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Site Investigation Case study

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1. Introduction

This report presents a preliminary site investigation and geotechnical assessment for a proposed development consisting of a restaurant, ice cream parlour, and manager's apartment, located on the Swansea foreshore. The purpose of this report is to evaluate the ground conditions, identify potential environmental and geotechnical risks, and propose appropriate foundation solutions based on the available data and engineering judgement.

The assessment is based on desk study sources, including geological maps, aerial imagery, and general geotechnical knowledge of coastal environments. No intrusive site investigation has been carried out at this stage; therefore, the conclusions are preliminary and intended to support early design decisions.

2. Site Location and Description

The proposed development site is located along the Swansea foreshore, adjacent to the coastal promenade and existing urban infrastructure. The site is characterised by relatively flat topography, with ground levels approximately between 8 and 10 metres above sea level.



Figure 1: Site location (Google Earth, 2026)

The surrounding area includes a mix of urban development, parking areas, and open coastal frontage. The proximity to the sea is a key factor influencing both ground conditions and environmental risks. The site appears accessible and partially developed, which suggests previous ground disturbance or the presence of made ground.



Figure 2: Detailed aerial view of the proposed site showing site boundaries and surrounding context (Google Earth, 2026).

Due to its coastal location, the site is likely to be affected by marine processes, including tidal variation, saltwater exposure, and potential erosion. This setting has important implications for both soil behaviour and long-term structural performance.

Furthermore, the coastal location increases the likelihood of a shallow and fluctuating groundwater table influenced by tidal cycles, which may result in periodic saturation of the soil profile. This can lead to reduced effective stress, lower shear strength, and more challenging excavation conditions. The presence of marine sediments and potential made ground may also introduce variability in soil composition, including layers of loose sand or soft alluvium. In addition, long-

term exposure to a saline environment may accelerate the deterioration of construction materials, particularly concrete and steel, requiring appropriate design measures such as protective treatments and suitable material selection. These factors highlight the need for careful geotechnical assessment and robust foundation design to ensure durability and structural stability.



Figure 3: Coastal conditions at Swansea foreshore viewed from an elevated position at Meridian Tower (Author, 2026).

Figure 3 illustrates the coastal setting of the site, highlighting its direct exposure to the marine environment. The proximity to the shoreline suggests potential risks related to flooding, groundwater influence and aggressive environmental conditions. The flat topography and visible tidal exposure further indicate a shallow groundwater table, which may affect foundation design.

3. Ground Conditions

Based on regional geological information and a nearby historical borehole record provided by the British Geological Survey (BGS, 1975), the site is interpreted to be underlain by a sequence of superficial deposits overlying bedrock. The borehole data indicates the presence of made ground and variable superficial materials, including sands, silts and clay deposits, which are consistent with typical coastal and estuarine conditions in Swansea. These deposits are likely to be heterogeneous and may vary significantly in strength and compressibility across the site.

