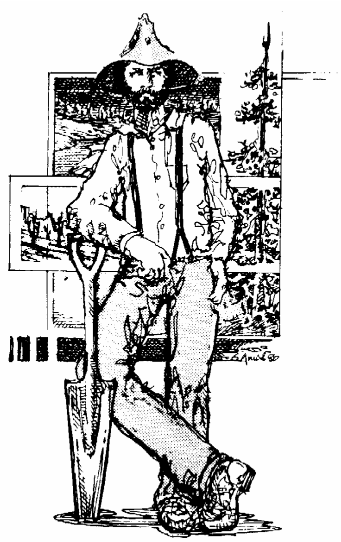
PRELIMINARY RESTORATION PLANS
HINES SPRING, HIDDEN LAKE,
and
WARREN LAKE

Prepared for:

Ecosystems Sciences



WHITEHORSE ASSOCIATES
Smithfield, Utah

Whitehorseassociates.com

September 2005

ACKNOWLEDGEMENTS

Completion of preliminary restoration plans was a team effort. Ecosystems Sciences (ES) provided the opportunity and useful information. Los Angeles Department of Water and Power (LADWP) provided materials. Ted Dean (WHA) operated the GIS. Sherman Jensen (WHA) was principal investigator and is responsible for any errors. Draft phase I, II, and III mitigation reports prepared by Otis Bay Ecological Consultants were reviewed prior to completion of these preliminary restoration plans.

EXECUTIVE SUMMARY

A memorandum of understanding (MOU) requires Los Angeles Department of Water and Power (LADWP) to provide 1,600 acre-feet of water per year for restoration as mitigation for impacts to springs/seeps resulting from groundwater pumping. The purpose of these preliminary restoration plans is to evaluate if restoration of water/wetland at Hines Spring, Hidden Lake, and Warren Lake is feasible. Information regarding the relative benefits and costs for various feasible alternatives are provided, from which the reasonableness of various feasible alternatives can be determined.

The preliminary restoration plan for Hines Spring is founded on a recently completed inventory of 2000 conditions and the plan for Hidden Lake is founded on an inventory of the Blackrock Waterfowl Management Area. Warren Lake was mapped from the 2000 orthophoto and field reconnaissance for this report. Two field reviews were conducted in July and August 2005. Project areas were also reviewed stereoscopically from 1:12,000 scale color photos dated October, 1996.

A water budget was estimated for each area. Long-term bedloss (2 to 3 feet per year) was estimated from man-induced wetlands in the BWMA. Evapotranspiration was estimated from Greenbook values for discrete vegetation types. Changes in hydrologic parameters viewed in context of landtypes were used to predict future vegetation types from analogous settings in Owens Valley. Fiscal, habitat, and hydrogeomorphic (HGM) assessments were conducted for both existing and predicted conditions. An experimental design will be further developed for the selected restoration alternative(s).

The Hines Spring area was divided into three *zones*. One or more *areas* consisting of landtypes best suited for creation of wetlands was identified in each zone, resulting in a total of 7 zones/areas. Two areas were considered for Hidden Lake. Two alternative hydrologic regimes were considered for Warren Lake. The extent of vegetation associations, areas suitable for riparian trees/shrubs, water budget, and costs were predicted for each zone/area/alternative.

Fiscal, habitat, and HGM function assessments were conducted for 18 feasible combinations of zones/areas/alternatives for the three project areas. Assessments were ranked. The top combinations are:

- **Hines Spring (includes 5 areas in three zones):** This area would require about 1,325 acre-feet of water to enhance 221 acres, including 155 acres of water/wetland. About 75 acres would be suitable for establishing riparian trees and shrubs. The cost would be about $3,800 per acre of water/wetland. The habitat rank indicates the potential for establishing uncommon habitats is moderate and the function rank indicates a high net increase in functional units. Discrete zones/areas may provide opportunities for a more comprehensive experimental design, which could be integrated with the BWMA. The Hines area is flanked by the LORP riparian area on the east and the BWMA on the south; it occupies the position of a 'key stone" for the LORP watershed. Efforts to create wetland/water in this area are likely to benefit the Drew management unit in the BWMA and the incised reach of the LORP riparian area, where existing resource values are lowest.

- **Warren Lake/Alternative 1:** This alternative is to supply water to the lake bed throughout the growing season. It would require about 1,425 acre-feet of water to enhance 344 acres, including 300 acres of water/wetland. About 75 acres would be suitable for establishing riparian trees and shrubs. The projected cost, $20 per acre of wetland/water, is very low. Because relatively uncommon (saltgrass) habitats will be replaced by more common (marsh) habitats, the habitat rank was high (indicating more common predicted habitats), although the net gain in functional units was the highest of all sites considered. Establishment of water/wetland in Warren Lake is the simplest, most predictable, and easiest to monitor of all sites considered.

- **Hidden Lake/Area 2:** This area includes two contiguous fault basins (north and Hidden Lake) that would be supplied by a pipeline from the aqueduct. It would require about 235 acre-feet to enhance 40 acres, including 28 acres of water/wetland. The projected cost, $15,000 per acre of water wetland, is high. The habitat rank indicates relatively uncommon (e.g. open water) habitats are predicted. The low net gain in function units resulted in a high function rank. The high cost of getting water to the area and the relatively small area of predicted water/wetland are the principal limitations.

- **Warren Lake/Alternative 2:** This alternative is to supply seasonal water to the lake bed in the spring. It would require about 450 acre-feet of water to enhance 344 acres, including 200 acres of water/wetland. About 295 acres would be suitable for establishing riparian trees and shrubs. The projected cost, $30 per acre of wetland/water, is very low. This alternative is best suited for use of allocated water (1600 acre-feet) not utilized for other sites.

Other smaller combinations and discrete areas/alternatives ranked low in the overall assessment, primarily because of the high fiscal cost and relatively small predicted areas of water/wetland.

I recommend the 1600 cfs be used primarily for Hines Spring (includes 5 areas and three zones). Water not used at Hines Spring could be used for seasonal flooding of Warren Lake.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

Avg = Average
bp = before present
BWMA = Blackrock Waterfowl Management Area
CIR = Color infrared
DEMs = Digital Elevation Models
DHA = Delta Habitat Area
DVD = Digital video disk
ES = Ecosystem Sciences
ET = Evapotranspiration
EPA = Environmental Protection Agency
FAC = Facultative
FACW = Facultative wetland
ICWD = Inyo County Water Department
LADWP = Los Angeles Department of Water and Power
LORP = Lower Owens River Project
MORP = Middle Owens River Project
MOU = Memorandum of understanding
N = number of items
NI = not an indicator species
NRCS = Natural Resource Conservation Service
OB = Otis Bay
OBL = Obligate
PDF = Adobe file
TIFF = Tagged interchange file format (image files)
USU = Utah State University
WHA = White Horse Associates

1.0 INTRODUCTION

A memorandum of understanding (MOU) requires Los Angeles Department of Water and Power (LADWP) to provide 1,600 acre-feet of water per year for restoration as mitigation for impacts to springs/seeps resulting from groundwater pumping. At the direction of Ecosystems Sciences (ES) *preliminary* restoration plans were prepared for Hines Spring using well 355, Hidden Lake, and Warren Lake using water from the Big Pine Canal. The purpose of the preliminary restoration plans is to evaluate if restoration of water/wetland at the three sites is feasible. Information regarding the relative benefits and costs for various feasible alternatives are also provided, from which the reasonableness of various feasible alternatives can be determined. The intent is to provide information from which the sites to be restored can be selected from a range of alternatives. Information will also serve as a basis for final restoration plans for selected alternatives.

2.0 APPROACH

The preliminary restoration plan for Hines Spring is founded on a recently completed inventory of 2000 conditions (WHA 2005) and the plan for Hidden Lake is founded on an inventory of the Blackrock Waterfowl Management Area (WHA 2004d). Warren Lake was mapped from the 2000 orthophoto and field reconnaissance for this report. Two field reviews were conducted in July and August 2005. Project areas were also reviewed stereoscopically from 1:12,000 scale color photos dated October, 1996.

The approach entailed documentation of existing landtypes (e.g. *spring drainage, paleochannel, fault basin, etc.*), water regimes (e.g. *high water table, low water table, saturated, etc.*) and vegetation types (series and associations). Landtypes that evolved in response to more hydric historic conditions were judged to be best suited for creation of water/wetland. Preliminary restoration plans are intended to establish more hydric water regimes in suitable landtypes. The soils, topography, microrelief, and existing vegetation reserves of suitable landtypes evolved over many thousands of years and cannot be easily reconstructed. Disturbance to soil and existing vegetation in order to construct idealized conditions not inherent to the site will be minimized. Given existing landtypes and intended water regimes, future vegetation types were predicted based on analogous settings in the vicinity (WHA 2004a,b,c,d).

There are numerous examples of passive colonization by hydric herbaceous vegetation in response to hydrologic management in Owens Valley. More than 800 acres of diverse herbaceous wetlands have colonized barren lake-bed in the Delta Habitat Area since the mid-1960s (WHA 2004a). More than 1,800 acres of wetlands have recolonized the lower Owens River in response to flow management (WHA 2004b) instigated in the 1980s. More than 1,100 acres of man-induced wetlands have evolved in response to water management in the BWMA (WHA 2004c). Hydric vegetation has colonized rivulets from flowing wells along the middle Owens River (WHA 2004d). Hydric vegetation has developed in response to long-term irrigation on alluvial terraces (WHA 2004e). We anticipate passive colonization of herbaceous vegetation in response to more hydric conditions in suitable landtypes. Passive herbaceous colonization could also be compared with more aggressive techniques (e.g. seeding, transplanting, or sod).

Although the areas for establishing riparian trees and shrubs is not specified, the areas (acres) of suitable habitat was estimated as the area where alkali meadow (saltgrass) and wet alkali meadow (saltgrass-rush) was predicted. The approach to establishing riparian trees/shrubs may entail adjusting hydrologic conditions to encourage survival of propogules from existing populations, establishment from cuttings of local populations, and/or transplanting of nursery stock developed from local sources. The best areas and methods for establishing riparian trees/shrubs will be identified after water regimes and herbaceous vegetation have been reestablished. Similarly, the introduction of rare plant/animal species will not be considered until restored conditions are established and it's suitability for the species evaluated.

An estimate of bedloss, the rate at which water infiltrates below the root zone, contributes to the water table, and becomes unavailable for sustaining wetland, is needed to derive water budgets. In November 2003, LADWP conducted six double ring infiltrometer tests in the vicinity of Hines Spring where alluvium covers volcanic bedrock. The average measured infiltration rate was 1,935 feet of water per year. This estimate should be viewed as the expected bedloss when water is first released to the area. This initial rate in residual land is probably much higher than for some other landtypes (e.g. lacustrine, paleochannel, and fault basin) where soils are finer and less permeable. Changes induced by wetland conditions (e.g. saturation of soils, sorting of surface materials, colonization by vegetation, swelling of soil structure, and deflocculating of soil peds) are expected to reduce bedloss over time.

LADWP infiltrometer test, site 3.

The long-term bedloss for established wetlands was estimated from man-induced wetlands in the BWMA (WHA 2004d). The Blackrock Ditch provides most of the water to the Drew, Twin Lakes, Winerton, Waggoner, and Goose Lake management units. Landtypes in these units include fault basins, paleochannel, spring drainage, and lacustrine land similar to those in the Hines Spring area. The major sources of water to these management units are the Blackrock Ditch (4,485 ac-ft/year for the 1990-2002 period) and the Blackrock Siphon (244 ac-ft/year for 1990-2002). The 4,729 acre-feet/year input sustains about 1,471 acres of hydric vegetation (Table 2-1) with an estimated evapotranspiration (ET) of about 2,992 acre-feet/year. Assuming no surface outflow from the area and 6 inches annual precipitation, the average long-term bedloss for established wetland in fault basin, paleochannel, spring drainage, and lacustrine land is 2-3 feet per year.

Table 2-1. Estimated ET in BWMA management units supplied by the Blackrock Ditch.				
Vegetation Type		ET Rate	Area	ET
Code	Name	(ft/year)	(acres)	(ac-ft)
121	Bulrush-cattail	4.2	383	1610
131	Saltgrass-rush	1.4	212	297
135	Reedgrass	1.4	2	3
151	Saltgrass	1.4	135	189
252	Tamarisk/saltgrass	1.4	2	3
312	Goodding-red willow/Creeping wildrye-saltgrass	2.8	5	19
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	1.0	697	697
500	Water	5.0	35	175
--	**TOTAL**	**--**	**1471**	**2992**

Costs were estimated for structural features needed to accomplish the preliminary plans. Unit costs for features (Table2-2) were estimated by LADWP. Additional costs for vegetation planting, monitoring, and reporting are expected to be similar, regardless of which projects are selected. These additional costs will be projected in a final restoration plan for selected alternatives.

Table 2-2. Estimated costs for structural features

Feature	Description	Cost
Buried pipeline	6 inch diameter; 0.5 cfs capacity	$75/foot
Buried pipeline	4 inch diameter;	$60/foot[1]
Well 355	Refurbishing	$45,000
Power to Well 355	--	$130,000
Fencing	--	$3.50/foot
Cattle guard	--	$4,000
Culvert	18 inch; installed in dirt	$4,000
Headgates	--	$5,000
Flow gages	--	$6,000
Minor earthwork	< 3 cubic yards	$1,200
Major earthwork	excavation for ponds; onsite disposal	$26,000/acre
Road work	Raise grade of 200 meters of Goodale Road 2 feet	?
Open ditch	--	?

[1] Estimated by WHA based on LADWP estimates for larger pipes.

Assessments of various zones, areas, and alternatives for the Hines Spring, Hidden Lake, and Warren Lake areas are based on inventories of existing conditions, predicted future conditions, and costs. Three discrete assessments were conducted.

- **Fiscal Assessment:** The total cost for structural features was divided by the net gain (predicted minus existing) in wetland/water resources (acres). Results were ordered from low-to-high and assigned a fiscal rank[2].

- **Habitat Assessment:** The net gain of specific habitats (e.g. vegetation types) were estimated (predicted minus existing). The extent (acres) of similar habitats throughout Owens Valley was estimated from inventories (WHA 2004a,b,c,d). Vegetation associations in Owens Valley were combined into groups distinguished by hydrologic conditions (i.e. water regime) and ecological potential. The areas of these association groups were sorted from low-to-high and assigned a rank (1-10). A habitat score was calculated for each zone/area/alternative as the average rank, weighted by the net gain of specific types. The habitat scores for specific zones, areas, and alternatives were then sorted (low-to-high) and assigned a habitat rank.

- **Hydrogeomorphic (HGM) Assessment:** HGM assessments were developed for habitats similar to those predicted for the Hines Spring, Hidden Lake, and Warren Lake areas (WHA 2004g). Variables and indexes developed for LORP, MORP, DHA, and BWMA were applied to both existing and predicted conditions. The net gains of hydrologic, biogeochemical, and habitat functions were estimated for each zone/area/alternative. Net gains were sorted from high-to-low and assigned a function rank (1-10).

Ranks were defined as the range in values divided into ten equal intervals. The most favorable extreme (i.e. lowest cost/acre, most uncommon predicted habitats, greatest net gain in HGM function) were assigned a rank of 1 and the least favorable a rank of 10. An average rank was calculated from the fiscal, habitat, and HGM ranks.

The MOU states that restoration will serve as a research project on how to re-establish water/wetland. The anticipated dependent variables are the extent and quality of aquatic and vegetated habitats. Monitoring of dependent variables (e.g. plant species composition, cover, community extent, survival of tree/shrub plantings, etc.) will be specified in more refined restoration plans for selected alternatives. Independent variables are expected to include hydrologic variables (e.g. inflow and outflow) and propagation techniques (e.g. seeding, cuttings, nursery stock). Stream gages are specified in the preliminary plans because they influence fiscal assessments. Although the total area where riparian trees and shrubs could be established is reported for each alternative, propagation techniques and variables that may be important for the experimental design are not discussed. The experimental design will be further developed for the selected restoration alternative(s).

2

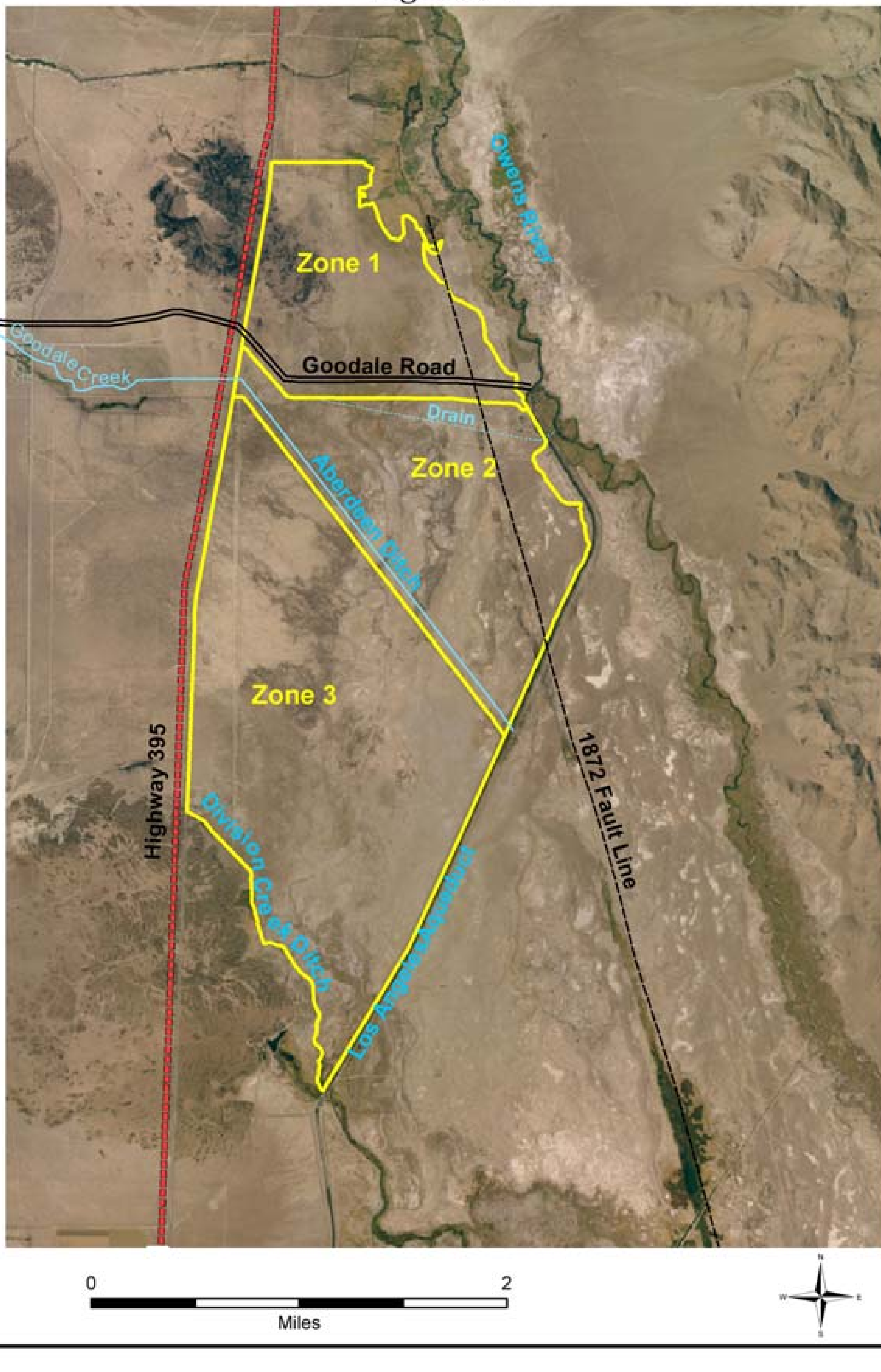
3.0 PRELIMINARY DESIGN PLANS

Preliminary design plans are founded on the Hines Spring inventory (WHA 2005a), the BWMA inventory (WHA 2004d) that includes Hidden Lake, and new mapping of Warren Lake. Preliminary designs are not intended to identify what should be done, but rather, what could be done, assuming adequate water supply. Preliminary designs are the basis for costs (chapter 4.0), assessments (chapter 5.0), and recommendations (chapter 6.0).

3.1 Hines Spring

The Hines Spring area was divided into three *zones* (Figure 3-1). One or more *areas* consisting of landtypes (see chapter 4.1 of Hines Spring Inventory) best suited for creation of wetlands was identified in each zone. At the direction of Ecosystem Sciences (ES), well 355 was the only water source considered for creating water/wetland habitats. We anticipate a seasonal water budget with higher demands in summer (up to about 4 cfs) and lower demands in winter (possibly less than 1 cfs) to meet the ET of created water/wetland habitats.

Hines Spring Area
Map Index
Figure 3-1



- **Zone 1 (641 acres):** North of Goodale Road. This zone includes three potential wetland creation areas (Figure 3-2) where a total of about 32 acres of water/wetland could be created and another 10 acres of alkali meadow and alkali scrub/meadow (non-wetland) would could be created or maintained. A total of about 42 acres could be enhanced.

  - **Area 1 (3.7 acres):** The spring drainage arising from the contemporary vent of Hines Spring. The spring drainage crosses both residual and alluvial lands (Figure 3-3). The narrow spring drainage is incised and confined along most of its course. Existing vegetation is mostly alkali forb (2.2 acres), alkali meadow (1.2 acres), and alkali scrub/meadow (0.3 acres).

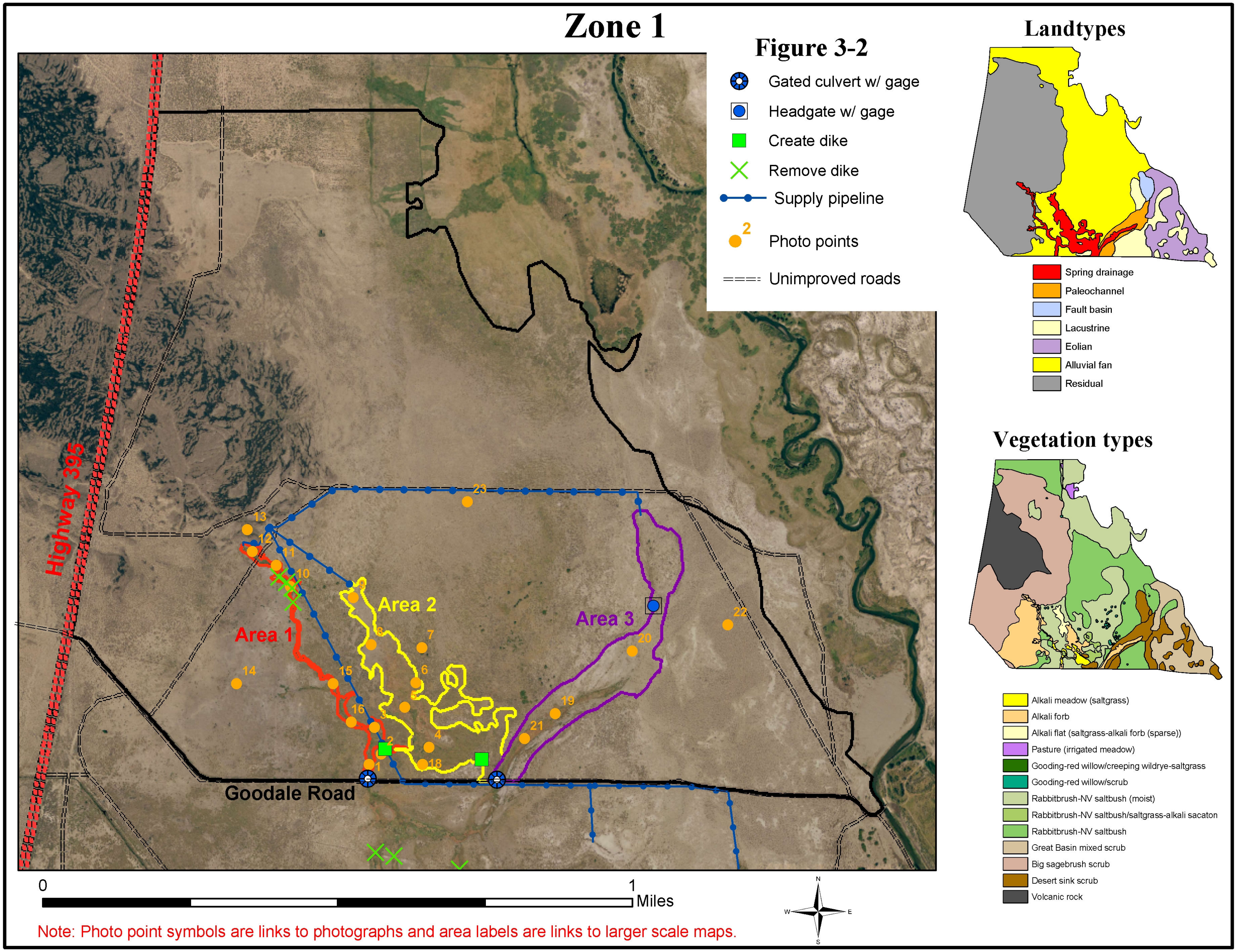
    Water will be delivered to the head of area 1 via a 360 foot long, 4 inch diameter buried pipeline from well 355. Three small dikes in the spring drainage will be removed and a small dike will be created to block a drainage that links area 1 and area 2. The existing culvert at Goodale Road will be modified to include an adjustable head-gate and streamflow gage.

