

MinImpact

Management of sulfide soils in landfills and embankments

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Management of excavated sulfide soil

Reason:

Poor bearing capacity

Solution for geotechnic:

Excavation

Management:

Disposal

Use in construction

Solution:

Cover to limit
oxygen diffusion

Addition of binder to
improve strength

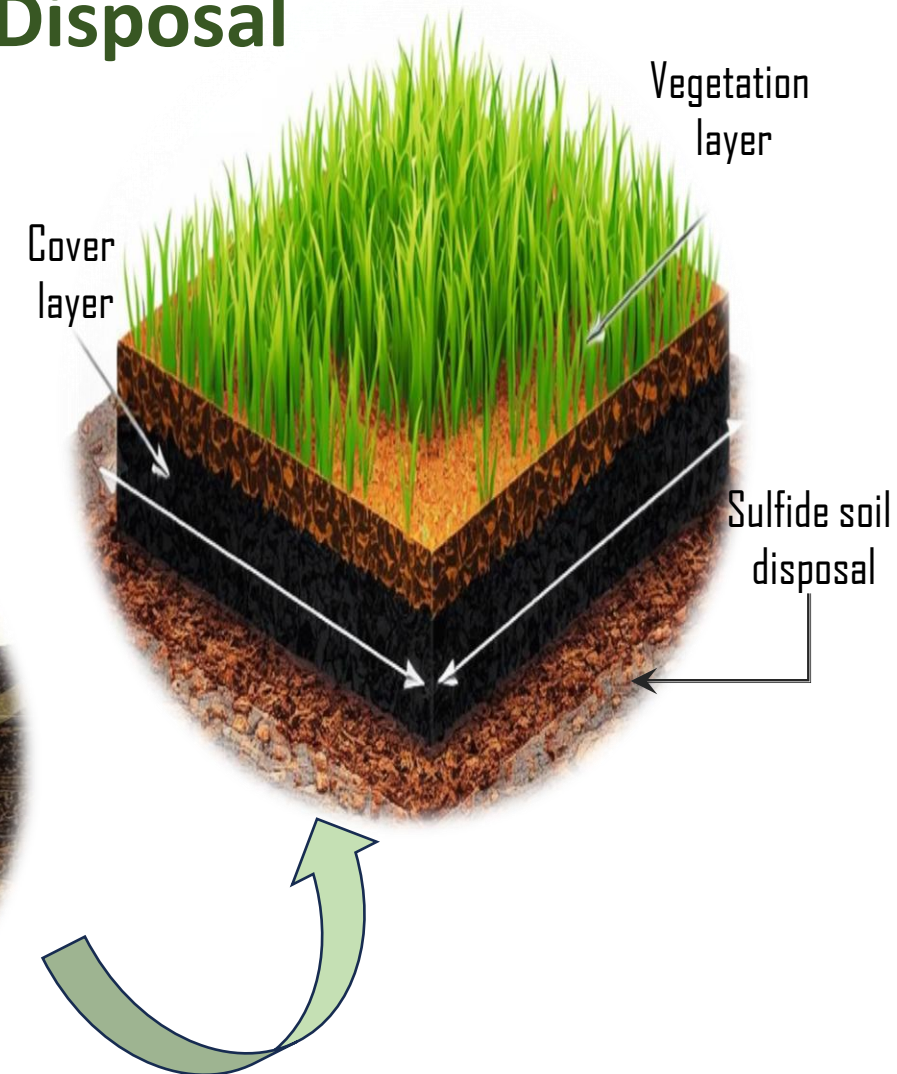
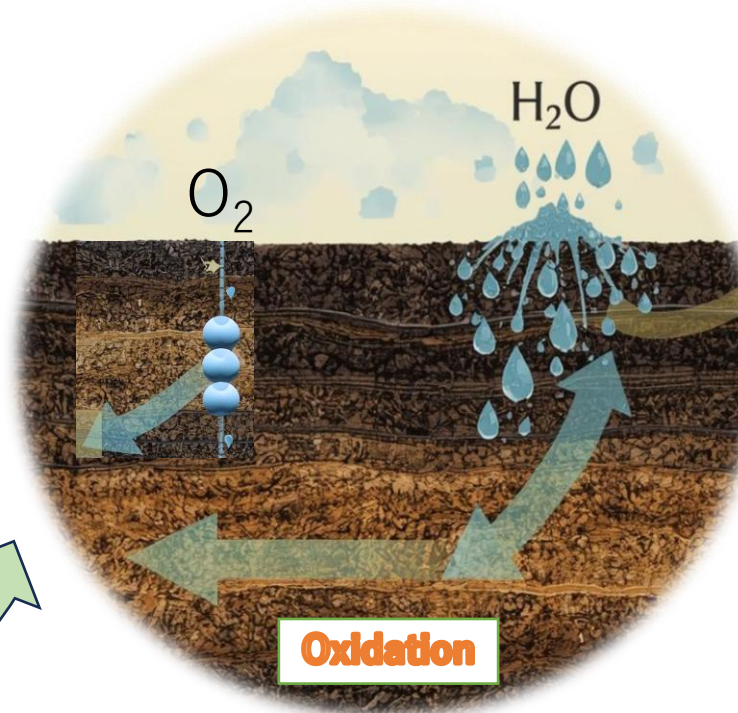
Challenge:

