Big Bend Substation Project

Powering a community into the future

April 2018

Canadian Consulting Engineering Awards 2018

Big Bend Substation

To address the growing demand for electricity in the Big Bend neighbourhood of southern Burnaby, Wood was engaged by BC Hydro Power and Authority to design and develop a new 69/12 kV substation. In anticipation of growing energy demands, the substation was designed such that it can be expanded in the future to 200 MVA load with supply at 230 kV and distribution at 25 kV. Wood incorporated innovative design solutions to deal with extremely challenging soil conditions, nearby creeks and environmentally sensitive areas, closely located businesses, and integration into a modern business park.

Big Bend Substation Entrance

Innovation

A variety of ground improvement techniques and foundation systems were explored during the initial design to eliminate, as much as possible, the risks and effects the seismically-challenging soil conditions that the project site presented. Compressible soils located beneath the site were estimated to cause long-term settlements of up to 2 m which could not be tolerated considering the need for the substation to maintain post-disaster operability. The site, situated on a slope next to two creeks, was also at risk of destabilization and sliding failure during a seismic event. Wood's project team used an innovative ground-stabilizing technique, structural and architectural design to develop a substation that can be relied on to meet current demand and, with minimal maintenance, remain operational despite settlement with post-disaster functionality.

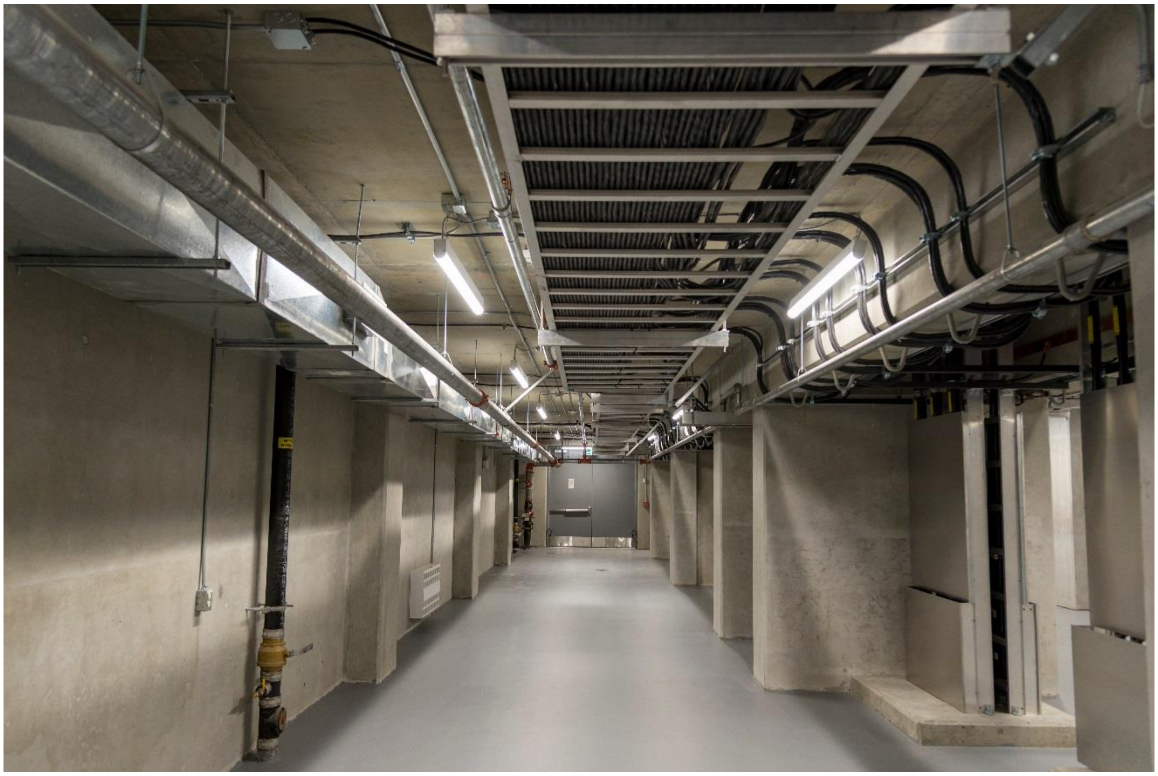
Deep soil mixing (DSM) was chosen as the optimal solution to address the challenging soil conditions. At Big Bend, multiple columns up to 21 m deep were created adjacent to each other to form a large grid of DSM stabilized soil across the site. This grid helps ensure the stability of the site in the event of an earthquake and provides a bearing surface on which above-ground structures can be supported. All structures are supported on large concrete mat foundations which were designed to span onto the DSM grid to ensure settlement is minimized so that substation remains operations. The grid needed to be designed to allow for future expansion without power interruption and to transition to the distribution network. All underground utilities and services such as pipes and duct banks were routed along the DSM grid or had to be designed to span in-between the DSM grid, essentially acting as bridges over untreated soil areas.

Methane generation was the second major concern that added complexities to the design of the substation. All areas with potential to accumulate methane were required to have mitigation measures. Simple spaces such as cable trenches, transformer pull vaults and manholes have simple vents to allow for methane to escape into the atmosphere. For the GIS and Control buildings, a passive ventilation system was chosen for robustness and safety. The design was completed to allow for a future upgrade to a dedicated active ventilation system. A gravel venting layer was placed above the foundation raft with a vapour barrier and slab-on-grade over the top. Perforated pipes embedded within the venting gravel layer collect any accumulating methane and vent it through solid pipes running up through the building into the atmosphere. Backup fans, along with methane detectors support methane removal if methane is accumulating faster than the passive system can dissipate.

