Central Valley Wetlands Water Supply Investigations

CVPIA 3406 (d)(6)(A,B)

A Report to Congress

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Executive Summary

This is a report to Congress mandated by the Central Valley Project Improvement Act (CVPIA), Section 3406(d)(6). The Congressional directive requires investigations of: (1) the adequacy of and needs for water supplies to ***existing private wetlands*** in the Central Valley; and (2) water supply and delivery requirements to permit full habitat development on 120,000 acres of ***supplemental wetlands*** (which may be public or private), and feasible means of meeting those requirements.

SCOPE OF THIS REPORT

These investigations were very specific to assessing water supplies to meet the needs of wetlands in the Central Valley as requested in the Congressional directive. The water needs were based on identified private wetlands and on the goals of the Central Valley Habitat Joint Venture's (Joint Venture) "Implementation Plan" dated April 19, 1990, for 120,000 acres of additional supplemental wetlands. Actions are underway by many public and private organizations and partnerships to meet supplemental wetlands goals, and considerable progress has already been made. However, those efforts are outside the scope of this report, which is limited to addressing issues of water supply adequacy, reliability, and availability to wetlands.

In order to address water supply issues for supplemental wetlands, it was necessary to identify where these wetlands might be. This effort was limited to identifying land areas that could be appropriate for wetlands. Lands far in excess of the Joint Venture's stated goals were identified for this report, based primarily on attributes such as soil types, adjacent land uses, and proximity to other wetlands. The specific suitability of any particular parcel of land was not included in the scope of the investigations. This report should contribute significantly to programs which focus on restoring wetlands by providing reliable information on water supply needs and availability. Although a key factor, water supply is only one of the many factors to be considered in wetlands planning, and other issues would have to be investigated individually for each site proposed for wetlands restoration or development.

CONDUCT OF THE INVESTIGATIONS

This is a report on concurrent investigations conducted on two topics: existing private wetlands, and supplemental wetlands. The Chapter 1 introduction and overview applies to both investigations. Chapter 2 describes the private wetlands investigations. Chapter 3 describes the supplemental wetlands investigations. Chapter 4 presents the findings of both.

To conduct these investigations, the 10-million-acre Central Valley was divided into nine basins. Similar conditions exist within each basin, but there are significant differences in water supply needs and conditions from one basin to another. The most dramatic differences are between basins in the north (Sacramento Valley) and south (San Joaquin Valley). A geographic information system (GIS) model was developed to conduct these investigations. It was also designed to provide the data in a form that would be useful for future wetlands planning by Federal, State, and local agencies and private organizations.

These investigations bring together data from many sources, and are the result of cooperative efforts by Federal and State agencies, local water suppliers, and private organizations. The GIS model used for these investigations was first developed by Ducks Unlimited, Inc. in 1996, under contract with the California Department of Fish and Game, the Wildlife Conservation Board, and the U.S. Bureau of Reclamation. The investigations were guided by a Focus Group made up of Central Valley Habitat Joint Venture partners, under the management of the U.S. Fish and Wildlife Service. Initial investigations and further GIS model development were conducted by the California Department of Water Resources as a contractor. Follow up work was done by a private contractor, who conducted interviews with water supply agencies throughout the Central Valley to establish and document water supply data.

ORGANIZATION AND CONTENT

Chapter 1 is an introduction and overview that explains the purpose of these investigations and how they were conducted. This chapter presents background information that is important to an understanding of wetlands water needs, relating to both existing private wetlands and supplemental wetlands. It explains the basis for establishing water needs for this report, and the general approach of these investigations.

Chapter 2 contains all the specific information on the private wetlands investigations. It includes background, study approach and methodology, and individual basin investigations for nine basins in the Central Valley.

Chapter 3 contains similar information as provided in Chapter 2, but on the supplemental wetlands investigations.

Chapter 4 summarizes the findings of this report. In essence, there is an estimated shortfall of about 108,500 acre-feet per year of water needed to supply existing private wetlands full deliveries in an average year. For the remaining supplemental wetlands needed to meet established goals, there is an estimated shortfall in reliable water supplies of about 179,007 acre-feet per year. The report identifies potential means to obtain the needed water supplies.

It must be recognized that the Central Valley Project is not capable of meeting all needs of Central Valley Project water service contractors for water and the additional environmental needs mandated by CVPIA and other Federal and State environmental laws and regulations. California's other developed water supplies are similarly over-committed. Federal and State agencies are working together with stakeholders to find solutions to the state's overall water supply shortages. This situation has created strong competition for existing and future water supplies, which makes it uncertain that wetlands water needs for optimum management will be met. The most likely options for achieving wetlands goals appear to be through land retirement, water banking, and conversion from one land use to another.

This report presents findings of the investigations, which will help in forming the basis for future wetlands water supply planning, but it should be noted that this report does not extend to recommendations or conclusions. The purpose of the report was to *identify needs and means to provide* adequate and reliable water for Central Valley wetlands. Any specific actions to provide for the Central Valley's wetlands water needs will require cooperation and negotiation among diverse water users and interested parties to balance competing water needs, and are beyond the scope of this report. In summary, this report will tell you what the water needs are, and how they might be met. It is up to the public agencies and other interested parties, including wetlands proponents, to develop specific actions to meet those water needs.

COMMENTS ON THE AUGUST 2000 DRAFT REPORT

The August 2000 Draft Report was distributed for review to all the agencies and organizations that contributed information and to other interested parties. Comments on the August 2000 Draft Report were received from two water agencies and several CVHJV participants.

All specific comments noting errors or needed clarification have been addressed by revisions to this report. There were also general comments relating to the way the investigations were conducted, and to issues which were beyond the scope of this report. General comments and responses are presented in Chapter 4 - Findings.

Chapter 1. Introduction

Wetlands are among the most diverse habitats on earth. Once regarded by many as "worthless swamps", wetlands are now universally recognized as vital habitat to maintain precious birds and wildlife. They provide food, nesting areas, resting areas, and cover for numerous species of migratory waterfowl, shorebirds, songbirds, and resident wildlife, and propagation areas for unique plant species. California's Central Valley wetlands support large annual migrations of ducks, geese and other waterfowl, and are critical to the survival of 20 percent of North America's continental waterfowl populations.

This is a report to Congress on the Central Valley Wetlands Water Supply Investigations mandated by the Central Valley Project Improvement Act (CVPIA), Title 34 of Public Law 102-575, passed by Congress on October 30, 1992. A major purpose of the CVPIA was to change the management of the Central Valley Project (CVP) to make fish, wildlife, and associated habitat protection and restoration a project purpose equivalent to that of supplying water and power for municipal and agricultural purposes. The CVPIA identifies wetlands as a key component of wildlife protection and enhancement in the Central Valley, and specifies actions to improve their water supplies, and these investigations to further assess their water needs and supply opportunities.

This report specifically addresses water supply conditions and requirements for existing private wetlands and additional supplemental wetlands throughout California's Central Valley. The report, and the baseline data and geographical information system model developed for the report, will also be available to others as a resource for future planning by Federal, State, local and private agencies and groups in their efforts to protect, restore, or enhance wetlands.

ORGANIZATION OF THIS REPORT

This report consists of four chapters. Background information is presented in appendices following the report. The chapters are:

Chapter 1. Introduction: This chapter describes the CVPIA mandate for this report, the general purpose and nature of the investigations, and the background context of California's water supply conditions in which the investigations were performed. It includes a description of the importance of wetlands and their various types in the Central Valley, the relative water needs of the various types of wetlands, and the general water supply conditions in California that will affect the ability to provide reliable water supplies to wetlands. This chapter outlines the objectives of these investigations, a description of the study area, the basis for optimum water needs estimated for the various wetland types and other assumptions and definitions, and the investigations approach.

Chapter 2. Private Wetlands Investigations: This chapter outlines the specific approach used for private wetlands investigations, and basin-by-basin results. The overall findings are summarized in Chapter 4.

Chapter 3. Supplemental Wetlands Investigations: This chapter outlines the specific approach used for supplemental wetlands Investigations, and basin-by-basin results. The overall findings are summarized in Chapter 4.

Chapter 4. Findings of the Investigations: This chapter presents the overall findings of these investigations.

CENTRAL VALLEY WETLANDS WATER SUPPLY INVESTIGATIONS

CVPIA Section 3406(d) directs the Secretary of the Interior to provide reliable water supplies of suitable quality to maintain and improve Central Valley wetland habitat on Federal refuges, State wildlife management areas, and private wetlands within the Grasslands Resource Conservation District (Grasslands RCD). This is being accomplished through the Refuge Water Supply and Conveyance Program, which is providing additional and more reliable water supplies to these wetlands. This program has greatly improved the ability to maintain the designated wetlands. However, it applies only to about one-third of the Central Valley's wetland habitat. The remaining two-thirds are on private lands, where maintenance as wetlands is dependent on water availability and the landowners' ability and willingness to apply the amounts of water required.

Without these private wetlands, and additional supplemental wetlands, the acreage that is within refuges would be completely inadequate to support the Central Valley's wintering waterfowl and resident wildlife populations. To fully address the adequacy of Central Valley wetlands habitat, the CVPIA also mandated water supply investigations to assess the status of water supplies for existing private wetlands, and for additional wetlands habitat needed to assure the health and survival of resident and migrating bird populations.

The Central Valley wetlands water supply investigations that are the subject of this report are mandated by CVPIA Section 3406(d)(6) which requires the following:

> *"The Secretary, in consultation with the State of California, the Central Valley Habitat Joint Venture, and other interests, shall investigate and report on the following supplemental actions by not later than September 30, 1997:*
>
> *(A) alternative means of improving the reliability and quality of water supplies currently available to privately owned wetlands in the Central Valley and the need, if any, for additional supplies; and*
>
> *(B) water supply and delivery requirements necessary to permit full habitat development for water dependent wildlife on one hundred and twenty thousand acres supplemental to the existing wetland habitat acreage identified in Table 8 of the Central Valley Habitat joint Venture's "Implementation Plan" dated April 19, 1990, as well as feasible means of meeting associated water supply requirements."*

Responding to this CVPIA mandate has required developing baseline data and using it in a geographical information system (GIS) model which was not fully developed until 1997. This requirement, along with time required to collect data on existing water supplies for private wetlands, has delayed the preparation of this report. Private wetlands restoration is an ongoing process, and preparing a report of existing private wetlands water supplies necessarily required a data cutoff point (November of 1996) in order to complete the report. These investigations were limited to the time period for which data was available from satellite imagery on the locations of private wetlands, and investigation of the water supplies available in those locations. The satellite imagery used in the investigations is from the summer of 1993 and January of 1994. Additional private wetlands have been developed since then, some in other areas not investigated, and will require further investigation. However, updating the GIS model with this information will be relatively easy to do now that the model is established.

This report provides, in a single document, an overview of existing Central Valley private wetlands and associated water needs and supply opportunities. It also identifies areas in the Central Valley that are best suited for wetland restoration based upon land use, soil type, location, and water supplies. The report, along with the GIS model that was developed for its preparation, will serve as important resources for those agencies, organizations, water districts and individuals involved with wetlands planning and conservation. They will also be useful to agencies concerned with water supply and distribution; flood control and flood plain management; open space planning; and other activities where wetlands and water issues are relevant. The information contained in this report will serve as the foundation from which further site-specific analyses can be performed

<u>CVPIA Section 3406(d)(6)(A) Investigations</u>. For the purposes of these investigations, private wetlands were considered to be those wetlands and associated uplands which are actively managed by landowners to provide habitat for waterfowl and other wetland dependent wildlife. Wetland data derived from the GIS analysis and presented in this report should in no way be interpreted as wetland data for any regulatory purpose. The response to Section 3406(d)(6)(A)] focused on lands where wetland functions are the primary management purpose, and where water is actively applied through a managed process. Unmanaged wetlands and flooded agricultural land were not included in the investigations.

<u>CVPIA Section 3406(d)(6)(B) Investigations</u>. This second part of the investigations [i.e., response to Section 3406(d)(6)(B)] deals with supplemental wetlands that may be added or restored in the future, either in refuges or on private lands, to meet the need for additional wetlands habitat to support wildlife and waterfowl populations. Although specific areas were not identified, general areas have been identified where conversions to wetlands are most likely to occur in the future. These general areas of lands suitable for wetlands restoration have existing land uses that are compatible with wetlands and soils that are capable of supporting the vegetation that is essential to good quality wetlands habitat. In many instances, these suitable lands are in areas adjacent to existing wetlands.

Central Valley Habitat Joint Venture (CVHJV)

Pursuant to the Congressional requirement, the investigations were conducted in consultation with the State of California and the Central Valley Habitat Joint Venture (CVHJV). (The CVHJV "Implementation Plan" dated April 19, 1990, is the basis for the objectives for the supplemental wetlands portion of these investigations.)

The CVHJV was formally established by a working agreement signed in July, 1988. The CVHJV is comprised of seven private organizations (Private Partners) and nine Federal and State agencies (Public Partners).

Technical assistance and advice for this report was provided by the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), and other Joint Venture partners. A CVHJV technical committee (the CVHJV Focus Group) oversaw the investigations.

CVHJV Partners and Focus Group. The CVHJV Partners and CVHJV Focus Group are shown in the following tabulation.

CVHJV Private Partners	
American Farmland Trust	National Audubon Society
California Waterfowl Association	The Nature Conservancy
Ducks Unlimited, Incorporated	The Trust for Public Land
Point Reyes Bird Observatory	
CVHJV Public Partners	
California Department of Fish and Game	California Department of Water Resources
California Wildlife Conservation Board	U.S. Army Corps of Engineers
U.S. Bureau of Land Management	U.S. Bureau of Reclamation
U.S. Environmental Protection Agency	U.S. Fish and Wildlife Service
U.S. Natural Resources Conservation Service	

CVHJV Wetlands Water Supply Investigations Focus Group	
California Waterfowl Association	Ducks Unlimited, Inc.
California Dept of Fish and Game	California Dept of Water Resources
California Wildlife Conservation Board	U.S. Bureau of Reclamation
The Nature Conservancy	U.S. Fish and Wildlife Service

CVHJV Implementation Plan Objectives

The CVHJV Implementation Plan outlines objectives for the Central Valley wetlands needed to provide habitat to assure the health and protection of birds and wildlife dependent on Central Valley wetlands. [For the purposes of this report, some differences should be noted to interpret the objectives as they apply to these investigations. The CVHJV Plan objectives include public refuges as well as private wetlands. The existing wetlands portion of this report deals only with existing private wetlands, because refuge water supplies have been addressed in a separate program. The plan objectives for additional wetlands include both public and private wetlands, and are together addressed in the supplemental wetlands portion of this report.]

The CVHJV Implementation Plan Objectives are as follows:

1. Protect 80,000 acres of wetlands through fee acquisition or conservation easement.
2. Protect and restore 120,000 acres of former wetlands.
3. Enhance 291,155 acres of existing wetlands.
4. Enhance waterfowl habitat on 443,000 acres of private agricultural land.
5. Secure 402,450 acre-feet of water annually for existing State Wildlife Areas, National Wildlife Areas, and the Grasslands Resource Conservation District (Grasslands RCD).
6. Secure CVP power for National Wildlife Refuges, State Wildlife Areas, the Grasslands RCD, and other private lands dedicated to wetland management.

The Central Valley Wetlands Water Supply Investigations relate primarily to items 1 through 3 of the CVHJV Plan Objectives. Although considerable progress has already been made toward meeting the wetland acreage objectives since the plan was developed in 1990, the availability of water supplies remains highly relevant to the success of the protection, restoration and enhancement of these wetlands areas. The water supply investigations are intended to determine whether existing supplies are adequate for existing private wetlands, and how their reliability and quality can be improved. The investigations are also intended to determine the water requirements for the supplemental wetlands, and feasible means of meeting them.

BACKGROUND

The Central Valley of California, located between the Coast Range and the Sierra Nevada, extends 400 miles south from Red Bluff to Bakersfield (**Figure 1-1**). Covering 10 million acres in 19 counties (approximately 10% of the State), this broad plain once contained more than 4 million acres of seasonal and permanent wetlands. Rivers flooded in winter, spread over the valley floor, and created vast seasonal wetlands and permanent marshes, providing prime habitat for waterfowl, other migratory birds, and resident wildlife.

Over the past 150 years, about 95 percent of the Central Valley's original wetlands have been lost. Before wetlands restoration efforts began about 30 years ago, only about 300,000 acres of wetlands remained in the Central Valley. This significant loss is attributable primarily to the cumulative effects of 150 years of human manipulation of hydrology to facilitate mining, agriculture, flood protection, water project development, and urbanization. About one-third of the wetlands that exist today are within Federal refuges and State Wildlife Management Areas, and the rest are on private lands.

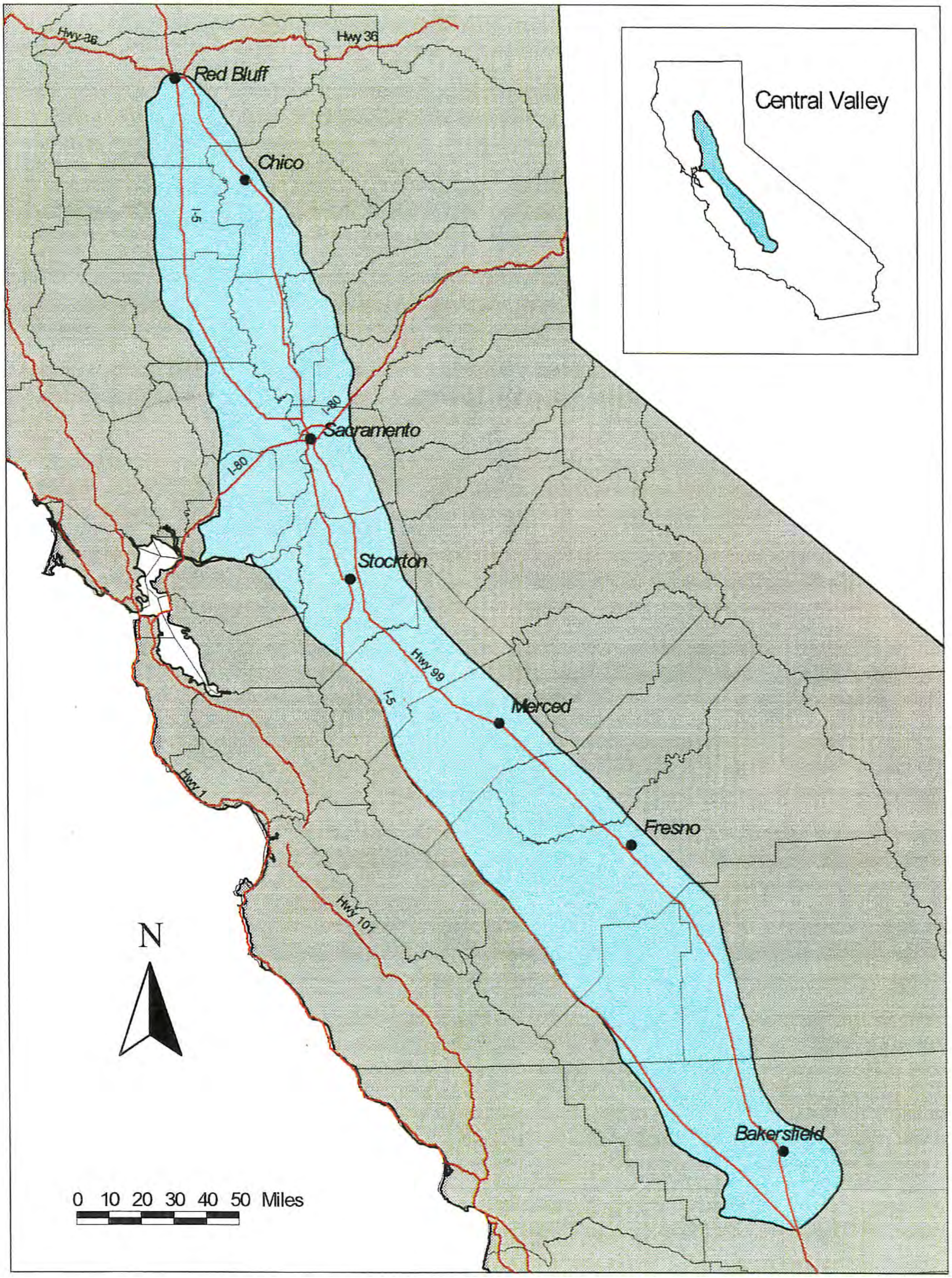
The way that wetlands receive water has also changed. Natural uncontrolled "overflow" flooding from rainfall and snow-melt that historically watered Central Valley wetlands has been replaced by flooding through managed systems with controlled diversions and pumped flow from ditches, rivers, sloughs, or wells. Now most wetlands rely on the application of water through managed systems. Most wetlands must use existing water delivery and flood control systems that serve agricultural and urban needs, and the availability and delivery of wetlands water supplies is affected by these competing uses.

Importance of Wetlands and Associated Upland Habitat

Central Valley wetlands play a major role in international waterfowl conservation. The Central Valley is one of the two most important wintering areas for waterfowl in North America (the other is southern Louisiana). Central Valley wetlands provide critical wintering habitat for: 1) 60% of the Pacific Flyway's migrating waterfowl (3 to 5 million birds annually) and 2) up to 20% of North America's migrating dabbling and diving ducks, including nearly 65% of the northern pintails, a species of special concern, in the United States.

Central Valley wetlands are internationally designated under the North American Waterfowl Management Plan as the highest priority wetlands for winter habitat preservation. The Valley is the primary wintering area for the tule white-fronted goose and threatened Aleutian Canada goose, and the principal migration and wintering breeding habitat for scores of other geese, swans, and ducks. Central Valley wetlands also provide essential wintering habitat for myriad other migratory birds and resident wildlife. Many biologists believe that nowhere else in North America do so many waterfowl rely on so few wetlands.

Figure 1-1. Investigations Study Area
Central Valley Wetlands Water Supply Investigations



The National Wetlands Policy Forum, *Issues in Wetlands Protection*, has reported that almost 35 percent of all rare and endangered animal species are either located in wetland areas or dependent upon them, although wetlands constitute only about 5 percent of the nation's land. An even greater percentage of wildlife rely on wetlands at some point in their life-cycle, and over 55% of California's threatened or endangered bird and mammal species require wetland habitat annually during their life cycle.

The various Central Valley wetlands types provide habitat for amphibian, bird, crustacean, fish, insect, reptile, mammal and plant species that are now Federal and/or California-listed as endangered or threatened or are candidates for such Federal and/or State listing. These species are identified in **Table 1-1**. As shown by **Table 1-1**, Central Valley wetlands are habitat for:

- eleven bird species that are Federally and/or State listed as either threatened or endangered;
- three mammal species that are Federally and/or State listed as either threatened or endangered and one mammal species that is a candidate for Federal listing;
- two insect species that are Federally listed as threatened;
- one reptile species that is Federally and State listed as threatened;
- three crustacean species that are Federally listed as endangered (one also State listed as endangered); and two Federally listed as threatened;
- one amphibian species that is Federally listed as threatened, and one that is a candidate for Federal listing; and
- one fish species that is Federally and State listed as endangered and one that is a candidate for Federal listing.

The dramatic loss of Central Valley wetlands and resulting environmental impacts to wildlife, fish and other resources is now widely recognized. Wetland protection, enhancement, and restoration programs and activities are actively being conducted throughout the Central Valley by Federal, State, and local agencies; private and nonprofit organizations; corporations; and the public.

Recognizing the importance of the Central Valley wetlands, in 1993 California's governor issued Executive Order W-59-93, which established the State's wetlands policy framework and a strategy to bring the goals and objectives to reality. The main goals are to:

- Ensure no net loss of wetlands and achieve a long-term net gain in wetland quantity, quality, and permanence.
- Reduce procedural complexity in administering State and Federal wetlands conservation programs.
- Encourage partnerships between public and private landowners for wetlands conservation and restoration.

Under this policy direction, the State expects overall wetland acreage to increase by 30 to 50 percent in the 1993 to 2010 period.

Table 1-1. Wetland Dependent Endangered, Threatened, Proposed, and Candidate Species of the California Central Valley

Central Valley Wetlands Water Supply Investigations

Species	FE	FT	SE	ST	SR	FP	FC	SP	SC
Amphibians:									
California red-legged frog		X							
California tiger salamander							X		
Birds:									
Aleutian Canada goose		X							
American peregrine falcon			X						
bank swallow				X					
California black rail				X					
California clapper rail	X		X						
Greater sandhill crane				X					
light footed clapper rail	X			X					
little willow flycatcher			X						
southwestern flycatcher	X								
Swainson's hawk				X					
western yellow-billed cuckoo			X						
Crustaceans:									
California freshwater shrimp	X		X						
Conservancy fairy shrimp	X								
longhorn fairy shrimp		X							
vernal pool fairy shrimp		X							
vernal pool tadpole shrimp	X								
Fishes:									
Fall-run chinook salmon							X		
Winter-run chinook salmon	X		X						

FE = Federally Listed Endangered
FT = Federally Listed Threatened
SE = State Listed Endangered
ST = State Listed Threatened
SR = State Rare
SP = State Proposed
SC = State Candidate
FP = Federal Proposed
FC = Federal Candidate

Table Continued on Next Page

Table 1-1. Wetland Dependent Endangered, Threatened, Proposed, and Candidate Species of the California Central Valley, Continued
Central Valley Wetlands Water Supply Investigations

Species	FE	FT	SE	ST	SR	FP	FC	SP	SC
Insects:									
Delta green ground beetle		X							
valley elderberry longhorn beetle		X							
Reptiles:									
giant garter snake		X		X					
Mammals:									
Buena Vista Lake shrew							X		
Riparian brush rabbit	X		X						
Riparian woodrat	X								
salt-marsh harvest mouse	X			X					
Plants:									
Butte County meadowfoam	X		X						
California seablight	X								
California vervain		X		X					
carpenteria				X					
Chinese Camp brodiaea		X	X						
Colusa grass		X	X						
Contra Costa goldfields	X		X						
Delta coyote-thistle			X						
fleshy owl's-clover		X	X						
Green's tuctoria	X				X				
Greenhorn adobe-lily				X					
hairy Orcutt grass	X		X						
Hartweg's golden sunburst	X		X						

FE = Federally Listed Endangered
FT = Federally Listed Threatened
SE = State Listed Endangered
ST = State Listed Threatened
SR = State Rare
SP = State Proposed
SC = State Candidate
FP = Federal Proposed
FC = Federal Candidate

Table Continued on Next Page

Table 1-1. Wetland Dependent Endangered, Threatened, Proposed, and Candidate Species of the California Central Valley, Continued
Central Valley Wetlands Water Supply Investigations

Species	FE	FT	SE	ST	SR	FP	FC	SP	SC
Plants, continued:									
Hoover's spurge		X							
Indian Valley brodiaea			X						
palmate-bracted bird's-beak	X		X						
slender Orcutt grass		X	X						
Sacramento Orcutt grass	X		X						
salt marsh bird's-beak	X		X						
San Joaquin Valley Orcutt grass		X	X						
San Joaquin adobe sunburst		X	X						
soft bird's-beak	X				X				
Solano grass	X		X						
Suisun thistle	X								

FE = Federally Listed Endangered
FT = Federally Listed Threatened
SE = State Listed Endangered
ST = State Listed Threatened
SR = State Rare
SP = State Proposed
SC = State Candidate
FP = Federal Proposed
FC = Federal Candidate

Water Supply Development in the Central Valley

Most of California's water supply originates north of the Sacramento/San Joaquin Delta (Delta), while most of the demand is south of the Delta. Water development from the 1940s through the 1970s produced the State's two major water projects, the Federal Central Valley Project, and the State Water Project. These projects include five major Central Valley reservoirs (Shasta, Oroville, Folsom, New Melones and Friant). Together with more than 100 smaller facilities, these five major reservoirs store much of the State's water supply. **Figure 1-2** shows California's major water projects.

Figure 1-2. California's Major Water Projects

Map courtesy of California Department of Water Resources

The combination of societal pressure for environmental restoration, limited money for new infrastructure, and increased cost of water development ended California's major water development era in the 1970s. Since then, the emphasis for water management agencies has been on improved water management and conservation to stretch existing water supplies. In this setting of severe limits on additional water supply development, a water supply crisis has developed, particularly in dry or critically dry years. Increases in population and urban water demand and increases in allocations of water supply to environmental uses have resulted in water shortages that are forecast to become more severe and more frequent as demands for urban water supply and environmental water allocations continue to increase. In 1993, the California Department of Water Resources (DWR) stated in its update of the *California Water Plan*:

> *"California's water management system no longer provides adequately reliable service; its future reliability is highly uncertain. Current supplies are insufficient to meet present urban, agricultural, and environmental demands. Without improved water management and additional facilities by 2020, water shortages are expected to be more severe and more frequent in the future. Such shortages would severely impact all users including wetlands water users, unless options to develop additional supplies are identified and implemented."*

The most recent update (Bulletin 160-98) estimates statewide water shortages at 1.6 million acre-feet (MAF) in average water years, and 5.1 MAF in drought years--increasing by year 2020 to 2.4 MAF and 6.2 MAF, respectively (based on a 1995 level of water supply development).

Approximately half of California's surface water passes into the Delta where about 50 percent of it is diverted and pumped south and the remainder discharges to San Francisco Bay and the Pacific Ocean. The sensitive ecosystem of the Bay-Delta may be affected by water diversions, particularly in drought years, and the courts have intervened to assure that adequate fresh water enters this system. Complying with the Endangered Species Act also requires releases from dams to regulate water temperatures and in-stream flows, and restrictions on water diversions to protect fish when certain runs are imperiled from pumps or diversions. These factors have greatly increased the concerns about water reliability and heightened controversy over the uses of existing water supplies, making all Californians highly sensitive to the implications of pending decisions about their water supplies.

Federal and State agencies are working with local water agencies and other stakeholders to find solutions to California's water shortages through a program called CALFED, established in 1995. CALFED's focus is to improve water management for beneficial use of the Bay-Delta system. A plan has been developed outlining the first seven years of a 30-year program, and CALFED is being reorganized to establish a framework for the plan's implementation.

Participation in CALFED has provided a means for Federal, State and local agencies and stakeholders to coordinate the many individual programs underway for ecosystem restoration for fish and wildlife. CALFED's comprehensive and adaptive approach to Delta water management will be important for improving flexibility in operating the CVP and SWP. For example, CALFED's plan proposes to establish an Environmental Water Account with participation in storage options. This is envisioned as a means to provide water for environmental restoration in a way that will lessen the adverse effects for other water users.

Some CALFED water conservation programs could result in less water for wetlands in some areas. Other CALFED programs may benefit wetlands by increasing available water supplies. Participation in CALFED by Federal and State agencies concerned with wetlands can help to assure that wetlands water supplies are fully considered among the other competing demands for water, as specific CALFED projects are further developed.

OBJECTIVES OF THE CENTRAL VALLEY WETLANDS WATER SUPPLY INVESTIGATIONS

Objectives of the private wetlands and supplemental wetlands investigations were as follows:

- Provide complete responses to the Congressional requirements.
- Provide these responses in a single baseline information document that will assist in planning water supplies and restoration sites.

CENTRAL VALLEY WETLANDS WATER SUPPLY INVESTIGATIONS STUDY AREA

For these investigations, the 10 million acre Central Valley was divided into the nine basins used in the Central Valley Habitat Joint Venture's Implementation Plan. The Implementation Plan addresses the habitat needs for migratory waterfowl in the Central Valley, and establishes habitat protection, enhancement and restoration objectives for the nine basins. Summary descriptions of the nine basins are provided in **Table 1-2**.

Central Valley Basins in Northern Sacramento Valley and Delta

These seven basins, which cover approximately 7,200 square miles (~46% of the Central Valley) are shown on **Figure 1-3**. This group includes the 55,000-acre (86-square mile) Suisun Marsh, the largest remaining coastal wetland in the State.

Central Valley Basins in the San Joaquin Valley

These two basins, which cover approximately 8,500 square miles (~54% of the Central Valley) are shown on **Figure 1-4**.

Table 1-2. Basin Summary Descriptions
Central Valley Wetlands Water Supply investigations

Basin	General Location	Boundaries	Area, acres	Area, sq. miles
Colusa	Northwest Sacramento Valley	Extends 110 miles from Red Bluff south to (but not including) Cache Creek. Bordered on the east by the Sacramento River and on the west by the Coast Range foothills. Divided in half (north to south) by Interstate 5 (I-5).	1,145,600	1,790
Butte	Northeast Sacramento Valley	Extends 75 miles from Red Bluff south to the Sutter Buttes. Bordered on the west by the Sacramento River and on the east by the Sierra Nevada foothills and the Feather River.	704,000	1,100
Sutter	North-Central Sacramento Valley	Extends 40 miles from the Sutter Buttes south to the confluence of the Feather and Sacramento rivers. Diagonally split by Butte Slough/Sutter Bypass.	224,000	350
Yolo	Southwest Sacramento Valley	Extends 50 miles from Verona south to the Montezuma Hills in southeastern Solano County. Bordered on the east by the Sacramento River and Ship Channel and on the west by the Coast Range foothills.	512,000	800
American	Southeast Sacramento Valley	Extends 65 miles from the City of Oroville south to the American River. Bordered on the west by the Feather and Sacramento rivers and on the east by the Sierra Nevada foothills.	550,400	860
Delta	Middle of the Central Valley	Lies between the American River on north and the Stanislaus River on the south. Bordered on east by the Sierra Nevada foothills, on the northwest by the Sacramento River and the Ship Channel and on the southwest by the Coast Range.	1,334,000	2,100

Table 1-2. Basin Summary Descriptions, Continued
Central Valley Wetlands Water Supply investigations

Basin	**General Location**	**Boundaries**	**Area,** acres	**Area,** sq. miles
Suisun Marsh	Middle of the Central Valley	Lies in southern Solano County to the west of the Sacramento-San Joaquin Delta and to the east of the Carquinez Strait.	108,800	170
San Joaquin	North San Joaquin Valley	Extends 80 miles from the Stanislaus River south to the San Joaquin River. Bordered on the west by I-5 and on the east by the southern Sierra Nevada.	1,856,000	2,900
Tulare	South San Joaquin Valley	Extends 140 miles from the San Joaquin River south to the Tehachapi Mountains. Bordered on the west by the Coast Range and on the east by the southern Sierra Nevada.	3,584,000	5,600
		Total Land Area =	10,028,800	15,670

Figure 1-3. CVHJV Basins in the Northern Sacramento Valley and Delta

Central Valley Wetlands Water Supply Investigations

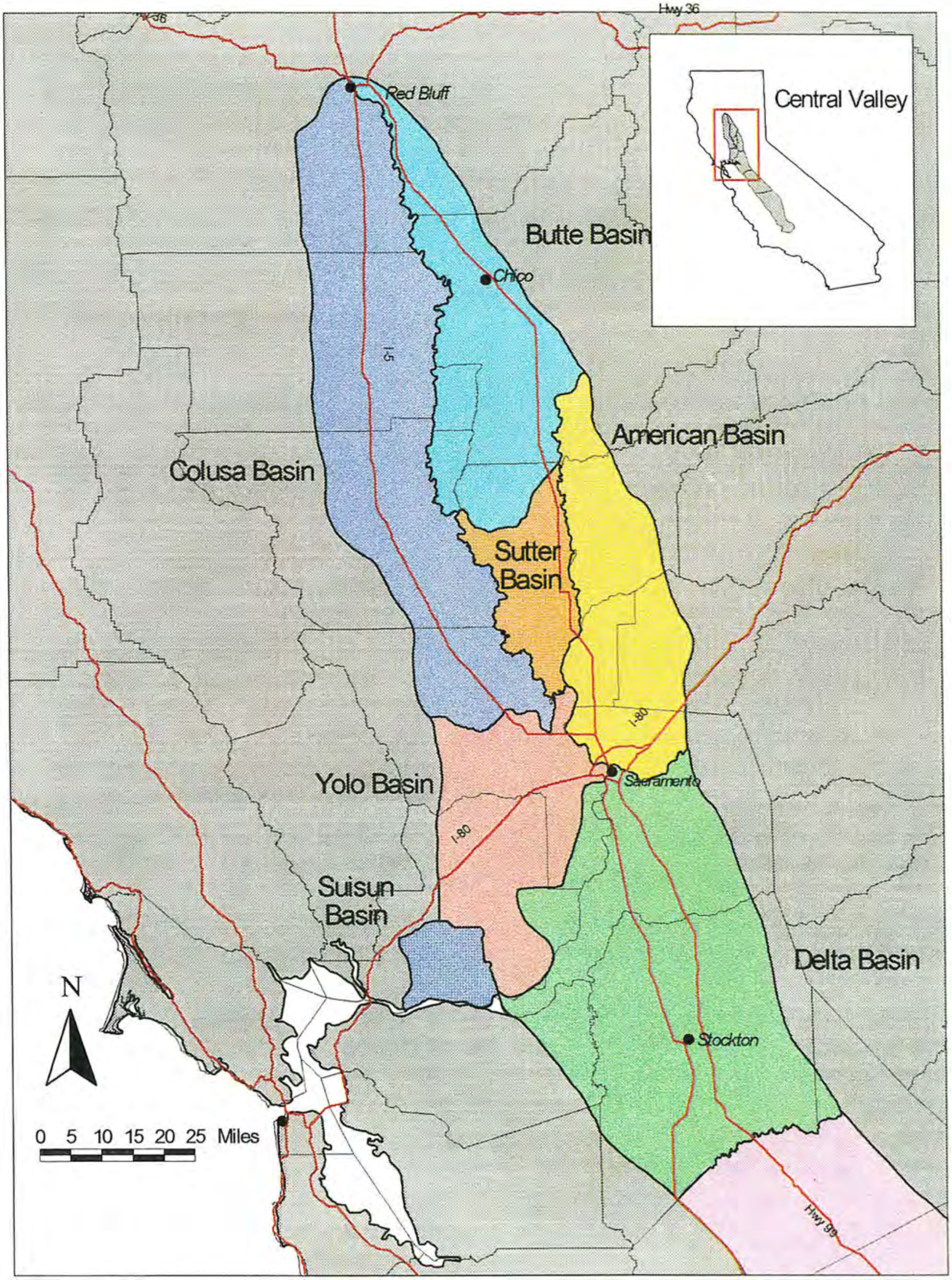
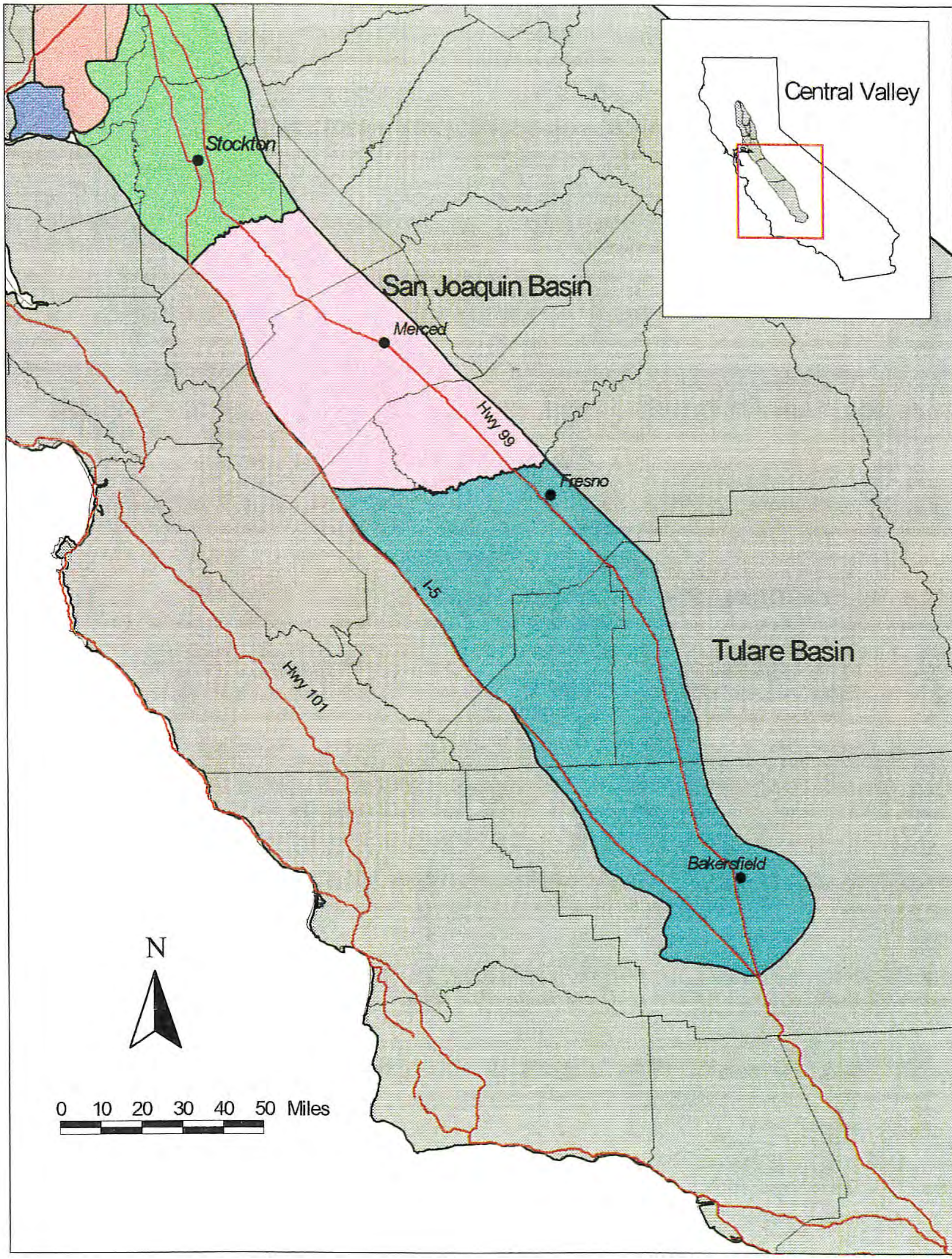


Figure 1-4. CVHJV Basins in the San Joaquin Valley
Central Valley Wetlands Water Supply Investigations



OPTIMUM MANAGEMENT WETLANDS WATER NEEDS

Optimum management (i.e., full management) water needs are water quantities needed for the best management of wetlands developed according to CDFG and USFWS guidelines. The CVHJV Implementation Plan addresses three wetland habitat types, consisting of Seasonal, Semipermanent, and Permanent habitats. Habitat characteristics and optimum management water needs are summarized below. Optimum management water supply requirements by habitat type and month are illustrated on **Figures 1-5, 1-6, and 1-7**.

Table 1-3 shows the estimated percentages of wetland land area for each of the three habitat types on private land in the Central Valley together with information on the flooding and irrigation regimes required for optimum management of each habitat type. Because of differences in habitat type percentages and flooding and irrigation regimes, the tabulation is divided into: 1) the Sacramento Valley and Delta and 2) the San Joaquin Valley.

The water supply requirements and the timing of water application varies greatly for the three types of wetlands. Seasonal wetlands are flooded shallowly from fall through spring, and usually require at least one spring/summer irrigation for moist-soil plants. Semi-permanent wetlands are typically flooded from October through mid-July to meet the needs of locally breeding ducks and other waterbirds. These wetlands must be kept flooded during the entire period, and need maintenance water deliveries throughout the spring and early summer to offset evapotranspiration. Permanent wetlands are flooded year-round, and require much higher water use than the other types.

Seasonal Wetlands

Seasonal wetlands, the prevalent habitat type, provide temporary waterfowl habitat during October through March. Optimum management of Seasonal wetlands requires monthly water application as shown on **Figure 1-5**.

- Annual water use ranges from 4.8 to 5.6 acre-feet per acre (AF/acre).
- Seasonal wetlands are flooded shallowly from September or October through March or April. Early fall flooding (mid-August to mid-September) occurs in the Central Valley, but is usually dependent on water availability. Most ponds are completely flooded by mid-October or before waterfowl hunting season. If water supplies are sufficient, water levels are maintained until dewatering is initiated in March or April.

Note: The water use estimates shown on **Figure 1-5** reflect only one seasonal wetland management scenario. Much like the diversity of irrigated agricultural crops, water use and timing depends on the seasonal wetlands management focus (e.g., production of watergrass, mixed marsh, etc,) and seasonal weather patterns. Monthly water budgets for seasonal wetlands are generalized to demonstrate the time period in which the majority of irrigation occurs. In actuality, there is some water use for seasonal wetland irrigation during all months of the year (including June and July) in all basins.

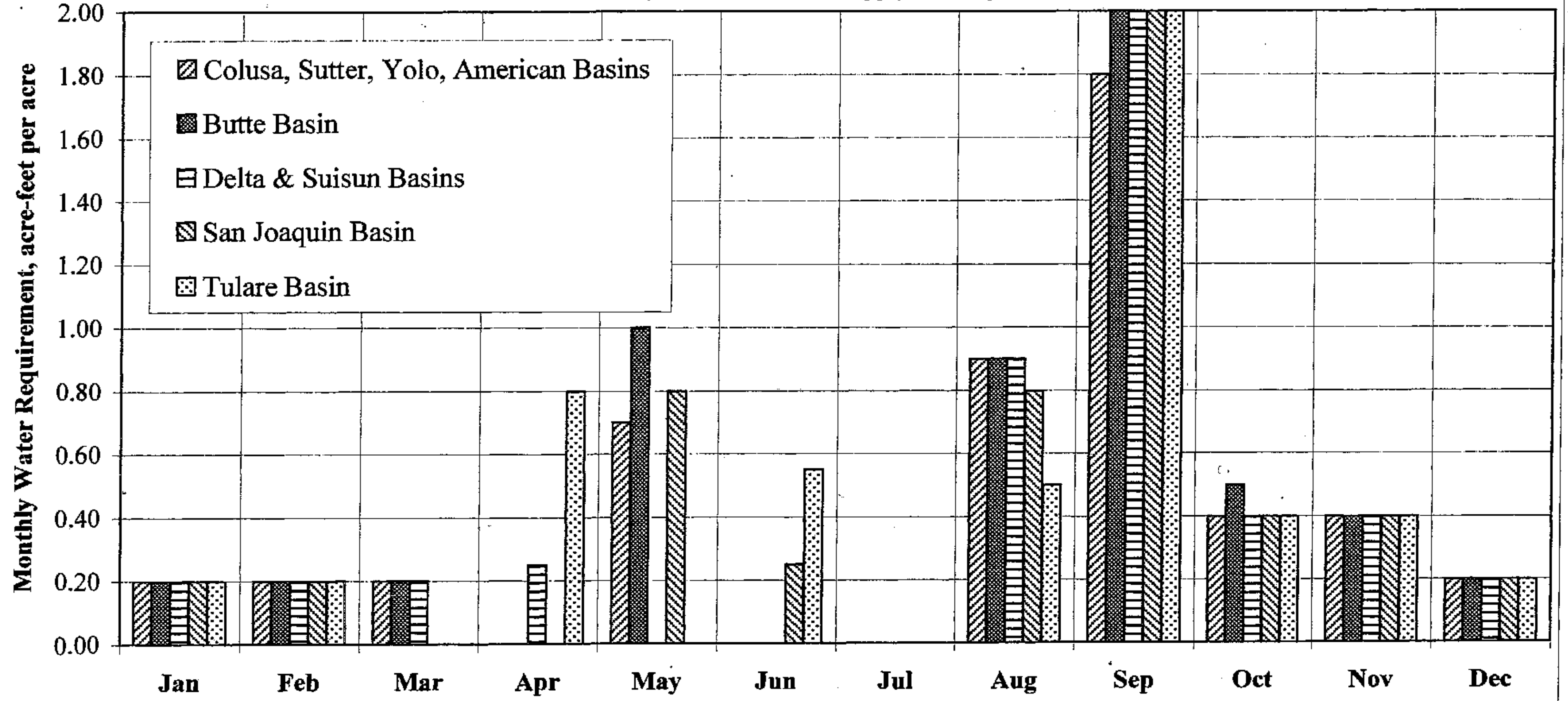
The June 1998 *Interagency Coordinated Program for Wetland Water Use Planning, Central Valley California, Final Task Force Report* (ICP Report) cites a broader range of annual water requirements for seasonal wetlands of from 4.1 to 8.5 AF/acre. On average, 12 to 15 percent of seasonal wetlands are managed more intensively for the production of specific moist-soil plants. These plants (e.g., watergrass and smartweed) require one or more summer irrigations for maximum seed production, resulting in annual water requirements of up to 8.5 AF/acre.

This wider range reflects the true water use variability occurring due to soils, topography, etc. The range of water supply needs has been narrowed in these investigations and report to allow development of quantitative estimates of water needs for use in water supply discussions. It is expected that, like the wetlands addressed in the ICP report, some of the wetlands discussed herein will have water use requirements outside the narrow range presented in this report.

Table 1-3. Wetland Habitat Types and Flooding and Irrigation Regimens
Central Valley Wetlands Water Supply Investigations

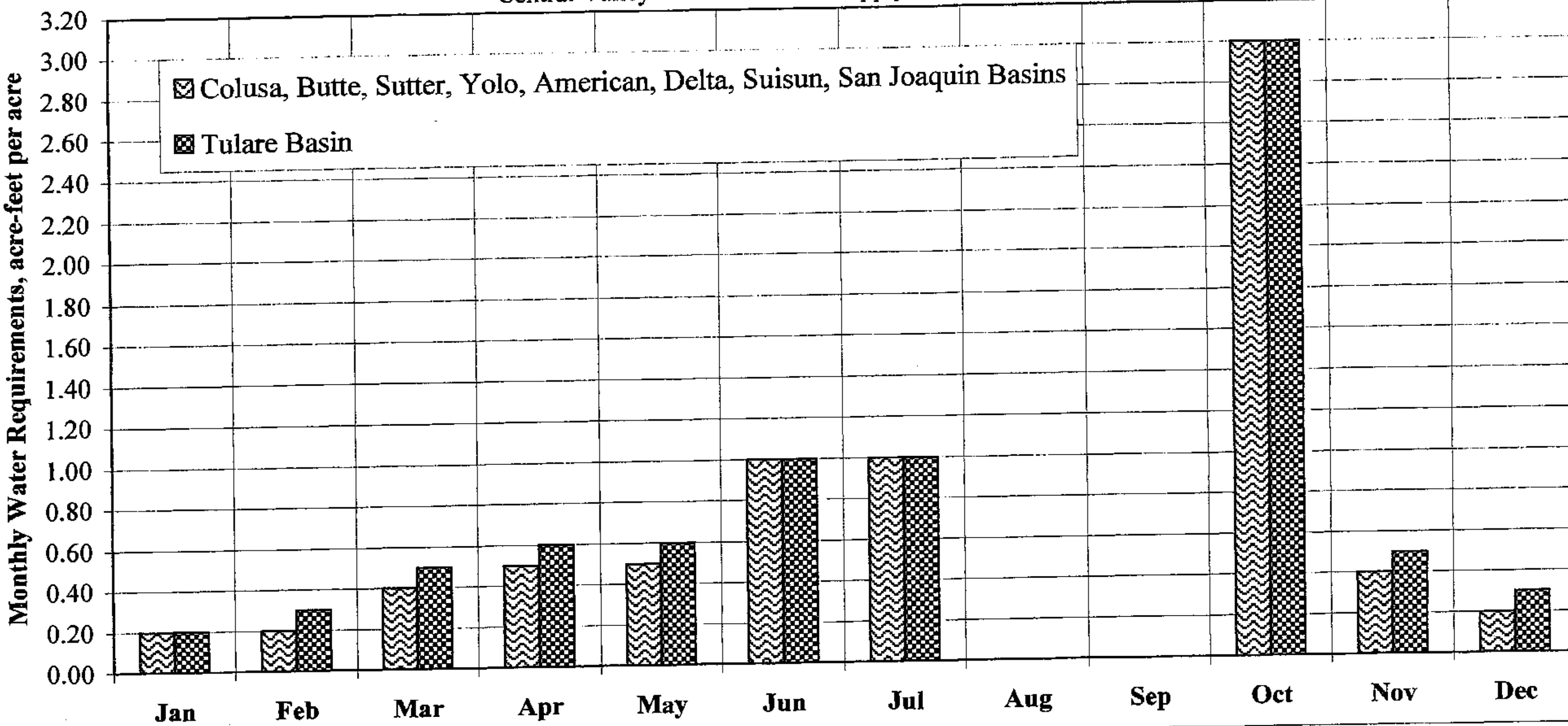
Wetland Habitat Type	Percent of Wetland Land Area	Flooding and Irrigation Regimen	
		Average Water Depth, inches	Typical Time of Flooding
Sacramento Valley and Delta			
Seasonal	85	6-12	August/September through March/April flooding with a single irrigation (3-6 inches deep, 7-14 days duration) between May and July to ensure adequate seed production by moist soil plants.
Semi-permanent	10	6-24	October through mid-July flooding. No water application in August and September.
Permanent	5	18-36	Year-round flooding.
San Joaquin Valley			
Seasonal	90	6-12	August/September through March/April flooding with one to two irrigations between May and July to ensure adequate seed production by moist soil plants.
Semi-permanent	7	6-24	October through mid-July flooding. No water application in August and September.
Permanent	3	18-36	Year-round flooding.

Figure 1-5. Optimum Management Monthly Water Supply Requirements - Seasonal Wetlands
Central Valley Wetlands Water Supply Investigations



(1) May water requirement is provided in a single (1) irrigation. June water requirement is provided in two (2) irrigations.
(2) Variations in monthly and total annual water requirements from basin to basin are due primarily to variations in evapotranspiration rates, but also reflect differing evaporation and seepage rates.
(3) Total Annual Water Requirement ranges from 4.75 AF/acre (Delta & Suisun) to 5.6 AF/acre (Butte).
(4) See text regarding zero water use shown for seasonal wetlands in some months.

Figure 1-6 Optimum Management Monthly Water Supply Requirements - Semipermanent Wetlands
Central Valley Wetlands Water Supply Investigations

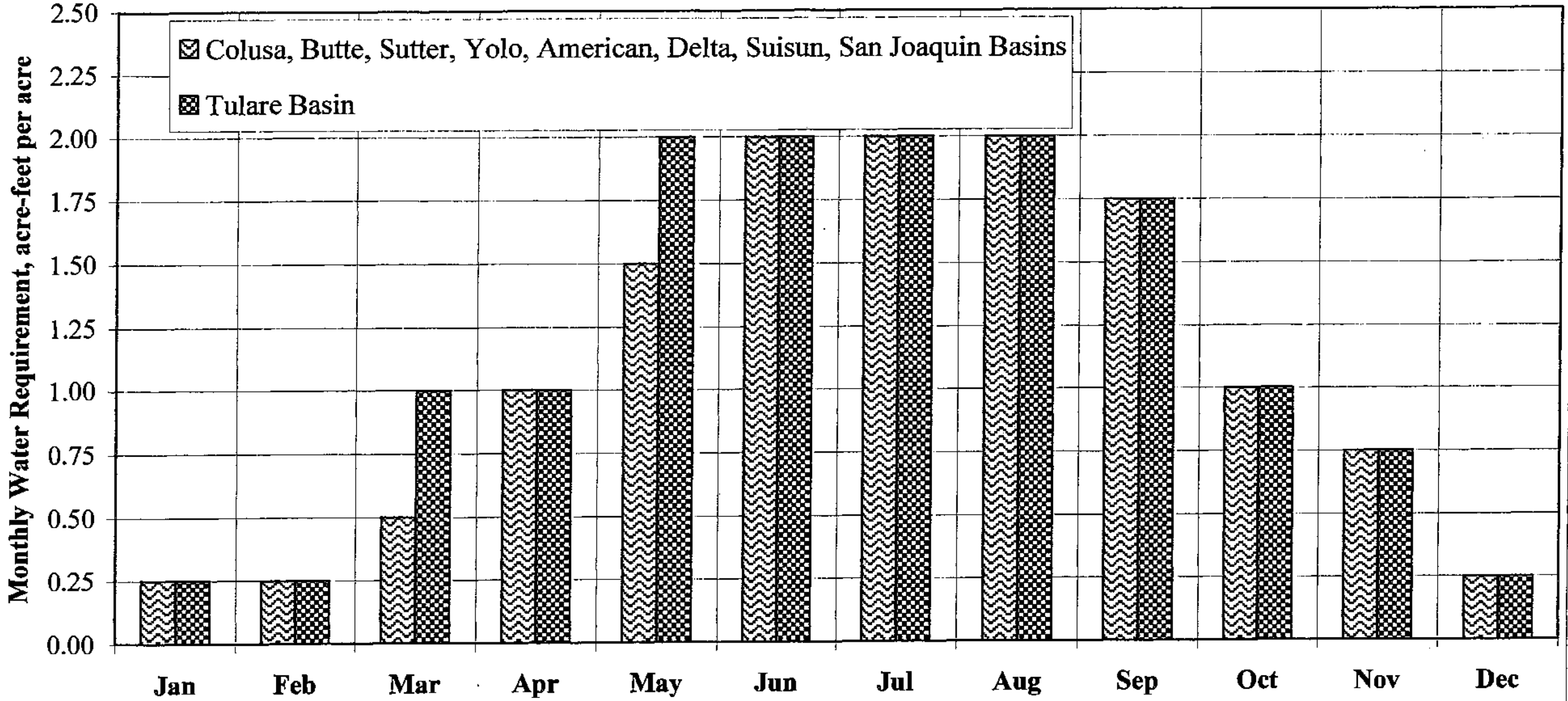


(1) Total Annual Water Requirement for Colusa, Butte, Sutter, Yolo, American, Delta, Suisun, and San Joaquin Basins is 7.4 AF/acre.

(2) Total Annual Water Requirement for Tulare Basin is 8.0 AF/acre.

(3) Higher water requirements for Tulare Basin are due to higher evapotranspiration.

Figure 1-7. Optimum Management Monthly Water Supply Requirements - Permanent Wetlands
Central Valley Wetlands Water Supply Investigations



(1) Total Annual Water Requirement for Colusa, Butte, Sutter, Yolo, American, Delta, Suisun, and San Joaquin Basins is 13.25 AF/acre.
(2) Total Annual Water Requirement for Tulare Basin is 14.25 AF/acre.
(3) Higher March, May and total water requirements for Tulare Basin are due to higher evapotranspiration.

Semipermanent Wetlands

Semipermanent wetlands provide October through mid-July breeding habitat for ducks and other waterbirds. Optimum management of Semipermanent wetlands requires water application in all months except August and September (see **Figure 1-6**). Because flooding must be sustained during the entire October through mid-July period, maintenance water deliveries are necessary to offset evapotranspiration.

- Annual water use is typically about 7.4 AF/acre (8.0 AF/acre in Tulare Basin).
- Water use during the October-mid-July sustained flooding period ranges from a minimum of 0.2 AF/acre per month in December through February to a maximum of 3 AF/acre in October.

Most privately-owned Semipermanent wetlands are the result of Federal and State incentive programs (e.g., CDFG's California Waterfowl Habitat Program -- "Presley Program", U.S. Department of Agriculture Water Bank Program, Conservation Resource Program, etc.) or landowner desire to improve waterfowl populations without such incentives. Semipermanent habitat has become increasingly prevalent on private wetlands with reasonably priced water supplies.

