Planning Appeal
APP/M1900/W/21/3278097

Land at Hatfield Aerodrome, off Hatfield Road

Proof of Evidence of Jenny Lightfoot

Issue | 19 October 2021

Job number 280446-61

Ove Arup & Partners Ltd
9th Floor 3 St Paul's Place
Norfolk Street
Sheffield S1 2JE
United Kingdom
www.arup.com

ARUP

Contents

Appendices

1 Qualifications and experience

1. My name is Jenny Lightfoot. I am a Chartered Geologist, a Chartered Scientist and a Specialist in Land Condition with 29 years of relevant experience. I hold a Bachelor of Science honours degree in Geological Sciences and a Master of Science degree in Hydrogeology. I am registered as a 'Suitably Qualified Person' under the National Quality Mark Scheme for Land Contamination Management.

2. I am an Associate of Ove Arup and Partners Ltd (Arup) and I lead the Geoenvironmental discipline in the North West and Yorkshire region of Arup. At Arup I am responsible for projects involving all aspects of subsurface contamination and specialise in managing the risks associated with groundwater contamination.

3. I am familiar with preparing planning and permit submissions for new developments such as highway, rail, water, waste and energy schemes, including environmental impact assessments and contamination risk assessments.

4. Prior to joining Arup I led the Environment Agency regulatory team responsible for protecting groundwater resources from hazards such as coal mining legacy, landfill, contaminated land, and pollution incidents in Yorkshire.

5. I was previously aware of the Hertfordshire bromate contamination issues under consideration from general knowledge in the industry – this is well known as one of the most significant issues in England relating to groundwater contamination.

2 Scope of expert role

2.1 Instructions

6. I have been instructed by Hertfordshire County Council ('HCC') to provide an objective expert opinion on the proposed quarry operations at Hatfield Aerodrome off Hatfield Road, and specifically the possible implications associated with the extensive existing plume of groundwater contaminated with bromate and bromide present to the north of the quarry site.

7. This proof reviews the 2016 planning application associated subsequently submitted documents. It does not assess the 2021 revised planning application, as instructed by HCC, although I comment on the possible impacts of no pumping from LMH below.

8. My evidence is limited to assessment of the possible effects of the proposed quarry operation on the existing groundwater contamination plume and the possible outcome of any identified effects.

2.2 Tasks completed

9. In undertaking this expert role I have reviewed relevant documentation on the Hertfordshire County Council planning portal associated with the appeal and previous planning application submissions (planning ref: 5/0394-16 CM0961).

10. I have had open and constructive expert-to-expert meetings with the following:

    - Keith Spence, Jenny Thomas and Clay Durrant (Environment Agency) on 15th October 2021;
    - Peter Rowland and Luke Wilkinson (SLR) on 15th October 2021;
    - Dr Mike Rivett (GroundH2O+) on 13th October 2021;
    - Ilias Karapanos (Affinity Water) on 18th October 2021.

11. I have produced this proof of evidence to succinctly present the most important issues I have identified. It does not present a comprehensive commentary of my review and focuses on relevant aspects only.

12. I received a draft Statement of Common Ground (SoCG) on 18 October 2021, jointly drafted by the Environment Agency (EA) and Affinity Water (AW) and seeking input from HCC. I have not had the chance to consider the SoCG in detail in preparation of this proof. I will review it as a priority following submission of this proof (deadline 19 October 2021) and will address the consequence of the SoCG for my proof in due course.

13. The structure of the proof is as follows:

    - **Background** – brief summary description of the hydrogeology, groundwater contamination and proposed development.

- **Issues of potential concern** – this section presents four elements of the proposed development that have the potential to result in harm.
- **Assessment of the issues of potential concern** – this section considers the four issues in turn, the measures proposed by the appellant to address the components and considers the adequacy of these measures.
- **Residual concerns and possible solutions** – this section presents the residual concerns I have identified and outlines possible approaches to address these concerns.

2.3 Documents reviewed

14. Documents of importance to my proof include the following:

- Affinity Water (2018a) Letter to Hertfordshire County Council, 13 Aug 2018
- Affinity Water (2018b) Letter to Hertfordshire County Council, 18 Dec 2018
- Affinity Water (2019) Letter to Hertfordshire County Council, 20 May 2019
- Cook, S.J.C. (2010) The Hydrogeology of Bromate Contamination in the Hertfordshire Chalk: Incorporating Karst in Predictive Models, PhD thesis.
- EA (2016) Letter to Hertfordshire County Council, 5 Sep 2016
- EA (2018) Letter to Hertfordshire County Council, 6 July 2018
- EA (2019a) Letter to Hertfordshire County Council, 3 Jan 2019
- EA (2019b) Letter to Hertfordshire County Council, 28 Aug 2019
- EA (2019c) Letter to Hertfordshire County Council, 10 Oct 2019
- EA (2019d) Letter to Hertfordshire County Council, 18 Dec 2019
- EA (2020) Letter to Hertfordshire County Council, 3 July 2020
- Fitzpatrick, C.M. (2010) The hydrogeology of bromate contamination in the Hertfordshire Chalk: double-porosity effects on catchment-scale evolution, PhD thesis.
- HCC (2020) Public reports pack, 24 Sep 2020
- Rivett, M.O. (2019) Expert opinion on groundwater contamination aspects of the proposed quarrying activity Hatfield Aerodrome 14 December 2019
- Rivett, M.O. (2020) Summary of expert opinion on groundwater contamination aspects of the proposed quarrying activity Hatfield Aerodrome. Presentation to Development Control Committee 24 Sep 2020
- SLR (2015) Environmental Statement: Water Environment Chapter
- SLR (2016) Land Quality Risk Assessment, January 2016
- SLR (2019) Bromate monitoring data 2013 to 2019 (submitted to HCC)
- SLR (2020a) Hatfield Road Quarry: Groundwater and Water Management Plan, Final (Version 5), January 2020
- SLR (2020b) Response to Dr Rivett Report, June 2020.

