HB PROJECT SOLAR EVAPORATION PONDS

STEPPED AVIAN MONITORING AND MITIGATION PLAN

Prepared for

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1 INTRODUCTION

1.1 PROJECT DESCRIPTION

Intrepid Potash – New Mexico, LLC (Intrepid), is proposing pumping and conditioning of groundwater from Rustler Formation wells to form a salt-saturated brine solution to be injected into underground mine workings. The brine will dissolve the remaining potash and pregnant brine (enriched with potash or potassium chloride) will result. The pregnant brine will be extracted and transported to new solar evaporation ponds where the potassium and sodium salts will be deposited as a precipitate. The precipitated potassium and sodium salts will be harvested by a scraper and then transported to the HB Mill for processing. The proposed evaporation pond complex comprises an area of approximately 575 acres located in Section 2, Township 21 South, Range 29 East. There will be a series of discreet ponds that generally range in size between 20 and 25 acres. All ponds are shallow, designed to hold 2 feet of brine and precipitate with 18 to 24 inches of freeboard to contain the brine plus precipitation. The ponds will be lined with a geosynthetic liner placed over graded, screened, and compacted subgrade material and will be covered with an 18-inch-thick layer of consolidated and hardened salt to ensure that the integrity of the underlying liner is maintained. Surface water runoff will be kept out of the ponds by two diversion ditches. Harvesting of the ponds will be conducted throughout the year and on a rotational basis.

1.2 PURPOSE OF THE PLAN

This mitigation and monitoring plan was prepared to anticipate and prevent use of the ponds by waterfowl and any resulting risk of mortality. In addition to research on the toxicity of hypersaline ponds and lakes, some studies have been conducted on the effectiveness of bird deterrence techniques. SWCA Environmental Consultants (SWCA) has prepared this monitoring and mitigation plan using information from those studies with input from Intrepid staff and discussions with Bureau of Land Management and U.S. Fish and Wildlife Service personnel.

In the last two decades, the potential impact of hypersaline lakes and evaporation ponds on waterbirds has been the focus of much research, including one study conducted at Laguna Toston and other playa lakes of southeastern New Mexico (Dein et al. 1997). Birds landing on hypersaline waters can become encrusted with salt and drown, or their ability to fly may become impaired. As a result of preening their feathers, birds can also become sick or die due to ingesting too much salt. They may suffer from cold stress as the salt crystals reduce the insulating ability of the feathers.

Dein et al. (1997) monitored eight playa lakes—including Laguna Toston, a playa used by Mississippi Chemical as a salt tailings discharge area for the East Plant—in March and April 1995. The researchers reported a total of 1,572 individual waterfowl observed at those eight playa lakes during the monitoring period. In total, 67 dead birds and 25 sick birds were also found. Blood samples were taken from sick birds, and carcasses were sent to the National Wetlands Research Center for examination, the results showing significant elevations of sodium found in the blood and brain. Dein et al. (1997) also experimentally subjected captive-bred mallards to hypersaline conditions at Toston Lake and nearby Williams Sink by placing them in pens with direct contact with lake water and/or with lake water available to drink. All birds in the water pens were adversely affected within three hours of exposure, with death or euthanasia occurring within 35 hours. Sodium and potassium blood levels were significantly elevated in all cases. Birds in land pens drank hypersaline water and showed elevations of sodium in the brain and blood, but those elevations of sodium concentration did not reach a toxic level.

During Dein et al.'s (1997) study, the waterfowl species most often detected at playa lakes was the northern shoveler (*Anas clypeata*); other common waterfowls were green-winged teal (*Anas crecca*), gadwall (*Anas strepera*), American wigeon (*Anas americana*), lesser scaup (*Aythya affinis*), and ruddy duck (*Aythya collaris*). Dead birds of all six species were found at the playa lakes monitored by Dein et al. (1997).

2 PROJECT AREA DESCRIPTION

2.1 VEGETATION

The project area falls within McLaughlin's (1989) Chihuahuan Desert floristic zone, which is a diverse ecoregion extending from just north of Mexico City north to about 47 miles south of Albuquerque, New Mexico, and from southeastern Arizona east to western Texas. The elevation is relatively high, even outside the mountains, and the vegetation is dominated by semi-desert grasslands and shrublands. As defined by the Southwest Regional Gap Analysis Project, the two cover types represented at the site are Desert Scrub and Mesquite Upland Scrub, described below.

Desert Scrub

Desert Scrub is composed of several land cover subtypes: the Chihuahuan Creosotebush Xeric Basin Desert Scrub, the Chihuahuan Mixed Desert and Thorn Scrub, and Chihuahuan Mixed Salt Desert Scrub. The Chihuahuan Creosotebush Xeric Basin Desert Scrub land cover subtype occurs in xeric basins and plains, the Chihuahuan Mixed Desert and Thorn Scrub is found in the transition zone between the foothills and lower montane woodlands, and the Chihuahuan Mixed Salt Desert Scrub occurs in saline basins, on alluvial flats, and around playas. Vegetation consists of creosotebush (*Larrea tridentata*) often found with other desert scrub species such as American tarwort (tarbush) (*Flourensia cernua*), catclaw mimosa (*Mimosa aculeaticarpa* var. *biuncifera*), juniper (*Juniperus* spp.), honey mesquite (*Prosopis glandulosa*), and plumed crinklemat (*Tiquilia greggii*). In the Chihuahuan Mixed Salt Desert Scrub areas, the dominant shrub species tend to be salt tolerant, such as fourwing saltbush (*Atriplex canescens*) and other saltbush species (*Atriplex* spp.) associated with the above shrub species. Herbaceous species have lower cover than shrubs in these areas and common species include sideoats grama (*Bouteloua curtipendula*), black grama (*B. eriopoda*), bush muhly (*Muhlenbergia porteri*), tobosagrass (*Pleuraphis mutica*), plains bristlegrass (*Setaria* spp.), plains lovegrass (*Eragrostis intermedia*), and alkali sacaton (*Sporobolus airoides*).

