Drilling Off Center…But On Purpose
Angled Drilling Applications

Moderator:
David Hermantin / *Brightcore Energy*
Panel:
Stan Reitsma / *GeoSource Energy*
Stefan Swartling / *Urban Geothermal Solutions*
Dmitry Kuravskiy / *Celsius Energy*

Presented Live at the NY-GEO 2023 Conference Albany, New York on April 26, 2023

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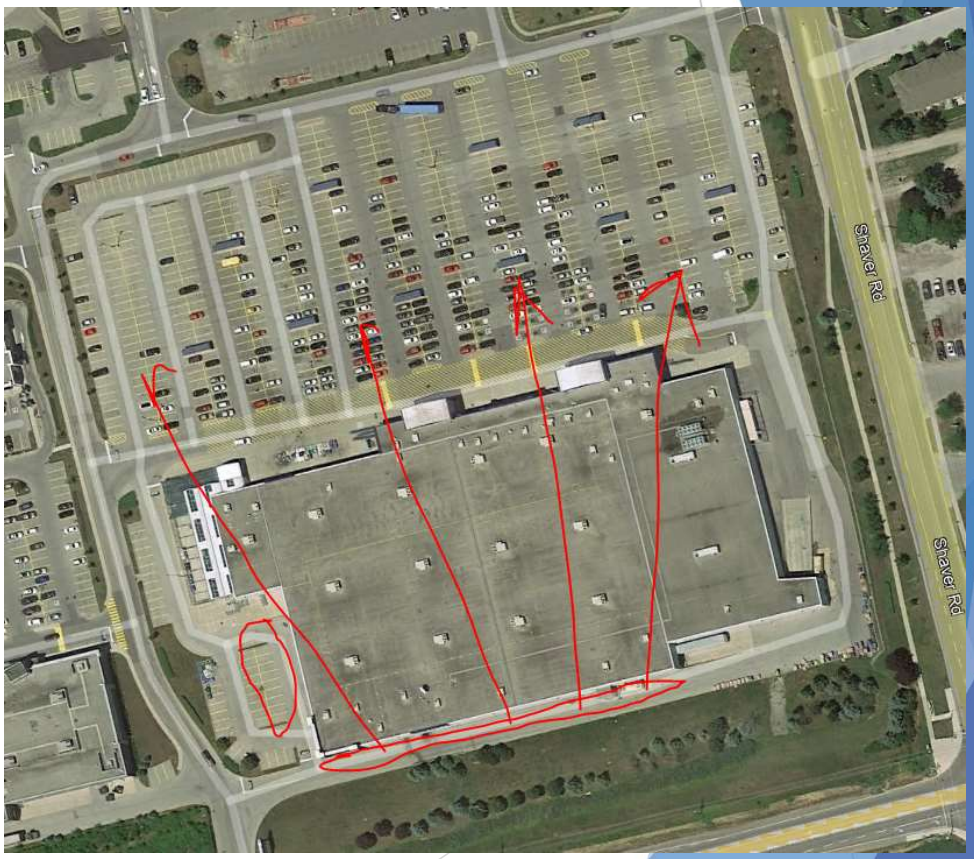
Why include angled boreholes?

- Main reason – to get geothermal capacity into ground in instances where you cannot access from surface with standard vertical spacing
- Reasons can be surface or subsurface obstruction, accessibility, future use, ongoing operation restrictions, site scheduling (and more)

Types of projects for which this is applicable

- Retrofit is a clear candidate – from homes, MURB, and institutional
- New construction – possible simplification of tie-in, reduction of interferences
- Reconstruction or retrofit of operational facilities

