



Digging Deeper

How trenchless technology is revolutionizing infrastructure development

05/2023 –Roberto Zillante (CTO)





Roberto Zillante

BS. Mechanical Engineering — Universidad Simon Bolivar
MS. Engineering and Management — Politecnico di Torino

Chief Technology Officer - Petra

Associated professor – Universidad Pontificia Javeriana

About the lecturer:

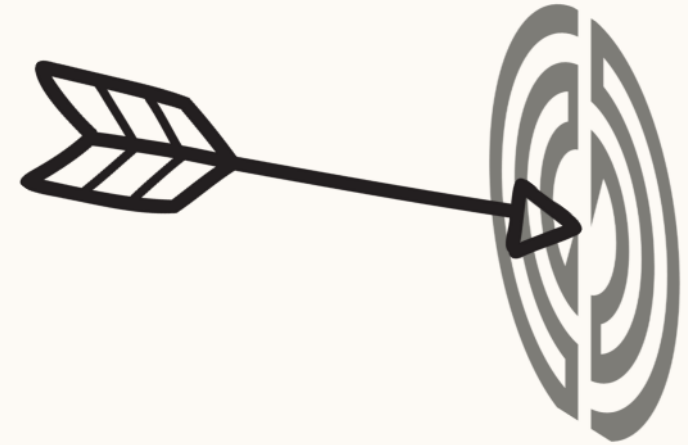
Inventor of multiple patents including a new trenchless technology: Assisted Dynamic Boring, with more than a decade of experience in the Trenchless industry.

Leader of PETRA (USA) Research and Development division and Zilper Trenchless (LATAM / Colombia).



“Quien no cambia con el cambio, por lo menos a
la velocidad que cambia el cambio,
el cambio lo cambia.”

