**INFRA 2000**
**6th Annual Urban Infrastructures Week**
November 13-15, 2000
Laval Convention Center – Quebec, Canada.

# Dry Directional Drilling™

## a trenchless technology with low environmental impact and high productivity for underground utility installation

**Dr. Ing. Renzo Chirulli**
**SE Industries, Inc.**

**www.trenchless.eu**

# Dry Directional Drilling™

1. Origin
2. Technology
3. Conclusion

Trenchless Technology

# 1. DDD origin

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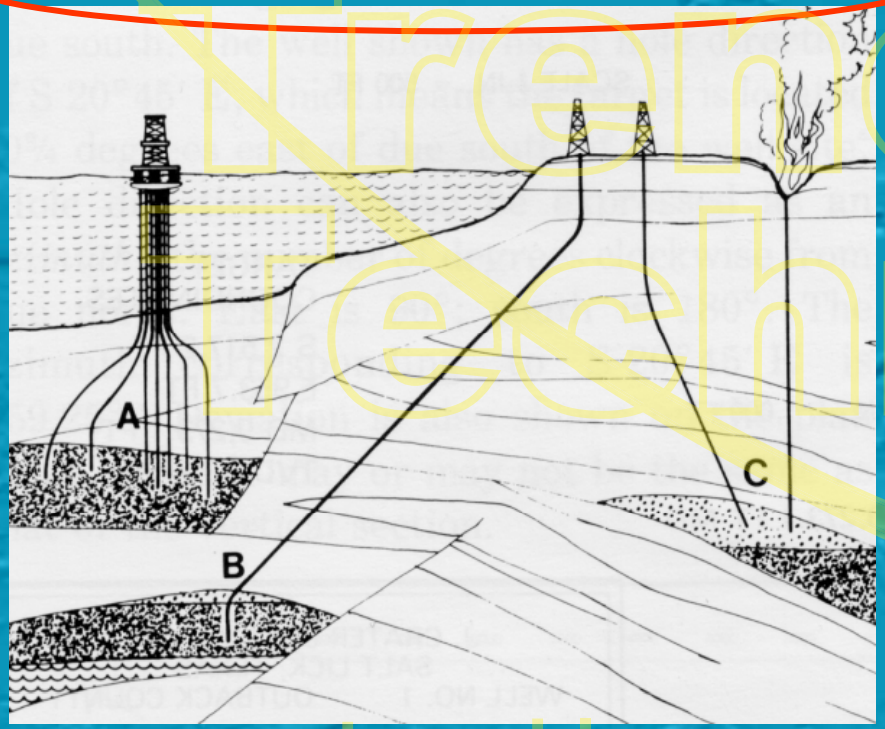
# Horizontal Directional Drilling (HDD) origin

oilfield directional drilling technology




bentonite mud

first “horizontal” application - (1970)

# Negative effects of the conventional open trench-digging method:

1. **interference with the transportation infrastructure and mobility** *(motor vehicles, other means of transport, pedestrians)*
2. **social costs** *(trade interference – stores, restaurants, banks, etc. – living and recreational activities, discomfort, etc.)*
3. **the cost of risks** *(associated with the method used)*
4. **environmental impact** *(air and noise pollution)*
5. **visual pollution**

**Directional drilling reduces or eliminates these negative effects and the associated costs.**

**Such benefits impact the project economics and the entire community.**

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The traditional HDD technology (wet boring) has some disadvantages, which are basically related to the characteristics of the technology that was originally used in the oilfields .

## mud-related environmental problems of the "traditional" directional drilling technology (wet boring methods)

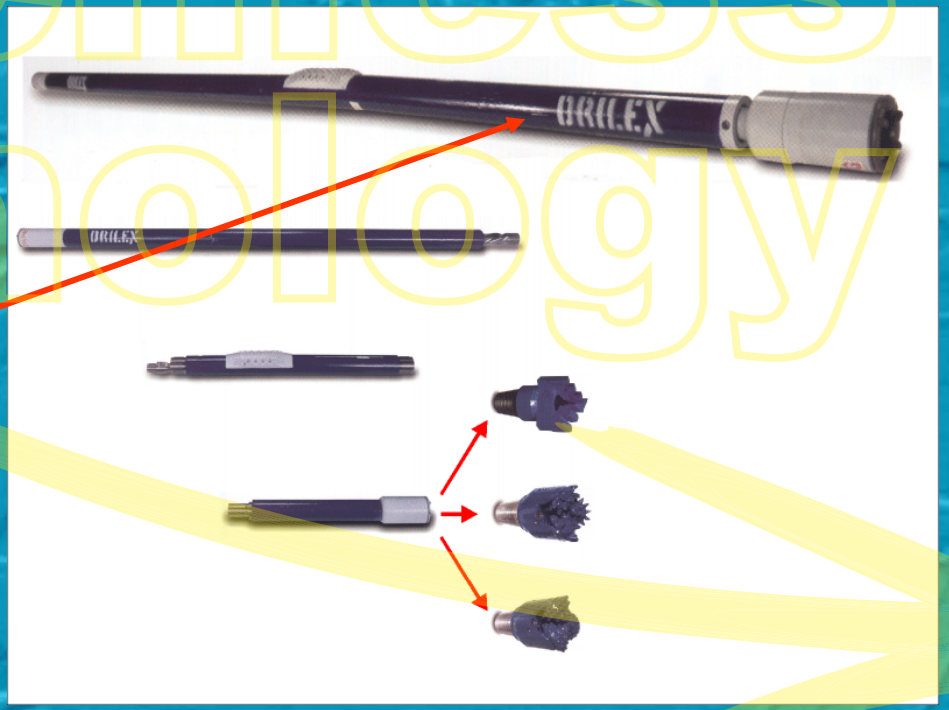
**the mud can:**

- **erupt to the surface**, fracturing the ground ("frac-out" phenomenon)
- **flood underground spaces** (garages, basements, storage areas)
- **pollute groundwater, and make surface water muddy** (rivers, lakes, ponds), with serious environmental implications

