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The Hagersville Tire Fire February 12 to 28, 1990

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INTRODUCTION

Between February 12 and March 1, 1990, fire consumed several million scrap rubber tires in an outside storage yard near Hagersville in southern Ontario. The fire had a significant negative impact on the local communities, agricultural activities and the environment. The column of dense smoke generated air-borne pollutants and led to the evacuation of a zone of 3 kilometre radius around the site. Oil, created by the breakdown of the heated tires, spread into the soil and surface water and reached the groundwater aquifer. The fire fighting resources of the local community were exceeded and an extensive organization of local and provincial government agencies was needed to assist in the management of fire suppression activities.

With the permission of the Fire Marshal of Ontario, a staff member of the National Fire Laboratory, a research laboratory of the Institute for Research in Construction of the National Research Council of Canada, visited the site on February 28 and March 1, 1990. Since the fire was declared extinguished on February 28, the purpose of the post-fire visit was to obtain general information that will contribute to an improved technical understanding of the fire hazards presented by outdoor scrap tire piles. This report summarizes observations on the nature of the fire and the suppression efforts.

SITE DESCRIPTION

The Tyre King tire dump is located on 6.9 hectares of land in a rural area near Hagersville, Ontario, which is about 35 kilometres south of Hamilton. The terrain is generally flat but well-drained, with agricultural fields or pasture land neighbouring the property on all sides. A layer of clay-based soil approximately 1 metre deep covers the limestone bedrock. Surface water drains from north to south across the property to a small creek (Sandusk Creek) located 300 metres.south of the property. Sandusk Creek drains into Lake Erie, and serves as a water supply for agricultural enterprises along the way.

Figure 1 shows a sketch of the Tyre King property, based on a 1:2000 scale aerial photograph of unknown date (Appendix A), and on measurements taken by the Ontario Ministry of Natural Resources at the time of the fire. The storage area measured 200 metres by 300 metres, or about 6 hectares, less approximately 1 hectare of land occupied by the residence and Quonset hut work shop. Thus, the tires themselves covered approximately 5 hectares. An informal road provided access to the west side of the pile and two transverse alleys divided the pile into three distinct sections. The transverse alleys are estimated from the aerial photograph to have been between 3 and 5 metres wide. There was no substantial fencing around the property.

The height of tires in the piles before the fire varied. Some mounds were reported to have been up to 7 metres high, but the average height was reported to be about 4 metres. In some piles, tires were densely interlocked, and, in others, randomly oriented. There is some uncertainty about the number of tires on the site. The owner reported that, based on his records, there were 12 to 14 million tires. However, attempts to estimate the number of tires using assumptions about the volume of space occupied by an "average" automobile tire suggest that there may have been considerably fewer than 12 million tires on the site. Assuming that all tires were heavily compressed (which would only be the case for tires deep within the pile) and arranged in the best packing order, a density of 40 tires per cubic metre might be possible. Piled 4 metres deep over 50,000 square metres, the total number of tires would be in the vicinity of 8 million.

