Groundwater monitoring studies – a comparison of different approaches for groundwater investigation

Stephan Klose [1], Florian Hegler [2], Stefan Reichenberger [2]

[1] Björnsen Consulting Engineers, Koblenz, Germany
(contact: S.Klose@bjoernsen.de)
[2] Dr. Knoell Consult GmbH, Mannheim, Germany

Introduction

In the tiered assessment scheme as laid out in FOCUSgw (European Commission, 2014) for the regulatory leaching risk assessment for active substances at EU level under Regulation (EC) 1107/2009, groundwater monitoring constitutes the highest tier.

The first step in a groundwater monitoring study is the selection of a study site with the desired level of groundwater vulnerability. The first part of the site selection process (pre-selection) usually consists of GIS analyses, using spatial datasets. Additionally, leaching vulnerability may be assessed (maps produced with a leaching model such as GeoPEARL).

The candidate areas identified with GIS are further narrowed down to individual field sites based on field investigations. Subsequently, the candidate field sites should be characterized to reconfirm their suitability and to be able to correctly install observation and sampling wells. A key prerequisite of a field site characterization is a profound understanding of the hydrogeological conditions at the respective sites.

The objective of this study was to illustrate the investigation of subsurface conditions which are crucial for the suitability of a field site for a groundwater monitoring study, and for the monitoring setup.

Materials and methods

The FOCUSgw modelling scenarios were used as a well known example. The specific protection goal (SPG) was defined as the annual average pesticide concentration measured in very shallow groundwater at >1 m below ground surface (bgs) originating from treated fields.

Two out of the 9 FOCUSgw scenarios were selected as case study sites: Sevilla and Hamburg. Each FOCUSgw scenario is intended to be a reasonable worst-case for leaching within the climatic zone that it represents and is a real site known to exist (EC, 2014), although for Hamburg the weather series comes from a different location than the soil profile. Hence, the two sites show nearly realistic conditions for the setup of a groundwater monitoring study integrated into the regulatory workflow.

FOCUSPEARL simulations with additional output depths were performed to calculate monthly recharge to groundwater and breakthrough times of a low-sorbing dummy substance (Kom = 15 L/kg, DT50 = 60 d) applied to winter cereals at emergence date.

Estimation of the linear field velocity of groundwater is based on reasonable assumptions of geo-hydraulic parameters (cf. Fig. 2 and Fig. 4). These have to be determined by field and laboratory tests (cf. Fig. 1.)

Conclusions

An individual assessment of the pre-selected site is indispensable. The heterogeneity of the aquifer is still a major source of uncertainty. The standardization of a general work plan (cf. Fig. 1), as far as possible, helps achieving high quality studies and gaining results that are as reproducible as possible.

The results must be evaluated referring to the specific protection goal at interim stages of the investigation. Possibly, the site selection or the monitoring plan (cf. Fig. 1, Fig. 2 and Fig. 3) will need to be adapted. If this is not feasible, the protection goal will have to be redefined.

Practical aspects of the monitoring set up need to be further evaluated, such as the spatial arrangement of the sampling wells (cf. Fig. 3 and Fig. 5) or the determination of sampling well / screening depth vs. "catchment scale and aquifer level monitoring" using wells tapping the entire thickness of the aquifer considering potential dilution effects, or the installation of multi-level sampling wells.

