POTENTIAL BIRD HAZARDS TO AIRCRAFT ASSOCIATED WITH A PROPOSED SANITARY LANDFILL ('SITE D') IN MILTON, HALTON REGION, ONTARIO

by

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for

Town of Milton, Ontario
and
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INTRODUCTION

see Kellas testimony + cross

The Regional Municipality of Halton wishes to open a new sanitary landfill site. One of the sites under evaluation, known as 'Site D', is located in the Town of Milton (Figure 1). Site D is about $3\frac{1}{2}$ km northeast of Burlington Air Park, an airport used by general aviation aircraft. Concern has been expressed that a landfill at Site D would attract increased numbers of birds, especially gulls, and that these birds might be a hazard to flight safety for aircraft using Burlington Air Park. LGL Ltd., environmental research associates, was asked to provide an independent evaluation of this possibility. The present document provides this review.

- now site E - see OMB decision in my files re bird hazard.

Several years ago, a different site about $2\frac{1}{2}$ km west-northwest of Site D and $2\frac{1}{2}$ km north-northwest of Burlington Air Park was proposed as a landfill site (Figure 1). In 1978, we reviewed the potential bird hazard that the previous site would have caused for aircraft using the Air Park (Richardson 1978). That report contained a review of gull activities in southern Ontario, comments on other species of birds that concentrate at landfill sites, and a summary of the literature on susceptibility of small aircraft to bird strikes. Most of that background information is equally relevant to the present discussion. Those sections of our earlier report are attached as Appendix 1.

Although the background information in Appendix 1 is still correct and directly relevant, there are important differences between the situations in 1978 and at present. The proposed location of the landfill is now NE, not NNW, of Burlington Air Park. This is important in relation to the probable flight-lines of gulls to and from the landfill. In addition, facilities at Burlington Air Park have been expanded since 1978, and the types and numbers of aircraft utilizing that airport have also changed somewhat. A further consideration is that more gulls are present in the Western Lake Ontario area now than in 1978. Thus, the potential bird hazard associated with Site D needs to be considered in terms of the present landfill plan, present utilization of the Air Park, and present gull population. Probable changes in use of the airport and in gull populations should also be taken into account, given that the expected lifetime of Site D as a landfill site is 20 years

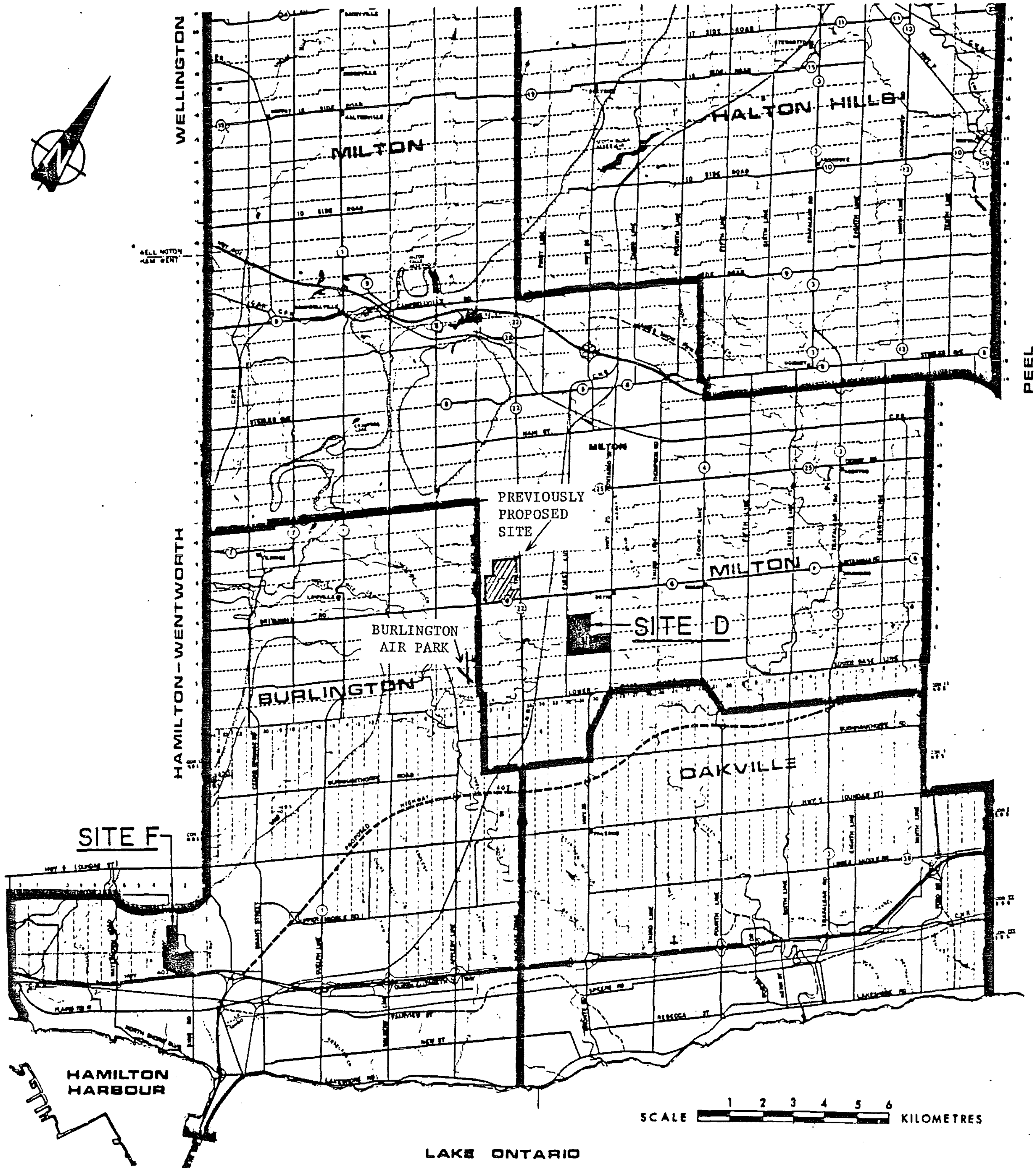


FIGURE 1. Map of Halton Region showing locations of 'Site D' and the Burlington Air Park in relation to Lake Ontario and Hamilton Harbour, where gulls are abundant. Modified from p 18 In Trow Hydrology Consultants (1986).

(Trow Hydrology Consultants 1986).

The present evaluation is based on several sources of information:

- The general technical literature concerning bird (especially gull) behaviour in relation to feeding, roosting, loafing and nesting areas;
- Summaries of bird-aircraft collision reports, especially for small general aviation aircraft;
- Literature and LGL's experience concerning ways of keeping birds away from food sources and other areas;
- Results of our 15-month study (1972-73) of gull populations and movements in the Toronto area (LGL Ltd. 1974), with emphasis on bird hazards to aircraft;
- Results of a 12-month study (1983) of gull use of landfill sites in Niagara Falls, NY, including experimental tests of the 'wire grid' method of deterring gulls from feeding at a landfill (McLaren et al. 1984);
- The general experience of LGL personnel and others concerning bird behaviour in relation to landfill sites, airports, aircraft, and scaring methods;
- My experience with birds in the Burlington area, where I was a resident and student ornithologist until I graduated from college in 1968;
- LGL's review of the potential bird hazards associated with a previously proposed landfill site near Burlington Air Park (Richardson 1978); in preparing that review during 1978, we observed gulls that were visiting the then-existing Oakville landfill site, and we visited the Air Park;
- A review of technical documents for the presently proposed Site D (Bird and Hale 1986; Trow Hydrology Consultants 1986);
- A visit to Burlington Air Park in December 1986, including an interview with the owner, Mr. V. Kovachik.

GULL POPULATIONS IN THE AREA

The species of gulls that visit landfill sites in southern Ontario are reviewed in Appendix 1. That section includes information about the seasonal variations in gull species, numbers and activities in the area. The behavior of gulls at landfill sites is also described. It is recommended that readers review Appendix 1 before reading the remainder of this report.

The Ring-billed Gull is one of two species of gulls that commonly visit landfill sites in southern Ontario. Its seasonal activities are described in Appendix 1. Because its numbers have increased drastically in recent years, the present section describes the current status of the Ring-billed Gull population in our region. This species nests in colonies along the shores of the Great Lakes. Numbers of Ring-billed Gulls nesting there have been increasing rapidly, at an average rate of about 11% per year (Blokpoel and Tessier 1986). Those authors report that, in 1984, there were an estimated 650,000 pairs of Ring-billed Gulls nesting in that region, i.e. 1,300,000 adult gulls plus an unknown number of subadults and, in the latter half of the year, large numbers of juveniles. Of the 650,000 nests, about 2/3 are on the Canadian side of the Great Lakes.

Western Lake Ontario supports a major proportion of these nesting Ring-billed Gulls. The long-established colony at Mugg's Island (Toronto waterfront) contained about 4000 nests in 1976, 6000 nests in 1980, and 7715 nests in 1984. The recently-established colony on Toronto's Eastern Headland ('Leslie Street Spit') increased from about 10,000 nests in 1976 and 23,000 in 1978 to 67,000 in 1980 and about 75,000 nests in 1984. Thus, numbers of gulls nesting in the Toronto area have increased drastically in the past decade. However, habitat limitations and active control programs will prevent the continued growth of the Toronto colonies (Blokpoel and Tessier 1986). In contrast, the third colony in Western Lake Ontario, in Hamilton Harbour, is still increasing rapidly and is expected to continue to increase. The Hamilton Harbour colony did not exist in 1976, but contained 329 nests in 1980, about 2000 nests in 1981, and about 11,000 in 1984 (Blokpoel and Tessier 1986).

