PUNCH
consulting engineers

New Council Chamber And Office Extension to Meath County Council Civic Offices

Engineering Planning Report

182196-PUNCH-XX-XX-RP-C-0001

December 2022

Document Control

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1 Introduction

1.1 Background and Scoping

This report was prepared to accompany a planning application for the proposed development on a site located at Buvinda House, Meath County Council, Navan, Co. Meath. This report deals specifically with the Storm water, Foul Water, Watermain, and Road Design associated with the site.

1.2 Existing Site

The existing site is located at Buvinda House, Meath County Council, Navan, Co. Meath. It is within the IDA Business & Technology Park, Navan, and is accessed via the access road to the industrial park, off the Bóthar Sion Road. The site is located southeast of Navan Town Centre and is bounded to the north by Bóthar Sion, to the east by the access road to the IDA business & Technology Park, to the south by a brownfield site, and to the west by the river Boyne and its adjoining floodplain.

The overall site area is 10.2 hectares. It is an existing developed site consisting of office buildings, car parking, and landscaped areas. The site is generally flat, with a dropped level area located to the rear (southwest) of the building. This area is accessible via a ramp. There are also sloping levels towards the Bóthar Sion Road and the River Boyne.

The site is currently developed and consists of infrastructure associated with the existing Meath County Council (MCC) office building.

Please refer to Figure 1-1 below indicating the site boundary.

Figure 1-1: Location of the Proposed Development.

1.3 Nature of the Proposed Development

The proposed development will consist of an extension to the existing Buvinda House, which is currently being used as Meath County Councils local government office. The extension to Buvinda House is proposed to the north-east of the building, which is currently a paved area for car parking for Meath County Council.

The proposed development provides all associated development works, including the redesign of storm water attenuation, the relocation of existing watermains within the car park and landscape area to facilitate the proposed building and provide a suitable ring main. Vehicular access to the development will be off the existing access road to the IDA business & Technology Park, via Bóthar Sion.

The proposed works are outlined in a series of architectural drawings prepared by Bucholz McEvoy Architects, M+E drawings prepared by Delap and Waller Services Engineers, landscape architecture drawings prepared by Bernard Seymour Landscape Architects, and engineering drawings prepared by PUNCH Consulting Engineers and supplied as part of the planning documentation.

2 Stormwater Drainage Design

2.1 Existing Stormwater Drainage

2.1.1 Public Network

Based on available records provided by Meath County Council an extract shown in Figure 2-1 below, there is shown to be limited public stormwater records adjacent to the site:

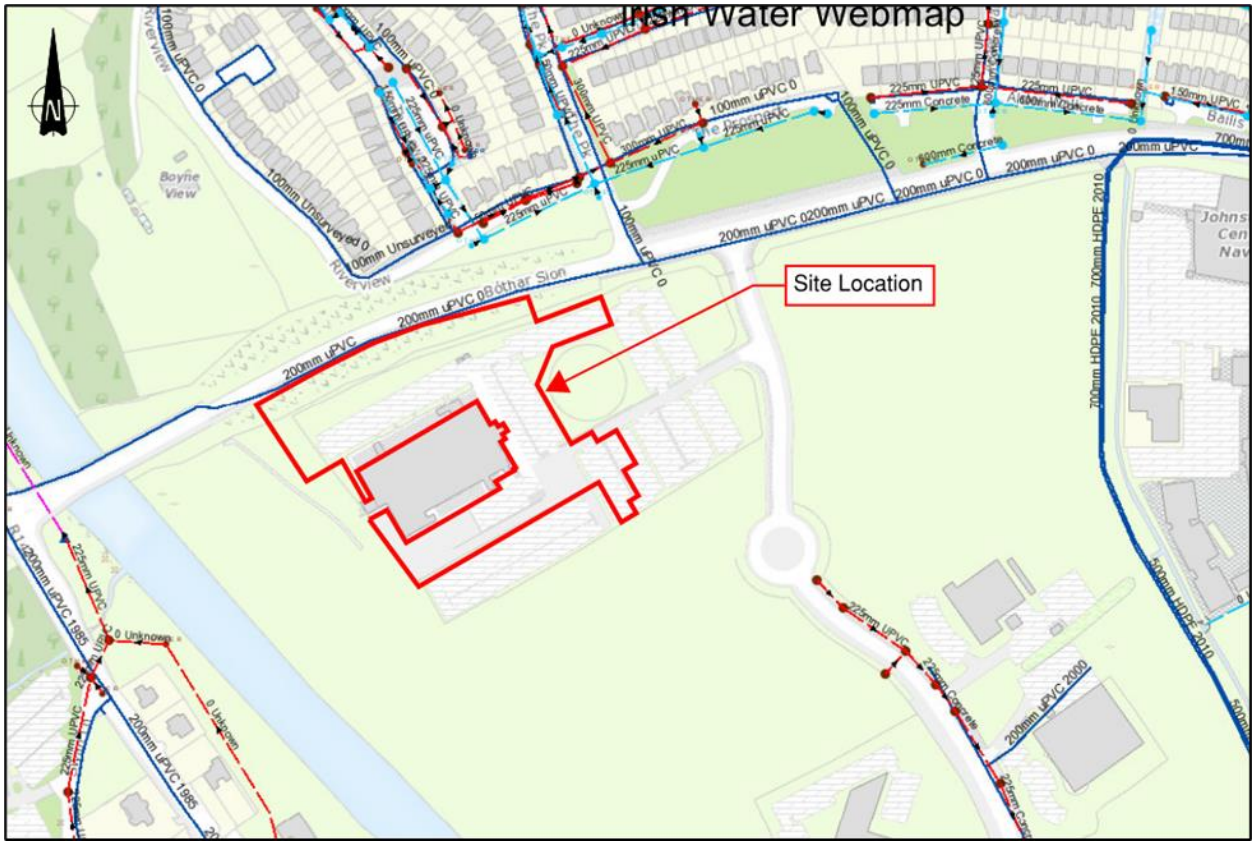


Figure 2-1: Existing Stormwater/ Foul Water Drainage Surrounding the Site (Extract from Irish Water/MCC Records)

2.1.2 Private Network

As Built Records and Ground Penetrating Radar Survey information are available for the site, which has confirmed the existing drainage arrangements in detail.

Based on available construction and as built drawings, the following stormwater exists in the vicinity of the site:

1. 3 no. 1500mm diameter, 77.5m in length used as below ground attenuation.
2. 4 no. 1050mm diameter pipes, 24m in length used as below ground attenuation.
3. At the downstream end of the 1500mm pipes there is a flow control device.
4. Upstream of the outfall manhole there is a Bypass Petrol Interceptor.

Please refer to Appendix B for As-Builts and Existing Survey Drawings illustrating the existing stormwater drainage arrangement.

2.2 Proposed Stormwater Drainage

2.2.1 General Design Approach

The proposed storm water drainage system has been designed using Causeway Flow software in accordance with the Department of Environment and Local Government's guidance document "Recommendations for Site Development Works for Housing Areas", with guidance taken from the "Greater Dublin Strategic Drainage Study" (GDSDS) and the Meath County Council Development Plan.

The proposed building extension is on top of existing over-sized pipes that serve as below ground attenuation for the wider site.

A new storm water sewer network shall be provided for the proposed development which will be entirely separated from the foul water sewer network. All storm water run-off from roof areas and hardstanding areas are designed to be collected by a gravity pipe network.

All proposed finished floor levels are 500mm above drainage water levels for a 100-year return period. The proposed stormwater drainage system will be designed with reference to the following documents:

- "Recommendations for Site Development Work for Housing Areas" – DOE
- "Greater Dublin Strategic Drainage Study" (GDSDS)
- Ciria Publications C644 – "Building Greener"
- Meath County Council Development Plan 2021-2027

2.2.2 Site Stormwater Drainage Overview

The storm water drainage for the proposed extension will be combined with the storm water drainage for the remainder of the site. The existing attenuation will be replaced, and associated drainage diverted.

The existing drainage infrastructure within the site to the north will be diverted to allow for the extension of the development. There are currently 3 no. 1500mm diameter storm water pipes within the site providing below ground attenuation to the north of the existing building. These pipes will be replaced with a new attenuation tank. There are also a further 4 no. 1050mm diameter stormwater pipes which serve as below ground attenuation to the west of the building, which are to be retained.

The proposed attenuation tank will service the proposed extension and will provide replacement for existing attenuation. Existing storm water drainage under the building will be demolished and a new storm water sewer diversion is proposed around the proposed extension.

A new hydrobrake is proposed at the outfall manhole and is to be sized based on existing and proposed site parameters.

2.2.3 Stormwater Drainage Modelling

The storm water drainage network has been designed using Causeway Flow software. A return period of 100 years was used throughout for pipeline design, with a 20% allowance for climate change.

The proposed development has been modelled with the FSR method, using Causeway Flow software. This software does not enable different runoff roughness values to be attributed to different areas. This software assumes all areas are impervious and have the same runoff characteristics.

2.2.4 Drainage Area

The proposed attenuation tank will service both the new extension and the remainder of the site that the previous attenuation tank drained.

Existing undeveloped and retained areas currently drained by the existing drainage and attenuation tank will have their drainage discharge reduced pro-rata compared to recorded discharge rates.

Proposed new development areas will have flow reduced in accordance with a new Qbar calculation.

2.2.5 Existing Flow Control

As built records indicate that the existing site has two hydrobrakes providing a final discharge rate of 19.9 l/s prior to discharge to the River Boyne. Please refer to As Built Records and utilities survey drawings in Appendix B.

2.2.6 Proposed Flow Control

The proposed site is to have its storm water flow controlled as summarised below:

1. Existing retained areas are to have a flow control reduced pro-rata compared to the existing flow control based on the ratio between existing site impervious area to retained existing site impervious area.
2. Proposed new development area is to have a flow control reduced to Qbar as explained in section 2.2.7, 2.2.8, and 2.2.9 below.
3. The total flow control discharge rate is proposed to be the combined sum of the retained area flow control and the new development flow control. Please refer to Table 2-1 below.

Table 2-1: Site Flow Control Calculation Summary

Ref.	Element	Area (sq. m)	Flow Control Discharge Rate (l/s)	Comment
1	Existing Area	26,464	19.9	Based on Drawing J6-110 SS-030 by Joseph O'Reilly Consulting Civil and Structural Engineers. Refer Appendix B.
2	Retained Existing Area	12,542	9.4	Pro-rata reduction from item 1 above
3	New development Area	11,036	4.1	Qbar as described in section 2.2.7, 2.2.8, and 2.2.9 below
	Total Site (No 2 + No 3)	**23,578**	**13.5**	

Refer to Figure 2-2 and Figure 2-3 below for illustration of the areas in Table 2-1 above. It can be seen from the above that the surface water discharge flow from the overall site is to be reduced compared to the existing discharge.

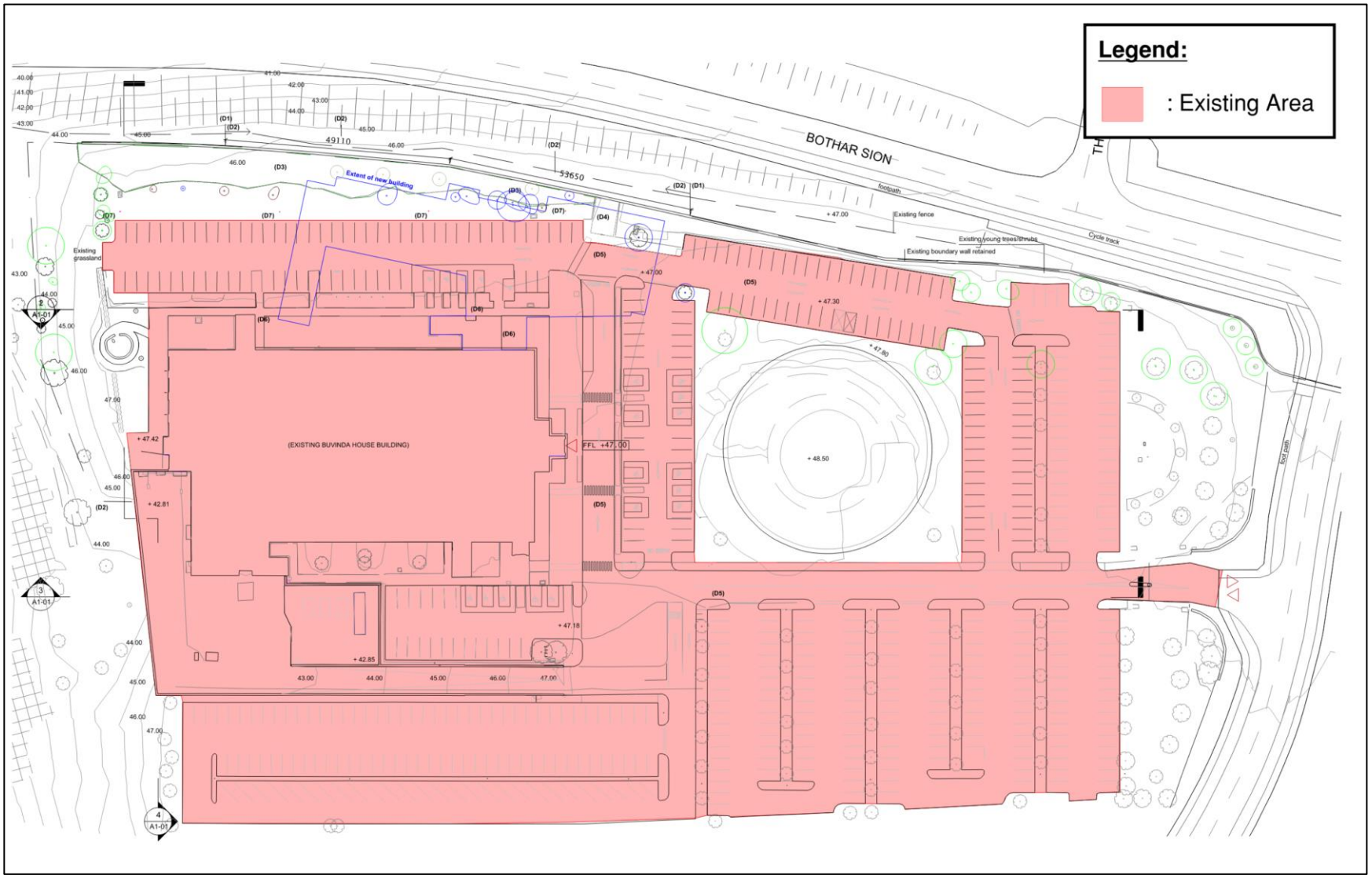


Figure 2-2: Existing Drainage Area

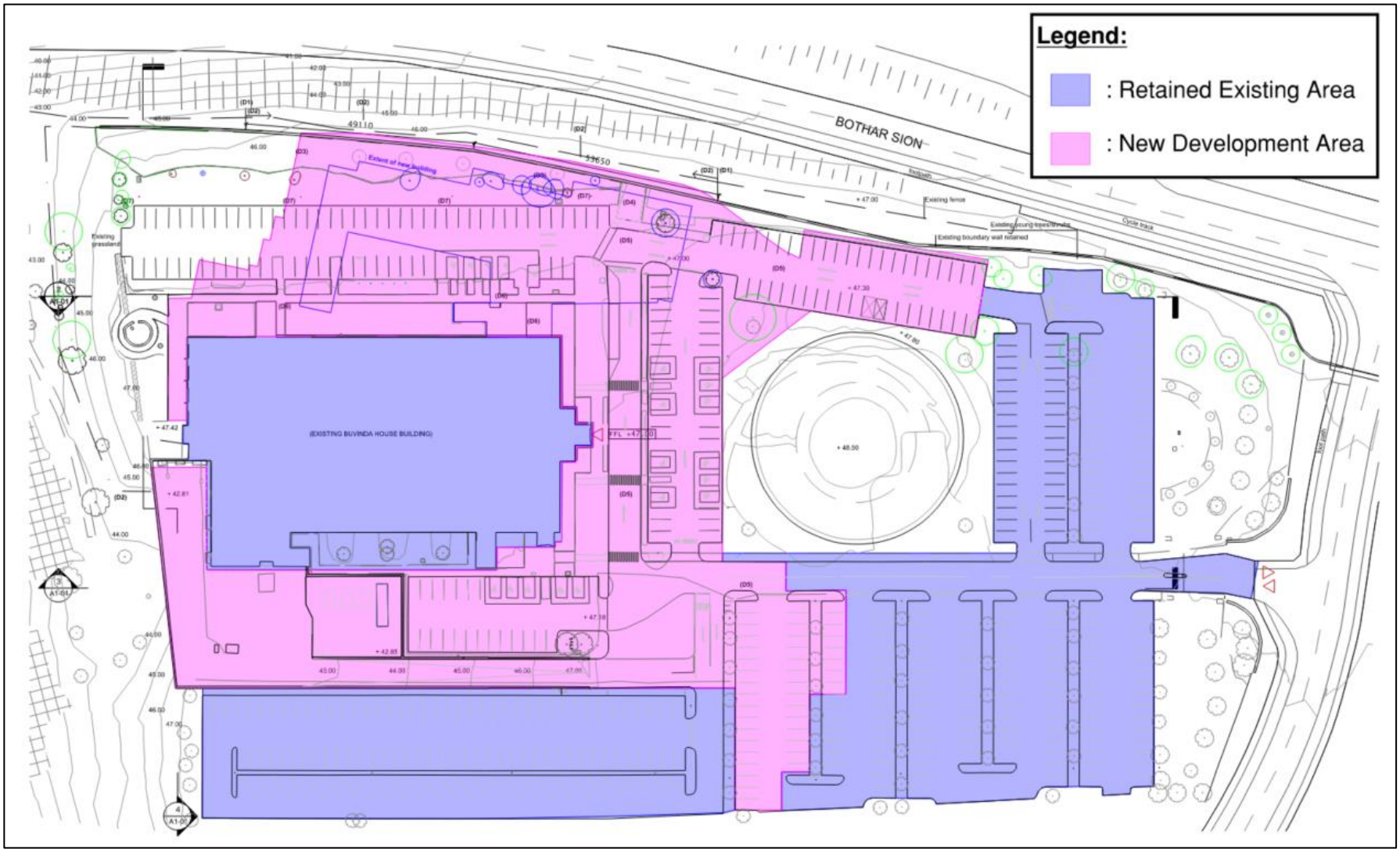


Figure 2-3: Retained Existing and New Development Drainage Areas

2.2.7 Qbar Calculation New Development Area - Soils and Geotechnical

The site investigation indicates that the soil type is made ground over sandy and silty soil, with areas of gravelly clay. GSI records indicate that the site is a gravelly geology. Please refer Figure 2-4 and Site Investigation Report included in Appendix F.

Based on this information, the site is taken to have an intermediate, silty poorly drained soil natural ground profile. Therefore, a SOIL type of 3 (medium runoff potential) has been utilised for the development, with a consequent SOIL value of 0.37 for the calculation of Qbar.

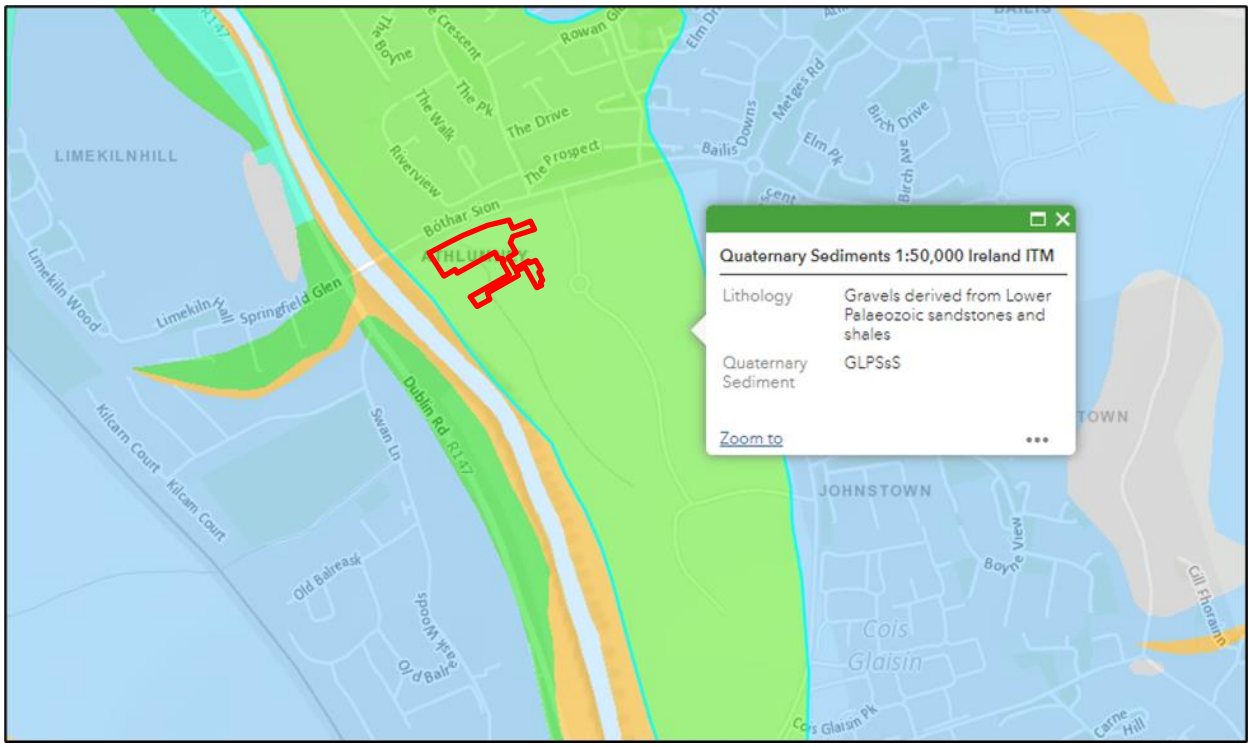


Figure 2-4: GSI Extract Map.

2.2.8 Qbar Calculation New Development - Rainfall

A value for the SAAR for the site has been obtained from MET Eireann website. This value is 859mm. Refer to Appendix G for details.

2.2.9 Qbar calculations – New Development

The following values have been used to calculate Qbar. Please note that the site area used for this calculation is as described in section 2.2.4 and 2.2.6 above, and not the entire site.

SAAR = 859mm (refer section 2.2.8 above)

Site impervious area = 11,036 square meters (AREA = $0.5km^2$)

SOIL = 0.37 (refer section 2.2.7 above)

To establish Qbar for a site less than 50Ha, Qbar for 50Ha is calculated, and then proportionately reduced to the actual site area.

Refer below for Qbar calculation:

Qbar for 50Ha

$$Qbar\ (50Ha) = 0.00108xAREA^{0.89}SAAR^{1.17}SOIL^{2.17} \div 1000$$

$$Qbar\ (50Ha) = 0.00108x0.50^{0.89}859^{1.17}0.37^{2.17} \div 1000 = 182.5l/s$$

Proportionate Qbar for 1.1 Ha:

$$Qbar\ (site) = \frac{Qbar(50Ha)\times Site\ area}{50}$$

$$Qbar\ (site) = \frac{182.5\times 1.21}{50} = 4.03l/s.$$

This results in a Qbar value of 4.03 l/s. The proposed stormwater sewers have been designed using Causeway Flow software. Table 2-1 describes the stormwater drainage design parameters used and detailed calculations are enclosed in Appendix C.

2.2.10 Attenuation Storage

As described in section 2.3.1, the SUDS proposed on the site are not effective at providing attenuation storage. The site design and allowable space also does not permit the use of other forms of attenuation storage i.e., ponds. As a result, the only possible solution within the site design is an attenuation tank.

Storm water collected from the site via the drainage network is proposed to be attenuated within the site in an underground attenuation tank, which caters to the 1:100-year storm event, plus 20% for climate change for the area drained.

The attenuation tank will be located at the north-western corner of the site, its outflow will be restricted to a discharge rate as described in section 2.2.9.

The attenuation tank serves as a combination of replacement for the existing removed attenuation tank and attenuating for the proposed building extension.

2.2.11 Storm Water Discharge Location

The existing storm water discharge location to the River Boyne is proposed to be retained. Refer section 2.2.5 for comments regarding flows.

2.2.12 Storm Water Drainage Summary

Please refer below table for summary of drainage design.

Table 2-1: Stormwater Drainage Design Summary

Description	Value
Total Impervious Site area	2.4 ha
Return period target	Pipe Design 1 in 5 years. Network Design 1 in 30 years + CC. Check 1 in 100 years + CC for flooding.
Climate Change	20%
M5-60	15.2
Ratio R	0.273
SOIL type	3 - intermediate silt
Soil value	0.37
SAAR	859mm
Flow reduction parameter	Qbar
Controlled Outflow	13.5 l/s
Flow restriction method	Hydrobrake
Drainage Connection Location	Existing discharge to river retained

Please see PUNCH drawing 182196-PUNCH-XX-XX-DR-C-0100 for the proposed storm water drainage layout including locations of hydrobrakes and volumes of storm water attenuation tank. Please refer to PUNCH drawing 182196-PUNCH-XX-XX-DR-C-0500 for attenuation tank detail and PUNCH drawing 182196-PUNCH-XX-XX-DR-C-0110 for drainage sections.

The final construction detail may deviate slightly from the planning design however the intent will remain. The final discharge location and the flow would not be adjusted. Refer to section 2.2.11 above.

2.3 Sustainable Urban Drainage System Proposals

The proposed development has been assessed in relation to Sustainable Urban Drainage Systems (SuDS). A variety of SuDS measures may be adopted to comply with Council recommendations. All SuDS measures are to be implemented with reference to the UK SuDs Manual and Meath County Council drainage requirements.

2.3.1 SuDS Effectiveness for Attenuation

Relatively small volumes of rainwater collected on the respective SuDS devices will enter the river discharge during typical low intensity storms. This is because the proposed SuDS measures will retain rainwater until it is either used via evapotranspiration in the green areas or reused within the development. With the exception of the attenuation tank, the SUDS systems are not effective at attenuating long duration storms or the large volumes of storm water that is required to be attenuated.

The SuDS processes decrease the impact of the development on the receiving environment by providing amenity and biodiversity in many cases. Regular maintenance of the SuDS proposals is required to ensure they are operating to their optimal level throughout their design life.

2.3.2 Green Roofs

Green roofs are areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of storm water runoff. It is proposed to provide a significant extent of green roofs within the development. These shall be provided at roof level in the form of sedum green roofs. Green roofs are widely recognised as an effective SuDS solution and an important tool in mitigating the adverse effects of development on rainfall run-off and for managing urban flood risk. The detail of the green roof as well as associated roof drainage and access systems are to be provided by the architect.

Research in the UK (Kellagher and Lauchlan, 2005, CIRIA, 2007) indicates that green roofs are effective in providing both attenuation and volume reduction in runoff for small rainfall events but suggests that these advantages are reduced (but not completely lost) for larger rainfall events.

Please refer to architectural documentation for location and layout of green roofs.

2.3.3 Rain Gardens

A proportion of surfaces are to runoff overland to rain gardens within the proposed courtyard area.

The proposed rain gardens will serve to provide treatment to pavement runoff for low intensity storms. Rainwater will be treated through evapotranspiration within the filter media of the rain garden structure.

These rain gardens are to comprise a landscape area with high permeability soil in the top 900mm depth. A perforated storm water drain is to be provided at a low level to drain any excess storm water.

The extent and detail of rain gardens is to be as per the landscape architects' drawings.

Any water that drains through the above-mentioned perforated drainage pipe will subsequently discharge to the main stormwater drainage system.

Refer to landscape architects / architects' documentation for specific locations of rain gardens

2.3.4 Attenuation Tank

The proposed attenuation tank is sized to reduce the peak runoff from the site.

2.3.5 Petrol Interceptor

A new petrol interceptor is proposed before the new attenuation tank.

2.3.6 Summary and overview of SUDS effectiveness

The combination of the above noted elements shall allow the proposed development to adhere to the principles of sustainable drainage practices while enhancing overall storm water quality.

There are several benefits from the promotion of these SuDS elements within the development, below is a list of such benefits:

- **Biodiversity and Ecology**: Habitats are maintained, created & linked to support existing & new wildlife. This increases biodiversity & improves the quality of ecosystems in urban environments.

- **Amenity and Economy**: Access to open, green spaces allows for activities such as walking, cycling & organised sports. This improves the physical & mental health & wellbeing of communities.

- **Water Quality**: SuDS filter sediment & contaminants from runoff which improves quality. They intercept rainfall & reduce the volume entering sewers & drains, reducing combined sewer overflow and the amount that needs treating.

- **Flood Risk Management**: SuDS mimic natural drainage patterns & reduce the volume of runoff reaching drains & watercourses. They provide areas to store water & slow the flow of water to reduce flood risk in urban areas. SUDS proposed as part of this development provide limited flood mitigation. The primary surface water volume control is the proposed below ground surface water attenuation tank.

- **Climate Resilience**: Vegetation and plants used, e.g. landscaped open spaces, can capture & store carbon and greenhouse gases to improve air quality. They can also regulate building temperatures and reduce air & water pollution.

3 Foul Water Drainage Design

3.1 Existing Foul Water Drainage

Based on available Irish Water record, the following public foul water drainage exists adjacent to the development site:

1. 225mm uPVC Concrete foul sewer flowing north south along the access road to the IDA business & Technology Park as shown in Figure 3-1.

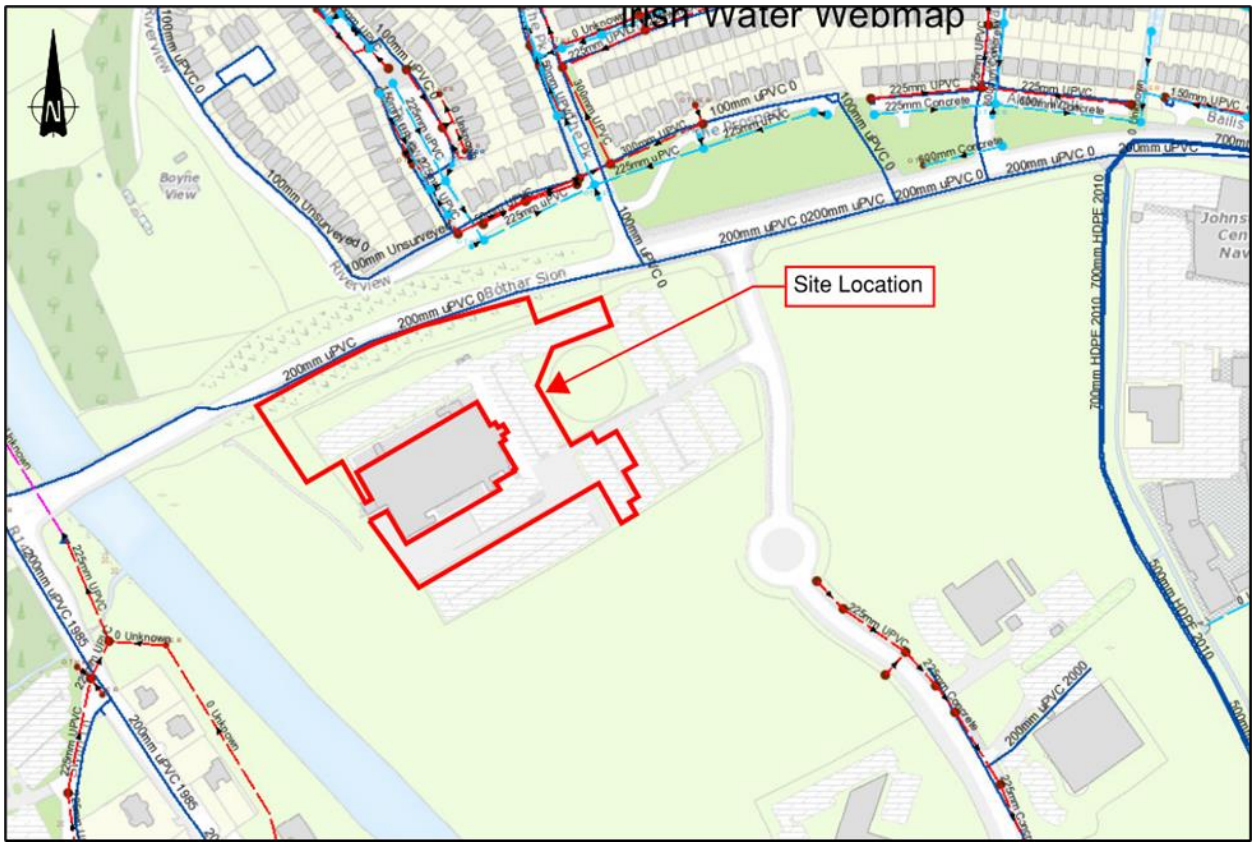


Figure 3-1: Existing Foul Water Drainage Surrounding the Site (Extract from Irish Water/MCC Records)

Based on available construction and as built drawings, the following foul water drainage exists within the site:

1. Foul drainage for existing building is drained to a foul pump station to the south of the site. It is then pumped to the 225mm uPVC concrete foul sewer on the IDA Business Park Access Road to the south of the site.

As Built Records and Ground Penetrating Radar Survey information is available for the site, which has confirmed the existing drainage arrangements in detail.

Please refer to Appendix B for Existing Survey Drawings illustrating the existing foul water drainage arrangement.

3.2 Proposed Foul Water Drainage

The proposed foul water sewers have been designed using Causeway Flow software in accordance with the DOE's "*Recommendations for Site Development Works for Housing Areas*". The foul loading has been calculated in accordance with "Code of Practice for Wastewater Infrastructure" (particularly clause 36, Appendix C and Appendix D) published by Irish Water.

It is proposed to connect the development sewerage via a new gravity foul sewer network that connects to the existing drainage that discharges to the existing pump station in the lower yard area to the south of the existing building, through the car park.

The pump station is to be retained and to be provided with below ground 24-hour wastewater storage for the development, including necessary additional storage for the extension. Please refer Table 3-2. The existing foul sewer discharge route to existing wastewater sewerage is to be retained.

Table 3-1 describes the foul water drainage design parameters used and detailed calculations are enclosed in Appendix B.

Table 3-1: Foul Water Drainage Design Parameters

Description	Value
Commercial Flow Rate	750 l/100m2/day
Infiltration	10%
Peaking Factor	4.5 DWF (Commercial)
Minimum Self Cleansing Velocity	0.75m/s
Minimum Pipe Diameter	150mm

Table 3-2 Foul Water Drainage Flows and Daily Storage

Category	Area	Flow Rate	Daily Flow / Storage Requirement (cubic metres/day)	DWF (l/s)	Design Peak Flow (4.5DWF) (l/s)
Existing Offices	7,710	825 l/per/day	63.6	0.73	3.3
Proposed Offices	3,220	825 l/per/day	26.6	0.31	1.4
Total	**10,930**		**90.2**	**1.04**	**4.7**

A confirmation of feasibility has been received from Irish Water in relation to the proposed development. Please refer to Appendix E for Irish Water correspondence.

Please see PUNCH drawing 182196-PUNCH-XX-XX-DR-C-0100 for the proposed foul sewer layout. Please refer PUNCH drawing 182196-PUNCH-XX-XX-DR-C-110 for drainage sections.

The final construction detail may deviate slightly from the planning design however the intent will remain.

4 Watermain Design

4.1 Existing Watermain

1. 200mm uPVC watermain to the north of the site as indicated in Figure 2-1.

Ground Penetrating Radar Survey information is available for the site, which has indicated an existing watermain infrastructure exists within the northern section of the site.

Please refer to Appendix A for Irish water records for the area and to Appendix B for record and survey drawings illustrating the existing watermain arrangement on site.

4.2 Proposed Watermain

It is generally accepted that the design loading for foul drainage can be used to evaluate an approximation of the water demand on the site. With reference to Irish Water's Code of Practice for Water Infrastructure, the average daily flow is calculated as the number of persons multiplied by the flow rate per person. The average day peak week flow is taken to be 1.25 x the average flow, and the peak demand is taken to be the average day peak week flow multiplied by a peaking factor of 5.

Table 4-1 describes the watermain design parameters used.

Table 4-4-1: Watermain Design Parameters

Description	Value
Commercial Flow Rate	750 l/100m2/day
Average Demand	1.25 DWF
Peak Demand	5 DWF

Table 4-2: Watermain Demands

Category	Floor Area	Flow Rate	Average Daily Demand (m^3/day)	Average Demand (1.25DWF) (l/s)	Peak Demand (5DWF) (l/s)
Existing Office	7,710	750 l/per/day	57.8	0.8	4.1
Proposed Office	3,220	750 l/per/day	24.2	0.4	1.7
Total	**10,930**		**82.0**	**1.2**	**5.9**

The watermain layout has been designed in accordance with "Irish Water Code of Practice for Water Infrastructure". All watermains are to be constructed in accordance with Irish Water Code of Practice and the Local Authority's requirements. Fire coverage is to be reviewed and certified by the fire consultant.

This feed will provide potable and firefighting water to the proposed development. The existing water meter serving the site will be retained for the proposed development. Fire coverage is to be reviewed and certified by the fire consultant.

To reduce the water demand on Local Authority water supplies and to reduce the foul discharge from the development, water conservation measures will be incorporated in the sanitary facilities throughout the development, e.g., dual flush toilets, monobloc low volume push taps and waterless urinals.

A Confirmation of Feasibility has been received from Irish Water for the proposed development. Please refer to Appendix E for Confirmation of Feasibility Letter.

See PUNCH drawing 182196-PUNCH-XX-XX-DR-C-0300 for the proposed watermain layout.

5 Roads and Access

5.1 Proposed Roads & Access

Access to the site will be off the existing access road to the IDA business & Technology Park, via the Bóthar Sion road.

The on-site vehicle access area comprises an on-grade car park. The majority of this is existing and to be retained. New areas have been provided with appropriate speed limits and associated vehicle movement controls.

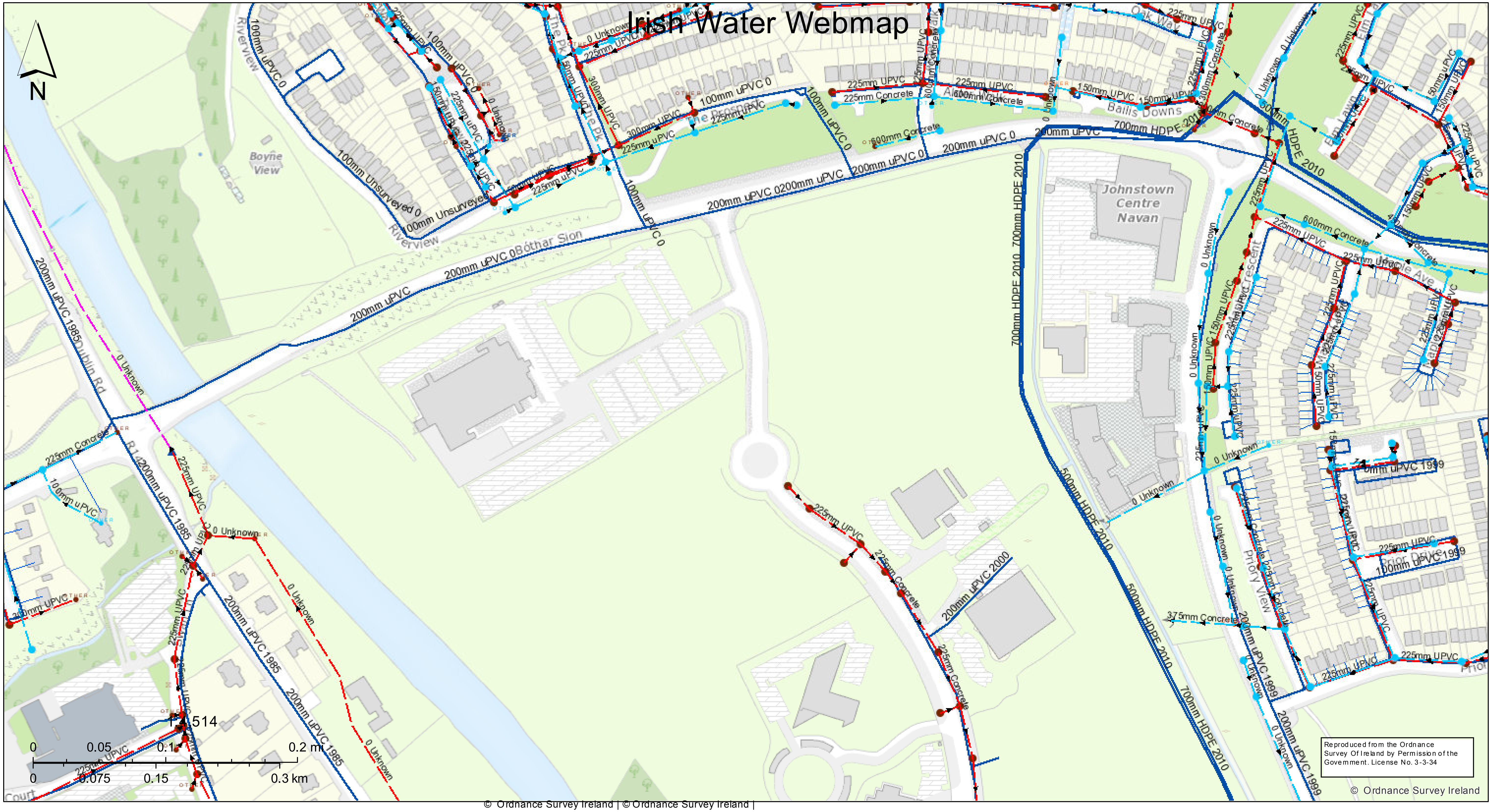
5.2 Car park rearrangement

The existing car park is to be rearranged to accommodate the development. Refer to architectural site plan and Mobility Management Plan *182196-PUNCH-XX-XX-RP-C-0004* accompanying this report for further information.

5.3 Autotrack

Autotrack assessments were carried out on the proposed road and car park network and demonstrate that a fire tender can safely negotiate the proposed car park network. Please refer PUNCH Drawings *182196-PUNCH-XX-XX-DR-C-0601* and *182196-PUNCH-XX-XX-DR-C-0602* for autotrack diagrams.

Appendix A Existing Record Drawings



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Legend

Stormwater Gravity Mains (Irish Water Owned)

- Surface

Stormwater Gravity Mains (Non-Irish Water Owned)

- Surface

Storm Manholes

- Cascade
- Catchpit
- Hatchbox

Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland. It should not be relied upon in the event of excavations or other works being carried out in the vicinity of the network. The onus is on the parties carrying out the works to ensure the exact location of the network is identified prior to mechanical works being carried out. Service pipes are not generally shown but their presence should be anticipated. © Irish Water

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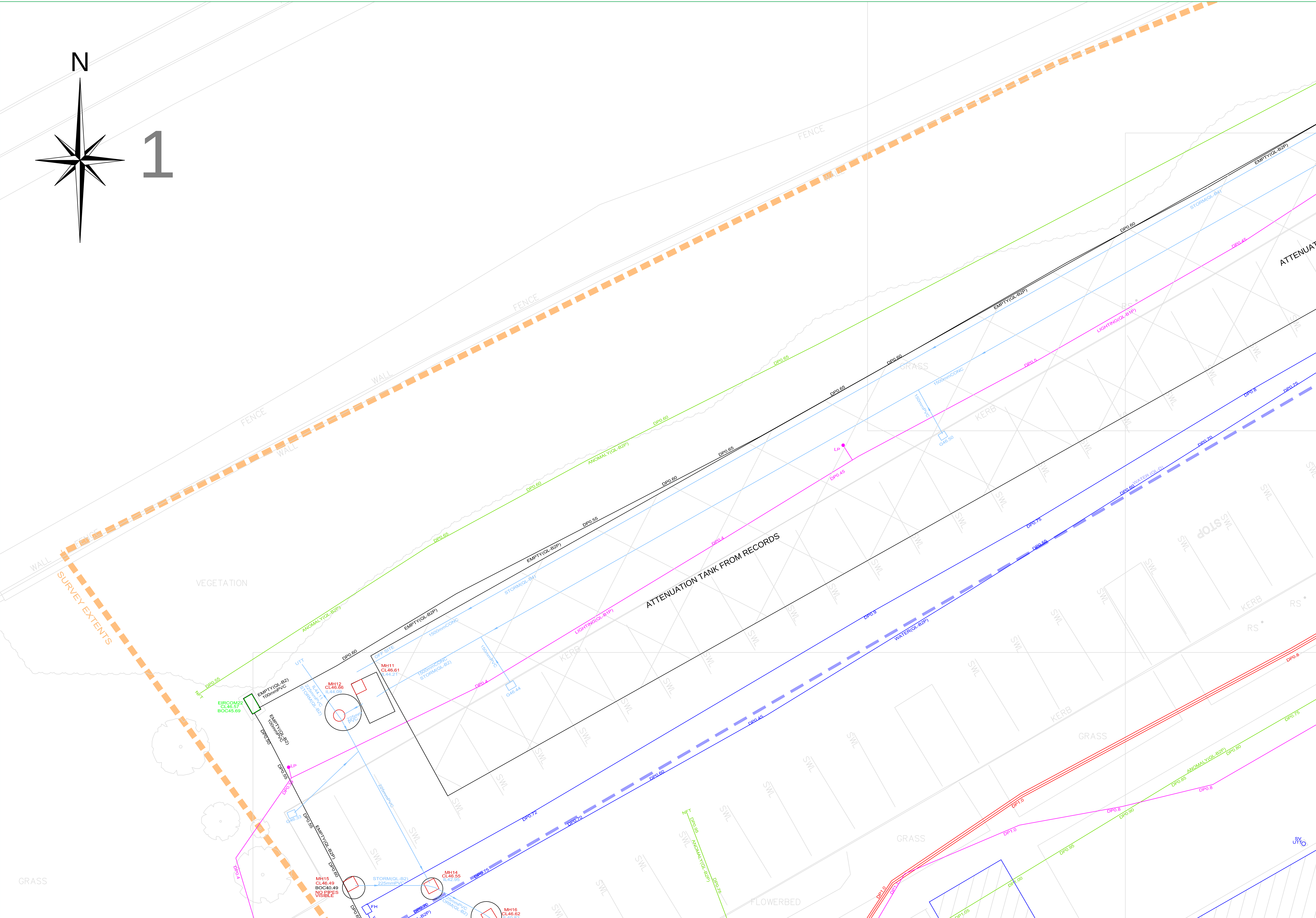
Appendix B Survey and As-Built Drawings



PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH	
QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
DETECTION	
QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
QL-B3	Horizontal location only of the utility detected by one of the geophysical techniques used
QL-B2	Horizontal and vertical location of the utility detected by one of the geophysical techniques used
QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques
VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

Apex Surveys Ltd. Disclaimer - Utility Survey

The interpretative nature and the non-intrusive, indirect and non-destructive survey methods must be taken into account when considering the results of the surveys. Therefore Apex Surveys, while using appropriate practice to execute, interpret and present the data, gives no guarantees that all underground utilities and underground structures will be located and mapped. Furthermore, Apex Surveys cannot guarantee the accuracy of the utility depths annotated on the survey drawings.
Apex Survey shall not be liable for any omissions or inaccuracies in the survey which arise due to the limitations of the service. No liability shall attach to Apex Surveys, in any circumstances, howsoever arising, in respect of any consequential loss or damages suffered by the Client.

