A little creativity goes a long way with the 12 Kv Distribution Feeder Cable Replacement Project

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Traffic tie ups, soft compressible soils and the possibility of giant floating concrete manholes: These are only a few of the challenges that BC Hydro staff faced when trying to run a new utility infrastructure through an already aging and congested underground corridor.

Add the threat of an earthquake and a nearby fish bearing creek and it becomes clear that building in the peat bogs of B.C.'s lower mainland is tough. Luckily, there were a few engineers that came up with solutions to deal with all of these potential difficulties in building a 12kV distribution feeder system.

When the project first began in January 2001, the feeder system was to run from the Newell Substation in Burnaby (one of the largest substations in the system) to the rapidly growing industrial park in the 'Big Bend' area of Burnaby. The first phase of construction began during the spring and summer months of 2001, and phase four wrapped up in December 2002.

The 4.5 kilometre feeder system is made up of 16 – five inch PVC ducts with manholes averaging every 200 metres - about 40 kilometres of single core cable. The final two kilometres of the job were constructed in soft soil areas.

Engineer Zvonco Petricevic (now retired) did the initial design of the system. Jeff Wilkins, Civil Inspector, surveyed the route two and a half months prior to the beginning of the project, then marked out the location.

Fred Thomson Contracting were awarded the first two and the fourth phases of the project. Hexcell Contracting completed Phase 3, where the soft soils were encountered and most of the innovations to deal with the challenges were developed.

Part of the problem with installing ducts is that for most of their length, the combined weight of the ducts and the backfill is heavier than the same volume of material that is being removed.

Distribution ducts are generally concrete encased, or have steel plates or concrete trench covers placed over them, an expensive procedure that is being re-evaluated. In good soil, it's not necessary except for protection from digging. In poor soil differential settlement can cause the concrete to break and shear the ducts. Adding additional trench protection in this case would have made the system even heavier causing greater long-term settlement, which presents other risks to the system. Using steel is expensive, so BC Hydro decided to take the risk and design the system without the protection.

"We wanted the ducts to move with the ground, and we knew the ground was going to move. Our engineers designed this system to accommodate some settlement, and the possibility of the manholes floating during high water," says Carl Badenhorst, the project manager for the project's final phases.

A number of interesting innovations were worked out between the contractor and the BC Hydro designers and inspectors.

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The ducts were back-filled with sand, separated using spacers and encased in a geotextile cloth instead of concrete. This serves a number of purposes: it prevents the fill from washing away into the soft surrounding soils which would allow the ducts to separate, and it adds strength to the system by stiffening the duct run. Flex joints were designed for connecting the ducts to the manholes using stainless steel couplings and a tough abrasion resistant vacuum hosing. A one-foot extension lip was also cast to make expanded base precast manholes. The lip allows for additional backfill on the manhole to resist the buoyant forces during high water, however it also made for a tight squeeze between the six inch gas main and the eight inch jet fuel line.

Styrofoam blocks up to 750mm thick were placed under most of the manholes depending on the thickness and the depth of the peat being removed. Styrofoam has to be used with caution because blocks that were too big could cause the 13,000 kilogram manhole to float, even if it was partially filled with water. Styrofoam blocks were also used over the duct runs to decrease the overall weight of the backfill.

Finally, as a last precaution, a tough biaxial geogrid, a plastic grid most commonly used in Lock-block retaining walls, was placed .3 m under the pavement, over and area larger than the manhole to spread the upward forces over a larger area.

Soft soils were only one of the challenges at this site, "taking a large structure (the duct is roughly a metre in cross section), through a heavily serviced corridor was my biggest challenge," says Scott Lytle, the project manager for Hexcel Construction Ltd. of Delta, B.C.

"We crossed a jet fuel line three times and had to give three days notice each time. We also had three locations where we crossed or worked beside a BC Gas distribution main, we had to give three days notice for each location," explains Scott. "We had to get permits and a Greater Vancouver Regional District (GVRD) inspector, and provide engineered drawings for temporary support of the gravity sanitary sewer when we crossed it. We ran into at least six abandoned services from five different utilities that we had to stop work for every time to get clearance before removing them. The contractor also had to tunnel under telephone duct banks that entered into a main telephone exchange from different directions which was very difficult.

The vertical alignment of the duct bank also had to be adjusted many times to accommodate the other services that are being added or upgraded. All underground services require a minimum cover, so at times the duct configuration was changed from four rows of four to two rows of eight. This allowed the duct to stay shallow and still have adequate cover when crossing over another utility, and to keep the excavation depths to a minimum when going under.

"The amount of cooperation and coordination involved in the project was simply incredible," says Carl. "The contractor was very careful with his work and his feedback so we were able to incorporate what we learned into the specifications for Phase 4 of the project where we had the most peat and expected the water table to be at or near the surface. We talked over all of the problems that we anticipated with the contractor, which gave them a chance to help solve them."

"This was a case where you really had to use your creativity and work as a team to get things done," says Jeff. "Sometimes it was frustrating trying to figure out how we would get a hold of custom made manholes or the proper type of flex joints, but we always managed to find some way of making it work properly and safely."