San Luis National Wildlife Refuge

Water Management Plan

2011 - 2015

December 2010

Record of Water Conservation Plan Adoption

By the wildlife refuge titled: **San Luis National Wildlife Refuge**

This refuge has developed a **final water conservation plan (2011-2015) dated December 15, 2010**. The plan was developed to meet the Bureau of Reclamation criteria for evaluating water conservation plans of wildlife refuges. The Bureau of Reclamation has indicated that the final plan meets the criteria.

I have the authority to adopt the plan and begin implementation. This serves as a record that I have done so.

_____ Date: 27 April 11

Printed Name: Kim Forrest

Title: Complex Refuge Manager – San Luis National Wildlife Refuge Complex

Section A - Background

1. *Identify the staff member responsible for developing and implementing the Plan. Provide their contact information*

Name Kim Forrest Title Refuge Manager

Address P.O. Box 2176, Los Banos, CA 93635

Telephone 209-826-3508 Fax 209-826-1445

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2. *Year refuge established* 1967

Define year-type used consistently throughout plan March 1 to February 28 (February 29th in the event of a Leap Year).

3. *Water supplies*

List each annual entitlement of surface water under each water right and/or contract

East of Highway 165

Supplier	*Water source*	*Contract #*	*Contract restrictions*	*Acre-feet/year*	*Supplier*
Federal level 2	San Luis Canal Co.	1165020013	NA	26,207	*Federal level 2*
Federal level 4	San Luis Canal Co.	1165020013	NA	3,603	*Federal level 4*
State	NA	NA	NA	NA	*State*
Appropriative	Salt Slough	NA	NA	*19,900*	*Appropriative*
Other, riparian	NA	NA	NA	*NA*	*Other, riparian*
Other, riparian	Groundwater	No contract	NA	NA	

East Bear Creek

Supplier	*Water source*	*Contract #*	*Contract restrictions*	*Acre-feet/year*
Federal level 2	Stevinson, Water District	10-WC-20-4038	"Reclamation shall acquire and pay for up to 7,295 acre-feet of Purchased Water per year for the period of June 25, 201 through	Up to 7,295 acre feet for the period June 25, 2010 through February 28, 2011.

			February 28, 2011."	
Federal level 2	Merced Irrigation District	10-WC-20-4078	"Reclamation shall acquire and pay for up to 500-acre feet of Base Water and up to 1,500 acre-feet of Discretionary water for the period starting with the execution of this agreement ((24th November 2010) through February 28, 2011."	Up to 2,000 acre feet for the period November 24, 2010 to February 28, 2011.
Federal level 4				4,432
State	None	None in place		
Appropriative	None	None in place		
Other, riparian	San Joaquin River			Floodwater – passive rights
Other, riparian	Bear Creek			If available
Other, riparian	Groundwater	None in place		0

West of Highway 165

Supplier	*Water source*	*Contract #*	*Contract restrictions*	*Acre-feet/year*
Federal level 2	Grasslands WD	81650-4-M220		15,290
Federal level 4	Grasslands WD			As available
State	None	None in place		
Appropriative	None	None in place		
Other, riparian	Groundwater	No contract		NA

4. *Provide a narrative on pre-CVPIA refuge water supplies and water management*

Appropriative sources, groundwater and drainwater provided most of the water supply used to manage the wetlands at the San Luis NWR before water through CVPIA became available.

Limited water supplies required the refuge to have minimal wetland acres and restrictive water management practices.

5. *Land use history* Please see attached map.

East of Highway 165

Identify habitat types specific to this refuge. Attach a refuge map showing habitat location and size

List refuge habitat-types with 5% or more of total acreage

Habitat type	*Original size*	*1992 acres*	*1997 acres*	*2010 acres*
Seasonal wetland – timothy (not irrigated)	0	0	0	0
Seasonal wetland – timothy (irrigated)	300	300	1526	2241
Seasonal wetland - watergrass	300	300	1018	751
Seasonal wetland –vernal pool	NA	NA	NA	NA
Permanent wetland	40	40	136	227
Semi-permanent wetland/brood pond	40	40	697	459
Riparian	1601	1601	3700	3700
Irrigated pasture	0	0	0	0
Upland	1596	1596	4665	4,690
Upland (not irrigated)	1536	1536	4665	4,690
Upland (irrigated)	30	30	0	0
Upland (crop lands)	30	30	0	0
Other (>5%)	0	0	0	0
Misc. habitat (<5%)	0	0	0	0
Sub-total – habitat acres	3877	3877	11742	12068
Roads, buildings, etc.	5	5	5	5
Total (size of refuge)	3,882	3,882	11,747	12,073

Describe refuge habitat-type water use characteristics

Habitat type	*AF/ac*	*# of irrigations*	*Flood date*	*Draw down date*
Seasonal wetland	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - timothy	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - watergrass	8.00	2	Aug-Nov	Feb-May
Seasonal wetland –vernal pool	NA	NA	NA	NA
Permanent wetland	10.00	NA	All year	NA
Semi-permanent wetland/brood pond	8.75	NA	Oct-Jan	Aug
Riparian				
Irrigated pasture	0	0	NA	NA
Upland (not irrigated)				
Upland (managed)	0	0	NA	NA
Upland (grains)				
Other (>5%)				
Misc. habitat (<5%)				

East Bear Creek Unit

Identify habitat types specific to this refuge. Attach a refuge map showing habitat location and size

List refuge habitat-types with 5% or more of total acreage

Habitat type	*Original size*	*1992 acres*	*1997 acres*	*2010 acres*
Seasonal wetland – timothy (not irrigated)	0	0	0	0
Seasonal wetland – timothy (irrigated)	0	0	0	715
Seasonal wetland - watergrass	0	0	0	0
Permanent wetland	0	0	0	0
Semi-permanent wetland/brood pond	0	0	0	0
Riparian	450	450	450	450
Irrigated pasture	500	0	0	0
Upland	3050	3550	3550	3550
Upland (not irrigated)	3050	3550	3550	3550
Upland (managed)				
Upland (grains)				
Other (>5%)				
Misc. habitat (<5%)				
Sub-total – habitat acres				
Roads, buildings, etc.				
Total (size of refuge)	0	0	4000	4000

Describe refuge habitat-type water use characteristics

Habitat type	*AF/ac*	*# of irrigations*	*Flood date*	*Draw down date*
Seasonal wetland	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - timothy	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - watergrass	8.00	2	Aug-Nov	Feb-May
Seasonal wetland –vernal pool				
Permanent wetland	10.00	NA	All year	NA
Semi-permanent wetland/brood pond	8.75	NA	Oct-Jan	Aug
Riparian	As needed	12	All year	NA
Irrigated pasture	0	0	NA	NA
Upland (not irrigated)				
Upland (managed)	0	0	NA	NA
Upland (grains)				
Other (>5%)				
Misc. habitat (<5%)				

West of Highway 165

Identify habitat types specific to this refuge. Attach a refuge map showing habitat location and size

List refuge habitat-types with 5% or more of total acreage

Habitat type	*Original size*	*1992 acres*	*1997 acres*	*2010 acres*
Seasonal wetland – timothy (not irrigated)	83	83	83	83

Seasonal wetland – timothy (irrigated)	1,057	1,057	1,057	1,037
Seasonal wetland - watergrass	65	65	65	109
Seasonal wetland –vernal pool	NA	NA	NA	NA
Permanent wetland	32	32	32	47
Semi-permanent wetland/brood pond	242	242	276	276
Riparian	3,100	3,100	3,100	3,100
Irrigated pasture				
Upland	5,663	5,663	5,932	5,932
Upland (not irrigated)	5,663	5,663	5,932	5,932
Upland (managed)				
Upland (grains)				
Other (>5%)				
Misc. habitat (<5%)				
Sub-total – habitat acres	10,242	10,242	10584	10,584
Roads, buildings, etc.	2	2	2	2
Total (size of refuge)	10,244	10,244	10,586	10,586

Describe refuge habitat-type water use characteristics

Habitat type	*AF/ac*	*# of irrigations*	*Flood date*	*Draw down date*
Seasonal wetland	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - timothy	8.00	1	Aug-Nov	Feb-May
Seasonal wetland - watergrass	8.00	2	Aug-Nov	Feb-May
Seasonal wetland – vernal pool				
Permanent wetland	10.00	NA	All year	NA
Semi-permanent wetland/brood pond	8.75	NA	Oct-Jan	Aug
Riparian				
Irrigated pasture	0	0	NA	NA
Upland (not irrigated)				
Upland (managed)	0	0	NA	NA
Upland (grains)				
Other (>5%)				
Misc. habitat (<5%)				

Section B - Water Management Related Goals and Objectives

1. *Describe the refuge mission relative to water management. (i.e. crop depredation, legislative mandates, service to landowners)*

The majority of purposes for San Luis NWR involve maintaining and improving habitat for wetland dependent wildlife species. In this highly managed and maintained system, efficient water management is critical to accomplishing these refuge purposes.

Purposes for the management units of the San Luis NWR:

On June 7, 1966 the Migratory Bird Conservation Commission, under the authority of the Migratory

Bird Conversation Act established the San Luis National Wildlife Refuge in Merced County, California. For lands acquired under the Migratory Bird Conservation Act (16 U.S.C. 715d), the purpose of the acquisition is "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds.

In 1969 the Kesterson National Wildlife Refuge (which is now a unit of the San Luis National Wildlife Refuge) was established. The enabling legislation for the refuge purpose states

"shall be administered by him [Secretary of the Interior] directly or in accordance with cooperative agreements .....and in accordance with such rules and regulations for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon..." 16 U.S.C. 664 (Fish and Wildlife Coordination Act)

"...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds 16 U.S.C. 715d (Migratory Bird Conservation Act).

2. *Describe specific habitat management objectives. Include pertinent information from refuge management plans*

The management goals and objectives of the San Luis NWR Complex include:

- Manage and provide habitat for endangered, threatened, and sensitive wildlife and plant species.
- Produce optimum habitat conditions for wintering waterfowl, waterbirds, and other migratory birds.
- Maintain and enhance the biodiversity associated with the Central Valley's plant communities.
- Provide an area for compatible recreational programs; which include environmental education, interpretation, wildlife observation, photography, hunting, and fishing; and management-oriented research and education/interpretation.

Seasonal Wetlands

Seasonal wetlands are inundated fields or ponds that are managed primarily to grow seed and to produce invertebrates for migratory waterfowl, shorebirds, and other wetland dependent wildlife. These wetlands are usually shallow, flooded October through March, and dry for the rest of the year except for summer irrigations. Some seasonal wetlands are inundated by early August, depending on the habitat required for early arriving waterfowl. Some seasonal wetlands may be kept inundated through April to provide habitat for migrants that do not depart to northern breeding habitats until that time.

Seasonal wetlands provide much of the life requirements for the primary migratory bird species for which the wildlife areas were acquired. These wetlands consist of two subtypes—leveled and unleveled.

Leveled seasonal wetlands are normally created by restoring wetlands from previously developed croplands. These lands were originally leveled by farmers using rough estimation in earlier years or laser levels more recently. Restoration may entail re-contouring a portion of the field to facilitate water flow, but most of the original contours are retained. All or part of the original levees and internal delivery ditches are usually incorporated into the unit design. This habitat subtype is easily managed to produce large quantities of waterfowl and shorebird food. Leveled seasonal wetlands have a fairly uniform water depth when inundated to the optimum elevation, not varying more than 1.5 feet and often varying less than 0.5 foot, within large ponds (40 acres or more). They are generally inundated levee to levee with little land surface above the water

other than loafing islands and the levees themselves. The construction of meandering levees and/or islands within these seasonal wetlands enhances the diversity of migratory bird usage.
Primary food production plant species found within this habitat type are watergrass (or wild millet), smartweed, swamp timothy, and alkali bulrush. Other plant species found in the leveled wetlands are cattails, hardstem bulrush, Baltic rush, cocklebur, jointgrass, spike rush, and other hydrophytes.

These shallow seasonal marsh areas provide feeding, loafing, and roosting habitat for a wide variety of waterfowl. They also provide all necessary habitat requirements for many species of shorebirds. Herons, egrets, white-faced ibis, and California gulls forage in seasonal wetlands and sandhill cranes loaf and roost in them. During the dry summer periods, many raptors, including northern harriers and Swainson's hawks, as well as mammalian predators forage for small mammals and other vertebrates in this habitat.

The unleveled subtype of seasonal wetlands (**natural basins, seasonally flooded channels, and vernal pools**) has greater variation in water depth and often deeper waters. The irregular topography and shorelines often combine to form a mosaic of open water, islands, stands of cattail/bulrush, shoreline points, and shallow flooded flats. Because of the varied water depth and reduced manageable acres in this subtype, seed production from moist soil food plants is greatly reduced. However, that same variation provides a greater diversity of aquatic plant species and different foraging substrates for a large array of waterfowl and shorebird species. The vernal pools produce dense populations of invertebrates that are heavily used by waterfowl and shorebirds during the pre-migration and nesting period. In addition, the islands and irregular shorelines of this habitat subtype generally provide a higher ratio of loafing sites to open water than any of the other habitat types described here.

Portions of the unleveled seasonal wetlands also provide excellent roosting and foraging habitat for geese and sandhill cranes. The shallow vegetated shorelines provide good habitat for many species of wading birds. Wetland plants within the subtype are similar to those in the leveled habitat. The adjacent upland portions are dominated by annual and perennial grasses (soft chess, beardless wild rye, saltgrass, and alkali sacaton), interspersed with native and introduced forbs.
The water requirements and scenario of water applications within seasonal wetlands varies, depending on the habitat subtype and type of plant foods desired. Vernal pools and some of the seasonally flooded channels will not receive any applied waters. The two most common scenarios for seasonal wetlands are for production of swamp timothy and watergrass, each having its own unique water requirements.

Swamp timothy. Production and management in an average water year would typically have the following water management pattern. Drawdown (draining of winter floodwater and drying of the soils) would occur in the last two weeks of March through the first two weeks of April. The soils dry and warm to allow germination of seeds and initial vegetative growth. A first irrigation, requiring approximately 0.75 foot of water, is applied sometime in the first two weeks of April through the first two weeks in May, depending on annual weather patterns and soil composition. A second irrigation to ensure heavy seed production and vegetative structure is applied during the last two weeks of May through the first two weeks of June. Swamp timothy is then left dry to let the plants mature and the seeds cure before fall. Fall flooding is initiated in September or October, depending on when wetlands are required for the migrating waterfowl. The initial inundation requires 2.0 feet of water. Over the two-month period of September and October, it takes 3.0 feet of water to cover the whole acreage. Part of the land is flooded in September and additional land is flooded in October. Approximately 0.5 foot of water must be applied to the seasonal wetland each month, November to March, — to maintain optimum water depth. This management scenario requires an annual average of 8.0 feet of water.

Mixed marsh (Watergrass) . Seasonal wetlands managed for watergrass (as the primary food plant) or other hydrophytes (such as smartweed) has the following pattern of water management and requirements in a normal year. Pond drawdown for watergrass germination can occur from early April through early May. The first irrigation is applied in late May or early June. This irrigation requires approximately 1.0 foot of water. Second and third irrigations require about the same amount of water as the first and are applied in late June and July. Again the crop is allowed to dry, promoting maturing and seed curing before fall flooding.