The following is a non-exhaustive list of the limitations of utility surveys:

The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located. Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- Size of Utility: The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
- Signal Jumping: Signal from surrounding services may 'jump' to a highly conductive line masking its true identity.
- Shadowing: (of deeper utilities by shallower objects) Shallow utilities will mask the existence of deeper utilities where they are in close proximity. Also, high reflective materials close to the surface i.e rebar may hide deeper anomalies.
- Surface Obstructions: The GPR system relies on a relatively flat and even surface on which to perform radar passes. If ground obstructions such as vehicles, organic material (long grass, scrub) or undulating ground surface are present then the acquired data will be of lower resolution and in some cases not viable.
- Loss of signal: It is not always possible to trace the entire length of each underground service.
- Connections between manholes: Connections between manhole chambers are assumed to be straight.
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Accuracy estimates:

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00353 1 691 0156

STREET FURNITURE :

BOLLARDS	BD
BUS STOP	BS
CRASH BARRIER	CB
GATE	
ELECTRICITY POLE	EP
TELEPHONE POLE	TP
EARTHING ROD	ER
LAMP POST	LP
MARKER POST	MKR
SIGN POST	SIGN
TRAFFIC LIGHT	TL
TELEPHONE BOX	TB
POST	POST
POST BOX	POST BOX
ROADSIGN	RS · RS
BORE HOLE	BH
TRIAL PIT	TPIT
BOTTOM OF CHAMBER	BOC
CAST-IRON	C/I
CONCRETE	CONC
DIAMETER	DIA

SERVICES :

AIR VALVE	AV
ARMSTRONG JUNCTION	AJ
CABLE TV IC	CATV
COVER LEVEL	CL
EIRCOM COVER	EIRCOM
EIRCOM JUNCTION BOX	EIRCOM BOX
ELECTRICAL CABLE PIT	ECP
ESAT COVER	ESAT
ESB COVER	ESB
ESB JUNCTION BOX	ESB BOX
FIRE HYDRANT	FH
GAS VALVE	GV
GULLY	G
INSPECTION COVER	IC
MANHOLE	MH
SEPTIC TANK	SEPTIC
SLUICE VALVE	SV
DOWNPIPE	DP
EARTHENWARE	E/W
NO FURTHER TRACE	NFT
OFFSITE	O/S

STOPCOCK	ST
SERVICE BOX (UNKNOWN)	BOX
TRAFFIC COVER	TLIC
VENT	VENT
WATER METER	WM +

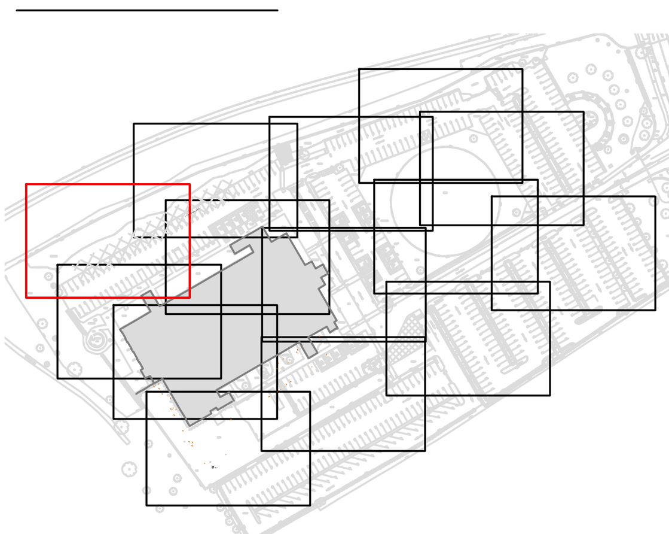
LEVELS :

BED LEVEL	+ BED101.50
FLOOR LEVEL	+ FL101.50
INVERT LEVEL	+ IL101.50
ROAD LEVEL	+ 101.50
SOFFIT LEVEL	+ SL101.50
SPOT LEVEL	+ 101.50
TOP OF WALL LEVEL	+ TOW101.50
WATER LEVEL	+ WL101.50
SURVEY CONTROL STATION	
START OF RUN	SOR
UNABLE TO OPEN	UTO
UNABLE TO TRACE	UTT

UNDERGROUND LEGEND :

WATER MAIN	WATER
GAS MAIN	GAS
STORM DRAIN	STORM
FOUL SEWER	FOUL
COMBINED SEWER	COMB
ELECTRIC CABLE	POWER
ELECTRIC LIGHTING	LIGHTING
EIRCOM	EIRCOM
FIBRE OPTIC CABLE	F.OPTIC
BROADBAND	BROADBAND
CABLE TV	TV
TRAFFIC AND SIGNAL CABLE	TRAFFIC
CCTV	CCTV
IRRIGATION PIPE	IRRIGATION
EMPTY DUCT	EMPTY
GPR ANOMALY	ANOMALY
UNKNOWN CABLE	CABLE
O/HEAD ELECTRICITY	OE
O/HEAD TELECOM	OT

SHEET LAYOUT :



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CLIENT:

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GRID SYSTEM: Irish Transverse Mercator
DATUM: Malin Head (OSGM15)
NOTES: Drawing Contains Scale Factor

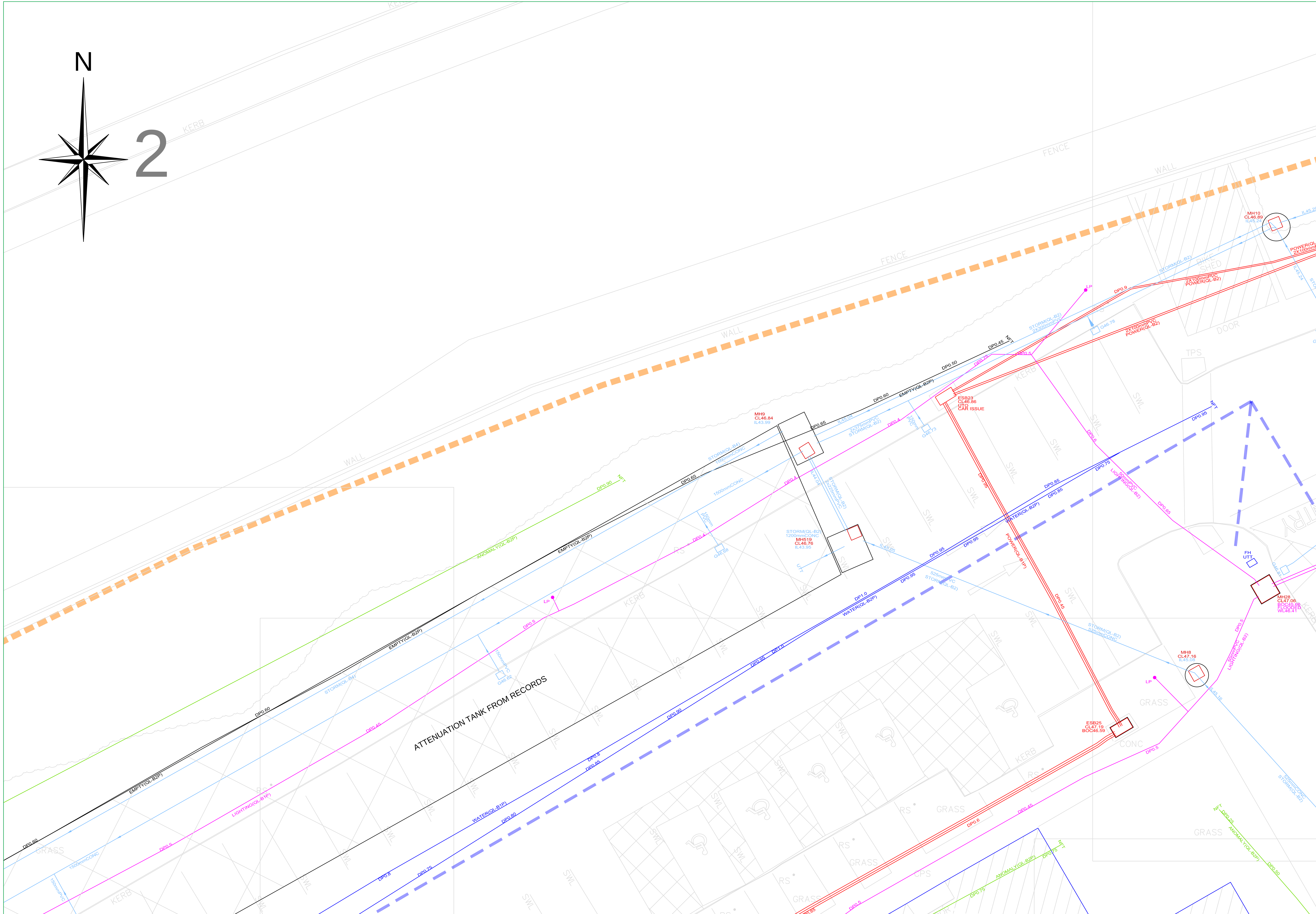
REVISIONS:

No.	Date	Description
001	N/A	Original Drawing
002	22/09/22	Additional Information Added
003	26/10/22	Additional Information Added

PROJECT:

Buvinda Housing Extension, Co. Meath

SCALE :	1/100 A1	DATE :	15/08/2022
DRG No:	5244	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Heitor Lapinskas
SHEET:	1 of 14	PROCESSED BY :	Muna Satardien
		CHECKED BY :	Alan Brady



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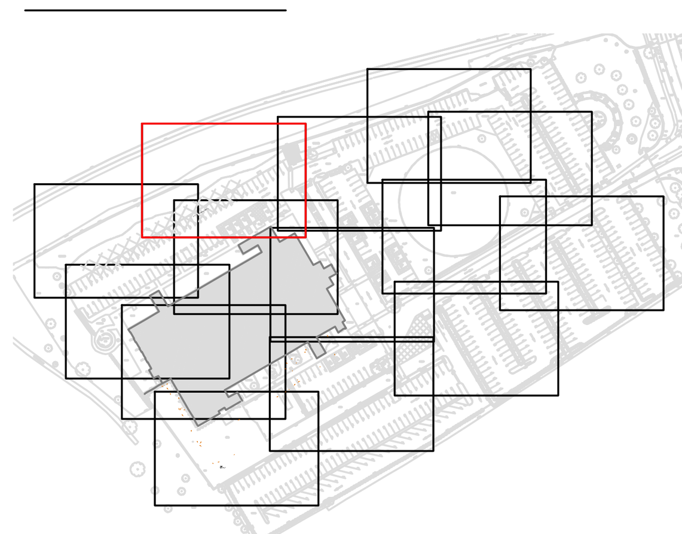

PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH

QL-D	Drafted from utility records

SITE RECONNAISSANCE

QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars

DETECTION

QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
QL-B3	Horizontal location only of the utility detected by one of the geophysical techniques used
QL-B2	Horizontal and vertical location of the utility detected by one of the geophysical techniques used
QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques

VERIFICATION

QL-A	Horizontal and vertical location of the top and/or bottom of the utility

Apex Surveys Ltd. Disclaimer - Utility Survey

The interpretative nature and the non-intrusive, indirect and non-destructive survey methods must be taken into account when considering the results of the surveys. Therefore Apex Surveys, while using appropriate practice to execute, interpret and present the data, gives no guarantees that all underground utilities and underground structures will be located and mapped. Furthermore, Apex Surveys cannot guarantee the accuracy of the utility depths annotated on the survey drawings.
Apex Survey shall not be liable for any omissions or inaccuracies in the survey which arise due to the limitations of the service. No liability shall attach to Apex Surveys, in any circumstances, howsoever arising, in respect of any consequential loss or damages suffered by the Client.

The following is a non-exhaustive list of the limitations of utility surveys:

The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located. Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- Size of Utility: The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
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GRID SYSTEM:	Irish Transverse Mercator
DATUM:	Malin Head (OSGM15)
NOTES:	Drawing Contains Scale Factor

REVISIONS:

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002	22/09/22	Additional Information Added
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SCALE :	1/100 A1	DATE :	15/08/2022
DRG No:	5244	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Heitor Lapinskas
SHEET:	2 of 14	PROCESSED BY :	Muna Satardien
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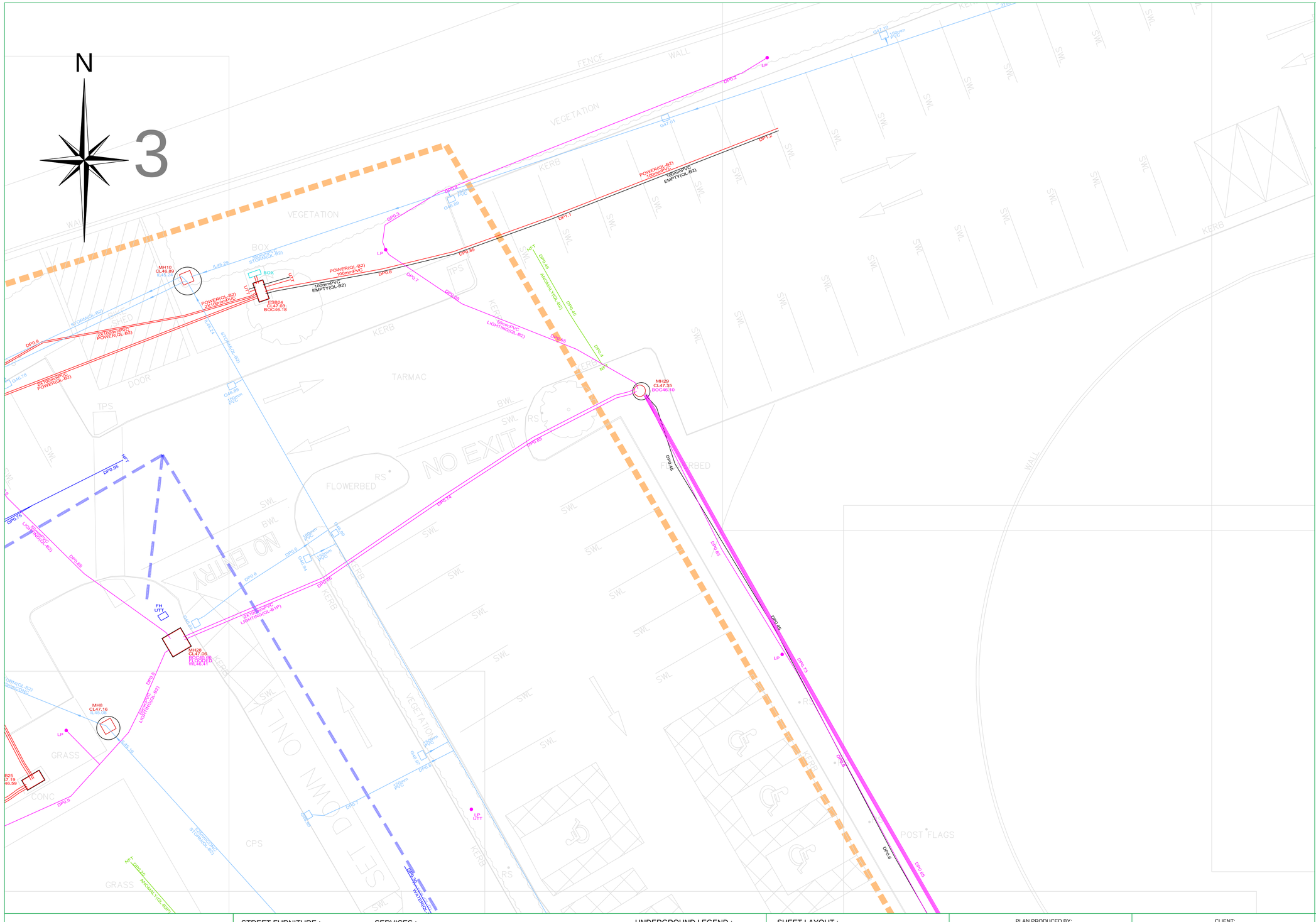

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VERIFICATION	
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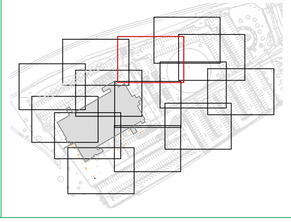

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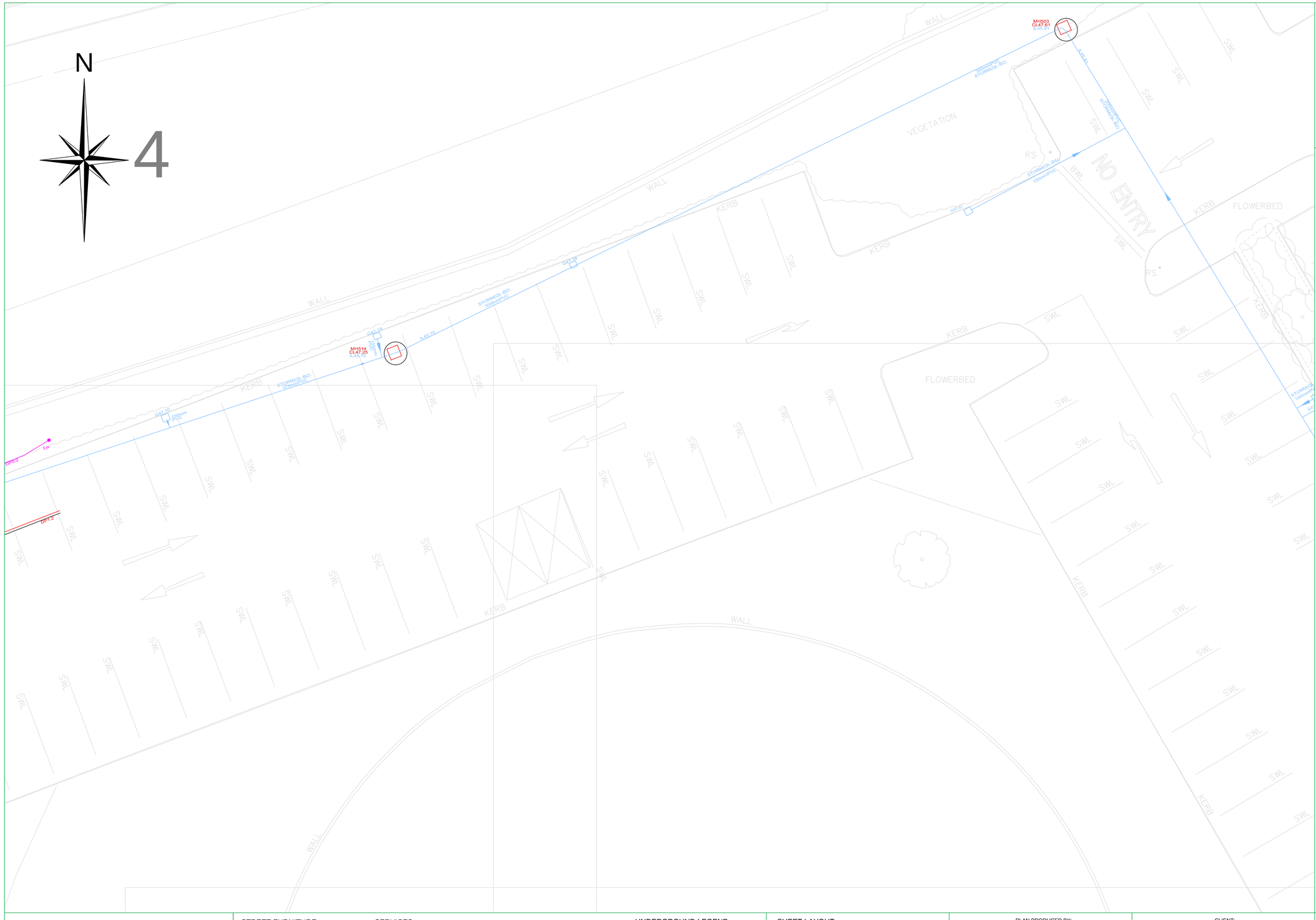

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VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

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STREET FURNITURE :

BOLLARDS	BD •	BOTTOM OF CHAMBER	BOC
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CRASH BARRIER	CB	CONCRETE	CONC
GATE		DIAMETER	DIA
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EARTHING ROD	ER +		
LAMP POST	LP •		
MARKER POST	MKR •		
SIGN POST	SIGN		
TRAFFIC LIGHT	TL •		
TELEPHONE BOX	TB		
POST	POST •		
POST BOX	POST BOX		
ROADSIGN	RS · RS		
BORE HOLE	BH +		
TRIAL PIT	TPIT +		

SERVICES :

AIR VALVE	AV	DOWNPIPE	DP
ARMSTRONG JUNCTION	AJ	EARTHENWARE	E/W
CABLE TV IC	CATV	NO FURTHER TRACE	NFT
COVER LEVEL	CL	OFFSITE	O/S
EIRCOM COVER	EIRCOM		
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STOPCOCK	ST •	START OF RUN	SOR
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LEVELS :

BED LEVEL	+ BED101.50
FLOOR LEVEL	+ FL101.50
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ROAD LEVEL	+ 101.50
SOFFIT LEVEL	+ SL101.50
SPOT LEVEL	+ 101.50
TOP OF WALL LEVEL	+ TOW101.50
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SURVEY CONTROL STATION	

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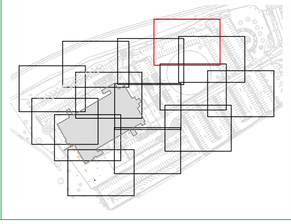
SHEET LAYOUT :



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PROJECT:

Buvinda Housing Extension, Co. Meath

GRID SYSTEM:	Irish Transverse Mercator
DATUM:	Malin Head (OSGM15)
NOTES:	Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	N/A	Original Drawing
002	22/09/22	Additional Information Added
003	26/10/22	Additional Information Added

SCALE :	1/100 A1
DATE :	15/08/2022
DRG No:	5244
DESCRIPTION :	2D Utilities
SURVEYED BY :	Heitor Lapinskas
SHEET:	4 of 14
PROCESSED BY :	Muna Satardien
CHECKED BY :	Alan Brady

PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH	
QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
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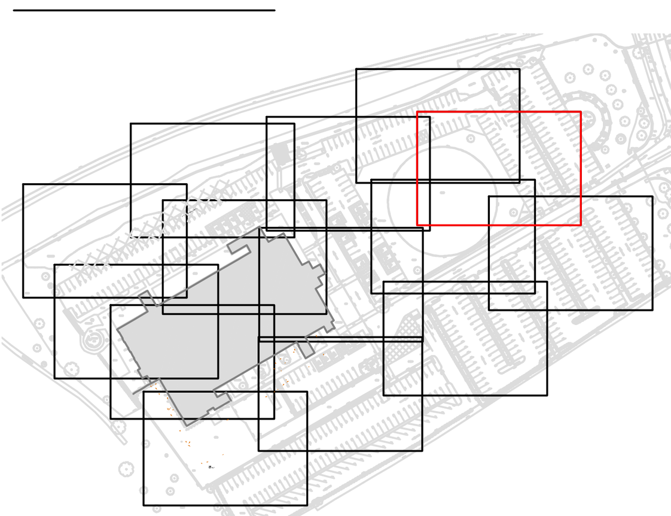

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SCALE : 1/100 A1

DATE : 15/08/2022

DRG No: 5244

SHEET: 5 of 14

DESCRIPTION : 2D Utilities
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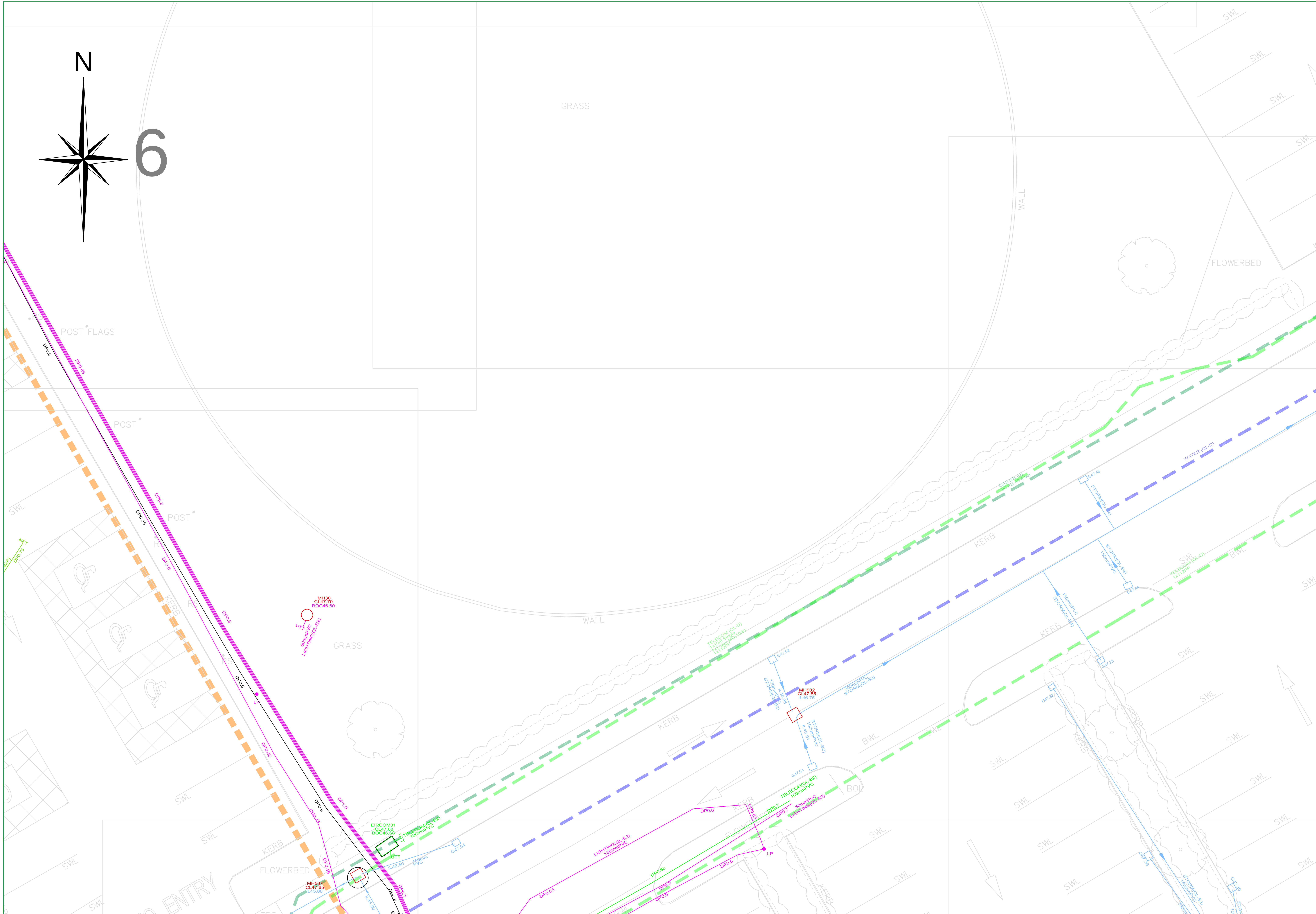

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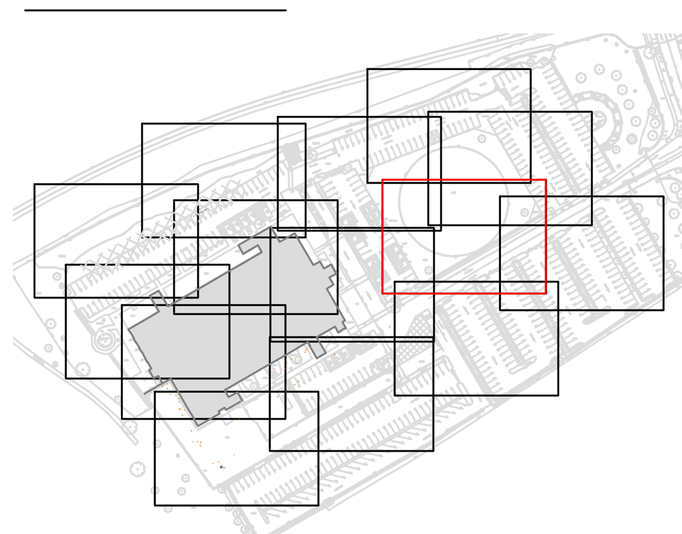

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Dunboyne, Co. Meath, Ireland
www.apexsurveys.ie
info@apexsurveys.ie
00353 1 691 0156

CLIENT:

Punch & Partners Consulting

GRID SYSTEM:	Irish Transverse Mercator
DATUM:	Malin Head (OSGM15)
NOTES:	Drawing Contains Scale Factor

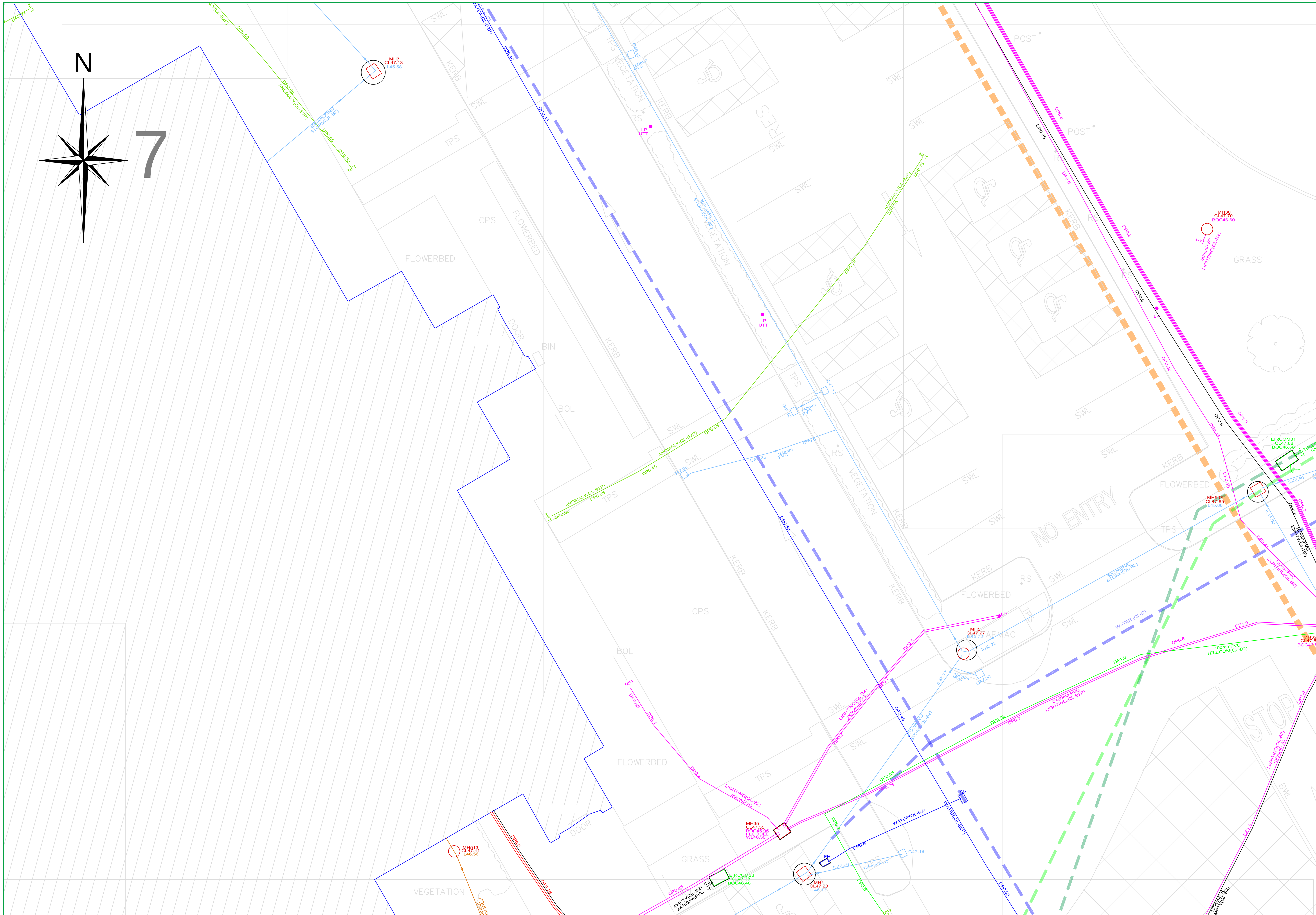
REVISIONS:

No.	Date	Description
001	N/A	Original Drawing
002	22/09/22	Additional Information Added
003	26/10/22	Additional Information Added

PROJECT:

Buvinda Housing Extension, Co. Meath

SCALE :	1/100 A1	DATE :	15/08/2022
DRG No:	5244	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Heitor Lapinskas
SHEET:	6 of 14	PROCESSED BY :	Muna Satardien
		CHECKED BY :	Alan Brady



PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH	
QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
DETECTION	
QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
QL-B3	Horizontal location only of the utility detected by one of the geophysical techniques used
QL-B2	Horizontal and vertical location of the utility detected by one of the geophysical techniques used
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VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

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The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located. Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- Size of Utility: The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
- Signal Jumping: Signal from surrounding services may 'jump' to a highly conductive line masking its true identity.
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Accuracy estimates:

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GATE	
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VENT	VENT
WATER METER	WM

LEVELS :

BED LEVEL	BED101.50
FLOOR LEVEL	FL101.50
INVERT LEVEL	IL101.50
ROAD LEVEL	101.50
SOFFIT LEVEL	SL101.50
SPOT LEVEL	101.50
TOP OF WALL LEVEL	TOW101.50
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SURVEY CONTROL STATION	
START OF RUN	SOR
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UNDERGROUND LEGEND :

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STORM DRAIN	STORM
FOUL SEWER	FOUL
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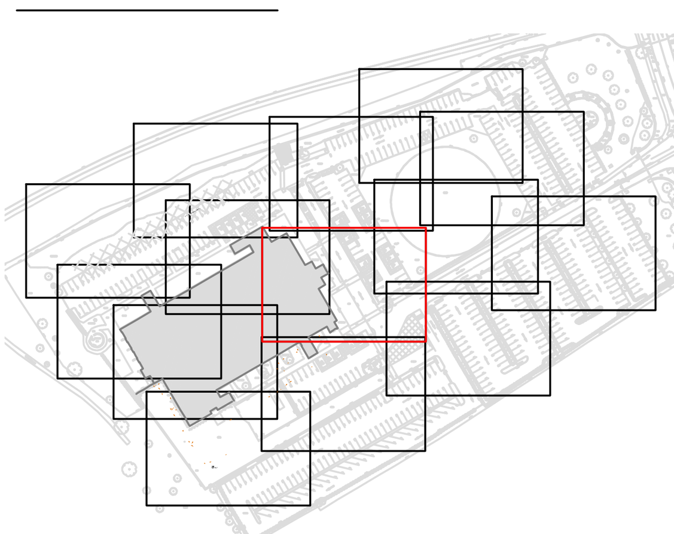
SHEET LAYOUT :



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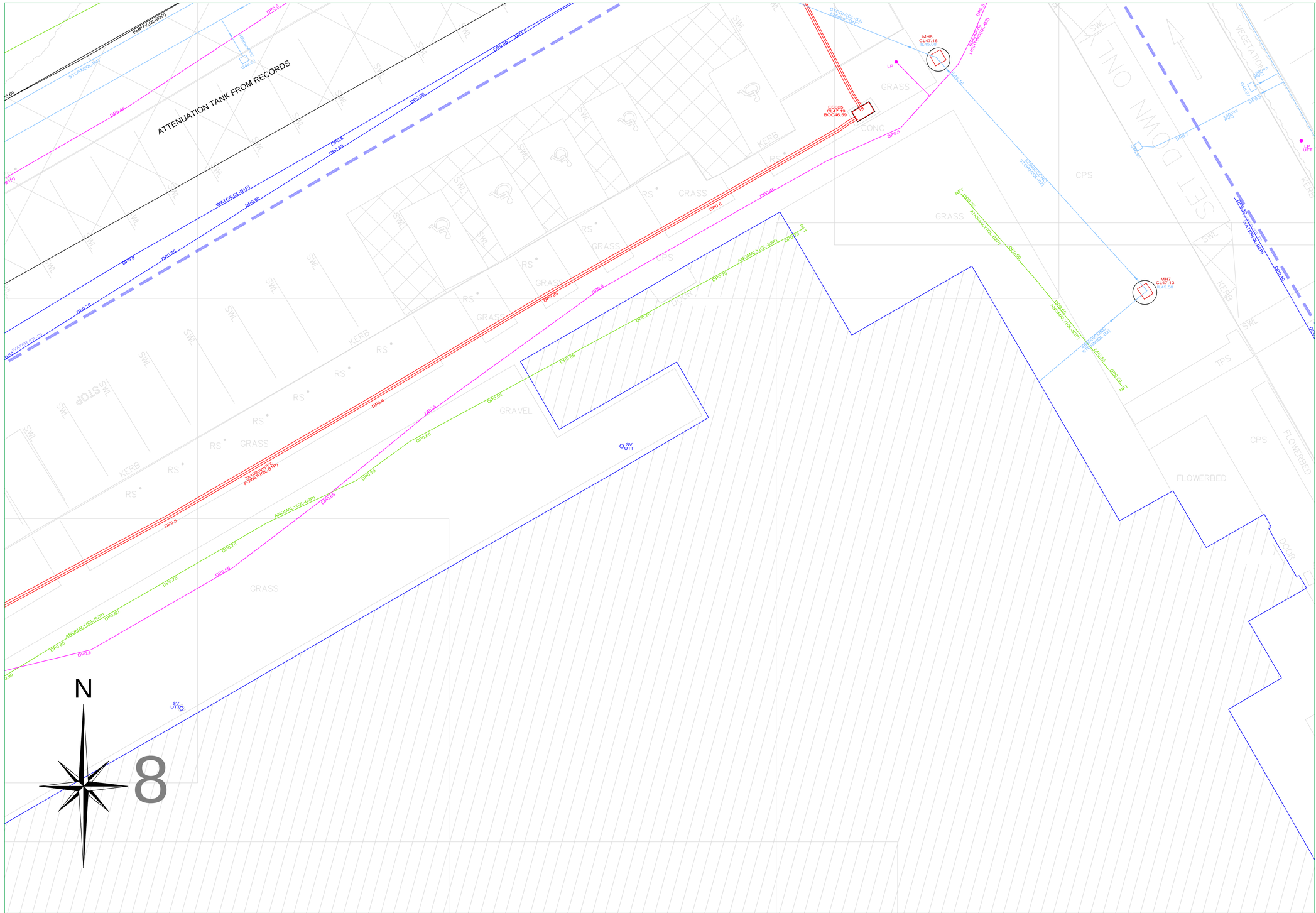

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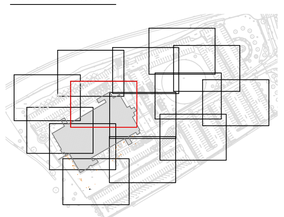

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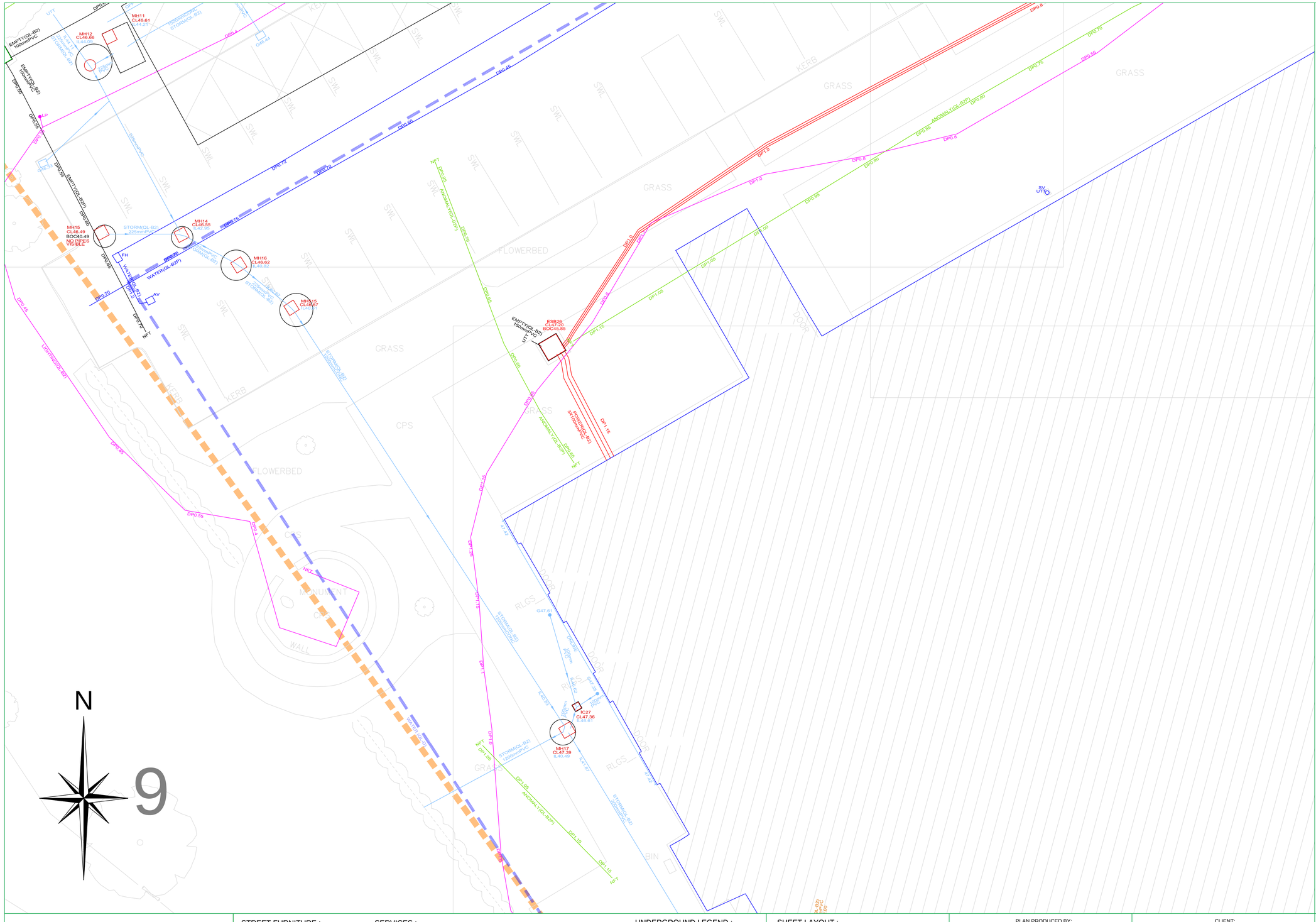

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SLUICE VALVE	SV	•

STOPCOCK	ST	•
SERVICE BOX (UNKNOWN)	BOX	
TRAFFIC COVER	TLIC	
VENT	VENT	•
WATER METER	WM	+

LEVELS :

BED LEVEL	+ BED101.50
FLOOR LEVEL	+ FL101.50
INVERT LEVEL	+ IL101.50
ROAD LEVEL	+ 101.50
SOFFIT LEVEL	+ SL101.50
SPOT LEVEL	+ 101.50
TOP OF WALL LEVEL	+ TOW101.50
WATER LEVEL	+ WL101.50
SURVEY CONTROL STATION	

BOTTOM OF CHAMBER	BOC	DOWNPIPE	DP
CAST-IRON	C/I	EARTHENWARE	E/W
CONCRETE	CONC	NO FURTHER TRACE	NFT
DIAMETER	DIA	OFFSITE	O/S
START OF RUN	SOR		
UNABLE TO OPEN	UTO		
UNABLE TO TRACE	UTT		

UNDERGROUND LEGEND :

WATER MAIN	WATER
GAS MAIN	GAS
STORM DRAIN	STORM
FOUL SEWER	FOUL
COMBINED SEWER	COMB
ELECTRIC CABLE	POWER
ELECTRIC LIGHTING	LIGHTING
EIRCOM	EIRCOM
FIBRE OPTIC CABLE	F.OPTIC
BROADBAND	BROADBAND
CABLE TV	TV
TRAFFIC AND SIGNAL CABLE	TRAFFIC
CCTV	CCTV
IRRIGATION PIPE	IRRIGATION
EMPTY DUCT	EMPTY
GPR ANOMALY	ANOMALY
UNKNOWN CABLE	CABLE
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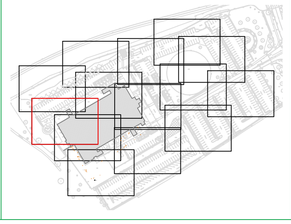
O/HEAD TELECOM	OT

SHEET LAYOUT :



PLAN PRODUCED BY:

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CONTACT INFORMATION:

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CLIENT:

