IN-SITU BURNING OF OIL SPILLS ON LAND: A CASE STUDY

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Introduction

In recent years, in-situ burning of oil spills at sea has gained favour as an effective, efficient response technique (Allen and Ferek, 1993). Much scientific effort has been expended on understanding the physics and chemistry of in-situ burning (Evans et al, 1992). What is not generally known is that in-situ burning has been used as a response technique for spills on land for many decades (Gormley, 1993). Unfortunately, most operational details, the circumstances leading to a decision to burn a spill, and the documentation of the effects of in-situ burning on land are never recorded or, if recorded are lost. This paper describes the events leading up to a spill, the measures taken to mitigate the effects of the spill, and the factors that should be considered before making a decision to burn.

Spill Scenario

On June 15th, 1990, a valve leading from the salt water treater to the production tanks at a tank battery site was left closed (Figure 1). Oil normally heading to the production tanks flowed back to the pop tank, entered the gas leg of the separator and ended up in the flare pit normally used only to flare gas and light hydrocarbons. Oil periodically reached the flare pit in this manner during these or other upset conditions. Since the facility had been acquired recently and had not yet been brought up to company standards there were no emergency shut down facilities or alarms in place. The closed valve was not detected until the following day when a contractor noticed oil on the lease. It is believed that oil was flowing into the flare pit for about sixteen hours before the spill was discovered. The flare pit overflowed allowing about 100 m^3 of oil on to the lease. Recent heavy rains inundated the area flooding the bermed areas (including the flare pit) and washed out dikes surrounding the battery site. Consequently, between 40 and 100 m^3 of oil escaped the diked area and entered a small stream that drains into a nearby bog of about 5 acres in area. Imperial Oil management, BC Forestry, the Ministry of the Environment and the Ministry of Mines, Energy and Petroleum Resources were informed of the spill.

Environment Canada. Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, 17th Proceedings. Volume 1. June 8-10, 1994, Vancouver, British Columbia, Environment Canada, Ottawa, Ontario, 651-655 pp, 1994.

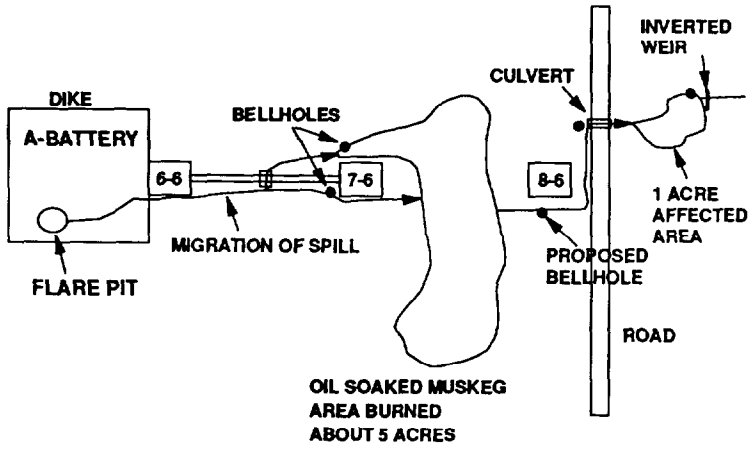

Figure 1. Drawing of Land Spill Site (not to scale)

Initial Spill Response

When the spill was discovered, the facility was immediately shut down. Containment was put into place and repairs were made to the battery dikes to prevent additional oil from escaping the lease. The oil travelled about 1450 metres downstream through the bog and was stopped with an inverted weir. A system of bellholes was constructed allowing recovery of the oil by draining the bog. By 2:00 p.m. on June 16, the first day of the spill, it was clear to the on-scene commander that the water level in the bog was approaching a level that would result in oil saturating the underlying peat. Recovery of the oil was suspended and water flow from the stream halted to maintain the level in the bog. Officials from the Ministry of the Environment, BC Forestry and the Ministry of Natural Resources were invited to tour the site in an effort to convince them that conventional recovery techniques would result in greater environmental damage and longer reclamation time than would an in-situ burn. In anticipation of approval, a cat operator was instructed to start construction of a fire guard and a dike around the area. This had the additional beneficial effect of raising the water level in the bog. By 9:00 a.m. of the second day of the spill approvals were received from all government agencies. Imperial Oil management was informed of the spill and the decision to burn.

Preparations

A ten to twenty foot wide fire guard was constructed completely around the site. Pumps and hoses were distributed around the site using a four-wheeled ATV, and tank trucks of fresh water for fire fighting were located near the site in case of secondary fires. Because of the recent rains, the fire guard promptly filled with water indicating that the soil was fully saturated. Another fire guard was constructed around a stand of spruce trees in the centre of the spill area. A preliminary burn was conducted to test its effectiveness and to familiarize the crew with the response technique. The main burn started at 2:45 p.m. of the second day of the spill. A small amount of gasoline was used to help ignite the oil.

