TECHNICAL MEMORANDUM

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TO:	Catriona Ryan	**DATE:**	11 February 2008
CC:		**JOB NO:**	07 5071 80251
FROM:	PETER CORRIGAN		
EMAIL:	pcorrigan@golder.com		
RE:	**REVIEW OF SLOPE STABILITY OF THE RATH LUGH NATIONAL MONUMENT, LISMULLEN, CO. MEATH**		

Dear Catriona,

Further to my site inspection of 18 December 2007 and review of the letter report from Dr. Eric Farrell of AGL Consulting Ltd. (AGL) regarding the geotechnical stability of the Rath Lugh National Monument near Lismullen in Co. Meath, I now wish to record my observations from my site inspection and comments from the review of the AGL geotechnical report.

INTRODUCTION

The Rath Lugh National Monument is located in the townland of Lismullen about 2.5km northwest of the Hill of Tara in Co. Meath. Rath Lugh lies under dense vegetation and tree cover. The route of the M3 Motorway skirts to the southwest of the base of the elevated promontory on which Rath Lugh is located. The height of the top of the elevated promontory is approximately 20m above the surrounding land. Plate 1 shows an approach view of Rath Lugh and Plate 2 shows some of the remaining walls of the ancient rath.

Due to the proximity of the motorway alignment in a cut area to the south eastern slope of the monument, it is necessary to carry out some steepening of the existing slope. It is currently proposed to use a 60° soil nail slope to achieve this. It is this steepening and consequences on the geotechnical stability of the monument that this technical memorandum and the AGL report pertain.

The brief that Golder Associates Ireland (Golder) has been commissioned to carry out includes a geotechnical assessment and analysis of the AGL report. To this effect, a site walkover was held on Tuesday 18 December 2007. No topographical surveying was carried out to determine the existing conditions. The information supplied by the NRA and used by AGL has been assumed to be correct in this regard.

OBSERVATIONS FROM SITE VISIT

The site visit was carried out on 18 December by a Chartered Geotechnical Engineer from Golder. The following summarises the main observations from this site visit;

- The weather on the day of the site visit was dry and cold. There had not been heavy rain during the preceding days.

- Plate 1 shows The Rath Lugh as approached from the south east. The promontory is elongated running northeast to southwest with the southwest end having been steepened in recent times

- The topsoil has been stripped from the alignment of the motorway. It is believed that this was done some months ago and that no further work has been performed in the location since. The relevant section of the motorway site can be viewed in Plates 3 and 4;

- A settlement has been constructed at the top of the sloping ground to the south west of the fort, as can be seen in Plate 4. This appears to be sitting on granular soils although there also appears to be a certain amount of rounded gravel in the area and it is uncertain as to whether this is due to glacial deposition or construction of the ancient rath. The area to be steepened is directly below this settlement and is indicated on Plate 5;

- It would appear on visual examination that the majority of the soils forming the promontory upon which the rath is founded are of granular nature, generally sandy gravels with occasional to frequent cobbles. Plate 6 shows the up-chainage side of the promontory which consists generally of these granular soils. This is consistent with that expected from the geology associated with esker deposition;

- On the down-chainage side of the rath, an area of exposed silt was observed; this material was described as compact *brown very sandy SILT*. Some damp areas were noted in certain locations within this face of silt which was standing at a steep incline without any buttressing or support. This indicates that the material although silt by nature would exhibit reasonably good shear strength characteristics while dry. Plates 5 and 7 both provide differing views of this silt face.; and

- A single occurrence of a confined slump in the ground was observed. This is shown in Plate 8 and is thought to be the location of a pre-stripping trial pit carried out by the contractor which has consolidated in recent months.

REVIEW OF AGL CONSULTING REPORT

The following are comments on some of the points made in the AGL report;

- A desk study was carried out by AGL which consisted of a review of the six inch drift maps;

- The soil exposed in the main body of the slope under Rath Lugh was described as granular in nature with rounded or sub-rounded particles; it continues on to state that this type of material is consistent with that expected in esker deposits. A sample (sample No. 2) was taken of this material which was described in the laboratory as slightly silty/clayey sandy Gravel. The laboratory tests carried out on this sample indicated that the sample had a moisture content of 15%, co-efficient of cohesion (c') of 9kPa and an angle of internal friction of 41° approximately at a bulk density of 2.11 Mg/m^3;

