

Pipeline Construction and Crossings

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Introduction

- **Construction principles lecture**
- **Pipeline spreads and terms**
- **Construction sequence and special tools**
- **Methodologies**
- **Crossings**
 - Open cut
 - Augur
 - Horizontal Directional Drilling (HDD)
 - Tunnelling

Terminology

- **Pipeline spreads and terms used.**
- **Spread – total area of land used for construction**
- **Working Width – width of temporary strip used for construction and access to the WW**
- **Stringing – laying pipes along the spread**
- **Welding – joining pipes**
- **Ditching – Laying pipes into trench**
- **Backfilling – Replacing soil**
- **Re-instatement – Leaving it as it was before.**

Construction costs matter

- **Pipeline construction costs.**
- **Construction costs typically 55 to 60% of total cost, excluding line pipe (25 to 30%).**
- **Optimisation possible during early stages of design and routing, not during construction**
- **Problems and issues can lead to large cost overruns, claims and delay.**

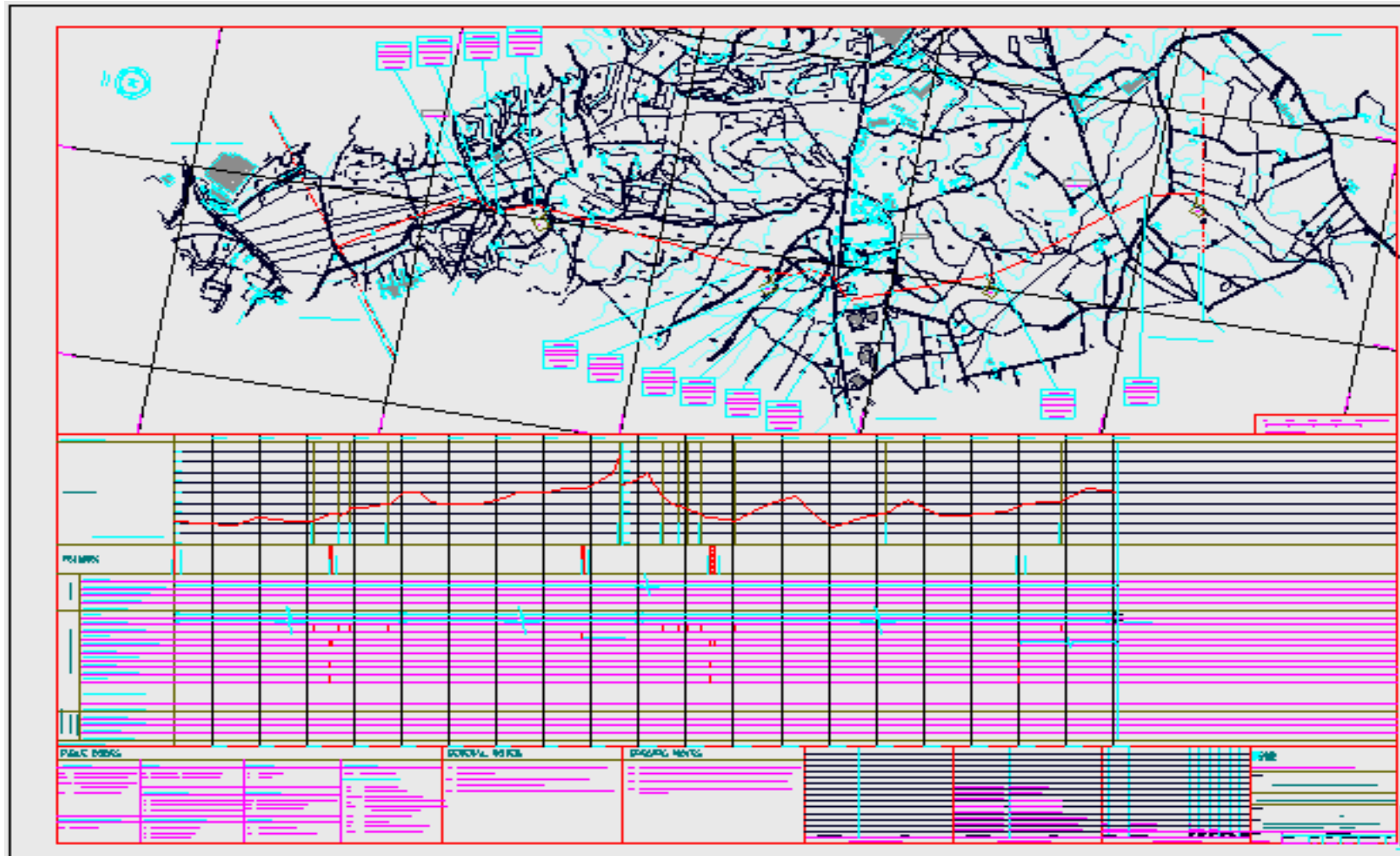
Reducing risk

- **Ground conditions knowledge in advance**
- **Avoidance of major crossings**
- **Minimise disturbance to land**
- **Avoid difficult terrain**
- **Minimise route length**
- **Comply with legislation**
- **Build safely**

Pre-construction activities

- **Route survey inc geo tech and other (ordnance)**
- **Third party services identification**
- **High quality alignment sheet production**
- **Land drainage**
- **Pipe dumps and construction camp location**
- **Air strips**
- **Access roads**
- **Logistic survey (ports, roads, railways)**

Design data



Design data on plan

PLAN DATA

- Optimum pipeline route with chainage markers, Grid with north arrow
- Map route symbols such as IP's (Intersection point or bends) and crossings inc third party
- topographic and / or satellite images, cadastral maps

PROFILE

- Longitudinal profile at set vertical scale different from horizontal scale

TABULATED PIPELINE ENGINEERING DATA

- Landowners & occupiers
- Linepipe Material, Class Field bend angle , formed bends
- Cathodic protection
- Crossings Drawing Details
- Special Coatings etc..

