Design & construction considerations for TT new pipeline installations

ICTIS: Instituto Colombiano de Tecnologías de Infraestructura Subterránea

AUGUST 22, 2016

BAMI-I

Trenchless Technology Center

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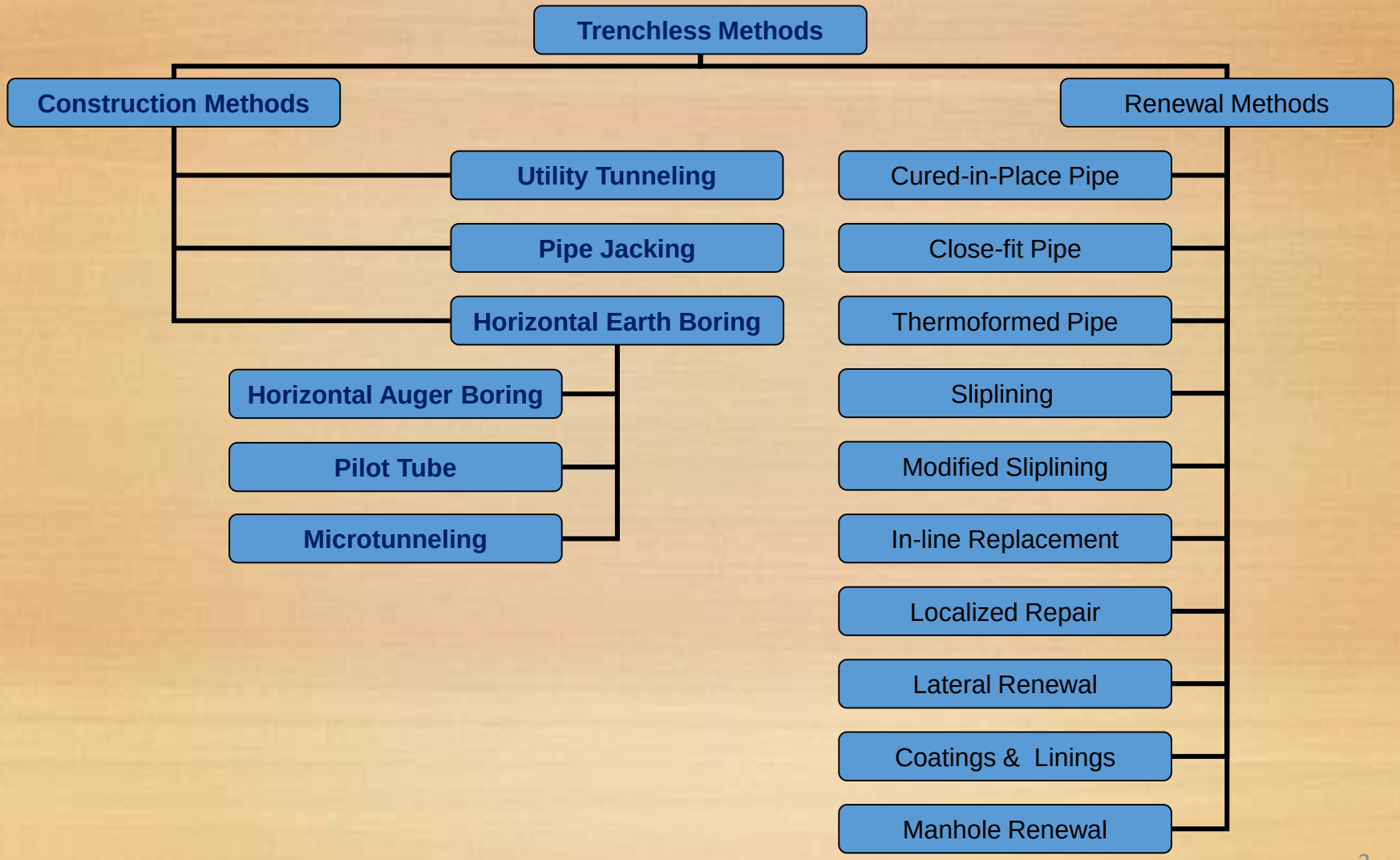
- Professor, Louisiana Tech University
- Director, Trenchless Technology Center (TTC)
- Chair, Buried Asset Management Institute-International (BAMI-I)

TRENCHLESS TECHNOLOGY METHODS



Utility Tunneling Method

- Utility Tunneling
  - **Performed in two steps**
    - Excavation & Installation of Primary Support
    - Installation of pipe (Secondary Support/Liner System)
  - Product pipe sizes 42” & larger
  - Limitations on length & size based on logistical considerations & safety

Pipe Jacking

- Pipe jacking first used around 1900
- First used as person-entry, hand excavation method
- Large diameters
- Soils and mixed ground
- Various levels of face support
- Long distances
- Above the water table
- Steerable

Pipe Jacking Method

- Similar to Utility Tunneling, except **it combines the excavation & pipe installation into one step**
- Product pipe sizes 42” & larger
- Limitations on length & size based on logistical considerations & safety

Jacking Pipe

PIPE JACKING METHOD

Machines are available for pipe jacking in most ground conditions

Source: Pipe Jacking Association

PIPE JACKING METHOD

Drive Lengths and Diameters - HSE Recommendations

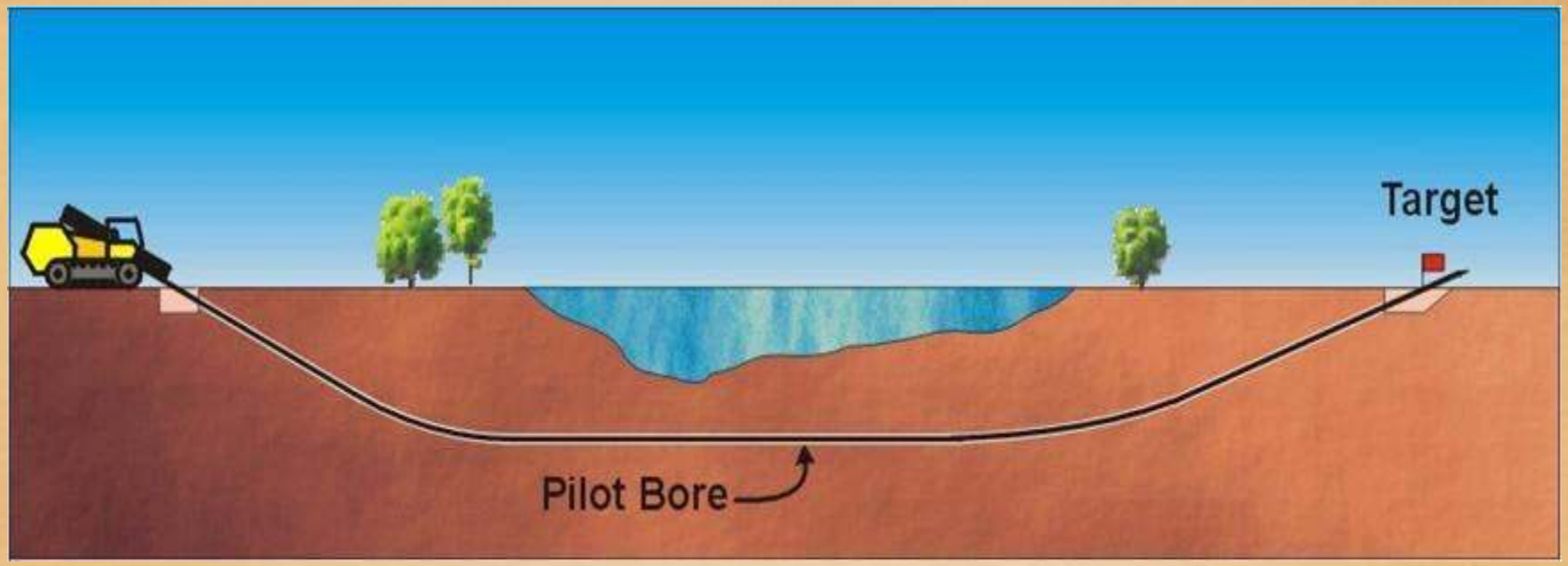
EXCAVATION TECHNIQUE	<0.9M	0.9M	1.0M	1.2M	1.35M	1.5M	1.8M	>1.8M
Pipe jack – machine; remote operation from surface	Drive length limited only by capacity of jacking system			250m		400m	>500m	
	Man entry not acceptable		Avoid man entry					
Pipe jack – machine; operator controlled below ground	Not Acceptable			125m	200m	300m	500m	>500m
Pipe jack – hand dig	Not Acceptable			25m	50m	75m	100m	
				2 drive lengths			1 drive length	
							Use minidigger if > 2.1m	

