Extension of Linhay Hill Quarry

Additional information requirements regarding hydrogeology, hydrology and land stability

1. Introduction

A planning application was submitted to Dartmoor National Park Authority (DNPA) in June 2016 for the deepening and extension of Linhay Hill Quarry in Ashburton. The application was accompanied by an Environmental Statement (ES) prepared by Atkins Ltd. on behalf of the applicant E&JW Glendinning Ltd (Glendinning).

Wood (Wood Environment & Infrastructure Solutions UK Ltd), then known as Amec Foster Wheeler, was appointed by the DNPA to review the planning application and ES. Two requests have been made by Wood since June 2016 for further information to ensure that the ES meets the requirements of the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (the EIA Regulations). These requests were made in December 2016 and September 2018 under Regulation 22 of the EIA Regulations and are known as Regulation 22 Request 2016 and 2018 respectively.

In response to these requests, the applicant has made four separate information submissions which have been referred to as Tranche #1 to Tranche #4. The DNPA has examined these submissions, together with two 'Other Information' documents submitted by the applicant in July and October 2019, and considers that further information is required in respect of hydrogeology, hydrology and land stability. This third DNPA request under Regulation 22 of the EIA Regulations for further information is referred to as 'Regulation 22 Request 2020', and we expect that the applicant's response will be named Tranche #5.

2. Background

In February 2019 Atkins, on behalf of E&JW Glendinning Limited, issued its response to the Regulation 22 Requests 2016 and 2018, which included the following:

- A revised ES Chapter 12 Flood Risk and Effect on Water Resources (Revised ES), presented in Appendix 8.1 of Reg 22 Tranche #3;
- A revised and updated Hydrogeological Impact Assessment (HIA), presented as Appendix 12B of the ES;
- A revised and updated ES Chapter 17 on Land Stability, presented as Appendix 8.2 of Reg 22 Tranche #3; and
- A revised and updated Land Stability Risk Assessment (LSRA), presented as Appendix 17.1 of the ES.

Since that submission, a number of discussions and exchanges of correspondence have taken place between Glendinning, Atkins, DNPA and Wood regarding matters of hydrogeology, hydrology and land stability, and a number of relevant third party representations have also been made to the application. In response, Atkins

has recently (October 2019) issued further information in support of the ES (Other Information Document #2). This section of Regulation 22 Request 2020 therefore provides a brief summary of Wood's understanding of the current position, based on the submissions, representations and discussions seen to date, and provides context for the later information request (Section 3).

Much of the work undertaken to date by Glendinning and Atkins has been focussed on completing ground investigations to try to confirm the existing 'baseline' groundwater flow regime in the vicinity of the quarry. This then provides the basis for understanding how the proposed quarry deepening and extension would affect the groundwater flow regime, and the associated surface (including land stability) environment.

The ground investigations that have been undertaken to date are welcomed, and the recent focus has been on the interpretation of the results and how typical they are of the wider limestone aquifer. The results have been the subject of a number of different interpretations, but based on Other Information Document #2 it appears to now be agreed that the results of the investigations do not preclude the possibility that the groundwater in the shallow limestone 'epikarst' and the deeper limestone is in some hydraulic continuity (or connectivity, potentially via both conduit and diffuse flow) with the water table close to the surface and supporting a number of surface water features. This being the case, as the quarry deepens and extends shallow groundwater conditions in an area around the quarry and extension could be affected, with potential consequences for groundwater-dependent surface water features and the possibility of further sinkhole development. However, it is the degree of hydraulic connectivity that determines the lateral extent and magnitude of such effects, and there is currently no consensus of opinion as to how connected the shallow and deeper limestone aquifer is.

A theme amongst some of the third-party representations received, and the focus of some of the discussions between Glendinning, Atkins, DNPA and Wood, has been whether additional investigation work could provide sufficient information to clarify the hydrogeological conceptual model for the area. Wood considers that there is benefit in further investigation, in that it would allow more informed decisions to be made regarding the impacts that the proposed quarry extension could have on the water environment and also in terms of land stability. Whilst the investigations are unlikely to be able to address all uncertainties, they would also focus the 'monitor-and-mitigate' scheme, and so are considered worthwhile.

There has also been considerable discussion regarding the adequacy or otherwise of the applicant's proposals to 'monitor-and-mitigate' quarrying impacts. Wood considers that the applicant's proposals with regard to mitigation are not yet adequate, particularly given the current limited understanding of the hydrogeological regime and the potential impacts of the quarrying proposals. It is hoped that the applicant's response to this Regulation 22 Request will address this situation.

