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INTRODUCTION

4.1. This section sets out additional information relating to Hindlow Tunnel in response to Derbyshire County Council's request dated 26th May 2015, under Regulation 22 of the Town and Country Planning (Environmental Impact Assessment) Regulations 2011.

4.2. The Hindlow tunnel that bisects the quarry is strategically important railway infrastructure and the request for additional information relates to the impacts of continuing quarrying operations at the site on the tunnel, in particular blast vibration, geology and land stability.

Blast Vibration Impact

4.3. Bullet point 1 of the Regulation 22 request dated 26th May 2015 stated that *"insufficient data has been provided to adequately assess the impact of blasting on the tunnel and surrounding rockhead."*

4.4. Chapter 11 of the original ROMP submission in November 2013 used a British Standard relating to buildings as there is not an equivalent standard relating to the effects of blast vibration on railway tunnels or below ground structures.

4.5. Rock Environmental Limited carried out a report in 1987 into vibration effects for the tunnel, with monitoring both in the tunnel and on the surface and what vibrations would likely cause damage to a tunnel structure. It was concluded that "*it is considered that recordings taken at the surface above the tunnel correlate very well to the actual vibration to which the tunnel wall is being subjected"* and they set a limit of 100mm/sec allowing for a large factor of safety with this limit.

4.6. Since late 2014 Lhoist have been in discussion with Network Rail regarding the regime required to blast near (adjacent and on top of) the Hindlow railway tunnel. In January of that year a topographic survey of the quarry was supplied to Network Rail and in June, Network Rail contractors carried out a survey in the tunnel and on the surface.

4.7. In July 2015 a detailed geotechnical assessment of the rock surrounding the tunnel was carried out by Key Geo Solutions including rock testing from two diamond core drill holes to ascertain whether the rock by the tunnel had the same properties/geotechnical structure as rock elsewhere in the quarry. This report is included as Appendix 4A to this document.

4.8. In August 2015 2 short holes were fired and vibrations monitored on the surface at regular intervals in a direct line from the blast. This information was used to design the next test blast. A meeting was held between Network Rail, Lhoist and their advisors to discuss the findings of the monitoring work completed to date. After the meeting Donaldson Associates were commissioned by Network Rail to do further studies of the rock mass and

stability assessments relating to materials on top of the tunnel to validate the logic behind the existing 10 m standoff surrounding the tunnel.

4.9. In August 2015 EPC UK Ltd then carried out a test blast in a different area of the quarry to gain an idea how vibration from the blast would pass through the rock and also to see whether the blast with a low MIC was move the rock.

4.10. Method statements and monitoring methods were then agreed with Network Rail and geophones were installed in the tunnel before a further test blast took place on the flank of the tunnel. Vibration predictions were carried out before each blast and the blast designs were amended accordingly. Vibration data was sent to Network Rail after each blast. They were also sent blast designs and the blast vibration predictions for each subsequent blast.

4.11. Network Rail are commissioning Donaldson Associates to carry out further investigations into the state of the rock head surrounding the tunnel lining to allow a safe working level above the tunnel to be ascertained.

4.12. In total, during early 2016, 8 production blasts were carried out with the railway closed for the duration of each blast and a tunnel walkthrough pre and post blast to check the condition of the tunnel. All vibration levels (max single plane vibration) received in the tunnel were below 12mm/sec.

4.13. The geophones were removed after the last blast and Lhoist are now waiting to hear from Network Rail whether the cables need to be removed from the tunnel.

4.14. A proposal email was sent to Network Rail in March 2016 for future production blast monitoring and Lhoist are waiting to see what their preferred option is. The 2 proposed feasible options for future vibration monitoring are as follows:

- Option 1 is to continue with surface monitoring as has been carried out at the site for the last 20 years and then apply a formula to convert it to a measurement that would have been received at depth using a relationship Lhoist has been investigating during the recent tunnel blasts;
- Option 2 is to install geophones in 4 boreholes located at intervals along the length of the tunnel to allow coverage for any future blasting. These would be connected to a central monitoring location that can be accessed from the surface without the need to enter the tunnel. The geophones would be located at the same height as the tunnel in line with some of the refuges and they would be drilled to the north of the tunnel under the edge protection bund so there was no risk of any damage from passing vehicles etc. This would mean that the vibration measured in the boreholes would be slightly higher than if it was measured nearer to the tunnel due to the distance relationship, however if the results comply with the limits agreed for the tunnel at these locations the tunnel would always receive a vibration lower than the limit. If this option was preferred by Network Rail then Lhoist would need the co-ordinates for the remaining refuges so the boreholes could be located accurately; and

- A third option is now being discussed to refit the geophones in the tunnel and to continue monitoring the vibration from each production blast inside the tunnel. This option would rely on Network Rail installing and maintaining the geophones as there would be an increased risk of damage to either the cables or the geophones either from weather effects, vermin or human interference. Lhoist would however cover the cost of purchasing the equipment and carry out the monitoring.

Land Stability

4.15. Bullet point 2 of the Regulation 22 request dated 26th May 2015 stated that *"Land stability has not been considered as part of the ES, and therefore the stability of the rockhead above and surrounding the tunnel is not given due consideration.."*

4.16. Land stability was assessed as part of the process of compiling the original ROMP submission. Lhoist have a geotechnical assessment every 2 years and there have been no concerns raised about the safety of the tunnel in relation to the designed work or the stocking of materials or the face conditions surrounding the tunnel. Additional geotechnical work is described above.

Topographical Survey

4.17. Bullet point 3 of the Regulation 22 request dated 26th May 2015 required *".Information on the current depth of ground between the surface at the quarry to the tunnel structure (i.e. the thickness of intact rock above the tunnel)…"*

4.18. The topographical survey included in the original ROMP submission of November 2013, was dated 2012. As described above, an updated topographical survey was undertaken by Lhoist in December 2015 and this is now included in this document as Drawing BQ 3/1 Rev A.

4.19. Network Rail contractors also carried out a survey in June of the tunnel and on the surface. This has allowed both parties to understand the current depth of ground between the surface of the quarry and the tunnel structure (i.e. the thickness of intact rock about the tunnel).

Mitigation measures

4.20. Bullet point 4 of the Regulation 22 request dated 26th May 2015 stated that "*Sufficient mitigation measures for the Hindlow tunnel have not been included in the ES.*"

4.21. Whilst the investigation work mentioned in paragraph 4.11 is ongoing, Lhoist have undertaken to not extract limestone directly above the tunnel during a 7 month period from the date of a letter sent to Network Rail (February 2016). This is in response to a request from Network Rail's Mining Department to allow sufficient time for the investigations in to the rock mass surrounding the tunnel to be completed.

4.22. Whilst blasting alongside the railway tunnel, very small blasts were carried out with very low maximum instantaneous charge weight and minimal burden and spacings and electronic detonators were used to initiate the blast, all of which helped to reduce vibration levels received by the tunnel.

4.23. Blasting directly above the tunnel has now been ruled out due to insufficient data on how vibration acts in a vertical direction. The mineral above the tunnel will be extracted using a ripping method.