Holburn Hill, Millom

Proposed Housing

Geotechnical Report

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1.0 INTRODUCTION

Mr. Joe English (JE) proposes to develop a site off Holburn Hill in Millom, with seven traditional detached houses. However, several of the plots have been sold for self-build developments.

JE has appointed M & P Gadsden Consulting Engineers (MP) as the structural engineers for the scheme, and they have appointed GroundSolve Ltd (GSL) on behalf of JE to undertake a desk study and site investigation at the site.

The site lies within a backfilled quarry, consequently, the desk study and site investigation have identified the edge of the quarry and the nature of the backfill material and presents geotechnical recommendations for the development of the site.

However, this commission did not include any chemical testing or environmental risk assessments, as it is understood these issues have already been agreed with the Local Authority.

2.0 THE SITE

2.1 Site Location and Description

The site is located to the north of Holborn Hill, Millom, at National Grid Reference SD 168 804, see Figure 1.

It is bounded by Holborn Hill to the south, with Pannett Hill to the east and north of the site, and existing housing to the west, see Figure 2.

The site is some 80m long and up to 60m wide and covers an area of 0.34 ha. A topographical survey of the site has been supplied by JE, which shows the site to be fairly flat, at an elevation of just over 25mAOD. However, it also shows a mound in the northwestern section of the site, which corresponds to a stockpile of quarry spoil, which has since been spread across the site.

The site is accessed from a gate on the southern section of the site off Holburn Hill. However, Pannett Hill rises in a northerly direction to an elevation of 31mAOD on the northern site boundary.

The north western, northern and northern eastern sides of the site are surrounded by old quarry faces, much of which is overgrown. There is a blockwork wall on the northern site boundary, with a steel lintel at the top supporting the pavement above. The remainder of the site is bounded by stone/blockwork walls, although these have been demolished on the eastern site boundary to make way for the new site access.

Photographs of the site are presented in Appendix A.

2.2 Geology and Hydrogeology

The geology of the site has been studied on the following sources:

- 1:50,000 scale geology plan, Sheet 48,
- Geology of the country around Ulveston edited by BGS.

The geology plan shows the site to be underlain by glacial till (Clay) overlying the Brathay Formation, which is Silurian in age, and comprises laminated silty mudstone, with occasional bentonite beds.

An anticline (bowl shaped structure) is shown crossing the centre of the site trending in a NE to SW direction. To the north of the anticline the bedding is shown dipping at 30° in a NNE direction.

Nearby borehole information obtained from the BGS website on a site on Horn Hill, some 80m south of the site, encountered glacial till, described as firm, brown red clay, changing to very soft, silty clay, on encountering groundwater, before becoming a firm to stiff, brown red

boulder clay to a depth of 6.10m. A second borehole 120m south west of the site, recorded firm, brown red clay, passing to firm, red brown, boulder clay to depth of 6.30m. The borehole logs and their locations are presented in Appendix B.

The bedrock deposits are classified as a Secondary Aquifer – B, these are mainly lower permeability layers that may store and yield limited amounts of groundwater through fissures and openings or eroded layers.

The superficial deposit are classified as a Secondary Aquifer –Undifferentiated, this is where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type.

Groundwater flows would be anticipated to be in a southerly direction, within the shallow bedrock following the topography.

2.3 History

The history of the site has been studied on old 1:2,500 scale Ordnance Survey (OS) plans, dating from 1862, unless stated otherwise, and recent aerial photographs.

The 1862 OS plan shows the site to be largely in open fields, with a small quarry in the northern section of the site. A road had already been constructed on the southern site boundary and several buildings are located along the road, with a Public House opposite the site, see Figure 3a. Spot heights on the road on the southern site boundary show it to be falling in a easterly direction towards Millom. Some 160m north of the site another quarry is shown. The 1:10,560 scale OS plan dated 1867, confirms the Whitehaven and Furness junction railway had been constructed to the south of the site.

By the 1899 OS plan the quarry had been expanded to cover most of the site, with a small building present on the southern site boundary. However, it appears that the quarry is now flooded and full of water, whilst the quarry to the north also contains standing water. The road on the southern site boundary was now called Holburn Hill, with Bay View road on the eastern site boundary and Pannet Hill on the northern side. The site is now surrounded by residential development, although a Methodist Chapel had been constructed to the north of the site, and the Public House to the south is called the Ship Inn, see Figure 3b.