Standard cross country sequence

- **Land access and pre-work (drainage, hedge removal etc)**
- **Pipe stringing and welding**
- **Inspection and coating field joints**
- **Ditching**
- **Backfill**
- **Re-instatement**

Centre line survey



Fencing and top soil stripping



Pipe stringing



Welding, FJ coating, trench digging



Ditching



Ditching



Backfill



Subsoil backfill



Topsoil backfill



Final re-instatement and re-seeding



Sequence

Pipeline sequence – cross country.

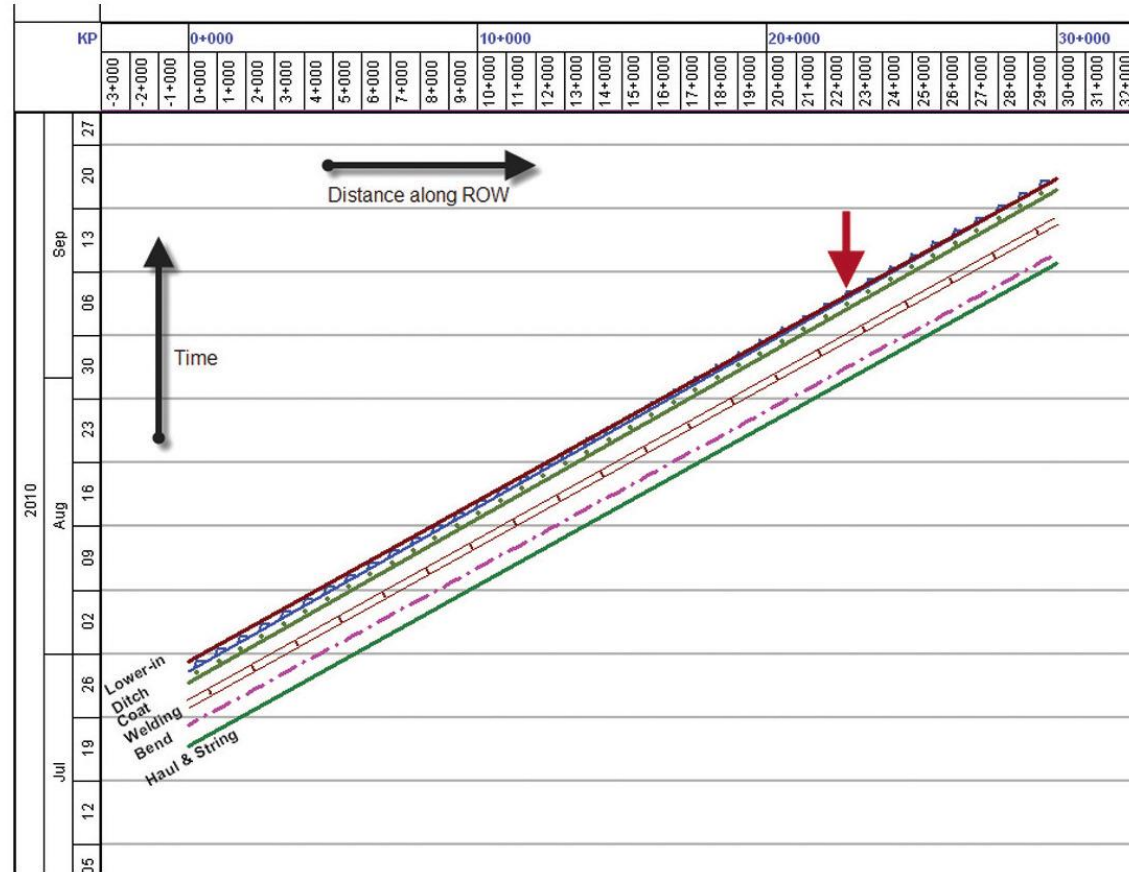
- **Sequence moves as a “convoy” at speed of slowest element.**
- **Different section may require additional support depending on conditions**
- **Plan required for pipe and camp locations, logistics of sequence**
- **Crossings dictate “turnarounds”**
- **Consider long pipes or double ending pipes**