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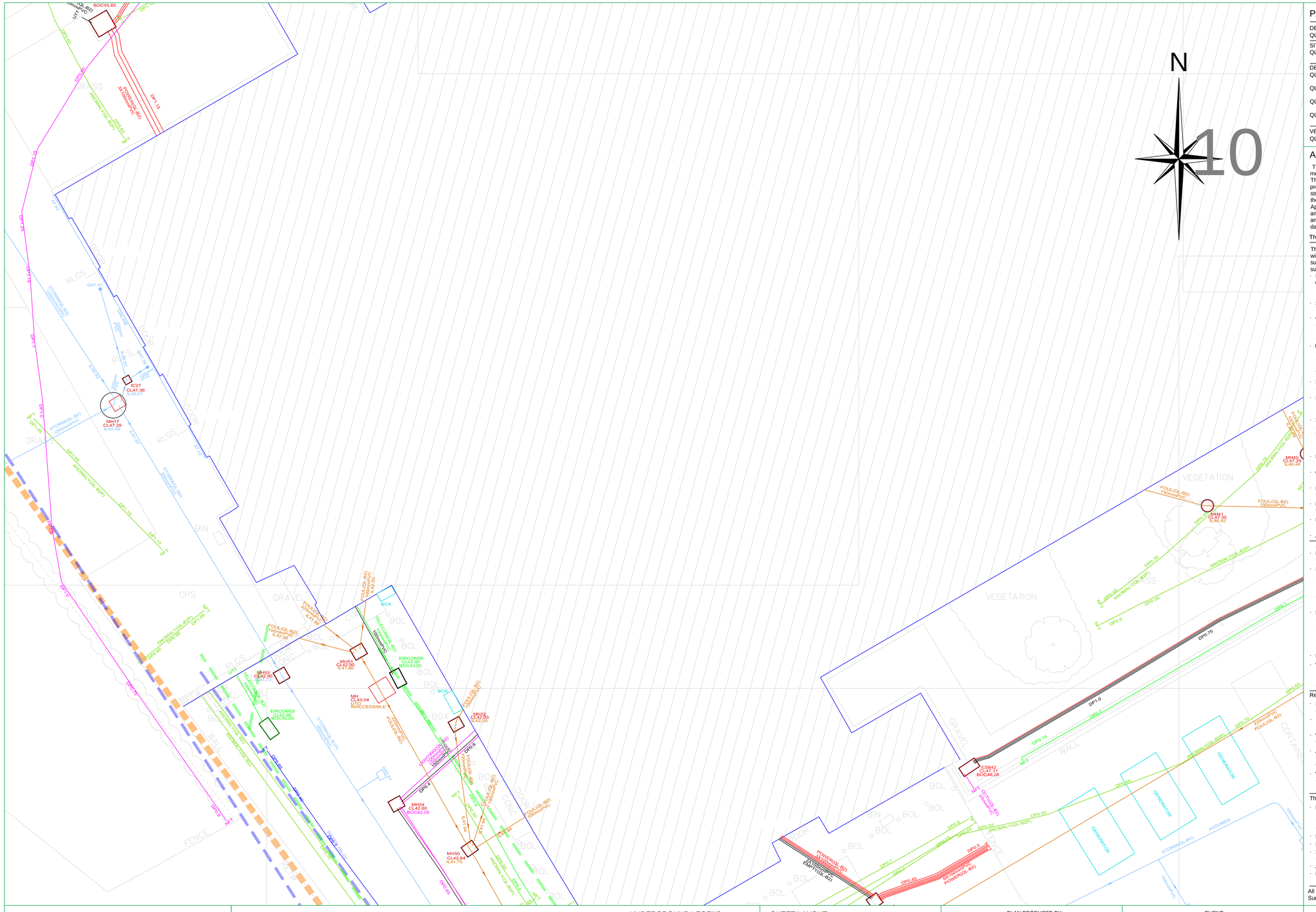
PROJECT:

Buvinda Housing Extension, Co. Meath

GRID SYSTEM:	Irish Transverse Mercator		
DATUM:	Malin Head (OSGM15)		
NOTES:	Drawing Contains Scale Factor		
SCALE :	1/100 A1	DATE :	15/08/2022
DRG No:	5244	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Heitor Lapinskas
SHEET:	9 of 14	PROCESSED BY :	Muna Satardien
		CHECKED BY :	Alan Brady

REVISIONS:

No.	Date	Description
001	N/A	Original Drawing
002	22/09/22	Additional Information Added
003	26/10/22	Additional Information Added



PAS 128: 2014 (Quality of Survey Level Outputs):

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QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
DETECTION	
QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
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QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques
VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

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- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
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GATE	
ELECTRICITY POLE	EP •
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EARTHING ROD	ER ⏚
LAMP POST	LP •
MARKER POST	MKR +
SIGN POST	SIGN
TRAFFIC LIGHT	TL •
TELEPHONE BOX	TB
POST	POST •
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SURVEY CONTROL STATION	

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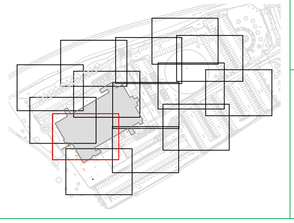

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NOTES:	Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
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003	26/10/22	Additional Information Added

SCALE : 1/100 A1

DATE : 15/08/2022

DRG No: 5244

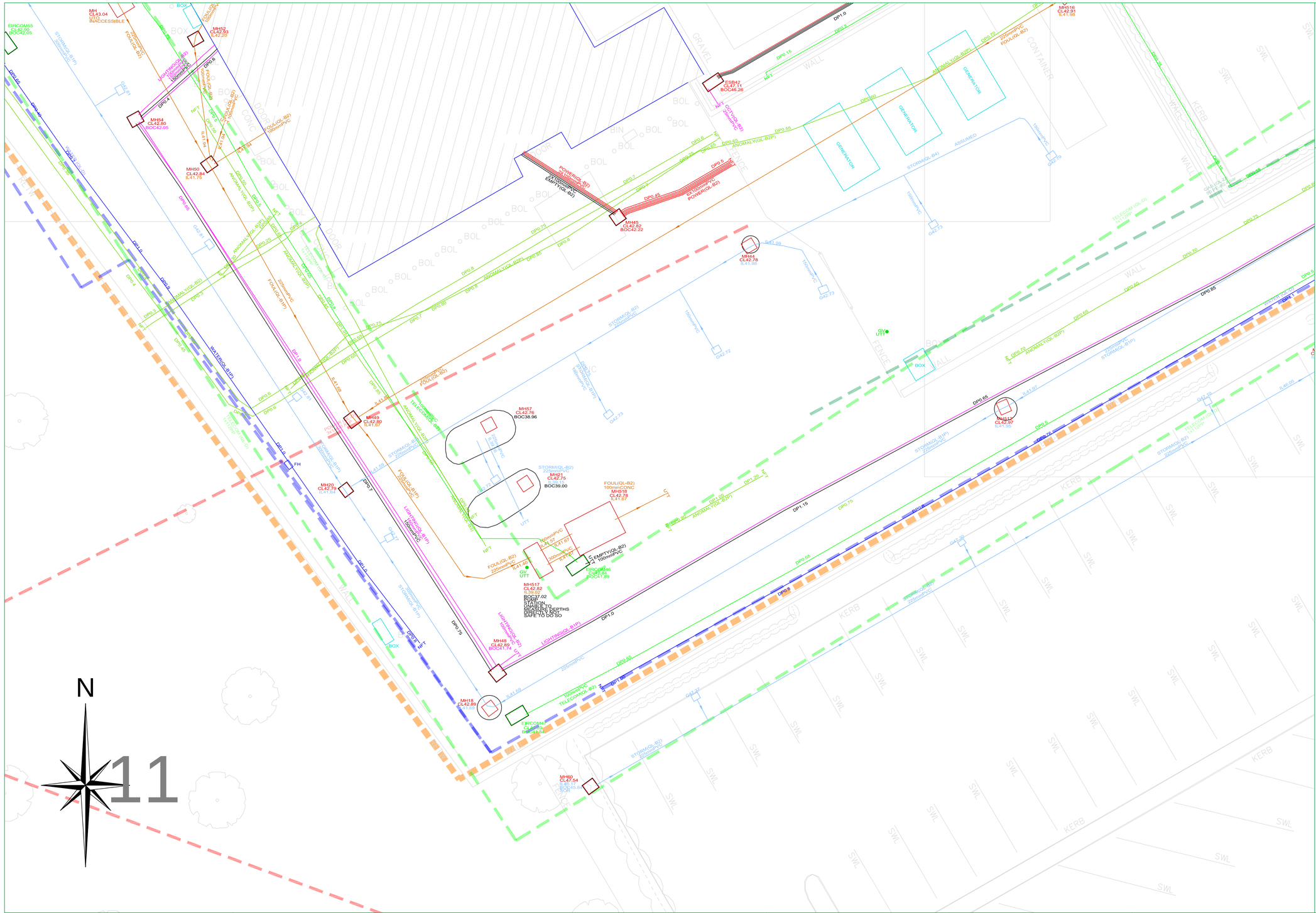
SHEET: 10 of 14

DESCRIPTION : 2D Utilities

SURVEYED BY : Heitor Lapinskas

PROCESSED BY : Muna Satardien

CHECKED BY : Alan Brady



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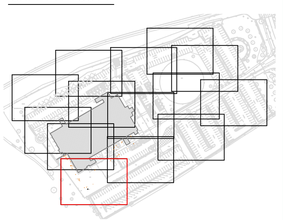

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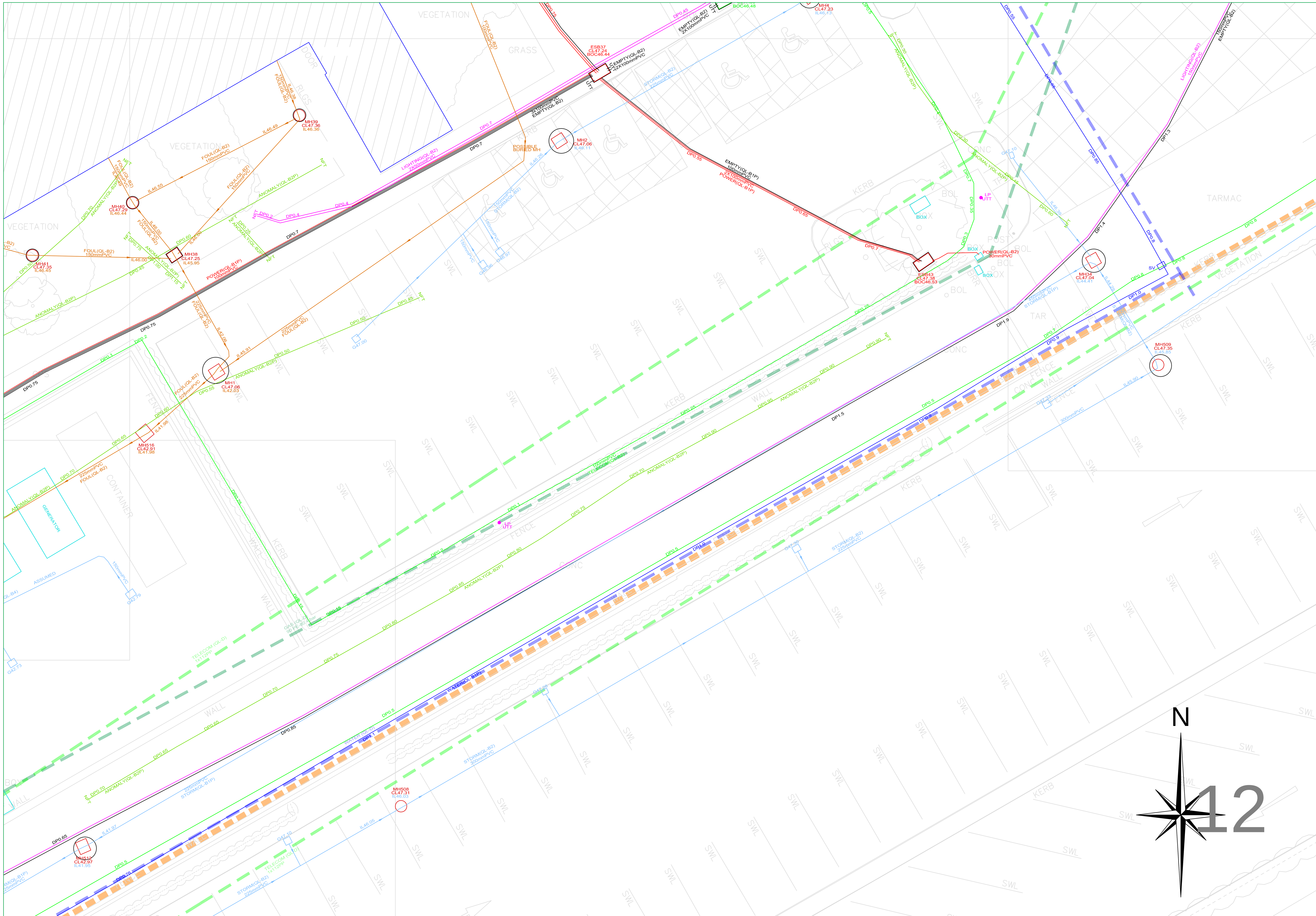

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APEX SURVEYS

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info@apexsurveys.ie
00353 1 691 0156

STREET FURNITURE :

BOLLARDS	BD
BUS STOP	BS
CRASH BARRIER	CB
GATE	
ELECTRICITY POLE	EP
TELEPHONE POLE	TP
EARTHING ROD	ER
LAMP POST	LP
MARKER POST	MKR
SIGN POST	SIGN
TRAFFIC LIGHT	TL
TELEPHONE BOX	TB
POST	POST
POST BOX	POST BOX
ROADSIGN	RS · RS
BORE HOLE	BH
TRIAL PIT	TPIT

SERVICES :

AIR VALVE	AV
ARMSTRONG JUNCTION	AJ
CABLE TV IC	CATV
COVER LEVEL	CL
EIRCOM COVER	EIRCOM
EIRCOM JUNCTION BOX	EIRCOM BOX
ELECTRICAL CABLE PIT	ECP
ESAT COVER	ESAT
ESB COVER	ESB
ESB JUNCTION BOX	ESB BOX
FIRE HYDRANT	FH
GAS VALVE	GV
GULLY	G
INSPECTION COVER	IC
MANHOLE	MH
SEPTIC TANK	SEPTIC
SLUICE VALVE	SV
STOPCOCK	ST
SERVICE BOX (UNKNOWN)	BOX
TRAFFIC COVER	TLIC
VENT	VENT
WATER METER	WM

LEVELS :

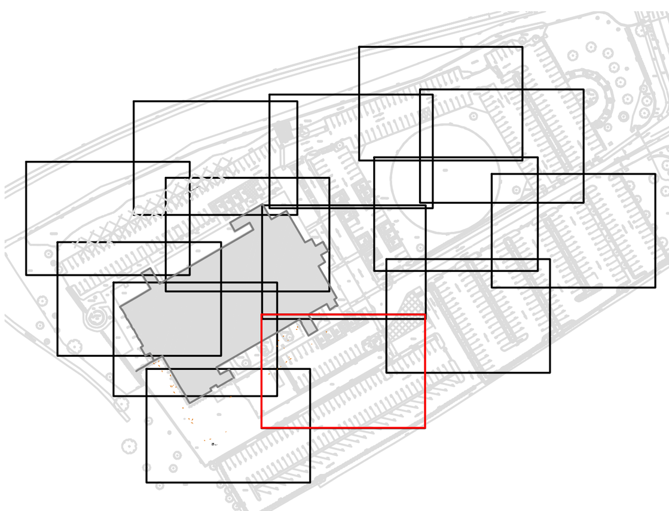
BED LEVEL	BED101.50
FLOOR LEVEL	FL101.50
INVERT LEVEL	IL101.50
ROAD LEVEL	101.50
SOFFIT LEVEL	SL101.50
SPOT LEVEL	101.50
TOP OF WALL LEVEL	TOW101.50
WATER LEVEL	WL101.50
SURVEY CONTROL STATION	

BOTTOM OF CHAMBER	BOC	DOWNPIPE	DP	START OF RUN	SOR
CAST-IRON	C/I	EARTHENWARE	E/W	UNABLE TO OPEN	UTO
CONCRETE	CONC	NO FURTHER TRACE	NFT	UNABLE TO TRACE	UTT
DIAMETER	DIA	OFFSITE	O/S		

UNDERGROUND LEGEND :

WATER MAIN	WATER
GAS MAIN	GAS
STORM DRAIN	STORM
FOUL SEWER	FOUL
COMBINED SEWER	COMB
ELECTRIC CABLE	POWER
ELECTRIC LIGHTING	LIGHTING
EIRCOM	EIRCOM
FIBRE OPTIC CABLE	F.OPTIC
BROADBAND	BROADBAND
CABLE TV	TV
TRAFFIC AND SIGNAL CABLE	TRAFFIC
CCTV	CCTV
IRRIGATION PIPE	IRRIGATION
EMPTY DUCT	EMPTY
GPR ANOMALY	ANOMALY
UNKNOWN CABLE	CABLE
O/HEAD ELECTRICITY	OE
O/HEAD TELECOM	OT

SHEET LAYOUT :



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CLIENT:

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PROJECT:

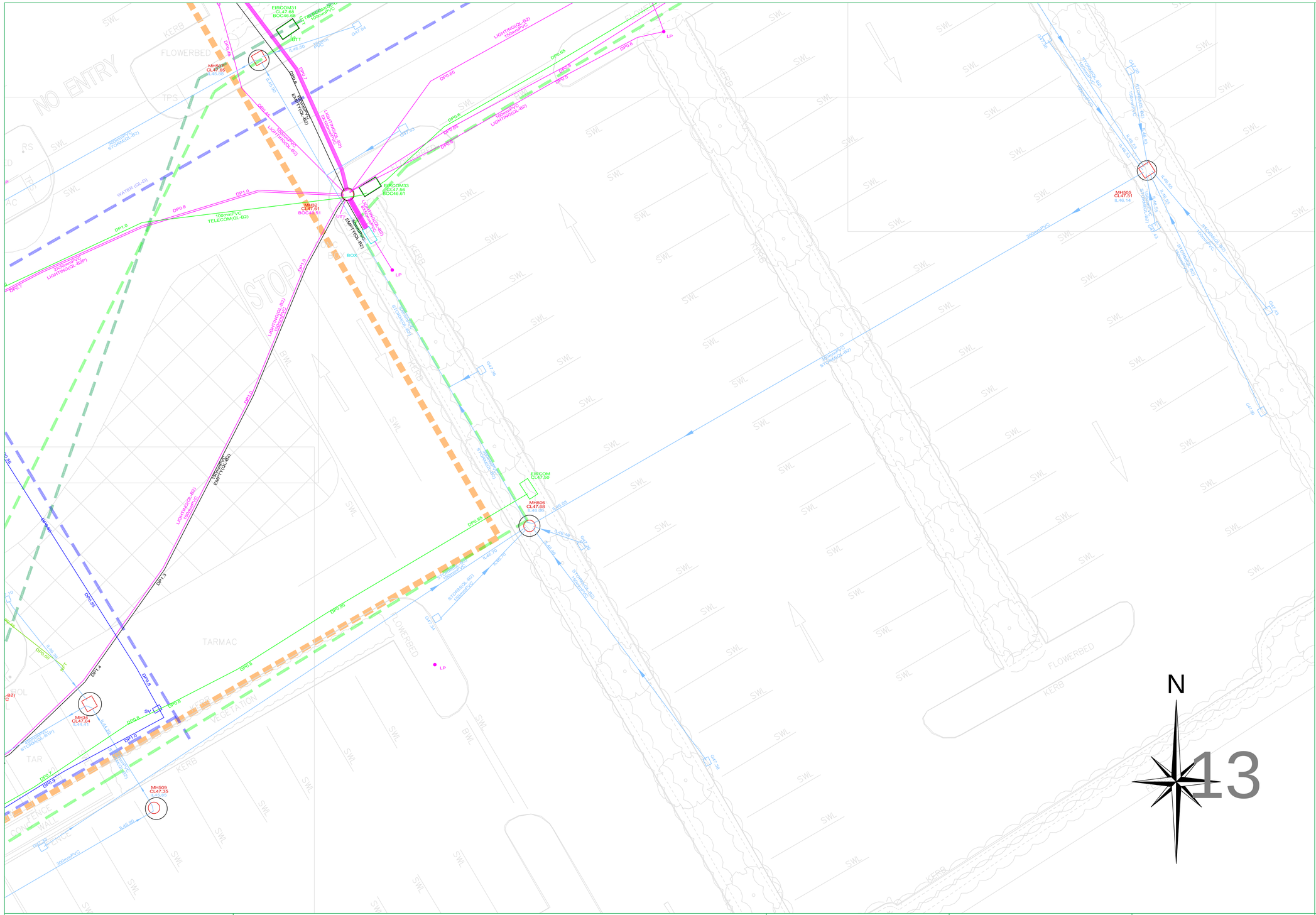
Buvinda Housing Extension, Co. Meath

GRID SYSTEM:	Irish Transverse Mercator
DATUM:	Malin Head (OSGM15)
NOTES:	Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	N/A	Original Drawing
002	22/09/22	Additional Information Added
003	26/10/22	Additional Information Added

SCALE :	1/100 A1	DATE :	15/08/2022
DRG No:	5244	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Heitor Lapinskas
SHEET:	12 of 14	PROCESSED BY :	Muna Satardien
		CHECKED BY :	Alan Brady



PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH	
QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
DETECTION	
QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
QL-B3	Horizontal location only of the utility detected by one of the geophysical techniques used
QL-B2	Horizontal and vertical location of the utility detected by one of the geophysical techniques used
QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques
VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

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The following is a non-exhaustive list of the limitations of utility surveys:

The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located.
  Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
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- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
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GATE	
ELECTRICITY POLE	EP •
TELEPHONE POLE	TP •
EARTHING ROD	ER +
LAMP POST	LP •
MARKER POST	MKR +
SIGN POST	SIGN ——
TRAFFIC LIGHT	TL •
TELEPHONE BOX	TB
POST	POST •
POST BOX	POST BOX
ROADSIGN	RS - RS ——
BORE HOLE	BH +
TRIAL PIT	TPIT +

BOTTOM OF CHAMBER	BOC
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BED LEVEL	+ BED101.50
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START OF RUN	SOR
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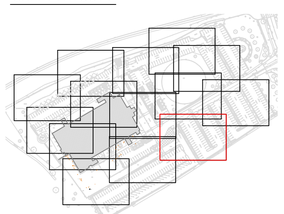

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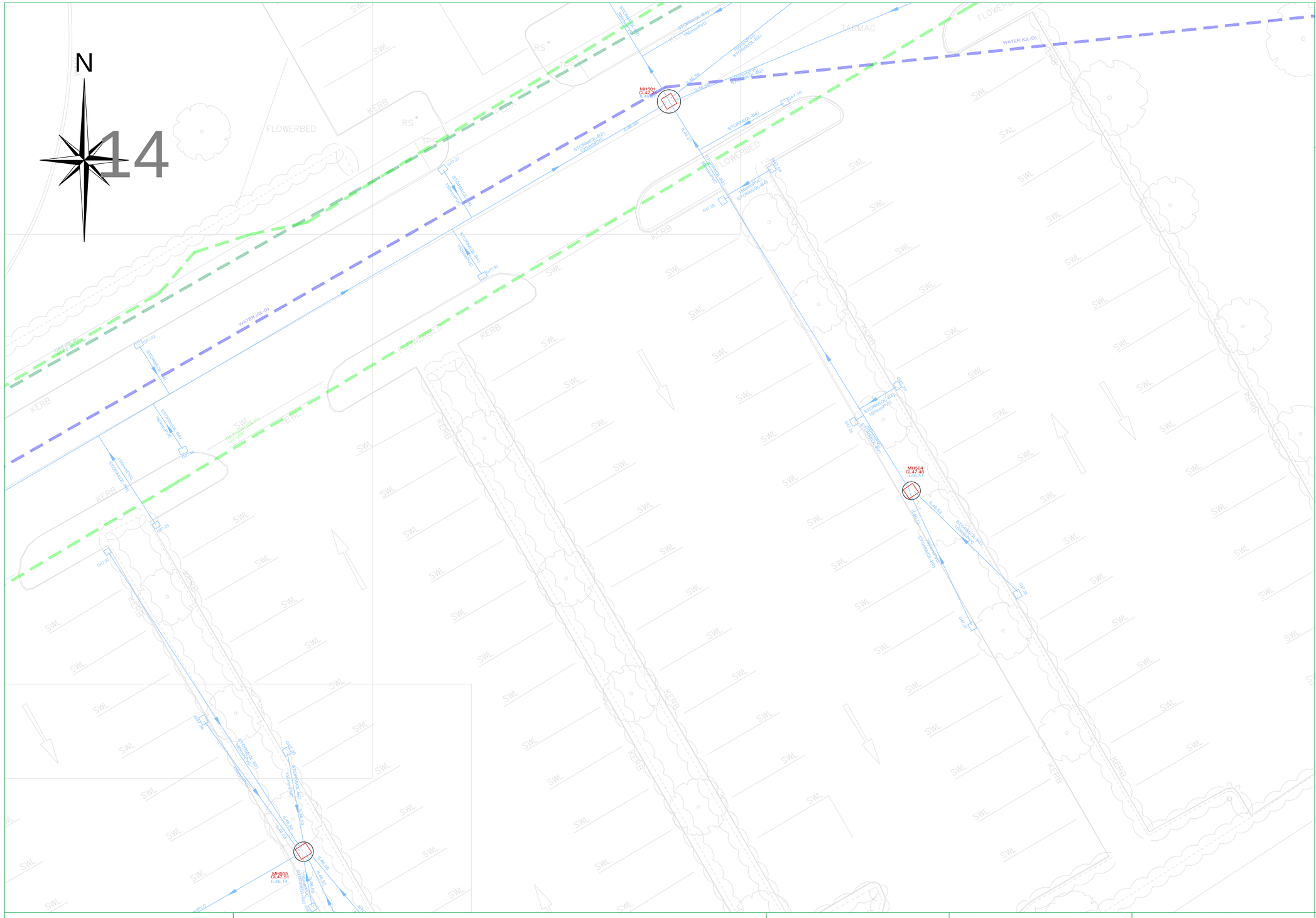

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LEVELS :

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DOWNPIPE	DP
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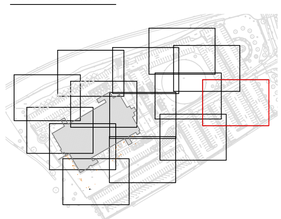

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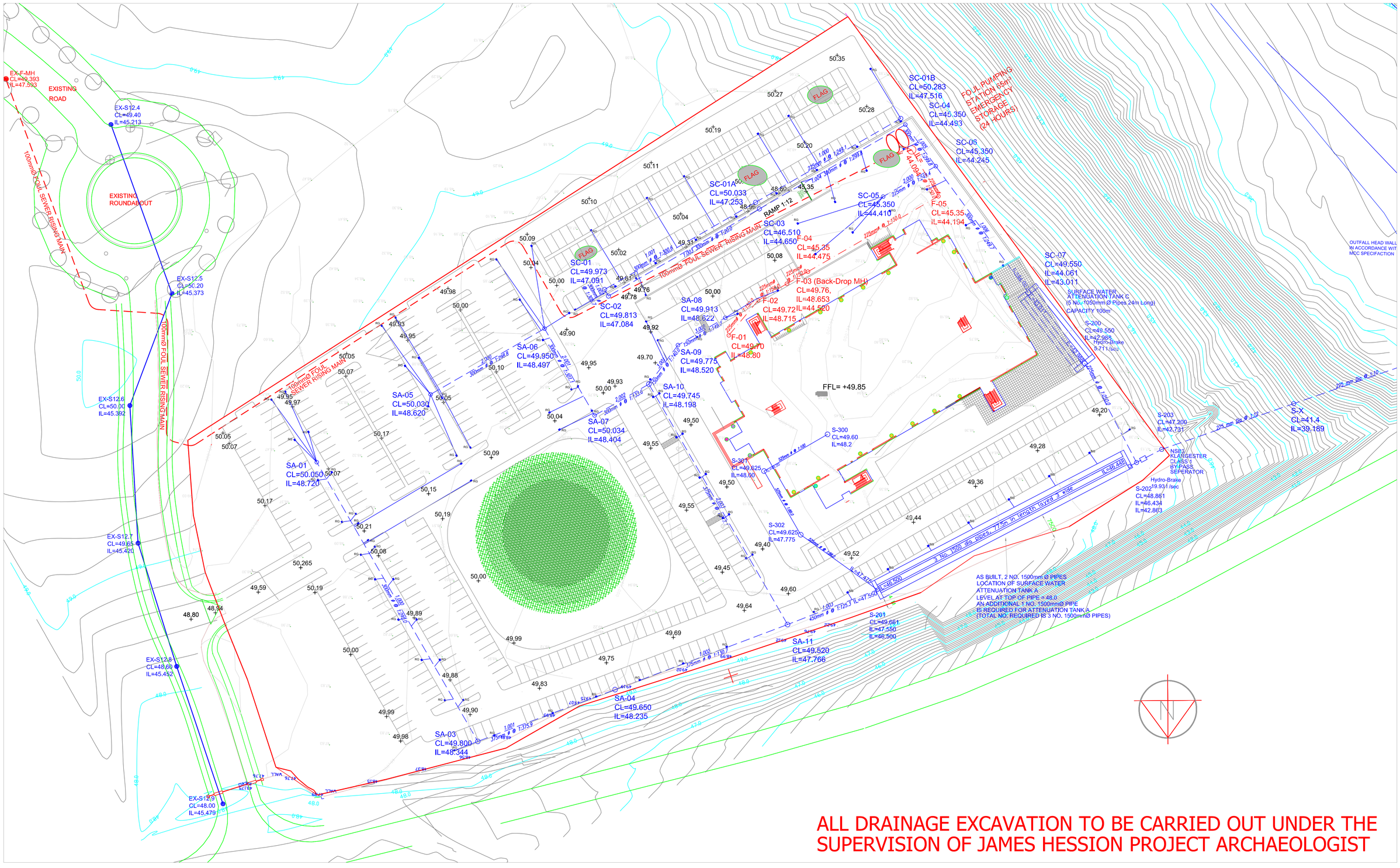

LEGEND

- PROPOSED STORM DRAINAGE
- S-01 PROPOSED STORM MANHOLE
- PROPOSED FOUL DRAINAGE
- F-01 PROPOSED FOUL MANHOLE
- PROPOSED FOUL RISING MAIN
- EXISTING STORM DRAINAGE
- EX-S-MH EXISTING STORM MANHOLE
- EXISTING FOUL DRAINAGE
- EX-F-MH EXISTING FOUL MANHOLE
- ACO ROAD DRAIN
- RG ROAD GULLY
- ×49.23 EXISTING GROUND LEVEL
- × +49.43 PROPOSED GROUND LEVEL
- FFL +=49.85 FINISHED FLOOR LEVEL

REV	DATE	DETAILS	REV	DATE	DETAILS
H	06-03-08	CARPARK AMENDED			
G	08-02-08	ISSUED OF INFORMATION	O	19-06-08	OUTFALL LAYOUT
F	06-02-08	VOLUME OF PUMPING STATION AMMENDED	N	08-05-08	CARPARK AMENDED, DRAINAGE AMENDED TO PT McWILLIAMS RECCOMENDATIONS
E	04-02-08	ISSUED FOR CONSTRUCTION	M	21-04-08	CARPARK LEVELS AMENDED
D	01-02-08	ISSUED OF INFORMATION	L	21-04-08	CARPARK AMENDED, DRAINAGE AMENDED TO PT McWILLIAMS RECCOMENDATIONS
C	28-01-08	ISSUED OF INFORMATION	K	04-04-08	AS BUILT LOCATION OF ATTENUATION TANK A ADDED
B	26-10-07	ISSUED OF INFORMATION			
A	26-07-07	ISSUED OF INFORMATION	J	18-03-08	CARPARK AMENDED

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PROJECT
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TITLE
SITE SERVICES
SURFACE WATER AND FOUL SEWER DRAINAGE LAYOUT

SCALE	DATE	DRAWN BY:	CHECKED BY:
1:500 @ A1	JUL. 2007	AN	MS

JOB No.	DRAWING No.	REV
J6-110	SS-030	O

Appendix C Causeway Stormwater Drainage Design Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	15.200	Minimum Backdrop Height (m)	0.200
Ratio-R	0.273	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S5-0 (ExMH 502)	0.037	4.00	47.550	1200	688209.620	766721.748	0.800
S6-0 (ExMH 504)	0.103	4.00	47.460	1200	688264.447	766726.263	1.150
S5-1 (ExMH 501)	0.048	4.00	47.210	1200	688251.942	766746.581	0.940
S5-2 (ExMH 503)	0.196	4.00	47.610	1200	688217.302	766803.194	1.700
S5-3 (ExMH 514)	0.112	4.00	47.250	1350	688182.442	766786.438	1.500
S1-0 (Ex MH505)	0.087	4.00	47.510	1200	688232.914	766707.533	1.370
S1-1 (Ex MH506)	0.262	4.00	47.680	1200	688200.852	766689.087	1.620
S1-2 (Ex MH507)			47.650	1200	688186.860	766713.287	1.762
S2-0 (Ex MH2)	0.091	4.00	47.060	1200	688150.402	766686.047	0.800
S2-1 (Ex MH4)	0.060	4.00	47.230	1200	688163.313	766693.447	1.100
S1-3 (Ex MH5)	0.074	4.00	47.270	1350	688171.552	766704.875	1.550
S3-0 (Ex MH**)	0.373	4.00	47.000	1350	688135.444	766730.369	1.350
S3-1			47.000	1350	688140.953	766734.995	1.400
S1-4			47.000	1350	688151.417	766740.125	1.581
S1-5			47.000	1350	688146.961	766774.661	3.100
S1-6	0.324	4.00	47.000	1350	688144.575	766777.698	3.139
S1-7			46.000	1350	688085.179	766755.794	2.775
S1-8	0.030	4.00	46.000	1350	688068.199	766748.569	2.960
Petrol Interceptor			46.000	1350	688068.970	766727.084	3.175
S1-9	0.029	4.00	46.600	1350	688069.533	766722.106	3.825
S1-10			46.600	1800	688051.039	766711.022	4.041
S7-0 (ExMH 12)	0.014	4.00	46.610	1200	688041.238	766719.808	2.520
S8-0 (ExMH 15)		4.00	46.490	1200	688041.978	766711.240	3.390
S7-1 (ExMH 14)			46.550	1200	688045.866	766711.186	3.600
S1-11 (Ex MH16)			46.620	1500	688048.741	766709.679	5.800
S1-12 (Ex MH 515)	0.070	4.00	46.670	2100	688051.731	766707.247	6.060
S9-0 (Ex MH 512)	0.133	4.00	42.970	1200	688125.723	766649.499	1.020
S9-1 (Ex MH18)	0.085	4.00	42.890	1200	688098.993	766633.856	1.200
S10 (Ex MH44)	0.055	4.00	42.780	1200	688112.523	766657.847	0.800
S9-2 (Ex MH20)	0.066	4.00	42.790	1200	688091.475	766645.151	1.400
S1-13 (Ex MH17)	0.067	4.00	47.390	1500	688065.989	766685.362	7.050
Outfall			47.000	1350	688058.485	766681.474	6.829

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
S5.000 (Ex)	S5-0 (ExMH 502)	S5-1 (ExMH 501)	49.070	0.600	46.750	46.270	0.480	102.2	225	4.85	50.0
S6.000 (Ex)	S6-0 (ExMH 504)	S5-1 (ExMH 501)	23.858	0.600	46.310	46.270	0.040	596.5	300	4.62	50.0
S5.001 (Ex)	S5-1 (ExMH 501)	S5-2 (ExMH 503)	66.370	0.600	46.270	45.910	0.360	184.4	300	5.81	50.0
S5.002 (Ex)	S5-2 (ExMH 503)	S5-3 (ExMH 514)	38.678	0.600	45.910	45.750	0.160	241.7	300	4.64	50.0
S5.003 (Ex)	S5-3 (ExMH 514)	S1-6	37.384	0.600	45.750	45.376	0.374	100.0	300	5.04	50.0
S1.000 (Ex)	S1-0 (Ex MH505)	S1-1 (Ex MH506)	36.990	0.600	46.140	46.080	0.060	616.5	300	4.99	50.0
S1.001 (Ex)	S1-1 (Ex MH506)	S1-2 (Ex MH507)	27.954	0.600	46.060	45.900	0.160	174.7	300	5.38	50.0
S1.002 (Ex)	S1-2 (Ex MH507)	S1-3 (Ex MH5)	17.467	0.600	45.888	45.780	0.108	161.7	300	5.62	50.0
S2.000 (Ex)	S2-0 (Ex MH2)	S2-1 (Ex MH4)	14.881	0.600	46.260	46.130	0.130	114.5	225	4.20	50.0
S2.001 (Ex)	S2-1 (Ex MH4)	S1-3 (Ex MH5)	14.088	0.600	46.130	45.770	0.360	39.1	225	4.31	50.0
S1.003 (Ex)	S1-3 (Ex MH5)	S1-4	40.595	0.600	45.720	45.494	0.226	179.6	375	6.29	50.0
S3.000	S3-0 (Ex MH**)	S3-1	7.194	0.600	45.650	45.600	0.050	143.9	450	4.07	50.0
S3.001	S3-1	S1-4	11.654	0.600	45.600	45.419	0.181	64.4	450	4.15	50.0
S1.004	S1-4	S1-5	34.838	0.600	45.419	45.333	0.086	405.1	450	6.87	50.0
S1.006	S1-5	S1-6	3.862	0.600	43.900	43.861	0.039	100.0	450	6.90	50.0
S1.007	S1-6	S1-7	63.604	0.600	43.861	43.225	0.636	100.0	450	7.42	50.0
S1.008	S1-7	S1-8	18.546	0.600	43.225	43.040	0.185	100.0	450	7.57	50.0
S1.009	S1-8	Petrol Interceptor	21.499	0.600	43.040	42.825	0.215	100.0	450	7.75	50.0
S1.010	Petrol Interceptor	S1-9	5.010	0.600	42.825	42.775	0.050	100.0	450	7.79	50.0
S1.011	S1-9	S1-10	21.561	0.600	42.775	42.559	0.216	100.0	450	7.97	50.0
S1.012	S1-10	S1-11 (Ex MH16)	2.662	0.600	42.559	42.532	0.027	100.0	450	7.99	50.0
S7.000 (Ex)	S7-0 (ExMH 12)	S7-1 (ExMH 14)	9.786	0.600	44.090	42.950	1.140	8.6	225	4.04	50.0
S8.000 (Ex)	S8-0 (ExMH 15)	S7-1 (ExMH 14)	3.888	0.600	43.100	42.950	0.150	25.9	225	4.03	50.0
S7.001 (Ex)	S7-1 (ExMH 14)	S1-11 (Ex MH16)	3.246	0.600	42.950	42.820	0.130	25.0	225	4.06	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
S5.000 (Ex)	1.293	51.4	5.1	0.575	0.715	0.037	0.0	48	0.833
S6.000 (Ex)	0.636	45.0	13.9	0.850	0.640	0.103	0.0	115	0.563
S5.001 (Ex)	1.154	81.6	25.5	0.640	1.400	0.189	0.0	115	1.025
S5.002 (Ex)	1.007	71.2	52.1	1.400	1.200	0.385	0.0	191	1.096
S5.003 (Ex)	1.572	111.1	67.3	1.200	1.324	0.497	0.0	168	1.644
S1.000 (Ex)	0.626	44.2	11.8	1.070	1.300	0.087	0.0	105	0.531
S1.001 (Ex)	1.186	83.8	47.3	1.320	1.450	0.349	0.0	161	1.221
S1.002 (Ex)	1.233	87.2	47.3	1.462	1.190	0.349	0.0	157	1.257
S2.000 (Ex)	1.221	48.5	12.4	0.575	0.875	0.091	0.0	77	1.022
S2.001 (Ex)	2.097	83.4	20.5	0.875	1.275	0.151	0.0	76	1.746
S1.003 (Ex)	1.348	148.9	77.8	1.175	1.131	0.574	0.0	192	1.362
S3.000	1.693	269.2	50.6	0.900	0.950	0.373	0.0	131	1.311
S3.001	2.536	403.4	50.6	0.950	1.131	0.373	0.0	107	1.757
S1.004	1.004	159.6	128.4	1.131	1.217	0.947	0.0	307	1.111
S1.006	2.033	323.3	128.4	2.650	2.689	0.947	0.0	196	1.919
S1.007	2.033	323.3	239.6	2.689	2.325	1.768	0.0	290	2.217
S1.008	2.033	323.3	239.6	2.325	2.510	1.768	0.0	290	2.217
S1.009	2.033	323.3	243.7	2.510	2.725	1.798	0.0	293	2.224
S1.010	2.033	323.3	243.7	2.725	3.375	1.798	0.0	293	2.224
S1.011	2.033	323.3	247.7	3.375	3.591	1.828	0.0	297	2.231
S1.012	2.033	323.3	247.7	3.591	3.638	1.828	0.0	297	2.231
S7.000 (Ex)	4.493	178.6	1.9	2.295	3.375	0.014	0.0	16	1.479
S8.000 (Ex)	2.580	102.6	0.0	3.165	3.375	0.000	0.0	0	0.000
S7.001 (Ex)	2.629	104.5	1.9	3.375	3.575	0.014	0.0	21	1.009

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
S1.013 (Ex)	S1-11 (Ex MH16)	S1-12 (Ex MH 515)	3.854	0.600	40.820	40.610	0.210	18.4	450	8.55	50.0
S1.014 (Ex)	S1-12 (Ex MH 515)	S1-13 (Ex MH17)	26.120	0.600	40.610	40.490	0.120	217.7	1050	8.77	50.0
S9.000 (Ex)	S9-0 (Ex MH 512)	S9-1 (Ex MH18)	30.971	0.600	41.950	41.690	0.260	119.1	225	4.43	50.0
S9.001 (Ex)	S9-1 (Ex MH18)	S9-2 (Ex MH20)	13.568	0.600	41.690	41.640	0.050	271.4	300	4.67	50.0
S10.000 (Ex)	S10 (Ex MH44)	S9-2 (Ex MH20)	24.581	0.600	41.980	41.590	0.390	63.0	225	4.25	50.0
S9.002 (Ex)	S9-2 (Ex MH20)	S1-13 (Ex MH17)	47.607	0.600	41.390	40.490	0.900	52.9	300	4.99	50.0
S1.015	S1-13 (Ex MH17)	Outfall	8.453	0.600	40.340	40.171	0.169	50.0	450	8.82	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
S1.013 (Ex)	4.762	757.4	249.6	5.350	5.610	1.842	0.0	177	4.289
S1.014 (Ex)	2.331	8075.2	259.1	5.010	5.850	1.912	0.0	126	1.099
S9.000 (Ex)	1.197	47.6	18.0	0.795	0.975	0.133	0.0	95	1.113
S9.001 (Ex)	0.949	67.1	29.4	0.900	0.850	0.217	0.0	139	0.920
S10.000 (Ex)	1.650	65.6	7.5	0.575	0.975	0.055	0.0	51	1.108
S9.002 (Ex)	2.166	153.1	45.9	1.100	6.600	0.339	0.0	112	1.900
S1.015	2.880	458.1	314.0	6.600	6.379	2.317	0.0	275	3.093

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
S5.000 (Ex)	49.070	102.2	225	Circular	47.550	46.750	0.575	47.210	46.270	0.715
S6.000 (Ex)	23.858	596.5	300	Circular	47.460	46.310	0.850	47.210	46.270	0.640
S5.001 (Ex)	66.370	184.4	300	Circular	47.210	46.270	0.640	47.610	45.910	1.400
S5.002 (Ex)	38.678	241.7	300	Circular	47.610	45.910	1.400	47.250	45.750	1.200
S5.003 (Ex)	37.384	100.0	300	Circular	47.250	45.750	1.200	47.000	45.376	1.324
S1.000 (Ex)	36.990	616.5	300	Circular	47.510	46.140	1.070	47.680	46.080	1.300
S1.001 (Ex)	27.954	174.7	300	Circular	47.680	46.060	1.320	47.650	45.900	1.450
S1.002 (Ex)	17.467	161.7	300	Circular	47.650	45.888	1.462	47.270	45.780	1.190
S2.000 (Ex)	14.881	114.5	225	Circular	47.060	46.260	0.575	47.230	46.130	0.875
S2.001 (Ex)	14.088	39.1	225	Circular	47.230	46.130	0.875	47.270	45.770	1.275
S1.003 (Ex)	40.595	179.6	375	Circular	47.270	45.720	1.175	47.000	45.494	1.131
S3.000	7.194	143.9	450	Circular	47.000	45.650	0.900	47.000	45.600	0.950
S3.001	11.654	64.4	450	Circular	47.000	45.600	0.950	47.000	45.419	1.131