3 Discussion

3.1 Background

15. A plume of contaminated chalk groundwater has resulted from historical release of contamination into the ground at a former industrial site in Sandridge (c.3km northwest of the application site). Groundwater flow in the chalk aquifer has distributed the bromate and bromide contamination dissolved in groundwater across an extensive area to the southeast and east of Sandridge, referred to in this proof as 'the bromate plume' (Figure 1).

16. The plume has been widely studied and reported in technical publications as it is one of the most significant recorded groundwater pollution incidents in the UK. Further expansion of the plume is controlled by pumping from the Affinity Water's Hatfield source, also referred to as Bishops Rise, (c.2km southeast of the application site) to 'scavenge' contaminated groundwater and prevent it from adversely affecting public water sources, namely abstractions at Essendon (c.6.5km east of the application site) operated by Affinity Water, and other sources further east operated by Thames Water. AW also operate two public supply sources at Roestock and Tyttenhanger (c.2 to 3km south of the application site.)

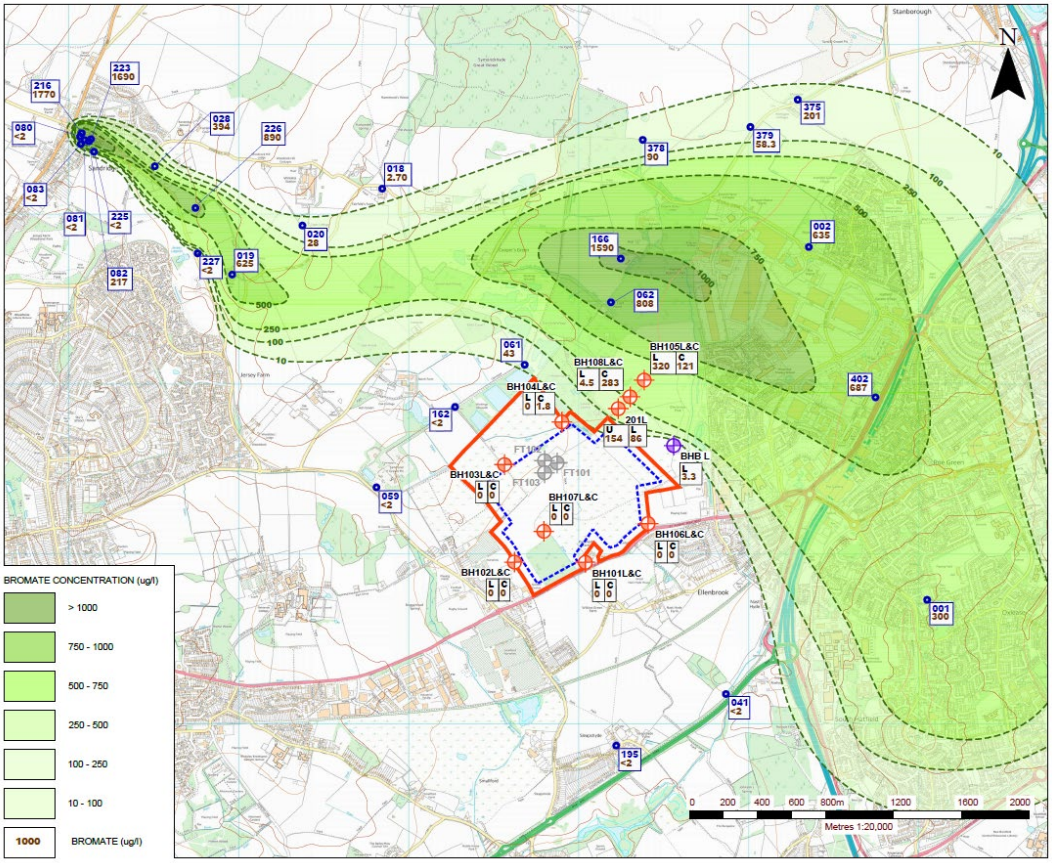
17. Environment Agency and site monitoring data indicates the bromate plume passes the application site close to the northeast site boundary in the Chalk Principal Aquifer and the overlying Lower Mineral Horizon (LMH). Recent monitoring data indicates the entire application site is within the AW Hatfield catchment which means that all groundwater beneath the application site is moving towards AW Hatfield under current pumping regime (and not to Roestock or Tyttenhanger).

18. The proposed quarry ('the site') will progressively extract the Upper Mineral Horizon (UMH), remove the interburden followed by extraction of the LMH. The LMH void will be backfilled with surplus site won material, overlain by a clay layer to reinstate the interburden, and the UMH will be backfilled by inert landfill.

