

Sacramento National Wildlife Refuge

Water Management Plan

December 19, 2005
Revised May 11, 2006

Section A - Background

1. *The staff member responsible for developing and implementing the Plan.*

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2. *Year Refuge established* 1937

<i>Define year type used consistently throughout plan</i> <u>March 1 through February 28</u>
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3. *Water Supplies*

Annual entitlements of surface water with water right and/or contract information

<i>Agency</i>	<i>Water Source</i>	<i>Contract #</i>	<i>Contract restrictions</i>	<i>Acre-feet/year</i>
<i>Federal Level 2</i>	GCID Canal	1425-98-FC-20-17620	None	46,400
<i>Federal Level 4</i>	GCID Canal	1425-98-FC-20-17620	None	3,600
<i>State</i>	NA	NA	NA	0
<i>Other, riparian</i>	Logan Creek	SWRCB	Oct - March	60 cfs

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

The history of water rights, contracts, and use on the Sacramento NWR Complex (Complex) is a complicated one. To summarize, until October of 1992, the Complex had no firm water supply and often suffered from lack of water availability from late November through early April.

In the mid-1980's, BOR began construction of a cross-tie from Stony Creek to the Tehama-Colusa Canal to divert 80 cfs to meet water contract demands from irrigation districts. The Refuge was promised utilization of any or all of this 80 cfs pending other current requests. The crosstie was scheduled for completion in late December of 1987. Unfortunately, the plight of the winter-run Chinook salmon in the Sacramento River necessitated the raising of the Red Bluff Diversion Dam gates. This shut down any water deliveries via the Tehama-Colusa Canal and eliminated any possibilities for winter water for the Complex. The plan is to maintain the Dam in an open position each winter, until the end of February, to allow passage of the salmon.

The Glenn-Colusa Irrigation District (GCID) serves Sacramento NWR, Delevan NWR, and Colusa NWR. GCID takes its water from the Sacramento River via lift pumps near Hamilton City. A problem with the taking of salmon via these pumps has been identified since 1920. This problem remained unresolved; and on August 19, 1991, an injunction filed against GCID by the National Marine Fisheries Service for the taking of threatened winter-run Chinook salmon took effect. GCID's pumping at the Hamilton City plant was immediately reduced from approximately 2,300 cfs to 1,100 cfs. This amount has since been increased due to work done by GCID to improve the efficiency of their fish screens at the Hamilton City pumping plant.

Sacramento NWR has four appropriative licenses to divert a total of 60 cfs for irrigation and/or wildlife purposes on 4,575 acres. In addition, we historically had a contract with GCID for delivery of up to 50,000 acre-feet of BOR Central Valley Project (CVP) water. Allowing for a 20 percent conveyance loss, the actual amount of CVP water that was available to the Sacramento Refuge was 37,000 acre-feet annually. The problem was, GCID was only operative from April 1 to December 1, and water was only delivered to the Refuge on an as-available basis.

5. *Land use history*

Habitat types specific to this refuge

See attachment A - map showing habitat location and size.

6. *Refuge habitat-types with 5% or more of total acreage*

<i>Habitat type</i>	<i>Original size</i>	<i>1992 acres</i>	<i>1997 acres</i>	<i>2004 acres</i>
<i>Seasonal wetland: timothy</i>	Not Avail	6,016	5,932	6,457
<i>Seasonal wetland: smartweed</i>	Not Avail	0	100	0
<i>Seasonal wetland: watergrass</i>	Not Avail	467	483	462
<i>Permanent wetland</i>	Not Avail	284	58	231
<i>Semi-permanent wetland / brood pond</i>	Not Avail	398	591	366
<i>Riparian</i>	Not Avail	254	254	259
<i>Upland</i>	Not Avail	3,207	3,208	2,887
<i>Reverse-cycle wetlands</i>	Not Avail	0	0	0
<i>Other (<5%) vernal pools / alkali mdws</i>	Not Avail	107	107	107
<i>Misc. habitat (less than 5 percent)</i>	Not Avail	0	0	0
<i>Sub-total – habitat acres</i>	Not Avail	10,733	10,733	10,769
<i>Roads, buildings, etc.</i>	Not Avail	50	50	50
<i>Total (size of refuge)</i>	10,783	10,783	10,783	10,819

7. *Refuge habitat-type water use characteristics*

<i>habitat type</i>	<i>AF/ac</i>	<i># of irrigations</i>	<i>Flood date</i>	<i>Draw down date</i>
<i>Seasonal wetland: swamp timothy</i>	5.0	0	Aug-Sep	Apr 1
<i>Seasonal wetland: smartweed</i>	7.5	1	Aug-Sep	Mar 15
<i>Seasonal wetland: watergrass</i>	7.5	1	Aug-Sep	May 1
<i>Permanent wetland</i>	13.25	0	Jan 1	Dec 31
<i>Semi-permanent wetland / brood pond</i>	9.0	0	Oct 1	July 15
<i>Riparian</i>	0	0		
<i>Upland</i>	0	0		
<i>Reverse-cycle wetlands</i>	0	0		
<i>Other (<5%) vernal pools / alkali mdws</i>	0	0		
<i>Misc. habitat (less than 5 percent)</i>	0	0		

Section B - Water Management Related Goals and Objectives

1. *The Refuge mission relative to water management.*

The majority of purposes for Sacramento NWR involve habitat for wetland dependant species. In this artificially created and maintained system, efficient water management is critical to accomplishing these purposes

Purposes for this Unit:

... as a refuge and breeding ground for migratory birds and other wildlife: ... Executive Order 7562, dated Feb. 27, 1937

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

... to conserve (A) fish or wildlife which are listed as endangered species or threatened species... or (B) plants ... 16 U.S.C. 1534 (Endangered Species Act of 1973)

... suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species ... 16 U.S.C. 460k-1 ... the Secretary ... may accept and use ... real... property. Such acceptance may be accomplished under the terms and conditions of restrictive covenants imposed by donors ... 16 U.S.C. 460k-2 (Refuge Recreation Act (16 U.S.C. 460k-460k-4), as amended).

... for the development, advancement, management, conservation, and protection of fish and wildlife resources ... 16 U.S.C. 742f(a)(4) ... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude... 16 U.S.C. 742f(b)(1) (Fish and Wildlife Act of 1956)

2. *Specific habitat management objective. Include pertinent information from Refuge management plans.*

Seasonally Marshes – swamp timothy: By far the most numerous and diverse of the wetland habitat types, these units comprise about 70 percent of the wetland habitat base and are typically flooded from early September through mid-April. Their diversity is the product of a variety of water depths that result in diverse patterns of plant species (vegetation) that, in combination, provide habitat for the greatest number of wildlife species throughout the course of a year. Through the fall and winter, seasonally flooded marshes are used by spectacular concentrations of waterfowl and smaller numbers of egrets, herons, ibis, and grebes, to name a few. In addition, a full compliment of raptors descends upon the waterbird prey base for their winter food supply. As water is removed in the spring, large concentrations of shorebirds utilize the shallow depths and exposed mudflats on their northern migration. Seed-producing plants germinate and grow to maturity on the moist pond bottoms during the spring and early summer. Flood-up in the fall makes this food available to early migrant waterfowl and other waterbirds.

Seasonally Marshes - watergrass/smartweed: Comprising approximately 12 to 15 percent of the wetland habitat base, these units are typically flooded from late August through early May. An irrigation is usually accomplished in mid-June to bring large quantities of watergrass, sprangletop, and smartweed plants to maturity. During these irrigation periods, these units are often utilized by locally-nesting colonial waterbirds (egrets, herons). Because this habitat type often results in thick monocultures, openings are disced or mowed prior to flood-up. Though not as diverse, once flooded these units provide an abundant food source for waterfowl at a very important time (potential crop depredation) of the year. In addition, a number of wading-bird species frequent them throughout the year.

Semi-permanent wetland/brood pond: Combined with permanent ponds, these habitats make up 5 to 10 percent of the wetland base. During the summer growing season, water is often used to encourage growth in certain sparsely vegetated units. Two water management strategies are employed: in some units, water

removal will not take place until late July; in others, normal drawdown (April) is done, scheduled work is completed, and then the unit is flooded for the remainder of the year. Both practices serve to promote plant growth while providing wetland habitat for "resident" wildlife during the hot summer months.

Permanent Pond: Combined with Semi-permanent wetland/brood pond, these habitats make up 5 to 10 percent of the wetland base and remain flooded throughout the year. Characterized by both emergent and submergent aquatic plants, these units provide brood and molting areas for waterfowl, secure roosting and nesting sites for wading birds and other over-water nesters, and feeding areas for species like cormorants and pelicans. These units are drawn down every four to five years to recycle nutrients to increase their productivity and discourage carp populations.

Riparian Woodland: Comprised primarily of black willow, but with patches of sandbar willow and Fremont's cottonwood, riparian habitat occurs along Logan Creek and other managed waterways of the Refuge. Willows and cottonwoods also occur sparsely in and around some managed marsh unit. The larger "riparian tracts" are located in Tract 30 ("Sherwood Forrest"), Tract 37 ("The Heron Rookery"), and Tract E Cell 4. Willows and cottonwoods provide nesting, roosting, and feeding habitat for passerine species and raptors, and shelter and screening for waterfowl. Deer, small mammals, and duck broods utilize creeks and water delivery systems during the summer, when most marsh units are dry.

Vernal pools and alkali meadows: Most plant species in these communities are natives and occur in a variety of patterns, which yield the most diverse vegetation on the Refuge. Nine Federal, State, and California Native Plant Society (CNPS) special status plant species occur in these habitats; as well as three special status invertebrates. During the wet season, cackling geese, wigeon, and coots graze on the depauperate grasses in the alkali meadows, and dabbling ducks and shorebirds feed in the vernal pools. Killdeer, stilts, and avocets nest in these habitats. Alkali meadows and vernal pools are the native, indigenous habitats of the Colusa Plains (Basin), once known as the "hard alkali gooseland"; now, Sacramento NWR, Delevan NWR, and Colusa NWR are virtually all that remain.

Upland: annual and perennial grasslands

3. Strategies used to attain objectives listed above.

On an annual basis conduct a review of the previous habitat management plan, which involves a planning team visiting each habitat unit on each refuge to document accomplishments, establish needs and develop plans for the upcoming year. Compile these findings to produce the next habitat management plan.

4. 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.

5. 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 budget and staffing limitations.

Section C - Policies and Procedures

1. Refuge policies/procedures on accepting agricultural drainage water as supply.

Delevan Refuge accepts upslope drainage water because GCID canal deliveries include upslope drainage water. Refuge flow-through practices result in habitat units that are on the refuge border releasing flow-through quantities into outflow drains. There is no formal policy or procedure concerning the quality of water that the refuge will accept. No standards have been established and no water quality testing is conducted.

2. Refuge policies/procedures on water pooling, transfers, reallocations or exchange.

The refuge has no Sacramento NWR Complex or US Fish & Wildlife policies or procedures on pooling, transfers, reallocations or exchange but follows those established by the CVPIA and in the water supply contracts.

POOLING OF WATER SUPPLIES

6. (a) Whenever the maximum quantities of Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies depicted in Exhibit AB@ are reduced pursuant to Article 9 of this Contract, the remaining Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies may be pooled for use on other Refuge(s); Provided, that no individual Refuge shall receive more Level 2 Water Supplies than would have been made available to it absent a reduction pursuant to Article 9 of this Contract; or be reduced by more than twenty-five (25) percent; Provided further, that the Contracting Officer makes a written determination that pooling of water for use on other Refuge(s) would not have an adverse impact, that cannot be reasonably mitigated, on Project operations, other Project Contractors, or other Project purposes; Provided further, that the Contracting Officer determines that such reallocation is permitted under the terms and conditions of the applicable underlying water right permit and/or license; and Provided still further, that water made available under this contract may not be scheduled for delivery outside the Contractor=s Boundary without prior written approval of the Contracting Officer.

(b) An Interagency Refuge Water Management Team, to be chaired by the Contracting Officer and to be established upon execution of this Contract, shall be entitled to collaboratively allocate the pooled water supplies and provide a schedule for delivery of the pooled supplies to meet the highest priority needs of the Refuge(s) as depicted in Exhibit AB@; Provided, however, nothing in this Article is intended to require the Contractor to pool the water supply provided for in this Contract. The Interagency Refuge Water Management Team shall be composed of designees of the Bureau of Reclamation, the United States Fish and Wildlife Service, the California Department of Fish and Game, and the Grassland Water District.

TRANSFERS, REALLOCATIONS OR EXCHANGES OF WATER

7. Subject to the prior written approval of the Contracting Officer, the Project Water made available under this Contract may be transferred, reallocated or exchanged in that Year to other Refuge(s) or Project contractors if such transfer, reallocation or exchange is requested by the Contractor and is authorized by applicable Federal and California State laws, and then-current applicable guidelines or regulations.

3. Refuge water accounting policies/procedures for inflow, internal flow and outflow.

Irrigators estimate quantity delivery by month for individual units. Deliveries are measured by the local irrigation district at the point of delivery. Outflow points have no measurement devices.

4. *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 unit to be flooded.

Section D - Inventory of Existing Facilities

1. *Mapping.*

The attached maps (Attachment B) show points of delivery, turnouts (internal flow), and outflow (spill) points, measurement locations, and the conveyance system. Sac NWR does not have storage facilities, an operational loss recovery system, active wells, or water quality monitoring locations and thus these are not shown on the attached facilities map.

2. *Water Measurement.*

a. *Inflow/deliveries*

Total # of inflow locations/points of delivery 6

Total # of measured points of delivery 6

Percentage of total inflow (volume) measured in 2004 100

<i>Delivering Agency</i>	<i>Conveyance facility</i>	<i>Measuring Point</i>	<i>Refuge Distribution facility</i>	<i>% of total inflow</i>	<i>Type of Measurement</i>	<i>Measuring Agency</i>
GCID	Lateral 26.2	26.2	Main canal	72	Flow meter	GCID
GCID	Lateral 35.1 C	35.1 C	West canal	1	Flow meter	GCID
GCID	Lateral 25.1	25.1	North Canal	11	Flow meter	GCID
GCID	Logan Creek	Dam 1	Logan Creek, N Fk	11	Flow meter	GCID
GCID	Logan Creek	Dam 2	Logan Creek, N Fk	3	Flow meter	GCID
GCID	Logan Creek	Dam 3	Logan Creek	2	Flow meter	GCID

b. *Internal flow at turnouts*

Total # of Refuge water management units 136

Total # of Refuge water management unit turnouts 68

Total # of measured turnouts 0

Estimated percentage of internal flow (volume) in 2004 that was measured at a turnout 0

<i>Measurement Type</i>	<i>Number of Devices</i>	<i>Acres Served</i>	<i>Accuracy (avg or range)</i>	<i>Reading frequency</i>	<i>Calibration frequency (months)</i>	<i>Maintenance frequency (months/days)</i>
<i>Orifices</i>						
<i>Propeller</i>						
<i>Weirs</i>						

<i>Flumes</i>						
<i>Venturi</i>						
<i>Metered gates</i>						
<i>Other, stop-log</i>	68	7,516	58 – ±20%	weekly	Never	weekly

c. *Outflow*

Outflow (AF/yr) Unknown quantity

Total # of outflow locations/points of spill 46

Total # of measured outflow points 0

Percentage of total outflow (volume) measured during report year 0

<i>Outflow point</i>	<i>Measuring point</i>	<i>Type of measurement</i>	<i>Percent of total outflow</i>	<i>Measuring agency</i>	<i>Acres drained</i>
Logan Creek, N Fk	Pool 5	None	12	None	887
Logan Creek, N Fk	Pool 7	None	6	None	400
Logan Creek	Pool 10 north	None	11	None	760
Logan Creek	Pool 10 south	None	10	None	760
Logan Creek	Pool 11	None	6	None	428
Hunter Creek	Hunter Creek	None	5	None	342
Various - 38	Various	None	50	None	3,565

3. *Type and length of the Refuge internal distribution system*

<i>Miles unlined canal</i>			<i>Miles lined canal</i>	<i>Miles piped</i>	<i>Miles - other</i>	
<i>Delivery</i>	<i>Drain</i>	<i>Delivery/Drain</i>			<i>Delivery</i>	<i>Drain</i>
20.5	12.4	18.4	0	0	17.8	0

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

Refuge staff has not identified any significant leaks or areas of higher than average canal seepage. No areas of high seepage due to soil type (gravel lens, etc.) have been identified.

4. *Refuge operational loss recovery system.*

NONE

5. *Groundwater.*

Availability, quality and potential for use

USBR drilled four test wells – found limited quantity (hundreds of gallons instead of thousands) and poor quality (boron and/or arsenic). The groundwater basin under the refuge is considered to be of very limited usefulness.

Groundwater Plan No X Yes _____

Groundwater basin(s) that underlie the Refuge

<i>Name of basin</i>	<i>Size (sq.</i>	<i>Usable</i>	<i>Safe yield</i>	<i>Management</i>	<i>Relevant reports</i>
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<i>underlying refuge</i>	<i>mi.)</i>	<i>capacity (AF)</i>	<i>(AF/Y)</i>	<i>agency</i>	
Colusa Subbasin	1,434	900,000	NA	Glenn County	DWR Bulletin 118

Refuge operated wells

<i>Location</i>	<i>Status</i>	<i>Yield (AF/Y)</i>	<i>Future Plans</i>
NW corner, tract one	idle	200 gpm	None

Section E Environmental Characteristics

1. Topography - impact on water management

Relatively flat with slope from NW to SE. The water impact of this gentle NW to SE slope is that the refuge takes a maximum amount of delivered water on along the north and west boundaries to that the supply can be used in multiple units as it gravity flows towards the SE spill points.

2. Soils - impact on water management

The soils of the Sacramento NWR (Attachment C is a soils map) are fairly tight soils that minimize seepage and are thus beneficial for wetland type habitats. There are no areas of problem soils so water management is very efficient.