Mesquite Upland Scrub

The Mesquite Upland Scrub cover type is composed of upland shrublands and is typically found in the transition zone of foothills and piedmonts of the Chihuahuan Desert Ecoregion. It is typically found on alluvium-derived substrates that are often gravelly. Vegetation is typically dominated by shrubs with little grass cover. The deep-rooted shrubs are able to exploit the deep soil moisture that is unavailable to grasses and cacti. Species include honey mesquite, littleleaf sumac (*Rhus microphylla*), soapberry (*Sapindus* spp.), and other succulent species. Desertification has increased the extent of Mesquite Upland Scrub.

2.2 GENERAL WILDLIFE

Species recorded in July 2011 by SWCA in or near the project area included birds such as Harris's hawk (*Parabuteo unicinctus*), mourning dove (*Zenaida macroura*), ash-throated flycatcher (*Myiarchus cinerascens*), and northern mockingbird (*Mimus polyglottos*). Based on habitat associations, mammals likely to occur in the general area include black-tailed jackrabbit (*Lepus californicus*), kangaroo rats (*Dipodomys* spp.), pocket mice (*Perognathus* spp.), woodrats (*Neotoma* spp.), and deer mice (*Peromyscus* spp.). Some additional birds likely to be present in the area consist of greater roadrunner (*Geococcyx californianus*), curve-billed thrasher (*Toxostoma curvirostra*), scaled quail (*Callipepla squamata*), and cactus wren (*Campylorhynchus brunneicapillus*). Several lizards with distributions centered on the Chihuahuan Desert may occur in the general area of the proposed ponds. These species consist of Texas horned lizard (*Phrynosoma cornutum*), greater earless lizard (*Cophosaurus texanus*), and several species of spiny lizards (*Scelpoprus* spp.). Representative snakes include the whipsnakes (*Masticophis flagellum*) (Brown 1994).

2.3 WATERFOWL MIGRATION AND WINTERING GROUNDS

Four major migratory flyways exist in North America: the Atlantic Flyway along the Atlantic Coast; the Mississippi Flyway in the Mississippi River region; the Central Flyway of the Great Plains states, Texas, and New Mexico; and the Pacific Flyway from the Rocky Mountains west to the Pacific Coast. The Pecos River valley and the general area of the proposed ponds lie in the Central Flyway (Figure 1), which is also called "the flyway of the Great Plains" because it encompasses all of that vast region lying between the valley of the Mississippi River and the Rocky Mountains, the principal wheat-growing region of both Canada and the United States. In the United States, the Central Flyway merges toward the east with the Mississippi Flyway and is bounded in that direction by the Missouri River (Nutty Birdwatcher 2011). In the south U.S. side, the flyway runs through western Missouri, Arkansas, and Louisiana, and then follows the Gulf Coast of Mexico southward. On its western boundary the Central Flyway is an important breeding area for waterfowl at the northern end of Great Salt Lake, Utah. The Central Flyway is relatively simple, as the majority of the birds that use it make direct north and south journeys from breeding grounds in the north to winter quarters in the south.

Waterfowl generally start migrating through the Central Flyway in late August, with peak migration occurring in October and ending in December. Spring migration is approximately from February through mid-May. Table 1 lists all waterfowl species with the potential to occur in the general area of the proposed ponds. Notes on the regional distribution and time of occurrence is based on information from the searchable eBird (2011) online database (queried for both Eddy County and Brantley Lake State Park) and the checklist of birds recorded at Bitter Lake National Wildlife Refuge (NWR) in Chaves County (U.S. Geological Survey 2011). Brantley Lake State Park is located within the Pecos River valley, which is migratory route of the Central Flyway. Brantley Lake State Park is considered a New Mexico hotspot by eBird (2011). Most waterfowl species documented in Eddy County or at Bitter Lake are found primarily during late fall, winter, and spring months, reflecting the importance of the region during migration and as overwintering grounds.