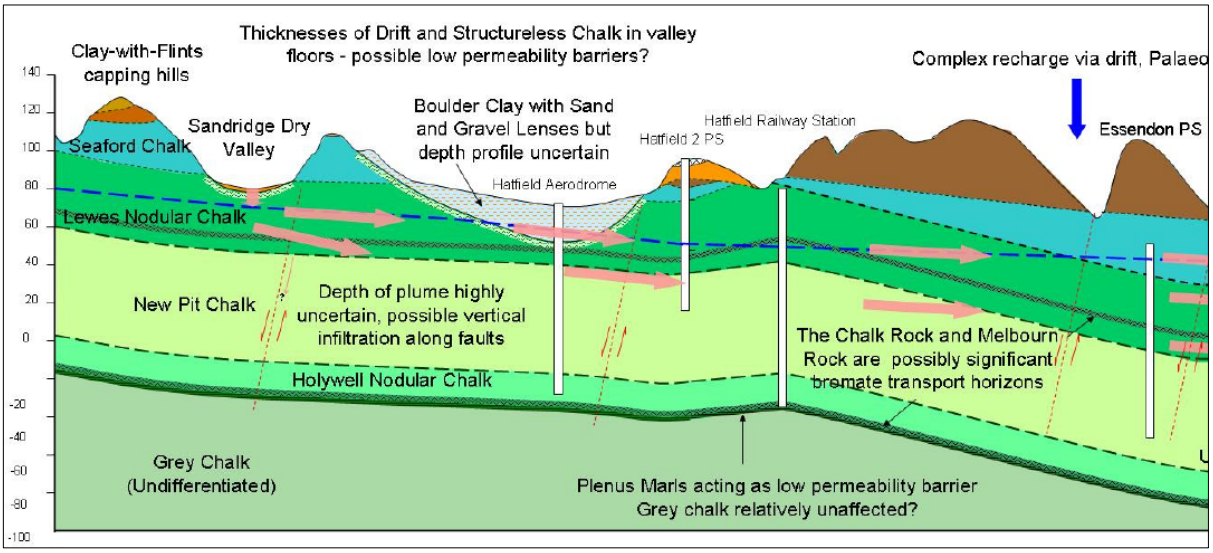
19. The UMH extraction and inert landfill placement are effectively hydraulically isolated from the LMH, chalk aquifer and bromate plume as groundwater in the UMH represents a shallow perched aquifer (Cook, 2010). The UMH extraction and inert landfill placement are not considered further in this proof.

20. Quarrying in the LMH has the potential to affect the bromate plume, as discussed below.

21. Figure 1: Regional bromate plume July 2014 (SLR, 2016)



22. Figure 2: Schematic geological cross section, northwest to southeast (Cook, 2010) showing the bromate source in Sandridge dry valley, indicative bromate plume (pink arrows) in chalk, relationship to LMH/UMH (grey) and AW Hatfield public supply source (shown as 'Hatfield 2 PS')



3.2 Issues of potential concern

23. This section presents the main issues of potential concern I have identified arising from the proposed quarry operations relating to the bromate/bromide plume.

3.2.1 LMH pumping drawing plume onto quarry site

24. Following removal of the Upper Mineral Horizon (UMH) the appellant proposes to excavate and stockpile the interburden, followed by excavation of the underlying Lower Mineral Horizon (LMH).

25. One of the proposed methods of removal of the interburden includes localised pumping of groundwater from the LMH (SLR, 2020a). Pumping from the LMH will locally lower groundwater level and draw groundwater towards the pumping location. The location of pumping will move from phase to phase as the quarry is progressively worked. Water pumped from the LMH will be discharged back to the LMH via the Lower Mineral Lagoon (LML) on the eastern site boundary.

26. Groundwater monitoring has shown bromate concentration increases from less than 2µg/l to c.500µg/l within 300m of the northeast site boundary and occasional elevated results have been recorded within the site.

27. The appellant estimates the required LMH pumping rate as 2500m^3/d to 4500m^3/d (SLR, 2020a). This would be a large abstraction in the area and would thus have the potential to significantly impact flows in the aquifer. For comparison, the AW Hatfield abstraction is licensed to pump up to c.9000m^3/d.

28. The proposed pumping and discharge will inevitably locally alter the groundwater flow regime by locally lowering groundwater levels and causing a mounding effect, respectively. This will be locally complex but has the potential to draw the southern edge of the bromate plume towards the site. The change in groundwater flow regime is temporary and will continue whilst pumping from the LMH or discharge to the LML continues. The significance of this potential effect is discussed in Section 3.3.1 below.

29. If the LMH was extracted without pumping the potential impact would be vastly reduced. The mineral removed would be replaced with groundwater flowing in to the void however the groundwater flow as a result of this displacement of mineral is insufficient to affect the bromate plume and is orders of magnitude lower than the LMH pumping described above.

