

GEOTECHNICAL REVIEW

3rd October 2025

Project Name: 18 Midford Lane, Limpley Stoke, Bath

Project No: -----

Revision: P01

Reference: ML-BWB-ZZ-XX-TDN-GE-4001-S1-P01.1

Author: Ian Gardner

Reviewer:

Approver:

1. INTRODUCTION

BWB Consulting Ltd (BWB) had been appointed by ARC Property Development Ltd (ARC) to act as their Designers Geotechnical Advisor (DGA) as defined by DMRB CD 622 Rev 1, with a specific remit related to the proposed drainage strategy for 18 Midford Lane, Limpley Stoke, Bath.

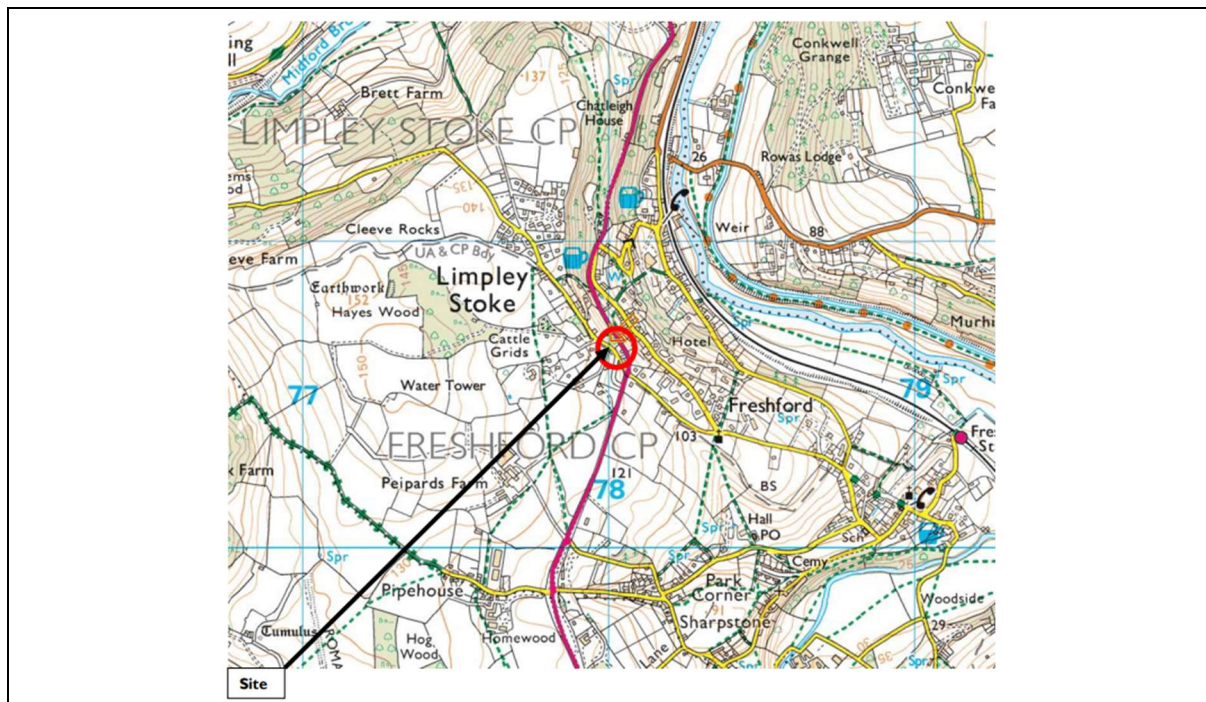


Figure 1-1: Site Location Plan

The development at 18 Midford Lane will comprise the construction of a pair of semi-detached properties, that shall be supported off piled foundations. The development will include minor re-profiling of the land, as well as the installation of drainage and the connection of other

services. The site itself is located to the immediate West of the A36, Warminster Road, as indicated in **Figure 1-1**.

The residential development will be formed on a small section of land above the A36, with an approximate change in elevation of around 7.5m between the ground floor level and the centreline of the A36 carriageway. The height differential increases from South to North, as the A36 trends downwards and the upper ground level on the development increases. There is a difference in elevation between the two semi-detached properties, with the ground floor level of the Northern unit set at approximately 116.5m OD and the Southern at 115.5m OD.

Beyond the building's footprint, the ground level reduces down to the edge of the carriageway, following the pre-existing profile, which is also very heavily vegetated with a large number of existing mature trees.

As part of the planning process, NH are a Statutory Consultee. Prior to BWB's involvement with the project, a protracted period of discussion had been on-going between ARC, their other Consultants, and National Highways (NH). NH had raised concerns related to the proposed development.

An outstanding issue prior to BWB's involvement, related to the proposed drainage of the site. Due to a number of other constraints, it is understood that the site would have to adopt a drainage strategy without a permanent discharge for storm and surface water. As such the site would require some form of retention and attenuation, to enable the development to be completed. It was to address this specific point that BWB had become engaged in the project with Ian Gardner acting as the DGA on behalf of ARC.

A number of documents have been provided to BWB for review, including the following sources of information.