Thickness

Dosage and durability

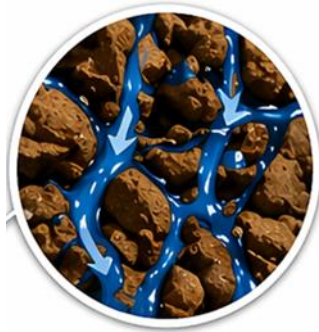


Cover Systems for Sulfide Soil Disposal

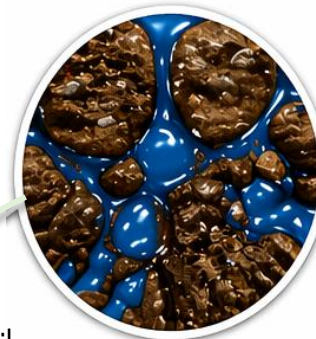


How soil controls water and oxygen?

Hydraulic conductivity
(How easily water flows)

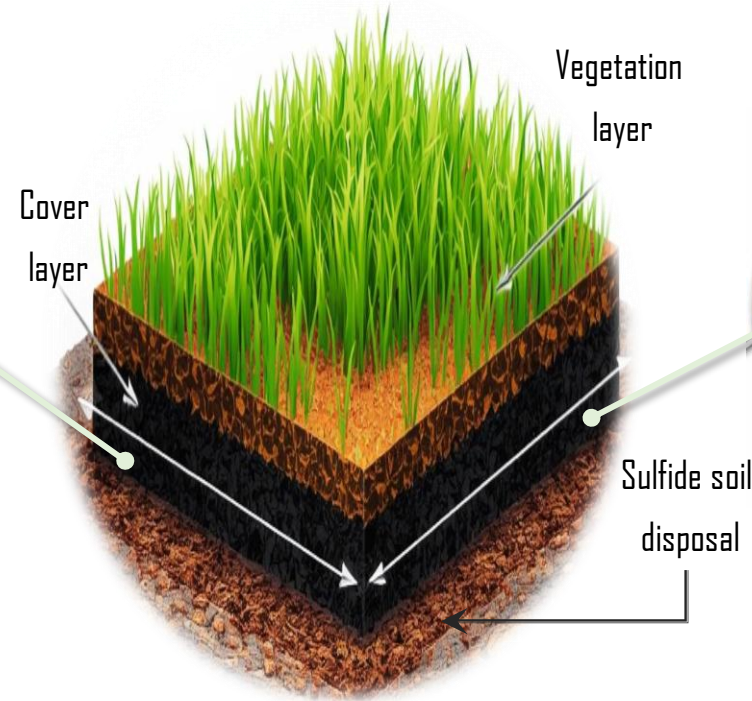


Water retention
(How much water soil holds)



Material is used to limit water infiltration should have a low hydraulic conductivity ($<10^{-8}$ m/s)

Material is used as oxygen barrier should have high water saturation $> 85\%$



Our recommendations



Well-graded cover

At least 25–30% fines (clay and silt) to hold water and resist internal erosion.