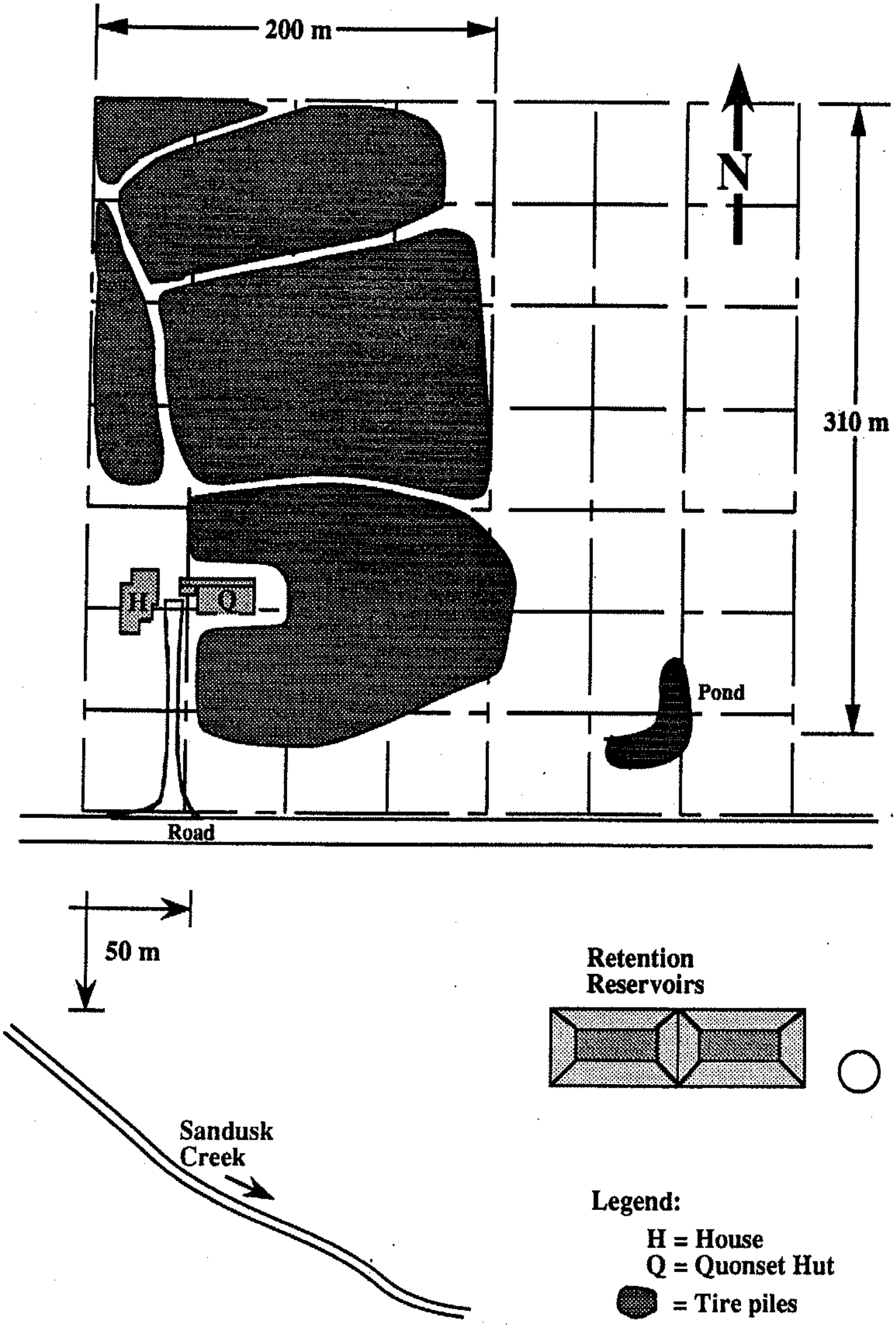


Figure 1: Plan of Tyre King scrap tire storage yard, Hagersville, Ontario. Taken from sketch prepared by Ontario Ministry of Natural Resources staff at time of fire.

There was no permanent water supply for fire fighting purposes available on the property. A small dugout pond located 250 metres east of the owner's house was a potential source of water for first responding fire fighters.

FIRE SPREAD

Ontario Provincial Police suspect that the fire was deliberately started, on February 12, in the northwest corner of the pile. It spread rapidly. By the end of the first day all 5 hectares were involved. The fire easily jumped the two internal separating alleys, evident in the aerial photo, probably aided by the wind. The owner reportedly asked arriving volunteer fire fighters to move trucks and hoses into one of the transverse alleys, in order to stop the advance of the fire but the fire fighters concluded that they would lose their equipment if they moved into that location, and did not do so.

Newspaper photographs taken during the daytime show an enormous column of dense black and gray smoke rising from the fire. In these photos, the visible flames appear to rise no more than a metre or two above the tires. Persons who were present during the night, however, report that much higher flames could be seen inside the lower portions of the smoke column. Radiant heat from the smoke column was probably intense. On the upwind (west) side of the fire, however, several piles of tires were within 2 metres of burning tires but did not ignite; also a number of trees located within 3 metres of burning tires showed only scorching on one side. Further, the owner's house was located on the upwind side within 15 metres of burning tires, but showed no signs of heat exposure. (Fire did spread into and consume tires stored inside the Quonset hut, probably through an open door at the rear of building.) Fire fighters reported that a crust of ash and wire which covered the edges of the burning piles acted as a shield against horizontal radiation from the intense heat deeper within. Where such a shield formed, horizontal radiation at ground level was probably not as severe as a few metres higher above the ground.