- I-DRN. 2025.18 Midford Lane, Limply Stoke. Infiltration Trench Design, Stormwater Controls.
- M2 Civil & Structural Engineers. 2025. 18 Midford Lane, Limply Stoke. Gravel Filled Soakaway Sections.
- M2 Civil & Structural Engineers. 2025. 18 Midford Lane, Limply Stoke. Drainage Layout Drawing. Drawing reference M2-2801-SK-606-P2.
- M2 Civil & Structural Engineers. 2025. 18 Midford Lane, Limply Stoke. Surface Water Drainage Layout Drawing. Drawing reference M2-2801-SK-603-P1.
- M2 Civil & Structural Engineers. 2025. 18 Midford Lane, Limply Stoke. Drainage Strategy Drawing. Drawing reference M2-2801-SK-602-P1.
- M2 Civil & Structural Engineers. 2024. 18 Midford Lane, Limply Stoke. Surface Water Drainage Strategy Drawing. Drawing reference M2-2081-SK-601-P1.
- M2 Civil & Structural Engineers. 2024. 18 Midford Lane. Piling Setting Out Drawing. Drawing reference M2-2081-GA-099-C3.
- M2 Civil & Structural Engineers. 2024. 18 Midford Lane. Cut & Fill Sections, Sheet 2 Drawing. Drawing reference 2081-M2S-00-DR-C-7003-S2-P1.
- M2 Civil & Structural Engineers. 2024. 18 Midford Lane. Cut & Fill Sections, Sheet 1 Drawing. Drawing reference 2081-M2S-00-DR-C-7002-S2-P1.

- M2 Civil & Structural Engineers. 2024. 18 Midford Lane. Cut & Fill Site Plan Drawing. Drawing reference 2081-M2S-00DR-C-7001-S2-P1.
- GeMech Foundations Ltd. 18 Midford Lane, Limpley Stoke, Bath. Site diary Piling, for the installation of Odex piles.
- GeMech Foundations Ltd. 18 Midford Lane, Limpley Stoke, Bath. Odex Piles Design Calculations, Geotechnical Design Report. Document Reference GC 2171.
- Surveybase Limited. 2024. 18 Midford Lane, Limpley Stoke, Bath, BA2 7GP. Topographical Survey, Sheet 1 of 1, A0, Drawing. Drawing reference SB10329-TOPO.
- Integrale Limited. 2019. Proposed Residential Development, Land Southeast of 18 Midford Lane, Limpley Stoke. Geotechnical and Phase II Contamination Report. Document Reference 18022.
- Greenfield Environmental Ltd. 2018. Midford Lane Desk Study & Ground Investigation Report. Document Reference 20180309 Rev0.

The content of this Technical Design note (TDN) presents BWB's independent review of the factual records, in conjunction with the proposed development. It has been prepared by Ian Gardner, acting as an approved Designer's Geotechnical Advisor (DGA). The preparation of this TDN follows a series of meetings and discussions held with National Highways Sophie Collins, who is the Principal Geotechnical Advisor, for their Southwest Division.

2. GEOLOGICAL GROUND MODEL (GM)

Two ground investigation reports (GIRs) have been provided for review. Whilst the general sequence of geology presented in both reports are in accord, the overall interpretation of the ground model does differ.

The general geological sequence across the site was proven to comprise the following:

- Made Ground, quarry backfill and reworked materials, of variable thickness and deposition.
 - The profile of the Made Ground/quarry backfill was considered in both reports to be consistent with some form of excavation and quarrying, but the type and extent of this activity was interpreted differently each report.
- Highly weathered Limestone.
- Weathered Limestone.
- Intact Limestone.

From a review of BGS records, the sequence of limestone below the site has been interpreted to comprise the following:

- Above 126m OD, Forest Marbel Formation
- Between 126m OD and 108m OD, Upper Rags and Bath Oolite
- Between 108m OD and 104m OD, Twinhoe Beds.
- Between 104m OD and 94m OD, Coombe Down Oolite.

- Below 94m OD, Fullers Earth.

The above levels in m OD are indicative only and should only be used for guidance on the sequence of each geological unit.

The first GIR, prepared in 2018 by Greenfield Environmental Ltd (GEL), recorded a variable thickness of Made Ground. GEL considered that this was representative of localised surface excavation and quarrying of readily available limestone. The GEL GIR indicated maximum depths of quarry backfill and Made Ground to be in the order of 2.5 to 3.5m below the original ground level.

The second GIR, prepared in 2019 by Integral Ltd (Integral), also recorded similar Made Ground. However, Integral had interpreted this to be consistent with much more extensive below ground quarrying, using a pillar and stall method, with the voids later filled in. The Integral GIR interpreted the results of their dynamic probing to suggest that the quarry backfill was up to 8 to 10m below the original ground level, which would be close to or below the level of the A36.

Integral went further in their own interpretation of the data to present an indicative geological cross-section through the site, presenting their view of the arrangement of the pillar and stall workings, with localised roof collapse.

Due the impact that stormwater inundation could have, if there was deep, uncontrolled Made Ground and quarry backfill to the extent suggested by Integral, concerns were raised on the geotechnical stability of the site. The concerns centred around the impact that water inundating into the backfill could have and that this may then lead to instability adjacent to the A36, in particular associated with the very steep face along the Northbound carriageway.

BWB were approached to provide an independent review of the data, and to develop a Ground Model and Geotechnical Design Model, which would then be suitable to assess the geotechnical risk from the proposed drainage solution.