3.2.2 Backfill in LMH forming a barrier to flow

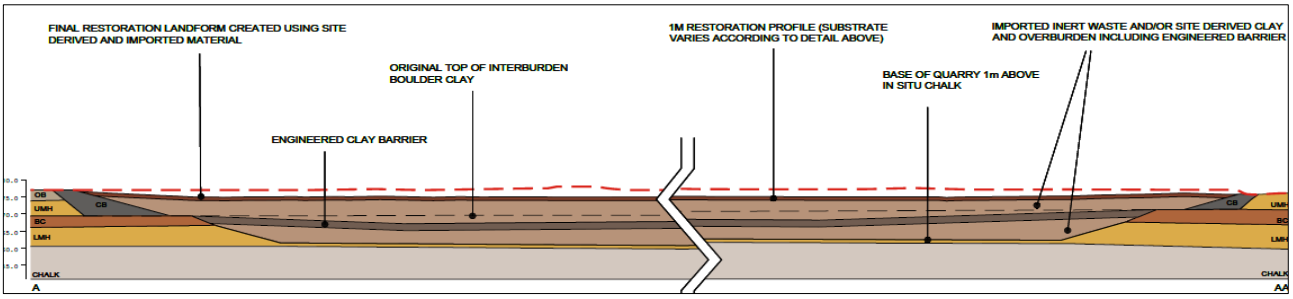
30. Following mineral removal, the LMH void will be progressively backfilled with surplus site won material, primarily of lower permeability than the LMH. This will result in a layer of less permeable material c.5m thick replacing the LMH beneath the site. Groundwater flow through the LMH, normally northwest to southeast, will be prevented from flowing through the backfill at the same rate and will be diverted around or under the backfill to an extent, depending on the permeability difference between the LMH and backfill.

31. This 'barrier effect' in the LMH will be a permanent alteration of the groundwater flow regime. The significance of this potential effect is discussed in Section 3.3.2 below.

3.2.3 Removal of contamination storage capacity in LMA

32. The bromate plume is mostly within the chalk aquifer that extends across the region. A swathe of primarily sand and gravel deposits (LMH and UMH) overlies the chalk between St Albans and Hatfield, including the site (Figure 2). The chalk aquifer is hydraulically in continuity with the LMH meaning groundwater can flow mostly unimpeded between the chalk and LMH so it acts as one unit hydraulically. The UMH is hydraulically separated from the LMH by the interburden. The upper part of the bromate plume passes through the LMH on its southeasterly flowpath. The hydrogeological properties of the LMH may result in a slowing and storage effect, and this 'attenuation capacity' will be removed when the LMH void is backfilled with lower permeability material. The significance of this potential effect is discussed in Section 3.3.3 below.

33. Figure 3: Schematic cross section of the restored site[1] (SLR, 2015)



1Note: vertical exaggeration – LMH backfill thickness c.5m and chalk effective aquifer thickness c.60m

3.2.4 Change in AW Hatfield pumping regime causing plume movement onto quarry site

34. Whilst not a direct result of quarrying at the site and not within the control of the appellant, varying the abstraction rate at AW Hatfield has been observed to change the location of the plume (Cook, 2010). AW Hatfield is currently pumping at less than its licensed rate at c.4500m^3/d (AW, verb. comm.). If the pumping rate was increased, for example with the objective of capturing more of the bromate plume, conceptually this may result in the southern plume edge moving further south in the LMH, potentially across the site.

35. If the increase in AW Hatfield pumping rate occurred *after* quarrying and backfilling was completed and to a sufficient extent that the margin of the plume was pulled across the site, this has the potential to divert the bromate-contaminated water in LMH around the south of the site, resulting in a significantly greater extent of chalk aquifer being affected and diverting a proportion of the plume into the catchment of Roestock and Tyttenhanger sources. This issue overlaps with the 'barrier effect' considered in Section 3.2.2.

36. If the increase in AW Hatfield pumping rates occurred *before* completion of LMH quarrying it could result in contaminated groundwater being encountered in the LMH during pumping and mineral extraction. Quarry operation may be adversely affected as contingency actions must be agreed with EA, HCC and AW and would likely result in the quarry being required to cease pumping of bromate-contaminated groundwater from the LMH. The significance and implications of this potential effect is discussed in Section 3.3.4 below.

3.3 Assessment of the issues of potential concern

37. This section describes my assessment of the key areas of concern identified in the preceding section. It also discusses measures included in the proposed scheme to address the areas of concern and assesses the adequacy of these measures.

3.3.1 LMH pumping drawing plume onto quarry site

38. As described in 3.2.1 pumping from LMH at the pumping rates estimated by the appellant (SLR, 2020a) could draw the southern edge of the plume towards and onto the site. Whilst there have been occasional detections of bromate, the appellant and EA consider the plume to not be located within the site (EA, 2019c and SLR & EA verb. comm.) and I agree with this assessment.

39. The LMH pumping rate estimated and assessed by the appellant in the Environmental Statement (SLR, 2016) (155 to 811m^3/d) appears to have been superceded in the more recent GWMP document (SLR, 2020) where LMH pumping rate estimated is an order of magnitude higher (2500-4500m^3/d). This estimated maximum daily pumping rate is very large and could have a major effect on LMH water levels and potentially the southern edge of the plume. No proposed annual pumping rate has been provided in the GWMP. However it is understood pumping is proposed to be minimised as far as practicable and will not be continuous (SLR, verb. comm.).

40. No calculations have been provided to underpin the pumping rate estimates by the appellant. Moreover no numerical assessment of the impact of the LMH pumping on the groundwater flow regime and the bromate plume has been presented. I understand a pumping test has been completed (EA and SLR, verb. comm.) and used to inform assessment of required pumping but I do not have the pumping test data or interpretation. I understand the pumping test involved extensive monitoring and did not identify any changes in bromate concentrations as a result of pumping (EA & SLR, verb. comm.). The EA is satisfied that the pumping test provided evidence the pumping effects would not affect the bromate distribution (EA, verb. comm.).