- The AGL report also discusses the soil exposed in the cut face on the down-chainage side of the steepened slope. This material was described as comprising predominantly soft/firm sandy Silt/Clay and silty Sand. A sample (sample No. 1) of this material was taken and described in the laboratory as very sandy Silt. Laboratory tests carried out on this sample indicated that the sample had a moisture content of 11%, co-efficient of cohesion (c') of 23kPa and an angle of internal friction of 40° approximately at a bulk density of 1.79 Mg/m^3;

- The AGL report states that these soils would not be expected to show cohesion due to their granular nature and hence these values have been reduced to zero for the slope stability analysis. This assumption is appropriate although slightly conservative;

- Further, the AGL report takes 39° as the appropriate angle of internal friction for the two different soils. Based on test results above, this is a reasonable design value for the soils identified as making up the slope.

- This report also indicates that there was no evidence of ground water seepages in the exposures and that given the granular nature of the soils; the groundwater levels may be relatively low. For the purposes of the slope stability analysis, AGL assumed ground water to be 1m below the toe of the slope and 3m below the top of the slope. This is suitably conservative for this analysis as it is unlikely that the actual ground water levels are this high in this area even during the winter months. During the Golder December site inspection, some dampness was observed in the exposed silt face, this was thought to be due to surface drainage from the rath itself, as opposed to being indicative of a high ground water level in the area.

- An assessment of the drawings provided to AGL by the NRA has not been carried out as part of this brief. It is assumed that the most appropriate section has been selected.

It is noted that the cross section at Ch 28,870 does seem appropriate for that observed on site.

- The stability analysis, which was carried out using Slope/W, was based on a 6m high face at the edge of the motorway and indicates a factor of safety of 1.56 which is adequate given that this is a short term situation. The 6m high face is based on information in the drawings provided by the NRA.

- This report does highlight the risk arising during construction of the exposed face being greater than the 6m allowed in the analysis. It indicates that this should be considered in the design of the face.

- It further indicates that the current 3m slopes although stable, would be expected to become unstable over time, leading to local slumping and unravelling of the surface. The placement of granular material against the face with an intervening geosynthetic filter layer is recommended should it be necessary to leave the face unsupported for a long period of time. It further indicates that this local stability would not affect the overall stability of Rath Lugh.

CONCLUSIONS

- The laboratory tests carried out included moisture contents and shear box tests carried out in a 60mm shear box. It is noted that the material was passed through a 3.17mm sieve prior to the test being carried out. Although the large (300mm) shear box, may have been more suitable for the material contained in sample No. 1, the methodology used would be expected to provide a conservative result for the material described.

- The factor of safety obtained from the slope stability analysis is adequate for a short term situation. A generally conservative approach has been taken in the assumptions and in the selection of design criteria.

- There is silt exposed extensively on one of the slope faces. Silt by its nature is highly susceptible to erosion and degradation with exposure to weather. Therefore its condition can deteriorate fairly quickly with time. It is therefore recommended that the completion works in this area be undertaken as quickly as possible so that the exposed slope can be regarded, stabilised and protected. If final completion works are to be delayed, then temporary protection measures should be instituted. Such temporary protection works could comprise gravel sheeting over a suitable geotextile filter fabric.

- In addition, due to the presence of silt soils within the slope, there is a potential for liquefaction of these silts as a result of vibrations from adjacent construction works. This is not thought to be a major factor since the slope appears reasonably dry and provided reasonable precautions are exercised to avoid extended use of heavy equipment near the toe of the slope.

- It is considered that the most critical stage for the stability of the slope and the supported national monument structure is during the period of further construction in the immediate area and especially during the construction of the soil nail slope. The sequencing of works during any excavation and construction phase should be considered prior to the commencement of such works. The contractor should provide a Method Statement addressing how these works will be undertaken and confirming that such additional works will not cause any further disturbance to the slopes and ancient structure. Independent monitoring of such works in the area may be advisable. It is imperative that these works are carried out in recognition of the proximity of the monument. As noted above, these completion works should be expedited as a matter of urgency.

I trust that this information is in keeping with your expectations. If you have any additional comments or questions, please do not hesitate to contact the undersigned.

Regards,

Peter Corrigan BA BAI C.Eng. MIEI

Chartered Geotechnical Engineer