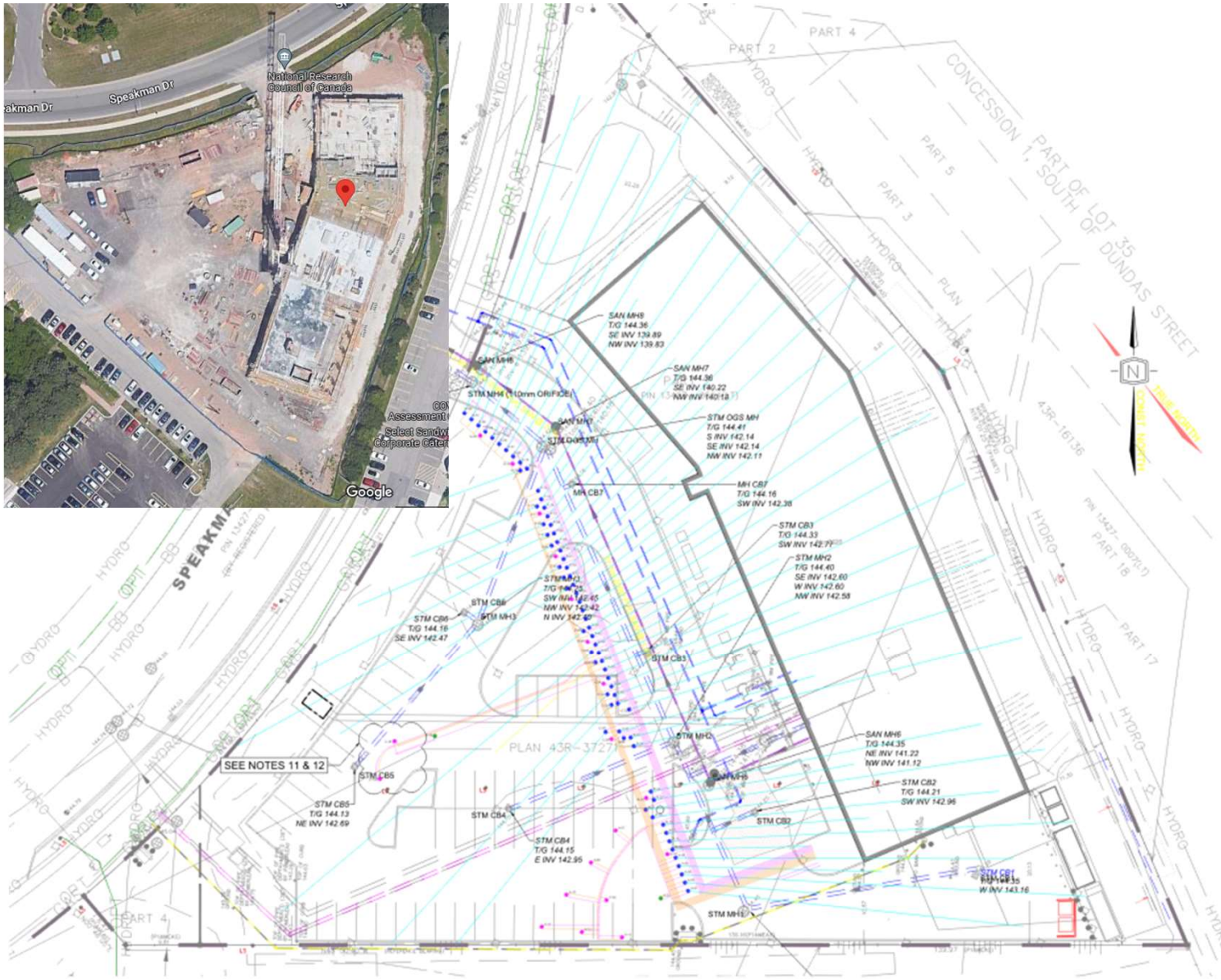


Rig Considerations for Angled Drilling

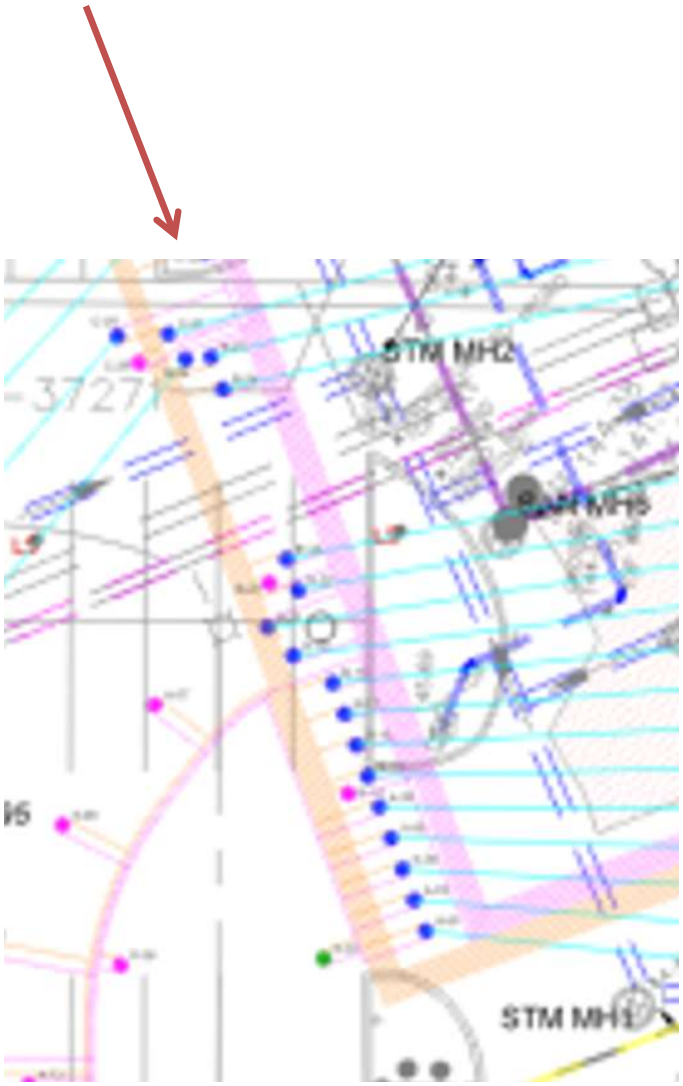
- Mast orientation
- Positioning
- Rod/casing handling

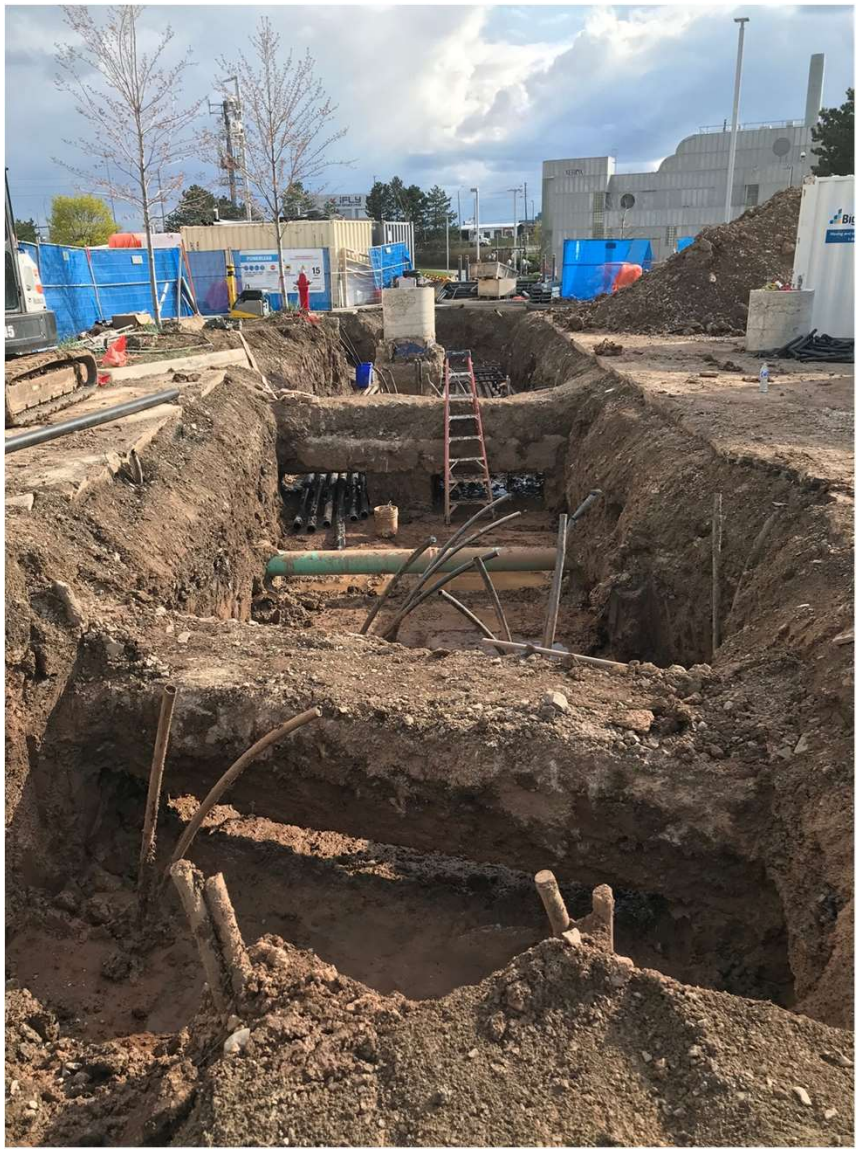
2620 Speakman Drive

- 88 boreholes of 850' length (17 vertical, 71 angled)
- Building was already constructed when geo-exchange was considered, requiring an angled approach to maximize geo-exchange potential.



