DRAFT TECHNICAL MEMORANDUM
SURVEY OF WILDLIFE ACTIVITY IN THE EVAPORATION PONDS AREAS AT THE YERINGTON MINE SITE

ABSTRACT

The Atlantic Richfield Company (ARC) conducted studies at the Yerington Mine Site (Site) to determine if the former lined evaporation ponds and the operational pumpback ponds were being used by wildlife and whether such use would result in significant contact with Site surface water and sediments. Two study methods, infrared-triggered camera trapping and point count surveys of bird populations, were used to compare wildlife usage of these ponds to several sewage treatment ponds nearby. The camera trap and point count surveys show that several types of wildlife are potentially exposed to water or sediment in the pumpback and lined evaporation ponds, but that wildlife site use and contact with these media appears to be much less than that in the nearby sewage treatment ponds.

INTRODUCTION

The Yerington Mine is an inactive copper mine in northern Nevada located amidst shrub-steppe habitat (Figure 1). The major natural aquatic feature in the vicinity of the Site is the Walker River, which flows north-northeast between the Site and the town of Yerington, and flows within a quarter mile of the Site at its southeastern end. The Walker River and surrounding areas are located along the Pacific Flyway migratory bird route (Zimmerman 1998) and provide habitat for several species of birds and resident mammals, including mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), and black-tailed jackrabbit (*Lepus californicus*). Although riparian systems comprise an extremely small fraction of the Great Basin region, they are critical centers of biodiversity; more than 75 percent of the species in the region are strongly associated with riparian vegetation (Brussard and Dobkin 2006). The Walker River is typical of Great Basin riparian systems in being dominated by woody plants, such as cottonwood and aspen (*Populus* spp.), and willows (*Salix* spp.). Saltbush (*Atriplex* spp.) may be abundant if riverbank soil is saline (Anonymous 2001). The riparian corridor of the Walker River is likely a strong attractant for both resident and migrating wildlife in an arid landscape, as it provides vegetative cover, water, and aquatic habitat.

The proximity of the Site to the Walker River likely increases site use by wildlife; for example, migratory birds initially attracted by the river may discover and come to rest on the aquatic areas of the Site. The Site contains bodies of water, some of which may attract area wildlife. These features include a large pit lake, pumpback evaporation ponds, lined evaporation ponds, sewage treatment ponds, process ponds, localized areas associated with heap leach pads, and other depressional areas that may collect water. Water levels in many features fluctuate seasonally or may become dry during the summer months or extended

drought periods as a result of local climatic conditions. Water levels in the pumpback evaporation ponds are actively managed. The Yerington Pit Lake, pumpback evaporation ponds, and sewage treatment ponds contain water year-round. The Walker River also provides irrigation to agricultural fields located north of the Site. The transport via ditches and drains, and localized ponding of irrigation water on agricultural fields in the area of the Site may also attract wildlife.

In April 2006, an unidentified bird was found dead near standing fluids in the sulfide tailings area at the Site, and this occurrence was reported to the U.S. Environmental Protection Agency Region 9 (EPA), the regulatory agency responsible for the Site. Subsequent investigations revealed elevated levels of metals and low pH in the pumpback and lined evaporation ponds (USEPA 2006 pers. comm.). Consequently, EPA has expressed concern that wildlife exposed to the pumpback and lined evaporation ponds may be harmed and has requested that ARC evaluate potential mitigation measures to prevent wildlife exposure to these waters. Migratory birds, in particular, were thought to be at risk of potential exposure through contact with and ingestion of mine site waters. Birds such as ducks, grebes, and coots, which seek refuge on waters when threatened, account for the majority of avian deaths at similar mine sites (Read 1999). Consequently, a study was undertaken with the following objectives:

- To determine the presence of and types of wildlife in pumpback evaporation, lined evaporation, and sewage treatment pond areas
- To determine what animals are most likely exposed to the waters of these ponds
- To determine level of use of the pond areas by wildlife to help focus mitigation decisions
- To make preliminary recommendations for the types of mitigation measures that might be effective in minimizing wildlife exposure to the ponds.

Ponded or standing water at the Site may be accessible to a variety of desert wildlife, from nocturnal mammals and migrating birds to diurnal resident songbirds. Study methods were designed to capture both the diversity and the abundance of species present in these pond areas. In addition, a numerical basis of comparison of the numbers and species of birds among the pond sites was developed because birds were thought to be among the animals most likely exposed to the pond waters.

METHODS

Two study methods were implemented to identify wildlife: infrared-triggered camera trapping of terrestrial access points to pond waters, and point count surveys of bird populations in the different pond areas. The infrared-triggered camera trapping study was designed to identify the types of wildlife and exposure present at Site waters and the relative wildlife activity among the three different pond sites. The goals of the point count surveys were to compare bird diversity, richness, and abundance among pond sites.

Infrared-triggered Camera Trap Survey

Six infrared triggered digital camera traps (Silent Image PM35)[1] were deployed on the Site: five on April 5, 2007 and one on May 14, 2007.[2] The camera traps ran continuously from their dates of deployment until their collection on July 10, 2007. Each camera trap contained a 1 gigabyte (GB) memory card (capable of storing more than 20,000 photographs) and was powered by eight C-cell alkaline batteries; maintenance visits consisting of battery and memory card replacement occurred approximately once per month (May 14 and June 6, 2007) to ensure continuous camera operation. The cameras were placed at points along pond shorelines where mammals were likely to approach pond waters (e.g., along apparent animal paths). Three traps were located around the northern pumpback evaporation pond, one trap was located by the dry lined evaporation pond, and two traps were located by the eastern sewage treatment ponds (Figure 2). The cameras were secured to steel fence posts at a height of approximately 1 meter, and their fields of view were positioned with non-overlapping fields of view to portray animals along the shores and in the waters of the ponds (Figure 3). The cameras' infrared triggers were adjusted to their most sensitive setting, and the cameras were programmed to take three photographs 1 second apart at each trigger (motion) event with no latency period between events. These settings were designed to provide constant surveillance of access points. The sensitivity of these settings also resulted in high potential for false positive imagery. Consequently, images were downloaded after the first month of observation and inspected for false positive photos. Camera No. 1 was repositioned at that time to eliminate triggering images by vehicles on a nearby maintenance road and by sporadic discharge of water in a nearby culvert.

Each digital photograph taken by a camera trap was downloaded to a photographic database[3] and then exported to a photo management system for image classification and editing[4]. Photographs were organized by camera trap location and sorted by date and time before analysis. All three photographs taken during a trigger event were labeled with keywords for animal types and behaviors identified in any or all of the photographs in the sequence. Photographs from trigger event sequences without any apparent animals in the frame were determined to be false positive events, and were removed from further analysis. The presence of one or more animals in any one of the frames in a photographic series defined a motion event. Animal contact with water or sediment in any one of the frames in the photographic series defined an exposure event. Camera and keyword metadata were then combined in a single database[5] for statistical analysis. Wildlife activity and exposure levels, as measured by numbers of motion or exposure events per camera trap, were compared between pond areas using general linear models of natural log-transformed data.