Permanent Wetlands

Permanent wetlands are flooded year-round to support emergent and submergent aquatic vegetation and provide habitat for local wildlife (see **Figure 1-7**).

- Annual water use is typically 13.3 AF/acre (14.3 AF/acre in Tulare Basin).
- Water use ranges from a minimum of 0.25 AF/acre per month in December through February to a maximum of 2 AF/acre per month in June through August.

Permanent wetlands are relatively uncommon on private land due to high water use demands and associated water costs. Because of their relative scarcity, they are extremely important to the continued survival of resident plant and animal species, including several special status species.

Importance of Water Depth

Water depth is a primary factor influencing waterbird use of wetlands in the Central Valley. Most waterfowl, shorebirds, and wading birds require water less than 10 inches deep for foraging. Dabbling waterfowl foraging behaviors are limited by the birds' body and neck length. Likewise, small shorebirds are limited by their leg and bill length. Shallow water is especially important in late winter when waterfowl and shorebirds prey heavily on protein-rich invertebrates found in the wetlands. The availability of these prey species is important to waterfowl and shorebirds preparing for the energetic demands of spring migration and breeding.

INVESTIGATIONS APPROACH

Through the CVPIA, Congress directed that two separate investigations be conducted:

- Investigation of the available water supplies and means of providing additional water for existing private wetlands [mandated by CVPIA Section 3406(d)(6)(A)].
- Investigation of the water supply and delivery requirements for supplemental wetlands [mandated by CVPIA Section 3406(d)(6)(B)].

Because of the similarity of the investigations, the Focus Group (pg. 1-4) determined that the responses to both requirements could be combined into one report. Therefore, this report contains two distinct sections:

- Water Supply Needs of Existing Private Wetlands, discussed in Chapter 2 (Private Wetlands Investigations).
- Water Supply Needs of Supplemental Wetlands, discussed in Chapter 3 (Supplemental Wetlands Investigations).

The following discussion is focused on the general approach that was taken for both components of the investigations. The discussion includes aspects of the approach that were the same or similar in both components. Approach details that are unique to each one are provided in Chapter 2 or Chapter 3, respectively.

Existing Privately-managed Wetlands Investigations

Investigations of existing privately-managed wetlands for response to CVPIA Section 3406(d)(6)(A) required identification of the following:

- Private wetlands land areas, locations and possible sources of water supply
- Water supply needs for optimum management of the private wetlands
- Current water quantities available to the private wetlands
- Water supply deficiencies preventing optimum management of the private wetlands
- Water supply infrastructure that serves the private wetlands
- Infrastructure problems affecting the availability and reliability of water supplies
- Regulatory problems affecting the availability and reliability of water supplies
- Contractual problems affecting the availability and reliability of water supplies

Supplemental Wetlands Investigations

Supplemental wetlands investigations for response to CVPIA Section 3406(d)(6)(B) required identification of the following:

- Lands suitable for wetlands restoration and potential sources of water supply
- Water supply needs for optimum management of supplemental wetlands
- Water quantities that may be available for supplemental wetlands
- Supply quantity deficiencies that could prevent optimum management of the wetlands
- Water supply infrastructure that might serve supplemental wetlands
- Infrastructure problems that could affect the availability and reliability of water supplies
- Regulatory problems that could affect the availability and reliability of water supplies
- Contractual problems that could affect the availability and reliability of water supplies

Analytical Tool – Geographic Information System (GIS)

A GIS model was used to combine, edit, store, and display data for both the existing private wetlands and the supplemental wetlands investigations. With GIS, features displayed on a map can be combined with information associated with those features that is stored in tabular data files. This provides flexibility in displaying and querying information about an area.

GIS capability in merging information from different features for analysis was used for analytical tasks such as merging data about soil characteristics favorable for wetland habitat development with a land use map showing existing development in a particular area to create a new set of data. This new data set was then used to determine where current land use is compatible with land that is suitable for wetland development. With GIS, additional information can be incorporated into data sets as it becomes available, and can be used to further refine the process of identifying land potentially available for wetland habitat.

Specifics of the use of GIS in the existing private wetlands and the supplemental wetlands investigations are provided in Chapters 2 and 3, respectively. Additional information on the GIS model is provided in **Appendix A.**

Interviews of Water Supply Entities

A meaningful report of the existing private wetlands and the supplemental wetlands investigations required accurate water supply information that was best obtained by interviews of water supply entities (i.e., irrigation districts, water districts, mutual water companies, reclamation districts, water storage districts, water users associations, etc.). Such interviews were a key element of the water supply investigations. In accordance with a commitment made to the water supply entities as a condition of their participation in the interviews, certain kinds of information and data obtained in the interviews are generalized and summarized by basin, with findings only, and not identified with specific suppliers. An identical set of questions was posed in all of the interviews.

The contact list for the interviews consisted of the following:

- Nearly all water entities identified in the existing private wetlands investigations as having privately-managed wetlands within their service area boundaries (some entities with existing private wetlands less than 10 to 20 acres were not included).
- Water entities without privately-managed wetlands in their service areas that:
  - were known to be involved in private wetlands water supply to lands outside their boundaries
  - were considered to be potential suppliers to existing privately-managed wetlands outside their service areas
  - were considered to be potential suppliers to future (i.e., supplemental) wetlands inside and/or outside their service areas

Surface Water Supply Reliability Classifications

For this report, surface water supply reliability for Central Valley lands is classified as High, Moderate, Low, or Unknown. Criteria for these classifications is as follows:

High Reliability. Surface water supply is considered highly reliable if the supply:

- fully meets water rights or contract allocation during normal and wet years and
- is not reduced by more than 50% during a single dry year or cumulatively by more than 100% of supply during any long-term drought.

Moderate Reliability. Surface water supply is considered moderately reliable if the supply:

- fully meets water right or contract allocation during above-normal and wet years, but
- is reduced more than 50% in a single dry year or more than 100% during any long-term drought.

Low Reliability. Surface water supply is considered to have low reliability if the supply:

- does not always fully meet demands during above normal and wet years,
- is reduced more than 70% in a single dry year or more than 150% during any long-term drought, or
- source is from tailwater (agricultural return flow) or a low priority contract.

Unknown Reliability. Surface water supply reliability is unknown in areas where there is not sufficient supply reliability information for High, Moderate, or Low classification.

The surface water supply reliability criteria and classifications were developed and assigned to the various Central Valley lands by DWR. Mapping of existing private wetlands and lands selected as suitable for wetlands restoration included water supply reliability classification.

Wetlands Water Supply Sources

Wetlands receive water from several kinds of sources. These include supplies provided through various kinds of local water agencies and supplies derived directly from landowner wells and landowner water rights. The water supply investigations included work to identify:

- the specific water supply sources now used by private wetlands in each of the basins, and
- water supply sources that could be available for wetlands restoration.

Supplies Provided through Local Water Agencies. Supplies provided through local water agencies (i.e., irrigation districts, water districts, mutual water companies, reclamation districts, water storage districts, etc.) include water obtained by the agencies:

- under CVP and State Water Project (SWP) water supply contracts,
- under contracts with other local water agencies and private corporations,
- under various kinds of agency-held surface water diversion rights,
- from agency-owned water wells, and
- from irrigation tailwater.

Supplies Derived from Landowner Resources. Supplies derived from landowner resources include water obtained through:

- direct diversions of local surface water under various landowner-held water rights,
- pumping of landowner wells,
- irrigation tail water, and
- in a few instances, landowner-held CVP water supply contracts.

Supply Restrictions Affecting Water Use for Wetlands. Goals of the water supply source identification included identifying restrictions affecting water use for wetlands. Water agency interviews included questions regarding the following kinds of restrictions that affect water use for existing private wetlands, or could affect water use for supplemental wetlands:

- Supply contract restrictions preventing or affecting 12-month/year water supply.
- Supply contract restrictions precluding use of water for wetlands.
- Water rights permit restrictions preventing or affecting 12-month/year water diversion.
- Water rights permit restrictions precluding use of water for wetlands.
- Supply contract restrictions preventing transfer of water to existing or new wetlands outside of water agency boundaries.
- Water rights restrictions preventing transfer of water to existing or new wetlands outside the agency's boundaries.
- Water agency policies preventing transfer of water to existing or new wetlands outside the agency's boundaries.

- Groundwater supply restrictions precluding use of water for wetlands.
- Restrictions affecting water supply to lands converted from existing uses to new wetlands.

Options for Meeting Water Supply Needs of Wetlands

The wetlands water supply options evaluated for this report consisted of the following:

- surface water
- groundwater
- agricultural return flow (tailwater)
- water conservation
- water marketing and transfers

In general, Central Valley wetlands water supply deficiencies tend to occur during the September through November flood-up period and throughout the winter months when wetlands require maintenance water. Although surplus natural flows are available in most years after the start of heavy winter rains, their use for wetlands is limited by conveyance facility operations and other factors. Water demands for crops and wetlands often occur at different times. In predominantly agricultural areas, conveyance facilities are often operated only during the irrigation season, and are often shut down for maintenance or repairs during the non-irrigation season, at the time when wetland water demands are high.

The practicality of using surplus flows for wetlands depends on a number of factors. Permits must be granted by the SWRCB for appropriation, which could be protested by other water users. The granting of permits would also depend on a finding that water is available, that it is a "beneficial" use under State law, and that quantities of use for wetlands are "reasonable". Issues of conveyance facilities would also have to be addressed.

Surplus natural flows are available during winter and spring of most years in the Sacramento River and the Delta. The surplus natural flows can be diverted and used by wetlands. Water rights for specific wetlands should be acquired from the SWRCB for the use of surplus water in the wetland areas. Based on an operational study conducted by DWR using the 1922 through 1994 time period for current conditions, the amount of monthly surplus flows was developed and aggregated into time periods for wetland use (**Table 1-4**). December through March offers the greatest potential for obtaining surface supplies for wetlands. However, in most cases, surplus flows will not be available for September flood-up. Other water supply sources should be investigated for the flood-up period.

The operational study conducted to estimate the availability of surplus natural flow in the Delta is based on current conditions. Future water management programs, and changes in existing programs could impact the availability of surplus flows. Various programs currently under consideration will, if implemented, limit the availability of future surplus flows. A CALFED off-stream storage program, for example, is designed to divert surplus flows for storage. Programs such as the Anadromous Fish Restoration Program (adopted by the U.S. Department of the

Interior) could allocate a substantial portion of surplus flows to instream use, hence reducing availability of flows for wetlands use in the future. Wetland managers should actively participate in the formulation of these programs to ensure that future water supply of wetlands is considered.

Table 1-4. Surplus Flows in the Sacramento-San Joaquin Delta, (in AF)
Central Valley Wetlands Water Supply Investigations

	Fall Sept – Nov	Winter Dec – March	Spring Apr – June	Summer July – Aug	Total
Average Year Delta Surplus	306,200	3,349,000	750,000	0	4,405,000
Drought Year Delta Surplus	293,000	1,415,000	152,000	0	1,806,000

For the San Joaquin Valley, the winter flows could be diverted from the Delta and conveyed through State Water Project or Central Valley Project facilities to the basin. However, the primary issue is having the conveyance and distribution systems to convey water from major facilities such as SWP and CVP to wetlands. For lands in the Tulare Basin, conveyance facilities to a majority of the private wetlands do not exist. The Tulare Basin Wetlands Association is planning a distribution system that could result in the future use of surplus Delta flows. North of the Delta, canal and distribution systems are earth-lined and need annual maintenance that is often completed between January and March, making them unavailable for winter flow conveyance.

Basin-by-basin discussions in Chapters 2 and 3 address the applicability of these options for meeting or improving water supplies for wetlands within the various basins. Findings are summarized in Chapter 4.

Chapter 2. Private Wetlands Investigations

This chapter provides an overview of water demands and water supplies for privately owned wetlands in the Central Valley. Discussion includes the approach, methodology, and results of investigations conducted to address the directive of the Central Valley Project Improvement Act (CVPIA), Section 3406(d)(6)(A) to investigate and report on:

> *"(A) Alternative means of improving the reliability and quality of water supplies currently available to privately owned wetlands in the Central Valley and the need, if any, for additional supplies . . ."*

Supplemental wetlands investigations conducted to address the directive of CVPIA, Section 3406(d)(6)(B) are presented in Chapter 3. This chapter is limited to existing private wetlands and reports on the following:

- Location of private wetlands
- Current water supplies
- Need for additional water supplies
- Means of improving reliability and quality of water supplies

The chapter includes general information on private wetlands, a description of the investigation approach and methodology relevant to private wetlands, and the assumptions and definitions used as a basis for the investigations. Following the discussion that applies to all of these private wetlands investigations is a basin-by-basin presentation of the above information for each of the nine Central Valley basins identified and generally described in Chapter 1 **(Figures 1-3 and 1-4 and Table 1-2).** The overall findings of both the private wetlands investigations and the supplemental wetlands investigations are summarized in Chapter 4.

GENERAL OVERVIEW

Private Wetland Designation

Investigations for this report found that the Central Valley currently contains approximately 108,500 acres of private wetlands which are actively managed by landowners to provide habitat for waterfowl and other wetland-dependent wildlife. This investigation identified privately-owned managed wetlands of 2 acres or more, where wetland functions are the primary management purpose, and where water is actively applied through a managed process. [These lands may or may not be protected under Federal or State perpetual easement.] Unmanaged wetlands and flooded agricultural land were not included in this investigation. *For the remainder of this report, the term private wetlands refers to privately-owned managed wetlands.*

Managed versus Unmanaged Private Wetlands

Although there are approximately 200,000 acres of Central Valley wetlands on private land, nearly half of these lands are considered unmanaged private wetlands, because they do not receive applied water. The unmanaged wetlands occur naturally as a result of rainfall, runoff, seepage, or other hydrologic factors, and include vernal pools, sloughs, potholes, tidal wetlands, and emergent marshes associated with waterways such as rivers and streams. Wetlands that receive water from natural sources (unmanaged wetlands) typically do not have a need for developed water supplies, thus are not within the scope of these investigations.

Importance of Private Wetlands

Chapter 1 discusses the importance of Central Valley wetlands and associated upland habitat in international waterfowl conservation and in the preservation of sensitive and endangered amphibian, bird, crustacean, fish, insect, reptile, mammal and plant species in detail. Private wetlands are extremely critical because they constitute the majority of the managed wetlands in the Central Valley (i.e., these investigations identified ~108,500 acres of apparent existing private wetlands as compared to ~49,500 acres of publically-managed wetlands).

Waterfowl Hunting

Many of the private wetlands areas in the Central Valley have been maintained and survive because of the cultural importance of waterfowl hunting among private residents, many of whom collectively maintain duck clubs. Historically, many rice growers and other Central Valley farmers have followed a practice of intentionally leaving unharvested and uncultivated areas for the propagation and survival of pheasants, ducks and other wildlife, both to enhance hunting and to protect the environment. Central Valley farmers recognize the value of wetlands habitat, and support efforts to restore and enhance wetlands where they are compatible with existing agriculture. Restoration of wetlands to date has been highly successful because of the support and participation of private landowners, who consider wetlands habitat important to the rural quality of life.

Although hunting is an important motivation to maintain wetlands on private land, it has been recognized that working with growers can lead to other cooperative efforts to create wildlife habitat while serving the needs of agriculture. A good example of this is the practice of flooding rice lands for rice straw decomposition, rather than burning the stubble. This serves wildlife by providing additional habitat for wintering waterfowl, and also contributes to clean air by reducing rice straw burns. This additional wildlife habitat is extremely important to the health and survival of the huge avian populations that rely on the relatively small remaining wetlands areas of the Central Valley. The acres of temporary wildlife habitat on flooded rice land now outnumber the total acreage of public refuges in the Central Valley. Although flooded rice land is not included in the private wetlands considered in this report, the private wetlands still constitute two-thirds of all Central Valley wetlands, with publicly-managed wetlands (refuges and managed wildlife areas) making up only one third.

Habitat Variety

Private wetlands are managed to produce a variety of habitats attractive to wetland wildlife, including seasonal wetlands, semi-permanent wetlands ("brood ponds") and permanent marshes. While not every property contains all three of the primary habitat types, these habitats are usually provided collectively within groups of adjacent private wetlands. Waterfowl foods produced in private wetlands include the seeds of moist-soil plants such as swamp timothy, smartweed, watergrass, and sprangletop, as well as aquatic invertebrates, graze, and tubers. According to experts, well-managed private wetlands typically produce about 1,500 pounds of food per acre.

Economics of Private Wetlands

The private wetlands in the Central Valley are set apart from those of other regions of the United States by their extremely high cost of annual operation and management. These costs generally range from $70-$150 per acre per year. This annual expenditure is many times greater than what is required by the owner of a tract of bottomland forest habitat in Louisiana or Mississippi, for example, to achieve flooded wetland habitat. The difference is primarily due to the cost of water.

While waterfowl habitat conservation and waterfowl hunting are important motivations for landowners in both circumstances, the relationship between economics and wetland habitat quality is much more direct in California. Wetlands will flood naturally throughout most of the South, regardless of the management activities of landowners; but much of the Central Valley's private wetlands would not be sustained if landowners were not purchasing or pumping water to flood their wetlands.

Importance of Reasonably-priced Water Supply

The annual investment of funds in habitat management is necessarily related to a certain level of recreational opportunity. It is unlikely that landowners will spend great sums of money to flood and manage their wetlands if they do not have a reasonable expectation of hunting waterfowl on their properties. While future waterfowl hunting quality will likely follow a cyclic course consistent with waterfowl populations, landowners must have access to necessary water supplies at reasonable cost, particularly in times of low waterfowl populations or poor hunting, to prevent wetland abandonment. For these reasons, the provision and maintenance of reasonably priced water supplies for private wetlands is of key importance to assuring water supplies for wetlands.

Water Supply Implications of Water Depth Requirements

As explained in Chapter 1, most waterfowl require water less than 10 inches deep. Maintaining shallow water requires timely application of "maintenance flows" from fall until spring drawdown. Because many water districts commonly perform routine maintenance on their water delivery systems during January, February, and March, landowners often must flood their lands too deeply for optimal waterbird foraging depth in the fall to prevent premature drying in late winter or early spring. For private landowners to maintain high-quality wetland habitat, water must be available on a year-round basis, or at least with only relatively brief interruptions in service.

STUDY APPROACH AND METHODOLOGY

General information about the scope of work, overall study approach and methodology can be found in Chapter 1. The following information is specific to the private wetlands Investigations.

As explained in Chapter 1, the CVHJV Implementation Plan divides the Central Valley into nine basins based on hydrology and drainage. The same nine basins were used in this investigation. The investigations were conducted by basin, and the results are presented by basin in this chapter.

The key elements of the private wetlands investigation were:

- Identify private wetland locations in the Central Valley
- Evaluate existing water supplies, including quality and reliability
- Evaluate needs for additional water supplies and potential sources

Definitions and Assumptions of the Private Wetlands Investigation

Private Wetlands

For this investigation, private wetlands were defined as privately owned, managed wetlands a minimum of 2 acres in size, including lands which may or may not be under Federal or State easement. The study team separated managed from unmanaged wetlands based on a single criterion: whether water is intentionally applied annually to the wetland or not. Wetlands that receive water only from rainfall, runoff, or other natural sources were eliminated from the investigations.

Reliability of Existing Water Supplies

Surface water reliability classifications used to evaluate specific water supplies were " high, moderate, low, and unknown", as described and discussed in Chapter 1. The Focus Group defined "reliable" in terms of surface water supplies as those that are available in all except dry and critically dry years, when shortages of up to 50% may occur. Supplies meeting this criterion are classified as having "high" reliability. The reliability of other sources, such as groundwater and agricultural irrigation return flows ("tailwater"), varies within each basin, and is discussed in the individual basin summaries. Agricultural return flows as water supply refer to surface flows, also called "tailwater", and not to subsurface drainage. Generally (with a few exceptions, which are noted) "tailwater" was not considered a reliable source.

Groundwater was considered to be a reliable source, but when the cost exceeds $20 per AF, private wetland owners can seldom afford to use it for full optimum wetland management. In such instances, wetland quality is compromised dramatically through limiting of flooding to only the months of duck hunting season (October-January).

Needs for Additional Water Supplies

To determine needs, some assumption had to be made about the objective, or the desirable level of management compared with present management. The assumption for this investigation was that private wetlands would be enhanced to optimum wetland management if adequate water supplies were available. Wetland management experts (CDFG and USFWS) defined optimum wetland management and the associated water supply requirements for existing wetlands for the acreages and conditions in each basin. Needs by basin were then calculated, based on the difference between current water applications for present levels of management and those for optimum wetland management. There may be other factors that influence owners of private wetlands in their decisions about the level of management of their wetlands. The scope of this report was limited to establishing the water needs to allow optimum management.

Potential Sources for Additional Water Supplies

The investigation of alternate means to improve the reliability and quality of current water supplies, and the need for additional supplies, required identifying new sources of water supplies for wetlands. DWR has predicted increasing water shortages in the Central Valley, and for California overall, which will increase competition for water already in great demand, and will also raise the price of water. Recognizing these constraints, this report included consideration of all the reasonable alternatives, at a reconnaissance level, which may be explored to obtain additional reliable water supplies for wetlands. Additional investigations will be needed to determine the feasibility of obtaining additional or more reliable water supplies for specific wetlands. The scope of this report was limited to identifying the alternatives, and the issues and considerations that will be involved in securing additional water supplies.

Identification of Private Wetlands and Possible Sources of Water Supply

Apparent private wetlands were determined using GIS information prepared for CDFG by Ducks Unlimited, Inc. (DU) [See **Appendix A** for more detail on the GIS model.] Apparent wetlands land areas were identified from satellite imagery collected in the summer of 1993 and January of 1994. The imagery was evaluated based on vegetation and other features indicating managed wetlands. The determination of managed versus unmanaged wetlands was made by CDFG and USFWS wetland biologists with extensive knowledge of Central Valley wetlands. Small isolated wetlands shown by the satellite imagery that were not in areas of known managed wetlands were "screened out" and thereby not addressed in this report. These wetlands were assumed to be vernal pools or other unmanaged wetlands. The resulting CDFG wetland mapping model developed by DU in 1996 depicts the location of all Central Valley wetland habitat--public and private--detectable from the imagery. The minimum resolution for identification of wetlands from this imagery was 2 acres.

Sizes, locations, and vegetation types on wetlands tend to fluctuate over the course of a single year as well as from one year to the next. Delineation of existing wetlands based on interpretation of imagery in the dry season (summer) and wet season (winter) of a single 6-month period does not show the extremes of wetland coverage that may occur during years of flood or drought.

The identification of private wetlands eliminated publicly-managed wetlands (i.e., Federal and State wildlife refuges), flooded agricultural land, and "unmanaged" (natural) wetlands (e.g., vernal pools and riparian vegetation along the waterways and canals). The identified wetlands may be owned by a CVHJV private partner, enrolled in a Federal or State easement program, or may be a private wetland not affiliated with any program or organization. Apparent private wetlands land areas were quantified as to acreage and plotted on Basin maps. Possible water sources were identified by comparing water entity (district) boundaries to the wetlands maps.

Using Butte Basin as an example, **Figure 2-1** illustrates how GIS data layers can be used to show different kinds of information. The first part of **Figure 2-1** shows all wetlands in the Butte Basin and the second part shows managed private wetlands in the Butte Basin after Federal, State, and unmanaged wetland areas have been screened out.

Identified Existing Private Wetlands

Existing private wetland land areas (108,500 acres) identified in the investigations are presented in **Table 2-1** for the nine Central Valley Basins. The tabulation shows apparent existing private wetland acreage lying inside and outside the boundaries of water entities (Districts). The table includes existing publicly-managed wetlands acreage that was excluded from the identification of private wetlands.

Identification of Possible Sources of Water Supply

Possible water sources were identified for wetlands inside and outside of water entities (Inside Districts and Outside Districts) as follows:

- The presence of apparent private wetlands within the boundaries of a water supply entity is evidence that the entity may be a private wetlands water supplier (i.e., the entity is classified as a Possible Water Supplier to existing private wetlands).
- Apparent private wetlands lying outside of entity boundaries are considered to be self-supplied by groundwater or (depending on proximity to rivers, streams, drainage channels, or sloughs) by direct diversion of surface water.

Note: Where private wetlands are outside of, but close to, an entity boundary, the entity was considered to be a Possible Water Supplier subject to confirmation in discussions with the entity.

Figure 2-1. Example Using GIS as a Tool to Identify Butte Basin Private Wetlands
Central Valley Wetlands Water Supply Investigations

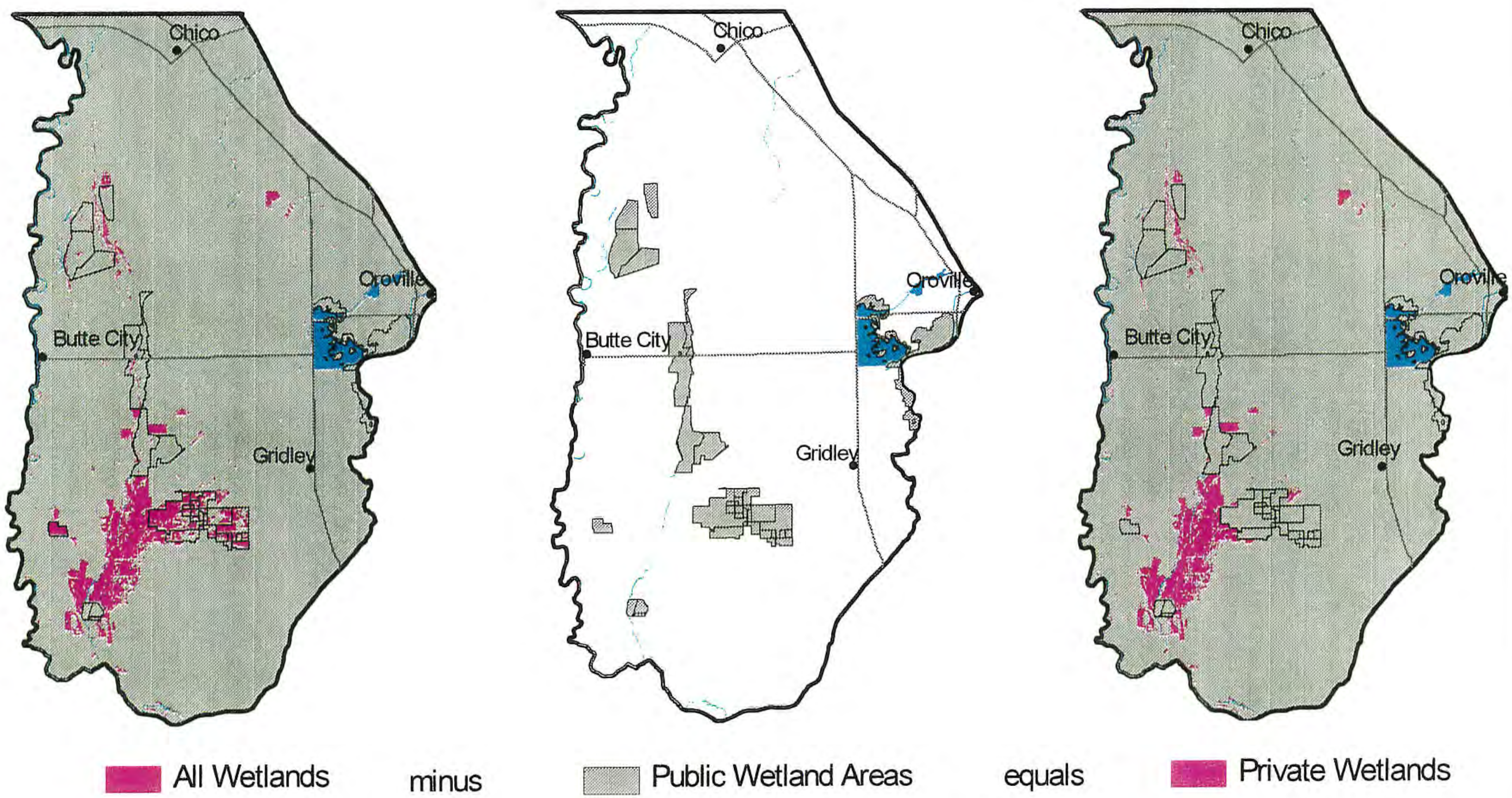


Table 2-1. Existing Private and Public Wetlands – Central Valley Basins
Central Valley Wetlands Water Supply Investigations

		Existing Wetlands						
		Existing Privately-managed Wetlands						
		Inside Districts		Outside Districts				
Basin	**Basin Land Area, acres**	Wetland Land Area, acres	Percent of Private Total	Wetland Land Area, acres	Percent of Private Total	**Existing Private Total, acres**	**Existing Publically-managed Wetlands, acres**	**Existing Private and Public Total, acres**
Colusa	1,145,160	9,180	90%	1,040	10%	10,220	12,785	23,005
Butte	704,000	6,640	43%	8,680	57%	15,320	5,479	20,799
Sutter	224,000	110	100%	0	0%	110	2,005	2,115
Yolo	512,000	5,890	97%	170	3%	6,060	50	6,110
American	550,400	990	74%	350	26%	1,340	0	1,340
Delta	1,344,000	2,390	96%	100	4%	2,490	2,900	5,390
Suisun Marsh	108,800	10	0.3%	29,710	100%	29,720	8,080	37,800
San Joaquin	1,856,000	31,590	79%	8,300	21%	39,890	11,080	50,970
Tulare	3,584,000	3,310	100%	0	0%	3,310	7,145	10,455
Central Valley Totals =	10,028,800	60,110	55%	48,350	45%	108,460	49,524	157,985

WATER SUPPLY NEEDS FOR OPTIMUM MANAGEMENT OF EXISTING PRIVATE WETLANDS

As discussed in the introduction, optimum management water supply needs vary according to wetlands habitat type (i.e., seasonal, semipermanent, permanent). The satellite imagery evaluations used to identify apparent existing private wetlands are not capable of distinguishing habitat types. Accordingly, the distribution of existing Private wetlands by habitat type is assumed to be the CVHJV objectives habitat type mix shown in **Table 2-2.**

Table 2-2. CVHJV Habitat Mix Objectives
Central Valley Wetlands Water Supply Investigations

Wetland Habitat Type	Percent of Wetland Area, Sacramento Valley and Sacramento-San Joaquin Delta Basins[1]	Percent of Wetland Area, San Joaquin Valley Basins[2]
Seasonal	85	90
Semi-permanent	10	7
Permanent	5	3

[1] Colusa, Butte, Sutter, Yolo, American, Delta, and Suisun Basins
[2] San Joaquin and Tulare Basins

Although most of the existing private wetlands are Seasonal Wetlands (the least water-demanding of the habitat types), for this report the assumption was made that the habitat distribution would be the same mix of habitat types as in the CVHJV objectives. This serves the directive for the water supply investigations by providing estimates of water needs that will be adequate to manage existing wetlands to meet the CVHJV habitat objectives.

Optimum Management annual water supply needs of existing private wetlands lying inside and outside the boundaries of water entities (Districts) are shown in **Table 2-3** for each of the nine Central Valley Basins. The tabulation shows a range of water supply needs as follows:

- Minimum need based on the assumption that all existing private wetlands are Seasonal.
- Maximum annual need based on the assumption that existing private wetlands evolve to a mix of Seasonal, Semipermanent, and Permanent habitat types.

This presentation is not intended as an option that would ensure a reliable water supply only to the extent needed for optimum management of Seasonal wetlands. It illustrates the following important points relevant to the availability and reliability of the water supplies for the 108,460 acres of existing private wetlands identified in this study, which as noted earlier, are mostly Seasonal wetlands:

- The optimum management reliable water supply requirements of 108,460 acres of Seasonal wetlands (554,240 AF/year) are 90 percent of the optimum management reliable water supply requirements of the same wetlands area developed to meet the mix of habitat types of the CVHJV habitat objectives.
- The assumption, used in these investigations, that all the existing private wetlands are a mix of Seasonal, Semipermanent, and Permanent wetlands reflecting the CVHJV habitat objectives does not significantly overestimate water supply needs and shortfalls.

Table 2-3. Existing Private Wetlands – Central Valley Basins
Optimum Management Water Requirements
Central Valley Wetlands Water Supply Investigations

	Inside Districts		Outside Districts				
Basin	Minimum Annual Total [1], AF/Yr	Maximum Annual Total [2], AF/Yr	Minimum Annual Total [1], AF/Yr	Maximum Annual Total [2], AF/Yr	**Basin Minimum Annual Total [1], AF/Yr**	**Basin Maximum Annual Total [2], AF/Yr**	**Basin Minimum Annual as Percent of Maximum Annual**
Colusa	45,900	51,890	5,200	5,879	51,100	57,769	88.5%
Butte	37,184	40,919	48,608	53,491	85,792	94,410	90.9%
Sutter	550	622	0	0	550	622	88.4%
Yolo	29,450	33,293	850	961	30,300	34,254	88.5%
American	4,950	5,595	1,750	1,979	6,700	7,574	89.5%
Delta	11,353	13,002	475	544	11,828	13,546	87.3%
Suisun Marsh	48	55	141,123	161,622	141,171	161,677	87.3%
San Joaquin	165,848	178,183	43,575	46,817	209,423	225,000	93.1%
Tulare	17,378	18,908	0	0	17,378	18,908	91.9%
Central Valley Totals =	312,661	342,467	241,581	271,293	554,242	613,760	90.3%

[1] Minimum assumes that all existing private wetlands are Seasonal Habitat.
[2] Maximum assumes that existing private wetlands evolve to a mix of Seasonal, Semipermanent, and Permanent Habitats reflecting the CVHJV habitat objectives.

Assessment of Water Supplies

DWR had primary responsibility for the assessment of the reliability of water supplies of existing private wetlands. The basis was staff knowledge of basin hydrology, water supplies and water uses as a result of work on the *California Water Plan* (Bulletin 160 series); associated land use surveys; groundwater data collection; and other studies. Estimates of reliable water supply were based on current operating conditions and estimates of habitat management and water availability for the private wetlands. In areas outside of water service supply boundaries, water supply availability was based on previous land use studies and water source mapping.

Assessment of Additional Water Supply Needs

Existing supplies for private wetlands were evaluated in terms of current level of management and compared with CDFG's definition of optimum management for the different wetland habitat types, which were based on interviews with wetland managers throughout the Valley. Where an umbrella organization, such as the Grasslands RCD, existed, these organizations were contacted for information about management levels currently attained and how water supply availability influences these management levels. The difference between the optimum and current levels of management was evaluated to determine the amount of water needed over what was being applied, and its associated or most likely source. These shortages, whether caused by management practices or supply availability, were aggregated for each basin. Agricultural return flow was not considered reliable except in a few instances (e.g., Butte Sink 1922 Agreement lands) where the existence of water contracts or firm agreements deemed it very reliable. In those cases, it was added into the mix of supply shortages to determine the highest range (most conservative level) of additional reliable water supply needs for the basin.

Estimates of the size, locations, and habitat characteristics of wetlands determined by DU required assumptions and judgments about the relationship between the aerial imagery and wetland habitats. The wetlands acreage and vegetation fluctuate from year to year. Private wetland acreage estimates were based upon imagery collected over a short period of time with limited ground truthing. Therefore, detailed site specific investigations will be needed to further refine wetlands acreage as well as their water needs.

Table 2-4 presents existing Privately-managed wetlands land areas and water needs by basin for each of the nine Central Valley basins. The table shows:

- existing Privately-managed wetlands land areas by Seasonal (S), Semi-permanent (SP), and Permanent (P) habitat types,
- optimum management annual water needs by habitat type,
- existing total reliable water supplies, and
- additional reliable water supply needed.

The basin-by-basin discussion in this chapter addresses the options evaluated to meet or improve water supply and reliability.

Table 2-4. Private Wetlands Land Areas and Water Needs by Basin
Central Valley Wetlands Water Supply Investigations

Basins	Wetlands Habitat Type			Total acres	Total Water Need for Optimum Habitat	Existing Total Reliable Water Supply	Additional Reliable Water Supply Needed
	S	SP	P				
Colusa:							
Area, acres	8,687	1,022	511	10,220			
Water Need, AF/yr	43,435	7,563	6,771		57,769	44,729	13,040
Butte:							
Area, acres	13,022	1,532	766	15,320			
Water Need, AF/yr	72,923	11,337	10,150		94,410	62,683	31,726
Sutter:							
Area, acres	93.5	11	5.5	110			
Water Need, AF/yr	467.5	81.4	72.9		621.8	0	621.8
Yolo:							
Area, acres	5,151	606	303	6,060			
Water Need, AF/yr	25,755	4,484	4,015		34,254	29,619	4,635
American:							
Area, acres	1,139	134	67	1,340			
Water Need, AF/yr	5,695	991.6	887.8		7,574	5,483	2,091
Delta:							
Area, acres	2,117	249	125	2,490			
Water Need, AF/yr	10,053	1,843	1,650		13,546	10,445	3,101
Suisun:							
Area, acres	25,262	2,972	1,486	29,720			
Water Need, AF/yr	119,995	21,993	19,690		161,677	161,677	0
San Joaquin:							
Area, acres	35,901	2,792	1,197	39,890			
Water Need, AF/yr	188,480	20,663	15,856		225,000	178,476	46,524
Tulare:							
Area, acres	2,979	232	99	3,310			
Water Need, AF/yr	15,640	1,854	1,415		18,908	17,833	1,076
Totals:							
Area, acres	94,351	9,550	4,559	108,460			
Water Need, AF/yr	482,444	70,810	60,508		613,760	510,945	102,815

INDIVIDUAL BASIN INVESTIGATIONS

The rest of this chapter presents the results of the private wetlands investigations for each of the nine basins. Each basin discussion includes a brief description of the basin, basin hydrology, water supply, water supply reliability and options, and findings specific to the basin.

Colusa Basin

Total Basin Land Area, acres	**1,145,600**
Total Privately-Managed Wetland Land Area, acres	**10,220**
Private Wetlands as Percent of Total Basin Area	**0.89%**

BASIN DESCRIPTION

Located in northwestern Sacramento Valley, the Colusa Basin extends 106 miles from Red Bluff in the north to (but not including) Cache Creek in the south. Covering about 1,790 square miles, it is bordered by the Sacramento River on the east and the Coast Range foothills on the west (**Figure 2-2**). In the lower two-thirds of the basin, numerous ephemeral streams flow into the Colusa Basin Drain, which conveys the drainage and runoff flows to the Sacramento River. Interstate 5 divides the basin in half from north to south. Almost all existing privately-managed wetlands are between Interstate 5 and the Sacramento River.

Within the basin, there are 10,220 acres of privately-managed wetlands. In the 1994-95 winter, an estimated 30,500 acres of rice land were also flooded for rice straw decomposition and duck hunting. Although not considered wetlands, post-harvest flooded rice lands provide important foraging habitat for many water birds.

BASIN HYDROLOGY

Elder, Thomes, and Stony creeks are direct tributaries to the Sacramento River in the upper part of Colusa Basin. Reservoir development has occurred only on Stony Creek. To protect agricultural and urban development, levees were built to prevent overflow onto adjacent lands.

South of Orland and north of Cache Creek, the basin becomes a shallow trough and is lower in elevation than the Sacramento River. Historically, when natural flow exceeded the river channel capacity during winter storms and spring snowmelt, the overflow created marsh and swamp lands where the water was either slow to drain or was prevented from returning to the river.

During the late 1800s, reclamation for agricultural use began through the development of an extensive network of levees, drains, and pumping plants. This prevented the Sacramento River from overflowing the basin. The Colusa Basin Drain was built to convey natural runoff and irrigation drainage through the basin and back to the river. During wet winters today, only parts of the lower Colusa Basin Drain become inundated, and only for a short time. Extensive networks of irrigation and drainage canals serve most of the basin. Around 1980, the Tehama-Colusa Canal began serving irrigation water to land along the western side of the basin.

PRIVATELY-MANAGED WETLANDS

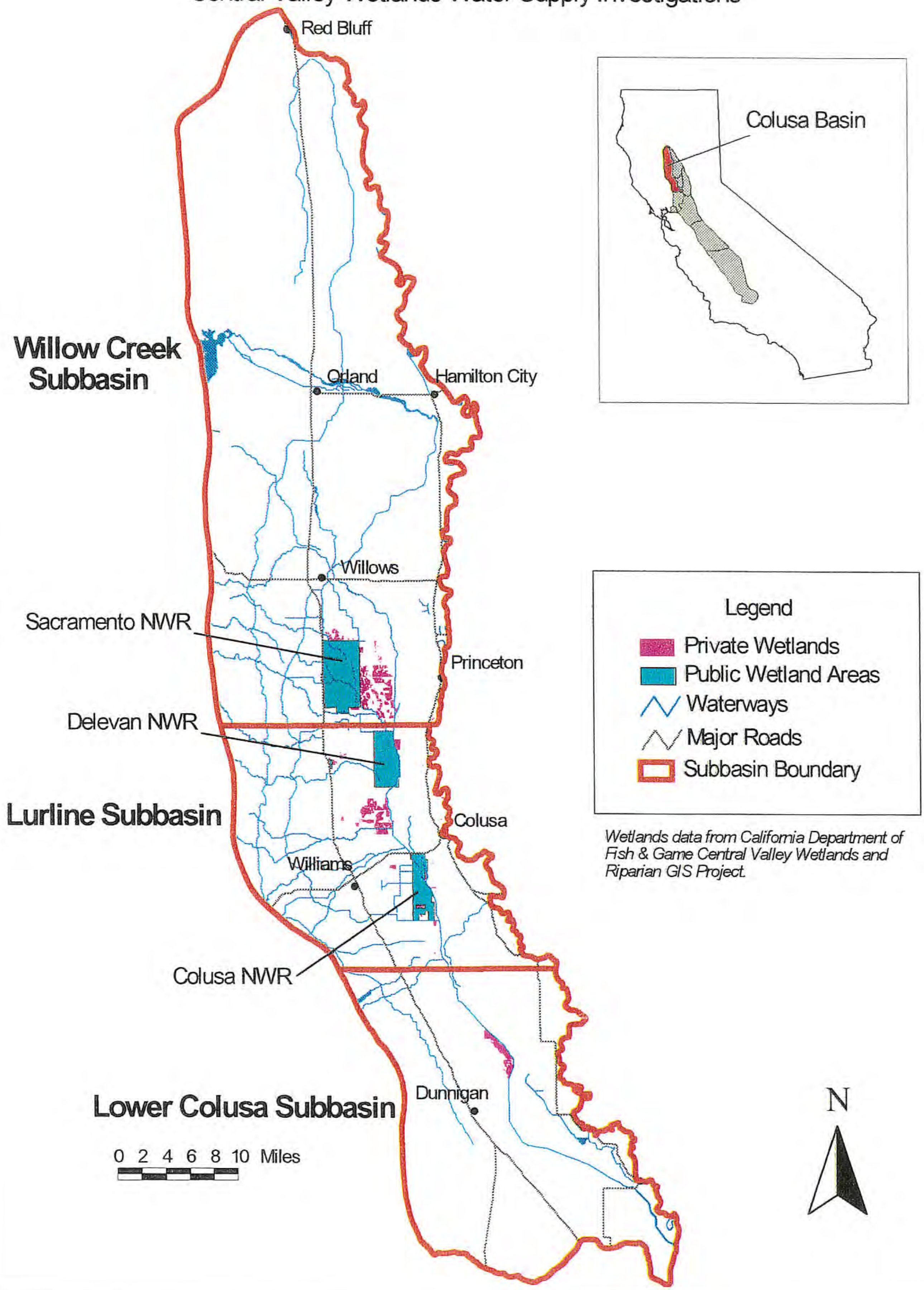
For these investigations, the Colusa Basin was divided into the Willow Creek, Lurline, and Lower Colusa subbasins (**Figure 2-2**). Water entities with service areas within these three subbasins are identified in **Table 2-5**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Table 2-5. Water Entities with Service Areas in Study Area, Colusa Basin
Central Valley Wetlands Water Supply Investigations

	Subbasin			Apparent Private Wetlands
Colusa Basin Water Entities	Willow Creek	Lurline	Lower Colusa	
Colusa Drain Water Users Association	X	X	X	**Yes**
Glenn-Colusa Irrigation District	X	X		**Yes**
Princeton-Codura-Glenn Irrigation District	X			**Yes**
Provident Irrigation District	X			No
Willow Creek Mutual Water Company	X			**Yes**
Reclamation District 2047	X	X		No
City of Colusa Water System		X		No
Elizabeth Dommer/Barb King		X		No
Maxwell ID		X		**Yes**
Maxwell PUD		X		No
Olive Percy Davis		X		**Yes**
Roberts Ditch Irrigation Company		X		No
Colusa County Water District			X	**Yes**
Reclamation District 108			X	**Yes**
River Garden Farms Company			X	No
Yolo-Zamora Water District			X	No

Figure 2-2. Colusa Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Wetlands Water Supply Conveyance Facilities and Water Agencies

Distribution of water to existing private wetlands within the Colusa Basin is a mix of deliveries received through conveyance systems of overlying agencies and pumping from stream or drainage channels directly onto the wetlands or into an existing distribution system for delivery to a wetland.

Interviews of water agencies with apparent privately-managed wetlands within their service areas disclosed that some either did not supply water to these wetlands, or were unaware that they did so. Efforts were made to determine how these wetlands received their water supplies, including follow up interviews with several agencies. These interviews revealed that although a district may not market water to private wetlands directly, water supplied to the landowner for other purposes may reach wetlands in other ways. For example, the farmer has control of return flows as long as they are on his property. The farmer may divert these flows to wetlands areas on the farm property. The following are examples of wetlands within agencies which are not served directly:

- Colusa County Water District - 700 acres of wetlands shown by the GIS analysis use Colusa Drain water.
- Glenn-Colusa ID - 1,100 acres of wetlands shown by the GIS analysis are not supplied by the District directly, but receive water from GCID's canal in other ways.
- Olive-Percy-Davis - 50 acres of wetlands shown by the GIS analysis are low spots and ponds on the Davis Ranch, but not managed (Ranch is not a water supplier).
- Princeton-Codura-Glenn ID - 10 acres of wetlands shown by the GIS analysis are not supplied by the District. The District is applying to the State Water Resources Control Board (SWRCB) for winter use of water for rice straw decomposition.
- RD 2047 - 560 acres shown by the GIS analysis are not supplied by the District (District is not a water supplier – just maintains drainage canals).

Existing Private Wetlands Location

The GIS analysis identified a total of 10,220 acres of apparent privately-managed wetlands in the Colusa Basin. Approximately 90% (8,180 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the three subbasins is shown in **Table 2-6.**

Table 2-6. Existing Private Wetlands Acreage, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Colusa Basin	Apparent Privately-managed Wetlands					
		% of Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
Willow Creek	4,440	43%	4,290	97%	150	3%
Lurline	3,820	37%	3,160	83%	660	17%
Lower Colusa	1,960	19%	1,730	88%	230	12%
Colusa Basin Totals =	10,220		9,180	90%	1,040	10%

Wetlands Water Supply

Surface water and groundwater supplies are generally good in the Colusa Basin. Groundwater use is limited primarily by cost or localized quality problems. Nearly all of the private wetlands are located in the southern half of the basin where water use by source is approximately 77% surface water and 23% groundwater. Estimated annual average agricultural groundwater extraction in the basin amounts to 425,000 AF.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High for 35% of the lands. Areas with Moderate and Low Reliability comprise the remaining 65%. Supply reliability for apparent existing privately-managed wetlands in each of the three subbasins is shown in **Table 2-7**.

Table 2-7. Water Supply Reliability of Private Wetlands, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Colusa Basin	**Apparent Privately-managed Wetlands**					
	Water Reliability, acres			Water Reliability, percent of acres		
Subbasin	High	Moderate	Low	High	Moderate	Low
Willow Creek	850	0	3,590	19%	0%	81%
Lurline	2,650	0	1,170	69%	0%	31%
Lower Colusa	120	1,840	0	6%	94%	0%
Basin Totals =	3,620	1,840	4,760	35%	18%	47%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies in the three subbasins reflect the availability of CVP-derived supplies from overlying water agencies.

Wetlands with Moderate Reliability Supplies. The significant percentage of wetlands with Moderate reliability supply in Lower Colusa Subbasin results from the wetlands supplies being a mix of irrigation tailwater diverted from the Colusa Basin Drain and CVP water supplied by overlying water agencies.

Wetlands with Low Reliability Supplies. The high percentage of wetlands with Low reliability supply in Willow Creek Subbasin results from dependence on water that is acquired through contracts with "outside" suppliers (i.e., the overlying water agency provides water acquired from other local agencies). The significant percentage of wetlands with Low reliability supply in Lurline Subbasin results from dependence of the wetlands on irrigation tailwater diverted from the Colusa Basin Drain.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-8 shows the current private wetland water demands, sources of reliable supplies, and current water supply shortfall. Private wetlands currently use one or more sources of supply when available and economically practical. Agricultural return flow from rice fields, usually co-mingled with water from the Sacramento River, is the major water source for these private wetlands. This supply can be adversely affected by drought, water conservation/recirculation measures, and water banking/transfers in upstream service areas. Although limited by cost, groundwater is generally available except in a few areas with groundwater quality problems. Agricultural return flow (tailwater) is a current reliable source, but may not be reliable for private wetlands in the future. Accordingly, tailwater supply is included in the listing of low reliability water supply.

Table 2-8. Estimated Water Demands and Supplies for Existing Private Wetlands, Colusa Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	8,687	1,022	511	10,220
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	43,435	7,563	6,771	57,769
Available Water Supply, AF/year				
Surface Water	33,011	6,132	5,749	44,891
Groundwater	3,590	493	352	4,435
Total Available Water, AF/year	36,601	6,625	6,101	49,327
Estimated Shortfall, AF/year	6,834	938	670	8,442
Low Reliability Water Supply, AF/year				
	3,318	650	630	4,598
Total Available Reliable Water Supply, AF/year				
	33,283	5,975	5,471	44,729
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	10,152	1,588	1,300	13,040

Note: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications. Low reliability water supplies include irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needs for optimum management of private wetlands in Colusa Basin are 57,769 AF/year (**Table 2-8**). Available water supplies for these wetlands are estimated to be only 49,327 AF/year (i.e., there is currently a supply shortfall of 8,442 AF/year). The available supply is 91% surface water and 9% groundwater. An estimated 4,598 AF/year of this supply is low reliability surface water from a combination of: 1) water obtained in contracts between overlying water agencies and other local agencies and 2) irrigation tailwater diverted from the Colusa Basin Drain. The combination of the 8,442 AF/year available supply shortfall and the 4,598 AF/year low reliability supply results in an estimated available, reliable supply shortfall of 13,040 AF/year.

The following options are available to improve water supply availability and reliability.

Surface Water

Existing surface water supplies to privately-managed wetlands consist of about 44,900 AF/year of appropriative and contracted water. These supplies provide ~91% of the water used by the wetlands, but only 78% of the water that is needed for optimum management. An additional 8,440 AF/year of surface water is needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is largely due to unavailability of CVP contract-derived and water rights-derived supplies during the fall and winter months.

Sources of Additional Surface Water Supply

Additional surface supplies could be purchased from willing sellers within the Colusa Basin or the Sacramento Valley area. Negotiations would involve water purchases or transfers as well as water conveyance and wheeling. Surplus natural flows (both from flooding and from unallocated surplus flows) are available in December through March of most years. Water rights would have to be acquired from the SWRCB for diversion and use of surplus supplies for private wetlands. A significant amount (~10%) of the existing private wetlands are outside of water supplier service areas. Managers of these wetlands might need to arrange for conveyance facilities to transfer their purchased water supplies.

In the Colusa Basin, water cost is an important issue. Because of limited economic returns on private wetlands, compared with agricultural lands, wetlands need a low-cost water supply. Groundwater often is too costly for optimum wetlands management. Purchases, transfers, and wheeling charges may require negotiated agreements through the U.S. Bureau of Reclamation (USBR) and SWRCB depending on the time of year and supply sources involved. DWR has estimated that water purchase and wheeling costs could range from $15 to $50 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source.

Surface Water Supply Issues

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Rights and Contract Modifications
- High Conveyance Losses
- Conveyance Difficulties
- Red Bluff Diversion Dam Operations and Fish Screen
- Potential High Cost
- Competition with Other Buyers

District Operations and Maintenance. Solution of the contract and water rights supply availability problems will not completely solve the supply availability problem. The absence of agricultural irrigation demand during the winter months leads to shutdown of some agency delivery systems during the October through March period. Water agencies use this shutdown period to perform system maintenance. Interviews of Colusa Basin water agencies disclosed the following fall and winter system shutdown practices:

- Contracts with users provide for interruption for maintenance during the period December through January, but such interruption does not occur every year.
- Delivery is suspended during period November through February. Gates are left open to allow for cross drainage of runoff from hills. This agency is working on a winterization project to solve this problem.
- Delivery is suspended for short maintenance periods during January through March.
- System is closed for one month around October for cleaning. Portions of system are closed after October (does not affect ability to serve current needs). System is closed at the end of December until Spring irrigation resumes.

As indicated above, water conveyance is subject to interruptions during the agricultural non-irrigation season (November through March). The duration of such interruptions varies from agency to agency. In most cases delivery interruption during the non-irrigation season is not continuous. Delivery interruptions include shutdowns for removal of vegetation from unlined canals. Canal cleaning interruptions could be reduced by potentially expensive canal modifications (e.g., lining).

Water Rights and Water Contract Modification. With SWRCB cooperation, USBR and other water rights holders (water districts) could perhaps restructure their water rights/contracts for wetlands water use in the fall and winter. For example, the current contracts with USBR pertain to water use between April and October. USBR has applied to SWRCB to permit winter use of CVP water. Specific information about water rights during the November through March period would need to be investigated for individual contractors, water right holders, and SWRCB to determine the potential for fall and winter use. Under appropriative rights permits, the season of diversion cannot be changed, so a new application would have to be filed for winter diversions.

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). However, with lower deliveries expected in the winter, the percentage of loss of total supply becomes significantly high (i.e., 40 to 50% of water put into the conveyance system).

Conveyance Difficulties. Conveying any water through the Colusa Basin Drain may present problems because unauthorized diversions are known to occur, and because a significant amount of land uses water that is diverted out of the Colusa Basin Drain for rice straw decomposition. In some cases, monitoring would be required to ensure delivery if small quantities are delivered to a specific point.

Red Bluff Diversion Dam Operations and Fish Screen. Diversion of Sacramento River water to Tehama Colusa Canal for delivery to wetlands is limited due to Red Bluff Diversion Dam operation. CVP deliveries through Red Bluff Diversion Canal are curtailed during period September 16 through May 14 due to Endangered Species Act limitations (salmon protection). This delivery curtailment limits the use of these facilities for water supply to wetlands during important fall, winter, and spring months.

Potential High Cost. Purchasing long-term supplies could include the cost of water, wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Most private wetlands landowners could not afford these costs.

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Competing with other buyers from the San Joaquin Valley and Southern California could be difficult for private wetland owners, who may not be able to afford the prices others would be willing to pay.

Groundwater

Existing groundwater supplies to privately-managed wetlands provide approximately 8% of the water needed for optimum management of the wetlands.

Groundwater Quality and Availability

Groundwater quality and groundwater availability in the Colusa Basin range from poor to good depending on location. The following assessment of groundwater conditions was obtained in interviews of Colusa Basin water agencies.

1. Willow Creek Subbasin - Two agencies with service areas in the eastern area of Willow Creek Subbasin characterized groundwater quality in their service areas as good. Both agencies have AB3030 groundwater management plans, and both are conducting studies of groundwater availability. [AB 3030 is California's Groundwater Management Act, which became effective January 1, 1993, and provides for voluntary groundwater management at the local level.] Another agency in the eastern area of Willow Creek Subbasin had no information on groundwater quality or availability. An agency whose service area is in the western area of the Willow Creek Subbasin had no information on groundwater quality or availability.

2. Lurline Subbasin - An agency that serves the central area of the Lurline Subbasin characterized groundwater quality and availability in its service area as good. Two other agencies had no information on groundwater quality or availability. The service area of one of these is in the western area of the Lurline Subbasin, and the service area of the other is in the eastern area.

3. Lower Colusa Subbasin - An agency whose service area is west of the Colusa Drain characterized groundwater quality and availability in its service area as poor, with groundwater quality problems that include multi-valent chromium and selenium. Another agency whose service area is east of the Colusa Drain characterized groundwater quality in its service area as good to moderate and groundwater availability as good.

4. Areas in Vicinity of Colusa Drain (All Subbasins) - An agency whose service area is along the Colusa Drain characterized groundwater quality as good in the northern and southern areas and sometimes poor in the middle area. The agency characterized groundwater availability as good throughout its area.

Potential Limitations on Groundwater Use for Wetlands

Groundwater is generally available, and water quality problems are generally local. The use of groundwater for private wetlands is potentially limited for reasons that include:

- Well Development Costs - This basin has numerous small parcels of private wetlands. Small irrigation wells, approximately 300 to 500 feet deep, can cost approximately $100,000. Groundwater development can be cost-prohibitive for private wetlands.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping are an issue for private wetland owners.

- Water Quality Limitations - Localized water quality problems include high levels of salinity, boron, manganese, fluoride, magnesium, sodium, iron, chloride, total dissolved solids, ammonia, and phosphorus, multi-valent chromium, and selenium.

- Groundwater Management - Colusa Basin agencies with some form of groundwater management include Colusa County Flood Control and Water Conservation District. In areas with groundwater management, wetland operators must comply with groundwater regulations for groundwater development and pumping. These regulations primarily require well drilling permits and monitoring of groundwater conditions. According to one of the interviewed Colusa Basin water agencies, all northern California counties have ordinances restricting new well development for area of origin protection. Concern is groundwater use to provide water for transfers, and diminishment of local supplies, as occurred in California's Owens Valley when groundwater was exported to supply Los Angeles. "Tehama County is the most restrictive. Colusa County, Glenn County, and others are also dedicated to preventing new wells".

Agricultural Return Flow

Agricultural return flow is generally available except during drought, and its use is critical to private wetlands throughout the basin. Some wetlands divert water from Colusa Basin Drain, which is inexpensive (e.g., ~$2/AF versus ~$30/AF for District surface water), but not consistently available. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Issues relating to return flow include:

- Return Flow Timing - Water releases from rice fields in late August and early September occur before fall flooding of wetland habitat normally takes place. During certain times of the year, return flow is used by private wetlands in lieu of surface or groundwater, to the extent possible. Coordinating with upstream water districts on rice pre-harvest releases could improve return flow use before turning to new supplies. The time of wetland water application could be modified to use existing, inexpensive return flow to create the appropriate habitat.

- Effects of Water Conservation, Water Banks, and Water Transfers - Water conservation, water banks, and water transfer efforts could significantly reduce the amount of return flow available to private wetlands, as these measures are usually designed to reduce, redirect, or capture outflow from the fields.

COLUSA BASIN FINDINGS

These investigations found that the Colusa Basin private wetlands:

1. Need additional water to improve the reliability of their current water supplies; and
2. Need an additional 13,040 AF of water per year to bring all of the existing private wetlands to full supply and optimum management levels.