2620 Speakman Drive





CELSIUS ENERGY

A Decarbonization Solution for Buildings

26 April 2023 | NY-GEO

Celsius Energy **Benefits Beyond the Norm**

200 ft^2 Land Impact

Preserve Real Estate

Retrofit Flexibility

CO_2 Reduction

Energy Reduction

No Heat Island

Optimized Design

Digital Control

Turnkey Solution

Invisible

Quiet

Resilient

Less Bores

Less Piping

Less OPEX

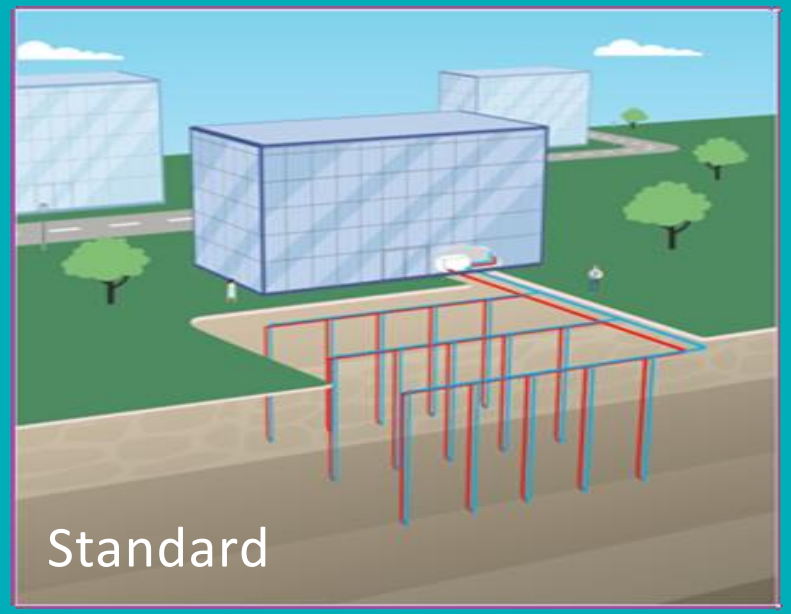
Single Building

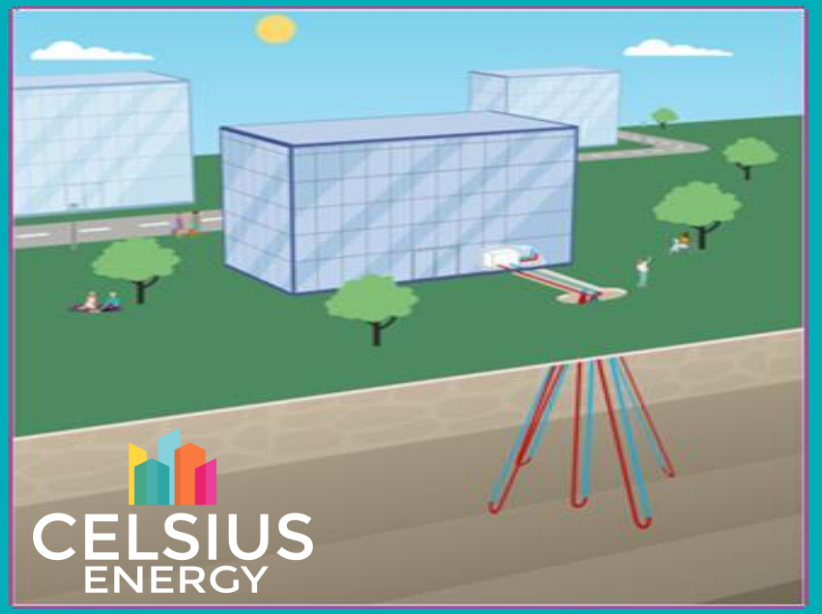
District

Community

Optimized Borehole Heat Exchanger

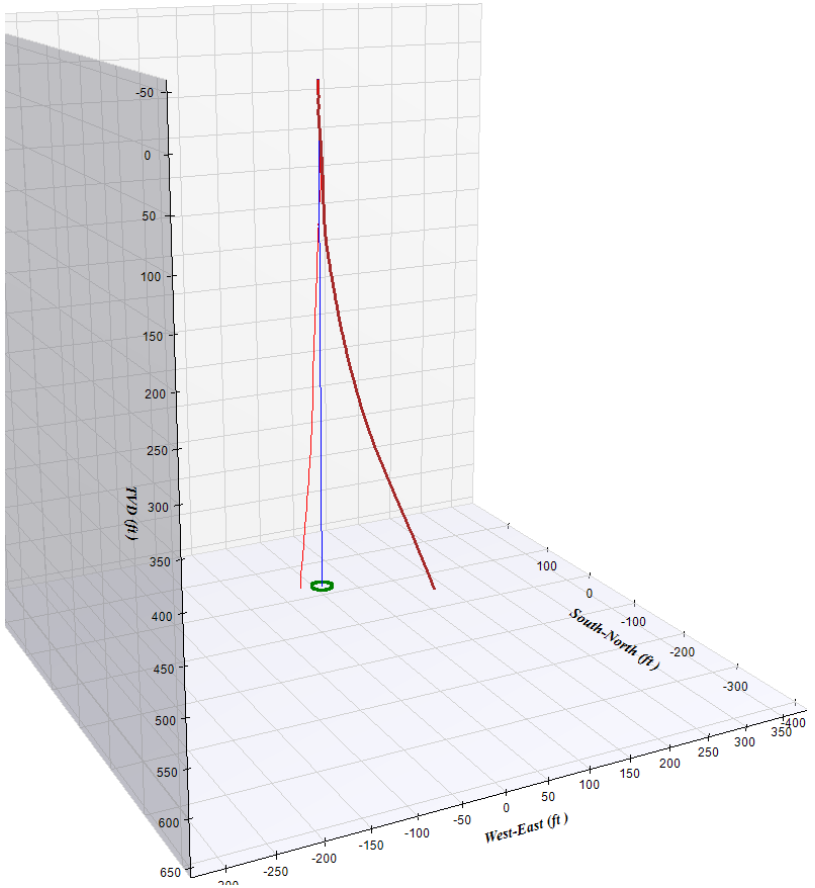
- Less wells
- Less horizontal piping
- Less site impact
- Preservation of real estate
- Flexible construction planning
- COST EFFICIENCY!





