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## **THE USE OF NIGHT LANDFILLING TO REDUCE BIRD HAZARDS TO AIRCRAFT SAFETY**

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**Abstract:** The Atlantic County Utilities Authority (ACUA) operates a ‘bulky waste’ (non-putrescible waste) landfill at a site that is 10,300 ft from the end of the main runway at the Atlantic City (NJ) International Airport (ACY). The airport supports the Federal Aviation Administration’s Technical Center. The ACUA also operates a transfer station at its site. Municipal solid waste (msw = putrescible) is delivered to the transfer station during the day. Previously, the msw was loaded onto transfer trucks and shipped to an out-of-state landfill. In October 1997, the ACUA received a permit to conduct a 2-year experiment to dispose of the msw at its own landfill at night. The night landfilling was designed to prevent birds from feeding at the waste and creating a hazard to aircraft.

The research project is subject to intensive monitoring and the results for the first 15 months are presented in this paper. At the time of writing, 12 months had been completed. During this period, no birds were attracted to the active waste disposal area during 314 nights of landfilling. The question then became were birds, primarily gulls, attracted to the covered msw area during the following day. A bird control program was in place at the landfill and a biologist conducted regular surveys. Several hundred gulls flew directly over the site every morning en route to inland feeding areas. Gulls were present on the covered msw disposal area only 4 times during 249 days when Biologist Surveys were conducted.

The ACUA night landfilling experiment has been successful. The paper will present the results of the monitoring program and discuss why this approach was successful at this location and why the approach might or might not be successful at other locations and situations.

## **Introduction**

Under Permit from the New Jersey Department of Environmental Protection (NJDEP), the Atlantic County Utilities Authority (ACUA) is experimentally disposing of municipal solid waste (msw) in its landfill at the Haneman Environmental Park in Egg Harbor, New Jersey. The msw is disposed of at night to reduce attractions to birds that might create a bird hazard to aircraft safety at the Atlantic City International Airport (ACY) located about 2 miles away. The experiment is being closely monitored to insure that bird hazards to aircraft safety are not created. This paper summarizes the results of the monitoring for the 12-month period 15 December 1997 to 14 December 1998.

Disposal of about 100 tons of msw per week night began at the ACUA site on 14 October 1997. This was increased to 300 tons per night beginning on 16 December 1997. Disposal begins no earlier than one hour after sunset and is completed about 5-6 hours later. The msw is compacted during disposal and it is then covered with 6 inches of cover material. The cover material is carefully checked by the ACUA Night Landfill Manager and any exposed waste is covered before operations terminate for the night. Any msw that is received that is in excess of the permitted disposal limits is unloaded in the transfer station and then loaded onto transfer trucks that carry the waste to an out-of-state landfill.

On 17 September 1998, the NJDEP modified the ACUA permit to allow disposal of up to 800 tons of msw per night with a weekly maximum of 3,600 tons per week. Waste disposal was increased to 6 nights per week.

Several monitoring activities are being conducted. These are described below and the results for this period are presented.

## **Night Observations**

The first question to be asked about night landfilling is whether diurnal species such as gulls are attracted to the site at night. To evaluate this question, observations are made at the landfill when waste is being delivered, the active working face is exposed, and food is available to species, such as gulls. Table 1 summarizes the results of the night observations for the study to date.

Two types of observations are made. The Night Manager at the landfill is the equipment operator. He is active at the site during the entire period when it is lighted. Gulls or other species attracted to the waste would be very obvious to him. The Night Managers have not seen any birds at the site during the 314 nights of observations to date (Table 1). In addition, observations at the landfill are made about twice per week by a biologist, usually by the second author, ACUA's Wildlife Biologist. The biologist has not recorded any birds at the msw disposal area on the 117 nights with biological observations.