On the 1924 OS plan the site is referred to as "Holbornhill quarry (disused)". It appears to be slightly larger than on the 1899 OS plan. In the surrounding area the only changes were the addition of several more buildings, the quarry to the north is no longer shown, and is assumed to have been backfilled, see Figure 3c.

On the 1:10,000 scale OS plan dated 1956 no changes are shown on the site, although additional development had taken place around the site, see Figure 3d.

By the 1968 OS plan the quarry had been backfilled and the site was being used by Cumberland City Council as a Council Depot. Two new buildings had been constructed on site, one on the western site boundary, and one in the south east section of the site. On the west and eastern sections of the site the quarry sides are still visible. The Chapel to the north had been converted into a Bakery, see Figure 3e.

No changes are shown on site on the 1978 to 1984 OS plan, see Figure 3f. New housing had been constructed to the north east of the site.

No changes are shown on site on the 1995 OS maps, see Figure 3g.

An aerial photograph dated 2000 shows the site being used as a Council Depot, with several vehicles parked on the site, see Figure 3h.

No changes are shown on site on the 2006 and 2018 OS plans at 1:10,000 scale, see Figure 3i and 3j. In addition, no changes are shown on aerial photographs dated between 2001 and 2014.

Recently, JE has broken out the bedrock on the eastern site of the site and used this material to spread around the site to provide a cover system in the gardens.

3.0 ENVIRONMENTAL SEARCHES

An Envirocheck report has been obtained for the site, the main points are summarised below, and the report presented in full in Appendix C.

Agency and Hydrological

- The BGS have identified a limited potential for groundwater flooding to occur on site,
- There are no discharge consents within 500m of the site,
- The closest water feature is some 432 north west of the site,
- There are no LAPPC within 500m of the site,
- The closest recorded pollution incident to controlled water is 624m north west of the site, which was a Category 2 – Significant incident,
- There are no water abstractions within 1km of the site,
- The site is not at risk of flooding from rivers without defenses.

Waste

- There are no historic landfills within 500m of the site,
- There are no licensed waste management facilities within 500m of the site,
- The closest potentially infilled land (non-water) is 165m north of the site and the potentially infilled land (water) is on site.

Geological

The BGS have presented estimated soil chemistry for the site as follow:

- Arsenic 25-35mg/kg,
- Cadmium < 1.8mg/kg,
- Chromium 60-90mg/kg,
- Lead <100mg/kg,
- Nickel 30-45mg/kg.

In addition, the following geological information is presented:

- The site contains a recorded BGS mineral site 171m north of the site, called Pannet Hill, which was an opencast for clay and shale, another BGS mineral site 302m north east of the site, called King's quarry, which was an opencast for clay and shale,
- In an area that might not be affected by coal mining,
- The site is in an area with very low hazard for collapsible ground,
- There is no hazard for compressible ground on the site,
- There is no dissolution hazard,
- There is a very low hazard for land sliding,
- The potential for running sand is very low on the site,
- There is a very low hazard for shrinking or swelling clay,

- The site is in a low probability radon area as less than 1% of homes are estimated to be above the action level,
- Therefore, no radon protection measures will be required in the construction of new dwellings or extensions.

Industrial Land Use

- The closest fuel station entry is 313m south east of the site, which is also the closest industrial land use.

Sensitive Land Use

- The site is not affected by any environmentally sensitive land uses.

4.0 PROPOSED DEVELOPMENT

MHL propose to develop seven detached dwellings off Holborn Hill in Millom. The proposed development layout is presented on Figure 4.

At present foundation loads have not been provided, but based on experience of similar schemes, foundation loads are likely be between 50 to 75kN/m run, with floor slab loadings not exceeding 5kN/m².

However, floor slab levels range between 25.90mAOD for Plot 1 to 26.50mAOD for Plot 5, see Figure 4. Based on current ground levels the ground levels will need to be raised slightly.

The recommendations presented in this report are based on these assumptions and should be reviewed, and if necessary revised during the detailed design process.