In developing the BWB ground model, information was available for inclusion which had not been available when GEL and Integral prepared their models. Of particular note are the following:

- Pile records provided by GeMech.
 - Piles were installed by GeMech in 2024, and records have been provided on the length of each pile, as installed.
 - The Odex pile design was based upon a minimum embedment into competent limestone of 3m.
 - The base of the installed Odex Piles has been included in the ground model, identifying a layer that had been recorded as competent limestone, when the piles were installed.
 - A second layer has been added to the BWB Ground Model, set at 3m above the base of the piles, corresponding to where the pile installers judged that they were drilling through competent limestone.
- Intermediate surveys taken during the works.

- Part way through the development, the Client for the project changed, which necessitated both a new topographical survey, as well as images on the state of progress.
- Photographic records, including:
 - the exposed face of the limestone following the reprofiling to allow piles to be installed
 - The excavated limestone, prior to it being crushed and processed.
- Ground model for the development, based on final ground levels, for the actual buildings to be constructed.

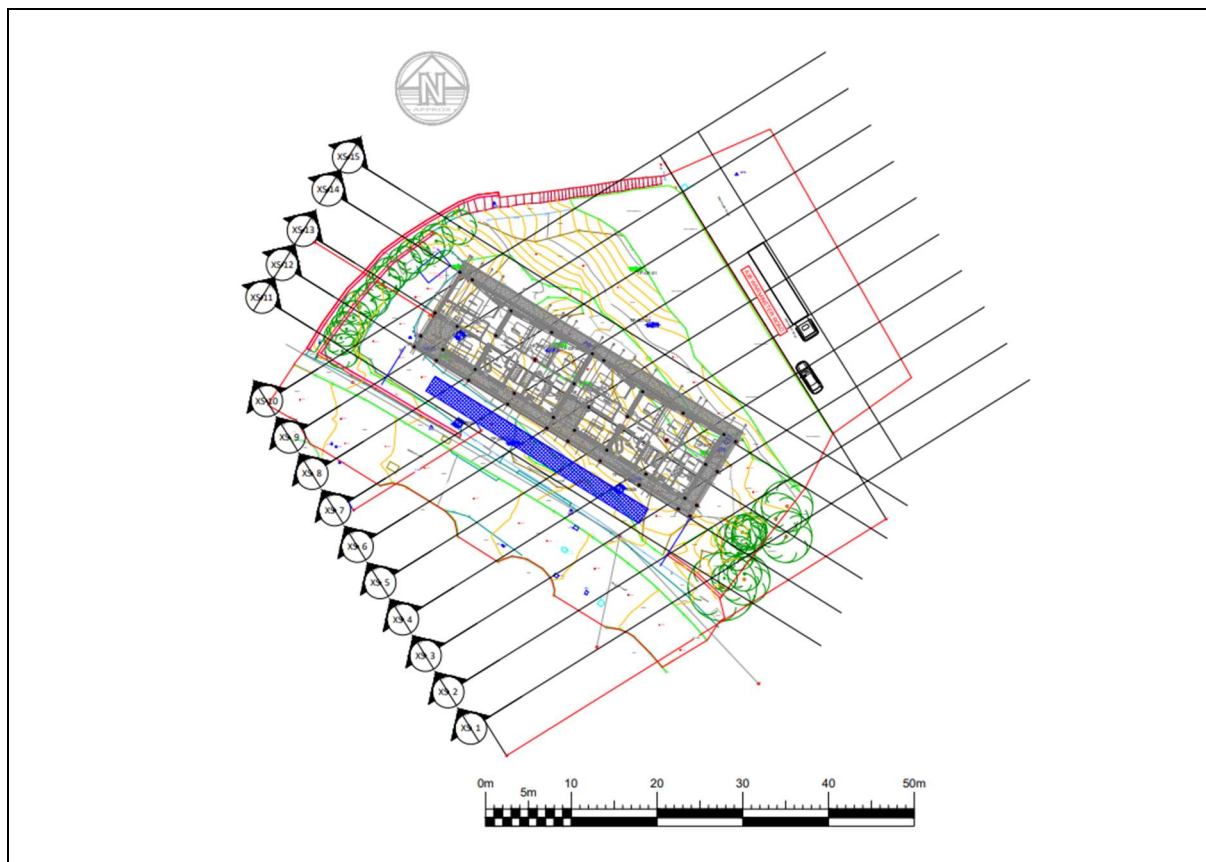


Figure 2-1: General site arrangement, BWB Drawing ML-BWB-ZZ-XX-DR-GE-4001, Sheet 1