3. Climate

National Weather Service –Willows (049699), July 1948 to December 2001

	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>	<i>Annual</i>
<i>avg precip</i>	3.65	3.29	2.44	1.10	0.65	0.32	0.04	0.13	0.29	0.97	2.47	2.71	18.06
<i>avg. temp</i>	44.9	49.7	53.1	58.8	66.0	73.1	77.4	75.7	72.5	64.3	53.0	45.5	61.20
<i>max temp</i>	54.4	60.6	65.3	72.9	80.7	88.6	94.1	92.5	89.1	79.4	65.0	55.5	74.80
<i>min temp</i>	35.5	38.7	40.9	44.6	51.3	57.7	60.7	58.8	56.0	49.2	41.0	35.6	47.50
<i>ETo ('04)</i>	0.95	1.73	4.30	5.60	6.48	7.70	7.74	6.99	5.86	3.61	1.97	1.31	54.24

The impact of climate, and any microclimates, on water management

Mild damp winters and long hot summers. 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 have the greatest amount of water-use per habitat acre. The hot summers, and the resulting evaporative losses, limit the extent to which the refuge can provide permanent water habitats. No microclimates exist within the refuge borders.

4. Water Quality Monitoring

<i>Analyses performed</i>	<i>Frequency range</i>	<i>Concentration range</i>	<i>Average</i>
pH	Once	7.7 - 8.4	8.0
Dissolved solids	Once	166 - 237	210
Dissolved oxygen	Once	6.6 - 9.7	7.7
Alkalinity as CaCO3	Once	120 - 157	139
Calcium	Once	15 - 20	18
Chloride	Once	5.8 – 8.2	7.1

Magnesium	Once	12 – 17	15
Nitrogen	Once	<0.1 – 0.15	<0.11
Potassium	Once	1.0 – 1.7	1.4
Sodium	Once	24 – 38	33
Sulfate	Once	18 – 36	29
Arsenic	Once	1 - 2	1.4
Boron	Once	110 - 170	143
Cadmium	Once	All <1	<1
Chromium	Once	All <1	<1
Copper	Once	1 - 2	1.3
Lead	Once	All <5	<5
Mercury	Once	All <0.1	<0.1
Molybdenum	Once	<1 - 2	<1.2
Selenium	Once	All <1	<1
Uranium	Once	0.5 – 0.7	.6
Vanadium	Once	4 - 6	5.2
Zinc	Once	<3 - 28	<8.3

The impact of water quality on water management

A baseline study (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988) found no water quality problems that affect water management decisions. Water management decisions are based on this baseline study since it is the only source of water quality data specific for the refuge.

Section F Transfers, Exchanges and Trades

1. Transfers, exchanges and trades.

Information on any transfers, exchanges and/or trades into or out of the Refuge.

<i>From whom</i>	<i>To whom</i>	<i>2004 (AF)</i>	<i>Use</i>
None			
	TOTAL		

Section G Water Inventory

1. Refuge Water Supplies Quantified

Surface water supplies, imported and originating within the District, by month. Table 1

Ground water extracted by the Refuge, by month. Table 1

Precipitation by Habitat Type Table 3

Upslope Drain Water, by month. Table 1

Other supplies, by month Table 1

Refuge water inventory. Table 4

Ten-year history of Refuge water supplies Table 5

2. Water Used Quantified

1. Conveyance losses, including seepage, evaporation, and operational losses. Table 2

2. Applied Habitat water, evapotranspiration, water used for cultural practices (e.g., disease control, etc.). Table 3

3. Estimated deep percolation (seepage) within Habitat areas. Table 3

4. Habitat spill or drain water leaving the Refuge. Table 4

See Attachment D - detailed water inventory spreadsheet

Section H Critical Best Management Practices

Critical BMPs

1. Management Programs

a. Education

Program	Estimated cost (in \$)				
	2005	2006	2007	2008	2009
Irrigator training – 4 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Interpretive displays	\$10,000	\$1,000	\$1,000	\$10,000	\$1,000
Environmental Education – 2 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000

Program specifics

The four refuge irrigators are sent to yearly training in distribution system management, flow control and turnout calibration. The Environmental Education program hosts more than 5,000 students visit each year. The materials for this program include handouts, videos and visual displays. New interpretive displays are purchased about every three years and there is an on-going expense to maintain them.

b. Water Quality Monitoring

Type of water	Estimated cost (in \$1,000s)				
	2005	2006	2007	2008	2009
Surface – USBR and riparian	NA				
Upslope Drain	NA				
Groundwater	NA				
Outflow – into GCID drains	NA				

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

The Refuge Complex is a member of Colusa Sub-basin watershed of the Sacramento Valley Coalition for monitoring water quality. No water quality problems were identified during 2004-2005. Past studies (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988; etc.) have indicated no surface water (inflow and outflow) quality issues.

c. Cooperative Efforts

The refuge is working with GCID to improve the delivery and measurement (partially through the use of SCADA) capabilities to Sacramento, Delevan and Colusa refuges. Continuing to work with USBR to secure delivery for Sutter NWR.

d. Pump Evaluations - NA

Total number of groundwater pumps on refuge: 0

Total number of surface water (low-lift) pumps on refuge: 0

Groundwater Pumps	Estimated cost (in \$1,000s)				
	2005	2006	2007	2008	2009
# of groundwater pumps to be tested	NA				
# of pumps to be fixed or replaced	NA				
# of surface water pumps to be tested	NA				
# of pumps to be fixed or replaced	NA				

e. *Policy Evaluation.*

1. Ability to change USBR pre-determined/scheduled monthly quantities so that the refuge can use available supply in response to unpredictable weather conditions and changing habitat needs,
2. The right to move unused allocated water between refuges within our complex, to other CVP refuges, to State F&G, and to other CVP contractors
3. US F&W joins Seven Party Agreement so that outflow (into a canal/drain) from upstream refuges (Sac NWR) is available for diversion to downstream refuges (Colusa Refuge) at no charge. This would keep the US government (USBR) from having to buy the same water multiple times.

2. *Water Shortage Contingency Plan*

Existing plan Yes Please attach No Projected Completion Date 2007
 (knowledge from 1978 and 1987 drought is being compiled into a plan)

Section I Exemptible Best Management Practices

1. *Improve management unit configuration*

Unit name	Current acres	Reason for change	Proposed acres	Estimated Cost (In \$1,000s)				
				2005	2006	2007	2008	2009
Tract G & H	402	Better water mgmt	402	0	\$25	\$290	TBD	TBD

Changes to unit configuration are determined if needed during the annual habitat management planning cycle.

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)				
			2005	2006	2007	2008	2009
15 structures yearly – 2005 in tract 2, 4, 8, 9, lateral 26.2	concrete	Replace old CMP control structures	\$13.8	\$14.3	\$14.8	\$15.3	\$15.8

b. *Line/Pipe sections of distribution system*

Proposed reach/sect.	Reason for new structure	Estimated Cost (In \$1,000s)				
		2005	2006	2007	2008	2009
T 26.2	200' pipe for independent water delivery to cell 2	0	\$3,750	TBD	TBD	TBD

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

c. *Independent water control for each unit*

Proposed control point	Reason for new control point	Estimated Cost (In \$1,000s)				
		2005	2006	2007	2008	2009
T 8.1	Independent water control for brood pond	\$2	TBD	TBD	TBD	TBD

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

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

<i>Proposed new section</i>	<i>Units served</i>	<i>Reason for new section</i>	<i>Estimated Cost (In \$1,000s)</i>				
			2005	2006	2007	2008	2009
T AB & C	Pool 1, 1B, 3, TE, TF	Better water mgmt	\$32	\$250	\$190	TBD	TBD

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

3. *Automate water distribution system*

<i>Proposed automation location</i>	<i>Type of improvement</i>	<i>Reason for improvement</i>	<i>Estimated Cost (In \$1,000s)</i>				
			2005	2006	2007	2008	2009
None		No pumps, no precise timing					

The refuge plans to focus its resources on the other BMPS. The 2005 and 2006 habitat management plans will study the benefits of automating appropriate parts of the conveyance system. The results of this study will be provided in the 2006 and 2007 annual updates.

4. *Measurement*

a. Plan to measure outflow

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

<i>Identify locations</i>	<i>Estimated cost (in \$1,000s)</i>				
	2005	2006	2007	2008	2009
Install measuring devices on major outlets			40	40	40

There are a number of ongoing water monitoring planning efforts off the refuge that may affect our water measurement plan and implementation. Currently, six potential sites have been identified for meters (two in Pool 10, one in the Pool 5, one in Pool 7, one in Pool 11, and one in the southwest corner of Tract 43) which would enable measuring outflow from approximately 50 percent of the refuge wetlands.

5. *Incentive Pricing (Grasslands Water District only)*

NOT Applicable

6. *Construct and operate operational loss recovery systems*

<i>Proposed location</i>	<i>Reason for improvement</i>	<i>Estimated Budget (in \$1,000s)</i>				
		2005	2006	2007	2008	2009
None						

US F&W is exploring the possibility of joining the Seven Party Agreement so that outflow/spill from upstream refuges can be credited to downstream diversions. Outflow credits could be used to fund outflow/spill measurement programs. The refuge will report on the result of negotiations regarding this issue in the annual updates.

7. *Optimize conjunctive use of surface and groundwater*

<i>Proposed production/ injection well</i>	<i>Anticipated yield</i>	<i>Estimated Budget (in \$1,000s)</i>				
		<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>
NA – no usable groundwater						

8. *Facilitate use of available recycled urban wastewater*

NA - no recycled urban wastewater is available

9. *Mapping - COMPLETE*

<i>GIS maps</i>	<i>Estimated Budget (in \$1,000s)</i>				
	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>
<i>Map 1 – Distribution System</i>	Complete				
<i>Map 2 –Drainage System and outflow points</i>	Complete				

10. *State and Federal water use efficiency goals*

Description of past, present, or future plans that address the goals identified for this refuge

Sacramento and Delevan NWR's

1. *Describe actions that reduce the salinity of surface return water. This addresses TB 24 - Reduce electrical conductivity in Colusa Drain.*

None - no salinity or conductivity problems have been documented on any of the refuge's wetlands.

2. *Describe actions that reduce nonproductive evapotranspiration (ET). This addresses TB 25 - Reduce nonproductive ET.*

The refuge has a continuous program to minimize or eradicate invasive aquatic plants (parrots feather, primrose and Arundo).

Section J BMP Exemption Requests

Summary of BMP exemptions

<i>BMP</i>	<i>Constraint</i>	<i>Outstanding Need</i>
NONE		

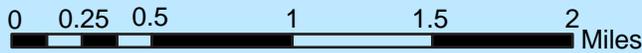
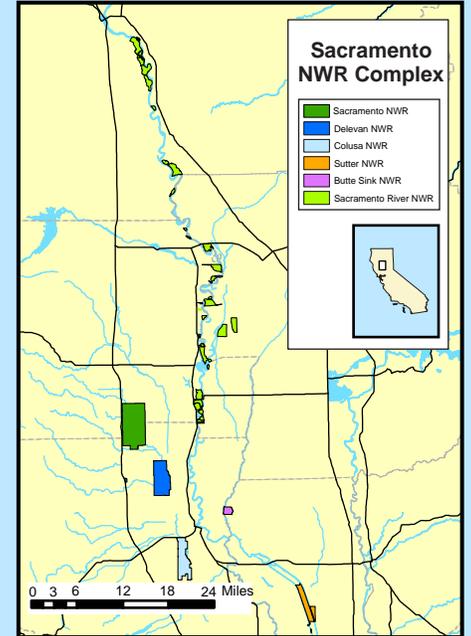
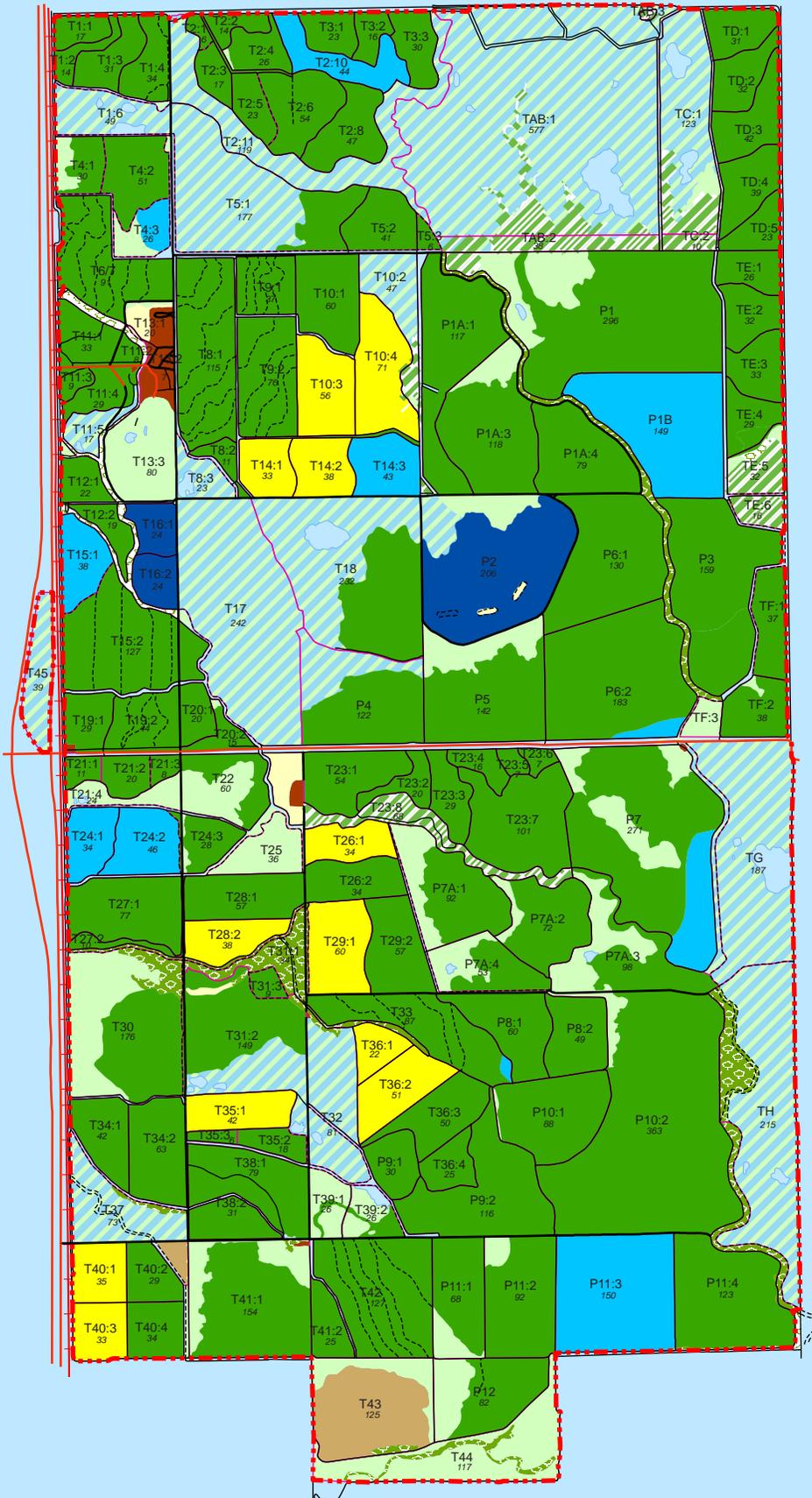
Attachment A

Sacramento National Wildlife Refuge

Habitat Map

December 16, 2005

Sacramento National Wildlife Refuge



Attachment B

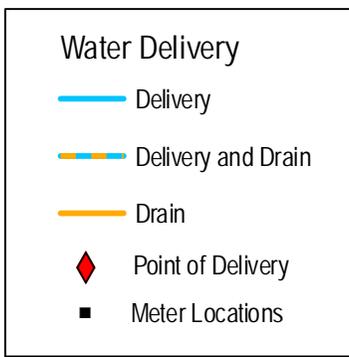
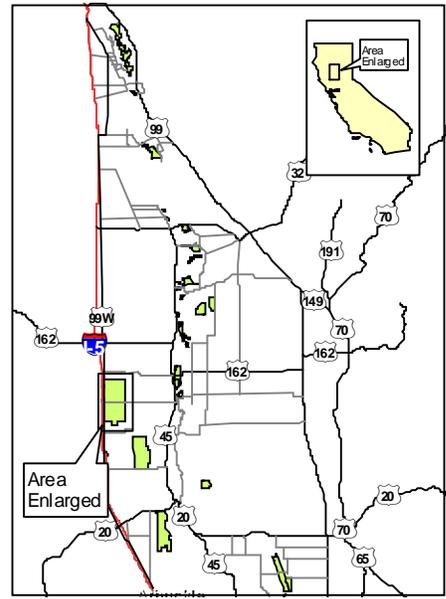
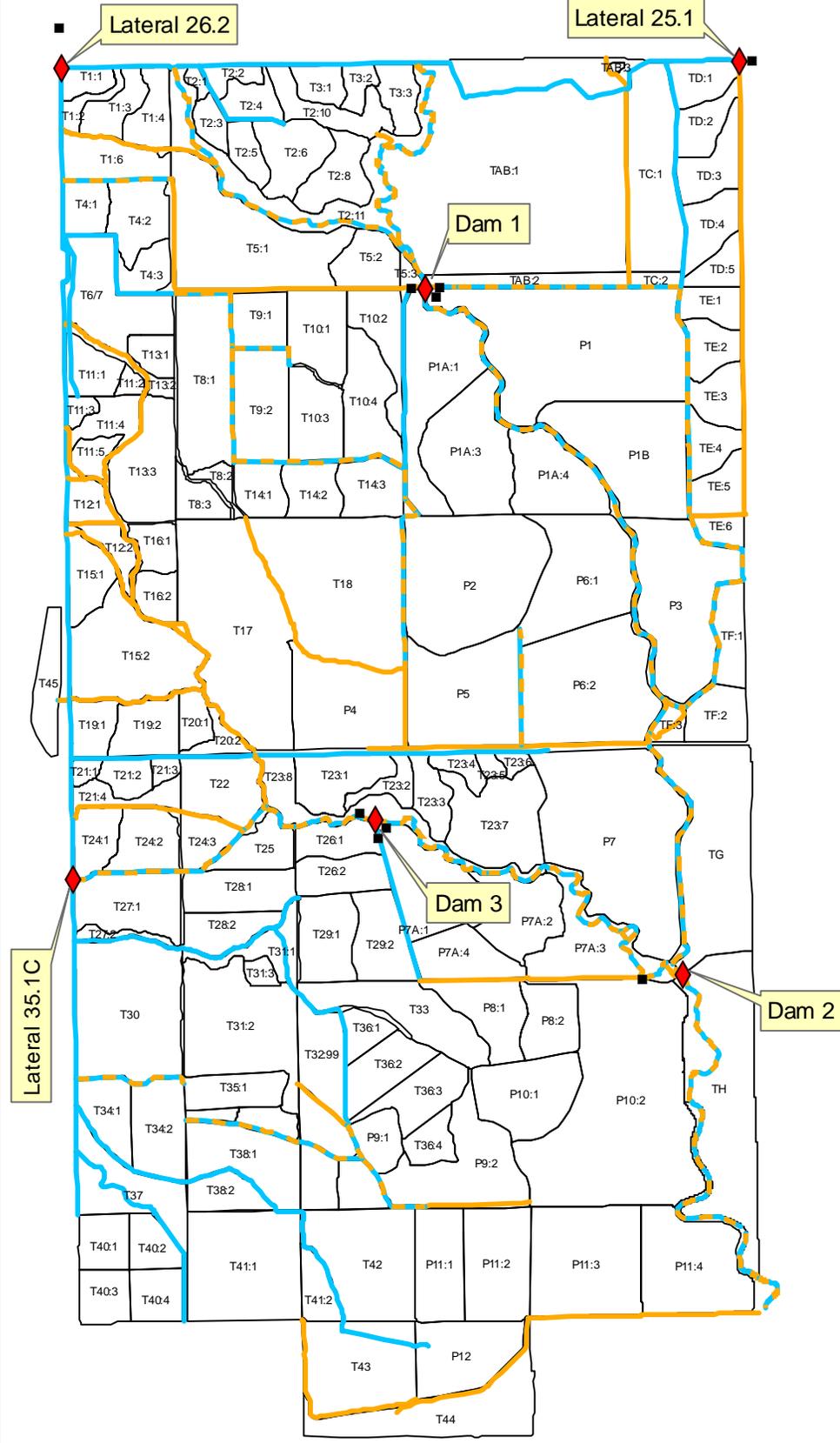
Sacramento National Wildlife Refuge