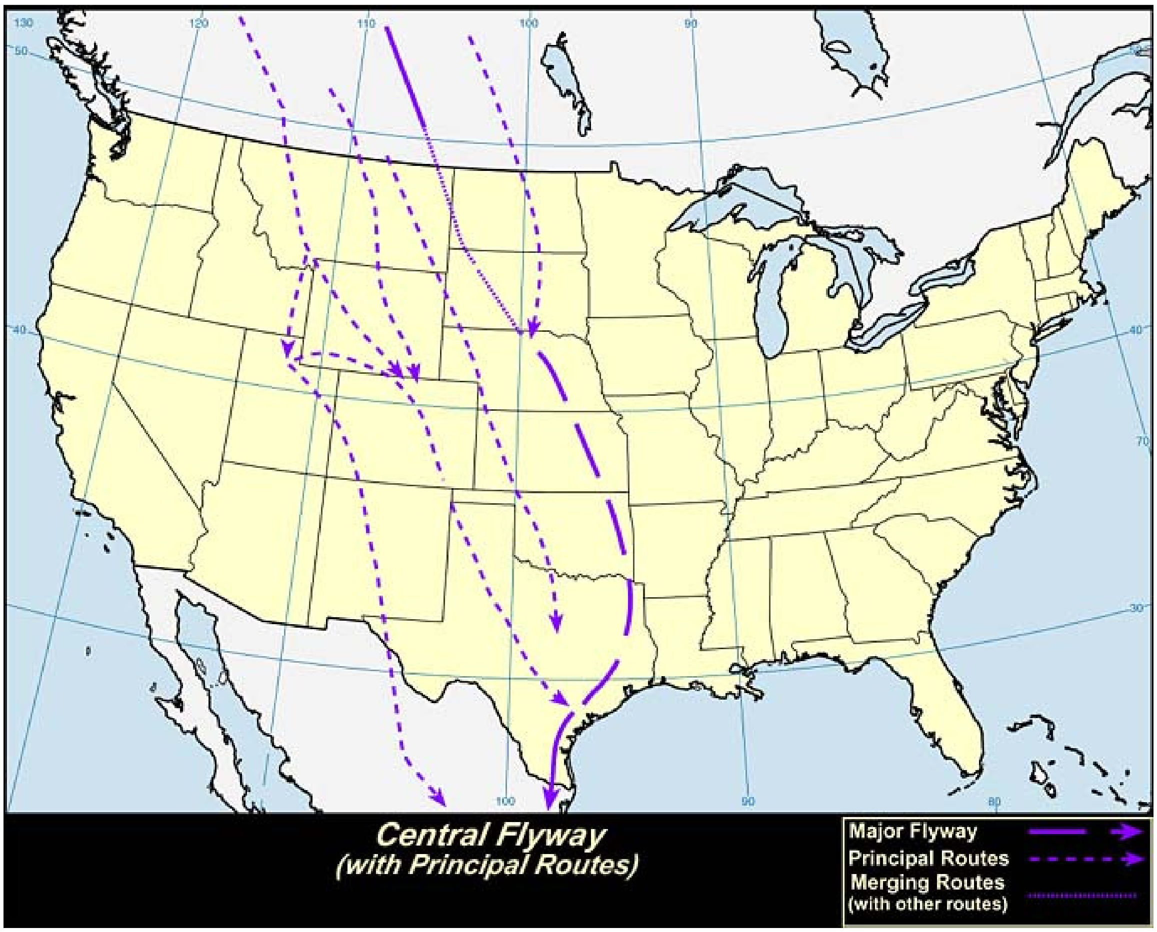

Figure 1. Central Flyway. Reproduced from www.birdnature.com

Table 1. Waterfowl with the Potential to Occur in the Project Area, with Notes on Regional Distribution and Seasons of Occurrence

Family	Common Name	Scientific Name	Regional Distribution and Season of Occurrence
Podicipedidae	Pied-billed grebe	*Podilymbus podiceps*	Observed in most months in Eddy County, especially in winter and spring. Documented at Laguna Toston (Dein et al. 1997). Occurs year-round at Bitter Lake NWR, where breeding has been recorded.
	Eared grebe	*Podiceps nigricollis*	Observed in most months in Eddy County, especially in winter and spring. Found at Laguna Toston (Dein et al. 1997). Common in spring and fall, rare to uncommon in other seasons at Bitter Lake NWR
	Western grebe	*Aechmophorus occidentalis*	Rare to occasional at Bitter Lake NWR; rare in Eddy County, but documented at one playa lake by Dein et al. (1997).
	Clark's grebe	*Aechmophorus clarkii*	Rare at Bitter Lake NWR and in Eddy County.
Anatidae	Snow goose	*Chen caerulescens*	Primarily a winter resident in New Mexico, though a few birds may rarely remain into the summer in the central part of the state (Cartron et al. 2008) and at Bitter Lake NWR. Recent records from Eddy County are from December through April and documented at Brantley Lake State Park in late January and early February.
	Ross's goose	*Chen rossii*	Primarily a winter resident in New Mexico from October through March, with a few birds remaining into April. Common in fall, winter, and spring at Bitter Lake NWR. Recorded at Brantley Lake State Park in January and March, and in Eddy County in general from December through March.
	Canada goose	*Branta canadensis*	Common year-round at Bitter Lake NWR. Reported from Brantley Lake State Park in May and December. Most records for Eddy County in general are in November–February; absent in summer.
	Wood duck	*Aix sponsa*	Only reported from fall, winter, and spring at Bitter Lake NWR, where the species is occasional. Occurs in Eddy County from fall through spring, primarily in February; absent in summer.
	Gadwall	*Anas strepera*	Primarily a winter resident in New Mexico, but some breeding records exist from the Middle Rio Grande and Bitter Lake NWR. Common in fall, winter, and spring at Bitter Lake NWR. Occurs in Eddy County from October (and especially November) through the end of April. Reported from Brantley Lake State Park in late August.
	American wigeon	*Anas americana*	Common to abundant in fall, winter, and spring at Bitter Lake NWR, where uncommon in summer with no breeding records. Also common to abundant in Eddy County in fall, winter, and spring, with no recent summer records. Documented in winter and spring at Brantley Lake State Park.