    Predicted vegetation types that could be created (Figure 3-3) includes a small pond (0.1 acres), marsh (3.2 acres), alkali scrub/meadow (0.3 acres), and a small area of wet meadow (<0.1 acre). Two existing tree willow (<0.1 acres) could also be enhanced. The total area of wetland that could be created is about 3.4 acres. Less than 0.1 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 15 acre-feet/year and the long-term bedloss is predicted to be 11 acre-feet/year[3]. The water budget for this area is 26 acre-feet.

Table 3-1. Predicted Vegetation, Zone 1/Area 1.

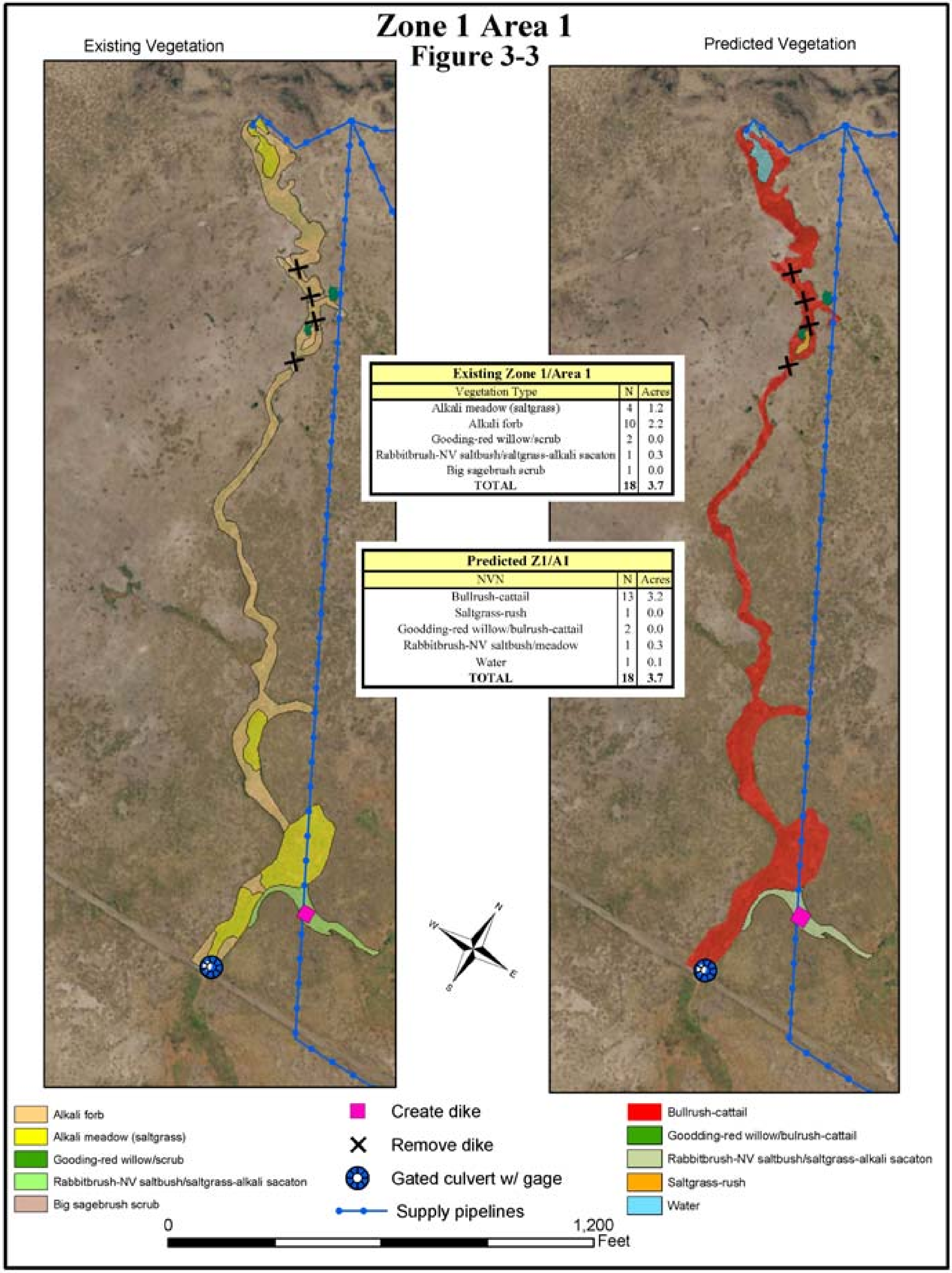
Predicted Vegetation	N	Acres	ET (ft/year)	ET (ac-ft)
Bulrush-cattail	13	3.2	4.2	13.6
Saltgrass-rush	1	0.0	1.4	0.0
Goodding-red willow/bulrush-cattail	2	0.0	4.2	0.1
Rabbitbrush-NV saltbush/meadow	1	0.3	1	0.3
Water	1	0.1	4	0.6
TOTAL	**18**	**3.7**	--	**14.6**

[3] LADWP estimated initial bedloss will be excessive, at least where the drainage crosses residual land near the head of the spring drainage. Average long-term bedloss estimated for spring drainage, paleochannel, fault basin, and lacustrine lands in the BWMA may underestimate bedloss for residual lands. If bedloss continues to be excessive in this area, adaptive management to reduce the water allocated to this area to that needed to sustain bulrush/cattail in the immediate vicinity of the contemporary spring vent should be considered.



Zone 1
Figure 3-2
Gated culvert w/ gage
Headgate w/ gage
Create dike
Remove dike
Supply pipeline
Photo points
Unimproved roads
Landtypes
Spring drainage
Paleochannel
Fault basin
Lacustrine
Eolian
Alluvial fan
Residual
Vegetation types
Alkali meadow (saltgrass)
Alkali forb
Alkali flat (saltgrass-alkali forb (sparse))
Pasture (irrigated meadow)
Gooding-red willow/creeping wildrye-saltgrass
Gooding-red willow/scrub
Rabbitbrush-NV saltbush (moist)
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton
Rabbitbrush-NV saltbush
Great Basin mixed scrub
Big sagebrush scrub
Desert sink scrub
Volcanic rock
Highway 395
Area 1
Area 2
Area 3
Goodale Road
0
1
Miles
Note: Photo point symbols are links to photographs and area labels are links to larger scale maps.

Zone 1 Area 1
Figure 3-3



Existing Zone 1/Area 1		
Vegetation Type	N	Acres
Alkali meadow (saltgrass)	4	1.2
Alkali forb	10	2.2
Gooding-red willow/scrub	2	0.0
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	1	0.3
Big sagebrush scrub	1	0.0
TOTAL	18	3.7

Predicted Z1/A1		
NVN	N	Acres
Bullrush-cattail	13	3.2
Saltgrass-rush	1	0.0
Goodding-red willow/bulrush-cattail	2	0.0
Rabbitbrush-NV saltbush/meadow	1	0.3
Water	1	0.1
TOTAL	**18**	**3.7**

- **Area 2 (17.7 acres):** What appears to be an old spring vent[4] is at the head of this broadly concave, unconfined spring drainage. The vent has not been active since prior to 1944. There is no apparent channel through the broad spring drainage. Prominent existing vegetation includes alkali forb (5.3 acres), alkali scrub/meadow (3.7 acres), sparsely vegetated alkali flat (3.4 acres), alkali meadow (2.7 acres), and alkali scrub (2.4 acres)). An old drain about 100 meters southeast of Hines Spring link area 1 with the head of area 2. The head of area 2 is about 250 meters southeast of well 355.

  Water will be delivered to the head of area 2 via an 890 foot long buried pipeline from well 355. Minor excavation will be needed to allow this area to overflow to the paleochannel in Zone 1/Area 3.

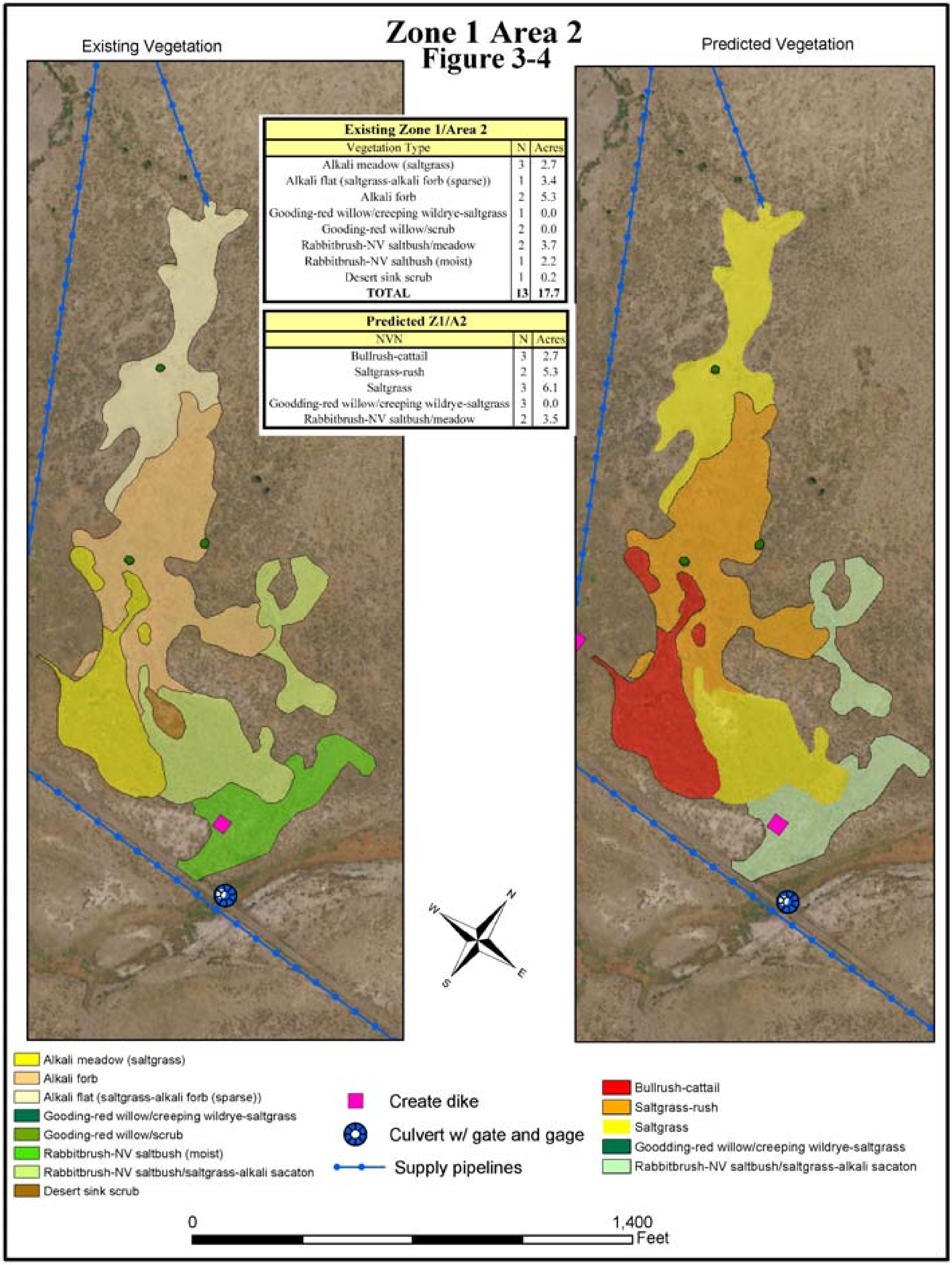
  Predicted vegetation types that could be created (Figure 3-4) include marsh (2.7 acres), wet meadow (5.3 acres), alkali meadow (6.1 acres), alkali scrub/meadow (3.5 acres). Three tree willow (<0.1 acres) would be enhanced. The total area of wetland that could be created is about 14.2 acres. About 11 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 31 acre-feet/year and the long-term bedloss is predicted to be 53 acre-feet/year. The water budget for this area is 84 acre-feet.

Table 3-2. Predicted Vegetation, Zone 1/Area 2.

Predicted Vegetation Type	N	Acres	ET (ft/year)	ET (ac-ft)
Bulrush-cattail	3	2.7	4.2	11.4
Saltgrass-rush	2	5.3	1.4	7.5
Saltgrass	3	6.1	1.4	8.6
Goodding-red willow/creeping wildrye-saltgrass	3	0.0	2.8	0.1
Rabbitbrush-NV saltbush/meadow	2	3.5	1	3.5
TOTAL	**13**	**17.7**	**--**	**31.0**

[4] Alternatively, the alkali conditions indicative of former wetlands in this area might have evolved in response to diversion of water from the contemporary spring drainage via a drain, the remnants of which remain visible immediately north of the area.

Zone 1 Area 2
Figure 3-4



Existing Zone 1/Area 2		
Vegetation Type	N	Acres
Alkali meadow (saltgrass)	3	2.7
Alkali flat (saltgrass-alkali forb (sparse))	1	3.4
Alkali forb	2	5.3
Gooding-red willow/creeping wildrye-saltgrass	1	0.0
Gooding-red willow/scrub	2	0.0
Rabbitbrush-NV saltbush/meadow	2	3.7
Rabbitbrush-NV saltbush (moist)	1	2.2
Desert sink scrub	1	0.2
TOTAL	**13**	**17.7**

Predicted Z1/A2		
NVN	N	Acres
Bullrush-cattail	3	2.7
Saltgrass-rush	2	5.3
Saltgrass	3	6.1
Goodding-red willow/creeping wildrye-saltgrass	3	0.0
Rabbitbrush-NV saltbush/meadow	2	3.5

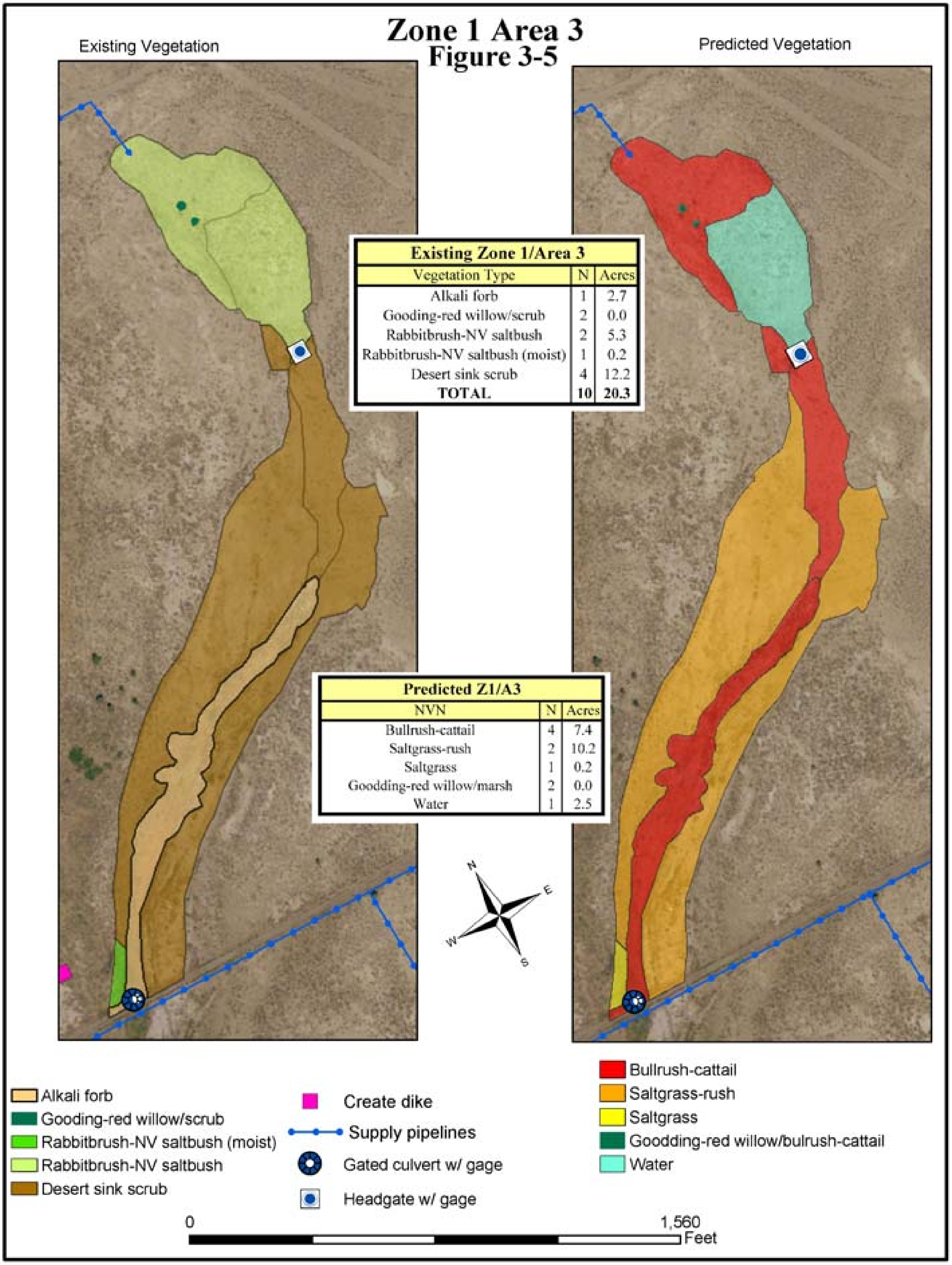
- **Area 3 (20.3 acres):** Includes a fault basin (5.5 acres), paleochannel (12.2 acres), and spring drainage (2.7 acres) inset to the paleochannel. Surfaces are broadly concave and drainage would be unconfined. Existing vegetation is mostly desert sink scrub (12.2 acres), rabbitbrush-NV saltbush scrub (5.5 acres), and alkali forb (2.7 acres). The fault basin at the head of this area is about 1,000 meters east of well 355.

  Water will be delivered to the fault basin at the head this area via a 3,620 foot long buried pipeline from well 355. A 2.5 acre pond will be excavated 2-3 feet. A channel (300-400 feet) will be excavated to facilitate drainage of the pond to the paleochannel. A gated and gauged culvert will be installed where the paleochannel crosses Goodale Road.

  Predicted vegetation types that could be created (Figure 3-5) includes a pond (2.5 acres) in the fault basin, marsh (7.4 acres), wet meadow (10.2 acres), and alkali meadow (0.2 acres). Two tree willow (<0.1 acres) would be enhanced. The total area of water/wetland that could be created is about 20.1 acres. About 10 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 58 acre-feet/year and the long-term bedloss is predicted to be 61 acre-feet/year. The water budget for this area is 118 acre-feet.

Table 3-3. Predicted Vegetation, Zone 1/Area 3.

Predicted Vegetation	N	Acres	ET	
			(ft/year)	(ac-ft)
Bulrush-cattail	4	7.4	4.2	31.0
Saltgrass-rush	2	10.2	1.4	14.3
Saltgrass	1	0.2	1.4	0.3
Goodding-red willow/marsh	2	<0.1	4.2	0.1
Water	1	2.5	5	12.7
TOTAL	**10**	**20.3**	**--**	**58.3**



Existing Zone 1/Area 3		
Vegetation Type	**N**	**Acres**
Alkali forb	1	2.7
Gooding-red willow/scrub	2	0.0
Rabbitbrush-NV saltbush	2	5.3
Rabbitbrush-NV saltbush (moist)	1	0.2
Desert sink scrub	4	12.2
TOTAL	**10**	**20.3**

Predicted Z1/A3		
NVN	**N**	**Acres**
Bullrush-cattail	4	7.4
Saltgrass-rush	2	10.2
Saltgrass	1	0.2
Goodding-red willow/marsh	2	0.0
Water	1	2.5

- **Zone 2 (889 acres)**: This zone (Goodale Road to Aberdeen Ditch) includes three potential wetland creation areas (Figure 3-6) where a total of about 101 acres of water/wetland could be created and another 54 acres of alkali meadow and alkali scrub/meadow could be created or maintained. A total of about 155 acres could be enhanced.

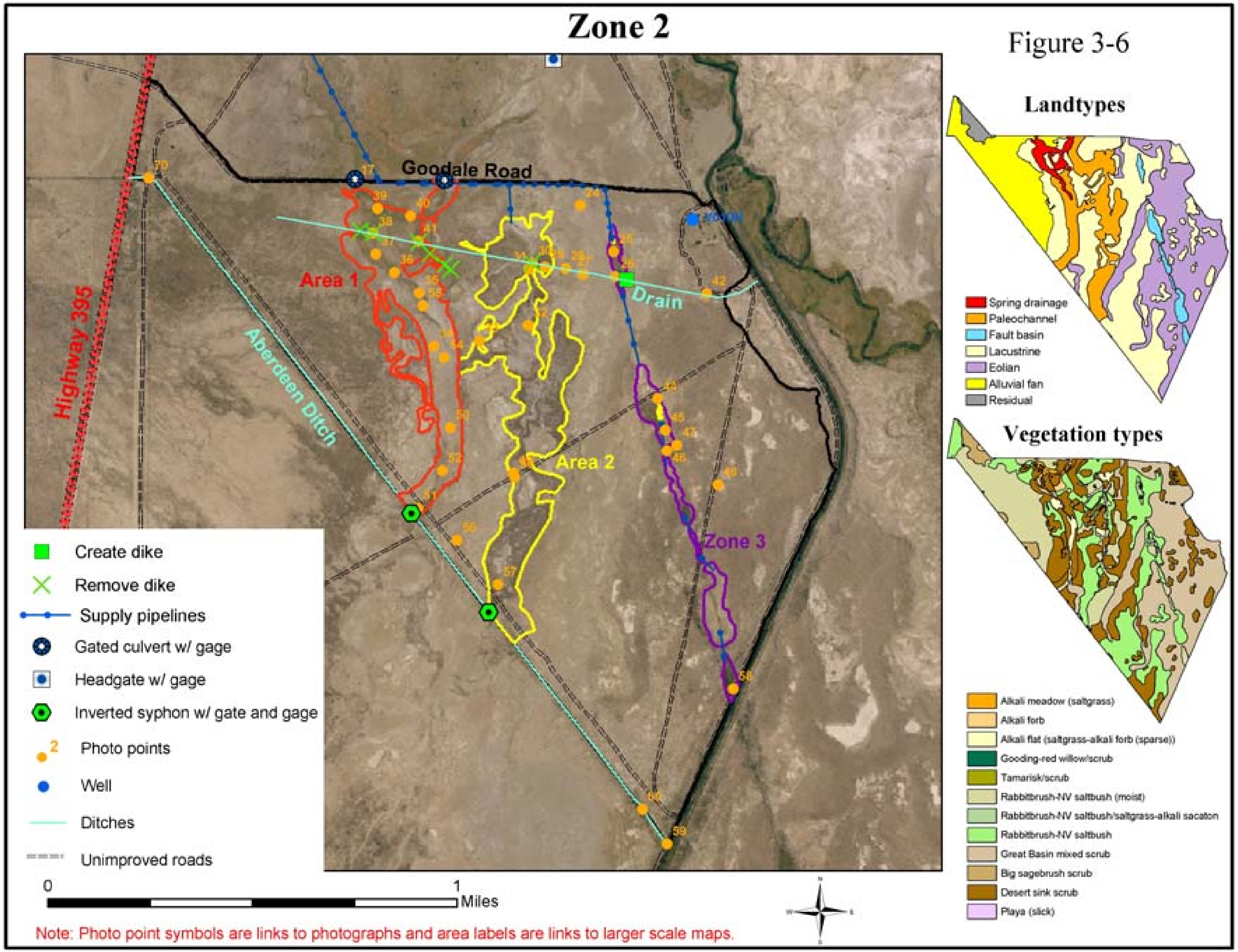
    - **Area 1 (59.7 acres):** Drainage from Zone 1 merges about 100 meters south of Goodale Road in this area. The area includes both spring drainage (14.0 acres) and paleochannel (39.8) landtypes. Prominent existing vegetation types are alkali scrub (38.8 acres), sparsely vegetated alkali flat (8.5 acres), alkali forb (7.3 acres), and alkali meadow (5.1 acres).