presentation objectives



Make trenchless projects more cost-effective than open cut



Introducing a new trenchless technology for **unstable** ground conditions



Introducing a new trenchless technology for **extreme hard rock** conditions

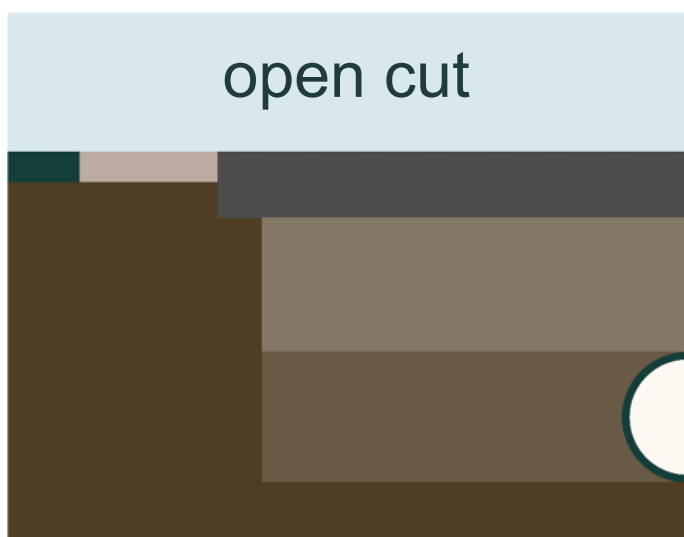


Introducing a new multi-technology platform to increase **versatility**



Understanding critical

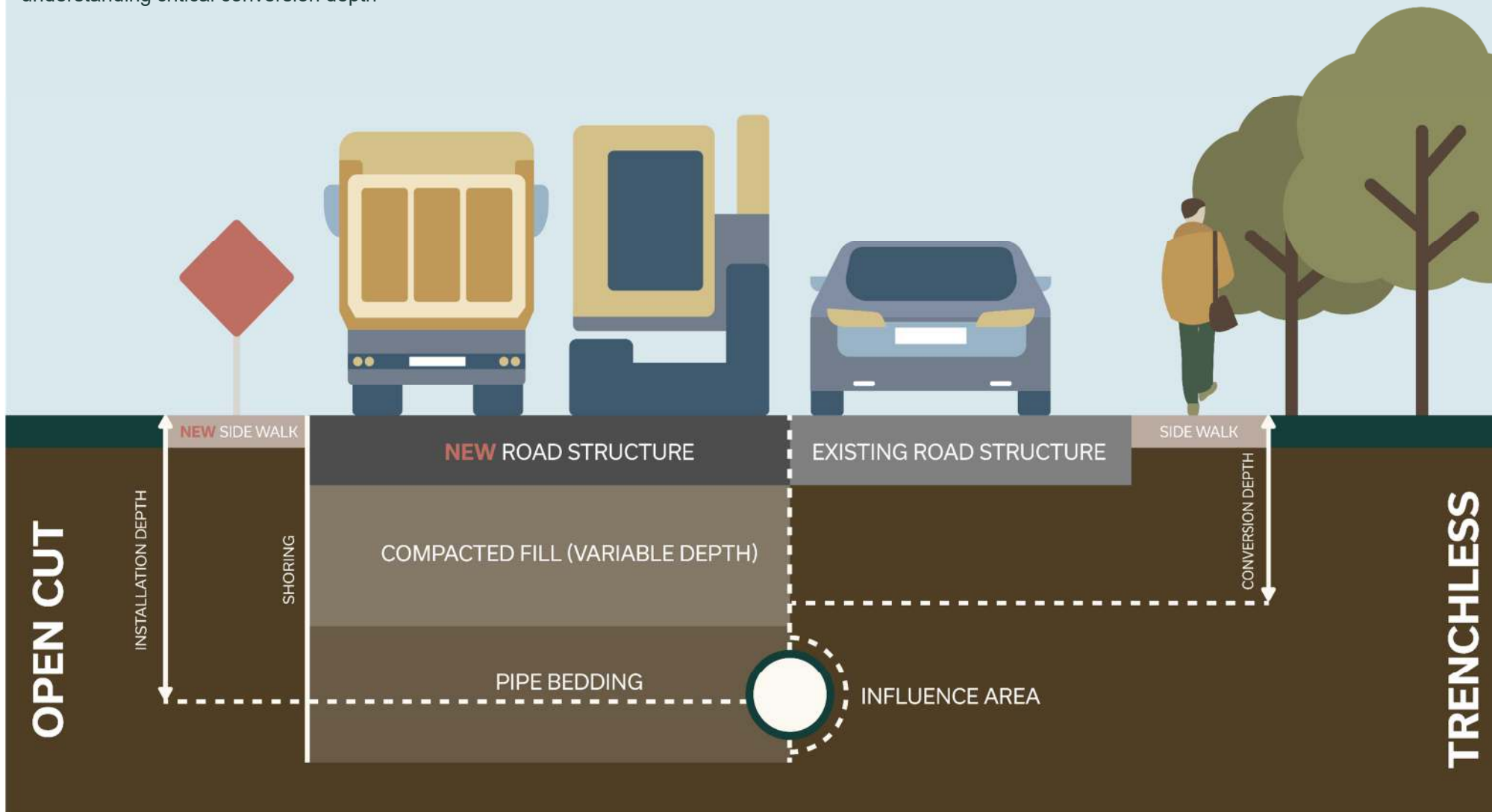
conversion depth

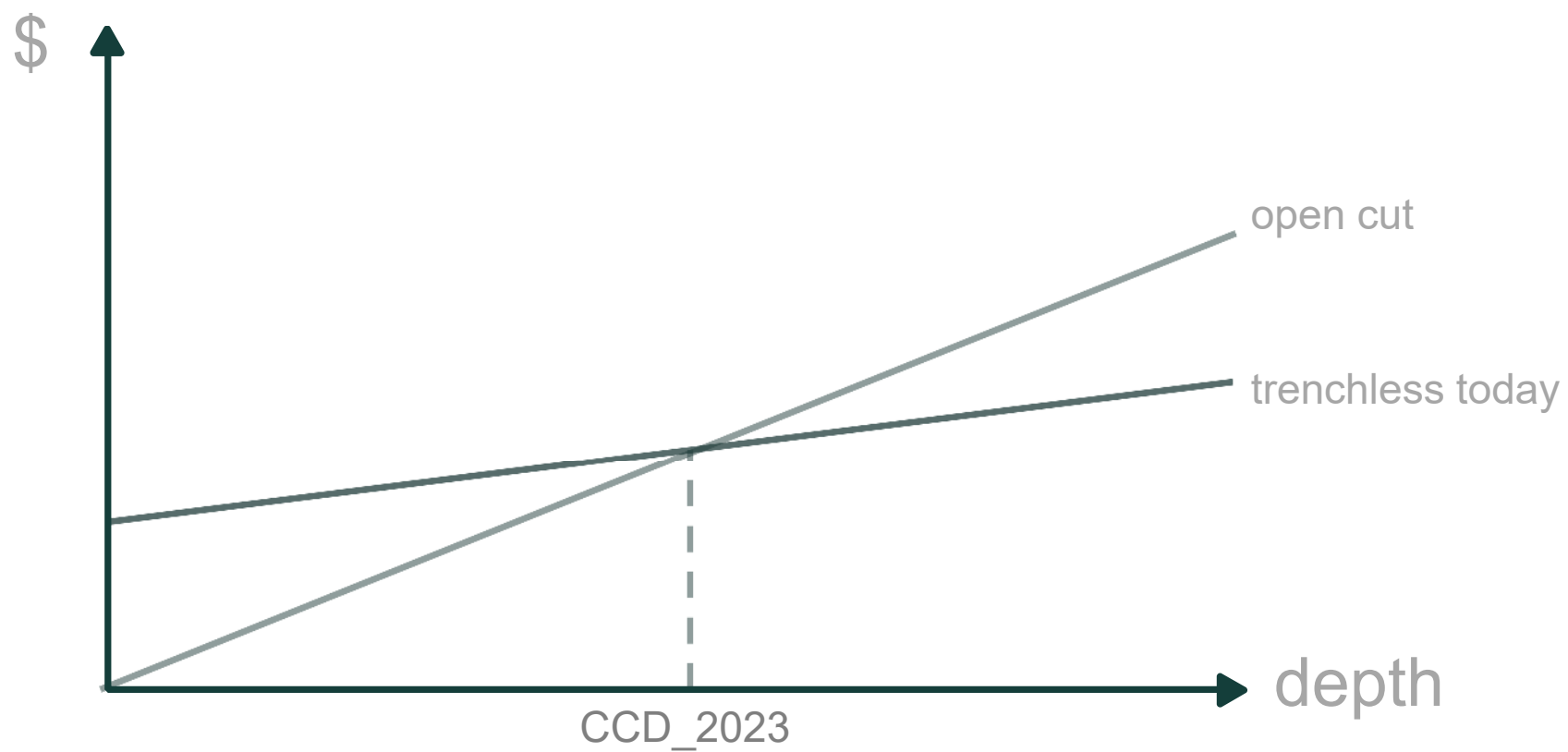


VS



understanding critical conversion depth





Why so
important?



— why so important?

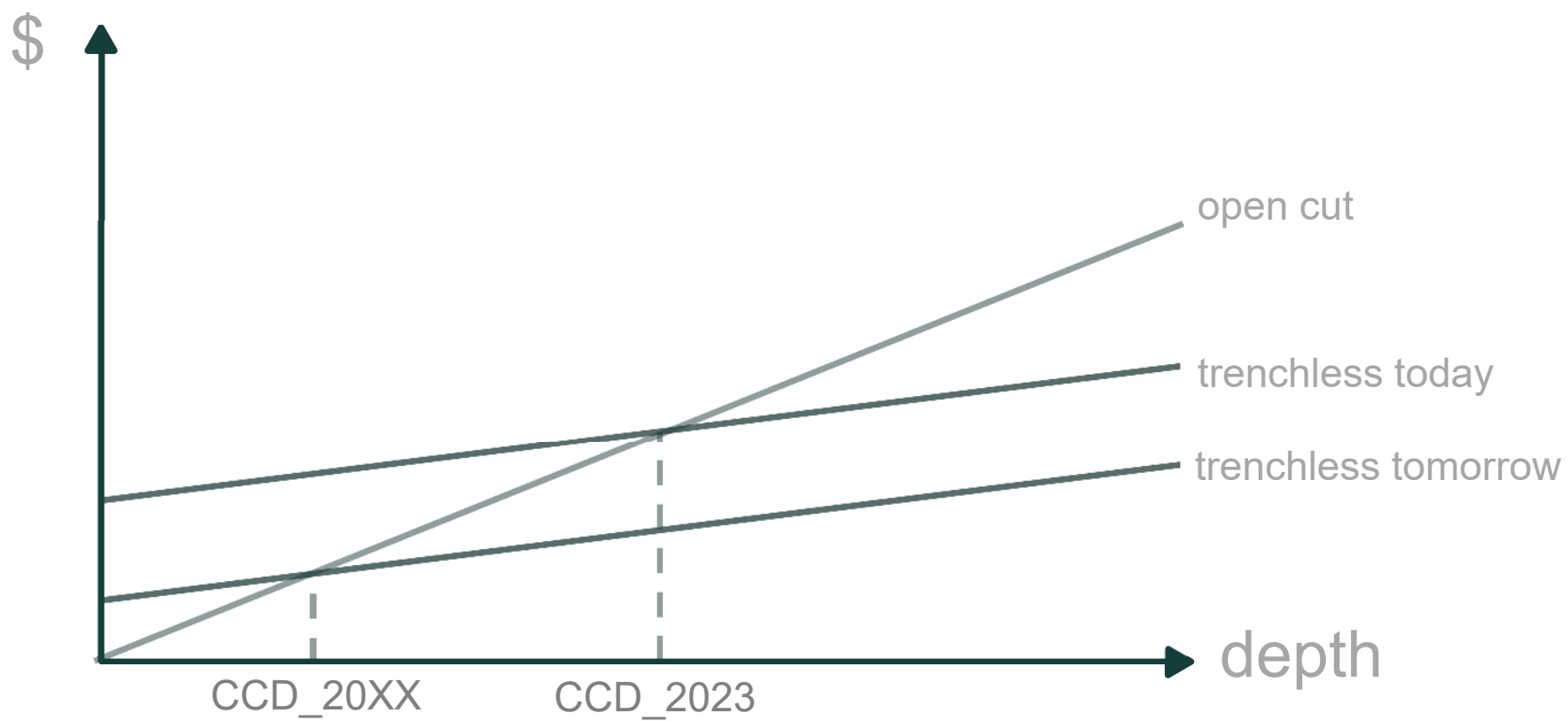
Installing new
underground infrastructure
using open-cut is
messy and costly



What
Can we do?



— why so messy and costly?





Why so

Expensive today?

