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Remediation of Hydrocarbon-Contaminated Sites by Monitored Natural Attenuation

Investigate monitored natural attenuation of hydrocarbon contamination as a cost-effective method of cleaning up sites in Alberta's upstream petroleum industry

What is the purpose of this project?

Recent U.S. studies have shown that many petroleum industry subsurface contaminants do not migrate as far as expected. Contaminant plumes often stabilize or shrink due to a series of naturally-occurring physical, chemical and biological processes.

Monitored natural attenuation (MNA) describes how such natural processes reduce the environmental impacts of these contaminants over time and meet cleanup goals without human intervention. These attenuation processes can include dilution, sorption, volatilization, chemical transformation, plant uptake and biodegradation.

The purpose of this five-year project is to evaluate monitored natural attenuation as a cost-effective method of remediating contaminated sites to acceptable environmental levels at upstream oil and gas sites in Alberta. At many such sites, the subsurface soils and groundwater have been contaminated by BTEX, condensate, crude oil, other soluble processing chemicals and salts.

A major focus of this study is to better understand how attenuation processes work in different situations – various contaminants in different soils and geological formations – so as to better predict where this approach will work in a timely fashion. If MNA proves effective, it would offer an economical alternative, in many cases, to more aggressive interventions such as intercepting or excavating the contamination plume. The monitoring aspect of this approach is important to confirm that natural attenuation processes are indeed working, and that contaminant plumes are not threatening nearby landowners or sensitive ecosystems.

How is the project being conducted?

The study's first phase began in 2000 with researchers evaluating data from 124 upstream Alberta sites containing 261 contamination plumes. To help define typical Alberta plumes, this assessment looked at such things as the plume concentrations and size, plume trends in space and time, and migration speed of contaminants at these sites.

The second phase, which started in 2001, involves detailed assessments at four Alberta sites to demonstrate that natural attenuation is occurring. This process includes detailed site characterization, sampling, and biodegradation testing and groundwater monitoring. Ways to enhance the natural attenuation process are also being investigated.

One research focus in 2002 was to improve the model for characterizing what is happening at the average MNA site and to better understand how local conditions such as soil types and temperatures affect the process. As well, sulphates with bromide tracers were injected into one field site and their movement and depletion rates tracked over the summer. Work also continued on gaining sufficient evidence and understanding of natural attenuation to help Alberta Environment develop science-based MNA standards.

What are the results?

The project's first phase was completed and a final report issued in late 2001. The review of historical data from contaminated plumes at the 124 upstream sites showed that, as expected, some 75% of petroleum hydrocarbon plumes were stable or shrinking. Fewer inorganic plumes – mostly chloride but also some sulphate and nitrate – were shrinking while more were growing compared to petroleum hydrocarbon plumes.

In phase two, initial sampling at one site provided excellent evidence that natural attenuation was working, though further confirmatory sampling was needed. The MNA injection test in 2002 provided good evidence of hydrocarbon degradation.