      Areas 1 and 3 in Zone 1 will overflow to this area. Inflow will be monitored at two gated culverts under Goodale Road that will be fitted with flow recording gages. Several small dikes, three of which are associated with an existing drain, will be removed. A gauged, gated, inverted siphon will be installed under the Aberdeen Ditch to facilitate overflow to Zone 3.

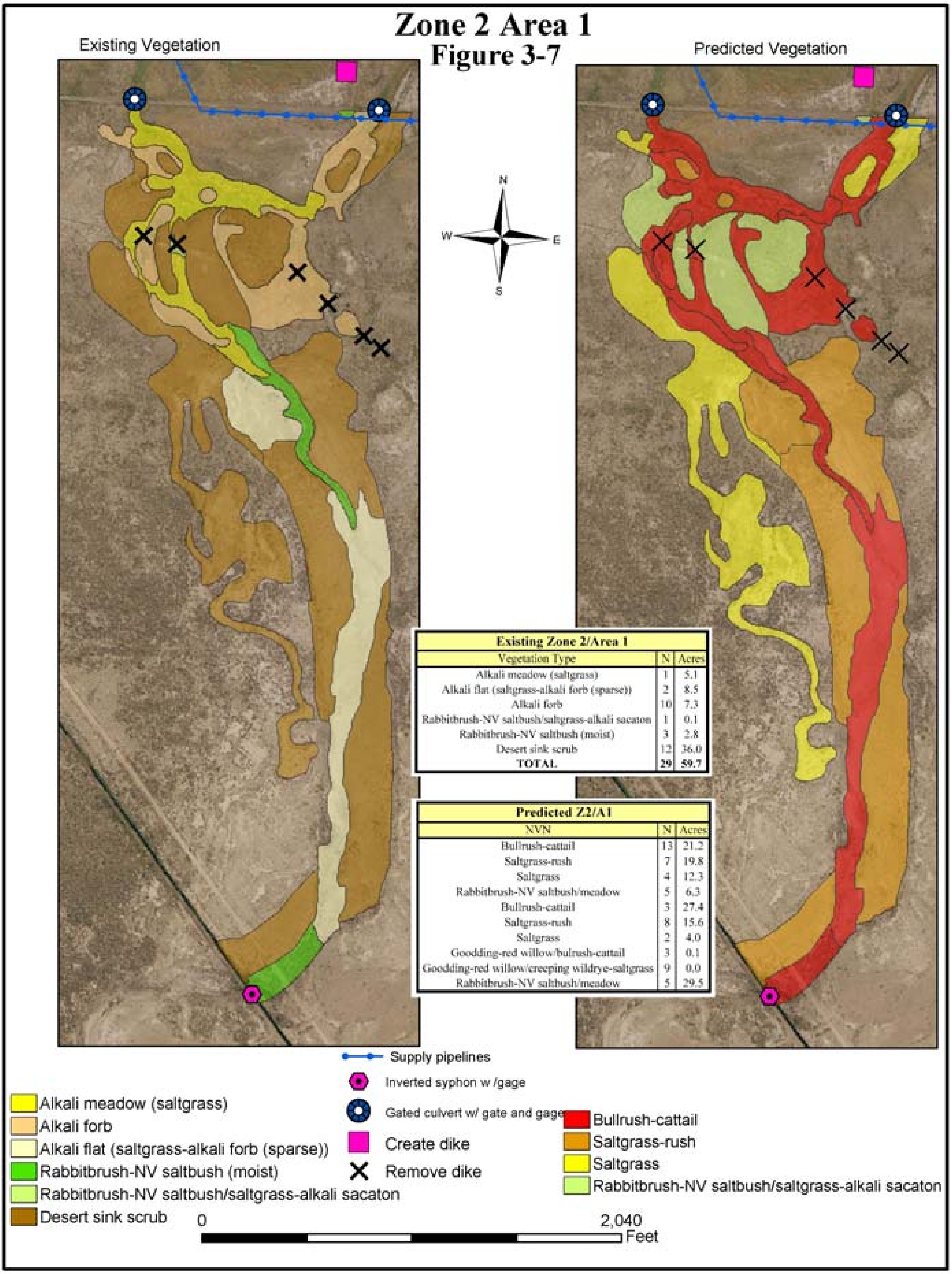
      Predicted vegetation types that could be created (Figure 3-7) include marsh (21.2 acres), wet meadow (19.8 acres), alkali meadow (12.3 acres), and alkali scrub/meadow (6.3 acres). The total area of wetland that could be created is about 41 acres. About 32 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 140 acre-feet/year and the long-term bedloss is predicted to be 179 acre-feet/year. The water budget for this area is 320 acre-feet.

Table 3-4. Predicted Vegetation, Zone 2/Area 1.

Predicted Vegetation	N	Acres	ET	
			(ft/year)	(ac-ft)
Bulrush-cattail	13	21.2	4.2	89.2
Saltgrass-rush	7	19.8	1.4	27.7
Saltgrass	4	12.3	1.4	17.2
Rabbitbrush-NV saltbush/meadow	5	6.3	1	6.3
TOTAL	**29**	**59.7**	**--**	**140.4**


Zone 2
Figure 3-6
Landtypes
Spring drainage
Paleochannel
Fault basin
Lacustrine
Eolian
Alluvial fan
Residual
Vegetation types
Alkali meadow (saltgrass)
Alkali forb
Alkali flat (saltgrass-alkali forb (sparse))
Gooding-red willow/scrub
Tamarisk/scrub
Rabbitbrush-NV saltbush (moist)
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton
Rabbitbrush-NV saltbush
Great Basin mixed scrub
Big sagebrush scrub
Desert sink scrub
Playa (slick)
Goodale Road
Highway 395
Area 1
Area 2
Zone 3
Drain
Aberdeen Ditch
Create dike
Remove dike
Supply pipelines
Gated culvert w/ gage
Headgate w/ gage
Inverted syphon w/ gate and gage
Photo points
Well
Ditches
Unimproved roads
0
1
Miles
Note: Photo point symbols are links to photographs and area labels are links to larger scale maps.

Zone 2 Area 1
Figure 3-7



Existing Zone 2/Area 1

Vegetation Type	N	Acres
Alkali meadow (saltgrass)	1	5.1
Alkali flat (saltgrass-alkali forb (sparse))	2	8.5
Alkali forb	10	7.3
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	1	0.1
Rabbitbrush-NV saltbush (moist)	3	2.8
Desert sink scrub	12	36.0
TOTAL	**29**	**59.7**

Predicted Z2/A1

NVN	N	Acres
Bullrush-cattail	13	21.2
Saltgrass-rush	7	19.8
Saltgrass	4	12.3
Rabbitbrush-NV saltbush/meadow	5	6.3
Bullrush-cattail	3	27.4
Saltgrass-rush	8	15.6
Saltgrass	2	4.0
Goodding-red willow/bulrush-cattail	3	0.1
Goodding-red willow/creeping wildrye-saltgrass	9	0.0
Rabbitbrush-NV saltbush/meadow	5	29.5

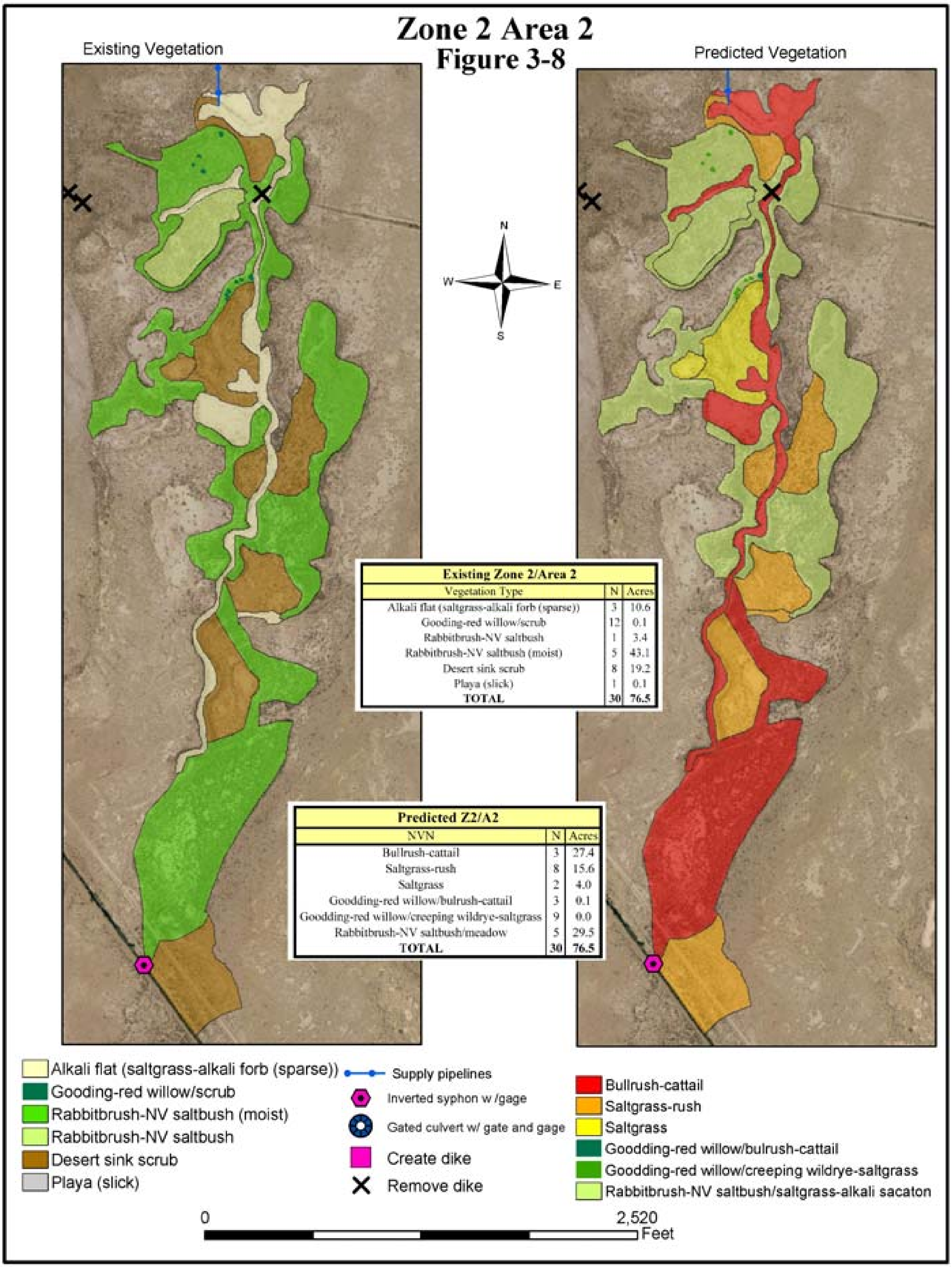
- **Area 2 (76.5 acres):** In 1944 (see Figure 4-6 of the Hines Spring Inventory Report) a drain captured part of the Hines Spring effluent in Zone 2 and carried it towards the Los Angeles Aqueduct. The drain leaked into area 2, creating a large area of wetland. Alkali flat (10.6 acres), rabbitbrush-NV saltbush (46.5 acres), and desert sink scrub (19.2 acres) are the prominent existing vegetation types.

  A 4,760 foot pipeline will be constructed from well V355 to the head of this area. A small dike associated with the existing drain will be removed. A gauged, gated, inverted siphon could be installed under the Aberdeen Ditch to facilitate overflow to Zone 3. Alternately, the area could be managed to not overflow to Zone 3.

  Predicted vegetation types that could be created (Figure 3-8) include marsh (27.4 acres), wet meadow (15.6 acres), alkali meadow (4.0 acres), and alkali scrub/meadow (29.5 acres). A dozen tree willows (0.1 acres) would be enhanced. The total area of wetland that could be created is about 43 acres. About 20 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 172 acre-feet/year and the long-term bedloss is predicted to be 230 acre-feet/year. The water budget for this area is 402 acre-feet.

Table 3-5. Predicted Vegetation, Zone 2/Area 2.

Predicted Vegetation	N	Acres	ET (ft/year)	ET (ac-ft)
Bulrush-cattail	3	27.4	4.2	115.1
Saltgrass-rush	8	15.6	1.4	21.8
Saltgrass	2	4.0	1.4	5.5
Goodding-red willow/bulrush-cattail	3	0.1	4.2	0.3
Goodding-red willow/creeping wildrye-saltgrass	9	0.0	2.8	0.1
Rabbitbrush-NV saltbush/meadow	5	29.5	1	29.5
TOTAL	**30**	**76.5**	**--**	**172.2**



Existing Zone 2/Area 2		
Vegetation Type	N	Acres
Alkali flat (saltgrass-alkali forb (sparse))	3	10.6
Gooding-red willow/scrub	12	0.1
Rabbitbrush-NV saltbush	1	3.4
Rabbitbrush-NV saltbush (moist)	5	43.1
Desert sink scrub	8	19.2
Playa (slick)	1	0.1
TOTAL	**30**	**76.5**

Predicted Z2/A2		
NVN	N	Acres
Bullrush-cattail	3	27.4
Saltgrass-rush	8	15.6
Saltgrass	2	4.0
Goodding-red willow/bulrush-cattail	3	0.1
Goodding-red willow/creeping wildrye-saltgrass	9	0.0
Rabbitbrush-NV saltbush/meadow	5	29.5
TOTAL	**30**	**76.5**

- **Area 3 (18.3 acres)**: This area consists of a string of 6 fault basins. As demonstrated in the BWMA, fault basins are well suited for creating both open water and wetland. Alkali scrub/meadow (1.6 acres), rabbitbrush-NV saltbush scrub (15.9 acres) and slicks (0.8 acres) are the prominent existing vegetation types.

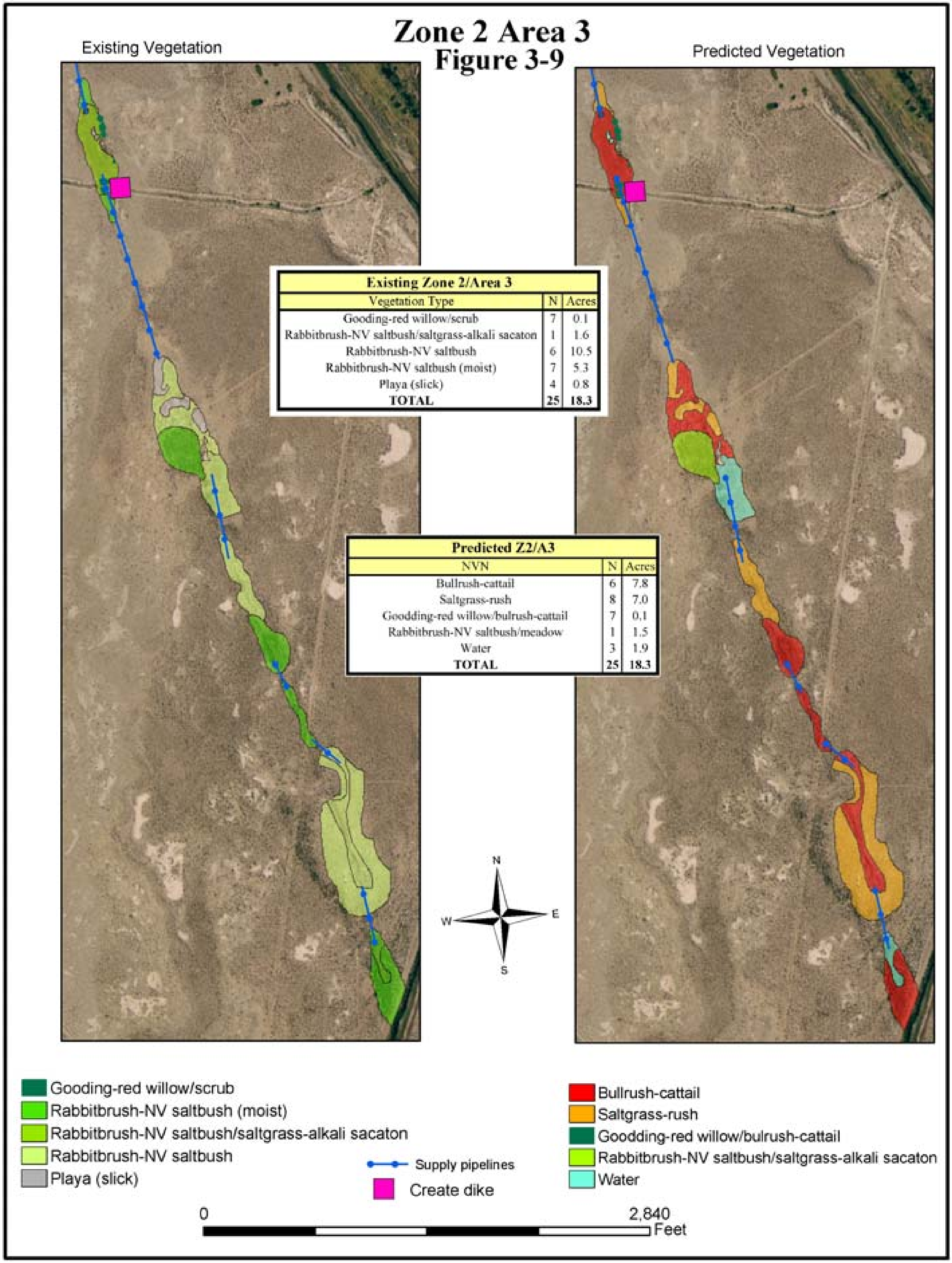
  A 6,200 foot long pipeline and five buried pipelines or open ditches (2,600 feet) to link the six fault basins was considered, but determined to be infeasible because surfaces between basins are 8 to 10 feet above that in the fault basins.

  Predicted vegetation types that could be created (Figure 3-9) include 3 small ponds (1.9 acres), marsh (7.8 acres), wet meadow (7.0 acres), and alkali scrub/meadow (1.5 acres). Seven tree willows (0.1 acres) could be enhanced. The total area of water/wetland that could be created is about 17 acres. About 7 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 52 acre-feet/year and the long-term bedloss is predicted to be 61 acre-feet/year. The water budget for this area is 107 acre-feet.

Table 3-6. Predicted Vegetation, Zone 2/Area 3.

Predicted Vegetation	N	Acres	ET (ft/year)	ET (ac-ft)
Bulrush-cattail	6	7.8	4.2	32.7
Saltgrass-rush	8	7.0	1.4	9.8
Goodding-red willow/bulrush-cattail	7	0.1	4.2	0.6
Rabbitbrush-NV saltbush/meadow	1	1.5	1.0	1.5
Water	3	1.9	4.0	7.6
TOTAL	**25**	**18.3**	**--**	**52.3**

Zone 2 Area 3
Figure 3-9



Existing Zone 2/Area 3		
Vegetation Type	N	Acres
Gooding-red willow/scrub	7	0.1
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	1	1.6
Rabbitbrush-NV saltbush	6	10.5
Rabbitbrush-NV saltbush (moist)	7	5.3
Playa (slick)	4	0.8
TOTAL	**25**	**18.3**

Predicted Z2/A3		
NVN	N	Acres
Bullrush-cattail	6	7.8
Saltgrass-rush	8	7.0
Goodding-red willow/bulrush-cattail	7	0.1
Rabbitbrush-NV saltbush/meadow	1	1.5
Water	3	1.9
TOTAL	**25**	**18.3**

- **Zone 3 (1699 acres):** This area is south of Aberdeen Ditch and north of the Division Creek Ditch (Figure 3-10). Nearly half of the area (803 acres) is paleochannel and lacustrine land well suited for creating wetland. A single smaller area, consisting mostly of paleochannel, best suited for creation of wetlands was considered. Both the predicted water/wetland and the water budget are conservative.

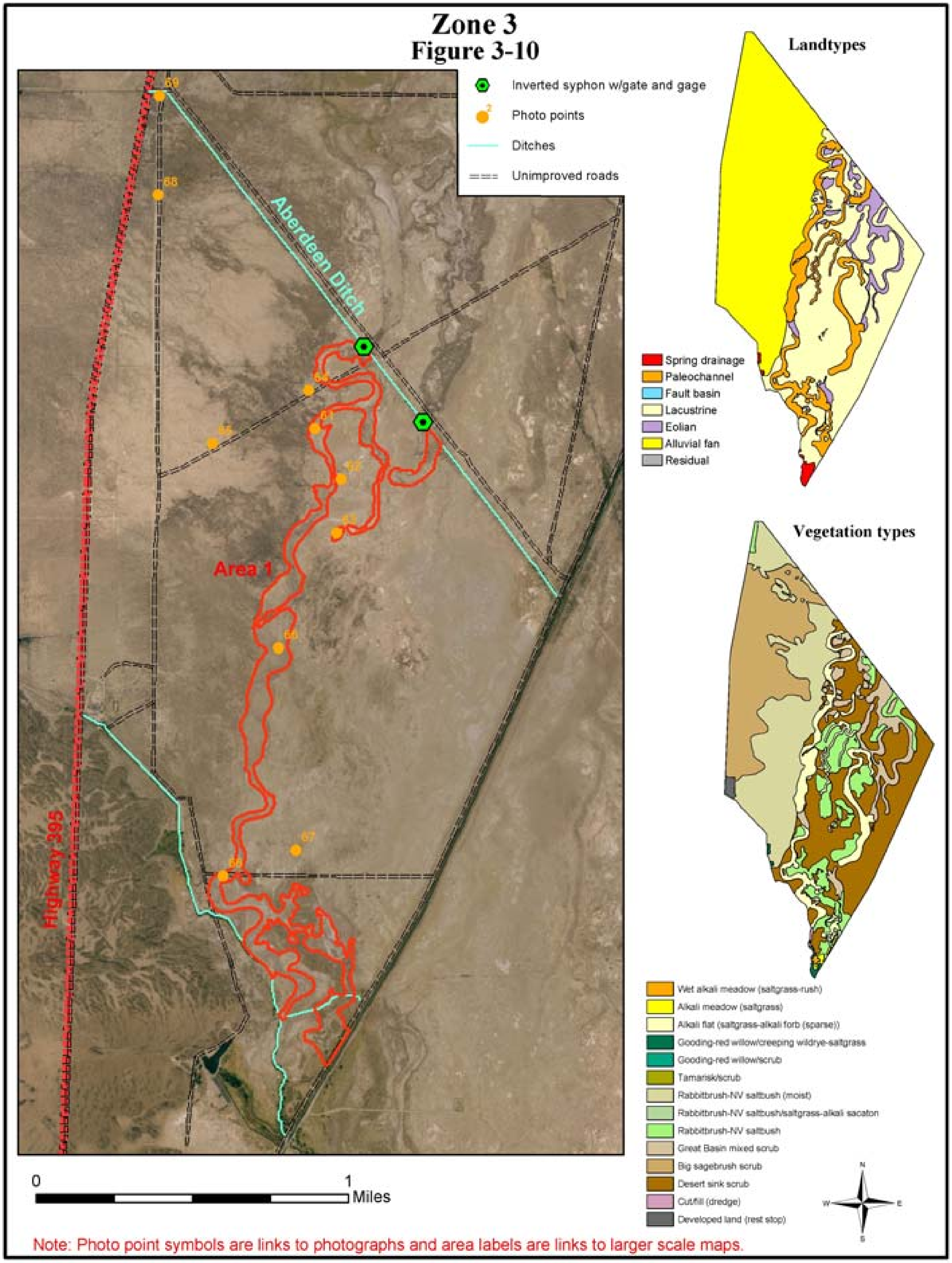
    - **Area 1 (119.7 acres):** Inflow to this area would be provided via one or two inverted siphons draining Zone 2. If flow reaches the southern part of the area, it would be contained by existing dikes along the Division Creek Ditch and the Los Angeles Aqueduct. Alkali flat (79.8 acres), rabbitbrush-NV saltbush (10.9 acres), desert sink scrub (26.3 acres), and Great Basin mixed scrub (2.2 acres) are the prominent existing vegetation types.

      No structures are anticipated at this time, although dikes might be considered later to facilitate spreading the water. A few scattered tamarisks will be removed.