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[1] Silent Image, Reconyx, LLP, 3828 Creekside Lane Suite 2, Holmen, WI 54636.
[2] Camera No. 6 was not available at the beginning of the survey and was deployed at the SW corner of the North Pumpback Pond on May 14, 2007.
[3] Silent Image, Reconyx, LLP, 3828 Creekside Lane Suite 2, Holmen, WI 54636.
[4] Photoshop Lightroom 1.3.1, Adobe Systems Incorporated, 345 Park Avenue, San Jose, CA 95110.
[5] Access 2003, Microsoft Corp., Redmond, WA, 98053

Point Count Survey

Point count surveys were conducted according to a design modified from standard methods (Ralph et al. 1993, Nur et al. 1999, Hostetler and Main 2006). These surveys comprised repeated measures of bird presence and numbers around the pumpback evaporation, lined evaporation, and sewage treatment ponds. Due to low, sparse vegetation and little apparent habitat on Site, the observation points were designed with large (100 m) radii; each point count lasted 10 minutes; and the field of view was limited to the pond associated with observation point. Thirteen count stations were distributed between two transects to maximize observation coverage of the study ponds: six stations were located in the pumpback evaporation pond area, six in the lined evaporation pond area, and one in the sewage treatment pond area (Figure 4). The surveys were conducted by two observers trained in bird identification; observers switched transects each day to minimize individual observer bias. A survey was conducted in April 2007 to coincide with predicted peak waterfowl migration, and a May 2007 survey was conducted to measure migrating shorebirds (Oring et al. 2006). During each survey period, point counts were conducted daily at each station at times of high bird activity beginning approximately 1 hour before dawn and again beginning approximately 2 hours before sunset. In addition to recording bird species and numbers, point count observers noted any incidence of birds' exposure to Site waters.

Count data of species abundance (number of individuals) and richness (number of species) were compared among pond sites by Poisson regressions and were also used to estimate indices of community diversity, evenness, and similarity (Magurran 1988).

RESULTS

Infrared-triggered Camera Trap Survey

The six camera traps deployed at the Yerington Mine took a total of 73,580 photographs over 97 days. A total of 30,434 of these photographs contained one or more animals (Figure 5), representing 10,145 motion events and 6,069 exposure events distributed over the three ponds (Table 1).[6] Birds, mammals, and reptiles that were identified in the photographs and the frequency of their observation for each of the ponds are summarized in Table 2. Few animals were observed in the lined evaporation ponds, where camera traps recorded a total of six coyote and three jackrabbits. For the pumpback ponds, jackrabbits and shorebirds each accounted for about 44 percent of the 1,590 animal observations. At the sewage treatment ponds, waterfowl, songbirds, and shorebirds collectively accounted for 89 percent of the 37,507 animal observations.

[6] All photos are provided as an Adobe Photoshop Lightroom catalog in Appendix B.

The camera by the dry lined evaporation pond captured three motion events over the season. The cameras at the pumpback evaporation ponds captured 175 events per active camera. At the sewage treatment ponds, 4,808 motion events were taken per camera. For analysis, the photograph counts in each area were converted to numbers of motion events per camera per day. This method allowed us to account for the different numbers of cameras near each pond and for the third camera that was added later in the season to monitor the pumpback evaporation pond. The average numbers of motion events per camera per day were 0.031 in the lined evaporation pond area, 2.4 in the pumpback evaporation pond area, and 67 in the sewage treatment pond area (Figure 6). Statistical comparisons by GLM show that there is a highly significant ($p<<0.001$) relationship between pond location and the number of motion events per day. Multiple comparisons among means show that the number of motion events in the lined evaporation ponds were significantly less than those in pumpback ponds, which in turn were significantly lower than those in the sewage treatment ponds (Table 3).

The number of exposure events per camera (sequences of three frames in which one or more animals were seen touching water) varied by pond type (Table 1). The camera traps at the sewage treatment ponds captured 2,928 exposure events per camera; those in the pumpback evaporation ponds captured 71 exposure events per camera.

Species on camera exposed to sediment or water at the pumpback evaporation ponds included shorebirds (American avocet, killdeer, sandpiper species) and mammals (black-tailed jackrabbit, coyote). Animals exposed to water or sediment captured on camera at the sewage treatment ponds included waterfowl (American coot, duck species), shorebird (American avocet, killdeer), songbird (yellow-headed blackbird, sparrow species), raptor (great horned owl), and mammal (black-tailed jackrabbit, coyote) species (Table 4). The camera traps at the sewage treatment pond captured signs of on-site breeding, including photographs of chicks of American coot, American avocet, yellow-headed blackbird and duck species, and courting and copulation of yellow-headed blackbirds.

Point Count Survey

A total of 17 point count surveys were conducted at the Site; the results of these surveys are summarized in Table 5 and listed comprehensively in Appendix A. These data were then normalized by numbers of point count stations per pond area for statistical comparisons and for determination of ecological indices of diversity, evenness, and similarity. The normalized measures of bird abundance and species richness were 5 to 10 times greater in the sewage treatment pond than in other areas (Table 6, Figure 7, Figure 8). The Shannon diversity and evenness indices were higher in the lined evaporation pond and pumpback pond areas than in the sewage treatment ponds (Table 7). These results indicate similar numbers of bird species in the three areas but dominance by higher abundances of some species (e.g., yellow-headed blackbird) at the sewage treatment ponds. Comparisons of community similarity indices confirm this observation. Sorenson's qualitative similarity index, which is based exclusively on presence of species, indicates that the lined evaporation ponds and pumpback evaporation ponds were more similar to each other than either one was to the

sewage treatment ponds. Sorenson's quantitative similarity index, which is based on both presence of species and their abundance, clearly shows that the evaporation and pumpback ponds are similar to one another but dissimilar in comparison to the sewage treatment ponds.

Seventy-two incidents of bird exposure to sediment or water were observed during point counts. Six of these occurred on the dried sediment of the lined evaporation ponds, 26 in the sediment or waters of the pumpback evaporation ponds, and 40 in the sediment or waters of the sewage treatment ponds (Table 8). Birds exposed to dry sediment in the lined evaporation pond area included songbirds (horned lark, raven) and a raptor (American kestrel). In the pumpback ponds, observations of exposure were predominantly of shorebirds (65 percent) and songbirds (19 percent). In the sewage treatment ponds, observations of exposure were predominantly of waterfowl (63 percent) and shorebirds (19 percent). When normalized by number of point count stations and surveys, there were 0.059 exposure incidents per station per survey in the lined evaporation ponds, 0.25 exposure incidents per station per survey in the pumpback evaporation ponds, and 2.3 exposure incidents per station per survey in the sewage treatment ponds.

DISCUSSION

The camera trap and point count surveys both confirmed the presence of animals at the ponds located in the northern portion of the Site. They also demonstrated differences in animal presence and activity among different ponds. While both surveys reflected common trends in bird presence, abundance, richness, and activity at the different areas of the Site, only the camera-trap survey provided information on mammal activity near the ponds. Combined, both survey methods provided strong evidence that animals used all three pond areas, and that the sewage treatment ponds were used significantly more by a higher number of animals than the lined evaporation and pumpback evaporation ponds.

The rate ratios derived from the point count analysis of bird abundance (Table 6) demonstrate this trend: for every 100 birds counted at the sewage treatment ponds, an expected seven would be counted at the pumpback evaporation ponds and five would be counted at the lined evaporation ponds. These findings complement the results of the camera trap survey, which indicate that animal activity at the sewage treatment ponds was more than 25 times higher than at the pumpback evaporation ponds, and nearly 2,200 times higher than at the lined evaporation ponds. Both survey methods' estimates of animal exposure to sediment or water were higher in the sewage treatment ponds than in the other two areas. The point count survey captured animal exposure to the dried sediments of the lined evaporation ponds; the camera trap did not. The camera traps did record evidence of black-tailed jackrabbits and American avocets drinking from the pumpback ponds, which is a behavior that was not seen during point count surveys.