Finally, a number of concerns have been expressed regarding the adequacy of the EIA. Wood considers that the importance criteria are not sufficiently rigorous in a number of respects, commonly confusing receptor importance with vulnerability to effect. Furthermore, the findings of both the receptor importance and 'residual' effect assessments are insufficiently explained, and because of flaws in the importance criteria and current uncertainty about the degree of hydraulic connectivity in the hydrogeological conceptual model, the assessments are open to challenge. A number of potential receptors of quarrying effects also appear to have been missed by the assessment. The information request provides an opportunity for the applicant to address these issues with the EIA, and in so doing help to focus its 'monitor-and-mitigate' strategy.

The purpose of the Regulation 22 request set out in Section 3 below is to help the applicant address these outstanding concerns. On receipt of the requested information, it is hoped that Wood will be able to issue definitive guidance advising DNPA and other interested parties of its position with respect to the proposed development.

3. Regulation 22 Request

Under Regulation 22 of the EIA Regulations, further information is requested in relation to the aspects outlined below.

3.1 Hydrogeological conceptualisation

There is a benefit in better understanding the 'baseline' hydrogeological flow regime, as it informs the assessment of the lateral extent and magnitude of future quarrying effects and the form of the future 'monitor-and-mitigate' strategy. In particular, there is a need to better determine the degree of hydraulic connectivity present within the aquifer and also between the aquifer and overlying surface water features. By way of example of both the deficiencies in the current 'baseline' understanding and how to address them, Wood has previously suggested the following:

- a reappraisal of existing groundwater level information, to look more closely for signs of vertical hydraulic connectivity in the aquifer;
- the drilling and monitoring of additional observation boreholes (OBHs), including a number of locations with closely spaced OBHs monitoring different (e.g. two or three) depths of the aquifer, in order to better establish the degree of vertical hydraulic connectivity in the aquifer, and also to address 'gaps' in the existing monitoring network both east and west of the quarry;
- the drilling and monitoring of additional shallow OBHs close to potential surface water receptors such as watercourses and conservation sites, primarily to determine their degree of groundwater-dependence;
- completion of a longer duration pumping 'signal' test, rather than a conventional aquifer parameter test. A 'signal' test perturbs the aquifer and utilises the resulting extended monitoring network in order to establish the existence and degree of vertical hydraulic connectivity between the deeper and shallow aquifer, and also between the aquifer and the potential surface water receptors. The maximum abstraction rate in the test should be sufficient to achieve drawdowns of tens of metres in the pumping well, in order to approximate the proposed quarry dewatering requirements; and
- a reassessment of the aquifer and quarry water balances, in order to better resolve individual surface inflows and outflows, to better rationalise the 'out-of-balance' terms and to delineate a potential quarry groundwater catchment.

Works such as these would be best undertaken in unison, but also have merit in their own right. For example, the monitoring of additional OBHs outwith a formal signal test format would still provide useful information regarding lateral and vertical variations in groundwater level and hydraulic gradient.

However, whilst due consideration should be given to the above suggestions of further work, it is for the applicant to determine what investigations it adopts to lessen or resolve the identified conceptual uncertainties. For example, there may be merit in deploying other investigation techniques, such as further surface- and downhole-geophysics and groundwater tracing. Other examples of potentially suitable techniques are mentioned in the Environment Agency 'Hydrogeological impact appraisal for dewatering abstractions' Science Report SC040020/SR1 and elsewhere in the karst hydrogeology literature. Whichever investigation techniques are deployed, a refined hydrogeological conceptual model should be presented by the applicant on receipt and interpretation of the additional data. This is likely to include a number of conceptual cross-sections (pre- and post-development) and maps delineating baseline and development quarry groundwater catchment areas and associated potential receptors.

Previous discussions between the parties regarding further site investigation were well advanced, but Wood recognises an understandable reticence by the developer to commit to such work when it's outcomes may not be conclusive. Wood would only point out that without further investigation the current uncertainty regarding the hydrogeological conceptual model and potential impacts will remain, leading to the need for a more precautionary EIA and a more onerous 'monitor-and-mitigate' strategy.

3.2 Monitor-and-mitigate strategy

Hydrogeology

A 'monitor-and-mitigate' strategy needs to be formulated by the applicant to address impacts that are identified in the revised EIA. The outcome of the revised EIA outlined in Section 3.4 below cannot be prejudged, but for the purposes of the discussion presented here all of the receptors identified in the ES and in subsequent discussions are regarded by Wood as potentially needing to be included in the strategy e.g. including Pridhamsleigh Cavern Site of Scientific Interest (SSSI), Water Framework Directive surface and groundwater bodies and the local limestone aquifer itself. In reality, the formulation of the strategy will be informed by the results of the revised EIA.