Since the fire spread for the most part in the direction of the prevailing wind, but less so in the upwind direction, it is possible that convective as well as radiant heat transfer were significant mechanisms of fire spread across the two transverse alleys.

FIRE SUPPRESSION

During the first seven days, volunteer fire fighters limited their suppression efforts to the perimeter of the pile, because of the intense heat and because of their inability to reach the centre of the pile with either hose streams or equipment. On February 17 and 18, Ministry of Natural Resources fire fighters and equipment were moved onto the site, and forest fire fighting techniques were adopted. Heavy equipment was used to construct access roads, two on the west and north sides of the property, and one into the southeast corner. A "geo-textile" fabric was laid on top of the native soil, and suitable clay-silt fill was used to construct the road surface. The flat terrain and frozen ground facilitated construction of these roadways. A steeply sloping site, a ravine filled with tires or a muskeg soil condition would not have been as suited to the use of the heavy equipment needed to construct access roads and later to overhaul the piles.

Nine tanker trucks were occupied in transporting water from lakes or ponds up to 7 kilometres away. On one better-than-average day, 286,000 litres of water were trucked to the site. The need to control the run-off of the fire fighting water became the controlling factor in managing this fire. The rate at which water could be applied to the fire was limited to the rate at which the run-off could be impounded, skimmed of oil, and pumped into tanker trucks. At one point, when the run-off collection capacity was exceeded, a pump and irrigation piping were installed so that run-off could be sprayed back onto the property through irrigation spray nozzles. The already-contaminated site was therefore used to retain surface run-off, thus permitting more water to be applied to the fire.

Apart from exposure protection of the residence, fire fighting actions involved overhauling the ash and cinders left after the bulk of the tires had burned off and the heat from the fire had diminished. Starting from the outside edges and working inward, a large backhoe would dig into the pile and pull out still unburned tires. Fire fighters located on each side of the backhoe would direct hose streams into the ash and onto the backhoe to cool it. Plain water was determined to be less effective than foam in extinguishing the flames. A mixture of 0.3% concentration of a chemical foaming agent in water provided the best "steam generating" characteristics, and would stick to the vertical surfaces of the backhoe arm. Steam would expand within the bucket-load of ash and tires and suffocate the flames. Once extinguished, the piles of ash and wire and the few unburned tires were spread out in wind-rows by bulldozers. There was concern about re-ignition of these wind-rows so they were repeatedly sprayed with foam.

A water bomber aircraft such as is used for forest fire fighting was available. Due to below-freezing temperatures, however, it was only able to fly two days out of 16, so it was not a major factor in bringing the fire under control. On those days when it was used, the water bomber took its water from nearby Lake Erie, which was free of ice-cover some distance out from the shore. Backhoes first broke the pile apart, then the water bomber dropped a 0.3% concentration of foaming agent in water on the flames. Flames were knocked down for a few minutes, then would flare back. Fire fighters report that hand-held hose streams were more effective in achieving extinguishment.

Fire fighting operations on the ground were difficult. Fire fighters had to wade through deep, oily mud, wearing self-contained breathing apparatus at all times. Surgical gloves were worn under their heavy work gloves to prevent absorption through their skin of potentially harmful chemicals in the oil. Provincial Ministry of Labour safety representatives ensured that safe practices were observed by all personnel on site. Fine wire and cable left after the tires had burned became tangled in the tread mechanisms of the bulldozers and backhoes, which created a concern that one of the machines could "throw" a tread and be stranded in the fire area.

Fire fighting operations continued for 12 hours per day, cycling two teams of fire fighters for 6 hours each. The exhausting nature of the work, the hazards of smoke, oil and mud for the fire fighters and of the wire getting caught in the machinery made it hazardous to continue operations at night.

