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The Tire Fire at Saint Amable, Quebec, May 16 to 19, 1990

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INTRODUCTION

A fire in a large pile of scrap rubber tires, located near the town of Saint Amable, Quebec, started on the afternoon of May 16, 1990. The scrap tire yard is less than a kilometre from the town on the south shore of the Saint Lawrence river. The column of black smoke from the fire was visible from the metropolitan area of Montreal, 40 km away. The Saint Amable fire is the second major tire fire to occur in Canada in four months. A fire in Hagersville, Ontario burned for 17 days in February of this year.

On May 23, 1990, a member of the staff of the National Fire Laboratory of the Institute for Research in Construction visited the fire site to obtain details about the suppression efforts and site conditions. The municipal inspector for the town of Saint Amable, Mr. Jean-Pierre Eybalin, who played a key role in the town's response to the fire, provided information on the progress of the fire and suppression efforts.

SITE DESCRIPTION

The scrap tire storage yard is located on a long, narrow piece of property less than 700 m from a mobile home park in the town of Saint Amable, on the south shore of the Saint Lawrence river. There are an estimated 1.8 million people living within a radius of 30 km of Saint Amable, and 3.5 million within a radius of 60 km. The property is 585 m deep by 78 m wide (see Figure 1), and is bordered by farmland on the south, bush on the north and a tree farm on the west end. The only vehicle access is from William Road at the east end.

The site is almost level, but surface water drains generally from south to north across the property. A drainage course, named Leonard Creek on the municipal plan (also referred to as Ruisseau Parent) crosses the property through a culvert approximately 150 m west of the entrance at William Road. A second drainage ditch crosses the property at the west property line, furthest from the road. The soil profile on the site consists of approximately 1 m of sand overlying 12 m of clay. The water table is located at the interface between the clay and the overlying sand.

The first 150 m in from William Road, at the eastern end of the property, was used for receiving and sorting tires. At the time of the fire, this area was being used to shred tires in an attempt to recycle the rubber, and thereby reduce the number of tires on the site. The mass of scrap tires that burned had been built up over many years on the back part of the property, stretching from Leonard Creek in a continuous pile 410 m to the west property line, across the full 78 m width of the property. No roadway had been constructed around the perimeter of the pile, and an internal roadway, that at one time provided access to the west end of the property, had reportedly become blocked with tires.

A crane had been used to pile tires to an estimated height of 13 m at the east end of the pile, nearest the stream. Beyond the reach of the crane, however, the average height of the tire pile was only about 3.5 m. In total, the pile covered an area of 31,000 m^2 to an average depth of 3.5 m, with a mound approximately 13 m high stretching for about 20 m at one end. It is very difficult to estimate the number of tires contained in the pile, given that large truck tires were mixed with smaller automobile tires. It may be more accurate to characterize the size of the fuel load by the overall volume of the pile, rather than the number of tires. In this case, the total volume of tires is estimated to have been about 125,000 m^3.