Sequence – March Charts

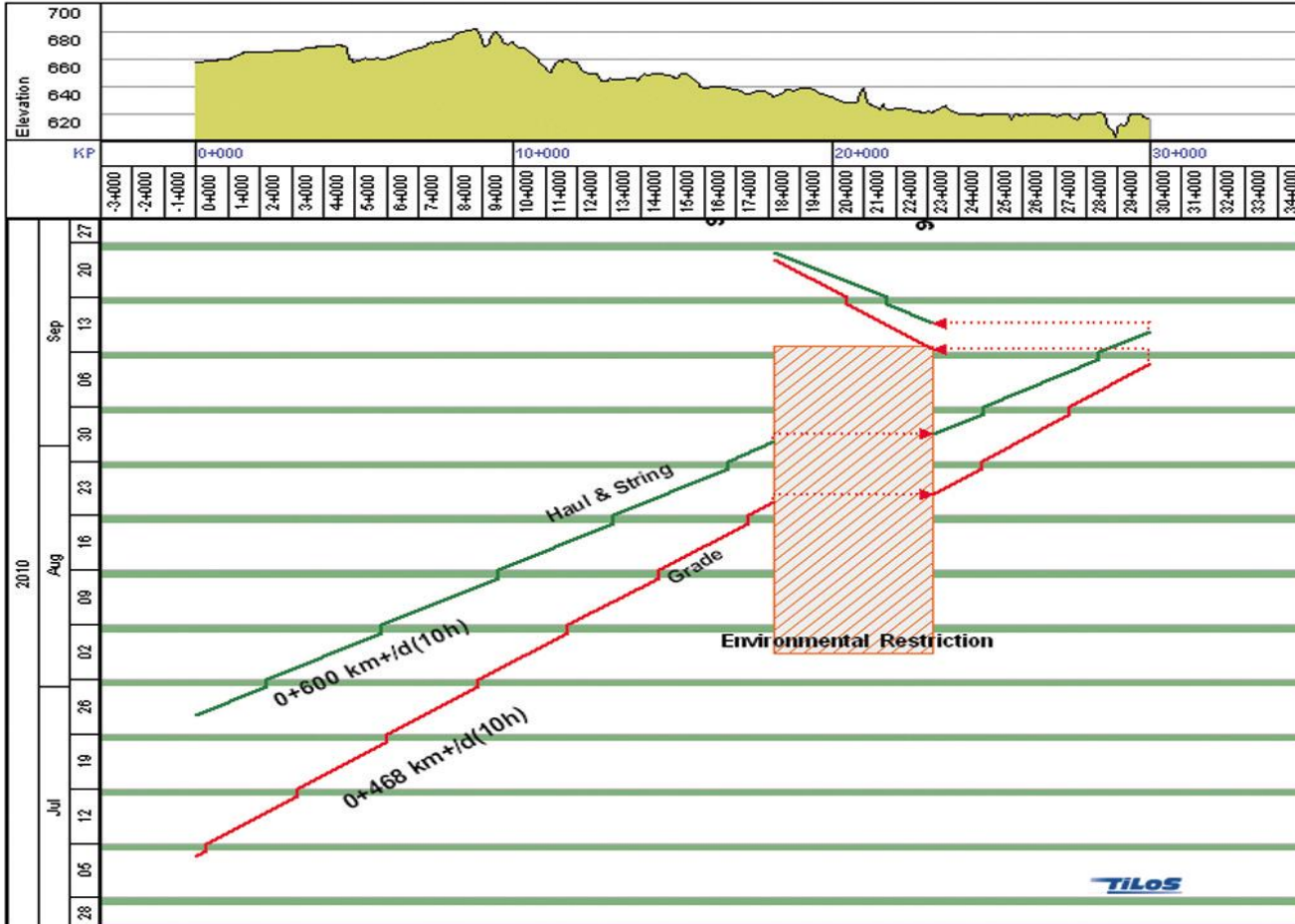
Pipeline sequence – March charts.

- **March charts used by companies to plan construction activities**
- **Time goes up, distance goes L to R**
- **Used to plot lock out locations, crossings and rate of progress**
- **See “Onshore Pipelines the Road to Success – IPLOCA”**