Status of Current Water Supplies

Water supplies are generally good in the Colusa Basin. Much of the shortfall in reliable water supplies for private wetlands is due to dependence on tailwater, which is not a reliable supply.

The GIS identified 10,220 acres of apparent private wetlands, with 90% located within water agency boundaries. However, interviews with agencies indicated that nearly 2,000 acres within their boundaries were not being served by their districts. These private wetlands may be using tailwater because it is less costly. These wetlands may be able to improve their water reliability simply by buying the water from the districts based on the allocation to lands within the district, unless the district's conveyance system does not serve their area.

Securing Additional Supplies

Augmenting the surface supply with groundwater and purchasing surface water supplies from local districts willing to sell might be the best opportunity for most of the wetlands within this basin. Groundwater and purchased water will be necessary for September and October flood-up. Appropriating and using surplus winter natural flows then may be used for maintaining water levels in the wetlands during the late fall and winter.

Surface water supplies will have wheeling charges and some conveyance system modification issues to resolve. Wheeling could come through local water suppliers or some small diverters. Conveyance options for these areas need to address monitoring to ensure deliveries.

For maximum reliability in drought years, groundwater development could provide flexibility in maintaining optimum private wetlands management. Well development and pumping costs could be prohibitive for most private wetland owners in this basin. Financial incentives would likely be necessary to make this option economically feasible for the private wetlands landowners.

Issues Affecting Water Availability and Reliability

Because of conveyance system maintenance, the use of surface supplies in some cases could be limited in the winter. However, there may be enough surplus local natural runoff from upstream areas to provide winter maintenance supply during most years. Additional conveyance facilities may be needed to deliver the water to private wetlands.

Private wetlands rely on agricultural return flow for flood-up, maintenance flows, and summer irrigations for habitat management. Although inexpensive, this source of supply is not consistently available; however, wetland managers can expect to continue to use this source for the foreseeable future. Future water conservation measures may reduce the amount of agricultural return flow available in the basin, which would affect wetlands that depend on this supply.

Salmon protection operations of the Red Bluff Diversion Dam limit deliveries to wetlands during important fall, winter and spring months. This situation is being addressed in other CVPIA programs (Anadromous Fish Restoration Program-Structural Solutions).

Water supply availability and reliability improvement options and issues for Colusa Basin privately-managed wetlands are summarized in **Table 2-9.**

Table 2-9. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Colusa Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Surplus surface supply Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Conveyance Difficulties • Red Bluff Diversion Dam Operations and Fish Screen Operations • Potential for High Cost • Competition with Other Buyers
Groundwater	Existing wells New Wells	• Water Cost • Well Development Cost • Water Quality Limitations • Groundwater Management
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Butte Basin

Total Basin Land Area, acres	**704,000**
Total Privately-Managed Wetland Land Area, acres	**15,320**
Private Wetlands as Percent of Total Basin Area	**2.2%**

BASIN DESCRIPTION

The Butte Basin covers approximately 1,100 square miles in the northeastern portion of the Sacramento Valley and extends 75 miles from Red Bluff south to the geological feature known as the Sutter Buttes. It is bordered by the Sacramento River on the west and the Sierra Nevada foothills and the Feather River on the east (**Figure 2-3**). The Sacramento River and its tributaries (Antelope, Mill, Deer, Big Chico, and Butte creeks) flow through the basin. Butte Creek drains the basin between the City of Chico and the Sutter Buttes.

BASIN HYDROLOGY

Historically, the creeks north of the City of Chico (Antelope, Mill, Deer, and Big Chico) overflowed on to adjacent lands. These lands now are occupied by orchards and urban development, and are protected by small levees. Below Chico, Butte Creek typically overflowed onto adjacent lands and sloughs during winter storms and spring snowmelt, creating a vast floodplain. High flows from the Sacramento River also would spread, eventually reaching the area called the Butte Sink, a large marsh created by these overflows. The numerous sloughs and riparian lands captured the water and created seasonal marshes.

In the early 1900s, reclamation for agriculture created a combination of levees and drainage facilities to contain some of the flood waters. The southwestern part of the Butte Basin is used by the Sacramento River Flood Control Project to convey flood flows into the Sutter Bypass, creating large flooded areas for extended periods. Inundation varies from weeks to several months, depending on the magnitude and duration of high river flows.

The Butte Sink, in the lower Butte Creek watershed, evolved to its present condition as a result of Sacramento Valley rice culture development in the early 1900s and the use of this natural basin to convey and detain Sacramento River flood flow during winter and spring. Butte Sink is flooded annually beginning in August with return flows from upstream rice fields, which has resulted in development of extensive emergent marsh and forest wetland habitat. Landowners maintain their wetlands in a flooded condition throughout the fall and winter. In many years, Butte Sink is inundated between December and May with flood waters for periods ranging from a few weeks to several months. The resultant wetland habitat is some of the most significant in the Central Valley; and preserving the Butte Sink's ecological values is essential to Pacific Flyway waterfowl conservation.

PRIVATELY-MANAGED WETLANDS

For these investigations, the Butte Basin was divided into the Upper Butte and Butte Sink subbasins (**Figure 2-3**). Water entities with service areas within these two subbasins are identified in **Table 2-10**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

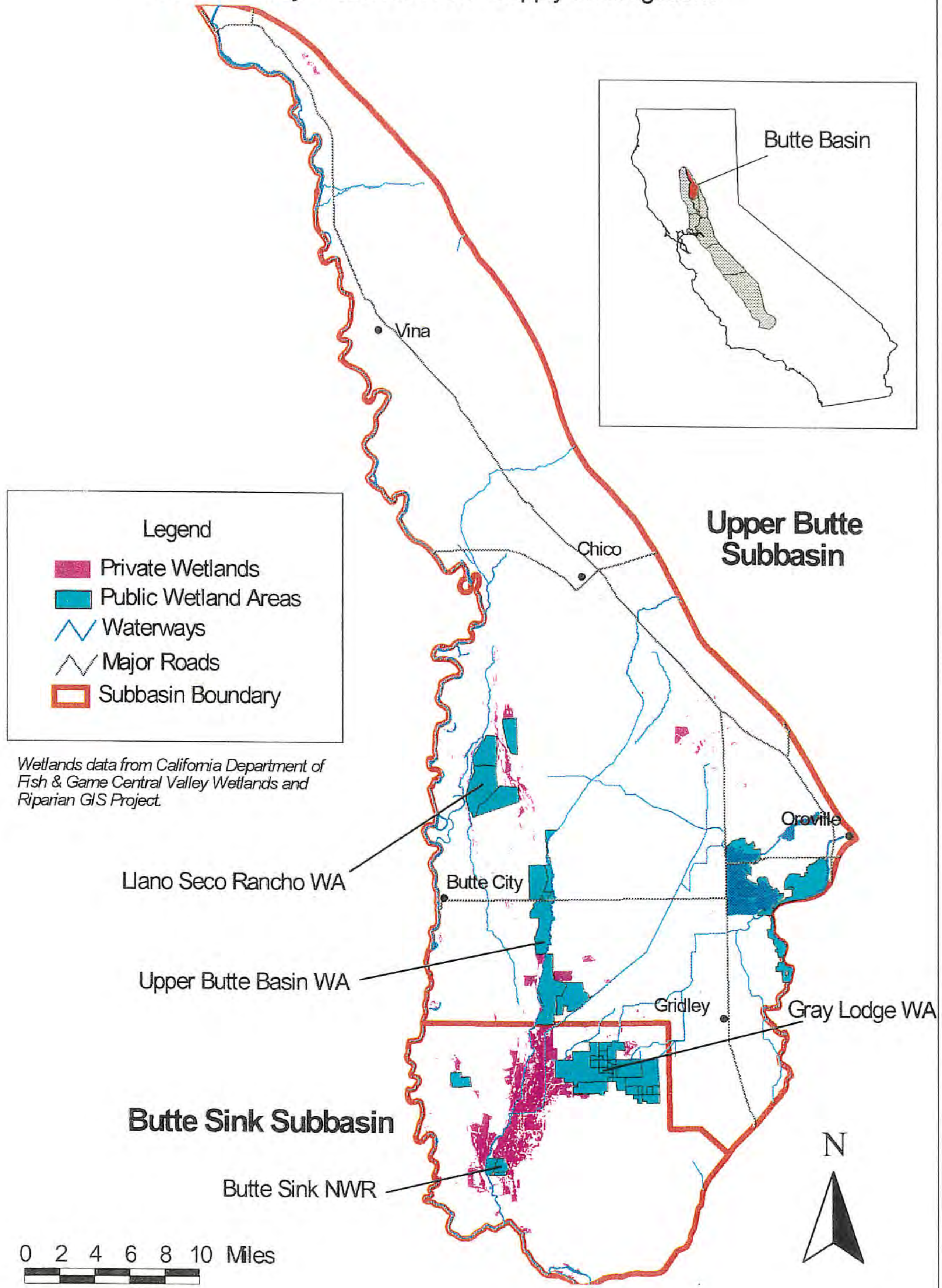
Table 2-10. Water Entities with Service Areas in Study Area, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin Water Entities	**Subbasin**		Apparent Private Wetlands
	Upper Butte	Butte Sink	
Biggs-West Gridley Water District	X	X	**Yes**
Butte Water District	X		No
Dayton Mutual Water Company	X		No
Durham Mutual Water Company	X		No
Llano Seco Rancho	X		**Yes**
M&T Chico Ranch, Inc.	X		**Yes**
Reclamation District 1004	X	X	**Yes**
Richvale Irrigation District	X		**Yes**
Sutter Bypass/Buttes Slough Water Users Association	X	X	**Yes**
Western Canal Water District	X		**Yes**
Sartain Mutual Water Company		X	

Wetlands Water Supply Conveyance Facilities and Water Agencies

Distribution of water to existing private wetlands within the Butte Basin is a mix of deliveries received through conveyance systems of overlying agencies and pumping from stream or drainage channels directly onto the wetlands or into an existing distribution system for delivery to a wetland.

Figure 2-3. Butte Basin Private Wetlands
Central Valley Wetlands Water Supply Investigations



Interviews of water agencies with apparent privately-managed wetlands within their service areas disclosed that one is not involved in water supply to privately-managed wetlands and another does not know the extent to which it serves wetlands. These agencies are:

- Sutter Bypass/Buttes Slough Water Users Association - 170 acres of wetlands shown by the GIS analysis are not supplied by the Association. The Association does not now have a water supply, but is currently negotiating a supply contract with another local agency. Association says that landowners in its area have groundwater supplies as well as appropriative water rights to Butte Slough and Sutter Bypass channels and tributaries, and that the majority of rice farm land uses flooding for rice straw decomposition).

- Reclamation District 1004 - 820 acres of wetlands shown by the GIS analysis are not supplied by the District (District does provide water for rice straw decomposition). The District does not market water to private wetlands directly, however, water supplied to the landowner for other purposes may reach wetlands in other ways. For example, the farmer has control of return flows as long as they are on his property. The farmer may divert these flows to wetlands areas on the farm property.

Butte Basin Water Supply Regions

To evaluate the potential for wetlands water supplies for the private wetlands in this basin, the Butte Basin can be divided into six primary water supply regions, based on the service areas of water suppliers. More than 90% of the private wetlands are in these regions, although, as noted above, several of the water suppliers are not now supplying water to private wetlands. Wetlands within each of the primary water supply regions could be served by the same water supplier, thus they generally would have similar water rights and water contracts. These wetlands would also be subject to similar ditch maintenance schedules and water pricing, and would utilize the same conveyance facilities. Small areas of additional wetlands also exist in the Butte Slough and Los Molinos water service areas. These water supply regions are:

- Butte Sink 1922 Agreement Lands
- Reclamation District 1004
- Eastern Butte Sink 833 Drain
- Richvale Irrigation District
- Western Canal Water district
- Large Ranches

Butte Sink 1922 Agreement Lands

In 1922, a group of Butte Sink landowners signed an agreement with the Western Canal Water District to accept late summer agricultural return flows (tailwater) from rice fields in return for a guaranteed water supply through the end of waterfowl hunting season. Since then, these private wetlands, known as the 1922 Agreement Lands, have been flooded annually beginning in August. Currently, this agreement encompasses 10 properties totaling over 5,000 acres of private wetlands. Western Canal Water District utilizes agricultural return flows and Feather River water to meet their obligations under the 1922 Agreement. Western Canal WD's diversion of surface water is based on its pre-1914 appropriative water right, and is provided by DWR via the SWP's Lake Oroville complex. Western Canal WD ceases water delivery after January to perform winter maintenance, however the 1922 Agreement Lands receive sufficient natural flows during late winter and early spring to maintain high quality wetland habitat.

Reclamation District 1004

RD 1004 service area covers private wetlands, most of which are located along the west side of Butte Creek adjacent to the 1922 Agreement Lands. Some private wetlands also exist north of the Butte Sink in the RD 1004 service area. RD 1004 has Sacramento River CVP water rights to supplement its Butte Creek diversions. Wetlands in this area would most likely be flooded and maintained with Butte Creek water, which is cheaper to deliver since the Sacramento River water must be pumped and conveyed to the wetland sites. For some lands, Butte Creek is the only source of water available. There is some groundwater development within the district, but very little groundwater is used annually to flood private wetlands.

Eastern Butte Sink 833 Drain

Private wetlands are located east of the 1922 Agreement Lands, southeast of Gray Lodge Wildlife Area (Gray Lodge WA). These wetlands lie outside of any water supplier service districts, and therefore receive only return flows via Cherokee Canal and the 833 Main Drain, which is made up of return flows from Biggs-West Gridley WD, Western Canal WD, and Richvale ID. Because these private wetlands rely exclusively on the return flows of upstream agricultural and wetland water users, the water supply for these lands is not considered to be reliable. However, adequate tailwater and natural run-off has been in the Cherokee/833 Drain system in most years for landowners in the region to grow rice, irrigate pastures, or flood their wetlands during the fall and winter. Future water conservation practices or land use changes upstream could dramatically reduce private wetland water supplies in all but wet years.

Western Canal Water District

Western Canal WD's diversion of surface water is based on its pre-1914 appropriative water right, and is provided by DWR via the SWP's Lake Oroville complex. The district is a participant in the 1922 Agreement for wetlands water supply to lands in the Butte Sink, and utilizes agricultural return flows and Feather River water to meet obligations under the 1922 Agreement. The district shuts down its system for winter maintenance in mid-January (end of the waterfowl hunting season) after supplying the 1922 Agreement water and typically does not resume deliveries until April. There is usually enough return flow and natural runoff through the Little Butte Creek system during the winter for wetland maintenance water. Supplies may be reduced during droughts, especially during the water right limitation period of April 1 through October 31.

Richvale ID

Under terms of a 1969 agreement with DWR for delivery of Feather River water, Richvale ID can contract for Feather River water delivery only to those served by the 1922 Agreement. Richvale ID delivers water to private wetland areas within the district or extended service areas. Most of the private wetlands are in extended service areas with a low-priority water right and there is not enough water available to annex these areas with full priority rights. Most of the private wetlands are in the southwestern portion of the district, which is the secondary service area. These lands are typically well managed with adequate supplies of surface flows combined with agricultural return flows. The location of these lands allows them to use return flows before they leave the district.

Richvale ID has adequate water supply to provide additional water to existing wetlands in its primary service area. Although district deliveries are shut down for canal maintenance from mid-January through March, agricultural return flow and natural runoff may be sufficient to supply wetlands during shutdowns. Groundwater is an option to provide added reliability during canal maintenance periods and critically dry years.

Large Ranches (M & T Chico Ranch, Llano Seco Ranch, Rancho Esquon)

M & T Chico Ranch and Llano Seco Ranch are large ranches in the northwest corner of the Upper Butte Basin. Both have sufficient water sources from Butte Creek and the Sacramento River to maintain their existing private wetland habitats, including existing slough areas. A significant amount of private wetland acreage lies in the Cherokee Strip and in Rancho Esquon, which are roughly northeast of the Western Canal WD service area. Some lands in the Cherokee Strip depend solely on groundwater, thus lacking any conveyance system for the limited amount of surface water in the Dry Creek area (none available during flood-up). There is a conveyance system in the eastern portion of the Strip for diversion of surface water in the Dry Creek area.

There is some concern that groundwater pumping as a substitute for surface water for the 1994 Water Bank by Western Canal WD may have influenced a decline in groundwater pumping depths during this dry year. Groundwater is extensively used on Rancho Esquon lands. The ranch's right to Butte Creek water applies only to the natural flow, which typically ends in June or July, depending on the year.

Existing Private Wetlands Locations

The GIS analysis identified a total of 15,320 acres of apparent privately-managed wetlands in the Butte Basin. Approximately 43% (6,640 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the two subbasins is shown in **Table 2-11.**

The majority of Butte Basin wetlands occur along the lower Butte Creek watershed in the region known as the Butte Sink. Private wetlands in the Butte Sink are characterized by tule marshes and forested wetlands with extensive stands of willows, cottonwoods, and buttonbush. These wetlands are intensively managed to provide foraging and loafing habitat for wintering waterfowl, but also provide significant benefits to colonial nesting waterbirds and a wide range of wetland-associated wildlife. The Butte Sink provides excellent habitat for threatened, endangered, or sensitive species including the giant garter snake, greater sandhill crane, and white-faced ibis.

Table 2-11. Existing Private Wetlands Acreage, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin	**Apparent Privately-managed Wetlands**					
		% of Basin	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres	Total	acres	Percent	acres	Percent
Upper Butte	2,890	19%	2,300	80%	590	20%
Butte Sink	12,430	81%	4,340	35%	8,090	65%
Butte Basin Totals =	15,320		6,640	43%	8,680	57%

Most of the remaining Butte Basin private wetlands occur in the Upper Butte Basin region between the Gridley-Colusa highway and Chico. Nearly 3,000 acres of private wetlands are scattered throughout this rice-dominated agricultural area. Small clusters of wetlands exist around the Llano Seco Unit of the Sacramento River NWR and the three units of the State owned Upper Butte Basin Wildlife Area. A few small parcels of private wetlands also exist north of Chico and near Red Bluff.

Private wetlands in the Upper Butte Basin provide critical habitat for dabbling ducks such as wood ducks, mallards, pintails, widgeon, and green-winged teal. The area is also an important fall staging and wintering area for sandhill cranes, including the state-listed-threatened greater sandhill crane. Wetland management typically focuses on developing a mixture of tules, smartweed, and watergrass in seasonal wetlands, which generally involves at least one spring/summer irrigation. Some landowners periodically flood their wetlands for 9 to 10 months of the year to establish tules, cattails, and other emergent marsh structure. Most landowners along the Butte Creek corridor actively encourage willows and cottonwoods in an effort to restore native riparian zones and integrate their wetlands with the forested habitats of the Butte Sink.

Wetlands Water Supply

Private wetland water supplies are generally good in the Butte Basin. The water supply for most private wetlands consists of either: 1) contracted surface water from the Sacramento River, Butte Creek, or the Feather River, 2) agricultural return flows, or 3) a mixture of contracted surface water and agricultural return flows. Groundwater pumping for private wetland management is limited to a few isolated areas that lack an adequate surface water supply. However, other landowners augment their surface water supplies in dry or critically dry years through groundwater pumping. Groundwater supplies are typically very good in the Butte Basin, but excessive pumping costs limit the use of groundwater in most circumstances.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High for 43% of the lands. Areas with Moderate, Low and Unknown Reliability comprise the remaining 57%. Supply reliability for apparent existing privately-managed wetlands in each of the two subbasins is shown in **Table 2-12.**

Table 2-12. Water Supply Reliability of Private Wetlands, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin	**Apparent Privately-managed Wetlands**							
	Water Reliability, acres				Water Reliability, percent of acres			
Subbasin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
Upper Butte	2,300	0	100	490	80%	0%	3%	17%
Butte Sink	4,290	5,580	2,450	110	34%	45%	20%	1%
Basin Totals =	6,590	5,580	2,550	600	43%	36%	17%	4%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies in both subbasins reflect the availability of CVP, SWP and water rights-derived supplies from overlying water agencies.

Wetlands with Moderate Reliability Supplies. The significant percentage of wetlands with Moderate reliability supply in Butte Sink Subbasin are on lands that are outside the boundaries of water supply agencies. Water supply to most of these lands is based on a 1922 agreement between a group of Butte Sink landowners and the Western Canal Water District, previously described in this section. These landowners agreed to accept late summer agricultural return flows from rice fields in return for a guaranteed water supply through the end of waterfowl hunting season. These private wetlands, known as the 1922 Agreement Lands, are flooded annually beginning in August. Western Canal WD ceases water delivery from January 15 to April 1 to perform system maintenance, however the 1922 Agreement Lands receive sufficient natural flows during late winter and early spring to maintain high quality wetland habitat.

Wetlands with Low Reliability Supplies. Wetlands with Low reliability supply are located east of the 1922 Agreement Lands, southeast of Gray Lodge WA. These wetlands lie outside of any water supplier service districts, and therefore receive only return flows via Cherokee Canal and the 833 Main Drain, which is made up of return flows from Biggs-West Gridley WD and Richvale ID. Because these private wetlands rely exclusively on the return flows of upstream agricultural and wetland water users, the water supply for these lands is not considered to be reliable. However, adequate tailwater and natural run-off has been in the Cherokee/833 Drain system in most years for landowners in the region to grow rice, irrigate pastures, or flood their wetlands during the fall and winter. Future water conservation practices or land use changes upstream could dramatically reduce these private wetland water supplies in all but wet years.

Wetlands with Unknown Reliability Supplies. Wetlands with Unknown reliability supply are on lands that are outside the boundaries of water supply agencies.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-13 shows the current private wetland water demands, sources of reliable supplies, and current water supply shortfall.

Table 2-13. Estimated Water Demands and Supplies for Existing Private Wetlands, Butte Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	13,022	1,532	766	15,320
Optimum Management Water Requirements, AF/acre/year	5.6	7.4	13.25	
Total Water Requirement, AF/year	72,923	11,337	10,150	94,410
Available Water Supply, AF/year				
Surface Water	55,464	8,898	8,342	72,704
Groundwater	2,332	363	325	3,020
Total Available Water, AF/year	57,797	9,261	8,667	75,724
Estimated Shortfall, AF/year	15,127	2,076	1,483	18,686
Low Reliability Water Supply, AF/year				
	9,948	1,596	1,496	13,041
Total Available Reliable Water Supply, AF/year				
	47,848	7,665	7,170	62,683
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	25,075	3,672	2,979	31,726

Note: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications. Low reliability water supplies include irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needs for optimum management of private wetlands in Butte Basin are 94,410 AF/year (**Table 2-13**). Most of the private wetlands are in the southern portion of the basin (called the Butte Sink), where some private wetlands have an agreement for water from the Western Canal Water District. Under this 1922 agreement, duck clubs receive a guaranteed water supply through the end of the waterfowl hunting season from a combination of agricultural return flows from rice fields and water supply from Western Canal WD. These lands have adequate supplies during average years, and are considered some of the best-managed private wetlands in the Sacramento Valley. In other areas, private wetlands in the Butte Basin are supplied by agencies with SWP agreements or water rights on Butte Creek. Only one potential private wetlands supplier receives CVP water, which is only 20% of its supply. A few wetlands in the basin use groundwater. The predominant water supply to private wetlands in the Butte Basin is from agricultural return flows from rice lands.

To meet and improve water supply reliability, the following options are available.

Surface Water

Currently, about 72,700 AF/year of the approximately 94,400 AF/year of water required for wetlands in this basin is supplied by surface water. This supply includes a low reliability component (irrigation tailwater) of approximately 13,000 AF/year (i.e., the reliable surface water supply is approximately 59,700 AF/year). Additional reliable surface water could be purchased from willing sellers within the Sacramento Valley area, and the water purchased could be wheeled by local districts, provided that there is conveyance capacity available. This may require an agreement between the districts, DWR, and/or USBR. DWR has estimated that water purchase and wheeling costs could range from $10 to $25 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source. Surplus natural flows (from flooding and unallocated supply) are available in December through March of most years, which is sufficient to provide winter maintenance supply in most years. If there is water available, and if others do not protest diversions for this purpose, water rights could be acquired from SWRCB to divert and use these surplus supplies on private wetlands.

Surface Water Supply Issues

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Rights and Contract Modifications
- High Conveyance Losses
- Conveyance Difficulties
- Potential High Cost
- Competition with Other Buyers

District Operations and Maintenance. None of the districts provide year-round conveyance, although several can divert water at all times of the year. Maintenance on canals is usually performed from January through March, but some districts have said they normally require only a few weeks for maintenance.

Water Right/Contract Modification. Districts with CVP contracts do not receive water from November through March. USBR has applied to SWRCB for modifications of water right permits to serve water during fall and winter. Districts receiving SWP water can usually divert in fall and winter if water is available and depending on the amount of water in or entering Oroville Dam. Individual appropriative water right holders or water districts could apply to SWRCB to amend their permits or licenses to allow for wetlands water use in fall and winter if their present use is limited to the irrigation season. Current contracts with USBR pertain to water use between April and October.

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in the winter to those that occur during irrigation season (spring/summer). With lower deliveries expected during the winter, the percentage of loss of the total supply becomes significantly higher (i.e., 40 to 50% of water conveyed might be lost to seepage). These losses could be reduced if private wetlands deliveries were timed to coincide with deliveries to refuges by their water suppliers, to maximize system efficiency.

Conveyance Difficulties (Unauthorized Diversions). Unauthorized diversions are known to occur during transport of water through the network of small diversion points while conveying water to areas along lower Butte Creek and Butte Slough. Monitoring may be necessary to ensure delivery if small quantities are delivered to a specific point. Timing of deliveries can also be a factor in providing water to private wetlands during late summer/early fall. For example, conveyance seepage adjacent to rice fields during August and September in Biggs-West Gridley WD causes significant problems for harvesting. In this case, Biggs-West Gridley WD minimizes canal usage during these times.

Potential High Cost Purchasing long-term supplies could include the cost of water, wheeling costs, and costs of conveyance modifications, which when combined can be expensive.

Competition with Other Buyers. Because of shortages statewide, the concept of water marketing and transfers, and the passage of enabling legislation (including legislation to protect the seller's water rights), have recently generated great interest. Competing with buyers from the San Joaquin Valley and Southern California could be difficult for private wetland owners, who may not be able to afford the prices others would be willing to pay.

Groundwater

Groundwater is assumed to provide approximately 4% of the water needed for optimum management of the private wetlands. Groundwater pumping for private wetlands is assumed to be limited to a few isolated areas that lack an adequate surface water supply. Groundwater is generally available, and water quality problems are generally local. The use of groundwater for private wetlands is potentially limited for reasons that include:

- Well Development Costs - A typical 16-inch cased irrigation well approximately 300 to 500 feet deep can cost about $100,000.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping are an issue for private wetland owners.

- Groundwater Development and Management - Groundwater extraction/distribution could be affected by current and future local management plans. Tehama County Flood Control and Water Conservation District has a groundwater management plan, and the Butte Basin Water Users Association is working on a groundwater model and management plan. Unless there is a condition of overdraft, this management would likely be limited to well drilling permits and monitoring of groundwater conditions. Tehama County and several other northern counties have or are considering ordinances to prevent groundwater development for export outside the county.

Agricultural Return Flow

Agricultural return flow is generally available except during drought, and its use is critical to private wetlands throughout the basin. This source is usually inexpensive, but has not been consistently available in all years. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Outside of CVP service areas, contract agreements may be available, and private wetland owners could pursue options with districts willing to make this source of supply available on a more consistent basis. Issues include:

- Return Flow Timing - Return flow may be available during the irrigation season for certain wetland management practices, such as irrigation for waterfowl food crops. However, in this basin most of the pre-harvest water releases from rice fields occur in late August through September before most of the wetlands flood for fall and winter habitat. Most private wetlands make use of available return flow to the extent possible. Return flow use may be limited for wetlands irrigations in May and June because rice field flooding occurs at the same time. When rice fields are flooded, the timing of wetland irrigation and maintenance could be somewhat modified to use available inexpensive return flow to maintain appropriate habitat. Coordinating (and obtaining options) with upstream districts for return flow releases could improve the reliability prior to exploring alternatives for new supplies.

- Effects of Water Conservation, Water Banks, and Water Transfers - Water conservation efforts could reduce the amount of return flow now available to private wetlands. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. These programs are designed to reduce agricultural water use and reduce outflow from the rice fields, hence reducing the amount of return flow in the basin. A considerable amount of the Butte Basin wetland acreage uses return flow, which is generally considered a moderately reliable supply in this basin, particularly for 1922 Agreement lands.

BUTTE BASIN FINDINGS

These investigations found that existing private wetlands in the Butte Basin:

1. Need significant improvement in the reliability of their current water supplies; and

2. Need an estimated additional reliable water supply of 31,726 AF/year to bring them all to full supply and optimum management levels.

The Butte Basin has 15,320 acres of existing private wetlands, of which only 43% are within the boundaries of water suppliers.

Status of Current Water Supplies

The predominant water supply to private wetlands in this basin is from tailwater from rice lands. Within the 1922 Agreement Lands in the Butte Sink, this is a reliable water supply. In other areas tailwater is a less reliable water source. Most wetlands supplied by water agencies do not receive deliveries from mid-January through March.

Securing Additional Supplies

Surface and groundwater are options to enhance the reliability of private wetlands water supply. Purchased surface water supplies will have wheeling charges and some potential system or conveyance modification issues to overcome. Wheeling agreements could be arranged through local water suppliers. Because of unauthorized diversions, monitoring would be needed to ensure that the contracted supplies are received.

There may be enough natural runoff and return flows from upstream areas to provide winter maintenance supply in most years; however, groundwater and purchased water will be needed for September and October flood-up. In some average and most wet years, the southern basin will flood, thus naturally supplying all of the private wetlands areas.

Groundwater development in the southern basin could provide flexibility for private wetland owners in maintaining optimum wetlands management and could augment surface water supply. However, groundwater development and pumping costs may be prohibitive for private wetland owners, and could be limited in development by water quality or future local groundwater management programs.

Issues Affecting Water Availability and Reliability

Timing of deliveries may be a factor in wetlands water supply reliability. Water district managers may be willing to assist private wetlands managers by recommending ways to improve reliability, such as timing deliveries to allow maximum efficiency for the districts. Some districts wheel water to refuges, and may find it most efficient to convey water to private wetlands at the same time.

Some private wetlands may be able to request additional supplies from the overlying water district, or become annexed into a local district. If annexation is feasible, conveyance facilities would be needed. Neither the wetlands owner nor the district could be expected to bear this cost without incentives or funding assistance.

A considerable amount of private wetland water supply is from agricultural return flow. Although inexpensive, this source of supply is not consistently available and may be affected by future management options by upstream users. However, private wetlands in the 1922 Agreement lands have a guaranteed supply from this source through the end of the waterfowl hunting season because of their agreement to take return flow beginning in August. Other private wetlands owners may be able to make similar agreements.

Water conservation efforts, water banks, and water transfers could reduce the amount of return flow available to some of the private wetlands by reducing the initial amount of water applied to agricultural fields.

Table 2-14 summarizes the water supply options and related issues for improving water reliability for private wetlands in the Butte Basin.

Table 2-14. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Butte Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Potential for High Cost • Competition with Other Buyers
Groundwater	Use existing wells New Wells	• Pumping Costs • Well Development Costs • Groundwater Management
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Sutter Basin

Total Basin Land Area, acres	**224,000**
Total Privately-Managed Wetland Land Area, acres	**110**
Private Wetlands as Percent of Total Basin Area	**0.05%**

BASIN DESCRIPTION

Extending south from the Sutter Buttes to the confluence of the Feather and Sacramento rivers, the Sutter Basin covers 350 square miles of low-lying, fertile land. Roughly 37 miles long and 17 miles wide, the basin is diagonally split by the Butte Slough/Sutter Bypass portion of the Sacramento River flood control system (**Figure 2-4**).

Private wetlands are uncommon in the Sutter Basin, which is dominated by rice, grain, row crops, and orchards. The few existing private wetlands (approximately 110 acres) are generally within the Sutter Bypass and typically support good numbers of wintering waterfowl and other wetland-dependent species. These wetlands are managed to provide good loafing areas for waterfowl with a mixture of emergent vegetation, swamp timothy, and other moist-soil plants.

BASIN HYDROLOGY

Historically, overflow from the Sacramento River, Butte Sink, and the Feather River flooded a large part of the Sutter Basin during the winter and spring, and would create 40,000 to 50,000 acres of marsh which have since been converted to agriculture. A significant part of the basin remained flooded year-round, providing a vast breeding and wintering area for waterfowl and other water-related wildlife. Water not retained in the basin drained south and reentered the Sacramento River. Construction of the Sutter Bypass and flood control systems on the Sacramento and Feather rivers in the early 1900s now prevents most flooding in the basin.

PRIVATELY- MANAGED WETLANDS

The Sutter Basin was not divided into sub-basins as most of the private wetlands in the basin are located within the Sutter Bypass. Water entities with service areas within the Sutter Basin are identified in **Table 2-15**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Table 2-15. Water Entities with Service Areas in Study Area, Sutter Basin
Central Valley Wetlands Water Supply Investigations

Sutter Basin Water Entities	Apparent Private Wetlands	Sutter Basin Water Entities	Apparent Private Wetlands
Butte Slough Irrigation District	No	Sutter Bypass/Buttes Slough Water Users Association	**Yes**
Feather Water District	No	Sutter Extension Water District	**Yes**
Meridian Farms Water Company	No	Sutter Mutual Water Company	No
Newhall Land and Farming Co.	No	Tisdale Irrigation and Drainage Co.	No
Reclamation District 1500	No	Tudor Irrigation District	No

Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the Sutter Basin is a mix of deliveries through conveyance systems of water agencies and pumping from stream or drainage channels directly onto the lands or into an existing distribution system for delivery to points of use. Interviews of the two water agencies with apparent privately-managed wetlands within their service areas disclosed that neither is involved in water supply to privately-managed wetlands.

Existing Private Wetlands Location

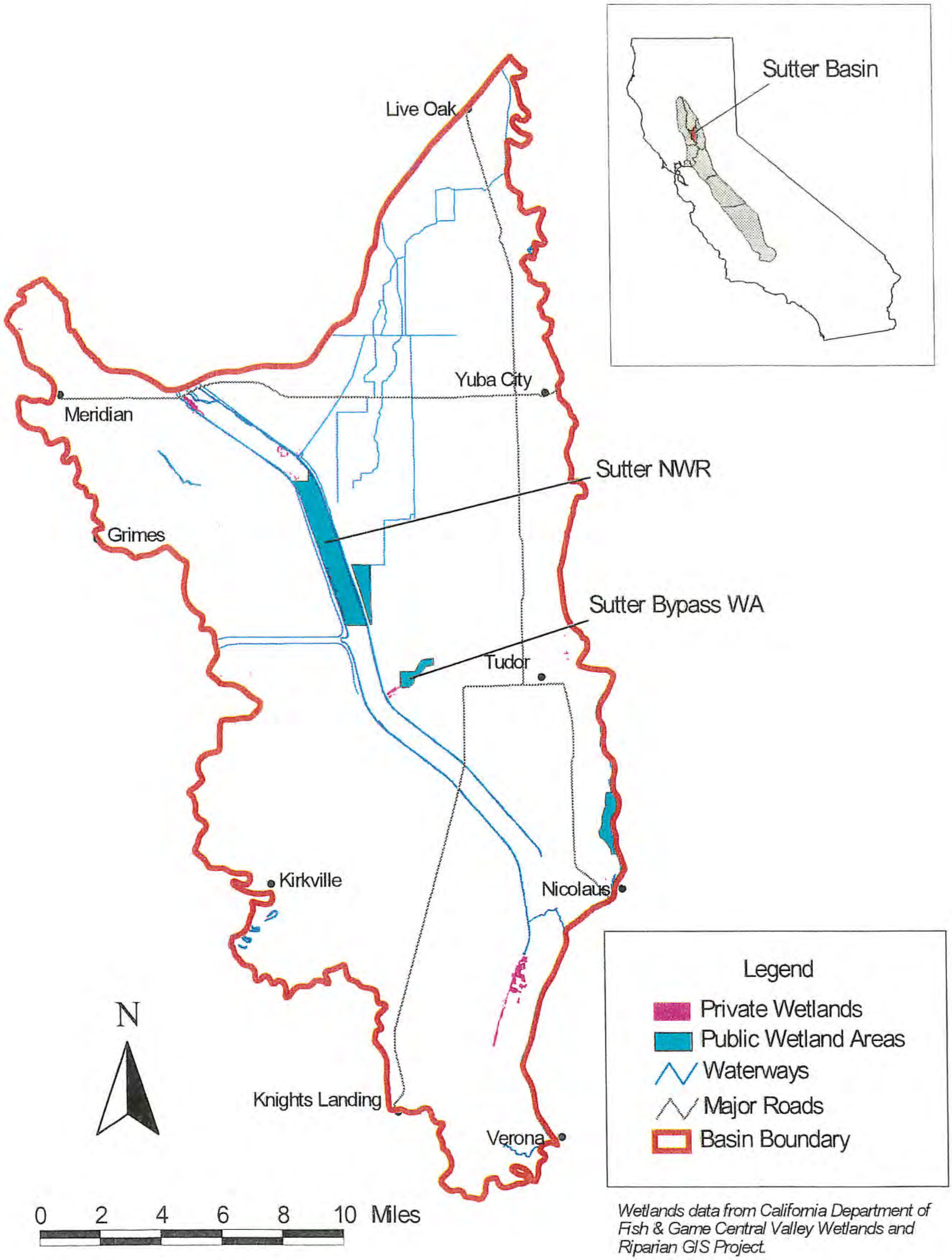
The GIS analysis identified a total of 110 acres of apparent privately-managed wetlands in the Sutter Basin. All 110 acres are inside the boundaries of two water agencies. Occurrence of these wetlands is shown in **Table 2-16.**

Table 2-16. Existing Private Wetlands Acreage, Sutter Basin
Central Valley Wetlands Water Supply Investigations

Sutter Basin	Apparent Privately-managed Wetlands	
	acres	% of Sutter Basin Total
Agency A	70	64%
Agency B	40	36%
Outside of Water Agencies	0	0%
Sutter Basin Totals =	110	100%

Figure 2-4. Sutter Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Most of the private wetlands in the Sutter Basin are located within the Sutter Bypass. The one wetland area outside the Bypass is Gilsizer Slough WCB project, but these wetlands are not intensively managed. Only one of the three interviewed water agencies was aware of privately-managed wetlands in its service area. All three agencies said that landowners flood some rice lands for rice straw decomposition, and one said that there was some flooding for duck hunting, but the extent of managed wetlands was not known. One agency with no identified privately-managed wetlands estimated that from 2,000 to 4,000 acres were usually flooded for rice straw decomposition, the amount varying by year.

Wetlands Water Supply

Surface water is the predominant source of supply in this basin. Agricultural return flows supply most of the late summer and fall uses for private wetlands. Surface supplies are primarily from the Feather River, Sacramento River, Butte Creek, and agricultural return flows. Groundwater is limited for agricultural and wetland uses in some areas due to water quality problems (e.g., salinity, arsenic). Most private wetlands depend on agricultural return flows as a source of supply.

Water Supply Reliability

Water supply reliability of all 110 acres of apparent existing privately-managed wetlands is Low **(Table 2-17)**.

Table 2-17. Water Supply Reliability of Private Wetlands, Sutter Basin
Central Valley Wetlands Water Supply Investigations

	Apparent Privately-managed Wetlands	
Sutter Basin	Low Water Reliability, acres	Low Water Reliability, percent of acres
Agency A	70	100%
Agency B	40	100%
Sutter Basin Totals =	110	100%

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-18 shows the current private wetland water demands, sources of reliable supplies, and current water supply shortfall.

Table 2-18. Estimated Water Demands and Supplies for Existing Private Wetlands, Sutter Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	94	11	6	110
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	468	81	73	622
Available Water Supply, AF/year				
Surface Water	355	66	62	483
Groundwater	0	0	0	0
Total Available Water, AF/year	355	66	62	483
Estimated Shortfall, AF/year	112	15	11	139
Low Reliability Water Supply, AF/year				
	355	66	62	483
Total Available Reliable Water Supply, AF/year				
	0	0	0	0
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	468	81	73	622

Note: Total Available Reliable water supply consists of those supplies that are in High and/or Moderate reliability classifications. Low reliability supplies include irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needs for optimum management of private wetlands in Sutter Basin are 622 AF/year (**Table 2-18**). Surface water supplies available to the private wetlands are estimated to consist of about 483 AF/year of low reliability irrigation tailwater.

The following options are available to improve water supply availability and reliability.

Surface Water

Surface water supply options consist of surplus stream flows during the winter and water purchases and transfers. Most of the 622 AF/year shortage shown for this basin is for September wetland flood-up. Surplus natural flows are not generally available in September. Almost all private wetlands in this basin are outside of water supplier service areas, which creates a problem of conveyance as well as supply. For water purchases or transfers, arrangements would also have to be made for water conveyance and/or wheeling. DWR has estimated that water purchase and wheeling costs could range from $10 to $25 per AF, or more, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source.

There is a Joint Water District, which is a governing board representing the four water districts (Richvale ID, Butte WD, Biggs-West Gridley WD, and Sutter Extension WD) that receive Feather River water through Thermalito Afterbay. Under terms of its water right agreement, the Joint Water District cannot deliver water outside of its service areas without an amendment even if it had water to sell, which it may not. However, there may be some potential in the Sutter Extension WD to wheel supplies if there is capacity in its system, and if that capacity is available during its operation period between April and mid-January. Sutter Mutual Water Company can sell water to lands outside its service area, but service area needs come first.

Surface Water Supply Issues

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Right/Contract Modifications
- Conveyance Problems
- Water Transfer and Marketing Programs
- Potential High Costs

District Operations and Maintenance. Most Sutter basin districts do not deliver water year-round. They use the period January through March to perform canal maintenance, but the maintenance usually requires only a few weeks. Most districts said they do not deliver during this period because there is no agricultural irrigation at this time and no demand. Districts might be able to modify their operations for wetlands deliveries during the non-irrigation season if they were compensated for the extra personnel and expense this would require. Perhaps this would not be feasible for only a few acres of wetlands; it would depend on specific conditions and would have to be considered on a case-by-case basis.

Water Right/Contract Modification. USBR, DWR, and other water rights holders (water districts) could possibly amend their water rights/contracts for wetlands use in fall and winter. Two examples are: (1) the current contracts with USBR provide for water use between April and October, and USBR has applied to SWRCB for contract modifications to deliver water during November through March; and (2) if there is water to sell, DWR and the Joint Water Districts could amend their agreement and negotiate providing service to wetlands outside of the JWD service areas if the parties desired to do so.

Conveyance Problems. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). However, with lower deliveries expected during the winter, the percentage of loss of the total supply becomes significantly high (i.e., 40 to 50% of water conveyed might be lost to seepage). Other conveyance losses could occur through unauthorized diversions, which are known to occur along Butte Slough and portions of the Sutter Bypass through the network of small diversion points. Monitoring may be necessary to ensure delivery if small quantities are delivered to a specific point.

Potential High Cost. Purchasing long-term supplies could include the cost of water, wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Water districts (sellers) may be willing to enter into short-term water sales at prices affordable to private wetlands landowners, but would likely keep their options open for long-term sales at greater prices.

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest among water-short urban and agricultural water users. Competing with other buyers from the San Joaquin Valley and Southern California could be difficult for private wetlands owners, who may not be able to afford the prices others would be willing to pay.

Groundwater

Groundwater can be limited depending on the location of the wells because of quality problems. Groundwater quality is generally poor in the Sutter Bypass area where most of the existing private wetlands are located. There is local concern about how and where this limited resource is used, and developing groundwater management programs could regulate how private wetlands in that jurisdiction use and develop groundwater. The use of groundwater for private wetlands also is limited for the following reasons:

- Well Development Costs - This basin has numerous small parcels of private wetlands. Small irrigation wells, approximately 300 to 500 feet deep, could cost approximately $100,000. These costs make groundwater development cost-prohibitive for most private wetlands in the basin

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30/AF. With low economic returns, costs for well construction and pumping are an issue for private wetland owners.

- Water Quality Limitations - Good quality water occurs only in areas along the Sacramento River and a few areas within the basin. All other areas have problems with salinity, arsenic, and other elements. However, good quality groundwater could be pumped and conveyed to private wetlands if conveyance capacity is available and the cost is not excessive. Such a transfer could incur high conveyance losses.

- Conveyance Systems - A lack of conveyance systems near developed well sites restricts using groundwater as a source of water for private wetlands.

Agricultural Return Flow

Agricultural return flow is generally available except during drought. Most private wetlands use return flow when it is available, because it is inexpensive. Issues relating to return flow include:

- Return Flow Timing - Water releases from rice fields in late August and early September occur before fall flooding of wetland habitat normally takes place. During certain times of the year, return flow is used by private wetlands in lieu of surface or groundwater, to the extent possible. Coordinating with upstream water districts on rice pre-harvest releases could improve return flow use before turning to new supplies. The timing of wetland water application could be modified to use existing, inexpensive return flow to create the appropriate habitat.

- Reliability - Water conservation could significantly reduce the return flow currently available to private wetlands, because as less water is applied to agricultural land, less water will run off the fields and return to surface water systems such as the Sacramento River. Previously implemented drought water banks, established during the 1987-92 drought, substantially reduced return flow available to downstream users. Water transfers could also lessen the amount of water available to agricultural fields, which in turn would produce a corresponding reduction in return flow.

SUTTER BASIN FINDINGS

These investigations found that existing private wetlands in the Sutter Basin:

1. Have unreliable water supplies; and

2. Need an estimated 622 AF/year of reliable water supply to bring them to full supply and optimum management levels.

Status of Current Water Supplies

All private wetlands in the Sutter Basin are outside the boundaries of water supply agencies. Most rely on agricultural return flows in the summer and fall, and natural runoff and flooding in the bypass in the winter. Pumping groundwater is generally too expensive for private wetlands use, and there are water quality problems in many areas.

Securing Additional Supplies

To satisfy the 622 AF/year need, purchasing surface water supplies from willing sellers might be the best option. If surface water supplies are available for purchase or transfer, arrangements will also be needed to provide for conveyance or wheeling. Wheeling could come through some local water suppliers; however, conveyance facility modification--especially to wetlands outside of water service areas--could be a costly and contentious issue to overcome. Monitoring may be needed to ensure water supply delivery. Off-irrigation-season shut-down of conveyance systems generally makes surface supplies undeliverable for approximately 3 months a year (i.e., January through March). However, there is usually enough natural runoff and return flows to provide winter maintenance supply during most years; for example, the Sutter Bypass floods to some degree during that time in most years.

Groundwater development is limited because most groundwater supplies in the Sutter Basin have salinity problems. Well development and pumping costs could be prohibitive for some private wetlands, and since many of the current wells are not near these lands, conveyance becomes an issue. There is also local concern about how and where this limited resource is used, and there is the potential for future groundwater management programs to regulate how private wetlands use and develop groundwater.

Issues Affecting Water Availability and Reliability

As with other basins in the Sacramento Valley, agricultural return flow, primarily from rice fields, contributes significantly to private wetland water supply. This source is inexpensive, but not consistently available. Water conservation efforts, water banking, or water transfer may reduce the amount of future return flow, making this an even less certain source of supply than it is now.

Table 2-19 summarizes the water supply options and related issues for improving water availability and reliability for private wetlands in the Sutter Basin.

Table 2-19. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Sutter Basin
Central Valley Wetland Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Conveyance Difficulties • Potential for High Cost • Competition with Other Buyers
Groundwater	Existing wells New wells	• Pumping Costs • Well Development Costs • Water Quality Limitations • Conveyance Systems
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Yolo Basin

Total Basin Land Area, acres	**512,000**
Total Privately-Managed Wetland Land Area, acres	**6,060**
Private Wetlands as Percent of Total Basin Area	**1.18%**

BASIN DESCRIPTION

The Yolo Basin covers approximately 800 square miles in the southwestern part of the Sacramento Valley between Verona in the north and the Montezuma Hills in southeastern Solano County. This 50-mile-long basin is bordered on the east by the Sacramento River and Sacramento Ship Channel and on the west by the foothills of the Coast Range (**Figure 2-5**). Watercourses in the Yolo Basin include Cache, Putah, and Ulatis creeks. Cottonwood and Willow sloughs are among the intermittent streams and sloughs that drain the valley floor. Other important features include the southernly trending Dunnigan Hills and Plainfield Ridge. The southern part of the basin extends into what is known as the "Legal Delta". Water supplies to private wetlands within the boundaries defined as the "Legal Delta" may be subject to water quality and flow regulations established by the courts and the SWRCB for protection of the Sacramento-San Joaquin Delta.

BASIN HYDROLOGY

Historically, low-lying areas of the Yolo Basin received overflow waters from the Sacramento River, Cache Creek, Putah Creek, and Ulatis Creek. In areas near the Delta, surface waters subject to tidal influence supported permanent marshes in low areas of the basin. Winter and spring floods supported seasonal wetlands adjacent to these permanent marshes.

Basin hydrology has been modified by levees and flood control structures. The Yolo Bypass, which covers an extensive area along the eastern side of the basin, is subject to overflow from the Sacramento River during high runoff and provides flood protection for adjacent land. The dams, levees, and settling basin construction along Cache Creek have altered its hydrology and increased the level of flood protection in the surrounding area. In Solano County, channels of the Ulatis Flood Control Project are managed to minimize flooding of agricultural land downstream from Vacaville. Basin hydrology also has been modified by levee construction to protect Delta islands and tracts during high outflow and high tides.

PRIVATELY-MANAGED WETLANDS

For these investigations, the Yolo Basin was divided into the North Yolo and South Yolo subbasins (**Figure 2-5**). Water entities with service areas within these two subbasins are identified in **Table 2-20**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Table 2-20. Water Entities with Service Areas in Study Area, Yolo Basin
Central Valley Wetlands Water Supply Investigations

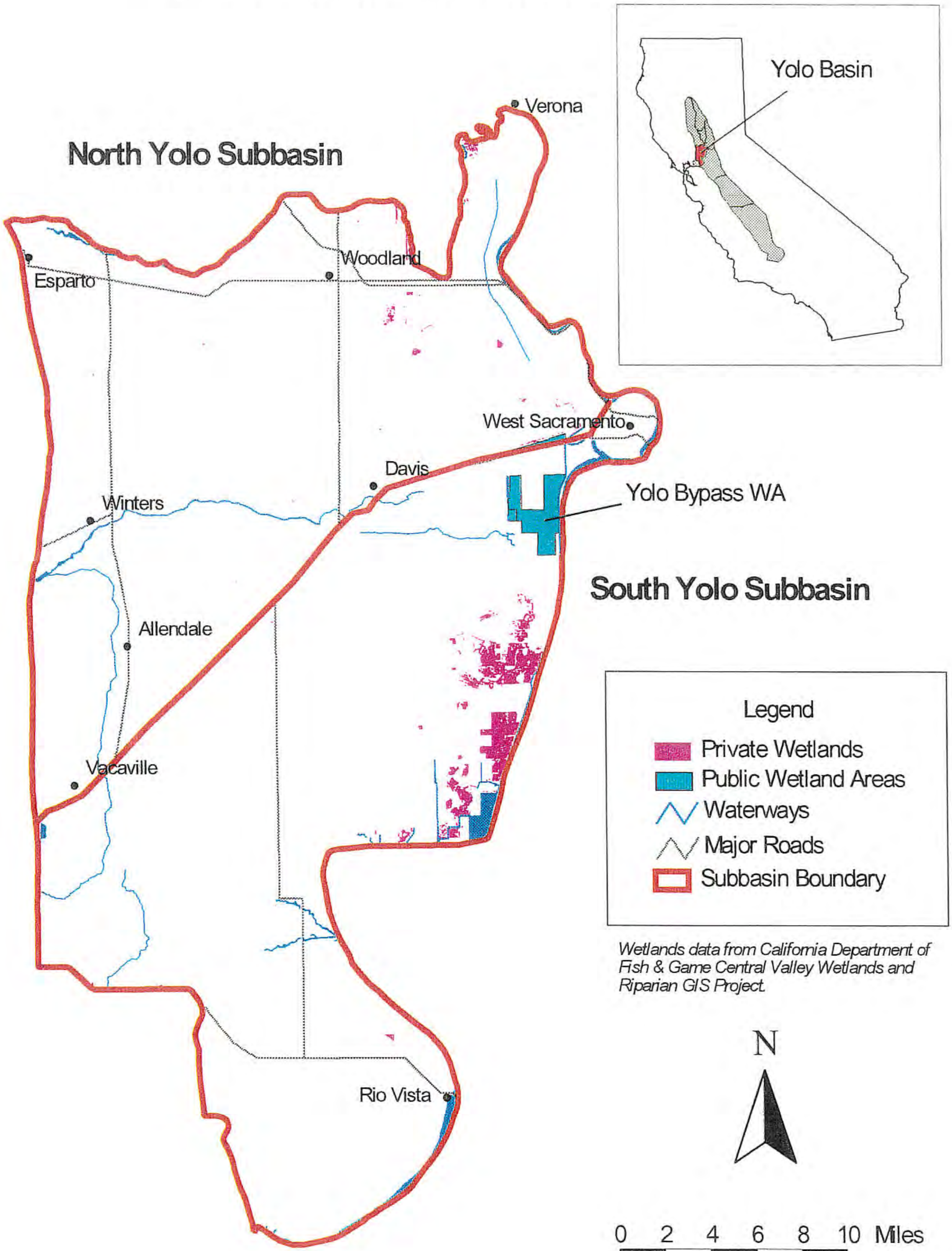
Yolo Basin Water Entities	Subbasin		Apparent Private Wetlands
	North Yolo	South Yolo	
City of West Sacramento Water Service Area	X	X	**Yes**
Colusa Drain Water Users Association	X		No
Deseret Farms of California	X		No
Maine Prairie Water District		X	No
Natomas Central Mutual Water District	X		No
North Delta Water Agency	X	X	**Yes**
Reclamation District 900	X	X	**Yes**
Reclamation District 2035	X		**Yes**
Reclamation District 2068		X	**Yes**
Yolo County FCWCD	X	X	**Yes**

Wetlands Water Supply Conveyance Facilities and Water Agencies

Distribution of water to existing private wetlands within the Yolo Basin is primarily by pumping from the channel directly onto the wetlands or into an existing distribution system for delivery to a wetland. The basin waterways are earthen sloughs or canals, which may result in conveyance losses in areas with low water tables. Water agencies with apparent privately-managed wetlands within their service areas were interviewed. These interviews disclosed that two of the districts have wetlands areas totaling 40 acres that are levee project mitigation banks, storm detention reservoirs, and areas associated with the Port of Sacramento that are not privately-managed wetlands. The two agencies (City of West Sacramento and RD 900) are urban water supply and drainage agencies that are not now, and are unlikely to become, involved in privately-managed wetlands water supply.

Figure 2-5. Yolo Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



The following agencies or districts are involved, directly or indirectly, in privately-managed wetlands water supply:

- North Delta Water Agency (North Yolo and South Yolo Subbasins)
- RD 2035 (North Yolo Subbasin)
- RD 2068 (South Yolo Subbasin)
- Yolo County Flood Control and Water Conservation District (North Yolo and South Yolo Subbasins)

Existing Private Wetlands Location

The GIS analysis identified a total of 6,100 acres of apparent privately-managed wetlands in the Yolo Basin. Approximately 97% (5,930 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the two subbasins is shown in **Table 2-21**.

Table 2-21. Existing Private Wetlands Acreage, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Yolo Basin	Apparent Privately-managed Wetlands					
		Percent of Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
North Yolo	240	4%	120	50%	120	50%
South Yolo	5,860	96%	5,810	99%	50	1%
Basin Totals =	6,100		5,930	97%	170	3%

Most private wetlands in the Yolo Basin are in the Yolo Bypass, south of Interstate 80 (South Yolo Subbasin). These private wetlands are in two distinct blocks consisting of: (1) an intensively managed 2,500-acre northern segment with excellent wintering waterfowl values, and (2) a larger southern segment used for both cattle grazing and duck hunting. These two wetlands blocks combine to support good numbers of wintering waterfowl from October through April. Many landowners are enrolled in State or Federal wetland easement and incentive programs.

Wetlands Water Supply

Surface water supplies are generally good throughout the Yolo Basin. Groundwater supplies are subject to both quality and availability problems that vary according to location. Some factors which could impact water supply availability and reliability for private wetlands include water purchases and transfers, water conservation efforts, and CALFED programs.

Water use within the Yolo Basin is dominated by irrigated agriculture whose water demands are met by a combination of surface water, groundwater, and agricultural return flow depending on location. The estimated 1990 applied water demands were 92% agriculture, 7% urban, and 1%

environmental. Surface water sources include the Sacramento River, the Ship Channel Toe Drain (located along the west edge of Sacramento Ship Channel), the Tule Canal, Cache Creek, Clear Lake, Indian Valley Reservoir, Willow Slough, Putah Creek (Lake Berryessa), Knights Landing Ridge Cut, and associated return flows.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High for 85% of the lands. Areas with Moderate, Low and Unknown Reliability comprise the remaining 15%. Supply reliability for apparent existing privately-managed wetlands in the two subbasins is shown in **Table 2-22.**

Table 2-22. Water Supply Reliability of Private Wetlands, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Yolo Basin Subbasin	**Apparent Privately-managed Wetlands**							
	Water Reliability, acres				Water Reliability, percent of acres			
	High	Mod.	Low	Unknown	High	Mod.	Low	Unknown
North Yolo	110	10	50	70	46%	4%	21%	29%
South Yolo	5,090	0	0	770	77%	0%	0%	13%
Basin Totals =	5,200	10	50	840	85%	0.2%	0.8%	14%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies in the North Yolo Subbasin are in the service areas of two agencies that are not typical water suppliers.

- North Delta Water Agency - This Agency covers 250,000 acres in the Yolo Basin and the adjoining Delta Basin. Its Yolo Basin service area includes parts of the City of West Sacramento and the Maine Prairie Water District and two reclamation districts that provide drainage. Within the Yolo Basin, the Agency's service area includes the entire length of the Ship Channel Toe Drain and extends to distances of 4 to 12 miles west of the Toe Drain. The Agency has a 1981 SWP contract that is for releases to protect the quality of Delta water diverted under appropriative and riparian water rights for agricultural, municipal and industrial uses in its service area. Lands within the Agency's boundaries are entitled to divert water without dry year curtailment pursuant to the SWP contract. The contract provides that the State will maintain, within the Agency, a dependable water supply of adequate quantity and quality for agricultural uses. The Agency levies a per acre landowner assessment for such water. When a drought emergency exists and the State is unable to meet water quality objectives, the contract provides that the State will compensate the user for loss of net income resulting from the poorer quality water. The annual assessment rates are currently about $1.50 per acre.

- Reclamation District - This reclamation district (RD) does not have a CVP, SWP or other contract supply or a supply derived from its own surface water diversion rights. Landowners within the RD service area have various appropriative and riparian water rights as well as groundwater supplies. The RD operates wells and pumping stations of some landowners as well as its own pumping stations and drainage canals to transport landowner groundwater and surface water supplies from their sources to points of use.