Source: Pipe Jacking Association

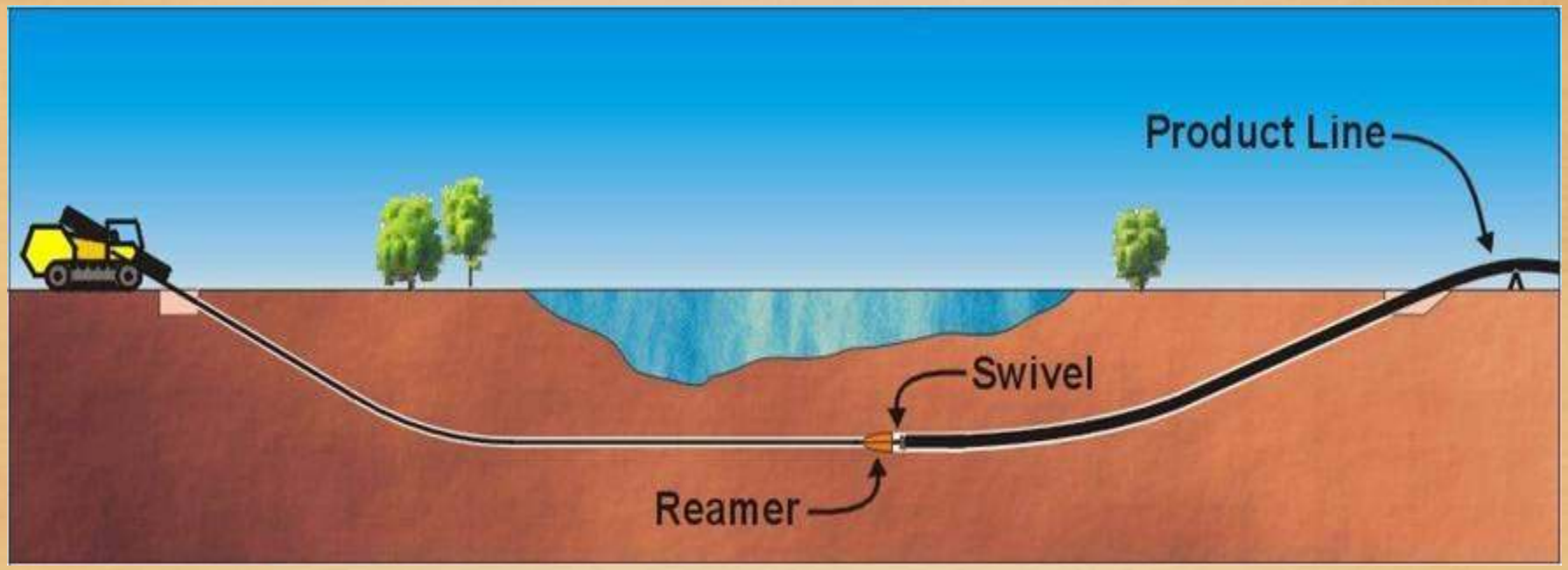
Horizontal Directional Drilling (HDD)

- Lengths of up to 7,300 ft.
- Diameters of 2” to 48”
- Applications:
  - utility conduits
  - pipelines
  - gravity sewers
  - force mains
  - horizontal remediation wells
  - geotechnical investigations

HDD Process



HDD Process



Back Reamers

Brief History of HAB

- Started in the 1930s in the coal mining industry
- In 1936, CRC Evans developed the Cradle HAB machine
- In the late 1940s: was developed by Vin Carthy, Salem Tool Company, and Charlie Kandal.
- In 1960, Richmond built machines with expanded capabilities
- In 1970: Leo Barbera established American Augers
- In the 1980s, National Utility Contractors Association (NUCA) Horizontal Boring and Pipe Jacking Committee was formed. (ASCE 2004)

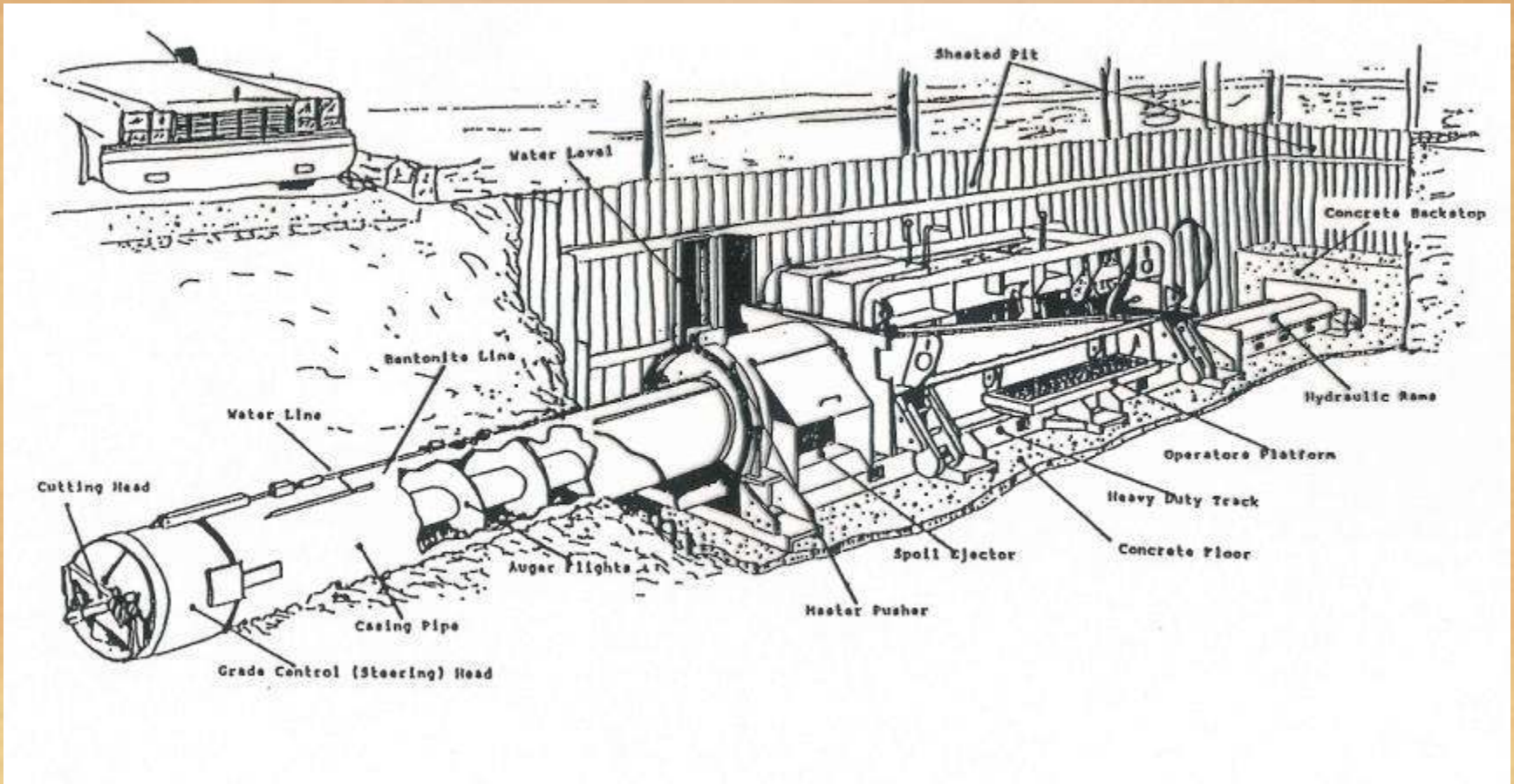
Horizontal Auger Boring Method

- Process of simultaneously jacking casing through the earth while removing the spoil inside the encasement by means of a rotating flight auger