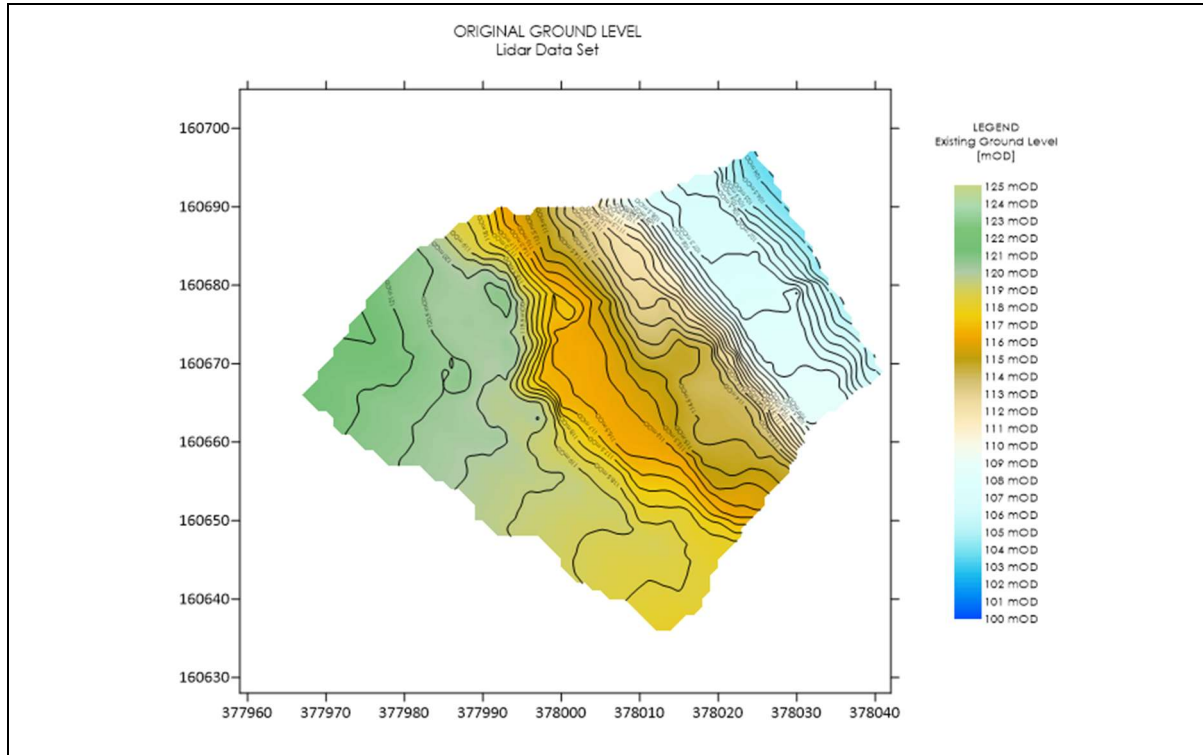


Figure 2-2: Original ground level, before commencement of development, Lidar data

In addition to the above, LIDAR data has been sourced for the wider area, so as to represent the ground profile, before any works commenced.

BWB have undertaken an independent review of the factual records and developed their own Ground Model (GM), in accordance with the guidance provided in BS EN 1997-2:2024, Clause 4. The GM is presented as a series of figures within this TDN.