## mud-related environmental problems of the "traditional" directional drilling technology (wet boring methods)

- **Jet Boring**
  40-80 gal./min
  at 1000-4000 psi

- **Mud motors**
  40-660 gal./min
  at 500-750 psi



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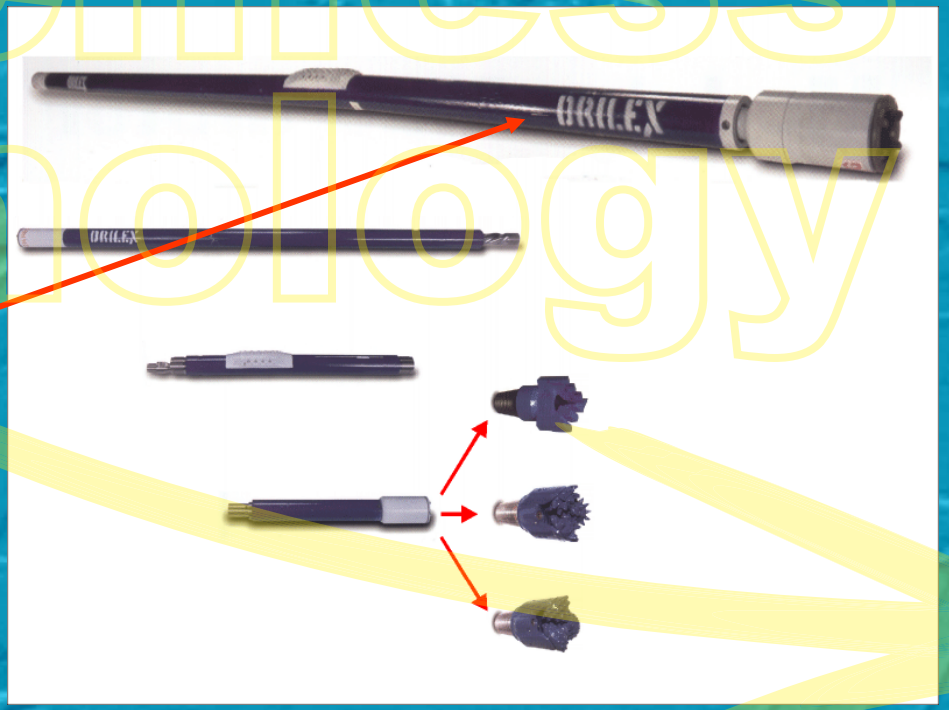


## underground utility installation market

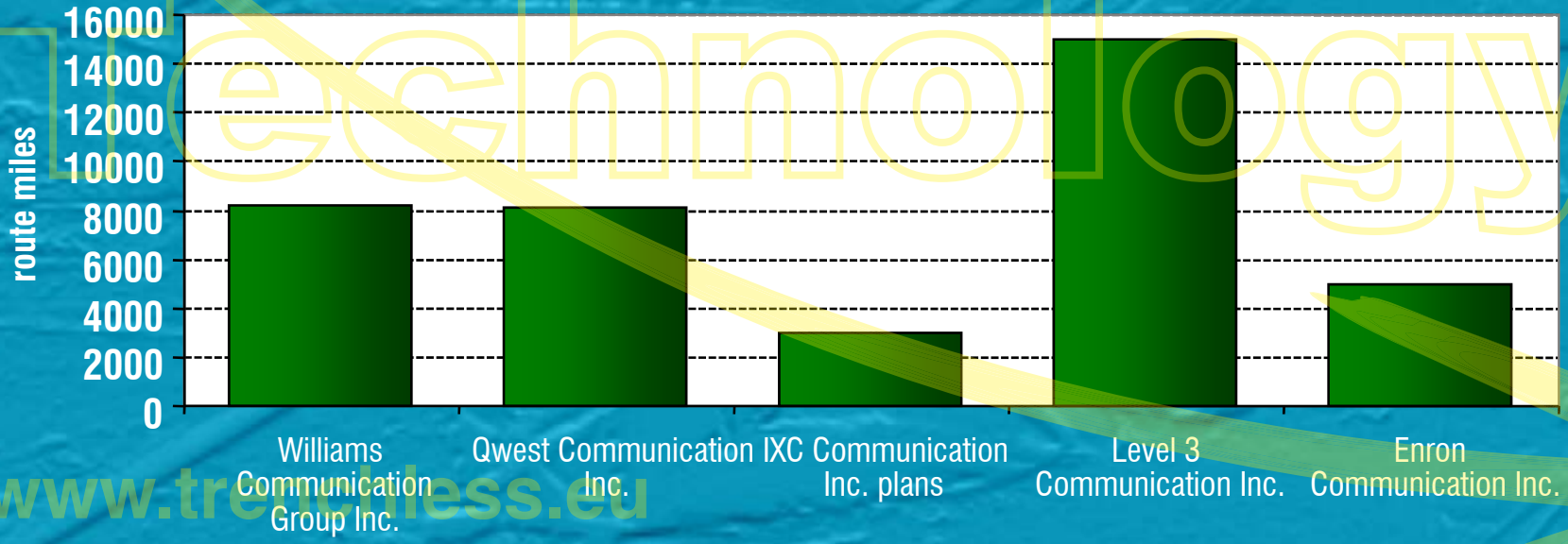
- telecommunication
- power lines
- gas systems
- waterworks
- sewer

