

1. Introduction

This preliminary geotechnical report has been prepared for a proposed new residential development located on Church Street, Castleford, WF10 1ES, United Kingdom. The report is based on publicly available data, including terrain and flood risk information, as well as summarised data derived from open Digital Elevation Model (DEM) sources. The objective of this report is to provide an initial assessment of the geotechnical conditions at the site, which will inform the design and construction processes for the proposed development.

The terrain data indicates an approximate site elevation of 18.4 m, with a local elevation range of 4.7 m, while the flood risk assessment categorises the site within Flood Zone 2, indicating a medium risk level. It is important to note that the flood risk data is based on test datasets and should be validated with the Environment Agency Flood Map for Planning data for more accurate flood risk assessment. This report aims to serve as a foundational document for further geotechnical investigations and analyses as the project progresses.

2. Environmental Setting and Site Description

The site located at Church Street, Castleford, WF10 1ES, is situated within a predominantly urban environment characterized by a mix of residential and commercial developments. The terrain is relatively flat, with an approximate elevation of 18.4 m, and a local elevation variation of 4.7 m observed in the vicinity. The area is likely underlain by superficial deposits typical of the region, which may include clay, silt, and sand, although specific geological data should be obtained through further site investigations. The proximity to existing infrastructure, including roads and utilities, facilitates access to the site, which is essential for construction activities. Vegetation in the area is typical of urban settings, with limited tree cover and landscaped areas, which may influence surface water drainage patterns.

The climate in Castleford is classified as temperate maritime, characterized by moderate rainfall throughout the year. Average annual precipitation is approximately 800 mm, with the wettest months typically occurring in late autumn and winter. Snowfall is infrequent but can occur during winter months, contributing to seasonal variations in soil moisture content. Humidity levels generally range from 70% to 90%, particularly during the summer months. Average temperatures range from 1°C in winter to 20°C in summer, which can affect soil properties and behaviour. The combination of these climatic factors, along with the site's elevation and proximity to water bodies, necessitates careful consideration of drainage and flood risk management in the design and construction phases of the proposed development.

Site Location Maps

The maps below show the approximate site location for general orientation purposes only. The marker indicates the approximate coordinates provided by the user and does not represent a confirmed legal site boundary.