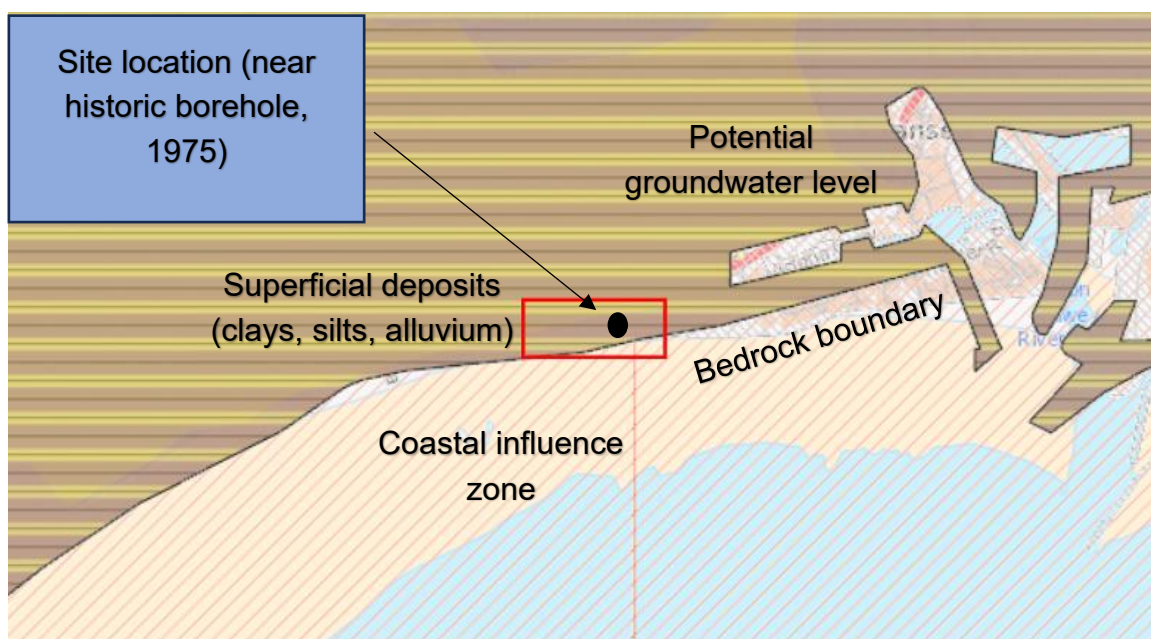


Figure 4: Superficial geological map showing site location (BGS, 2026)

Figure 4 shows that the site is underlain by superficial deposits, likely consisting of fine-grained soils such as clays and silts. These materials are typically compressible and may lead to settlement issues, which is consistent with the conditions identified in the nearby borehole record (BGS, 2026).

The site is underlain by fine-grained soils, including clays, silts and alluvial deposits. These materials are likely to be variable and may range from soft to stiff consistency. Such soils are typically compressible and may present a significant risk of settlement, particularly under structural loading. Differential settlement may occur due to variations in soil properties and the presence of softer zones (BGS, 2026). The presence of groundwater within these deposits may further

reduce soil strength and lead to unstable conditions during excavation. In addition, chemical content such as sulphates may affect the durability of construction materials.

These characteristics suggest that shallow foundations may not be suitable for the proposed development. Such soils are generally variable in composition and may have low to moderate bearing capacity. Fine-grained materials such as silts and clays can be compressible, leading to settlement under load. In contrast, sandy or gravelly materials may provide better drainage but can be prone to instability if loose (BGS, 2026).

The groundwater table is expected to be relatively shallow due to the proximity to the sea. This may significantly affect both soil strength and excavation conditions. High groundwater levels can reduce the effective stress in the soil, resulting in lower shear strength and an increased risk of settlement.

In addition, coastal soils may be affected by weathering processes, including chemical and physical changes, which can further influence their engineering properties. The presence of aggressive chemical agents, such as chlorides and sulphates, should also be considered.