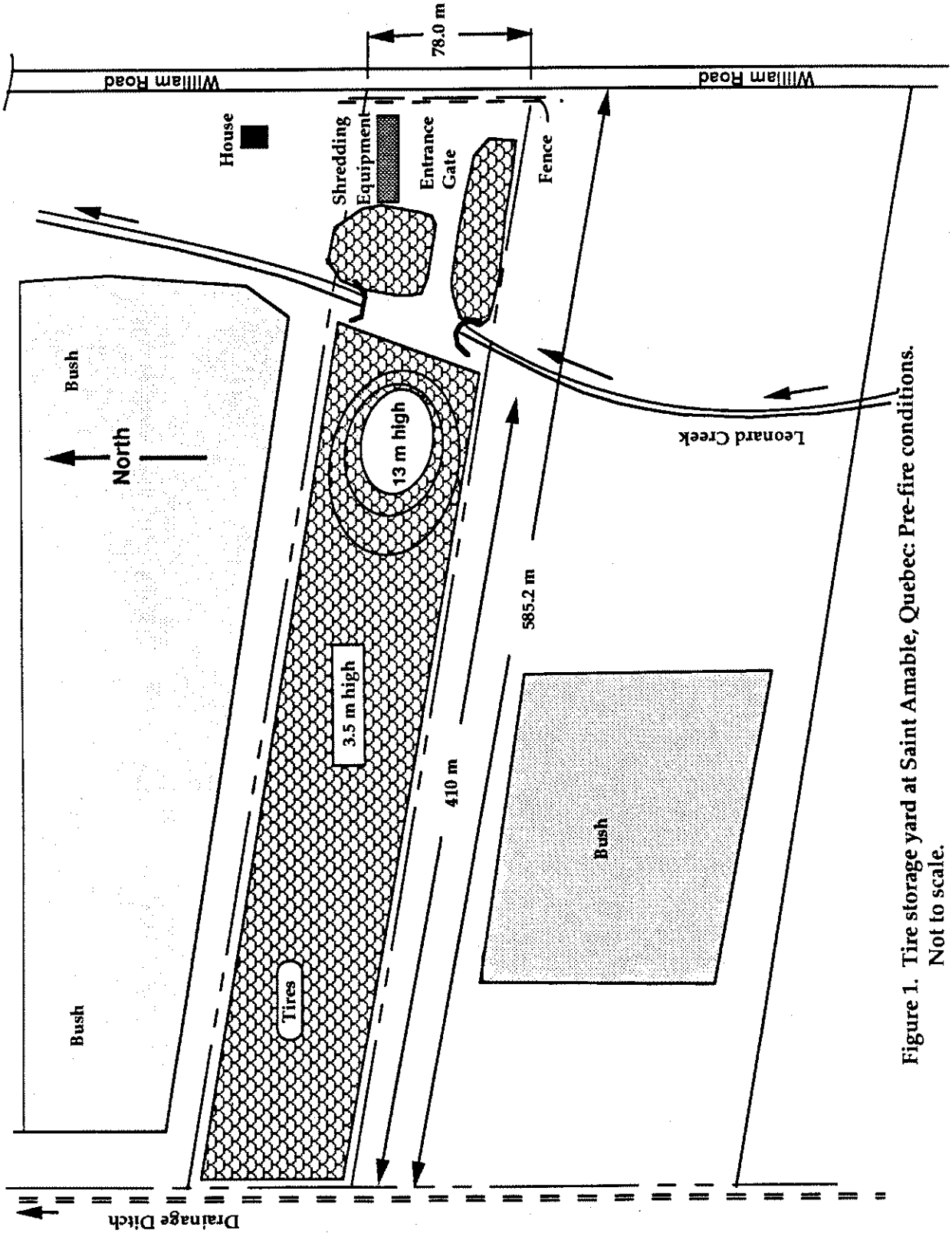

Figure 1. Tire storage yard at Saint Amable, Quebec: Pre-fire conditions. Not to scale.

Also noteworthy is the fact that a number of discarded fuel tanks were buried within the pile at Saint Amable. The fuel tanks were the cause of several explosions that occurred during the progress of the fire. These explosions, which were visible as small "fire balls" in the television coverage, caused some concern for the safety of fire fighters.

PRE-FIRE SAFETY CONDITIONS

The local municipality of Saint Amable had been concerned for some time about the possibility of a fire on the site. Starting in August 1989, brush on the neighbouring properties had been cut to provide a 20 to 30 m clear space around the perimeter of the pile. The clear space was intended to reduce the likelihood of a brush fire spreading to the tire pile. The clear space could not be used as a road to facilitate regular inspection, however, as the ground was too soft for wheeled vehicles. There was a fence along William Road, but not on any of the other three sides of the property. No provision had been made for a pressurized water supply and hoses on the site.

As a result of the recent tire fire at Hagersville, Ontario, the Quebec Ministry of the Environment had ordered work to begin to remove the tires from this site. The shredding operation, previously mentioned, had already removed approximately 20 percent of the tires. A recently-introduced ministry order, to divide scrap tire piles at all storage sites into small islands of about 50,000 tires each by means of 30 m wide separating alleys, had been stayed for the Saint Amable site. The order was stayed on the basis that there was no room on the site to store the tires that would have to be removed to create the separations and in recognition of the fact that shredding operations had begun.

The site was guarded by security personnel between 2200 and 0600 hours Monday to Thursday, and 24 hours per day during the weekend. Because of the absence of a perimeter road and the size of the property, however, the surveillance zone for the security guards was limited to the William Road end of the site.

The local volunteer fire department had prepared an emergency plan for the site. They had also requested that a foam truck be purchased or be made available for use in the event of a fire in the scrap tire storage yard. Such a truck was not readily available at the time of the fire.

