ATTACHMENT D

Protocol for Assessing Mitigation for Unavoidable Losses to Non-breeding Birds as a Result of Operations of the TLDD Mid Evaporation Basin

Tulare Lake Drainage District
January 2014

The proposed TLDD Mid Evaporation Basin (MEB) would encompass an area of approximately 1,800-acres that has been in agricultural production for a century. Observation and wildlife monitoring at the existing TLDD South and Hacienda evaporation basins has shown relatively high number of waterbirds use the evaporation basins for foraging, resting and loafing, and for some species reproduction. Although a number of modifications and activities have been undertaken by TLDD over the past two decades to reduce and minimize bird use and potential risk of adverse effects at the evaporation basins substantial numbers of non-breeding waterbirds continue to seasonally inhabit the evaporation basins. Similar patterns of seasonal use of the proposed MEB by non-breeding water birds are expected. Operation of the MEB has the potential to attract and adversely affect non-breeding birds through:

- Reproductive impairment resulting from selenium (Se) exposure;
- Risk of predation;
- Risk of salt and selenium ingestion resulting in sublethal effects;
- Hazing disturbance resulting in increased energy expenditure;
- Risk of disease; and
- Risk of salt encrustation and handling stress.

As part of the California Environmental Quality Act (CEQA) and Regional Water Quality Control Board (Regional Board) permitting for the proposed MEB TLDD has committed to providing mitigation habitat for adverse effects to shorebirds. Mitigation for unavoidable impacts to shorebirds at the proposed MEB is included as a mitigation commitment in the Final Mitigated Negative Declaration certified by TLDD (State Clearing House No. 2012121057), prepared to comply with CEQA. Mitigation for shorebirds would occur at the TLDD Compensation Habitat (T21S R21E Section 3 South Half; Appendix A) and TLDD Winter Wetland Habitat (T21S R21S Section 3 North Half; Appendix A and B) as part of the Regional Board Waste Discharge Requirements (WDR) for the proposed project. A separate protocol has been developed for estimating mitigation of unavoidable losses to non-breeding shorebirds as

a consequence of MEB operations (compensation for nonbreeding shorebird impacts would be 77 acres of habitat at the TLDD Winter Wetland Habitat). The mitigation for unavoidable losses at the proposed MEB for avocets, stilts, and other breeding shorebirds outlined below would occur at the TLDD Compensation Habitat. The Compensation Habitat has been designed specifically to provide high quality habitat (e.g., large areas of open water, shallow water depths, high food production, nesting areas, etc.) for breeding shorebirds (Appendix A). The Compensation Habitat has been in operation since 1995 providing approximately 307 acres of open shallow water and nesting habitat during the late winter-summer (late February-August). The WDR for the TLDD South and Hacienda evaporation basins requires 207 acres of habitat for breeding waterbirds at the Compensation Habitat.

Under the proposed project TLDD would commit and be obligated to operate an additional 3.6 acres of habitat at the Compensation Habitat (the total acres of habitat required by the WDRs is 210.6 acres out of the 307 acre Compensation Habitat) to compensate for effects of MEB operations in accordance with the conditions outlined below and included in the WDR for the MEB. Figure 1 shows the locations of the TLDD proposed project, Compensation Habitat, and Winter Waterfowl Habitat.

In addition to providing shorebird habitat as part of the proposed MEB project, TLDD has also committed to implement a number of avoidance and minimization measures to reduce the potential for adverse effects to breeding shorebirds. Despite implementation of these avoidance measures it is anticipated that unavoidable effects on breeding shorebirds may result from operations of the MEB. To mitigate for these potential adverse effects to breeding birds the following protocol has been developed to identify the mitigation habitat that would be required to compensate for unavoidable effects.