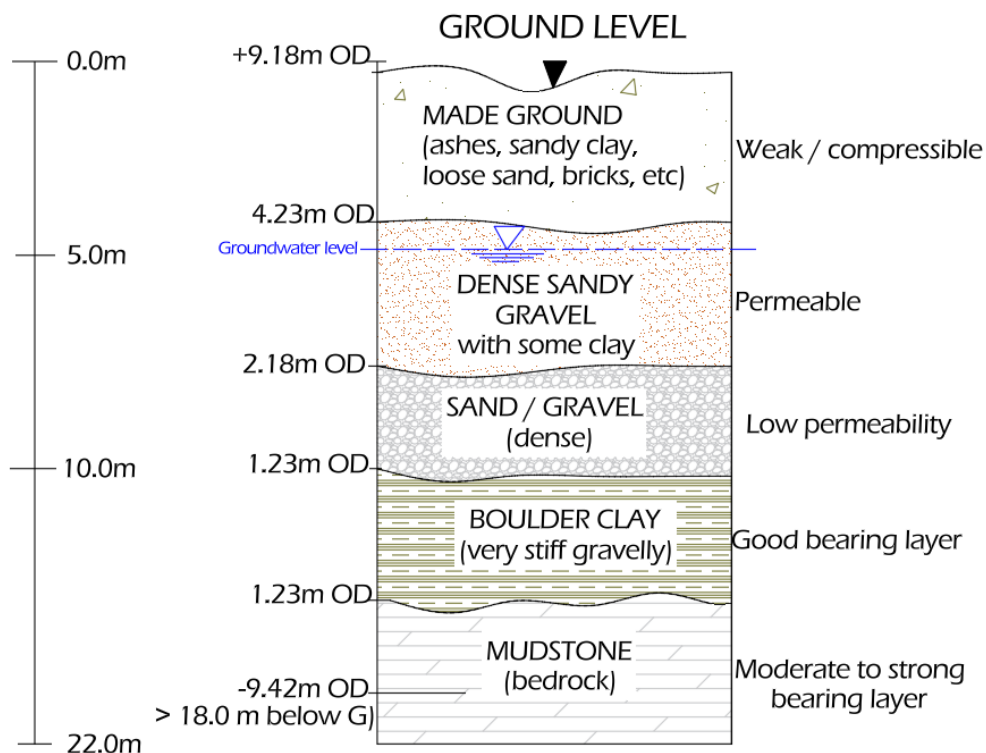


Figure 5: Representative borehole profile showing soil stratification and groundwater level (author's own sketch, adapted from BGS data, 2026)

Figure 5 illustrates the variation in soil layers with depth, highlighting weak superficial deposits overlying more competent strata. The presence of groundwater further supports the need for deep foundation solutions.

To further understand the engineering behaviour of the ground conditions, data obtained from BGS engineering geology datasets is summarised in Table 1 and 2. (See Appendix A and B). Detailed engineering geology characteristics, including foundation implications, are summarised in Appendix C.

Although bedrock provides a competent bearing stratum, its depth and variability make it impractical for direct foundation support. Instead, piled foundations should transfer loads to intermediate dense soils or stiff clay layers to ensure stability and minimise settlement.

Overall, the ground conditions suggest that the site is characterised by weak and compressible superficial soils overlying more competent strata at depth. Detailed borehole data used to interpret the ground conditions is provided in Appendix D.

4. Environmental Considerations

The coastal environment introduces several important factors that need to be considered in the design and construction process. One of the main concerns is the risk of flooding, particularly during storm surges or extreme tidal events. The relatively low elevation of the site increases this risk.

Groundwater conditions also play an important role. A high-water table can create difficulties during excavation and may require dewatering or specialised construction methods. In addition, fluctuations in groundwater levels can affect long-term stability.

Another consideration is the presence of aggressive ground conditions. Coastal environments often contain salts that can affect the durability of concrete and lead to corrosion of reinforcement. This requires the use of appropriate materials and protective measures.

Environmental impact assessments (EIA) may also be required, particularly if the development affects local ecosystems, coastal processes or nearby

infrastructure. Factors such as biodiversity, landscape impact and community considerations should be considered.

5. Geotechnical Risks

Several geotechnical risks are associated with the proposed site. One of the most significant is settlement, particularly where the underlying soils are compressible. Differential settlement could lead to structural damage if not properly controlled.

Groundwater-related issues are also important. High groundwater levels can reduce soil strength and make foundation construction more difficult. There is also a risk of water ingress into structures if appropriate waterproofing measures are not provided.

Another potential risk is soil variability. Coastal and made ground conditions can be highly variable, leading to unpredictable behaviour under load. This increases the importance of carrying out a detailed site investigation.

Chemical attack is an additional concern. The presence of sulphates and chlorides can lead to the deterioration of construction materials over time, particularly concrete and steel.

Finally, there is a potential risk of erosion or long-term ground movement due to coastal processes. This should be considered in the overall design strategy.

6. Foundation Recommendations

Based on the anticipated ground conditions and associated risks, the use of deep foundations is likely to be the most appropriate solution for this development.

Piled foundations are recommended, as they can transfer structural loads through weaker superficial soils to more competent underlying strata. This reduces the risk of excessive settlement and improves overall stability.

Different types of piles may be suitable depending on site conditions. Driven precast concrete piles offer high load capacity and durability, while bored piles may be more appropriate where vibration needs to be minimised.

The depth of the piles will depend on the thickness of the weak soils and the level at which competent bearing strata are encountered. In similar coastal environments, pile depths may range from approximately 10 to 20 metres; however, this should be confirmed through site investigation.

Pile caps would be used to distribute loads from the superstructure to the piles. The design should also consider durability requirements due to the aggressive coastal environment.