FIRE SPREAD

The fire started on Wednesday, May 16 at approximately 1500 hours, while employees were shredding tires near the entrance to the property. At 1510 hours, an employee reported a fire burning in the east end of the pile at the base of the 13 m high mound. The cause of ignition is not known, although the fact that the fire started at the occupied end of the property while employees were present, suggests that the cause could have been accidental or due to negligence, rather than a criminal act. The wind was from the east at 15 km per hour. Aided by the wind, fire spread through the high mound of tires, and moved west along the south edge of the pile. By 1700 hours approximately 20 percent of the 410 m length of the pile was reported to be in flames. At that time (1700 hours) a local contractor with a bulldozer and a mechanical shovel (backhoe with treads) drove along the north side of the pile and began cutting a fire break through the pile about 250 m from the east end. A swathe the width of the bulldozer blade (3 m) was pushed through, but towards 1900 hours, observers in a helicopter flying overhead advised that all equipment be removed from the fire break because the fire was advancing rapidly. The fire jumped the 3 m wide break by 1900 hours. By 2145 hours, the entire pile was on fire.

During the first few hours of a tire fire, the tires near the surface of the pile are fully exposed to the air. They burn with unrestricted vigour, creating energetic, billowing flames that, at night, are visible high above the pile within the smoke plume. During this first phase of burning, radiant heat from the smoke plume is intense, which aids the spread of fire into unburned tires downwind of the plume. After a few hours of such burning, the mass of wire from the consumed tires begins to form a "crust" over the tires that are still burning deeper within the pile. The pile "settles down" for a prolonged burn. At this second phase of burning, there is a much lower flame, and radiant heat is much reduced. Fire fighters can then approach the fire to begin extinguishment operations. By Friday morning, May 18, much of the pile at Saint Amable was burning in the second phase.

Environment Canada reports that, in the month of May, the wind normally comes from the west in the Montreal region. An east wind, such as occurred on the day the fire started, occurs only 2.5 percent of the time. The light easterly wind may have contributed somewhat to the rapid fire spread from east to west across the site. On the other hand, the unusual east wind blew the thick smoke away from the town of Saint Amable and the trailer park located only 700 m to the south of the pile. It was somewhat fortuitous that the fire did not result in immediate forced evacuation of the town. Over the course of the fire, some families decided voluntarily to evacuate for a short time.

The wind direction gradually shifted until by May 19 (Saturday), the wind blew from the south. Heavy rains on Friday and Saturday (May 18 and 19) brought the smoke plume down to ground level. At this time about 150 residents living downwind, within 2 km of the site along William Road, were evacuated because of concern about the hazard of breathing the smoke.

As previously mentioned, there were a number of scrap fuel tanks buried under the tires. The twisted remains of several exploded automobile gas tanks were visible in the debris on the site. One large (1000 L) intact tank was also visible on the edge of the pile. From the video evidence of explosions and small "fire balls," there were certainly vapours, and perhaps even liquid fuel, in at least some of these tanks. Gasoline and residues in such tanks could have contributed to the toxicity of the smoke (lead). The fire services in Canada have expressed concern in the past about the undesirability of having drums of hazardous waste "hidden" within scrap tire piles, creating hazards of projectiles and introducing unknown toxic elements to the smoke and runoff from the site.

FIRE SUPPRESSION

Preliminary Suppression Efforts

The employees who discovered the fire were unable to take any first aid action due to the absence of hoses and an on-site water supply. First-arriving volunteer fire fighters laid hoses and applied water, supplied by a pumper truck, but with no effect on the developing fire. A connection was made to the town water system. For several hours fire fighters applied water to the edges of the fire to slow it down and to protect exposures at the east end of the pile. The water supply to the town was reportedly cut off during this period in order to supply the fire lines. The absence of an on-site water supply, of adequate volume and pressure for first-aid suppression and exposure protection, appears to have been a factor in the failure to achieve early control of the fire, in spite of the early detection.

The Saint Amable Volunteer Fire Department had some unexpected problems with their emergency plan for the site. The most serious were the lack of water and the difficulty with communications because of the jamming of telephone lines as the local population

became aware of the fire. Despite these problems, a mutual-aid plan was soon put into effect to bring in fire fighters from the surrounding volunteer departments. The Ministry of the Environment of Quebec was involved immediately in the response actions since their employees were already on site in conjunction with the shredding operations. By 1535 hours provincial authorities had advised federal authorities at the National Environmental Emergency Centre in Ottawa of a possible need for assistance. Within 2 hours a network of municipal, provincial and federal agencies was in place and preparing to provide the physical, organizational and financial resources necessary for an extended suppression effort and to deal with the fire's impact on the surrounding area. At the federal level, the multi-disciplinary resource group, that had been assembled during the recent Hagersville tire fire, was notified and consulted quickly by telephone conference call.