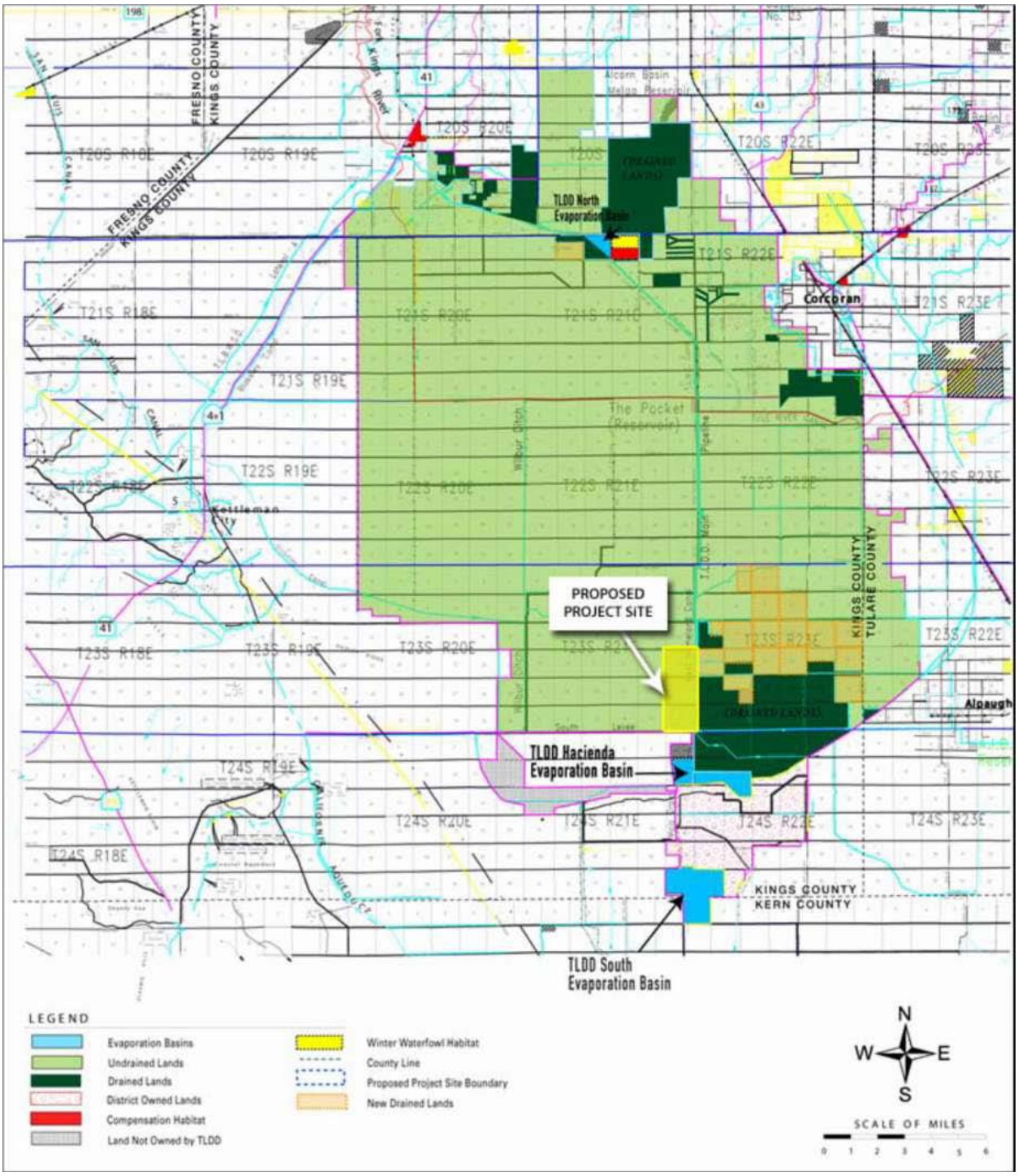

Figure 1. Tulare Lake Drainage District service area boundaries showing the location of the Proposed MEB, TLDD Compensation Habitat, and Winter Waterfowl Habitat.

Compensation Habitat Design

To offset potential unavoidable impacts to nesting shorebirds from use of the proposed MEB, and in compliance with the WDR for its other evaporation basins, TLDD operates a Compensation Wetland Habitat to offset impacts on nesting shorebird species (American avocet and black-necked stilt) resulting from existing and proposed evaporation basin operations. The Compensation Wetland Habitat is flooded during the nesting season (late February -August). The seasonal Compensation Wetland Habitat has been designed to mitigate for unavoidable losses to nesting shorebirds resulting from evaporation basin operations. TLDD constructed the 307 acres of wetland habitat to insure adequate compensation for unavoidable losses to shorebirds as a result of operation of the South and Hacienda evaporation basins. The habitat is to the east of the North Evaporation Basin (Figure 1). The habitat was established on property that had been farmed since the early 1900's. As part of compensating for unavoidable losses of nesting shorebirds as a result of operations and maintenance of the MEB, TLDD will commit to allocating acreage at the Compensation Habitat to mitigate impacts at the MEB.

The area of Compensation Habitat required by the Regional Board for the existing TLDD evaporation basins (South and Hacienda ponds) was originally calculated using a protocol, data and assumptions developed by Hanson (1993) as presented in the 1993 TLDD technical report. Based on results of compensation habitat calculations presented in the 1993 technical report, which were considered to be conservative, the TLDD WDR required construction and operation of a 207-acre Compensation Habitat. TLDD subsequently voluntarily constructed a seasonal wetland habitat totaling 307 acres, specifically designed and managed to provide nesting and foraging habitat for American avocet and black-necked stilts. The Compensation Wetland Habitat initiated operations in 1995. The entire 307 acre area within the Compensation Habitat has been flooded for use as breeding and foraging habitat every spring since 1995 when it was constructed. The Compensation Habitat includes low-profile lanes immediately adjacent to extensive shallow-water areas that support macroinvertebrate production and provide extensive foraging habitat. Each lane has a gentle sloping shoreline, with 12:1 slope, to encourage shorebird foraging and nesting. The Compensation Habitat is operated to maintain a water depth of 4 to 6 inches, the preferred foraging water depth for shorebirds.

The Compensation Habitat was designed specifically to provide foraging and nesting habitat for American avocets and black-necked stilts. General guidelines for developing foraging and nesting habitat included a wetted foraging area to nest area ratio of approximately two to one and a preferred foraging water depth of four to six inches with a high level of invertebrate production. Studies indicated avocets and stilts prefer a gradually sloped shoreline to a more abrupt shoreline. American avocet and black-necked stilts inhabit saline areas where production and abundance of macroinvertebrate prey species is high.

The Compensation Habitat has been designed to use a variety of alternative water supply sources. Distribution and control structures have been included to allow for the

use of freshwater, low selenium saline drainage water, or a blend of freshwater and saline waters. The selection of a water supply or a blending between supplies is based, in part, upon selenium concentrations within drainage water sources. Water quality samples are collected to monitor selenium concentrations and electrical conductivity when drainage water is being used. Monitoring results are used to manage water quality conditions within the Compensation Habitat within acceptable limits.

The Compensation Habitat has a flow-through design with no terminal ponding. This allows a constant flow of water through the system, thereby reducing the impact of evaporation on water quality. The entire habitat can also be flushed seasonally on an as-needed basis.

Predation of eggs and chicks was also considered in the design of the Compensation Habitat. The primary predator of concern is the coyote, although raccoon, opossum, skunk, and badger are also known predators in the area. The Compensation Habitat is completely surrounded by an electrified predator-exclusion fence. The primary predator of concern in the area is the coyote, although raccoon, opossum, snakes, various avian predators, skunk, and badger are also known predators in the area. Although fencing does not inhibit predation from birds, it does inhibit larger mammalian predators. Results of the biological monitoring program indicate that predation losses at the Compensation Habitat were very low. The average predation loss over the period from 2004 through 2014 was 8.4%.