41. The lack of quantative and express assessment of the potential impacts of LMH pumping is a significant deficiency in the appellant's planning submission. Numerical representation of the hydrogeological system in a groundwater model would be informative in predicting the effects of LMH pumping. I consider detailed analysis, preferably with a groundwater model, to be necessary to assess whether the proposed pumping will potentially draw contaminated water into the site and thus extend the plume over a wider area.

42. In theory groundwater monitoring can be implemented that would provide early warning of changes in groundwater levels as a result of operations that may result in plume edge movement towards the site and this can prompt contingency actions to be implemented by the operator. These contingency actions would have to be sufficient to ensure that they prevented further plume movement as a result of the quarry activities, such a cessation of LMH pumping. Over a period of time without LMH pumping at the quarry I would expect the plume to gradually move back to its pre-quarry pumping location.

43. The question as to whether that adequate safeguards will be in place to ensure monitoring and contingency actions will be implemented by the operator at the site is now considered.

44. The EA has recommended planning conditions (Appendix A) that require the operator to produce a water monitoring and management plan. This plan must be approved prior to commencement of works and be reviewed and approved in advance of commencement of each phase. The planning condition requires the plan to include the location and details of monitoring locations, testing suites and frequencies. It also requires the plan to include 'details of contingency actions in the event of impact'. I consider that this condition gives some reassurance that the quarrying operations will be monitored and managed appropriately. It relies on the operator to behave responsibly and robust regulation by the EA as a consultee of the planning authority.

45. The appellant has submitted a Groundwater and Water Management Plan ('GWMP') (SLR, 2020a) in response to the draft planning conditions, identified as the 'initial' plan. The initial GWMP notes a phase-specific water management plan will be produced prior to each phase of quarry working. The adequacy of the monitoring plan and contingency action plan in the initial GWMP is discussed below.

46. The initial GWMP (SLR, 2020) includes a groundwater monitoring plan, identifying wells, frequencies and parameters to be monitored. The initial GWMP notes monitoring well specific control levels will be defined following assessment of baseline data. It also notes that a series of contingency actions will be enacted if these control levels are exceeded in any well, as follows:

> *A review of operations in the period prior to the exceedance will be made and an assessment of the likely cause identified, and appropriate mitigation measures implemented. Notification of the exceedance will be provided to the Agency, HCC and Affinity within one week of the exceedance. Detailed analytical results, an assessment of the cause of the exceedance and mitigation measures implemented will be sent to the Agency, HCC and Affinity within six weeks of the initial exceedance being recorded. Any changes to operational practice will be agreed with these parties should the nature and source of the contamination relate to on-site operations.*

47. Whilst this approach is reasonable there are two areas where significant uncertainty remains:

- The initial GWMP does not identify the hierarchy of contingency actions that could or would be implemented if control levels were exceeded and does not demonstrate how these contingency actions would be successful.
- The spacing of the monitoring wells proposed the initial GWMP is so large (c.500m spacing) that it may not effectively identify plume movement.

48. I consider that confidence in the proposals would be significantly enhanced if the appellant identified at this stage the hierarchy of contingency actions that would be implemented at particular benchmarks. This would give the public confidence, prior to planning approval, that action could be taken that would prevent irreversible environmental damage or water resources impact. The most effective contingency action would be cessation of pumping from the LMH and no further pumping from LMH.

49. I have discussed my concerns regarding potential for plume movement as a result of LMH pumping with the EA and AW. Both the EA and AW consider the long-term dataset (over 20 years) relating to the bromate plume provides a robust basis for characterisation of the plume behaviour (EA & AW verb. comm.). They noted that the dataset has covered wet and dry years and a range of pumping scenarios at public supply wells.

50. I understand (AW verb. comm.) that AW requested additional analysis from the appellant that has involved monitoring and assessing the impact of varying pumping at the AW Hatfield source on groundwater levels at the application site. This interpretation has been used to set control levels based on groundwater level in the monitoring wells at the site (AW, verb. comm.). The private agreement between AW and the appellant which I have not seen apparently requires additional monitoring, data provision to AW and sets control levels and a sequence of contingency actions (AW, verb. comm.).

51. I understand the EA would expect the GWMP submitted to discharge the planning condition to include more phase-specific detail. The EA indicated that if the initial GWMP was submitted it would be deemed insufficient (EA, verb. comm.). The appellant has indicated additional monitoring wells would be included in the phase-specific monitoring plan to be produced in advance of each phase (SLR, verb. comm.)

52. It is apparent through their planning consultation responses and my recent meetings that the EA and AW consider the assessment of the impacts of LMH pumping to have been undertaken to their satisfaction. The EA is satisfied that any impact can be managed via the planning condition and licensing regime (EA, verb. comm.) and AW is similarly satisfied with their private agreement with the appellant in addition to the EA's regulatory controls (AW, verb. comm.)

53. An alternative method for removal of the interburden that does not require LMH pumping is presented in the GWMP (SLR, 2020) and at my meeting with the appellant it was confirmed that the 2021 application would not include any LMH pumping (SLR, verb. comm.). If the proposal did not include LMH pumping the concerns identified in this section will be largely addressed.

54. If the proposal requires LMH pumping, I consider the publicly available assessments presented by the appellant that I have viewed to be inadequate to demonstrate the impacts of LMH pumping can be effectively managed. In particular the assessment of the required pumping rate, the effects of the pumping, the groundwater monitoring during pumping and the contingency actions have not been adequately presented.