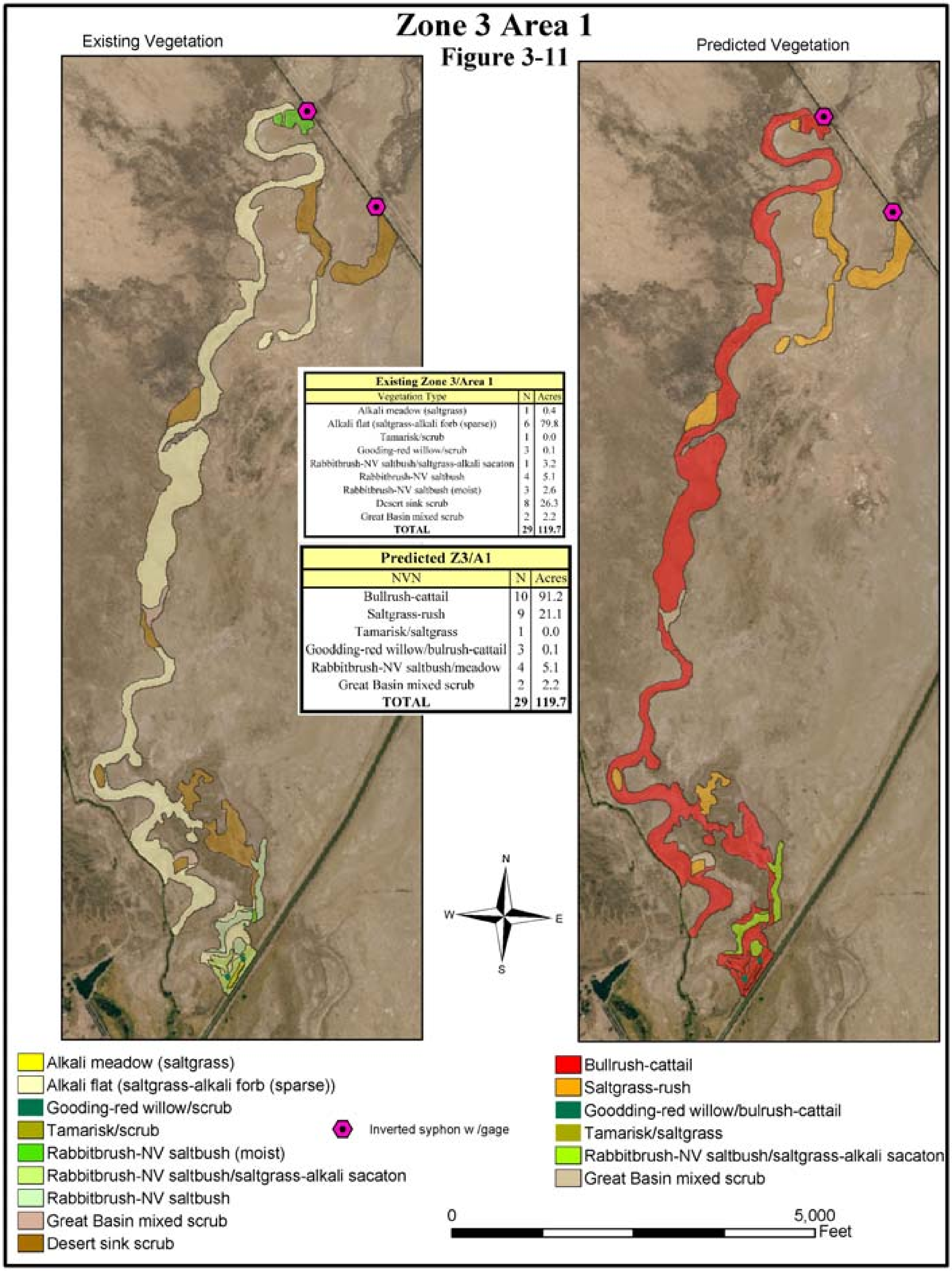
      Predicted vegetation types that could be created (Figure 3-11) include marsh (91.2 acres), wet meadow (21.1 acres), and alkali scrub/meadow (5.1 acres). Three tree willows (0.1 acres) would be enhanced. Conservatively, the total area of wetland that could be created is about 112 acres. About 21 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 418 acre-feet/year and the long-term bedloss is predicted to be 359 acre-feet/year. The water budget for this area is 777 acre-feet.

Table 3-7. Predicted Vegetation, Zone 3/Area 1.

Predicted Vegetation	N	Acres	ET (ft/year)	ET (ac-ft)
Bulrush-cattail	10	91.2	4.2	383.1
Saltgrass-rush	9	21.1	1.4	29.5
Goodding-red willow/bulrush-cattail	3	0.1	4.2	0.6
Rabbitbrush-NV saltbush/meadow	4	5.1	1	5.1
Great Basin mixed scrub	2	2.2	0	0.0
TOTAL	**29**	**119.7**	**--**	**418.3**


Zone 3
Figure 3-10
Inverted syphon w/gate and gage
Photo points
Ditches
Unimproved roads
Aberdeen Ditch
Area 1
Highway 395
0
1
Miles
Landtypes
Spring drainage
Paleochannel
Fault basin
Lacustrine
Eolian
Alluvial fan
Residual
Vegetation types
Wet alkali meadow (saltgrass-rush)
Alkali meadow (saltgrass)
Alkali flat (saltgrass-alkali forb (sparse))
Gooding-red willow/creeping wildrye-saltgrass
Gooding-red willow/scrub
Tamarisk/scrub
Rabbitbrush-NV saltbush (moist)
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton
Rabbitbrush-NV saltbush
Great Basin mixed scrub
Big sagebrush scrub
Desert sink scrub
Cutfill (dredge)
Developed land (rest stop)
Note: Photo point symbols are links to photographs and area labels are links to larger scale maps.

Zone 3 Area 1
Figure 3-11



Existing Zone 3/Area 1

Vegetation Type	N	Acres
Alkali meadow (saltgrass)	1	0.4
Alkali flat (saltgrass-alkali forb (sparse))	6	79.8
Tamarisk/scrub	1	0.0
Gooding-red willow/scrub	3	0.1
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	1	3.2
Rabbitbrush-NV saltbush	4	5.1
Rabbitbrush-NV saltbush (moist)	3	2.6
Desert sink scrub	8	26.3
Great Basin mixed scrub	2	2.2
TOTAL	**29**	**119.7**

Predicted Z3/A1

NVN	N	Acres
Bullrush-cattail	10	91.2
Saltgrass-rush	9	21.1
Tamarisk/saltgrass	1	0.0
Goodding-red willow/bulrush-cattail	3	0.1
Rabbitbrush-NV saltbush/meadow	4	5.1
Great Basin mixed scrub	2	2.2
TOTAL	**29**	**119.7**

The areas of predicted water regimes and vegetation types that could be established in the Hines Spring area, assuming adequate water supply, are summarized in Table 3-8. The total area of water/wetland that could be created in all zones is about 246 acres. Twenty nine tree willows (0.4 acres) would be enhanced. An additional 70 acres of alkali meadow and alkali scrub/meadow vegetation could be created or maintained. A total of more than 316 acres could be created or enhanced. About 103 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 868 acre-feet/year and the long-term bedloss is predicted to be 948 acre-feet/year. The water budget is 1,816 acre-feet.

Table 3-8. Predicted Vegetation, All Zones.

Predicted Vegetation	N	Acres	ET	
			(ft/year)	(ac-ft)
Bulrush-cattail	52	160.9	4.2	676.0
Goodding-red willow/bulrush-cattail	17	0.4	4.2	1.7
Saltgrass-rush	38	80.3	1.4	112.4
Tamarisk/saltgrass	1	<0.1	1.4	0.1
Goodding-red willow/creeping wildrye-saltgrass	12	0.1	2.8	0.3
Saltgrass	10	22.6	1.4	31.6
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	18	46.1	1.0	46.1
Great Basin mixed scrub	1	0.9	0.0	0.0
TOTAL	**149**	**315.9**	**--**	**868.2**

Table 3-9. Predicted water regimes and vegetation types.						
Zone	Area	Water Regime	Vegetation Type	Wetland?	N	Acres
1	1	Permanently flooded	Water	Yes	1	0.1
1	1	Saturated	Bulrush-cattail	Yes	13	3.2
1	1	Saturated	Goodding-red willow/bulrush-cattail	Yes	2	<0.1
1	1	High water table	Saltgrass-rush	Yes	1	<0.1
1	1	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	1	0.3
1	**1**	**TOTAL**	**TOTAL**	**--**	**18**	**3.7**
1	2	Saturated	Bulrush-cattail	Yes	3	2.7
1	2	High water table	Saltgrass-rush	Yes	2	5.3
1	2	High water table	Goodding-red willow/creeping wildrye-saltgrass	Yes	2	<0.1
1	2	Low water table	Saltgrass	No	3	6.1
1	2	Low water table	Goodding-red willow/creeping wildrye-saltgrass	No	1	<0.1
1	2	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	2	3.5
1	**2**	**TOTAL**	**TOTAL**	**--**	**13**	**17.7**
1	3	Permanently flooded	Water	Yes	1	2.5
1	3	Saturated	Bulrush-cattail	Yes	4	7.4
1	3	Saturated	Goodding-red willow/bulrush-cattail	Yes	2	<0.1
1	3	High water table	Saltgrass-rush	Yes	2	10.2
1	3	Low water table	Saltgrass	No	1	0.2
1	**3**	**TOTAL**	**TOTAL**	**--**	**10**	**20.3**

Table 3-9. Predicted water regimes and vegetation types.

Zone	Area	Water Regime	Vegetation Type	Wetland?	N	Acres
1	All	Permanently flooded	Water	Yes	2	2.7
1	All	Saturated	Bulrush-cattail	Yes	3	2.7
1	All	Saturated	Bulrush-cattail	Yes	17	10.6
1	All	Saturated	Goodding-red willow/bulrush-cattail	Yes	4	<0.1
1	All	High water table	Saltgrass-rush	Yes	5	15.6
1	All	High water table	Goodding-red willow/creeping wildrye-saltgrass	Yes	2	<0.1
1	All	Low water table	Saltgrass	No	4	6.3
1	All	Low water table	Goodding-red willow/creeping wildrye-saltgrass	No	1	0.0
1	All	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	3	3.8
1	**All**	**TOTAL**	**TOTAL**	**--**		**41.7**
2	1	Saturated	Bulrush-cattail	Yes	13	21.2
2	1	High water table	Saltgrass-rush	Yes	7	19.8
2	1	Low water table	Saltgrass	No	4	12.3
2	1	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	5	6.3
2	**1**	**TOTAL**	**TOTAL**	**--**	**29**	**59.7**
2	2	Saturated	Bulrush-cattail	Yes	3	27.4
2	2	Saturated	Goodding-red willow/bulrush-cattail	Yes	3	0.1
2	2	High water table	Saltgrass-rush	Yes	8	15.6
2	2	Low water table	Saltgrass	No	2	4.0
2	2	Low water table	Goodding-red willow/creeping wildrye-saltgrass	No	9	<0.1
2	2	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	5	29.5
2	**2**	**TOTAL**	**TOTAL**	**--**	**30**	**76.5**

Table 3-9. Predicted water regimes and vegetation types.						
Zone	Area	Water Regime	Vegetation Type	Wetland?	N	Acres
2	3	Permanently flooded	Water	Yes	3	1.9
2	3	Saturated	Bulrush-cattail	Yes	6	7.8
2	3	Saturated	Goodding-red willow/bulrush-cattail	Yes	7	0.1
2	3	High water table	Saltgrass-rush	Yes	8	7.0
2	3	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	1	1.5
2	**3**	**TOTAL**	**TOTAL**	**--**	**25**	**18.3**
2	All	Permanently flooded	Water	Yes	3	1.9
2	All	Saturated	Bulrush-cattail	Yes	22	56.4
2	All	Saturated	Goodding-red willow/bulrush-cattail	Yes	10	0.2
2	All	High water table	Saltgrass-rush	Yes	23	42.4
2	All	Low water table	Saltgrass	No	6	16.2
2	All	Low water table	Goodding-red willow/creeping wildrye-saltgrass	No	9	<0.1
2	All	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	11	37.3
2	**All**	**TOTAL**	**TOTAL**	**--**	**84**	**154.5**
3	1	Saturated	Bulrush-cattail	Yes	10	91.2
3	1	Saturated	Goodding-red willow/bulrush-cattail	Yes	3	0.1
3	1	High water table	Saltgrass-rush	Yes	9	21.1
3	1	High water table	Tamarisk/saltgrass	Yes	1	<0.1
3	1	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	4	5.1
3	1	Very low water table	Great Basin mixed scrub	No	2	2.2
3	**1**	**TOTAL**	**TOTAL**	**--**	**29**	**119.7**

Table 3-9. Predicted water regimes and vegetation types.						
Zone	Area	Water Regime	Vegetation Type	Wetland?	N	Acres
All	All	Permanently flooded	Water	Yes	5	4.6
All	All	Saturated	Bulrush-cattail	Yes	52	160.9
All	All	Saturated	Goodding-red willow/bulrush-cattail	Yes	17	0.4
All	All	High water table	Saltgrass-rush	Yes	38	80.3
All	All	High water table	Tamarisk/saltgrass	Yes	1	<0.1
All	All	High water table	Goodding-red willow/creeping wildrye-saltgrass	Yes	2	<0.1
All	All	Low water table	Saltgrass	No	10	22.6
All	All	Low water table	Goodding-red willow/creeping wildrye-saltgrass	No	10	0.1
All	All	Low water table	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	No	18	46.1
All	All	Very low water table	Great Basin mixed scrub	No	1	0.9
All	**All**	**TOTAL**	**TOTAL**	**--**	**154**	**315.9**

3.2 Hidden Lake

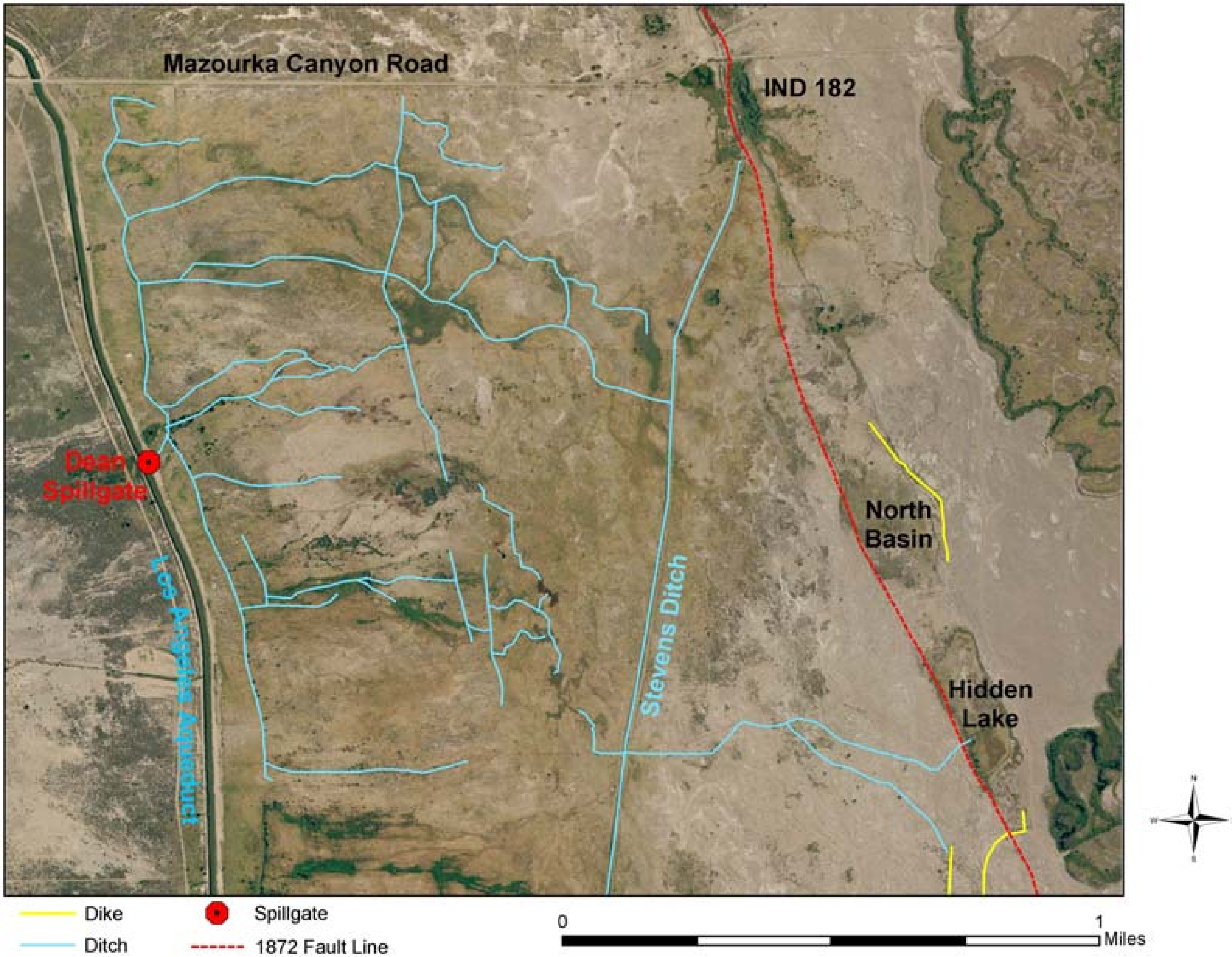
The Hidden Lake area (Figure 3-12) is south of Mazourka Canyon Road and includes two fault basins that are well suited for creating water/wetland. A flowing well is sustaining water/wetland in a similar fault basin (spring site IND182) near Mazourka Canyon Road. The northern part of Stevens Ditch appears to receive seepage from IND182 and runoff from fields irrigated by the Dean Spill-gate. Stevens Ditch is used for stock water in winter (Dale Schmidt personal communication). Dikes along the east side of the north basin and south of Hidden Lake suggest that the area has been used to spread water. A ditch that is normally dry links the Stevens Ditch to Hidden Lake.

Hidden Lake was mapped as part of an inventory of springs (IND168) and as part of the BWMA (WHA 2004d). Mapping of 2000 conditions (ibid.) was refined at larger-scale based on field reconnaissance of the two fault basins in August 2005 (Figure 3-13). The two fault basins (North and Hidden Lake) comprise about 40 acres. Predominate vegetation types in the two fault basins (Table 3-10) includes tamarisk (13 acres), alkali scrub/meadow (16 acres), and alkali scrub (7 acres). Several dozen scattered Russian olive and Goodding-red willow, mostly along the west flank of Hidden Lake, cover less than an acre. Two nearly barren slicks comprise about an acre. The Hidden Lake fault basin (20 acres) is about 3 meters deep (USGS 1982). The north basin (19 acres) is broader and shallower.

Table 3-10. Existing vegetation in north and Hidden Lake fault basins.

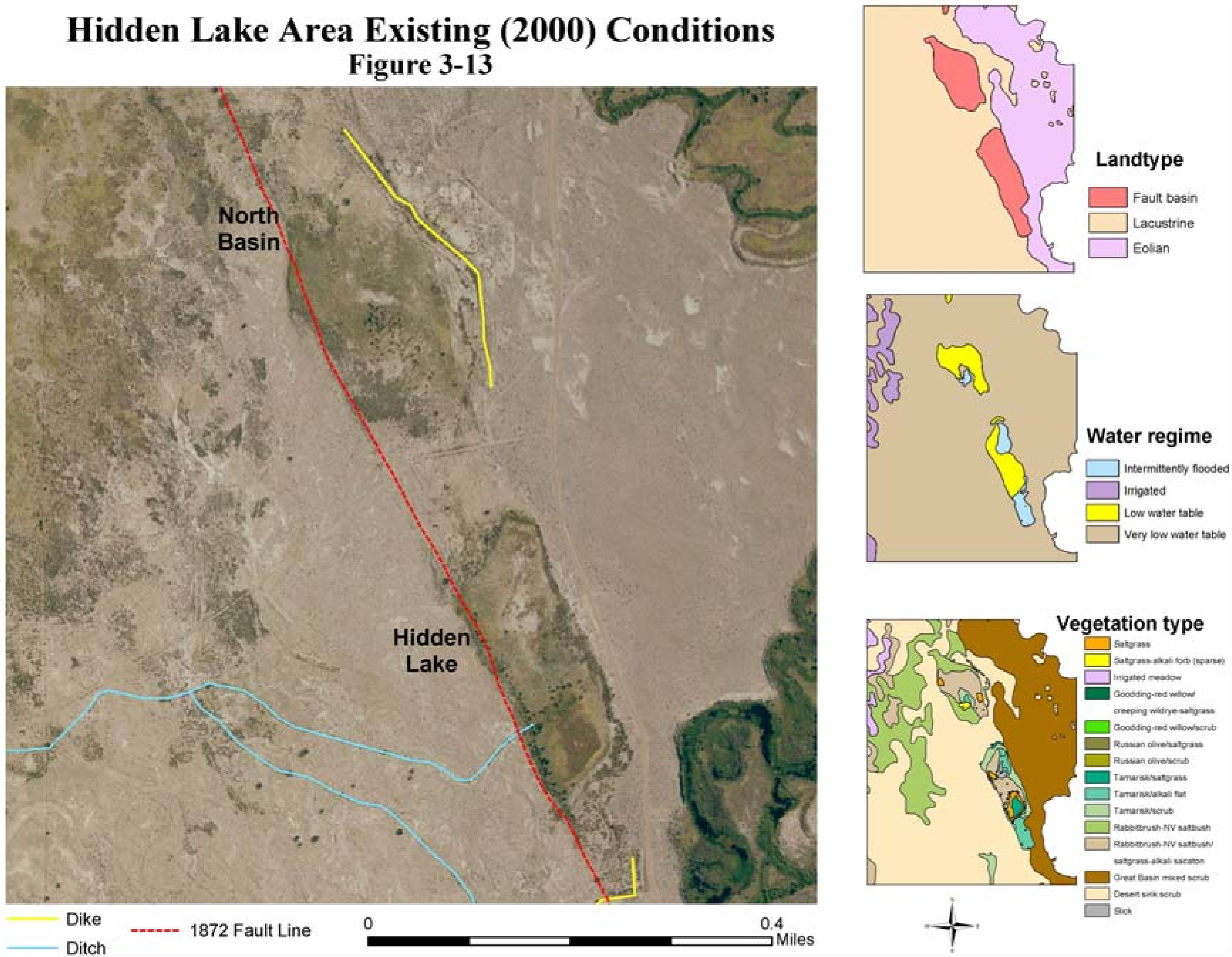
Vegetation Type		N	Area	
Code	Name		(acres)	(%)
151	Saltgrass	4	2.2	5.5
161	Saltgrass-alkali forb (sparse)	1	0.4	0.9
251	Tamarisk/alkali flat	5	5.7	14.5
252	Tamarisk/saltgrass	2	1.5	3.9
253	Tamarisk/scrub	4	5.8	14.6
262	Russian olive/saltgrass	4	0.0	0.1
263	Russian olive/scrub	10	0.1	0.3
312	Goodding-red willow/creeping wildrye-saltgrass	6	0.2	0.4
315	Goodding-red willow/scrub	14	0.3	0.7
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	2	15.5	39.1
415	Rabbitbrush-NV saltbush	2	7.3	18.4
551	Slick	1	0.7	1.8
--	**TOTAL**	**55**	**39.6**	**100.0**

Hidden Lake Area
Figure 3-12



Hidden Lake Area Existing (2000) Conditions

Figure 3-13



Two overlapping areas (Figure 3-14) were considered for creating water/wetland: 1) Hidden Lake fault basin; and 2) North and Hidden Lake fault basins.

- **Area 1 – Hidden Lake fault basin (20 acres):** Tamarisk communities with alkali flat understory (5.4 acres), saltgrass understory (1.5 acres), and scrub understory (4.6 acres) comprise 59 percent of the basin. Alkali meadow (saltgrass) comprises 8 percent and alkali scrub/meadow comprises 30 percent of the basin. Russian olive and Goodding-red willow are scattered throughout the basin, especially along the high east flank. There is no existing wetland in the basin.

  Water could be delivered to the high middle-ground of the basin via a 7,550 meter buried pipeline from a new diversion to be installed on the Los Angeles aqueduct. Alternatively, water could be delivered to the north end of the basin via an 8,200 meter pipeline from the existing Dean spill-gate. A flow gage will be installed at the inlet or the outlet of the pipeline. Piping water from Stevens Ditch to Hidden Lake was considered, but the availability of sufficient year-round flow in the ditch could not be confirmed. Tamarisk and Russian olive along the periphery of the basin will be eradicated. It may be more practical to burn the tamarisk in the bottom of the basin where flooding is expected to preclude recolonization. The basin will be filled with water to a maximum depth of 1.5-2.0 meters, or to the depth that the basin starts to overflow. Existing dikes south of Hidden Lake will divert inadvertent overflow west, away from the Owens River.