The 307-acre Compensation Habitat has been operated in 1996-2015 in accordance with the design criteria established to provide maximum effective shallow-water foraging areas and suitable nesting habitat. The water supply for the Compensation Habitat has been provided exclusively by suitable (see criteria below) agricultural drainage water. The water supply to the Compensation Habitat was routinely monitored at the inlet and at various locations within the Compensation Habitat for both waterborne selenium concentrations and electrical conductance.

Biological monitoring is performed at the Compensation Habitat each year to assess bird use, nesting, and nesting success. High densities of nesting avocets and stilts have been documented each year (TLDD 2012; Davis *et al.,* 2008). High rates of nesting success (hatching) and low rates of predation and other sources of mortality have also been documented (TLDD 2012; Davis *et al.,* 2008).

Compensation Habitat Water Supplies

The development of wetland habitat within the southern San Joaquin Valley to mitigate for adverse effects on shorebirds, particularly species such as American avocet and blacknecked stilt, has been constrained by the availability of a reliable water supply source. Many of the shorebird species of interest inhabit coastal marine areas. Macroinvertebrates, which provide the forage base for many of these species, also occur in relatively high abundance in saline waters. Based on these and other considerations, saline agricultural drainage water, having low selenium concentrations,

has been used by TLDD as a water supply source for the wetland habitat. Saline drainwater has been used as the sole water supply source for the TLDD Compensation Wetland Habitat since 1999. The WDR issued for TLDD evaporation basin operations and Compensation Habitat permitted the use of low-selenium saline drainwater as a water supply for the Compensation Habitat. The WDR identifies selenium criteria for water use at the Compensation Habitat as having a geometric mean selenium concentration of 2.7 [illegible] samples) with no single sample exceeding 3.5 [illegible]g/L. TLDD routinely monitors selenium, arsenic, and boron concentrations monthly (April-June) in the water supply to the Compensation Habitat during the spring and summer period of operation. During the late summer, fall, and winter the habitat is dry and TLDD conducts vegetation control and other maintenance at the Compensation Habitat. Results of egg selenium and embryo condition at the TLDD Compensation Habitat provide information on the relationship between water quality meeting the WDR selenium criteria and selenium in eggs of American avocet and black-necked stilts. The TLDD Compensation Habitat has been operated using lowselenium water supplies for breeding shorebirds for a number of years. The geometric mean egg selenium concentration and embryo condition from previous monitoring as reported in the TLDD annual compliance reports and the evaluation of the Compensation Habitat performance (Appendix A) are summarized below.

Geometric Mean Egg Se Concentrations ug/g dry weight	Waterborne Se Concentration Geometric Mean ug/L	Waterborne Se Concentration Min ug/L	Waterborne Se Concentration Max ug/L	American Avocet	Blacknecked Stilt
1995	1.1	<0.05	23.0[a]	5.3	4.1
1996	0.9	<0.05	3.0	2.7	3.1
1997	1.4	<0.05	3.3	3.0	3.5
1998	2.0	1.2	4.2	2.8	2.4
1999	1.2	0.7	2.7	2.0	5.1
2000	1.4	1.2	1.8	2.0	2.4
2001	1.9	<0.05	3.2	2.7	2.2
2002	2.0	1.3	3.0	2.2	2.3
2003	1.2	0.8	1.9	4.5	3.0
2004	1.6	1.4	2.2	2.7	2.5
2005	0.9	<0.5	1.0	2.13	2.65
2006	1.3	0.5	2.2	2.54	
2007	0.9	0.5	1.2	2.49	
2008	2.2	1.8	2.6	2.95	2.69
2009	2.2	1.7	2.9	4.62	3.75
2010	1.4	1.2	1.6	2.39	3.58
2011	1.2	1.2	1.3	2.35	
2012	0.7	<0.5	1.4	1.04	1.16
2013	0.8	<0.5	1.5	2.04	3.17
Geometric Mean				2.60	2.84

a. Based on other data the maximum recorded in 1995 appears to be a sampling error.

The water quality criteria included in the WDR for Compensation Habitat water supplies were developed through discussions with the Regional Board, US Fish and Wildlife

Service, and California Department of Fish and Wildlife. Annual monitoring of egg selenium concentrations and embryo condition for evidence of terrata at the Compensation Habitat described in Davis et al. (2008) and TLDD annual monitoring reports has shown no adverse impacts to nesting shorebirds as a result of operating the Compensation Habitat in accordance with these water quality criteria.

Protocol of Assessing Mitigation for Mid-Evaporation Basin Impacts to Breeding Shorebirds

Various approaches have been proposed for calculating compensation habitat required to mitigate for unavoidable shorebird losses as a result of evaporation basin operations (Hanson 1993; USFWS 1995; Hanson 1995). Data collected at the existing TLDD evaporation basins on water quality, shorebird abundance, nesting and nest fate, and the relative habitat utility and use between evaporation basins and TLDD Compensation Habitat provide empirical information useful in the calculation of compensation habitat to mitigate unavoidable losses to breeding birds for the proposed MEB. Information collected in compliance with monitoring requirements of the existing TLDD WDR have been used to update and refine assumptions regarding the performance of avoidance actions in reducing the risks of adverse effects on shorebirds at the South and Hacienda evaporation basins as well as the performance of the TLDD Compensation Habitat in attracting birds and providing suitable habitat for breeding birds. Information from biological monitoring at the existing evaporation basins (1999-2013) and Compensation Habitat over the period from 1995 through 2013 have been used to develop the proposed mitigation protocol. Current monitoring data at the evaporation basins reflects the implementation of avoidance measures and modifications to the facilities as required by the existing TLDD WDR, which also represent the design criteria for construction and operation of the proposed MEB.