Horizontal Auger Boring Method

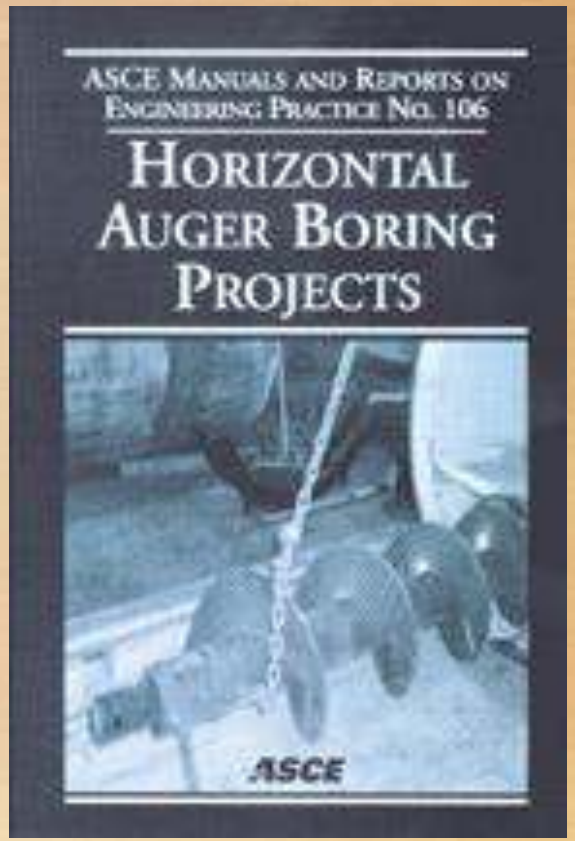
- Horizontal Auger Boring
  - Performed in two steps:
    - Excavation & installation of the casing pipe
    - Installation of carrier pipe & filling annular space with grout
  - Crossing technique
  - Available with
    - Dynamic grade control
    - Dynamic line & grade control

Auger Boring Process



Major Components

- Track System
- Machine
- Casing Pipe
- Cutting Head
- Augers



Limitations of HAB

- Low steering capacity
- High settlement risk in running sands
- The accuracy in Auger Boring is about 1 to 2 percent of the length
- Radial overcut is about 0.50 to 1 inch
- Challenging ground conditions include running sands, very soft clays, mixed soil conditions, ground water, and rock.

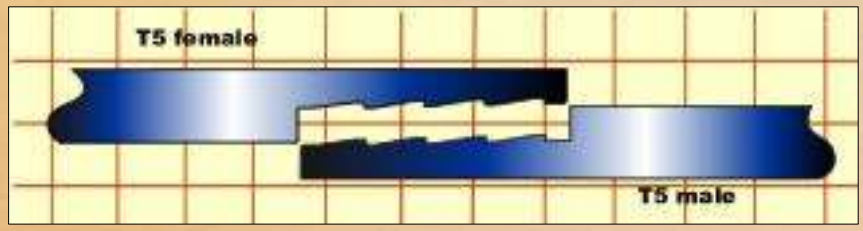
The Advantages of HAB

- It is an economical trenchless method for suitable ground conditions that include:
  - Medium to dense sands,
  - Medium to stiff clays,
  - Silty and clayed gravels, and
  - Cobbles and boulders less than one third diameter.

- Short construction duration and a relatively small work area.
- Augers can be pulled back to access face and remove objects.
- The typical range of diameter for the HAB:
  - 8 to 84 inches
- The typical range of length for the HAB:
  - 100 to 400 feet

Welding Steel Casing

Interlocking steel pipes



Interlocking pipe joining system (Permalok, 2002)

The 2nd annual TTC Auger Boring School
October 3-7, 2016

http://ttcspecialtyschools.com/abs/

What is Microtunneling?

Microtunneling US History

- Developed in Japan in the 1970's.
- First US Microtunnel job in Florida in 1985.
- Major Advancement in US during Houston Waste Water Program starting in 1989.
- Three major Equipment manufactures in the late 1900's.
  - Iseki
  - Soltau
  - Herrenknecht

Why Microtunneling?

- Minimal surface disruptions
- Avoids utility conflicts
- Highly accurate
- Can handle most types of soils
- Remote controlled system
- Offers earth counter balance pressure (no dewatering)
- Excavate earth and install pipe simultaneously!

Types of Microtunneling

- Pilot Tube Microtunnel

- Slurry Microtunneling

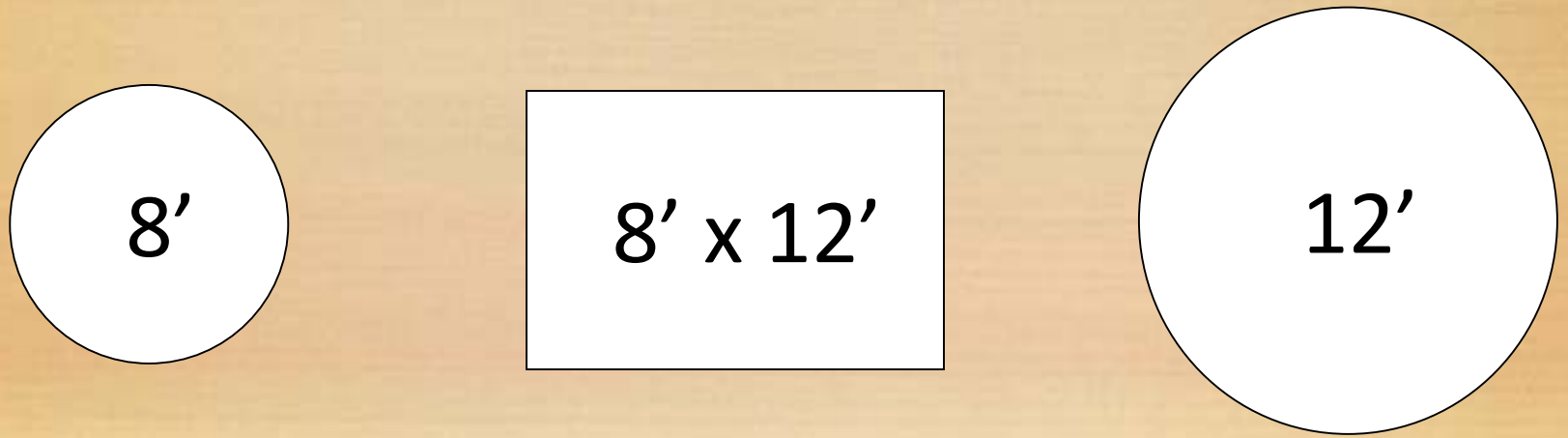
BRH GARVER

Pilot Tube Microtunneling (GBM)

- Small footprint
- Line and grade set with theodolite
- Diameters from 10” to 30” nominal
- Drive lengths to 350ft
- Spoil removal via auger
- 3-step process
  - Pilot Installation (displacement tool)
  - Temporary Support
  - Permanent Support

Pilot Tube Microtunneling (GBM)

- Small Footprint



Pilot Tube Microtunneling (GBM)

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Pilot Tube Microtunneling (GBM)