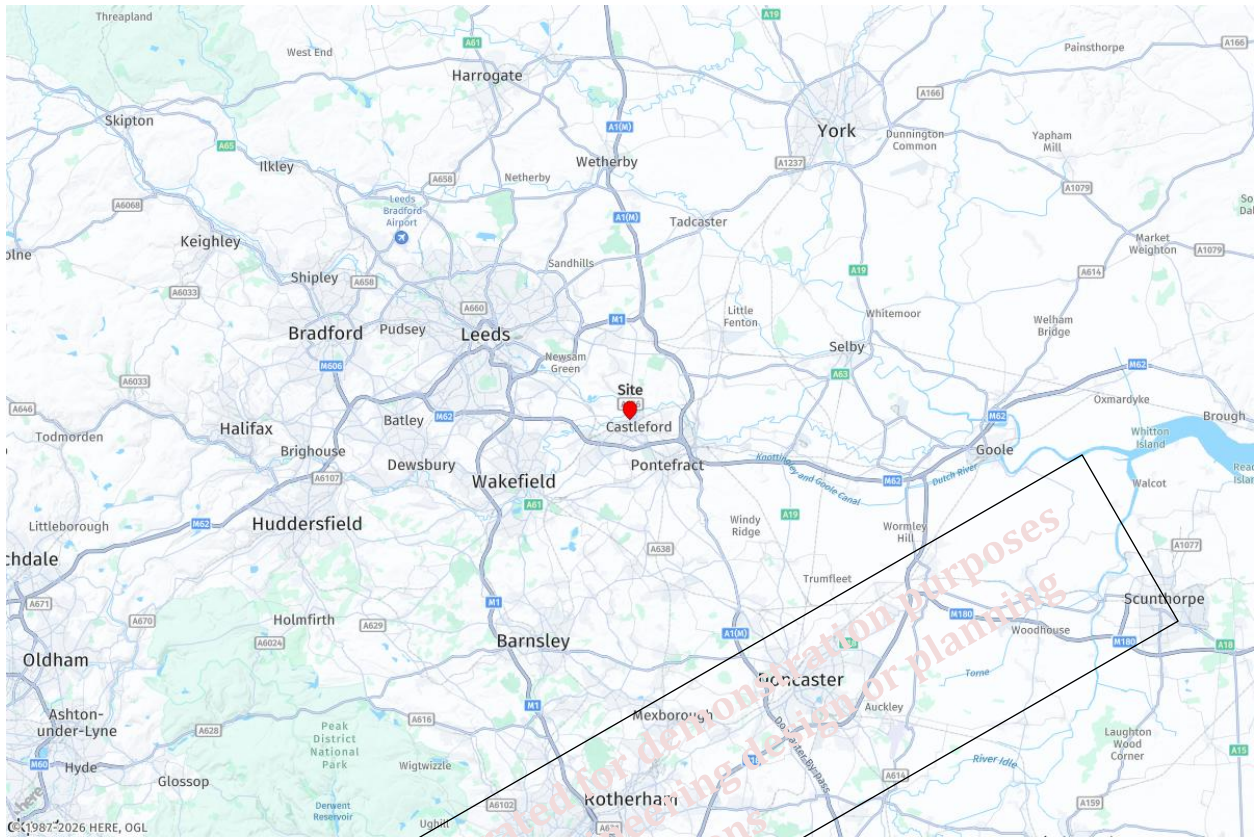


Figure 1. Wider site location map.