Efforts to control the fire with water were stopped during the night of Wednesday–Thursday, due to its obvious lack of effect as well as concern about spreading the oil that was beginning to flow from the burning pile into the two water courses crossing the property and into the shallow layer of sand covering the water table. For this reason, two water-bomber aircraft, that had been placed on standby, were dismissed. Plans were made to bring in a Department of National Defence foam-truck from the airport at St. Hubert, a nearby community. However, this foam truck was never used.

By Thursday morning, a "let-it-burn" strategy was being recommended by the provincial authorities. It was felt that it was better to burn off as much oil and rubber as possible to minimize the quantity of oil available to contaminate the surface and groundwater and the amount of contaminated material that would have to be cleaned up after the fire. Given the visibility of the smoke plume, due to its proximity to a major metropolitan area, and concern about the possible toxicity of the smoke, fire fighters were under considerable pressure to quickly bring the fire under control. They found the let-it-burn strategy frustrating but accepted the recommendation of provincial environmental officials, at least for the duration of the period of intense burning of the tires.

Access Road Construction

On Thursday, sand and gravel were brought in from nearby pits to construct an access road along the north side and around the southeast corner of the pile (see Figure 2), upwind of the smoke plume. Late Friday, the wind shifted to come from the south, pushing the column of dense, black smoke to the north thus making the north side inaccessible. Equipment operators then began building a road and drainage trench along the south side of the pile. In addition, a road was pushed in from the south, across the adjacent fields, along the drainage ditch at the west end of the property.

Drainage Control

Work began on Thursday to construct sand-fill dams across Leonard Creek to retain the oil that was beginning to flow out of the inferno of burning tires. Sand was pushed into the stream to cover a culvert laid on the bottom of the creek bed. Water could continue to flow through the culvert, but oil floating on the surface was trapped behind the dam. In addition, floating booms were laid across the creek downstream and upstream of the property to hold back any floating oil that might escape the property.

In order to reduce the flow of water in Leonard Creek, an engine-driven dewatering pump was set up approximately 350 m upstream (south) of the property (see Figure 2). Pipe was then laid on the surface of the ground to William Road. A local contractor installed a pipe under William Road using a "push-pipe" technique, so that water from the creek could be diverted into the drainage ditch on the south side of William Road without

