We're freezing the ground in D.C.

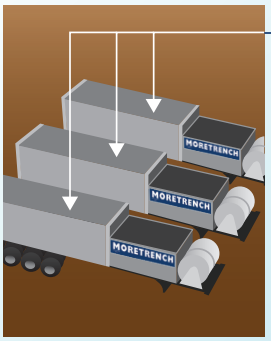
Here's what this involves:

In Washington, D.C., the neighborhoods of Bloomingdale and LeDroit Park feature beautiful Victorian-era row homes along narrow, tree-lined streets. A less desirable characteristic is regular flooding due to low-lying geography. DC Water's First Street Tunnel project will alleviate that flooding by constructing a 20-foot-diameter, 2,700-foot-long tunnel. When this tunnel enters service – scheduled for April 2016 – it will store up to nine million gallons of rainwater that would otherwise fill streets and soak basements. That water will then be pumped into D.C.'s sewer system.

But how are we constructing this tunnel system beneath dense city streets while striving for minimal disturbance to residents? Key to our solution is ground freezing, which converts water within soil pores to ice. With this, we create ice walls up to nearly 10 feet thick that enable us to safely excavate while keeping groundwater out. But more important to nearby residents is that ground freezing involves far less noise and vibration and requires a smaller work area than conventional methods.

Here's how we're going about this:

1. It starts with giant refrigerators…



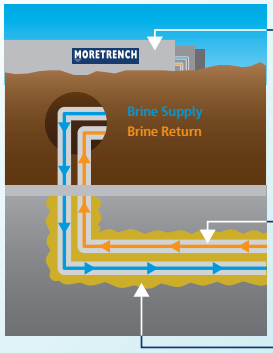
Three tractor-trailer size "freeze plants" are the heart of this system. They use ammonia to cool the brine from -15 degrees to -22 degrees F.

Brine is a saltwater mixture similar to that used to treat winter roads.

1,000 gallons of brine solution is moved every minute by 50 horsepower pumps into these mobile refrigeration units.

A mobile app is used by our team to remotely check the system's performance. It's critical that the system always works flawlessly so the ground doesn't thaw!

2. Then the chilled solution is piped far...



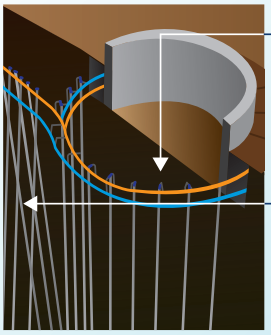
To reduce noise, all three mobile refrigeration units are grouped in one location furthest from houses.

2,600 feet is the longest distance from mobile refrigeration units to the 27-foot-diameter vertical shafts that we're using ground freezing to support.

High-density plastic brine supply and return lines - 12 inches in diameter - are buried in a four-foot-deep utility trench carved in an alley parallel to First Street.

Foam encases the pipes, both to keep geothermal heat from warming the brine and to avoid freezing any nearby water lines and other utilities.

3. Before it's piped deep into the ground…



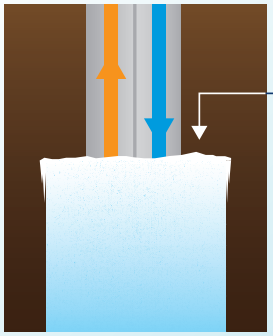
331 four-inch-diameter steel pipes were drilled about 150 feet deep to carry the chilled brine to the specific ground we needed frozen.

Strategic locations were chosen carefully for each pipe, even though some might look haphazard. Some pipes were drilled at angles to avoid disturbing utilities, streets or homes.

To avoid icing utilities, we insulated the top 10 feet of each vertical freeze pipe.

Rock - at almost twice the depth of the 90-foot shafts - is the ending point of the freeze pipes. This forms a seal to prevent ground water from pushing up through the shaft bottom.

4. For the ground freezing to start.



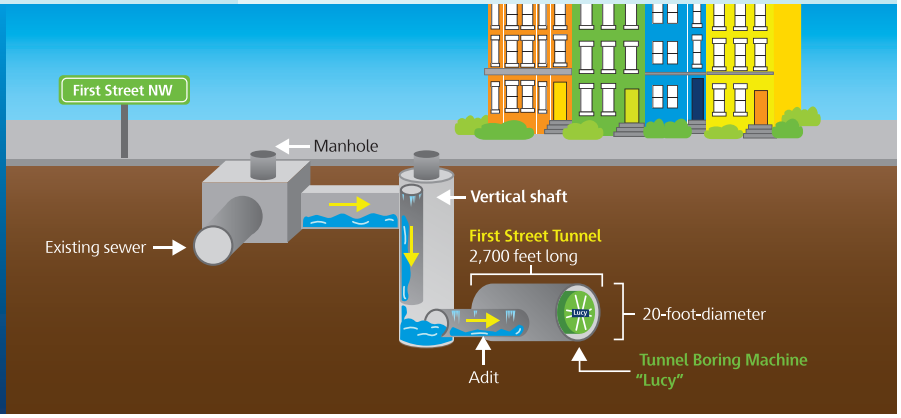
Ice columns between nearly seven and 10 feet thick are formed by each freeze pipe after six to eight weeks of chilled brine being pumped through them. Together, these columns form a structurally sound and watertight ice wall around shafts to be excavated.

Insulated blankets were hung at the end of daily shaft excavation work to cover the exposed frozen ground. Over weekends, spray foam was used.

Concrete was poured to line each excavated shaft.

5. How the whole system comes together

The vertical shafts and other underground structures for which we're using ground freezing are important parts of this project, which is also highlighted by **Lucy, a 1,582-ton tunnel boring machine**. The First Street Tunnel is part of DC Water's long-term initiative to improve the health of the Anacostia and Potomac rivers by reducing combined sewer overflows.



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