The mitigation protocol for breeding birds uses monitoring data presented in the TLDD annual monitoring reports for the 1996-2011 period on breeding bird counts at the Hacienda Evaporation Basin, located approximately 2 miles from the proposed MEB, to estimate the average density (number of birds per acre) of nest attempts at the evaporation basin during the April-July nest monitoring period. The average density of avocet and stilt nests observed at the evaporation basin is then multiplied by the acreage of the proposed MEB (1800 acres) to estimate the number of avocet and stilt nests that would be expected at the MEB. Estimates and assumptions were then developed to assess the potential losses or adverse sublethal effects on breeding avocets and stilts associated with the potential impact mechanisms resulting from operations and maintenance of the MEB. Based on the instantaneous estimated losses or sublethal effects to breeding birds at the proposed evaporation basin, and the average density of breeding avocet and stilt nests estimated from nest surveys at the TLDD Compensation Habitat reflecting the habitat utility of the managed wetland for breeding birds, an estimate was calculated of the wetland habitat area (acres of suitable habitat) that would be required to compensate for the estimated adverse effects to breeding avocets and stilts resulting from MEB operations. The basis for the key assumptions used in developing the protocol are briefly discussed below.

Selenium Exposure

Information on the effects of dietary exposure to elevated selenium concentrations within an evaporation basin on stilt and avocet reproductive impairment used in the mitigation protocols was developed by USFWS. The relationships developed by USFWS were included in the 1995 USFWS Henwise and Eggwise model calculations and subsequently in the Hanson 1995 protocol. Results of more recent investigations and analyses of the relationship between selenium exposure and reproductive impairment in shorebirds have been developed by Adams *et al.* (1998, 2000), Fairbrother *et al.* (1999, 2000) and Ohlendorf (2003). Results of these more recent investigations have shown that threshold levels of selenium resulting in reproductive impairment are substantially higher than the levels originally estimated by USFWS. The higher selenium thresholds for reproductive impairment established in the recent scientific literature would result in a reduction in the risk of adverse impacts to shorebird reproductive success at the proposed MEB when compared to that estimated using the 1995 USFWS assumptions. For purposes of this mitigation assessment the more conservative selenium thresholds for reproductive impairment developed by USFWS (1995) have been used to calculate a worst-case scenario for estimating habitat requirements at the Compensation Habitat to mitigate for unavoidable impacts to shorebird nesting and reproduction at the proposed evaporation basin.

Predation

The MEB is anticipated to attract shorebirds resulting in a local increase in bird abundance at the evaporation basin. Increased abundance of shorebirds at the basin is expected to result in attraction and increased abundance of terrestrial and avian predators (e.g., raptors). The incremental effect of shorebird attraction to an evaporation basin on the increased risk of predation mortality has not been quantified. Predation by raptors on breeding shorebirds has, however, been observed at other TLDD evaporation basins. As part of developing the 1995 TLDD compensation habitat protocol for reproducing stilts and avocets it was assumed that predation mortality would be 5%. Predation mortality at the TLDD evaporation basins has been high (typically over 50% or more) on shorebird eggs and chicks by predators such as raccoon, coyotes, skunks, snakes, and other terrestrial predators. Predation mortality at the TLDD Compensation Habitat was reduced substantially (typically to 5% or less) by use of an electrified fence that surrounds the habitat and effectively excludes ground-based predators. Breeding shorebirds have the ability to actively avoid predators thereby reducing predation risk, especially when compared to non-mobile eggs and chicks that showed evidence of high predation levels at the evaporation basins in the past. In the absence of additional information on the increased risk of predation on breeding shorebirds at the proposed MEB 21% level of effect was assumed in the protocol.

Salt Ingestion

Agricultural drainage water is characterized by elevated concentrations of salts. As a result of evaporation, salt concentrations increase within individual basin cells, reaching highest concentrations, which may be hypersaline (e.g., having salt concentrations greater than seawater), in the terminal evaporation basin cells. Concern has been expressed regarding the potential for adverse effects on shorebirds resulting from salt ingestion or salt encrustation (CH2M Hill *et al.* 1993; Euliss *et al.* 1989; Barnum 1992; Gordus *et al.* 2002).

Exposure of shorebirds to high salinity has been documented to have adverse effects on shorebirds (CH2M Hill *et al.* 1993, Gordus *et al.* 2002)**.** Ingestion of highly saline water can cause elevated sodium levels within the brain, reduced growth rates, and higher mortality of ducklings (Mitcham and Wobeser 1988, Swanson *et al.* 1994 in CH2M Hill *et al.* 1993). Gordus *et al.* (2002) also observed high sodium concentrations in ruddy ducks found dead within an evaporation basin. Reduced growth rates associated with exposure to high salinity levels have been documented for mallard ducklings (Mitcham and Wobeser 1988), a species found more often in freshwater environments than in saline habitats; similar studies have not been conducted for avian species that typically use saline environments for a portion of their life cycles (e.g., eared grebes, snowy plovers).

Lethal and sublethal effects on breeding birds from salt ingestion at the TLDD evaporation basins have not been documented, but the potential for impacts exists given the high levels of salinity anticipated to occur in the terminal cells of the proposed MEB evaporation basin. Water salinity (EC) levels in the terminal cells of the South and Hacienda Evaporation Basins have been greater than levels identified by CH2M Hill *et al.* (1993) to cause lethal and sublethal effects on ducklings. As a result of water management practices, salinities vary substantially among individual cells within an evaporation basin. Therefore, ducklings and other shorebirds could be exposed to a wide range of salinity conditions from brackish water to hypersaline, depending upon their exposure to an individual cell. Because of the close proximity among evaporation basin cells at the proposed MEB, shorebirds have the opportunity to readily move from one pond cell to another, thereby having the potential to avoid adverse salinity conditions and/or dilute the effects of adverse salinity by preferentially moving to cells having lower salt concentrations. Water conveyance and supply canals (e.g., West Homeland Canal) also exist within the immediate vicinity of the proposed MEB cells, providing additional opportunities for shorebirds to utilize lower saline waters when compared to the hypersaline conditions observed in evaporation basin terminal cells where the risk of salt ingestion impacts are greatest. Observations made during wildlife abundance and nest surveys have shown that waterfowl may move from higher salinity cells to lower salinity areas within an evaporation basin in response to hazing activity and/or habitat preference. Movement of shorebirds from hypersaline cells to areas of lower salinity serves to reduce the potential for adverse impacts associated with salt ingestion.