Wetlands with High reliability supplies in the South Yolo Subbasin are in the service areas of the North Delta Water Agency and two reclamation districts.

- North Delta Water Agency - Nearly all of the wetlands in the South Yolo Subbasin are in the Agency's service area on lands that are adjacent to the Sacramento Ship Channel Toe Drain or have access to the Toe Drain. Lands in this area have appropriative water rights to the tidally-influenced Toe Drain that are protected in terms of water quantity and quality by the Agency's SWP contract (see North Yolo Subbasin discussion). There is no other overlying agency. Landowners pump directly from the Toe Drain throughout the year.

- Reclamation Districts - One RD is entirely within the City of West Sacramento. According to this RD, the only "wetlands" (~20 acres) within its service area are small areas along the Sacramento River that are maintained by the RD as levee projects "mitigation". The RD says that another 20 acres that show up as wetlands within the City are part of the Port of Sacramento and storm detention reservoirs. The other RD supplies ("duck club") wetlands during the period October through December with water derived from its post-1914 appropriative rights.

Wetlands with Moderate Reliability Supplies. Wetlands with Moderate reliability supplies in the North Yolo Subbasin are in the service area of a water supply agency that holds pre- and post-1914 appropriative water rights as well as riparian water rights.

Wetlands with Low Reliability Supplies. Wetlands with Low reliability supplies in the North Yolo Subbasin are outside the service areas of water agencies.

Wetlands with Unknown Reliability Supplies. Wetlands with Unknown reliability supplies in the South Yolo Subbasin consist of scattered areas totaling 50 acres that are outside the service areas of water agencies and 720 acres that are within the North Delta Water Agency service area. The 720 acres that are within the North Delta Water Agency area lie between Reclamation District 2068 to the west and the Ship Channel Toe Drain to the east. Although these lands are contiguous to lands that are adjacent to, or have access to, the Toe Drain, their source of water supply is unknown. The fact that most of these lands lie along channels that are connected to the Toe Drain suggests that they are likely supplied by diversions from these tidally-influenced channels and, in reality, have high reliability supplies.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-23 shows the current private wetland water demands, reliable supplies, and current reliable water supply shortfall. Most private wetlands in this basin get their supply from appropriative and riparian water rights of individual landowners or overlying water agencies. These surface water supplies are currently considered to be reliable. Agricultural return flow (tailwater) is a current reliable source, but may not be reliable for private wetlands in the future. Accordingly, tailwater supply is included in the listing of low or unknown reliability water supply.

Table 2-23. Estimated Water Demands and Supplies for Existing Private Wetlands, Yolo Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	5,151	606	303	6,060
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	25,755	4,484	4,015	34,254
Available Water Supply, AF/year				
Surface Water	25,622	4,466	4,002	34,090
Groundwater	133	18	13	164
Total Available Water, AF/year	25,755	4,484	4,015	34,254
Estimated Shortfall, AF/year	0	0	0	0
Low or Unknown Reliability Water Supply, AF/year				
	3,485	607	543	4,635
Total Available Known Reliable Water Supply, AF/year				
	22,270	3,878	3,472	29,619
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	3,485	607	543	4,635

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater. Unknown Reliability Surface Water Supply includes supplies to lands that are outside the boundaries of water supply agencies.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needs for optimum management of private wetlands in this basin are 34,254 AF/year. The water supply needs of existing privately-managed wetlands are currently being met through the use of surface water and groundwater. The estimated 34,090 AF/year of existing available surface water supply includes a significant component (4,635 AF/year) of low or unknown reliability water, nearly all of which is in the unknown reliability classification. This water supply component results in an identified shortfall of 4,635 AF/year in available known reliable supply. The following options are available to improve water supply availability and reliability.

Surface Water Supplies and Issues

Existing surface water supplies to privately-managed wetlands are estimated to consist of about 34,100 AF/year of riparian, appropriative, and contracted water. These supplies provide over 99% of the water needed for optimum management of the existing wetlands, but include a significant unknown reliability component.

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- Conveyance Losses
- Legal Issues
- Water Transfer and Marketing Programs
- Water Quality
- Conveyance Difficulties

Conveyance Losses

Although evaporative losses are lower in the winter, conveyance losses due to infiltration may be similar to those occurring during the irrigation season (spring/summer). With lower deliveries expected in the winter, conveyance losses through natural channels may be significant (e.g., 40 to 50%).

Legal Issues

Pending SWRCB decisions about how to meet flow requirements in the Delta could affect many water rights holders. This could affect wetlands water supplies in the Yolo Basin.

Water Transfer and Marketing Programs

Water transfers and water marketing programs are complex and involve a myriad of public, private, economic, urban, agricultural, and environmental factors. Concerns about these programs include the effect on local water rights, third party impacts, and the impact on the local economy and tax revenues. Most local agencies oppose out-of-basin transfers. Supplies derived through water marketing would most likely be cost-prohibitive for private wetlands.

Water Quality

Water quality in the basin, although generally good for agriculture, varies in suitability for wetlands. Delta water quality standards for environmental and urban use are established and must be met by outflow or treatment. Because the Yolo Basin extends into the Legal Delta, the basin will be affected by water management operations to meet Delta water quality standards.

Conveyance System Use Conflicts

Conveyance facilities used to carry water for agricultural irrigation could compete with private wetlands irrigation during the growing season. Required canal maintenance and the need to use drainage canals for their wet season flood control purposes competes with wetland water delivery during the off-season. In the case of competing irrigation uses, agreements could be made between users for sharing costs or time of use. Conflicts between the need for irrigation supply during the wet season and the need to maintain dual-purpose irrigation/drainage canals in flood control readiness are not easily resolved short of constructing expensive separate winter water delivery facilities. Winter wetlands water supplies in such instances will most likely be dependent on natural runoff or groundwater.

Groundwater

Existing groundwater supplies to privately-managed wetlands provide less than 1% of the water needed by the existing wetlands.

Groundwater Quality and Availability

Groundwater quality and groundwater availability in the Yolo Basin both range from good to poor. The following assessment of groundwater conditions was obtained in interviews of Yolo Basin water agencies:

- North of Interstate 80 in Areas Remote from Sacramento River (North Yolo Subbasin). There are: 1) areas of major groundwater depletion and land subsidence, 2) areas where water tables are okay, but there is a delicate balance and need to replenish, and 3) areas with ample supplies, but water quality problems (boron, selenium, nitrates). Groundwater quality in this area is characterized as moderate to poor, and groundwater availability is characterized as poor.

- North of Interstate 80 in Areas near Sacramento River (North Yolo Subbasin). There are some groundwater quality problems (iron, boron), but most water quality is acceptable. Availability is limited in some areas. Overall quality and availability in this area are characterized as good.

- South of Interstate 80 (South Yolo Subbasin). Quality conditions are geographically sensitive and vary from moderate to poor. Availability of groundwater in this area ranges from "unknown" to poor.

Potential Limitations in Groundwater Use for Wetlands

The use of groundwater for the private wetlands is potentially limited for reasons that include:

- Well Development Costs - Development costs are ~$120,000 for a typical irrigation well.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $30 to $50 per AF, which could be prohibitive to some private wetland owners. With low economic returns, costs for well construction and pumping are a serious issue for private wetland owners.

- Groundwater Development and Management - The Yolo County Flood Control and Water Conservation District monitors groundwater elevations in most of Yolo County and provides this data to DWR; it is also shared with USBR. The District has a comprehensive water management plan with a groundwater component. Two of the Reclamation Districts involved in existing private wetlands water supply have groundwater management plans under AB 3030.

- Groundwater Quality - Groundwater quality varies from good to poor in the basin, with most areas characterized as having moderate to poor quality groundwater. If groundwater is considered as a supplemental supply for private wetlands, site-specific water quality sampling could be required to determine suitability.

- Groundwater Overdraft and Land Subsidence - Excessive groundwater extraction may lead to groundwater overdraft and land subsidence. If groundwater is used more extensively in this basin as a source for wetlands, this could lead to a requirement for aquifer monitoring.

Agricultural Return Flow

There is some use of agricultural return flows in the Yolo Basin. Increasing the use of tailwater can be investigated as a potential source for private wetlands, and may be available except during drought. Issues include the following:

- Water Quality - Monitoring of agricultural return flow for residual constituents from agricultural runoff could be required.

- Effects of Water Conservation, Water Banks, and Water Transfers - Water conservation could reduce the quantity of agricultural return flow available to private wetlands by reducing the amount of water applied on agricultural fields. Reduced return flows could impact the size of wetlands supported on a continuing basis.

YOLO BASIN FINDINGS

These investigations found that private wetlands in the Yolo Basin:

1. Appear to have enough water supplies to meet their current water needs, but face some future reliability concerns because of water supply problems statewide, and pending decisions particularly affecting the Delta; and

2. May need an additional 4,635 AF/year of reliable water supply to bring all of the existing private wetlands to full supply and optimum management levels, unless supplies identified with "unknown" reliability prove in fact to be reliable.

Status of Current Water Supplies

Lands within the Yolo Bypass which retain rights to Delta water have a relatively reliable source of water, although environmental, economic, legal, political, and cost issues may need to be addressed. Delta water quality and flow requirements may limit water supplies in some areas.

Issues Affecting Water Availability and Reliability

Most of the water source for private wetlands in the Yolo Basin is surface water, which may be affected by upstream or downstream water regulations and water conservation efforts. Local officials have raised concerns about protecting water rights and in-basin versus out-of-basin use of water are important issues.

Groundwater is and can be used mostly as a minor supplemental source to surface water, primarily because of cost. The expense to develop and pump groundwater may be cost-prohibitive to most private wetland owners.

Agricultural return flow is a current source of water for private wetlands in Yolo Basin.

Table 2-24 summarizes the options and issues which may affect water availability and reliability for private wetlands in the Yolo Basin.

Table 2-24. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Yolo Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Purchases Transfers	• Conveyance Losses • Legal Issues • Water Transfer/water Marketing Programs • Water Quality • Conveyance Difficulties
Groundwater	Existing wells New Wells	• Groundwater Development and Management • Groundwater Quality • Water Costs • Well Development Costs • Land Subsidence
Agricultural Return Flow	Continue current practices	• Water Quality • Effects of Water Conservation, Water Banks, and Water Transfers

American Basin

Total Basin Land Area, acres	**550,400**
Total Privately-Managed Wetland Land Area, acres	**1,340**
Private Wetlands as Percent of Total Basin Area	**0.24%**

BASIN DESCRIPTION

The American Basin covers approximately 860 square miles in the southeastern portion of the Sacramento Valley, between the City of Oroville in the north and the American River in the south. This 65-mile-long basin is bordered by the Feather and Sacramento rivers to the west and the foothills of the Sierra Nevada to the east (**Figure 2-6**). Major streams and rivers include Honcut Creek and the Sacramento, Feather, Yuba, and Bear rivers. Numerous ephemeral creeks, streams, ravines and sloughs drain the foothill and valley floor areas.

There are approximately 1,340 acres of private wetlands in this basin, most of which are seasonal. In winter 1994-95, an estimated 31,500 acres of rice fields were flooded for rice straw decomposition and duck hunting. Although not considered wetlands, post-harvest flooded rice fields provide important foraging habitat for many water birds.

BASIN HYDROLOGY

Historically, low-lying areas of this basin were flooded by overflow waters of the American, Yuba, Feather, Sacramento, and Bear rivers. These rivers were originally confined within broad natural levees formed by sediment deposits during floods. Coarse sediments were deposited close to the river channel and finer sediments were deposited farther out. As flood waters subsided, clays and silts settled in basins set within the low fan terraces. Tules and marsh grasses, supported by periodic flooding, grew in these low-lying areas prior to flood control levee construction.

In addition to constructed levees, structures which have improved the flood protection level and modified the hydrology within this basin include the dams at Folsom, Oroville, and Bullard's Bar, ditches to collect and deliver water for mining and agriculture, and many smaller facilities.

PRIVATELY-MANAGED WETLANDS

For these investigations, the American Basin was divided into the District 10/Honcut and Lower American subbasins (**Figure 2-6**). Water entities with service areas within these two subbasins are identified in **Table 2-25**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

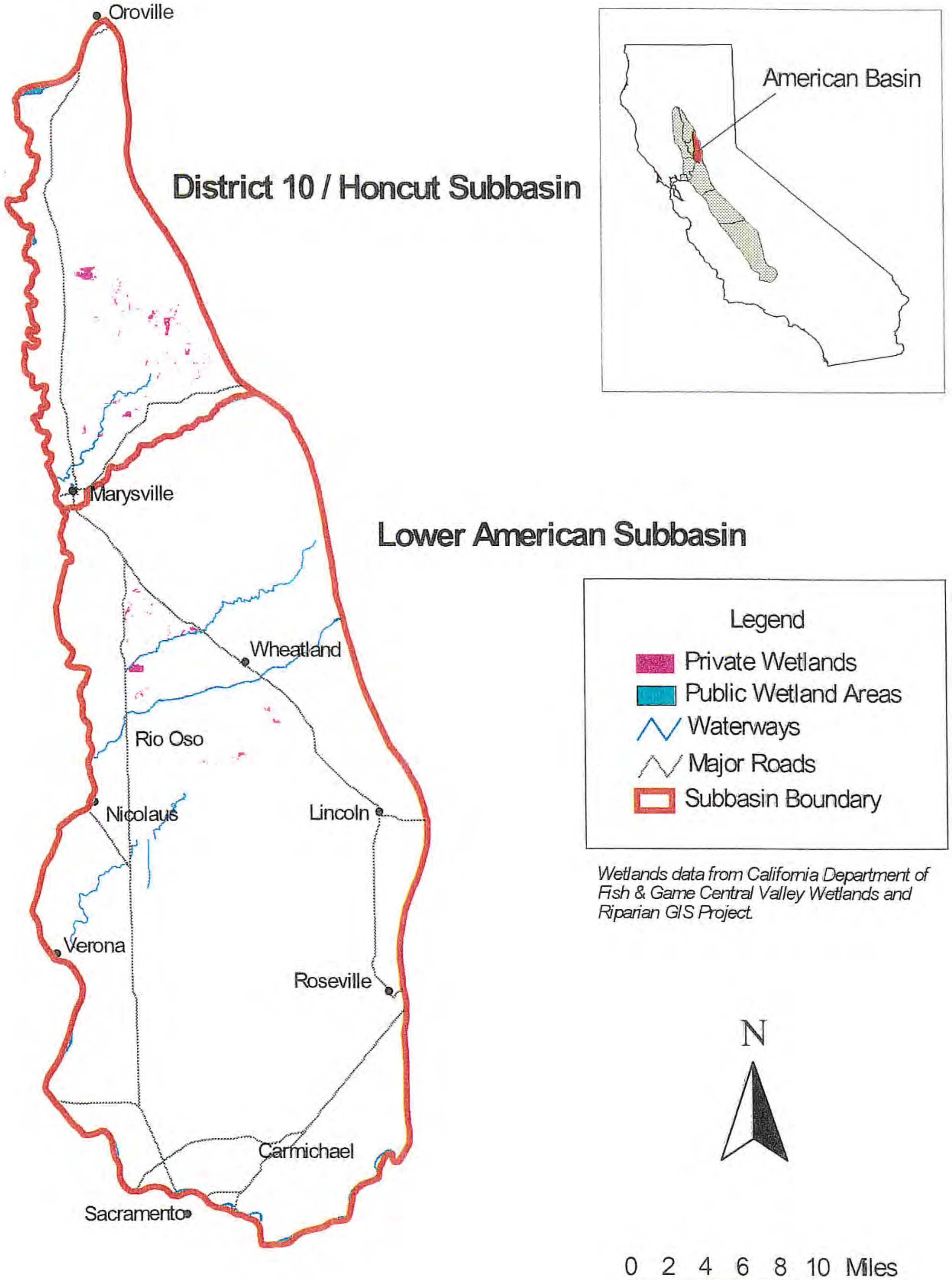
Table 2-25. Water Entities with Service Areas in Study Area, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin Water Entities	Subbasin		Apparent Private Wetlands
	District 10/Honcut	Lower American	
Browns Valley Irrigation District	X		**Yes**
City of Marysville Water Service Area	X		No
Cordua Irrigation District	X		**Yes**
Hallwood Irrigation Company	X	X	**Yes**
Ramirez Water District	X		**Yes**
Reclamation District 10	X		No
Camp Far West Irrigation District		X	No
City of Sacramento Water Service Area		X	No
Dantoni Area		X	No
Natomas Central Mutual Water District		X	No
Placer County Water Agency		X	No
Plumas Mutual Water Company		X	No
Reclamation District 784		X	No
South Sutter Water District		X	**Yes**
South Yuba Water District		X	**Yes**
Western Placer Irrigation District		X	No
Wheatland Water District		X	**Yes**

Wetlands Water Supply Conveyance Facilities and Water Agencies

American Basin water agencies are listed in the tabulation above. The primary conveyance facilities in this basin are earth-lined canals. The largest facilities are those of Browns Valley ID (including Virginia Ranch Dam and Collins Lake), South Sutter WD, and a ditch, the "All American Canal" built by South Yuba WD, Brown's Valley WD, and Brophy WD, for Yuba County Water Agency to deliver their water. Bullard's Bar Dam provides storage for South Yuba WD. Camp Far West Reservoir stores water from the Bear River.

Figure 2-6. American Basin Private Wetlands
Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Existing Private Wetlands Location

The GIS analysis identified a total of 1,340 acres of apparent privately-managed wetlands in the American Basin. Approximately 74% (990 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the two subbasins is shown in **Table 2-26.**

Table 2-26. Existing Private Wetlands Acreage, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin	Apparent Privately-managed Wetlands					
		% of American Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
District 10/Honcut	960	72%	630	66%	330	34%
Lower American	380	28%	360	95%	20	5%
American Basin Totals =	1,340		990	74%	350	26%

Wetlands Water Supply

Surface water and groundwater supplies are generally good for this basin. Most of the private wetlands use surface water and some agricultural return flow from rice fields. Pumping costs limit the use of groundwater for wetlands, but it is used above Honcut Creek and below the Bear River in areas where it is the only available source.

Private wetlands in the rice-growing region known as "District 10" have reliable water supplies from the Yuba River, except during drought years. Although districts give first priority to agricultural use, the water suppliers in this region can meet all landowners' needs most of the time. Fish screens have just been completed on the Yuba River, so diversions are not at risk for interruption because of fish migrations. This is one of the few areas where suppliers indicated that they could supply additional water to wetlands in any season if the wetlands owners requested it.

Wetlands located south of Marysville also have good water supplies from the Yuba River. Water is now supplied to wetlands until January, but the supply for rice straw decomposition and wetlands could be cut off in October. This depends on Yuba County Water Agency continuing to provide it by informal agreement, and on continued storage in the dam of water for non-irrigation uses.

In the South Sutter area, south of the Bear River, surface supplies are from the Bear River and small intermittent sources (Kuhu Creek, Markham Ravine, Bunkham Slough). Landowners in South Sutter WD receive only about one third of the amount needed to grow rice, the primary crop in the area, and have to pump groundwater for the rest. Some land is not in production. Wetlands in this area have to use supplemental groundwater. Those outside South Sutter WD service area are entirely dependent on groundwater.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High for 72% of the lands. Areas with Low and Unknown Reliability comprise the remaining 28%. Supply reliability for apparent existing privately-managed wetlands in the two subbasins is shown in **Table 2-27.**

Table 2-27. Water Supply Reliability of Private Wetlands, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin	**Apparent Privately-managed Wetlands**					
	Water Reliability, acres			Water Reliability, percent of acres		
Subbasin	High	Low	Unknown	High	Low	Unknown
District 10/Honcut	600	320	40	63%	33%	4%
Lower American	370	10	0	97%	3%	0%
American Basin Totals =	970	330	40	72%	25%	3%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies in both subbasins reflect the availability of water rights-derived supplies from area water agencies. In some instances, the supplies of agencies include contract supplies from the Yuba County Water Agency which holds the water rights of landowners within its area. **Note:** There are no CVP or SWP-derived supplies currently available to privately-managed wetlands in the American Basin.

The highest reliability supplies are serviced by three water districts that derive their water from the Yuba River and serve the agricultural needs of the rice-growing region known as "District 10." Surface water supplies are adequate for all needs, and additional water could be supplied to private wetlands if needed.

Wetlands with Low Reliability Supplies. The significant percentage of wetlands with Low reliability supply in District 10/Honcut Subbasin reflects wetlands that are outside of water agency boundaries. Wetlands with Low reliability supply in the Lower American Subbasin are in the service area of a "supplemental" water supply agency that does not have sufficient supply to serve the agricultural water needs of its service area. Water users in these low-reliability areas must depend to some extent on groundwater.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-28 shows the current private wetland water demands, sources of reliable supplies, and current water supply shortfall.

Table 2-28. Estimated Water Demands and Supplies for Existing Private Wetlands, American Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	1,139	134	67	1,340
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	5,695	992	888	7,574
Available Water Supply, AF/year				
Surface Water	4,328	804	754	5,886
Groundwater	0	0	0	0
Total Available Water, AF/year	4,328	804	754	5,886
Estimated Shortfall, AF/year	1,367	188	134	1,688
Low Reliability Water Supply, AF/year				
	206	86	111	403
Total Available Reliable Water Supply, AF/year				
	4,123	718	643	5,483
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	1,573	274	245	2,091

Note: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications. Low reliability water supplies include irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needed for optimum management of private wetlands in the American Basin is 7,574 AF/year. The following options are available to improve water supply availability and reliability.

Surface Water

Existing surface water supplies available to the wetlands consist of 5,886 AF/year. This available supply includes low reliability agricultural return flows of 403 AF/year. Surface water is currently available to most private wetlands in this basin except those outside agency service areas. General water costs in local service areas are reasonable ($5 to $15 per AF).

Private wetlands located outside local water district boundaries could explore the possibility of annexation to a local district. The feasibility of annexation would depend, first, on whether the water district has available water to serve the additional lands. Other factors would include the district's policies on annexation, and the concerns of district landowners. Conveyance facilities might be needed to deliver water to the annexed land. This is a cost private wetland owners could probably not afford, and other district landowners could not be expected to bear.

Some water could be purchased from local districts, but conveyance issues would need to be addressed, and would require negotiated agreements with water districts and other affected parties. DWR has estimated that water purchase and wheeling costs could range from $10 to $25 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source.

Surface Water Supply Issues

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Conveyance Concerns
- Water Transfer and Marketing Programs
- Potential High Cost of Purchased Water

District Operations and Maintenance. Most districts do not operate their water delivery systems from January through March. A few weeks during that period may be needed for maintenance, but most districts in this basin said there was no demand for water January through March. For wetlands, natural runoff is usually adequate during wet or normal years to provide winter maintenance flows.

Conveyance Concerns. Conveyance losses in this basin recharge groundwater and may not be of major concern during the irrigation season when there are large deliveries and systems are full. However, with lower deliveries expected in the winter and less water in canals, conveyance losses may be significant (i.e., 40 to 50%). A second concern is whether conveyance facilities are available if water can be obtained from local districts. Conveyance facilities may not be available for wetlands outside of district service areas. If annexation to a local district is feasible for these wetlands, new facilities might be required to deliver the water. Most private wetlands owners could not afford the cost of conveyance facilities. Districts landowners could be expected to object to annexation unless the district receives funding or some other incentive to offset the cost of building facilities to serve annexed lands.

Water Marketing and Transfer Programs. Water marketing and transfers offer some potential for additional water supplies for wetlands, although this may be an expensive source. There have been few long-term water transfers within the Sacramento Valley, and this option has not been fully explored. However, most water planners expect that water marketing and transfers will encourage uses with higher economic returns than wetlands. Because of high water demands, water-short urban areas and agricultural areas with high-value crops will be willing to pay higher prices for water supplies. Water districts may be willing to enter into short-term water sales at prices affordable for wetlands, but would be likely to seek long-term sales at higher prices.

Potential High Cost of Purchased Water. Purchasing long-term supplies for wetlands could include the cost of water, wheeling costs, and costs of conveyance facilities or improvements, which when combined would be expensive. Private wetlands owners may not be able to afford these costs.

Groundwater

Groundwater does not appear to have a significant role in the water supply to the private wetlands. Groundwater is generally available, and water quality problems are usually local. The use of groundwater for the private wetlands is potentially limited for reasons that include:

- Well Development Costs - This basin has numerous small parcels of private wetlands. Irrigation wells, about 400 to 600 feet deep, can cost around $100,000 to develop.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping make groundwater use cost-prohibitive for most private wetlands in the basin.

- Water Quality Limitations - There are some local areas with groundwater quality problems, but quality is reported as good in most areas.

- Groundwater Management Programs - Groundwater extraction and development could be affected by current or future local management plans. Butte Basin Water Users Association covers part of the northern American Basin. Currently, this Butte County association is working on a groundwater model and management plan. Many other local agencies throughout the Central Valley are developing groundwater management plans under AB 3030, a State law which granted some regulatory authority over groundwater to additional local agencies without such authority. The effects of these programs will likely be limited to requiring well drilling permits and monitoring of groundwater conditions, unless an area has a serious condition of overdraft to be addressed.

Agricultural Return Flow

Agricultural return flow is generally available except during drought. Current return flow use amounts to approximately 400 AF/year on private wetlands which are outside of local water service areas. This source is usually inexpensive, but may not be consistently available in all years. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Issue relating to return flow include:

- Return Flow Timing - Water releases from rice fields in late August and early September occur before fall flooding of wetland habitat normally takes place. Coordinating with upstream water districts on rice pre-harvest releases could increase wetlands use of return flows before turning to new supplies.

- Effects of Water Conservation, Water Banks, and Water Transfers - Conservation efforts could reduce the return flow currently available to private wetlands by reducing the amount of water initially applied to agricultural fields. Water bank/transfer programs could also reduce the amount of return flow supplies for essentially the same reason: water that used to return to the rivers and streams would instead be stored or transferred elsewhere.

AMERICAN BASIN FINDINGS

These investigations found that the American Basin private wetlands:

1. Need some improvement in the reliability of their current water supplies; and

2. Need an estimated 2,091 AF/year of additional reliable water to bring all of the existing private wetlands to full supply and optimum management levels.

Status of Current Water Supplies

Surface water and groundwater supplies are generally good for this basin overall, but some areas of the basin face chronic shortages, lacking adequate surface water for all of their agricultural needs. Many of the private wetlands in the American Basin have adequate and very reliable water supplies, and their suppliers could provide more water if needed. The deficits occur in areas which have no surface water supplies, or only partial supplies available for maintaining agricultural lands or wetlands, and are dependent on groundwater. Some rely on agricultural return flows, which are not a reliable source of supply.

Securing Additional Supplies

Annexing private wetlands to water service areas can be explored as the best option to ensure a reliable water source to lands outside service areas. New conveyance facilities may be needed, and will require funding. If this is not feasible, private wetland managers could purchase surface water supplies from local districts willing to sell. These surface water supplies will have wheeling charges and some potential system or conveyance modification issues to address.

Continued groundwater use could enhance reliability in drought years; and some groundwater development could provide flexibility to private wetland managers who could conjunctively use this source to take advantage of the available return flows and natural runoff. However, financial incentives will likely be necessary to make this option economically feasible for the private wetland owners.

Agricultural return flow makes up approximately one-eighth of the current water use by private wetlands in the American Basin. Coordinating release flows with upstream water districts could improve current use of this source.

Issues Affecting Water Availability and Reliability

Water conservation efforts, water banks, and water transfers could reduce the amount of water used upstream, thereby reducing the amount of water available as return flow. Water conservation may also reduce water quality. With water conservation, there will be less tailwater, so these return flows will have somewhat higher salt concentrations.

South Yuba WD uses Bullard's Bar Dam to store water, and removal of this dam is being considered by the Department of the Interior. Removal of this dam would affect the reliability of the district's supply, and thus the reliability of current water supplies to some private wetlands.

Water suppliers to rice growers in the American Basin are concerned that some CALFED programs will adversely affect their water supplies by requiring flushing flows to control the temperature of the river at the same time growers need to flood rice lands. This would also affect water supplies to wetlands that depend on tailwater from rice lands.

Table 2-29 summarizes the options and issues that affect improving water supply availability and reliability for private wetlands in the American Basin.

Table 2-29. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in American Basin
Central Valley Wetlands Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers Annexation	• District Operations and Maintenance • High Conveyance Losses • Conveyance Difficulties • Potential High Cost of Purchased Water • Competition with Other Buyers
Groundwater	Use existing wells New wells	• Pumping Costs • Well Development Costs
Agricultural Return Flow	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Delta Basin

Total Basin Land Area, acres	**1,344,000**
Total Privately-Managed Wetland Land Area, acres	**2,490**
Private Wetlands as Percent of Total Basin Area	**0.19%**

BASIN DESCRIPTION

The Sacramento-San Joaquin Delta Basin (Delta Basin) covers 2,100 square miles in the center of the Central Valley, between the American River to the north and the Stanislaus River to the south. This basin is bordered by the Sierra Nevada foothills to the east, the Sacramento River and Deep Water Ship Channel to the northwest, and the Coast Range to the southwest (**Figure 2-7**).

The Delta Basin is part of the wintering habitat for tens of thousands of waterfowl and other birds. In the Central Delta, approximately 20,000 to 30,000 acres of field crops and grain are post-harvest flooded each winter, yet few managed wetlands exist in this area. A significant managed private wetland in the Central Delta is a 395-acre State easement project on Empire Tract west of Lodi. There also are small parcels of private wetlands throughout the basin which are primarily natural riparian areas.

BASIN HYDROLOGY

The Delta, comprised of about 500,000 acres of rich farmland, is interlaced with hundreds of miles of waterways. Much of the land is below sea level, and relies on more than 1,000 miles of levees for protection against flooding. Waterways in the Delta include the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras rivers; sloughs; streams; and ephemeral creeks. These waterways create a network of channels and islands throughout the basin.

In the mid-1800s, the Delta was mostly a tidal marsh, part of an interconnected estuary system that included the Suisun Marsh and San Francisco Bay. Until reclaimed by levees, the Delta was a great inland lake during the flood season; when flood waters receded, the network of sloughs and channels reappeared throughout the marsh.

Development of today's Delta began in the late 1850s when the Swamp Land Act conveyed ownership of all swamp and overflow land, including Delta marshes, from the Federal government to the State. Proceeds from the State's sale of swamp lands were to go toward reclaiming them. By the early 1900s, nearly all Delta marsh land had been reclaimed and converted to agricultural use.

PRIVATELY-MANAGED WETLANDS

Water entities with service areas within the Delta Basin are identified in **Table 2-30**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Table 2-30. Water Entities with Service Areas in Study Area, Delta Basin
Central Valley Wetlands Water Supply Investigations

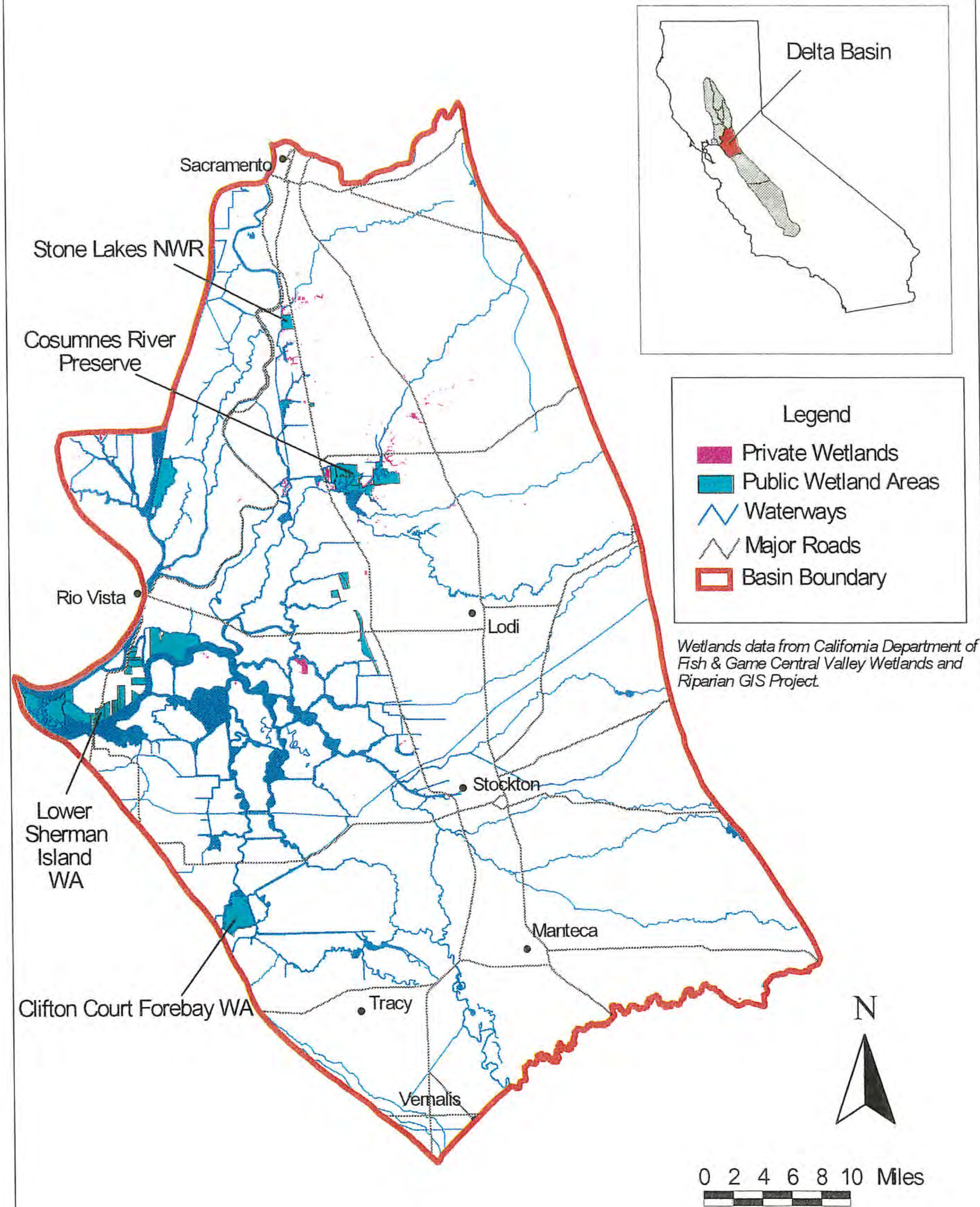
Delta Basin Water Entities	Apparent Private Wetlands
Banta-Carbona Irrigation District	No
Byron Bethany Irrigation District	No
Central Delta Water Agency	**Yes**
City of Manteca Water Service Area	No
City of Sacramento Water Service Area	No
Diablo Water District	No
Main Prairie Water District	No
North Delta Water Agency	**Yes**
Omochumne-Hartnell Water District	No
Reclamation District 900	No
River Junction Reclamation District 2064	No
Sacramento County Water Agency	**Yes**
Sacramento County Water Maintenance District	**Yes**
South Delta Water Agency	No
South San Joaquin Irrigation District	No
Woodbridge Irrigation District	No
Woodbridge WUCD	No

Wetlands Water Supply Conveyance Facilities and Water Agencies

Water supplies are derived largely from landowners' riparian or appropriative rights. Distribution of water to existing private wetlands in the Delta Basin is almost entirely by diversion from Delta channels and tributaries directly onto the properties, and not supplied or distributed by water agencies. A few wetlands areas use groundwater from landowner wells.

Figure 2-7. Delta Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Existing Private Wetlands Location

The GIS analysis identified a total of 2,490 acres of apparent privately-managed wetlands in the Delta Basin. Approximately 2,400 acres (96%) are inside the boundaries of three water agencies, however none of these agencies serve water to wetlands. Occurrence of these wetlands is shown in **Table 2-31.**

Table 2-31. Existing Private Wetlands Acreage, Delta Basin
Central Valley Wetlands Water Supply Investigations

Delta Basin	Apparent Privately-managed Wetlands	
	acres	% of Delta Basin Total
Central Delta Water Agency	420	17%
North Delta Water Agency	1,080	43%
Sacramento County Water Agency	890	36%
Outside Water Agencies	100	4%
Delta Basin Totals =	2,490	

Wetlands Water Supply

Surface water supplies are generally good for this basin. Sources are the Cosumnes River, Delta channels and sloughs, and associated agricultural return flows. Most private wetlands in the Delta occur in areas where water can be diverted or siphoned from adjacent sloughs under the owners' riparian rights. The only cost is for the pumping needed to lift it out of the adjacent slough, or the pumping needed to drain water from Delta islands that are below sea level. There may be some potential limits on groundwater use due to water quality problems. Groundwater availability varies throughout the basin, and quality ranges from poor to good.

Unresolved Delta Issues

There are a number of unresolved issues that could affect water supplies for private wetlands. The Delta Basin is the center of statewide controversy over water supplies and water quality in the Delta and the San Francisco Bay-Delta Estuary. Resolution of the Delta issues could have implications for water supply availability and reliability for private wetlands which are still unknown. Unresolved questions include CALFED Delta solutions, and SWRCB determinations about where the water will come from to meet Delta water quality standards, which could potentially affect water right holders. Other issues that could affect private wetlands water supplies include water marketing and transfers, anadromous fish programs, and other ESA requirements in the Delta.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High Reliability (1,730 acres or 69%) and Unknown Reliability (820 acres or 31%). Water supply reliability for apparent existing privately-managed wetlands is shown in **Table 2-32.**

Table 2-32. Water Supply Reliability of Private Wetlands, Delta Basin
Central Valley Wetlands Water Supply Investigations

	Apparent Privately-managed Wetlands			
	Water Reliability, acres		Water Reliability, percent of acres	
Delta Basin	High	Unknown	High	Unknown
Central Delta WA	420	0	100%	0%
North Delta WA	1,080	0	100%	0%
Sacramento County WA	130	760	15%	85%
Outside Water Agencies	100	0	100%	0%
Delta Basin Totals =	1,730	760	69%	31%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies in the Delta Basin are in the service areas of three water agencies that are not water suppliers in the traditional sense.

- North Delta Water Agency - This Agency covers 250,000 acres in the Delta Basin and the adjoining Yolo Basin. The Agency has a 1981 SWP contract that is for releases to protect the quality of Delta water diverted under Appropriative and Riparian water rights for agricultural, municipal and industrial uses in its service area. Lands within the Agency's boundaries are entitled to divert water without dry year curtailment pursuant to the SWP contract. The contract provides that the State will maintain, within the Agency, a dependable water supply of adequate quantity and quality for agricultural uses. The Agency levies a per acre landowner assessment. When a drought emergency exists and the State is unable to meet water quality objectives, the Contract provides that the State will compensate the user for loss of net income resulting from the poorer quality water. The annual assessment rates are currently about $1.50 per acre.

- Central Delta Water Agency - This agency covers 120,000 acres, including portions of Woodbridge Irrigation District and Woodbridge Water Users Conservation District. The Agency does not have a water supply. According to the Agency, 100% of the water supply to lands within its boundaries is derived from riparian water rights of landowners who take water from Delta channels directly onto their lands for crop irrigation (mainly field corn, safflower and asparagus).

- Sacramento County Water Agency - This agency covers unincorporated areas of Sacramento County. Its purpose is to oversee the development and management of surface and groundwater supplies in its service area. The Agency is not a water supplier. The Sacramento County Water Maintenance District serves urban water, primarily residential, to the area, but does not serve agricultural lands or wetlands.

Wetlands with High reliability supplies include lands outside the boundaries of water agencies that have appropriative and/or riparian water rights to Delta channels.

Wetlands with Unknown Reliability Supplies. Wetlands with Unknown reliability water supplies (760 acres) consist of areas that are within the boundaries of the Sacramento County Water Agency, but outside the North Delta Water Agency area. Most of these lands (~570 acres) lie along the Cosumnes River and are believed to be served by diversions under landowner riparian water rights. Approximately 190 acres in the upper area of the Cosumnes watershed are away from the river and believed to be supplied by groundwater.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-33 shows the current private wetland water demands, sources of available supplies, and current water supply shortfall. Current supplies meet all the private wetland water requirements in this basin.

Table 2-33. Estimated Water Demands and Supplies for Existing Private Wetlands, Delta Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	2,117	249	125	2,490
Optimum Management Water Requirements, AF/acre/year	4.75	7.4	13.25	
Total Water Requirement, AF/year	10,053	1,843	1,650	13,546
Available Water Supply, AF/year				
Surface Water	9,286	1,702	1,524	12,512
Groundwater	767	141	126	1,034
Total Available Water, AF/year	10,053	1,843	1,650	13,546
Estimated Shortfall, AF/year	0	0	0	0
Unknown Reliability Water Supply, AF/year				
	2,301	422	378	3,101
Total Available Reliable Water Supply, AF/year				
	7,752	1,421	1,272	10,445
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	2,301	422	378	3,101

Notes: Total Available Reliable water supply consists of those supplies that are in High and/or Moderate reliability classifications.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needed for optimum management of private wetlands in the Delta Basin is 13,546 AF/year (**Table 2-33**). Current water supplies meet all the private wetlands water requirements. To improve future water supply reliability the following options were evaluated.

Surface Water

Existing surface water supply available to the private wetlands is 12,512 AF/year from riparian and appropriative surface water rights. This supply provides 92% of the water needed for optimum management of the wetlands. An estimated 3,101 AF/year (25%) of the available surface water supply is unknown reliability water (i.e., there is a shortfall in known reliable water supply of 3,101 AF/year).

Surface Water Supply Issues

Issues in sustaining the availability and reliability of wetlands surface water supplies are in the following categories:

- Delta Issues
- Legal Issues
- Water Transfer/Water Marketing Programs
- Water Quality

Delta Issues. Delta issues are complex, far reaching, and wide ranging. CALFED is developing solutions for these issues, which include but are not limited to: water quality, water supply reliability, Delta island flooding and land subsidence, levee stability, fish and wildlife issues, agricultural diversions and returns, channel capacities, water rights, distribution to all stakeholders, and long-term management. A potential CALFED alternative is an isolated conveyance facility and off-stream surface water reservoirs north of the Delta. If selected, this alternative could influence the surface water available to private wetlands, but to what extent is currently unknown.

Legal Issues. There is much concern about protecting local water rights in this basin because of pending action by SWRCB to determine contributions of water right holders to meeting Delta water quality standards.

Water Transfer/Water Marketing Programs. Concerns regarding this issue include in-basin versus out-of-basin use, and effects of transfers on water availability for present water users.

Water Quality. Surface water quality is good in most areas, and should continue to be high because of Delta regulatory programs. Established Delta water quality standards are met by natural flows and releases from the reservoirs.

Groundwater

Groundwater provides an estimated 8% of the available water for wetlands in the Delta Basin. Groundwater is believed to be the water source for wetlands that are in the upper area of the Cosumnes watershed in areas away from the river.

Groundwater is generally available throughout the Delta Basin, but its use for private wetlands is potentially limited for reasons that include:

- Well Development Costs - Groundwater development costs are approximately $100,000 for a typical irrigation well.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $30 to $50 per AF. With low economic returns, costs for well construction and pumping present a serious issue for private wetland owners.

- Water Quality Limitations - Groundwater quality is poor in parts of the southern basin, but good in the northern foothills area. If groundwater were used to supplement private wetlands water supply, site-specific water quality sampling would be required to determine the groundwater's suitability as a source.

- Land Subsidence/Saltwater Intrusion - Excessive groundwater extraction can lead to groundwater overdraft and land subsidence. If groundwater is used extensively for private wetlands, aquifer monitoring may be required. Groundwater pumping could also exacerbate saltwater intrusion problems in some areas.

Agricultural Return Flow

Currently, private wetlands in the Delta Basin do not use agricultural return flow as a source of water supply, except to the extent that they constitute a part of the supply in Delta channels and sloughs. If available, agricultural return flows should be considered as a potential water source for private wetlands. Water Conservation efforts could reduce the amount of return flow available to private wetlands because the efforts reduce the amount of water initially applied to agricultural land. Reductions in return flow may also reduce wetland acreage that could be supported with this source on a continual basis.

DELTA BASIN FINDINGS

These investigations found that private wetlands in the Delta Basin:

1. Appear to have adequate water supplies available to support optimum management of the existing private wetlands, and most private wetlands have reliable water supplies; but

2. Have unknown water reliability in a few areas, resulting in a possible reliable supply shortfall of 3,101 AF/year if these supplies are, in fact, not reliable.

Status of Current Water Supplies

Currently, no additional water supply appears to be needed in this basin to bring all of the existing private wetlands to full supply and optimum management levels. The *1993 Sacramento-San Joaquin Delta Atlas* reports that the average annual inflow to the Delta (Delta Inflow) is 27.8 million AF. Average annual Delta water use, including consumptive use, channel depletion, and diversions to outside areas totals approximately 6.8 million AF. Should additional water be required for the existing private wetlands within the Delta Basin, the demand could be met with the water in the Delta, assuming that the private wetlands in question have riparian or appropriative rights to this water.

Groundwater is a potential source of water supply for wetlands, but varying water quality and well development and pumping costs may make this a less desirable source than surface water. Groundwater is normally an expensive source of water compared with surface water supply in the Delta. Therefore, groundwater use may be cost-prohibitive for many private wetland owners.

Issues Affecting Water Availability and Reliability

The Delta is the hub of California's water supplies, and could be affected by any or all actions to provide water supply or reliability to other Central Valley water users or for instream flows. Reallocation of supplies or additional diversions could reduce the amount of water currently available to Delta private wetlands. However, at the present time most of the private wetlands water supplies in the Delta are highly reliable because of the generally superior riparian water rights held by most private wetland landowners in the basin. Although pending CALFED and SWRCB decisions create some uncertainties, it is possible that they will be resolved in ways that will benefit water quality and reliability for water users in the Delta, including private wetlands.

The water in Delta channels includes agricultural return flow, but it is effectively commingled with water already in the channels. Return flow is not distributed directly to private wetlands.

Table 2-34 summarizes the options and related issues for improving water reliability to private wetlands in the Delta Basin.

Table 2-34. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Delta Basin
Central Valley Wetlands Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers (Prop 204 upstream reservoirs)	• Delta Issues • Legal Issues • Water Transfer/water Marketing Programs • Water Quality • Conveyance Difficulties • Conveyance Losses
Groundwater	Use existing wells New wells	• Water Quality Limitations • Water Costs • Well Development Costs • Land Subsidence • Saltwater Intrusion
Agricultural Return Flow	Continue current practices	• Effects of Water Conservation

Suisun Marsh Basin

Total Basin Land Area, acres	**108,800**
Total Privately-Managed Wetland Land Area, acres	**29,720**
Private Wetlands as Percent of Total Basin Area	**27%**

BASIN DESCRIPTION

The Suisun Basin covers 170 square miles in southern Solano County to the west of the Delta and east of the Carquinez Strait. The Suisun Marsh is the primary wetland feature lying north of the Suisun Bay and south of the cities of Fairfield and Suisun (**Figure 2-8**). The Suisun Marsh is the largest contiguous brackish water wetland in California. The tidally-influenced Suisun Marsh Basin contains a myriad of sloughs that supply tidal, seasonal, and permanent marsh lands. Private wetland acreage in the Suisun Marsh Basin is undetermined, but much of it is managed for waterfowl hunting.

Approximately 200 species of birds, 45 species of mammals, and 36 species of amphibians and reptiles inhabit the Marsh. The Marsh provides a key habitat along the Pacific Flyway for wintering ducks including pintail, mallard, widgeon, green-winged teal, shoveler, canvasback, and ruddy duck. Canadian, white-fronted, and snow geese also use this area.

To protect the quality of the Marsh, landowners formed the 116,000-acre Suisun Resource Conservation District (Suisun RCD) in 1963, which consists of managed wetlands, unmanaged tidal wetlands, bays, sloughs, and upland grasslands. CDFG manages the 14,800-acre Grizzly Island Suisun Marsh Complex. There are 158 privately owned wetlands within Suisun RCD. Because of its location and significance on the Pacific Flyway, the Suisun Basin is highly regulated to maintain and enhance wetlands management and water quality standards. SWRCB water quality objectives for the basin are met through CVP and SWP releases which supplement Sacramento and San Joaquin rivers natural flows during the low-flow season. USBR, DWR, CDFG and the Suisun RCD signed a Suisun Marsh Preservation Agreement, and together participate in implementing a Plan of Protection. Private wetland managers must meet Suisun Marsh Preservation Act standards for wetland habitat and water quality as well. In 1995 SWRCB revised Suisun Marsh standards, based on the objectives in the 1995 Bay/Delta Plan. A time line of actions taken to protect the Marsh is presented in **Appendix B.**

BASIN HYDROLOGY

In the early 1800s, the Suisun Marsh was a brackish tidal basin covering more than 74,000 acres. Marsh soils are a buildup of peat soils combined with silt deposits from overflows of the Suisun and Montezuma sloughs and the Sacramento and San Joaquin rivers. The mixing of saltwater tidal cycles and fresh water outflows from the Delta creates brackish water quality conditions. Prior to development, large portions of the Marsh were subjected to submergence daily. These daily tidal fluctuations were removed after levees were built. After levee construction began in 1850, land development reduced these natural tidal lands to their current acreage.

The Suisun Marsh is affected by tidal inflow from the San Francisco Bay and fresh water outflow from the Delta. Suisun Bay, which connects these two sources, lies along the southern boundary of the basin with Grizzly and Honker bays extending northward to form the southern borders of the Marsh. Major waterways include Suisun (extending to Suisun City), Montezuma, and Nurse sloughs. Minor waterways include Goodyear, Cordelia, Harvey, Frank Horan, Chadbourne, Peltier, Wells, Sheldrake, Boynton, Peytonia, Duck, Hill, Cutoff, Volanti, Tree, Island, Frost, Cross, Hasting, Luco, Denverton, Grizzly, Roaring River, Howard, Champion, Mud and Norther sloughs. Some fresh water is introduced through Green Valley and Suisun creeks. The numerous waterways have created Morrow, Joice, Grizzly, Hammond, Simmons, Bradmoor, Wheeler, Dutton, Van Sickle, Chipps, Snag, Freeman, Ryer, and Roe islands.

PRIVATELY-MANAGED WETLANDS

Wetlands Water Supply Conveyance Facilities and Water Agencies

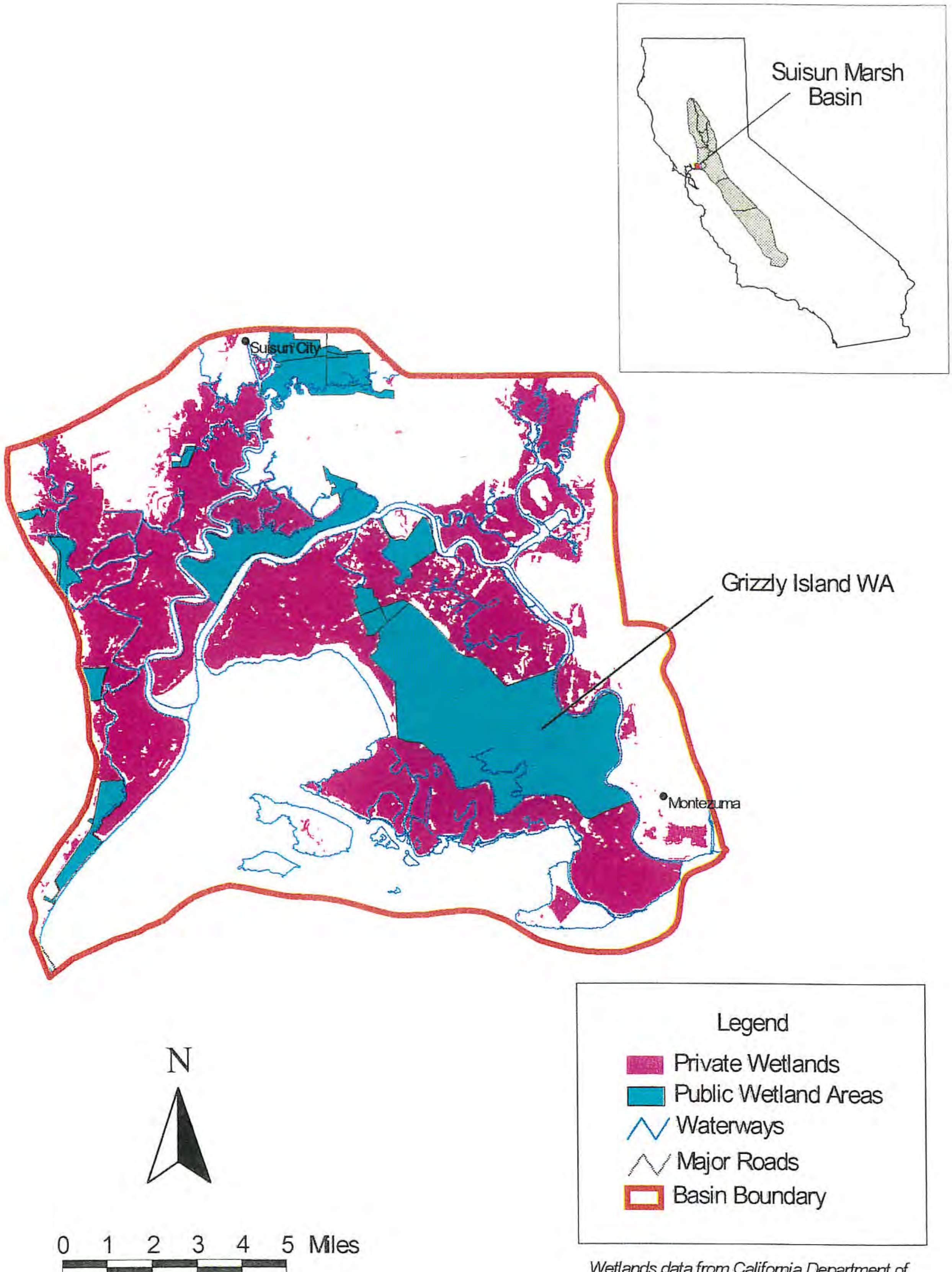
Water agencies with service areas within the Suisun Marsh Basin are the City of Fairfield and the Solano Irrigation District. Outside the boundaries of these agencies, water is diverted from the numerous sloughs and modified natural channels to private wetlands. There are no constructed overland conveyance facilities.

Existing Private Wetlands Location

The GIS analysis identified a total of 29,720 acres of apparent privately-managed wetlands in the Suisun Marsh Basin. Only 10 acres (0.03%) are inside the boundaries of water agencies. Occurrence of these wetlands is shown in **Table 2-35**.

Figure 2-8. Suisun Marsh Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Table 2-35. Water Entities with Service Areas in Study Area, Suisun Marsh Basin
Central Valley Wetlands Water Supply Investigations

Suisun Marsh Basin	Apparent Privately-managed Wetlands	
	acres	% of Suisun Marsh Basin Total
City of Fairfield Water Service Area	0	0%
Solano Irrigation District	10	0.03%
Outside Water Agencies	29,710	99.97%
Suisun Marsh Basin Totals =	29,720	

Wetlands Water Supply

Surface water is the only source of water for private wetlands in this basin. Generally, the supply availability and reliability is good. Some factors which impact private wetland habitat include on-field salinity management and fish screen restrictions on diversions.

Water is delivered to private wetlands in the Marsh through a network of sloughs and waterways, most of which are extensions of Montezuma Slough. The Suisun Marsh Salinity Control Gates are 3.1 miles to the west of the upstream end of Montezuma Slough where it branches off of the Sacramento River near Collinsville. These gates are used to tidally pump higher quality water from the river into the slough for distribution throughout the Marsh. During the incoming tide, fresh water from the Sacramento River near Collinsville is pushed northward and westward through Montezuma Slough. Without the gates the outgoing tide will create flow from Montezuma Slough to the Sacramento River and result in the drawing of saline water from Grizzly Bay into the western part of the slough. The tidal gate, which allows flow in one direction only, retains the higher quality Sacramento River water in the slough for use on private wetlands.

There is enough brackish water available of sufficient quality to satisfy the managed wetlands demands; however, current management levels on private wetlands limit the water use. All wetlands are flooded for the waterfowl hunting season, but most managers do not manage water to fully flush accumulated soil salinity from the wetlands, and optimum waterfowl forage conditions are not created through additional irrigations.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High for less than 0.02% of the lands and unknown for the remainder. Water supply reliability for apparent existing privately-managed wetlands is shown in **Table 2-36.**

Table 2-36. Water Supply Reliability of Private Wetlands, Suisun Marsh Basin
Central Valley Wetlands Water Supply Investigations

	Apparent Privately-managed Wetlands			
	Water Reliability, acres		Water Reliability, percent of acres	
Suisun Marsh Basin	High	Unknown	High	Unknown
City of Fairfield WSA	0	0	0%	0%
Solano Irrigation District	5	5	50%	50%
Outside Water Agencies	0	29,710	0%	100%
Suisun Basin Totals =	5	29,715	<02%	98%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies (only 5 acres) are in the service area of the Solano Irrigation District.

Wetlands with Unknown Reliability Supplies. Surface water is the only source of water for private wetlands in this basin. Although the vast majority of lands in the Suisun Marsh Basin are characterized by the DWR reliability analysis as having Unknown reliability water supply, the supply availability and reliability is good.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-37 shows the current private wetland demands, sources of supplies, and current water supply shortfalls.

Table 2-37. Estimated Water Demands and Supplies for Existing Private Wetlands, Suisun Marsh Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	25,262	2,972	1,486	29,720
Optimum Management Water Requirements, AF/acre/year	4.75	7.4	13.25	
Total Water Requirement, AF/year	119,995	21,993	19,690	161,677
Available Water Supply, AF/year				
Surface Water	119,995	21,993	19,690	161,677
Groundwater	0	0	0	0
Total Available Water, AF/year	119,995	21,993	19,690	161,677
Estimated Shortfall, AF/year	0	0	0	0
Unknown Reliability Water Supply, AF/year				
	119,974	21,989	19,686	161,650
Total Available Known Reliable Water Supply, AF/year				
	20	4	3	27
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	119,974	21,989	19,686	161,650

Notes: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications. Unknown Reliability water supply is the supply for 29,710 acres of wetlands that are outside the boundaries of water agencies.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needed for optimum management of private wetlands in the Suisun Marsh Basin is 161,677 AF/year. Surface water supply is adequate to meet all the private wetlands water needs. To improve water supply reliability, the following options are available.

Surface Water

There is enough surface water available to satisfy all current demands. Supply could be limited through fish screen restrictions, lack of proper facilities for optimum management, and soil salinity management. Issues include:

- Water Quality Limitations
- Wetland Soil Salinity Management
- Fish Screen Restrictions

Water Quality Limitations

Specific water quality standards are established which will generally improve water quality in the Marsh. Decision 1485, replaced by SWRCB Order WR 95-6, established Suisun Marsh water quality standards. Efforts should continue to maintain the Suisun Marsh water quality standards established through Decision 1485 and SWRCB Order WR 95-6.