Observed differences in animal activity among the surveyed ponds were likely attributable to differences in the ponds' characteristics during the spring of 2007. The sewage treatment

ponds appeared rich in nutrients: their waters visibly supported algae and invertebrates, and emergent vegetation and shoreline trees provided apparent shelter. These characteristics made the sewage treatment ponds apparently suitable for the greater variety of birds, mammals, and reptiles than were observed at the other ponds.

In contrast to the sewage treatment ponds, the pumpback evaporation ponds contained no emergent vegetation; shoreline vegetation was limited to graminoids and low-lying shrubs. Emergent insects were observed in the waters of the north pumpback evaporation pond; these may have attracted the shorebirds that the camera traps and point count observers recorded foraging in the pumpback evaporation pond waters. A pair of ring-necked ducks were observed in the water and on the shore of the pumpback evaporation ponds, and may have been sheltering or foraging there. Both ducks exhibited head shaking and repetitive preening, which are normal behaviors that are often associated with maintenance, foraging, or social interaction. Head shaking has also been associated with discomfort by laboratory birds exposed to low pH and metalliferous water (Hooper et al. 2007), but at concentrations generally much higher than previously reported in the pumpback ponds (USEPA 2006, pers. comm.).

The lined evaporation ponds did not contain standing water in 2007, and nearby vegetation was limited to sparse patches of graminoids and widely-spaced shrubs. The lack of water in the lined evaporation pond probably explains why the camera trap, which was placed to capture animals drinking from the pond's predicted edge, recorded only three motion events (two coyotes and a black-tailed jackrabbit). Most birds in the lined evaporation pond area during the point count survey were seen from the northern stations, which overlooked a strip of shrub habitat between the pond banks and a road. Birds which were apparently exposed to the dried sediments of the ponds themselves included horned larks that were seen singing on the sediment of the lined evaporation pond; a raven and a kestrel perched on the dried sediment; and a pair of northern rough-winged swallows that were nesting in a pipe protruding from the northern lined evaporation pond's banks.

Unlike measures of abundance, richness, activity, and exposure, measures of avian community diversity and evenness were not highest at the sewage treatment ponds. This observation is explained by the predominance of a few species (especially yellow-headed blackbirds) at the sewage treatment ponds, combined with the occasional observations in the pumpback and lined evaporation pond areas of birds that were not seen in other areas (e.g., lesser yellowlegs and American kestrel). By all other measures, the sewage treatment ponds contained higher quality habitat than the other ponds.

SUMMARY

Studies were conducted at the north end of the Site to determine if the former lined evaporation ponds and the operational pumpback ponds are being used by wildlife and whether such use results in significant contact with Site contaminated surface water and sediments. Two study methods, infrared-triggered camera trapping and point count surveys

of bird populations, were used to compare wildlife usage of these ponds to several sewage treatment ponds nearby. Both methods confirmed wildlife presence at each of the three pond types but differences in animal presence and activity among pond types were observed.

Six camera traps captured a total of 30,434 animal photographs, including birds, mammals, and reptiles. The lined evaporation ponds (which were dry in 2007) had the lowest average numbers of motion events per active camera per day at 0.031 followed by the pumpback evaporation ponds at 2.4 and the sewage treatment ponds at 67; all of which were significantly different from one another. The number of exposure events (animals contacting water or sediments) per camera differed by pond type with none at the evaporation ponds, 71 at the pumpback ponds, and 2,928 at the sewage treatment ponds. The camera traps at the sewage treatment pond also captured evidence of on-site breeding, including photographs of courtship, copulation, and chicks.

Seventeen point count surveys were conducted at the Site with results normalized to the number of stations at each pond. Bird abundance and species richness were highest and indices of diversity and evenness were lowest at the sewage treatment ponds in comparison with the evaporation and pumpback ponds. Bird abundance and species richness in the sewage treatment ponds were respectively 4 to 10 times that in the lined and pumpback evaporation ponds. Based on community similarity indices the lined evaporation ponds and the pumpback ponds were more similar to each other than either one was to the sewage treatment ponds.

Bird exposure to sediment or water was observed on 72 occasions during the point count surveys. Exposure incidents per station per survey were 0.059 for the lined evaporation ponds, 0.25 for the pumpback ponds, and 2.4 for the sewage treatment ponds. Observations of exposure were predominantly of songbirds and a raptor in the evaporation ponds, shorebirds and songbirds in the pumpback ponds, and waterfowl and shorebirds in the sewage treatment ponds.

The camera trap and point count surveys show that several types of wildlife inhabit and are exposed to the Yerington Mine pumpback and lined evaporation ponds, but that wildlife site use and contact with sediment or water in these areas appears to be much less than in the nearby sewage treatment ponds

ACKNOWLEDGEMENTS

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FIGURES

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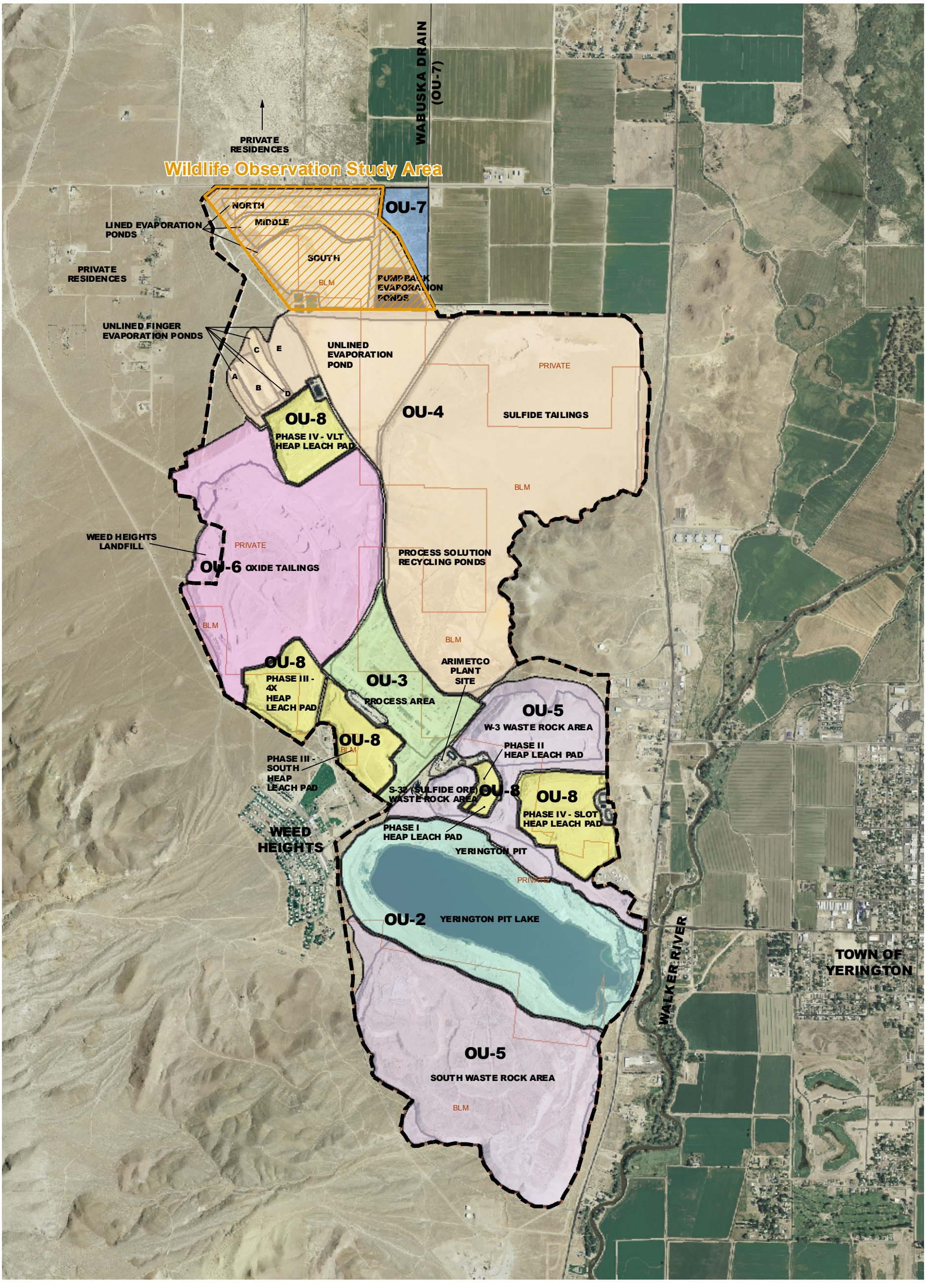