Hazing Disturbance

In addition to structural and operational modifications to the evaporation basins, TLDD conducts intensive hazing at both the South and Hacienda evaporation basins. The hazing program has been modified and improved based upon results of biological monitoring used to evaluate the success of the hazing effort each year. The hazing program is focused on reducing shorebird foraging and nesting during early spring and summer. The hazing program includes the use of all-terrain vehicles (ATV) and cracker shells to facilitate hazing within both the South and Hacienda evaporation basins from perimeter and interior levees. To augment hazing, TLDD uses foil reflector tape on stakes placed at approximately 10-15 foot intervals in areas of observed pre-nesting and nesting attempt activities at both the South and Hacienda evaporation basins. TLDD also uses portable propane cannons to augment the basic hazing program. Hazing and maintenance activities shall not be conducted within 50 feet of any active nest, with the exception of those activities on the top of the basin levees, which can be conducted within 15 feet of any active nest.

Hazing using a variety of methods outlined above will be used as part of standard operations at the MEB.

Hazing activities are included as a routine measure to avoid, reduce and minimize shorebird use of the TLDD evaporation basins and are included in the operations of the MEB. There is also some disturbance due to operation and maintenance activities on the ponds. Although hazing contributes to reduced bird abundance and potential exposure of shorebirds to adverse effects, hazing also results in disturbance of birds resulting in increased energy expenditure and potentially sublethal effects to health and fitness. Hazing and increased shorebird movement may also contribute to increased risk of predation as birds move from one area to another. No data are available, however, to quantify the sublethal effects of hazing activity on health or condition of shorebirds or increased predation risk. For purposes of estimating a hazing effect it was assumed that each individual bird present at the MEB would be disrupted and experience increased energy expenditure over a period of 30 minutes within a 24 hour day. Based on the assumed level of potential effect the protocol includes a 2% level of effect on breeding shorebirds as a result of hazing activity.

Disease

Shorebirds using the TLDD evaporation basins, and other water bodies in the San Joaquin Valley, have the potential to transmit and be adversely affected by diseases such as avian cholera and botulism. The risk of disease transmission and infection is increased in areas where the density of shorebirds is greatest. As part of routine hazing and maintenance activities at the South and Hacienda evaporation basins, observations are made of the occurrence of dead or dying birds as a result of disease. TLDD routinely accesses the evaporation basins year-round using a variety of methods such as tractors and four-wheel drive vehicles (“gators”) during periods when the soils are wet and slick. As part of accessing the evaporation basin to check water levels, control

gates, perform maintenance activities, and monitor basin water quality and groundwater depths and quality as required by the WDR observations are also made of locations, abundance, occurrence of sick or dead shorebirds, etc. These observations have shown that the frequency and magnitude of dead birds at the evaporation basins is very low in comparison to bird abundance. In recognition of a low level of disease outbreaks the protocol assumes that disease would adversely affect 0.2% of the birds present at the proposed MEB. The estimated level of disease effect (0.2%) represents an average loss of 15 shorebirds per year which is greater than the number of dead or dying shorebirds observed at the existing TLDD evaporation basins.

Compensation Habitat Estimates

Compensation habitat required to mitigate for unavoidable evaporation basin losses to blacknecked stilt and American avocet has been estimated for the proposed MEB using the protocol included in the TLDD 1993 EIR (Hanson 1993), the U.S. Fish and Wildlife Service Henwise and Eggwise protocols (USFWS 1995), and the modified protocol developed by Hanson (1995) as updated to reflect results of current biological monitoring at the existing evaporation basins and Compensation Habitat. As noted above, the conservative assumptions regarding the relationship between selenium exposure and reproductive impairment developed by USFWS (1995) have been used in the calculations to reflect the worst-case conditions. These different analyses yield different compensation requirements; for purposes of mitigation, TLDD has performed the various analyses and will implement mitigation based on the analysis that yields the highest mitigation requirement. Results of calculating compensation habitat requirements using each of these alternative methods, based on data from recent surveys, are summarized below.

Compensation Habitat based on 1993 EIR Compensation Protocol

As part of the TLDD technical report prepared in 1993, a protocol was developed and used for calculating compensation habitat (Hanson 1993). The protocol includes consideration of the anticipated numbers of American avocet and black-necked stilt nests at the proposed evaporation basin based on results of recent monitoring at the TLDD Hacienda Evaporation Basin (nesting is assumed to be proportional to evaporation basin surface area and design and implementation of the same facilities and avoidance measures at the proposed basin as required under the current WDR), an assumed safety factor (assumed to be 50%) to account for undetected nests during nesting surveys (the safety factor was used to avoid underestimating total nesting activity at the basin), reductions in nest exposure attributable to mitigation actions implemented at the MEB, losses of shorebirds associated with exposure to elevated selenium concentrations (reproductive impairment), losses due to predation, and losses due to nest flooding to calculate an estimate of the total number of unavoidable nest losses resulting from proposed evaporation basin operations. For purposes of this analysis, it has been assumed that nesting at the existing Hacienda Evaporation Basin after modifications in 1995 (1996-2011) would be representative of the nesting and vulnerability of shorebirds to adverse impacts at the proposed evaporation basin.

Results of nest monitoring at the existing Compensation Habitat (1996-2011) have been used to estimate performance of the mitigation facility to calculate the compensation habitat required to mitigate for unavoidable losses at the proposed evaporation basin.