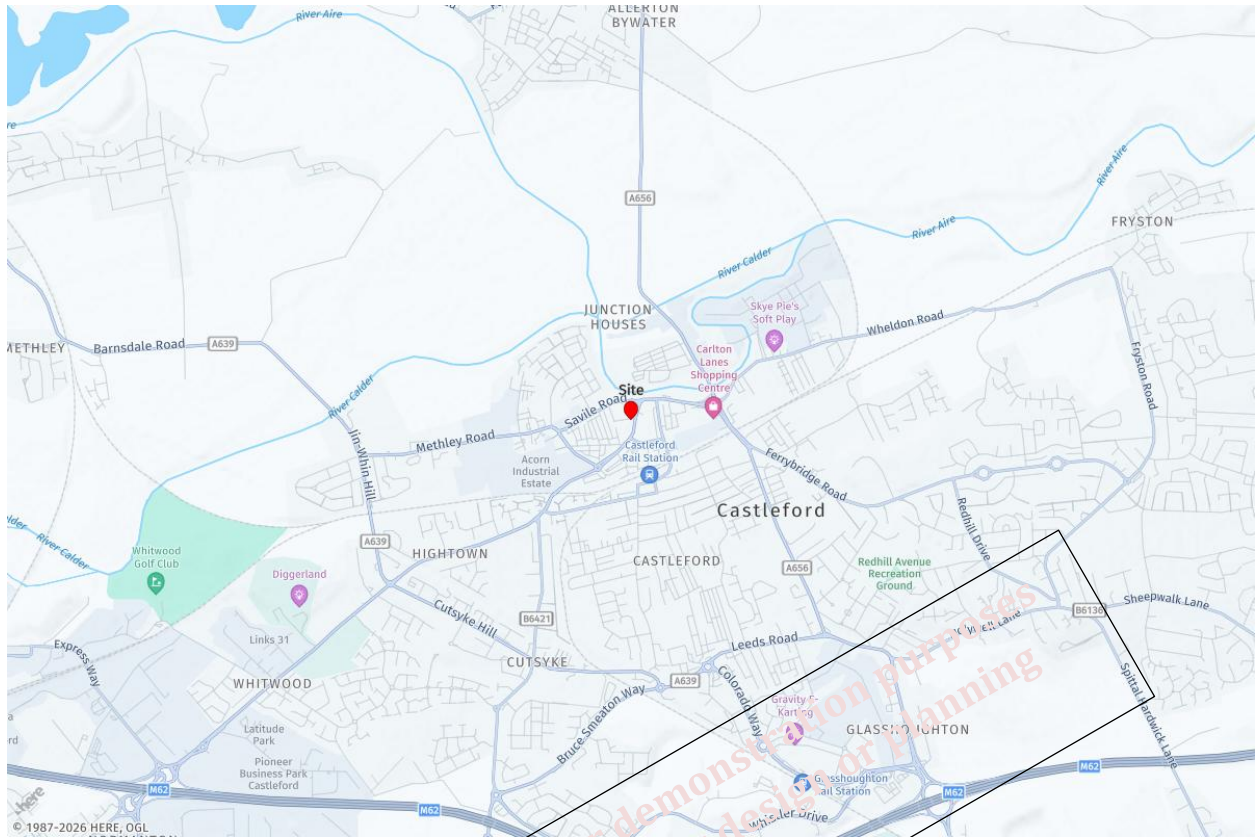


Figure 2. Local site context map.

3. Site History

The site at Church Street, Castleford, WF10 1ES, has a historical context that may influence its geotechnical characteristics. Historically, this area has been part of an urban landscape, likely featuring a mix of residential and commercial developments. Given its location, it is plausible that the site has undergone various phases of construction and land use, including the establishment of roads and utility infrastructure. The presence of nearby urban developments suggests that the land may have been graded or excavated to accommodate these structures, potentially altering the natural soil profile.

There is limited specific historical data available regarding prior excavations or grading directly on the site; however, the urban nature of Castleford indicates that the area may have experienced disturbances associated with construction activities. Such disturbances can affect the bearing capacity and stability of the subsurface materials. Additionally, the potential for historical flooding in the region, as indicated by the site's classification within Flood Zone 2, raises concerns about past water table fluctuations that could have influenced soil conditions, particularly in terms of saturation and consolidation.

While there is no direct evidence of contamination reported for the site, the proximity to urban infrastructure raises the possibility of encountering residual pollutants from

historical land use practices. This necessitates careful consideration during the design and construction phases to mitigate any potential risks associated with soil contamination.

Overall, the historical land use and urban development patterns in Castleford suggest that the site may be disturbed, with implications for subsurface conditions that could affect the geotechnical design and construction of the proposed residential development. Further investigation is recommended to assess the specific geotechnical implications of the site's history.

4. Terrain and Elevation

The site at Church Street, Castleford, WF10 1ES, is characterised by a relatively flat terrain, with an approximate elevation of 18.4 m above sea level. The local elevation data indicates a minimum sampled elevation of 13.7 m and a maximum sampled elevation of 18.4 m, resulting in an approximate local elevation range of 4.7 m. This data, derived from open Digital Elevation Model (DEM) sources, provides a preliminary understanding of the site's topography.

The flat nature of the terrain suggests that significant variations in elevation are not present within the immediate vicinity, which may facilitate construction activities. However, the elevation range indicates that there are minor undulations in the landscape that could influence surface water flow patterns. The elevation data is suitable for initial desktop screening but should be supplemented with detailed site surveys to confirm the topographical characteristics and to inform design considerations for the proposed residential development.

Given the elevation data, it is essential to consider the implications of the site's topography in relation to drainage and flood risk management, particularly in light of the site's classification within Flood Zone 2. Further investigations may be warranted to assess how the terrain interacts with local hydrology and to ensure that the design accommodates any potential surface water runoff effectively.

5. Regional and Site Geology

The regional geology of the area surrounding Church Street, Castleford, WF10 1ES, is characterised by a sequence of sedimentary deposits primarily from the Quaternary period. The predominant lithology includes alluvial and glacial deposits, which are typical of lowland river valleys in the United Kingdom. These deposits are often composed of a mixture of clay, silt, sand, and gravel, reflecting the dynamic depositional environment shaped by historical river activity and glacial movements. The presence of these materials suggests a variable subsurface profile, which may include layers of cohesive and non-cohesive soils that can significantly influence the geotechnical properties of the site.