Overhaul operations began in earnest on February 19th, after the first week of the fire, and advanced into the pile at an average rate of 0.5 hectares (1.2 acres) per day. Overhaul continued to February 28, when the last mound of ash was overturned and extinguished. Only two or three small piles of unburned tires remained, one on the west side, and another at the southwest corner of the property. Almost all of the tires were burned off, leaving only a few small mounds of ash and steel, and oil-contaminated soil.

ALTERNATIVE SUPPRESSION STRATEGIES

Two alternative approaches to controlling the tire fire were considered impractical in the circumstances at Hagersville. One alternative involved burying the burning tires under a layer of sand or other granular soil. Apart from the difficulty of locating and transporting sufficient volumes of soil, it would have been very slow work to safely spread soil over 5 hectares of burning tires. It was also feared that the additional soil would be contaminated by oil, which would greatly increase the cost of post fire clean-up of the site.

A second alternative involved a technique called grouting that has been used for fires in piles of mine waste and other porous refuse. This technique involves pushing pipes into the heart of the pile, then pumping fly-ash, portland cement or a liquid slurry into the internal voids. In the case of densely stacked steel-belted rubber tires, it was anticipated that it would be extremely difficult to force a pipe into the pile. In addition, concern about increasing the volume of contaminated material to be removed from the site and treated made this alternative less desirable than the approach actually used.

ENVIRONMENTAL EFFECTS

Since almost all of the tires on the site were consumed in the fire, most of the pollutants created by the fire went into the atmosphere as smoke. Long term monitoring will be required to determine if fallout of particulates from the smoke on the adjacent homes and farm lands will have any negative effects on either humans, livestock or plants in the vicinity.

A great deal of oil was released from the burning tires. It is possible that because of the intense heat and unrestrained burning in the interior portions of the property (away from the fire fighting activity at the edges), much of the oil was burned away. Still, significant quantities of oil either ran off with the fire fighting water or soaked into the soil on the site. Trenches were dug and sand-bag barriers laid to direct run-off to ponding areas, where oil was skimmed from the surface and collected in tanker trucks. About 700,000 litres of oil had been collected by the time the fire was extinguished, and about twice that volume of contaminated water. Oil and water were trucked to nearby refineries for treatment. Monitoring of surface water quality in Sandusk Creek has indicated that contaminants (benzene and toluene, among others) have reached the creek. Observation wells have been drilled around the property to monitor the quality of the ground water, as it was feared that oily water may have penetrated the clay overburden and entered fissures in the limestone bedrock.

Long term environmental monitoring will be required to determine the extent of damage to the ground and surface water. The Ontario Ministry of the Environment has constructed two large retention reservoirs in the field between the Tyre King property and Sandusk Creek. All surface run-off from the site will be collected in the reservoirs, skimmed of oil, and put through carbon filtration units before being released into the creek.

Samples of air, water and oil were tested for the presence of dioxins. Chemical analysis of run-off water and oil from past tire fires in the United States had not indicated the presence of dioxins, so it was unexpected when very low concentrations of dioxin were found in the Hagersville samples. Although the small concentrations of dioxins may not create a significant health hazard in the long term, the presence of even small amounts of such toxins in the oil, water and smoke appear to justify the safety precautions taken by fire fighters in terms of breathing apparatus and skin protection. Further analysis of the products involved in manufacture of tires is needed to determine the actual source of the dioxins detected near this fire.

COSTS

Volunteer fire fighters who first responded to the Tyre King property soon realized that they lacked the manpower and equipment to sustain the extended operations required to gain control of the fire. Mutual aid from the surrounding municipalities was also found to be insufficient. Volunteer fire fighters in rural communities are not usually called away from their jobs for such extended fire fighting operations. Ultimately, an organization involving the local municipal government, adjacent municipalities providing mutual aid and later provincial ministries, was put into operation. Various levels of government responded sequentially as local resources reached their limit. The Ontario Ministry of Natural Resources eventually provided 35 forest fire fighters who were able to supplement the local volunteers. The Ontario Office of the Fire Marshal provided support equipment for refilling air tanks for breathing apparatus and advisors and safety specialists to assist the on-site operations. The Ministry of the Environment began measures to minimize air and water pollution. Public Health and Agricultural ministries responded to manage the impact of the fire on the evacuees, concerned neighbouring communities, and the agricultural enterprises located within the zone of influence of the fire. The provincial government provided the financial support to pay for manpower, tools and equipment and office and communications facilities, for the duration of the incident.

