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Deadline *9* submissions to Planning Inspectorate, National Infrastructure Planning: Ref. TR010025

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PART ONE: **Summary response to Highways England's Deadlines 7 and 8 submissions REP7-081 and REP8-013 on matters relating to Flood risk, groundwater protection, geology and land contamination.**

PART TWO: **Response to Highways England's Deadline 8 Submission REP8-018: Written Summary of oral submissions put at Flood Risk, groundwater protection, geology and land contamination hearing on 29 August 2019, Appendix A - Highways England Comments on Dr GM Reeves Presentation.**

1. INTRODUCTION

In attempting to limit repetition of our findings and our responses to the Applicant's often repetitive comments on our submissions, we have, first, combined our responses to documents comprising Highways England's most recent comments with an overview of our concerns.
Finally, we provide specific responses to Highways England's comments on Dr Reeves' presentation given at ISH 10 (REP8-.

2. PART ONE: Summary response to Highways England's Deadlines 7 and 8 submissions REP7-081 and REP8-013

2.1. Despite Highways England's rebuttal claims, denials and challenges in their documents REP7-021 (Deadline 7 submission - 8.44 - Comments on any further information requested by the ExA and received at Deadline 5 and 6 and REP8-013 (Deadline 8 submission - 8.49 - Comments on any further information requested by the Examining Authority and received to Deadline 7), the following situations still persist in the presentation of geoscientific data (geology, rock properties, groundwater conditions) with respect to the necessity for geotechnical controls during tunnelling.

2.2. These situations are as presented by the Stonehenge Alliance in evidence given in oral submissions and/or presentations (on 11th and 12th June, and 21st and 29th August 2019 by Dr GM Reeves), and in written submissions, submissions of presentation materials, and responses to rebuttals by Highways England. The Examining Authority is particularly asked, please, to refer to The Alliance's (Dr Reeves') submission REP8-053 (Summary of oral submissions at ISH 10).

2.3. In summary, the key areas of concern to any tendering tunnelling contractor for this work should therefore be:

- Poorly understood Chalk rock property and diggabiliity performance concerns, with potential solution effects, especially in the Phosphatic Chalk horizons (with possible contamination and reactivation of solution features) from lowered Ph levels in rainfall and/or flowing groundwater recharge systems.
- Lack of accessible 3-D interpretations of combined geoscientific data from Site Investigation results, together with all available published and confidential (i.e., unpublished by Highways England) drilling, geological, hydrogeological and geophysical data.
- Totally inappropriate and inadequate groundwater modelling, both in detail and in adequate depth and lateral extent relevant especially to the scale, depth and detail of the proposed tunnel route.
- The consequent unavailable accurate and adequate predictions of future groundwater conditions and effects on springs, private and agricultural abstractions from boreholes and wells, and upon the Avon SAC, especially if extensive grouting is required to stabilise both poor rock and invasive groundwater conditions during tunnelling.

2.4. *Conclusions*

All the above major geological, hydrogeological and geotechnical "unknowns", will lead to very significant amounts of downtime, cost over-runs and no doubt significant contractual claims and escalating costs, if this project goes ahead, following the proposals in the Highways England/The Examining Authority's draft Development Consent Order, published on 3 September 2019.

2.5. *Postscript*

2.5.1. As mentioned in our ISH 10 summary of oral submissions, in examining the detail of groundwater and lithological data relating to the Whitway Rock horizon, it was noticed that Highways England had used a dated (2012) figure, attributed to Professor Rory Mortimore in his 2012 Glossop Lecture publication (for ease of reference, please see reproduction below). It remains uncertain if the AWM groundwater modellers have superimposed the profile of the proposed tunnel (as defined in the HEng A303 Amesbury to Berwick Down, Project Documents: 2.7 Engineering Section Drawings (Plan and Profiles documents) onto their Figure 2.

2.5.2. The groundwater levels and postulated zone range of the Whitway Rock horizon are also problematic (see figure below, as used in Stonehenge Alliance's presentation to ISH 10).

2.5.3. There is no obvious reason, nor any explanation why the Mortimore 2012 version of the proposed A303 tunnel route section is used and represented in AWM Report No. TR010025 Document 8.23 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment (republished with tracked changes, dated 31.05.19) by Travis et al. Why was Mortimore's 2012 figure used in preference to the presumably up-dated figure (16a) in Mortimore et al., 2017? (shown below for ease of reference)

Figure 2: from AWM Report No. TR010025 Document 8.23 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment (republished with tracked changes, dated 31.05.19) - Travis et al.