General work plan

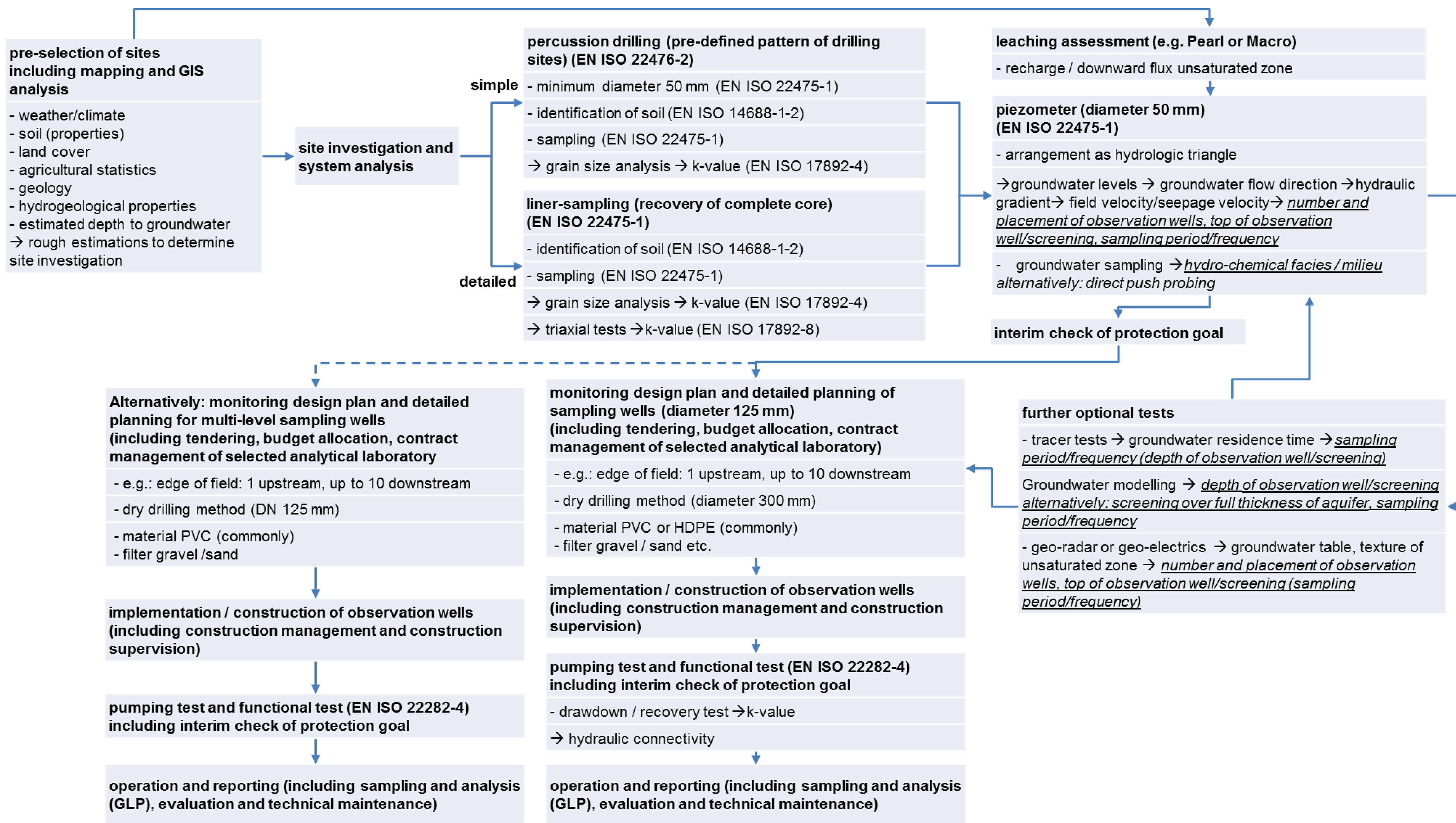

Fig. 1: Standardized general work plan for site pre-selection and field site characterization