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**Table 1. Summary of Gull Observations during night disposal of MSW at the ACUA Landfill Site- 1997-98**

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<u>Period</u>	<u>Night Staff Observations</u>		<u>Biologist Observations</u>	
	<u># Nights Observed</u>	<u># Nights with gulls</u>	<u># Nights Observed</u>	<u># Nights with gulls</u>
<b>1997</b>				
14 Oct-14 Nov	24	0	9	0
15 Nov-14 Dec	19	0	6	0
15 Dec-14 Jan	21	0	10	0
<b>1998</b>				
15 Jan-14 Feb	22	0	8	0
15 Feb-14 Mar	19	0	8	0
15 Mar-14 Apr	22	0	9	0
15 Apr-14 May	22	0	9	0
15 May-14 Jun	21	0	8	0
15 Jun-14 Jul	24	0	8	0
15 Jul-14 Aug	23	0	8	0
15 Aug-14 Sep	20	0	9	0
15 Sep-14 Oct	26	0	10	0
15 Oct-14 Nov	27	0	7	0
15 Nov-14 Dec	<u>24</u>	<u>0</u>	<u>8</u>	<u>0</u>
Totals	314	0	117	0

No diurnal birds have been recorded on or adjacent to the active landfill at night during the 12 months of this study or during the two preceding months.

### **Cover Inspections**

Gulls regularly fly inland from the coast in the morning to feed. Many of these birds pass over the ACUA site. It is essential, therefore, to insure that no food is visible through the daily cover at the msw disposal area. If food is exposed, it will be seen by the gulls, which will then be attracted to the site. As noted, the daily cover applied at night is carefully examined by the Night Manager. As an extra precaution, the cover is inspected in the morning by the ACUA Biologist. If any food is exposed, it is immediately covered by hand or by using the day shift's equipment. During the first fourteen months, there was one major and five minor instances where exposed food was discovered during the morning inspections necessitating at least some remedial action. The failsafe precaution of an early morning inspection has proven its value.

Because of the importance of insuring that no food particles from the msw are visible during the day, the active disposal areas used for the msw and for the bulky waste are kept separate. The separation insures that the compactors used on the inedible bulky waste, which is disposed of during the day, do not inadvertently expose food (msw) waste deposited on a previous night.

### **Daytime Observations**

Gulls frequented the ACUA site before the disposal of msw began. Small numbers of gulls occasionally visited the bulky waste landfill where they were scared off by pyrotechnics fired by the equipment operators. The main gull attraction was a substantial area of standing water (=Flats Pond) to the east of the active landfill cells. This large flat area and its standing water provided excellent loafing habitat for gulls during their flights to and from inland feeding areas. Gulls loafing in this area were beyond the range of the pyrotechnic pistols used by the equipment operators; thus, the loafing gulls were not harassed. The area of standing water was being filled, as supplies of demolition debris became available. The filling of the Flats Pond was essentially completed in late August of 1998. Thus, a major element of the loafing habitat at the ACUA site was eliminated. Canada Geese also used this area.

During much of 1998, construction of a new cell, Cell 4, was ongoing adjacent to the operating Cell 2. Waste disposal into Cell 4 began in the evening of 4 December 1998.

Bird numbers at the ACUA site are monitored in several ways that are discussed in the following sections.

## **Permit Surveys**

Bird numbers at the ACUA site have been monitored since 1992 under the terms of various Permit Conditions issued by the NJDEP. The surveys involve thrice daily counts at each unit of the ACUA site. These include the Administration Building, Recycling Center, Vehicle Maintenance Center, Transfer Station, Vegetative Composting Site, Landfill Excavation Area (= the flats), Landfill Cell 1, Landfill Cell 2, and Sedimentation Pond. These sites are visited at 07:00, 11:00 and 15:00, six days per week. The landfill cells have also been visited at 09:00 in recent years to determine whether gulls have been attracted to residue from the recycling center that was disposed of between 08:00 and 09:00. This residue was diverted to the msw (Type 10) waste stream on 12 March 1998 and the 09:00 survey was deleted after that date.

These Permit Surveys have been conducted by landfill staff who have received minimal, basic training. The surveys have been conducted in the same manner since 15 June 1992. Therefore, the results can be used to document trends in bird numbers over the years.

To allow comparisons among years, the results of the Permit Surveys for the period 15 December 1997 to 14 December 1998 in each of the 6-7 years from 1992-93 to 1998 were summarized. The data for the landfill (landfill cells plus the flats) are summarized in Figure 1. In this figure, the highest numbers of gulls recorded on any single survey of the landfill during each month are presented. From this figure it is clear that the numbers of gulls utilizing the ACUA landfill area have been greatly reduced since the bird control program was instituted in October 1997. This reduction applies to all months.