Imagine the next generation of trenchless machines

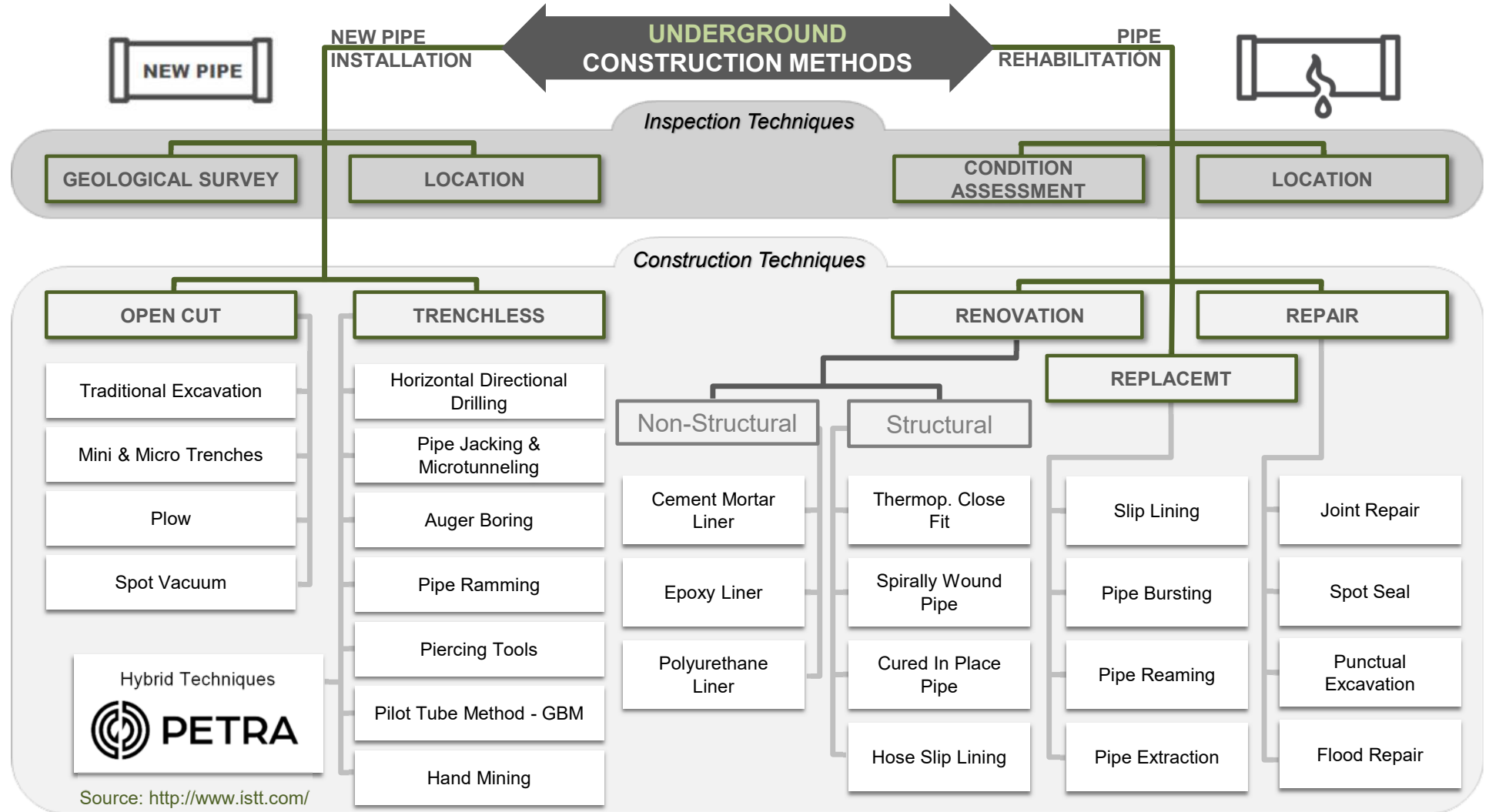
Multi-geologies
Highly automated
Multi-diameters and precise



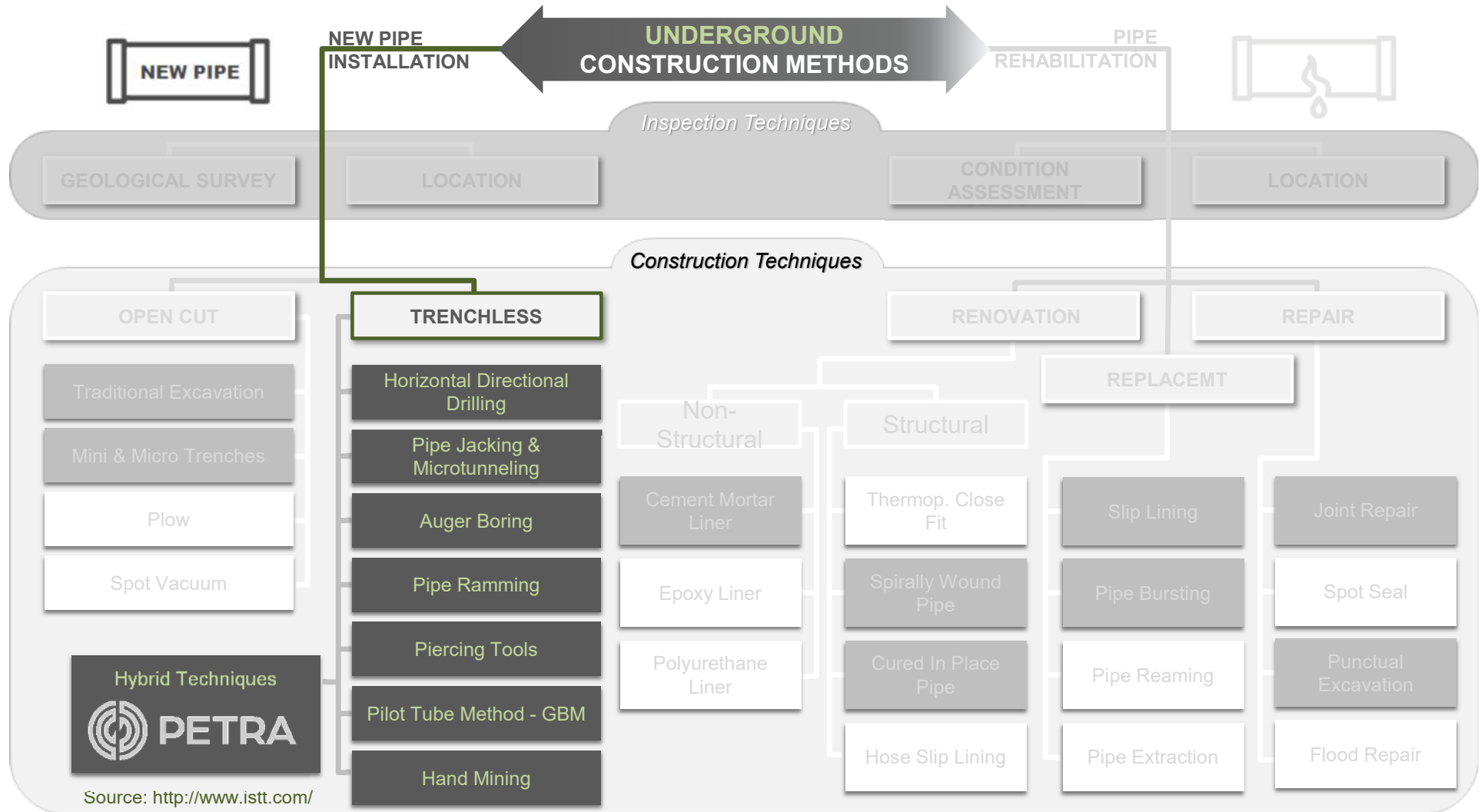
What is
out there?



what is out there?