# underground utility installation market

## *United States*

Breakdown of **TLC** programmed network

(source Underground Construction - Dec. 1999)



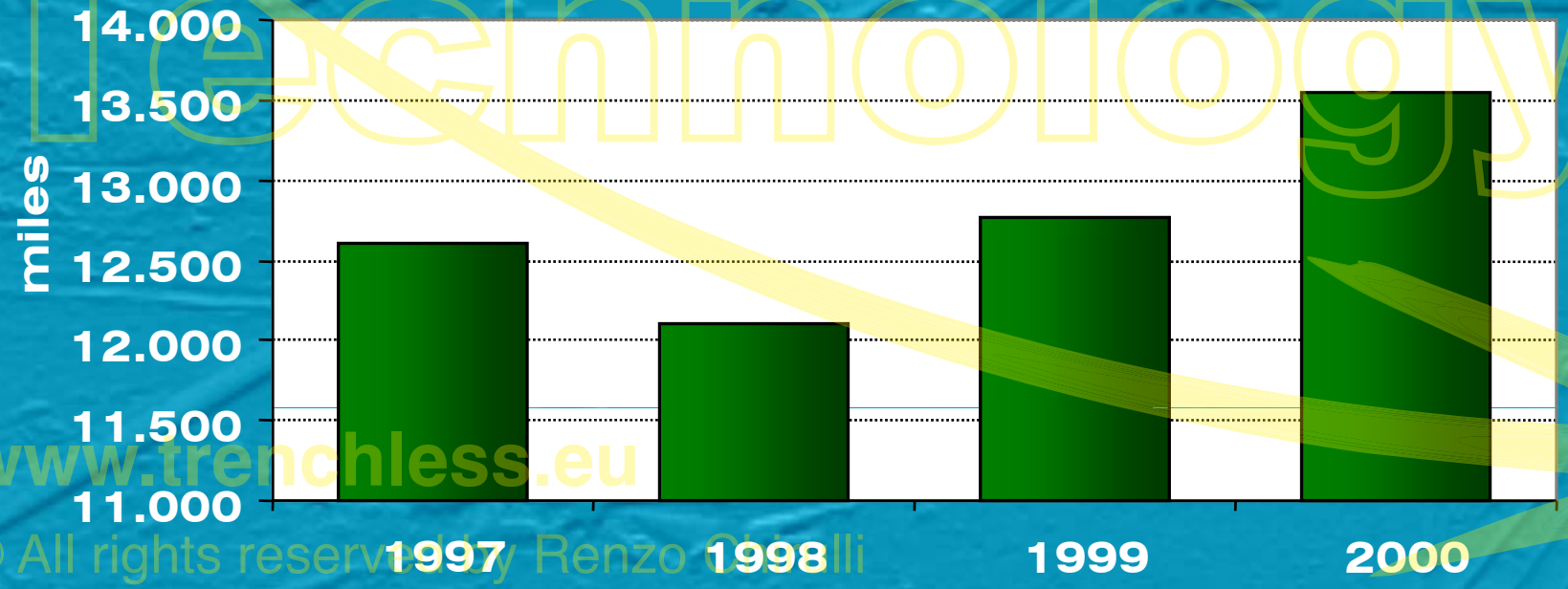

**Total = 39.335 route miles**

# underground utility installation market

## *United States*

### GAS Systems - New Mains

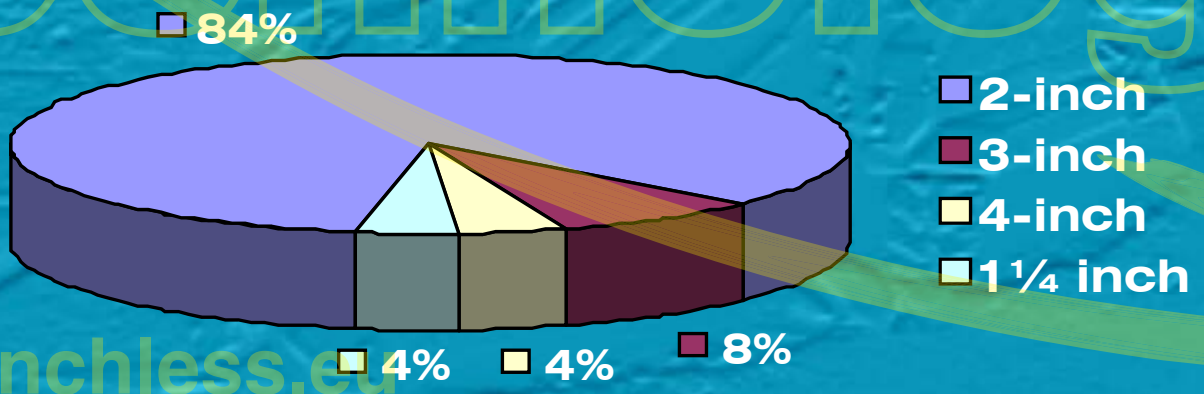
(source - Pipeline & Gas Journal - Dec. 1999)