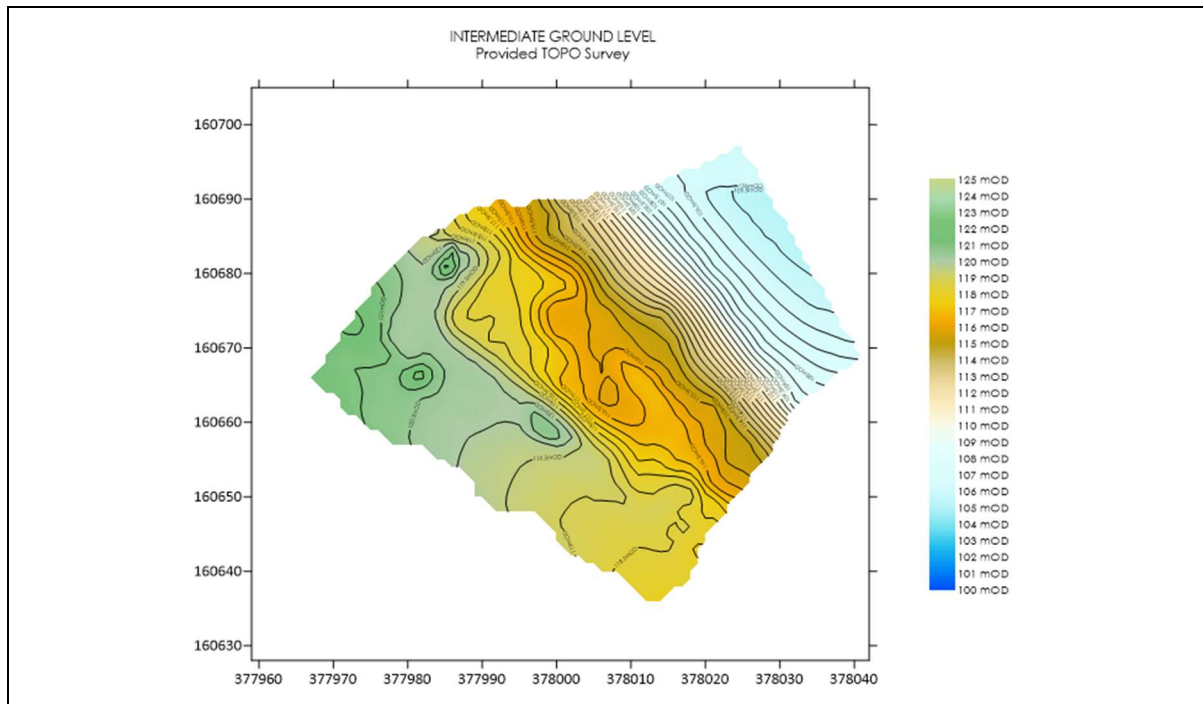


Figure 2-3: Intermediate survey, March 2024

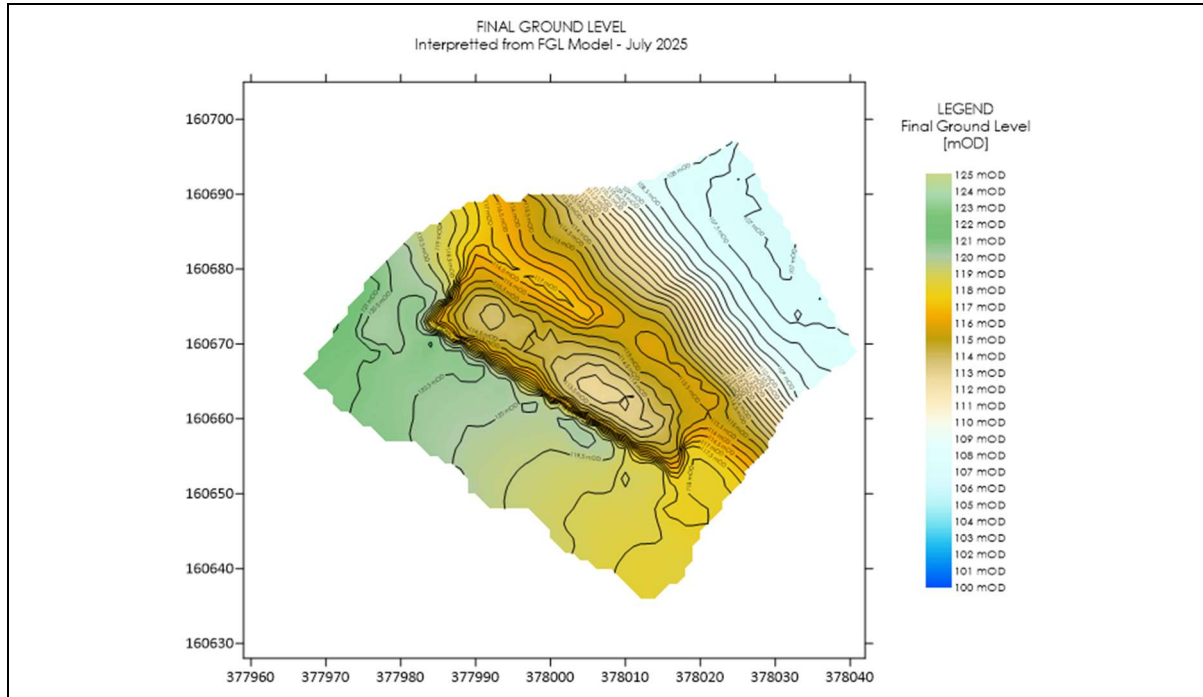


Figure 2-4: Proposed final ground level

Based on the records of the pile installation by GeMech, a surface was also produced based on the inferred top of the instance limestone. As the data was limited to where piles had been installed, the extent of this surface was limited to the building outline.