12kV Feeder Building and Reactors

69kV Switchyard and Transformers

12kV Gas Insulated Switchgear Feeder sections



Cable entry to 12kV Feeder Buildings

Complexity

The Big Bend Substation Project faced three major challenges: poor soil conditions presented ground settlement and seismic design challenges, the presence of methane gas was a significant safety concern, the integration of the substation into the community and business park provided architectural challenges.

Seismically-challenging soil conditions required the project to perform ground improvement works through a process called Deep Soil Mixing (DSM). This mitigated potential risks and concerns due to ground settlement and seismic stability. The DSM technology required substantial additional thought and consideration during the design phase to ensure the compatibility of the substation and its systems in its interaction with the ground-improvement solution while at the same time mitigating geotechnical risks.

Geotechnical challenges also existed the during installation of a large 26m tall steel monopole to house a new microwave antenna inside the Annacis Substation. Strict antenna alignment tolerances and the presence of liquefiable soils necessitated the use of a large concrete piled foundation. The solution involved the use of a drilled cast-in-place concrete pile with vibration monitoring during installation to ensure vibrations were kept below thresholds which could cause damage to existing structures.

Telecom Tower at Annacis Substation

The soils in the chosen location further generate methane gas which, over time, could accumulate in sufficient quantities to create catastrophic events such as fires or explosions. The rate at which methane is being generated is of such magnitude that all structures containing enclosed spaces (such as manholes and buildings) required mitigation measures to prevent dangerous accumulation levels.

Finally, the business park location presented a unique opportunity to integrate the substation with the surrounding areas through the use and combination of engineering and architectural elements not typically seen in these types of projects and provide an area of recreation.

Social and/or Economic Benefits

The Big Bend Substation, located within a growing business park and situated beside a community golf course, celebrates the aesthetics of electrical infrastructure. The substation includes grounds for a future expansion of the switchyard equipment. Expansion plans are not anticipated in the near future, so these empty grounds could remain an eyesore in the business park for some time. To provide a more cohesive neighbourhood, they were developed into a temporary park that provides public access to trails. The temporary park includes a large grassed area, berms of native plant species, boulevard trees, a winding path, wooden benches and a dry-creek feature for rainstorm drainage. At the trailhead there is a water fountain with bench to complete a good walk and planting was reinstated planting to re-establish access along the creek.

wood.

View of Substation from adjacent recreation area reserved for future expansion.

View of Big Bend substation from adjacent parkland area created for expansion

Security fencing for substations is critical for safety. Open chain link fencing is effective but can be unsightly in large exposed sites. Solid fencing is one solution to this issue, but cutting off visual access to equipment areas is dangerous and can increase the likelihood of crime. To balance these concerns, the design used a secure metal stave fence with intermittent solid panels to break up site lines across the electrical switchyard.

Industrial structures that house the electrical equipment kept their simple form. The materials and detailing provide a continuous unbroken insulated wall and roof system that is both energy efficient and economical. This compliments the building services that are equally efficient, integrating natural ventilation for summer cooling loads and LED lighting throughout.

Environmental Benefits

The Big Bend Substation property is edged by fish bearing creeks and public trails on two sides. As such, erosion and sediment control was an important part of this project. Various measures were undertaken, including:

- Installation of settlement ponds as part of sediment and erosion control.
- Landscaping and trees to reinstate, along with the site developer, public access along the creek ensuring draining during flood events.
- Installation of catch basin liners within the paved portion of the work area.
- Pumping of seepage water collected within excavated trenches to excavated pit (30 m from any storm sewer or waterbody) or to an existing/relic drainage feature.
- Back-filled material in trenches and other work areas was graded and compacted within 24 hours of placement. Only clean aggregate material, free of organics, was used in trench back-fills.
- All stockpiled material located within 30 metres of a storm sewer or waterbody was covered with appropriately anchored (e.g. tires, boulders) plastic sheets.
- Sediment control measures implemented for the project were inspected daily and repaired as required.

The native soil in the substation area also presented concerns in that consists of lowland peat deposits and rich organic deposits that lead to methane gas generation. A design solution was incorporated that included a monitoring and ventilation system below the foundation areas.

The substation was also designed with sustainability in mind. This included the use sustainable materials, LED lighting and natural ventilation for summer cooling loads. The temporary park created in the site marked for future development also provides an environmental benefit to the community.

Meeting Client's Needs

To address the growing demand for electricity in the Big Bend neighbourhood of southern Burnaby, Wood was engaged by BC Hydro Power and Authority to design and develop a new 69/12 kV substation, initially rated at 100 MVA. In anticipation of greater future growth, the substation was designed such that it can be expanded to 200 MVA load with supply at 230 kV and distribution at 25 kV.

Beyond the need to accommodate growing power demands, the client's goals for this project included:

- Ensuring substation can be easily expanded for future growth.
- Ensuring substation post-disaster functionality.
- Ensuring that substation remains operational with minimal maintenance despite settlement.
- Providing community recreation space.

Wood led the project team and in close collaboration with the client, the contractors and geotechnical consultants, introduced innovative solutions to bring this substation into service ready to integrate the substation into the client's transmission and distribution network.

Future expansion plans were implemented into the design such that future connections can be easily made. Post-disaster functionality was addressed through the use of DSM to stabilize the soil and by incorporating venting and other systems to address accumulating methane. Structures were designed to address seismic concerns and were placed on large concrete mat foundations that span the DSM grid to address settlement concerns. Finally, areas reserved for future expansion were repurposed to provide a temporary park that provides access to trails and integrates the substation into the community.