*15. IMPACTS OF A 7,400-GALLON SPILL OF NO. 6 FUEL OIL ON LAKE WINONA

DISCOVERY OF THE SPILL

On April 15, 1979, when Lake Winona was about 25% ice-free, an oil slick was observed in open water near the municipal bathing beach. Some of the oil appeared as a sheen, but most of it resembled tar.

It was speculated that the oil was No. 6 fuel oil, and that it had entered the lake through a submerged storm sewer. It was obvious from a storm sewer map that the Winona State University (WSU) heating plant was the only user of such oil in the affected storm sewer sector. On the afternoon of April 15, Winona's Director of Parks and Recreation notified the U.S. Coast Guard (USCG), the Minnesota Pollution Control Agency (MPCA), and the U.S. Fish and Wildlife Service (FWS). The MPCA subsequently examined the WSU heating plant and found that the oil had accidentally escaped into the storm sewer with boiler blowdown water and that the oil had escaped unnoticed because it had entered the lake under ice cover.

University officials referred the USCG Marine Safety Office to the State of Minnesota Architect and Engineers Office. The State of Minnesota refused cleanup responsibility, and at that time the USCG forwarded a notice of federal action via a telegram. Under the auspices of the USCG, a federal removal activity thus began at 1120 hours on April 16.

Most of the lake's ice cover was gone by April 16. The magnitude of the spill was then realized and its first ecological impacts were seen. The spring migration of waterfowl was in full force, but FWS personnel successfully rallied most ducks with motorboats and kept them off the lake. Because of these efforts, less than a dozen ducks (golden eyes) were known to have been killed. Six pinioned Canada geese, which had been introduced into the lake, were also killed. It was not possible to clean the heavy oil from any of the birds, and all those that came in contact with it died. (Fig. 15-1).

THE CLEANUP

The St. Paul-based Fuel Recovery Company (FRC) began to remove oil from the lake on the afternoon of April 16. As the black, tar-like oil was warmed by the sun, it became less viscous, and much of it was corralled by skirted booms and pumped into tank trucks. Additional oil was gathered with straw and absorbent pads, and the offending storm sewer was flushed to ensure that it did not contain more oil.

*Extracted from an article by Calvin R. Fremling published in the Proceedings of the 1981 Oil Spill Conference, March 2-5, 1981, Atlanta, Georgia.

By April 18, the lake was free of ice, most of the oil had been cleaned up, and the recovery company left. On April 20, however, more oil was seen. The normal sheen was present, but hundreds of globules of oil from 1 to 12 inches in diameter were seen floating at the surface, and others were observed rising slowly from the lake bottom. Often, a large globule which was resting on the lake bottom would extend upward as far as 3 ft to the surface of the lake as a sinuous, snake-like strand. As it touched the surface, a sheen of lighter oil was released.

Surveys revealed that the globules were rising from the area around the storm sewer outlet and that they were being distributed throughout the lake by the wind. Although the globules remained intact as long as they were in the water, they stuck to everything they touched. Globules were also observed to sink again after they had released their sheen of light ends. The movements of the oil resembled those seen in "lava lamps".

On April 29, large quantities of oil reappeared on the surface of the lake. On April 30, an assessment of the situation was made by the federal On-Scene Coordinator (OSC), and the State of Minnesota again declined its option of assuming the task of removal or contracting for cleanup. The State did, however, assure OSC representatives of its intention to pay cleanup costs.

The FRC was rehired for cleanup at 0800 hours on May 1. In addition to the continued efforts of the FRC and the Winona Parks and Recreation Department, the USCG Atlantic Strike Team was requested to advise and assist in the continuing cleanup and removal efforts.