Low permeability

Permeability not above 10^{-8} m/s so the cover keeps water longer.



Some organic matter

A certain organic content helps retain moisture in the cover layer.



Reuse treated soil

Lime-treated sulfide soil can serve as cover material instead of till.



Design for the site

Adapt the design to local conditions, above all the distance to the groundwater table.



Landfill design matters

Design to retain water and limit oxygen – cover thickness, as important as stability.

Recommendation 1: choose the right cover material

$\geq 25\text{--}30\%$

fines (clay + silt)

Improves water retention and reduces the risk of internal erosion.

$\leq 10^{-8}$ m/s

permeability

Ensures the cover performs as intended and holds water better and longer.

Organic

matter content

A certain content is advantageous it helps keep moisture in the cover.



Lime-treated sulfide soil works as cover material

Lime treatment did not significantly change the hydraulic properties – water retention and low permeability were preserved. This can reduce landfilling and the need for new materials such as till.

Recommendation 2: design the pile, not only the cover



Distance to the groundwater table

Close to groundwater = high saturation by capillary rise.
If the distance exceeds the capillary rise, rain is the only water source and a thicker cover is needed.



Hight of the pile

Layers above the capillary rise drain.
Tall piles can also become unstable
so these piles are usually low.



Thickness and composition of the cover

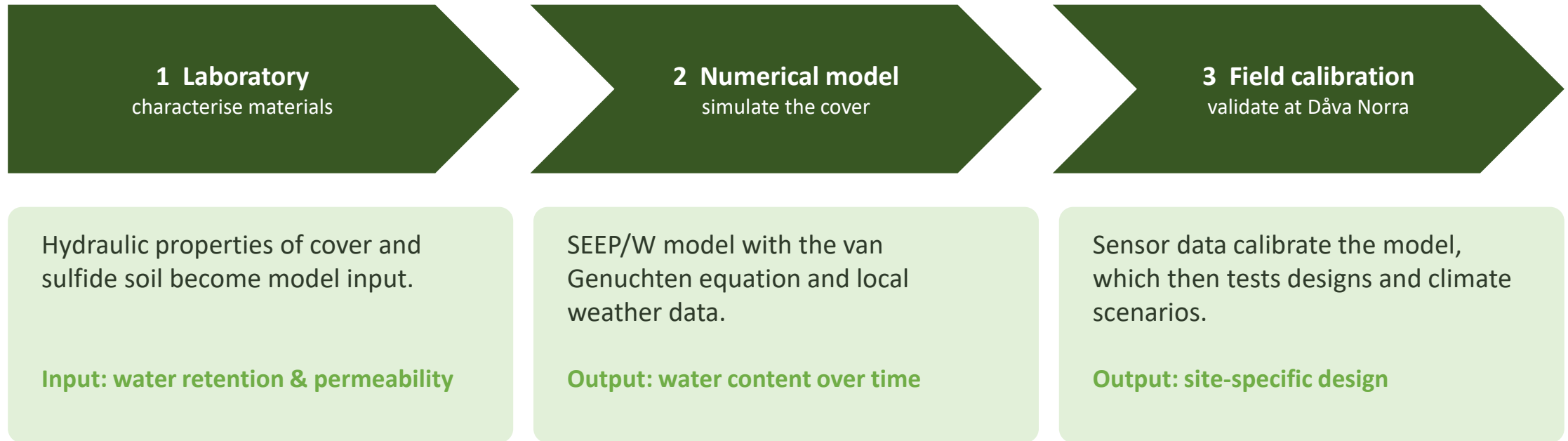
1 m is routine in Sweden but often over-dimensioned.
Fit the thickness to groundwater level, pile size and material.