The geological formations in this region may pose several challenges for the proposed

residential development. The variability in soil composition can lead to differential settlement, particularly if the foundation design does not adequately account for the presence of softer, compressible layers. Additionally, the alluvial deposits may exhibit high moisture content, which could affect the stability of excavations and the performance of shallow foundations. The potential for groundwater fluctuations, especially given the site's classification within Flood Zone 2, necessitates careful consideration of drainage solutions to mitigate risks associated with soil saturation and hydrostatic pressure. Therefore, a thorough geotechnical investigation is essential to characterise the subsurface conditions accurately and inform appropriate foundation design and construction methodologies for the new development.

6. Hydrogeology and Groundwater Conditions (estimated)

The hydrogeological conditions at the proposed residential development site on Church Street, Castleford, are influenced by the underlying Quaternary sedimentary deposits, which predominantly consist of alluvial and glacial materials. These deposits typically exhibit variable permeability characteristics, with clay and silt layers likely to impede groundwater movement, while sand and gravel layers may facilitate more rapid drainage.

Based on the geological context, it is anticipated that the groundwater table may be encountered at depths ranging from 1.5 m to 3.0 m below the surface, although this can vary significantly depending on local hydrological conditions and seasonal fluctuations. Seasonal variations in groundwater levels are expected, particularly during periods of heavy rainfall or snowmelt, which may lead to temporary rises in the water table. The presence of alluvial deposits, which are often saturated, suggests that groundwater levels may be more elevated during wetter months, potentially impacting construction activities and foundation design.

The interaction between groundwater and the soil types present at the site is critical for the geotechnical design of the proposed development. The presence of high moisture content in the alluvial deposits can lead to challenges such as reduced bearing capacity and increased risk of settlement if not adequately addressed in the foundation design. Furthermore, the potential for groundwater to rise during heavy rainfall necessitates the incorporation of effective drainage solutions to manage hydrostatic pressure and prevent water accumulation around foundations.

In addition, the classification of the site within Flood Zone 2 indicates a medium risk of flooding, which further underscores the importance of understanding groundwater conditions. The design must account for potential groundwater ingress during construction and the long-term performance of the development. Effective drainage systems, including surface water management and sub-surface drainage, will be essential to mitigate the risks associated with groundwater fluctuations and to ensure the stability and longevity of the structures.

Overall, the hydrogeological and groundwater conditions at the Church Street site will significantly influence the geotechnical design and construction methodologies employed for the new residential development. A thorough understanding of these conditions is essential to develop appropriate strategies for foundation design, drainage management, and overall site stability.

7. Soil and Ground Type in The Area

The soil and ground types encountered at the proposed residential development site on Church Street, Castleford, are expected to reflect the regional geological characteristics, primarily comprising Quaternary sedimentary deposits. The uppermost layers are likely to consist of alluvial materials, including clay and silt, which are prevalent in floodplain environments. These fine-grained soils typically exhibit low permeability, leading to potential challenges in drainage and increased susceptibility to saturation during periods of heavy rainfall. Beneath these layers, sand and gravel deposits may be present, providing improved drainage characteristics and higher bearing capacities. The transition from clay and silt to sand and gravel is anticipated to occur at varying depths, potentially between 1.5 to 3.0 meters, aligning with the expected groundwater table. This variability in soil composition necessitates careful consideration in foundation design, as the presence of softer, compressible layers could lead to differential settlement if not adequately addressed.

In terms of geohazards, the site presents several considerations that could impact the proposed development. The presence of saturated alluvial deposits raises concerns regarding reduced bearing capacity, which may necessitate the use of deep foundations or ground improvement techniques to ensure structural stability. Additionally, the medium flood risk classification of the site, as indicated by its location within Flood Zone 2, highlights the potential for groundwater fluctuations that could exacerbate soil saturation and hydrostatic pressure. This necessitates the implementation of effective drainage solutions to mitigate the risk of flooding and ensure the longevity of the development. Furthermore, the variability in soil types and the potential for differential settlement underscore the importance of a comprehensive geotechnical investigation to inform design decisions and construction methodologies.