- Line and grade set with theodolite

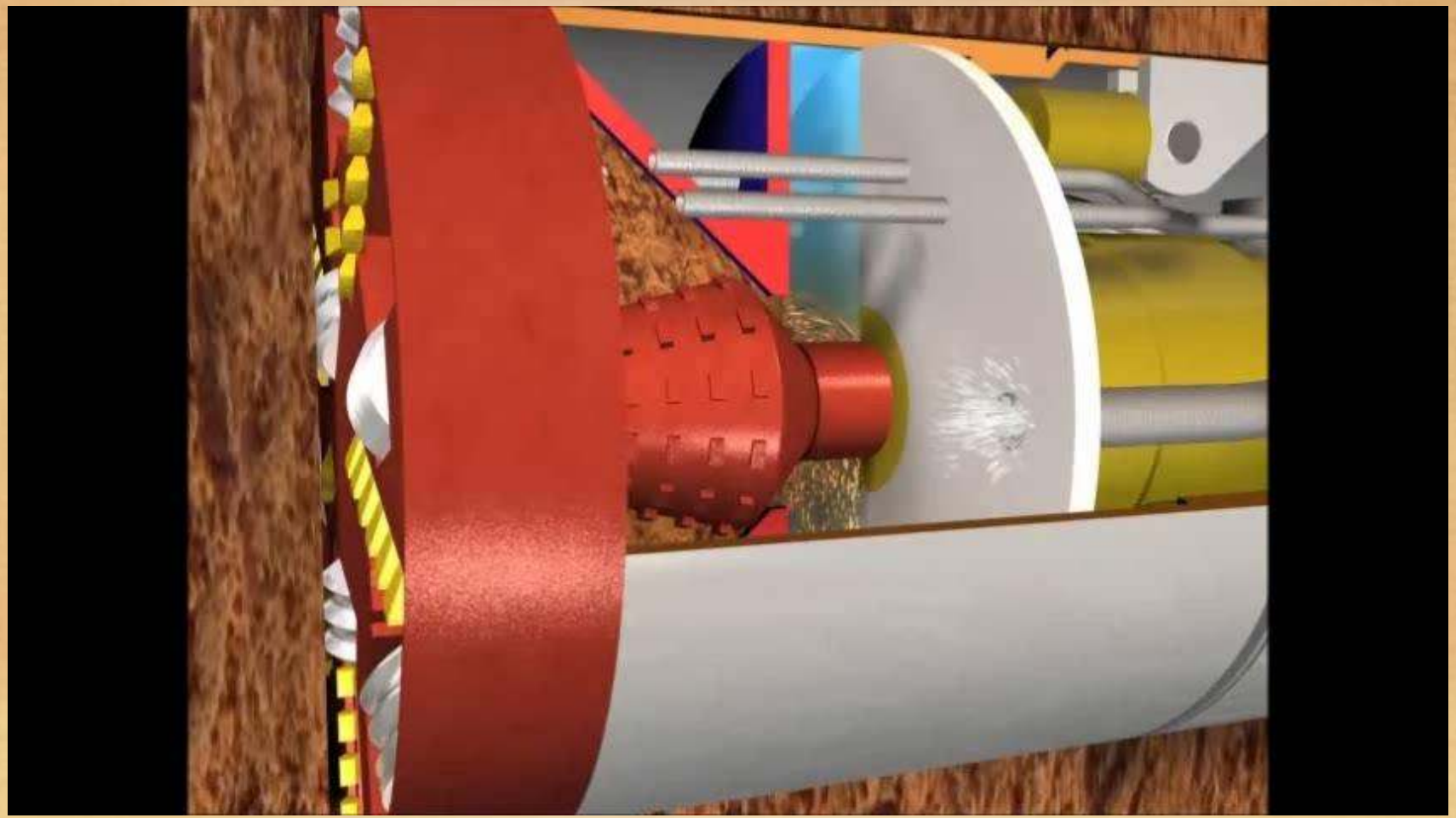
Pilot Tube Microtunneling (GBM)