# underground utility installation market

## *United States*

**Proportion of New Main by Diameter in Undeveloped Areas**



# underground utility installation market

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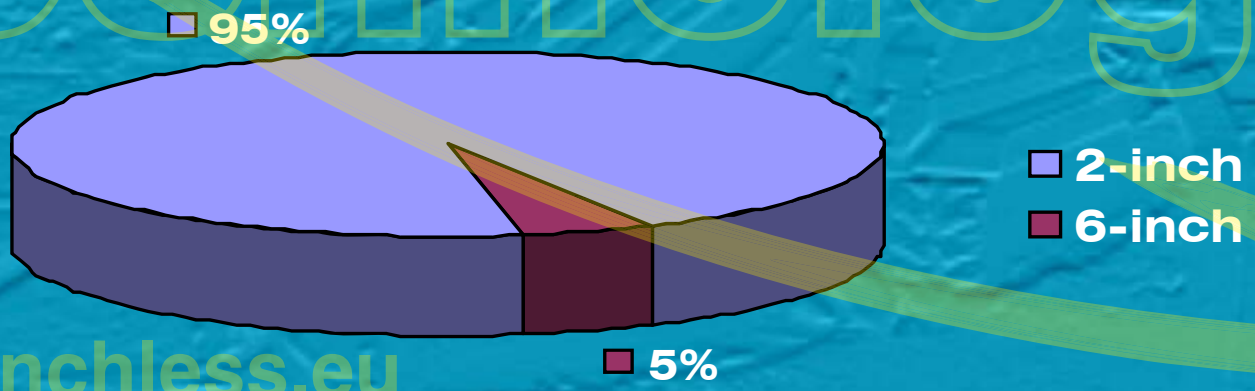
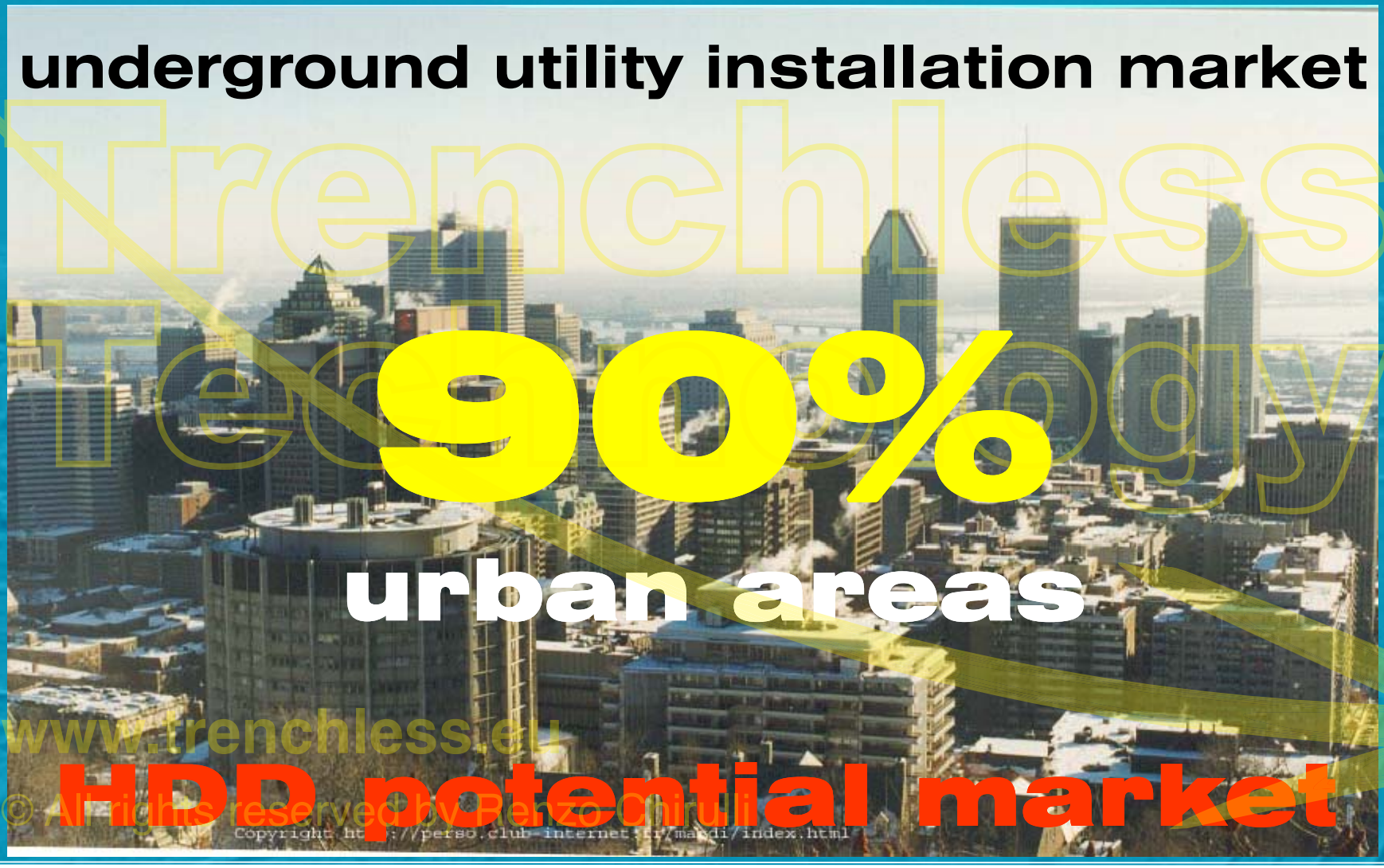
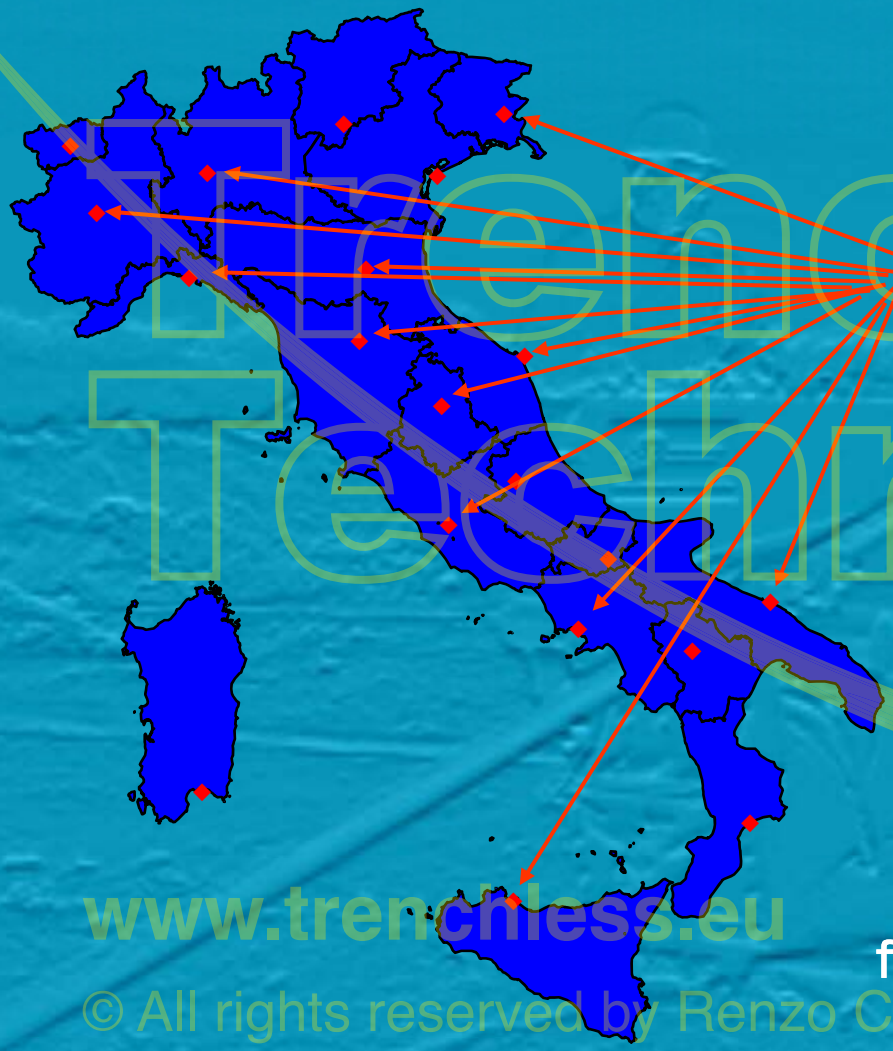