NOTES:
1.) PROJECTION: NEVADA STATE PLANE, WEST ZONE 1927 NORTH AMERICAN DATUM (FEET)
2.) BASE PHOTO TAKEN OCTOBER 3, 2001
3.) LAND STATUS OBTAINED FROM BLM 2002

EXPLANATION

- MINE SITE BOUNDARY
- MINE UNIT
- BLM - PRIVATE LAND BOUNDARY

Note: Operable Units designations provided by EPA. The Sitewide Groundwater OU (OU-1) is not shown.

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integral consulting inc.

Date: Mar 2008

Atlantic Richfield Company

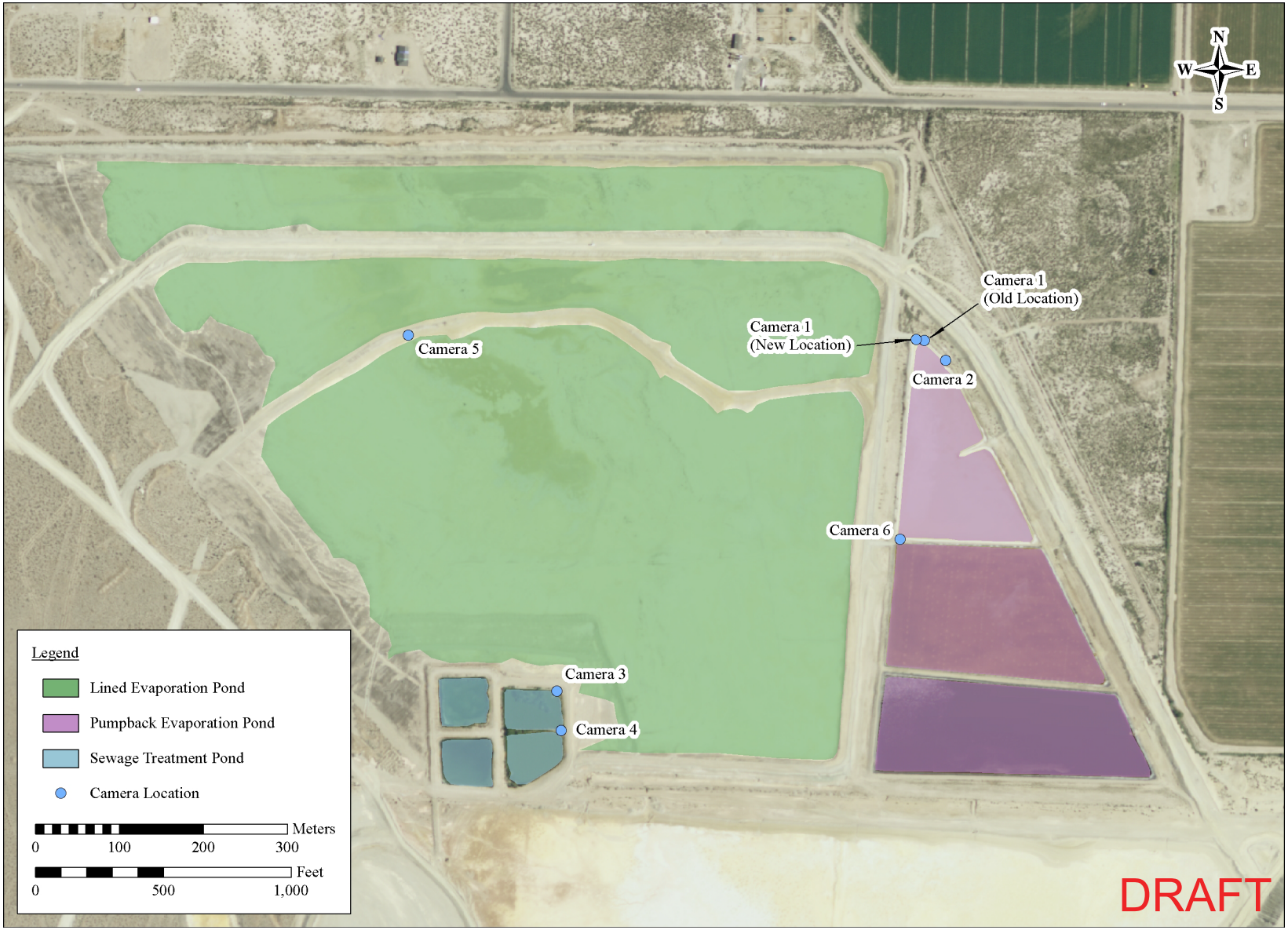
Project: 134557

N W E S

1,000 500 0 1,000 2,000 Feet

Figure 1

Yerington Mine Operable Units and Arimetco Facilities



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Yerington Mine, Nevada

Figure 2

Location of Infrared-Triggered Camera Traps

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Figure 3

Infrared-triggered Camera Trap and Approximate Field of View of North Pumpback Evaporation Pond