Angled drilling **regulations and control**

Why



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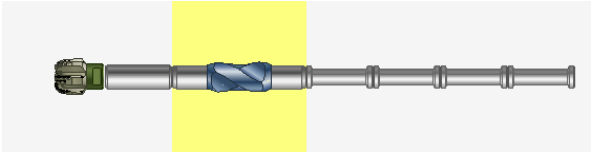
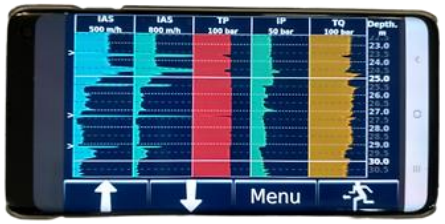
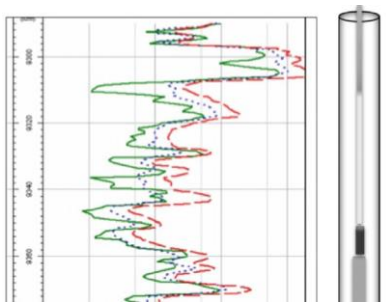






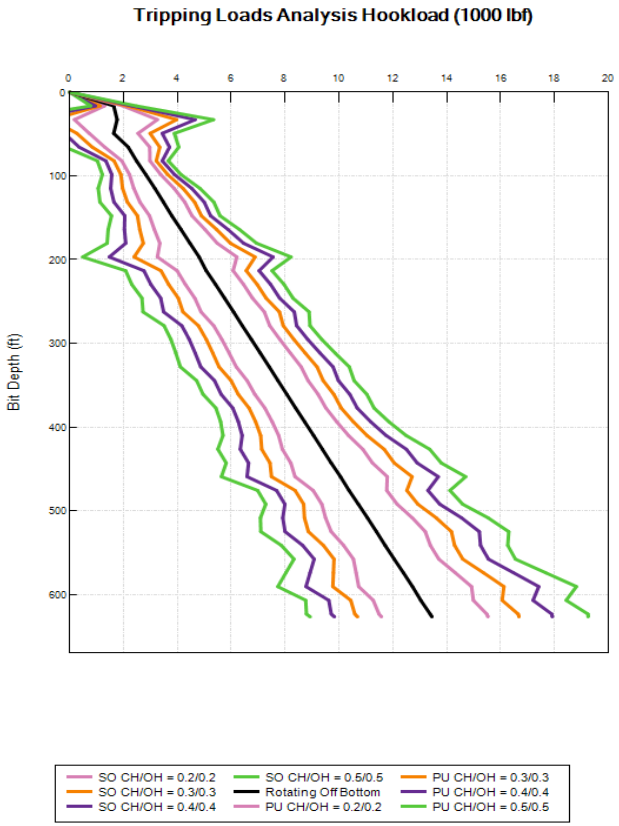
How

- ❑ Survey Standard
- ❑ Well Survey Reporting
- ❑ Well Survey Data base

- ❖ Exit property line
- ❖ Collision risks
- ❖ Risk to surface facilities

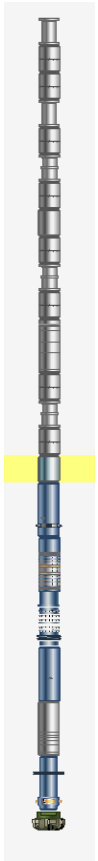
Angled drilling **price vs. challenges & requirements**

Why



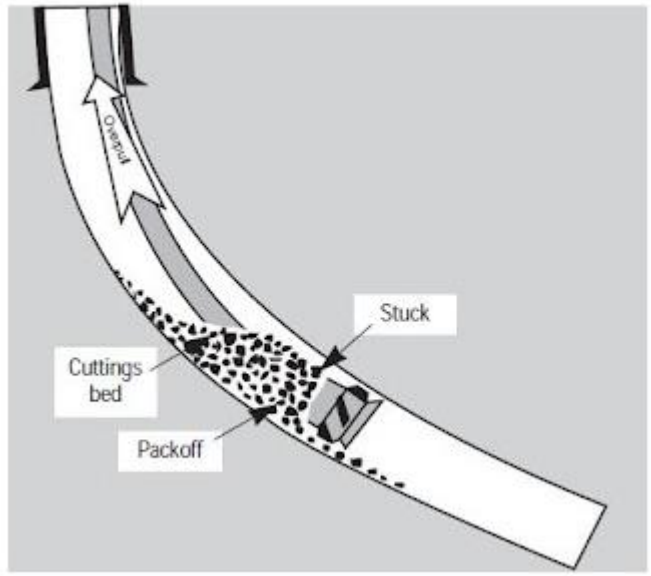
Drag Forces (Drilling & Completion)

What



Complex BHA (Design & Delivery)

How



Borehole Delivery risk

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Does your project meet one of these two criteria?

Area > 10,000 Sq Ft

Or

Heating and/or cooling needs > 300 kBTU/Hr

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Inclined Bore holes – Why ?

Allows geothermal solutions in areas previously not considered !

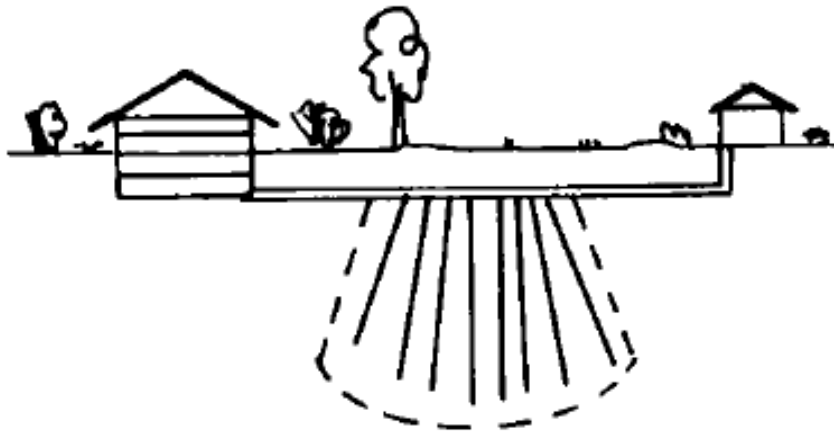
Accessing more rockmass with from limited surface area !!

Install geothermal solution in existing buildings !!!

Limit geothermal systems impact on existing and future underground infrastructure !!!!

Stefan Swartling,
Urban Geothermal Solutions

Inclined bore holes – Early days

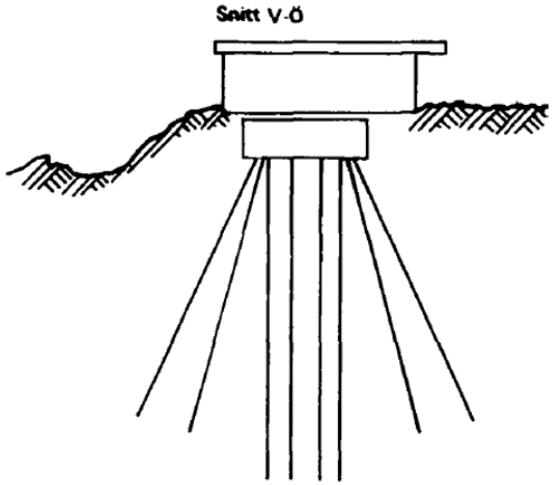


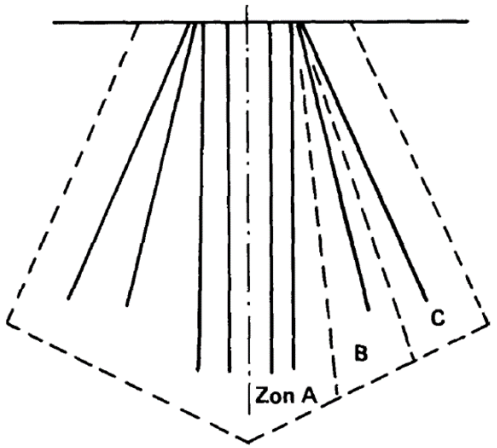
First inclined BTES in Sigtuna, Sweden **1977**