# 1. DDD origin



TELECOM ITALIA

**SOCRATE project**

**1995**

**13,000 ITL bn**

*(≈6 US$ bn)*

for cabling the biggest Italian cities

# 1. DDD origin

**No-Dig technology requirements:**

1) low environmental impact
2) mudless
3) rock drilling capability
4) high productivity
5) low operational costs (to compete with traditional open-cut methods)

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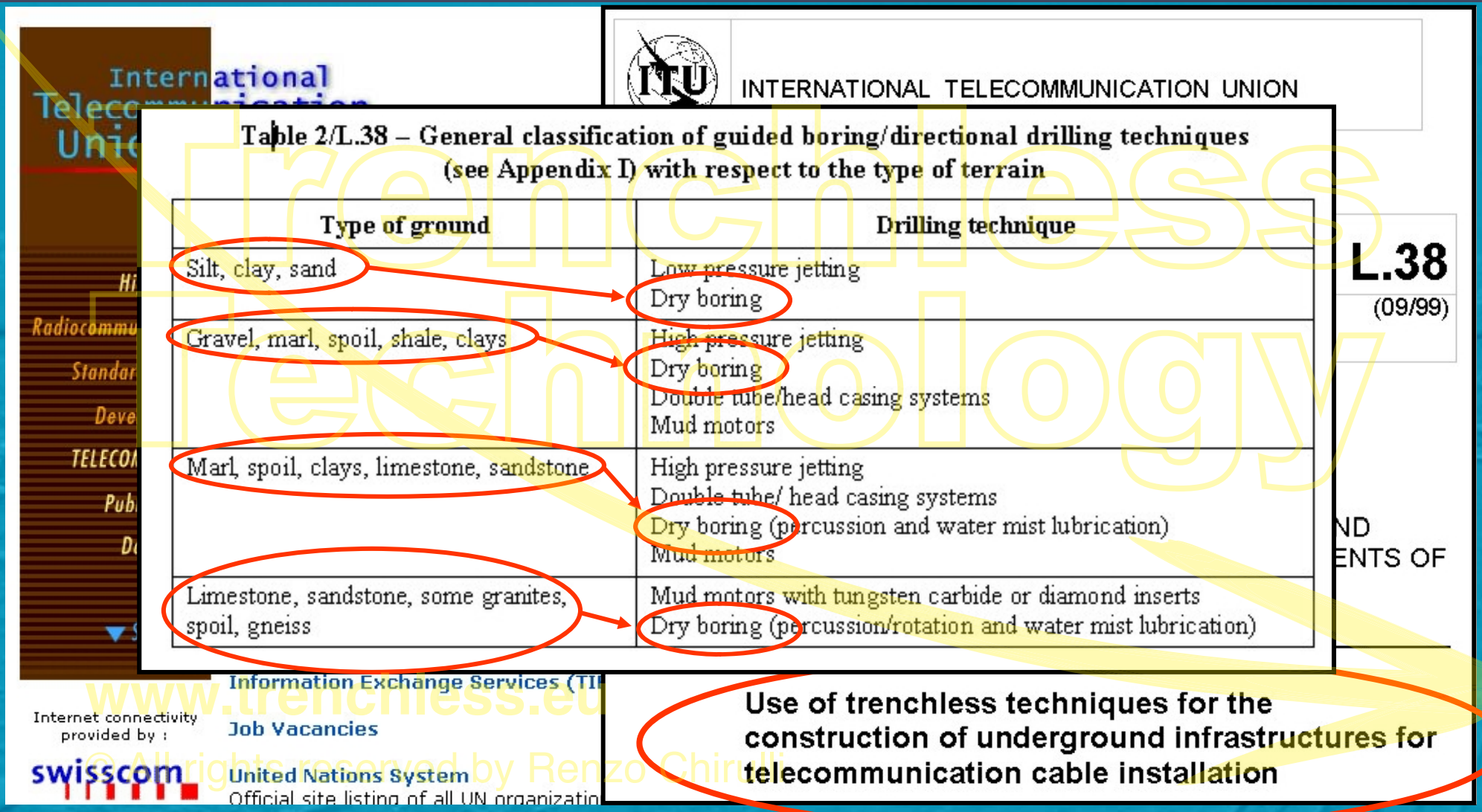
TELECOM ITALIA