The next flooding of watergrass occurs between August and October. The August flooding (0.25 foot) of some seasonal wetland habitat is essential for early fall migrant waterfowl that start arriving in mid-August. A September flooding requires about 0.75 foot. Recent aerial surveys (1987-1991) have shown 80,000 to 95,000 waterfowl in the Grasslands by September 15. Thousands of migratory shorebirds may also be present during this period. The first flooding (about October) requires approximately 2 feet. An additional 0.5-foot every month after flood-up until March is required to maintain optimum foraging conditions. This scenario requires an annual average of 8.0 feet of water. Watergrass is sometimes cultured similar to rice with the ponds kept wet or flooded from the time the plants emerge until early spring. The water level is kept under the growing vegetation. This method produces much more vegetation and requires up to 50 percent more water to maintain. This also produces an abundance of invertebrates and crustaceans, thus providing both a food base and cover for a variety of resident bird species.

Semi-permanent Wetlands

Semi-permanent wetlands are kept flooded approximately 8 months or more of the year and are managed to provide wetlands when the expanses of seasonal wetlands are not flooded (summer). Water is maintained at greater depths in semi-permanent wetlands than in seasonal wetlands and this type is dominated by different organisms. The dominant plant species are cattails and hardstem bulrush with submerged vegetation, including sago pondweed and horned pondweed, in the open water area. Duckweed grows on the surface of these wetlands. Scattered black willows are established on the perimeter of these ponds. Most of the plant organisms found in seasonal wetlands are also found in small quantities in the shallow edges of semi-permanent wetland.

Semi-permanent wetlands provide production habitat for many species of resident waterbirds and foraging habitat for other wetland dependent wildlife. This habitat provides nesting, foraging, and roosting habitats for black-crowned night herons and marsh wrens; foraging and roosting habitat for egrets; nesting and roosting habitat for tri-colored blackbirds and white- faced ibis; brooding habitat for ducks; foraging habitat for raccoons and giant garter snakes; and summer marsh habitat for a host of other wetland dependent wildlife.

Water requirements for semi-permanent wetlands are significantly greater than that required for seasonal wetlands of a comparable size because they are flooded for a longer period each year and are maintained through the hottest, driest times of the year.

Ponds managed as semi-permanent wetlands in some years may be managed as seasonal wetlands in others and vice versa as a management technique to manipulate vegetation types and densities. This allows for greater diversity within the management unit as a whole.

Water required to manage semi-permanent wetlands will vary with the length and timing of inundation. Some ponds will be allowed to go dry as early as August as other seasonal wetlands are flooded, while other semi-permanent wetlands will require water February through November. Water requirements in a typical semi-permanent wetland in a normal water year will be approximately 0.5 foot during February and November, 0.75 foot during March, April, and October; 1.0 foot May through July; and 1.25 feet in August

and September, for an average annual total of 8.75 feet. These amounts vary slightly from wetland to wetland, so but the total annual average is approximately 3.5 feet.

Permanent Wetlands

Permanent wetland habitat includes two subtypes. One type (freshwater marsh) is wetland areas that are inundated year round, are not flowing, contain emergent vegetation, but do not support woody vegetation. A second type is freshwater lakes. Water depths in permanent wetlands are deeper than in seasonal wetlands but are still relatively shallow. Even in the freshwater lakes, water rarely exceeds 8 feet deep. When properly situated, permanent wetlands can act as reservoirs for supply to other habitats and can also be maintained through runoff from other habitats.

Vegetation in permanent wetlands is dominated by cattails and hardstem bulrush. Black willows grow in scattered groups on the edges of freshwater lakes. The margins of permanent wetlands support plants typical of seasonal wetlands. Submerged vegetation in the permanent wetlands is common and includes sago pondweed, wigeongrass, water milfoil, and horned pondweed.

Permanent wetlands provide habitat for numerous fish species such as striped bass, sunfish, catfish, and largemouth bass. Bullfrogs, western pond turtles, and giant garter snakes inhabit the edges of this habitat. White pelicans, double-crested cormorants, California gulls, and several species of diving ducks use these areas as resting and feeding places. Other benefits of permanent wetlands are very similar to those of semi-permanent wetlands.

Water requirements for permanent wetlands are similar to those of semi-permanent wetlands once they are filled. A typical permanent wetland in a normal water year will require approximately 0.5 foot, February and November; 0.75 foot, March and October; 1.0 foot, April through June; and 1.5 feet, July through September, for an annual total of 10 feet.

Croplands

Croplands are fields that are managed to produce food and cover crops that do not occur naturally and require more intensive farming to maintain than the food and cover produced in the wetland habitats. Croplands as managed on wildlife areas normally have three distinct subtypes, each having different water requirements and production objectives. The three subtypes are irrigated pasture, corn production, and small grain production.

One scenario of managing irrigated pasture is indicated here. Other management regimes are used at different times or by different agencies. The irrigated pasture may be managed to create tall (2- to 3-foot) dense nesting habitat during the spring months for ducks, pheasant, northern harriers, short-eared owls, other ground nesting birds, and mammals. The same pastures may be managed to produce short green grazing and loafing habitat for sandhill cranes and geese in the winter. The dual use will be accomplished through a closely controlled haying and/or livestock grazing program after each nesting season.

Vegetation within the irrigated pasture may consist of Dallas grass, perennial fescues, ryegrass, clover, vetch, and trefoil. This vegetation will require periodic irrigations through the long summer to remain vigorous. Typical annual water requirements for irrigated pasture are 0.5 foot, April and May; and 0.75 foot, March, June, July, and September. The average annual water requirement is 4.0 feet. Other management regimes within the irrigated pasture subtype may differ from the details presented here.

Corn production is labor intensive and requires considerable water. However, corn produces large quantities of high energy food (carbohydrates) used by seed eating wildlife. The primary reason the crop is grown is to feed sandhill cranes and geese during the winter. Additionally, blackbirds, mourning doves, pheasants, finches, ducks, meadow voles, deer mice, cottontails, ground squirrels, and many other species use the corn grain throughout the year. These species in turn are preyed upon by both avian and mammalian predators. Typical water requirements for corn are 1.5 feet in May (pre-irrigation and planting) and 1.0 foot each month in June through August. The average annual water requirement for corn is 4.5 feet.

Small grain production croplands are used to produce food and cover. The primary crops grown are barley, wheat, safflower, and vetch. All of these crops are planted in the fall or winter and produce good crops of high energy (carbohydrates) food using little water. These crops provide nesting and escape cover in the spring and summer. The same species that use the corn crop use these crops and obtain the same benefits, but the sandhill cranes prefer mowed corn. Also, the vetch and safflower are not heavily used by waterfowl as a source of food unless flooded. The advantage of small grains is that they provide fall green feed and diversity and can be produced with a minimum of water during a typical mild winter. These crops are rotated within the fields so the soils do not become depleted of nutrients by producing the same plants year after year. Water required for all of these plant species is 1.0 foot in late October or early November as a pre-irrigation to germinate the seed and start growth. The plants then grow using naturally occurring winter moisture until spring (March) when another 0.75-foot irrigation is applied to ensure heavy seed production. The average annual water requirement for small grain production is 1.75 feet.

The Service uses cooperative farming agreements to produce wildlife food on the cropland areas. Organic farming principles (crop rotation, green manure plowdown, natural fertilizers, integrated pest management, etc.) are mandated. Pastures and alfalfa crops are periodically hayed by the permittee, with a 4-6 inch growth left for the wintering flocks of sandhill cranes and geese. The small grains and corn are normally mowed or lightly disced for maximum use by the geese, cranes, and several species of ducks.

Riparian Habitat

Riparian habitat is permanent and semi-permanent wetland habitat along both natural or man-made water channels and their backwaters. Riparian habitat is found in association with the San Joaquin River, Bear Creek, Salt Slough, Mud Slough North, and Mud Slough South. Riparian habitat is managed to enhance the dense mixture of trees, shrubs, and streamside vegetation that naturally occurs. Native tree species indigenous to the vicinity are occasionally planted to accelerate the restoration of riparian habitats. Dominant plant species in the riparian corridors are black and sandbar willow, cottonwood, valley oak, buttonbush, atriplex, and wildrose. Subdominant riparian corridor vegetation includes burr reed, cattail, hardstem bulrush, rabbitsfoot grass, creeping wildrye, and many other species. The riparian corridors provide suitable habitat for a variety of resident and migratory passerine birds as well as various hawks, owls, egrets, and herons. The riparian habitat also supports raccoon, beaver, mink, muskrat, western pond turtles, and giant garter snakes.

Water to maintain riparian habitat is critical but is not managed. The habitat is dependent on the flows in the streams that support it, and no water is directly allocated or provided to the habitat except that which first passes through or is used in one of the other habitat types. However, because riparian habitat is very limited but crucial to many sensitive wildlife species in the San Joaquin Valley, it is essential to provide sufficient water to maintain it.

Natural Grass Uplands

Natural grass uplands are portions of wildlife areas that mostly have natural topography and support self-sustaining vegetation. They are managed to maintain the native vegetation and wildlife species they support. Common plant species found within the natural grass uplands are soft chess, filaree, tarweed, creeping wild rye, alkali sacaton, saltgrass, red brome, fescue, and meadow barley. This habitat supports deer mice, meadow voles, kangaroo rats, ground squirrels, long-tailed weasels, cottontail, coyotes, San Joaquin kit fox, horned larks, meadowlarks, and many other wildlife species.

No imported water is used in the natural grass upland except for that applied to seasonal wetlands that meander through them. This habitat is managed by controlled burns and closely controlled livestock grazing.

Fire and grazing are used to reduce non-native annual grass growth, increase native perennial grass vigor and seed production, enhance native forbs, and improve grazing and loafing conditions for sandhill cranes and geese. Other upland-dependent bird species, such as the long-billed curlew, mountain plover, and horned larks also benefit from burning and grazing.

3. Describe the strategies used to attain objectives listed above
On an annual basis conduct a review of the previous habitat management plan, which involves visiting each habitat unit to document accomplishments, establish needs and develop plans for the upcoming year and compile these findings to produce the next habitat management plan.

4. Describe constraints that prevent attainment of objectives and explain the effect on operations
The habitat planning process identifies a far greater workload than can be accomplished in a single year, given present funding, staffing and existing priorities. Typically, CVPIA budget cycles do not allocate water acquisition funding until six months into the fiscal year, preventing refuge managers from planning an entire year of habitat management and results in inefficient water use.

5. Describe the strategies used to remedy the constraints listed above
Continue to refine management techniques, to improve efficiency, and develop alternate/additional funding sources to help address present staffing and water limitations.

Section C - Policies and Procedures

1. Describe the refuge policies/procedures on accepting agricultural drainage water as supply
Upslope drainage water is mixed with the San Luis National Wildlife Refuge water supply because the Island C Canal, San Luis Canal, Santa Fe Canal, and Fremont Canal, which are used for San Luis NWR water deliveries, include upslope drainage water. In addition, Salt Slough which supplies water to the San Luis NWR via appropriative water rights also contains upslope drainage water.

2. Describe the refuge policies/procedures on water pooling, transfers, reallocations or exchanges
The refuge and US FWS has no policies or procedures on pooling, transfers, reallocations or exchange but follows those established by the CVPIA and in the water supply contracts.

3. Describe the refuge water accounting policies/procedures for inflow, internal flow and outflow
Refuge staff collects inflow data daily. Internal flow is monitored and controlled to meet established targets. Outflow is currently estimated. Water deliveries, groundwater use, the use of the refuge operational loss recovery system, and the use of appropriative water rights to Salt Slough are functions that are monitored by the refuge management staff.

4. Describe the refuge water shortage policies/procedures

Based on established refuge purposes (see B1) and the projected water supply, we will determine critical habitat needs, analyze existing water use records by both refuge unit and habitat type, to determine the amount, distribution and timing of each habitat to be flooded or drained.

Section D - Inventory of Existing Facilities

1. Mapping

Attach existing facilities map(s) that show points of delivery, turnouts (internal flow), and outflow (spill) points, measurement locations, conveyance system, storage facilities, operational loss recovery system, wells, and water quality monitoring locations. Describe in the body of the plan the information contained in each attached map

Please see the four attached maps – one each for the area East of Highway 165, the East Bear Creek Unit, the area West of Highway 165 and one for the refuge operational loss recovery system.

2. Water measurement

East of Highway 165

a. Inflow/deliveries

The San Luis NWR lands east of Highway 165 and excluding the East Bear Creek unit receive delivered water via the Island C Canal, by operating a operational loss recovery system and by exercising Appropriative Water Rights to the Salt Slough.

Total # of inflow locations/points of delivery 4

Total # of measured points of delivery 3

Percentage of total inflow (volume) measured during report year 100%

Delivering agency	*Conveyance facility*	*Measuring point*	*Refuge distribution facility*	*% of total inflow*	*Type of measurement*	*Measuring agency*
San Luis Canal Co./Henry Miller Reclamation District	Island C Canal	South Boundary of San Luis Unit	C Canal	95.8%	Water Meter	San Luis Canal Company and Refuge
San Luis Canal Co./Henry Miller Reclamation District	D Canal	South of Boundary of San Luis Unit	D Canal	Used only as an inflow point when C	Visual	San Luis Canal Company and Refuge

				Canal cannot be used		
Appropriative water rights to Salt Slough	Lift 1, San Luis Unit	Salt Slough intake	Lift Canal	2.1%	Water Meter and Logbooks	Refuge
Appropriative water rights to Salt Slough	Lift 5, San Luis Unit	Salt Slough intake	Lift Canal	2.1%	Water Meter and Logbooks	Refuge

b. Internal flow at turnouts

Total # of refuge water management units (units) 79

Total # of refuge water management unit turnouts 66

Total # of measured turnouts 15

Estimated percentage of total internal flow (volume) during report year that was measured at a turnout
The water conveyance system on the refuge is characterized by a large number of turnouts. The precise measurement of water flow at these locations is not a management priority.

Number of turnouts supplying more than one unit or not directly off delivery system 40

Measurement type	*Number of devices*	*Acres served*	*Accuracy (avg or range)*	*Reading frequency*	*Calibration frequency (months)*	*Maintenance frequency (months/days)*
Orifices						
Propeller	2	3531	±4%	Daily	San Louis Canal Company	Daily
Weirs						
Flumes						
Venturi						
Alfalfa valves						
Metered gates						
Other, stop-log and screwgates	222	3531	None	Monitored, not read	Daily, as needed	Variable according to season

3. Outflow

Outflow (AF/yr) Not known

Total # of outflow locations/points of spill 19

Total # of measured outflow points 8

Percentage of total outflow (volume) measured during report year One hundred percent is estimated.