3.3.2 Backfill in LMH forming barrier to flow

55. Backfilling of the LMH void with lower permeability material has the potential to create a barrier to groundwater flow in the LMH, resulting in diversion of groundwater around and/or beneath the site.

56. The LMH replaced with low permeability deposits is c.5m thick. A minimum of 1m thickness of unworked LMH will remain at the base (SLR, 2015). Beneath the LMH the Upper Chalk is c.30m thick beneath the site, underlain by a further c.50 to 60m of Middle Chalk (Cook, 2010). Groundwater flow within the chalk is complex, with some evidence of high velocity flow paths (Cook, 2010). The chalk effective aquifer thickness is typically considered to be c.60m (EA & SLR, verb. comm.)

57. The Environment Agency (at the development control committee meeting, Sept 2020) indicated their understanding that the historical mineral workings located to the northwest of the site extend into the LMH and the infill already forms a barrier to groundwater flow to the south to an unspecified extent. The EA implied that as the existing workings form a barrier, the application site would not create a significant additional barrier as it is located 'behind' the existing barrier. This was discussed with the EA and, whilst EA personnel have observed workings northwest of the site that extend to the chalk, no documentary record is available (EA, verb. comm.) including of the depth or the nature of the fill.

58. Assessment of the barrier effect of the proposed LMH backfill has not been presented by the appellant. In the Land Quality Risk Assessment (SLR, 2016) the appellant identifies the Hatfield Quarry Landfills as possibly presenting a barrier diverting the plume to the east (SLR, 2016). However I queried this with SLR, who confirmed this is not their current interpretation. SLR indicated they do not predict a significant barrier effect due to the relatively thin new low permeability layer (c.5m thick) compared to the c.60m aquifer thickness.

59. Dr Rivett raised the concern that diversion of groundwater flow to the north of the site could push the bromate plume northwards, potentially resulting in increased bromate at the Essendon public supply source (Rivett, 2020). Considering the observed stability of the plume under wide-ranging groundwater conditions it seems highly unlikely that such a significant effect could result (EA and AW, verb. comm.).

60. Affinity Water initially noted their concern that the barrier effect may divert the plume to the south of the site and towards Tyttenhanger and Roestock public supply sources (AW, 2018b). Subsequently Affinity Water entered an agreement with the appellant that included additional controls that provide 'a direct ability to ensure the sources…are protected during quarrying activity' and withdrew their

objection (AW, 2020). I have not seen the agreement between Affinity Water and the appellant. However SLR indicated the additional controls include specific level monitoring requested by AW on the west side of the site (SLR, verb. comm.). Given that they are not in the public domain and are not enforceable by the Council I am unable to comment on the efficacy of these controls in terms of detecting and then preventing movement of the plume and/or consequential impacts. This is essentially the same concern considered in 3.3.4 (*after* completion of quarrying scenario).

61. However, I consider the barrier effect is highly unlikely to result in significant adverse impact for several reasons: a) most importantly, the backfill layer forms a relatively thin barrier when compared to the full aquifer thickness and groundwater can be diverted beneath as well as around the site; b) diversion north of the site will have a local impact only and will not push the plume to the north due to the dominant effect of pumping from AW Hatfield; c) diversion of bromate contamination to the south is less likely as the plume would need to be already drawn across the site by another process (see Section 3.2.1 or 3.2.4), a situation that is considered unlikely due to the observed stability of the plume, and in any case any diverted concentrations are likely to be very low in the plume margin only; d) monitoring at the quarry would provide early warning of plume movement and contingency action could be implemented. I consider this to be a precautionary approach. In addition previous Hatfield Quarry workings may reduce the effect of the proposed quarry as a new barrier, however no documentary evidence for this has been viewed and no confidence can be expressed on this. Further analysis and quantification of the barrier effect of the proposed quarry could be undertaken by groundwater modelling (see Section 3.3.1) and would increase confidence in the acceptability of the proposals but is not considered necessary to consider the barrier effect alone.

3.3.3 Removal of contamination storage capacity in LMH

62. Whilst there have been occasional elevated results, the majority of the groundwater quality data from the site indicates the bromate plume is not beneath the site. Therefore the LMH is not currently providing significant contaminant storage. Removal of this storage capacity will not make a difference under current conditions.

63. Replacement of the LMH with low permeability backfill removes the *future* potential for the LMH to provide contamination storage. The storage capacity benefit would only arise if the plume moved across the site. The bromate plume is likely to extend through the full thickness of LMH and throughout the thickness of the Upper Chalk (c.30m thickness beneath the site) and partly into the Middle Chalk (c.50 to 60m beneath the site) (Cook, 2010). Therefore the LMH thickness that will be replaced with low permeability deposits is thin compared to the likely plume thickness, and the majority of contaminant mass would be in the chalk beneath the site. For these reasons the removal of future storage capacity in the LMH by replacement with low permeability material is unlikely to make an appreciable difference applying a precautionary approach.

3.3.4 Change in AW Hatfield abstraction regime causing plume movement onto quarry site

64. As noted in 3.2.4 changes in pumping rate at AW Hatfield can influence the location of the plume and therefore the likelihood of: a) the LMH pumping pulling the plume onto the site during LMH pumping; and b) the southern edge of the plume being diverted around the south after backfilling.