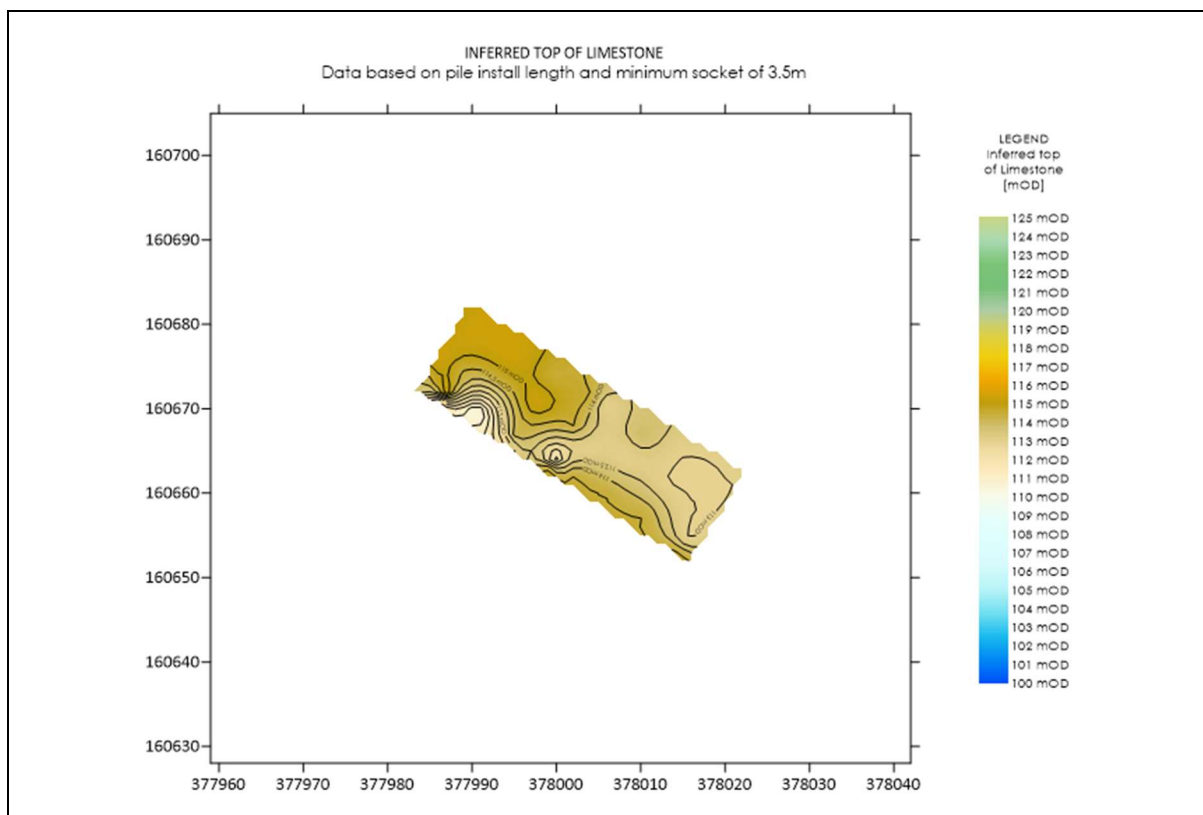


Figure 2-5: Inferred top of intact limestone, GeMech pile installation records.

The GM has been used to develop a series of cross-sections, as indicated in **Figure 2-1**, and as presented on BWB Drawing ML-BWB-ZZ-XX-DR-GE-4001, Sheet 1 to 3, copies of which are provided at Appendix A.

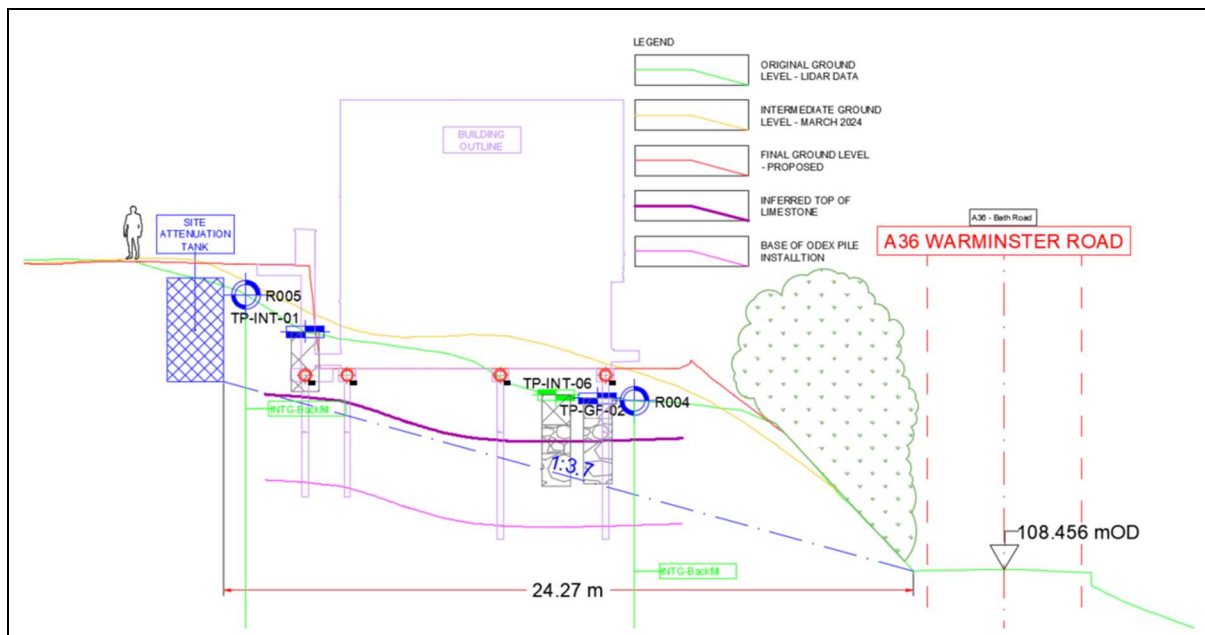


Figure 2-6: Typical cross-section through Ground Model

Figure 2-6 presents a typical cross-section through the ground model. The section contains a lot of information, from a range of sources, as summarised below:

- Original Ground Level, Lidar Data
 - This is presented a green line, and includes the measured elevation at the centreline of the A36 Warminster Road.
- Intermediate Ground Level, March 2024.
 - This is presented as a dark yellow line and represents the level at the time the current development team took ownership of the site, and before the installation of the piles.
- Final Ground Level, Proposed
 - This is presented as a red line
- Approximate extent of established vegetation and trees.
 - Presented as a hatched area, and typically located on the slope down from the site to the edge of the A36 Warminster Road.
- Ground Investigation Records
 - The borehole and trial pit reference has been added, at the correct elevation, closest to the cross-section line.
 - References with GF, represent records from Greenfield Environmental Ltd.

- References with INT, represent records from Integral
- Green vertical lines represent the position of the rotary probing undertaken by Integral, with notes added reflecting their interpretation of the data
- Building outline
 - Presented as a Purple line.
 - The outline includes the closest piles to the section line, with the pile number and length of pile correct to the coordinated position.
 - The outline includes the indicative extent of a retaining wall which is formed at the West of the new buildings.
- Inferred top of competent limestone
 - This is presented as a solid dark red line, and is set 3m above the base of the installed piles
 - A second line is presented as the modelled base of the piles, noting the pile locations as shown are the closest to the section line.
- Attenuation tank.
 - This is presented as a hatched blue block and is located to the left (West) of the new buildings.
 - A blue hatched line from the base of the attenuation tank, to the edge of the site/A 36 Warminster road is presented, along with the corresponding slope.