Case study: FOCUSgw scenario Sevilla

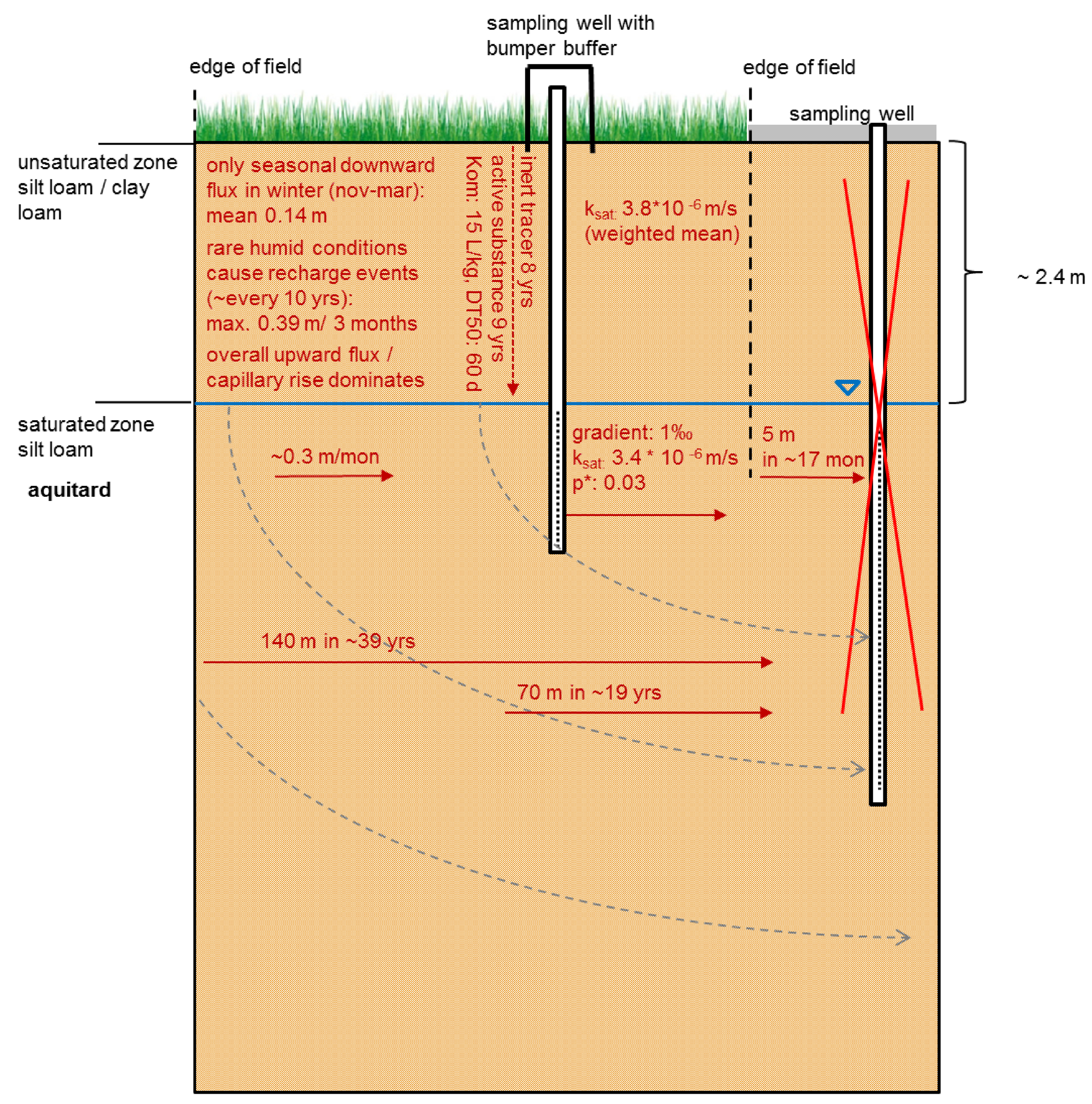

Fig. 2: Schematic section of the Sevilla site

Case study: FOCUSgw scenario Hamburg

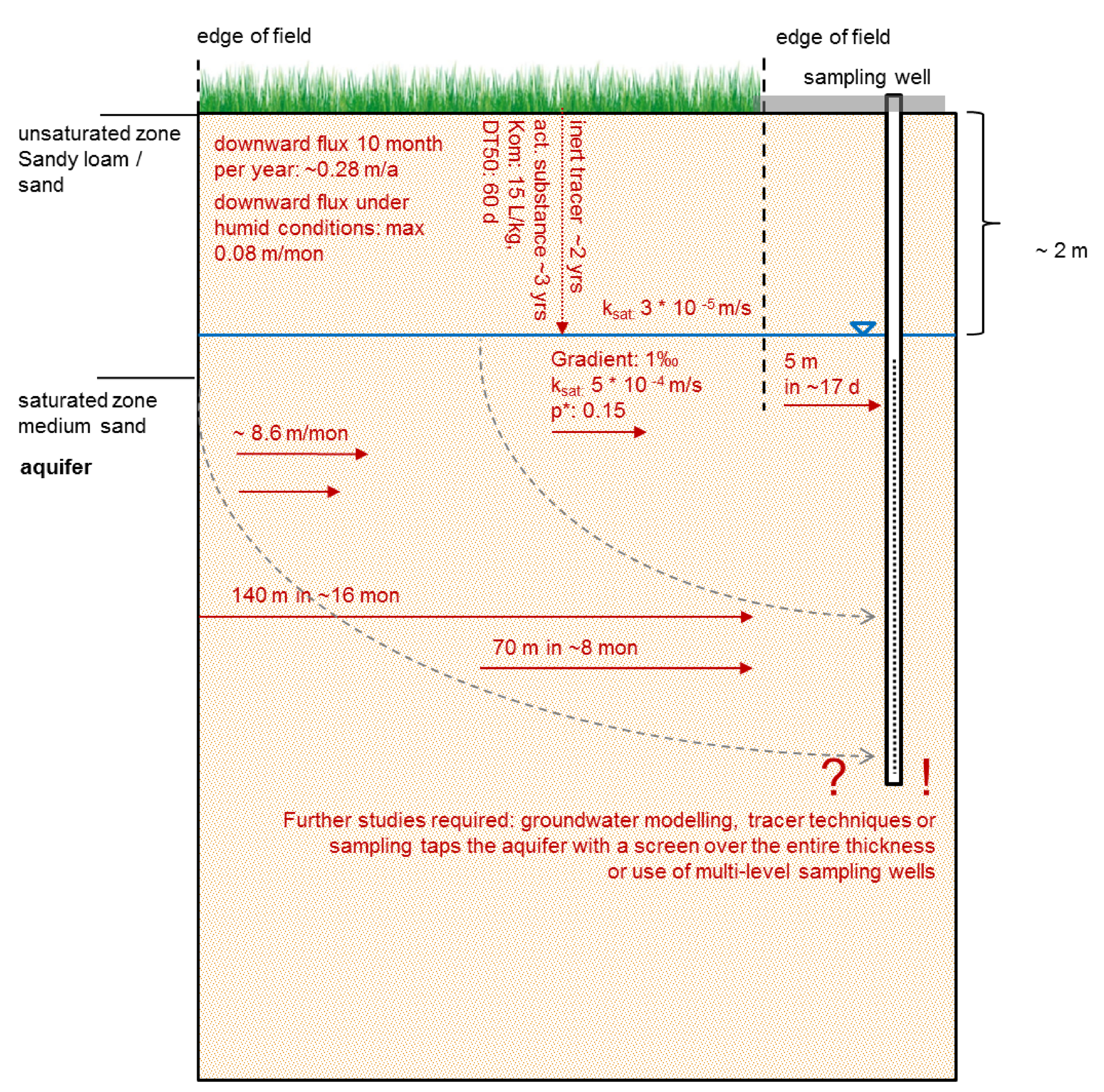

Fig. 4: Schematic section of the Hamburg site

Results and Discussion

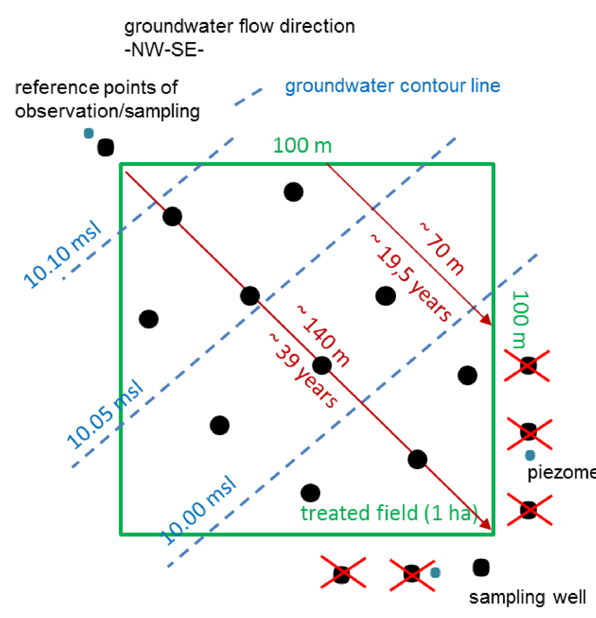

Fig. 3: Schematic spatial arrangement of monitoring wells in Sevilla

→ edge-of-field installation of sampling wells would not be appropriate because percolation and groundwater flow take a long time

→ in-field arrangements are required considering all other concerns such as machine use for tillage, right of way, avoidance of GW contamination via the well

→ retrospective: further analysis of precipitation time series (min. 20 yrs); estimation of local water balance; investigation of application history

→ prospective: only for long term studies; not appropriate for studies < 12 years because of low and irregular recharge