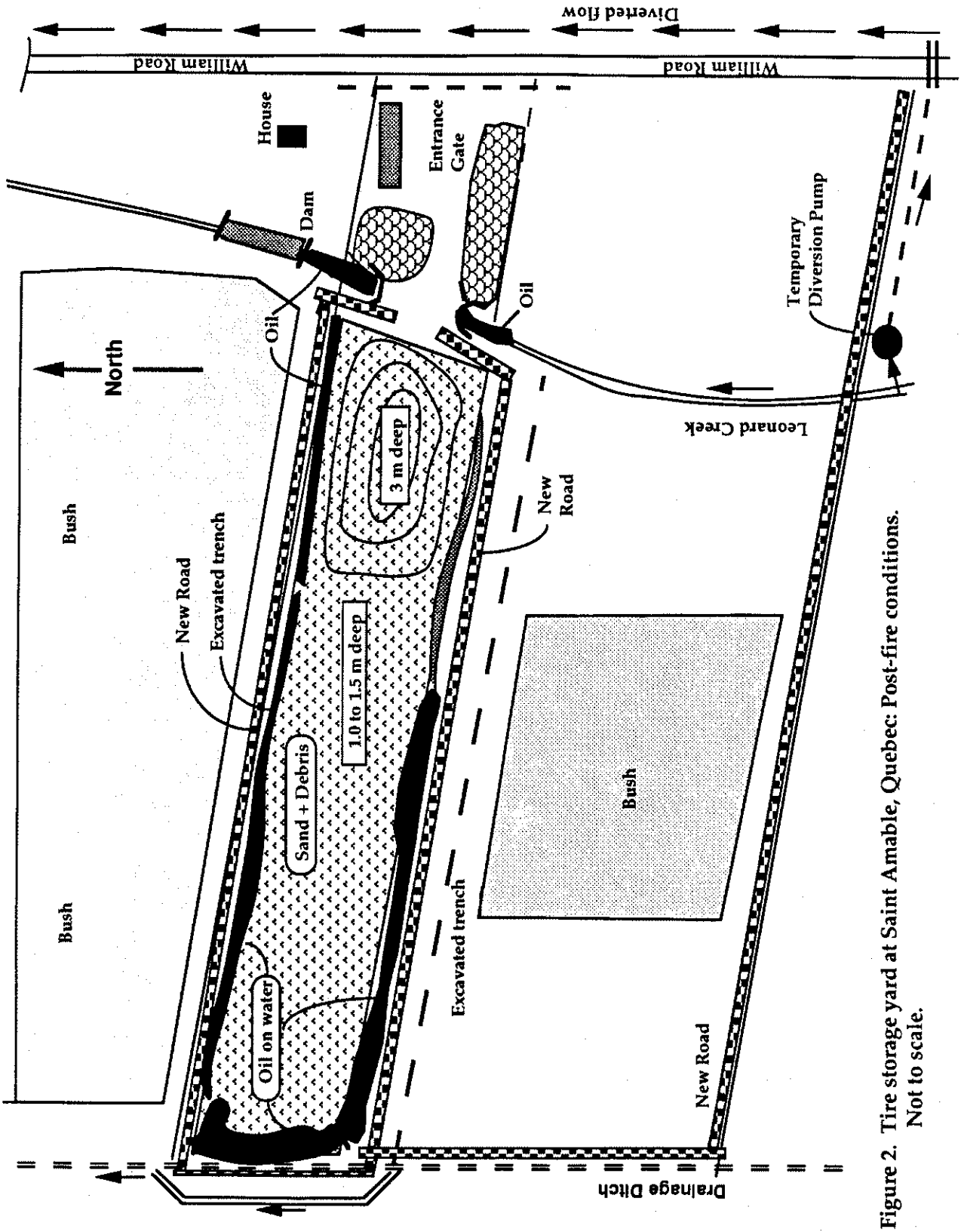

Figure 2. Tire storage yard at Saint Amable, Quebec: Post-fire conditions. Not to scale.

interrupting traffic. The capacity of the temporary pumping arrangement was sufficient to divert a significant portion, but not all, of the average flow in Leonard Creek.

Floating dams were laid across the west drainage ditch to retain the oil floating on the surface of the water. By Saturday, when equipment was able to reach the west end of the property, a large basin was excavated, from the bed of the existing ditch, to retain surface water and oil. Trenches were excavated down to the clay along the full length of the north and south sides of the pile, in order to prevent oil from seeping along the water table at the clay/sand interface. With these two trenches completed, all run-off could be directed to the retention basins at the east and west ends of the pile.

Final Suppression Efforts

On Thursday, while access roads were being constructed and bulldozers moved unburned tires away from the edges of the pile, the equipment operators began to cover the unburnt tires with sand to prevent them from becoming involved. This action seemed to be effective in extinguishing the burning tires at the edge as well. Encouraged by this, operators began pushing sand onto some of the burning tires, starting in the northeast corner. As there was an abundant supply of sand in the vicinity, and a sand and gravel contractor with the necessary equipment located in the town, local fire officials recommended a plan to bury burning tires under sand. There was initial reluctance to do this on the part of provincial and federal environmental officials, who were concerned about increasing the volume of contaminated material on the site, as well as possible continued pyrolysis of tires due to heat trapped inside the pile. This was resolved on Friday morning, when the provincial officials agreed to let the local fire officials proceed with their plan to bury the tires.

Between noon Friday and 2300 hours Saturday evening, more than 50 trucks delivered 903 truckloads of sand, approximately 14,000 metric tonnes in total. Trucks dumped their sand adjacent to the pile, and bulldozers pushed the sand onto the burning tires to form a working base for a mechanical shovel, which was then able to spread sand ahead of itself. Six backhoes were used, each assisted by several bulldozers, at different locations on the pile. Work began in the northeast corner and proceeded around the south side of the pile as the wind shifted the smoke column towards the north. Once the wind had shifted, work began on the southwest corner of the pile as well. Where the tires had been piled only 3 m high, the work progressed most rapidly. The most difficult portion of the fire to cover was at the east end where tires had been piled up to 13 m high. Although there was "a certain risk" for the heavy equipment operating on top of the potentially unstable pile, no accidents occurred. It rained heavily throughout most of this operation on Friday and Saturday.

The fire was declared "out" at 2300 hours Saturday evening. Throughout the rest of the night and all day Sunday, equipment moved around, as necessary, to cover "hot spots" or small "geysers" of smoke and flame that broke through the sand. By Monday there were fewer, and by Wednesday May 23rd there were no further visible outbreaks of smoke from the pile. However, it is likely that heat trapped inside the deepest parts of the pile at the east end will cause unburned tires to continue to pyrolyze and release oil for an unknown period of time.