However, several of the plots (1, 3, 4 and 6) have already had raft foundations designed for them, by Brian Bleasdale Ltd (BBL), see Appendix D, on behalf of JE in 2018. Apparently based on trial hole information an allowable bearing pressure of 40kN/m² was assumed in the design, although the actual bearing pressure was calculated as 25.7kN/m². However, the trial pit information was not presented. The rafts were also designed to span a soft spot of 3m and to cantilever 1.5m at its edge.

5.0 THE INVESTIGATIONS

5.1 Previous Reports

In July 2008, Evolution produced an Historic Land Contamination Evaluation Report for the site for Derek Hicks & Thew (Kendal) Ltd. The relevant points are summarised below and the report presented in full in Appendix E.

At the time of the inspection in 2008 the site was reported to be levelled and hard surfaced and being used by the Council as a highway/building materials storage yard. The two buildings on site comprised a small brick building, with tin roof, housing the offices and workshop. The second building was a large brick building, with high bays and open, being a three sided shed.

- No significant contamination was apparent, however, a possibility exists that ground contamination may be present beneath the site,
- It recommended trial pits and boreholes to investigate the risk,
- Samples were taken from shallow trial pits in 2006 proved to be below SGV and ICRCL values at the time,
- Site was considered suitable for residential development,
- The site in 1994 was recorded as accepting:
    - storage and transfer of inert waste, reclaimed material and subsoil and topsoil,
    - storage of materials for highway and building works.
- Building on site was used to store
    - house decorative materials, with a workshop containing paints, electrical tools and a vehicle engine,
    - Scrap metal, mainly old washing machines, although several car batteries were noted.

In addition, several trial pits have been excavated by the owners of the self-build plots, two pits excavated at the back and front of Plot 2 encountered tarmac at a depth of around 1.0m as reported by the plot owner. Whilst in Plot 6 the owner reported encountering rock at the front and back of the property.

5.2 This Investigation

This investigation was undertaken on the 30th May 2018 and comprised seven machine excavated trial pits to a maximum depth of 1.80m. The pits were logged by a chartered engineering geologist from GSL in accordance with BS 5930, Reference 1.

The locations of the trial pits are shown on Figure 4, with the logs presented in Appendix F.

Samples were taken of the made ground on site and taken to the laboratories of ALS in Chester for pH and sulphate determination (2:1 water extract). The results are summarized below and presented in full in Appendix G.

6.0 GROUND CONDITIONS

6.1 General Stratigraphy

The following general stratigraphy was encountered at the site. When discussing the ground conditions, the history of the site is important.

The site is currently largely covered by quarry spoil derived from the breaking up of the remainder of the rock on site, which has then been used to cap the site.

The site was previously a Council Depot, which had a tarmac surfacing within the confines of the rock faces. On abandonment of the quarry the old quarry backfill was covered with what appears to be material derived from local excavations in glacial till.

The tarmac surfacing was encountered in the trial pits within the quarry and abutting the rock face in several trial pits.

TP No	Quarry Spoil (m)	Made Ground (m)	Tarmac (m)	Bedrock (m)	Groundwater (m)
1	0-0.70	0.0-1.30 1.50-1.70	1.30-1.50	0.0	1.30
2	0.00-0.35	0.35-0.95 1.35-1.80	0.95-1.35		0.95
3		0.0-1.80			1.70
4	0.0-0.95/1.30	1.40-1.80	1.30-1.40	0.5	1.40
5	0.0-0.35	0.35-1.30	1.30-1.50		N/E
6	0.0-0.50	0.50-0.65 0.80-1.60	0.65-0.80		1.40
7	0.0-0.20	0.20-1.30			1.10

N/E Not encountered

6.2 Made Ground

The following descriptions are in descending order.

The quarry spoil was described as loose, grey, platey, cobble and boulder of siltstone in a silt/sand matrix.

The material used to cap the tarmac when the Council abandoned their depot was described as soft/soft to firm, brown, slightly organic, slightly gravelly clay, mainly derived from excavations in glacial till.

A layer of tarmac was encountered within the old quarry, which was between 0.1 and 0.40m thick. It proved to be very tough and difficult to excavate through and the variable thickness is probably due to the Council laying any spare tarmac from jobs in their own yard.