Table 1. Waterfowl with the Potential to Occur in the Project Area, with Notes on Regional Distribution and Seasons of Occurrence

Family	Common Name	Scientific Name	Regional Distribution and Season of Occurrence
	Mallard	*Anas platyrhynchos*	Found year-round in Eddy County; most abundant during winter and spring months; least abundant during summer.
	Blue-winged teal	*Anas discors*	Primarily occurs during March–May and August–October in Eddy County; rare in summer and not known to occur in winter. Breeding records exist from Bitter Lake NWR in Chaves County.
	Cinnamon teal	*Anas cyanoptera*	Recorded in Eddy County from December through mid-June and in late August–early September. Breeding records exist from Chaves County at Bitter Lake NWR.
	Northern shoveler	*Anas clypeata*	Recorded in Eddy County from December through May and in August–September. Uncommon in Chaves County at Bitter Lake NWR during summer, with breeding records.
	Northern pintail	*Anas acuta*	Primarily a winter resident in Eddy County, though also recorded during spring (late March–early May) and fall (late August–mid October) migration. Uncommon breeding summer resident at Bitter Lake NWR.
	Green-winged teal	*Anas crecca*	Primarily a winter resident in Eddy County, though also recorded during spring (April–May) and fall (August–October) migration. Uncommon summer resident at Bitter Lake NWR.
	Canvasback	*Aythya vasilineria*	Recorded in Eddy County from December through April. Rare at Bitter Lake NWR during summer.
	Ring-necked duck	*Aythya collaris*	Winter resident and migrant. Recorded in Eddy County from October through May, mainly December through April. Absent in Eddy County and at Bitter Lake NWR in Chaves County in summer.
	Lesser scaup	*Aythya affinis*	Recorded from December through April in Eddy County (in March at Brantley Lake State Park). Rare in summer at Bitter Lake NWR, where breeding has been recorded.
	Bufflehead	*Bucephala albeola*	Recorded from December through April in Eddy County; rare in summer at Bitter Lake NWR.
	Common goldeneye	*Bucephala clangula*	Occurs in Eddy County (including at Brantley Lake State Park) from December through February. Uncommon in winter at Bitter Lake NWR, where rare to occasional the rest of the year.
	Hooded merganser	*Lophodytes cucullatus*	Occurs in Eddy County in December and January. Also recorded in spring and fall at Bitter Lake NWR.
	Common merganser	*Merganser merganser*	Mainly recorded from December through February, less often in March, in Eddy County. Uncommon in spring and fall and rare in summer at Bitter Lake NWR.

Table 1. Waterfowl with the Potential to Occur in the Project Area, with Notes on Regional Distribution and Seasons of Occurrence

Family	Common Name	Scientific Name	Regional Distribution and Season of Occurrence
	Red-breasted merganser	*Mergus serrator*	Occurs in Eddy County (including at Brantley Lake State Park) from December through February. Occasional in spring and fall at Bitter Lake NWR.
	Ruddy duck	*Oxyura jamaicensis*	Recorded throughout most of the year in Eddy County but absent in summer. Uncommon in summer at Bitter Lake NWR.
Rallidae	American coot	*Fulica americana*	Occurs year-round in Eddy County, especially during winter and spring months. Documented at Laguna Toston (Dein et al. 1997). Common to abundant year-round at Bitter Lake NWR.

Except where otherwise noted, all information is from the U.S. Geological Survey's checklist of birds (U.S. Geological Survey 2011) at Bitter Lake NWR and the searchable eBird (2011) online database.

3 OVERVIEW OF THE EFFECTIVENESS OF BIRD HAZING AND FRIGHTENING TECHNIQUES AVAILABLE FOR EVAPORATION PONDS

Methods, techniques, and strategies—and their respective effectiveness—to deter migratory birds from using evaporation ponds and hypersaline lakes have been reviewed in various published manuals. Table 2 lists bird hazing and frightening techniques or strategies based primarily on Marsh et al.'s (1991) assessment, together with notes on their applicability to the proposed Intrepid solar ponds. Seven of the techniques or strategies are referred to as "passive;" they are aimed at deterring waterfowl from using the ponds and require no human intervention other than the preventative installation of some visual cue or device. Thirteen of the techniques are "active," requiring some form of human installation based on observations of use of the ponds by waterfowl. Some active and passive techniques have shown to be more effective than others or be less prone to bird habituation. In evaluating bird deterrence techniques and strategies, environmental conditions (e.g., wind) and cost also play an important role.