Although the Hagersville fire crisis management organization was handled by the Province of Ontario, several federal government agencies were prepared to assist as well. Environment Canada, Agriculture Canada, the Department of Indian and Northern Affairs (there are two Indian reserves near the site, which are under federal jurisdiction), Canada Health and Welfare and the Department of National Defense are a few of the federal agencies which committed significant resources in following the progress of the fire and preparing to assist the province if requested. The National Fire Laboratory of the National Research Council provided a consultative service to other federal agencies, contributing information received from fire researchers in other countries on tire fires, and advising on the role of Canada's model Fire Code in regulating outdoor tire storage facilities.

The total cost of providing the supporting organization, fire fighters, equipment and materiel needed to fight the Hagersville tire fire is not yet known, but it will certainly be in the millions of dollars. Additional costs will be incurred over the next year, at least, as environmental monitoring of surface and ground water continues and the contaminated soil on the site is removed and treated. If the groundwater aquifer has been permanently damaged, local farms which depend on it for watering livestock may suffer significant financial hardship. Costs will also be incurred as provincial and federal regulatory governments focus on the matter of regulating outdoor tire dumps to prevent future incidents of this magnitude.

The perception of having been the victim of a major environmental trauma will persist for some time in the attitudes of the local communities. Some dairy and poultry farms in the vicinity are reported to have already encountered a reduction in the marketability of their products. It is difficult to estimate the long term cost that these negative effects will have on the communities affected.

DISCUSSION

The Hagersville fire confirmed that burning rubber tires are difficult to extinguish and that they present a serious risk of air, surface and ground water pollution. Even when tires are packed densely in deep piles, there is ample air within the pile to sustain combustion. The overlapping tires and intense heat prevent water or foam from reaching the seat of the fire. It is even difficult to push pipes through the pile so as to inject suppressants into the seat of the fire, because of the steel bands in tires.

Burying burning tires under clay or sand may appear to stop combustion, but heat will be trapped under the covering soil and rubber will continue to break down into oil. The oil will follow natural surface drainage paths out of the pile or into the groundwater aquifers. Final overhaul and rehabilitation of the site will inevitably require removal and treatment of the contaminated clay or sand covering as well as the contaminated native soil.