Sequence – March Charts



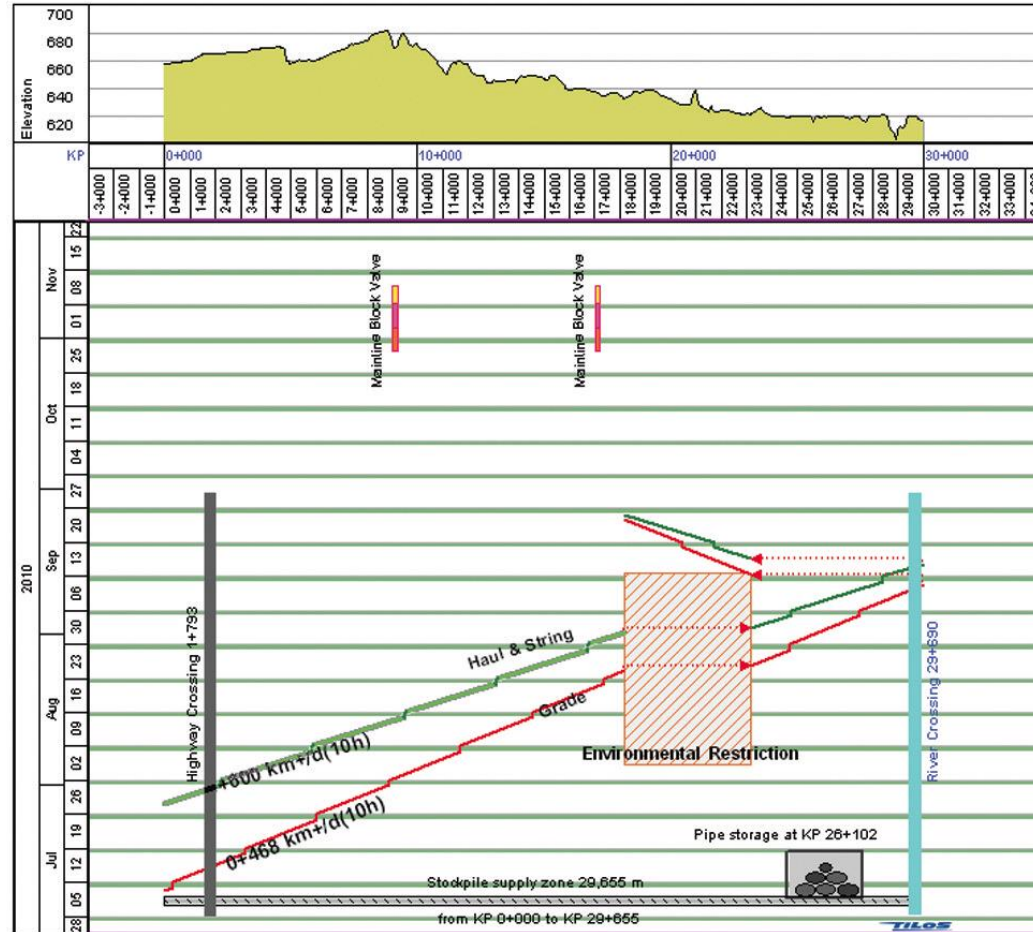
Sequence – March Charts



Move around

Environmental lock out location

Sequence – March Charts



Single item such as valve or Pump Stations can be included

Location of pipe dumps and crossings

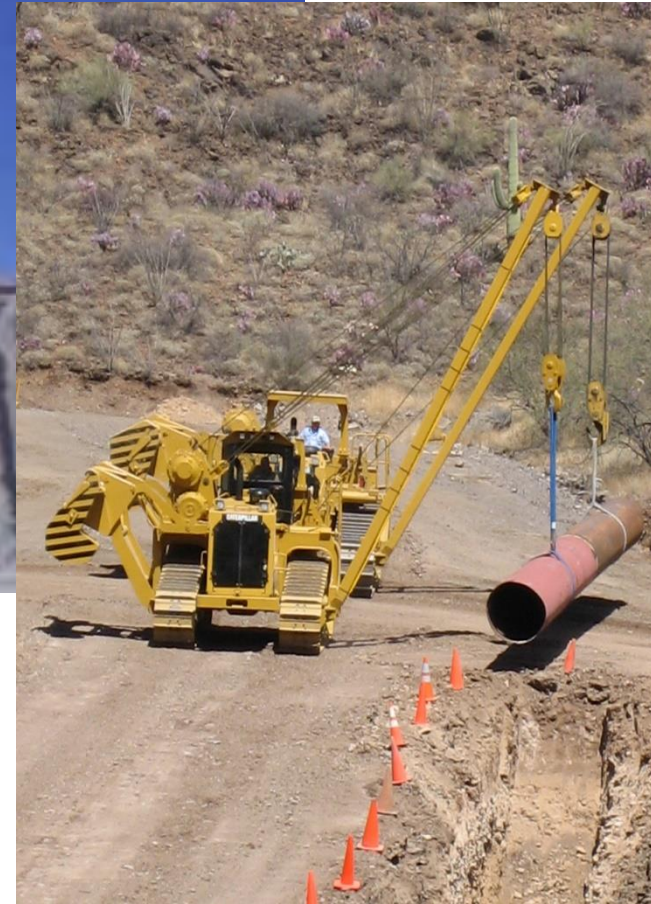
Construction issues

- **Other significant items for construction**
- **Pipe store and handling**
- **Field bending**
- **Welding**
- **Field Joint coating**
- **Impermeable barriers**
- **Pre-commissioning**
- **Hydrotesting**

Pipe store / dump



Pipe handling



Field bending – 40D



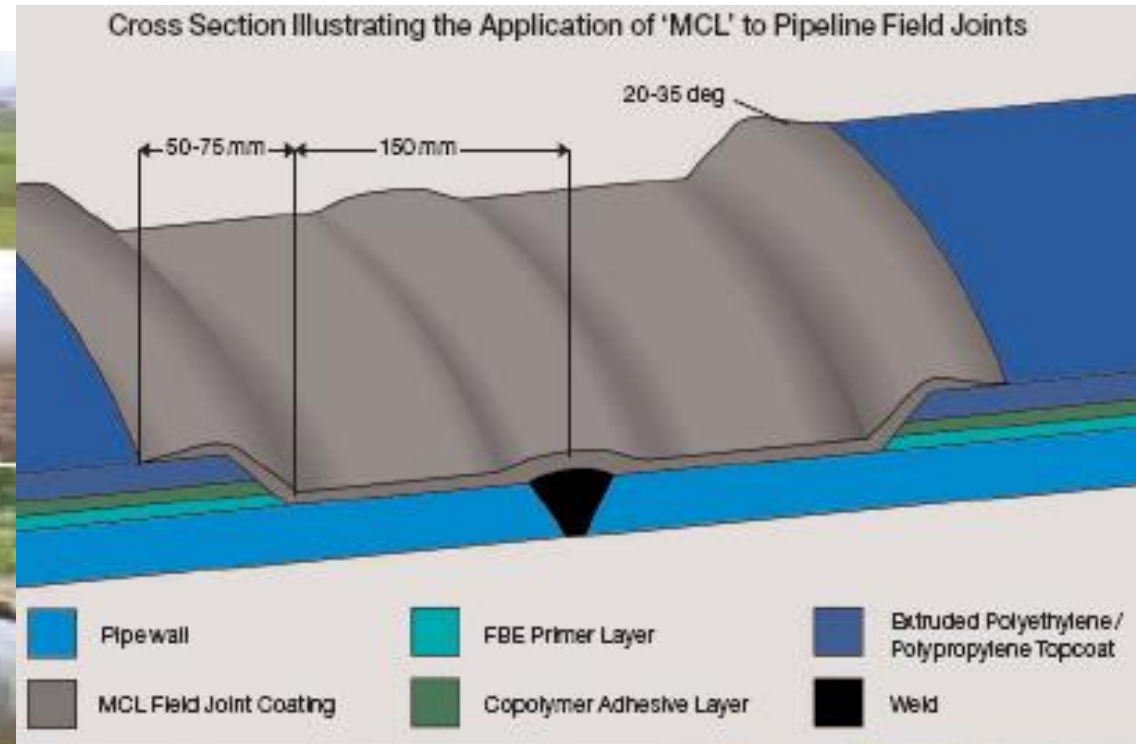
Ditch crossing



Welding



Field joint coating



Anti washout



Test ends



Pipeline crossings

- **Open cut**
- **Pipe Jacking**
- **Augur Bore**
- **Directional Drill**
- **Micro tunnel**
- **Tunnel and shaft**
- **Escarpments**

Crossing issues

- **Regulatory approval**
- **Third party conditions / approvals**
- **Ground conditions**
- **Distance**
- **Other services / multiple pipes**
- **Safety**
- **Environmental restrictions**

Open cut

- **Simple, used for small roads, rivers and streams / ditches.
Disruptive to traffic/ water flow, can permanently damage roads.
Never used for railways.**
- **Deep crossing may cause collapse**
- **Services in / next to roads need to go under – risk of damage / collapse**
- **Re-instatement of river banks problematic**