Outflow point	*Measuring point*	*Type of measurement*	*Percent of total outflow (estimated)*	*Measuring agency*	*Acres drained*
Accipiter Slough			1	Refuge	110
Quail Slough			1	Refuge	5
Mallard Slough outlet to Salt Slough	Same	Weir/ mobile flow meter	12	Refuge	560
Nevada North	Same		3	Refuge	74
Deadman West Outlet	Same		21	Refuge	1326
Deadman at Lift #5 outlet	Same	Weir/mobile flow meter	21	Refuge	1326
SL001 (Moffit 1 West outlet)	Same	Weir/mobile flow meter	10	Refuge	352
SL037 (Chester Marsh outlet)		Weir/mobile flow meter	2	Refuge	28
Saw-wet Slough			2	Refuge	42
Outlaw Slough			2	Refuge	103
WB010 W (Blackjack Slough)	Same	Weir/Flow Meter	3	Refuge	80
Crane Flat			3	Refuge	120
(WB003 NW) Valley Marsh	Same	Weir/Flow Meter	3	Refuge	115
Pintail Flat			3	Refuge	130
Fiddleneck			2	Refuge	70
Oxbow Pond			2		25
Woody Pond			2		40
WB008 N (Snow Goose)	Same	Weir/Flow Meter	3		95
WB002 N (Raccoon Marsh)	Same	Weir/Flow Meter	4		100

East Bear Creek Unit

a. *Inflow/deliveries*

The East Bear Creek Unit receives water deliveries from the Stevinson Water District and the Merced Irrigation District via Bear Creek.

Total # of inflow locations/points of delivery 1

Total # of measured points of delivery 1

Percentage of total inflow (volume) measured during report year 100%

Delivering agency	*Conveyance facility*	*Measuring point*	*Refuge distribution facility*	*% of total inflow*	*Type of measurement*	*Measuring agency*
Stevinson Water District	East Bear Creek and the East Bear Creek Pumping Plant and Pipeline	East Bear Creek Pumping Plant	East Bear Creek Pipeline	100% From March through October	Meter	U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service
Merced Irrigation District	East Bear Creek and the East Bear Creek Pumping Plant and Pipeline	East Bear Creek Pumping Plant	East Bear Creek Pipeline	100% from November through February	Meter	U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service

4. Internal flow at turnouts

Total # of refuge water management units (units) 5

Total # of refuge water management unit turnouts 23

Total # of measured turnouts 0

Estimated percentage of total internal flow (volume) during report year that was measured at a turnout 0

Number of turnouts supplying more than one unit or not directly off delivery system 18

Measurement type	*Number of devices*	*Acres served*	*Accuracy (avg or range)*	*Reading frequency*	*Calibration frequency (months)*	*Maintenance frequency (months/days)*
Orifices						
Propeller						
Weirs						
Flumes						
Venturi						
Alfalfa valves						
Metered gates						
Other, stop-log and screwgates	One	715	NA	Daily	NA	Daily

5. Outflow

Outflow (AF/yr) Not known

Total # of outflow locations/points of spill 4

Total # of measured outflow points 3

Percentage of total outflow (volume) measured during report year One hundred percent is estimated.

Outflow point	*Measuring point*	*Type of measurement*	*Percent of total outflow (estimated)*	*Measuring agency*	*Acres drained*
EBC 2	Outlet structure	Weir/mobile flow meter	30%	U.S. Fish and Wildlife Service	179 (172 acres from unit 2 and 7 acres from unit 3)
EBC 4	Outlet structure	Weir/mobile flow meter	10%	U.S. Fish and Wildlife Service	119
EBC 5	Outlet structure	Weir/mobile flow meter	20%	U.S. Fish and Wildlife Service	158
EBC 1			40%		259

West of Highway 165

a. Inflow/deliveries

The San Luis NWR lands West of Highway 165 receive delivered water from the Grassland Water District via the Santa Fe Canal, San Luis Canal, and Fremont Canal.

Total # of inflow locations/points of delivery 3

Total # of measured points of delivery 3

Percentage of total inflow (volume) measured during report year 100%

Delivering agency	*Conveyance facility*	*Measuring point*	*Refuge distribution facility*	*% of total inflow*	*Type of measurement*	*Measuring agency*
Grasslands Water District	Santa Fe Canal	At Skeleton Weir	Refuge Santa Fe Canal	38%	Water Meter	Grasslands Water District
Grasslands	San Luis	Near refuge	Refuge San Luis	58%	Water Meter	Grasslands

Water District	Canal	boundary	Canal			Water District
Grasslands Water District	Fremont Canal	Near refuge boundary	Refuge Fremont Canal	4%	Screwgate	Grasslands Water District

6. *Internal flow at turnouts*

Total # of refuge water management units (units) 44

Total # of refuge water management unit turnouts 31

Total # of measured turnouts 0

Estimated percentage of total internal flow (volume) during report year that was measured at a turnout 0

Number of turnouts supplying more than one unit or not directly off delivery system 13

Measurement type	*Number of devices*	*Acres served*	*Accuracy (avg or range)*	*Reading frequency*	*Calibration frequency (months)*	*Maintenance frequency (months/days)*
Orifices (submerged screw gate)	One	369	NA	Daily during water season	NA	Daily
Doppler Radar	3	1552	±2%.	Daily during water season	NA	Daily
Other, stop-log and screwgates	107	1552	NA	Monitored, not read	Not calibrated	Daily

7. *Outflow*

Outflow (AF/yr) Not known

Total # of outflow locations/points of spill 18

Total # of measured outflow points 6

Percentage of total outflow (volume) measured during report year One hundred percent is estimated.

Outflow point	*Measuring point*	*Type of measurement*	*Percent of total outflow (estimated)*	*Measuring agency*	*Acres drained*
BG001 W (Lower Schwab)			21		339
FS014 N (Swan Lake)			5		83
Secret Slough			1		5
Crescent Lake			2		50
FS005 N (Zahms Lake)	Outlet structure at	Flow meter	6	U.S. Bureau	117

	cobble crossing	and weir		of Reclamation and U.S. Fish and Wildlife Service	
KN021 (West Gadwall Drain)	Outlet structure at San Luis Drain	Flow meter and weir	8	U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service	124
Windmill Pond			4		73
KN 009 (West Big Lake)	Outlet structure	Flow meter and weir	9	U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service	135
Horseshoe Pond			5		198
Curlew Flat			2		30
Three Partners			9		94
Midge Marsh			2		30
KN008 Sprig Lake			9		234
KN002 N (Widgeon Pond)	Outlet structure	Weir	9	U.S. Fish and Wildlife Service	141
North Teal		Weir	1		149
KN006 (West Teal)			1		65
Sand Slough	Channel at cobble road crossing	Flow meter	5	U.S. Fish and Wildlife Service	65
BG006 N (Triangle Pond)	Outlet structure	Flow meter and weir	1	U.S. Fish and Wildlife Service	20

8. *Identify the type and length of the refuge internal distribution system*

East of Highway 165

Miles unlined canal	*Miles lined canal*	*Miles piped*	*Miles – other*
21	0	0	0

Describe the location and types of identified leaks and areas of higher than average canal seepage, and any relation to soil type.

East Bear Creek Unit

Miles unlined canal	*Miles lined canal*	*Miles piped*	*Miles – other*
0	0	2.0	0

Describe the location and types of identified leaks and areas of higher than average canal seepage, and any relation to soil type.

West of Highway 165

Miles unlined canal	*Miles lined canal*	*Miles piped*	*Miles – other*
13	0	0	0

*4. Describe the refuge operational loss recovery system (**This exists East of Highway 165 – only**)*

Approximately 2652 acres of wetlands on the San Luis and West Bear Creek units of the refuge drain into Deadman Slough. This water is in turn pumped back into the refuge A canal which in turn supplies water to refuge wetlands via water control structures (weirs) that are constructed at turnouts off the canal.

Pump #	Location	HP
Lift Pump #4	Deadman Slough	25 HP
Lift Pump #6	Deadman Slough	30 HP

5. Groundwater

East of Highway 165

Describe groundwater availability, quality and potential for use

Groundwater Plan *No* ___X___ *Yes* _____.

Groundwater basin(s) that underlie the refuge

Name of basin underlying refuge	*Size (sq. mi.)*	*Usable capacity (AF)*	*Safe yield (AF/Y)*	*Management agency*	*Relevant reports*
San Joaquin Basin	13,500	80,000,000	Unknown	None	USBR

Identify refuge-operated deep wells

#	*Location*	*Status*	*HP*	*2003 (AFY)*	*Future plans*
Well #1	Lift Canal/San Luis Unit	Active	50	50	Electric power –

					and reasonable water quality maintain
Well #2	A-Canal/San Luis Unit	Active	40	50	Electric power – maintain in short term but water has high salinity so long term plan is to replace in new location
Well#3a	Lift Canal/San Luis Unit	Active	50	50	Electric power – and reasonable water quality maintain
Well#3b	West Bear Creek Unit at Fiddleneck Marsh	Active	75	40	Has to be powered by a mobile diesel motor but has reasonable water quality and location is good, so maintain
Well #4a	W.B.C. Unit at Pintail Pintail Flat	Active but scarcely used – see future plans column for reason	75	40	Available but pumping sand so only used in emergency water scarcity situation needs to be replaced in new more central location water quality is not good either as water is high in salinity
Well# 6	At Crane Flat and C Canal West Bear Creek Unit	Active	75	40	Has to be powered by a mobile diesel motor but has reasonable water quality and location is good, so maintain

East Bear Creek

Describe groundwater availability, quality and potential for use

Groundwater Plan *No* ___X___ *Yes* _____.

Groundwater basin(s) that underlie the refuge

Name of basin underlying refuge	*Size (sq. mi.)*	*Usable capacity (AF)*	*Safe yield (AF/Y)*	*Management agency*	*Relevant reports*
San Joaquin Basin	13,500	80,000,000	Unknown	None	USBR

Identify refuge-operated deep wells

#	*Location*	*Status*	*HP*	*2003 (AFY)*	*Future plans*
3	East Bear Creek Unit	Inactive	unknown	0	None at present. Reporting suggests that these wells are in poor condition and that the water quality available should they be rehabilitated is very poor

Section E Environmental Characteristics

1. Topography - describe and discuss impact on water management
The terrain is generally very flat; drainage via low flow channels in marshes must be created or enhanced.

2. Soils - describe and discuss impact on water management (please see attached map)
Soils can generally be characterized as poorly drained and alkaline. The soils in the valley basin, along the floodplain of the San Joaquin River, formed in mixed alluvium that is predominantly granite transported from the Sierra Nevada. Soils on the alluvial fans and the valley basin rim west of the river formed in mixed alluvium derived predominantly from sedimentary rock form the Coast Range Mountains. The water table is near the surface throughout the area.

Soil texture ranges from dense clay to sandy loam in the project area, with evidence of a total of 14 soil series. Local soils are calcareous and often salt affected. Trace element concentrations generally are within the range typical for western soils – generally low to moderately elevated.

Sandy soils in some units lead to water loss via seepage.

3. Climate

CIMIS-Station 56 - Los Banos, CA. (Jun 1988 - Nov 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
avg precip	1.66	2.07	1.51	0.61	0.42	0.06	0.04	0.03	0.14	0.49	0.69	1.26	8.9
avg. temp	55.5	61.3	67.4	72.3	80.1	87.1	92.4	91.7	88.1	78.1	65	55	74.5
max temp	59.2	65.5	73.8	77.9	88.6	91.2	91.2	106	106	82.4	71.7	60.1	81.1
min temp	48.7	58.8	59.2	66.4	72.5	81.5	48.7	87.5	48.7	73.3	58.3	50.2	62.8
ETo	1.08	1.87	3.73	5.45	7.42	8.05	8.57	7.5	5.61	3.84	1.89	1.06	56.1

Discuss the impact of climate, and any microclimates, on water management

Mild damp winters and long hot summers. While refuge objectives result in the majority of wetlands being flooded during the fall and winter (to mimic historic hydrologic patterns) those acres that remain flooded during spring and summer result in the greatest amount of water used per habitat acre.

4. *Water quality monitoring (attach water quality test result forms)*

The refuge conducts bi-monthly water quality monitoring at 51 locations which include inlets, outlets, and wetland units. Water quality monitoring conducted at these locations tests for specific conductivity, temperature, total dissolved solids, salinity, dissolved oxygen, and pH. When they are operational grab samples are also taken at each of the 8 well locations. The U.S. Bureau of Reclamation conducts water quality monitoring for the same parameters at 2 inlets and 3 outlets to the San Luis NWR under a project implemented with the Grassland Water District. The Westside San Joaquin Watershed Coalition conducts water quality monitoring at 26 locations (3 inlets and 23 discharge points) that encompasses the San Luis National Wildlife Refuge and a large contiguous area. Please see the attached Westside San Joaquin River Watershed Coalition Semi-Annual Monitoring Report dated June 15, 2010 (attached) or visit the Coalition website at http://www.sldmwa.org/sjv_drainage_auth_.htm

If the refuge has a water quality monitoring program complete this table

Analyses performed	*Frequency range*	*Concentration range*	*Average*
Specific Conductivity uS/cm			
Temperature			
TDS g/l			
Salinity ppt			
Dissolved Oyxgen (%)			
Dissolved Oxygen (mg/l)			
pH			

Discuss the impact of water quality on water management

Comprehensive water quality information is lacking, however, datasets are being established which will soon be adequate to assist with the development and enhancement of existing refuge habitat management plans. This information is now being collected across the full range of refuge water facilities and wetland types and preliminary data summary and analysis has been initiated.

What is known about delivered water supplies to the San Luis NWR suggests that water delivered to the refuge tends to exhibit a higher specific conductivity and higher TDS as one moves from East to West. The concerns over water quality remain a constraint when balancing the ecological needs of waterbird species against the possibly deleterious effects of salts and other contaminants found in delivered water supplies. For example, a slow drawdown rate on seasonal wetlands is generally thought to maximize the duration of exposure of foraging areas (mudflats) that are important feeding areas for shorebirds. However, a slow drawdown will also cause greater salt deposition into soils and a faster drawdown is favored to avoid excessive salt deposition.

Section F Transfers, Exchanges and Trades

Provide information on any transfers, exchanges and/or trades into or out of the refuge

From whom	To whom	Report year (AF)	Use
None	None	0	
	TOTAL	0	

Section G Water Inventory

See Tables

Please see the three attached tables – one each for the area East of Highway 165, the East Bear Creek Unit, the area West of Highway 165.

Section H Critical Best Management Practices

Describe the 5-year implementation plan and the proposed 3-year funding budget.

1. *Management programs*
   a. *Education*

Program	Estimated cost (in 1,000s)				
	2011	2012	2013		
Write Refuge Brochure	5 K				
Public Events	5K	5K	5K		
Student Tours	2K	2K	2K		
Educational Materials	2K	2K			
Staff Meetings/Informal Sessions	2K	2K	2K		
Water Management Courses	2K	2K	2K		

1. Complete a general San Luis National Wildlife Refuge Complex brochure, which includes San Luis NWR, Merced NWR and San Joaquin River NWR, which includes a section on water management and water supplies.

2. On an annual basis assist the Water Education Foundation with tours of the Refuge Complex wetland and water conveyance systems and assist with tours associated with the San Joaquin River Restoration.

3. Complex staff will participate in public events with a focus on natural resources such as the opening of the San Luis National Wildlife Refuge Complex Administrative Facility and Visitor Center (summer 2011) and the Wild on Wetlands Festival in Los Banos. These outreach events will include messages on water management and water supplies.