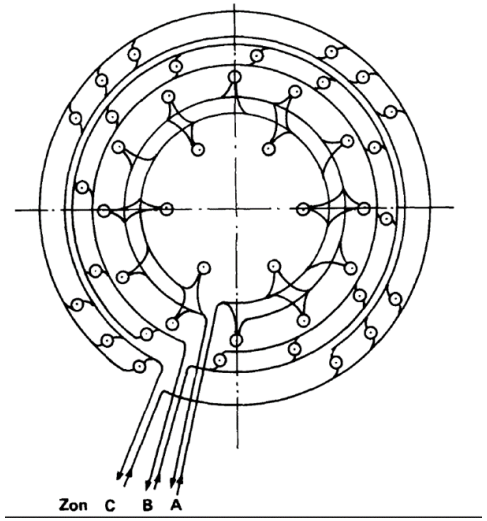
Difficult terrain and existing buildings limited areas to drill from.

Storage of solar heat 37 holes x 65 m

Zone design





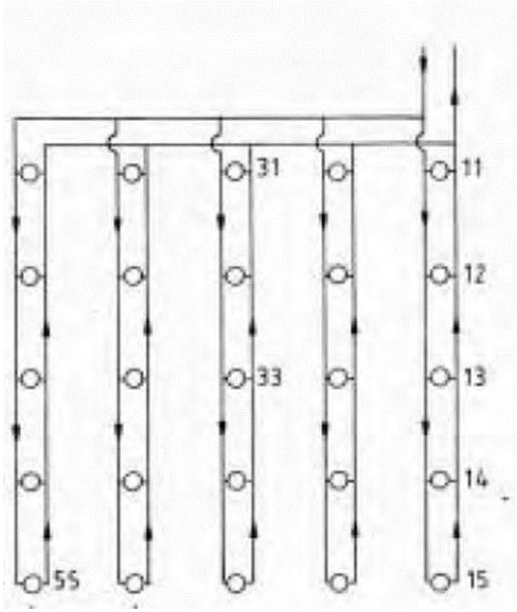


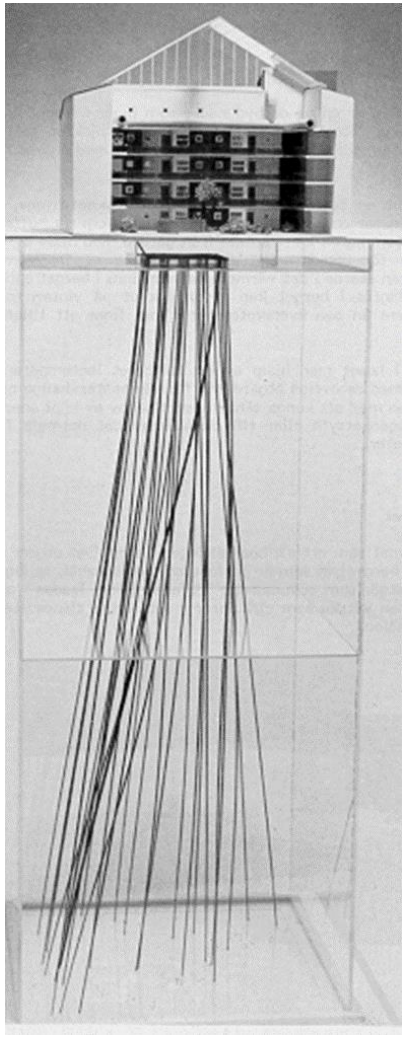
Early projects

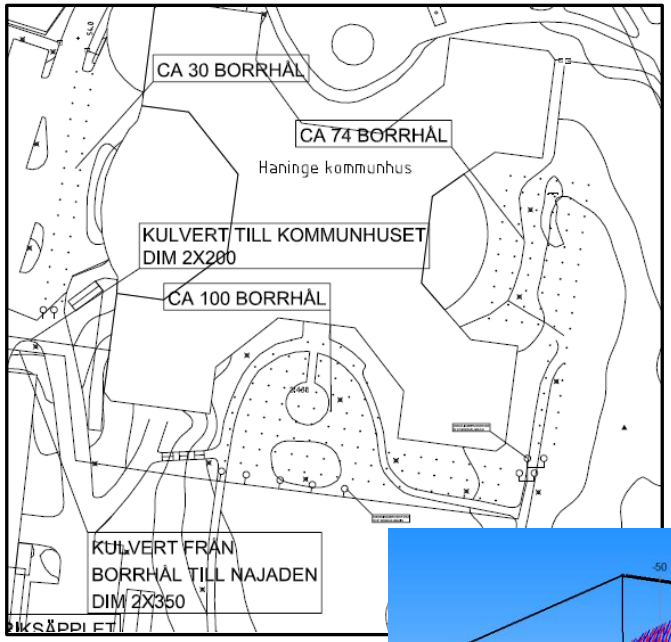
Sun Court, 1986 & Najaden design, Sweden