Open cut



Under existing services



Augur Bore

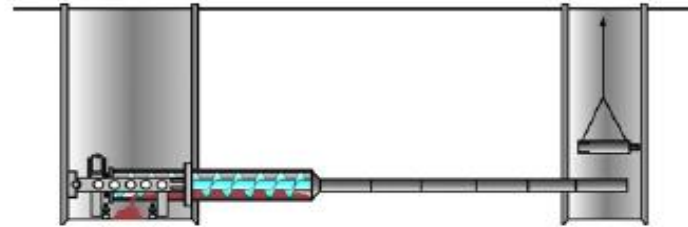
- **Need two pits, one large**
- **Limited length, circa 80 m**
- **Directional accuracy limited (1m in 10) especially for small pipes diameters.**
- **Not suitable for rocks, cobbles or stony ground**
- **Can cause ground heave / subsidence**
- **Use of casing pipe or sacrificial pipe in front of line pipe – may use additional coating protection (Rock guard or similar)**
- **Hydraulic rams require good anchor / strong back to push against.**

Augur bore sequence

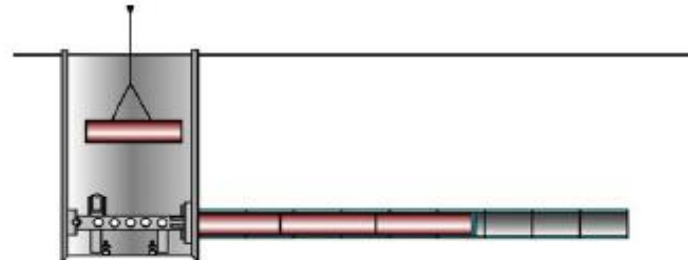
Piloting



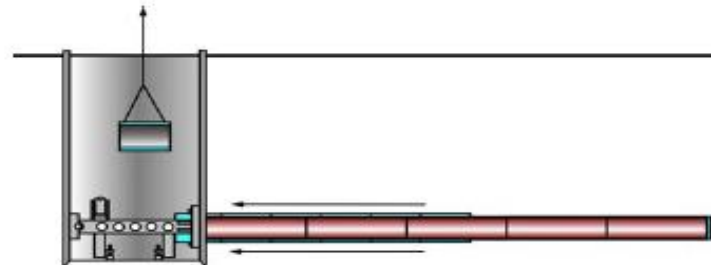
Auger boring



**Insertion of
product pipe**



**Removal of
steel casings**



Vid



Augur bore reality



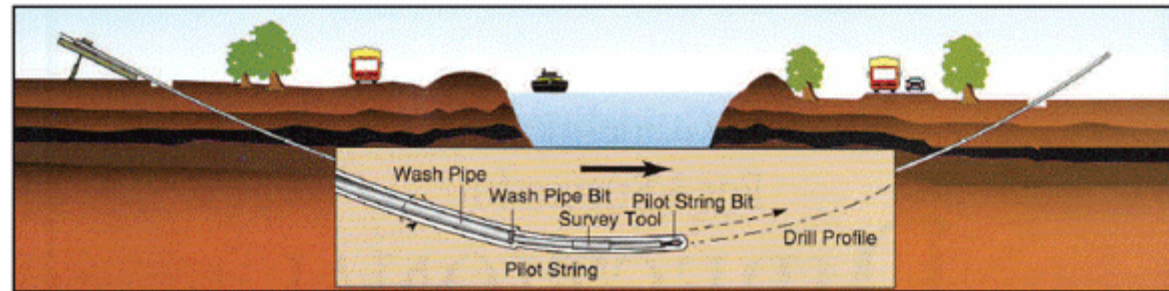
Horizontal Directional Drill (HDD)

- **Used for crossings up to 2 km or longer if used with push – pull techniques**
- **Need good ground, no cobbles or boulders or gravel - Geotechnical investigations vital**
- **Need min 10m under river bed to avoid risk of failure / blowout**
- **Need a Mud return line or tanker shuttle**
- **Accurate if tracked well on surface (+/- 5m at 500m)**
- **Require long lay down area on one side for pipe string – single continuous pull recommended**
- **Can get stuck / hole collapse**
- **Potential environmental issues from loss of mud / breakout**

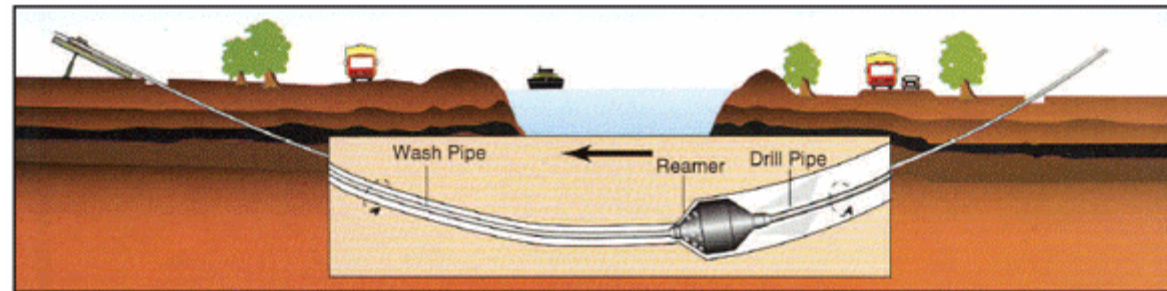
HDD sequence

- **Pilot drill – 4” to 6” pushed from drill machine. Acts as central guidance. Radius min 600D of main pipe.**
- **One or more reamers used to expand hole to accept pipeline**
- **Mud pumped from drill rig emerges at hole with spoil**
- **Connect pipeline to final reamer with universal joint**
- **Pull pipeline into hole – pipeline pre made and tested on rollers**
- **Pipe entry angle limited to 5 to 7 degrees to be able to accept pipe**