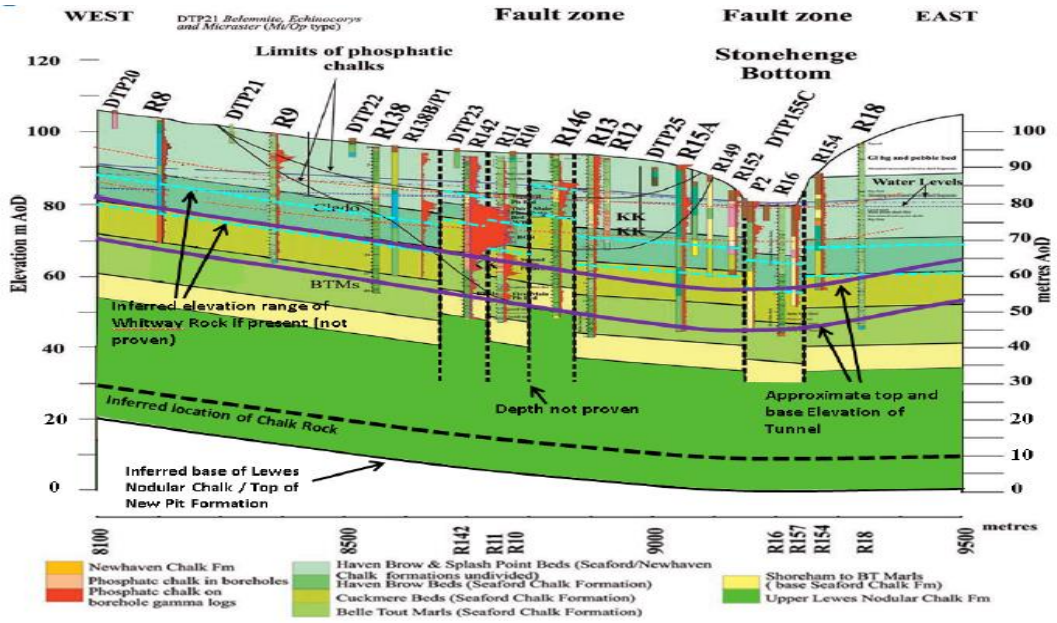

Figure 2: Chalk Stratigraphy with Tunnel and Chalk Rock Elevations (adapted from Mortimore (2012))