**SOCRATE project**

**1995 - 1996**

**Dry Directional Drilling™**

# 1. DDD origin



INTERNATIONAL TELECOMMUNICATION UNION

**Table 2/L.38 – General classification of guided boring/directional drilling techniques (see Appendix I) with respect to the type of terrain**

| Type of ground | Drilling technique |
|---|---|
| Silt, clay, sand | Low pressure jetting<br>Dry boring |
| Gravel, marl, spoil, shale, clays | High pressure jetting<br>Dry boring<br>Double tube/head casing systems<br>Mud motors |
| Marl, spoil, clays, limestone, sandstone | High pressure jetting<br>Double tube/ head casing systems<br>Dry boring (percussion and water mist lubrication)<br>Mud motors |
| Limestone, sandstone, some granites, spoil, gneiss | Mud motors with tungsten carbide or diamond inserts<br>Dry boring (percussion/rotation and water mist lubrication) |

L.38 (09/99)

**Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation**

# 2. DDD™ technology

Trenchless Technology

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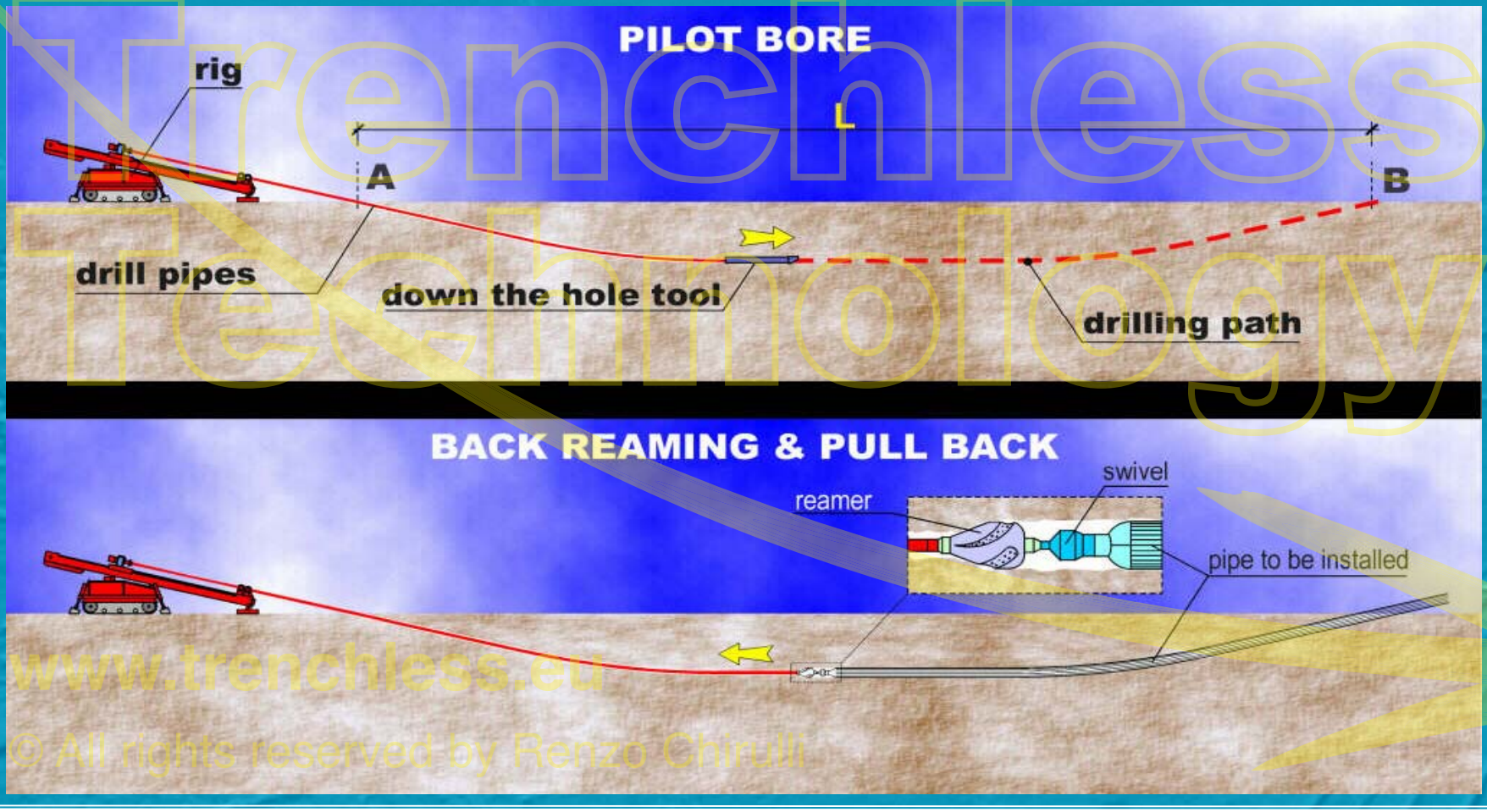
# Dry Directional Drilling™

