INTERNATIONAL SOCIETY FOR TRENCHLESS TECHNOLOGY	**TRENCHLESS TECHNOLOGIES RESOURCE CENTRE**	
	TRENCHLESS TECHNOLOGY OVERVIEWS	SECOND EDITION
	OFF LINE REPLACEMENT	UPDATED JUNE 2006

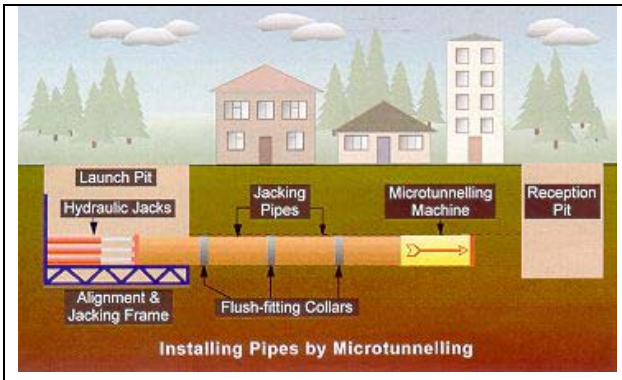
DEFINITION

Off line Replacement includes all processes used to install a pipeline along a new route either as a replacement for an existing line or as a new installation. This group of processes includes the following technologies

a) OPEN TRENCH METHODS
   a. Conventional open trench methods
   b. Narrow trench and mole ploughing

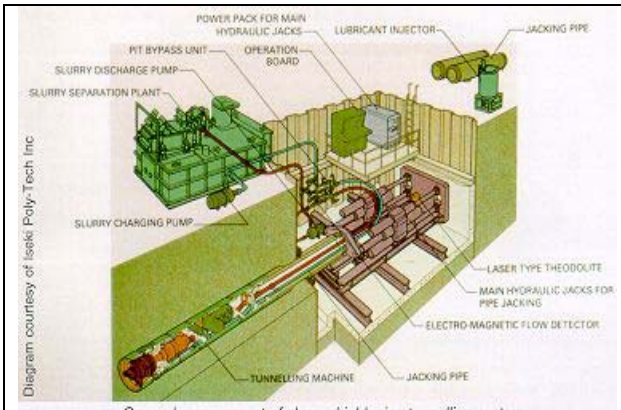
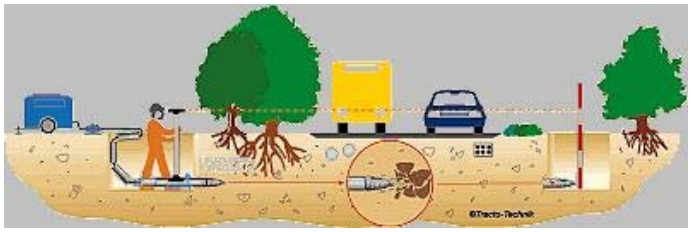
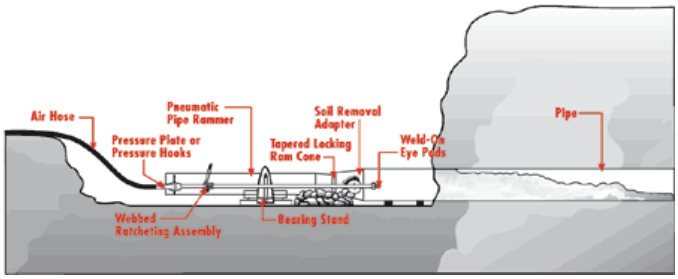
b) TRENCHLESS METHODS
   a. Pipe jacking and Microtunnelling
   b. Impact Moling and Ramming
   c. Auger Boring
   d. Horizontal Directional drilling

All of the Trenchless Methods involve use of a machine to excavate a horizontal hole between an entry and an exit point into which the product pipes are pulled or pushed.