The applicability of these techniques for the solar evaporation ponds are based on expected site conditions and effectiveness of techniques currently being utilized by Intrepid at its existing operations.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Gunfire/Cracker shells – Gunfire with ammunition or fixed projectiles. Similar to fireworks, these devices rely on an explosion or other type of loud noise to deter birds from an area. Certain types may also produce visual stimuli such as a flash of light or burst of smoke. Devices include rifles and shotguns firing live ammunition or blanks and 12-gauge shotguns and flare pistols that shoot exploding or noisy projectiles, including shell crackers, bird bombs, bird whistles, whistle bombs, or racket bombs.	These devices can be especially useful in situations where sites need only be protected for relatively short periods of time (e.g., 1–4 weeks). Most bird species become habituated to these noises if used repeatedly over a long period of time. Gunfire is considered more effective over longer periods when supplemented with other frightening methods, such as gas exploders, air horns, etc.	Use of cracker shells has proven effective at Intrepid facilities.
Active	Human patrols – On foot, or in vehicles, generally used in combination with other techniques, such as shooting or firing cracker shells, to provide variety in an integrated hazing program. Trained dogs may be used in combination with humans. Boat Use – Hazing waterbirds by airboats or boats propelled by outboard motors is recommended in some situations and presents another means of transportation for human patrols. Remote-controlled model boats would also likely be effective in some situations, but little information exists on their use for such purposes. Hovercraft has also been considered, but nothing could be found in the literature where it was actually used. Small, shallow-draft aluminum boats with noisy outboard motors are the least costly for hazing waterfowl or other water-loving birds from large containment ponds. Boats are particularly useful for large pond sites where hazing from shore is not effective in moving birds from the center of the pond.	Reactions vary among species, and many may rapidly habituate or, if approached too closely, move only a short distance away and return soon after the people depart. Use of airboats is most effective for waterfowl.	This is the current method used by Intrepid at the West, East, and North plants coupled with use of cracker shells. This method has proven effective and can be supplemented immediately as needed with additional human patrols. Individual ponds are bermed and accessible by human patrols. Boat use is not practical in the shallow ponds and issues with moving a boat easily between ponds.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Biosonics – Based on acoustical signals emitted by birds and other animals to convey information to conspecifics, and sometimes, closely related species. Two audible bird warning stimuli, distress and alarm calls, have been explored and/or used for acoustically repelling birds.	More effective than the use of unnatural sounds and noises to repel nuisance birds as the birds do not habituate as rapidly to the distance or alarm calls. Not all bird species emit alarm or warning calls, however, and the distinction between alarm and distress calls is not clear for some species. Warning calls are most commonly emitted by gregarious species, and large flocks usually are more responsive than small flocks or individuals.	May be considered as a supplement to human patrols and cracker shells.
Active	Fireworks – The loud unnatural noises produced by these devices, especially when exploded overhead, frighten most birds away from the source of the noise, at least temporarily.	If repeated day after day, the birds habituate to such noises; however, if used with occasional gunfire, they may perceive them to be a real danger for a longer period. Thus, some type of reinforcement is usually needed for these devices to be most efficacious or to remain effective for a prolonged period.	Potential fire danger from errant fireworks minimizes or eliminates use of this option.
Passive	Colored water – Colors have been examined as to those preferred and those shunned or avoided by ducks and geese. Various other studies have found waterfowl to avoid red- and orange-dyed water, with more tendency to avoid orange water.	The feasibility and practicality of coloring the water of larger ponds seems questionable from a cost basis. A possible alternative would be to strategically place brightly painted floating styrofoam rafts throughout the pond. These would probably have to be large enough (10–20 feet in diameter) and numerous enough (one per 5–10 acres) to give the conspicuousness needed.	Ponds may be colored blue to enhance evaporation. Other colors are not desirable from a production or visual standpoint.

