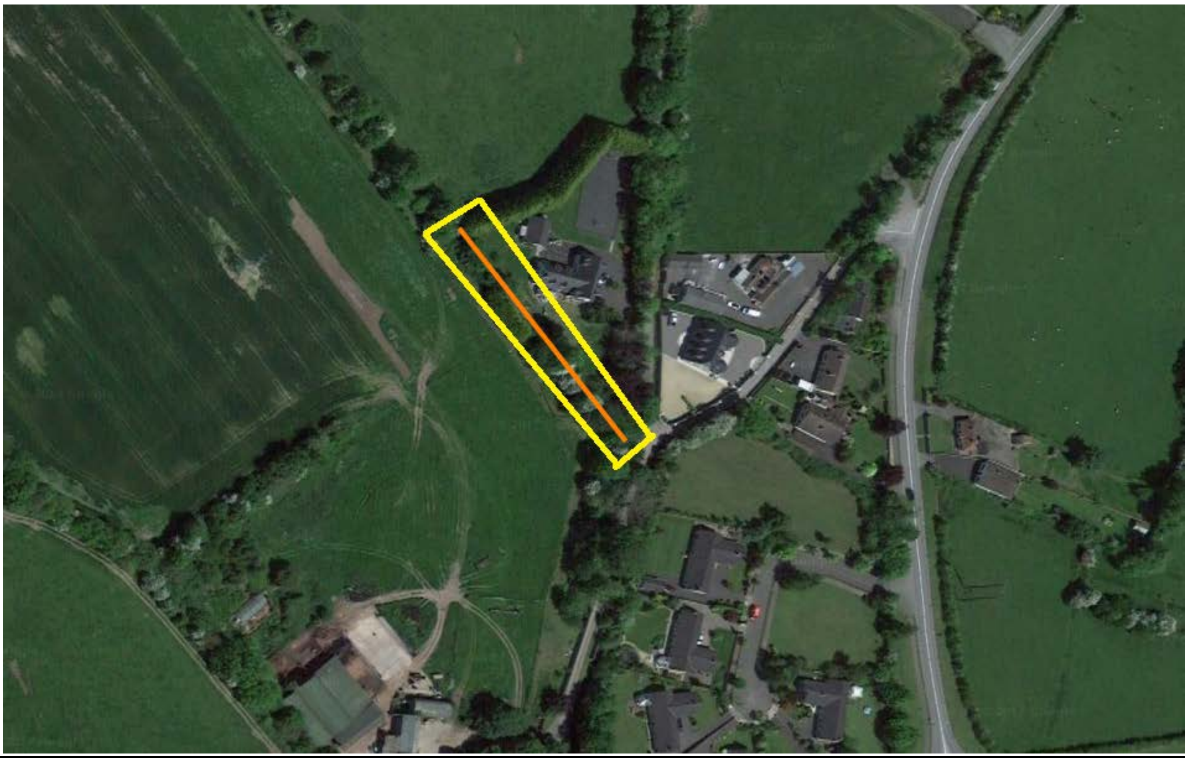

Figure 18 - Kill 1 plan view

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Appendix K

Preliminary Design Report

Appendix K

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APPENDICES

N/A

LIST OF FIGURES

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1 INTRODUCTION

The Morell River catchment in County Kildare has been subject to significant recurring flooding in past two decades and hence was prioritised within the Eastern Catchment-based Flood Risk Assessment and Management (CFRAM) Study programme (under which it is known as Turnings/Killeenmore Area for Further Assessment (AFA)) for the development of a Flood Management Scheme (FMS) Study. The purpose of this study was to fully assess the flood risk within the Morell catchment and develop a series of potential Flood Risk Management (FRM) Options.This River Morell FMS study was funded by the OPW and undertaken by RPS, on behalf of Kildare County Council (KCC). KCC has declared several surface water and flooding flood risk management policies in the 2017-2023 County Development Plan including policy SW 19 which commits to "Liaise with the Office of Public Works in delivering flood management and alleviation programmes. This policy includes delivery of the Morell River Flood Management Scheme and it should be noted that The County Development Plan has been effect from 1st March, 2017. The scheme was also identified in the previous County Development Plan 2011-2017 in the KCC Capital programme.

This Feasibility Study resulted in the establishment of three potential Flood Risk Management (FRM) Options, plus a 'do nothing' Option. A preferred option to address the flood risk in the Morell River catchment was identified during this process. The preferred option involves using hard defences, including retaining walls and embankments, to protect properties at risk of flooding during a 1% AEP event. The proposed defences protect the clusters of properties identified, by diverting flow paths away from the properties at risk. The preferred feasibility stage option also proposed the upgrade of some existing culverts to improve channel conveyance for the 1% AEP flows. This included restoring the capacity of the culvert conveying the Slane River under the N7 at Junction 6 Castlewarden exit, and improvement works on culverts at various other locations, including the Dublin-Cork Railway crossings.

The Feasibility Stage option has evolved into the final proposed scheme following feedback from a technical review undertaken by the OPW. The option has also been adapted to incorporate landowner requirements (where possible without being detrimental to the scheme). This report details the alterations and improvements made to the scheme design between the feasibility stage to the planning stage. The final scheme is being brought forward for a Part 10 planning application to An Bord Pleanála and RPS has undertaken an Environmental Impact Assessment (EIA) to facilitate this application. The objective of the Morell River FMS is to provide optimum flood relief with minimal environmental impact, whilst also controlling the overall capital investment required.

1.1 STUDY AREA

The Morell River catchment is located in County Kildare and is situated in the Eastern River Basin District (ERBD), within Hydrometric Area (HA) 09 (also referred to as Unit of Management (UoM) 09). The main rivers in the catchment are the Morell River (itself a tributary of the River Liffey) and its tributaries the Hartwell, Haynestown, Slane and Kill Rivers (note that the Slane and Kill Rivers combine into the Painestown River). The Grand Canal travels through the catchment from northeast to southwest. **Figure 1.1** below shows the study area of the Morell River Flood Management Scheme (FMS).

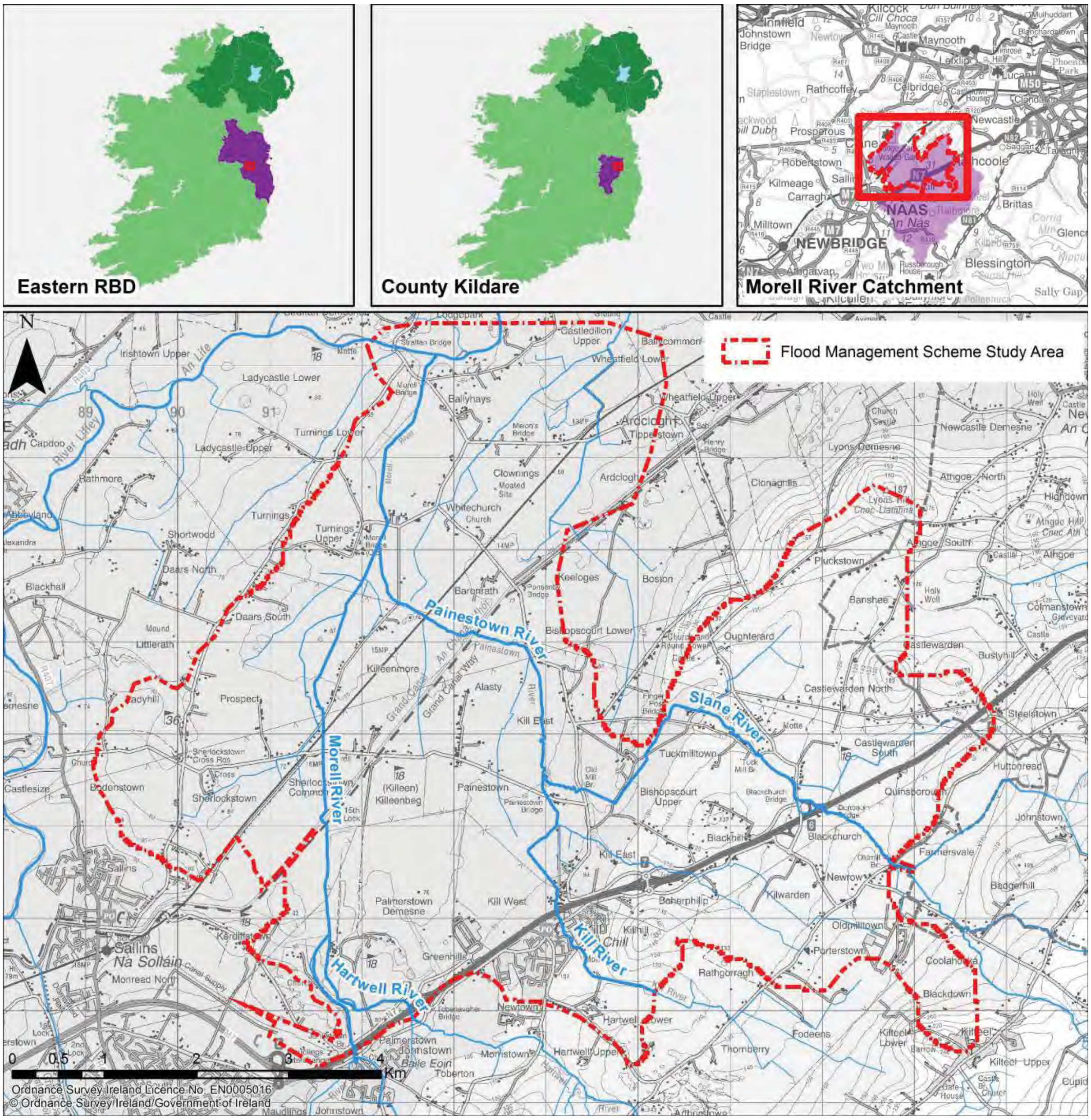


Figure 1.1 Study Area

1.2 FLOODING HISTORY

There is a history of flooding in the catchment. In recent years, the severity and frequency of the flood events have resulted in severe hardship for residents, farms and enterprises in the area. **Figure 1.2** illustrates the existing floodplain for the catchment. The principal source of flood risk within the catchment is fluvial flooding, caused by intense rainfall or prolonged and heavy rainfall with antecedent wet conditions, as identified in the 'HA09 Inception Report' (RPS, 2012) for the Eastern CFRAM Study. Notable historical flood events in the catchment occurred in April 1998, November 2000, November 2002, January 2008 and November 2009. The relatively flat topography of the area in conjunction with the railway and canal embankments traversing the Morell and Painestown rivers has resulted in extensive areas being flooded in the past. The culverts on the Morell and Painestown rivers which pass under the Grand Canal restrict conveyance, preventing flood water from progressing downstream on both rivers. Downstream of the canal, the channel capacity is less than the flows passing under the canal, resulting in out-of-bank flooding of the area between the canal and the railway embankments. The out-of-bank flood waters pass to the downstream side of the railway embankment via four culverts. These culverts convey water to the Killeenmore Road area, flooding a number of properties. A watermain trench was also identified as a flow path from the upstream to downstream side of the railway embankment. Downstream of the Morell/ Painestown confluence, the Old Morell Bridge restricts the flow resulting in out of bank flooding. The out of bank flooding progresses west along L6019 and north east across predominantly agricultural land towards the River Liffey (at higher return periods).

On the River Slane, culvert capacity causes out-of-bank flooding which occurs at the Junction 6 N7 interchange, resulting in flooding of the road network. The Slane crossing at Junction 6 has a history of flood events causing traffic disruption to the N7 and substantial works were carried out to address the insufficient capacity by the National Roads Authority (NRA) in 2011 – 2012, in line with the "*Castlewarden - Flood Mitigation - Minor Works"* detailed design (J.B. Barry & Partners, 2011). Due to concerns that implementing the works in full would result in an exacerbation of flooding to properties in downstream areas, not all the improvement works designed were fully implemented. As a consequence a severe flood risk remains at Castlewarden Junction 6. This issue highlights the importance of adopting a catchment-based approach to managing flood risk, rather than focusing resources on individual problem areas.

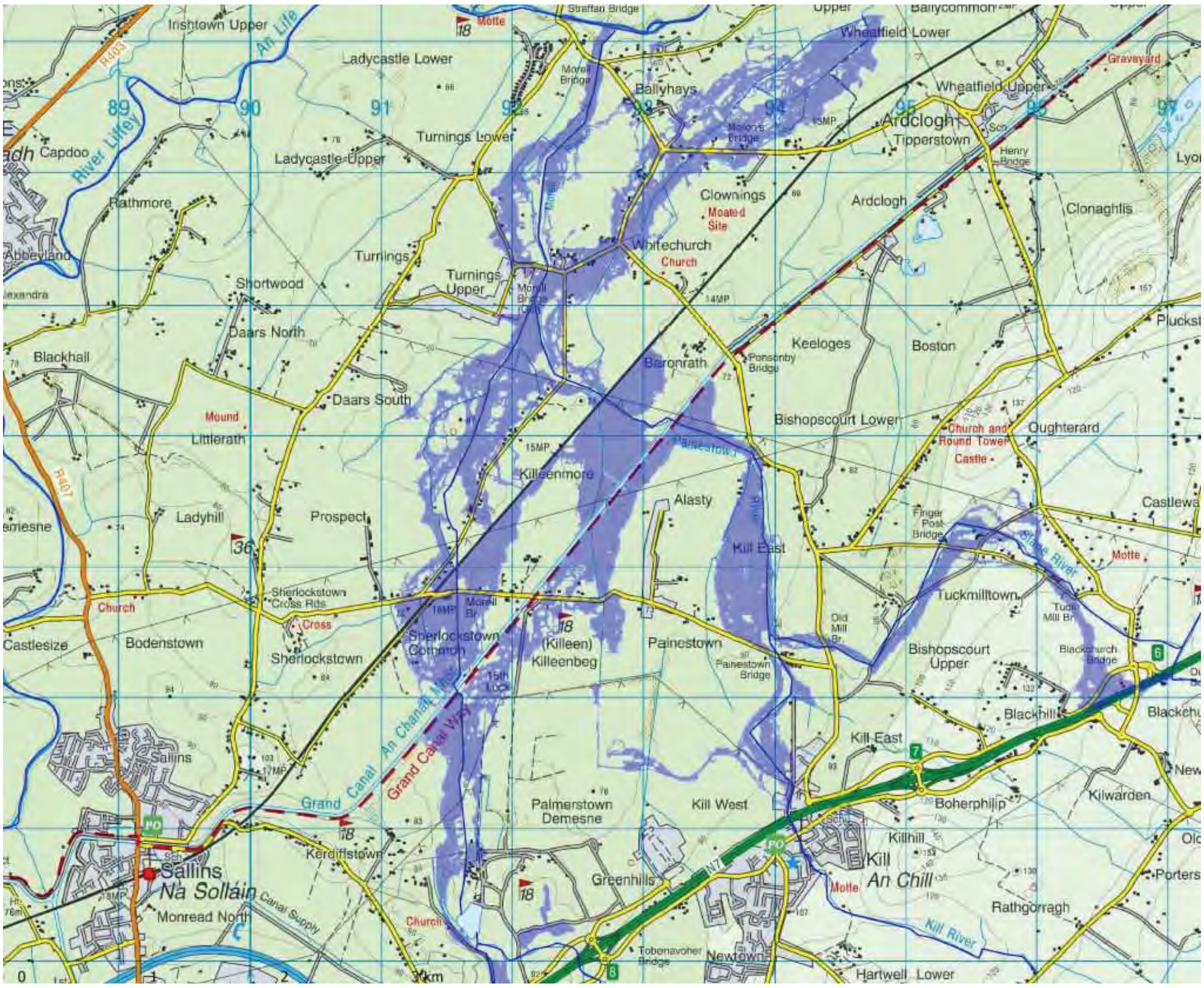


Figure 1.2 Existing 1% AEP Flood Extents

1.3 FEASIBILITY STAGE - PREFERRED SCHEME

The Feasibility Study resulted in the establishment of three potential Flood Risk Management (FRM) Options, plus a 'do nothing' Option. The FRM Options considered for the Morell River FAS are outlined in **Table 1.1** below. As a preliminary assessment, prior to progression to the full Multi-Criteria Analysis (MCA), the three potential Options (excluding the Option 4 – 'Do Nothing' scenario) were further analysed to ensure they were technically, socially, environmentally and economically feasible. It was concluded that Option 1 and Option 2 both met the minimum required objectives which were to ensure the N7 and all properties are protected in a 1% AEP event with no residual property damage and were further assessed by MCA.

The FRM Option 1 and Option 2 that progressed to the MCA were both found to be technically, socially, environmentally and economically feasible. In order to select the overall preferred Option for the Morell catchment, each Option was considered against a range of criteria and objectives to determine the optimum solution. As part of this process, the Option 4 – 'Do Nothing' provided a scenario against which the technical, social, environmental and economic feasibility could be compared. The comparative analysis was undertaken by scoring each Option against the following three criteria to provide an overall score for each:

- Economic Benefit Cost Ratio (BCR) - The ratio between the monetary benefit of adopting a FRM Option and the overall cost of constructing, operating and maintaining the Option. A ratio of one or greater must be achieved for an Option to be considered further.
- MCA Benefit Score - The sum weighted score of all of the objectives set in the MCA. This score represents the non-monetary benefit of adopting the FRM Option.
- Overall Net MCA BCR - This is a ratio between the non-monetary benefit of adopting a FRM Option and the overall cost of constructing, operating and maintaining the Option.

The economic review and the MCA both presented a clear conclusion that Option 1, the combination of improved conveyance and hard defences was more economically viable and technically robust than Option 2, upstream storage and hard defences. For both Options, the potential environmental impacts were judged to be broadly equivalent, although Option 2 achieved a slightly better score for environment in the MCA. **Option 1 was consequently taken forward by Kildare County Council for further development and design by RPS and review by OPW. Figure 1.3** below shows the preferred option defences presented at the feasibility stage.

Table 1.1 Summary of FRM Options that were assessed for Morell FMS

Proposed FRM Option	Methods Included
Option 1 **Improved Conveyance / Defence**	Storage adjacent to channel, Hard Defences, Localised protection works, Culverting
Option 2 **Upstream Storage (Offline)**	Retention Ponds, Hard Defences, Culverting, Localised protection works
Option 3 **Full Channel Conveyance**	Hard Defences, Culverting
Option 4 **'Do Nothing'**	Maintain the Existing Regime

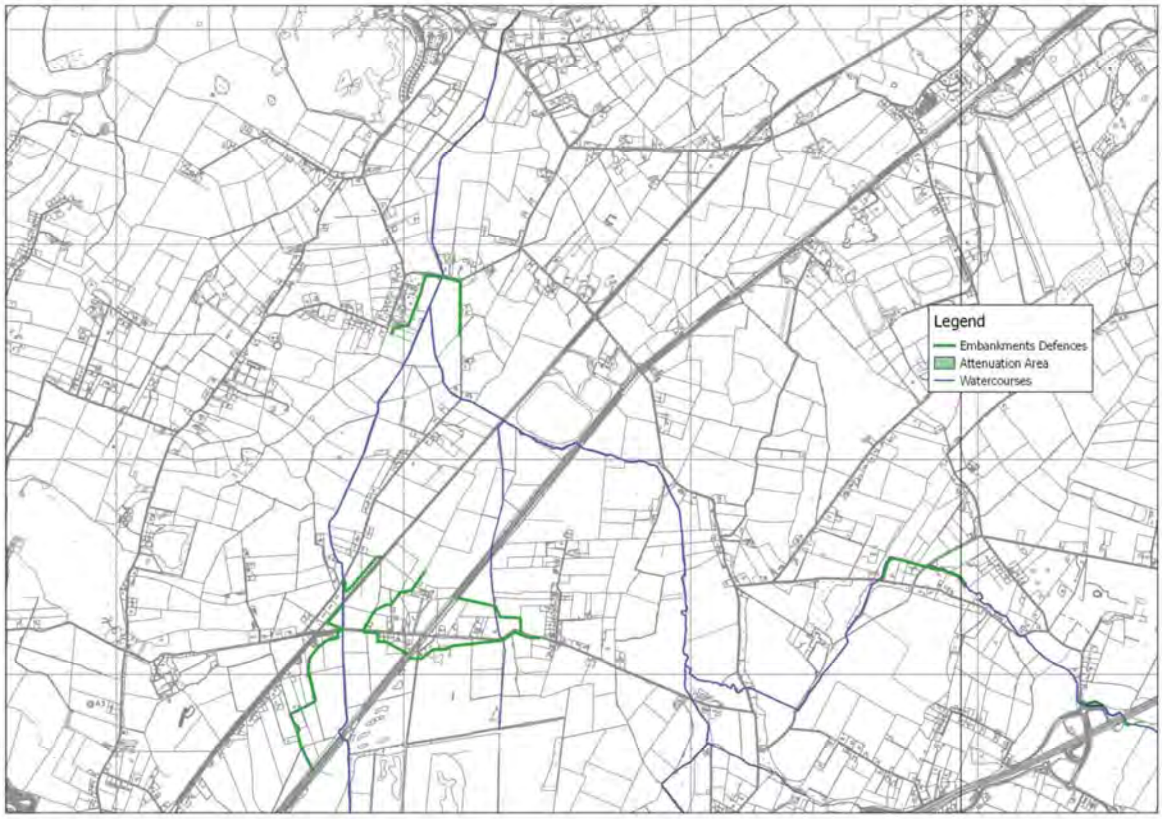


Figure 1.3 Morell River Flood Management Scheme Defences – Feasibility Report

1.4 PLANNING & EIA STAGE - FINAL SCHEME

The final scheme being brought forward to Part 10 planning and being assessed by the EIA has evolved and been improved from that presented in the Morell Flood Management Scheme Feasibility Report. The improvements have occurred through refinements in the hydraulic model to improve its accuracy at the site specific scale. It also included changes to embankment locations following landowner and stakeholder consultation. The alterations made to the proposed defences and the overall design philosophy is outlined in the following sections. The changes to the scheme were largely instigated by the following factors:

- Updating of the hydraulic model to account for an additional stream identified during public consultation
- Review of embankment location and footprint following landowner liaison
- Concern that that the canalisation of the Morell River was causing flood levels to rise on the southern side of the Dublin-Cork railway line

The implications of these changes and their impact on the final scheme design are discussed further in Chapter 4.

1.5 REPORT STRUCTURE

The updating hydrological model inputs required by the inclusion of an additional stream and the re-evaluation of the upstream section of the Painestown River are as described in Section 2. A summary of the hydraulic analysis, instigated by the change in hydrological inputs, carried out to inform the development of the final flood management measures is presented in Section 3. Section 4 examines the changes in the scheme from feasibility stage to planning stage. A broad overview of the planning context for development of the scheme and the findings of the EIA are presented in Section 5.

2 HYDROLOGY & HYDRAULICS

2.1 INTRODUCTION

The hydrology and hydraulic modelling for the Morell catchment was firstly developed as part of the Eastern CFRAM Study. It was further developed during the preliminary design stage to account for site specific conditions to improve the accuracy of the model, the inclusion of an additional stream (this stream is unnamed and for the purposes of this report will be known as the Alasty Stream) and an the expansion of the model extent at the upstream section of the Painestown River.

In terms of hydrology, the objectives were to estimate the design flows and input hydrographs for the 1% Annual Exceedance Probability (AEP) flood event to facilitate option development and design. The hydraulic analysis comprised the construction of a calibrated linked 1D-2D river model used to produce flood risk and hazard maps for a the 1% AEP design flood event and inform and assess proposed potential flood risk management measures.

2.2 EASTERN CFRAM HYDROLOGY & HYDRAULICS

The Eastern CFRAM Study hydrology for the Morell catchment was developed over three stages. The first stage included data collection of relevant datasets for use in the Study and conducting an initial analysis on the data prior to a more detailed analysis being carried out in the second stage.

In the second stage design flood flows were estimated using hydrological analysis methodologies.

For the final stage the hydrological outputs were input into a hydraulic model developed by RPS for the Morell River Catchment as part of the Eastern CFRAM study. The hydraulic modelling software 'MIKE' was used to estimate the flood flows and floodplain extent. The model produced was then used to develop flood management options and to help choose the preferred flood management option.

2.2.1 Stage 1 - Data Collection

Data collected as part the first stage included:

- Flood Relief/Risk Management Measures -Previous reports or studies concerning flood hazard or risk or possible flood relief measures
- Historic Flood Data - Information on historic flooding, Maps of flood extents, Flood levels, Flood depths
- Hydrometric Data - Information on recorded water levels data, flows, flow gaugings and ratings (stage discharge relationships) for all gauging stations in the catchment
- Meteorological Data - Information on rainfall, air pressure, wind speed and direction, temperature and evapotranspiration for all rainfall stations in the catchment.
- Land-use Data - Information on current and past land use.
- Soil and Geological Data- Data on soil classifications, sub-soils, geology and aquifers.
- Mapping – OSI Maps, LiDAR, Aerial Photography

- Existing Survey Data - Topographical, channel and structural survey data
- Environmental Data - Information, reports, studies, zoning or assessments of environmental and archaeological status, issues, constraints and impacts.

The first stage also included a preliminary assessment of:

- Hydrometric Data – A rating review was undertaken for the hydrometric stations in the catchment. This entailed site visits, a review of the water level recordings, river channel surveys upstream and downstream of the station location and hydraulic modelling techniques to extrapolate rating curves to construct a theoretical rating curve that provides a relationship between stage and discharge for flood flows. Four hydrometric stations were specified for this analysis within HA09; and
- Historic Flood Data - A historical review of the severity of all flood events was carried out and subject to the availability of continuous water level records, a number of major flood events were selected to examine further their causes/mechanisms, behaviour and their frequency of occurrences. Based on the review flood events were selected for the hydraulic model calibration and verification. Where no flow records were available level information and photographs / mapped flood outlines were used to validate the models.

2.2.2 Stage 2 - Hydrology

For the development of the hydrological processes in Stage 2, the data from Stage 1 was used to identify:

- Hydrological Estimation Points (HEPs) - These are located along the watercourses to denote points where hydrological analysis was required for the estimation of design flows that were used as hydraulic model inputs. They also served as check points at gauging station locations, so that the design flood events were properly derived.
- Catchment boundaries - Provided by the OPW but were reviewed by checking mapping, GIS datasets and LiDAR data where available.

Stage 2 primarily involved design flow estimation undertaken using two processes depending on the location of the HEP being analysed. These processes were:

- Rainfall run off modelling using the MIKE NAM software
- Flood estimation mathematical equations based on catchment characteristics (such as land use, rainfall, soil properties). Flood estimation for catchments less than 25km^2 was carried out using the Institute of Hydrology Report 124 (IH 124) equation. For catchments greater than 25km^2 the OPW Flood Studies Update (FSU) 7 variable equation was used. The flood estimation derived from the FSU 7 variable equation can also be adjusted by gauging station which has similar hydrological characteristics or is geographically close.

2.2.3 Stage 3 – Hydraulic Modelling

Stage 3 involved the building of a hydraulic model using the hydraulic modelling software MIKE. The river channels and structures were developed from topographical survey collected from Stage 1 and supplemented by additional survey data procured in stages 2 and 3 if data gaps where identified.

The surface of the land was generated from LiDAR data and combined together with the topographical surveys to create a representation of the river channel and its surrounding lands. The design flow estimates from stage 2 where input into the model to estimate flows and flood extents.

Stage 2 and Stage 3 form an integrated process between hydrology and hydraulics so when the design flows were derived, they were input into the hydraulic model and the outputs compared with observed flows at the gauging stations. Thus hydrological inputs were iteratively adjusted until calibration with the gauging station was achieved. Flood extents were calibrated against aerial photography taken post flooding events.

The first stage is detailed in the Eastern CFRAM Study Hydrometric Area (HA) 09 Inception Report. The second stage is detailed in Eastern CFRAM Study Hydrometric Area (HA) 09 Hydrology Report and the Analysis of the Dublin Radar Data for the Eastern CFRAM Study Area Report. Stage 3 is detailed in the Eastern CFRAM Study Hydrometric Area (HA)09 Hydraulics Report - Turnings / Killeenmore Model.

2.3 RATIONAL FOR UPDATING HYDROLOGY AND HYDRAULIC MODELLING

Following public consultation, which took place on 23rd October 2014, concerns were raised by members of the local community that the flooding in two areas of the catchment were not representative of the reality on the ground. These areas included Alasty and Kill East. In Alasty it was noted that an existing unnamed stream was not included within the CFRAM hydraulic model. The stream would have been omitted from the original model as the CFRAM models take a catchment wide approach and did not and cannot analyse all minor streams. The models also have to rationalise where they include river cross sections and therefore can inadvertently miss localised riverbank depressions which may contribute to the misrepresentation of flooding in some areas.

In response to these concerns, additional cross sections along the Painestown River and the Alasty Stream were procured and added to the hydraulic model. The hydrology was then updated to account for these additional sections of watercourse. The hydrological inputs were derived using the same CFRAM catchment characteristics based methods and adjusted where appropriate as described in Section 2.2.2. The hydraulic model was rerun using the updated hydrological inputs to identify the existing 1% AEP Scenario as shown in Figure 1.2. This resulted in a small reduction in flood extents in the Alasty area and an increase in the existing 1% AEP flood extents in the Kill East, Turnings and Whitechurch areas from the Feasibility Stage.

2.4 MODEL RUNS FOR THE FINAL SCHEME

To generate the post-scheme flood extents, the proposed defences were added to the hydraulic model and iterative process was followed to refine the extent and height of the defences. Consultation with landowners and the OPW resulted in multiple hydraulic runs being carried out to account for changes to the design of the scheme and to optimise the defences. Chapter 3 details the changes in defences from the feasibility stage to the planning stage.

3 EVOLUTION OF FINAL SCHEME

3.1 INTRODUCTION

The final scheme has evolved from that presented in the Morell Flood Management Scheme Feasibility Report due to improvements in the accuracy of the hydraulic model, changes to embankment locations following landowner and stakeholder consultations and technical review by the OPW.

Landowner liaison was an integral part of the development of the final scheme. Two public consultation days and approximately 40 individual meetings with landowners were held throughout the design phase to address affected landowners concerns and where possible incorporate them into the scheme. Design changes were assessed with the entire scheme in mind, to ensure that the core requirement of the scheme to protect properties was not compromised. It was also verified that there was a negligible increase in risk to areas to either upstream or downstream as a result of the changes to defences since the feasibility stage.

Following a technical review of the feasibility stage scheme by the OPW, a reassessment of the flow paths underneath the Cork-Dublin railway line was carried out as concerns were raised about the increase in water levels on the southern side of the railway which could have long term impacts on its structural stability. The changes to defences and their design philosophy are outlined in the following sections. **Figure 3.1** below shows the defences within scheme as presented in the 2015 Feasibility Report, while **Figure 3.2** shows the final scheme which is being brought forward for a Part 10 planning application to An Bord Pleanála.

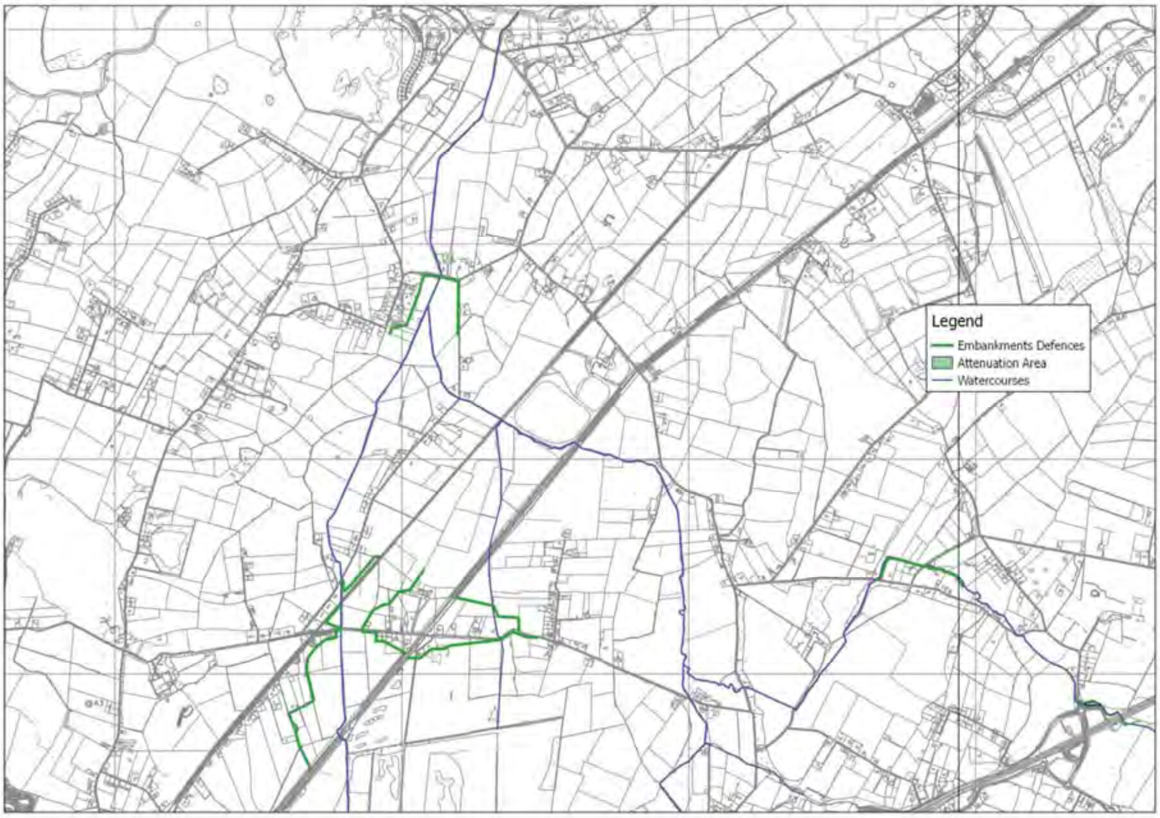


Figure 3.1 Morell River Flood Management Scheme Defences – Feasibility Report

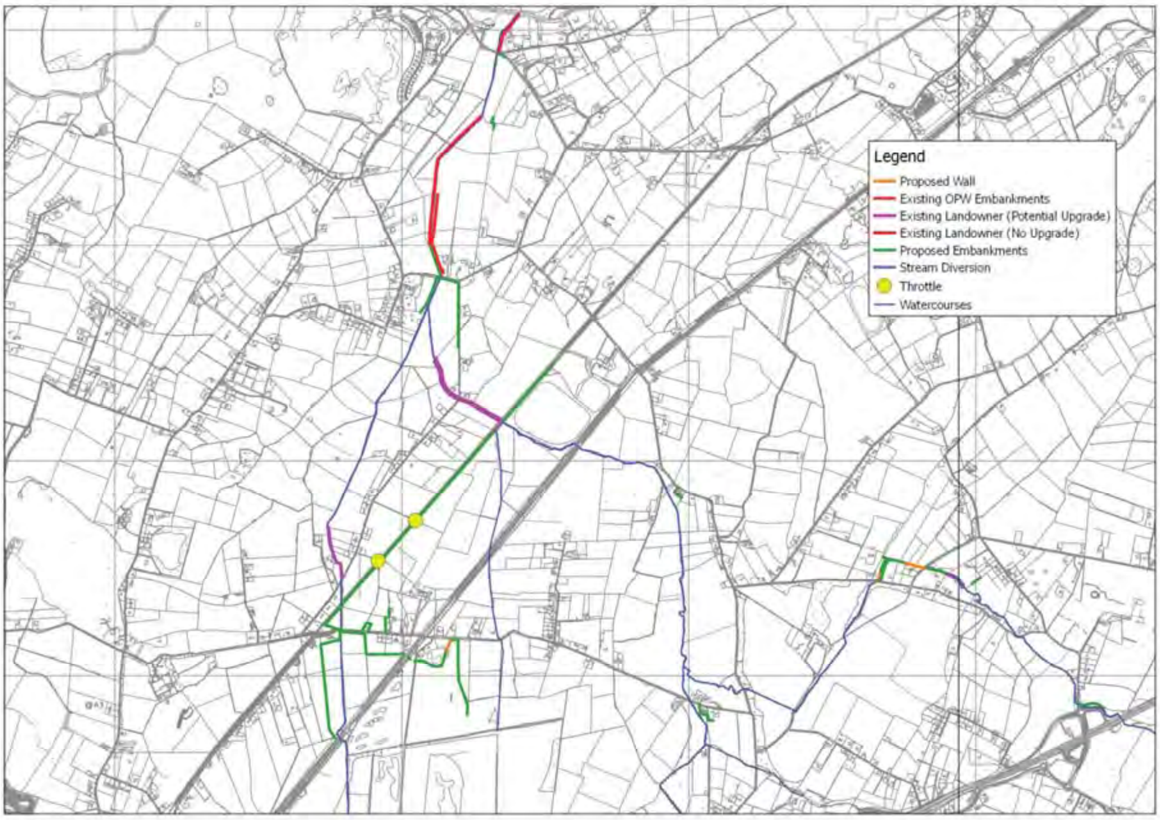


Figure 3.2 Morell River Flood Management Scheme Defences – Part 10 Planning

3.2 TOWNLAND - BALLYHAYS

Figure 3.3 below shows defences were added at the downstream section of the Morell River closer to the confluence with the River Liffey. This emanated from concerns raised at a public consultation day an additional stream was added upstream in the townland of Alasty (as discussed in section 2.3) and to account for this stream the hydrology for the scheme was revised which had the effect of increasing flows and water levels downstream. Defences were added to prevent flood water flow paths affecting properties. Defences were placed along existing field boundaries following consultation with affected landowners.

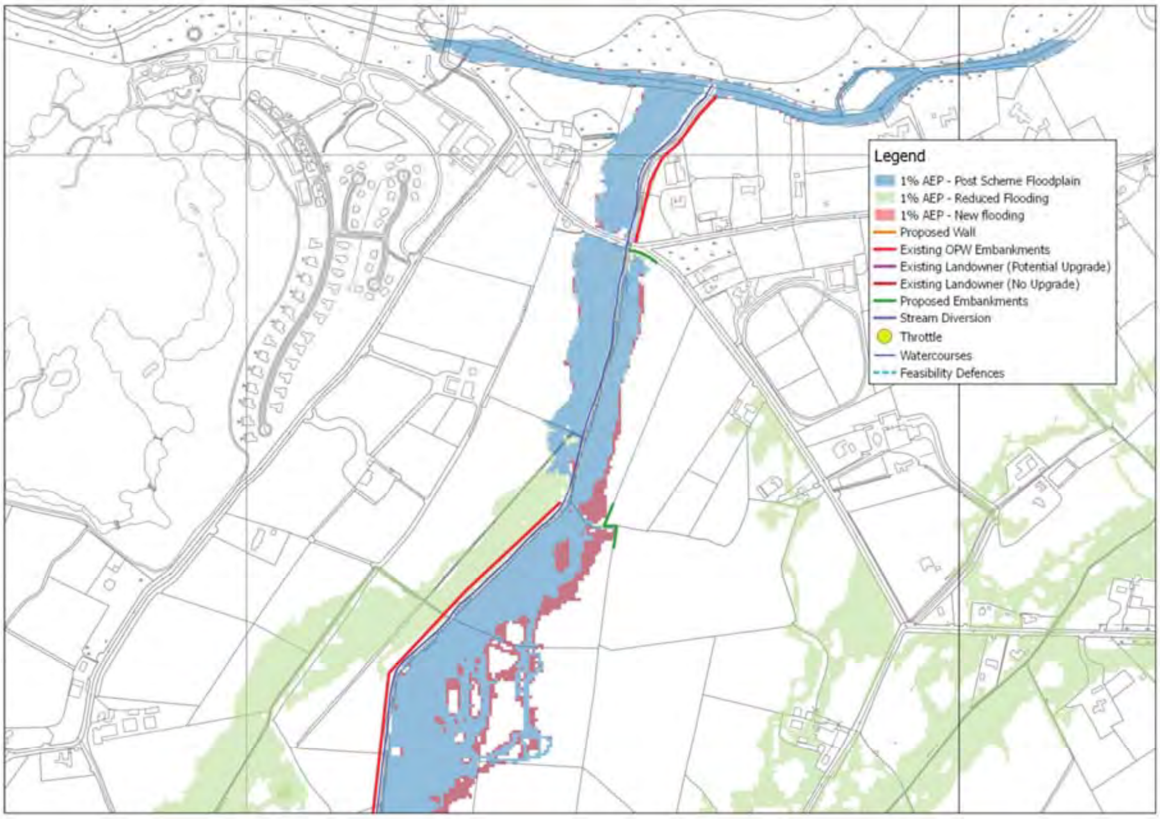


Figure 3.3 Flood Defences in the Ballyhays area

3.3 TOWNLAND - TURNINGS

Figure 3.4 shows defences in the townland of Turnings were rationalised and adjusted on the left bank upstream of the abattoir bridge following landowner consultation. Defences were removed as the 1% AEP predicted flood waters do not pose a risk to the residential properties along the left bank. The remaining defence on the left bank was moved closer to the river to reduce flooding in the field of the affected landowner to compensate for some additional flooding on their land on the right bank. **Figure 3.4** also shows an additional embankment downstream of the bridge. This embankment is also as a consequence of the revised hydrology and increased water levels as described in Section 3.2 above and Chapter 2. Existing embankments along the Morell River as highlighted in purple in **Figure 3.4** will be incorporated into the maintenance of the scheme and will be structurally inspected to ensure that they are fit for purpose, if any improvements of these embankments are required it will be carried out as part of the scheme.

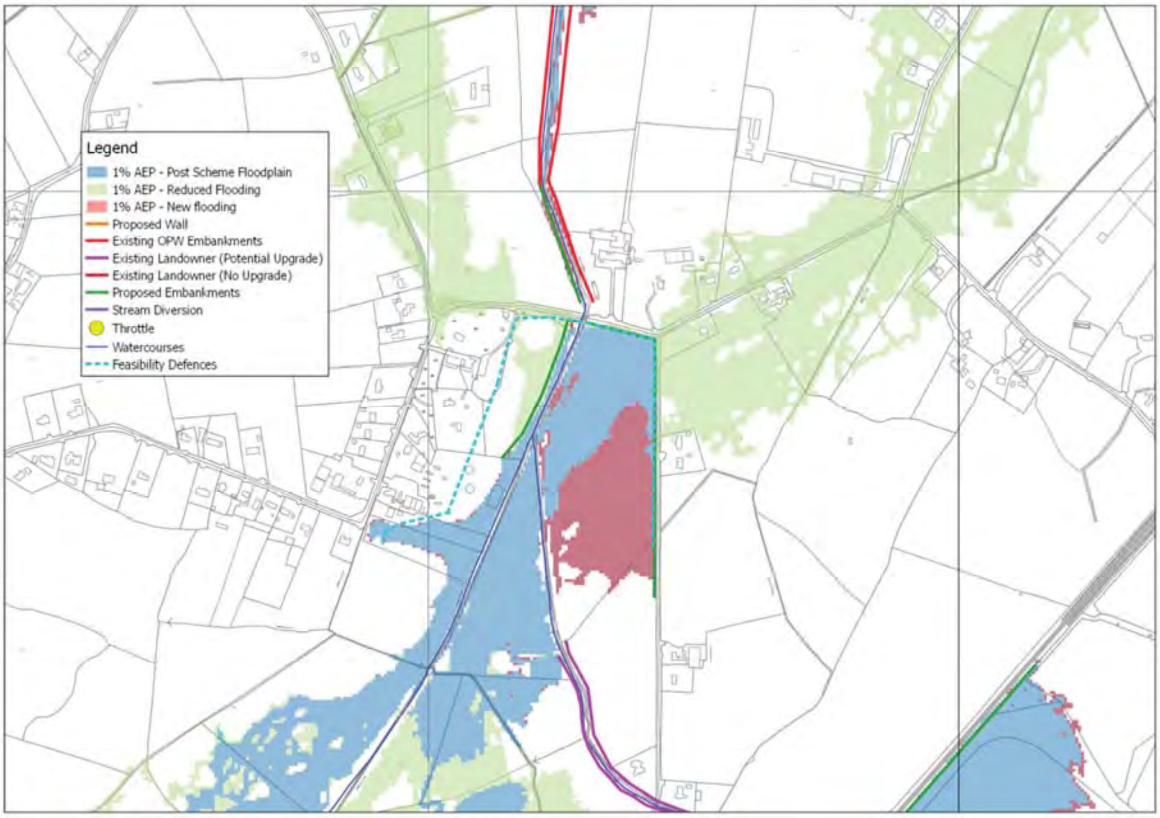


Figure 3.4 Flood Defences in the Turnings area

3.4 TOWNLANDS – KILLEENMORE & BARONRATH

Additional defences have been added in the Killeenmore area alongside the Cork-Dublin railway line. To facilitate these defences a minor stream diversion must also be undertaken at the confluence of the Alasty Stream and Painestown River. Due to proposed management of sections of the Morell River upstream, water levels will increase on the southern side of the railway. To negate any long term risk of undermining and destabilisation of the railway, the additional embankment has been included. To ensure that flood waters do not travel under the railway, existing land drainage culverts will be throttled to only allow low return period flows pass through and hence not pose a risk to residents in the Killeenmore area. As described in Section 3.3, existing embankments along the Morell River (highlighted in purple in **Figure 3.2**) will be incorporated into the maintenance of the scheme and will be structurally inspected to ensure that they are fit for purpose.

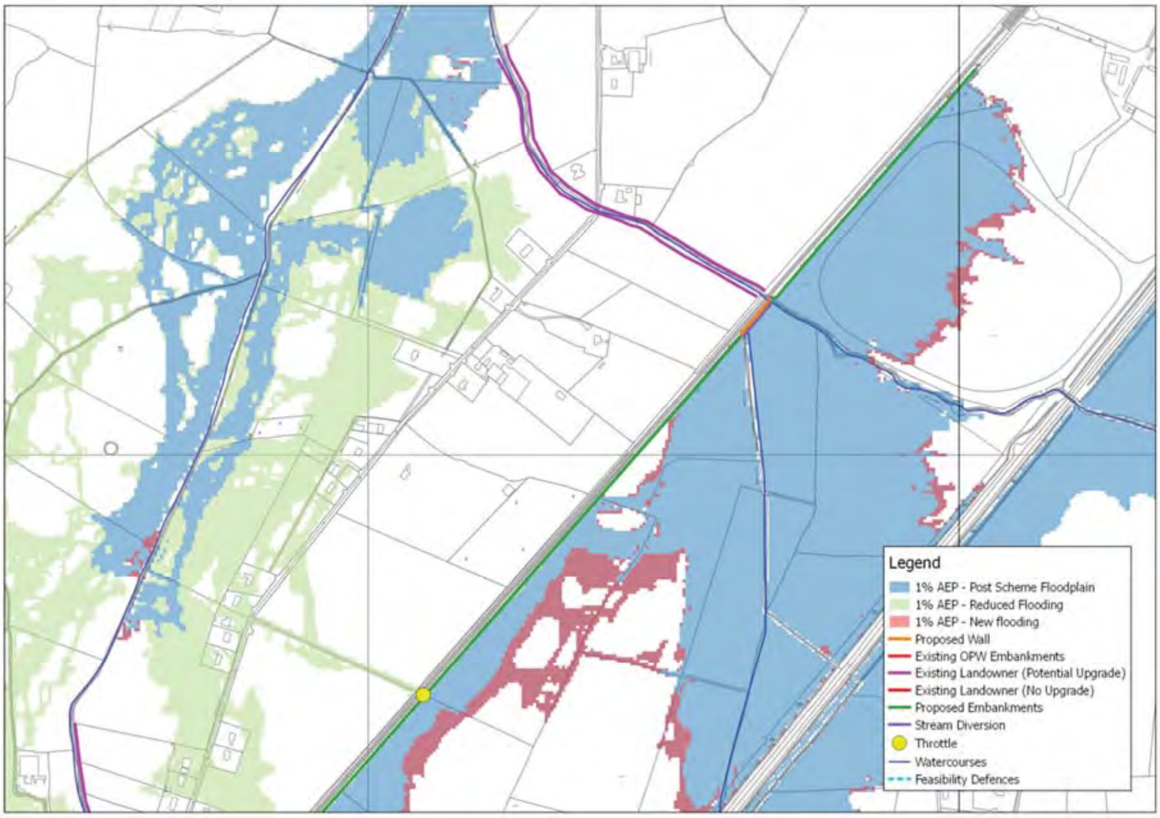


Figure 3.5 Flood Defences in Killeenmore & Baronrath

3.5 TOWNLANDS – SHERLOCKSTOWN & KILLEENMORE

As described in section 3.4, additional defences have been added in the Killeenmore area alongside the Cork-Dublin railway line. The culverts underneath the railway line are also proposed to be throttled. In the Feasibility Stage, flood waters were allowed to flow underneath the railway line and were proposed to be redirected back into the Morell River by a stream diversion and proposed walls/embankments. This option however was removed due to the concerns about the long term stability of the railway line embankment. The design was altered to throttle the culverts under the railway line and allow the excess flood waters to be stored upstream of the railway line and flow towards the Painestown River Railway Culvert, therefore bypassing the Killeenmore area.

Other defences in Killeenmore and Sherlockstown were rationalised following landowner consultation to reduce their footprint and also to accommodate landowner requests. The positions of defences were changed to follow existing field boundaries where possible. Defences along the Alasty Stream were removed following the revised hydrology and updated hydraulic modelling (as discussed in Chapter 2) which indicated reduced the flooding in the area. The rationalisation of defences adjacent to the golf course also reduced flood water flow paths towards the Alasty area from the Morell River.

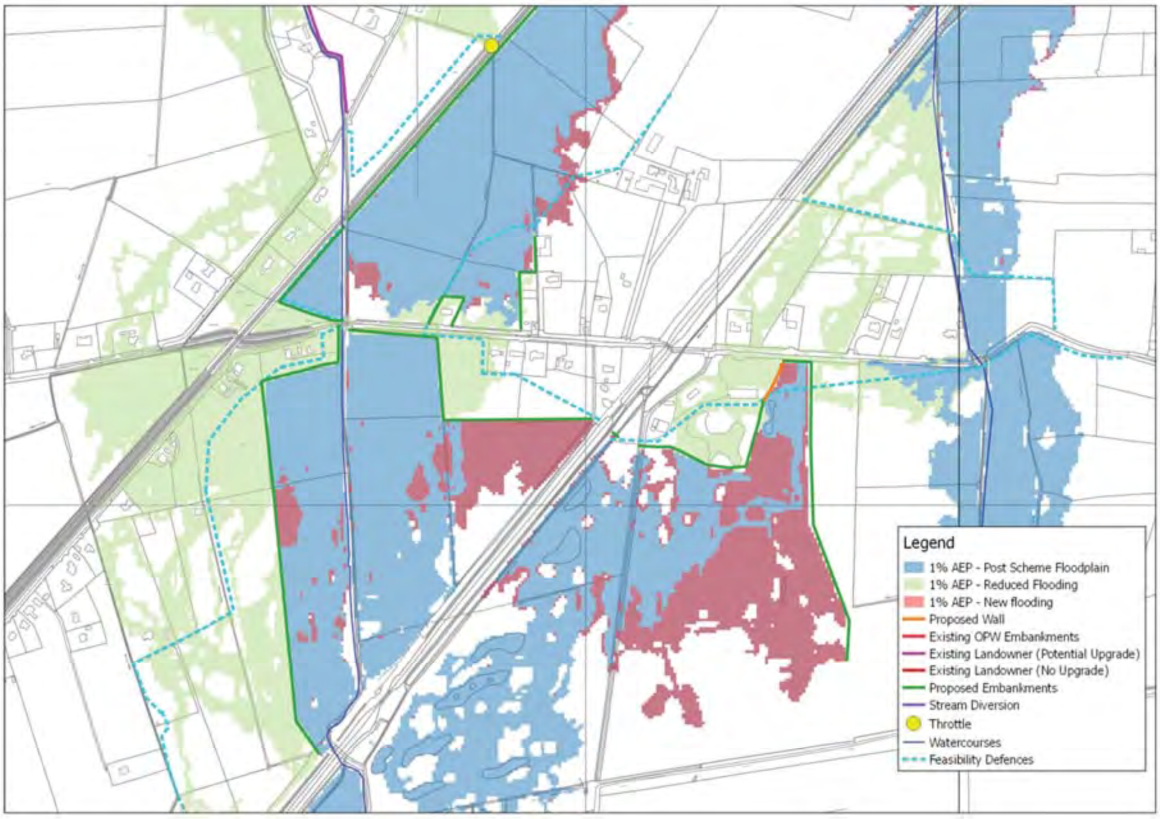


Figure 3.6 Flood Defences in Sherlockstown & Killeenmore

3.6 TOWNLANDS – KILL EAST

Following concerns raised at a public consultation meeting that the flooding in the Kill East area was not representative of the existing scenario, the hydraulic model was updated to include additional cross sections and to expand the extent of the model. **Figure 3.7** shows that an additional embankment was added to protect the rear of properties from overland flooding associated with the Painestown River. The road drainage ditch along the road in front of the row of houses shall be incorporated in the maintenance requirements of the final scheme to ensure that the additional defence is not compromised from its northern side as there is a history of surface water drainage problems from the road in this area.

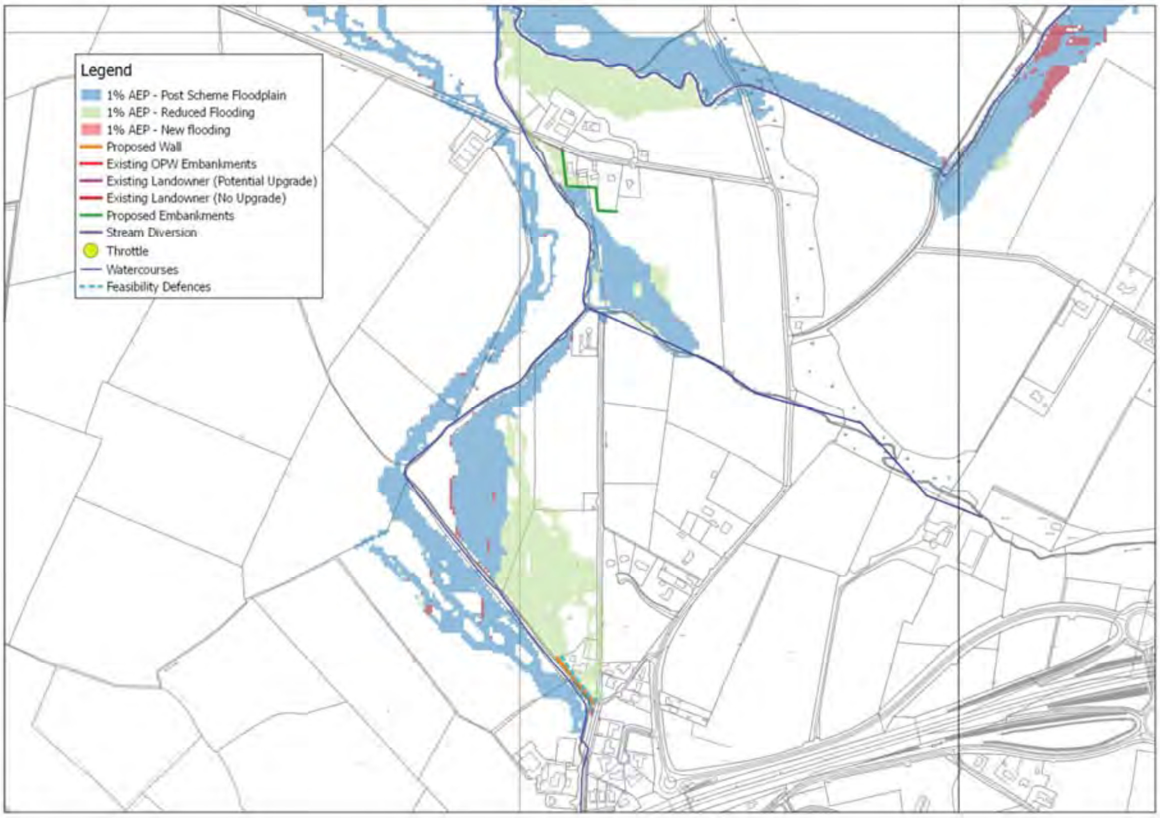


Figure 3.7 Flood Defences in Kill East

3.7 TOWNLANDS – TUCKMILLTOWN

Figure 3.8 below highlights that two additional flood management works have been included. An additional embankment is proposed to prevent an overland flow from the Slane River impacting properties to the north of the river. Following a public consultation meeting a localised erosion problem (further discussed in Section 3.9.5) was brought to the attention of the design team. Part of the river bank is being eroded and undermining the foundations of an electricity pole. A stream diversion is proposed at this location to further prevent the erosion of the river bank and thus preventing the collapse of the electricity pole.

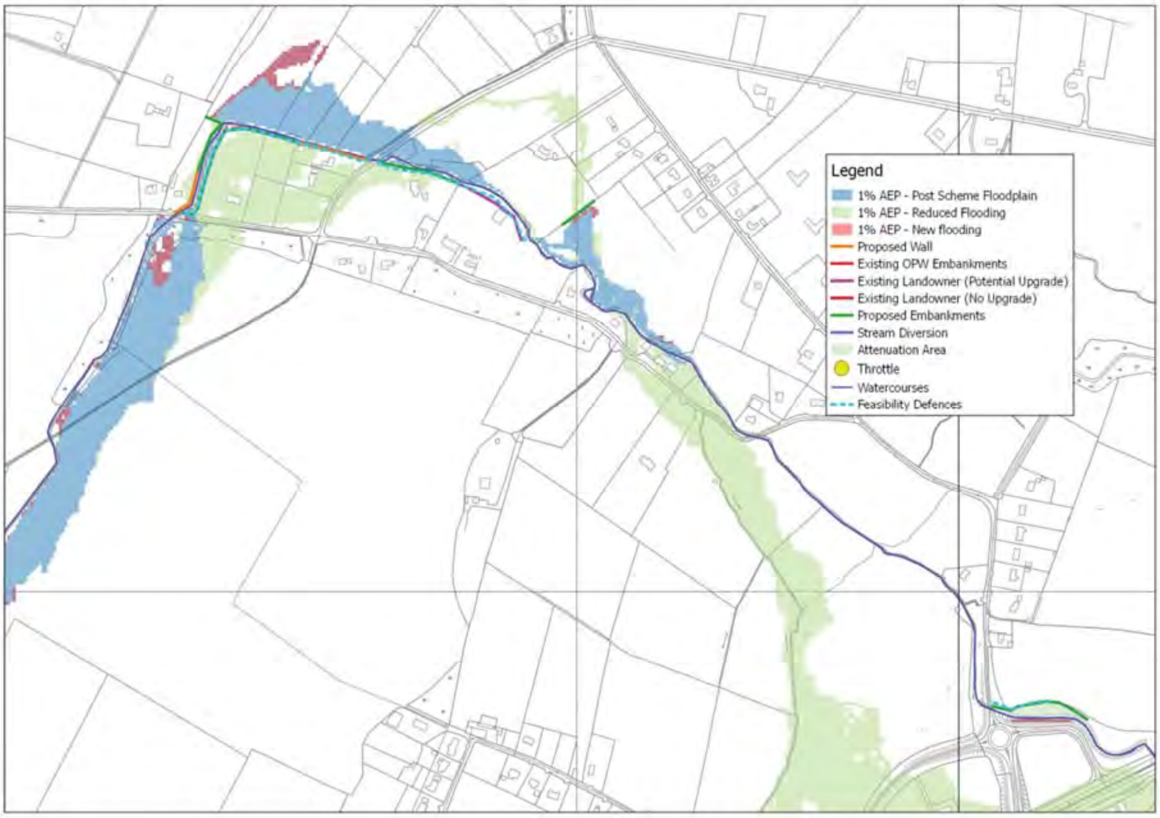


Figure 3.8 Flood Defences in Tuckmilltown

3.8 PROPOSALS

In accordance with the preferred design standards identified by the OPW, the scheme has been designed to alleviate flooding to properties for the 1% AEP, with provision for future adaptability to the Mid-Range Future Scenario for climate change.

The brief also required the Consultant to consider flood risks associated with more significant events than those of the preferred or proposed design standard (e.g. 0.1% AEP or 1 in 1000 probability) as part of the appraisal, to assess the impacts of failure of the Scheme or other measures, and, if appropriate, include for in the design of the Scheme.

The proposed scheme as shown overleaf in **Figure 3.2** consists of the construction or restoration of over 9,000 metres of embankment, the construction of up to 480m of flood walls to direct the flood water away from high risk areas, two stream re-alignments and up to 11 culvert alterations. **Table 3.1** and **Table 3.2** below show the final scheme measures. The EIS should be referred to for a full description of the proposed scheme.

Table 3.1 Final Scheme Measures - Embankments and Walls

Layer	Townland	EIS Ref	Length (m)	Max Height (m)	Average Height (m)	Description
Embankment	Ballyhays	Morr 1	50	1.1	0.9	Located along edge of field and road boundary. Will tie into Culvert 1 beneath R406.
Embankment	Ballyhays	Morr 1a	100	0.84	0.7	Located along field boundary. Required to cut off new overland flow path caused by additional flows through culvert 2
Embankment	Turnings Lower	Morr 2	217	1.25	1.18	Located along riverbank - upgrade to existing embankment. Will tie into Culvert 2 beneath L6016. Required to cut off overland flow path created by additional flows flowing through culvert 2.
Embankment	Turnings	Morr 3	293	1.40	1.14	Located along riverbank in agricultural field. Access adjacent to Road L6016 needs to be maintained. Will tie into Culvert 2 beneath L6016. Will tie into existing high ground at other end.
Embankment	Turnings	Paines 1	569	2.06	1.69	Located on boundary of agricultural field adjacent to the L60161. Local field access needs to be maintained. Will tie into Culvert 2 beneath L6016.
Existing Landowner Embankment (Possible Upgrade)	Turnings	Paines 2	649	2.00	NA	Located along riverbank in agricultural field.
Existing Landowner Embankment (Possible Upgrade)	Turnings	Paines 3	665	1.80	NA	Western and Eastern end - riverbank agricultural field. Middle Section (either side of road) - riverbank residential garden
Embankment	Killeenmore	Morr 4	1613	1.6	1.18	Located upstream of railway. Tie ins to culvert 5, culvert 4 and culvert 4a required.
Culvert Upgrade	Killeenmore	Morr 5	NA	NA	NA	Throttle required on culvert 4
Culvert Upgrade	Killeenmore	Morr 6	NA	NA	NA	Throttle required on culvert 4a
Wall	Killeenmore	Morr 7	76	1.69	1.4	For this section, tributary of Painestown runs adjacent to the rail line. Wall required rather than embankment due to space restrictions. Tie in to culvert 10 required.
Stream Diversion	Killeenmore	Morr 8	79	NA	NA	Painestown Tributary to be diverted to allow for construction of flood defence. Stream currently adjacent to railway embankment in this location.
Embankment	Baronrath	Morr 9	532	1.52	1.31	Located upstream of railway. Eastern side of Painestown River. Tie in to culvert 10 required.
Existing Landowner Embankment (Possible Upgrade)	Killeenmore	Morr 10	374	NA	NA	Riverbank - Field Boundary Agricultural field
Embankment	Killeenmore	Morr 15	290	1.47	1.25	Located at boundary of agricultural field, runs adjacent to the Dublin-cork railway line and L2010. Local field access needs to be maintained. Will tie into upgraded Culvert 5 beneath Dublin-Cork Railway. Will tie into Culvert 7 beneath L2010.
Embankment	Killeenmore	Morr 16	143	0.75	0.65	Located at boundary of agricultural field but also around the boundary of a property.
Embankment	Killeenmore	Morr 16a	187	0.82	0.7	Located along boundary of agricultural fields and laneway. Local field access needs to be maintained.
Embankment	Sherlockstown	Morr 17	867	1.70	1.13	Located along field boundary and through agricultural field – as agreed with landowner. Local field access needs to be maintained. Will tie into Culvert 7 beneath L2010. Internal field access required.
Embankment	Killeenmore	Morr 19	555	1.73	1.32	Located along field boundary in agricultural field adjacent to the L2010. Path agreed with landowner. Local field access needs to be maintained. Will tie into Culvert 7 beneath L2010.

Layer	Townland	EIS Ref	Length (m)	Max Height (m)	Average Height (m)	Description
Embankment + Culvert	Killeenmore	Morr 20	11	1.05	1.05	Located in ditch running along canal – Throttle introduced to limit flows through ditch during floods. Low flows to be unaffected.
Embankment	Killeenmore	Morr 21	314	1.73	1.73	Located within golf course lands. Defences will tie into existing landscape of Golf Course.
Wall	Killeenmore	Morr 22	76	1.9	1.8	Located within golf course lands. Upgrade to existing boundary wall for golf club car park and tie into the other golf club defences
Embankment	Killeenmore	Morr 23	578	2.06	1.51	Located within golf course lands. Defences will tie into existing landscape of Golf Course and down along the boundary of the golf club.
Embankment	Alasty	Paines 4	107	0.50	0.50	Located along agricultural field and property boundary. Internal field access required.
Embankment	Painestown	Paines 5	186	1.20	1.20	Located along riverbank and adjacent to property boundaries.
Wall	Tuckmilltown	Slane 1	90	1.40	1.40	Riverbank - Boundary residential garden / field. Will tie into Culvert 18 beneath L6021.
Embankment	Tuckmilltown	Slane 2	121	1.40	1.40	Riverbank - Boundary residential garden / field.
Embankment	Tuckmilltown	Slane 3	302	1.80	1.40	Riverbank - Boundary residential garden / field. Will tie into Culvert 18 beneath L6021.
Wall	Tuckmilltown	Slane 4	131	1.60	1.40	Riverbank - Boundary residential garden. Will tie into Culvert 19 beneath L6019.
Embankment	Tuckmilltown	Slane 5	144	1.30	1.30	Riverbank - Boundary residential garden. Will tie into Culvert 19 beneath L6019.
Existing Landowner Embankment (Possible Upgrade)	Tuckmilltown	Slane 6	155	2.00	2.00	Riverbank - Boundary commercial yard
Embankment	Blackchurch	Slane 7	177	1.50	1.50	Located along riverbank. Boundary with agricultural field. Access to retention area required.
Stream Realignment	Tuckmilltown	Slane 8	21	N/A	N/A	Field - realignment of stream to prevent further erosion of river bank.
Embankment	Tuckmilltown	Slane 9	67	0.75	0.6	Located along field boundary to cut off overland flow path
Culvert Opening	Blackchurch	Slane 10	NA	NA	NA	Opening of throttle installed on culvert below N7
Excavation	Blackchurch	Slane 11	NA	NA	NA	Excavation of a flood storage zone between the Slane River and Slane 7 embankment.
Wall	Kill East	Kill 1	101	1.5	1.5	Riverbank - Boundary residential garden. Will tie into Culvert 15 beneath L6014.

Appendix K

Table 3.2 Proposed Scheme Measures - Culverts

Name	Townland	River	Road / Railway / Canal	Scheme Interaction
Culvert 1	Ballyhays	Morell	R406	Morr 1 will tie into culvert.
Culvert 2	Turnings Lower	Morell	L6016	Morr 2, Morr 3 and Paines 1 will tie into culvert.
Culvert 3	Killeenmore	Morell	L60161	
Culvert 4	Killeenmore	Morell	Dublin-Cork Railway	Throttle to be installed upstream of culvert. Morr 4 to tie into culvert.
Culvert 4a	Killeenmore	Morell	Dublin-Cork Railway	Throttle to be installed upstream of culvert. Morr 4 to tie into culvert.
Culvert 5	Killeenmore	Morell	Dublin-Cork Railway	N/A
Culvert 6	Killeenmore	Morell	L60161	Morr 4, Morr 15 will tie into culvert.
Culvert 7	Sherlockstown	Morell	L2010	Morr 15, Morr 17 and Morr 19 will tie into culvert.
Culvert 8	Sherlockstown	Morell	Grand Canal	No Change
Culvert 9	Killeenmore	Painestown	L60161	Possible upgrade required. Culvert in poor condition.
Culvert 10	Baronrath	Painestown	Dublin-Cork Railway	Morr 7 and Morr 9 will tie into culvert. Morr 8 Stream diversion will join Painestown upstream of this culvert.
Culvert 11	Alasty	Alasty Stream	Grand Canal	No Change
Culvert 12	Killeenbeg	Alasty Stream	L2010	No Change
Culvert 13	Alasty	Painestown	Grand Canal	No Change

Culvert 14	Painestown	Painestown	L2010	No Change
Culvert 15	Kill West	Kill	L6014	Kill 1 will tie into culvert.
Culvert 16	Painestown	Slane	L2007	No Change
Culvert 17	Kill East	Painestown	L2007	No Change
Culvert 18	Tuckmilltown	Slane	L6021	Slane 1 and Slane 3 will tie into culvert.
Culvert 19	Tuckmilltown	Slane	L6019	Slane 4 and Slane 5 will tie into culvert.
Culvert 20	Tuckmilltown	Slane	L6021	No Change
Culvert 21	Blackchurch	Slane	L6021	No Change
Culvert 22	Blackchurch	Slane	N7	Opening Culvert, the existing culvert is partially sealed, the ends of the culvert will opened to facilitate the scheme

3.9 CONSTRUCTION METHODOLOGIES

The construction methodologies for the elements of the flood management scheme are described in the sections below.

3.9.1 Construction of New Embankments

The proposed scheme involves the construction of approximately 7,423 metres of new embankments. These new embankments will consist of a clay core with surrounding fill materials covered in topsoil. The required height of the embankment will determine the overall width, as the slope will have to be appropriate for the location. For example, some embankments will have low gradient slopes to allow vehicular access to the enclosed area and others will have steep slopes, to prevent access and act as a boundary for the site. Generic details for embankments are shown in **Figure 3.9**. Where required, emergency spillways will be designed into the embankments in order to provide a safe overtopping mechanism in the event where flood flows larger than the design event occur.

Approximately 70,000m³ of fill material will be required for construction of the new embankments. Fill material will be sourced from licenced quarries/suppliers, however consideration will also be given to the potential for re-use of suitable construction fill from complementary engineering projects elsewhere in the local region, subject to obtaining the relevant permissions. Opportunities for sourcing suitable material available for beneficial re-use will be investigated prior to construction. Once completed, embankments will be seeded with grass. Any temporary working areas used during the construction activities will also be reinstated to their original condition. Where treeline, hedgerow or scrub removal as part of the proposed scheme was unavoidable, a new native planting scheme will be implemented to function as replacement habitat for that removed.

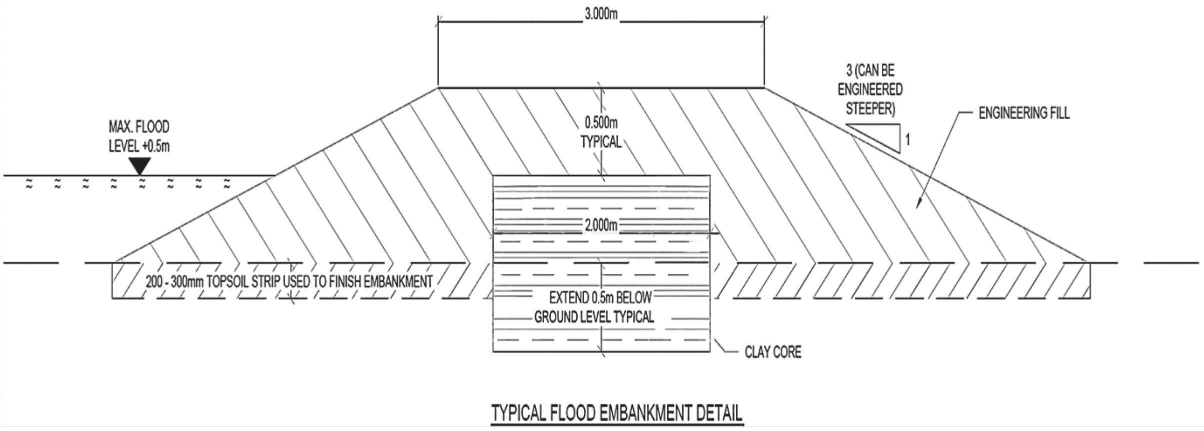


Figure 3.9 Typical Flood Embankment Detail

3.9.2 Examination and Restoration of Existing Embankments

There are approximately 1,842m of existing embankments that may require restoration works to be carried out in order to meet the minimum standard of protection required under the scheme. These embankments will be assessed for structural integrity prior to the scheme's detailed design. The report on this integrity will determine the level and extent of the restoration required. The type of restoration work required is expected to range from stripping back and expanding the width and/or height of the embankment up to complete removal and reconstruction. The typical details for the remediated embankments will be the same as those for new embankments as detailed in **Figure 3.9**.

Additional fill required for remediation of existing embankments will be sourced as per Section 3.9.1 above for new embankments. Restoration of vegetation in temporary working areas will also be as per that for new embankments, see 3.9.1 above. It should be noted that **Figure 3.2** also shows a number of existing embankments which have previously been constructed by the OPW (displayed as green lines on this figure). These embankments have been shown on this figure and throughout the EIS for information purposes only and no works are proposed at these embankments.

3.9.3 Construction of New Flood Walls

The scheme will require approximately 474m of new flood walls, ranging in height from 1.0m to 2.0m. Walls will be constructed from reinforced concrete poured in situ. A plan and cross-sections for a typical flood wall is shown in Figure 3.10. The contractor will be required to excavate foundations for the proposed flood walls. Where possible, foundations will be kept as shallow as possible to minimise the amount of exposed earth and temporary works required to support excavations. Excavated materials will be stockpiled in the temporary working area with topsoil kept separately, and reused.

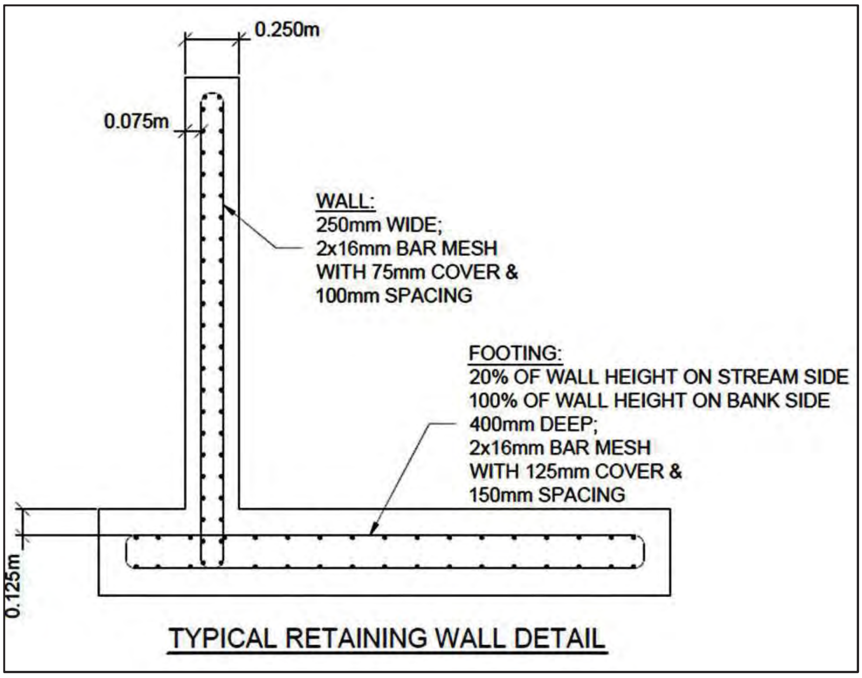


Figure 3.10 Section view of Typical Flood Wall

3.9.4 Culvert Alterations

In-channel works relating to the upgrade of three existing culverts within the Morell catchment will be required. These works will include maintenance works to open up a blocked culvert (Culvert 22) whilst Culverts 5 and 10 will require in stream works for the installation of scour protection measures. Culvert 9 is in a poor state of repair and will require restoration work to bring it to the required standard. There are two small culverts (Culvert 4 and Culvert 4a) crossing the railway that will be throttled in order to limit flow through them.

It is proposed that flood defences will tie into culverts 1, 2, 7, 18 and 19. These culverts will be structurally assessed at the detailed design stage to determine if they require scour protection measures or underpinning in which case these works will be subject to an approved Method Statement. It is proposed that any in-channel works are carried out 'in the dry'. A temporary enclosure to keep out water will be constructed in the "work zone" to permit dewatering and to allow the necessary construction works to be carried out in safe, dry conditions.

3.9.5 Stream Realignment and Tie Ins

3.9.5.1 Stream Realignment

Stream realignment works are also proposed at Slane 08 and Morr 08 in Tuckmilltown and Killeenmore. The stream realignments are to be carried out in accordance with the recommendations within the Inland Fisheries Ireland (IFI) document '*Requirements for the protection of Fisheries Habitat during construction and Development Works at River Sites*' (ERFB, 2003). The proposed realignment in Tuckmilltown (Slane 08) will remove the sharp ox-bow bend that currently exists by excavating a new channel to divert the flow as shown in **Image 3.1.** Following a public consultation meeting a localised erosion problem was brought to the attention of the design team. Part of the river bank is being eroded and undermining the foundations of an electricity pole. A stream diversion is proposed at this location to further prevent the erosion of the river bank and thus preventing the collapse of the electricity pole. The river flow will be diverted through the new channel which will improve the flow regime and reduce the level of erosion that occurs during periods of high flow .The proposed diversion in Killeenmore (Morr 08), shown in is required to allow a flood defence to be constructed between the stream and the railway embankment.

Image 3.1 Slane 08 Re-alignment Location

It is proposed that the plant required to construct the diversion can operate from the river bank without need to enter the stream. However, works have the potential for significant sediment disturbance and run-off during this operation. Mitigation measures are described in more detail in the EIS which include methods to prevent silt being discharged into the watercourse. A detailed Method Statement for the realignment will be discussed and agreed with the relevant authorities in advance of the works commencing. An outline Construction & Environmental Management Plan (CEMP) containing the outline methodology is included in chapter 3 of the EIS.

For the proposed channel realignments at Slane 08 and Morr 08, the excavation works to construct the new channel alignment will be carried out in dry conditions without connection to the existing watercourse and shall be completed well in advance of their use so that native bankside vegetation can be established. The stream diversions will have a natural stream bed and will replicate in so far as practicable the stream bed material characteristics of the watercourse. The connection of the new stream channel to the existing watercourse shall only be made during timing window agreed with IFI for in-stream works. IFI shall be consulted on the construction of in-stream features as outlined in IFI document '*Guidelines on Protection of Fisheries during Construction works in or adjacent to Waters*' (IFI, 2016). The IFI will be consulted on the need to relocate resident fish stocks from the sections of watercourse to be abandoned. The relocation of resident fish stocks will be undertaken without delay and with minimum stress to the fish stocks.

4 PLANNING AND EIA CONTEXT

4.1 INTRODUCTION

RPS undertook a screening assessment of the feasibility stage preferred scheme to determine if an Environmental Impact Assessment (EIA) was required in relation to the proposed flood risk management options in the Morell catchment.

Screening is the term used to describe the process of ascertaining whether a development requires an EIA and is determined by reference to mandatory and discretionary provisions. In interpreting which projects are likely to have significant environmental effects, the provisions and criteria as set out in the *Planning and Development Act 2000* (as amended) (the '2000 Act') and the *Planning and Development Regulations 2001* (as amended) (the '2001 Regulations') must be adhered to. Determination criteria are also outlined within the European Communities (Environmental Impact Assessment) Regulations (1989 to 2001) which implements the EIA Directive 85/337/EC, as amended in 1997, 2003 and 2009. The overriding consideration in determining whether a development should be subject to EIA is the likelihood of significant environmental effects. Significant effects may arise by virtue of the type of development, the scale or extent of the development and the location of the development in relation to sensitive environments.

4.2 LEGISLATIVE REQUIREMENT

The EIA Directive lists those projects for which an EIA is mandatory (Annex I) and those projects for which EIA may be required (Annex II). Flood relief works are listed in Annex II. With regard to Annex II projects, Member States can choose to apply thresholds or use case-by-case examination or a combination of both to assess whether these projects require EIA. For development schemes in Ireland, a combination of both is used.

The 2000 Act and the 2001 Regulations outline the requirements for the assessment of the effects of certain public and private projects on the environment.

Schedule 5, Part II of the 2001 Regulations specifies the classes of development prescribed for the purposes of Section 176 of the 2000 Act. It includes at item 10 (f) (ii):

> *(f)(ii) Canalisation and flood relief works, where the immediate contributing sub-catchment of the proposed works (i.e. the difference between the contributing catchments at the upper and lower extent of the works) would exceed 100 hectares or where more than 2 hectares of wetland would be affected or where the length of river channel on which works are proposed would be greater than 2 kilometres.*

4.3 EIA SCREENING AND PLANNING CONCLUSION

The upper extent of the feasibility stage works is at the culvert at the N7 and the lower extent of the works is at the Old Morell Bridge, The length of channel between these two points is 8.6 kilometres and the contributing catchment in relation to this stretch of channel is 40 km^2 in area (including the tributaries).

EIA Screening was undertaken by RPS in 2014 and it was determined that in line with the thresholds specified in Schedule 5, Part II, item 10 (f) (ii) of the 2001 Regulations the feasibility stage works for the Morell catchment is a class of development for the purposes of section 176 of the 2000 Act; accordingly Kildare County Council must prepare, or cause to be prepared, an EIS in respect of the proposed develoment.

4.4 ENVIRONMENTAL IMPACT STATEMENT

Following the EIA screening conclusion RPS was appointed by Kildare County Council to produce an Environmental Impact Statement (EIS) for the Morell River FMS. The EIS forms an integral part of the applications for consent for the proposed scheme, which are discussed in Section1.4 'Legislative & Policy Context'. In this regard, it will also act as a basis for public consultation and informed comment. In addition to the completion of the EIS, an Appropriate Assessment Screening Statement was also undertaken for this project in order to fulfil the requirements of the Habitats Directive (92/43/EEC) and the Birds and Natural Habitats Regulations (S.I. 477 of 2011), and is included in Appendix D in Volume 3 of the EIS.

The EIS has considered the construction activities, operation and maintenance of the following elements of the proposed scheme:

- New Embankments (approximately 7,400m)
- Remediation of Existing Embankments (approximately 1,800m);
- New Flood Walls (approximately 480m);
- Culvert Alterations (6 No.) and new embankment/wall tie ins with 5 No. culverts;
- Stream Realignment Works on the Slane River (approximately 35m),

Once in place, no systems, controls or dedicated management practices are required to operate this scheme, however maintenance will be required.

It is not anticipated that the above elements will be decommissioned; hence the EIS has not considered decommissioning of these elements.

It should be noted that the EIS was based on the preliminary design. During the detailed design process, the scheme may be subject to some minor refinements prior to construction.

This Environmental Impact Statement (EIS) was prepared in accordance with the requirements of the European Communities (Environmental Impact Assessment) Regulations, 1989 to 2006; the Planning and Development Act 2000 (as amended); and the Planning and Development Regulations 2001 (as amended). This legislation requires the assessment of the effects of certain public and private projects on the environment.

The general headings of the topics and issues reported on in the Environmental Statement are

- Human Beings
- Terrestrial Ecology
- Air Quality and Climate
- Landscape and Visual Impact
- Soil, Geology and Hydrogeology
- Traffic
- Aquatic Ecology
- Noise and Vibration
- Hydrology and Drainage
- Cultural Heritage

The EIS report assesses the likely significant impacts arising from the proposed Morell Flood Management Scheme. The EIS provides a summary of the potential impacts identified and describes the mitigation measures proposed to reduce or eliminate these impacts. The timescale during which the mitigation is appropriate is also outlined, as well as who will be responsible for implementing the mitigation. For the list of these impacts and mitigation measures refer to Chapter 15 of the EIS. The EIS also includes an outline Construction Environmental Management Plan (CEMP) in its appendices. The purpose of the CEMP is to ensure that the mitigation measures outlined in the EIS and any other requirements that arise from the planning process will be carried forward to the construction phase of the project. This CEMP will be developed by the main works contractor into a final CEMP and agreed with the relevant authorities in advance of the works.

4.5 PART 10 PLANNING

As noted in section 4.4, Section 175 provides that local authority projects, subject to Environmental Impact Assessment (EIA), may not be carried out unless approved by An Bord Pleánala with or without modifications.

The subject application for approval is therefore made by Kildare County Council to An Bord Pleanála in accordance with Section 175 of the 2000 Act and Part 10, Chapter 4 of the 2001 Regulations.

A planning report has been prepared to accompany the application for approval. The purpose of this report is to present, in summary, the issues associated with the proposed development. It is intended to assit the Board in determining whether approval should be granted for the proposed development.

This River Morell FMS study was funded by the OPW and undertaken by RPS, on behalf of Kildare County Council. Kildare County Council has declared several surface water and flooding flood risk management policies in the 2017-2023 County Development Plan including policy SW 19 which commits to “Liaise with the Office of Public Works in delivering flood management and alleviation programmes. This policy includes delivery of the Morell River Flood Management Scheme and it should be noted that the County Development Plan has been effect from 1st March, 2017.

5 CONCLUSIONS

The Morell River catchment in County Kildare has been subject to significant recurring flooding in past two decades and hence was prioritised within the Eastern CFRAM Study programme for the development of a FMS Study. The purpose of this study was to fully assess the flood risk within the Morell catchment and develop a series of potential FRM Options. Kildare County Council has declared several surface water and flooding flood risk management policies in the 2017-2023 County Development Plan including policy SW 19 which commits to "Liaise with the Office of Public Works in delivering flood management and alleviation programmes. This policy includes delivery of the Morrell River Flood Management Scheme and it should be noted that The County Development Plan has been in effect from 1st March, 2017.

A preferred feasibility stage option to address the flood risk in the Morell River catchment was identified that involves using hard defences, including retaining walls and embankments, to protect properties with flood risk in a 1% AEP event. The preferred feasibility stage option also proposed the upgrade of existing culverts to improve channel conveyance of the 1% AEP flows. This included restoring the capacity of the culvert conveying the Slane River under the N7 at Junction 6 Castlewarden exit, and improvement works on culverts at various other locations, including the Dublin-Cork Railway crossings.

The Feasibility Stage option has evolved into the final proposed scheme due to refinements in the hydraulic model to improve the accuracy of it at site specific level, to account for changes to embankment location following landowner liaison and requirements of a stakeholder technical review.

Landowner liaison was an integral part of the development of the final scheme. Two public consultation days and approximately 40 individual meetings with landowners were held throughout the design phase to address affected landowners concerns and where possible incorporate design changes. Design changes were assessed with the entire scheme in mind to ensure that the core requirement of the scheme to protect properties was not compromised and upstream or downstream impacts were not caused by changes to defences from the feasibility stage.

The final scheme is being brought forward for a Part 10 planning application to An Bord Pleanála and RPS has undertaken an Environmental Impact Statement (EIS) to facilitate this application. The objective of the Morell River FMS is to provide optimum flood relief with minimal environmental impact, whilst also controlling the overall capital investment required.

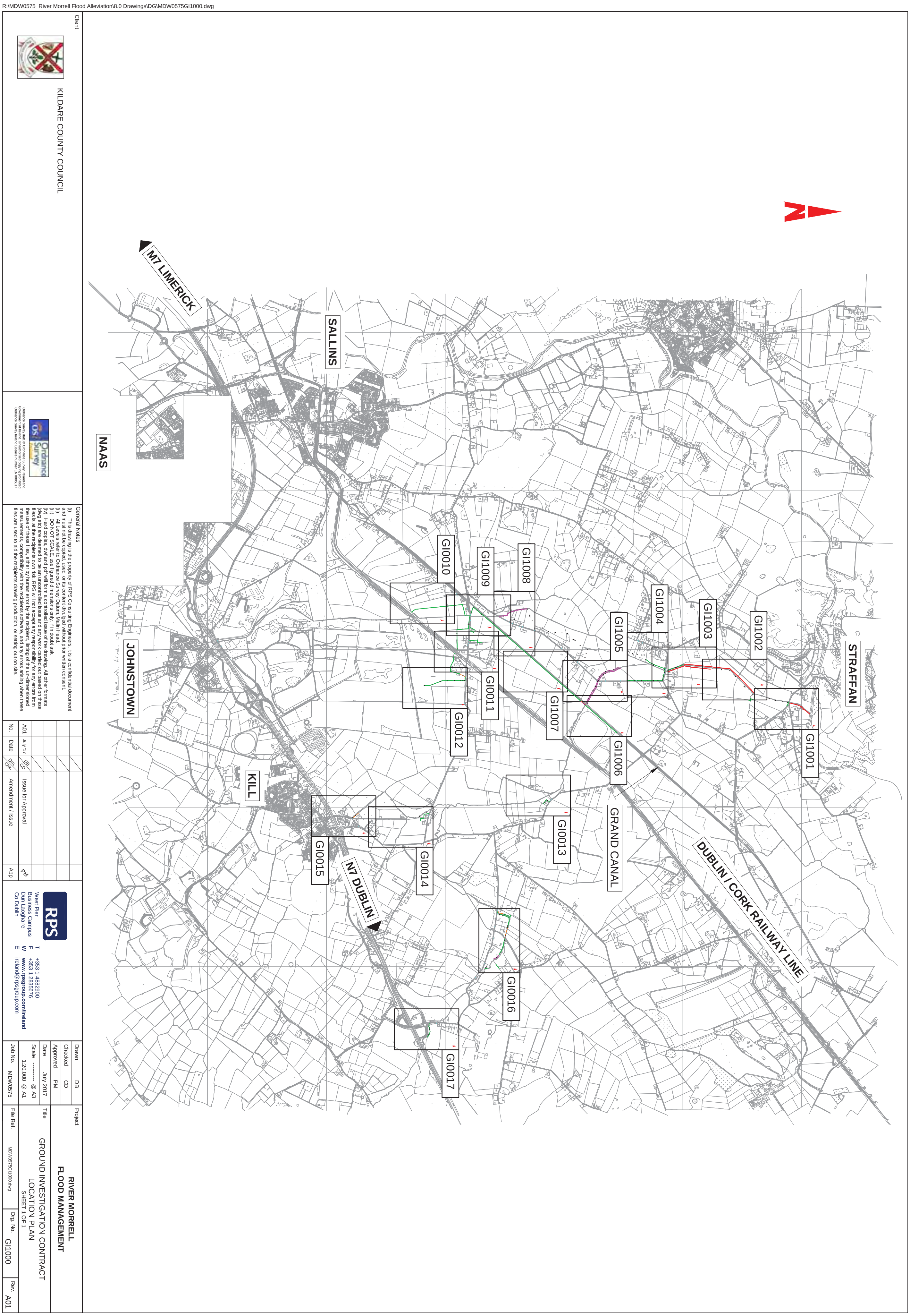
RPS

Appendix L

Ground Investigations

Appendix L

GROUND INVESTIGATIONS – LOCATION FIGURES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SALLINS
NAAS
JOHNSTOWN
KILL
N7 DUBLIN
STRAFFAN
GRAND CANAL
DUBLIN / CORK RAILWAY LINE
GI1001
GI1002
GI1003
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No.
Date
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Scale 1:20,000 @ A1
Job No. MDW0575
Project
RIVER MORRELL
FLOOD MANAGEMENT
Title
GROUND INVESTIGATION CONTRACT
LOCATION PLAN
SHEET 1 OF 1
File Ref.
MDW0575GI1000.dwg
Drg. No.
GI1000
Rev.
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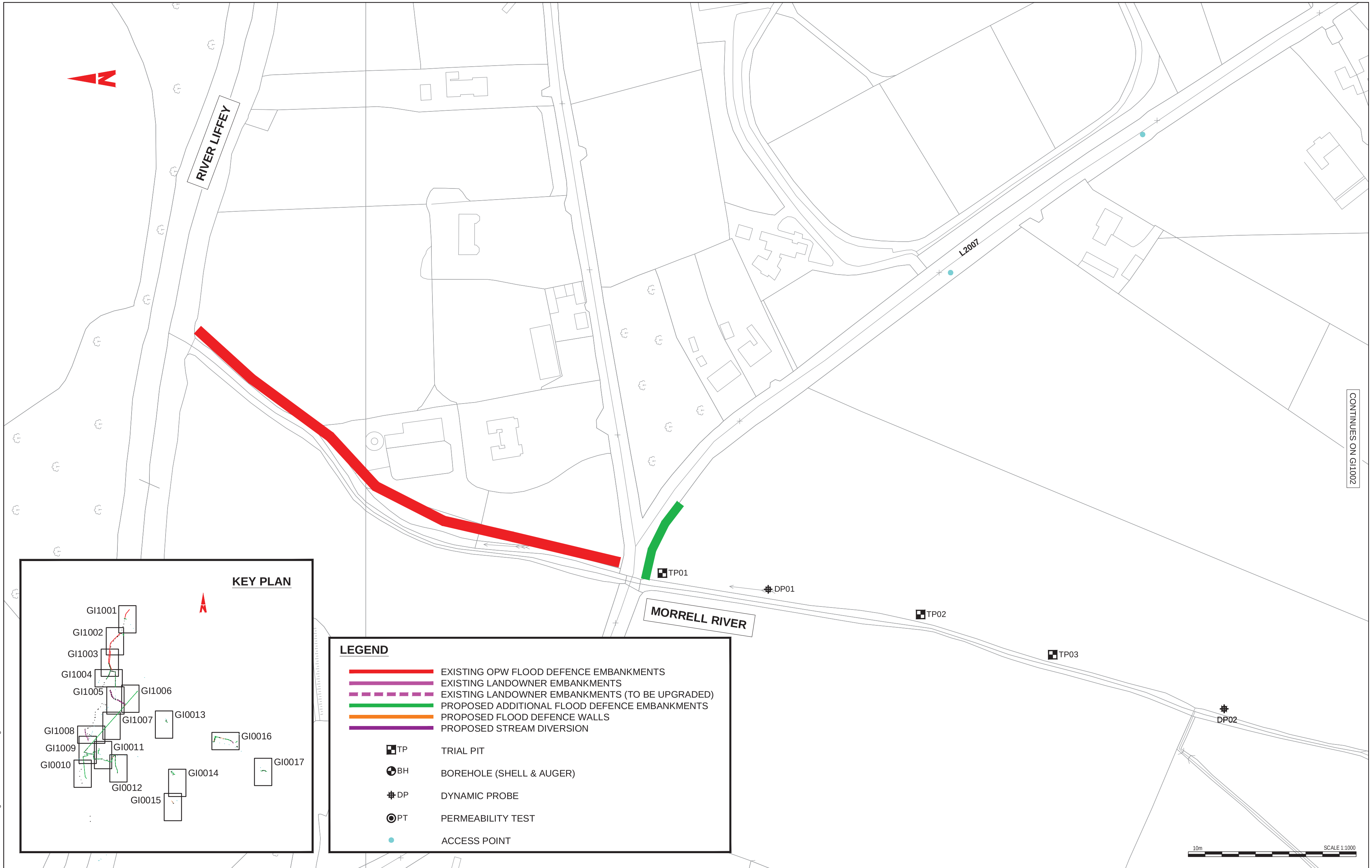

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Approved	PM
Date	July 2017
Scale	1:2000 @ A3 1:1000 @ A1
Job No.	MDW0575

Project: RIVER MORRELL FLOOD MANAGEMENT

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION
SHEET 1 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1001 | Rev. A01

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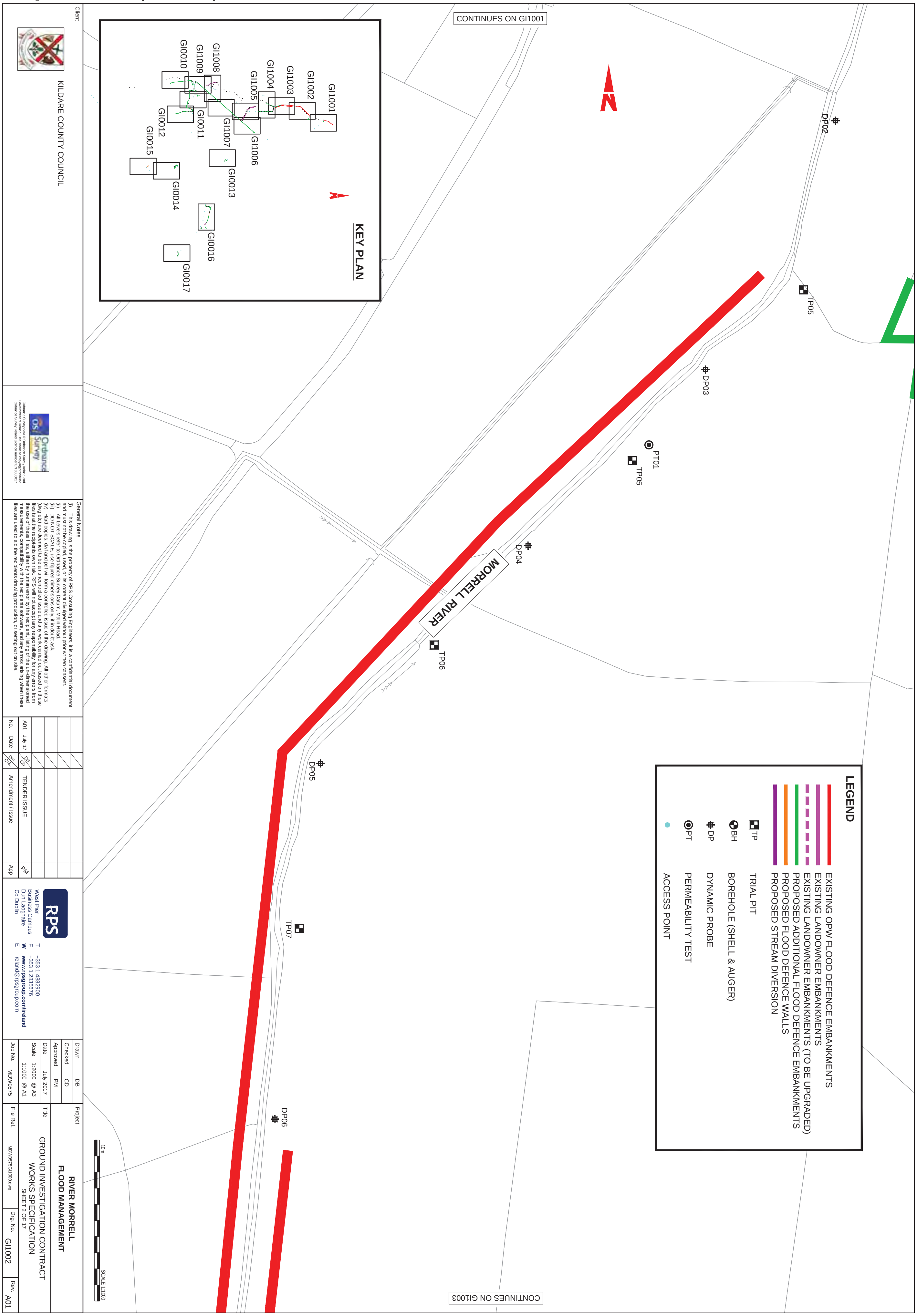

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DP04
MORRELL RIVER
TP06
DP05
TP07
DP06
LEGEND
EXISTING OPW FLOOD DEFENCE EMBANKMENTS
EXISTING LANDOWNER EMBANKMENTS
EXISTING LANDOWNER EMBANKMENTS (TO BE UPGRADED)
PROPOSED ADDITIONAL FLOOD DEFENCE WALLS
PROPOSED FLOOD DEFENCE EMBANKMENTS
PROPOSED STREAM DIVERSION
TP TRIAL PIT
BH BOREHOLE (SHELL & AUGER)
DP DYNAMIC PROBE
PT PERMEABILITY TEST
ACCESS POINT
CONTINUES ON GI1003
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Date July 2017
Scale 1:2000 @ A3 1:1000 @ A1
Job No. MDW0575
Project
RIVER MORRELL FLOOD MANAGEMENT
Title
GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION
SHEET 2 OF 17
File Ref. MDW0575GI1000.dwg
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Rev. A01
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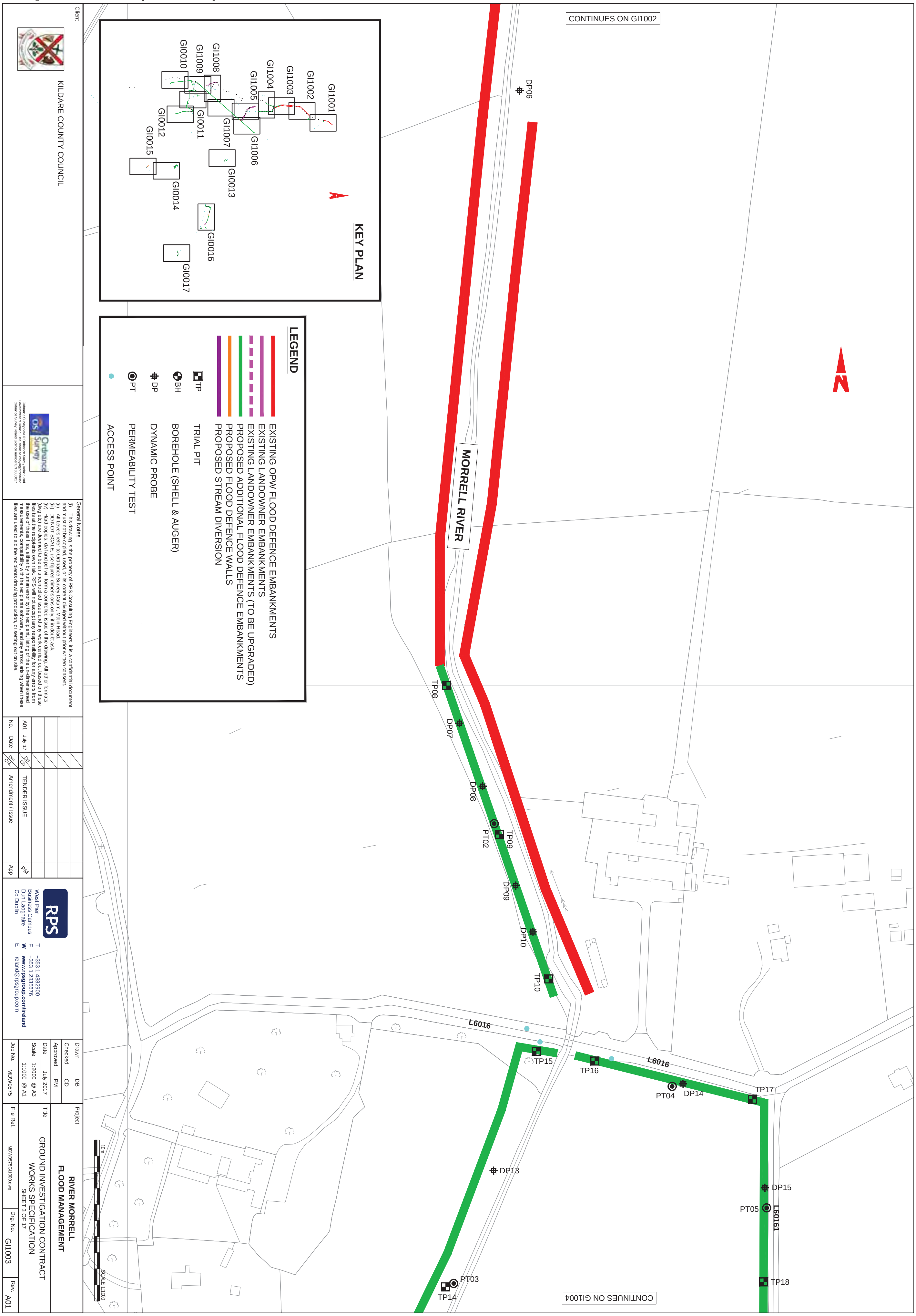

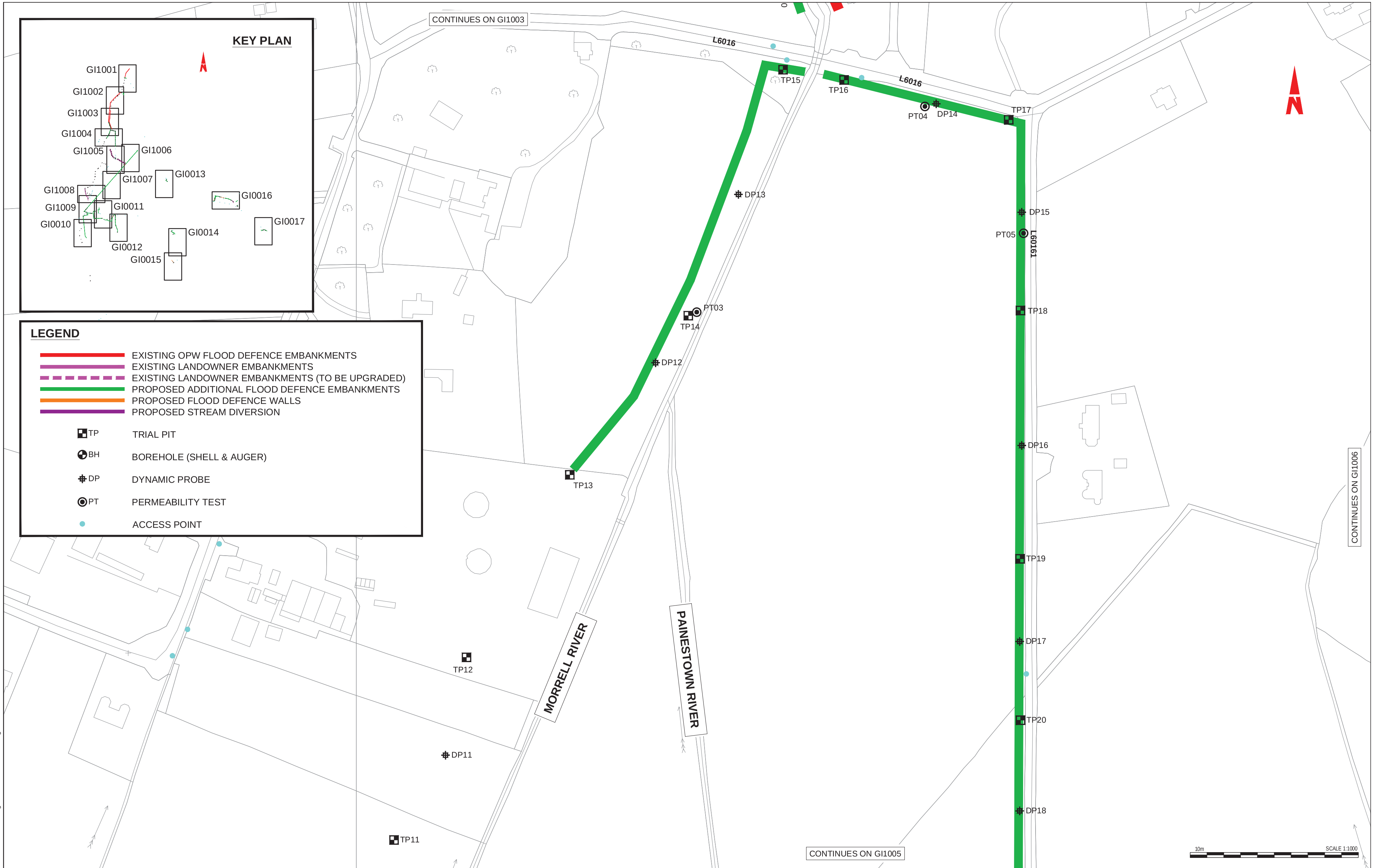

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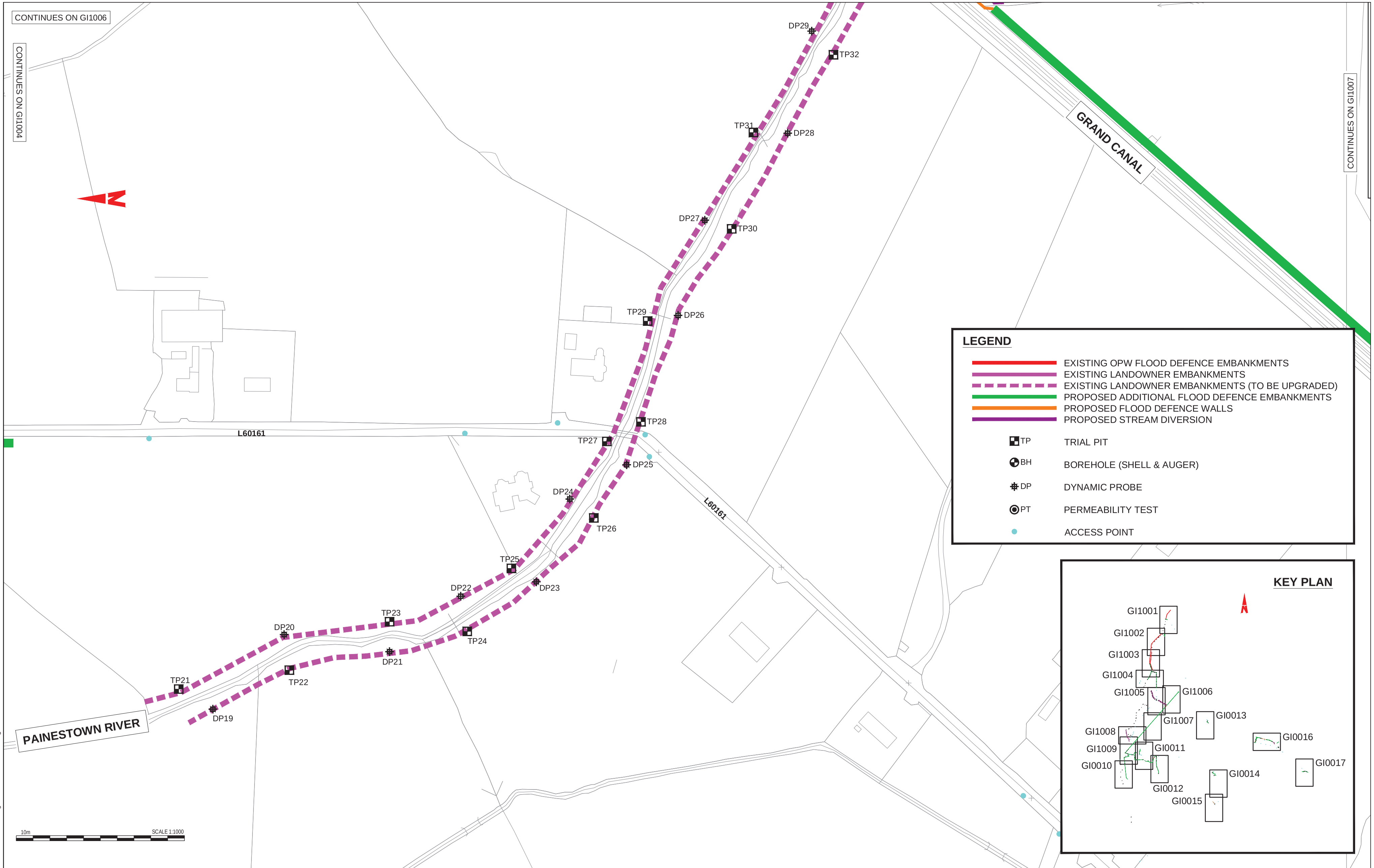
Project
RIVER MORRELL FLOOD MANAGEMENT

