



Enbridge's Norman Wells Pipeline (Line 21)

Slope inspection and monitoring

Pipelines are designed to pass through geographically diverse areas including slopes and other terrain. Enbridge manages these areas by identifying, inspecting, monitoring and, where necessary, remediating slopes where ground movement could impact the pipeline.

Slope inspection and monitoring allow us to assess ground movement in key locations along our pipelines. Slopes identified with the potential for movement, or with known movement, are carefully managed through aerial, ground and in-line inspections.

Where significant movement is observed or suspected, a variety of instruments may be employed to monitor slope movement and subsurface conditions.

These instruments provide important information such as depth, direction and rate of movement as well as about factors that may be contributing to the movement.

Where slope movement is detected, assessments are carried out to determine the effect of the movement on the pipeline. If these assessments indicate that ground movement could adversely affect the service of the pipeline, remediation of the slope and/or pipeline would be carried out.

Some Examples of Slope Instrumentation Equipment

Slope Inclinometer

A Slope Inclinometer is an instrument installed in the ground in a vertical plastic tube or casing. The idea is that the tube moves when/if the ground moves. When a geotechnical expert visits the site, a specialized probe is installed down a borehole. The probe is attached via an electronic cable to a data recorder box and moved through the plastic casing at set intervals. Measurements record the depth and angle from vertical. Readings are taken with the probe on a regular basis and can be compared to previous data.



Slope monitoring instruments on the Enbridge Line 21 pipeline right-of-way near the town of Tulita, Northwest Territories. A variety of instruments are used measure ground movement in key locations along the pipeline.

Thermistor

A Thermistor is an electronic cable with special sensors to measure temperature. It is most often installed vertically into a borehole. Measuring ground temperature allows us to confirm the presence of permafrost, monitor seasonal trends and to estimate the thermal properties of the soil for computer modelling. When a geotechnical expert visits the site, they connect a special readout box to the cable and record the readings.

Line 21 are connected to earth stations which collect, store and transmit the recorded data. Solar panels and batteries power the earth station and the SAAs.

Vibrating Wire Piezometer

A Vibrating Wire Piezometer measures water pressure. It consists of a small metal tube at the end of an electronic cable and is most often installed vertically in a borehole. The metal tube contains a filter which allows water to flow into it and press against a diaphragm. Measuring ground water pressure allows us to monitor seasonal trends and to do computer modelling. These instruments also measure temperature like a thermistor. When a geotechnical expert visits the site, they connect a special readout box to the cable and record pressure on the diaphragm as measured electronically.

Shape Accel Array

A Shape Accel Array is similar to the slope inclinometer, except there are many sensors which stay in the ground and measure an angle from vertical. These sensors also measure temperature like a thermistor. This means a person does not need to visit the site. Spacing between the sensors is pre-set. The SAAs on Enbridge's



An Enbridge earth station with solar panels, batteries, a data logger and antenna. Earth stations are used in remote areas to power slope monitoring instruments which measure and record ground movement.

Photo courtesy of Amec Foster Wheeler