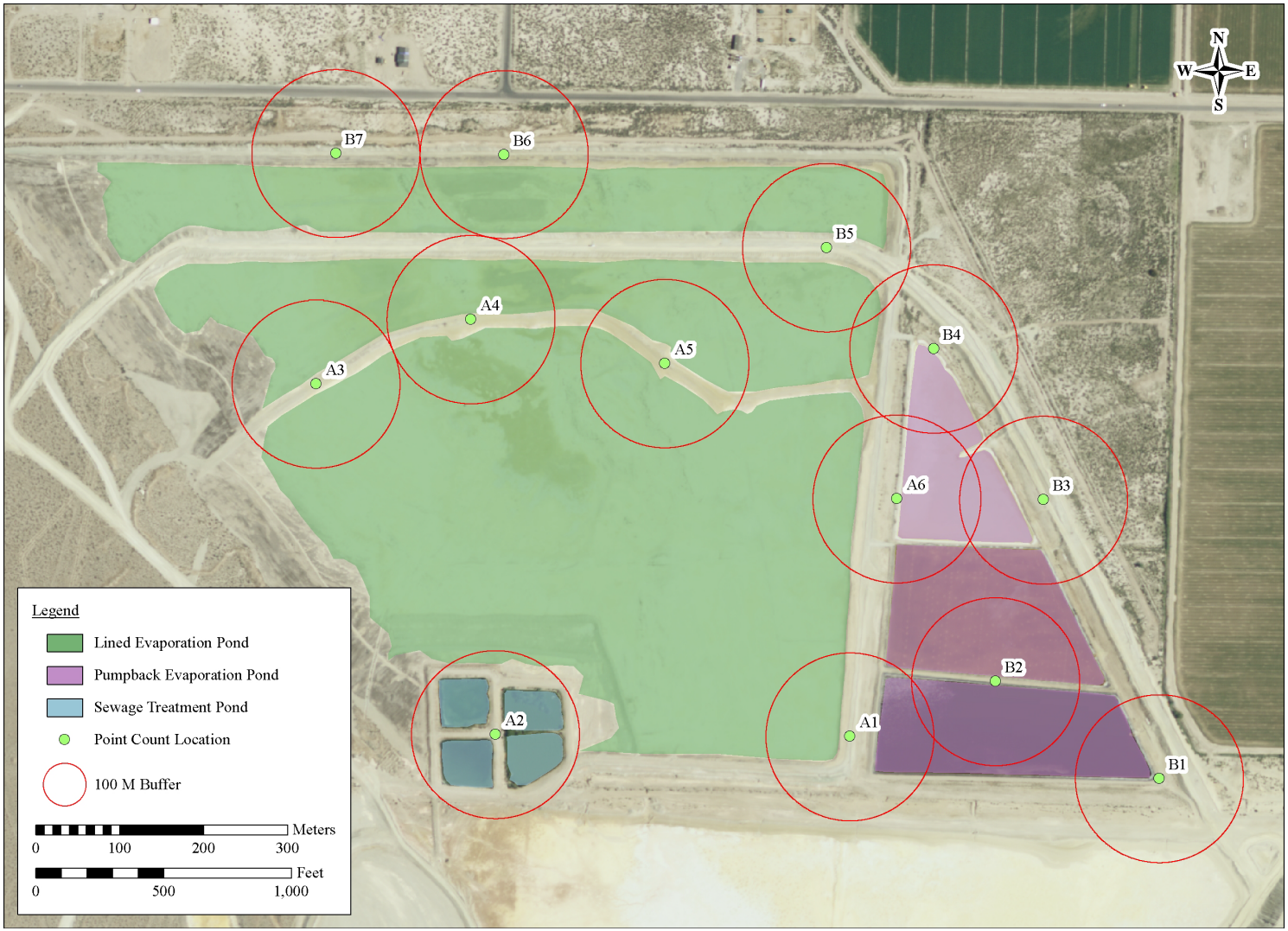

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Figure 4

Location of Point Count Stations at Yerington Mine Evaporation Ponds, Pumpback Ponds, and Sewage Treatment Ponds

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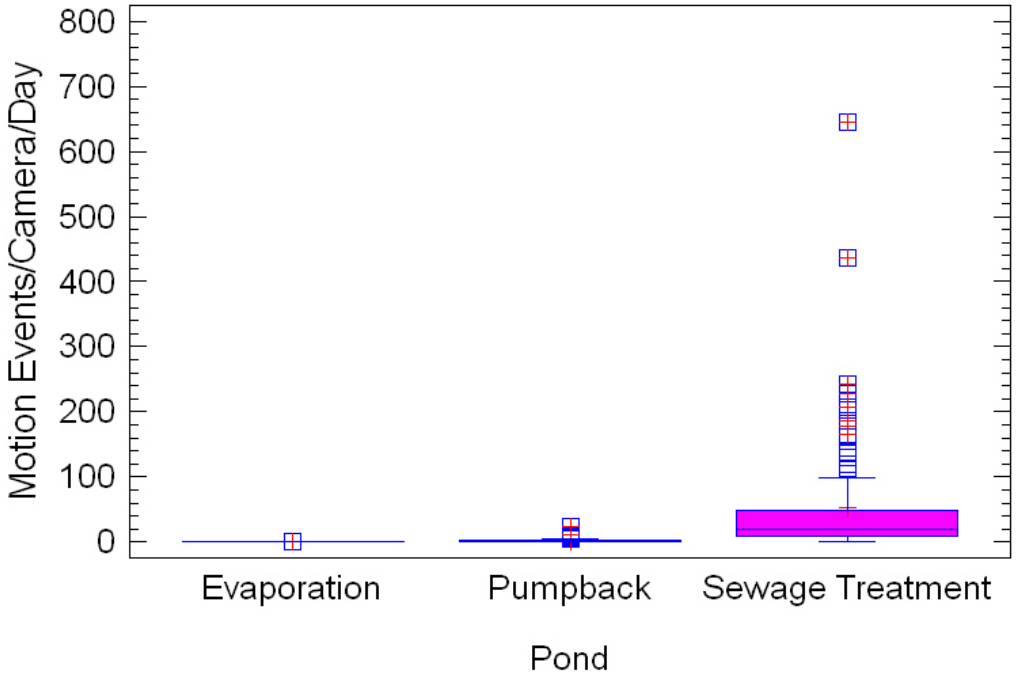
Figure 5

Example of Exposure Event Captured by Infrared-Triggered Camera Trap at Northern Pumpback Evaporation Pond



Note: The boxes represent the interquartile range; the dark line is the median. The outer fences represent the highest and lowest values within 1.5 times the quartile range from the median.

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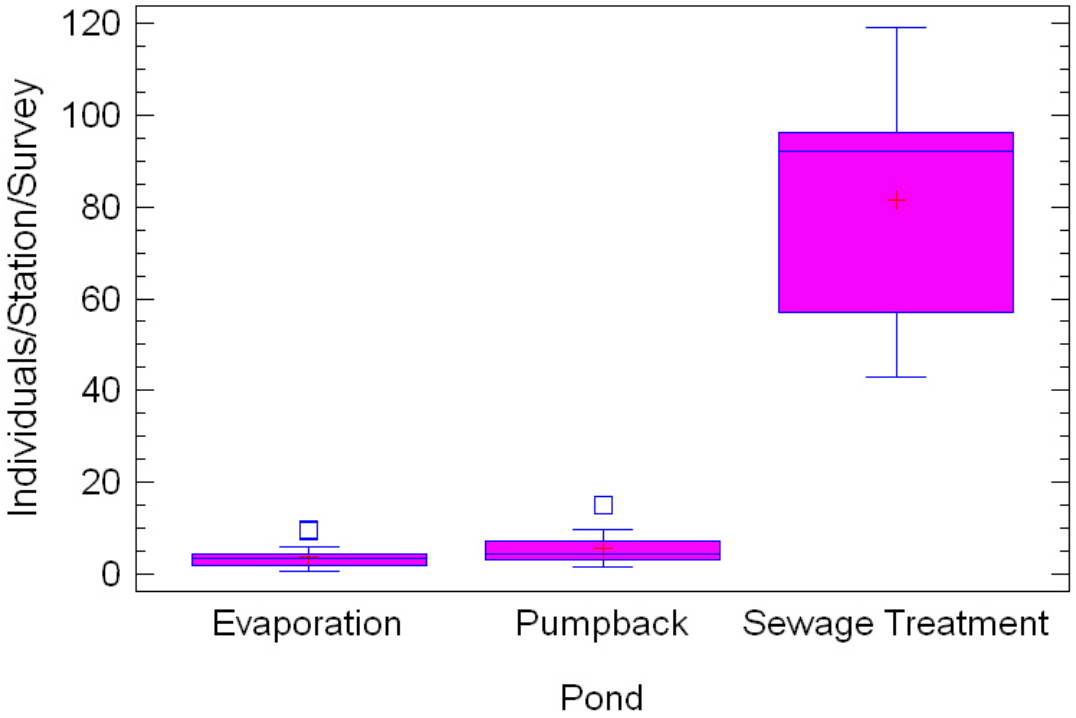
Figure 6

Boxplot of Motion Events Per Day Per Camera in Three Different Areas of the Yerington Mine



Note: The boxes represent the interquartile range; the dark line is the median. The outer fences represent the highest and lowest values within 1.5 times the quartile range from the median.