The use of the maximum numbers of gulls seen (Figure 1) provides a worst case approach. In Figure 2, the monthly averages of the peak daily counts are examined. This is a more appropriate measure since it provides information over the entire month and is less susceptible to sampling biases and errors. The data for the average of the peak daily counts for all years and all months are summarized in Figure 2. Again, the substantial reductions in gull numbers brought about by the gull control program are evident in all 12 months that are depicted.

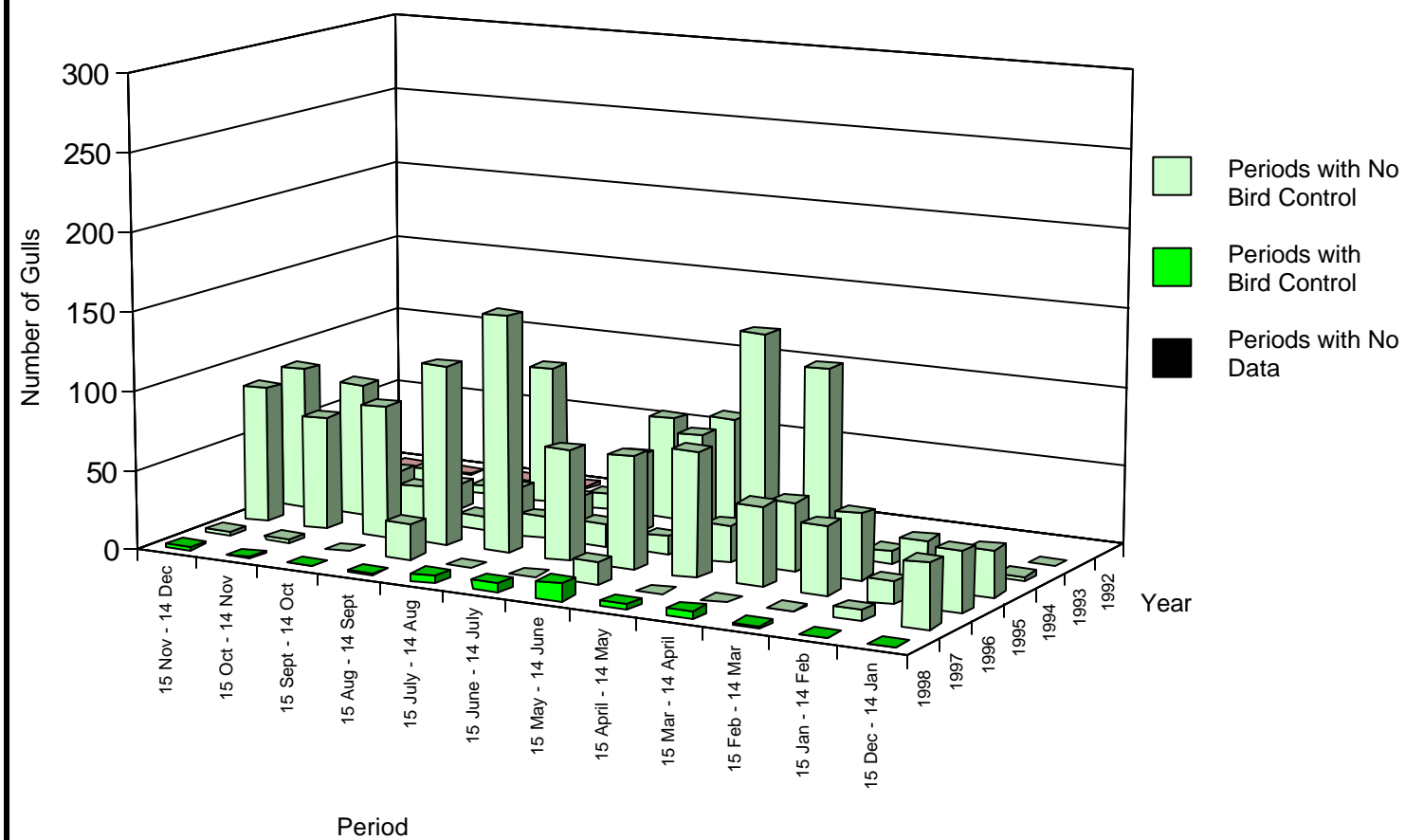
## **Biologist Surveys**

The most important bird areas on the site are also surveyed five times on most days by the ACUA Biologist. These surveys are expected to record more individuals and more information about their behavior than are the surveys by landfill staff. Thus, the results are not directly comparable with the Permit Surveys. It is for this reason that the Permit Surveys were continued in their traditional format for the first year of the full monitoring program. An additional difference is that the Biologist Surveys are interrupted to disperse any gulls that are found at the site.