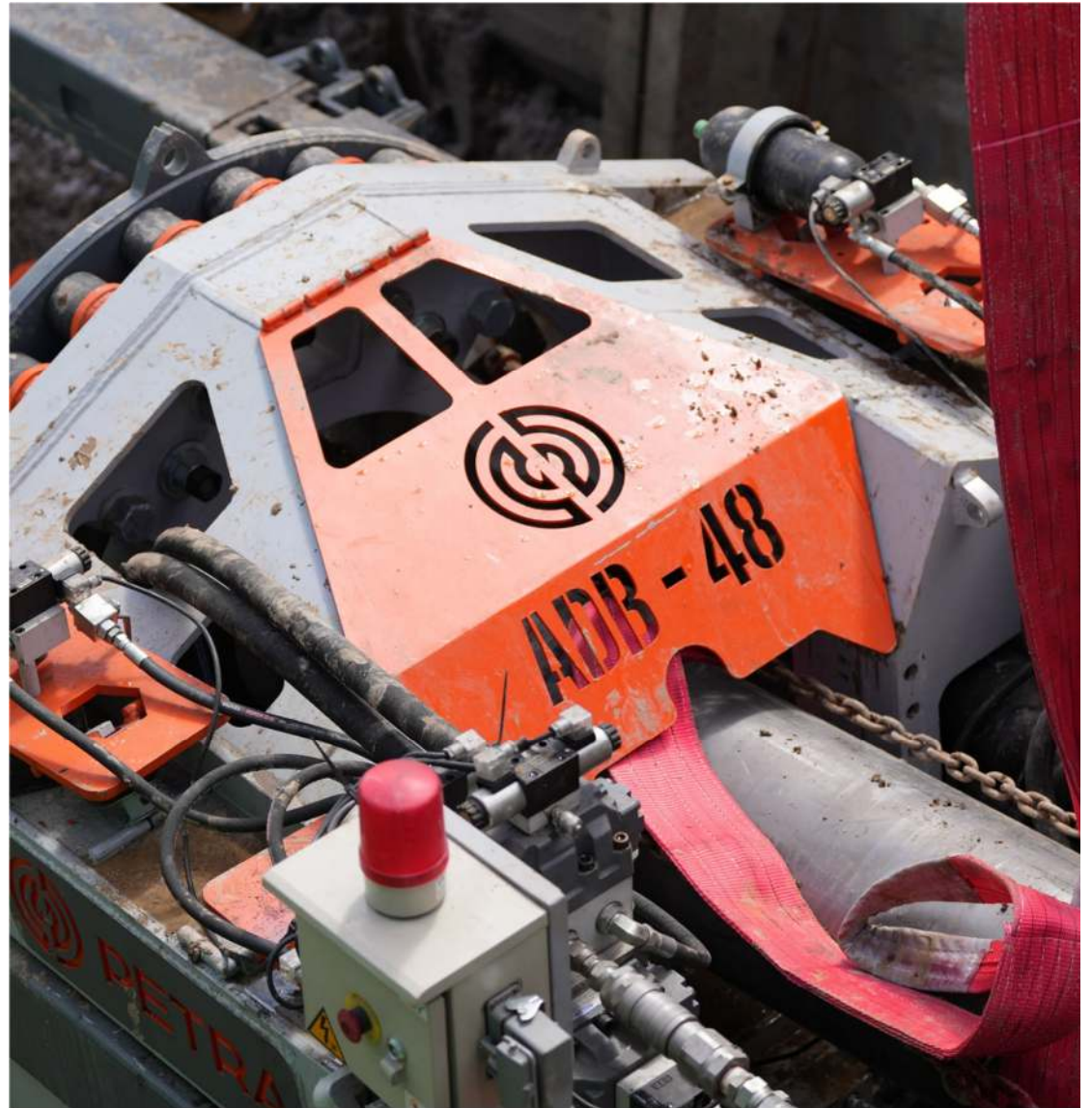


what is out there?



Introducing a new
trenchless technology

Assisted Dynamic Boring



— assisted dynamic boring



PETRA

Hybrid techniques - ADB

Specifications



6 - 120ML



8" - 72"