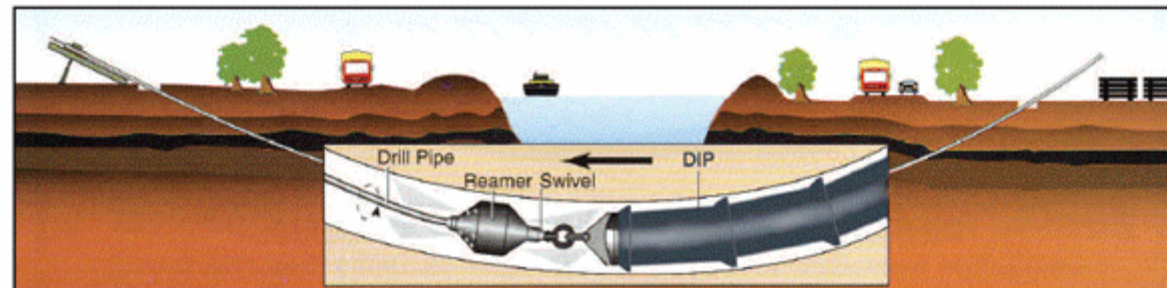
HDD sequence



PILOT HOLE

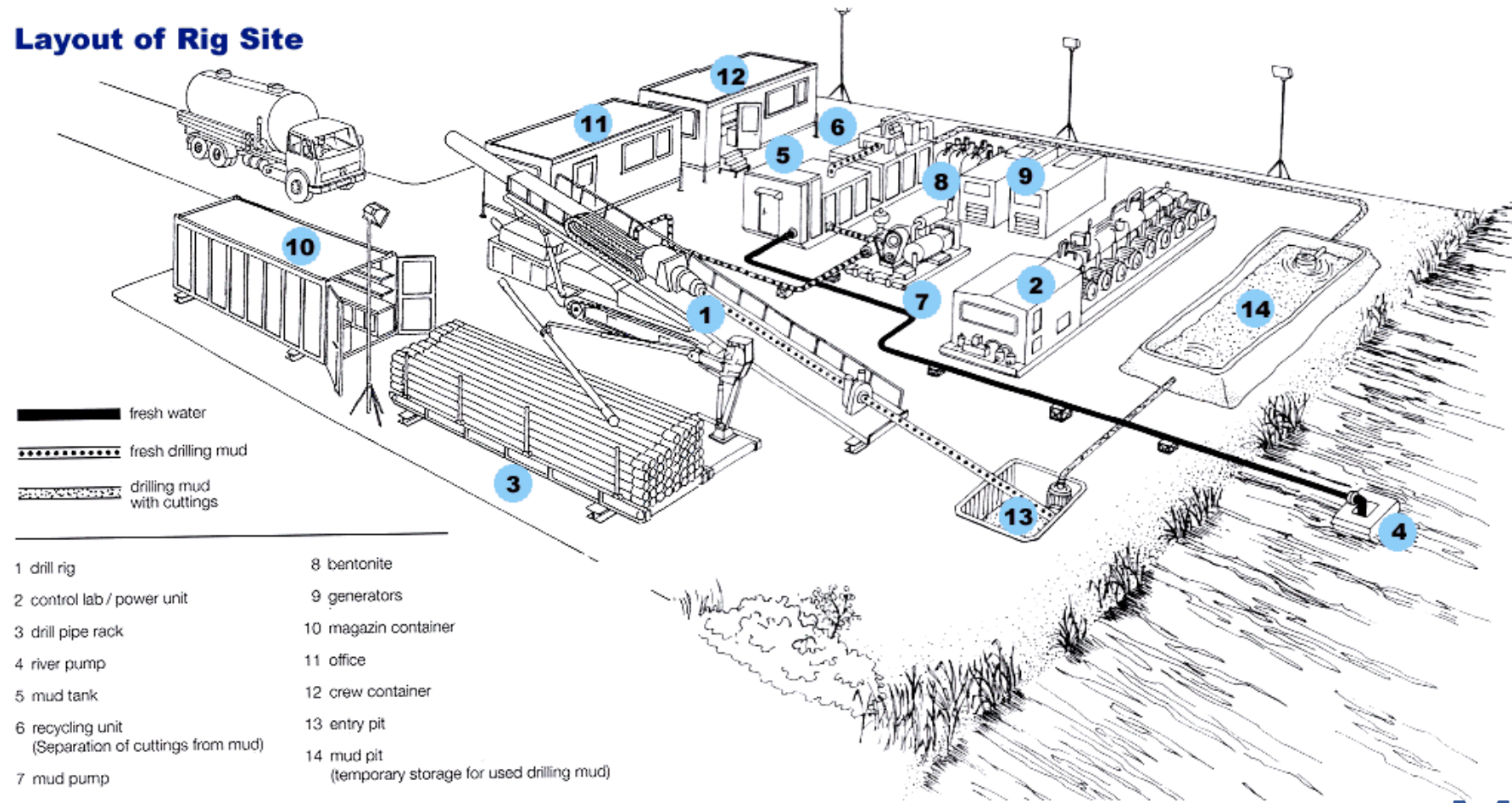


PRE-REAMING

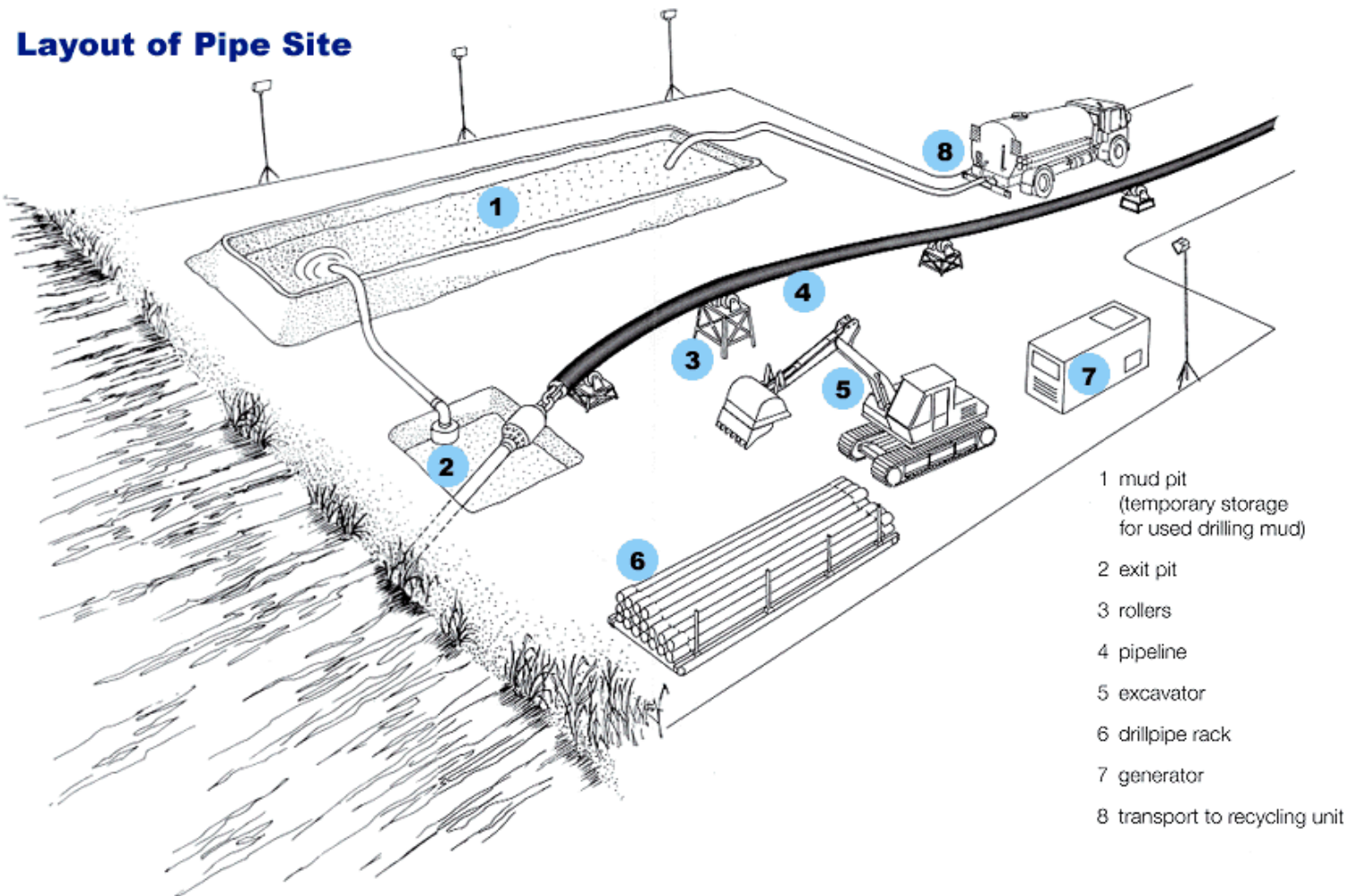


HDD rig layout - ideal

Layout of Rig Site



HDD layout - ideal



HD



HDD reality



HDD layout - reality



Micro tunnel and shaft

- **Used where space is very limited**
- **Can be used for multiple pipes / cables**
- **Expensive**
- **Requires two shafts**