Results of these calculations are summarized in Tables 1 and 2, using the average number of nests observed at the Hacienda Evaporation Basins (mean 13 nests from 1996-2011) and the more conservative estimate (worst-case condition) based on the highest observed nesting between 1996 and 2011 (65 nests in 1996), respectively. Based on the ratio of existing evaporation size (1,110 acres) and the area of the proposed evaporation basin (1,800 acres at the proposed MEB) the projected number of nests at the proposed facility is 21 nests based on the average density and 105 nests based on the 1996 peak density. The estimated compensation habitat required to mitigate for unavoidable losses to American avocet and black-necked stilts as a result of operation and exposure to water quality constituents at the proposed TLDD evaporation basin was 0.4 acres, based on results of 1996-2011 average (Table 1) surveys, and 3.0 acres based on results of the 1996 surveys (Table 2).

Table 1. Avocet and stilt Compensation Habitat calculation based on the 1993 EIR protocol as revised using the *average* number of nests observed from 1996- 2011.

LOSSES DUE TO REPRODUCTIVE IMPAIRMENT	AVERAGE NESTING
Nest Attempts (Predicted)	21
Total Estimated Nests	32
Nests Subject to Reproductive Impairment (13%)[(1)]	5
Predation Loss (21%)	(1)
Unavoidable Loss	4
Losses Due to Flooding/Vehicles (2%)	0
Combined Loss (nests)	4

1. Based on USFWS (1995) Henwise egg selenium impairment (0.781 x 0.17) = 0.13. See discussion above regarding selenium thresholds assumed in these analyses. Reproductive impairment was estimated based on the proportion of randomly sampled eggs collected from the South and Hacienda Evaporation Basins between 1995 and 2001 (insufficient numbers of nests have occurred in later years to assess egg selenium concentrations) having selenium concentrations ranging from 5.1 to 20 ppm as outlined in the USFWS protocol.

1996-2011 average number of nests hatched and presumed hatched at the TLDD Compensation Habitat = 3,271 nests.

3,271 nests/307 acres = 10.66 nests/acres
4 nests lost/10.66 nests/acre = 0.4 acres

Table 2. Avocet and stilt Compensation Habitat calculation based on the 1993 EIR protocol and the *highest* observed nesting at the Hacienda Evaporation Basin, 1996-2011.

LOSSES DUE TO REPRODUCTIVE IMPAIRMENT	1996 NESTING
Nest Attempts (Predicted)	105
Total Estimated Nests	158
Nests Subject to Reproductive Impairment (13%)[(1)]	21
Predation Loss (21%)	(4)

LOSSES DUE TO REPRODUCTIVE IMPAIRMENT	1996 NESTING
Unavoidable Loss	17
Losses Due to Flooding/Vehicles (2%)	0
Combined Loss (nests)	17

[1.] Based on USFWS (1995) Henwise egg selenium impairment (0.781 x 0.17) = 0.13. See discussion above regarding selenium thresholds assumed in these analyses

The 1996 nest fates classified as hatched and presumed hatched at the TLDD Compensation
Habitat = 1,771 nests.

1,771 nests/307 acres = 5.77 nests/acres
17 nests lost/5.77 nests/acre = 3.0 acres

Compensation Habitat based on U.S. Fish and Wildlife Service Henwise Basis

The U.S. Fish and Wildlife Service (1995) developed a proposed protocol for calculating compensation habitat using the following equations:

$$CC = HU * [(F1 * L1) + (F2 * L2) + (F3 * L3) + (F4 * L4) + (F5 * L5)]$$

Where:

CC = compensation coefficient = the multiple of an evaporation basin's acreage that, on average, would be required in predominantly shallow wetland acreage to replace lost production;

F1 = the proportion of randomly sampled eggs containing 0 to 5 ppm selenium;

F2 = the proportion of randomly sampled eggs containing 5.1 to 20 ppm selenium;

F3 = the proportion of randomly sampled eggs containing 21 to 40 ppm selenium;

F4 = the proportion of randomly sampled eggs containing 41 to 70 ppm selenium;

F5 = the proportion of randomly sampled eggs containing 71 or more ppm selenium;

L1 = proportion of production lost when egg contamination is from 0 to 5 ppm selenium (L1 = 0.0 from USFWS 1995);

L2 = proportion of production lost when egg contamination is from 5.1 to 20 ppm selenium (L2 = 0.17 from USFWS 1995);

L3 = proportion of production lost when egg contamination is from 21 to 40 ppm selenium (L3 - 0.26 from USFWS 1995);

L4 = proportion of production lost when egg contamination is from 41 to 70 ppm selenium (L4 = 0.52 from USFWS 1995);

L5 = proportion of production lost when egg contamination is 71 or more ppm selenium (L5 = 0.93 from USFWS 1995);

HU = the relative habitat utility for evaporation basins.

Results of the calculation of compensation habitat using data collected at the evaporation basins and Compensation Habitat during 1996-2011 are presented in Table 3. The resulting estimate of habitat to compensate for unavoidable losses at the proposed MEB using the USFWS Henwise method is 2.3 acres.

Table 3. Calculation of TLDD Compensation Habitat using the USFWS (1995) Henwise protocol and 1996-2011 monitoring data.

CC = HU * [(F1 x L1) + (F2 + L2)]
Where: F1 = 0.135(1) F2 = 0.781(1) L1 = 0 (2) L2 = 0.17 (2) HU = 0.01(3) Then: CC = 0.01 [(0.135 * 0) + (0.781 * 0.17)] = 0.0013 Compensation habitat = (1,800 acres at the proposed TLDD evaporation basin)*(0.0013) = 2.3 acres

Notes:
(1) Selenium data is from 1995-2001 egg sampling at the South and Hacienda Evaporation Basins since an insufficient number of nests have been detected at the South and Hacienda Evaporation Basins in recent years to assess egg selenium concentrations;
(2) From USFWS 1995 (See discussion above regarding selenium thresholds assumed in these analyses); and
(3) HU was calculated based on the average stilt and avocet nesting predicted on the proposed TLDD evaporation basin (32 nests from Table 2-8) and the average nesting in 1996-2011 at the Compensation Habitat (3,271 nests).