The new Hamilton Harbour colony is the closest gull colony to Site D and the Burlington Air Park. The harbour is located about 15 km south of the Air Park and 18 km south of Site D. As described in Appendix 1, Ring-billed Gulls do not travel far inland from their colonies while they are actually nesting. However, Ring-billed Gulls commonly do visit landfills 18 km or more inland during the spring before nesting begins, and from the end of nesting in mid summer until they migrate south in autumn (LGL Ltd. 1974). The presence of the colony at Hamilton Harbour will increase the number of gulls in that area, and thus increase the number of gulls that are likely to come inland in spring and in mid-summer through autumn. The direct flight-line from Hamilton Harbour to Site D would bring gulls close to Burlington Air Park (Figure 1). Because of the recent establishment of the Hamilton Harbour colony, this is a new factor that was not a concern when we prepared our report on the previously proposed site (Richardson 1978).

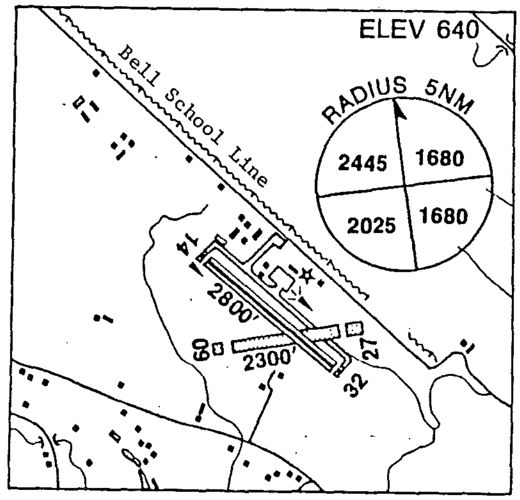
The Herring Gull is the other species of gull that commonly visits landfill sites in southern Ontario. Most members of this species nest farther north than our area, but large numbers of Herring Gulls are present during migration and in winter (see Appendix 1 for details). Herring Gulls are common in winter, when most Ring-billed Gulls have migrated south. Thus, at least one of the two species is common in the area all year, and at least one species visits landfills at all times of year other than the breeding season in late spring (see Figure 3 in Appendix 1).

BURLINGTON AIR PARK OPERATIONS

Burlington Air Park is located on Bell School Line in northeastern Burlington (43°27'N, 79°51'W). It is a privately owned and operated airport. However, it is Publicly Licensed by Transport Canada, and must meet Transport Canada's safety and other standards.

Burlington Air Park has one paved and lighted runway 2800 ft long, oriented 140°/320° (i.e. roughly parallel to Bell School Line. A second unpaved runway 2300 ft in length is oriented 090°/270°. The runway layout is shown on Figure 1 and, in more detail, on Figure 2.

BURLINGTON AIRPARK ONT ·ZBA



REF	N43 27 W79 51 9°W UTC-5(4) Elev 640' VTA A5000 F-21
OPR	V. Kovachik 416-335-6759/3005 Pub Lic* Opr 13-23Z (DT 12-22Z)
PF	B-1 C-2,3,4,5,6
FLT PLN FSS TWB	 Toronto 800-387-0403 See Toronto Area TWB
SERVICES FUEL OIL S	 100 65, 80, 100 1,2,3,4,5,6,7
RWY DATA* RCR	Rwy 14/32 2800x75 asphalt/turf, centre 40' asphalt. Rwy 14 displ 100'. Rwy 32 displ 100'. Rwy 09/27 2300x200 turf. Rwy 09 displ 170'. Rwy 27 displ 280'. Opr or Spectrum Airways 416-336-4010, No win maint rwy 09/27.
LIGHTING	14-(T LO), 32-(T LO) ARCAL-122.7 type J. Dusk til midnight, O/T PNR.

B60 AERODROME/FACILITY DIRECTORY

BURLINGTON AIRPARK ONT (Cont'd)

COMM ATF	 unicom ltd hrs O/T tfc 122.7 5NM below 2500 ASL
PRO	Circuit hgt 1500' ASL. Rgt hand circuits rwy 27 & 32. Glider activity wkends & hols May-June, Sept-Oct.

FIGURE 2. Copy of the listing for Burlington Air Park in the 'Canada Flight Supplement' (18 Dec 1986 edition).

The normal flight pattern at most airports is for 'left hand circuits', i.e. aircraft make a series of left turns when approaching the airport, or when flying locally around the airport. Any unusual circuit patterns required at specific airports are specified in the Canada Flight Supplement (Figure 2). At Burlington Air Park, the circuits for runways 09 and 14 follow the usual left hand pattern. Thus, aircraft departing eastward on runway 09 or southeastward on runway 14 would turn north or northeast in order to return to the airport. Such a turn brings aircraft close to Site D. At most airports, aircraft departing from runways 27 and 32 would also turn left, which would be to the west or northwest and away from Site D. However, because the Niagara Escarpment is present 2½ km southwest and 5 km northwest of Burlington Air Park, the circuits for runways 27 and 32 are right hand circuits. This fact is specified in the bottom portion of Figure 2. Thus flying is concentrated north and east of the Air Park no matter which runway is used. Aircraft flying around the circuits pass within about 1 km of Site D while on the 'downwind' leg of the circuit, and are normally about 1000 ft above ground at that time.

Burlington Air Park is the base for about 95-100 piston-engined aircraft (V. Kovachik, pers. comm.). Most of these are single engined, but several light twin-engined aircraft are now based at Burlington Air Park. No turbo-prop aircraft are based there, but light turbo-props (e.g. Turbo-Beaver, Turbo Commander, Conquest) do land and occasionally remain overnight. The airport owner expects that light turbine aircraft may be permanently based at Burlington Air Park in the near future.

Burlington Air Park is used throughout the year. Peak flying activity is on weekends and during the daytime, but there is also considerable weekday flying and some night flying. An increasing amount of instructional flying is being done at Burlington Air Park. Several training aircraft are based there. Instructional flying occurs all year and on all days of the week when the weather is good. At some times of the spring, summer and autumn there is considerable glider flying by Air Cadets. An aeroplane tows gliders aloft and releases them near the Air Park. The gliders remain within about 3 km of the airport and below about 2500 ft altitude, and return to the airport to land (V. Kovachik, pers. comm.).

Operations at Burlington Air Park have expanded considerably since our earlier review in 1978. One runway has been lengthened and paved, the number of aircraft based at the Air Park has increased, there is more instructional flying, and turbo-prop aircraft have begun to use the Air Park.

PROPOSED LANDFILL SITE OPERATIONS

The proposed operations at Site D have been described by Trow Hydrology Consultants (1986). The discussion below mentions only those operational procedures that are relevant to the potential bird hazard to aircraft.

Landfilling is to be done six days a week, from 8:00 AM to 5:30 PM. The working face is to be kept as small as possible; the daily cell dimensions will be about 10-12 m wide by 34-41 m long by 3 m high (Trow Hydrology Consultants 1986, p 81). The material received each day will be covered by clean material each night. Modern landfilling procedures of these types attract fewer gulls than do uncovered dumps. However, even at landfill sites using the modern procedures proposed for Site D, many gulls are attracted (e.g. Lake 1984; McLaren et al. 1984). Gulls become very adapted to the presence of heavy machinery; gulls feed at the active face even when it is small and when they must move frequently in order to avoid being hit by trucks and machinery.

Daytime landfilling of the type proposed at Site D is the normal method of operation at most landfills. It should be noted, however, that attractiveness of a landfill to gulls can be reduced if it is practical to landfill at night. Gulls visit inland areas like landfills only during the daytime. If landfilling is done at night and the active area is covered by clean fill during the daytime, there is little attraction for gulls (see Appendix 1, sect. 3.6).

Storm water retention ponds are planned at Site D for two reasons: to handle excess water and to assure the availability of water for use in any fire emergency (Trow Hydrology Consultants 1986, p 68-70). These ponds are to be grass-lined. The presence of standing water in an inland area attracts gulls, and it is widely agreed that the presence of standing water near a landfill site increases the attractiveness of the landfill operation to gulls (e.g. Drury 1965; Cooke and Ross 1972).

Four bulk bins are to be available for use of individual haulers bringing mixed residential wastes to Site D (Trow Hydrology Consultants 1986, p 73). We assume that these bins will be open, at least during the daytime. Such bins can provide gulls and other birds with access to food (i.e. kitchen wastes) at a second location on the landfill site aside from the active working face. This will increase the attractiveness of the overall site to gulls.

If Site D is selected, it is expected to be used as a landfill site for about 20 years. Landfilling would commence in Cell 1 at the northwest corner of Site D, and proceed southeastward to Cell 5 in the southern corner. Because Burlington Air Park is to the southwest of Site D, the portions of Site D that are to be used are those closest to the Air Park. The flight line from the Hamilton Harbour gull colony to the northwest corner of Site D, where the first landfilling is to done, would pass slightly closer to the Air Park (1 km from the SE end of runway 14/32) than would the gull flight line to any other part of Site D. However, flight lines from Hamilton Harbour to any part of Site D would pass through the circuits for all four runways.