Title
GROUND INVESTIGATION CONTRACT
WORKS SPECIFICATION
SHEET 4 OF 17

File Ref. MDW0575GI1000.dwg
Drg. No. GI1004
Rev. A01



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Title

GROUND INVESTIGATION CONTRACT
WORKS SPECIFICATION
SHEET 6 OF 17

File Ref. MDW0575GI1000.dwg
Drg. No. GI1005
Rev. A01

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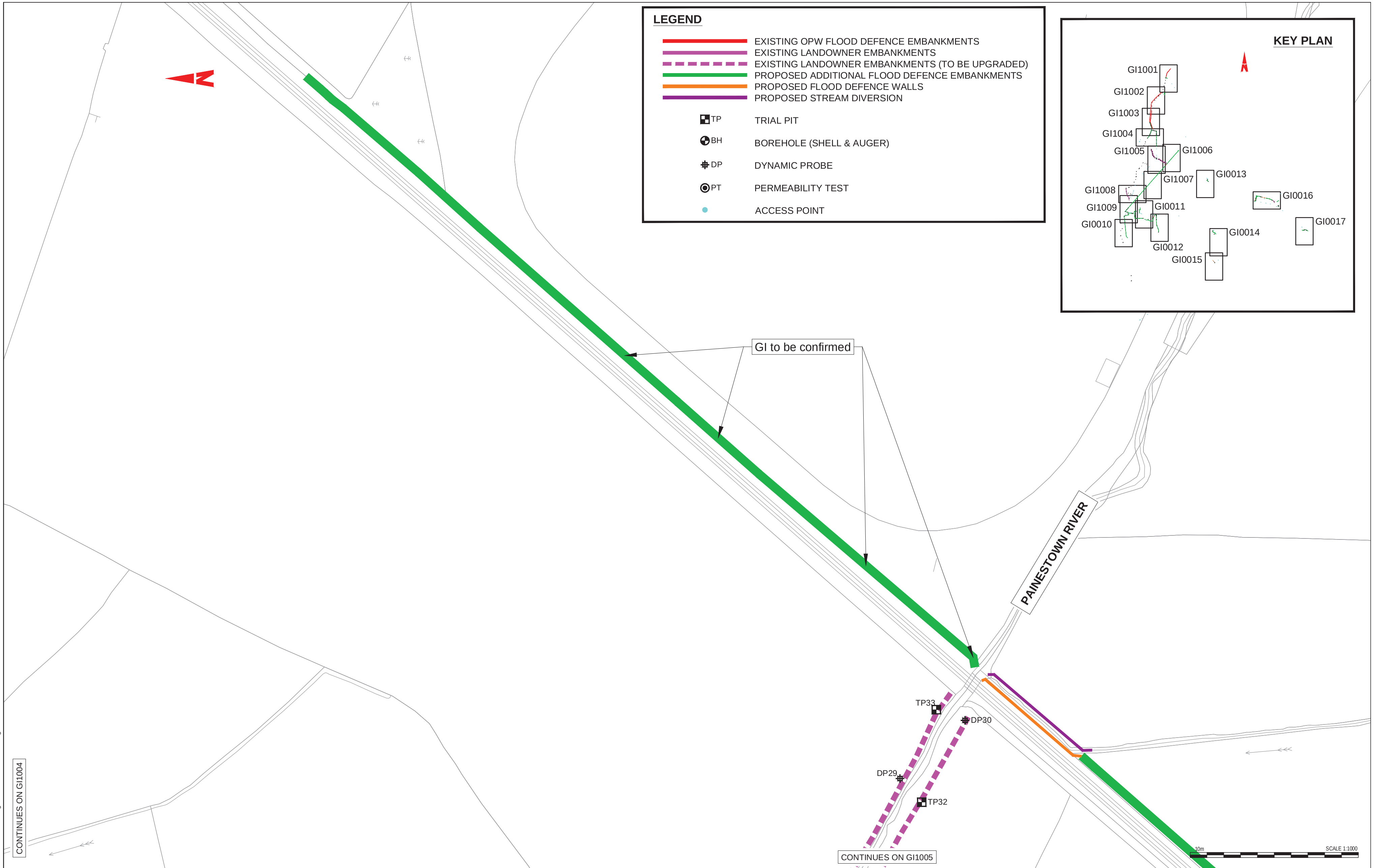

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File Ref. MDW0575GI1000.dwg
Drg. No. GI1006
Rev. A01

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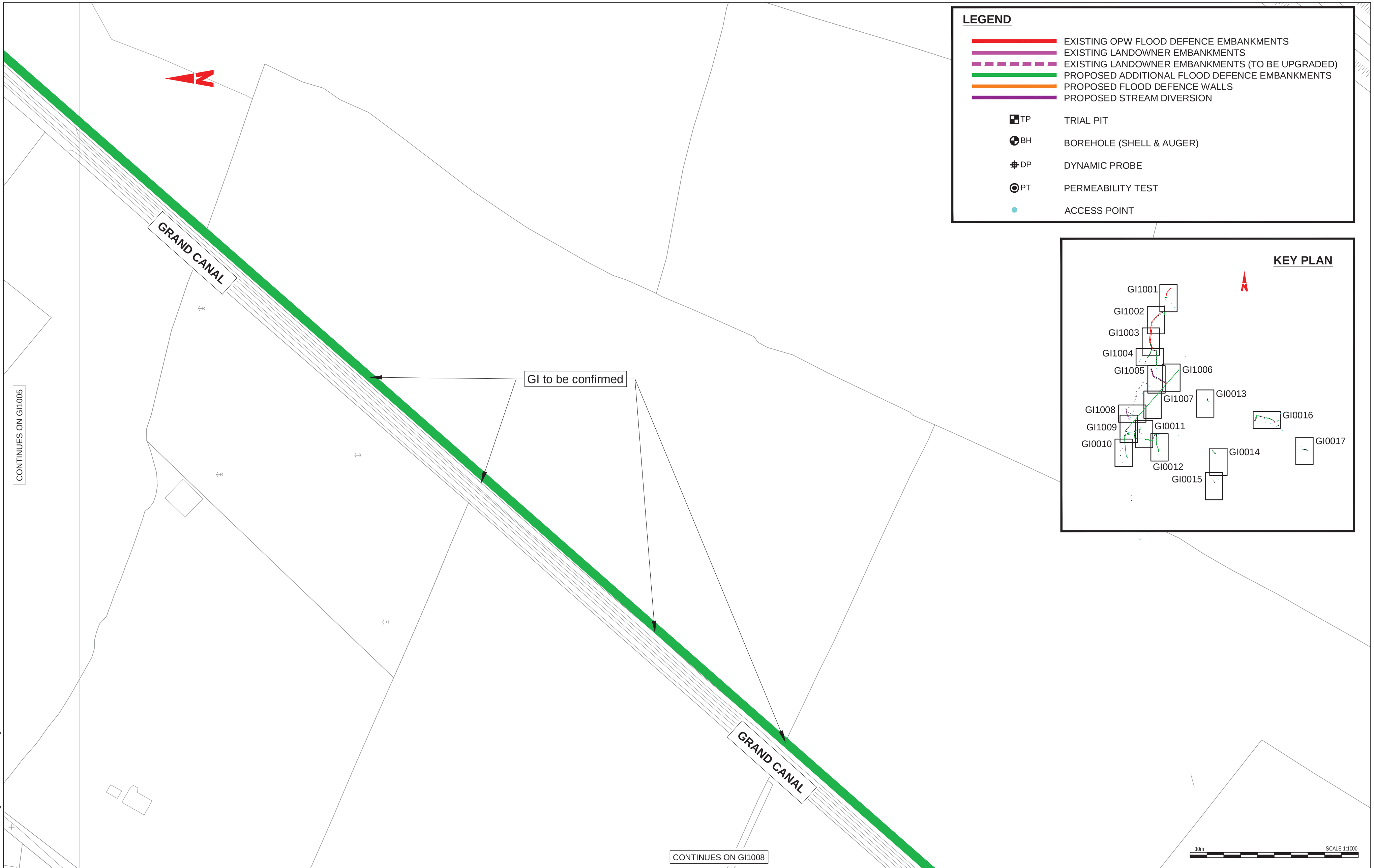

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Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION SHEET 7 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1007 | Rev. A01

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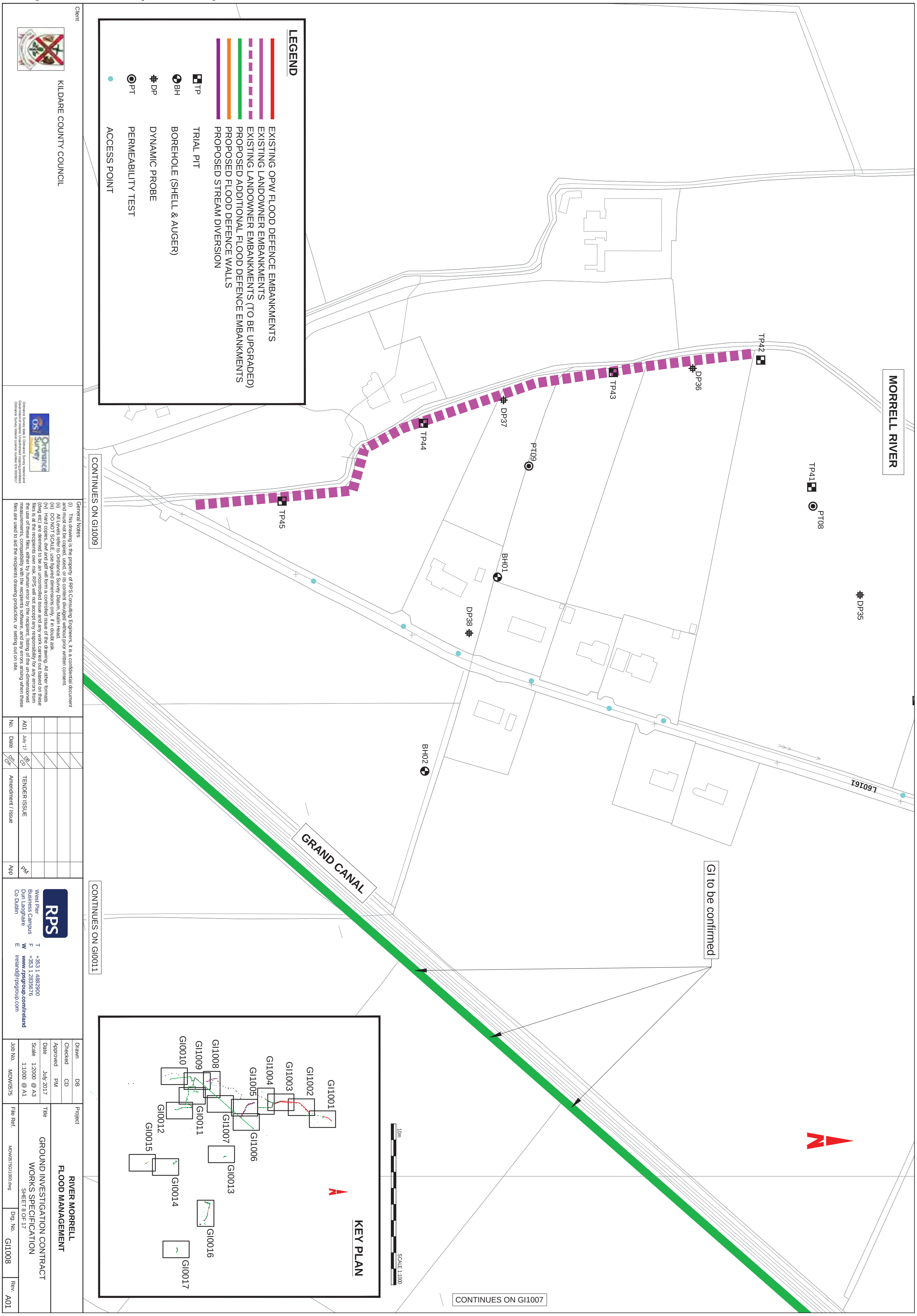

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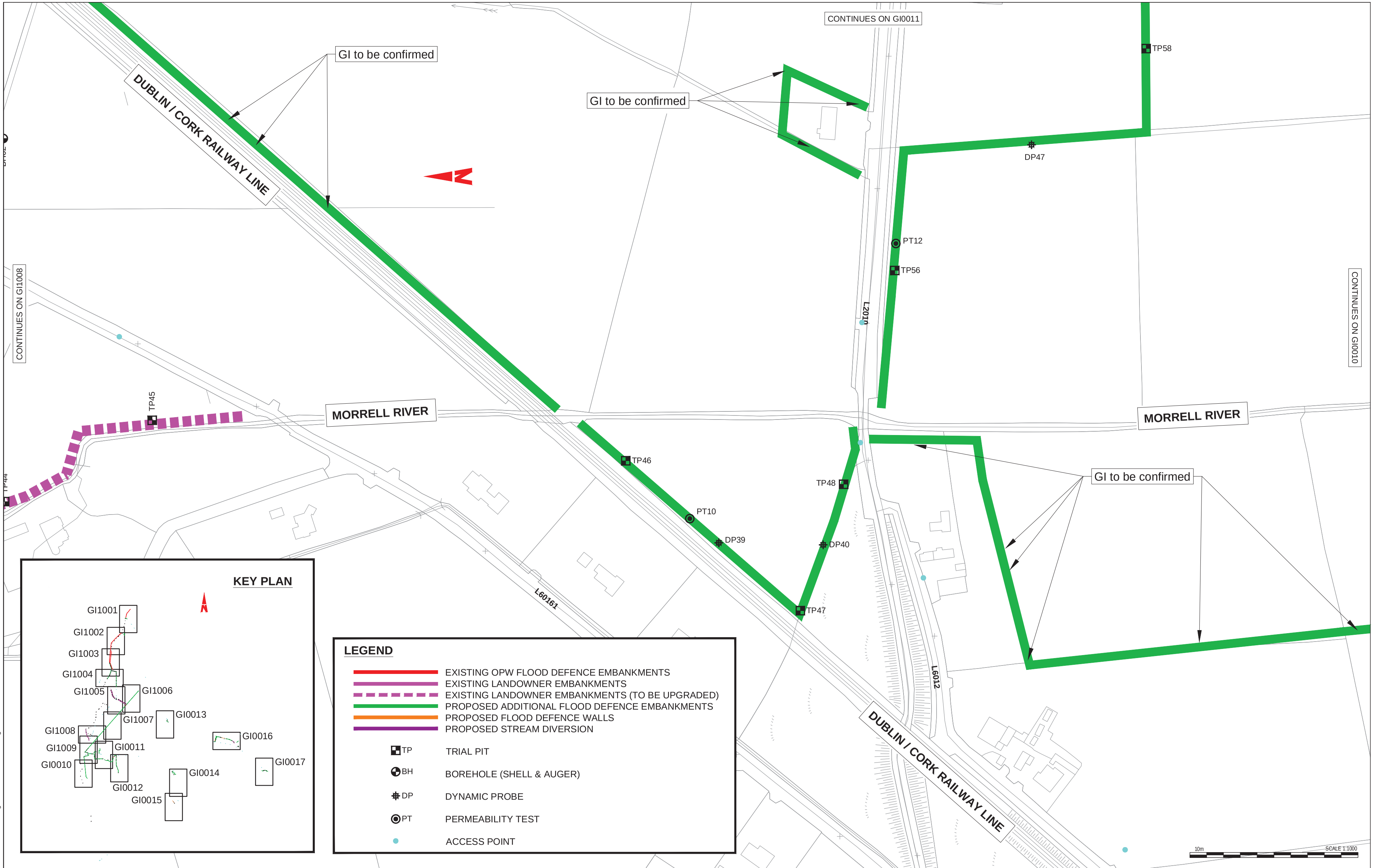

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Project

RIVER MORRELL FLOOD MANAGEMENT

Title

GROUND INVESTIGATION CONTRACT
WORKS SPECIFICATION
SHEET 9 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1009 | Rev. A01

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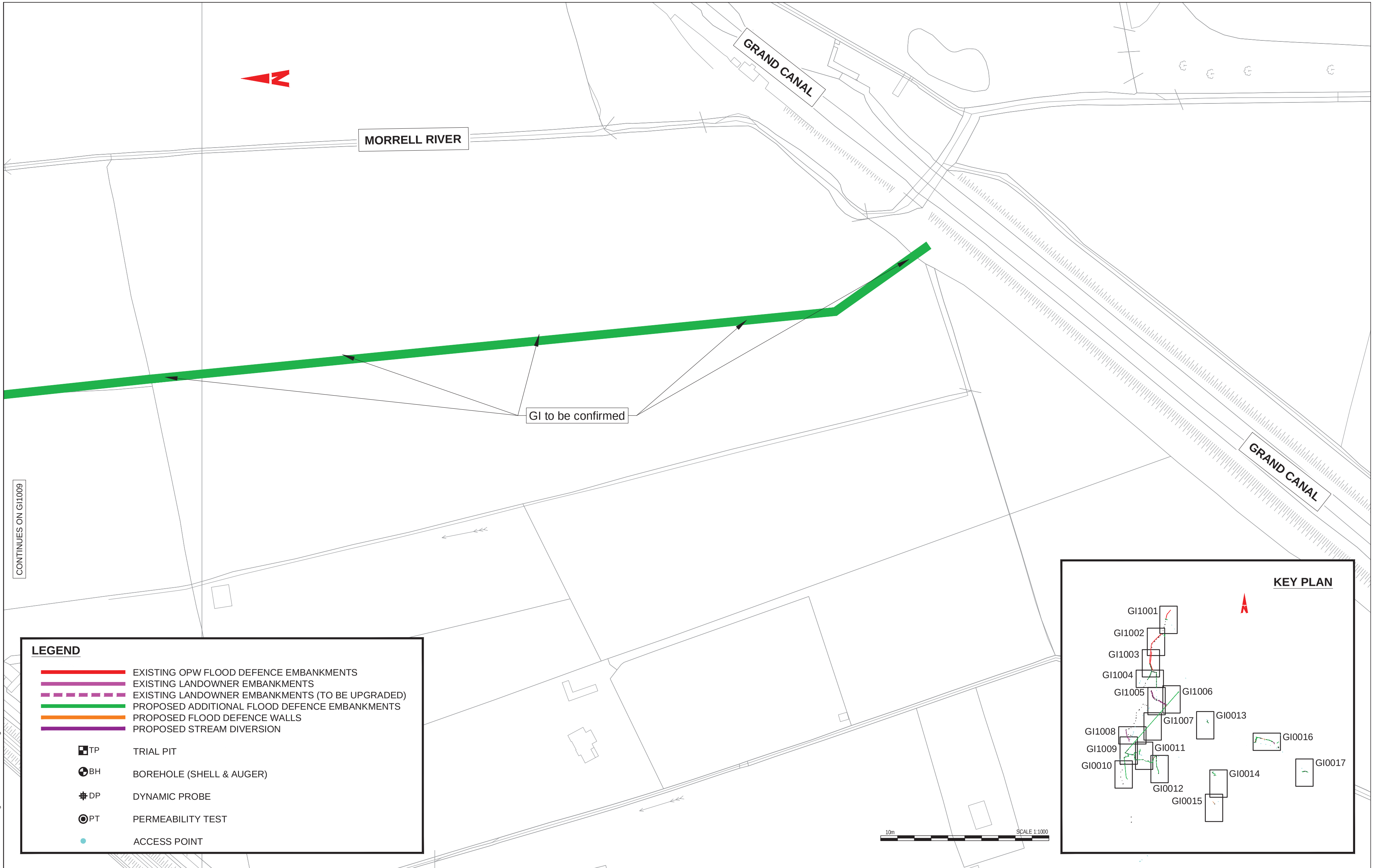

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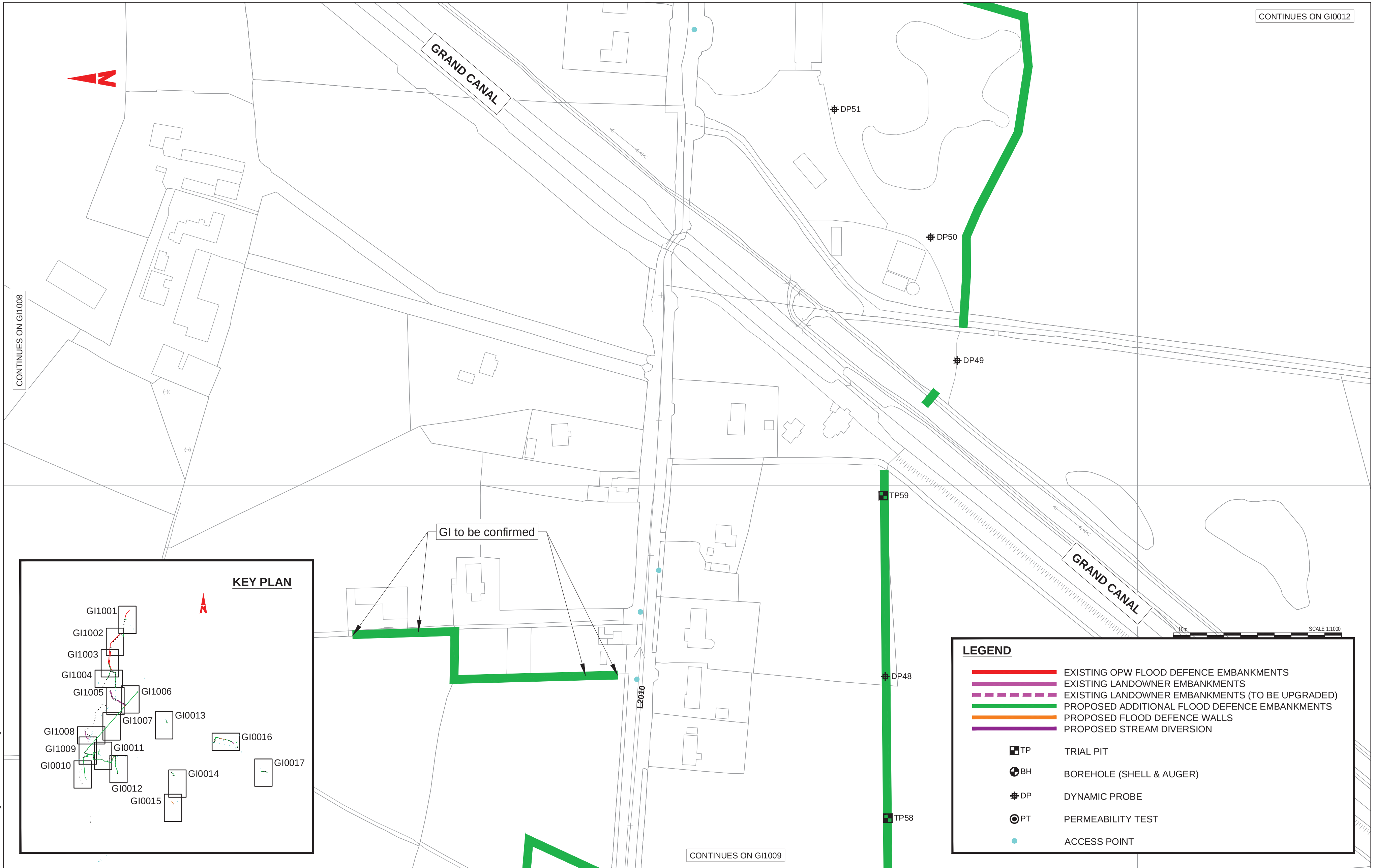
Project: RIVER MORRELL FLOOD MANAGEMENT

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION
SHEET 10 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1010 | Rev. A01



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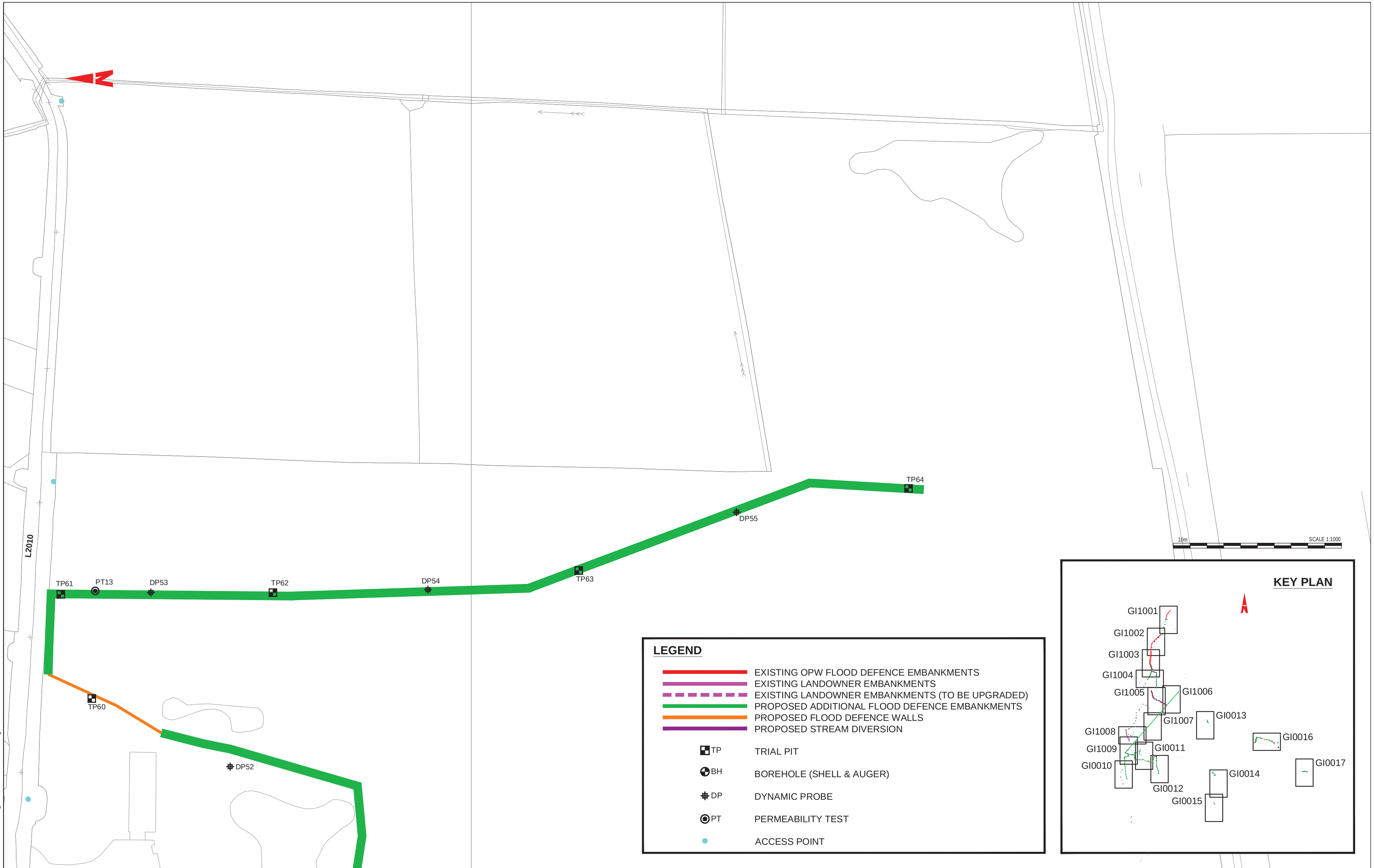
Project

RIVER MORRELL FLOOD MANAGEMENT

Title

GROUND INVESTIGATION CONTRACT
WORKS SPECIFICATION
SHEET 11 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1011 | Rev. A01



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Project: RIVER MORRELL FLOOD MANAGEMENT

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION SHEET 12 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1012 | Rev. A01

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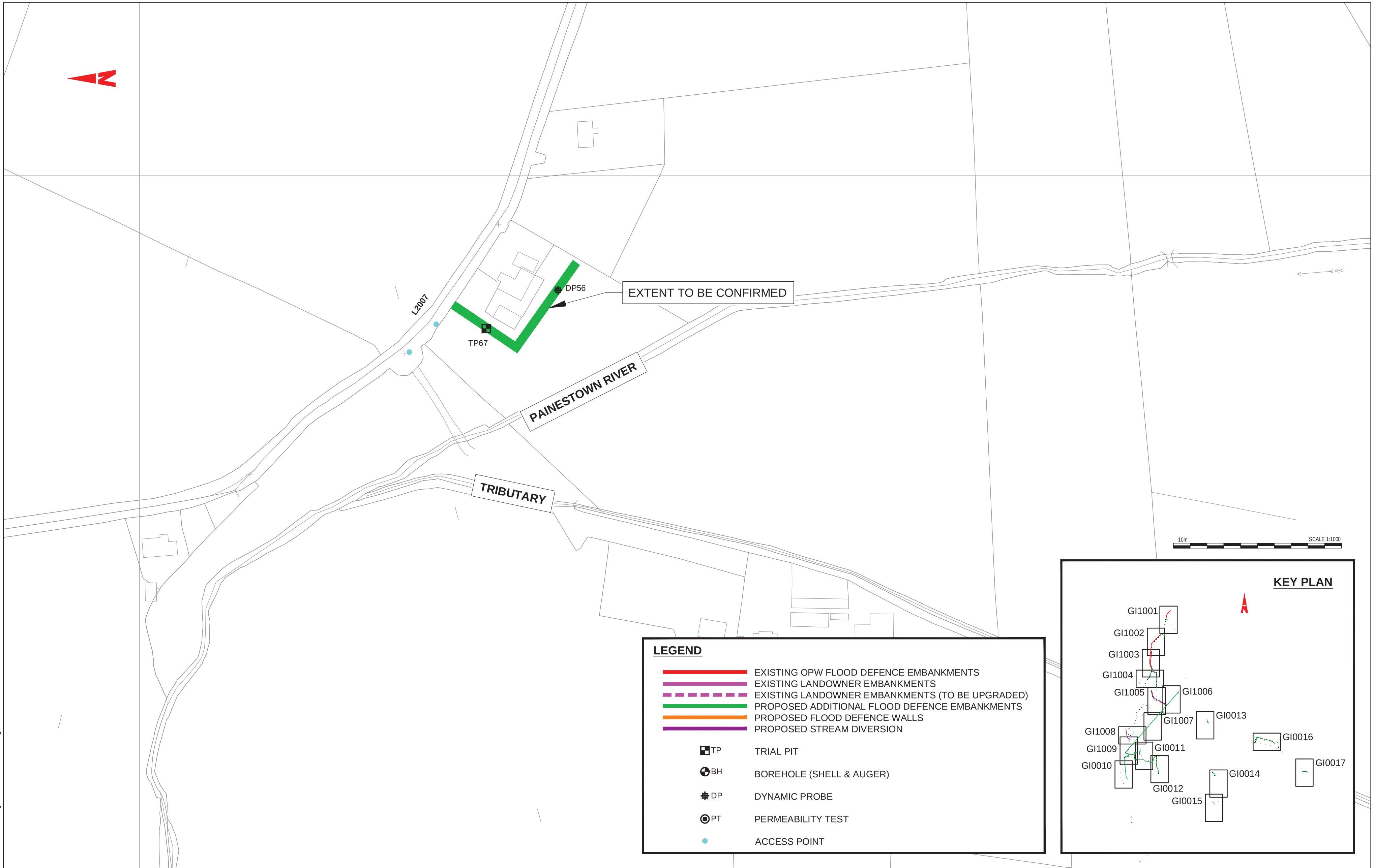

LEGEND

- EXISTING OPW FLOOD DEFENCE EMBANKMENTS
- EXISTING LANDOWNER EMBANKMENTS
- EXISTING LANDOWNER EMBANKMENTS (TO BE UPGRADED)
- PROPOSED ADDITIONAL FLOOD DEFENCE EMBANKMENTS
- PROPOSED FLOOD DEFENCE WALLS
- PROPOSED STREAM DIVERSION
- TP — TRIAL PIT
- BH — BOREHOLE (SHELL & AUGER)
- DP — DYNAMIC PROBE
- PT — PERMEABILITY TEST
- ACCESS POINT

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Project: **RIVER MORRELL FLOOD MANAGEMENT**

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION
SHEET 13 OF 17

File Ref. MDW0575GI1000.dwg | Drg. No. GI1013 | Rev. A01

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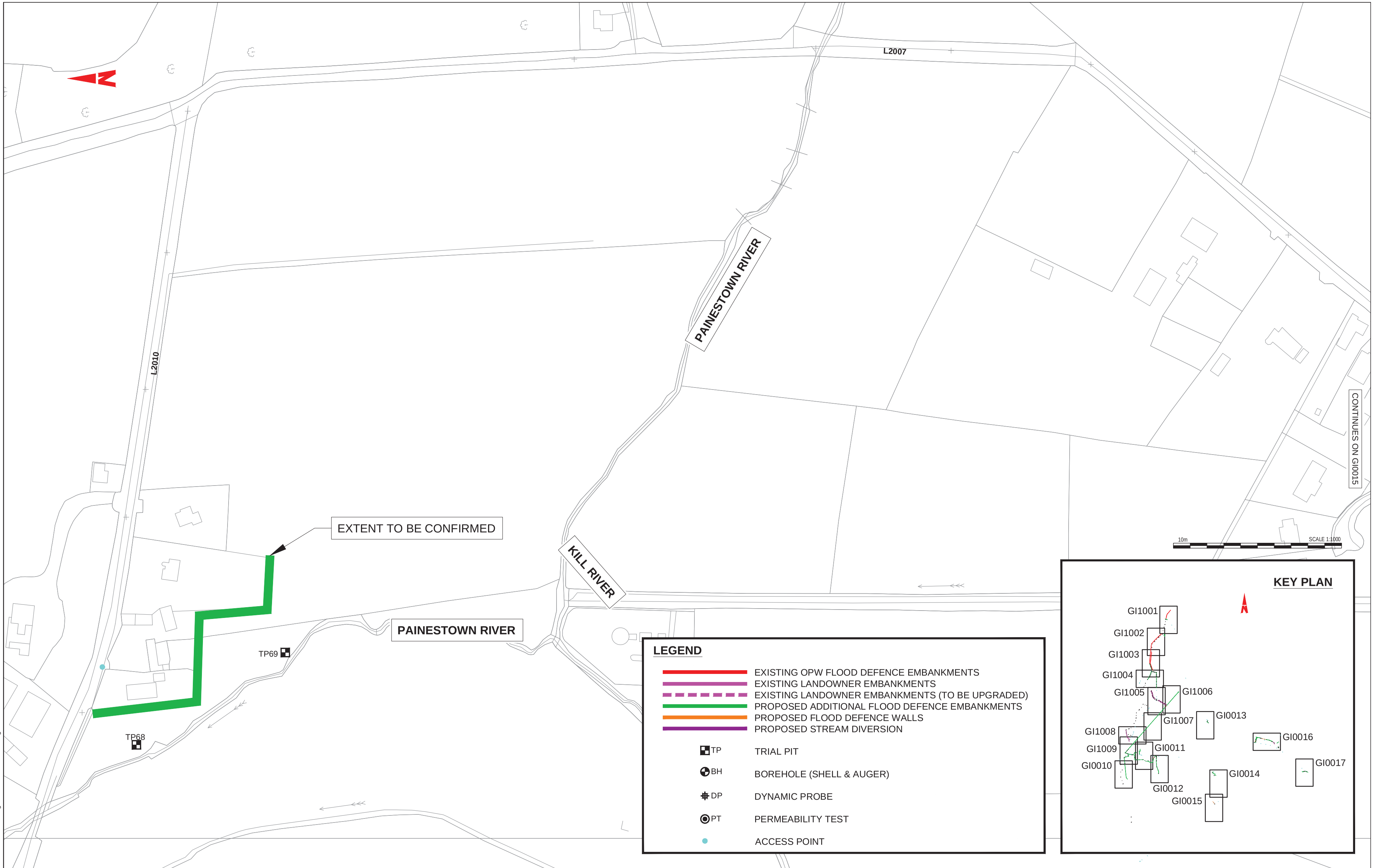

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Project: RIVER MORRELL FLOOD MANAGEMENT

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION SHEET 16 OF 17

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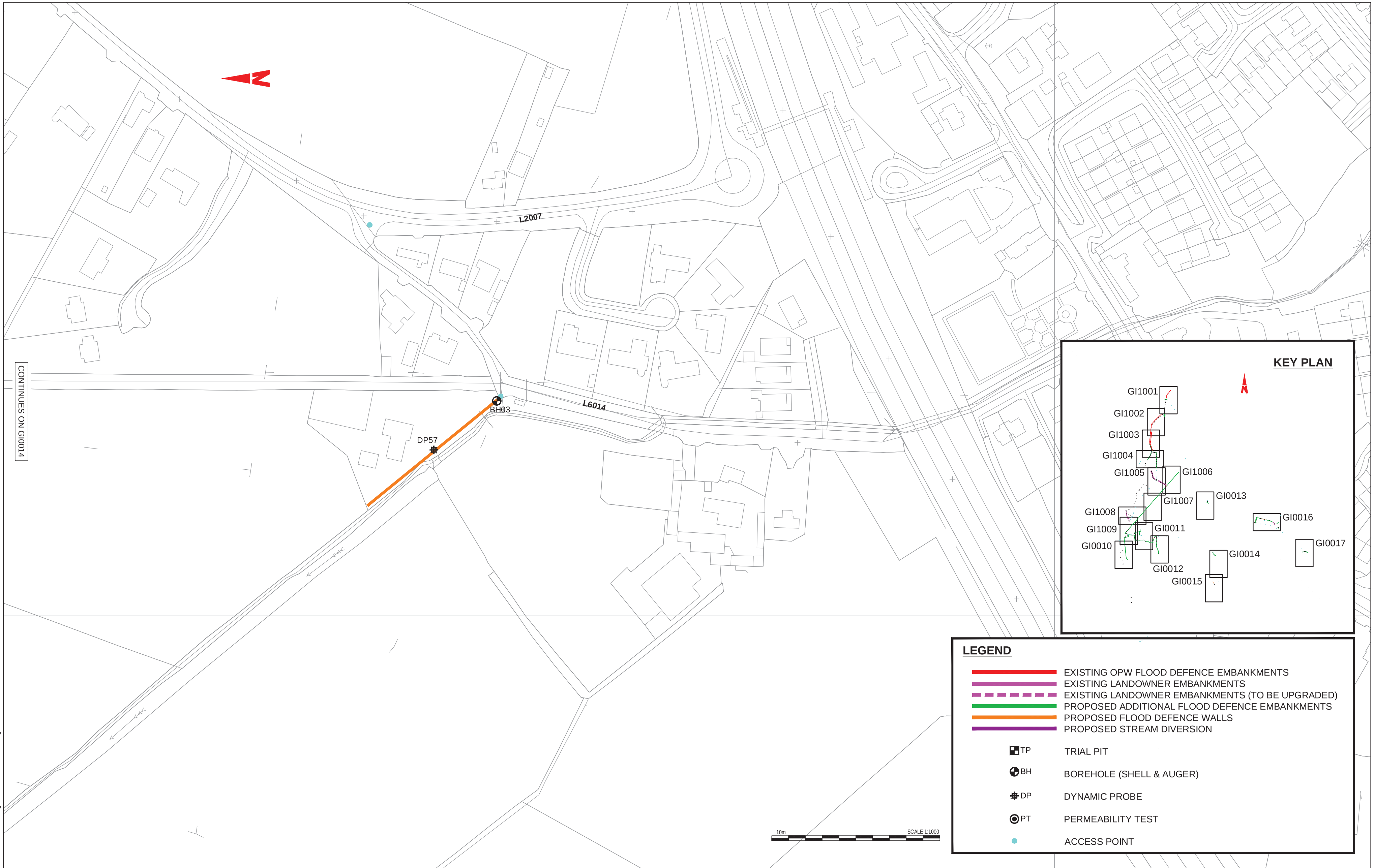

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Project: RIVER MORRELL FLOOD MANAGEMENT

Title: GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION SHEET 15 OF 17

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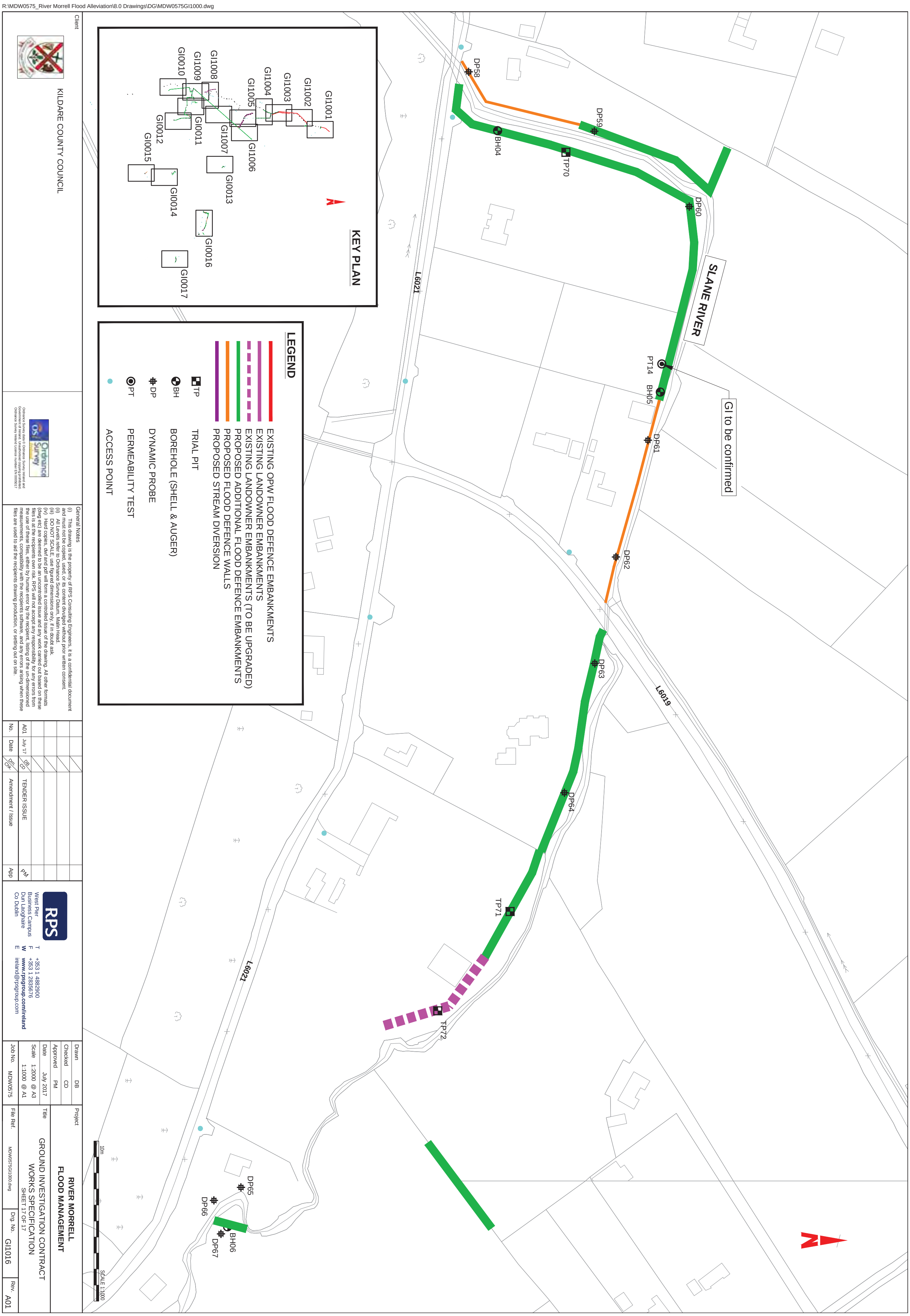
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GI1005
GI1006
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GI1008
GI1009
GI0010
GI0011
GI0012
GI0013
GI0014
GI0015
GI0016
GI0017
LEGEND
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PROPOSED FLOOD DEFENCE EMBANKMENTS
PROPOSED STREAM DIVERSION
TP TRIAL PIT
BH BOREHOLE (SHELL & AUGER)
DP DYNAMIC PROBE
PT PERMEABILITY TEST
ACCESS POINT
SLANE RIVER
GI to be confirmed
L6021
L6019
DP58
DP59
DP60
DP61
DP62
DP63
DP64
DP65
DP66
DP67
BH04
BH05
BH06
TP70
TP71
TP72
PT14
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GROUND INVESTIGATION CONTRACT WORKS SPECIFICATION
SHEET 17 OF 17
File Ref. MDW0575GI1000.dwg
Drg No. GI1016
Rev. A01
SCALE 1:1000

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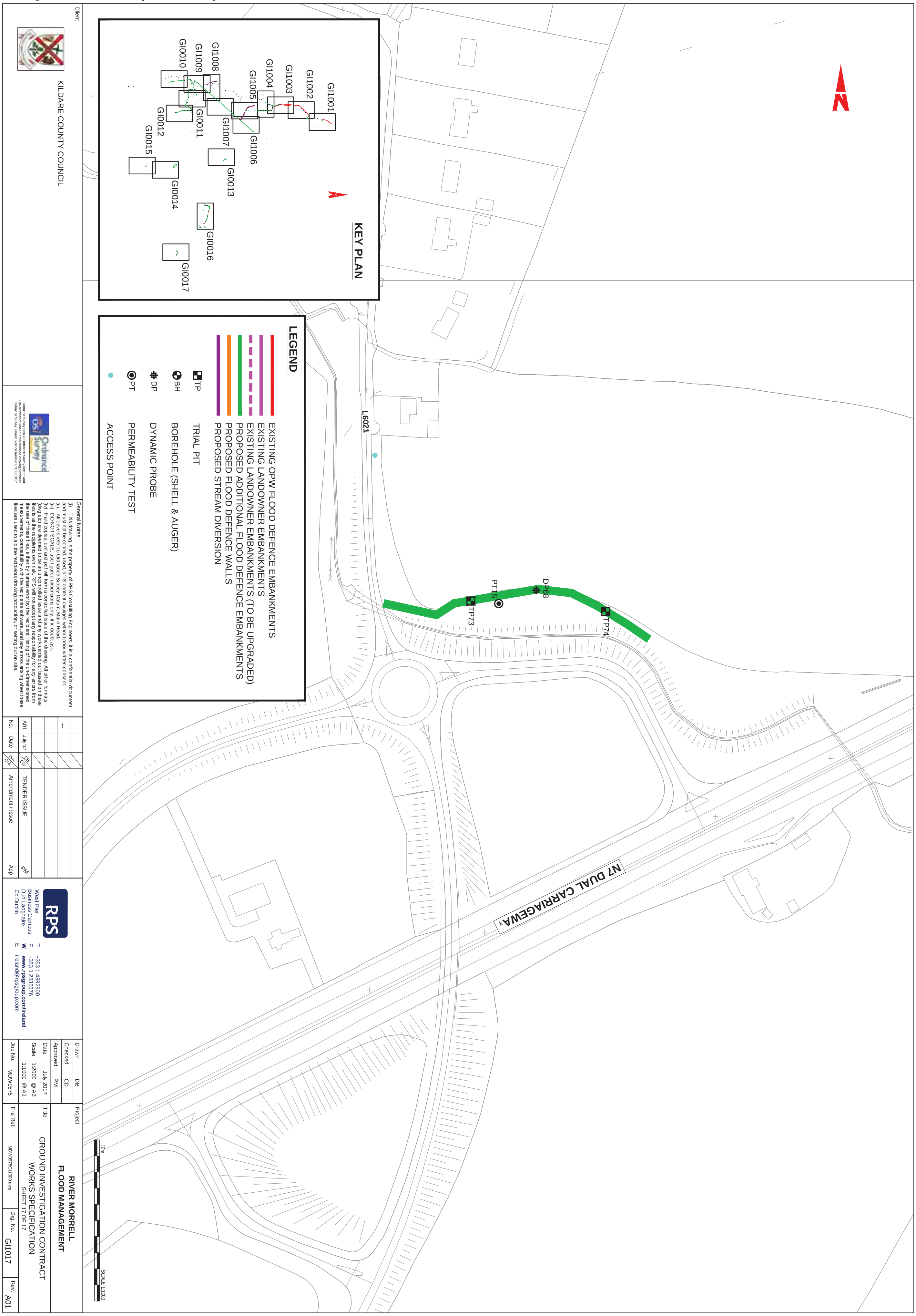

GROUND INVESTIGATIONS – REPORT

FINAL
FOR ISSUE

River Morrell Flood Alleviation Scheme Ground Investigation

Primary Author:	Matthew Gilbert
Client:	Kildare County Council
Client's Representative:	RPS Consulting Engineers
Completed:	December 2015
Report No.:	15-272
File Location:	15-272 Report

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CONTENTS

APPENDICES

Document Control Sheet

Report No.: 15-272

Project title: River Morrell Flood Alleviation Scheme – Ground Investigation

Client: Kildare County Council

Client's Representative: RPS Consulting Engineers

Revision	Status	Report prepared by:	Report reviewed by:	Report approved by:	Issue date
A03	For issue	Matthew Gilbert MEarthSci FGS	Darren O'Mahony BSc MSc MIEI	Paul Dunlop BEng PhD CEng MIEI	4th December 2015

The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2010) BS 5930:1999 + A2: 2010, Code of practice for site investigations. Incorporating Amendment Nos. 1 and 2, as partially replaced by:

- BS EN 1997-2:2007: Eurocode 7. Geotechnical design. Ground investigation and testing
- BS EN ISO 22475-1:2006: Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution
- BS EN ISO 14688-1:2002/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Identification and description
- BS EN ISO 14688-2:2004/Amd 1:2013: Geotechnical investigation and testing. Identification and classification of soil. Principles for a classification
- BS EN ISO 14689-1:2003: Geotechnical investigation and testing. Identification and classification of rock. Identification and description
- BS EN ISO 22476-2:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Dynamic probing
- BS EN ISO 22476-3:2005/Amd 1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in Section 6 of BS 5930: 1999 + A2: 2010, The Code of Practice for Site Investigation. The amendments revised the Standard to remove text superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and EN ISO 14689-1:2003 and refers to the relevant standard for each affected subclause. However, the following terms are used in the description of fine-grained soils, where applicable:

- soft to firm: fine-grained soil with consistency description close to the boundary between soft and firm soil (Table 13 of BS5930).
- firm to stiff: fine-grained soil with consistency description close to the boundary between firm and stiff soil (Table 13 of BS5930).

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample
P	Nominal 100mm diameter undisturbed piston sample
B	Bulk disturbed sample
D	Small disturbed sample
W	Water sample
ES / EW	Soil sample for environmental testing / Water sample for environmental testing
SPT	Standard penetration test using a split spoon sampler (small disturbed sample obtained)
SPT (C)	Standard penetration test using 60 degree solid cone
x,x/x,x,x,x	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length. The length achieved is stated (mm) for any test increment less than 75mm
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm)
N=X/Z	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given test length 'Z' (mm)
V VR	Shear vane test (borehole) Hand vane test (trial pit) Shear strength stated in kPa V: undisturbed vane shear strength VR: remoulded vane shear strength
dd/mm/yy: 1.0 dd/mm/yy: dry	Date & water level at the borehole depth at the end of shift and the start of the following shift
Abbreviations relating to rock core – reference Clause 44.4.4 of BS 5930: 1999	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.

River Morrell Flood Alleviation Scheme – Ground Investigation

1 AUTHORITY

On the instructions of RPS Consulting Engineers ("the Client's Representative"), acting on the behalf of Kildare County Council ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information for input to the design and construction of proposed flood alleviation works within the Morrell River catchment area.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results.

All information given in this report is based upon the ground conditions encountered during the site investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included boreholes, trial pits, dynamic probes, soil sampling, in-situ and laboratory testing, and the preparation of a factual report on the findings.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted over a wide area within the Morrell River Catchment, between the N7 Naas Road and Straffan. The majority of exploratory holes were located in farmland close to the river.

The existing site is presented on the site and exploratory hole location plans in Appendix A.

4 SITE OPERATIONS

Site operations, which were conducted between the 16th and 29th July 2015, included:

- five cable percussion boreholes
- fifty-seven trial pits
- fifty-six dynamic probes.

An additional phase of investigation was carried out between 5 and 12 November 2015 for the purpose of assessing the in-situ permeability of the granular soils. This scope of works comprised:

- thirteen boreholes drilled by light percussion/dynamic sampling
- in-situ permeability testing by variable (falling) head method in each of the boreholes.

The exploratory holes and in situ tests were located as instructed by the Client's Representative, as shown on the exploratory hole location plan in Appendix A.

4.1 Boreholes

Five boreholes (BH01-BH02 and BH04-BH06) were put down to completion in minimum 200mm diameter using Dando 2000 light cable percussion soil boring rigs. All boreholes were terminated either at their scheduled completion depths, or else on encountering virtual refusal on obstructions, including large boulders and weathered bedrock.

Hand dug inspection pits were carried out between ground level and 1.2m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Disturbed (bulk and small bag) samples were taken within the encountered strata. Undisturbed (UT100 and U100) samples were taken where appropriate and as directed within cohesive soils.

Standard penetration tests were carried out in accordance with EC7 at standard depth intervals using the split spoon sampler (SPT). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections. The SPT hammer energy measurement report is provided in Appendix G. Details of the SPT hammer used are provided on the individual borehole logs.

Any water strikes encountered during boring were recorded along with any changes in their levels as the borehole proceeded.

Appendix B presents the borehole logs.

4.2 Trial Pits

Fifty-seven trial pits (TP01-10, TP13-21, TP23-26, TP28-33, TP35-48, TP56, TP58-63, TP67-69, and TP71-74) were excavated using a 6t tracked excavator fitted with a 600mm wide bucket, to depths of up to 4.9m.

Disturbed (bulk bag) samples were taken at standard depth intervals and at change of strata.

Any water strikes encountered during excavation were recorded along with any changes in their levels as the excavation proceeded. The stability of the trial pit walls was noted on completion.

Appendix C presents the trial pit logs with photographs of the pits and arising provided in Appendix D.

4.3 Dynamic probes

Fifty-six dynamic probes (DPBH01-10, DPBH12-23, DPBH25-40, DPBH47-56, DPBH58-59, DPBH61-64 and DPBH67-68) were conducted using the DPSH-B method as described in BSEN ISO 22476-2. The method entails a 63.5kg hammer falling 0.75m onto a 90° cone of 50.5mm diameter.

Appendix E provides the dynamic probe logs in the form of plots, against depth, of the number of blows per 100mm penetration.

4.4 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R6 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish National) and ground elevation at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

4.5 In-situ permeability testing

Thirteen boreholes (PT01-07, PT09, PT10, PT12-15) were put down by light percussion boring methods using a Dando Terrier rig over 4 to 12 November 2015, for the purpose of carrying out in-situ permeability tests by falling head method. The boreholes were drilled to depths of up to 4m below ground level.

In-situ permeability tests were carried out in each of the boreholes by variable (falling) head permeability methods.

The permeabilities were calculated using Hvorslev's formula k=A/FT as defined in BS 5930:1999 (pg 52). The results are presented in Appendix E.

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described and their descriptions incorporated into the borehole logs.

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **compressibility:** one dimensional consolidation (oedometer)
- **shear strength** (total stress): unconsolidated undrained triaxial tests
- **shear strength** (effective stress): consolidated drained triaxial tests
- **direct shear:** shear box tests
- **compaction:** dry density/moisture content relationship, MCV at natural moisture content, and California bearing ratio tests
- **soil chemistry:** pH, water soluble sulphate, and organic matter content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute (1990) *BS 1377:1990, Methods of test for soils for civil engineering purposes. Parts 1 to 9.*

The test results are presented in Appendix F.

5.2 Environmental laboratory testing of soils

In addition, environmental testing was conducted on selected environmental samples by Chemtest at its laboratory in Newmarket, Suffolk. Results of environmental testing are presented in Appendix F.

6 GROUND CONDITIONS

6.1 General geology of the area

Superficial deposits in the area dominantly consist of glacial tills, with local alluvial and fluvioglacial deposits. The underlying bedrock consists of a range of sedimentary rocks of the Silurian (calcareous greywacke, siltstone and shale) as well as Carboniferous argillaceous and bioclastic limestone and calcareous shale to the north and west.

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Topsoil:** many of the exploratory holes went through topsoil at the surface, typically 100-300mm thick.
- **Made Ground (fill):** reworked gravelly clay, often present at the surface or beneath topsoil, generally to depths of about 1.0-1.5m, occasionally deeper (e.g. 2.5m in TP15).
- **Made Ground (sub-base):** approximately 100-600mm of aggregate fill at the surface or beneath clay fill, found in several boreholes.
- **Alluvium:** typically soft to firm sandy or gravelly clays and silts found beneath topsoil or made ground in many of the exploratory holes.
- **Fluvioglacial:** sands and gravels with localised pockets of firm sandy gravelly clays interspersed throughout.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth. Found towards the base of most exploratory holes, typically from below depths of 2-3m.

6.3 Groundwater

Groundwater was encountered during percussion boring through soil as water strikes in each of the boreholes. Water strikes were also observed in most of the trial pits, at varying levels. In some cases the inflow of water was sufficient to prevent further excavation.

Details of the individual groundwater strikes, along with any relative changes in levels as works proceeded, are presented on the exploratory hole logs for each location.

7 REFERENCES

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930+A2: 2010: Code of practice for site investigations (Amendment 2). British Standards Institution.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1: 2002: Geotechnical investigation and testing - Identification and classification of soil - Part 1 Identification and description. British Standards Institution.

Building Research Establishment (2005) BRE Special Digest 1, Concrete in aggressive ground.

Appendix A
Site and exploratory hole location plans

PROJECT:	Morrell River Flood Alleviation - Site Investigation Contract		TITLE:	Exploratory hole location plan		
CLIENT:	Kildare County Council	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 31/08/2015	
ENGINEER:	RPS Consulting Engineers			DRWN: BS / CHCK: DO'M	SERIES: 1 of 1	DWG No: 15-272-EHL-Overview

PROJECT:	Morrell River Flood Alleviation - Site Investigation Contract		TITLE:	Site location plan		
CLIENT:	Kildare County Council	KEY:	CAUSEWAY GEOTECH	SCALE: NTS@A3	DATE: 31/08/2015	
ENGINEER:	RPS Consulting Engineers			DRWN: BS / CHCK: DO'M	SERIES: 1 of 1	DWG No: 15-272-SL-001

PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

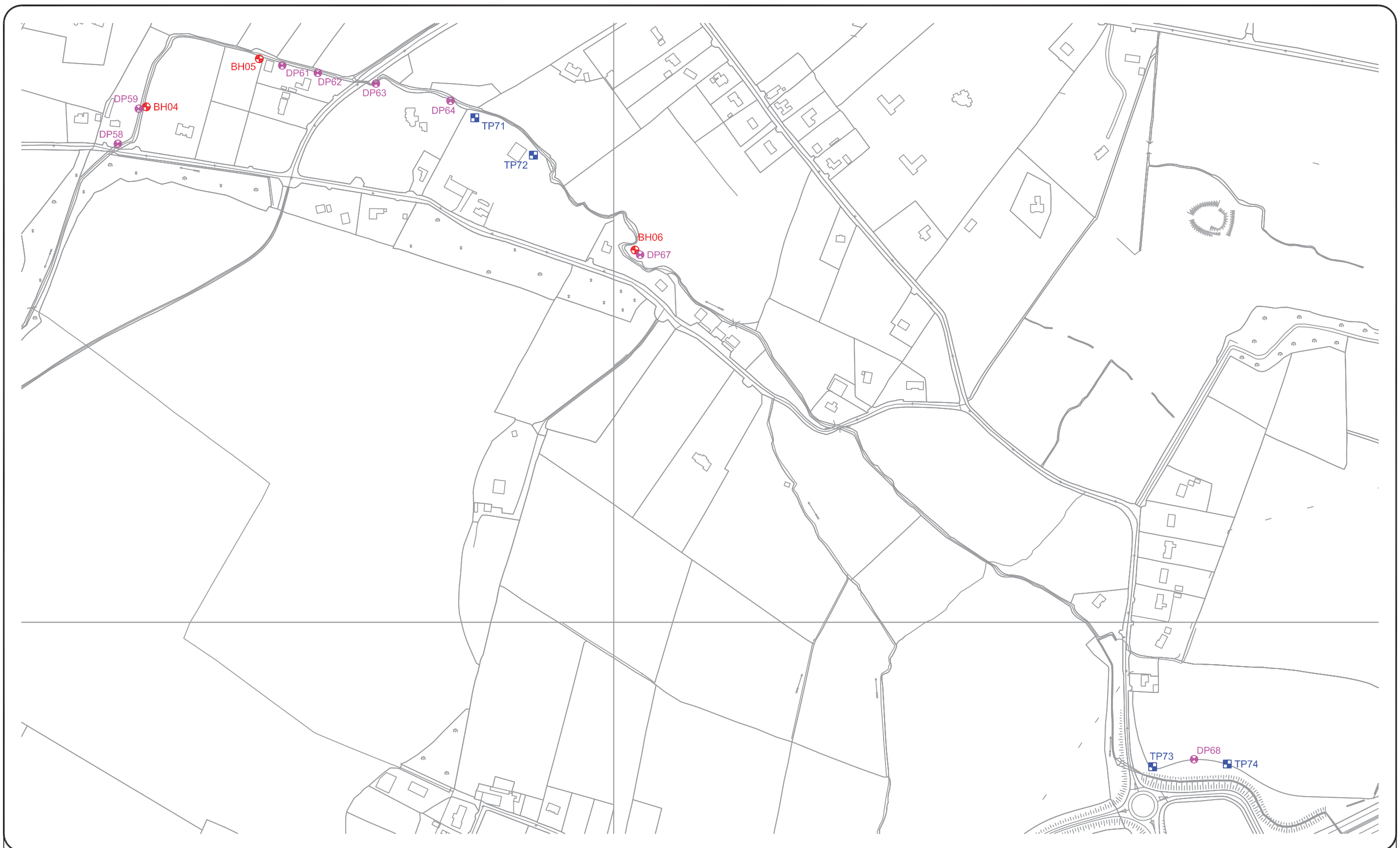
DATE: 31/08/2015

DRWN: BS

CHCK: DO'M

SERIES: 2 of 8

DWG No: 15-272-EHL-002



PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

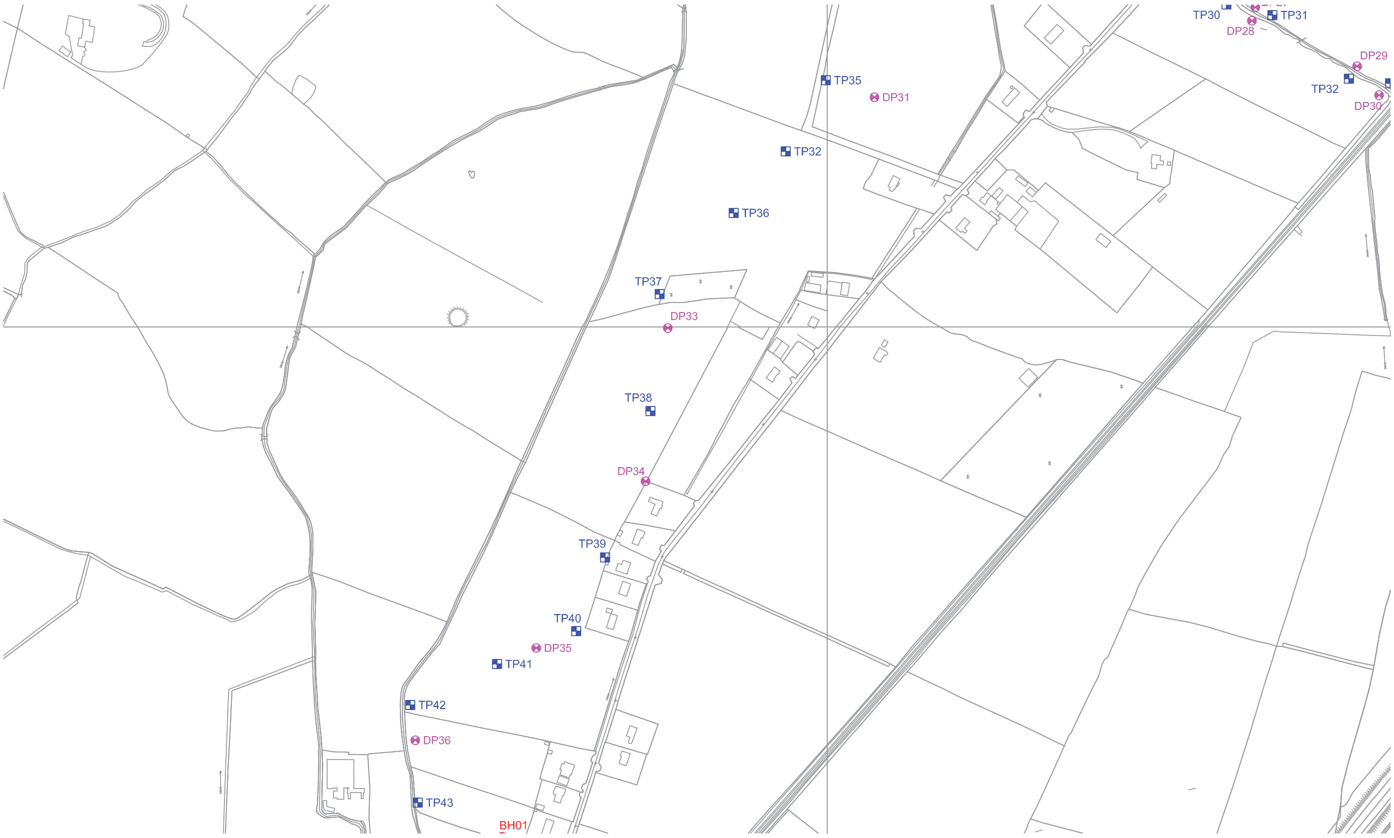
DATE: 31/08/2015

DRWN: BS

CHCK: DO'M

SERIES: 1 of 8

DWG No: 15-272-EHL-001



PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

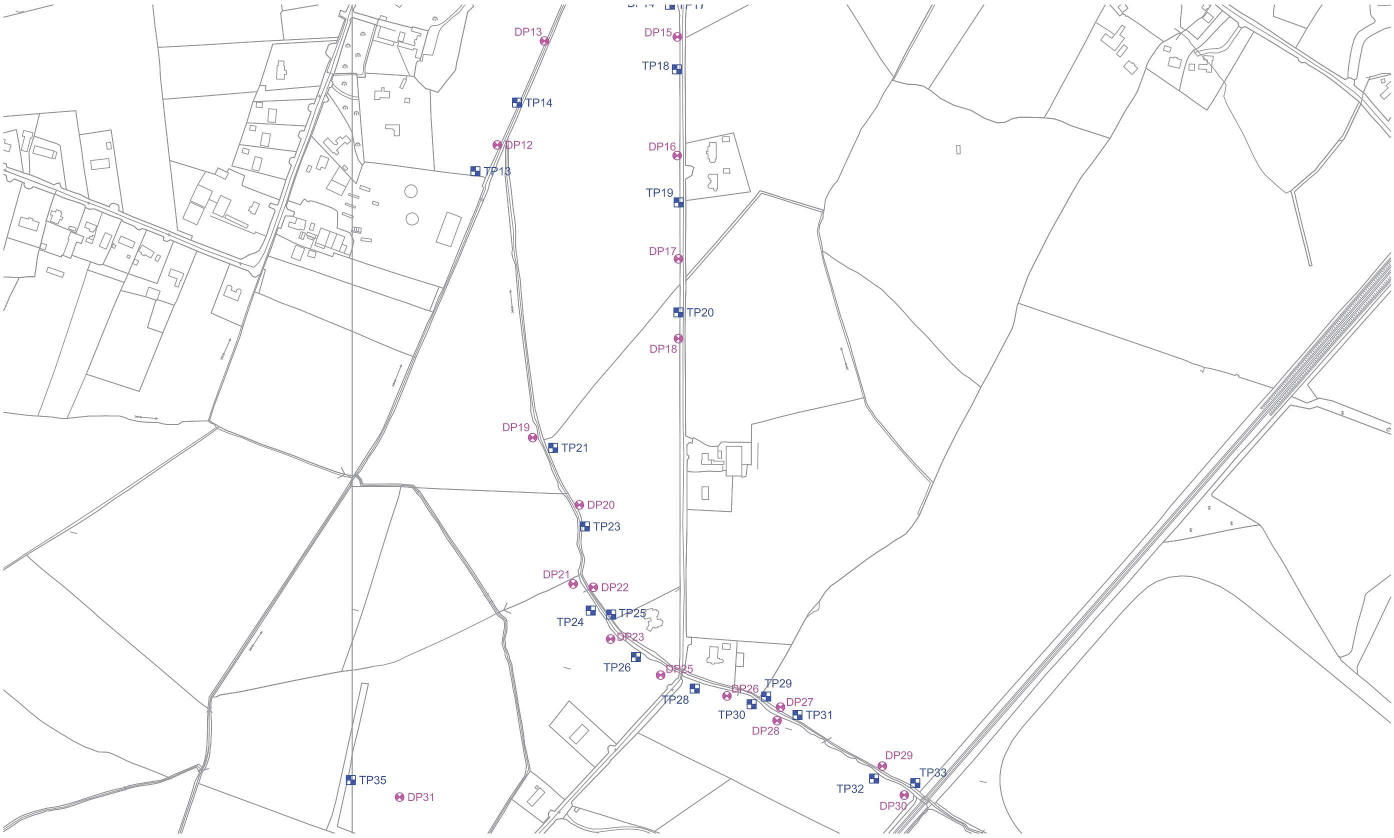
KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3 | DATE: 31/08/2015

DRWN: BS | SERIES: 4 of 8 | DWG No: 15-272-EHL-004

CHCK: DO'M



PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

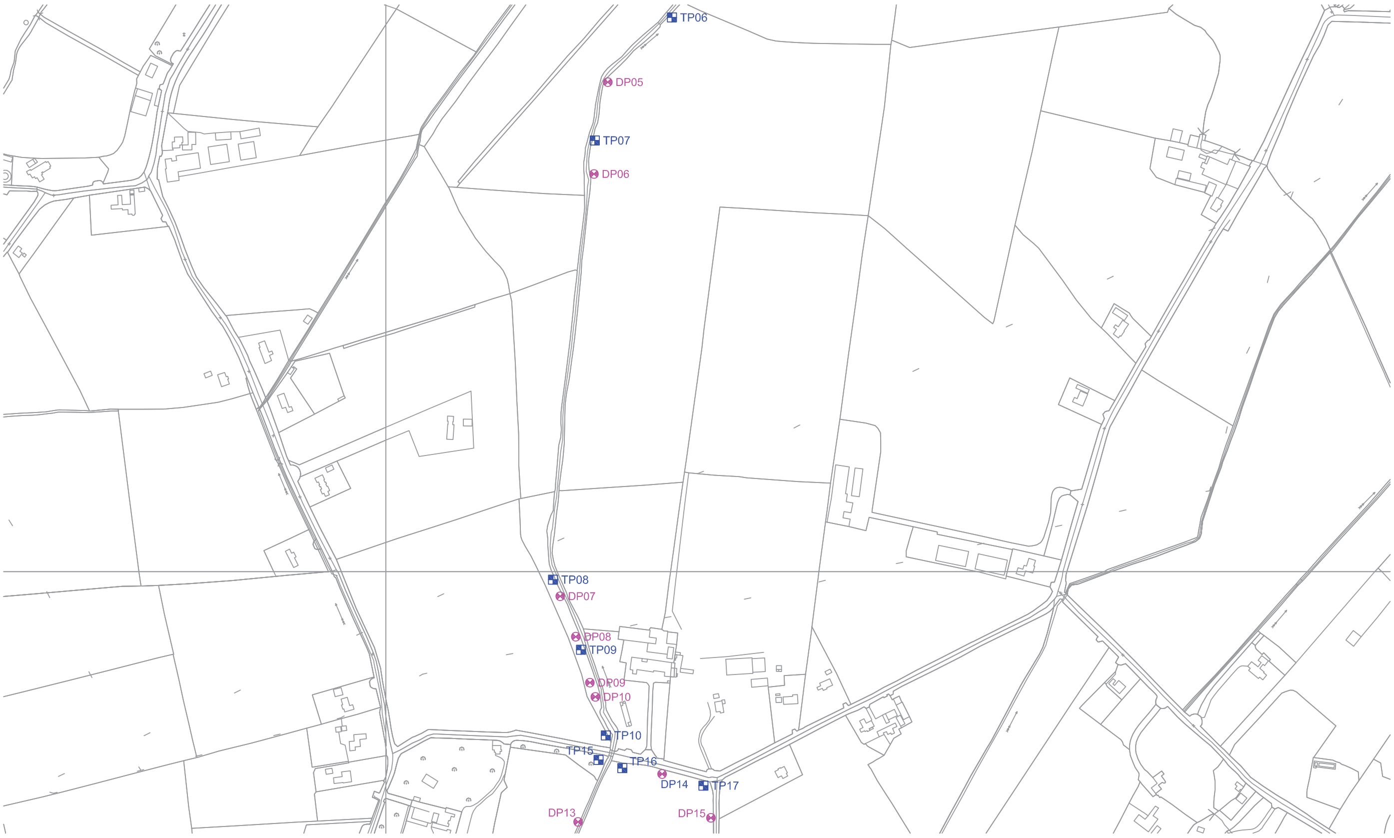
KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

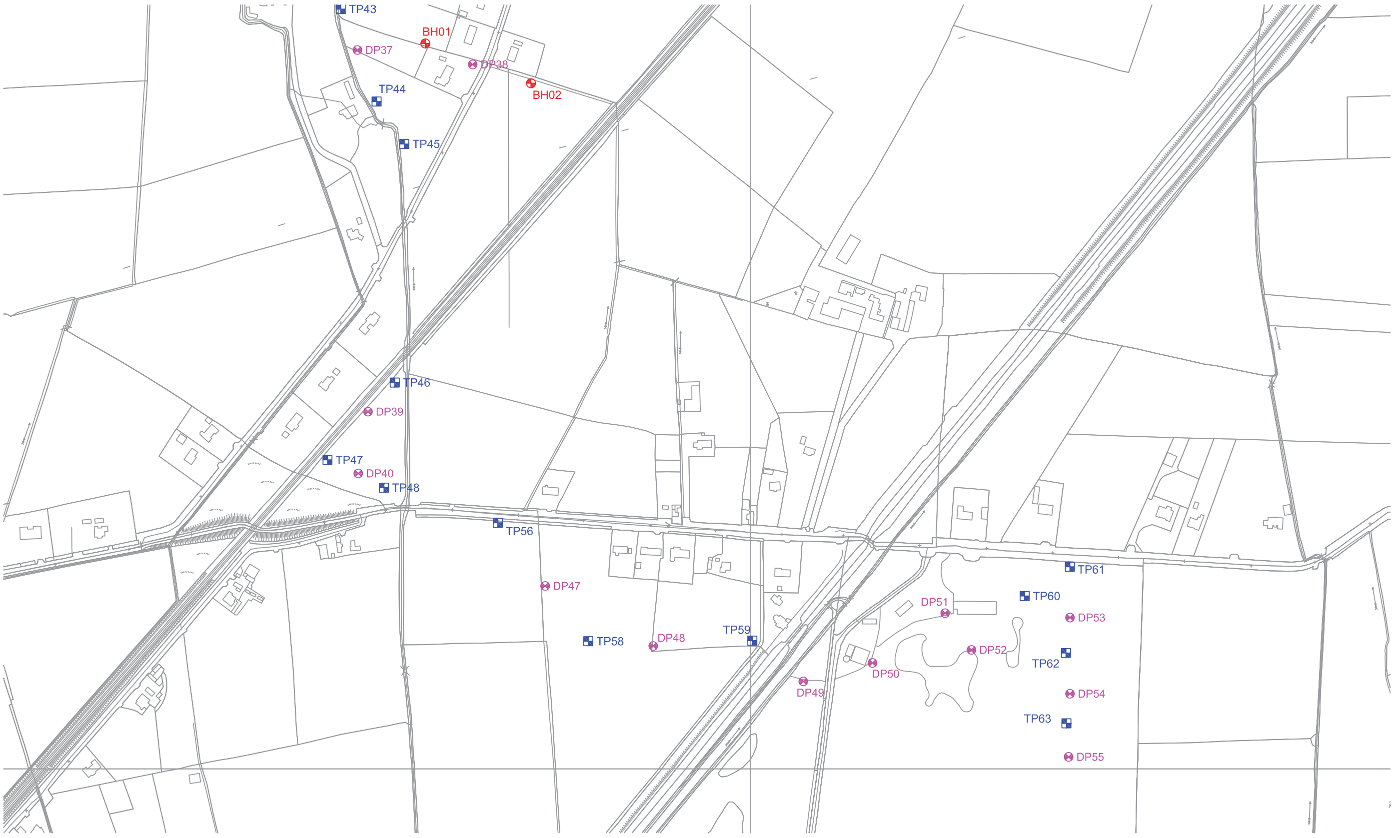
SCALE: NTS@A3 | DATE: 31/08/2015

DRWN: BS | SERIES: 3 of 8 | DWG No: 15-272-EHL-003

CHCK: DO'M



PROJECT: Morrell River Flood Alleviation - Site Investigation Contract		TITLE: Exploratory hole location plan	
CLIENT: Kildare County Council	KEY: Borehole; TP:Trial Pit; DP: Dynamic Probe	SCALE: NTS@A3	DATE: 31/08/2015
ENGINEER: RPS Consulting Engineers	CAUSEWAY GEOTECH	DRWN: BS; CHCK: DO'M	SERIES: 6 of 8; DWG No: 15-272-EHL-006



PROJECT: Morrell River Flood Alleviation - Site Investigation Contract		TITLE: Exploratory hole location plan	
CLIENT: Kildare County Council	KEY: Borehole; TP:Trial Pit; DP: Dynamic Probe	SCALE: NTS@A3	DATE: 31/08/2015
ENGINEER: RPS Consulting Engineers	CAUSEWAY GEOTECH	DRWN: BS; CHCK: DO'M	SERIES: 5 of 8; DWG No: 15-272-EHL-005

PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 31/08/2015

DRWN: BS

CHCK: DO'M

SERIES: 8 of 8

DWG No: 15-272-EHL-008

PROJECT: Morrell River Flood Alleviation - Site Investigation Contract

TITLE: Exploratory hole location plan

CLIENT: Kildare County Council

ENGINEER: RPS Consulting Engineers

KEY:
- Borehole
- TP:Trial Pit
- DP: Dynamic Probe

CAUSEWAY GEOTECH

SCALE: NTS@A3

DATE: 31/08/2015

DRWN: BS

CHCK: DO'M

SERIES: 7 of 8

DWG No: 15-272-EHL-007

Appendix B
Borehole logs

Causeway Geotech Ltd	Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Borehole No. BH01
Method: Cable Percussion	Co-ords: 291605.67mE 225380.85mN	Client: Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando 2000	Ground Level: 69.45MOD	Dates: 17/07/2015 - 20/07/2015	Driller: BM
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.10) 69.35 0.10	TOPSOIL
0.20	B				(0.20) 69.15 0.30	Soft brown organic sandy CLAY. Sand is fine to coarse.
0.40	B				(0.30)	Soft yellowish grey sandy SILT. Sand is fine to coarse.
0.60	B				68.85 0.60	Medium dense grey gravelly fine to coarse SAND. Gravel is subangular to subrounded, fine to medium.
1.00 1.00 1.00	B D SPT(S)			N=29 (3,5/7,7,7,8)	(0.80)	
1.40	B				68.05 1.40	Firm grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00 2.00 2.00	B D SPT(S)			N=10 (2,2/2,2,3,3)		
3.00 3.00	B U				(4.00)	
4.00 4.00	B U					
5.00 5.00 5.00	B D SPT(S)			N=36 (5,6/7,8,10,11)		
					64.05 5.40	Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
6.00 6.00 6.00	B D SPT(S)			N=40 (6,6/8,9,11,12)	(2.60)	
7.00 7.00	B U					
8.00 8.00	D SPT(S)			50 (16 for 75mm/50 for 75mm)	61.45 8.00	End of borehole at 8.00 m

Remarks

SPT's carried out using SPT Hammer SPT-SPT1

Chiselling:

From (m)	To (m)	Time (hh:mm)
3.10	3.50	01:00
8.10	8.20	01:00

Water Strikes:

Struck (m)	Rose to (m)	Time (min)
1.40	1.40	10

Water Added:

From (m)	To (m)

Casing:

To (m)	Diameter (mm)
8.00	200

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Causeway Geotech Ltd — Borehole BH02

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Borehole No.** BH02
Method: Cable Percussion	**Co-ords:** 291733.92mE 225332.57mN	**Client:** Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000	**Ground Level:** 69.36MOD	**Dates:** 16/07/2015 - 17/07/2015	**Driller:** BM
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.10) 69.26 0.10	TOPSOIL
0.20	B				(0.20) 69.06 0.30	Soft brown organic sandy CLAY. Sand is fine to coarse.
0.40	B				(0.30) 68.76 0.60	Soft yellowish grey sandy SILT. Sand is fine to medium.
0.60	B					Firm brownish grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
1.00 1.00 1.00	B D SPT(S)			N=10 (2,2/2,2,3,3)		
2.00 2.00	B U					
3.00 3.00 3.00	B D SPT(S)			N=13 (2,2/3,3,3,4)	(4.90)	
4.00 4.00	B U					
5.00 5.00 5.00	B D SPT(S)			N=64 (9,13/12,16,17,19)		
					63.86 5.50	Firm to stiff grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
6.00 6.00 6.00	B D SPT(S)			N=66 (8,14/14,15,17,20)	(1.00)	
					62.86 6.50	End of borehole at 6.50 m

Remarks

SPT's carried out using SPT Hammer SPT-SPT1

Chiselling: From (m)	To (m)	Time (hh:mm)
5.30	5.50	01:00
6.30	6.50	01:00

Water Strikes: Struck (m)	Rose to (m)	Time (min)
4.50	3.4	20

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
6.50	200

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Causeway Geotech Ltd — Borehole BH04

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Borehole No.** BH04
Method: Cable Percussion	**Co-ords:** 295348.96mE 225218.11mN	**Client:** Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000	**Ground Level:** 97.24MOD	**Dates:** 21/07/2015 - 21/07/2015	**Driller:** BM
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.30)	TOPSOIL
0.30	B				96.94 0.30	Soft grey sandy organic CLAY. Sand is fine to coarse.
					(0.40) 96.54 0.70	Soft dark grey to black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
1.00 1.00	B U				(0.70)	
1.40	B				95.84 1.40	Firm to stiff grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
2.00 2.00	B SPT(S)			N=13 (2,2/3,3,3,4)		
3.00 3.00	B U				(3.60)	
4.00 4.00	B SPT(S)			N=37 (4,4/5,7,11,14)		
5.00 5.00	B SPT(S)			N=35 (6,7/7,8,9,11)	92.24 5.00	Grey very sandy very silty fine to coarse subrounded GRAVEL with cobbles. Sand is fine to coarse.
6.00 6.00	B SPT(S)			N=54 (8,8/11,13,14,16)	(2.50)	
7.00 7.00	B SPT(S)			0 (50 for 25mm/0 for 0mm)		
7.50	B				89.74 7.50	Stiff to very stiff grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
					(0.50)	
8.00 8.00	B U				89.24 8.00	End of borehole at 8.00 m

Remarks

SPT's carried out using SPT Hammer SPT-SPT1

Chiselling: From (m)	To (m)	Time (hh:mm)
7.10	7.50	01:00

Water Strikes: Struck (m)	Rose to (m)	Time (min)
1.20	1.20	10
4.80	1.20	10

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
8.00	200

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Method: Cable Percussion	**Project no.** 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract	**Borehole No.** BH05
	Co-ords: 295506.24mE 225285.00mN	**Client:** Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000	**Ground Level:** 98.78MOD	**Dates:** 22/07/2015 - 22/07/2015	**Driller:** BM
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.50)	TOPSOIL
0.30	B					
					98.28 0.50 (0.30)	Soft grey sandy organic CLAY. Sand is fine to coarse.
					97.98 0.80	Firm grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
0.90	B					
1.00	B					
1.00	U					
					(2.10)	
2.00	B					
2.00	SPT(S)			N=10 (2,2/2,2,3,3)		
					95.88 2.90	Medium dense to dense brownish grey slightly silty sandy subrounded to rounded fine to coarse GRAVEL with cobbles. Sand is fine to coarse.
3.00	B					
3.00	U					
4.00	B				(2.20)	
4.00	SPT(S)			N=29 (4,5/7,7,9,6)		
4.50	B					
5.00	B			N=51 (7,9/10,12,14,15)		
5.00	SPT(S)				93.68 5.10	Stiff to very stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
6.00	B					
6.00	U				(2.20)	
7.00	B			40 (10,29/40 for 75mm)		
7.00	SPT(S)					
					91.48 7.30	End of borehole at 7.30 m

Remarks

SPT's carried out using SPT Hammer SPT-SPT1

Chiselling: From (m)	To (m)	Time (hh:mm)
3.10	3.40	00:30
7.30	7.40	01:00

Water Strikes: Struck (m)	Rose to (m)	Time (min)
1.60	1.6	10

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)
7.30	200

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Method: Cable percussion	**Project no.** 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract	**Borehole No.** BH06
	Co-ords: 296029.47mE 225018.67mN	**Client:** Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	**Scale:** 1:50
Plant: Dando 2000	**Ground Level:** 104.90MOD	**Dates:** 23/07/2015 - 23/07/2015	**Driller:** BM
			Logged By: DOM

Depth (m)	Sample / Test	Casing Depth (m)	Water Depth (m)	Field Records	Level & Depth	Stratum Description
					(0.50)	TOPSOIL
0.40	B					
					104.40 0.50	Medium dense grey slightly silty very sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse.
0.80	B					
1.00	B					
1.00	U					
					(1.90)	
2.00	B			N=20 (4,4/4,5,5,6)		
2.00	SPT(S)					
					102.50 2.40	Stiff grey slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.
3.00	B			N=36 (9,7/7,8,10,11)		
3.00	SPT(S)					
4.00	B					
4.00	U					
5.00	B			N=40 (5,7/8,9,11,12)		
5.00	SPT(S)				(5.40)	
6.00	B			N=52 (6,6/8,13,15,16)		
6.00	SPT(S)					
7.00	B					
7.00	U					
					97.10 7.80 (0.20)	Very stiff brown slightly sandy gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.
8.00	B			N=83 (6,10/11,11,30,31)	96.90 8.00	End of borehole at 8.00 m
8.00	SPT(S)					

Remarks

SPT's carried out using SPT Hammer SPT-SPT1

Chiselling: From (m)	To (m)	Time (hh:mm)
2.10	3.70	02:00

Water Strikes: Struck (m)	Rose to (m)	Time (min)
1.30	1	10

Water Added: From (m)	To (m)

Casing: To (m)	Diameter (mm)

Last Revised:

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CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT01
Coordinates: 292467.42 E, 228298.76 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 61.51 mOD	Driller: JC
	Dates: 12/11/2015 - 12/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water	Backfill
					61.31	(0.20) 0.20	TOPSOIL		
					60.61	(0.70) 0.90	Light brown silty fine SAND		
				Water Strike at 1.0m	59.51	(1.10) 2.00	Grey silty sandy subangular to subrounded fine to coarse GRAVEL with many cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded fine to medium	▼	
							End of borehole at 2.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.00	1.00	0	0.00

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
2.00	150			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT02
Coordinates: 292226.00 E, 227418.59 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 64.05 mOD	Driller: JS
	Dates: 05/11/2015 - 05/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water	Backfill
					63.90	(0.15) 0.15	TOPSOIL		
					63.45	(0.45) 0.60	Soft to firm brown sandy CLAY with some roots. Sand is fine to coarse		
					63.25	(0.20) 0.80	Firm orange brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
				Water Strike	62.45	(0.80) 1.60	Brown sandy rounded to subrounded fine to coarse GRAVEL. Sand is fine to coarse	▼	
					61.35	(1.10) 2.70	Grey sandy subangular to subrounded fine to coarse GRAVEL with some cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
					60.05	(1.30) 4.00	Stiff grey sandy gravelly CLAY with some cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
							End of borehole at 4.000m		

Remarks

Refusal met

Water Added From (m)	Water Added To (m)	Water Strike - Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.60	1.60	5	1.50

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
3.00	150			
4.00	100			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	**PT03**
Coordinates: 292200.29 E 227133.32 N	Client: Kildare County Council	Sheet 1 of 1
	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Method: Light Percussion		Driller: JS
Plant: Dando Terrier	Ground Level: 64.79 mOD	Dates: 05/11/2015 - 05/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					64.64	(0.15) 0.15		TOPSOIL		
					64.19	(0.45) 0.60		Soft to firm brown very sandy CLAY. Sand is fine to coarse		
					63.49	(0.70) 1.30		Brown silty gravelly fine to coarse SAND. Gravel is rounded to subrounded fine to coarse		
				Water Strike	61.49	(2.00) 3.30		Grey sandy subangular to subrounded fine to coarse GRAVEL with some cobbles and boulders. Sand is fine to coarse. Cobbles and boulders are subangular to subrounded	▼ 1.80	
								End of borehole at 3.300m		

Remarks: Refusal met

Water Added From (m)	Water Added To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.80	1.80	5	1.60

Casing To (m)	Diam (mm)	Chiselling From (m)	To (m)	Time (hh:mm)
3.00	150			
3.30	100			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	**PT04**
Coordinates: 292336.52 E 227255.47 N	Client: Kildare County Council	Sheet 1 of 1
	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Method: Light Percussion		Driller: JS
Plant: Dando Terrier	Ground Level: 64.19 mOD	Dates: 04/11/2015 - 04/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					63.99	(0.20) 0.20		TOPSOIL		
					63.39	(0.60) 0.80		Soft to firm brown sandy silty CLAY with occasional roots. Sand is fine to coarse		
					62.59	(0.80) 1.60		Brown sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse		
				Water Strike	62.19	(0.40) 2.00		Grey sandy subangular to subrounded fine to coarse GRAVEL with some cobbles and boulders. Sand is fine to coarse. Cobbles and boulders are subangular to subrounded	▼ 1.80	
								End of borehole at 2.000m		

Remarks:

Water Added From (m)	Water Added To (m)	Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.80	1.80	5	1.60

Casing To (m)	Diam (mm)	Chiselling From (m)	To (m)	Time (hh:mm)
1.00	150			
2.00	100			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT05
Coordinates: 292395.18 E 227180.03 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
		Driller: JS
Plant: Dando Terrier	Ground Level: 64.15 mOD	Dates: 04/11/2015 - 04/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					63.95	(0.20) 0.20		TOPSOIL		
					63.35	(0.60) 0.80		Soft to firm brown sandy silty CLAY with some roots. Sand is fine to coarse		
					62.95	(0.40) 1.20		Grey sandy subangular to subrounded fine to coarse GRAVEL with some cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded		
				Seepage	62.35	(0.60) 1.80		Firm dark grey gravelly very sandy CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
				Water Strike	61.15	(1.20) 3.00		Dark grey gravelly very silty fine to coarse SAND with some cobbles and boulders. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subangular to subrounded		
								End of borehole at 3.000m		

Remarks

Refusal met

Water Added From (m)	Water Added To (m)	Water Strike - General: Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.80	1.80	0	0.00
		2.80	2.80	5	2.30

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
2.00	150			
3.00	100			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT06
Coordinates: 291873.82 E 226125.25 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
		Driller: JC
Plant: Dando Terrier	Ground Level: 66.30 mOD	Dates: 09/11/2015 - 09/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					66.10	(0.20) 0.20		TOPSOIL		
				Water Strike	65.40	(0.70) 0.90		Soft grey sandy gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
					63.30	(2.10) 3.00		Grey sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse.		
								End of borehole at 3.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - General: Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.00	1.00	10	0.20

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
3.00	150			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT07
Coordinates: 291791.38 E, 225893.33 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 67.25 mOD	Driller: JS
	Dates: 11/11/2015 - 11/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					66.85	(0.40) 0.40		TOPSOIL		
				Water Strike at 0.9m	65.25	(1.60) 2.00		Grey silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded	▼	
								End of borehole at 2.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		0.90	0.90	0	0.00

Casing Details To (m)	Diam (mm)	Chiselling From (m)	To (m)	Time (hh:mm)
2.00	150			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT09
Coordinates: 291583.21 E, 225386.78 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 69.63 mOD	Driller: JC
	Dates: 09/11/2015 - 09/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					69.33	(0.30) 0.30		TOPSOIL		
					68.33	(1.00) 1.30		Stiff light brown sandy gravelly silty CLAY with occasional subangular to subrounded fine cobbles. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.		
					67.13	(1.20) 2.50		Soft grey sandy gravelly silty CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse.		
					66.93	(0.20) 2.70		Stiff grey sandy gravelly silty CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse.		
					66.63	(0.30) 3.00		Stiff greyish brown sandy gravelly silty CLAY with subangular to subrounded fine to medium cobbles . Sand is fine. Gravel is subangular to subrounded fine to coarse		
								End of borehole at 3.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details To (m)	Diam (mm)	Chiselling From (m)	To (m)	Time (hh:mm)
3.00	150			

Borehole No.: PT10 — Sheet 1 of 1

CAUSEWAY GEOTECH

Project No.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Coordinates	291520.27 E, 224915.28 N
Client	Kildare County Council
Method	Light Percussion
Client's Representative	RPS Consulting Engineers
Plant	Dando Terrier
Ground Level	70.40 mOD
Dates	10/11/2015 - 10/11/2015
Scale	1:50
Driller	JC
Logger	DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					70.10	(0.30) 0.30	TOPSOIL
				Water Strike	68.40	(1.70) 2.00	Grey silty sandy subangular to subrounded fine to coarse GRAVEL with occasional subangular to subrounded fine to medium cobbles. Sand is fine to coarse.
							End of borehole at 2.000m

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - General: Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		0.50	0.50	10	0.40

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
2.00	150			

Borehole No.: PT12 — Sheet 1 of 1

CAUSEWAY GEOTECH

Project No.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Coordinates	291670.04 E, 224800.32 N
Client	Kildare County Council
Method	Light Percussion
Client's Representative	RPS Consulting Engineers
Plant	Dando Terrier
Ground Level	71.18 mOD
Dates	10/11/2015 - 10/11/2015
Scale	1:50
Driller	JC
Logger	DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					70.78	(0.40) 0.40	TOPSOIL
				Water Strike	69.18	(1.60) 2.00	Grey silty sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse.
							End of borehole at 2.000m

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - General: Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		0.90	0.90	10	0.90

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
2.00	150			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT13
Coordinates: 292393.29 E, 224728.05 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 71.70 mOD	Driller: JC
	Dates: 11/11/2015 - 11/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water	Backfill
					71.40	0.30 (0.30)	TOPSOIL		
					71.10	0.60 (0.30)	Firm light brown dessicated sandy gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to medium		
				Water Strike at 1.1m	70.50	1.20 (0.60)	Grey sandy subangular to subrounded fine to coarse GRAVEL with many cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded	▼	
					68.70	3.00 (1.80)	Firm to stiff grey sandy gravelly silty CLAY with occasional cobbles. Sand is fine. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
							End of borehole at 3.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - General Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
		1.10	1.10	0	0.00

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
3.00	150			

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
15-272	Morrell River Flood Alleviation - Site Investigation Contract	PT14
Coordinates: 295487.97 E, 225291.92 N	Client: Kildare County Council	Sheet 1 of 1
Method: Light Percussion	Client's Representative: RPS Consulting Engineers	Scale: 1:50
Plant: Dando Terrier	Ground Level: 98.80 mOD	Driller: JS
	Dates: 11/11/2015 - 11/11/2015	Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Water	Backfill
					98.30	0.50 (0.50)	TOPSOIL		
					97.80	1.00 (0.50)	Soft to firm brown very sandy CLAY. Sand is fine		
					97.20	1.60 (0.60)	Soft to firm light grey SILT		
					96.70	2.10 (0.50)	Grey silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded		
					96.00	2.80 (0.70)	Firm dark grey sandy gravelly silty CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse		
					95.80	3.00 (0.20)	Dark grey silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Sand is fine to coarse. Cobbles are subangular to subrounded fine to medium		
							End of borehole at 3.000m		

Remarks

Water Added From (m)	Water Added To (m)	Water Strike - General Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details To (m)	Diam (mm)	Chiselling Details From (m)	To (m)	Time (hh:mm)
3.00	150			

CAUSEWAY GEOTECH

Method: Light Percussion	**Project No.:** 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract	**Borehole No.:** PT15
	Coordinates: 296794.09 E 224304.08 N	**Client:** Kildare County Council	Sheet 1 of 1
		Client's Representative: RPS Consulting Engineers	**Scale:** 1:50
Plant: Dando Terrier	**Ground Level:** 82.79 mOD	**Dates:** 10/11/2015 - 10/11/2015	**Driller:** JC
			Logger: DOM

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					82.59	(0.20) 0.20		MADE GROUND: 5-50mm Aggregate		
					82.19	(0.40) 0.60		MADE GROUND: Granular Fill including concrete fragments, brown sandy gravel with occasional cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
					81.39	(0.80) 1.40		Firm brown sandy gravelly CLAY with occasional cobbles. Sand is fine. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
					80.09	(1.30) 2.70		Soft to firm light brown sandy gravelly CLAY with occasional cobbles. Sand is fine. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
					79.79	(0.30) 3.00		Stiff grey sandy gravelly CLAY with occasional cobbles. Sand is fine. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded		
								End of borehole at 3.000m		

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5

Remarks

Water Added

From (m)	To (m)

Water Strike - General

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	150

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Causeway Geotech Ltd — Trialpit No. TP01

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP01
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292668.55mE 228814.16mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Bearing: (deg. N)	Ground Level: 59.40MOD	Dates: 20/07/2015
Length: 1.50m			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.50)	TOPSOIL		
0.50	B		58.90 0.50	Soft brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coars. Gravel is subangular to subrounded fine to coarse.		
			(0.60)			
1.00	B		58.30 1.10	Soft brown black slightly sandy gravelly silty CLAY with occasional cobbles and boulders. Sand is fine to coars. Gravel is subangular to subrounded fine to coarse.		
			(1.20)			
2.00	B					
			57.10 2.30	End of trial pit at 2.30 m		

Remarks

Water Strikes:

Struck (m)	Flow Details
2.10	Water seepage

Stability: Side walls collapsing below 1.1m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP02

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP02
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292646.73mE 228662.24mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Bearing: (deg. N)	Ground Level: 60.02MOD	Dates: 20/07/2015
Length: 1.50m			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.60)	TOPSOIL		
			59.42 0.60	Soft brown slightly gravelly sandy CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.00	B		(0.90)			
			58.52 1.50	Soft black brown slightly gravelly sandy silty CLAY with cobbles and boulders. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.		
1.80	B		(0.90)			
2.30	B					
			57.62 2.40	End of trial pit at 2.40 m		

Remarks

Refusal met on possible bedrock

Water Strikes:

Struck (m)	Flow Details
2.50	Water seepage

Stability: Side walls collapsing below 1.1m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP03

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP03
Method: Trail Pitting	Plant: 6T	Co-ords: 292620.27mE 228588.11mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Length: 1.50m	Bearing: (deg. N)	Ground Level: 60.22MOD
Dates: 20/07/2015			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.90)	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
1.00	B		59.32 0.90 (1.10)	Soft brown slightly gravelly sandy CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
2.00	B		58.22 2.00 (0.40)	Soft black brown slightly gravelly sandy silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.20	B			
			57.82 2.40 (0.20)	Weathered BEDROCK
			57.62 2.60	End of trial pit at 2.60 m

Remarks: Refusal met on possible bedrock

Water Strikes:

Struck (m)	Flow Details
2.40	Water seepage

Stability: Side walls collapsing below 1.4m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP04

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP04
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292558.00mE 228382.67mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Length: 1.50m	Bearing: (deg. N)	Ground Level: 61.01MOD
Dates: 20/07/2015			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.40)	TOPSOIL
0.50	B		60.61 0.40 (0.30)	Grey slightly silty gravelly SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B		60.31 0.70 (0.90)	Orangey brown sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		59.41 1.60 (1.20)	Soft to firm dark brown slightly sandy slightly gravelly silty CLAY with weathered rock fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			58.21 2.80	End of trial pit at 2.80 m

Remarks:

Water Strikes:

Struck (m)	Flow Details
2.60	

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP05

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP05
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292422.40mE 228247.30mN	**Client:** Kildare County Council
Sheet 1 of 1	**Scale:** 1:25	**Crew:** MG	**Client's Representative:** RPS Consulting Engineers
Width: 1.00m	**Length:** 1.50m	**Bearing:** (deg. N)	**Ground Level:** 61.76MOD
Dates: 20/07/2015	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.20)	TOPSOIL
			61.56 0.20	Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coars. Gravel is subangular to subrounded fine to coarse.
			(1.00)	
1.00	B			
			60.56 1.20	Soft to firm dark brown slightly gravelly sandy silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		(0.70)	
			59.86 1.90	Soft to firm black very sandy gravelly slightly silty CLAY with cobbles and boulders. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.
2.50	B		(1.60)	
			58.26 3.50	End of trial pit at 3.50 m

Remarks

Refusal met on possible bedrock

Water Strikes:

Struck (m)	Flow Details
3.50	Water seepage

Stability: Side walls collapsing below 1.9m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP06

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP06
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292347.20mE 228172.49mN	**Client:** Kildare County Council
Sheet 1 of 1	**Scale:** 1:25	**Crew:** MG	**Client's Representative:** RPS Consulting Engineers
Width: 1.00m	**Length:** 1.50m	**Bearing:** (deg. N)	**Ground Level:** 61.43MOD
Dates: 20/07/2015	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				Firm slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
			(0.90)	
			60.53 0.90	Brown sandy GRAVEL. Sand is fine to coarse. Gravel subangular to subrounded fine to coarse.
1.00	B			
			(1.00)	
			59.53 1.90	Soft to firm brown black slightly sandy gravelly slightly silty CLAY with cobbles and large boulders. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse.
2.00	B			
			(0.60)	
			58.93 2.50	End of trial pit at 2.50 m

Remarks

Refusal met on possible bedrock or large boulders

Water Strikes:

Struck (m)	Flow Details
1.60	

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP07
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292253.56mE 228023.23mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N) C D A B	**Ground Level:** 62.27MOD	**Crew:** MG
Length: 1.50m	**Dates:** 20/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.		
0.40	B						
				(1.10)			
			61.17	1.10	Soft brown slightly gravelly slightly sandy silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.20	B			(0.30)			
			60.87	1.40	Brown sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
				(0.90)			
2.00	B						
			59.97	2.30	Soft to firm dark brown slightly sandy slightly gravelly silty CLAY with cobbles and large boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
				(0.30)			
			59.67	2.60	End of trial pit at 2.60 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:	Difficulty:
	2.50		Side walls collapsing below 1.0m	

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP08
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292202.98mE 227490.19mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N) C D A B	**Ground Level:** 64.09MOD	**Crew:** MG
Length: 1.50m	**Dates:** 20/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					Firm brown slightly sandy gravelly silty CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.		
				(1.20)			
1.00	B						
			62.89	1.20	Soft to firm brownish orange slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
				(0.40)			
1.50	B						
			62.49	1.60	Grey sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
				(0.30)			
			62.19	1.90	Soft to firm dark brown slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
				(1.00)			
2.50	B						
			61.19	2.90	End of trial pit at 2.90 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:	Difficulty:
Refusal met on possible bedrock	1.60	Water seepage	Stable	

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Causeway Geotech Ltd — Trialpit No. TP09

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP09
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292236.86mE 227405.11mN	Client: Kildare County Council
Width: 1.00m	Bearing: (deg. N)	Ground Level: 64.39MOD	Client's Representative: RPS Consulting Engineers
Length: 1.50m	Dates: 21/07/2015	Sheet 1 of 1	Scale: 1:25
Crew: MG	Logged By: DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(1.30)	Soft to firm brown slightly sandy slightly gravelly SILT with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
0.50	B			
			63.09 1.30	Grey sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
1.50	B		(1.00)	
			62.09 2.30	Soft black slightly sandy gravelly SILT with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.50	B		(1.20)	
			60.89 3.50	End of trial pit at 3.50 m

Remarks

Water Strikes:

Struck (m)	Flow Details
2.00	Water seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP10

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP10
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292267.07mE 227301.24mN	Client: Kildare County Council
Width: 1.00m	Bearing: (deg. N)	Ground Level: 65.46MOD	Client's Representative: RPS Consulting Engineers
Length: 1.50m	Dates: 21/07/2015	Sheet 1 of 1	Scale: 1:25
Crew: MG	Logged By: DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.30)	TOPSOIL
			65.16 0.30	MADE GROUND - Soft to firm brown slightly sandy slightly gravelly CLAY with concrete, glass and organic content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.70)	
2.00	B		63.46 2.00	Brown gravelly fine to coarse SAND. Gravel is fine to coarse subangular to subrounded.
			(0.70)	
			62.76 2.70	Soft black slightly sandy slightly gravelly SILT with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.00	B		(0.70)	
			62.06 3.40	End of trial pit at 3.40 m

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP13

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP13
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292149.49mE 227038.27mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N)	**Client's Representative:** RPS Consulting Engineers	**Crew:** MG
Length: 1.50m	**Ground Level:** 65.11MOD	**Dates:** 21/07/2015	**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.20)	TOPSOIL		
			64.91 0.20	Soft to firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.		
0.50	B					
			(1.20)			
			63.71 1.40	Soft to firm black slightly sandy slightly gravelly silty CLAY with cobbles and large boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.50	B					
			(1.80)			
3.00	B					
			61.91 3.20	End of trial pit at 3.20 m		

Remarks

Water Strikes:

Struck (m)	Flow Details
3.20	Water seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP14

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP14
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292199.98mE 227121.36mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N)	**Client's Representative:** RPS Consulting Engineers	**Crew:** MG
Length: 1.50m	**Ground Level:** 64.78MOD	**Dates:** 21/07/2015	**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.20)	TOPSOIL		
			64.58 0.20	Soft to firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.		
0.50	B					
			(1.00)			
			63.58 1.20	Brown slightly gravelly SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
			(0.40)			
1.50	B					
			63.18 1.60	Grey very sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(1.10)			
2.50	B					
			62.08 2.70	End of trial pit at 2.70 m		

Remarks

Trial Pit terminated at 2.7m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
2.20	Water flow

Stability: Side walls collapsing below 1.6m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP15
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292258.11mE 227271.50mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Width: m	**Bearing:** (deg. N) C D A B	**Client's Representative:** RPS Consulting Engineers	**Crew:** MG
Length: m		**Ground Level:** 65.53MOD	**Dates:** 21/07/2015
			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10) 65.43 0.10	TOPSOIL		
0.40	B			MADE GROUND - Soft to firm grey brown sandy gravelly CLAY with cobbles and boulders. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse		
			(1.40)			
1.00	B					
1.40	B					
			64.03 1.50	MADE GROUND - Soft to firm grey brown sandy gravelly CLAY with cobbles, boulders concrete timber and stone. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse		
			(1.00)			
			63.03 2.50	Soft black slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.80	B		(0.70)			
			62.33 3.20	End of trial pit at 3.20 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:
Trial Pit terminated at 3.2m due to side walls collapsing			Side walls collapsing below 2.5
			Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP16
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292287.04mE 227261.62mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N) C D A B	**Client's Representative:** RPS Consulting Engineers	**Crew:** MG
Length: 1.50m		**Ground Level:** 64.07MOD	**Dates:** 21/07/2015
			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.05) 64.02 0.05	TOPSOIL		
			(0.05) 63.97 0.10	MADE GROUND Brown hardcore fill		
0.40	B		(0.40)	Soft to firm slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
0.50	B		63.57 0.50 (0.10)	Brown gravelly SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			63.47 0.60 (1.40)	Grey sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00	B		62.07 2.00	End of trial pit at 2.00 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:
Trial Pit terminated at 2.0m due to water filling hole and side walls collapsing	1.80	Water flowing	Side walls falling in
			Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP17

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP17
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292385.44mE 227240.23mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.50m	Length: 1.50m	Bearing: (deg. N)	Ground Level: 64.17MOD
Dates: 21/07/2015			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.15) 64.02 0.15	TOPSOIL
0.30	B		(0.25) 63.77 0.40	Brown sandy fine to coarse subangular to subrounded GRAVEL. Sand is fine to coarse.
1.00	B		(1.60)	Grey sandy fine to coarse subangular to subrounded GRAVEL. Sand is fine to coarse.
2.00	B		62.17 2.00	End of trial pit at 2.00 m

Remarks

Trial Pit terminated at 2.0m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.30	Water flow

Stability: Side walls collapsing

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP18

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP18
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292394.02mE 227161.82mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Length: 1.50m	Bearing: (deg. N)	Ground Level: 64.17MOD
Dates: 21/07/2015			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10) 64.07 0.10	TOPSOIL
0.50	B		(0.50) 63.57 0.60	Firm brownish orange slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(0.30) 63.27 0.90	Soft to firm brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B			Soft black slightly sandy gravelly SILT with occasional cobbles. Sand is fine to coarse. Gravel is is subangular to subrounded fine to coarse.
1.50	B		(1.10) 62.17 2.00	
3.00	B		(1.20) 60.97 3.20	Very soft black slightly sandy slightly gravelly silty CLAY with occasional cobbles. Sand is fine to coare. Gravel is is subangular to subrounded fine to coarse.
				End of trial pit at 3.20 m

Remarks

Water Strikes:

Struck (m)	Flow Details
3.20	Water flow

Stability: Side collapsing below 2.0m

Difficulty:

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Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP19
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292396.14mE 227000.40mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: m	**Bearing:** (deg. N)	**Ground Level:** 64.35MOD	**Crew:** MG
Length: m	**Dates:** 21/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10)	TOPSOIL		
			64.25 0.10	Soft to firm brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coars. Gravel is subangular to subrounded.		
0.50	B		(0.70)			
			63.55 0.80	Soft black slightly sandy slightly gravelly silty CLAY with cobbles and large boulders. Sand is fine to coars. Gravel is subangular to subrounded fine to coarse.		
			(1.70)			
2.00	B					
2.50	B		61.85 2.50	End of trial pit at 2.50 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability
Trial Pit terminated at 2.5m due to side walls collapsing and large boulders	1.90	Water seepage	Side walls collapsing below 1.6m

Difficulty:

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Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP20
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292395.73mE 226866.85mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 64.97MOD	**Crew:** MG
Length: 1.50m	**Dates:** 22/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.30)	TOPSOIL		
			64.67 0.30	Firm orangey brown slightly gravelly slightly sandy CLAY. Sand is fine to coarse. Gravel is subrounded to subangular fine to medium.		
0.50	B		(0.50)			
			64.17 0.80	Firm grey brown slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B		(0.60)			
			63.57 1.40	Soft black slightly sandy gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(1.00)			
2.00	B					
			62.57 2.40	Very soft black slightly sandy gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(0.60)			
2.80	B					
			61.97 3.00	End of trial pit at 3.00 m		

Remarks	Water Strikes: Struck (m)	Flow Details	Stability
Trial Pit terminated at 2.5m due to side walls collapsing	2.30	Water seepage	Side walls collapsing below 2.3m

Difficulty:

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Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP21
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292243.81mE 226702.56mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 65.57MOD	**Crew:** MG
Length: 2.00m	**Dates:** 22/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
0.50	B			MADE GROUND - Firm brown slightly sandy gravelly CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(1.50)	
1.00	B			
			64.07 1.50	Firm brown slightly sandy CLAY. Sand is fine.
			(0.50)	
			63.57 2.00	Soft greyish brown slightly sandy slightly gravelly silty CLAY. Gravel is subangular to subrounded fine. Sand is fine to coarse.
			(0.80)	
2.50	B			
			62.77 2.80	Grey gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
3.00	B			
			(0.90)	
			61.87 3.70	Firm black slightly sandy gravelly slightly silty CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
4.00	B		(0.60)	
			61.27 4.30	End of trial pit at 4.30 m

Remarks

Water Strikes:

Struck (m)	Flow Details
3.00	Water flow

Stability: Stable

Difficulty:

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Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP23
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292282.39mE 226607.09mN	Sheet 1 of 1
Client: Kildare County Council	**Client's Representative:** RPS Consulting Engineers		**Scale:** 1:25
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 66.08MOD	**Crew:** MG
Length: 2.00m	**Dates:** 22/07/2015		**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
0.50	B			MADE GROUND - Firm brown slightly sandy slightly gravelly CLAY with glass brick fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(1.30)	
			64.78 1.30	Firm to stiff brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
1.50	B			
			(1.30)	
			63.48 2.60	Grey gravelly slightly silty fine t coarse SAND. Gravel is subangular to subrounded fine to coarse.
2.70	B			
			(0.50)	
			62.98 3.10	Firm black slightly sandy slightly gravelly slightly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
3.50	B			
			(1.40)	
			61.58 4.50	End of trial pit at 4.50 m

Remarks

Water Strikes:

Struck (m)	Flow Details
2.80	Water seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP24

Project no.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Method	Trial Pitting
Plant	6T Excavator
Co-ords	292289.40mE 226505.01mN
Client	Kildare County Council
Client's Representative	RPS Consulting Engineers
Width	1.00m
Length	1.50m
Bearing	(deg. N)
Ground Level	66.69MOD
Dates	24/07/2015
Sheet	1 of 1
Scale	1:25
Crew	MG
Logged By	DOM

Depth (m)	Sample / Test	Field Records	Level	Depth (Thickness)	Stratum Description
1.00	B		65.59	1.10 (1.10)	MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		64.69	2.00 (0.90)	Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
2.50	B		63.99	2.70 (0.70)	Soft grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine.
3.00	B		63.59	3.10 (0.40)	Grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.50	B		62.49	4.20 (1.10)	Soft to firm black slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.

