Ground movement and sinkhole near Hyde Heath – Frequently Asked Questions

High Speed Two (HS2) is the new high speed railway for Britain. We have produced this document to answer frequently asked questions about ground movement (sinkhole) near Hyde Heath, which occurred on 9 November 2023 during construction of the HS2 Chiltern tunnels, and how we continue work to minimise such occurrences during our works. The information within this document is correct at the time of creation (29.01.2024).

Why were we tunnelling near Hyde Heath?

We were tunnelling near Hyde Heath as this is where the Chiltern Tunnel is being constructed along the HS2 line of route, as denoted in the HS2 Act.

Geology

What are the ground conditions in the Chilterns?

The Chilterns are a landscape formed on chalk bedrock. Chalk is a type of limestone composed mainly of calcium carbonate, and over geological time is susceptible to dissolving in rainwater. Chalk is usually white or light grey. Above the chalk it is common to find relatively thin layers of soils such as clay with flints or gravels.

Tunnelling in chalk

With chalk as the predominant geology in the area, this is the material within which the tunnels had to be constructed. There are many previous examples of successful tunnelling in chalk in the UK, including the Channel Tunnel Rail Link (High Speed 1), Crossrail (now the Elizabeth Line) and the Thames Tideway super sewer, which all use the same tunnelling techniques as HS2.

What is a sinkhole?

Sinkholes are a well-known geological features, which form through weathering of chalk. Sinkholes are caused by rainwater dissolving the chalk very slowly (over geological timescales) in fissures and fractures in the rock. They are not easily visible from the ground surface because they become infilled with soils. The infilled soils do not always completely fill the void left by the dissolving chalk and so can be unstable.

Do sinkholes happen naturally in the Chilterns and how? Why?

Yes, sinkholes occur naturally, and they occasionally collapse naturally. This can happen when the chalk in and around the sinkhole is dissolved further and gravity causes infill

material to collapse, or when the infill material is loosened by water entering the sinkhole and again collapse occurs as gravity acts on the infill.

When tunnelling in chalk there is a risk of encountering a sinkhole. In most cases the Tunnel Boring Machine (TBM) controls the material infilling the sinkhole, however, occasionally the material in the ground movement is loose and/or there is a void, and this can lead to the infill material falling in to the hole, in a similar way to a natural sinkhole collapse.

Sinkhole near Hyde Heath

Which factors contributed to the sinkhole identified on 9 November?

Florence, one of the Align Tunnel Boring Machines (TBM), was tunnelling under the edge of a woodland, in a valley with low cover between the tunnel and ground above. There is a known geological fault and a mapped dissolution feature in this area, though this did not extend on to the path of Florence. Through our live monitoring equipment on the TBM and our assessments we identified the need for additional monitoring at the surface above the tunnel. This additional visual monitoring by supervisors at the surface was put in place and a member of the team observed the ground movement take place and sinkhole appear.

How was HS2 informed about the sinkhole appearing?

The Align supervisors were on site to carry out planned monitoring and identified settlement above Florence. They ensured that the site was isolated and fenced off to keep the public safe.

Why haven't you stopped the TBMs again whilst the ground movement is repaired?

Keeping Florence moving is the safest course of action to prevent further ground movement because we need to complete installation of the concrete tunnel lining segments to stabilise the ground above. Tunnelling operations have continued and both TBMs are on their approach to the Chiltern Tunnel North Portal having passed Chesham Road Vent Shaft in December 2023.

When did you repair the area impacted by ground movement and how?

We worked closely with the landowner and tenant to ensure we had the right permissions to access the area. The ground was reinstated in November 2023 using a grout mix; we continued with some further remediation works at the beginning of January 2024 and we have monitored the area post reinstatement to ensure the ground remains stable. The remedial measures were discussed with Buckinghamshire Council, the Environment Agency, Affinity Water, the landowner and their tenant and other nearby residents ahead of works taking place.