Oil continued to rise from the lake bottom, however, and it was obvious that a significant reservoir of sunken oil existed in the deep area off the end of the storm sewer. On May 11, using SCUBA, the author and another diver located the end of the submerged storm sewer (a 24-in. corrugated metal pipe, 110 ft. from shore) in 6 ft. of water and followed its outfall pattern out into the lake to a depth of about 20 ft. The outflow from the sewer had scoured a trench about 2 ft. deep into the lake bottom and the trench was full of heavy oil. The path of the oil, which continued outward into the lake toward an adjacent deep area, branched repeatedly and there were puddles of oil along its course. The oil could not be seen readily because it was covered with silt and detritus, but glossy, black domes and strands of oil protruded upward through the silt. The slightest swimming movements disturbed the oil and it billowed upward, covering the scuba gear, the lenses of face masks, and diving lights. Thus incapacitated, further exploration had to be postponed (Fig. 15-3).

Figure 15-1. Canada goose covered with oil. Waterfowl mortality was minimal because U.S. Fish and Wildlife personnel frightened birds off the lake with motorboats.

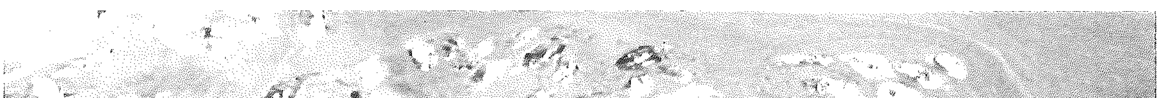

Figure 15-2. An estimated 190,000 bluegills died between May 30 and June 8, apparently because of a stressed-caused infection by <u>Flexibacter</u> <u>columnaris</u> bacteria.

Figure 15-3. Diver covered with oil. A 1,700-gallon pool of heavy density oil was discovered on the lake bottom by SCUBA divers.

On May 13, commercial divers were called in. A large on-shore pump enabled the heavily-weighted divers to rest on the lake bottom while they "vacuumed" the area with hoses. The resultant slurry of oil, silt, detritus, and water was pumped to an on-shore tank where it was allowed to separate (Fig. 15-4). By May 24, diver surveys indicated that most of the sunken oil had apparently been recovered and the operation was halted. The FRC estimated that it removed a total of 5,800 gallons of oil from the lake during its entire operation, 1,700 gallons of which were from the lake bottom.

Routine cleanup operations with straw and absorbent pads were continued on a daily basis by city employees until August 24. Under contract with the USCG until June 1, 1979, they removed an additional 1650 gallons of oil, based on an estimated 5 gallons of oil per 1.5 cubic yard of straw removed. In spite of using high pressure sprays of water along the entire shoreline, it was impossible to recover the tar-like fraction which painted an 18-inch wide band around the 3.6 mile perimeter of the lake basin. Also, a portion of the light fractions undoubtedly evaporated, and some heavy oil became incorporated with benthic sediments.

BIOLOGICAL AND AESTHETIC PROBLEMS

On May 30, large numbers of dead and dying bluegills were seen floating on the surface of the affected lake basin. On the basis of shoreline samples, it was estimated that about 190,000 bluegills died between May 30 and June 8. The kill, which also affected a few crappies (Pomoxis nigromaculatus), continued with lessened severity through July 22 and was confined to the affected basin. No dead fish were observed in the upper basin. Examination of the dead fish revealed the pathology associated with the bacterium Flexibacter columnaris, which is a common cause of dieoffs among crowded, stressed fish. It was the consensus of area fisheries biologists that the sunken oil had probably added a critical stress to the spawning bluegills which were already stressed from winter conditions, crowding, and the rigors of nest building and spawning. Bluegills scour out saucer-shaped nests in the lake bottom when they spawn, and this activity probably brought them into direct contact with sunken oil. Because other species of fish were not affected, it seemed likely that the oil may have irritated the pharyngeal areas of the bluegills and provided a portal for bacterial infection. Bacterial infections of fish have been previously associated with spills of heavy oils (Brown, 1980).