Wetland Soil Salinity Management

The primary obstacle to achieving optimum wetland habitat is soil salinity, which impedes growth of vegetation used by waterfowl. Additional diversion and drainage facilities for each wetland site, coupled with additional on-field management for leaching the soil salinity, could alleviate this problem.

Fish Screen Restrictions

Current fish screen restrictions severely reduce the ability to apply water to maintain optimum habitat conditions. Restrictions occur for salmon and delta smelt from November through mid-January; mid-February to late March; and from early March to late May. The restrictions affect necessary maintenance flows and soil salinity management.

SUISUN MARSH BASIN FINDINGS

These investigations found that the Suisun Basin existing private wetlands:

1. Have adequate and reliable water supplies; and

2. Need to improve conditions limiting optimum wetland habitat management, and affecting water quality.

Status of Current Wetland Habitat Management and Water Quality

No additional water supplies for existing private wetlands are needed in the Suisun Basin. However, optimum wetland habitat management is not realized because of the fish screen restrictions for winter run salmon and delta smelt, which can limit water operations from mid-February to late May.

Habitat conditions are also adversely affected by soil salinity. This problem could be alleviated through improved on-field diversion and drainage facilities coupled with additional soil management to create a greater leaching cycles for salts.

Financial incentives, funding of facilities, or technical assistance may be necessary to encourage and enable optimum private wetlands management in the basin.

Options and Issues for Improving Water Quality and Wetland Habitat Management

Water quality and management options and issues for Suisun Basin privately-managed wetlands are summarized in **Table 2-38.**

Table 2-38. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Suisun Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Continue current practices	• Water Quality Limitations • Wetland Soil Salinity Management • Fish Screen Restrictions

San Joaquin Basin

Total Basin Land Area, acres	**1,856,000**
Total Privately-Managed Wetland Land Area, acres	**39,890**
Private Wetlands as Percent of Total Basin Area	**2.15%**

BASIN DESCRIPTION

The San Joaquin Basin covers 2,900 square miles in northern San Joaquin Valley from the Stanislaus River in the north to roughly the San Joaquin River near the town of Mendota in the south. This 80-mile-long basin is bordered by the SWP California Aqueduct to the west and the southern Sierra Nevada Mountains to the east (**Figure 2-9**). Major tributaries to the San Joaquin River include the Chowchilla, Merced, Stanislaus, and Tuolumne rivers, and numerous creeks and sloughs that drain into the river. California's two major water supply development projects, CVP and SWP, convey water through the Delta-Mendota Canal and the California Aqueduct, respectively; both have storage in the CVP/SWP San Luis Reservoir. Other features include the Chowchilla Canal, and the Eastside and Mariposa bypasses. The basin also contains wildlife refuges, wetlands, and stretches of rivers that are designated Wild and Scenic under the National Wild and Scenic Rivers Act.

BASIN HYDROLOGY

The San Joaquin Basin's major wetland areas historically were along the San Joaquin River, near Los Banos and Merced, up to the confluence with the Stanislaus River.

Historically, tens of thousands of acres of seasonal and semi-permanent palustrine marsh occurred from floods of the San Joaquin, Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus rivers. A significant portion remained flooded year-round, providing a vast breeding and wintering area for migratory waterfowl and other water-related wildlife. Surface water not retained in the Basin drains north and reenters the San Joaquin River.

Today, levees along the major streams in this basin protect productive agricultural land from frequent flooding. Along the western side of the valley, more than 100,000 acres have soil conditions that favor wetland environments. These soils are derived from marine sediments, which are high in salts and trace elements. Former irrigation practices dissolved these substances into the shallow groundwater, and the agricultural return flow was used as a water source for wetlands. Scientists later discovered that the selenium in the water was damaging to a wide range of waterbirds, and the use of return flow for wetlands has been greatly reduced. However, return flow still is conveyed to the San Joaquin River.

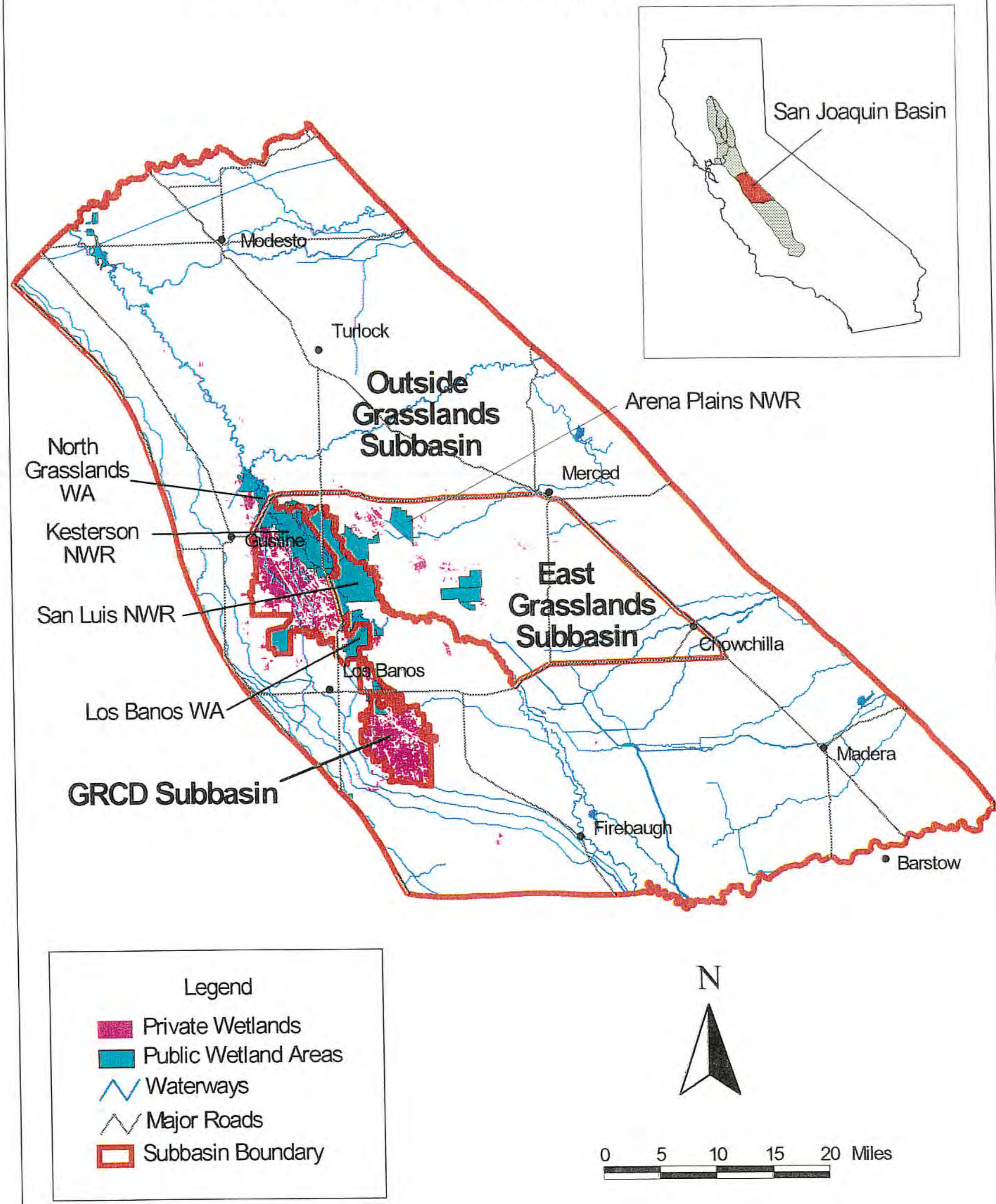
PRIVATELY-MANAGED WETLANDS

For these investigations, the San Joaquin Basin was divided into Grasslands RCD, East Grasslands and Outside Grasslands subbasins (**Figure 2-9**). Water entities with service areas in these subbasins are identified in **Table 2-39**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Table 2-39. Water Entities with Service Areas in Study Area, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

	Subbasin			Apparent Private Wetlands
San Joaquin Basin Water Entities	Grasslands RCD	East Grasslands	Outside Grasslands	
Broadview Water District			X	No
Central California Irrigation District	X		X	**Yes**
City of Newman Service Area			X	No
Del Este Water Company			X	No
Eagle Field Water Company			X	No
El Nido Irrigation District		X		No
Firebaugh Canal Water District			X	No
Grassland Water District	X		X	**Yes**
Laguna Water District			X	No
Merced Irrigation District		X	X	No
Mercy Springs Water District			X	No
Modesto Irrigation District			X	No
Oro Loma Water District			X	No
Pacheco Water District			X	No
Panoche Water District			X	No
San Luis Canal Company	X	X	X	**Yes**
San Luis Water District			X	**Yes**
Santa Nella County Water District			X	No
South Delta Water Agency			X	No
Turlock Irrigation District			X	No
West Stanislaus Irrigation District			X	No
Widren Water District			X	**Yes**

Figure 2-9. San Joaquin Basin Private Wetlands
Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Wetlands Water Supply Conveyance Facilities and Agencies

Surface water supplies for private wetlands in the San Joaquin Basin are obtained from natural waterways and from flood control, drainage, and irrigation conveyance systems.

Interviews of water agencies with apparent private wetlands in their service areas disclosed that two of the five are not involved in water supply to privately-managed wetlands. These are:

- San Luis Water District - 170 acres of wetlands shown by the GIS analysis are not supplied by the District.

- Widren Water District - This district could not be contacted and may no longer exist. The 130 acres of wetlands shown by the GIS analysis are apparently not served by any water agency.

Interviews of two other agencies (Turlock and Modesto Irrigation Districts) that were thought to be possible suppliers to private wetlands outside their service areas disclosed that neither is involved in water supply to privately-managed wetlands.

Conveyance facilities that are known to be involved in water supply to existing private wetlands are the USBR Delta-Mendota Canal, the San Luis Canal Company's San Luis Canal, and the Central California Irrigation District's Main Canal.

Conveyance systems that have potential for involvement in improving the availability and reliability of private wetlands water supplies include the following:

- Local Eastside Valley Water Agency Conveyance Systems - These are: 1) the Merced, Tuolumne, Stanislaus, Chowchilla and San Joaquin rivers; 2) Bear, Owens, Mariposa, and Deadman creeks; 3) South and Duck sloughs; and 4) the Eastside Bypass; Chowchilla, Merced, Turlock, Stevenson, and Modesto ID canals and the Merquin WD canal.

- SWP Westside Water Agency Conveyance Systems - Contra Costa ID Main Canal, California Aqueduct, and the North and Outside Canals and Garzas, Owens, Los Banos, Orestima, and Del Puerto creeks (natural drainage systems which converge with the San Joaquin River).

Existing Private Wetlands Location

The GIS analysis identified a total of 39,890 acres of apparent privately-managed wetlands in the San Joaquin Basin. Approximately 79% (31,590 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the three subbasins is shown in **Table 2-40.**

Table 2-40. Existing Private Wetlands Acreage, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

San Joaquin Basin	**Apparent Privately-managed Wetlands**					
			Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres	% of Basin Total	acres	Percent	acres	Percent
Grasslands RCD	32,560	82%	29,970	92%	2,590	8%
East Grasslands	2,490	6%	0	0%	2,490	100%
Outside Grasslands	4,840	12%	1,620	33.5%	3,220	66.5%
San Joaquin Basin Totals =	39,890		31,590	79%	8,300	21%

Nearly all of the apparent privately-managed wetlands in the Grasslands RCD Subbasin are within the Grasslands RCD. Wetlands in the East Grasslands Subbasin are in areas east of the San Joaquin River. Wetlands in the Outside Grasslands Subbasin are in areas west of the San Joaquin River outside the boundaries of the Grasslands RCD.

Wetlands Water Supply

Basin water supplies consist of local surface water, imported surface water, and groundwater. Average-year supplies are approximately 75% surface water and 25% groundwater. Drought-year supplies are approximately 65% surface water and 35% groundwater.

- Local Surface Water - Local surface water (from the nine major Sierra Nevada river systems that flow into the valley) provides approximately 35% of the area's total supply during average years.

- Imported Surface Water - Basin water supplies are augmented by two major importation projects (CVP's Delta-Mendota Canal and SWP's California Aqueduct) that mostly serve agriculture. Approximately 2 million AF/year of Delta water is imported into the San Joaquin Basin. Most is carried by the Delta-Mendota Canal.

- Groundwater - Groundwater pumping is limited because of overdraft concerns. Groundwater quality throughout the basin varies from poor to good. Most groundwater use is on-farm only. Within the basin, groundwater availability, well capacities, quality, and pumping costs vary enormously.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is High Reliability (32,450 acres or 81%) and Unknown Reliability (7,440 acres or 19%). Water supply reliability for apparent existing privately-managed wetlands in each of the three subbasins is shown in **Table 2-41.**

Table 2-41. Water Supply Reliability of Private Wetlands, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

San Joaquin Basin	**Apparent Privately-managed Wetlands**			
	Water Reliability, acres		Water Reliability, percent of acres	
Subbasin	High	Unknown	High	Unknown
Grasslands RCD	30,580	1,980	94%	6%
East Grasslands	50	2,440	2%	98%
Outside Grasslands	1,820	3,020	38%	62%
San Joaquin Basin Totals =	32,450	7,440	81%	19%

Wetlands with High Reliability Supplies. Wetlands with High reliability supplies consist of wetlands within and outside the service areas of water supply agencies:

- Grasslands RCD Subbasin - Approximately 97.5% of wetlands with High reliability supplies in the Grasslands RCD Subbasin are in the service areas of three water agencies with CVP contract water supplies. The remaining 2.5% (780 acres) are outside the service areas of water agencies. Two of the three water agencies provide wetlands water supplies 12 months per year, and the third agency provides wetlands water from January 15 through October 31. Wetlands in Grasslands RCD are served by the Grassland Water District. The CVPIA provided a guaranteed water supply for the private wetlands in the Grasslands RCD. These wetlands were allocated 180,000 AF/year of non-reimbursable water to be phased in over a 10-year period to allow optimal water management of private wetlands in the Grasslands. A coordinated water management plan was developed for the Grasslands RCD lands.

- East Grasslands Subbasin - Wetlands with High reliability supplies in the East Grasslands Subbasin are all outside the service areas of water agencies.

- Outside Grasslands Subbasin - Approximately 69% of wetlands with High reliability supplies in the Outside Grasslands Subbasin are in the service areas of three water agencies with CVP contract water supplies. The remaining 31% (560 acres) are outside the service areas of water agencies. Two of the three water agencies provide wetlands water supplies 12 months per year, and the third agency provides wetlands water from January 15 through October 31.

Wetlands with Unknown Reliability Supplies. The majority (93%) of wetlands with Unknown reliability supplies are outside the service areas of water agencies.

- Grasslands RCD Subbasin - 170 acres of wetlands with Unknown reliability supplies are in the service area of the Grassland WD. The remaining 1,810 acres are outside the service areas of water agencies.

- East Grasslands Subbasin - All wetlands with Unknown reliability supplies are outside the service areas of water agencies. Water supplies to these wetlands are believed to consist mainly of irrigation tailwater from Merced ID, natural runoff, and groundwater. Water rights and surface water supplies are very poor throughout most of the region.

- Outside Grasslands Subbasin - 260 acres of wetlands with Unknown reliability supplies are in the service areas of the Grassland WD and two other agencies. The remaining 2,660 acres are outside the service areas of water agencies.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-42 shows the current private wetland water demands, sources of reliable water supplies, and current water supply shortfall. Agricultural return flow (tailwater) is a current source, but may not be reliable for private wetlands in the future. Accordingly, tailwater supply is included in the listing of low reliability water supply.

Table 2-42. Estimated Water Demands and Supplies for Existing Private Wetlands, San Joaquin Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	35,901	2,792	1,197	39,890
Optimum Management Water Requirements, AF/acre/year	5.25	7.4	13.25	
Total Water Requirement, AF/year	188,480	20,663	15,856	225,000
Available Water Supply, AF/year				
Surface Water	179,435	19,678	15,253	214,367
Groundwater	2,241	244	149	2,634
Total Available Water, AF/year	181,676	19,922	15,403	217,001
Estimated Shortfall, AF/year	6,804	741	454	7,998
Unknown Reliability Surface Water Supply, AF/year				
	28,854	5,032	4,639	38,525
Total Available Reliable Water Supply, AF/year				
	152,822	14,890	10,763	178,476
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	35,658	5,773	5,093	46,524

Note: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications. Unknown reliability water supply includes irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needed for optimum management of private wetlands in the San Joaquin Basin is 225,000 AF/year (**Table 2-42**). Available water supplies for these wetlands are estimated to be 217,001 AF/year (i.e., there is currently an available supply shortfall of 7,998 AF/year). The available supply is 99% surface water and 1% groundwater. An estimated 38,525 AF/year of this supply is unknown reliability surface water. The combination of the 7,998 AF/year available supply shortfall and the 38,525 AF/year unknown reliability surface supply results in an estimated available, reliable supply shortfall of 46,524 AF/year.

The following options are available to improve water supply availability and reliability.

Surface Water

Existing surface supplies to privately-managed wetlands include a significant component of unknown reliability surface water (35,525 AF/year) believed to be comprised largely of irrigation tailwater that is not considered a reliable supply for long-term optimum wetlands habitat.

Additional surface water could be purchased from willing sellers within the San Joaquin Valley area. However, the potential for success in this is extremely limited due to the general shortage of supply in the region and the prospect that imported water supplies (CVP and SWP) will be reduced in the future. DWR has estimated that surface water transfers could involve water purchase and wheeling costs ranging from $50 to $150 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source. CVP mitigation water is another possible source for wetlands in the Outside Grasslands Subbasin that are successful in gaining annexation to Grassland Water District. SWP could also contribute environmental water for private wetlands management. CALFED programs may also offer solutions for water-short San Joaquin private wetlands.

<u>Surface Water Supply Issues</u>

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Rights and Contract Modification
- Conveyance Losses
- Potential High Cost
- Competition with Other Buyers

<u>District Operations and Maintenance</u>. Year-round conveyance is not available in some canals near private wetlands because of canal maintenance outages. However, existing natural channels could be used during winter maintenance periods. Most districts perform maintenance at some time during the period from January to March.

<u>Water Rights and Contract Modification</u>. With SWRCB cooperation, USBR and other water rights holders (water districts or individuals) could restructure their water rights, or amend contracts with others, for wetlands water use in the fall and winter. For example, the current contracts with USBR limit water use to the irrigation season between April and October. USBR has applied to SWRCB for contract modifications, and others could apply for changes if their use is restricted to April through October. Whether contracts could be modified to permit fall and winter use would depend on the water rights or contracts held for the source of supply.

<u>High Conveyance Losses</u>. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). The earthen canals used to deliver CVP water have been lined with clay over the years and have minimal conveyance losses, but some smaller earthen canal and ditches have high seepage losses. Conveyance losses can range from 15 to 25% of the water delivered. Some local districts have water conservation programs which target these canals for lining.

<u>Potential High Cost</u>. Purchasing long-term supplies could include the cost of water, wheeling costs, and costs of conveyance modifications, which when combined would be expensive. Severe water shortages have created a strong seller's market for water. Water

districts (sellers) may be willing to enter into short-term sales agreements at prices affordable for private wetlands landowners, but might be reluctant to enter into long-term water sales agreements, preferring to keep their options open for long-term sales at greater prices.

Competition with Other Buyers. Because of increasing competition for water supplies, the concept of water marketing, and the passage of enabling legislation (including legislation to protect sellers' water rights) have recently generated great interest. Competing with other buyers from the San Joaquin Valley and Southern California could be difficult for private wetland owners, who may not be able to afford the prices others would be willing to pay.

Groundwater

Existing groundwater supplies to privately-managed wetlands provide approximately 1% of the water needed for optimum management of the wetlands.

Groundwater Quality and Availability

Groundwater quality throughout the basin varies from poor to good. Most groundwater use is confined to on-farm use only. Within the basin, groundwater availability, well capacities, quality, and pumping costs vary enormously. In areas near most private wetland sites, high water tables are common and surface and subsurface drainage is often a problem.

Potential Limitations on Groundwater Use for Wetlands

The use of groundwater for private wetlands is potentially limited for reasons that include:

- Well Development Costs - Groundwater wells in this basin likely would be 500 to 800 feet deep, and development costs could range from $100,000 to $125,000. These expenses, and pumping costs, make groundwater development cost-prohibitive for most San Joaquin Basin private wetlands.

- Groundwater Overdraft and Land Subsidence - Groundwater overdraft and land subsidence are major concerns in the south basin. Subsidence can damage water conveyance systems and cause changes in channel capacities. Subsidence has been documented along the California Aqueduct near Mendota, at Mendota Dam, along the Delta-Mendota Canal, and along the Eastside Bypass. Groundwater overdraft and subsidence limit the groundwater availability in the basin.

- Water Quality Limitations - Groundwater of acceptable quality is available generally between 400 to 600 feet below the land surface. This deep groundwater, while acceptable in terms of total dissolved solids, may be affected by high arsenic, selenium, and salinity.

Agricultural Return Flow

The existing wetlands in the San Joaquin Basin are in a heavy water reuse area, where water applied and not used consumptively becomes available for reuse either through groundwater recharge or surface water runoff. Agricultural return flow is available except during drought. This source is usually inexpensive, but has not been consistently available or of usable quality. Issues relating to return flow include:

- Areas Outside of Districts - Some areas have no water source except groundwater. If agricultural return flows could be used to a greater extent than is currently done, groundwater overdraft might be reduced.

- Availability of Conserved Water to Wetlands - Water conservation efforts could result in either an increase, or a decrease, of surface water available for private wetlands. If less is diverted, more water would remain in the source; but reduction of agricultural return flow would mean less available to private wetlands. Infrastructure and irrigation system improvements needed to conserve water can be very costly. Some agricultural water districts have turned to urban water districts outside of the basin to fund these conservation measures in exchange for buying the conserved water. Therefore, conserved water will be transferred to urban areas, reducing return flows currently used by private wetlands.

SAN JOAQUIN BASIN FINDINGS

These investigations found that the San Joaquin Basin private wetlands:

1. Need significant improvement in the reliability and quality of their current water supplies; and

2. Need an estimated additional reliable water supply of 46,524 AF/year to bring all of the existing private wetlands to full supply and optimum management levels.

The San Joaquin Basin has a total of 39,890 acres of private wetlands, of which 32,560 are within Grasslands RCD. CVPIA specifically provided for additional water supplies (180,000 AF/year), to be phased in over a 10-year period, for lands within Grasslands RCD. This report addresses the needs of all existing private wetlands in the San Joaquin Basin, and takes into account the additional water provided to those within Grasslands RCD.

Status of Current Water Supplies

The reliability of all current private wetlands water supplies is uncertain in the San Joaquin Basin because of basin-wide water shortages for all uses. This uncertainty applies to all sources--surface water, groundwater, and agricultural return flow--because all are threatened with reduction from various causes.

Surface water supplies are always uncertain because of Central Valley cycles of floods and drought. However, even in normal years, CVP contractors in the San Joaquin Basin expect to receive less than their full allocations because of added demands on the supply from CVPIA, ESA, and Delta Flow Standards. Groundwater supplies are declining because of overdraft. Agricultural return flows may be reduced by water conservation and recharge programs.

To improve the reliability and quality of water supplies currently available to San Joaquin Basin private wetlands, additional water supplies are needed, as well as other means to extend the current water supplies.

Securing Additional Supplies

Water could be purchased from suppliers within the basin or outside the basin. In either case, the water would be expensive, and conveyance facilities or wheeling costs may also be involved. Depending on location, wheeling possibilities would be local water service providers, SWP, or CVP. These alternatives would probably be cost-prohibitive for private wetlands landowners, without funding assistance.

Groundwater development costs and subsidence issues limit groundwater as a potential source for additional water. Groundwater is highly variable in quality, quantity, and pumping costs. This alternative could be expensive to develop, maintain, and operate. Some financial incentives may be necessary to make this a viable private wetland water source.

Agricultural return flow is unreliable as a source for private wetlands water supply in this basin because of water quality problems, and because it is not consistently available.

Issues Affecting Water Availability and Reliability

Based on interviews with water suppliers to private wetlands in the San Joaquin Basin, there are limited opportunities to gain additional water. Most have supply deficits for their demands, and some have supplies that can only provide allocations in the range of 2 to 3 AF/acre per year, which leave most agricultural users water-short, and would be inadequate for maintaining most wetlands. Others have supplies that may allow 5 AF/acre per year.

The age and condition of the Mendota Dam affects the reliability of wetlands water supplies. The California Division of Safety of Dams requires dewatering of Mendota Pool every two years, mid-November to mid-January. This primarily affects wetlands, because they are the only ones taking water at that time. A new Mendota Dam downstream would improve the reliability of water to wetlands from this cause.

Water supply availability and reliability improvement options and issues for San Joaquin Basin privately-managed wetlands are summarized in **Table 2-43.**

Table 2-43. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Conversion of agricultural lands Purchases and transfers Purchase of additional land with water	• District Operations and Maintenance • Water Right/contract Modification • Conveyance Losses • Potential for High Cost • Competition with Other Buyers
Groundwater	Use existing wells New wells	• Well Development Costs • Subsidence • Water Quality Limitations • Groundwater Development and Management
Agricultural Return Flows and Water Conservation	Continue current practices Additional conservation opportunities	• Areas Outside of Districts • Availability of Conserved Water to Private Wetlands

Tulare Basin

Total Basin Land Area, acres	**3,584,000**
Total Privately-Managed Wetland Land Area, acres	**3,310**
Private Wetlands as Percent of Total Basin Area	**0.09%**

BASIN DESCRIPTION

The Tulare Basin covers approximately 5,600 square miles in the southern San Joaquin Valley between the San Joaquin River in the north and the Tehachapi Mountains in the south. This 135-mile-long basin is bordered by the Coast Range to the west and the southern Sierra Nevada to the east (**Figure 2-10**). The San Joaquin River divides the San Joaquin and Tulare basins. Tributaries to the San Joaquin River include the Kings, Kaweah, Tule, and Kern rivers. The Tulare Basin is bounded by the California Aqueduct on the west side and the Friant-Kern Canal on the east side.

BASIN HYDROLOGY

Although the Tulare Basin is the driest region of the Central Valley, historically it contained the largest single block of wetland habitat in California, Tulare Lake, providing about 260,000 acres of permanent wetland and an additional 260,000 acres of seasonally flooded scrubland. The Tulare Lake area, located in the southernmost portion of the basin, originally contained four distinct lakes: Tulare, Boose, Buena Vista and Kern lakes. The lakes were fed primarily by winter and spring snowmelt from the Kern, Tule, Kaweah, and Kings rivers. During most years, the Basin functioned as a sink, where water from the Sierra Nevada flowed down streams into a series of shallow lake basins. These lakes provided habitat for millions of migrant waterfowl and shorebirds. The rivers now all terminate on the valley floor in lakes or sinks. Water does not find its way to the ocean from the basin, except in extremely wet years.

The historic Tulare Lake was once the largest body of fresh water west of the Mississippi River, and the second largest fresh water lake in the United States, based on surface area. Under drought conditions the lake was known to evaporate completely, but on average the lake approached 40 feet in depth near its northwest shore. Tulare Lake had no perennial surface outlet and all water fed into the lake was confined within its shoreline by a ridge 30 feet higher than the lakebed, if the lake surface elevation was below 207 feet. When the water surface of the lake rose to that elevation, water would flow north, often flowing into the San Joaquin River. There may also have been considerable underground flow from Tulare Lake to the San Joaquin River.

Agricultural development has changed the hydrology of the Tulare Basin. By 1979, nearly all of the San Joaquin Valley floor and many of the flatter upland areas were urbanized or converted to cultivated land, in response to water supplies provided by Federal and State water projects. Tulare Lake was dried out and turned into productive agricultural land. Natural stream flow to the currently developed agricultural land is not adequate for irrigation water demand; therefore, water is imported and groundwater is pumped to augment water supply. As of 1988, less than 15,000 acres of wetland habitat occurred annually in the basin during average water years, of which 5,000 acres were at the Kern National Wildlife Refuge (NWR) Complex and privately managed duck clubs.

PRIVATELY-MANAGED WETLANDS

For these investigations, the Tulare Basin was divided into the Mendota/Helm and Tulare Lake subbasins (**Figure 2-10**). Water entities with service areas within these two subbasins are identified in **Table 2-44**. Entities identified in the GIS analysis as having apparent privately-managed wetlands within their service areas are as indicated.

Wetlands Water Supply Conveyance Facilities

The following are existing conveyance facilities which either provide or could provide water to private wetlands.

- Fresno Slough and James Bypass - conveyance of natural and drain flows from the Kings, Kaweah, and Tule rivers watershed and water service areas to the San Joaquin River. CVP Mendota Pool water is conveyed through Fresno Slough to the Mendota NWR, the James Irrigation District and Tranquillity Irrigation District. (Conveyance of water transfers through Fresno Slough is possible.)

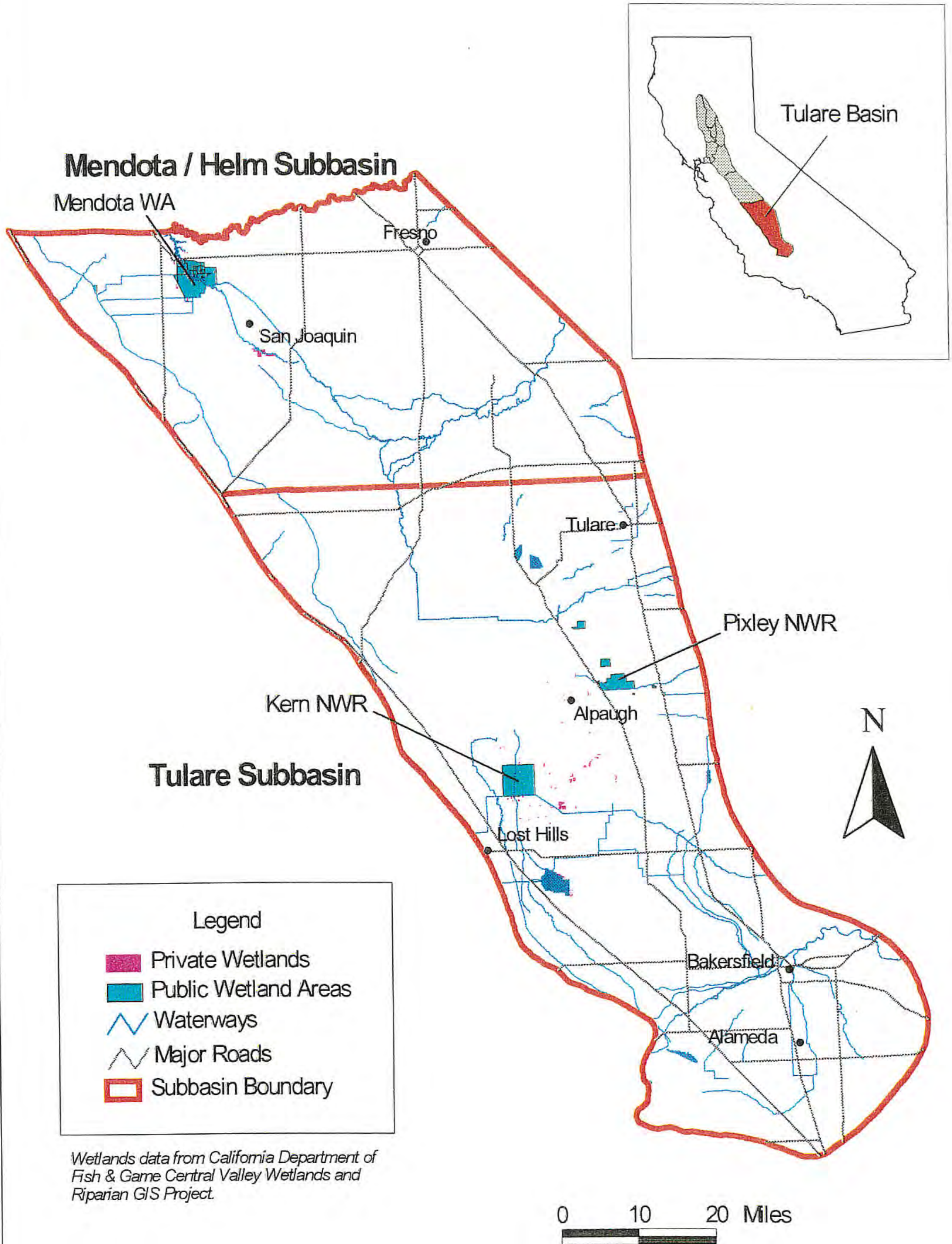
- Main Drain - conveyance of runoff from the Buena Vista WSD area north to Goose Lake and the Kern NWR. (It is of limited capacity and would probably not serve well in water transfers.)

- Main Delivery Canals - Semitropic WSD operates a pressurized distribution system for SWP water; Buena Vista WSD operates some earth-lined canals (East Side and West Side Canals).

- Small Systems - Stinson Canal and Irrigation Company, Stinson Water District (inactive); and Goose Lake Channel.

Figure 2-10. Tulare Basin Private Wetlands

Central Valley Wetlands Water Supply Investigations



Wetlands data from California Department of Fish & Game Central Valley Wetlands and Riparian GIS Project.

Table 2-44. Water Entities with Service Areas in Study Area, Tulare Basin
Central Valley Wetlands Water Supply Investigations

Tulare Basin Water Entities	Subbasin	
	Mendota/Helm	Tulare Lake
Alpaugh Irrigation District		X
Angiola Water District		X
Atwell Island Water District		X
Buena Vista Water Storage District		X
Buttonwillow Improvement District		X
Coelho Family Trust	X	
Delano-Earlimart Irrigation District		X
Earlimart Public Utilities District		X
Farmers Water District	X	
Fresno Slough Water District	X	
James Irrigation District	X	
Lower Tule River Irrigation District		X
Mid-Valley Water District	X	
Mid-Valley Water Authority SA	X	X
Pixley Irrigation District		X
Pond Poso Improvement District		X
Reclamation District 1606	X	
Semitropic Water Storage District		X
Shafter-Wasco Irrigation District		X
Tranquility Irrigation District	X	
Westlands Water District	X	

Existing Private Wetlands Location

The GIS analysis identified a total of 3,310 acres of apparent privately-managed wetlands in the Tulare Basin. All are inside the boundaries of water agencies. Occurrence of these wetlands in each of the two subbasins is shown in **Table 2-45**.

Table 2-45. Existing Private Wetlands Acreage, Tulare Basin
Central Valley Wetlands Water Supply Investigations

Tulare Basin	Apparent Privately-managed Wetlands					
		% of Tulare Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
Mendota/Helm	420	13%	420	100%	0	0%
Tulare Lake	2,890	87%	2,890	100%	0	0%
Tulare Basin Totals =	3,310		3,310	100%	0	0%

The Tulare Lake Subbasin has scattered private wetlands that are mostly along the southern and eastern edges of the historic Tulare Lake bed and in the Goose Lake region. Most of the wetlands are small isolated parcels, however a sizeable block (1,000 acres) of private wetlands exists along Poso Creek southeast of Kern NWR. Most of the private wetlands in the Mendota/Helm Subbasin are near Helm.

Wetlands Water Supply

Local surface and groundwater supplies are not adequate for current agricultural, urban, and environmental use in this basin. Surface water is imported from the Delta and stored in the Eastside reservoirs.

The Tulare Basin has nearly 3.1 million acres of irrigated land. Water supply by source is 60% surface water (45% of which is imported) and 40% groundwater. The groundwater supply component is not sustainable because the basin is in a condition of groundwater overdraft (i.e., groundwater production exceeds groundwater recharge). Agricultural return flow supplies some water to private wetlands. Factors which could affect water supply availability and reliability for private wetlands include water purchases and transfers, land retirement, and CVP water supply reductions due to CVPIA, Endangered Species Act (ESA), and CALFED programs.

The area's chronic water shortage forces water users to rely on groundwater to make up for surface water shortages. Consequently, groundwater overdraft is a serious problem in the basin. Overdraft lowers groundwater tables, causes ground subsidence and degrades groundwater quality over time.

Conjunctive use of surface water and groundwater supplies is a very important water management practice in the basin. Conjunctive use is one element of DWR's overall program to improve California's water supply reliability by encouraging existing surface water diverters to make greater use of groundwater resources during drought periods, thereby making undiverted surface water available for other users. Groundwater extractions are replaced during subsequent wetter periods, through natural recharge, direct artificial recharge, or in-lieu recharge (supply of additional surface water to permit reduction of normal groundwater pumping). An example of the application of this approach was the Drought Water Bank (DWB). In 1991, 1992, and 1994, the DWB executed several contracts to compensate Sacramento Valley agricultural districts for reducing their diversions of surface water. Increased groundwater extractions from existing wells of individual agricultural water users were used to replace most of the reduced surface water diversions.

The Tulare Basin currently has about 3,310 acres of private wetlands, and the water supply to most originates from agricultural return flow, winter stream flows, floodwater, and groundwater. Surface sources vary from year to year, and groundwater is expensive to pump. Agricultural return flow quality sometimes can be so poor it cannot be used for wetland habitat. These wetland water sources are adversely affected by drought, expanding implementation of on-farm water conservation measures, upstream reuse of agricultural return flow, groundwater recharge practices, and the general increased competition for water by all uses.

Water Supply for Wetlands in Tulare Lake Subbasin. The water supply to private wetlands in the Tulare Lake Subbasin is currently almost entirely groundwater. Very little surface water has been available to the private wetlands in the last 20 years. Groundwater is very expensive to pump in the region due to basin overdraft and resulting low water tables. Private wetland acreage declined for this reason from 4,000 acres in the mid-1970's to less than 2,000 acres in the early 1990's. Some surface water supplies are currently provided to certain wetlands to replace groundwater pumping, as part of a conjunctive use groundwater banking project involving the Semitropic Water Storage District and Metropolitan Water District of Southern California. This project provides a water supply only if it replaces groundwater pumping. Metropolitan provides water only for storage, and does not provide any water specifically for wetlands.

Water Supply for Wetlands in Mendota/Helm Subbasin. Private wetlands in the Mendota/Helm Subbasin receive extensive flows from local runoff during winter storms, and have a variety of water sources available, but lack a reliable water supply during portions of the year.

Wetlands Water Supply Reliability

The water supply reliability of the apparent existing privately-managed wetlands is Moderate for 50% of the lands. Areas with Low and Unknown Reliability comprise the remaining 50%. Supply reliability for apparent existing privately-managed wetlands in each of the two subbasins is shown in **Table 2-46**.

Table 2-46. Water Supply Reliability of Private Wetlands, Tulare Basin
Central Valley Wetlands Water Supply Investigations

Tulare Basin	**Apparent Privately-managed Wetlands**					
	Water Reliability, acres			Water Reliability, percent of acres		
Subbasin	Moderate	Low	Unknown	Moderate	Low	Unknown
Mendota/Helm	0	180	240	0%	43%	57%
Tulare Lake	1,640	0	1,250	57%	0%	43%
Tulare Basin Totals =	1,640	180	1,490	50%	5%	45%

Wetlands with Moderate Reliability Supplies. Wetlands with Moderate reliability water supplies are in the service area of agencies that are part of the Semitrophic Water Storage District.

Wetlands with Low Reliability Supplies. Wetlands with Low reliability water supplies are in service areas of water agencies with CVP contract supplies.

Wetlands with Unknown Reliability Supplies. Wetlands with Unknown reliability water supplies are outside the service areas of water supply agencies or are in the service areas of water agencies that do not have water supplies. These wetlands are believed to be supplied almost entirely by groundwater.

Existing Privately-managed Wetlands Water Demands and Supplies

Table 2-47 shows the current wetland water demands, sources of reliable supply, and current supply shortfall. Because agricultural return flow is considered unreliable for private wetlands, it is not included in the water supply mix.

Table 2-47. Estimated Water Demands and Supplies for Existing Private Wetlands, Tulare Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	2,979	232	99	3,310
Optimum Management Water Requirements, AF/acre/year	5.25	8.0	14.25	
Total Water Requirement, AF/year	15,640	1,854	1,415	18,908
Available Water Supply, AF/year				
Surface Water	1,241	163	107	1,511
Groundwater	13,940	1,638	1,266	16,844
Total Available Water, AF/year	15,181	1,802	1,373	18,355
Estimated Shortfall, AF/year	459	52	42	553
Low Reliability Surface Water Supply, AF/year				
	344	92	86	522
Total Available Reliable Water Supply, AF/year				
	14,837	1,710	1,287	17,833
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	803	144	128	1,076

Note: Total Available Reliable water supply consists of those supplies that are in the High and/or Moderate reliability classifications.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

Water needs for optimum management of private wetlands in the Tulare Basin are 18,908 AF/year (**Table 2-47**). The water supply currently available to the private wetlands is estimated to be 18,355 AF/year (i.e., there is currently an available supply shortfall of 553 AF/year). The available supply includes a low reliability surface water component of 522 AF/year. The combination of the available supply shortfall and low reliability surface water results in a shortfall of 1,076 AF/year in available reliable water supply. It is noted that the available water supply is estimated to be 92% groundwater.

The following options are available to improve water supply availability and reliability.

Surface Water

All water suppliers in the Tulare Basin lack adequate surface water supplies to serve their demands for agricultural irrigation, as well as private wetlands. The basin has year-round irrigation demand for water, and districts serve water all year, with only brief down time for maintenance. All of the apparent private wetlands identified in the Tulare Basin GIS analysis are within the boundaries of water agency service areas. However, the allocations of surface water are small. Wetlands may receive less than one AF/acre per year. Most districts are looking for additional supplies anywhere they can get them, and participate in water banking and transfers to increase their water supplies. All are willing to serve wetlands if supplies are available, but most districts give the first priority to agricultural use.

One option for gaining additional surface water would be purchases from willing sellers. However, in such a water-short area, the price would be high, and probably not affordable for private wetlands landowners. For this option, conveyance facilities or wheeling may be needed. Local water districts could wheel supplies if there were capacity available in their systems. Using SWP or CVP conveyance facilities would require negotiations with either DWR or USBR. DWR has estimated that water and wheeling costs could range from $50 to $200 per AF, depending on the negotiated water purchase price, location of the wetlands, and location and nature of the seller's water source. Another potential source would be to appropriate surplus winter Delta outflow (see discussion of Surplus Delta Outflow in Chapter 1).

Surface Water Supply Issues

Issues in sustaining and improving the availability and reliability of wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Rights and Contract Modification
- Conveyance Losses
- Potential High Cost
- Competition with Other Buyers

District Operations and Maintenance. Year-round conveyance is available in most cases, because Tulare Basin has a year-round demand for agricultural irrigation. Districts may shut down delivery systems for brief maintenance periods, but seldom shut systems down entirely. Some districts may stop agricultural deliveries to deliver or wheel water to refuges. One of those interviewed said water management was extremely important to extend supplies, and private wetlands could enhance availability by taking water at the same time the district is delivering to refuges, for system efficiency.

Water Right/Contract Modification. USBR, DWR, and other water rights holders (water districts) could restructure their water rights/contracts for wetlands water use in the fall and winter if their present water rights or contracts restrict use to March through October, as many do. (This is unlikely to be the case in this area of year-round irrigation demand.) Application to SWRCB could be made for appropriating surplus winter flows, if any are available in the Tulare Basin. This is unlikely because of the year-round demand.

Conveyance Losses. Water losses due to seepage in conveyance systems are similar in the winter to those occurring during the irrigation season (spring/summer). Estimated conveyance losses in the basin could range from 10 to 20% of water delivered. However, in this area of close water management, most districts are lining canals and taking any actions they can to reduce losses.

Conveyance Difficulties. Some conveyance facility modification and construction would be necessary to convey water to private wetland areas from the Kern River or SWP through the network of small canals and structures that serve these wetlands. Monitoring may be required to ensure delivery. Semitropic WSD delivery facilities do not cover the entire district, and could be extended to serve additional private wetlands. This would be too costly for private wetlands landowners, and the district would need funding or some incentive to offset this cost.

Groundwater

Existing groundwater supplies to privately-managed wetlands provide approximately 89% of the water needed for optimum management of the wetlands, and the existing available water supply to private wetlands is estimated to be 92% groundwater.

Groundwater Quality and Availability

Groundwater use is prevalent throughout the basin. Groundwater quality ranges from good to poor and groundwater overdraft is a serious problem. Most water supply districts operate wells and some also have agreements with landowners to use their wells when they are not using them. Districts practice conjunctive use, and during drought years have had to rely entirely on groundwater.

Potential Limitations on Groundwater Use for Wetlands

The use of groundwater for private wetlands is potentially limited for reasons that include:

- Well Development Costs - Small and relatively low-yielding wells, approximately 100 to 200 feet deep, could cost between $30,000 to $50,000 each. Wells about 500 to 800 feet deep could cost between $100,000 to $125,000 each. These costs include pumps and development costs. Sustained yield would be uncertain because of conditions of overdraft in the basin. One of the interviewed water agencies noted that, in Kern County, a fully equipped 800 foot deep well could cost on the order of $200,000 because of a recent requirement that all well drilling personnel be paid prevailing wages under Teamster rates.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $35 to $75 per AF in the north basin and $75 to $120 per AF in the south basin. With low economic returns, costs for well construction and pumping present a serious issue for private wetland owners.

- Water Quality Limitations - Groundwater quality ranges from good to poor. Future quality is likely to be affected by the overdraft problem. There are localized problems with groundwater quality, with very high salt content in some areas. In some parts of the basin, groundwater quality may be acceptable from a total dissolved solids perspective, but it may be unusable for wetlands because of elevated arsenic, selenium, or salinity levels.

- Groundwater Development and Management - Groundwater extraction and distribution could be affected by current and future local management plans to control overdraft. The Semitropic WSD has a special rate for private wetlands water that is 27% of the agricultural rate set up to discourage pumping in the interest of groundwater protection. (The rate is also proportional to use--in this basin wetlands pump less water than agricultural uses.)

- Conveyance Systems - There is a general lack of conveyance systems adjacent to current well development to serve private wetlands. Groundwater deliveries are only to adjacent fields. This restricts the use of groundwater as a supply to more distant private wetlands.

Agricultural Return Flow

The existing wetlands in the Tulare Basin are in a heavy water reuse area, where water applied and not used consumptively becomes available for reuse either through groundwater recharge or surface water runoff, except during drought. This source is usually inexpensive, but has not been consistently available or of usable quality. Issues relating to return flow include:

- Areas Outside of Districts - These areas do not have surface water supplies; therefore, they are dependent on groundwater or agricultural return flow.

- Availability of Conserved Water to Wetlands - Water conservation efforts, such as improved on-farm or district water application or delivery efficiencies, could result in either benefits or detriments to private wetlands, depending on their nature. They could increase surface water remaining in the source, making more available for private wetlands; or, they could result in a decrease in the volume and quality of agricultural return flows available to private wetlands.

- Funding of Water Conservation Measures - The necessary infrastructure and irrigation system improvements needed to efficiently conserve water can be very costly. Some agricultural water districts in the Tulare Basin have turned to urban water districts outside of the basin to fund these conservation measures. In return, the urban water districts purchase the conserved water. Therefore, conserved water will be transferred to urban areas, reducing return flows currently used by private wetlands.

TULARE BASIN FINDINGS

These investigations found that the Tulare Basin private wetlands:

1. Need significant improvement in the reliability and quality of their current water supplies; and

2. Need an estimated additional reliable water supply of 1,076 AF/year to bring all of the existing private wetlands to full supply and optimum management levels.

Status of Current Water Supplies

The reliability of all current private wetlands water supplies is uncertain in the Tulare Basin because of basin-wide water shortages for all uses. This uncertainty applies to all sources (surface water, groundwater, and agricultural return flow) because all are threatened with reduction from various causes.

There is always some uncertainty of surface water supplies because of Central Valley cycles of floods and drought. However, even in normal years, CVP contractors in the Tulare Basin are expecting to receive less than their full allocations because of added demands on the supply from CVPIA, ESA, and Delta Flow Standards. Groundwater supplies are declining because of overdraft. Agricultural return flows may be reduced by water conservation and recharge programs.

To improve the reliability and quality of water supplies currently available to Tulare Basin private wetlands, additional water supplies are needed, as well as other means to extend the current water supplies.

Securing Additional Supplies

Water could be purchased from suppliers within the basin or outside the basin. In either case, the water would be expensive, and conveyance facilities or wheeling costs may also be involved.

Conveyance was a significant limiting factor in the past, but significant conveyance improvements have occurred in the 1990s. The CDFG, the Wildlife Conservation Board, and the California Waterfowl Association have been active in linking private wetlands together with common conveyance facilities, particularly along Poso Creek in the Kern-Wasco area. In some areas, conveyance facilities may be needed. Depending on location, wheeling possibilities would be local water service providers, SWP, or CVP.

Issues Affecting Water Availability and Reliability

Based on interviews with water suppliers to private wetlands in Tulare Basin, there are some opportunities to work with the suppliers to gain additional water. However, the general shortage of water in the basin makes it difficult to secure supplies adequate for wetlands. A conjunctive use groundwater banking project involving the Semitropic Water Storage District and Metropolitan Water District provides some surface water supplies to replace groundwater pumping. Some private wetlands within the district receive water priced at 27% of the agricultural rate in this program, designed to protect groundwater resources from over-pumping. However, if there are shortages, lands with a surface water service contract have first priority and wetlands needs may not be met. It may be possible for wetlands managers to purchase additional water from Semitropic WSD, but it would be costly because of prices others are willing to pay for water in this basin.

Semitropic WSD believes that water supplies for private wetlands could be improved by groundwater storage (banking) within the District. Private wetland owners could take advantage of the District's ability to firm up supplies through groundwater banking to better manage water to improve reliability. Some private or public wetlands may have intermittent supplies they do not fully use when available. They could make this water available to the District in exchange for getting delivery when needed. Private wetlands owners could take other cooperative measures to extend surface water supplies, such as taking water at the same time public refuges are taking water, for system efficiency. Similar cooperative measures may be possible with other suppliers to private wetlands in this basin.

Water supply availability and reliability improvement options and issues for Tulare Basin privately-managed wetlands are summarized in **Table 2-48**. Reliability may also be gained by improving management of current sources.

Current Developments in the Tulare Basin

Federal and State agencies have identified the Tulare wetlands as the most threatened in the State. Most private wetlands occur in the extreme northern section of the basin and on the southern edge of the historic Tulare Lake bed and in the Goose Lake area. These areas contain seasonal wetlands, semi-permanent wetlands, alkali sinks, and associated uplands that are characterized by shallow open-water ponds featuring alkaline soils, swamp timothy, and in many cases, greasewood or iodine bush. The shallow wetlands provide ideal foraging opportunities for shorebirds such as dowitchers, dunlin, yellowlegs, phalaropes, and sandpipers, as well as wading birds such as white-faced ibis.

Private wetland acreage has declined dramatically in the basin since the mid-1980s, mostly due to land conversion and water supply limitations. Natural streams flow-ins are not adequate for irrigation water demand; therefore, groundwater is pumped to augment water supply, and can be very costly.

Table 2-48. Water Supply Availability and Reliability Improvement Options and Issues, Existing Privately-managed Wetlands in Tulare Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Conversion of agricultural lands Purchases and transfers Purchase of additional land with water Appropriation of surplus Delta outflow	• District Operations and Maintenance • Water Right/contract Modification • Conveyance Losses • Conveyance Difficulties • Potential for High Cost • Competition with Other Buyers
Groundwater	Use existing wells New wells	• Water Costs • Well Development Costs • Water Quality Limitations • Groundwater Development and Management
Agricultural Return Flow	Continue current practices Additional conservation opportunities	• Areas Outside of Water Districts • Availability of Conserved Water to Wetlands

As stated in the 1990 CVHJV Implementation plan, there are no objectives for supplemental wetland restoration in this basin. However, in response to the decline of private wetlands since the signing of the Plan, the CVHJV Board agreed in 1994 to modify its protection and restoration objectives to reflect the current situation. The objectives now read, "to protect 2,000 acres (formerly 5,000 acres) of existing wetlands and to restore and protect 3,000 acres (formerly zero acres)". The CVHJV is currently in the process of updating its Implementation Plan and it is anticipated that during this process, the Tulare Basin restoration objective will be reevaluated.

Since the passage of CVPIA, firm water supplies have become available for public wetlands in the basin, allowing for additional restoration opportunities on NWRs and State Wildlife Areas. Private wetland land owners in the southern portion of the basin have also expressed interest in developing additional semi-permanent and permanent wetlands and are actively supporting efforts of the California Wildlife Conservation Board and other Joint Venture Partners to increase water delivery infrastructure to duck clubs east of Kern NWR. Restoration efforts led by Ducks Unlimited are underway in the Goose Lake area, where water supply quantity and quality are favorable. In addition, the USDA Wetland Reserve Program (WRP) alone has restored and protected a mosaic of over 6,000 acres of wetland/upland habitat in the basin since 1992. [Although landowners currently have adequate water supplies for habitat management, the WRP does not require the addition of applied water to sustain wetland habitat; consequently, in dry years these wetlands may be dry.] Other landowners have expressed interest in options for wetlands conservation in the Tulare Basin.

Chapter 3. Supplemental Wetlands Investigations

This chapter provides information on potential areas for wetlands restoration and potential water demands and water supplies for wetland restoration to meet the Central Valley Habitat Joint Venture (CVHJV) objective to restore and protect 120,000 acres of supplemental wetlands in the Central Valley. Discussion includes the approach, methodology, and results of investigations conducted to address the directive of the Central Valley Project Improvement Act (CVPIA) , Section 3406(d)(6)(B) to investigate and report on:

> ***"(B) Water supply and delivery requirements necessary to permit full habitat development for water dependent wildlife on 120,000 acres supplemental to the existing wetland habitat acreage identified in Table 8 of the Central Valley Habitat Joint Venture's "Implementation Plan" dated April 19, 1990, as well as feasible means of meeting associated water supply requirements."***

The nine Central Valley Basins addressed by the CVHJV Implementation Plan are identified and generally described in Chapter 1 (**Figures 1-3 and 1-4** and **Table 1-2**). Key points of the presentation in this chapter for each Basin are as follows:

1. Basin Map - Each basin presentation begins with a map showing basin boundaries, water bodies, major roads, and other information as follows:
   - Boundaries of Nucleus Areas (the Nucleus Area investigation concept is discussed in detail in the "Study Approach and Methodology" section of this introduction).
   - Locations of Existing Private and Public Wetlands.
   - Boundaries of any Subbasins Used in the Investigations.
   - Land Areas Suitable for Wetlands Restoration.

2. Statistical Summary - The text of each basin presentation begins with a statistical summary of:
   - CVHJV Wetlands Restoration Objective, acres.
   - Wetland Acres Protected and Restored.
   - Remaining Wetland Acreage to Meet the Restoration Objective.
   - Total Basin Land Area, acres.
   - Total Existing Wetlands (Private and Public), acres.

3. Basin Description - Each Basin is described in terms of geography, including location and boundaries.

4. Basin Hydrology - Historic and current basin drainage features are identified, including modifications (levees and flood control features, etc.) that have been made to "reclaim and protect" lands for agricultural and urban land uses.

5. Nucleus Areas and Existing Wetlands - Nucleus Areas and existing private and public wetlands are shown in tabular form, with a breakdown by subbasin in basins where subbasins were used in the investigations.

6. Lands Suitable for Wetlands Restoration - Lands suitable for wetlands restoration are identified and discussed with regard to the following:
   - Basin water entities shown by the GIS analysis to have 500 or more acres of suitable lands in their service areas.
   - Water Supply Conveyance Facilities and Water Agencies.
   - Suitable Lands Location - Includes identification of acres inside and outside water agency boundaries and shows suitable lands by subbasin.
   - Suitable Lands Water Supply - Includes: 1) an overview of water supply sources to the suitable lands, 2) water supply reliability, and 3) the water demands and supplies of the supplemental wetlands needed to accomplish the remaining restoration objective.

7. Water Supply Availability and Reliability Improvement Options - Options for improvement of the availability and reliability of water supplies for supplemental wetlands restoration are presented for potential surface water, groundwater, and agricultural return flow supplies. Surface water supply discussions include issues to be confronted in obtaining and conveying suitable supplies to the restoration sites. Discussion of groundwater supplies includes well development and pumping cost and the potential effects of current and potential future basin groundwater management plans. Discussion of agricultural return flow supplies includes issues that now affect or may in the future affect return flow availability and water quality.

8. Findings - Each Basin discussion concludes with a summary of findings of the investigations.

INVESTIGATION BACKGROUND

This discussion of background for the Supplemental Wetlands Investigations includes the following topics that directly or indirectly influenced the approach and scope of the work:

- Waterfowl Population Objective - North American Waterfowl Management Plan (NAWMP).
- CVHJV Implementation Plan Restoration Objectives and Priorities.
- Existing Restored and Protected Wetlands.
- Importance of Wetlands and Associated Upland Habitat.
- Water, Land Use, and Socioeconomic Issues.
- Partnerships for Wetland Restoration, Enhancement, and Protection.

Waterfowl Population Objective - North American Waterfowl Management Plan

The waterfowl population objective of the May 1986 NAWMP is to double the number of birds wintering in the United States. Evidence from the high populations in the mid-1970s and from bioenergetics calculations suggests that existing habitat will not be able to adequately support an expanded population of this magnitude. With higher population levels, crowding will increase disease risks and lead to overuse of foods and other resources by waterfowl in intensively managed wetlands.

CVHJV Implementation Plan Wetlands Restoration Objectives and Priorities

Table 8 of the CVHJV "Implementation Plan" referenced in CVPIA Section 3406(d)(6)(B) identifies wetland restoration objectives by basin for seven of the nine Central Valley basins, and includes a prioritization of restoration by basin that reflects comparison of the total wetlands area needed to the wetlands area that existed when the "Implementation Plan" was adopted.

The CVHJV Implementation Plan (page 56) includes the following statement of objective:

> ***"Increase wetland area by 120,000 acres and protect these wetlands in perpetuity by acquisition of fee-title or conservation easements. Because of the elaborate water delivery system in the Central Valley, this wetland creation could conceivably occur on lands that were not formerly wetlands; however, most restoration is anticipated on sites that were historically wetlands. This objective is derived from the biological needs of waterfowl and is based on realistic expectations of the potential for restoration. The objective is broken down by basin in Table 8 and priorities established by a habitat deficit index, a measure of relative need."***

"Biological needs of waterfowl" (i.e., wintering and resident waterfowl habitat needs) were identified in the CVHJV Plan by biologists of USFWS, CDFG, DU, and the California Waterfowl Association (CWA). The habitat deficit index used to establish the priorities was calculated by dividing the total wetlands needed by the current wetland acreage in each basin, resulting in an index of relative need. Restoration may be accomplished on either public or private land.

Table 3-1 shows: 1) the CVHJV restoration acreage objectives and priorities for each of the nine Central Valley basins, 2) the extent to which objectives were accomplished between May 1986 and November 1996, and 3) the wetlands acreage remaining to be restored to accomplish the objectives.