Fig. 16 (a) from Mortimore et al., 2017

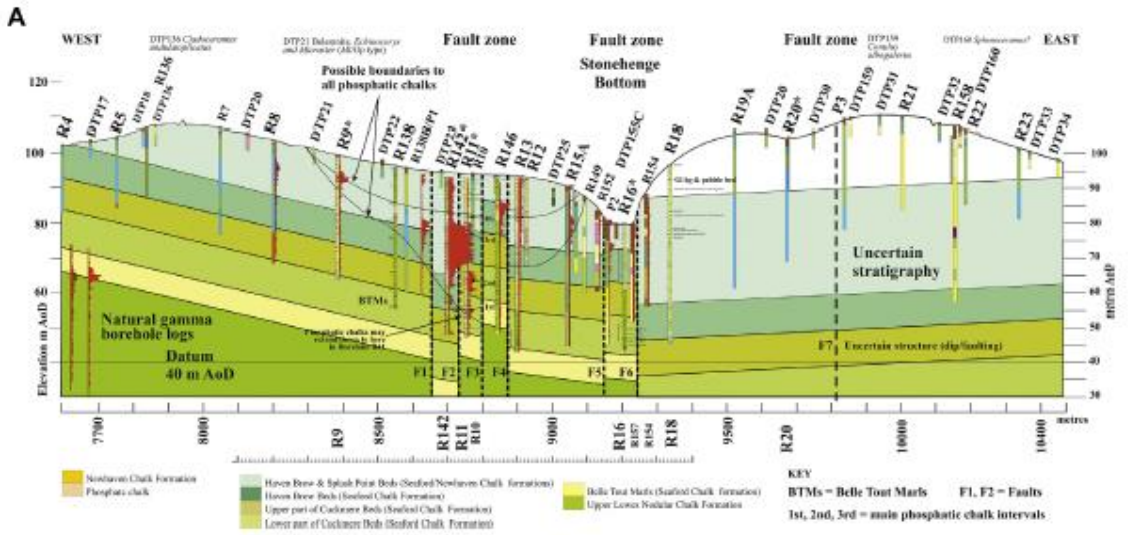

Fig. 16. (a) The control boreholes used to establish the stratigraphical position and thicknesses of the chalk beds and the phosphatic chalks. Fully-cored boreholes R9, R142, R11, R16 and R20 have been biostratigraphically analysed for macro- and nannofossils and provide the controls for recognising bed displacements caused by faults and the stratigraphical position of the phosphatic-chalks. In addition, other boreholes with Natural Gamma geophysical logs (red spiky profiles), show where phosphatic-chalks are present. Mt = *Marsupites testudinarius*, Op = *Offaster pilula*. (b) Sedimentary model 1: A multichannel interpretation for the Stonehenge phosphatic chalks constructed from boreholes and trial pits showing the zones of north–south faulting defining the eastern limit of the channels (no phosphatic-chalks east of Stonehenge Bottom). The geological section shows the location of the two largest channels and 18 smaller ones in a complex fault zone (Modified from Mortimore, 2011, 2014). The thickest deposits are located in a down-faulted area between faults F1 and F2. Mt = *Marsupites testudinarius*, Op = *Offaster pilula*. (c) Sedimentary model 2: A single major channel interpretation for the Stonehenge phosphatic-chalks linking the thickest deposits with fewer smaller ones. The large channel incorporates phosphatic-chalk Event 3 (P3) in BHR11 and R142 and is presumed to incorporate the thick phosphatic-chalks in BHR12. Earlier phosphatic-chalk Events P1 and P2 and the later P4 event are represented by smaller channels. Mt = *Marsupites testudinarius*, Op = *Offaster pilula*.

References:

AWM Report No. TR010025 Document 8.23 – Implications of 2018 Ground Investigations to the Groundwater Risk Assessment (republished with tracked changes, dated 31.05.19) by Travis et al.

R. N. Mortimore, "Making sense of Chalk: a total-rock approach to its engineering geology", *Quarterly Jnl. of Engineering Geology and Hydrogeology* 45 (2012), pp.252–334

R.N. Mortimore, *et al*., "Stonehenge—a unique Late Cretaceous phosphatic Chalk geology: implications for sea-level, climate and tectonics and impact on engineering and archaeology", *Proc. Geol. Assoc*. 128 (2017), pp.564-–598

3. <u>PART TWO</u>: Response to Highways England's Deadline 8 Submission REP8-018: Written Summary of oral submissions put at Flood Risk, groundwater protection, geology and land contamination hearing on 29 August 2019, Appendix A - Highways England Comments on Dr GM Reeves Presentation.

3.1. We submit the following observations/comments by the Applicant corresponding to the numbering of Dr Reeves' presentation slides

Slide 1. The Applicant has possibly not noticed the section produced as Fig.14a in Mortimore et al. 2017, which shows the uncertainty of the geology east of Stonehenge Bottom and that the Whitway/Stockbridge Rock horizon could therefore be lower than 90–100m and, indeed, be the cause of the Blick Mead/Amesbury Abbey Springs. We believe this issue needs to be more fully investigated.

Slide 2 (iii). Dr Reeves examined over 6,000 pages of site investigation reports, borehole logs, core logging and geophysical data as part of the Stonehenge Alliance submissions and presentations prepared and given to the ExA. These were from the 2001-2004 site investigation reports, from the BGS GeoIndex database, and the (previously confidential) 2017 drilling reports released at the Stonehenge Alliances' specific request in March 2018 by Highways England. The additional 4,000 2018/2019 site investigation reports, which Highways England have refused to release could well provide additional informative data to assist in the understanding of ground conditions along the proposed tunnel and road route.
(iv). As far as we know, no specific groundwater testing (eg. Packer testing, the use of multiple completion instrumentation systems, such as Westbay, or even specific large-scale pumping testing) has been targeted at the western portion of the proposed tunnel route (i.e., to the west of Stonehenge Bottom). It is in this area that, together with the complications of poor rock conditions in the Phosphatic Chalk zones, difficult groundwater conditions due to the recorded sub-horizontal fracturing (as detailed in Section 2, above) may cause difficulties and delays to the TBM.

Slide 3. We agree that the Whitway Rock may not appear as a continuous feature across the A303 Scheme which is one of the reasons why we have expressed caution. See our response to the Applicant's comments on Slide 1. Please see also our statements at Slides 7 and 9.
Dr Reeves made no mention of karst features in his evidence.