8. Soil / Ground Properties (inferred)

- Soil Classification (USCS): Predominantly CL (Clay) and ML (Silt) for the upper layers, transitioning to SP (Sand) and GP (Gravel) at greater depths.
- Approximate Undrained Shear Strength Range:
 - Upper layers (clay and silt): 25 to 50 kPa
 - Sand and gravel layers: 50 to 100 kPa
- Estimated Bearing Capacity Range:
 - Shallow foundations on clay and silt: 100 to 150 kPa

- Deep foundations or improved ground conditions: 200 to 300 kPa
- Compressibility:
 - Clay and silt layers: High compressibility, with potential for significant settlement
 - Sand and gravel layers: Low compressibility, providing better stability
- Permeability:
 - Clay and silt layers: Low permeability, potentially leading to saturation
 - Sand and gravel layers: High permeability, facilitating drainage

These values are inferred based on the geological context and should be confirmed through site-specific investigation to ensure accuracy and reliability for design purposes.

9. Geohazards and Environmental Risks

- Liquefaction Potential:

The potential for liquefaction at the site is considered low due to the predominance of clay and silt in the upper layers, which exhibit high plasticity and low permeability. These characteristics reduce the likelihood of pore water pressure build-up during seismic events. However, the underlying sand and gravel layers, while providing good drainage, could be susceptible to liquefaction under certain conditions, particularly if saturated.

- Seismic Hazards:

The site is located in an area with a relatively low seismic risk. However, the presence of sandy and gravelly layers beneath the clay and silt could amplify seismic waves, potentially affecting the stability of structures if not adequately designed. It is essential to consider seismic design parameters in the foundation design to mitigate any potential impacts from seismic activity.

- Erosion or Landslides:

Given the site's topography and soil composition, the risk of erosion is moderate, particularly during heavy rainfall events when the upper layers may become saturated. The low permeability of the clay and silt can lead to surface runoff, increasing the potential for erosion. However, the relatively flat terrain and absence of steep slopes reduce the likelihood of landslides.

- Presence of Expansive Soils:

The clay layers present at the site may exhibit expansive behaviour, particularly when subjected to moisture fluctuations. This characteristic can lead to significant volume changes, which may impact the structural integrity of foundations if not properly accounted for in the design phase.

- Contaminated or Disturbed Ground:

There is no specific historical data indicating that the site has been previously used for industrial purposes; however, a thorough investigation is recommended to assess the potential for contamination. If the site has been disturbed or previously developed, there may be risks associated with contaminated soil or groundwater, necessitating appropriate remediation measures before construction.

The assessment of these geohazards and environmental risks is crucial for the successful design and construction of the proposed residential development. A comprehensive geotechnical investigation, including soil sampling and laboratory testing, is recommended to further evaluate these risks and inform appropriate mitigation strategies.

10. Preliminary Geotechnical Recommendations

- Shallow footings are likely suitable for the proposed residential development, particularly in areas underlain by the Pennine Middle Coal Measures Formation, which exhibits moderate to high bearing capacities (500–2000 kPa). However, careful assessment of weathering effects on the mudstone and siltstone layers is essential, as these materials may weather to clay and exhibit potential for swelling.

- For areas where the underlying geology consists of Paleozoic sedimentary rocks or the Cadeby Formation, which require further investigation, it is recommended to conduct a detailed site investigation to ascertain the material properties and bearing capacities. Depending on the findings, alternative foundation solutions such as piles or caissons may be necessary.

- Subgrade preparation should include the removal of any unsuitable materials, particularly in areas where clay may expand with moisture changes. Ground improvement techniques, such as soil stabilisation or the use of geogrids, may be required to enhance the load-bearing capacity and reduce settlement risks.

- Excavation considerations must account for the potential for slope instability, particularly in areas with clay-rich soils. Proper shoring and bracing techniques should be employed during excavation to ensure safety and stability.

- Groundwater control measures will be necessary, especially given the low permeability of the upper clay and silt layers, which may lead to saturation issues. Installation of drainage systems or sump pumps may be required to manage groundwater levels during construction.