  Predicted vegetation types that could be created (Figure 3-15) includes two ponds (3.4 acres), marsh (6.1 acres), wet alkali meadow (2.9 acres), alkali meadow (7.1 acres), and alkali scrub/meadow (0.6 acres). About 17 existing tree willows (0.3 acres) will be maintained[5]. The total area of water/wetland that could be created is about 12.7 acres. About 10 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 58 acre-feet/year (Table 3-11) and the long-term bedloss is predicted to be 62 acre-feet/year. The water budget for this area is 120 acre-feet/year.

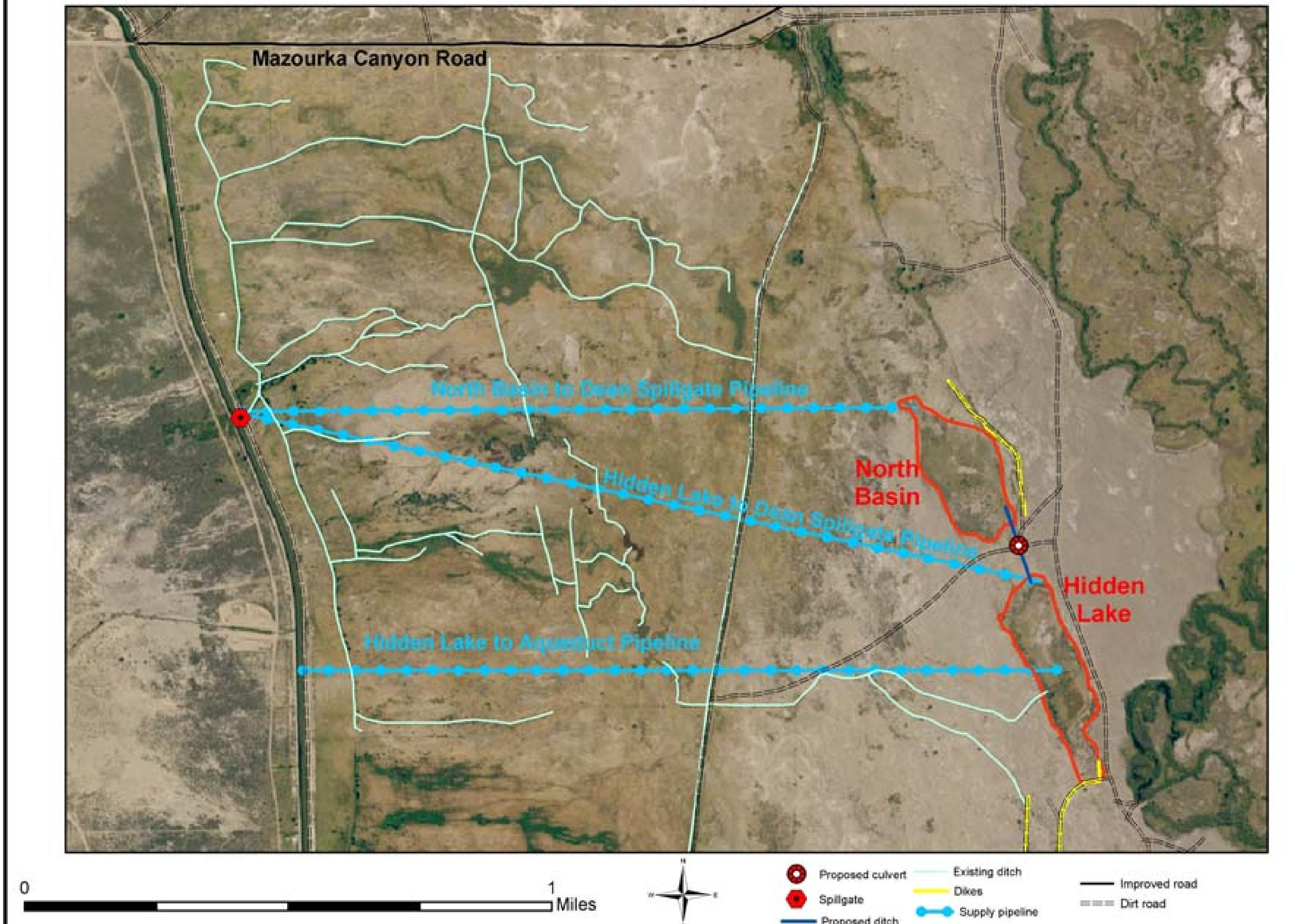
Table 3-11. Predicted vegetation, Hidden Lake.

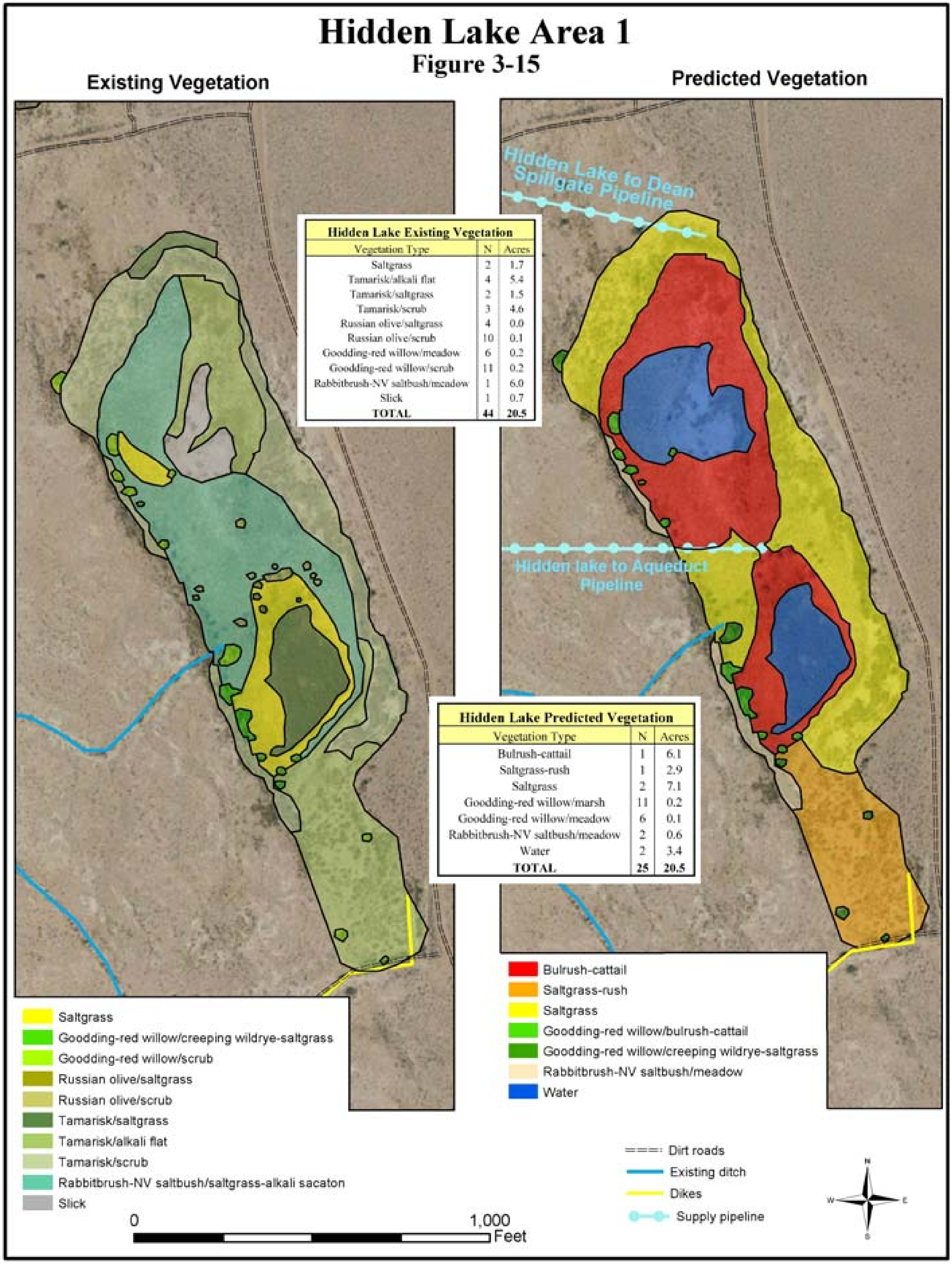
Predicted Vegetation Type	N	Acres	ET	
			(ft/yr)	(ac-ft)
Bulrush-cattail	1	6.1	4.2	25.6
Saltgrass-rush	1	2.9	1.4	4.1
Saltgrass	2	7.1	1.4	10.0
Goodding-red willow/marsh	11	0.2	4.2	1.0
Goodding-red willow/creeping wildrye-saltgrass	6	0.1	2.8	0.4
Rabbitbrush-NV saltbush/meadow	2	0.6	1	0.6
Water	2	3.4	5	16.8
TOTAL	**25**	**20.5**	**--**	**58.4**

[5] Tree willow predicted to develop marsh understory will succumb to wetness over the long-term.

Hidden Lake Map Index

Figure 3-14





Hidden Lake Area 1
Figure 3-15

Hidden Lake Existing Vegetation

Vegetation Type	N	Acres
Saltgrass	2	1.7
Tamarisk/alkali flat	4	5.4
Tamarisk/saltgrass	2	1.5
Tamarisk/scrub	3	4.6
Russian olive/saltgrass	4	0.0
Russian olive/scrub	10	0.1
Goodding-red willow/meadow	6	0.2
Goodding-red willow/scrub	11	0.2
Rabbitbrush-NV saltbush/meadow	1	6.0
Slick	1	0.7
TOTAL	**44**	**20.5**

Hidden Lake Predicted Vegetation

Vegetation Type	N	Acres
Bulrush-cattail	1	6.1
Saltgrass-rush	1	2.9
Saltgrass	2	7.1
Goodding-red willow/marsh	11	0.2
Goodding-red willow/meadow	6	0.1
Rabbitbrush-NV saltbush/meadow	2	0.6
Water	2	3.4
TOTAL	**25**	**20.5**

- **Area 2 – North and Hidden Lake fault basins (40 acres):** Tamarisk communities with alkali flat understory (5.7 acres), saltgrass understory (3.9 acres), and scrub understory (5.8 acres) comprise 33 percent of the two basins. Alkali meadow (saltgrass) comprises 6 percent, alkali scrub/meadow comprises 39 percent, and alkali scrub comprises 18 percent of the basins. Scattered Russian olive and Goodding-red willow cover less than 2 percent of the basins. Barren and sparsely vegetated slicks comprise the remaining 3 percent of the basins. There is no existing wetland in the basins.

  Water will be delivered to the north end of the north basin via a 6,900 foot buried pipeline from the Dean spill-gate. A flow gage will be installed at the inlet or outlet of the pipeline. Piping water from Stevens Ditch to the north basin was considered, but the availability of sufficient year-round flow in the ditch could not be confirmed. An 820 foot long ditch (or buried pipe) will be constructed to link the north basin with Hidden Lake. A culvert will be installed under the existing road between the two basins. Tamarisk and Russian olive along the periphery of the basin will be eradicated. It may be more practical to burn the tamarisk in the bottom of the basin where flooding is expected to preclude recolonization. The north basin will be filled with water to a depth of 1.0-1.5 meters, or to the elevation necessary to overflow to the south. Hidden lake will be filled to a maximum depth of about 1.5-2.0 meters, or to the depth that the basin starts to overflow. Existing dikes south of Hidden Lake will divert inadvertent overflow west away from the Owens River.

  Predicted vegetation types that could be created (Figure 3-16) includes four ponds (5.9 acres), marsh (14.3 acres), wet alkali meadow (7.6 acres), alkali meadow (7.8 acres), and alkali scrub/meadow (3.5 acres). About 20 existing tree willow (0.4 acres) will be maintained[6] of the basin could also be enhanced. The total area of water/wetland that could be created is about 28.2 acres. About 15 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 116 acre-feet/year (Table 3-12) and the long-term bedloss is predicted to be 119 acre-feet/year. The water budget for this area is 235 acre-feet.

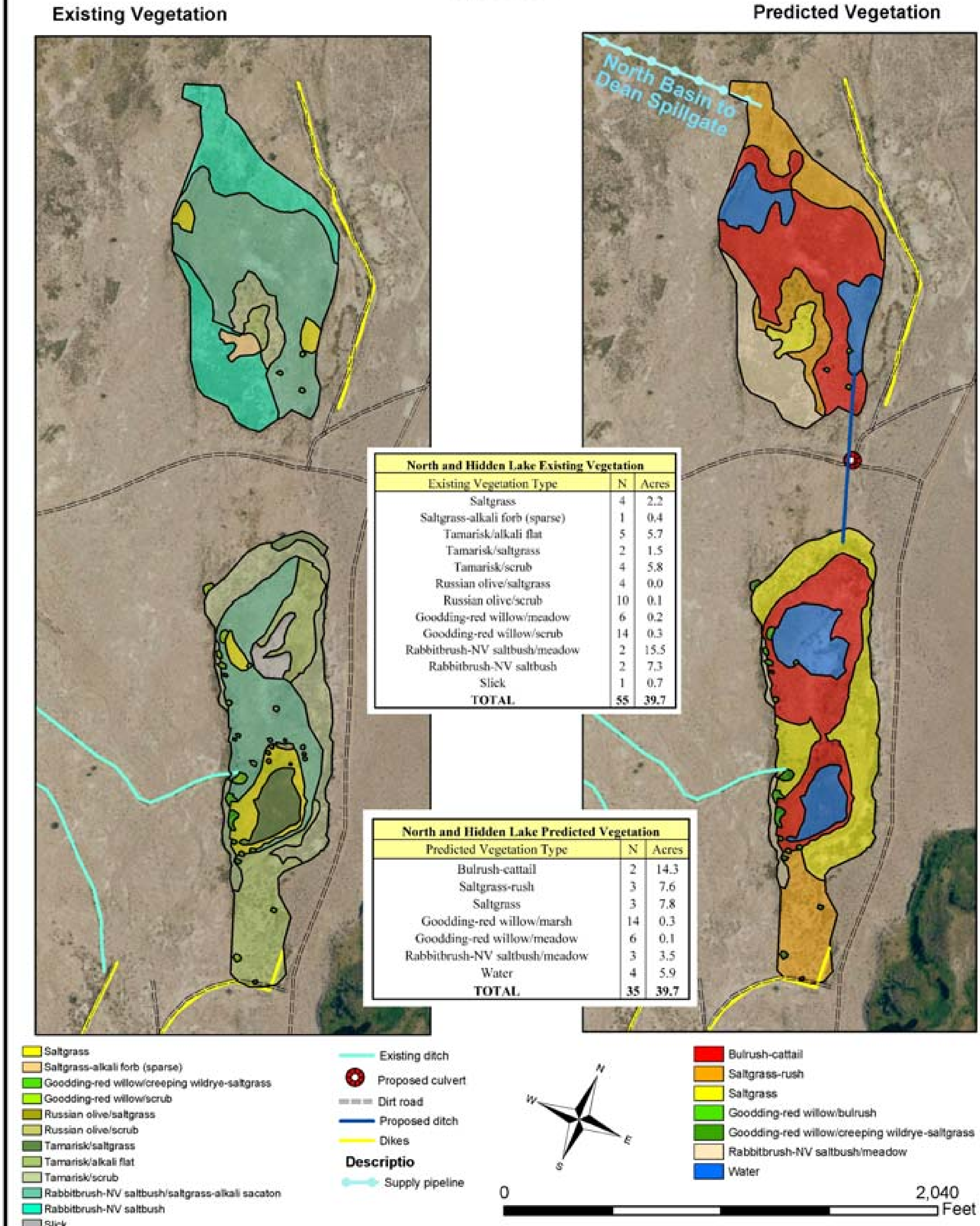
Table 3-12. Predicted vegetation, north basin and Hidden Lake.

Predicted Vegetation Type	N	Acres	ET	
			(ft/yr)	(ac-ft)
Bulrush-cattail	2	14.3	4.2	60.2
Saltgrass-rush	3	7.6	1.4	10.7
Saltgrass	3	7.8	1.4	11.0
Goodding-red willow/marsh	14	0.3	4.2	1.1
Goodding-red willow/creeping wildrye-saltgrass	6	0.1	2.8	0.4
Rabbitbrush-NV saltbush/meadow	3	3.5	1.0	3.5
Water	4	5.9	5.0	29.5
TOTAL	**35**	**39.6**	**--**	**116.4**

[6] Tree willow predicted to develop marsh understory will succumb to wetness over the long-term.

Hidden Lake Area 2

Figure 3-16



North and Hidden Lake Existing Vegetation		
Existing Vegetation Type	N	Acres
Saltgrass	4	2.2
Saltgrass-alkali forb (sparse)	1	0.4
Tamarisk/alkali flat	5	5.7
Tamarisk/saltgrass	2	1.5
Tamarisk/scrub	4	5.8
Russian olive/saltgrass	4	0.0
Russian olive/scrub	10	0.1
Goodding-red willow/meadow	6	0.2
Goodding-red willow/scrub	14	0.3
Rabbitbrush-NV saltbush/meadow	2	15.5
Rabbitbrush-NV saltbush	2	7.3
Slick	1	0.7
TOTAL	**55**	**39.7**

North and Hidden Lake Predicted Vegetation		
Predicted Vegetation Type	N	Acres
Bulrush-cattail	2	14.3
Saltgrass-rush	3	7.6
Saltgrass	3	7.8
Goodding-red willow/marsh	14	0.3
Goodding-red willow/meadow	6	0.1
Rabbitbrush-NV saltbush/meadow	3	3.5
Water	4	5.9
TOTAL	**35**	**39.7**

3.3 Warren Lake

Warren Lake (Figure 3-17) is about 3 miles northwest of the town of Big Pine. Greenbook mapping (Figure 3-18) shows permanent lakes/reservoirs, rush-sedge meadow, alkali meadow, and desert sink scrub vegetation types. Soil mapping (Figure 3-18) shows the lake bed to be intermittent water. An existing spill-gate on the Big Pine Canal was last used to release water to Warren Lake during high-water years in the 1980s. The basin briefly overflowed to Klondike Lake during this period (Wayne Hopper, personal communication). Except after major storms, the lake bed has been dry since the 1980s.

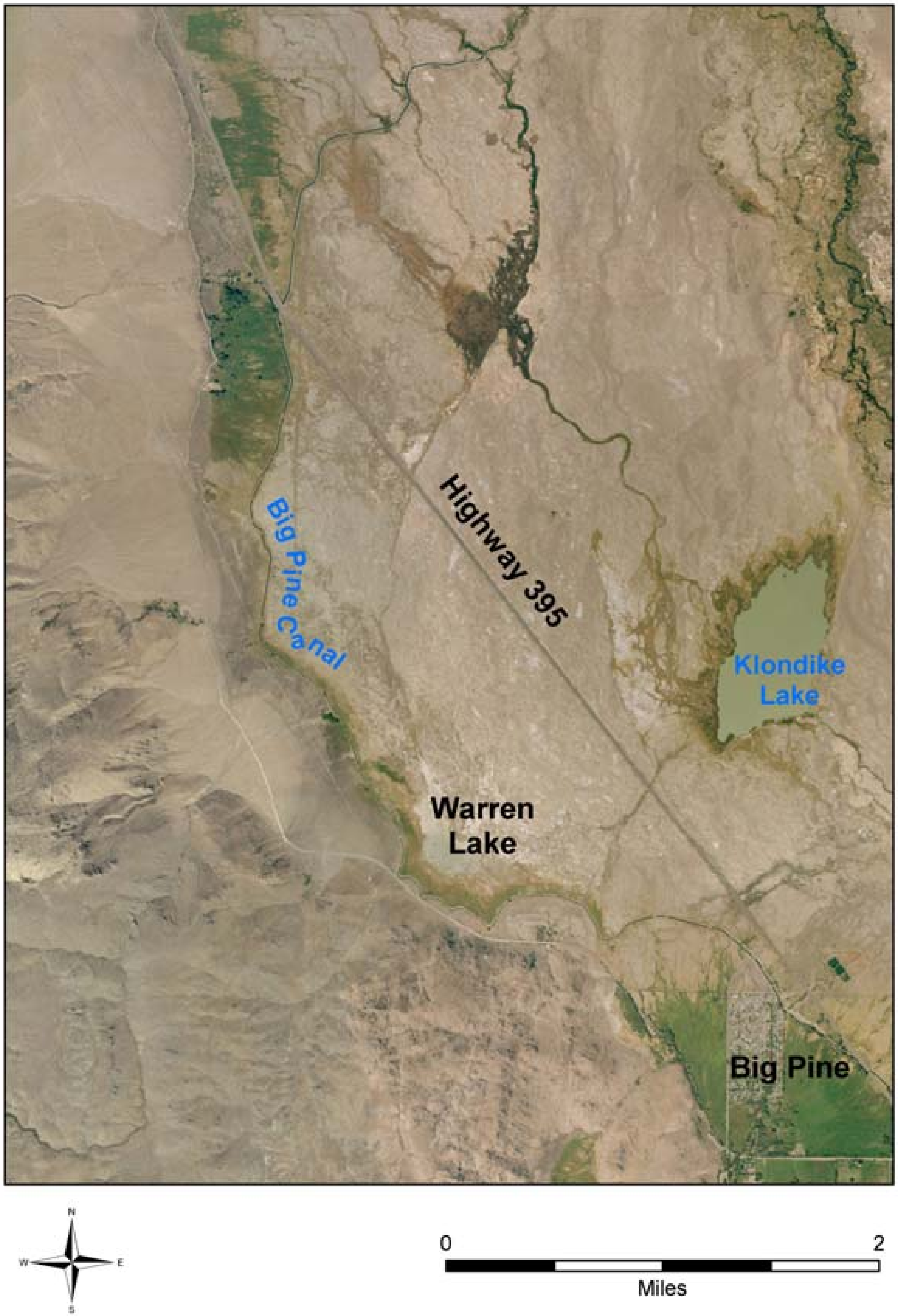
Long-term bedloss for Warren Lake is expected to be significantly less than that estimated for dissimilar landtypes in the BWMA (3 feet/year). Long-term bedloss for Warren Lake is expected to be similar to that of Klondike Lake, located about 1.5 miles to the northeast. Klondike Lake is typically full in September, when inflow is shut down until the following May. During this 7 month winter period, Klondike Lake drops 1 to 2 feet (Wayne Hopper, personal communication). Most of the water loss may be attributed to evaporation. The Warren Lake bed is sodic clay with high shrink/swell and very slow infiltration. The long-term bedloss for Warren Lake was assumed to be about 1 foot/year.

Existing vegetation types of Warren Lake were mapped from the 2000 orthophoto and a brief field reconnaissance in August 2005 (Figure 3-19). Prominent types in the lake basin (Table 3-13) include intermittently flooded playa (57 acres), saltgrass (76 acres), and a complex of desert sink scrub, saltgrass, and playa (167 acres). About 52 acres of wet alkali meadow (saltgrass-rush) are sustained by sub-irrigation from the Big Pine Canal. About eight cottonwoods and tree willow are scattered along the west flank of the lake bed. There is about 52 acres of existing wetland.