Copies of the drawings presenting the plan and associated cross-sections prepared by BWB are provided at Appendix A.

The modelling presented in the cross-sections and the preceding figures has been based on the actual records presented in the previous GIRs, with no interpretation applied to them, to infer the nature, type and extent of quarrying they may have been carried across the site.

In addition to the survey records, BWB have also been provided with a series of images taken during the site preparation works in 2024, prior to an following the installation of the piles. These have been reviewed and used in a new interpretation of the ground. Selected images are presented in the following Plates.



Plate 2.1: Image facing South, with position of piles marked on ground. Intact weathered limestone forming the face of the excavation



Plate 2.2: Excavated limestone boulders, as part of plot preparation, awaiting crushing.

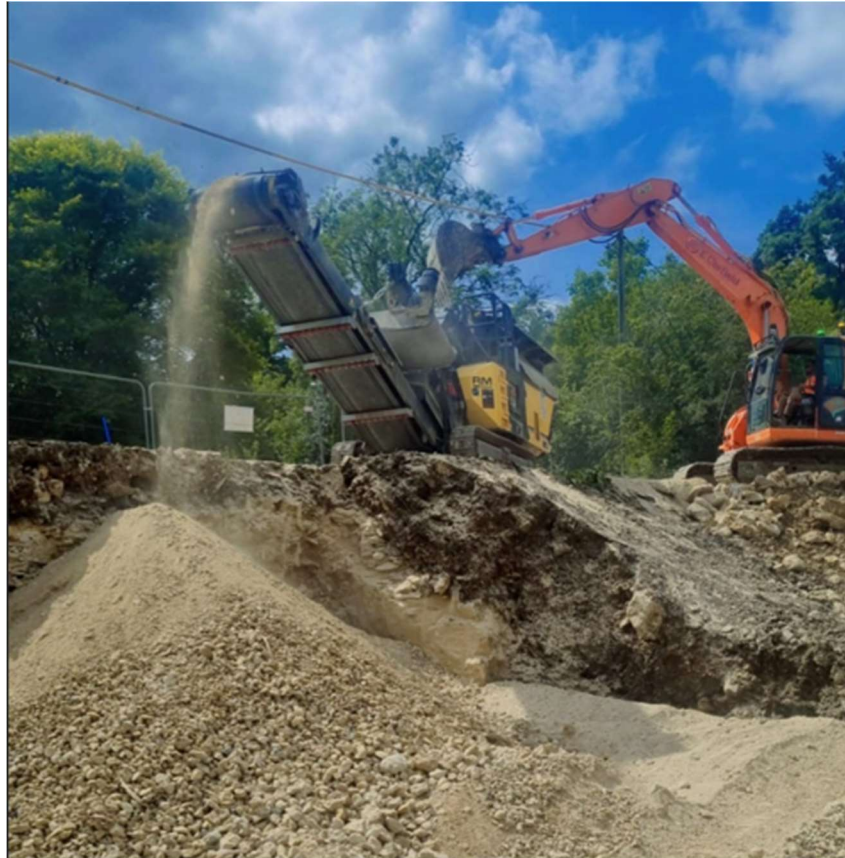


Plate 2.3: Crushing of excavated limestone, for use as aggregate within the development.



Plate 2.4: Exposed face of cutting, indicating localised historical surface excavation of limestone. No evidence of below ground workings.



Plate 2.5: Installation of Odex piles by GeMech.

The factual GM has been taken forward into the Geotechnical Design Model, as set out in Section 3.

3. GEOTECHNICAL DESIGN MODEL (GDM)

The Geotechnical Design Model (GDM) has been developed in accordance with the general guidance from BS EN 1997-1:2024: Clause 4 and is based upon the GM presented in Section 2.

As described previously, the conceptual ground model presented in the two GIRs differed from each other. GEL suggested that localised surface excavation of limestone had occurred, with further investigation required. Integral inferred that the majority of the site was underlain by below ground mine workings, using the pillar and stall method.

A review of the factual records by BWB, including photographic records taken during the site preparation, had not identified any feature that would support the hypothesis that the site was underlain by pillar and stall workings.

Consideration has been given to the process of pillar and stall workings including the competency of the overlying stone that would permit a stable roof to be formed between columns, to allow the workers to excavate the limestone. An example of the inside of pillar and stall workings, from the nearby Coombe Down mine, is presented as Plate 3.1.

Whilst Plate 3.1 clearly shows part of the roof, over time, has spalled and fallen to the ground, it is clear that the roof itself must have a sufficient level of competency so as to be able to span between pillars. From comparison between the exposed face of the limestone presented in Section 2, and in particular Plate 2.1 and 2.3m the highly weathered limestone is not considered to have been able to span between columns.

Within the Integral report, they suggested that following the quarrying exercise, the voids between the pillars had subsequently been infilled. This hypothesis is not supported by the subsequent imagery, nor does it seem practical that this would have been done.