4. Complex staff will continue to provide student tours on refuge units and include messages on water management and water supplies.

5. Produce education materials for the public which include a water management theme for natural resources at the Complex.

6. On an annual basis have Assistant Refuge Managers, Wildlife Biologists, Irrigators and other staff review current and potential best management practices for water management at the San Luis National Wildlife Refuge Complex.

7. Periodically, send Complex staff to water management training courses.

Describe the specifics of each program (number of participants, topics, purpose, etc.) and attach program materials, if available.

b. Water quality monitoring

Type of water	*Existing Estimated cost (in $1,000s)*		
	2011	*2012*	*2013*
Surface – USBR and riparian	30	30	30
Upslope drain			
Groundwater	2	2	2
Outflow	10	10	10

Short description of existing or planned program – i.e., required by which agency, coordinated with whom, constituents monitored and frequency

The refuge conducts bi-monthly water quality monitoring at 51 locations which include inlets, outlets, and wetland units. When they are operational grab samples are also taken at each of the 8 well locations. The U.S. Bureau of Reclamation conducts water quality monitoring at 2 inlets and 3 outlets at the San Luis NWR under a project implemented with the Grassland Water District.

The known or potential water quality issues for Refuge Complex discharges include those associated with boron, selenium, salts, nutrients, dissolved oxygen and planktonic algae (measured as chlorophyll a and pheophytin). Wetlands in the Grasslands area of the San Joaquin Valley have been implicated as a potential cause or source of elevated levels of salts, dissolved oxygen depleting nutrients and seed algae in the San

Joaquin River. The San Joaquin River, Mud Slough and Salt Slough are listed on the Central Valley Regional Water Quality Control Board 303d list of Impaired Water bodies as salt impaired and wetlands are specifically listed as a potential source for salts in the San Joaquin River, Mud Slough and Salt Slough. Mud Slough and Salt Slough are receiving waters for San Luis NWR drainages and both are tributaries of the San Joaquin River

Monitoring program objectives have previously been stated in both the Watershed Evaluation Report (WER), March 2004 and the Monitoring and Reporting Plan (MRP), March 2004 (Both produced by the U.S. Fish and Wildlife Service) and are consistent with the requirements of the Conditional Waiver of Waste Discharge Requirements for the Discharges from Irrigated Lands within the Central Valley. The most significant objectives from the WER and MRP, restated here, also address the need for a quality of monitoring that will facilitate loading calculations for important water constituents such as salt and boron.

Monitoring Program Objectives:

1.) Characterize major discharges from the Refuge Complex both in terms of water quality and flows

2) Characterize major inputs of water to the Refuge Complex both in terms of water quality and flows.

3.) Document both wetland and upland management actions on the Refuge Complex

4.) Continue to apply Best Management Practices on the Refuge Complex as stated in the WER.

c. Cooperative efforts

The U.S. Fish and Wildlife Service has partnered with the U.S. Bureau of Reclamation and the Grassland Water District in the implementation of a three-year water quality and water quantity monitoring study. The objectives of the study are to monitor the volume of water, as well as salt load, of major water sources entering the wetlands of the Grassland Resource Conservation District (GRCD) and major outflows draining from the region.

In addition, the San Luis NWR Complex regularly partners with academic institutions and and public sector agencies to monitor abiotic and biotic components of wetland, upland, and riparian habitats on the refuge complex. There are several such studies being conducted at the San Luis National Wildlife Refuge at the present time.

d. Pump evaluations (mobile labs)

Total number of groundwater pumps on refuge 8

Total number of surface water (low-lift) pumps on refuge 11

Groundwater pumps	*Estimated cost (in $1,000s)*		
	2011	*2012*	*2013*
# of groundwater pumps tested	2	2	2
# of pumps to be fixed or replaced	10	10	10
# of low-lift pumps to be tested	2	2	2
# of pumps to be fixed or replaced	10	10	10

e. Policy evaluation

The Complex staff reviews policy and how it can achieve optimal water management on the refuge units on an annual basis. A common comment is the need for the ability to change USBR pre-determined/scheduled monthly quantities so that the refuge can use the available supply in response to unpredictable weather conditions and changing habitat needs.

4. Water management coordinator

Name: Kim Forrest *Title:* Refuge Manager

Address: *P.O. Box 2176, Los Banos, CA 93635*

Telephone: 209-826-3508 *E-mail:* Kim_Forrest@fws.gov

Section I Exemptible Best Management Practices

Describe the 5-year implementation plan and the proposed 3-year funding budget.

1. Improve management unit configuration

Unit name	*Current acres*	*Reason for change*	*Proposed acres*	*Estimated cost (in $1,000s)*		
				2011	*2012*	*2013*
South Marsh 2	*90*	Improve water retention through construction of dike	*90*	*6*		
Dickenson 2/5	111	Improve ability to irrigate unit by removing levee	111		5	
Chester Marsh	35	Improve water retention of unit	35			6
Moraga 1	50	Remove levee	70			4
East Bear Creek Units 001-004	446	Improve ability to flood and drain through selective earthwork with scraper and bulldozer	250	4	8	8

2. Improve internal distribution system

a. New control structures within distribution system

Proposed location	Type of structure	Reason for new structure	Estimated cost (in $1,000s)		
			2011	2012	2013
SL038	Weir	Improve drainage	5		
SL053	Weir	Improve turnout			5
KN018	Weir	Improve drainage		5	
SL066	Weir	Improve turnout	6		
FS005	Weir	Improve inlet		5	
FS003 & FS004	Weirs	Improve inlets			10

KN012	Weir	Improve outlet		5	
SL003	Weir	Improve drainage	5		
SL030	Weir	Improve drainage			5
SL048	Weir	Improve drainage	5		
SL005	Weir	Improve turnout		5	
KN021	Weir	Improve inlet			5
BG004	Weir	Improve outlet	5		
BG008	Weir	Improve inlet		5	
FS008	Weir	Improve inlet			5
KN005	Weir	Improve inlet	5		
WB015	Weir	Improve inlet		5	
KN010	Weir	Improve drainage			5
WB017	Weir	Improve inlet		5	
C canal	Inline structures (3)	Improve water delivery management	15		
E canal	Inline structures (9)	Improve water delivery management			45
D canal	Inline structures (3)	Improve water delivery management	15		
San Luis Canal	Inline structures (6)	Improve water delivery management		30	
Proposed location	Type of structure	Reason for new structure	Estimated cost (in $1,000s)		
			2011	2012	2013
EB001	Weirs (3)	Improve water level management	15		
EB002	Weirs (5)	Improve water level management		25	
EB003	Weirs (1)	Improve water level management			5
EB004	Weirs (3)	Improve water level management	15		
Moffitt 5 ditch	Weirs (2)	Improve water level management		10	
Lift 4 canal	Weirs (2)	Improve water level management			10
Lift canal	Weirs (2)	Improve turnouts	8	8	
A Canal	Weirs (3)	Improve turnouts	10		5

b. Line/pipe sections of distribution system

Proposed reach/sect.	*Reason for new structure*	*Estimated cost (in $1,000s)*		
		2011	*2012*	*2013*
EBC005	Improve conveyance to managed riparian habitat			50

c. Independent water control for each unit

Proposed control point	*Reason for new control point*			*Estimated cost (in $1,000s)*		
				2011	*2012*	*2013*
East Bear	Review section for independent			5		

Creek	water control of units - ongoing					
East of Highway 165	Review section for independent water control of units - ongoing				5	
West of Highway 165	Review section for independent water control of units -ongoing					5

d. New internal distribution sections (pipe, canal) to provide water to existing and new habitat units

Proposed new section	*Units served*	*Reason for new section*	*Estimated cost (in $1,000s)*		
			2011	*2012*	*2013*
East Bear Creek pipeline from San Luis Unit (Island C canal) to existing East Bear Creek pipeline	EB001 EB002 EB003 EB004 EB005	Secure water quantities are not currently available to convey to the East Bear Creek pumping plant and pipeline during the months of November - February	50	100	100

3. Develop a Water Use Schedule: Please see attached schedules

Plan element	*Completion date*	*Estimated development/update cost (in $1,000s)*		
		2011	*2012*	*2013*
Flood-up dates by unit	Complete			
Drawdown dates by unit	Complete			
Irrigation dates by unit	Complete			

4. Plan to measure outflow

Identify locations, prioritize, determine best measurement method/cost, submit funding proposal

	Estimated cost (in $1,000s)		
	2011	*2012*	*2013*
Identify locations	2		
Estimate outflow quantity/rank	2		
Develop plan		10	
Estimate construction start date			5
Estimate construction completion date			5

5. (GRCD only) ~~Incentive pricing~~

6. Construct and operate operational loss recovery systems

Proposed location	*Reason for improvement*	*Estimated cost (in $1,000s)*		
		2011	*2012*	*2013*

Retrofit lift 6 for water meter	Better understanding and management of water operational loss recovery system	15		
Repair Lift 5	Pump needs to be pulled, inspected, and repaired as necessary		20	
Remove and Service Lift 4	Pump needs to be pulled and inspected, and repaired as necessary			15

7. *Optimize conjunctive use of surface and groundwater*

Proposed production/injection well	*Anticipated yield*	*Estimated cost (in $1,000s)*		
		2011	*2012*	*2013*
Well maintenance and repair (6 wells)	300 Acre Feet			120
Maintain diesel motors to operate deep wells (2)	250 Acre feet	10	10	
Repair Lift 2A	Pump needs to be pulled, inspected, and repaired as necessary		15	
Repair Lift 2B	Pump needs to be pulled, inspected, and repaired as necessary		15	
Remove and Service Lift 3	Pump needs to be pulled and inspected, and repaired as necessary	15		
Remove and Service Lift 1	Pump needs to be pulled, inspected, and repaired as necessary		15	

Explore a conjunctive use program if appropriate at the refuge. Continue to manage surface and groundwater in a coordinated way so as to meet current and future demands and achieve increased water supply. This may involve developing programs with neighboring groundwater users. Explore the ability and potential water management value of this BMP with the Bureau of Reclamation during the reporting period ending in FY 2013.

8. *Facilitate use of available recycled urban wastewater that otherwise would not be used beneficially, meets all health and safety criteria, and does not cause harm to wildlife management goals.*

Explore the ability and potential water management value of this BMP with the Bureau of Reclamation during the reporting period ending in FY 2013.

9. *Mapping*

GIS map layers	*Estimated cost (in $1,000s)*		
	2011	*2012*	*2013*
Improve water conveyance infrastructure maps	10		
Develop/enhance/finalize vegetation GIS Layer	5	10	

Develop/enhance/finalize riparian GIS Layer			10

10. CALFED Quantifiable Objectives

Describe any past, present, or future plans that address the goals identified for this refuge

CalFed quantifiable objectives: The CalFed Bay-Delta Program is a cooperative effort among state and federal agencies and the public to ensure a healthy ecosystem, reliable water supplies, good quality water, and stable levees. Quantifiable Objectives represent an approximation of the practical and cost-effective contribution irrigated agriculture or refuges can potentially make towards achieving CalFed's Quantified Target Benefits. These benefits include reducing salinity of return water, reducing nonproductive evapotranspiration, conjunctive use, reducing selenium and boron concentrations, and increasing additional river flows. The following CAL-FED quantifiable objectives have been identified for the San Luis NWR: describe actions that provide additional flow to San Joaquin River (TB 148), describe actions that reduce salinity at Vernalis. (TB 154), and describe actions that reduce nonproductive ET (TB 157).

To meet these objectives the following management practices will be employed and examined for use to both improve the water management efficiency and water quality at the refuge. These include policies, programs, practices, or uses of devices that allow refuge managers to more efficiently manage both their limited water amounts for migratory birds and other trust species as well as improving water quality. Some BMPs are considered the basic elements of good refuge habitat management. Restraints or cost of course make some BMPs difficult if not impossible to attain.

1. Delivery timing: Improve delivery timing to avoid water "stacking" or other inefficient water storage procedures. Refuge Progress: Staff works to achieve this goal in most instances, but there are times of the year when water stacking is an unavoidable measure taken to maintain adequate habitat during the late December/early January period.

2. Control of individual management units: Provide independent water control for each wetland unit. This action involves the improvement of control structures to improve habitat, water distribution, and assist with other refuge objectives. Specifically, may involve the addition of water control structures or the construction of shallow swale drains through ponds.

3. New and old control structures: Determining whether modifications to canals, pipelines, or gates would improve habitat, water distribution, and assist with other refuge objectives. New structures can increase water efficiency at refuge units and replacement of worn and leaky water control structures maintains and increases water efficiency. Roughly ten percent of the refuge water control structures, mostly risers, are usually replaced every year, resulting in a complete turnaround every 10 years.

4. Lining or piping sections of the distribution system: This action may increase distribution system flexibility and capacity; decrease maintenance; and reduce evaporation losses and seepage from earthen ditches and canals.

5. New internal distribution sections (such as a pipe or canal) to provide water to existing and new habitat units: For refuge units that cannot receive the quantity of water necessary at the correct time. May involve a new or improved delivery system sections to create better habitat, water distribution, and assist with other refuge objectives.

6. Interagency coordination: Coordinate water use and habitat and species maintenance goals with other refuges with the region. These cooperative efforts may be with federal or state agencies, other refuges, agricultural and urban contractors, public interest groups, and neighboring landowners. Programs include water supply trades based on water year precipitation, pooling of water supply or training programs.

7. Contour dikes: Install contour dikes to compensate for variable depth, where such practice is cost-effective and compatible with management objectives. This BMP is of limited value to refuges because it is not a cost-effective practice for FWS to implement or to meet its natural resource objectives. Existing variable depths in refuge wetlands, in most cases, are the desired situation, helping staff to manage the most diverse habitat for a diverse list of migratory birds.

8. Monitoring: Water management plans are updated annually by Complex staff and include the effectiveness of water use so that decisions can be modified in the future to improve water efficiency.

9. Leveling units: Level moist soil units, where appropriate, to increase production of high carbohydrate forage per unit of water applied. Practice may be limited by biodiversitv and endangered species concerns and management objectives. Refuge wetland units usually have varied depths to meet several different refuge management objectives.

10. Pond bottom contours: Increase the unevenness of bottom contours to improve wetland productivity. Most refuge wetland units have varying depths but the Complex will examine this option for several wetland units.

11. Internal conveyance: Improve the efficiency of delivery by reducing evaporation via vegetation control. Reduce seepage from delivery ditches where appropriate (i.e., where not required for riparian vegetation management).

12. Unproductive areas: Manage unproductive units, or those that consistently use more water than others, as uplands to conserve water. Annually review water holding capacity of wetland units.

13. Conjunctive use: Implement a conjunctive use program if appropriate. Managing the two sources in a coordinated way so as to meet current and future demands and achieve increased water supply. This may involve developing programs with neighboring groundwater users. All refuge units in the local area are currently being evaluated in a comprehensive groundwater study, conducted by CH2M-HiII, to see if there are further conjunctive use opportunities for state, federal, and private wetland areas.