Shallow foundations may only be considered if ground improvement techniques are implemented and soil conditions are proven to be adequate. However, this is less likely given the expected variability and groundwater conditions.

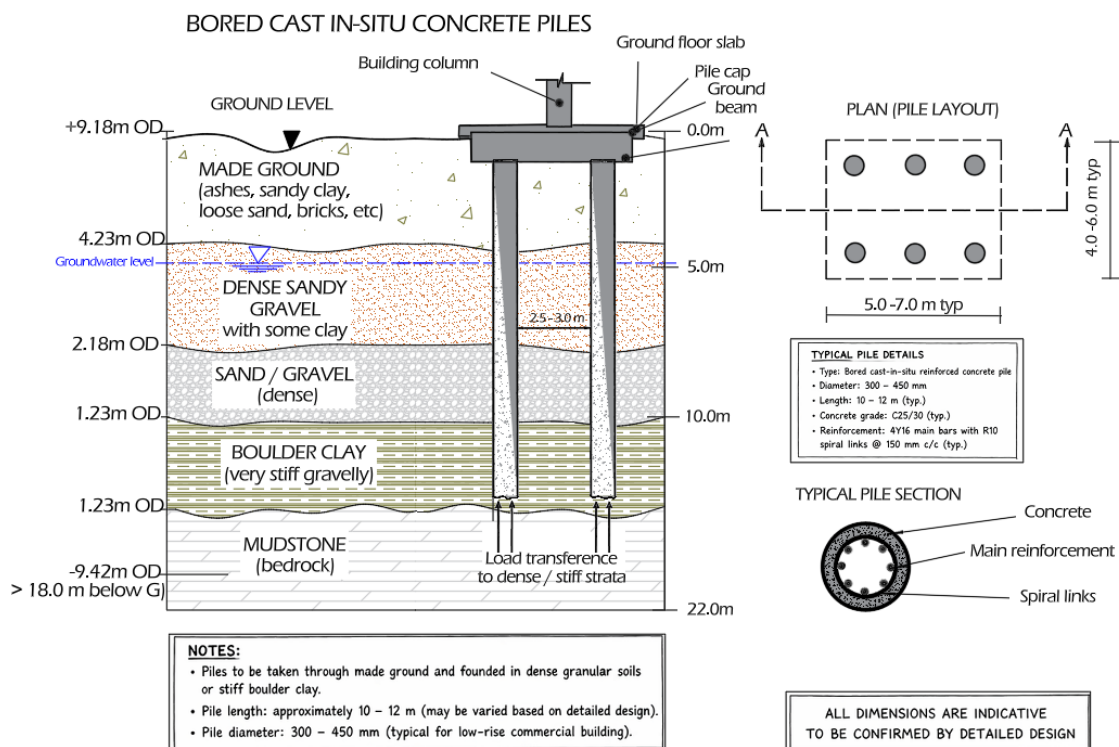


Figure 6: Schematic representation of a bored cast-in-situ reinforced concrete pile system illustrating load transfer from superstructure elements through made ground and weak soils to deeper competent strata (author's own sketch Interpretation based on lecture material, 2026).

Figure 6 illustrates a bored cast-in-situ reinforced concrete piling system selected based on the available borehole data. The ground investigation indicates the presence of made ground and loose granular soils in the upper layers, which provide insufficient bearing capacity for shallow foundations. As a result, a deep

foundation solution is required to safely transfer structural loads to deeper, more competent strata.

The piles extend through weak and compressible layers and are founded within dense granular deposits or stiff clay, as identified in the borehole profile. Load transfer occurs primarily through end-bearing at the pile toe, with additional contribution from shaft friction depending on the surrounding soil conditions. This combination improves the overall load-carrying capacity of the foundation system and enhances its performance under variable ground conditions.

This approach reduces the risk of excessive or differential settlement associated with heterogeneous soils and the presence of groundwater. It also provides greater reliability in terms of long-term structural performance, particularly in a coastal environment where ground conditions may change over time.

The selection of bored piles is also appropriate where vibration and noise need to be minimised, especially in proximity to existing infrastructure. This method allows for greater control during construction and is suitable for sites with restricted access or sensitive surroundings.