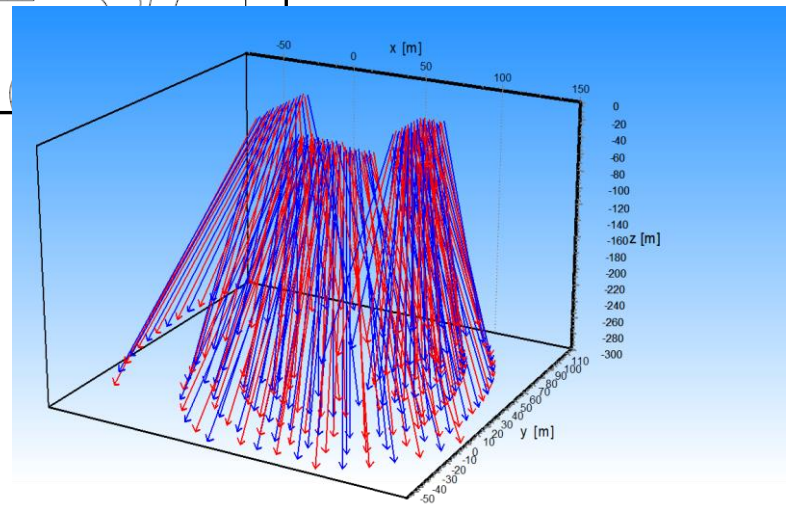
Sun Court

- 25 boreholes x 260 Ft
- 10-15° angle
- 5x5 grid
- 6,5´ spacing at surface







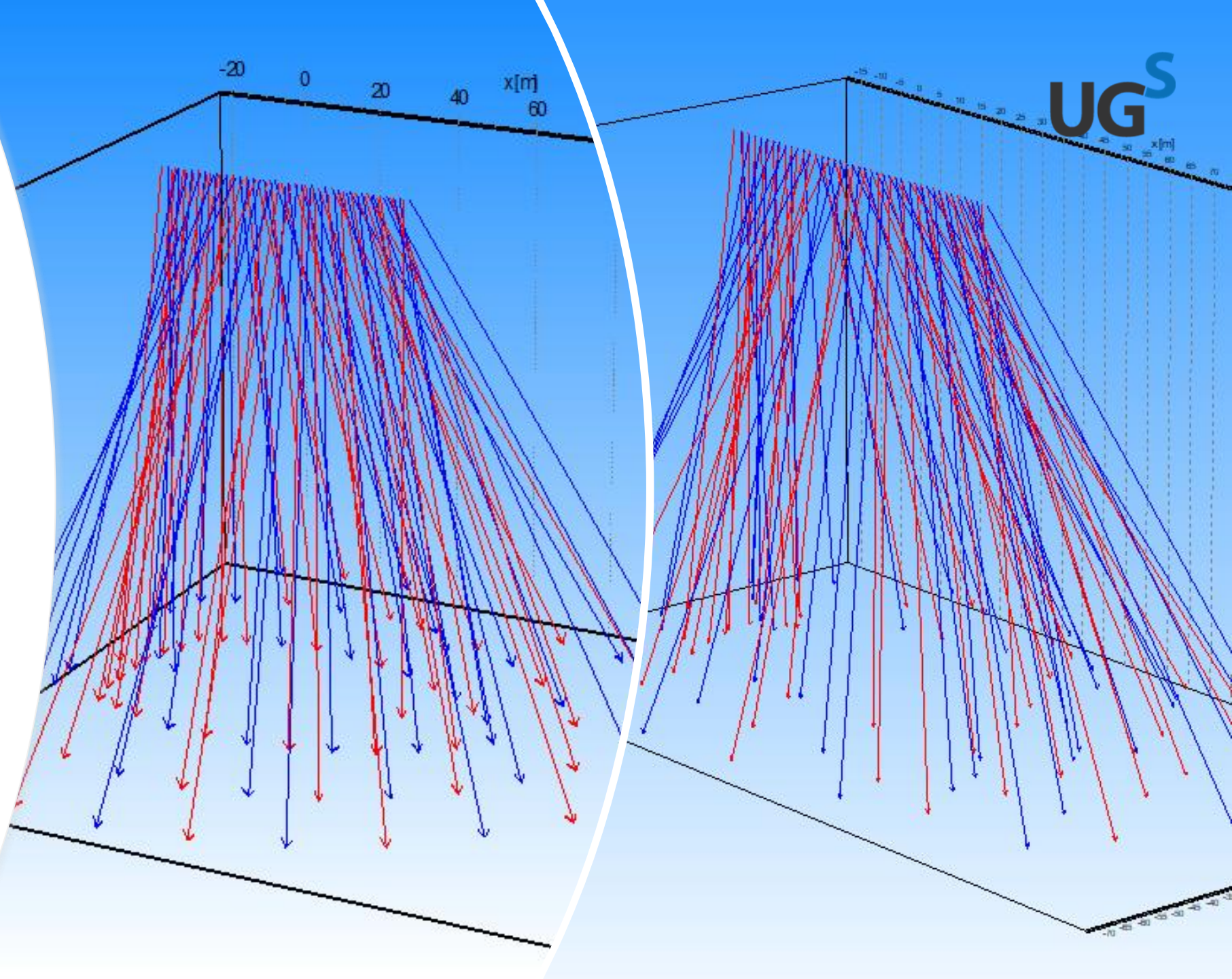


Najaden 1997
Design only

Early projects

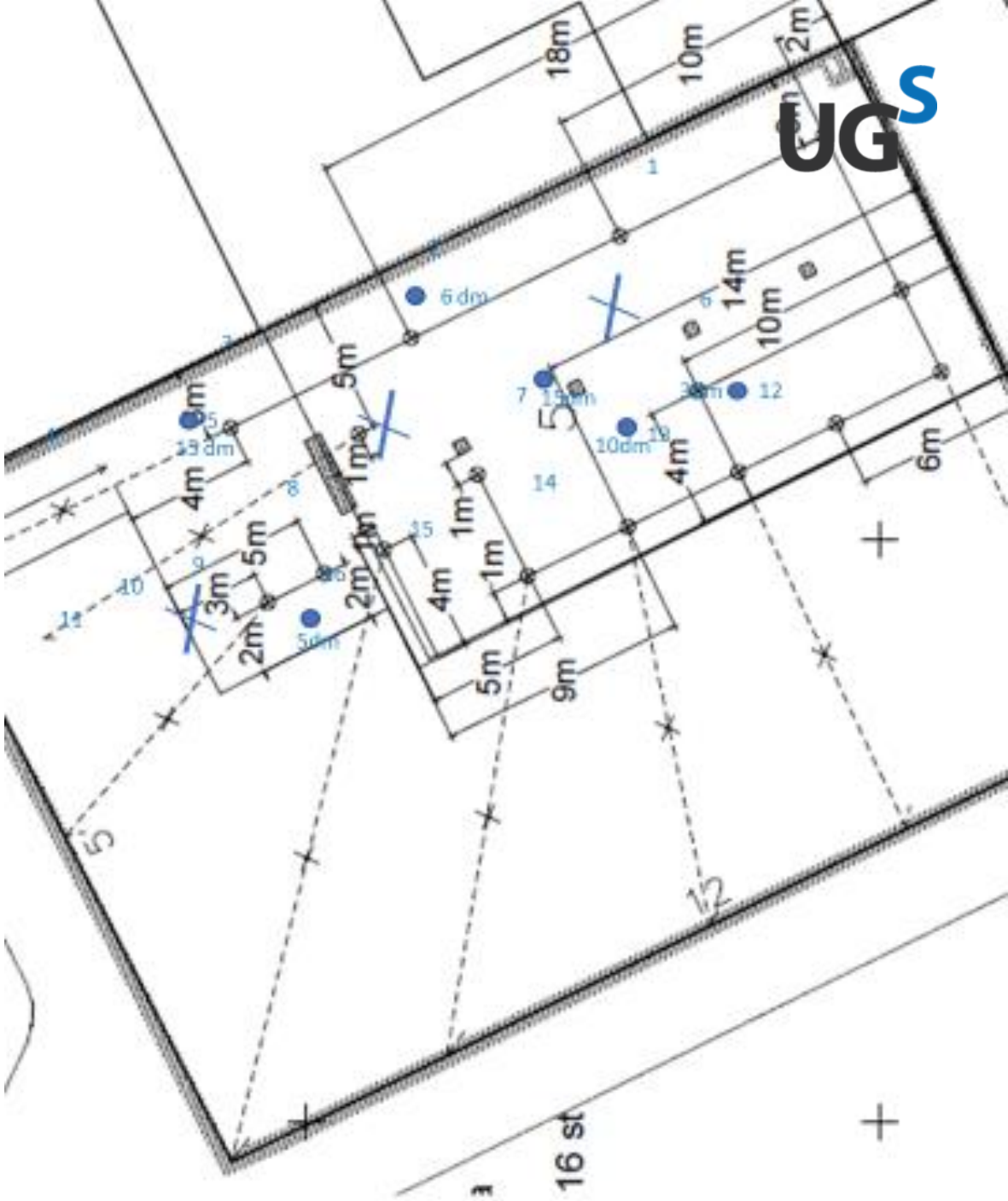
Campus Konradsberg, Stockholm

- Data server hall
- Heat and free cooling
- 82 boreholes x 980 ft
- Deviation ~ 2,8 º, 28 ft
- 2 rows , 6,5 ft apart
- Hole spacing at surface
- Drilling along existing building



Inclined bore holes – Basement Stockholm 2018

- 16 holes x 250 m (825 ft)
- Garage / basement
- Wassara water hammer WDTH
- Dia 3,5” hole , special loop



Geothermal Energy Storage

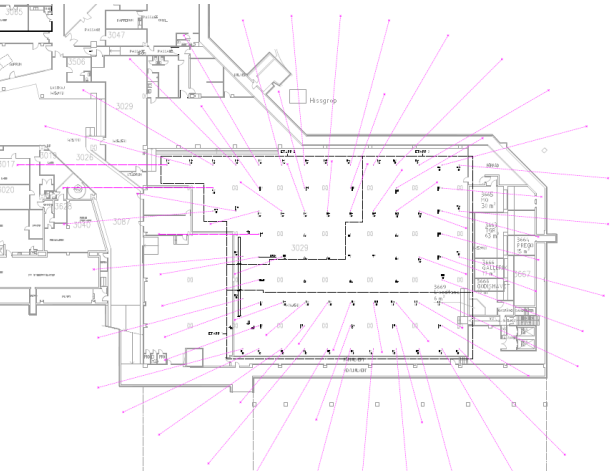