- **Tunnelling machines increase safety**
- **Good geology information required**
- **Can break through**
- **Micro tunneling 400mm to 3000mm diameter.**
- **Segmentally lined tunnel length unlimited**

Tunnels

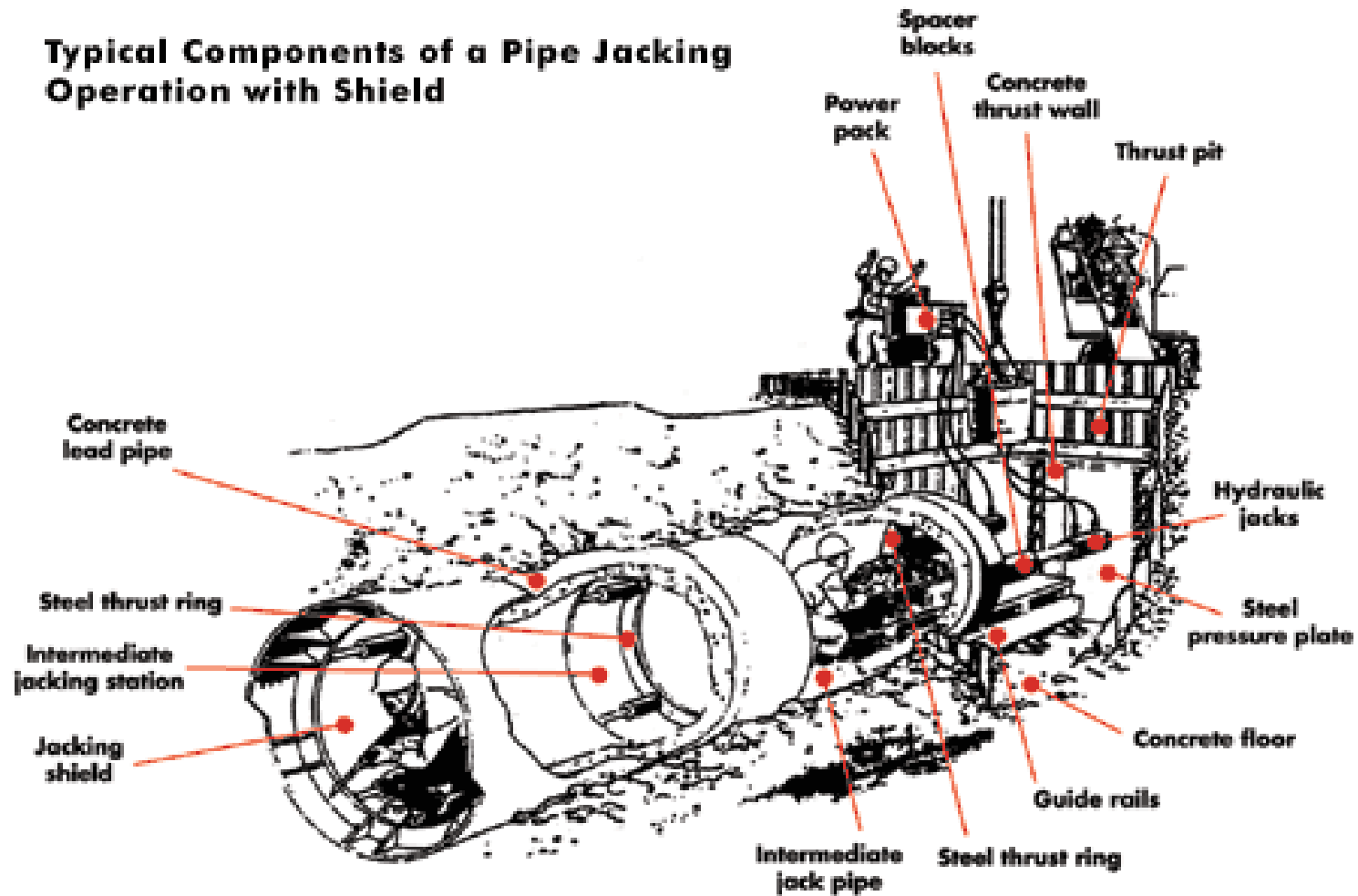
- **High cost and complexity**
- **Confined spaces**
- **Subject to flooding**
- **Issues for hazardous pipelines**
- **Maintenance & inspection difficult**
- **Can be deep and used for multiple pipes and cables**