A detailed version of the proposed piled foundation system is provided in Appendix E to enhance clarity and allow for a clearer interpretation of the structural arrangement and load transfer mechanism. The enlarged schematic illustrates the relationship between the superstructure, pile elements and underlying soil strata, including the transition through made ground and weak superficial deposits into more competent layers at depth. This additional detail supports the justification of the selected foundation solution based on the interpreted ground conditions and borehole data.

This solution is consistent with the borehole data and the requirement to transfer loads to competent strata, as illustrated in Appendix F.

7. Conclusion

- a. The analysis of the proposed site at Swansea foreshore indicates that the ground conditions are characterised by variable and potentially weak superficial deposits, including made ground and fine-grained soils such as clays, silts and alluvial materials. These soils are generally compressible and may present a significant risk of both total and differential settlement under structural loading.
- b. The presence of a shallow groundwater table, influenced by the site's coastal location and tidal variation, further reduces soil strength and may lead to instability during excavation. In addition, the potential presence of aggressive chemical agents such as sulphates and chlorides may affect the long-term durability of construction materials.
- c. Although more competent strata, such as dense sand, gravel and stiff boulder clay, are present at depth, their variability and depth, together with the presence of made ground, suggest that shallow foundations are unlikely to be suitable for this development.
- d. Therefore, piled foundations are recommended as the most appropriate solution, allowing structural loads to be transferred to deeper, more competent strata while minimising settlement risks. A detailed intrusive site investigation, including site-specific borehole data, is required to confirm ground conditions, groundwater levels and the depth of suitable bearing strata prior to final design.

8. References

British Geological Survey (BGS) (2026) GeoIndex Onshore. Available at: <https://mapapps.bgs.ac.uk/geoindex/home.html> (Accessed: 30 April 2026).

British Geological Survey (BGS) (1975) Borehole Record SS69SE345 (Paxton Street, Swansea). Available via: GeoIndex Onshore (Accessed: 30 April 2026).

British Geological Survey (BGS) (2026) Engineering geology datasets and superficial deposits data. Available via: GeoIndex Onshore (Accessed: 30 April 2026).

Nantel, A. (2026) Foundations. University of Wales Trinity Saint David

9. APPENDICES

Appendix A: Summary of superficial engineering geology conditions (BGS, 2026).

Appendix B: Summary of bedrock engineering geology conditions (BGS, 2026)

Appendix C: Supporting Engineering Geology Data

Appendix D: Historical borehole record provided by the British Geological Survey (BGS, 1975) Sequence

Appendix E: Detailed schematic of proposed piled foundation system (Author's sketch, 2026)

Appendix F: Bored Cast-in-Situ Pile Foundation System and Construction

APPENDIX A - Table 1: Summary of superficial engineering geology conditions (BGS, 2026)

Superficial Engineering Geology

Name	Description	Foundations	Excavation	Engineered Fill	Site Investigation
Fine Soil	Very soft to very stiff sometimes sandy CLAY or SILT. Desiccation of top few metres may result in firm to stiff material overlying soft to very soft deposits at depth. Generally very low to moderate permeability flow dominantly through fissures. Includes lacustrine deposits, glaciolacustrine deposits, fine marine deposits, estuarine alluvium and lowland river alluvium (any of which may contain peat beds or lenses) and loess/loessic soils.	Variable foundation conditions, dependant on shear strength and consolidation characteristics. Settlement rates usually slow but with potentially high total settlements. Possible foundation design considerations may include the potential risk of severe differential settlements in soft, highly compressible zones the potential for sudden collapse of loessic deposits when saturated under engineering loads potentially high sulphide contents of some estuarine alluvium and frost-susceptibility of near surface silty and fine sandy lithologies.	Easy digging. Excavations usually require immediate support but stiff clays may be stable in short-term where groundwater ingress is controlled or absent. Running conditions may occur in silts and sands below the water table presence of water-bearing sand/silt layers will require groundwater control measures.	May be suitable as selected cohesive fill depending on grading, plasticity, water content and sulphate/sulphide contents where buried concrete and steel are likely to be used otherwise suitable as general cohesive fill. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet. Material containing a significant proportion of organics, such as some alluvium, are unsuitable as fill.	Important to determine lithological variability and the presence, depth and extent of any soft compressible zones (and depth to sound strata). Assessment of shrink-swell potential and sulphate/sulphide contents in clay deposits and the potential for rapid collapse settlement in loessic deposits is advisable. In situ loading tests advisable to assess bearing strength at selected sites.