14. Pump efficiency evaluations: Achieve maximum efficiency at pumps and control points. A program to evaluate and improve the efficiencies of such pumps may result in energy savings, peak load reductions, or reveal capacity limitations due to inefficient facilities. Pump replacement may allow the reduction of operational costs and improve operational efficiency; making currently unused water supplies cost-effective. Deep will pumps are periodically checked to achieve maximum efficiency. Electrical energy rates are periodically reviewed to assure cost effectiveness of pump operations.

15. Water measurement: Achieve a better knowledge of volumes of water delivered to the refuge boundary and moved within the refuge to improve water management planning and management.

16. Water Quality Monitoring: Applies to refuges that rely on groundwater, upslope drainwater, or poor quality surface water (potential constituent problems include salts, boron, arsenic, selenium, or pesticides).

The refuge may be in a drainage problem area or where outflow spill water quality is a concern, where these constituents may adversely affect habitat quality.

17. Water recirculation and cycling: Explore water re-use programs within the wetland units of the refuge. Several wetland units currently make use of water from upslope wetland units.

18. Education: Either sponsoring or conducting educational seminars/workshops for refuge staff or public. Examples include information on weather, habitat characteristics and water delivery scheduling, and water distribution planning. Preferably involves technical experts, if available, and may rely on local, state, or federal agencies such as the Agricultural Research Service and U.C. Cooperative Extension. Workshops can be used to communicate the importance of specific conservation plans, describe conservation procedures that refuge staff can utilize, or provide a forum for refuge staff to exchange ideas and experiences. In addition, two full-time refuge staff spends the majority of their time consulting with private wetland owners regarding optimizing habitat and the best management of the limited resources; as well as forming funding partnerships to implement these actions. Staff participates in the yearly landowner meetings held at the Grassland Water District. Occasional agency/conservation group "wetland workshops" are held every few years to share ideas, describe successful programs, problem-solving, etc.

19. Policy evaluation: Changes to the rules and regulations of the refuge's water suppliers and/or conveying entities that would allow for more efficient water use and operations. Water Projects (CVP, SWP, etc.) provide water based on policies that sometimes make refuge management more difficult. For instance, policies that require scheduling water months in advance or that restrict carry-over of unused water, can encourage unnecessary water use. Other examples include restrictions on timing and duration of deliveries or limited flexibility in scheduling changes.

20. Water shortage contingency planning: These plans address ways that maintain habitat during reductions in normal supply of up to 50 percent.

21. Improving management unit configuration: Evaluating whether modifications to units would improve habitat, water distribution, and assist in other refuge objectives.

22. Automate water distribution system: May increase flexibility in water deliveries and increase the refuge's control over its water supplies, thus providing the opportunity to improve the efficiency of water use. This has not been used extensively in wetland management due to the high expense involved in instituting the equipment. Also, the most effective marsh management requires someone to be on the site evaluating that particular day's habitat condition and the necessary amount of water application.

23. Measurement: A plan to measure outflow to determine the amount of water leaving the refuge using methods or devices that are operated and maintained to a reasonable degree of accuracy, under most conditions, to +/-20.

24. Construct and operate operational loss recovery systems: May involve the design and construction of interceptor systems designed to capture and transport operational spills throughout a refuge internal distribution system.

25. Mapping: Developing and maintaining detailed maps which delineate the refuge's distribution system, water control structures, canals, pipelines, outflow locations, and measurement device locations.

26. Annual Water Quality Meetings and BMP Updates: Initiate annual water quality meetings among the federal and state agencies to discuss monitoring efforts, studies, management actions, and to update this plan.

27. Conduct Studies of Water Needs of Different Wetland Types: Investigate the actual water needed for managing various wetland types as well as the drainwater produced by each.

28. Conduct Studies of the Quality of Water Used in Wetland Management: Document the water quality of incoming and outgoing water on wetland units to ascertain if wetland management changes water quality.

29. Conduct Water Quality Studies of Drainwater from Different Wetland Sub-Units of the Refuge. Ascertain if the water quality of drainwater varies and to what extent through the Refuge to identify if specific problem areas exist.

30. Work with Water Districts to Improve Water Quality: Partner with water districts to identify water quality issues of delivered water and develop corrective actions where feasible.

31. Cap Wells with Water Quality Issues: Close wells in the refuge where water quality issues have been identified.

If reducing nonproductive ET involves removing invasive plants, complete the following:

Invasive unwanted species name	Estimated acres			*Estimated cost (in $1,000s)*		
	2011	*2012*	*2013*	*2011*	*2012*	*2013*
Perennial pepperweed	1000			40		
Perennial pepperweed		1000			40	
Perennial pepperweed			1000			40

San Luis NWR, Grassland Resource Conservation District

1. Describe actions that reduce salinity in the San Joaquin River, Grassland Marshes and Mud and Salt Sloughs. (TB 95, 96, 98)
2. Describe actions that reduce salinity in the Grassland Marshes and Mud and Salt Sloughs. (TB 102, 103, 104) (All of these six contaminant TBs could be incorporated into one Refuge manager response, e.g. addressed through the Grassland Drainage Program.

Response to questions one and two. The U.S. Fish and Wildlife Service is an active participant and partner in the Grassland Bypass Project. The Service supports this project through biotic and abiotic monitoring and by permitting drainage water from the Grassland Bypass Project to be drained into refuge waterways (Mud Slough) thereby bypassing the Grasslands Ecological Area via the San Luis Drain.

The U.S. Fish and Wildlife Service maintains appropriative water rights to Salt Slough and execrcises these rights judiciously so as to permit maximal dilution of slough water during low flow periods and so as to avoid salt and contaminant deposition on Service lands during periods of high TDS in this system.

3. Describe actions that reduce nonproductive ET. (TB 107)

The U.S. Fish and Wildlife Service prioritizes the control of perennial pepperweed on the San Luis National Wildlife Refuge and applies spot treatment of the herbicide Telar over approximately 1000

acres per annum to halt the spread and to diminish the occurrence (distribution and abundance) of this pernicious weed over the landscape. Prescribed fire, grazing of sheep and cattle, and mechanical control are also control methods that are used to reduce the impacts of this species.

Section J BMP Exemption Requests

For each BMP for which the refuge is seeking an exemption, provide a detailed narrative and complete the summary table

Summary of BMP exemptions

BMP	*Constraint*[1]	*Outstanding Need*[2]
		N/A

1. *Constraint – list existing constraint. Use additional rows for multiple BMPs or constraints. Identify Legal (L), Environmental (EN), or Economic (EC) issues using code. If the BMP is not seen as beneficial, provide detailed information*
2. *Outstanding need – identify assistance required to implement the BMP. State specific funding or other assistance required*

Provide a detailed exemption request below for each BMP listed in the summary table

Non-Applicability (N/A) of Exemptible BMPs

To establish that a BMP is not applicable to the Refuge, the Plan should explain the reasons why the BMP does not apply to the Refuge. This justification must be consistent with Section A of the Criteria titled, "Background." Examples of non-applicability for each exemptible BMP are listed below. This list is not all-inclusive.

Section I, B. Exemptible Best Management Practices

2. Improve the Distribution System
b. Line/pipe sections of distribution system
NA if the Current system can distribute water effectively with regular maintenance and on-going improvements to open channels – thus maximizing habitat.

6. Construct and operate operational loss recovery systems
NA if system is completely piped and there are no spill points.

7. Optimize conjunctive use of surface and groundwater NA
NA is there is no usable groundwater

8. Facilitate use of available recycled urban wastewater that otherwise would not be used beneficially, meets all health and safety criteria, and does not cause harm to wildlife management goals.
NA is no recycled urban wastewater is available

Flood-up Schedule
Kesterson, Freitas, and Blue Goose Units

WETLAND UNIT	ACRES	PROPOSED FLOOD DATE	CUMULATIVE ACRES	% OF TOTAL FLOODED
Swan Lake	83	Permanent		
Windmill Pond	30	Permanent	113	7
Sprig Lake	121	Aug . 25		
Beaver Pond	6	Sept. 1		
Redhead Pond	31	Sept. 1		
Eastside Slough	23	Sept. 5		
Zahm Lake Lower	4	Sept. 10		
E&W Three Partners	28	Sept. 10		
North Sprig	19	Sept. 10		
Secret Slough	5	Sept. 15		
Big Lake Channel	20	Sept.15		
East Big Lake	62	Sept. 20		
Wigeon Pond	17	Sept. 20		
Gallinule Pond	5	Sept.25		
Curlew Flat	30	Sept. 25	484	31
West Teal	65	Oct. 1		
80 Club		Oct. 1		
South Shoveler	120	Oct. 1		
Gadwall	70	Oct. 5		
Rail Pond	60	Oct. 5		
West Big lake	45	Oct. 5	844	54
West Gadwall	26	Oct. 10		
Stilt Lake	56	Oct. 10		
Southeast Windmill	20	Oct.10		
North Shoveler	97	Oct. 10		
North Teal	44	Oct. 10		
Willow Pond	30	Oct. 15		
South Teal	105	Oct. 15		
East Gadwall	13	Oct.15		
North Gadwall	15	Oct. 20	1250	80
Schwab	60	Oct. 25		
South Slough	20	Oct.25	1330	85
Zahm Pond Upper	15	Nov. 1		
Crescent Lake	13	Nov. 1		
Midge Marsh	30	Nov. 1		
Coyote Flat	36	Nov. 5		
Triangle Pond	7	Nov. 10		
Mink Marsh	40	Nov.15		
Horseshoe Pond	18	Nov. 20	1489	95
Bittern Pond	4	Dec. 1		
Avocet Pond	15	Dec. 1		

N & S Muskrat	6	Dec. 15		
Middle Teal	15	Jan. 15		
Long Lake	37	Feb.1	1566	100
	1566		1566	100

Flood-up Schedule
San Luis Unit

WETLAND UNIT	ACRES	PROPOSED FLOOD DATE	CUMULATIVE ACRES	% OF TOTAL FLOODED
Deadman Slough	39	Permanent		
South Marsh 3 west	23	Permanent		
East Teal	20	Permanent		
S Marsh 4S (Winton)	10	Permanent		
Mallard Slough D/E	30	Perm/Riparian		
Mallard Slough 6	8	permanent		
Sousa 9 middle	26	Permanent	156	6
Check Sta Marsh	36	Sept. 5		
East Marsh Channel	60	Sept. 5		
East Marsh N&S	65	Sept. 10		
Yokuts N & S	.	Sept. 10		
Mallard Slough A	6	Sept. 15		
Mallard Slough B	35	Sept.15		
Santa Rita West	20	Sept. 15		
Moffit 3	94	Sept. 15		
Loaf Lake	114	Sept. 20		
Moffit 6 South	25	Sept. 20		
Yokuts West	25	Sept.20		
Mallard Slough C	12	Sept. 20		
Moffit 6 North	28	Sept. 20		
Big Lake	211	Sept. 25		
Moffit 1 E&W	14	Sept. 25		
Moffit 5	56	Sept.25		
Moffit 2	58	Sept. 25		
North Marsh	225	Oct. 1	957	37
Moraga 3	53	Oct. 1		
Chester Marsh	28	Oct. 1		
North Ruddy	30	Oct. 1		
Dickenson 3	42	Oct.1		
Santa Rita North	35	Oct. 5		
Moraga 2	24	Oct. 5		
Dickenson 2/5	111	Oct. 5		
Dickenson 6	64	Oct. 10	stage flood-benches Nov 1	
East Ruddy	32	Oct. 10		
Moraga 1	25	Oct.10		

Flood-up Schedule West
Bear Creek Unit

WETLAND UNIT	ACRES	PROPOSED FLOOD DATE	CUMULATIVE ACRES	% OF TOTAL FLOODED
Moffit 7	2	Oct. 10		
Dickenson 4	54	Oct. 15		
Souza South	56	Oct. 15		
Moffit 4	51	Oct. 15		
South Marsh 1	62	Oct. 15		
Souza North	115	Oct. 20		
West Ruddy	30	Oct. 20		
Middle Teal	25	Oct. 20		
South Marsh 4 N	26	Oct.25	2105	82
South Marsh 3 E	80	Nov. 1		
Santa Rita East	38	Nov. 1		
Horseshoe Ponds	10	Nov. 5		
Moffit 8	92	Nov. 10		
Sousa Forest	36	Nov. 20		
Accipiter Slough	18	Nov. 20		
Saw Whet Slough	4	Nov. 20		
Moorhen Marsh	10	Nov. 20	2393	93
West Teal	20	Dec. 1		
South Marsh 2	60	Oct. 10		
Mallard Oxbow	5	Dec. 20		
Grosbeak Slough	1	Jan. 5		
Sunflower Slough	10	Jan.20		
Cottonwood Slough	7	Jan. 20		
Nevada North	40	Feb. 1		
Nevada South	34	Feb. 1	2570	100
	2570		2570	100

Flood-up Schedule
East Bear Creek Unit*

WETLAND UNIT	ACRES	PROPOSED FLOOD DATE	CUMULATIVE ACRES	% OF TOTAL FLOODED
Channel 1		Under Restoration	Not Available	Not Available
Channel 4		Jun. 1	119	27
Channel 2		Aug. 15	158	35
Channel 3		Aug. 15	20	4
Channel 5 south		Sept. 1	60	14
Channel 5 north		Sept. 15	59	13
E Bear Creek Oxbow		Sept. 25	30	7

*The East Bear Creek Unit is being restored and wetland acreage will increase as this work progresses.