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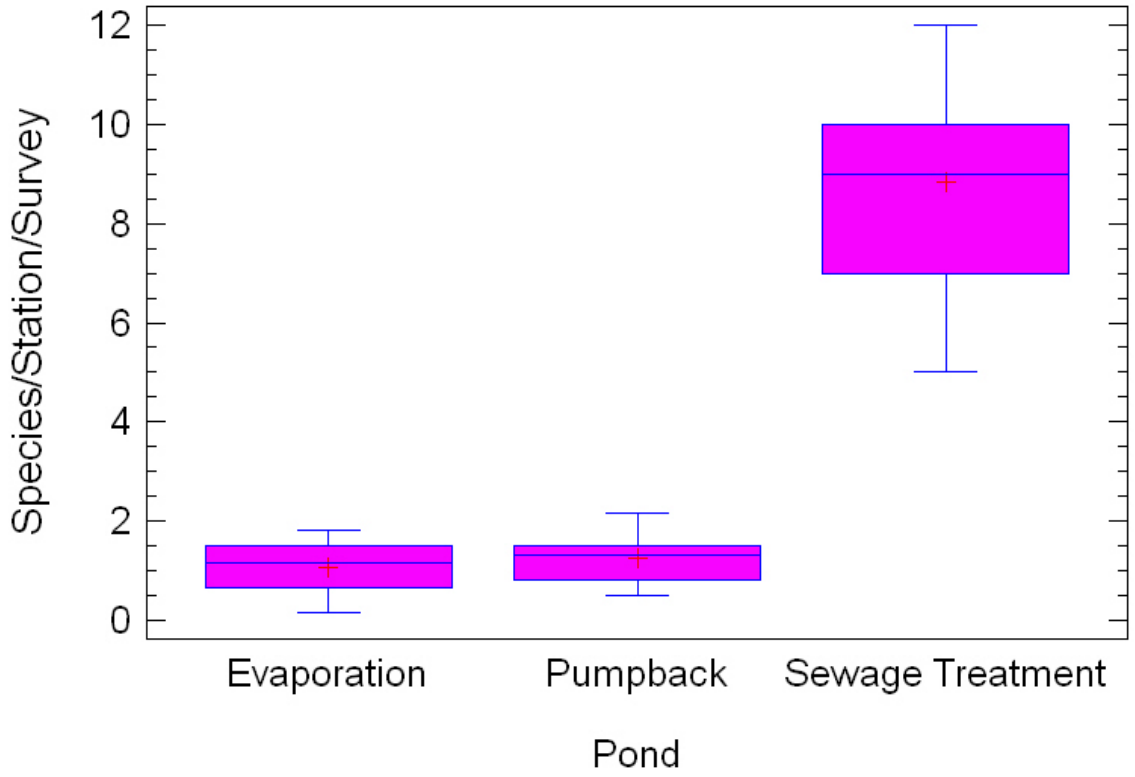
Figure 7

Boxplot of Individual Birds Counted Per Station in Three Different Areas of the Yerington Mine



Note: The boxes represent the interquartile range; the dark line is the median. The outer fences represent the highest and lowest values within 1.5 times the quartile range from the median.

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Figure 8

Boxplot of Distinct Bird Species Counted Per Station in Three Different Areas of the Yerington Mine

TABLES

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Table 1. Camera Trap Activity Patterns.

Event Category	Lined Evaporation	Pumpback	Sewage Treatment
No. cameras	1	3	2
Observation days	97	97[a]	97[b]
Motion events			
Per area	3	526	9616
Per camera	3	175	4808
Per camera/day	0.031	2.4	67
Exposure Events			
Per area	N/A	214	5855
Per camera	N/A	71	2928
Per camera/day	N/A	1.21	40.7
% Motion Events	N/A	0.406844106	0.608881032

Notes:

[a] Camera No. 3 at the North Pumpback Pond was deployed on May 14, 2007, and was only operational for 67 days.

[b] Camera No. 2 at the Sewage Treatment Ponds ran out of available memory on June 23, 2007, and was only operational

Table 2. Wildlife Observed in Camera Trap Photographs.

Animal Type	Species	Lined Evaporation	Pumpback	Sewage Treatment
Birds				
Doves	Mourning Dove	0	0	747
	Rock Dove	0	0	9
Galliform	California Quail	0	3	0
Raptors	Great Horned Owl	0	0	21
	Unknown Owl	0	3	3
Shorebirds	American Avocet	0	312	1,248
	Killdeer	0	354	3,768
	Killdeer Chick	0	0	3
	Sandpiper sp.	0	15	0
	Unknown Shorebird	0	12	144
	White-faced Ibis	0	0	3
	Wilson's Phalarope	0	0	9
Songbirds	Dark-eyed Junco	0	0	12
	Raven	0	15	57
	Sparrow sp.	0	0	24
	Starling	0	3	18
	Swallow sp.	0	0	3
	Unknown Songbird	0	15	123
	Western Kingbird	0	63	36
	White-crowned Sparrow	0	0	297
	Yellow-headed Blackbird	0	0	10,791
Waterfowl	American Coot	0	0	3,435
	American Coot Chick	0	0	531
	Canada Goose	0	0	123
	Cinnamon Teal	0	0	6
	Mallard	0	0	1,014
	Redhead	0	0	33
	Ruddy Duck	0	0	24
	Unknown Duck	0	3	6,786
	Unknown Bird	0	42	4,342
	Unknown Chick	0	9	546
Mammals				
	Bat sp.	0	3	0
	Black-tailed Jackrabbit	3	705	2,937
	Coyote	6	30	372
	Kit Fox	0	0	3
	Mouse sp.	0	0	18
	Skunk	0	0	3
Reptile				
	Unknown lizard	0	3	18
Total Wildlife Observations		**9**	**1,590**	**37,507**

Note:

These data represent the number of times an animal was observed in any of the camera trap photos. Depending on the species, one to many individuals may be observed in any given photo.

Table 3. Multiple Comparisons of Log Transformed[a] Motion Events Among Ponds by Fischer's Least Significant Difference Procedure.

Pond	N	Mean	SD	Homogeneous Groups[b]		
Evaporation Pond (EP)	97	0.0142917	0.0847822	■		
Pumpback Pond (PB)	97	0.74211	0.0847822		■	
Sewage Treatment Pond (ST)	97	3.17549	0.0847822			■

Notes:

[a] Ln (x + 1), where x = motion events per camera per day.

[b] Each pond is homogeneous and significantly different from the other ponds as indicated by the following contrasts:

EP < PB ($p < 0.05$)

PB < ST ($p < 0.05$)

EP < ST ($p < 0.05$)

Table 4. Camera Trap Observations of Wildlife Exposed to Sediments or Water.