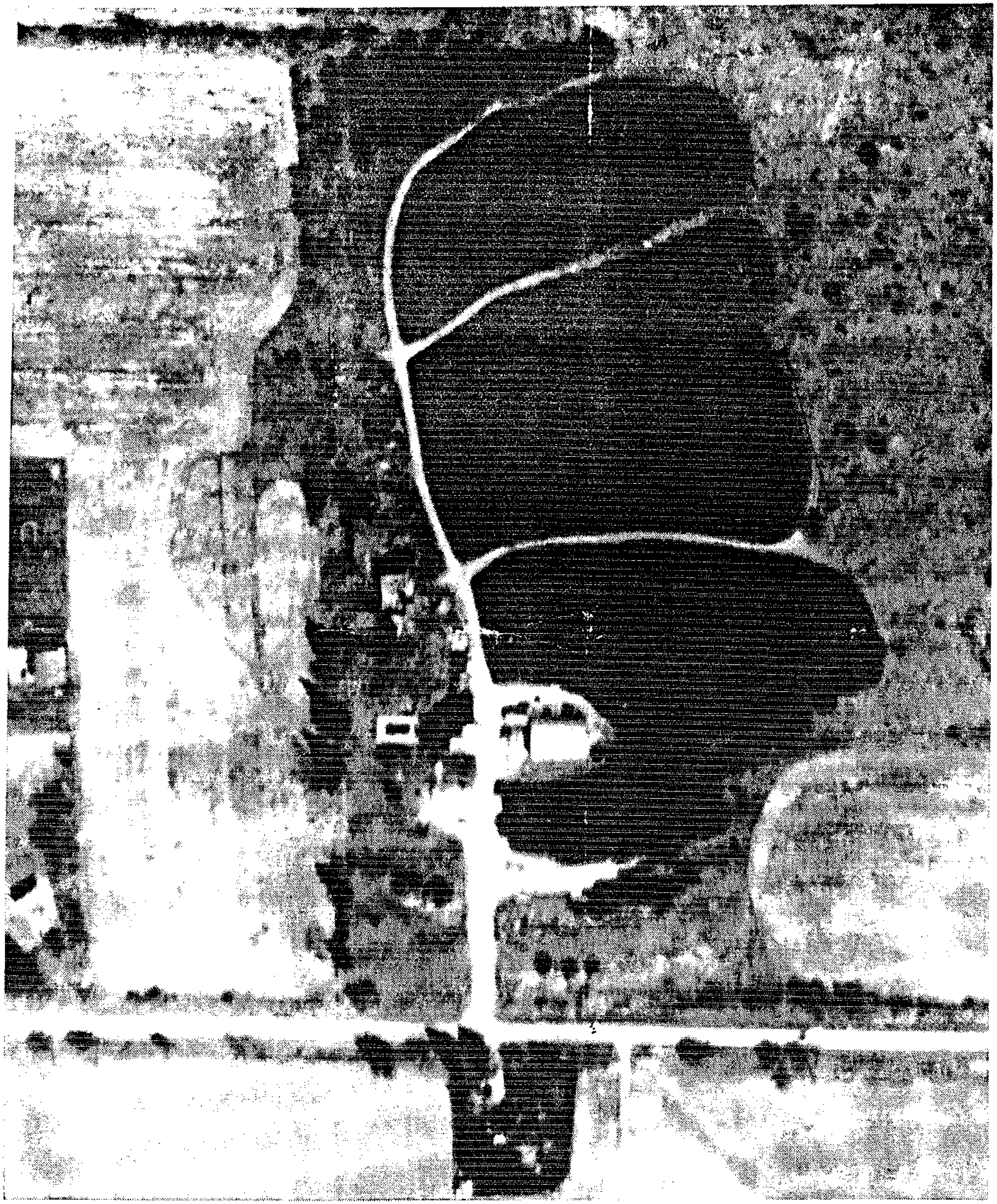
Controlled early extinguishment of a fully involved tire pile may not be achievable except in ideal circumstances. In the case of the Hagersville fire, the strategy of working from the perimeter and digging methodically into the piles after the heat and flames had diminished and using controlled amounts of water and foam to complete extinguishment, appears to have been an acceptable one for that site.

The following factors could be considered as having had a significant influence on the outcome of this incident:

(a) The absence of fencing made it easy for vandals to enter and leave the property.
(b) The absence of in-place perimeter roads to provide safe access to all sides of the pile caused delay in fighting the fire. However, the level site and firm ground conditions were advantageous to access road construction, control of run-off and thorough overhaul of the site.
(c) The fact that the tires were in very large piles without sufficiently wide internal separations contributed to the very rapid fire spread and the difficulty in suppression.
(d) Absence of an on-site water supply delayed and restricted fire fighting operations during the critical first hours of the fire.
(e) The need to control run-off of fire fighting water and oil from the site dictated the rate at which suppressants could be added to the fire.
(f) The health hazards presented by potentially toxic smoke and oil and the physical hazards presented by the wire left after the tires have burned, made fire fighting dangerous and exhausting.
(g) The activities of fire fighting, evacuation of the surrounding population, and environmental monitoring required that an inter-disciplinary and inter-governmental management organization be developed and sustained. The cost of such an effort quickly exceeded the financial resources of the municipal levels of government.

A primary lesson learned from the Hagersville tire fire is that it is necessary to limit the size of a fire by limiting the size of the piles of tires. This fire also demonstrates that site conditions such as road access and control over drainage determine the degree of difficulty that will be experienced in extinguishing a fire. Given that it is not possible to ensure that a fire will never start, the overall fire protection strategy for outdoor tire salvage yards must be to minimize the impact that such a fire would have on the environment and the adjacent community.

APPENDIX A



Appendix A. Aerial photograph of the Tyre King scrap tire storage yard near Hagersville, Ontario. Approximate scale 1:2000. Date of photograph unknown.