Water Delivery and Drainage Map

Water Drainage Areas Map

December 16, 2005

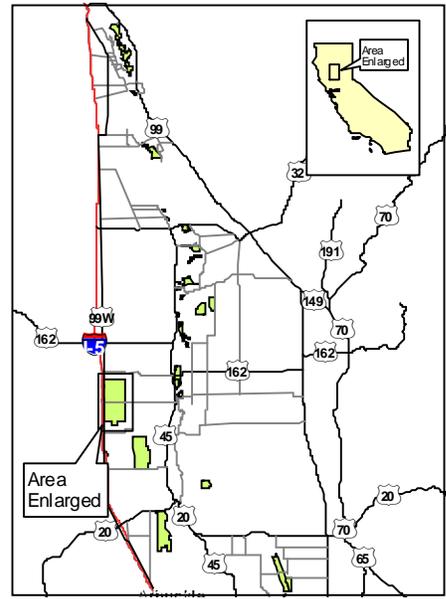
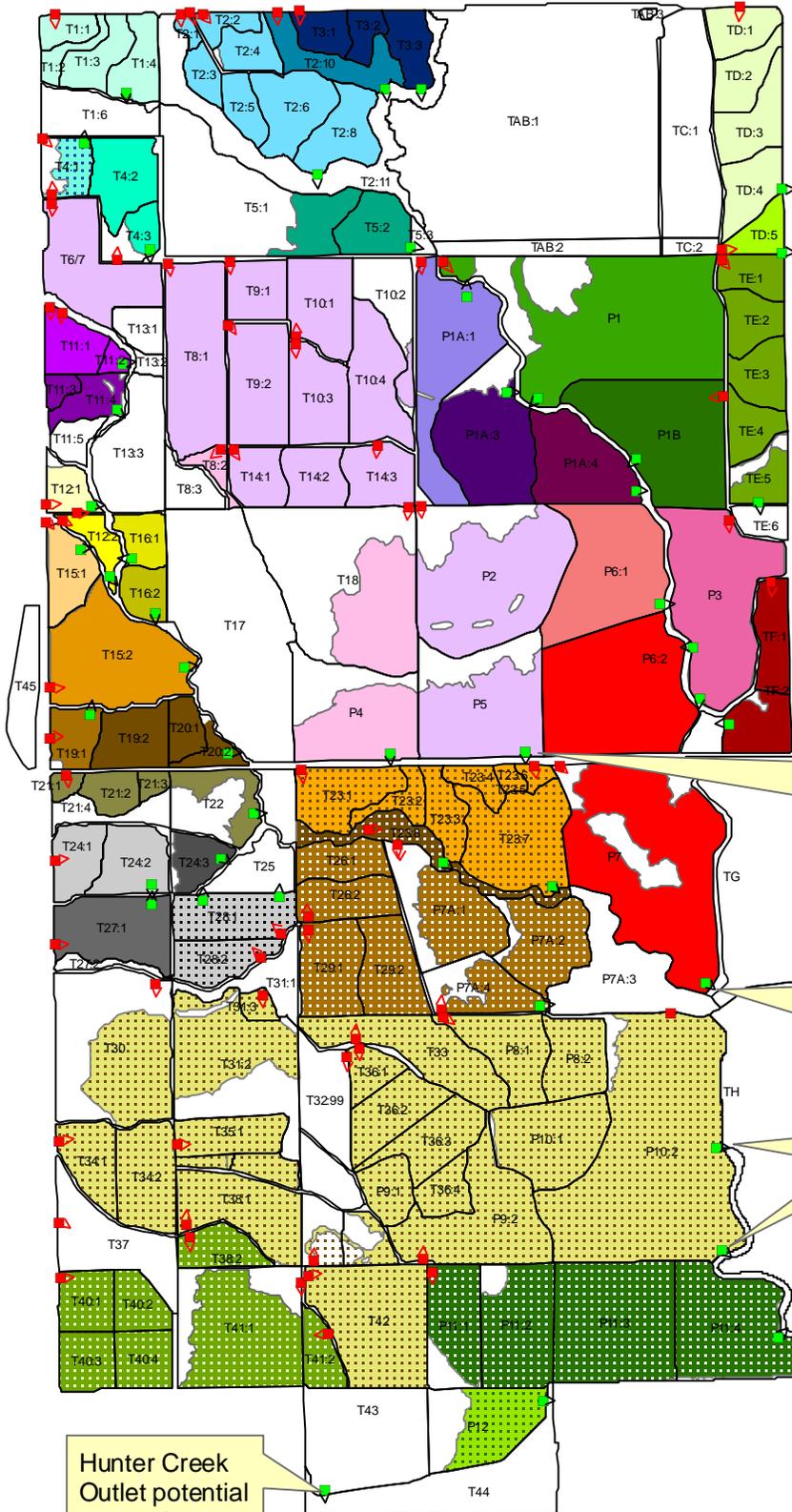
Sacramento National Wildlife Refuge



Map produced by Sacramento NWRC
 Projection: UTM Zone 10N
 Datum: NAD83
 November 2005



Sacramento National Wildlife Refuge



Drainage Areas	
T1.1 - T1.4	TD.1 - TD.4
T2.1 - T2.8	TD.5
T2.10	TE.1 - TE.5
T3	TF
T4.1	P1
T4.2 - T4.3	P1A.1
T5.1 - T5.2	P1A.3
T6/7, T8.1, T9-10, T14, P2, P5	P1A.4
T8.2, T18, P4	P1B
T11.1 & T11.2	P3
T11.3 & T11.4	P6.1
T12.1	P6.2 & P7
T12.2	P11
T15.1	P12
T15.2	Outlet
T16.1	Inlet
T16.2	
T19.1	
T19.2 & T20	
T21-22	
T23.1 - T23.7	
T23.8	
T24.1 & T24.2	
T24.3	
T26, T29, P7A	
T27.1	
T28	
T30-36, T38.1, T39, T42, P8-10	
T38.2, T40-41	



Map produced by Sacramento NWRC
 Projection: UTM Zone 10N
 Datum: NAD83
 November 2005

Attachment C

Sacramento National Wildlife Refuge

Soils Map

December 16, 2005

Sacramento National Wildlife Refuge Soil Series/Types*

Glenn County

Rma = Riz Silt Loam, slightly saline/alkaline
Rnb = Riz Silty Clay Loam, moderately saline/alkaline
Rnc = Riz Silty Clay Loam, strongly saline/alkaline

Wca = Willows Clay, slightly saline/alkaline
Wcb = Willows Clay, moderately saline/alkaline
Wcc = Willows Clay, strongly saline/alkaline

Ap = Arbuckle Gravelly Loam

H1 = Hillgate Clay Loam

Colusa County

105 = Willows Silty Clay, 0 to 1 percent slopes, occasionally flooded

113 = Westfan Loam, sodic, 0 to 2 percent slopes

144 = Hillgate Clay Loam, 0 to 2 percent slopes

155 = Alcapay Clay, 0 to 1 percent slopes

652 = Water

* from USDA Soil Survey for Glenn County, California issued May, 1968 and Map Unit Legend Summary for Colusa County, California on NRCS Web Soil Survey.

Attachment D

Sacramento National Wildlife Refuge

Water Inventory Tables

December 16, 2005

Table 1

2004*	Water Supply						Total (acre-feet)
	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Other (riparian) (acre-feet)	Other Wtr (define) (acre-feet)	
Method	M1						
Jan-2005	1,770	0	0	0	0	0	1,770
February	570	0	0	0	0	0	570
Mar-2004	1,048	0	0	0	0	0	1,048
April	734	0	0	0	0	0	734
May	1,885	0	0	0	0	0	1,885
June	2,453	0	0	0	0	0	2,453
July	1,445	0	0	0	0	0	1,445
August	3,129	0	0	0	0	0	3,129
September	6,938	0	0	0	0	0	6,938
October	10,076	0	0	0	0	0	10,076
November	6,233	0	0	0	0	0	6,233
December	4,226	0	0	0	0	0	4,226
TOTAL	40,507	0	0	0	0	0	40,507

*March 1, 2004 - February 28, 2005

Table 2

Internal Distribution System

Year	2004*								
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 popup)	Total (acre-feet)
Main - 26.2	24,000	15	360,000	9.62	37.36	3,000	1,300	E3	(4,328)
26.2 - a	4,000	10	40,000	1.07	4.15				(3)
26.2 - b	12,000	10	120,000	3.21	12.45				(9)
26.2 - c	2,600	10	26,000	0.69	2.70				(2)
26.2 - d	12,000	10	120,000	3.21	12.45				(9)
26.2 - e	5,280	10	52,800	1.41	5.48				(4)
26.2 - f	2,600	10	26,000	0.69	2.70				(2)
North Lat	13,000	15	195,000	5.21	20.23				(15)
Dam 1	5,280	15	79,200	2.12	8.22				(6)
Dam 3	2,000	15	30,000	0.80	3.11				(2)
Dam 3	5,000	15	75,000	2.00	7.78				(6)
25.1 - a	13,500	15	202,500	5.41	21.01		150		(166)
			0						0
TOTAL	101,260		1,326,500	35	138	3,000	1,450		(4,552)

30 acres

Table 3

Managed Lands Water Needs

Year	2004*										
Habitat Type	Area (habitat acres)	Habitat Needs (AF/ac)	Water Delivered (AF/ac)	AF/ac water Delivered (AF/ac)	Delivered Water (Total AF)	Precip (AF/Ac)	Shallow Groundwtr (AF/Ac)	Evap (AF/Ac)	Cultural Practices (AF/Ac)	Seepage (AF/Ac)	Balance (acre-feet)
Seasonal wetlands: timothy	6,457	5.00	5.00	5.00	32,285	1.16	0.00	1.64	1.50	1.50	9,777
Seasonal wetlands		6.00	7.50	7.50	0	1.16	0.00	2.75	2.00	1.50	0
Seasonal wetlands: watergrass	462	8.00	7.50	7.50	3,465	1.16	0.00	2.75	2.00	1.50	1,113
Permanent wetlands	231	12.00	13.25	13.25	3,061	1.16	0.00	4.52	3.00	3.00	900
Semi-perm wetlands/brood pond	366	10.00	9.00	9.00	3,294	1.16	0.00	4.52	2.50	2.00	419
Riparian	259	12.00	0.00	0.00	0	1.16	0.00	4.52	0.00	0.00	(870)
Irrigated pasture		3.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0
Upland	2,887	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0
Other (vernal pool/alkali mdw)	107	0.00	0.00	0.00	0				0.00	0.00	
Misc. habitat (less than 5%)	0				0				0.00	0.00	
Total Habitat Acres	10,769	4.23	3.91	3.91	42,105						11,338

Table 4

Refuge Water Inventory

Year	2004*	Reference		
Total Water Supply		Table 1		40,507
Precipitation		Table 2	plus	35
Evaporation		Table 2	minus	138
Seepage		Table 2	minus	3,000
Operational Losses		Table 2	minus	1,450
			Deliveries to Managed Lands	35,955
Managed Land needs		Table 3	minus	45,521
Difference		(calculated)		(9,566)
			Balance (Table 3)	11,338
			Water Inventory Balance	1,772

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)	Other (riparian) (acre-feet)	Other Wtr (define) (acre-feet)	Total (acre-feet)
1995	29,686	0	0	0	5,459	0	35,145
1996	22,893	0	0	0	14,022	0	36,915
1997	22,459	0	0	0	7,032	0	29,491
1998	23,730	0	0	0	0	0	23,730
1999	18,486	0	0	0	3,068	0	21,554
2000	27,266	0	0	0	7,744	0	35,010
2001	29,254	0	0	0	5,636	0	34,890
2002	38,909	0	0	0	0	0	38,909
2003	36,842	0	0	0	0	0	36,842
2004	40,507	0	0	0	0	0	40,507
Total	290,032	0	0	0	42,961	0	332,993
Average	29,003	0	0	0	4,296	0	33,299

Delevan National Wildlife Refuge

Water Management Plan

December 19, 2005
Revised May 11, 2006

Section A - Background

1. *The staff member responsible for developing and implementing the Plan.*

Name Steve Emmons Title Assistant Refuge Manager
Address 752 County Road 99 W, Willows, CA 95988
Telephone 530-934-2801 Fax 530-934-7814
E-mail steve_emmons@fws.gov

2. *Year Refuge established* 1962

Define year type used consistently throughout plan March 1 through February 28

3. *Water Supplies*

Annual entitlements of surface water with water right and/or contract information

<i>Agency</i>	<i>Water Source</i>	<i>Contract #</i>	<i>Contract restrictions</i>	<i>Acre-feet/year</i>
<i>Federal Level 2</i>	GCID Canal	1425-98-FC-20-17620	None	20,950
<i>Federal Level 4</i>	GCID Canal	1425-98-FC-20-17620	None	9,050
<i>State</i>	NA	NA	NA	0
<i>Other, riparian</i>	NA	SWRCB	NA	0

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

The history of water rights, contracts, and use on the Sacramento NWR Complex (Complex) is a complicated one. To summarize, until October of 1992, the Complex had no firm water supply and often suffered from lack of water availability from late November through early April.

In the mid-1980's, BOR began construction of a cross-tie from Stony Creek to the Tehama-Colusa Canal to divert 80 cfs to meet water contract demands from irrigation districts. The Refuge was promised utilization of any or all of this 80 cfs pending other current requests. The crosstie was scheduled for completion in late December of 1987. Unfortunately, the plight of the winter-run Chinook salmon in the Sacramento River necessitated the raising of the Red Bluff Diversion Dam gates. This shut down any water deliveries via the Tehama-Colusa Canal and eliminated any possibilities for winter water for the Complex. The plan is to maintain the Dam in an open position each winter, until the end of February, to allow passage of the salmon.

The Glenn-Colusa Irrigation District (GCID) serves Sacramento NWR, Delevan NWR, and Colusa NWR. GCID takes its water from the Sacramento River via lift pumps near Hamilton City. A problem with the taking of salmon via these pumps has been identified since 1920. This problem remained unresolved; and on August 19, 1991, an injunction filed against GCID by the National Marine Fisheries Service for the taking of threatened winter-run Chinook salmon took effect. GCID's pumping at the Hamilton City plant was immediately reduced from approximately 2,300 cfs to 1,100 cfs. This amount has since been increased due to work done by GCID to improve the efficiency of their fish screens at the Hamilton City pumping plant.

Delevan does not have any water rights. All water rights were sold by the landowner prior to acquisition of the refuge by the Service. Historically, the Glenn-Colusa Irrigation District had a contract to deliver Central Valley Project interim flow water to the refuge on a non-priority basis

5. *Land use history*

Habitat types specific to this refuge

See attachment A - map showing habitat location and size.

