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В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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HORIZONTAL DIRECTIONAL DRILLING TECHNOLOGY AS AN EFFECTIVE WAY OF TRENCHLESS LAYING OF UNDERGROUND COMMUNICATIONS

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Horizontal Directional Drilling (HDD) technology originated in the petroleum industry during the 1970s and has evolved with additional technology that was developed in water well installation and in the utility industry. Much of modern HDD technology evolved from boring techniques employed in the 1960s for the underground installation of cables and conduits in urban areas. Trenching or open-cut methods were commonly used at that time to install a variety of utilities. Over time, the method has matured from relatively simple utility borings to installation of large diameter pipes (50 inch diameter and larger) for as far as 4000 to 5000 feet. These methods allow the installation of both small and large diameter ducts, pipes, and conduits without the risk of environmental damage often associated with trenching operations. HDD is defined as a steerable system for the installation of pipes and conduits and cables using a surface-launched drilling rig. It can be characterized as a two-stage process. First, a pilot bore is created along a planned path using both thrust of the drilling rig for changing direction, and rotation of the drill rods and bit to advance in that direction. In the second stage of the process after the pilot bore is completed, a backreamer is attached to the end of the drill string, followed by the desired flexible or semi-flexible utility product pipe. The pipe is installed along a bentonite mud slurry pathway that is created when the backreaming is complete. Tracking of the pilot bore and backreaming process is enabled by a radio sonde that is contained within a housing that is within the drill bit. Accuracies of installation within one inch are possible using the HDD process. 6.2 Description of Horizontal Directional Drilling (HDD) method Directional drilling methods utilize steerable drilling systems to install both small and large diameter lines. The pilot hole is drilled with a diameter of 1 inch to 5 inches along the proposed design centerline. Then, the pilot hole is enlarged by back reaming to the desired diameter, sometimes by successive passes of different-sized back reamers, to install the desired utility product pipe. The product pipe is connected to the end of the drilling rod and back reamer assembly by a swivel and pulled through the enlarged pilot hole. The pilot hole is normally drilled by a surface launched rig with an inclined carriage, that is typically adjusted at an angle of 8 to 18 degrees from the surface of the ground for entrance and between 8 and 12 degrees at the exit. Rotating the drill bit, assisted by the thrust force transferred from the drill string, performs soil cutting in the mechanical drilling process. The mechanical drill bits may vary from a slim cutting head with a slanted face for small and short bore applications to a diamond mounted roller cutter used with mud motors for large and long crossings. For small systems utilizing mini-HDD, directional steering control is accomplished mainly by the bias created by the slanted cutter head face. For large systems used for maxi-HDD, a bent housing (a slightly bent section between 0.5 and1.5 degrees of the drill rod) is used to deflect the cutter head axis from the following drill string. In both small and large systems, pushing the drill head without rotating can follow a curved path, and a straight path can be drilled by applying simultaneous thrust and torque to the drill head. High-pressure jetting is used in utility boring applications (a technique that is seldom used today). It is an effective method for cutting through soft formations and lends itself to directionally controlling the course of the borehole through the unique shape of the jet bit. The utility boring method utilizes high pressure, low-volume drilling fluid, usually bentonite mud, to jet through shallow, soft soil

formations to ensure the surrounding formation will not become saturated and unstable. HDD, on the other hand, uses mechanical cutting and high-volume and highpressure fluid through soft formations with a bentonite or polymer-based mud as the bit advances. High volume and velocity in HDD are necessary to carry cuttings back to the surface through the bore annulus. It should be emphasized that utility boring is mechanically-assisted fluid cutting of formations, while HDD is fluid-assisted mechanical cutting of formations. This difference is important in preventing settlement under structures and roads.

Why Drill Wells That Are Non-Vertical?

Directional and horizontal drilling have been used to reach targets beneath adjacent lands, reduce the footprint of gas field development, increase the length of the "pay zone" in a well, deliberately intersect fractures, construct relief wells and install utility service beneath lands where excavation is impossible or extremely expensive.
Below is a list of six reasons for drilling non-vertical wells. They are graphically illustrated by the six drawings in the right column of this page.

A) Hit targets that can not be reached by vertical drilling.

Sometimes a reservoir is located under a city or a park where drilling is impossible or forbidden. This reservoir might still be tapped if the drilling pad is located on the edge of the city or park and the well is drilled at an angle that will intersect the reservoir.

B) Drain a broad area from a single drilling pad.

This method has been used to reduce the surface footprint of a drilling operation. In 2010, the University of Texas at Arlington was featured in the news for drilling 22 wells on a single drill pad that will drain natural gas from 1100 acres beneath the campus. Over a 25 year life-time the wells are expected to produce a total of 110 billion cubic feet of gas. This method significantly reduced the footprint of natural gas development within the campus area.

C) Increase the length of the "pay zone" within the target rock unit.

If a rock unit is fifty feet thick, a vertical well drilled through it would have a pay zone that is fifty feet in length. However if the well is turned and drilled horizontally through the rock unit for five thousand feet then that single well will have a pay zone that is five thousand feet long - this will usually result in a significant productivity increase for the well. When combined with hydraulic fracturing, horizontal drilling can convert unproductive shales into fantastic reservoir rocks.

D) Improve the productivity of wells in a fractured reservoir.

This is done by drilling in a direction that intersects a maximum number of fractures. The drilling direction will normally be at right angles to the dominant fracture direction. Geothermal fields in granite bedrock usually get nearly all of their water exchange from fractures. Drilling at right angles to the dominant fracture direction will drive the well through a maximum number of fractures.