Common applications



water



sewer

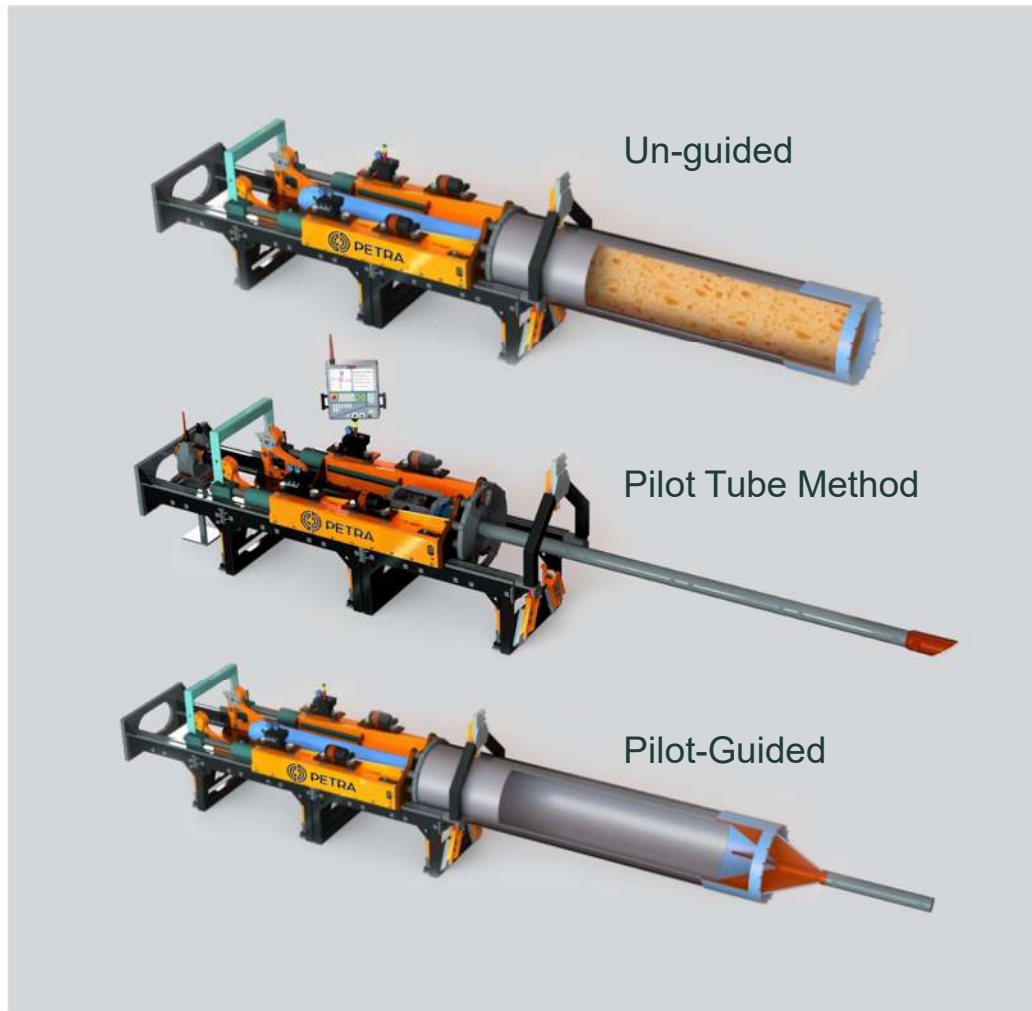


elec & telecom



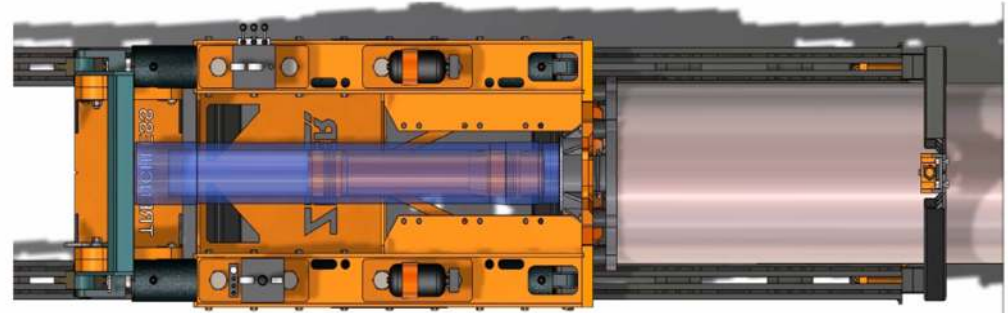
oil & gas

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— assisted dynamic boring

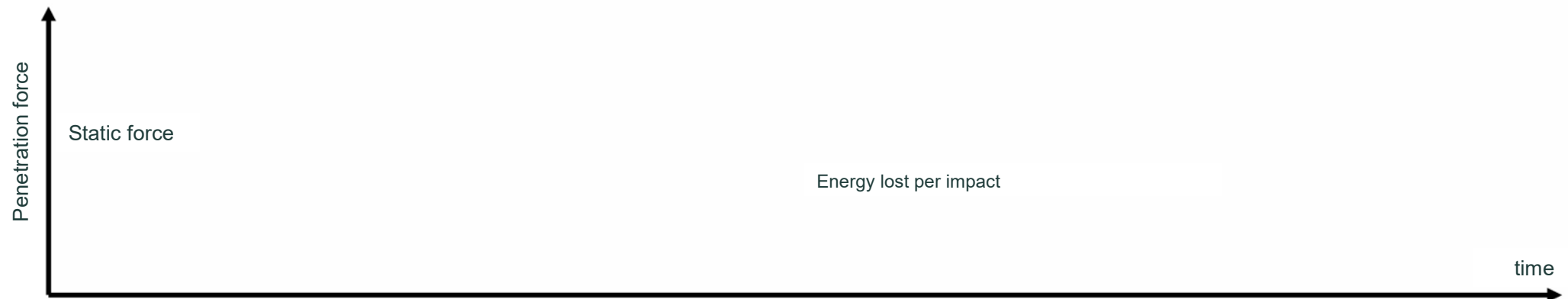




Assisted Dynamic Boring

vs.

Conventional Ramming



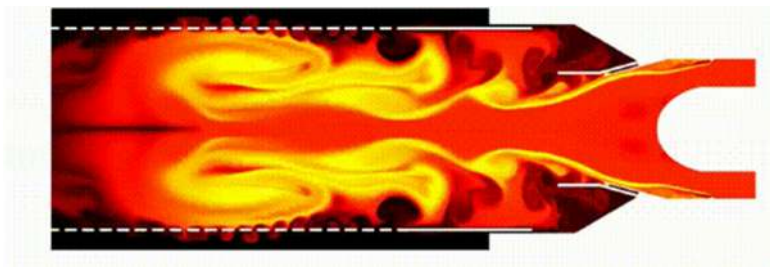
— assisted dynamic boring

assisted dynamic boring



Introducing a new
trenchless technology

Jet boreTM





PETRA

JET BORE

A proprietary trenchless method that uses a non-contact cutterhead to excavate bedrock for installing underground utilities, making it the only economically viable method for small diameter pipelines in such conditions.