65. AW controls the pumping rate at the Hatfield source. AW pumps Hatfield at the maximum achievable rate considering the constraint of sewer capacity for treated waste water (c.4500m^3/d) and it is understood AW intends to continue pumping similarly into the future as this has been demonstrated to be most effective in protecting AW's Essendon source from bromate (AW, verb. comm.).

66. The plume has been monitored for c.20 years, including periods of drought, very wet years and a range of pumping scenarios at AW Hatfield. For contaminated-water in the plume to be diverted to the south of the quarry a significant plume movement to the south would be needed. Under no groundwater conditions in the last 20 years has such movement been indicated (EA & AW, verb. comm.). In this period the plume has remained stable and this has given AW and the EA confidence in the plume behaviour under a wide range of conditions (EA & AW, verb comm.).

67. Affinity Water initially objected to the proposed quarry on the grounds of risk to Tyttenhanger and Roestock public supply sources, specifically noting 'the assessment needs to consider the impact of the quarrying activities against maximum scavenging abstraction rates by Affinity Water' at AW Hatfield (AW, 2018a). AW note this was a precautionary approach (AW, verb. comm.) and resulted in extensive dialogue between AW and the appellant regarding the technical details of the proposals. The appellant has undertaken additional assessment of the effects of pumping at Hatfield on groundwater contours at the site and has developed monitoring and associated control levels that specifically address AW's concerns (AW & SLR, verb. comm.). Affinity Water and the appellant have entered a private agreement and AW has withdrawn the objection (Affinity Water, 2019).

68. This is reassuring as it suggests AW's initial concerns regarding diversion of bromate-contaminated water towards Tyttenhanger and Roestock have been addressed. However I have not seen the content of the agreement between the appellant and Affinity Water and therefore I am unable to assess whether this concern has been adequately addressed. I would like to see the details of the agreement and the additional assessments undertaken by the appellant.

69. In Section 3.2.4 I also identified the potential for a change in pumping regime at AW Hatfield resulting in contaminated groundwater being encountered in the LMH during pumping and mineral extraction at the quarry. As noted above the EA and AW have assessed the plume as stable under current, and proposed future, AW Hatfield pumping regime. Without LMH pumping at the quarry there is unlikely to be any appreciable movement of bromate contaminated water towards the quarry. However under both pumping and no pumping scenarios planning

conditions will require monitoring and contingency actions to be agreed in advance with AW, HCC and EA, as noted in Section 3.3.1.

3.4 Residual concerns and possible solutions

70. This section summarises the residual concerns I have identified and outlines possible approaches to address these concerns.

71. Of the four initially identified issues of potential concern, I am satisfied that there are no residual concerns associated with the second and third (the barrier effect and contamination storage capacity).

72. Residual concerns associated with the first and fourth initially identified issues (LMH pumping and AW Hatfield changes) are now considered.

73. I consider groundwater pumping from LMH to be the most significant residual issue as it results in the potential to draw bromate-contaminated water onto the site.

74. If the proposal requires LMH pumping, I consider the assessments presented by the appellant that I have viewed to be inadequate to demonstrate that the impacts of LMH pumping can be effectively managed. The assessment of the required pumping rate, the effects of the pumping, the groundwater monitoring during pumping and the contingency actions have not been adequately presented. No calculations have been provided to underpin the pumping rate estimates by the appellant. Moreover no numerical assessment of the impact of the LMH pumping on the groundwater flow regime and the bromate plume has been presented. I consider detailed analysis, preferably with a groundwater model, to be necessary to assess whether the proposed LMH pumping will potentially draw contaminated water into the site and thus cause expansion of the plume.

75. The appellant has indicated that the quarry can be worked without LMH pumping and that the new 2021 application does not include any LMH pumping (SLR, verb. comm.). A planning condition that prevents the appellant from undertaking LMH pumping would remove my concerns described in the preceding paragraph.

76. Groundwater monitoring and the approach to identifying contingency actions are proposed by the appellant in an initial Groundwater and Water Management Plan (SLR, 2020a). The initial GWMP notes a more detailed phase-by-phase GWMP would be produced in advance of commencement of each phase. The appellant intends to add to the currently proposed monitoring wells for each phase (SLR, verb. comm.). A phase-by-phase detailed GWMP would be required by planning condition, as recommended by the EA (see draft condition 26 in Appendix A). The EA has indicated they would expect to see much more detail in advance of each phase, as required by the EA-recommended planning conditions (EA, verb. comm.). The EA is satisfied that controls via the EA-recommended planning conditions and abstraction licensing regime are adequate to robustly regulate the site (EA, verb. comm.). I do not comment on the legal efficacy of that approach.

77. I consider the most significant limitations of the initial GWMP (SLR, 2020a) relate only to the LMH pumping scenario and are: a) the lack of defined hierarchy of contingency actions that would be implemented if site monitoring indicated

exceedance of control levels; and b) the lack of demonstration that measures are available that would prevent significant irreversible water resources impact. If points a) and b) were addressed by the appellant prior to planning approval, public confidence in the proposals would be expected to be significantly increased. If no LMH pumping is proposed, plume movement onto the site is considered to be very unlikely, as no quarry activities will substantially lower water levels or draw the plume onto the site and the plume has been observed to be stable over many years (see below).

