TECHNICAL ARTICLE TRENCHLESS INSTALLATION · GROUND INVESTIGATION

Investigation depth for HDD crossings

Why the exploration depth follows from the drill path – and the drill path from the ground

GeoStudys Consulting, Geotechnical consultancy for ground engineering, environment and geothermal energy, Berlin

ABSTRACT

For HDD crossings, the exploration depth is often fixed before the drill path is designed; beneath water the path then runs deeper. The article derives the investigation depth from DIN EN 1997-2, Annex B.3, and practice, and shows with a lake crossing in Brandenburg how a crossing sheet reveals the gap.

KEYWORDS · Horizontal directional drilling · Investigation depth · DIN EN 1997-2 · DIN 18324 · Crossing sheet

1 Background

Cable routes are usually explored to a uniform depth; the drill path follows later from cover, bending radius and rig. If it lies below the holes, the bore runs through uninvestigated ground: gravel, cobbles or gyttja go undetected, and the homogeneous zones to DIN 18324 [3], [4] lack evidence.

2 Normative basis and practice

DIN EN 1997-2 [1] with DIN 4020 [2] does not explicitly mention HDD. Closest are Annex B.3 (8) for pipelines and trenches – at least 2.0 m below the invert – and B.3 (9) for small tunnels, with one to two times the excavation width. For reamed diameters D_B below 1 m, paragraph (8) governs. The invert is the bottom of the reamed borehole:

$$t_E \geq h_A + D_B/2 + \Delta z_E, \quad \Delta z_E \geq 2.0\ \text{m} \tag{1}$$

t_E investigation depth below ground · h_A depth of the governing (lowest) path below the hole's collar · Δz_E margin below the borehole

Practice recommends 2 to 5 m below the planned bore [5], a US guideline at least 15 ft, approx. 4.6 m [6]. The 2.0 m applies only to a fixed path; if it may still change, we consider 3 to 5 m appropriate.

3 The path is not a constant

The depth of cover limits the path from above. It is set by the road, railway or water authority; rule of thumb: 10 to 15 times the borehole diameter [5]. Drill length, radius and rig limit it from below – and, for holes already drilled, Eq. (1). In between lies the entry geometry:

$$L = R \cdot \sin\alpha \qquad \Delta z = R \cdot (1 - \cos\alpha) \tag{2}$$

With R = 300 m and α = 12°, this gives $L \approx 62$ m and $\Delta z \approx 6.6$ m. Shore holes usually lie at entry and exit, where the path is still shallow; it reaches its lowest position only beneath the obstacle.

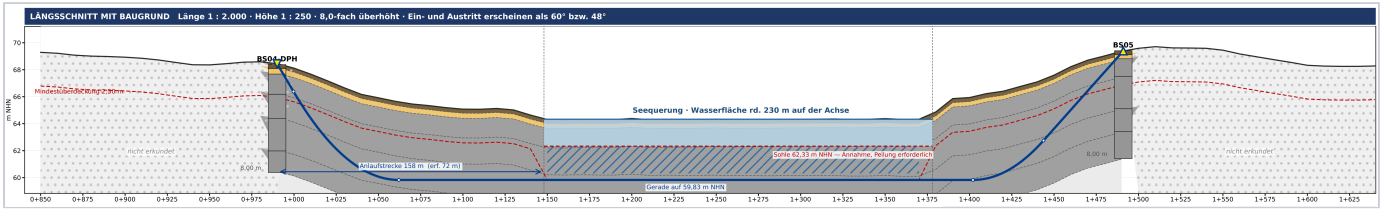


Figure 1. Crossing sheet of a lake crossing in Brandenburg, longitudinal section with ground model (detail, anonymised, 8× vertical exaggeration). Shore holes at entry and exit 8 m deep, straight path at 59.83 m NHN, approx. 8.5 m below their collar; lake bed and depth of cover (2.5 m) assumed. Ground below the holes marked 'not investigated'. (Drawing labels in German.)

4 Example: lake crossing

An underground cable route crosses a lake; along the path the water surface is approx. 230 m wide, the bore approx. 500 m long (Figure 1). At entry and exit the window sampling holes reach 8 m. The straight path lies approx. 8.5 m below their collar; with D_B = 0.35 m, Eq. (1) gives:

$$t_E \geq 8.5 + 0.2 + 2.0 \approx 10.7\ \text{m} \cdot \text{actual } 8.0\ \text{m} \tag{3}$$

The holes end above the level of the path; beneath the lake there is no exploratory point at all. The assumed 2.5 m of cover is also below the rule of thumb (3.5 to 5.3 m); the path may move deeper still. Recommended: deepen the shore holes to ≥ 12 m, sound the lake bed, then fix the path.

Table 1. Governing investigation depth per section

SECTION	GOVERNED BY	MINIMUM DEPTH
Bore, straight	B.3 (8), (9)	Eq. (1)
Entry and exit	Path depth per station	Eq. (1) per station
Beneath water	Sounding, conditions	Eq. (1), lowest path

5 Recommendations

- Fix a provisional path before investigating, identify channels and hollows from the DTM, set each hole's depth by Eq. (1).
- Place holes at most approx. 5 m from the path and seal them (clay pellets, grout) – otherwise an escape path for the drilling fluid [5].
- Mark the ground below the holes as 'not investigated'.

STANDARDS AND REFERENCES

[1] **DIN EN 1997-2:2010-10** with NA:2010-12 – Erkundung des Baugrunds
[2] **DIN 4020:2010-12** Geotechnische Untersuchungen für bautechnische Zwecke
[3] **DIN 18324:2019-09** VOB/C – Horizontalspülbohrarbeiten
[4] **DVGW GW 321 (A):2003-10**, corr. 2009-01 – Horizontale Spülbohrverfahren (by analogy for cables)
[5] **Bunger, S. (n.d.)** Anforderung an Planung und Ausführung einer horizontalen Spülbohrung. Max Wild
[6] **Wallin, M.; Neher, M.; Wallin, K. (2025)** Geotechnical Considerations for HDD. Trenchless Technology, 12/2025