## DDD™

**DRY** because the rigs are provided with drilling equipment powered by compressed air at a low pressure.

**DIRECTIONAL DRILLING** because the rigs are equipped with a down-the-hole guidance and steering system to control the underground drilling and the installation of pipes and ducts along any path.

## Dry Directional Drilling™ operating phases



## drilling head steering

## drilling fluids

- bentonite mud
- water-polymers mixing **wet boring**
- water

- air **dry directional drilling™**

## drilling fluids



**with DDD™ the drilling fluid is compressed AIR at a low pressure.**

**(12 bar – 175 psi)**

## compressed air



air compressor performance for a 24 t rig (53.000 lb)

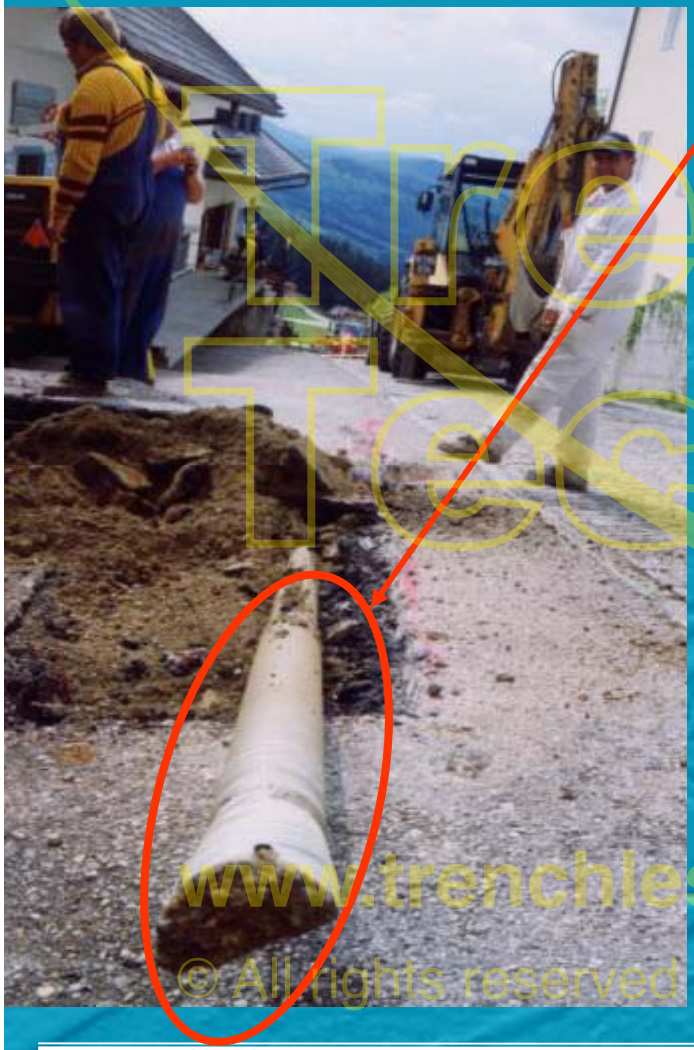
**15,000 l/min at 12 bar**

**540 ft³/min at 175 psi**

## air functions

- cleaning the down-the-hole
- debris circulation
- down the hole tools cooling
- down the hole tool power

# 2. DDD™ technology



## down the hole (DTH) percussive tool

The DTH tool performs an high frequency percussive action (900-1.400 blows/min)

It is capable to drill a wide range of soil condition.

It is particularly effective in very hard rock(*).

(*) compressive strength >200 MPa – 29.000 psi

# 2. DDD™ technology

**air additives**

they improve:

- **the DTH tools cooling**
- **the hole lubrication**
- **the debris circulation**

**water + foam(*) + polymers(*)**

**0,5÷20 gal/h**

(*) **biodegradability (>95%)**

# system performances

| Soil conditions | steerability | | | drilling rate | |
|---|---|---|---|---|---|
| | deviation per drill pipe (10 ft.) | | equivalent bending radius | with medium incidence of curves along the drilling using a 4" down-the-hole tool equipped with a 5" drilling head. | |
| | | | | wedge shaped drilling head | eccentric drilling head |
| | % | deg | ft. | ft/h | |
| very hard rock (>10.000 psi) | 2,00% | 1,15 | 495 | - | 15-30 |
| soft rock (< 10.000 psi) | 6,00% | 3,43 | 165 | 65 | 85 |
| soft soil | 7,00% | 4,00 | 140 | 300-400 | - |
| compact clay | 10,00% | 5,71 | 100 | 130-200 | - |

## imperial units

# system performances

| Soil conditions | steerability | | | drilling rate | |
|---|---|---|---|---|---|
| | deviation per drill pipe (10 ft.) | | equivalent bending radius | with medium incidence of curves along the drilling using a 4" down-the-hole tool equipped with a 5" drilling head. | |
| | | | | wedge shaped drilling head | eccentric drilling head |
| | % | deg | m | m/h | |
| very hard rock (>10.000 psi) | 2,00% | 1,15 | 150 | - | |
| soft rock (< 10.000 psi) | 6,00% | 3,43 | 50 | 20 | 25 |
| soft soil | 7,00% | 4,00 | 43 | 90 / 120 | - |
| compact clay | 10,00% | 5,71 | 30 | 40 / 60 | - |

## metric units

## air advantages

1. zero supply costs, because air is a free resource;
2. the supply is practically inexhaustible;
3. it is non-polluting; and
4. there are no disposal costs.