6. *Refuge habitat-types with 5% or more of total acreage*

<i>Habitat type</i>	<i>Original size</i>	<i>1992 acres</i>	<i>1997 acres</i>	<i>2004 acres</i>
<i>Seasonal wetland: timothy</i>	Not Avail	3,637	3,637	3,398
<i>Seasonal wetland: smartweed</i>	Not Avail	0	0	0
<i>Seasonal wetland: watergrass</i>	Not Avail	511	511	599
<i>Permanent wetland</i>	Not Avail	276	276	226
<i>Semi-permanent wetland / brood pond</i>	Not Avail	134	134	299
<i>Riparian</i>	Not Avail	0	0	0
<i>Upland</i>	Not Avail	1,199	1,199	1,199
<i>Reverse-cycle wetlands</i>	Not Avail	0	0	0
<i>Other (<5%) vernal pools / alkali mdws</i>	Not Avail	29	29	29
<i>Misc. habitat (less than 5 percent)</i>	Not Avail	0	0	36
<i>Sub-total – habitat acres</i>	Not Avail	5,786	5,786	5,786
<i>Roads, buildings, etc.</i>	Not Avail	11	11	11
<i>Total (size of refuge)</i>	5,522	5,797	5,797	5,797

7. *Refuge habitat-type water use characteristics*

<i>Habitat type</i>	<i>AF/ac</i>	<i># of irrigations</i>	<i>Flood date</i>	<i>Draw down date</i>
<i>Seasonal wetland: swamp timothy</i>	5.0	0	Aug-Sep	Apr 1
<i>Seasonal wetland: smartweed</i>	7.5	1	Aug-Sep	Mar 15
<i>Seasonal wetland: watergrass</i>	7.5	1	Aug-Sep	May 1
<i>Permanent wetland</i>	13.25	0	Jan 1	Dec 31
<i>Semi-permanent wetland / brood pond</i>	9.0	0	Oct 1	July 15
<i>Riparian</i>	0	0		
<i>Upland</i>	0	0		
<i>Reverse-cycle wetlands</i>	0	0		
<i>Other (<5%) vernal pools / alkali mdws</i>	0	0		
<i>Misc. habitat (less than 5 percent)</i>	0	0		

Section B - Water Management Related Goals and Objectives

1. *The Refuge mission relative to water management.*

The majority of purposes for Delevan NWR involve habitat for wetland dependant species. In this artificially created and maintained system, efficient water management is critical to accomplishing these purposes

Purposes for this Unit:

... 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. *Specific habitat management objective. Include pertinent information from Refuge management plans.*

Seasonally Marshes – swamp timothy: Marsh: By far the most numerous and diverse of the wetland habitat types, these units comprise about 70 percent of the wetland habitat base and are typically flooded from early September through mid-April. Their diversity is the product of a variety of water depths that result in diverse patterns of plant species (vegetation) that, in combination, provide habitat for the greatest number of wildlife species throughout the course of a year. Through the fall and winter, seasonally flooded marshes are used by spectacular concentrations of waterfowl and smaller numbers of egrets, herons, ibis, and grebes, to name a few. In addition, a full compliment of raptors descends upon the waterbird prey base for their winter food supply. As water is removed in the spring, large concentrations of shorebirds utilize the shallow depths and exposed mudflats on their northern migration. Seed-producing plants germinate and grow to maturity on the moist pond bottoms during the spring and early summer. Flood-up in the fall makes this food available to early migrant waterfowl and other waterbirds.

Seasonally Marshes - watergrass/smartweed: Comprising approximately 12 to 15 percent of the wetland habitat base, these units are typically flooded from late August through early May. An irrigation is usually accomplished in mid-June to bring large quantities of watergrass, sprangletop, and smartweed plants to maturity. During these irrigation periods, these units are often utilized by locally-nesting colonial waterbirds (egrets, herons). Because this habitat type often results in thick monocultures, openings are disced or mowed prior to flood-up. Though not as diverse, once flooded these units provide an abundant food source for waterfowl at a very important time (potential crop depredation) time of the year. In addition, a number of wading-bird species frequent them throughout the year.

Semi-permanent wetland/brood pond: Combined with permanent ponds, these habitats make up 5 to 10 percent of the wetland base. During the summer growing season, water is often used to encourage growth in certain sparsely vegetated units. Two water management strategies are employed: in some units, water removal will not take place until late July; in others, normal drawdown (April) is done, scheduled work is completed, and then the unit is flooded for the remainder of the year. Both practices serve to promote plant growth while providing wetland habitat for "resident" wildlife during the hot summer months.

Permanent Pond: Combined with Semi-permanent wetland/brood pond, these habitats make up 5 to 10 percent of the wetland base and remain flooded throughout the year. Characterized by both emergent and submergent aquatic plants, these units provide brood and molting areas for waterfowl, secure roosting and nesting sites for wading birds and other over-water nesters, and feeding areas for species like cormorants and pelicans. These units are drawn down every four to five years to recycle nutrients to increase their productivity and discourage carp populations.

Riparian Woodland: Comprised primarily of black willow, but with patches of sandbar willow and Fremont's cottonwood, riparian habitat occurs along Logan Creek and other managed waterways of the Refuge. Willows and cottonwoods also occur sparsely in and around some managed marsh unit. The larger "riparian tracts" are located in Tract 30 ("Sherwood Forrest' "), Tract 37 ("The Heron Rookery"), and Tract E Cell 4. Willows and cottonwoods provide nesting, roosting, and feeding habitat for passerine species and raptors, and shelter and screening for waterfowl. Deer, small mammals, and duck broods utilize creeks and water delivery systems during the summer, when most marsh units are dry.

Vernal pools and alkali meadows: Most plant species in these communities are natives and occur in a variety of patterns, which yield the most diverse vegetation on the Refuge. Nine Federal, State, and California Native Plant Society (CNPS) special status plant species occur in these habitats; as well as three special status invertebrates. During the wet season, cackling geese, wigeon, and coots graze on the depauperate grasses in the alkali meadows, and dabbling ducks and shorebirds feed in the vernal pools. Killdeer, stilts, and avocets nest in these habitats. Alkali meadows and vernal pools are the native, indigenous habitats of the Colusa Plains (Basin), once known as the "hard alkali gooseland"; now, Sacramento NWR, Delevan NWR, and Colusa NWR are virtually all that remain.

Upland: annual and perennial grasslands

3. *Strategies used to attain objectives listed above.*

On an annual basis conduct a review of the previous habitat management plan, which involves a planning team visiting each habitat unit on each refuge to document accomplishments, establish needs and develop plans for the upcoming year. Compile these findings to produce the next habitat management plan.

4. *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.

5. *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 budget and staffing limitations.

Section C - Policies and Procedures

1. *Refuge policies/procedures on accepting agricultural drainage water as supply.*

Delevan Refuge accepts upslope drainage water because GCID canal deliveries include upslope drainage water. Refuge flow-through practices result in habitat units that are on the refuge border releasing flow-through quantities into outflow drains. There is no formal policy or procedure concerning the quality of water that the refuge will accept. No standards have been established and no water quality testing is conducted.

2. *Refuge policies/procedures on water pooling, transfers, reallocations or exchange.*

The refuge has no Sacramento NWR Complex or US Fish & Wildlife policies or procedures on pooling, transfers, reallocations or exchange but follows those established by the CVPIA and in the water supply contracts.

POOLING OF WATER SUPPLIES

6. (a) Whenever the maximum quantities of Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies depicted in Exhibit AB@ are reduced pursuant to Article 9 of this Contract, the remaining Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies may be pooled for use on other Refuge(s); Provided, that no individual Refuge shall receive more Level 2 Water Supplies than would have been made available to it absent a reduction pursuant to Article 9 of this Contract; or be reduced by more than twenty-five (25) percent; Provided further, that the Contracting Officer makes a written determination that pooling of water for use on other Refuge(s) would not have an adverse impact, that cannot be reasonably mitigated, on Project operations, other Project Contractors, or other Project

purposes; Provided further, that the Contracting Officer determines that such reallocation is permitted under the terms and conditions of the applicable underlying water right permit and/or license; and Provided still further, that water made available under this contract may not be scheduled for delivery outside the Contractor's Boundary without prior written approval of the Contracting Officer.

(b) An Interagency Refuge Water Management Team, to be chaired by the Contracting Officer and to be established upon execution of this Contract, shall be entitled to collaboratively allocate the pooled water supplies and provide a schedule for delivery of the pooled supplies to meet the highest priority needs of the Refuge(s) as depicted in Exhibit AB@; Provided, however, nothing in this Article is intended to require the Contractor to pool the water supply provided for in this Contract. The Interagency Refuge Water Management Team shall be composed of designees of the Bureau of Reclamation, the United States Fish and Wildlife Service, the California Department of Fish and Game, and the Grassland Water District.

TRANSFERS, REALLOCATIONS OR EXCHANGES OF WATER

7. Subject to the prior written approval of the Contracting Officer, the Project Water made available under this Contract may be transferred, reallocated or exchanged in that Year to other Refuge(s) or Project contractors if such transfer, reallocation or exchange is requested by the Contractor and is authorized by applicable Federal and California State laws, and then-current applicable guidelines or regulations.

3. *Refuge water accounting policies/procedures for inflow, internal flow and outflow.*

Irrigators estimate quantity delivery by month for individual units. Deliveries are measured by the local irrigation district at the point of delivery. Outflow points have no measurement devices.

4. *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 unit to be flooded.

Section D - Inventory of Existing Facilities

1. *Mapping.*

The attached maps (Attachment B) show points of delivery, turnouts (internal flow), and outflow (spill) points, measurement locations, and the conveyance system. Delevan NWR does not have storage facilities, an operational loss recovery system, active wells, or water quality monitoring locations and thus these are not shown on the attached facilities map.

2. *Water Measurement.*

a. *Inflow/deliveries*

Total # of inflow locations/points of delivery 1

Total # of measured points of delivery 1

Percentage of total inflow (volume) measured in 2004 100

<i>Delivering Agency</i>	<i>Conveyance facility</i>	<i>Measuring Point</i>	<i>Refuge Distribution facility</i>	<i>% of total inflow</i>	<i>Type of Measurement</i>	<i>Measuring Agency</i>
GCID	Hunter Ck 2A	HC2A	Main Distribution	100	Par. Flume	GCID

b. Internal flow at turnouts

Total # of Refuge water management units 64

Total # of Refuge water management unit turnouts 50

Total # of measured turnouts 0

Estimated percentage of internal flow (volume) in 2004 that was measured at a turnout 0

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						
Metered gates						
Other, stop-log	50	4,522	61 - ±20%	weekly	Never	weekly

c. Outflow

Outflow (AF/yr) Unknown quantity

Total # of outflow locations/points of spill 13

Total # of measured outflow points 0

Percentage of total outflow (volume) measured during report year 0

Outflow point	Measuring point	Type of measurement	Percent of total outflow	Measuring agency	Acres drained
2047 drain	T25 north	None	23%	Delevan NWR	1,028
2047 drain	T25 south	None	22%	Delevan NWR	1,028
MID Canal	T5.2	None	4%	Delevan NWR	165
2047 drain	T5.5	None	6%	Delevan NWR	250
Stone Corral	East drain	None	14%	Delevan NWR	641
2047 drain	SE corner	None	20%	Delevan NWR	903
2047 drain	T31	None	1%	Delevan NWR	59
2047 drain	T35	None	2%	Delevan NWR	69
Stone Corral	T37.2	None	2%	Delevan NWR	78
2047 drain	T41	None	0%	Delevan NWR	16
2047 drain	T44.1	None	1%	Delevan NWR	60
2047 drain	T44.2	None	1%	Delevan NWR	43
Stone Corral	Maxwell Rd	None	4%	Delevan NWR	182
			100%		4,522

3. Type and length of the Refuge internal distribution system

Miles unlined canal	Miles lined canal	Miles piped	Miles - other
---------------------	-------------------	-------------	---------------

Delivery	Drain	Delivery/Drain			Delivery	Drain
14.1	5.8	14.6	0	0.5	0	7.3

Location / types of identified leaks, areas of above average canal seepage, and relation to soil type.
 Refuge staff has not identified any significant leaks or areas of higher than average canal seepage. No areas of high seepage due to soil type (gravel lens, etc.) have been identified.

4. *Refuge operational loss recovery system.*
 NONE

5. *Groundwater.*

Availability, quality and potential for use

USBR drilled four test wells on the Sacramento NWR and found limited quantity (hundreds of gallons instead of thousands) and poor quality (boron and/or arsenic). The groundwater basin under the Sacramento and Delevan refuges is considered to be of very limited usefulness.

Groundwater Plan No X Yes _____

Groundwater basin(s) that underlie the Refuge

<i>Name of basin underlying refuge</i>	<i>Size (sq. mi.)</i>	<i>Usable capacity (AF)</i>	<i>Safe yield (AF/Y)</i>	<i>Management agency</i>	<i>Relevant reports</i>
Colusa Subbasin	1,434	900,000	NA	Colusa County	DWR Bulletin 118

Refuge operated wells

<i>Location</i>	<i>Status</i>	<i>Yield (AF/Y)</i>	<i>Future Plans</i>
None			

Section E Environmental Characteristics

1. *Topography - impact on water management*

Relatively flat with slope from NW to SE. The water impact of this gentle NW to SE slope is that the refuge takes all delivered water at the northwest corner is used in all multiple units as it gravity flows towards the east and south spill points.

2. *Soils - impact on water management*

The soils of the Delevan NWR (Attachment C is a soils map) are fairly tight soils that minimize seepage and are thus beneficial for wetland type habitats. There are no areas of problem soils so water management is very efficient.

3. *Climate*

National Weather Service –Willows (049699), July 1948 to December 2001

	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>	<i>Annual</i>
<i>avg precip</i>	3.65	3.29	2.44	1.10	0.65	0.32	0.04	0.13	0.29	0.97	2.47	2.71	18.06
<i>avg. temp</i>	44.9	49.7	53.1	58.8	66.0	73.1	77.4	75.7	72.5	64.3	53.0	45.5	61.20
<i>max temp</i>	54.4	60.6	65.3	72.9	80.7	88.6	94.1	92.5	89.1	79.4	65.0	55.5	74.80

<i>min temp</i>	35.5	38.7	40.9	44.6	51.3	57.7	60.7	58.8	56.0	49.2	41.0	35.6	47.50
<i>ETo ('04)</i>	0.95	1.73	4.30	5.60	6.48	7.70	7.74	6.99	5.86	3.61	1.97	1.31	54.24

The impact of climate, and any microclimates, on water management

Mild damp winters and long hot summers. 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 have the greatest amount of water-use per habitat acre. The hot summers, and the resulting evaporative losses, limit the extent to which the refuge can provide permanent water habitats. No microclimates exist within the refuge borders.

4. *Water Quality Monitoring*

If the Refuge has a water quality-monitoring program complete this table.

<i>Analyses performed</i>	<i>Frequency range</i>	<i>Concentration range</i>	<i>Average</i>
pH	Once	7.8 - 8.0	7.8
Dissolved solids	Once	193 - 399	302
Dissolved oxygen	Once	5.8 – 8.2	6.7
Alkalinity as CaCO ₃	Once	125 - 238	191
Calcium	Once	19 - 31	26
Chloride	Once	10 – 33	21
Magnesium	Once	13 – 26	20
Nitrogen	Once	<0.1 – 0.23	<0.14
Potassium	Once	1.3 – 2.1	1.7
Sodium	Once	28 – 77	55
Sulfate	Once	19 – 60	41
Arsenic	Once	1 - 3	1.8
Boron	Once	110 - 260	188
Cadmium	Once	All <1	<1
Chromium	Once	All <1	<1
Copper	Once	1 - 2	1.3
Lead	Once	<5 - 17	<7
Mercury	Once	All <0.1	<0.1
Molybdenum	Once	<1 - 1	<1
Selenium	Once	<1 - 5	<1.6
Uranium	Once	<0.4 – 1.5	<0.6
Vanadium	Once	3 - 6	4.2
Zinc	Once	<3 - 39	<17.8

The impact of water quality on water management

A baseline study (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988) found no water quality problems that affect water management decisions. Water management decisions are based on this baseline study since it is the only source of water quality data specific for the refuge.

Section F Transfers, Exchanges and Trades

1. *Transfers, exchanges and trades.*

Information on any transfers, exchanges and/or trades into or out of the Refuge.

<i>From whom</i>	<i>To whom</i>	<i>2004 (AF)</i>	<i>Use</i>
None			
	TOTAL		

Section G Water Inventory

1. Refuge Water Supplies Quantified

Surface water supplies, imported and originating within the District, by month. Table 1

Ground water extracted by the Refuge, by month. Table 1

Precipitation by Habitat Type Table 3

Upslope Drain Water, by month. Table 1

Other supplies, by month Table 1

Refuge water inventory. Table 4

Ten-year history of Refuge water supplies Table 5

2. Water Used Quantified

1. Conveyance losses, including seepage, evaporation, and operational losses. Table 2

2. Applied Habitat water, evapotranspiration, water used for cultural practices (e.g., disease control, etc.). Table 3

3. Estimated deep percolation (seepage) within Habitat areas. Table 3

4. Habitat spill or drain water leaving the Refuge. Table 4

See Attachment D - detailed water inventory spreadsheet

Section H Critical Best Management Practices

1. Management Programs

a. Education

<i>Program</i>	<i>Estimated cost (in \$1,000s)</i>				
	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>
Irrigator training – 4 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Interpretive displays	\$10,000	\$1,000	\$1,000	\$10,000	\$1,000
Environmental Education – 2 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000

Program specifics

These programs apply to the Sacramento NWR Complex. The four refuge irrigators are sent to yearly training in distribution system management, flow control and turnout calibration. The Environmental Education program hosts more than 5,000 students visit each year. The materials for this program include handouts, videos and visual displays. New interpretive displays are purchased about every three years and there is an on-going expense to maintain them.

b. Water Quality Monitoring

Type of water	Estimated cost (in \$1,000s)				
	2005	2006	2007	2008	2009
Surface – USBR and riparian	NA				
Upslope Drain	NA				
Groundwater	NA				
Outflow – into GCID drains	NA				

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

The Refuge Complex is a member of Colusa Sub-basin watershed of the Sacramento Valley Coalition for monitoring water quality. No water quality problems were identified during 2004-2005. Past studies (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988; etc.) have indicated no surface water (inflow and outflow) quality issues.

c. Cooperative Efforts

The refuge is working with GCID to improve the delivery and measurement (partially through the use of SCADA) capabilities to Sacramento, Delevan and Colusa refuges. Continuing to work with USBR to secure delivery for Sutter NWR.

d. Pump Evaluations - NA

Total number of groundwater pumps on refuge: 0

Total number of surface water (low-lift) pumps on refuge: 0

Groundwater Pumps	Estimated cost (in \$1,000s)				
	2005	2006	2007	2008	2009
# of groundwater pumps to be tested	NA				
# of pumps to be fixed or replaced	NA				
# of surface water pumps to be tested	NA				
# of pumps to be fixed or replaced	NA				

e. Policy Evaluation.

1. Ability to change USBR pre-determined/scheduled monthly quantities so that the refuge can use available supply in response to unpredictable weather conditions and changing habitat needs,
2. The right to move unused allocated water between refuges within our complex, to other CVP refuges, to State F&G, and to other CVP contractors
3. US F&W joins Seven Party Agreement so that outflow (into a canal/drain) from upstream refuges (Sacramento NWR) is available for diversion to downstream refuges at no charge. This would keep the US government (USBR) from having to buy the same water multiple times.