End of trial pit at 4.20 m

Remarks: Depths taken from or on top of the embankment

Water Strikes:

Struck (m)	Flow Details
2.80	Water seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP25

Project no.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Method	Trial Pitting
Plant	6T Excavator
Co-ords	292314.31mE 226500.22mN
Client	Kildare County Council
Client's Representative	RPS Consulting Engineers
Width	1.00m
Length	2.00m
Bearing	(deg. N)
Ground Level	66.57MOD
Dates	22/07/2015
Sheet	1 of 1
Scale	1:25
Crew	MG
Logged By	DOM

Depth (m)	Sample / Test	Field Records	Level	Depth (Thickness)	Stratum Description
0.50	B		65.37	1.20 (1.20)	MADE GROUND - Firm brown slightly sandy gravelly clay with glass and brick fragments. Gravel is subangular to subrounded fine to coarse.
1.50	B		64.77	1.80 (0.60)	Firm brown slightly sandy gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		64.37	2.20 (0.40)	Soft brown grey sandy silty CLAY. Sand is fine to medium.
			64.17	2.40 (0.20)	Grey sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse.
2.50	B		62.57	4.00 (1.60)	Soft black slightly sandy slightly gravelly slightly silty CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.00	B				
4.00	B				

End of trial pit at 4.00 m

Remarks:

Water Strikes:

Struck (m)	Flow Details
2.30	Water seepage

Stability: Side walls collapsing below 2.4m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP26

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP26
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292344.30mE 226448.68mN	Client: Kildare County Council
Sheet 1 of 1	Scale: 1:25	Crew: MG	Logged By: DOM
Width: 1.00m	Length: 1.50m	Bearing: (deg. N)	Ground Level: 66.93MOD
Client's Representative: RPS Consulting Engineers	Dates: 24/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
1.00	B		(1.30) 65.63 1.30	MADE GROUND - Firm brown slightly sandy gravelly CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		(0.60) 65.03 1.90	Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		(0.80) 64.23 2.70	Brown very gravelly very silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
3.00	B		(2.20) 62.03 4.90	Soft to firm black slightly sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
				End of trial pit at 4.90 m

Remarks

Depths taken from or on top of the embankment

Water Strikes:

Struck (m)	Flow Details
2.00	Water seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP28

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP28
Method: Trial Pitting	Plant: 6T	Co-ords: 292415.63mE 226410.36mN	Client: Kildare County Council
Sheet 1 of 1	Scale: 1:25	Crew: MG	Logged By: DOM
Width: 1.00m	Length: 2.00m	Bearing: (deg. N)	Ground Level: 67.28MOD
Client's Representative: RPS Consulting Engineers	Dates: 22/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
0.50	B		(1.20) 66.08 1.20	MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		(0.80) 65.28 2.00	Soft to firm brown slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
2.50	B		(0.60) 64.68 2.60	Soft to firm slightly sandy CLAY. Sand is fine.
2.60 3.50	B B		(1.90) 62.78 4.50	Soft to firm slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
				End of trial pit at 4.50 m

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

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Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP29
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292502.31mE 226400.66mN	Client: Kildare County Council
Width: m	Bearing: (deg. N)	Ground Level: 67.34MOD	Client's Representative: RPS Consulting Engineers
Length: m			Dates: 22/07/2015
Sheet 1 of 1	Scale: 1:25	Crew: MG	Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and large boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.00)	
			66.34 1.00	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse
1.50	B		(1.30)	
			65.04 2.30 (0.20)	Whitish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.40	B			
			64.84 2.50	Soft dark brown slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.00	B		(1.50)	
4.00	B		63.34 4.00	End of trial pit at 4.00 m

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Unstable - Side walls collapsing

Difficulty:

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Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP30
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292484.63mE 226391.40mN	Client: Kildare County Council
Width: 1.00m	Bearing: (deg. N)	Ground Level: 68.06MOD	Client's Representative: RPS Consulting Engineers
Length: 1.50m			Dates: 22/07/2015
Sheet 1 of 1	Scale: 1:25	Crew: MG	Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.00)	
			67.06 1.00	Soft to firm brown slightly gravelly sandy silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		(0.80)	
			66.26 1.80	Soft to firm black slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B			
			(1.40)	
3.00	B			
			64.86 3.20	End of trial pit at 3.20 m

Remarks

Trial Pit terminated at 3.2m due to side walls collapsing

Water Strikes:

Struck (m)	Flow Details
3.20	Water seepage

Stability: Unstable - Side walls collapsing below 2.0m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP31

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP31
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292540.37mE 226378.35mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Bearing: (deg. N)	Ground Level: 67.65MOD	Logged By: DOM
Length: 1.50m	Dates: 22/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.16) 67.49 0.16	MADE GROUND - Firm brown slightly sandy slightly gravelly CLAY with large boulders, cobbles, concrete and brick fragments. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B		(2.04)	Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		65.45 2.20	
2.50	B		(0.80)	Soft to firm greyish brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.50	B		64.65 3.00 (1.00)	Soft black slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			63.65 4.00	End of trial pit at 4.00 m

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:
			Unstable - Side walls collapsing below 3.0m
			Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP32

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP32
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 292633.23mE 226301.15mN	Sheet 1 of 1
Client: Kildare County Council			Scale: 1:25
Client's Representative: RPS Consulting Engineers			Crew: MG
Width: 1.00m	Bearing: (deg. N)	Ground Level: 68.10MOD	Logged By: DOM
Length: 2.00m	Dates: 22/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
0.50	B		(0.80)	MADE GROUND - Firm brown slightly gravelly sandy SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
0.90	B		67.30 0.80 (0.20)	Firm grey brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			67.10 1.00 (0.60)	Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.50	B		66.50 1.60	Soft black slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		(2.20)	
3.50	B			
			64.30 3.80	End of trial pit at 3.80 m

Remarks	Water Strikes: Struck (m)	Flow Details	Stability:
Trial Pit terminated at 2.0m due to side walls collapsing	3.80	Water seepage	Unstable - Side walls collapsing from 2.0m
			Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP33

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP33
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292682.25mE 226293.55mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 68.85MOD	**Logged By:** DOM
Length: 2.00m	**Dates:** 22/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and large boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.00)	
			67.85 1.00	Firm brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(0.70)	
1.50	B			
			67.15 1.70	Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
2.00	B		(0.60)	
			66.55 2.30	Grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(0.30)	
2.50	B			
			66.25 2.60	Soft black slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(1.20)	
3.50	B			
			65.05 3.80	End of trial pit at 3.80 m

Remarks

Water Strikes:

Struck (m)	Flow Details
2.40	Water seepage

Stability: Unstable - Side walls collapsing

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP35

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP35
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291998.31mE 226299.30mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 66.15MOD	**Logged By:** DOM
Length: 2.00m	**Dates:** 23/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10)	TOPSOIL
			66.05 0.10	Soft to firm slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(0.40)	
0.50	B		65.65 0.50	Grey sandy very silty fine to coarse subrounded GRAVEL with occasional cobbles. Sand is fine to coarse.
			(1.50)	
1.50	B			
			64.15 2.00	End of trial pit at 2.00 m

Remarks

Trial Pit terminated at 2.0m due to side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.20	

Stability: Side walls collapsing below 1.2m

Difficulty:

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Project no.	15-272
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract
Trialpit No.	TP36
Sheet	1 of 1
Method:	Trial Pitting
Plant:	6T Excavator
Co-ords:	291886.54mE 226138.25mN
Client:	Kildare County Council
Client's Representative:	RPS Consulting Engineers
Scale:	1:25
Crew:	MG
Width:	1.00m
Length:	1.00m
Bearing: (deg. N)	
Ground Level:	66.67MOD
Dates:	23/07/2015
Logged By:	DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10)	TOPSOIL
			66.57 0.10	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
			(0.40)	
0.60	B		66.17 0.50	Brownish grey gravelly slightly silty SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			(0.40)	
			65.77 0.90	Grey sandy silty fine to coarse subrounded GRAVEL with occasional cobbles. Sand is fine to coarse.
1.50	B		(1.40)	
			64.37 2.30	End of trial pit at 2.30 m

Remarks

Trial Pit terminated at 2.3m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.40	

Stability: Unstable - Side walls collapsing below 1.4m

Difficulty:

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Project no.	15-272
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract
Trialpit No.	TP37
Sheet	1 of 1
Method:	Trial Pitting
Plant:	6T Excavator
Co-ords:	291796.67mE 226039.88mN
Client:	Kildare County Council
Client's Representative:	RPS Consulting Engineers
Scale:	1:25
Crew:	MG
Width:	1.00m
Length:	1.00m
Bearing: (deg. N)	
Ground Level:	67.21MOD
Dates:	23/07/2015
Logged By:	DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.20)	TOPSOIL
			67.01 0.20	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
			(0.30)	
0.50	B		66.71 0.50	Grey sandy silty fine to coarse subrounded GRAVEL with occasional cobbles. Sand is fine to coarse.
1.00	B			
			(2.00)	
2.50	B		64.71 2.50	End of trial pit at 2.50 m

Remarks

Trial Pit terminated at 2.5m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
0.80	

Stability: Unstable - Side walls collapsing below 1.0m

Difficulty:

AGS

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP38
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291785.48mE 225897.85mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 67.26MOD	**Logged By:** DOM
Length: 1.50m	**Dates:** 23/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10)	TOPSOIL
			67.16 0.10 (0.40)	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
1.00	B		66.76 0.50 (0.80)	Grey gravelly very silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
1.50	B		65.96 1.30 (0.50)	Grey sandy silty fine to coarse subrounded GRAVEL. Sand is fine to coarse.
2.50	B		65.46 1.80 (0.70)	Soft to firm slightly sandy gravelly silty CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
			64.76 2.50	End of trial pit at 2.50 m

Remarks

Trial Pit terminated at 2.5m side walls collapsing

Water Strikes: Struck (m)	Flow Details
1.50	

Stability: Unstable - Side walls collapsing below 1.5m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP39
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291730.39mE 225720.23mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 68.04MOD	**Logged By:** DOM
Length: 1.50m	**Dates:** 23/07/2015		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10)	TOPSOIL
0.30	B		67.94 0.10 (0.30)	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
1.00	B		67.64 0.40 (1.00)	Firm greyish brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B		66.64 1.40 (1.80)	Soft to firm black slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.00	B			
			64.84 3.20	End of trial pit at 3.20 m

Remarks

Water Strikes: Struck (m)	Flow Details

Stability: Unstable - Side wall collapsing below 1.4m

Difficulty:

AGS

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Causeway Geotech Ltd — Trialpit No. TP40

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP40
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291695.46mE 225630.78mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m **Length:** 1.50m	**Bearing:** (deg. N)	**Ground Level:** 68.11MOD	**Dates:** 23/07/2015
			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10) 68.01 0.10	TOPSOIL		
0.30	B		(0.30) 67.71 0.40	Soft to firm slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular, fine to coarse.		
1.00	B		(0.80) 66.91 1.20	Grey sandy silty fine to coarse subrounded GRAVEL. Sand is fine to coarse.		
2.00	B		(2.00) 64.91 3.20	Soft black slightly sandy slightly gravelly slightly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.00	B					
				End of trial pit at 3.20 m		

Remarks

Water Strikes:

Struck (m)	Flow Details
3.00	Water Seepage

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP41

Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP41
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291599.29mE 225590.85mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m **Length:** 1.50m	**Bearing:** (deg. N)	**Ground Level:** 68.50MOD	**Dates:** 23/07/2015
			Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.20) 68.30 0.20	TOPSOIL		
0.30	B		(0.20) 68.10 0.40	Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.		
			(0.70) 67.40 1.10	Firm brown slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00	B		(1.00) 66.40 2.10	Firm black slightly sandy slightly gravelly CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.50	B		(0.50) 65.90 2.60	Soft black slightly gravelly sandy silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
				End of trial pit at 2.60 m		

Remarks

Trial Pit terminated at 2.7m due to side walls collapsing.

Water Strikes:

Struck (m)	Flow Details
2.50	Water seepage

Stability: Unstable - side walls collapsing below 2.1m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP42
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291493.94mE 225541.18mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m **Length:** 1.50m	**Bearing:** (deg. N) D C A B	**Ground Level:** 69.62MOD	**Logged By:** DOM
Dates: 23/07/2015			

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10)		TOPSOIL		
			69.52	0.10	Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
			(1.20)				
1.00	B						
			68.32	1.30	Firm brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.50	B		(0.50)				
			67.82	1.80	Soft to firm brown slightly gravelly sandy CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00	B		(0.40)				
			67.42	2.20	Soft black slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coars. Gravel is subangular to subrounded fine to coarse.		
2.50	B		(0.50)				
			66.92	2.70	End of trial pit at 2.70 m		

Remarks

Water Strikes:

Struck (m)	Flow Details

Stability: Unstable - side walls collapsing below 1.3m

Difficulty:

AGS

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP43
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291503.03mE 225422.62mN	Sheet 1 of 1
Client: Kildare County Council			**Scale:** 1:25
Client's Representative: RPS Consulting Engineers			**Crew:** MG
Width: 1.00m **Length:** 1.50m	**Bearing:** (deg. N) D C A B	**Ground Level:** 69.42MOD	**Logged By:** DOM
Dates: 23/07/2015			

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
					MADE GROUND - Firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse.		
			(0.80)				
0.50	B						
			68.62	0.80	Firm brown slightly sandy gravelly silty CLAY with frequent cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.50	B		(1.60)				
			67.02	2.40	Grey sandy silty subangular to subrounded fine to medium GRAVEL. Sand is fine to coarse.		
			(0.20)				
			66.82	2.60	Soft to firm dark brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.00	B		(0.90)				
			65.92	3.50	End of trial pit at 3.50 m		

Remarks

Depths taken from or on top of the embankment

Water Strikes:

Struck (m)	Flow Details
2.50	Water seepage

Stability: Side walls collapsing below 2.5m

Difficulty:

AGS

Causeway Geotech Ltd — Trialpit No. TP44

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP44
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291546.57mE 225310.35mN	**Client:** Kildare County Council
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 69.77MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m		**Dates:** 24/07/2015	Sheet 1 of 1; **Scale:** 1:25; **Crew:** MG; **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(1.50)	MADE GROUND - Firm brown slightly sandy gravelly CLAY with a high cobble content, and occasional boulders. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse.
1.00	B			
			68.27 1.50 (1.00)	Firm brownish grey slightly sandy gravelly CLAY with cobbles and occasional boulders. Gravel is fine to coarse, subangular to subrounded. Sand is fine to coarse.
2.00	B			
			67.27 2.50 (0.50)	Soft grey sandy silty CLAY. Sand is fine to medium.
3.00	B		66.77 3.00 (0.60)	Grey slightly gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded.
			66.17 3.60 (0.90)	Soft to firm black slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded.
4.00	B			
			65.27 4.50	End of trial pit at 4.50 m

Remarks: Depths taken from or on top of the embankment

Water Strikes: Struck (m)	Flow Details
3.20	Water seepage

Stability: Stable

Difficulty:

AGS

Causeway Geotech Ltd — Trialpit No. TP45

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP45
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 291580.09mE 225258.81mN	**Client:** Kildare County Council
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 70.16MOD	**Client's Representative:** RPS Consulting Engineers
Length: 1.50m		**Dates:** 24/07/2015	Sheet 1 of 1; **Scale:** 1:25; **Crew:** MG; **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.10)	TOPSOIL
			70.06 0.10 (0.60)	MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and boulders. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
0.50	B			
			69.46 0.70	Soft to firm slightly sandy slightly gravelly SILT. Gravel is subangular to subrounded fine to coarse Sand is fine to coarse.
1.00	B		(0.80)	
			68.66 1.50 (0.40)	Grey slightly gravelly silty fine to coarse SAND. Sand is fine to coarse.
1.80	B			
			68.26 1.90	Soft to firm black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded.
2.00	B		(0.90)	
			67.36 2.80	End of trial pit at 2.80 m

Remarks

Water Strikes: Struck (m)	Flow Details
1.70	Water seepage

Stability: Stable

Difficulty:

AGS

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Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Trialpit No. TP46
Method: Trial Pitting	Plant: 6T Excavator	Sheet 1 of 1
Co-ords: 291568.54mE 224969.12mN	Client: Kildare County Council	Scale: 1:25
Width: 0.50m	Client's Representative: RPS Consulting Engineers	Crew: MG
Length: 2.00m	Bearing: (deg. N)	Logged By: DOM
Ground Level: 70.36MOD	Dates: 28/07/2015	

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.20)	TOPSOIL		
			70.16 0.20	Soft brown slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to coarse.		
			(0.40)			
0.50	B					
			69.76 0.60	Whitish grey gravelly slightly silty SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.		
			(0.30)			
0.80	B					
			69.46 0.90	Grey sandy silty GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(1.10)			
1.50	B					
			68.36 2.00	End of trial pit at 2.00 m		

Remarks

Trial Pit terminated at 2.0m due to side walls collapsing

Water Strikes: Struck (m)	Flow Details
1.70	

Stability: Unstable - Side walls collapsing below 0.9m

Difficulty:

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Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Trialpit No. TP47
Method: Trial Pitting	Plant: 6T Excavator	Sheet 1 of 1
Co-ords: 291486.93mE 224875.17mN	Client: Kildare County Council	Scale: 1:25
Width: 0.50m	Client's Representative: RPS Consulting Engineers	Crew: MG
Length: 2.00m	Bearing: (deg. N)	Logged By: DOM
Ground Level: 70.66MOD	Dates: 28/07/2015	

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.15)	TOPSOIL		
			70.51 0.15	Soft to firm brown sandy CLAY.		
			(0.30)			
0.40	B					
			70.21 0.45	Grey slightly sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(1.25)			
1.50	B					
			68.96 1.70	End of trial pit at 1.70 m		

Remarks

Trial Pit terminated at 1.7m due to water filling hole and side walls collapsing

Water Strikes: Struck (m)	Flow Details
1.40	

Stability: Unstable - side walls collapsing below 1.5m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP48

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No.: TP48
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 291555.43mE 224841.41mN	Client: Kildare County Council
Width: 0.50m	Bearing: (deg. N)	Ground Level: 70.93MOD	Client's Representative: RPS Consulting Engineers
Length: 2.00m	Dates: 28/07/2015	Sheet 1 of 1, Scale: 1:25	Crew: MG, Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.15) 70.78 0.15	TOPSOIL
0.40	B		(0.35) 70.43 0.50	Soft to firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse.
0.50	B		(0.10) 70.33 0.60	Soft to firm brown sandy silty CLAY. Sand is fine.
1.50	B		(1.20) 69.13 1.80	Grey slightly sandy GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
				End of trial pit at 1.80 m

Remarks: Trial Pit terminated at 1.8m due to water filling hole and side walls collapsing.

Water Strikes:

Struck (m)	Flow Details
1.50	

Stability: Unstable - Side walls collapsing below 1.5m.

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP56

Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No.: TP56
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 291693.58mE 224798.90mN	Client: Kildare County Council
Width: 1.00m	Bearing: (deg. N)	Ground Level: 71.11MOD	Client's Representative: RPS Consulting Engineers
Length: 1.50m	Dates: 27/07/2015	Sheet 1 of 1, Scale: 1:25	Crew: MG, Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
0.30	B		(0.50) 70.61 0.50	Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.60	B		(0.40) 70.21 0.90	Firm brown very sandy CLAY. Sand is fine to medium.
1.50	B		(1.30) 68.91 2.20	Grey silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
				End of trial pit at 2.20 m

Remarks: Trial Pit terminated at 2.3m

Water Strikes:

Struck (m)	Flow Details
1.70	

Stability: Unstable - Side walls collapsing below 0.9m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP58
Method: Trial Piting	**Plant:** 6T Excavator	**Co-ords:** 291803.44mE 224654.95mN	**Client:** Kildare County Council
Client's Representative: RPS Consulting Engineers			Sheet 1 of 1
Width: 1.00m	**Bearing:** (deg. N) D / A / B / C	**Ground Level:** 71.37MOD	**Scale:** 1:25
Length: 1.50m	**Dates:** 27/07/2015	**Crew:** MG	**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.10) 71.27 0.10	TOPSOIL		
0.30	B		(0.40) 70.87 0.50	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B		(0.60) 70.27 1.10	Grey silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse		
1.50	B		(0.50) 69.77 1.60	Grey very gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to medium.		
				End of trial pit at 1.60 m		

Remarks

Trial Pit terminated at 1.6m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.40	

Stability: Unstable - Side wall falling in below 0.5m

Difficulty:

AGS

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP59
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292002.60mE 224655.70mN	**Client:** Kildare County Council
Client's Representative: RPS Consulting Engineers			Sheet 1 of 1
Width: 1.00m	**Bearing:** (deg. N) D / A / B / C	**Ground Level:** 71.52MOD	**Scale:** 1:25
Length: 1.50m	**Dates:** 27/07/2015	**Crew:** MG	**Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.15) 71.37 0.15	TOPSOIL		
0.50	B		(0.45) 70.92 0.60	Soft to firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B		(1.20) 69.72 1.80	Grey slightly silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00	B		(0.40) 69.32 2.20	Grey gravelly fine to coarse SAND. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
				End of trial pit at 2.20 m		

Remarks

Trial Pit terminated at 2.2m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.80	

Stability: Unstable - Side walls collapsing below 1.6m

Difficulty:

AGS

Causeway Geotech Ltd — Trialpit No. TP60

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.:** TP60
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292333.16mE 224709.86mN	**Client:** Kildare County Council
Width: 0.50m	**Bearing:** (deg. N)	**Ground Level:** 71.72MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m	**Dates:** 27/07/2015	**Sheet** 1 of 1	**Scale:** 1:25
Crew: MG	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description
					Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
				(1.20)	
1.00	B				
			70.52	1.20	Grey slightly silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.30	B				
				(0.80)	
2.00	B		69.72	2.00	End of trial pit at 2.00 m

Remarks
Trial Pit terminated at 2.0m due to water filling hole and side walls collapsing

Water Strikes:

Struck (m)	Flow Details
1.70	

Stability: Unstable - Side walls falling in below 1.4m

Difficulty:

Causeway Geotech Ltd — Trialpit No. TP61

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.:** TP61
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292388.12mE 224745.45mN	**Client:** Kildare County Council
Width: 0.50m	**Bearing:** (deg. N)	**Ground Level:** 71.69MOD	**Client's Representative:** RPS Consulting Engineers
Length: 1.50m	**Dates:** 27/07/2015	**Sheet** 1 of 1	**Scale:** 1:25
Crew: MG	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level	Depth	Stratum Description
					MADE GROUND - Soft to firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
0.50	B			(1.00)	
1.00	B		70.69	1.00	Soft brown very sandy CLAY. Sand is fine to medium.
				(0.50)	
			70.19	1.50	Grey gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium.
1.70	B			(0.40)	
			69.79	1.90	Grey slightly silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
2.00	B			(0.40)	
			69.39	2.30	Soft to firm black slightly sandy slightly gravelly CLAY with cobbles and occasional boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.50	B			(0.40)	
			68.99	2.70	End of trial pit at 2.70 m

Remarks
Trial Pit completed on embankment
Trial Pit terminated at 2.7m

Water Strikes:

Struck (m)	Flow Details
2.00	

Stability: Side walls collapsing below 2.0m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP62
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 292383.27mE 224640.77mN	**Client:** Kildare County Council
Width: 0.50m	**Bearing:** (deg. N)	**Ground Level:** 71.36MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m		**Dates:** 27/07/2015	Sheet 1 of 1; **Scale:** 1:25; **Crew:** MG; **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				MADE GROUND - Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.20)	
			70.16 1.20	Grey gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
			(0.40)	
1.50	B			
			69.76 1.60	Grey slightly silty SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to subrounded.
1.80	B		(0.50)	
			69.26 2.10	Soft to firm black slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.20	B		(0.40)	
			68.86 2.50	End of trial pit at 2.50 m

Remarks
Depths taken from or on top of the embankment

Water Strikes:

Struck (m)	Flow Details
2.00	

Stability: Stable

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP63
Method: Trial Piting	**Plant:** 6T Excavator	**Co-ords:** 292383.86mE 224555.23mN	**Client:** Kildare County Council
Width: 0.50m	**Bearing:** (deg. N)	**Ground Level:** 71.62MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m		**Dates:** 27/07/2015	Sheet 1 of 1; **Scale:** 1:25; **Crew:** MG; **Logged By:** DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
				MADE GROUND - Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles and occasional boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B		(1.10)	
			70.52 1.10	Grey sandy silty fine to coarse subrounded GRAVEL. Sand is fine to coarse.
			(0.50)	
1.50	B			
			70.02 1.60	Grey gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
			(0.50)	
2.00	B			
			69.52 2.10	Soft to firm black slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.30	B		(0.40)	
			69.12 2.50	End of trial pit at 2.50 m

Remarks
Depths taken from side of the embankment

Water Strikes:

Struck (m)	Flow Details
2.00	

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP67

Project no.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Method	Trial Pitting
Plant	6T
Co-ords	293909.02mE 225785.75mN
Client	Kildare County Council
Client's Representative	RPS Consulting Engineers
Width	1.00m
Length	1.50m
Bearing (deg. N)	
Ground Level	73.33MOD
Dates	28/07/2015
Sheet	1 of 1
Scale	1:25
Crew	MG
Logged By	DOM

Depth (m)	Sample / Test	Field Records	Level	Depth (thickness)	Stratum Description
				(0.15)	TOPSOIL
			73.18	0.15 (0.50)	Soft to firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse.
0.50	B				
			72.68	0.65 (1.05)	Soft to firm grey brown slightly gravelly slightly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B				
			71.63	1.70 (0.80)	Soft to firm grey slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B				
			70.83	2.50	End of trial pit at 2.50 m

Remarks

Trial Pit terminated at 2.5m due to side walls collapsing

Water Strikes:

Struck (m)	Flow Details
2.30	Water seepage

Stability: Unstable - Side walls collapsing below 1.70m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP68

Project no.	15-272
Project Name	Morrell River Flood Alleviation - Site Investigation Contract
Method	Trial Pitting
Plant	6T Excavator
Co-ords	294063.92mE 224246.74mN
Client	Kildare County Council
Client's Representative	RPS Consulting Engineers
Width	0.50m
Length	1.50m
Bearing (deg. N)	
Ground Level	82.27MOD
Dates	29/07/2015
Sheet	1 of 1
Scale	1:25
Crew	MG
Logged By	DOM

Depth (m)	Sample / Test	Field Records	Level	Depth (thickness)	Stratum Description
				(0.60)	MADE GROUND - Firm brown slightly sandy gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.50	B				
			81.67	0.60 (0.80)	Soft dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium.
1.00	B				
			80.87	1.40 (0.60)	Soft brownish slightly sandy very gravelly SILT. Sand is fine to coarse. Gravel is fine to coarse, subangular to subrounded.
1.50	B				
2.00	B		80.27	2.00 (0.80)	Soft brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.80	B		79.47	2.80	End of trial pit at 2.80 m

Remarks

Trial Pit terminated at 2.8m side walls collapsing

Water Strikes:

Struck (m)	Flow Details

Stability: Unstable - Side walls collapsing below 2.0m

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP69

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP69
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 294127.91mE 224165.41mN	**Client:** Kildare County Council
			Sheet 1 of 1
Width: 0.50m	**Bearing:** (deg. N)		**Client's Representative:** RPS Consulting Engineers
Length: 1.50m		**Ground Level:** 82.77MOD	**Dates:** 27/07/2015
Scale: 1:25	**Crew:** MG	**Logged By:** DOM	

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(1.20)	Soft to firm brown slightly sandy gravelly CLAY. Gravel is subangular to subrounded fine to medium. Sand is fine to coarse.
1.00	B			
			81.57 1.20 (0.20)	Dark brown slightly sandy GRAVEL with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.30	B			
			81.37 1.40 (1.80)	Soft to firm brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
2.00	B			
			79.57 3.20	End of trial pit at 3.20 m

Remarks

Water Strikes: Struck (m) | Flow Details

Stability: Stable

Difficulty:

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Causeway Geotech Ltd — Trialpit No. TP71

Project no.: 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP71
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 295806.52mE 225202.85mN	**Client:** Kildare County Council
			Sheet 1 of 1
Width: 0.50m	**Bearing:** (deg. N)		**Client's Representative:** RPS Consulting Engineers
Length: 2.00m		**Ground Level:** 102.82MOD	**Dates:** 28/07/2015
Scale: 1:25	**Crew:** MG	**Logged By:** DOM	

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description
			(0.50)	MADE GROUND - Firm slightly sandy gravelly CLAY with frequent brick, timber and concrete fragments. Gravel is subangular to subrounded fine to coarse. Sand is fine to coarse.
0.40	B			
			102.32 0.50 (0.30)	Soft to firm slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
0.60	B			
			102.02 0.80 (1.20)	Firm brown slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B			
			100.82 2.00 (0.90)	Soft greyish brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse
2.50	B			
			99.92 2.90 (0.20)	Grey slightly sandy fine to coarse subrounded GRAVEL. Sand is fine to coarse.
3.00	B			
			99.72 3.10 (0.40)	Soft to firm black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
3.20	B			
			99.32 3.50	End of trial pit at 3.50 m

Remarks

Water Strikes:

Struck (m)	Flow Details
3.00	

Stability: Stable

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP72
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 295888.04mE 225150.74mN	**Client:** Kildare County Council
Width: 1.00m	**Bearing:** (deg. N)	**Ground Level:** 103.47MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m	**Dates:** 28/07/2015	Sheet 1 of 1	**Scale:** 1:25
Crew: MG	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
1.00	B		(1.50)	MADE GROUND - Firm brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			101.97 1.50 (0.20)	MADE GROUND - Hardcore fill		
2.00	B		101.77 1.70 (1.20)	Soft brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.00	B		100.57 2.90 (0.30)	Firm black slightly sandy slightly gravelly CLAY with occasional cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
3.40	B		100.27 3.20 (0.30)	Brown gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.		
4.00	B		99.97 3.50 (1.00)	Grey silty very sandy fine to coarse subangular to subrounded GRAVEL. Sand is fine to coarse.		
			98.97 4.50	End of trial pit at 4.50 m		

Remarks

Trial Pit completed on embankment
Trial Pit terminated at 2.7m

Water Strikes:

Struck (m)	Flow Details

Stability: Side walls collapsing below 3.5m

Difficulty:

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Project no. 15-272	**Project Name:** Morrell River Flood Alleviation - Site Investigation Contract		**Trialpit No.** TP73
Method: Trial Pitting	**Plant:** 6T Excavator	**Co-ords:** 296750.48mE 224298.88mN	**Client:** Kildare County Council
Width: 0.50m	**Bearing:** (deg. N)	**Ground Level:** 120.07MOD	**Client's Representative:** RPS Consulting Engineers
Length: 2.00m	**Dates:** 29/07/2015	Sheet 1 of 1	**Scale:** 1:25
Crew: MG	**Logged By:** DOM		

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.60)	MADE GROUND - Subangular fine to coarse slightly sandy slightly silty GRAVEL (Hardcore Fill)		
1.00	B		119.47 0.60 (0.70)	Soft to firm brown sandy SILT. Sand is fine to medium.		
1.50	B		118.77 1.30 (0.40)	Soft to firm slightly sandy slightly gravelly CLAY with cobbles. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
2.00	B		118.37 1.70 (0.50)	Firm black slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			117.87 2.20	End of trial pit at 2.20 m		

Remarks

Refusal met on possible bedrock or boulders at 2.2m

Water Strikes:

Struck (m)	Flow Details
2.20	

Stability: Stable

Difficulty:

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Project no.: 15-272	Project Name: Morrell River Flood Alleviation - Site Investigation Contract		Trialpit No. TP74
Method: Trial Pitting	Plant: 6T Excavator	Co-ords: 296854.49mE 224302.62mN	Client: Kildare County Council	Sheet 1 of 1
Width: 0.50m	Bearing: (deg. N) D / C A / B		Client's Representative: RPS Consulting Engineers	Scale: 1:25
Length: 2.00m		Ground Level: 122.01MOD	Dates: 29/07/2015	Crew: MG
				Logged By: DOM

Depth (m)	Sample / Test	Field Records	Level & Depth	Stratum Description	Legend & Water Strikes	Backfill Installs
			(0.70)	MADE GROUND - Firm brown slightly sandy slightly gravelly CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
0.50	B					
			121.31 0.70	Soft to firm brown slightly sandy slightly gravelly silty CLAY with cobbles and boulders. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
			(1.40)			
1.50	B					
			119.91 2.10	End of trial pit at 2.10 m		

Remarks

Refusal met on possible large boulders at 2.2m

Water Strikes:

Struck (m)	Flow Details

Stability: Stable

Difficulty:

Appendix D
Trial pit photographs

Trial pit TP01

Trial pit TP01

Trial pit TP02

Trial pit TP01

Trial pit TP02

Trial pit TP02

Trial pit TP03

Trial pit TP03

Trial pit TP04

Trial pit TP03

Trial pit TP04

Trial pit TP04

Trial pit TP05

Trial pit TP05

Trial pit TP06

Trial pit TP05

Trial pit TP06

Trial pit TP06

Trial pit TP07

Trial pit TP07

Trial pit TP08

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Trial pit TP09

Trial pit TP10

Trial pit TP10

Trial pit TP13

Trial pit TP13

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Trial pit TP15

Trial pit TP15

Trial pit TP16

Trial pit TP15

Trial pit TP16

Trial pit TP16

Trial pit TP17

Trial pit TP17

Trial pit TP17

Trial pit TP18
(Photo board incorrectly labelled)

Trial pit TP18
(Photo board incorrectly labelled)

Trial pit TP18
(Photo board incorrectly labelled)

Trial pit TP19

Trial pit TP19

Trial pit TP20

Trial pit TP19

Trial pit TP20

Trial pit TP20

Trial pit TP21

Trial pit TP21

Trial pit TP23
(Photo board incorrectly labelled)

Trial pit TP21

Trial pit TP23
(Photo board incorrectly labelled)

Trial pit TP23
(Photo board incorrectly labelled)

Trial pit TP24

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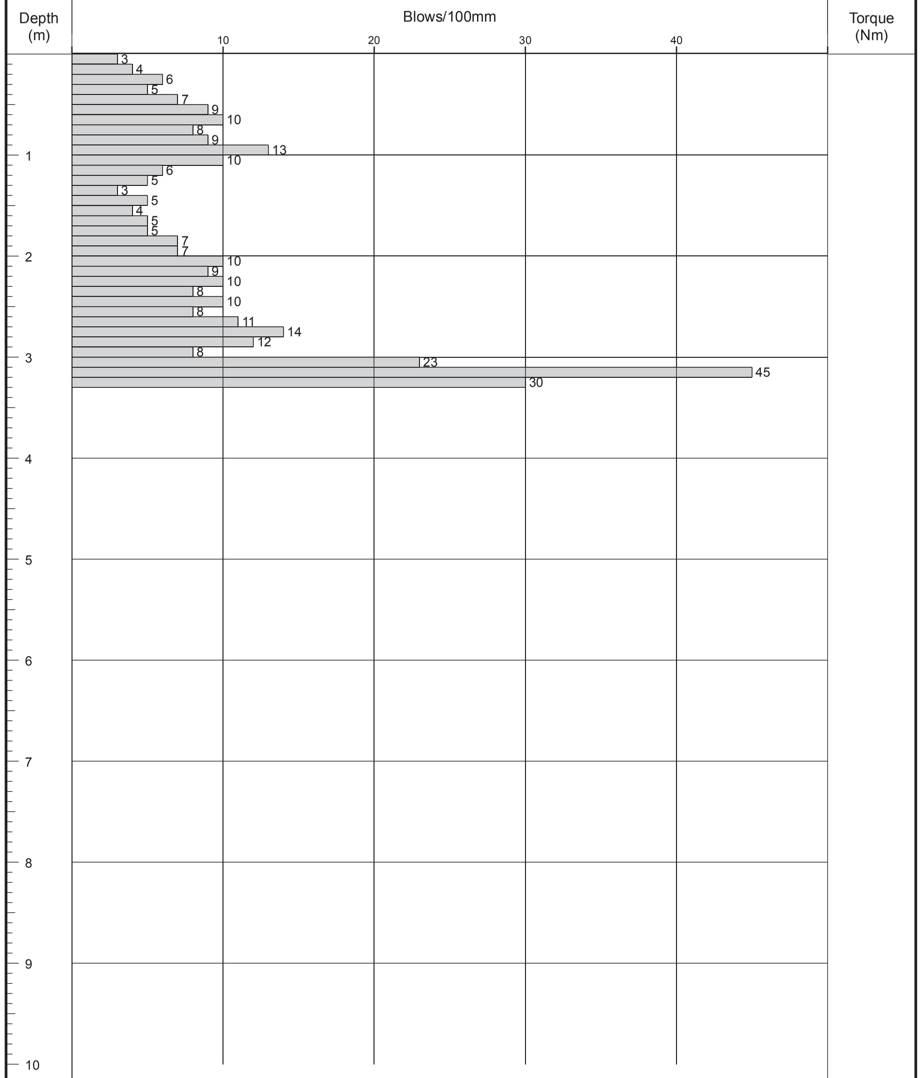
Trial pit TP74

Trial pit TP74

Appendix E
Dynamic probe logs

Probe Log

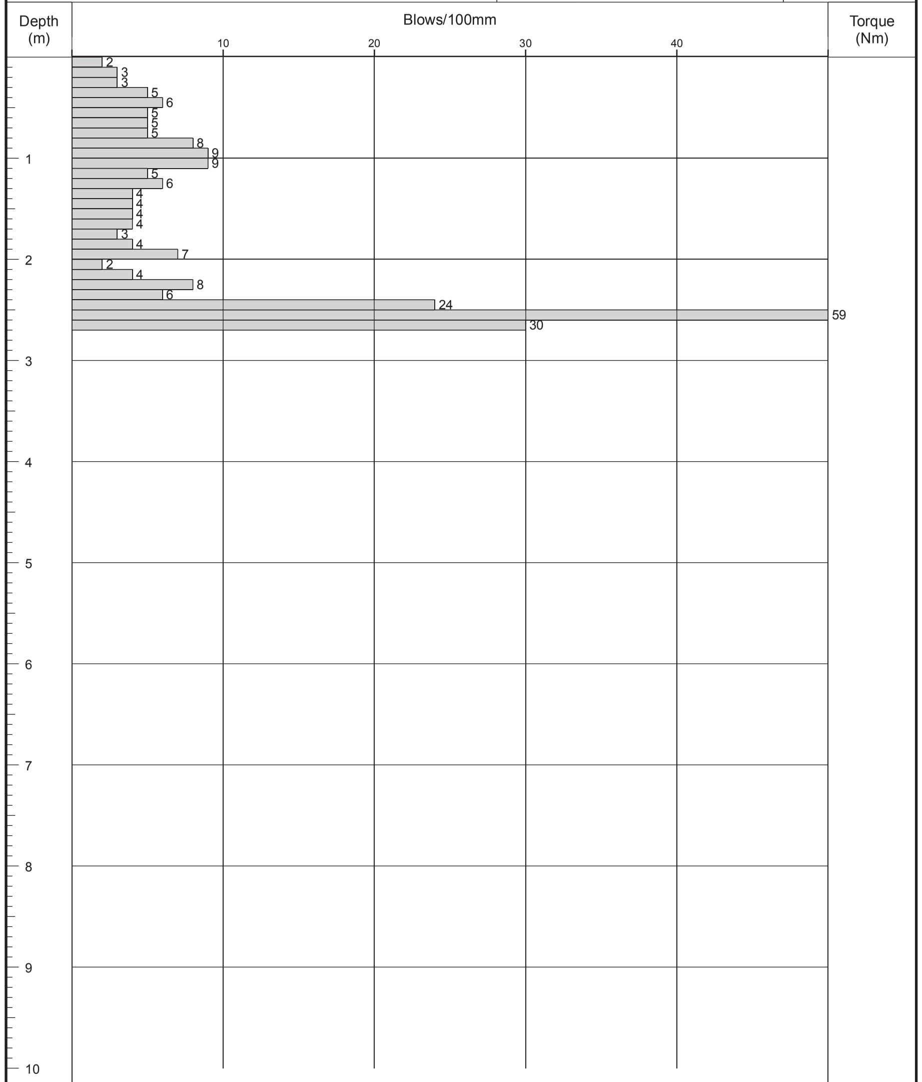
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292659.26 - 228765.49	Borehole No. **DPBH01** Sheet 1 of 1
Location:		Level:	59.61	Hole Type DP / Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



Remarks

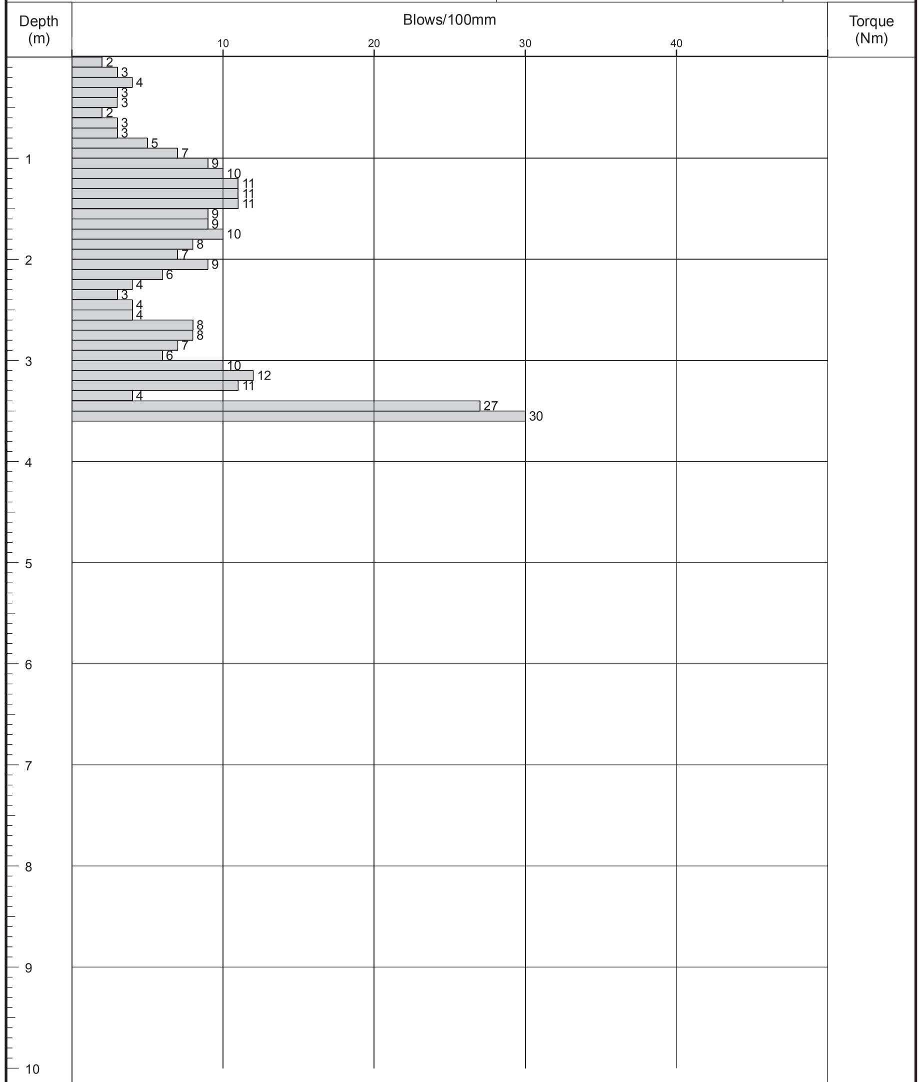
Fall Height	750	Cone Base Diameter	
Hammer Wt	64	Final Depth	3.30
Probe Type	DPSH-B	Log Scale	1:50

CAUSEWAY GEOTECH	**Probe Log**		Borehole No. **DPBH02** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292589.63 - 228490.42	Hole Type DP
Location:		Level: 60.53	Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -	Logged By



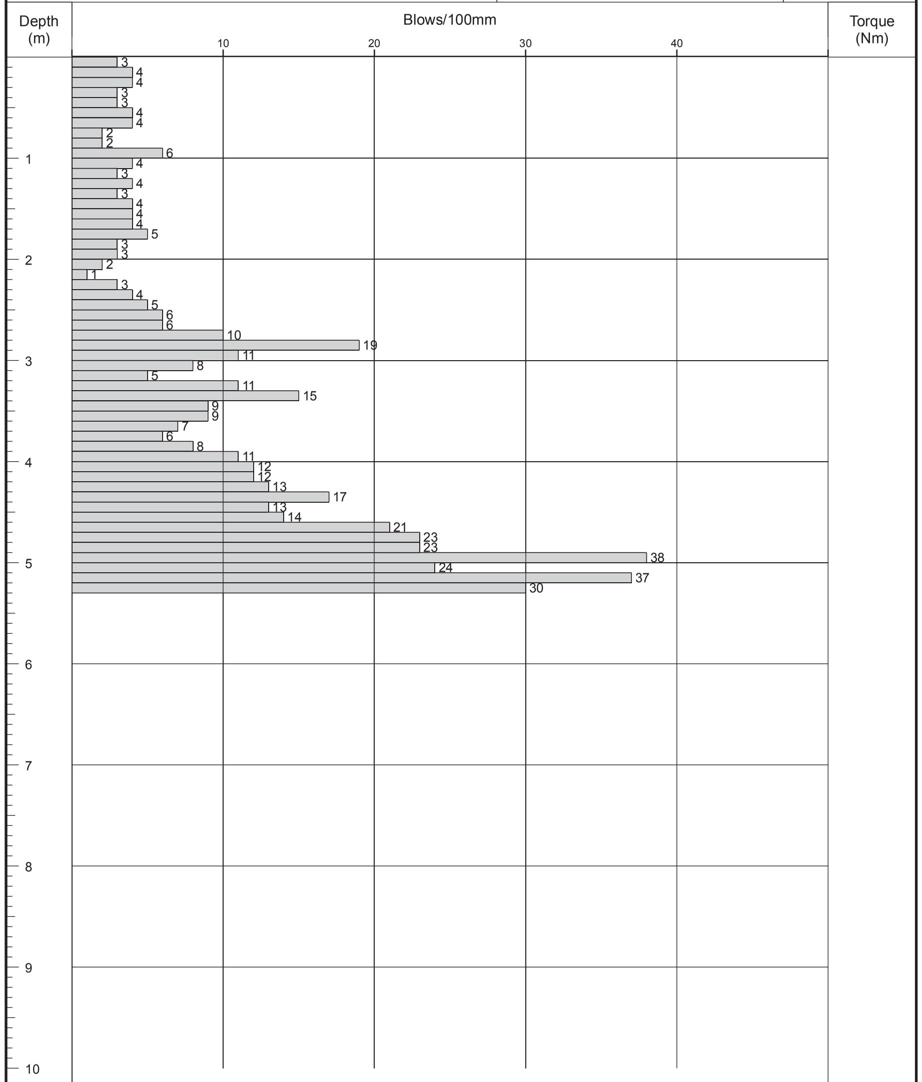
Remarks	Fall Height 750	Cone Base Diameter	AGS
	Hammer Wt 64	Final Depth 2.60	
	Probe Type DPSH-B	Log Scale 1:50	

CAUSEWAY GEOTECH	**Probe Log**		Borehole No. **DPBH03** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292472.42 - 228300.85	Hole Type DP
Location:		Level: 61.52	Scale 1:50
Client: Kildare County Council		Dates: 24/07/2015 -	Logged By



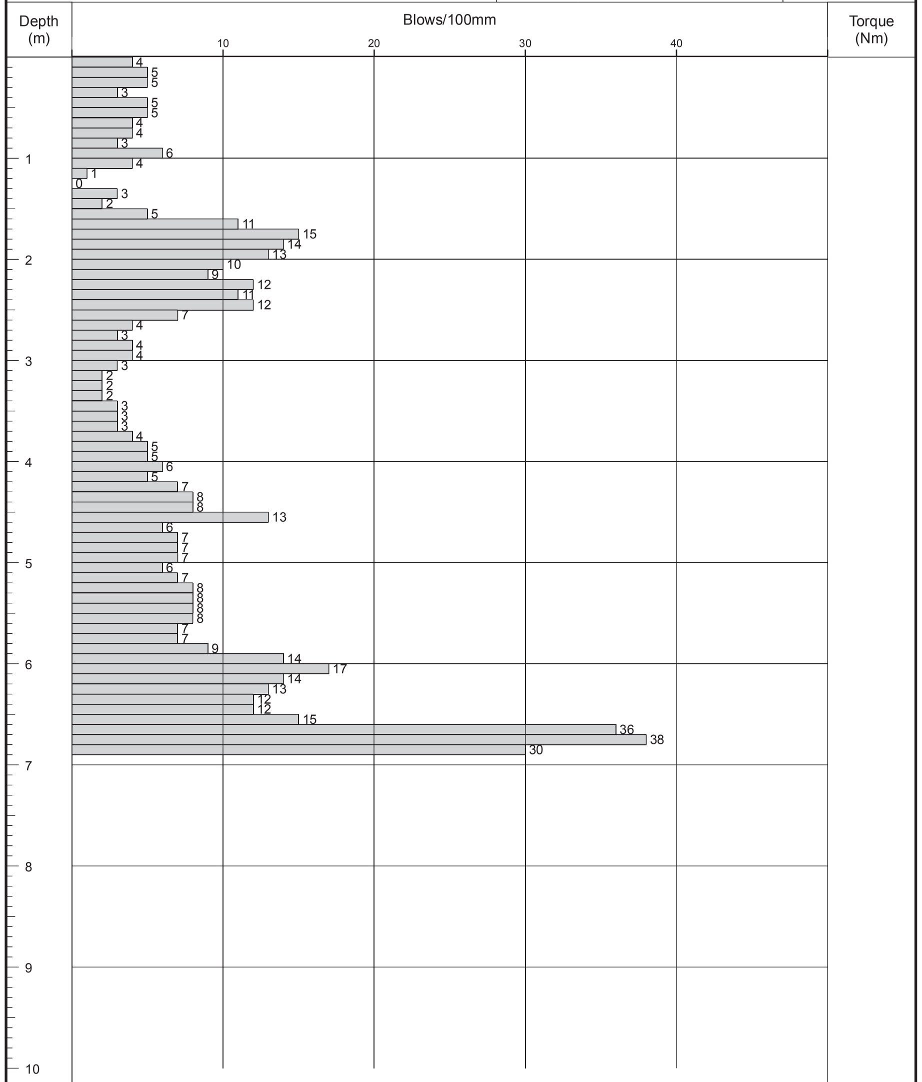
Remarks	Fall Height 750	Cone Base Diameter	AGS
	Hammer Wt 64	Final Depth 3.50	
	Probe Type DPSH-B	Log Scale 1:50	

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH04** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292377.75 - 228201.76	Hole Type DP
Location:		Level:	61.69	Scale 1:50
Client: Kildare County Council		Dates:	24/07/2015 -	Logged By



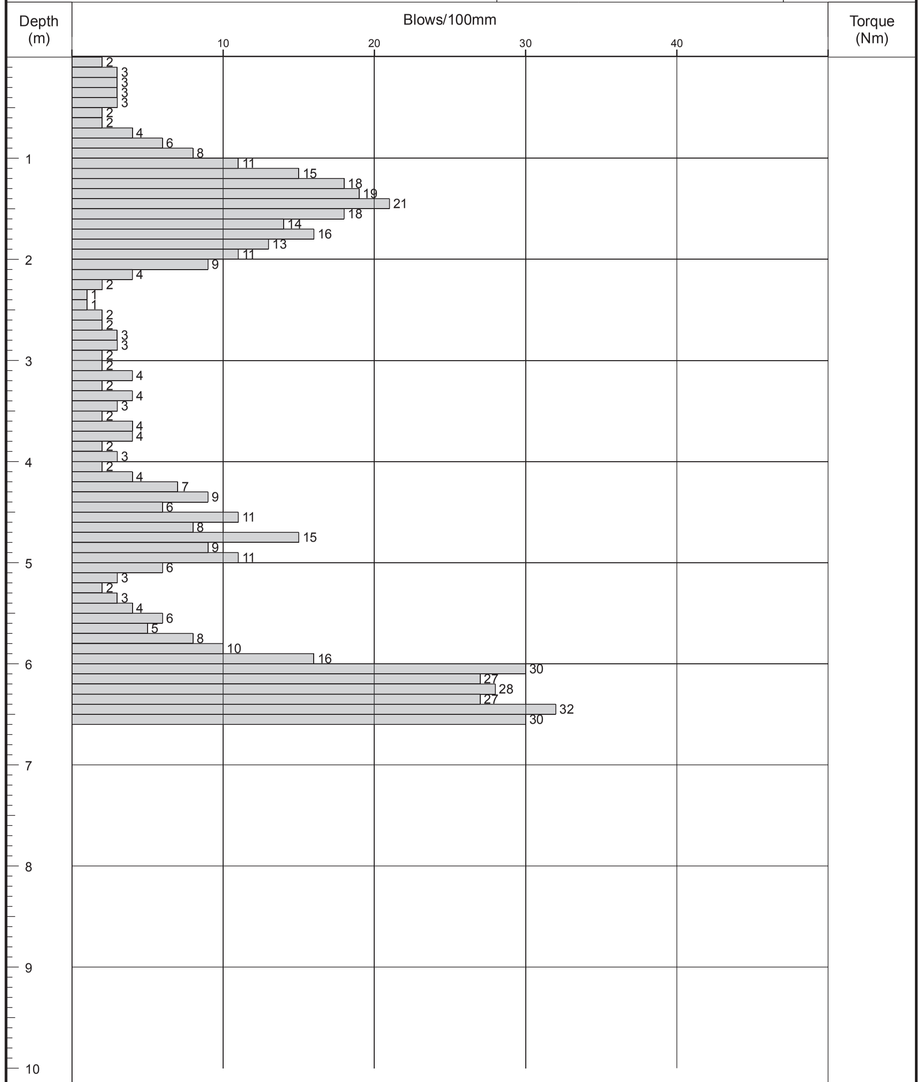
Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	5.20	
	Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH05** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292269.39 - 228094.01	Hole Type DP
Location:		Level:	62.47	Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	6.80	
	Probe Type	DPSH-B	Log Scale	1:50	

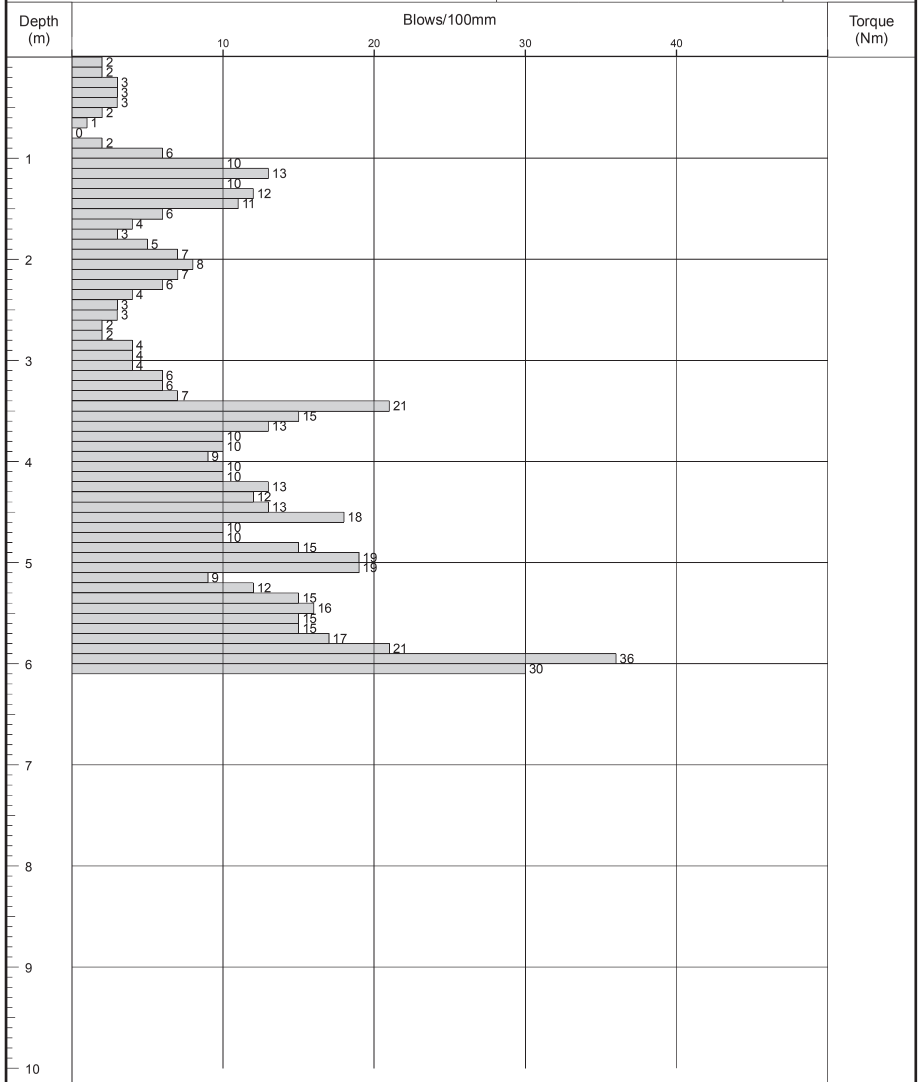
	Probe Log	Borehole No. DPBH06 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292252.61 - 227982.51	Hole Type DP
Location:		Level: 62.37	Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	6.50
	Probe Type	DPSH-B	Log Scale	1:50

AGS

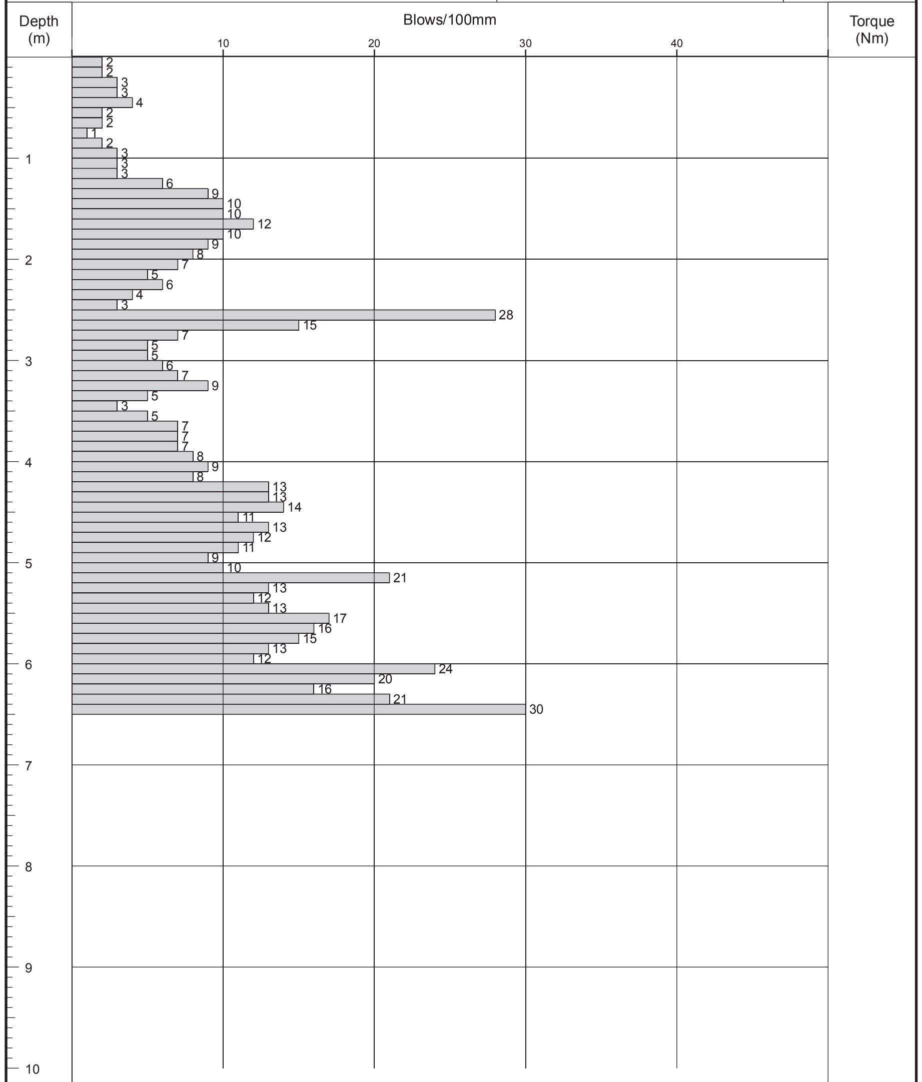
	Probe Log	Borehole No. DPBH07 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292211.60 - 227470.13	Hole Type DP
Location:		Level: 64.09	Scale 1:50
Client: Kildare County Council		Dates: 22/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	6.00
	Probe Type	DPSH-B	Log Scale	1:50

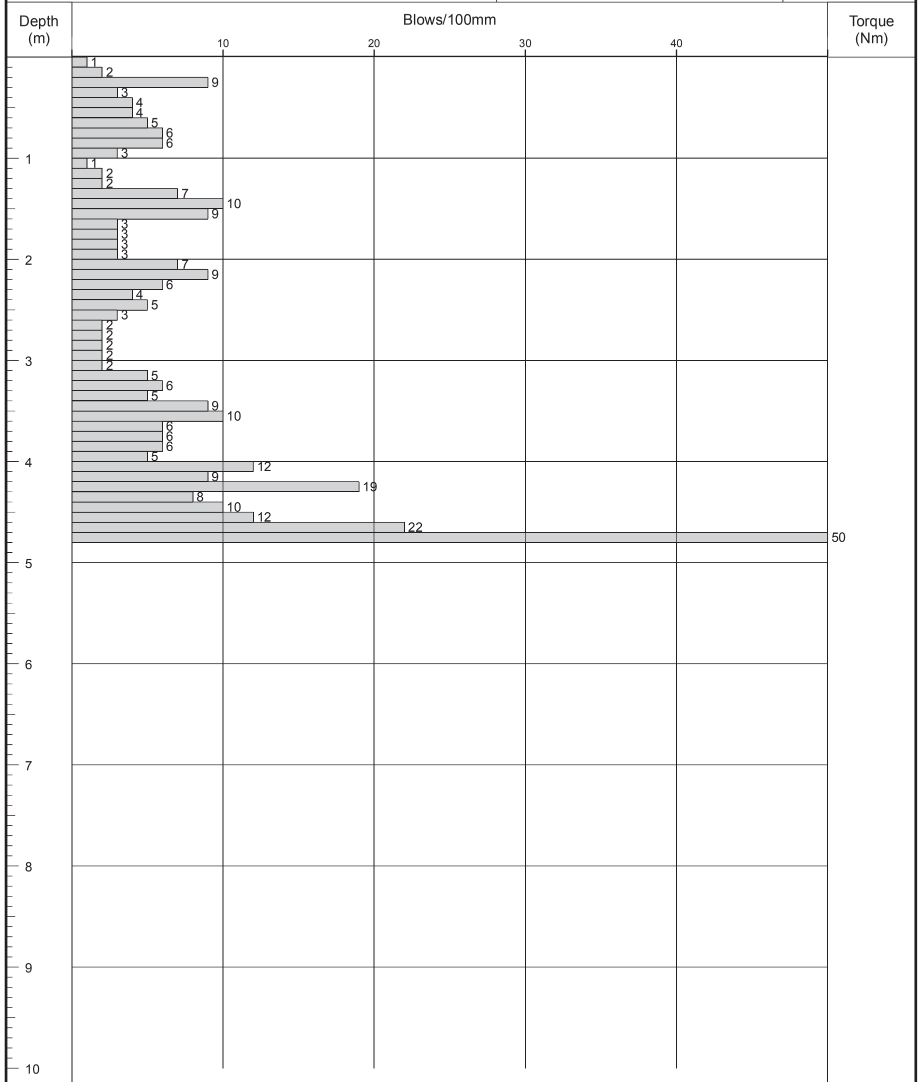
AGS

CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH08 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292230.50 - 227420.99	Hole Type DP
Location:		Level:	64.06	Scale 1:50
Client: Kildare County Council		Dates:	21/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	6.40	
	Probe Type	DPSH-B	Log Scale	1:50	

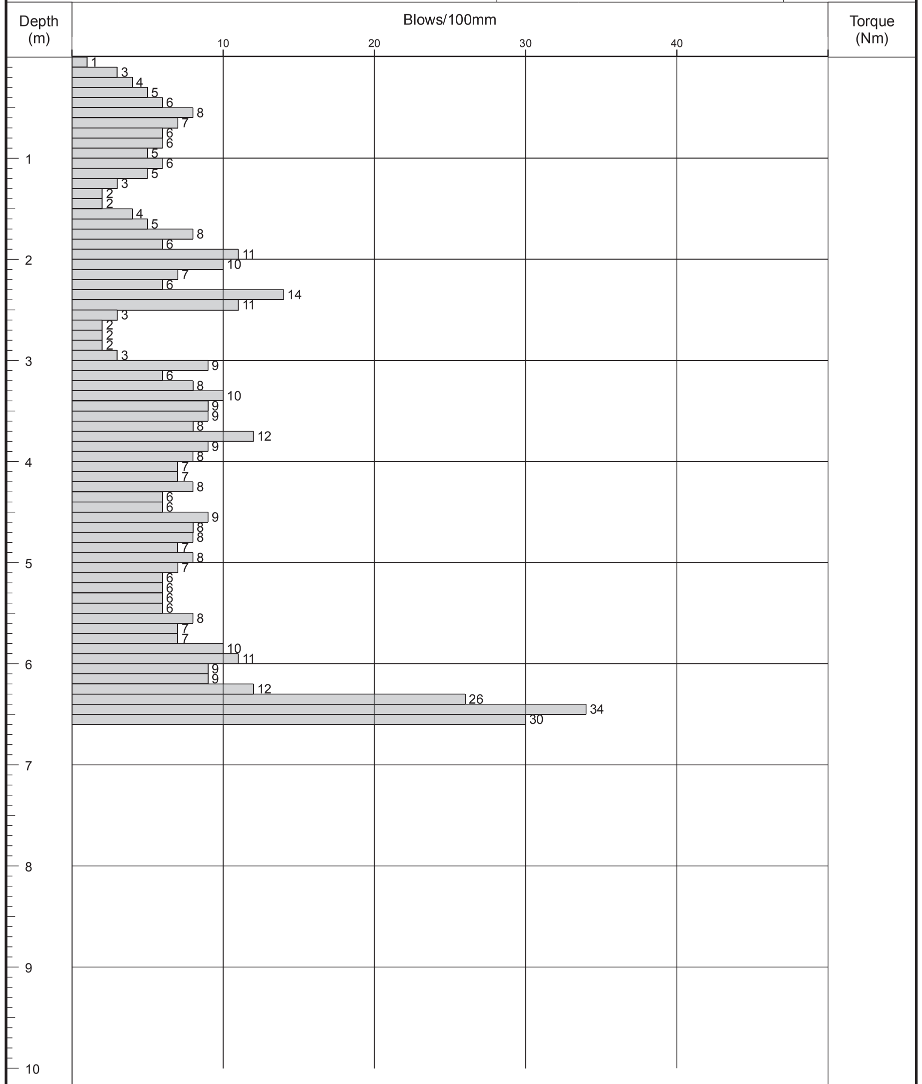
CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH09 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292247.63 - 227365.25	Hole Type DP
Location:		Level:	64.04	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	4.70	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

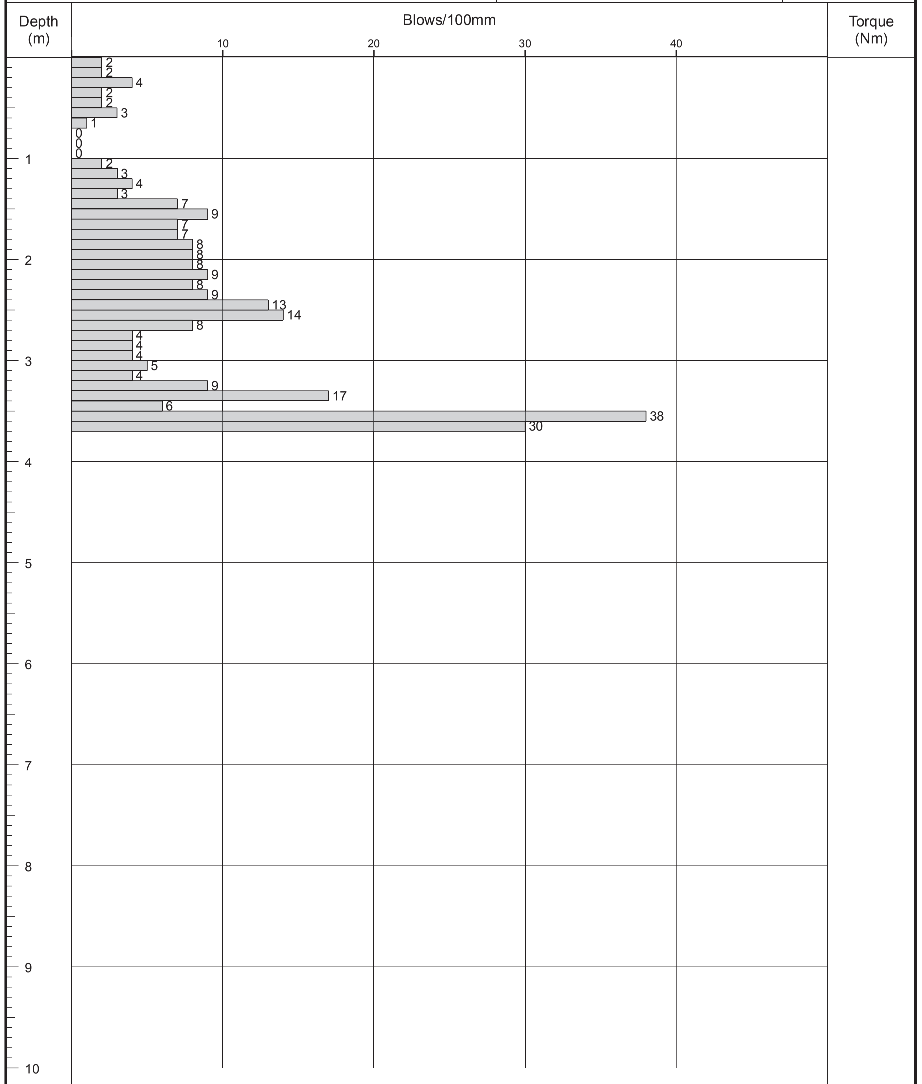
CAUSEWAY GEOTECH		Probe Log			Borehole No. **DPBH10** Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292254.29 - 227347.96	Hole Type DP
Location:			Level:	64.09	Scale 1:50
Client:	Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	6.50	
Probe Type	DPSH-B	Log Scale	1:50	

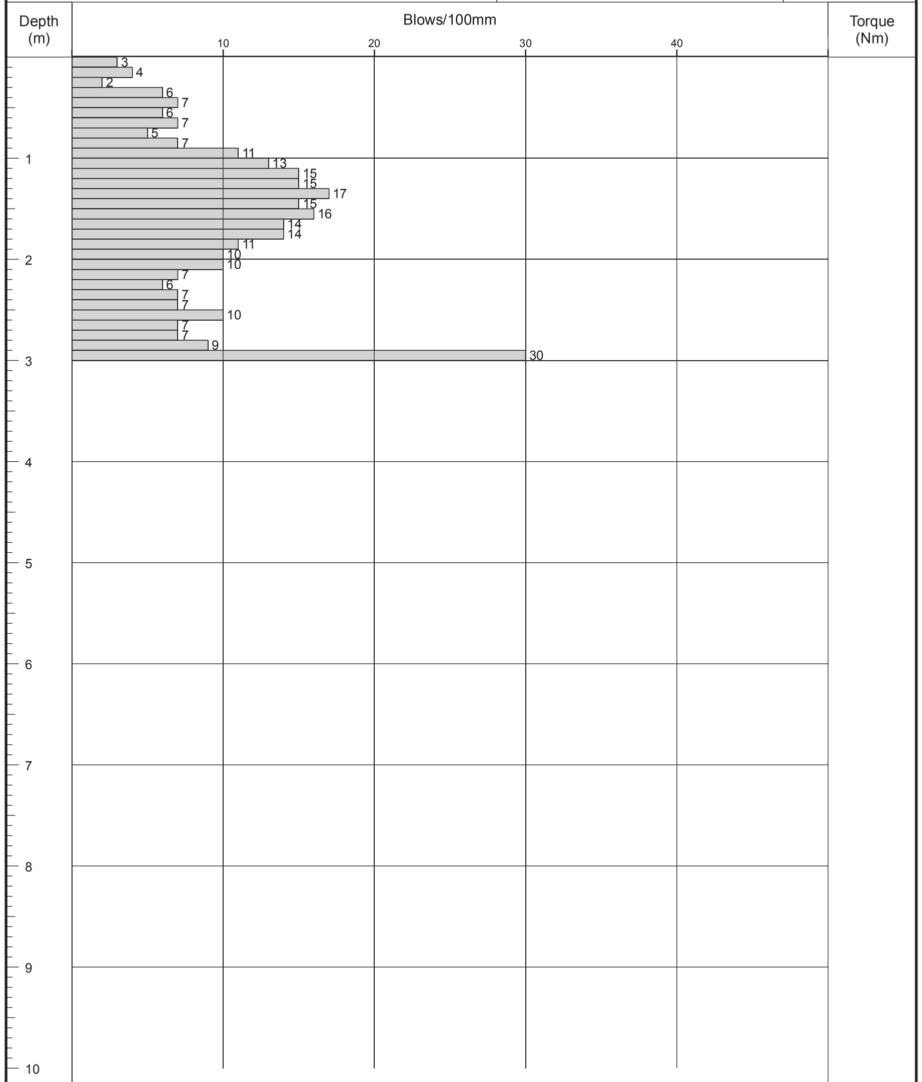
Probe Log

CAUSEWAY GEOTECH		Probe Log			Borehole No. **DPBH12** Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292176.06 - 227070.09	Hole Type DP
Location:			Level:	64.65	Scale 1:50
Client:	Kildare County Council		Dates:	21/07/2015 -	Logged By



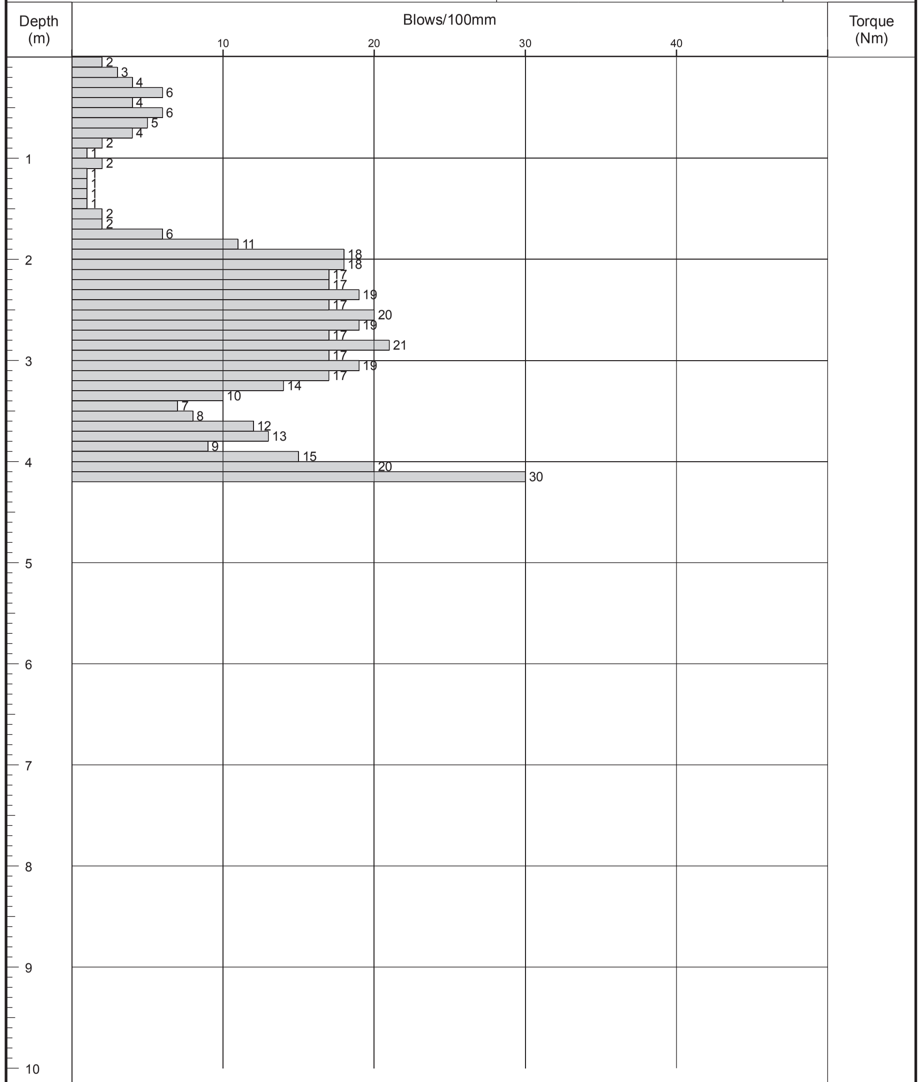
Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	3.60	
Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	# Probe Log	Borehole No. **DPBH13** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292233.27 - 227196.25	Hole Type DP
Location:		Level: 64.74	Scale 1:50
Client: Kildare County Council		Dates: 21/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	2.90
	Probe Type	DPSH-B	Log Scale	1:50

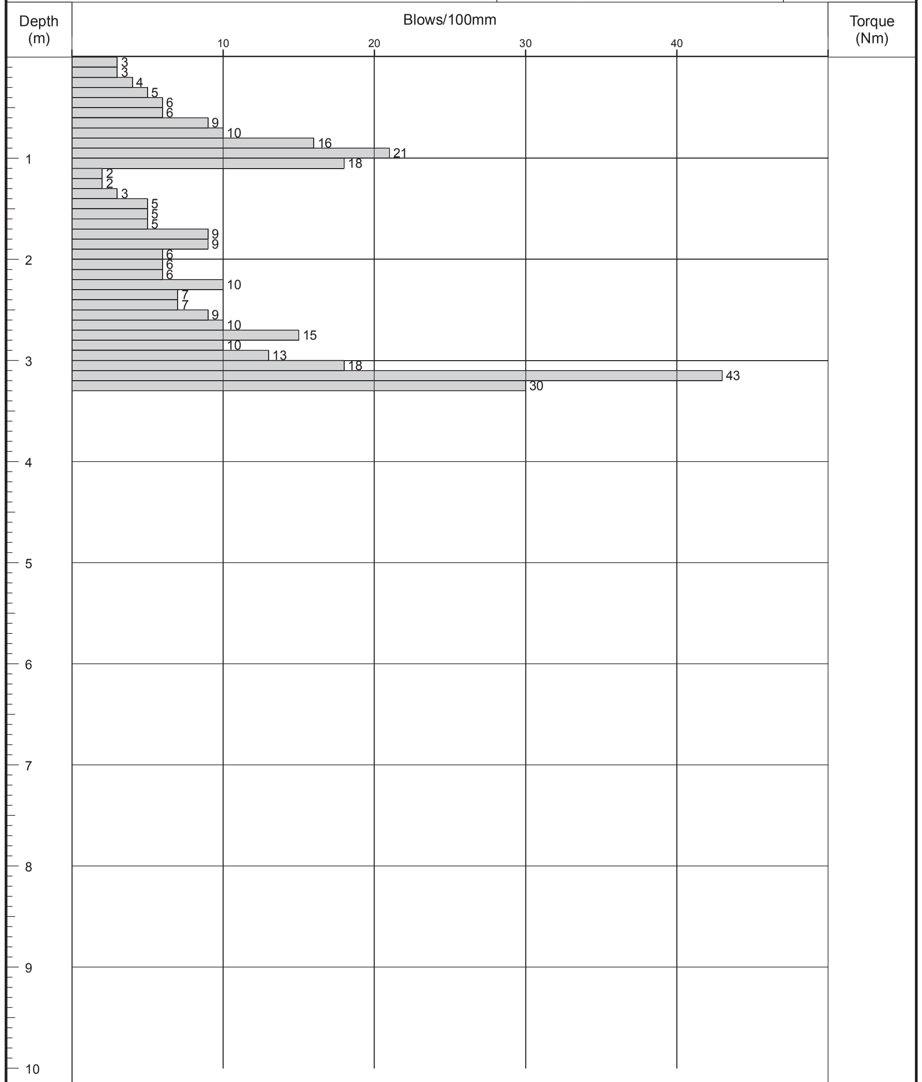
CAUSEWAY GEOTECH	# Probe Log	Borehole No. **DPBH14** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292335.31 - 227254.38	Hole Type DP
Location:		Level: 64.19	Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	4.10
	Probe Type	DPSH-B	Log Scale	1:50

Probe Log

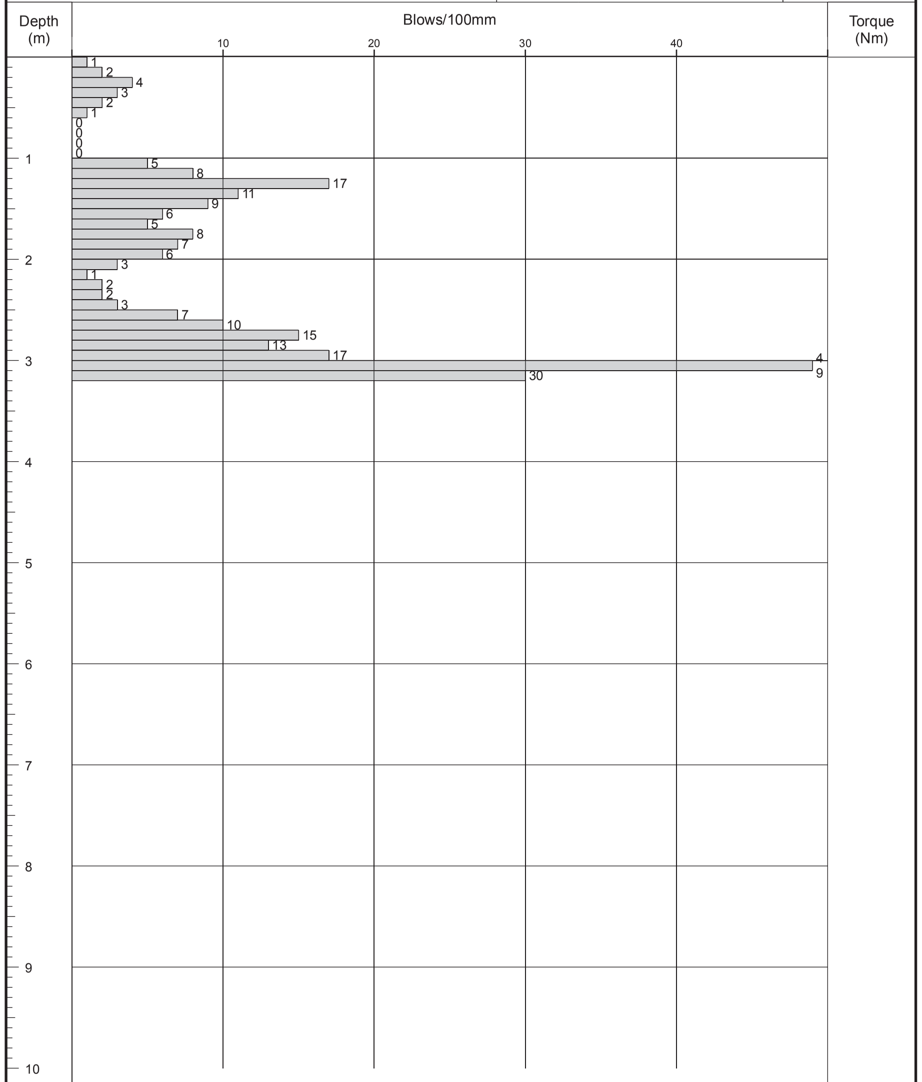
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292394.56 - 227201.20		Borehole No. DPBH15 Sheet 1 of 1
				Hole Type DP
Location:		Level: 63.89		Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -		Logged By



Remarks	Fall Height 750		Cone Base Diameter	
	Hammer Wt 64		Final Depth	3.20
	Probe Type DPSH-B		Log Scale	1:50

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292394.32 - 227057.22		Borehole No. DPBH16 Sheet 1 of 1
				Hole Type DP
Location:		Level: 64.14		Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -		Logged By

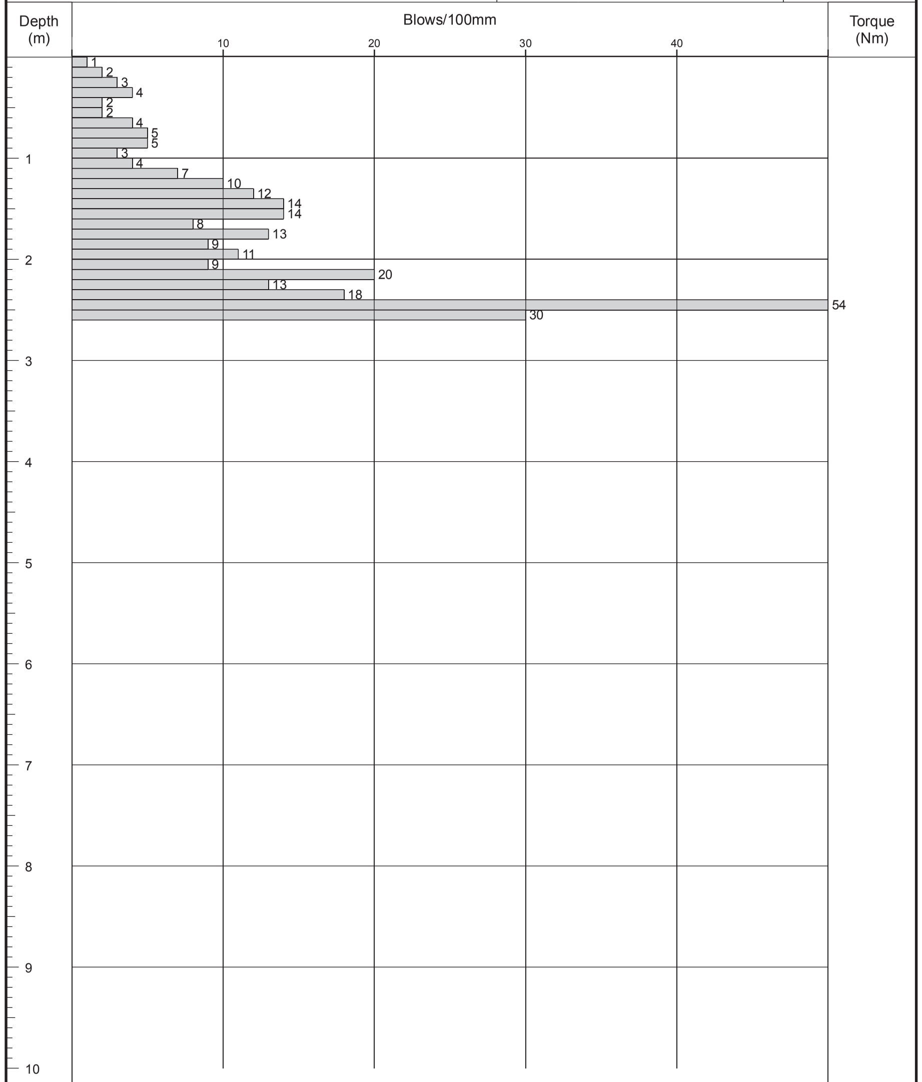


Remarks	Fall Height 750		Cone Base Diameter	
	Hammer Wt 64		Final Depth	3.10
	Probe Type DPSH-B		Log Scale	1:50

Probe Log

Borehole No.	DPBH17	Sheet 1 of 1

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292395.96 - 226931.81	Hole Type DP
Location:		Level:	64.64	Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



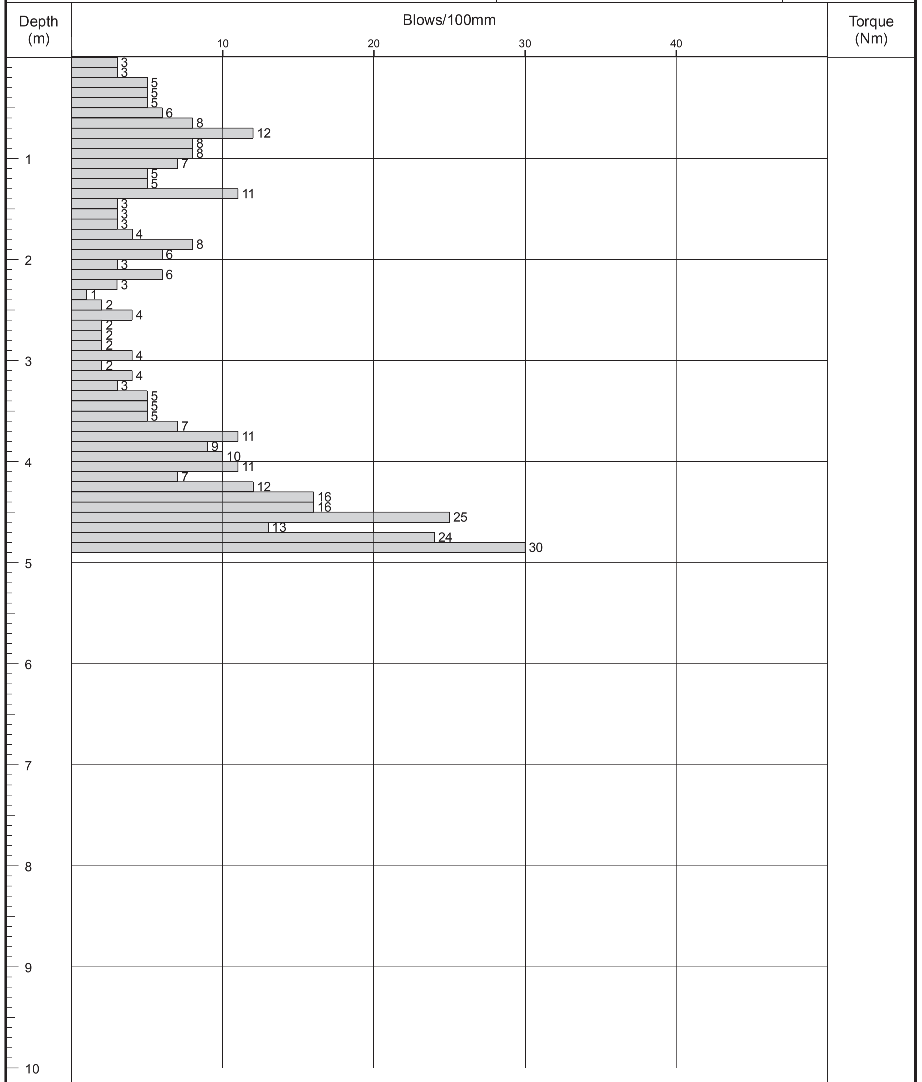
Remarks

Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	2.50	
Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

Borehole No.	DPBH18	Sheet 1 of 1

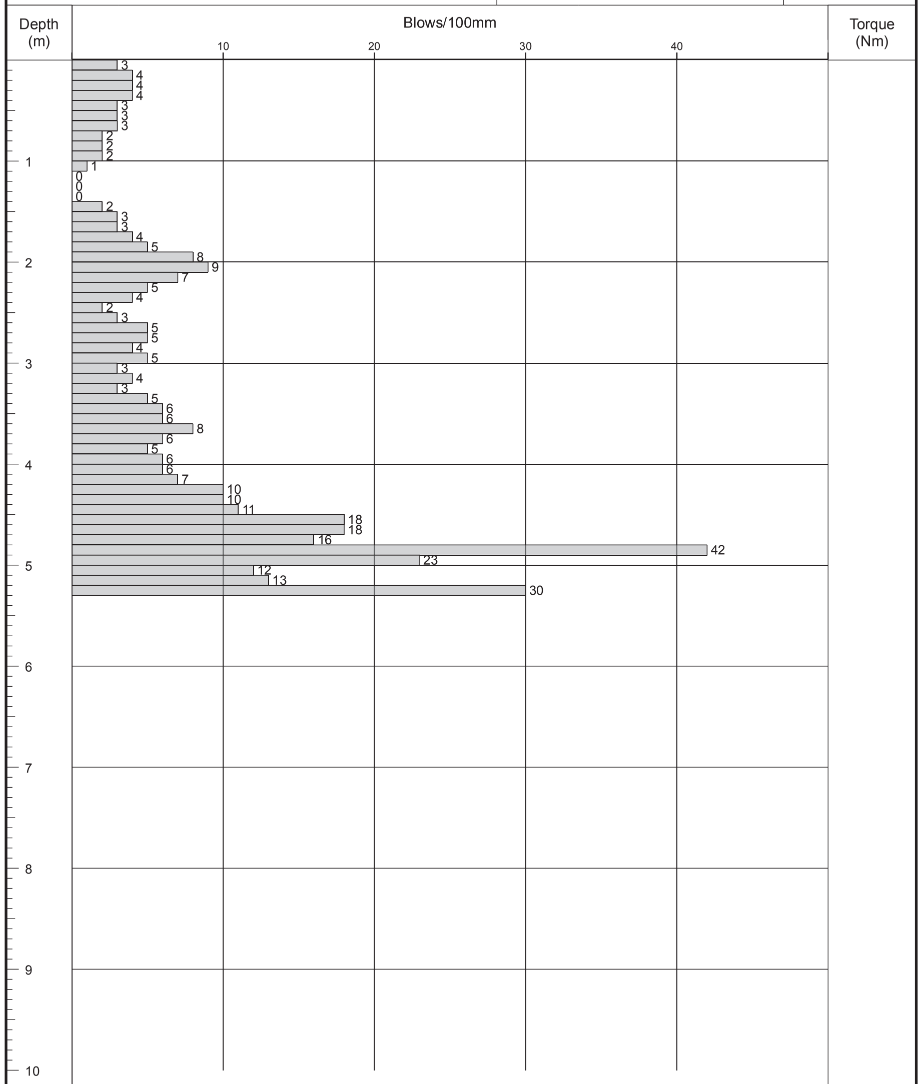
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292395.95 - 226835.11	Hole Type DP
Location:		Level:	65.09	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks

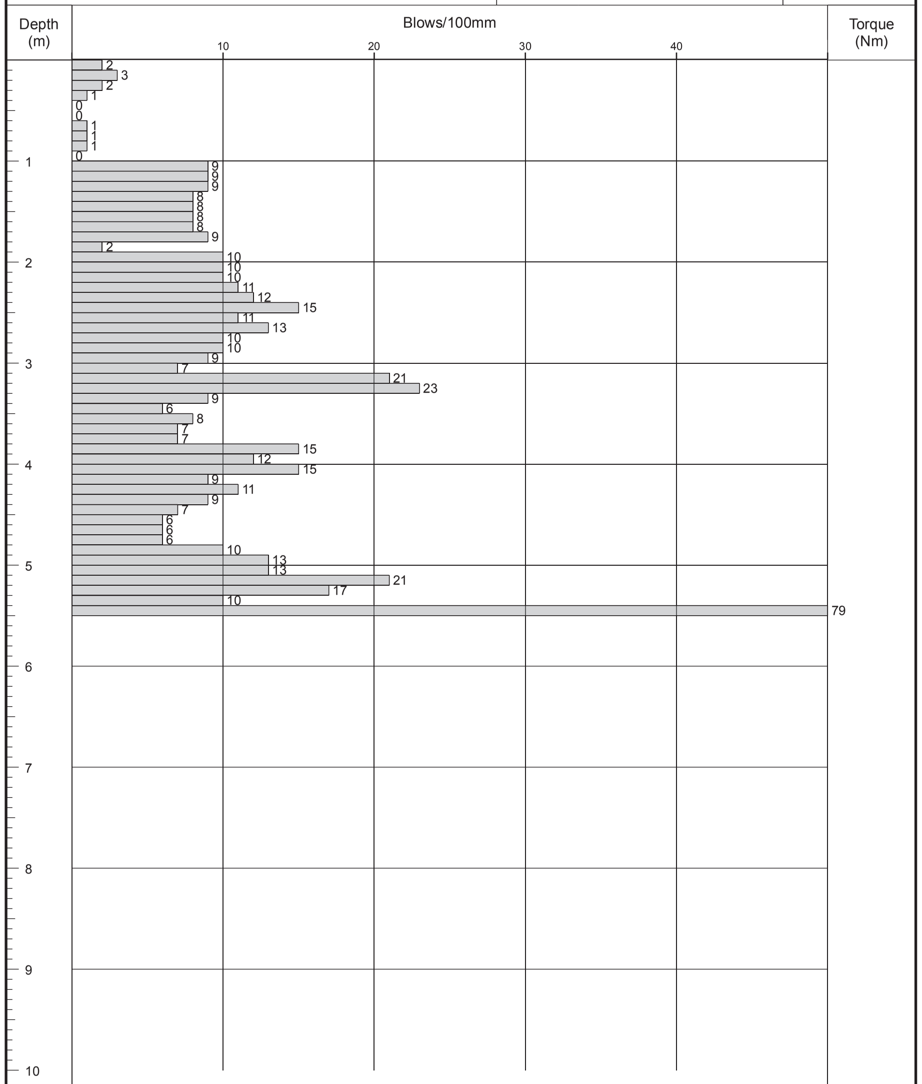
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	4.80	
Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	**Probe Log**			Borehole No. **DPBH19** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292218.95 - 226714.90	Hole Type DP
Location:		Level:	66.21	Scale 1:50
Client: Kildare County Council		Dates:	30/07/2015 -	Logged By



Remarks	Fall Height 750	Cone Base Diameter		AGS
	Hammer Wt 64	Final Depth	6.30	
	Probe Type DPSH-B	Log Scale	1:50	

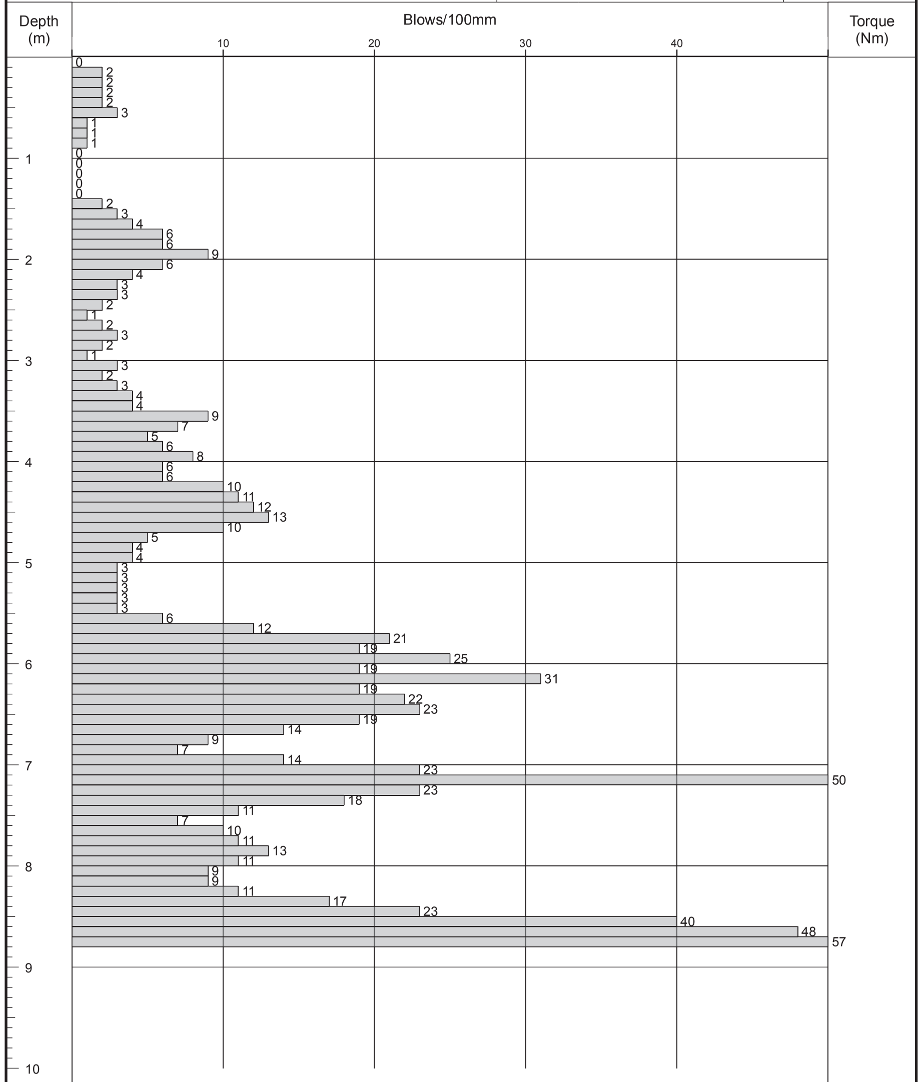
CAUSEWAY GEOTECH	**Probe Log**			Borehole No. **DPBH20** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292275.65 - 226633.34	Hole Type DP
Location:		Level:	65.74	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks	Fall Height 750	Cone Base Diameter		AGS
	Hammer Wt 64	Final Depth	5.40	
	Probe Type DPSH-B	Log Scale	1:50	

Probe Log

CAUSEWAY GEOTECH	Probe Log		Borehole No. **DPBH21** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292268.16 - 226537.38	Hole Type DP
Location:		Level: 66.60	Scale 1:50
Client: Kildare County Council		Dates: 24/07/2015 -	Logged By