The results of the 1,174 Biologist Surveys for the period (15 December 1997 to 14 December 1998) are summarized Table 2. Over the full year, gulls were present at the landfill area



**Figure 2. Average Peak Daily Counts of Gulls at Landfill by Month  
At the ACUA Environmental Park**





**Table 2. Numbers of gulls recorded during the Biologist Surveys at ACUA Site - 1997-98.**

Period	Landfill/Flats					Transfer Station		
	# of Surveys	# Surveys With Gulls (%)	# of Gulls Sighted	Peak #	# of Gulls /Survey	# Surveys With Gulls (%)	# of Gulls Sighted	# of Gulls /Survey
15 Dec-14 Jan	99	12(12%)	65	41	0.7	4(4%)	4	0.0
15 Jan-14 Feb	100	22(22%)	83	22	0.8	10(10%)	12	0.1
15 Feb-14 Mar	87	25(29%)	359	169	4.1	4(5%)	4	0.0
15 Mar-14 Apr	94	14(15%)	352	97	3.7	1(1%)	2	0.0
15 Apr-14 May	92	31(34%)	1001	97	10.9	6(7%)	48	0.5
15 May-14 Jun	91	24(26%)	761	165	8.4	18(20%)	102	1.1
15 Jun-14 Jul	82	16(29%)	220	47	2.7	29(35%)	165	2.0
15 Jul-14 Aug	91	29(32%)	462	66	5.1	32(35%)	148	1.6
15 Aug-14 Sep	95	13(14%)	111	18	1.2	21(22%)	75	0.8
15 Sep-14 Oct	111	2(2%)	5	4	<0.1	2(2%)	7	0.1
15 Oct-14 Nov	121	10(8%)	98	35	0.8	0(0%)	0	0.0
15 Nov-14 Dec	111	16(14%)	521	100	4.7	0(0%)	0	0.0
Overall	1174	214(18%)	4038	169	3.4	127(11%)	567	0.5

on 18% of the surveys and at the transfer station 11% of the time. The peak number of gulls at the landfill area was 169 and the average number was 3.4 gulls (Table 2). The average number of gulls at the transfer station was 0.5 with almost all sightings being of Laughing Gulls during the May through mid September period (Table 2). Overall, there was an average of 3.9 gulls on the site during each survey.

It is clear from the Biologist Surveys that the gulls were not attracted to the ACUA site by the presence of the municipal solid waste (msw) when the cover was complete. Gulls were recorded at the covered msw disposal area only 4 times during 248 days when Biologist Surveys were conducted. In 3 cases, 16 July, 2 September and 29 October, there were small gaps in the cover that were discovered by the biologist during his early morning inspection. Gulls were easily scared off with pyrotechnics until the cover was repaired. The fourth incident, which occurred on 28 November, was more serious. Torrential rains washed the cover material off the msw exposing the food to gulls. Three biologist surveys conducted before the msw could be re-covered averaged nearly 100 gulls per survey. Control efforts during the period were intensive until the waste was re-covered whereupon the gulls left the area.

### **Weekend Surveys**

Gulls sometimes feed at landfills during the weekend when the landfills are closed. The ACUA Biologist conducted spot checks of the landfill on Sundays to insure that gulls were not feeding at the covered msw site. None have been found feeding there, although 4 Laughing Gulls were present on the Flats on 26 July and 13 Ring-billed Gulls were loafing on the Flats on 13 December (Table 3). Any loafing gulls using the area during the weekend visits are dispersed from the site.

### **Bird Control Activities**

Gull control activities presently occur at two levels at the ACUA site. The equipment operators at the bulky waste disposal area fire pyrotechnics at any gulls that investigate or land nearby. The numbers of shots by the equipment operators in each month period are summarized in Table 4.

The amount of control required, as measured by the numbers of pyrotechnic shells fired, varied over the 12-month period. The increase to 6-8 shots per day in the 15 January-14 March period was associated with influxes of gulls driven inland from the coast during storms and periods of strong east and northeast winds. The increased control efforts in the mid May through mid July period (Table 4) were necessitated by the increased numbers of gulls in the area and the presence of Laughing Gulls that were somewhat harder to control. While the numbers of shots during 15 May-14 June (17.1/day) and 15 June-14 July (16.6) are relatively high compared to other months, they

Table 3. Surveys of the ACUA Environmental Park on weekend days when the landfill is closed.