The surviving bluegills grew rapidly during the ensuing two summers and it was obvious that their accelerated growth rate was because of reduced competition from the dieoff. Interviews with anglers revealed that the oil did not cause taste or odor problems in the flesh of any species of fish from the lake. No laboratory studies were done, however, to determine the uptake of oil by fish.

Figure 15-4. Heavily-weighted SCUBA divers with dry suits used hoses to remove heavy density oil from the lake bottom. The oil was sucked upward by a pump on a pontoon boat and piped to a temporary storage container on shore.

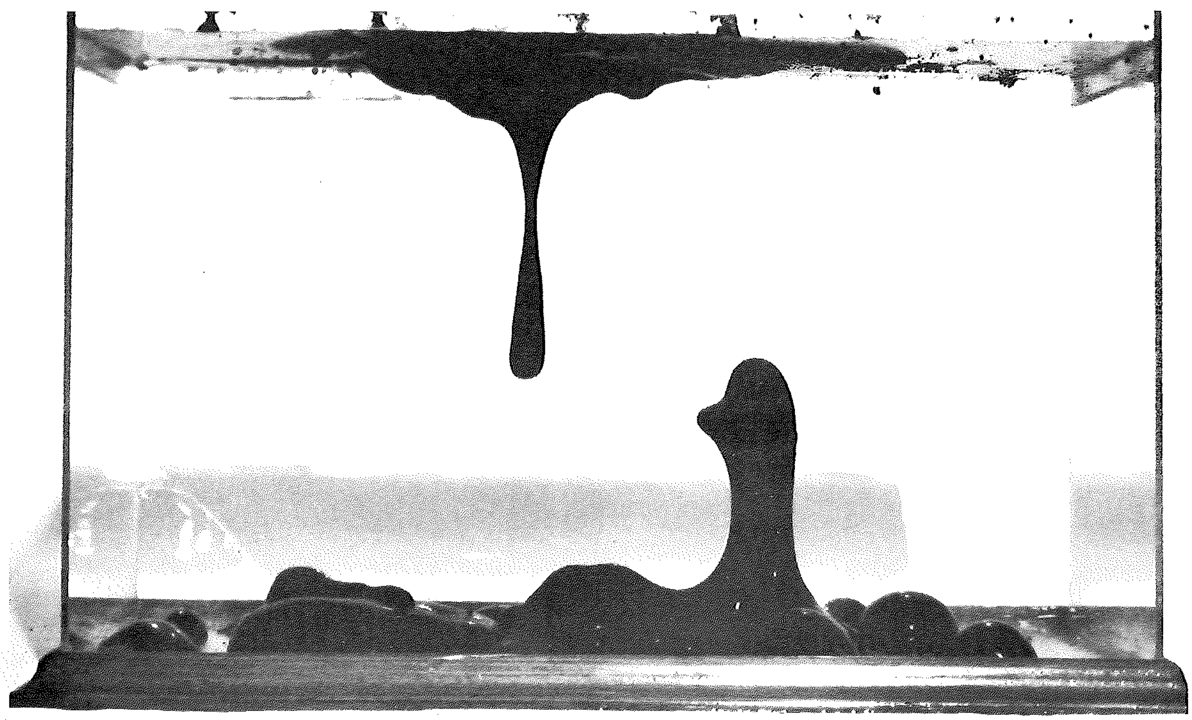

Figure 15-5. Aquarium simulation of oil behavior in the lake showed that complex factors caused oil density to change, causing it to alternately rise and sink.

The oil was a chronic problem during the summer following the spill and it did serious aesthetic damage. The swimming beach was kept open by cordoning off the area with floating absorbent booms and skirted booms. Oil-saturated beach sand was trucked away and replaced. Oil and dead fish became entangled in a lush growth of aquatic plants (Potamogeton crispus) and the plants had to be cut before the oil and fish could be removed. Because the spill occurred when the lake level was high, a black ring was left along the rip-rapped sections of the shore when the water receded. All efforts to remove the ring have failed.