Landfilling operations at Site D are proposed to follow normal, modern procedures for a sanitary landfill, but not to include any special measures to minimize attractiveness to birds (Trow Hydrology Consultants 1986, p 40). Those authors quote Bird and Hale (1986) as having stated that 'proximity of the site to the Burlington Air Park could cause potential problems which could be mitigated by proper site management techniques'. However, Bird and Hale (1986) indicated that special measures to deter birds may be necessary--not just the 'standard accepted practices of landfilling' that Trow Hydrology Consultants (1986) propose. Based on the literature and on our experience at other landfill sites in and near southern Ontario, we can state with assurance that large numbers of gulls <u>will</u> be attracted to Site D if only the 'standard accepted practices of landfilling' are followed. In the absence of specific bird deterrent measures, hundreds of gulls will fly to the proposed site on many days of the year. Over 1000 gulls are likely to congregate at the proposed site on some days, especially in summer and autumn.

EVALUATION OF POTENTIAL BIRD HAZARD

Although many types of birds can be a hazard to aircraft, gulls are involved in a high proportion of the bird-aircraft collisions (e.g. Blokpoel 1976). This is true in southern Ontario (Blokpoel 1980) as well as in many other parts of the world. The main problem involving gulls, airports and landfills is that gulls travel between the landfill sites where they feed in the daytime and waterbodies where they roost at night. Even before there was a gull colony in Hamilton Harbour, many gulls frequented the Burlington lakeshore, and were expected to visit a landfill site in southern Milton (Richardson 1978). The recent increase in gull numbers in western Lake Ontario, including the establishment of a major colony of Ring-billed Gulls in Hamilton Harbour, will increase the numbers of gulls that would fly daily to a landfill site in southern Milton.

Most of the aircraft using Burlington Air Park are small, single-engined, and piston-powered. However, a few light twin-engined aircraft use the Air Park, including occasional visits by light turbo-prop aircraft. Any of these types of aircraft can suffer serious damage as a result of a bird strike (e.g. Blokpoel 1976; Thorpe 1984). However, as described in Appendix 1, piston engined aircraft are generally considered to be much less susceptible to damage by birds than are turbine-powered aircraft. There have been only a few known cases of light piston engined aircraft being involved in fatal accidents as a result of colliding with birds (Appendix 1; Thorpe 1984). Collisions causing structural damage to light aircraft but no human injury are much more common, although the published statistics on these incidents are very incomplete.

Some airports are located near locations where gulls concentrate. In Ontario, examples include Toronto Island Airport, which is near the Ring-billed Gull colonies at Mugg's Island and Leslie St. Spit; CFB Trenton, which is near a landfill site that attracts gulls; and the North Bay Airport, which is also near a landfill site. No crashes or human fatalities have occurred as a result of bird strikes at these airports. However, collisions of aircraft with gulls have occurred at each of these airports. These collisions, the consequent damage to aircraft, and the threat to human life have been of sufficient concern such that gull deterrent measures have been implemented at these three airports (Blokpoel 1977, 1980).

The extensive instructional and glider flying done at Burlington Air Park are of special concern with respect to bird hazards to aircraft. A student pilot is more likely than an experienced pilot to lose control of his aircraft after a bird strike. The fatal crash of a very small aircraft (Turbulent) flown by an amateur pilot after a gull hit but did not penetrate the windscreen is a relevant example (Stables and New 1968). Similarly, a tow-plane pulling a glider is operating closer to its safety margins than is likely during normal aicraft operations; damage caused by a bird strike is more likely to have serious consequences in the case of a heavily-loaded tow-plane.

Because of the greater susceptibility of turbine-powered aircraft to bird strikes, the start of turbine operations at Burlington Air Park since the time of our earlier review (Richardson 1978) is a significant factor. The few turbine aircraft that are presently using Burlington Air Park are turbo-propeller aircraft, as opposed to 'pure jet' (i.e. turbo-jet or turbo-fan) aircraft. Turbo-propeller aircraft are apparently less susceptible to bird strikes than are pure jets. Most of the smaller pure jet aircraft are business jets. Business jets are particularly susceptible to serious bird strikes; there have been several fatal crashes of business jets because of bird strikes. Most of these accidents have involved either gulls or birds attracted to landfill sites (Blokpoel 1976; Thorpe 1984). At present, the paved runway at Burlington Air Park is not long enough for most types of pure jet aircraft. However, consideration should be given to the possibility that the Air Park will expand to accomodate such aircraft within the projected 20-year lifetime of the landfill operation. The proximity of a landfill site, and the gulls that it would attract, would be a serious concern if business jet operations were contemplated.

It is a generally accepted principle among bird hazard to aircraft specialists that the presence of a landfill site near an airport is among the most serious contributors to the bird hazard to aircraft problem. As a result, Transport Canada specifies that 'Food Waste Landfill Sites' (along with coastal commercial fish plants) are 'extremely hazardous land use practices' for the vicinity of airports because they are 'extremely attractive to bird species that are: (i) a high hazard to aircraft ... and (ii) far-ranging in their daily food-searching activities. These practices are not recommended for areas 5 miles (8.0 km) or less from the airport boundary, and should be at even greater distances.' The relevant part of Transport Canada's Land Use document is provided in Appendix 2. These land use guidelines apply to any Publicly Licensed airport, whether owned by Transport Canada or, as in the case of Burlington Air Park, a private operator. The size of the airport and the types of aircraft operating there are not considered; the land use guidelines apply in all cases.

Burlington Air Park is about 3½ km from Site D, well within the 8 km radius within which Transport Canada recommends against the presence of landfill sites. The Transport Canada guideline does not make any specific mention about the spatial configuration of the airport, landfill site, and source of birds. However, it is widely recognized that the presence of a landfill site and a roosting area on opposite sides of an airport is one of the most serious contributors to the bird/aircraft collision hazard. Burlington Air Park is only about 1 km to the side of a direct line between Site D and the newly-established gull colony in Hamilton Harbour, 18 km from Site D (Figure 1). Gulls commonly fly 18 km or more inland to reach landfill sites. Thus, we can predict with confidence that a major gull flight line will be established between Hamilton Harbour and Site D. This flight line will pass close to Burlington Air Park and certainly through the area east and southeast of the Air Park where circuit flying occurs.

The Federal Aviation Administration's policy on landfill sites near U.S. airports differs somewhat from the Canadian policy, and the nature of the differences is instructive. The FAA makes a distinction between airports and runways used by piston-engine aircraft vs. turbine aircraft. In the U.S.A., landfills are discouraged within 5,000 ft of runways used by piston aircraft and within 10,000 ft of those used by turbine aircraft. Landfills farther from the airport than 5,000 or 10,000 ft are discouraged if they are positioned such that birds would fly through aircraft approach or climb-out paths while en route between roosting areas and the landfill site (see Appendix 3). Site D is about 10,000 ft from Burlington Air Park, but the expected flight lines of gulls would pass through approach and climb out patterns.

While gulls are actually feeding at the landfill site they would not be a hazard to aircraft; the hazard would occur when the gulls were en route to and from the landfill, or when they circled over it. Gulls usually fly at altitudes of about 300 ft or less above ground level (AGL) while en route between roosting areas and landfills, with some up to 500 ft or more. Thus, gulls that are en route are most likely to be encountered immediately before an aircraft lands or just after it takes off. It is at these times that an aircraft is most vulnerable to any mechanical problem or to any momentary distraction of the pilot.

Under certain weather conditions (mainly on sunny days), gulls sometimes soar up to altitudes of 2000-3000 ft AGL while en route between landfills and roosting areas, or over the landfill itself (Appendix 1). On these occasions, aircraft flying over or near Site D at the usual circuit altitude of about 1000 ft AGL could encounter gulls.

Although it can be assumed that gulls will sometimes attempt to avoid oncoming aircraft, reports of collisions show that gulls do not always do so successfully--even when approached by small, slow-speed piston aircraft. Furthermore, pilots of such aircraft sometimes do not see gulls in time to take successful evasive action. The probability of a collision when a gull and small aircraft are initially on a collision course is unknown. This probability seems to be small, but it is clearly non-zero since such collisions do occur. Thus, attraction of gulls to the proposed landfill site will inevitably increase the probability of a gull-aircraft collision for aircraft using the Burlington Air Park. Even so, the rarity of reported serious collisions between birds and light aircraft, despite the fact that airports are often situated in areas with many gulls, implies that a serious collision is unlikely. However, if Site D is established as a landfill site, Burlington Air Park will be in an unusually hazardous position almost directly between Site D and the gull concentration area in Hamilton Harbour.

As discussed in Appendix 1, section 4, several other types of birds in addition to gulls are attracted to landfill sites. These birds, mainly crows, starlings, blackbirds and pigeons, are unlikely to fly high enough to be a hazard to aircraft in the immediate vicinity of the landfill site, where aircraft are normally about 1000 ft above ground. However, flocks of these birds flying toward or from the landfill may enter the approach and climb-out paths of the Air Park on occasion. These cases would contribute to the overall increase in bird hazard to aircraft that the landfill operation would cause. However, we believe that gulls are the birds most likely to be involved in collisions.