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
S5.000 (Ex)	S5-0 (ExMH 502)	1200	Manhole	Adoptable	S5-1 (ExMH 501)	1200	Manhole	Adoptable
S6.000 (Ex)	S6-0 (ExMH 504)	1200	Manhole	Adoptable	S5-1 (ExMH 501)	1200	Manhole	Adoptable
S5.001 (Ex)	S5-1 (ExMH 501)	1200	Manhole	Adoptable	S5-2 (ExMH 503)	1200	Manhole	Adoptable
S5.002 (Ex)	S5-2 (ExMH 503)	1200	Manhole	Adoptable	S5-3 (ExMH 514)	1350	Manhole	Adoptable
S5.003 (Ex)	S5-3 (ExMH 514)	1350	Manhole	Adoptable	S1-6	1350	Manhole	Adoptable
S1.000 (Ex)	S1-0 (Ex MH505)	1200	Manhole	Adoptable	S1-1 (Ex MH506)	1200	Manhole	Adoptable
S1.001 (Ex)	S1-1 (Ex MH506)	1200	Manhole	Adoptable	S1-2 (Ex MH507)	1200	Manhole	Adoptable
S1.002 (Ex)	S1-2 (Ex MH507)	1200	Manhole	Adoptable	S1-3 (Ex MH5)	1350	Manhole	Adoptable
S2.000 (Ex)	S2-0 (Ex MH2)	1200	Manhole	Adoptable	S2-1 (Ex MH4)	1200	Manhole	Adoptable
S2.001 (Ex)	S2-1 (Ex MH4)	1200	Manhole	Adoptable	S1-3 (Ex MH5)	1350	Manhole	Adoptable
S1.003 (Ex)	S1-3 (Ex MH5)	1350	Manhole	Adoptable	S1-4	1350	Manhole	Adoptable
S3.000	S3-0 (Ex MH**)	1350	Manhole	Adoptable	S3-1	1350	Manhole	Adoptable
S3.001	S3-1	1350	Manhole	Adoptable	S1-4	1350	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
S1.004	34.838	405.1	450	Circular	47.000	45.419	1.131	47.000	45.333	1.217
S1.006	3.862	100.0	450	Circular	47.000	43.900	2.650	47.000	43.861	2.689
S1.007	63.604	100.0	450	Circular	47.000	43.861	2.689	46.000	43.225	2.325
S1.008	18.546	100.0	450	Circular	46.000	43.225	2.325	46.000	43.040	2.510
S1.009	21.499	100.0	450	Circular	46.000	43.040	2.510	46.000	42.825	2.725
S1.010	5.010	100.0	450	Circular	46.000	42.825	2.725	46.600	42.775	3.375
S1.011	21.561	100.0	450	Circular	46.600	42.775	3.375	46.600	42.559	3.591
S1.012	2.662	100.0	450	Circular	46.600	42.559	3.591	46.620	42.532	3.638
S7.000 (Ex)	9.786	8.6	225	Circular	46.610	44.090	2.295	46.550	42.950	3.375
S8.000 (Ex)	3.888	25.9	225	Circular	46.490	43.100	3.165	46.550	42.950	3.375
S7.001 (Ex)	3.246	25.0	225	Circular	46.550	42.950	3.375	46.620	42.820	3.575
S1.013 (Ex)	3.854	18.4	450	Circular	46.620	40.820	5.350	46.670	40.610	5.610
S1.014 (Ex)	26.120	217.7	1050	Quad circ	46.670	40.610	5.010	47.390	40.490	5.850
S9.000 (Ex)	30.971	119.1	225	Circular	42.970	41.950	0.795	42.890	41.690	0.975
S9.001 (Ex)	13.568	271.4	300	Circular	42.890	41.690	0.900	42.790	41.640	0.850
S10.000 (Ex)	24.581	63.0	225	Circular	42.780	41.980	0.575	42.790	41.590	0.975
S9.002 (Ex)	47.607	52.9	300	Circular	42.790	41.390	1.100	47.390	40.490	6.600
S1.015	8.453	50.0	450	Circular	47.390	40.340	6.600	47.000	40.171	6.379

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
S1.004	S1-4	1350	Manhole	Adoptable	S1-5	1350	Manhole	Adoptable
S1.006	S1-5	1350	Manhole	Adoptable	S1-6	1350	Manhole	Adoptable
S1.007	S1-6	1350	Manhole	Adoptable	S1-7	1350	Manhole	Adoptable
S1.008	S1-7	1350	Manhole	Adoptable	S1-8	1350	Manhole	Adoptable
S1.009	S1-8	1350	Manhole	Adoptable	Petrol Interceptor	1350	Manhole	Adoptable
S1.010	Petrol Interceptor	1350	Manhole	Adoptable	S1-9	1350	Manhole	Adoptable
S1.011	S1-9	1350	Manhole	Adoptable	S1-10	1800	Manhole	Adoptable
S1.012	S1-10	1800	Manhole	Adoptable	S1-11 (Ex MH16)	1500	Manhole	Adoptable
S7.000 (Ex)	S7-0 (ExMH 12)	1200	Manhole	Adoptable	S7-1 (ExMH 14)	1200	Manhole	Adoptable
S8.000 (Ex)	S8-0 (ExMH 15)	1200	Manhole	Adoptable	S7-1 (ExMH 14)	1200	Manhole	Adoptable
S7.001 (Ex)	S7-1 (ExMH 14)	1200	Manhole	Adoptable	S1-11 (Ex MH16)	1500	Manhole	Adoptable
S1.013 (Ex)	S1-11 (Ex MH16)	1500	Manhole	Adoptable	S1-12 (Ex MH 515)	2100	Manhole	Adoptable
S1.014 (Ex)	S1-12 (Ex MH 515)	2100	Manhole	Adoptable	S1-13 (Ex MH17)	1500	Manhole	Adoptable
S9.000 (Ex)	S9-0 (Ex MH 512)	1200	Manhole	Adoptable	S9-1 (Ex MH18)	1200	Manhole	Adoptable
S9.001 (Ex)	S9-1 (Ex MH18)	1200	Manhole	Adoptable	S9-2 (Ex MH20)	1200	Manhole	Adoptable
S10.000 (Ex)	S10 (Ex MH44)	1200	Manhole	Adoptable	S9-2 (Ex MH20)	1200	Manhole	Adoptable
S9.002 (Ex)	S9-2 (Ex MH20)	1200	Manhole	Adoptable	S1-13 (Ex MH17)	1500	Manhole	Adoptable
S1.015	S1-13 (Ex MH17)	1500	Manhole	Adoptable	Outfall	1350	Manhole	Adoptable

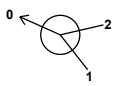
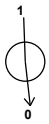
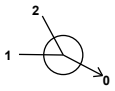
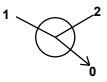
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S5-0 (ExMH 502)	688209.620	766721.748	47.550	0.800	1200	 0	S5.000 (Ex)	46.750	225
S6-0 (ExMH 504)	688264.447	766726.263	47.460	1.150	1200	 0	S6.000 (Ex)	46.310	300

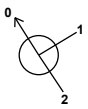
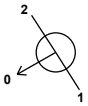
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S5-1 (ExMH 501)	688251.942	766746.581	47.210	0.940	1200	1 2 0	S6.000 (Ex) S5.000 (Ex) S5.001 (Ex)	46.270 46.270 46.270	300 225 300
S5-2 (ExMH 503)	688217.302	766803.194	47.610	1.700	1200	1 0	S5.001 (Ex) S5.002 (Ex)	45.910 45.910	300 300
S5-3 (ExMH 514)	688182.442	766786.438	47.250	1.500	1350	1 0	S5.002 (Ex) S5.003 (Ex)	45.750 45.750	300 300
S1-0 (Ex MH505)	688232.914	766707.533	47.510	1.370	1200	0	S1.000 (Ex)	46.140	300
S1-1 (Ex MH506)	688200.852	766689.087	47.680	1.620	1200	1 0	S1.000 (Ex) S1.001 (Ex)	46.080 46.060	300 300
S1-2 (Ex MH507)	688186.860	766713.287	47.650	1.762	1200	1 0	S1.001 (Ex) S1.002 (Ex)	45.900 45.888	300 300
S2-0 (Ex MH2)	688150.402	766686.047	47.060	0.800	1200	0	S2.000 (Ex)	46.260	225
S2-1 (Ex MH4)	688163.313	766693.447	47.230	1.100	1200	1 0	S2.000 (Ex) S2.001 (Ex)	46.130 46.130	225 225
S1-3 (Ex MH5)	688171.552	766704.875	47.270	1.550	1350	1 2 0	S2.001 (Ex) S1.002 (Ex) S1.003 (Ex)	45.770 45.780 45.720	225 300 375
S3-0 (Ex MH**)	688135.444	766730.369	47.000	1.350	1350	0	S3.000	45.650	450
S3-1	688140.953	766734.995	47.000	1.400	1350	1 0	S3.000 S3.001	45.600 45.600	450 450
S1-4	688151.417	766740.125	47.000	1.581	1350	1 2 0	S3.001 S1.003 (Ex) S1.004	45.419 45.494 45.419	450 375 450
S1-5	688146.961	766774.661	47.000	3.100	1350	1 0	S1.004 S1.006	45.333 43.900	450 450

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1-6	688144.575	766777.698	47.000	3.139	1350	 1	S1.006	43.861	450
						2	S5.003 (Ex)	45.376	300
						0	S1.007	43.861	450
S1-7	688085.179	766755.794	46.000	2.775	1350	 1	S1.007	43.225	450
						0	S1.008	43.225	450
S1-8	688068.199	766748.569	46.000	2.960	1350	 1	S1.008	43.040	450
						0	S1.009	43.040	450
Petrol Interceptor	688068.970	766727.084	46.000	3.175	1350	 1	S1.009	42.825	450
						0	S1.010	42.825	450
S1-9	688069.533	766722.106	46.600	3.825	1350	 1	S1.010	42.775	450
						0	S1.011	42.775	450
S1-10	688051.039	766711.022	46.600	4.041	1800	 1	S1.011	42.559	450
						0	S1.012	42.559	450
S7-0 (ExMH 12)	688041.238	766719.808	46.610	2.520	1200				
						0	S7.000 (Ex)	44.090	225
S8-0 (ExMH 15)	688041.978	766711.240	46.490	3.390	1200				
						0	S8.000 (Ex)	43.100	225
S7-1 (ExMH 14)	688045.866	766711.186	46.550	3.600	1200	 1	S8.000 (Ex)	42.950	225
						2	S7.000 (Ex)	42.950	225
						0	S7.001 (Ex)	42.950	225
S1-11 (Ex MH16)	688048.741	766709.679	46.620	5.800	1500	 1	S7.001 (Ex)	42.820	225
						2	S1.012	42.532	450
						0	S1.013 (Ex)	40.820	450
S1-12 (Ex MH 515)	688051.731	766707.247	46.670	6.060	2100	 1	S1.013 (Ex)	40.610	450
						0	S1.014 (Ex)	40.610	1050
S9-0 (Ex MH 512)	688125.723	766649.499	42.970	1.020	1200				
						0	S9.000 (Ex)	41.950	225
S9-1 (Ex MH18)	688098.993	766633.856	42.890	1.200	1200	 1	S9.000 (Ex)	41.690	225
						0	S9.001 (Ex)	41.690	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S10 (Ex MH44)	688112.523	766657.847	42.780	0.800	1200				
						0	S10.000 (Ex)	41.980	225
S9-2 (Ex MH20)	688091.475	766645.151	42.790	1.400	1200				
						1	S10.000 (Ex)	41.590	225
						2	S9.001 (Ex)	41.640	300
						0	S9.002 (Ex)	41.390	300
S1-13 (Ex MH17)	688065.989	766685.362	47.390	7.050	1500				
						1	S9.002 (Ex)	40.490	300
						2	S1.014 (Ex)	40.490	1050
						0	S1.015	40.340	450
Outfall	688058.485	766681.474	47.000	6.829	1350				
						1	S1.015	40.171	450

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	15.200	Additional Storage (m³/ha)	20.0
Ratio-R	0.273	Check Discharge Rate(s)	x
Summer CV	0.750	Check Discharge Volume	x
Analysis Speed	Detailed		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Node S1-10 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	42.559	Product Number	CTL-SHE-0109-7000-2000-7000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	7.0	Min Node Diameter (mm)	1200

Node S1-13 (Ex MH17) Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	40.340	Product Number	CTL-SHE-0152-1350-2000-1350
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	13.5	Min Node Diameter (mm)	1500

Node S1-10 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.559
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	360.0	0.0	2.250	360.0	0.0	2.251	0.0	0.0

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.63%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S5-0 (ExMH 502)	12	47.121	0.371	14.4	0.7659	0.0000	SURCHARGED
15 minute summer	S6-0 (ExMH 504)	11	46.981	0.671	39.1	1.9579	0.0000	SURCHARGED
15 minute summer	S5-1 (ExMH 501)	12	46.987	0.717	67.7	1.5465	0.0000	FLOOD RISK
15 minute summer	S5-2 (ExMH 503)	11	46.889	0.979	123.6	3.3641	0.0000	SURCHARGED
15 minute summer	S5-3 (ExMH 514)	11	46.640	0.890	134.9	2.6050	0.0000	SURCHARGED
15 minute summer	S1-0 (Ex MH505)	11	47.163	1.023	32.9	2.4525	0.0000	SURCHARGED
15 minute summer	S1-1 (Ex MH506)	11	47.147	1.087	117.2	4.7454	0.0000	SURCHARGED
15 minute summer	S1-2 (Ex MH507)	12	46.939	1.051	92.6	1.1886	0.0000	SURCHARGED
15 minute summer	S2-0 (Ex MH2)	12	46.918	0.658	34.7	2.2481	0.0000	FLOOD RISK
15 minute summer	S2-1 (Ex MH4)	12	46.882	0.752	55.3	1.6670	0.0000	SURCHARGED
15 minute summer	S1-3 (Ex MH5)	12	46.787	1.067	149.4	2.5455	0.0000	SURCHARGED
15 minute summer	S3-0 (Ex MH**)	11	46.579	0.929	141.7	6.4672	0.0000	SURCHARGED
15 minute summer	S3-1	11	46.561	0.961	122.3	1.3749	0.0000	SURCHARGED
15 minute summer	S1-4	11	46.540	1.121	245.7	1.6043	0.0000	SURCHARGED
15 minute summer	S1-5	11	46.306	2.406	238.4	3.4431	0.0000	SURCHARGED
15 minute summer	S1-6	11	46.235	2.374	437.2	8.3025	0.0000	SURCHARGED
1440 minute summer	S1-7	1050	45.861	2.636	55.1	3.7725	0.0000	FLOOD RISK
1440 minute summer	S1-8	1050	45.861	2.821	54.8	4.6098	0.0000	FLOOD RISK
1440 minute summer	Petrol Interceptor	1050	45.861	3.036	54.5	4.3444	0.0000	FLOOD RISK
1440 minute summer	S1-9	1050	45.861	3.086	55.2	4.8910	0.0000	SURCHARGED
1440 minute summer	S1-10	1050	45.860	3.301	55.0	778.0732	0.0000	SURCHARGED
15 minute summer	S7-0 (ExMH 12)	10	44.117	0.027	5.4	0.0334	0.0000	OK
15 minute summer	S8-0 (ExMH 15)	1	43.100	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S7-1 (ExMH 14)	10	42.988	0.038	5.4	0.0433	0.0000	OK
240 minute summer	S1-11 (Ex MH16)	188	42.490	1.670	29.6	2.9504	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S5-0 (ExMH 502)	S5.000 (Ex)	S5-1 (ExMH 501)	14.1	0.551	0.275	1.9516	
15 minute summer	S6-0 (ExMH 504)	S6.000 (Ex)	S5-1 (ExMH 501)	36.2	0.749	0.805	1.6801	
15 minute summer	S5-1 (ExMH 501)	S5.001 (Ex)	S5-2 (ExMH 503)	64.5	0.972	0.790	4.6737	
15 minute summer	S5-2 (ExMH 503)	S5.002 (Ex)	S5-3 (ExMH 514)	92.3	1.311	1.298	2.7237	
15 minute summer	S5-3 (ExMH 514)	S5.003 (Ex)	S1-6	112.7	1.758	1.014	2.6326	
15 minute summer	S1-0 (Ex MH505)	S1.000 (Ex)	S1-1 (Ex MH506)	23.6	0.460	0.534	2.6048	
15 minute summer	S1-1 (Ex MH506)	S1.001 (Ex)	S1-2 (Ex MH507)	92.6	1.315	1.104	1.9685	
15 minute summer	S1-2 (Ex MH507)	S1.002 (Ex)	S1-3 (Ex MH5)	87.5	1.289	1.004	1.2300	
15 minute summer	S2-0 (Ex MH2)	S2.000 (Ex)	S2-1 (Ex MH4)	32.7	1.129	0.673	0.5918	
15 minute summer	S2-1 (Ex MH4)	S2.001 (Ex)	S1-3 (Ex MH5)	45.2	1.303	0.542	0.5603	
15 minute summer	S1-3 (Ex MH5)	S1.003 (Ex)	S1-4	146.8	1.331	0.986	4.4775	
15 minute summer	S3-0 (Ex MH**)	S3.000	S3-1	122.3	1.496	0.454	1.1398	
15 minute summer	S3-1	S3.001	S1-4	108.3	1.098	0.269	1.8465	
15 minute summer	S1-4	S1.004	S1-5	238.4	1.504	1.493	5.5199	
15 minute summer	S1-5	S1.006	S1-6	244.8	1.545	0.757	0.6119	
15 minute summer	S1-6	S1.007	S1-7	424.5	2.679	1.313	10.0776	
1440 minute summer	S1-7	S1.008	S1-8	53.9	1.186	0.167	2.9385	
1440 minute summer	S1-8	S1.009	Petrol Interceptor	54.5	0.917	0.169	3.4064	
1440 minute summer	Petrol Interceptor	S1.010	S1-9	54.3	0.908	0.168	0.7938	
1440 minute summer	S1-9	S1.011	S1-10	55.0	1.099	0.170	3.4162	
1440 minute summer	S1-10	S1.012	S1-11 (Ex MH16)	8.8	0.827	0.027	0.0283	
15 minute summer	S7-0 (ExMH 12)	S7.000 (Ex)	S7-1 (ExMH 14)	5.4	1.545	0.030	0.0348	
15 minute summer	S8-0 (ExMH 15)	S8.000 (Ex)	S7-1 (ExMH 14)	0.0	0.000	0.000	0.0087	
15 minute summer	S7-1 (ExMH 14)	S7.001 (Ex)	S1-11 (Ex MH16)	5.4	1.298	0.052	0.0135	
240 minute summer	S1-11 (Ex MH16)	S1.013 (Ex)	S1-12 (Ex MH 515)	38.1	1.473	0.050	0.6106	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.63%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	S1-12 (Ex MH 515)	188	42.490	1.880	54.1	6.9454	0.0000	SURCHARGED
240 minute summer	S9-0 (Ex MH 512)	188	42.491	0.541	14.9	2.0194	0.0000	SURCHARGED
240 minute summer	S9-1 (Ex MH18)	188	42.491	0.801	24.4	2.0351	0.0000	SURCHARGED
240 minute summer	S10 (Ex MH44)	188	42.491	0.511	6.2	1.2858	0.0000	FLOOD RISK
240 minute summer	S9-2 (Ex MH20)	188	42.491	1.101	38.0	2.2830	0.0000	FLOOD RISK
240 minute summer	S1-13 (Ex MH17)	188	42.490	2.150	45.5	4.2069	0.0000	SURCHARGED
240 minute summer	Outfall	188	40.224	0.053	13.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	S1-12 (Ex MH 515)	S1.014 (Ex)	S1-13 (Ex MH17)	-15.4	0.401	-0.002	90.1283	
240 minute summer	S9-0 (Ex MH 512)	S9.000 (Ex)	S9-1 (Ex MH18)	14.9	0.782	0.313	1.2317	
240 minute summer	S9-1 (Ex MH18)	S9.001 (Ex)	S9-2 (Ex MH20)	24.4	0.872	0.364	0.9554	
240 minute summer	S10 (Ex MH44)	S10.000 (Ex)	S9-2 (Ex MH20)	6.2	1.034	0.095	0.9776	
240 minute summer	S9-2 (Ex MH20)	S9.002 (Ex)	S1-13 (Ex MH17)	38.0	0.962	0.248	3.3525	
240 minute summer	S1-13 (Ex MH17)	S1.015	Outfall	13.8	1.256	0.030	0.0927	343.7

Appendix D Causeway Foul Water Drainage Design Calculations

Design Settings

Frequency of use (kDU)	0.00	Additional Flow (%)	0	Preferred Cover Depth (m)	1.200
Flow per dwelling per day (l/day)	750	Minimum Velocity (m/s)	1.00	Include Intermediate Ground	✓
Domestic Flow (l/s/ha)	0.0	Connection Type	Level Soffits		
Industrial Flow (l/s/ha)	0.0	Minimum Backdrop Height (m)	0.200		

Nodes

Name	Cover Level (m)	Manhole Type	Easting (m)	Northing (m)	Depth (m)
F1-0	46.000	Adoptable	688090.033	766756.251	1.300
F1-1	47.000	Adoptable	688143.674	766775.838	2.681
F1-2	46.900	Adoptable	688153.124	766750.710	2.762
F1-3	46.900	Adoptable	688152.579	766728.687	2.909
F1-4	47.350	Adoptable	688165.785	766692.142	3.618
F1-5 Ex	47.060	Adoptable	688132.561	766674.111	3.580

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
F1.000	F1-0	F1-1	57.110	1.500	44.700	44.319	0.381	150.0	150
F1.001	F1-1	F1-2	27.209	1.500	44.319	44.138	0.181	150.0	150
F1.002	F1-2	F1-3	22.031	1.500	44.138	43.991	0.147	150.0	150
F1.003	F1-3	F1-4	38.863	1.500	43.991	43.732	0.259	150.0	150
F1.007	F1-4	F1-5 Ex	37.801	1.500	43.732	43.480	0.252	150.0	150

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)
F1.000	0.000	0.714	12.6	0.0	1.150	2.531	0.000	0	0.0	0.0	0
F1.001	0.000	0.714	12.6	0.0	2.531	2.612	0.000	0	0.0	0.0	0
F1.002	0.000	0.714	12.6	0.0	2.612	2.759	0.000	0	0.0	0.0	0
F1.003	0.000	0.714	12.6	0.0	2.759	3.468	0.000	0	0.0	0.0	0
F1.007	0.000	0.714	12.6	0.0	3.468	3.430	0.000	0	0.0	0.0	0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
F1.000	57.110	150.0	150	Circular	46.000	44.700	1.150	47.000	44.319	2.531
F1.001	27.209	150.0	150	Circular	47.000	44.319	2.531	46.900	44.138	2.612
F1.002	22.031	150.0	150	Circular	46.900	44.138	2.612	46.900	43.991	2.759
F1.003	38.863	150.0	150	Circular	46.900	43.991	2.759	47.350	43.732	3.468
F1.007	37.801	150.0	150	Circular	47.350	43.732	3.468	47.060	43.480	3.430

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
F1.000	F1-0	1200	Manhole	Adoptable	F1-1	1200	Manhole	Adoptable
F1.001	F1-1	1200	Manhole	Adoptable	F1-2	1200	Manhole	Adoptable
F1.002	F1-2	1200	Manhole	Adoptable	F1-3	1200	Manhole	Adoptable
F1.003	F1-3	1200	Manhole	Adoptable	F1-4	1200	Manhole	Adoptable
F1.007	F1-4	1200	Manhole	Adoptable	F1-5 Ex	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
F1-0	688090.033	766756.251	46.000	1.300	1200				
						0	F1.000	44.700	150
F1-1	688143.674	766775.838	47.000	2.681	1200	1	F1.000	44.319	150
									
						0	F1.001	44.319	150
F1-2	688153.124	766750.710	46.900	2.762	1200	1	F1.001	44.138	150
									
						0	F1.002	44.138	150

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
F1-3	688152.579	766728.687	46.900	2.909	1200		1	F1.002	43.991	150
							0	F1.003	43.991	150
F1-4	688165.785	766692.142	47.350	3.618	1200		1	F1.003	43.732	150
							0	F1.007	43.732	150
F1-5 Ex	688132.561	766674.111	47.060	3.580	1200		1	F1.007	43.480	150

Appendix E Irish Water Confirmation of Feasibility

CONFIRMATION OF FEASIBILITY

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

Seosamh O'Coileir

Carnegie House
Library Road
Dun Laoghaire
Dublin

21 November 2022

Our Ref: CDS22008207 Pre-Connection Enquiry
Buvinda House,, Meath County Council, Navan,, Meath

Dear Applicant/Agent,

We have completed the review of the Pre-Connection Enquiry.

Irish Water has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Business Connection of 1 unit(s) at Buvinda House,, Meath County Council, Navan,, Meath, (the **Development)**.

Based upon the details provided we can advise the following regarding connecting to the networks;

• **Water Connection**	-	Feasible without infrastructure upgrade by Irish Water
• **Wastewater Connection**	-	Feasible without infrastructure upgrade by Irish Water

This letter does not constitute an offer, in whole or in part, to provide a connection to any Irish Water infrastructure. Before the Development can be connected to our network(s) you must submit a connection application and be granted and sign a connection agreement with Irish Water.

As the network capacity changes constantly, this review is only valid at the time of its completion. As soon as planning permission has been granted for the Development, a completed connection application should be submitted. The connection application is available at www.water.ie/connections/get-connected/

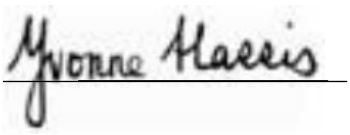
Where can you find more information?

- **Section A -** What is important to know?

This letter is issued to provide information about the current feasibility of the proposed connection(s) to Irish Water's network(s). This is not a connection offer and capacity in Irish Water's network(s) may only be secured by entering into a connection agreement with Irish Water.

For any further information, visit **www.water.ie/connections, email** newconnections@water.ie or contact 1800 278 278**.**

Yours sincerely,



Yvonne Harris
Head of Customer Operations

Section A - What is important to know?

What is important to know?	Why is this important?
Do you need a contract to connect?	• Yes, a contract is required to connect. This letter does not constitute a contract or an offer in whole or in part to provide a connection to Irish Water's network(s). • Before the Development can connect to Irish Water's network(s), you must submit a connection application and be granted and sign a connection agreement with Irish Water.
When should I submit a Connection Application?	• A connection application should only be submitted after planning permission has been granted.
Where can I find information on connection charges?	• Irish Water connection charges can be found at: https://www.water.ie/connections/information/charges/
Who will carry out the connection work?	• All works to Irish Water's network(s), including works in the public space, must be carried out by Irish Water*. *Where a Developer has been granted specific permission and has been issued a connection offer for Self-Lay in the Public Road/Area, they may complete the relevant connection works
Fire flow Requirements	• The Confirmation of Feasibility does not extend to fire flow requirements for the Development. Fire flow requirements are a matter for the Developer to determine. • **What to do?** - Contact the relevant Local Fire Authority
Plan for disposal of storm water	• The Confirmation of Feasibility does not extend to the management or disposal of storm water or ground waters. • **What to do?** - Contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges.
Where do I find details of Irish Water's network(s)?	• Requests for maps showing Irish Water's network(s) can be submitted to: datarequests@water.ie

What are the design requirements for the connection(s)?	• The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this Development shall comply with ***the Irish Water Connections and Developer Services Standard Details and Codes of Practice,*** available at www.water.ie/connections
Trade Effluent Licensing	• Any person discharging trade effluent** to a sewer, must have a Trade Effluent Licence issued pursuant to section 16 of the Local Government (Water Pollution) Act, 1977 (as amended). • More information and an application form for a Trade Effluent License can be found at the following link: https://www.water.ie/business/trade-effluent/about/ **trade effluent is defined in the Local Government (Water Pollution) Act, 1977 (as amended)

Appendix F Site Investigation

Buvinda House, Navan – Ground Investigation

INTERPRETATIVE REPORT

Client:	Meath County Council
Client's Representative:	PUNCH Consulting Engineers
Report No.:	19-0890
Date:	18th October 2019
Status:	Final for Issue

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Approved: ISO 9001 • ISO 14001 • OHSAS 18001

CONTENTS

APPENDICES

Document Control Sheet

Report No.:		19-0890			
Project Title:		Buvinda House, Navan			
Client:		Meath County Council			
Client's Representative:		PUNCH Consulting Engineers			
Revision:	A01	**Status:**	Final for Review	**Issue Date:**	18th October 2019
Prepared by:		**Reviewed by:**		**Approved by:**	
 Carin Cornwall BSc MSc PhD		 Neil Haggan BSc (Hons) MSc FGS		 Darren O'Mahony BSc MSc MIEI EurGeol PGeo	

The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2015) BS 5930:2015, Code of practice for site investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015, The Code of Practice for Site Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler).
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler).
P	Nominal 100mm diameter undisturbed piston sample.
B	Bulk disturbed sample.
LB	Large bulk disturbed sample.
D	Small disturbed sample.
C	Core sub-sample (displayed in the Field Records column on the logs).
L	Liner sample from dynamic sampled borehole.
W	Water sample.
ES / EW	Soil sample for environmental testing / Water sample for environmental testing.
SPT (s)	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.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015	
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.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Buvinda House, Navan

1 AUTHORITY

On the instructions of PUNCH Consulting Engineers, ("the Client's Representative"), acting on the behalf of Meath 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 a proposed extension to the existing headquarters of Meath County Council in Navan.

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. A discussion on the recommendations for construction is also provided.

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 recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of 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 trenches, soil and rock core sampling, environmental sampling, groundwater and ground gas monitoring, in-situ and laboratory testing, and the preparation of a report on the findings including recommendations for construction.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted on the site of the current Meath County Council offices in Navan. The works site is bordered by the River Boyne to the west, the Bothar Sion carriageway to the north, existing office buildings to the south, and existing car park to the east. The site is flat within the works area, with a well vegetated area to the north.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 12th and 29th August 2019, comprised:

- two light cable percussion only boreholes
- six light cable percussion with rotary follow-on boreholes
- a standpipe installation in three boreholes
- two machine dug trial trenches
- soil and rock core sampling

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.

4.2 Boreholes

A total of eight boreholes were put down in a minimum diameter of 150mm through soils and rock strata to their completion depths by a combination of methods, including light cable percussion boring by a Dando 2000 rig, and rotary drilling (by Comacchio 601 and Hanjinn 8D tracked rotary drilling rigs).

The borehole logs state the methodology and plant used for each location, as well as the appropriate depth ranges.

A summary of the boreholes, subdivided by category in accordance with the methods employed for their completion, is presented in the following sub-sections.

4.2.1 Light cable percussion boreholes

Two No boreholes (RC03 and RC03A) were put down using a light cable percussion boring rig. Both boreholes were terminated on encountering storm drain in the grassed verge area.

Hand dug inspection pits were carried out to ensure boreholes were put down at locations clear of services or subsurface obstructions; the storm drains were encountered between 1.10-1.20m within the inspection pits.

Appendix B presents the borehole logs.

4.2.2 Boreholes by combined percussion boring and rotary follow-on drilling

Six boreholes (RC01-RC02, RC03B, RC04-RC06) were put down by a combination of light cable percussion boring and rotary follow-on drilling techniques with core recovery in bedrock. Where the cable percussion borehole had not been advanced onto bedrock, rotary percussive methods were employed to advance the borehole to completion/bedrock. Symmetrix cased full-hole drilling was used, with SPTs carried out at standard intervals as required.

Hand dug inspection pits were carried out between ground level and 1.20m depth to ensure boreholes were put down at locations clear of services or subsurface obstructions.

Standard penetration tests were carried out in accordance with BS EN 22476-3:2005+A1:2011 at standard depth intervals throughout the overburden using the split spoon sampler ($SPT_{(s)}$) or solid cone attachment ($SPT_{(c)}$). 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 I.

Where coring was carried out within bedrock strata, Geobor S Coring was used. The core was extracted in up to 1.5m lengths using a SK6L core barrel, which produced core of nominal 102mm diameter, and was placed in single channel wooden core boxes.

The core was subsequently photographed and examined by a qualified and experienced Engineering Geologist, thus enabling the production of an engineering log in accordance with *BS 5930: 2015: Code of practice for ground investigations*.

Appendix B presents the borehole logs, with core photographs presented in Appendix C.

4.3 Trial trenches

Two trial trenches (TT01 and TT02) were excavated using a combination of hand digging and mechanical excavation using a compact 3t tracked excavator fitted with a 600mm wide toothless bucket, to locate and identify buried services at the site to include the storm drains encountered in both RC03 and RC03A.

Drawing of the trenches and the locations of services encountered during excavation are shown on the trial trench logs in Appendix D, with photographs presented in Appendix E.

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 R10 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates (Irish National Grid) and ground elevation (mOD Malin) 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 Groundwater and ground gas monitoring

Following completion of site works, groundwater and ground gas monitoring was conducted over two rounds. Ground water monitoring was carried out using a water interface probe. Ground gas measurements were carried out using a GA5000 gas meter.

The monitoring records are presented in Appendix F.

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.
- **shear strength** (total stress): unconsolidated undrained triaxial tests
- **soil chemistry:** pH, water soluble sulphate content, and organic matter content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute: *BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).*

The test results are presented in Appendix G.

5.2 Geotechnical laboratory testing of rock

Laboratory testing of rock sub-samples comprised:

- point load index
- unconfined compressive strength (UCS) tests

Test	Test carried out in accordance with
Point load index	ISRM Suggested Methods (1985) Suggested method for determining point-load strength. Int. J. Rock Mech. Min. Sci. Geomech. Abstr. 22, pp. 53–60
Uniaxial compression strength tests	ISRM Suggested Methods (1981) Suggested method for determining deformability of rock materials in uniaxial compression, Part 2 and ISRM (2007) Ulusay R, Hudson JA (eds) The complete ISRM suggested methods for rock characterization, testing and monitoring, 2007

The test results are presented in Appendix G.

5.3 Environmental laboratory testing of soils

Environmental testing, as specified by the Client's Representative was conducted on selected environmental soil samples by Chemtest at its laboratory in Newmarket, Suffolk.

WAC suite of analysis was carried out on two samples for landfill disposal criteria. This included testing for a range of determinants, including:

- Metals
- Chromium (Trivalent and Hexavalent)
- Speciated total petroleum hydrocarbons (TPH) aliphatic and aromatic
- Total polycyclic aromatic hydrocarbons (PAH)
- Total polychlorinated biphenyls (PCB) 7 congeners
- Methyl Tert-Butyl Ether (MTBE)
- Total organic carbon (TOC), loss on ignition (LOI)
- Total dissolved solids (TDS)
- Asbestos screen
- pH

Results of environmental laboratory testing are presented in Appendix H.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits underlying the site comprise gravels and Glacial Till. These deposits are underlain by dark grey limestones and shales of the Lucan Formation.

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:

- **Paved surface:** boreholes RC01-RC02, RC03B, RC04-RC06 encountered 100mm of macadam surfacing.
- **Topsoil:** where encountered in RC03 and RC03A typically 200mm thickness.
- **Made Ground (sub-base):** approximately 100-200mm of aggregate fill beneath the paved surface.
- **Made Ground (fill):** reworked sandy gravelly silty clay fill, occasionally with pockets of gravel and cobbles; extends to a maximum depth of 3.20m in RC03B.
- **Fluvioglacial deposits:** typically, loose to medium dense gravelly sands with occasional cobbles and boulders.
- **Glacial Till:** sandy gravelly clay, frequently with low cobble content, typically firm or stiff in upper horizons, becoming very stiff with increasing depth. Overlain by a bed of firm to stiff silt in RC04 and RC06.
- **Bedrock (mudstone, limestone):** Rockhead was encountered at depths ranging from 8.50m in RC01 to 14.15m in borehole RC06, showing a trend of dipping to the east.

6.3 Groundwater

Groundwater was encountered during percussion boring through soil as water strikes at 3.3-5.2m in boreholes RC01 and RC02. The other boreholes were dry.

Details of the individual groundwater strikes are presented on the exploratory hole logs for each location.

Groundwater was not noted during drilling at the other borehole locations. However, it should be noted that the casing used in supporting the borehole walls during drilling may have sealed out any groundwater strikes and the possibility of encountering groundwater during excavation works should not be ruled out.

It should be noted that any groundwater strikes within bedrock may have been masked by the fluid used as the drilling flush medium.

Subsequent groundwater monitoring of the standpipes recorded water levels as shown in Table 1.

Table 1: Groundwater monitoring

Date	Water level		
	RC01	RC04	RC05
29/08/2019	6.91m	DRY	5.07m
10/10/2019	4.65m	DRY	4.90m
17/10/2019	6.70m	DRY	4.90m

Seasonal variation in groundwater levels should also be factored into design considerations.

Continued monitoring of the three installed standpipes will give an indication of the seasonal variation in groundwater level which should be factored into design considerations.

Details of the groundwater monitoring, as well as results of gas monitoring, are presented in Appendix F.

7 DISCUSSION

7.1 Proposed construction

It is proposed to construct an extension to the existing office buildings on the site.

No further details were available to Causeway Geotech at the time of preparing this report and any designs based on the recommendations or conclusions within this report should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory holes. Causeway Geotech were commissioned to provide a geotechnical report, and it is outwith our remit to advise on structure design.

7.2 Recommendations for construction

7.2.1 Summary

The ground conditions across the site (highly variable made ground and fluvioglacial material), coupled with increased depths to a suitable bearing stratum will render the implementation of any shallow (spread) foundations problematic, and in most areas of the site not suitable. The variation between fine-grained and coarse-grained soils across the footprints of the building units could also lead to the occurrence of differential settlements, which should be avoided. It follows that the most practicable solution for installing safe working foundations across the site will be by a “deep” foundation method, such as piling to transfer loadings to depth.

7.2.2 Soil strength parameters

When estimating the shear strength of fine soils (silt/clay), reference is made to the results of Standard Penetration Tests (SPT's) carried out within the boreholes. The undrained shear strength of fine soils can be estimated using the correlation developed by Stroud & Butler:

$$C_u = f_1 \times N$$

where f_1 is typically in the range 4 to 6. A median f_1 value of 5 is adopted for this report.

For granular soils (sand/gravel), a graphical relationship between SPT "N" value and angle of shearing resistance, φ, has been developed by Peck, Hanson and Thorburn. This is published in *Foundation Design and Construction* (Tomlinson, 2001) and is referenced in this report when deriving angles of shearing resistance for the gravel soils.

7.2.3 Foundations and ground floor construction

Foundations should transfer loading to below any Made Ground or subsoil. The recommended foundation construction and allowable bearing pressure (ABP) at the borehole locations are presented in Table 2.

Table 2: Construction recommendations

Borehole	Depth below EGL* to suitable bearing stratum	Estimated ABP (kPa)	Strata description	Foundation type	Ground floor construction	Groundwater
RC01	6.10m	>250	Very Stiff Glacial Till	Piled	Suspended	5.20mbgl
RC02	5.70m	190	Very Stiff Glacial Till	Piled	Suspended	3.30mbgl
RC03B	6.00m	205	Very Stiff Glacial Till	Piled	Suspended	Not encountered
RC04	7.00m	105	Stiff Glacial Till	Piled	Suspended	Not encountered
RC05	6.50m	>250	Very Stiff Glacial Till	Piled	Suspended	Not encountered
RC06	9.00m	>250	Very Stiff Glacial Till	Piled	Suspended	Not encountered

*Existing Ground Level

The practicable foundation solution is:

1. Piling to transfer loadings to depth:

Piling to transfer loadings to depth is suggested to be the most practicable and applicable option given the depth to a consistent bearing stratum across the site.

Driven piles are the preferred pile type – of precast concrete or steel/ductile iron. The piles should be driven to a predetermined set – each pile will, therefore, be effectively proof tested by the installation method.

If the surrounding land use precludes the use of hard drive piles, due to environmental restrictions with respect to noise and vibration, low vibration driven piles, continuous flight auger (CFA) or continuous helical displacement (CHD) piles will be required.

Piles will acquire capacity from shaft friction through the fluvioglacial and glacial deposits, and end bearing on the weathered sedimentary bedrock.

Where site levels are to be raised, piles should be designed to resist additional loading that will arise due to negative skin friction along the pile length passing through Made Ground and soft soils.

The detailed design of piles should be undertaken in conjunction with specialist piling contractors. Their proposals should include the means to verify that the required load capacity has been achieved: for example, dynamic pile tests and/or static load tests.

Where pile foundation solution is adopted, floor slabs should be supported by ground beams spanning between piles caps supported by piles.

7.2.4 Floor slabs

Floor slabs should not bear directly onto Made Ground or soft soils. Consequently, the use of ground bearing floor slabs is only appropriate following the removal of any surface Made Ground and soft clay layers and their replacement using well-graded well-compacted granular fill. However, a suspended floor slab should be adopted where the difference in levels of the proposed floor and the base of Made Ground/soft soils is greater than 600mm.

Therefore, given the depth to the base of Made Ground and relative low strength of upper natural soil layers, a suspended floor slab may be required over parts of the site. The use of intermediate lines of support stub walls would reduce the spans required for flooring units.

7.2.5 Excavations for services

For the installation of services ducts/trenches, it is suggested that open trenching will be the most practicable construction method. Generally speaking, the ground conditions should render the use of open trenching by backhoe excavator possible, with some trench support possibly required for the uppermost granular strata.

Where working in open trenches, it is thought that trench support systems, by way of a trench box (or possibly sheet piles), will be required to maintain trench stability and safe working conditions. Groundwater control at these locations should be possible by means of sump pumping.

To preclude the eventuality of differential settlements in pipes, they should be laid on a consistent stratum of appropriate allowable bearing capacity and protected with appropriate fill cover.

Where ducts and chambers must be installed in areas where localised soft spots are encountered, the use of geogrid reinforcement along the base of the excavation on is recommended. This will stiffen the base of the trench and help control longitudinal differential settlement.

Backfilling of trenches may be completed by using compacted Cl 804 granular fill and reinstated as appropriate.

7.2.6 Soil aggressivity

An assessment of the Aggressive Chemical Environment for Concrete (ACEC) was undertaken through reference to the Building Research Establishment (BRE) Special Digest 1 (2017).

As noted by BRE Special Digest 1, sulphates in the soil and groundwater are the chemical agents most likely to attack concrete. The extent to which sulphates affect concrete is linked to their concentrations, the type of ground, the presence of groundwater, the type of concrete and the form of construction in which concrete is used.

BRE Special Digest 1 identifies four different categories of site which require specific procedures for investigation for aggressive ground conditions:

- Sites not subjected to previous industrial development and not perceived as containing pyrite;
- Sites not subjected to previous industrial development and perceived as containing pyrite;
- Brownfield sites not perceived as containing pyrite;
- Brownfield sites perceived as containing pyrite.

For the purposes of this report the site was classified as brownfield sites not perceived as containing pyrite.

The results of chemical tests (pH and water-soluble sulphate contents) on soil samples indicate Design Sulphate Class DS-1 and ACEC Class AC-1s – reference Table C2 of BRE Special Digest 1 (Building Research Establishment, 2005). The Special Digest does not require any measures to protect underground concrete elements greater that 140mm thick.

7.3 Site contamination and waste disposal

Two samples were tested for a Waste Acceptance Criteria (WAC) suite to assess the potential categorisation of waste from the site.

In assessment of the waste acceptance criteria (WAC) results, the test results have been compared with the European Union Directive limits for Inert waste landfill, Stable, Non-reactive hazardous waste in non-hazardous landfill and hazardous waste landfill criteria. From the samples tested for WAC analysis material, the site may potentially be classified as inert/non-hazardous. Any material excavated for off-site disposal would have to be classified under guidance in the National Hazardous Waste Management Plan (EPA, 2014).

8 REFERENCES

Geotechnical Society of Ireland (2016), Specification & Related Documents for Ground Investigation in Ireland

IS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS 5930: 2015: Code of practice for ground investigations. British Standards Institution.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description.

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

Building Research Establishment (2005) BRE Special Digest 1, Concrete in aggressive ground.

Contaminated Land Report (CLR) 11, (2009) Model Procedures for the Management of Land Contamination, The Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency.