Table 3-1. CVHJV Implementation Plan Objectives/Accomplishments to Restore 120,000 Acres of Former Wetlands

Central Valley Wetlands Water Supply Investigations

Basin[1]	Priority	Restoration Objective, acres	Restoration Accomplished as of November 1996[2], acres	Remaining to Meet Objective, acres
Sacramento Valley and Delta Basins				
Sutter	1	11,000	580	10,420
American	2	10,000	173	9,827
Delta	3	20,000	2,646	17,354
Butte	4	34,000	9,714	24,286
Yolo	5	10,000	4,066	5,934
Colusa	6	15,000	3,195	11,805
Suisun	--	0	5	0
San Joaquin Valley Basins				
San Joaquin	7	20,000	8,822	11,178
Tulare	--	0	3,518	0
Total		120,000	32,719	90,804

[1] Basins are described in Chapter 1 (Figures 1-3 and 1-4 and Table 1-2).

[2] Accomplishments as of November 1996, when the water supply investigations were begun.

Existing Restored and Protected Wetlands

As shown in **Table 3-1**, the CVHJV Plan objectives have been partially (~27%) accomplished. Accomplishments in voluntary restorations as of November 1996 totaled 32,719 acres. The accomplishments included 3,518 acres in Tulare Basin and 5 acres in Suisun Basin for which the 1990 "Implementation Plan" did not set objectives. Existing restored and protected Central Valley wetlands consist of the following:

- Existing purchased lands which receive water under the CVPIA.
- Other public land not receiving water under the CVPIA.
- Private wetlands.

For this investigation, restored wetland acreage to date is assumed to be about 32,700. This is the acreage that was reported as restored by November 1996, when water supply investigations for supplemental wetlands were begun. The restored acreage includes public and privately managed wetlands restored and protected since the May 1996 NAWMP. Additional acres have been restored since November 1996 (restored total is now about 43,000 acres).

Wetlands Restoration Habitat Type Distribution Objectives

CVHJV objectives for wetlands restoration are in three habitat types with differing water requirements. These habitat types and water requirements are described in detail in Chapter 1. The habitat types (Seasonal, Semi-permanent and Permanent) are the main habitats now occurring on private lands. Current amounts of each habitat type vary according to landowner preferences, water availability, or the presence of wetland incentive programs supporting target acreage of particular wetland habitat types. Some landowners manage only seasonal wetlands to minimize flooding costs, or because of water supply quantity or delivery system limitations that prevent habitat diversification.

Importance of Wetlands and Associated Upland Habitat

Chapter 1 discusses, in detail, the importance of Central Valley wetlands and associated upland habitats in international waterfowl conservation and in the preservation of sensitive and endangered bird, mammal, fish, reptile, crustacean and insect species.

Water, Land Use, and Socioeconomic Issues

Complicated water, land use, and socioeconomic issues apply to most potential wetland sites. Additional investigations will likely be needed to evaluate wetland restoration opportunities and water supply on a site-specific basis. Issues to be addressed in such site-specific investigations will include:

1. Economic and property rights impacts of land use conversions to wetlands. Although all land conversions to wetlands will be voluntary, site-specific potential may exist for economic and property rights impacts on other properties in the area. Interviews of local water agencies in these investigations disclosed economic impact concerns that ranged from increased costs for water distribution system operation to supply wetlands during the agricultural non-irrigation season to local community economic impacts (loss of agribusiness-related jobs, equipment sales and service, etc.) in situations where major tracts of agricultural land are removed from agricultural production.

2. Competing water supply needs and demands for:
   - protection and enhancement of fisheries,
   - preservation of a healthy agricultural economy,
   - municipal and industrial (urban) water uses, and
   - protection of water quality for all beneficial uses.

3. Conformance by wetland water diversions to regulations and standards that:
   - protect anadromous fisheries,
   - govern and protect agricultural and urban water rights, and
   - protect water quality for all beneficial uses.

Because of the complex water, land use, and socioeconomic issues involved with most potential wetland restoration sites on other than Federal or State lands, the investigations conducted for this report identified land for potential wetland restoration at generally three times CVHJV Plan objectives for each basin. This will provide additional flexibility in selecting specific lands for restoration programs, including considerations for acquiring lands from willing sellers. Future site-specific investigations will explore each opportunity to determine the feasibility or practicality of restoring wetlands from an existing land use. The identification of potential restoration sites and associated water need and supply in this report provides the foundation for the site-specific investigations.

Partnerships for Wetland Restoration, Enhancement, and Protection

Wetland restoration, enhancement, and protection programs and activities are conducted by Federal, State, and local agencies; private and nonprofit organizations; corporations; and the public. The CVHJV is a consortium of these entities (see listing of the CVHJV Private and Public Partners in Chapter 1).

The U.S. Natural Resource Conservation Service's Wetland Reserve Program, the California Wildlife Conservation Board's Inland Wetlands Conservation Program, and the DU Marsh Program exemplify wetland restoration efforts where partnerships are an integral part of the program. Federal and State legislative directives such as the CVPIA and California Wetlands Conservation Policy (August 1993) mandate investigations for wetlands restoration, protection, and water supplies in an effort to stop wetland loss in the Central Valley and Delta.

STUDY APPROACH AND METHODOLOGY

General information about the scope of work, overall study approach and methodology can be found in Chapter 1. This discussion is specific to the Supplemental Wetlands Investigations. As explained in Chapter 1, the CVHJV Implementation Plan divides the Central Valley into nine basins based on hydrology and drainage. The same nine basins were used in this investigation. The investigations were conducted by basin, and the results are presented by basin in this chapter.

Identification of Suitable Land Areas and Potential Water Sources

Suitable Lands were identified from satellite imagery in combination with information on soils and existing land use. The Suitable Lands identification process excluded existing private wetlands, publically-managed Wetlands, and unmanaged (i.e., natural) wetlands. The process also excluded areas with existing land uses that are not compatible with, or otherwise unsuitable for wetlands.

Suitable Land areas were quantified as to acreage and plotted on basin maps. Potential water supply sources were identified by comparing water entity boundaries to the Suitable Lands maps.

Nucleus Areas

The geographic area of the Suitable Lands investigation was narrowed by focusing on "Nucleus Areas" in each of the basins. The Nucleus Area concept has the following values:

- Nucleus Areas are areas near existing managed wetlands and, therefore, are the most likely areas for wetland restoration that will be of greatest value to wildlife.
- Nucleus Area lands are the most desirable based on current waterfowl use, proximity to existing wetlands, existing land use, known reliable water supply availability.
- In some instances, lands in Nucleus Areas are the most desirable based on their potential role in recovery efforts for special status species.

The focus of the investigation on lands within Nucleus Areas does not mean that areas outside Nucleus Areas that have all the desirable characteristics for wetland restoration should be precluded from consideration. It simply means that those areas are not evaluated in the analysis.

Land Suitability Analysis

Figure 3-1 illustrates how GIS was used in the following steps of the Wetlands Restoration land suitability analysis:

1. Identifying areas within the Nucleus Areas that meet criteria of:
   - Suitable Land Use,
   - Suitable Soils, and
   - Not an Existing Wetland.

2. Preparing three separate map layers showing "Suitable" and "Not Suitable" Land Use, "Suitable" and "Not Suitable" Soils, and "Existing Wetlands".

3. Overlaying the three map layers to provide a composite map showing conformance to the land use, soils, and existing wetlands criteria.

4. Using the composite map to categorize the various parts of the Nucleus Area lands as:
   - Not Suitable for Wetlands Restoration
   - Suitable for Wetlands Restoration
   - Private Wetlands
   - Public Wetlands

Analyses for Criteria Conformance

Land use data, soils data, and data on existing wetlands were evaluated to rate and rank Nucleus Area lands with respect to the selection criteria.

Suitable Land Use. Land Use data were used to identify areas with land uses suitable for wetlands restoration. Suitable and unsuitable land uses are shown in **Table 3-2**. Suitable land uses are as follows:

- Lands employed in agricultural uses that require ample and reliable water supplies
- Idle crop lands
- Barren and waste lands
- Lands with water surfaces (ponds, streams, etc.)
- Lands with selected types of native vegetation

Unsuitable Land Use. Lands eliminated from consideration due to unsuitable land use are as follows:

- Urban lands and farmsteads
- Livestock feedlots, dairies, poultry farms, and vineyards
- Lands used in producing citrus and subtropical crops or deciduous fruits and nuts
- Lands with selected types of riparian (i.e., water associated) vegetation, including existing natural or managed wetlands and meadows

Suitable Soils. Soils data from the U.S. Natural Resources Conservation Service was used to rank soils based on their suitability for wetland restoration. Rankings are based on soil capability to support the diversity of vegetation essential to healthy wetlands. Factors accounted for in the rankings include depth to water, soil depth, water retention capability, drainage capability, permeability, texture, root zone depth, and alkalinity.

Using this methodology, over 900,000 acres of land suitable for wetland restoration were identified in the Central Valley. **Table 3-3** shows acreage of Suitable Land inside and outside of water entity (District) boundaries. Land acreage identified as suitable for wetland habitat in each of the Central Valley basins far exceeds the acreage necessary to meet the Implementation Plan objectives. The presentation of investigations results in this report for the individual Central Valley Basins generally identifies lands suitable for wetland habitat, but does not recommend specific lands for restoration.

Figure 3-1. Wetlands Restoration Land Suitability Analysis
Central Valley Wetlands Water Supply Investigations

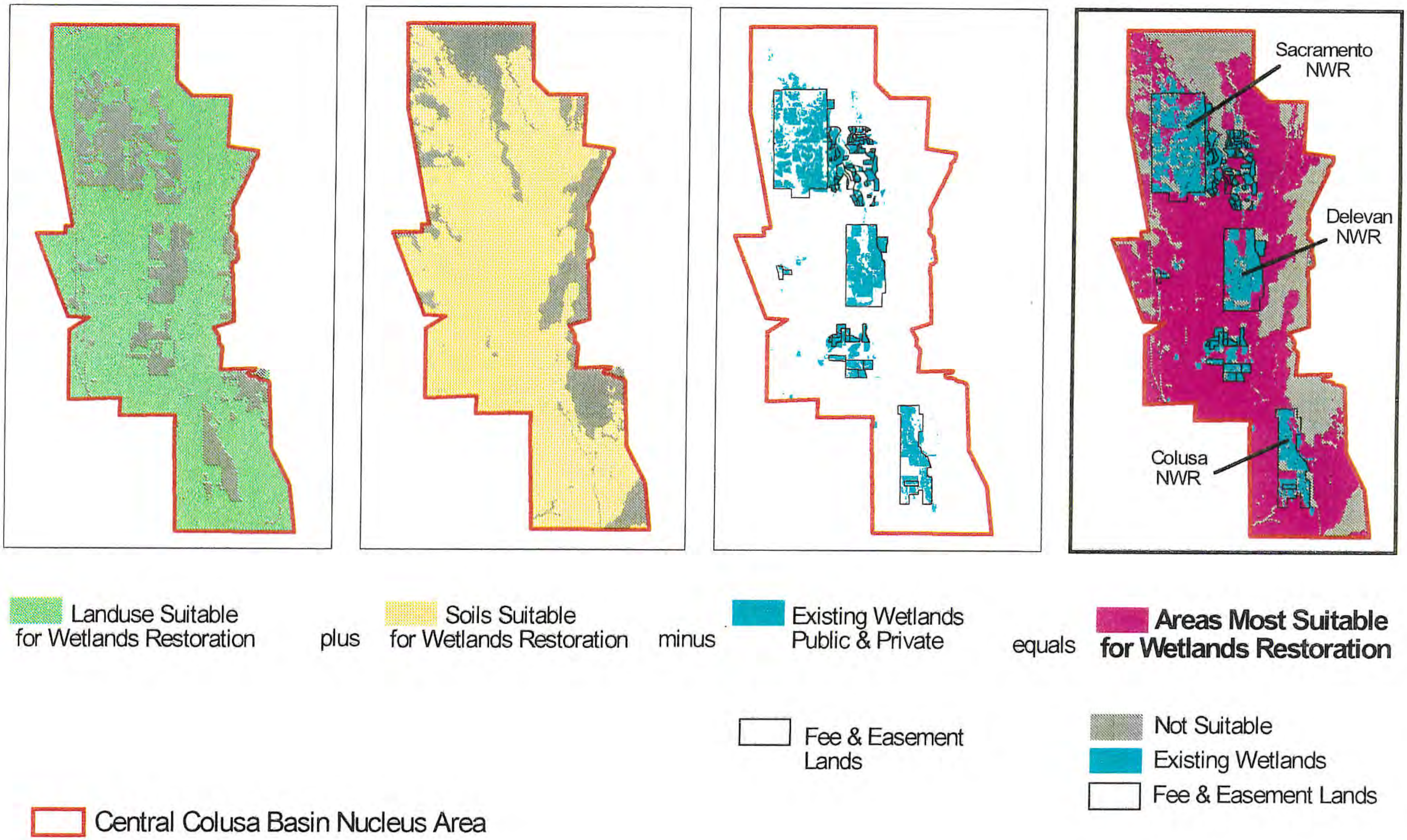


Table 3-2. Land Use Suitability for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations

Suitable Land Use	Not Suitable Land Use
Grain, Hay, or Field Crop Production	Urban Land
Truck, Nursery, or Berry Crop Production	Farmstead
Rice Crop Production	Livestock Feed Lot
Pasture Land (livestock grazing)	Dairy
Idle Crop Land	Poultry Farm
Barren and Waste Land	Vineyard
Water Surface (ponds, streams, etc.)	Citrus and Subtropical Crop Production
Unsegregated Native Vegetation	Deciduous Fruits and Nuts Production
Land with the following Native Vegetation: • Grass Land • Oak Grass Land • Light, Medium, or Heavy Brush • Brush and Timber • Forest	Land with the following Riparian Vegetation: • Marsh Lands, Tules, and Sedges • Natural High Water Table Meadow • Trees, Shrubs, or other larger stream side or water-source vegetation • Seasonal Duck Marsh (dry or only partially wet in summer) • Permanent Duck Marsh (flooded in summer)

Table 3-3. Wetlands Restoration Suitable Lands Analysis – Central Valley Basins
Central Valley Wetlands Water Supply Investigations

		Suitable Lands in Nucleus Areas					Wetlands Restoration Objective Remainder	
		Inside Districts		Outside Districts				
Basin	**Basin Nucleus Areas, acres**	Suitable Land Area, acres	Percent of Basin Total	Suitable Land Area, acres	Percent of Basin Total	**Suitable Land Total, acres**	Remaining acres	Percent of Suitable Lands
Colusa	236,000	153,960	96%	6,510	4%	160,470	11,805	7%
Butte	237,000	91,810	86%	15,130	14%	106,940	24,286	23%
Sutter	60,000	40,220	93%	3,080	7%	43,300	10,420	24%
Yolo	160,000	101,200	84%	19,320	16%	120,520	5,934	5%
American	156,000	14,030	73%	5,120	27%	19,150	9,827	51%
Delta	250,000	182,100	87%	28,000	13%	210,100	17,354	8%
Suisun Marsh	NA	NA	NA	NA	NA	NA	0	NA
San Joaquin	391,000	89,150	37%	154,110	63%	243,260	11,178	5%
Tulare	NA	NA	NA	NA	NA	NA	0	NA
Central Valley Totals =	1,490,000	672,420	74%	231,270	26%	903,740	90,804	10%

Identification of Potential Sources of Supplemental Wetlands Water Supply

Potential sources of water supply to supplemental wetlands include supplies derived from direct diversion of surface water, supplies derived from groundwater, and supplies provided by water entities. Potential water sources were identified for Suitable Lands inside and outside of water entities (Inside Districts and Outside Districts) as follows:

- The presence of Suitable Land within the boundaries of a water supply entity is an indication that the entity may be a potential supplemental wetlands water supplier (i.e., the entity is likely a supplier for existing water uses on the Suitable Land).
- Suitable Lands lying outside of entity boundaries are considered to be self-supplied by groundwater or (depending on proximity to rivers, streams, drainage channels, or sloughs) by direct diversion of surface water.

Where the Suitable Land is outside of, but close to, an entity boundary, that entity is considered to be a Potential Water Supplier. The presentation of investigations results in this report for the individual Central Valley Basins generally identifies potential sources of water supply for supplemental wetlands, but does not recommend specific sources.

Water Supply Needs for Optimum Management of Supplemental Wetlands

Table 3-4 presents Supplemental wetlands land areas and water needs by basin for the seven Central Valley Basins where wetlands restoration objectives have not yet been accomplished. The table shows:

- supplemental wetlands restoration land areas by Seasonal (S), Semi-permanent (SP), and Permanent (P) habitat types,
- optimum management annual water needs by habitat type,
- existing total reliable water supplies, and
- additional reliable water supply needed.

The basin-by-basin discussion in this chapter addresses the options evaluated to meet or improve water supply and reliability.

Table 3-4. Supplemental Wetlands Land Areas and Water Needs by Basin
Central Valley Wetlands Water Supply Investigations

Basins	Supplemental Wetlands Habitat Type S	Supplemental Wetlands Habitat Type SP	Supplemental Wetlands Habitat Type P	Total acres	Total Water Need for Optimum Habitat	Existing Total Reliable Water Supply	Additional Reliable Water Supply Needed
Colusa:							
Area, acres	10,034	1,181	590	11,805			
Water Need, AF/yr	50,170	8,739	7,818		66,727	51,662	15,065
Butte:							
Area, acres	20,646	2,429	1,215	24,290			
Water Need, AF/yr	115,618	17,975	16,099		149,692	99,415	50,277
Sutter:							
Area, acres	8,857	1,042	521	10,420			
Water Need, AF/yr	44,285	7,711	6,903		58,899	0	58,899
Yolo:							
Area, acres	5,044	593	297	5,934			
Water Need, AF/yr	25,220	4,388	3,935		33,543	28,819	4,724
American:							
Area, acres	8,355	983	492	9,830			
Water Need, AF/yr	41,775	7,274	6,519		55,568	40,223	15,345
Delta:							
Area, acres	14,751	1,735	868	17,354			
Water Need, AF/yr	70,067	12,842	11,497		94,406	72,795	21,611
San Joaquin:							
Area, acres	10,062	783	335	11,180			
Water Need, AF/yr	52,826	5,794	4,439		63,059	49,973	13,086
Central Valley Totals:							
Area, acres	77,749	8,746	4,318	90,813			
Water Need, AF/yr	399,961	64,723	57,210		521,894	342,887	179,007

WATER SUPPLY ANALYSIS METHODOLOGY FOR SUPPLEMENTAL WETLANDS

Lands restored to meet the 120,000-acre CVHJV Implementation Plan objective for supplemental wetlands will likely include the water supplies associated with the property. Sources of these supplies will include deliveries received from water local supply agencies (irrigation districts, mutual water companies, water districts, reclamation districts, etc.) as well as surface water supplies derived from appropriative and riparian water rights of landowners. In some instances, the supplies to restored lands are expected to include groundwater.

Differences in the timing of agricultural and wetlands water use are likely to necessitate modification of existing water rights permits and water supply contracts to provide water during the fall and winter months, outside the typical April though October agricultural irrigation season. The analysis of wetlands water supply availability identifies needs for these changes.

Estimated Water Supply Needs

Estimated water supply needs for supplemental wetlands restoration are based on the following:

- Remaining Acreage to Meet Objectives - This is the CVHJV objective minus the wetland acreage restored by November 1996.

- Distribution of Remaining Wetland Acreage by Habitat Type - The distribution of the remaining acreage to habitat types (i.e., Seasonal, Semi-permanent, and Permanent) is based on the CVHJV wetland enhancement objectives and CDFG's management approach for private wetlands that are enrolled in the California Waterfowl Habitat Program. These habitat types are described in Chapter 1, together with the needed percentages of wetlands land in each of the habitat types in each of the basins.

- Estimated Annual Water Supply Requirements - CDFG and USFWS compiled water use data for each habitat type from refuges and wildlife areas that are operating at optimum habitat management capacity. By using this data from Nucleus Area refuges, representative water requirements for each habitat type within a basin are determined. Wetlands watering requirements by habitat type are described in Chapter 1. Annual water needed for optimum wetland management is determined by multiplying the acreage of each wetland habitat type by its associated water requirement.

Estimated Available Water Supply

Estimated available water supply for supplemental wetlands restoration is based on the following:

- Geographical Distribution of Supplemental Wetlands - The geographical distribution of existing privately-managed wetlands within each of the basins was used to estimate the geographical distribution of the supplemental wetlands. This approach is based on the expectation that additional wetland development will tend to occur in areas where landowners have already willingly developed wetlands. This approach recognizes that measures taken to ensure the availability and reliability of optimum management water supplies for existing privately-managed wetlands could be efficiently coordinated with those required to meet the needs of restored supplemental wetlands.

- Available Water Supply - Estimation of available water supply for supplemental wetlands is based on the availability of water supplies to existing privately-managed wetlands (i.e., supply availability assumes that the geographical distribution of supplemental wetlands mimics the geographical distribution of existing private wetlands). The available water supply analyses includes estimates of available surface water and groundwater supplies.

Estimated Shortfall in Available Water Supply

The Estimated Shortfall in Available Water Supply is the difference in the water supply need for optimum management of the supplemental wetlands and the available water supply. This shortfall typically reflects unavailability of surface water supplies during fall and winter months due to reasons that include: 1) supply contract and/or water rights restrictions that do not allow winter water use and 2) fall and winter shutdown of local water supply agency water supply conveyance systems that predominantly serve agriculture.

Estimated Reliability of Available Water Supply

The surface water supply reliability for supplemental wetlands is based on the reliability of surface water supplies to existing privately-managed wetlands (i.e., supply reliability assumes that the geographical distribution of supplemental wetlands mimics the geographical distribution of existing private wetlands). The surface water supply reliability classifications of High, Moderate, Low, and Unknown reliability are discussed in Chapter 1. Available surface water supplies in the Low and Unknown reliability classifications are used to identify the low and/or unknown reliability components of the available water supply.

Estimated Shortfall in Available Reliable Water Supply

The Estimated Shortfall in Available Reliable Water Supply is the sum of the shortfall in available supply and the low and/or unknown reliability components of the available water supply.

INDIVIDUAL BASIN INVESTIGATIONS

The rest of this chapter presents the results of the Supplemental Wetlands Investigations for each of the nine basins. Each basin discussion includes a brief description of the basin, basin hydrology, water supply, water supply reliability and options, and findings specific to the basin.

Colusa Basin

CVHJV Wetlands Restoration Objective, acres	**15,000**
Wetland Acres Protected & Restored	**3,195**
Remaining Wetland Acreage to Meet Objective	**11,805**
Total Basin Land Area, acres	**1,145,600**
Total Existing Wetlands (Private and Public), acres	**23,000**

BASIN DESCRIPTION

Located in northwestern Sacramento Valley, the Colusa Basin extends 106 miles from Red Bluff in the north to (but not including) Cache Creek in the south. Covering about 1,790 square miles, it is bordered by the Sacramento River on the east and the Coast Range foothills on the west (**Figure 3-2**). In the lower two-thirds of the basin, numerous ephemeral streams flow into the Colusa Basin Drain, which conveys the drainage and runoff flows to the Sacramento River. Interstate 5 divides the basin in half from north to south.

BASIN HYDROLOGY

Elder, Thomes, and Stony creeks are direct tributaries to the Sacramento River in the upper part of Colusa Basin. Reservoir development has occurred only on Stony Creek. To protect agricultural and urban development, levees were built to prevent overflow onto adjacent lands.

South of Orland and north of Cache Creek, the basin becomes a shallow trough and is lower in elevation than the Sacramento River. Historically, when natural flow exceeded the river channel capacity during winter storms and spring snowmelt, the overflow created marsh and swamp lands where the water was either slow to drain or was prevented from returning to the river.

During the late 1800s, reclamation for agricultural use began through the development of an extensive network of levees, drains, and pumping plants. This prevented the Sacramento River from overflowing the basin. The Colusa Basin Drain was built to convey natural runoff and irrigation drainage through the basin and back to the river. During wet winters today, only parts of the lower Colusa Basin Drain becomes inundated, and only for a short time. Extensive networks of irrigation and drainage canals serve most of the basin. Around 1980, the Tehama-Colusa Canal began serving irrigation water to land along the western side of the basin.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the Colusa Basin was divided into the Willow Creek, Lurline, and Lower Colusa Subbasins. Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-5**. The three subbasins and the locations of the Nucleus Areas and existing wetlands are shown on **Figure 3-2**.

Table 3-5. Nucleus Area and Existing Wetlands Acreage, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	Existing Wetlands, acres			Colusa Basin Nucleus Areas, acres
	Public	Private	Total	
Willow Creek	6,182	4,440	10,622	
Lurline	6,603	3,820	10,423	
Lower Colusa	0	1,960	1,960	
Colusa Basin Totals	12,785	10,220	23,005	236,020

There are approximately 23,000 acres of managed wetlands in the Colusa Basin. Nucleus areas include both privately and publicly managed wetlands. The nucleus areas for potential supplemental wetland restoration in the Colusa Basin were identified in the areas surrounding three refuges and in the lower Colusa Basin.

LANDS SUITABLE FOR WETLANDS RESTORATION

Colusa Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-6.**

Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the Colusa Basin is a mix of deliveries through conveyance systems of water agencies and pumping from stream or drainage channels directly onto the lands or into an existing distribution system for delivery to points of use. Colusa Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-6.**

Figure 3-2. Colusa Basin – Lands Suitable for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations

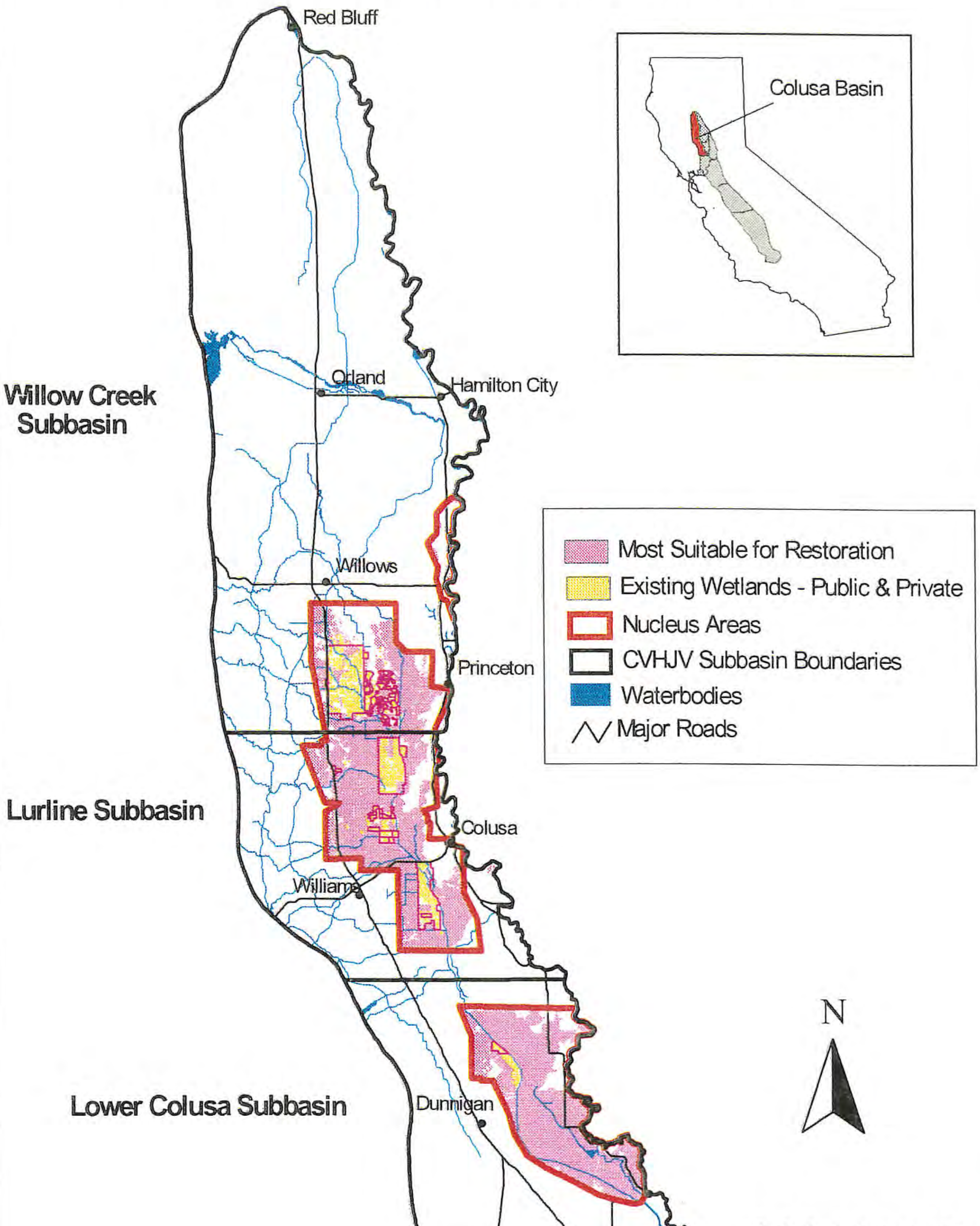


Table 3-6. Water Entities with Lands Suitable for Wetlands Restoration, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Colusa Basin Water Entities	Subbasin			Suitable Lands 500 acres or More
	Willow Creek	Lurline	Lower Colusa	
Colusa Drain Mutual Water Company	X	X	X	18,210
Glenn-Colusa Irrigation District	X	X		43,690
Princeton-Codura-Glenn Irrigation District	X			4,310
Provident Irrigation District	X			5,380
Willow Creek Mutual Water Company	X			1,610
Reclamation District 2047	X	X		16,700
Maxwell ID		X		4,830
Olive Percy Davis		X		4,910
Colusa County Water District			X	4,300
Reclamation District 108			X	42,490
River Garden Farms Company			X	7,330
Note: 500-acre cutoff eliminates any entity with less than 0.31% of basin-wide Suitable Lands (total Suitable Lands in the service areas of five unlisted entities is 200 acres).				

Suitable Lands Location

The GIS analysis identified a total of 160,470 acres of Lands Suitable for Wetlands Restoration in Colusa Basin. Approximately 96% (153,960 acres) are inside the boundaries of water agencies. Occurrence of these Suitable Lands in each of the three subbasins is shown in **Table 3-7**.

Table 3-7. Lands Suitable for Wetlands Restoration, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Colusa Basin	Lands Suitable for Wetlands Restoration					
		% of Colusa Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
Willow Creek	27,500	17%	27,050	98%	450	2%
Lurline	68,500	43%	67,990	99%	510	1%
Lower Colusa	64,470	40%	58,920	91%	5,550	9%
Colusa Basin Totals =	160,470		153,960	96%	6,510	4%

Suitable Lands that lie within the boundaries of water agencies are approximately 1,300% of the 11,805-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Colusa Basin.

Suitable Lands Water Supply

Surface water and groundwater supplies are generally good in the Colusa Basin. Groundwater use is limited primarily by cost or localized quality problems. Nearly all of the Nucleus Areas are located in the southern half of the basin where water use by source is approximately 77 percent surface water and 23 percent groundwater. Estimated annual average agricultural groundwater extraction in the basin amounts to 425,000 AF. Data from well completion reports indicate groundwater yield and pump lifts averaged 2,300 gallons per minute and 72 feet, respectively, factors which contribute to the cost of groundwater.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (108,310 acres or 67%), Moderate Reliability (10,290 acres or 7%), Low Reliability (39,750 acres or 25%) and Unknown Reliability (2,120 acres or 1%). Water supply reliability for the Suitable Lands in each of the three subbasins is shown in **Table 3-8.**

Table 3-8. Water Supply Reliability of Suitable Lands, Colusa Basin
Central Valley Wetlands Water Supply Investigations

Colusa Basin	**Lands Suitable for Wetlands Restoration**							
	Water Reliability, acres				Water Reliability, percent of acres			
Subbasin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
Willow Creek	23,310	0	4,190	0	85%	0%	15%	0
Lurline	36,460	0	32,040	0	53%	0%	47%	0
Lower Colusa	48,540	10,290	3,520	2,120	75%	16%	5%	1%
Colusa Basin Totals =	108,310	10,290	39,750	2,120	67%	7%	25%	1%

Suitable Lands with High reliability water supply are approximately 917% of the 11,805-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Colusa Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-9 shows the estimated water requirements for the remaining 11,805 acres of supplemental wetlands in Colusa Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

Table 3-9. Estimated Water Demands and Supplies for Supplemental Wetlands, Colusa Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	10,034	1,181	590	11,805
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	50,170	8,739	7,818	66,727
Available Water Supply, AF/year				
Surface Water	38,127	7,082	6,640	51,850
Groundwater	4,147	569	407	5,123
Total Available Water, AF/year	42,274	7,652	7,046	56,972
Estimated Shortfall, AF/year	7,896	1,088	771	9,755
Low Reliability Surface Water Supply, AF/year				
	3,832	750	728	5,310
Total Available Reliable Water Supply, AF/year				
	38,442	6,901	6,319	51,662
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	11,728	1,838	1,499	15,065

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Colusa Basin are 66,727 AF/year (**Table 3-9**). Available water supplies for these wetlands are estimated to be only 56,972 AF/year (i.e., there is a potential supply shortfall of 9,755 AF/year). The available supply is 91% surface water and 9% groundwater.

An estimated 5,310 AF/year of this supply is low reliability surface water from a combination of:

1. water obtained in contracts between water agencies that serve the supplemental wetlands and other local agencies and
2. irrigation tailwater diverted from the Colusa Basin Drain.

The combination of the 9,755 AF/year available supply shortfall and the 5,310 AF/year low reliability supply results in an estimated available, reliable supply shortfall of 15,065 AF/year.

Water supply availability and reliability improvement options and issues for Colusa Basin supplemental wetlands are identified in **Table 3-10** and discussed below.

Table 3-10. Water Supply Availability and Reliability Improvement Options and Issues, Supplemental Wetlands in Colusa Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Surplus surface supply Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Conveyance Difficulties • Red Bluff Diversion Dam Operations and Fish Screen Operations • Potential for High Cost • Competition with Other Buyers
Groundwater	Existing wells New Wells	• Pumping Cost • Well Development Cost • Water Quality Limitations • Groundwater Management
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 51,900 AF/year of appropriative and contracted water.

<u>Surface Water Supply Shortfall</u>

The above-described surface water supplies would provide 91% of the water used by the supplemental wetlands, but only 78% of the water that would be needed. An additional 9,755 AF/year of surface water would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is largely due to unavailability of CVP contract-derived and water rights-derived supplies during the fall and winter months. Remedies to this seasonal surface water supply shortfall lie in restructuring water supply contracts and water rights for wetlands water use in the fall and winter.

Surplus natural flows (both from flooding and from unallocated flows) are available in December through March of most years. Use of this surplus water for winter wetlands maintenance, would require water rights from the SWRCB.

Low Reliability Surface Water Supply

A significant amount (~10%) of the surface water supply available to supplemental wetlands is low reliability supply derived from sources that include tailwater by lands that are outside the service areas of water supply agencies and lands that are served by agencies that rely on supply contracts with other local agencies. Tailwater is unreliable for optimum habitat management and may be affected by future water management actions.

Low reliability surface water supplies could be supplemented and replaced as needed by purchase or transfer of higher reliability supplies from willing sellers within the Colusa Basin and/or Sacramento Valley area. Water purchases and transfers would require agreements and/or approvals that could involve the USBR and local districts. In situations where purchased water could not be conveyed from source to user in natural channels, it would have to be wheeled through the systems of local water agencies. DWR has estimated that water purchase and wheeling costs could range from $15 to $50 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source.

In the Colusa Basin, water cost is an important issue. Because of limited economic returns on private wetlands, compared with agricultural lands, wetlands need a low-cost water supply. Groundwater often is too costly for optimum wetlands management. Where the low reliability surface water supply problem cannot be satisfactorily resolved by purchase of reliable supplies, the alternative is the use of groundwater (discussed later).

Surface Water Supply Issues

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- Water Rights and Contract Modification
- District Operations and Maintenance
- High Conveyance Losses
- Conveyance Difficulties
- Red Bluff Diversion Dam Operations and Fish Screen
- Potential High Cost of Purchased Water
- Competition with Other Buyers

Water Rights and Water Contract Modification. With SWRCB cooperation, USBR and other water rights holders (water districts) could restructure their water rights/contracts for wetlands water use in the fall and winter. For example, the current contracts with USBR pertain to water use between April and October. USBR has applied to SWRCB to make water available to wetlands during November through March, but additional information about water rights during the November through March period needs to be investigated with the water suppliers and SWRCB.

District Operations and Maintenance. Solution of the contract and water rights supply availability problems will not completely solve the supply availability problem. The absence of agricultural irrigation demand during the winter months leads to shutdown of some agency delivery systems during the October through March period. Water agencies use this shutdown period to perform system maintenance. Interviews of Colusa Basin water agencies disclosed a variety of fall and winter practices. Four agencies responded that deliveries can be made 12-months per year. Five agencies identified periods of water delivery suspension as follows:

- Agency A - Contracts with users provide for interruption for maintenance during the period December through January, but such interruption does not occur every year.

- Agency B - November through February delivery suspension when system gates must be left open to allow cross-drainage of wet weather runoff. The agency is working on a winterization project to solve this problem.

- Agency C - Delivery is suspended for short maintenance periods during January through March.

- Agency D - Delivery is suspended for short maintenance periods during January through March.

- Agency E - System is closed for one month around October for cleaning. Portions of system are closed after October (does not affect ability to serve current needs). System is closed at the end of December until Spring irrigation resumes.

As indicated above, water conveyance is subject to interruptions during the agricultural non-irrigation season (November through March). The duration of such interruptions varies from agency to agency. In most cases delivery interruption during the non-irrigation season is not continuous. Delivery interruptions include shutdowns for removal of vegetation from unlined canals. Canal cleaning interruptions could be reduced by potentially expensive canal modifications (e.g., lining).

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). However, with lower deliveries expected in the winter, the percentage of loss of total supply becomes significantly high (i.e., 40 to 50 percent of water put into the conveyance system).

Conveyance Difficulties. Conveying any water through the Colusa Basin Drain may present problems because unauthorized diversions are known to occur, and because a significant amount of land uses water that is diverted out of the Colusa Basin Drain for rice straw decomposition. In some cases, monitoring would be required to ensure delivery if small quantities are delivered to a specific point.

Red Bluff Diversion Dam Operations and Fish Screen. Diversion of Sacramento River water to Tehama Colusa Canal for delivery to wetlands is limited due to Red Bluff Diversion Dam operation. CVP deliveries through Red Bluff Diversion Canal are curtailed during period September 16 through May 14 due to Endangered Species Act limitations (salmon protection). This delivery curtailment limits the use of these facilities for water supply to wetlands during important fall, winter, and spring months.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with buyers from the San Joaquin Valley and Southern California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed to provide approximately 8% of the water needed for optimum management of the supplemental wetlands.

Groundwater Quality and Availability

Groundwater quality and groundwater availability in the Colusa Basin range from poor to good depending on location. The following assessment of groundwater conditions was obtained in interviews of Colusa Basin water agencies.

1. Willow Creek Subbasin - Two agencies with service areas in the eastern area of Willow Creek Subbasin characterized groundwater quality in their service areas as good. Both agencies have AB3030 groundwater management plans, and both are conducting studies of groundwater availability. Another agency in the eastern area of Willow Creek Subbasin had no information on groundwater quality or availability. An agency whose service area is in the western area of the Willow Creek Subbasin had no information on groundwater quality or availability.

2. Lurline Subbasin - An agency that serves the central area of the Lurline Subbasin characterized groundwater quality and availability in its service area as good. Two other agencies had no information on groundwater quality or availability. The service area of one of these is in the western area of the Lurline Subbasin, and the service area of the other is in the eastern area.

3. Lower Colusa Subbasin - An agency whose service area is west of the Colusa Drain characterized groundwater quality and availability in its service area as poor, with groundwater quality problems that include multi-valent chromium and selenium. Another agency whose service area is east of the Colusa Drain characterized groundwater quality in its service area as good to moderate and groundwater availability as good.

4. Areas in Vicinity of Colusa Drain (All Subbasins) - An agency whose service area is along the Colusa Drain characterized groundwater quality as good in the northern and southern areas and sometimes poor in the middle area. The agency characterized groundwater availability as good throughout its area.

Potential Limitations on Groundwater Use for Wetlands

Groundwater is generally available, and water quality problems are generally local. The use of groundwater for supplemental wetlands is potentially limited for reasons that include:

- Well Development Costs - Small irrigation wells, approximately 300 to 500 feet deep, can cost approximately $100,000. Groundwater development can be cost-prohibitive for private wetlands.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping are an issue for private wetland owners.

- Water Quality Limitations - Localized water quality problems include high levels of salinity, boron, manganese, fluoride, magnesium, sodium, iron, chloride, total dissolved solids, ammonia, and phosphorus, multi-valent chromium, and selenium.

- Groundwater Management - Colusa Basin agencies with some form of groundwater management include Colusa County Flood Control and Water Conservation District. In areas with groundwater management, wetland operators must comply with groundwater regulations for groundwater development and pumping. These regulations primarily require well drilling permits and monitoring of groundwater conditions. According to one of the interviewed Colusa Basin water agencies, "All northern California counties have ordinances restricting new well development for area of origin protection. Concern is groundwater use for transfers. Tehama County is the most restrictive. Colusa County, Glenn County, and others are also dedicated to preventing new wells".

Agricultural Return Flow

Agricultural return flow is generally available except during drought, and its use is critical to private wetlands throughout the basin. Some existing wetlands divert water from Colusa Basin Drain, which is inexpensive (e.g., ~$2/AF versus ~$30/AF for District surface water), but not consistently available. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Issues relating to return flow include:

- <u>Return Flow Timing</u> - Water releases from rice fields in late August and early September occur before fall flooding of wetland habitat normally takes place. During certain times of the year, return flow is used by private wetlands in lieu of surface or groundwater, to the extent possible. Coordinating with upstream water districts on rice pre-harvest releases could improve return flow use before turning to new supplies. The time of wetland water application could be modified to use existing, inexpensive return flow to create the appropriate habitat.

- <u>Effects of Water Conservation, Water Banks, and Water Transfers</u> - Water conservation efforts could reduce the amount of return flow available to wetlands. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. Water conservation and water bank/transfer programs result in reduction of agricultural water use and reduced outflow from the fields, hence reducing the amount of return flow in the basin.

COLUSA BASIN FINDINGS

These investigations found that the 11,805 acres of Colusa Basin supplemental wetlands would need an additional reliable water supply of 15,065 AF/year to provide the 66,730 AF/year that would be needed for full supply at optimum management levels. An estimated 5,300 AF/year of the additional reliable supply would be needed to eliminate dependence on low reliability irrigation tailwater. The remainder would be needed to make up a 9,760 AF/year shortfall in available surface water supply.

Status of Water Supplies for Supplemental Wetlands

Water supplies are generally good in the Colusa Basin. Much of the shortfall in reliable water supplies for supplemental wetlands under the supplemental wetlands distribution assumptions used in this water supply analysis is due to dependence on tailwater, which is not a reliable supply.

The GIS analysis identified more than 160,000 acres of lands suitable for supplemental wetlands, with 96% located within water agency boundaries. Approximately 67% of the suitable lands (over 108,000 acres) have high water supply reliability (i.e, there is an abundance of Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on low reliability irrigation tailwater).

Interviews with water agencies indicated that over 3,000 acres of existing private wetlands within their boundaries were not being served by their districts. These private wetlands may be using tailwater because it is less costly.

Securing Additional Supplies

Augmenting the surface supply with groundwater and purchasing surface water supplies from local districts willing to sell might be the best opportunity for most of the supplemental wetlands within this basin. Groundwater and purchased water will be necessary for September and October flood-up. Appropriating and using surplus winter natural flows then may be used for maintaining water levels in the wetlands during the late fall and winter.

Surface water supplies would have wheeling charges and some conveyance system modification issues to resolve. Wheeling could come through local water suppliers or some small diverters. Conveyance options for these areas would need to address monitoring to ensure deliveries.

For maximum reliability in drought years, groundwater development could provide flexibility in maintaining optimum private wetlands management. Well development and pumping costs could be prohibitive for supplemental wetland owners. Financial incentives would likely be necessary to make this option economically feasible for the supplemental wetlands.

Issues Affecting Water Availability and Reliability

Because of conveyance system maintenance, the use of surface supplies in some cases could be limited in the winter. However, there may be enough surplus local natural runoff from upstream areas to provide winter maintenance supply during most years. Additional conveyance facilities may be needed to deliver the water to private wetlands.

Private wetlands rely on agricultural return flow for flood-up, maintenance flows, and summer irrigations for habitat management. Although inexpensive, this source of supply is not consistently available; however, wetland managers can expect to continue to use this source for the foreseeable future. Future water conservation measures may reduce the amount of agricultural return flow available in the basin, which would affect wetlands that depend on this supply.

Salmon protection operations of the Red Bluff Diversion Dam limit deliveries to wetlands during important fall, winter and spring months. This situation is being addressed in other CVPIA programs (Anadromous Fish Restoration Program – Structural Solutions).

Butte Basin

CVHJV Wetlands Restoration Objective, acres	**34,000**
Wetland Acres Protected & Restored	**9,714**
Remaining Wetland Acreage to Meet Objective	**24,286**
Total Basin Land Area, acres	**645,500**
Total Existing Wetlands (Private and Public), acres	**26,000**

BASIN DESCRIPTION

The Butte Basin covers approximately 1,100 square miles in the northeastern portion of the Sacramento Valley and extends 75 miles from Red Bluff to the Sutter Buttes. It is bordered by the Sacramento River on the west and the Sierra Nevada foothills and the Feather River on the east (**Figure 3-3**). The Sacramento River and its tributaries (Antelope, Mill, Deer, Big Chico, and Butte Creeks) flow through the basin. Butte Creek drains the basin between the City of Chico and the geological feature known as the Sutter Buttes.

BASIN HYDROLOGY

Historically, the creeks north of the City of Chico (Antelope, Mill, Deer, and Big Chico) overflowed on to adjacent lands. These lands now are occupied by orchards and urban development, and are protected by small levees. Below Chico, Butte Creek typically overflowed onto adjacent lands and sloughs during winter storms and spring snowmelt, creating a vast floodplain. High flows from the Sacramento River also would spread, eventually reaching the area called the Butte Sink, a large marsh created by these overflows. The numerous sloughs and riparian lands captured the water and created seasonal marshes.

In the early 1900s, land reclamation for agriculture created a combination of levees and drainage facilities to contain some of the flood waters. The southwestern part of the Butte Basin is used by the Sacramento River Flood Control Project to convey flood flows into the Sutter Bypass, creating large flooded areas for extended period. This inundation varies from weeks to several months, depending on the magnitude and duration of high river flow.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the Butte Basin was divided into the Upper Butte and Butte Sink subbasins. Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-11**. The two subbasins and the locations of the Nucleus Areas and existing wetlands are shown on **Figure 3-3**.

Table 3-11. Nucleus Area and Existing Wetlands Acreage, Butte Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	Existing Wetlands, acres			Butte Basin Nucleus Areas, acres
	Public	Private	Total	
Upper Butte	521	2,890	3,411	
Butte Sink	4,958	12,430	17,388	
Butte Basin Totals	5,479	15,320	20,799	236,777

LANDS SUITABLE FOR WETLANDS RESTORATION

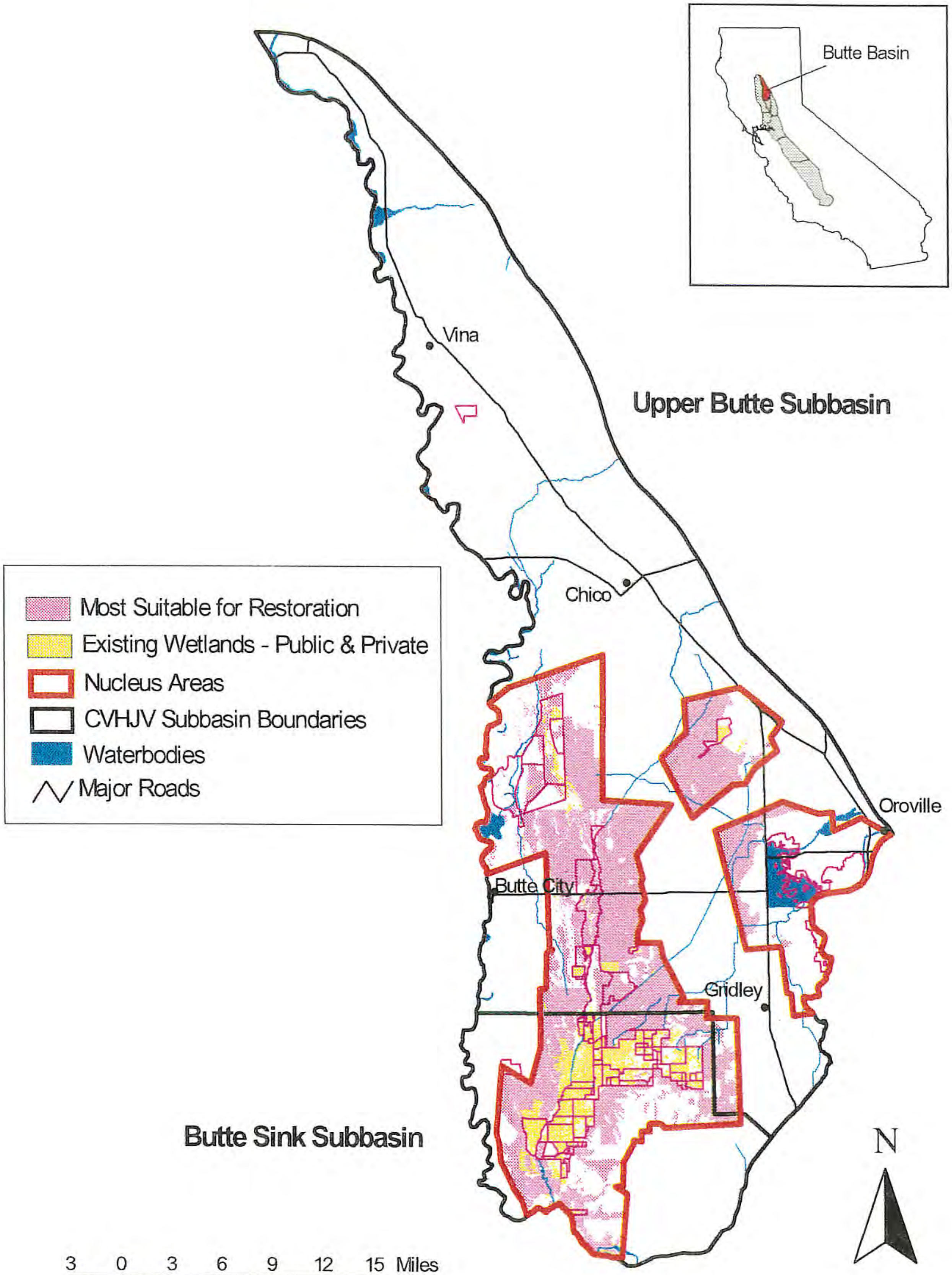
Butte Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-12.**

Table 3-12. Water Entities with Lands Suitable for Wetlands Restoration, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin Water Entities	Subbasin		Suitable Lands 500 acres or More
	Upper Butte	Butte Sink	
Biggs-West Gridley Water District	X	X	12,600
Butte Water District	X		1,510
Llano Seco Rancho	X		4,120
Reclamation District 1004	X	X	11,370
Richvale Irrigation District	X		14,790
Sutter Bypass/Buttes Slough Water Users Association	X	X	1,900
Western Canal Water District	X		44,050
Joan Wilmarth S. Lewis		X	590

Note: 500-acre cutoff eliminates any entity with less than 0.47% of basin-wide Suitable Lands (total Suitable Lands in the service areas of five unlisted entities is 880 acres).

Figure 3-3. Butte Basin – Lands Suitable for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations



Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the Butte Basin is a mix of deliveries through conveyance systems of water agencies and pumping from stream or drainage channels directly onto the lands or into an existing distribution system for delivery to points of use. Butte Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-12.**

Suitable Lands Location

The GIS analysis identified a total of 106,940 acres of Lands Suitable for Wetlands Restoration in the Butte Basin. Approximately 86% (91,810 acres) are inside the boundaries of water agencies. Occurrence of these Suitable Lands in the two subbasins is shown in **Table 3-13.**

Table 3-13. Lands Suitable for Wetlands Restoration, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin	**Lands Suitable for Wetlands Restoration**					
		% of Butte Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
Upper Butte	80,030	75%	73,810	92%	6,220	8%
Butte Sink	26,910	25%	18,000	67%	8,910	33%
Butte Basin Totals =	106,940		91,810	86%	15,130	14%

The majority of Suitable Lands are in areas along Butte Creek and below Oroville Dam (around Thermalito Afterbay. Suitable Lands that lie within the boundaries of water agencies are approximately 380% of the 24,286-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Butte Basin.

Suitable Lands Water Supply

Surface water and groundwater supplies are generally good throughout the Butte basin. Groundwater well development may require permits in Butte County.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (81780 acres or 76%), Moderate Reliability (440 acres or 0.4%), Low Reliability (13,310 acres or 12.4%) and Unknown Reliability (11,410 acres or 10.6%). Water supply reliability for the Suitable Lands in each of the two subbasins is shown in **Table 3-14**.

Table 3-14. Water Supply Reliability of Suitable Lands, Butte Basin
Central Valley Wetlands Water Supply Investigations

Butte Basin	**Lands Suitable for Wetlands Restoration**							
	Water Reliability, acres				Water Reliability, percent of acres			
Subbasin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
Upper Butte	63,820	0	5,690	10,520	80%	0%	7%	13%
Butte Sink	17,960	440	7,620	890	67%	2%	28%	3%
Butte Basin Totals =	81,780	440	13,310	11,410	76%	0.4%	12.4%	10.6%

Suitable Lands with High water supply reliability are approximately 340% of the 24,286-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Butte Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-15 shows the estimated water requirements for the remaining 24,286 acres of supplemental wetlands in Butte Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

Table 3-15. Estimated Water Demands and Supplies for Supplemental Wetlands Butte Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	20,646	2,429	1,215	24,290
Optimum Management Water Requirements, AF/acre/year	5.6	7.4	13.25	
Total Water Requirement, AF/year	115,618	17,975	16,099	149,692
Available Water Supply, AF/year				
Surface Water	87,966	14,112	13,230	115,308
Groundwater	3,699	575	515	4,789
Total Available Water, AF/year	91,665	14,687	13,745	120,097
Estimated Shortfall, AF/year	23,952	3,287	2,354	29,595
Low Reliability Surface Water Supply, AF/year				
	15,778	2,531	2,373	20,682
Total Available Reliable Water Supply, AF/year				
	75,887	12,156	11,372	99,415
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	39,730	5,819	4,727	50,277

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Butte Basin are 149,692 AF/year (**Table 3-15**). Available water supplies for these wetlands are estimated to be only 120,097 AF/year (i.e., there is a potential supply shortfall of 29,595 AF/year). The available supply is 96% surface water and 4% groundwater.

An estimated 20,682 AF/year of this supply is low reliability surface water consisting of return flows from upstream agricultural and wetland water users and natural run-off diverted from Cherokee Canal and the 833 Main Drain. Although these tailwater supplies have been adequate in most years for landowners to grow rice, irrigate pastures, or flood wetlands in the fall and winter, future upstream water conservation practices or land use changes could dramatically reduce these supplies in all but wet years.

The combination of the 29,595 AF/year available supply shortfall and the 20,682 AF/year low reliability supply results in an estimated available, reliable supply shortfall of 50,277 AF/year.

Water supply availability and reliability improvement options and issues for Butte Basin supplemental wetlands are identified in **Table 3-16** and discussed below.

Table 3-16. Water Supply Availability and Reliability Improvement Options and Issues, Supplemental Wetlands in Butte Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Potential for High Cost • Competition with Other Buyers
Groundwater	Use existing wells New Wells	• Pumping Costs • Well Development Costs • Groundwater Management
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 115,300 AF/year comprised of: 1) CVP, SWP, and water rights-derived supplies; 2) agricultural and other wetlands return flows (tailwater); and 3) mixtures of tailwater and CVP, SWP, and water rights-derived supplies.

Surface Water Supply Shortfall

The above-described surface water supplies would provide ~96% of the water used by the supplemental wetlands, but only 77% of the water that would be needed. An additional 29,595 AF/year of surface water would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is largely due to unavailability of CVP, SWP, and water rights-derived supplies during the fall and winter months. Remedies to this seasonal surface water supply shortfall lie in restructuring water supply contracts and water rights for wetlands water use in the fall and winter.

Natural runoff is available for appropriation in December through March of most years. During average and wet years, the Butte Sink area becomes inundated for weeks to months from surplus water flows of Butte Creek and the Sacramento River. Use of this surplus water for winter wetlands maintenance, would require water rights from the SWRCB.

Low Reliability Surface Water Supply

A significant amount (~18%) of the surface water supply available to supplemental wetlands is low reliability supply derived from tailwater and natural run-off by lands that are outside the service areas of water supply agencies. Tailwater is unreliable for optimum habitat management and may be affected by future water management actions.

Low reliability surface water supplies could be supplemented and replaced as needed by purchase or transfer of higher reliability supplies from willing sellers within the Butte Basin and/or Sacramento Valley area. Water purchases would require agreements and/or approvals that could involve the USBR, DWR, and local districts. In situations where purchased water could not be conveyed from source to user in natural channels, it would have to be wheeled through the systems of local water agencies. DWR has estimated that water purchase and wheeling costs could range from $10 to $25 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source.

Where the low reliability surface water supply problem cannot be satisfactorily resolved by purchase of reliable supplies, the alternative is the use of groundwater (discussed later).

Surface Water Supply Issues

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- Water Rights and Water Contract Modification
- District Operations and Maintenance
- High Conveyance Losses
- Conveyance Difficulties
- Potential High Cost of Purchased Water
- Competition with Other Buyers

Water Rights and Water Contract Modification. With SWRCB cooperation, DWR, USBR and other water rights holders (water districts) could restructure their water rights/contracts for wetlands water use in the fall and winter. For example, the current contracts with USBR pertain to water use between April and October. USBR has applied to SWRCB to make water available to wetlands during November through March, but additional information about water rights during the November through March period needs to be investigated with the water suppliers and SWRCB. If there is water to sell, USBR, DWR, and local water districts would need to negotiate how to provide service to land outside of a district's service area.

District Operations and Maintenance. Solution of the contract and water rights supply availability problems will not completely solve the supply availability problem. The absence of agricultural irrigation demand during the winter months leads to shutdown of some agency delivery systems during January through early April. Water agencies use this shutdown period to perform system maintenance.

Interviews of Butte Basin water agencies disclosed a variety of winter practices. Two agencies responded that deliveries can be made 12-months per year. Three agencies identified periods of water delivery suspension as follows:

- Agency A - Delivery is suspended for maintenance from February through March.
- Agency B - Delivery is suspended for maintenance from late January through early April. Moss and vegetation grows in canal, limiting capacity.
- Agency C - Delivery is suspended for maintenance from January 15 through April 1.