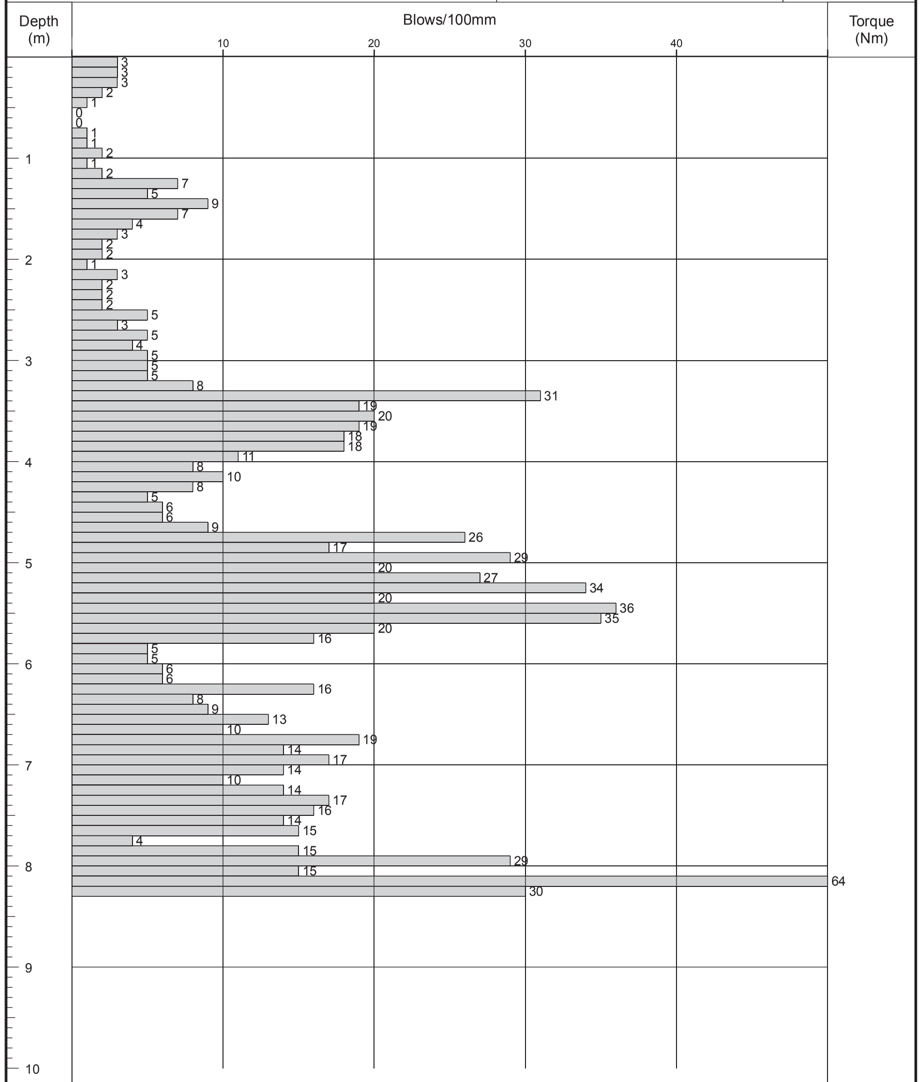


Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	8.70
	Probe Type	DPSH-B	Log Scale	1:50

AGS

Probe Log

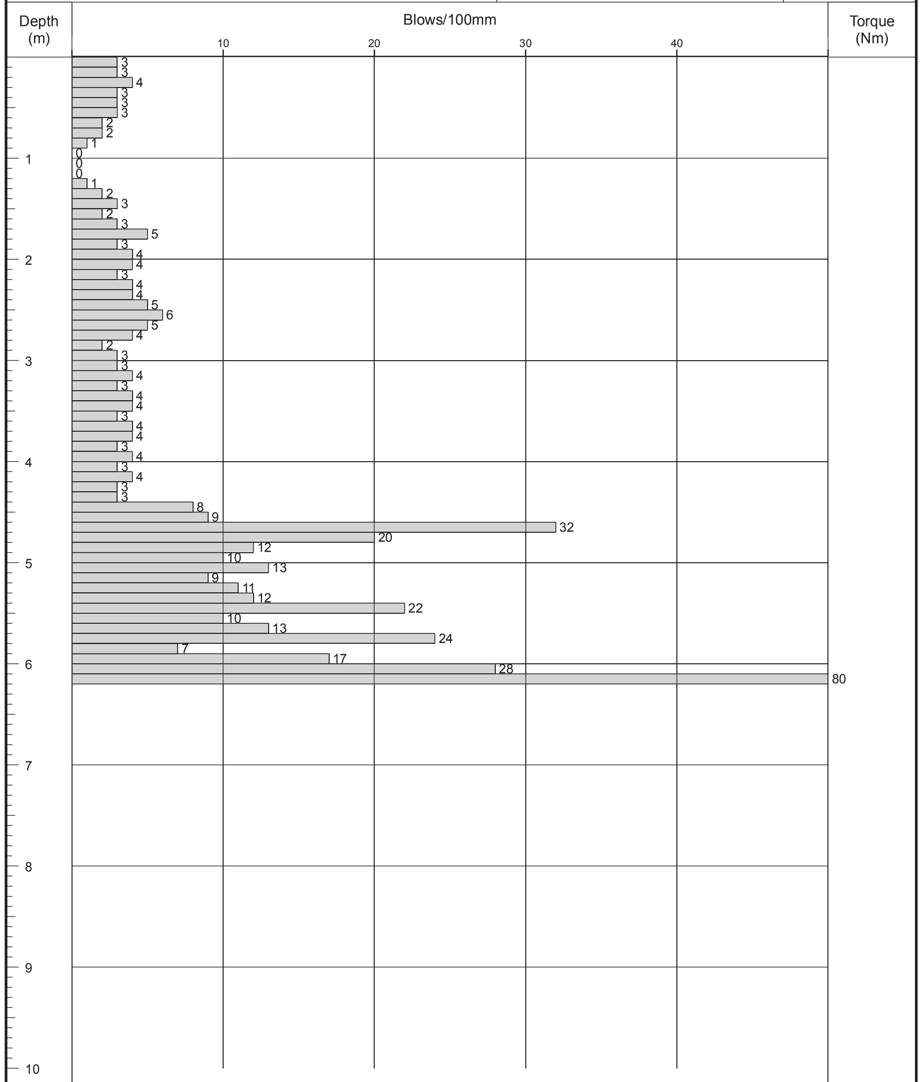
CAUSEWAY GEOTECH	Probe Log		Borehole No. **DPBH22** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292292.58 - 226533.26	Hole Type DP
Location:		Level: 66.29	Scale 1:50
Client: Kildare County Council		Dates: 22/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	8.20
	Probe Type	DPSH-B	Log Scale	1:50

AGS

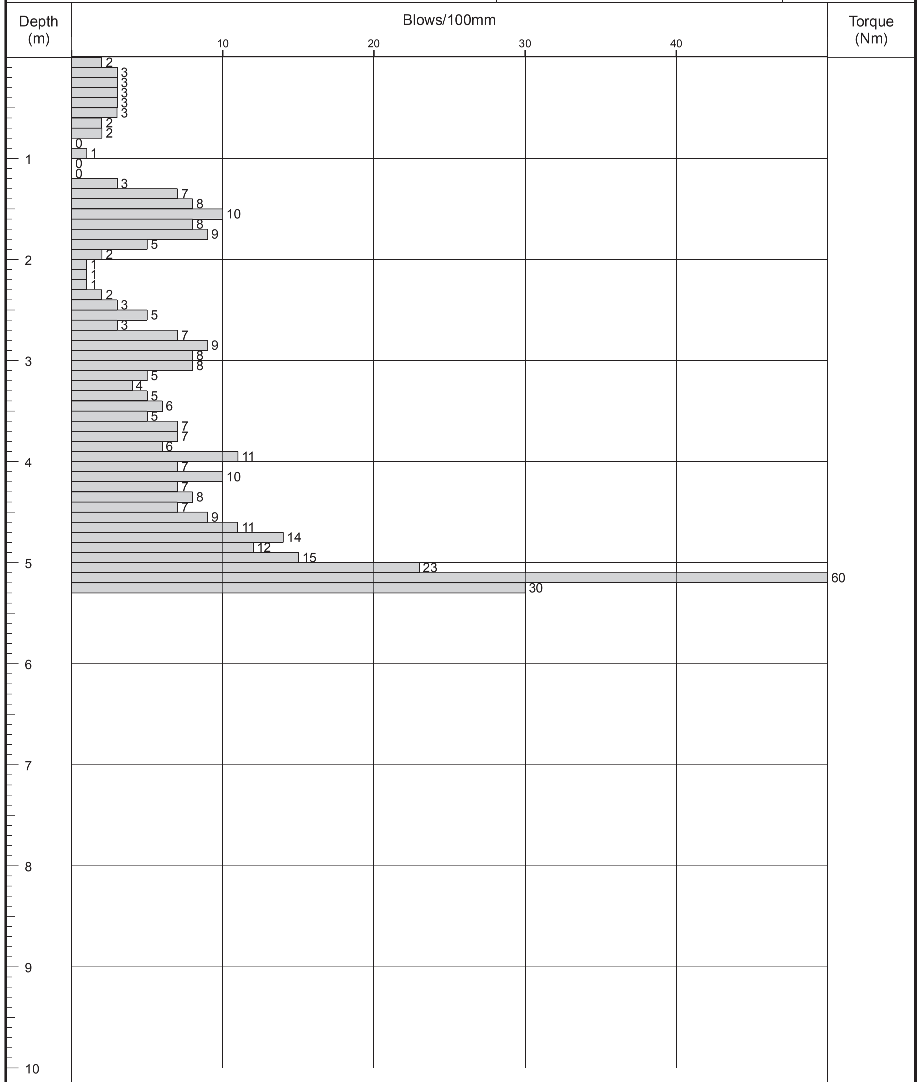
CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH23 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292313.56 - 226470.50	Hole Type DP
Location:		Level:	66.77	Scale 1:50
Client: Kildare County Council		Dates:	24/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	6.10
	Probe Type	DPSH-B	Log Scale	1:50

AGS

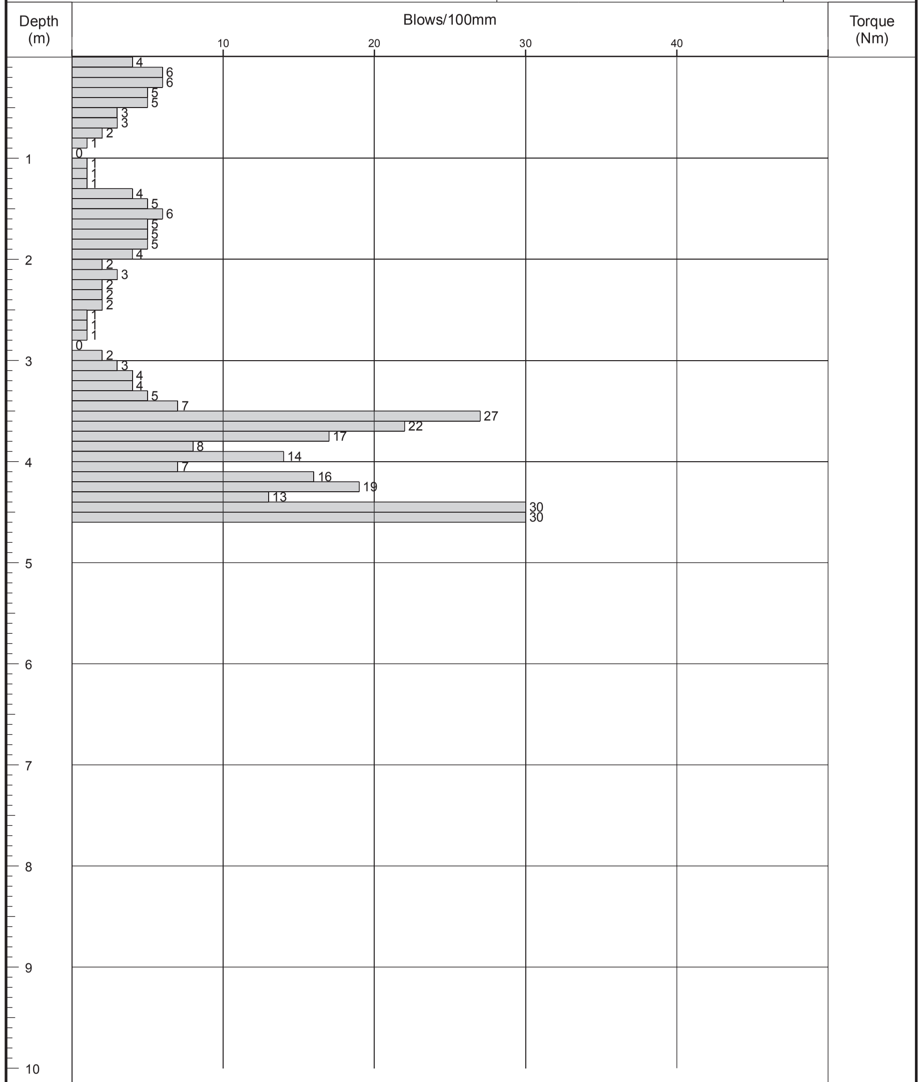
CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH25 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292374.26 - 226426.71	Hole Type DP
Location:		Level:	67.05	Scale 1:50
Client: Kildare County Council		Dates:	24/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	5.20
	Probe Type	DPSH-B	Log Scale	1:50

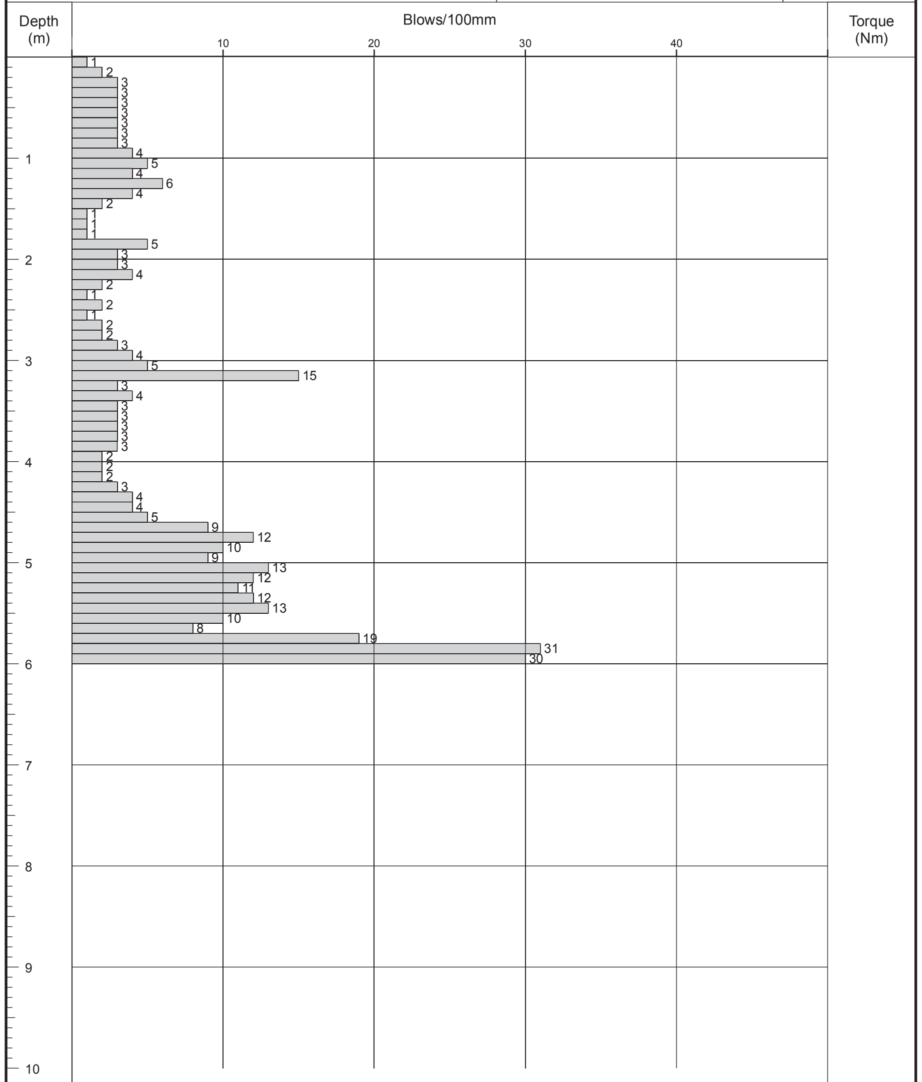
AGS

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH26** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292454.73 - 226401.45	Hole Type DP
Location:		Level:	67.47	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	4.50	
	Probe Type	DPSH-B	Log Scale	1:50	

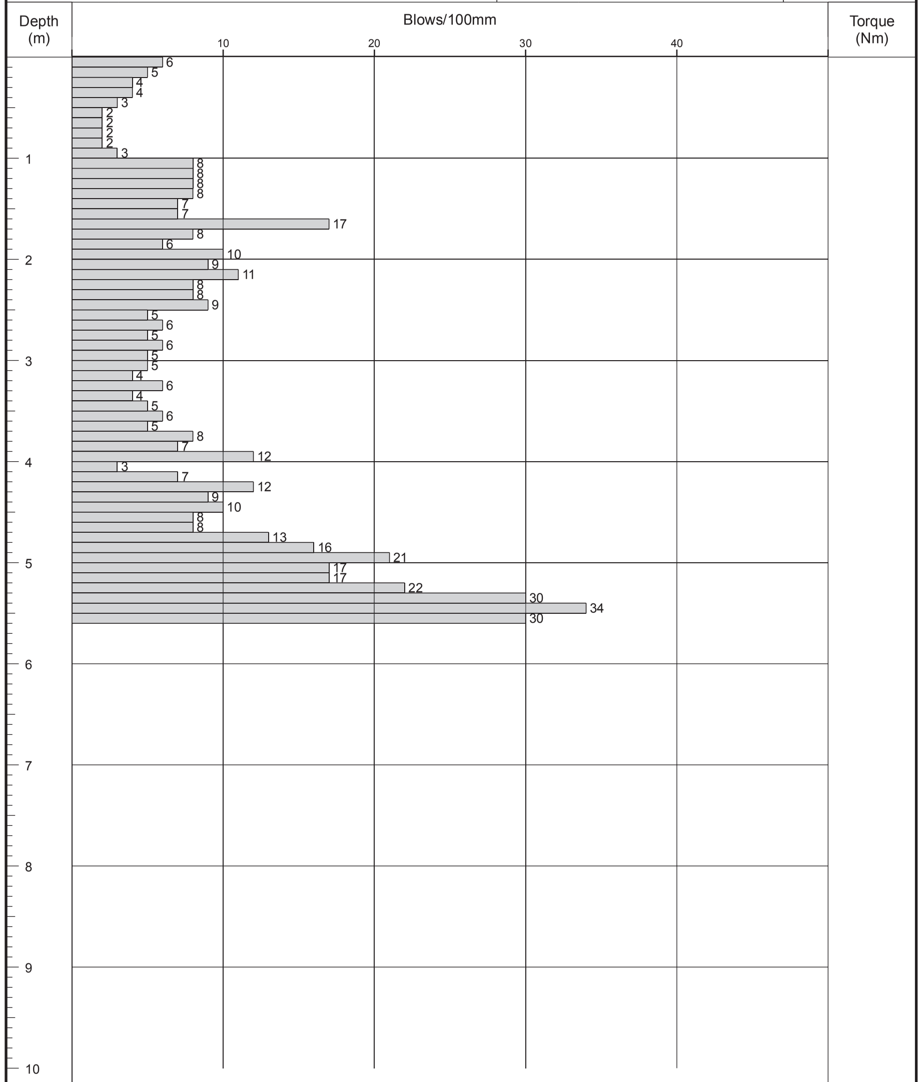
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH27** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292519.68 - 226387.84	Hole Type DP
Location:		Level:	67.39	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	5.90	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

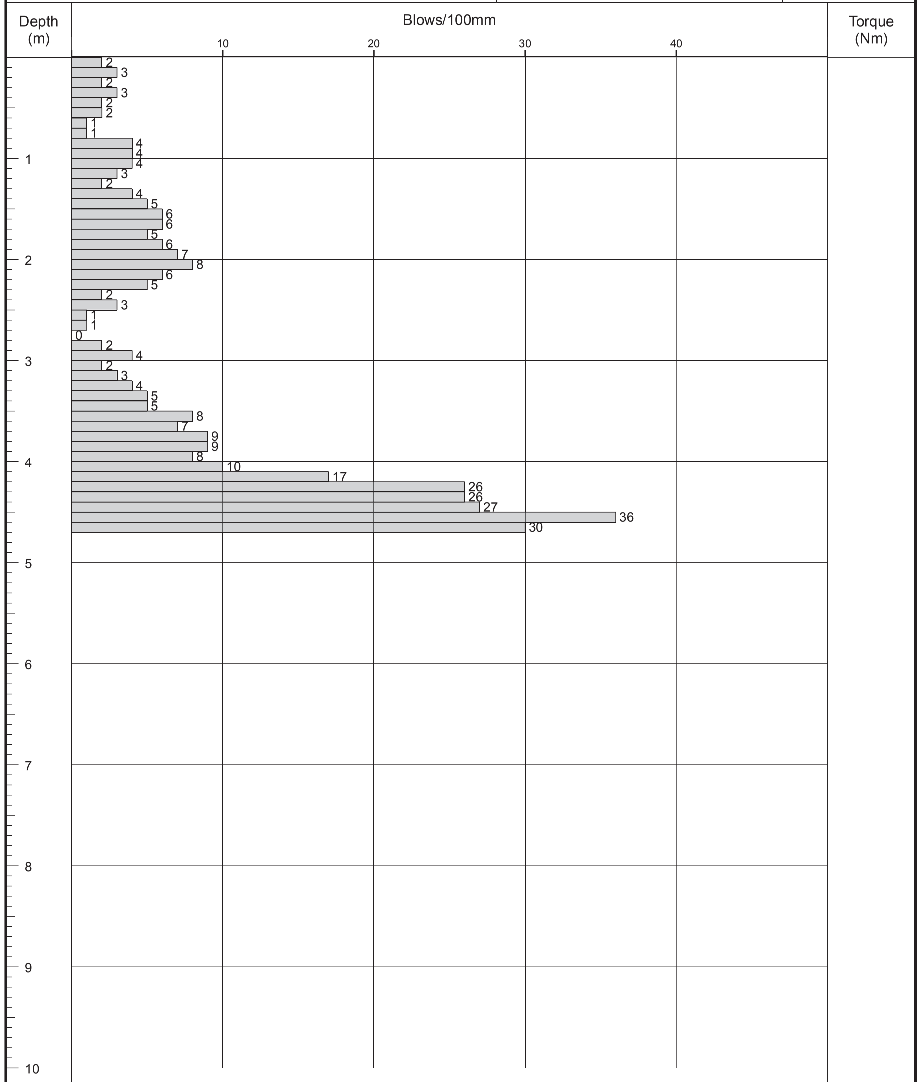
CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH28 Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292515.57 - 226371.45	Hole Type DP
Location:			Level: 68.32	Scale 1:50
Client:	Kildare County Council		Dates: 22/07/2015 -	Logged By



Remarks				
	Fall Height 750	Cone Base Diameter		AGS
	Hammer Wt 64	Final Depth	5.50	
	Probe Type DPSH-B	Log Scale	1:50	

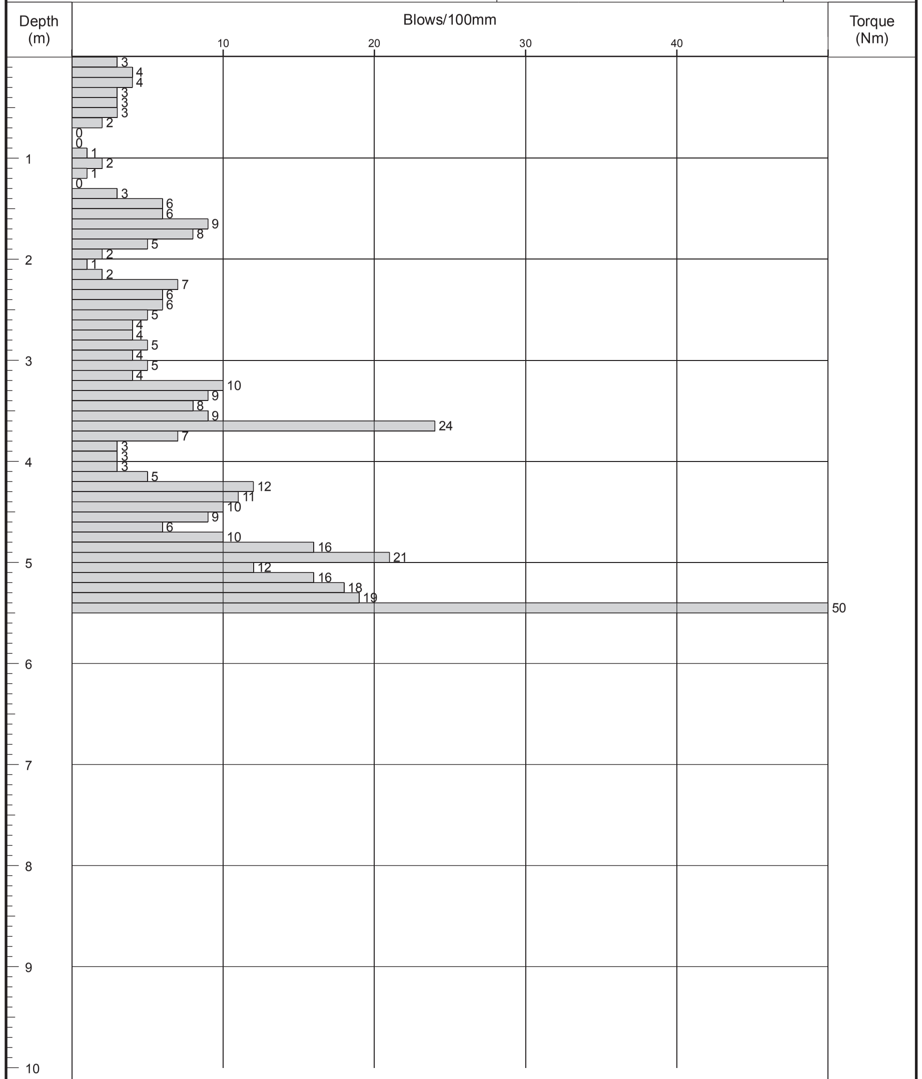
Probe Log

CAUSEWAY GEOTECH	Probe Log			Borehole No. DPBH29 Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292643.23 - 226316.27	Hole Type DP
Location:			Level: 68.02	Scale 1:50
Client:	Kildare County Council		Dates: 22/07/2015 -	Logged By



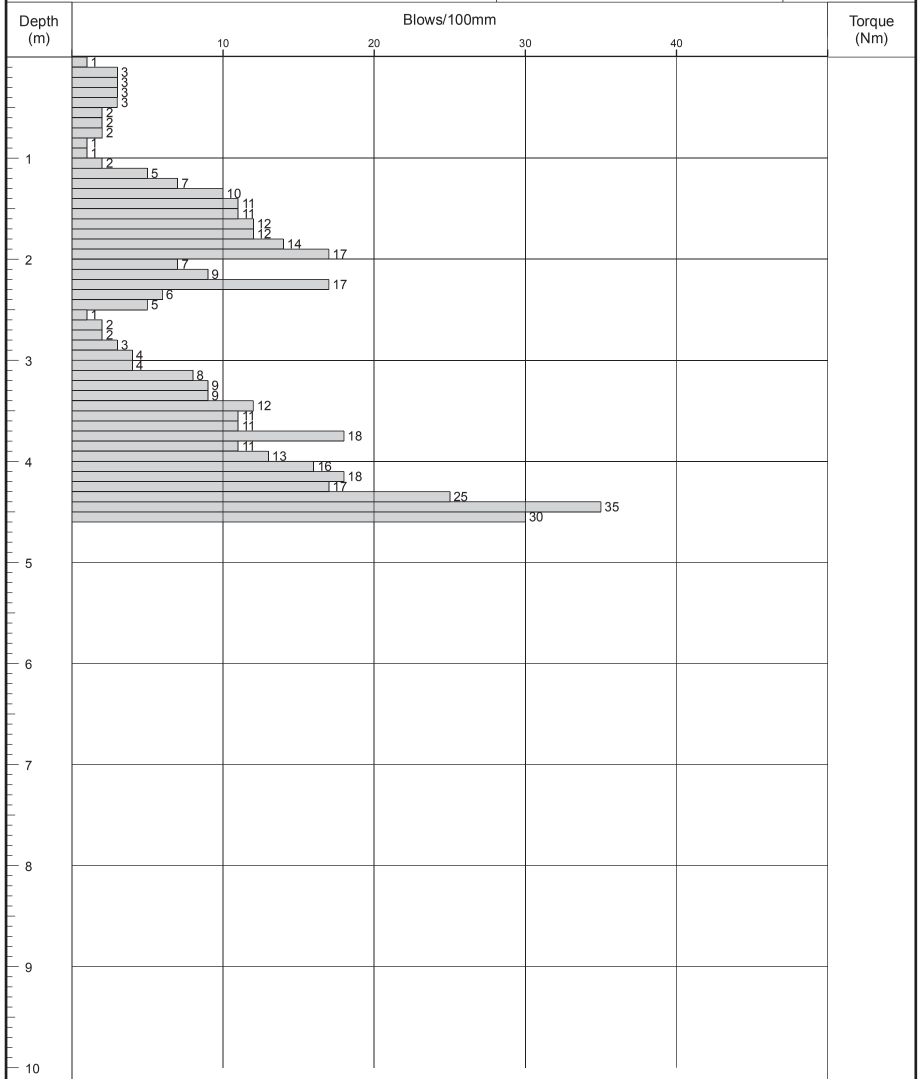
Remarks				
	Fall Height 750	Cone Base Diameter		AGS
	Hammer Wt 64	Final Depth	4.60	
	Probe Type DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH30** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292669.91 - 226281.15	Hole Type DP
Location:		Level:	68.19	Scale 1:50
Client: Kildare County Council		Dates:	22/07/2015 -	Logged By



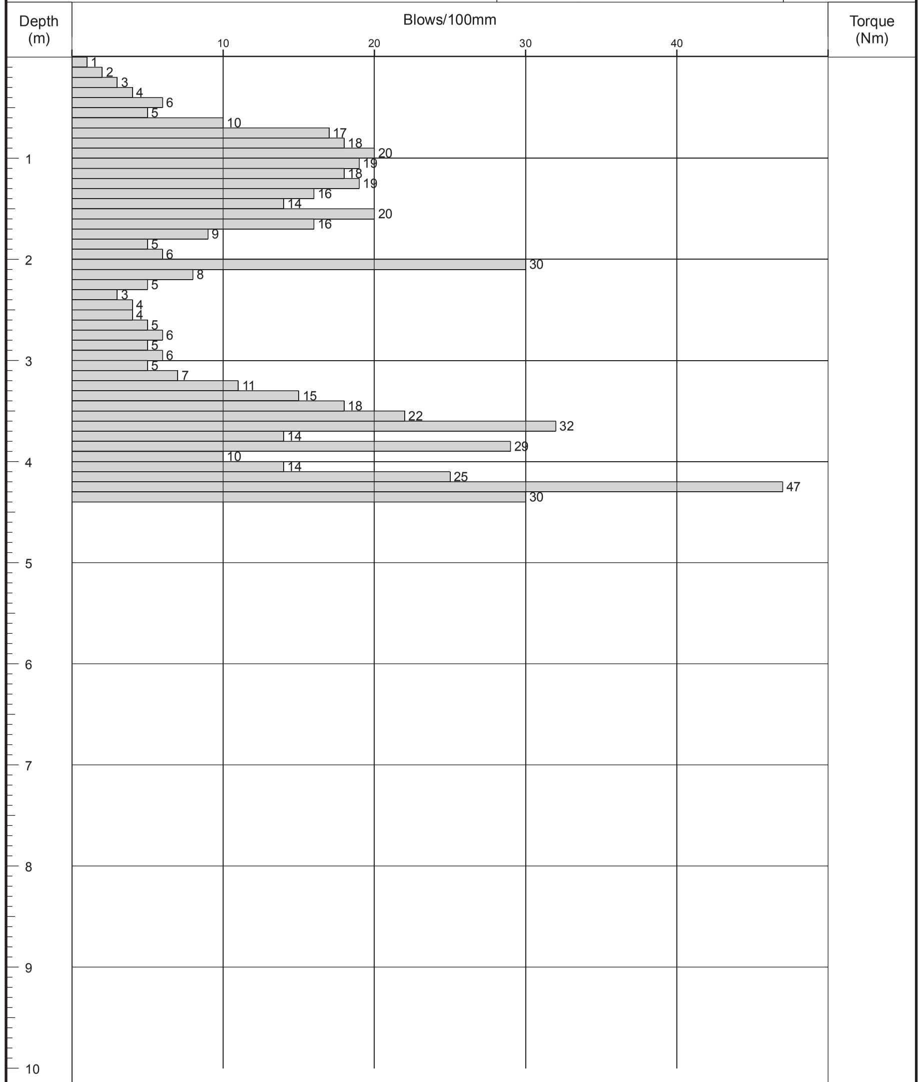
Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	5.40	
	Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH31** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292057.50 - 226278.63	Hole Type DP
Location:		Level:	66.04	Scale 1:50
Client: Kildare County Council		Dates:	30/07/2015 -	Logged By



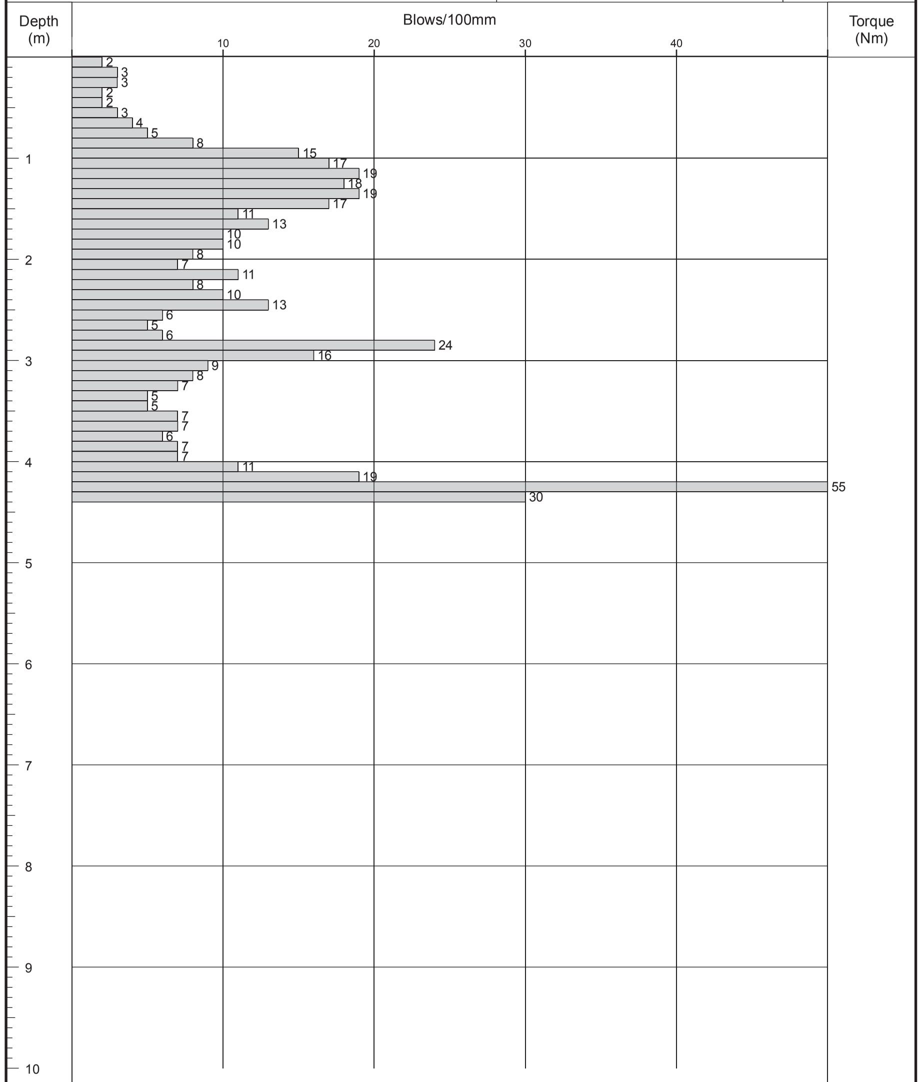
Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	4.50	
	Probe Type	DPSH-B	Log Scale	1:50	

Causeway Geotech	Probe Log			Borehole No. **DPBH32** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	291949.76 - 226212.96	Hole Type DP
Location:		Level:	66.38	Scale 1:50
Client: Kildare County Council		Dates:	30/07/2015 -	Logged By



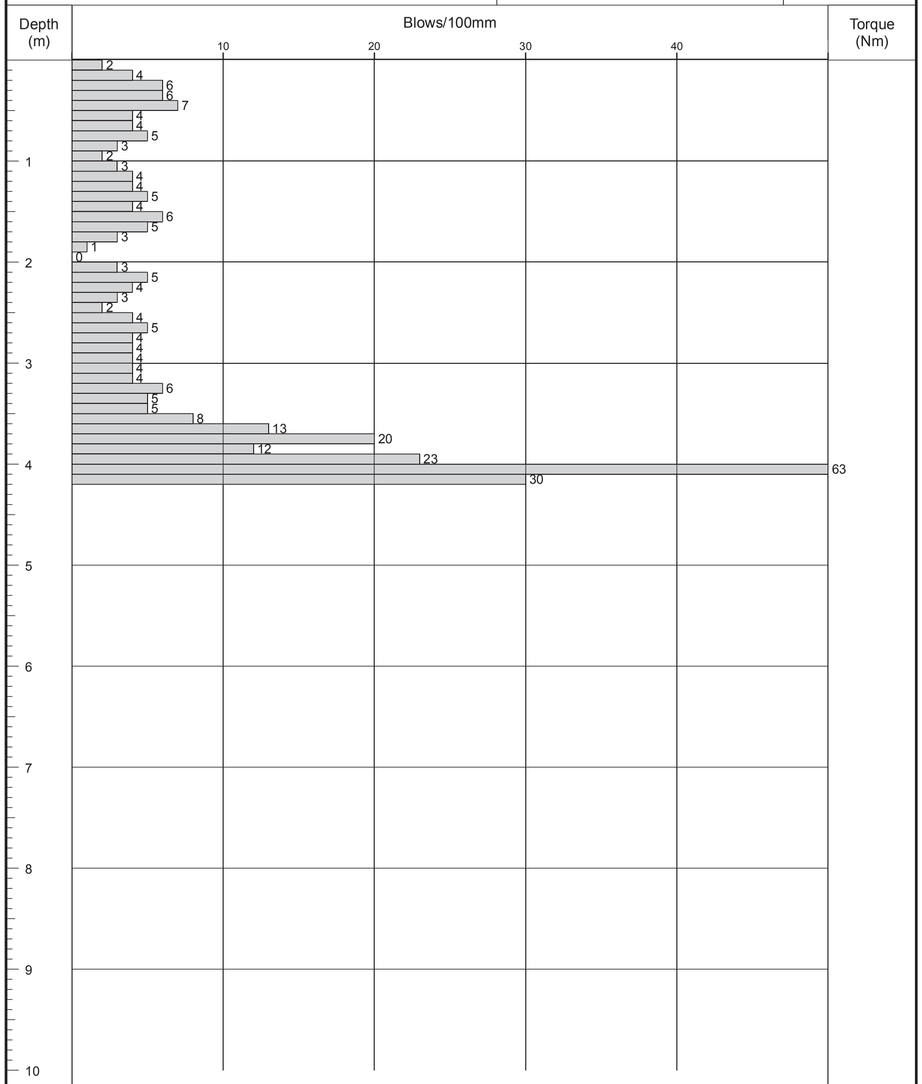
Remarks	Fall Height 750	Cone Base Diameter	
	Hammer Wt 64	Final Depth	4.40
	Probe Type DPSH-B	Log Scale	1:50

Causeway Geotech	Probe Log			Borehole No. **DPBH33** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	291806.58 - 225998.66	Hole Type DP
Location:		Level:	67.20	Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



Remarks	Fall Height 750	Cone Base Diameter	
	Hammer Wt 64	Final Depth	4.30
	Probe Type DPSH-B	Log Scale	1:50

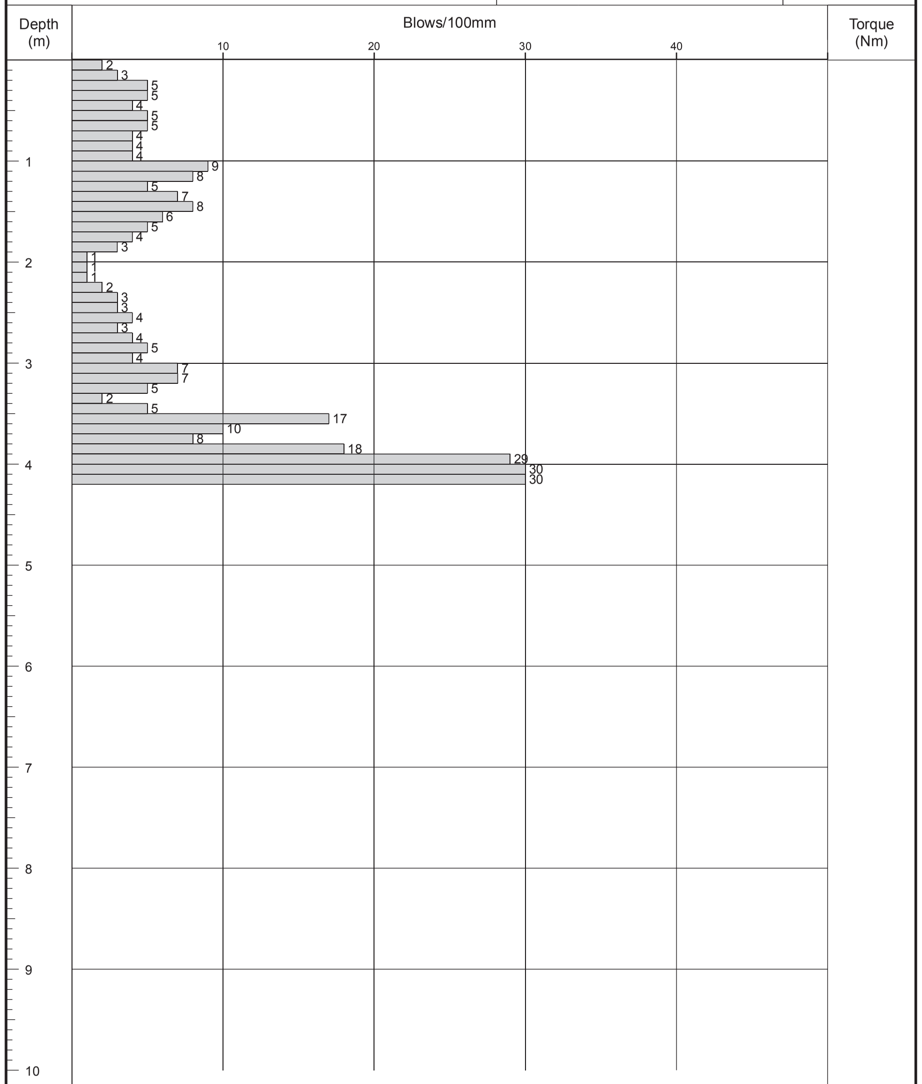
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH34** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	291779.63 - 225812.75	Hole Type DP
Location:		Level:	67.57	Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



Remarks				
	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	4.10
	Probe Type	DPSH-B	Log Scale	1:50

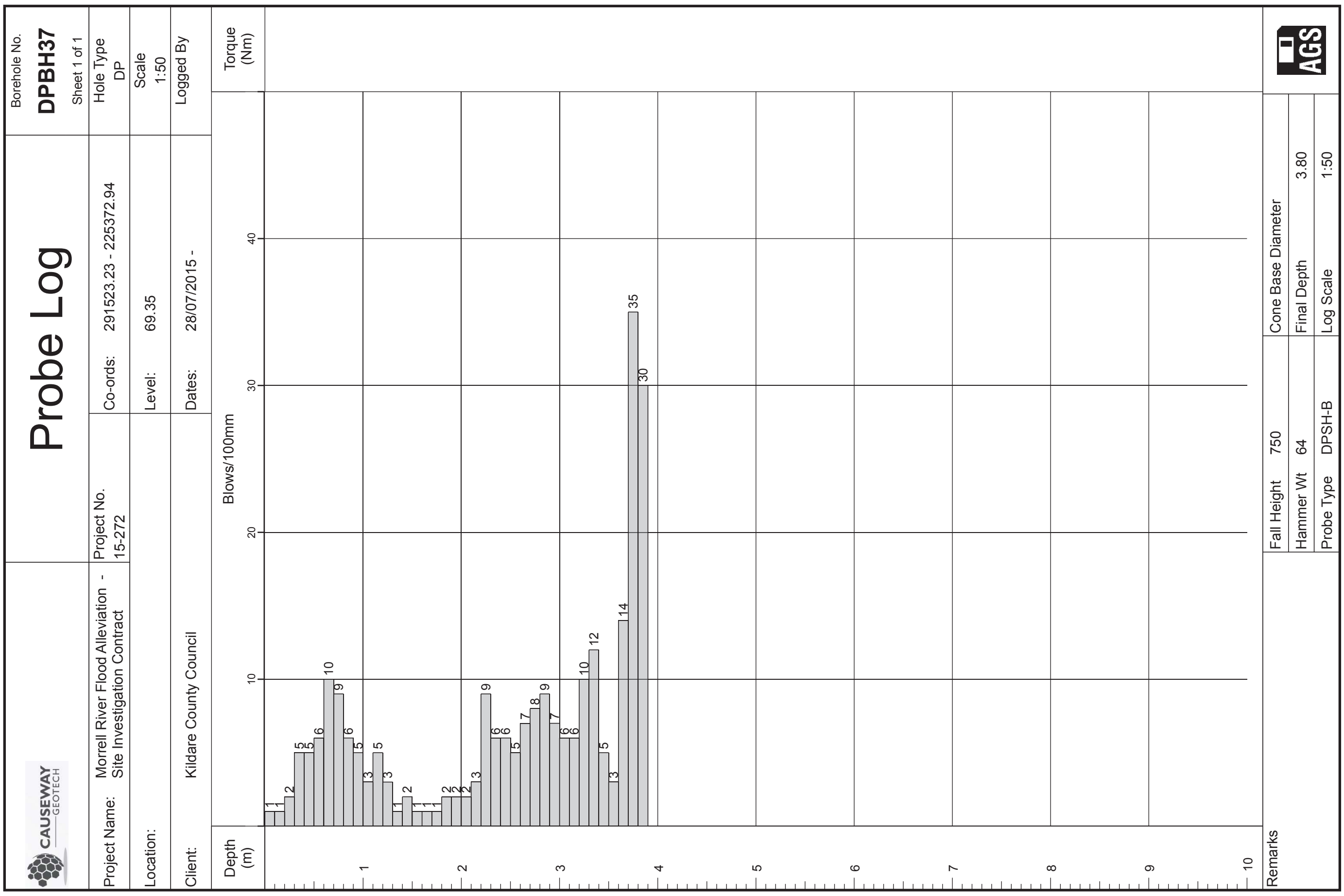
AGS

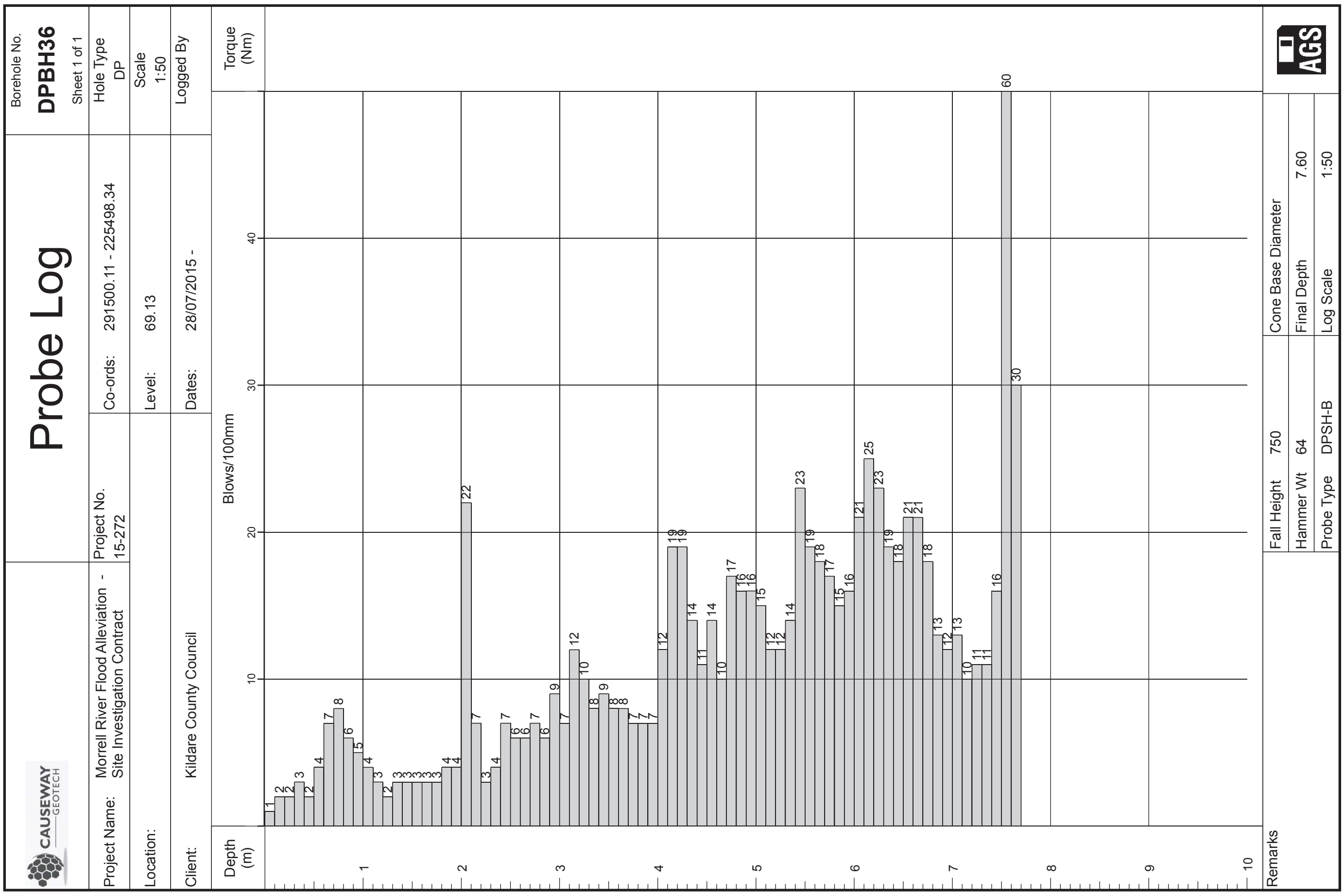
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH35** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	291646.90 - 225610.31	Hole Type DP
Location:		Level:	68.19	Scale 1:50
Client: Kildare County Council		Dates:	23/07/2015 -	Logged By



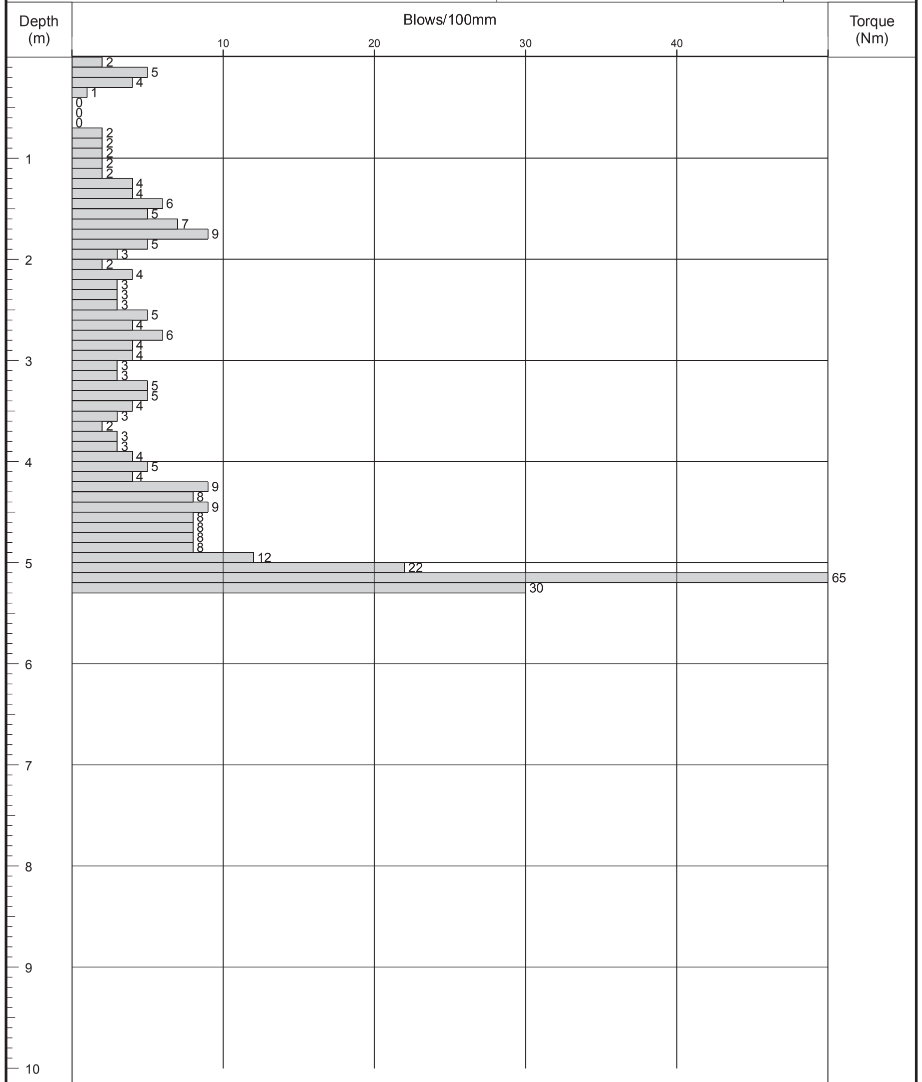
Remarks				
	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	4.10
	Probe Type	DPSH-B	Log Scale	1:50

AGS


CAUSEWAY GEOTECH
Probe Log
Borehole No.
DPBH37
Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract
Project No. 15-272
Co-ords: 291523.23 - 225372.94
Hole Type DP
Level: 69.35
Scale 1:50
Location:
Client: Kildare County Council
Dates: 28/07/2015 -
Logged By
Depth (m)
Blows/100mm
Torque (Nm)
Remarks
Fall Height 750
Hammer Wt 64
Probe Type DPSH-B
Cone Base Diameter
Final Depth 3.80
Log Scale 1:50
AGS

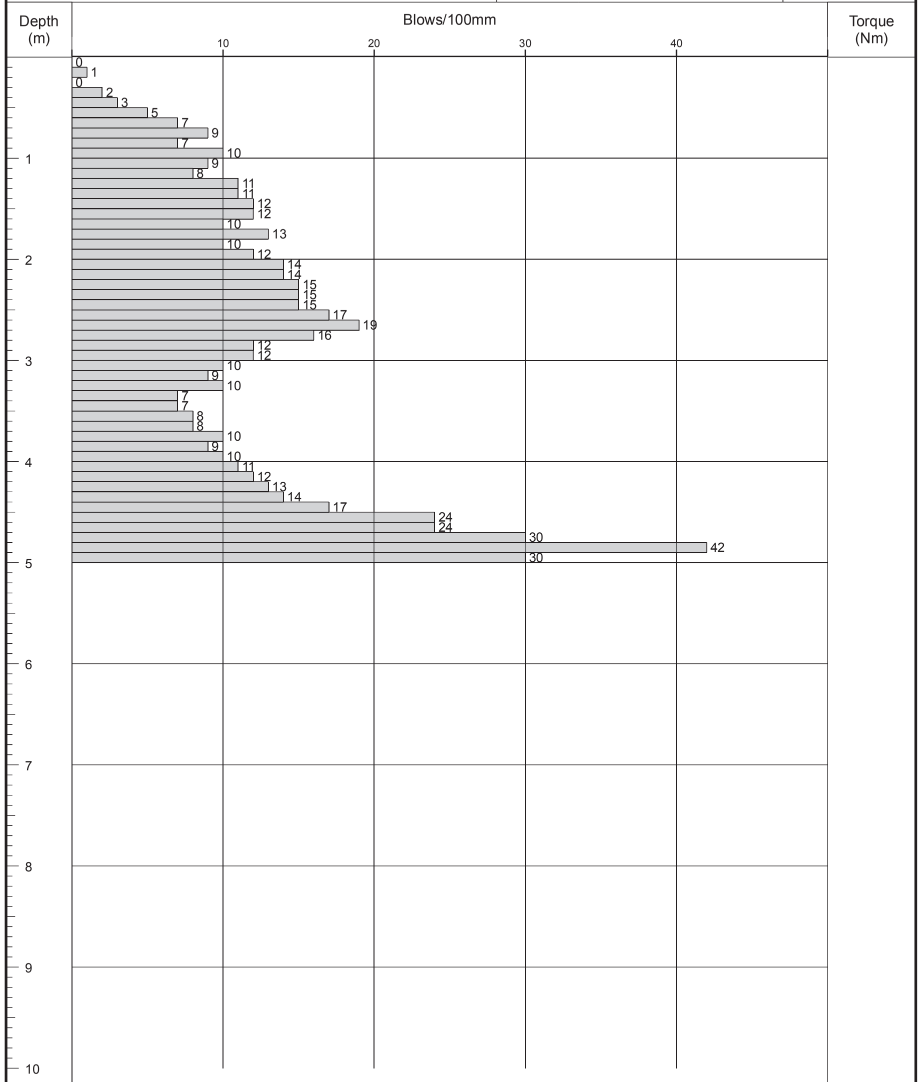

CAUSEWAY GEOTECH
Probe Log
Borehole No.
DPBH36
Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract
Project No. 15-272
Co-ords: 291500.11 - 225498.34
Hole Type DP
Level: 69.13
Scale 1:50
Location:
Client: Kildare County Council
Dates: 28/07/2015 -
Logged By
Depth (m)
Blows/100mm
Torque (Nm)
Remarks
Fall Height 750
Hammer Wt 64
Probe Type DPSH-B
Cone Base Diameter
Final Depth 7.60
Log Scale 1:50
AGS

	Probe Log	Borehole No. DPBH38 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 291663.23 - 225355.36
Location:	Level: 70.20	Hole Type DP
Client: Kildare County Council	Dates: 28/07/2015 -	Scale 1:50 / Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	5.20
	Probe Type	DPSH-B	Log Scale	1:50

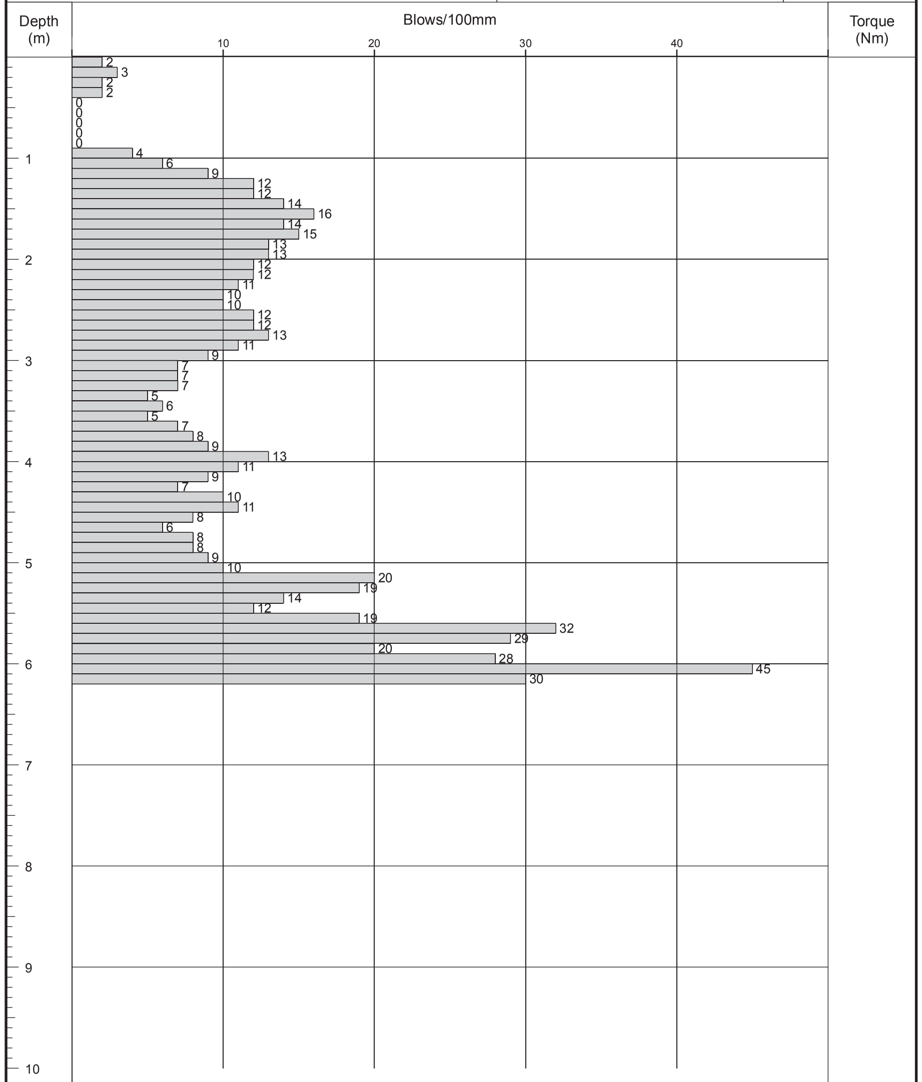
	Probe Log	Borehole No. DPBH39 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 291536.08 - 224933.77
Location:	Level: 70.18	Hole Type DP
Client: Kildare County Council	Dates: 28/07/2015 -	Scale 1:50 / Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	4.90
	Probe Type	DPSH-B	Log Scale	1:50

Probe Log

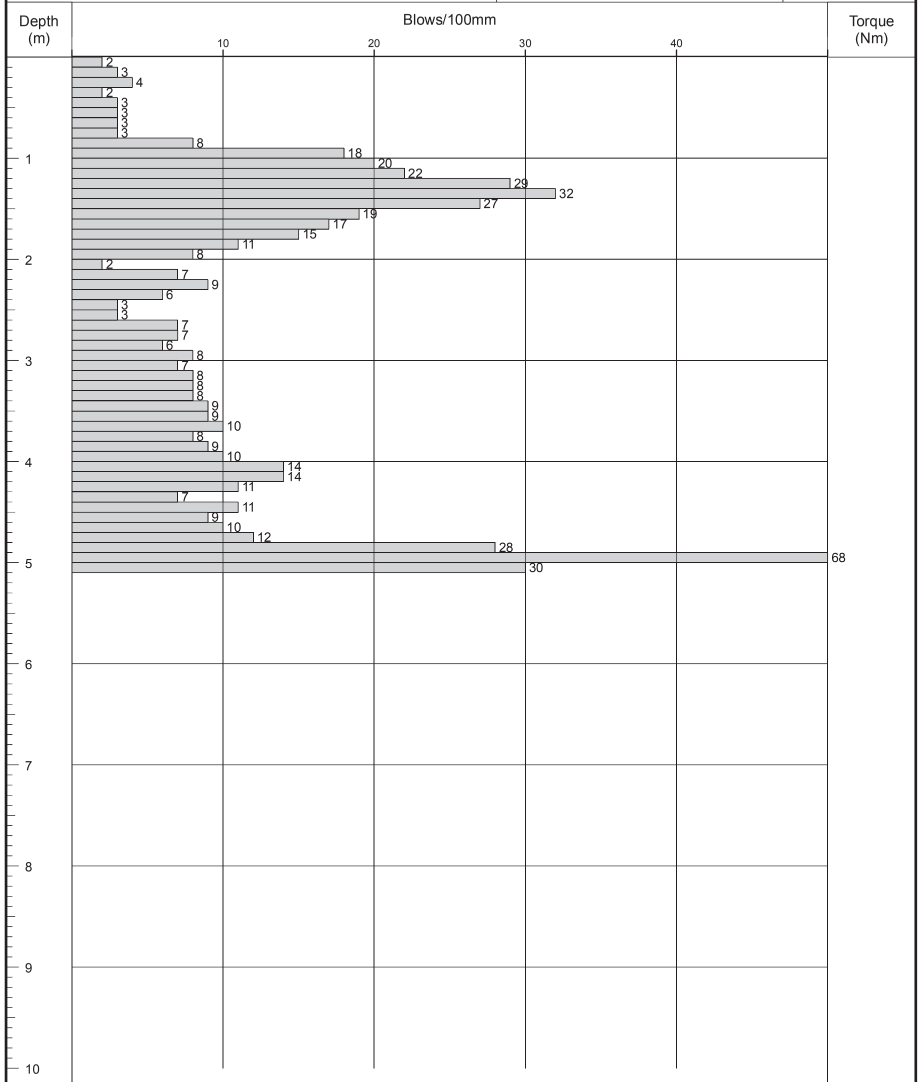
CAUSEWAY GEOTECH				Borehole No. **DPBH40** Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 291524.25 - 224858.73	Hole Type DP
Location:			Level: 70.63	Scale 1:50
Client:	Kildare County Council		Dates: 28/07/2015 -	Logged By



Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	6.10	
Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

CAUSEWAY GEOTECH				Borehole No. **DPBH47** Sheet 1 of 1
Project Name:	Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 291751.13 - 224722.14	Hole Type DP
Location:			Level: 71.04	Scale 1:50
Client:	Kildare County Council		Dates: 27/07/2015 -	Logged By

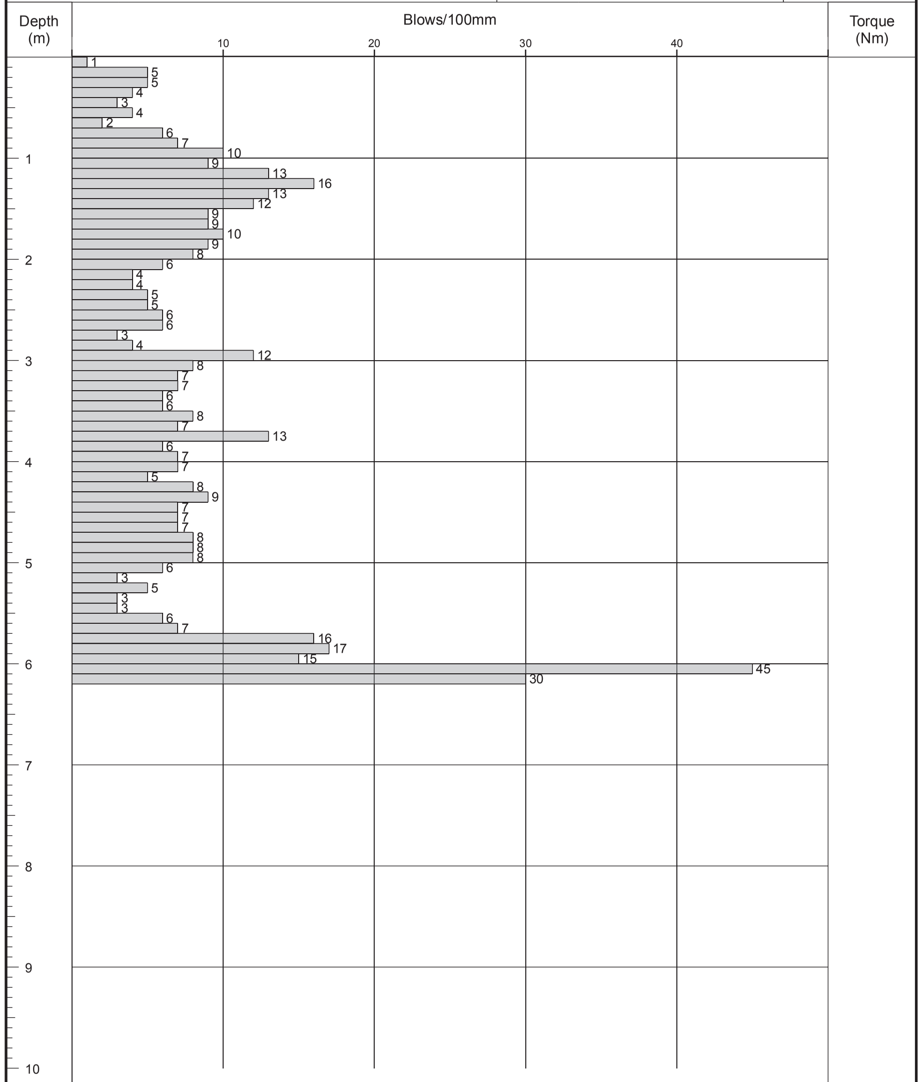


Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	5.00	
Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	291882.30 - 224649.24	Borehole No. DPBH48 Sheet 1 of 1
Location:		Level:	71.13	Hole Type DP
Client: Kildare County Council		Dates:	27/07/2015 -	Scale 1:50
				Logged By



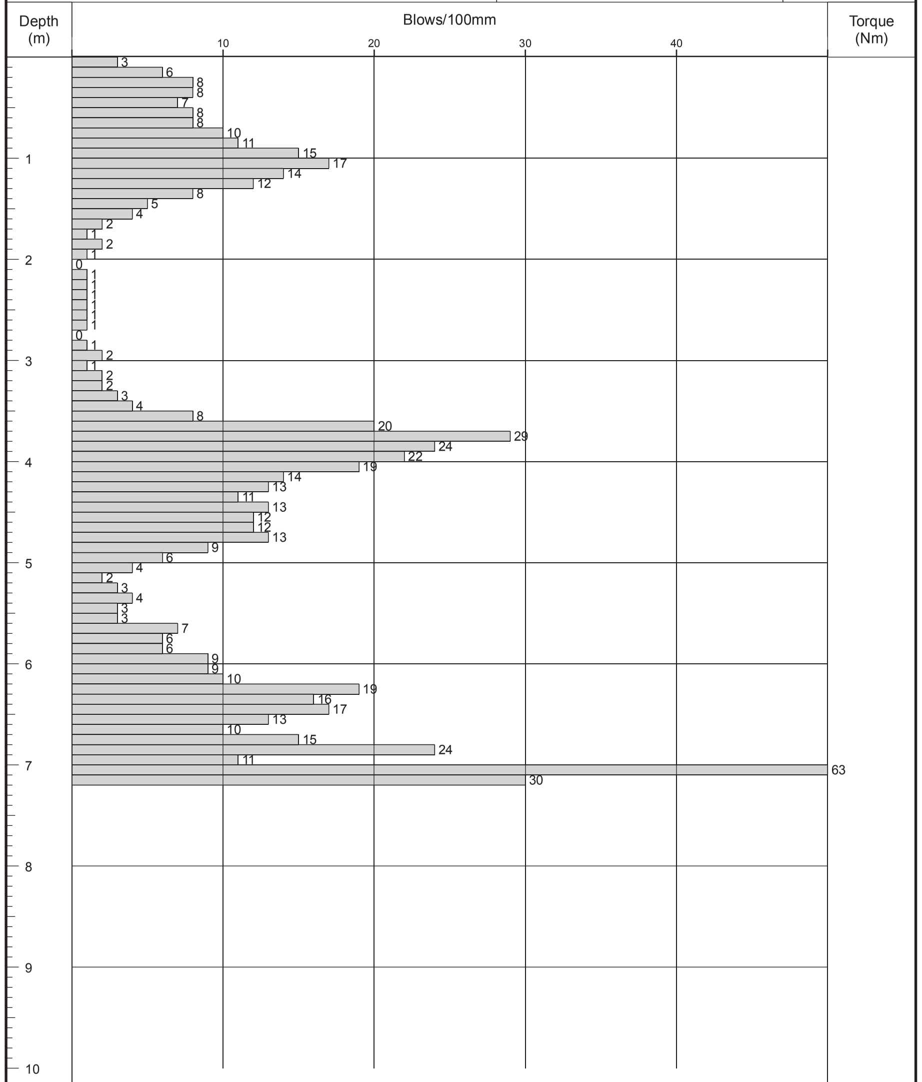
Remarks				
	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	6.10
	Probe Type	DPSH-B	Log Scale	1:50

AGS

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292064.45 - 224606.20	Borehole No. DPBH49 Sheet 1 of 1
Location:		Level:	74.38	Hole Type DP
Client: Kildare County Council		Dates:	27/07/2015 -	Scale 1:50
				Logged By

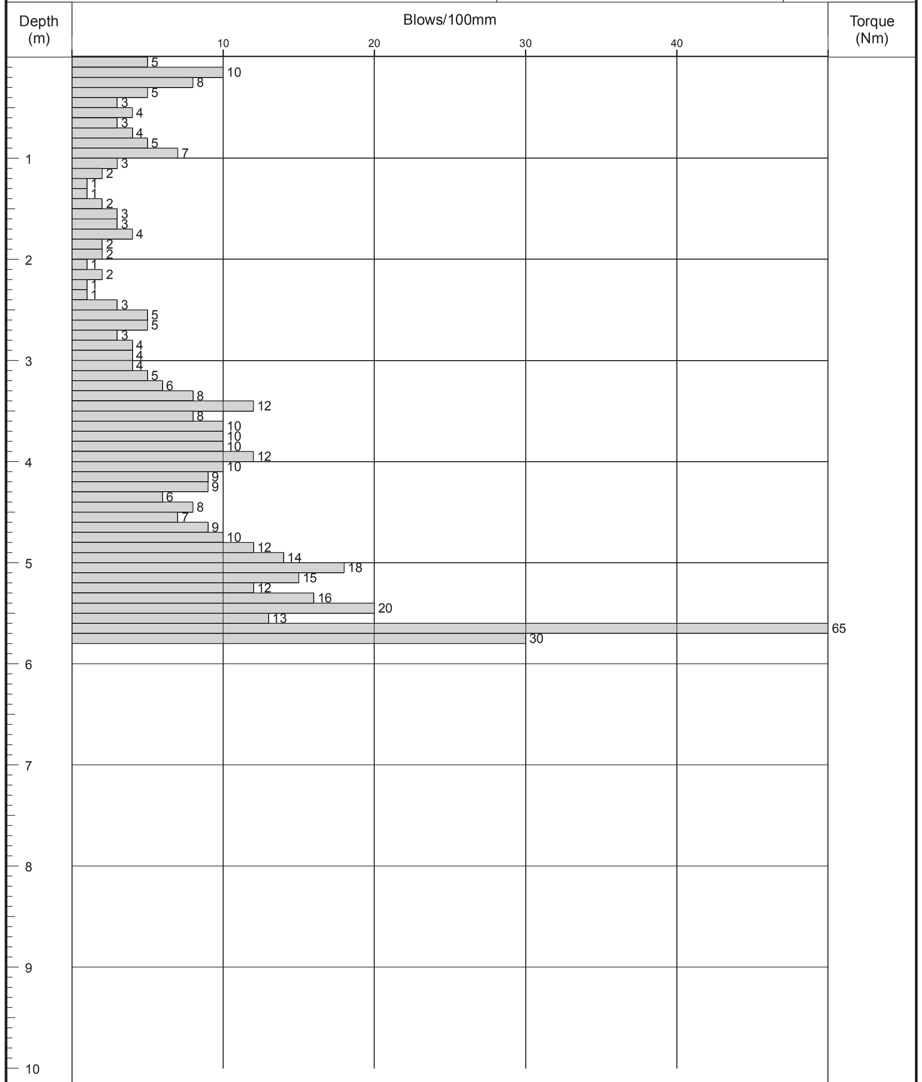


Remarks				
	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	7.10
	Probe Type	DPSH-B	Log Scale	1:50

AGS

Probe Log

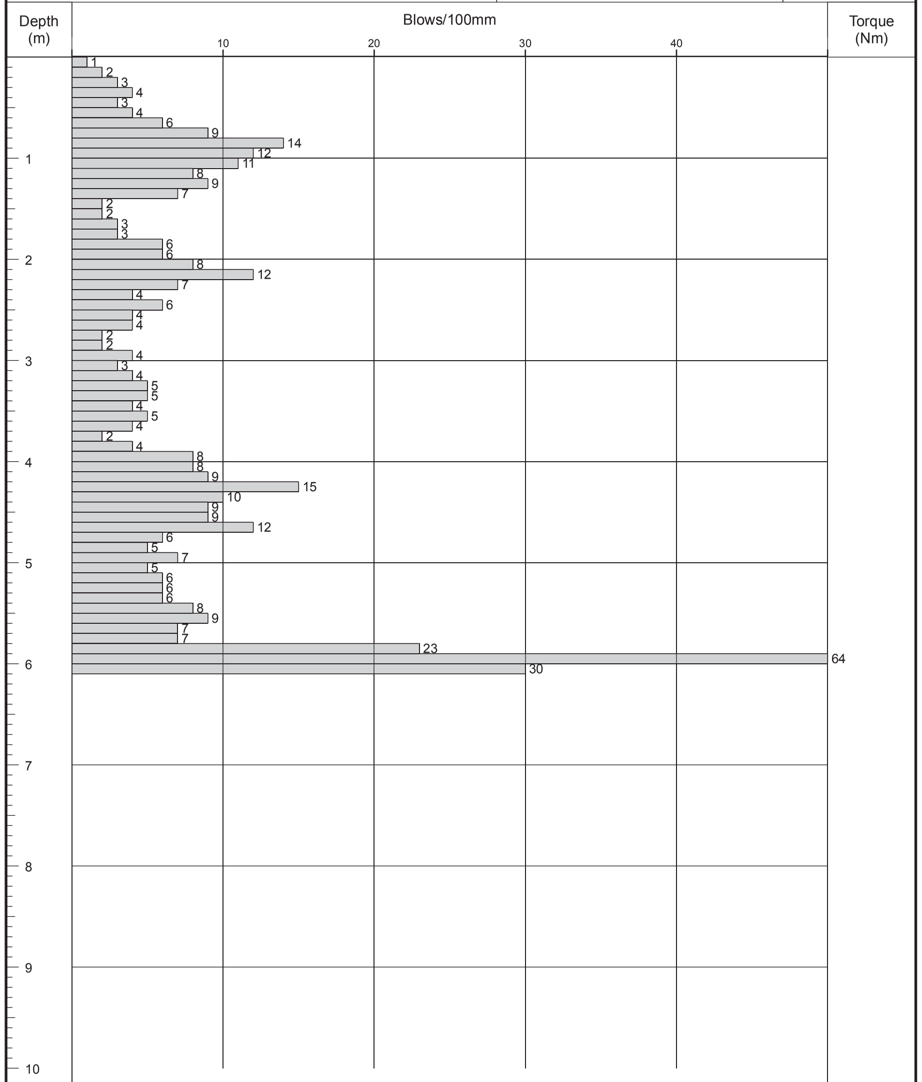
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH50** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292148.50 - 224628.60	Hole Type DP
Location:		Level:	71.60	Scale 1:50
Client: Kildare County Council		Dates:	27/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	5.70	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

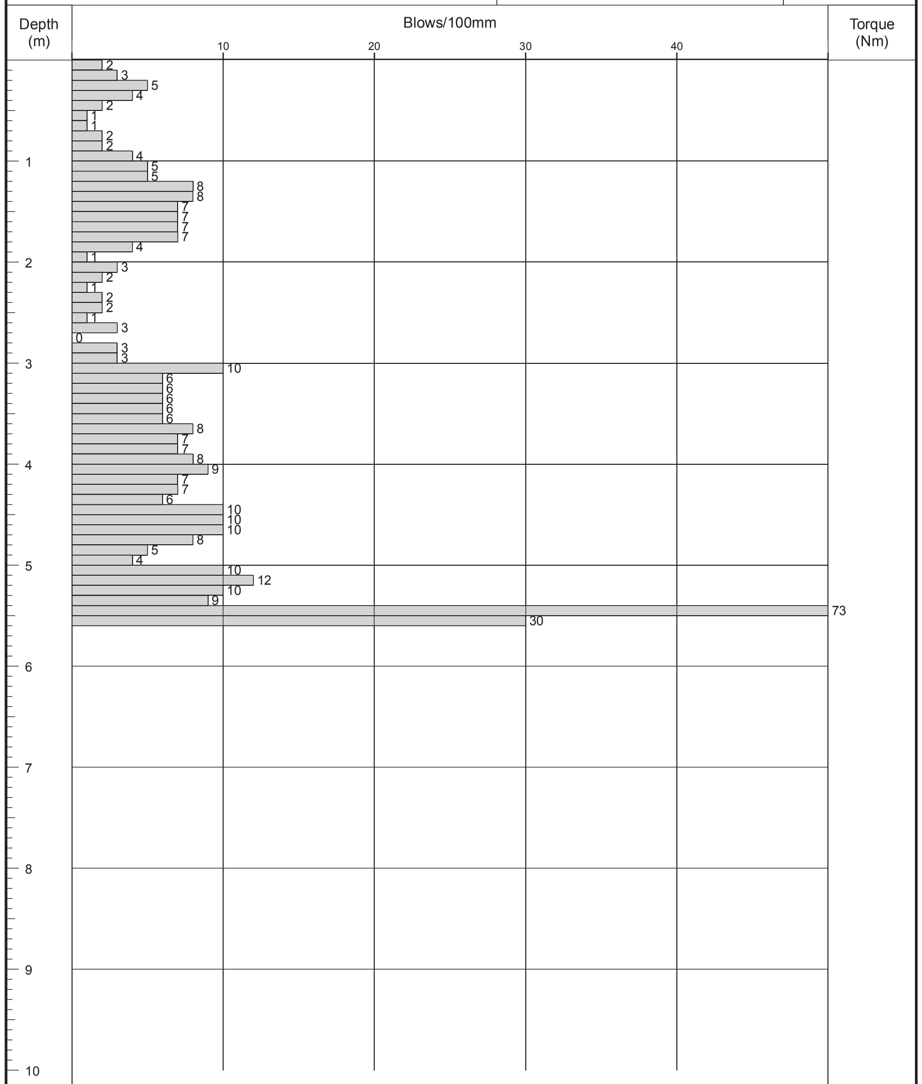
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH51** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292236.66 - 224689.13	Hole Type DP
Location:		Level:	71.22	Scale 1:50
Client: Kildare County Council		Dates:	27/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	6.00	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

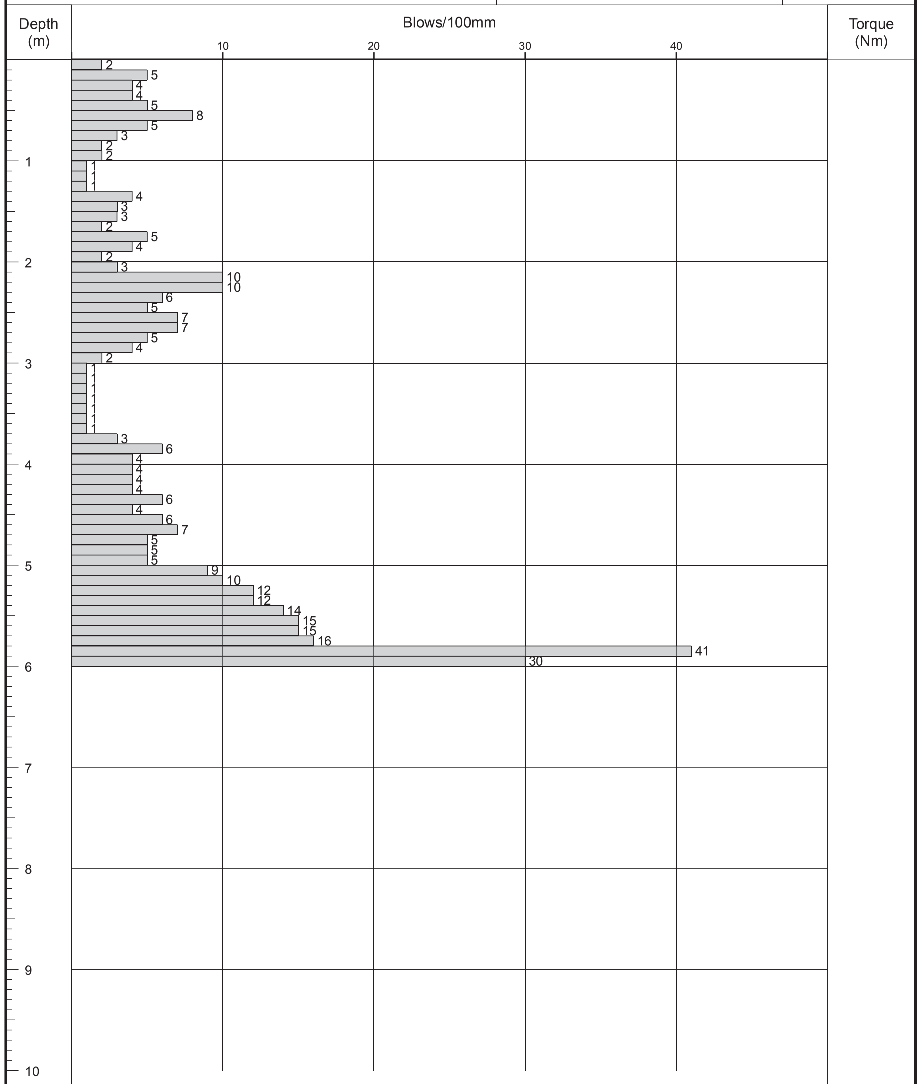
CAUSEWAY GEOTECH	Probe Log		Borehole No. **DPBH52** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292268.58 - 224644.47	Hole Type DP
Location:		Level: 71.25	Scale 1:50
Client: Kildare County Council		Dates: 27/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	5.50
	Probe Type	DPSH-B	Log Scale	1:50

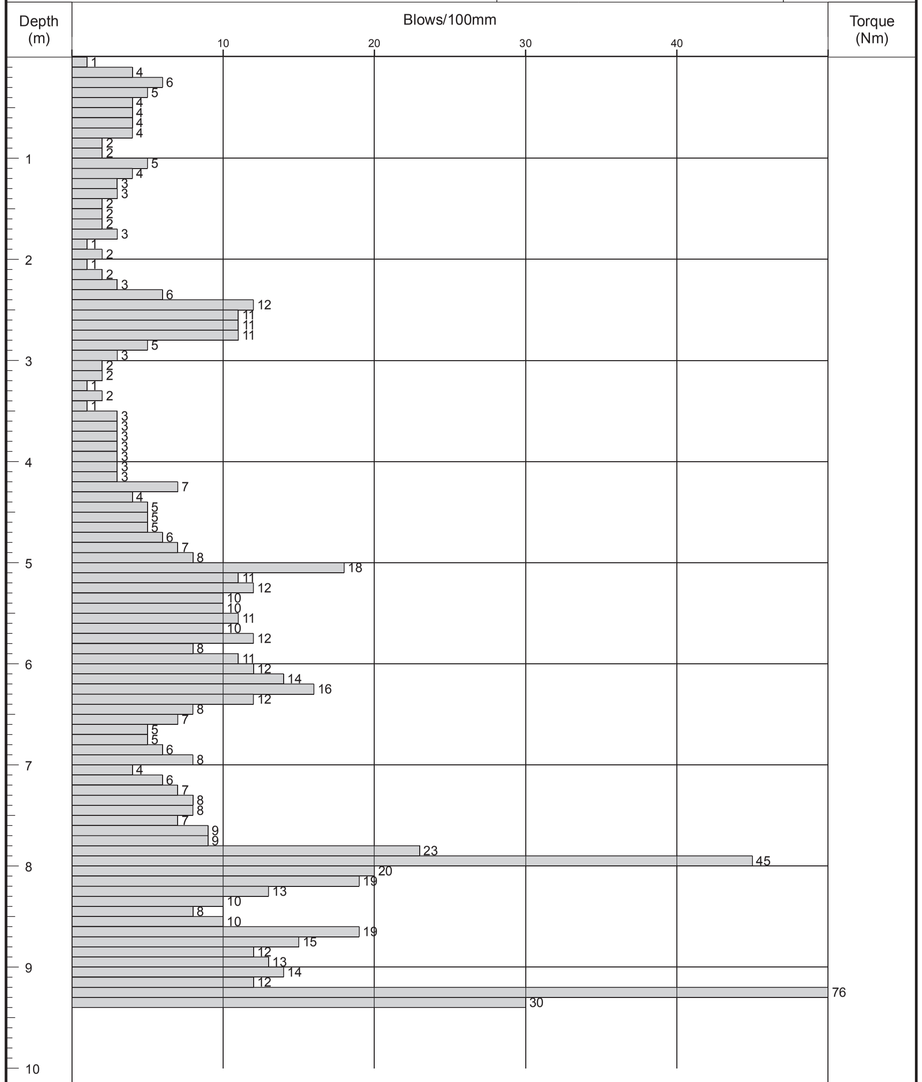
Probe Log

CAUSEWAY GEOTECH	Probe Log		Borehole No. **DPBH53** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 292388.23 - 224683.70	Hole Type DP
Location:		Level: 72.09	Scale 1:50
Client: Kildare County Council		Dates: 27/07/2015 -	Logged By



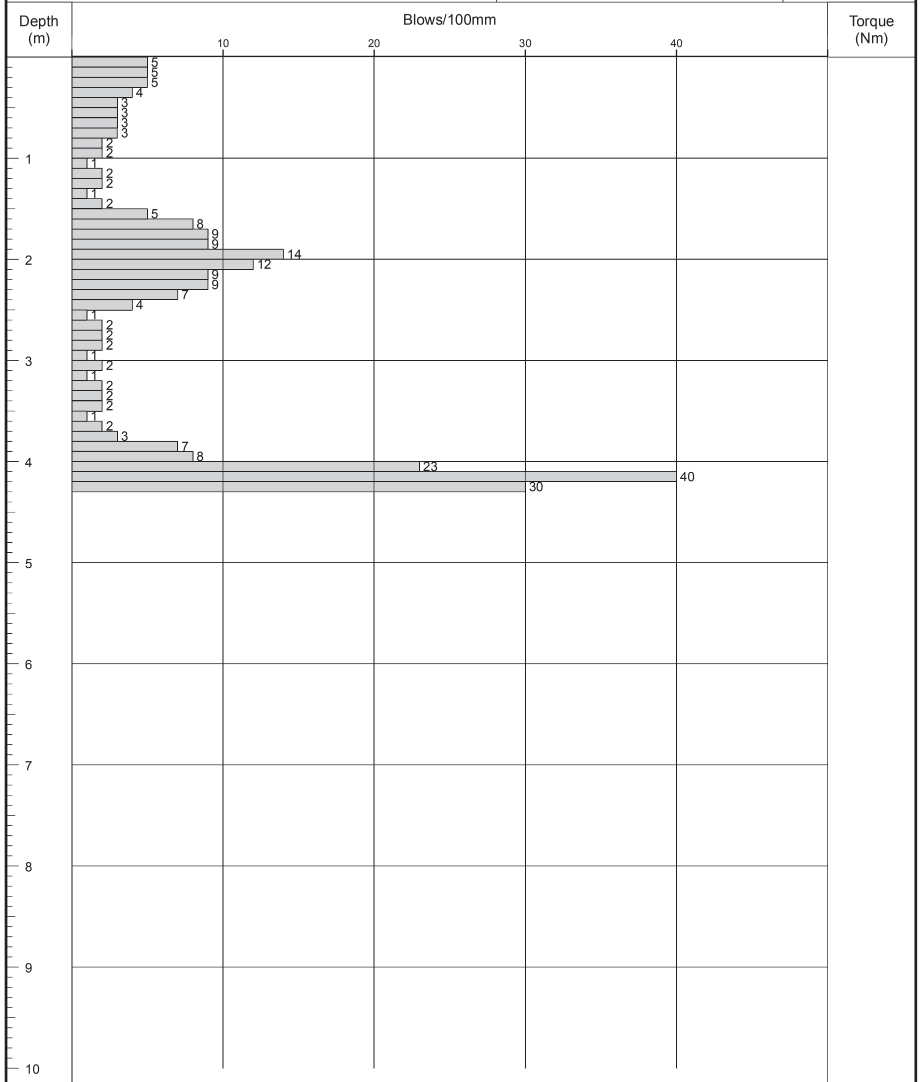
Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	5.90
	Probe Type	DPSH-B	Log Scale	1:50

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH54** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292388.17 - 224591.26	Hole Type DP
Location:		Level:	73.05	Scale 1:50
Client: Kildare County Council		Dates:	27/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	9.30	
	Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH55** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	292386.52 - 224514.53	Hole Type DP
Location:		Level:	72.42	Scale 1:50
Client: Kildare County Council		Dates:	27/07/2015 -	Logged By

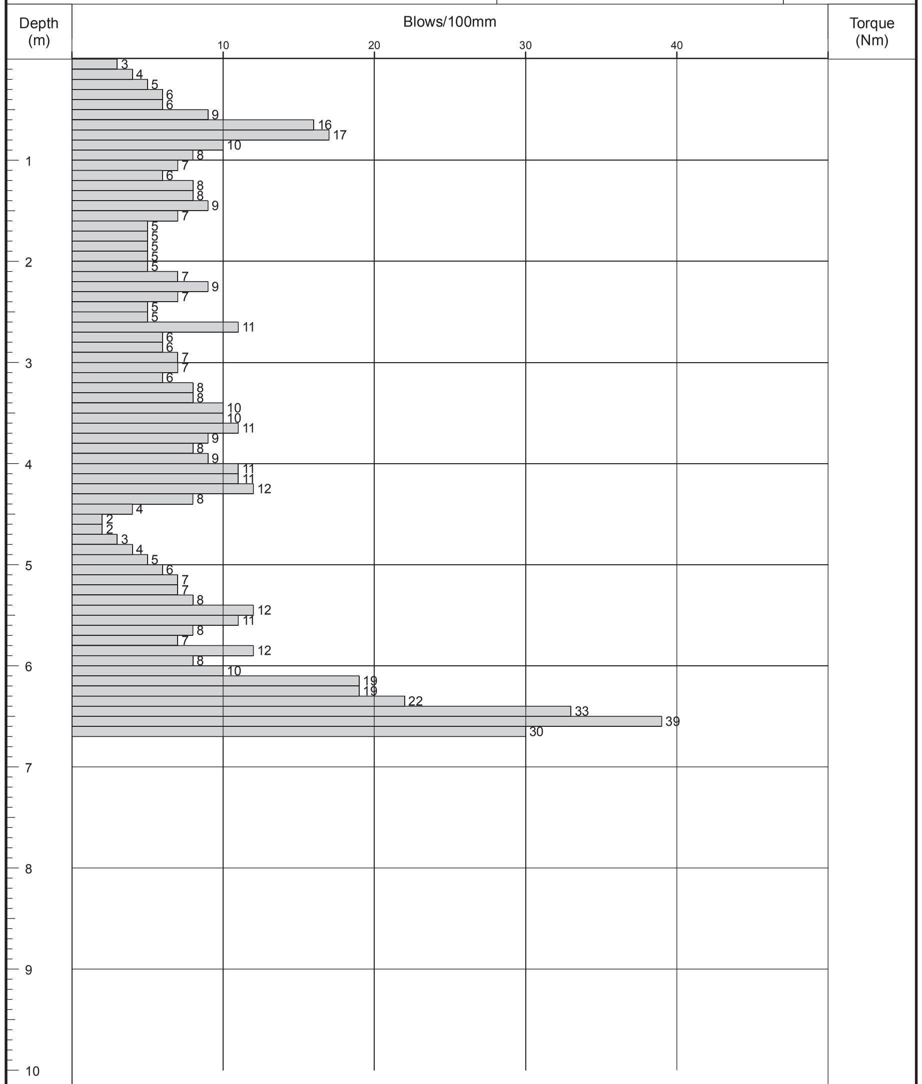


Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	4.20	
	Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH

Probe Log

Borehole No.	DPBH56	Sheet 1 of 1	
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 293927.40 - 225744.27	Hole Type DP
Location:		Level: 73.66	Scale 1:50
Client: Kildare County Council		Dates: 28/07/2015 -	Logged By

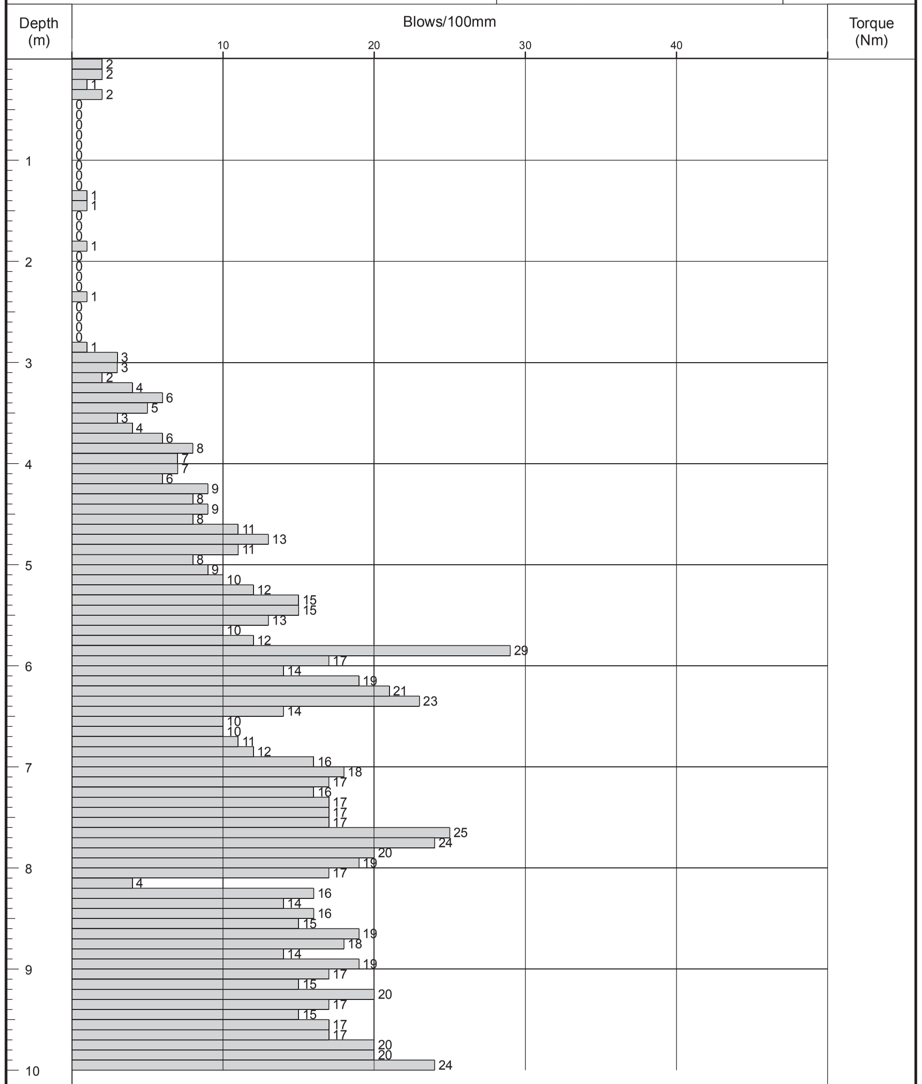


Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	6.60	
Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH

Probe Log

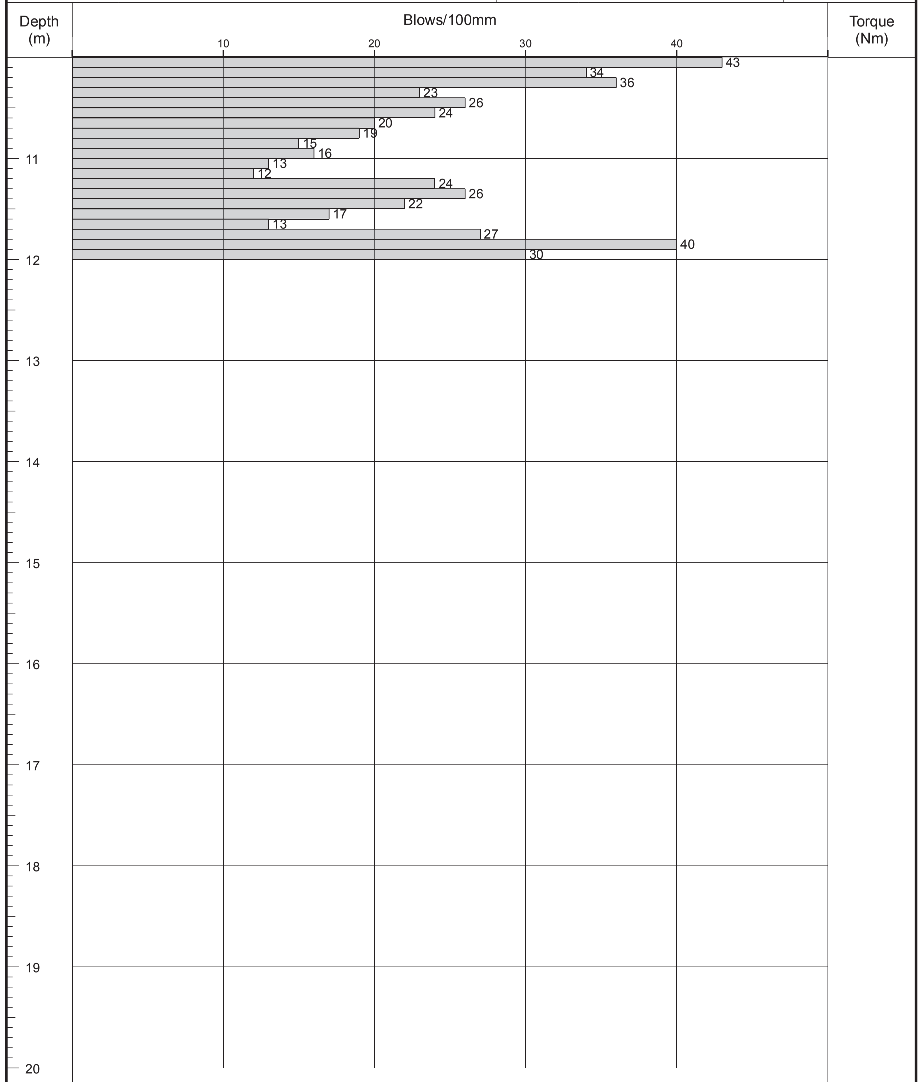
Borehole No.	DPBH58	Sheet 1 of 2	
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 295309.24 - 225166.62	Hole Type DP
Location:		Level: 97.31	Scale 1:50
Client: Kildare County Council		Dates: 30/07/2015 -	Logged By



Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	12.00	
Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

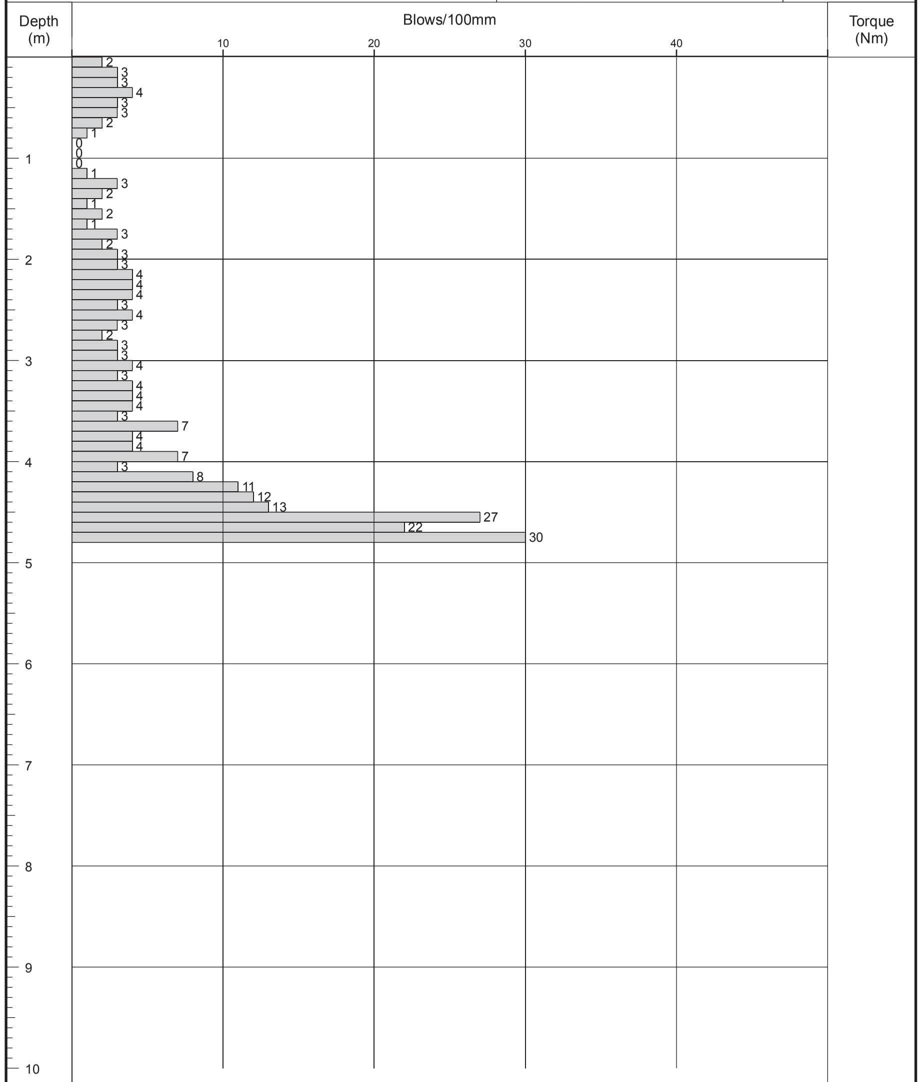
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH58** Sheet 2 of 2
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	295309.24 - 225166.62	Hole Type DP
Location:		Level:	97.31	Scale 1:50
Client: Kildare County Council		Dates:	30/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	12.00	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

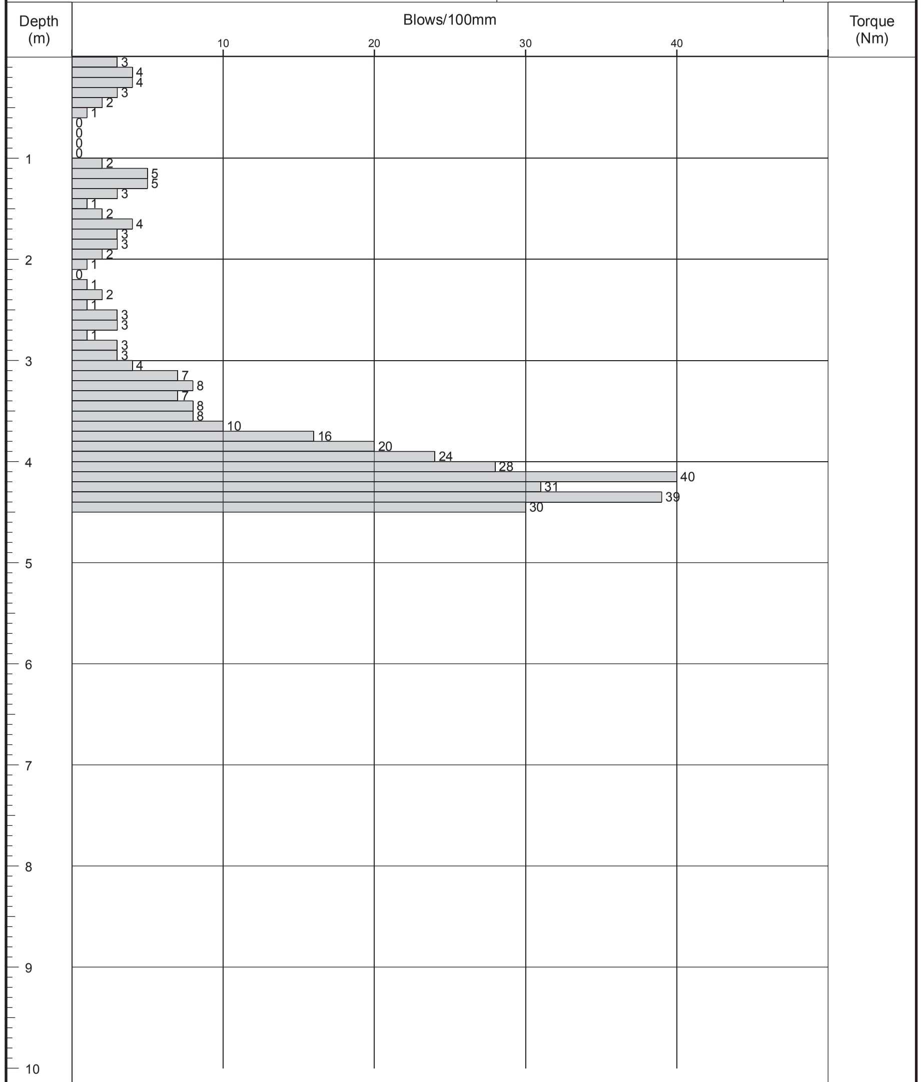
CAUSEWAY GEOTECH	Probe Log			Borehole No. **DPBH59** Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	295338.41 - 225215.49	Hole Type DP
Location:		Level:	97.51	Scale 1:50
Client: Kildare County Council		Dates:	30/07/2015 -	Logged By