ENVIRONMENTAL EFFECTS

Negative environmental effects from a tire fire include immediate reduction in the quality of air in the zone of the smoke plume, damage to the soil and plant life within the first few kilometres of the smoke fallout zone and to the surface and groundwater falling

onto or passing through the site. Results of tests of air, soil and water around the Saint Amable site indicate that the smoke plume was no more dangerous than smoke from other fires. However, the contamination of the soil and water, by the oil that was released from burning tires, poses the most serious long term problem for the environment.

Air

The clouds of dense, black smoke from a major tire fire appear to create an immediate environmental hazard. Burning rubber tires release a great deal of heat, which generates strong convection forces to push dense smoke hundreds of metres into the air. At Saint Amable, the smoke plume rose to 700 m within the first hour and was visible to the entire metropolitan area of Montreal. Public concern about the environmental hazard presented by the dramatic smoke plume adds to the atmosphere of crisis associated with major tire fires.

Smoke presents a potential health hazard for fire fighters and people living near the site who may have to breathe it for an extended period of time. At Saint Amable, due to fortuitous wind conditions which blew the smoke over unoccupied agricultural land, it was not necessary to evacuate people from the adjacent town, at least not during the first 24 hours. On Friday, when the wind changed direction and heavy rains and a low cloud ceiling brought the smoke down to ground level, approximately 150 persons were evacuated within 2 km north of the site.

Air sampling during the fire by environment officials indicated that air contamination was negligible outside the immediate vicinity of the fire. Levels of polycyclic aromatic hydrocarbons, zinc and other contaminants were no worse than are commonly found in an urban environment. Some elevated readings of lead were found, but the source of the lead was uncertain. Precautions, normally taken by fire fighters to minimize inhalation of smoke during an extended fire and measures to evacuate civilians within the smoke zone, may be sufficient to adequately manage this aspect of the hazard.

The smoke plume engulfed young deciduous trees in bush areas on both the north and south sides of the property. On the south side, which was affected during the first hours of the fire when the smoke was hottest, the trees were defoliated for a distance of approximately 100 m from the fire. On the north side, which was affected by cooler smoke on the last day of the fire, foliage on the trees was blackened by soot for a distance of 50 m from the edge of the fire. The damage to the trees did not appear to be critical.

Soil

Soil contamination caused by the tire fire is distinctly different off-site from on-site. Off-site contamination occurs from particulate matter that falls out of the smoke cloud or is washed out by rain. Tests were conducted on deposits of particulates on plants in the zone under the smoke plume close to the fire. The levels of contaminants in this zone were less than considered dangerous for human health. Further from the site, particulate matter washed out of the plume by rain is assumed to be more dilute than close to the fire and, therefore, not dangerous for human health.

Soil contamination on the site is caused by contact with the oil given off as the rubber in the tires pyrolyzes. With up to 5 L of oil available for release from each tire and an estimated 4 million tires in the pile, potentially 20 million litres of oil could be released. Because of the rapid suppression of the fire, not all the tires burned so not all of the oil was released. Also, some of the oil that was released burned off. Even after such deductions,

it is still possible that the fire produced several million litres of oil which continues to seep out of the mass of sand, ash and debris on the site.

A portion of the oil was skimmed from the surface of the retention basins at the east and west ends of the pile and pumped into trucks. The rest will be held in the pore spaces of the native soil underlying the pile, and in the ash and imported sand in the pile. If this contaminated soil is not removed from the site, rain water will leach contaminants out of the pile and into the surface and groundwater for a long period of time.

Surface and Groundwater

At the time of the site visit, oil was visibly seeping out of the debris and accumulating on surface water impounded at each end of the pile. A company, experienced in handling hazardous wastes, pumped the oil and contaminated water from the east impoundment basin into a tanker truck. As a result of the contact with the oil, the surface water in the immediate vicinity of the fire was heavily contaminated with hydrocarbons, heavy metals and very low levels of dioxin.

Several agricultural enterprises downstream from the site use Leonard Creek as a source of water for their livestock. A substantial effort will be required to control or re-route the two surface water drainage channels that cross the property to prevent spread of contaminated surface water. Even with the stream re-routed, retention basins on the site itself will have to be enlarged if they are to retain all the runoff from a rainstorm. The oil-covered water in the retention ponds also poses a threat to wild birds that use the adjacent habitat.