As indicated above, water conveyance is subject to interruptions during the agricultural non-irrigation season (November through March) in some, but not all, of the agency distribution systems. The timing of such interruptions varies from agency to agency. Delivery interruptions include shutdowns for removal of vegetation from unlined canals. Canal cleaning interruptions could be reduced by potentially expensive canal modifications (e.g., lining).

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in the winter to those that occur during irrigation season (spring/summer). With lower deliveries expected during the winter, the percentage of loss of the total supply becomes significantly high (i.e., 40 to 50 percent of water put into the conveyance system).

Conveyance Difficulties. Conveyance difficulties are in two categories (unauthorized diversions and timing of deliveries).

- Unauthorized diversions are known to occur during transport of water through the network of small diversion points while conveying water to areas along lower Butte Creek and Butte Slough. Monitoring may be necessary to ensure delivery if small quantities are delivered to a specific point.
- Timing of deliveries can be a factor in providing water to wetlands during late summer and early fall. For example, conveyance seepage adjacent to rice fields during August and September in Biggs-West Gridley WD causes significant problems for harvesting. In this case, Biggs-West Gridley WD minimizes canal usage during these times.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with buyers from the San Joaquin Valley and Southern

California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed to provide approximately 4% of the water needed for optimum management of the supplemental wetlands. Groundwater pumping for supplemental wetlands is assumed to be limited to a few isolated areas that lack an adequate surface water supply. Groundwater is generally available, and water quality problems are generally local. The use of groundwater for supplemental wetlands is potentially limited for reasons that include:

- Well Development Costs - A typical 16-inch cased irrigation well, approximately 300 to 500 feet deep, could cost $100,000 to develop. Such costs can be prohibitive for private wetlands.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping are an issue for private wetland owners.

- Groundwater Management - Groundwater extraction and distribution could be affected by current and future local management plans. Tehama County Flood Control and Water Conservation District has a groundwater management plan, and the Butte Basin Water Users Association is working on a groundwater model and management plan. Butte County has a water commission that may become involved in future well development, particularly relative to groundwater subsidence and groundwater transfers. This management would likely be limited to well drilling permits and monitoring of groundwater conditions.

Agricultural Return Flow

Agricultural return flow is generally available except during drought, and its use is critical to wetlands throughout the basin. This source is usually inexpensive, but has not been consistently available in all years. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Wetland managers could pursue options with districts willing to make this source of supply available on a more consistent basis. Issues relating to return flow include the following:

- Return Flow Timing - During the irrigation season return flows may be available for certain wetland management practices, such as irrigation for waterfowl food crops and habitat management. However, in this basin most of the pre-harvest water releases from rice fields occur in late August through September before the majority of wetlands flood for fall and winter habitat. Most private wetlands make use of available return flow to the extent possible. Return flow use may be limited for wetlands irrigations in May and June because rice field flooding occurs at the same time. When rice fields are flooded, the timing of wetland irrigation and maintenance could be somewhat modified to use available, inexpensive, return flow to maintain appropriate habitat. Coordinating with upstream districts for return flow releases could improve the reliability prior to exploring alternatives for new supplies.

- Effects of Water Conservation, Water Banks, and Water Transfers - Conservation efforts could reduce the amount of return flow now available. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. These programs result in reduced agricultural water use and reduced outflow from the fields, hence reducing the amount of return flow.

BUTTE BASIN FINDINGS

These investigations found that the 24,290 acres of Butte Basin supplemental wetlands would need an additional reliable water supply of 50,277 AF/year to provide the 149,692 AF/year that would be needed for full supply at optimum management levels. An estimated 20,682 AF/year of the additional reliable supply would be needed to eliminate dependence on low reliability irrigation tailwater. The remainder would be needed to make up a 29,595 AF/year shortfall in available surface water supply.

Status of Current Water Supplies

Water supplies are generally good in the Butte Basin. Much of the shortfall in reliable water supplies for supplemental wetlands under the supplemental wetlands distribution assumptions used in this water supply analysis is due to dependence on tailwater, which is not a reliable supply.

The GIS analysis identified more than 106,900 acres of lands suitable for supplemental wetlands, with 86% located within water agency boundaries. Approximately 76% of the suitable lands (over 81,700 acres) have high water supply reliability (i.e, there is an abundance of Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on low reliability irrigation tailwater).

The predominant water supply to existing private wetlands in this basin is tailwater from rice lands. Within the 1922 Agreement Lands in the Butte Sink, this is a reliable water supply. In other areas tailwater is a less reliable water source. Most existing wetlands supplied by water agencies do not receive deliveries from mid-January through March. This is reflected in the supplemental wetlands water supply analysis.

Securing Additional Supplies

Surface and groundwater are options to enhance the reliability of supplemental wetlands water supply. Purchased surface water supplies would have wheeling charges and some potential system or conveyance modification issues to overcome. Wheeling agreements could be arranged through local water suppliers. Because of unauthorized diversions, monitoring would be needed to ensure that the contracted supplies are received.

There may be enough natural runoff and return flows from upstream areas to provide winter maintenance supply in most years; however, groundwater and purchased water will be needed for September and October flood-up. In some average and most wet years, the southern basin will flood, thus naturally supplying all of the supplemental wetlands areas.

Groundwater development in the southern basin could provide flexibility for supplemental wetland owners in maintaining optimum wetlands management and could augment surface water supply. However, groundwater development and pumping costs may be prohibitive for private wetland owners, and could be limited in development by water quality or future local groundwater management programs.

Issues Affecting Water Availability and Reliability

Timing of deliveries may be a factor in supplemental wetlands water supply reliability. Water district managers may be willing to assist supplemental wetlands managers by recommending ways to improve availability and reliability, such as timing deliveries to allow maximum efficiency for the districts. Some districts wheel water to refuges, and may find it most efficient to convey water to private wetlands at the same time.

Some supplemental wetlands owners may be able to request additional supplies from the overlying water district, or become annexed into a local district. If annexation is feasible, conveyance facilities would be needed. Neither the wetlands owner nor the district could be expected to bear this cost without incentives or funding assistance.

A considerable amount of the supplemental wetlands water supply is assumed to be from agricultural return flow. Although inexpensive, this source of supply is not consistently available and may be affected by future management options by upstream users. However, supplemental wetlands in the 1922 Agreement lands have a guaranteed supply from this source through the end of the waterfowl hunting season because of their agreement to take return flow beginning in August. Other supplemental wetlands owners may be able to make similar agreements.

Water conservation efforts, water banks, and water transfers could reduce the amount of return flow available to some of the supplemental wetlands by reducing the initial amount of water applied to agricultural fields.

Sutter Basin

CVHJV Wetlands Restoration Objective, acres	**11,000**
Wetland Acres Protected & Restored	**580**
Remaining Wetland Acreage to Meet Objective	**10,420**
Total Basin Land Area, acres	**224,000**
Total Existing Wetlands (Private and Public), acres	**2,115**

BASIN DESCRIPTION

Extending south from the Sutter Buttes to the confluence of the Feather and Sacramento rivers, the Sutter Basin covers 350 square miles of low-lying fertile land. Roughly 37 miles long and 17 miles wide, the basin is diagonally split by the Butte Slough/Sutter Bypass portion of the Sacramento River flood control system (**Figure 3-4**).

BASIN HYDROLOGY

Historically, overflow from the Sacramento and Feather rivers and the Butte Sink flooded a large portion of Sutter Basin in the winter and spring, creating 40,000 to 50,000 acres of marsh. Since the mid-1800s, however, the land slowly began being converted to agricultural use. Water not retained in the basin drained south and reentered the Sacramento River.

The Sutter Basin contained some of the most significant waterfowl habitat in California prior to European immigration, but only Sutter NWR and a few private duck clubs and managed wetlands provide waterfowl habitat today. Construction of the Sutter Bypass and flood control systems on the Sacramento and Feather rivers now prevents most flooding in the basin, although the bypass provides significant waterfowl resting habitat when it floods during wet winters.

NUCLEUS AREAS AND EXISTING WETLANDS

Sutter Basin Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-17** and on **Figure 3-4**.

Table 3-17. Nucleus Area and Existing Wetlands Acreage, Sutter Basin
Central Valley Wetlands Water Supply Investigations

Sutter Basin	Existing Wetlands, acres			Sutter Basin Nucleus Areas, acres
	Public	Private	Total	
Sutter Basin Totals	2,005	110	2,115	59,891

Managed wetlands totaling approximately 2,100 acres within the basin consist primarily of refuge lands with some private wetlands. Nucleus areas include both privately and publicly managed wetlands. The nucleus areas for potential supplemental wetlands restoration were identified in the heart of the basin and to the north as an extension of the Butte Basin.

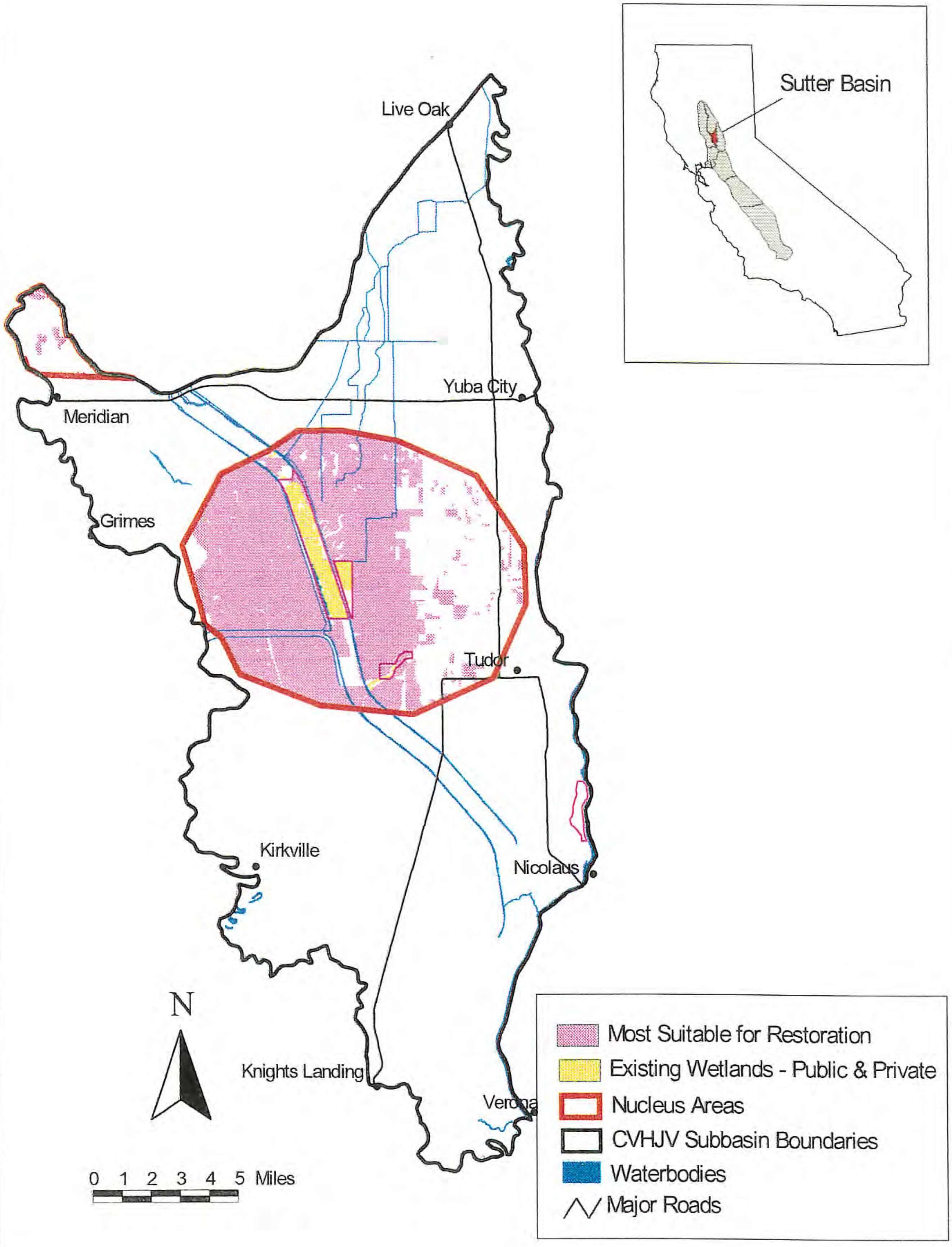
LANDS SUITABLE FOR WETLANDS RESTORATION

Sutter Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-18.**

Table 3-18. Water Entities with Lands Suitable for Wetlands Restoration, Sutter Basin
Central Valley Wetlands Water Supply Investigations

Sutter Basin Water Entities	Suitable Lands 500 acres or More
Butte Slough Irrigation District	1,830
Feather Water District	1,200
Newhall Land and Farming Company	2,390
Oji Brothers Farm, Inc.	650
Reclamation District 1500	710
Sutter Bypass/Buttes Slough Water Users Association	10,260
Sutter Extension Water District	14,360
Sutter Mutual Water Company	6,700
Tisdale Irrigation and Drainage Company	2,110
Note: 500-acre cutoff eliminates any entity with less than 1.15% of basin-wide Suitable Lands (total Suitable Lands in the service areas of two unlisted entities is 10 acres).	

Figure 3-4. Sutter Basin – Lands Suitable for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations



Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the Sutter Basin is a mix of deliveries through conveyance systems of water agencies and pumping from stream or drainage channels directly onto the lands or into an existing distribution system for delivery to points of use. Sutter Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-18.**

Suitable Lands Location

The GIS analysis identified a total of 43,300 acres of Lands Suitable for Wetlands Restoration in the Sutter Basin. Approximately 93% (43,300 acres) are inside the boundaries of water agencies. Occurrence of these Suitable Lands is shown in **Table 3-19.**

Table 3-19. Lands Suitable for Wetlands Restoration, Sutter Basin
Central Valley Wetlands Water Supply Investigations

Sutter Basin	Lands Suitable for Wetlands Restoration	
	acres	% of Sutter Basin Total
Inside Water Agency Boundaries	40,220	93%
Outside Water Agency Boundaries	3,080	7%
Sutter Basin Totals =	43,300	100%

Suitable Lands that lie within the boundaries of water agencies are approximately 386% of the 10,420-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Sutter Basin.

Suitable Lands Water Supply

Sutter Basin surface water supply availability is generally good, except during drought. Surface water supplies are derived from the Feather River, Sacramento River, Butte Creek, and agricultural return flows (tailwater). A majority of the groundwater basin underlying the suitable lands is unusable due to high salt concentrations, arsenic, and other constituents. Basin water use by source is ~23 percent tailwater, 66 percent other surface water, and 11 percent groundwater.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (22,720 acres or 52%), Moderate Reliability (24,110 acres or 6%), Low Reliability (17,310 acres or 40%) and Unknown Reliability (860 acres or 2%). Water supply reliability for the Suitable Lands is shown in **Table 3-20.**

Table 3-20. Water Supply Reliability of Suitable Lands, Sutter Basin
Central Valley Wetlands Water Supply Investigations

	Lands Suitable for Wetlands Restoration							
	Water Reliability, acres				Water Reliability, percent of acres			
Sutter Basin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
	22,720	24,110	17,310	860	52%	6%	40%	2%

Suitable Lands with High reliability water supply are approximately 218% of the 10,420-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Sutter Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-21 shows the estimated water requirements for the remaining 10,420 acres of supplemental wetlands in Sutter Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

**Table 3-21. Estimated Water Demands and Supplies for Supplemental Wetlands
Sutter Basin**
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	8,857	1,042	521	10,420
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	44,285	7,711	6,903	58,899
Available Water Supply, AF/year				
Surface Water	33,657	6,252	5,861	45,770
Groundwater	0	0	0	0
Total Available Water, AF/year	33,657	6,252	5,861	45,770
Estimated Shortfall, AF/year	10,628	1,459	1,042	13,129
Low Reliability Surface Water Supply, AF/year				
	33,657	6,252	5,861	45,770
Total Available Reliable Water Supply, AF/year				
	0	0	0	0
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	44,285	7,711	6,903	58,899

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Sutter Basin are 58,899 AF/year (**Table 3-21**). Available water supplies for these wetlands are estimated to be only 45,770 AF/year (i.e., there is a potential supply shortfall of 13,129 AF/year). The available supply is 100% surface water and is entirely low reliability tailwater.

The combination of the 13,129 AF/year available supply shortfall and the 45,770 AF/year low reliability supply results in an estimated available, reliable supply shortfall of 58,899 AF/year.

Water supply availability and reliability improvement options and issues for Sutter Basin supplemental wetlands are identified in **Table 3-22** and discussed below.

Table 3-22. Water Supply Availability and Reliability Improvement Options and Issues, Supplemental Wetlands in Sutter Basin
Central Valley Wetland Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • High Conveyance Losses • Potential for High Cost • Competition with Other Buyers
Groundwater	Existing wells New wells	• Pumping Costs • Well Development Costs • Water Quality Limitations • Groundwater Management
Agricultural Return Flows	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Surface Water

Surface water supplies available to supplemental wetlands are assumed to consist of about 45,800 AF/year of irrigation tailwater.

Surface Water Supply Shortfall

The above-described surface water supplies would provide ~100% of the water used by the supplemental wetlands, but only 78% of the water that would be needed. An additional 13,129 AF/year of surface water would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is due to unavailability of irrigation tailwater-derived supplies during the fall and winter months.

Remedies to this seasonal surface water supply shortfall lie in obtaining fall and winter water supplies through water purchases or transfers from willing sellers within the Sutter Basin and/or Sacramento Valley area. This solution would be complicated by the fact that potential sources of such purchased or transferred supplies (sellers with CVP, SWP, and/or water rights-derived supplies) may not have water during the fall and winter period due to CVP and SWP contract or water rights restrictions. In order to provide the needed water, sellers would need to obtain restructured water supply contracts and water rights for fall and winter water use.

Low Reliability Surface Water Supply

A significant amount (~10%) of the surface water supply available to supplemental wetlands is low reliability supply derived from sources that include tailwater by lands that are outside the service areas of water supply agencies and lands that are served by agencies that rely on supply contracts with other local agencies. Tailwater is unreliable for optimum habitat management and may be affected by future water management actions.

Low reliability surface water supplies could be supplemented and replaced as needed by purchase or transfer of higher reliability supplies from willing sellers within the Sutter Basin and/or Sacramento Valley area. A potential source of such water is the group of four SWP contract water agencies (Richvale ID, Butte WD, Biggs-West Gridley WD, and Sutter Extension WD) who receive Feather River water through Thermalito Afterbay. These four districts are represented by a governing board known as the Joint Water District (JWD). Under the terms of its 1969 water rights agreement with SWP, the JWD is unable to sell or transfer water to lands outside its service areas. The best potential for solving the supplemental wetlands water supply problem may lie in an arrangement such as that made for supply of the Sutter NWR. Under that arrangement, CVPIA supplies will be delivered through the SWP's Thermalito Afterbay facilities and wheeled to the refuge in the local water district facilities. This type of transfer would require negotiations with both USBR and DWR. DWR has estimated that water purchase and wheeling costs could range from $10 to $25 per AF, depending on the negotiated purchase price, location of the wetlands, location and nature of the seller's water source, and the extent to which delivery could utilize Butte Slough and Butte Creek.

<u>Surface Water Supply Issues</u>

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- Water Rights and Water Contract Modification
- District Operations and Maintenance
- High Conveyance Losses
- Conveyance Difficulties
- Potential High Cost of Purchased Water
- Competition with Other Buyers

<u>Water Rights and Water Contract Modification</u>. With SWRCB cooperation, DWR, USBR and other water rights holders (water districts) could restructure their water rights/contracts for wetlands water use in the fall and winter. Two examples are as follows:

- The current contracts with USBR pertain to water use between April and October. USBR has applied to SWRCB to make water available to wetlands during November through March, but additional information about water rights during the November through March period needs to be investigated with the water suppliers and SWRCB.

- If JWD member districts have water to sell, DWR and JWD would need to negotiate how to provide water to lands outside of the JWD service areas.

District Operations and Maintenance. Solution of the contract and water rights supply availability problems will not completely solve the supply availability problem. The absence of agricultural irrigation demand during the winter months leads to shutdown of some agency delivery systems during the October through March period. Water agencies use this shutdown period to perform system maintenance.

Interviews of two Sutter Basin water agencies disclosed the following fall and winter practices:

- Agency A - Delivery is suspended for maintenance during the period January through March.

- Agency B - Delivery suspended for maintenance briefly in October or March. Delivery is stopped in December and resumes in March or April (this corresponds to demand).

As indicated above, water conveyance is subject to interruptions during the agricultural non-irrigation season (October through March). The duration of such interruptions varies from agency to agency. Delivery interruptions include shutdowns for removal of vegetation from unlined canals. Canal cleaning interruptions could be reduced by potentially expensive canal modifications (e.g., lining).

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). However, with lower deliveries expected in the winter, the percentage of loss of total supply becomes significantly high (i.e., 40 to 50 percent of water put into the conveyance system).

Conveyance Difficulties. Numerous diversions occur along Butte Slough and portions of the Sutter Bypass and may require monitoring to ensure delivery of water to wetlands.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with buyers from the San Joaquin Valley and Southern California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed not to have a role in water supply to supplemental wetlands. Good quality water occurs only in areas along the Sacramento River, Feather River, and a few other areas within the basin. All other areas have problems with salinity, arsenic, and other elements. Most of the potential supplemental wetland areas overlie unusable groundwater resources.

Agricultural Return Flow

Agricultural return flow is generally available except during drought. Return flow is the only existing water supply source to supplemental wetlands under the water supply scenario presented in **Table 3-21**. This source is usually inexpensive, but has not been consistently available in all years. Wetland managers can expect to continue to use return flow, if available, to reduce the need for water from other sources. Wetland managers could pursue options with districts willing to make this source of supply available on a more consistent basis. Issues relating to return flow include the following:

- <u>Return Flow Timing</u> - During the irrigation season return flows may be available for certain wetland management practices, such as irrigation for waterfowl food crops and habitat management. However, in this basin most of the pre-harvest water releases from rice fields occur in late August through September before the majority of wetlands flood for fall and winter habitat. Return flow use may be limited for wetlands irrigations in May and June because rice field flooding occurs at the same time. When rice fields are flooded, the timing of wetland irrigation and maintenance could be somewhat modified to use available, inexpensive, return flow to maintain appropriate habitat. Coordinating with upstream districts for return flow releases could improve the reliability prior to exploring alternatives for new supplies.

- <u>Effects of Water Conservation, Water Banks, and Water Transfers</u> - Water conservation efforts could reduce the amount of return flow now available to private wetlands. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. These programs result in reduction of agricultural water use and reduced outflow from the fields, hence reducing the amount of return flow.

SUTTER BASIN FINDINGS

These investigations found that the 10,420 acres of Sutter Basin supplemental wetlands would need an additional reliable water supply of 58,899 AF/year to provide the 58,899 AF/year that would be needed for full supply at optimum management levels. The entire amount of the additional reliable supply would be needed to eliminate dependence on low reliability irrigation tailwater.

Status of Current Water Supplies

Water supplies are generally good in the Sutter Basin. The shortfall in reliable water supplies for supplemental wetlands under the supplemental wetlands distribution assumptions used in this water supply analysis is due to dependence on tailwater, which is not a reliable supply.

The GIS analysis identified more than 43,000 acres of lands suitable for supplemental wetlands, with 93% located within water agency boundaries. Approximately 52% of the suitable lands (over 22,700 acres) have high water supply reliability (i.e, there is an abundance of Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on low reliability irrigation tailwater).

All existing private wetlands in the Sutter Basin are outside the boundaries of water supply agencies. Most rely on agricultural return flows in the summer and fall, and natural runoff and flooding in the bypass in the winter. Pumping groundwater is generally too expensive for private wetlands use, and there are groundwater quality problems in many areas. This is water supply setting is reflected in the supplemental wetlands water supply analysis.

Securing Additional Supplies

To satisfy the 58,899 AF/year reliable water supply need, purchasing surface water supplies from willing sellers might be the best option. If surface water supplies are available for purchase or transfer, arrangements will also be needed to provide for conveyance or wheeling. Wheeling could come through some local water suppliers; however, conveyance facility modification--especially to wetlands outside of water service areas--could be a costly and contentious issue to overcome. Monitoring may be needed to ensure water supply delivery. Off-irrigation-season shut-down of conveyance systems generally makes surface supplies undeliverable for approximately 3 months a year (i.e., January through March). However, there is usually enough natural runoff and return flows to provide winter maintenance supply during most years; for example, the Sutter Bypass floods to some degree during that time in most years.

Groundwater development is limited because most groundwater supplies in the Sutter Basin have salinity problems. Well development and pumping costs could be prohibitive for some supplemental wetlands, and since many of the current wells are not near these lands, conveyance becomes an issue. There is also local concern about how and where this limited resource is used, and there is the potential for future groundwater management programs to regulate how private wetlands use and develop groundwater.

Issues Affecting Water Availability and Reliability

As with other basins in the Sacramento Valley, agricultural return flow, primarily from rice fields, contributes significantly to existing private wetland water supply in the Sutter Basin. This is reflected in the supplemental wetlands water supply analysis. This source is inexpensive, but not consistently available. Water conservation efforts, water banking, or water transfer may reduce the amount of future return flow, making this an even less certain source of supply than it is now.

Yolo Basin

CVHJV Wetlands Restoration Objective, acres	**10,000**
Wetland Acres Protected & Restored	**4,066**
Remaining Wetland Acreage to Meet Objective	**5,934**
Total Basin Land Area, acres	**512,000**
Total Existing Wetlands (Private and Public), acres	**6,150**

BASIN DESCRIPTION

The Yolo Basin covers approximately 800 square miles in the southwestern part of the Sacramento Valley between Verona in the north and the Montezuma Hills in southeastern Solano County. This 50-mile-long basin is bordered on the east by the Sacramento River and Sacramento Ship Channel and on the west by the foothills of the Coast Range (**Figure 3-5**). Watercourses in the Yolo Basin include Cache, Putah, and Ulatis creeks. Cottonwood and Willow sloughs are among the intermittent streams and sloughs that drain the valley floor. Other important features include the southernly trending Dunnigan Hills and Plainfield Ridge. The southern part of the basin extends into what is known as the "Legal Delta". Private wetlands in the "Legal Delta" are subject to Sacramento-San Joaquin Delta protection regulations.

BASIN HYDROLOGY

Historically, low-lying areas of the Yolo Basin received overflow waters from the Sacramento River, Cache Creek, Putah Creek, and Ulatis Creek. In areas near the Delta, surface waters subject to tidal influence supported permanent marshes in low areas of the basin. Winter and spring floods supported seasonal wetlands adjacent to these permanent marshes.

Basin hydrology has been modified by levees and flood control structures. The Yolo Bypass, which covers an extensive area along the eastern side of the basin, is subject to overflow from the Sacramento River during high runoff and provides flood protection for adjacent land. The dams, levees, and settling basin construction along Cache Creek have altered its hydrology and increased the level of flood protection in the surrounding area. In Solano County, channels of the Ulatis Flood Control Project are managed to minimize flooding of agricultural land downstream from Vacaville. Basin hydrology also has been modified by levee construction which protected Delta islands and tracts during high outflow and high tides.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the Yolo Basin was divided into the Upper Yolo and Lower Yolo subbasins. Nucleus Area and existing private and public wetland acreage are shown in **Table 3-23**. The two subbasins and the locations of the Nucleus Areas and existing wetlands are shown on **Figure 3-5**.

Table 3-23. Nucleus Area and Existing Wetlands Acreage, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	Existing Wetlands, acres			Yolo Basin Nucleus Areas, acres
	Public	Private	Total	
North Yolo	50	240	290	
South Yolo	0	5,860	5,860	
Yolo Basin Totals	50	6,100	6,150	159,626

Managed wetlands totaling 6,150 acres are mostly in the Yolo Bypass south of Interstate 80. These wetlands exist in two distinct blocks: 1) an intensively managed 2,500-acre northern segment with excellent wintering waterfowl values, and 2) a larger southern segment used for seasonal cattle grazing and duck hunting. These wetlands combine to support good numbers of wintering waterfowl from October through April. Nucleus areas include both privately and publically-managed wetlands. The nucleus areas for potential supplemental wetlands restoration were identified in regions around the Yolo Bypass and in the south-central Yolo County area.

LANDS SUITABLE FOR WETLANDS RESTORATION

Yolo Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-24.**

Water Supply Conveyance Facilities and Water Agencies

Distribution of water to suitable lands within the Yolo Basin is primarily by pumping from the channel directly onto the lands or into an existing distribution system for delivery to points of use. The basin waterways are earthen sloughs or canals, which may result in conveyance losses in areas with low water tables. Yolo Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-24**.

Figure 3-5. Yolo Basin -- Lands Suitable for Wetlands Restoration

Central Valley Wetlands Water Supply Investigations

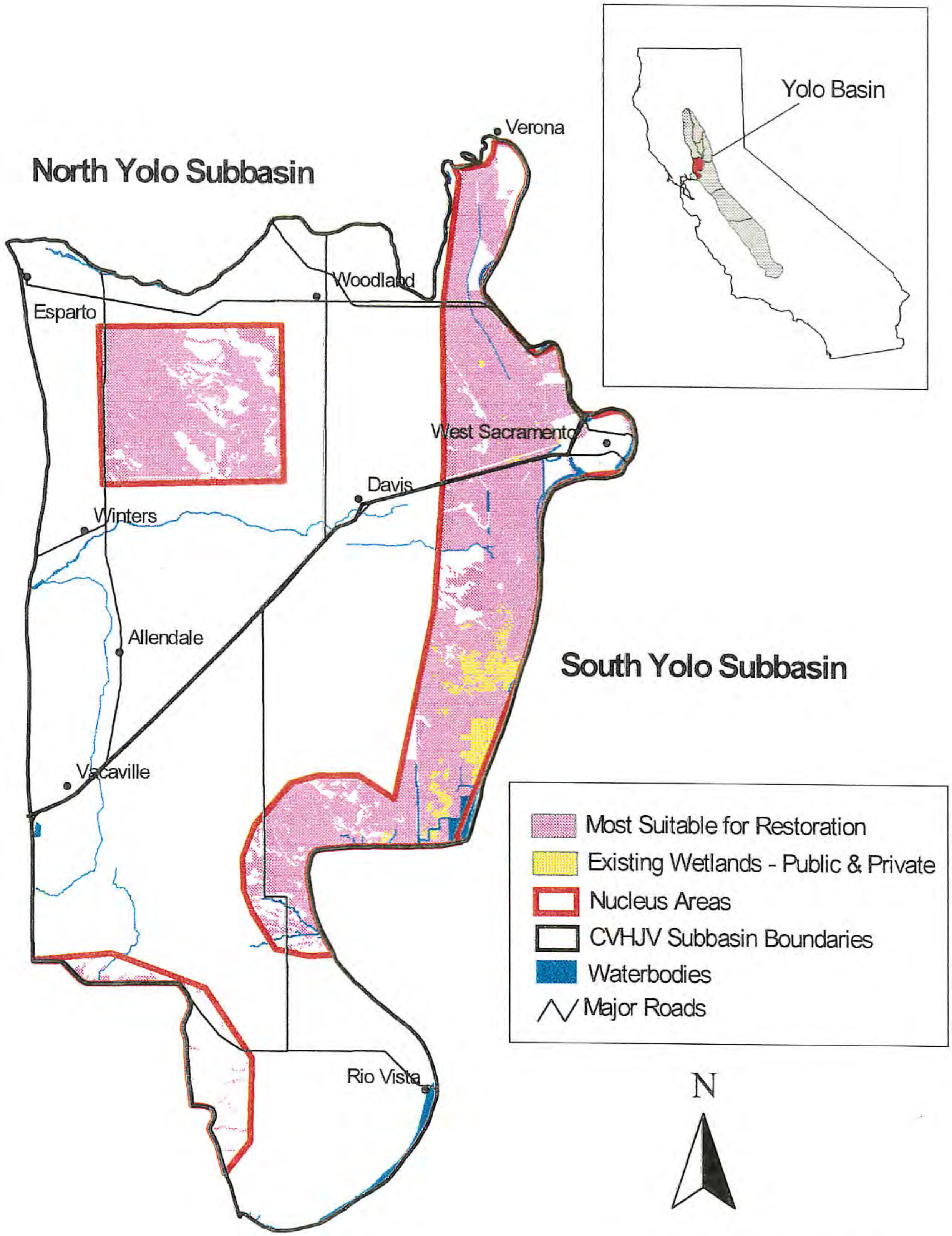


Table 3-24. Water Entities with Lands Suitable for Wetlands Restoration, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Yolo Basin Water Entities	Subbasin		Suitable Lands 500 acres or More
	North Yolo	South Yolo	
City of West Sacramento Water Service Area	X	X	560
Colusa Drain Water Users Association	X		1,710
Deseret Farms of California	X		930
Main Prairie Water District		X	6,020
North Delta Water Agency	X	X	44,740
Reclamation District 2035	X		9,270
Reclamation District 2068		X	3,640
Yolo County Flood Control and Water Conservation District	X	X	33,800

Note: 500-acre cutoff eliminates any entity with less than 0.41% of basin-wide Suitable Lands (total Suitable Lands in the service areas of two unlisted entities is 530 acres).

Suitable Lands Location

The GIS analysis identified a total of 120,520 acres of Lands Suitable for Wetlands Restoration in the Yolo Basin. Approximately 84% (101,200 acres) are inside the boundaries of water agencies. Occurrence of these Suitable Lands in each of the two subbasins is shown in **Table 3-25**.

Table 3-25. Lands Suitable for Wetlands Restoration, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Yolo Basin Subbasin	Lands Suitable for Wetlands Restoration					
			Inside Water Agency Boundaries		Outside Water Agency Boundaries	
	acres	% of Yolo Basin Total	acres	Percent	acres	Percent
North Yolo	58,050	48%	42,900	74%	15,150	26%
South Yolo	62,470	52%	58,300	93%	4,170	7%
Yolo Basin Totals =	120,520		101,200	84%	19,320	16%

Suitable Lands that lie within the boundaries of water agencies are approximately 1,700% of the 5,934-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Yolo Basin.

Suitable Lands Water Supply

Surface water and groundwater supply availability is generally good for current uses in this basin. Surface water is drawn from the Sacramento River, the Toe Drain located along the west edge of the Deep Water Ship Channel, the Tule Canal, Cache Creek, Clear Lake, Indian Valley Reservoir, Willow Slough, Putah Creek, Knights Landing Ridge Cut, and associated return flows. Although surface water quality is generally good, abandoned mercury mines in the upper watershed of Cache Creek could be a potential source of pollution to downstream wetlands. Monitoring programs have been initiated in cooperative efforts of county, State, and Federal agencies to collect data within this watershed. Results of these studies could provide information useful for the evaluation of proposed wetland sites in this area.

Water use in the Yolo Basin is dominated by irrigated agriculture, and most water demands are met by a combination of groundwater and surface water. Groundwater quality is generally good throughout the basin.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (49,280 acres or 41%), Moderate Reliability (31,040 acres or 26%), Low Reliability (15,180 acres or 12.5%), and Unknown Reliability (25,020 acres or 20.5%). Water supply reliability for the Suitable Lands in each of the two subbasins is shown in **Table 3-26**.

Table 3-26. Water Supply Reliability of Suitable Lands, Yolo Basin
Central Valley Wetlands Water Supply Investigations

Yolo Basin	**Lands Suitable for Wetlands Restoration**							
	Water Reliability, acres				Water Reliability, percent of acres			
Subbasin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
North Yolo	10,870	29,970	6,290	10,920	18.5%	52%	11%	18.5%
South Yolo	38,410	1,070	8,890	14,100	62%	1.5%	14%	22.5%
Yolo Basin Totals =	49,280	31,040	15,180	25,020	41%	26%	12.5%	20.5%

Suitable Lands with High reliability water supply are approximately 830% of the 5,934-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Yolo Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-27 shows the estimated water requirements for the remaining 5,934 acres of supplemental wetlands in Yolo Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

Table 3-27. Estimated Water Demands and Supplies for Supplemental Wetlands Yolo Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	5,044	593	297	5,934
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	25,220	4,388	3,935	33,543
Available Water Supply, AF/year				
Surface Water	24,931	4,346	3,894	33,170
Groundwater	129	18	13	159
Total Available Water, AF/year	25,060	4,363	3,906	33,329
Estimated Shortfall, AF/year	160	25	29	214
Low or Unknown Reliability Surface Water Supply, AF/year				
	3,391	590	529	4,510
Total Available Reliable Water Supply, AF/year				
	21,669	3,773	3,378	28,819
Estimated Shortfall in Available Known Reliable Water Supply, AF/year				
	3,551	615	557	4,724

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater. Unknown Reliability Surface Water Supply includes supplies to lands that are outside the boundaries of water supply agencies.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Yolo Basin are 33,543 AF/year (**Table 3-27**). Available water supplies for these wetlands are estimated to be 33,339 AF/year (i.e., there is a potential supply shortfall of 214 AF/year). The available supply is 99.5% surface water and 0.5% groundwater.

An estimated 4,510 AF/year of this supply is low or unknown reliability surface water associated with lands that are outside the service areas of water supply agencies.

The combination of the 214 AF/year available supply shortfall and the 4,510 AF/year low or unknown reliability supply results in an estimated available, known reliable supply shortfall of 4,724 AF/year.

Water supply availability and reliability improvement options and issues for Yolo Basin supplemental wetlands are identified in **Table 3-28** and discussed below.

Table 3-28. Water Supply Availability and Reliability Improvement Options and Issues Supplemental Wetlands in Yolo Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	Purchases Transfers	• Conveyance Losses • Legal Issues • Water Transfer/water Marketing Programs • Water Quality • Conveyance Difficulties
Groundwater	Existing wells New Wells	• Groundwater Development and Management • Groundwater Quality • Water Costs • Well Development Costs • Land Subsidence
Agricultural Return Flow	Continue current practices	• Water Quality • Effects of Water Conservation, Water Banks, and Water Transfers

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 33,200 AF/year of riparian, appropriative, and contracted water.

Surface Water Supply Shortfall

The above-described surface water supplies would provide 99.5% of the water used by the supplemental wetlands, but only 98.9% of the water that would be needed. An additional 214 AF/year of surface water would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is due to unavailability of some delivery systems during the winter months. In some instances, delivery systems are converted to flood control mode in the wet season and cannot be used for water delivery. The least expensive remedy to this seasonal surface water supply shortfall is probably the use of groundwater during this period.

Low and Unknown Reliability Surface Water Supply

A significant amount (~14%) of the surface water supply available to supplemental wetlands is low or unknown reliability supply associated with suitable lands that are outside the service areas of water supply agencies. A substantial area of suitable lands with unknown reliability surface water supply in the South Yolo Subbasin is within the North Delta Water Agency service area. These lands lie between Reclamation District 2068 to the west and the Ship Channel Toe Drain to the east. Although these lands are contiguous to lands that are adjacent to, or have access to, the Toe Drain, their source of water supply is unknown. The fact that most of these lands lie along channels that are connected to the Toe Drain suggests that they are likely supplied by diversions from these tidally-influenced channels and, in reality, have high reliability supplies.

Low reliability water supplies could be supplemented and replaced as needed by the use of groundwater or by purchase or transfer of higher reliability supplies from willing sellers within the Yolo Basin and/or Sacramento Valley. Because lands with low and unknown reliability supplies lie outside the service areas of water supply agencies, purchased and/or transferred supplies would have to be wheeled through combinations of the distribution systems of local water agencies and natural channels. Wheeling through local agency delivery systems would be complicated by unavailability of many of these delivery systems during the winter months (see earlier discussion of Surface Water supply Shortfall). An alternative to wheeling through local agency distribution systems would be the construction of new systems to wheel the purchased or transferred water.

Surface Water Supply Issues

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- Conveyance Losses
- Legal Issues
- Water Transfer and Marketing Programs
- Water Quality
- Conveyance Difficulties

Conveyance Losses. Although evaporative losses are lower in the winter, conveyance losses due to seepage may be similar to those occurring during the irrigation season (spring/summer). With lower deliveries expected in the winter, conveyance losses through natural channels may be significant (i.e., 40 to 50 percent of water put into the conveyance system).

Legal Issues. Changes in water supply allocations may involve many water rights holders, particularly in the Delta. All stakeholders must be considered in any future water allocation program.

Water Transfer and Marketing Programs. Water transfers and water marketing programs are complex and involve a myriad of public private, economic, urban, agricultural, and environmental factors. Concerns about these programs include the effect on local water rights, third party impacts, and the impact on the local economy and tax revenues. Most local agencies oppose out of basin transfers. Supplies derived through water marketing would most likely be cost-prohibitive for wetlands because of price competition by San Joaquin and Southern California buyers. Costs for purchased or transferred supplies for wetlands that are outside the service areas of water supply agencies would be further increased by the need for wheeling of purchased and transferred supplies.

Water Quality. Water quality in the basin, although generally good for agriculture, varies in suitability for wetlands. Delta water quality standards for environmental and urban use are established and must be met by outflow or treatment. Because the Yolo Basin extends into the Legal Delta, the basin will be affected by water management operations to meet Delta water quality standards.

Conveyance System Use Conflicts. Conveyance facilities used to carry water for agricultural irrigation could compete with wetlands irrigation during the growing season. Required canal maintenance and the need to use drainage canals for their wet season flood control purposes competes with wetland water delivery during the off-season. In the case of competing irrigation uses, agreements could be made between users for sharing costs or time of use. Conflicts between the need for irrigation supply during the wet season and the need to maintain dual-purpose irrigation/drainage canals in flood control readiness are not easily resolved short of constructing expensive separate winter water delivery facilities. Winter wetlands water supplies in such instances will most likely be dependent on groundwater.

Groundwater

Groundwater is assumed to provide less than 1% of the water needed for optimum management of the supplemental wetlands.

Groundwater Quality and Availability

Groundwater quality and groundwater availability in the Yolo Basin both range from good to poor. The following assessment of groundwater conditions was obtained in interviews of Yolo Basin water agencies:

- North of Interstate 80 in Areas Remote from Sacramento River (North Yolo Subbasin). There are: 1) areas of major groundwater depletion and land subsidence, 2) areas where water tables are okay, but there is a delicate balance and need to replenish, and 3) areas with ample supplies, but water quality problems (boron, selenium, nitrates). Groundwater quality in this area is characterized as moderate to poor, and groundwater availability is characterized as poor.

- North of Interstate 80 in Areas near Sacramento River (North Yolo Subbasin). There are some groundwater quality problems (iron, boron), but most water quality is acceptable. Availability is limited in some areas. Overall quality and availability in this area are characterized as good.

- South of Interstate 80 (South Yolo Subbasin). Quality conditions are geographically sensitive and vary from moderate to poor. Availability of groundwater in this area ranges from "unknown" to poor.

Potential Limitations in Groundwater Use for Wetlands

The use of groundwater for supplemental wetlands is potentially limited for reasons that include:

- Well Development Costs - These costs are ~$120,000 for a typical 16-inch irrigation well.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $30 to $50 per AF, which could be prohibitive to some private wetland owners. With low economic returns, costs for well construction and pumping are a serious issue for private wetland owners.

- Groundwater Development and Management - The Yolo County Flood Control and Water Conservation District monitors groundwater elevations in most of Yolo County and provides this data to DWR; it is also shared with USBR. The District has a comprehensive water management plan which has a groundwater component in it. Two of the Reclamation Districts involved in existing private wetlands water supply have groundwater management plans under AB 3030.

- Groundwater Quality - Groundwater quality varies from good to poor in the basin, with most areas characterized as having moderate to poor quality groundwater. If groundwater is considered as a supplemental supply for new wetlands, site-specific water quality sampling could be required to determine suitability.

- Groundwater Overdraft and Land Subsidence - Excessive groundwater extraction may lead to groundwater overdraft and land subsidence. If groundwater is used more extensively in this basin as a source for wetlands, this could lead to a requirement for aquifer monitoring.

Agricultural Return Flow

Agricultural return flow should be studied as a potential source for supplemental wetlands, and may be available except during drought. Issues include the following:

- Water Quality - Monitoring of agricultural return flow for residual constituents from agricultural runoff could be required.

- Effects of Water Conservation, Water Banks, and Water Transfers - Conservation efforts could reduce the amount of return flow now available. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. These programs result in reduction of agricultural water use and reduced outflow from the fields, hence reducing the amount of return flow.

YOLO BASIN FINDINGS

These investigations found that the 5,934 acres of Yolo Basin supplemental wetlands would need an additional reliable water supply of 4,724 AF/year to provide the 33,543 AF/year that would be needed for full supply at optimum management levels. An estimated 4,510 AF/year of the additional reliable supply would be needed to eliminate dependence on unknown reliability surface water, unless the unknown reliability supplies prove in fact to be reliable. The remainder would be needed to make up a 214 AF/year shortfall in available surface water supply.

Status of Current Water Supplies

Supplemental wetlands areas within the Yolo Bypass which retain rights to water from the Delta have a relatively reliable source of water, although environmental, economic, legal, political, and cost issues may need to be addressed. Water quality and flow requirements in the Delta may limit water supplies to some areas.

Most of the water source for supplemental wetlands in the Yolo Basin is surface water, which may be affected by upstream or downstream water regulations and water conservation efforts. Local officials have raised concerns about protecting water rights and in-basin versus out-of-basin use of water are important issues.

Groundwater is and can be used mostly as a minor supplemental source to surface water, primarily because of cost. The expense to develop and pump groundwater may be cost-prohibitive to most supplemental wetland owners.

Agricultural return flow would be a source of water for some of the supplemental wetlands in Yolo Basin.

American Basin

CVHJV Wetlands Restoration Objective, acres	**10,000**
Wetland Acres Protected & Restored	**173**
Remaining Wetland Acreage to Meet Objective	**9,827**
Total Basin Land Area, acres	**550,400**
Total Existing Wetlands (Private and Public), acres	**1,340**

BASIN DESCRIPTION

The American Basin covers 860 square miles in the southeastern portion of the Sacramento Valley, between the City of Oroville in the north and the American River in the south. This 65-mile-long basin is bordered by the Feather and Sacramento rivers to the west and the foothills of the Sierra Nevada to the east (**Figure 3-6**). Major rivers and streams include the Sacramento and Feather rivers, Honcut Creek, Yuba River, and Bear River. Numerous ephemeral creeks, streams, ravines and sloughs drain the foothill and valley floor areas.

BASIN HYDROLOGY

Historically, low-lying areas of this basin were flooded by overflow waters of the American, Yuba, Feather, Sacramento, and Bear rivers. These rivers were originally confined within broad natural levees formed by sediment deposits during floods. Coarse sediments were deposited close to the river channel and finer sediments were deposited farther out. As flood waters subsided, clays and silts settled in basins set within the low fan terraces. Tules and marsh grasses, supported by periodic flooding, grew in these low-lying areas prior to flood control levee construction.

In addition to constructed levees, structures which have improved the flood protection level and modified the hydrology within this basin include the dams at Folsom, Oroville, and Bullards Bar, ditches to collect and deliver water for mining and agriculture, and many smaller facilities.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the American Basin was divided into the District 10/Honcut and Lower American subbasins. Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-29**. The two subbasins and the locations of the Nucleus Areas and existing wetlands are shown on **Figure 3-6**.

Table 3-29. Nucleus Area and Existing Wetlands Acreage, American Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	**Existing Wetlands, acres**			**American Basin Nucleus Areas, acres**
	Public	Private	Total	
District 10/Honcut	0	960	960	
Lower American	0	380	380	
American Basin Totals	0	1,340	1,340	155,530

Managed wetlands totaling 1,340 acres are all privately-managed. The majority of these wetlands are in the upper half of the basin to the north of the Bear River.

LANDS SUITABLE FOR WETLANDS RESTORATION

American Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-30.**

Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the American Basin is a mix of deliveries through conveyance systems of water agencies and pumping from stream or drainage channels directly onto the lands or into an existing distribution system for delivery to points of use. American Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-30**.

Figure 3-6. American Basin -- Lands Suitable for Wetlands Restoration

Central Valley Wetlands Water Supply Investigations

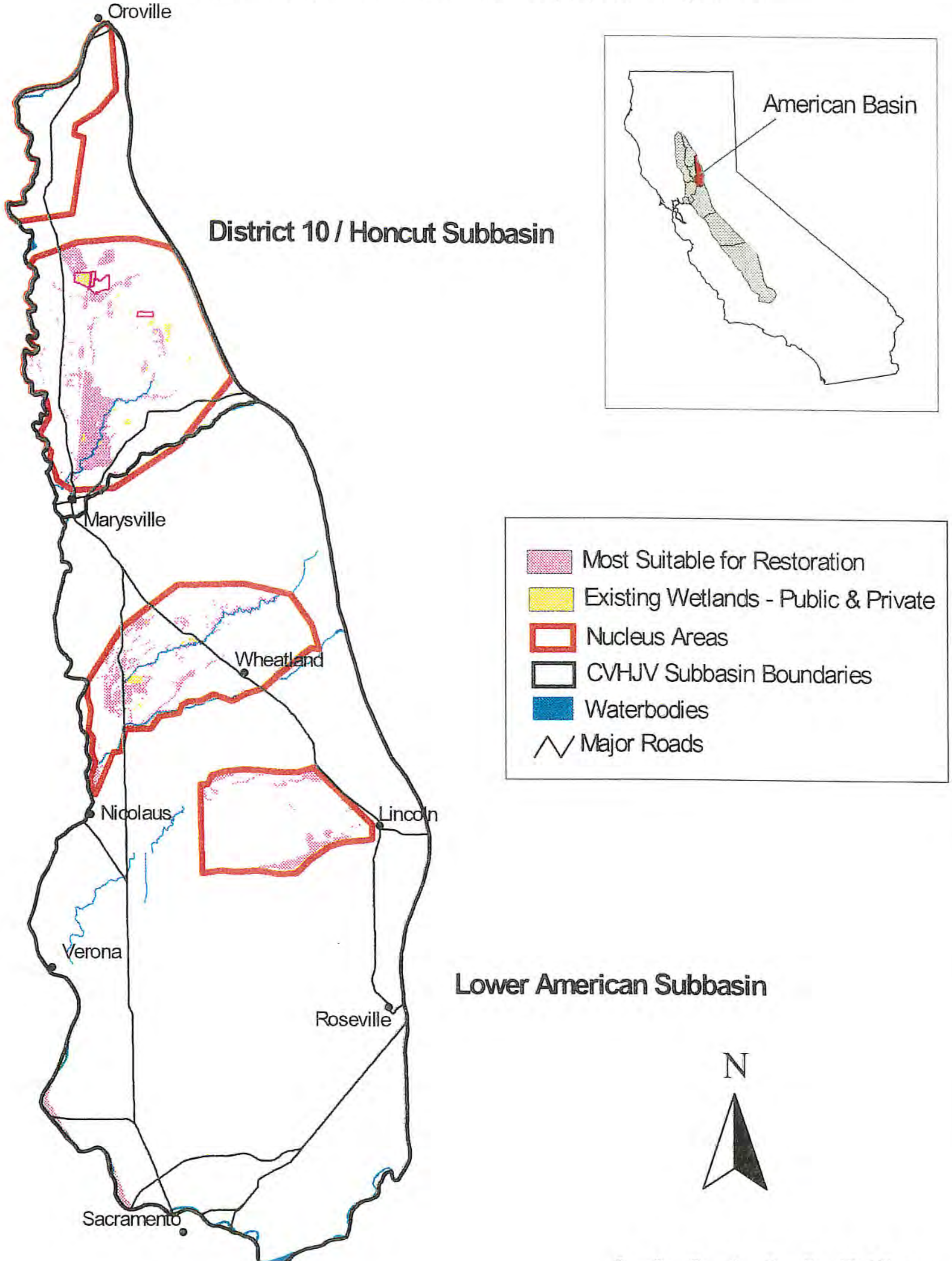


Table 3-30. Water Entities with Lands Suitable for Wetlands Restoration, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin Water Entities	Subbasin		Suitable Lands 500 acres or More
	District 10/Honcut	Lower American	
Cordua Irrigation District	X		1,810
Hallwood Irrigation Company	X	X	3,370
Ramirez Water District	X		890
Natomas Central Mutual Water District		X	830
Plumas Mutual Water Company		X	1,330
South Sutter Water District		X	1,200
South Yuba Water District		X	1,710
Western Placer Irrigation District		X	1,070
Wheatland Water District		X	820
Note: 500-acre cutoff eliminates any entity with less than 2.6% of basin-wide Suitable Lands (total Suitable Lands in the service areas of eight unlisted entities is 1,000 acres).			

Suitable Lands Location

The GIS analysis identified a total of 19,150 acres of Lands Suitable for Wetlands Restoration in the American Basin. Approximately 73% (14,030 acres) are inside the boundaries of water agencies. Occurrence of these wetlands in each of the two subbasins is shown in **Table 3-31.**

Table 3-31. Lands Suitable for Wetlands Restoration, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin	Lands Suitable for Wetlands Restoration					
	Total	% of American Basin Total	Inside Water Agency Boundaries		Outside Water Agency Boundaries	
Subbasin	acres		acres	Percent	acres	Percent
District 10/Honcut	8,910	47%	6,830	77%	2,080	23%
Lower American	10,240	53%	7,200	70%	3,040	30%
American Basin Totals =	19,150		14,030	73%	19,150	27%

Suitable Lands that lie within the boundaries of water agencies are approximately 151% of the 9,287-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for American Basin.

Suitable Lands Water Supply

Surface water supplies are generally good throughout the American Basin. There are some county ordinances on new well development, but in general the groundwater supply availability and quality are good except in the far northern portion of the basin, where yields may be severely limited.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (11,270 acres or 59%), Moderate Reliability (1,590 acres or 8%), Low Reliability (4,250 acres or 22%), and Unknown Reliability (2,040 acres or 11%). Water supply reliability for the Suitable Lands in each of the two subbasins is shown in **Table 3-32.**

Table 3-32. Water Supply Reliability of Suitable Lands, American Basin
Central Valley Wetlands Water Supply Investigations

American Basin	**Lands Suitable for Wetlands Restoration**							
	Water Reliability, acres				Water Reliability, percent of acres			
Subbasin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
District 10/Honcut	5,740	190	2,760	220	64%	2.5%	31%	2.5%
Lower American	5,530	1,400	1,490	1,820	54%	14%	14%	18%
American Basin Totals =	11,270	1,590	4,250	2,040	59%	8%	22%	11%

Suitable Lands with High reliability water supply are approximately 114% of the 9,827-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for American Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-33 shows the estimated water requirements for the remaining 9,830 acres of supplemental wetlands in American Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

Table 3-33. Estimated Water Demands and Supplies for Supplemental Wetlands American Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	8,355	983	492	9,830
Optimum Management Water Requirements, AF/acre/year	5.0	7.4	13.25	
Total Water Requirement, AF/year	41,775	7,274	6,519	55,568
Available Water Supply, AF/year				
Surface Water	31,752	5,898	5,530	43,179
Groundwater	0	0	0	0
Total Available Water, AF/year	31,752	5,898	5,530	43,179
Estimated Shortfall, AF/year	10,023	1,376	989	12,389
Low Reliability Surface Water Supply, AF/year				
	1,509	632	815	2,957
Total Available Reliable Water Supply, AF/year				
	30,243	5,266	4,714	40,223
Estimated Shortfall in Available Reliable Water Supply, AF/year				
	11,532	2,008	1,805	15,345

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Low Reliability Surface Water Supply includes irrigation tailwater.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Butte Basin are 55,568 AF/year (**Table 3-33**). Available water supplies for these wetlands are estimated to be only 43,179 AF/year (i.e., there is a potential supply shortfall of 12,389 AF/year). The available supply is 100% surface water.

An estimated 2,957 AF/year of this supply is low reliability water from a combination of:

1. water provided by a "supplemental" water supply agency that does not have sufficient supply to serve the agricultural water needs of its service area and

2. Irrigation tailwater.

The combination of the 12,380 AF/year available supply shortfall and the 2,957 AF/year low reliability supply results in an estimated available, reliable supply shortfall of 15,345 AF/year.

Water supply availability and reliability improvement options and issues for American Basin supplemental wetlands are identified in **Table 3-34** and discussed below.

Table 3-34. Water Supply Availability and Reliability Improvement Options and Issues, Supplemental Wetlands in American Basin
Central Valley Wetlands Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers Annexation	• District Operations and Maintenance • High Conveyance Losses • Conveyance Difficulties • Potential for High Cost • Competition with Other Buyers
Groundwater	Use existing wells New wells	• Pumping Costs • Well Development Costs
Agricultural Return Flow	Continue current practices	• Return Flow Timing • Effects of Water Conservation, Water Banks, and Water Transfers

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 43,200 AF/year comprised of: 1) water rights-derived supplies controlled by Yuba County Water Agency and provided by contract to some local districts, 2) supplies derived from the water rights of local districts, and 3) mixtures of tailwater and water rights-derived supplies.

Surface Water Supply Shortfall

The above surface water supplies would provide ~100% of the water used by the supplemental wetlands, but only 78% of the water that would be needed. An additional 12,389 AF/year would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is the result of water supply agency maintenance-related water delivery suspensions in the fall and winter months. If this shortfall cannot be eliminated by changes in agency delivery suspension practices (e.g., change from November through March total shutdowns to intermittent winter shutdowns), the alternative is the use of groundwater (discussed later).

Low Reliability Surface Water Supply

Approximately 7% of the surface water supply available to supplemental wetlands is low reliability supply derived from the following:

- Irrigation tailwater use by lands that are outside water supply agency service areas.
- Water provided by a "supplemental" water agency that does not have sufficient supply to serve agricultural needs in its service area.

Low reliability surface water supplies could be supplemented and replaced as needed by one or more of the following:

- Water agency annexation of lands that are outside of agency service areas.
- Water purchases or transfers of higher reliability supplies from willing parties within the American Basin and/or Sacramento Valley.
- Use of groundwater (discussed later).

Surface Water Supply Issues

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- High Conveyance Losses
- Conveyance Difficulties
- Potential High Cost of Purchased Water
- Competition with Other Buyers

District Operations and Maintenance. The absence of agricultural irrigation demand during winter months leads to shutdown of some agency delivery systems during January through early April. Water agencies use this shutdown period to perform system maintenance. Interviews of five American Basin water agencies disclosed the following fall and winter practices:

- Agency A - Delivery is suspended for maintenance temporarily only - no regular time.
- Agency B - Delivery is suspended for maintenance during the period February through March. Some landowners occasionally use wells in February and March.
- Agency C - Delivery is not suspended for maintenance. "Can deliver as long as there is enough water in Yuba River and delivery system is not damaged."
- Agency D - Delivery is suspended for maintenance during the period October 15 through April 15.
- Agency E - Delivery suspended for maintenance during January 15 through March 15.

As indicated above, water conveyance is subject to interruptions during the agricultural non-irrigation season (October through March) in some, but not all, of the agency distribution systems. The timing of such interruptions varies from agency to agency. Delivery interruptions include shutdowns for removal of vegetation from unlined canals. Canal cleaning interruptions could be reduced by potentially expensive canal modifications (e.g., lining).

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in the winter to those that occur during irrigation season (spring/summer). With lower deliveries expected during the winter, the percentage of loss of the total supply becomes significantly high (i.e., 40 to 50 percent of water put into the conveyance system). Any conveyances through natural channels may have significant conveyance losses.