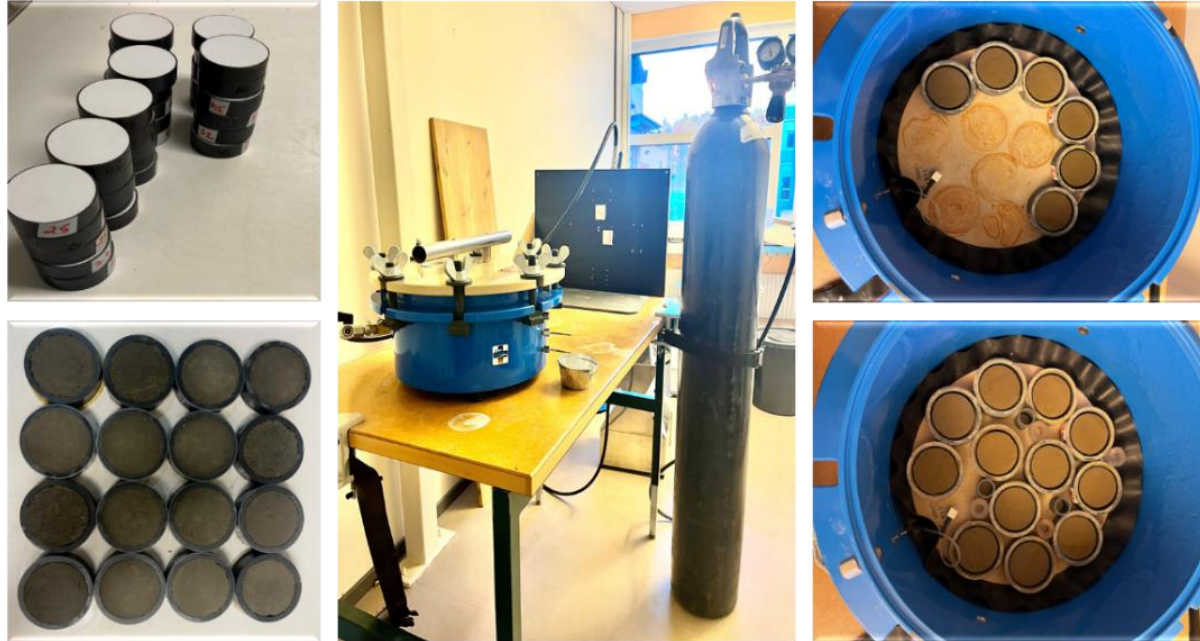
Avoid creating drains

- Mixing coarse-grained material into the sulfide soil
- Layers of coarser material embedded in the pile
- Any permeable path that lets water drain and oxygen enter