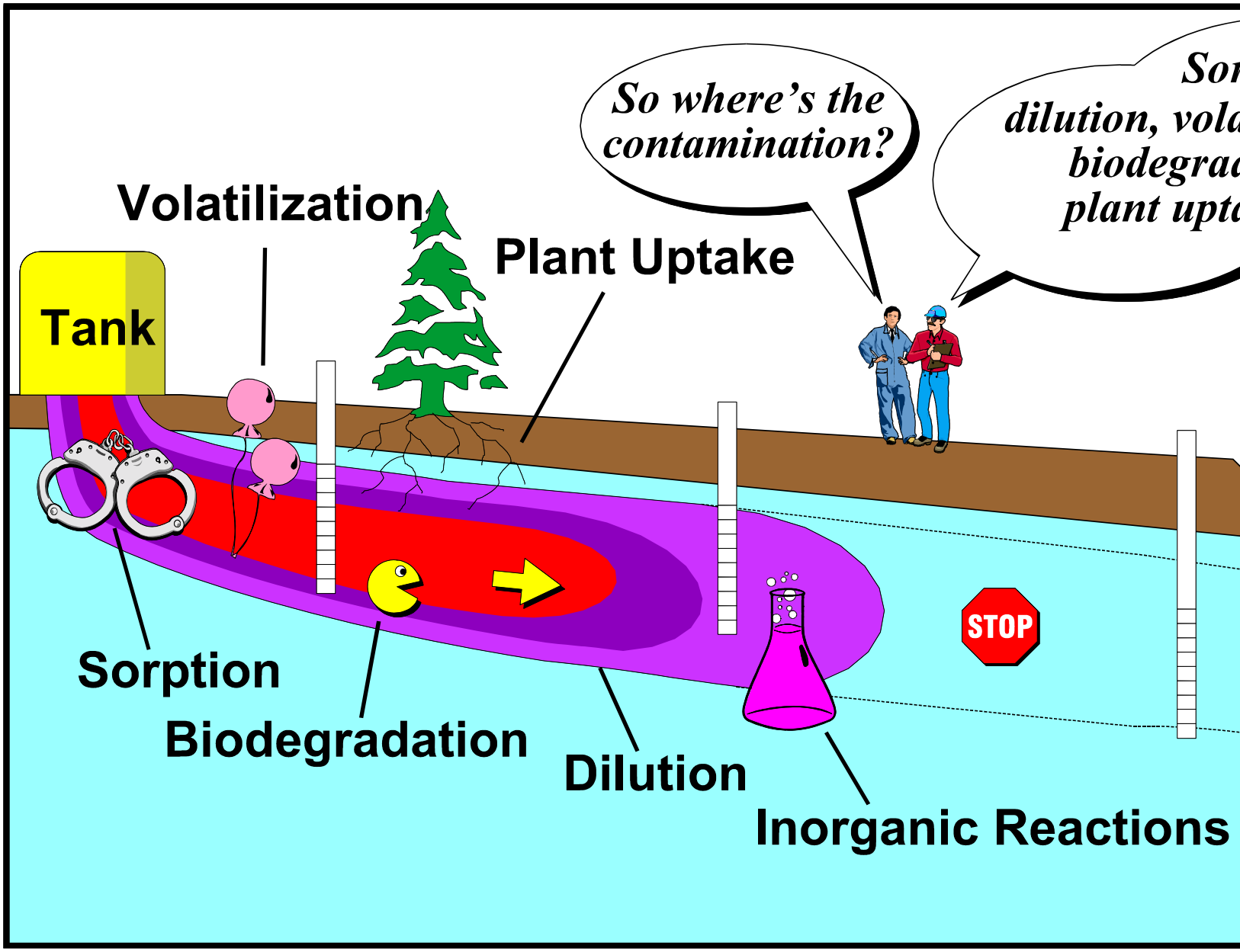
Overall, good monitoring data is being collected in support of monitored natural attenuation as a viable remediation strategy for Alberta's upstream oil and gas industry. Draft guidelines for using MNA in Alberta are being developed.