Tunneling

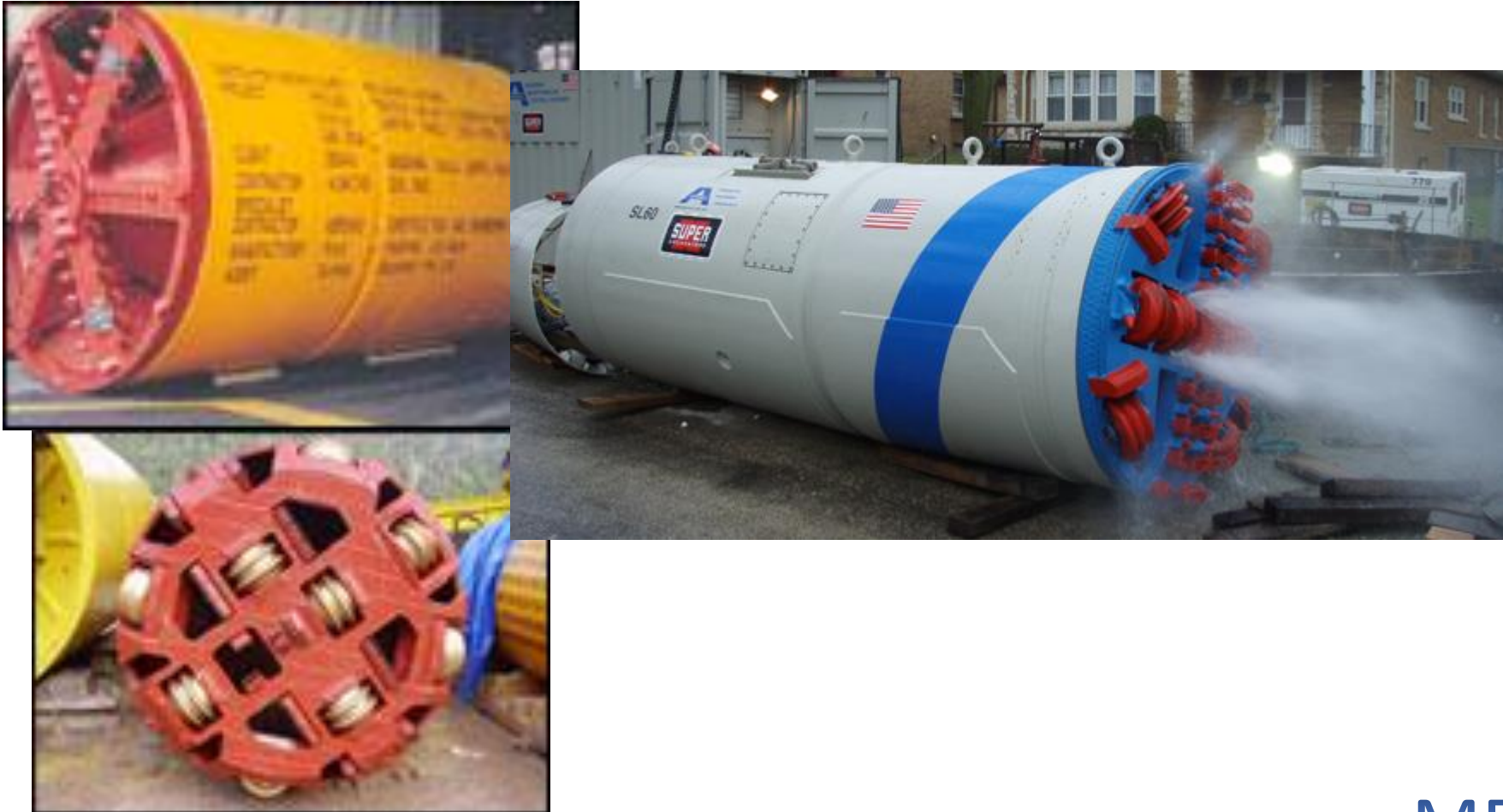


Pipe Jack

Typical Components of a Pipe Jacking Operation with Shield



Microtunnel



Tunnel pipeline installation



Escarpment ramp



Surface berm



Summary

- **Construction sequence**
- **Special tools and systems**
- **Open cut crossings**
- **Augur bore / pipe jack crossing**
- **Directional drill**
- **Tunnel / microtunnel**
- **Escarpment / poor ground**

The background of the slide is an abstract, swirling pattern in shades of blue and black, resembling a vortex or a stylized eye. The text is positioned on the left side of this background.

Thank You

Any questions?