Date	Day	Time	Vegetative Composting	Flats	Cell 2 Bulky Area	Cell 2 MSW Area	Transfer Station
<b>1997</b>							
26-Oct	Sun	15:00	---	0	0	0	---
09-Nov	Sun	15:00	---	0	0	0	---
23-Nov	Sun	11:00	0	0	0	0	Mal-3, Str-13
07-Dec	Sun	15:00	Cr-2	0	0	0	Cr-3, Str-7
<b>1998</b>							
11-Jan	Sun	8:00	0	CG-32	0	0	Mal-2, Str-14
25-Jan	Sun	10:00	Cr-4	CG-8	Str-25	0	Mal-14, Str-35
08-Mar	Sun	11:00	0	CG-7, BIDk-2	Cr-3, Str-17	0	CG-12, Mal-4
19-Apr	Sun	13:00	Cr-6	CG-4, Mal-2	Cr-8	0	CG-2, Mal-1, Str-18
17-May	Sun	14:30	0	CG-6	0	0	Mal-1, Cr-1, Str-4
21-Jun	Sun	11:30	BIDk-7	CG-18	0	0	Mal-5, Cr-1, Str-2
26-Jul	Sun	7:30	BIDk-4	LG-4	0	0	Mal-4, Cr-3
16-Aug	Sun	8:00	0	0	0	0	Mal-2, Cr-1, Str-6
13-Sep	Sun	8:00	0	0	0	0	0
20-Sep	Sun	8:30	Cr-3	0	0	0	Cr-3, Str-7
27-Sep	Sun	7:00	0	0	0	0	CG-12
04-Oct	Sun	7:00	0	0	0	0	0
11-Oct	Sun	7:00	0	0	0	0	CG-6, Mal-2
18-Oct	Sun	7:00	0	0	0	0	0
25-Oct	Sun	15:00	0	0	0	0	Cr-2, Str-12
01-Nov	Sun	7:30	0	0	0	0	0
08-Nov	Sun	7:30	0	0	0	0	0
15-Nov	Sun	7:30	0	0	0	0	0
22-Nov	Sun	7:30	0	0	0	0	0
29-Nov	Sun	7:30	0	0	0	0	0
6-Dec*	Sun	7:00	0	0	0	0	Str-25
13-Dec	Sun	7:30	0	RbG-12	0	0	0

\* Cell 4 Bulky and Cell 4 MSW replace Cell 2 from this date onward.

CG=Canada Goose; Mal=Mallard; RbG=Ring-billed Gull; Cr=Crow; Str=European Starling

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**Table 4. Summary of gull control effort by ACUA Equipment Operators - 1997-98.**


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<b>Period</b>	<b># of Days</b>	<b># Pyrotechnic Shots</b>	<b># Shots Per Day</b>
15 Dec-14 Jan	25	0	0.0
15 Jan-14 Feb	27	183	6.8
15 Feb-14 Mar	24	202	8.4
15 Mar-14 Apr	28	119	4.3
15 Apr-14 May	26	173	6.7
15 May-14 Jun	26	444	17.1
15 Jun-14 Jul	26	432	16.6
15 Jul-14 Aug	27	150	5.6
15 Aug-14 Sep	25	83	3.3
15 Sep-14 Oct	26	43	1.7
15 Oct-14 Nov	27	20	0.7
15 Nov-14 Dec	25	24	1.0
Overall	312	1873	6.0

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are still small compared to the numbers used at many landfills. For example, the Britannia Landfill near Toronto's Pearson International Airport routinely fires over 200 shots per day.

The second level of control is provided by the ACUA Biologist. The main areas of gull use at the ACUA site have been the flats area and pond to the east of Landfill Cell 2. Gulls were formerly mostly undisturbed when they bathed, drank, and loafed in this area. Now, they are dispersed whenever they are found there. Also, the pond has now been filled and was unavailable to birds after late August 1998. The results of the Biologist's control efforts are summarized in Table 5.