Remarks	Fall Height	750	Cone Base Diameter		AGS
	Hammer Wt	64	Final Depth	4.80	
	Probe Type	DPSH-B	Log Scale	1:50	

Probe Log

CAUSEWAY GEOTECH	Probe Log		Borehole No. DPBH61 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 295538.18 - 225275.72	Hole Type DP
Location:		Level: 98.80	Scale 1:50
Client: Kildare County Council		Dates: 28/07/2015 -	Logged By

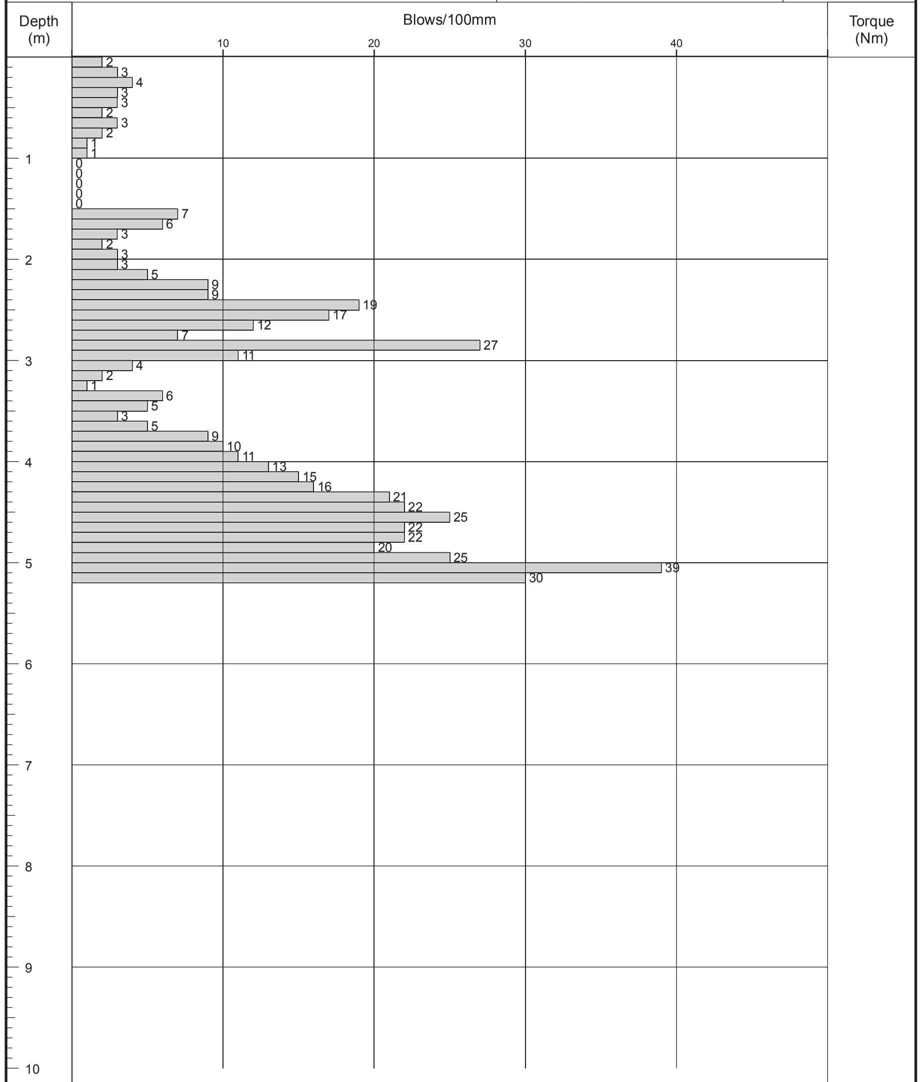


Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	4.40
	Probe Type	DPSH-B	Log Scale	1:50

AGS

Probe Log

CAUSEWAY GEOTECH	Probe Log		Borehole No. DPBH62 Sheet 1 of 1
Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 295587.69 - 225265.37	Hole Type DP
Location:		Level: 99.62	Scale 1:50
Client: Kildare County Council		Dates: 28/07/2015 -	Logged By



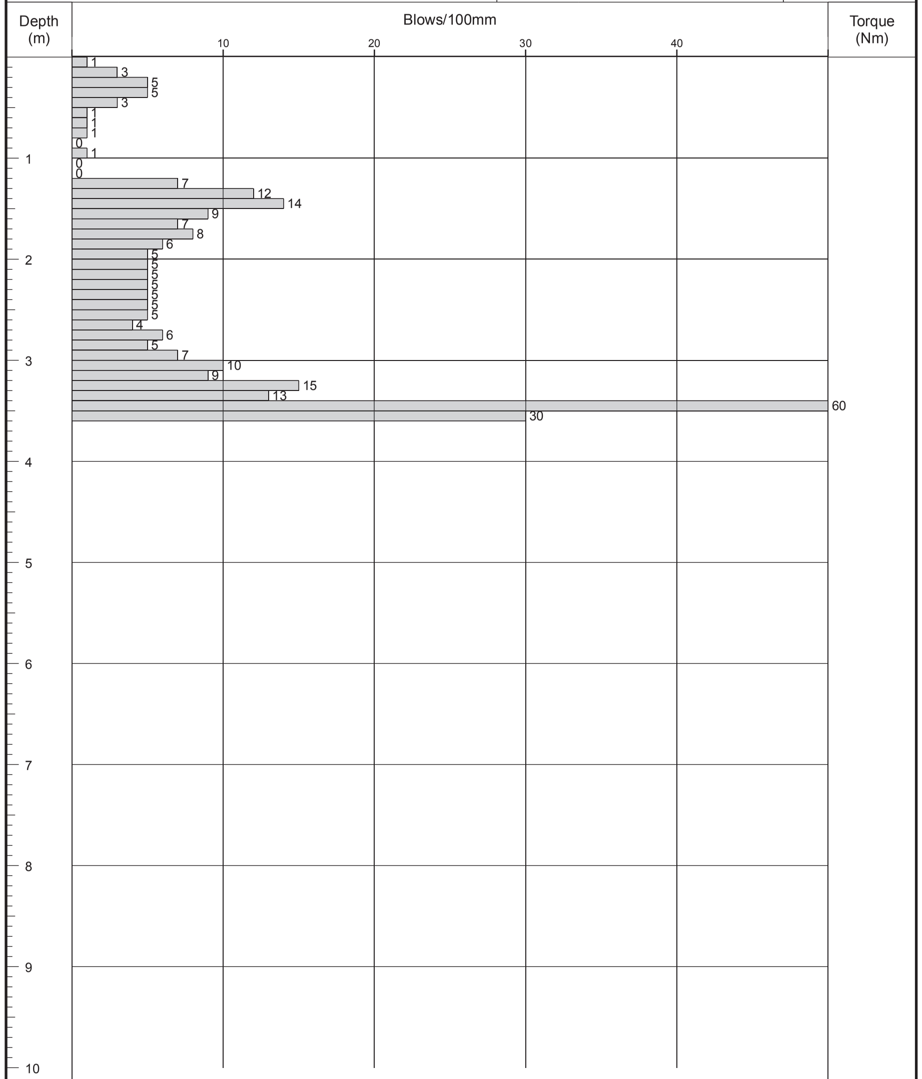
Remarks	Fall Height	750	Cone Base Diameter	
	Hammer Wt	64	Final Depth	5.10
	Probe Type	DPSH-B	Log Scale	1:50

AGS

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	295668.73 - 225250.50	Borehole No. **DPBH63** Sheet 1 of 1
Location:		Level:	100.12	Hole Type DP
Client: Kildare County Council		Dates:	28/07/2015 -	Scale 1:50
				Logged By



Remarks

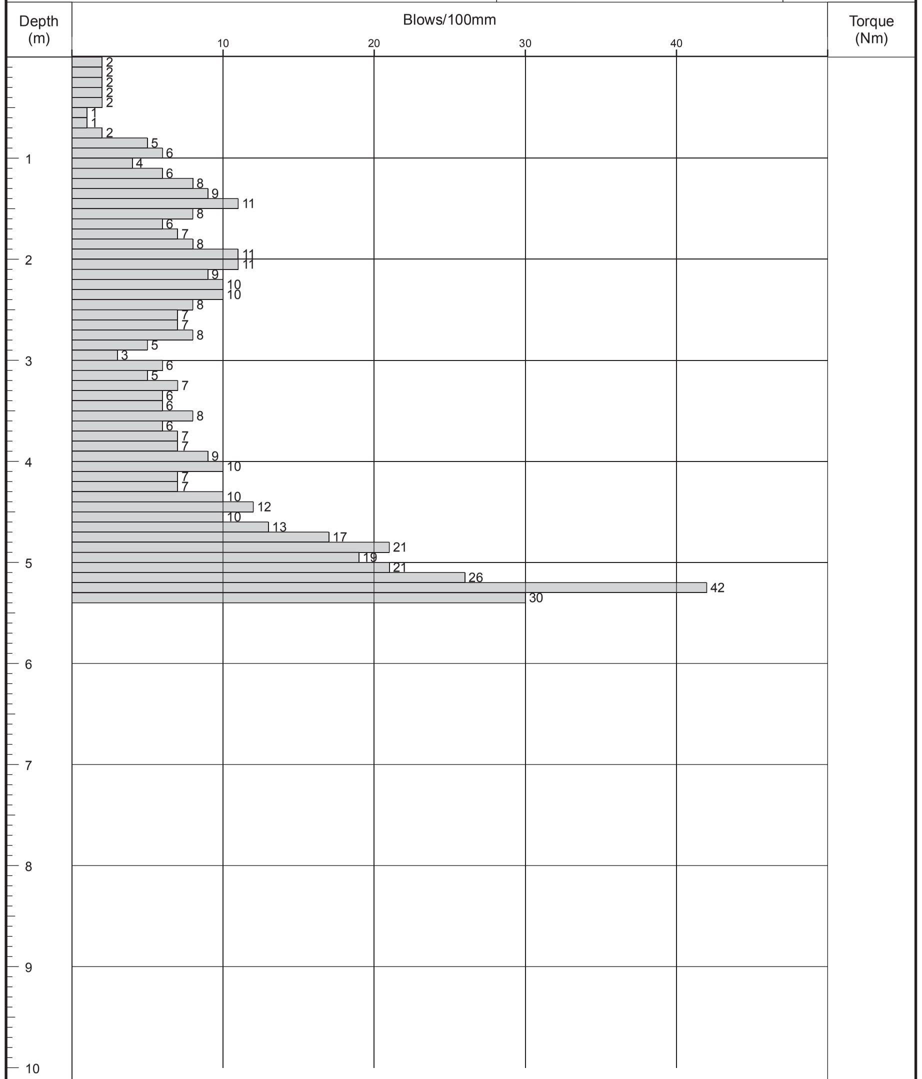
Fall Height	750	Cone Base Diameter	
Hammer Wt	64	Final Depth	3.60
Probe Type	DPSH-B	Log Scale	1:50

AGS

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords:	295772.58 - 225226.41	Borehole No. **DPBH64** Sheet 1 of 1
Location:		Level:	100.89	Hole Type DP
Client: Kildare County Council		Dates:	30/07/2015 -	Scale 1:50
				Logged By



Remarks

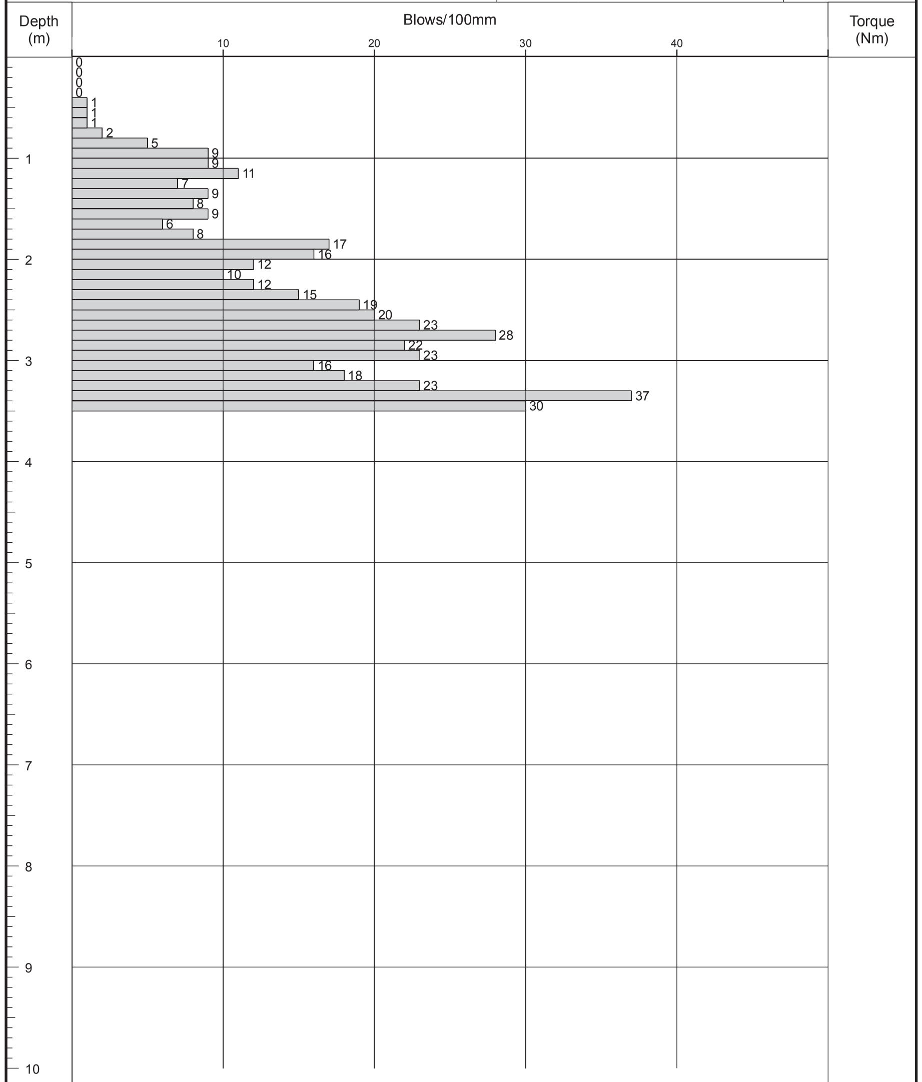
Fall Height	750	Cone Base Diameter	
Hammer Wt	64	Final Depth	5.40
Probe Type	DPSH-B	Log Scale	1:50

AGS

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 296036.69 - 225011.97	Borehole No. **DPBH67** Sheet 1 of 1
			Hole Type DP
Location:		Level: 104.87	Scale 1:50
Client: Kildare County Council		Dates: 23/07/2015 -	Logged By

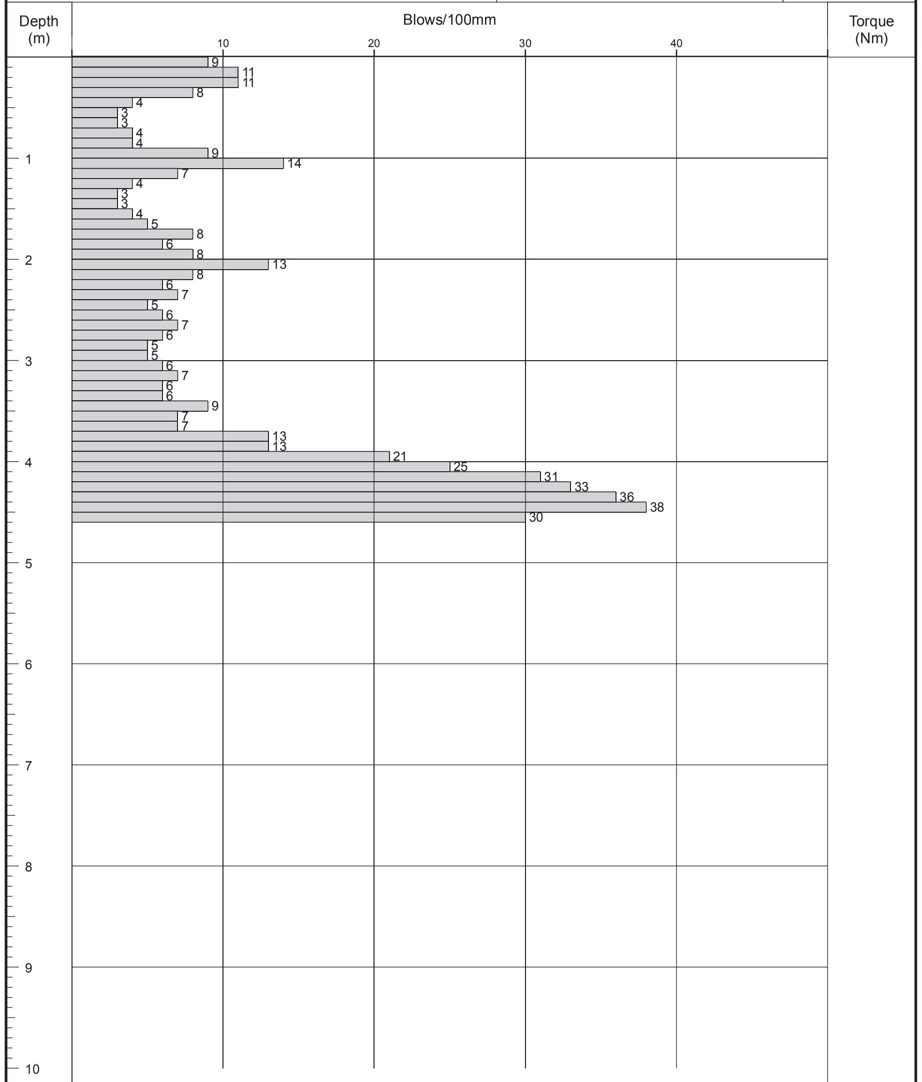


Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	3.40	
Probe Type	DPSH-B	Log Scale	1:50	

CAUSEWAY GEOTECH

Probe Log

Project Name: Morrell River Flood Alleviation - Site Investigation Contract	Project No. 15-272	Co-ords: 296808.22 - 224309.27	Borehole No. **DPBH68** Sheet 1 of 1
			Hole Type DP
Location:		Level: 120.81	Scale 1:50
Client: Kildare County Council		Dates: 30/07/2015 -	Logged By



Remarks				
Fall Height	750	Cone Base Diameter		AGS
Hammer Wt	64	Final Depth	4.60	
Probe Type	DPSH-B	Log Scale	1:50	

Appendix F
Laboratory test results

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SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

To:	**Kildare County Council**
Copy:	**RPS Consulting Engineers**
From:	**Stephen Watson** **Laboratory Manager** **Causeway Geotech Ltd**
Tel:	**+44(0)2827666640**
E-mail:	**stephen.watson@causewaygeotech.com**
Date:	**28/08/15**
Ref:	**15-272/1**

Morrell River Flood Alleviation - Site Investigation Contract

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the *Contents page(s)*.

The samples were delivered to our laboratory in Ballymoney, Co. Antrim on 27/07/15 and tested in accordance with the electronic schedule received on 11/08/15. All testing was performed 12/08/15 to 28/08/15.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of one month from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Approved Signatory

Stephen Watson
Laboratory Manager

Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
Co. Antrim, N. Ireland, BT53 7QL

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Project Name **Morrell River Flood Alleviation - Site Investigation Contract**

Report Reference. **15-272/1**

The table below details the tests carried out, the specifications used and the number of tests included in this report:

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	Number of test results included in the report
SOIL	Moisture content - oven drying method	BS 1377-2:1990	59
SOIL	Liquid limit - cone penetrometer	BS 1377-2:1990	41
SOIL	Liquid limit - cone penetrometer - one point	BS 1377-2:1990	41
SOIL	Plastic limit	BS 1377-2:1990	41
SOIL	Plasticity index and liquidity index	BS 1377-2:1990	41
SOIL	Particle size distribution - wet sieving	BS 1377-2:1990	32
SOIL	Particle size distribution - dry sieving	BS 1377-2:1990	32
SOIL	Particle size distribution -sedimentation hydrometer method	BS 1377-2:1990	19
SOIL	Dry density/moisture content relationship (2.5 kg rammer)	BS 1377-4:1990	2
SOIL	MCV	BS 1377-4:1990	10
SOIL	California Bearing Ratio (CBR)	BS 1377-4:1990	8
SOIL	One-dimensional consolidation properties	BS 1377- 5:1990	4
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377- 7:1990	6

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Registered in Northern Ireland. Company Number: NI610766
Approved: ISO 9001 • ISO 14001 • OHSAS 18001

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SOIL	Shear strength by direct shear	BS1377 : Part 7 : Clause 4 : 1990	7
SOIL	pH Value of Soil	BS 1377-3 : 1990	25
SOIL	Sulphate Content water extract	BS 1377-3 : 1990	25
SOIL	Organic matter	BS 1377-3 : 1990	4

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

Summary of Classification Test Results

Project No. 15-272

Project Name: Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425μm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
BH01	1	0.20		B	Brown slightly sandy gravelly CLAY.			34.0	25	25 -1pt	16	9		
BH01	5	1.40		B	Grey sandy gravelly CLAY.			9.9	54	61 -1pt	49	12		
BH01	18	6.00		D	Brown sandy gravelly CLAY.			20.0	62	34 -1pt	21	13		
BH02	3	0.20		B	Brown slightly sandy CLAY.			9.9	40	23 -1pt	15	8		
BH02	6	1.00		B	Brownish grey sandy gravelly CLAY.			9.7	55	21 -1pt	13	8		
BH02	11	6.00		B	Grey sandy gravelly CLAY			6.2	30	22 -1pt	13	9		
BH04	6	4.00		B	Grey sandy gravelly CLAY.			10.0						
BH04	10	7.50		B	Grey sandy gravelly CLAY			11.0	44	26 -1pt	16	10		
BH05	3	1.00		B	Firm grey sandy gravelly CLAY.			26.0	68	35 -1pt	22	13		
BH05	6	4.00		B	Medium dense to dense grey very sandy subrounded to rounded fine to coarse GRAVEL with cobbles and boulders.			5.1						
BH05	9	6.00		B	Brown sandy gravelly CLAY.			11.0	78	25 -1pt	15	10		
BH06	6	1.00		B	Medium dense grey very sandy subangular to subrounded fine to coarse GRAVEL.			6.0						
BH06	9	4.00		B	Grey sandy gravelly CLAY			11.0	59	24 -1pt	14	10		
BH06	13	8.00		B	Brown sandy gravelly CLAY			7.9	45	24 -1pt	14	10		
TP01	3	2.00		B	Brown black very sandy gravelly slightly silty CLAY with occasional cobbles and boulders			11.0	49	21 -1pt	15	6		
TP03	2	2.00		B	Black brown sandy gravelly slightly silty CLAY			9.6	58	22 -1pt	16	6		
TP05	2	1.50		B	Brown black sandy gravelly slightly silty CLAY			8.6	13	22 -1pt	14	8		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test: Linear measurement unless : wd - water displacement; wi - immersion in water

Liquid Limit: 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density: sp - small pyknometer; gj - gas jar

Date Printed: 28/08/2015

Approved By: Stephen.Watson

Table 1

sheet 1

Summary of Classification Test Results

Project No. 15-272

Project Name: Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425μm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
TP06	2	2.00		B	Brown black very sandy gravelly slightly silty CLAY			9.4						
TP07	2	1.20		B	Brown sandy gravelly CLAY			11.0	58	36 -1pt	25	11		
TP09	1	0.50		B	Brown sandy gravelly clayey SILT			9.4	34	40 -1pt	29	11		
TP09	3	2.50		B	Black slightly sandy slightly gravelly SILT			10.0	49	21 -1pt	14	7		
TP13	1	0.50		B	Brown sandy gravelly CLAY			15.0	59	30 -1pt	21	9		
TP14	3	2.50		B	Grey sandy GRAVEL.			4.8						
TP15	4	2.80		B	Black sandy gravelly silty CLAY.			11.0	42	23 -1pt	14	9		
TP16	1	0.40		B	Brown sandy gravelly clayey SILT.			13.0	52	32 -1pt	25	7		
TP17	1	0.30		B	Brown slightly gravelly SAND.			16.0						
TP18	2	1.00		B	Black sandy gravelly clayey SILT.			8.4	34	23 -1pt	18	5		
TP18	4	3.00		B	Black sandy gravelly silty CLAY			11.0	51	29 -1pt	18	11		
TP20	3	2.00		B	Black slightly sandy gravelly slightly silty CLAY.			8.6	40	23 -1pt	14	9		
TP21	2	1.00		B	MADE GROUND - Firm brown gravelly CLAY with frequent cobbles and boulders.			28.0	84	31 -1pt	13	18		
TP24	2	1.50		B	Brown gravelly clayey SILT.			22.0	77	36 -1pt	25	11		
TP24	5	3.50		B	Black sandy gravelly CLAY			12.0	64	24 -1pt	15	9		
TP26	3	2.00		B	Brown gravelly SAND.			11.0						
TP28	2	1.50		B	Brown slightly gravelly clayey SILT.			17.0	67	42 -1pt	28	14		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test: Linear measurement unless : wd - water displacement; wi - immersion in water

Liquid Limit: 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density: sp - small pyknometer; gj - gas jar

Date Printed: 28/08/2015

Approved By: Stephen.Watson

Table 2

sheet 2

Summary of Classification Test Results

Project No. 15-272

Project Name: Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
TP29	5	4.00		B	Black brown sandy gravelly slightly silty CLAY			7.6	35	22 -1pt	14	8		
TP30	2	1.50		B	Brown sandy slightly gravelly clayey SILT.			14.0	52	36 -1pt	25	11		
TP31	1	1.00		B	Brown sandy gravelly CLAY.			10.0	42	38 -1pt	24	14		
TP32	1	0.50		B	MADE GROUND - Brown gravelly clayey SILT.			11.0	60	37 -1pt	27	10		
TP33	2	1.50		B	Brown sandy gravelly CLAY.			33.0	78	48 -1pt	26	22		
TP35	2	1.50		B	Grey sandy gravelly clayey SILT			14.0						
TP36	2	1.50		B	Grey sandy silty GRAVEL			15.0						
TP37	2	1.00		B	Grey sandy silty GRAVEL			9.7						
TP38	1	1.00		B	Grey sandy gravelly SILT			14.0						
TP38	3	2.50		B	Grey brown sandy gravelly clayey SILT			7.9	28	18 -1pt	12	6		
TP43	2	1.50		B	Brown slightly sandy gravelly clayey SILT.			13.0	44	33 -1pt	24	9		
TP45	2	1.00		B	Grey slightly gravelly sandy SILT			22.0	89	50 -1pt	35	15		
TP46	3	1.50		B	Grey sandy GRAVEL.			15.0						
TP48	3	1.50		B	Grey slightly sandy GRAVEL.			13.0						
TP56	3	1.50		B	Grey SAND and GRAVEL			13.0						
TP59	2	1.00		B	Grey SAND and GRAVEL			16.0						
TP60	1	1.00		B	Brown sandy gravelly silty CLAY			15.0	35	34 -1pt	22	12		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test: Linear measurement unless : wd - water displacement; wi - immersion in water

Liquid Limit: 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density: sp - small pyknometer; gj - gas jar

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Summary of Classification Test Results

Project No. 15-272

Project Name: Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
TP63	2	1.50		B	Grey SAND and GRAVEL.			8.4						
TP65	2	1.00		B	Soft dark brownsandy gravelly SILT			35.0	75	42 -1pt	33	9		
TP65	3	1.50		B	Brownish grey sandy SILT.			8.5	15	33 -1pt	25	8		
TP67	3	2.00		B	Grey slightly sandy GRAVEL			9.5						
TP69	3	2.00		B	Brown sandy gravelly CLAY			14.0	49	25 -1pt	16	9		
TP72	5	4.00		B	Grey sandy gravelly SILT			7.9						
TP73	1	1.00		B	Brown sandy gravelly SILT			37.0	82	50 -1pt	35	15		
TP74	1	0.50		B	Brown sandy gravelly CLAY			13.0	38	38 -1pt	23	15		

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test: Linear measurement unless : wd - water displacement; wi - immersion in water

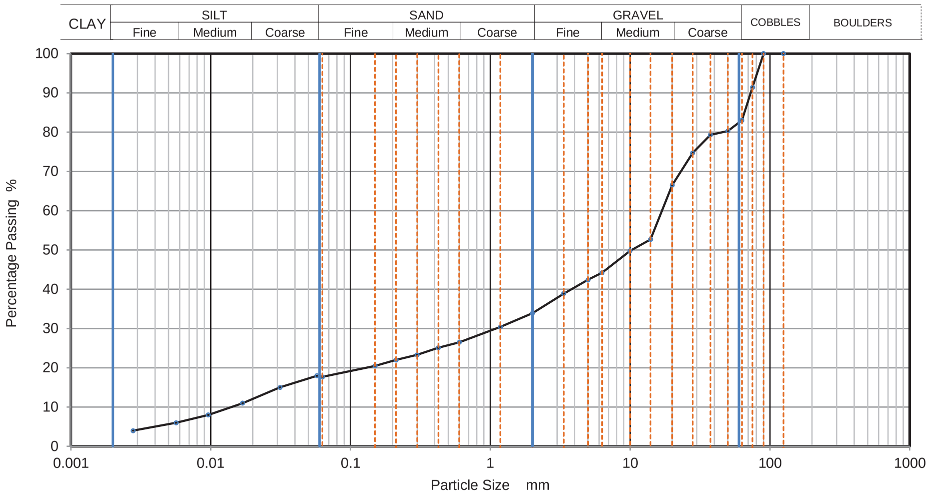
Liquid Limit: 4pt cone unless : cas - Casagrande method; 1pt - single point test

Particle density: sp - small pyknometer; gj - gas jar

Date Printed: 28/08/2015 | Approved By: Stephen.Watson | Table 4 | sheet 4

PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	BH01
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	5
Soil Description	Grey sandy gravelly CLAY.	Depth, m	1.40
Specimen Reference	6 · Specimen Depth · m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812595



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	18
90	100	0.0313	15
75	91	0.0169	11
63	83	0.0096	8
50	80	0.0057	6
37.5	79	0.0028	4
28	75		
20	67		
14	53		
10	50		
6.3	44		
5	42		
3.35	39		
2	34		
1.18	30		
0.6	27	Particle density	(assumed)
0.425	25	1.50	Mg/m3
0.3	23		
0.212	22		
0.15	21		
0.063	18		

Dry Mass of sample, g	6740

Sample Proportions	% dry mass
Cobbles	17
Gravel	49
Sand	16
Fines <0.063mm	18

Grading Analysis		
D100	mm	
D60	mm	16.9
D30	mm	1.09
D10	mm	0.013
Uniformity Coefficient		1300
Curvature Coefficient		5.4

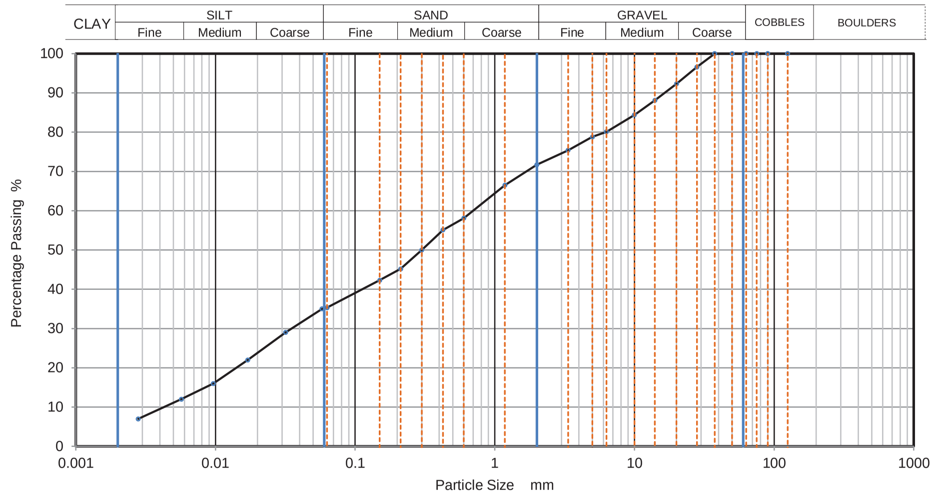
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 1
Stephen.Watson	28/08/2015 12:13	Sheet

PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	BH02
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	6
Soil Description	Brownish grey sandy gravelly CLAY.	Depth, m	1.00
Specimen Reference	6 · Specimen Depth · m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812615



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	35
90	100	0.0317	29
75	100	0.0170	22
63	100	0.0097	16
50	100	0.0057	12
37.5	100	0.0028	7
28	97		
20	92		
14	88		
10	84		
6.3	80		
5	79		
3.35	75		
2	72		
1.18	67		
0.6	58	Particle density	(assumed)
0.425	55	1.50	Mg/m3
0.3	50		
0.212	45		
0.15	42		
0.063	35		

Dry Mass of sample, g	5137

Sample Proportions	% dry mass
Cobbles	0
Gravel	28
Sand	36
Fines <0.063mm	35

Grading Analysis		
D100	mm	
D60	mm	0.698
D30	mm	0.0353
D10	mm	0.00425
Uniformity Coefficient		160
Curvature Coefficient		0.42

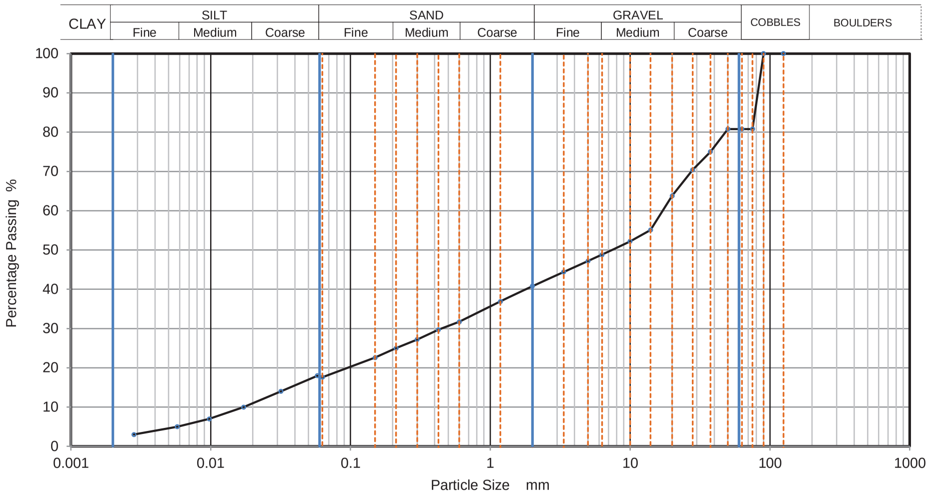
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 2
Stephen.Watson	28/08/2015 12:13	Sheet

PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	BH02
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	11
Soil Description	Grey sandy gravelly CLAY	Depth, m	6.00
Specimen Reference	6 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812620



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	18
90	100	0.0317	14
75	81	0.0172	10
63	81	0.0098	7
50	81	0.0058	5
37.5	75	0.0028	3
28	70		
20	64		
14	55		
10	52		
6.3	49		
5	47		
3.35	44		
2	41		
1.18	37		
0.6	32	Particle density (assumed)	
0.425	30	1.50	Mg/m3
0.3	27		
0.212	25		
0.15	23		
0.063	18		

Dry Mass of sample, g	8169

Sample Proportions	% dry mass
Cobbles	19
Gravel	40
Sand	23
Fines <0.063mm	18

Grading Analysis		
D100	mm	
D60	mm	17.1
D30	mm	0.444
D10	mm	0.0168
Uniformity Coefficient		1000
Curvature Coefficient		0.68

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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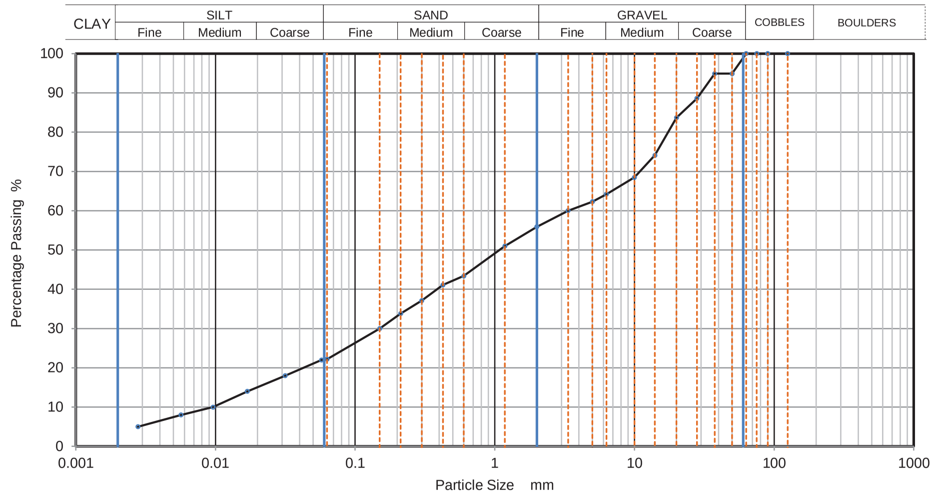
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	BH04
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	6
Soil Description	Grey sandy gravelly CLAY.	Depth, m	4.00
Specimen Reference	4 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812630



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	22
90	100	0.0315	18
75	100	0.0169	14
63	100	0.0096	10
50	95	0.0057	8
37.5	95	0.0028	5
28	89		
20	84		
14	74		
10	69		
6.3	64		
5	62		
3.35	60		
2	56		
1.18	51		
0.6	43	Particle density (assumed)	
0.425	41	1.50	Mg/m3
0.3	37		
0.212	34		
0.15	30		
0.063	22		

Dry Mass of sample, g	8749

Sample Proportions	% dry mass
Cobbles	0
Gravel	44
Sand	34
Fines <0.063mm	22

Grading Analysis		
D100	mm	
D60	mm	3.34
D30	mm	0.15
D10	mm	0.00878
Uniformity Coefficient		380
Curvature Coefficient		0.77

Remarks

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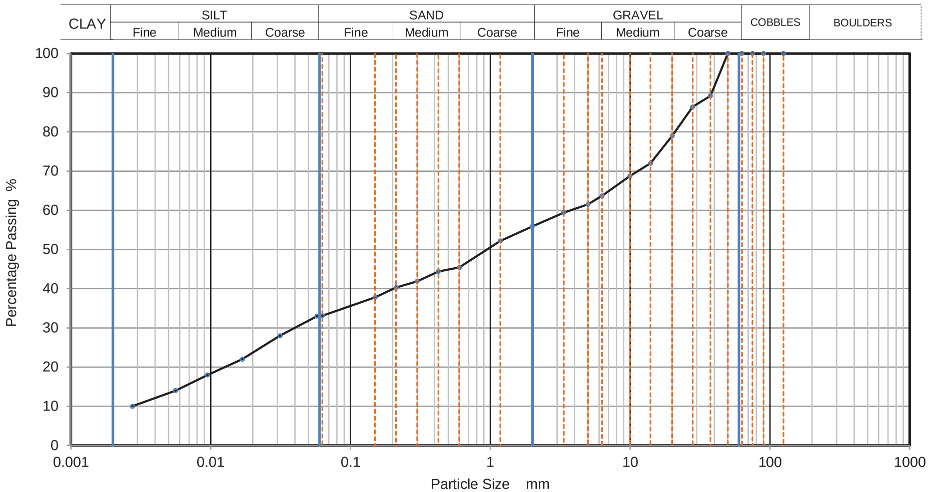
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272				
Borehole/Pit No.	BH04				
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	10		
Soil Description	Grey sandy gravelly CLAY	Depth, m	7.50		
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812634		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	33
90	100	0.0313	28
75	100	0.0168	22
63	100	0.0095	18
50	100	0.0056	14
37.5	89	0.0028	10
28	86		
20	79		
14	72		
10	69		
6.3	64		
5	62		
3.35	59		
2	56		
1.18	52		
0.6	45	Particle density	(assumed)
0.425	44	1.50	Mg/m3
0.3	42		
0.212	40		
0.15	38		
0.063	33		

Dry Mass of sample, g: 4738

Sample Proportions	% dry mass
Cobbles	0
Gravel	44
Sand	23
Fines <0.063mm	33

Grading Analysis		
D100	mm	
D60	mm	3.77
D30	mm	0.0391
D10	mm	0.00289
Uniformity Coefficient		1300
Curvature Coefficient		0.14

Remarks

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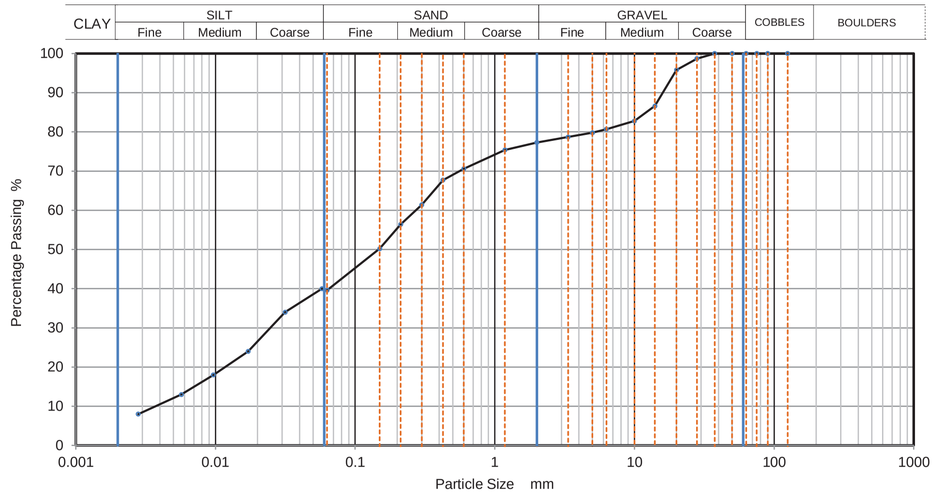
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272				
Borehole/Pit No.	BH05				
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3		
Soil Description	Grey sandy gravelly CLAY.	Depth, m	1.00		
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812641		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	40
90	100	0.0315	34
75	100	0.0171	24
63	100	0.0097	18
50	100	0.0057	13
37.5	100	0.0028	8
28	99		
20	96		
14	87		
10	83		
6.3	81		
5	80		
3.35	79		
2	77		
1.18	75		
0.6	71	Particle density	(assumed)
0.425	68	1.50	Mg/m3
0.3	61		
0.212	56		
0.15	50		
0.063	40		

Dry Mass of sample, g: 3178

Sample Proportions	% dry mass
Cobbles	0
Gravel	23
Sand	38
Fines <0.063mm	40

Grading Analysis		
D100	mm	
D60	mm	0.271
D30	mm	0.0251
D10	mm	0.00355
Uniformity Coefficient		77
Curvature Coefficient		0.65

Remarks

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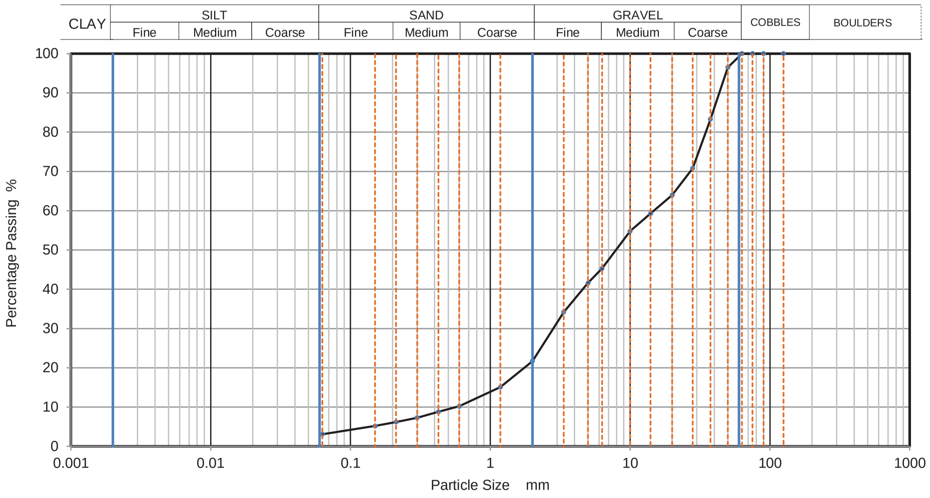
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole/Pit No.	BH05
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	6
Soil Description	Medium dense to dense grey very sandy subrounded to rounded fine to coarse GRAVEL with cobbles and boulders.	Depth, m	4.00
Specimen Reference	4	Specimen Depth	m
Sample Type	B		
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812644



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	97		
37.5	83		
28	71		
20	64		
14	59		
10	55		
6.3	45		
5	42		
3.35	34		
2	22		
1.18	15		
0.6	10		
0.425	9		
0.3	7		
0.212	6		
0.15	5		
0.063	3		

Dry Mass of sample, g: 8461

Sample Proportions	% dry mass
Cobbles	0
Gravel	78
Sand	19
Fines <0.063mm	3

Grading Analysis	
D100 mm	
D60 mm	14.8
D30 mm	2.81
D10 mm	0.574
Uniformity Coefficient	26
Curvature Coefficient	0.93

Remarks

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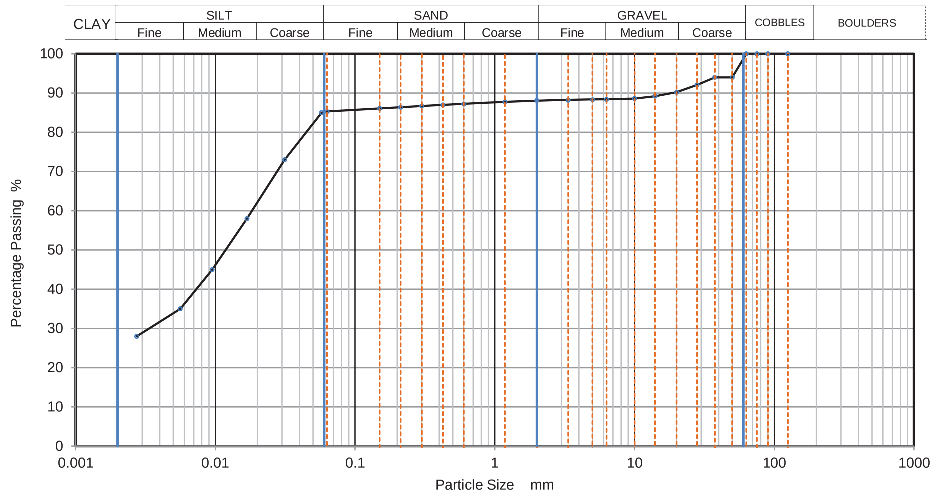
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole/Pit No.	BH05
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	9
Soil Description	Brown sandy gravelly CLAY.	Depth, m	6.00
Specimen Reference	6	Specimen Depth	m
Sample Type	B		
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812647



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0575	85
90	100	0.0313	73
75	100	0.0168	58
63	100	0.0095	45
50	94	0.0056	35
37.5	94	0.0027	28
28	92		
20	90		
14	89		
10	89		
6.3	88		
5	88		
3.35	88		
2	88		
1.18	88		
0.6	87	Particle density	(assumed)
0.425	87	1.50	Mg/m3
0.3	87		
0.212	86		
0.15	86		
0.063	85		

Dry Mass of sample, g: 8147

Sample Proportions	% dry mass
Cobbles	0
Gravel	12
Sand	3
Fines <0.063mm	85

Grading Analysis	
D100 mm	
D60 mm	0.0185
D30 mm	0.00344
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

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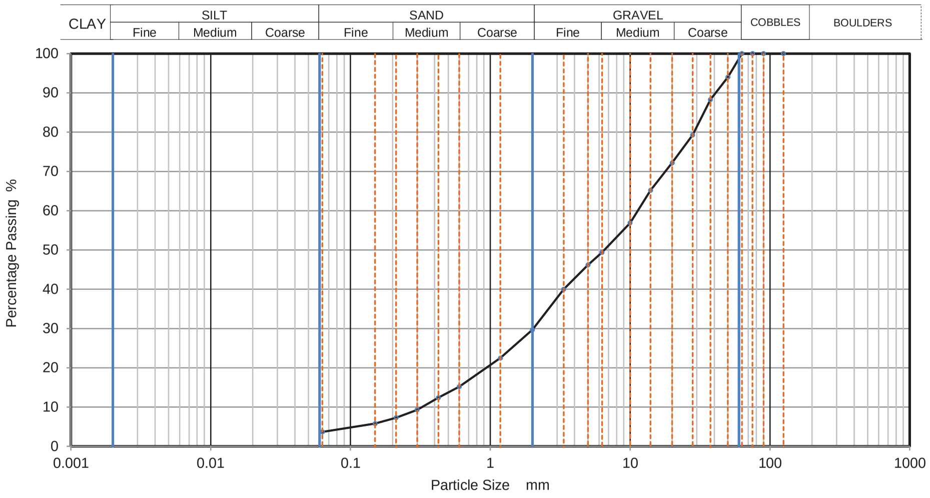
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**15-272**
		Borehole/Pit No.	BH06
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	6
Soil Description	Medium dense grey very sandy subangular to subrounded fine to coarse GRAVEL.	Depth, m	1.00
Specimen Reference	4 / Specimen Depth / m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812657



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	94		
37.5	88		
28	79		
20	72		
14	65		
10	57		
6.3	49		
5	46		
3.35	40		
2	30		
1.18	23		
0.6	15		
0.425	12		
0.3	9		
0.212	7		
0.15	6		
0.063	4		

Dry Mass of sample, g: 10852

Sample Proportions	% dry mass
Cobbles	0
Gravel	70
Sand	26
Fines <0.063mm	4

Grading Analysis		
D100	mm	
D60	mm	11.3
D30	mm	2.03
D10	mm	0.324
Uniformity Coefficient		35
Curvature Coefficient		1.1

Remarks

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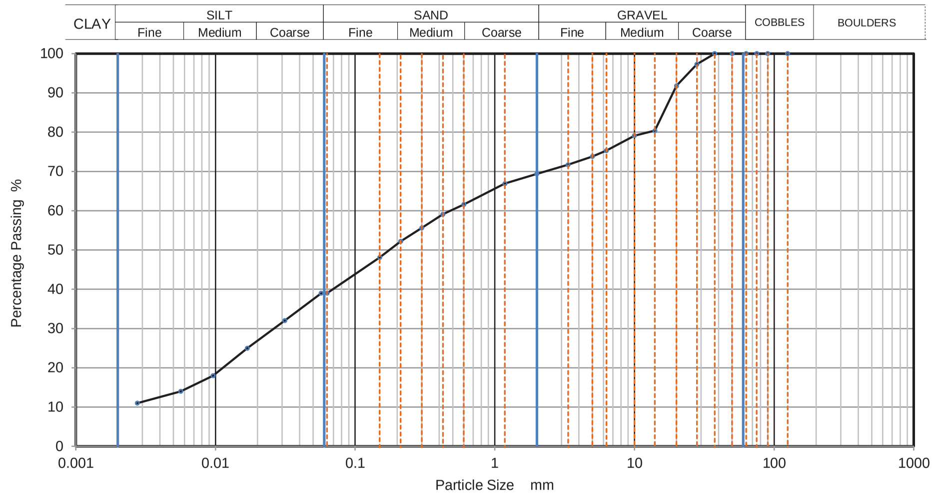
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**15-272**
		Borehole/Pit No.	BH06
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	9
Soil Description	Grey sandy gravelly CLAY	Depth, m	4.00
Specimen Reference	6 / Specimen Depth / m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812660



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0571	39
90	100	0.0313	32
75	100	0.0169	25
63	100	0.0096	18
50	100	0.0056	14
37.5	100	0.0028	11
28	97		
20	92		
14	80		
10	79		
6.3	75		
5	74		
3.35	72		
2	69		
1.18	67		
0.6	62	Particle density	(assumed)
0.425	59	1.50	Mg/m3
0.3	56		
0.212	52		
0.15	48		
0.063	39		

Dry Mass of sample, g: 4044

Sample Proportions	% dry mass
Cobbles	0
Gravel	31
Sand	30
Fines <0.063mm	39

Grading Analysis		
D100	mm	
D60	mm	0.479
D30	mm	0.0261
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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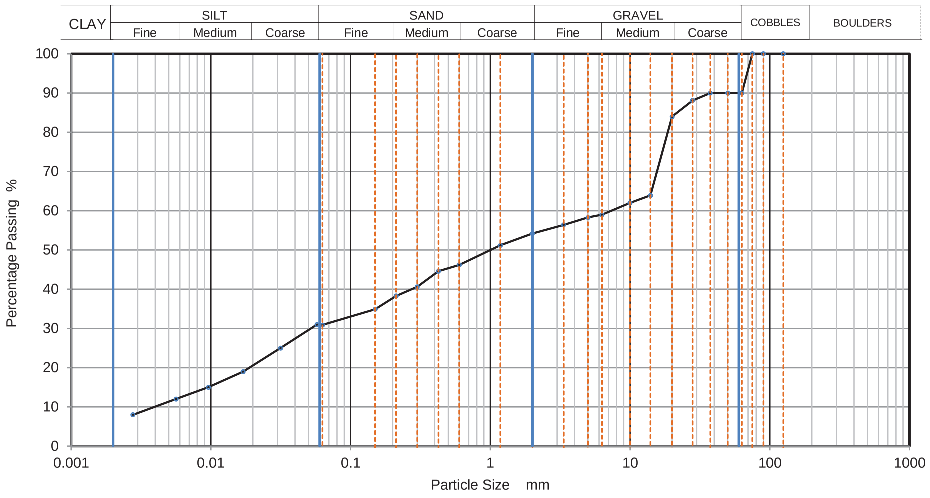
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	BH06
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	13
Soil Description	Brown sandy gravelly CLAY	Depth, m	8.00
Specimen Reference	6 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812664



Sieving: Particle Size mm	Sieving: % Passing	Sedimentation: Particle Size mm	Sedimentation: % Passing
125	100	0.0575	31
90	100	0.0315	25
75	100	0.0170	19
63	90	0.0096	15
50	90	0.0056	12
37.5	90	0.0028	8
28	88		
20	84		
14	64		
10	62		
6.3	59		
5	58		
3.35	56		
2	54		
1.18	51		
0.6	46	Particle density (assumed)	
0.425	45	1.50	Mg/m3
0.3	41		
0.212	38		
0.15	35		
0.063	31		

Dry Mass of sample, g	5077

Sample Proportions	% dry mass
Cobbles	10
Gravel	36
Sand	23
Fines <0.063mm	31

Grading Analysis		
D100	mm	
D60	mm	7.37
D30	mm	0.0521
D10	mm	0.00395
Uniformity Coefficient		1900
Curvature Coefficient		0.093

Remarks

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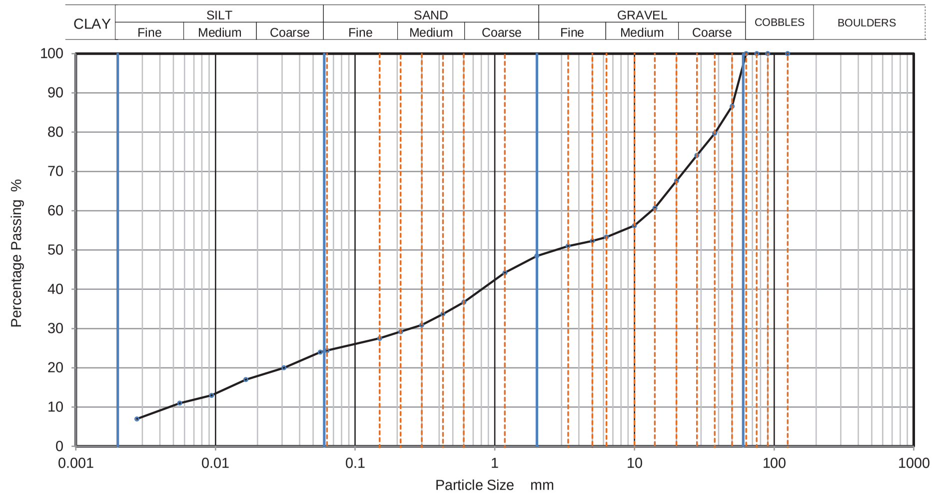
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	TP06
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Brown black very sandy gravelly slightly silty CLAY	Depth, m	2.00
Specimen Reference	4 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812681



Sieving: Particle Size mm	Sieving: % Passing	Sedimentation: Particle Size mm	Sedimentation: % Passing
125	100	0.0563	24
90	100	0.0309	20
75	100	0.0165	17
63	100	0.0094	13
50	87	0.0055	11
37.5	80	0.0027	7
28	74		
20	68		
14	61		
10	56		
6.3	53		
5	52		
3.35	51		
2	49		
1.18	44		
0.6	37	Particle density (assumed)	
0.425	34	1.50	Mg/m3
0.3	31		
0.212	29		
0.15	28		
0.063	24		

Dry Mass of sample, g	8356

Sample Proportions	% dry mass
Cobbles	0
Gravel	52
Sand	24
Fines <0.063mm	24

Grading Analysis		
D100	mm	
D60	mm	13.3
D30	mm	0.251
D10	mm	0.00493
Uniformity Coefficient		2700
Curvature Coefficient		0.96

Remarks

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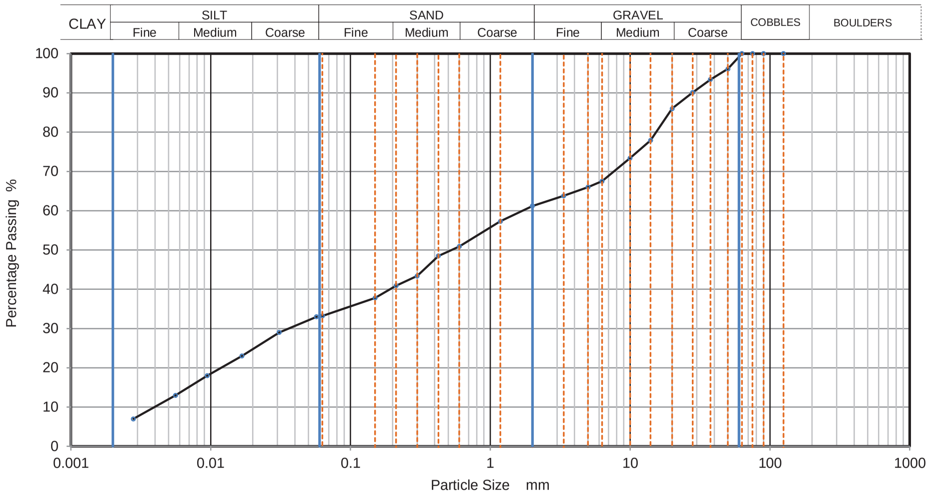
PARTICLE SIZE DISTRIBUTION

Job Ref	15-272	Borehole/Pit No.	TP09
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Black slightly sandy slightly gravelly SILT	Depth, m	2.50
Specimen Reference	6	Specimen Depth (m)	
Sample Type	B		
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812690



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100	0.0571	33
90	100	0.0309	29
75	100	0.0167	23
63	100	0.0094	18
50	96	0.0056	13
37.5	93	0.0028	7
28	90		
20	86		
14	78		
10	73		
6.3	68		
5	66		
3.35	64		
2	61		
1.18	57		
0.6	51	Particle density (assumed)	
0.425	49	1.50	Mg/m3
0.3	43		
0.212	41		
0.15	38		
0.063	33		

Dry Mass of sample, g: 10360

Sample Proportions	% dry mass
Cobbles	0
Gravel	39
Sand	28
Fines <0.063mm	33

Grading Analysis	
D100 mm	
D60 mm	1.7
D30 mm	0.034
D10 mm	0.00398
Uniformity Coefficient	430
Curvature Coefficient	0.17

Remarks

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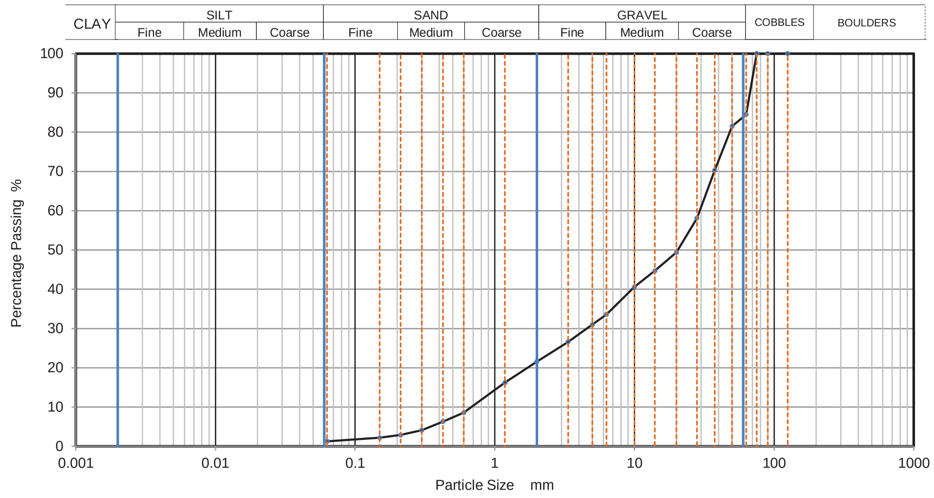
PARTICLE SIZE DISTRIBUTION

Job Ref	15-272	Borehole/Pit No.	TP14
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey sandy GRAVEL.	Depth, m	2.50
Specimen Reference	4	Specimen Depth (m)	
Sample Type	B		
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812699



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100		
90	100		
75	100		
63	85		
50	82		
37.5	70		
28	58		
20	49		
14	45		
10	41		
6.3	34		
5	31		
3.35	27		
2	22		
1.18	16		
0.6	9		
0.425	6		
0.3	4		
0.212	3		
0.15	2		
0.063	1		

Dry Mass of sample, g: 12565

Sample Proportions	% dry mass
Cobbles	16
Gravel	63
Sand	20
Fines <0.063mm	1

Grading Analysis	
D100 mm	
D60 mm	29.3
D30 mm	4.56
D10 mm	0.679
Uniformity Coefficient	43
Curvature Coefficient	1

Remarks

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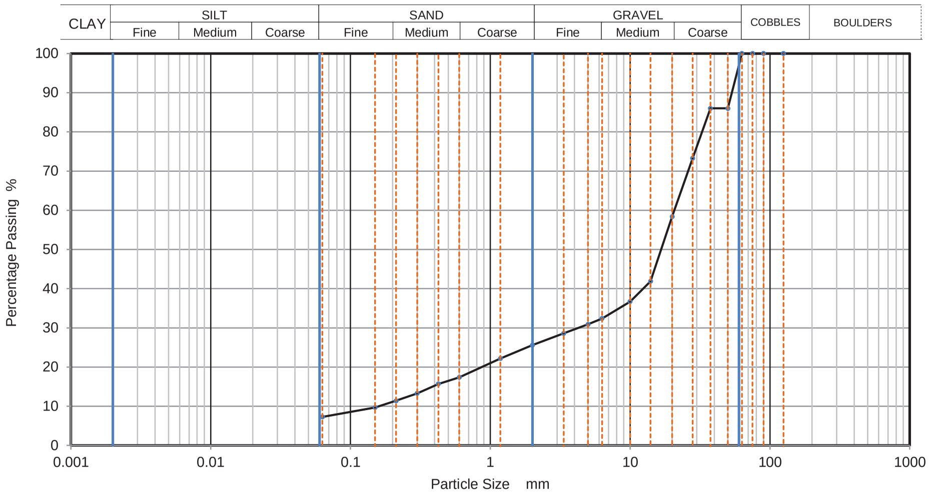
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole/Pit No.	TP17
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown slightly gravelly SAND.	Depth, m	0.30
Specimen Reference	4	Specimen Depth	m
Sample Type	B	Test Method	BS1377:Part 2:1990, clause 9.2
KeyLAB ID	Caus20150812707		



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100		
90	100		
75	100		
63	100		
50	86		
37.5	86		
28	73		
20	58		
14	42		
10	37		
6.3	32		
5	31		
3.35	29		
2	26		
1.18	22		
0.6	17		
0.425	16		
0.3	13		
0.212	11		
0.15	10		
0.063	7		

Dry Mass of sample, g: 2678

Sample Proportions	% dry mass
Cobbles	0
Gravel	74
Sand	18
Fines <0.063mm	7

Grading Analysis		
D100	mm	
D60	mm	20.8
D30	mm	4.25
D10	mm	0.16
Uniformity Coefficient		130
Curvature Coefficient		5.4

Remarks

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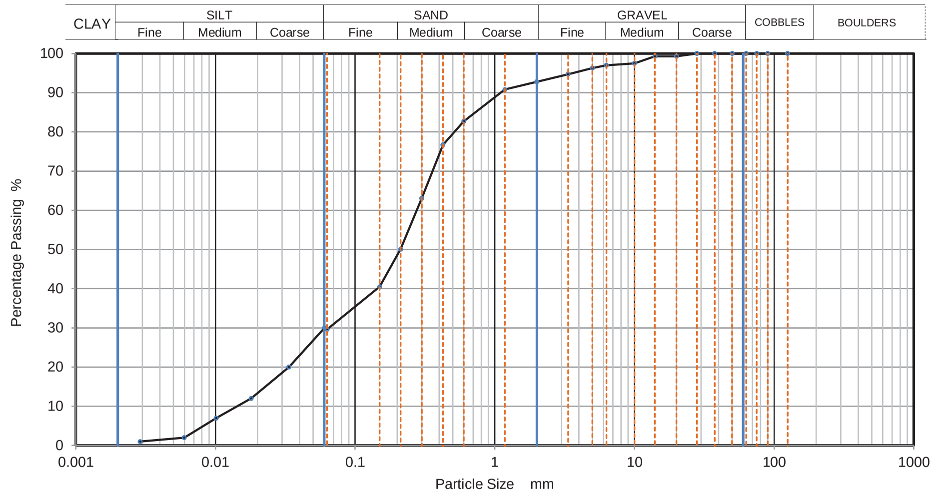
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole/Pit No.	TP24
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Brown gravelly clayey SILT.	Depth, m	1.50
Specimen Reference	6	Specimen Depth	m
Sample Type	B	Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5
KeyLAB ID	Caus20150812731		



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100	0.0604	30
90	100	0.0336	20
75	100	0.0180	12
63	100	0.0101	7
50	100	0.0060	2
37.5	100	0.0029	1
28	100		
20	99		
14	99		
10	98		
6.3	97		
5	96		
3.35	95		
2	93		
1.18	91		
0.6	83	Particle density	(assumed)
0.425	77	1.50	Mg/m3
0.3	63		
0.212	50		
0.15	41		
0.063	30		

Dry Mass of sample, g: 3076

Sample Proportions	% dry mass
Cobbles	0
Gravel	7
Sand	63
Fines <0.063mm	30

Grading Analysis		
D100	mm	
D60	mm	0.276
D30	mm	0.0651
D10	mm	0.0145
Uniformity Coefficient		19
Curvature Coefficient		1.1

Remarks

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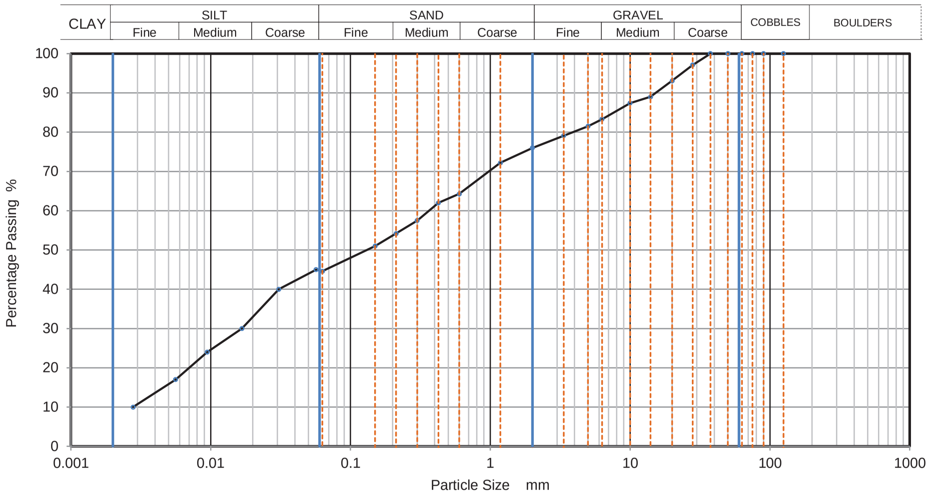
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP24
		Sample No.	5
Soil Description	Black sandy gravelly CLAY	Depth, m	3.50
Specimen Reference	6 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812734



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0567	45
90	100	0.0307	40
75	100	0.0167	30
63	100	0.0094	24
50	100	0.0056	17
37.5	100	0.0028	10
28	97		
20	93		
14	89		
10	87		
6.3	83		
5	82		
3.35	79		
2	76		
1.18	72		
0.6	64	Particle density (assumed)	
0.425	62	1.50	Mg/m3
0.3	58		
0.212	54		
0.15	51		
0.063	45		

Dry Mass of sample, g	3648

Sample Proportions	% dry mass
Cobbles	0
Gravel	24
Sand	32
Fines <0.063mm	45

Grading Analysis	
D100 mm	
D60 mm	0.363
D30 mm	0.017
D10 mm	0.00281
Uniformity Coefficient	130
Curvature Coefficient	0.28

Remarks

Preparation and testing in accordance with BS1377 unless noted below

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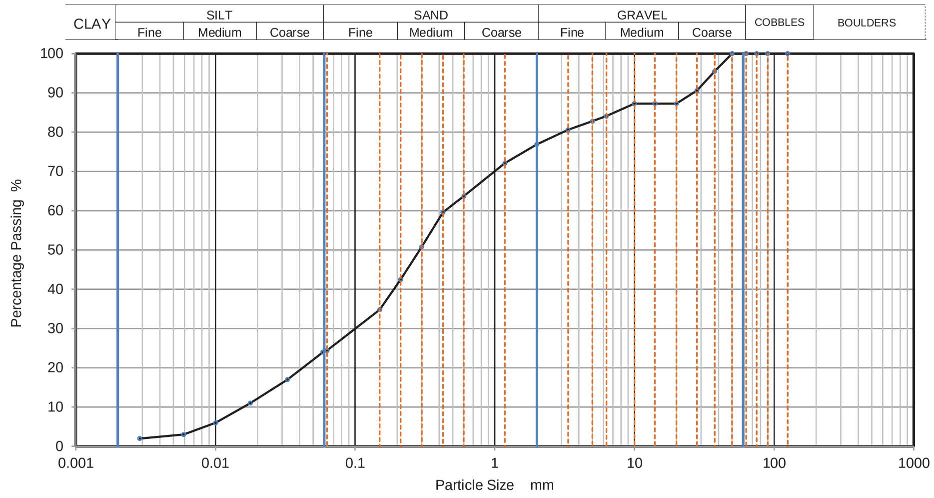
CAUSEWAY GEOTECH

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP26
		Sample No.	3
Soil Description	Brown sandy gravelly SILT	Depth, m	2.00
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812743



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0588	24
90	100	0.0328	17
75	100	0.0177	11
63	100	0.0100	6
50	100	0.0059	3
37.5	96	0.0029	2
28	91		
20	87		
14	87		
10	87		
6.3	84		
5	83		
3.35	81		
2	77		
1.18	72		
0.6	64	Particle density (assumed)	
0.425	60	1.50	Mg/m3
0.3	51		
0.212	43		
0.15	35		
0.063	24		

Dry Mass of sample, g	6600

Sample Proportions	% dry mass
Cobbles	0
Gravel	23
Sand	53
Fines <0.063mm	24

Grading Analysis	
D100 mm	
D60 mm	0.44
D30 mm	0.101
D10 mm	0.0157
Uniformity Coefficient	28
Curvature Coefficient	1.5

Remarks

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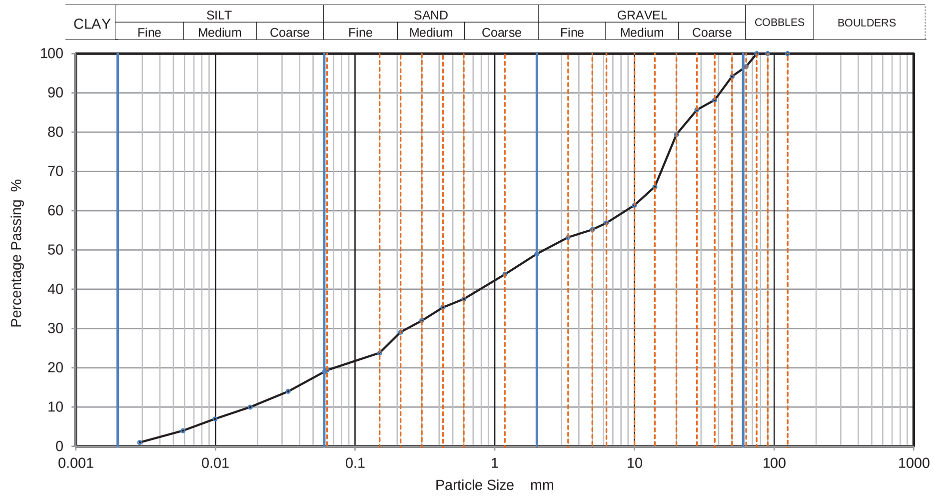
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH				Job Ref	15-272
				Borehole/Pit No.	TP29
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	5
Soil Description	Black brown sandy gravelly slightly silty CLAY			Depth, m	4.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus20150812754



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0604	19
90	100	0.0332	14
75	100	0.0177	10
63	97	0.0099	7
50	94	0.0059	4
37.5	88	0.0029	1
28	86		
20	79		
14	66		
10	61		
6.3	57		
5	55		
3.35	53		
2	49		
1.18	44		
0.6	38	Particle density (assumed)	
0.425	35	1.50 Mg/m3	
0.3	32		
0.212	29		
0.15	24		
0.063	19		

Dry Mass of sample, g	11404

Sample Proportions	% dry mass
Cobbles	3
Gravel	48
Sand	30
Fines <0.063mm	19

Grading Analysis	
D100 mm	
D60 mm	8.66
D30 mm	0.236
D10 mm	0.0175
Uniformity Coefficient	490
Curvature Coefficient	0.37

Remarks

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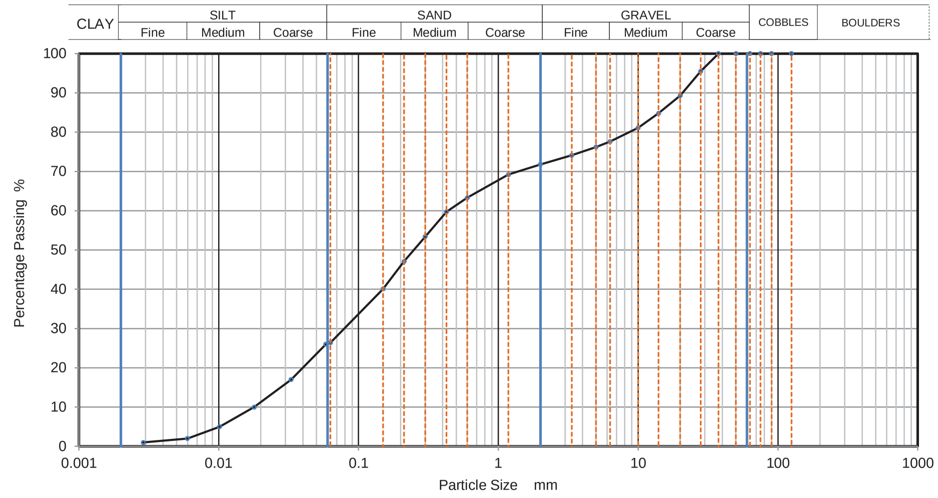
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH				Job Ref	15-272
				Borehole/Pit No.	TP32
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	MADE GROUND - Brown gravelly clayey SILT.			Depth, m	0.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus20150812763



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	26
90	100	0.0330	17
75	100	0.0179	10
63	100	0.0101	5
50	100	0.0060	2
37.5	100	0.0029	1
28	96		
20	89		
14	85		
10	81		
6.3	78		
5	76		
3.35	74		
2	72		
1.18	69		
0.6	63	Particle density (assumed)	
0.425	60	1.50 Mg/m3	
0.3	53		
0.212	47		
0.15	40		
0.063	26		

Dry Mass of sample, g	4201

Sample Proportions	% dry mass
Cobbles	0
Gravel	28
Sand	45
Fines <0.063mm	26

Grading Analysis	
D100 mm	
D60 mm	0.438
D30 mm	0.079
D10 mm	0.0181
Uniformity Coefficient	24
Curvature Coefficient	0.79

Remarks

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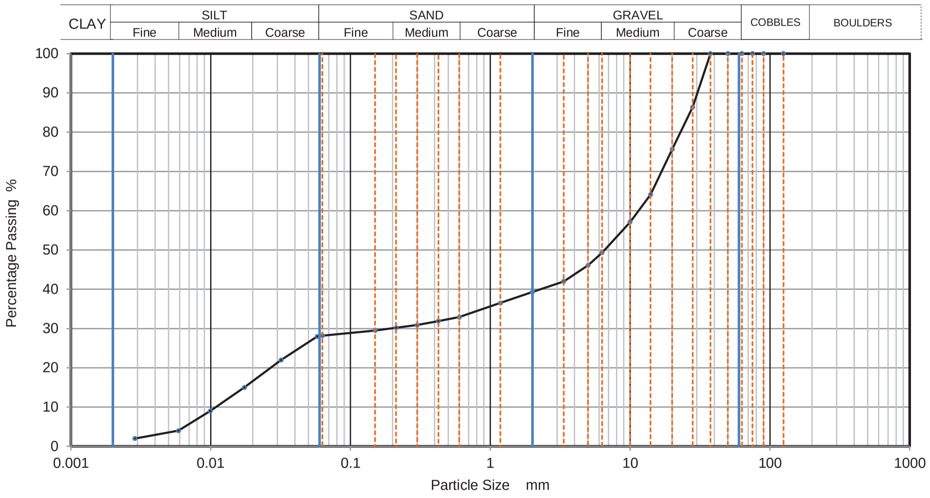
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	TP35
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Grey sandy gravelly clayey SILT	Depth, m	1.50
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812774



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0580	28
90	100	0.0320	22
75	100	0.0174	15
63	100	0.0099	9
50	100	0.0059	4
37.5	100	0.0029	2
28	86		
20	76		
14	64		
10	57		
6.3	49		
5	46		
3.35	42		
2	39		
1.18	37		
0.6	33	Particle density 1.50	(assumed) Mg/m3
0.425	32		
0.3	31		
0.212	30		
0.15	30		
0.063	28		

Dry Mass of sample, g: 2936

Sample Proportions	% dry mass
Cobbles	0
Gravel	61
Sand	11
Fines <0.063mm	28

Grading Analysis		
D100	mm	
D60	mm	11.5
D30	mm	0.189
D10	mm	0.0114
Uniformity Coefficient		1000
Curvature Coefficient		0.27

Remarks
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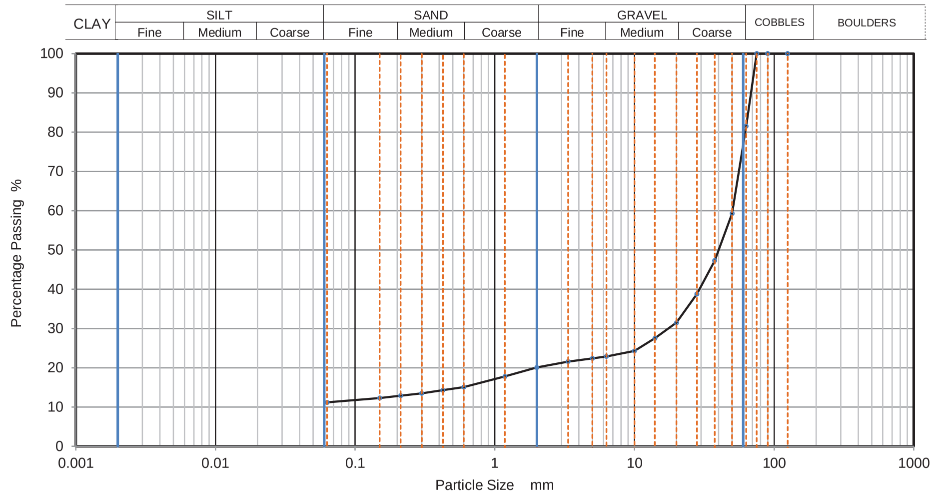
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	TP36
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Grey sandy silty GRAVEL	Depth, m	1.50
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812776



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	82		
50	59		
37.5	47		
28	39		
20	32		
14	28		
10	24		
6.3	23		
5	22		
3.35	22		
2	20		
1.18	18		
0.6	15		
0.425	14		
0.3	14		
0.212	13		
0.15	12		
0.063	11		

Dry Mass of sample, g: 8840

Sample Proportions	% dry mass
Cobbles	19
Gravel	61
Sand	9
Fines <0.063mm	11

Grading Analysis		
D100	mm	
D60	mm	50.4
D30	mm	17.5
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
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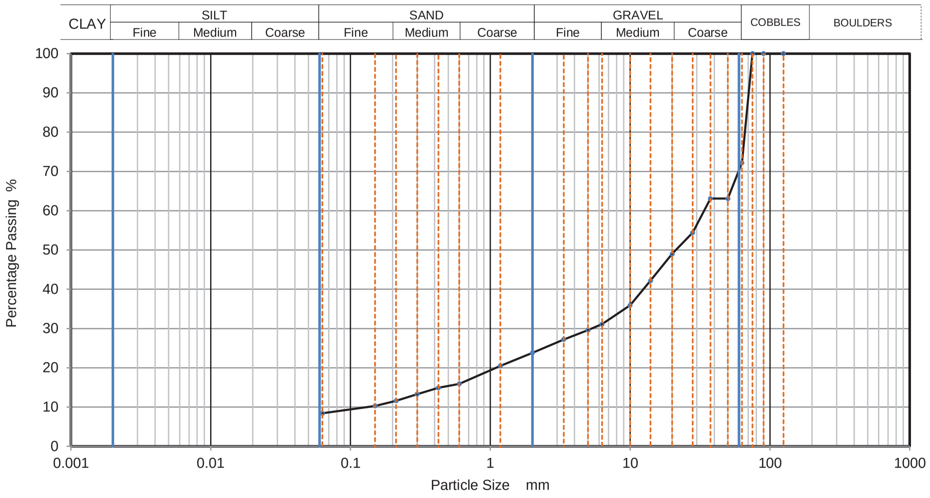
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH		Job Ref	15-272
		Borehole/Pit No.	TP37
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Grey sandy silty GRAVEL	Depth, m	1.00
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812778



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	72		
50	63		
37.5	63		
28	54		
20	49		
14	42		
10	36		
6.3	31		
5	30		
3.35	27		
2	24		
1.18	21		
0.6	16		
0.425	15		
0.3	13		
0.212	12		
0.15	10		
0.063	8		

Dry Mass of sample, g	2950

Sample Proportions	% dry mass
Cobbles	28
Gravel	48
Sand	15
Fines <0.063mm	8

Grading Analysis	
D100 mm	
D60 mm	33.8
D30 mm	5.34
D10 mm	0.133
Uniformity Coefficient	250
Curvature Coefficient	6.3

Remarks

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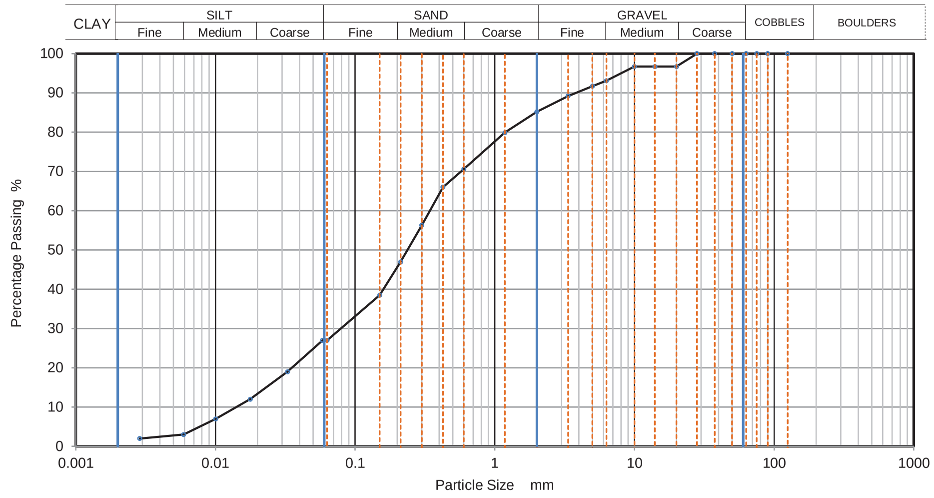
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH		Job Ref	15-272
		Borehole/Pit No.	TP38
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Grey sandy gravelly SILT	Depth, m	1.00
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812780



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0584	27
90	100	0.0328	19
75	100	0.0177	12
63	100	0.0100	7
50	100	0.0059	3
37.5	100	0.0029	2
28	100		
20	97		
14	97		
10	97		
6.3	93		
5	92		
3.35	89		
2	85		
1.18	80		
0.6	71	Particle density	(assumed)
0.425	66	1.50	Mg/m3
0.3	56		
0.212	47		
0.15	39		
0.063	27		

Dry Mass of sample, g	6598

Sample Proportions	% dry mass
Cobbles	0
Gravel	15
Sand	58
Fines <0.063mm	27

Grading Analysis	
D100 mm	
D60 mm	0.343
D30 mm	0.0791
D10 mm	0.0145
Uniformity Coefficient	24
Curvature Coefficient	1.3

Remarks

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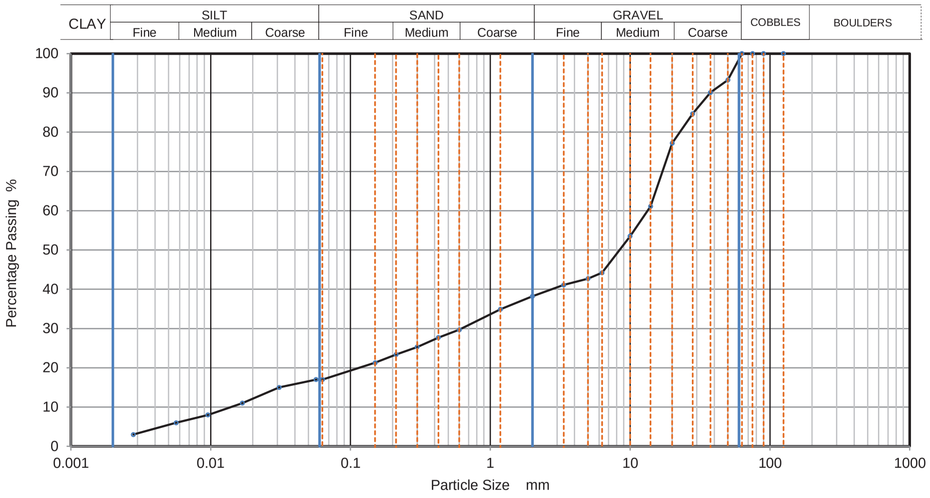
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	TP38
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey brown sandy gravelly clayey SILT	Depth, m	2.50
Specimen Reference	6 · Specimen Depth · m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812782



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0567	17
90	100	0.0309	15
75	100	0.0168	11
63	100	0.0095	8
50	93	0.0057	6
37.5	90	0.0028	3
28	85		
20	77		
14	61		
10	54		
6.3	44		
5	43		
3.35	41		
2	38		
1.18	35		
0.6	30	Particle density (assumed)	
0.425	28	1.50	Mg/m3
0.3	25		
0.212	23		
0.15	21		
0.063	17		

Dry Mass of sample, g: 9263

Sample Proportions	% dry mass
Cobbles	0
Gravel	62
Sand	21
Fines <0.063mm	17

Grading Analysis	
D100 mm	
D60 mm	13.4
D30 mm	0.628
D10 mm	0.0142
Uniformity Coefficient	940
Curvature Coefficient	2.1

Remarks

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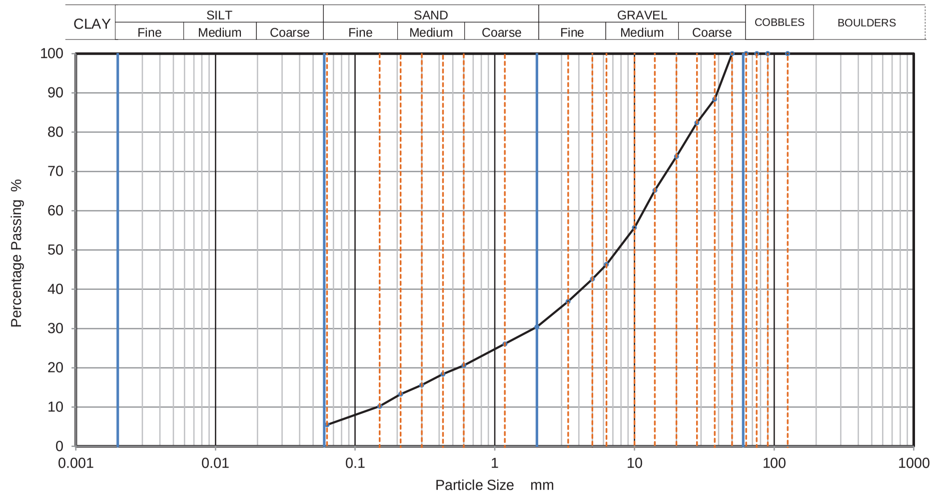
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION	Job Ref	15-272
		Borehole/Pit No.	TP46
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey sandy GRAVEL.	Depth, m	1.50
Specimen Reference	4 · Specimen Depth · m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812811



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	88		
28	82		
20	74		
14	65		
10	56		
6.3	46		
5	43		
3.35	37		
2	30		
1.18	26		
0.6	21		
0.425	18		
0.3	16		
0.212	13		
0.15	10		
0.063	6		

Dry Mass of sample, g: 9130

Sample Proportions	% dry mass
Cobbles	0
Gravel	70
Sand	25
Fines <0.063mm	5

Grading Analysis	
D100 mm	
D60 mm	11.6
D30 mm	1.91
D10 mm	0.145
Uniformity Coefficient	80
Curvature Coefficient	2.1

Remarks

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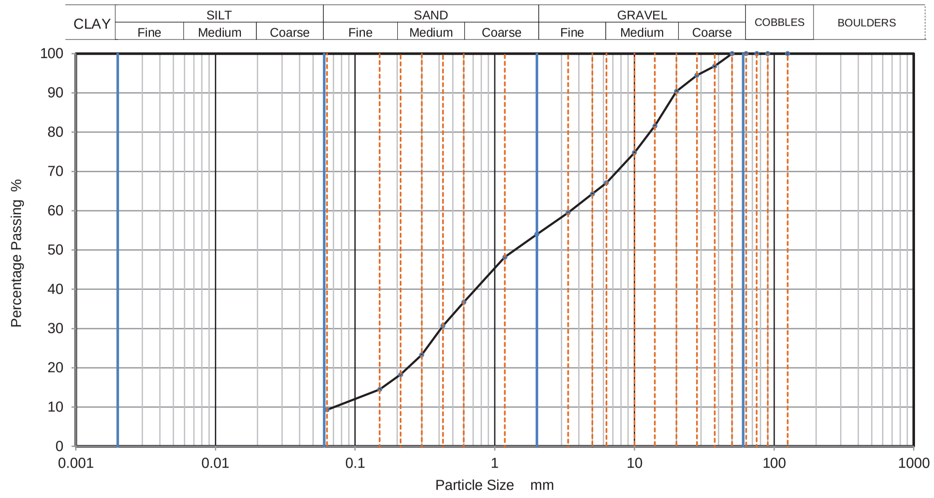
CAUSEWAY GEOTECH		Job Ref	15-272
		Borehole/Pit No.	TP56
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey SAND and GRAVEL	Depth, m	1.50
Specimen Reference	4 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812819



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	97		
28	95		
20	90		
14	82		
10	75		
6.3	67		
5	64		
3.35	60		
2	54		
1.18	48		
0.6	37		
0.425	31		
0.3	23		
0.212	18		
0.15	15		
0.063	9		

Dry Mass of sample, g	6637

Sample Proportions	% dry mass
Cobbles	0
Gravel	46
Sand	45
Fines <0.063mm	9

Grading Analysis		
D100	mm	
D60	mm	3.48
D30	mm	0.412
D10	mm	0.0709
Uniformity Coefficient		49
Curvature Coefficient		0.69

Remarks

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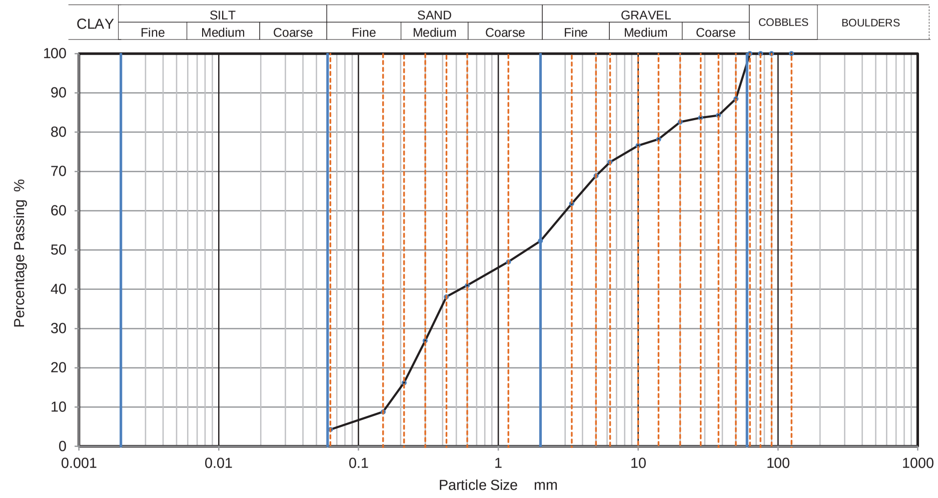
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH		Job Ref	15-272
		Borehole/Pit No.	TP59
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Grey SAND and GRAVEL	Depth, m	1.00
Specimen Reference	4 / Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812824



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	89		
37.5	84		
28	84		
20	83		
14	78		
10	77		
6.3	72		
5	69		
3.35	62		
2	52		
1.18	47		
0.6	41		
0.425	38		
0.3	27		
0.212	16		
0.15	9		
0.063	4		

Dry Mass of sample, g	5277

Sample Proportions	% dry mass
Cobbles	0
Gravel	48
Sand	48
Fines <0.063mm	4

Grading Analysis		
D100	mm	
D60	mm	3.04
D30	mm	0.33
D10	mm	0.158
Uniformity Coefficient		19
Curvature Coefficient		0.23

Remarks

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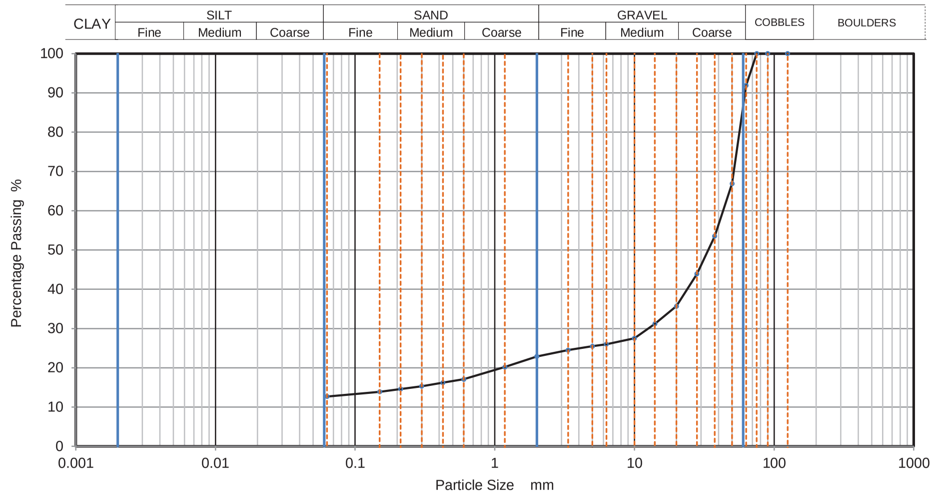
CAUSEWAY GEOTECH

		Job Ref	**15-272**
		Borehole/Pit No.	TP63
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Grey SAND and GRAVEL.	Depth, m	1.50
Specimen Reference	4 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812839



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	92		
50	67		
37.5	54		
28	44		
20	36		
14	31		
10	28		
6.3	26		
5	26		
3.35	25		
2	23		
1.18	20		
0.6	17		
0.425	16		
0.3	15		
0.212	15		
0.15	14		
0.063	13		

Dry Mass of sample, g	7866

Sample Proportions	% dry mass
Cobbles	8
Gravel	69
Sand	10
Fines <0.063mm	13

Grading Analysis	
D100 mm	
D60 mm	43.1
D30 mm	12.6
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

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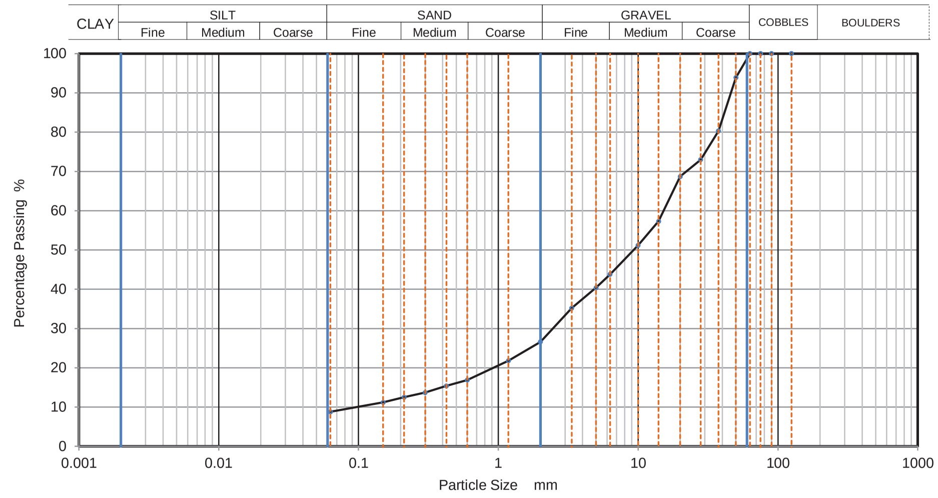
CAUSEWAY GEOTECH

		Job Ref	**15-272**
		Borehole/Pit No.	TP65
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Brownish grey sandy SILT.	Depth, m	1.50
Specimen Reference	6 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812844



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	94		
37.5	80		
28	73		
20	69		
14	57		
10	51		
6.3	44		
5	40		
3.35	35		
2	27		
1.18	22		
0.6	17		
0.425	15		
0.3	14		
0.212	13		
0.15	11		
0.063	9		

Dry Mass of sample, g	5712

Sample Proportions	% dry mass
Cobbles	0
Gravel	73
Sand	18
Fines <0.063mm	9

Grading Analysis	
D100 mm	
D60 mm	15.2
D30 mm	2.45
D10 mm	0.0966
Uniformity Coefficient	160
Curvature Coefficient	4.1

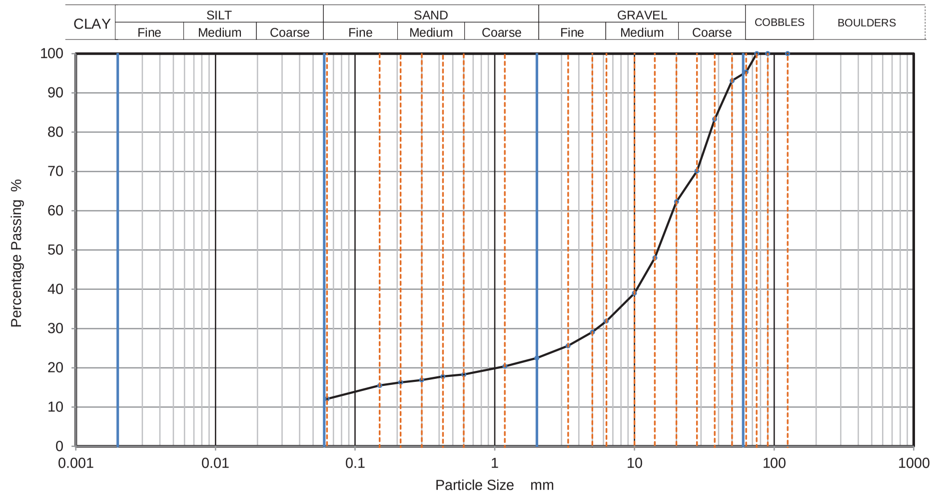
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 30
Stephen.Watson	28/08/2015 12:13	Sheet

PARTICLE SIZE DISTRIBUTION

Job Ref	15-272	Borehole/Pit No.	TP67
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey slightly sandy GRAVEL	Depth, m	2.00
Specimen Reference	4	Specimen Depth	m
Sample Type	B		
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus20150812849



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100		
90	100		
75	100		
63	95		
50	93		
37.5	83		
28	70		
20	62		
14	48		
10	39		
6.3	32		
5	29		
3.35	26		
2	23		
1.18	20		
0.6	18		
0.425	18		
0.3	17		
0.212	16		
0.15	16		
0.063	12		

Dry Mass of sample, g: 8667

Sample Proportions	% dry mass
Cobbles	5
Gravel	73
Sand	11
Fines <0.063mm	12

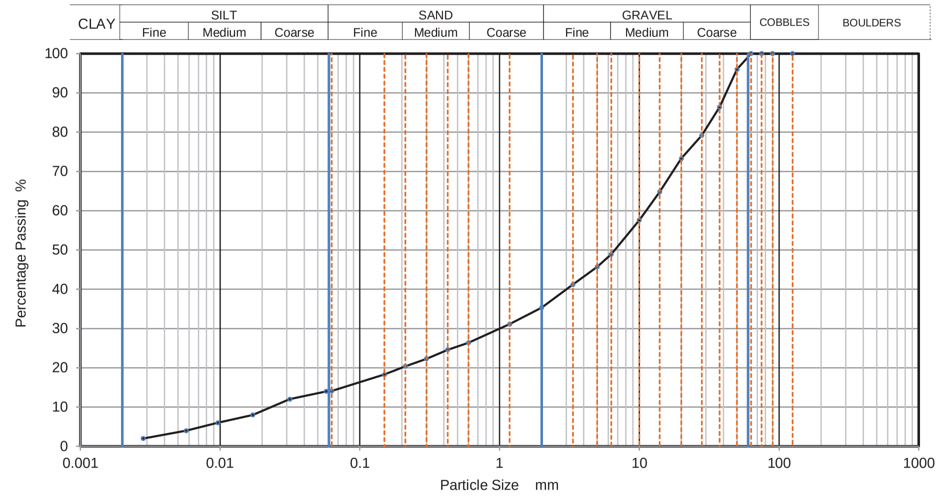
Grading Analysis		
D100	mm	
D60	mm	18.9
D30	mm	5.39
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 31
Stephen.Watson	28/08/2015 12:14	Sheet

PARTICLE SIZE DISTRIBUTION

Job Ref	15-272	Borehole/Pit No.	TP72
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	5
Soil Description	Grey sandy gravelly SILT	Depth, m	4.00
Specimen Reference	4	Specimen Depth	m
Sample Type	B		
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus20150812863



Sieving Particle Size mm	Sieving % Passing	Sedimentation Particle Size mm	Sedimentation % Passing
125	100	0.0575	14
90	100	0.0315	12
75	100	0.0171	8
63	100	0.0097	6
50	96	0.0057	4
37.5	86	0.0028	2
28	79		
20	73		
14	65		
10	58		
6.3	49		
5	46		
3.35	41		
2	35		
1.18	31		
0.6	26	Particle density	(assumed)
0.425	25	1.50	Mg/m3
0.3	22		
0.212	20		
0.15	18		
0.063	14		

Dry Mass of sample, g: 7418

Sample Proportions	% dry mass
Cobbles	0
Gravel	65
Sand	21
Fines <0.063mm	14

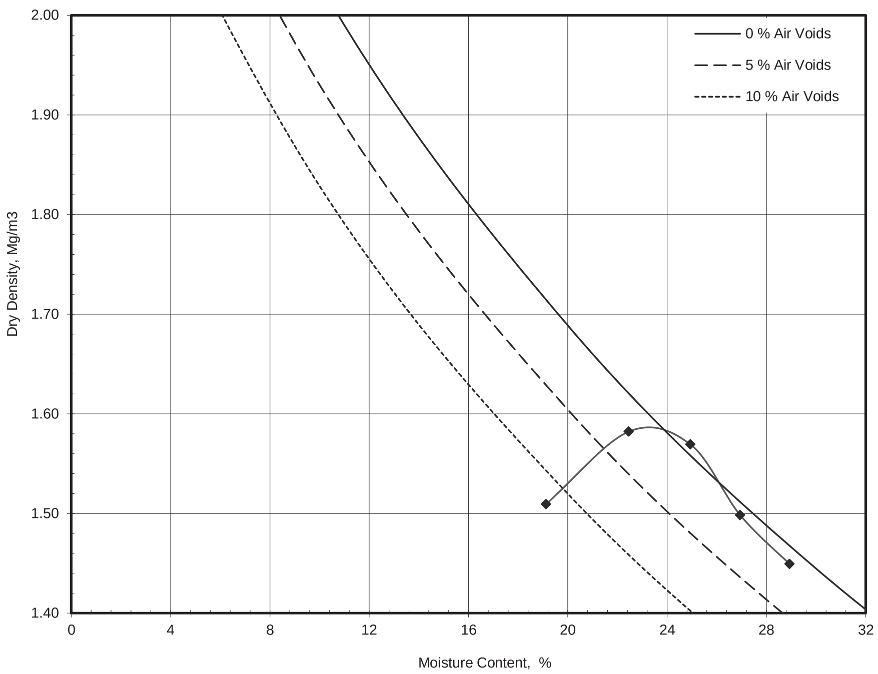
Grading Analysis		
D100	mm	
D60	mm	11.2
D30	mm	1
D10	mm	0.0234
Uniformity Coefficient		480
Curvature Coefficient		3.8

Remarks
Preparation and testing in accordance with BS1377 unless noted below

Approved	Sheet printed	Fig 32
Stephen.Watson	28/08/2015 12:14	Sheet

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP33
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Brown sandy gravelly CLAY.	Depth	1.50 m
Specimen Ref.	6 / Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150812769
		Compaction Test Reference/No.	

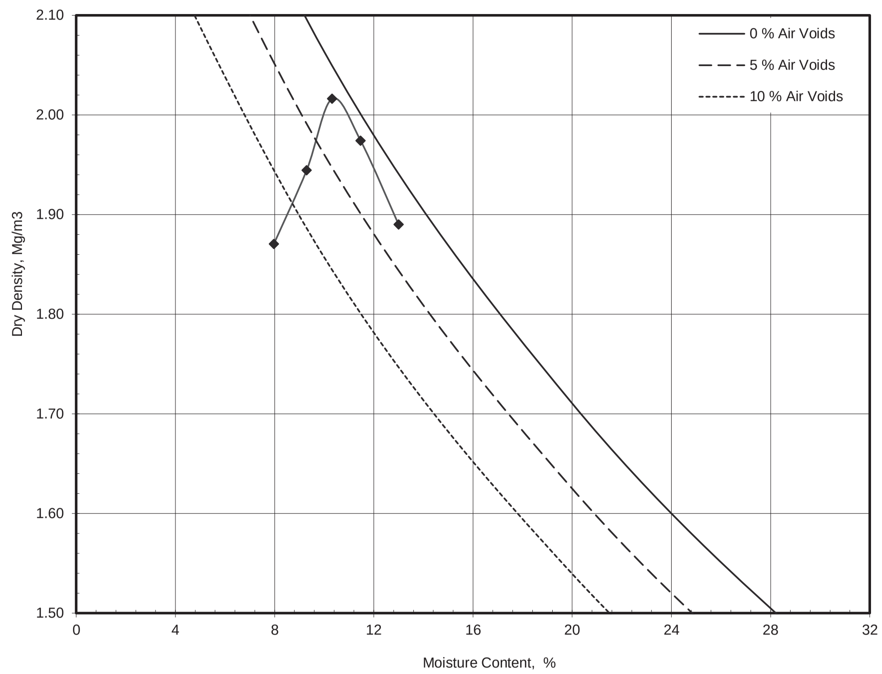


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	0
Particle Density - Assumed	Mg/m³	2.55
Maximum Dry Density	Mg/m³	**1.58**
Optimum Moisture Content	%	**25**

Approved	Remarks GRADING ZONE 1	**Fig**
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP69
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	3
Soil Description	Brown sandy gravelly CLAY	Depth	2.00 m
Specimen Ref.	6 / Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.4, 2.5kg rammer	Keylab ID	Caus20150812852
		Compaction Test Reference/No.	