How we solved it: a three-step approach



Technique 1: laboratory



Investigation of soil water retention capacity. Photo: Abdalla Saafan



What we measured

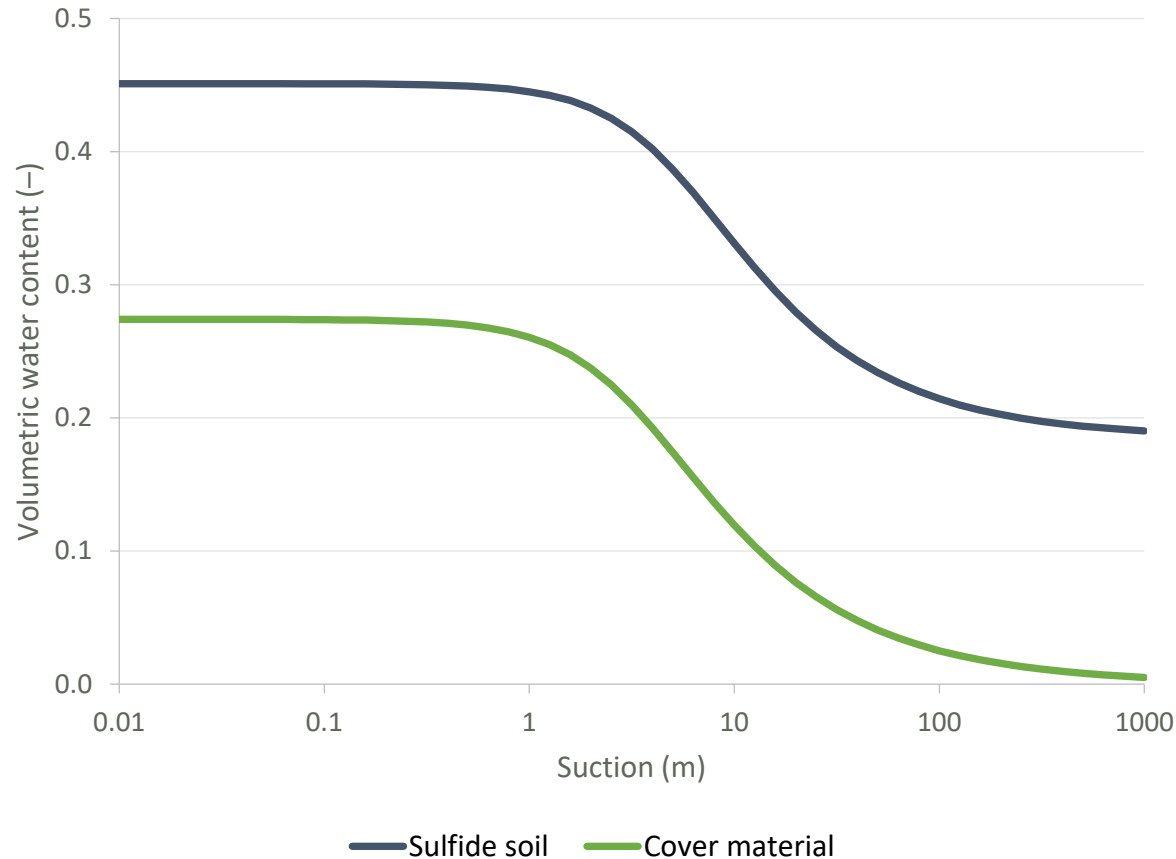
- Water retention capacity
- Permeability (saturated hydraulic conductivity)



Materials tested

- Sulfide soil, till and peat
- Untreated and lime-treated sulfide soil – coarse and ultrafine limestone at different dosages

Technique 3: numerical modelling of the cover



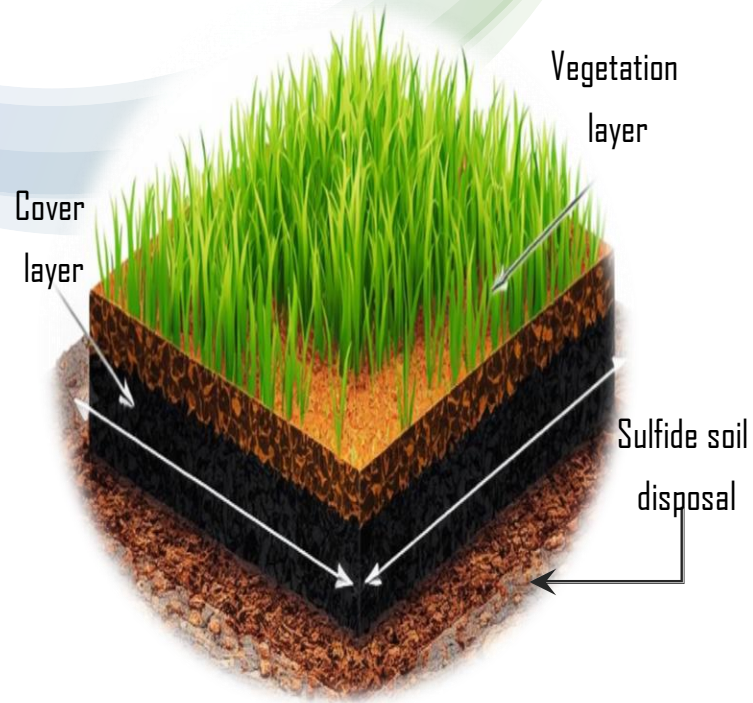
Water retention curves

The cover material dries out as suction increases, while the sulfide soil keeps its water even at high suction.