The numbers of control events by the ACUA Biologist increased as the numbers of gulls at the site increased through the winter and spring (Table 5). The highest levels were reached in the 15 May-14 June period when the numbers of control events averaged 6.4 per day and the numbers of gulls per event averaged 23.3 (Table 5). During this period, the average number of shots per control event rose to 1.8 or an average of 11.4 shots per day. This is in addition to the 17.1 shots fired by the equipment operators. In practice, average days do not occur very often. On some days, large numbers of gulls visited the site and control events were frequent, whereas on other days little control effort was required.

Control efforts declined through the summer (Table 5). By the 15 August-14 September period, the number of control events per day had declined to 3.3 with an average of 1.1 shots per event and an average flock size of 6 gulls. The decline continued into the fall with the number of control events ranging from 0.3 to 0.9 per day in the last 3 months. There was, however, an increase in the number of shots per control event (1.65) and the number of gulls per event (19.9) in the 15 November-14 December period. Most of this increase was caused by the events of the morning of 28 November when heavy rain washed away the cover over the msw that had been deposited the previous night. Over 15 pyrotechnics were fired during 3 control events involving 130 gull sightings. Without this episode the number of pyrotechnic shots per control event would have been 1.1.

### **Regional Monitoring**

It is important to understand the seasonal changes in gull numbers in the region surrounding the ACUA site so that any changes at the site can be correctly interpreted. Two types of surveys were conducted to assess regional numbers: Morning Flyover Observations and Offsite Observations.

#### **Morning Flyover Observations**

Gulls in the Atlantic City region spend the night at roosts on water along the coast. In the morning, many of these gulls fly inland to feeding areas that can be many miles, or even tens of miles, from the coast. Thus, there is a morning movement of gulls over the ACUA site to inland

**Table 5. Summary of bird control effort by the ACUA Biologist - 1997-98.**

Period	# of			#			# Gulls Sighted	# Gulls Peak #	# Gulls Per Event
	# Days on Duty	Control Events	# Events Per Day	Pyrotechnic Shots	# Shots Per Day	# Shots Per Event			
15 Dec-14 Jan	21	15	0.71	4	0.19	0.27	92	41	6.1
15 Jan-14 Feb	21	31	1.48	35	1.67	1.13	112	22	3.6
15 Feb-14 Mar	18	39	2.17	60	3.33	1.54	585	205	15.0
15 Mar-14 Apr	20	25	1.25	30	1.50	1.20	571	97	22.8
15 Apr-14 May	19	71	3.74	96	5.05	1.35	1415	97	19.9
15 May-14 Jun	18	116	6.44	205	11.39	1.77	2699	165	23.3
15 Jun-14 Jul	17	77	4.53	111	6.53	1.44	702	63	9.1
15 Jul-14 Aug	21	150	7.14	196	9.33	1.31	1128	51	7.5
15 Aug-14 Sep	20	66	3.30	75	3.75	1.14	396	32	6.0
15 Sep-14 Oct	24	8	0.33	8	0.33	1.00	23	7	2.9
15 Oct- 14 Nov	26	13	0.50	13	0.50	1.00	133	35	10.2
15 Nov- 14 Dec	23	20	0.87	33	1.43	1.65	398	57	19.9
Overall	248	631	2.54	866	3.49	1.37	8254	72.7	13.1

areas. The numbers and species of gulls involved vary with season. These variations are monitored from the ACUA site. In the period from 15 minutes before sunrise to 120 minutes after sunrise, the numbers of gulls passing directly over the site ranged from 22 to 441 during the 15 December 1997 to 14 December 1998 period. It is clear that the numbers of gulls in the Atlantic City region are largest in spring and summer and that the gulls pass inland over a period of several hours. Thus, the stated numbers are minimum estimates.

### **Offsite Observations**

The offsite survey covered 15 inland areas that are attractions to gulls. These included regional and local shopping malls, schools and campuses, urban parks, a racetrack, and a farm. Gulls feed and loaf at these sites independent of any activities at the ACUA Environmental Park. Thus, the offsite surveys provide a good estimate of the relative numbers of gulls travelling inland at any particular time of year. The surveys were conducted weekly with the results for the one-year study period presented in Table 6.

The average numbers of gulls at each site during the 52 surveys are summarized in Table 7. The averages ranged from 0.5 at the closed pig farm to 56.5 at Hamilton Mall, a large regional mall. Overall, the 15 sites averaged 215.6 gulls per weekly survey. The average number of gulls per site per survey was 14.4 birds. This compares with an average of 3.9 gulls per Biologist Survey at the ACUA site. The latter average is based on 1,174 surveys over 248 days (Table 2). It is clear that the numbers of gulls at the ACUA site now fall comfortably within the range of background levels for sites in the Atlantic County area.