- Construction constraints may arise from the presence of weathered materials and the

potential for swelling in clay-rich zones. It is crucial to monitor moisture conditions and implement appropriate construction techniques to mitigate these risks.

These recommendations are preliminary and must be verified by a detailed intrusive geotechnical investigation to ensure the suitability of the proposed foundation solutions and to address any site-specific conditions.

11. Further Investigations Required

- Conduct a series of boreholes across the site to a depth of at least 5.0 meters to obtain continuous soil samples. Borehole spacing should be approximately 10 to 15 meters apart to ensure adequate coverage of the site's variability.
- Perform Standard Penetration Tests (SPT) at each borehole location to assess the in-situ density and strength of the soil layers. SPT should be conducted at regular intervals, ideally every 1.0 meter, to capture variations in soil properties.
- Implement Cone Penetration Testing (CPT) to provide continuous profiles of soil resistance and stratigraphy. CPT should be performed at selected borehole locations to complement SPT data, with spacing similar to that of the boreholes.
- Undertake laboratory testing on collected soil samples, including:
 - Triaxial tests to determine the shear strength parameters of the clay and silt layers, which are critical for foundation design.
 - Consolidation tests to evaluate the compressibility and settlement characteristics of the clay and silt deposits.
 - Atterberg limits tests to assess the plasticity and moisture content characteristics of the clay and silt, which will inform potential expansion and shrinkage issues.
- Conduct groundwater monitoring to establish the seasonal fluctuations of the water table, which is essential for understanding hydrostatic pressures and drainage requirements.
- Evaluate the potential for contamination through soil sampling and analysis, particularly in areas with historical urban activity. This may include tests for heavy metals, hydrocarbons, and other pollutants.
- Consider geophysical surveys, such as electrical resistivity or ground-penetrating radar, to provide additional insights into subsurface conditions and identify any anomalies that may not be captured through boreholes.

It is essential that the investigation be tailored based on budget constraints and the specific design stage of the project to ensure that all relevant geotechnical parameters are accurately assessed.

12. Names of potential contractors for further investigation

The following are potential contractors for further geotechnical soil and ground investigations in proximity to Church Street, Castleford, WF10 1ES, United Kingdom:

Check BGA website.

13. Glossary

Abutment: A structure that supports the ends of a bridge or a similar structure, often built on the banks of a river or at the edge of a roadway.

Atterberg Limits: A series of tests used to determine the plasticity characteristics of fine-grained soils, specifically the liquid limit, plastic limit, and shrinkage limit, which help in understanding soil behaviour under varying moisture conditions.

Borehole: A deep, narrow hole drilled into the ground to obtain soil samples for geotechnical investigation.

Cone Penetration Testing (CPT): A method of in-situ testing that involves pushing a cone-shaped penetrometer into the ground to measure soil resistance, providing a continuous profile of soil stratigraphy and strength.

Flood Zone 2: An area at risk of flooding, defined by the Environment Agency, where the likelihood of flooding is between 1 in 100 and 1 in 1000 years.

Geophysical Surveys: Techniques used to investigate subsurface conditions without drilling, often employing methods such as seismic, resistivity, or electromagnetic surveys to identify anomalies in soil and rock layers.

Groundwater Monitoring: The process of observing and measuring the levels and quality of groundwater over time to assess its impact on soil stability and construction.

Laboratory Tests: Controlled tests conducted on soil samples to determine various physical and mechanical properties, including shear strength, compressibility, and moisture content.

Standard Penetration Test (SPT): A widely used in-situ test that measures the resistance of soil to penetration by a standard sampler, providing information on soil density and strength.

Soil Sampling: The process of collecting soil specimens from various depths and locations to analyse their physical and chemical properties, essential for assessing contamination and suitability for construction.

Subsurface Anomalies: Irregularities or variations in the soil or rock layers beneath the surface that may affect construction, such as voids, buried structures, or changes in material properties.

Triaxial Test: A laboratory test used to determine the shear strength of soil under controlled conditions of confining pressure, providing valuable data for foundation design.

Water Table: The upper surface of the zone of saturation in the ground, where soil pores are fully filled with water, which can fluctuate seasonally and impact soil stability.