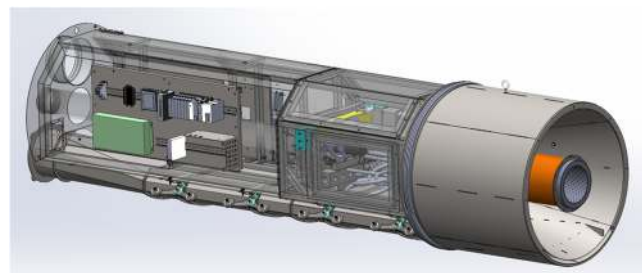
Specifications

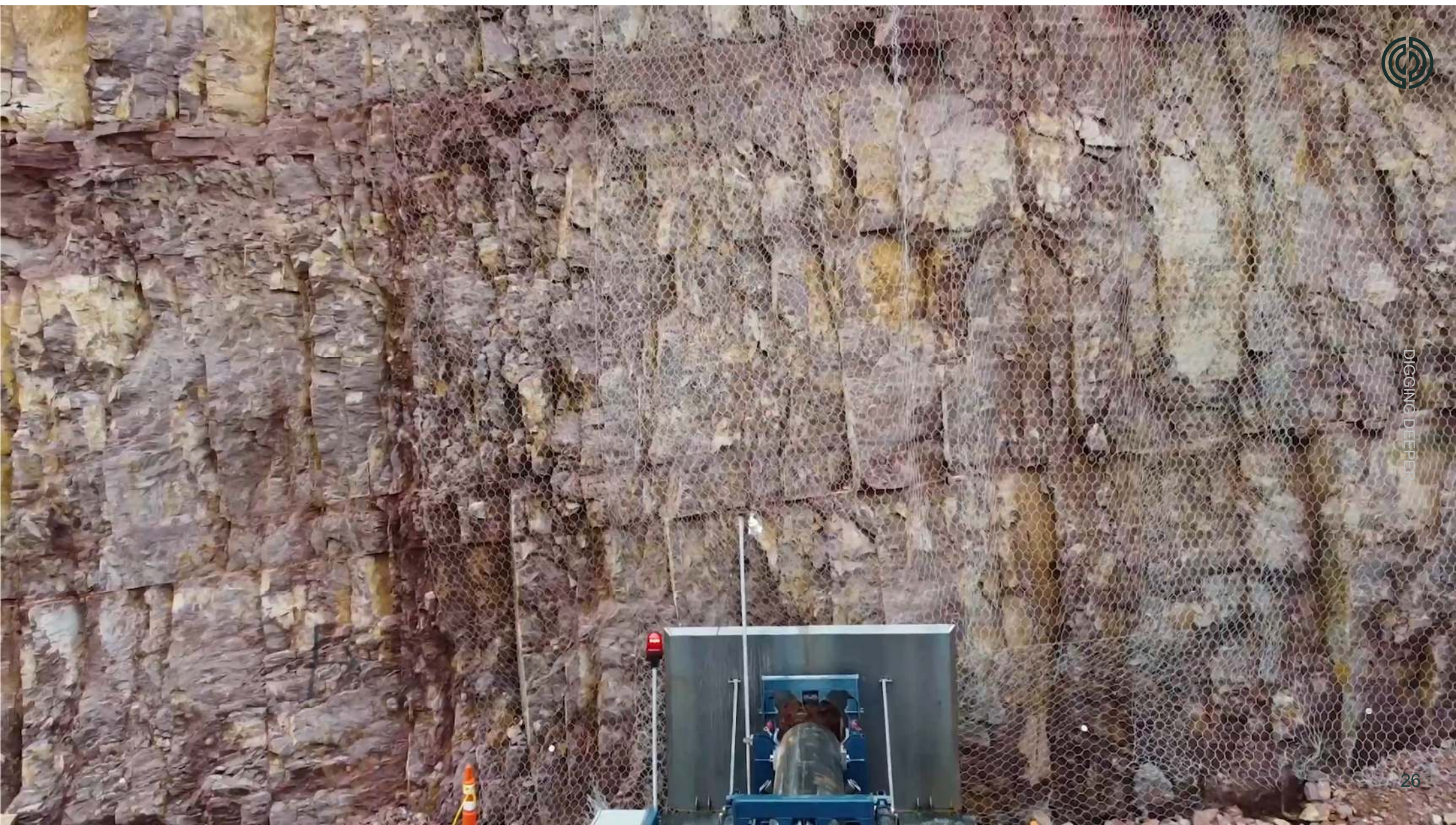


18" - 48"



+/- 0.5%





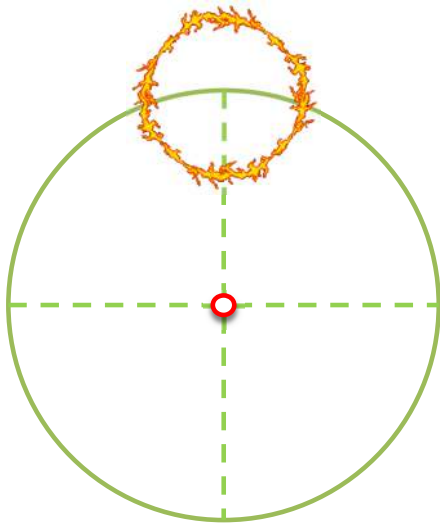


A whole new way to

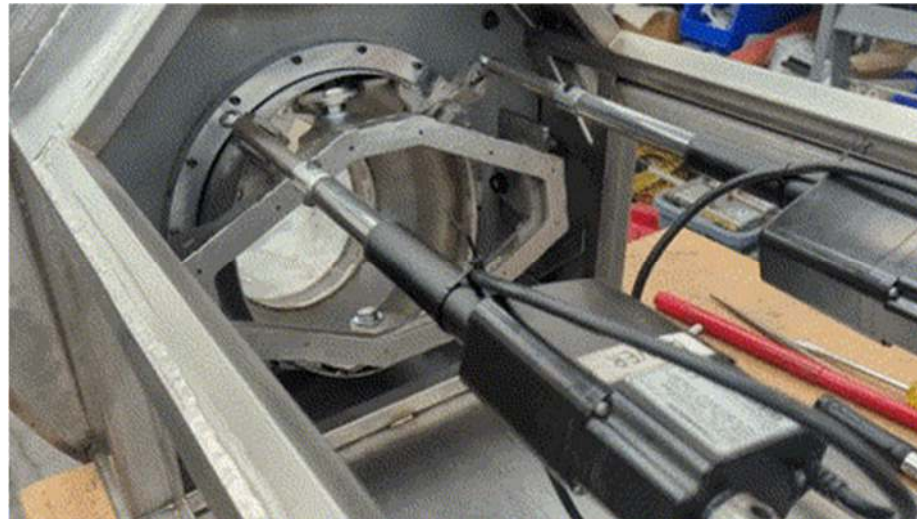
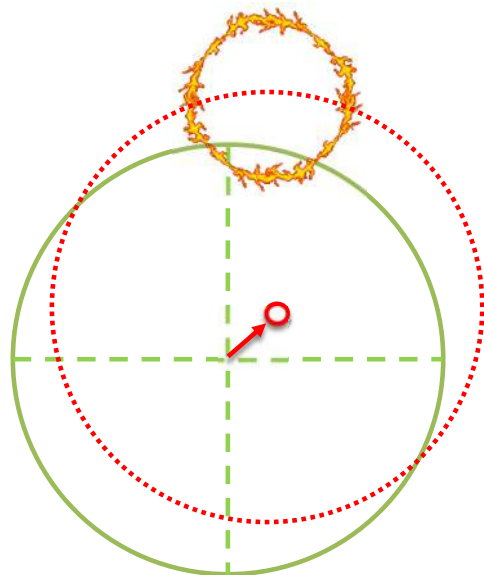
Steer in rock