Slide 4. Groundwater modelling using a 250 metre node spacing, adapted from the Wessex Basin aquifer-wide 2012 based regional model is not "fit for purpose" for this proposed £1 .7 billion plus 3.3 km tunnel and road scheme.

Slides 7, 8 and 9. Please see our statements at Slides 1 and 3. We suggested that Professor Mortimore might be asked to attend the Examination to give his opinion but he was not brought forward by Highways England; nor have his verbal observations been referenced by the Applicant.

Slide 10. Borehole records from Borehole Nos. R501 (at tunnel soffit level; 32.50 to 33.10m depth/circa 60m AOD, recorded as "sub-horizontal fractures, open to moderately wide plus occasional brown stained sponges"); R502B (30.95 to 31.70m depth/72.28 to 71.53m AOD, recorded as "Fractures subhorizontal . . . open to wide undulating . . . plus highly brown stained Chalk"); R503B (34.90 to 36.20m/69.38 to 68.08m AOD, recorded as "brown stained Chalk Fractures sub-horizontal . . . core loss between 34.90 and 36.10 - Grade C3 - plus brown stained sponges"); R507A (recorded as Seaford Chalk from surface with much brown staining and sub-horizontal fracturing up to 21.95m depth/70.38mAOD); P2 (heavily orange stained from 10 to 18m depth/70 to 62mAOD); R18 (circa 70m AOD; Geophysical logs and core box evidence); plus numerous other 2001 to 2004 Site Investigation boreholes, all indicate sub-horizontal fracturing, evidence of "brown staining" plus or minus sponge-type materials.

Little detailed analysis of the investigation of the possibility of the "Whitway Rock Horizon", and its possible effect on rock quality and especially hydrogeological conditions is evident in Highways England's Environmental Statement or, most important, in their Groundwater Assessment reports.

Observations of spring flow into Amesbury Abbey Pool, together with fissure flow observed from the bedrock exposed in the Blick Mead archaeological investigations (Andrew C. J. Rhind-Tutt, Additional submission accepted at the discretion of the Examining Authority – Video titled 'Blick Mead Spring – Amesbury June 2019') indicate an eastern component of groundwater movement, as does Mortimore *et al.* (2017) Figure 28. In this 2017 conceptual groundwater flow regime map, there is indicated an SE component of groundwater movement north of the current A303, both towards Stonehenge Bottom and also towards West Amesbury Spring. There is no other structural feature to generate spring flow to the Amesbury Abbey springs system than the "Whitway Rock Horizon", even if it is highly variable and/or not a continuous sub-horizontal feature westwards.

Slide 11. Until more detailed ground investigation data is available, it is impossible for any geologist to come to the conclusion that its provision is or is not "necessary", or "appropriate" in giving clarity or important further details to an existing geoscientific database. Please see also our comments under Slide 2, above.

Slide 13. We have not said that the hard bands of ground rock are continuous, rather that they may not be and that they have not been fully investigated. The assured groundwater risk assessment should have been made available to the Examination in order to satisfy the concerns of private borehole users, etc. before any DCO may be granted.

Slide 14. Please see our comments under Slide 10, above.

3.2. Summary

The construction of cross passages, introduced at the last stages of the Issue Specific Hearing on 29th August is another poorly presented and explained step proposed for the tunnel construction. Presumably these will be mostly hand-excavated (or partially hand-excavated) after construction of the twin bores, with the expectation that rock stability and groundwater control have been successfully gained. It was admitted at ISH 10 that some dewatering might be necessary in construction of the cross passages and the Environment Agency reminded the Examination that there would be limits to the amount of dewatering permissable. The concern remains, therefore, that greater amounts of dewatering might be necessary, with knock-on effects at Blick Mead, private boreholes, etc. The Applicant has provided no certainty that this could not happen.

No comparative Chalk tunnelling project in an unconfined and locally important aquifer has been undertaken in the UK in the vicinity of such an important archaeological landscape as the Stonehenge World Heritage site.

Since the use of a closed-face bentonite slurry based TBM method was only adopted and announced by Highways England after the Examination had started (specifically by Highways England's QC, Mr. Taylor on 23rd May 2019, well after the Highways England scheme documentation was published), it would appear that this fact, together with all the above shortcomings of the investigation and design process, especially relating to ground (specifically rock) and groundwater conditions leaves many unanswered questions, and a great deal to be desired in thorough and complete understanding of a potentially extremely difficult tunnelling environment.

Dr G.M. Reeves 24.9.19