Parameter	Sulfide soil	Cover
α (1/m)	0.189	0.300
θ_s (-)	0.451	0.274
θ_r (-)	0.185	0.000
n (-)	1.749	1.702

Model: SEEP/W with the van Genuchten equation, driven by meteorological data from the site.

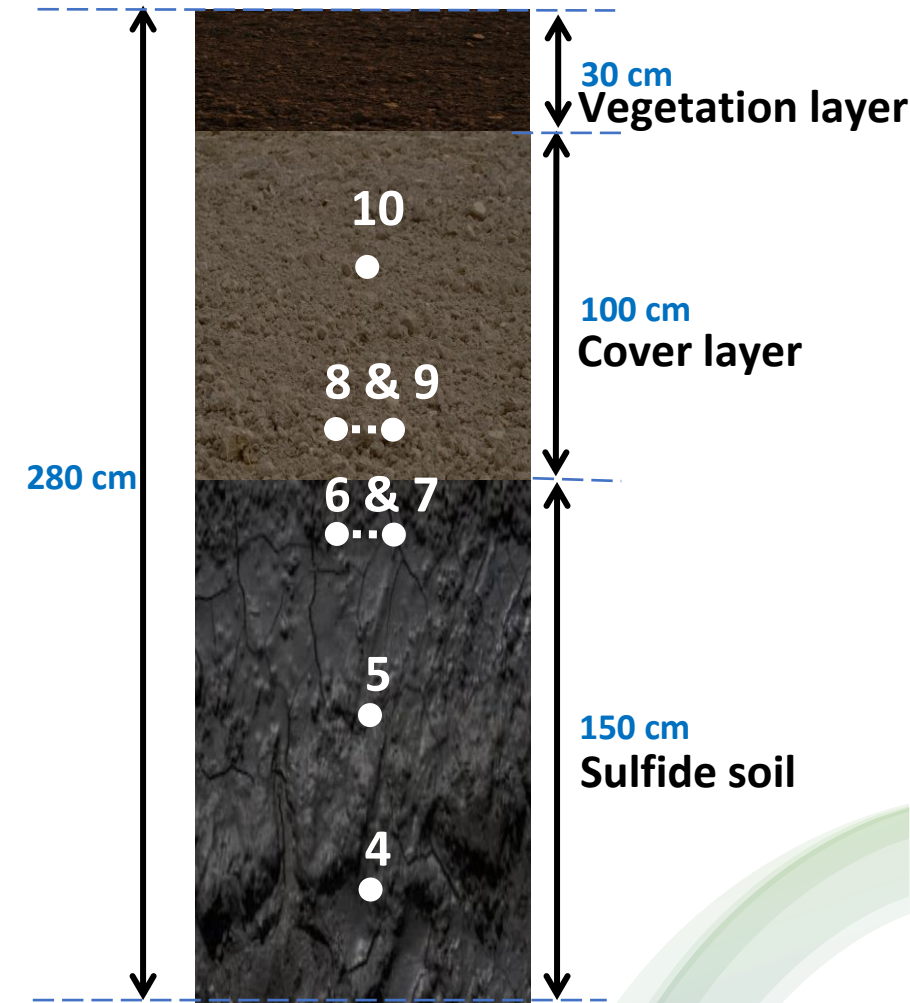
Installation monitoring station in Dåva landfill



7 Soil Moisture
Sensor
Teros 12



7 Soil Water Potential
Sensor
Teros 21



Installation monitoring station in Dåva landfill



What we found

The 1 m cover at Dåva Norra is over-dimensioned: both cover and sulfide soil stayed above 85% saturation all year.



Lime-treated sulfide soil

keeps its hydraulic properties and can be used as cover.



Site-specific design

can reduce material use while still managing the environmental risk.



Disposal under water

is effective long-term but not always cost-effective.

Three numbers to remember



> 85%

degree of water saturation

Keeps oxygen out of the sulfide soil and stops oxidation.



25–30%

minimum fines in the cover

Clay and silt make the cover hold water and resist erosion.



$<10^{-8}$ m/s

permeability

Cover keeps water longer, even in dry summers.

Thank You

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