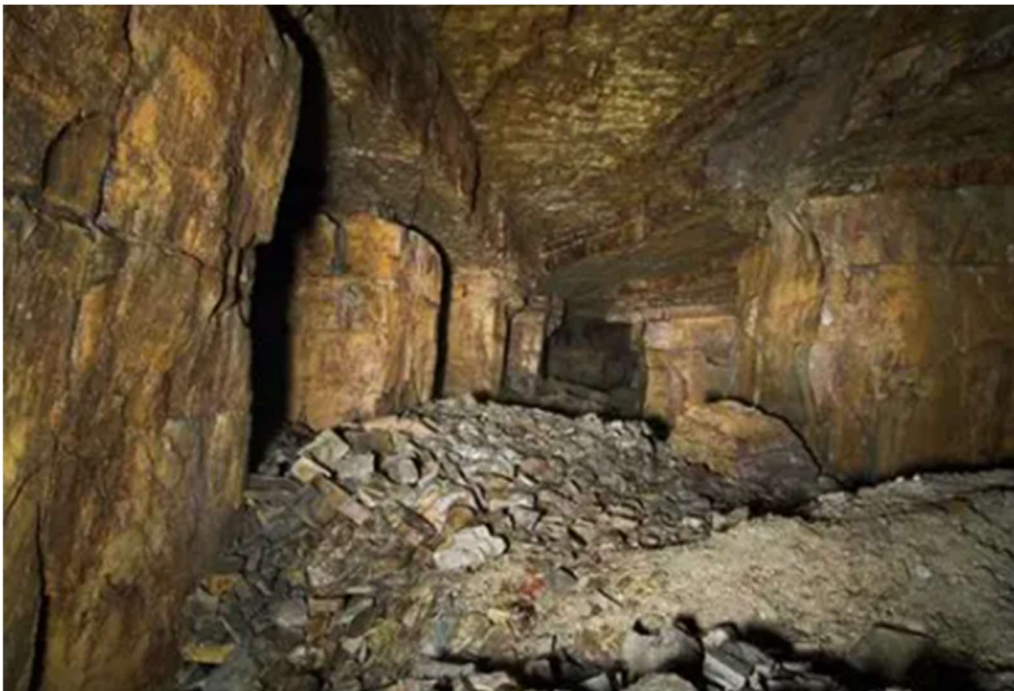


Plate 3.1: Typical pillar & stall mine workings, Coombe Down mine. Publicly available image.

It is considered that large scale surface excavation of limestone was not undertaken, as the visual evidence recorded during the works indicates that large portions of the site still contained highly weathered and weathered limestone, in bedding planes consistent with an undisturbed deposit. If such large scale excavations had been carried out, and given the close proximity of the A 36, which is an 'ancient' road, in all likelihood the land would have been left low (commensurate with the level of the road). There is no evidence to indicate that quarrying extended across the entire site.

It is considered that below ground quarrying of limestone, using pillar and stall methods, was not carried out, as the competency of the overlying limestone rock would not have been able to span between pillars.

It is considered that localised excavation of weathered limestone was undertaken, and in all likelihood the excavated material was used for buildings (adjacent to the plot) and associated stone walls.

Large scale limestone excavation was undertaken in the near vicinity to the study area, but the ground conditions at those locations had a landform that was relatively flat, and the weathering profile of the limestone lent itself to quarrying.

The study site is on the face of a slope forming a large valley, and the profile of weathering would be expected to follow the original landform. As such the quality of limestone near surface would have limited the suitability of the stone for construction, and material near the face of the slope would have been of low quality. This may explain why the only evidence of quarrying is set back from the face of the slope, and did not extend towards the road, as the stone quality reduced the nearer to the face of the slope the excavation went.

Overall, the review of the factual records is considered consistent with both the profile of pile installation (deeper piles further from the face of the slope) and imagery. Where excavation of limestone had occurred, it was limited in depth and extent and did not cover the entire site.

4. DRAINAGE ATTENUATION

The storm drainage design comprises a large attenuation tank, located to the West of the properties which is designed to accommodate the storm water. Reference should be made to M2 drawing M2-2801-SK-603-P1, dated February 2025 a copy of which is provided at Appendix A. This drawing and design supersedes the previous strategy where a combination of attenuation tanks and borehole soakaways were proposed to be installed to the East of the properties (e.g, between the buildings and the A 36). Copies of both strategies were provided to BWB, however only the drawings relevant to the current design have been included in Appendix A.

The adoption of the large attenuation tank to the far side (West) of the buildings has ensured the maximum lateral distance between attenuation and the A36. The closest measured distance from the attenuation tank to the A 36 is in the order of 23m, (in the South) increasing to 36m in the North. The base of the attenuation tank is around 7m above the A 36, but given the lateral distance, the potential for attenuating through the ground an impacting the highway or the face of the slope is considered to be negligible.

5. CONCLUSIONS

In conclusion, the review of the factual data has allowed a revision of the Ground Model and Geotechnical Model to be made. The review has concluded that the extent of quarrying was limited to easily accessible less weathered limestone, and did not extend across the whole site, nor did it comprise below ground pillar and stall workings.

The revised drainage strategy, had already relocated the site attenuation to a position as far from the A 36 as was practicable. Whilst the base of the attenuation tank is above the level of the highway, the lateral distance from the A 36 is significant and highly unlikely that water would travel laterally that far. The base of the attenuation tank is founded, for the majority if not all of its length, within undisturbed, highly weathered limestone.

The weathering profile of the limestone does reduce with depth, however the records would suggest that the majority of this deposit is weathered to a noticeable depth.

A review of the ground conditions, and the position of the attenuation tank is not considered to impact the stability of the face of the slope and would have a negligible impact on the NH assets, including the A 36.

APPENDIX A: DRAWINGS