Animal Type	Species	Lined Evaporation	Pumpback	Sewage Treatment
Birds				
Raptors	Great Horned Owl			■
Shorebirds	American Avocet		■	■ [a]
	Killdeer		■	■
	Sandpiper sp.		■	
Songbirds	Sparrow sp.			■
	Yellow-headed Blackbird			■ [a]
Waterfowl	American Coot			■ [a]
	American Coot Chick			■
	Canada Goose			■
	Cinnamon Teal			■ [a]
	Mallard			■ [a]
	Redhead			■ [a]
	Ruddy Duck			■ [a]
	Unknown Duck			■ [a]
Mammals				
	Black-tailed Jackrabbit		■	■
	Coyote		■	■

Note:
[a] Courtship and breeding activity observed.

Table 5. Total Number of Individual Birds in All Point Count Surveys.

Type	Species	Pond Area		
		Evaporation	Pumpback	Sewage Treatment
Raptor	Kestrel	3	2	
	Merlin			1
	Northern Harrier			1
	Red-tailed Hawk	2	1	
	Turkey Vulture	20	2	3
Nightjar	Common Poorwill		1	
Songbird	Bank Swallow		1	
	Barn Swallow	15	149	27
	Blackbird sp.			20
	Brewer's Blackbird	158	5	
	Dark-eyed Junco	2		
	Horned Lark	31	67	
	House Sparrow	8		
	Meadowlark		1	
	Northern Rough-winged Swallow	24	11	
	Raven	25	30	1
	Red-winged Blackbird	3		0
	Robin	1	2	
	Sage Sparrow	13		
	Sage Thrasher	2		
	Say's Phoebe	1	5	1
	Sparrow sp.	2	5	2
	Starling	1	1	
	Swallow sp.	12	118	231
	Unknown Songbird	12		
	Western Kingbird	13	18	5
	White-crowned Sparrow		3	13
	Yellow-headed Blackbird	6	27	755
Upland	California Quail	2	2	
	Mourning Dove	7	4	12
	Rock Dove	19	17	4
Shorebird	American Avocet	3	37	32
	Killdeer	4	30	45
	Lesser Yellowlegs		1	
	Sandpiper sp.		12	3
	Wilson's Phalarope		1	24
Waterbird	Double-crested cormorant		1	
	Gull sp.		2	
Waterfowl	Cinnamon Teal		2	36
	Coot			62
	Mallard	2	8	57
	Redhead		7	34
	Ring-necked Duck		2	2
	Ruddy Duck			12
Unknown	Unknown		2	

Table 6. Poisson Regression Coefficients[a] and Incident Rate Ratios Comparing Total Individual Birds and Species Richness in Pumpback and Lined Evaporation Pond Areas to the Sewage Treatment Pond Area.

Comparison	Parameter	Estimate	Std. Error	p-value	Rate Ratio[b]
Total Individual Birds	Intercept	4.40	0.0269	<<0.001	81.4
	Pumpback	-2.67	0.0496	<<0.001	0.0695
	Evaporation	-3.06	0.0573	<<0.001	0.0471
Species Richness	Intercept	2.18	0.0816	<<0.001	8.82
	Pumpback	-1.93	0.1259	<<0.001	0.144
	Evaporation	-2.11	0.1173	<<0.001	0.121

Notes:

[a] Poisson analysis is presented in Appendix B.

[b] The incident rate ratio is the exponentiated coefficient estimate, and describes the expected rate of change in bird and species counts from the sewage treatment ponds to the other ponds.

Table 7. Comparisons of Bird Abundances and Ecological Indices Among Ponds Based on Data Normalized to the Number of Stations in Each Area.

Point Count Area (abbreviation	Individuals per Station per Survey	Species Richness	Shannon Diversity	Shannon Evenness	Sorenson's Similarity[a]					
					Qualitative			Quantitative		
					EP vs. PB	PB vs. ST	ST vs. EP	EP vs. PB	PB vs. ST	ST vs. EP
Evaporation Ponds (EP)	3.83	5	2.36	0.716	0.689	--	--	0.808	--	--
Pumpback Ponds (PB)	5.66	6	2.46	0.698	--	0.655	--	--	0.130	--
Sewage Treatment Ponds (ST)	81.4	24	1.72	0.542	--	--	0.510	--	--	0.090

Note:

[a]Similarity indices are calculated in a pairwise fashion as indicated to determine how different or similar habitats are from one another (Maggurran 1988). The qualitative index is based on species presence or absence. The quantitative index is based on the number of species present and their abundance (birds/station).

Table 8. Incidence of Observed Bird Exposure to Sediment or Water Based on 17 Point Count Surveys in April and May 2007.

		Pond		
Type	Species	Evaporation	Pumpback	Sewage Treatement
Nightjar	Common Poorwill		1	
Raptor	Kestrel	1		
Shorebird	American Avocet		5	4
	Killdeer		5	4
	Lesser Yellowlegs		1	
	Sandpiper sp.		5	
	Wilson's Phalarope		1	1
Songbird	Barn Swallow		5	
	Horned Lark	4		
	Raven	1		
	Swallow sp.			1
	Yellow-headed Blackbird			5
Waterbird	Gull sp.		1	
Waterfowl	Cinnamon Teal			6
	Coot			6
	Mallard			6
	Redhead			3
	Ring-necked Duck		2	
	Ruddy Duck			4
Summary:				
Total Exposure Incidents		6	26	40
Exposure Incidents/Station/Survey		0.059	0.25	2.4
Number of Species Exposed		3	9	10

APPENDIX A

POINT COUNT OBSERVATIONS BY LOCATION AND SURVEY

Appendix A. Point Count Observations by Location and Survey.