2. *Water Shortage Contingency Plan*

Existing plan Yes Please attach No X Projected Completion Date 2007
 (Knowledge from 1978 and 1987 drought is being compiled into a plan)

Section I Exemptible Best Management Practices

1. Improve management unit configuration

Unit name	Current acres	Reason for change	Proposed acres	Estimated Cost (In \$1,000s)				
				2005	2006	2007	2008	2009
T 5.2-5	391	Better wtr mgn	391	\$0	\$56	TBD	TBD	TBD

Changes to unit configuration are determined if needed during the annual habitat management planning cycle.

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)				
			2005	2006	2007	2008	2009
10 yearly – 2005 in T 5,7, 9, 16	concrete	Replace old CMP control structures	\$9	\$9.5	\$10	\$10.5	\$11

b. Line/Pipe sections of distribution system

Proposed reach/sect.	Reason for new structure	Estimated Cost (In \$1,000s)				
		2005	2006	2007	2008	2009
See comment below						

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

c. Independent water control for each unit

Proposed control point	Reason for new control point	Estimated Cost (In \$1,000s)				
		2005	2006	2007	2008	2009
T 5.2	Independent control for brood pond	\$4	TBD	TBD	TBD	TBD

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

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)				
			2005	2006	2007	2008	2009
See comment below							

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

3. Automate water distribution system

Proposed automation location	Type of improvement	Reason for improvement	Estimated Cost (In \$1,000s)				
			2005	2006	2007	2008	2009

See comment below							

The refuge plans to focus its resources on the other BMPS. The 2004 and 2005 habitat management plans will study the benefits of automating appropriate parts of the conveyance system. The results of this study will be provided in the 2006 and 2007 annual updates.

4. Measurement

a. Plan to measure outflow

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

Identify locations	Estimated cost (in \$1,000s)				
	2005	2006	2007	2008	2009
Install measuring devices on major outlets			40	20	80

There are a number of ongoing water monitoring planning efforts off the refuge that may affect our water measurement plan and implementation. Currently, five potential sites have been identified for meters (two in Tract 25, one in the southeast corner of Tract 43), and two in the East Drain which would enable measuring outflow from approximately 79 percent of the refuge wetlands.

~~5. Incentive Pricing (Grasslands Water District only)~~

6. Construct and operate operational loss recovery systems

Proposed location	Reason for improvement	Estimated Budget (in \$1,000s)				
		2005	2006	2007	2008	2009
See comment below						

US F&W is exploring the possibility of joining the Seven Party Agreement so that outflow/spill from upstream refuges can be credited to downstream diversions. Outflow credits could be used to fund outflow/spill measurement programs. The refuge will report on the result of negotiations regarding this issue in the annual updates.

7. Optimize conjunctive use of surface and groundwater

Proposed production/injection well	Anticipated yield	Estimated Budget (in \$1,000s)				
		2005	2006	2007	2008	2009

8. Facilitate use of available recycled urban wastewater

No urban wastewater available

9. Mapping - COMPLETE

GIS maps	Estimated Budget (in \$1,000s)				
	2005	2006	2007	2008	2009
Map 1 – Distribution System					
Map 2 – Drainage System and outflow points					

10. State and Federal water use efficiency goals

Description of past, present, or future plans that address the goals identified for this refuge

Sacramento and Delevan NWRs

1. Describe actions that reduce the salinity of surface return water. This addresses TB 24 - Reduce electrical conductivity in Colusa Drain.

None - no salinity or conductivity problems have been documented on any of the refuge's wetlands.

2. Describe actions that reduce nonproductive evapotranspiration (ET). This addresses TB 25 - Reduce nonproductive ET.

The refuge has a continuous program to minimize or eradicate invasive aquatic plants (parrots feather, primrose and Arundo).

Section J BMP Exemption Requests

Summary of BMP exemptions

<i>BMP</i>	<i>Constraint</i>	<i>Outstanding Need</i>
NONE		

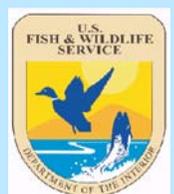
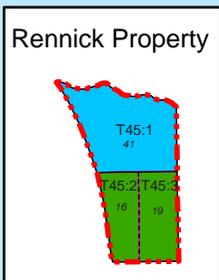
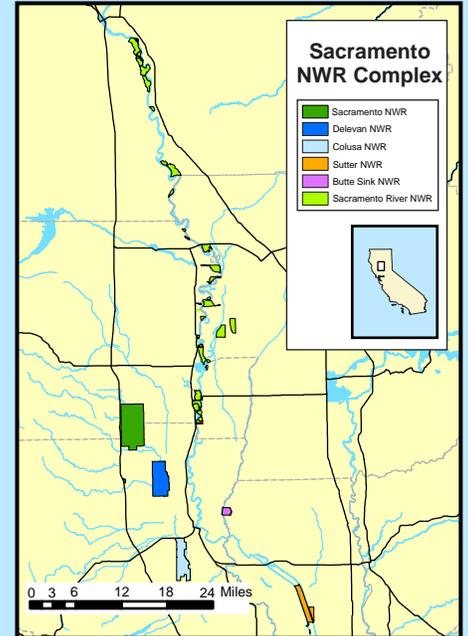
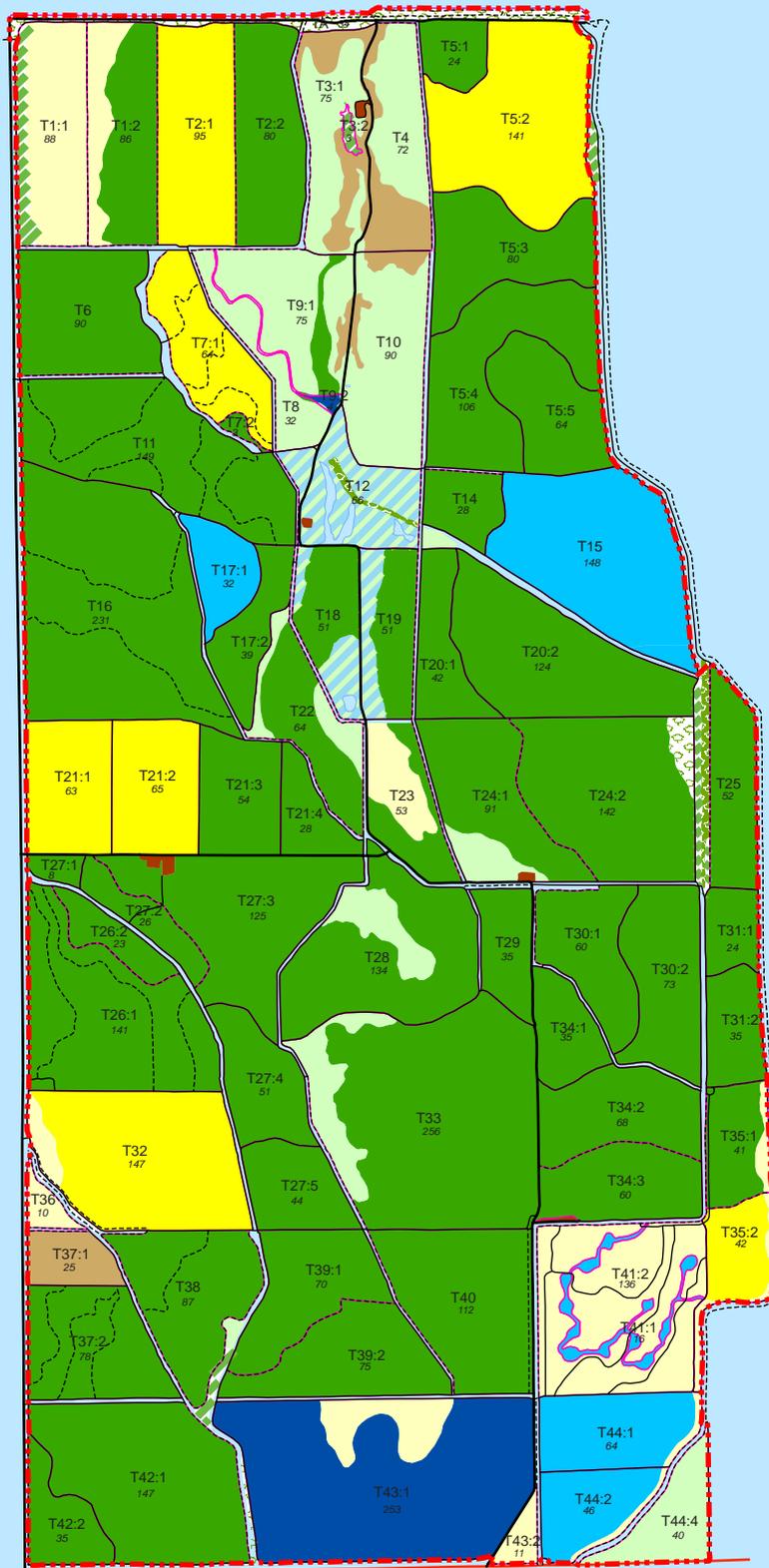
Attachment A

Delevan National Wildlife Refuge

Habitat Map

December 16, 2005

Delevan NWR



Attachment B

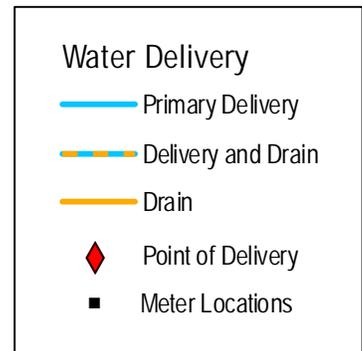
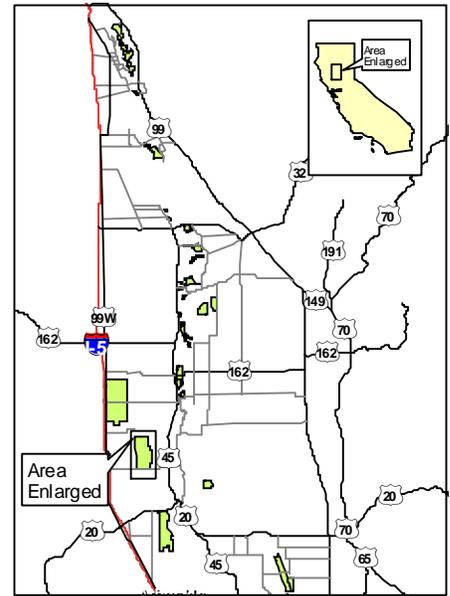
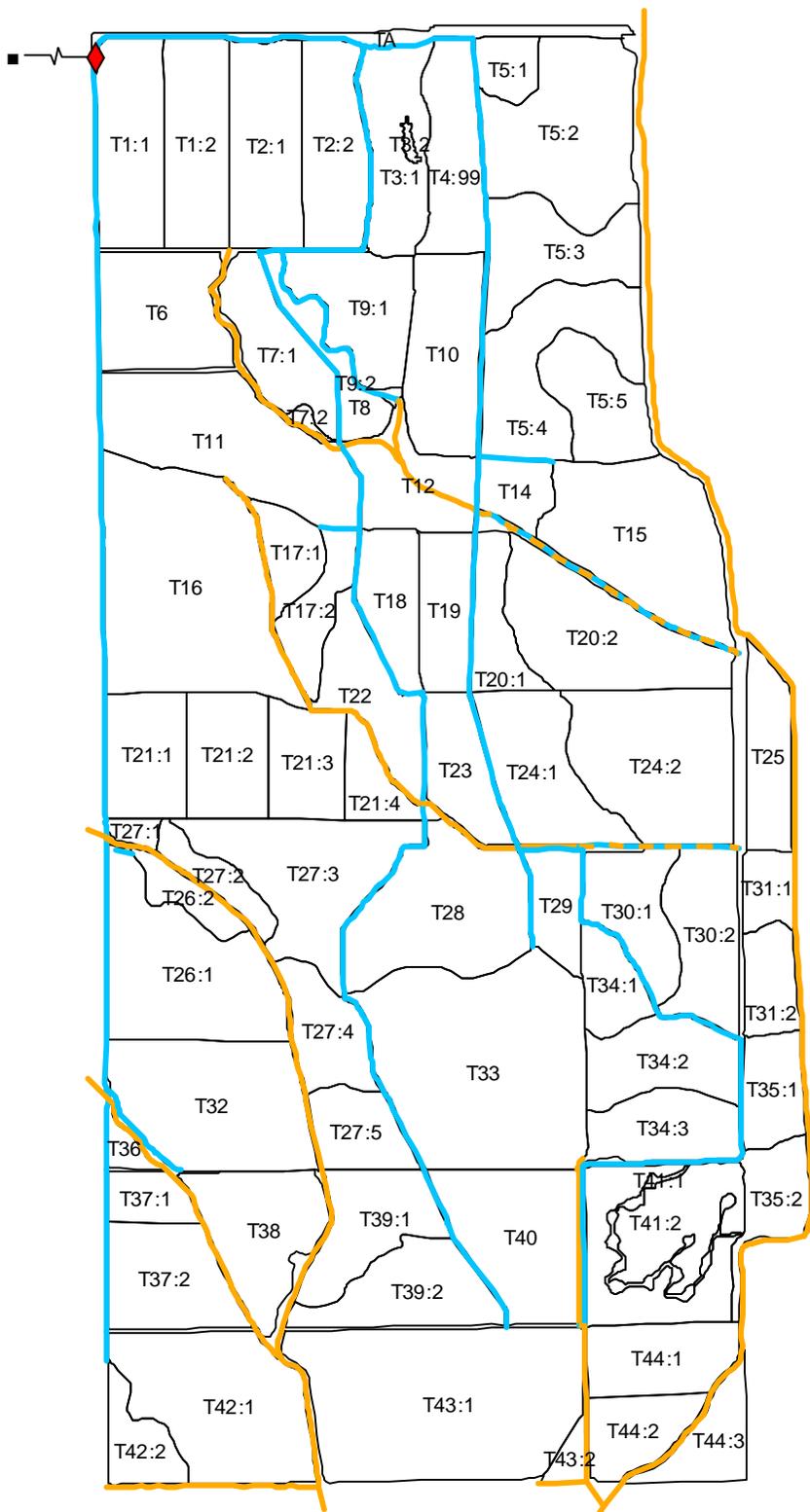
Delevan National Wildlife Refuge

Water Delivery and Drainage Map

Water Drainage Areas Map

December 16, 2005

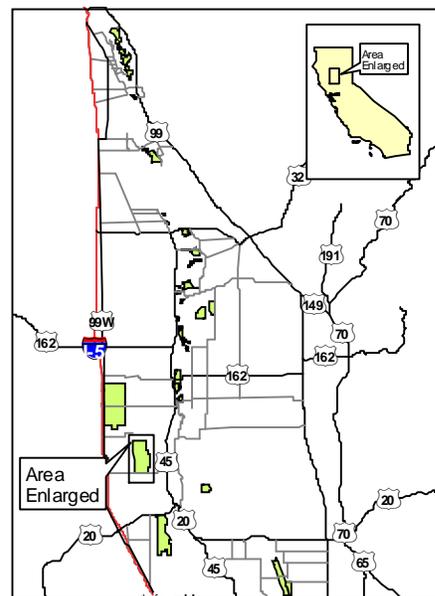
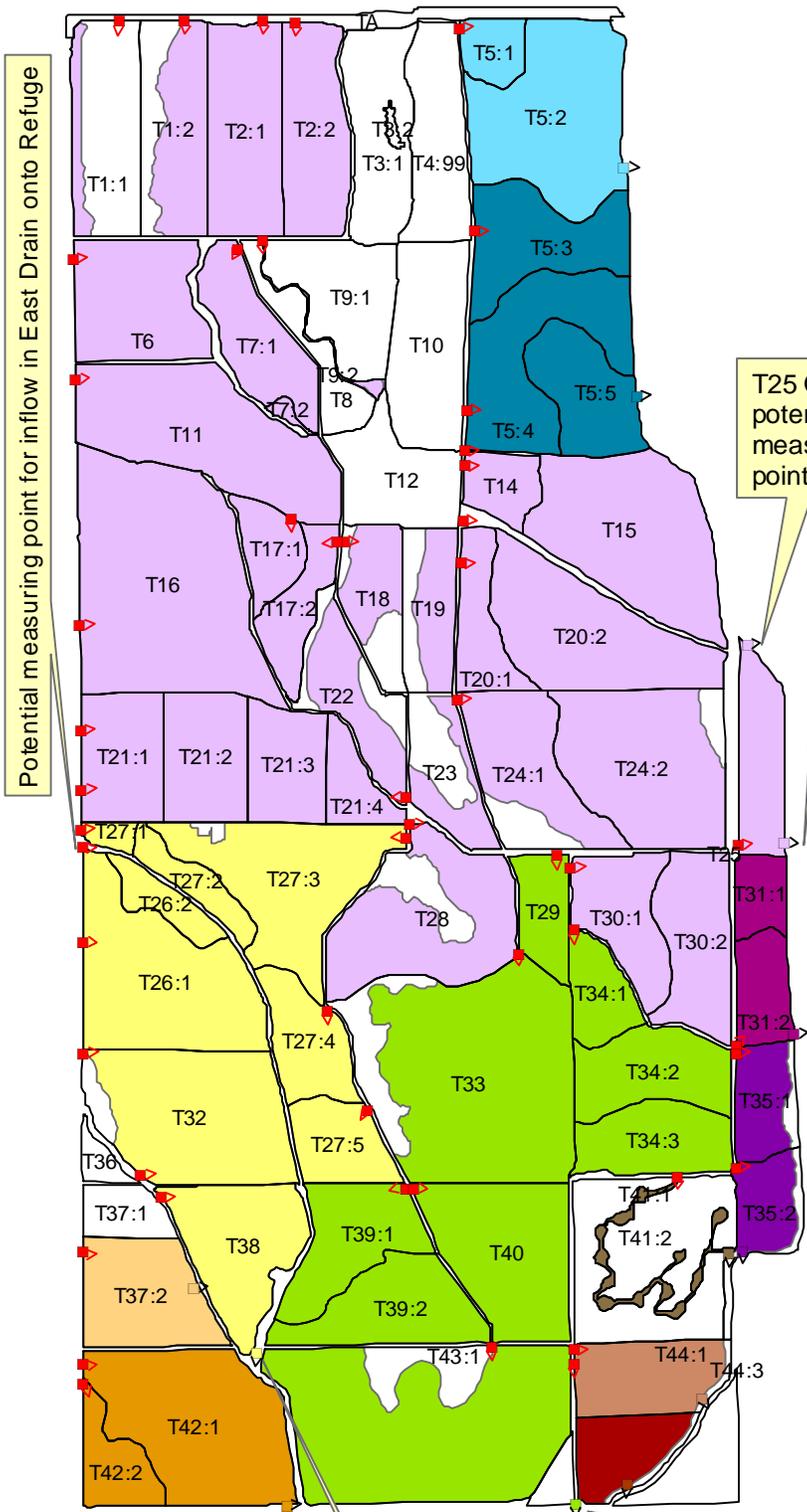
Delevan National Wildlife Refuge