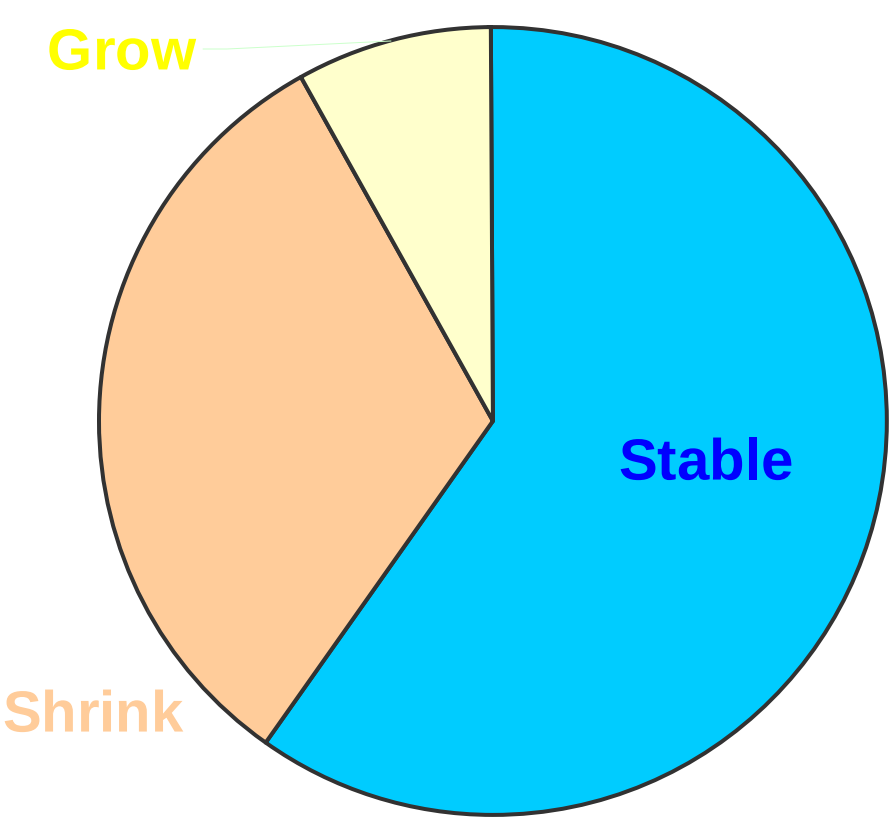
What happens next?

The detailed evaluations will continue for the next two years, with a final report expected to be issued in 2005. Outstanding issues include assessing the effects of co-contaminants such as salts and developing guidelines for how long it takes, on average, for contaminated sites to be considered sufficiently cleaned up by natural attenuation.

Project funding and in-kind support

This study is funded by the Canadian Association of Petroleum Producers, Natural Sciences and Engineering Research Council (NSERC) industrial partners led by Conoco Canada Resources and Devon Canada and Alberta Environment, Environment Canada and Coordination of University Research for Synergy and Effectiveness. In-kind support has been provided by Komex International, Maxxam Analytics, the National Water Research Institute and staff from the Universities of Alberta and Calgary.


So where's the contamination?
Volatilization
Plant Uptake
Tank
STOP
Sorption
Biodegradation
Dilution
Inorganic Reactions



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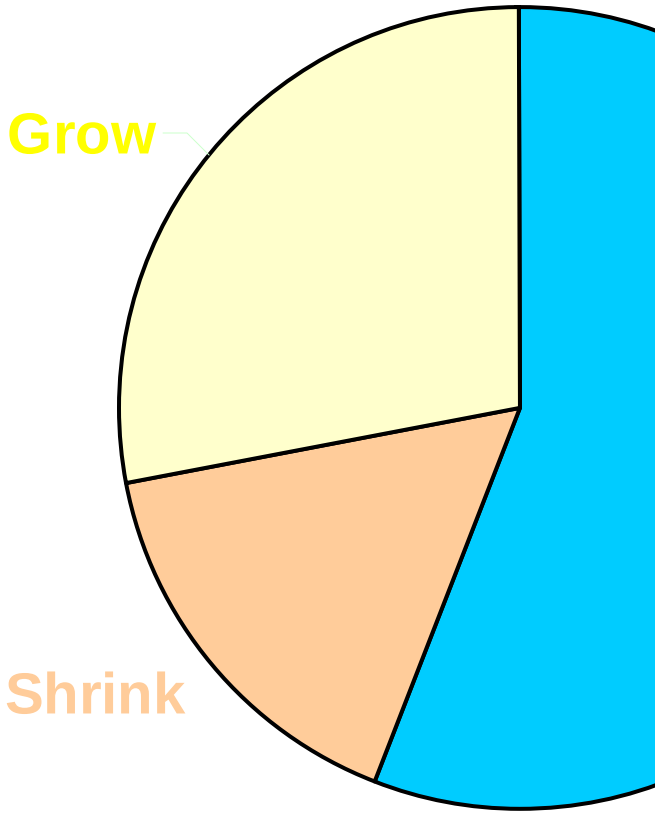

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Plume Trends