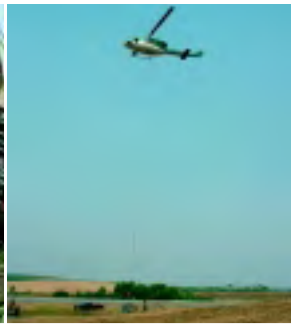
CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

GEOPHYSICAL EXPLORATION PRACTICES

I. Changes in Geophysical Exploration Practices

Changes in geophysical exploration practice are driven by the desire to:

- Reduce timber fibre loss.
- Reduce creation of travel corridors for predators (i.e., wolves).
- Reduce creation of new public access and associated impacts on wildlife.
- Increase rate of re-growth and regeneration to natural vegetation to reduce net footprint persistence of corridor on the landscape.
- Reduce surface disturbance and soil erosion thereby reducing need to seed.
- Reduce concerns with fish habitat by implementation of improved stream crossings.
- Allow access to areas for geophysical exploration which are environmentally more sensitive or which cannot tolerate the impact of conventional seismic.

II. Definitions

Conventional seismic

- Historically, conventional seismic activity used straight, very wide lines to enable access for heavy equipment.
- Historic line widths were approximately 8m wide, with increased widths at turn-around locations.
- Currently anything greater than 5.5m wide is considered conventional, although most definitions also refer to the straightness of the line.
- Construction of conventional lines involved cutting of surface vegetation and removal of stumps, as necessary, and could result in some soil disturbance.

Low impact seismic (LIS)

LIS refers to techniques employed to reduce impact or disturbance and may include some or all of the following:

- Maximum line width less than 5.5m, with typical receiver lines 1.75m wide and source lines between 2.5m and 5.5m wide.
- Line of sight mitigation by meandering of lines, moose blinds, and doglegs at intersections.
- Minimal ground disturbance, including protection of the duff layer, avoidance of rutting in wet areas.
- Non-mechanical line cutting methods such as handout and limbing (1 – 2.5m).
- Low Ground Pressure mechanical cutting methods using cats (3 – 5.5m).
- Mechanical cutting using mulchers or hydro-axe (1.75 – 5.5m).

- Line widths less than 3m require the use of "envirodrills".
- Tracked and low pressure vehicles minimize duff layer disturbance.
- Cost approximately 30-50% higher than conventional depending on line width and timber density.
- Formally defined in Alberta (GFR Policy and Procedures, January 2002).

Heli-assist seismic

- Employed during the recording phase to support ground activities (i.e., move equipment).
- The equipment is deployed to the ground locations using a helicopter and a long line.
- Ground access is required for the other phases (surveying, line cutting etc.).
- Eliminates the requirement for vehicles to travel along receiver lines.

Heli-portable seismic

- Generally considered to cause the lowest habitat impact.
- Helicopters used extensively on the project for deployment of equipment and personnel.
- Shot holes are drilled using lightweight heli-portable drill rigs.
- Lines are usually hand-cut or minimal cut (under canopy cutting), with foot access only.
- Minimal ATV access.
- Distance between drill sites varies depending on program parameters. Typical spacing between source points are approximately 100 m. Drill sites (drop zones) require 4-7m diameter clearings, depending on the tree canopy. Natural open areas or existing clearings are used when possible, but some new drop zones may be required.
- Heli-pads are required for drop-off/pick-up and safety of personnel. Heli-pads are approximately 35m in diameter and are located every 1 km. Natural open areas or existing clearings are used when possible, but some new heli-pads may be required.
- Costs approximately 150% – 300% higher than conventional.
- Formally defined in Alberta (GFR Policy and Procedures, January 2002).

Mechanical-cut lines

- Line cleared by vehicle mounted equipment (e.g., dozer, "cat", gyrotrack, mulcher, hydro-ax).
- Line widths range from 1.75m to 7m.

Hand-cut lines

- Hand-cut lines typically involve 4 man crews, using chain saws or other hand-held cutting device.
- Hand-cut lines are typically 1.75m in width and can be straight or avoidance (meandering).
- Approximate a narrow, infrequently used hiking trail.
- The risk of erosion is minimal (stumps left in place), therefore seeding typically not required.
- A minimum 1.5m width is dictated by BC WCB to allow for stretcher access, unless additional medics on ground with crews (see safety).

Hand-cut methods are typically used in the following instances:

- Heli-portable seismic.
- 3D program receiver lines.
- Riparian management zones (adjacent to stream crossings).
- Line-of-sight mitigation technique (dogleg) crossing major public access routes.
- Identified wildlife corridors.
- Other sensitive areas.
- Typically 150% cost of mechanical cut lines, although costs are very site specific.