Map produced by Sacramento NWRC
 Projection: UTM Zone 10N
 Datum: NAD83
 November 2005



Delevan National Wildlife Refuge



Drainage Areas	
	T1-2, T6-7, T9, T11-12, T14-25, T28, T30
	T5.1 & T5.2
	T5.3 - T5.5
	T26-27, T32, T38
	T29, T33-34, T39-40, T43
	T31
	T37
	T42
	T41
	T44.1
	T44.2
	Inlet
	T25 Outlet
	T5.2 Outlet
	T5.5 Outlet
	East Drain Outlet
	SE Corner Outlet
	T31 Outlet
	T35 Outlet
	T37.2 Outlet
	Maxwell Road Outlet
	T41 Outlet
	T44.1 Outlet
	T44.2 Outlet



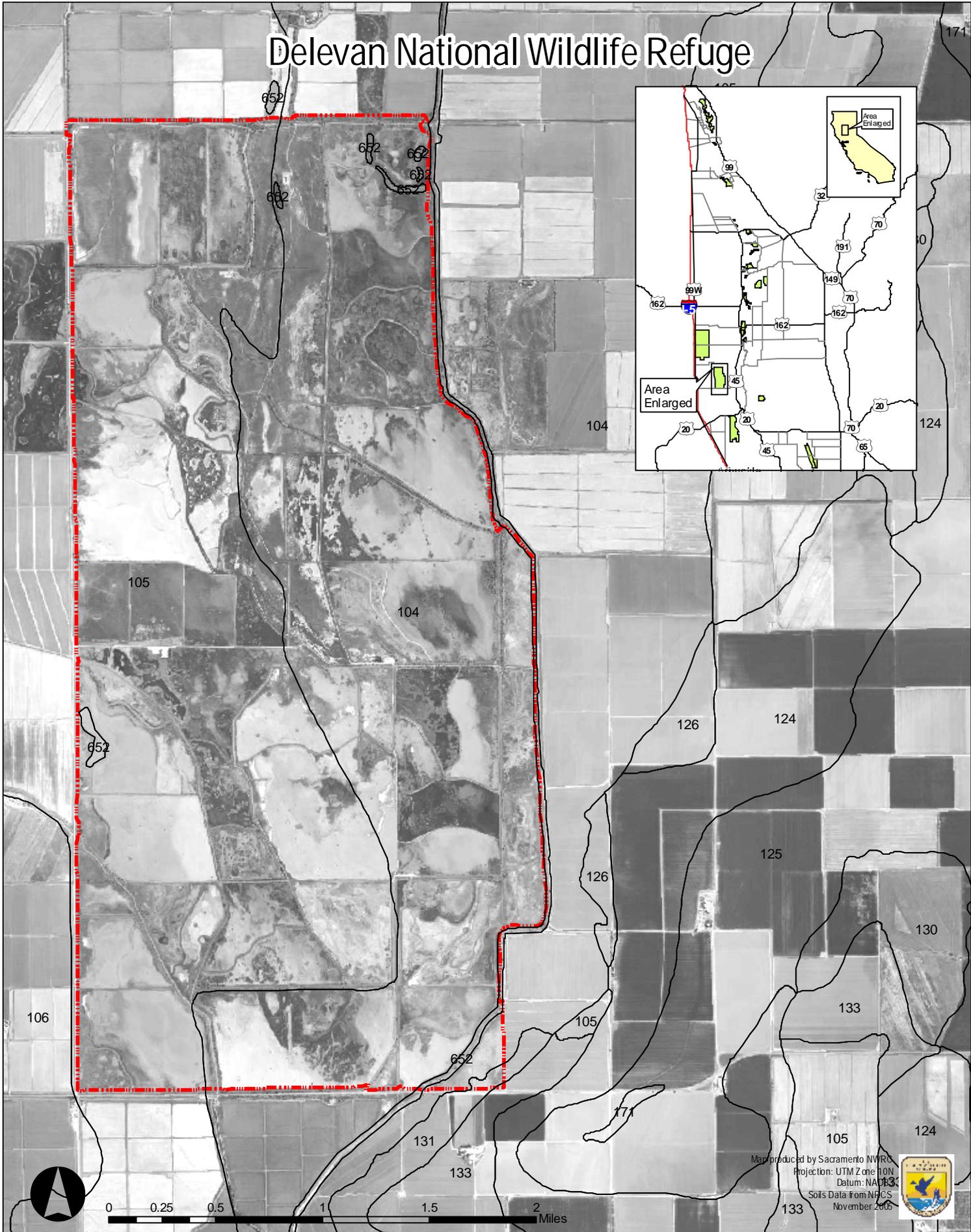
Attachment C

Delevan National Wildlife Refuge

Soils Map

December 16, 2005

Delevan National Wildlife Refuge



Map produced by Sacramento NWRC
Projection: UTM Zone 10N
Datum: NAD83
Soils Data From NRCS
November 2006



Delevan National Wildlife Refuge Soil Series/Types*

Colusa County

104 = Willows Silty Clay, 0 to 1 percent slopes, frequently flooded

105 = Willows Silty Clay, 0 to 1 percent slopes, occasionally flooded

131 = Corbiere Silt Loam, 0 to 2 percent slopes, frequently flooded

652 = Water

* from USDA Map Unit Legend Summary for Colusa County, California on NRCS Web Soil Survey.

Attachment D

Delevan National Wildlife Refuge

Water Inventory Tables

December 16, 2005

Table 1

2004*	<i>Water Supply</i>						Total (acre-feet)
	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Other (riparian) (acre-feet)	Other Wtr (define) (acre-feet)	
Method	M1						
Jan-2005	0	308	0	0	0	0	308
February	0	0	0	0	0	0	0
Mar-2004	75	0	0	0	0	0	75
April	452	0	0	0	0	0	452
May	944	0	0	0	0	0	944
June	1,156	0	0	0	0	0	1,156
July	549	0	0	0	0	0	549
August	1,288	1,000	0	0	0	0	2,288
September	4,377	1,000	0	0	0	0	5,377
October	4,465	1,000	0	0	0	0	5,465
November	2,568	1,000	0	0	0	0	3,568
December	1,024	1,000	0	0	0	0	2,024
TOTAL	16,898	5,308	0	0	0	0	22,206

*March 1, 2004 - February 28, 2005

Table 2

Internal Distribution System

Year	2004*								
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 popup)	Total (acre-feet)
North	6,336	15	95,040	2.54	9.86	300	120	E3	(427)
East	26,928	15	403,920	10.80	41.91	1,000	450		(1,481)
Center	26,400	12	316,800	8.47	32.87	1,000	450		(1,474)
West	17,952	15	269,280	7.20	27.94	700	280		(1,001)
									0
									0
									0
									0
									0
									0
									0
									0
			0						0
TOTAL	77,616		1,085,040	29	113	3,000	1,300		(4,384)

25 acres

Table 3

Managed Lands Water Needs

Year	2004*									
Habitat Type	Area (habitat acres)	Habitat Needs (AF/ac)	Water AF/ac water Delivered (AF/ac)	Delivered Water (Total AF)	Precip (AF/Ac)	Shallow Groundwtr (AF/Ac)	Evap (AF/Ac)	Cultural Practices (AF/Ac)	Seepage (AF/Ac)	Balance (acre-feet)
Seasonal wetlands: timothy	3,398	5.00	5.00	16,990	1.16	0.00	1.64	1.50	1.50	5,145
Seasonal wetlands	0	6.00	7.50	0	1.16	0.00	2.75	2.00	1.50	0
Seasonal wetlands: watergrass	599	8.00	7.50	4,493	1.16	0.00	2.75	2.00	1.50	1,443
Permanent wetlands	226	12.00	13.25	2,995	1.16	0.00	4.52	3.00	3.00	880
Semi-perm wetlands/brood pond	299	10.00	9.00	2,691	1.16	0.00	4.52	2.50	2.00	342
Riparian	0	12.00	0.00	0	1.16	0.00	4.52	0.00	0.00	0
Irrigated pasture		3.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0
Upland	1,199	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0
Other (vernal pool/alkali mdw)	29		0.00	0				0.00	0.00	
Misc. habitat (less than 5%)	16			0				0.00	0.00	
Total Habitat Acres	5,766	4.77	4.71	27,168						7,810

Table 4

Refuge Water Inventory

Year	2004*	Reference		
Total Water Supply		Table 1		22,206
Precipitation		Table 2	plus	29
Evaporation		Table 2	minus	113
Seepage		Table 2	minus	3,000
Operational Losses		Table 2	minus	1,300
			Deliveries to Managed Lands	17,822
Managed Land needs		Table 3	minus	27,484
Difference		(calculated)		(9,662)
			Balance (Table 3)	7,810
			Water Inventory Balance	(1,852)

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)	Other (riparian) (acre-feet)	Other Wtr (define) (acre-feet)	Total (acre-feet)
1995	19,693	0	0	0	0	0	19,693
1996	21,018	0	0	0	0	0	21,018
1997	23,909	0	0	0	0	0	23,909
1998	19,582	0	0	0	0	0	19,582
1999	15,537	2,027	0	0	0	0	17,564
2000	18,062	2,445	0	0	0	0	20,507
2001	19,570	0	0	0	0	0	19,570
2002	19,621	1,500	0	0	0	0	21,121
2003	16,969	5,355	0	0	0	0	22,324
2004	16,898	5,308	0	0	0	0	22,206
Total	190,859	16,635	0	0	0	0	207,494
Average	19,086	1,664	0	0	0	0	20,749

Colusa National Wildlife Refuge

Water Management Plan

December 19, 2005
Revised May 11, 2006

Section A - Background

1. *The staff member responsible for developing and implementing the Plan.*

Name Mike Peters Title Assistant Refuge Manager

Address 752 County Road 99 W, Willows, CA 95988

Telephone 530-934-2801

Fax 530-934-7814

E-mail mike_peters@fws.gov

2. *Year Refuge established* 1945

<i>Define year type used consistently throughout plan</i> <u>March 1, 2004 through February 28, 2005</u>
--

3. *Water Supplies*

Annual entitlements of surface water with water right and/or contract information

<i>Agency</i>	<i>Water Source</i>	<i>Contract #</i>	<i>Contract restrictions</i>	<i>Acre-feet/year</i>
<i>Federal Level 2</i>	GCID Canal	1425-98-FC-20-17620	None	25,000
<i>Federal Level 4</i>	GCID Canal	1425-98-FC-20-17620	None	0
<i>State</i>	NA	NA	NA	0
<i>Other, riparian</i>	2047 main drain	SWRCB	Apr 15 – Nov 1	8 cfs

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

The history of water rights, contracts, and use on the Sacramento NWR Complex is a complicated one. To summarize, until October of 1992, the Complex had no firm water supply and often suffered from lack of water availability from late November through early April.

In the mid-1980's, BOR began construction of a crosstie from Stony Creek to the Tehama-Colusa Canal to divert 80 cfs to meet water contract demands from irrigation districts. The Refuge was promised utilization of any or all of this 80 cfs pending other current requests. The crosstie was scheduled for completion in late December 1987. Unfortunately, the plight of the winter-run Chinook salmon in the Sacramento River necessitated the raising of the Red Bluff Diversion Dam gates. This shut down any water deliveries via the Tehama-Colusa Canal and eliminated any possibilities for winter water for the Complex. The plan is to maintain the Dam in an open position each winter, until the end of February, to allow passage of the salmon.

The Glenn Colusa Irrigation District (GCID) serves Sacramento NWR, Delevan NWR, and Colusa NWR. GCID takes its water from the Sacramento River via lift pumps near Hamilton City. A problem with the taking of salmon via these pumps has been identified since 1920. This problem remained unresolved; and on August 19, 1991, an injunction filed against GCID by the National Marine Fisheries Service for the taking of threatened winter-run chinook salmon took effect. GCID's pumping at the Hamilton City plant was immediately reduced from approximately 2,300 cfs to 1,100 cfs. This amount has since been increased due to work done by GCID to improve the efficiency of their fish screens at the Hamilton City pumping plant.

Colusa has two appropriative licenses for relatively small quantities of water. Historically, the Glenn-Colusa Irrigation District had a contract to deliver Central Valley Project interim flow water to the Refuge on a non-priority basis.

5. *Land use history*

Habitat types specific to this refuge

See attachment A - map showing habitat location and size.

6. *Refuge habitat-types with 5% or more of total acreage*

<i>habitat type</i>	<i>Original size</i>	<i>1992 acres</i>	<i>1997 acres</i>	<i>2004 acres</i>
<i>Seasonal wetland: timothy</i>	Not Avail	2,851	2,851	2,851
<i>Seasonal wetland: smartweed</i>	Not Avail	0	0	0
<i>Seasonal wetland: watergrass</i>	Not Avail	247	247	247
<i>Permanent wetland</i>	Not Avail	150	150	150
<i>Semi-permanent wetland / brood pond</i>	Not Avail	101	101	101
<i>Riparian</i>	Not Avail	4	4	4
<i>Upland</i>	Not Avail	613	613	613
<i>Reverse-cycle wetlands</i>	Not Avail	0	0	0
<i>Other (<5%) vernal pools / alkali mdws</i>	Not Avail	424	424	424
<i>Misc. habitat (less than 5 percent)</i>	Not Avail	93	93	93
<i>Sub-total – habitat acres</i>	Not Avail	4,483	4,483	4,483
<i>Roads, buildings, etc.</i>	Not Avail	143	143	143
<i>Total (size of refuge)</i>	4,040	4,626	4,626	4,626

7. *Refuge habitat-type water use characteristics*

<i>habitat type</i>	<i>AF/ac</i>	<i># of irrigations</i>	<i>Flood date</i>	<i>Draw down date</i>
<i>Seasonal wetland: timothy</i>	5.0	0	Aug-Sep	Apr 1
<i>Seasonal wetland: smartweed</i>	7.5	1	Aug-Sep	Mar 15
<i>Seasonal wetland: watergrass</i>	7.5	1	Aug-Sep	May 1
<i>Permanent wetland</i>	13.25	0		
<i>Semi-permanent wetland / brood pond</i>	9.0	0	Oct 1	July 15
<i>Riparian</i>	0	0		
<i>Upland</i>	0	0		
<i>Reverse-cycle wetlands</i>	0	0		
<i>Other (<5%) vernal pools / alkali mdws</i>	0	0		
<i>Misc. habitat (less than 5 percent)</i>	0	0		

Section B - Water Management Related Goals and Objectives

1. *Refuge mission relative to water management.*

The majority of purposes for Sacramento NWR involve habitat for wetland dependant species. In this artificially created and maintained system efficient water management is critical to accomplishing these purposes

Purposes for this Unit:

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

... to conserve (A) fish or wildlife which are listed as endangered species or threatened species... or (B) plants ... 16 U.S.C. 1534 (Endangered Species Act of 1973)

... for management and control of migratory waterfowl and other wildlife ... 16 USC 695 (Lea Act)

2. *Specific habitat management objective. Include pertinent information from Refuge management plans.*

Seasonally Marshes - timothy: Marsh: By far the most numerous and diverse of the wetland habitat types, these units comprise about 70 percent of the wetland habitat base and are typically flooded from early September through mid-April. Their diversity is the product of a variety of water depths that result in diverse patterns of plant species (vegetation) that, in combination, provide habitat for the greatest number of wildlife species throughout the course of a year. Through the fall and winter, seasonally flooded marshes are used by spectacular concentrations of waterfowl and smaller numbers of egrets, herons, ibis, and grebes, to name a few. In addition, a full compliment of raptors descend upon the waterbird prey base upon which they depend. As water is removed in the spring, large concentrations of shorebirds utilize the shallow depth and exposed mudflats on their northern migration. Seed-producing plants germinate and grow to maturity on the moist pond bottoms during the spring and early summer. Flood-up in the fall makes this food available to early migrant waterfowl and other waterbirds.

Seasonally Marshes - watergrass/smartweed: Comprising approximately 12 to 15 percent of the wetland habitat base, these units are typically flooded from late August through early May. An irrigation is usually accomplished in mid-June to bring large quantities of watergrass, sprangletop, and smartweed plants to maturity. During these irrigation periods, these units are often utilized by locally-nesting colonial waterbirds (egrets, herons). Because this habitat type often results in thick monocultures, openings are disced or mowed prior to flood-up. Though not as diverse, once flooded these units provide an abundant food source for waterfowl at a very important (potential crop depredation) time of the year. In addition, a number of wading-bird species frequent them throughout the year.

Semi-permanent wetland/brood pond: Combined with permanent ponds, these habitats make up 5 to 10 percent of the wetland base. During the summer growing season, water is often used to encourage growth in certain sparsely vegetated units. Two water management strategies are employed: in some units, water removal will not take place until late July; in others, normal drawdown (April) is done, scheduled work is completed, and then the unit is flood for the remainder of the year. Both practices serve to promote plant growth while providing habitat for "resident" wildlife during the hot summer months.

Permanent Pond: Combined with Semi-permanent wetland/brood pond, these habitats make up 5 to 10 percent of the wetland base and remain flooded throughout the year. Characterized by both emergent and submergent aquatic plants, these units provide brood and molting areas for waterfowl, secure roosting and nesting sites for wading birds and other over-water nesters, and feeding areas for species like cormorants and pelicans. These units are drawn down every four to five years to recycle nutrients to increase their productivity and discourage carp populations.