Compensation Habitat based on U.S. Fish and Wildlife Service Eggwise Basis

The U.S. Fish and Wildlife Service (1995) has proposed an alternative protocol for calculating compensation habitat, using the following equation:

$$CC = HU * [(F1 * L1) + (F2 * L2)]$$

Where:

CC = compensation coefficient = the multiple of an evaporation basin's acreage that, on average, would be required in predominantly shallow wetland acreage to replace lost production;

F1 = the weighted proportion of randomly sampled eggs containing 3.9 to 9.9 ppm selenium;

F2 = the weighted proportion of randomly sampled eggs containing 10 or more ppm selenium;

L1 = proportion of production lost when egg contamination is from 3.9 to 9.9 ppm selenium
(L1 = 0.10 from USFWS 1995);

L2 = proportion of production lost when egg contamination is 10 ppm selenium or more
(L2 = 0.30 from USFWS 1995); and

HU = The relative habitat utility of evaporation basins.

Results of the Eggwise calculation of compensation habitat, using data collected from the evaporation basins during 1996-2011 (after the majority of actions had been implemented at the Hacienda Evaporation Basin to reduce shorebird usage) are summarized in Table 4. The estimated habitat required to compensate for unavoidable losses at the proposed MEB using the USFWS Eggwise Protocol is 3.6 acres.

Table 4. Calculation of TLDD Compensation Habitat using the USFWS Eggwise Protocol and 1996-2011 monitoring data.

CC = HU [(F1 * L1) + (F2 * L2)]
Where: F1 = 0.406(1) F2 = 0.531(1) L1 = 0.10(2) L2 = 0.30 (2) HU = 0.01(3)) Then: CC = 0.01 [(0.406 * 0.1) + (0.531 * 0.3)] = 0.002 Compensation habitat = (1,800 acres at the proposed TLDD evaporation basin)*(0.002) = 3.6 acres

Notes:

(1) Selenium data is from 1995-2001 egg sampling at the South and Hacienda Evaporation Basins since an insufficient number of nests have been detected at the South and Hacienda Evaporation Basins in recent years to assess egg selenium concentrations;

(2) From USFWS 1995 (See discussion above regarding selenium thresholds assumed in these analyses); and

(3) HU was calculated based on the average stilt and avocet nesting predicted to nest at the proposed TLDD evaporation basin (32 nests from Table 2-8) and the average nesting in 1996 - 2011 at the Compensation Habitat (3,271 nests).

Compensation Habitat based on 1995 Compensation Protocol

The protocol developed and presented in the 1993 EIR was revised in 1995 to reflect the availability of new information and to address issues and concerns in the assumptions and application of the 1993 protocol. The revised protocol (Hanson 1995) combined approaches from the 1993 TLDD technical report, and the compensation protocols developed by the U.S. Fish and Wildlife Service (1995). The 1995 protocol also refined assumptions and relationships regarding factors such as predation mortality on shorebird nests, water level fluctuations, maintenance activity, and biological observer disruption as factors affecting nesting and nest success at the evaporation basins. The revised protocol relied on the numbers of American avocet and black-necked stilts observed in nest surveys at the South and Hacienda evaporation basins, a risk of reproductive impairment based on exposure to selenium as determined by the relative proportion of eggs sampled from the population at the evaporation basins having different concentrations of selenium (see discussion above regarding selenium thresholds assumed in these analyses), a 21% loss resulting from predation, and a 75% effectiveness of mitigation measures implemented at the evaporation basins in reducing exposure of shorebirds to adverse effects (since the proposed evaporation basin has been designed and will be operated to meet the avoidance criteria outlined in the current WDR the effectiveness is reflected in the nesting data for the Hacienda Evaporation Basin after modification and no further adjustment to the compensation calculation is needed). Nest flooding and maintenance vehicle losses were also considered as part of the calculation of unavoidable impacts. The equation used for calculating compensation habitat is:

Unavoidable nest loss = (number of nests predicted at the proposed MEB) ((F1 x L1) + (F2 x L2) + (F3 x L3) + (F4 x L4) + (F5 x L5)) x (1 - effectiveness of site-specific actions)/(1 – predation loss), where:

> *F* and *L* are described in the U.S. Fish and Wildlife Service (1995) Henwise Basis for calculating compensation habitat.

Then:

> Compensation habitat acres = number of unavoidable nest losses predicted at the proposed evaporation basins/nest density observed at the TLDD Compensation Habitat.

Based on these calculations (Table 5), using results of the 1996-2011 average nesting, the estimated acreage of compensation habitat for the proposed TLDD evaporation basin is 0.5 acres. Assuming nesting abundance of 105 nests, based on results of the 1996 surveys (worstcase condition), the estimated Compensation Habitat requirement is 3.0 acres.

Table 5. Alternative protocol for calculating Compensation Habitat requirements (Hanson 1995) based on 1996-2011 monitoring data.

Nest Loss = (Number nests predicted at the proposed evaporation basin)[(F1 x L1) + (F2 + L2) + (F3 + L3) + (F4 + L4) + (F5 + L5)] (1-effectiveness of site actions) / (1-predation loss)

Where:

Number of nests = 21[(1)]

F1 = 0.33[(2)]
F2 = 0.67
F3 = 0
F4 = 0
F5 = 0
L1 = 0
L2 = 0.17
L3 = 0.26
L4 = 0.52
L5 = 0.93

Predation loss at the MEB is assumed to be 21% based on nest fate monitoring at the South and Hacienda Evaporation Basins. Effectiveness of actions is assumed to be 0 since all measures are anticipated to be implemented as part of the proposed evaporation basin design and construction.