Under-canopy cutting/ minimal impact line

- Involves hand-cut, meandering lines, minimal cutting of shrubs, limbing of trees, and zero to minimal breaks in skyward canopy. "Hazard" trees may be felled for safety reasons, or line will deviate to safe side of the hazard.
- This technique is appropriate for receiver lines only. Minimal impact lines are too narrow and "enclosed" (no breaks in the canopy) to provide access for drilling equipment.
- Associated with heli-portable seismic, although may also be used in sensitive areas.
- Essentially "zero" impact, lines are considered to be zero meters in width, trail not identifiable after 1 growing season.
- Requires advanced positioning technology, Global Positioning System (GPS) or inertial guidance technology.
- The reduced line width necessitates additional safety risk management.
- Relatively new technique, not practicable everywhere.
- Costs higher than mechanical cut programs by approximately 200%.
- Defined as Minimal Impact Line in Alberta (GFR Policy and Procedures, January 2002).

Stream crossings

- A Snowfill may be used as temporary stream crossing. The snow is free of debris and the water is frozen to the bottom.
- An Ice bridge may be used as a temporary crossing for larger streams and rivers. The water body is generally not frozen to the bottom.
- A log fill may be used as an alternative to portable free span bridges.
- Stream crossings are constructed in a manner that; will not cause disturbance to the stream banks, preserve the riparian environment and eliminate fish mortality.
- Stream crossings are designed to prevent erosion and sediment load increases.

III. Equipment

Survey – Global Positioning Systems (GPS)

- Conventional survey required a line of sight. GPS technology can accurately produce survey lines/shot hole and receiver line locations (3D) providing the canopy does not prevent the GPS equipment from receiving positioning data from a constellation of satellites.

Survey – Inertial Navigation System (INS)

- Inertial guidance surveying uses a combination of mutually orthogonal accelerometers to detect pitch roll and yaw. This system may use limited updates from satellites but is not dependant on continually receiving positioning data from a constellation of satellites.
- Allows seismic line (source and receivers) to be produced without requiring a line of site.

Survey – Light Detecting and Ranging (LIDAR)

- Method of evaluating and surveying an area from the air. This system provides detailed information about the surface topography and vegetation heights.
- Provides precision survey "pixels" that can be used to navigate under canopy in order to position seismic lines with minimal disturbance of vegetation.
- Can create precise Digital Elevation Models (DEM) which can be incorporated as a seismic planning tool and for future development planning.

All terrain vehicles

- ATVs can be used as transportation for survey, line cutting, drilling/loading shot holes, QA/QC of receivers and recording equipment, line cleanup etc.
- In some cases drilling/loading shot holes may be done with ATV's.
- Typically require a 2.5m line, or open canopy to drive down.

Shot hole drills

- The type of drill rig used in an area will depend on the access, the line width and terrain.
- The drills in increasing widths are as follows: hand drills, heli-drills, enviro-drills, buggy drills, wheeled tandem drills, Nodwell drills, and finally large buggy drills.
- In some cases the ground pressure of the equipment is a limiting factor.
- Drilling costs increase as line widths decrease.

Hydro-axe (Gyrotrack/ Mulchers/ Mowers)

- Mechanical cutting systems which clear brush and small to medium sized (10" and under) trees and reduces them to wood chips and mulch. The mulch is left on the line.
- Relatively popular with local forestry officers because of the reduced line width and rapid revegetation.
- Some issues with mulch being too deep, limiting natural re-growth. Also some concern that the chip-path is provides a good trail attractive to public.
- Lines between 1.75 and 5.5m wide.

Vibroseis

- Terrain and near surface conditions may make vibroseis the preferred geophysical exploration technique (e.g., frozen muskeg, presence of subsurface sand and gravel deposits).
- Typically not be used in areas with steep terrain. In project/ site specific cases vibroseis equipment may be lifted/ winched into a steep terrain area.
- Large Vibrators on 2D lines may require up to 6.5m wide lines depending on tree density and snow loads. On a 3D source line the vibrators generally require 4.5m lines. Smaller vibrators (mini-vibes) typically require a 3m line. Mini-vibes are usually not applicable for geological targets in excess of 1000m.

IV. Use of Old Lines

- Existing lines may or may not be used, depending on level of re-growth (i.e., re-disturbing a recovering line may not be allowed by regulator and/ or can be more difficult to clear because of dense bush).
- Existing lines may not meet the technical objective of the survey (well ties, shot point ties, geometry constraints).

V. Safety

- Narrower, meandering lines may result in reduced access, which introduces additional safety issues such as longer response times for emergency medical care.
- In some cases, WCB regulations may regulate a minimum line width for worker safety.