Riparian Woodland: Comprised primarily of black willow, but with patches of sandbar willow and Fremont's cottonwood, riparian habitat occurs along Logan Creek and other managed waterways of the Refuge. Willows and cottonwoods also occur sparsely in and around some managed marsh unit. The larger "riparian tracts" are located in Tract 30 ("Sherwood Forrest' "), Tract 3 7 ("The Heron Rookery"), and Tract E Cell 4. Willows and cottonwoods provide nesting, roosting, and feeding habitat for passerine species and raptors, and shelter and screening for waterfowl. Deer, small mammals, and duck broods utilize creeks and water delivery systems during summer when most marsh units are dry.

Vernal pools and alkali meadows: Most plant species in these communities are natives and occur in a variety of patterns, which yield the most diverse vegetation on the Refuge. Nine Federal, State, and California Native Plant Society (CNPS) special status plant species occur in these habitats; as well as three special status invertebrates. During the wet season, cackling geese, wigeon, and coots graze on the depauperate grasses in the alkali meadows, and dabbling ducks and shorebirds feed in the vernal pools. Killdeer, stilts, and avocets nest in these habitats. Alkali meadows and vernal pools are the native, indigenous habitats of the Colusa Plains (Basin), once known as the "hard alkali gooseland"; now, Sacramento NWR, Delevan NWR, and Colusa NWR are virtually all that remain.

Upland: annual and perennial grasslands

3. Strategies used to attain objectives listed above.

On an annual basis conduct a review of the previous habitat management plan, which involves a planning team, visiting each habitat unit on each refuge to document accomplishments, establish needs and develop plans for the upcoming year. Compile these findings to produce the next habitat management plan.

4. 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.

5. 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 budget and staffing limitations.

Section C - Policies and Procedures

1. Refuge policies/procedures on accepting agricultural drainage water as supply.

Delevan Refuge accepts upslope drainage water because GCID canal deliveries include upslope drainage water. Refuge flow-through practices result in habitat units that are on the refuge border releasing flow-through quantities into outflow drains. There is no formal policy or procedure concerning the quality of water that the refuge will accept. No standards have been established and no water quality testing is conducted.

2. Refuge policies/procedures on water pooling, transfers, reallocations or exchange.

The refuge has no Sacramento NWR Complex or US Fish & Wildlife policies or procedures on pooling, transfers, reallocations or exchange but follows those established by the CVPIA and in the water supply contracts.

POOLING OF WATER SUPPLIES

6. (a) Whenever the maximum quantities of Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies depicted in Exhibit AB@ are reduced pursuant to Article 9 of this Contract, the remaining Level 2 Water Supplies and/or the Incremental Level 4 Water Supplies may be pooled for use on other Refuge(s); Provided, that no individual Refuge shall receive more Level 2 Water Supplies than would have been made available to it absent a reduction pursuant to Article 9 of this Contract; or be reduced by more than twenty-five (25) percent; Provided further, that the Contracting Officer makes a written determination that pooling of water for use on other Refuge(s) would not have an adverse impact, that cannot be reasonably mitigated, on Project operations, other Project Contractors, or other Project purposes; Provided further, that the Contracting Officer determines that such reallocation is permitted under the terms and conditions of the applicable underlying water right permit and/or license; and Provided still further, that water made available under this contract may not be scheduled for delivery outside the Contractor=s Boundary without prior written approval of the Contracting Officer.

(b) An Interagency Refuge Water Management Team, to be chaired by the Contracting Officer and to be established upon execution of this Contract, shall be entitled to collaboratively allocate the pooled water supplies and provide a schedule for delivery of the pooled supplies to meet the highest priority needs of the Refuge(s) as depicted in Exhibit AB@; Provided, however, nothing in this Article is intended to require the Contractor to pool the water supply provided for in this Contract. The Interagency Refuge Water Management Team shall be composed of designees of the Bureau of Reclamation, the United States Fish and Wildlife Service, the California Department of Fish and Game, and the Grassland Water District.

TRANSFERS, REALLOCATIONS OR EXCHANGES OF WATER

7. Subject to the prior written approval of the Contracting Officer, the Project Water made available under this Contract may be transferred, reallocated or exchanged in that Year to other Refuge(s) or Project contractors if such transfer, reallocation or exchange is requested by the Contractor and is authorized by applicable Federal and California State laws, and then-current applicable guidelines or regulations.

3. Refuge water accounting policies/procedures for inflow, internal flow and outflow.

Irrigators estimate quantity delivery by month for individual units. Deliveries are measured by the local irrigation district at the points of delivery. Outflow points have no measurement devices.

4. 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.

Section D - Inventory of Existing Facilities

1. Mapping.

The attached maps (Attachment B) shows points of delivery, turnouts (internal flow), and outflow (spill) points, measurement locations, and the conveyance system. Sac NWR does not have storage facilities, an operational loss recovery system, active wells, or water quality monitoring locations and thus these are not shown on the attached facilities map.

2. Water Measurement.

a. Inflow/deliveries

Total # of inflow locations/points of delivery 3

Total # of measured points of delivery 3

Percentage of total inflow (volume) measured in 2004 100

Delivering Agency	Conveyance facility	Measuring Point	Refuge Distribution facility	% of total inflow	Type of Measurement	Measuring Agency
GCID	West Canal	64.1	West Canal	86	Flow meter	GCID
GCID	2047	Main Pump	West Canal	4	Flow meter	GCID
GCID	Hwy 20 Canal	Hwy 20 Pump	Hwy 20 Canal	10	Flow meter	GCID

b. Internal flow at turnouts

Total # of Refuge water management units 60

Total # of Refuge water management unit turnouts 28

Total # of measured turnouts 0

Estimated percentage of internal flow (volume) in 2002 that was measured at a turnout 0

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						
Metered gates						
Other, stop-log	28	3,209	0	daily	Never	weekly

c. Outflow

Outflow (AF/yr) Unknown quantity

Total # of outflow locations/points of spill 7

Total # of measured outflow points 0

Percentage of total outflow (volume) measured during report year 0

<i>Outflow point</i>	<i>Measuring point</i>	<i>Type of measurement</i>	<i>Percent of total outflow</i>	<i>Measuring agency</i>	<i>Acres drained</i>
2047 drain	T1, cell 4	None	9	Colusa NWR	300
Powell Slough	T9, south outlet	None	1	Colusa NWR	20
East West J-Drain	T12A outlet	None	25	Colusa NWR	826
2047 drain	Pool 6 outlet	None	45	Colusa NWR	1,472
2047 drain	T14, cell 2	None	2	Colusa NWR	52
2047 drain	Able Road, T17	None	16	Colusa NWR	538
2047 drain	T19, cell 4	None	3	Colusa NWR	91

3. *Type and length of the Refuge internal distribution system*

<i>Miles unlined canal</i>			<i>Miles lined canal</i>	<i>Miles piped</i>	<i>Miles - natural</i>	
<i>Delivery</i>	<i>Drain</i>	<i>Delivery/Drain</i>			<i>Delivery</i>	<i>Drain</i>
9.5	8.5	.75	0	0	0	.5

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

Refuge staff has not identified any significant leaks or areas of higher than average canal seepage. No areas of high seepage due to soil type (gravel lens, etc.) have been identified.

Refuge operated lift pumps

<i>#</i>	<i>Location</i>	<i>Status</i>	<i>HP</i>
Highway 20	Tract 1	active	25
Main	Tract 6	active	25
Tract 5 lift	Tract 5	active	25

4. *Refuge operational loss recovery system.*

NONE

5. *Groundwater.*

Availability, quality and potential for use

USBR drilled four test wells – found limited quantity (hundreds of gallons instead of thousands) and poor quality (boron and/or arsenic). The groundwater basin under the refuge is considered to be of very limited usefulness.

Groundwater Plan No X Yes _____

Groundwater basin(s) that underlie the Refuge

<i>Name of basin underlying refuge</i>	<i>Size (sq. mi.)</i>	<i>Usable capacity (AF)</i>	<i>Safe yield (AF/Y)</i>	<i>Management agency</i>	<i>Relevant reports</i>
Colusa Subbasin	1,434	900,000	NA	Colusa County	DWR Bulletin 118

Refuge operated wells

<i>Location</i>	<i>Status</i>	<i>Yield (AF/Y)</i>	<i>Future Plans</i>
None			

Section E Environmental Characteristics

1. Topography - impact on water management

Relatively flat with slope from NW to SE. The water impact of this gentle NW to SE slope is that the refuge takes a maximum amount of delivered water on along the north and west boundaries to that the supply can be used in multiple units as it gravity flows towards the SE spill points.

2. Soils - impact on water management

The soils of the Sac NWR (Attachment C is a soils map) are fairly tight soils that minimize seepage and are thus beneficial for wetland type habitats. There are no areas of problem soils so water management is very efficient.

3. Climate

National Weather Service –Willows (049699), July 1948 to December 2001

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
<i>avg precip</i>	3.65	3.29	2.44	1.10	0.65	0.32	0.04	0.13	0.29	0.97	2.47	2.71	18.06
<i>avg. temp</i>	44.9	49.7	53.1	58.8	66.0	73.1	77.4	75.7	72.5	64.3	53.0	45.5	61.20
<i>max temp</i>	54.4	60.6	65.3	72.9	80.7	88.6	94.1	92.5	89.1	79.4	65.0	55.5	74.80
<i>min temp</i>	35.5	38.7	40.9	44.6	51.3	57.7	60.7	58.8	56.0	49.2	41.0	35.6	47.50
<i>ETo ('04)</i>	0.95	1.73	4.30	5.60	6.48	7.70	7.74	6.99	5.86	3.61	1.97	1.31	54.24

The impact of climate, and any microclimates, on water management

Mild damp winters and long hot summers. 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 have the greatest amount of water-use per habitat acre. The hot summers, and the resulting evaporative losses, limit the extent to which the refuge can provide permanent water habitats. No microclimates exist within the refuge borders.

4. Water Quality Monitoring

<i>Analyses performed</i>	<i>Frequency range</i>	<i>Concentration range</i>	<i>Average</i>
pH	Once	7.2 - 8.0	7.6
Dissolved solids	Once	252 - 513	394
Dissolved oxygen	Once	4.7 - 8.2	6.6
Alkalinity as CaCO ₃	Once	171 - 287	230
Calcium	Once	24 - 40	32
Chloride	Once	14 - 31	25
Magnesium	Once	18 - 35	26
Nitrogen	Once	<0.1 - 0.24	<0.3
Potassium	Once	1.6 - 2.1	1.8
Sodium	Once	36 - 94	73
Sulfate	Once	35 - 110	75
Arsenic	Once	2 - 7	3.8
Boron	Once	150 - 350	270
Cadmium	Once	All <1	<1
Chromium	Once	<1 - 1	<1

Copper	Once	1 - 3	1.8
Lead	Once	<5 - 17	<5.5
Mercury	Once	All <0.1	<0.1
Molybdenum	Once	1 - 2	1.3
Selenium	Once	All <1	<1
Uranium	Once	0.5 – 1.4	.9
Vanadium	Once	3 - 9	5
Zinc	Once	<3 - 12	<6

The impact of water quality on water management

A baseline study (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988) found no water quality problems that affect water management decisions. Water management decisions are based on this baseline study since it is the only source of water quality data specific for the refuge.

Section F Transfers, Exchanges and Trades

1. *Transfers, exchanges and trades.*

Information on any transfers, exchanges and/or trades into or out of the Refuge.

<i>From whom</i>	<i>To whom</i>	<i>2002 (AF)</i>	<i>Use</i>
None			
	TOTAL		

Section G Water Inventory

1. Refuge Water Supplies Quantified

Surface water supplies, imported and originating within the District, by month. Table 1

Ground water extracted by the Refuge, by month. Table 1

Precipitation by Habitat Type Table 3

Upslope Drain Water, by month. Table 1

Other supplies, by month Table 1

Refuge water inventory. Table 4

Ten-year history of Refuge water supplies Table 5

2. Water Used Quantified

1. Conveyance losses, including seepage, evaporation, and operational losses. Table 2

2. Applied Habitat water, evapotranspiration, water used for cultural practices (e.g., disease control, etc.). Table 3

3. Estimated deep percolation (seepage) within Habitat areas. Table 3

4. Habitat spill or drain water leaving the Refuge. Table 4

Section H Critical Best Management Practices

1. *Management Programs*

a. *Education*

<i>Program</i>	<i>Estimated cost (in \$1,000s)</i>				
	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
Irrigator training – 4 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000
Interpretive displays	\$10,000	\$1,000	\$1,000	\$10,000	\$1,000
Environmental Education – 2 staff	\$2,000	\$2,000	\$2,000	\$2,000	\$2,000

Program specifics

The four refuge irrigators are sent to yearly training in distribution system management, flow control and turnout calibration. The Environmental Education program hosts more than 5,000 students visit each year. The materials for this program include handouts, videos and visual displays. New interpretive displays are purchased about every three years and there is an on-going expense to maintain them.

b. Water Quality Monitoring

<i>Type of water</i>	<i>Estimated cost (in \$1,000s)</i>				
	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
<i>Surface – USBR and riparian</i>	NA				
<i>Upslope Drain</i>	NA				
<i>Groundwater</i>	NA				
<i>Outflow – into GCID drains</i>	NA				

Description of existing or planned program – required by which agency, coordinated with whom, constituents monitored and frequency

The Refuge Complex is a member of Colusa Sub-basin watershed of the Sacramento Valley Coalition for monitoring water quality. No water quality problems were identified during 2004-2005. Past studies (Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Sacramento National Wildlife Refuge Complex. 1988; etc.) have indicated no surface water (inflow and outflow) quality issues.

c. Cooperative Efforts

The refuge is working with GCID to improve the delivery and measurement (partially through the use of SCADA) capabilities to Sacramento, Delevan and Colusa refuges. Continuing to work with USBR to secure delivery for Sutter NWR.

d. Pump Evaluations - NA

Total number of groundwater pumps on refuge: 0

Total number of surface water (low-lift) pumps on refuge: 0

<i>Groundwater Pumps</i>	<i>Estimated cost (in \$1,000s)</i>				
	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
<i># of groundwater pumps to be tested</i>	NA				
<i># of pumps to be fixed or replaced</i>	NA				
<i># of surface water pumps to be tested</i>	NA				
<i># of pumps to be fixed or replaced</i>	NA				

e. Policy Evaluation.

1. Ability to change USBR pre-determined/scheduled monthly quantities so that the refuge can use available supply in response to unpredictable weather conditions and changing habitat needs,
2. The right to move unused allocated water between refuges within our complex, to other CVP refuges, to State F&G, and to other CVP contractors
3. US F&W joins Seven Party Agreement so that outflow (into a canal/drain) from upstream refuges (Sac NWR) is available for diversion to downstream refuges (Colusa Refuge). This would keep the US government from having to buy the same water multiple times.

2. *Water Shortage Contingency Plan*

Existing plan Yes _____ Please attach No X Projected Completion Date 2007
 (knowledge from 1978 and 1987 droughts is being compiled into a plan)

Section I Exemptible Best Management Practices

1. *Improve management unit configuration*

Unit name	Current acres	Reason for change	Proposed acres	Estimated Cost (In \$1,000s)				
				2006	2007	2008	2009	2010
None								

Changes to unit configuration are determined if needed during the annual habitat management planning cycle.

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)				
			2006	2007	2008	2009	2010
4 structures yearly	Concrete	Replace old CMP control structures	4	4.1	4.3	4.5	4.6

b. *Line/Pipe sections of distribution system*

Proposed reach/sect.	Reason for new structure	Estimated Cost (In \$1,000s)				
		2006	2007	2008	2009	2010
No proposed	changes in 5 year period					
See comments below						

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

c. *Independent water control for each unit*

Proposed control point	Reason for new control point	Estimated Cost (In \$1,000s)				
		2006	2007	2008	2009	2010
T13.3 inlet	Independent inlet		2			

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

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

<i>Proposed new section</i>	<i>Units served</i>	<i>Reason for new section</i>	<i>Estimated Cost (In \$1,000s)</i>				
			<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
Pool 5 inlet	Pool 5&6	Improve water management					TBD
See comments below							

Changes to the distribution system are determined if needed during the annual habitat management planning cycle.

3. Automate water distribution system

<i>Proposed automation location</i>	<i>Type of improvement</i>	<i>Reason for improvement</i>	<i>Estimated Cost (In \$1,000s)</i>				
			<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
None							
See comments below							

The refuge plans to focus its resources on the other BMPS. The 2004 and 2005 habitat management plans will study the benefits of automating appropriate parts of the conveyance system. The results of this study will be provided in the 2005 and 2006 annual updates.

4. Measurement

a. Plan to measure outflow

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

<i>Identify locations</i>	<i>Estimated cost (in \$1,000s)</i>				
	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
<i>Install measuring devices on major outlets</i>			40	40	20

There are a number of ongoing water monitoring planning efforts off the Refuge that may affect our water measurement plan and implementation. Potential outflow measuring sites include Tract 1.3 outlet, Tract 10A outlet, Tract 12A outlet, Tract 17 outlet, and Pool 6 outlet.

~~5. Incentive Pricing (Grasslands Water District only)~~

6. Construct and operate operational loss recovery systems

<i>Proposed location</i>	<i>Reason for improvement</i>	<i>Estimated Budget (in \$1,000s)</i>				
		<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
None						
See comments below						

US F&W is exploring the possibility of joining the Seven Party Agreement so that outflow/spill from upstream refuges can be credited to downstream diversions. Outflow credits could be used to fund outflow/spill measurement programs. The refuge will report on the result of negotiations regarding this issue in the annual updates.

7. Optimize conjunctive use of surface and groundwater

<i>Proposed production/injection well</i>	<i>Anticipated yield</i>	<i>Estimated Budget (in \$1,000s)</i>				
		<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
NA - no useable groundwater						

8. *Facilitate use of available recycled urban wastewater*
 No urban wastewater available

9. *Mapping*

<i>GIS maps</i>	<i>Estimated Budget (in \$1,000s)</i>				
	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>
<i>Map 1 – Distribution System</i>		2.5			
<i>Map 2 –Drainage System and outflow points</i>		2.5			

10. *State and Federal water use efficiency goals*

Description of past, present, or future plans that address the goals identified for this refuge Colusa and Sutter NWR's

1. Describe actions that reduce nonproductive ET. (TB 33)

The refuge has a continuous program to minimize or eradicate invasive aquatic plants (parrots feather, primrose and arundo).