As shown in Table 1, the superficial deposits consist predominantly of fine-grained soils such as clays and silts. These materials are typically compressible and exhibit low permeability, which can lead to poor drainage conditions and increased risk of settlement. The variability in consistency, ranging from soft to stiff, indicates that ground conditions may be highly heterogeneous across the site.

APPENDIX B - Table 2: Summary of bedrock engineering geology conditions (BGS, 2026)

Bedrock Engineering Geology

Name	Description	Foundations	Excavation	Engineered Fill	Site Investigation
Madstone	Very weak to medium strong usually fissured MUDSTONE. Weathers to a firm to stiff silty clay generally within 2-6 m of ground surface highly weathered mudstone clasts in a silt/clay matrix may occur to depths of 10-15 m. Generally low permeability, higher permeability in fissured near-surface material flow dominantly through discontinuities. Includes SILTSTONE and calcareous types.	Generally good foundation conditions, depending on nature and thickness of the weathered zone. In open excavations, foundation levels in moisture susceptible mudstones need protection to prevent rapid deterioration. In some strata potentially high sulphate/sulphide contents and/or shrink-swell movements need to be accounted for in foundation design.	Weathered mudstones may be excavatable by hard digging but ripping may be required at depth or for major excavations. Base of excavations may heave on the removal of overburden in wet conditions. Excavated slopes in fresh or slightly weathered material are often stable in short to medium term weathered and/or fissured mudstones may require immediate support.	Suitable as general granular fill and certain types of selected granular fill if placed under controlled compaction conditions. Should generally be subject to minimum construction traffic when wet. Where present, pyrite-rich material may oxidise and produce acidic, sulphate-rich conditions, which should be accounted for where buried concrete and steel are used	Important to determine in situ variability in lithology and properties, including depth and nature of the weathered zone. In situ loading tests advisable to assess bearing strength at selected sites. Assessment of shrink-swell potential and sulphate/sulphide contents highly advisable
Strong sandstone	Medium strong to extremely strong medium to widely jointed thinly to thickly bedded fine to coarse-grained SANDSTONE may contain slate or mudstone and siltstone beds. Weathers to a loose to very dense sand, gravel or silty/clayey sand. Low to high permeability flow is through matrix and discontinuities. Includes GREYWACKES.	Usually very good foundation conditions, depending on nature and thickness of the weathered zone.	Highly weathered rock may be excavatable by hard digging . In fresher material ripping or blasting is required depending on joint/bedding spacing and orientation. Where fresh to slightly weathered excavated slopes may maintain long-term stability.	Suitable as selected granular fill if care is taken in selection and abstraction.	Site Investigation: Important to determine intact rock strength, spacing, orientation and nature of discontinuities (including water flows) and nature/depth of weathered zone materials.

APPENDIX C - Table 3: Summary of bedrock engineering geology conditions (BGS, 2026)

Engineering Geology Formation Study Reports

Formation	Description	References
Coal Measures	The Coal Measures Supergroup contains the Scottish Coal Measures Group, Pennine Coal Measures Group, and South Wales Coal Measures Group. Coal measures comprise a complex sequence of interbedded sandstone, mudstone, siltstone and coal.	F G Bell; D C Entwisle; M G Culshaw. 1997. A geotechnical survey of some British Coal Measures mudstones, with particular emphasis on durability. ENGINEERING GEOLOGY -AMSTERDAM- 46, no. 2, (1997): 115-130.
	Engineering hazards frequently occur associated with former coal mining activities. These include underground voids, ground gas migration, acid mine drainage, ground settlement, potentially aggressive ground conditions associated with high sulphate/sulphide contents and large volumes of made ground (colliery spoil).	D. C. Entwisle. The swelling characteristics of weathered coal measures mudrocks from Sydalit near Wrexham, Clwyd, Wales : British Geological Survey, Engineering Geology Series, Technical Report WN/89/8, 1989 - [iv], [41]p:ill