San Luis Unit - San Luis NWR
Drawdown - Irrigation - Management Goals
2010

	WETLAND UNIT	Drawdown Rate	Actual Drawdown Date	FIRST IRRIGATION START DATE	SECOND IRRIGATION START DATE	MANAGEMENT GOAL OR PRESCRIPTION
Mar 1-10	Dickenson 3	Slow				Smartweed, mixed marsh
Mar 1-10	East Marsh Channel	Fast				Smartweed, swamp timothy
Mar 1-10	East Marsh N	Fast				Smartweed, swamp timothy
Mar 1-10	East Marsh S	Fast				Total Rehab
Mar 1-10	Santa Rita North	Fast				Post rehab swamp timothy
Mar 11-20	Moffit 2	Fast				Post rehab swamp timothy
Mar 11-20	Loaf Lake	Fast				Swamp Timothy Unit
Mar 11-20	Moraga 4	Fast				Smartweed, Mixed Marsh
Mar 11-20	Yocuts N & S	Fast				Post rehab swamp timothy
Mar 21-31	North Marsh	Fast				Swamp Timothy Unit
Mar 21-31	Moraga 2	Slow				Alkali bulllrush swamp timothy
Mar 21-31	Check Station Marsh	fast				Swamp Timothy Unit
Apr 1-10	Moffit 3	fast				Swamp Timothy Unit
Apr 1-10	Big Lake	Fast				Mixed marsh
Apr 1-10	Santa Rita East					Mixed Marsh
Apr 1-10	Dickenson 6					Watergrass, mixed marsh
Apr 11-20	Ruddy East	Slow				Rehab
Ap[illegible]20	Santa Rita west					Smartweed
A[illegible]0	Moffit 6 South					Swamp timothy
Apr [illegible]-20	Dickenson 2&5	Slow				Total Rehab
Apr 11-20	Moraga 1					Mixed marsh
Apr 21-30	Souza South	slow				Swamp timothy
Apr 21-30	Dickenson 4	fast				Swamp Timothy Unit
Apr 21-30	Moffit 5					Mixed marsh
Apr 21-30	Moraga 3					Watergrass mixed marsh
Apr 21-30	Moffit 8					Watergrass, smartweed
Apr 21-30	Moffit 4	fast				Swamp Timothy Unit
May 1-10	South Marsh 1					Mixed marsh
May 1-10	South Marsh 2					Total Rehab
May 1-10	Moffit 1 East					
May 1-10	Ruddy North					Mixed Marsh
May 1-10	Souza North					Total Rehab
May 1-10	Ruddy West	fast				Mixed Marsh
May 1-10	West Teal	Slow				Total Rehab
May11-20	Middle Teal					Total rehab
May 11-20	Souza Forest					riparian and open channels
May 11-20	Crane Slough					Short grass riparian
May 21-30	South Marsh 3 East					Total rehab

San Luis Unit - San Luis NWR
Drawdown - Irrigation - Management Goals
2010

Drawdown Date	WETLAND UNIT	Drawdown Rate	Actual Drawdown Date	FIRST IRRIGATION START DATE	SECOND IRRIGATION START DATE	MANAGEMENT GOAL OR PRESCRIPTION
June 1-10	South Horseshoe					Late seasonal marsh
June 1-10	Moffit 1 West					Late seasonal marsh
June 1-10	West Horseshoe					Late seasonal marsh
June 11-20	Mallard Slough A	Let evaporate				Riparian channel
June 11-20	Mallard Slough B	Let evaporate				Riparian channel
June 11-20	Mallard Slough 6	Slow				Woody riparian
June 11-20	Accipter Slough	Let evaporate				Riparian Oxbow
Jjune 21-30	Saw-whet Slough	Let evaporate				Riparian Oxbow
June 21-30	Cottonwood Slough	Let evaporate				Riparian Oxbow
July 1-10	Chester Marsh	Let evaporate				Semi-permanent
July 1-10	Sun Flower Slough					Herbaceous Riparian
July 20-31	South Marsh 4 North	fast				Semi-permanent
Aug 15-25	Nevada North					Reverse Cycle Wetland
Aug 15-25	Nevada South					Reverse Cycle Wetland
Aug 15-25	West Yokuts					Reverse Cycle Wetland
Aug 15-25	Deadman Slough	let evaporate				Recirculation reservoir
Permanent	South Marsh 3 West					Permanent, maintain w/ pump
Permanent	Quail Slough					Permanent
Permanent	Mallard Slough C/D/E					Permanent
Permanent	Souza 9					Permanent
Permanent	Winton Marsh					Permanent
Permanent	East Teal					Permanent

Kesterson, Frietas and Blue Goose Units
DRAWDOWN - IRRIGATION - MANAGEMENT GOALS 2010

PROPOSED DRAWDOWN DATE	WETLAND UNIT	DRAWDOWN RATE	Actual Drawdown Date	FIRST IRRIGATION START DATE	MANAGEMENT GOAL OR PRESCRIPTION
Feb 20-28	Middle Teal	let evap			mimic sheet flooding
Feb 20-28	Bittern Pond (upper)				mimic sheet flooding
Mar 1-10	Rail Pond				Smartweed
Mar 1-10	West Teal	Fast			Post rehab Swamp Timothy
Mar 11-20	South Shoveler	slow			Swamp timothy
Mar 11-20	Willow Pond	fast			Post rehab mixed marsh
Mar 21-31	North Shoveler	Fast			Post rehab Swamp Timothy
Mar 21-31	East Gadwall				Swamp timothy
Mar 21-31	Main Gadwall				Swamp timothy
Mar 21-31	West Big Lake				Mixed Marsh
Apr 1-10	Mink Marsh				Rehab NAWCA restoration
Apr 1-10	Sprig Lake (main body)	slow			Swamp Timothy
Apr 1-10	Schwab (upper)				
Apr 11-20	North Teal	slow			Swamp Timothy
Apr 11-20	Curlew Flat	slow			Swamp Timothy
Apr 21-30	South Teal	Slow			Total Rehab
Apr 21-30	East Big Lake	slow			Swamp timothy
Apr [illegible]	Muskrat Ponds	fast			Pair water
May 1-10	Stilt Lake	slow			Mixed Marsh
May 1-10	Sprig Lake (bottom)	Slow			disk tule patches e & n
May 11-20	Midge Marsh				Total Rehab
May 11-20	SE Arm Windmill				Mixed Marsh
May 21-30	Wigeon Pond	slow			Total Rehab
May 21-30	Avocet Pond	slow			Mixed Marsh
May 21-30	Coyote Flat	Slow			Mixed Marsh
June 1-10	North Gadwall	Let evap			
June 1-10	West Gadwall	Let evap			Linear deep channel
June 1-10	Gallinule Pond				
June 1-10	Big Lake channel				or dd after cattle removed
June 10-20	Zahm's Lake (upper)	Let evap			or dd after cattle removed
June 10-20	East Side Slough				Spot disk
July 21-30	Long Lake	Let evap			Reverse Cycle Wetlands
Aug 1-10	Three Partners	Fast			Semi Permanent
Aug [illegible]0	Crescent Lake	Fast			Semi Permanent
Aug 25-30	Zahm's Lake (lower)	Fast			Semi Perm germ. pondweed
Aug 25-30	South Slough	Fast			Semi Permanent

Kesterson, Frietas and Blue Goose Units
DRAWDOWN - IRRIGATION - MANAGEMENT GOALS 2010

Permanent	Windmill Pond			Permanent
Perr nt	Swan Lake			Permanent
Pe it	Redhead Pond			Permanent

WEST BEAR CREEK UNIT

DRAWDOWN -IRRIGATION - MANAGEMENT GOALS

2010

PR. ED DRAWDOWN DATE	WETLAND UNIT	DRAWDOWN RATE	Actual Drawdown Date	FIRST IRRIGATION START DATE	SECOND IRRIGATION START DATE	MANAGEMENT GOAL OR PRESCRIPTION
Mar 11-20	Crane Flat	slow				Swamp Tim. Rehab half unit
Mar 20-31	Fiddleneck Pond					Swamp Timothy
Mar 20-31	Pintail Flat					Post rehab swamp timothy
Apr 1-10	Oxbow Lake (Upper)	slow				Swamp Timothy
Apr 21-30	Valley Marsh	fast				Watergrass
Apr 21-30	Sacaton Pond	Slow				Rehab
May 1-10	Woody Pond	Fast				Swamp Timothy
May 1-10	Willow Slough (upper)	Let evap				Oxbow-drawdown for trees
May 1-10	Mallard Hole (upper)	Let evap				Oxbow-drawdown for trees
June 1-10	Oak Pond (upper)	Let evap				Oxbow-drawdown for trees
June 1-10	Snow Goose Marsh	slow				Mixed Marsh
June 15-20	Outlaw Slough	let evap				mimic sheet flooding
June 15-20	Blackjack Slough North (bench)	Slow				mimic sheet flooding
Jur	Sora Slough	Let evap				mimic sheet flooding
Jun	Tananger Slough	Let evap				Oxbow-draw for trees
Jun 20-31	Mallard Hole (Lower)	Let evap				Oxbow-draw for trees
Jun 20-31	Willow Slough (lower)	Let evap				Oxbow-draw for trees
Jun 20-31	Specklebelly Slough	Let evap				Summer brood water
July 1-10	Oak Pond (lower)	Let evap				Oxbow-drawdown for trees
Permanent	Oxbow Pond (lower)					Permanent
Currently dry	Raccoon Marsh					Burn and disc for rehab

Drought Contingency Plan for the San Luis National Wildlife Refuge and Merced National Wildlife Refuge

In the event of drought the management of water dependent habitats and biotic communities will be adjusted according to the severity of the water reduction as well as the timing of the shortage. Drought notifications and water shortages can occur at any time during the year and span a number of years. Because of the variability of drought notifications and severity we do not have a specific prescription for the San Luis NWR and Merced NWR instead based on the time of year notification and predicted duration we will examine several water management parameters to gauge the most efficient way to employ a reduced water impact while minimizing the impacts to wildlife and other natural resources. Wetland and upland management actions which will be considered in the event of drought are outlined in this plan.

Wetland Management

Wetlands on the San Luis and Merced National Wildlife Refuges are managed to provide optimal habitat conditions for wintering waterfowl, waterbirds, and a large suite of other biota. Managed wetland habitats include seasonal wetlands, reverse cycle wetlands, semi-permanent wetlands, and permanent wetlands.

If the drought is scheduled far enough in advance (for example before the annual flood-up of seasonal wetlands which begins in late August), a decision may be made to reduce the acreage of managed wetlands impacted by delaying or deferring flood-up of certain units or reducing the number of managed units receiving water. If a mid-winter drought occurs, water may be stockpiled on managed wetland units by filling the units to capacity. This strategy may be enhanced by reducing drainage off the units to the minimum necessary to assure adequate water quality. Another strategy which may be employed is an early drawdown of wetlands to reduce the total amount of water needed to maintain the extant wetland acreage.

When delivered water supplies run short, water rights to surface water resources may be exploited via lift pumps. Deep wells may also be used to pump groundwater into canals or directly into managed wetlands to augment or replace inadequate delivered water supplies.

Upland Management

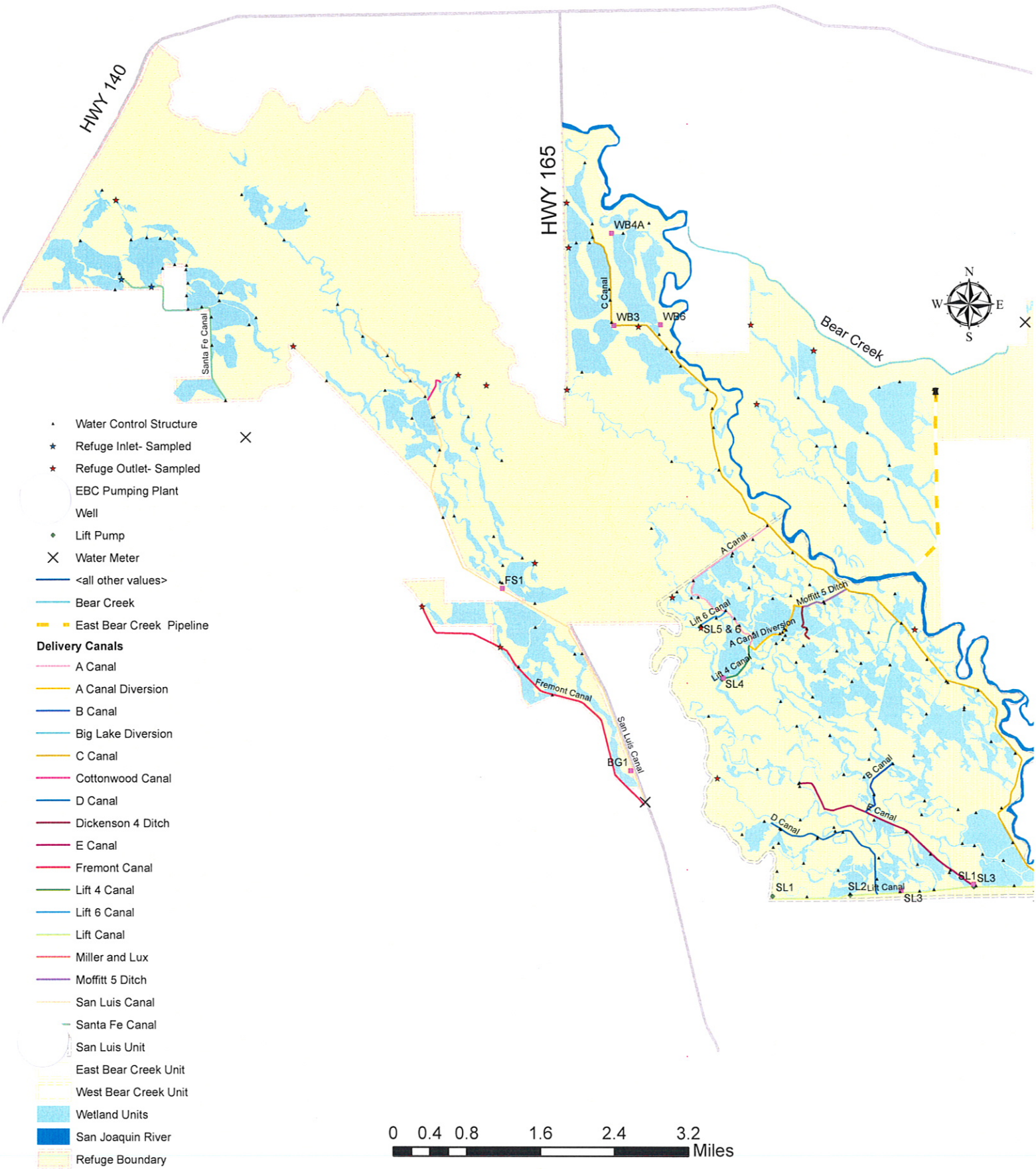
Uplands on the San Luis and Merced National Wildlife Refuges are managed to provide optimal habitat conditions for a suite of short grass-dependent species such as the long billed curlew, arctic nesting geese, and the San Joaquin kit fox as well as for grassland nesting birds. Categories of uplands include restored upland, irrigated pasture, cereal grain plantings and special ecological communities (Iodine Bush and vernal pool).