Preparation		Material used was air dried and oven dried at 105degC
Mould Type		CBR
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	5
Material Retained on 20.0 mm Sieve	%	10
Particle Density - Assumed	Mg/m³	2.60
Maximum Dry Density	Mg/m³	**2.02**
Optimum Moisture Content	%	**10**

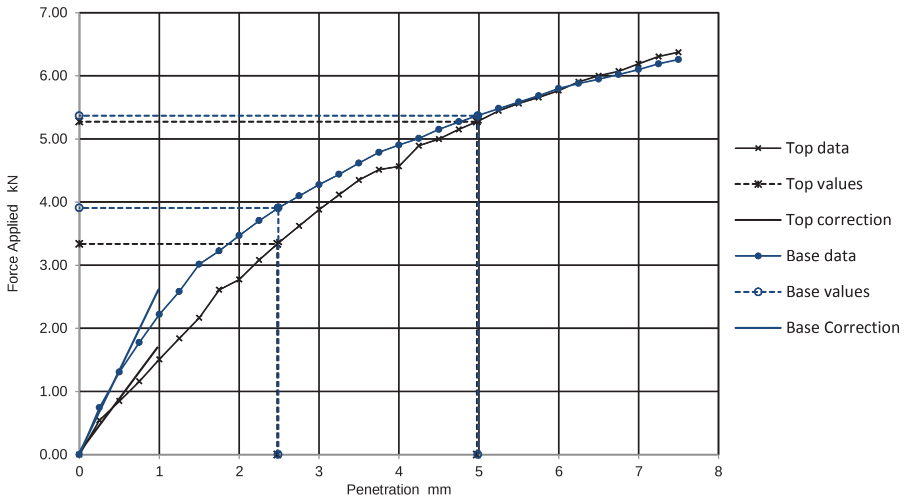
Approved	Remarks GRADING ZONE 4	**Fig**
Stephen.Watson		Sheet 1 of 1

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)			Job Ref	15-272
				Borehole/Pit No.	TP07
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Brown sandy gravelly CLAY.			Depth m	0.40
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Specimen Description	Soft brown gravelly silty CLAY			KeyLAB ID	Caus20150812682
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		0	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.20	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.87	Mg/m3		8	kPa
	Moisture content	17.9	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	25.0	26.0	26.0	28.0	17.9
BASE	Yes	30.0	27.0	30.0		18.6

General remarks	Test specific remarks	Approved	Fig No. 1
Tested at natural moisture content		Stephen.Watson	Sheet No 1

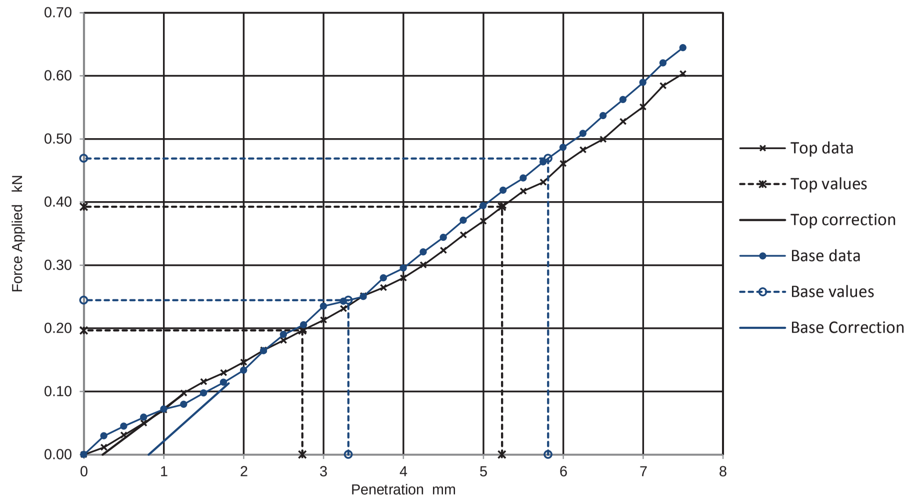
Lab Sheet Reference :

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)			Job Ref	15-272
				Borehole/Pit No.	TP16
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Brown sandy gravelly clayey SILT.			Depth m	0.40
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Specimen Description	Soft sandy gravelly CLAY.			KeyLAB ID	Caus20150812704
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		17	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.20	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.91	Mg/m3		8	kPa
	Moisture content	15.1	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	1.5	2.0	2.0	2.2	15.1
BASE	Yes	1.9	2.3	2.3		15.8

General remarks	Test specific remarks	Approved	Fig No. 2
Tested at natural moisture content		Stephen.Watson	Sheet No 2

Lab Sheet Reference :

California Bearing Ratio (CBR)				Job Ref	15-272
				Borehole/Pit No.	TP30
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	2
Soil Description	Brown sandy slightly gravelly clayey SILT.			Depth m	1.50
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff brown sandy slightly gravelly CLAY			KeyLAB ID	Caus20150812756
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

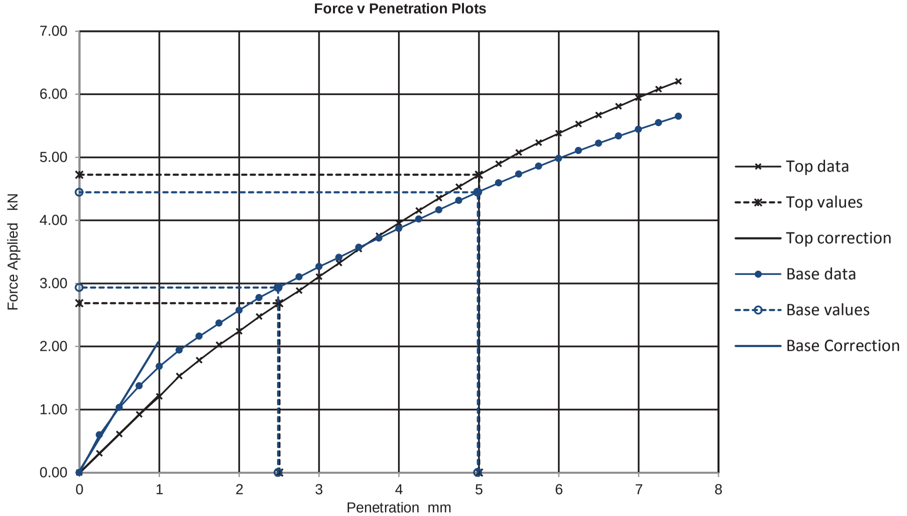
Material retained on 20mm sieve removed: 5 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 1.97 Mg/m3
Dry density: 1.73 Mg/m3
Moisture content: 13.8 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	20.0	24.0	24.0	23.0	13.8
BASE	Yes	22.0	22.0	22.0		13.0

General remarks	Test specific remarks	Approved
Tested at natural moisture content		Stephen.Watson

Fig No. 3
Sheet No 3

Lab Sheet Reference :

California Bearing Ratio (CBR)				Job Ref	15-272
				Borehole/Pit No.	TP40
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Soft to firm sandy gravelly CLAY.			Depth m	0.30
Specimen Reference	2	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff sandy gravelly silty CLAY.			KeyLAB ID	Caus20150812787
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

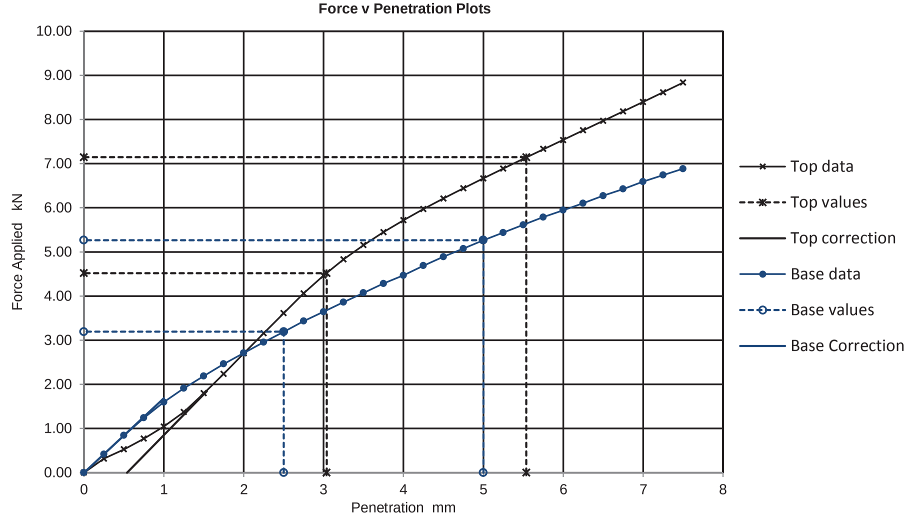
Material retained on 20mm sieve removed: 10 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 2.03 Mg/m3
Dry density: 1.77 Mg/m3
Moisture content: 14.8 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	34.0	36.0	36.0		14.8
BASE	Yes	24.0	26.0	26.0		15.1

General remarks	Test specific remarks	Approved
Tested at natural moisture content		Stephen.Watson

Fig No. 4
Sheet No 4

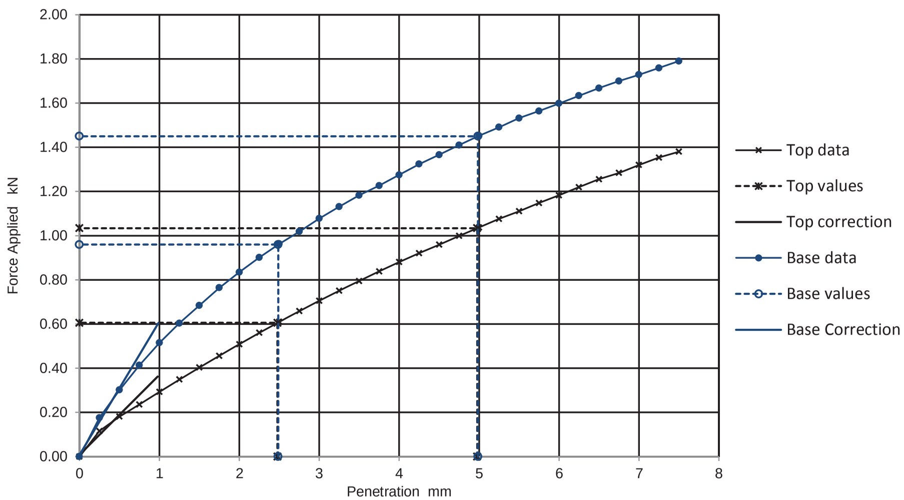
Lab Sheet Reference :

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)			Job Ref	15-272
				Borehole/Pit No.	TP45
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	2
Soil Description	Grey slightly gravelly sandy SILT			Depth m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff grey sandy clayey SILT			KeyLAB ID	Caus20150812806
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		0	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	1.85	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.44	Mg/m3		8	kPa
	Moisture content	28.5	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average		Moisture Content %
TOP	Yes	4.6	5.2	5.2			28.5
BASE	Yes	7.3	7.2	7.3			27.8

General remarks	Test specific remarks	Approved	Fig No.	5
Tested at natural moisture content		Stephen.Watson	Sheet No	5

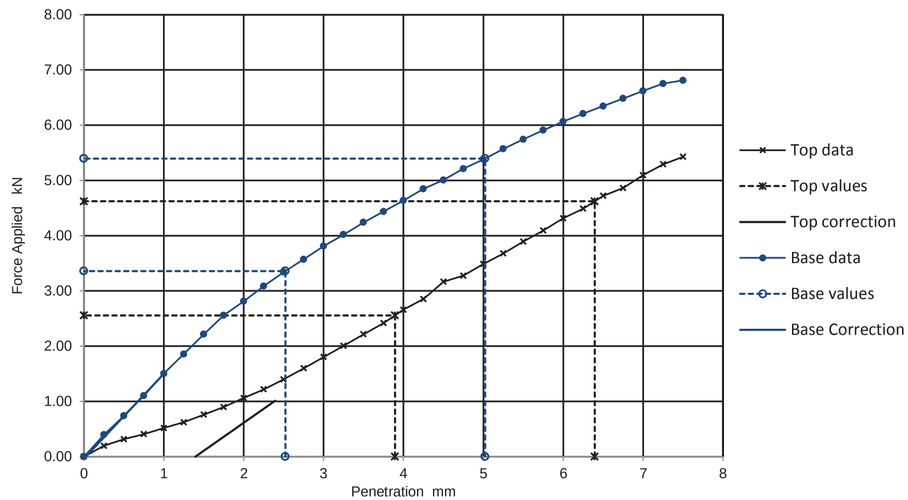
Lab Sheet Reference :

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)			Job Ref	15-272
				Borehole/Pit No.	TP60
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Brown sandy gravelly silty CLAY			Depth m	1.00
Specimen Reference	6	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff brown sandy gravelly CLAY with cobbles.			KeyLAB ID	Caus20150812826
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition				Soaking details	Not soaked	
Details				Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		8	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.08	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.80	Mg/m3		8	kPa
	Moisture content	15.8	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average		Moisture Content %
TOP	Yes	19.0	23.0	23.0	25.0		15.8
BASE	Yes	25.0	27.0	27.0			15.7

General remarks	Test specific remarks	Approved	Fig No.	6
Tested at natural moisture content		Stephen.Watson	Sheet No	6

Lab Sheet Reference :

California Bearing Ratio (CBR)

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP65
		Sample No.	2
Soil Description	Soft dark brownsandy gravelly SILT	Depth m	1.00
Specimen Reference	6 Specimen Depth m	Sample Type	B
Specimen Description	Soft dark brown slightly gravelly CLAY.	KeyLAB ID	Caus20150812843
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

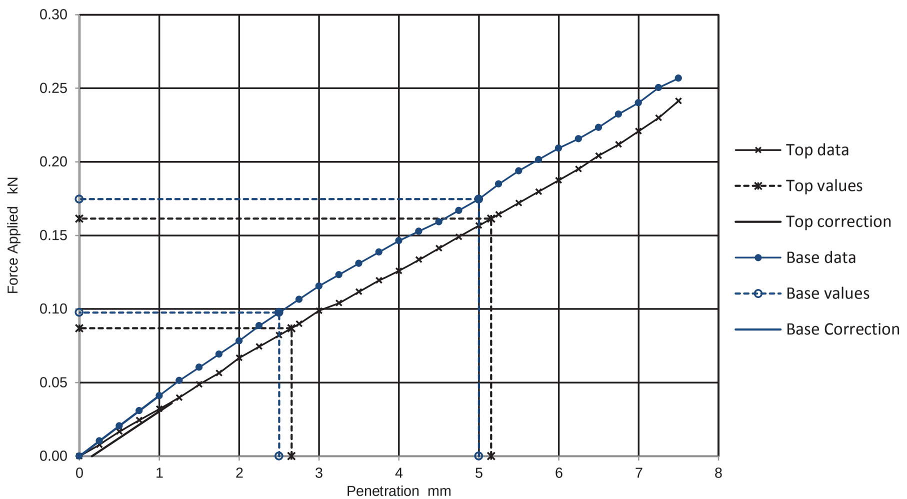
Material retained on 20mm sieve removed: 1 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 1.81 Mg/m3
Dry density: 1.38 Mg/m3
Moisture content: 31.2 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	0.7	0.8	0.8	0.8	31.9
BASE	Yes	0.7	0.9	0.9		30.9

General remarks	Test specific remarks	Approved	Fig No. 7
Tested at natural moisture content		Stephen.Watson	Sheet No 7

Lab Sheet Reference :

California Bearing Ratio (CBR)

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP74
		Sample No.	1
Soil Description	Brown sandy gravelly CLAY	Depth m	0.50
Specimen Reference	6 Specimen Depth m	Sample Type	B
Specimen Description	Stiff brown sandy gravelly CLAY	KeyLAB ID	Caus20150812867
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

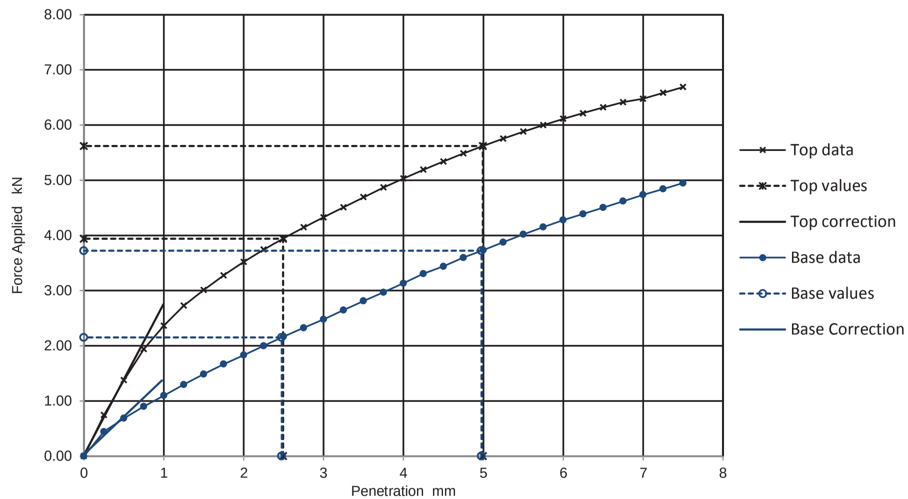
Material retained on 20mm sieve removed: 13 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 1.96 Mg/m3
Dry density: 1.72 Mg/m3
Moisture content: 14.2 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	30.0	28.0	30.0		14.2
BASE	Yes	16.0	19.0	19.0		13.7

General remarks	Test specific remarks	Approved	Fig No. 8
Tested at natural moisture content		Stephen.Watson	Sheet No 8

Lab Sheet Reference :

Moisture Condition Value at Natural Moisture Content
Summary of Results

Project No.	Project Name
15-272	Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Retained on 20mm sieve %	Moisture Content <20mm %	Moisture Condition Value	Method of Interpretation	Remarks
TP01	3	2.00		B	Brown black very sandy gravelly slightly silty CLAY with occasional cobbles and boulders	25	11.8	4.2	Best fit line	
TP04	2	1.00		B	Orange brown sandy GRAVEL.	34	7.9	12.0	Best fit line	
TP05	2	1.50		B	Brown black sandy gravelly slightly silty CLAY	28	9.4	4.6	Best fit line	
TP08	1	1.00		B	Brown sandy gravelly CLAY.	1	22.5	15.6	Best fit line	
TP14	1	0.50		B	Soft to firm brown gravelly CLAY.	37	19.2	17.6	Best fit line	
TP18	2	1.00		B	Black sandy gravelly clayey SILT.	10	9.2	13.3	Best fit line	
TP28	2	1.50		B	Brown slightly gravelly clayey SILT.	3	19.7	17.1	Best fit line	
TP31	1	1.00		B	Brown sandy gravelly CLAY.	48	10.1	15.9	Best fit line	
TP43	2	1.50		B	Brown slightly sandy gravelly clayey SILT.	56	13.6	15.2	Best fit line	
TP73	1	1.00		B	Brown sandy gravelly SILT	0	30.7	11.4	Best fit line	

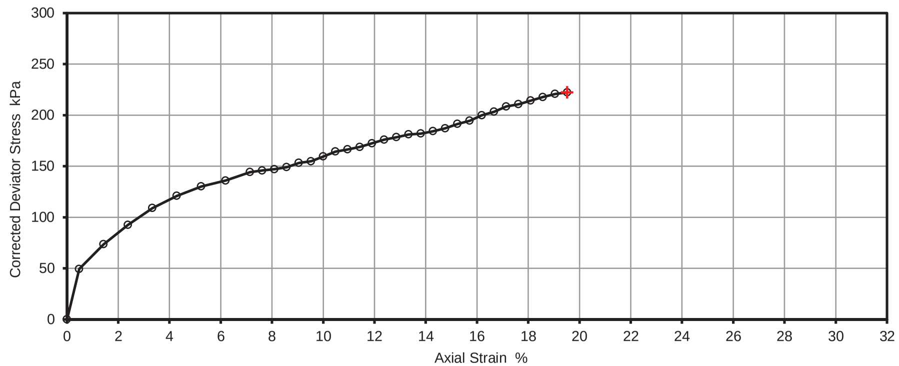
Key	Date Printed	Approved By	Table
Test performed in accordance with BS1377:Part4:1990, clause 5.4 unless annotated otherwise	28/08/2015	Stephen.Watson	sheet

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

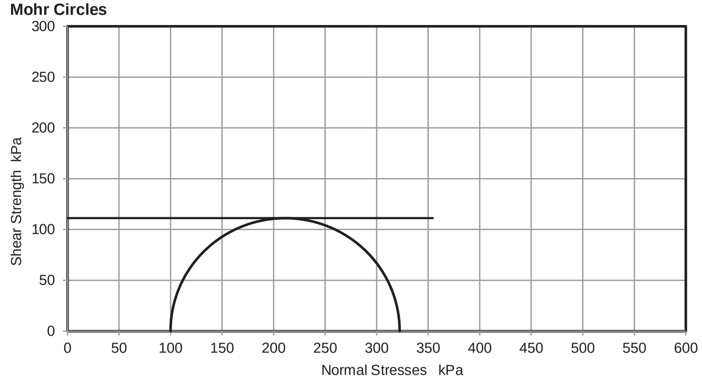
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Job Ref	15-272
Soil Description	Brownish grey sandy gravelly CLAY.			Borehole/Pit No.	BH02
Specimen Reference	4	Specimen Depth	m	Sample No.	2
Specimen Description	Stiff brownish grey sandy gravelly CLAY.			Depth	4.00
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Sample Type	U
				KeyLAB ID	Caus20150812611
				Date of test	

Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		2.32	Mg/m^3
Moisture Content		9.7	%
Dry Density		2.12	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		100	kPa
At failure	Axial Strain	19.5	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	222	kPa
	Undrained Shear Strength, c_u	111	kPa $= ½(\sigma_1 - \sigma_3)_f$
	Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Strengths corrected for area change, and membrane effects based on Fig 11 BS1377

Lab Sheet Reference :

Approved	Printed	Fig. No.	Sheet
Stephen.Watson	28/08/2015 14:15	1	1

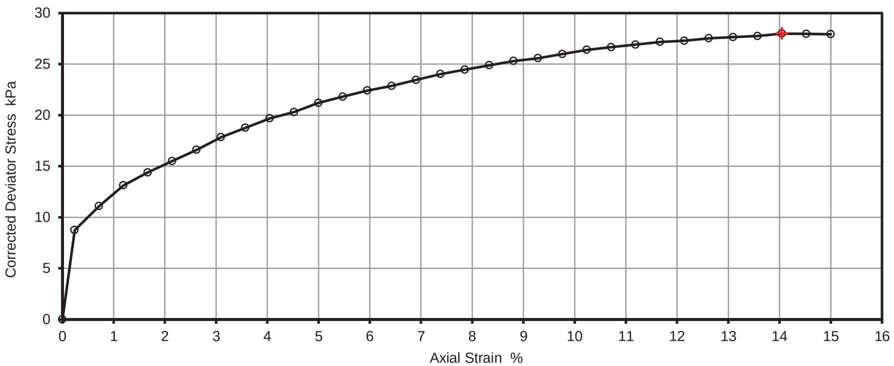
Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

CAUSEWAY GEOTECH

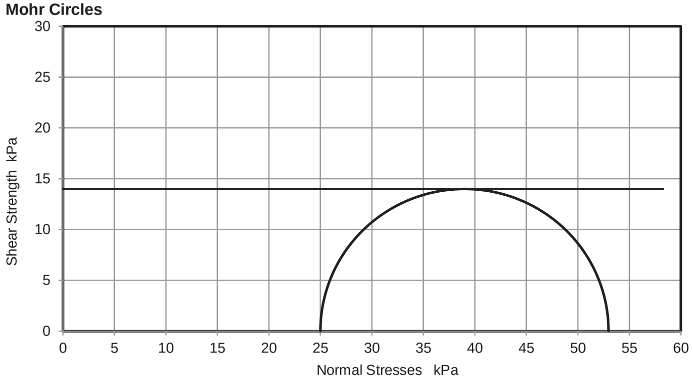
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	BH04
		Sample No.	12
Soil Description	Dark grey to black sandy gravelly CLAY	Depth	1.00
Specimen Reference	4 — Specimen Depth: m	Sample Type	U
Specimen Description	Soft dark grey to black sandy gravelly CLAY	KeyLAB ID	Caus20150812636
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Date of test	

Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		1.80	Mg/m^3
Moisture Content		40.0	%
Dry Density		1.28	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		25	kPa
At failure	Axial Strain	14.0	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	28	kPa
	Undrained Shear Strength, c_u	14	kPa $= ½(\sigma_1 - \sigma_3)_f$
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Strengths corrected for area change, and membrane effects based on Fig 11 BS1377

Lab Sheet Reference :

Approved	Printed	Fig. No.	Sheet
Stephen.Watson	28/08/2015 14:16	1	1

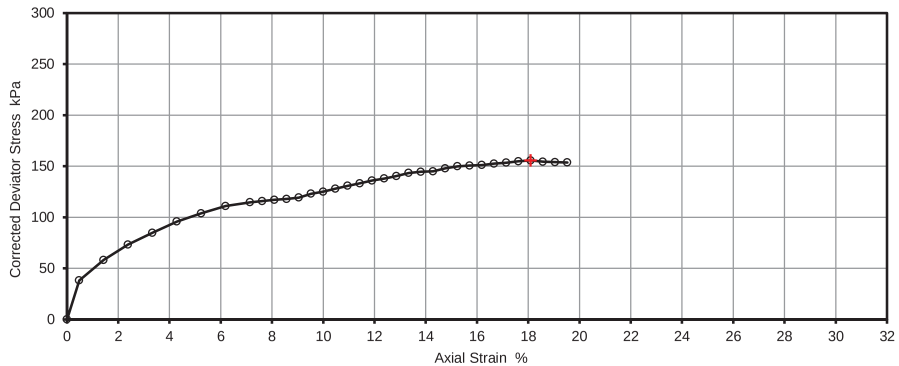
Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

CAUSEWAY GEOTECH

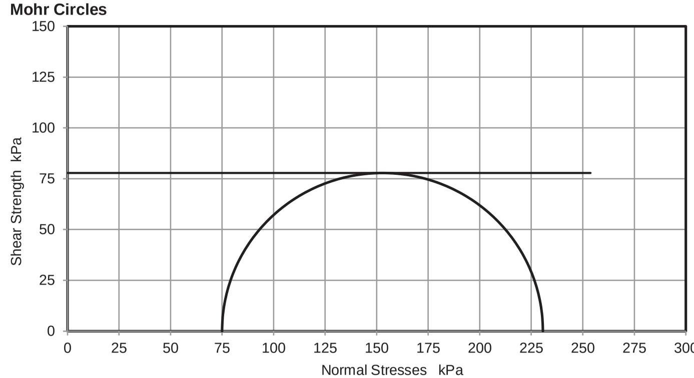
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	BH04
		Sample No.	13
Soil Description	Grey sandy gravelly CLAY	Depth	3.00
Specimen Reference	2 — Specimen Depth: m	Sample Type	U
Specimen Description	Firm to stiff grey sandy gravelly CLAY	KeyLAB ID	Caus20150812899
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Date of test	

Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		2.41	Mg/m^3
Moisture Content		7.8	%
Dry Density		2.24	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		75	kPa
At failure	Axial Strain	18.1	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	156	kPa
	Undrained Shear Strength, c_u	78	kPa $= ½(\sigma_1 - \sigma_3)_f$
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Strengths corrected for area change, and membrane effects based on Fig 11 BS1377

Lab Sheet Reference :

Approved	Printed	Fig. No.	Sheet
Stephen.Watson	28/08/2015 14:16	1	1

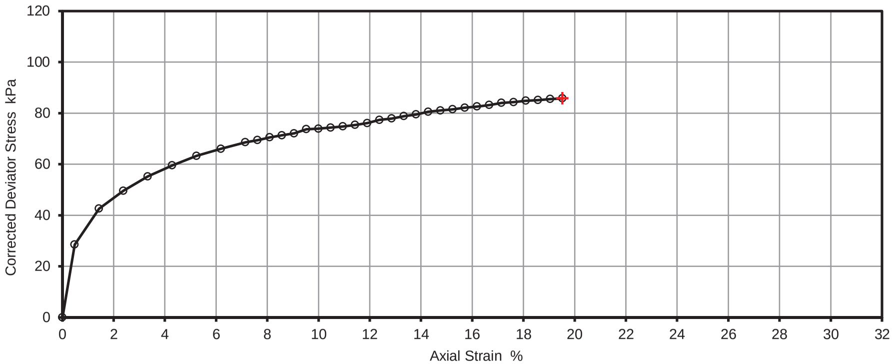
Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

CAUSEWAY GEOTECH

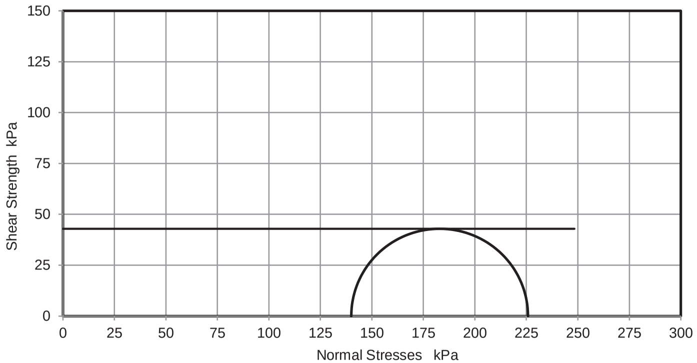
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
Soil Description	Brown sandy gravelly CLAY.	Borehole/Pit No.	BH05
Specimen Reference	4	Specimen Depth	m
Specimen Description	Firm brown sandy gravelly CLAY.	Sample No.	13
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Depth	6.00
		Sample Type	U
		KeyLAB ID	Caus20150812651
		Date of test	

		Value	Unit
Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		2.22	Mg/m^3
Moisture Content		10.6	%
Dry Density		2.01	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		140	kPa
At failure	Axial Strain	19.5	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	86	kPa
	Undrained Shear Strength, c_u	43	kPa $= ½(\sigma_1 - \sigma_3)_f$
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Testing terminated at 20% strain

Approved: Stephen.Watson

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Lab Sheet Reference :

Fig. No. 1

Sheet 1

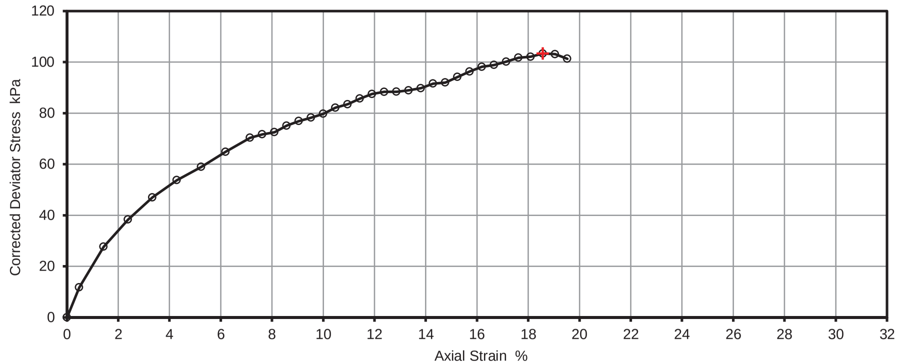
Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

CAUSEWAY GEOTECH

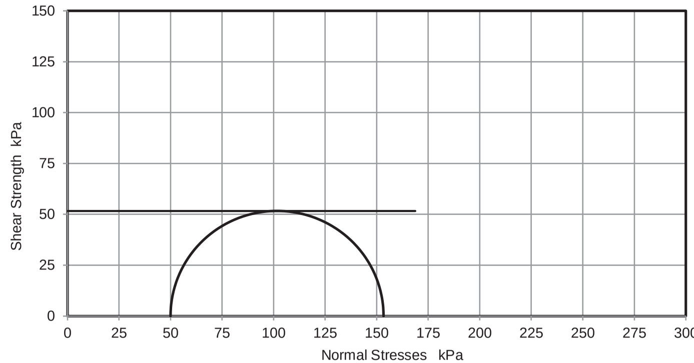
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
Soil Description	Grey sandy gravelly CLAY.	Borehole/Pit No.	BH01
Specimen Reference	4	Specimen Depth	m
Specimen Description	Firm grey sandy gravelly CLAY.	Sample No.	12
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Depth	3.00
		Sample Type	U
		KeyLAB ID	Caus20150812602
		Date of test	

		Value	Unit
Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		2.38	Mg/m^3
Moisture Content		10.2	%
Dry Density		2.16	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		50	kPa
At failure	Axial Strain	18.6	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	103	kPa
	Undrained Shear Strength, c_u	52	kPa $= ½(\sigma_1 - \sigma_3)_f$
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks

Strengths corrected for area change, and membrane effects based on Fig 11 BS1377

Approved: Stephen.Watson

Printed: 28/08/2015 14:15

Lab Sheet Reference :

Fig. No. 1

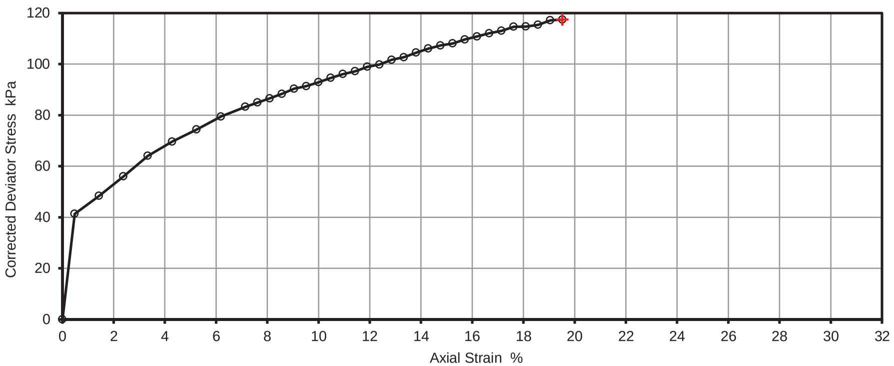
Sheet 1

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

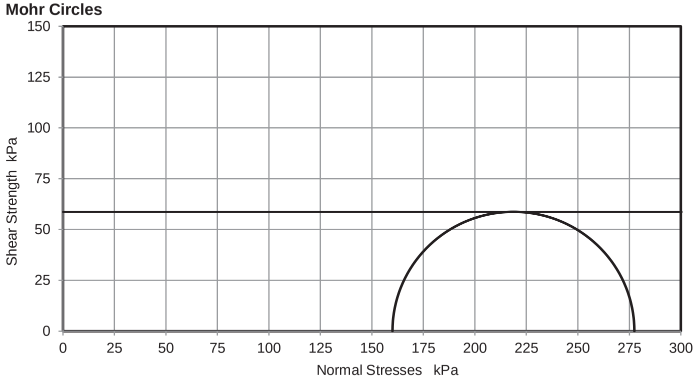
CAUSEWAY GEOTECH	Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen	Job Ref	15-272
		Borehole/Pit No.	BH06
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	3
Soil Description	Grey sandy gravelly CLAY.	Depth	7.00
Specimen Reference	4 / Specimen Depth: m	Sample Type	U
Specimen Description	Firm grey sandy gravelly CLAY	KeyLAB ID	Caus20150812654
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen	Date of test	

Test Number		1	
Length		210.0	mm
Diameter		105.0	mm
Bulk Density		2.22	Mg/m^3
Moisture Content		9.7	%
Dry Density		2.02	Mg/m^3
Rate of Strain		2.0	%/min
Cell Pressure		160	kPa
At failure	Axial Strain	19.5	%
	Deviator Stress, $(\sigma_1 - \sigma_3)_f$	117	kPa
	Undrained Shear Strength, c_u	59	kPa $= \frac{1}{2}(\sigma_1 - \sigma_3)_f$
	Mode of Failure	Plastic	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377. This is provided for information only.

Remarks

Testing terminated at 20% strain

Lab Sheet Reference :

Approved: Stephen.Watson

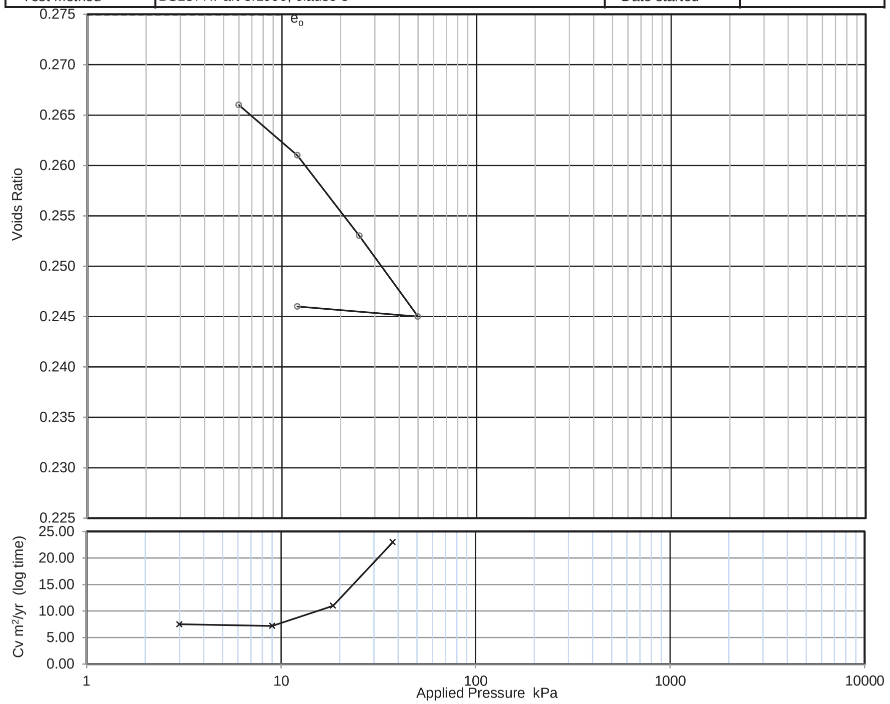
Printed: 28/08/2015 14:16

Fig. No. 1

Sheet 1

ONE DIMENSIONAL CONSOLIDATION TEST BS1377:Part 5:1990, clause 3

CAUSEWAY GEOTECH	ONE DIMENSIONAL CONSOLIDATION TEST BS1377:Part 5:1990, clause 3	Job Ref	15-272
		Borehole/Pit No.	BH02
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Brownish grey sandy gravelly CLAY.	Depth	4
Specimen Reference	3 / Specimen Depth: m	Sample Type	U
Specimen Description	Brownish grey sandy gravelly CLAY.	KeyLAB ID	Caus20150812611
Test Method	BS1377:Part 5:1990, clause 3	Date started	



Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
	0.275	-	-	-	-
6	0.266	1.2	7.5	14	0.00017
12	0.261	0.67	7.2	8.9	0.00029
25	0.253	0.49	11	66	0.00029
50	0.245	0.24	23	53	0.00038
12	0.246	0.0057			

Preparation

Index tests Liquid limit % Plastic limit %

Particle density assumed 2.65 Mg/m3

Specimen details	Initial	Final	
Diameter	76.10	-	mm
Height	19.00	18.56	mm
Moisture Content	12.5	11.0	%
Bulk density	2.34	2.31	Mg/m3
Dry density	2.08	2.08	Mg/m3
Voids Ratio	0.275	0.272	
Saturation	120	107	%
Average temperature for test			oC
Swelling Pressure			kPa
Settlement on saturation			%
Remarks			

Final values should be used with caution

Cv plotted at mid point of load increments

Cv corrected to 20oC

Approved

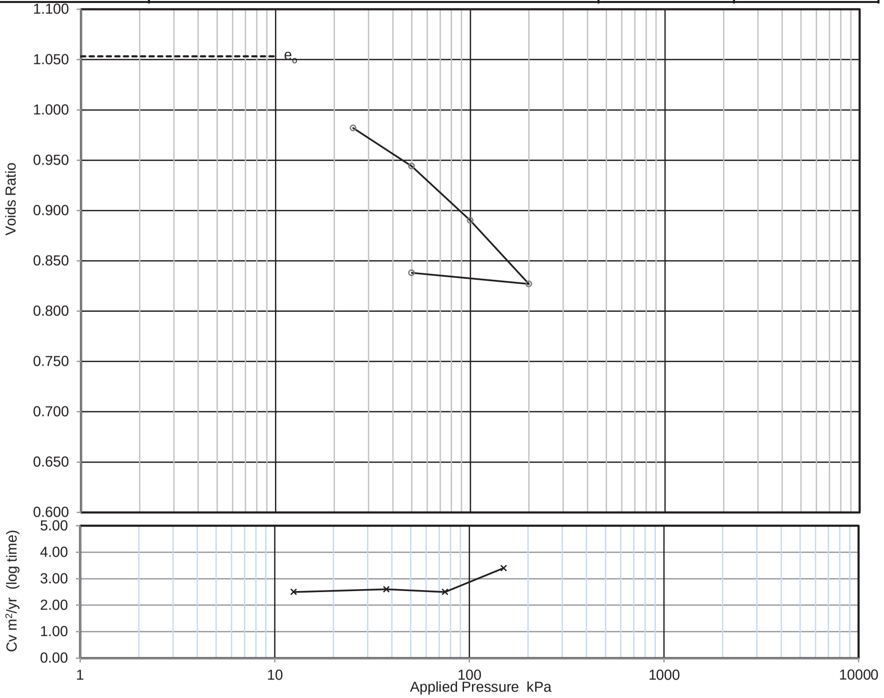
Printed : 28/08/2015 15:57

Fig. No 1

ONE DIMENSIONAL CONSOLIDATION TEST
BS1377:Part 5:1990, clause 3

CAUSEWAY GEOTECH

Job Ref			15-272
Borehole/Pit No.			BH04
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	12
Soil Description	Dark grey to black sandy gravelly CLAY	Depth	1
Specimen Reference	3 / Specimen Depth: m	Sample Type	U
Specimen Description	Dark grey to black sandy gravelly CLAY	KeyLAB ID	Caus20150812636
Test Method	BS1377:Part 5:1990, clause 3	Date started	



Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
	1.053	-	-	-	-
25	0.982	1.4	2.5	2.5	0.0033
50	0.944	0.78	2.6	4.6	0.0023
100	0.890	0.55	2.5	3.4	0.0026
200	0.827	0.33	3.4	4.7	0.0028
50	0.838	0.04			

Preparation

Index tests Liquid limit % Plastic limit %

Particle density assumed 2.65 Mg/m3

Specimen details	Initial	Final	
Diameter	76.10	-	mm
Height	18.00	16.11	mm
Moisture Content	41.5	35.6	%
Bulk density	1.83	1.96	Mg/m3
Dry density	1.29	1.44	Mg/m3
Voids Ratio	1.053	0.838	
Saturation	104	113	%
Average temperature for test			oC
Swelling Pressure			kPa
Settlement on saturation			%
Remarks			

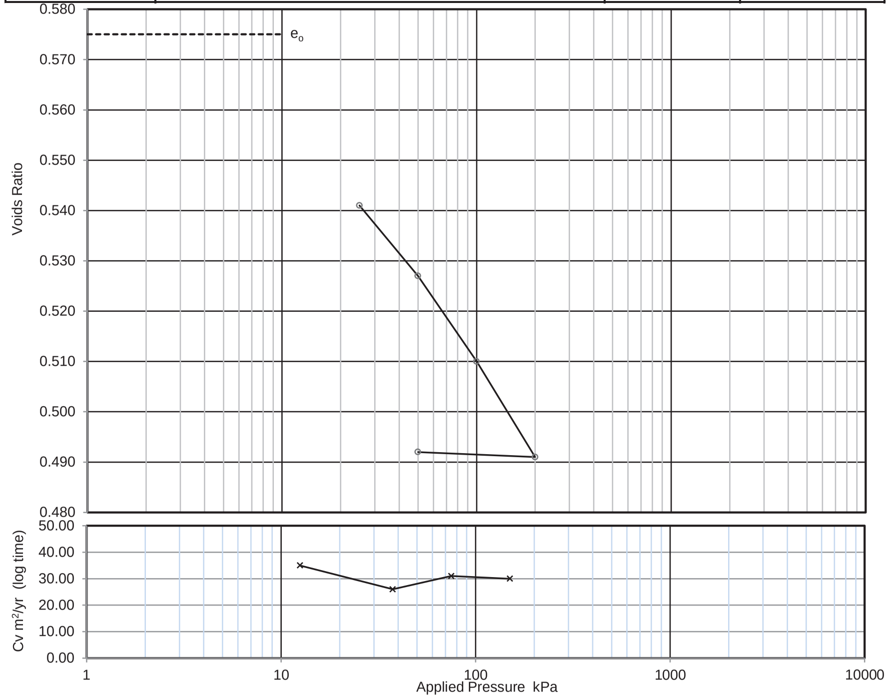
Final values should be used with caution
Cv plotted at mid point of load increments
Cv corrected to 20oC

Approved | Printed : 28/08/2015 15:57 | Fig. No 2

ONE DIMENSIONAL CONSOLIDATION TEST
BS1377:Part 5:1990, clause 3

CAUSEWAY GEOTECH

Job Ref			15-272
Borehole/Pit No.			BH05
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	11
Soil Description	Grey sandy gravelly CLAY.	Depth	1
Specimen Reference	1 / Specimen Depth: m	Sample Type	U
Specimen Description	Grey sandy gravelly CLAY.	KeyLAB ID	Caus20150812908
Test Method	BS1377:Part 5:1990, clause 3	Date started	



Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
	0.575	-	-	-	-
25	0.541	0.87	35	67	0.00062
50	0.527	0.36	26	53	0.00073
100	0.510	0.22	31	80	0.00083
200	0.491	0.13	30	95	0.00093
50	0.492	0.004			

Preparation

Index tests Liquid limit % Plastic limit %

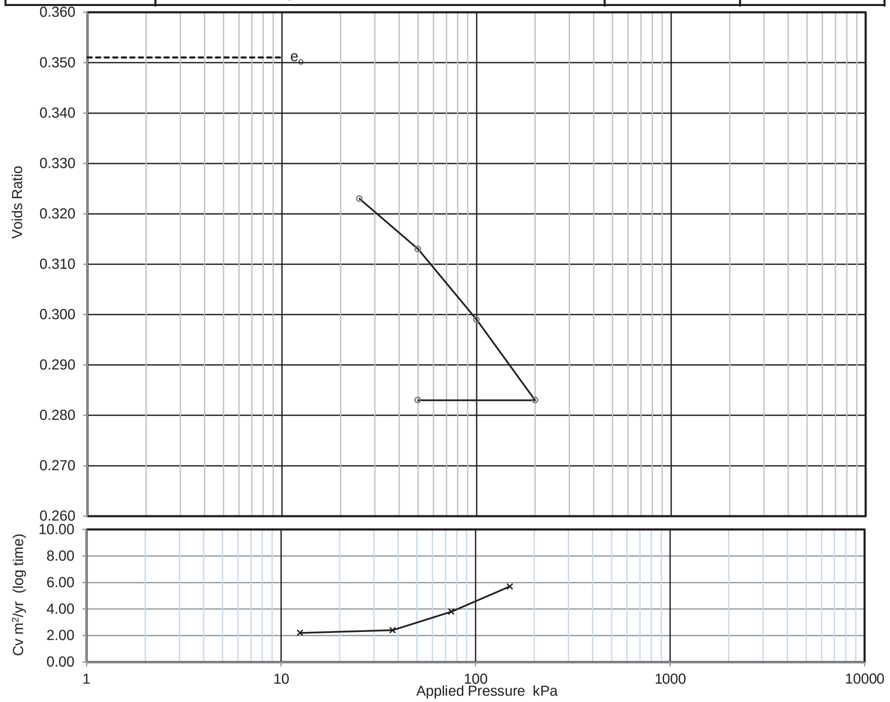
Particle density assumed 2.65 Mg/m3

Specimen details	Initial	Final	
Diameter	76.20	-	mm
Height	17.70	16.77	mm
Moisture Content	24.1	21.7	%
Bulk density	2.09	2.16	Mg/m3
Dry density	1.68	1.78	Mg/m3
Voids Ratio	0.575	0.492	
Saturation	111	117	%
Average temperature for test			oC
Swelling Pressure			kPa
Settlement on saturation			%
Remarks			

Final values should be used with caution
Cv plotted at mid point of load increments
Cv corrected to 20oC

Approved | Printed : 28/08/2015 15:57 | Fig. No 3

ONE DIMENSIONAL CONSOLIDATION TEST BS1377:Part 5:1990, clause 3		Job Ref	15-272
		Borehole/Pit No.	BH05
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	13
Soil Description	Brown sandy gravelly CLAY.	Depth	6
Specimen Reference	3 / Specimen Depth: m	Sample Type	U
Specimen Description	Brown sandy gravelly CLAY.	KeyLAB ID	Caus20150812651
Test Method	BS1377:Part 5:1990, clause 3	Date started	



Applied Pressure kPa	Voids ratio	Mv m2/MN	Cv (t50, log) m2/yr	Cv (t90, root) m2/yr	Csec
	0.351	-	-	-	-
25	0.323	0.83	2.2	2.4	0.00058
50	0.313	0.3	2.4	3.4	0.00058
100	0.299	0.22	3.8	11	0.00048
200	0.283	0.12	5.7	23	0.00058
50	0.283	0.00037			

Preparation

Index tests Liquid limit % Plastic limit %

Particle density assumed 2.65 Mg/m3

Specimen details	Initial	Final	
Diameter	76.10	-	mm
Height	19.00	18.04	mm
Moisture Content	15.1	12.8	%
Bulk density	2.26	2.33	Mg/m3
Dry density	1.96	2.07	Mg/m3
Voids Ratio	0.351	0.283	
Saturation	114	120	%
Average temperature for test			oC
Swelling Pressure			kPa
Settlement on saturation			%
Remarks			

Final values should be used with caution Cv plotted at mid point of load increments Cv corrected to 20oC	Approved	Printed : 28/08/2015 15:57	Fig. No 4

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP48		Thickness mm	32.8
Depth m	1.5m			
Our Ref	F		σ'_v kPa	
Soil type	Silty sandy Gravel			
Rate of shearing mm/min			0.04	40
<6mm removed				80
				160

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	52	40	39
80	92	80	86
160	161	160	144

Loading 40 kPa	
Initial wet mass g	650
Bulk Density mg/m3	1985
Final wet mass g	640
Dry mass g	524
Initial water content %	24.0
Final water content %	22.1
Loading 80 kPa	
Initial wet mass g	721
Bulk Density mg/m3	1985
Final wet mass g	690
Dry mass g	572
Initial water content %	26.0
Final water content %	20.6
Loading 160 kPa	
Initial wet mass g	650
Bulk Density mg/m3	1985
Final wet mass g	627
Dry mass g	515
Initial water content %	26.2
Final water content %	21.7

Peak angle of internal friction 45
Ultimate angle of internal friction **42**

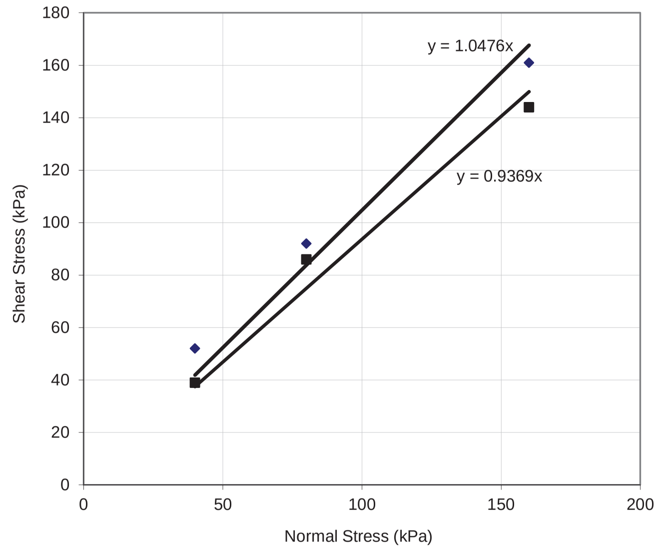
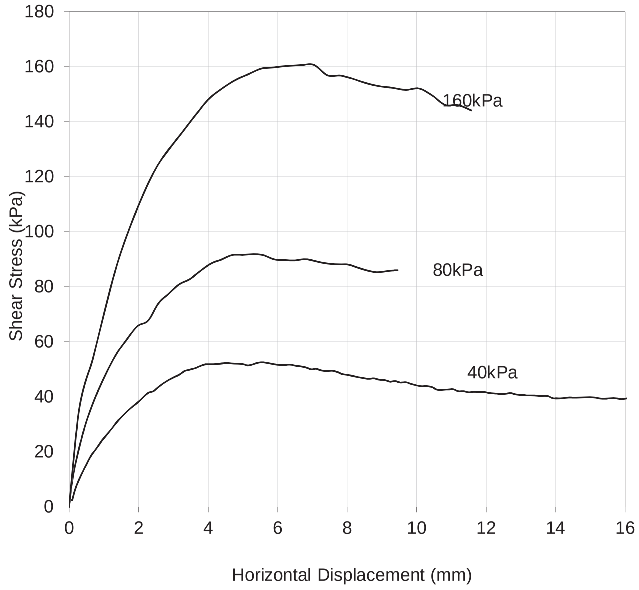


Figure 1 Failure Envelope

Shear Box Test



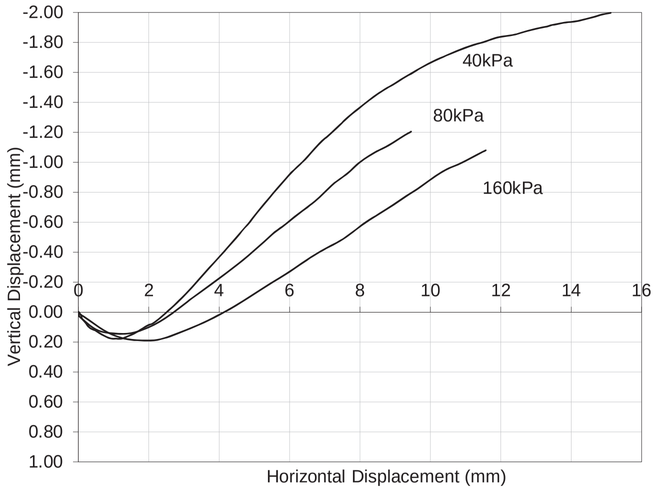


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test   Morrell River

Ref:	15-272	Size mm	100	
BH	TP17	Thickness mm	32.3	
Depth m	0.3m			
Our Ref	B		σ'_v kPa	
Soil type	Silty sandy Gravel			
Rate of shearing mm/min		0.04	40	
<6mm removed			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	39	40	32
80	72	80	62
160	145	160	125

Loading 40 kPa	
Initial wet mass g	597
Bulk Density mg/m3	1882
Final wet mass g	587
Dry mass g	469
Initial water content %	27.3
Final water content %	25.2
Loading 80 kPa	
Initial wet mass g	590
Bulk Density mg/m3	1882
Final wet mass g	587
Dry mass g	472
Initial water content %	25.0
Final water content %	24.4
Loading 160 kPa	
Initial wet mass g	607
Bulk Density mg/m3	1882
Final wet mass g	595
Dry mass g	482
Initial water content %	25.9
Final water content %	23.4

Peak angle of internal friction	41
Ultimate angle of internal friction	**37**

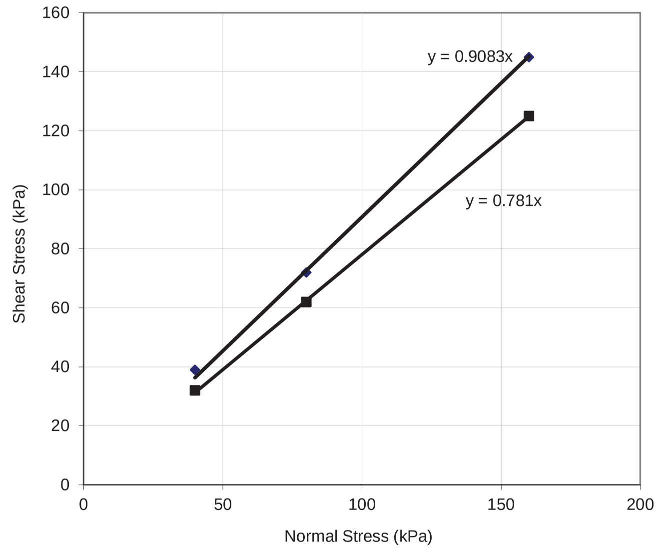


Figure 1 Failure Envelope

Shear Box Test

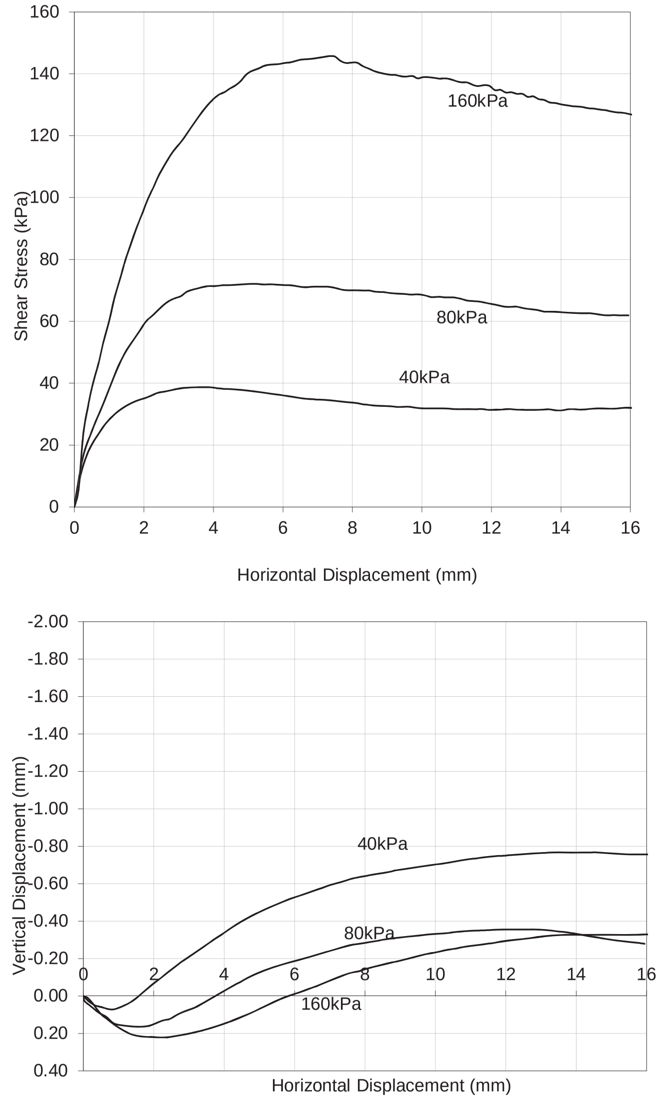


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP26		Thickness mm	33.8
Depth m	2m			
Our Ref	D		σ'$_v$ kPa	
Soil type	Silty sandy Gravel			
Rate of shearing mm/min		0.04	40	
<6mm removed			80	
			160	

Peak		Ultimate	
σ'$_n$ kPa	τ kPa	σ'$_n$ kPa	τ kPa
40	44	40	30
80	75	80	60
160	141	160	134

Loading 40 kPa	
Initial wet mass g	595
Bulk Density mg/m3	1864
Final wet mass g	618
Dry mass g	505
Initial water content %	17.8
Final water content %	22.4
Loading 80 kPa	
Initial wet mass g	629
Bulk Density mg/m3	1864
Final wet mass g	642
Dry mass g	533
Initial water content %	18.0
Final water content %	20.5
Loading 160 kPa	
Initial wet mass g	626
Bulk Density mg/m3	1864
Final wet mass g	636
Dry mass g	529
Initial water content %	18.3
Final water content %	20.2

Peak angle of internal friction 42
Ultimate angle of internal friction **39**

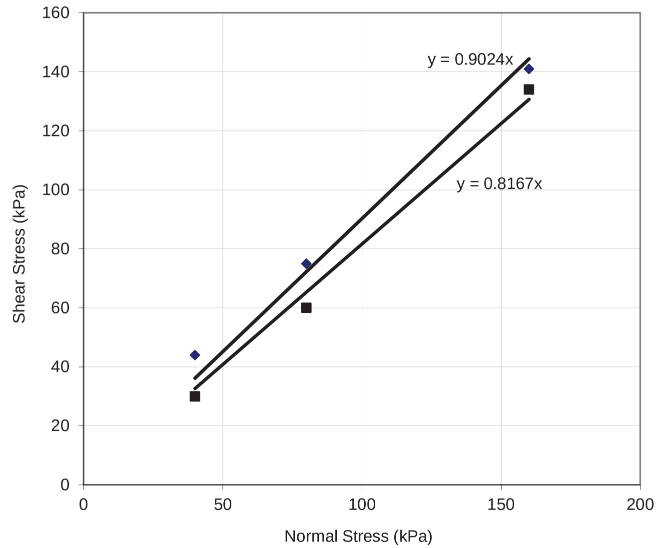
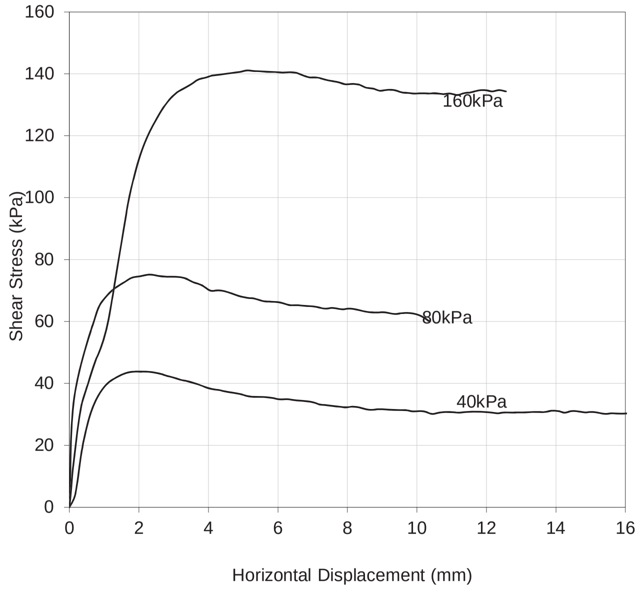


Figure 1 Failure Envelope

Shear Box Test



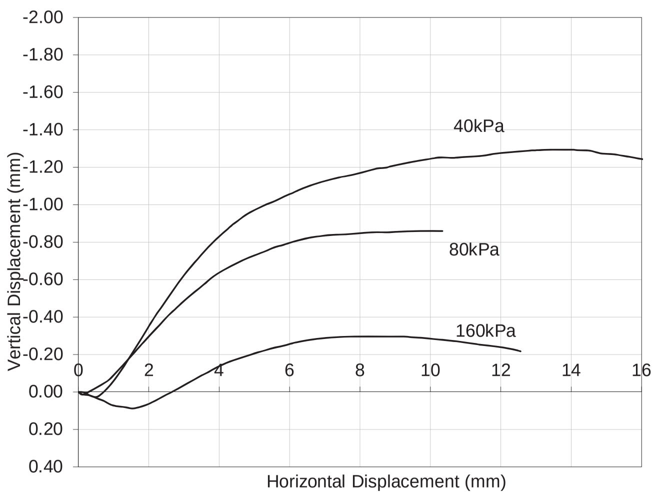


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP35		Thickness mm	34.7
Depth m	1.5m			
Our Ref	F		σ'_v kPa	
Soil type	Silty sandy Gravel			
Rate of shearing mm/min		0.8	40	
<6mm removed			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	41	40	38
80	79	80	68
160	157	160	152

Loading 40 kPa	
Initial wet mass g	735
Bulk Density mg/m3	2118
Final wet mass g	719
Dry mass g	604
Initial water content %	21.7
Final water content %	19.0
Loading 80 kPa	
Initial wet mass g	675
Bulk Density mg/m3	2118
Final wet mass g	664
Dry mass g	562
Initial water content %	20.1
Final water content %	18.1
Loading 160 kPa	
Initial wet mass g	740
Bulk Density mg/m3	2118
Final wet mass g	718
Dry mass g	605
Initial water content %	22.3
Final water content %	18.7

Peak angle of internal friction 44
Ultimate angle of internal friction **41**

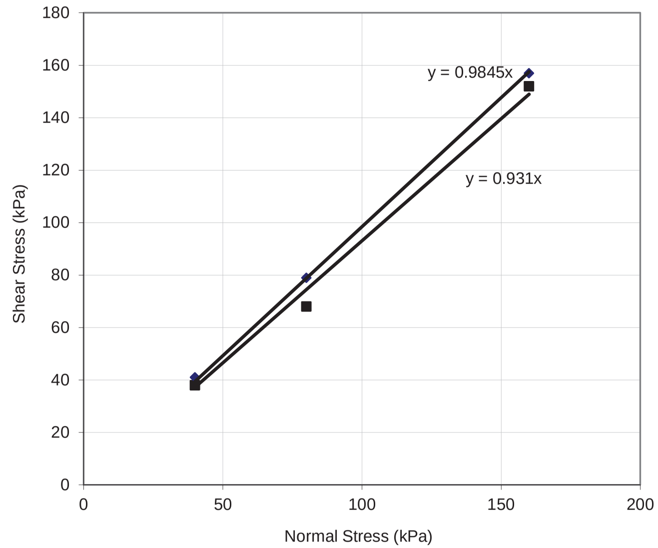


Figure 1 Failure Envelope

Shear Box Test

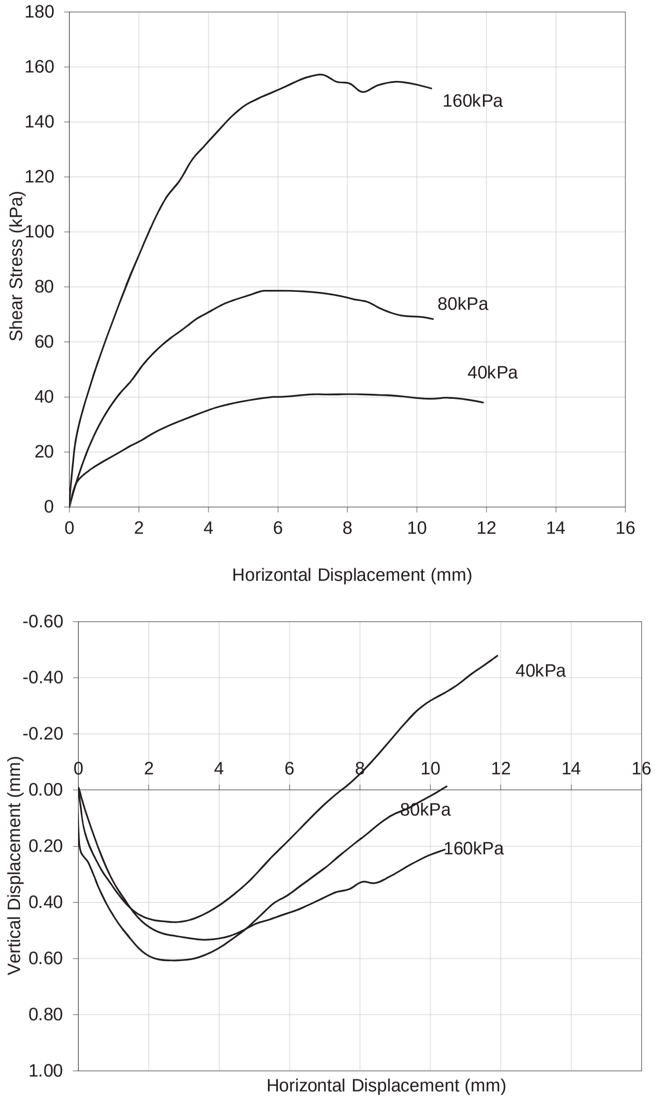


Figure 2 Stress-strain behaviour

QUB				Geotechnical Testing Laboratory		
Shear Box Test	**Morrell River**					
Ref:	15-272		Size mm	100	Initial wet mass g	695
BH	TP36		Thickness mm	35.2	Bulk Density mg/m3	1974
Depth m	1.5m					
Our Ref	A			σ'$_v$ kPa		
Soil type	Silty sandy Gravel					
Rate of shearing mm/min			0.04	40		
				80		
				160		

Peak		Ultimate	
σ'$_n$ kPa	τ kPa	σ'$_n$ kPa	τ kPa
40	50	40	37
80	90	80	70
160	174	160	128

Peak angle of internal friction 46
Ultimate angle of internal friction **39**

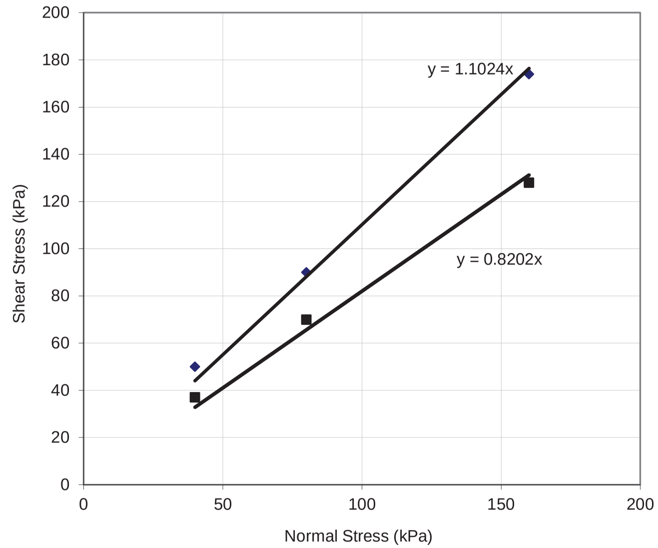


Figure 1 Failure Envelope

Shear Box Test

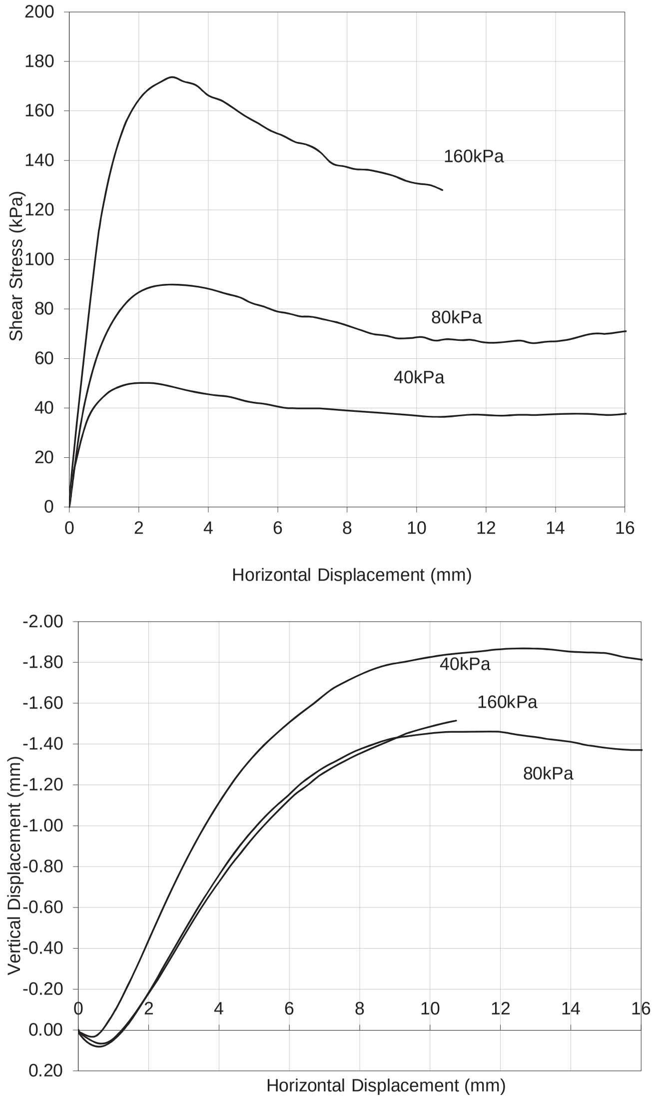


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272	Size mm	100	
BH	TP37	Thickness mm	34.8	
Depth m	1m			
Our Ref	D			σ'$_v$ kPa
Soil type	Silty sandy Gravel			
Rate of shearing mm/min			0.04	40
<6mm removed				80
				160

Peak		Ultimate	
σ'$_n$ kPa	τ kPa	σ'$_n$ kPa	τ kPa
40	44	40	31
80	72	80	62
160	131	160	119

Loading 40 kPa	
Initial wet mass g	725
Bulk Density mg/m3	2086
Final wet mass g	711
Dry mass g	605
Initial water content %	19.8
Final water content %	17.5
Loading 80 kPa	
Initial wet mass g	695
Bulk Density mg/m3	2086
Final wet mass g	684
Dry mass g	577
Initial water content %	20.5
Final water content %	18.5
Loading 160 kPa	
Initial wet mass g	667
Bulk Density mg/m3	2086
Final wet mass g	660
Dry mass g	560
Initial water content %	19.1
Final water content %	17.9

Peak angle of internal friction 39
Ultimate angle of internal friction **36**

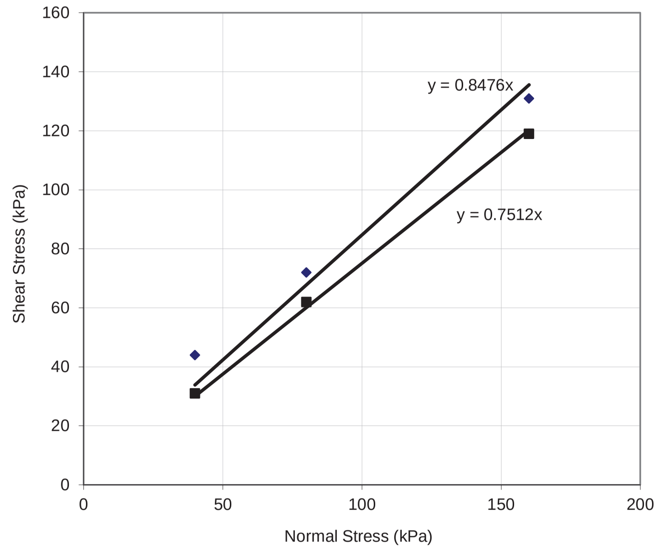


Figure 1 Failure Envelope

Shear Box Test

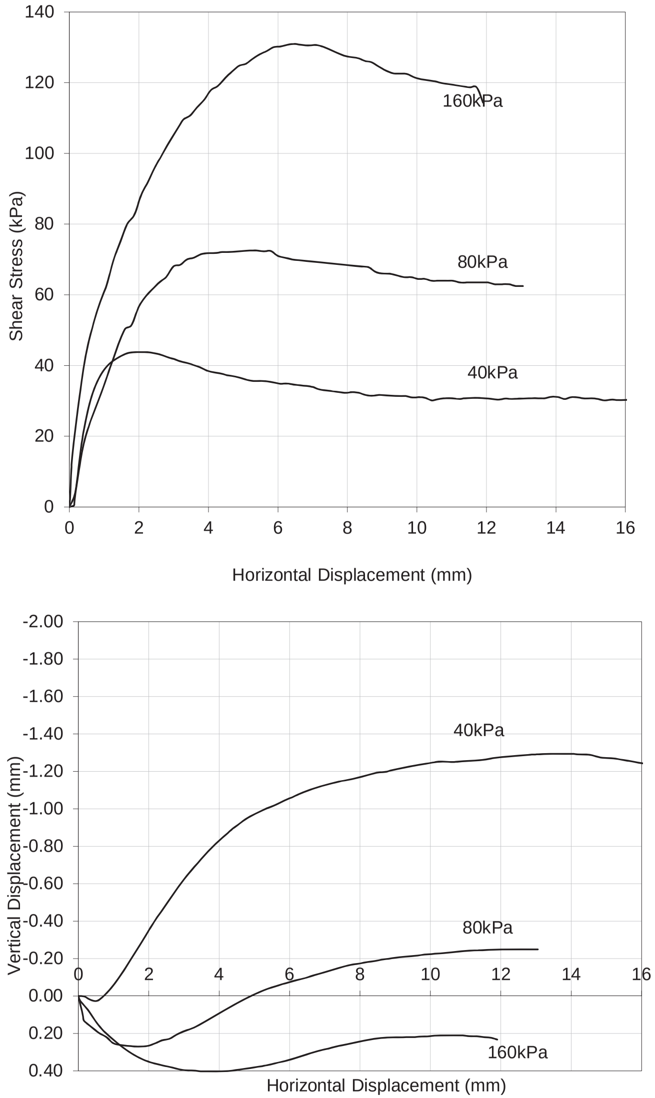


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP17		Thickness mm	34.2
Depth m	0.3m			
Our Ref	B		σ'_v kPa	
Soil type	Silty sandy Gravel			
Rate of shearing mm/min		0.04	40	
<6mm removed			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	58	40	35
80	84	80	70
160	157	160	133

Loading 40 kPa	
Initial wet mass g	620
Bulk Density mg/m3	1813
Final wet mass g	624
Dry mass g	478
Initial water content %	29.7
Final water content %	30.5
Loading 80 kPa	
Initial wet mass g	526
Bulk Density mg/m3	1813
Final wet mass g	539
Dry mass g	401
Initial water content %	31.2
Final water content %	34.4
Loading 160 kPa	
Initial wet mass g	586
Bulk Density mg/m3	1813
Final wet mass g	587
Dry mass g	444
Initial water content %	32.0
Final water content %	32.2

Peak angle of internal friction 45
Ultimate angle of internal friction **40**

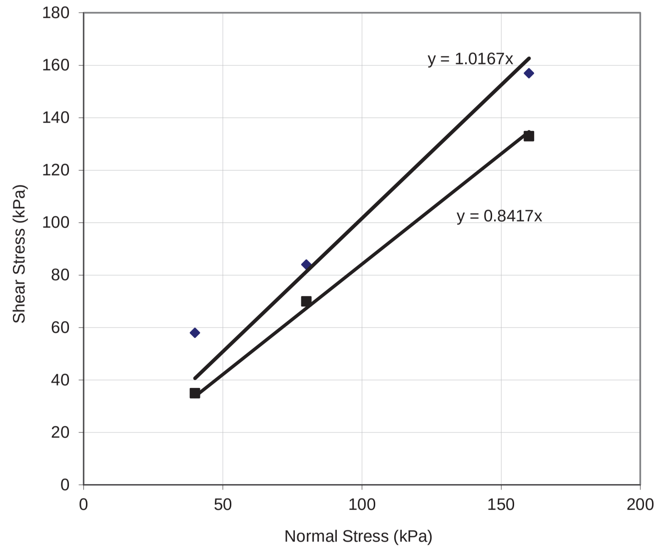
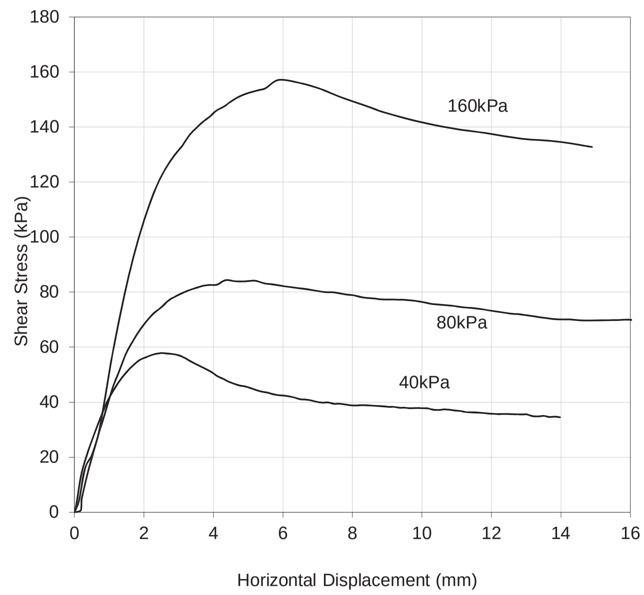


Figure 1 Failure Envelope

Shear Box Test



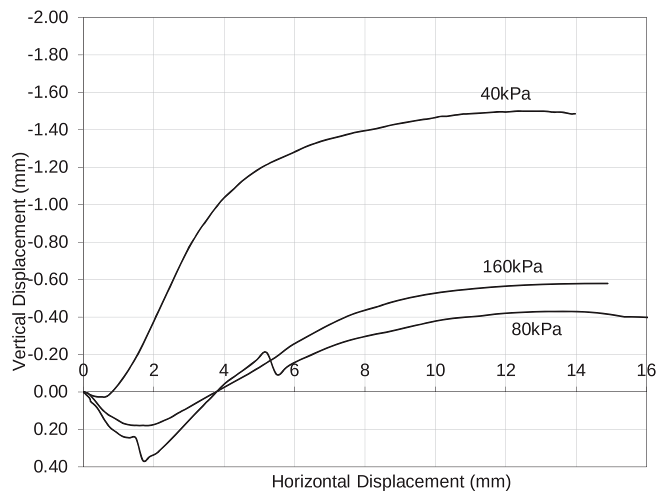


Figure 2 Stress-strain behaviour

LABORATORY RESTRICTION REPORT

Project Reference	15-272	To	Darren O'Mahony
Project Name	Morrell River Flood Alleviation	Position	Project Manager
TR reference	15-272 / 1	From	Stephen Watson
		Position	Laboratory Manager

The following sample(s) and test(s) are restricted as detailed below.

Hole Number	Sample Number	Sample Depth (m)	Sample Type	Test Type	Reason for Restriction	Required Action
BH01		7	U	Oedometer	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH02		2	U	Oedometer	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH04		3	U	Oedometer	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH04		8	U	Oedometer Quick triaxial	U100 failed. No sample recovery	Testing cancelled
BH05		8	U	Oedometer Quick triaxial	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH05		1	U	Quick triaxial	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH06		4	U	Oedometer Quick triaxial	Unable to form suitable test specimen. Sample too granular	Testing cancelled
BH06		7	U	Oedometer	Unable to form suitable test specimen. Sample too granular	Testing cancelled
TP02		1	B	CBR	Greater than 25% gravel retained on the 20mm test sieve. Grading Zone (X) - Testing not applicable.	Testing cancelled
TP09		0.5	B	CBR	Greater than 25% gravel retained on the 20mm test sieve. Grading Zone (X) - Testing not applicable.	Testing cancelled
TP13		0.5	B	CBR	Greater than 25% gravel retained on the 20mm test sieve. Grading Zone (X) - Testing not applicable.	Testing cancelled
TP03		2	B	2.5kg Compaction	Greater than 10% gravel retained on the 37.5mm test sieve. Greater than 30% retained on the 20mm test sieve (Grading Zone (X) - Testing not applicable).	Testing cancelled
TP07		1.2	B	2.5kg Compaction	Greater than 10% gravel retained on the 37.5mm test sieve. Greater than 30% retained on the 20mm test sieve (Grading Zone (X) - Testing not applicable).	Testing cancelled
TP20		2	B	2.5kg Compaction	Greater than 10% gravel retained on the 37.5mm test sieve. Greater than 30% retained on the 20mm test sieve (Grading Zone (X) - Testing not applicable).	Testing cancelled

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature	Project Manager Signature
Stephen Watson	Darren O'Mahony
Date 28 August 2015	Date 28 August 2015

CAUSEWAY GEOTECH

TEST RESTRICTION FORM

Issue No. 1
Page 1 of 1
Date 28/08/2015

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SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

To:	**Kildare County Council**
Copy:	**RPS Consulting Engineers**
From:	**Stephen Watson** **Laboratory Manager** **Causeway Geotech Ltd**
Tel:	**+44(0)2827666640**
E-mail:	**stephen.watson@causewaygeotech.com**
Date:	**14/10/15**
Ref:	**15-272/2**

Morrell River Flood Alleviation - Site Investigation Contract

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the *Contents page(s)*.

The samples were delivered to our laboratory in Ballymoney, Co. Antrim on 27/07/15 and tested in accordance with the electronic schedule received on 18/09/15. All testing was performed 28/09/15 to 14/10/15.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of one month from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Approved Signatory

Stephen Watson
Laboratory Manager

Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
Co. Antrim, N. Ireland, BT53 7QL

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info@causewaygeotech.com
www.causewaygeotech.com

Project Name **Morrell River Flood Alleviation - Site Investigation Contract**

Report Reference. **15-272/2**

The table below details the tests carried out, the specifications used and the number of tests included in this report:

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	Number of test results included in the report
SOIL	Dry density/moisture content relationship (2.5 kg rammer)	BS 1377-4:1990	20
SOIL	MCV	BS 1377-4:1990	11
SOIL	California Bearing Ratio (CBR)	BS 1377-4:1990	11
SOIL	Shear strength by direct shear	BS1377 : Part 7 : Clause 4 : 1990	12
SOIL	Consolidated drained triaxial	BS:1377 Part 8	3

Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
Co. Antrim, N. Ireland, BT53 7QL

Registered in Northern Ireland. Company Number: NI610766
Approved: ISO 9001 • ISO 14001 • OHSAS 18001

Moisture Condition Value at Natural Moisture Content
Summary of Results

Project No.: 15-272

Project Name: Morrell River Flood Alleviation - Site Investigation Contract

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Retained on 20mm sieve %	Moisture Content <20mm %	Moisture Condition Value	Method of Interpretation	Remarks
TP02	2	1.80		B	Soft black brown slightly gravelly sandy silty CLAY	8	10.4	7.3	Best fit line	
TP03	3	2.20		B	Soft black brown slightly gravelly sandy silty CLAY	47	11.8	4.5	Best fit line	
TP07	3	2.00		B	Soft brown sandy gravelly CLAY	25	17.6	8.5	Best fit line	
TP13	3	3.00		B	Firm black slightly sandy slightly gravelly silty CLAY	12	9.8	10.6	Best fit line	
TP19	2	2.00		B	Firm black slightly sandy slightly gravelly silty CLAY	35	9.6	7.4	Best fit line	
TP20	2	1.00		B	Stiff grey brown slightly sandy slightly gravelly CLAY	30	10.5	11.4	Best fit line	
TP25	3	2.00		B	Soft brown grey sandy silty CLAY.	0	36.5	4.4	Best fit line	
TP39	3	2.00		B	Firm black slightly sandy slightly gravelly CLAY	21	12.8	8.2	Best fit line	
TP41	3	2.50		B	Firm black slightly gravelly sandy silty CLAY	16	10.7	10.2	Best fit line	
TP69	2	1.30		B	Dark brown sandy gravelly CLAY	22	12.0	9.3	Best fit line	
TP71	3	1.00		B	Firm brown slightly sandy slightly gravelly CLAY	3	23.8	9.4	Best fit line	

Key: Test performed in accordance with BS1377:Part4:1990, clause 5.4 unless annotated otherwise

Date Printed: 14/10/2015

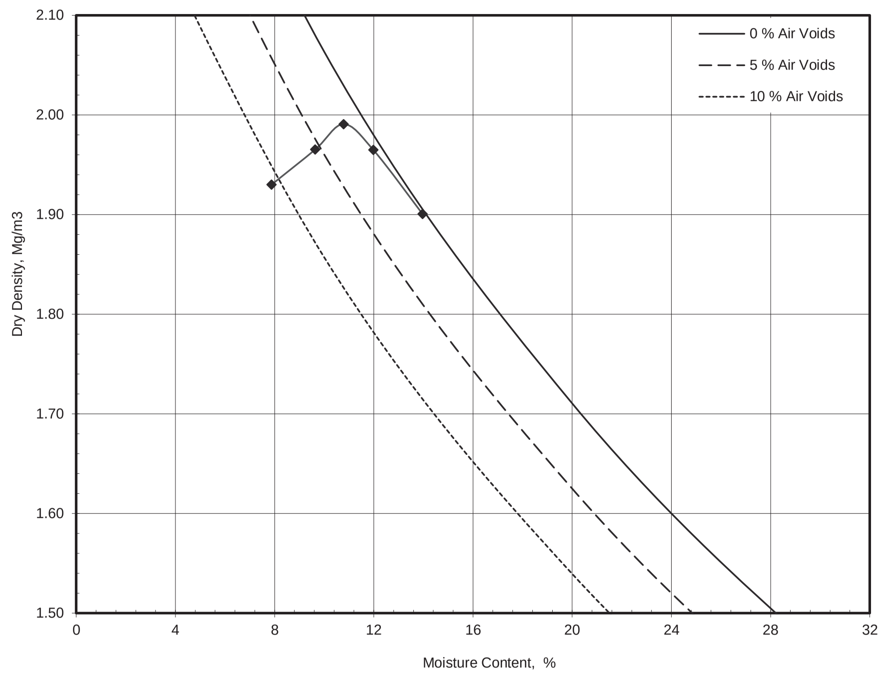
Approved By: Stephen.Watson

Table

sheet

Dry Density / Moisture Content Relationship
Light Compaction

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole / Pit No	TP02
		Sample No	3
Soil Description	Black brown slightly gravelly sandy silty CLAY	Depth	2.30 m
Specimen Ref.	1; Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917306
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	14
Material Retained on 20.0 mm Sieve	%	38
Particle Density - Assumed	Mg/m³	2.60
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.99**
Optimum Moisture Content	%	**11**

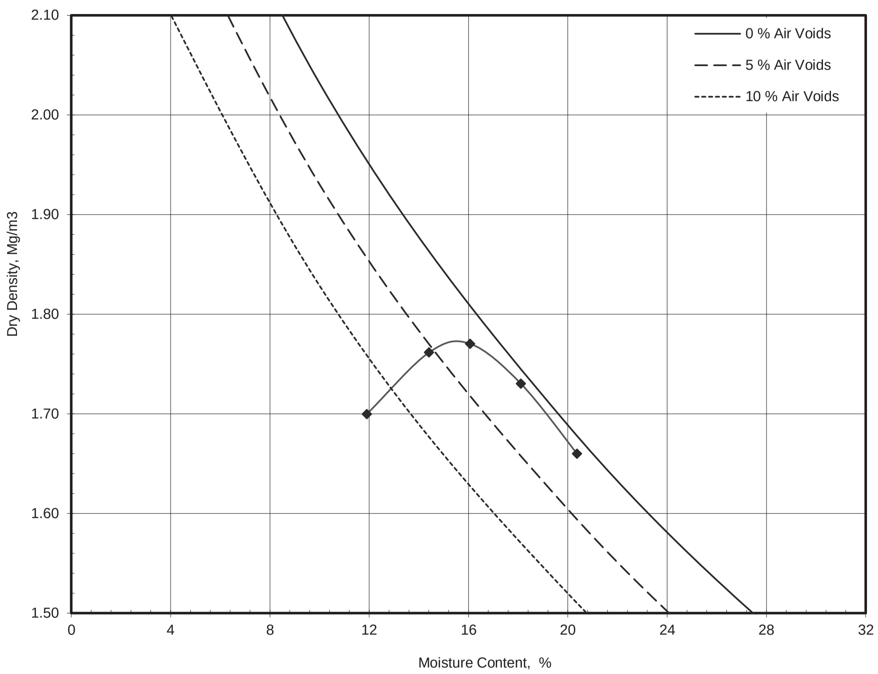
Approved: Stephen.Watson

Remarks: Non-standard test result

Fig

Sheet 1 of 1

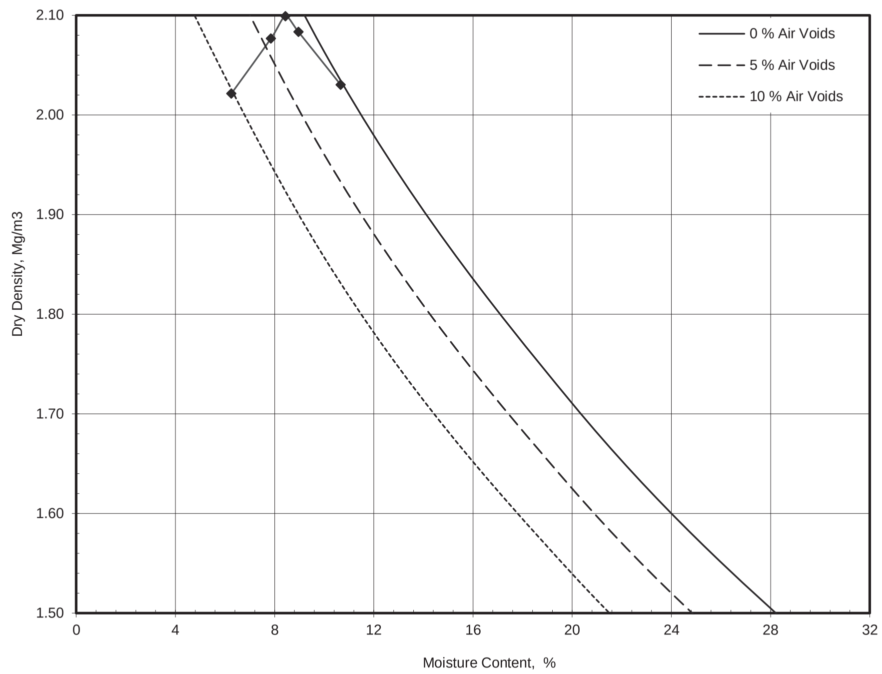
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction			Job Ref	15-272
				Borehole / Pit No	TP04
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**			Sample No	3
Soil Description	Dark brown slightly sandy silty CLAY.			Depth	2.00 m
Specimen Ref.	1	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer			Keylab ID	Caus20150917310
				Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	0
Particle Density - Assumed	Mg/m³	2.55
GRADING ZONE		1
Maximum Dry Density	Mg/m³	**1.77**
Optimum Moisture Content	%	**16**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction			Job Ref	15-272
				Borehole / Pit No	TP05
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**			Sample No	3
Soil Description	Black sandy gravelly slightly silty CLAY.			Depth	2.50 m
Specimen Ref.	1	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer			Keylab ID	Caus20150917312
				Compaction Test Reference/No.	



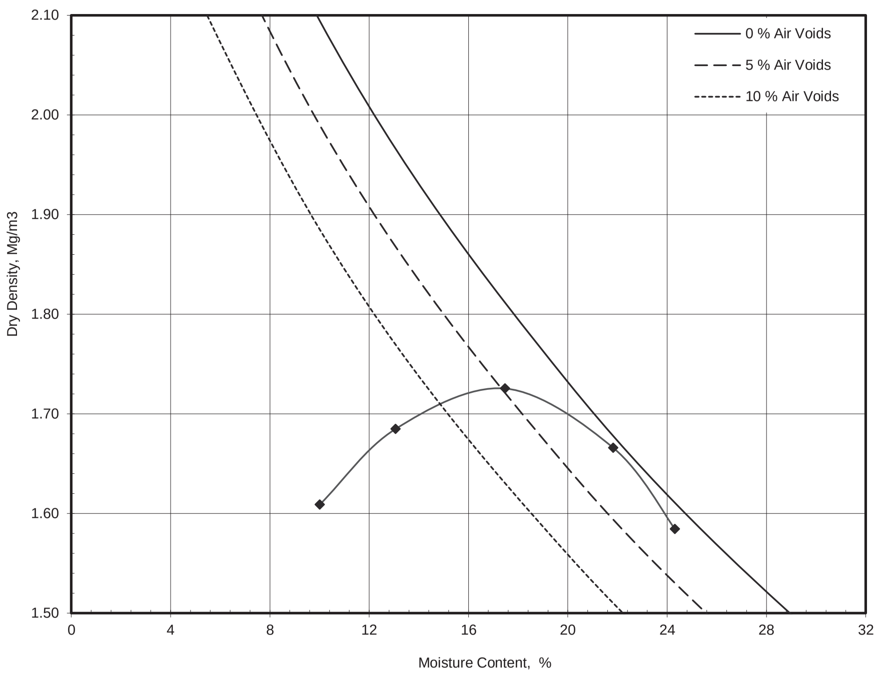
Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	32
Material Retained on 20.0 mm Sieve	%	35
Particle Density - Assumed	Mg/m³	2.60
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**2.10**
Optimum Moisture Content	%	**8.4**

Approved	Remarks Non-standard test	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole / Pit No	TP08
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No	2
Soil Description	Orange brown slightly sandy slightly gravelly CLAY	Depth	1.50 m
Specimen Ref.	2 — Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.4, 2.5kg rammer	Keylab ID	Caus20150917315
		Compaction Test Reference/No.	



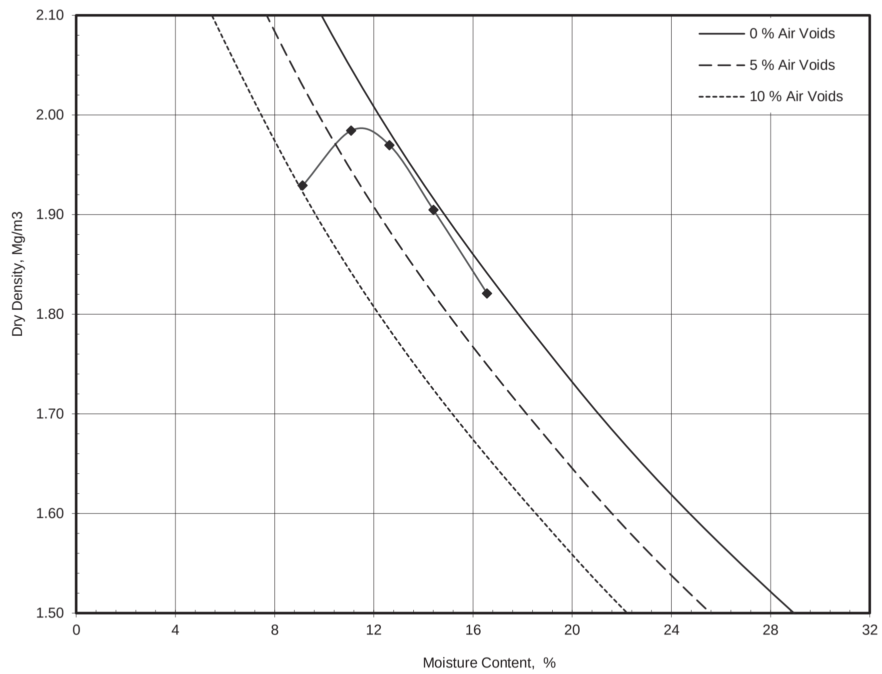
Preparation		Material used was oven dried at 105degC
Mould Type		CBR
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	7
Material Retained on 20.0 mm Sieve	%	10
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		5
Maximum Dry Density	Mg/m³	**1.73**
Optimum Moisture Content	%	**17**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH

Job Ref	15-272	Borehole / Pit No	TP08
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No	3
Soil Description	Dark brown slightly sandy slightly gravelly silty CLAY.	Depth	2.50 m
Specimen Ref.	1 — Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917316
		Compaction Test Reference/No.	

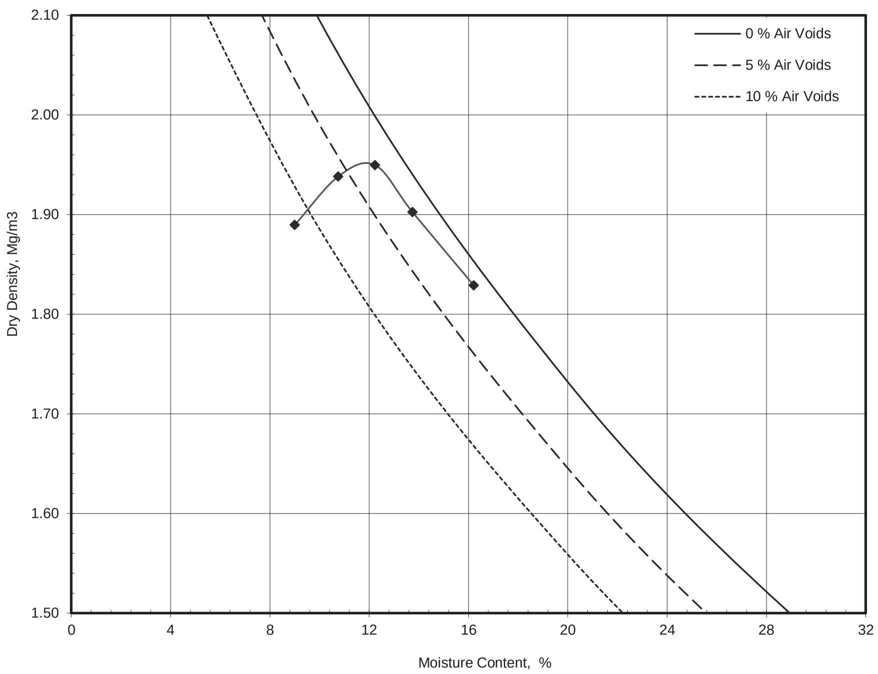


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	5
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.98**
Optimum Moisture Content	%	**13**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	**15-272**
		Borehole / Pit No	TP13
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Black sandy gravelly silty CLAY.	Depth	1.50 m
Specimen Ref.	1 / Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917321
		Compaction Test Reference/No.	

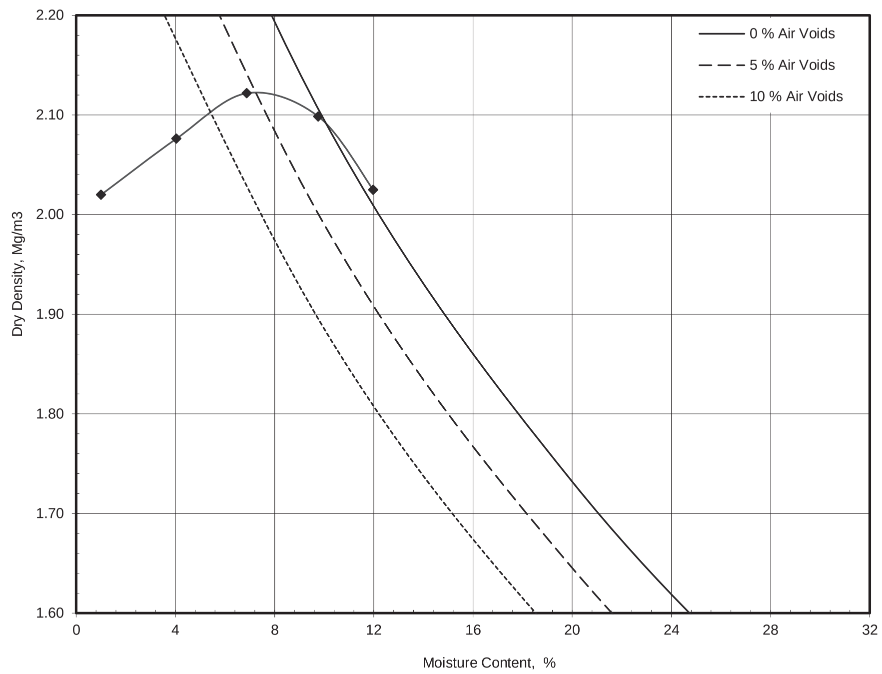


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	18
Material Retained on 20.0 mm Sieve	%	21
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.95**
Optimum Moisture Content	%	**12**

Approved	Remarks Non-standard test	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	**15-272**
		Borehole / Pit No	TP18
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	3
Soil Description	Soft black slightly sandy gravelly SILT with occasional cobbles	Depth	1.50 m
Specimen Ref.	1 / Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.4, 2.5kg rammer	Keylab ID	Caus20150917332
		Compaction Test Reference/No.	

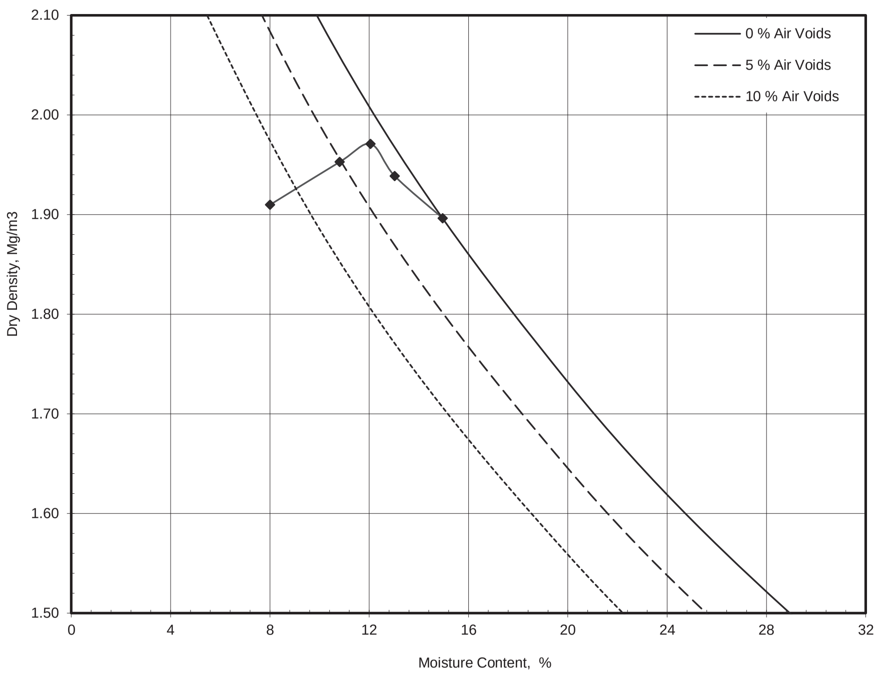


Preparation		Material used was oven dried at 105degC
Mould Type		CBR
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	5
Material Retained on 20.0 mm Sieve	%	17
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		4
Maximum Dry Density	Mg/m³	**2.12**
Optimum Moisture Content	%	**6.9**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

Job Ref	15-272	Borehole / Pit No	TP19
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No	3
Soil Description	Black slightly sandy gravelly silty CLAY	Depth	2.50 m
Specimen Ref.	1 — Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917335
		Compaction Test Reference/No.	