### **Conclusions**

The results of the first two months and the next 12 months (reported here) of msw disposal at the ACUA site have been very encouraging. Birds have not visited the msw disposal area at night. The cover at the msw disposal area has been excellent. Thus, during the day, gulls do not feed at the msw landfill. Furthermore, gulls have not shown interest in the covered msw area, even though many gulls have flown directly over it. On a couple of occasions, small amounts of food showed through the cover and control was needed for a short period until the integrity of the cover was restored. On one occasion, the cover was compromised by heavy rain and some gulls did attempt to feed at the site. Intensive pyrotechnic control measures were needed until the cover was repaired.

Overall, the numbers of gulls present, and the time spent loafing, at the ACUA site have been greatly reduced through harassment by the ACUA Biologist and the equipment operators. The increase in tonnage of msw disposal has not increased the number of birds and there have been no detrimental effects on air safety.

Table 6. Summary of Gull Numbers in the Vicinity of the ACUA Park - 28 Nov 97 to 13 Mar 98.

Date:	Start:	Location														TOTAL SIGHTINGS	
		Birch Grove Pk	Rickels	Cardiff Plaza	Shore Mall	English Creek	Hamilton Mall	AC Race Course	Stockton College	Absegami HS	Galloway Munic.	Pitney Rd. PS	Kraly's Pig Farm	Smithville	Starn's Shoprite		Holy Spirit HS
28-Nov	10:00	21	22	1	35	38	93	0	0	0	0	0	0	0	0	0	210
05-Dec	9:50	28	44	2	8	11	167	0	0	0	0	0	2	28	1	4	295
19-Dec	10:30	39	17	1	0	10	117	0	1	0	0	0	0	17	0	0	202
26-Dec	10:15	20	61	0	0	20	158	0	0	0	2	0	0	18	11	2	292
02-Jan	12:35	1	0	7	2	16	121	0	0	0	0	1	0	18	7	0	173
09-Jan	10:30	18	13	0	5	20	83	16	0	0	3	0	0	41	25	28	252
23-Jan	12:30	12	22	0	0	14	117	3	0	0	0	1	0	23	18	12	222
27-Jan	10:30	0	56	0	0	2	126	0	0	0	0	0	0	8	1	32	225
06-Feb	10:30	16	8	2	3	27	131	0	0	3	0	0	0	19	14	25	248
13-Feb	10:30	9	11	0	0	17	118	12	0	0	0	0	0	15	21	8	211
20-Feb	10:30	16	7	0	1	16	113	2	0	0	0	0	0	20	7	22	204
26-Feb	13:30	10	6	0	9	37	89	6	0	0	2	0	0	19	14	23	215
06-Mar	10:30	21	13	2	6	13	96	9	0	2	0	0	0	12	8	17	199
13-Mar	12:30	26	11	0	4	23	112	6	0	0	0	0	0	31	12	27	252
19-Mar	12:30	26	7	0	0	9	14	57	0	0	6	25	0	24	13	15	196
27-Mar	10:40	2	18	0	0	13	45	0	0	0	0	0	0	27	0	4	109
03-Apr	11:15	8	25	0	0	15	87	0	0	0	0	0	0	12	11	8	166
08-Apr	10:30	17	26	0	0	9	29	0	0	0	0	0	0	18	11	16	126
17-Apr	10:30	65	0	0	0	83	11	176	1	6	15	8	0	27	11	123	526
24-Apr	11:00	19	8	0	1	0	70	2	0	0	0	2	1	17	22	30	172
01-May	11:00	33	12	4	7	35	52	37	11	9	23	12	0	17	8	41	301
04-May	11:30	16	17	0	3	43	42	12	3	0	0	0	0	28	11	32	207
13-May	10:30	70	18	3	8	50	34	5	7	3	12	18	2	41	27	62	360
20-May	12:30	29	10	21	7	17	42	6	2	0	0	0	1	34	15	30	214
29-May	10:30	26	35	11	15	39	56	23	14	7	27	5	3	26	32	56	375
05-Jun	10:30	14	22	4	6	32	48	16	3	0	0	0	0	41	23	31	240
12-Jun	14:00	33	48	16	23	49	82	94	32	27	38	26	6	37	36	77	624
17-Jun	10:30	16	23	2	8	34	36	0	1	0	0	0	0	21	27	41	209
26-Jun	10:30	23	15	0	1	13	22	3	0	0	0	0	0	15	32	17	141
02-Jul	10:30	18	24	1	3	6	5	0	2	0	0	0	2	23	17	30	131
10-Jul	10:30	24	15	0	2	1	4	4	0	0	0	0	0	13	10	21	94
17-Jul	10:30	15	20	0	3	22	24	0	0	0	0	0	0	7	31	17	139
24-Jul	10:30	34	11	3	1	16	35	2	0	0	0	0	1	12	7	22	144
31-Jul	12:30	18	13	0	0	34	26	4	1	0	0	0	0	18	16	40	170
07-Aug	14:30	12	8	2	6	14	21	2	3	0	0	0	3	16	19	9	115
14-Aug	11:30	23	31	1	4	35	42	0	7	0	0	0	1	26	37	29	236
18-Aug	0:30	17	21	2	0	31	30	0	0	0	0	0	0	13	27	17	158



