METHOD | BOREHOLE + CPT

Layer boundaries with confidence level

How one borehole and several CPTs become a geotechnical cross-section – and how the sheet shows which boundary is confirmed and which is adopted.

AT A GLANCE

PURPOSE
Geotechnical cross-section per site, e.g. beneath a wind turbine foundation.

INPUT
Borehole log of a key borehole (soil type, soil group, origin, carbonate content); raw CPT data q_c,f_s; collar elevations with source and accuracy.

OUTPUT
One A4 landscape sheet per site: section at true spacing, confidence level per boundary, legend, site plan.

CALCULATION
Reproducible: same input, same boundaries. Thresholds (in-house, not standardised) are stated on the sheet.

LIMITATIONS
Without a difference in strength or material behaviour, a boundary stays invisible in the CPT. Below the borehole, only the position of a boundary is confirmed, not the soil type.

STANDARDS
DIN EN ISO 22476-1, DIN EN ISO 14688-1, DIN 18196, DIN EN 1997-2, DIN 4020

> **The CPT tells you where a boundary lies. The borehole tells you what lies there.**
>
> Principle of the method

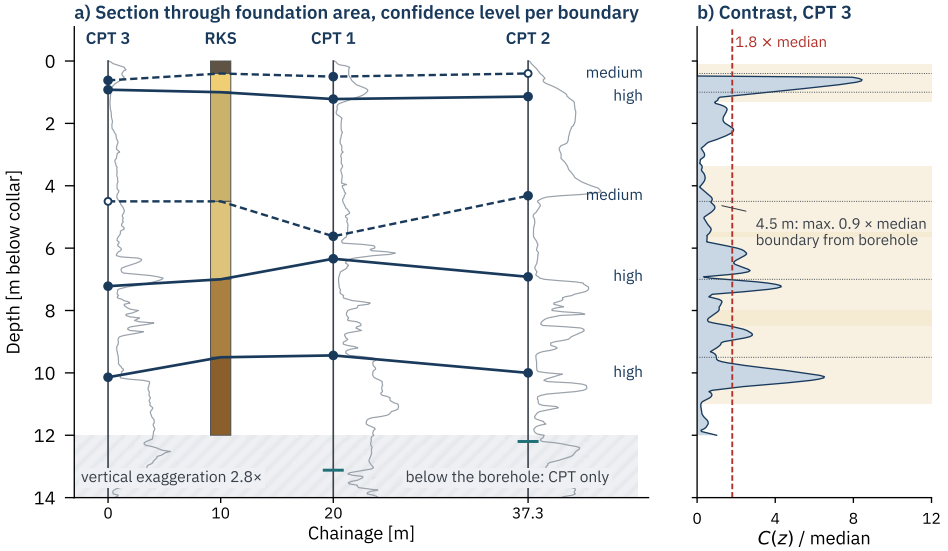


Figure 1. Wind turbine site in Saalian ground moraine (anonymised). a) RKS window sample and three CPTs, each 10 m apart, q_c grey (0–40 MPa); filled dot: boundary detected in the CPT, open dot: adopted from the borehole. b) Contrast function of CPT 3 with search windows (beige) and acceptance threshold. Section approx. 2.8× vertically exaggerated.

01 Procedure

1. **Reference boundaries from the borehole.** The borehole log gives the depth and content of each boundary.
2. **Contrast per CPT.** Step in log q_c and in the modified SBT index I_B across a 0.50 m window, Eq. (1).
3. **Assign.** Search window ±0.25·z (0.30 to 1.50 m); accepted from 1.8 times the median, top down and monotonic.
4. **Set the confidence level** per Table 1 and draw it as line style in the section.
5. **Below the borehole** only maxima above 2.5 times the median, spacing ≥ 1.0 m, as a short mark without correlation.
6. **Final check.** Every borehole boundary visible, elevations with source, exaggeration stated, one sheet per site.

$$C(z) = |\langle \log q_c \rangle_u - \langle \log q_c \rangle_o| + |\langle I_B \rangle_u - \langle I_B \rangle_o| \,/\, 40 \qquad I_B = 100(Q_{tn} + 10) \,/\, (Q_{tn} \cdot F + 70) \tag{1}$$

$\langle\,\rangle_o$, $\langle\,\rangle_u$ mean over 0.50 m above and below z · Q_{tn} normalised cone resistance · F normalised friction ratio [%] · I_B modified SBT index [4], clay-like below 22, sand-like above 32 · weighting 1/40 and thresholds 1.8 and 2.5 are in-house method parameters. I_B complements log q_c where material behaviour changes but strength hardly does. Beneath CPT 1, q_c alone separates the layers (sand 5–10 MPa, glacial till 25.5 MPa); I_B classes the till as sand-like (approx. 85) – only the borehole settles the soil type.

02 Confidence level

Level	Condition	Line	Example
high	detected in all CPTs	———	1.0 · 7.0 · 9.5 m
medium	partly detected, otherwise from the borehole	- - - - - - -	0.4 · 4.5 m
low	detected in none	·····	–

Table 1. Levels and result at the site in Figure 1; depths of the borehole boundaries.

03 What the check reports

- ☑ **Map vs borehole:** map shows ground moraine, borehole meltwater sand to 7.0 m – flagged as a discrepancy.
- ☑ **Boundary without contrast:** at 4.5 m, CPT 3 reaches only 0.9 times the median. It remains visible as a borehole boundary.
- ☑ **Foundation level:** not drawn without a confirmed working platform elevation.
- ☑ **Elevations:** from the terrain model, ±0.15 m, marked as not surveyed.

STANDARDS AND REFERENCES

[1] **DIN EN ISO 22476-1:2023-04** Felduntersuchungen – Teil 1: Drucksondierungen mit elektrischen Messwertaufnehmern
[2] **DIN EN ISO 14688-1:2020-11** Benennung und Beschreibung von Boden · **DIN 18196:2023-02** Bodenklassifikation für bautechnische Zwecke
[3] **DIN EN 1997-2:2010-10** Eurocode 7 – Erkundung und Untersuchung des Baugrunds · **DIN 4020:2010-12** Geotechnische Untersuchungen für bautechnische Zwecke
[4] **Robertson, P. K. (2016)** Cone penetration test (CPT)-based soil behaviour type (SBT) classification system – an update. Canadian Geotechnical Journal 53, 1910–1927. doi:10.1139/cgj-2016-0044, accessed 24 Sept. 2026