


### Trenchless Technology and Their Impact on Urban Utility Systems

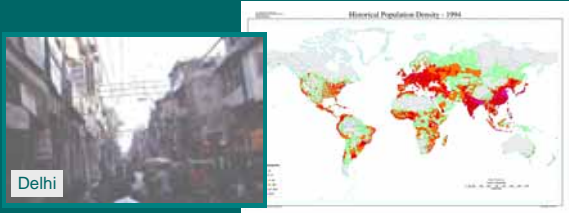
Underground Space Challenges in Urban Development  
January 28, 2008



Approximately 11 million miles in U.S.  
Existing investment in the trillions of dollars  
Haphazard, poorly documented, neglected

Ray Sterling  
Trenchless Technology Center

### World Population and Urbanization



- Total Population
 

1950	2.5 billion
2007	6.6 billion
- Urban Population
 

1900	13%
May 2007	= 50%

### Changing Underground Infrastructure Needs

- ◆ Affected by societal development
  - Agricultural Society
  - Industrial Society
  - Automobile Society
  - Information Society
- ◆ Affected by urban development
  - Village
  - Small town
  - Small city
  - Large city
  - Conurbation



### Why does it matter?

- ◆ Big cities typically need underground infrastructure and underground space use as they grow but only later in their development.
- ◆ The cost and usefulness of the underground space use is affected by the prior use of the underground.
- ◆ Existing utilities are a major difficulty for new underground projects in urban areas.

### Above versus Underground Utilities






Sydney Botanical Gardens

Tokyo

### Problems with Cut-and-Cover




- Underground space in public right-of-way is heavily used
- Traffic congestion growing
- Street pavement damage
- Cost of surface restoration
- Direct and indirect business loss

Total amount of traffic congestion delay, reaching 3.7 billion hours in 2003.

Wasted fuel, totaling 2.3 billion gallons lost to engines idling in traffic jams.

Texas Transportation Institute, 2005



## What is Trenchless Technology?

- ◆ A set of technologies for the remote installation, rehabilitation and repair of utilities, pipelines and small tunnels -- linked by their lack of need for digging a continuous trench for the installation of new pipes or the repair of old pipes

## Areas of Trenchless Technology

- ◆ Location/ Inspector/ Assessment
- ◆ New Installation
- ◆ Pipe rehabilitation
- ◆ Manhole rehabilitation
- ◆ Trenchless pipe replacement



## Displacement: Impact Molding

- ◆ Installation of small pipes, cables or ducts under roads, driveways, etc, using a percussive tool, generally of a torpedo shape
- ◆ Non-steerable or steerable
- ◆ Self-propelled
- ◆ Power source:
  - pneumatic or hydraulic



## Displacement: Pipe Ramming

- ◆ Installation of steel pipes or casings under roads, railroads and other obstacles using a percussive hammer from a drive pit
- ◆ Pipes from 4-in to 72-in
- ◆ Distances up to 150-ft (300-ft)
- ◆ Non-steerable



## Microtunneling

- ◆ Remotely controlled
- ◆ Laser guided
- ◆ Jacked pipes
- ◆ Face support



## Horizontal Directional Drilling

- ◆ Steerable drilling technique
  - Install pilot hole
  - Enlarge as necessary through reaming
  - Pull in pipe



### Mini/Midi HDD: Smaller crossings, urban installations

◆ Layout issues:

- Avoid existing utilities
- Maximum curvature restrictions
- Safe distance below road pavement



Courtesy: Ditchwitch

### Pilot Tube Microtunneling



Soltau – RVS80

### Location / Inspection / Assessment

- ◆ Increasingly included in the “trenchless” family of methods
- ◆ Effective management of buried utilities
- ◆ Effective preparation for other trenchless work

### Utility Location: Non-Destructive/Geophysical Methods

- ◆ Introduce wave or signal into ground
- ◆ Response affected by physical properties of object located in the ground
- ◆ Information about the properties of the object and its location is inferred from the response



Courtesy of N. Simicevic, Louisiana Tech Univ.

### Inspection Methods: CCTV

- ◆ High quality images
- ◆ Ability to see water flow, etc.