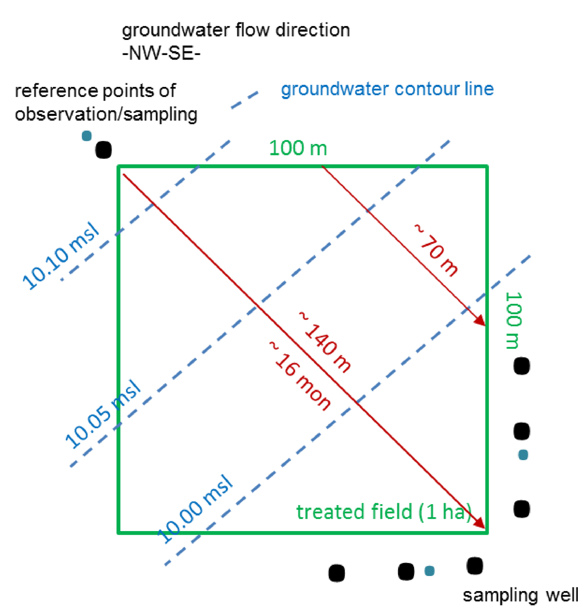

Fig. 5: Schematic spatial arrangement of monitoring wells in Hamburg

→ edge-of-field installations are appropriate because percolation and groundwater flow are fast enough, making it likely that an effect is observable in a reasonable timeframe

→ catchment scale and aquifer level monitoring downstream of a field cluster may be also appropriate

→ delineation of groundwater catchment is required

→ retrospective: further analysis of precipitation time series (min. 9 yrs) or local water balance estimation and application history would be required

→ prospective: sampling starts not later than 2 years after first application

References

European Commission (2014) "Assessing Potential for Movement of Active Substances and their Metabolites to Ground Water in the EU".
Report of the FOCUS Ground Water Work Group, EC Document Reference Sanco/13144/2010 version 3, 613 pp.

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