For safety reasons the bridleway remained closed from 9 November until 22 December 2023 whilst we carried out these works. We notified our stakeholders and local residents as soon as the bridleway was reopened.

Future Tunnelling

How deep are the TBMs and does their depth make sinkholes more common?

Dissolution features, such as sinkholes, develop from the dissolution of the chalk by surface water through fractures. The first few metres of chalk are therefore more prone to dissolution. These features are therefore encountered more commonly at shallow depths (generally <15m) but can in some cases go deeper.

The TBMs and tunnels once constructed are approximately 20m below the surface in this area.

Why do you stop the TBMs and how often?

Pausing the TBMs intermittently and for short periods of time happens frequently to carry out maintenance on the tools at the head of the machine that cuts into the ground. We stop the TBMs at the vent shaft sites for a variety of reasons, for example to make a connection to one of the vertical access and ventilation shafts or more commonly to carry out maintenance on the tools at the head of the machine that cuts into the ground.

Are there any further dissolution features between Hyde Heath and the North Portal? Will more ground movement events occur?

We take all necessary precautions to ensure that the tunnelling is carried out safely. We have undertaken extensive monitoring of the ground along the route of the TBMs and we know that there is a further dissolution feature along the line of the route. There may also be other unknown features that we could encounter. To provide more stability we have installed 96 barrettes on the approach to the North Portal. These barrettes are vertical concrete ground reinforcement structures that have been built in advance to ensure that the ground remains stable as the TBMs approach break out at the North Portal.

How do HS2 plan for the risk of sinkholes?

What ground investigation do you carry out?

To understand the ground conditions and buried hazards that we may encounter when constructing the Align section of HS2, we have undertaken a significant number of investigations along with the original desk study; including physical boreholes to extract samples of the ground to the depth of the tunnel and non-invasive geotechnical

investigations, comprising of LIDAR (Light detection and ranging) surveys, and various geophysical investigations such as electrical resistivity imaging, microgravity and seismic surveys.
These geotechnical investigations target assets including critical infrastructure, such as the River Misbourne, M25 and the Chiltern Railway, as well as utilities, highways, buildings, overbridges, embankments, retaining walls and other waterways which we have successfully tunnelled below without incident.

We also have a monitoring regime of key assets and structures above the route of the tunnel, including properties, highways, bridges etc. which monitors any changes in ground movement.

Water and the aquifer

What danger does this ground movement event have on impacting the chalk aquifer?

The ground subsidence occurred 25m above ground water level in superficial deposits. The ground movement at the surface should not have a long-term impact on local groundwater flow paths or hydrogeology.
Although potentially accelerated by the boring of the tunnel, this kind of ground subsidence is a natural phenomenon that commonly occurs in the Chilterns and does not have long or short-term effects on the aquifer. The Environment Agency has concluded that the earlier ground movement event at Shardeloes Estate had no impact on water quality: https://www.bbc.co.uk/news/uk-england-beds-bucks-herts-67030442.amp

Are there risks to the drinking water?

Before any work below the water table is started, a comprehensive risk assessment is completed and provided to the Environment Agency and Affinity Water for review, comment and approval. Each organisation issues a consent to allow the work to progress if the work is approved. The assessments take into account numerous protective measures to reduce the risk of adversely affecting drinking water. The protective measures include the selection of the cleanest construction techniques, choice of materials, the implementation of robust pollution prevention measures, the provision of enhanced protection at pumping stations and an extensive monitoring programme to check on effects and implement additional mitigation if required.

What will the impact be on the chalk aquifer?

HS2 Ltd is committed to protecting the chalk aquifer within the requirements for the construction and operation of the new railway. The ground subsidence occurred 25m

above ground water level and does not have long or short-term effects on the aquifer. We are undertaking daily monitoring of the boreholes in the Hyde Heath area. We have not observed any changes in water level or water quality outside of typical values. Substantial assessment and liaison with the regulators are undertaken prior to any works starting close to or below the water table and a comprehensive monitoring regime is in place.