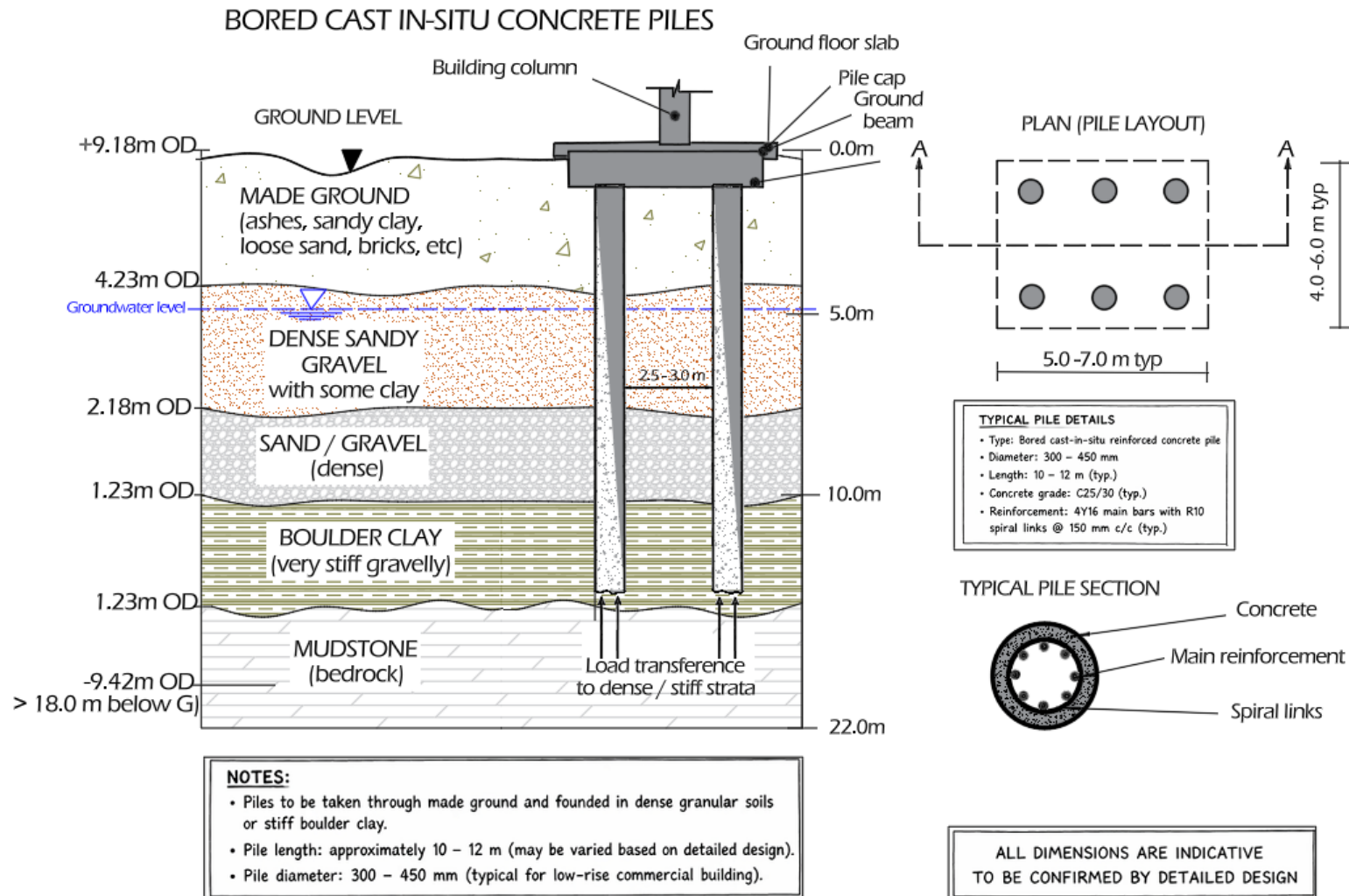
APPENDIX D: Borehole Log Data (BGS, 1975)