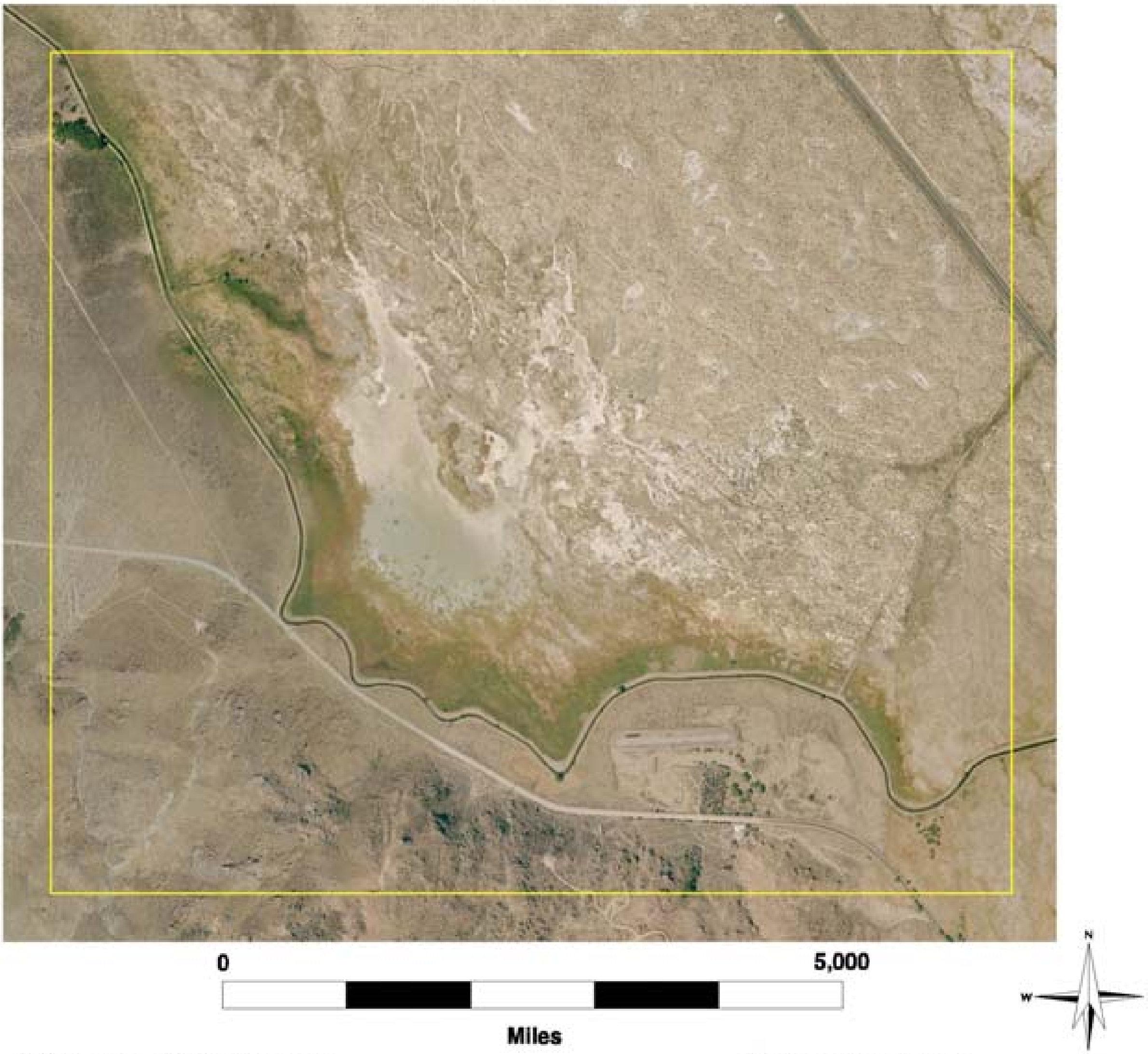
Table 3-13. Existing vegetation in the Warren Lake bed.

Vegetation Type		N	Area	
Code	Name		(acres)	(%)
151	Alkali meadow (saltgrass)	5	76.3	21.7
131	Wet alkali meadow (saltgrass-rush)	4	51.8	14.7
332	Fremont cottonwood/saltgrass-creeping wildrye	8	0.2	0.0
552	Playa (intermittent lake bed)	1	56.9	16.1
440-151-552	Desert sink-saltgrass-playa complex	2	167.0	47.4
--	**TOTAL**	**20**	**352.2**	**100.0**

Warren Lake Vicinity
Figure 3-17



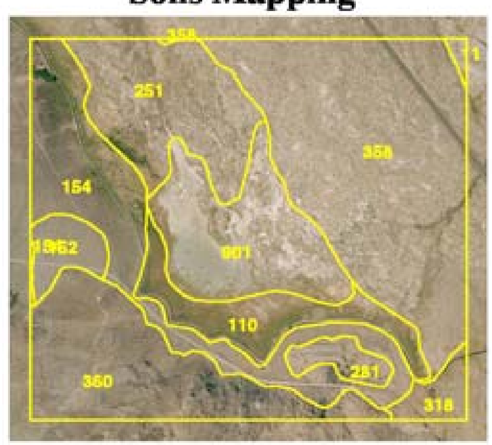
Warren Lake
Figure 3-18



Greenbook Mapping

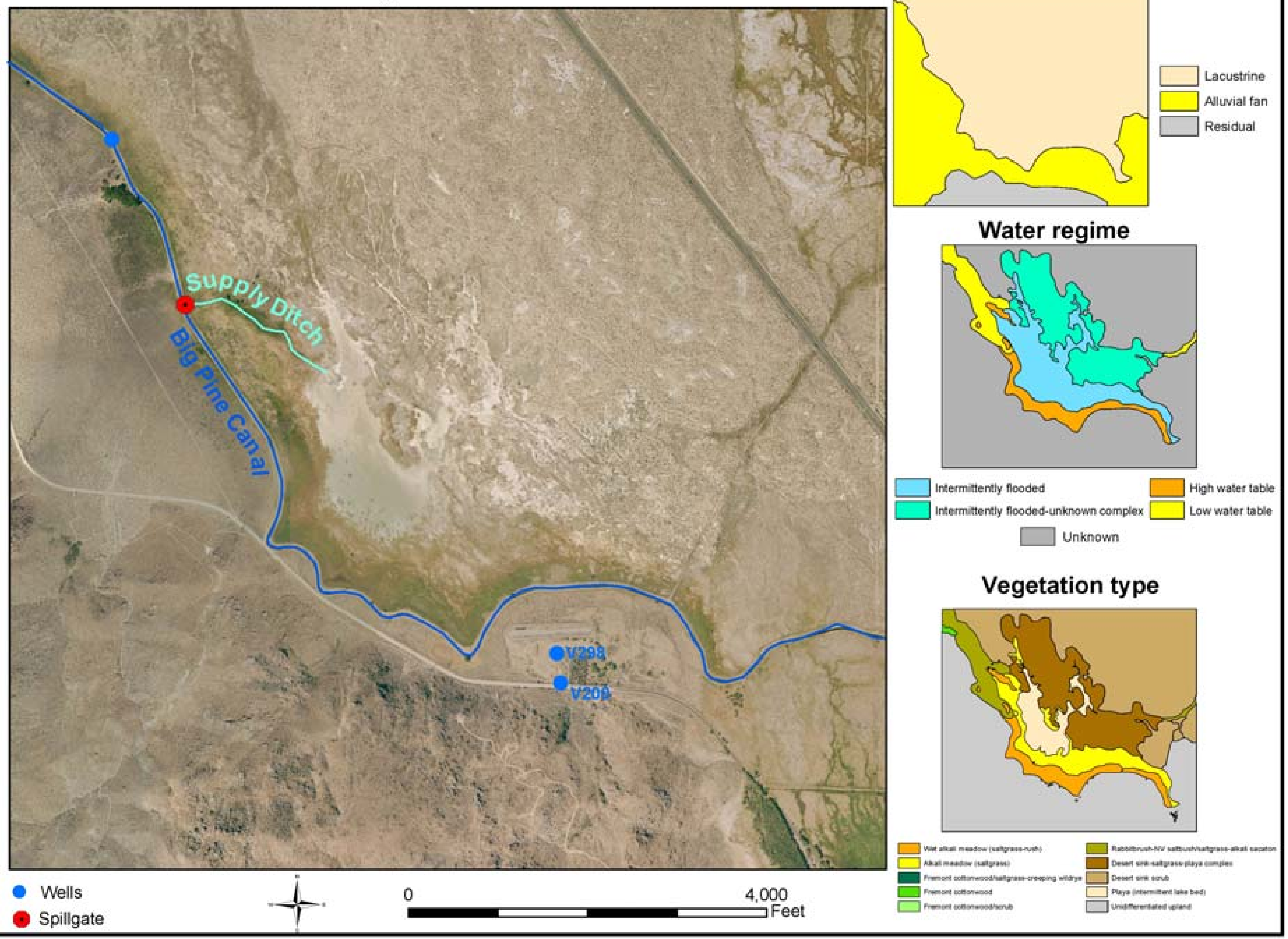
AM - Alkali Meadow
ARTRS - Big Sagebrush Scrub
DSS - Desert Sink Scrub
GBMS - Great Basin Mixed Scrub
PWAT - Permanent Lakes & Reservoirs
RSM - Rush/Sedge Meadow

Soils Mapping



110 - Aquents-Aquic Torripsamments association
152 - Cartago gravelly loamy coarse sand
154 - Cartago gravelly loamy sand
251 - Manzanar-Westguard association
281 - Pits-Dumps complex
318 - Shondow-Hessica association
358 - Westguard-Rienhakel association
360 - Whitewolf-Toquerville families association
901 - Intermittent Water

Warren Lake Area
Figure 3-19



Water will be delivered to the Warren Lake bed via an existing spill-gate and supply ditch from the Big Pine Canal. A flow gage will be installed at the spill-gate. Two alternatives were considered.

- **Alternative 1 – Supply water throughout the growing season:** Water will be supplied to maintain flooding of the lake bed from May through September. Predicted habitats and vegetation types that could be created or maintained (Figure 3-20) include open water (57 acres), marsh (76 acres), wet meadow (52 acres), and 167 acres of wet meadow-marsh complex. Eight existing cottonwood/willow trees would be maintained. The net area of water/wetland that could be created is about 300 acres. About 52 acres of predicted habitat would be suitable for establishing riparian trees and shrubs. The total predicted ET is 1,122 acre-feet/year (Table 3-14) and the long-term bedloss is predicted to be 300 acre-feet/year[7]. The water budget for this area is 1,422 acre-feet.

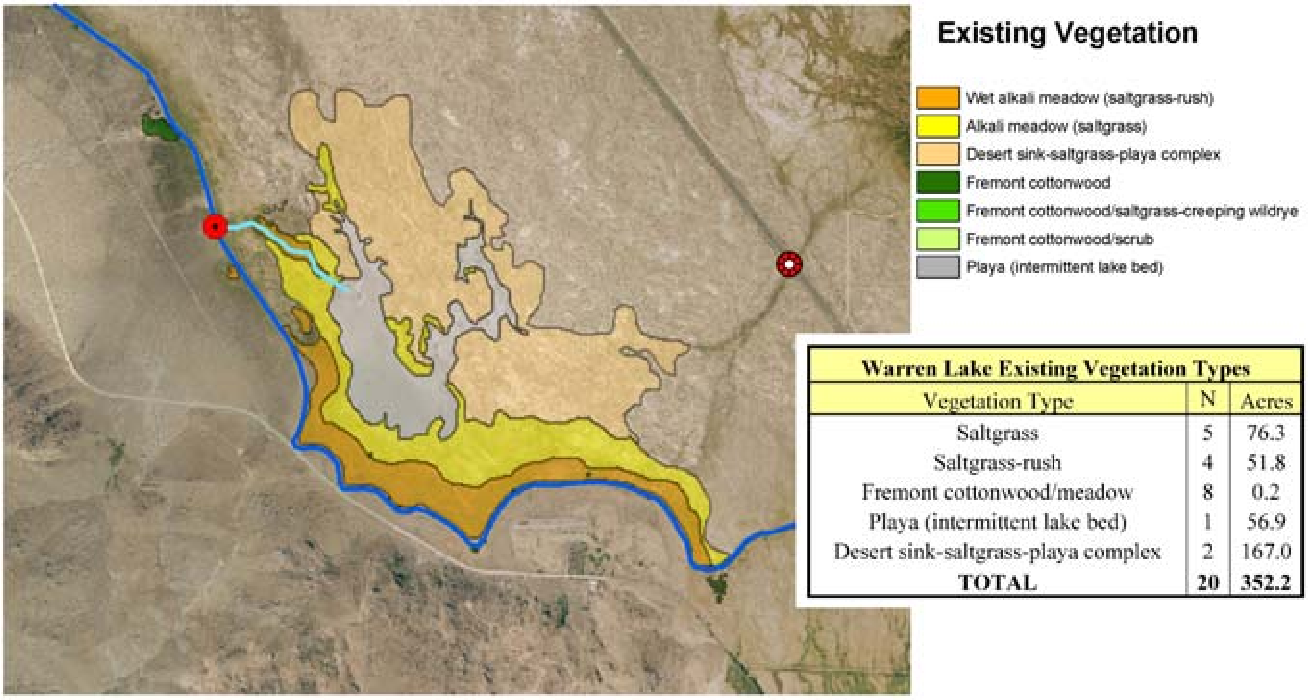
Table 3-14. Warren Lake predicted vegetation, alternative 1.

Predicted Vegetation Type	N	Area (acres)	ET (ft/yr)	ET (ac-ft/yr)
Bulrush-cattail	5	76.3	4.2	320.5
Saltgrass-rush	4	51.8	1.6	82.9
Fremont cottonwood/marsh	1	0.0	4.2	0.2
Fremont cottonwood/creeping wildrye-saltgrass	7	0.1	2.8	0.3
Water	1	56.9	5	284.3
Wet meadow-marsh complex	2	167.0	2.6	434.3
TOTAL	**20**	**352.2**	**--**	**1122.5**

[7] The 52 acres of saltgrass rush along the Big Pine Canal was not included in the bedloss estimate.

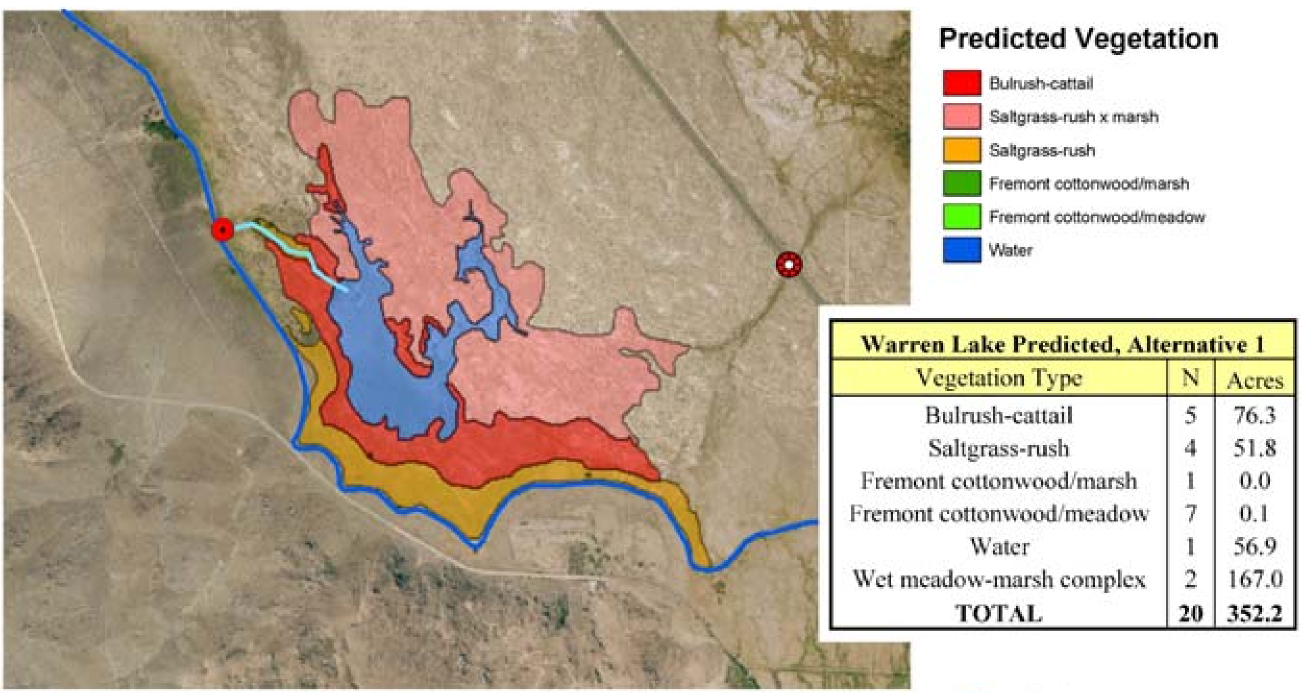
Warren Lake Alternative 1

Figure 3-20



Warren Lake Existing Vegetation Types

Vegetation Type	N	Acres
Saltgrass	5	76.3
Saltgrass-rush	4	51.8
Fremont cottonwood/meadow	8	0.2
Playa (intermittent lake bed)	1	56.9
Desert sink-saltgrass-playa complex	2	167.0
TOTAL	**20**	**352.2**



Warren Lake Predicted, Alternative 1

Vegetation Type	N	Acres
Bulrush-cattail	5	76.3
Saltgrass-rush	4	51.8
Fremont cottonwood/marsh	1	0.0
Fremont cottonwood/meadow	7	0.1
Water	1	56.9
Wet meadow-marsh complex	2	167.0
TOTAL	**20**	**352.2**

- **Alternative 2 – Supply seasonal water during the Spring:** About 450 acre-feet of water will be supplied once in the spring of each year, corresponding to about a 1.5 foot depth over the 300 acre lake bed[8]. Predicted habitats and vegetation types that could be created or maintained (Figure 3-21) include intermittent water (57 acres), wet alkali meadow 128 acres), and 167 acres of alkali meadow-wet alkali meadow complex. Eight existing cottonwood/willow trees would be maintained. The net area of water/wetland that could be created is about 200 acres[9]. About 295 acres of predicted habitat would be hydrologically suitable for establishing riparian trees and shrubs, but high alkalinity may inhibit establishment. Monthly ET for predicted vegetation types were estimated from annual values by assuming a consistent rate over 6 months. The total predicted monthly ET is 120 acre-feet/month (Table 3-15) and the long-term bedloss is predicted to be 25 acre-feet/month[10]. Initial bedloss when the lake bed is first filled is expected to be appreciably higher than the long-term bedloss. Conservatively, water may be present for 1 to 2 months of the growing season.

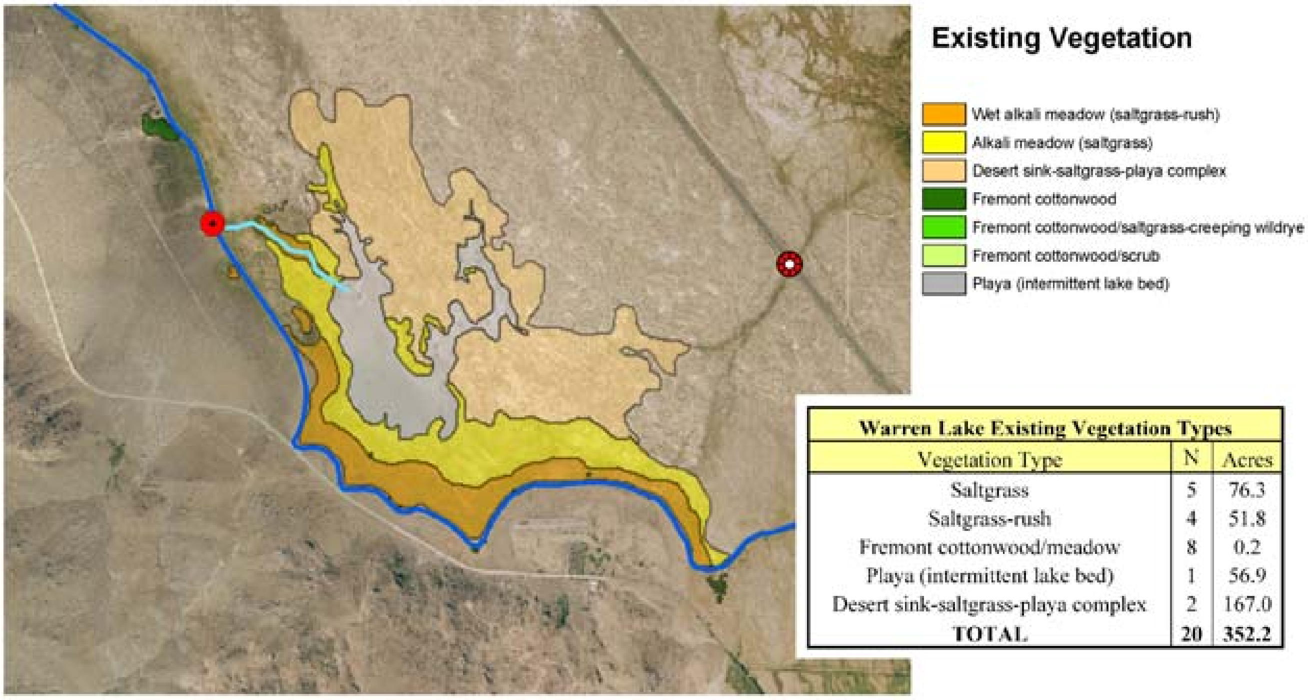
Table 3-15. Warren Lake predicted vegetation, alternative 2.

Predicted Vegetation Type	N	Area (acres)	ET (ft/month)	ET (ac-ft/month)
Saltgrass-rush	6	128.1	0.25	32.0
Fremont cottonwood/saltgrass-creeping wildrye	8	0.2	0.5	0.1
Intermittent water	1	56.9	0.8	45.5
Saltgrass x saltgrass-rush complex	2	167.0	0.25	41.8
TOTAL	**17**	**352.2**	**--**	**119.4**

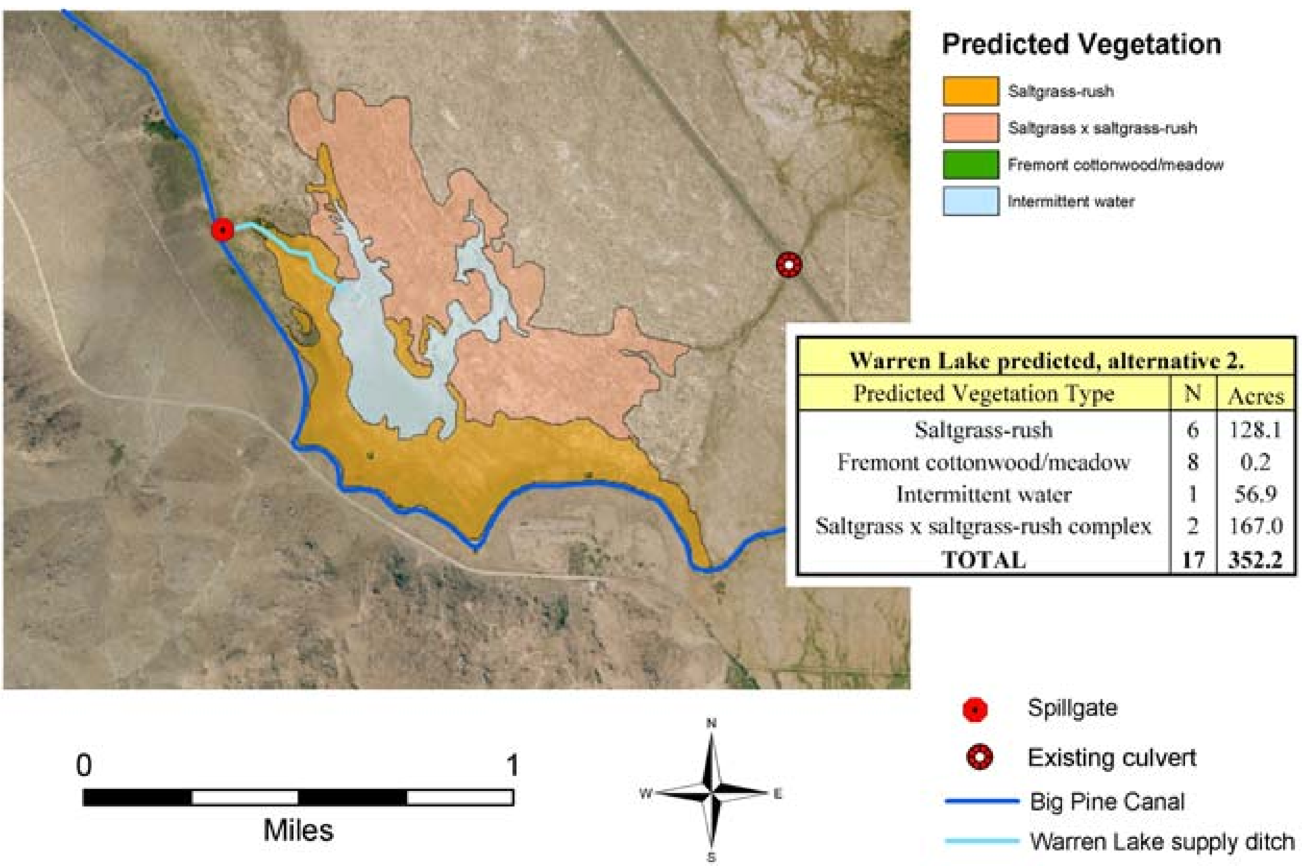
[8] Larger/smaller or more/less frequent releases could also be considered.
[9] This assumes that 60 percent of the predicted complex will be saltgrass (not wetland) and 40 percent will be saltgrass-rush (wetland).
[10] The 52 acres of saltgrass rush along the Big Pine Canal was not included in the bedloss estimate.