Contaminated water presently held in the retention basins cannot readily penetrate the low-permeability clay. However, because the overlying sand is much more permeable than the clay, contaminated water could spread laterally through the sand unless an impermeable lining is installed.

COSTS

An evaluation of the total cost of a major tire fire must take into consideration not only the immediate costs incurred during the suppression effort, but also the long term costs involved in rehabilitating the site to the satisfaction of environmental authorities. At Saint Amable, the municipality estimated the total cost for the involvement of fire fighters, the trucking of sand, engagement of heavy equipment and a hazardous waste handling firm to collect the oil, as well as costs of evacuating 150 persons for a short period, to be approximately $500,000. This estimate does not include any of the costs incurred by provincial or federal ministries in providing technical and physical support for the fire fighting operations by the municipality. Nor does it include any of the future cost of site clean-up.

DISCUSSION

The Saint Amable tire fire raises several issues of general interest that warrant discussion:

(a) How does the Saint Amable incident compare with the Hagersville Tire Fire?
(b) What factors contributed to the ignition and rapid fire spread?
(c) What are the minimum hazard management measures that should be mandatory at a scrap tire storage site?

Comparison to the Hagersville Fire

For comparison purposes, the tire pile which burned in February 1990, at Hagersville, Ontario occupied an area of 50,000 m^2 to an average depth of 4 m, for an approximate volume of 200,000 m^3 (1). The tire pile at Saint Amable occupied an area of 31,000 m^2, with an estimated volume of 125,000 m^3. The Saint Amable pile was therefore about 60 percent of the area and 65 percent of the volume of the pile at Hagersville. In both cases, the piles were essentially a continuous mass of tires, with no effective interior separations. In both cases, the fire spread throughout the entire volume of tires within 8 hours of ignition. At Saint Amable, a number of scrap automobile fuel tanks and removed underground fuel tanks were buried in the tire pile. These exploded from time to time during the fire, creating an unexpected hazard and possibly adding to the toxicity (lead) of the smoke. Also at Saint Amable, two surface streams crossing the site complicated the problem of containing oil released from the burning tires.

At Saint Amable, fire fighters chose to suffocate the burning tires under a blanket of sand. The difficulty of controlling run-off of surface water from the site appeared to favour this approach over the one used at Hagersville, which involved a labour-intensive overhaul of the perimeter of the pile, the concentrated application of water and foam at the overhaul points and the collection of all runoff liquids. At Saint Amable, a local sand and gravel contractor provided a ready source of sand, which was spread over the still-burning tires in 40 hours of continuous labour. The sand stopped the visible flames and smoke, thus relieving immediate local and regional concerns about environmental contamination of the air and surrounding agricultural land. However, the mass of oil-contaminated sand and native soil, burnt and unburnt tires, steel wire and old steel fuel tanks left on the site poses an enormous clean-up problem. Until it is cleaned up, oil will continue to seep or be leached out of the debris. It appears at this time that the site clean-up is likely to last longer and incur greater costs than at Hagersville, where the tires were almost entirely consumed and no materials were added to the site.

Organizational aspects of the two fires were similar. A major tire fire involves multi-levels of government, including local mutual aid groups, provincial ministries, and, to a certain extent, federal government agencies. The potential for a conflict over who has the ultimate authority for managing the incident is high. A somewhat cumbersome "management by committee" process results. These types of organizational problems should be anticipated when developing an emergency plan for a tire storage facility.

As previously mentioned, the cost to the town of Saint Amable for the fire suppression effort was estimated to be $500,000. An estimate of the cost of the Hagersville fire, at a similar stage after the suppression effort but before the environmental clean-up began and not including any of the costs absorbed by provincial and federal government agencies, was $1.5 million. That fire involved a 50 percent greater volume of tires and lasted 4 times longer than the fire at Saint Amable, because of the different strategy used for extinguishing the fire. However, at the Saint Amable site, the cost of re-routing the surface water drainage around the site, then excavating the contaminated soil, separating the steel and tires from the sand, and cleaning or disposing of the large volume of soil and other debris, could likely exceed the cost of clean up at the Hagersville site.

Ignition and Fire Spread

The cause of ignition is not known, although the fire was initially thought to have been deliberately set. The owner reported having received telephone threats to "blow it (the pile) up" the weekend before the fire, but the police concluded that there was not enough evidence to justify pursuing an arson inquiry. Besides, with almost a kilometre of

unguarded perimeter in which to start a fire, why would an arsonist choose to start the fire so near to workers on the site? The police suggest that the fire could have started through negligence or by accident.