### Deteriorated Sewer Pipe



Courtesy: City of Portland

### Advanced Inspection Techniques

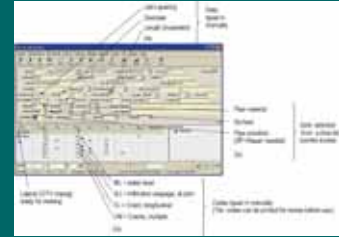
- ◆ Laser pipe deformation measurement
- ◆ External pipe void detection
- ◆ Tracing alignment
- ◆ Pipe internal surface scanning



Courtesy: City of Portland

### Condition Assessment and Asset Management Software

- ◆ Consistent condition and defect assessment (e.g. PACP coding)
- ◆ Effective asset management

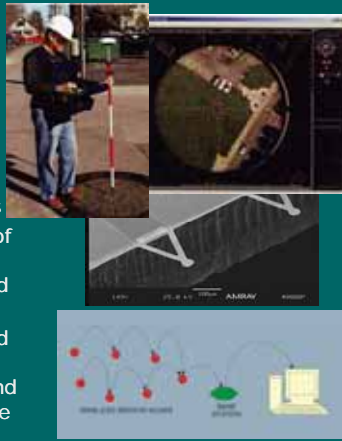


Example: Flexidata Software

PACP = Pipeline Assessment Certification Program

### Asset Management

- ◆ Integrated GPS/GIS/damage prevention systems
- ◆ Effective adoption of asset management strategies for buried utilities
- ◆ Low-cost distributed sensor systems to monitor material and system performance



### Pipe Rehabilitation / Replacement Methods

- ◆ Rehabilitation: In situ renovation to improve the performance and extend the life of a defective pipeline, incorporating the fabric of that pipeline
  - May address structural and/or hydraulic weakness
- ◆ Trenchless Replacement: Replacement of existing pipe with a new pipe along the same alignment and with minimal surface disturbance.



Courtesy: Avanti

### Cured-in-place Pipe (1)

- ◆ Original and most widely used lining technique
- ◆ A fabric is impregnated with a fluid resin
- ◆ The fabric and resin are "inverted" or pulled into the existing pipe and inflated against the pipe while curing



(Close-Fit Lining)

### Large Diameter CIPP Lining



### Fold-and-Form

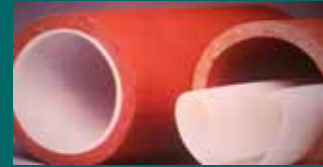
- ◆ PVC pipe extruded in folded shape
- ◆ Heated for flexibility, inserted into pipe and reformed using heat and pressure



(Close-Fit Lining)

### Deform-Reform

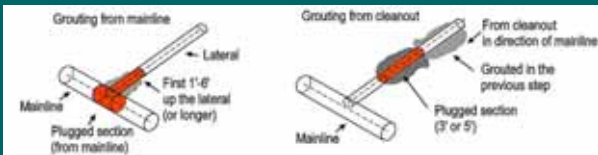
- ◆ HDPE pipe extruded in round shape
- ◆ Deformed to U-shape
- ◆ Inserted into existing pipe and reformed



(Close-Fit Lining)

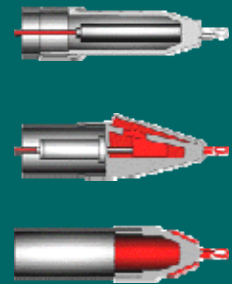
### Chemical Grouting (1)

- ◆ Seals cracks and joints
- ◆ Not a structural repair
- ◆ A low-cost sealing approach



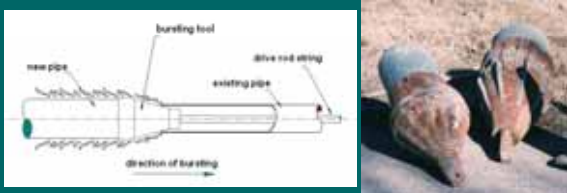
### Trenchless Pipe Replacement

- ◆ A family of techniques for providing a new pipe in the same location as the old pipe but without exposing the full line from the surface



### Static Pipe Bursting

- ◆ Large tensile force applied



### Water / Sewer Spending in 2005

(Source: 9<sup>th</sup> Annual Municipal Sewer and Water Survey, Underground Construction, Feb. 2006)

Type of Work	Spending Level (billions US\$)	Expected trenchless proportion
Rehabilitation	4.5	68.1%
New Construction	7.7	15.7%

## Concluding Remarks

- ◆ We have a (relatively) new tool kit for working with underground facilities – allowing us to do things that simply were not possible before.
- ◆ Underground utility installation and repair work is expected to grow due to the aging of the utility networks and increasing standards for their operation
- ◆ Trenchless methods are expected to continue to grow as a proportion of total utility work
- ◆ While offering great advantages for utility installation and maintenance, planning issues especially with regard to utility placement and utility location records need to be addressed.

## Further Information

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