Site of July 2019 oil spill in northern Alberta.

SURFACTANT-BASED EXTRACTION PRODUCT HELPS MINIMIZE IMPACTS FROM LARGE SPILL IN ALBERTA

By **George (Bud) Ivey** and **Adam Dunn**

In July 2019, a failure of pump equipment led to the spill of about 320,000 litres of a mixture of crude oil and produced water at an oil storage and processing facility located in remote northern Alberta. As the facility operator reported, approximately 99% of the spilled fluids were recovered, having been contained in an on-site bermed area, which already held about 300 m³ of pooled surface water. Some of the product, however, breached the containment area and was released into the local environment.

Calgary-based Earthmaster Environmental Strategies Inc. was retained to assess cleanup options and implement the remedy for cleaning up the spill. They reported that the liquid product that breached the containment area had flowed down a relatively steep slope (20% – 30% grade) about 180 m to the south-southwest. It was affecting herbaceous vegetation and associated trees and shrubs along its pathway.

An environmental receptor of concern was a small creek flowing near the base of the slope. Released fluids did not enter the creek, but there was some fluid infiltration into the shallow soil horizon and some oil sorption into vegetation and surface debris.

Released fluid consisted of 66 m³ of oil and 254 m³ of salt/produced water. No salt impacts were detected along the spill path, but the contaminants of concern (COC) included hydrocarbon fractions F1 (C6-C10), F2 (C10-C16) to F3 (C16-C34), benzene, toluene, ethylbenzene and xylenes (BTEX).

The steep slope and the presence of merchantable timber, vegetation, leaf litter and organic debris, along with irregular surface contours, presented logistical and safety challenges for efforts to recover the fluid and clean up the area. Further challenges arose as a result of a number of precipitation events, some being significant.

In fact, a storm was predicted to dump about 150 mm of rain two days after the spill. This prompted Earthmaster to delay the selection and implementation of a final cleanup remedy while it prepared for the storm. The firm installed several lined bell-shaped holes to catch runoff

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from the rain.

The application of LIDAR (light detection and ranging) remote sensing following the storm, confirmed that the bell holes were properly placed to prevent liquids from reaching the stream. As it turned out, they were also used for the final remedy chosen, which was flushing, or washing, as opposed to excavation and off-site disposal of the affected soil.

Excavation and removal is a common solution for many spills into the environment, but it presented several prohibitive challenges at this site, because of potential environmental damage. Deforestation of the hillside would have brought about erosion problems and a sedimentation threat to the nearby creek. There were cost issues as well, including a requirement to pay upwards of $50,000 or more for the lost timber to the holder of the forest management agreement that covered the hillside.

Bioremediation and chemical oxidation were also deemed to be impractical for this particular spill. Bioremediation would not have addressed spill migration, which threatened the waterway, and ongoing monitoring and laboratory services would have been extended for several years and been very costly. Stoichiometrically chemical oxidation is also very costly when used to address free-product spills. It has the potential to kill vegetation, and requires special PPE handling as a hazardous material.

Fortunately, sampling at the site showed that the oil/water mixture that escaped from the containment area had coursed down the hill rather than penetrated into the soil to any significant depth. So, the consultant decided that it could "do a flush" rather than a "scrape", which, more precisely, was passive and active surface flushing, rather than excavation and off-site disposal.

> **"Ivey-sol has the unique ability to selectively desorb contamination at low application concentrations from surfaces, including free-product layers.**

A surfactant-based remedy was thus deemed optimal, and due to the remediation contractor's familiarity with the Ivey-sol® surfactant product developed and marketed by Ivey International Inc. (IVEY), that product was chosen for the cleanup job. It is biodegradable, pH neutral, non-caustic, non-corrosive, and free of undesirable impurities.

The Ivey-sol surfactant-enhanced extraction (SEE) products consist of a series of non-ionic formulations that can selectively desorb sorbed contaminants and render non-aqueous-phase liquids miscible in the aqueous phase.

SEE products achieve three goals. Surfactants overcome the "limitation" challenges associated with contaminant sorption and solubility. Then, they lower the relative surface tension of water, thereby improving its wetting and associated hydraulic conductivity properties. Finally, through their selective dissolving of COCs below the critical micelle concentration (CMC), the surfactants broaden the range of contaminants that can be treated. Thus, they enhance in situ and ex situ physical, biological and chemical remediation.

These surfactant products are non-toxic and readily biodegradable, so they do not persist in the environment after application. This can be verified with field surfactant test kits developed by IVEY, and by using any of three U.S. Environmental Protection Agency laboratory test methods.

The products have some disadvantages that careful application can overcome. For example, their effectiveness may be diminished if the surfactant/water mixtures freeze during storage, and their deployment may suppress volatile organic compounds, making them less detectable by standard, handheld vapour meters.