Arson is often suspected as the cause of tire fires because it is not easy to ignite rubber tires "by accident." A negligently discarded cigarette or even lit match would not ignite a tire, unless something more combustible than tires was present to start burning. Assuming no criminal act, it could be speculated that fuel leaking from one of the tanks buried within the pile "enhanced" the ignitibility of the tires. There is no evidence to prove or disprove that fuel leaking from a discarded tank contributed to ignition of the tires at Saint Amable, however, such a scenario is possible. It is not safe, therefore, to assume that tires will always be difficult to ignite when planning for fire safety on a scrap tire storage site if highly combustible materials or volatile liquids are stored with the rubber tires.

Section 3.5. "Salvage Shops and Salvage Yards including Automobile Wrecking Yards," of the 1990 National Fire Code (NFC) requires all tanks and drums in a scrap yard to be stored separately from other materials and that all such tanks or drums be first emptied of any flammable and combustible liquids. The situation at Saint Amable appears to justify these Code requirements.

The 1990 edition of the NFC also contains other requirements that apply to storage yards used for scrap tires. For example, fencing is required around a scrap yard, pile size is limited to 100 m^2 in area and 3 m high, with 3 m wide separations between piles. Considering how easily the fires at Saint Amable and at Hagersville jumped 3 m wide separations, it is clear that further consideration of this requirement will no doubt be undertaken by the Code-writing Committees.

A number of standards and regulations in Canada and the United States (NFPA 231D, "Storage of Rubber Tires," for example) recommend a 30 m separation between piles of scrap tires stored outdoors. (The separation distance may vary, depending on the configuration of the exposed materials.) Despite the problems that such a space-consuming requirement would create for a tire storage facility, a separation of 30 m may be justified to ensure that fire, if it begins, is restricted to the pile of origin. The only alternative to spatial separation would be a physical barrier, such as a fire resistive wall extending several metres above the top of the tires.

Recommended Minimum Fire Safety Measures

The ideal solution to the fire problem posed by storage of large quantities of scrap rubber tires is to develop methods for recycling the tires so that they do not accumulate in such quantities. Until viable recycling technologies are developed, however, outdoor storage facilities for scrap tires will continue to exist. Such facilities should incorporate design features to minimize the risk of fire ignition and spread, as well as the potential impact of the fire. Experience gained from the Saint Amable and Hagersville tire fire incidents suggests that the following factors should be considered in designing for fire safety at scrap tire storage facilities.

1. Select a level site with impervious soil, as far as possible from surface water courses or groundwater recharge points and from habitations. Avoid sites with streams on the property or close to the property. Provide for complete control of drainage of surface water from the site under emergency conditions.

2. Fence the entire site to discourage intruders but provide a gate wide enough to permit fire fighting vehicles to enter the site.
3. Construct an all-season perimeter access road inside the fenced area to permit regular inspections and access for fire fighting.
4. Prohibit the storage of flammable or combustible liquids, hazardous wastes or other easily-ignitable materials within 30 m of scrap tires.
5. Subdivide the tires into individual storage areas with a surface area of perhaps 250 m^2 and a maximum storage height of 3 m, separated from other piles or combustibles by spatial separations of at least 30 m or by fire resistive walls.
6. Provide an on-site pressurized water supply with hoses so that immediate first-aid action can be taken by on-site personnel to either stop the fire, if small, or protect exposures such as adjacent piles or parked vehicles.
7. Prepare an emergency plan for the property that anticipates the suppression strategy most appropriate for the site conditions, control of run-off, the availability of materials and equipment and the need for cooperative interaction between fire and environmental authorities.

CONCLUSION

The tire fires at Saint Amable and at Hagersville confirm that large tire fires cause serious environmental damage, as well as economic problems for the community. The cost of suppression and post-fire site clean-up may surpass even the combined resources of adjacent communities. Fire prevention measures and damage-limiting design of a scrap tire storage site appear to be the best way to avoid having a disastrous fire. Damage-limiting design includes measures to prevent ignition, to limit fire size and spread, to provide for suppressing a fire in the earliest stages and to provide for complete control of the oily run-off from the fire. It is also important to develop an emergency plan that anticipates how a fire incident would impact on the community and how the situation should be handled. If such safety measures are implemented and maintained, a fire in a scrap rubber tire storage yard could be controlled using a minimum of fire-fighting resources, without creating a major incident.

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