Ground movement and sinkhole near Little Missenden – 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 and the sinkhole near Little Missenden, which occurred 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 (10.07.2023).

Why are we tunnelling near Little Missenden

We are tunnelling near Little Missenden 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?

A sinkhole is a well-known geological feature, which forms 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 sinkhole 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 the natural sinkhole collapse.

Sinkhole near Little Missenden

What caused the sinkhole identified on 13 May?

Cecilia, one of the Align Tunnel Boring Machines (TBM), stopped to undertake planned maintenance of the TBM before passing under the River Misbourne. This stop location was planned with a broad understanding of the ground conditions to minimise the risk of ground movement. Cecilia successfully restarted, but following an unexpected mechanical issue an unplanned stop was necessary. It is now evident that this second stop took place in close proximity to a dissolution feature. When Cecilia restarted, a ground movement led to the creation of a sinkhole.

The second TBM, Florence, was ahead of Cecilia and had previously travelled through this area without incident.

How was HS2 informed about the sinkhole appearing?

The Align site surveyors were on site to carry out planned monitoring and identified settlement above Cecilia. They ensured that the site was fenced off as soon as possible to keep the public safe.

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

A meeting was held and concluded that moving Cecilia into more stable ground was the safest course of action to prevent further ground movement. Representatives from Affinity Water and the Environment Agency were involved in subsequent discussions. Tunnelling operations have continued, both TBMs have tunnelled beneath the River Misbourne and are on their approach to Little Missenden Vent Shaft.

When will you be repairing the area impacted by ground movement?

We are working closely with the landowner and tenant to ensure we have the right permissions to access the area. We aim to complete reinstatement works as soon as possible and will continue to monitor the area for a number of weeks post reinstatement to ensure the ground is stable.

The remedial measures will be discussed with Buckinghamshire Council, Historic England, the Environment Agency, Affinity Water and the landowner and tenant.

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?

We stop the TBMs for a variety of reasons, for example to make a connection to one of the ventilation shafts or more commonly to carry out maintenance on the tools at the head of the machine that cuts into the ground. Pausing the TBMs intermittently and for short periods of time happens frequently. Longer stoppages are carefully planned and carried out in areas away from buildings and where ground is expected to be stable.

Did you stop the TBMs again before tunnelled under the River Misbourne?

After the sinkhole was identified on 13 May Florence underwent no further planned stops before passing under the River Misbourne. Cecilia underwent one additional planned maintenance stop prior to passing under the River Misbourne - as agreed previously with the Environment Agency and Affinity Water.

Did you stop under the River Misbourne?

The TBMs passage under the River Misbourne is now complete and no stops took place under the River Misbourne. All planned maintenance was carried out ahead of crossing the river in order to keep the TBMs moving whilst we are mining through this sensitive location. Both Florence and Cecilia tunnelled under the River Misbourne in 2022 when the TBM's passed beneath the river for the first time at Chalfont St Giles and have now completed their second crossing.

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.

We also have a monitoring regime of key assets and structures above the route of the tunnel, including properties, highways, bridges etc. This 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 10m above ground water level in superficial deposits.

The sinkhole 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.

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 10m 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 Little Missenden area. We have not observed any changes in water level or water quality outside of typical values over the weekend of the 13 and 14 May and there have also been no observed changes in water levels within Shardeloes Lake outside of typical ranges.

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.