Then:

Nest loss = (21 nests)[(0.33 x 0)+ (0.67 x 0.26)] (1.0) / (0.79) = 4.6 nests (assume 5 nests)

Based on the 1996-2011 Compensation Habitat (hatched/presumed hatched) nesting density of 10.66 nests/acre, the Compensation Habitat requirement is:

Compensation Habitat (acres) = 5 nests/10.66 nests/acre = 0.5 acres

Assuming 105 nests based on 1996 results at the evaporation basins (Table 2-9) and Compensation Habitat, the compensation habitat requirement would be 17 nests/5.77 nests/acre = 3.0 acres

Notes:
(1) Predicted nests at the proposed MEB is based on the average density of stilt and avocet nests observed at the Hacienda Evaporation Basin in 1996-2011 assuming the MEB has a surface area of 1,800 acres.

(2) *F* and *L* are calculated using the USFWS (1995) Henwise Protocol. See discussion above regarding selenium thresholds assumed in these analyses

Summary of Compensation Habitat Estimates

Four separate protocols were used to estimate the compensation habitat required to mitigate for unavoidable impacts to nesting shorebirds as a result of operation of the proposed MEB. The protocols were originally developed as part of the 1993 site-specific technical report for TLDD evaporation operations by Hanson and subsequently updated and refined in 1995, and by the USFWS in 1995 for application to evaporation basins within the San Joaquin Valley. The four protocols were used to assess habitat requirements to compensate for unavoidable losses at the MEB based on a proportional

estimate of the average nest densities at the Hacienda Evaporation Basin (closest evaporation basin location to the proposed MEB) over the period 1996-2011 and for a worst-case condition based on the peak density of nesting shorebirds (1996). Results of the estimates of compensation habitat for the MEB are summarized below:

Estimated compensation habitat acres for nesting shorebirds:

Protocol	**Acreage based on 1996-2005 average density**	**Acreage based on the 1997 peak density**	**Acreage based on egg selenium concentration**
1993 Hanson Protocol	0.4	3.0	
1995 USFWS Henwise Protocol			2.3
1995 USFWS Eggwise Protocol			3.6
1995 Hanson Revised Protocol	0.5	3.0	

Based on results of the compensation habitat calculations presented above, it was concluded that 3.6 acres of habitat would need to be dedicated at the existing TLDD Compensation Habitat to mitigate for unavoidable impacts to shorebirds associated with operation of the proposed evaporation basin. The 3.6 acre habitat estimate was chosen as the compensation requirement since it represents the highest (most conservative) estimate for the MEB using any of the available protocols. TLDD has also developed and operates a winter waterfowl habitat that will further contribute habitat in the area. Based on the formulation of the mitigation protocol for breeding birds as a result of MEB operations it was estimated that the mitigation habitat requirement would total 3.6 acres of suitable wetland habitat for shorebirds in addition to the current compensation requirement of 207 acres for compensation of effects of South and Hacienda evaporation basin operations at the TLDD Compensation Habitat. The wetland habitat would be operated to provide a minimum of 210.6 acres (based on the current requirement of 207 acres to compensate for effects of South and Hacienda evaporation basin operations and 3.6 acres to compensate for MEB operations) of habitat during the seasonal period of greatest abundance of breeding shorebirds extending from late February through August each year. The habitat may be dewatered during the fall and winter months (September-early February) for maintenance and vegetation control. As with the existing TLDD evaporation maintenance activities best management practices would be employed to avoid impacts of maintenance activity on birds and nests that may occur adjacent to the Compensation Habitat. As part of future monitoring, shorebird abundance surveys would be routinely conducted at the MEB as currently required for the South and Hacienda evaporation basins, and at the Compensation Habitat, to further assess the performance of the mitigation measure in providing suitable habitat for breeding shorebirds to offset potential unavoidable effects of MEB operations. Nest surveys at the MEB and Compensation Habitat will be conducted at least every other week from April through July. In addition, if new nests are observed by field biologists when conducting the bird surveys, those nests shall be flagged and included in the nest survey counts.

Performance Review

TLDD routinely conducts annual monitoring of bird abundance and species composition, nesting, and nest fate monitoring at the evaporation basins and Compensation Habitat. Water quality sampling for electrical conductivity, selenium concentrations, and other constituents in compliance with monitoring requirements of the WDR is also performed. TLDD anticipates that the WDR issued for the MEB will also require wildlife and water quality monitoring that will be reported in quarterly and annual reports. The annual monitoring reports will be provided to the Regional Board and California Department of Fish and Wildlife for review. The compensation protocols presented above are based on results of water selenium concentrations, avocet and stilt abundance, nest fate, and egg selenium concentrations from the TLDD South and Hacienda Evaporation Basins and Compensation Habitat. For purposes of estimating compensation habitat for breeding stilts and avocets at the MEB the protocols assume that selenium concentrations in the South and Hacienda Evaporation Basins water and waterbird eggs is representative of selenium exposure in the MEB. As part of monitoring at the MEB water quality samples will be collected for selenium analysis monthly from April through June and up to five each of stilt and /avocets eggs if available (for a maximum of ten total eggs) will be collected each year for egg selenium analysis. Results of these collections will be compared to the South and Hacienda basin results in each annual monitoring report. In addition, the annual monitoring reports for the MEB will also re-calculate compensation habitat using each of the protocols outlined above. The annual monitoring reports will be distributed to both CDFW and the Regional Board for review. In the event that monitoring results at the MEB show greater impacts to breeding birds than those estimated above, the MEB compensation habitat requirement will be revised accordingly and additional minimization and avoidance actions may be implemented by TLDD to reduce unavoidable impacts to breeding waterbirds.

Based on results of monitoring at the MEB and Compensation Habitat, CDFW may request a review of the Compensation Habitat protocols at a frequency of approximately every five years. TLDD will work collaboratively with the Regional Board and CDFW staff to incorporate these any changes into the WDR monitoring and reporting program and/or WDR if needed.