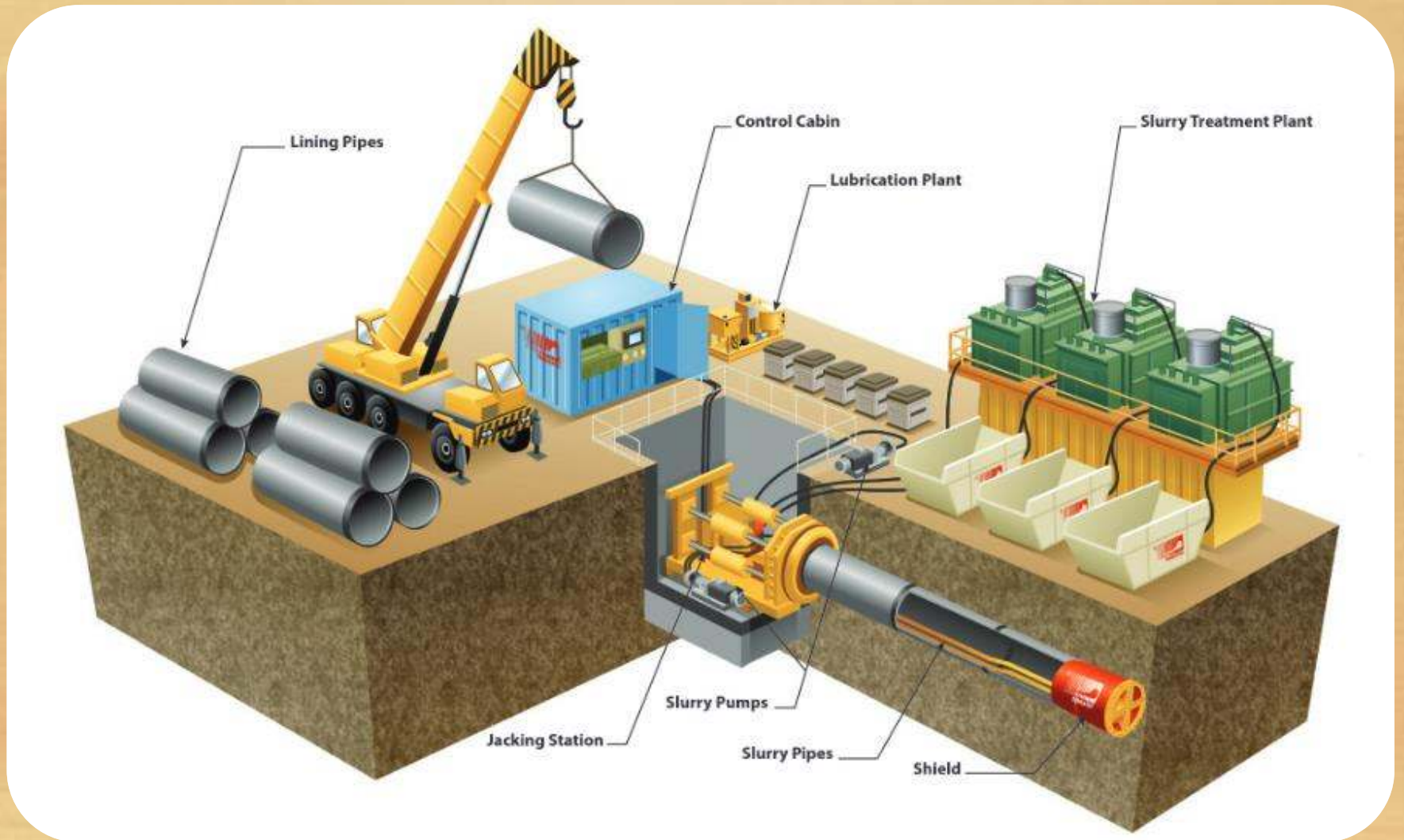
- Diameters from 10” to 30” nominal

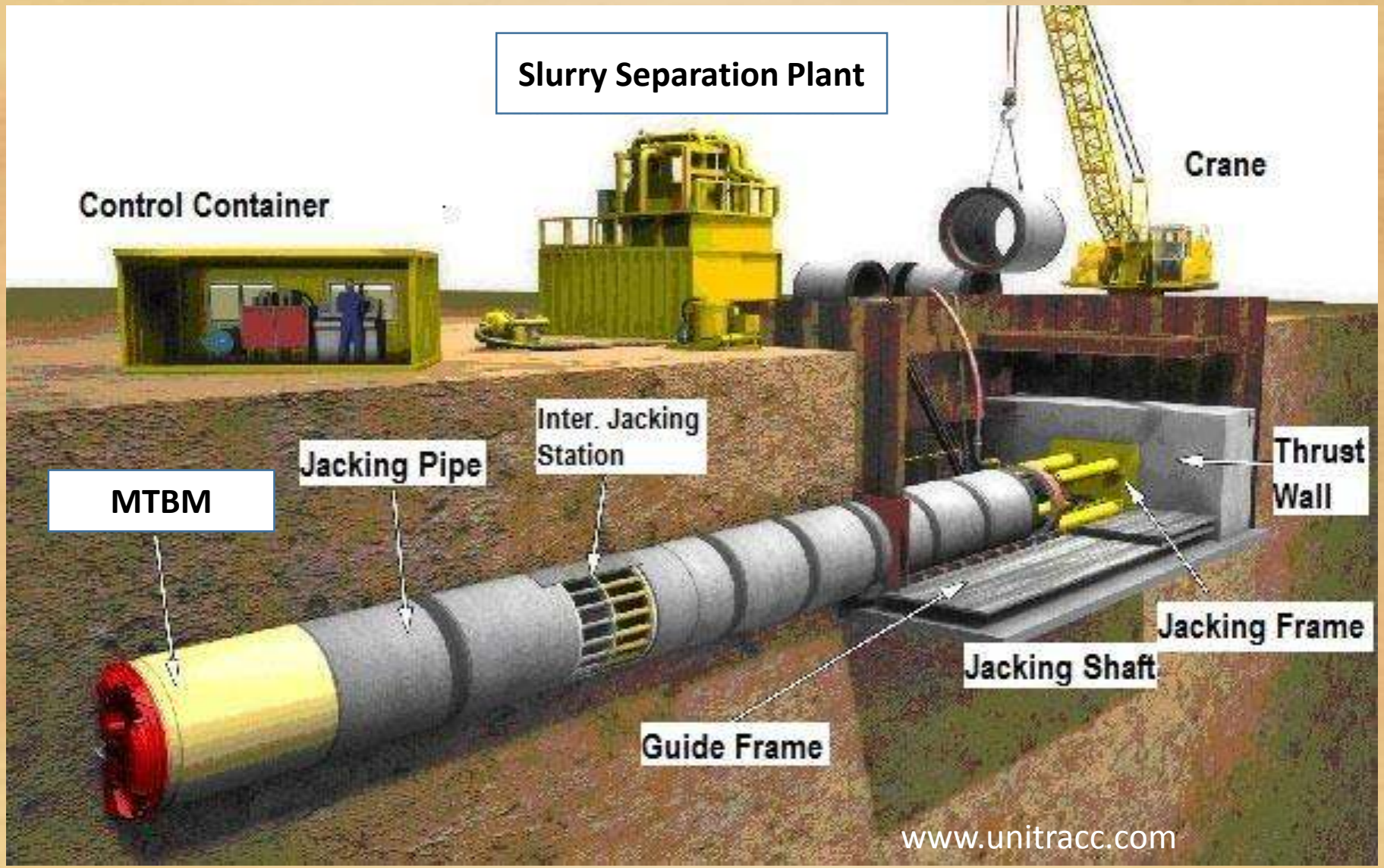
Pilot Tube Microtunneling (GBM)