E) Seal or relieve pressure in an "out-of-control" well.

If a well is out-of-control a "relief well" can be drilled to intersect it. The intersecting well can be used to seal the original well or to relieve pressure in the out-of-control well.

F) Install underground utilities where excavation is not possible.

Horizontal drilling has been used to install gas and electric lines that must cross a river, cross a road, or travel under a city.

Trenchless Applications

Trenchless installation methods can improve the esthetics and function of a great variety of projects. Bay State Piping Company has a broad range of experience in methods and applications of trenchless technology. Our first-hand knowledge allows us to offer suggestions as to the economics and feasibility of methods for your project.

Applications common to many trenchless installations are listed below:

Railroad Crossings - Because railroad tracks sustain a great deal of weight, standards are rigid when pipeline crossings are proposed. The permitting process is generally extensive, and installation depths are increased. Horizontal directional drilling is a popular method for railroad crossings.

When installed properly, very little soil displacement is experienced, and great depths can be

reached without compromising the integrity of the rails. For larger diameter crossings, or crossings where setup area is limited, horizontal auger boring is also commonly used.

Figure 1. Horizontal drilling equipment

Conservation Areas - When pipelines are installed in environmentally sensitive areas, the installation should require as little area disruption as possible. Directional drilling can install pipelines through areas with little more than human feet touching the earth above the pipeline.

Water Crossings - The horizontal directional drilling process was invented specifically for this purpose. Directional drilling can install pipelines under rivers, lakes, and other bodies of water.

City Streets - Below ground level in modern U.S. cities, the pipeline network can often be so cluttered to make open trench installations inconceivable. Restoration costs and traffic problems are also extensive. By using directional drilling as an installation method, traffic disruption is minimized to a small setup area, restoration is reduced to an entry pit and an exit pit, and product can be installed deep below the maze of pipelines. Preparation should be extensive in city installations, as many of the underground utilities are unmapped.

Highway Crossings - Installing pipelines under major highways requires trenchless installation methods. Directional drilling and Horizontal Auger Boring are usually the most practical depending on size and soil conditions.

Basement Building Entry - Sometimes a pipeline must be installed into the basement of an existing building. This may pose a problem in areas where the basement is very deep below the surface, or an obstruction prevents the wall from being uncovered directly, such as an addition or a city sidewalk above the basement wall. In this type of situation, the pipeline can be installed directly from the surface through the basement wall with installation methods such as directional drilling, steerable rod pushing or horizontal auger boring. When the rod or product reaches the wall, a hole can be core-drilled through the basement wall, and the product installed directly.

Under Roads & Driveways - Percussion moling is an excellent method for installing small diameter piping below roads and driveways. In a vast majority of instances, moling can greatly reduce the cost of installation under pavement over open trench installations.

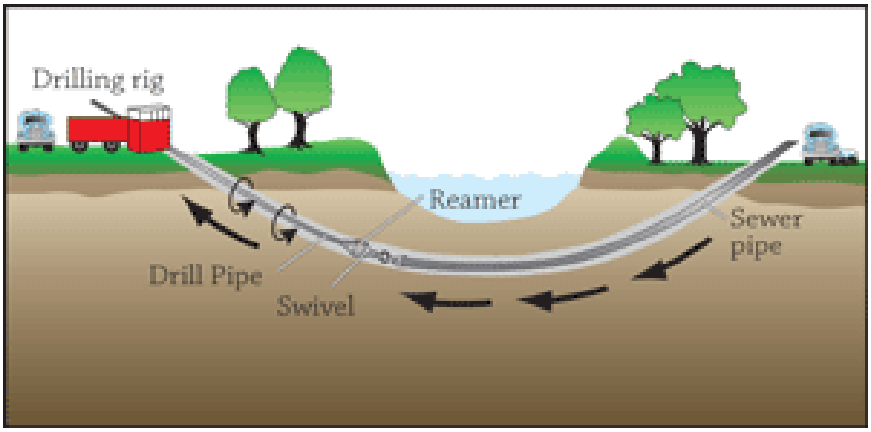

Figure 2. Horizontal drilling scheme

Golf Course Improvements - Meticulously landscaped areas, such as golf courses, benefit from trenchless installation methods. Directional drilling or percussion moling are excellent alternatives to straight open-trench installations. In both methods, only entry and exit pits are required, leaving small areas to be restored. Golf course sprinkler systems are excellent applications for directional drilling, because the pipe can be steered below the surface to exit where the sprinkler head is desired.

Residential Areas - Landscaping, paving, and public relations are all excellent reasons to consider adding trenchless installation to all or sections of a residential installation project. Directional drilling can all but eliminate restoration, percussion moling can make driveway, road, and garden crossings without disrupting the surface, and horizontal auger boring or steerable rod pushing can cross roads with larger diameter pipe.

Environmental Remediation Wells - Horizontal environmental remediation wells installed by directional drilling are gaining acceptance, and with proper preparation, can result in far superior remediation efficiency and cost savings. Screened pipelines can be installed far below the surface, and attached to pumps at ground level.

Soil Testing - Directional drilling has limitless applications, and one of the newest is soil testing capabilities. To sample soils in locations not accessible from the surface, such as beneath structures or under waterways, directional drilling makes the impossible, possible. A specialized drilling head with a sampling container is used to steer the drill rods to the specific location. The location and depth are then verified and the sampling container opens to collect the soil, and the drill rods and the soil sample are pulled back out of the ground.

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ГЕОАҚПАРАТТЫҚ ЖҮЙЕНІҢ КАРТОГРАФИЯДАҒЫ РӨЛІ

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