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Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Gas-operated exploders (gas or propane cannons) – Produce extremely loud, intermittent explosions, usually at fixed 1- to 10-minute intervals as desired, that exceed the blast of a 12-gauge shotgun.	Migratory species usually are more effectively repelled than are resident species firmly established at a site. Habituation can be a problem when using gas exploders. Birds may become accustomed to the loud blasts after only a few days. To alleviate habituation, exploders should be moved periodically (e.g., every 1 to 3 days) within the area needing protection.	May be effective for solar ponds. However, due to proximity to highway traffic, may not be acceptable from a public safety/public relations standpoint. Habituation may lessen effectiveness.
Passive	Scarecrows and predator models – Scarecrows (human form) and models of owls and hawks may be effective. Models of snakes or cats are rarely of any value. Scarecrow and raptor models should appear lifelike, be highly visible, and be moved frequently at the site to help alleviate habituation. Floating a human form scarecrow in a pond may deter non-resident waterfowl from entering a pond.	Dangling streamers or reflectors from scarecrows and using brightly colored loose clothing may help increase their effectiveness because they move in the wind and birds react more readily to colored and moving objects. If possible, a sound or motion triggered by the presence of birds may greatly increase the effectiveness of the model. Animated models of raptor species may also be effective.	May not be effective due to the number of ponds and areas of ponds. Floating scarecrows are not practical due to active harvesting of ponds, and high salt content of brine will coat scarecrows white.
Passive	Lights – These can include flashing lights, strobes, rotating beacons, and spotlights.	Birds become habituated to lights quickly. Most of the studies that tested the effectiveness of lights involved birds feeding at night at fish hatcheries.	More effective techniques are available.
Active	Sonic devices (Av-Alarm) – The original Av-Alarm units emit loud, intermittent, electronically synthesized sounds that are similar to the noisy chirping of a large number of birds. These are sometimes referred to as synthetic bird alarm sounds. Such sounds are supposed to cause psychological "jamming" in birds and other pest animals.	These have been found to be relatively ineffective, and biosonics seem to work better. In most field tests, birds were scared away only temporarily.	More effective methods exist.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	High frequency sound devices – Ultrasonic frequencies are those exceeding 20,000 cps. Their main attraction for pest control is that ultrasonic sounds are neither audible nor disturbing to humans.	Ultrasonic devices have not been proven efficacious for repelling birds. Hearing ranges for several bird species have been measured in the laboratory. Values ranged from 60 to 15,000 cps, which is well within the hearing range of man (20 to 20,000 cps) and below ultrasonic frequencies. Even if such sounds were heard by birds, they might not be practical for use over large areas. Power requirements are probably too high because ultrasonic frequencies diminish much more rapidly than audible sounds with increasing distance from their source.	More effective techniques are available.
Active	Trained falcons and hawks – These can be used to disperse birds. They are often used in conjunction with another method.	Most studies on the effectiveness of trained birds of prey involved dispersing birds from airports and runways.	More effective techniques are available.
Passive	Aerial visual devices – Includes colored balloons, hawk-shaped kites, and balloon-supported hawk kites. Balloons may be painted with eyespots to increase the fright response. These types of deterrents need to be moved around to reduce habituation.	Free-flying kites work best in a breeze or moderate wind but may not be suitable in calm conditions or in strong winds. Lighter-than-air balloons work in calm conditions, breezes, or light winds. Some birds may habituate to the presence of balloons and hawk kites if exposed for long periods. Some wind movement of the balloons or kites suspended from balloons is preferred as the motion increases the fright responses of birds. Using the hawk kite and balloon together is usually more effective than using either alone. Response appears to vary among species as some birds habituate more rapidly than others to the presence of hawk kites.	Not practical due to high winds that occur in the area.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Passive	Flagging, reflectors, and reflecting tape – Various types of visual devices have been used or tested as frightening stimuli, including bird-scaring reflecting tape, various types of reflectors and spinners, and colored flags and streamers. Bird-scaring reflecting tape is marketed in Japan. Reflecting tape is 0.43 inch wide and 0.001 inch thick and is usually suspended at parallel intervals by twisting and stretching it between erect poles. The colored Mylar coating on the tape (silver and red on opposite sides) reflects sunlight, causing a flashing effect, and its vibration in a breeze produces a humming noise. Under windy conditions, a thunder-like or roaring noise may be produced. Thus, under optimum conditions, reflecting tape produces both unnatural visual and acoustical stimuli for frightening birds. However, it may be more suitable for protecting small areas.	Birds become habituated to these techniques rapidly. Efficacy depends on the bird species present and the type and size of area that needs protection. Wind conditions also are important because motion increases their effectiveness. Most of these devices probably are not effective for any prolonged length of time if used alone. Some may, however, provide some temporary protection, which may be extended somewhat when used with other bird-scaring methods or techniques (e.g., gas exploders, pyrotechnics).	Not practical due to the size of pond area and active harvesting of ponds.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Passive	Overhead wires – Networks of overhead wires have been used with varying degrees of success. The wires are suspended horizontally in one direction or criss-crossed to form a grid or irregularly shaped network of lines above the area needing protection. Monofilament fishing line or stainless steel or other types of non-rusting wire are most commonly used for overhead wiring.	Overhead wire networks can be expensive to install, but they generally require little maintenance other than replacing an occasional broken wire. The wire must be sufficiently strong to withstand strong winds and occasional bird impacts. In some situations, however, depending on wire spacings and species present, birds may become entangled in wires, necessitating periodic inspections to release them. Perimeter wires or fencing may be needed at some sites to prevent birds from landing and walking into a protected area from the side. This type of learned entrance behavior frequently occurs with some bird species.	Not practical due to size of pond area, high winds in the area, and ability for waterfowl to walk into ponds.
Passive	Netting – Complete exclosure by netting or screening can be one of the most effective methods of excluding birds from a site needing protection. It is the only sure method for total exclusion. Plastic or fabric netting is used more often than wire screening because it is less expensive and easier to install. Both wire and fiber netting have been used, but the development of ultraviolet stabilized plastic netting in the early 1970s resulted in stronger, more durable material that is easier to apply or install over large areas. This netting, usually made from polypropylene plastic, is lightweight and more resistant than most other plastics to corrosion and breakdown by sunlight.	The feasibility and costs of netting a containment pond depend on its size and configuration. A rectangular basin is easier and cheaper to cover than a square basin of equivalent size because a less extensive ground-support system is needed and smaller diameter cable is used. If the span exceeds 1,000 feet, midpoint supports such as floating drums may be needed to support the interior netting and minimize cable whipping and undulation in windy conditions.	Not practical due to active harvesting of ponds.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Aircraft – Aircraft represent a costly but often highly effective means of hazing birds from large areas. Types of aircraft used or tested include fixed-winged airplanes, ultra-light recreational aircraft, helicopters, and radio-controlled model aircraft. Model aircraft may be designed to look like birds of prey.	Bird reactions can be influenced by many factors, including noise levels, height, color, speed, and flight pattern of the aircraft; their previous experience with aircraft; whether birds are migrants or well-established residents; and probably others. Nevertheless, where appropriate and feasible, hazing by aircraft can be a highly effective method of dispersing birds. Use of model aircraft is less effective. Birds often become habituated and return to the site after the aircraft has landed.	Not practical due to high winds that can occur in the area.
Active	Water-spraying devices – Water sprays from rotating sprinklers can be used to deter some bird species. Such devices are probably most effective and economical for protecting small ponds. To be effective, the water spray must cover most or the entire pond or birds may enter between the spraying water. Because birds may habituate to a continuous spray, best results occur when sprinklers are operated on an on-off cycle. The start-up noise and sudden spray of water helps startle and frighten the birds.	In general this method is not very effective. However, there is a process whereby pond water is pumped through a large number of elevated sprinkler heads to increase water evaporation. This patented process was developed in Israel by Ormat Engineering, Inc., to concentrate brine waters for mineral recovery (Bradford et al. 1989). Observations of its use in Israel indicate that waterbirds prefer not to enter the shower spray. This may be a potential method to both increase evaporation and keep birds from using the ponds. A previous study found that the spray need only cover about 50% of the surface to move gulls, but it is suspected that more coverage would be needed to repel all water-loving species and that the spray patterns would have to be nearly overlapping and cover most of the entire pond surface to effectively reduce the bird numbers.	Not practical due to size of ponds and salt plugging of water sprays.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Underwater sounds – Underwater acoustical devices currently being used or experimentally tested for deterring marine mammals may be worthy of investigation for repelling waterbirds from containment ponds. The potential advantage of underwater sounds is that they are conducted more efficiently than sounds in air. Sound velocity approaches 1,800 yards/sec in seawater compared to only about 400 yards/sec in air, and attenuation is lower). Underwater sounds of appropriate frequencies and loudness might be disturbing to diving birds (e.g., ducks, grebes, etc.) and waders (e.g., avocets, stilts, dowitchers) that submerge their heads below the water surface to obtain food. If effective in causing the birds to leave the pond area, the devices could be used singly or alternately to provide variety to a hazing program by intermittently combining underwater sound with other scare methods (e.g., gas exploders, shell crackers, etc.), thereby furthering the concept of variability in negative reinforcement.	Underwater sound has several important advantages over airborne sound. When used near residences, it would not be disturbing to people. Secondly, the sound and its projection are not influenced by strong winds. However, the shallowness of the water in some evaporation ponds may work against its potential effectiveness. The effects of disturbing the pond bottom sedimentation would also have to be considered.	Not practical due to size of ponds, active harvesting of ponds, and corrosive nature of brine.
Active	Electric shockers – Electrified wires providing nonlethal shocks have been used as a repelling tactile stimulus to deter birds. Although operating on high voltages, they are not lethal because of low amperages.	The birds must come into direct contact with the charged wires in order to be repelled, and this proves to be the major limiting factor in their usefulness.	Not practical due to size of ponds and active harvesting.