POSSIBLE MITIGATIVE MEASURES

Previously Proposed Measures

In our report on a previously proposed landfill site near Burlington Air Park we listed several measures that might reduce the bird hazard to aircraft if a landfill site was established near the Air Park (Richardson 1978, p 20-23). All of these points are equally applicable to the present proposal. Briefly summarized, the measures discussed in our earlier report were as follows:

- area of exposed refuse should be as small as possible and exposed as briefly as possible; keep other parts of the site clean;
- make the habitat of inactive parts of the site as unattractive as possible, e.g. by eliminating standing water and maintaining the least-favoured grass length;
- consider using active bird scaring methods, but recognize that they may be manpower-intensive over the lifetime of the landfill, effective only briefly, or effective only partially;
- alert users of the Air Park to the bird hazard problem;
- consider making changes in the circuit pattern and/or altitude if this is feasible.

These measures are all discussed in more detail in Richardson (1978). Many of these points were also discussed by Bird and Hale (1986) with specific reference to Site D.

We also mentioned in our earlier report that, if a landfill site must be placed near the Air Park, the bird hazard would be much less if the landfill were south or SW rather than north or NE of the Air Park. Also, the hazard would be much reduced if landfilling were done only at night. It is recognized that re-location and night operations are outside the scope of this review of present plans for Site D.

Both Richardson (1978) and Bird and Hale (1986) mentioned that an active bird dispersal program might be needed to control numbers of gulls coming to the landfill site. Such programs are conducted at many major airports in order to reduce the probability of bird-aircraft collisions. Most such programs employ a variety of dispersal methods, including some combination of shotgun patrols, shellcrackers or other pyrotechnics, gas cannons (noisemakers), 'scare-crow' methods, playbacks of distress calls, and falconry. In some cases, these dispersal programs have extended to nearby landfill sites. The general consensus among bird control personnel is that

- such techniques work best in combination rather than individually,
- scaring techniques should be varied from time to time to reduce habituation effects,
- scaring efforts must be maintained virtually continuously; if efforts are relaxed, birds will return quickly,
- in order to scare birds from a location that is otherwise attractive to them, the program will have to be manpower intensive and it is likely to be costly.

These points have been confirmed in a few recent evaluations of the effectiveness of 'traditional' bird control programs for airports and nearby landfills (Blokpoel 1980; Risley and Blokpoel 1984; Southern and Southern 1984). These evaluations reconfirm that it is a difficult task, requiring daily effort by experienced personnel, to deter gulls and other birds from visiting a landfill. This is true even with the resources that can sometimes be made available (often with difficulty) at a large urban airport and any nearby landfills. We are not aware of any small airport, i.e. any airport comparable to Burlington Air Park, where there is a bird control program of the magnitude necessary to be effective.

Bird and Hale (1986) point out that bird deterrent methods might need to be employed at Burlington Air Park as well as the landfill site. Some gulls flying between and Site D and Lake Ontario (or Hamilton Harbour) are likely to land at the Air Park. The parties concerned may wish to consider in advance the question of financial responsibility for any deterrent program at the Air Park.

Wire Grid Method for Deterring Gulls

In the last few years, another bird deterrent method that requires much less manpower has been used to reduce gull numbers at a few landfills (and other areas). When a horizontal grid of fine wires is suspended over places where food is available to gulls, the number of gulls coming to the food is greatly reduced. The wires can be spaced quite widely, sometimes 6 m or more apart, and still reduce the numbers of gulls. The wires can be high enough, e.g. 10 m above the working face, to allow trucks and machinery to operate below the wires. Gulls apparently do not like to fly down between the wires even though the spaces between wires may be more than adequate to allow a gull to fly between them.

The first use of wire grids over landfills was apparently in California, but their effectiveness in reducing gull numbers was not documented in those instances. More recently, papers have been published describing two systematic and controlled studies done to determine the effectiveness of the wire grid method at landfills located near airports, and to develop an optimal grid design. We conducted a 1-year study at Niagara Falls, N.Y. (McLaren et al. 1984), and Forsythe and Austin (1984) conducted a 2-month study in South Carolina. These studies showed that a wire grid over the active face of a landfill could reduce the number gulls on the active area by 80-90% or more. Numbers of gulls visiting the landfill site as a whole were also reduced, typically by 60-70%.

Fine stainless steel wires or nylon monofilament up to 300 m long can be used. Thus, it is feasible to place a series of parallel, long wires over an entire landfill cell. The height of the support poles must be increased from time to time as the working level increases, but it may not be necessary to move the wire system horizontally until the entire cell is filled. One major advantage of a wire grid system is that, once installed, it does not require the constant effort needed for more traditional bird scaring programs. Furthermore, and quite surprisingly, gulls do not habituate to the wire grid; it does not seem to lose its effectiveness over time.

Although the wire grid system has been shown to be a useful method of reducing the attractiveness of certain landfill sites to gulls, it is not a perfect solution. Many gulls do continue to visit landfills where wire grids are in place. It is the number of gulls coming to the landfill site as a whole that is important, not the lower number of gulls under the wires at any one time. During our study at Niagara Falls, numbers of gulls on the landfill site as a whole were reduced by the reduced accessibility of the active area to gulls, but large numbers of gulls did still visit the site. It should also be recognized that the capital cost of a wire grid is significant, and it is not always easy to find a way to emplace the necessary supporting poles. Wires do break through wind or ice action, or when the height of the landfill increases enough for a machine to contact a wire. If the wire grid is to be even partially effective, broken wires must be noticed and replaced promptly. Also, the wire grid system is effective primarily for gulls; most other groups of birds seem to ignore it.

Thus, a wire grid system might be desirable at Site D as a method for reducing gull problems to aircraft using Burlington Air Park. However, even with a wire grid at Site D, numbers of gulls flying over and near the Air Park would increase when landfilling began. Furthermore, the grid would have to be carefully monitored and maintained in order to retain even partial effectiveness.

CONCLUSIONS

1. The proposed landfill at Site D is almost sure to attract large numbers of gulls (hundreds and occasionally over 1000) on a daily basis through much of the year. Peak numbers are expected in summer and autumn.

2. The recent establishment of a colony of Ring-billed Gulls in Hamilton Harbour is a new concern, especially since the numbers of gulls nesting at this colony are still increasing rapidly. The 18 km distance between Hamilton Harbour and Site D is well within the distance that gulls will fly on a twice-daily basis in order to visit a landfill site.

3. Most gulls coming to Site D will fly either through the approach or climb-out paths for Burlington Air Park, or through its circuit pattern southeast and east of the Air Park. Most of these gulls will be at altitudes of 25-500 ft above ground level (AGL). Thus, they will intersect approach and climb-out paths, although most will be below the normal altitude of aircraft elsewhere in the circuit (1000 ft AGL). Aircraft will occasionally encounter gulls at altitudes of 1000 ft AGL or more, especially when over or close to the landfill site itself.

4. Other birds such as crows, Starlings, members of the blackbird family and pigeons are also likely to be attracted to the landfill site. These birds will occasionally fly through approach and climb-out paths.

5. Birds and aircraft that are on collision courses are more likely to avoid one another if the aircraft is a slow-flying and small piston-engined aircraft than if it is a larger and faster aircraft. Burlington Air Park is used primarily by small piston-powered aircraft.

6. Despite point (5), gulls and other birds do on rare occasions collide with light piston-powered aircraft. Most such collisions apparently cause little or no damage, partly because of the comparatively low speeds of light piston aircraft, and partly because piston engines are less susceptible than turbines. However, serious damage can occur, and there are records of a few crashes of light aircraft after collisions with gulls

and other birds.

7. Burlington Air Park is beginning to be used by small turbo-propeller aircraft, and use by turbine aircraft is expected to increase in the future. Turbine-powered aircraft are more susceptible than piston-engined aircraft to bird strikes. At present, the longest runway at Burlington Air Park is only 2800 ft long, and the Air Park is not used by 'pure jet' aircraft (e.g. business jets). Small jets are especially susceptible to damage from bird strikes. In considering the potential bird hazard, the possible expansion of the Burlington Air Park over the 20 year lifetime of the landfill site should be considered.

8. The probability of a serious collision of a bird and an aircraft from Burlington Air Park will be increased considerably by establishment of the landfill. No numerical estimate of this increase is possible. The rarity of reported serious collisions between birds and light aircraft, even though birds often congregate near airports, suggests that even after establishment of the landfill a serious collision will be unlikely. However, this probability will be higher for light aircraft using Burlington Air Park than for those using most other airports. The Air Park will be in a doubly hazardous situation: (a) it will be close to the direct line between the landfill site and gull concentration areas in western Lake Ontario (including Hamilton Harbour), and (b) the circuits for all runways will pass close to the landfill itself.

9. Transport Canada indicates that presence of a landfill site within 8 km of an airport is an especially hazardous situation from a bird strike viewpoint. If a landfill site must be located within 8 km of Burlington Air Park, the bird hazard would be least if the landfill were to the south or southwest rather than to the north or northeast of the Air Park. The hazard would also be reduced if landfill operations could be conducted at night rather than by day. Neither of these possibilities is part of the present plan for Site D.

10. If the present plan for Site D is approved, there are several measures that could be taken to reduce the bird hazard. Most of these measures are manpower intensive, and all involve significant costs. To our knowledge, mitigative measures of the magnitude necessary to reduce the bird hazard significantly are presently applied only at much larger airports. Even with diligent application of the available types of mitigative measures, the bird hazard to light aircraft using the Burlington Air Park will be higher than at present.

