Diesel Spill Scenario

Barge Spill in the Columbia River near Hood River

Setting

A single-hull oil barge carrying 25,000 barrels of diesel fuel is proceeding upriver 12 miles past Bonneville Dam. Another vessel traveling down river has steering difficulties and crosses the navigation channel where it tears a gash in the barge hull just below the waterline, penetrating two center tanks containing a total of 262,500 gallons. Tanks in the bow section are protected by the location of the oil barge in the tow with a cargo barge out front. Product immediately starts flowing out of the damaged tanks. There is no risk of igniting the diesel fuel.

The accident occurs in the reservoir behind the dam. Surface water flow is westerly at about 0.6 knots (1 ft per second or less). Winds are 20 knots across the river from the south, and wave action is a 1 to 2 foot chop.

The width of the river between the spill site and the dam ranges from 2,500 to 5,000 feet with depths greater than 50 feet in the main channel.

Impact Issues

This area of the river is used extensively for recreational boating, fishing and wind surfing. A fish ladder at the dam allows salmon and other fish to migrate upstream. There are two fish hatcheries on the north shore of the river downstream of the spill site.

Key variables affecting the eventual (residual) impact of the spill are the dynamics of flow in the river (flow and mixing energy), time of year in relation to recreational use and salmon migration, and downstream habitat.

Spill Characteristics and Behavior

The spill occurs rapidly, with the barge losing an average of 30,000 gallons per hour as water flows in and displaces oil in the tanks. Within four hours after the accident, salvage actions reduce the rate of oil loss to less than 10,000 gallons per hour, and portable pumps brought to the site by the response team begin transferring product at rates up to 1,000 gallons per minute from damaged tanks to available space in tanks on the undamaged side. Within 6 hours the spill is over and no oil remains in the damaged compartments.

The total volume spilled into the water is 140,000 gallons or 53% of the contents of the two tanks affected by the collision.

The product evaporates relatively slowly (compared to gasoline), and a large proportion of the spill remains on the surface of the river to spread downstream at close to the same rate as the surface water flow (about half a knot). At the same time as it drifts downstream, the spill quickly spreads laterally with wind and wave action, moving towards the north shore at between 0.5 and 1 knot. As it spreads under current and wind forces, the diesel oil breaks into elongated strips and patches (called windrows) on the surface.

Over 24 hours an estimated 10 to 15% of the spill has evaporated Up to forty percent of the oil remaining on the surface is dispersed and held in suspension in the river as fine droplets within a mile of drift away from the spill site. Dispersion is greatly aided by wave action and low viscosity, both characteristics of this scenario. A much smaller proportion of the spill (in the order of one percent or less) is dissolved into the water. A portion of the dispersed oil resurfaces near-shore in calmer areas.

Note that actual measurements of dissolved hydrocarbons beneath oil slicks are relatively rare and most examples in the literature are for slicks at sea. McAuliffe (1986) quotes values of less than 0.1 ppm for short periods while there is still a defined slick present on the water; Payne et al. (1980) measured up to 0.1 ppm of benzene, toluenes, xylenes and other low molecular weight hydrocarbons in seawater samples taken immediately beneath a thick surface slick by an offshore blowout of crude oil.

Within two hours of the spill, long patches of thin oil slicks and sheens (very thin films in the order of four millionths of an inch thick) are visible within one mile downstream of the spill site, and along the north shore of the river. The soluble fraction of the spill has mixed to within the upper ten feet of the river but away from the immediate vicinity of the barge, the actual concentrations of dissolved hydrocarbons fall rapidly to much less than 1 part per million (ppm) as the surface slick breaks up through wind and wave action.

As the spill proceeds, dispersion and spreading (and to a lesser extent evaporation) continue such that product is only visible as isolated patches on the surface and along the shoreline beyond two miles downstream. At this stage in the spill, there is evidence that a portion of the diesel fuel is forming stable water in oil emulsions, which increase the overall volume, viscosity and persistence of the oil on the surface. At the same time, the formation of emulsions significantly reduces the volume of oil, which is available to be dispersed into the water column. Emulsions will "stick" to shorelines but the degree of penetration into the sediments is also greatly reduced as a result of the increased viscosity. This emulsified oil tends to remain static in physical properties and appearance for hours or days after it strands onshore, facilitating mechanical recovery.

Immediate Response Actions

Immediately following the collision, and once the safety of all crew members is confirmed, the tug pushes the tow across the river and securely grounds the damaged barge in shallow water near shore. At no time, is the barge in any risk of sinking or overturning even with two tanks flooded on one side.

Calls go out within fifteen minutes to all of the required agencies, dam operators. fish hatchery operators and other commercial concerns along the river, as well as Tidewater's own response organization. Spill and safety response is coordinated between the agencies unified through the Incident Command System (ICS).