Table 2. Deterrence Techniques Evaluated for Their Applicability for the Proposed Intrepid Solar Ponds

Type of Deterrence Technique (Passive/Active)	Description	Notes on Effectiveness	Applicability Based on Cost and Effectiveness
Active	Air horns and sirens – Air horns operate with compressed air to produce a loud, braying blast. Such units often are made up with a 12-volt air compressor and two trumpets to intensify the noise produced. The longer trumpet (8.5 inches) produces sound at a frequency of 1,000 cycles per second (cps). A second, shorter trumpet (6.5 inches) emits a blast at 800 cps. The interval between blasts is determined by the operator and can be varied as desired with an automatic timer. Sirens may be used, if mounted on a truck for mobility.	Electric or air-produced nonspecific, audible loud sounds have limited potential for bird hazing. Because of expense, they are best used for protecting small areas or adding variety to a hazing program incorporating other frightening stimuli.	Intrepid has found this technique to be ineffective at its facilities.

Information is from Marsh et al. (1991) except where otherwise noted.

4 STEPPED MONITORING AND MITIGATION PLAN

In developing the plan below, three factors were considered: 1) observed incidence of waterfowl use of the ponds, 2) bird habituation to deterrence techniques or devices based on Intrepid experience at existing operations, and 3) bird mortality.

4.1 DAILY MONITORING

Daily patrols will be conducted around the solar ponds by trained Intrepid personnel. Additional monitoring patrols by trained personnel may be warranted in the event of regular and/or high use of the ponds or findings of bird mortality. Other options Intrepid might consider include the installation and use of motion cameras to supplement daily monitoring activities. A priority of monitoring will be to provide initial estimates of the frequency of use of the ponds by month and season.

4.2 STEPPED MITIGATION MEASURES AND ASSOCIATED TRIGGERS

Step 1

Under Step 1 of the plan, the ponds will be patrolled daily with use of a vehicle. If any waterfowl is observed using the ponds, monitoring staff will respond immediately with use of cracker shells. If increased waterfowl usage of the solar ponds is observed (such as during migration season or in winter), the frequency of human patrols will be increased from once to twice a day. The Environment Department Manager will be responsible for recommending increased frequency of human patrols combined with use of cracker shells based on daily monitoring observations.

Step 2

If human patrols and use of cracker shells are not effective in hazing waterfowl from ponds, Intrepid will attempt to use other biosonic devices. Intrepid will also install mobile, aerial visual stimulus (hawk lookalike) devices around the pond areas. The aerial devices will be moved around the ponds on a daily basis. The Environment Department Manager will be responsible for recommending alternative hazing techniques if increased human patrols and use of cracker shells are found to be ineffective.

Step 3

If complete habituation to the above deterrence methods occurs and use of ponds results in waterfowl mortality, Intrepid will implement continuous human patrols during daylight hours until waterfowl use of the solar ponds can be managed again by routine daily patrols. Additionally, Intrepid will consult with qualified consultants, or other waterfowl expert biologists, to evaluate reasons for increased use of solar ponds, assess waterfowl use patterns and effectiveness of hazing methods, and develop other hazing options based on those evaluations. Continuous human patrols would remain in place until alternative hazing options are implemented and determined to be effective. The Environment Department Manager will be responsible for recommending alternative hazing techniques if increased human patrols and use of cracker shells are found to be ineffective. Implementation of alternative hazing techniques will be approved by the General Manager.

Training

A training manual will be developed prior to use of the ponds. The training manual will include a section with color photographs of waterfowl species having the potential to occur in the area of the ponds. The training manual will also specify all monitoring and mitigation procedures, and provide detailed guidance regarding reporting of observations. A meeting/presentation will be scheduled with all monitoring crew personnel to go over the training manual. Training will also include the safe operation of hazing equipment, such as firearms and cracker shells, along with secure storage and log-out procedures for hazing equipment.