CAUSEWAY GEOTECH

APPENDIX A

SITE AND EXPLORATORY HOLE LOCATION PLANS

CAUSEWAY GEOTECH

Project No.:	19-0890	**Client:**	Meath County Council
Project Name:	Buvinda House, Navan	**Client's Representative:**	PUNCH Consulting Engineers

Legend Key

Title:

Site Location Plan

Last Revised:	**Scale:**
04/10/2019	1:40000

CAUSEWAY GEOTECH

Project No.:	19-0890	**Client:**	Meath County Council
Project Name:	Buvinda House, Navan	**Client's Representative:**	PUNCH Consulting Engineers

Legend Key

- Locations By Type - CP
- Locations By Type - CP+RC
- Locations By Type - TT

Title:

Site Location Plan

Last Revised:	**Scale:**
04/10/2019	1:500

CAUSEWAY GEOTECH

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion Rotary Coring	Dando 2000 Hanjin D8	0.00 8.50	8.50 11.20

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC01

Coordinates: 288133.60 E, 266706.50 N

Client: Meath County Council

Client's Representative: PUNCH Consulting Engineers

Ground Level: 46.59 mOD

Dates: 15/08/2019 - 28/08/2019

Sheet 1 of 2

Scale: 1:50

Driller: BM+KW

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					46.49	(0.10)	BITMAC
					46.39	(0.20)	
0.30	ES17						MADE GROUND: Dense grey sandy angular to subangular fine to coarse GRAVEL. Sand is fine to coarse.
0.50	B1				46.19	0.40	BOULDER
						(0.80)	MADE GROUND: Firm brownish grey slightly sandy slightly gravelly CLAY fill. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
1.00	B2						
1.20	D10				45.39	1.20	
1.20 - 1.65	SPT (S) N=9		Dry	N=9 (2,2/3,2,2,2) Hammer SN = 0643			Soft grey slightly sandy gravelly silty CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.
2.00	B3						
2.00	D11						
2.00 - 2.45	SPT (S) N=4	1.50	Dry	N=4 (2,2/1,1,1,1) Hammer SN = 0643		(2.50)	
3.00	B4						
3.00	D12						
3.00 - 3.45	SPT (S) N=7	3.00	Dry	N=7 (1,1/1,2,2,2) Hammer SN = 0643			
					42.89	3.70	Medium dense grey gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.
4.00	B5						
4.00	D13						
4.00 - 4.45	SPT (S) N=17	4.00	Dry	N=17 (3,3/4,4,4,5) Hammer SN = 0643			
						(2.40)	
5.00	B6						
5.00	D14						
5.00 - 5.45	SPT (S) N=27	5.00	Dry	N=27 (6,6/7,7,7,6) Hammer SN = 0643 Water strike at 5.20			
6.00	B7						
6.00	D15				40.49	6.10	
6.00 - 6.44	SPT (S)	6.00	5.00	N=50 (7,8/50 for 295mm) Hammer SN = 0643			Very stiff grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.
						(0.90)	
					39.59	7.00	Very stiff blackish grey slightly sandy gravelly silty CLAY with fragments of bedrock throughout. Sand is fine to coarse. Gravel is angular to subangular fine to coarse.
7.50	B8						
7.50 - 7.95	U16	7.50	Dry	Ublow=50 100%		(1.50)	
8.40	B9						
8.50 - 8.57			15	N=50 (25 for 25mm/50 for 50mm) Hammer SN = 0643	38.09	8.50	Medium strong to strong (locally weak) indistinctly thinly bedded dark grey LIMESTONE. Partially weathered: Slightly reduced strength, closer fracture spacing and up to 10mm of gravelly infill between some joints. Discontinuities: 1. 20-35 degree bedding fractures (30/125/350), planar, smooth, unstained, up to 10mm of gravelly clay infill at 8.90m and 10.20m 2. 30-45 degree joints, medium spaced (200/500/800), planar, rough, patchy brown staining on joint surfaces, occasional with 10-30mm of soft dark grey gravelly clay infill. 3. 75-85 degree joint from 10.70m to 11.20m stepped, smooth, unstained.
9.25				C1			
9.40			5	C2		(2.70)	
9.70							
			16				
	TCR: 90	SCR: 83	RQD: 46	FI			

Remarks
Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 2.70m competent core

Core Barrel: SK6L

Flush Type:

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
5.20	5.20		

Water Added		Casing Details	
From (m)	To (m)	To (m)	Diam (mm)
		8.50	200

Chiselling Details		
From (m)	To (m)	Time (hh:mm)
8.40	8.50	01:00

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
19-0890	Buvinda House, Navan	RC01
Coordinates:	**Client:**	Sheet 2 of 2
288133.60 E	Meath County Council	
266706.50 N	**Client's Representative:** PUNCH Consulting Engineers	**Scale:** 1:50
Ground Level: 46.59 mOD	**Dates:** 15/08/2019 - 28/08/2019	**Driller:** BM+KW
		Logger: NH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.50
Rotary Coring	Hanjin D8	8.50	11.20

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.40	100	69	31	6	C3				Medium strong to strong (locally weak) indistinctly thinly bedded dark grey LIMESTONE. Partially weathered: Slightly reduced strength, closer fracture spacing and up to 10mm of gravelly infill between some joints. Discontinuities: 1. 20-35 degree bedding fractures (30/125/350), planar, smooth, unstained, up to 10mm of gravelly clay infill at 8.90m and 10.20m 2. 30-45 degree joints, medium spaced (200/500/800), planar, rough, patchy brown staining on joint surfaces, occasional with 10-30mm of soft dark grey gravelly clay infill. 3. 75-85 degree joint from 10.70m to 11.20m stepped, smooth, unstained.		
11.20						35.39	11.20		End of Borehole at 11.20m		

TCR	SCR	RQD	FI

Remarks
Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 2.70m competent core

Core Barrel
SK6L

Flush Type

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
5.20	5.20		

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)
8.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.40	8.50	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion Rotary Coring	Dando 2000 Hanjin 8D	0.00 8.50	8.50 14.50

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC02

Coordinates: 288153.45 E, 266709.32 N

Client: Meath County Council

Sheet 1 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+KW

Ground Level: 46.70 mOD

Dates: 13/08/2019 - 27/08/2019

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.60	(0.10)		BITMAC		
0.30	ES16					(0.40)		MADE GROUND: Grey slightly sandy angular to subangular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse. Cobbles are angular.		
0.50	B1				46.20	0.50		MADE GROUND: Very stiff brownish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B2					(0.80)				
1.20	D7									
1.20 - 1.65	SPT (S) N=43	0.00	Dry	N=43 (5,6/7,9,10,17)	45.40	1.30		Firm greyish brown slightly sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded.		
2.00	B3					(1.50)				
2.00	D8									
2.00 - 2.45	SPT (S) N=6	1.80	Dry	N=6 (4,2/1,2,1,2)						
					43.90	2.80		Loose grey gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium.		
3.00	B4									
3.00	D9									
3.00 - 3.45	SPT (S) N=6	3.00	Dry	N=6 (3,2/1,2,2,1) Water Strike at 3.30m		(1.20)			▼	
4.00	B5				42.70	4.00		Medium dense grey gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium.		
4.00	D10									
4.00 - 4.45	SPT (S) N=15	4.00	Dry	N=15 (2,2/3,3,4,5)		(1.00)				
5.00	B6				41.70	5.00		Medium dense grey silty fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL.		
5.00	D11									
5.00 - 5.45	SPT (S) N=28	5.00	Dry	N=28 (6,6/7,7,7,7)		(0.70)				
		5.00	Dry	13-08-2019						
		5.00	Dry	14-08-2019						
					41.00	5.70		Very stiff brownish grey slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium. Cobbles are subrounded.		
6.00	B12									
6.00	D14									
6.00 - 6.45	SPT (S) N=38	6.00	5.80	N=38 (5,6/6,10,10,12)						
						(2.80)				
7.50	B13									
7.50	D15									
7.50 - 7.87	SPT (S)	7.50	7.40	N=50 (8,9/50 for 220mm)						
						8.50				
8.50 - 8.57	47	0	0	N=50 (25 for 25mm/50 for 50mm) 14-08-2019	38.20			LOW RECOVERY: Dark grey slightly sandy clayey subangular fine to coarse GRAVEL with high cobble content. Sand is fine to coarse. Possible weathered limestone.		
						(1.80)				
10.00 - 10.08				N=50 (25 for 50mm/50 for 30mm)						
10.00					36.40	10.30				
	TCR	SCR	RQD	FI						

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.00m competent core

Core Barrel: SK6L

Flush Type:

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.30	3.00	20	3.30

Water Added

From (m)	To (m)
5.00	5.70

Casing Details

To (m)	Diam (mm)
8.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.30	8.50	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion Rotary Coring	Dando 2000 Hanjin 8D	0.00 8.50	8.50 14.50

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC02

Coordinates: 288153.45 E 266709.32 N

Client: Meath County Council

Sheet 2 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+KW

Ground Level: 46.70 mOD

Dates: 13/08/2019 - 27/08/2019

Logger: NH

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
	100	47	19	>20					Very weak to weak (locally medium strong) very thinly bedded dark grey carbonaceous MUDSTONE with medium spaced thin beds of medium strength grey limestone. Distinctly weathered: Reduced strength, much closer fracture spacing and up to 10mm of clay infill between joints. Discontinuities: 1. 10-30 degrees bedding fractures closely spaced (20/75/250), planar, smooth, unstained up to 10mm of clay infill. 2. 75-85 degree joints probably medium spaced, planar, smooth, unstained.		
11.20				3	C1		(1.95)				
11.50 - 11.54					N=50 (20 for 5mm/50 for 40mm)						
11.50											
12.30	100	47	13	>20	C2	34.45	12.25		Medium strong (locally strong) very thinly bedded grey LIMESTONE with medium spaced thin beds of weak dark grey carbonaceous mudstone. Partially weathered: Slightly reduced strength, closer fracture spacing, and patches of brownish orange staining on fracture surfaces. Discontinuities: 1. 25-45 degree joints medium spaced (20/250/500), planar, smooth, some patches of brownish orange staining on joint surfaces. 2. 65-85 degree joint from 14.00-14.20m, planar, smooth, unstained. 3. 0-25 degree joints medium spaced (20/225/750), planar, smooth, some patches of brownish orange staining on joint surfaces.		
13.00 - 13.08					N=50 (25 for 50mm/50 for 25mm)						
13.00							(2.25)				
13.60	93	51	23	10	C3						
14.25					C4						
14.50						32.20	14.50		End of Borehole at 14.50m		

TCR	SCR	RQD	FI

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.00m competent core

Core Barrel SK6L

Flush Type

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)
3.30	3.00	20	3.30

Water Added

From (m)	To (m)
5.00	5.70

Casing Details

To (m)	Diam (mm)
8.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.30	8.50	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2500	0.00	1.10

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC03

Coordinates: 288171.16 E, 266736.67 N

Client: Meath County Council

Sheet 1 of 1

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM

Ground Level: 46.74 mOD

Dates: 12/08/2019 - 12/08/2019

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.54	(0.20) 0.20		TOPSOIL		
						(0.60)		MADE GROUND: Soft brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
					45.94	0.80				
						(0.30)		MADE GROUND: Dense grey sandy angular to subangular fine to coarse GRAVEL. Sand is fine to coarse.		
					45.64	1.10		End of Borehole at 1.10m		

Remarks

Hand dug inspection pit to 1.10m - storm drain in base of inspection pit

Terminated due to presence of storm drain in inspection pit

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2500	0.00	1.20

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC03A

Coordinates: 288169.15 E, 266739.81 N

Client: Meath County Council

Sheet 1 of 1

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM

Ground Level: 46.75 mOD

Dates: 12/08/2019 - 12/08/2019

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.55	(0.20) 0.20		TOPSOIL		
						(0.50)		MADE GROUND: Soft brownish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
					46.05	0.70				
						(0.50)		MADE GROUND: Dense grey sandy angular to subangular fine to coarse GRAVEL. Sand is fine to coarse.		
					45.55	1.20		End of Borehole at 1.20m		

Remarks

Hand dug inspection pit to 1.20m - storm drain in base of inspection pit

Terminated due to presence of storm drain in inspection pit

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)

Casing Details

To (m)	Diam (mm)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.30
Rotary Drilling	Hanjin 8D	8.30	8.50
Rotary Coring	Hanjin 8D	8.50	15.70

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC03B

Coordinates: 288159.93 E, 266725.62 N

Client: Meath County Council

Sheet 1 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+KW

Ground Level: 46.63 mOD

Dates: 16/08/2019 - 28/08/2019

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.53	(0.10)		BITMAC		
					46.43	(0.20)				
0.30	ES1					(0.30)		MADE GROUND: Black slightly sandy angular to subangular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse. Cobbles are angular.		
0.50	B2				46.13	0.50		MADE GROUND: Soft black sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B3							MADE GROUND: Soft to firm brownish grey slightly sandy slightly gravelly CLAY with pockets of sandy GRAVEL and low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.		
1.20	D10									
1.20 - 1.65	SPT (S) N=10	1.00	Dry	N=10 (2,2/3,2,2,3) Hammer SN = 0643						
						(2.70)				
2.00	B4									
2.00	D11									
2.00 - 2.45	SPT (S) N=5	1.50	Dry	N=5 (3,2/1,1,1,2) Hammer SN = 0643						
3.00	B5									
3.00	D12				43.43	3.20				
3.00 - 3.45	SPT (S) N=8	3.00	Dry	N=8 (1,2/1,2,2,3) Hammer SN = 0643				Medium dense brown gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.		
4.00	B6									
4.00	D13									
4.00 - 4.45	SPT (S) N=19	4.00	3.60	N=19 (3,4/5,5,5,4) Hammer SN = 0643						
						(2.80)				
5.00	B7									
5.00	D14									
5.00 - 5.45	SPT (S) N=28	5.00	4.00	N=28 (6,7/6,7,7,8) Hammer SN = 0643						
6.00	B8				40.63	6.00				
6.00	D15							Very stiff grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
6.00 - 6.45	SPT (S) N=41	6.00	4.50	N=41 (5,6/9,10,10,12) Hammer SN = 0643						
						(2.50)				
7.50	B9									
7.50	D16									
7.50 - 7.95	SPT (S) N=49	7.50	5.00	N=49 (6,7/11,12,12,14) Hammer SN = 0643						
						8.50				
8.20 - 8.25	100	0	0	N=50 (25 for 25mm/50 for 25mm) Hammer SN = 0643 16-08-2019	38.13			Very stiff brownish grey slightly sandy gravelly CLAY with medium cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse		
						(3.70)				
9.70 - 9.78				N=50 (25 for 50mm/50 for 30mm) Hammer SN = 0200						
9.70										
	TCR	SCR	RQD	FI						

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.70m competent core

Core Barrel

SK6L

Flush Type

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.20	6.00

Casing Details

To (m)	Diam (mm)
7.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.20	8.30	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.30
Rotary Drilling	Hanjin 8D	8.30	8.50
Rotary Coring	Hanjin 8D	8.50	15.70

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC03B

Coordinates: 288159.93 E, 266725.62 N

Client: Meath County Council

Sheet 2 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+KW

Ground Level: 46.63 mOD

Dates: 16/08/2019 - 28/08/2019

Logger: NH

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
	100	0	0						Very stiff brownish grey slightly sandy gravelly CLAY with medium cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse		
11.20 - 11.21					N=50 (25 for 5mm/50 for 5mm) Hammer SN = 0200						
11.20	100	31	27								
						34.43	12.20				
				10			(0.60)		Weak (locally very strong) indistinctly very thinly bedded dark grey argillaceous LIMESTONE. Distinctly weathered: reduced strength, closer fracture spacing, discolouration on joint surfaces. Discontinuities: 1. 20-30 degree bedding fractures, closely spaced (30/100/300), planar, smooth, patchy brown staining on fracture surfaces. 2. 40-60 degree joints, medium spaced (150/250/300), planar, rough, brown staining on joint surfaces.		
12.60					C1						
12.70						33.83	12.80				
13.20				4	C2						
13.30	100	87	59		C3				Medium strong to strong (locally weak) indistinctly thinly bedded dark grey argillaceous LIMESTONE. Discontinuities: 1. 20-35 degree bedding fractures, closely spaced (30/180/500), planar, smooth, unstained. 2. 40-60 degree joints, medium spaced (100/550/>900), undulating, rough, patchy brown stains on joint surfaces.		
				18							
14.20							(2.90)				
14.50				5	C4						
	100	85	65	>20							
				3							
15.70						30.93	15.70		End of Borehole at 15.70m		

TCR	SCR	RQD	FI

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.70m competent core

Core Barrel: SK6L

Flush Type:

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.20	6.00

Casing Details

To (m)	Diam (mm)
7.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.20	8.30	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.80
Rotary Drilling	Comacchio 601	8.80	10.00
Rotary Coring	Comacchio 601	10.00	16.70

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC04

Coordinates: 288184.45 E, 266726.73 N

Client: Meath County Council

Sheet 1 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Ground Level: 46.95 mOD

Dates: 26/08/2019 - 28/08/2019

Driller: BM+JG

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.85	(0.10)		BITMAC		
					46.75	(0.20)		MADE GROUND: Black slightly sandy angular to subangular fine to coarse GRAVEL with low cobble content. Sand is fine to coarse.		
0.50	B1							MADE GROUND: Soft brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
1.00	B2									
1.20	D9									
1.20 - 1.65	SPT (S) N=9	1.00	Dry	N=9 (2,3/2,3,2,2) Hammer SN = 0643		(2.80)				
2.00	B3									
2.00	D10									
2.00 - 2.45	SPT (S) N=6	1.50	Dry	N=6 (2,2/2,1,1,2) Hammer SN = 0643						
3.00	B4				43.95	3.00		Medium dense brown slightly gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine.		
3.00	D11									
3.00 - 3.45	SPT (S) N=17	3.00	Dry	N=17 (3,4/4,4,4,5) Hammer SN = 0643						
4.00	B5									
4.00	D12					(2.40)				
4.00 - 4.45	SPT (S) N=12	4.00	3.90	N=12 (2,2/2,3,3,4) Hammer SN = 0643						
5.00	B6									
5.00	D13									
5.00 - 5.45	SPT (S) N=15	5.00	4.70	N=15 (2,2/3,3,4,5) Hammer SN = 0643	41.55	5.40		Medium dense to dense brown silty fine to coarse SAND.		
6.00	B7									
6.00	D14					(1.60)				
6.00 - 6.45	SPT (S) N=43	6.00	5.90	N=43 (18,6/19,14,5,5) Hammer SN = 0643						
					39.95	7.00		Stiff grey slightly gravelly sandy silty CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
7.50	B8									
7.50	D15									
7.50 - 7.95	SPT (S) N=21	7.50	7.30	N=21 (3,4/5,5,5,6) Hammer SN = 0643		(1.80)				
8.80 - 8.88	SPT (S)	8.50	Dry	N=50 (25 for 50mm/50 for 25mm) Hammer SN = 0643	38.15	8.80		Very stiff grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.		
		8.50	Dry	26-05-2019						
								Very stiff greyish brown slightly sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.		

TCR	SCR	RQD	FI

Remarks

Hand dug inspection pit excavated to 1.20m.

Terminated on recovery of 2.70m competent core

Core Barrel: SK6L

Flush Type: Polymer

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.20	5.00

Casing Details

To (m)	Diam (mm)
8.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.60	8.80	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	8.80
Rotary Drilling	Comacchio 601	8.80	10.00
Rotary Coring	Comacchio 601	10.00	16.70

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC04

Coordinates: 288184.45 E, 266726.73 N

Client: Meath County Council

Sheet 2 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+JG

Ground Level: 46.95 mOD

Dates: 26/08/2019 - 28/08/2019

Logger: NH

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.00 - 10.03	100	0	0		N=50 (25 for 10mm/50 for 20mm) Hammer SN = 0209		(1.50)		Very stiff greyish brown slightly sandy gravelly CLAY with low cobble and boulder content. Sand is fine to coarse. Gravel is subangular fine to coarse.		
11.50 - 11.52 11.50	100	0	0		N=50 (25 for 10mm/50 for 10mm) Hammer SN = 0209	35.45	11.50 (4.70)		Very stiff dark brownish grey slightly sandy gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse		
12.50					C2		(2.50)				
13.00 - 13.01 13.00	100	0	0		N=50 (25 for 5mm/50 for 5mm) Hammer SN = 0209	33.45	13.50				
14.00					C3	32.95	14.00		Medium strong to very strong (locally very weak) thinly bedded dark grey argillaceous LIMESTONE. Partially weathered: some patches of brown oxidation staining on joint surfaces Discontinuities: 1. 5-25 degree bedding fractures medium spaced (50/210/550), planar, smooth, some orange oxidation staining. 2. 65-85 degree joint from 15.70-16.70m, stepped, smooth, some orange oxidation staining on joint surface 3. 45-65 degree joints medium spaced (90/500/1000), planar, smooth, unstained.		
14.00 14.60	100	0	0		C4						
15.50 16.00	100	71	29	7	C5		(2.70)				
16.70						30.25	16.70		End of Borehole at 16.70m		
	TCR	SCR	RQD	FI							

Remarks

Hand dug inspection pit excavated to 1.20m.

Terminated on recovery of 2.70m competent core

Core Barrel

SK6L

Flush Type

Polymer

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.20	5.00

Casing Details

To (m)	Diam (mm)
8.50	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
8.60	8.80	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	5.00
Rotary Drilling	Hanjin 8D	5.00	7.00
Rotary Coring	Hanjin 8D	7.00	12.60

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC05

Coordinates: 288217.24 E, 266754.27 N

Client: Meath County Council

Sheet 1 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Driller: BM+KW

Ground Level: 46.90 mOD

Dates: 27/08/2019 - 29/08/2019

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.80	(0.10) 0.10		TOPSOIL		
						(0.20)		MADE GROUND: Grey sandy subangular to subrounded fine to coarse GRAVEL Sand is fine to coarse.		
					46.60	0.30		MADE GROUND: Firm brownish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
0.50	B1									
1.00	B2					(1.20)				
1.20	D7									
1.20 - 1.65	SPT (S) N=9	1.20	Dry	N=9 (2,2/2,3,2,2) Hammer SN = 0643	45.40	1.50		Loose to medium dense brown silty fine to coarse SAND.		
2.00	B3									
2.00	D8									
2.00 - 2.45	SPT (S) N=7	1.70	Dry	N=7 (1.5,1.5/1.5,1.5,2,2) Hammer SN = 0643						
3.00	B4									
3.00	D9					(3.20)				
3.00 - 3.45	SPT (S) N=12	3.00	2.80	N=12 (2,2/3,3,3,3) Hammer SN = 0643						
4.00	B5									
4.00	D10									
4.00 - 4.45	SPT (S) N=15	4.00	3.90	N=15 (2,3/4,3,4,4) Hammer SN = 0643						
					42.20	4.70				
						(0.30)		BOULDER		
5.00	B6				41.90	5.00				
5.00	D11							Medium dense very gravelly silty fine to coarse SAND with low cobble and boulder content. Gravel is subangular to subrounded fine to coarse. Cobbles and boulders are subrounded.		
5.00 - 5.05	SPT (S)	5.00	4.90	N=50 (25 for 25mm/50 for 25mm) Hammer SN = 0643		(1.50)				
5.50 - 5.95	SPT (C) N=16	5.50	5.40	N=16 (3,3/3,4,4,5) Hammer SN = 0200						
					40.40	6.50				
						(0.50)		Very stiff grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
					39.90	7.00				
7.40	100 0 0			C1				Very stiff brownish grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse.		
8.10 - 8.13				N=50 (25 for 20mm/50 for 10mm) Hammer SN = 0200						
8.10						(2.70)				
8.80	100 0 0			C2						
9.60 - 9.62				N=50 (25 for 10mm/50 for 5mm) Hammer SN = 0200						
9.60					37.20	9.70		Medium strong to strong (locally weak) very thinly bedded dark grey argillaceous LIMESTONE with medium spaced thin beds of weak black carbonaceous mudstone. Partially weathered: slightly closer fracture spacing and possibly slightly reduced strength.		
	TCR SCR RQD FI		14							

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 2.60m competent core

Core Barrel

Flush Type

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added	
From (m)	To (m)
2.40	5.00

Casing Details	
To (m)	Diam (mm)
5.00	200

Chiselling Details		
From (m)	To (m)	Time (hh:mm)
4.70	5.00	01:00

CAUSEWAY GEOTECH

Project No.:	Project Name:	Borehole No.:
19-0890	Buvinda House, Navan	RC05
Coordinates:	**Client:**	Sheet 2 of 2
288217.24 E	Meath County Council	
266754.27 N	**Client's Representative:** PUNCH Consulting Engineers	**Scale:** 1:50
Ground Level: 46.90 mOD	**Dates:** 27/08/2019 - 29/08/2019	**Driller:** BM+KW
		Logger: NH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	5.00
Rotary Drilling	Hanjin 8D	5.00	7.00
Rotary Coring	Hanjin 8D	7.00	12.60

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
10.40	100	67	37	10	C3				Medium strong to strong (locally weak) very thinly bedded dark grey argillaceous LIMESTONE with medium spaced thin beds of weak black carbonaceous mudstone. Partially weathered: slightly closer fracture spacing and possibly slightly reduced strength. Discontinuities: 1. 15-30 degree bedding fractures, closely spaced (30/150/350), planar, smooth, unstained. 2. 65-85 degree joints, probably medium spaced, planar, smooth stained greyish brown.		
10.85				>20	C4						
11.10				7							
	100	100	41	12			(2.90)				
12.10				8	C5						
12.60						34.30	12.60		End of Borehole at 12.60m		

TCR	SCR	RQD	FI

Remarks
Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 2.60m competent core

Core Barrel

Flush Type

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added	
From (m)	To (m)
2.40	5.00

Casing Details	
To (m)	Diam (mm)
5.00	200

Chiselling Details		
From (m)	To (m)	Time (hh:mm)
4.70	5.00	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.70
Rotary Drilling	Comacchio 601	9.70	10.00
Rotary Coring	Comacchio 601	10.00	17.50

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC06

Coordinates: 288199.71 E, 266738.88 N

Client: Meath County Council

Sheet 1 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Ground Level: 46.93 mOD

Dates: 26/08/2019 - 29/08/2019

Driller: BM+JG

Logger: NH

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
					46.83	(0.10) 0.10		BITMAC		
					46.63	(0.20) 0.30		MADE GROUND: Blackish sandy subangular to subrounded fine to coarse GRAVEL. Sand is fine to coarse.		
0.50	B1							MADE GROUND: Firm brownish grey slightly sandy gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular to subrounded.		
1.00	B2									
1.20	D10									
1.20 - 1.65	SPT (S) N=10	1.00	Dry	N=10 (2,2/3,2,3,2) Hammer SN = 0643		(2.10)				
2.00	B3									
2.00	D11									
2.00 - 2.45	SPT (S) N=7	1.20	Dry	N=7 (1.5,1.5/1.5,1.5,2,2) Hammer SN = 0643	44.53	2.40		Medium dense brown gravelly silty fine to coarse SAND. Gravel is subangular to subrounded fine to medium.		
3.00	B4									
3.00	D12									
3.00 - 3.45	SPT (S) N=13	3.00	Dry	N=13 (2,2/3,3,3,4) Hammer SN = 0643						
4.00	B5									
4.00	D13									
4.00 - 4.45	SPT (S) N=14	4.00	3.90	N=14 (2,3/4,3,3,4) Hammer SN = 0643						
5.00	B6					(5.10)				
5.00	D14									
5.00 - 5.45	SPT (S) N=14	5.00	4.80	N=14 (2,3/3,3,4,4) Hammer SN = 0643						
6.00	B7									
6.00	D15									
6.00 - 6.45	SPT (S) N=18	6.00	5.20	N=18 (2,3/3,4,5,6) Hammer SN = 0643						
7.50	B8				39.43	7.50				
7.50	D16							Firm grey slightly gravelly sandy clayey SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
7.50 - 7.95	SPT (S) N=15	7.50	7.30	N=15 (3,3/3,4,4,4) Hammer SN = 0643						
						(1.50)				
9.00	B9				37.93	9.00				
9.00	D17							Very stiff grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
9.00 - 9.40	SPT (S)	9.00	8.40	N=50 (10,12/50 for 245mm) Hammer SN = 0643		(1.00)				
					36.93	10.00		Very stiff brownish grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded		
	TCR	SCR	RQD	FI						

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.20m competent core

Core Barrel: SK6L

Flush Type: Polymer

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.30	5.50

Casing Details

To (m)	Diam (mm)
9.70	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
9.40	9.70	01:00

CAUSEWAY GEOTECH

Method	Plant Used	Top	Base
Cable Percussion	Dando 2000	0.00	9.70
Rotary Drilling	Comacchio 601	9.70	10.00
Rotary Coring	Comacchio 601	10.00	17.50

Project No.: 19-0890

Project Name: Buvinda House, Navan

Borehole No.: RC06

Coordinates: 288199.71 E, 266738.88 N

Client: Meath County Council

Sheet 2 of 2

Client's Representative: PUNCH Consulting Engineers

Scale: 1:50

Ground Level: 46.93 mOD

Dates: 26/08/2019 - 29/08/2019

Driller: BM+JG

Logger: NH

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Legend	Description	Water	Backfill
9.70 - 9.78					N=50 (25 for 30mm/50 for 45mm) Hammer SN = 0643				Very stiff brownish grey slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse.		
10.00 - 10.04	100	0	0		N=50 (25 for 15mm/50 for 25mm) Hammer SN = 0209		(2.10)				
11.50 - 11.52					N=50 (25 for 10mm/50 for 15mm) Hammer SN = 0209						
11.50	100	0	0			34.83	12.10		Very stiff brownish grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse.		
							(1.10)				
13.00 - 13.01					N=50 (25 for 5mm/50 for 5mm) Hammer SN = 0209						
13.00	100	23	23			33.73	13.20		Very stiff brownish grey slightly sandy gravelly CLAY with high cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse		
							(0.95)				
				5		32.78	14.15		Weak (locally medium strong to very strong) thinly bedded dark grey carbonaceous MUDSTONE with medium spaced thin beds of medium strong light grey limestone. Partially weathered: Slightly reduced strength, slightly close fracture spacing. Discontinuities: 1. 0-30 degrees bedding fractures closely spaced (50/100/250), planar, smooth, unstained. 2. 75-85 degree joints probably medium spaced, undulating, smooth, unstained.		
14.50					C1						
14.50											
15.20	100	89	0	17	C2						
							(3.35)				
16.00											
16.80	100	97	67	11	C3						
17.50						29.43	17.50		End of Borehole at 17.50m		
	TCR	SCR	RQD	FI							

Remarks

Hand dug inspection pit excavated to 1.20m

Terminated on recovery of 3.20m competent core

Core Barrel: SK6L

Flush Type: Polymer

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Water Added

From (m)	To (m)
3.30	5.50

Casing Details

To (m)	Diam (mm)
9.70	200

Chiselling Details

From (m)	To (m)	Time (hh:mm)
9.40	9.70	01:00

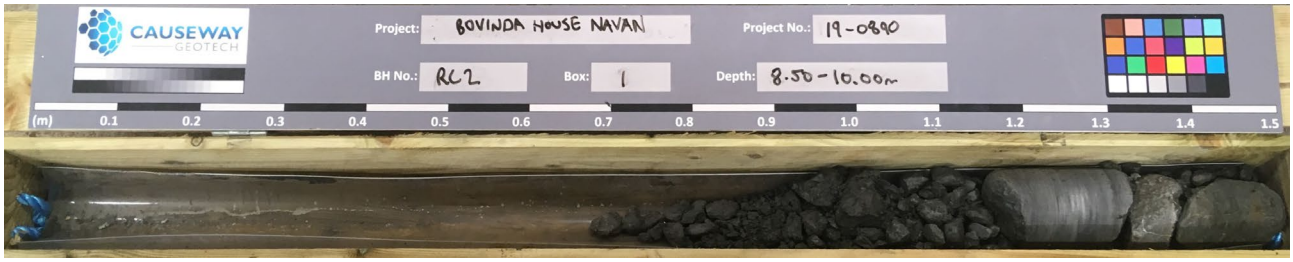
CAUSEWAY GEOTECH

APPENDIX C

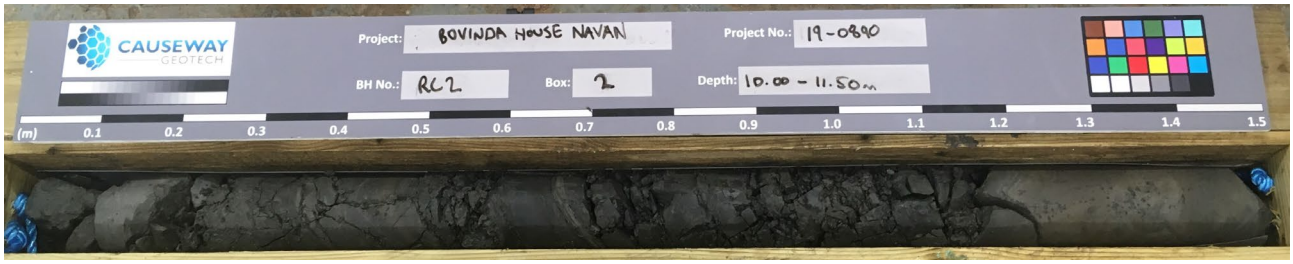
CORE PHOTOGRAPHS

RC01 Box 1 (8.50 to 9.70m)

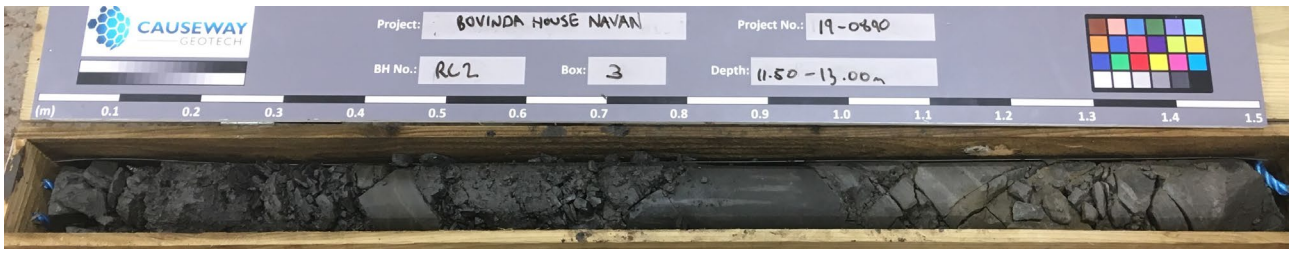
RC01 Box 2 (9.70 to 11.20m)



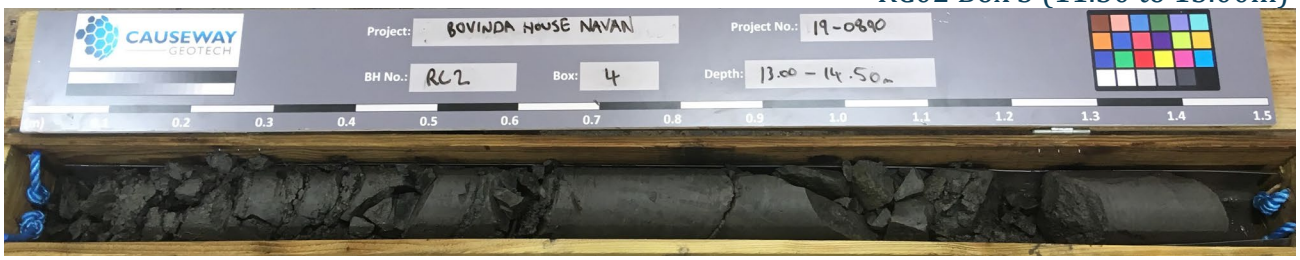
RC02 Box 1 (8.50 to 10.00m)



RC02 Box 2 (10.00 to 11.50m)

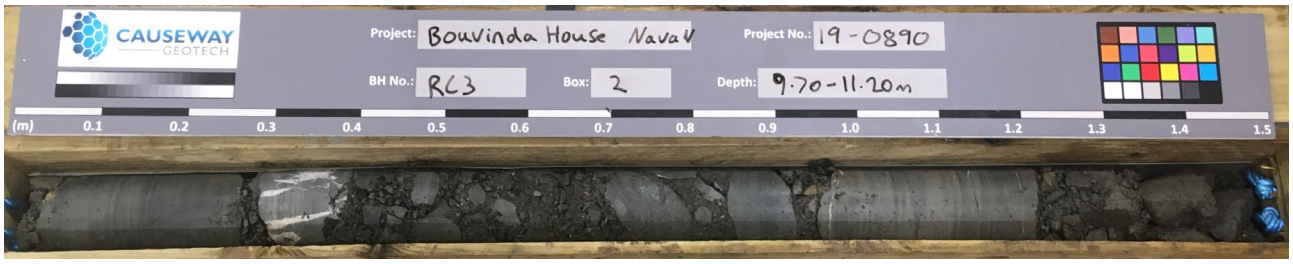


RC02 Box 3 (11.50 to 13.00m)



RC02 Box 4 (13.00 to 14.50m)

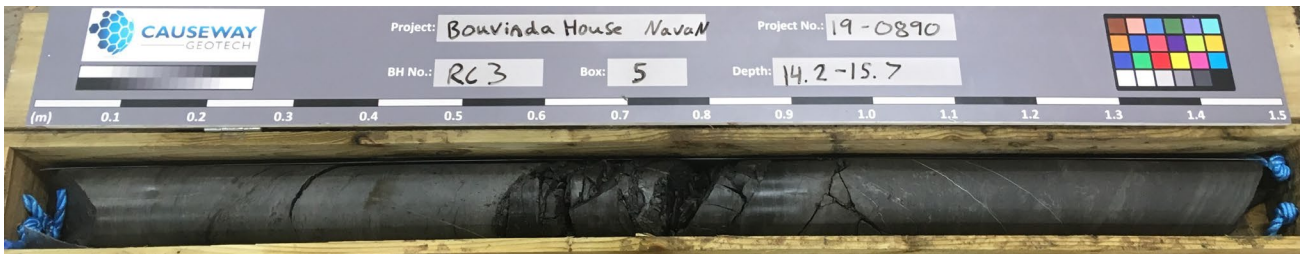
RC03B Box 1 (8.50 to 9.70m)



RC03B Box 2 (9.70 to 11.20m)

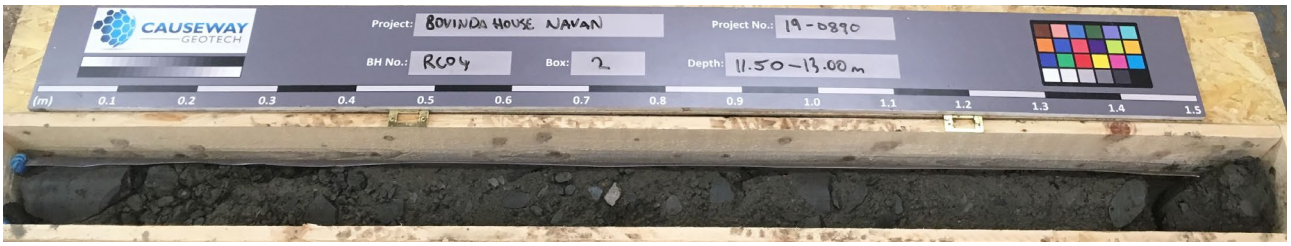
RC03B Box 3 (11.20 to 12.70m)

RC03B Box 4 (12.70 to 14.20m)



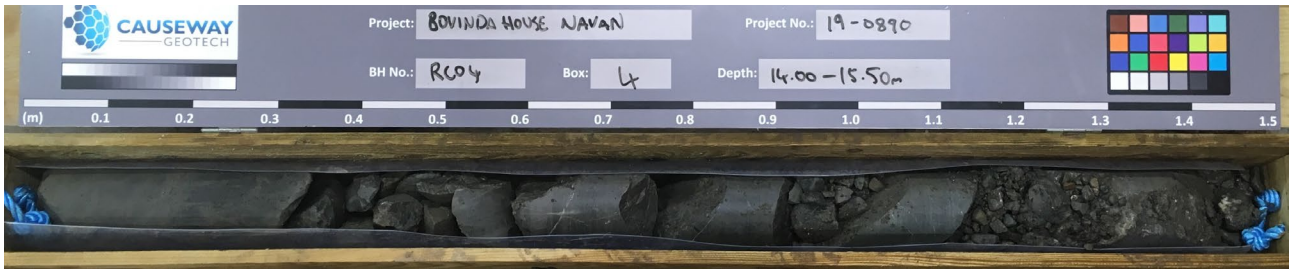
RC03B Box 5 (14.20 to 15.70m)

RC04 Box 1 (10.00 to 11.50m)



RC04 Box 2 (11.50 to 13.00m)

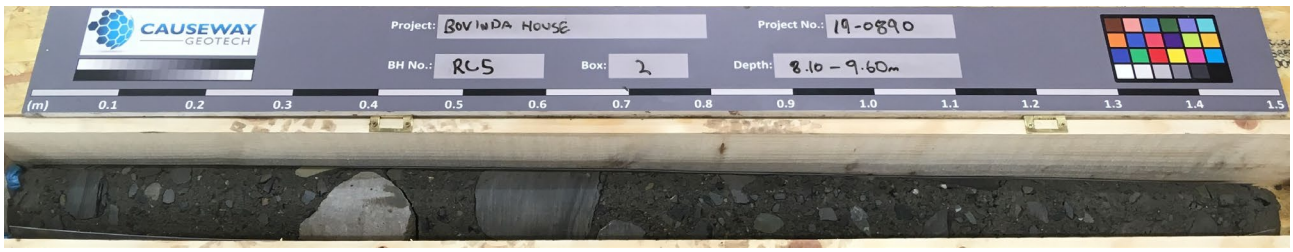
RC04 Box 3 (13.00 to 14.00m)



RC04 Box 4 (14.00 to 15.50m)

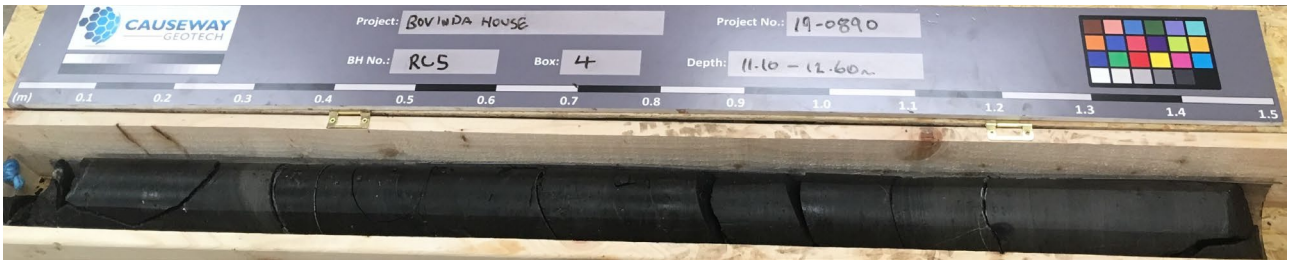
RC04 Box 5 (15.50 to 16.70m)

RC05 Box 1 (7.00 to 8.10m)



RC05 Box 2 (8.10 to 9.60m)

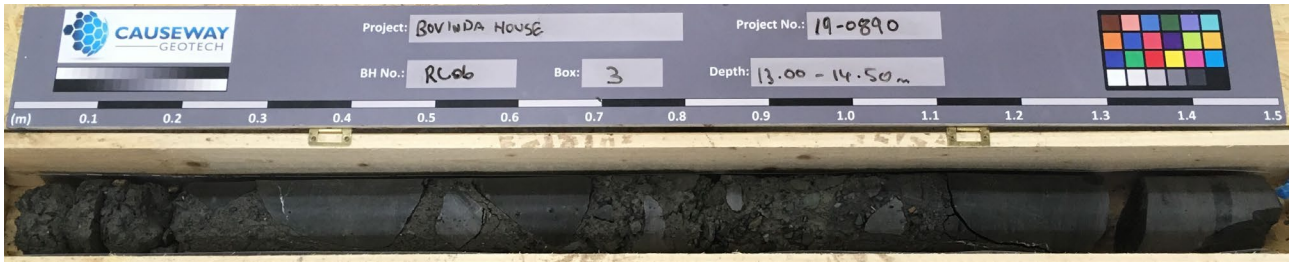
RC05 Box 3 (9.60 to 11.10m)



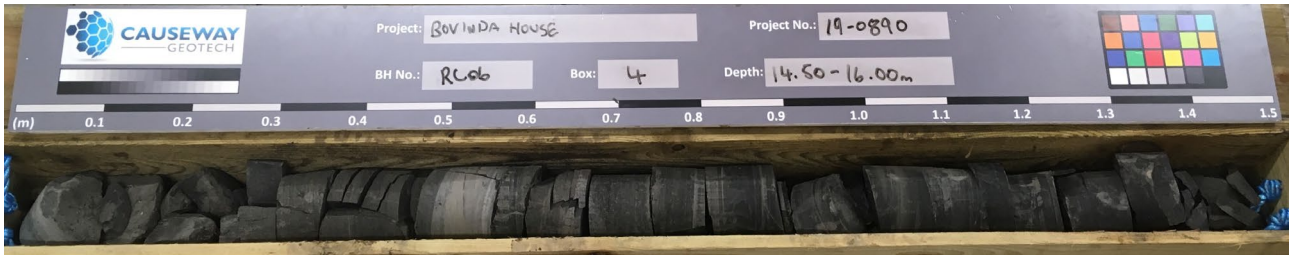
RC05 Box 4 (11.10 to 12.60m)

RC06 Box 1 (10.00 to 11.50m)

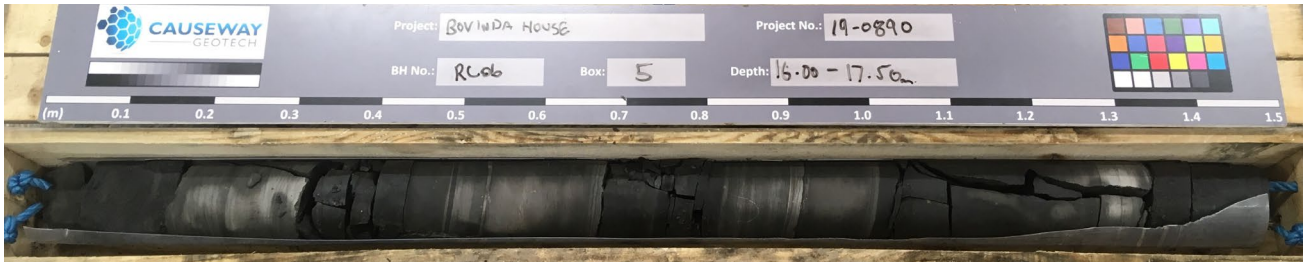
RC06 Box 2 (11.50 to 13.00m)



RC06 Box 3 (13.00 to 14.50m)



RC06 Box 4 (14.50 to 16.00m)



RC06 Box 5 (16.00 to 17.50m)

CAUSEWAY GEOTECH

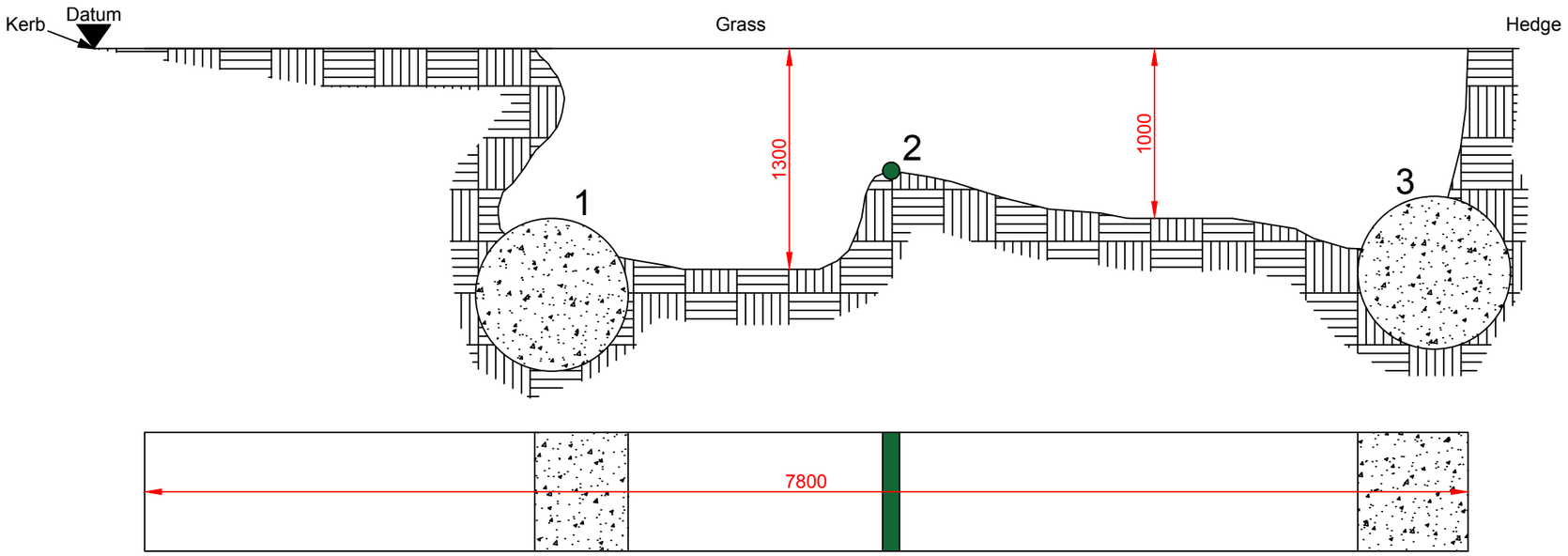
APPENDIX D

TRIAL TRENCH SKETCHES

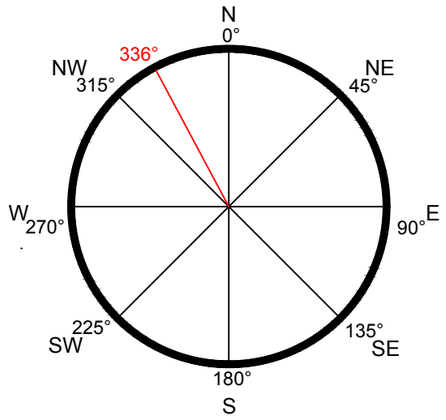
JOB NUMBER: 19-0890	JOB NAME: Buvinda House, Navan	LOCATION: TT01