Once the barge is safely secured near-shore, booms stored onboard the tug are deployed around the site of the hull rupture to collect the escaping diesel product. The crew assesses the damage and makes preliminary efforts to slow the leak by introducing available materials in an effort to plug the hole. Further salvage and transfer actions wait for the fully equipped response team and trained tankerman to arrive. The nearest empty oil barge in the system is directed to the scene to standby as needed to receive recovered product skimmed from the water and/or transferred product from the damaged barge. Estimated time of arrival for this barge is four hours.

Response teams mobilize gear to assist in plugging the leak, portable pumps and hose, oil boom and skimmers and travel to the site. The nearest pre-staged equipment stockpiles to the spill site are at Tidewater's maintenance facility in Vancouver WA. Sundial Marine Shipyard in Troutdale OR, and the Port of Hood River maintenance yard.

Within two hours of receiving word of the spill, response teams arrive and implement a site action plan. Sensitive areas downstream are identified through existing contingency plans and geographic response plans. Diversion booms or protective booms are deployed to keep oil away from critical areas such as wildlife habitat, hatcheries and fish ladders.

Using portable pumps, crews begin transferring product from the damaged tanks into available space elsewhere on the oil barge or into other tanks such as empty general cargo barges in the tow. They launch the spill response boats, deploy additional boom around the barge and begin skimming operations to recover contained product on the water. Other response crew members and contracted diving services work with the tug crew to plug the leak and slow or stop the outflow of product using equipment and materials brought to the site and stored onboard the tug.

These actions result in full boom containment at the site within three hours (supplementing booms already deployed by the tug crew), initiation of transfer pumping out of the damaged tanks within four hours, and a reduction in the leak rate by two thirds (from 30,000 to 10,000 gallons per hour) within four hours after the accident.

By the time the spill is finished (six hours after the accident), crews have recovered 72,000 gallons (51% of the oil spilled) by containing with booms and skimming alongside the barge. Other clean-up operations are still under way to recover any oil, which stranded onshore. In addition, crews are dispatched to collect any oil, which fetches up against the dam further down river.

Within 72 hours of the spill, an estimated 25% of the oil, which drifted away from the barge, is mechanically recovered from shorelines downstream from the site. The total recovery effectiveness is calculated as 62% (volume recovered/volume spilled). An estimated 15% of the total spill volume, 21,000 gallons, is removed through natural processes (primarily evaporation). In all, the combination of mechanical recovery and natural processes remove 77% of the total spill volume. The remaining oil is present in thin films, sheens and dispersed droplets, which are not considered practical to recover.

Post-Emergency

Once the spill has stopped and the barge is safely removed, crews assess damage and any evidence of residual emulsified diesel, which may be trapped near shore or onshore. Minor accumulations are visible as viscous patches stranded along the waterline for up five miles. Clean-up continues until all of the oil physically available is recovered from the environment. Diversion and protective booms are maintained for as long as there is any evidence of oil moving downstream or any potential for oil to lift off the shoreline further upstream and drift into sensitive areas.

Expected Consequences

The exact consequences of any oil spill depend on a wide variety of factors including the success of mechanical recovery operations, degree of natural cleaning, type of oiled habitats and wildlife presence and life cycle at the time of the spill.

The following general comments are derived from a summary of the natural recovery of cold water marine environment after an oil spill, prepared by a number of world recognized scientists led by Dr. Jennifer Baker (1990). These comments are not intended to provide a comprehensive review of oil spill effects, only to highlight a number of important points regarding a range of long term impacts, which could occur in the light of past experience.

Most of the toxic components in a spill of fresh petroleum product on the water surface evaporate with time. Remaining toxic components from surface marine spill dissolve and disperse in the water column to low concentrations.

Oil does not penetrate easily into fine sediments along the shore but can sink into shingle, gravel and course sand. Microbial degradation is an important process contributing to the eventual disappearance of residual oil from the marine environment. Residence times for oil in the sediments are highly variable depending on the type of shoreline, oil viscosity, wave energy etc. It is possible for small quantities of weathered (relatively non-toxic) oil to persist in sheltered backwater areas for periods of years. Natural recovery through colonizing organism can begin in the presence of residual oil one the toxicity or other adverse property of the oil has declined to a tolerable level. The actual toxicity of hydrocarbons remaining in sediments can vary widely depending on the organisms, oil composition and extent to which the oil can be degraded naturally.

Kills of adult fish from exposure to oil are rare in the oil spill literature (exceptions would be rockfish and shellfish in ocean settings, and fish in aqua farms). Losses of pelagic eggs and fish larvae when present at the time of a spill have had no detectable impact on long term fish stocks.

Given the opportunity for mixing and dispersion of residual oil over a wide area, and within a massive volume of water (relative to the spill volume) it appears unlikely that there will be any lasting environmental effects as a result of the spill described in this scenario.