Restored upland habitats which include restored wetland meadow, grassland, and woodland habitat, are typically irrigated two to three times between February and August. Irrigated pasture is typically irrigated bi-monthly between April and November. Drought will be addressed in these habitats by lengthening the period between irrigations or

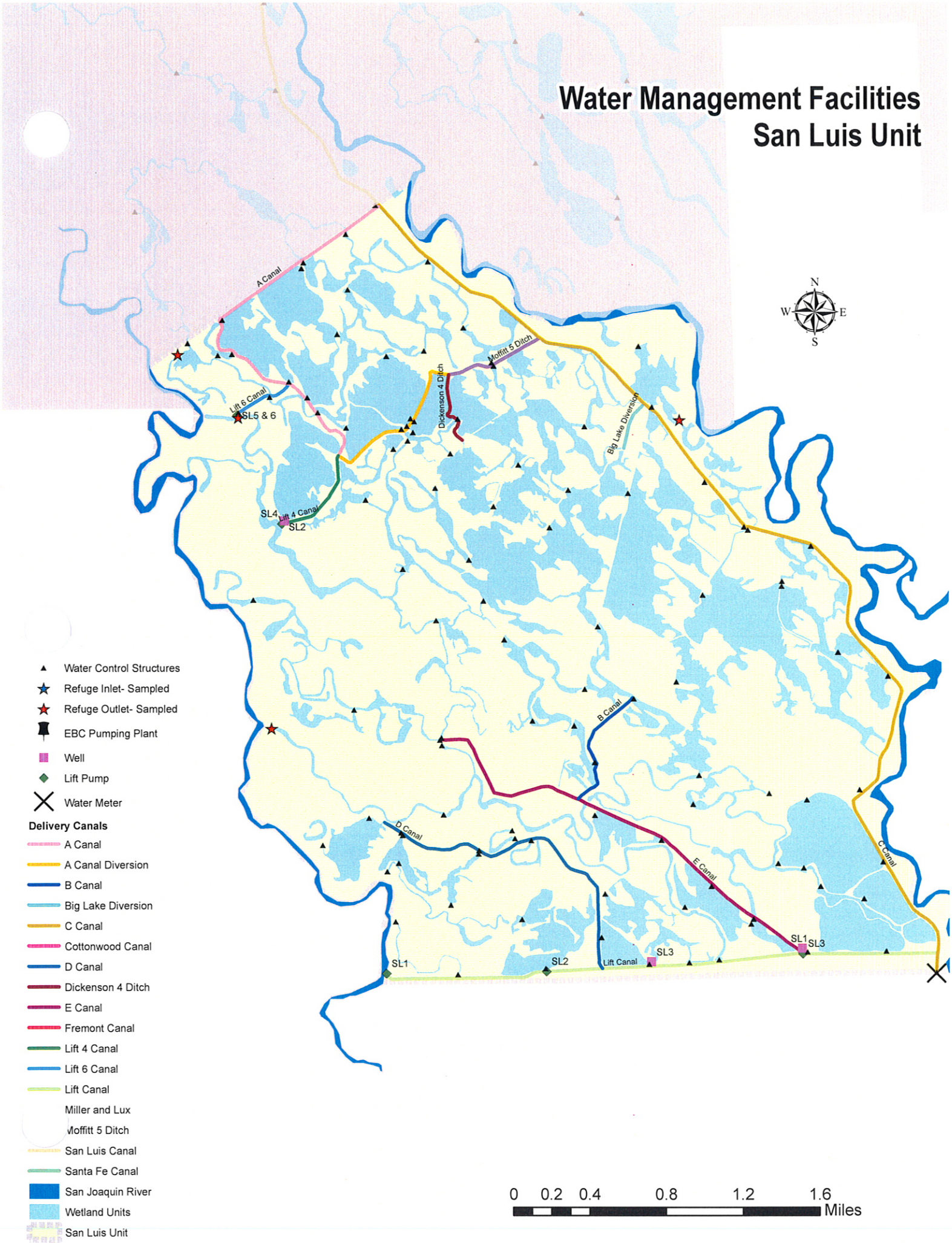
reducing acreage being irrigated. Water shortage to planted cereal grains will be addressed by planting winter wheat later in the season and by utilizing dry farming techniques. Reductions will be made in the total acreage of corn planted based on projected water availability.

Non – irrigated habitats including Iodine Bush and vernal pool communities will not be affected by reduced water allocations. These communities are extremely resilient in the face of drought.

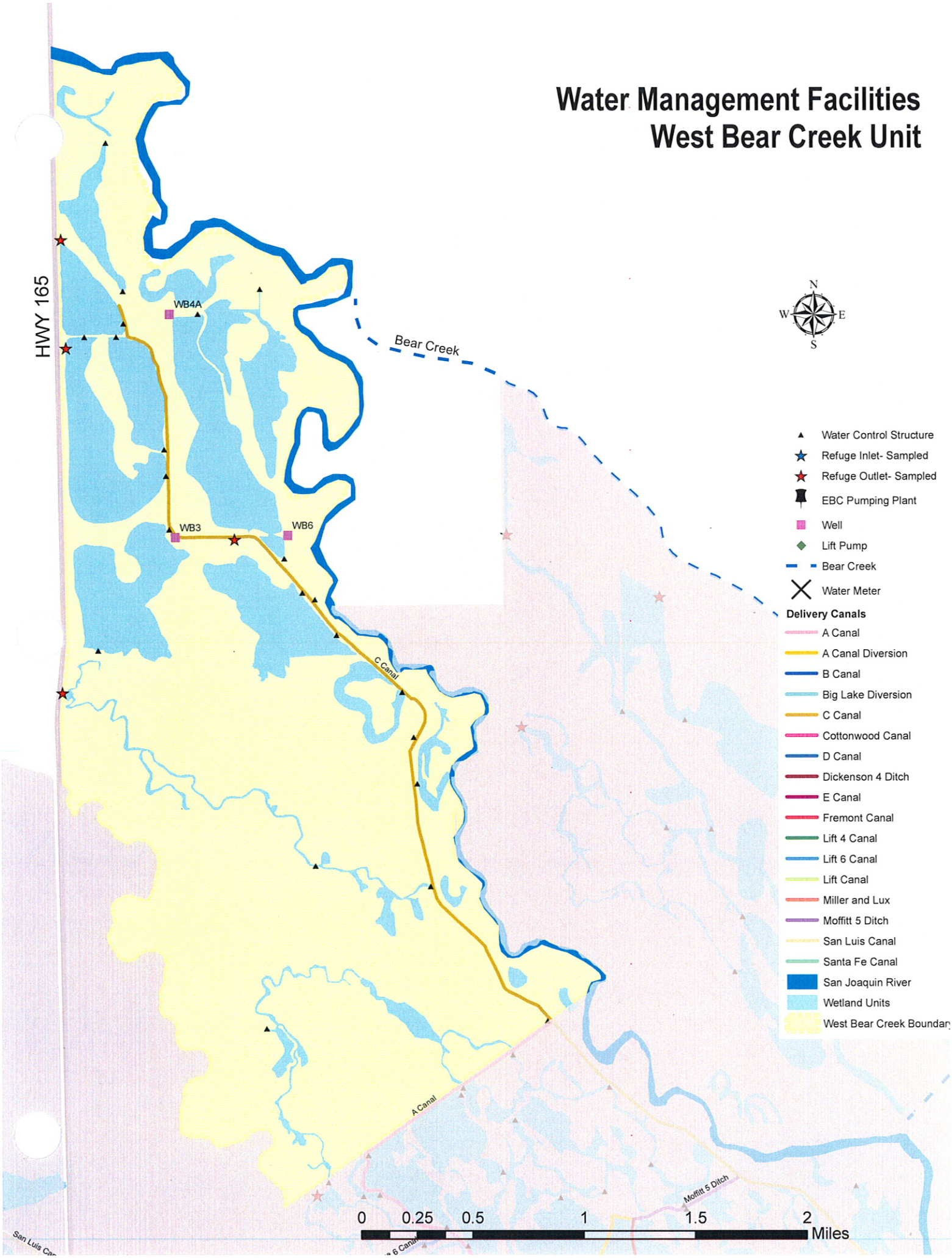
Water Management Facilities
San Luis National Wildlife Refuge



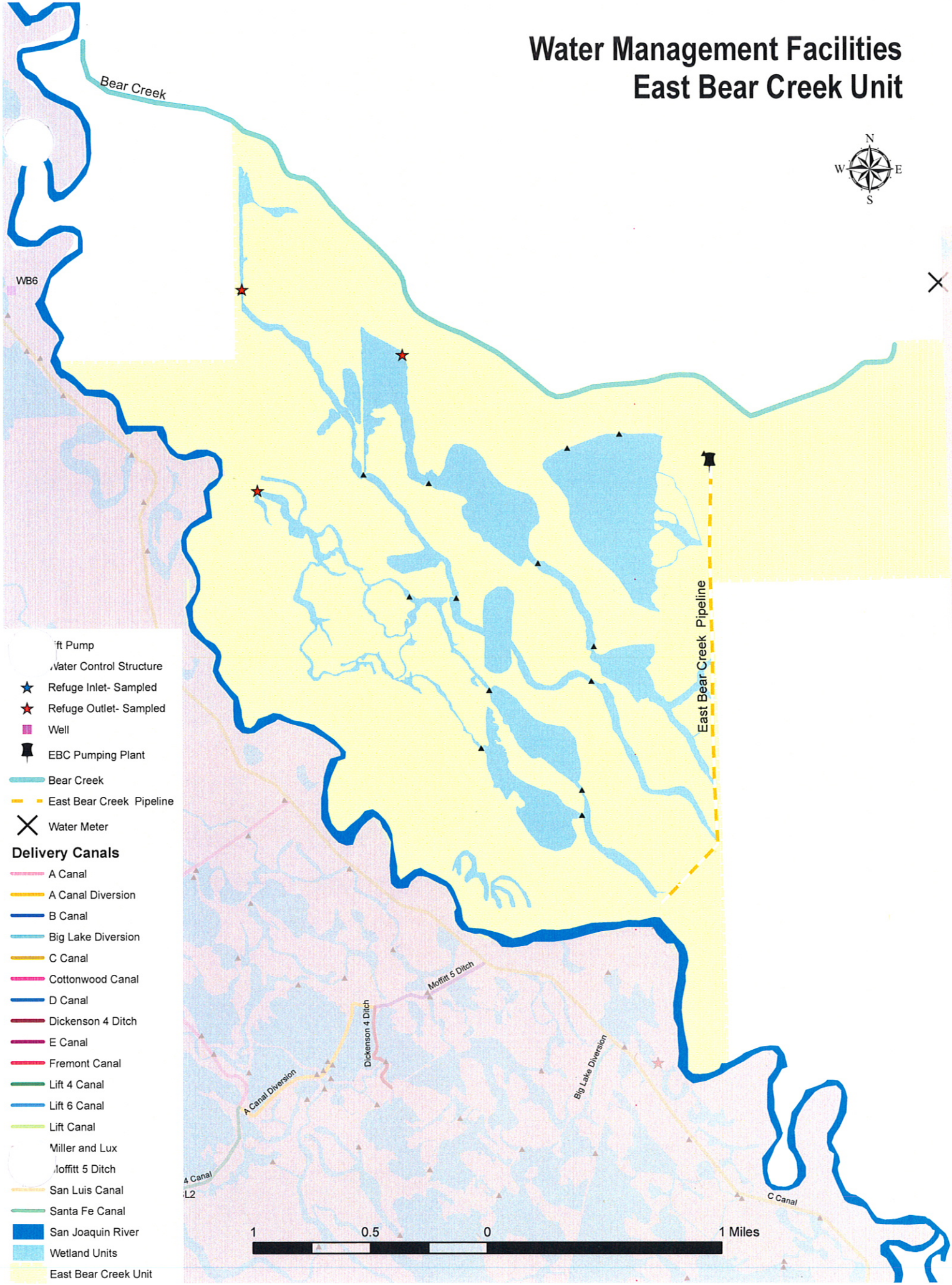
Water Management Facilities
San Luis Unit



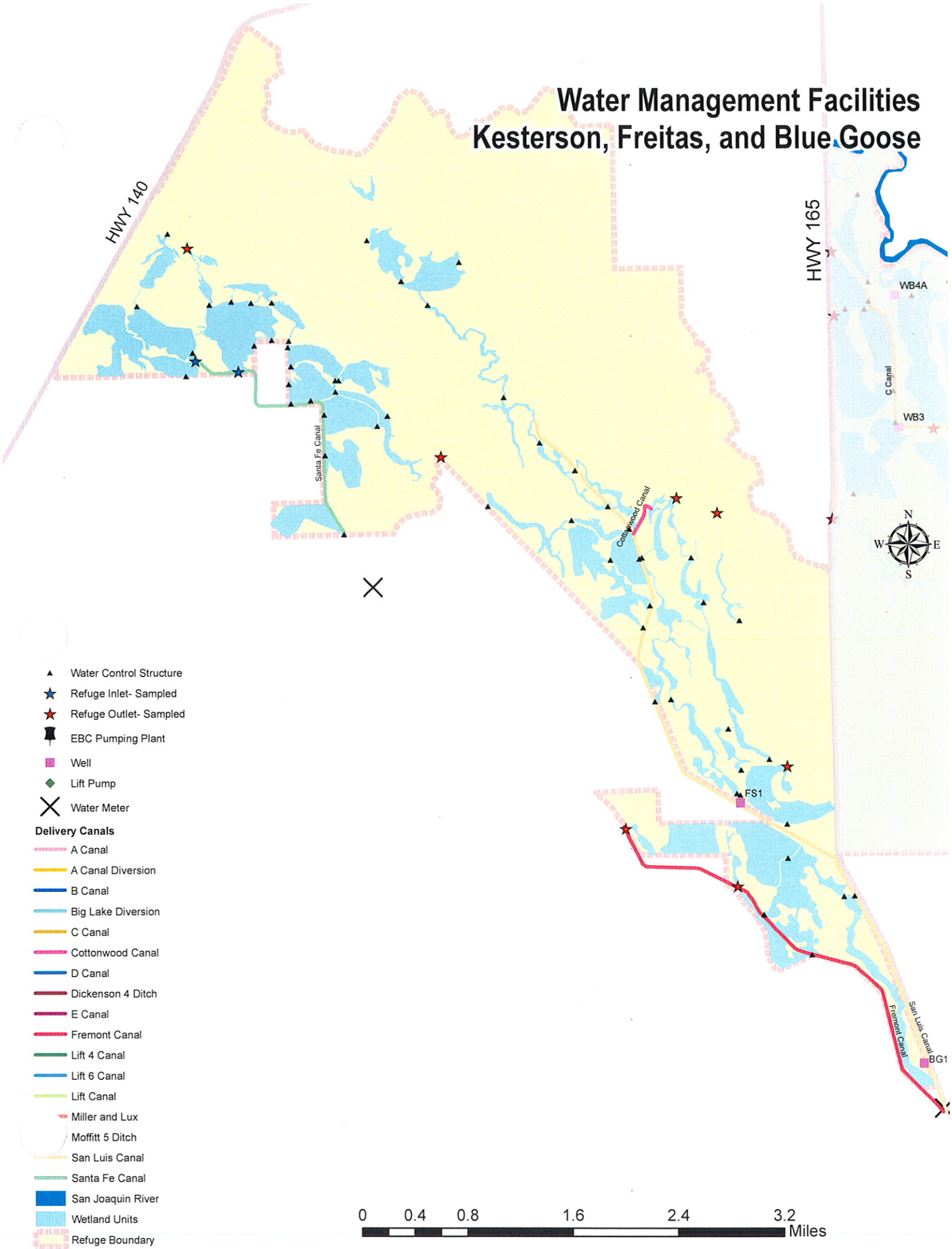
Water Management Facilities
West Bear Creek Unit



Water Management Facilities
East Bear Creek Unit



Water Management Facilities
Kesterson, Freitas, and Blue Goose



San Luis National Wildlife Refuge

Operational Loss Recovery System

(San Luis & West Bear Creek)