Reaming Head

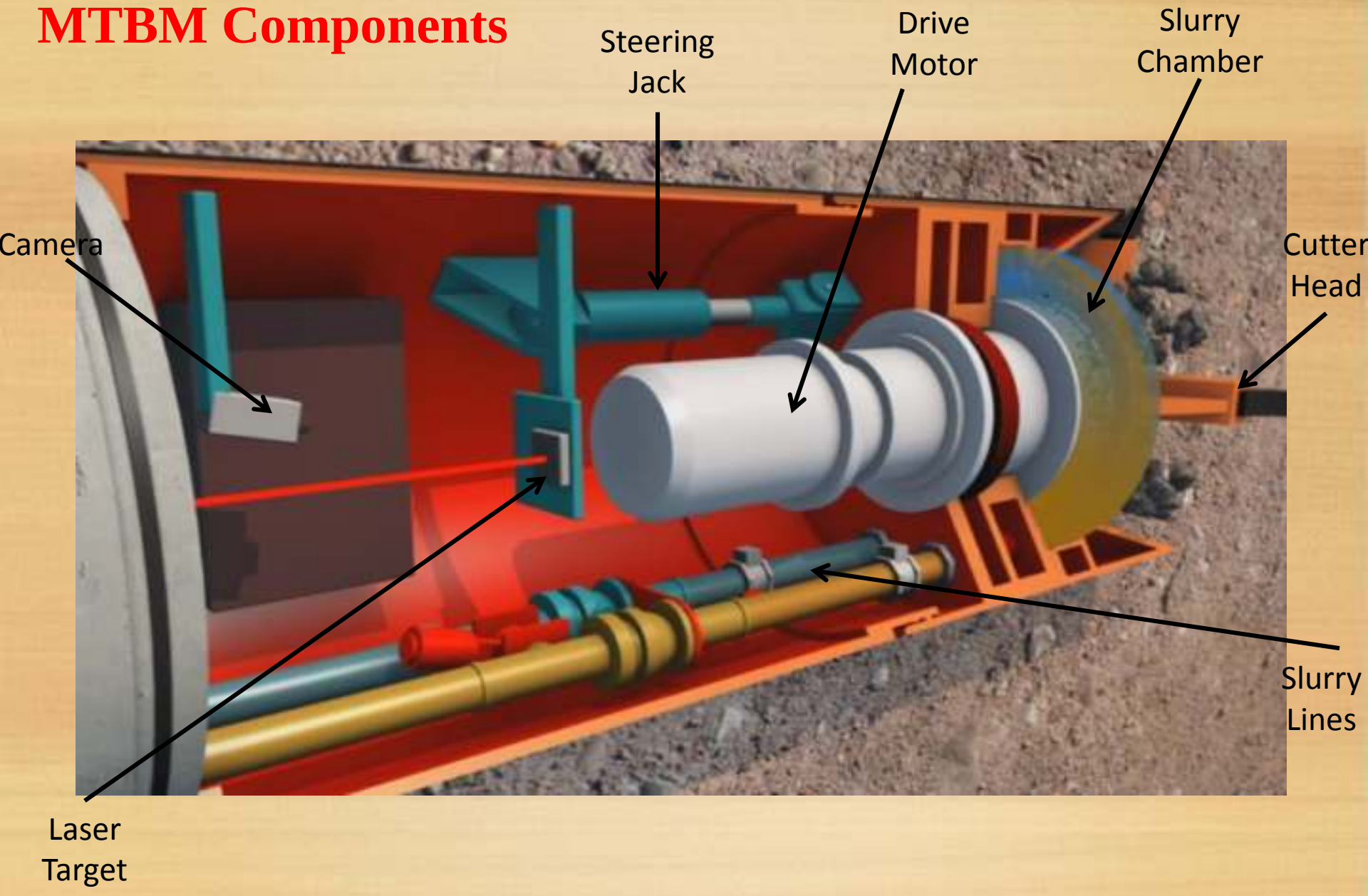
Slurry Microtunneling



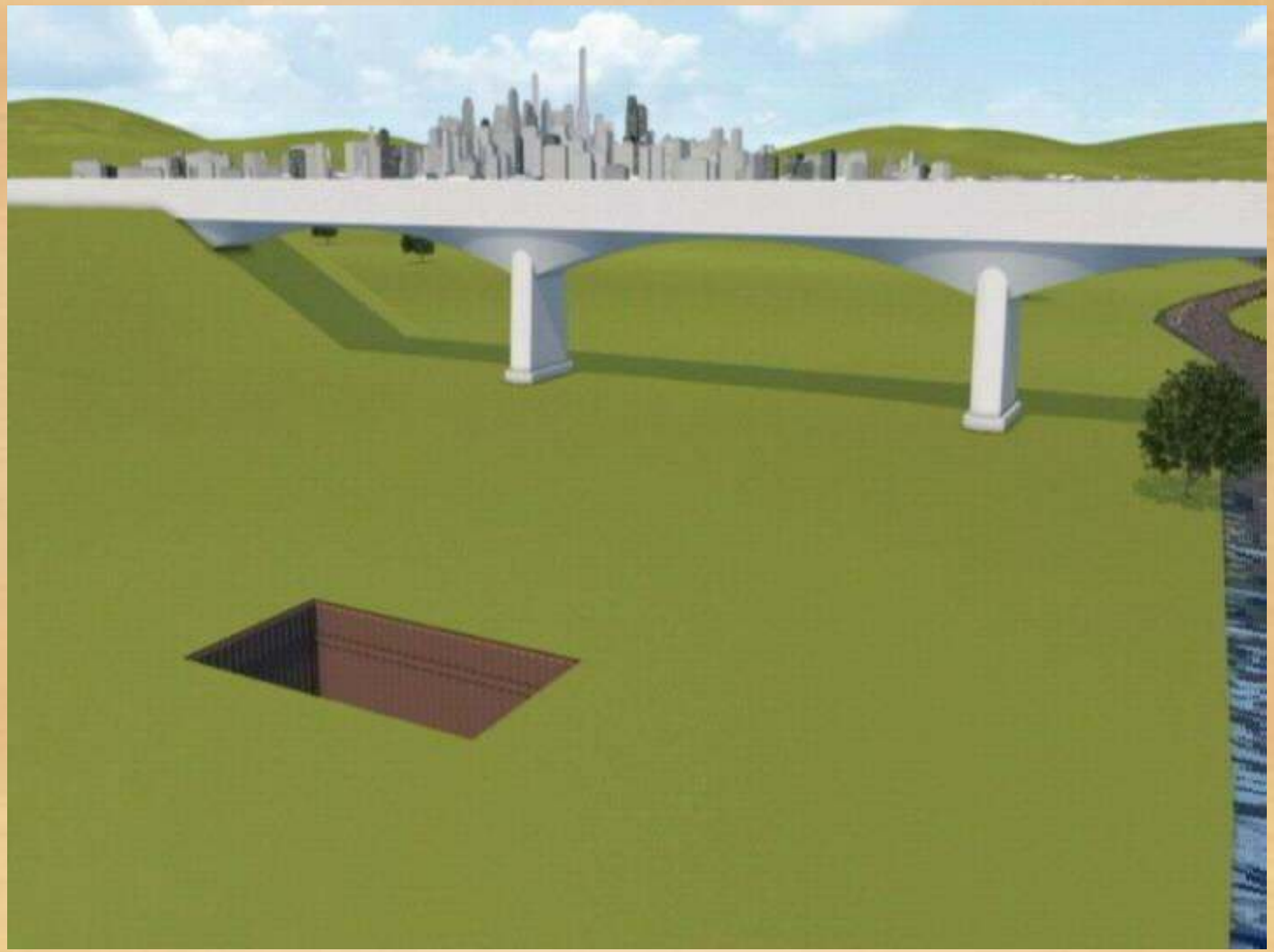

Lining Pipes
Control Cabin
Lubrication Plant
Slurry Treatment Plant
Slurry Pumps
Jacking Station
Slurry Pipes
Shield


Slurry Separation Plant
Crane
Control Container
Inter. Jacking Station
Jacking Pipe
MTBM
Thrust Wall
Jacking Frame
Jacking Shaft
Guide Frame
www.unitracc.com

MTBM Components



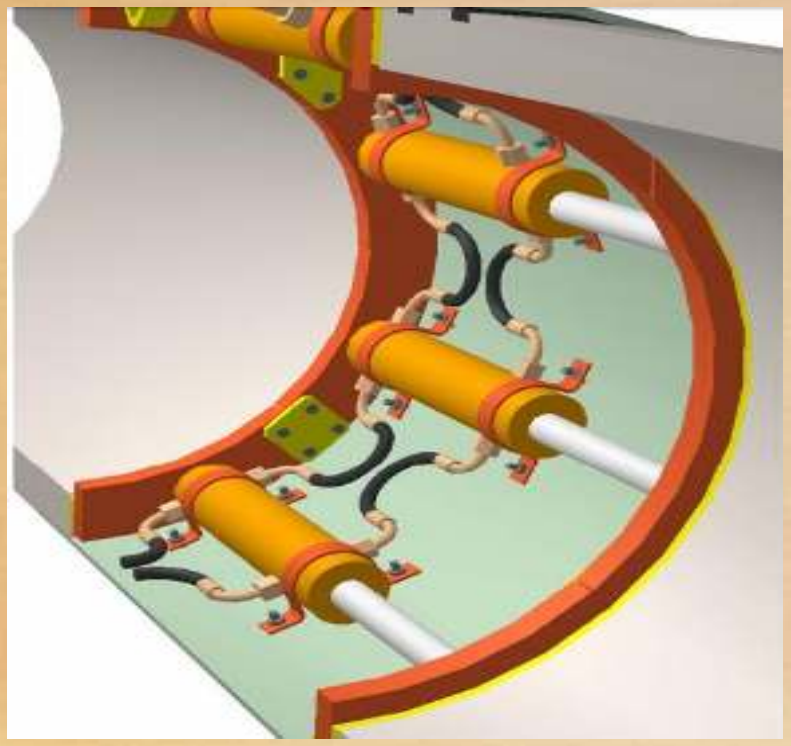
Microtunneling Process



Microtunneling Process

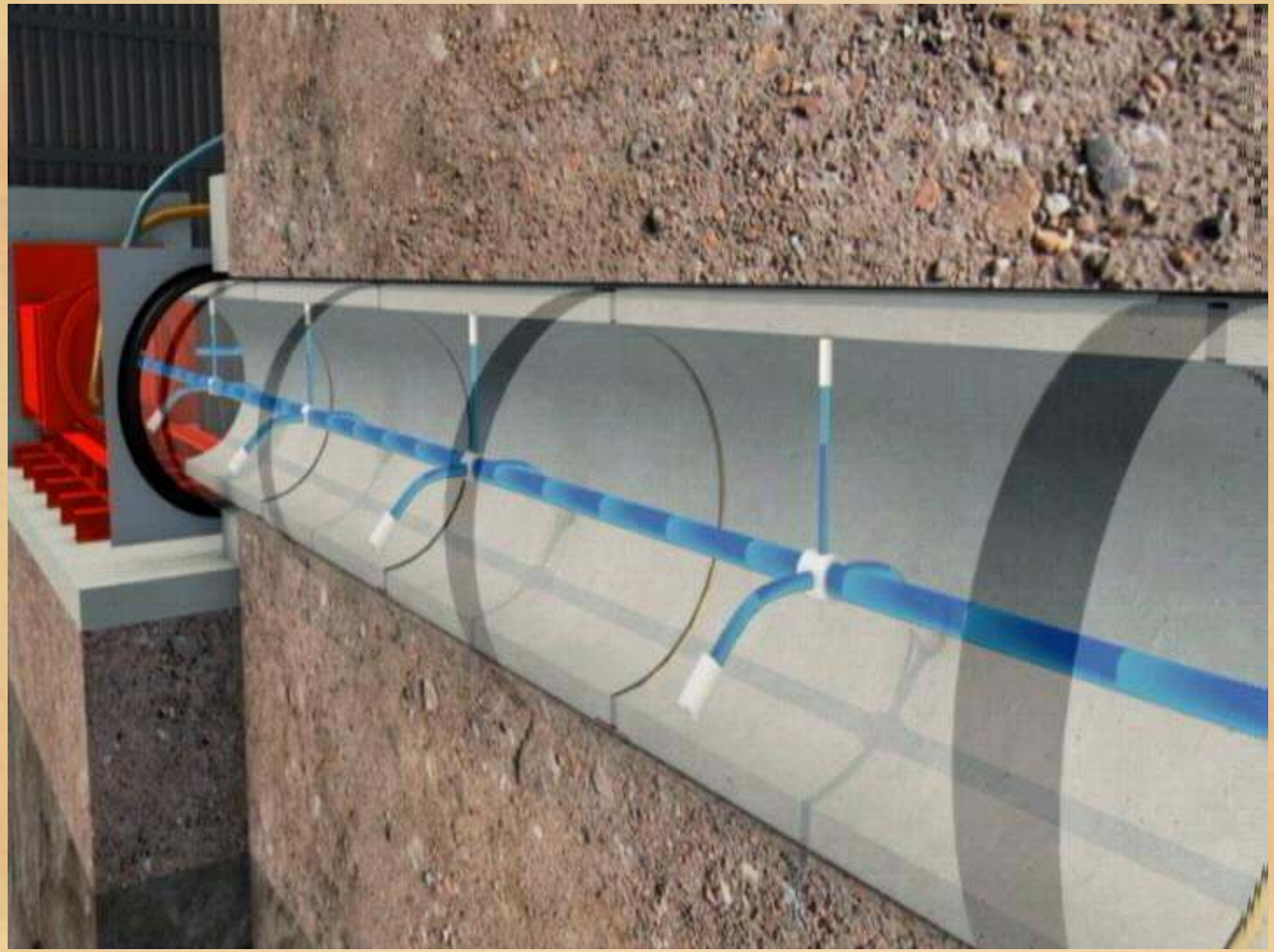
Jacking and Intermediate Jacking Stations