Warren Lake Alternative 2

Figure 3-21



Warren Lake Existing Vegetation Types		
Vegetation Type	N	Acres
Saltgrass	5	76.3
Saltgrass-rush	4	51.8
Fremont cottonwood/meadow	8	0.2
Playa (intermittent lake bed)	1	56.9
Desert sink-saltgrass-playa complex	2	167.0
TOTAL	**20**	**352.2**



Warren Lake predicted, alternative 2.		
Predicted Vegetation Type	N	Acres
Saltgrass-rush	6	128.1
Fremont cottonwood/meadow	8	0.2
Intermittent water	1	56.9
Saltgrass x saltgrass-rush complex	2	167.0
TOTAL	**17**	**352.2**

4.0 COSTS

Costs were estimated based on estimated costs for structural features (Table 2-2) and dimensions discussed for specific project areas, zones, areas, and alternatives.

The cost for providing power and refurbishing well 355 to supply the Hines Spring area will be about $175,000 (Table 4-1). In addition, structural features for Zone 1/Area 1 will be about $27,600, Zone 1/Area 2 about $59,400, and Zone 1/Area 3 about 289,200. [11] The total cost for Zone 1, including the well, will be about $551,200.

Hines Spring Zone 2/Area 1 is only feasible if Zone 1/Area 1 and/or Zone 1/Area 3 are first established. It will cost about $31,000. Zone 2/Area 2 and Zone 2/Area 3 could be constructed independent of Zone 1 for a cost of about $290,600 and $375,000, respectively. If both Zone 2/Area 2 and Zone 2/Area 3 are constructed using a common supply pipeline, the total cost would be about $380,600.

Zone 3/Area 1 of Hines Spring is only feasible if at least one of two conditions are met:

1. Zone1/Area 1 and/or Zone 1/Area 3 and Zone 2/Area 1 are established; and/or
2. Zone 2/Area 2 is established.

The cost for Zone 3/Area 1 will be about $11,000 if only one area is established in Zone 2 (requiring a single inverted siphon and gage). It will be about $22,000 if both Areas 1 and 2 are established in Zone 2.

The cost for establishing all areas in Zone 1, Zone 2/Area 1, and Zone 3 will be about $835,600.

Two overlapping areas, one of which entails two alternatives were considered in the Hidden Lake project area. Area 1 (Hidden Lake basin only) will cost about $462,000 if the supply pipeline is brought from the closest point on the aqueduct and about $501,000 if the supply pipeline is brought from the Dean spill-gate (Table 4-2). Area 2 (north basin and Hidden Lake) will cost about $423,000.

Two alternatives were considered for Warren Lake (Table 4-3). Alternative 1 entails supplying water to the lake bed throughout the growing season. Alternative 2 entails filling the lake bed once in the spring. The cost for either alternative is $6,000.

[11] It may be feasible to use the sandy spoils cut for the pond to build up Goodale Road.

Table 4-1. Hines Spring costs for structural features.					
Zone	Area	Feature	Dimension	Cost/unit	Cost
All	All	Upgrade well 355	--	$45,000	$45,000
All	All	Power to well 355	--	$130,000	$130,000
All	**All**	**TOTAL**	**--**	**--**	**$175,000**
1	1	4" buried pipe	360 feet	$60	$21,600
1	1	Remove dikes	4 dikes	$500	$2,000
1	1	Create dike	1 dike	$1,000	$1,000
1	1	Flow meter at well	1	$3,000	$3,000
1	1	Fencing	?	$3.50/ft	?
1	**1**	**TOTAL**	**--**	**--**	**$27,600**
1	2	4" buried pipe	890 feet	$60	$53,400
1	2	Minor excavation	1 area	$3,000	$3,000
1	2	Flow meter at well	1	$3,000	$3,000
1	2	Fencing	?	$3.50/ft	?
1	**2**	**TOTAL**	**--**	**--**	**$59,400**
1	3	4" buried pipe	3620	$60	$217,200
1	3	Minor excavation	1 area	$3,000	$3,000
1	3	**Excavate pond (on-site disposal)**	1	--	$66,000
1	3	Flow meter at well	1	$3,000	$3,000
1	3	Fencing	?	$3.50/ft	?
1	**3**	**TOTAL**	**--**	**--**	**$289,200**
1	**TOTAL**	**--**	**--**	**--**	**$551,200**

Table 4-1. Hines Spring costs for structural features.						
Zone	Area	Alt	Feature	Dimension	Cost/unit	Cost
2	1	--	18" gated culvert	2	$3,000	$6,000
2	1	--	Raise Goodale Road Grade	500 feet	?	$10000?
2	1	--	Flow gage at culverts	2	$6,000	$12,000
2	1	--	Remove small dikes	6	$500	$3,000
2	1	--	Fencing	?	$3.50/ft	?
2	**1**	**--**	**TOTAL**	--	--	**$21,000**
2	2	--	4" buried pipe	4760	$60	$285,600
2	2	--	Remove small dike	1	$500	$500
2	2	--	Flow meter at well	1	$3,000	$3,000
2	2	--	Fencing	?	$3.50/ft	?
2	**2**	**--**	**TOTAL**	**--**	**--**	**$289,100**
2	3	--	4" buried pipe	6200	$60	$372,000
2	3	--	4" buried pipe	1440	$60	$86,400
2	3	--	Flow meter at well	1	$3,000	$3,000
2	3	--	Fencing	?	$3.50/ft	?
2	**3**	**--**	**TOTAL**	**--**	**--**	**$461,400**
3	1	1	Inverted siphons w/ gate	2	$5,000	$10,000
3	1	1	Flow gage at siphon	2	$6,000	$12,000
3	1	1	Fencing	?	$3.50/ft	?
3	**1**	**1**	**TOTAL**	**--**	**--**	**$22,000**
3	1	2	Inverted siphons w/ gate	1	$5,000	$5,000
3	1	2	Flow gage at siphon	1	$6,000	$6,000
3	1	2	Fencing	?	$3.50/ft	?
3	**1**	**2**	**TOTAL**	**--**	**--**	**$11,000**

Table 4-2. Hidden Lake costs for structural features.					
Area	Alt	Feature	Dimension	Cost/unit	Cost
1	1	4" buried pipe	7550	$60	$453,000
1	1	Intake structure	1	$3,000	$3,000
1	1	Flow meter	1	$6,000	$6,000
1	1	Fencing	?	$3.50/ft	?
1	**1**	**TOTAL**	**--**	**--**	**$462,000**
1	2	4" buried pipe	8200	$60	$492,000
1	2	Intake structure	1	$3,000	$3,000
1	2	Flow meter	1	$6,000	$6,000
1	2	Fencing	?	$3.50/ft	?
1	**2**	**TOTAL**	**--**	**--**	**$501,000**
2	1	4" buried pipe	6900	$60	$414,000
2	1	Intake structure	1	$3,000	$3,000
2	1	Flow meter	1	$6,000	$6,000
2	1	Ditch	820 feet	?	?
2	1	Fencing	?	$3.50/ft	?
2	**1**	**TOTAL**	**--**	**--**	**$423,000**

Table 4-3. Warren Lake costs for structural features.				
Alternative	Feature	Dimension	Cost/unit	Cost
1	**Flow meter**	**1**	**$6,000**	**$6,000**
2	**Flow meter**	**1**	**$6,000**	**$6,000**

5.0 ASSESSMENT

Fiscal, habitat, and hydrogeomorphic (HGM) function assessments were conducted for project areas/zones/areas/alternatives and/or for selected combinations of zones/areas/alternatives. Some zones/areas/alternatives that would receive overflow from other zones are only feasible if considered together. There are several dozen feasible combinations of areas/alternatives for Hines Spring. Assessments were conducted for individual areas/alternatives that could function independently, and for selected combinations of areas/alternatives that are interdependent. Fourteen combinations of projects/zones/areas/alternatives were assessed.

1. Hines/Zone 1/Area 1 (contemporary spring drainage)
2. Hines/Zone 1/Area 2 (middle basin)
3. Hines/Zone 1/Area 3
4. Hines/Zone 1/Areas 1, Area 2, and Area 3
5. Hines/Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3
6. Hines/Zone 2/Area 2
7. Hines/Zone 2/Area 3
8. Hines/Zone 2/Areas 2 and 3
9. Hines/Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3
10. Hidden Lake/Area 1/Alternative 1
11. Hidden Lake/Area 1/Alternative 1
12. Hidden Lake/Area 2
13. Warren Lake/Alternative 1
14. Warren Lake/Alternative 2

5.1 Fiscal Assessment

The fiscal assessment for Hines Spring is complicated in that the cost for well 355 ($175,000) is fixed whether one, several or all areas are considered. Also, some areas of Hines Spring are feasible only in they get overflow from other areas (e.g. Zone 1 overflows to Zone 2/Area 1, which overflows to Zone 3). Fiscal assessments are also compiled for 3 areas/alternatives for Hidden Lake and 2 alternatives for Warren Lake.

The costs per acre of water/wetland (includes water, intermittent water, marsh, and wet meadow) was tabulated for each of the 18 areas/alternatives and sorted from low-to-high. A rank (1-10) was assigned to each area/alternative based the range in cost/acre of water/wetland (Table 5-1). The range in cost was $20 to $60,000 per acre.

Warren Lake (both alternatives) and combinations including two or three zones of Hines Spring (Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3; Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3) ranked lowest (best). Because of the cost for piping water to Hidden Lake and the relatively small area of wetland/water predicted, the cost/acre of wetland/water ranked moderate to high. The cost for well 355 and the small area of wetland/water that could be created in the contemporary spring channel of Hines Spring (Zone 1/Area 1) ranked highest ($59,588/acre).

Table 5-1. Fiscal assessment of selected areas/alternatives.						
Project	Zone/Area/Alternative	Cost	Water/Wetland (acres)	Cost/acre	Rank	
Warren	Alternative 1	$6,000	300	$20	1	**Low Cost**
Warren	Alternative 2	$6,000	200	$30	1	
Hines	Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	$583,200	155	$3,763	1	
Hines	Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	$572,200	101	$5,665	1	
Hines	Zone 2/Areas 2 and 3	$639,900	60	$10,665	2	
Hines	Zone 2/Area 2	$464,100	43	$10,793	2	
Hines	Zone 1/Areas 1, 2, and 3	$551,200	38	$14,621	3	
Hidden	Area 2	$423,000	28	$15,000	3	
Hines	Zone 1/Area 2	$234,400	14	$16,507	3	
Hines	Zone 1/Area 3	$464,200	20	$23,095	4	
Hidden	Area 1/Alternative 1	$462,000	13	$36,378	7	
Hines	Zone 2/Area 3	$636,400	17	$37,435	7	
Hidden	Area 1/Alternative 2	$501,000	13	$39,449	7	
Hines	Zone 1/Area 1	$202,600	3	$59,588	10	**High Cost**

5.2 Habitat Assessment

The intent of this assessment is to identify areas where the least common types of habitat are predicted. The areas of vegetation associations in the MORP, LORP, DHA, and BWMA (WHA 2004a,b,c,d) were compiled and summarized. Vegetation associations with similar water regimes and understory vegetation were merged into *association groups* and each group was assigned a rank (Table 5-2) based on the total area relative to other groups in the MORP, LORP, DHA, and BWMA.

Table 5-2. Association group ranks

Association Group	Acres	Rank[12]	
Water	1272	3	**Uncommon**
Bulrush-cattail and other saturated associations	2451	4	
Saltgrass and other herbaceous associations with low water table	2752	5	
Saltgrass-rush and other associations with high water table (includes irrigated pasture)	4208	8	
Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	7214	10	
Other upland	27192	10	**Common**

[12] The range in areas of rabbitbrush-NV saltbush/meadow (7,214 acres) and open water (1,271 acres) was divided into 10 ranks, each spanning 600 acre intervals.

Habitat scores were calculated as the average association *group rank*, weighted by the areas of predicted or existing vegetation (Table 5-3). A low habitat score indicates the presence or potential for uncommon vegetation associations. A high habitat score indicates the presence or potential for more common vegetation associations. The change in habitat scores is the difference between predicted and existing habitat scores. A large negative number (e.g. -3.7) indicates a potential for establishing more uncommon vegetation associations than a smaller negative number (e.g. -3.0).

The net change in habitat scores for zones/areas/alternatives was then sorted (low-to-high) and assigned a *habitat rank*[13]. A lower habitat rank indicates potential for establishing more uncommon vegetation associations than a higher rank. The habitat ranks for zones/areas/alternatives for the three projects are listed in Table 5-4.

The areas where the most uncommon habitats could be created are mostly fault basins (Hidden Lake/Areas 1 and 2; Hines/ Zone 1/Area 3) where a higher proportion of open water, the least common association group, was predicted. Warren Lake ranked towards the bottom because the existing saltgrass association (group rank 5) was predicted to change to more common bulrush-cattail (alternative 1) or saltgrass-rush (alternative 2).

[13] The range in net habitat scores (2.3 to 4.3) was divided into 10 ranks, each spanning an interval of 0.2.

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Group Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Hines Zone 1/Area 1								
121	Bulrush-cattail	5	3.2	0.0	3.2	16.2	0.0	16.2
131	Saltgrass-rush	8	0.0	0.0	0.0	0.2	0.0	0.2
151	Saltgrass	5	0.0	1.2	-1.2	0.0	6.0	-6.0
311	Goodding-red willow/bulrush-cattail	5	<0.1	0.0	<0.1	0.0	0.0	0.0
315	Goodding-red willow/scrub	10	0.0	<0.1	-<0.1	0.0	0.0	0.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	0.3	0.3	0.0	3.0	3.0	0.0
500	Water	3	0.1	0.0	0.1	0.4	0.0	0.4
--	Other upland	10	0.0	2.2	-2.2	0.0	22.0	-22.0
--	**TOTAL/AVERAGE**	**--**	**3.7**	**3.7**	**--**	**5.4**	**8.4**	**-3.0**
Hines Zone 1/Area 2								
121	Bulrush-cattail	5	2.7	0.0	2.7	13.5	0.0	13.5
131	Saltgrass-rush	8	5.3	0.0	5.3	42.7	0.0	42.7
151	Saltgrass	5	6.1	2.7	3.4	30.7	13.5	17.1
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	3.5	3.7	-0.2	34.7	37.0	-2.3
--	Other upland	10	0.0	11.3	-11.3	0.0	113.0	-113.0
--	**TOTAL/AVERAGE**	**--**	**17.7**	**17.7**	**--**	**6.9**	**9.2**	**-2.3**
Hines Zone 1/Area 3								
121	Bulrush-cattail	5	7.4	0.0	7.4	36.8	0.0	36.8
131	Saltgrass-rush	8	10.2	0.0	10.2	81.6	0.0	81.6
151	Saltgrass	5	0.2	0.0	0.2	0.9	0.0	0.9
311	Goodding-red willow/bulrush-cattail	5	<0.1	0.0	<0.1	0.0	0.0	0.0
315	Goodding-red willow/scrub	10	0.0	<0.1	-<0.1	0.0	0.0	0.0
500	Water	3	2.5	0.0	2.5	7.6	0.0	7.6
--	Other upland	10	0.0	20.3	-20.3	0.0	203.0	-203.0
--	**TOTAL/AVERAGE**	**--**	**20.3**	**20.3**	**--**	**6.3**	**10.0**	**-3.7**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Hines Zone 1/Areas 1, 2, and 3								
	Bulrush-cattail	5	13.3	0.0	13.3	66.6	0.0	66.6
	Saltgrass-rush	8	15.6	0.0	15.6	124.6	0.0	124.6
	Saltgrass	5	6.3	3.9	2.4	31.6	19.5	12.1
	Goodding-red willow/bulrush-cattail	5	<0.1	0.0	<0.1	0.0	0.0	0.0
	Goodding-red willow/scrub	10	0.0	<0.1	-<0.1	0.0	0.0	0.0
	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	3.8	4.0	-0.2	37.7	40.0	-2.3
	Water	3	2.7	0.0	2.7	8.1	0.0	8.1
	Other upland	10	0.0	33.8	-33.8	0.0	338.0	-338.0
	TOTAL/AVERAGE		**41.7**	**41.7**	**--**	**6.4**	**9.5**	**-3.1**
Hines Zone 2/Area 1								
121	Bulrush-cattail	5	21.2	0.0	21.2	106.1	0.0	106.1
131	Saltgrass-rush	8	19.8	0.0	19.8	158.5	0.0	158.5
151	Saltgrass	5	12.3	5.1	7.2	61.4	25.7	35.8
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	6.3	0.1	6.2	63.3	1.0	62.3
--	Other upland	10	0.0	54.5	-54.5	0.0	545.0	-545.0
--	**TOTAL/AVERAGE**	**--**	**59.7**	**59.7**	**--**	**6.5**	**9.6**	**-3.0**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3								
121	Bulrush-cattail	5	34.5	0.0	34.5	172.7	0.0	172.7
131	Saltgrass-rush	8	35.4	0.0	35.4	283.1	0.0	283.1
151	Saltgrass	5	18.6	9.0	9.6	93.0	45.2	47.8
311	Goodding-red willow/bulrush-cattail	5	<0.1	0.0	<0.1	0.0	0.0	0.0
315	Goodding-red willow/scrub	10	0.0	<0.1	-<0.1	0.0	0.0	0.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	10.1	4.1	6.0	101.0	41.0	60.0
500	Water	3	2.7	0.0	2.7	8.1	0.0	8.1
--	Other upland	10	0.0	88.3	-88.3	0.0	883.0	-883.0
--	**TOTAL/AVERAGE**	**--**	**101.3**	**101.4**	**--**	**6.5**	**9.6**	**-3.1**
Hines Zone 2/Area 2								
121	Bulrush-cattail	5	27.4	0.0	27.4	137.0	0.0	137.0
131	Saltgrass-rush	8	15.6	0.0	15.6	124.4	0.0	124.4
151	Saltgrass	5	4.0	0.0	4.0	19.8	0.0	19.8
311	Goodding-red willow/bulrush-cattail	5	0.1	0.0	0.1	0.5	0.0	0.5
312	Goodding-red willow/creeping wildrye-saltgrass	5	<0.1	0.0	<0.1	0.0	0.0	0.0
315	Goodding-red willow/scrub	10	0.0	0.1	-0.1	0.0	1.0	-1.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	29.5	0.0	29.5	294.7	0.0	294.7
--	Other upland	10	0.0	76.4	-76.4	0.0	764.0	-764.0
--	**TOTAL/AVERAGE**	**--**	**76.5**	**76.5**	**--**	**7.5**	**10.0**	**-2.5**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Code	Vegetation Association Name	Rank	Area (acres) Predicted	Area (acres) Existing	Area (acres) Change	Habitat Scores Predicted	Habitat Scores Existing	Habitat Scores Change
Hines Zone 2/Area 3								
121	Bulrush-cattail	5	7.8	0.0	7.8	39.0	0.0	39.0
131	Saltgrass-rush	8	7.0	0.0	7.0	56.2	0.0	56.2
315	Goodding-red willow/scrub	10	0.0	0.1	-0.1	0.0	1.0	-1.0
311	Goodding-red willow/bulrush-cattail	5	0.1	0.0	0.1	0.5	0.0	0.5
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	1.5	1.6	-0.1	14.6	16.0	-1.4
500	Water	3	1.9	0.0	1.9	5.7	0.0	5.7
--	Other upland	10	0.0	16.6	-16.6	0.0	166.0	-166.0
--	**TOTAL/AVERAGE**	**--**	**18.3**	**18.3**	**--**	**6.3**	**10.0**	**-3.7**
Hines Zone 2/Area 2 and 3								
121	Bulrush-cattail	5	35.2	0.0	35.2	176.0	0.0	176.0
131	Saltgrass-rush	8	22.6	0.0	22.6	180.7	0.0	180.7
151	Saltgrass	5	4.0	0.0	4.0	19.8	0.0	19.8
311	Goodding-red willow/bulrush-cattail	5	0.2	0.0	0.2	1.0	0.0	1.0
312	Goodding-red willow/creeping wildrye-saltgrass	5	<0.1	0.0	<0.1	0.0	0.0	0.0
315	Goodding-red willow/scrub	10	0.0	0.2	-0.2	0.0	2.0	-2.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	30.9	1.6	29.3	309.3	16.0	293.3
500	Water	3	1.9	0.0	1.9	5.7	0.0	5.7
--	Other upland	10	0.0	93.0	-93.0	0.0	930.0	-930.0
--	**TOTAL/AVERAGE**	**--**	**94.8**	**94.8**	**--**	**7.3**	**10.0**	**-2.7**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Hines Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3								
121	Bulrush-cattail	5	125.8	0.0	125.8	628.8	0.0	628.8
131	Saltgrass-rush	8	56.4	0.0	56.4	451.5	0.0	451.5
151	Saltgrass	5	18.6	9.4	9.2	93.0	47.2	45.8
311	Goodding-red willow/bulrush-cattail	5	0.1	0.0	0.1	0.5	0.0	0.5
315	Goodding-red willow/scrub	10	0.0	0.1	-0.1	0.0	1.0	-1.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	15.2	7.3	7.9	152.0	73.0	79.0
500	Water	3	2.7	0.0	2.7	8.1	0.0	8.1
--	Other upland	10	2.2	204.3	-202.1	21.8	2043.0	-2021.2
--	**TOTAL/AVERAGE**	--	**221.0**	**221.0**	**--**	**6.1**	**9.8**	**-3.7**
Hidden Lake Area 1								
121	Bulrush-cattail	5	6.1	0.0	6.1	30.5	0.0	30.5
131	Saltgrass-rush	8	2.9	0.0	2.9	23.5	0.0	23.5
151	Saltgrass	5	7.1	1.7	5.4	35.6	8.5	27.1
311	Goodding-red willow/bulrush-cattail	5	0.2	0.0	0.2	1.0	0.0	1.0
312	Goodding-red willow/creeping wildrye-saltgrass	5	0.2	0.2	0.0	1.0	1.0	0.0
315	Goodding-red willow/scrub	10	0.0	0.2	-0.2	0.0	2.0	-2.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	0.6	6.0	-5.4	5.5	60.0	-54.5
500	Water	3	3.4	0.0	3.4	10.1	0.0	10.1
--	Other upland	10	0.0	12.4	-12.4	0.0	124.0	-124.0
--	**TOTAL/AVERAGE**	**--**	**20.5**	**20.5**	**--**	**5.2**	**9.5**	**-4.3**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Hidden Lake Area 2								
121	Bulrush-cattail	5	14.3	0.0	14.3	71.6	0.0	71.6
131	Saltgrass-rush	8	7.6	0.0	7.6	61.1	0.0	61.1
151	Saltgrass	5	7.8	2.2	5.6	39.2	11.0	28.2
311	Goodding-red willow/bulrush-cattail	5	0.3	0.0	0.3	1.5	0.0	1.5
312	Goodding-red willow/creeping wildrye-saltgrass	5	0.2	0.2	0.0	1.0	1.0	0.0
315	Goodding-red willow/scrub	10	0.0	0.3	-0.3	0.0	3.0	-3.0
412	Rabbitbrush-NV saltbush/saltgrass-alkali sacaton	10	3.5	15.5	-12.0	35.3	155.0	-119.7
500	Water	3	5.9	0.0	5.9	17.7	0.0	17.7
--	Other upland	10	0.0	21.5	-21.5	0.0	215.0	-215.0
--	**TOTAL/AVERAGE**	**--**	**39.7**	**39.7**	**--**	**5.7**	**9.7**	**-4.0**
Warren Lake Alternative 1								
121	Bulrush-cattail	5	143.1	0.0	143.1	715.5	0.0	715.5
131	Saltgrass-rush	8	152.0	51.8	100.2	1216.0	414.4	801.6
151	Saltgrass	5	0.0	76.3	-76.3	0.0	381.5	-381.5
321	Fremont cottonwood/bulrush-cattail	5	0.2	0.0	0.2	1.0	0.0	1.0
322	Fremont cottonwood/creeping wildrye-saltgrass	5	0.0	0.2	-0.2	0.0	1.0	-1.0
500	Water	3	56.9	0.0	56.9	170.7	0.0	170.7
--	Other upland	10	0.0	223.9	-223.9	0.0	2239.0	-2239.0
--	**TOTAL/AVERAGE**	**--**	**352.2**	**352.2**	**--**	**6.0**	**8.6**	**-2.6**

Table 5-3. Predicted and existing habitat scores for areas/alternatives.								
Vegetation Association		Rank	Area (acres)			Habitat Scores		
Code	Name		Predicted	Existing	Change	Predicted	Existing	Change
Warren Lake Alternative 2								
131	Saltgrass-rush	8	195.1	51.8	143.3	1560.8	414.4	1146.4
151	Saltgrass	5	100.0	76.3	23.7	500.0	381.5	118.5
322	Fremont cottonwood/creeping wildrye-saltgrass	5	0.2	0.2	0.0	1.0	1.0	0.0
501	Intermittent water	3	56.9	0.0	56.9	170.7	0.0	170.7
--	Other upland	10	0.0	223.9	-223.9	0.0	2239.0	-2239.0
--	**TOTAL/AVERAGE**	**--**	**352.2**	**352.2**	**--**	**6.3**	**8.6**	**-2.3**

Table 5-4. Habitat ranks for zones/areas.					
Project/Zone/Area	Habitat Scores			Habitat Rank	
	Predicted	Existing	Net		
Hidden Lake Area 1	5.2	9.5	-4.3	1	**Uncommon**
Hidden Lake Area 2	5.7	9.7	-4	2	
Hines Zone 1/Area 3	6.3	10	-3.7	3	
Hines Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	6.1	9.8	-3.7	4	
Hines Zone 2/Area 3	6.3	10	-3.7	4	
Hines Zone 1/Areas 1, 2, and 3	6.4	9.5	-3.1	7	
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	6.5	9.6	-3.1	7	
Hines Zone 1/Area 1	5.4	8.4	-3	7	
Hines Zone 2/Area 2 and 3	7.3	10	-2.7	9	
Warren Lake Alternative 1	6	8.6	-2.6	9	
Hines Zone 2/Area 2	7.5	10	-2.5	10	
Hines Zone 1/Area 2	6.9	9.2	-2.3	10	
Warren Lake Alternative 2	6.3	8.6	-2.3	10	**Common**

5.3 Hydrogeomorphic (HGM) Assessment

Hydrogeomorphic (HGM) assessments were developed for LORP (WHA 2004g). The *reference domain* is the union of all wetlands within a defined geographic region that belong to a single geomorphic subclass. The reference domain for this application included riverine wetlands in the MORP, LORP, and DHA (WHA 2004a,b,c), and man-induced wetlands in the BWMA (WHA 2004d).