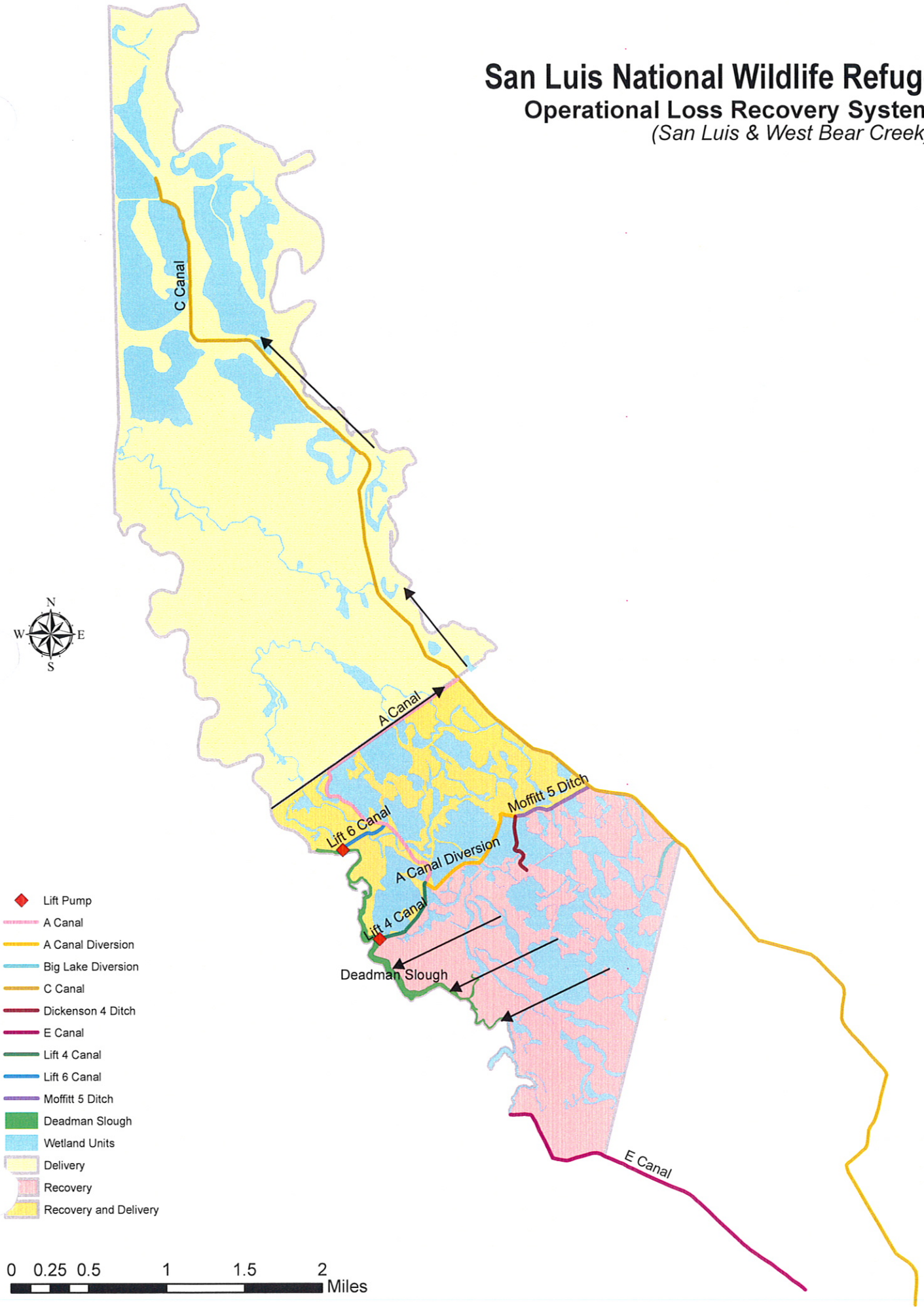


Table 1

Water Supply

2010	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
Method							
Jan-2010	1,400	0	0	0	0	0	1,400
February	1,000	0	0	0	0	0	1,000
Mar-2009	1,300	0	0	0	0	0	1,300
April	650	0	0	0	0	0	650
May	1,550	0	0	0	0	0	1,550
June	600	0	0	0	0	0	600
July	0	0	0	0	0	0	0
August	350	0	0	0	0	0	350
September	1,700	0	0	0	0	0	1,700
October	2,500	0	0	0	0	0	2,500
November	2,290	0	0	0	0	0	2,290
December	1,950	0	0	0	0	0	1,950
TOTAL	15,290	0	0	0	0	0	15,290

*March 1, 2009 - February 28, 2010

Measurement Method Definiti	
M1	Measured sum
M2	Measured sum
M3	Measured sum
C1	Calculated (mc
C2	Calculated usi
C3	Calculated usi
E1	Estimated usin
E2	Estimated usin
E3	Estimated usin
O1	Other (attach a

Table 2

Internal Distribution System

Year	2010								
Canal, lateral	Length (feet)	Width (feet)	Surface Area (square feet)	Precip. (acre-feet)	Evaporation (acre-feet)	Seepage (acre-feet)	Operational losses (acre-feet)	Measure method see Cell K5	Total (acre-feet)
All west, unlined	68,640	20	1,372,800	14.94	135.31	238	153	E3*	(511)
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
TOTAL	**68,640**		**1,372,800**	**15**	**135**	**238**	**153**		**(511)**

32 acres

Table 3

Managed Lands Water Needs

Year	2010								
Habitat Type	Area habitat acres	Habitat Water Needs (AF/ac)	AF/ac water (AF/ac)	Delivered Water (Total AF)	Precip (AF/Ac)	Shallow Groundwtr (AF/Ac)	Evap (AF/Ac)	Cultural Practices (AF/Ac)	Seepage (AF/Ac)
Seasonal wetlands: timothy	1,120	8.00	8.00	8,960	0.42	0.00	1.75	0.00	4.65
Seasonal wetlands: smartweed				0	0.45	0.00	2.94	0.00	
Seasonal wetlands: watergrass	109	8.00	8.00	872	0.45	0.00	2.94	0.00	3.46
Permanent wetlands	47	10.00	10.00	470	0.47	0.00	4.29	0.00	3.71
Semi-perm wetlands/brood pond	276	8.75	8.75	2,415	0.47	0.00	4.29	0.00	2.71
Riparian	0	0.00	0.00	0	0.45	0.00	2.94	0.00	0.00
Irrigated pasture				0	3.50	0.00	3.69	0.00	0.00
Upland				0	0.63	0.00	2.55	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
Total Habitat Acres	**1,552**	**8.19**	**8.19**	**12,717**					

Table 4

Refuge Water Inventory

Year	2010	Reference		
Total Water Supply		Table 1		15,290
Precipitation		Table 2	plus	15
Evaporation		Table 2	minus	135
Seepage		Table 2	minus	238
Operational Losses		Table 2	minus	153
		Deliveries to Managed Lands		14,779
Managed Land needs		Table 3	minus	12,717
Difference		(calculated)		2,062
		Balance (outflow?) (Table 3)		3,218
		Water Inventory Balance		5,280

Table 5

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwt r (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
2001	15,290	0	0	10	0	0	**15,300**
2002	15,225	0	0	10	0	0	**15,235**
2003	15,030	0	0	10	0	0	**15,040**
2004	15,270	0	0	10	0	0	**15,280**
2005	14,732	0	0	0	0	0	**14,732**
2006	14,898	0	0	0	0	0	**14,898**
2007	15,053	0	0	0	0	0	**15,053**
2008	14,582	0	0	0	0	0	**14,582**
2009	**15064**	0	0	0	0	0	**15,064**
2010	15,290	0	0	0	0	0	**15,290**
Total	**135,144**	**0**	**0**	**40**	**0**	**0**	**150,474**
Average	**15,016**	**0**	**0**	**4**	**0**	**0**	**15,047**

Table 1

Water Supply

2010	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
Method							
Jan-2010	950	0	0	0	0	0	**950**
February	813	0	0	0	0	0	**813**
Mar-2009	600	0	0	0	0	0	**600**
April	500	0	0	0	0	0	**500**
May	800	0	0	0	0	0	**800**
June	600	0	0	0	0	0	**600**
July	200	0	0	0	0	0	**200**
August	400	0	0	0	0	0	**400**
September	600	0	0	0	0	0	**600**
October	900	0	0	0	0	0	**900**
November	1,100	0	0	0	0	0	**1,100**
December	1,400	0	0	0	0	0	**1,400**
TOTAL	**8,863**	**0**	**0**	**0**	**0**	**0**	**8,863**

***March 1, 2009 - February 28, 2010**

Measurement Method Definiti	
M1	Measured sum
M2	Measured sum
M3	Measured sum
C1	Calculated (mc
C2	Calculated usir
C3	Calculated usir
E1	Estimated usin
E2	Estimated usin
E3	Estimated usin
O1	Other (attach a

Table 2

Internal Distribution System

Year	2010								
Canal, lateral	Length (feet)	Width (feet)	Surface Area (square feet)	Precip. (acre-feet)	Evaporation (acre-feet)	Seepage (acre-feet)	Operational losses (acre-feet)	Measure method see Cell K5	Total (acre-feet)
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
TOTAL	0		0	0	0	0	0		0

0 acres

Table 3

Managed Lands Water Needs

Year 2010									
Habitat Type	Area habitat acres	Habitat Water Needs (AF/ac)	AF/ac water (AF/ac)	Delivered Water (Total AF)	Precip (AF/Ac)	Shallow Groundwtr (AF/Ac)	Evap (AF/Ac)	Cultural Practices (AF/Ac)	Seepage (AF/Ac)
Seasonal wetlands: timothy	612	8.00	8.00	4,896	0.42	0.00	1.75	0.00	4.65
Seasonal wetlands: smartweed				0	0.45	0.00	2.94	0.00	
Seasonal wetlands: watergrass				0	0.45	0.00	2.94	0.00	
Permanent wetlands				0	0.47	0.00	5.04	0.00	
Semi-perm wetlands/brood pond				0	0.47	0.00	5.04	0.00	
Riparian				0	0.45	0.00	2.94	0.00	0.00
Irrigated pasture				0	3.50	0.00	4.44	0.00	0.00
Upland				0	0.63	0.00	3.29	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
Total Habitat Acres	**612**	**8.00**	**8.00**	**4,896**					

Table 4

Refuge Water Inventory

Year	2010	Reference		
Total Water Supply		**Table 1**		8,863
Precipitation		**Table 2**	**plus**	0
Evaporation		**Table 2**	**minus**	0
Seepage		**Table 2**	**minus**	0
Operational Losses		**Table 2**	**minus**	0
		Deliveries to Managed Lands		8,863
Managed Land needs		**Table 3**	**minus**	4,896
Difference		**(calculated)**		3,967
		Balance (outflow?) (Table 3)		1,237
		Water Inventory Balance		5,204

Table 5

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
2001	6,100	0	0	0	0	0	**6,100**
2002	3,008	0	0	0	0	0	**3,008**
2003	7,400	0	0	0	0	0	**7,400**
2004	8,542	0	0	0	0	0	**8,542**
2005	0	0	0	0	0	0	**0**
2006	0	0	0	0	0	0	**0**
2007	0	0	0	0	0	0	**0**
2008	3,528	0	0	0	0	0	**3,528**
2009	4,084	0	0	0	0	0	**4,084**
2010	8,863	0	0	0	0	0	**8,863**
Total	**41,525**	**0**	**0**	**0**	**0**	**0**	**41,525**
Average	**4,153**	**0**	**0**	**0**	**0**	**0**	**4,153**

Table 1

Water Supply

2010	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
Method							
Jan-2010	2,650	0	0	360	0	0	3,010
February	2,107	0	0	360	0	0	2,467
Mar-2009	1,500	0	0	0	0	0	1,500
April	1,700	0	0	0	0	0	1,700
May	2,200	0	0	0	0	0	2,200
June	900	0	0	0	0	0	900
July	0	0	0	0	0	0	0
August	400	0	0	0	0	0	400
September	2,900	0	0	0	0	0	2,900
October	4,750	0	0	0	0	0	4,750
November	3,950	0	0	360	0	0	4,310
December	3,150	0	0	0	0	0	3,150
TOTAL	26,207	0	0	1,080	0	0	27,287

*March 1, 2009 - February 28, 2010

Measurement Method Definiti	
M1	Measured sum
M2	Measured sum
M3	Measured sum
C1	Calculated (m
C2	Calculated usi
C3	Calculated usi
E1	Estimated usin
E2	Estimated usin
E3	Estimated usin
O1	Other (attach a

Table 2

Internal Distribution System

Year	2010								
Canal, lateral	Length (feet)	Width (feet)	Surface Area (square feet)	Precip. (acre-feet)	Evaporation (acre-feet)	Seepage (acre-feet)	Operational losses (acre-feet)	Measure method see Cell K5	Total (acre-feet)
All East, Unlined	110,880	20	2,217,600	24.14	218.57	295	273	E3*	(763)
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
			0	0.00	0.00				0
TOTAL	110,880		2,217,600	24	219	295	273		(763)

51 acres

Table 3

Managed Lands Water Needs

Year 2010									
Habitat Type	**Area habitat acre:**	**Habitat Water Needs (AF/ac)**	**AF/ac water (AF/ac)**	**Delivered Water (Total AF)**	**Precip (AF/Ac)**	**Shallow Groundwtr (AF/Ac)**	**Evap (AF/Ac)**	**Cultural Practices (AF/Ac)**	**Seepage (AF/Ac)**
Seasonal wetlands: timothy	2,191	8.00	8.00	17,528	0.42	0.00	1.75	0.00	4.65
Seasonal wetlands: smartweed				0	0.45	0.00	2.94	0.00	
Seasonal wetlands: watergrass	751	8.00	8.00	6,008	0.45	0.00	2.94	0.00	3.46
Permanent wetlands	227	10.00	10.00	2,270	0.47	0.00	4.29	0.00	3.71
Semi-perm wetlands/brood pond	459	8.75	8.75	4,016	0.47	0.00	4.29	0.00	2.71
Riparian				0	0.45	0.00	2.94	0.00	0.00
Irrigated pasture				0	3.50	0.00	3.69	0.00	0.00
Upland				0	0.63	0.00	2.55	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
(define)				0	0.00	0.00	0.00	0.00	0.00
Total Habitat Acres	**3,628**	**8.22**	**8.22**	**29,822**					

Table 4

Refuge Water Inventory

Year	2010	Reference		
Total Water Supply		Table 1		27,287
Precipitation		Table 2	plus	24
Evaporation		Table 2	minus	219
Seepage		Table 2	minus	295
Operational Losses		Table 2	minus	273
		Deliveries to Managed Lands		26,524
Managed Land needs		Table 3	minus	29,822
Difference		(calculated)		(3,298)
		Balance (outflow?) (Table 3)		7,555
		Water Inventory Balance		4,257

Table 5

Annual Water Quantities Delivered Under Each Right or Contract

Year	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwt r (acre-feet)	Up Slope Drain Wtr (acre-feet)	other (define) (acre-feet)	Total (acre-feet)
2001	26,135	0	0	400	0	0	**26,535**
2002	27,383	0	0	400	0	0	**27,783**
2003	28,628	0	0	400	0	0	**29,028**
2004	27,007	0	0	400	0	0	**27,407**
2005	25,396	0	0	400	0	0	**25,796**
2006	25,926	0	0	400	0	0	**26,326**
2007	25,526	0	0	400	0	0	**25,926**
2008	26,207	0	0	400	0	0	**26,607**
2009	25,809	0	0	400	0	0	**26,209**
2010	26,207	0	0	1,080	0	0	**27,287**
Total	**238,089**	**0**	**0**	**4,680**	**0**	**0**	**268,904**
Average	**26,454**	**0**	**0**	**468**	**0**	**0**	**26,890**