Intermediate Jacking Stations (IJS)

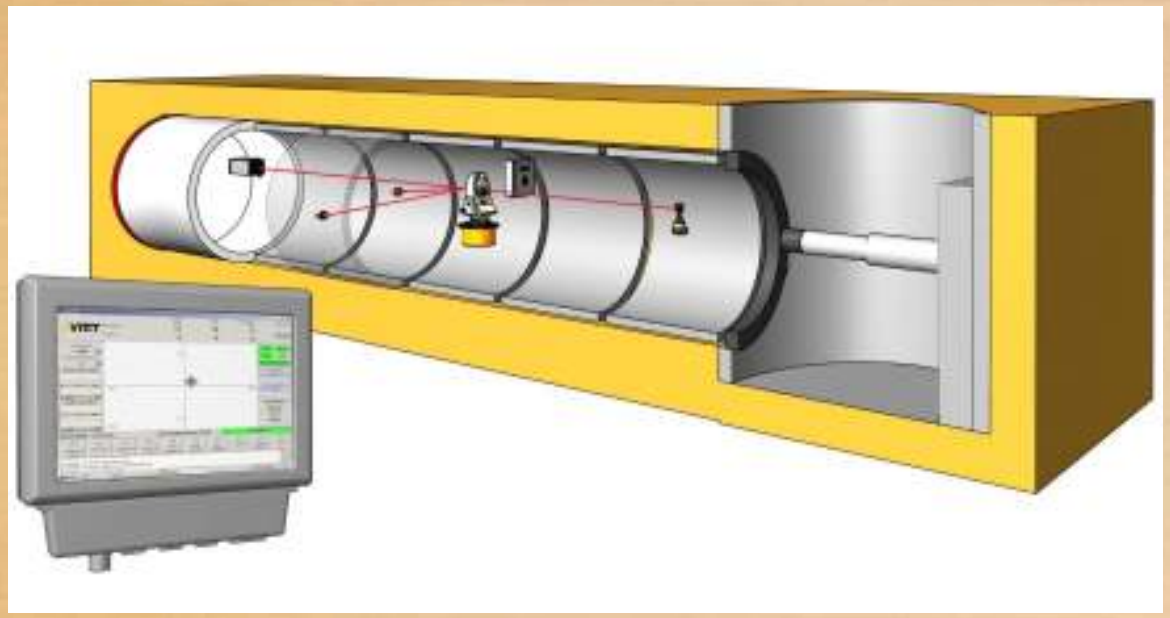


- Intermediate jacking stations should be spaced no more than 100m (328ft) apart.

Lubrication



Microtunneling: Guidance System



- Extra important for the curved drives

Cutting Heads

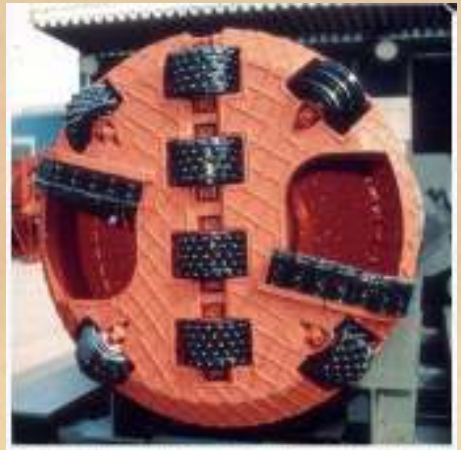
Cutting head design for use in soil and rock - Scraper cutting head with fixed soil entry openings [FI-ACH]

Microtunnelling machine with hydraulic spoil removal - Rock cutting head with disc cutters [FI-Herrenknecht]

Cutting head design for use in soil and rock - Rock cutting head with [illegible]

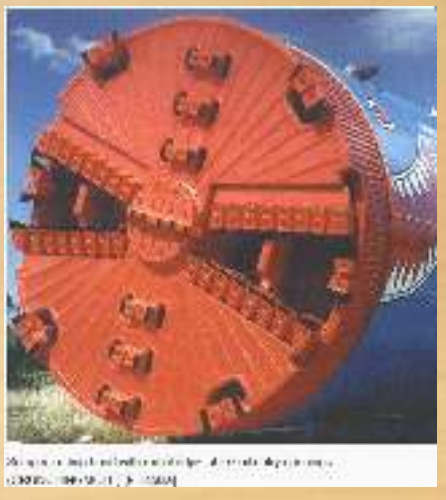
Microtunnelling machine with hydraulic spoil removal - Standard cutting head in the form of cutting spokes [FI-Herrenknecht]

Microtunnelling machine with hydraulic spoil removal - Standard cutting head in the form of cutting spokes [FI-Herrenknecht]



Cutting head design for use in soil and rock - Rock cutting head with disc and insert roller cutters [FI-Herrenknecht]

Cutting head design for use in soil and rock - Rock cutting head with insert roller cutters and small entry openings [FI-Herrenknecht]



Microtunnelling machine with hydraulic spoil removal - Standard cutting head in the form of cutting spokes [FI-Herrenknecht]

Direct Pipe® - Herrenknecht AG

- Combination of HDD and microtunneling
- Installs welded steel pipe from launch site
- Grips exterior of pipe to provide thrust
- High thrust, borehole collapse issues mitigated

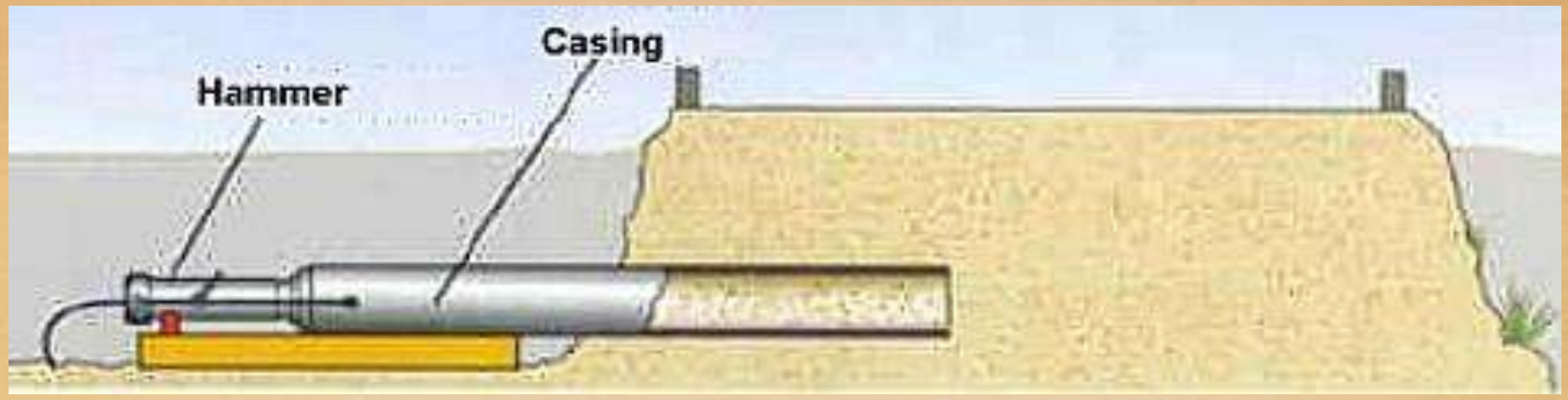
The Advantages Compared to Standard Tunneling Technologies