Jet bore™

Going straight



Steering

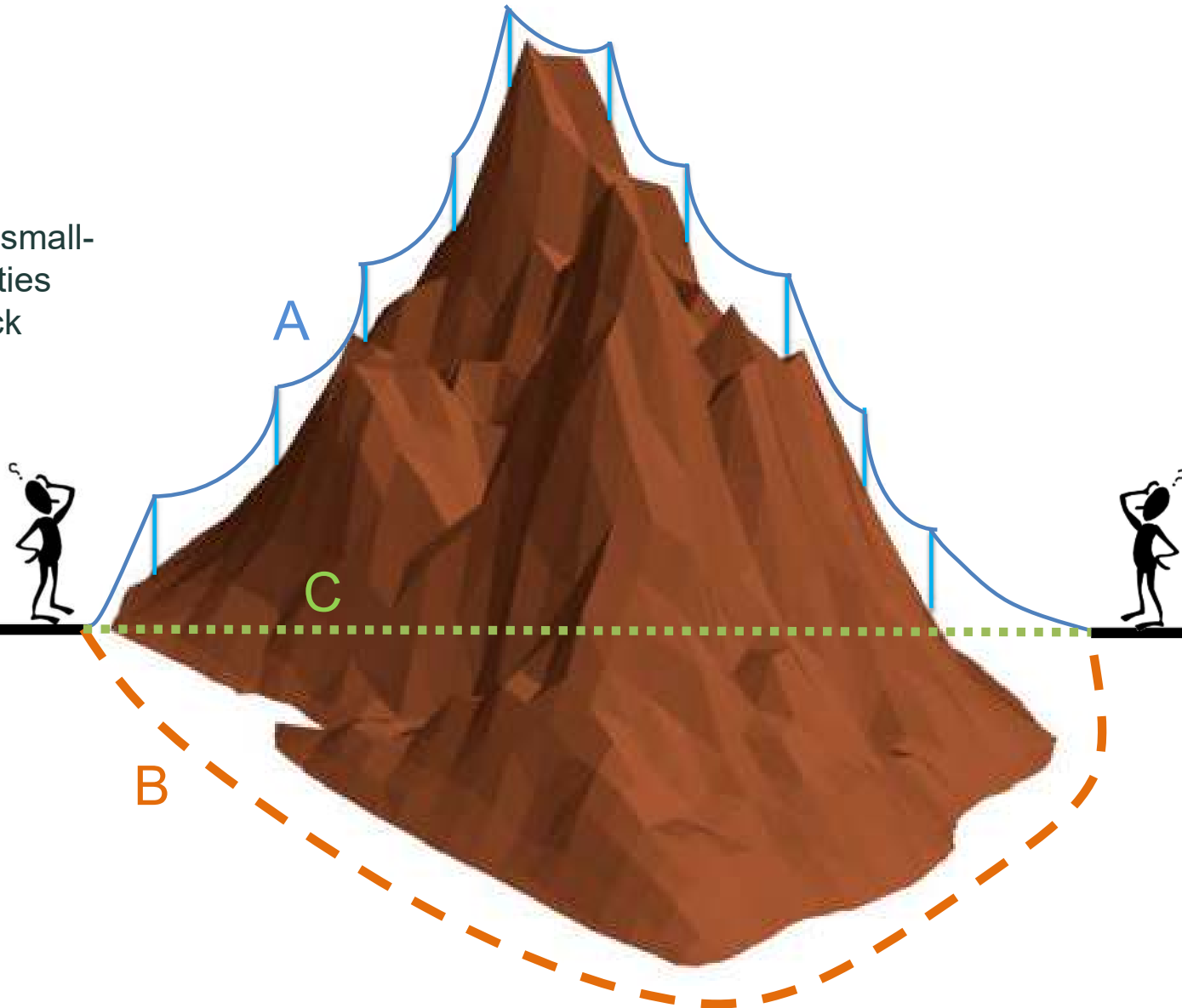




Re-thinking how to install utilities in rock



The problem of small-diameter utilities through rock



Jet bore™

The small-diameter
problem in rock

**The race against
wear in
microtunneling**



Hard rock



Extreme Hard rock





The small-diameter
problem in rock

**The race against
wear in
microtunneling**





results in
quartzite

Impressive initial results

In November 2021, Petra completed a field test of its robot in extremely hard and abrasive Sioux Quartzite (Minnesota, USA). This is a lithology normally bored using dynamite.

- Diameter: 25"
- Length: 250"
- Max Penetration Rate: 1.12"/min.
- Steady State Mass/Volume Removal Rate: ~ imperial ton (1016.05 kg) per hour at 0.723 in/min
- Compressive strength of rock: 44,285 psi (305 MPa)
- Cerchar Abrasivity: 4.2
- Depth: at surface
- Operation: is semi-autonomous (controlled by two operators remotely from and Ops cabin)
- Set Up: 3 days
- Tear Down: 2 days
- Utilization: ~6% (as a prototype)





A non-contact approach removes thrust and tool wearing from the equation





We are boring nightmare geologies

- Excels in hard, abrasive rock
(projected 500 ft/day in Quartzite, Basalt, Granite, Dolostone, etc. in laboratory environments at 16-25" diameters)
- No human required in tunnel
- Minimal moving parts require less down time for part maintenance.
Up to 10x faster than conventional
- Non-contact method eliminates cutterhead tool wear & no need for reaction forces/large infrastructure
- Can shape the bore, allowing for a tighter turning radius, variable diameter, small overall footprint
- Spallated spoils are easier to handle & process
(No muck, no additional cutting fluids)



Taconite



Slate



Siltstone



Andesite



Schist



Sandstone



Rhyolite



Gabbro



Quartzite



Granite



Gneiss



Dolostone



Diorite



Diabase



Chert



Basalt



Jet bore

performance



We have tested many other rock types successfully

Red Granite



Origin: Colorado, USA

Advance rate:

0.68 in/min (19 inch dia)
0.35 in/min (30 inch dia)

Excavation rate:

TBD in³/min

UCS: 28,000 PSI

Basalt



Origin: Idaho, USA

Advance rate:

2.2 in/min (18 inch dia)

Excavation rate:

TBD in³/min

UCS: ~15,000–20,000 PSI

White Granite



Origin: Minnesota, USA

Advance rate:

5.5 in/min (4.5 inch dia)
0.5 in/min (32 inch dia)

Excavation rate:

49.3 in³/min

UCS: 22,000 PSI

Quartzite



Origin: Minnesota, USA

Advance rate:

8 in/min (4.5 inch dia)
1.3 in/min (16 inch dia)
0.74 in/min (26 inch dia)

Excavation rate:

125.3 in³/min

UCS: 44,000 PSI

Dolostone



Origin: Wisconsin, USA

Advance rate:

11.2 in/min (4 inch dia)
2.1 in/min (20 inch dia)

Excavation rate:

197 in³/min

UCS: ~8,000–12,000 PSI

Biotite Gneiss



Origin: Colorado, USA

Advance rate:

4.1 in/min (6 inch dia)

Excavation rate:

113.0 in³/min

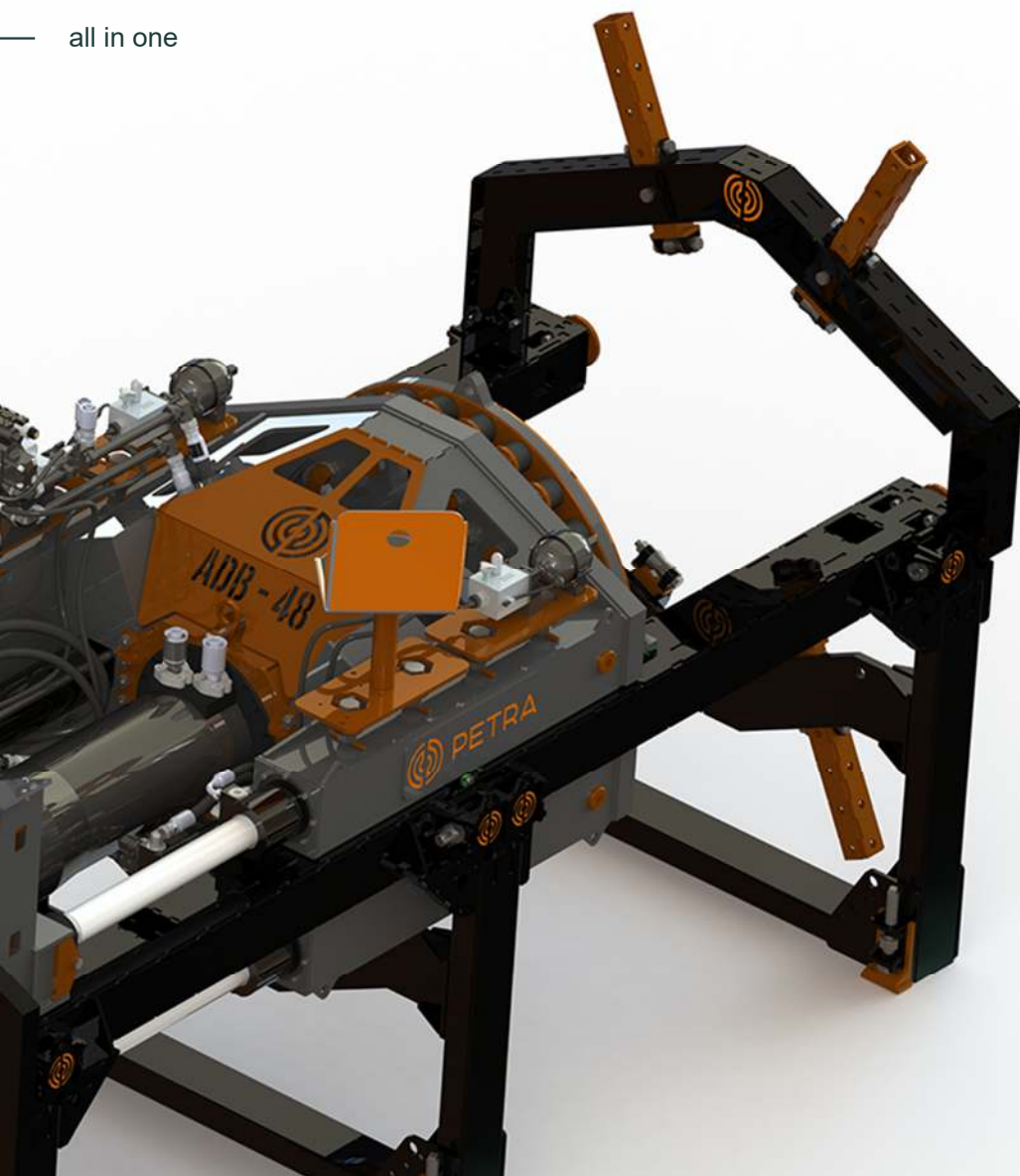
UCS: ~15,000–25,000 PSI

The all-geology
problem





all in one

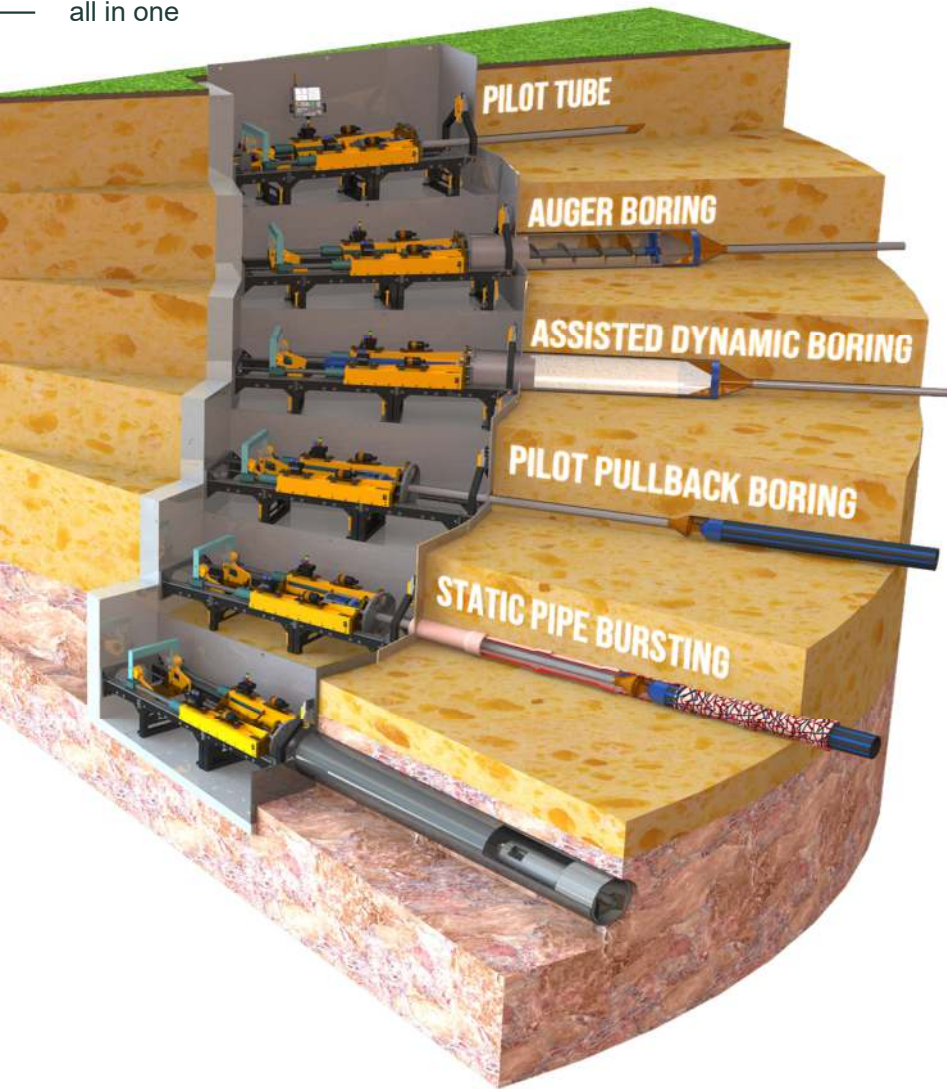


Introducing the first multiplatform ever AI1



DIGGING DEEPER

all in one



Six trenchless methodologies,
one package

Ai1





Pilot Bore

Piloting, the process of creating a small diameter borehole using a guidance system and steerable drill head, can be utilized to accurately establish the path and depth of installation before pulling a final product pipe (such as High-Density Polyethylene (HDPE) pipes) through the pilot borehole via the pilot pullback technique.

Power Sources



Grid



Renewable
Diesel

Specifications



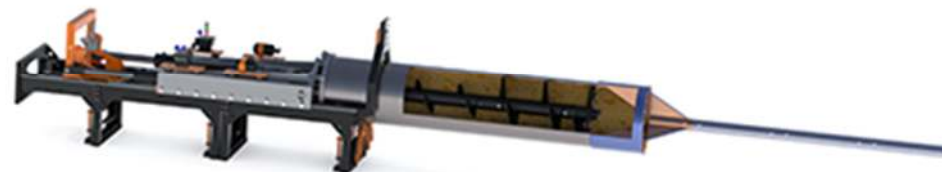
Diameters
4.5"



Max Drive
300+ feet



Accuracy
+/- 0.05%



Auger Boring

Auger and Guided Boring is a trenchless method that combines the use of a piloting system with Auger boring, which involves jacking a casing pipe into the ground while helical augers rotate to remove the excavated spoil.

Power Sources



Grid



Renewable
Diesel

Specifications



Diameters
12" – 48"



Max Drive
400 feet



Accuracy
+/- 0.05% - 0.5%



Assisted Dynamic Boring (ADB)

Assisted Dynamic Boring is our proprietary trenchless method that combines hydraulic force and high-frequency percussive impacts to install underground utilities with significantly increased penetration force.

Power Sources



Grid



Renewable
Diesel

Specifications



Diameters
8" – 48"



Max Drive
300+ feet



Accuracy
+/- 0.05% - 1%



Pilot Pullback

Piloting, the process of creating a small diameter borehole using a guidance system and steerable drill head, can be utilized to accurately establish the path and depth of installation before pulling a final product pipe (such as High-Density Polyethylene (HDPE) pipes) through the pilot borehole via the pilot pullback technique.

Power Sources



Grid



Renewable
Diesel

Specifications



Diameters
6" – 14"



Max Drive
300+ feet



Accuracy
+/- 0.05%

all in one



Pipe Bursting

Pipe rehabilitation is a trenchless method of rehabilitating existing pipelines using various techniques such as slip lining and pipe bursting to improve their structural integrity and extend their service life without the need for extensive excavation.

Power Sources



Grid



Renewable
Diesel

Specifications



Diameters
4" – 16"



Max Drive
300+ feet



Jet Bore

Jet Boring is a proprietary trenchless method that uses a non-contact cutterhead to excavate bedrock for installing underground utilities, making it the only economically viable method for small diameter pipelines in such conditions.

Power Sources



Diesel



Renewable
Diesel

Specifications



Diameters
18" – 48"



Max Drive
100 feet



Accuracy
+/- 0.5%

all in one



DIGGING DEEPER



DIGGING DEEPER

Conclusions

Questions?