Based on the understanding that sorption and free-product formation greatly limit the "availability" of contaminants for remediation, Ivey-sol has the unique ability to selectively desorb contamination at low application concentrations from surfaces, including free-product layers. This means they are more available for physical treatment, as evidenced by this challenging yet positive site application.

The Alberta Energy Regulator approved the use of the Ivey-sol technology at the

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Views of area near Bell Hole 3 before and after flushing with the surfactant.

spill site. The client preferred it to environmentally destructive excavation alternatives.

At the spill site, the surfactant was deployed in varying concentrations, using various delivery methods in a roughly checkerboard configuration. The first trial was completed using backpack sprayers (with a surfactant-to-water ratio of 1:30), followed by pressure-washing.

There was not enough volume in this trial, however, to move the oil to the recovery bell holes for removal. In order to increase pressure and volume, the surfactant and water were mixed in the tank of a small hydrovac truck at a 1:40 ratio for the second trial and applied using the pressure wand. The oil could be recovered with this application with the right technique, but would splatter if too much pressure was used.

In the third trial, another surfactant-to-water ratio of 1:40 was mixed in the hydrovac truck tank, and the tank hose was used for application rather than the pressure wand. The surfactant effectively washed the oil off the vegetation using this application.

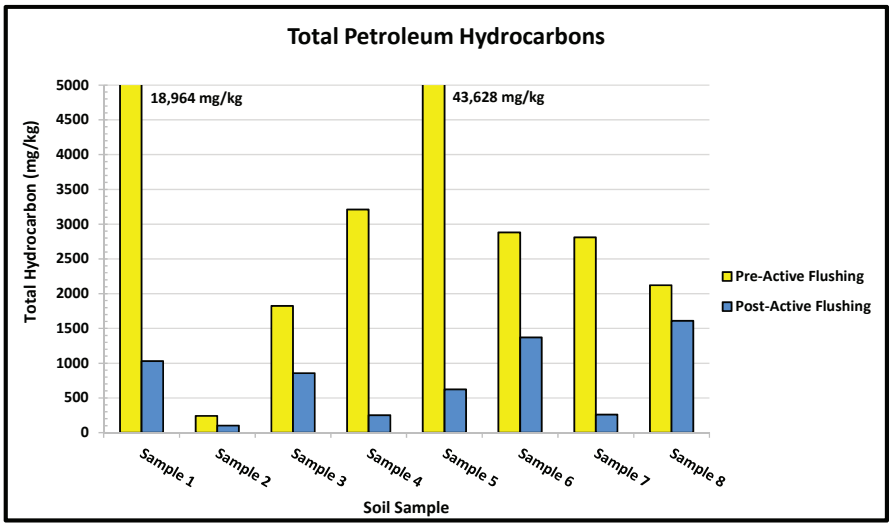
However, there was not enough pressure to move the fluid to the recovery bell holes, and suds were being produced. In order to optimize oil recovery and surfactant usage, ratios of 1:60 and 1:80 were applied and small local trenches were dug to collect and recover fluids.

The surfactant was applied over the course of four days, and the majority of the oil on the hillside was effectively liberated and flushed into the trenches and bell holes for removal. Visual observations indicated that the cleanup operation was generally effective, and soil sampling confirmed these findings.

Earthmaster decided that some heavily impacted areas where the leaf litter and vegetation was saturated with oil did not warrant the amount of surfactant and time required for complete removal. As a result, the contractor completed the remediation via surface soil/vegetation removal in these areas.

The flushing operation did not necessarily save much time compared with the typical spill response operation. But, it did realize significant cost savings in terms of avoiding the removal of merchantable timber on the hillside and the option of excavating and landfilling impacted soil and vegetation.

Cleanup crews flush forested impact site with Ivey-sol® surfactant.



Total PHC Bar Graph.

According to Earthmaster, there were numerous factors affecting project costs, and it was difficult to precisely quantify the cost savings attributable to choosing the flushing operation. The contractor estimates, however, that those cost savings could have been upwards of several hundred thousands of dollars. In light of this consideration, plus the avoidance of environmental damage, the Ivey-sol surfactant-based solution was deemed a sustainable success.

"In July 2019 we were faced with a 320,000 litre crude oil and produced water spill at a facility in northern Alberta," said Adam Dunn, vice president of operations at Earthmaster Environmental. "With our rapid spill response strategy, utilizing the Ivey-sol surfactant remediation technology, we achieved significant time, cost, and environmentally sustainable cleanup benefits, resolving more than 99% of the spill on the hillside." ■

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**Recently, Ivey International Inc. won a Top 10 Environmental Technology Solution Providers 2020 Award from Enterprise Technology Review, a U.S. media company, in recognition of their technological innovations.*

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