It is again for Glendinning and Atkins to consider the form of its response to this request, although Wood advises as follows with respect to the monitoring:

- the location and form of all existing/proposed monitoring structures need to be identified. Surface water receptors such as watercourses and conservation sites will need to be monitored by way of both flow devices and nearby shallow OBHs, and possibly at a number of locations e.g. as watercourses enter and leave the limestone outcrop/subcrop. The aquifer wellbeing will need to be monitored by OBHs at a number of locations and at varying depths. In some instances, the continued use of existing monitoring structures is acceptable;
- both water level and quality monitoring will be required;
- the water level monitoring should be by automated data logger if at all possible, and at an appropriate interval. The data loggers should be downloaded regularly;
- stringent quality control procedures need to be identified to ensure that any monitoring data are of satisfactory quality e.g. routine calibration of measuring instrumentation, verification of automated readings by manual measurements; and
- it is anticipated that monitoring to inform the mitigation will be undertaken for at least twelve months prior to the commencement of sub-water table quarrying operations i.e. the mitigation monitoring (as opposed to that required for hydrogeological conceptualisation) could be conditioned.

Wood recognises that the latest HIA provides some information in this regard, but the monitoring proposals should be reconsidered in the light of recent Wood, Environment Agency and third party comments, and extended to cover all receptors.

Wood considers that the current consideration of mitigation in the HIA and ES is limited, particularly given the current level of hydrogeological conceptualisation. In terms of mitigation, it is suggested that Glendinning and Atkins develop a means of providing compensation flows to the various receptor locations, including the consideration and mapping of provisional pipeline routes.

It is suggested that the Environment Agency is also consulted during the formulation of the 'monitor-and-mitigate' proposals, and that the ability to modify the strategy as further information regarding the hydrogeological flow regime comes to light needs to be emphasised. The development of appropriate 'trigger levels' to govern the mitigation effort is considered by Wood to be a matter for Glendinning and the

Environment Agency to address in due course, once adequate extended baseline monitoring has been undertaken.

3.3 Land stability

Whilst it is understood that changes to surface drainage and surface flow are likely to be a major cause of sinkhole development, quarry dewatering may also be a factor if there is vertical hydraulic connectivity in the aquifer. Subsidence sinkholes (Class B/C) may therefore develop where the lowering of groundwater induces downward vadose drainage and transport of sediment into voids. Also, buried sinkholes (Class A) may be locally aggravated if soil is washed out into underlying conduits and voids (Waltham and Fookes, 2003).

Therefore, there is a requirement to revisit the LSRA, the assessment of residual land stability effects, and the monitoring and mitigation actions proposed in the Karst Management Plan. Whilst it is for Glendinning and Atkins to consider what is needed to meet this requirement, Wood would advise that consideration is given to the following:

- increased frequency of monitoring proposed in LSRA (i.e. walkover inspections, structural surveys, ground and surface water monitoring) in areas of higher risk of sinkhole development and higher residual land stability risk. This could also include additional inspections in response to high rainfall events;
- comparison of sinkhole development with records of weather conditions, to ascertain if particular sinkholes have developed as a result of high rainfall, therefore indicating that they are due to downward percolation of surface water, rather than as a result of dewatering; and
- structural surveys of properties at Lower Waye, Alston Farm, Alston Cottage and Caton to commence prior to the commencement of quarrying.

3.4 EIA

The EIA needs to be revisited, in order to accommodate the refined conceptual model and 'monitor-and-mitigate' strategy resulting from the above work and to address the previously identified problems of the impact assessment, namely the following:

- the ES importance criteria based on Department of Transport guidance are considered not sufficiently rigorous in a number of respects, commonly confusing receptor importance with vulnerability to effect. Wood recommends that a robust set of importance criteria more relevant to a proposed mineral excavation are identified and implemented;
- the receptor importance and 'residual' effect assessments need to be revisited and better explained, because flaws in the importance criteria and current uncertainty about the degree of hydraulic connectivity in the hydrogeological conceptual model mean that they are open to challenge. For example, the rationale and findings of the assessment must be clearly stated in terms of receptor importance, potential magnitude of change (with embedded mitigation), potential significance, residual magnitude of change (with additional mitigation) and residual (final) significance; and
- a number of receptors also appear to have been missed by the current assessment and need to be considered e.g. the River Ashburn, Dart and Lemon WFD surface water bodies, the limestone aquifer and the Teign, Avon, Dart and Erme WFD groundwater body and the Pridhamsleigh Cavern SSSI.

Resolving these problems will have consequences for the 'monitor-and-mitigate' strategy.

Wood is expecting that during their formulation there will be some iteration between the 'monitor-and-mitigate' strategy and the EIA, in order to ensure that both deliverables are robust and supportive of each other. In the absence of conceptualisation informed by further investigation and analysis of the resulting data, the EIA would need to take a more precautionary approach. For example, a more extensive 'monitor and manage' strategy would need to be provided, as greater reliance would fall on this strategy to manage any effects that may occur.

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