It was not possible to prove the material extensively below the tarmac due to fast water inflows. However, where encountered in TP 2 and TP 6, it was described as medium dense to dense, dark brown, platey and sub angular, fine to coarse gravel, with a little cobble and fragments of tarmac.

In TP 3 excavated just outside of the quarry on the south west corner, encountered general Council waste, comprising concrete kerbs and concrete blocks in a fine to coarse gravel matrix, with traces of bottles, plastic, carpet timber.

In addition, TP 7 close to the site access encountered loose to medium dense, grey, sub angular and platey fine gravel to cobble of siltstone, in a silt/sand matrix.

pH of the made ground varied between 5.84 and 8.24 with Sulphate contents, when measured as 2:1 water extract between 0.0327 and 0.191g/l.

6.3 Bedrock

The bedrock was exposed in the recently cut face on the north eastern corner of the site. It was described as strong grey slightly weathered to fresh siltstone. However, approximately the top 1.0 m was completely weathered.

No obvious bedding was observed in the bedrock, although a shear zone was observed in the northern quarry face. Two main joint sets were observed one dipping at 80° to 060° and the other dipping at 68° towards 212°. The joints were generally widely spaced.

The edge of the quarry was proved in TP 1 and TP 4, where it was confirmed to be vertical for the top 1m. In addition, TP 5 was excavated to prove the edge of the quarry. However, as the plot had already been set out the excavation could only be taken up to the edge of the plot. At this location the trial pit was still encountering the top of the tarmac, with no rock being proven.

6.4 Groundwater

Slight groundwater seepages were generally encountered at the top of the tarmac, which appeared to be acting as a slight aquiclude, i.e. preventing water flow through the tarmac.

On breaking through the tarmac, the water inflows in the granular deposits were generally fast.

7.0 GEOTECHNICAL RECOMMENDATIONS

7.1 Excavations and Site Preparation

The site has been partially prepared, in that large quantities of rock have been broken out to provide the spoil for the 600mm cover required in the garden areas. The area where rock has been broken out and is either exposed at surface or covered by a thin veneer of quarry spoil is presented in Figure 4.

In the north western section of the site Plots 5 and 6 the bedrock is at/close to the surface and will require breaking out in places to ensure an adequate foundation depth in the underlying bedrock.

Elsewhere excavations will be in recently placed quarry spoil overlying made ground, placed after the Council abandoned their depot. Consequently, excavations will be possible using conventional earth moving equipment.

Excavations in the made ground deeper than 1.20m shall be battered back or shored for safety reasons.

Groundwater seepages are not anticipated in shallow excavations. However, deeper excavations for services and drainage runs, say below 1.20 to 1.50m, will encounter fast water flows in the made ground, which will be difficult to control as the material used to backfill the quarry is highly permeable and in hydraulic continuity.

Consequently, any pumping will effectively be dewatering the quarry. However, it should be noted that isolated oil contaminated water was encountered in some of the trial pits. It is therefore recommended that all service/drainage runs be kept as shallow as possible.

7.2 Foundations and Floor Slabs

Plots 2 to 4 are located within the confines of the quarry, where the ground conditions comprise loosely tipped quarry spoil, overlying soft to firm clay, resting on the tarmac. The underlying quarry fill appears to be well consolidated, which is not surprising given the sites previous use, which would have surcharged the made ground.

For these plots, raft foundations are recommended in conjunction with some ground improvement. This should comprise stripping the existing loose quarry spoil cover, which should be set aside. The underlying clay should then be proof rolled and any soft areas removed to the underlying tarmac. The Quarry spoil should then be placed in accordance with an approved earthworks specification, Reference 2, providing a compacted granular blanket beneath the raft foundation extending some 1m outside of the building footprint.

Following the ground treatment rafts shall be designed assumed an allowable bearing pressure of 50kN/m². They should be constructed with edge beams extending a minimum depth of 0.75m below final ground level to provide protection from frost heave.

Figure 4 shows the plotted position of Plots 2 and 3 spanning the edge of the quarry. However, the quarry edge is visible on the western site boundary. It would therefore be prudent to excavate further trial pits on the back gables of these properties to confirm that they are within the quarry.