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APPENDIX 1

REVIEW OF GULL BEHAVIOUR IN RELATION TO LANDFILL SITES,
OTHER BIRDS ATTRACTED TO LANDFILL SITES, AND
SUSCEPTIBILITY OF LIGHT AIRCRAFT:
Excerpts from a report from LGL Ltd. (Richardson 1978) for
M.M. Dillon Ltd. and the Regional Municipality of Halton

REGIONAL LANDFILL SITE

potential bird hazards to aircraft

PREPARED FOR M.M. DILLON LIMITED BY
LGL LIMITED, ENVIRONMENTAL RESEARCH ASSOCIATES

3. GULL BEHAVIOUR IN RELATION TO LANDFILL SITES

Gulls are the bird group most commonly involved in collisions with aircraft (Blokpoel 1976). Gulls have been reported to account for about 40% (Seubert 1976) or perhaps even 50% (Solman 1973) of the world's reported bird/aircraft collisions. Gulls are also the birds most commonly seen in flocks at dumps and landfill sites, at least in areas near lakes and seacoasts. Gulls occur in large numbers at landfill sites in southern Ontario (Cooke and Ross 1972; LGL Ltd. 1974). Thus, gulls are the primary concern in the present report.

3.1 Species of Gulls

The only gull species of particular concern here are the Herring Gull *Larus argentatus* and the Ring-billed Gull *L. delawarensis*. Both of these species nest in the Great Lakes area (and elsewhere), occur in Southern Ontario throughout the year, and commonly visit landfill sites and dumps. One other species, the Bonaparte's Gull *Larus philadelphia*, is abundant in Southern Ontario during spring and fall migration, but is not attracted to landfill sites (LGL Ltd. 1974). Other species that occur in Southern Ontario in winter are the Great Black-backed Gull *Larus marinus*, Iceland Gull *L. glaucoides* and Glaucous Gull *L. hyperboreus*. These last three species comprise only a small minority of the gulls present in winter and are not considered separately here.

3.2 Seasonal Abundance and Movements

The relative numbers of gulls in the western Lake Ontario area at different times of year are known from unsystematic observations over many years (e.g., Beardslee and Mitchell 1965; Tozer and Richards 1974) and from a systematic study in the Toronto area in 1972-73 (LGL Ltd. 1974). Numerous banding studies have revealed the broad features of migratory and other movements of Herring and Ring-billed Gulls nesting on the Great Lakes (e.g., Southern 1974a, b; Moore 1976; Southern and Kinkel 1976).

Most Herring Gulls that nest in the Great Lakes area nest at colonies in Lakes Superior, Michigan and Huron. Young from these colonies can fly by mid-July, and disperse in a variety of directions to all five Great Lakes. Numbers of Herring Gulls in the Toronto area increase from July until late October or early November (Fig. 1). Herring Gulls from colonies on the Atlantic coast do not disperse into the Great Lakes area. At the time of peak abundance in the autumn of 1972 and 1973 a total of about 10,000 Herring Gulls were found during censuses of 21 or 22 locations at which gulls concentrated in the Toronto area (from Brampton to Oshawa and from Lake Ontario north to Newmarket)(Fig. 1; LGL Ltd. 1974). Total numbers in the area were undoubtedly somewhat higher.

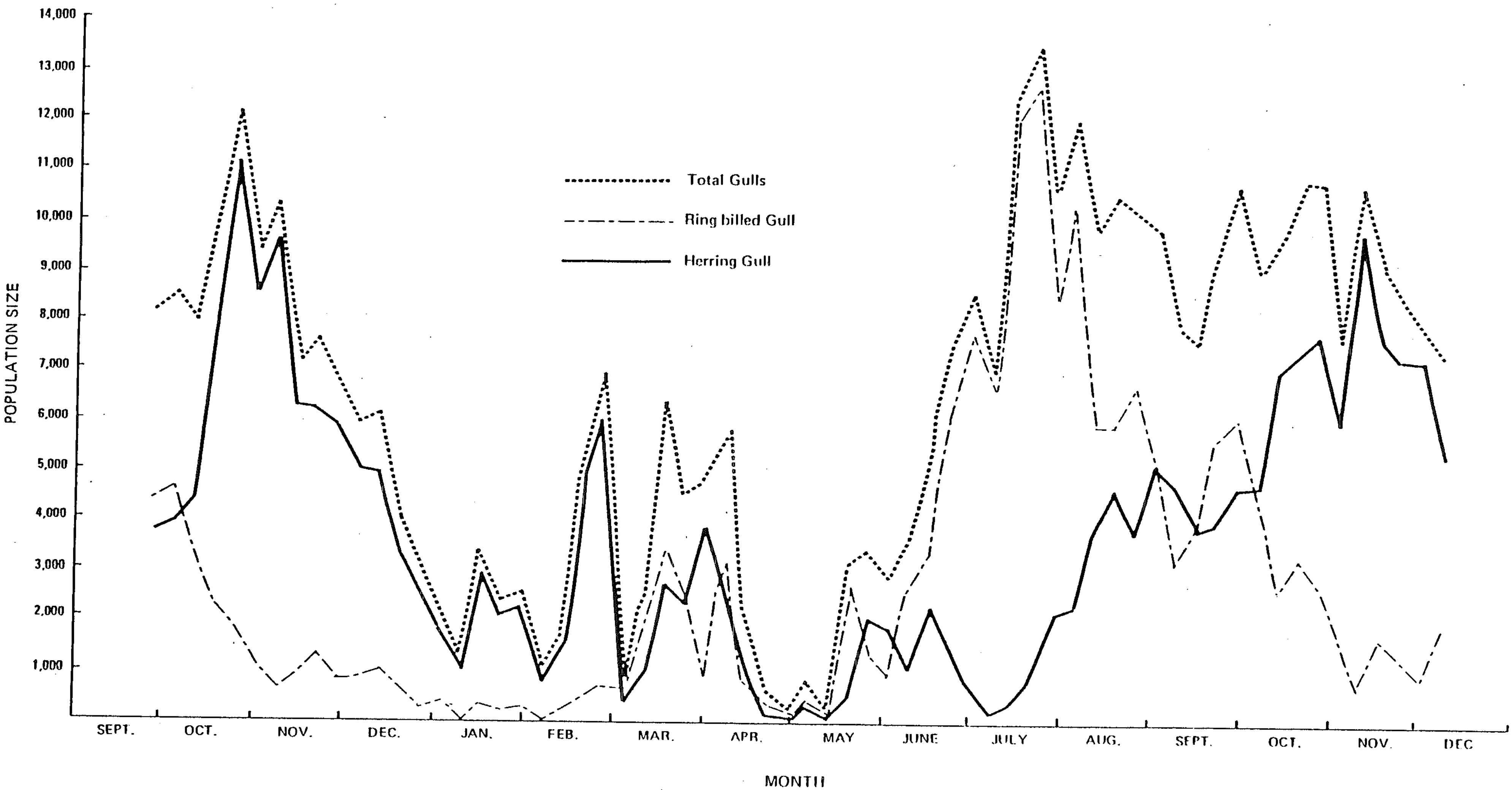
Most immature Herring Gulls from Great Lakes colonies remain in the Great Lakes area until November or December, when many migrate eastward along the St. Lawrence valley or southward along the Ohio and Mississippi River valleys. Adult Herring Gulls are more likely to remain on the Great Lakes in winter than are immature Herring Gulls or Ring-billed Gulls.

Influxes of migrating Herring Gulls occur intermittently from late February to early April (LGL Ltd. 1974). Most of these birds subsequently leave the western Lake Ontario area and move to their colonies to the northwest. However, small numbers of Herring Gulls do remain to nest on Lakes Ontario and Erie. Also, non-breeding immature Herring Gulls are common in late spring and early summer (Fig. 1), before the major influx of young-of-the-year and post-breeding adults.

Ring-billed Gulls are also abundant in the western Lake Ontario area, but their annual cycle of abundance differs from that of the Herring Gull. Fewer Ring-billed Gulls remain in winter, but large numbers nest in the area in summer. Migratory Ring-billed Gulls depart south from the area earlier than do migratory Herring Gulls (Fig. 1).

During the nesting season adult Ring-billed Gulls feed near their colonies, and do not use landfill sites and dumps. This accounts for the low numbers seen at day-use sites near Toronto in May 1973 (Fig. 1),

FIGURE 3. Weekly Fluctuations in the Numbers of Ring-billed and Herring Gulls at 21-22 Censused Day-Use Sites in the Toronto Area, Sept. 1972-Dec. 1973 (from LGL Ltd. 1974:262). Does not include gulls (mainly Ring-billed) at colonies along the Toronto waterfront.



when about 24,000 Ring-billed Gulls were nesting on the Toronto Islands. (Another large colony has subsequently formed on the Toronto Eastern Headland, also known as Leslie Spit (Blokpoel and Fetterolf 1978).) At least in 1973, numbers using day-use sites began to increase in late May when non-breeding one-year-olds arrived. In June and early July adults began to use these sites; young-of-the-year from various Great Lakes colonies (not just Toronto) began to use these sites in late July.

Autumn emigration of Ring-billed Gulls from the western Lake Ontario region is apparently most pronounced in October, but numbers using day-use sites, especially those several miles inland, began to decline much earlier (Fig. 1; LGL Ltd. 1974). Unlike the situation for Herring Gulls, most adult as well as immature Ring-billed Gulls leave the Great Lakes area in winter.