Frölunda Torg Shopping Mall

Conversion to geothermal / solar

80 boreholes x 650 ft (0 -10 degree angel)

Business as usual while drilling in basement

Water Down-the-hole hammer technology



Geothermal solution for Skandia

Geothermal Energy

Design loads

Heating 700 kW

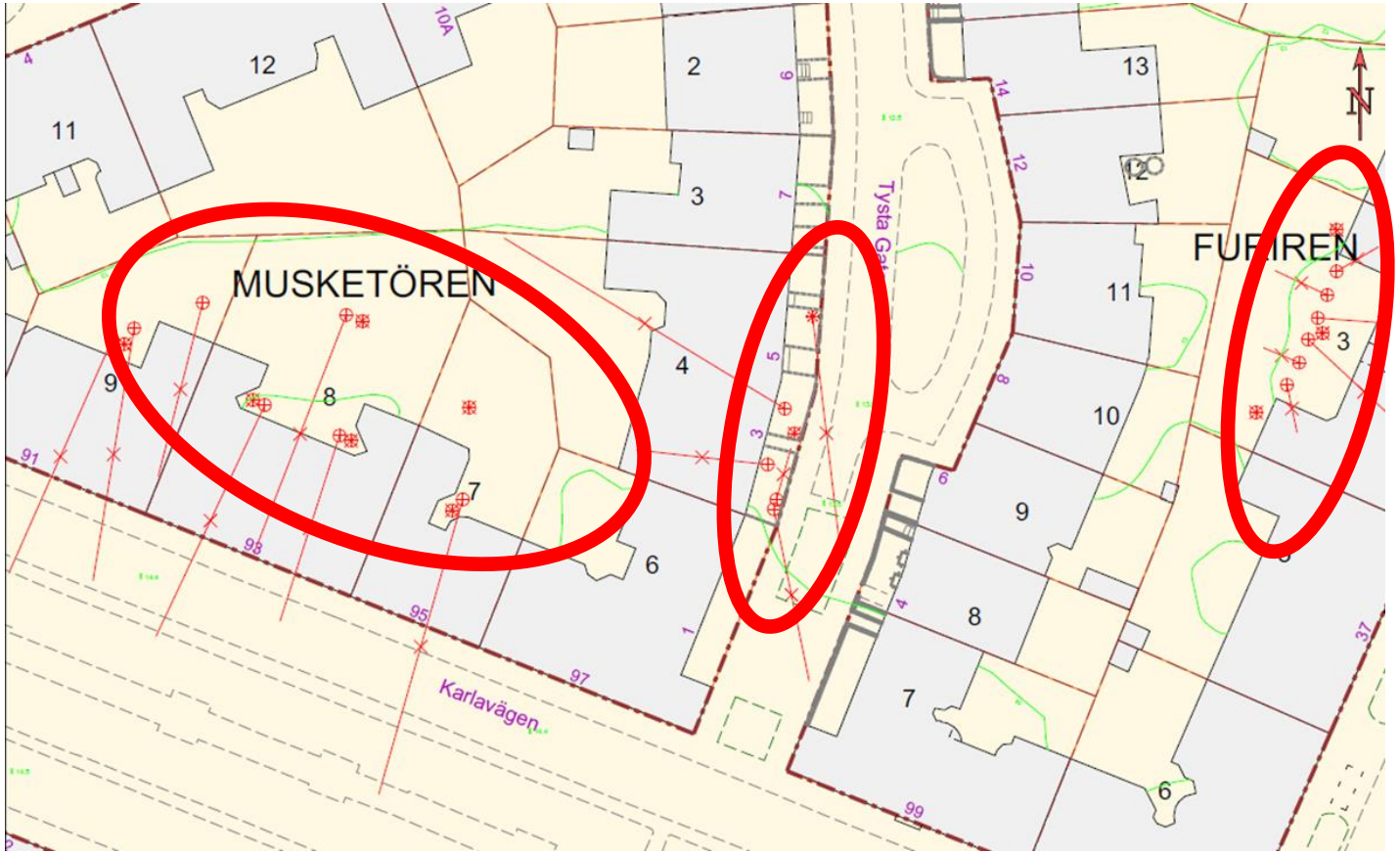
Active cooling 600 kW

Free cooling (bore holes) 200 kW

Power load coverage – heat 52%

Power load coverage – cooling 31%

Inclined bore holes – City Centre Residential



- Fully approved concept by Stockholm City Council
- Condominiums
- Drlling from inner court
- Drlling from street
- Drilling from garages
- Purpose to reach larger ground volumes

