Rebuilding The Terasen Pipeline

Bog, Environment Require Special Solutions

by Tonia Jurbin • Contributing Editor

Ten years after a major failure of an abandoned landfill in a peat bog pushed a 36-inch pipeline 11 feet, the replacement line was finally built. This gas transmission line is part of the looping system that serves the Greater Vancouver, Canada, area.

When the landfill in the Burns Bog slid into the pipeline right-of-way, the pipe only yielded rather than fail catastrophically. This unfortunate accident would give BC Gas, now Terasen Gas, a chance to rebuild a stronger pipeline that would withstand not only the predictable long-term settlements, but also make it less vulnerable to flooding from a nearby drainage ditch, and withstand a magnitude 7.2 earthquake.

Burns Bog is a raised estuarial dome-shaped bog created when the super absorbent sphagnum moss allows the water to wick above the level of the surrounding land. It is believed to be the only bog of this type found outside the subarctic regions. The resulting habitat is home to rare and fascinating flora and fauna, including carnivorous plants. Four levels of government are working to preserve this ecological treasure located just south of Vancouver on the south bank of the Fraser River in British Columbia, Canada. The soft organic silts and loose saturated sands that underlie this rare area create numerous engineering and construction challenges.

Before a new, reliable pipeline could be built, the soft ground of the bog would have to be improved to prevent excessive long-term settlement, or liquefaction of the underlying sand layers during an earthquake. The subsurface would somehow have to be densified by squeezing the excess water out of the ground. Ground improvement techniques generally require some time to implement so a temporary pipeline was required.

Preloading

Preloading is a popular ground improvement technique in this environment, especially if there is not a major time crunch. Preloading a site improves the soil by squeezing water out of the subsurface layers, usually with predictable settlement rates. Preloads have to be carefully designed and staged and water pressures monitored. If placed too quickly, soil failures can be induced. In fact, placing the preload was the biggest challenge for Terasen's Project Manager Vincent Yung.

"The short-term settlement was more than what was predicted during the preloading process so we had to constantly change the timing of placing the preload, the size of the lifts, and the traffic patterns on site," Yung pointed out.

The site was carefully monitored for horizontal movement as well as settlement, flooding and heaving of adjacent low lying sites that has been known to occur in urban areas as a result of preloading. "When we observed unexpected ground cracking in the preload, we had to change our installation procedures, and reinforce the weaker zone with geofabric," he said. "this happened several times."

The first phase of the project was to install a bypass at each end of the 1,500 foot section of pipeline to be replaced. Temporary 16- and 24-inch pipelines were placed above the ground on wood cribbing outside the right-of-way, adjacent to the city of Delta's drainage channel.

Though moving the bypass pipe outside the right-of-way allowed the site to be preloaded almost uniformly, there was still a high voltage transmission tower to deal with. The temporary pipeline had to be carefully monitored against sliding into the drainage ditch, or erosion from the slopes fouling the watercourse. The bypass tie-in shoring was constructed using a combination of sheet piling and lock blocks to provide a safe working space for the welding crews. A temporary bridge was also required near one of the tie-ins to protect the 42-inch GVRD water main and the city of Delta's 42-inch force sewer main.

The site vegetation was flattened to serve as a matt and covered with a 6- to 12-inch layer of sand placed directly over the peat. A geofabric was placed over the initial and subsequent sand layers to improve the stability of the preload. The total preload height ranged from 22 to 28

*Top: Michael Bloom (left), EIT and Vincent Yung, senior engineer, standing near the temporary bypass pipe. **Middle:** Installing a bend section very close to the BC Hydro tower. **Bottom:** "Tell Tales" for long-term, post construction settlement monitoring.*

feet. It was placed in eight stages which took about 20 months, then was left in place for another eight months. During the placement, the pore pressures were continually monitored to ensure that water pressures dissipated before placing more fill. Some of this preload material was used to permanently raise the site grade so the sand was properly compacted. Adequate compaction was also important for stability of the side slopes, and for future trenching work.

Wick drains

To speed up the settlement process, 30-foot-long wick drains were installed at 5-foot centers on a triangular grid. A wick drain has a corrugated polypropylene core surrounded by a stiff, highly permeable non-woven geotextile. It works by allowing water to enter through the fabric and then run down the grooves of the core. This provides many more drainage paths for the water to leave the layer being drained. Preloading alone without the drains only allows water to escape from the top and bottom of the layers. Safety watchers were on site to ensure that the limits of approach were not exceeded when installing the wick drains under the two 230 kV transmission lines. The total settlement from the preloading ranged from 6 to 13 feet.

The loading from the trucks moving around the site during this project caused some instability problems and unpredictable settlement rates. "The tie-ins had to be changed several times," explained Yung. "On the second phase of the project, we had to remove what we were hoping was going to be a longer term shoring system." A major fire in the adjacent landfill also contributed to unanticipated truck loading, and caused environmental concerns that were dealt with to the satisfaction of the stakeholders.

To complicate matters further, a 150-foot tall transmission tower was located in the middle of the right-of-way which prevented Terasen from preloading the site uniformly. The transmission tower was founded on legs made up of groups of 40-foot-long timber piles. These piles support the tower by the friction between the soil and the timber, but are not end-bearing piles so it was important to prevent excessive differential settlement. To protect the transmission tower, Terasen Gas was required to keep the toe of the fill well back from the structure footprint. Terasen built a permanent lock block retaining wall around the tower. The tower did settle about 8 - 10 inches; however, the differential settlement of the legs was limited to about 3 - 4 inches, easily handled by the lattice-type structure.

The 40-foot pipe lengths were supplied by Terasen and installed by MacDonald Ross Construction of Abbotsford, BC. The new pipeline was a 24 to 36-inch, ½-inch thick steel pipe with long seam welds that were staggered between 1 and 2 o'clock and 10 and 11 o'clock to improve the mechanical properties of the pipe. Every weld was numbered, x-ray inspected and epoxy coated. Temporary 'tell tales' similar to settlement gauges, were also installed on the pipe every 60 to 70 feet to monitor post construction pipeline settlement.

To further protect the pipe against the expected long-term settlements of 16 to 24-inches over the next 25 years, the pipe bend thickness was increased to 3/4 inch, and a camber equivalent to about one-half of the predicted long term settlement was installed in the vertical profile of the pipeline. A computer program has been set up to monitor the additional pipe stresses at 52 points along the alignment. Terasen will be watching how the pipe stresses increase during post construction settlement.

This project, as with any that is attempted in the peat bogs of the Greater Vancouver area, had many challenges. In the end, Terasen has a stronger pipeline that will perform well with respect to long-term post construction settlement, potential flooding and possible earthquakes. ■