3.3 Use of Landfill Sites and Dumps

Gulls that use landfills and dumps as food sources do not remain there continuously. Instead, they make regular flights, often along well-defined routes, between the landfill or dump and other areas used for roosting, loafing or nesting.

The most common of these types of flights are between landfills or dumps used in the daytime and specific roosting areas used at night. Roosts are normally on lakes or other waterbodies, or along the shores of these waterbodies. Gulls sometimes fly as much as 40 miles (80 miles round trip) from a roost to a landfill site or dump (Solman 1973). In the Toronto area, both Herring and Ring-billed Gulls flew from roosts on Lake Ontario to landfills 11-20+ miles inland (LGL Ltd. 1974). However, more gulls used landfills 2-8 miles inland than farther inland. The Oakville landfill site (5 mi inland) was used by at least 750 gulls on 17 Oct. 1978 and 900 gulls on 15 Nov. 1978 (this study). The majority of those gulls arrived from the SE, S or SW (the directions of Lake Ontario) in the morning and departed toward those directions in the afternoon. The proposed southern Milton site is 10 miles from Lake Ontario.

Not all gull roosts are on large waterbodies like Lake Ontario. Some are on small lakes, such as Wilcox Lake and Musselman Lake in the Toronto area. The lake at Kelso Conservation Area, 4-1/2 miles northwest of the proposed landfill site, would probably be used for roosting by some of the gulls that would be attracted to the proposed landfill.

The proportion of the gulls in an area that fly to landfill sites or dumps each day is variable but often high. During the nesting season, breeding adult Ring-billed Gulls at Toronto remain near their waterfront colonies (LGL Ltd. 1974). Shortly after leaving the colonies, most young Ring-billed Gulls also remain along the waterfront, even though the adults and subadults are then moving inland to landfills. However, during the period of peak Herring Gull abundance in October and November, most individuals found around Toronto were at inland sites, predominantly landfills. Elsewhere, Cogswell (1970) reported that in the San Francisco area about 70-84% of the gulls present were usually at or near one of the dumps in the area during the daytime. Schreiber (1968) reported that in interior Maine during autumn the majority of the total Herring Gull population visited dumps; never more than a fifth of the gulls could be found feeding in or near ploughed fields. More gulls appear to visit landfill sites and dumps on rainy, overcast or disturbed days than in clear weather (Cooke and Ross 1972; Forsythe 1974). In general, then, the proportion of the gulls in an area that visit landfills and dumps is variable, but is often high.

3.4 Flights To, From and Over Landfill Sites

Some gulls start to fly from roosts towards landfills before dawn; others do not fly to landfills until mid-morning. Thus there is often a continual flow of gulls along the flight lines between roosts and landfill sites for 3 or 4 hours in the morning. Numbers at the landfill site usually increase gradually in early morning, remain relatively constant from mid-morning to mid-afternoon, and then decrease gradually as gulls depart toward their roosts. Schreiber (1967) found that Herring Gulls in Maine return to their roosts earlier relative to sunset on long summer days than on shorter fall days, and that in fall they return to their roosts earlier on cloudy than on clear days. Most gulls arrive at their roost in the hour before sunset.

While en route between roosts and landfill sites or dumps, Herring and Ring-billed Gulls usually fly singly or in small groups of up to 30 or 40 birds (Cooke and Ross 1972; LGL Ltd. 1974). However, flocks of 75-300 occasionally occur. Most of these birds fly at altitudes of 50-300 feet above ground. However, with strong opposing winds they often fly very low (5-35 feet above treetops, according to Schreiber 1967). With favourable winds or thermals they sometimes fly or soar up to 500-2000 ft AGL or more while en route between landfills and roosts (Schreiber 1967; Gunn 1973; Cogswell 1974).

While at landfill sites, gulls feed, loaf and occasionally fly. Active feeding occupies only a minority of the time at a landfill site (10-15%, according to Forsythe 1974). Immature gulls are believed to spend a higher proportion of their time feeding than do adults (Cooke and Ross 1972), but both adults and immatures 'loaf' in a standing or crouching posture most of the time.

Flying gulls can be encountered in the airspace over and near a landfill site or dump throughout the daylight hours. Small numbers of gulls arrive at and leave the site intermittently, even during mid-day. Large numbers of gulls sometimes take off when disturbed by landfill operations or other disturbances, and sometimes without obvious disturbance. These gulls often swirl around at low altitude for a brief period (less than 5 minutes) and then land. However, occasionally they soar upward above the landfill site to an estimated altitude of 1000-3000 feet AGL (Cooke and Ross 1972; Solman 1973; Forsythe 1974; Jones 1976). These soaring flights are most common on sunny days, presumably because thermals are most pronounced on such occasions.

Three examples of this soaring phenomenon were observed at the Oakville landfill site during our two visits. On 17 October 1978, a sunny day, we observed the following:

- A group of about 80 gulls flushed by us soared up to at least 1000 ft AGL above the site over a period of about 10 minutes.
- Another group of about 200 flushed by us and/or trucks soared upward for about 10 minutes, with gradual 'dropping out' of a few individuals at a time; some of the gulls that continued to soar reached at least 1500 ft AGL.

Another example of high-altitude soaring over the Oakville site was observed on 15 November 1978, an overcast day:

- About 60 gulls circled up to about 500 ft AGL over a 5 min period, gradually drifting to the SE with the NW wind. Most then returned to the landfill, but 10-15 continued to circle and climb to an estimated 800-1000 ft AGL over a further 7-8 min period.

Gulls soaring above landfill sites have been the cause of at least two bird/aircraft collisions (Forsythe 1974; Jones 1976). In the latter case, a Lear Jet ingested gulls into both engines, but landed safely; both engines had to be replaced.

3.5 Flexibility in Choice of Landfill Sites

Studies in which gulls have been colour-marked have shown that individual gulls frequently use more than one landfill site within a single season (Cogswell 1974; LGL Ltd. 1974). Various studies have shown that gulls adapt rapidly to changes in the availability of food at particular landfill sites. When dumping operations cease, numbers of gulls at the site become much lower; if dumping resumes, gulls rapidly reappear (Drury 1965; Kuhring 1965; Forsythe 1974).

These observations indicate that gulls will begin to use a new landfill site almost immediately, and will cease to visit it if dumping operations cease.

A 'weekend effect' is evident at landfill sites that are active only 5 or 6 days a week. Provided that refuse is covered each night, fewer gulls are present on the landfill sites on days when there is no dumping (Cooke and Ross 1972; Forsythe 1974, 1976). The former authors found an average of 49% as many Herring Gulls at a Kingston, Ontario, landfill site on Sundays at mid-day as on week-days. Cooke and Ross suggested that the gulls flew to the landfill on Sunday mornings, found it to be inactive, and then dispersed to other areas.

3.6 Factors Affecting Choice of Landfill Sites

Several investigators have expressed opinions concerning the factors influencing the attractiveness of a landfill site to gulls, but we know of no systematic study designed to identify such factors.

Availability of food is undoubtedly a major factor affecting attractiveness of landfill sites to gulls. As noted above, gulls quickly cease to use sites where food is no longer available. It is recommended that in order to minimize attractiveness to gulls, food wastes should be exposed for as brief a time as possible, and in as small an area as possible (Davidson *et al.* 1971; Solman 1973). When landfill operations are conducted at night, and the refuse is covered before dawn, numbers of gulls visiting the site are much reduced (van Tets 1965; Solman 1973; Cogswell, cited by Forsythe 1974). Whether the refuse is milled into small fragments does not seem to affect the attractiveness of the landfill to gulls (Ham and Reinhardt 1973; Forsythe 1976).

Results from the Toronto area suggest that the average number of gulls visiting a landfill site is positively related to the daily tonnage dumped, and inversely related to distance between the landfill site and the associated roost (LGL Ltd. 1974). However, this result is very general and not sufficiently well established to use as the basis for predicting numbers that would visit a new landfill site.

Drury (1965) suggested, without corroborative analysis, that the sites attracting the most gulls in the Boston, Mass., area were those with a large open area for loafing, absence of trees at the edge of the site, and presence of a freshwater supply nearby. Cooke and Ross (1972) also indicate the significance of nearby water tc gulls at a landfill site.

3.7 Loafing Areas

Gulls may loaf on land at a landfill site, near their aquatic roost, or at some other location. Flat, open areas such as fields or airports are favoured. When open areas occur near a landfill site, or en route between a landfill site and the roost, they are especially likely to be used by loafing gulls. Blokpoel (1976:132) states that

> 'Particularly troublesome problems arise when birds make regular flights across the airport, for instance when they fly between roosts and feeding areas; and sometimes birds interrupt such flights to loaf or preen on the airfield. The worst problem at many airports is the nearby presence of one or more large refuse dumps that provide free food for a large crowd of regulars, which may then use the airfield to loaf and preen.'

4. OTHER BIRDS ATTRACTED TO LANDFILL SITES

Although gulls are the birds of most concern in the landfill-bird-aircraft relationship, Common Crows *Corvus brachyrhynchos*, Starlings *Sturnus vulgaris*, various icterids (blackbirds, cowbirds, grackles) and pigeons are also a potential hazard. All of these types of birds are commonly attracted to the food available at landfill sites and dumps (Davidson *et al.* 1971; Forsythe 1976). Cowbirds attracted to a dump at an airport in Atlanta, Georgia, were responsible for the crash of a Lear Jet in 1973 (Seubert and Meanley 1974; Blokpoel 1976).