CLIENT: Meath County Council	CLIENTS REPRESENTATIVE: PUNCH Consulting Engineers	CREW: BS	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 336° FROM NORTH

COORDINATES: DATUM (Kerb)

EASTING: 288121.62

NORTHING: 266704.39

ELEVATION: 46.58

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Storm Water	900	1.00	2.40	900mm Concrete Storm Water Pipe
02	Street Lighting	100	0.67	4.40	100mm Green Ribbed PVC Duct Street Lighting
03	Storm Water	900	0.87	7.60	900mm Concrete Storm Water Pipe
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 7.80

TRENCH DEPTH (m) : 1.30

TRENCH WIDTH (m) : 0.70

STABILITY: Ok

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: NH

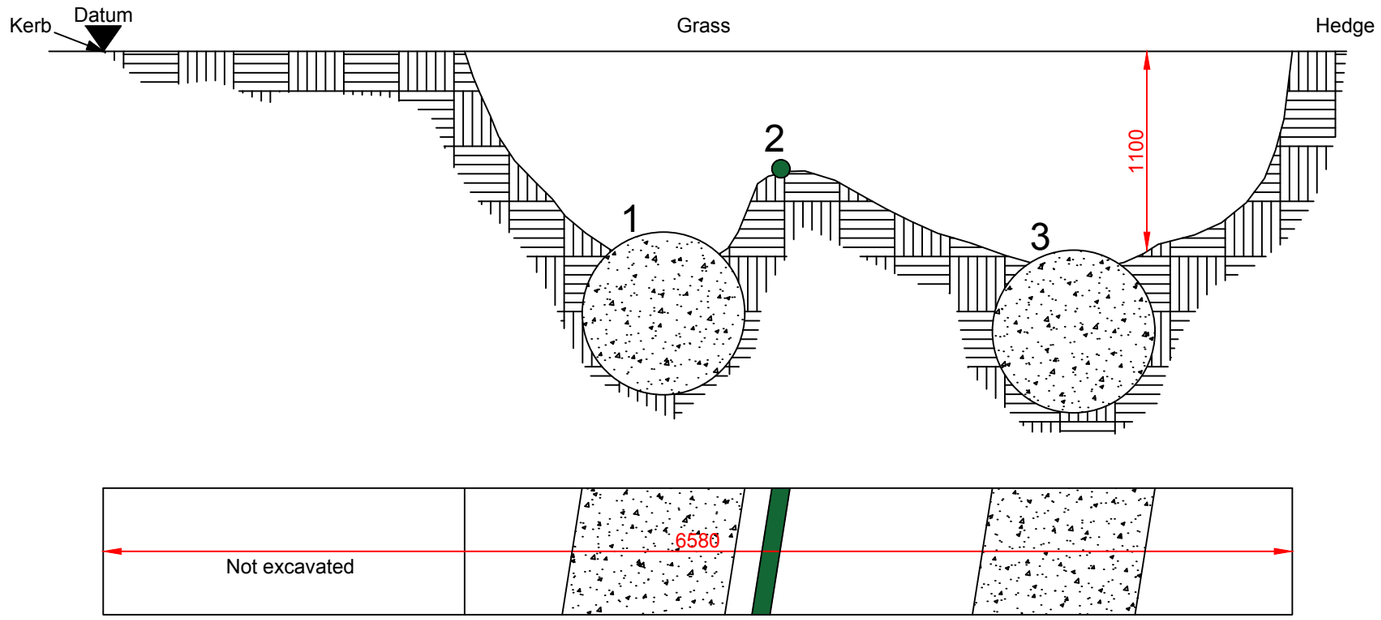
DATE EXCAVATED: 29/08/2019

CAUSEWAY GEOTECH

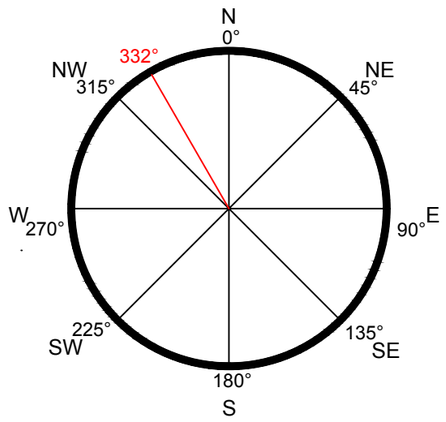
JOB NUMBER: 19-0890	JOB NAME: Buvinda House, Navan	LOCATION: TT02

CLIENT: Meath County Council	CLIENTS REPRESENTATIVE: PUNCH Consulting Engineers	CREW: BS	PLANT & EQUIPMENT 3 Tonne Excavator & Hand Tools

TRENCH: (SECTION & PLAN)



TRENCH - ORIENTATION



TRENCH ORIENTATED : 332° FROM NORTH

COORDINATES: DATUM (Kerb)

EASTING: 288174.46

NORTHING: 266734.93

ELEVATION: 46.74

No:	Type of Service:	Diameter (in mm)	Depth to Top of Service (m)	Distance to Centre of Service (m)	Details/Comments
01	Storm Water	900	1.00	3.10	900mm Concrete Storm Water Pipe
02	Street Lighting	100	0.60	3.75	100mm Green Ribbed PVC Duct Street Lighting
03	Storm Water	900	1.10	5.37	900mm Concrete Storm Water Pipe
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

TRENCH LENGTH (m) : 6.58

TRENCH DEPTH (m) : 1.10

TRENCH WIDTH (m) : 0.70

STABILITY: Ok

GROUNDWATER: None

SCALE: NTS@A3

DRAWN: BS

CHECKED: NH

DATE EXCAVATED: 29/08/2019

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

APPENDIX E

TRIAL TRENCH PHOTOGRAPHS

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT01

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

Trial Trench TT02

CAUSEWAY GEOTECH

APPENDIX F

GROUND WATER AND GAS MONITORING RECORDS

Job No: 19-0890
Job Name: Buvinda House
Ground Water Monitoring Results

EH No:	Depth to base of installation (mbgl)	Water Level		
		29.08.2019	***10.10.2019***	***17.10.19***
RC01 (rz 1.50-8.00m)	7.85	6.91m	4.65m	6.70m
RC04 (rz 0.50-3.50m)	3.40	DRY	DRY	DRY
RC05 (rz 10.00-12.60m)	12.45	5.07m	4.90m	4.90m
	Time of readings	09:15	15:45	10:30

Groundwater Ground Gas Monitoring

Site:	Buvinda House
Project No.:	19-0890
Date:	29/08/2019
Weather:	Dry, mild, cloudy

Equipment:		Geotechnical Instruments GA5000				
Ambient Conditions	Barometric Pressure	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
Before:	1013	0.1	0.1	21.5	0	0
After:	1013	0.1	0.1	21.5	0	0

RC01	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	1.4	3.9	10.1	1	0
60	1.4	4.1	9.9	1	0
90	1.4	4.4	9.6	1	0
120	1.6	4.5	9.2	1	0
150	1.8	4.5	9.1	1	0
180	1.9	4.6	8.9	1	0
240	1.9	4.6	8.7	1	0
300	1.9	4.6	8.6	1	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	6.91
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC04	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.1	2.7	14.1	0	0
60	0.1	2.7	14.1	0	0
90	0.1	2.8	13.9	0	0
120	0.1	2.9	13.9	0	0
150	0.1	3.1	13.8	0	0
180	0.1	3.0	13.7	0	0
240	0.1	3.2	13.5	0	0
300	0.1	3.2	13.5	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	-0.1
60	-0.1
90	-0.1
120	-0.1
150	0.0
180	0.0
240	0.0
300	0.0

Groundwater monitoring	mbgl
Depth to top of water (m)	DRY
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC05	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.1	2.9	16.7	1	0
60	0.1	2.9	16.8	1	0
90	0.1	2.9	16.8	1	0
120	0.1	2.9	16.8	1	0
150	0.1	2.9	16.7	1	0
180	0.1	3.0	16.7	1	0
240	0.1	3.0	16.7	1	0
300	0.1	3.0	16.6	1	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	5.07
Sample collected (Y/N)	N
Sample depth (m)	N/A

CAUSEWAY GEOTECH

Groundwater Ground Gas Monitoring

Site:	Buvinda House
Project No.:	19-0890
Date:	10/10/2019
Weather:	Cold, dry

Equipment:		Geotechnical Instruments GA5000				
Ambient Conditions	Barometric Pressure	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
Before:	995	0.1	0.1	21.4	0	0
After:	995	0.1	0.1	21.3	0	0

RC01	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	1.7	4.6	7.7	2	0
60	2.4	6.2	1.8	2	0
90	2.5	6.4	1.1	2	0
120	2.5	6.4	0.8	2	0
150	2.5	6.5	0.7	1	0
180	2.5	6.5	0.5	1	0
240	2.6	6.6	0.4	0	0
300	2.6	6.6	0.3	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	4.65
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC04	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.1	2.3	14.7	0	0
60	0.1	2.9	14.0	0	0
90	0.1	3.1	13.4	0	0
120	0.1	3.2	13.3	0	0
150	0.1	3.4	13.0	0	0
180	0.1	3.6	12.7	0	0
240	0.1	4.0	12.2	0	0
300	0.1	4.2	11.9	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	DRY
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC05	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.1	3.0	16.3	1	0
60	0.1	3.0	16.3	1	0
90	0.1	3.1	16.3	1	0
120	0.1	3.1	16.3	1	0
150	0.1	3.1	16.3	1	0
180	0.1	3.1	16.3	1	0
240	0.1	3.0	16.4	1	0
300	0.1	3.0	16.4	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	4.90
Sample collected (Y/N)	N
Sample depth (m)	N/A

CAUSEWAY GEOTECH

Groundwater Ground Gas Monitoring

Site:	Buvinda House
Project No.:	19-0890
Date:	17/10/2019
Weather:	Cold, dry

Equipment:		Geotechnical Instruments GA5000				
Ambient Conditions	Barometric Pressure	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
Before:	990	0.2	0.1	21.6	0	0
After:	990	0.2	0.1	21.6	0	0

RC01	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	2.8	6.5	3.5	0	0
60	2.8	6.6	0.4	0	0
90	2.8	6.6	0.3	0	0
120	2.8	6.6	0.3	0	0
150	2.8	6.6	0.3	0	0
180	2.8	6.6	0.2	0	0
240	2.8	6.6	0.2	0	0
300	2.8	6.7	0.1	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.1
120	0.1
150	0.1
180	0.1
240	0.1
300	0.1

Groundwater monitoring	mbgl
Depth to top of water (m)	6.70
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC04	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.3	3.5	11.2	0	0
60	0.2	3.4	11.4	0	0
90	0.2	3.4	11.4	0	0
120	0.2	3.4	11.4	0	0
150	0.2	3.5	11.4	0	0
180	0.2	3.6	11.3	0	0
240	0.2	3.7	11.2	0	0
300	0.2	3.9	11.0	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.1
90	0.2
120	0.2
150	0.2
180	0.2
240	0.2
300	0.2

Groundwater monitoring	mbgl
Depth to top of water (m)	DRY
Sample collected (Y/N)	N
Sample depth (m)	N/A

RC05	Gas readings				
Time (sec)	CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)
30	0.2	3.0	16.5	1	0
60	0.2	3.0	16.6	1	0
90	0.2	3.0	16.7	1	0
120	0.2	3.0	16.7	1	0
150	0.2	2.9	16.7	1	0
180	0.2	2.9	16.7	1	0
240	0.2	2.9	16.7	0	0
300	0.2	2.9	16.7	0	0

Flow rates	
Time (sec)	Flow (l/h)
30	0.1
60	0.2
90	0.2
120	0.2
150	0.2
180	0.2
240	0.2
300	0.2

Groundwater monitoring	mbgl
Depth to top of water (m)	4.90
Sample collected (Y/N)	N
Sample depth (m)	N/A

CAUSEWAY GEOTECH

CAUSEWAY GEOTECH

APPENDIX G

GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

HEAD OFFICE
Causeway Geotech Ltd
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Co. Antrim, N. Ireland, BT53 7QL
NI: +44 (0)28 276 66640
Registered in Northern Ireland.
Company Number: NI610766

REGIONAL OFFICE
Causeway Geotech (IRL) Ltd
Unit 3 Balbriggan Business Park, Balbriggan
Co Dublin, Ireland, K32 EH36
ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

24 September 2019

Project Name:	Buvinda House, Navan
Project No.:	19-0890
Client:	Meath County Council
Engineer:	PUNCH Consulting Engineers

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 attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days 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.

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Buvinda House, Navan

Report Reference: Soil Schedules 1 & 2

The table below details the tests carried out, the specifications used, and the number of tests included in this report.

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	9
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	7
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	17
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	13
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	1

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Chemtest Ltd *(UKAS 2183)*	pH Value of Soil		10
SOIL – Subcontracted to Chemtest Ltd *(UKAS 2183)*	Sulphate Content water extract		10
SOIL – Subcontracted to Chemtest Ltd *(UKAS 2183)*	Organic Matter Content		3

Summary of Classification Test Results

Project No.	Project Name
19-0890	Buvinda House, Navan

Hole No.	Sample				Soil Description	Density		*w*	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		bulk	dry							
						Mg/m3		%	%	%	%	%	Mg/m3	
RC01	11	2.00		D	Brown sandy gravelly silty CLAY with some cobbles.			15.0	57	24 -1pt	15	9		CL
RC01	16	7.50		U	Greyish brown sandy gravelly silty CLAY.			9.7	60	24 -1pt	15	9		CL
RC02	8	2.00		D	Greyish brown sandy gravelly silty CLAY.			6.8						
RC02	14	6.00		D	Greyish brown sandy slightly gravelly silty CLAY.			16.0	76	26 -1pt	14	12		CL
RC03B	10	1.20		D	Grey sandy very gravelly silty CLAY.			8.9	40	32 -1pt	21	11		CL
RC04	15	7.50		D	Grey sandy slightly gravelly SILT/CLAY.			9.1	44	21 -1pt	15	6		ML/CL
RC05	8	2.00		D	Greyish brown silty fine to coarse SAND.			12.0						
RC06	10	1.20		D	Brownish grey slightly sandy gravelly silty CLAY.			20.0	86	41 -1pt	21	20		CI
RC06	17	9.00		D	Greyish brown sandy slightly gravelly SILT.			16.0	82	20 -1pt	NP			

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 4

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

Date Printed

24/09/2019

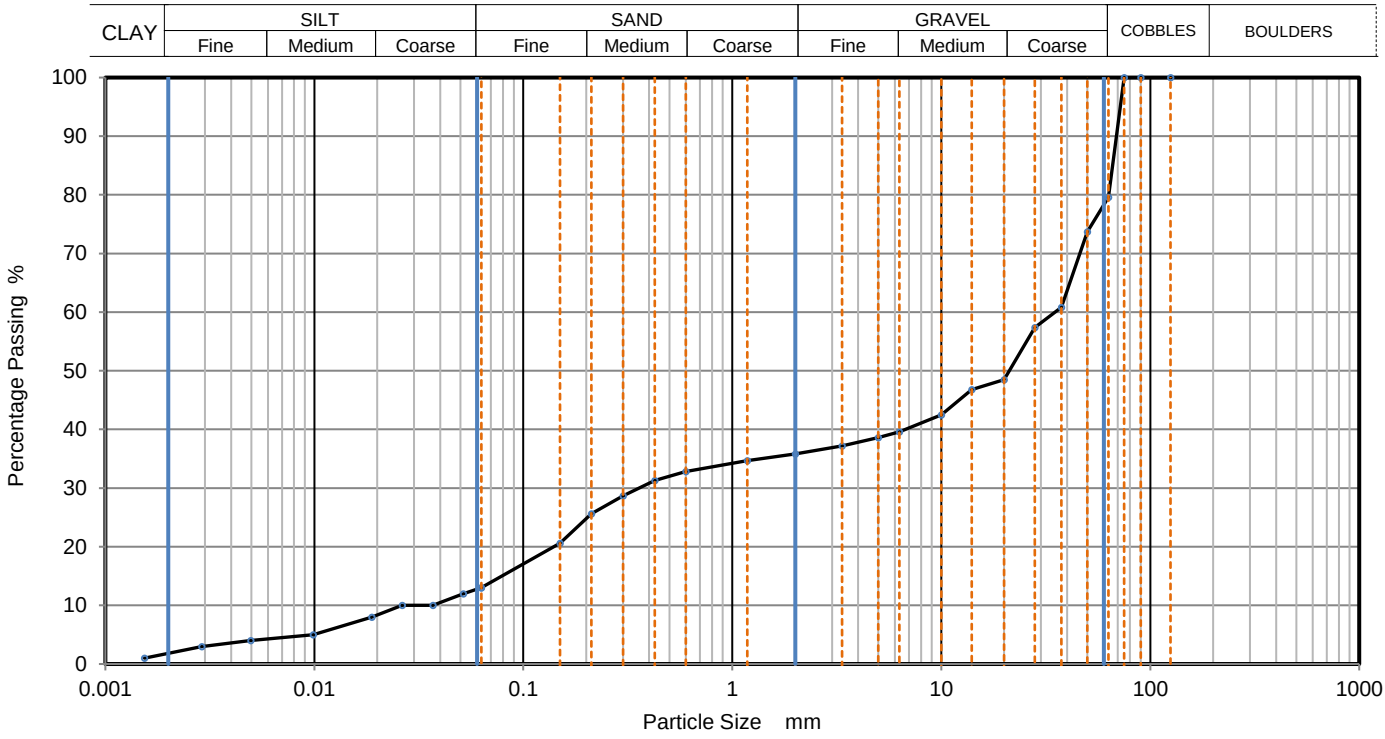
Approved By

Stephen.Watson

UKAS TESTING

10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC01
Site Name	Buvinda House, Navan			Sample No.	3
Soil Description	Brown sandy gravelly silty CLAY with some cobbles.			Depth, m	2.00
Specimen Reference	2	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090917



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	13
90	100	0.0517	12
75	100	0.0370	10
63	80	0.0263	10
50	74	0.0188	8
37.5	61	0.0099	5
28	57	0.0050	4
20	49	0.0029	3
14	47	0.0015	1
10	43		
6.3	40		
5	39		
3.35	37		
2	36		
1.18	35		
0.6	33	Particle density	(assumed)
0.425	31	2.65	Mg/m3
0.3	29		
0.212	26		
0.15	21		
0.063	13		

Dry Mass of sample, g	10673

Sample Proportions	% dry mass
Cobbles	20
Gravel	44
Sand	23
Silt	11
Clay	2

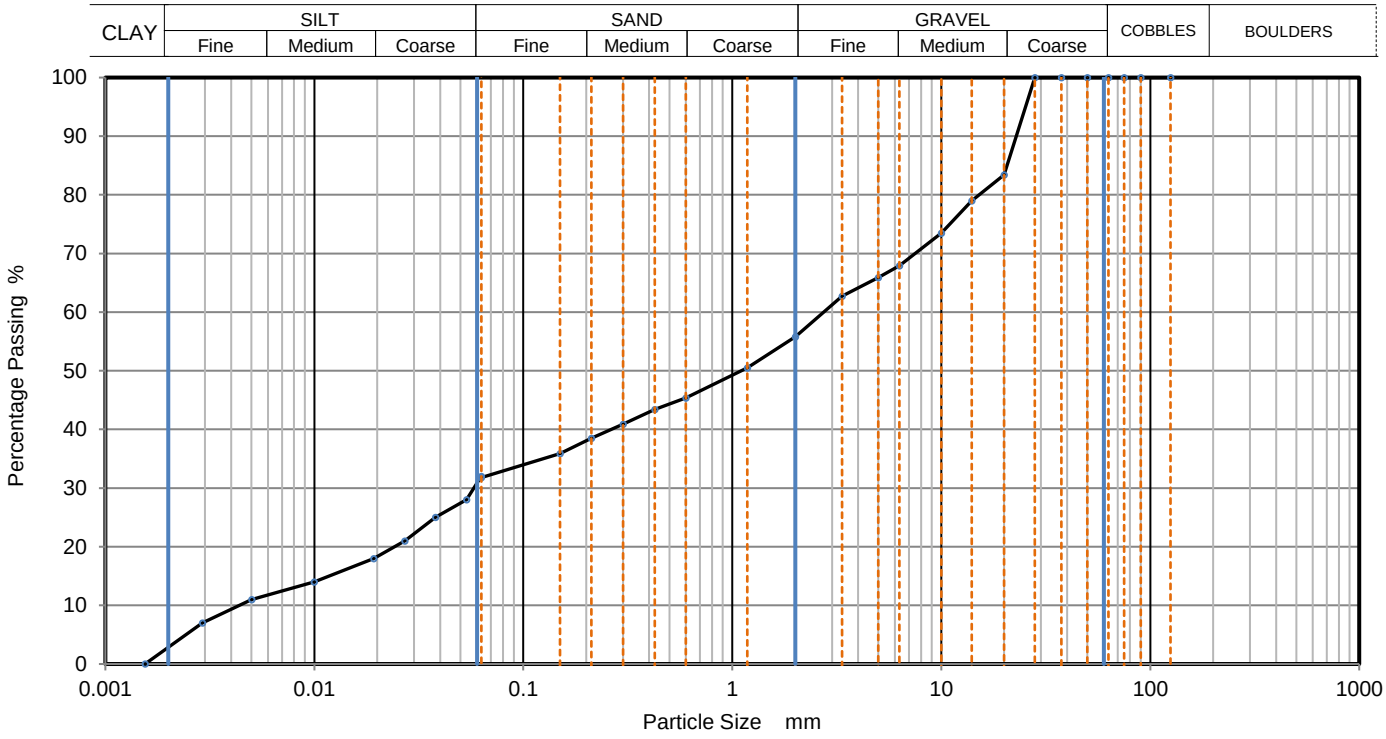
Grading Analysis		
D100	mm	
D60	mm	35.1
D30	mm	0.357
D10	mm	0.0316
Uniformity Coefficient		1100
Curvature Coefficient		0.12

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	19-0890
					Borehole/Pit No.	RC01
Site Name	Buvinda House, Navan				Sample No.	8
Soil Description	Greyish brown sandy gravelly silty CLAY.				Depth, m	7.50
Specimen Reference	2	Specimen Depth	7.5	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus2019090918



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	32
90	100	0.0535	28
75	100	0.0380	25
63	100	0.0270	21
50	100	0.0192	18
37.5	100	0.0100	14
28	100	0.0050	11
20	83	0.0029	7
14	79	0.0015	0
10	74		
6.3	68		
5	66		
3.35	63		
2	56		
1.18	51		
0.6	45	Particle density	(assumed)
0.425	43	2.65	Mg/m3
0.3	41		
0.212	39		
0.15	36		
0.063	32		

Dry Mass of sample, g	1214

Sample Proportions	% dry mass
Cobbles	0
Gravel	44
Sand	24
Silt	29
Clay	3

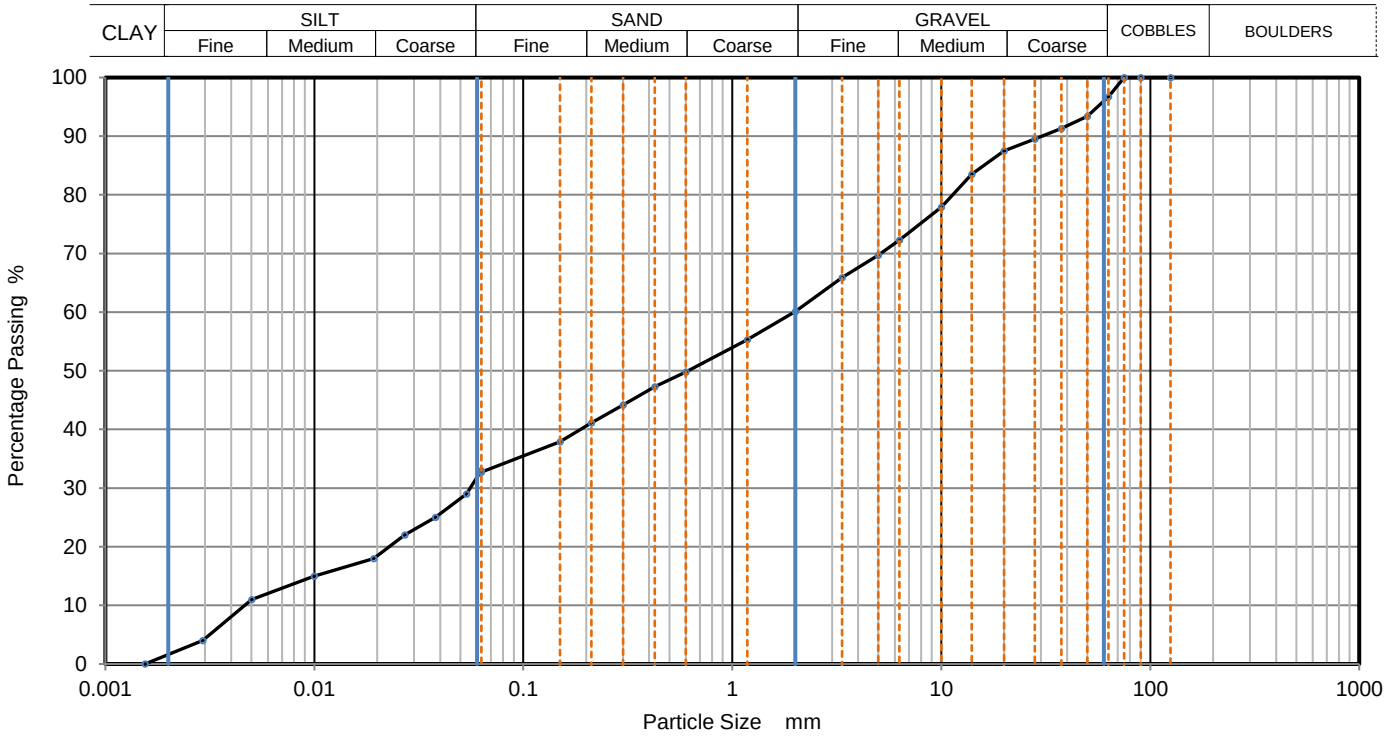
Grading Analysis		
D100	mm	
D60	mm	2.74
D30	mm	0.058
D10	mm	0.00457
Uniformity Coefficient		600
Curvature Coefficient		0.27

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	19-0890
				Borehole/Pit No.	RC02
Site Name	Buvinda House, Navan			Sample No.	3
Soil Description	Greyish brown sandy gravelly silty CLAY.			Depth, m	2.00
Specimen Reference	2	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090921



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	33
90	100	0.0535	29
75	100	0.0380	25
63	97	0.0270	22
50	93	0.0192	18
37.5	91	0.0100	15
28	90	0.0050	11
20	88	0.0029	4
14	84	0.0015	0
10	78		
6.3	72		
5	70		
3.35	66		
2	60		
1.18	55		
0.6	50	Particle density	(assumed)
0.425	47	2.65	Mg/m3
0.3	44		
0.212	41		
0.15	38		
0.063	33		

Dry Mass of sample, g	20418

Sample Proportions	% dry mass
Cobbles	3
Gravel	37
Sand	27
Silt	31
Clay	2

Grading Analysis		
D100	mm	
D60	mm	1.97
D30	mm	0.0558
D10	mm	0.00469
Uniformity Coefficient		420
Curvature Coefficient		0.34

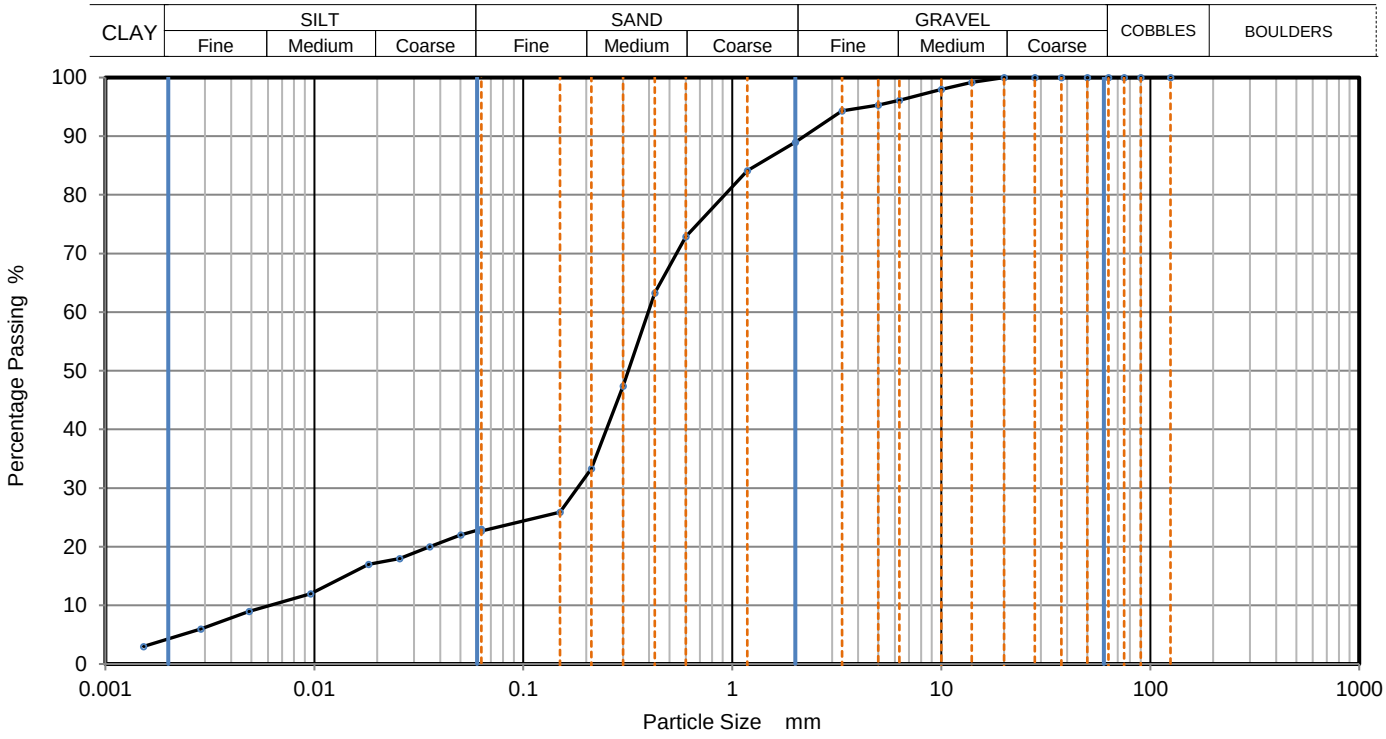
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	19-0890
				Borehole/Pit No.	RC02
Site Name	Buvinda House, Navan			Sample No.	5
Soil Description	Greyish brown slightly gravelly silty fine to coarse SAND.			Depth, m	4.00
Specimen Reference	2	Specimen Depth	4 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090922



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	23
90	100	0.0502	22
75	100	0.0357	20
63	100	0.0255	18
50	100	0.0182	17
37.5	100	0.0096	12
28	100	0.0049	9
20	100	0.0029	6
14	99	0.0015	3
10	98		
6.3	96		
5	95		
3.35	94		
2	89		
1.18	84		
0.6	73	Particle density	(assumed)
0.425	63	2.65	Mg/m3
0.3	47		
0.212	33		
0.15	26		
0.063	23		

Dry Mass of sample, g	530

Sample Proportions	% dry mass
Cobbles	0
Gravel	11
Sand	66
Silt	18
Clay	4

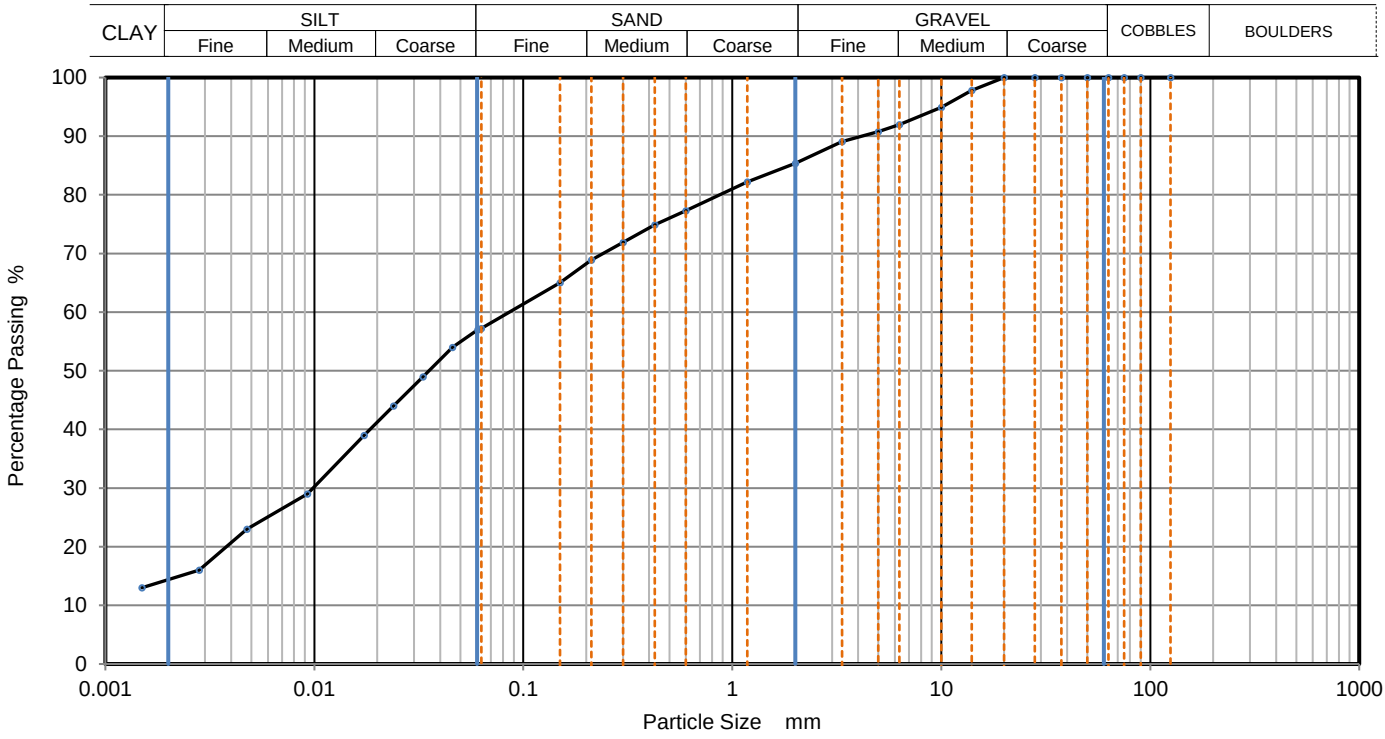
Grading Analysis		
D100	mm	
D60	mm	0.395
D30	mm	0.182
D10	mm	0.00586
Uniformity Coefficient		67
Curvature Coefficient		14

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC02
Site Name	Buvinda House, Navan			Sample No.	12
Soil Description	Greyish brown sandy slightly gravelly silty CLAY.			Depth, m	6.00
Specimen Reference	2	Specimen Depth	6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090923



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0606	57
90	100	0.0458	54
75	100	0.0331	49
63	100	0.0239	44
50	100	0.0173	39
37.5	100	0.0093	29
28	100	0.0048	23
20	100	0.0028	16
14	98	0.0015	13
10	95		
6.3	92		
5	91		
3.35	89		
2	85		
1.18	82		
0.6	77	Particle density	(assumed)
0.425	75	2.65	Mg/m3
0.3	72		
0.212	69		
0.15	65		
0.063	57		

Dry Mass of sample, g	513

Sample Proportions	% dry mass
Cobbles	0
Gravel	15
Sand	28
Silt	43
Clay	15

Grading Analysis		
D100	mm	
D60	mm	0.086
D30	mm	0.00962
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

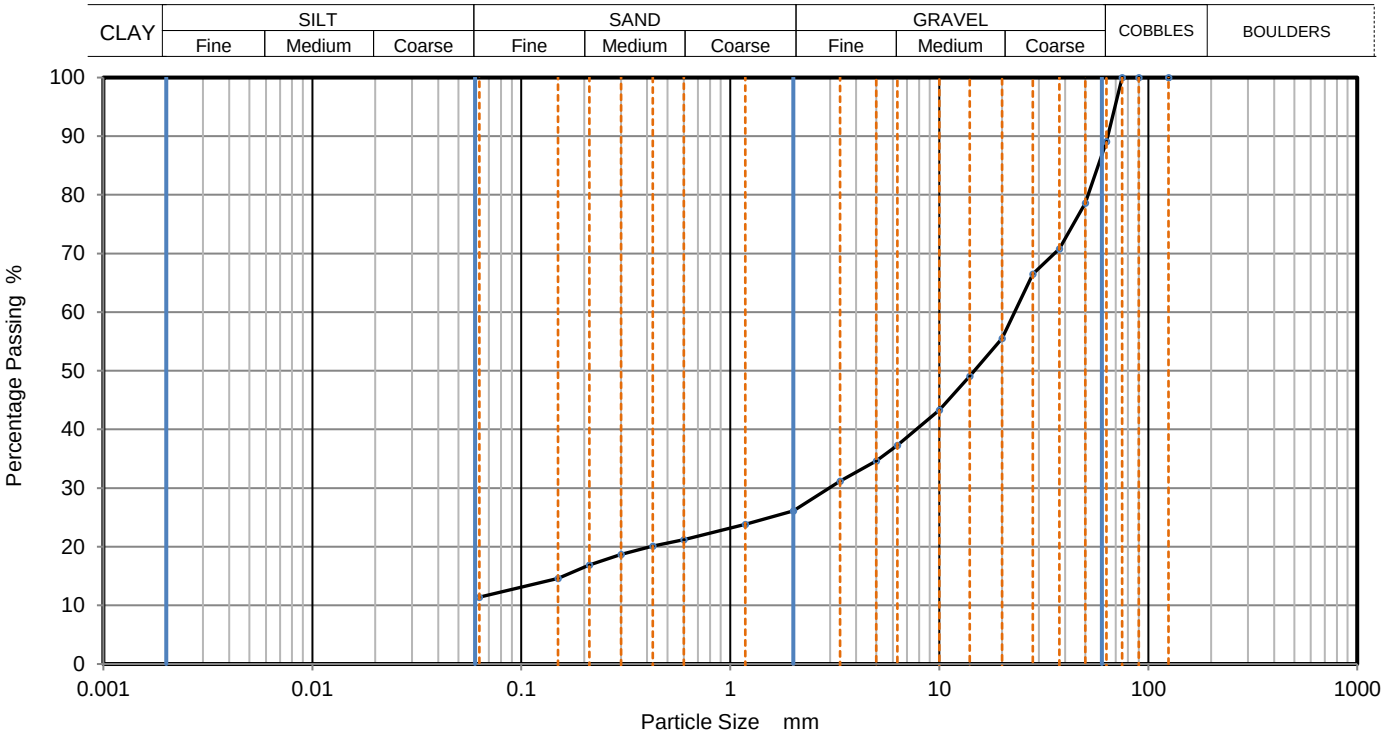
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

PARTICLE SIZE DISTRIBUTION

				Job Ref	**19-0890**
				Borehole/Pit No.	RC03B
Site Name	Buvinda House, Navan			Sample No.	3
Soil Description	Greyish brown slightly sandy slightly clayey subangular fine to coarse GRAVEL.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2019090925



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	89		
50	79		
37.5	71		
28	67		
20	56		
14	49		
10	43		
6.3	37		
5	35		
3.35	31		
2	26		
1.18	24		
0.6	21		
0.425	20		
0.3	19		
0.212	17		
0.15	15		
0.063	11		

Dry Mass of sample, g	11950

Sample Proportions	% dry mass
Cobbles	11
Gravel	63
Sand	15
Fines <0.063mm	11

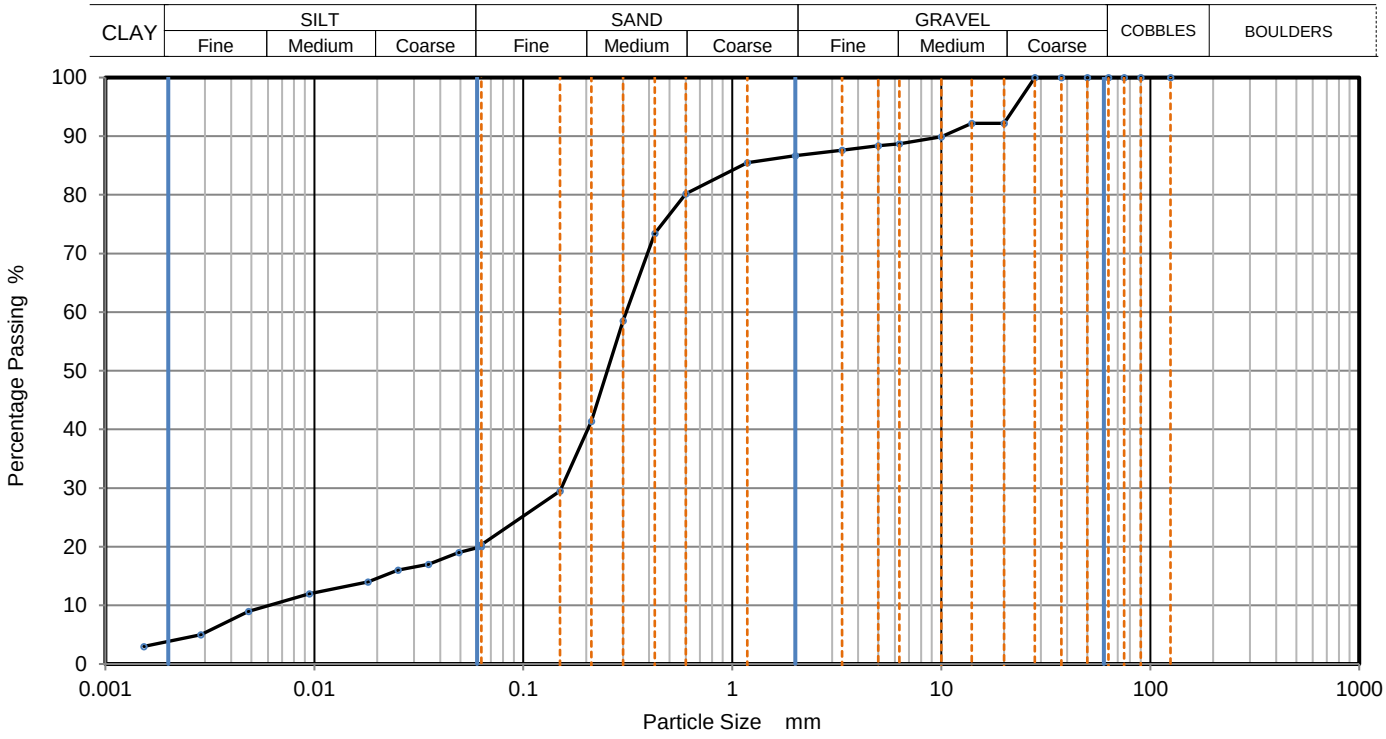
Grading Analysis		
D100	mm	
D60	mm	22.9
D30	mm	2.98
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	19-0890
				Borehole/Pit No.	RC03B
Site Name	Buvinda House, Navan			Sample No.	6
Soil Description	Greyish brown slightly gravelly silty fine to coarse SAND.			Depth, m	4.00
Specimen Reference	2	Specimen Depth	4 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090927



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	20
90	100	0.0491	19
75	100	0.0351	17
63	100	0.0252	16
50	100	0.0180	14
37.5	100	0.0095	12
28	100	0.0048	9
20	92	0.0029	5
14	92	0.0015	3
10	90		
6.3	89		
5	88		
3.35	88		
2	87		
1.18	86		
0.6	80	Particle density	(assumed)
0.425	73	2.65	Mg/m3
0.3	59		
0.212	41		
0.15	30		
0.063	20		

Dry Mass of sample, g	2761

Sample Proportions	% dry mass
Cobbles	0
Gravel	13
Sand	66
Silt	16
Clay	4

Grading Analysis		
D100	mm	
D60	mm	0.311
D30	mm	0.152
D10	mm	0.00656
Uniformity Coefficient		47
Curvature Coefficient		11

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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Stephen.Watson