Reference wetlands encompass the variation inherent to the geomorphic subclass. They are used to establish the range of functioning within the reference domain. The reference wetlands for this application are discrete combinations of landtype, water regime, and vegetation associations discussed in inventory reports (WHA 2004a,b,c,d).

Reference standards are conditions exhibited by reference wetlands that correspond to the highest level of functioning in the reference domain. Reference standards are specific to a function – the reference standard for hydrologic functions may be different from those for habitat functions. The reference standards for this application are discrete combinations of landtype/water regime, and vegetation association.

Hydrologic, biogeochemical and *habitat functions* were defined in terms of several dozen variables. Specific combinations of landtype, water regime, and vegetation association were assigned one of four *variable indexes* ranging from 0 (no value) to 1 (highest value). Reference standards were defined by the feature classes (be it landtype/water regime or vegetation association) that ranked highest amongst all features in the reference domain. Variable indexes were assigned to landtype/water regime or vegetation association.

Fourteen (14) *functional indexes* were calculated from variable indexes for each map parcel. *Functional units* are functional indexes weighted by area (acres) of the parcel. Functional units are analogous to "habitat units" of Habitat Evaluation Procedures (HEP) in that they are the product of an index (0-1) and area (acres). A functional unit may denote 1 acre with optimal functional index (1.0), 2 acres with moderate functional index (0.5), or a hundred acres with very low functional index (0.01). Average hydrologic, biogeochemical, habitat, and overall functional units were also calculated for each parcel.

Hydrologic (Table 5-5), biogeochemical (Table 5-6), and habitat (Table 5-7) functional units were estimated for existing and predicted conditions. The hydrologic, biogeochemical, and habitat functional units were averaged for existing and predicted conditions. The average net functional units for projects/zones/areas/alternatives (Table 5-8) were ranked[14]. Warren Lake/Alternative 1 and Hines Spring (Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3) ranked highest, followed by Warren Lake/Alternative 2.

[14] The range in net functional units (2 to 119) was divided into 10 ranks, each spanning an interval of 12 functional units.

Table 5-5. Existing and predicted hydrologic functional units.

Project/Zone/Area/Alternative	N	Acres	HDSWS			HED			HLTWS			HMGFD			HSSW			**HAVG**		
			Dynamic Surface Water Storage			Dynamic Surface Water Storage			Long-term Surface Water Storage			Moderation of Groundwater Flow or Discharge			Subsurface Storage of Water			**Average**		
			Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	**Existing**	**Predicted**	**Change**
Hines Zone 1/Area 1	18	3.7	0	3	3	0	3	3	2	4	2	0	3	3	2	2	0	**1**	**3**	**2**
Hines Zone 1/Area 2	13	17.7	0	6	6	0	6	6	9	11	3	0	8	8	9	14	5	**4**	**9**	**6**
Hines Zone 1/Area 3	10	20.3	0	14	14	0	13	13	10	18	8	0	18	18	10	11	1	**4**	**15**	**10**
Hines Zone 1/Areas 1, 2, and 3	41	41.7	0	24	24	0	22	22	21	33	12	0	29	29	21	27	6	**8**	**27**	**19**
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	70	101	0	58	58	0	55	55	44	71	27	0	67	67	51	63	12	**19**	**63**	**44**
Hines Zone 2/Area 2	30	76.5	0	39	39	0	39	39	34	51	18	0	41	41	38	53	15	**14**	**45**	**30**
Hines Zone 2/Area 3	25	18.3	0	13	13	0	12	12	9	16	7	0	15	15	9	10	1	**4**	**13**	**10**
Hines Zone 2/Area 2 and 3	55	95	0	52	52	0	50	50	43	67	24	0	56	56	47	64	16	**18**	**58**	**40**
Hines Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	99	221	0	160	160	0	158	158	99	177	78	0	174	174	111	125	14	**42**	**159**	**117**
Hidden Lake Area 1	52	20.5	0	11	11	0	9	9	11	16	5	0	13	13	10	14	4	**4**	**12**	**8**
Hidden Lake Area 2	70	39.9	0	24	24	0	20	20	20	32	12	0	27	27	20	26	6	**8**	**26**	**18**
Warren Lake Alternative 1	19	344.2	27	243	216	23	194	171	103	152	48	0	251	251	166	125	-41	**64**	**193**	**129**
Warren Lake Alternative 2	19	344.2	27	153	126	23	120	98	103	97	-6	0	131	131	166	179	12	**64**	**136**	**72**

Table 5-6. Existing and predicted biogeochemical functional units for areas/alternatives.																	
Project/Zone/Area/Alternative	N	Acres	BNC Nutrient Cycling			BOCE Organic Carbon Export			BRIC Removal of Imported Elements and Compounds			BRP Retention of Particulates			**BAVG Average**		
			Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	**Existing**	**Predicted**	**Change**
Hines Zone 1/Area 1	18	3.7	0	3	3	0	3	3	0	2	2	0	2	2	**0**	**3**	**3**
Hines Zone 1/Area 2	13	17.7	0	6	6	0	6	6	0	5	4	0	4	4	**0**	**5**	**5**
Hines Zone 1/Area 3	10	20.3	0	13	13	0	12	12	0	11	11	0	10	10	**0**	**11**	**11**
Hines Zone 1/Areas 1, 2, and 3	41	41.7	0	22	22	0	20	20	0	17	17	0	16	16	**0**	**19**	**19**
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	70	101	0	55	55	0	50	50	0	42	41	0	38	38	**0**	**46**	**46**
Hines Zone 2/Area 2	30	76.5	0	39	39	0	37	37	0	29	29	0	26	26	**0**	**33**	**33**
Hines Zone 2/Area 3	25	18.3	0	12	12	0	10	10	0	9	9	0	8	8	**0**	**9**	**9**
Hines Zone 2/Area 2 and 3	55	95	0	50	50	0	47	47	0	38	38	0	33	33	**0**	**42**	**42**
Hines Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	99	221	0	158	158	0	140	140	0	112	112	0	100	100	**0**	**127**	**127**
Hidden Lake Area 1	52	20.5	0	9	9	0	7	7	1	7	7	1	6	6	**0**	**7**	**7**
Hidden Lake Area 2	70	39.9	0	20	20	1	17	16	1	16	15	1	14	13	**1**	**17**	**16**
Warren Lake Alternative 1	19	344.2	5	105	100	21	184	162	37	178	141	34	163	129	**24**	**157**	**133**
Warren Lake Alternative 2	19	344.2	5	117	112	21	95	73	37	104	67	34	99	65	**24**	**104**	**79**

Table 5-7. Existing and predicted habitat functional units for areas/alternatives.																				
Project/Zone/Area/Alternative	N	Acres	HDB			HPC			HVERT			HCON			HSTRUCT			**HABAVG**		
			Maintain Characteristic Detrital Biomass			Maintain Characteristic Plant Community			Maintain Distribution and Abundance of Vertebrates			Maintain Interspersion and Connectivity			Maintain Spatial Structure of Habitat			**Average**		
			Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	Existing	Predicted	Change	**Existing**	**Predicted**	**Change**
Hines Zone 1/Area 1	18	3.7	0	1	1	0	0	0	1	3	2	0	3	3	0	0	0	**0**	**1**	**1**
Hines Zone 1/Area 2	13	17.7	0	3	2	0	4	4	4	9	5	0	6	6	1	2	1	**1**	**5**	**4**
Hines Zone 1/Area 3	10	20.3	0	5	5	0	3	3	2	15	13	0	13	13	0	2	2	**0**	**8**	**7**
Hines Zone 1/Areas 1, 2, and 3	41	41.7	1	9	8	0	7	7	7	26	19	0	21	21	1	4	3	**2**	**14**	**12**
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	70	101	1	21	20	0	18	18	15	62	47	0	50	50	2	11	9	**4**	**32**	**29**
Hines Zone 2/Area 2	30	76.5	0	14	14	0	7	7	7	43	36	0	31	31	2	9	7	**2**	**21**	**19**
Hines Zone 2/Area 3	25	18.3	0	4	4	0	2	2	2	13	11	0	11	11	1	2	1	**1**	**6**	**6**
Hines Zone 2/Area 2 and 3	55	95	0	18	18	0	9	9	9	56	47	0	42	42	2	11	9	**2**	**27**	**25**
Hines Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	99	221	1	56	55	0	25	25	33	145	113	0	134	134	4	25	22	**8**	**77**	**70**
Hidden Lake Area 1	52	20.5	1	4	3	0	4	3	4	13	9	0	10	10	2	2	1	**1**	**6**	**5**
Hidden Lake Area 2	70	39.9	1	8	6	0	5	5	9	26	17	0	20	20	3	4	1	**3**	**13**	**10**
Warren Lake Alternative 1	19	344.2	16	79	63	0	61	61	93	237	143	24	215	191	7	26	19	**28**	**124**	**96**
Warren Lake Alternative 2	19	344.2	16	57	41	0	96	96	93	228	135	24	128	105	7	36	29	**28**	**109**	**81**

Table 5-8. Ranking of the average net functional units.

Project/Zone/Area/Alternative	N	Acres	Average Functional Units			Functional Rank	
			Existing	Predicted	Increase		
Warren Lake/Alternative 1	19	344	39	158	119	1	**High Net Function**
Hines/Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	99	221	17	121	105	1	
Warren Lake/Alternative 2	19	344	39	116	77	4	
Hines/Zone 2/Area 2 and 3	55	95	7	42	36	7	
Hines Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	70	101	8	47	40	7	
Hines Zone 2/Area 2	30	76	5	33	27	8	
Hidden Lake/Area 2	70	40	4	18	15	9	
Hines Zone 1/Areas 1, 2, and 3	41	42	3	20	16	9	
Hines Zone 1/Area 1	18	4	0	2	2	10	
Hines Zone 1/Area 2	13	18	2	6	5	10	
Hidden Lake/Area 1	52	20	2	9	7	10	
Hines Zone 2/Area 3	25	18	1	10	8	10	
Hines Zone 1/Area 3	10	20	2	11	10	10	**Low Net Function**

5.4 Assessment Summary

Predicted areas that would be enhanced, water/wetland, and areas suitable for establishing riparian trees and shrubs are listed in Table 5-9 along with estimated water budgets and results of fiscal, habitat, and HGM assessments. Projects/zones/areas/alternatives are listed in order of an average rank that is the mean of fiscal, habitat and HGM ranks. The top combinations include Hines Spring, Warren Lake, and Hidden Lake.

- **Hines/Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3:** This area would require about 1,325 acre-feet of water to enhance 221 acres, including 155 acres of water/wetland. About 75 acres would be suitable for establishing riparian trees and shrubs. The cost would be about $3,800 per acre of water/wetland. The habitat rank (4) indicates the potential for establishing uncommon habitats is moderate and the function rank (1) indicates a high net increase in functional units. On the down-side, this complex area requires the most structures (e.g. gages to monitor both inflow and outflow of each area), all of which will require long-term maintenance and more intensive monitoring. On the up-side, the discrete zones/areas may provide opportunities for a more comprehensive experimental design to study factors influencing restoration. The experimental design could also be integrated with that for the BWMA, where similar efforts to create, sustain, and enhance wetland resources are anticipated. The Hines area is flanked by the LORP riparian area on the east and the BWMA on the south. It occupies the position of a 'key stone" for the LORP watershed. Efforts to create wetland/water in this area are likely to benefit the Drew management unit in the BWMA and the incised reach of the LORP riparian area, where existing resource values are lowest.

- **Warren Lake/Alternative 1:** This alternative is to supply water to the lake bed throughout the growing season. It would require about 1,425 acre-feet of water to enhance 344 acres, including 300 acres of water/wetland. About 75 acres would be suitable for establishing riparian trees and shrubs. The projected cost, $20 per acre of wetland/water, is very low. Because relatively uncommon (saltgrass) habitats will be replaced by more common (marsh) habitats, the habitat rank was high (9), although the net gain in functional units (119) was the highest of all sites considered. The setting of Warren Lake does not lend itself to a complex experimental design of factors influencing restoration. Results of such a study may be applicable only to similar settings, which are not extensive in Owens Valley (the DHA is an exception). Establishment of water/wetland in Warren Lake is the simplest, most predictable, and easiest to monitor of all sites considered. The large water requirement for this area would preclude developing other sites.

Table 5-9. Assessment summary for projects/zones/areas/alternatives.														
Project/Zone/Area/Alternative	Areas (acres)			Water Budget (ac-ft)			Assessments							
							Fiscal			Habitat Rank	HGM		Average Rank[15]
	Enhanced	Water/Wetland	Tree/shrub[16]	ET	Bedloss	Total	Cost	Cost/acre	Rank		Functional Unit Increase	Rank	
Hines/Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	221	155	75	662	663	1325	$583,200	$3,763	1	4	105	1	2
Warren Lake/Alt 1	344	300	52	1122	300	1422	$6,000	$20	1	9	119	1	4
Hidden Lake/Area 2	40	28	15	116	119	235	$423,000	$15,000	3	2	15	9	5
Hines/Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3	101	101	54	244	304	548	$572,200	$5,665	1	7	40	7	5
Warren Lake/Alt 2	344	200	295	355	95	450	$6,000	$30	1	10	77	4	5
Hines/Zone 1/Area 3	20	20	10	58	61	118	$464,200	$23,095	4	3	10	10	6
Hines/Zone 2/Area 2 and 3	95	60	27	224	291	509	$639,900	$10,665	2	9	36	7	6
Hidden Lake/Area 1/Alt 1	20	13	10	58	62	120	$462,000	$36,378	7	1	7	10	6
Hidden Lake/Area 1/Alt 2	20	13	10	58	62	120	$501,000	$39,449	7	1	7	10	6
Hines/Zone 1/Areas 1, 2, and 3	42	38	22	104	125	228	$551,200	$14,621	3	7	16	9	6
Hines Zone 2/Area 2	76	43	20	172	230	402	$464,100	$10,793	2	10	27	8	7
Hines Zone 2/Area 3	18	17	7	52	61	107	$636,400	$37,435	7	4	8	10	7
Hines Zone 1/Area 2	18	14	11	31	53	84	$234,400	$16,507	3	10	5	10	8
Hines Zone 1/Area 1	4	3	<1	15	11	26	$202,600	$59,588	10	7	2	10	9

[15] Average of fiscal, habitat, and HGM ranks.
[16] Denotes the total area where the predicted water regime is compatible for establishing riparian trees and shrubs, but not necessarily the area that will be created.

- **Hidden Lake/Area 2:** This area includes two contiguous fault basins (north and Hidden Lake) that would be supplied by a pipeline from the aqueduct. It would require about 235 acre-feet to enhance 40 acres, including 28 acres of water/wetland. The projected cost, $15,000 per acre of water wetland, is high. The habitat rank (2) indicates relatively uncommon (e.g. open water) habitats are predicted. The low net gain in function units (15) resulted in a high function rank (9). The high cost of getting water to the area and the relatively small area of predicted water/wetland are the principal limitations. On the upside, fault basins (e.g. Twin Lakes, Goose Lake, and Billy Lake) provide some of the best open-water habitat in Owens Valley.

- **Warren Lake/Alternative 2:** This alternative is to supply seasonal water to the lake bed in the spring. It would require about 450 acre-feet of water to enhance 344 acres, including 200 acres of water/wetland. About 295 acres would be suitable for establishing riparian trees and shrubs. The projected cost, $30 per acre of wetland/water, is very low. Because relatively uncommon (saltgrass) habitats will be replaced by more common (saltgrass-rush) habitats, the habitat rank was high (10), although the net gain in functional units (77) was relatively high. The setting of Warren Lake does not lend itself to a complex experimental design of factors influencing restoration. Results of such a study may be applicable only to similar settings, which are not extensive in Owens Valley (the DHA is an exception). Establishment of water/wetland in Warren Lake is the simplest, most predictable, and easiest to monitor of all sites considered. This alternative is best suited for use of allocated water (1600 acre-feet) not utilized for other sites. Benefits beyond that predicted for Warren Lake/Alternative 2 are expected if more than 450 acre-feet was available in early years, as would occur with the phased approach suggested for the Hines Spring site.

Other smaller combinations and discrete areas/alternatives ranked low in the overall assessment, primarily because of the high fiscal cost and relatively small predicted areas of water wetland.

6.0 RECOMMENDATIONS

I recommend the 1600 cfs be used primarily for Hines/Zone 3 and Zone 2/Area 1 and Zone 1/Areas 1, 2, and 3. The feasibility of using spoil from the excavated pond in Zone 1/Area 3 for raising the grade of Goodale Road near the paleochannel crossing should be evaluated. It is likely that other uses of fill will be identified in a more focused restoration design. I recommend the Hines Spring area be established in three phases:

1. **Phase 1 (1-2 year duration):** Establish hydrology throughout Zone 1 down to Goodale Road. Drainage out of Zone 1 will be controlled by gated culverts under Goodale Road and controlled release from Well 355. More than 1,000 acre-feet of water would be available for other projects during Phase 1.

2. **Phase 2 (1-2 year duration):** Establish hydrology throughout Zone 2/Area 1 down to the Aberdeen Ditch. Zone 1 will overflow to Zone 2 via gated culverts equipped with flow gages at Goodale Road. Flow from Well 355 will be adjusted to overflow Zone 1 and fill Zone 2/Area 1 to capacity. Outflow from Zone 2/Area 1 will be controlled by a gated/gauged inverted siphon under the Aberdeen Ditch. More than 600 acre-feet of water would be available for other projects during Phase 2.

3. **Phase 3:** Establish hydrology throughout Zone 3, which will receive overflow from Zone 2/Area 1 via an inverted siphon under the Aberdeen Ditch. About 275 acre-feet of water would be available for other projects. The predictions of wetland/water in this zone are conservative. Landtypes in Zone 3 that are suitable for creating wetland/water comprise about 800 acres.

A cumulative fiscal assessment (Table 6-1) shows that the cost per acre gained by adding successive Hines areas ($92/acre gained in Zone 3) demonstrates the advantage of focusing efforts in a single area.

Water not used at Hines Spring could be used for seasonal flooding of Warren Lake. The phased approach to Hines Spring would result in more water being released to Warren Lake in early years than in later years. During early years, Warren Lake would be flooded throughout most of the growing season, creating more hydric conditions than predicted for alternative 2, but less than alternative 1. Subsequent reduction in water input to Warren Lake will likely foster a diverse assemblage of marsh, wet alkali meadow, alkali meadow, and seasonally flooded playa.

Table 6-1. Cumulative fiscal assessment of selected Hines areas.						
Zone/Area	Water	Enhanced Area		Cost		
		Gained	Total			
	(ac-ft)	(acres)	(acres)	Total	Cost/Acre	Cost/acre gained
Zone 1/Area 1	26	3.7	3.7	$202,600	$54,757	$54,757
Zone 1/Area 1&2	110	17.7	21.4	$262,000	$12,243	$3,356
Zone 1/Area 1,2,&3	228	20.3	41.7	$497,800	$11,938	$11,616
Zone 2/Area 1 & Zone 1 (All)	548	59.7	101.4	$518,800	$5,116	$352
Zone 3 & Zone 2/Area 1 & Zone 1(All)	1325	119.7	221.1	$529,800	$2,396	$92

7.0 LITERATURE CITED

Benson, L.V., Currey, D.R., Dorn, R.I., Lajoie, C.G., Oviatt, S.W., Robinson, S.W., Smith, G.I. and S. Stine. 1990. Chronology of expansion and contraction of four Great Basin lake systems during the past 35,000 years. Paleography, Palaeoclimatology, Paleoecology, 78: 241-246.

Cowardin, L.M., Carter, V., Golet, F.C. and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31.

Hickman, J.C. (ed.). 1994. The Jepson Manual: Higher Plants of California. Berkeley: The University of California Press.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Unpublished mimeograph.

Inyo County and City of Los Angeles. 1990. Green book for the long-term groundwater management plan for Owens Valley and Inyo County. 174 pp.

Otis Bay and Stevens Ecological Consulting, LLC. 2005. Hines Spring Mitigation Draft Phase I Report. Report to LADWP and ICWD. 122 pp + APPENDICES.

Otis Bay Ecological Consultants. 2005. Hines Spring Mitigation, Draft Phase II and III Report. Report to LADWP and ICWD. 65 pp + APPENDICES.

Reed, Jr., P.B. 1988. National List of Plant Species That Occur in Wetlands: National Summary. U.S. Fish & Wildlife Service. Biol. Rep. 88 (24). 244 pp.

Smith, G.I. and F. Street-Perrott. 1983. Pluvial Lakes of the Western United States. In: Late-Quaternary Environments of the United States (ed. H.E. Wright, Jr.). pp. 190-211. University of Minnesota Press.

U.S Army Corps of Engineers. 1987. Wetland delineation manual. Waterways Experiment Station, Vicksburg, Mississippi.

U.S. Fish and Wildlife Service. 1986. Wetland plant list. Compiled for the National Wetlands Inventory. Wetland Ecology Group; St. Petersburg, Florida.

USGS. 1982. Independence Quadrangle, California-Inyo County, 7.5 minute series (topographic) with 2.5 meter supplemental contour interval.

White Horse Associates. 2005a. Hines Spring inventory, 2000 conditions. Report to LADWP and Inyo County.

White Horse Associates. 2004a. Delta Habitat Area vegetation inventory, 2000 conditions. Report to LADWP and Inyo County.

White Horse Associates. 2004b. Lower Owens River Project (LORP) riparian area vegetation inventory, 2000 conditions. Digital report, shapefiles, and access tables to LADWP and Inyo County.

White Horse Associates. 2004c. Blackrock Waterfowl Management Area (BWMA) vegetation inventory, 2000 conditions. Digital report, shapefiles, and access tables to LADWP and Inyo County.

White Horse Associates. 2004d. Middle Owens River Project (MORP) riparian area vegetation inventory, 2000 conditions. Digital report, shapefiles, and access tables to LADWP and Inyo County.

White Horse Associates. 2004e. Baker Inventory and Assessment, 2000 conditions. Digital report, shapefiles, and access tables to LADWP and Inyo County.

White Horse Associates. 2004f. Hogback Inventory and Assessment, 2000 conditions. Digital report, shapefiles, and access tables to LADWP and Inyo County.

White Horse Associates. 2004g. Lower Owens River Project (LORP) delineation, prediction, and assessment of wetland/riparian resources. Digital report, shapefiles, and access tables to LADWP and Inyo County.