In southern Ontario, concentrations of crows, Starlings and icterids are most likely to occur in late summer and autumn, when these kinds of birds are especially sociable and form large flocks. A large flock of crows was, in fact, seen at or near the Oakville landfill site on both our visits:

- On 17 Oct. 1978, about 250 crows approached from the south at treetop height at 10:00 EST. Most landed in trees adjacent to the site. Several flew to and landed on the landfill at 10:30 as we left.
- On 15 Nov. 1978, about 100 crows were feeding at the landfill site by 07:30 EST. At least 45 of these flew away at treetop height at 08:00 when bulldozer operations began; others flew around the site at altitudes below 200 ft AGL.

In general, the kinds of birds mentioned above are unlikely to fly at altitudes above 300-500 ft during flights to, from or near a landfill site. Flight lines of these birds are unpredictable, but it is quite possible that flocks attracted to or leaving the landfill would cross the approach or climb-out paths of the Burlington Air Park.

Small numbers of other kinds of birds are also likely to feed at any landfill site. It is unlikely, however, that their numbers would be large or that their average density near the proposed landfill site would be markedly increased by the presence of the landfill operation.

5. EVALUATION OF POTENTIAL HAZARD

5.1 Susceptibility of Light Aircraft

Piston-engine aircraft are generally considered to be much less susceptible to damage by birds than are turbine-powered aircraft. Concerning the engines themselves, Blokpoel (1976:43) states that

> 'The propellers on piston-engined aircraft are strong and, although often struck, they are rarely damaged by birds; further, the rotating propeller blades tend to protect the strong piston engines by chopping up the birds, and strikes causing severe damage to piston engines have not been reported. Turbine engines, however, are a different matter altogether. They are usually exposed and are quite vulnerable to bird impact. The rotor and stator blades of the engine's compressor may bend or break on heavy impact...and, in the worst cases are completely destroyed.'

H. Eccles (in Busnel and Giban 1965:69) suggests that, in comparison with jets, propeller aircraft are less likely to be involved in bird/aircraft collisions because their lower speed increases the chances (1) that the pilot will see and avoid the bird, and (2) that the bird will hear or see the approaching aircraft in time to avoid it. This interpretation seems intuitively probable, but documentary evidence is not available. Statistics concerning frequency of collisions between birds and light aircraft are extremely incomplete, but are sufficient to show that collisions do occur.

Low aircraft speed does not guarantee that collisions will always be avoided by action of either the pilot or the bird. Yakobi (1971) reports, for example, that in the Soviet Union the AN-2 accounted for about 13% of the reported bird/aircraft collisions. The AN-2 is a large, single-engined biplane used largely for agricultural work at extremely low altitudes and low speeds. Some birds do attempt to avoid oncoming aircraft (Larkin 1976), but there is no reliable information about the frequency of 'last-second avoidances' in relation to aircraft speed. Furthermore, Blokpoel (1976:59) suggests that gulls cannot accelerate quickly enough to avoid approaching aircraft, and that they sometimes try to outfly the aeroplane rather than dodge to the side.

The energy of an impact between a bird and an aircraft is strongly influenced by their relative speed. The energy of impact is roughly proportional to the square of the closing speed, other factors being equal (Stables and New 1968; McDonnell Douglas 1975; Blokpoel 1976). Since piston-powered aircraft generally fly slower than turbine-powered aircraft, damage to piston aircraft is likely to be less.*

Summaries of the circumstances of collisions between light aircraft and birds are rarely published. One such list published by the British Civil Aviation Authority (CAA 1973) shows that light piston aircraft (single engined and light twins) often collide with birds, most commonly gulls, but that the damage is usually nil or minor.

Birds occasionally do, however, cause serious damage to or even crashes of light aircraft. The first recorded human fatality caused by a bird/aircraft collision occurred in California in 1912 when a gull became entangled in the control cables of a light aircraft (Blokpoel 1976). In 1964, a Turbulent (an extremely small, one-seat piston-engined aircraft) struck a gull during final approach to an airport in Northern Ireland; despite the fact that the windscreen where the gull struck was not broken, the aircraft apparently stalled and the pilot was killed (Stables and New 1968). In 1977, an Aero Commander (twin piston engines), while taking off at Chicago, struck gulls and crashed (P. MacDonald, MOT, pers. comm.). A number of light aircraft and gliders have crashed after striking eagles or hawks (e.g., Blokpoel 1976; Nemergut *et al.* 1976). In some cases these raptors appear to attack rather than to avoid the aircraft. Another fatal crash occurred when a light aircraft, shortly after take-off, struck three geese (Seubert 1976). This incomplete list illustrates the fact that collisions between light aircraft and birds can, on rare occasions, cause human fatalities.

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* A seemingly contradictory report by Morse (1970) is probably explained by biases in statistics; Morse states that, in comparison with jets, a higher proportion of *reported* collisions between light aircraft and birds involve extensive damage. However, collisions with light aircraft are likely to be reported only if they are serious, whereas minor collisions with turbine-powered aircraft are often reported because formal reporting procedures have been established by many countries and operating agencies (Blokpoel 1976).

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APPENDIX 2

EXCERPT FROM TRANSPORT CANADA PUBLICATION TP 1247E,
'LAND USE IN THE VICINITY OF AIRPORTS', 5th ed., Nov. 1985

Transport Canada Transports Canada

Air Air

TP 1247E

AIR NAVIGATION SYSTEM REQUIREMENTS BRANCH

Land Use in the Vicinity of Airports

Fifth Edition
November 1985

Canada

PART III

BIRD HAZARDS

Birds of all types are hazardous to aircraft in the air because they can, through collisions with the aircraft, cause structural damage, loss of engine power, and possibly crashes and human deaths. The hazard created by birds is greatest at, and in the vicinity of airports due to the concentration of aircraft activity close to the ground, where the majority of birds fly.

Airports are naturally attractive areas to many species of birds because the wide open, short grass areas provide the basic elements of security from predators and humans, a place to nest and loaf (just generally sit about) and access to food and water sources. Programs at Transport Canada operated airports effectively reduce this natural attraction of birds to airport lands, primarily through major habitat management and manipulation projects, as well as through day to day vigilance and the use of bird-scaring techniques. While these on-airport activities are effective, they can be neutralized by the presence of attractive land use or activities outside the airport boundary. Hazardous bird types will be persistent in their attempts to use the airport as a convenient stopover and resting place before or after feeding at a nearby location. It is therefore important that land uses in the general airport-surrounding area be regulated with the same goal as on-airport land use, to minimize the attraction to birds.

The following information provides guidelines on the acceptability of different land use practices for the vicinity of airports. General land use practices have been evaluated on their relative attractiveness to the traditionally hazardous bird species.

A. EXTREMELY HAZARDOUS LAND USE PRACTICES:

The following land use practices are extremely attractive to bird species that are:

(i) a high hazard to aircraft because of their larger size, behavioral characteristics (flocking, soaring), and their preference for airport environments, and

(ii) far-ranging in their daily food-searching activities.

These practices are NOT RECOMMENDED FOR AREAS 5 MILES (8.0 KM) OR LESS, FROM THE AIRPORT BOUNDARY, and should be at even greater distance.

Food Waste Landfill Sites

Coastal Commerical Fish Plants

APPENDIX 3

FAA POLICY REGARDING SOLID WASTE DISPOSAL FACILITIES:

A paper by M.J. Harrison, Federal Aviation Administration, Washington,
including FAA Order 5200.5,
'FAA Guidance Concerning Sanitary Landfills On or Near Airports'
(p 213-218 from DOT/FAA/AAS/84-1, Fed. Aviat. Admin., Washington, 1984)

FAA POLICY REGARDING SOLID WASTE DISPOSAL FACILITIES

by

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SUMMARY

The Federal Aviation Administration's (FAA) policy regarding solid waste disposal facilities on and near airports is based on bird strike data, accident information and aircraft performance. Distance criteria used in FAA Order 5200.5, FAA Guidance Concerning Sanitary Landfills on or Near Airports, coincides with distances specified in Federal Aviation Regulation (FAR) Part 77, Objects Affecting Navigable Airspace. FAR Part 77 provides obstruction standards for use in several FAA safety programs designed to provide aircraft with proper clearance from objects.

HISTORICAL DEVELOPMENT OF POLICY

On February 26, 1973, a Learjet departed Peachtree-Dekalb Airport in Atlanta, Georgia, and struck a flock of Brown-headed Cowbirds resulting in complete failure of one engine and partial failure of the other. The pilot was unable to continue the takeoff climb and the plane crashed, killing both pilots, five passengers and one person on the ground. Adjacent to the airport was a sanitary landfill which attracted large numbers of birds. As a result of this accident and because several airports in the FAA's Southern Region also had garbage dumps nearby, the regional office developed a policy specifying that solid waste disposal sites on and near airports represented an incompatible land use.

On October 16, 1974, the Southern Region's policy was adopted nationally and is specified in FAA Order 5200.5. The purpose of an FAA national order is to define FAA policy or procedures and provide guidance to FAA employees on specific issues. Employees of the FAA are responsible for implementing policy within guidelines established in agency orders. With respect to FAA Order 5200.5, FAA employees are expected to assist airport owners in seeking compatible land use through local or state regulations and land use zoning for safety purposes.