PIPEJACKING AND MICROTUNNELLING, including pilot auger microtunnelling, are essentially from the same family of pipeline installation techniques and can be used for installations from about 120 mm diameter upwards. A pipejack is defined as a system of directly installing pipes behind a shield machine by hydraulic jacking from a drive shaft, such that the pipes form a continuous string in the ground. The pipes, which are specially designed to withstand the jacking forces likely to be encountered during installation, form the final pipeline once the excavation operation is completed.

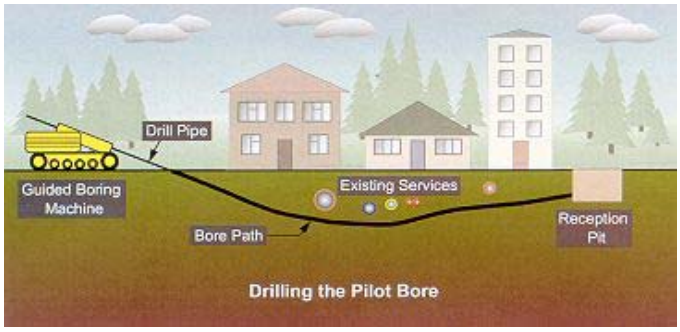
Within this description, microtunnelling is specifically defined as being a steerable, remote-controlled shield for installing a pipejack with an

 *General arrangement of slurry shield microtunnelling system*	internal diameter less than that permissible for man-entry. Microtunnellers often use a laser guidance system to maintain the line and level of the installation, though, as with larger pipejacking installations, both laser guidance and normal survey techniques can also be utilised
 *Schematic of the Impact Moling technique. Picture courtesy of Tracto-Technik.*  *Schematic of the Pipe Ramming Technique.*	IMPACT MOLING, or 'earth piercing' as it is commonly known in North America, is defined as the creation of a bore by the use of a tool that comprises a percussive hammer within a suitable cylindrical casing, generally torpedo shaped. The hammer may be hydraulic or pneumatic. The term is usually associated with non-steered or limited steering devices without rigid attachment to the launch pit, relying for forward movement upon the internal hammer action to overcome the frictional resistance of the ground. During operation the soil is displaced, not removed. An unsupported bore may be formed in suitable ground, or a pipe may be drawn or pushed in immediately behind the impact moling tool. Cables may also be pulled in. PIPE RAMMING is a non-steerable system of forming a bore by driving a steel casing, usually open-ended, using a percussive hammer from a drive pit. The soil may be removed from an open-ended casing by augering, jetting (with water) or compressed air. In appropriate ground conditions a closed casing may be used

A Typical Auger Boring set-up. Picture courtesy of Allen Watson Ltd.

AUGER BORING

As the name Auger Boring implies, the excavation technique employed is that of using a rotating auger chain/flight fitted with a cutter head. The cutter head is driven by, and is positioned at the lead end of, an auger string that has been established within the casing pipe, the auger diameter being dimensioned to the just below the full diameter of the casing to allow rotation. Rotating the helical auger chain within the casing pipe allows the cutter head to excavate the ground at the face, with spoil being removed back along the auger string within the casing pipe to the launch shaft or pit. Spoil is removed by hand or mechanically or placed into muck skips for removal as it exits the casing pipe.



Schematic of Horizontal Directional Drilling. Picture courtesy of Trcato-Technik

HORIZONTAL DIRECTIONAL DRILLING

Horizontal directional drilling or HDD (known also as Guided Boring) techniques are used for the trenchless installation of new pipelines, ducts and cables. The drill path may be straight or gradually curved, and the direction of the drilling head can be adjusted at any stage during the initial pilot bore to steer around obstacles or under highways, rivers or railways. Using the correct type of drilling rig, bores can be carried out between pre-excavated launch and reception pits, or from the surface by setting the machine to drill into the ground at a shallow angle.

Boring Fluid and Lubrication additives are vital to off-lie replacement technologies. Picture courtesy of Baroid International Drilling Products.

SPOIL HANDLING AND LUBRICATION FLUIDS, describes the wide range of spoil handling techniques and lubrication fluids which are essential to all the off line replacement technologies.