DRILLING METHOD Percussion 200 mm dia. to 15.0 m "Open hole" rotary drilling from 15.0 m to 22.0 m		GROUND LEVEL + 9.18 m O.D.		GRID REFERENCE SS 65399228 SS69SE 345		BOREHOLE NUMBER 2	
MACHINE Dando "Investigator"		CORE BARREL AND BIT DESIGN		ORIENTATION Vertical		SITE PROPOSED NEW COUNTY HALL PAXTON STREET SWANSEA	
SOIL SAMPLES DEPTH AND TYPES		DRILLING AND CASING PROGRESS		WATER RECOVERY % AND Q.M. LEVEL		R. Q. D.	
						CORE RECOVERY % AND SIZE	
						DESCRIPTION OF STRATA	
						THICKNESS	
						O.S. LEVEL	
						SYMBOL LOG	
1.00 P N= 8 1.50 P N= 6 3.00 P N= 9 4.00 P N= 75 for 150 mm 5.00 P N= 105 for 225 mm 6.00 P N= 75 for 150 mm 7.00 P N= 77 8.00 P N= 34 9.00 P N= 67 10.00 P N= 63		5.2.75 6.2.75 7.2.75 8.2.75 9.2.75 10.2.75 11.2.75 12.2.75 13.2.75 14.2.75 15.2.75 16.2.75 17.2.75 18.2.75 19.2.75 20.2.75 21.2.75 22.2.75				0.50 0.50 1.00 1.05 0.95 1.45 4.23 2.05 2.18 0.95 1.23 3.05	
						MADE GROUND consisting of ashes. MADE GROUND consisting of loose, light grey fine-medium sand. MADE GROUND consisting of grey sand with layers of soft sandy clay. MADE GROUND consisting of soft red-brown sand clay with brick shale. MADE GROUND consisting of dense bricks, ashes, sand and clay. Very dense brown sandy GRAVEL with traces of sandy clay. Very dense brown SAND with some gravel. Stiff grey-brown gravelly BOULDER CLAY	
						Borehole continued to 22.0 m.	
REMARKS Borehole drilled by STRATA SURVEYS Ltd Cheshire. P = Standard Penetration Test N = Number of blows for 300 mm (unless otherwise stated)				Scale 1:50 Water a.m. level Borehole chiselled from 4.0 m to 15.0 m		Sheet 1 of 3	
WEST GLAMORGAN COUNTY COUNCIL				COUNTY ENGINEER AND SURVEYOR'S DEPT.			

BGS ID: 370246 : BGS Reference: SS69SE345

SITE PROPOSED NEW COUNTY HALL PAXTON STREET SWANSEA				SHEET 2 OF 3		BOREHOLE NUMBER 556986 315 2		
SOIL SAMPLES DEPTH AND TYPES	DRILLING AND CASING PROGRESS	WATER RECOVERY % AND O.M. LEVEL	R.Q.D.	CORE RECOVERY % AND SIZE	DESCRIPTION OF STRATA	THICKNESS	O.D. LEVEL	SYMBOLIC LOG
11.00 P N=75 for 150mm	6.2.75 7.2.75				11.00		-1.82	
12.00 P N=75 for 150mm	7.2.75 10.2.75				Very stiff grey gravelly BOULDER CLAY			
13.00 P N=75 for 150mm								
14.00 CP N=75 for 75mm								
15.00 CP N=105 for 150mm	10.2.75 11.2.75					7.60		
16.50 CP N=75 for 150mm								
18.00 CP N=75 for 150mm	11.2.75 12.2.75				18.60	-9.42		
"Open hole" drilling due to pebbles falling in hole - coring not possible.					Grey MUDSTONE (Driller's description)	3.40 (penetrated)		
REMARKS P = Standard Penetration Test CP = Standard Penetration Test - solid cone N = Number of blows for 300 mm (unless otherwise stated) Borehole continued to 22.00m								
WEST GLAMORGAN COUNTY COUNCIL COUNTY ENGINEER AND SURVEYOR'S DEPT.								

APPENDIX E - Figure 7: Detailed schematic of proposed piled foundation system (Author's sketch, 2026)



APPENDIX F - Figure 8: Typical bored cast-in-situ pile foundation system including pile layout and construction sequence (based on lecture material and BGS data, 2026)