CRITERIA DEVELOPMENT

FAA Order 5200.5 was written after consultation with air safety specialists and ornithologists. The order evolves logically from a concept of direct conflict between aircraft and birds. Aircraft are in a high-risk condition from bird strikes during takeoff, initial climb, approach and landing. These airport-dependent flight phases place the aircraft in the low altitude environment which is also occupied by birds. By examining aircraft flight maneuvers and combining information about birds and bird strikes, a high-risk scenario can be developed, forming the basis for the criteria contained in FAA Order 5200.5.

Approximately 62 percent of all reported bird strikes occur at or below 500 feet above ground level (AGL). As altitude increases, the likelihood for bird strikes decreases. In the next 500 foot increment, up to 1,000 feet AGL, only an additional 7 percent of reported bird strikes are added. If an aircraft can takeoff and climb above 500 feet, the bird hazard risk is substantially reduced. As evidenced by bird strike statistics, most bird flight activity is below 500 feet AGL. With the notable exception of migratory flights, most day-to-day flight activity of birds is at low altitudes.

In developing criteria for FAA Order 5200.5, the agency took 500 feet AGL as the level below which a high-risk condition exists from bird hazards. Under normal operating conditions, an aircraft is in this high-risk area the longest during approach and landings, since takeoff and climb occur at a greater rate of change in altitude (feet/nautical mile). It is the approach and landing phase of flight which was used in developing distance criteria for the order.

Two types of fixed-wing aircraft are considered in the order, those powered by engines with pistons and those which are turbine powered (including turboprops). The need to distinguish between these two types of powerplants exists primarily because piston engine power aircraft are most often flown under visual flight rules and approaches are flown in a racetrack style traffic pattern. Turbine engine powered aircraft more frequently fly instrument approaches and straight-in landings as opposed to the visual racetrack pattern flown by piston engine powered aircraft.

The point at which the aircraft descends through 500 feet AGL was used to determine the distance criteria in the order. For piston powered aircraft, this horizontal distance is 5,000 feet. It represents the distance the aircraft is from the runway when it descends through 500 feet during the turn to final for the runway. For turbine engine powered aircraft, the distance is 10,000 feet, which corresponds to passage of the aircraft into the high-risk area at 500 feet while performing a descent on a 3 degree glideslope. These two distances, 5000 feet for airports used by piston engine powered aircraft, and 10,000 feet for airports used or planned to be used by turbine engine powered aircraft, represent minimum distances a solid waste disposal facility should be located from the airport. Some states have already adopted these criteria in their solid waste regulations.

Solid waste disposal facilities outside of these minimum distances are also subject to scrutiny by the agency on a case-by-case basis. If the landfill or other type of disposal facility is located below the conical surfaces defined in FAR Part 77, the landfill may be considered incompatible. The issue here is with birds who frequently feed at landfills (mainly gulls) and soar or spiral over the site to altitudes as high as 3000 feet, where this bird flight behavior may present a hazard to aircraft. FAA would consider the solid waste site as incompatible with air safety because of the hazard caused by soaring gulls or other birds.

The fourth and final criteria relating to compatible use is difficult to address from a zoning standpoint. It covers the situation where a solid waste site is located such that it attracts birds flying from other feeding, watering and/or roosting areas to the solid waste site and in the process, birds fly through aircraft flight patterns. Many of these situations exist and the agency must rely on observations of bird movements in documenting the problem. Likewise, proponents of new solid waste sites find it extremely difficult to determine whether their proposed site may create a flight hazard. Before FAA makes known its position regarding compatibility with a landfill which falls into this criteria, considerable data collection and review of bird and aircraft flight paths is required.

IMPLEMENTING POLICY

Depending on state and local solid waste laws and regulations, FAA states its policy position on specific landfill sites in many ways. In some states, FAA has approval authority on solid waste permit applications. The other extreme of the spectrum is similar to citizen participation in review of a proposed land use. Many states and communities hold administrative hearings before granting or denying permits. FAA frequently provides written and oral testimony at these hearings. FAA also reminds airport management of its responsibilities to achieve safe, compatible land use and FAA frequently works with state aviation organizations to assure safety of flight through compatible land use.

Unique situations may arise where a proposed land use will not create a hazard. Authority to waive criteria rests with FAA's Associate Administrator for Airports in consultation with other headquarters elements. Regional and field personnel provide necessary information for review of the situation. FAA will usually respond to the state or local community with a letter specifying no objection to a proposed permit or license to operate if evidence shows no hazard will exist.

CONCLUSION

FAA Order 5200.5 defines the policy regarding solid waste related bird hazards which has worked well since 1974 in preserving aviation safety. FAA is encouraging states to adopt solid waste regulations protecting the aircraft operator from unnecessary bird hazards. A copy of FAA Order 5200.5 is included in this paper.

ORDER DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

5200.5

10/16/74

SUBJ: FAA GUIDANCE CONCERNING SANITARY LANDFILLS ON OR NEAR AIRPORTS

1. PURPOSE. This order provides guidance concerning the elimination or monitoring of open dumps, waste disposal sites, and sanitary landfills on or in the vicinity of airports.

2. DISTRIBUTION. This order is distributed to Washington headquarters and Regional Airports, Flight Standards and Air Traffic offices to division level; all Airports District Offices; and Flight Standards and Air Traffic field facilities.

3. BACKGROUND. Garbage dumps, sanitary landfills or whatever title is used for this type of operation attract rodents and birds, erodes the airport environment, and where the dump is ignited, creates smoke - all which are undesirable and are potential hazards to aviation.

While the chance of an unforeseeable, random bird strike in flight will always exist, it is nevertheless possible to define the high-risk conditions within fairly narrow limits. Those high-risk conditions exist in the take-off, climb-out, approach and landing areas on and in the vicinity of airports. The increasing number of bird strikes reported on aircraft has become a matter of concern to the FAA and to airport management. Various studies and observations have resulted in the conclusion that sanitary landfills are artificial attractants to birds. Accordingly, landfills located in the vicinity of an airport may be incompatible with safe flight operations. Those conditions that are not compatible must be eliminated, to the extent practicable. Airport owners need guidance in making this decision, and the FAA must be in a position to assist. Some airports are not under the jurisdiction of the community or local governing body having control of land usage in the vicinity of the airport. In these cases, the airport owner should use its influence and best efforts to close or control landfill operations within the general vicinity of the airport.

4. ACTION.

a. Sanitary landfills located within the areas established for an airport by these guidelines as set forth in paragraph 5 of this order should be closed. If a sanitary landfill is determined as incompatible land use under guidelines of paragraph 5 and cannot be closed within a reasonable time, it should be designed and operated in accordance with the criteria and instructions issued by the Environmental Protection Agency, the Department of Health, Education and Welfare, and other such regulatory bodies that may have applicable requirements. FAA should advise airport owners against locating, permitting or concurring in the location of a landfill on or in the vicinity of airports.

b. The operation of a sanitary landfill located beyond the areas described in paragraph 5 and designed in accordance with the guidelines identified in the foregoing paragraph must be properly supervised to insure compatibility with the airport. If at any time the landfill, by virtue of its operation, presents a potential hazard to aircraft operations, the owner shall take action to correct the situation or terminate operation of the landfill. Failure to take corrective action could place the airport owner in noncompliance with the commitments under a grant agreement.

c. An inspection of current operations at existing landfill sites which have a reported potential bird hazard problem will periodically be made and evaluated. A Bird Hazard Group formed under Order 5200.4 dated 11/20/73 could appropriately be available for consultation regarding this activity. Should it be found that birds attracted to the landfill site do in fact constitute a potential hazard to aircraft, the condition will be reported to AAT-430, National Flight Data Center (NFDC), for possible inclusion in the Airman's Information Manual. The appropriate FAA office should immediately evaluate the situation to determine compliance with the grant agreement and take such action as may be warranted under the guidelines as prescribed in Order 5190.6, Airports Compliance Requirements.

d. This order does not apply to landfills used exclusively for the disposal of rock and earth.

e. This order is not intended to resolve all related problems, but is specifically directed toward eliminating sanitary landfills in the proximity of airports, thus providing a safer environment for aircraft operations.

f. The airport operations manual should require landfill site inspections at least semimonthly for those landfill operations that cannot be closed to assure that bird population is not increasing.

g. Additional information on solid waste disposal, bird hazard and related problems may be obtained from the following agencies:

Bureau of Sport Fisheries and Wildlife
U.S. Department of the Interior
18th and C Streets, N.W.
Washington, D.C. 20240

Office of Solid Waste Management
Programs (HM-562)
U.S. Environmental Protection Agency
1835 K Street, N.W.
Washington, D.C. 20406

U.S. Department of Health, Education & Welfare
330 Independence Avenue, S.W.
Washington, D.C. 20201

5. CRITERIA. Sanitary landfills will be considered as an incompatible use if located within areas established for the airport through the application of the following criteria:

a. Landfills located within 10,000 feet of any runway used or planned to be used by turbojet aircraft.

b. Landfills located within 5,000 feet of any runway used only by piston type aircraft.

c. Landfills outside of the above perimeters but within the conical surfaces described by FAR Part 77 and applied to an airport will be reviewed on a case-by-case basis.

d. Any landfill located such that it places the runways and/or approach and departure patterns of an airport between bird feeding, water, or roosting areas.

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