CAUSE OF THE SPILL AND BEHAVIOR OF THE OIL

During the year following the spill, it was possible to determine the exact causes of the spill and to explain the unusual behavior of the oil. No. 6 fuel oil is so viscous that it must be heated to about 120°F to make handling possible. Before it is injected into the burner, the oil is pumped at a pressure of 100 pounds per square inch (psi) through heaters which raise its temperature to 220°F. Each oil-filled heater contains a bundle of low-pressure steam tubes which contains blowdown steam at a pressure of 10 psi. During the winter of 1978-1979, a steam tube ruptured in one of the heaters, allowing oil to enter it. There, under reduced pressure, the oil partially fractionated into lighter and heavier components that trickled with condensate into a sump below the heating plant. A pump then mixed the fractions with water and air, and poured the slurry into the storm sewer that led to the lake. The temperatures in the storm sewer (50 to 60°F) were sufficient to keep the mixture moving as a semifluid. As it moved along the sewer, the mixture entrained sand, and as it entered the lake, its temperature dropped to about 39°F, causing the heavy fraction to assume a tarlike consistency. The leakage of oil apparently occurred over a prolonged period, but went unobserved because the spill occurred under the ice cover of the lake. Also, because the heating plant burns as much as 6,500 gallons of fuel per day during cold weather, the small daily loss was not noticed.

Laboratory tests showed that the No. 6 oil had a specific gravity of 0.986 - virtually the same as water. Distillation in the laboratory revealed, however, that 30 percent of the oil existed as a light fraction that had a specific gravity of 0.928, and that 70 percent had a specific gravity of 1.066. Because the oil entered the lake as a mixture of fractions, the oil was not homogeneous. Mixtures floated if they contained sufficient quantities of light fraction, but as the black mixtures were warmed by the sun they became less viscous, the light fraction escaped, either as a surface sheen or by evaporation, and much of the heavy fraction sank (Fig. 15-5). As the lake slowly warmed, heavy oil mixtures at the lake bottom also became less viscous and their light fractions flowed slowly upward through the oil mixtures. Thus buoyed, globules of the tarlike mixtures ballooned upward to the lake surface where the buoyant light fraction was released as a sheen, enabling the globules to sink again.

The situation was further compounded by entrained sand that weighted the oil down. As long as the depths of the lake were cold, the sand-oil mixture remained intact. As the lake warmed and the oil became less viscous, however, the sand was able to sift slowly downward through the oil until, relieved of its ballast, the oil floated to the surface. Laboratory studies showed that these processes were very slow and often required several days to occur--even at room temperatures.

The four Helixor aeration units in the affected basin were run all summer to circulate the lake, thus warming its depths in an effort to purge the lake of residual oil. This seemed to have been very successful throughout most of the basin.

Forty-three Ekman dredge samples were taken through the ice the following winter and they showed that small slugs of heavy oil were still intermixed with bottom sediments near the outlet of the storm sewer. The slugs of oil were commonly found within 75 feet of the outfall, but no slugs were found at distances over 100 feet.

During the second summer (1980), a few small floating globules of oil were seen near the sewer outfall, and minor oil sheens appeared during mid-summer, but they caused no serious nuisances. Fishing and other recreational uses have returned to normal, and only a black ring around the lake and an occasional sheen remind users of the spill that occurred in 1979.

COST

The State of Minnesota ultimately paid the entire federal removal activity cost($103,714.77). The state was also assessed a USCG civil penalty of $3,500 for polluting public waters.

MEASURES TO PREVENT RECURRENCE

Blowdown boiler water is now discharged into a municipal sanitary sewer instead of a storm sewer. In the event of future oil losses, a slick would be quickly observed in the primary settling tanks at the Winona sewage treatment plant. Also, a newly constructed visual inspection basin allows a check for oil in the blowdown water with each shift change of heating plant personnel.

ACKNOWLEDGMENTS

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