Burning Operations

By 2:55, the fire had generated enough heat to affect power lines in an uncontaminated area within the fire guard. The fire was suspended until the power lines could be disconnected and the fire restarted without incident. Burning continued until 9:00 p.m. by which time the majority of the spill had been burned. A fire watch was left on the site overnight to check for hot spots and to maintain the water level on the site.

On the third day of the spill, spot burning of the remaining oil continued. The gasoline used for ignition proved to be hazardous so was changed to a 1:1 mixture of gasoline and diesel. The operation then changed to a mopping up phase. Absorbent pads were used to remove the remaining oil and residue and were subsequently burned. Brush was cleared by a crew with chain saws and likewise burned. Water was drained from the bog and used to wash oil from the stream. The slash and burn operation proceeded for the next ten days. After this, the site was cleaned up using a cat. This involved filling in ditches and bellholes and re-contouring the site. An absorbent boom was placed downstream of the inverted weir (Figure 1) to collect any residual oil. Water samples were taken during and after the cleanup, and oil was detected neither at the boom nor in the water.

Site Reclamation

On the fifth day of the spill, new vegetation appeared on the site, indicating that the burn had no significant negative effect on soil biota. The site was seeded and fertilized once about two weeks after the end of the cleanup. After a site visit the following spring indicated that the vegetation was recovering and no oil was apparent either on the site or in the stream, an official from the Ministry of the Environment agreed that no further reclamation of the site would be necessary.

Visibility and Media Attention

On the second day of the spill, a spill was reported on Boundary Lake, an important migratory bird habitat. A crew was dispatched but nothing was found. The smoke from the burn was visible over 50 kilometres away and calls to the local radio station on the third day of the spill resulted in the spill being a topic of discussion on a talk show. Since this was a regular workday none of the Imperial Oil personnel was aware of this. The local Ministry of the Environment spill response official went on the radio to defend the cleanup method used, pointing out that greater environmental damage would have resulted if conventional techniques had been used.

Safety Concerns

As mentioned above, gasoline used as an accelerant was considered to be too hazardous. A less volatile mixture of gasoline and diesel was used without incident. Although the fire took place in a wooded area, secondary fires were not a problem due to the saturated conditions. Some spruce trees beside the site were burned and some poplar trees within twenty feet of the fire later died from heat stress, but by and large, the surrounding vegetation was not affected by the fire. The issue of greatest concern was the use of chain saws in the slash and burn phase of the cleanup. One contractor narrowly missed serious injury when the saw he was using contacted the safety leggings he was wearing. After this the use of leggings was emphasized at daily safety meetings.

Ironically, shut down of the battery facility caused two other spills. Due to improperly functioning pressure control switches, the pumps at two well heads continued to operate, over pressuring and rupturing the flow lines leading to the battery site. Fortunately, the resulting spills were not large.

Cost of the Cleanup

Approximately 60 k$ was spent on the cleanup, predominantly on manpower. About 5 k$ was spent on seeding and fertilizing the area, giving a total cost of 65 k$. In comparison, a conventional cleanup would have cost about 250 k$ and would have taken the entire summer to complete.

Follow-up Actions

The entire battery site has been rebuilt to Imperial Oil standards. This includes the installation of alarms and safety devices as well as implementation of guidelines for emergencies and maintenance schedules.

A site visit is scheduled for 1994 to survey the site for any residual oil and to examine the recovery of vegetation.

Burn Decision

It is always desirable to remove the oil from a spill site by conventional means, if for no other reason than to save the value of the oil. However, there are cases when conventional recovery techniques will have only limited success. Traditional recovery rates in peat bogs is on the order of 15%. In addition, the environmental damage resulting from long term operation in a conventional operation would greatly exceed the short term effects of burning. The decision to use burning must be made quickly to avoid unnecessary environmental damage. The criteria to be used should include the dryness of the area, proximity to buildings, availability of heavy equipment and fire protection equipment. On a spill of this size, it is important to appoint one person as liaison with the government agencies, relieving the supervisor of this time-consuming responsibility.

Conclusion

This example of in-situ burning on land demonstrated that this response technique is safe and effective. The technique requires adequate safety precautions and relatively calm winds. Moist conditions decrease the risk of secondary fires and soil damage. The effect on the environment is negligible and the site is restored to an acceptable state in relatively short order.

References

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