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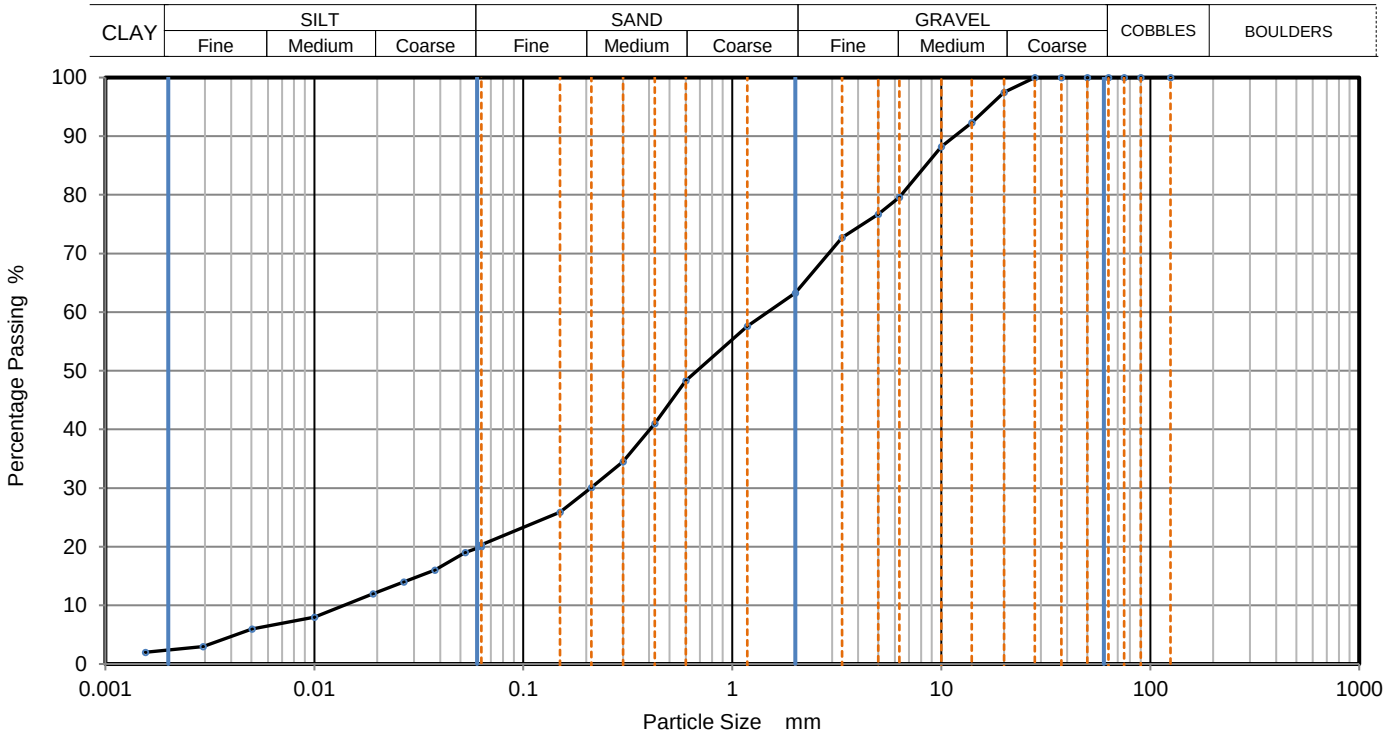
10122

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	19-0890
				Borehole/Pit No.	RC03B
Site Name	Buvinda House, Navan			Sample No.	8
Soil Description	Greyish brown sandy gravelly silty CLAY.			Depth, m	6.00
Specimen Reference	2	Specimen Depth	6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090928



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	20
90	100	0.0528	19
75	100	0.0377	16
63	100	0.0268	14
50	100	0.0191	12
37.5	100	0.0100	8
28	100	0.0050	6
20	98	0.0029	3
14	92	0.0016	2
10	88		
6.3	80		
5	77		
3.35	73		
2	63		
1.18	58		
0.6	48	Particle density	(assumed)
0.425	41	2.65	Mg/m3
0.3	35		
0.212	30		
0.15	26		
0.063	20		

Dry Mass of sample, g	1060

Sample Proportions	% dry mass
Cobbles	0
Gravel	37
Sand	43
Silt	18
Clay	2

Grading Analysis		
D100	mm	
D60	mm	1.47
D30	mm	0.21
D10	mm	0.0135
Uniformity Coefficient		110
Curvature Coefficient		2.2

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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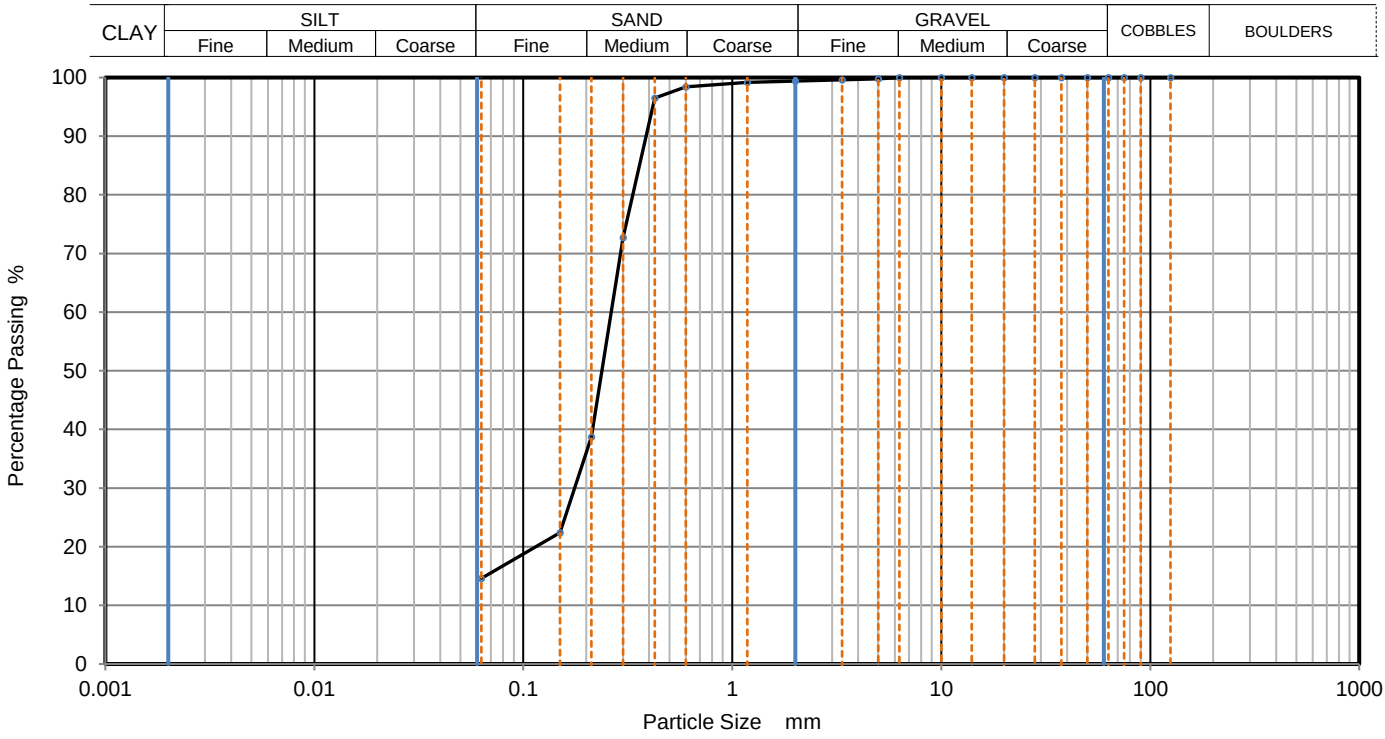
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	19-0890
					Borehole/Pit No.	RC04
Site Name	Buvinda House, Navan				Sample No.	4
Soil Description	Greyish brown slightly silty fine to coarse SAND.				Depth, m	3.00
Specimen Reference	2	Specimen Depth	3	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2				KeyLAB ID	Caus2019090929



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	99		
1.18	99		
0.6	98		
0.425	97		
0.3	73		
0.212	39		
0.15	22		
0.063	15		

Dry Mass of sample, g	230

Sample Proportions	% dry mass
Cobbles	0
Gravel	1
Sand	85
Fines <0.063mm	15

Grading Analysis		
D100	mm	
D60	mm	0.263
D30	mm	0.176
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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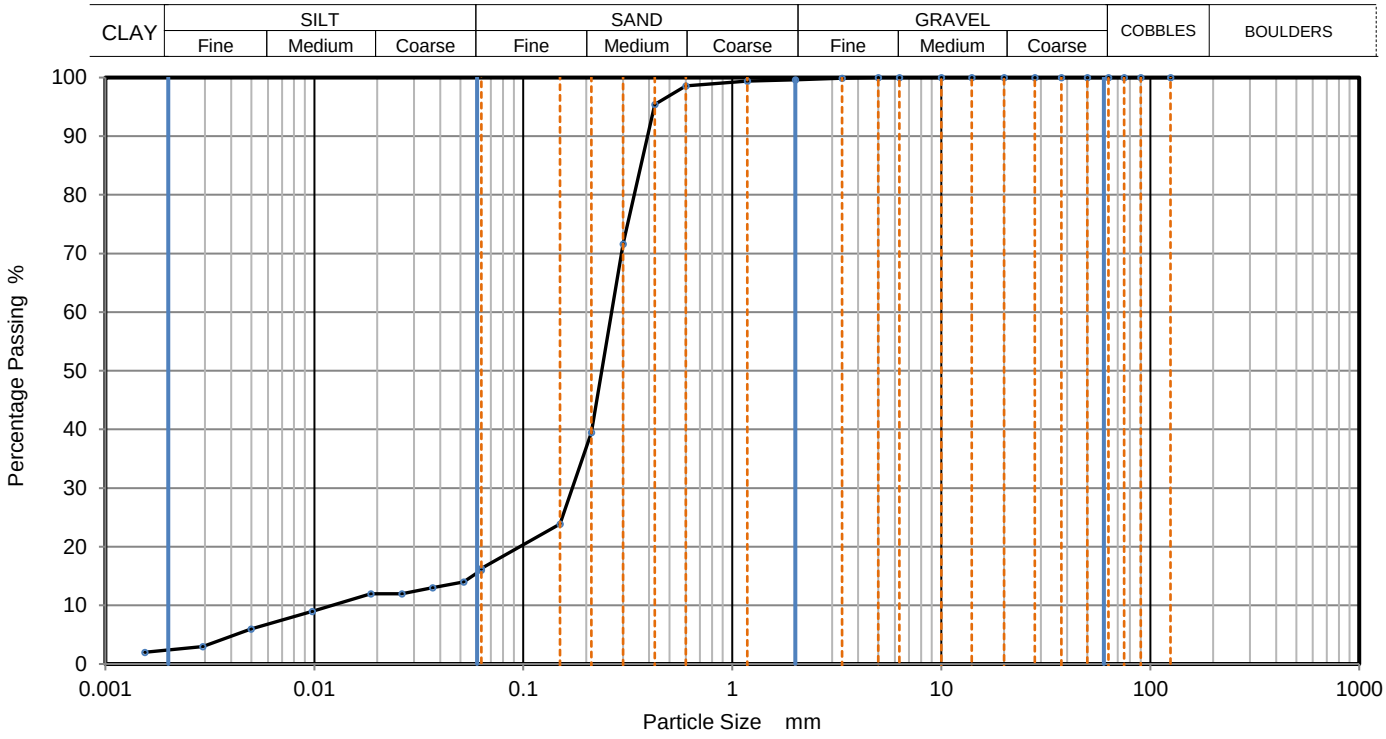
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC04
Site Name	Buvinda House, Navan			Sample No.	7
Soil Description	Greyish brown silty fine to coarse SAND.			Depth, m	6.00
Specimen Reference	2	Specimen Depth	6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090930



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	16
90	100	0.0517	14
75	100	0.0368	13
63	100	0.0262	12
50	100	0.0186	12
37.5	100	0.0098	9
28	100	0.0050	6
20	100	0.0029	3
14	100	0.0015	2
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	99	Particle density	(assumed)
0.425	95	2.65	Mg/m3
0.3	72		
0.212	40		
0.15	24		
0.063	16		

Dry Mass of sample, g	222

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	83
Silt	14
Clay	2

Grading Analysis		
D100	mm	
D60	mm	0.265
D30	mm	0.172
D10	mm	0.0133
Uniformity Coefficient		20
Curvature Coefficient		8.4

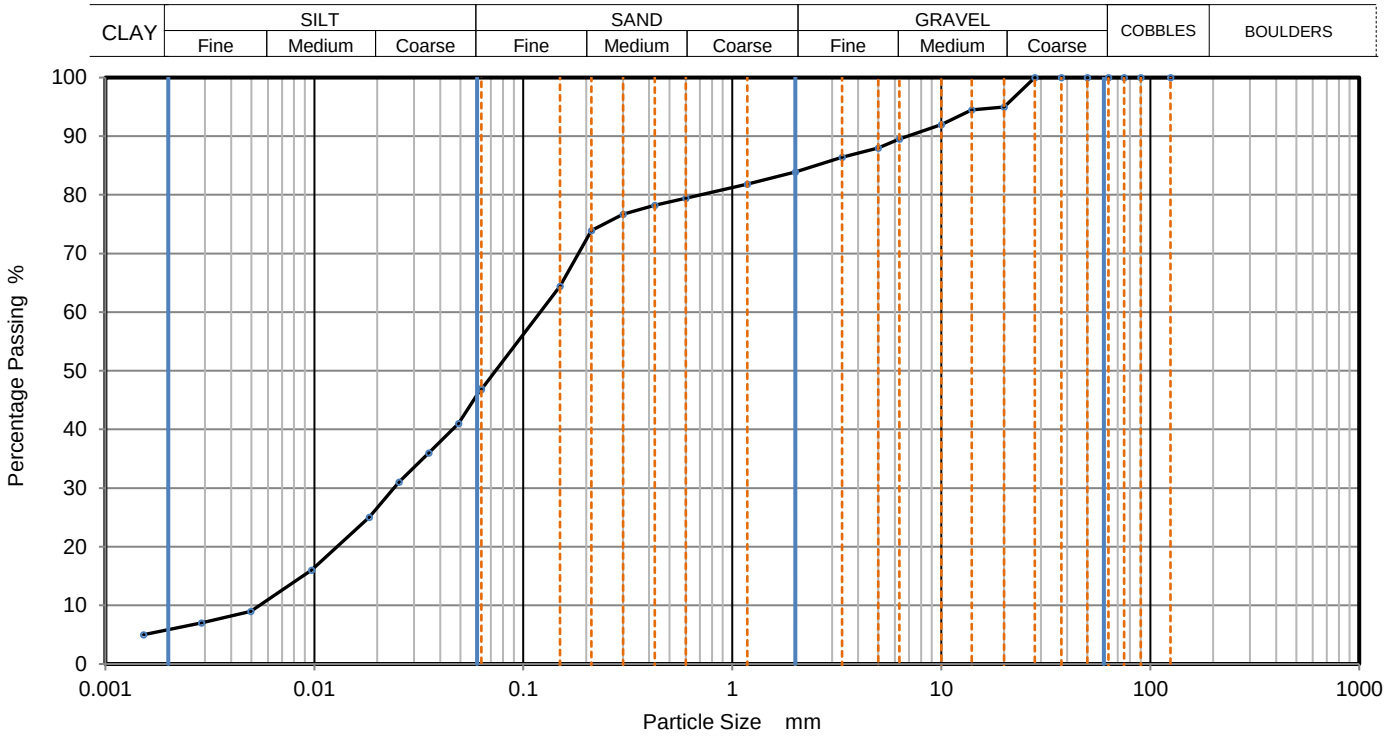
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION				Job Ref	19-0890
					Borehole/Pit No.	RC04
Site Name	Buvinda House, Navan				Sample No.	8
Soil Description	Grey sandy slightly gravelly SILT/CLAY.				Depth, m	7.50
Specimen Reference	2	Specimen Depth	7.5	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5				KeyLAB ID	Caus2019090931



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	47
90	100	0.0489	41
75	100	0.0352	36
63	100	0.0254	31
50	100	0.0183	25
37.5	100	0.0097	16
28	100	0.0050	9
20	95	0.0029	7
14	95	0.0015	5
10	92		
6.3	90		
5	88		
3.35	86		
2	84		
1.18	82		
0.6	79	Particle density	(assumed)
0.425	78	2.65	Mg/m3
0.3	77		
0.212	74		
0.15	64		
0.063	47		

Dry Mass of sample, g	2790

Sample Proportions	% dry mass
Cobbles	0
Gravel	16
Sand	37
Silt	41
Clay	6

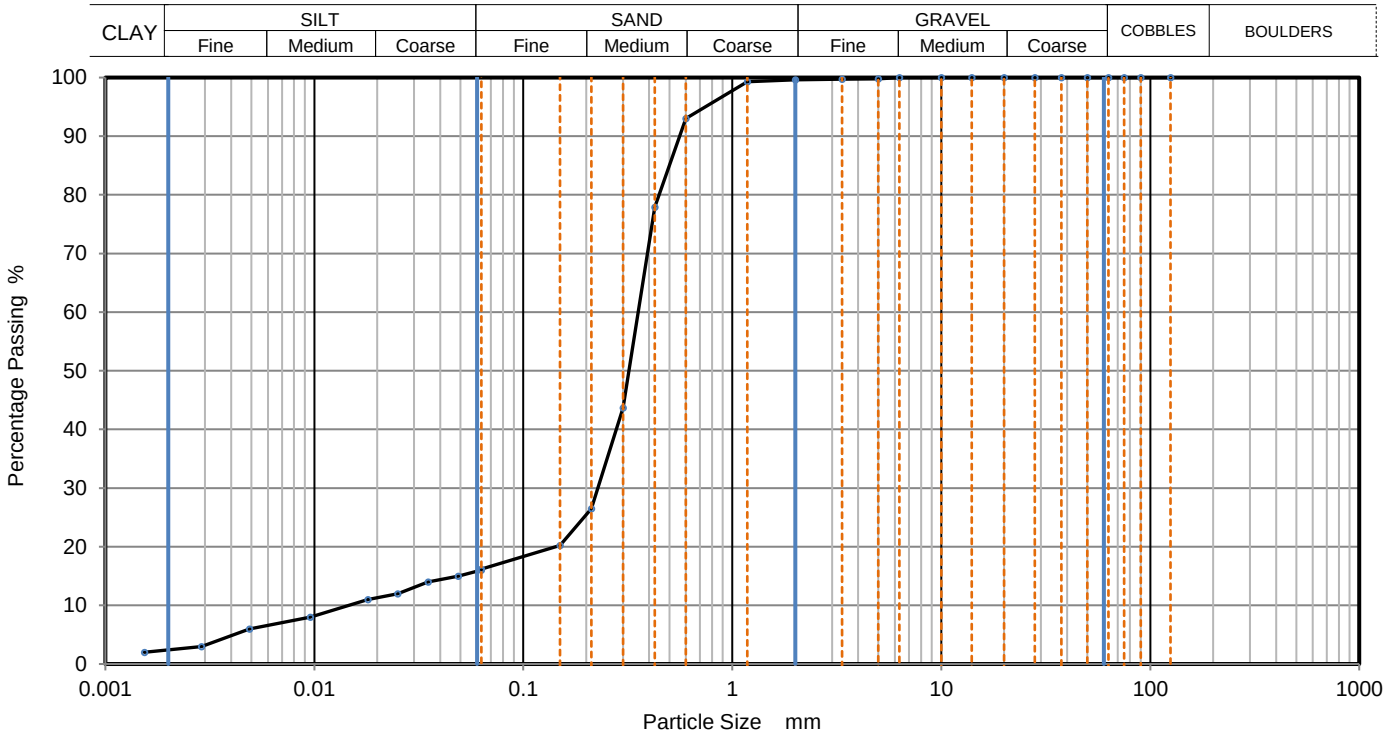
Grading Analysis		
D100	mm	
D60	mm	0.121
D30	mm	0.0245
D10	mm	0.00545
Uniformity Coefficient		22
Curvature Coefficient		0.91

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC05
Site Name	Buvinda House, Navan			Sample No.	3
Soil Description	Greyish brown silty fine to coarse SAND.			Depth, m	2.00
Specimen Reference	2	Specimen Depth	2 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090934



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	16
90	100	0.0489	15
75	100	0.0350	14
63	100	0.0251	12
50	100	0.0181	11
37.5	100	0.0096	8
28	100	0.0049	6
20	100	0.0029	3
14	100	0.0015	2
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	99		
0.6	93	Particle density	(assumed)
0.425	78	2.65	Mg/m3
0.3	44		
0.212	27		
0.15	20		
0.063	16		

Dry Mass of sample, g	202

Sample Proportions	% dry mass
Cobbles	0
Gravel	0
Sand	83
Silt	14
Clay	2

Grading Analysis		
D100	mm	
D60	mm	0.354
D30	mm	0.228
D10	mm	0.0155
Uniformity Coefficient		23
Curvature Coefficient		9.4

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

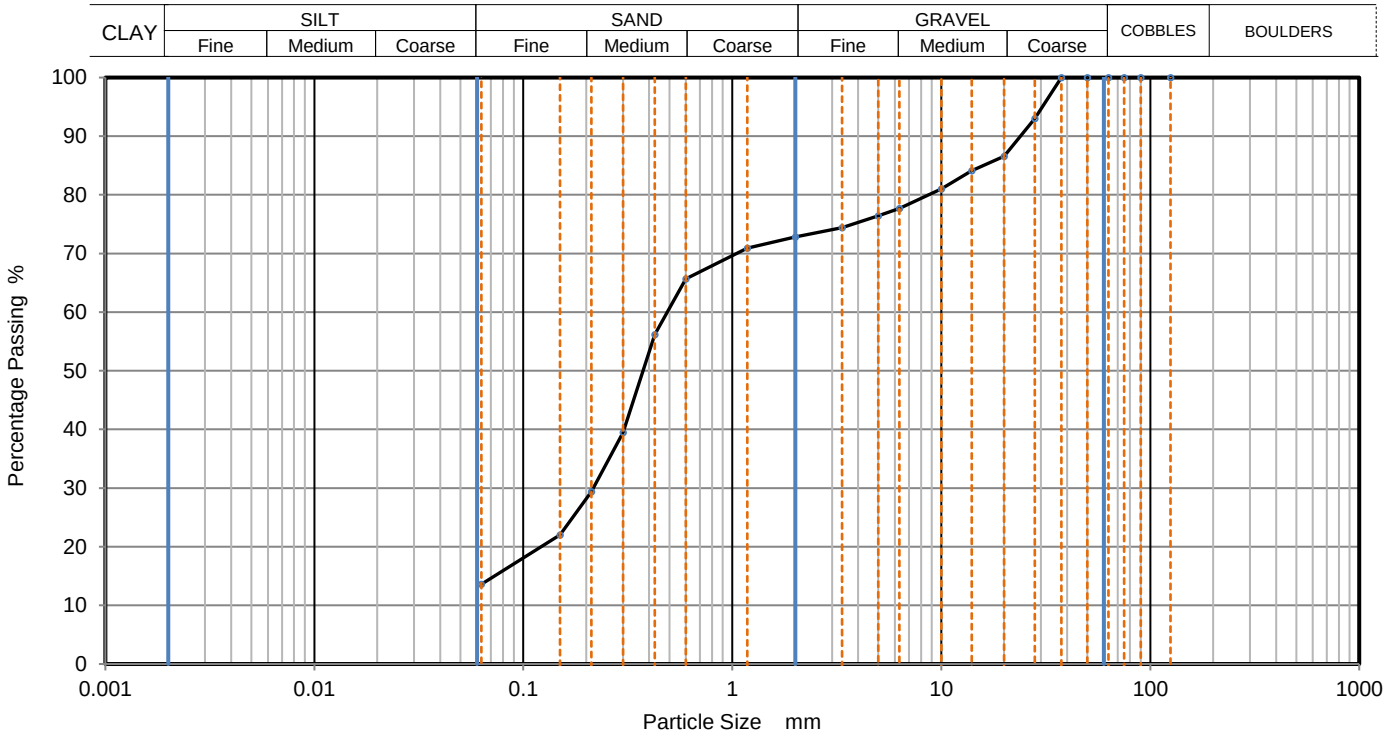
Approved
Stephen.Watson

UKAS TESTING

10122

PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH				Job Ref	**19-0890**
				Borehole/Pit No.	RC05
Site Name	Buvinda House, Navan			Sample No.	6
Soil Description	Greyish brown gravelly slightly silty fine to coarse SAND.			Depth, m	5.00
Specimen Reference	2	Specimen Depth	5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2019090935



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	93		
20	87		
14	84		
10	81		
6.3	78		
5	76		
3.35	74		
2	73		
1.18	71		
0.6	66		
0.425	56		
0.3	40		
0.212	29		
0.15	22		
0.063	14		

Dry Mass of sample, g	3703

Sample Proportions	% dry mass
Cobbles	0
Gravel	27
Sand	59
Fines <0.063mm	14

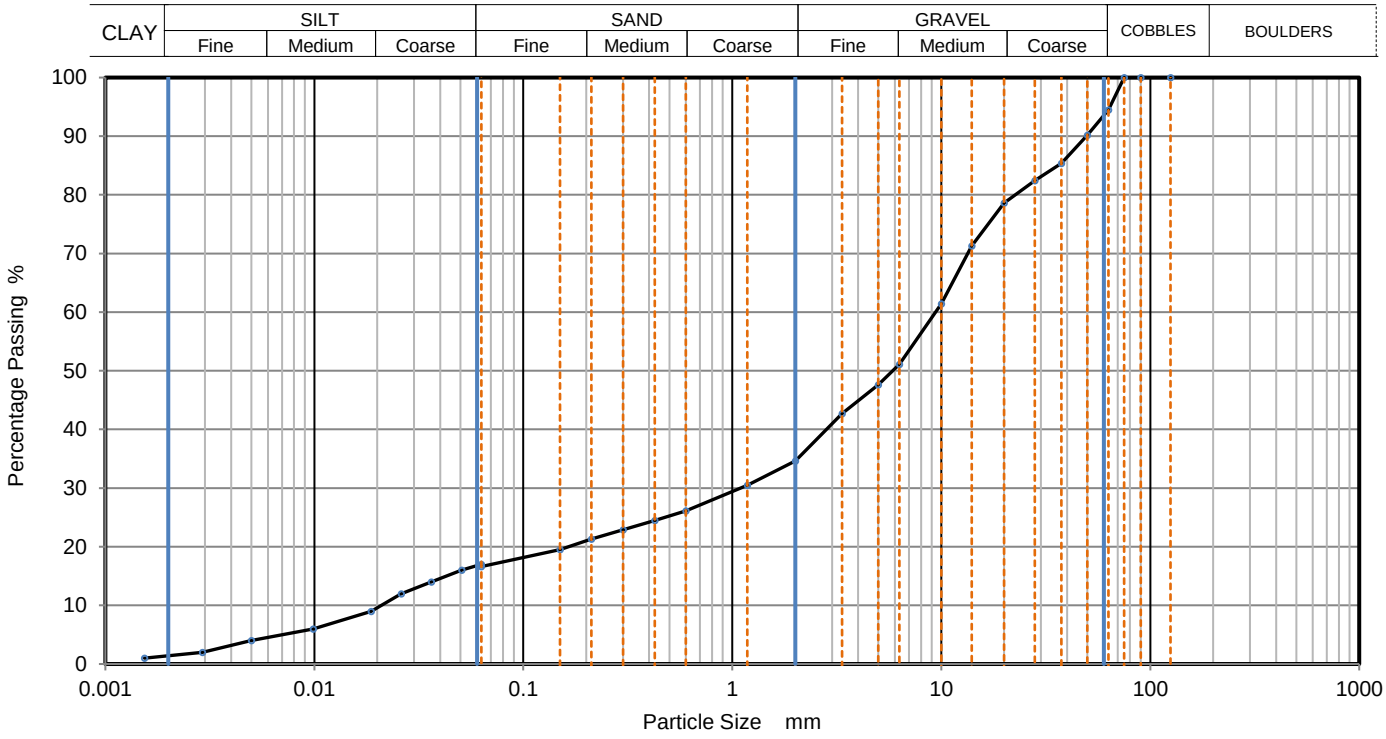
Grading Analysis		
D100	mm	
D60	mm	0.488
D30	mm	0.216
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	PARTICLE SIZE DISTRIBUTION			Job Ref	19-0890
				Borehole/Pit No.	RC06
Site Name	Buvinda House, Navan			Sample No.	2
Soil Description	Brownish grey slightly sandy gravelly silty CLAY with some cobbles.			Depth, m	1.00
Specimen Reference	2	Specimen Depth	1 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090936



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	17
90	100	0.0508	16
75	100	0.0363	14
63	95	0.0260	12
50	90	0.0187	9
37.5	85	0.0099	6
28	82	0.0050	4
20	79	0.0029	2
14	71	0.0015	1
10	61		
6.3	51		
5	48		
3.35	43		
2	35		
1.18	31		
0.6	26	Particle density	(assumed)
0.425	25	2.65	Mg/m3
0.3	23		
0.212	21		
0.15	20		
0.063	17		

Dry Mass of sample, g	24418

Sample Proportions	% dry mass
Cobbles	6
Gravel	60
Sand	18
Silt	15
Clay	1

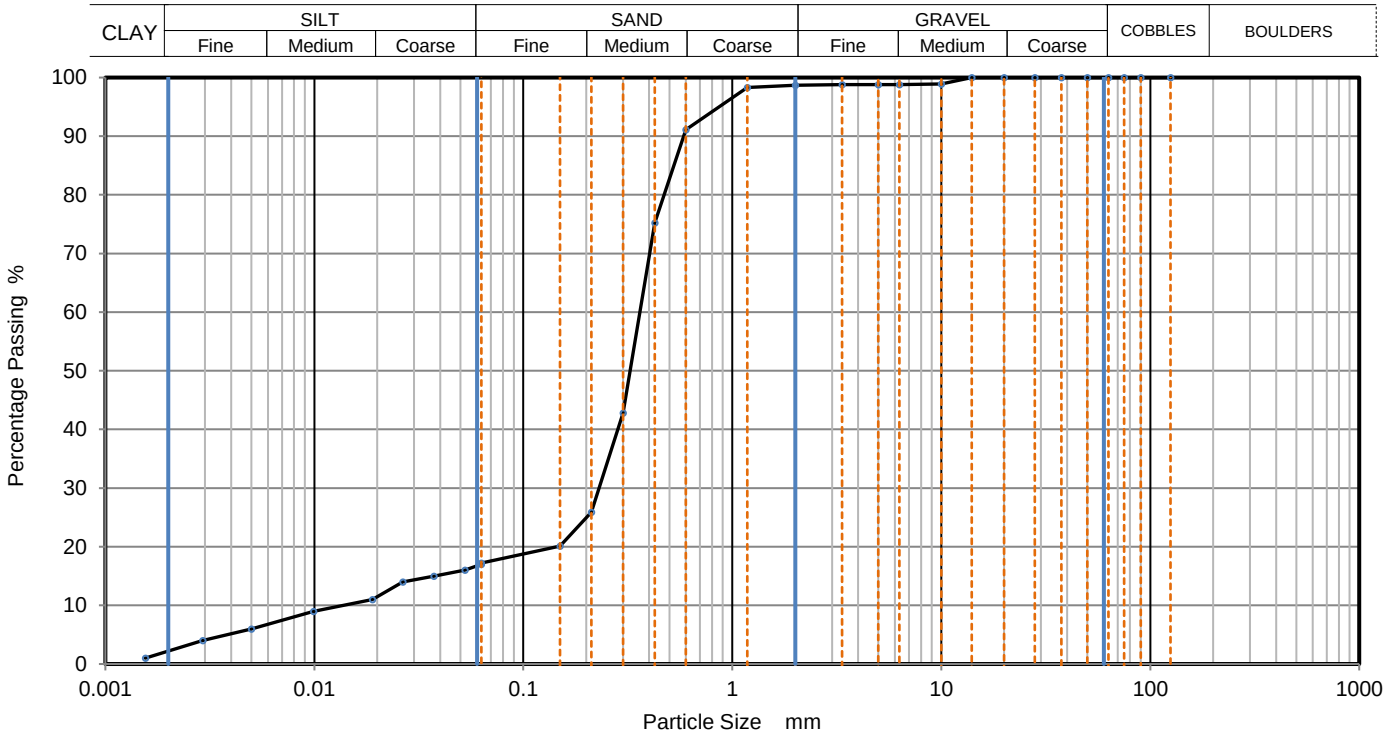
Grading Analysis		
D100	mm	
D60	mm	9.4
D30	mm	1.1
D10	mm	0.0205
Uniformity Coefficient		460
Curvature Coefficient		6.3

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC06
Site Name	Buvinda House, Navan			Sample No.	4
Soil Description	Greyish brown silty fine to coarse SAND.			Depth, m	3.00
Specimen Reference	2	Specimen Depth	3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090938



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	17
90	100	0.0525	16
75	100	0.0373	15
63	100	0.0265	14
50	100	0.0190	11
37.5	100	0.0099	9
28	100	0.0050	6
20	100	0.0029	4
14	100	0.0016	1
10	99		
6.3	99		
5	99		
3.35	99		
2	99		
1.18	98		
0.6	91	Particle density	(assumed)
0.425	75	2.65	Mg/m3
0.3	43		
0.212	26		
0.15	20		
0.063	17		

Dry Mass of sample, g	1244

Sample Proportions	% dry mass
Cobbles	0
Gravel	1
Sand	81
Silt	15
Clay	2

Grading Analysis		
D100	mm	
D60	mm	0.361
D30	mm	0.231
D10	mm	0.0143
Uniformity Coefficient		25
Curvature Coefficient		10

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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Stephen.Watson

LAB 05R Version 4

UKAS TESTING

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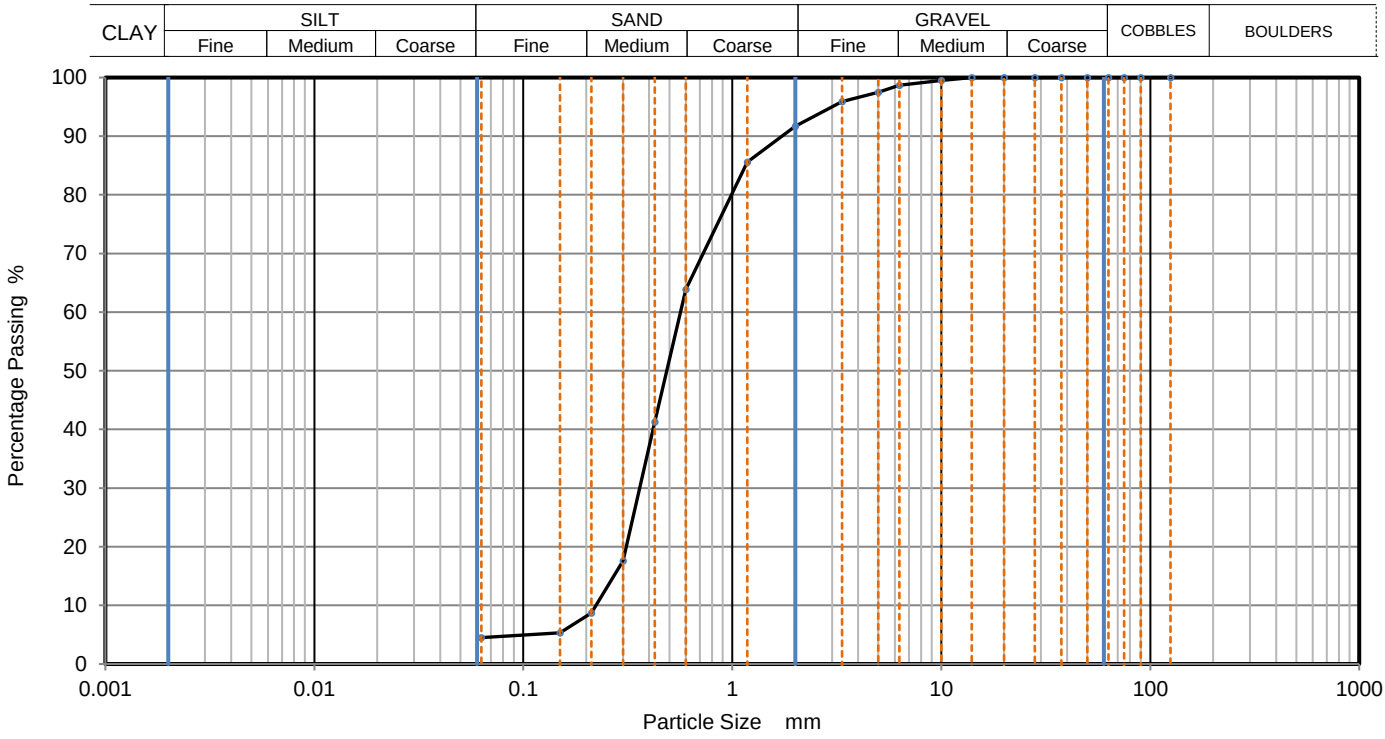
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH				Job Ref	**19-0890**
				Borehole/Pit No.	RC06
Site Name	Buvinda House, Navan			Sample No.	7
Soil Description	Greyish brown slightly gravelly slightly silty fine to coarse SAND.			Depth, m	6.00
Specimen Reference	2	Specimen Depth	6 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2019090939



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	99		
5	98		
3.35	96		
2	92		
1.18	86		
0.6	64		
0.425	41		
0.3	18		
0.212	9		
0.15	5		
0.063	5		

Dry Mass of sample, g	232

Sample Proportions	% dry mass
Cobbles	0
Gravel	8
Sand	87
Fines <0.063mm	5

Grading Analysis		
D100	mm	
D60	mm	0.565
D30	mm	0.36
D10	mm	0.223
Uniformity Coefficient		2.5
Curvature Coefficient		1

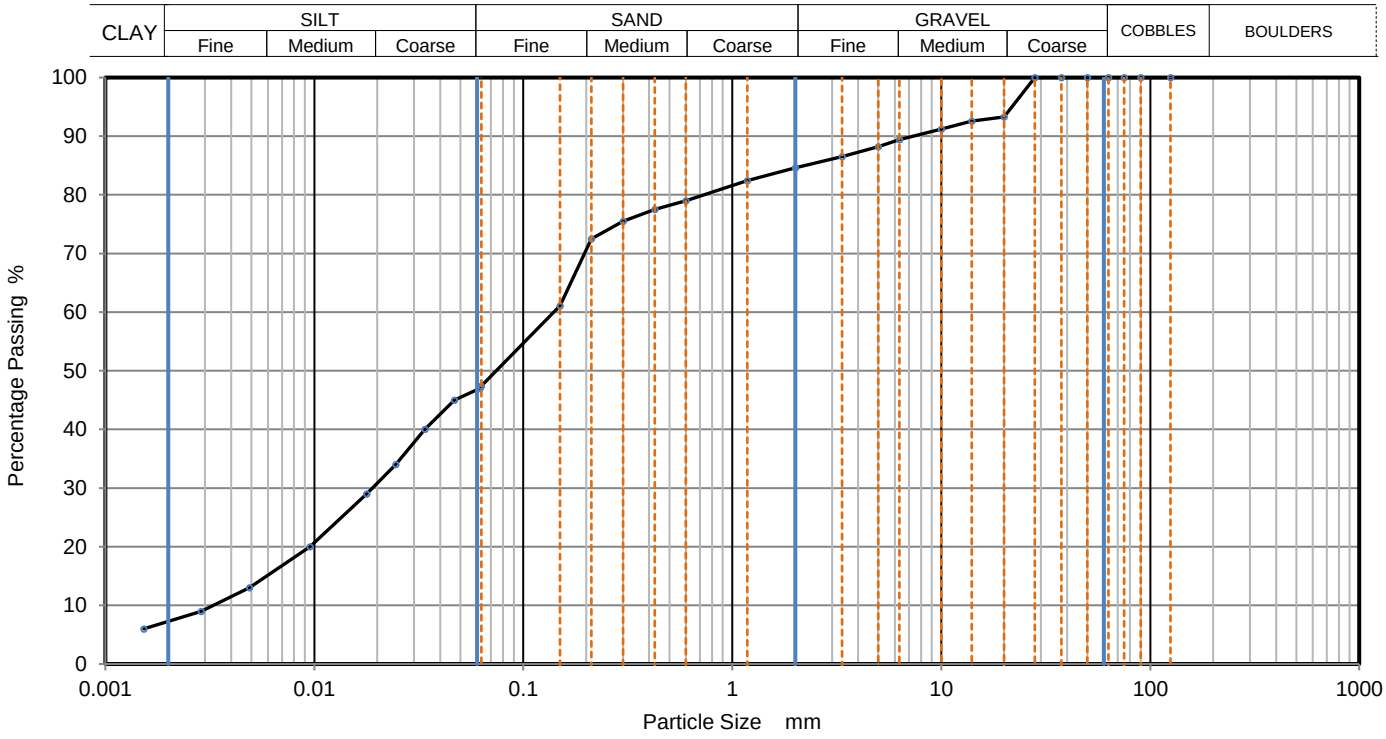
Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**19-0890**
				Borehole/Pit No.	RC06
Site Name	Buvinda House, Navan			Sample No.	9
Soil Description	Greyish brown sandy slightly gravelly SILT.			Depth, m	9.00
Specimen Reference	2	Specimen Depth	9 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2019090941



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0620	47
90	100	0.0468	45
75	100	0.0338	40
63	100	0.0245	34
50	100	0.0178	29
37.5	100	0.0095	20
28	100	0.0049	13
20	93	0.0029	9
14	93	0.0015	6
10	91		
6.3	89		
5	88		
3.35	87		
2	85		
1.18	82		
0.6	79	Particle density	(assumed)
0.425	78	2.65	Mg/m3
0.3	76		
0.212	73		
0.15	61		
0.063	47		

Dry Mass of sample, g	2654

Sample Proportions	% dry mass
Cobbles	0
Gravel	15
Sand	37
Silt	40
Clay	7

Grading Analysis		
D100	mm	
D60	mm	0.14
D30	mm	0.0191
D10	mm	0.00341
Uniformity Coefficient		41
Curvature Coefficient		0.76

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
Stephen.Watson

LAB 05R Version 4

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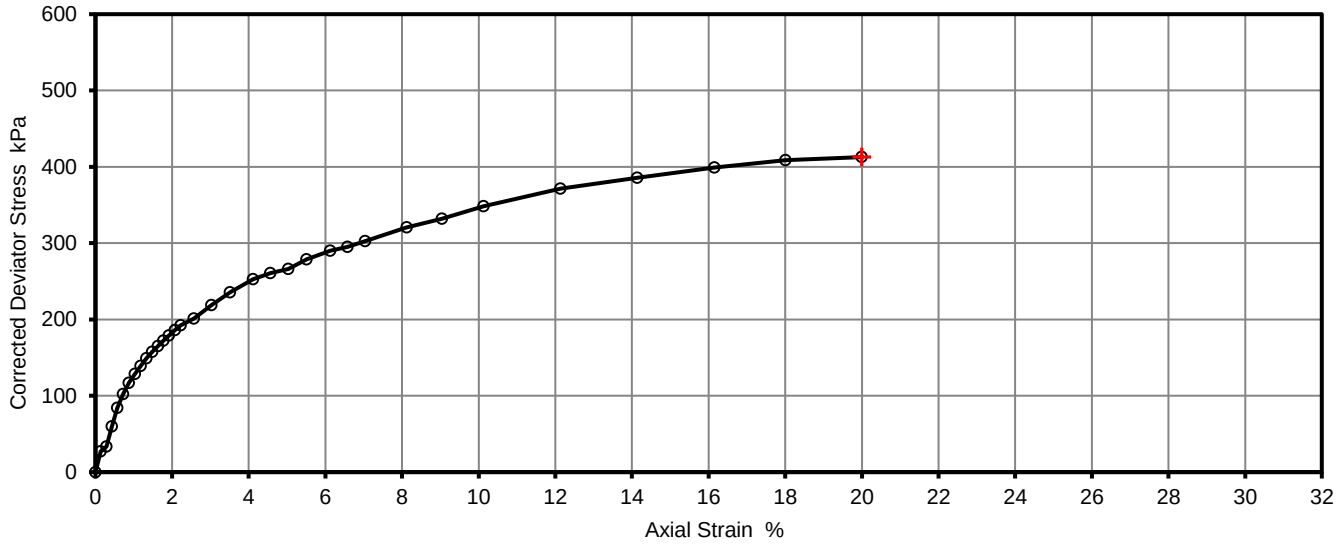
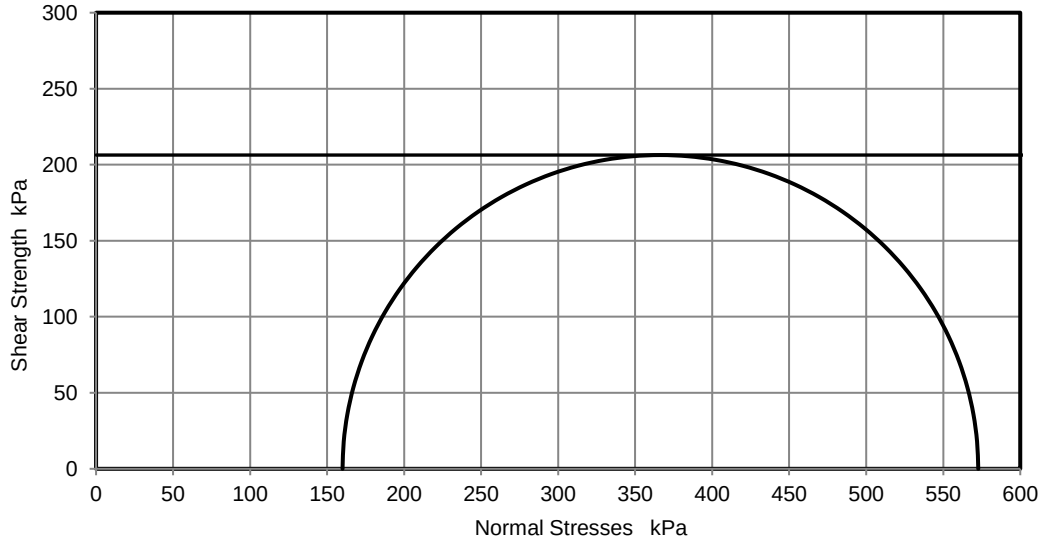
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**			Job Ref	19-0890
				Borehole/Pit No.	RC01
Site Name	Buvinda House, Navan			Sample No.	16
Soil Description	Greyish brown sandy gravelly silty CLAY.			Depth	7.50
Specimen Reference	6	Specimen Depth	7.55 m	Sample Type	U
Specimen Description	Stiff greyish brown sandy gravelly silty CLAY.			KeyLAB ID	Caus2019090919
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Date of test	18/09/2019

Test Number		1	
Length		210.5	mm
Diameter		105.1	mm
Bulk Density		2.11	Mg/m3
Moisture Content		5.4	%
Dry Density		2.00	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		160	kPa
At failure	Axial Strain	20.0	%
	Deviator Stress, (σ1 - σ3)f	413	kPa
	Undrained Shear Strength, cu	206	kPa ½(σ1 - σ3)f
	Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7.
This is provided for information only.