## operational cost reduction

1. no need to purchase, prepare, pump, recover, filter, and dispose the bentonite mud
2. no increased costs related with the use of special equipment, like mud motors to drill through hard materials
3. no costs associated with damages that can result from the use of mud
4. greater overall productivity on the job site.

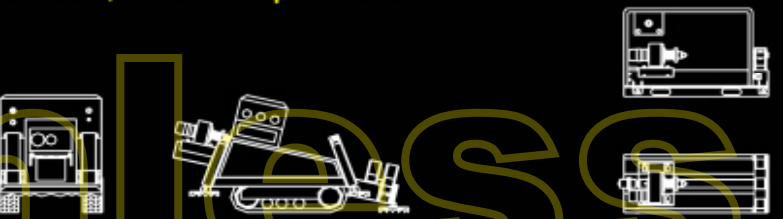
# 2. DDD™ technology

# 2. DDD™ technology

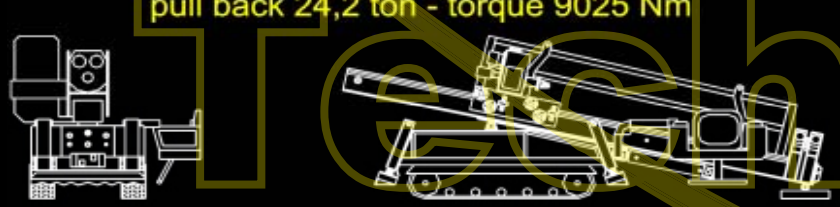
**SCORPIO 503**
pull back 13,3 ton - torque 5400 Nm

**SCORPIO 250**
pull back 5,5 ton - torque 2550 Nm

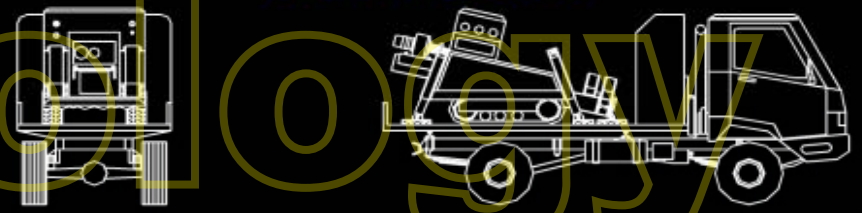
**SCORPIO 250 PL**



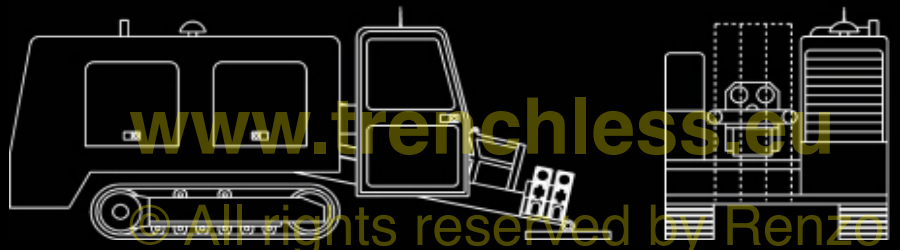
**SCORPIO 903**
pull back 24,2 ton - torque 9025 Nm



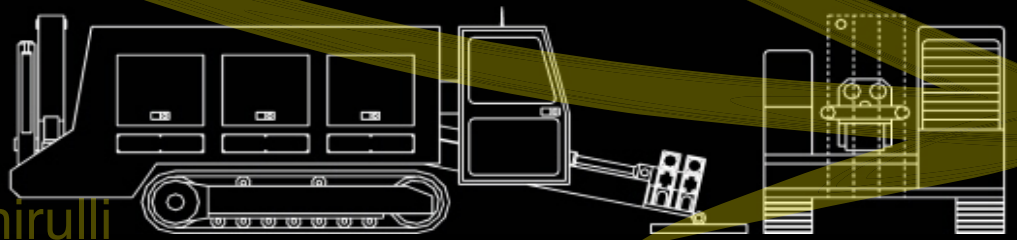
**SCORPIO 250 T**



**SCORPIO 1203**
pull back 36,5 ton - torque 11772 Nm



**SCORPIO 3003**
pull back 55 ton - torque 30000 Nm



# 3. Conclusion



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# Dry Directional Drilling

1. This technology makes it possible to operate on a wide range of soil conditions, without having to substitute or use expensive drilling tools .
2. Rigs are designed to be compact, resulting in reduced sizes, yet robust, with a remarkable power generated in the pull back and torque .
3. DDD systems cost less to operate than the “traditional” wet boring system
4. The use of DDD technology eliminates mud-related problems (flooding of underground rooms, mud eruptions).
5. Air does not generate any physical or chemical pollution, nor does it disturb existing water-bearing strata or surface streams and it is abundantly available.

# DDD™ photo gallery

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