Pipeline construction: prevention of impacts to agricultural lands

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A variety of methods are available to minimize the adverse effects of pipeline constructions on agricultural lands

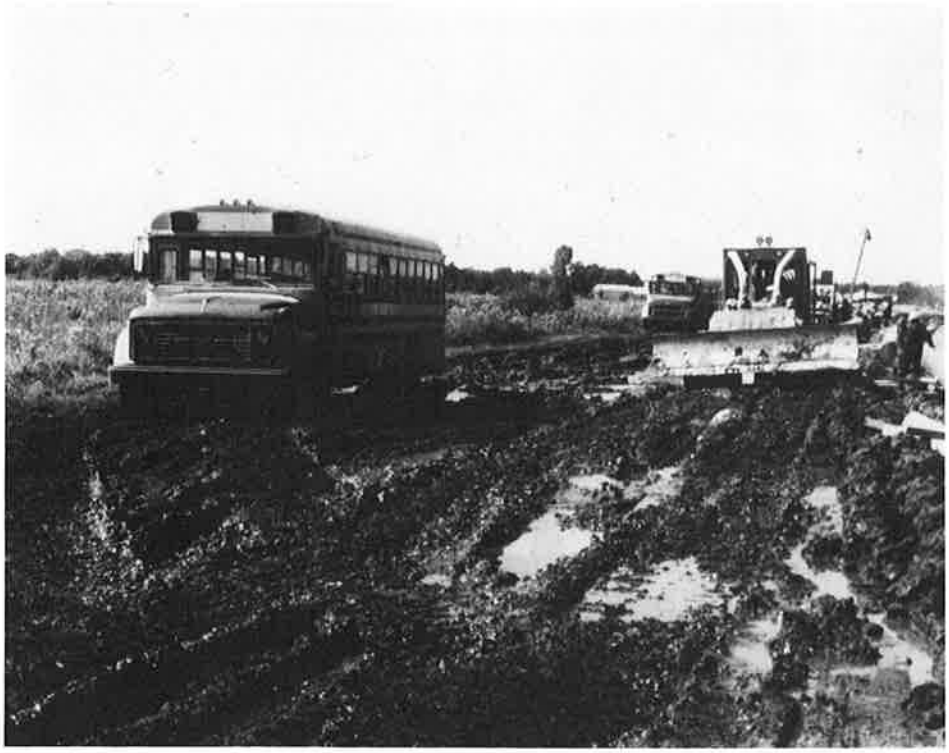
The construction of pipelines on agricultural lands has the potential for causing many adverse impacts. Most of those effects can be traced to improper soil storage and handling, and ground disturbance caused by ditching and vehicular traffic. Organic matter content and, hence, soil fertility are often reduced, while surface and subsurface soil compaction may occur. Those and other impacts often make restoration of the affected lands very difficult.

Potential impacts of construction

Soil compaction and mixing of topsoil with subsoil are the most commonly occurring impacts to agricultural soils (Culley *et al*, 1981) resulting from pipeline construction. The physical characteristics of the soil, its moisture content, and the construction and mitigation methods employed, all contribute to the degree to which a soil will be impacted from construction. Of those factors, soil moisture has the greatest influence on soil compactibility. Research into the relationship between soil moisture and compactibility indicates that the optimum conditions for compaction exist when soil moisture is at or near field capacity[1].

In general, sandy soils are most compactible when their moisture content is about 10%. Loamy and clayey soils tend to compact the most when their moisture contents are between 15-20% and 25-30%, respectively. Studies carried out by Raghaven *et al* (1977) in Québec concluded that clay soils were most heavily compacted when soil moistures ranged from 28-35%.

Although sandy soils are more com-



The right-of-way in this photograph was too wet to withstand the load-bearing pressures exerted by typical pipelining equipment and crew buses. As a result, the right-of-way became severely rutted. Rutting is known to lead to such problems as soil compaction and loss of topsoil.

pactible than clayey soils, it is the latter which under field conditions exhibit the most severe effects of a compacted condition. Those effects can include increased soil density and reduced permeability, which can lead to such problems as ponding of water, decreased root penetration and reduced aeration of the soil. Sandy soils are usually better drained and, therefore, are less apt to display moisture conditions which contribute to compaction.

Soil compaction is known to affect the heat budget of a soil by changing its bulk density, soil/water relationships and soil surface reflectivity (Willis and Raney, 1971). Compacted soils that retain excess water, warm more slowly in the spring, so plant growth can be either retarded or prevented altogether.

Whenever topsoil is lost or mixed with subsoil, concentrations of nitrogen (a valuable plant nutrient) are usually reduced. Phosphorus and potassium ions can also be depleted when topsoil and subsoil are mixed or when excessive soil moisture leaches those ions below a plant's normal rooting depth. Since most of the soil nutrients available to plants occur in the topsoil layer, every effort must be made to conserve or restore topsoil to its pre-construction condition.

Pipeline construction on agricultural lands can cause a decline in the structural stability of a soil. For example, when topsoil and its associated organic matter are stripped from prescribed sections of a right-of-way prior to pipe installation, the exposed subsoil often becomes susceptible to erosion by water and wind. Those forces, combined with the load-bearing pressures of pipelining equipment and operations such as pipe stringing, trenching and backfilling can lead to the destruction of soil structure and aggregate[2] stability in the surface and subsurface layers. Research by Coote *et al* (1981) has shown that almost any decline in the organic matter content of a mineral soil weakens it structurally, which can later lead to such problems as erosion and compaction. Specific studies carried out on Interprovincial Pipe Lines' Sarnia to Montreal Extension indicated that an average 33% reduction in crop yield was attributable to significant decreases in organic matter content of soils subjected to pipeline construction.

In the prairie regions of Canada, where soil salinity has increasingly become a concern, removal of the topsoil layer during clearing and grading can accelerate the migration of subsoil salts (primarily sodium) to the surface due to increased rates of evaporation, especially during the construction period. High levels of those salts can lead to the formation of dense subsurface soil horizons which can impede water infiltration and percolation, as well as root penetration.

Impact prevention and mitigation

The process of minimizing impacts to agricultural lands begins with pipeline routing and construction scheduling. Wherever possible, pipelines should be located on soils which are resistant to the effects of construction. In general, coarse-textured, well-drained soils with the topsoil having a high organic matter content are preferred. Fine-textured, poorly drained soils are highly susceptible to impacts resulting from construction. In addition, the high-quality soils tend to be more easily restored than poor-quality soils.

Construction scheduling is an important component in minimizing soil impacts resulting from construction. Preferably, where the ground normally freezes to a depth capable of supporting construction equipment, pipe installation should be carried out during the winter. Alternatively, work can be undertaken during the summer period when dry soil conditions can usually be expected.

In addition to proper pipeline routing and construction scheduling, a number of methods to be implemented during construction are available to prevent or mitigate adverse impacts. For example, standard practice where grading of the right-of-way is required, is that topsoil should be stripped from the entire area that is to be graded or used for spoil storage. That material is then carefully stockpiled for replacement after construction.

During construction, three separate areas can be identified on the right-of-way. The ditch in which the pipeline is