Remarks

Testing terminated at 20% axial strain.

Approved: Stephen.Watson

Printed: 24/09/2019 09:15

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10122

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.: 19-30884-1

Initial Date of Issue: 19-Sep-2019

Client Causeway Geotech Ltd

Client Address: 8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s): Carin Cornwall
Colm Hurley
Darren O'Mahony
Gabriella Horan
Joe Gervin
John Cameron
Lucy Newland
Matthew Gilbert
Neil Haggan
Paul Dunlop
Paul McNamara
Sean Ross
Stephen Franey
Stephen McCracken
Stephen Watson
Stuart Abraham
Tom McIntyre

Project 19-0890 Buvinda House Navan

Quotation No.:		**Date Received:**	13-Sep-2019
Order No.:		**Date Instructed:**	13-Sep-2019
No. of Samples:	10		
Turnaround (Wkdays):	5	**Results Due:**	19-Sep-2019
Date Approved:	19-Sep-2019		

Approved By:

Details: Amy Parekh-Pross, Technical Projects Manager

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 19-0890 Buvinda House Navan

Client: Causeway Geotech Ltd		**Chemtest Job No.:**			19-30884	19-30884	19-30884	19-30884	19-30884	19-30884	19-30884	19-30884	19-30884
Quotation No.:		**Chemtest Sample ID.:**			888438	888439	888440	888441	888442	888443	888444	888445	888446
Order No.:		Client Sample Ref.:			11	8	8	14	10	15	15	8	10
		Sample Location:			RC01	RC01	RC02	RC02	RC03B	RC03B	RC04	RC05	RC06
		Sample Type:			SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
		Top Depth (m):			2	7.5	2	6	1.2	6	7.5	2	1.2
		Date Sampled ($):			12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019	12-Sep-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Moisture	N	2030	%	0.020	12	8.6	9.1	11	3.5	6.5	12	11	12
pH	U	2010		N/A	8.5	8.6	8.7	8.6	9.0	9.0	8.7	8.5	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.015	0.14	0.035	0.11	0.013	0.016	0.081	< 0.010	0.047
Organic Matter	U	2625	%	0.40	0.72				< 0.40				0.62

Results - Soil

Project: 19-0890 Buvinda House Navan

Client: Causeway Geotech Ltd			**Chemtest Job No.:**		19-30884
Quotation No.:			**Chemtest Sample ID.:**		888447
Order No.:			Client Sample Ref.:		17
			Sample Location:		RC06
			Sample Type:		SOIL
			Top Depth (m):		9
			Date Sampled ($):		12-Sep-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Moisture	N	2030	%	0.020	7.3
pH	U	2010		N/A	8.4
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.10
Organic Matter	U	2625	%	0.40	

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"
$	This information has been supplied by the client and can affect the integrity of test data.

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, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated 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
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 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.com

CAUSEWAY GEOTECH

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Causeway Geotech Ltd
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Company Number: NI610766

REGIONAL OFFICE
Causeway Geotech (IRL) Ltd
Unit 3 Balbriggan Business Park, Balbriggan
Co Dublin, Ireland, K32 EH36
ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

3 October 2019

Project Name:	Buvinda House, Navan
Project No.:	19-0890
Client:	Meath County Council
Engineer:	PUNCH Consulting Engineers

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 attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days 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.

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Buvinda House, Navan

Report Reference: Rock Schedule 1

The table below details the tests carried out, the specifications used, and the number of tests included in this report.

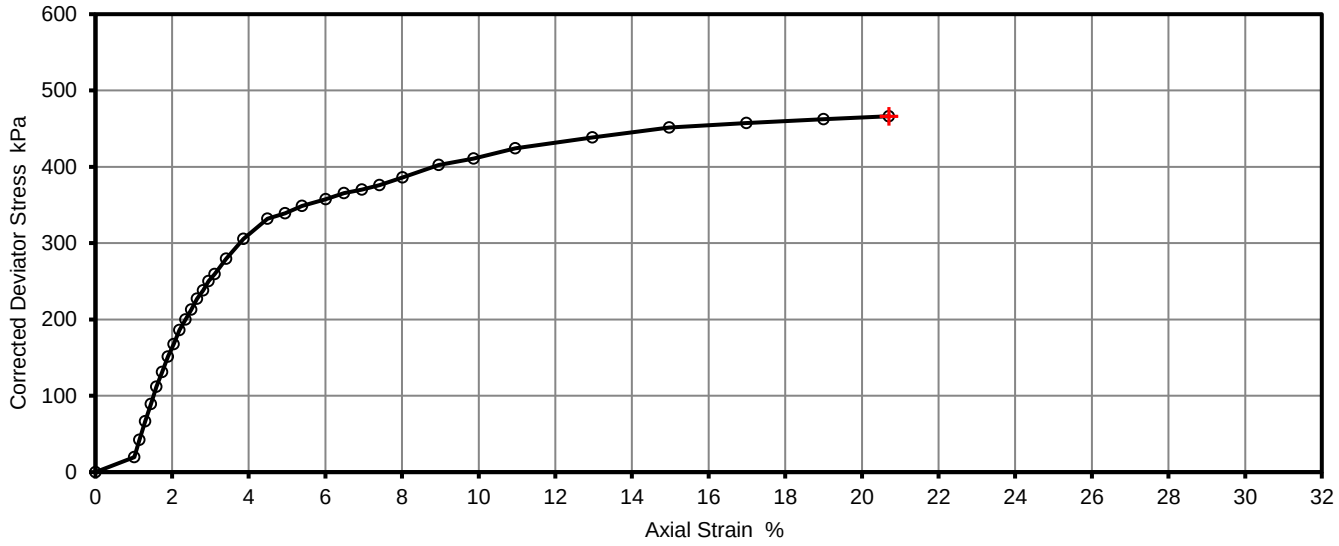
Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	3
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	15
ROCK	Uniaxial Compressive Strength (UCS)*	ISRM Suggested Methods -Rock Characterization Testing and Monitoring, Ed. E T Brown - 1981	5

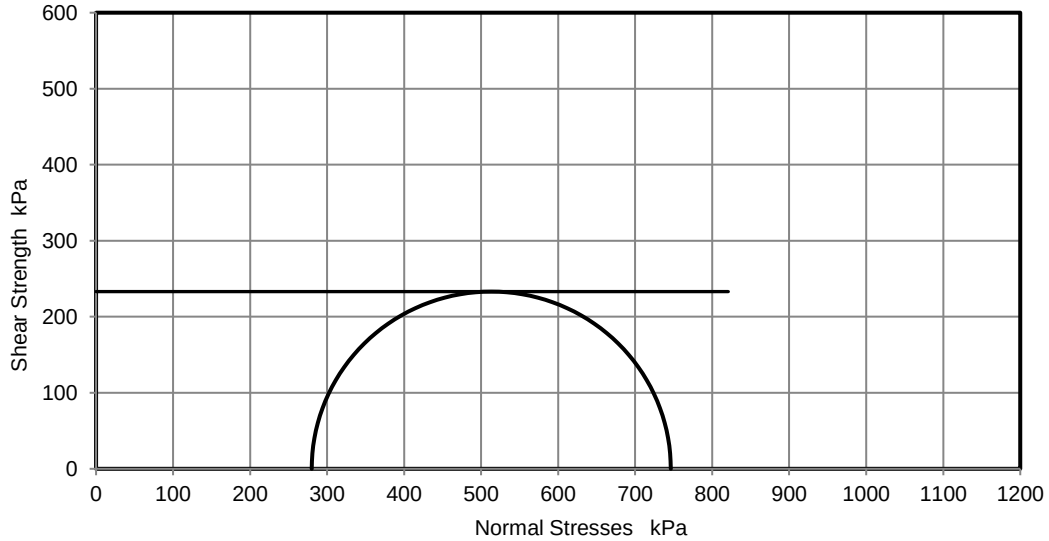
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**				Job Ref	19-0890
					Borehole/Pit No.	RC04
Site Name	Buvinda House, Navan				Sample No.	2
Soil Description	Grey sandy slightly gravelly silty CLAY.				Depth	12.50
Specimen Reference	2	Specimen Depth	12.55	m	Sample Type	C
Specimen Description	Stiff grey sandy slightly gravelly silty CLAY.				KeyLAB ID	Caus2019091226
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	02/10/2019

Test Number		1	
Length		210.4	mm
Diameter		103.7	mm
Bulk Density		2.32	Mg/m3
Moisture Content		8.4	%
Dry Density		2.14	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		280	kPa
At failure	Axial Strain	20.7	%
	Deviator Stress, (σ1 - σ3)f	466	kPa
	Undrained Shear Strength, cu	233	kPa ½(σ1 - σ3)f
	Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7.
This is provided for information only.

Remarks

Testing terminated at 20% axial strain

Approved	Printed
Stephen.Watson	03/10/2019 08:11

LAB 15R Version 4

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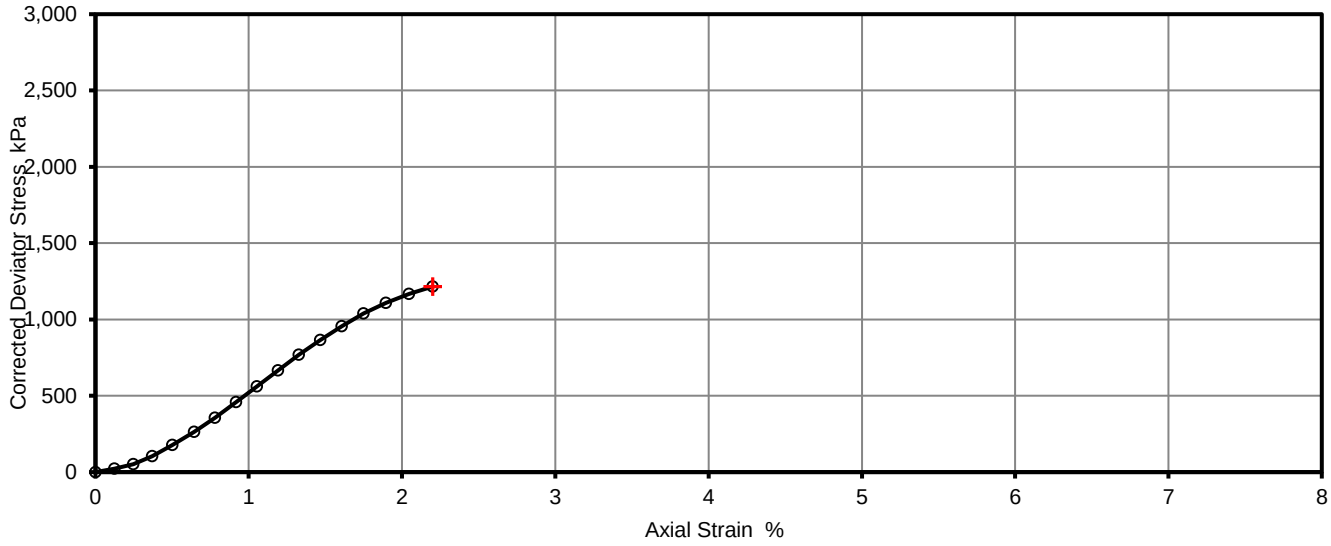
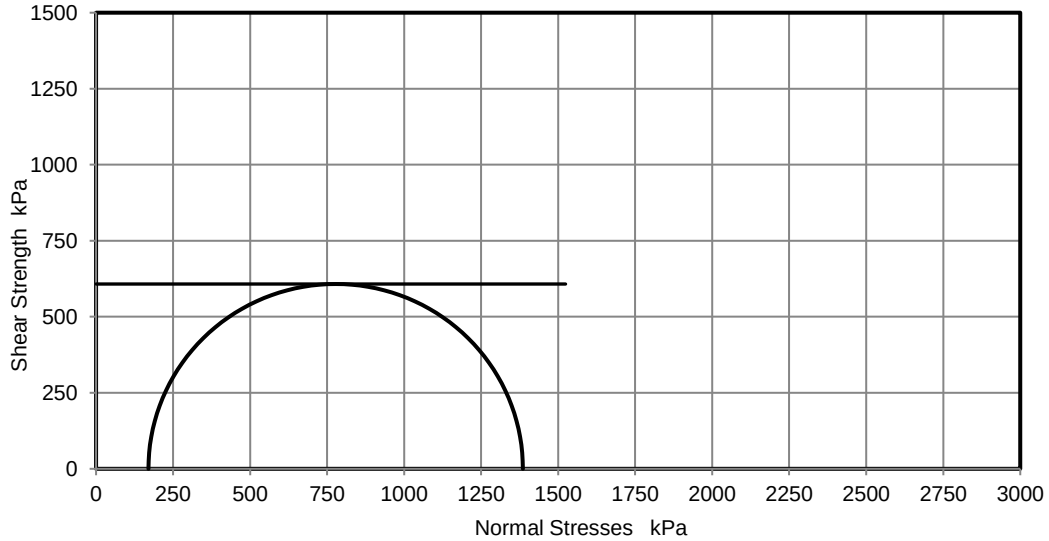
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**				Job Ref	19-0890
					Borehole/Pit No.	RC05
Site Name	Buvinda House, Navan				Sample No.	1
Soil Description	Grey sandy gravelly silty CLAY.				Depth	7.40
Specimen Reference	2	Specimen Depth	7.45	m	Sample Type	C
Specimen Description	Stiff grey sandy gravelly silty CLAY.				KeyLAB ID	Caus2019091230
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	30/09/2019

Test Number		1	
Length		210.3	mm
Diameter		102.7	mm
Bulk Density		2.36	Mg/m3
Moisture Content		6.7	%
Dry Density		2.21	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		170	kPa
At failure	Axial Strain	2.2	%
	Deviator Stress, (σ1 - σ3)f	1216	kPa
	Undrained Shear Strength, cu	608	kPa ½(σ1 - σ3)f
	Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7.
This is provided for information only.

Remarks

Testing terminated - Capacity of load ring met

Approved: Stephen.Watson

Printed: 03/10/2019 08:12

UKAS TESTING
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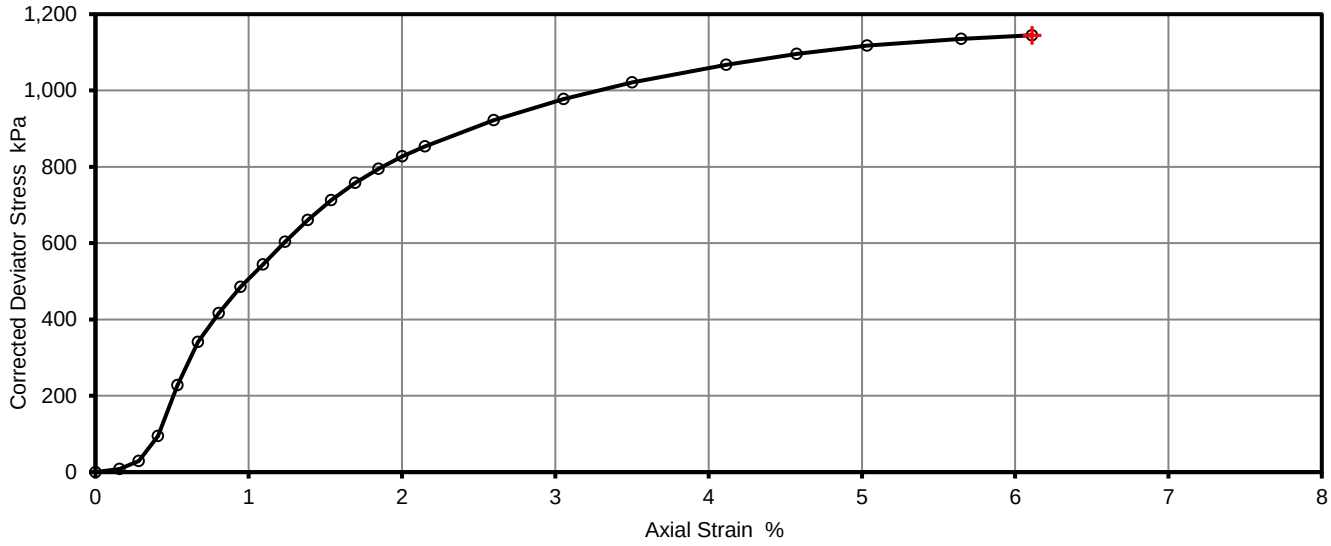
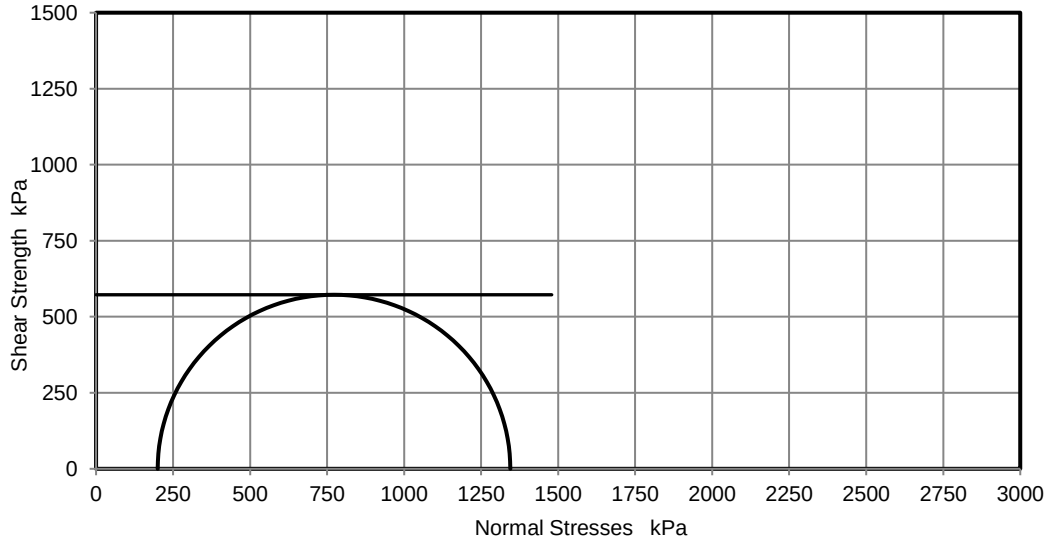
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**				Job Ref	19-0890
					Borehole/Pit No.	RC05
Site Name	Buvinda House, Navan				Sample No.	2
Soil Description	Grey sandy gravelly silty CLAY.				Depth	8.80
Specimen Reference	2	Specimen Depth	8.85	m	Sample Type	C
Specimen Description	Stiff grey sandy gravelly silty CLAY.				KeyLAB ID	Caus2019091231
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen				Date of test	01/10/2019

Test Number		1	
Length		210.4	mm
Diameter		104.1	mm
Bulk Density		2.33	Mg/m3
Moisture Content		5.9	%
Dry Density		2.20	Mg/m3
Rate of Strain		2.0	%/min
Cell Pressure		200	kPa
At failure	Axial Strain	6.1	%
	Deviator Stress, (σ1 - σ3)f	1145	kPa
	Undrained Shear Strength, cu	572	kPa ½(σ1 - σ3)f
	Mode of Failure		

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects based on Fig 11 BS1377-7:1990

Mohr circles and their interpretation is not covered by BS1377-7.
This is provided for information only.

Remarks

Testing terminated - Capacity of load ring met

Approved: Stephen.Watson

Printed: 03/10/2019 08:12

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10122

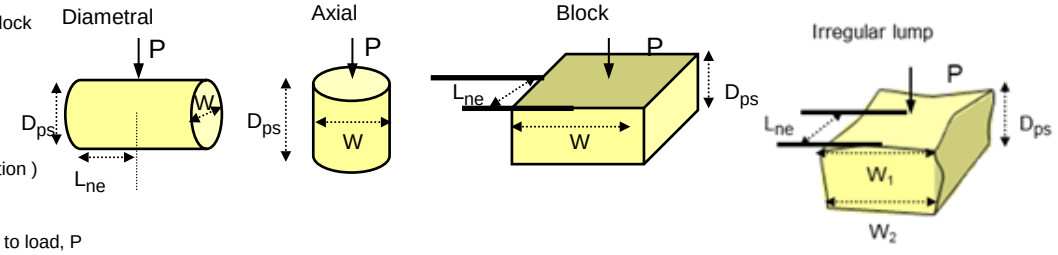
CAUSEWAY GEOTECH

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
19-0890	Buvinda House, Navan

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth	Ref.	Type	Ref.	Depth		Type (D, A, I, B)	Direction (L, P or U)		Lne	W	Dps	Dps'			Is	Is(50)	
	m				m					mm	mm	mm	mm	kN	mm	MPa	MPa	
RC01	9.40	2	C	1	9.40	LIMESTONE	D	U	NO	66.9	101.6	101.6	96.0	7.9	98.8	0.8	1.1	
RC01	10.40	3	C	1	10.40	LIMESTONE	A	U	NO		101.5	61.0	54.0	2.5	83.5	0.4	0.5	
RC02	12.30	2	C	1	112.30	LIMESTONE	D	U	NO	55.1	101.8	101.8	98.0	1.1	99.9	0.1	0.2	
RC02	13.60	3	C	1	13.60	LIMESTONE	D	U	YES	47.3	101.7	101.7	95.0	2.3	98.3	0.2	0.3	
RC02	14.25	4	C	1	14.25	LIMESTONE	D	U	YES	71.2	101.5	101.5	98.0	25.0	99.7	2.5	3.4	
RC03B	12.60	1	C	1	12.60	LIMESTONE	A	U	NO		101.8	41.0	40.0	26.2	72.0	5.1	6.0	
RC03B	13.30	3	C	1	13.30	LIMESTONE	D	U	NO	63.3	101.5	101.5	100.0	23.9	100.7	2.4	3.2	
RC03B	14.50	4	C	1	14.50	LIMESTONE	D	U	NO	83.0	101.5	101.5	100.0	22.0	100.7	2.2	3.0	
RC04	14.60	4	C	1	14.60	LIMESTONE	D	U	YES	70.2	101.6	101.6	96.0	19.6	98.8	2.0	2.7	
RC04	16.00	5	C	1	16.00	LIMESTONE	A	U	NO		100.5	91.0	89.0	1.1	106.7	0.1	0.1	
RC05	10.40	3	C	1	10.40	LIMESTONE	A	U	YES		101.3	41.0	37.0	15.6	69.1	3.3	3.8	
RC05	12.10	5	C	1	12.10	LIMESTONE	D	U	YES	44.8	101.2	101.2	96.0	5.4	98.6	0.6	0.8	
RC06	14.50	1	C	1	14.50	MUDSTONE	I	U	YES	45.0	83.5	83.5	63.0	28.1	81.8	4.2	5.2	
RC06	15.20	2	C	1	15.20	MUDSTONE	A	U	YES		100.4	100.4	69.0	0.1	93.9	0.0	0.0	
RC06	16.80	3	C	1	16.80	MUDSTONE	D	U	YES	91.4	100.9	100.9	96.0	11.0	98.4	1.1	1.5	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

LAB 17R Version 4

Date Printed: 10/04/2019 00:00

Approved By: Stephen.Watson

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UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Project No.	Project Name
19-0890	Buvinda House, Navan

Hole No.	Sample				Rock Type	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3			Remarks
	Ref	Top	Base	Type		Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Mode of failure	UCS MPa	
RC01	1	9.25		C	LIMESTONE	101.5	207.9	2.0	2.69	0.9	as received	F	60.3	
RC02	1	11.20		C	MUDSTONE	102.2	207.2	2.0	2.81	0.5	as received	AC	41.3	
RC03B	2	13.20		C	LIMESTONE	101.7	209.4	2.1	2.62	1.6	as received	MS	14.7	
RC04	3	14.00		C	LIMESTONE	101.3	211.2	2.1	2.65	0.4	as received	F	192.0	
RC05	4	10.85		C	LIMESTONE	101.5	209.7	2.1	2.72	0.7	as received	F	86.2	

Notes

1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

above notes apply unless annotated otherwise in the remarks

Mode of failure :

S - Single shear MS - multiple shear

AC - Axial cleavage F - Fragmented

Test Specification	Date Printed	Approved By	Table
International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007	10/04/2019 00:00	Stephen.Watson	1 sheet 1

LABORATORY RESTRICTION REPORT

Project Reference	19-0890	To	Neill Haggan
Project Name	Buvinda House, Navan	Position	Project Manager
TR reference	19-0890 / R01	From	Stephen Watson
		Position	Laboratory Manager

The following sample(s) and test(s) are restricted as detailed below. Could you please complete the "Required Action" column and return the completed form to the laboratory.

Hole Number	Sample			Test Type	Reason for Restriction	Required Action
	Number	Depth (m)	Type			
RC04	1	11.1	C	QUCK triaxial	Core fell apart on extrusion. High gravel content through middle of subsample.	Cancel
RC06	1	16.80-17.00	C	UCS	Core did not meet the length to diameter ISRM test requirements(too short).	Carry out additional point load test

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature	Project Manager Signature
Stephen Watson	Neil Haggan
Date	Date
02 October 2019	02 October 2019

CAUSEWAY GEOTECH

APPENDIX H

ENVIRONMENTAL LABORATORY TEST RESULTS

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.: 19-29566-1

Initial Date of Issue: 10-Sep-2019

Client Causeway Geotech Ltd

Client Address: 8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s): Carin Cornwall
Colm Hurley
Darren O'Mahony
Gabriella Horan
John Cameron
Lucy Newland
Lucy Peaker
Matthew Gilbert
Neil Haggan
Paul Dunlop
Paul McNamara
Sean Ross
Stephen Franey
Stephen Watson
Stuart Abraham

Project 19-0890 Buvinda House Extension,
Navan-Site Investigation

Quotation No.:		**Date Received:**	03-Sep-2019
Order No.:		**Date Instructed:**	03-Sep-2019
No. of Samples:	2		
Turnaround (Wkdays):	5	**Results Due:**	09-Sep-2019
Date Approved:	10-Sep-2019		

Approved By:

Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 19-0890 Buvinda House Extension, Navan-Site Investigation

Client: Causeway Geotech Ltd		Chemtest Job No.:			19-29566	19-29566
Quotation No.:		Chemtest Sample ID.:			882579	882581
Order No.:		Client Sample Ref.:			17	1
		Sample Location:			RC01	RC03B
		Sample Type:			SOIL	SOIL
		Top Depth (m):			0.30	0.30
		Date Sampled ($):			02-Sep-2019	02-Sep-2019
		Asbestos Lab:			COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
ACM Type	U	2192		N/A	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage	U	2192		N/A	-	-
Moisture	N	2030	%	0.020	3.9	4.1
Arsenic	U	2450	mg/kg	1.0	29	26
Barium	U	2450	mg/kg	10	58	53
Cadmium	U	2450	mg/kg	0.10	0.18	0.16
Chromium	U	2450	mg/kg	1.0	14	17
Molybdenum	U	2450	mg/kg	2.0	< 2.0	5.1
Antimony	N	2450	mg/kg	2.0	4.6	4.2
Copper	U	2450	mg/kg	0.50	14	18
Mercury	U	2450	mg/kg	0.10	< 0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	36	54
Lead	U	2450	mg/kg	0.50	14	20
Selenium	U	2450	mg/kg	0.20	0.60	1.1
Zinc	U	2450	mg/kg	0.50	36	39
Chromium (Trivalent)	N	2490	mg/kg	1.0	14	17
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50	< 0.50
Total Organic Carbon	U	2625	%	0.20	1.5	1.9
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	< 1.0	< 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0

Results - Soil

Project: 19-0890 Buvinda House Extension, Navan-Site Investigation

Client: Causeway Geotech Ltd					Chemtest Job No.:	19-29566	19-29566
Quotation No.:					Chemtest Sample ID.:	882579	882581
Order No.:					Client Sample Ref.:	17	1
					Sample Location:	RC01	RC03B
					Sample Type:	SOIL	SOIL
					Top Depth (m):	0.30	0.30
					Date Sampled ($):	02-Sep-2019	02-Sep-2019
					Asbestos Lab:	COVENTRY	COVENTRY
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0		< 5.0	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0		< 10	< 10
Benzo[j]fluoranthene	N	2700	mg/kg	0.10		< 0.10	< 0.10
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0		< 1.0	< 1.0

Results - Single Stage WAC

Project: 19-0890 Buvinda House Extension, Navan-Site Investigation

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	19-29566						
Chemtest Sample ID:	882579						
Sample Ref:	17						
Sample ID:							
Sample Location:	RC01						
Top Depth(m):	0.30						
Bottom Depth(m):							
Sampling Date ($):	02-Sep-2019						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%	1.5	3	5	6
Loss On Ignition	2610	U	%	1.5	--	--	10
Total BTEX	2760	U	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	U	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH	2010	U		8.5	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.038	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.0010	< 0.050	0.5	2	25
Barium	1450	U	0.030	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	< 0.0010	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	< 0.0010	< 0.050	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	< 0.0010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.0010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.0015	0.015	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	52	520	800	15000	25000
Fluoride	1220	U	0.40	4.0	10	150	500
Sulphate	1220	U	22	220	1000	20000	50000
Total Dissolved Solids	1020	N	91	910	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	3.3	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	3.9

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Results - Single Stage WAC

Project: 19-0890 Buvinda House Extension, Navan-Site Investigation

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	19-29566						
Chemtest Sample ID:	882581						
Sample Ref:	1						
Sample ID:							
Sample Location:	RC03B						
Top Depth(m):	0.30						
Bottom Depth(m):							
Sampling Date ($):	02-Sep-2019						
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%	1.9	3	5	6
Loss On Ignition	2610	U	%	1.7	--	--	10
Total BTEX	2760	U	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	U	mg/kg	< 0.10	1	--	--
TPH Total WAC (Mineral Oil)	2670	U	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH	2010	U		8.5	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.038	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1450	U	< 0.0010	< 0.050	0.5	2	25
Barium	1450	U	0.033	< 0.50	20	100	300
Cadmium	1450	U	< 0.00010	< 0.010	0.04	1	5
Chromium	1450	U	< 0.0010	< 0.050	0.5	10	70
Copper	1450	U	< 0.0010	< 0.050	2	50	100
Mercury	1450	U	< 0.00050	< 0.0050	0.01	0.2	2
Molybdenum	1450	U	< 0.0010	< 0.050	0.5	10	30
Nickel	1450	U	< 0.0010	< 0.050	0.4	10	40
Lead	1450	U	< 0.0010	< 0.010	0.5	10	50
Antimony	1450	U	< 0.0010	< 0.010	0.06	0.7	5
Selenium	1450	U	0.0014	0.014	0.1	0.5	7
Zinc	1450	U	< 0.0010	< 0.50	4	50	200
Chloride	1220	U	23	230	800	15000	25000
Fluoride	1220	U	0.42	4.2	10	150	500
Sulphate	1220	U	21	210	1000	20000	50000
Total Dissolved Solids	1020	N	85	850	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	2.6	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	4.1

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

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"
$	This information has been supplied by the client and can affect the integrity of test data.

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, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated 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
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 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.com

CAUSEWAY GEOTECH

APPENDIX I

SPT HAMMER ENERGY MEASUREMENT REPORT

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	0200
Test Date:	23/02/2019
Report Date:	26/02/2019
File Name:	0200.spt
Test Operator:	NPB

Instrumented Rod Data

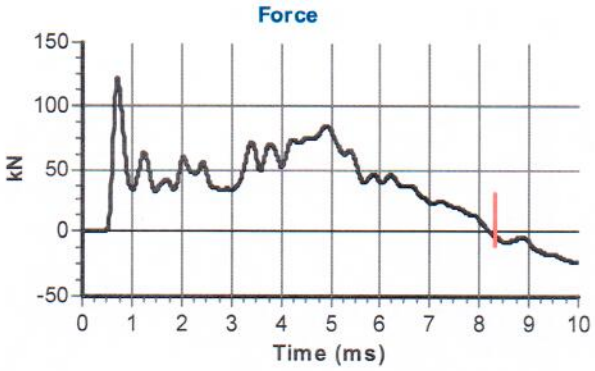
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

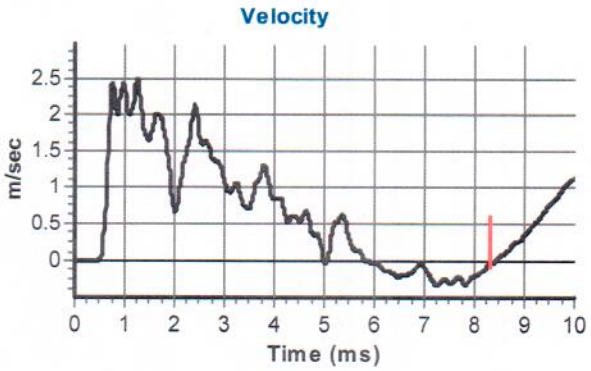
SPT Hammer Information

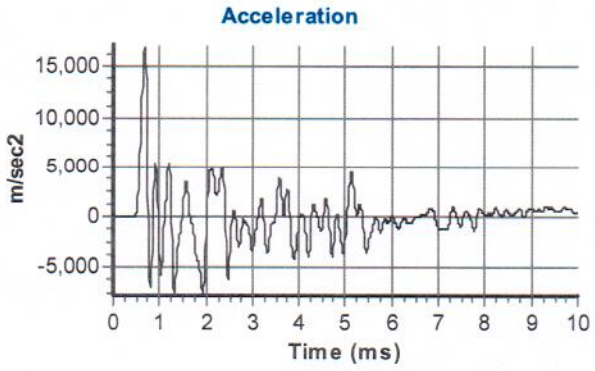
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

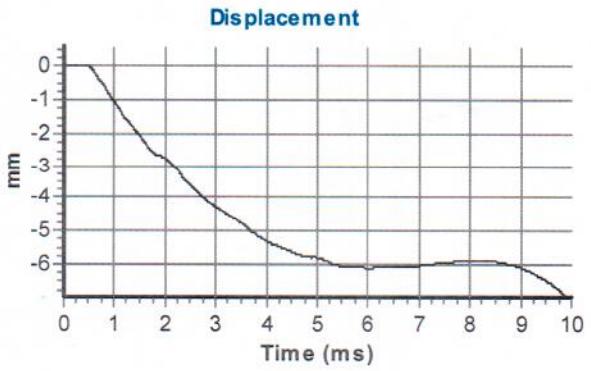
Comments / Location

CAUSEWAY









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	338

Energy Ratio E_r (%): **72**

The recommended calibration interval is 12 months

Signed: N P Burrows

Title: Field Operations Manager

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	0209
Test Date:	23/02/2019
Report Date:	26/02/2019
File Name:	0209.spt
Test Operator:	NPB

Instrumented Rod Data

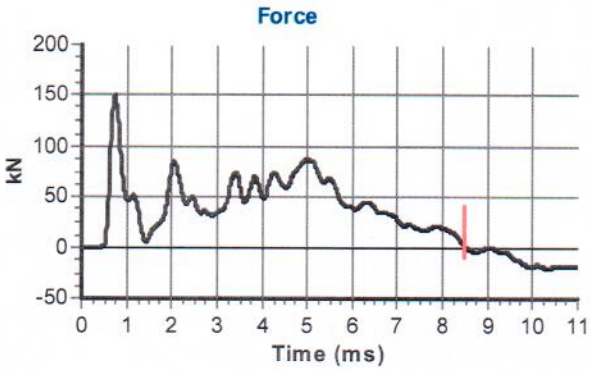
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

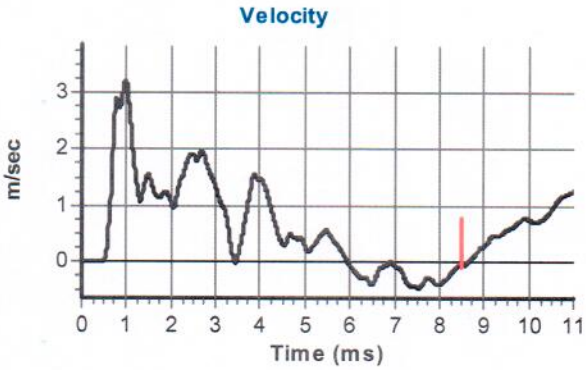
SPT Hammer Information

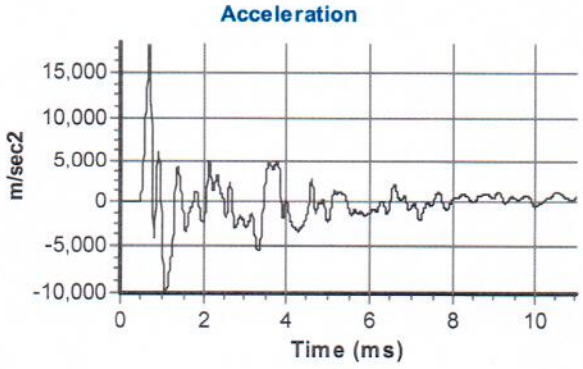
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

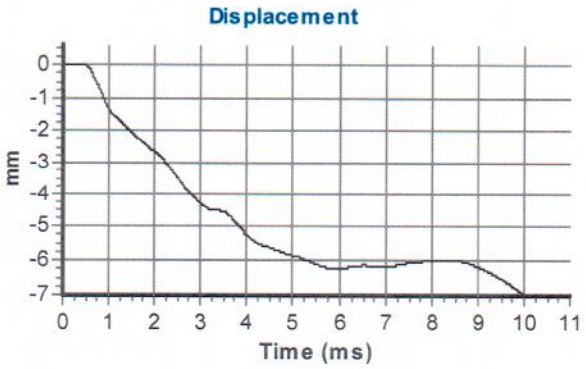
Comments / Location

CAUSEWAY









Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	330

Energy Ratio E_r (%): **70**

N P Burrows

Signed: N P Burrows

Title: Field Operations Manager

The recommended calibration interval is 12 months

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Neil Burrows
Southern Testing Laboratories
Unit 11
Charlwoods Road
East Grinstead
RH19 2HU

SPT Hammer Ref:	0643
Test Date:	23/02/2019
Report Date:	26/02/2019
File Name:	0643.spt
Test Operator:	NPB

Instrumented Rod Data

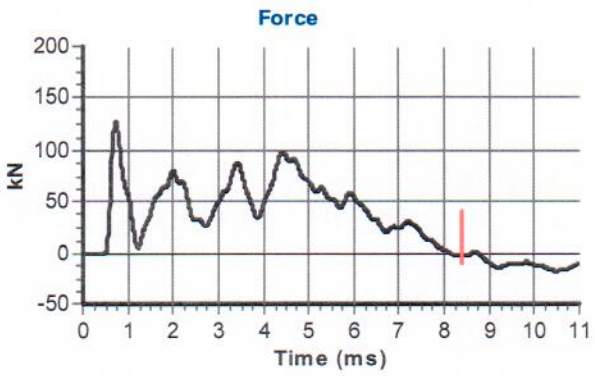
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.0
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	6458
Accelerometer No.2:	9607

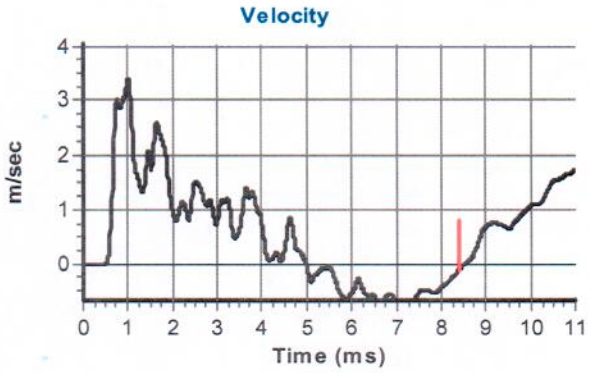
SPT Hammer Information

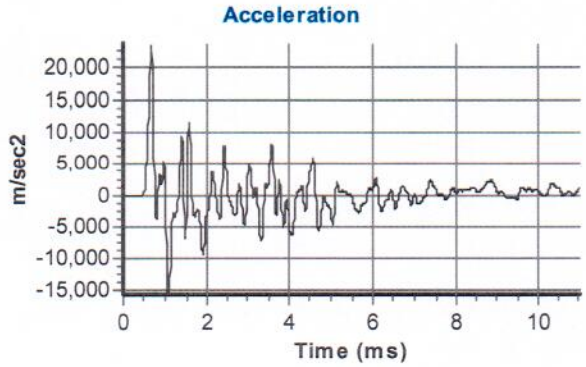
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	10.0

Comments / Location

CAUSEWAY







Calculations

Area of Rod A (mm2):	905
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	388

Energy Ratio E_r (%): 82

The recommended calibration interval is 12 months

Signed: N P Burrows

Title: Field Operations Manager

Appendix G Rainfall Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 288158, Northing: 266675,

	Interval		Years											
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.5,	4.0,	4.8,	5.3,	5.7,	7.0,	8.4,	9.3,	10.7,	11.8,	12.7,	14.1,	15.2,	16.1,	N/A ,
10 mins	3.5,	4.9,	5.6,	6.6,	7.3,	7.9,	9.7,	11.7,	13.0,	14.9,	16.5,	17.7,	19.7,	21.2,	22.4,	N/A ,
15 mins	4.1,	5.7,	6.5,	7.8,	8.6,	9.3,	11.4,	13.8,	15.3,	17.5,	19.4,	20.9,	23.1,	24.9,	26.3,	N/A ,
30 mins	5.5,	7.4,	8.5,	10.0,	11.1,	11.9,	14.4,	17.3,	19.2,	21.8,	24.0,	25.8,	28.5,	30.5,	32.2,	N/A ,
1 hours	7.2,	9.7,	11.0,	12.9,	14.2,	15.2,	18.3,	21.8,	24.0,	27.1,	29.8,	31.9,	35.1,	37.5,	39.5,	N/A ,
2 hours	9.5,	12.7,	14.3,	16.6,	18.2,	19.4,	23.2,	27.4,	30.1,	33.8,	37.0,	39.4,	43.2,	46.0,	48.4,	N/A ,
3 hours	11.2,	14.8,	16.6,	19.3,	21.1,	22.4,	26.7,	31.3,	34.3,	38.4,	41.9,	44.6,	48.7,	51.9,	54.4,	N/A ,
4 hours	12.6,	16.5,	18.5,	21.4,	23.3,	24.8,	29.4,	34.4,	37.6,	42.0,	45.9,	48.8,	53.1,	56.5,	59.2,	N/A ,
6 hours	14.8,	19.3,	21.6,	24.8,	27.0,	28.6,	33.8,	39.4,	42.9,	47.8,	52.0,	55.2,	60.0,	63.7,	66.7,	N/A ,
9 hours	17.4,	22.5,	25.1,	28.8,	31.2,	33.1,	38.8,	45.0,	49.0,	54.3,	59.0,	62.5,	67.8,	71.8,	75.0,	N/A ,
12 hours	19.6,	25.2,	28.0,	32.0,	34.6,	36.6,	42.8,	49.5,	53.8,	59.5,	64.5,	68.2,	73.9,	78.1,	81.6,	N/A ,
18 hours	23.1,	29.4,	32.6,	37.1,	40.0,	42.3,	49.2,	56.6,	61.3,	67.7,	73.1,	77.3,	83.4,	88.1,	91.9,	N/A ,
24 hours	25.9,	32.8,	36.3,	41.2,	44.4,	46.8,	54.3,	62.3,	67.3,	74.1,	80.0,	84.4,	91.0,	95.9,	100.0,	113.6,
2 days	32.6,	40.4,	44.2,	49.6,	53.0,	55.6,	63.6,	72.0,	77.2,	84.2,	90.1,	94.6,	101.2,	106.2,	110.2,	123.6,
3 days	38.3,	46.8,	50.9,	56.7,	60.4,	63.1,	71.6,	80.4,	85.8,	93.1,	99.3,	103.8,	110.6,	115.7,	119.8,	133.4,
4 days	43.5,	52.6,	57.0,	63.2,	67.1,	70.0,	78.8,	88.0,	93.7,	101.2,	107.6,	112.3,	119.3,	124.5,	128.7,	142.5,
6 days	52.9,	63.1,	68.0,	74.8,	79.0,	82.2,	91.8,	101.7,	107.8,	115.8,	122.5,	127.5,	134.9,	140.3,	144.7,	159.1,
8 days	61.5,	72.7,	78.0,	85.3,	89.9,	93.3,	103.6,	114.1,	120.5,	129.0,	136.0,	141.2,	148.9,	154.6,	159.1,	174.1,
10 days	69.6,	81.6,	87.3,	95.1,	99.9,	103.6,	114.5,	125.5,	132.3,	141.1,	148.5,	153.9,	161.9,	167.8,	172.5,	187.9,
12 days	77.3,	90.1,	96.1,	104.4,	109.5,	113.3,	124.8,	136.3,	143.4,	152.6,	160.2,	165.9,	174.1,	180.2,	185.1,	201.0,
16 days	92.1,	106.2,	112.9,	121.9,	127.5,	131.7,	144.1,	156.6,	164.1,	174.0,	182.1,	188.1,	196.9,	203.3,	208.4,	225.2,
20 days	106.1,	121.5,	128.7,	138.5,	144.5,	149.0,	162.2,	175.5,	183.5,	194.0,	202.6,	208.9,	218.1,	224.8,	230.2,	247.7,
25 days	123.1,	139.9,	147.7,	158.2,	164.7,	169.5,	183.8,	197.9,	206.4,	217.5,	226.6,	233.3,	243.0,	250.1,	255.7,	274.0,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

M5-60: 15.2

Ratio-R: 15.2/55.6
=0.273