Inclined bore holes in basements

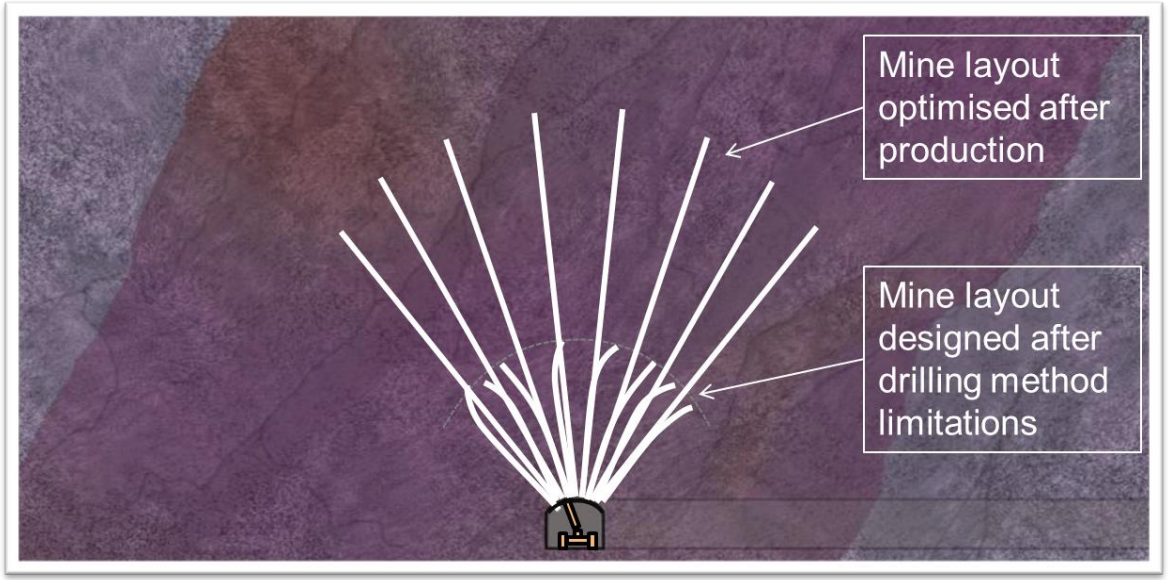
Ongoing project Copenhagen, Denmark

- Basment in late 1800´s building
- 36 holes x 200 m
- 0°-10° angles
- Sedimentary rock ,
- 90 ft overburden

Drilling Metod and Process

Design, configuration and equipment determines drilling method

- Productivity – ROP, processes, experience
- Hole size and depth
- Requirements for grouting
- Space limitations
- Sensitive environment / infrastructure
- Equipment and drillers available
- National and local laws, regulations

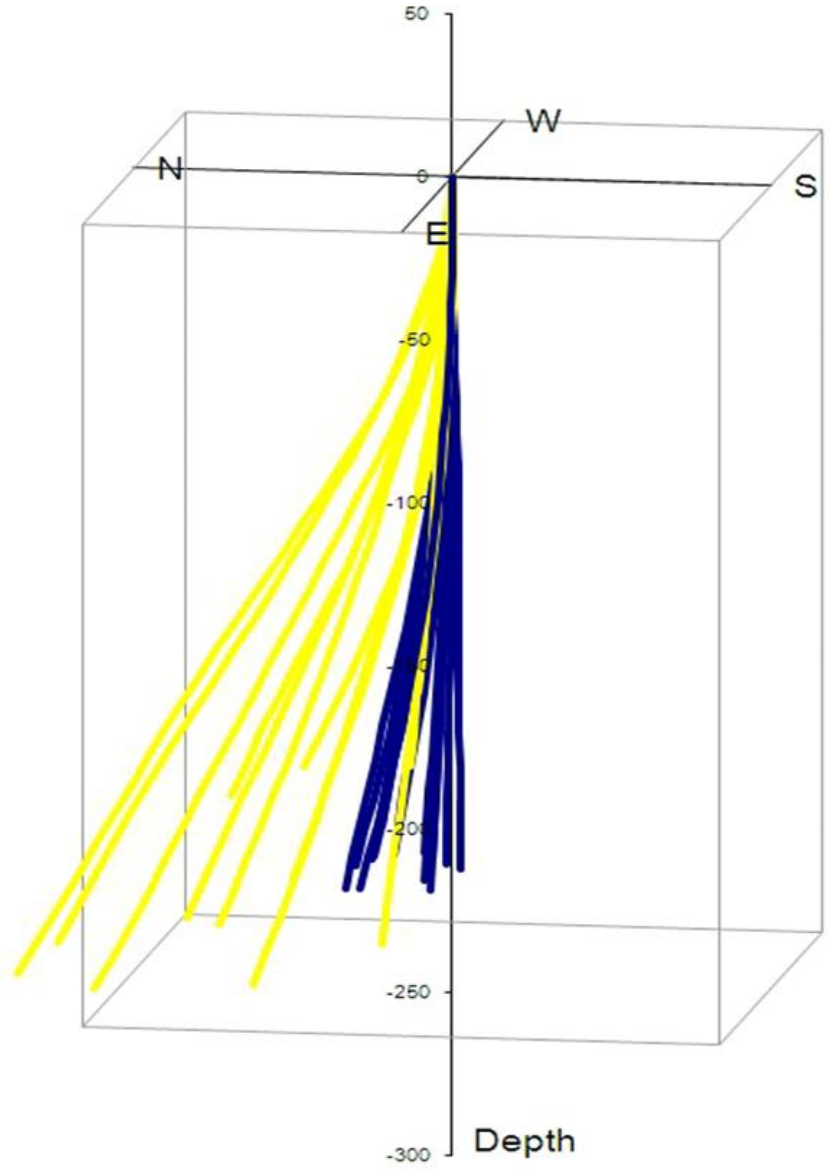


Drilling method developed to access more rock volume in mining , sub level caving
Wassara - Water DTH Hammer

Inclined bore holes – Accuracy

Factors effecting accuracy

- Geology
  - Faults, voids, rock orientation
- Equipment and tooling
  - Method , DTH, WTDH, rotary
  - Alignment and collaring
- Drilling parameters control
- Operator – Driller experience
- Hole size and depth



URBAN GEOTHERMAL SOLUTIONS

Thank you for listening,

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