78. I consider the wording of the EA-recommended planning conditions to require review to provide greater clarity. Draft planning condition 26 (Appendix A) includes three points i) to iii) the meaning of which has been debated (Rivett, 2020) and should be clarified. Also both EA-recommended conditions require a 'water management plan' to be produced with different objectives, leading to potential confusion.

79. Altering the pumping regime at AW's Hatfield source has the potential to cause changes in bromate concentrations at the site and changes in the AW-operated public supply catchments affected by the plume. However under a wide range of groundwater conditions monitored over 20 years the plume has not moved significantly to the south towards Roestock and Tyttenhanger (AW, verb. comm.). At AW's request the appellant has undertaken additional assessment of the effects of pumping at Hatfield on groundwater contours at the site and has developed monitoring and associated control levels that specifically address AW's concerns (AW & SLR, verb. comm.). These assessments are not in the public domain and I have not seen them. Affinity Water and the appellant have entered a private agreement that satisfies AW that their sources will be protected. I understand the agreement includes direct provision of agreed monitoring data to AW and control levels and contingency measures that are separate from any that will be agreed with the EA under the GWMP required by planning condition. AW thus have direct control, independent of EA regulation, and consider this to be a strongly precautionary approach to protect the AW public supply sources (AW, verb. comm.). AW has withdrawn the initial objection (AW, 2019 and verb. comm.).

80. Whilst this is reassuring I have not seen the content of the agreement between the appellant and Affinity Water, the additional assessments undertaken by the appellant, or the additional monitoring and contingency actions agreed and therefore I am unable to undertake my own assessment of the adequacy of these provisions.

81. I have discussed with the EA and AW their understanding of the bromate plume behaviour under different rainfall conditions and in response to pumping at AW Hatfield. EA and AW have developed this understanding with the evidence of over 20 years of monitoring data using EA, AW and third party data (including the appellant's site monitoring). I have also queried how the EA and AW have undertaken their assessment of the quarry proposals and the potential implications for the bromate plume and groundwater resources. Both the EA and AW have indicated they have undertaken detailed assessment and satisfied themselves of the acceptability of the proposals in terms of groundwater protection (EA & AW, verb. comm.).

4 Declaration

82. I hereby declare as follows:

83. This proof of evidence includes all facts which I regard as being relevant to the opinions that I have expressed and that the inquiry's attention has been drawn to any matters which would affect the validity of that opinion;

84. I believe the facts that I have stated in this proof of evidence are true and that the opinions expressed are correct; and

85. I understand my duty to the inquiry to help it with matters within my expertise and I have fully complied with that duty.

Appendix A

Relevant draft planning conditions

A1 Relevant draft planning conditions

Relevant draft planning conditions, taken from HCC (2020) Public reports pack, 24 Sep 2020

Groundwater - Condition 26

Each phase of the development hereby permitted shall not commence until a Water Monitoring & Management Plan, including a timetable of monitoring and submission of reports to the local planning authority, has been submitted to, and approved in writing by, the local planning authority. Reports as specified in the approved plan, including details of any necessary contingency action arising from the monitoring, shall be submitted to, and approved in writing by, the local planning authority.

Reason To protect controlled waters and to not exacerbate the existing groundwater pollution. ensuring no deleterious impact to groundwater quality, in accordance with Policy 16 (Soil, Air and Water) of the Hertfordshire Waste Core Strategy 2012; To prevent development that would have an unacceptable risk or adversely affect water pollution; To minimise the risks associated the flow and quantity of surface and groundwater and migration of contamination from the site, in accordance with paragraph 143 of the NPPF.

The Water Monitoring and Management Plan for each phase shall refine the Groundwater and Water Management Plan. Final (Version 5). Prepared for: Brett Aggregates Limited by SLR consulting and shall include:

1. Details of construction and water management during construction of the two infiltration lagoons.

2. Clarification of the restored site discharge point for the UML back-drain.

3. A long-term groundwater monitoring plan to continue during and post the operational phase.

4. A mechanism for periodic review.

The plan should include monitoring and reporting programs, location of monitoring points including additional monitoring boreholes particularly in the vicinity of the infiltration lagoons, analytical suites, limits of detection and groundwater level monitoring. Details of contingency actions in the event of impact shall also be included. The two infiltration lagoons and back drain shall be constructed in accordance with the approved Groundwater Management Plan prior to the commencement of mineral extraction.

Groundwater monitoring shall be conducted by the Mineral Operator in accordance with the long-term groundwater monitoring plan for the lifetime of the development. Prior to mineral extraction in each Phase, the Groundwater Management plan shall be reviewed and an updated plan submitted and approved in writing by the Mineral Planning Authority.

Water Management Plan – Condition 30

Prior to the commencement of mineral extraction in each Phase, a water management plan shall be submitted and approved in writing by the Mineral Planning Authority. The water management plan shall detail measures to manage water from the lagoons, including an exceedance route for discharge of water from the lagoons as surface water under exceptional circumstances, and include a mechanism for periodic review. The management of water shall be carried out in accordance with the approved Plan, or as otherwise agreed by the Mineral Planning Authority under the periodic view process, for the lifetime of the development.

Reason: to minimise the risk of surface water flooding and in the interests of water quality.

The management of water shall be carried out in accordance with the approved Plan, or as otherwise agreed by the Mineral Planning Authority under the periodic review process, for the lifetime of the development.