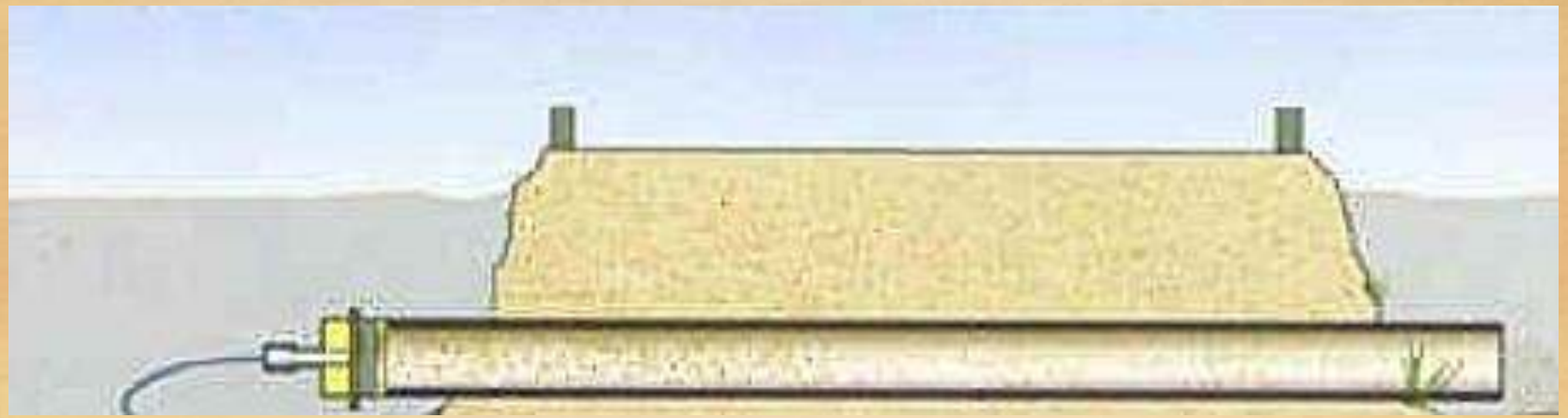
- One-step installation for prefabricated and tested pipelines
- Short construction time and economical installation process
- Appropriate for large pipe diameter (up to 60”)
- No costly and time-consuming shaft construction
- Optimum for access only from one side (e.g. sea outfalls)

Displacement: Pipe Ramming

- Installation of steel pipes or casings under roads, railroads and other obstacles using a percussive hammer from a drive pit
- HDD assist
- Pipe dia. to 2m
- Distances up to ~ 100 m
- Non-steerable

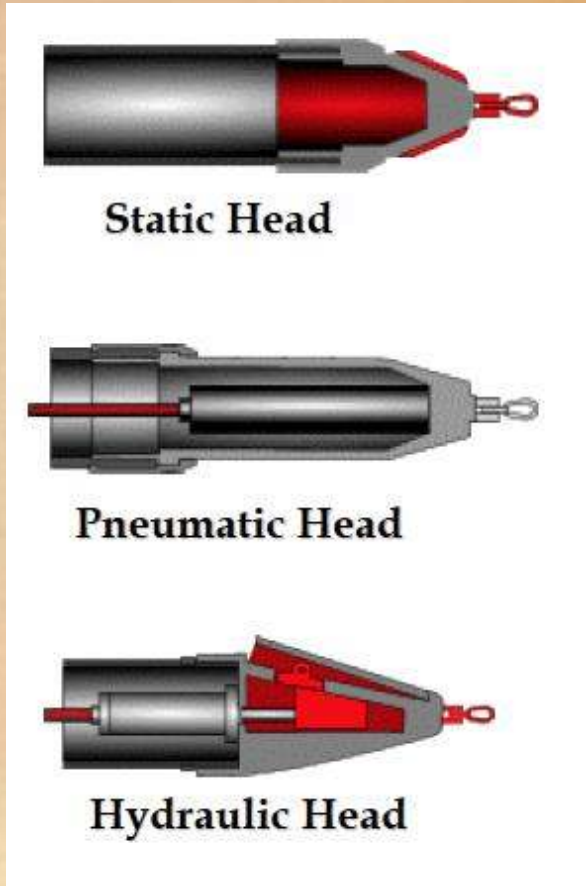
Typical Pipe Ramming Installation





Pipe Bursting

- Invented by British Gas
  - Replacing and upsizing
- Two main types
  - Static & Pneumatic
- Lengths of up to 3,000 ft
- Diameters up to 42”
- Applications:
  - Replacement of gas pipes
  - Replacement of force mains
  - Replacement of gravity sewers
  - Mains and laterals



What materials can be burst?

- **Fracturable Pipes**

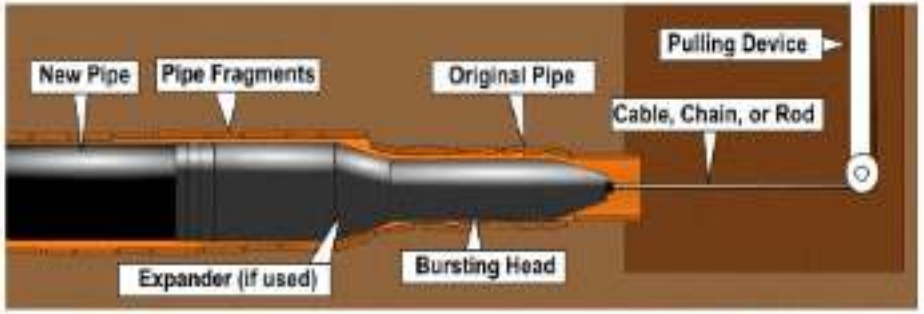
Cast iron, clay tile, concrete, reinforced concrete, asbestos cement, etc.

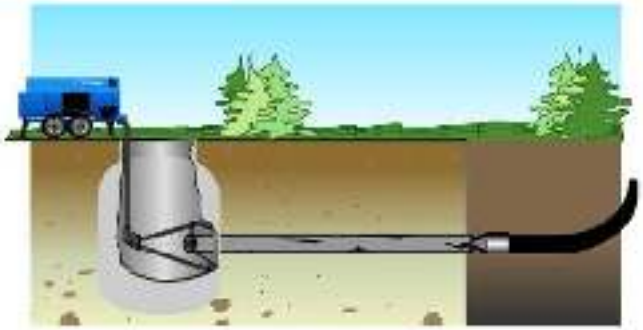
- **Non-Fracturable Pipes**

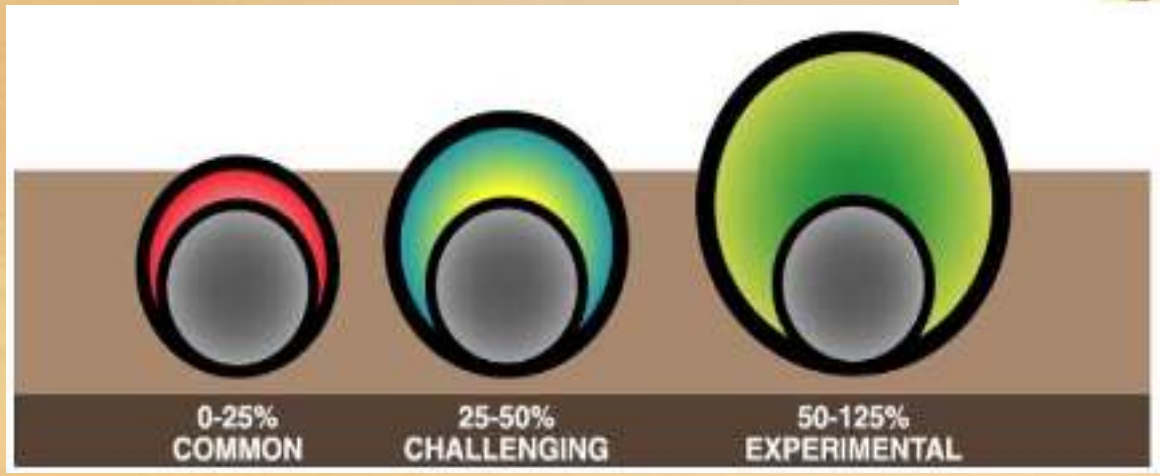
Ductile iron, steel, galvanized, HDPE, lined pipe, etc.

Pipe Bursting

- Upsizing
  - Soil conditions
  - Original trench width
  - Expand enough to overcut
  - Burst depth = 10 x upsize diameter







Thanks for your attention!

Questions?

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