**28-Aug 10:30 29 31 3 12 40 22 48 17 8 24 13 2 25 27 36 337**  
**Table 6. Summary of Gull Numbers in the Vicinity of the ACUA Park - 28 Nov 97 to 13 Mar 98.**

Date:	Start:	Location														TOTAL SIGHTINGS	
		Birch Grove Pk	Rickels	Cardiff Plaza	Shore Mall	English Creek	Hamilton Mall	AC Race Course	Stockton College	Absegami HS	Galloway Munic.	Pitney Rd. PS	Kraly's Pig Farm	Smithville	Starn's Shoprite		Holy Spirit HS
02-Sep	13:20	9	12	0	0	21	17	0	0	0	0	0	0	16	31	11	117
11-Sep	10:30	36	27	2	6	95	38	3	0	4	0	0	0	15	37	33	296
18-Sep	12:30	15	6	4	2	41	51	0	0	0	0	0	0	18	24	16	177
25-Sep	10:30	8	21	2	0	22	47	8	0	0	0	0	0	6	20	7	141
02-Oct	10:30	4	14	6	2	37	50	22	1	0	0	0	0	14	32	24	206
06-Oct	12:30	3	28	9	6	55	62	31	0	0	0	0	0	23	21	34	272
16-Oct	10:30	14	17	3	1	26	33	0	0	0	0	0	0	11	29	12	146
23-Oct	10:30	4	12	0	2	3	3	74	0	0	0	0	0	7	26	22	153
30-Oct	14:30	2	8	2	4	32	48	12	0	0	0	0	1	16	35	39	199
06-Nov	10:30	11	23	4	0	36	55	3	0	0	0	0	0	24	17	15	188
12-Nov	10:30	10	18	0	1	30	42	27	0	0	0	0	0	11	31	26	196
20-Nov	12:30	8	13	2	6	41	64	7	1	0	0	0	0	12	37	30	221
25-Nov	10:30	14	22	0	2	33	42	5	0	0	0	0	0	17	22	12	169
04-Dec	12:30	3	25	0	3	28	35	0	0	0	0	0	0	6	28	6	134
11-Dec	10:30	12	11	2	6	23	51	1	0	0	0	0	1	14	40	11	172

**Table 7. Average numbers of gulls at various sites in Atlantic County on 52 surveys during 15 December 1997 to 14 December 1998.**

<b>Location</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Total Gulls</b>	<b>Mean</b>
Birch Grove Park	0	70	951	18.3
Rickels	0	61	973	18.7
Cardiff Plaza	0	21	122	2.3
Shore Mall	0	23	185	3.6
English Creek Center	0	95	1,413	27.2
Hamilton Mall	3	158	2,940	56.5
Atlantic City Race Course	0	176	738	14.2
Stockton College	0	32	114	2.2
Absegami High School	0	27	69	1.3
Galloway Municipal	0	38	152	2.9
Pitney Road Public School	0	26	111	2.1
Krayls Pig Farm	0	6	25	0.5
Smithville	6	41	1,015	19.5
Starns Shop Right	0	40	1,075	20.7
Holy Spirit High School	0	123	1,327	25.5
<b>Overall</b>			11,210	215.5

Overall mean per site survey =14.4  
Average at ACUA site (Biologist Survey) = 3.9