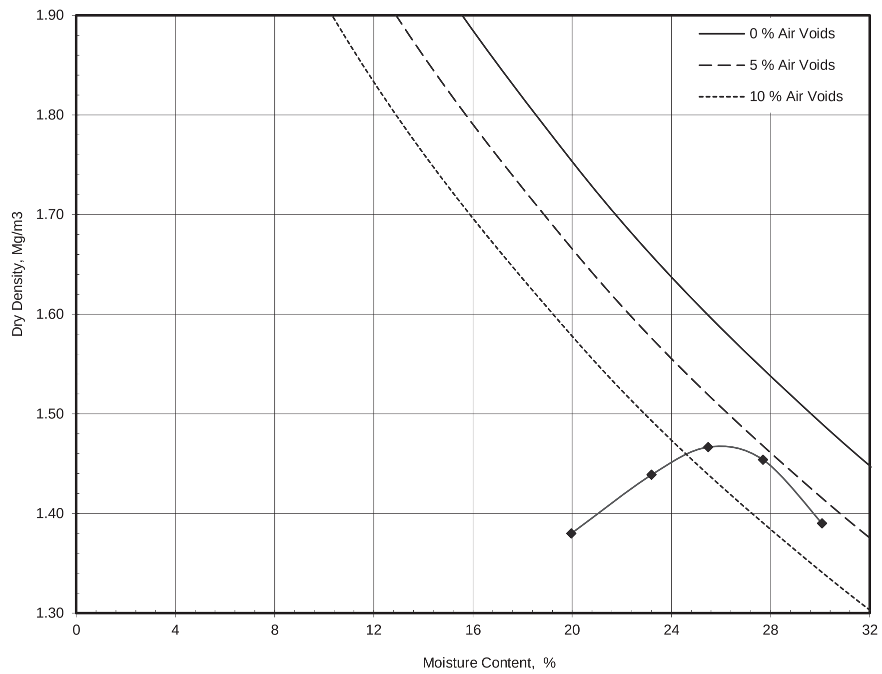


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	12
Material Retained on 20.0 mm Sieve	%	26
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.97**
Optimum Moisture Content	%	**12**

Approved	Remarks Non-standard test	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

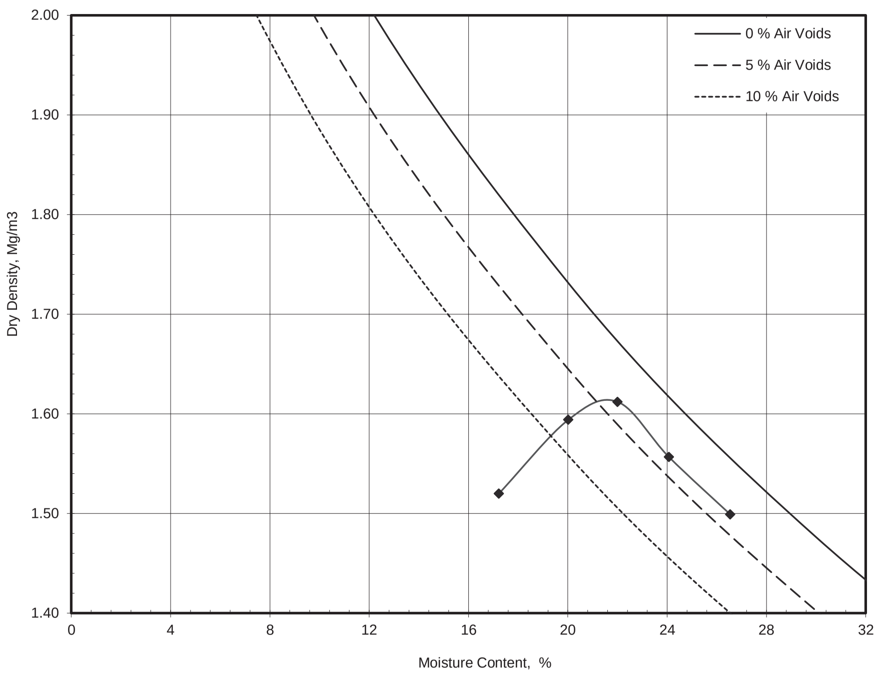
Job Ref	15-272	Borehole / Pit No	TP21
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No	3
Soil Description	Grey brown slightly sandy silty CLAY	Depth	2.50 m
Specimen Ref.	1 — Specimen Depth: m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917340
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	0
Particle Density - Assumed	Mg/m³	2.70
GRADING ZONE		1
Maximum Dry Density	Mg/m³	**1.47**
Optimum Moisture Content	%	**25**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

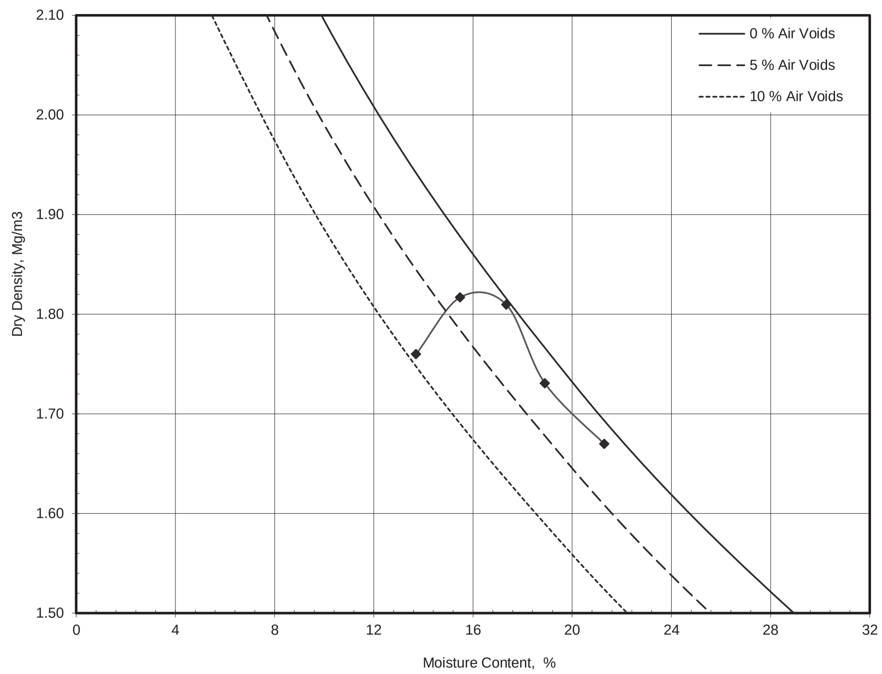
CAUSEWAY GEOTECH	**Dry Density / Moisture Content Relationship** **Light Compaction**	Job Ref	**15-272**
		Borehole / Pit No	TP25
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Brown sandy slightly gravelly CLAY	Depth	1.50 m
Specimen Ref.	1 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917350
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	4
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.61**
Optimum Moisture Content	%	**22**

Approved	Remarks	**Fig**
Stephen.Watson		Sheet 1 of 1

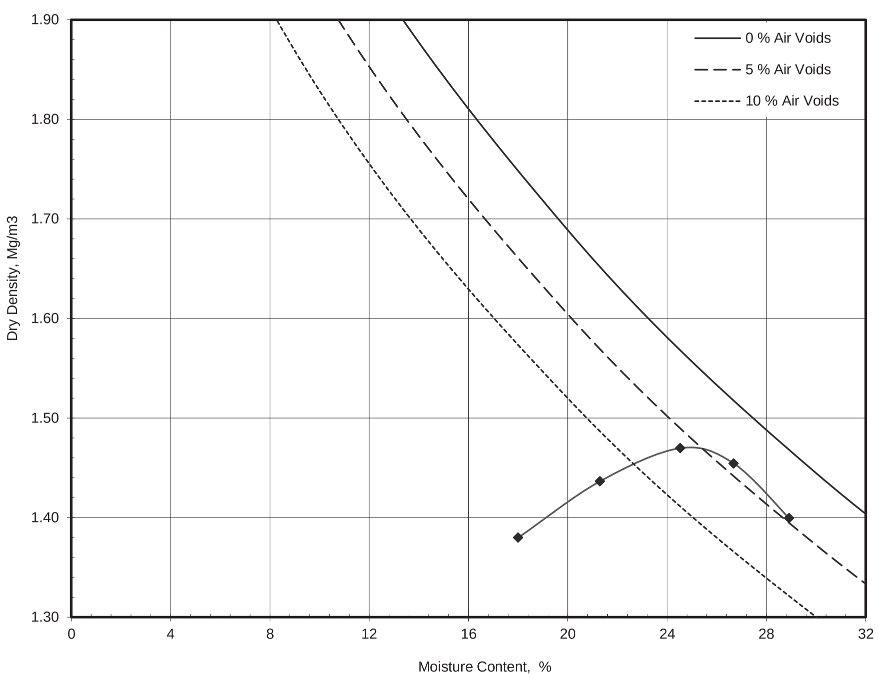
CAUSEWAY GEOTECH	**Dry Density / Moisture Content Relationship** **Light Compaction**	Job Ref	**15-272**
		Borehole / Pit No	TP30
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	3
Soil Description	Black sandy gravelly silty CLAY	Depth	2.00 m
Specimen Ref.	1 Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917367
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	11
Material Retained on 20.0 mm Sieve	%	19
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.82**
Optimum Moisture Content	%	**17**

Approved	Remarks Non-standard test	**Fig**
Stephen.Watson		Sheet 1 of 1

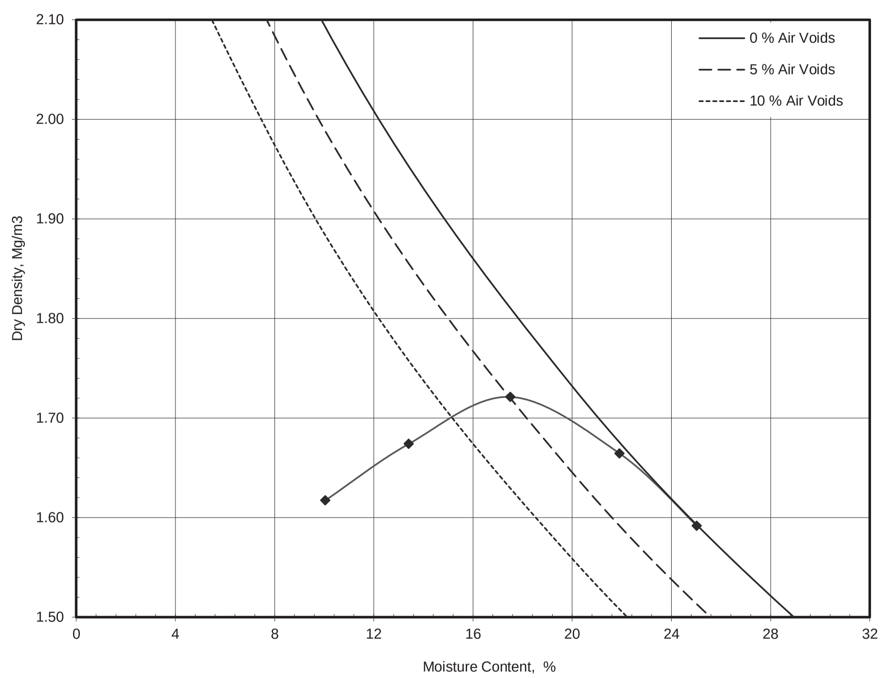
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP32
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	3
Soil Description	Brown sandy gravelly CLAY.	Depth	1.50 m
Specimen Ref.	1	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917373
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	3
Particle Density - Assumed	Mg/m³	2.55
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.47**
Optimum Moisture Content	%	**25**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP39
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Grey brown slightly sandy gravelly CLAY.	Depth	1.00 m
Specimen Ref.	1	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.4, 2.5kg rammer	Keylab ID	Caus20150917386
		Compaction Test Reference/No.	

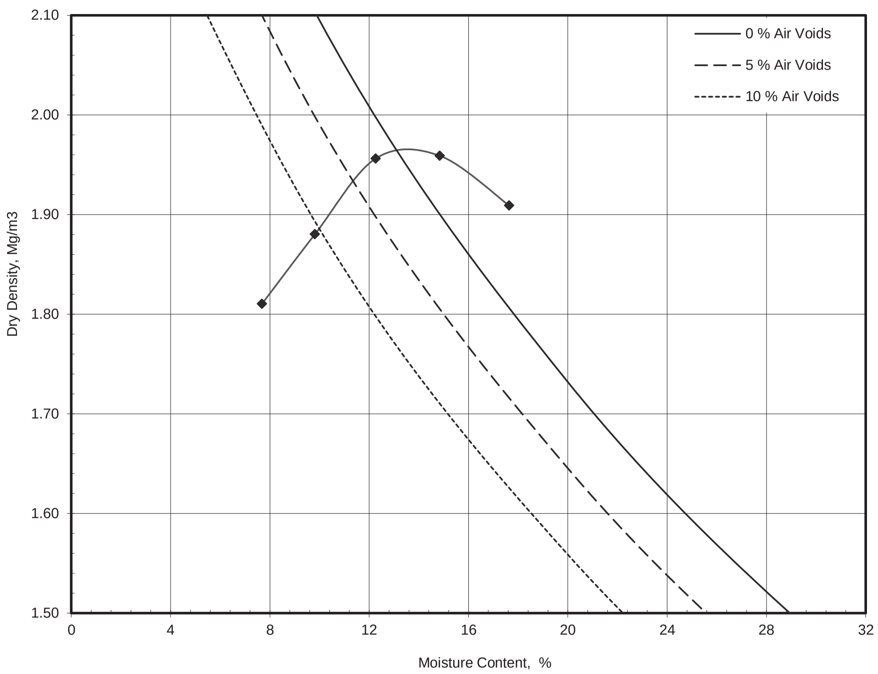


Preparation		Material used was oven dried at 105degC
Mould Type		CBR
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	6
Material Retained on 20.0 mm Sieve	%	20
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		5
Maximum Dry Density	Mg/m³	**1.72**
Optimum Moisture Content	%	**18**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	**15-272**
		Borehole / Pit No	TP41
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Black sandy gravelly CLAY	Depth	2.00 m
Specimen Ref.	1 — Specimen Depth — m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917393
		Compaction Test Reference/No.	

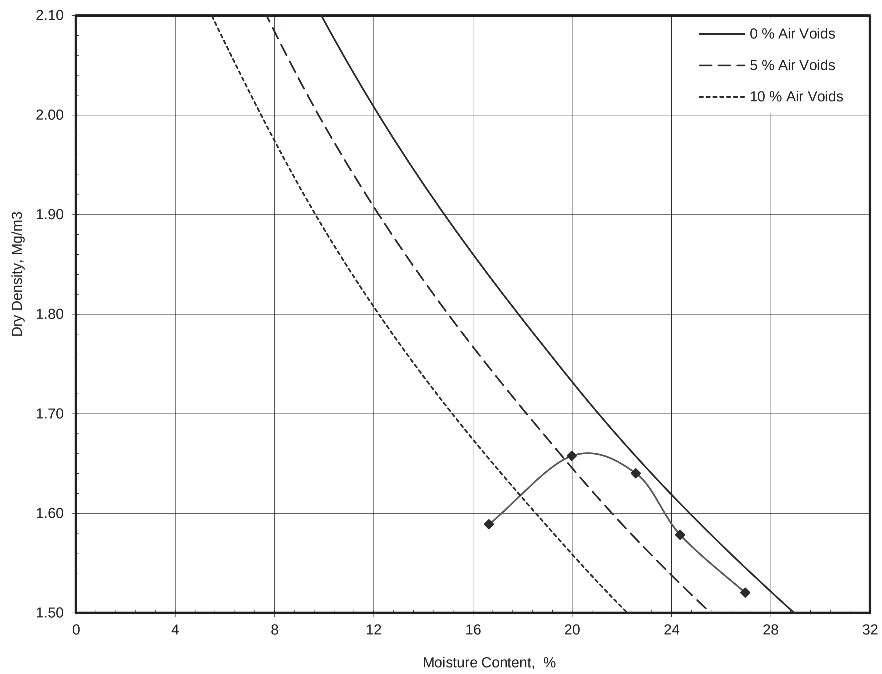


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	60
Material Retained on 20.0 mm Sieve	%	66
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.96**
Optimum Moisture Content	%	**12**

Approved	Remarks Non-standard test	Fig
Stephen.Watson		Sheet 1 of 1

Dry Density / Moisture Content Relationship
Light Compaction

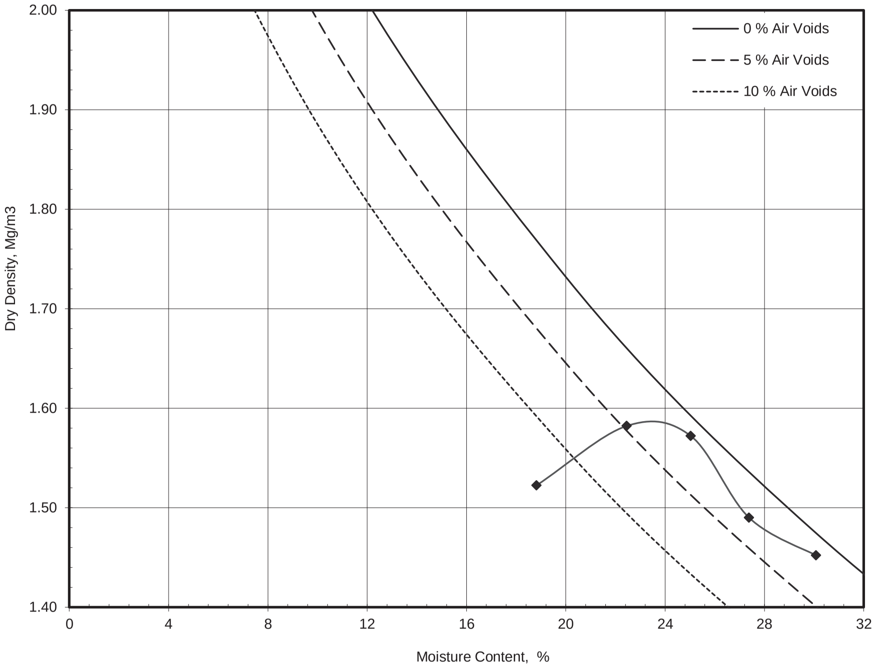
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	**15-272**
		Borehole / Pit No	TP42
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	1
Soil Description	Brown sandy slightly gravelly CLAY.	Depth	1.00 m
Specimen Ref.	1 — Specimen Depth — m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917395
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	2
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.66**
Optimum Moisture Content	%	**23**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

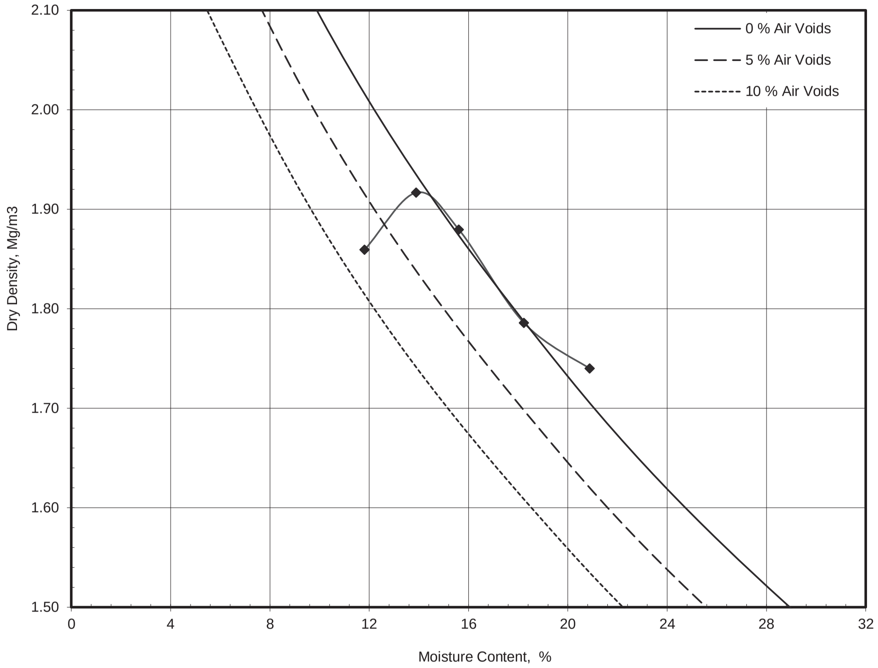
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP61
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Brown sandy CLAY.	Depth	1.00 m
Specimen Ref.	1 — Specimen Depth — m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917424
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Separate specimens tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	5
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.58**
Optimum Moisture Content	%	**25**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

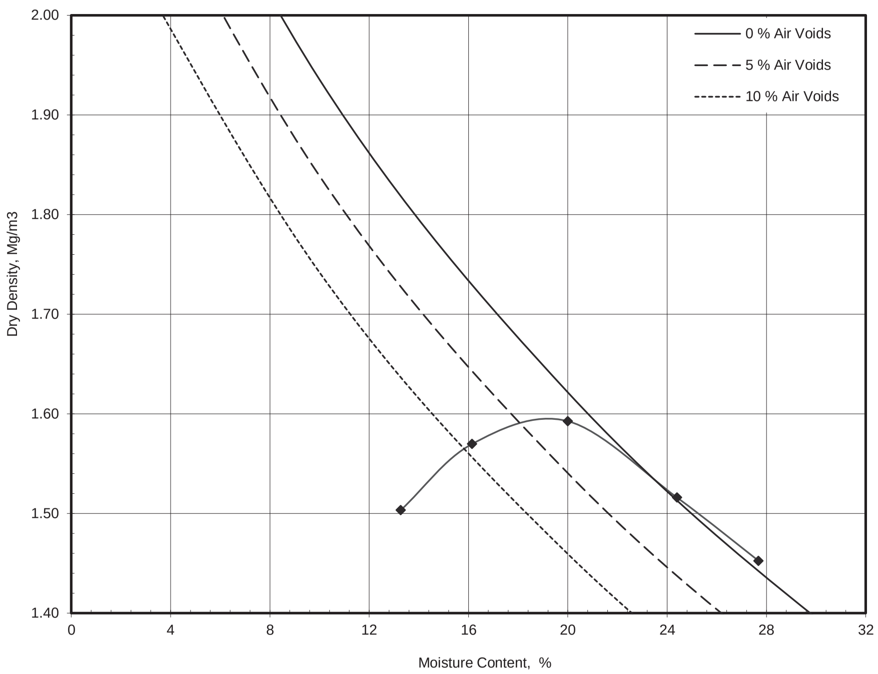
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP67
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	2
Soil Description	Grey brown sandy gravelly CLAY.	Depth	1.00 m
Specimen Ref.	1 — Specimen Depth — m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917436
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	20
Material Retained on 20.0 mm Sieve	%	25
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.92**
Optimum Moisture Content	%	**16**

Approved	Remarks Non-standard test	Fig
Stephen.Watson		Sheet 1 of 1

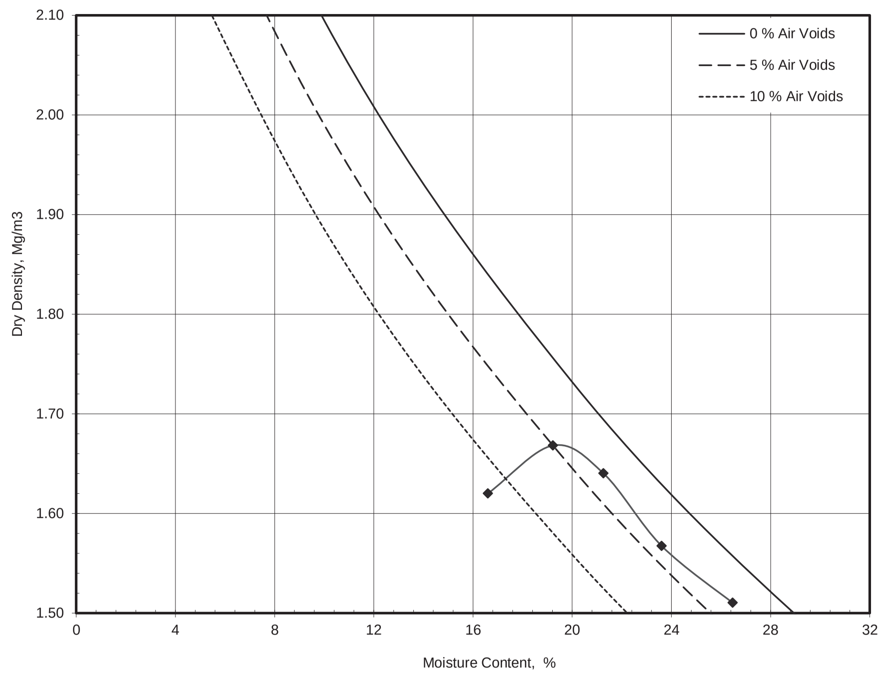
CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction		Job Ref	**15-272**
			Borehole / Pit No	TP69
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**		Sample No	1
Soil Description	Brown slightly sandy CLAY.		Depth	1.00 m
Specimen Ref.	1	Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer		Keylab ID	Caus20150917442
			Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	4
Particle Density - Assumed	Mg/m³	2.40
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.59**
Optimum Moisture Content	%	**20**

Approved	Remarks	**Fig**
Stephen.Watson		Sheet 1 of 1

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction		Job Ref	**15-272**
			Borehole / Pit No	TP71
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**		Sample No	2
Soil Description	Grey brown slightly sandy gravelly CLAY.		Depth	0.60 m
Specimen Ref.	1	Specimen Depth m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer		Keylab ID	Caus20150917445
			Compaction Test Reference/No.	

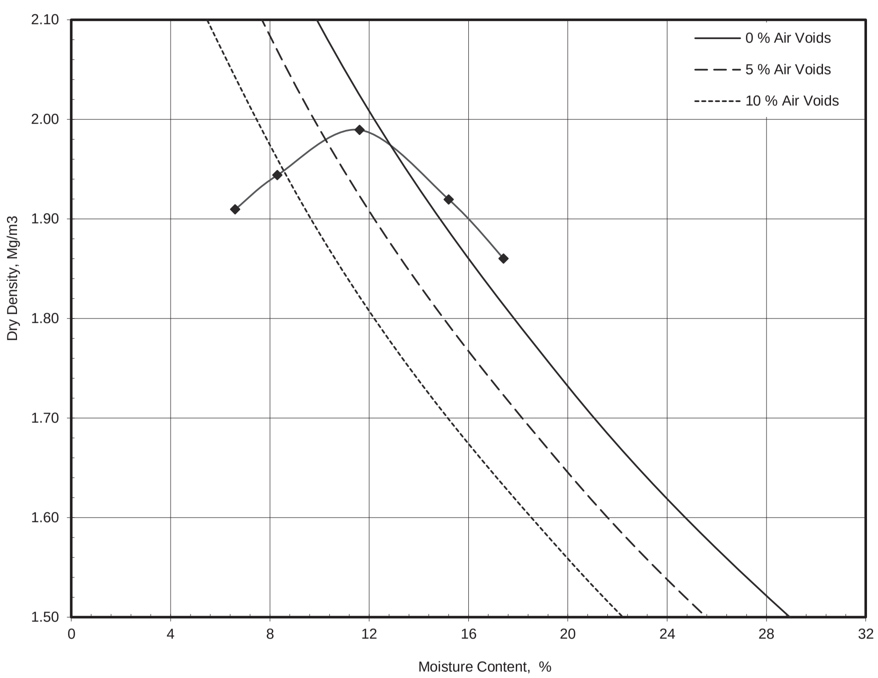


Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	15
Material Retained on 20.0 mm Sieve	%	23
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		X
Maximum Dry Density	Mg/m³	**1.67**
Optimum Moisture Content	%	**21**

Approved	Remarks Non-standard test	**Fig**
		Sheet 1 of 1

Dry Density / Moisture Content Relationship Light Compaction

CAUSEWAY GEOTECH	Dry Density / Moisture Content Relationship Light Compaction	Job Ref	15-272
		Borehole / Pit No	TP71
Site Name	**Morrell River Flood Alleviation - Site Investigation Contract**	Sample No	5
Soil Description	Grey slightly sandy gravelly CLAY	Depth	3.00 m
Specimen Ref.	1 — Specimen Depth — m	Sample Type	B
Test Method	BS1377:Part 4:1990, clause 3.3, 2.5kg rammer	Keylab ID	Caus20150917448
		Compaction Test Reference/No.	



Preparation		Material used was oven dried at 105degC
Mould Type		One Litre
Samples Used		Single sample tested
Material Retained on 37.5 mm Sieve	%	0
Material Retained on 20.0 mm Sieve	%	5
Particle Density - Assumed	Mg/m³	2.65
GRADING ZONE		2
Maximum Dry Density	Mg/m³	**1.99**
Optimum Moisture Content	%	**12**

Approved	Remarks	Fig
Stephen.Watson		Sheet 1 of 1

California Bearing Ratio (CBR)

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)	Job Ref	15-272
		Borehole/Pit No.	TP05
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown black sandy gravelly silty CLAY	Depth m	1.00
Specimen Reference	1 — Specimen Depth — m	Sample Type	B
Specimen Description	Soft brown black sandy gravelly silty CLAY	KeyLAB ID	Caus20150917311
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

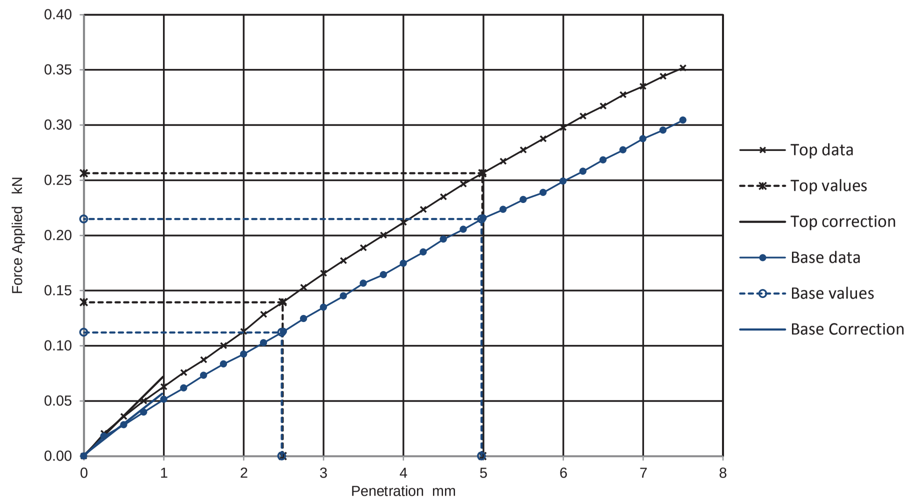
Material retained on 20mm sieve removed: 4 %

Initial Specimen details:
- Bulk density 2.02 Mg/m3
- Dry density 1.67 Mg/m3
- Moisture content 20.7 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	1.1	1.3	1.3	1.2	20.7
BASE	Yes	0.9	1.1	1.1		21.4

General remarks	Test specific remarks	Approved	
		Stephen.Watson	Fig No. 1
			Sheet No 1

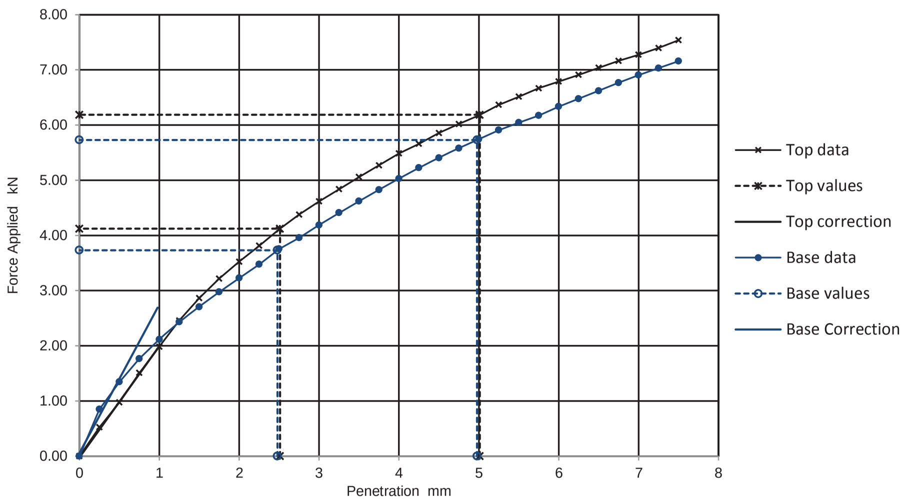
Lab Sheet Reference :

California Bearing Ratio (CBR)				Job Ref	15-272
				Borehole/Pit No.	TP18
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Brownish orange slightly sandy slightly gravelly CLAY			Depth m	0.50
Specimen Reference	1	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff brownish orange slightly sandy slightly gravelly CLAY			KeyLAB ID	Caus20150917331
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		22	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.07	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.85	Mg/m3		8	kPa
	Moisture content	11.6	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	31.0	31.0	31.0	30.0	11.6
BASE	Yes	28.0	29.0	29.0		13.0

General remarks	Test specific remarks	Approved	Fig No.	2
		Stephen.Watson	Sheet No	2

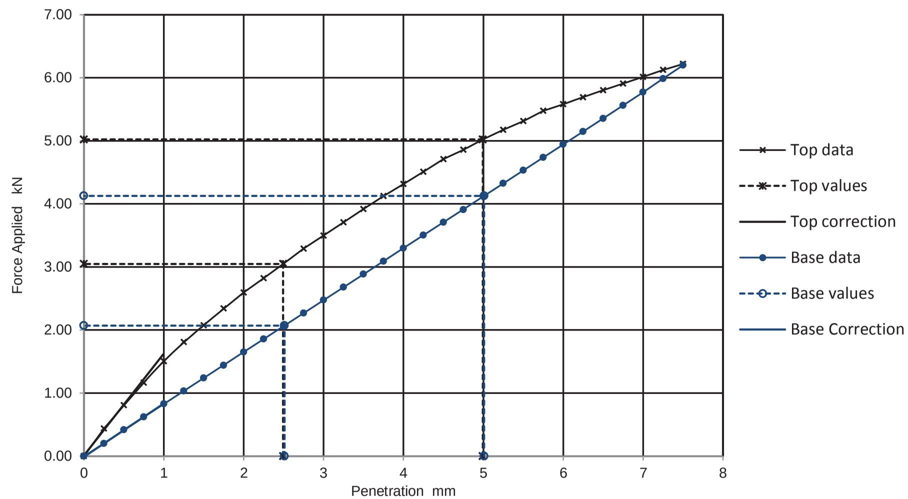
Lab Sheet Reference :

California Bearing Ratio (CBR)				Job Ref	15-272
				Borehole/Pit No.	TP20
Site Name	Morrell River Flood Alleviation - Site Investigation Contract			Sample No.	1
Soil Description	Orange brown slightly gravelly slightly sandy CLAY			Depth m	0.50
Specimen Reference	1	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff orange brown slightly gravelly slightly sandy CLAY			KeyLAB ID	Caus20150917336
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		5	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.00	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.72	Mg/m3		8	kPa
	Moisture content	16.2	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	23.0	25.0	25.0	23.0	16.2
BASE	Yes	16.0	21.0	21.0		15.8

General remarks	Test specific remarks	Approved	Fig No.	3
		Stephen.Watson	Sheet No	3

Lab Sheet Reference :

California Bearing Ratio (CBR)

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)	Job Ref	15-272
		Borehole/Pit No.	TP26
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	2
Soil Description	Brown slightly sandy CLAY.	Depth m	1.50
Specimen Reference	1 Specimen Depth m	Sample Type	B
Specimen Description	Stiff brown slightly sandy CLAY.	KeyLAB ID	Caus20150917356
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

Material retained on 20mm sieve removed: 1 %

Initial Specimen details: Bulk density 2.08 Mg/m3; Dry density 1.70 Mg/m3; Moisture content 22.6 %

Soaking details: Not soaked

Period of soaking: days

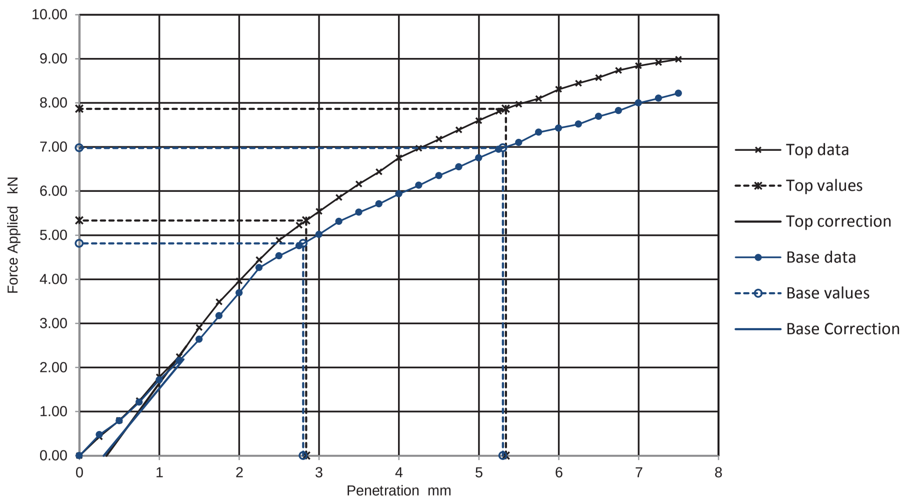
Time to surface: days

Amount of swell recorded: mm

Dry density after soaking: Mg/m3

Surcharge applied: 13.5 kg; 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	40.0	39.0	40.0	38.0	22.6
BASE	Yes	36.0	35.0	36.0		22.5

General remarks	Test specific remarks	Approved	Fig No. 4
		Stephen.Watson	Sheet No 4

Lab Sheet Reference :

California Bearing Ratio (CBR)

CAUSEWAY GEOTECH	California Bearing Ratio (CBR)	Job Ref	15-272
		Borehole/Pit No.	TP30
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	MADE GROUND - Brown slightly sandy gravelly CLAY	Depth m	0.50
Specimen Reference	1 Specimen Depth m	Sample Type	B
Specimen Description	MADE GROUND - Stiff brown slightly sandy gravelly CLAY	KeyLAB ID	Caus20150917366
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

Material retained on 20mm sieve removed: 15 %

Initial Specimen details: Bulk density 1.80 Mg/m3; Dry density 1.65 Mg/m3; Moisture content 9.3 %

Soaking details: Not soaked

Period of soaking: days

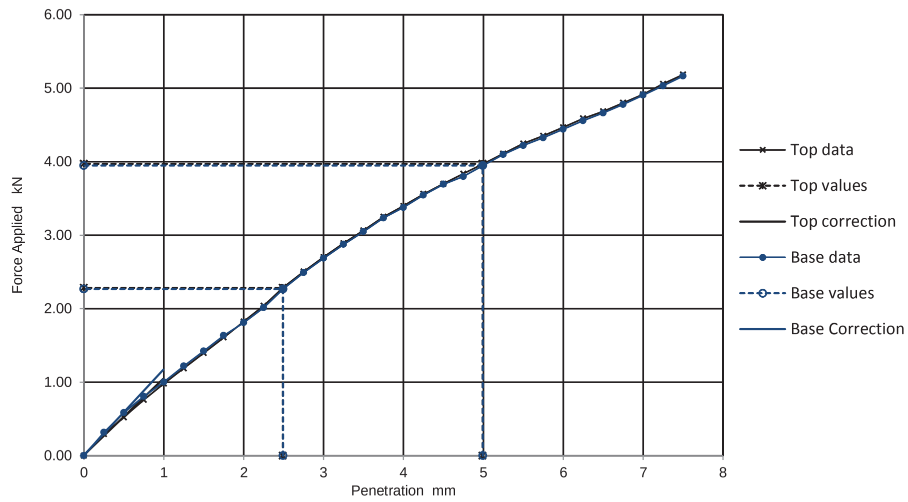
Time to surface: days

Amount of swell recorded: mm

Dry density after soaking: Mg/m3

Surcharge applied: 13.5 kg; 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	17.0	20.0	20.0	20.0	9.3
BASE	Yes	17.0	20.0	20.0		10.2

General remarks	Test specific remarks	Approved	Fig No. 5
		Stephen.Watson	Sheet No 5

Lab Sheet Reference :

California Bearing Ratio (CBR)

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP32
		Sample No.	2
Soil Description	Grey brown slightly sandy slightly gravelly CLAY.	Depth m	0.90
Specimen Reference	1 — Specimen Depth: m	Sample Type	B
Specimen Description	Stiff grey brown slightly sandy slightly gravelly CLAY.	KeyLAB ID	Caus20150917372
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

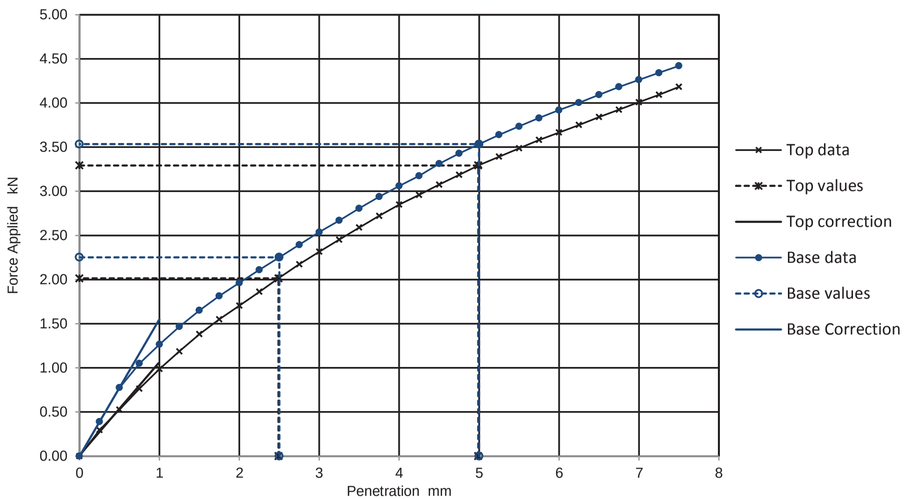
Material retained on 20mm sieve removed: 2 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 1.94 Mg/m3
Dry density: 1.66 Mg/m3
Moisture content: 16.7 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	15.0	16.0	16.0	17.0	16.7
BASE	Yes	17.0	18.0	18.0		15.0

General remarks:
Test specific remarks:
Approved: Stephen.Watson

Fig No. 6
Sheet No 6

Lab Sheet Reference :

California Bearing Ratio (CBR)

Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Job Ref	15-272
		Borehole/Pit No.	TP39
		Sample No.	1
Soil Description	Brown sandy gravelly CLAY.	Depth m	0.30
Specimen Reference	1 — Specimen Depth: m	Sample Type	B
Specimen Description	Stiff brown sandy gravelly CLAY.	KeyLAB ID	Caus20150917385
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition: REMOULDED

Details: Recompacted with specified standard effort using 2.5kg rammer

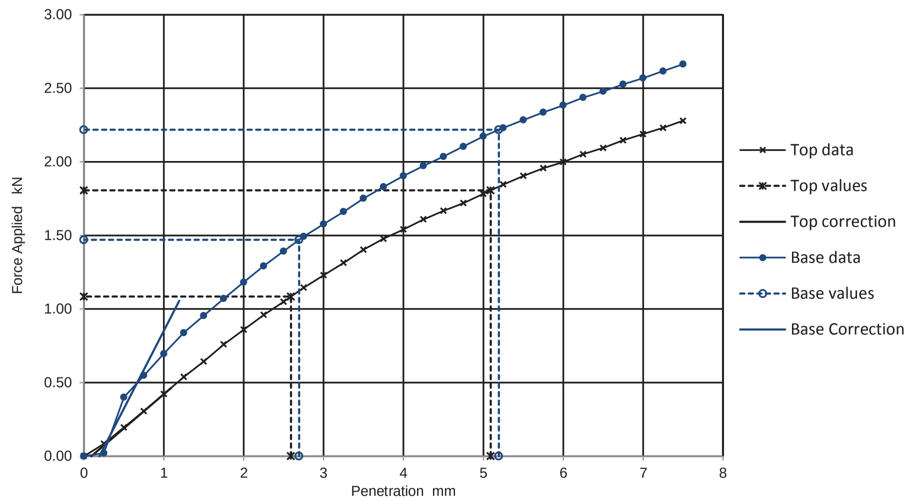
Material retained on 20mm sieve removed: 1 %

Soaking details: Not soaked
Period of soaking: days
Time to surface: days
Amount of swell recorded: mm
Dry density after soaking: Mg/m3

Initial Specimen details
Bulk density: 1.85 Mg/m3
Dry density: 1.49 Mg/m3
Moisture content: 23.8 %

Surcharge applied: 13.5 kg, 8 kPa

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	8.2	9.0	9.0		23.8
BASE	Yes	11.0	11.0	11.0		23.5

General remarks:
Test specific remarks:
Approved: Stephen.Watson

Fig No. 7
Sheet No 7

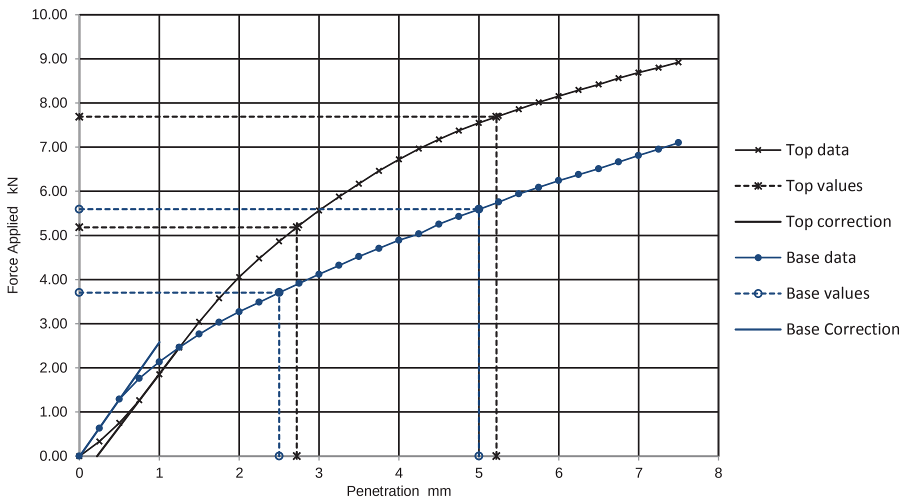
Lab Sheet Reference :

	California Bearing Ratio (CBR)	Job Ref	15-272
		Borehole/Pit No.	TP41
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown sandy gravelly CLAY.	Depth m	0.30
Specimen Reference	1 / Specimen Depth / m	Sample Type	B
Specimen Description	Stiff brown sandy gravelly CLAY.	KeyLAB ID	Caus20150917392
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		20	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	2.10	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.89	Mg/m3		8	kPa
	Moisture content	10.9	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	39.0	38.0	39.0		10.9
BASE	Yes	28.0	28.0	28.0		11.2

General remarks	Test specific remarks	Approved	Fig No.	8
		Stephen.Watson	Sheet No	8

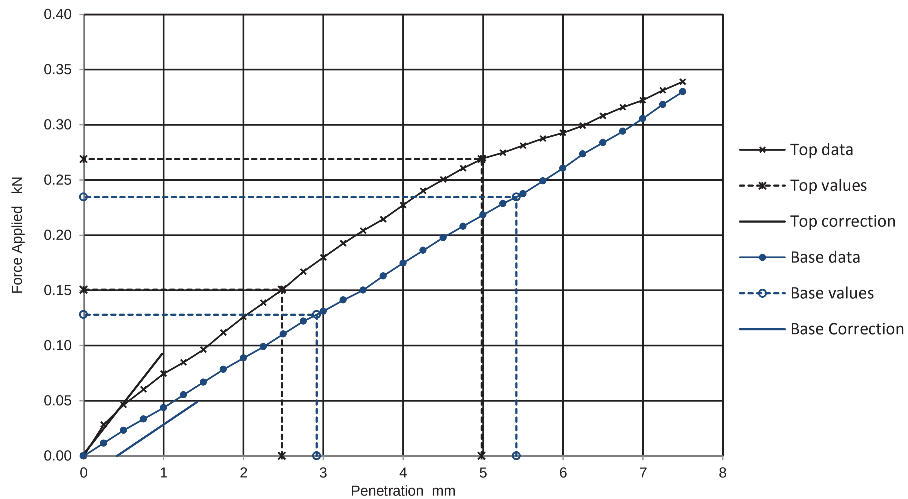
Lab Sheet Reference :

	California Bearing Ratio (CBR)	Job Ref	15-272
		Borehole/Pit No.	TP48
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown sandy CLAY.	Depth m	0.40
Specimen Reference	1 / Specimen Depth / m	Sample Type	B
Specimen Description	Soft brown sandy CLAY.	KeyLAB ID	Caus20150917412
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
				Amount of swell recorded		mm
Material retained on 20mm sieve removed		1	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	1.65	Mg/m3	Surcharge applied	13.5	kg
	Dry density	1.08	Mg/m3		8	kPa
	Moisture content	52.4	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	1.1	1.3	1.3	1.3	52.4
BASE	Yes	1.0	1.2	1.2		49.9

General remarks	Test specific remarks	Approved	Fig No.	9
		Stephen.Watson	Sheet No	9

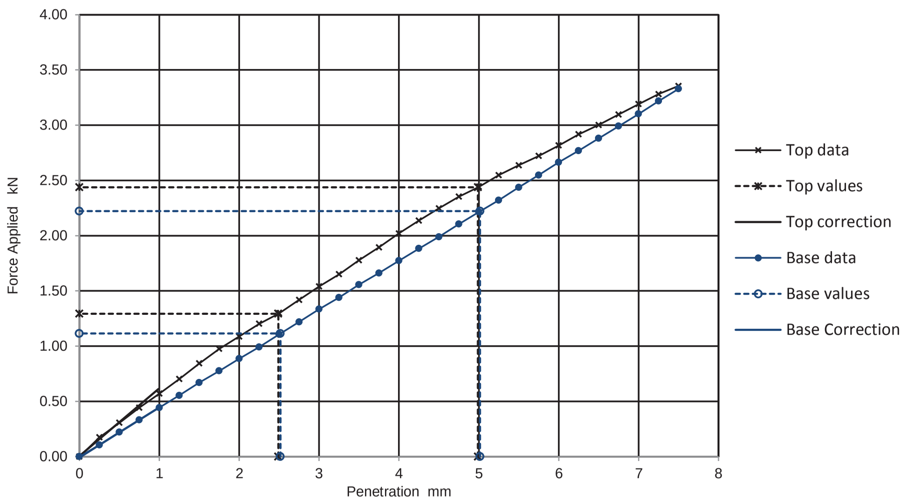
Lab Sheet Reference :

California Bearing Ratio (CBR)		Job Ref	15-272
		Borehole/Pit No.	TP56
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown slightly sandy slightly gravelly CLAY	Depth m	0.30
Specimen Reference	1	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff brown slightly sandy slightly gravelly CLAY	KeyLAB ID	Caus20150917414
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition	REMOULDED		Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer		Period of soaking	days
			Time to surface	days
			Amount of swell recorded	mm
Material retained on 20mm sieve removed		9 %	Dry density after soaking	Mg/m3
Initial Specimen details	Bulk density	1.73 Mg/m3	Surcharge applied	13.5 kg
	Dry density	1.49 Mg/m3		8 kPa
	Moisture content	16.0 %		

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	9.8	12.0	12.0	12.0	16.0
BASE	Yes	8.4	11.0	11.0		14.1

General remarks	Test specific remarks	Approved	Fig No. 10
		Stephen.Watson	Sheet No 10

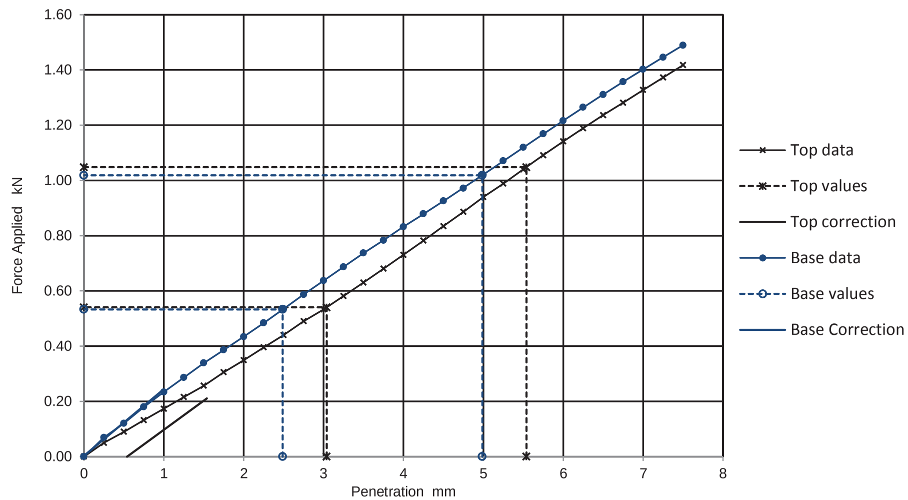
Lab Sheet Reference :

California Bearing Ratio (CBR)		Job Ref	15-272
		Borehole/Pit No.	TP67
Site Name	Morrell River Flood Alleviation - Site Investigation Contract	Sample No.	1
Soil Description	Brown slightly sandy slightly gravelly CLAY.	Depth m	0.50
Specimen Reference	1	Specimen Depth	m	Sample Type	B
Specimen Description	Stiff brown slightly sandy slightly gravelly CLAY.	KeyLAB ID	Caus20150917435
Test Method	BS1377 : Part 4 : 1990, clause 7	CBR Test Number	1

Specimen Preparation

Condition	REMOULDED		Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer		Period of soaking	days
			Time to surface	days
			Amount of swell recorded	mm
Material retained on 20mm sieve removed		1 %	Dry density after soaking	Mg/m3
Initial Specimen details	Bulk density	2.00 Mg/m3	Surcharge applied	13.5 kg
	Dry density	1.66 Mg/m3		8 kPa
	Moisture content	20.2 %		

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	Yes	4.1	5.2	5.2	5.2	20.2
BASE	Yes	4.0	5.1	5.1		20.1

General remarks	Test specific remarks	Approved	Fig No. 11
		Stephen.Watson	Sheet No 11

Lab Sheet Reference :

Consolidated undrained single triaxial test with pore water pressure measurements				
Tested in accordance with BS:1377 Part 8				
Location	Morrel River			
Job Ref	15-272			
Borehole No	TP23			
Depth	4m			
Soil type	Brown clayey SILT			
Sampling	Recompacted			
INITIAL CONDITIONS				
Stage No.		1	2	3
Diameter	mm	50		
Height	mm	100		
Initial Moisture content	%	31.9		
Moisture content after saturation	%	36.0		
Initial Bulk density	kg/m3	1916		
Initial dry density	kg/m3	1452		
Specific Gravity		2.70		
SATURATION STAGE				
Initial cell pressure	kPa	50		
Initial B value		<0.95		
Back pressure applied	kPa	300		
Period of saturation	Days	4		
Final B value	kPa	1		
CONSOLIDATION STAGE				
Cell pressure	kPa	349		
Back pressure	kPa	298		
Effective consolidation pressure	kPa	51		
Drainage conditions	T/B			
Period of consolidation	h	24		
Water content after consolidation%		35.1		
Void ratio		0.947		
COMPRESSION STAGE				
Total cell pressure	kPa	349		
Rate of strain	%/h	0.18		
Period of compression	h	24		
CONDITIONS AT FAILURE/CRITICAL STATE				
Mem. and side drains corrections	kPa	3		
Maximum deviator stress	kPa	118		
Pore water pressure	kPa	310		
Change in pore water pressure	kPa	14.0		
Strain at failure	%	4.38		
Minor principal total stress	kPa	349		
Major principal total stress	kPa	467		
Minor principal effective stress	kPa	39		
Major principal effective stress	kPa	154		
A_f		0.12		
Minor principal effective stress (critical state)	kPa			
Major principal effective stress (critical state)	kPa			
c' (kPa)				
ϕ' (degrees)				
Critical ϕ' (degrees)			34	
Test carried out and checked by VS (QUB)				

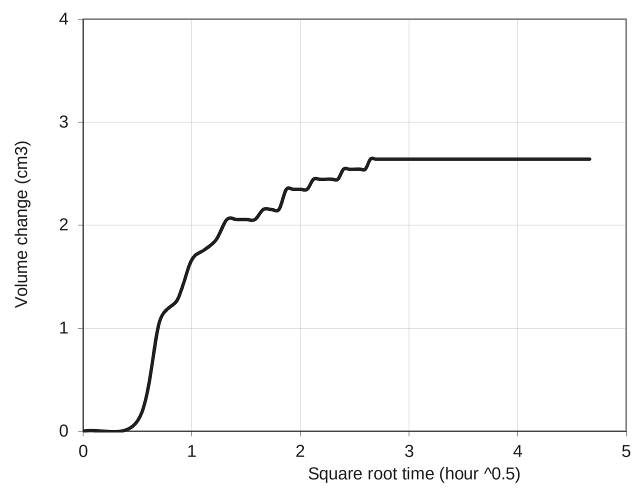


Figure 1 Consolidation: Volume change vs square root time

Consolidated Undrained Single Triaxial Test With Pore Water Pressure Measurements: 15-272, Morrel River TP23, 1.5m

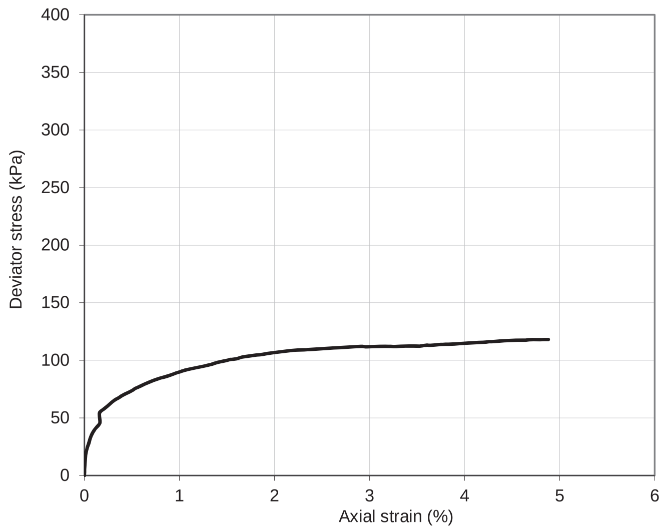


Figure 2 Deviator stress vs axial strain

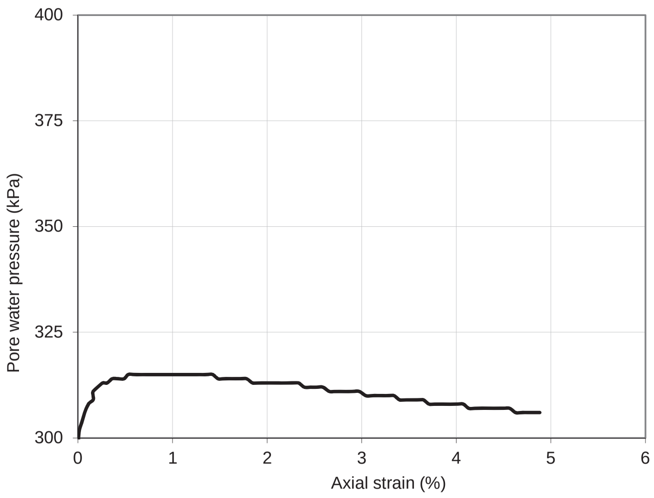


Figure 3 Pore water pressure vs axial strain

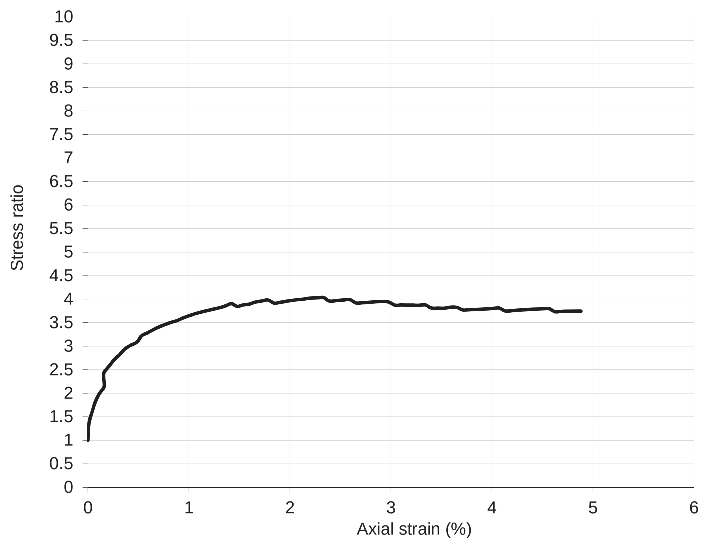


Figure 4 Stress ratio vs axial strain

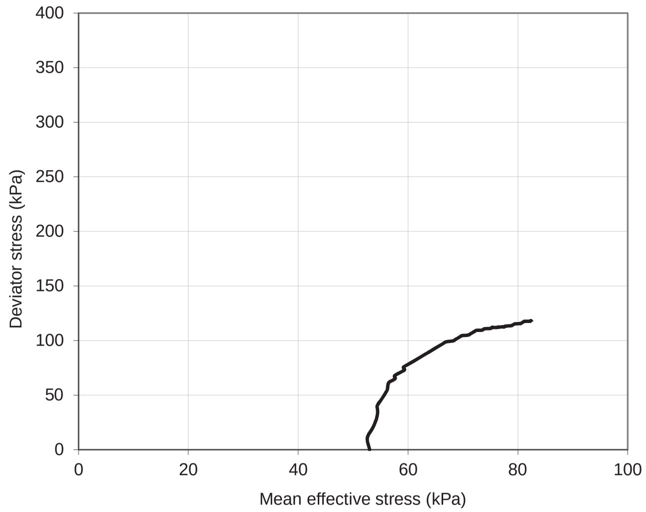


Figure 5 Deviator stress vs mean effective (stress paths)

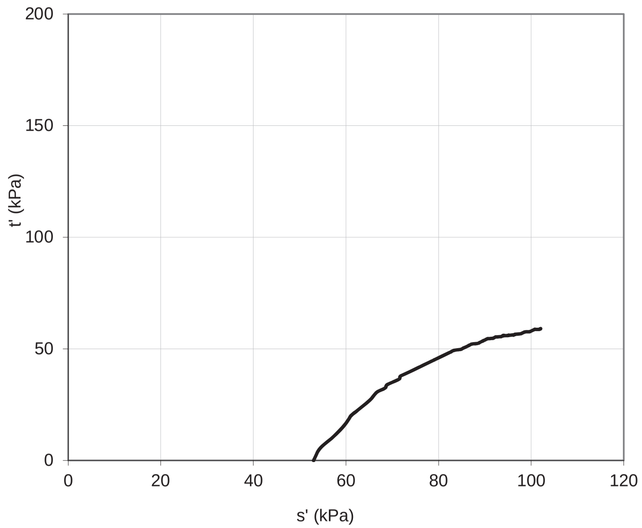


Figure 6 t' vs s' (stress paths)

Consolidated undrained multistage triaxial test with pore water pressure measurements				
Tested in accordance with BS:1377 Part 8				
Location	Morrel River			
Job Ref	15-272			
Borehole No	BH04			
Depth	8m			
Soil type	Very stiff grey Clayey sity sandy GRAVEL			
Sampling	U			
INITIAL CONDITIONS				
Stage No.		1	2	3
Diameter	mm	105		
Height	mm	200		
Initial Moisture content	%	11.4		
Moisture content after saturation	%	11.9		
Initial Bulk density	kg/m3	2287		
Initial dry density	kg/m3	2054		
Specific Gravity		2.70		
SATURATION STAGE				
Initial cell pressure	kPa	50		
Initial B value		<0.95		
Back pressure applied	kPa	300		
Period of saturation	Days	4		
Final B value	kPa	1		
CONSOLIDATION STAGE				
Cell pressure	kPa	350	397	498
Back pressure	kPa	303	304	301
Effective consolidation pressure	kPa	47	93	197
Drainage conditions	T/B			
Period of consolidation	h	29	29	25
Water content after consolidation%		11.3	10.8	10.4
Void ratio		0.305	0.292	0.281
COMPRESSION STAGE				
Total cell pressure	kPa	350	397	498
Rate of strain	%/h	0.10	0.10	0.08
Period of compression	h	14	24	46
CONDITIONS AT FAILURE/CRITICAL STATE				
Mem. and side drains corrections	kPa	3	3	3
Maximum deviator stress	kPa	143	317	580
Pore water pressure	kPa	311	310	339
Change in pore water pressure	kPa	8.0	6.0	37.0
Strain at failure	%	1.41	2.35	2.1
Minor principal total stress	kPa	350	397	498
Major principal total stress	kPa	493	714	1078
Minor principal effective stress	kPa	39	87	159
Major principal effective stress	kPa	179	401	736
A_f		0.06	0.02	0.06
Minor principal effective stress (critical state)	kPa			199
Major principal effective stress (critical state)	kPa			916
c' (kPa)	0			
ϕ' (degrees)	39			
Critical ϕ' (degrees)	39			
Test carried out and checked by VS (QUB)				

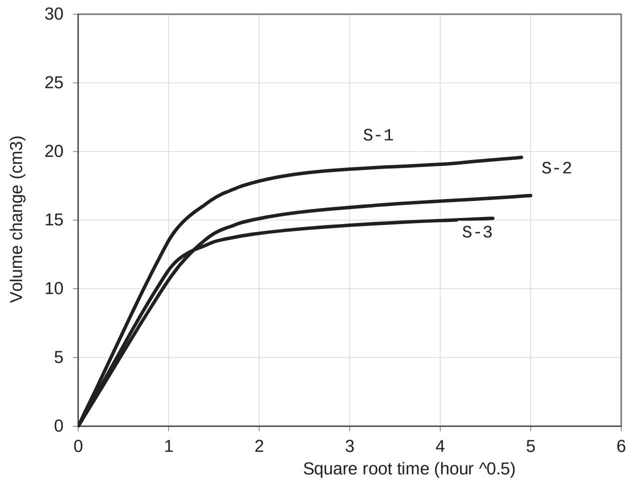


Figure 1 Consolidation: Volume change vs square root time

Consolidated Undrained Multistage Triaxial Test With Pore Water Pressure Measurements: 15-272, Morrel River BH04, 8m

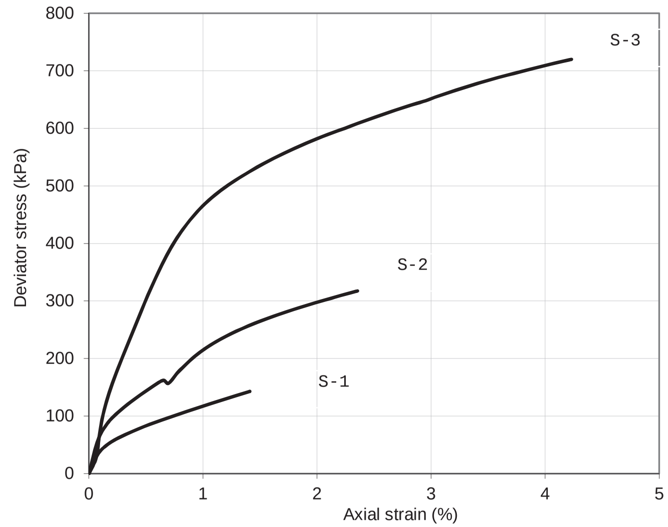


Figure 2 Deviator stress vs axial strain

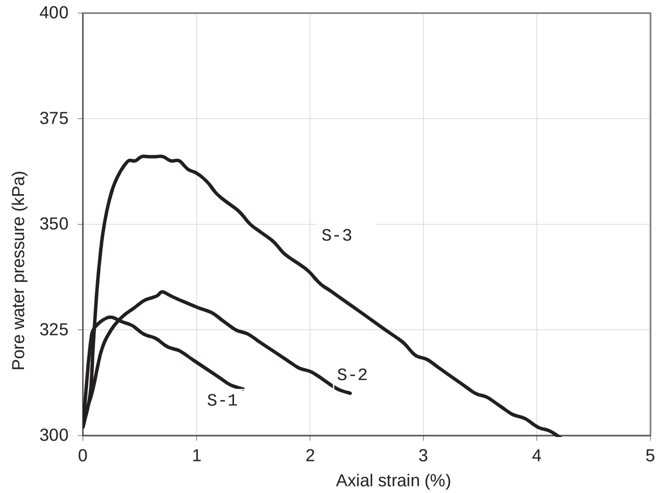


Figure 3 Pore water pressure vs axial strain

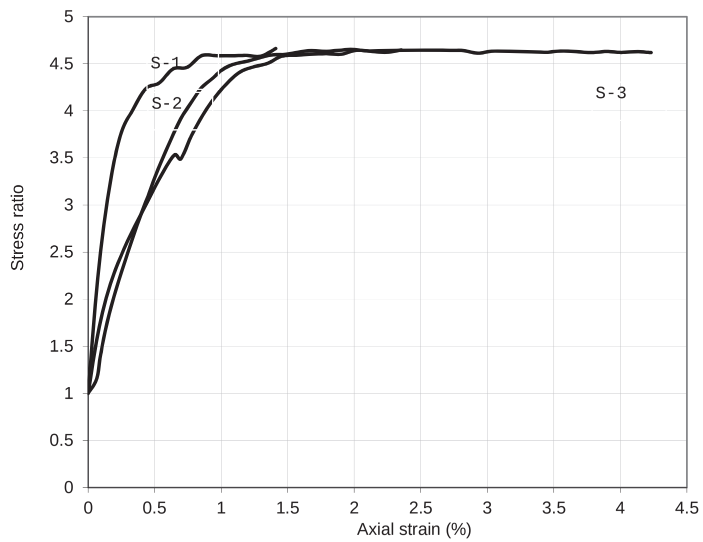


Figure 4 Stress ratio vs axial strain

Consolidated Undrained Multistage Triaxial Test With Pore Water Pressure Measurements: 15-272, Morrel River BH04, 8m

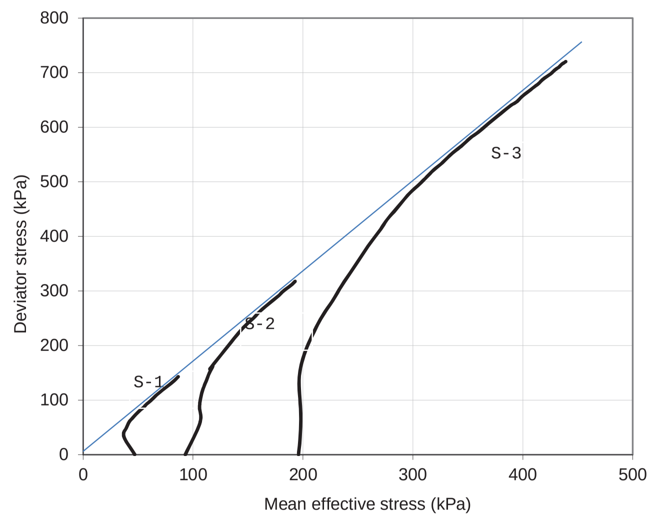


Figure 5 Deviator stress vs mean effective (stress paths)

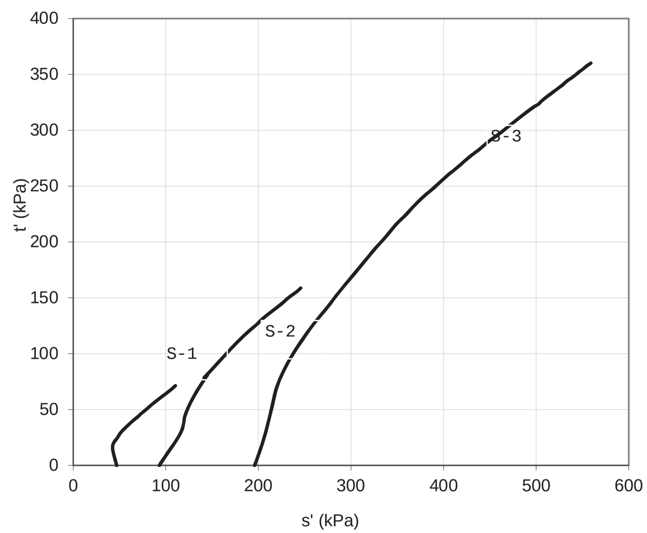


Figure 6 t' vs s' (stress paths)

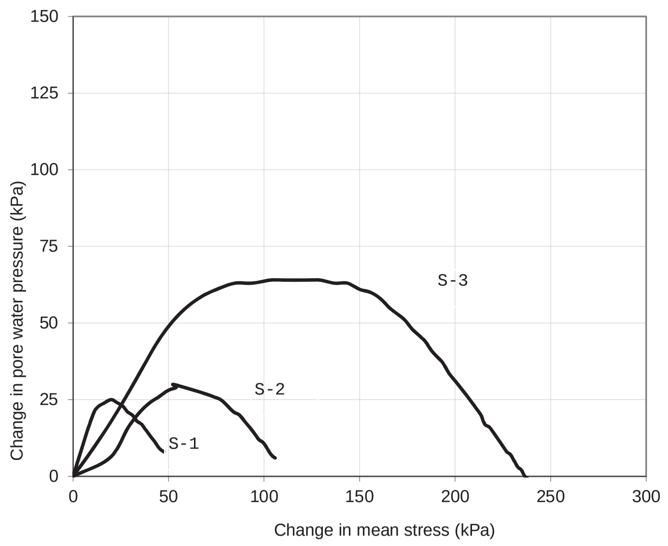


Figure 7 Change in pore water pressure vs change in mean stress

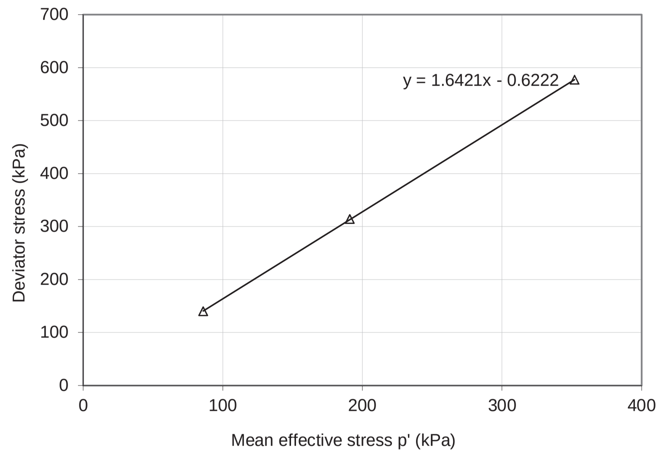


Figure 8 Deviator stress q vs mean effective stress at failure

Consolidated undrained multistage triaxial test with pore water pressure measurements				
Tested in accordance with BS:1377 Part 8				
Location	**Morrel River**			
Job Ref	**15-272**			
Borehole No	**BH01**			
Depth	**4m**			
Soil type	**Very stiff grey Clayey sity sandy GRAVEL**			
Sampling	**U**			
INITIAL CONDITIONS				
Stage No.		**1**	**2**	**3**
Diameter	**mm**	**105**		
Height	**mm**	**200**		
Initial Moisture content	**%**	**11.2**		
Moisture content after saturation	**%**	**11.6**		
Initial Bulk density	**kg/m3**	**2286**		
Initial dry density	**kg/m3**	**2057**		
Specific Gravity		**2.70**		
SATURATION STAGE				
Initial cell pressure	**kPa**	**50**		
Initial B value		**<0.95**		
Back pressure applied	**kPa**	**300**		
Period of saturation	**Days**	**4**		
Final B value	**kPa**	**1**		
CONSOLIDATION STAGE				
Cell pressure	**kPa**	**350**	**401**	**455**
Back pressure	**kPa**	**295**	**296**	**301**
Effective consolidation pressure	**kPa**	**55**	**105**	**154**
Drainage conditions	**T/B**			
Period of consolidation	**h**	**37**	**20**	**25**
Water content after consolidation%		**11.2**	**10.9**	**10.6**
Void ratio		**0.304**	**0.294**	**0.287**
COMPRESSION STAGE				
Total cell pressure	**kPa**	**350**	**401**	**455**
Rate of strain	**%/h**	**0.05**	**0.07**	**0.12**
Period of compression	**h**	**31**	**29**	**19**
CONDITIONS AT FAILURE/CRITICAL STATE				
Mem. and side drains corrections	**kPa**	**3**	**3**	**3**
Maximum deviator stress	**kPa**	**113**	**239**	**382**
Pore water pressure	**kPa**	**320**	**335**	**344**
Change in pore water pressure	**kPa**	**25.1**	**39.4**	**48.4**
Strain at failure	**%**	**1.3**	**1.6**	**2.2**
Minor principal total stress	**kPa**	**350**	**401**	**455**
Major principal total stress	**kPa**	**463**	**640**	**837**
Minor principal effective stress	**kPa**	**30**	**66**	**111**
Major principal effective stress	**kPa**	**140**	**302**	**490**
A_f		**0.22**	**0.17**	**0.13**
Minor principal effective stress (critical state)	**kPa**			**156**
Major principal effective stress (critical state)	**kPa**			**873**
c' (kPa)	**2**			
ϕ' (degrees)	**38**			
Critical ϕ' (degrees)				
Test carried out and checked by VS (QUB)				

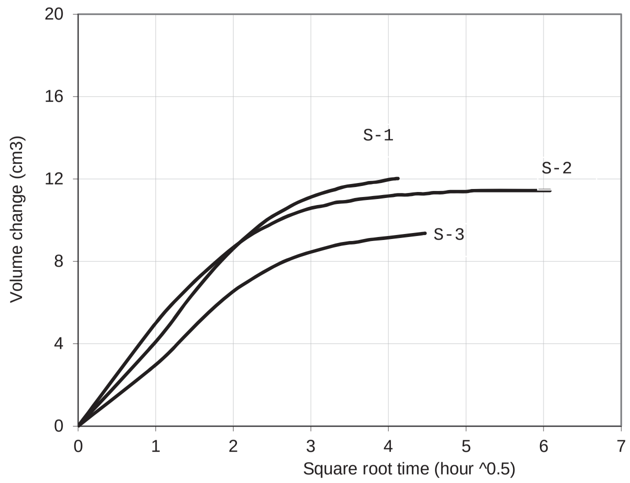


Figure 1 Consolidation: Volume change vs square root time

Consolidated Undrained Multistage Triaxial Test With Pore Water Pressure Measurements: 15-272, Morrel River BH04, 8m

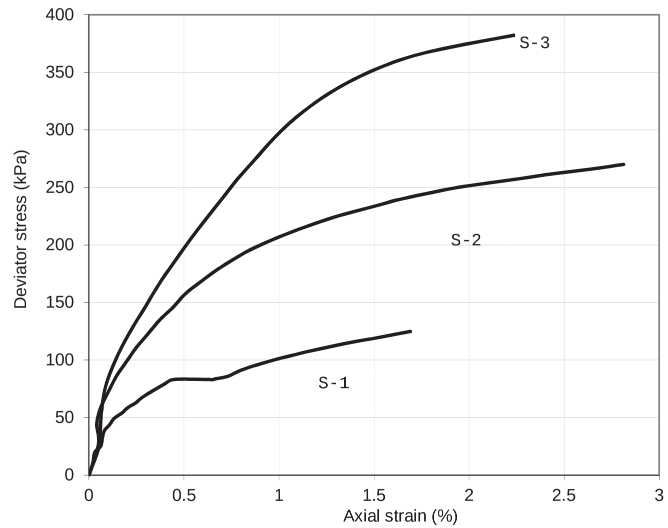


Figure 2 Deviator stress vs axial strain

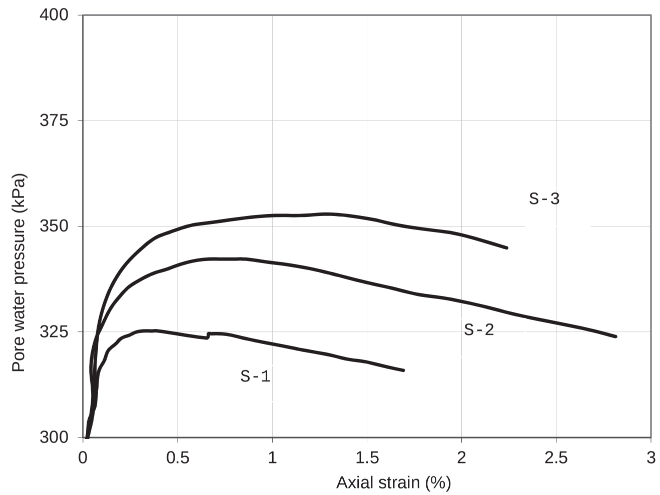


Figure 3 Pore water pressure vs axial strain

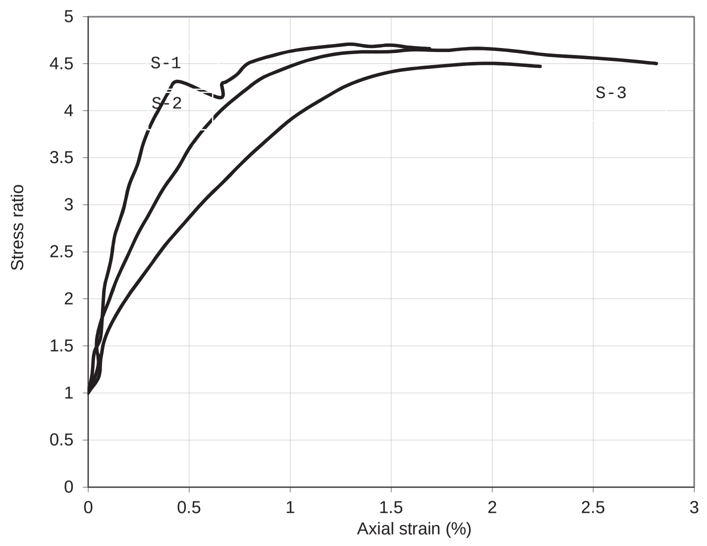


Figure 4 Stress ratio vs axial strain

Consolidated Undrained Multistage Triaxial Test With Pore Water Pressure Measurements: 15-272, Morrel River BH04, 8m

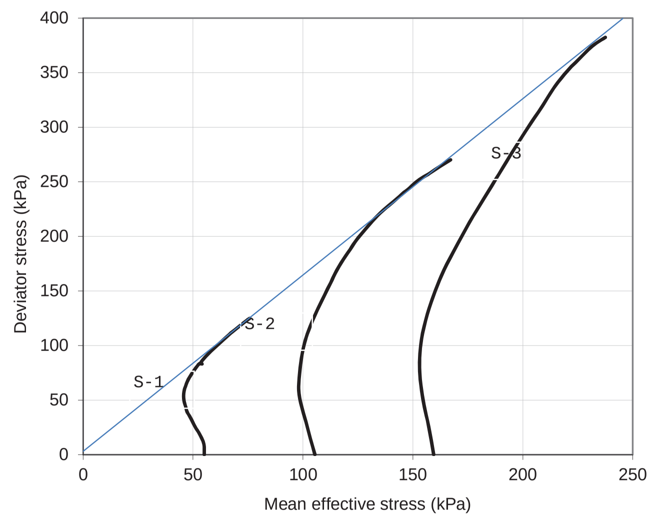


Figure 5 Deviator stress vs mean effective (stress paths)

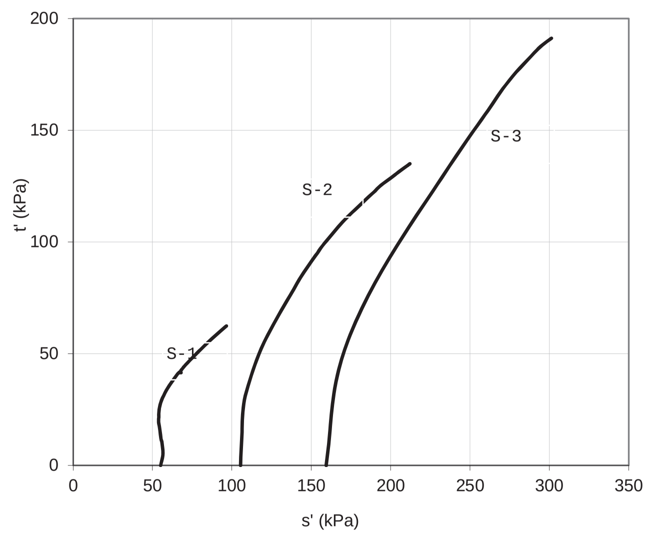


Figure 6 t' vs s' (stress paths)

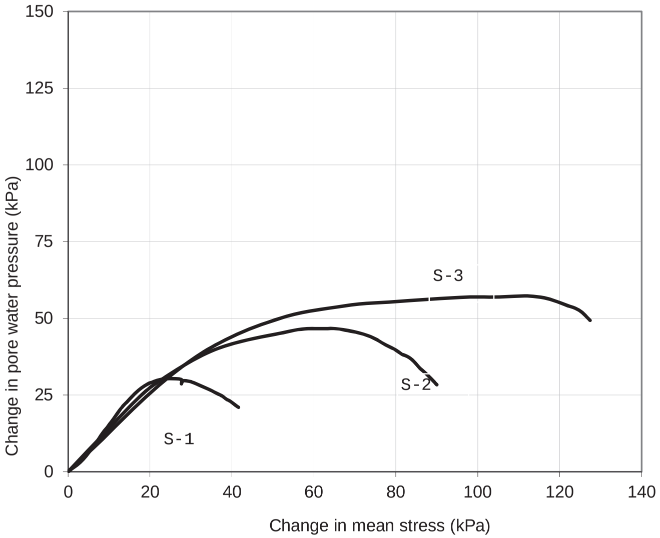


Figure 7 Change in pore water pressure vs change in mean stress

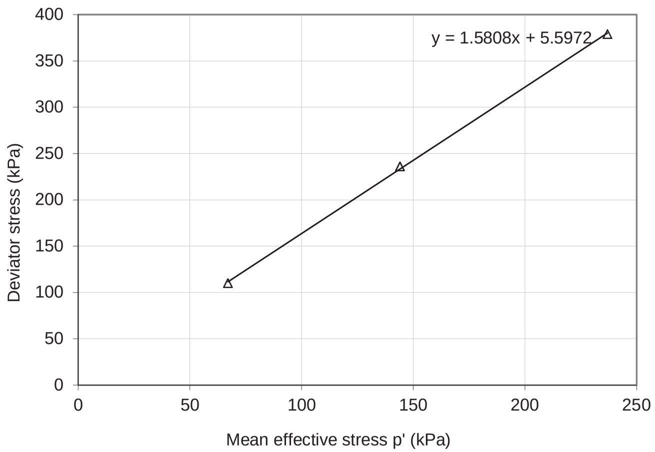


Figure 8 Deviator stress q vs mean effective stress at failure

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272	Size mm	100	
BH	TP31	Thickness mm	31.2	
Depth m	2m			
Our Ref	A		σ'_v kPa	
Soil type	Grey clayey sandy SILT cont gravel			
Rate of shearing mm/min		0.04	40	
<6mm removed			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	41	40	32
80	76	80	61
160	143	160	117

Loading 40 kPa	
Initial wet mass g	656
Bulk Density mg/m3	2103
Final wet mass g	660
Dry mass g	573
Initial water content %	14.5
Final water content %	15.2
Loading 80 kPa	
Initial wet mass g	678
Bulk Density mg/m3	2103
Final wet mass g	672
Dry mass g	586
Initial water content %	15.7
Final water content %	14.7
Loading 160 kPa	
Initial wet mass g	649
Bulk Density mg/m3	2103
Final wet mass g	645
Dry mass g	562
Initial water content %	15.5
Final water content %	14.8

Peak angle of internal friction	39
Cohesion	**7**
Ultimate angle of internal friction	36

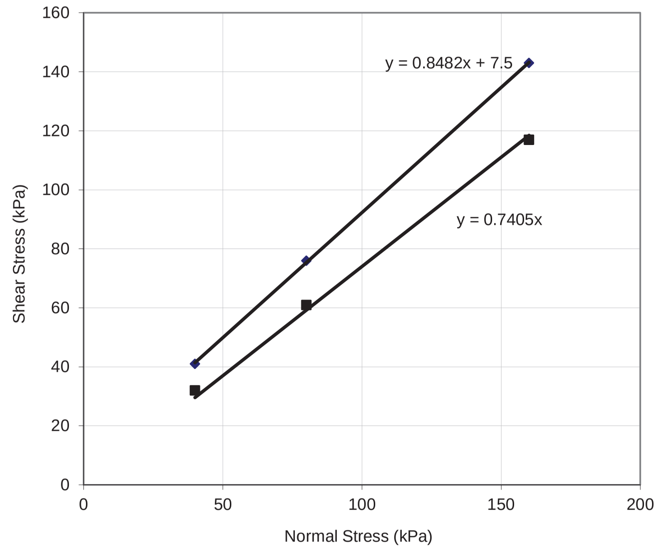


Figure 1 Failure Envelope

Shear Box Test

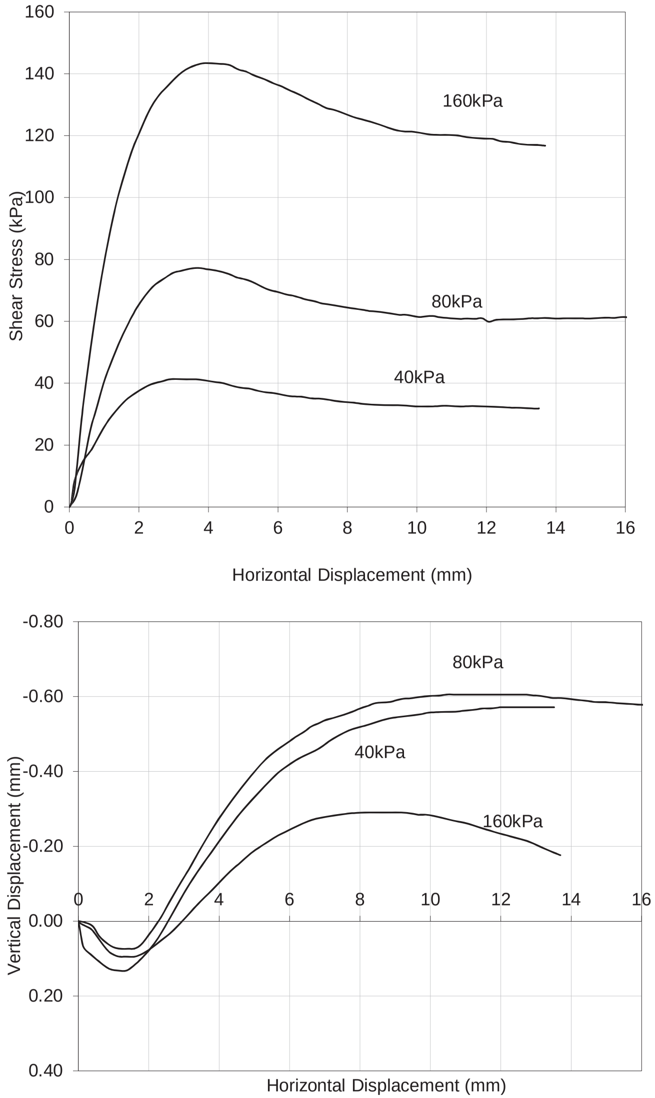


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

					Loading 40 kPa	
Ref:	15-272		Size mm	100	Initial wet mass g	590
BH	TP30		Thickness mm	33.3	Bulk Density mg/m3	1774
Depth m	2m					
Our Ref	M			σ'_v kPa		
Soil type	Brown gravelly SAND					
Rate of shearing mm/min			0.5	40		
>6mm removed				80		
				160		

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	32	40	31
80	65	80	53
160	133	160	132

Peak angle of internal friction	39
Cohesion	
Ultimate angle of internal friction	38

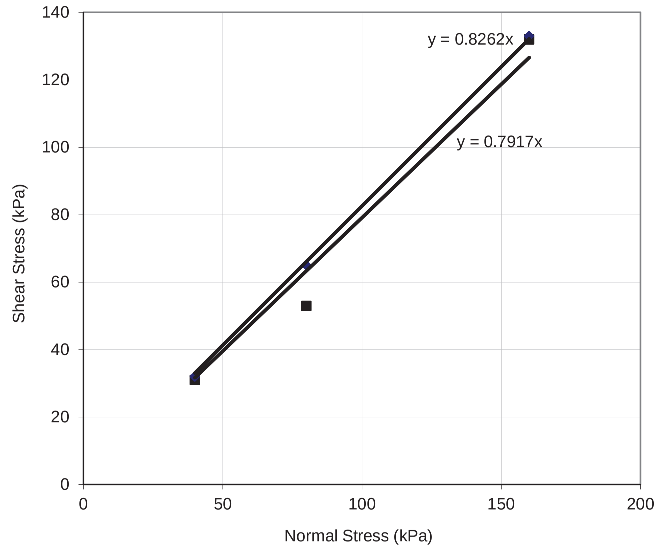


Figure 1 Failure Envelope

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

					Loading 40 kPa	
Ref:	15-272		Size mm	100	Initial wet mass g	592
BH	TP58		Thickness mm	31.8	Bulk Density mg/m3	1864
Depth m	1m					
Our Ref	L			σ'_v kPa		
Soil type	Grey Greavelly SAND					
Rate of shearing mm/min			0.5	40		
>6mm removed				80		
				160		

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	42	40	35
80	73	80	62
160	147	160	112

Peak angle of internal friction	42
Cohesion	
Ultimate angle of internal friction	35

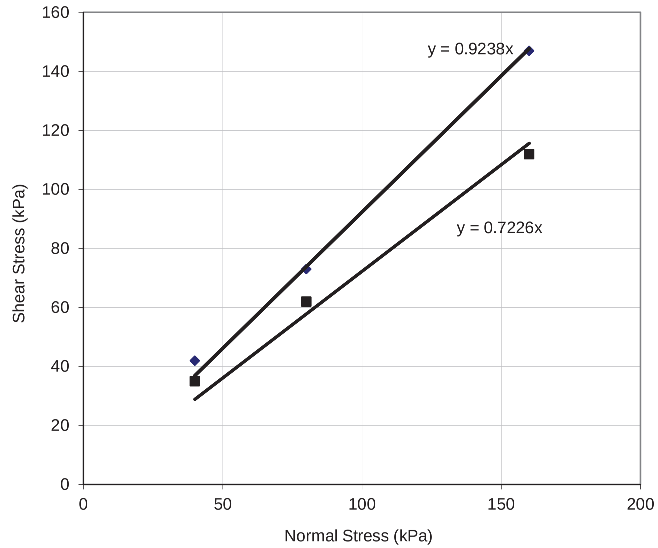


Figure 1 Failure Envelope

Shear Box Test

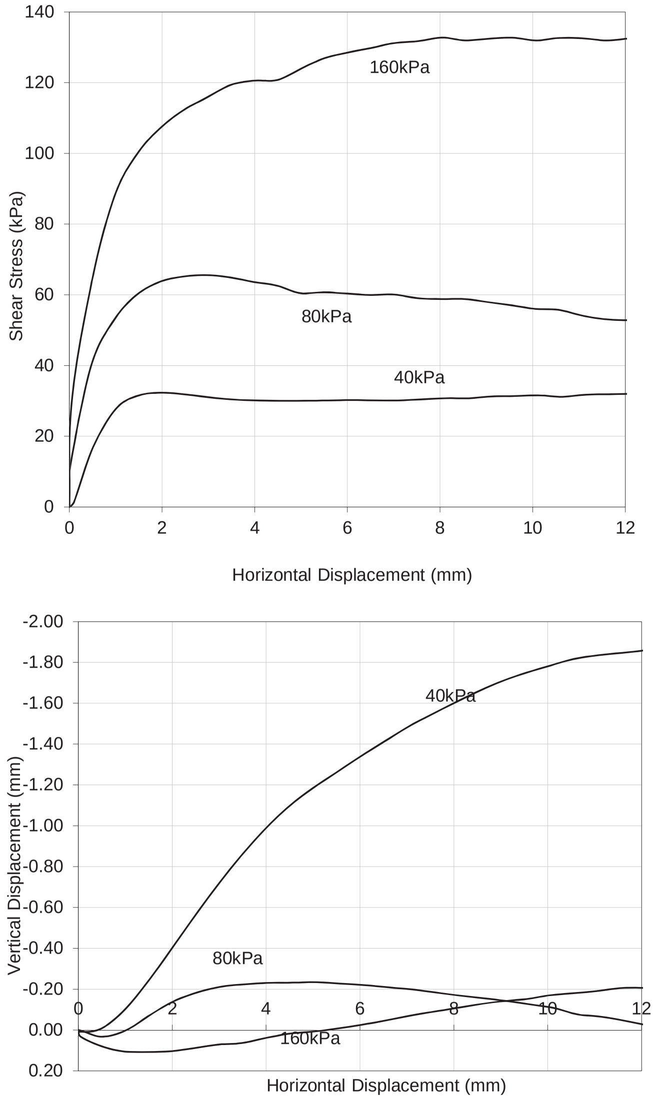


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test   Morrell River

Ref:	15-272		Size mm		100
BH	TP61		Thickness mm		33.8
Depth m	2m				
Our Ref	K			σ'_v kPa	
Soil type	Grey gravelly silty SAND				
Rate of shearing mm/min			0.04	40	
				80	
				160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	36
80		80	60
160		160	115

Loading 40 kPa	
Initial wet mass g	640
Bulk Density mg/m3	1936
Final wet mass g	626
Dry mass g	541
Initial water content %	18.3
Final water content %	15.7
Loading 80 kPa	
Initial wet mass g	658
Bulk Density mg/m3	1936
Final wet mass g	640
Dry mass g	528
Initial water content %	24.6
Final water content %	21.2
Loading 160 kPa	
Initial wet mass g	554
Bulk Density mg/m3	1936
Final wet mass g	562
Dry mass g	465
Initial water content %	19.1
Final water content %	20.9

Peak angle of internal friction
Cohesion
Ultimate angle of internal friction 36

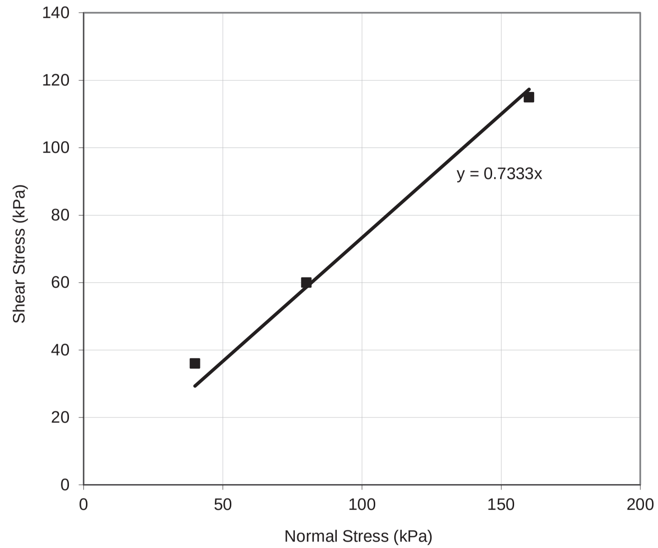


Figure 1 Failure Envelope

Shear Box Test

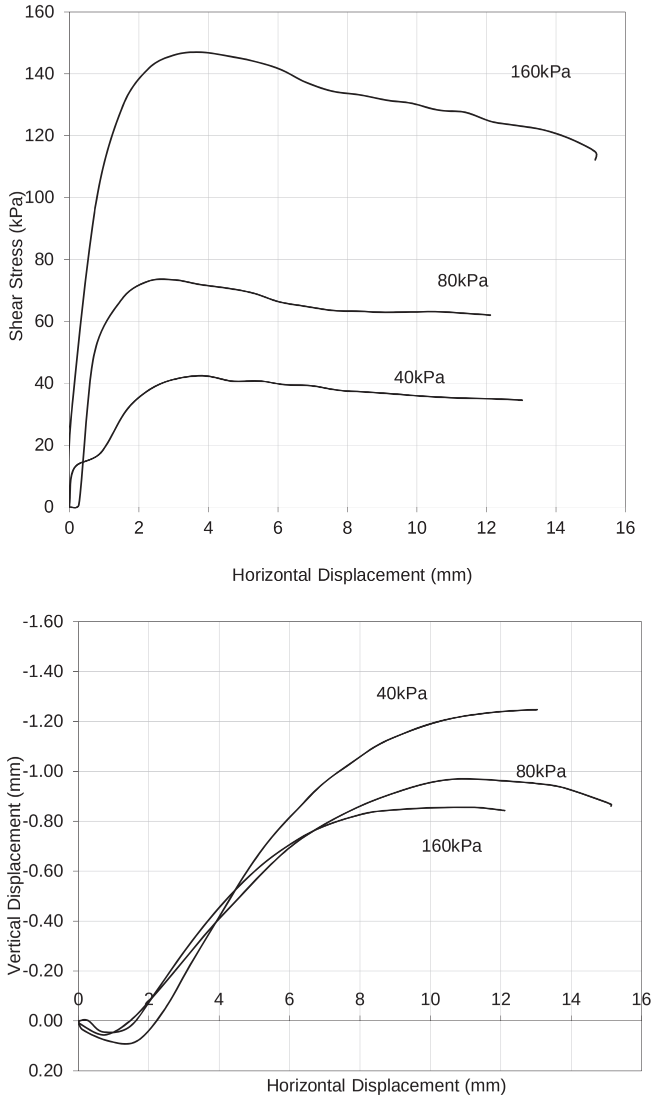


Figure 2 Stress-strain behaviour

Shear Box Test

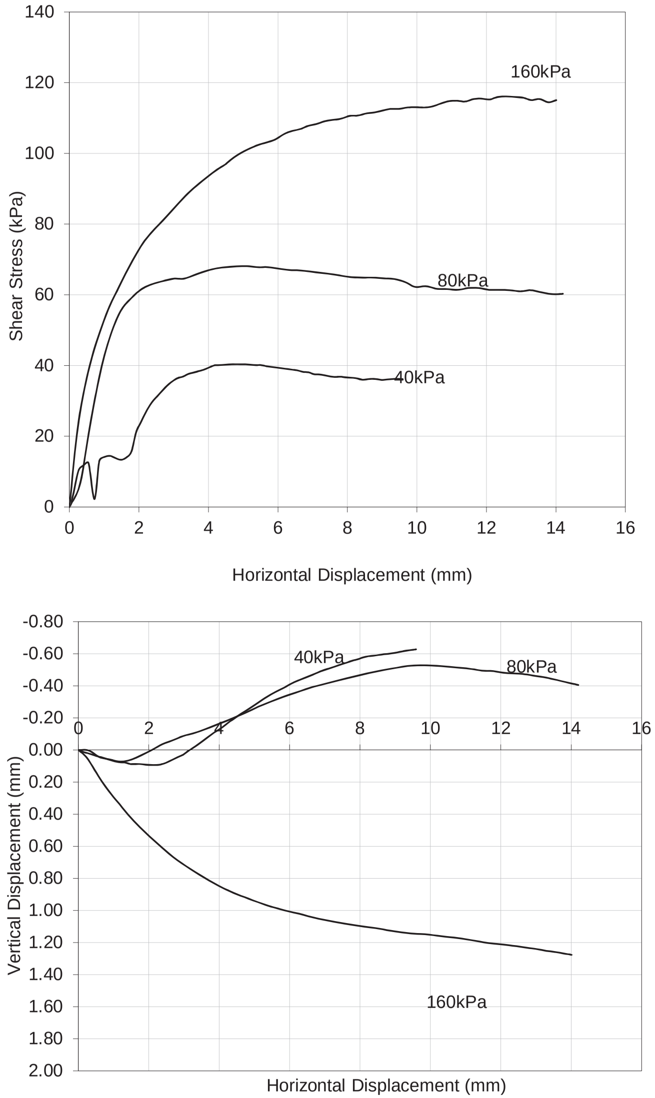


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP16		Thickness mm	33.8
Depth m	0.5m			
Our Ref	J			σ'_v kPa
Soil type	Brown sandy clayey SILT			
Rate of shearing mm/min			0.04	40
				80
				160

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	29
80		80	56
160		160	115

Loading 40 kPa	
Initial wet mass g	660
Bulk Density mg/m3	1956
Final wet mass g	633
Dry mass g	490
Initial water content %	34.7
Final water content %	29.2
Loading 80 kPa	
Initial wet mass g	660
Bulk Density mg/m3	1956
Final wet mass g	625
Dry mass g	507
Initial water content %	30.2
Final water content %	23.3
Loading 160 kPa	
Initial wet mass g	673
Bulk Density mg/m3	1956
Final wet mass g	640
Dry mass g	516
Initial water content %	30.4
Final water content %	24.0

Peak angle of internal friction	
Cohesion	
Ultimate angle of internal friction	35

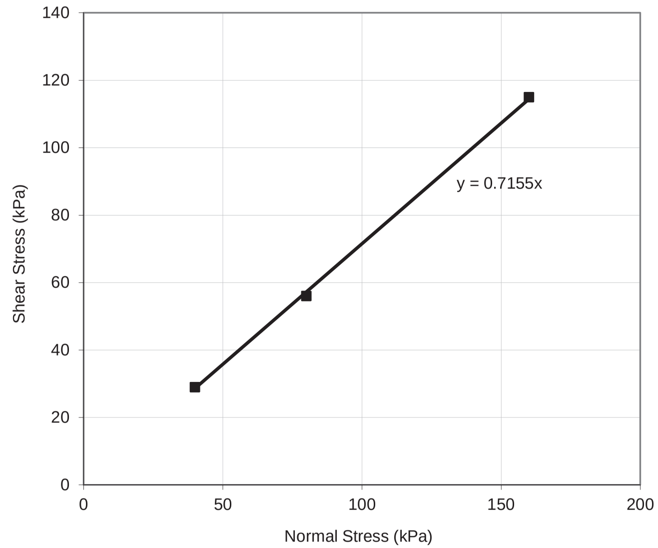


Figure 1 Failure Envelope

Shear Box Test

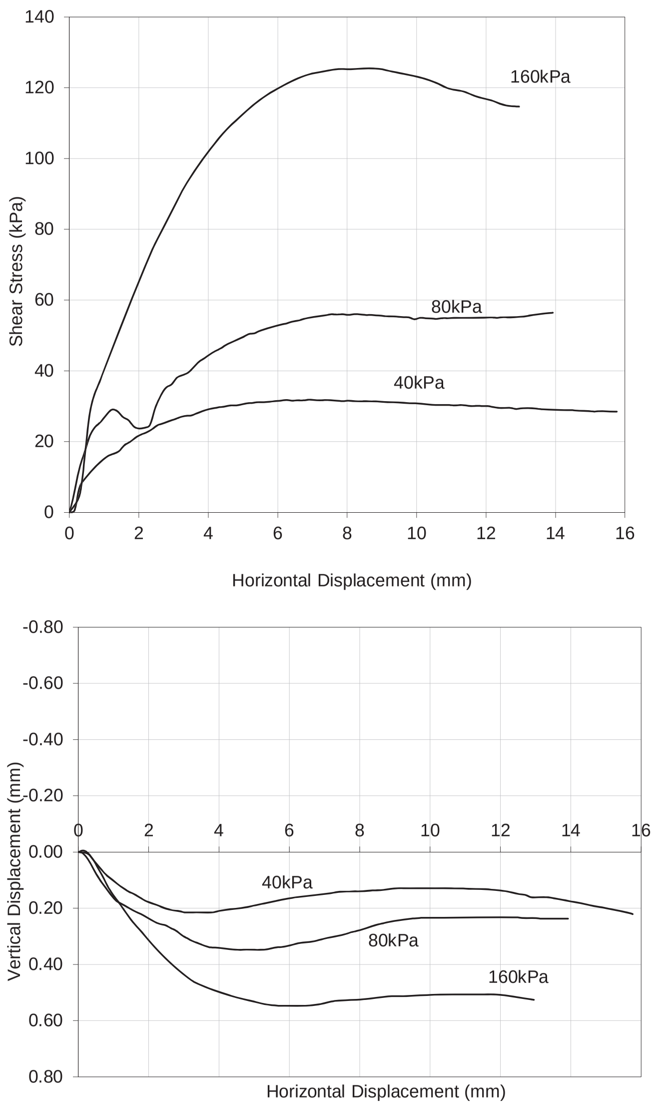


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP14		Thickness mm	32.8
Depth m	1.5m			
Our Ref	I		σ'_v kPa	
Soil type	Grey clayey silty SAND			
Rate of shearing mm/min		0.04	40	
			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	33
80		80	60
160		160	120

Loading 40 kPa	
Initial wet mass g	634
Bulk Density mg/m3	1936
Final wet mass g	642
Dry mass g	533
Initial water content %	18.9
Final water content %	20.5
Loading 80 kPa	
Initial wet mass g	619
Bulk Density mg/m3	1936
Final wet mass g	626
Dry mass g	521
Initial water content %	18.8
Final water content %	20.2
Loading 160 kPa	
Initial wet mass g	659
Bulk Density mg/m3	1936
Final wet mass g	651
Dry mass g	545
Initial water content %	20.9
Final water content %	19.4

Peak angle of internal friction	
Cohesion	
Ultimate angle of internal friction	36

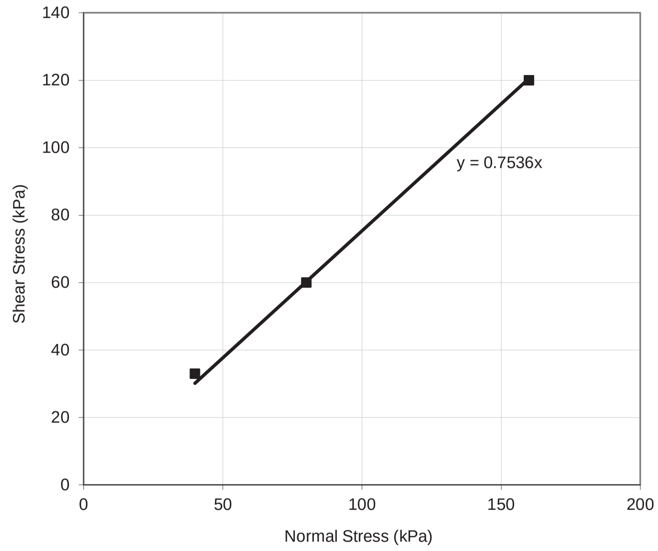


Figure 1 Failure Envelope

Shear Box Test

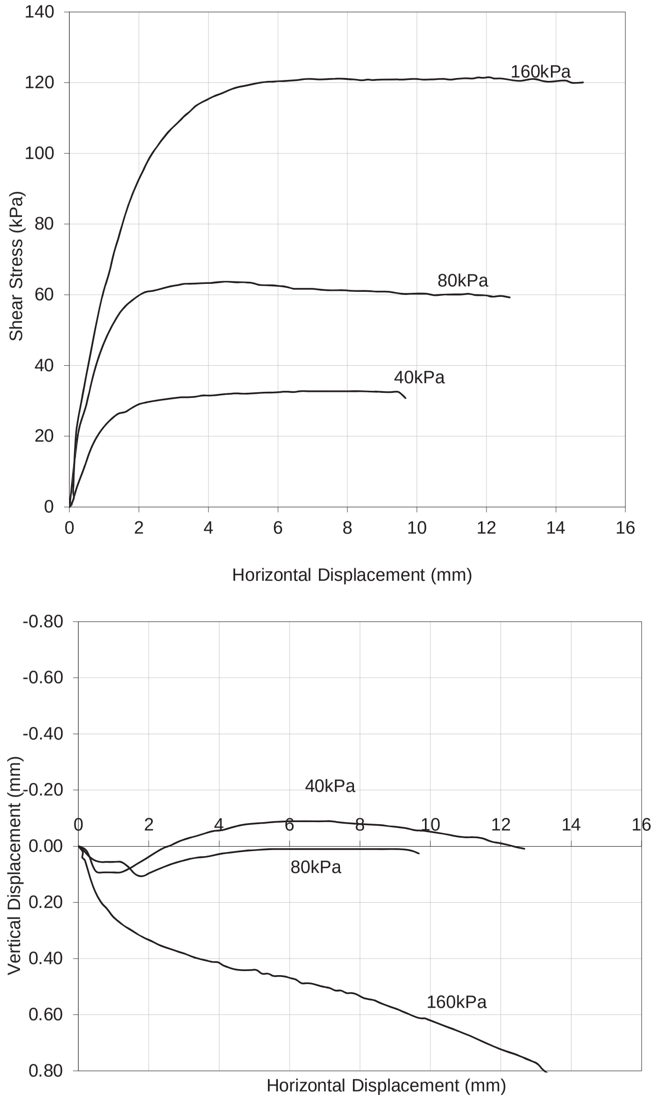


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

				Loading 40 kPa	
Ref:	15-272	Size mm	100	Initial wet mass g	636
BH	TP40	Thickness mm	33.8	Bulk Density mg/m3	1884
Depth m	1m				
Our Ref	H				
Soil type	Gravelly sity SAND				