Reporting and Adaptive Management

A monitoring report will be completed daily. If more than one daily monitoring occurrence is scheduled, a report will be completed for each occurrence. In the event that continuous human patrols are implemented for hazing, a daily report with a summary of the activities and observations made by the human patrols during the day will be completed.

The monitoring report will include:

- Date and time of monitoring period/event.
- Observed use of the ponds by waterfowl. At a minimum this information will include the number of waterfowl observed using the ponds and the pond number the birds were observed on.
- Hazing method employed. Brief description of response by trained personnel will be completed (i.e., type of deterrence technique used, response time, distance to waterfowl).
- Effectiveness of hazing. Brief description of waterfowl response will be completed.
- Waterfowl mortality. Any and all observed incidences of mortality will be documented in the daily reports. Trained monitoring personnel will be equipped with a digital camera to photograph dead birds. The exact location of the carcass will be recorded, together with the time of observed death and species identification. Waterfowl mortality will be verbally reported to the Intrepid Environment Department and General Manager the same day it is discovered.

All information will be recorded daily on a paper or electronic forms and turned into the Environmental Department. The monitoring forms will be stored in binders and/or on a computer server for a minimum of two years. Any photographs taken to supplement the daily report will be kept with the daily report.

The Environment Department Manager, or his or her assigned designee, will evaluate the reports on a weekly basis at a minimum. As part of the adaptive management, recommendations on adjustments to the number of daily monitoring patrols or hazing methods will be made to the General Manager based on observations from the daily patrols. Additionally, the Environment Department Manager, or assigned designee, will also evaluate factors that may contribute to increased waterfowl use of the ponds, should that occur. Factors may include pond color variations due to pond dye concentration and seasonality of migration season. Pond color dye concentrations may be adjusted in the pond system if evidence indicates certain shades of dye results in increased waterfowl usage and hazing does not provide an effective deterrent to the increased usage. A quarterly report will be prepared summarizing use of the ponds by waterfowl, effectiveness of hazing, adjustments made to daily monitoring schedule or hazing techniques, and observed mortality. The quarterly report will be sent to the Bureau of Land Management, Carlsbad Field Office and U.S. Fish and Wildlife Service by the end of the month following the close of the calendar quarter.

4.3 ROLES AND RESPONSIBILITIES

The Environment Department Manager will be responsible for evaluating the daily monitoring reports and recommending stepped mitigation measures based on increased use of ponds by waterfowl or determination that a hazing technique is not effective.

The Environment Department Manager will also be authorized to use a Technical Advisory Committee to assist Intrepid in developing changes or enhancements to the stepped mitigation measures described above. The Technical Advisory Committee would consist of Intrepid internal resource and qualified consultants or other waterfowl biologic experts. The Technical Advisory Committee would meet as needed, and as directed by the Environment Department Manager or General Manager, to evaluate and discuss any trends in use of the ponds by waterfowl, habituation to deterrence techniques, and bird mortality. On the basis of those trends, the Technical Advisory Committee would propose short- or long-term adjustments in the Monitoring and Mitigation Plan, including reductions in monitoring frequency in daily monitoring if conditions warrant. The Technical Advisory Committee may also propose to test new mitigation or deterrence techniques as they become known or are reported in the literature.

As described in Section 4.2, significant changes to the Monitoring and Mitigation Plan would be discussed in the quarterly report.

5 LITERATURE CITED

Bradford, D.F., D. Drezner, J.D. Shoemaker, and L. Smith. 1989. *Evaluation of Methods to Minimize Contamination Hazard to Wildlife using Agricultural Evaporation Ponds in the San Joaquin Valley, California*. Final Report to the California Department of Water Resources (Contract No. STCA/DWR B57037). Los Angeles: Environmental Science and Engineering Program, University of California.

Brown, D.E. 1994. *Biotic Communities of the Southwestern United States and Northwestern Mexico*. Salt Lake City: University of Utah Press.

Cartron, J.-L.E., D.C. Lightfoot, J.E. Mygatt, S.L. Brantley, and T.K. Lowrey. 2008. *A Field Guide to the Plants and Animals of the Middle Rio Grande Bosque*. Albuquerque: University of New Mexico Press.

Dein, F.J., L.A. Baeten, C.U. Meteyer, M.K. Moore, M.D. Samuel, P.D. Miller, C. Murphy, S. Sissler, C.W. Jeske, J.R. Jehl Jr., J.S. Yaeger, B. Bauer, and S.A. Mahoney. 1997. *Investigation into Avian Mortality in the Playa Lakes Region of Southeastern New Mexico*. Final report: June 1997. U.S. Geological Survey Biological Resources Division, National Wildlife Health Center, and National Wetlands Research Center.

eBird. 2011. eBird homepage. Available at: http://ebird.org/content/ebird. Accessed June 9, 2011.

Marsh, R.E., W.A. Erickson, and T.P. Salmon. 1991. Bird hazing and frightening methods and techniques (with emphasis on containment ponds). Wildlife Damage Management, Internet Center for Other Publications in Wildlife Management. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1051&context=icwdmother. Accessed June 9, 2011.

McLaughlin, S.P. 1989. Natural floristic areas of the western United States. *Journal of Biogeography* 16:239–248.

Nutty Birdwatcher. 2011. Nutty Birdwatcher homepage. Available at: http://www.birdnature.com. Accessed June 9, 2011.