Section J BMP Exemption Requests

Summary of BMP exemptions

<i>BMP</i>	<i>Constraint</i>	<i>Outstanding Need</i>
NONE		

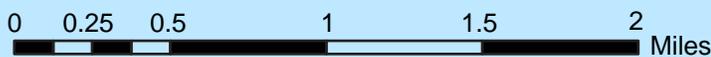
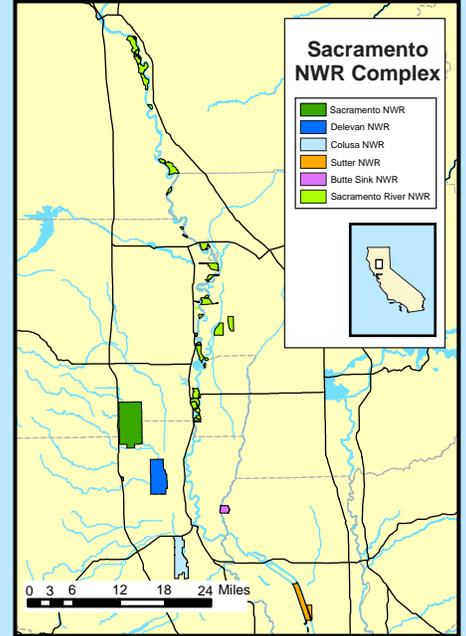
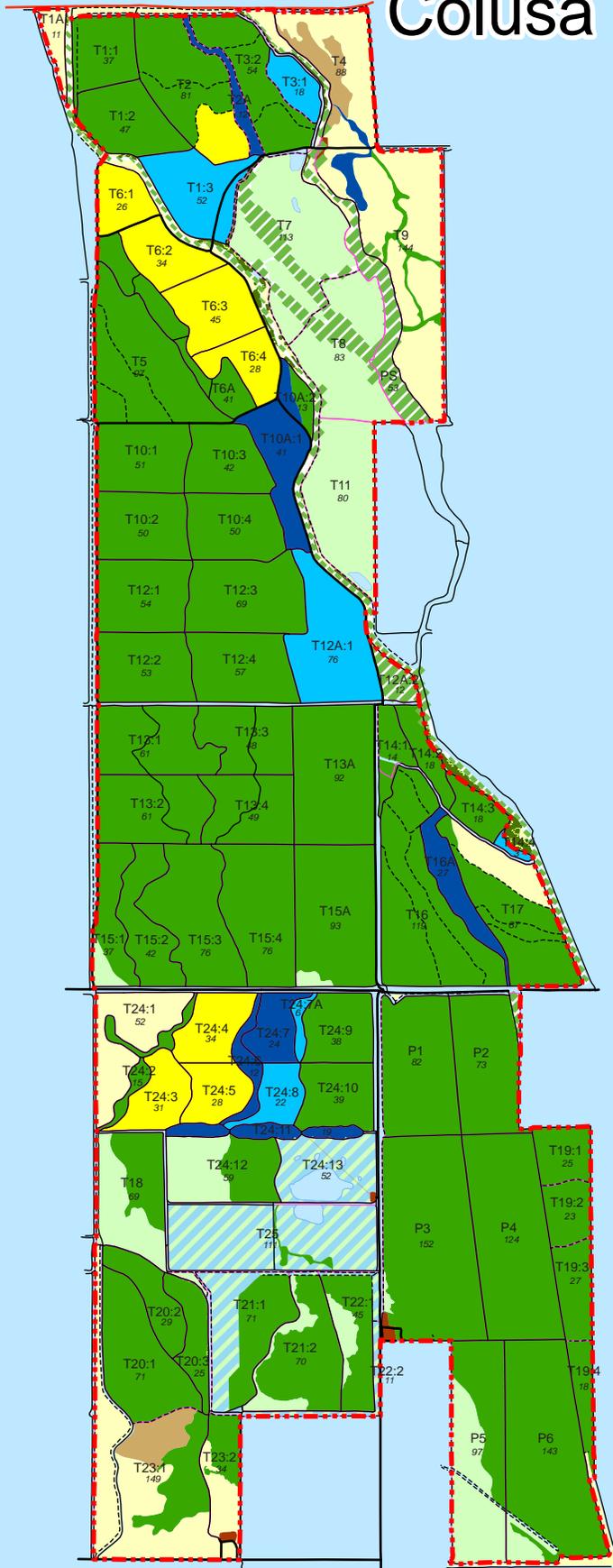
Attachment A

Colusa National Wildlife Refuge

Habitat Map

December 16, 2005

Colusa NWR



Attachment B

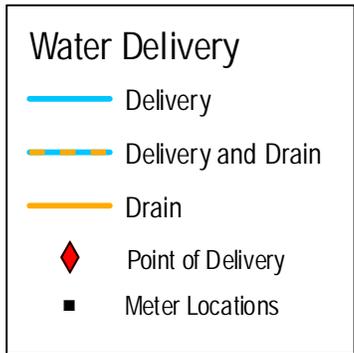
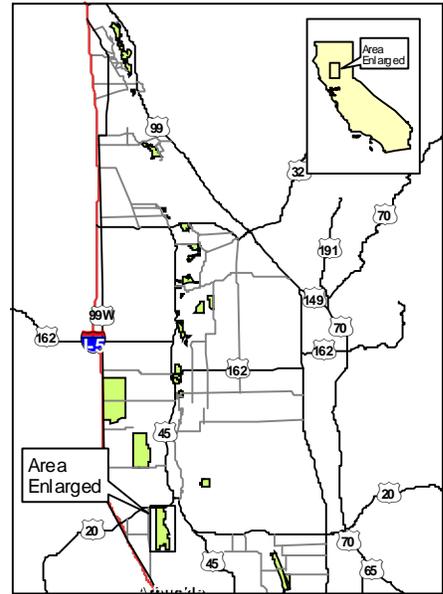
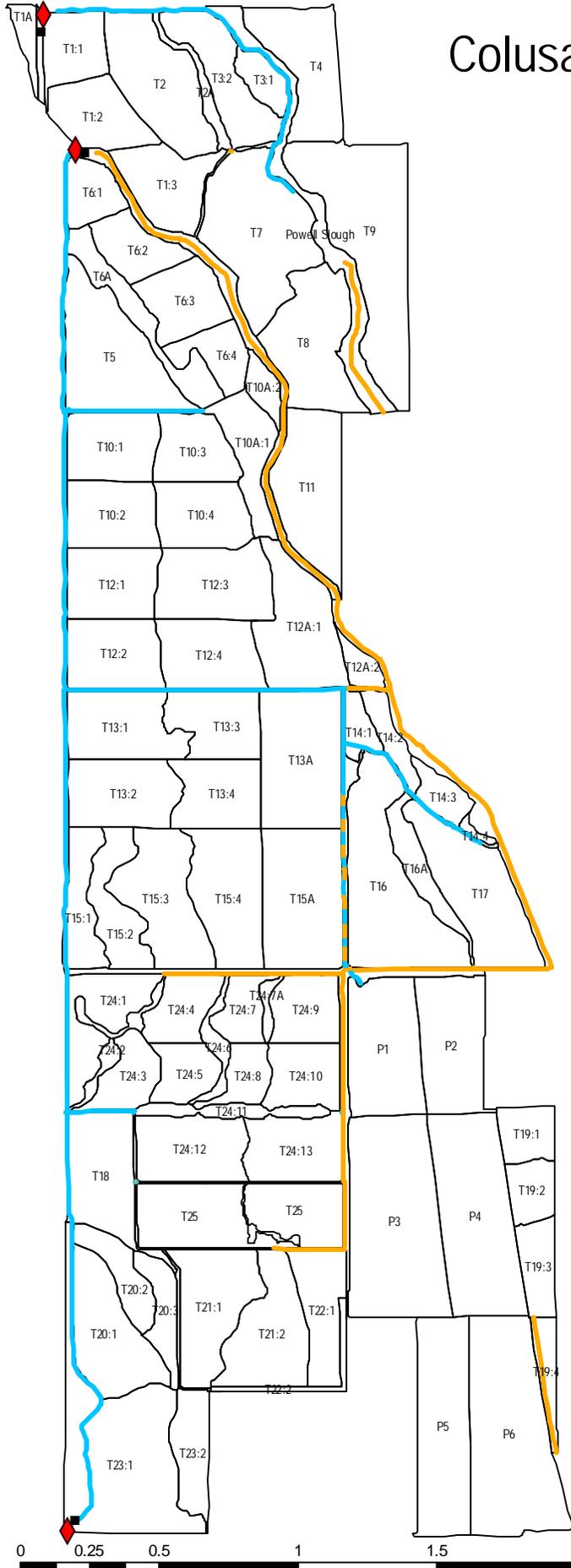
Colusa National Wildlife Refuge

Water Delivery and Drainage Map

Water Drainage Areas Map

December 16, 2005

Colusa National Wildlife Refuge

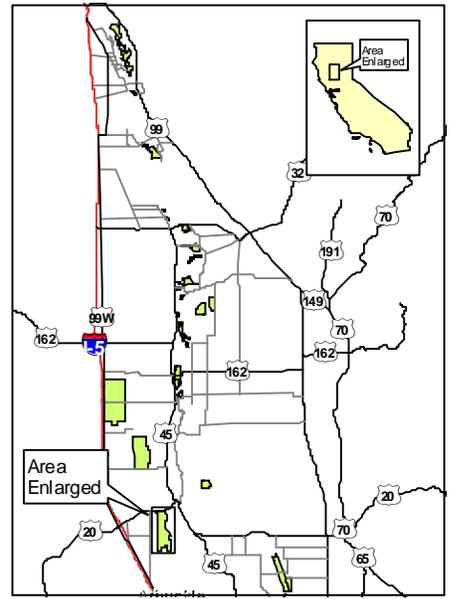
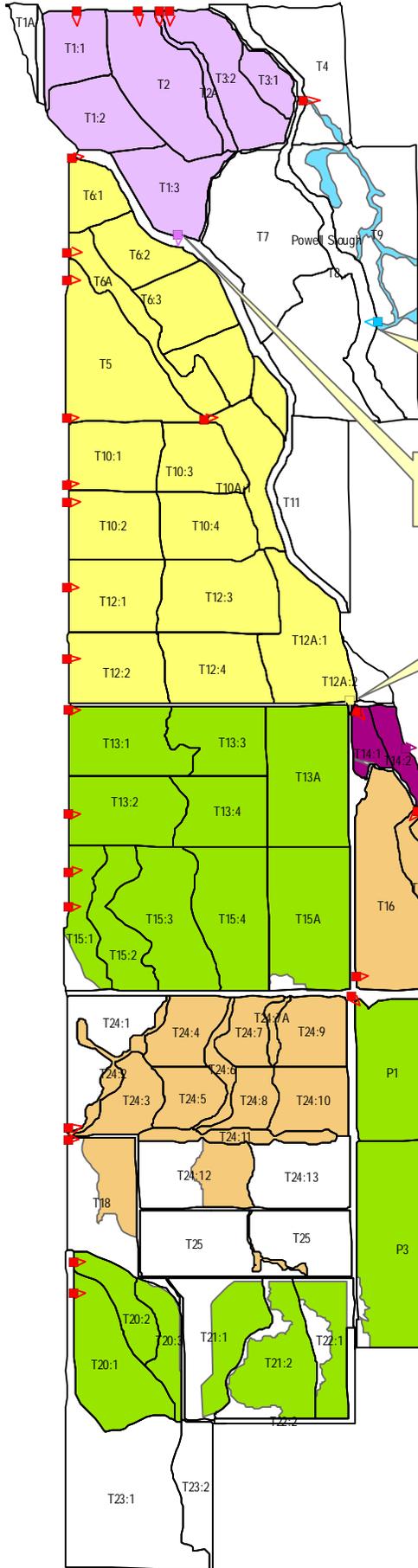


0 0.25 0.5 1 1.5 2 Miles

Map produced by Sacramento NWRC
 Projection: UTM Zone 10N
 Datum: NAD83
 November 2005



Colusa National Wildlife Refuge



Drainage Areas

- T1-3
- T4 & T9
- T5, T6, T10 & T12
- T13, T15, T20-22, P1-6
- T14
- T16-18 & T24-25
- T19
- Inlet
- T1-3 Outlet
- T4 & T9 Outlet
- T5 & 6, T10, T12 Outlet
- T13, T15, T20-22, P1-6 Outlet
- T14 Outlet
- T16-18 & T24-25 Outlet
- T19 Outlet



Map produced by Sacramento NWRC
 Projection: UTM Zone 10N
 Datum: NAD83
 November 2005



Attachment C

Colusa National Wildlife Refuge

Soils Map

December 16, 2005

Colusa National Wildlife Refuge Soil Series/Types*

Colusa County

#	Description
100	Capay clayloam, 0-1% slopes, occasionally flooded
103	Capay clayloam, 0-1% slopes, frequently flooded
105	Willows silty clay, 0-1% slopes, occasionally flooded
106	Willows silty clay, 0-1% slopes
107	Scribner silt loam, 0-1% slopes, occasionally flooded
109	Scribner silt loam, 0-1% slopes, frequently flooded
116	Clear Lake clay, calcareous, 0-2% slopes, occasionally flooded
117	Clear Lake clay, calcareous, 0-1% slopes, frequently flooded
128	Mallard loam, 0-1% slopes
136	Colusa loam, 0-2% slopes
155	Alcapay clay, 0-1% slopes
652	Water

* from USDA Map Unit Legend Summary for Colusa County, California on NRCS Web Soil Survey.

Attachment D

Colusa National Wildlife Refuge

Water Inventory Tables

December 16, 2005

Table 1

2004*	<i>Water Supply</i>						Total (acre-feet)
	Federal Wtr Level 2 (acre-feet)	Federal Wtr Level 4 (acre-feet)	Local Water Supply (acre-feet)	Refuge Groundwtr (acre-feet)	Other (riparian) (acre-feet)	Other Wtr ("J" drain) (acre-feet)	
Method	M1						
Jan-2004	879	0	0	0	0	0	879
February	1,119	0	0	0	0	0	1,119
Mar-2003	315	0	0	0	0	0	315
April	522	0	0	0	0	0	522
May	600	0	0	0	0	0	600
June	934	0	0	0	0	0	934
July	706	0	0	0	0	0	706
August	377	0	0	0	0	0	377
September	3,941	0	0	0	0	0	3,941
October	4,515	0	0	0	0	0	4,515
November	3,245	0	0	0	0	0	3,245
December	3,018	0	0	0	0	0	3,018
TOTAL	20,171	0	0	0	0	0	20,171

*March 1, 2004 - February 28, 2005

Table 2

Internal Distribution System

Year	2004*								
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 popup)	Total (acre-feet)
West Canal	26,400	20	528,000	14.11	54.79	500	0	M1	(541)
Hwy 20 Canal	6,864	15	102,960	2.75	10.68	150		M1	(158)
Tract 5 Canal	2,640	10	26,400	0.71	2.74	50			(52)
Tract 13 Canal	5,280	15	79,200	2.12	8.22	100			(106)
Tract 14 Canal	2,640	15	39,600	1.06	4.11	50			(53)
N/S J-Drain	5,280	30	158,400	4.23	16.44	100			(112)
Tract 18 Canal	1,320	15	19,800	0.53	2.05	50			(52)
									0
									0
									0
									0
									0
			0						0
TOTAL	50,424		954,360	26	99	1,000	0		(1,074)

22 acres

Table 3

Managed Lands Water Needs

Year	2004*										
Habitat Type	Area (habitat acres)	Habitat Needs (AF/ac)	Water AF/ac water Delivered (AF/ac)	Delivered Water (Total AF)	Precip (AF/Ac)	Shallow Groundwtr (AF/Ac)	Evap (AF/Ac)	Cultural Practices (AF/Ac)	Seepage (AF/Ac)	Balance (acre-feet)	
Seasonal wetlands: timothy	6,159	5.00	5.00	30,795	1.16	0.00	1.64	1.50	1.50	9,326	
Seasonal wetlands	70	6.00	7.50	525	1.16	0.00	2.75	2.00	1.50	169	
Seasonal wetlands: watergrass	455	8.00	7.50	3,413	1.16	0.00	2.75	2.00	1.50	1,096	
Permanent wetlands	249	12.00	13.25	3,299	1.16	0.00	4.52	3.00	3.00	970	
Semi-perm wetlands/brood pond	559	10.00	9.00	5,031	1.16	0.00	4.52	2.50	2.00	640	
Riparian	254	12.00	0.00	0	1.16	0.00	4.52	0.00	0.00	(853)	
Irrigated pasture		3.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0	
Upland	2,880	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00	0	
Other (vernal pool/alkali mdw)	107		0.00	0				0.00	0.00		
Misc. habitat (less than 5%)	0			0				0.00	0.00		
Total Habitat Acres	10,733	4.33	4.01	43,063						11,346	

Table 4

Refuge Water Inventory

Year	2004*	Reference		
Total Water Supply		Table 1		20,171
Precipitation		Table 2	plus	26
Evaporation		Table 2	minus	99
Seepage		Table 2	minus	1,000
Operational Losses		Table 2	minus	0
			Deliveries to Managed Lands	19,097
Managed Land needs		Table 3	minus	46,481
Difference		(calculated)		(27,384)
			Balance (Table 3)	11,346
			Water Inventory Balance	(16,037)

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)	Other (riparian) (acre-feet)	Other Wtr ("J" drain) (acre-feet)	Total (acre-feet)
1995	13,372	0	0	0	0	5,264	18,636
1996	21,517	0	0	0	0	7,159	28,676
1997	23,122	0	0	0	0	5,164	28,286
1998	10,113	0	0	0	0	6,974	17,087
1999	13,615	0	0	0	0	2,560	16,175
2000	15,730	0	0	0	0	0	15,730
2001	14,652	0	0	0	0	0	14,652
2002	14,952	0	0	0	0	0	14,952
2003	18,604	0	0	0	0	0	18,604
2004	20,171	0	0	0	0	0	20,171
Total	165,848	0	0	0	0	27,121	192,969
Average	16,585	0	0	0	0	2,712	19,297