		Evaporation Pond (6 observation stations)																	EP	EP	Pumpback Pond (6 observation stations)																	PB	PB
Type	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Sum	Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Sum	Avg.
Nightjar	Common Poorwill																											1										1	1.0
Raptor	Kestrel						1					1				1			3	1.0				1				1										2	1.0
	Merlin																																							
	Northern Harrier																																							
	Red-tailed Hawk			1		1											0		2	0.5			0		0						0	1						1	0.2
	Turkey Vulture		2	1									1		4		12		20	1.7							1	1					0			0		2	0.4
Shorebird	American Avocet	3																	3	3.0	2	4							4	4		2	4	5	0	10	2	37	1.9
	Killdeer						2			1				1					4	1.3	10	1	1	1	4				2	1			1	3	2	1	3	30	1.5
	Lesser Yellowlegs																								1														1	0.5
	Sandpiper sp.																																		9	2	1	12	2.4
	Wilson's Phalarope																															1						1	1.0
Songbird	Bank Swallow																																				1		1	1.0
	Barn Swallow											4			1	2	1	7	15	1.9	5	4	7	13	8	9	17	7	5	8	8	4	11	8	16	1	18	149	2.8
	Blackbird sp.																																							
	Brewer's Blackbird		3	1	0	5	0	2	5	46	8	10	10	10	12	13	6	27	158	5.6			0	0							2		2		1			5	0.7
	Dark-eyed Junco		2																2	2.0																			
	Horned Lark					1				1	1	3	2	2	13	2	3	3	31	1.7					4			3	10	1	7		9	27	1	1	4	67	3.5
	House Sparrow					2								3				3	8	2.7																			
	Meadowlark																																				1		1	1.0
	Northern Rough-winged Swallow									2	2	2	2	2		11		3	24	3.0										2	4	2	2				1	11	1.6
	Raven	5	2	4	2	1	1	0		0		1	0	1	1	1	3	3	25	0.9	0		2	3	4	2	2	2	4	0	2	3		3	0		3	30	1.0
	Red-winged Blackbird			0		3													3	1.5																			
	Robin					1													1	1.0	2																	2	2.0
	Sage Sparrow	1		1	2	1		1		2				1		2		2	13	1.3																			
	Sage Thrasher													2					2	2.0																			
	Say's Phoebe		1																1	1.0					1										1	2	1	5	1.3
	Sparrow sp.											0	2						2	1.0	1				2	1											1	5	1.3
	Starling													1					1	0.5																1		1	1.0
	Swallow sp.	1				1		1		2		5		1	1		0		12	1.0	3	2					3	1	23	27	4	0	29	5	5	0	16	118	3.3
	Unknown Songbird		12																12	12.0																			
	Western Kingbird				1					5		1	2	0	1	1		2	13	1.0								1	5	1	4		3	1	1		2	18	1.1
	White-crowned Sparrow																							1			2											3	1.5
	Yellow-headed Blackbird			0		1									1			4	6	1.5								1				26					27	9.0
Unknown	Unknown																				2				0													2	1.0
Upland	California Quail															2		0	2	1.0							2										2	2.0
	Mourning Dove										4				2			1	7	1.8												1			3		4	2.0
	Rock Dove	2	1	11	0		0	0		0	0			0		0	2	3	19	1.1				0		2	0			0		6	4	4		1	0	17	1.3
Waterbird	Double-crested cormorant																																		1			1	1.0
	Gull sp.																														2				0			2	1.0
Waterfowl	Cinnamon Teal																																				2	2	2.0
	Coot																																							
	Mallard												2						2	2.0								2	1								5	8	2.0
	Redhead																				7																		7	7.0
	Ring-necked Duck																																		2			2	0.7
	Ruddy Duck																																							
	Number of Individuals (N)	12	23	19	5	17	4	4	5	59	15	27	21	24	36	35	27	58	391	54.9	32	11	10	19	21	16	28	19	55	44	33	20	91	56	39	24	59	577	61.8
	Number of Species (S)	5	7	6	3	10	3	3	1	7	4	8	7	10	9	9	6	11	27	27.0	8	4	3	5	5	5	7	9	9	7	8	8	10	8	10	11	13	34	34.0
	Number of Individuals/Station (Nw)	2.0	3.8	3.2	0.8	2.8	0.7	0.7	0.8	9.8	2.5	4.5	3.5	4.0	6.0	5.8	4.5	9.7	65.2	9.2	5.3	1.8	1.7	3.2	3.5	2.7	4.7	3.2	9.2	7.3	5.5	3.3	15.2	9.3	6.5	4.0	9.8	96.2	10.3
	Number of Species/station (Sw)	0.83	1.17	1.00	0.50	1.67	0.50	0.50	0.17	1.17	0.67	1.33	1.17	1.67	1.50	1.50	1.00	1.83	4.50	4.5	1.33	0.67	0.50	0.83	0.83	0.83	1.17	1.50	1.50	1.17	1.33	1.33	1.67	1.33	1.67	1.83	2.17	5.67	5.7

Appendix A. Point Count Observations by Location and Survey.

		Sewage Treatment Ponds (1 observation station)																	ST	ST	Grand
Type	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Sum	Avg.	Total
Nightjar	Common Poorwill																				1
Raptor	Kestrel																				5
	Merlin					1													1	1.0	1
	Northern Harrier																1		1	1.0	1
	Red-tailed Hawk																				3
	Turkey Vulture								1								2		3	1.5	25
Shorebird	American Avocet	2		2						6	4	2	4		4	4		4	32	3.6	72
	Killdeer	11	1		1			2	2	4	4	4	4	2	2	2	4	2	45	3.2	79
	Lesser Yellowlegs																				1
	Sandpiper sp.															1	2		3	1.5	15
	Wilson's Phalarope								12				5		7				24	8.0	25
Songbird	Bank Swallow																				1
	Barn Swallow		2		7	2	6		8			2							27	4.5	191
	Blackbird sp.									20									20	20.0	20
	Brewer's Blackbird																				163
	Dark-eyed Junco																				2
	Horned Lark																				98
	House Sparrow																				8
	Meadowlark																				1
	Northern Rough-winged Swallow																				35
	Raven							1					0						1	0.5	56
	Red-winged Blackbird			0															0	0.0	3
	Robin																				3
	Sage Sparrow																				13
	Sage Thrasher																				2
	Say's Phoebe										1								1	1.0	7
	Sparrow sp.						2												2	2.0	9
	Starling																				2
	Swallow sp.		4				2	2	11	12	30	30	25	25	15	35	25	15	231	17.8	361
	Unknown Songbird																				12
	Western Kingbird												1	1		1		2	5	1.3	36
	White-crowned Sparrow			1		4		8											13	4.3	16
	Yellow-headed Blackbird	40	30	35	40	40	25	40	40	45	60	40	40	50	50	60	50	70	755	44.4	788
Unknown	Unknown																				2
Upland	California Quail																				4
	Mourning Dove				2				2				1	2	1			4	12	2.0	23
	Rock Dove												2				2		4	2.0	40
Waterbird	Double-crested cormorant																				1
	Gull sp.																				2
Waterfowl	Cinnamon Teal				2	4	3	4	3	2	2	2	2	2	2		2	6	36	2.8	38
	Coot	1	3	2		4	3	3	3	5	6	4	5	5	5	4	4	5	62	3.9	62
	Mallard	8	4		2	2	2	2	6	4	4	4	2	4	2	7	2	2	57	3.6	67
	Redhead	7	4	7	2				3	2		2			2	5			34	3.8	41
	Ring-necked Duck																2		2	2.0	4
	Ruddy Duck								1	1	2	1	1	1	2			3	12	1.5	12
	Number of Individuals (N)	69	48	47	56	57	43	62	92	101	113	91	92	92	92	119	96	113	1383	137.0	
	Number of Species (S)	6	7	5	7	7	7	8	12	10	9	10	12	9	11	9	11	10	24	24.0	
	Number of Individuals/Station (Nw)	69	48	47	56	57	43	62	92	101	113	91	92	92	92	119	96	113	1383	137.0	
	Number of Species/station (Sw)	6	7	5	7	7	7	8	12	10	9	10	12	9	11	9	11	10	24	24.0	

APPENDIX B

LIGHTROOM® PHOTOGRAPHIC DATABASE OF WILDLIFE MOTION EVENTS FROM APRIL TO JULY 2007 AT THREE EVAPORATION PONDS AT THE YERINGTON MINE SITE

– SEE ATTACHED DVD

Note: Viewing the appendix photos requires installation of Adobe Photoshop Lightroom® and the database files on a local (not network) drive. The original images taken by Reconyx® surveillance cameras are available upon request.

APPENDIX B

The attached DVD contains a Lightroom® photographic database of wildlife motion events from April to July 2007 at three evaporation ponds at the Yerington Mine Site. The database consists of the following:

- Yerington_2007_LightroomDB.lrcat Lightroom® catalog file, accessible via Adobe Photoshop Lightroom®
- Yerington_2007_LightroomDB Previews.lrdata Lightroom® data folder, containing thumbnail images accessible only via the Lightroom® Catalog listed above.

To view the appendix photos requires installation of Adobe Photoshop Lightroom® and the database files on a local (not network) drive. The original images taken by Reconyx® surveillance cameras are available on request.