		σ'$_v$ kPa
Rate of shearing mm/min	0.5	40
>6mm removed		80
		160

Peak		Ultimate	
σ'$_n$ kPa	τ kPa	σ'$_n$ kPa	τ kPa
40	32	40	31
80	65	80	65
160	128	160	124

Peak angle of internal friction
Cohesion
Ultimate angle of internal friction 38

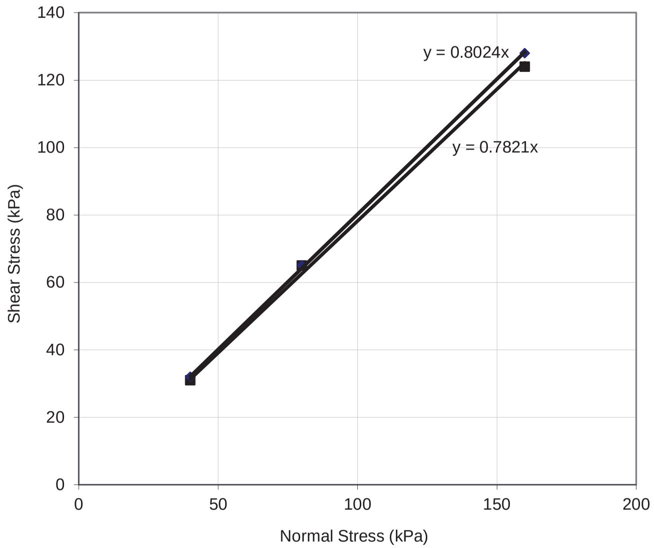


Figure 1 Failure Envelope

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100
BH	TP03		Thickness mm	32.3
Depth m	1m			
Our Ref	G		σ'_v kPa	
Soil type	Grey gravelly sandy SILT			
Rate of shearing mm/min		0.04	40	
>6mm removed			80	
			160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	31
80		80	59
160		160	108

Loading 40 kPa	
Initial wet mass g	597
Bulk Density mg/m3	1936
Final wet mass g	608
Dry mass g	517
Initial water content %	15.5
Final water content %	17.6
Loading 80 kPa	
Initial wet mass g	599
Bulk Density mg/m3	1936
Final wet mass g	606
Dry mass g	525
Initial water content %	14.1
Final water content %	15.4
Loading 160 kPa	
Initial wet mass g	607
Bulk Density mg/m3	1936
Final wet mass g	620
Dry mass g	512
Initial water content %	18.6
Final water content %	21.1

Peak angle of internal friction	
Cohesion	
Ultimate angle of internal friction	34

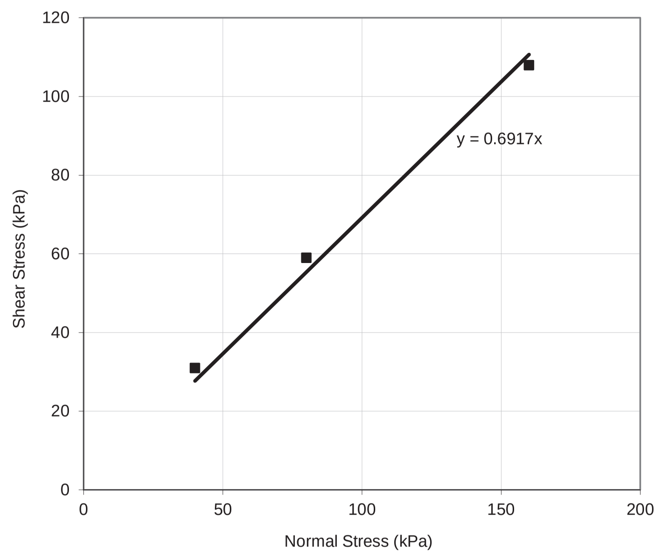


Figure 1 Failure Envelope

Shear Box Test

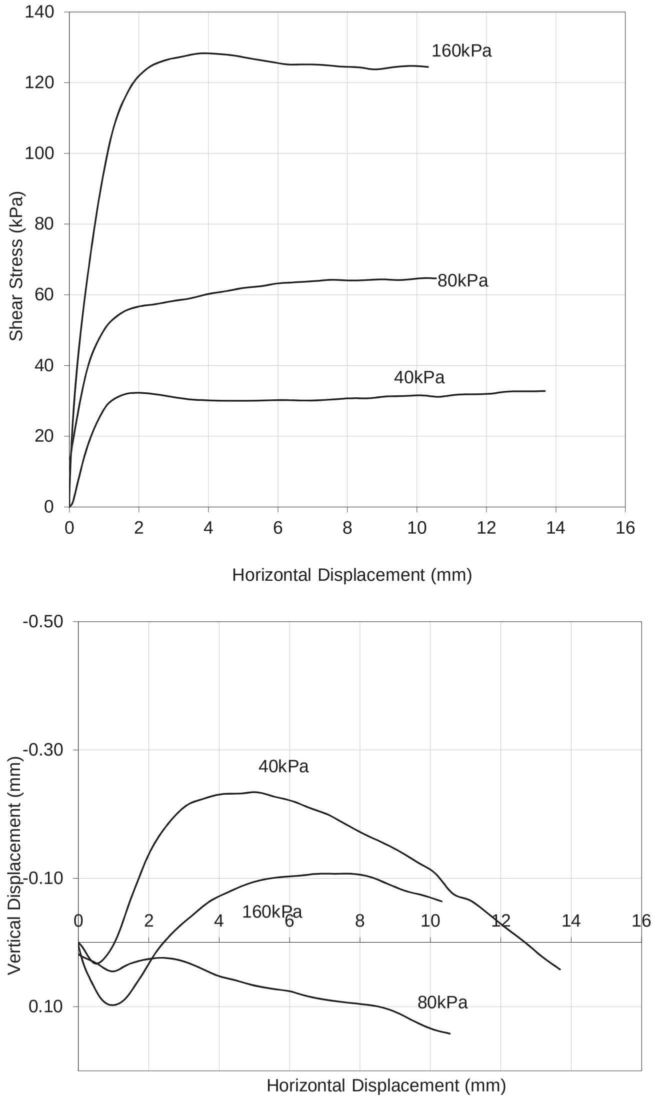


Figure 2 Stress-strain behaviour

Shear Box Test

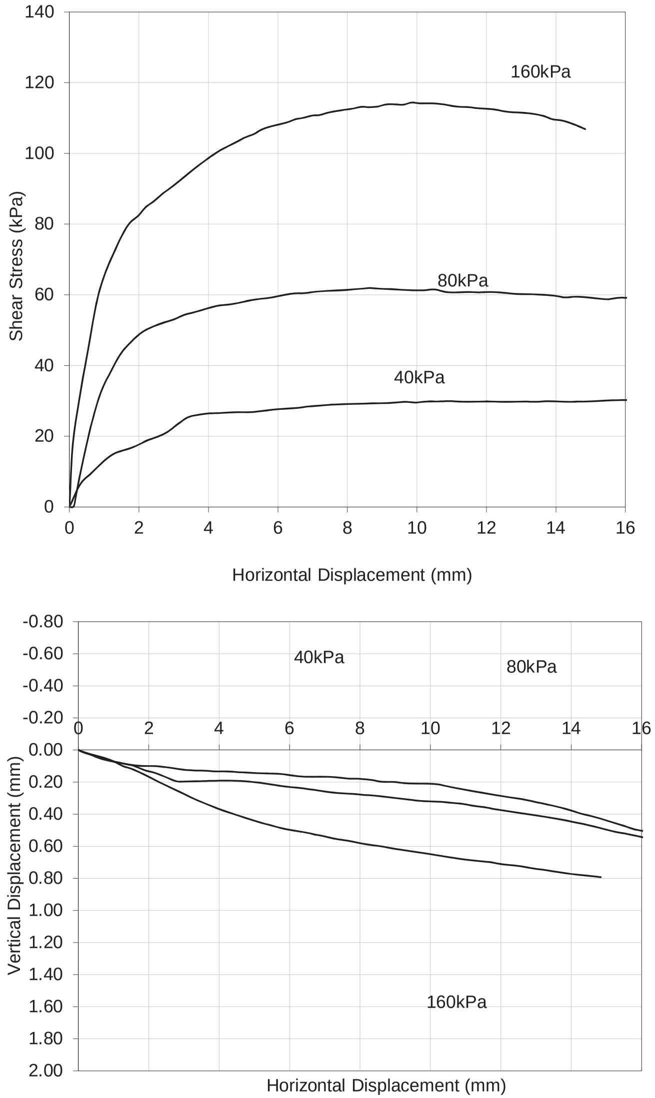


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test   Morrell River

Ref:	15-272		Size mm	100
BH	TP47		Thickness mm	30.2
Depth m	1.5m			
Our Ref	F			σ'$_v$ kPa
Soil type	Grey gravelly sandy clayey SILT			
Rate of shearing mm/min			0.04	40
<6mm removed				80
				160

Peak		Ultimate	
σ'$_n$ kPa	τ kPa	σ'$_n$ kPa	τ kPa
40		40	30
80		80	55
160		160	121

Loading 40 kPa	
Initial wet mass g	625
Bulk Density mg/m3	2070
Final wet mass g	650
Dry mass g	549
Initial water content %	13.8
Final water content %	18.4
Loading 80 kPa	
Initial wet mass g	631
Bulk Density mg/m3	2070
Final wet mass g	623
Dry mass g	566
Initial water content %	11.5
Final water content %	10.1
Loading 160 kPa	
Initial wet mass g	671
Bulk Density mg/m3	2070
Final wet mass g	635
Dry mass g	589
Initial water content %	13.9
Final water content %	7.8

Peak angle of internal friction	
Cohesion	
Ultimate angle of internal friction	36

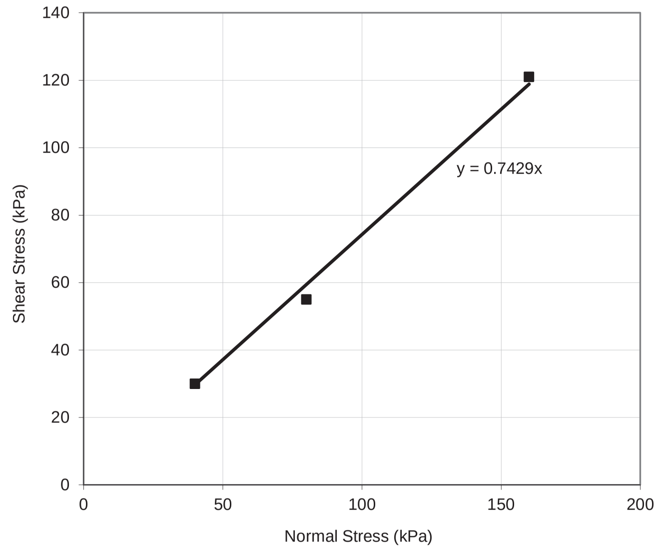


Figure 1 Failure Envelope

QUB — Geotechnical Testing Laboratory

Shear Box Test Morrell River

			Loading 40 kPa	
Ref:	15-272	Size mm	100	Initial wet mass g	629
BH	TP60	Thickness mm	33.8	Bulk Density mg/m3	1865
Depth m	1.2m				
Our Ref	E				
Soil type	Grey Greavelly SAND				

		σ'_v kPa
Rate of shearing mm/min	0.5	40
>6mm removed		80
		160

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40	39	40	34
80	79	80	71
160	134	160	122

Peak angle of internal friction 41
Cohesion
Ultimate angle of internal friction 38

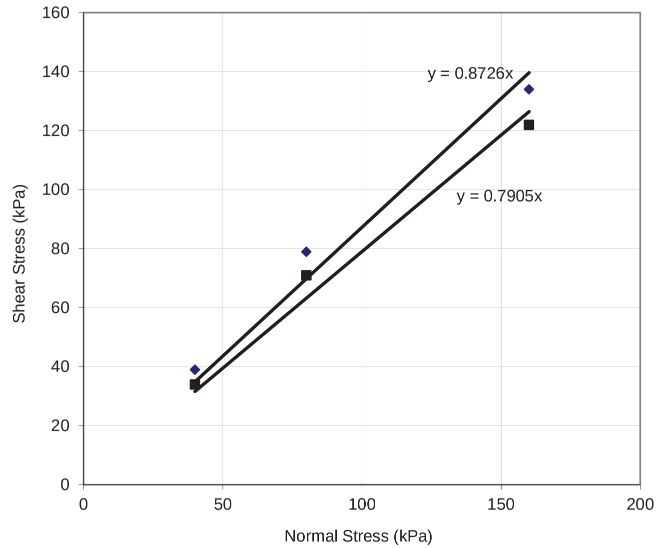
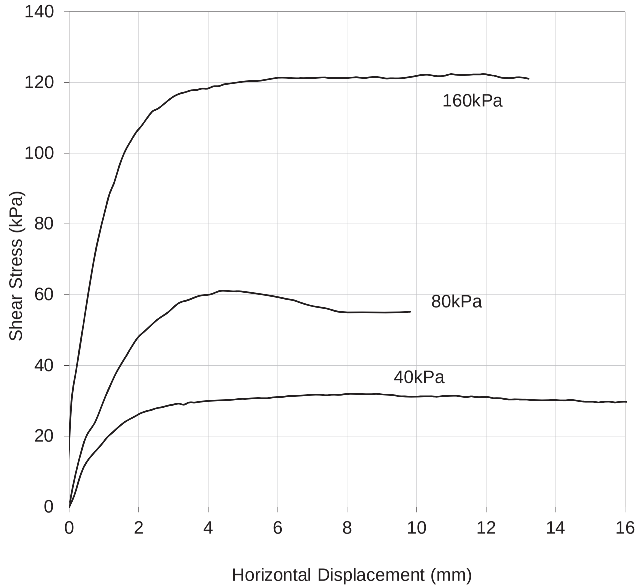


Figure 1 Failure Envelope

Shear Box Test



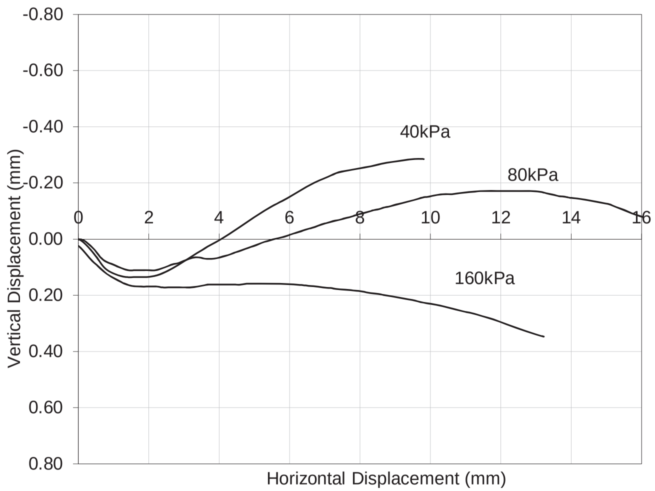


Figure 2 Stress-strain behaviour

Shear Box Test

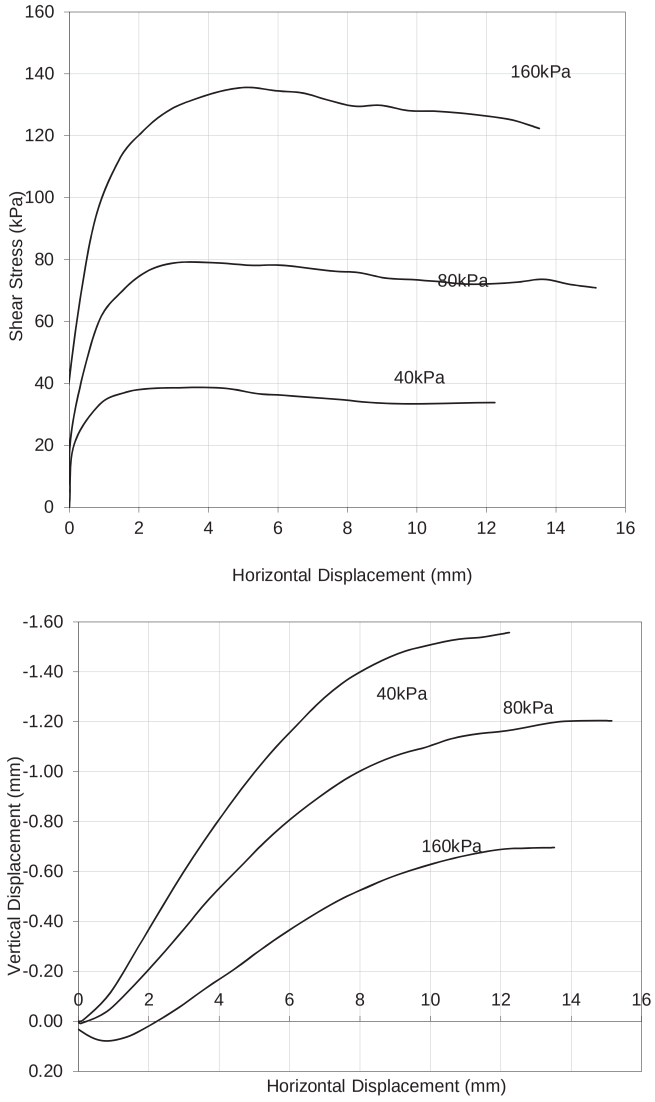


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm		100
BH	TP45		Thickness mm		36.3
Depth m	1.8m				
Our Ref	D		σ'_v kPa		
Soil type	Grey clayey silty sandy gravel				
Rate of shearing mm/min		0.04	40		
<6mm removed			80		
			160		

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	40
80		80	62
160		160	121

Loading 40 kPa	
Initial wet mass g	781
Bulk Density mg/m3	2152
Final wet mass g	772
Dry mass g	673
Initial water content %	16.0
Final water content %	14.7
Loading 80 kPa	
Initial wet mass g	731
Bulk Density mg/m3	2152
Final wet mass g	713
Dry mass g	624
Initial water content %	17.1
Final water content %	14.3
Loading 160 kPa	
Initial wet mass g	758
Bulk Density mg/m3	2152
Final wet mass g	741
Dry mass g	646
Initial water content %	17.3
Final water content %	14.7

Peak angle of internal friction
Cohesion
Ultimate angle of internal friction 37

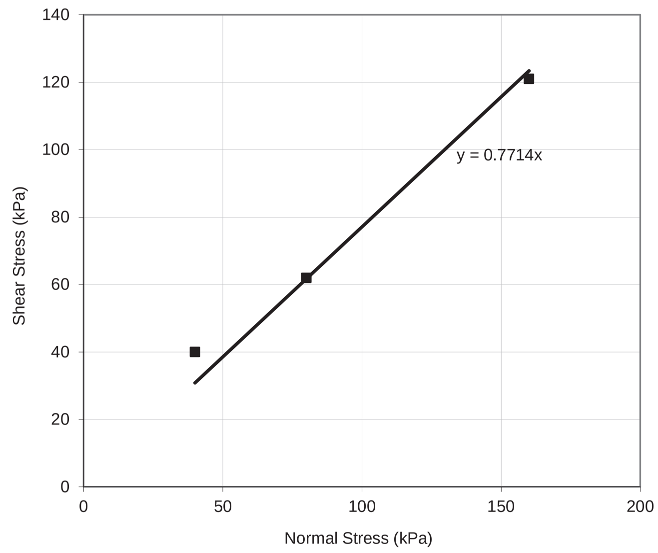


Figure 1 Failure Envelope

Shear Box Test

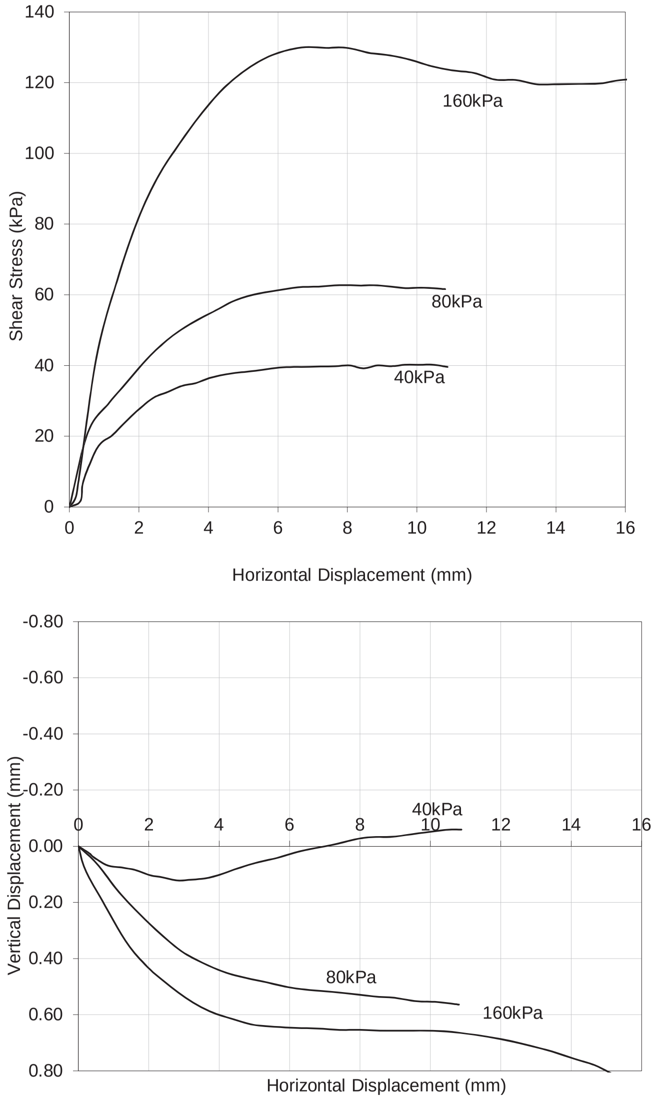


Figure 2 Stress-strain behaviour

QUB	Geotechnical Testing Laboratory

Shear Box Test Morrell River

Ref:	15-272		Size mm	100	
BH	TP01		Thickness mm	30.2	
Depth m	0.5m				
Our Ref	C			σ'_v kPa	
Soil type	Grey garavelly sity SAND				
Rate of shearing mm/min			0.04	40	
<6mm removed				80	
				160	

Peak		Ultimate	
σ'_n kPa	τ kPa	σ'_n kPa	τ kPa
40		40	34
80		80	61
160		160	120

Loading 40 kPa	
Initial wet mass g	545
Bulk Density mg/m3	1805
Final wet mass g	566
Dry mass g	482
Initial water content %	13.1
Final water content %	17.4
Loading 80 kPa	
Initial wet mass g	619
Bulk Density mg/m3	1805
Final wet mass g	642
Dry mass g	547
Initial water content %	13.2
Final water content %	17.4
Loading 160 kPa	
Initial wet mass g	585
Bulk Density mg/m3	1805
Final wet mass g	600
Dry mass g	518
Initial water content %	12.9
Final water content %	15.8

Peak angle of internal friction	
Cohesion	
Ultimate angle of internal friction	36

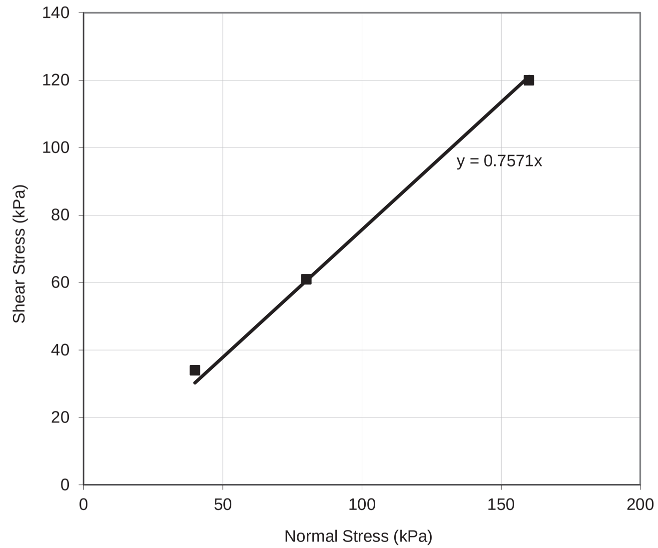


Figure 1 Failure Envelope

Shear Box Test

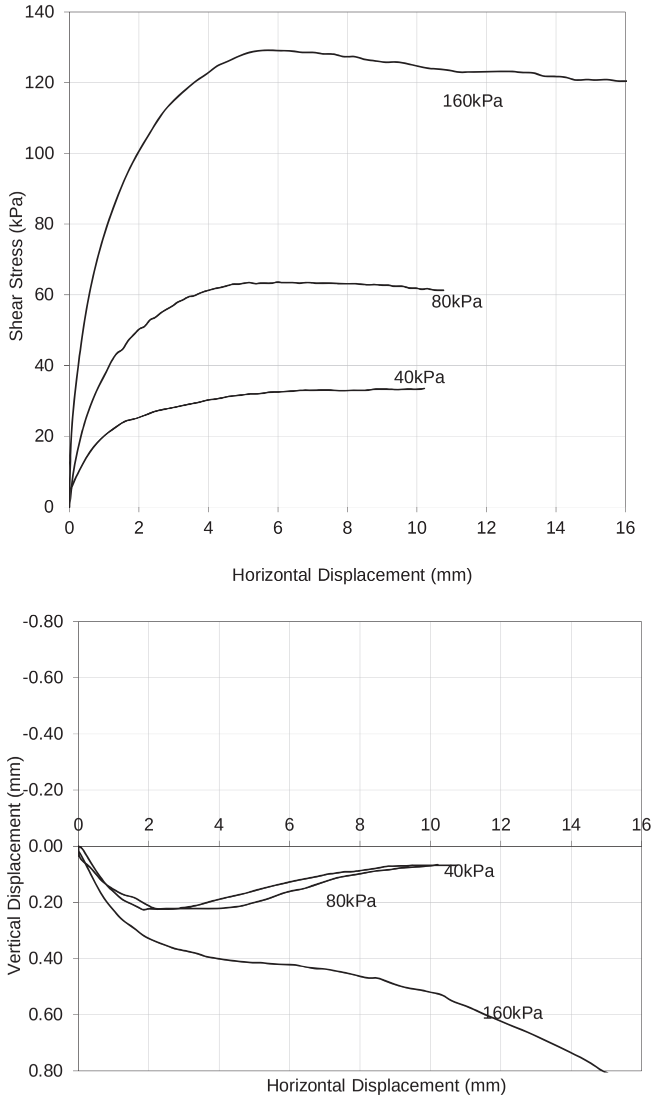


Figure 2 Stress-strain behaviour

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Chemtest Ltd.
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Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

Final Report

Report Number:	15-18967 Issue-1		
Initial Date of Issue:	21-Aug-2015		
Client:	Causeway Geotech Ltd		
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL		
Contact(s):	Darren O'Mahony Matthew Gilbert Paul Dunlop Stephen Franey Stephen Watson		
Project:	15-272 Morrell River Flood Alleviation		
Quotation No.:		**Date Received:**	18-Aug-2015
Order No.:		**Date Instructed:**	18-Aug-2015
No. of Samples:	25	**Target Due Date:**	20-Aug-2015
Turnaround: (Wkdays)	5	**Results Due Date:**	24-Aug-2015
Date Approved:	21-Aug-2015		
Approved By:			
Details:	Keith Jones, Technical Manager		

Results Summary - Soil

Project: 15-272 Morrell River Flood Alleviation

Client: Causeway Geotech Ltd				Chemtest Job No.:	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967
Quotation No.:				**Chemtest Sample ID.:**	180134	180135	180136	180137	180138	180139	180140	180141	180142	180143
Order No.:				Client Sample Ref.:	B	D	B	B	B	B	B	B	B	B
				Client Sample ID.:	BH01	BH01	BH02	BH02	BH02	BH04	BH04	BH05	BH05	BH05
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	0.20	6.00	0.20	1.00	6.00	4.00	7.50	1.00	4.00	6.00
				Bottom Depth(m):										
				Date Sampled:	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Moisture	N	2030	%	0.02	22	16	9.8	9.4	8.5	10	10	19	5.7	10
pH	U	2010			8.2	8.4	8.6	8.8	8.7	8.6	8.5	8.4	8.8	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01	0.015	0.019	< 0.010	< 0.010	0.037	0.11	0.035	< 0.010	0.038	0.075
Organic Matter	U	2625	%	0.4	5.3		0.79							

Results Summary - Soil

Project: 15-272 Morrell River Flood Alleviation

Client: Causeway Geotech Ltd				Chemtest Job No.:	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967	15-18967
Quotation No.:				**Chemtest Sample ID.:**	180144	180145	180146	180147	180148	180149	180150	180151	180152	180153
Order No.:				Client Sample Ref.:	B	B	B	B	B	B	B	B	B	B
				Client Sample ID.:	BH06	BH06	BH06	TP06	TP14	TP15	TP17	TP18	TP24	TP32
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	1.00	4.00	8.00	2.00	2.50	2.80	0.30	3.00	1.50	0.50
				Bottom Depth(m):										
				Date Sampled:	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Moisture	N	2030	%	0.02	5.2	10	7.4	12	6.3	6.4	17	11	18	10
pH	U	2010			8.8	8.4	8.5	8.4	9.1	8.8	8.5	8.3	8.4	8.3
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01	0.041	0.054	0.068	0.019	< 0.010	< 0.010	< 0.010	0.023	0.079	< 0.010
Organic Matter	U	2625	%	0.4						< 0.40		0.74		

Results Summary - Soil

Project: 15-272 Morrell River Flood Alleviation

Client: Causeway Geotech Ltd				**Chemtest Job No.:**	15-18967	15-18967	15-18967	15-18967	15-18967
Quotation No.:				**Chemtest Sample ID.:**	180154	180155	180156	180157	180158
Order No.:				Client Sample Ref.:	B	B	B	B	B
				Client Sample ID.:	TP37	TP46	TP56	TP63	TP72
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	1.00	1.50	1.50	1.50	4.00
				Bottom Depth(m):					
				Date Sampled:	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15	17-Aug-15
Determinand	**Accred.**	**SOP**	**Units**	**LOD**					
Moisture	N	2030	%	0.02	< 0.020	13	10	6.0	7.1
pH	U	2010			9.1	8.1	8.8	8.7	8.7
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.01	< 0.010	0.41	0.069	< 0.010	0.015
Organic Matter	U	2625	%	0.4					

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

Appendix G
SPT hammer energy measurement report

SPT Calibration Report

www.equipegroup.com

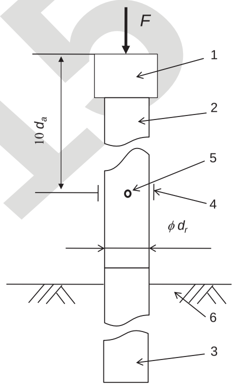
Hammer Energy Measurement Report

Type of Hammer	SPT HAMMER
Client	CAUSEWAY DRILLING
Test No	EQU1178
Test Depth (m)	6.50
Date of Test	10 January 2015
Valid until	10 January 2016
Hammer ID	SPT1

Mass of the hammer	m =	63.5kg
Falling height	h =	0.76m
E_{theor} =	$m \times g \times h$ =	473J

Characteristics of the instrumented rod

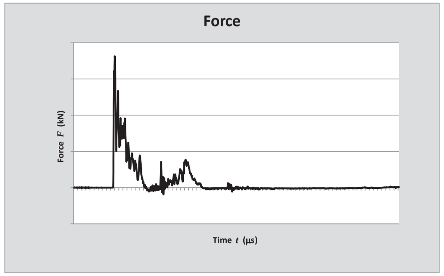
Diameter	d_r =	0.052 m
Length of the instrumented rod		0.558 m
Area	A =	11.61 cm^2
Modulus	E_a =	206843 MPa

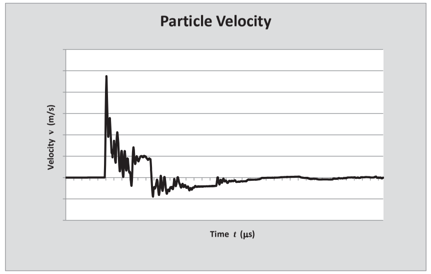


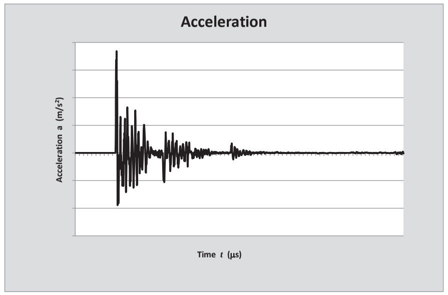
Key
1 Anvil
2 Part of instrumented rod
3 Drive Rod
4 Strain Gauge
5 Accelerometer
6 Ground

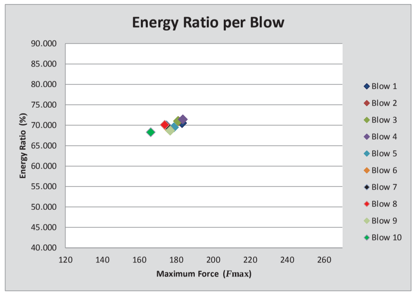
F Force
d_r Diameter of rod

Fig. B.1 and B.2 BS EN ISO 22476-3 : 2005 + A1 : 2011









Observations:
1.

E_{meas} = 0.330 kN-m

E_{theor} = 0.473 kN-m

Energy Ratio (E_r) = $\frac{E_{meas}}{E_{theor}}$ = 69.71%

Equipe SPT Analyzer Operators: MH

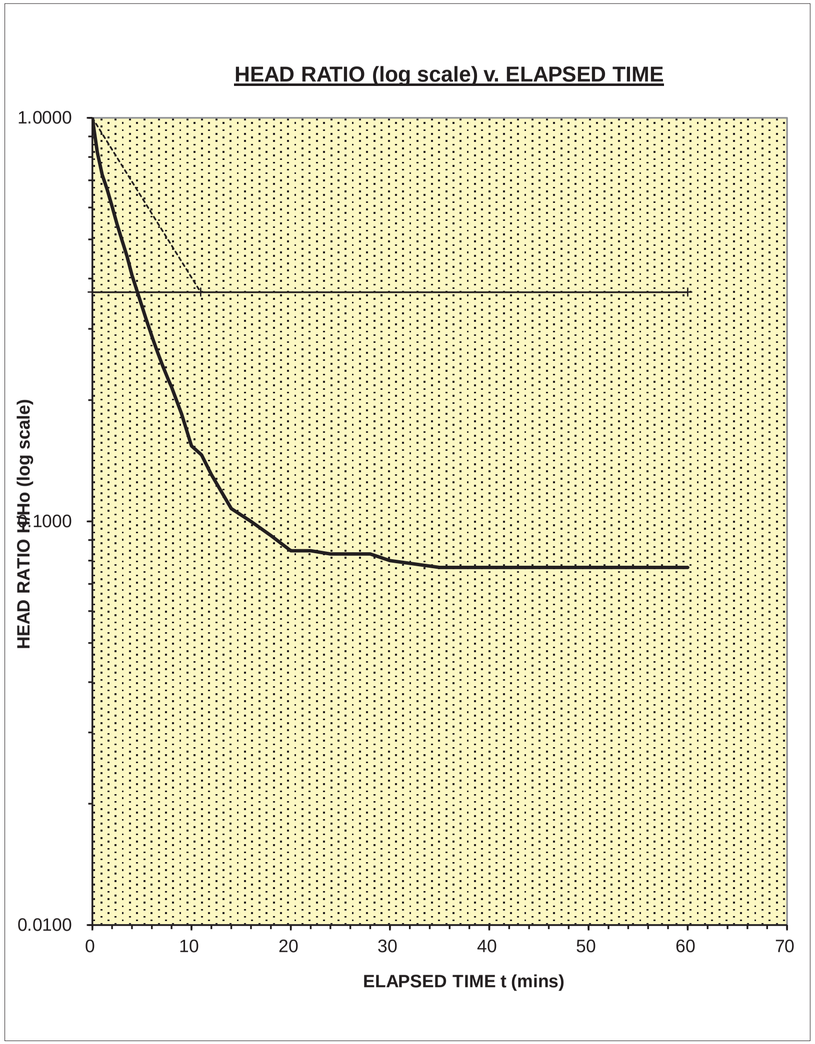
Prepared by:	[signature]	**Checked by:**		**Date**	10/06/2015

 Equipe Group, The Paddocks, Home Farm Offices, The Upton Estate, Banbury, Oxfordshire, OX15 6HU
Tel: 01295 670990 Fax: 01295 678232 Email: info@equipegroup.com

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: *FALLING* **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT01 **TEST #:** 1
DATE: 12-Nov-15



Basic Time Lag Factor T = 10.93 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT01 TEST No.: 1

DATE: 12-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D): *125* (mm)

Height of TOP of casing above ground level: *0.60* (m)

Depth to bottom of casing below ground level (m): *1.00* (m) (Withdrawn to impervious layer)

Depth to bottom of borehole below ground level before test: *1.50* (m)

Depth to bottom of borehole below ground level after test: *1.50* (m)

Standing ground water level (mbgl): *0.70* (m) on 12-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.30 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	1.3	1.0000
0.5	0.23	1.07	0.8231
1	0.36	0.94	0.7231
1.5	0.435	0.865	0.6654
2	0.515	0.785	0.6038
2.5	0.59	0.71	0.5462
3	0.655	0.645	0.4962
3.5	0.71	0.59	0.4538
4	0.77	0.53	0.4077
4.5	0.815	0.485	0.3731
5	0.855	0.445	0.3423
6	0.925	0.375	0.2885
7	0.98	0.32	0.2462
8	1.02	0.28	0.2154
9	1.06	0.24	0.1846
10	1.1	0.2	0.1538
11	1.11	0.19	0.1462
12	1.13	0.17	0.1308
14	1.16	0.14	0.1077
16	1.17	0.13	0.1000
18	1.18	0.12	0.0923
20	1.19	0.11	0.0846
22	1.19	0.11	0.0846
24	1.192	0.108	0.0831
26	1.192	0.108	0.0831
28	1.192	0.108	0.0831
30	1.196	0.104	0.0800
35	1.2	0.1	0.0769
40	1.2	0.1	0.0769
45	1.2	0.1	0.0769
50	1.2	0.1	0.0769
55	1.2	0.1	0.0769
60	1.2	0.1	0.0769

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT

where:

k is the permeability of soil

A is the cross-section area of borehole casing

F is the intake factor (see below)

T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:

F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]

i.e. F = 1.4998 (m)

and A = 0.0123 (m^2)

and T = *10.93* (mins);

(by best fitting and extraoplation of log H/Ho v Time data)

hence, k = 1.2E-05 m/s

i.e., k = 1.2 x10^{-5} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT02 TEST No.: 1

DATE: 5-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D): *125* (mm)

Height of TOP of casing above ground level: *0.00* (m)

Depth to bottom of casing below ground level (m): *0.50* (m) (Withdrawn to impervious layer)

Depth to bottom of borehole below ground level before test: *4.00* (m)

Depth to bottom of borehole below ground level after test: *1.60* (m)

Standing ground water level (mbgl): *1.50* (m) on 5-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.50 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.53	0.97	1.0000
0.5	1	0.5	0.5155
1	1.22	0.28	0.2887
1.5	1.29	0.21	0.2165
2	1.33	0.17	0.1753
2.5	1.34	0.16	0.1649
3	1.35	0.15	0.1546
3.5	1.36	0.14	0.1443
4	1.37	0.13	0.1340
4.5	1.38	0.12	0.1237
5	1.4	0.1	0.1031
6	1.44	0.06	0.0619
7	1.48	0.02	0.0206
8	1.48	0.02	0.0206
9	1.48	0.02	0.0206
10	1.48	0.02	0.0206
12	1.48	0.02	0.0206
14	1.48	0.02	0.0206
16	1.48	0.02	0.0206
18	1.48	0.02	0.0206
20	1.48	0.02	0.0206

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT

where:

k is the permeability of soil

A is the cross-section area of borehole casing

F is the intake factor (see below)

T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** , hence:

F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]

i.e. F = 5.4627 (m)

and A = 0.0123 (m^2)

and T = *3.39* (mins);

(by best fitting and extraoplation of log H/Ho v Time data)

hence, k = 1.1E-05 m/s

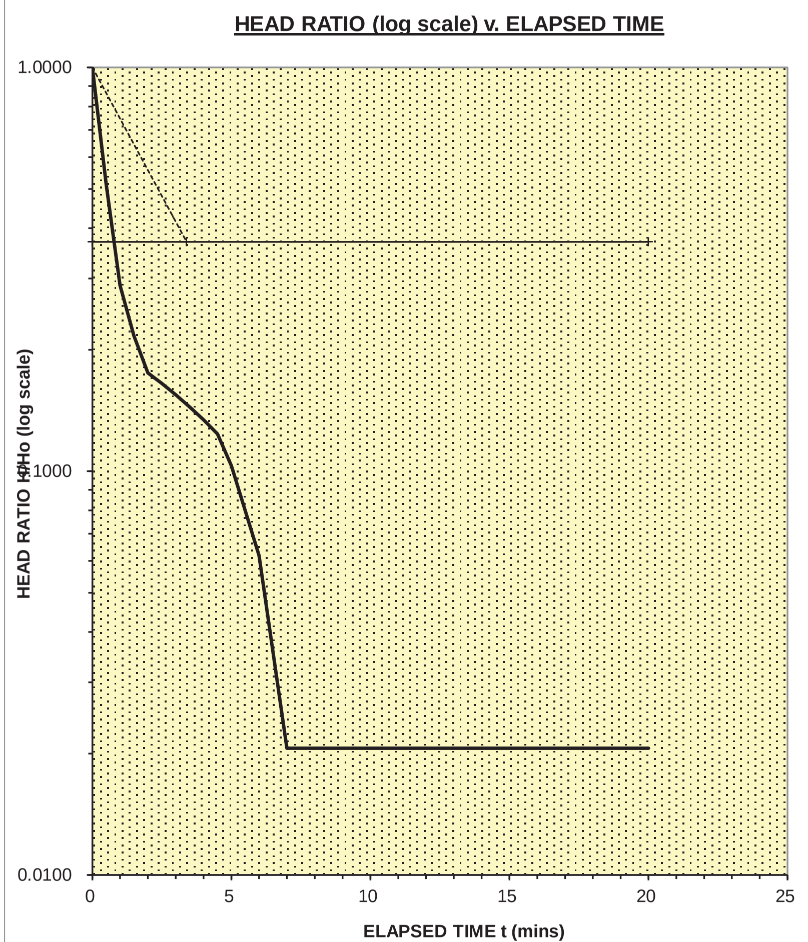
i.e., k = 1.1 x10^{-5} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT02 **TEST #:** 1
DATE: 5-Nov-15



Basic Time Lag Factor T = 3.39 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT03 TEST No.: 1
DATE: 5-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D):	*150* (mm)	
Height of TOP of casing above ground level:	*0.00* (m)	
Depth to bottom of casing below ground level (m):	*0.20* (m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*3.30* (m)	
Depth to bottom of borehole below ground level after test:	*3.30* (m)	
Standing ground water level (mbgl):	*1.60* (m)	on 5-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.60 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	1.6	1.0000
0.5	0.31	1.29	0.8063
1	0.52	1.08	0.6750
1.5	0.71	0.89	0.5563
2	0.87	0.73	0.4563
2.5	0.92	0.68	0.4250
3	1	0.6	0.3750
3.5	1.08	0.52	0.3250
4	1.18	0.42	0.2625
4.5	1.25	0.35	0.2188
5	1.3	0.3	0.1875
6	1.37	0.23	0.1438
7	1.39	0.21	0.1313
8	1.41	0.19	0.1188
9	1.43	0.17	0.1063
10	1.45	0.15	0.0938
12	1.49	0.11	0.0688
14	1.54	0.06	0.0375
16	1.57	0.03	0.0188
18	1.6	0	0.0000
20	1.6	0	0.0000

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 5.2328 (m)
and A = 0.0177 (m^2)
and T = *3.89* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.4E-05 m/s

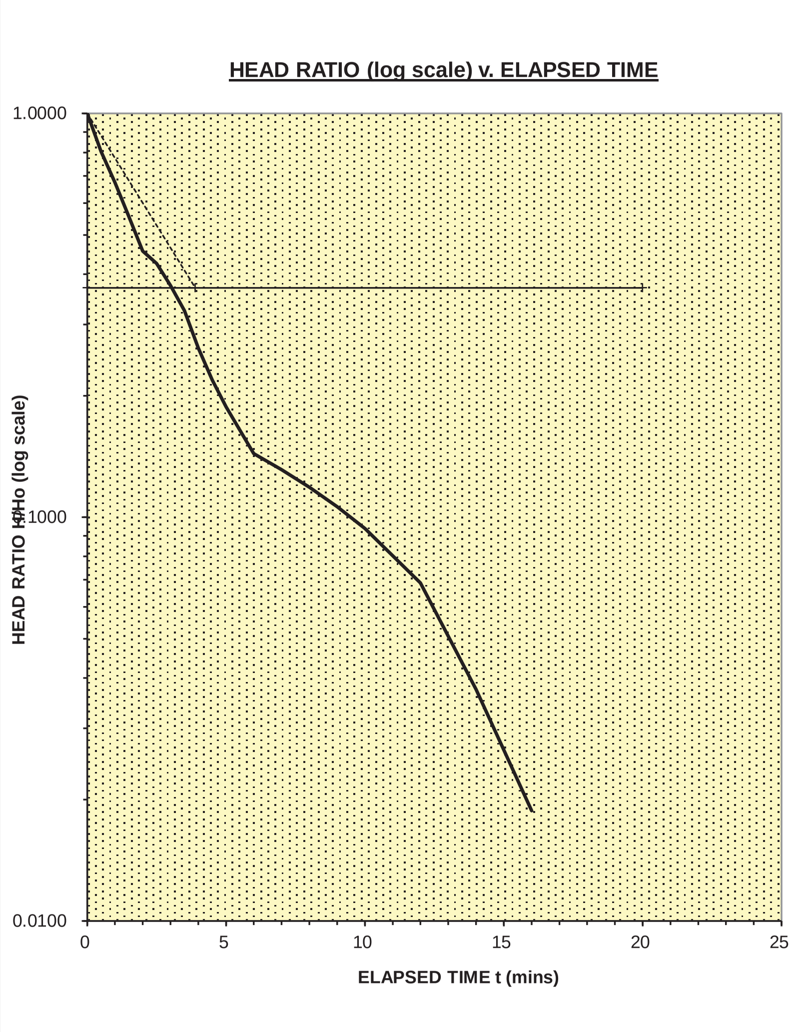
i.e., k = 1.4 x10^{-5} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT03 **TEST #:** 1
DATE: 5-Nov-15



Basic Time Lag Factor T = 3.89 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT04 TEST No.: 1
DATE: 5-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D):	*150* (mm)	
Height of TOP of casing above ground level:	*0.00* (m)	
Depth to bottom of casing below ground level (m):	*0.10* (m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*2.00* (m)	
Depth to bottom of borehole below ground level after test:	*2.00* (m)	
Standing ground water level (mbgl):	*1.50* (m)	on 5-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.50 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.17	1.33	1.0000
0.5	0.3	1.2	0.9023
1	0.38	1.12	0.8421
1.5	0.45	1.05	0.7895
2	0.51	0.99	0.7444
2.5	0.57	0.93	0.6992
3	0.6	0.9	0.6767
3.5	0.64	0.86	0.6466
4	0.66	0.84	0.6316
4.5	0.69	0.81	0.6090
5	0.7	0.8	0.6015
6	0.73	0.77	0.5789
7	0.76	0.74	0.5564
8	0.79	0.71	0.5338
9	0.8	0.7	0.5263
10	0.81	0.69	0.5188
12	0.84	0.66	0.4962
14	0.86	0.64	0.4812
16	0.88	0.62	0.4662
18	0.91	0.59	0.4436
20	0.93	0.57	0.4286
22	0.94	0.56	0.4211
24	0.96	0.54	0.4060
26	0.97	0.53	0.3985
28	0.97	0.53	0.3985
30	0.97	0.53	0.3985
35	0.97	0.53	0.3985
40	0.97	0.53	0.3985
45	0.97	0.53	0.3985
50	0.97	0.53	0.3985
55	0.97	0.53	0.3985
60	0.97	0.53	0.3985

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 3.6918 (m)
and A = 0.0177 (m^2)
and T = *33.47* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 2.4E-06 m/s

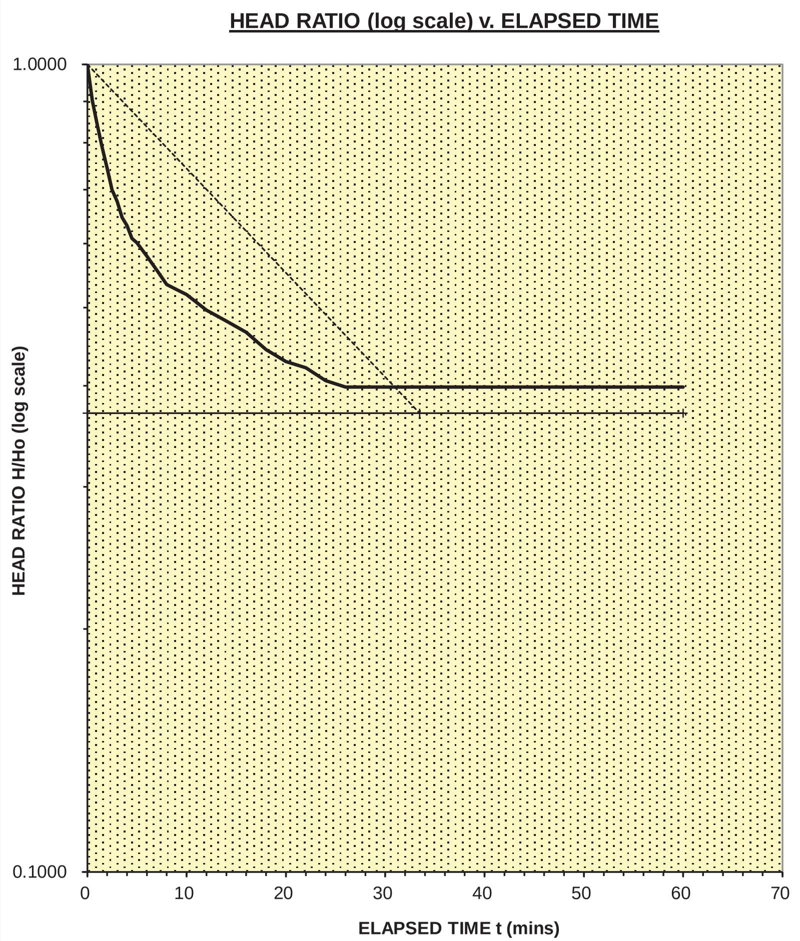
i.e., k = 2.4×10^{-6} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT04 **TEST #:** 1
DATE: 5-Nov-15



Basic Time Lag Factor T = 33.47 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT05 TEST No.: 1
DATE: 5-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D):	*150*	(mm)	
Height of TOP of casing above ground level:	*0.00*	(m)	
Depth to bottom of casing below ground level (m):	*0.20*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*3.00*	(m)	
Depth to bottom of borehole below ground level after test:	*1.90*	(m)	
Standing ground water level (mbgl):	*1.65*	(m)	on 5-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.65 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.37	1.28	1.0000
0.5	0.56	1.09	0.8516
1	0.65	1	0.7813
1.5	0.7	0.95	0.7422
2	0.73	0.92	0.7188
2.5	0.76	0.89	0.6953
3	0.78	0.87	0.6797
3.5	0.8	0.85	0.6641
4	0.83	0.82	0.6406
4.5	0.84	0.81	0.6328
5	0.85	0.8	0.6250
6	0.89	0.76	0.5938
7	0.9	0.75	0.5859
8	0.92	0.73	0.5703
9	0.93	0.72	0.5625
10	0.94	0.71	0.5547
12	0.95	0.7	0.5469
14	0.97	0.68	0.5313
16	0.98	0.67	0.5234
18	0.99	0.66	0.5156
20	1	0.65	0.5078
22	1.01	0.64	0.5000
24	1.03	0.62	0.4844
26	1.04	0.61	0.4766
28	1.05	0.6	0.4688
30	1.06	0.59	0.4609
35	1.1	0.55	0.4297
40	1.13	0.52	0.4063
45	1.16	0.49	0.3828
50	1.2	0.45	0.3516
55	1.23	0.42	0.3281
60	1.25	0.4	0.3125
70	1.29	0.36	0.2813
80	1.31	0.34	0.2656
90	1.33	0.32	0.2500
100	1.35	0.3	0.2344
110	1.36	0.29	0.2266
120	1.37	0.28	0.2188

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** , hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 4.8591 (m)
and A = 0.0177 (m^2)
and T = *36.29* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.7E-06 m/s

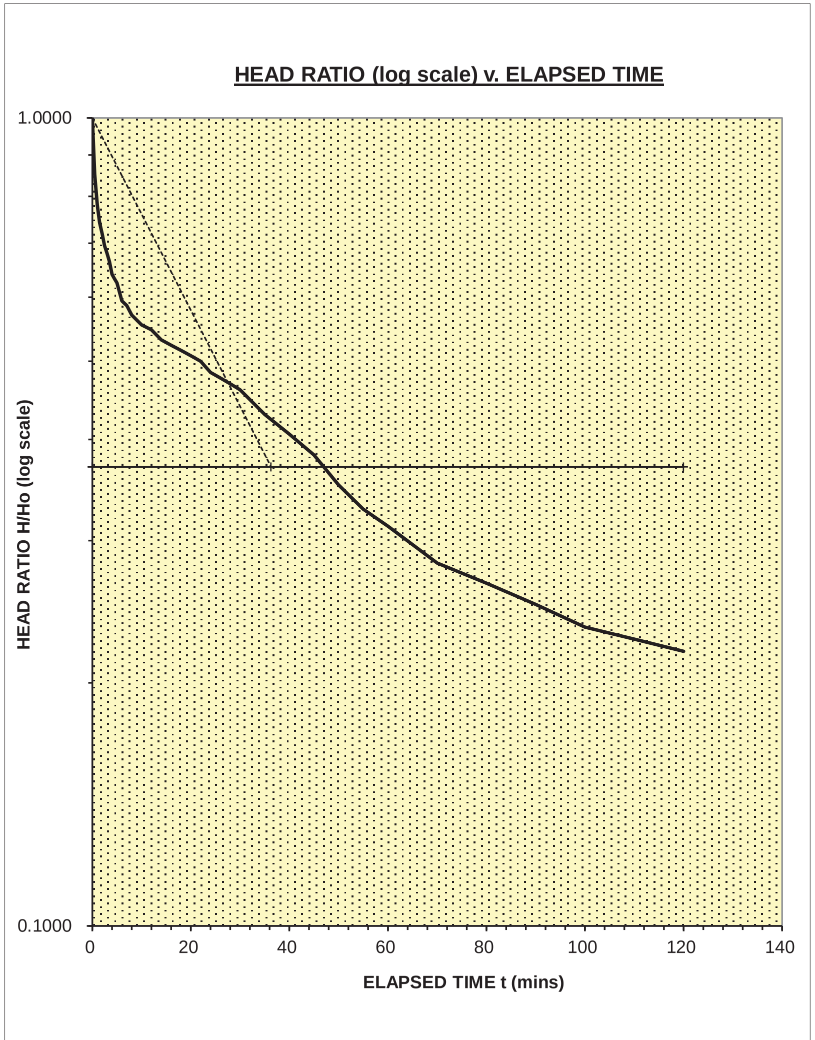
i.e., k = 1.7×10^{-6} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT05 **TEST #:** 1
DATE: 5-Nov-15



Basic Time Lag Factor T = 36.29 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT06 TEST No.: 1
DATE: 10-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D): *150* (mm)
Height of TOP of casing above ground level: *0.70* (m)
Depth to bottom of casing below ground level (m): *0.20* (m) (Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test: *3.00* (m)
Depth to bottom of borehole below ground level after test: *3.00* (m)
Standing ground water level (mbgl): *0.53* (m) on 10-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.23 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	1.23	1.0000
0.5	0.37	0.86	0.6992
1	0.44	0.79	0.6423
1.5	0.475	0.755	0.6138
2	0.49	0.74	0.6016
2.5	0.495	0.735	0.5976
3	0.495	0.735	0.5976
3.5	0.495	0.735	0.5976
4	0.495	0.735	0.5976
4.5	0.498	0.732	0.5951
5	0.5	0.73	0.5935
6	0.5	0.73	0.5935
7	0.5	0.73	0.5935
8	0.5	0.73	0.5935
9	0.5	0.73	0.5935
10	0.5	0.73	0.5935
12	0.5	0.73	0.5935
14	0.5	0.73	0.5935
16	0.5	0.73	0.5935
18	0.5	0.73	0.5935
20	0.5	0.73	0.5935
22	0.5	0.73	0.5935
24	0.5	0.73	0.5935
26	0.5	0.73	0.5935
28	0.5	0.73	0.5935
30	0.5	0.73	0.5935
35	0.5	0.73	0.5935
40	0.5	0.73	0.5935
45	0.51	0.72	0.5854
50	0.51	0.72	0.5854
55	0.51	0.72	0.5854
60	0.51	0.72	0.5854

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 4.8591 (m)
and A = 0.0177 (m^2)
and T = *32.96* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.8E-06 m/s

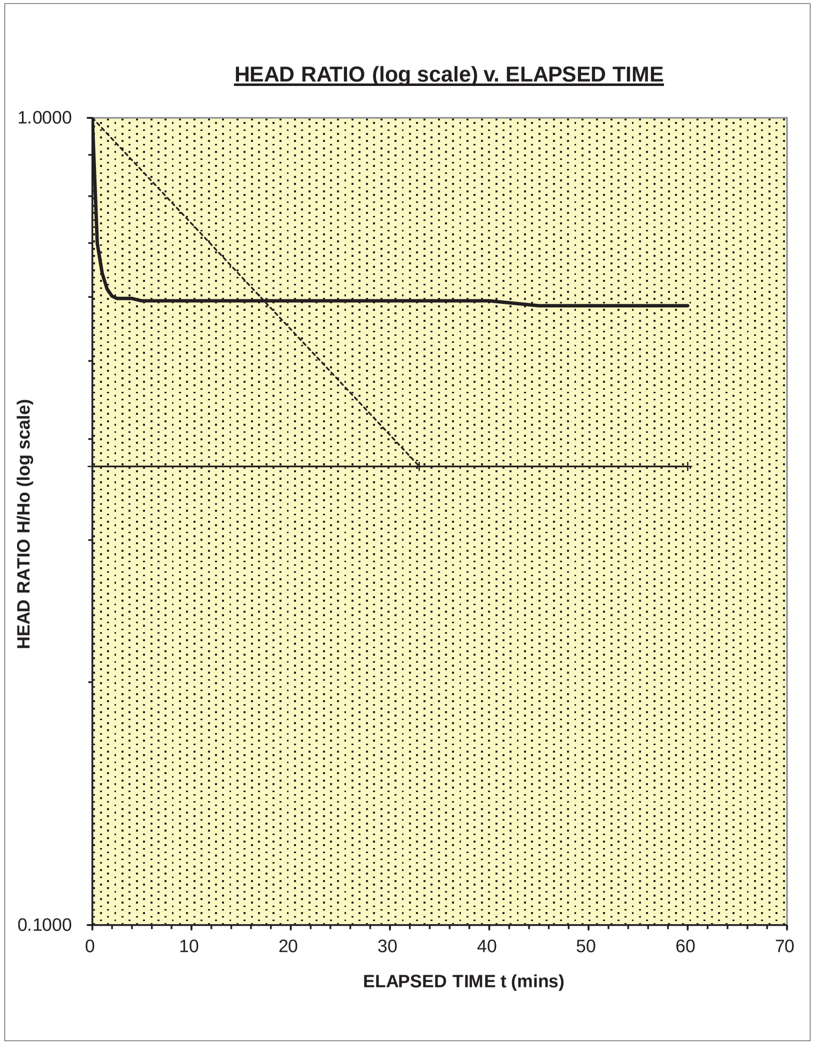
i.e., k = 1.8×10^{-6} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT06 **TEST #:** 1
DATE: 10-Nov-15



Basic Time Lag Factor T = 32.96 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT07 TEST No.: 1
DATE: 11-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D):	*125*	(mm)	
Height of TOP of casing above ground level:	*0.60*	(m)	
Depth to bottom of casing below ground level (m):	*1.50*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*1.56*	(m)	
Depth to bottom of borehole below ground level after test:	*1.56*	(m)	
Standing ground water level (mbgl):	*0.20*	(m)	on 11-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 0.80 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	0.8	1.0000
0.5	0.49	0.31	0.3875
1	0.59	0.21	0.2625
1.5	0.635	0.165	0.2063
2	0.645	0.155	0.1938
2.5	0.655	0.145	0.1813
3	0.66	0.14	0.1750
3.5	0.66	0.14	0.1750
4	0.66	0.14	0.1750
4.5	0.66	0.14	0.1750
5	0.66	0.14	0.1750
6	0.665	0.135	0.1688
7	0.665	0.135	0.1688
8	0.665	0.135	0.1688
9	0.665	0.135	0.1688
10	0.66	0.14	0.1750
12	0.66	0.14	0.1750
14	0.66	0.14	0.1750
16	0.66	0.14	0.1750
18	0.66	0.14	0.1750
20	0.66	0.14	0.1750
22	0.66	0.14	0.1750
24	0.66	0.14	0.1750
26	0.66	0.14	0.1750
28	0.66	0.14	0.1750
30	0.66	0.14	0.1750
35	0.66	0.14	0.1750
40	0.662	0.138	0.1725
45	0.662	0.138	0.1725
50	0.664	0.136	0.1700
55	0.666	0.134	0.1675
60	0.667	0.133	0.1663

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 0.8138 (m)
and A = 0.0123 (m^2)
and T = *16* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.6E-05 m/s

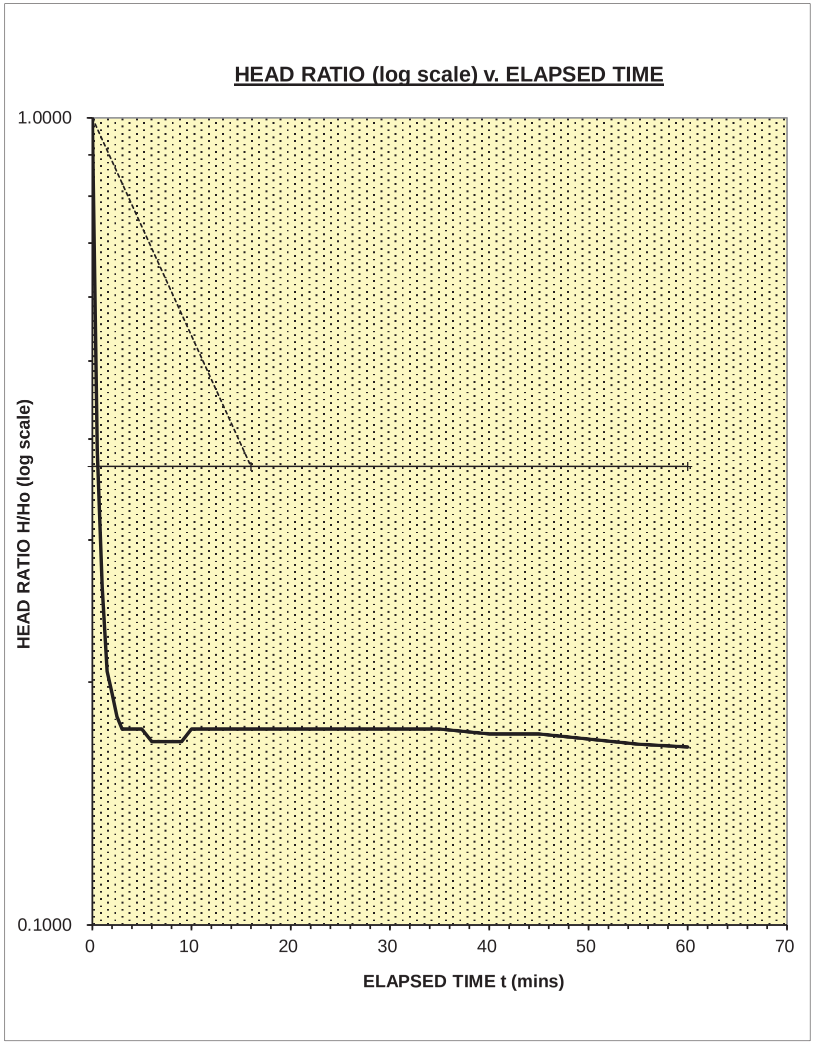
i.e., k = 1.6 x10^{-5}m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: *FALLING* HEAD

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT07 **TEST #:** 1
DATE: 11-Nov-15



Basic Time Lag Factor T = 16 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT09 TEST No.: 1
DATE: 9-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D):	*150*	(mm)	
Height of TOP of casing above ground level:	*0.30*	(m)	
Depth to bottom of casing below ground level (m):	*0.00*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*3.00*	(m)	
Depth to bottom of borehole below ground level after test:	*3.00*	(m)	
Standing ground water level (mbgl):	*3.00*	(m)	on 9-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 3.30 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	3.3	1.0000
0.5	0.01	3.29	0.9970
1	0.01	3.29	0.9970
1.5	0.01	3.29	0.9970
2	0.01	3.29	0.9970
2.5	0.01	3.29	0.9970
3	0.01	3.29	0.9970
3.5	0.01	3.29	0.9970
4	0.01	3.29	0.9970
4.5	0.01	3.29	0.9970
5	0.01	3.29	0.9970
6	0.01	3.29	0.9970
7	0.01	3.29	0.9970
8	0.01	3.29	0.9970
9	0.01	3.29	0.9970
10	0.01	3.29	0.9970
12	0.01	3.29	0.9970
14	0.01	3.29	0.9970
16	0.01	3.29	0.9970
18	0.01	3.29	0.9970
20	0.01	3.29	0.9970
22	0.01	3.29	0.9970
24	0.01	3.29	0.9970
26	0.01	3.29	0.9970
28	0.01	3.29	0.9970
30	0.01	3.29	0.9970
35	0.01	3.29	0.9970
40	0.01	3.29	0.9970
45	0.01	3.29	0.9970
50	0.01	3.29	0.9970
55	0.01	3.29	0.9970
60	0.01	3.29	0.9970

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case *D* ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 5.1090 (m)
and A = 0.0177 (m^2)
and T = *4317* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.3E-08 m/s

i.e., k = 1.3×10^{-8} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT09 **TEST #:** 1
DATE: 9-Nov-15

Basic Time Lag Factor T = 4317 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT10 TEST No.: 1
DATE: 10-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D):	*130* (mm)	
Height of TOP of casing above ground level:	*0.60* (m)	
Depth to bottom of casing below ground level (m):	*0.10* (m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*1.53* (m)	
Depth to bottom of borehole below ground level after test:	*1.53* (m)	
Standing ground water level (mbgl):	*1.00* (m)	on 10-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.60 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0.6	1	1.0000
0.5	0.87	0.73	0.7300
1	0.93	0.67	0.6700
1.5	0.94	0.66	0.6600
2	0.94	0.66	0.6600
2.5	0.945	0.655	0.6550
3	0.945	0.655	0.6550
3.5	0.95	0.65	0.6500
4	0.95	0.65	0.6500
4.5	0.95	0.65	0.6500
5	0.95	0.65	0.6500
6	0.95	0.65	0.6500
7	0.95	0.65	0.6500
8	0.95	0.65	0.6500
9	0.95	0.65	0.6500
10	0.95	0.65	0.6500
12	0.95	0.65	0.6500
14	0.95	0.65	0.6500
16	0.95	0.65	0.6500
18	0.95	0.65	0.6500
20	0.95	0.65	0.6500
22	0.95	0.65	0.6500
24	0.95	0.65	0.6500
26	0.95	0.65	0.6500
28	0.95	0.65	0.6500
30	0.95	0.65	0.6500
35	0.95	0.65	0.6500
40	0.95	0.65	0.6500
45	0.95	0.65	0.6500
50	0.95	0.65	0.6500
55	0.95	0.65	0.6500
60	0.95	0.65	0.6500

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:

k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 2.9048 (m)
and A = 0.0133 (m^2)
and T = *64.45* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.2E-06 m/s

i.e., k = 1.2 x10^{-6} m/s

Causeway Geotech Ltd

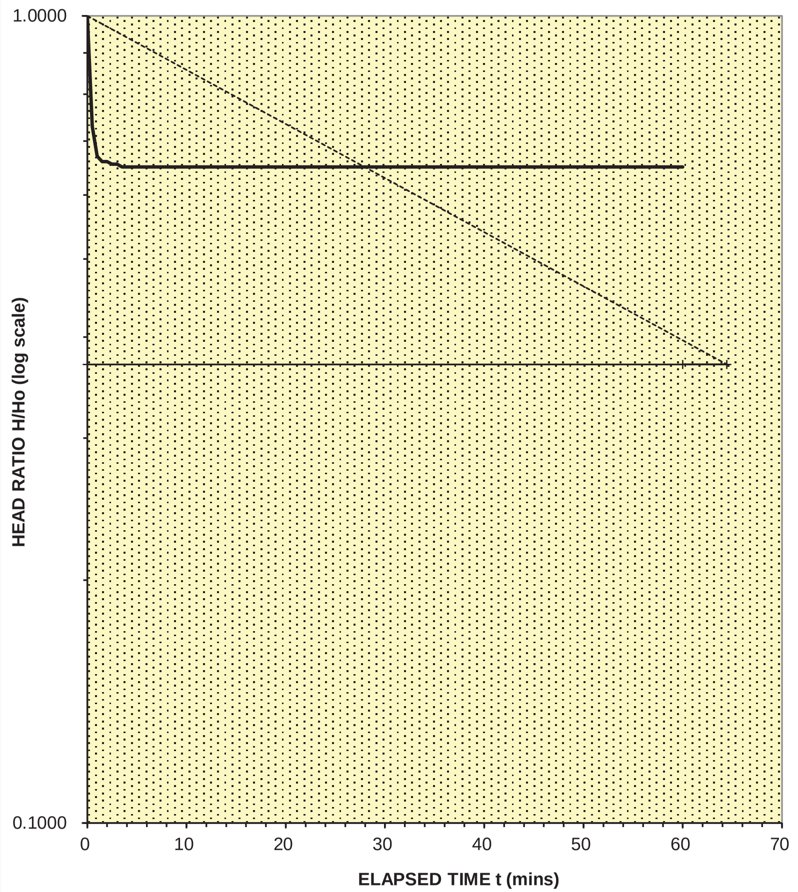
VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT10 **TEST #:** 1

DATE: 10-Nov-15

HEAD RATIO (log scale) v. ELAPSED TIME



Basic Time Lag Factor T = 64.45 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT12 TEST No.: 1

DATE: 10-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D):	*130*	(mm)	
Height of TOP of casing above ground level:	*0.60*	(m)	
Depth to bottom of casing below ground level (m):	*0.00*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*1.80*	(m)	
Depth to bottom of borehole below ground level after test:	*1.53*	(m)	
Standing ground water level (mbgl):	*1.09*	(m)	on 10-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 1.69 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	1.69	1.0000
0.5	0.3	1.39	0.8225
1	0.47	1.22	0.7219
1.5	0.59	1.1	0.6509
2	0.68	1.01	0.5976
2.5	0.75	0.94	0.5562
3	0.81	0.88	0.5207
3.5	0.87	0.82	0.4852
4	0.92	0.77	0.4556
4.5	0.945	0.745	0.4408
5	0.965	0.725	0.4290
6	1	0.69	0.4083
7	1.025	0.665	0.3935
8	1.04	0.65	0.3846
9	1.05	0.64	0.3787
10	1.06	0.63	0.3728
12	1.06	0.63	0.3728
14	1.06	0.63	0.3728
16	1.065	0.625	0.3698
18	1.065	0.625	0.3698
20	1.045	0.645	0.3817
22	1.065	0.625	0.3698
24	1.065	0.625	0.3698
26	1.065	0.625	0.3698
28	1.065	0.625	0.3698
30	1.065	0.625	0.3698
35	1.066	0.624	0.3692
40	1.068	0.622	0.3680
45	1.068	0.622	0.3680
50	1.069	0.621	0.3675
55	1.069	0.621	0.3675
60	1.07	0.62	0.3669

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT

where:

k is the permeability of soil

A is the cross-section area of borehole casing

F is the intake factor (see below)

T is the basic time lag factor

Values of intake factors (F) for various conditions,

Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** , hence:

F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]

i.e. F = 3.4040 (m)

and A = 0.0133 (m^2)

and T = *28.6* (mins);

(by best fitting and extraoplation of log H/Ho v Time data)

hence, k = 2.3E-06 m/s

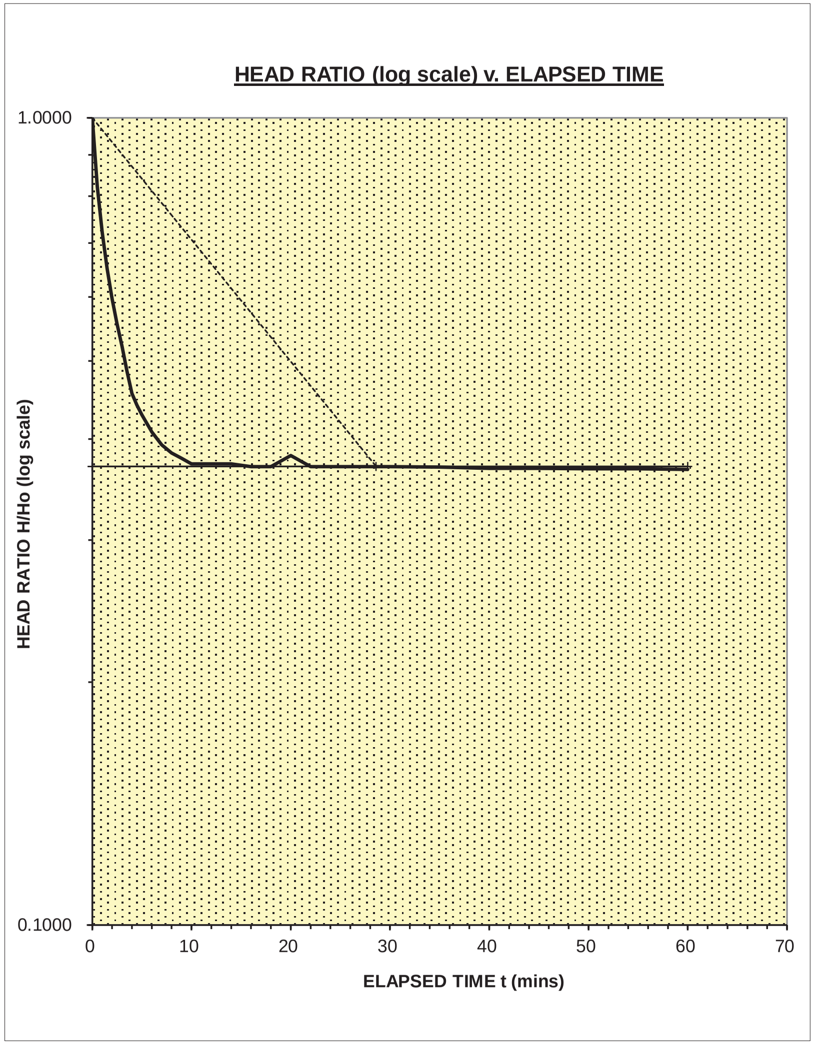
i.e., k = **2.3 x10^{-6} m/s**

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT12 **TEST #:** 1
DATE: 10-Nov-15



Basic Time Lag Factor T = 28.6 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT13 TEST No.: 1
DATE: 11-Nov-15

TYPE OF TEST: ***FALLING*** HEAD

Diameter of casing (D):	*125*	(mm)	
Height of TOP of casing above ground level:	*0.60*	(m)	
Depth to bottom of casing below ground level (m):	*2.50*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*3.00*	(m)	
Depth to bottom of borehole below ground level after test:	*2.95*	(m)	
Standing ground water level (mbgl):	*0.00*	(m)	on 11-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 0.60 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	0.6	1.0000
0.5	0.005	0.595	0.9917
1	0.005	0.595	0.9917
1.5	0.005	0.595	0.9917
2	0.005	0.595	0.9917
2.5	0.006	0.594	0.9900
3	0.007	0.593	0.9883
3.5	0.008	0.592	0.9867
4	0.008	0.592	0.9867
4.5	0.008	0.592	0.9867
5	0.008	0.592	0.9867
6	0.009	0.591	0.9850
7	0.009	0.591	0.9850
8	0.009	0.591	0.9850
9	0.009	0.591	0.9850
10	0.009	0.591	0.9850
12	0.009	0.591	0.9850
14	0.009	0.591	0.9850
16	0.01	0.59	0.9833
18	0.01	0.59	0.9833
20	0.01	0.59	0.9833
22	0.01	0.59	0.9833
24	0.011	0.589	0.9817
26	0.011	0.589	0.9817
28	0.011	0.589	0.9817
30	0.012	0.588	0.9800
35	0.012	0.588	0.9800
40	0.012	0.588	0.9800
45	0.013	0.587	0.9783
50	0.013	0.587	0.9783
55	0.014	0.586	0.9767
60	0.014	0.586	0.9767

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** , hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 1.4998 (m)
and A = 0.0123 (m^2)
and T = *1439* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 9.5E-08 m/s

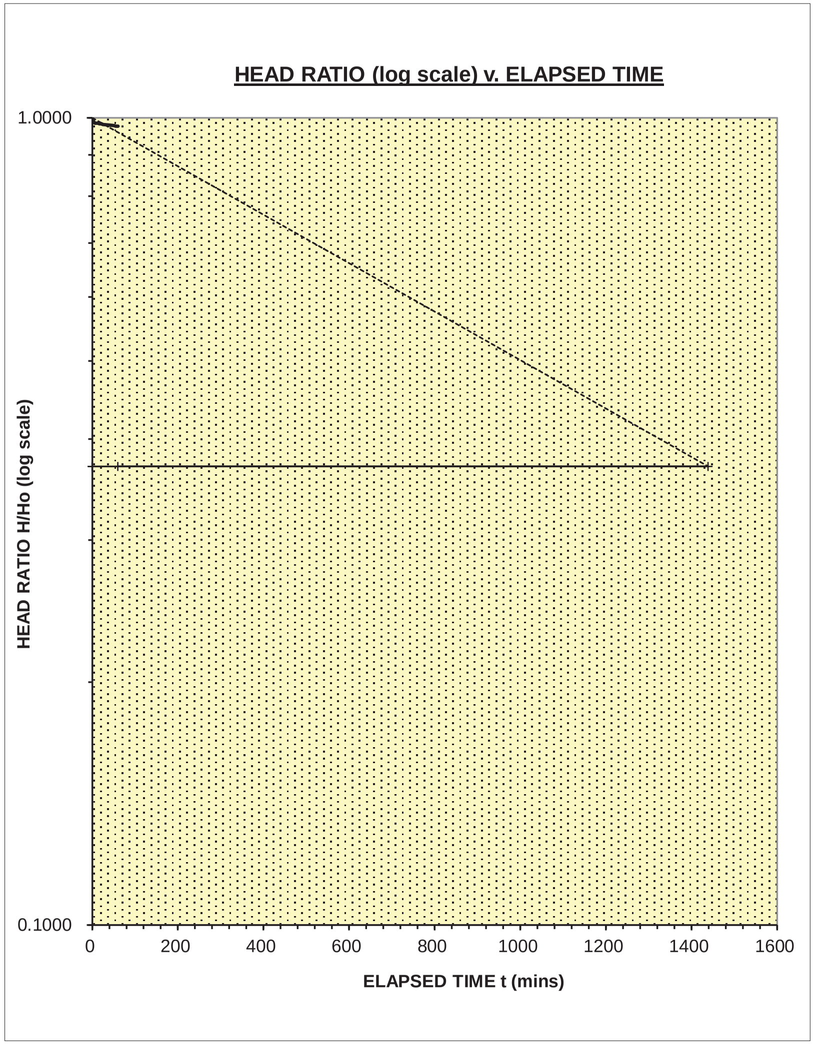
i.e., k = 9.5×10^{-8} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: *FALLING* HEAD

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT13 **TEST #:** 1
DATE: 11-Nov-15



Basic Time Lag Factor T = 1439 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT14 TEST No.: 1
DATE: 11-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D):	*125*	(mm)	
Height of TOP of casing above ground level:	*0.60*	(m)	
Depth to bottom of casing below ground level (m):	*2.50*	(m)	(Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test:	*3.00*	(m)	
Depth to bottom of borehole below ground level after test:	*2.90*	(m)	
Standing ground water level (mbgl):	*3.00*	(m)	on 11-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 3.60 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	3.6	1.0000
0.5	0.015	3.585	0.9958
1	0.017	3.583	0.9953
1.5	0.022	3.578	0.9939
2	0.025	3.575	0.9931
2.5	0.03	3.57	0.9917
3	0.037	3.563	0.9897
3.5	0.048	3.552	0.9867
4	0.055	3.545	0.9847
4.5	0.067	3.533	0.9814
5	0.074	3.526	0.9794
5.5	0.084	3.516	0.9767
6	0.092	3.508	0.9744
7	0.118	3.482	0.9672
8	0.135	3.465	0.9625
9	0.16	3.44	0.9556
10	0.183	3.417	0.9492
12	0.227	3.373	0.9369
14	0.274	3.326	0.9239
16	0.32	3.28	0.9111
18	0.36	3.24	0.9000
20	0.395	3.205	0.8903
22	0.43	3.17	0.8806
24	0.465	3.135	0.8708
26	0.5	3.1	0.8611
28	0.53	3.07	0.8528
30	0.562	3.038	0.8439
35	0.628	2.972	0.8256
40	0.695	2.905	0.8069
45	0.752	2.848	0.7911
50	0.802	2.798	0.7772
55	0.855	2.745	0.7625
60	0.89	2.71	0.7528

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** , hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 1.4998 (m)
and A = 0.0123 (m^2)
and T = *180* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 7.6E-07 m/s

i.e., k = 7.6 x10^{-7} m/s

Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT14 **TEST #:** 1
DATE: 11-Nov-15

Basic Time Lag Factor T = 180 mins

Sheet 2 of 2

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

CONTRACT: Morrell River Flood Alleviation BOREHOLE No.: PT15 TEST No.: 1
DATE: 11-Nov-15

TYPE OF TEST: *FALLING* HEAD

Diameter of casing (D): *125* (mm)
Height of TOP of casing above ground level: *0.60* (m)
Depth to bottom of casing below ground level (m): *2.50* (m) (Withdrawn to impervious layer)
Depth to bottom of borehole below ground level before test: *3.00* (m)
Depth to bottom of borehole below ground level after test: *3.00* (m)
Standing ground water level (mbgl): *3.00* (m) on 11-Nov-15

DATUM:All depths to water level measured from top of casing. i.e.SWL 3.60 m below datum.

TIME ELAPSED (mins)	WATER LEVEL* (m)	HEAD H (m)	HEAD RATIO H/Ho
0	0	3.6	1.0000
0.5	0.03	3.57	0.9917
1	0.055	3.545	0.9847
1.5	0.08	3.52	0.9778
2	0.095	3.505	0.9736
2.5	0.12	3.48	0.9667
3	0.14	3.46	0.9611
3.5	0.16	3.44	0.9556
4	0.175	3.425	0.9514
4.5	0.2	3.4	0.9444
5	0.22	3.38	0.9389
6	0.24	3.36	0.9333
7	0.275	3.325	0.9236
8	0.33	3.27	0.9083
9	0.365	3.235	0.8986
10	0.39	3.21	0.8917
12	0.45	3.15	0.8750
14	0.505	3.095	0.8597
16	0.55	3.05	0.8472
18	0.59	3.01	0.8361
20	0.64	2.96	0.8222
22	0.665	2.935	0.8153
24	0.695	2.905	0.8069
26	0.72	2.88	0.8000
28	0.75	2.85	0.7917
30	0.78	2.82	0.7833
35	0.825	2.775	0.7708
40	0.86	2.74	0.7611
45	0.89	2.71	0.7528
50	0.91	2.69	0.7472
55	0.93	2.67	0.7417
60	0.945	2.655	0.7375

CALCULATION OF PERMEABILITY OF SOIL:

Employing Hvorslev formula: k = A/FT
where:
k is the permeability of soil
A is the cross-section area of borehole casing
F is the intake factor (see below)
T is the basic time lag factor

Values of intake factors (F) for various conditions,
Cases (a)-(f), are given in Figure 6 of BS 5930:1999 (p 50):

Assumed condition: Case ***D*** ,hence:
F = 2*PI*L/loge[(L/D)+{1+(L/D)^2}^0.5]
i.e. F = 1.4998 (m)
and A = 0.0123 (m^2)
and T = *131* (mins);
(by best fitting and extraoplation of log H/Ho v Time data)
hence, k = 1.0E-06 m/s

i.e., k = 1.0×10^{-6} m/s

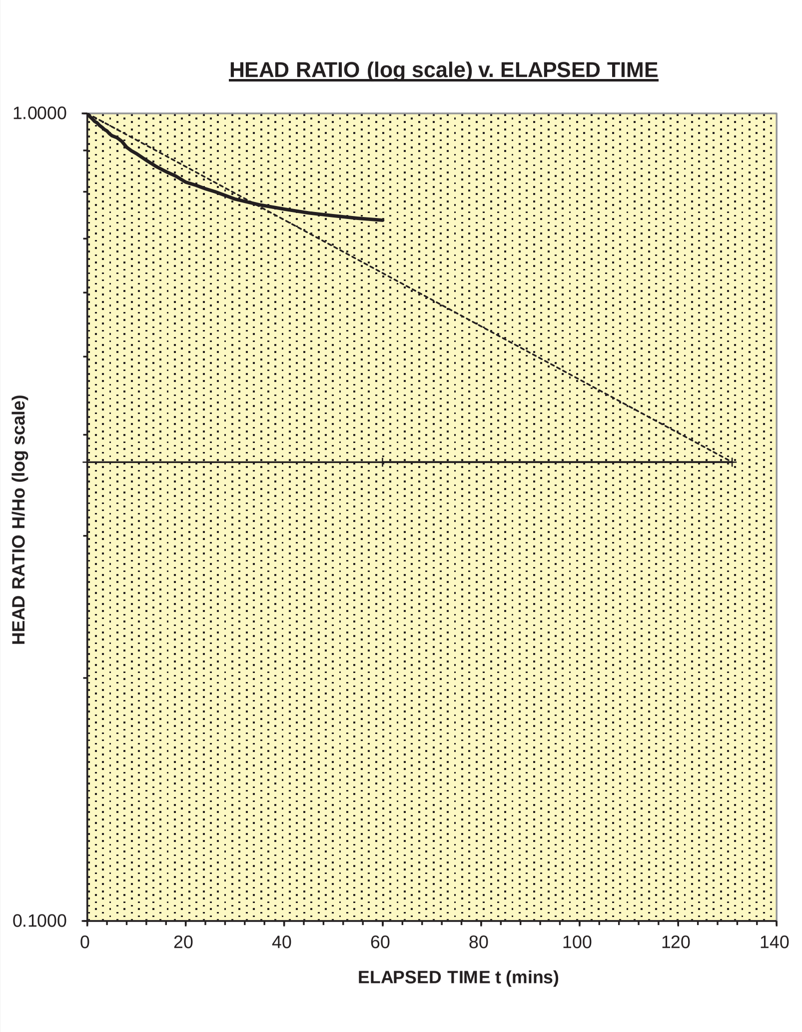
Causeway Geotech Ltd

VARIABLE HEAD PERMEABILITY TEST (BOREHOLE)

TYPE OF TEST: ***FALLING*** **HEAD**

CONTRACT: Morrell River Flood Alleviation **BOREHOLE No.:** PT15 **TEST #:** 1

DATE: 11-Nov-15



Basic Time Lag Factor T =	131	mins

Sheet 2 of 2

Appendix M

outline Waste Management Plan

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1 INTRODUCTION

This document provides an outline Waste Management Plan (WMP) for the Morell River Flood Management Scheme undertaken by RPS on behalf of Kildare County Council (KCC).

This WMP sets out control measures for managing all potential wastes arising from the construction phase of the Morell River Flood Management Scheme. Potential wastes expected to be generated have been identified and documented in the Morell River Flood Management Scheme Environmental Impact Statement (hereafter referred to as the EIS).

No statements in this document shall supersede those or be taken to replace the terms of the contract, or the design description issued with the contract tender. This outline plan will be developed and updated by the appointed Contractor as required in advance of the construction phase. This WMP should be read in conjunction with the outline Construction Environmental Management Plan (CEMP) presented in Appendix B of the EIS.

1.1 PROJECT DESCRIPTION

The Morell River Flood Management Scheme involves the construction of approximately 7,423m of new flood embankments and approximately 474m of flood walls in the catchment of the Morell River and its tributaries the Slane, Kill and Painestown rivers. The scheme also involves structural examination and potential remediation of up to 1,842m of existing embankments along the Morell, Painestown and Slane Rivers. The scheme also includes works at several existing culverts. The locations of the proposed works are shown in Figure 1.1.

1.2 WASTE ARISINGS

This WMP addresses all potential waste streams expected to be generated during the construction phase of the project, during the operational phase it is not expected that any waste will be generated.

Wastes generated during the construction phase are broadly categorised as follows:

- Construction and Demolition Wastes – including Made Ground, Green Waste, Hazardous Waste and Packaging; and
- General Waste – Mixed Dry Recyclables, Food Waste, Mixed Residual Wastes and Wastewater Wastes.

Management of these waste streams are described in detail in Section 3.

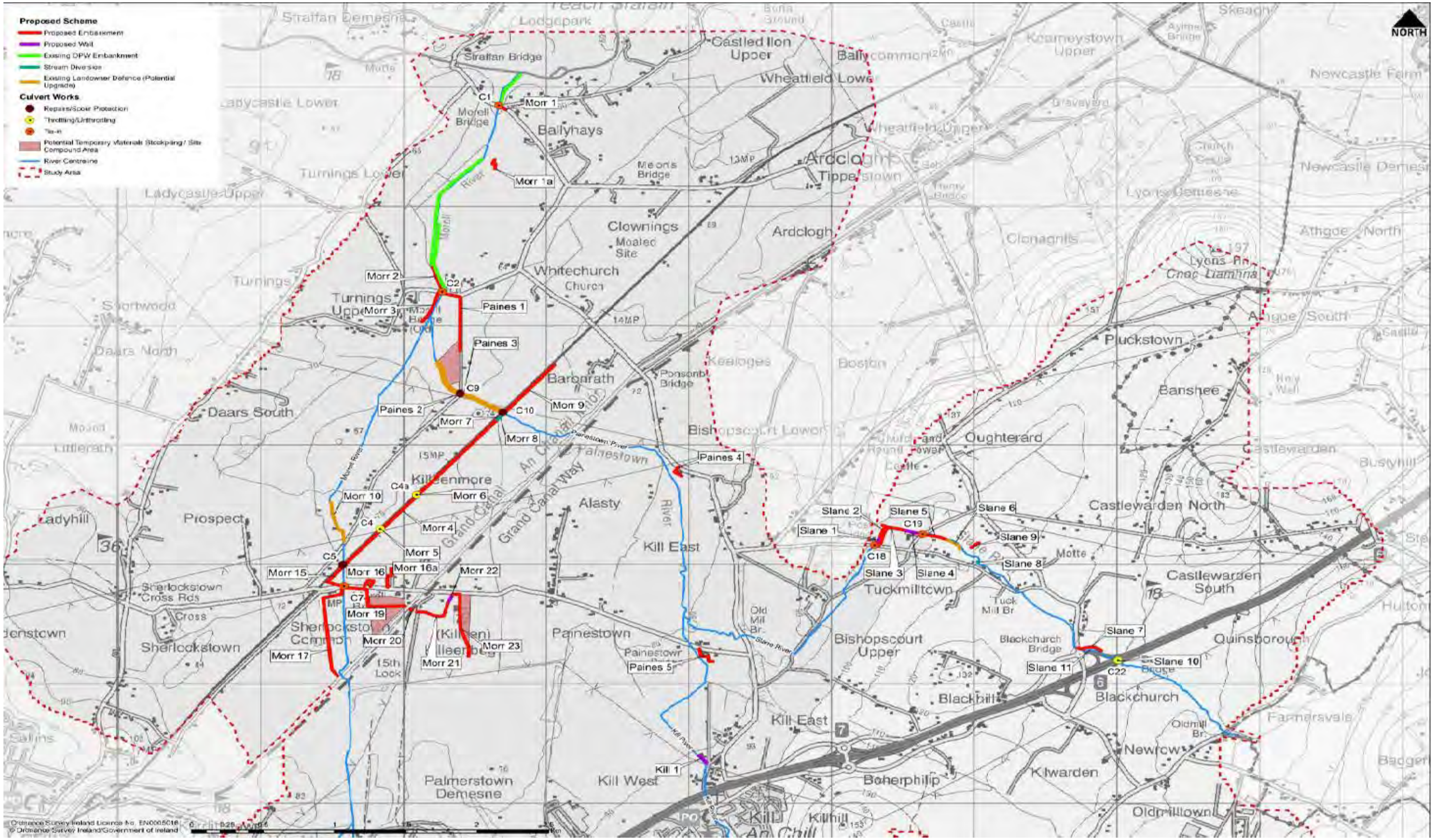

Figure 1.1: Proposed locations of works

2 WASTE POLICY AND BEST PRACTICE

The focus of Ireland's waste policy since 1998 has been to move waste management away from landfill and towards more environmentally sustainable solutions.

In the first national waste policy statement, Changing Our Ways (1998), the Department of the Environment, Community and Local Government, DECLG adopted the EU hierarchy of options for managing wastes. The design of the hierarchy favours higher tiered options over disposal. This philosophy sits at the core of waste management in Ireland and fundamentally aims to reduce our reliance on finite resources and minimise impact on the environment.

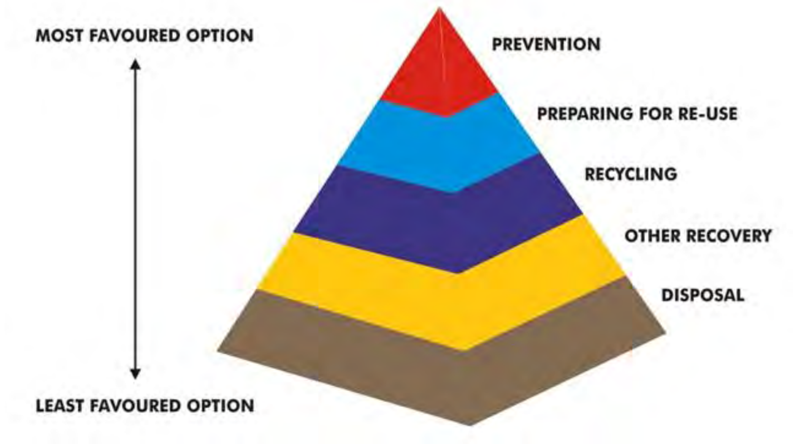

Figure 2.1: Hierarchy of Waste Management Options

With respect to Construction & Demolition (C&D) waste in particular, this can be defined as all waste that arises from construction, renovation and demolition activities and includes all wastes listed in Chapter 17 of the EWC (European Waste Catalogue), which includes hazardous and non-hazardous waste types.

'Waste Management - Changing Our Ways' set a target of 85% recycling of C&D waste over a 15 year period, which finished in 2013. In 2008, the EU Waste Framework Directive (2008/98/EC), required Member States to take the necessary measures to achieve the minimum target of 70% by weight for non-hazardous C&D waste, excluding naturally occurring material (soils & stones not containing dangerous substances). The Directive includes an overall 70% target but does not include targets for individual waste types belonging to C&D waste. The Directive specifies that such a target should be achieved by 'preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials'.

National guidelines to assist contractors and developers in the preparation of the waste plans were launched in July 2006 by the Department of the Environment Heritage and Local Government.

Each Plan is required to address the following aspects of the project:

- Analysis of the waste arisings/material surpluses;
- Specific waste management objectives for the project;
- Methods proposed for prevention, reuse and recycling of wastes;
- Material handling procedures; and,
- Proposals for education of workforce and plan dissemination programme.

3 WASTE MANAGEMENT STRATEGY

3.1 OBJECTIVES

The objectives of this WMP are outlined below:

- To set out a framework for the sustainable management of all wastes generated from the project;
- Compliance with all relevant policy, legislation and regulations on waste management;
- Investigation of encountered made ground to delineate any potential contamination;
- Identify made ground requiring excavation and disposal offsite;
- Appropriate classification, segregation and disposal of made ground requiring excavation and disposal offsite;
- Minimise waste generation during construction, through the implementation of waste prevention measures, where possible e.g. avoidance of over-ordering, appropriate storage of materials;
- Minimise the volume of waste being sent to landfill and reuse of materials on site where possible e.g. excavated topsoil, subsoil, made ground etc. ;
- Appropriate segregation and handling of different waste streams to ensure the various reusable, recyclable and recoverable wastes are separated from residual wastes and hazardous wastes;
- Appropriate management of hazardous wastes;
- Storage and handling of wastes in a manner that prevents any adverse impact on the environment; and,
- Communication of the established waste management practices on site, to all parties involved in the project.

3.2 WASTE SEGREGATION AND STORAGE

It is the responsibility of the Contractor to segregation and correctly store wastes. Strict segregation of the various waste types as they arise will take place to maximise the capacity for reuse, recycling and recovery of wastes and to ensure that residual waste volumes requiring disposal are kept to a minimum.

Separate storage receptacles will be provided for all of the individual waste streams identified in this plan. Adequate space will be provided within the site compound (waste storage area) to facilitate the separate storage of the various waste streams, including designated areas for stockpiling. All waste receptacles / storage areas will be clearly labelled. Successful waste segregation will require that all site operatives are fully appraised of the waste management practices and procedures for the project.

4 MANAGEMENT OF WASTES

This section outlines sustainable practices which will be employed onsite when managing each of the waste streams generated during construction.

4.1 CONSTRUCTION AND DEMOLITION WASTES

4.1.1 Encountered Made Ground

Made ground will be encountered during the construction of new embankments and restoration of existing embankments. The identified made ground was found to be composed of re-worked gravelly clays with rare inclusions of glass, concrete, timber and brick fragments. It is estimated approximately 17,391m^3 of made ground will be encountered.

Prior to excavation works at locations of identified made ground further site investigations are required to assess for potential contamination in accordance with BS5930:2015 and BS10175:2011+A1:2013. Site investigations will include the collection and analysis of a representative number of samples to analyse for potential contaminants.

Made ground confirmed to be non-contaminated can be reused onsite in the construction of embankments or soil spreading. If required made ground will be initially screened to remove general rubble, i.e. fragments of glass, concrete, timber and brick. The removed rubble will be suitable recycled if possible.

4.1.1.1 Testing

Contaminated made ground is unsuitable for reuse onsite and will be required to be correctly disposed of offsite. Disposal offsite requires Waste Acceptance Criteria (WAC) testing for correct classified as inert, non-hazardous or hazardous waste in accordance with '*Establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC)*'. (Made ground identified as non-contaminated during site investigations but not required for reused onsite will also require WAC testing for correct disposal offsite to an inert waste facility).

A representative number of WAC samples should be taken from the made ground areas which require disposal offsite prior to any excavation works. Samples should be sent to an accredited laboratory for analysis. Based on the WAC analytical results the made ground will be disposed of an appropriate inert, non-hazardous or hazardous waste management facility.

4.1.1.2 Excavation and Handling

During the excavation and handling of any contaminated made ground general mitigation measures to prevent pollution outlined in the CEMP and good housekeeping practices will be adhered to. Specifically, to minimise environmental and human health risks associated with contaminated made ground arising from leaching of contamination, surface runoff and exposure to contaminants the following measures will be implemented:

- Designated equipment will be used for the excavation and handling of contaminated made ground;
- Appropriately decontamination measures will be taken prior to subsequent use for uncontaminated material;
- During works caution should be taken to prevent spillages of contaminated made ground;
- Excavations and handling should not generate dust; and,
- Dedicated trucks for the transport of contaminated soils should be used.

4.1.1.3 Storage

Stockpiling of any potentially contaminated made ground onsite should be avoided, with any potentially contaminated made ground excavated and loaded directly into designated trucks for removal offsite. If temporary stockpiling is necessary, stockpile management should include measure to prevent the leaching and surface runoff of potential contaminants including;

- Stockpiling should be limited to a specific area of the site and not within 50m of any water course;
- Stockpiled made ground should be placed on impermeable plastic liners and covered to minimise rainfall infiltration; and,
- Berms should be constructed around the stockpiles.

4.1.1.4 Disposal

Based on the WAC results the excavated made ground will be classified as inert, non-hazardous or hazardous and will be correctly disposed of at an appropriate waste management facility. Further details of waste management facilities are discussed in Section 4.3.

4.1.2 Vegetation / Green Waste

Vegetation in the form of shrubs, hedgerows or trees etc. encountered along new embankment locations will be processed onsite using a mulching machine, to reduce the volume prior to transporting offsite. It will be transported directly to a licenced waste recovery facility that specialises in wood/timber recovery.

4.1.3 Hazardous Waste

Hazardous materials such as oils, batteries, paints, fuels, and other chemicals which will be used during the construction process will be treated carefully to minimise the risk of spillages, environmental pollution or accidents on-site, see the CEMP for more detail.

All chemicals will be handled, stored and disposed of in accordance with the associated Material Safety Data Sheets. Careful ordering of quantities and programming the timings of deliveries with the phasing of the works will result in the prevention of waste which can result from over-ordering or spoilage due to lengthy storage and associated risks.

Hazardous materials will be carefully handled and stored on-site in designated, secure areas with suitable protection from the weather. These areas will be separate from non-hazardous materials to avoid contaminations and pollution. Depending on the quantities of hazardous materials accepted at the site, it may be necessary to provide a temporary bunded area.

A policy of tight estimation of materials will be followed onsite to prevent unnecessary wastage. Sub-contractors will be responsible for hazardous waste arisings from their activities and will be required to conform to the requirements of the WMP.

Hazardous waste materials generated onsite will be stored safely and removed offsite by a Contractor permitted to transport hazardous wastes for safe recovery or disposal.

4.1.4 Packaging Waste

A policy of tight estimation of materials will assist with the prevention and minimisation of packaging waste. Suppliers which take back packaging waste from materials should be identified when sourcing materials to minimise packaging waste generation onsite. Any packaging material which can be returned to a supplier should be stored separately and securely and be presented in good condition for re-use or recycling.

Packaging material which cannot be returned to a supplier should be segregated into individual waste streams e.g. cardboard, paper, plastic, wood etc. for recycling/recovery off-site at an appropriate permitted or licensed facility.

4.2 GENERAL WASTE

4.2.1 Mixed Dry Recyclables

Mixed dry recyclable (MDR) material will be generated in areas such as site offices, canteen, workshops and equipment storage areas. This will include office paper, cardboard, newspaper, plastic packaging, aluminium and steel packaging, used beverage cartons etc. Glass may be accepted in the MDR bin, or the waste collector may provide separate receptacles for same. This material will be collected by a permitted waste collector and transferred to an authorised waste recovery facility for onward recycling/recovery. The collection frequency should be sufficient to avoid build-up of unmanageable volumes of MDR on site.

4.2.2 Food wastes

Food wastes will be collected in 120 litre wheeled bins at point of generation, and these will be removed daily to a covered storage container, located within the waste storage area, to limit the potential for odour. This material will be collected by a permitted waste collector and transferred to an authorised waste facility for composting. The collection frequency should be sufficient to avoid build-up of unmanageable volumes of food waste on site, and limit nuisance arising from same.

4.2.3 Mixed Residual Wastes

Mixed residual wastes (MRW) will be generated in all working areas such as site offices, canteen, workshops and equipment storage areas. Residual wastes are any materials that are not suitable for the MDR or the food waste bin e.g. soiled packaging, plastic packaging, sanitary waste (welfare facilities. The bins will be removed daily to a covered skip, located within the waste storage area. This material will be collected by a permitted waste collector and transferred to an authorised waste recovery facility for onward recovery or disposal. The collection frequency should be sufficient to avoid build-up of unmanageable volumes of MRW on site.

4.2.4 Wastewater Wastes

Wastewater generated at welfare and canteen facilities will be collected in holding tanks and subsequently tankered to a licensed wastewater treatment facility. Sewage from welfare facilities and portable lavatories will be removed from site using a tanker and transferred to a licensed wastewater treatment facility. Transfer of waste water and sewage will be carried out by a waste contractor with a valid waste collection permit. It will be established in advance that the receiving treatment facility has adequate capacity to treat the anticipated volumes to be generated over the course of the works.

4.3 WASTE HANDLING/ DISPOSAL

The main Contractor for the project will be responsible for the identification, source separation, storage and dispatch of waste from the site. The Contractor will also be responsible for maintaining good housekeeping standards.

The Contractor will be required to provide a series of suitably labelled and adequately sized waste skips designated for each of the waste streams outlined in Section 4.

All wastes will be source separated and placed in the designated skips by the Contractors. The Construction Manager, or a representative, will regularly inspect the skips to ensure no waste mixing has occurred.

All wastes should be removed from the site by the permitted waste operator as soon as practicable to minimise the unnecessary build-up of material and potential risk of the site.

Any waste removed from the site shall only be transported by a company which holds a valid Waste Collection Permit to transport such material. Waste Collection Permits for Kildare are issued by Kildare County Council. Any person transporting waste should have a copy of their Waste Collection Permit on the vehicle at all times. A list of operators who hold a current and valid waste collection permit is presented in the EPA website at:

http://www.epa.ie/wastepermit/

Any waste removed from the site shall only be taken to facilities which hold either a valid Waste Facility Permit issued by Kildare County Council or a Waste License issued by the EPA. A list of all current waste permitted operators in the Kildare area is available on the Kildare County Council website:

http://kildare.ie/countycouncil/Environment/WasteFacilityPermitRegistrations/

Excavated made ground will be appropriately disposed of at inert, non-hazardous or hazardous waste management facilities based on the results of the WAC analysis. Appropriate waste collection permits for the transport of the made ground will also be required.

5 PLAN IMPLEMENTATION

5.1 COMMUNITICATION

All construction personnel will receive induction training prior to commencing work on site. Collectively, all site personnel should be capable of the following:

- Understand the fate of the various waste streams and distinguish reusable materials from materials suitable for recycling, recovery or disposal;
- Ensure optimum segregation at source;
- Understand and be aware of the best locations for stockpiling reusable materials;
- Be aware of the location of the various separate waste stream storage areas; and
- Identify and liaise with operators of recovery outlets.

5.2 WASTE REPORTING

The Contractor will measure and record the quantities of all wastes generated and transported off site during the course of the project. Each consignment of waste removed off site should be documented to ensure full traceability of the waste from point of generation to end destination. Each consignment should be recorded on a separate record form. The use of waste reporting software should be considered to streamline this process and provide for easy interrogation of the data. The following details at minimum should be recorded for each consignment:

- EWC code for the waste;
- Description of the waste;
- Tonnage of waste;
- Date of consignment;
- Details of waste collector/haulier; and,
- Details of the waste destination

The Contractor will also receive similar documentation from the various waste collection facilities and these records need to be maintained.

This WMP should be considered a live document that should be updated throughout the project as required.

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