Whilst the position of Plot 7 is shown within the quarry, it was not possible to prove the underlying tarmac, as the materials were very loose and a high-water table was encountered. Whilst TP 7 proved loose granular material, TP 3 nearby proved Council Waste from highway jobs. For this plot it is recommended that a 1m thick compacted granular raft be constructed beneath the raft foundation.

Plots 5 to 7 are all shown spanning the edge of the quarry, see Figure 4. For Plot 5 the edge was proven in TP 01, whilst in Plot 7 it was proved in TP 04. As mentioned previously TP 5 was only excavated to the edge of the plot where it was still in tarmac. However, Figure 4 records the quarry extending beneath Plot 6.

A piled raft foundation is recommended for those plots which span the quarry edge, with the section on rock being cast directly onto a regulating layer of granular material on the rock and the sections over the hanging wall of the quarry being piled.

The most suitable pile type would be a rotary percussive mini pile, say 200 to 300mm diameter socketed into rock at the base of the quarry, which will require permanent casing in the quarry backfill.

Possible issues with piling are that the depth to the base of the quarry is not known, or the gradient of the hanging wall of the quarry. This would be important as a steep gradient could lead to piles being deflected off vertical. In additional, there is a possibility of contaminated water being brought to surface. However, this could be overcome by diverting water into nearby sumps and back into the quarry backfill.

Driven piles would also be possible, but would have to be capable of penetrating the underlying tarmac and also any obstructions in the quarry. They have the disadvantage in that they would be easily diverted by the quarry walls.

It is therefore recommended that boreholes be drilled to prove the base of the quarry for pile design. In addition, it would be worthwhile bringing a larger machine to site to excavate deeper trial pits down the edge of the quarry.

7.3 Drainage

The planning conditions required are surface water scheme, based on sustainable drainage principles to be designed. However, according to the direct tests have already been carried out and attenuation prior to discharge into the local drains has been agreed.

Due to the high-water table it is recommended that drainage runs be kept as shallow as possible.

7.4 Reuse of Materials

The possible re use of materials will be dependent on the final levels when compared to existing. At present there is significant quantities of quarry spoil across the eastern section of the site above the bedrock. This material is not required for garden cover and could be re used as a structural fill/capping elsewhere in the site.

7.5 Access Road and Hard Standings

The access roads and hard standings have been covered by loosely tipped quarry spoil. It will be necessary to excavate and recompact this material in accordance with an approved earthworks specification. Following which CBR values in excess of 15% can be achieved, requiring covering with a nominal sub base thickness of 150mm and any tarmac surfacing.

7.6 Protection of Buried Concrete

The chemical testing of the made ground has indicated that chemical attack of buried concrete is not an issue, and can therefore be designed in accordance with the following classes in accordance with Reference 3.

- DS – 1,
- ACEC – 1.

However, for pile design further samples will need to be taken from the quarry backfill and the groundwater.

7.7 Slope Stability

The existing rock slopes behind Plots 5 and 6 have been inspected and are considered to be stable. However, small fragments may still fall off from time to time. During construction it is recommended that these slopes be scaled of any loose material using a light scrape from a machine bucket.

It was not possible to inspect the slopes behind Plots 2 to 4, which were heavily vegetated.

7.8 Landfill and Radon Gas

The desk study did not record any landfills close to the site, although the underlying quarry has been backfilled.

In addition, the site is not in a radon area and gas protection measures will not be required.

7.9 Environmental Issues

Planning Condition 10 states, that, prior to occupancy of any of the properties the garden areas will be remediated by the use of a barrier system consisting of a geo-textile membrane overlaid with 600mm of clean cover, evidence that the topsoil used in clean and that the work has been undertaken must be submitted and approved in writing by the Local Planning Authority.

This work has already been undertaken and agreed with the Local Authority with 600mm of rock cover placed in the garden areas. The only matter requiring validation is the topsoil cover in the gardens.

REFERENCES

1. BS 5930, Code of Practice for Site Investigation, 2015
2. BS 6031 Code of practice of earthworks, 2009
3. BRE Special Digest 1, 2005, Concrete in Aggressive Ground.