Conveyance Difficulties. Unauthorized diversions are known to occur while transporting water through creeks, sloughs, and drains. Monitoring may be necessary to ensure delivery to the intended destination.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with buyers from the San Joaquin Valley and Southern California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed not to have a role in water supply to supplemental wetlands. Groundwater is generally available throughout the basin, and water quality problems are local. The use of groundwater for supplemental wetlands is potentially limited for the following reasons:

- Well Development Costs - Irrigation wells, about 400 to 600 feet deep, can cost around $100,000 to develop. These expenses make groundwater development cost-prohibitive for wetland restoration in the basin. Public financing or incentive programs can remedy this problem.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $15 to $30 per AF. With low economic returns, costs for well construction and pumping are a serious issue for private wetland owners.

Agricultural Return Flow

Agricultural return flow is available except during drought, and is used throughout the basin where available. This source is inexpensive, but has not been consistently available. Return flow can be used beginning in late August to reduce the need for water from other sources. Issues relating to return flow include:

- Return Flow Timing - During the irrigation season return flows may be available for certain wetland management practices, such as irrigation for waterfowl food crops and habitat management. However, in this basin most of the pre-harvest water releases from rice fields occur in late August through September before the majority of wetlands flood for fall and winter habitat. Most private wetlands make use of available return flow to the extent possible. Return flow use may be limited for wetlands irrigations in May and June because rice field flooding occurs at the same time. When rice fields are flooded, the timing of wetland irrigation and maintenance could be somewhat modified to use available, inexpensive, return flow to maintain appropriate habitat. Coordinating with upstream districts for return flow releases could improve the reliability prior to exploring alternatives for new supplies.

- Effects of Water Conservation, Water Banks, and Water Transfers - Water conservation efforts could reduce the amount of return flow now available. Water bank/transfer programs, such as those done in 1991, 1992, and 1994, could also reduce the amount of return flow supplies. These programs result in reduction of agricultural water use and reduced outflow from the fields, hence reducing the amount of return flow.

AMERICAN BASIN FINDINGS

These investigations found that the 9,830 acres of American Basin supplemental wetlands would need an additional reliable water supply of 15,345 AF/year to provide the 55,568 AF/year that would be needed for full supply at optimum management levels. An estimated 2,957 AF/year of the additional reliable supply would be needed to eliminate dependence on low reliability water that is a combination of irrigation tailwater and water supplied by a supplemental water agency. The remainder would be needed to make up a 12,389 AF/year shortfall in available surface water supply.

Status of Current Water Supplies

Surface water and groundwater supplies are generally good for this basin overall, but some areas of the basin face chronic shortages, lacking adequate surface water for all of their agricultural needs. Much of the shortfall in reliable water supplies for supplemental wetlands under the supplemental wetlands distribution assumptions used in this water supply analysis is due to dependence on low reliability water supplies.

The GIS analysis identified more than 19,100 acres of lands suitable for supplemental wetlands, with 73% located within water agency boundaries. Approximately 59% of the suitable lands (over 11,200 acres) have high water supply reliability (i.e, there is an abundance of Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on low reliability supplies).

Securing Additional Supplies

Annexing supplemental wetlands lands to water service areas can be explored as the best option to ensure a reliable water source to lands outside water service areas. New conveyance facilities may be needed, and will require funding. If this is not feasible, supplemental wetland managers could purchase surface water supplies from local districts willing to sell. These surface water supplies would have wheeling charges and some potential system or conveyance modification issues to address.

Groundwater use could enhance reliability in drought years; and some groundwater development could provide flexibility to wetland managers who could conjunctively use this source to take advantage of the available return flows and natural runoff. However, financial incentives will likely be necessary to make this option economically feasible for supplemental wetland owners.

Issues Affecting Water Availability and Reliability

Water conservation efforts, water banks, and water transfers could reduce the amount of water used upstream, thereby reducing the amount of water available as return flow. Water conservation may also reduce water quality. With water conservation, there will be less tailwater, so these return flows will have somewhat higher salt concentrations.

South Yuba WD uses Bullards Bar Dam to store water, and removal of this dam is being considered by the Department of the Interior. Removal of this dam would affect the reliability of the district's supply, and thus the reliability of current water supplies to some supplemental wetlands.

Water suppliers to rice growers in the American Basin are concerned that some CALFED programs will adversely affect their water supplies by requiring flushing flows to control the temperature of the river at the same time growers need to flood rice lands. This would also affect water supplies to supplemental wetlands that depended on tailwater from rice lands.

Delta Basin

CVHJV Wetlands Restoration Objective, acres	**20,000**
Wetland Acres Protected & Restored	**2,646**
Remaining Wetland Acreage to Meet Objective	**17,354**
Total Basin Land Area, acres	**1,344,000**
Total Existing Wetlands (Private and Public), acres	**5,400**

BASIN DESCRIPTION

The Delta Basin covers 2,100 square miles in the center of the Central Valley, between the American River to the north and the Stanislaus River to the south. This basin is bordered by the Sierra Nevada foothills to the east, the Sacramento River and Port of Sacramento Deep Water Ship Channel to the northwest, and the Coast Range to the southwest (**Figure 3-7**).

The Delta Basin is part of the wintering habitat for tens of thousands of waterfowl and other birds. In the Central Delta approximately 20,000 to 30,000 acres of field crops and grain are post-harvest flooded each winter, yet few managed wetlands exist in this area. A significant managed private wetland in the Central Delta is a 395-acre State easement project on Empire Tract west of Lodi. There also are small parcels of private wetlands throughout the basin which are primarily natural riparian areas.

BASIN HYDROLOGY

The Delta, comprised of about 500,000 acres of rich farmland, is interlaced with hundreds of miles of waterways. Much of the land is below sea level, and relies on more than 1,000 miles of levees for protection against flooding. Waterways in the Delta include the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras rivers; sloughs; streams; and ephemeral creeks. These waterways create a network of channels and islands throughout the basin.

In the mid-1800s, the Delta was mostly a tidal marsh, part of an interconnected estuary system that included the Suisun Marsh and San Francisco Bay. Until reclaimed by levees, the Delta was a great inland lake during the flood season. When flood waters receded, the network of sloughs and channels reappeared throughout the marsh.

Development of today's Delta began in the late 1850s when the Swamp Land Act conveyed ownership of all swamp and overflow land, including Delta marshes, from the Federal government to the State. Proceeds from the State's sale of swamp lands were to go toward reclaiming them. By the early 1900s, nearly all Delta marsh land had been reclaimed and converted to agricultural use.

NUCLEUS AREAS AND EXISTING WETLANDS

Delta Basin Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-35** and on **Figure 3-7**.

Table 3-35. Nucleus Area and Existing Wetlands Acreage, Delta Basin
Central Valley Wetlands Water Supply Investigations

	Existing Wetlands, acres			**Delta Basin Nucleus Areas, acres**
Delta Basin	Public	Private	Total	
Delta Basin Totals	2,900	2,500	5,400	250,340

The Delta Basin is part of the wintering habitat for tens of thousands of waterfowl and other birds. In the central Delta approximately 20,000 to 30,000 acres of field crops and grain are post-harvest flooded each winter, yet few managed wetlands exist in this area. Most of the nucleus areas in the Delta Basin are in either the northern or central part of the basin. Nucleus areas include both privately and publicly managed wetlands.

LANDS SUITABLE FOR WETLANDS RESTORATION

Delta Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-36.**

Water Supply Conveyance Facilities and Water Agencies

Distribution of water to lands in the Delta Basin is almost entirely by diversion from Delta channels and tributaries directly onto the properties. A few areas use groundwater from landowner wells. Delta Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-36.**

Figure 3-7. Delta Basin – Lands Suitable for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations

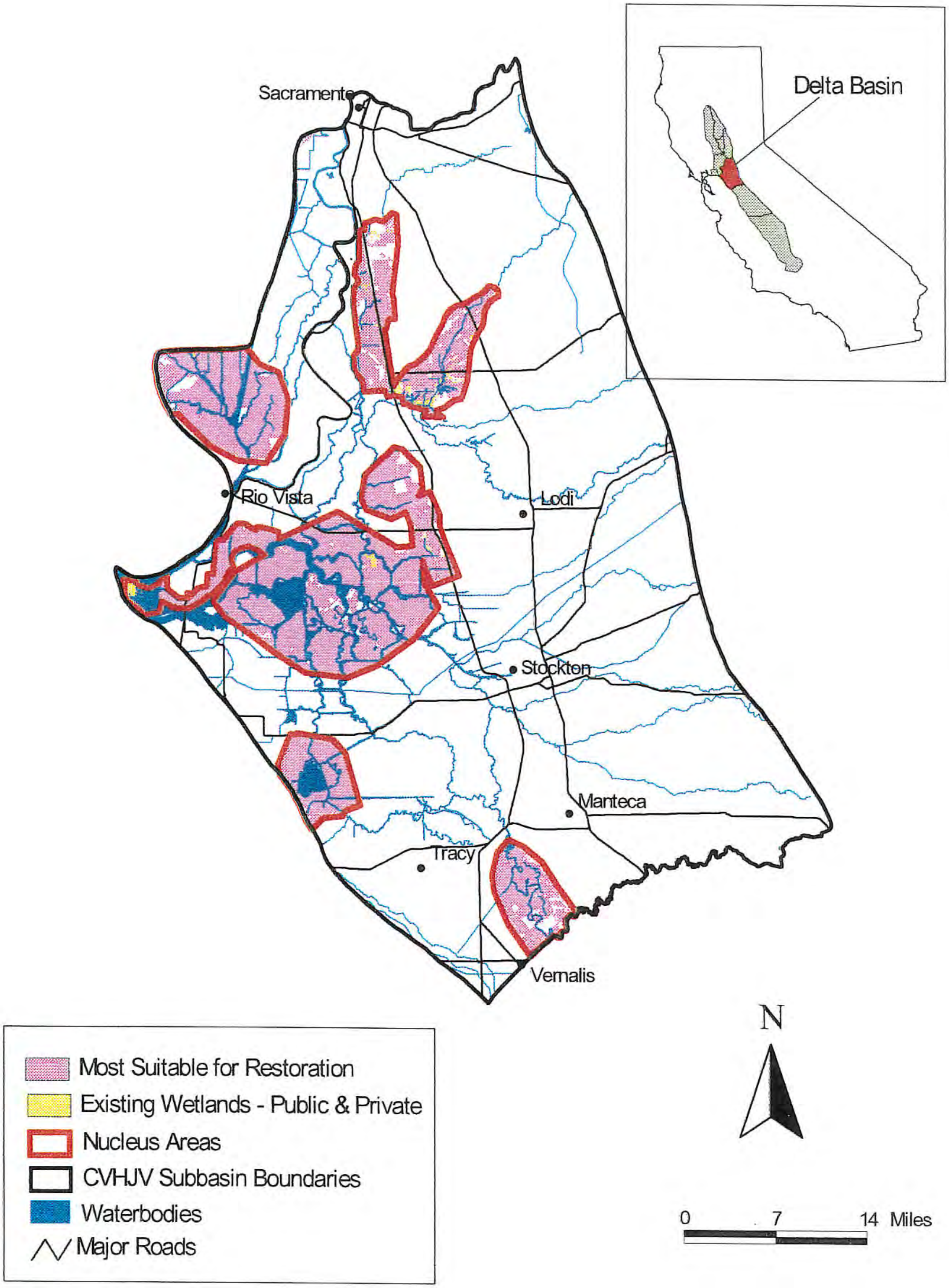


Table 3-36. Water Entities with Lands Suitable for Wetlands Restoration, Delta Basin
Central Valley Wetlands Water Supply Investigations

Delta Basin Water Entities	Suitable Lands 500 acres or More
Banta-Carbona Irrigation District	690
Byron Bethany Irrigation District	1,890
Central Delta Water Agency	61,070
Diablo Water District	1,000
North Delta Water Agency	63,710
Omochumne-Hartnell Water District	500
River Junction Reclamation District 2064	3,230
Sacramento County Water Agency	21,470
Sacramento County Water Maintenance District	680
South Delta Water Agency	21,260
Woodbridge Irrigation District	1,160
Woodbridge WUCD	3,340
Note: 500-acre cutoff eliminates any entity with less than 0.24% of basin-wide Suitable Lands (total Suitable Lands in the service areas of five unlisted entities is 1,210 acres).	

Suitable Lands Location

The GIS analysis identified a total of 210,100 acres of Lands Suitable for Wetlands Restoration in the Delta Basin. Approximately 87% (182,100 acres) are inside the boundaries of water agencies. Occurrence of these Suitable Lands is shown in **Table 3-37**.

Table 3-37. Lands Suitable for Wetlands Restoration, Delta Basin
Central Valley Wetlands Water Supply Investigations

	Lands Suitable for Wetlands Restoration	
Delta Basin	acres	% of Delta Basin Total
Inside Water Agency Boundaries	182,100	87%
Outside Water Agency Boundaries	28,000	13%
Delta Basin Totals =	210,100	

Suitable Lands that lie within the boundaries of water agencies are approximately 1,000% of the 17,354-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Delta Basin.

Suitable Lands Water Supply

Water supply for supplemental wetland restoration in the Delta Basin is most likely to come from surface water, but groundwater may also be used in some areas. Surface water quality is generally good, but some water quality issues--mostly salinity--exist in the western Delta during low outflow. In the areas southeast of Clifton Court Forebay and near the confluence of the Stanislaus and San Joaquin rivers, water quality may be impaired because of agricultural return flows. The overriding limitation on groundwater use is quality.

Surface water cost is low because most landowners have riparian and appropriative water rights for water diverted to their properties. Their primary surface water supply expenses are for the equipment, maintenance, and power supply for their pumps.

Unresolved Delta Issues

There are a number of unresolved issues that could affect water supplies for supplemental wetlands. The Delta Basin is the center of statewide controversy over water supplies and water quality in the Delta and the San Francisco Bay-Delta Estuary. Resolution of the Delta issues could have implications for water supply availability and reliability for supplemental wetlands which are still unknown. Unresolved questions include CALFED Delta solutions, and SWRCB determinations about where the water will come from to meet Delta water quality standards, which could potentially affect water right holders. Other issues that could affect supplemental wetlands water supplies include water marketing and transfers, anadromous fish programs, and other ESA requirements in the Delta.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (176,420 acres or 84%), Moderate Reliability (8,220 acres or 3.9%), Low Reliability (1,350 acres or 0.6%), and Unknown Reliability (24,060 acres or 11.5%). Water supply reliability for the Suitable Lands is shown in **Table 3-38**.

Suitable Lands with High reliability water supply are approximately 1,000% of the 17,354-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for Delta Basin.

Table 3-38. Water Supply Reliability of Suitable Lands, Delta Basin
Central Valley Wetlands Water Supply Investigations

	Lands Suitable for Wetlands Restoration							
	Water Reliability, acres				Water Reliability, percent of acres			
Delta Basin	High	Moderate	Low	Unknown	High	Moderate	Low	Unknown
Inside Water Agencies	148,530	8,220	1,350	24,000	81.5%	4.5%	0.8%	13.2%
Outside Water Agencies	27,940	0	0	60	99.8%	0%	0%	0.2%
Delta Basin Totals =	176,470	8,220	1,350	24,060	84%	3.9%	0.6%	11.5%

Supplemental Wetlands Water Demands and Supplies

Table 3-39 shows the estimated water requirements for the remaining 17,354 acres of supplemental wetlands in Delta Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in Delta Basin are 94,406 AF/year (**Table 3-39**). Available water supplies for these wetlands are estimated to be only 94,406 AF/year (i.e., the available supply meets the needs). The available supply is 92% surface water and 8% groundwater.

An estimated 21,611 AF/year of this supply is unknown reliability surface water associated with lands that are outside the service areas of water supply agencies. The 21,611 AF/year unknown reliability supply results in an estimated available, known reliable supply shortfall of 21,611 AF/year.

Water supply availability and reliability improvement options and issues for Delta Basin supplemental wetlands are identified in **Table 3-40** and discussed below.

Table 3-39. Estimated Water Demands and Supplies for Supplemental Wetlands Delta Basin

Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	14,751	1,735	868	17,354
Optimum Management Water Requirements, AF/acre/year	4.75	7.4	13.25	
Total Water Requirement, AF/year	70,067	12,842	11,497	94,406
Available Water Supply, AF/year				
Surface Water	64,720	11,862	10,620	87,202
Groundwater	5,346	980	877	7,204
Total Available Water, AF/year	70,067	12,842	11,497	94,406
Estimated Shortfall, AF/year	0	0	0	0
Unknown Reliability Surface Water Supply, AF/year	16,039	2,940	2,632	21,611
Total Available Known Reliable Water Supply, AF/year	54,027	9,902	8,865	72,795
Estimated Shortfall in Available Known Reliable Water Supply, AF/year	16,040	2,940	2,632	21,611

Note: Total Available Known Reliable water supply includes surface water supplies that are in High and/or Moderate reliability classifications. Unknown Reliability Surface Water Supply includes supplies to lands outside the boundaries of water supply agencies.

Table 3-40. Water Supply Availability and Reliability Improvement Options and Issues, Supplemental Wetlands in Delta Basin

Central Valley Wetlands Water Supply Investigation

Source	Options	Issues
Surface Water	Purchases and transfers	• Delta Water Quality and Flow Standards • Water Right/Contract Modification • District Operations and Maintenance • Potential High Cost of Water Transfers • Competition with Other Buyers • Water Quality
Groundwater	Use existing wells New wells	• Pumping Costs • Well Development Costs • Saltwater Intrusion • Water Quality
Agricultural Return Flow	Continue current practices	• Water Quality

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 86,860 AF/year of riparian and appropriative water.

Unknown Reliability Surface Water Supply

A significant (23%) of the surface water supply available to supplemental wetlands is unknown reliability supply associated with suitable lands that are inside the service area of the Sacramento County Water Agency, which is not a water supplier. Most of these lands lie along the Cosumnes River and are believed to be served by diversions under landowner riparian water rights.

If the water supply to these lands proves to be of low reliability, the supplies could be supplemented or replaced as needed by the use of groundwater, or by purchase or transfer of higher reliability supplies from willing sellers within the Delta Basin and/or Sacramento Valley. The absence of local water supply agencies with delivery systems in this area would make water wheeling difficult. One possibility would be the use of the Folsom South Canal to convey purchased or transferred water for release to the Cosumnes River upstream of the supplemental wetlands.

Surface Water Supply Issues

Issues in improving the availability reliability of supplemental wetlands surface water supplies are in the following categories:

- Delta Water Quality and Flow Standards
- Water Rights Modification
- Water Quality
- Potential High Cost of Purchased Water
- Competition with Other Buyers

Delta Water Quality and Flow Standards. Water quality standards could affect wetland water supplies. The appropriative water rights of some parcels are subject to curtailment when water is released by the water projects to meet the water quality standards and other in-basin entitlements in the Sacramento-San Joaquin Delta watershed.

Water Right/Contract Modification. Riparian water rights are limited to beneficial uses and to use of natural flows. Appropriative rights may restrict use to the agricultural irrigation season. Wetland development on these parcels may require approval from the SWRCB of a permit extending the season, rate, or quantity of diversion.

Water Quality. Salinity, selenium, and boron levels are elevated in some areas of the southern Delta Basin.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with buyers from the San Joaquin Valley and Southern California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed to provide approximately 8% of the water needed for optimum management of the supplemental wetlands. Groundwater is believed to be the water source for suitable lands that are in the upper area of the Cosumnes watershed in areas away from the river.

Groundwater is generally available throughout the Delta Basin, but its use for supplemental wetlands is potentially limited for reasons that include:

- Well Development Costs - Groundwater development and pumping costs are approximately $100,000 for a typical irrigation well. This expense may make groundwater development cost-prohibitive for most wetlands in the basin. Financial incentive programs could remedy this problem.

- Pumping Costs - DWR has estimated that groundwater pumping costs could range from $30 to $50 per AF. With low economic returns, costs for well construction and pumping present a serious issue for private wetland owners.

- Saltwater Intrusion - Groundwater pumping could exacerbate saltwater intrusion problems in some areas.

- Water Quality - Salinity, selenium, and boron levels are elevated in some areas of the southern Delta Basin.

Agricultural Return Flow

Agricultural return flow is currently available to meet some of the supplemental wetland water demands. Return flow quality may require evaluation in some areas (e.g., southwest of Clifton Court Forebay and the confluence of the Stanislaus and San Joaquin rivers).

DELTA BASIN FINDINGS

These investigations found that the 17,354 acres of Delta Basin supplemental wetlands would need an additional reliable water supply of 21,611 AF/year to provide the 94,406 AF/year that would be needed for full supply at optimum management levels. The entire additional reliable supply would be needed to eliminate dependence on unknown reliability water, unless the unknown reliability supplies prove, in fact, to be reliable.

Status of Current Water Supplies

Currently, no additional water supply appears to be needed in this basin to bring all of the supplemental wetlands to full supply and optimum management levels. The *1993 Sacramento-San Joaquin Delta Atlas* reports that the average annual inflow to the Delta is 27.8 million AF. Average annual Delta water use, including consumptive use, channel depletion, and diversions to outside areas totals approximately 6.8 million AF. Should additional water be required for supplemental wetlands within the Delta Basin, the demand could be met with the water in the Delta, assuming that the supplemental wetlands areas with unknown reliability supplies prove to have riparian or appropriative rights to this water.

The GIS analysis identified more than 210,000 acres of lands suitable for supplemental wetlands. Approximately 84% of the suitable lands (over 176,000 acres) have high water supply reliability (i.e, there is an abundance of Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on unknown reliability supplies).

Groundwater is a potential source of water supply for wetlands, but varying water quality and well development and pumping costs may make this a less desirable source than surface water. Groundwater is normally an expensive source of water compared with surface water supply in the Delta. Therefore, groundwater use may be cost-prohibitive for many of the private wetland owners

Issues Affecting Water Availability and Reliability

The Sacramento-San Joaquin Delta is the hub of California's water supplies, and could be affected by any or all actions to provide water supply or reliability to other Central Valley water users or for instream flows. Reallocation of supplies or additional diversions could reduce the amount of water currently available to Delta lands that are suitable for supplemental wetlands. However, at the present time most of the water supplies in the Delta are highly reliable because of the generally superior riparian water rights held by most landowners in the basin. Although pending CALFED and SWRCB decisions create some uncertainties, it is possible that they will be resolved in ways that will benefit water quality and reliability for water users in the Delta, including wetlands.

Suisun Marsh Basin

CVHJV Wetlands Restoration Objective, acres	**0**
Wetland Acres Protected & Restored	**5**
Remaining Wetland Acreage to Meet Objective	**0**
Total Basin Land Area, acres	**108,800**
Total Existing Wetlands (Private and Public), acres	**37,800**

BASIN DESCRIPTION

The Suisun Basin covers 170 square miles in southern Solano County to the west of the Delta and east of the Carquinez Strait. The Suisun Marsh is the primary wetland feature lying north of the Suisun Bay and south of the cities of Fairfield and Suisun (**Figure 3-8**). The Suisun Marsh is the largest contiguous brackish water wetland in California. The tidally influenced Suisun Marsh Basin contains a myriad of sloughs that supply tidal, seasonal, and permanent marsh lands.

Approximately 200 species of birds, 45 species of mammals, and 36 species of amphibians and reptiles inhabit the Marsh. The Marsh provides a key habitat along the Pacific Flyway for wintering ducks including pintail, mallard, widgeon, green-winged teal, shoveler, canvasback, and ruddy duck. Canadian, white-fronted, and snow geese also use this area.

To protect the quality of the Marsh, landowners formed the 116,000-acre Suisun Resource Conservation District (Suisun RCD) in 1963, which consists of managed wetlands, unmanaged tidal wetlands, bays, sloughs, and upland grasslands. CDFG manages the 14,800-acre Grizzly Island Suisun Marsh Complex. There are 158 privately owned wetlands within Suisun RCD. Because of its location and significance on the Pacific Flyway, the Suisun Basin is highly regulated to maintain and enhance wetlands management and water quality standards. SWRCB water quality objectives for the basin are met through CVP and SWP releases which supplement Sacramento and San Joaquin rivers natural flows during the low-flow season. USBR, DWR, CDFG and the Suisun RCD signed a Suisun Marsh Preservation Agreement, and together participate in implementing a Plan of Protection. Private wetland managers must meet Suisun Marsh Preservation Act standards for wetland habitat and water quality as well. In 1995, SWRCB revised Suisun Marsh standards based on the objectives in the 1995 Bay/Delta Plan. A time line of actions taken to protect the Marsh is presented in **Appendix B.**

BASIN HYDROLOGY

In the early 1800s, the Suisun Marsh was a brackish tidal basin covering more than 74,000 acres. Marsh soils are a buildup of peat soils combined with silt deposits from overflows of the Suisun and Montezuma sloughs and the Sacramento and San Joaquin rivers. The mixing of saltwater tidal cycles and fresh water outflows from the Delta creates brackish water quality conditions. Prior to development, large portions of the Marsh were subjected to submergence daily. These daily tidal fluctuations were removed after levees were built. After levee construction began in 1850, land development reduced these natural tidal lands to their current acreage.

The Suisun Marsh is affected by tidal inflow from the San Francisco Bay and fresh water outflow from the Delta. Suisun Bay, which connects these two sources, lies along the southern boundary of the basin with Grizzly and Honker bays extending northward to form the southern borders of the Marsh. Major waterways include Suisun (extending to Suisun City), Montezuma, and Nurse sloughs. Minor waterways include Goodyear, Cordelia, Harvey, Frank Horan, Chadbourne, Peltier, Wells, Sheldrake, Boynton, Peytonia, Duck, Hill, Cutoff, Volanti, Tree, Island, Frost, Cross, Hasting, Luco, Denverton, Grizzly, Roaring River, Howard, Champion, Mud and Norther sloughs. Some fresh water is introduced through Green Valley and Suisun creeks. The numerous waterways have created Morrow, Joice, Grizzly, Hammond, Simmons, Bradmoor, Wheeler, Dutton, Van Sickle, Chipps, Snag, Freeman, Ryer, and Roe islands.

NUCLEUS AREAS AND EXISTING WETLANDS

Suisun Marsh Basin Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-41**.

Table 3-41. Nucleus Area and Existing Wetlands Acreage, Suisun Marsh Basin
Central Valley Wetlands Water Supply Investigations

	Existing Wetlands, acres			**Suisun Marsh Basin Nucleus Areas, acres**
Suisun Marsh Basin	Public	Private	Total	
Suisun Marsh Basin Totals	8,080	29,720	37,800	89,760

WATER SUPPLY

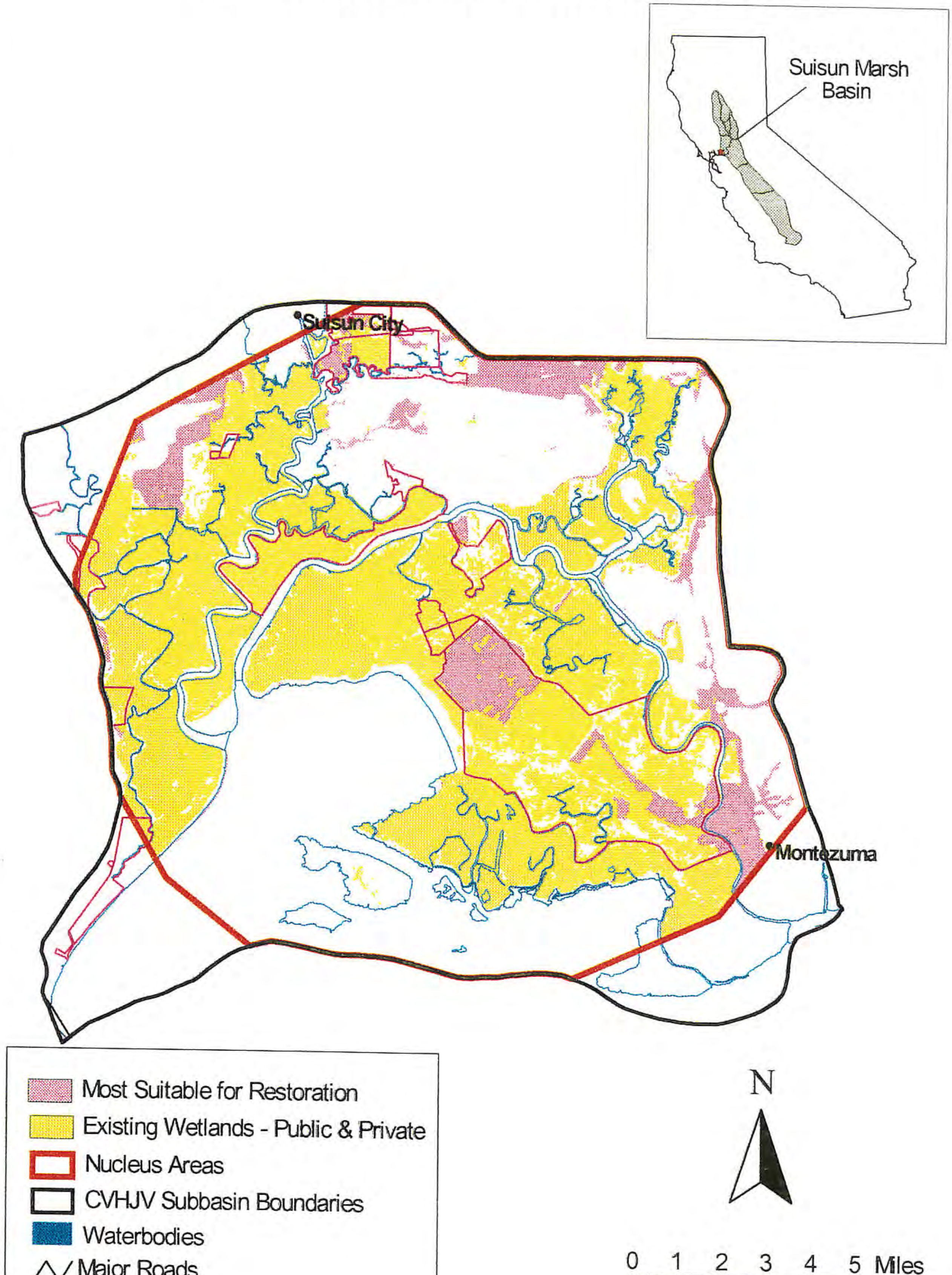
There are no CVHJV supplemental wetland restoration objectives for this basin. Currently, there is sufficient surface water to satisfy all existing water demands.

FINDINGS

There are no CVHJV objectives for supplemental wetland restoration for this basin. Current supplies are sufficient in quantity and quality to satisfy all demands for existing wetland habitat.

Figure 3-8. Suisun Basin -- Lands Suitable for Wetlands Restoration

Central Valley Wetlands Water Supply Investigations



San Joaquin Basin

CVHJV Wetlands Restoration Objective, acres	**20,000**
Wetland Acres Protected & Restored	**8,820**
Remaining Wetland Acreage to Meet Objective	**11,180**
Total Basin Land Area, acres	**1,856,000**
Total Existing Wetlands (Private and Public), acres	**50,970**

BASIN DESCRIPTION

The San Joaquin Basin covers 2,900 square miles in northern San Joaquin Valley between the Stanislaus River in the north to roughly the San Joaquin River near the town of Mendota in the south. This 80-mile-long basin is bordered by the SWP California Aqueduct to the west and the southern Sierra Nevada Mountains to the east (**Figure 3-9**). Major tributaries to the San Joaquin River include the Chowchilla, Merced, and Tuolumne rivers, and numerous creeks and sloughs drain into the river. California's two major water supply projects, CVP and SWP, convey water through the Delta-Mendota Canal and the California Aqueduct, respectively; both have storage in the CVP/SWP San Luis Reservoir. Other features include the Chowchilla Canal, and Eastside and Mariposa bypasses. The basin also contains wildlife refuges, wetlands, and stretches of rivers that are designated Wild and Scenic under the National Wild and Scenic Rivers Act.

BASIN HYDROLOGY

The San Joaquin Basin's major wetland areas historically were along the San Joaquin River, near Los Banos and Merced, up to the confluence of the Stanislaus River.

Historically, tens of thousands of acres of seasonal and semipermanent marsh occurred from floods of the San Joaquin, Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus rivers. A significant portion is flooded year round, providing a vast breeding and wintering area for migratory waterfowl and other water-related wildlife. Surface water not retained in the Basin drains north and reenters the San Joaquin River.

Today, levees along the major streams in this basin protect productive agricultural land from frequent flooding. Along the western side of the valley, more than 100,000 acres have soil conditions that favor wetland environments. These soils derived from marine sediments, which are high in salts and trace elements. Former irrigation practices dissolved these substances into the shallow groundwater, and the agricultural return flow was used as a water source for wetlands. Scientists later discovered that the selenium in the water was damaging to waterfowl, and the use of return flow for wetlands has lessened. However, return flow still is conveyed to the San Joaquin River.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the San Joaquin Basin was divided into the Grasslands Resource Conservation District (RCD), East Grasslands and Outside Grasslands subbasins. Nucleus Area and existing private and public wetland acreage are shown in **Table 3-42**. The three subbasins and the locations of the Nucleus Areas and existing wetlands are shown on **Figure 3-9**.

Table 3-42. Nucleus Area and Existing Wetlands Acreage, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	Existing Wetlands, acres			San Joaquin Basin Nucleus Areas, acres
	Public	Private	Total	
Grasslands RCD	6,310	32,560	38,870	
East Grasslands	820	2,490	3,310	
Outside Grasslands	3,950	4,840	8,790	
San Joaquin Basin Totals	11,080	39,890	50,970	391,260

San Joaquin Basin water entities shown by the GIS analysis to have 500 or more acres of Lands Suitable for Wetlands Restoration in their service areas are identified in **Table 3-43.**

Water Supply Conveyance Facilities and Agencies

Surface water supplies to Suitable Lands in the San Joaquin Basin are obtained from natural waterways and from flood control, drainage, and irrigation conveyance systems. San Joaquin Basin water agencies with potential for involvement in water supply to supplemental wetlands are those identified in **Table 3-43**.

Figure 3-9. San Joaquin Basin – Lands Suitable for Wetlands Restoration

Central Valley Wetlands Water Supply Investigations

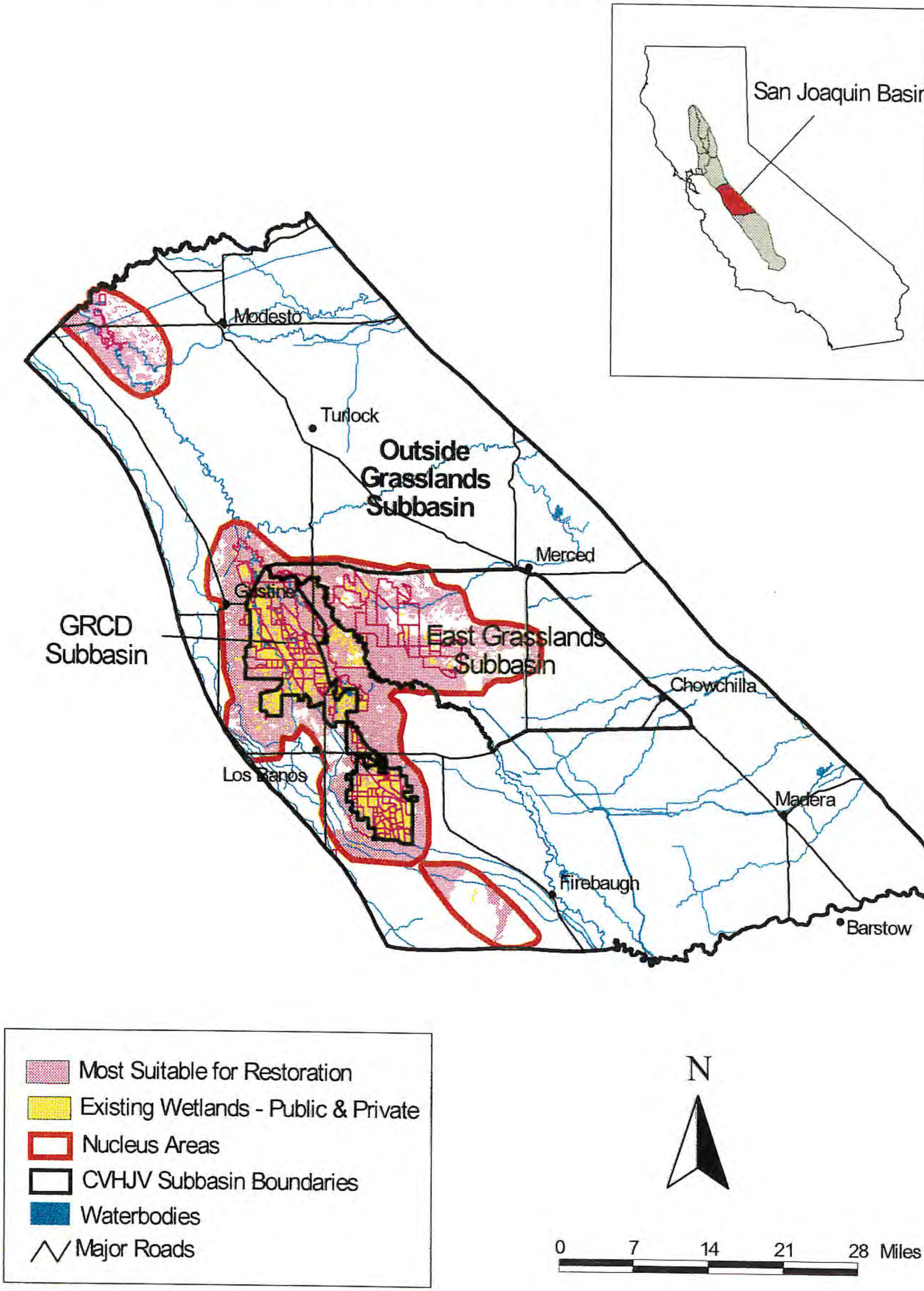


Table 3-43. Water Entities with Lands Suitable for Wetlands Restoration, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

San Joaquin Basin Water Entities	**Subbasin**			**Suitable Lands 500 acres or More**
	Grasslands RCD	East Grasslands	Outside Grasslands	
Broadview Water District			X	1,720
Central California Irrigation District	X		X	25,270
City of Newman Service Area			X	780
Eagle Field Water Company			X	1,140
Firebaugh Canal Water District			X	2,890
Grassland Water District	X		X	18,510
Merced Irrigation District		X	X	4,580
Mercy Springs Water District			X	2,400
Modesto Irrigation District			X	3,710
Oro Loma Water District			X	520
Pacheco Water District			X	580
Panoche Water District			X	1,520
San Luis Canal Company	X	X	X	19,740
San Luis Water District			X	3,610
Turlock Irrigation District			X	1,260

Note: 500-acre cutoff eliminates any entity with less than 0.21% of basin-wide Suitable Lands (total Suitable Lands in the service areas of seven unlisted entities is 920 acres).

Suitable Lands Location

The GIS analysis identified a total of 243,260 acres of Lands Suitable for Wetlands Restoration in the San Joaquin Basin. Approximately 37% (89,150 acres) are inside the boundaries of water agencies. Occurrence of Suitable Lands in each of the three subbasins is shown in **Table 3-44.**

Table 3-44. Lands Suitable for Wetlands Restoration, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

San Joaquin Basin Subbasin	**Lands Suitable for Wetlands Restoration**					
			Inside Water Agency Boundaries		Outside Water Agency Boundaries	
	acres	% of Basin Total	acres	Percent	acres	Percent
Grasslands RCD	36,570	15%	18,310	50%	18,260	50%
East Grasslands	68,900	28%	4,230	6%	64,670	94%
Outside Grasslands	137,700	57%	66,520	48%	71,180	52%
San Joaquin Basin Totals =	243,260		89,150	37%	154,110	63%

Suitable Lands that lie within the boundaries of water agencies are approximately 800% of the 11,178-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for San Joaquin Basin.

Most of the Suitable Lands are located close to currently developed private and public wetland sites. Most of these areas have characteristics which enhance their qualities for wetlands, such as high water tables, poor drainage, heavy soils, saline conditions, hydric classified soils, and are often near natural sloughs and rivers.

Suitable Lands Water Supply

San Joaquin Basin water supplies consist of local surface water, imported surface water, and groundwater. Average year supplies in the basin are ~75 percent surface water and 25 percent groundwater. Drought year supplies are ~65 percent surface water and 35 percent groundwater.

- Local Surface Water - Local surface water (from nine major Sierra Nevada river systems that flow into the valley) provides ~35 percent of the area's total supply during average years.

- Imported Surface Water - Basin water supplies are augmented by two major water importation projects (CVP's Delta-Mendota Canal and SWP's California Aqueduct) that mostly serve agriculture. About 2 million AF/year of Delta water is imported into San Joaquin Basin. Most of this water is carried by the Delta-Mendota Canal.

- Groundwater - Groundwater pumping is limited because of overdraft concerns. Groundwater quality throughout the basin varies from poor to good. Most groundwater use is confined to on-farm use only. Within the basin, groundwater availability, well capacities, quality, and pumping costs vary enormously.

Suitable Lands Water Supply Reliability

The water supply reliability of the Lands Suitable for Wetlands Restoration is High Reliability (58,300 acres or 24%), Low Reliability (16,450 acres or 7%), and Unknown Reliability (168,510 acres or 69%). Water supply reliability for the Suitable Lands in each of the three subbasins is shown in **Table 3-45.**

Table 3-45. Water Supply Reliability of Suitable Lands, San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

San Joaquin Basin	Lands Suitable for Wetlands Restoration					
	Water Reliability, acres			Water Reliability, percent of acres		
Subbasin	High	Low	Unknown	High	Low	Unknown
Grasslands RCD	19,320	0	17,250	53%	0%	47%
East Grasslands	4,210	0	64,780	6%	0%	94%
Outside Grasslands	34,770	16,450	86,480	25%	12%	63%
San Joaquin Basin Totals =	58,300	16,450	168,510	24%	7%	69%

Suitable Lands with High reliability water supply are approximately 520% of the 11,178-acre wetland restoration area needed to accomplish the remainder of the CVHJV Wetlands Restoration Objective for San Joaquin Basin.

Supplemental Wetlands Water Demands and Supplies

Table 3-46 shows the estimated water requirements for the remaining 11,180 acres of supplemental wetlands in San Joaquin Basin. The analyses of Available Water Supply, Low Reliability Surface Water Supply, Total Available Reliable Water Supply, and Estimated Shortfall in Available Reliable Water Supply are based on the assumption that the geographical distribution of restored wetlands mimics that of the existing private wetlands.

Table 3-46. Estimated Water Demands and Supplies for Supplemental Wetlands San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

	Wetland Habitat Type			
	Seasonal	Semi-Permanent	Permanent	Total
Wetland Acreage	10,062	783	335	11,180
Optimum Management Water Requirements, AF/acre/year	5.25	7.4	13.25	
Total Water Requirement, AF/year	52,826	5,794	4,439	63,058
Available Water Supply, AF/year				
Surface Water	50,242	5,510	4,271	60,023
Groundwater	627	68	42	738
Total Available Water, AF/year	50,869	5,578	4,313	60,760
Estimated Shortfall, AF/year	1,956	216	126	2,298
Unknown Reliability Surface Water Supply, AF/year	8,079	1,409	1,299	10,787
Total Available Reliable Water Supply, AF/year	42,790	4,169	3,014	49,973
Estimated Shortfall in Available Known Reliable Water Supply, AF/year	10,035	1,625	1,425	13,085

Note: Total Available Reliable water supply includes surface water supplies that are in the High and/or Moderate reliability classifications. Unknown Reliability Surface Water Supply includes supplies to lands that are outside the boundaries of water supply agencies.

WATER SUPPLY AVAILABILITY AND RELIABILITY IMPROVEMENT OPTIONS

This discussion of options for improvement of water supply availability and reliability is based on the assumption that supplemental wetlands would continue to receive the water supply allocated to the former land use. Water needs for optimum management of supplemental wetlands in San Joaquin Basin are 63,058 AF/year **(Table 3-46)**. Available water supplies for these wetlands are estimated to be only 60,760 AF/year (i.e., there is a potential supply shortfall of 2,298 AF/year). The available supply is ~99% surface water and 1% groundwater. An estimated 49,973 AF/year of this supply is unknown reliability surface water.

The combination of the 2,298 AF/year available supply shortfall and the 49,973 AF/year unknown reliability surface supply results in an estimated available, reliable supply shortfall of 13,085 AF/year.

Water supply availability and reliability improvement options and issues for San Joaquin Basin supplemental wetlands are identified in **Table 3-47** and discussed below.

Table 3-47. Water Supply Availability and Reliability Improvement Options and Issues Supplemental Wetlands in San Joaquin Basin
Central Valley Wetlands Water Supply Investigations

Source	Options	Issues
Surface Water	• Conversion of agricultural lands • Purchases and transfers	• District Operations and Maintenance • Water Right/contract Modification • Conveyance Losses • Potential High Cost of Purchased Water • Competition with Other Buyers
Groundwater	• Use existing wells • New wells	• Well Development Costs • Subsidence • Water Quality Limitations • Groundwater Development and Management
Agricultural Return Flows	• Continue current practices	• Areas Outside of Districts • Availability of Conserved Water to Private Wetlands
Water Conservation	• Additional conservation opportunities	• Effects of Conservation on Water Quality • High Cost of Implementation

Surface Water

Surface water supplies to supplemental wetlands are assumed to consist of about 60,000 AF/year comprised of:

- 49,200 AF/year of water provided by water supply agencies
- 10,800 AF/year of unknown reliability surface water (mostly irrigation tailwater)

Surface Water Supply Shortfall

The above-described surface water supplies would provide ~99% of the water used by the supplemental wetlands, but only 95% of the water that would be needed. An additional 2,298 AF/year of surface water would be needed to eliminate the estimated annual shortfall in available supply. The shortfall in available supply is due to the unavailability of irrigation tailwater during the fall and winter months. Remedies to this seasonal surface water supply shortfall lie in acquiring reliable additional fall and winter surface water supplies through: 1) purchases and transfers from willing parties within the San Joaquin Valley area and/or 2) obtaining rights to a small portion of the fall and winter "surplus natural flows" in the Delta. Surplus natural flows in the Delta are discussed in Chapter 1.

Unknown Reliability Surface Water

A significant amount (~18%) of the surface water supply available to supplemental wetlands is unknown reliability surface water (10,787 AF/year) believed to be comprised largely of irrigation tailwater that is not considered a reliable supply for long-term optimum wetlands habitat. Remedies to this reliability problem lie in supplementing or replacing the irrigation return flow supply with water purchased from willing sellers within the San Joaquin Valley area.

Solutions to the Supply Availability and Reliability Problems

The potential for success in purchase of additional surface water from willing sellers in the San Joaquin Valley is extremely limited due to the general shortage of supply in the region and the prospect that imported water supplies (CVP and SWP) will be reduced in the future. DWR has estimated that surface water transfers could involve water purchase and wheeling costs ranging from $50 to $150 per AF, depending on the negotiated purchase price, location of the wetlands, and location and nature of the seller's water source. CVP mitigation water is another possible source for supplemental wetlands in the Outside Grasslands Subbasin that are successful in gaining annexation to Grassland Water District.

Surface Water Supply Issues

Issues in improving the availability and reliability of supplemental wetlands surface water supplies are in the following categories:

- District Operations and Maintenance
- Water Rights and Water Contract Modification
- High Conveyance Losses
- Potential High Cost of Purchased Water
- Competition with Other Buyers

District Operations and Maintenance. Year-round conveyance is not available in some canals near private wetlands because of canal maintenance outages. However, existing natural channels could be used during winter maintenance periods. Most districts perform maintenance from January to March, if not longer. Maintenance time could be reduced with canal modifications (such as lining, realignment, etc.).

Water Rights and Water Contract Modification. With SWRCB cooperation, USBR and other water rights holders (water districts) could restructure their water rights/contracts for wetlands water use in the fall and winter. For example, the current contracts with USBR pertain to water use between April and October. USBR has applied to SWRCB for contract modifications, but additional information about water rights during the November through March period needs to be investigated with the water suppliers and SWRCB.

High Conveyance Losses. Water losses due to seepage in conveyance systems are similar in winter to those occurring during the irrigation season (spring/summer). The earthen canals used to deliver CVP water have been lined with clay over the years and have minimal conveyance losses, but some smaller earthen canal and ditches have high seepage losses. Conveyance losses can range from 15 to 25 percent of the water delivered. Some local districts have water conservation programs which target these canals for lining.

Potential High Cost of Purchased Water. Costs of purchased water would include the purchase price and likely would include wheeling costs, and costs of conveyance modifications, which when combined can be expensive. Willingness to invest in conveyance modifications to transport purchased supplies would be influenced by the level of confidence in the long-term availability of affordable supplies (see discussion of Competition with Other Buyers).

Competition with Other Buyers. The concept of water transfers and the passage of enabling legislation have recently generated great interest. Water sellers that are willing to enter into short-term sales agreements may be reluctant to enter into long-term agreements as they keep their options open for future sales at higher prices. A "bidding" atmosphere could seriously inflate water prices. Competition with other buyers from the San Joaquin Valley and Southern California may be difficult for wetland managers who may not be able to pay the same price for the water that the others can pay.

Groundwater

Groundwater is assumed to provide approximately 1% of the water needed for optimum management of the supplemental wetlands.

Groundwater quality throughout the basin varies from poor to good. Most groundwater use is confined to on-farm use only. Within the basin, groundwater availability, well capacities, quality, and pumping costs vary enormously. In areas near most supplemental wetland sites, high water tables are common and surface and subsurface drainage is often a problem.

Potential Limitations on Groundwater Use for Wetlands

The use of groundwater for supplemental wetlands is limited for reasons that include:

- Well Development Costs - Small wells approximately 100 to 200 feet deep could be constructed, developed, and pumps installed for between $30,000 to $50,000 each and yield would be low. However, water quality problems and overall efficiency make it more desirable to use larger, higher capacity wells. These larger wells, about 500 to 800 feet deep, could cost between $100,000 to $125,000 each, including pumps and development costs. Financial incentive programs could remedy this problem.

- Water Quality Limitations - In most of the nucleus areas, acceptable water quality is available below the Corcoran Clay, which lies generally between 400 to 600 feet under the land surface. While this deeper groundwater is acceptable from a total dissolved solids perspective, it may be affected by high arsenic levels. San Joaquin Valley shallow groundwater is highly saline and may contain high levels of selenium and arsenic. Some of the nucleus areas overlie shallow groundwater aquifers.

- Groundwater Management - Groundwater extraction and distribution could be affected by current and future local management plans. Some form of limited management may exist through various local water districts and local county jurisdiction. This management would likely be limited to well drilling permits, and monitoring groundwater conditions.

- Subsidence - Groundwater overdraft and land subsidence are major concerns in the south basin. These issues have impacts on water conveyance systems, changing channel capacities, and increasing the potential area for flooding. Subsidence has been documented along the California Aqueduct near Mendota, at Mendota Dam, along the Delta-Mendota Canal, and along the Eastside Bypass. Groundwater overdraft and subsidence limit the groundwater availability in the basin.

Agricultural Return Flow

Agricultural return flow is available except during drought. This source is usually inexpensive, but has not been consistently available. Issues relating to return flow include:

- Areas Outside of Water Supply Agencies - A significant amount of land used for farm irrigation and wetland habitat utilizes return flow from the Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Company, and Columbia Canal Company.

- Water Conservation Programs - Water conservation programs could potentially reduce the future availability of return flow for supplemental wetland restoration by reducing the amount of water initially applied to agricultural fields.

Water Conservation

Some water districts pursue water conservation as a means of increasing applied agricultural water efficiency. Issues related to water conservation include:

- Effects of Water Conservation on Water Quality - The San Joaquin Basin nucleus areas are in a heavy water reuse area, where water applied and not used consumptively becomes available for reuse either through groundwater recharge or surface water runoff. When reuse occurs, water quality degrades. This can result in return flow too high in salinity or too contaminated with specific ions, such as selenium, to be used for wetland restoration.

- High Cost of Implementation - The necessary infrastructure and irrigation system improvements needed to efficiently conserve water could be very costly. Some agricultural water districts in the San Joaquin Basin have turned to urban water districts outside of the basin to fund these conservation measures. In return, the urban water districts purchase the conserved water. Therefore, conserved water will be transferred to urban areas outside the basin and reduce return flow available to supplemental wetlands within the basin.

SAN JOAQUIN BASIN FINDINGS

These investigations found that the 11,180 acres of San Joaquin Basin supplemental wetlands would need an additional reliable water supply of 13,085 AF/year to provide the 63,058 AF/year that would be needed for full supply at optimum management levels. An estimated 10,787 AF/year of the additional reliable supply would be needed to eliminate dependence on low reliability irrigation tailwater. The remainder would be needed to make up a 2,298 AF/year shortfall in available surface water supply.

Status of Current Water Supplies

The reliability of supplemental wetlands water supplies is uncertain in the San Joaquin Basin because of basin-wide water shortages for all uses. This uncertainty applies to all sources--surface water, groundwater, and agricultural return flow--because all are threatened with reduction from various causes. Much of the shortfall in reliable water supplies for supplemental wetlands under the supplemental wetlands distribution assumptions used in this water supply analysis is due to dependence on tailwater, which is not a reliable supply.

Surface water supplies are always uncertain because of Central Valley cycles of floods and drought. However, even in normal years, CVP contractors in the San Joaquin Basin expect to receive less than their full allocations because of added demands on the supply from CVPIA, ESA, and Delta Flow Standards. Groundwater supplies are declining because of overdraft. Agricultural return flows may be reduced by water conservation and recharge programs.

The GIS analysis identified more than 243,000 acres of lands suitable for supplemental wetlands, with only 37% located within water agency boundaries. Only 24% of the suitable lands (58,300 acres) have high water supply reliability (i.e, there is Suitable Land with high water supply reliability where supplemental wetlands restoration could avoid dependence on low reliability irrigation tailwater).

To improve the reliability and quality of water supplies available to San Joaquin Basin supplemental wetlands, additional water supplies are needed, as well as other means to extend the current water supplies.

Securing Additional Supplies

Water could be purchased from suppliers within the basin or outside the basin. In either case, the water would be expensive, and conveyance facilities or wheeling costs may also be involved. Depending on location, wheeling possibilities would be local water service providers, SWP, or CVP. These alternatives would probably be cost-prohibitive for private supplemental wetlands landowners, without funding assistance.

Groundwater development costs and subsidence issues limit groundwater as a potential source for additional water. Groundwater is highly variable in quality, quantity, and pumping costs. This alternative could be expensive to develop, maintain, and operate. Some financial incentives may be necessary to make this a viable private wetland water source.

Agricultural return flow is unreliable as a source for supplemental wetlands water supply in this basin because of water quality problems, and because it is not consistently available.

Issues Affecting Water Availability and Reliability

Based on interviews with water suppliers to existing private wetlands in the San Joaquin Basin, there are limited opportunities to gain additional water. Most have supply deficits for their demands, and some have supplies that can only provide allocations in the range of 2 to 3 AF/acre per year, which leave most agricultural users water-short, and would be inadequate for maintaining most wetlands. Others have supplies that may allow 5 AF/acre per year.

The age and condition of the Mendota Dam affects the reliability of wetlands water supplies. The California Division of Safety of Dams requires dewatering of Mendota Pool every two years, mid-November to mid-January. This primarily affects wetlands, because they are the only ones taking water at that time. A new Mendota Dam downstream would improve the reliability of water to wetlands from this cause.

Tulare Basin

CVHJV Wetlands Restoration Objective, acres	**0**
Wetland Acres Protected & Restored	**2,680**
Remaining Wetland Acreage to Meet Objective	**0**
Total Basin Land Area, acres	**3,584,000**
Total Existing Wetlands (Private and Public), acres	**10,460**

BASIN DESCRIPTION

The Tulare Basin covers approximately 5,600 square miles in south San Joaquin Valley between the San Joaquin River in the north and the Tehachapi Mountains in the south. This 135-mile-long basin is bordered by the Coast Range to the west and the southern Sierra Nevada to the east (**Figure 3-10**). The San Joaquin River divides the San Joaquin and Tulare basins. Tributaries to the river include the Kings, Kaweah, Tule, and Kern rivers. The San Joaquin Valley is bounded by the California Aqueduct on the west side and the Friant-Kern Canal on the east side.

BASIN HYDROLOGY

Although the Tulare Basin is the driest region of the Central Valley, historically it contained the largest single block of wetland habitat in California, Tulare Lake, providing about 260,000 acres of permanent wetland and an additional 260,000 acres of seasonally flooded scrubland. The Tulare Lake area, located in the southernmost portion of the basin, originally contained four distinct lakes: Tulare, Boose, Buena Vista and Kern lakes. The lakes were fed primarily by winter and spring snowmelt from the Kern, Tule, Kaweah, and Kings rivers. During most years, the Basin functioned as a sink, where water from the Sierra Nevada flowed down streams into a series of shallow lake basins. These lakes provided habitat for millions of migrant waterfowl and shorebirds. The rivers now all terminate on the valley floor in lakes or sinks. Water does not find its way to the ocean from the basin, except in extremely wet years.

The historical Tulare Lake was once the largest body of fresh water west of the Mississippi River, and the second largest fresh water lake in the United States, based on surface area. Under drought conditions the lake was known to evaporate completely, but on average the lake approached 40 feet in depth near its northwest shore. Tulare Lake had no perennial surface outlet and all water fed into the lake was confined within its shoreline by a ridge 30 feet higher than the lakebed, if the lake surface elevation was below 207 feet. When the water surface of the lake rose to that elevation, water would flow north, often flowing into the San Joaquin River. There may also have been considerable underground flow from Tulare Lake to the San Joaquin River.

Agricultural development has changed the hydrology of this basin. By 1979, nearly all of the San Joaquin Valley floor and many of the flatter upland areas were urbanized or converted to cultivated cropland, in response to water supplies provided by Federal and State water projects. Tulare Lake was dried out and turned into productive agricultural land. Natural stream flow to the currently developed agricultural land is not adequate for irrigation water demand; therefore, water is imported and groundwater is pumped to augment water supply. As of 1988, less than 15,000 acres of wetland habitat occurred annually in the basin during average water years, of which 5,000 acres at the Kern NWR Complex and the privately managed duck clubs provide high value habitat.

NUCLEUS AREAS AND EXISTING WETLANDS

For these investigations, the Tulare Basin was divided into the Mendota/Helm and Tulare Lake subbasins. Nucleus Area and existing private and public wetlands acreage are shown in **Table 3-48.**

Table 3-48. Nucleus Area and Existing Wetlands Acreage, Tulare Basin
Central Valley Wetlands Water Supply Investigations

Subbasin	Existing Wetlands, acres			Tulare Basin Nucleus Areas, acres
	Public	Private	Total	
Mendota/Helm	7,110	420	7,530	
Tulare Lake	40	2,890	2,930	
Tulare Basin Totals	7,150	3,310	10,460	345,380

The Tulare Basin has more than 7,100 acres of publicly managed wetlands in the Kern, Mendota, and Pixley NWRs.

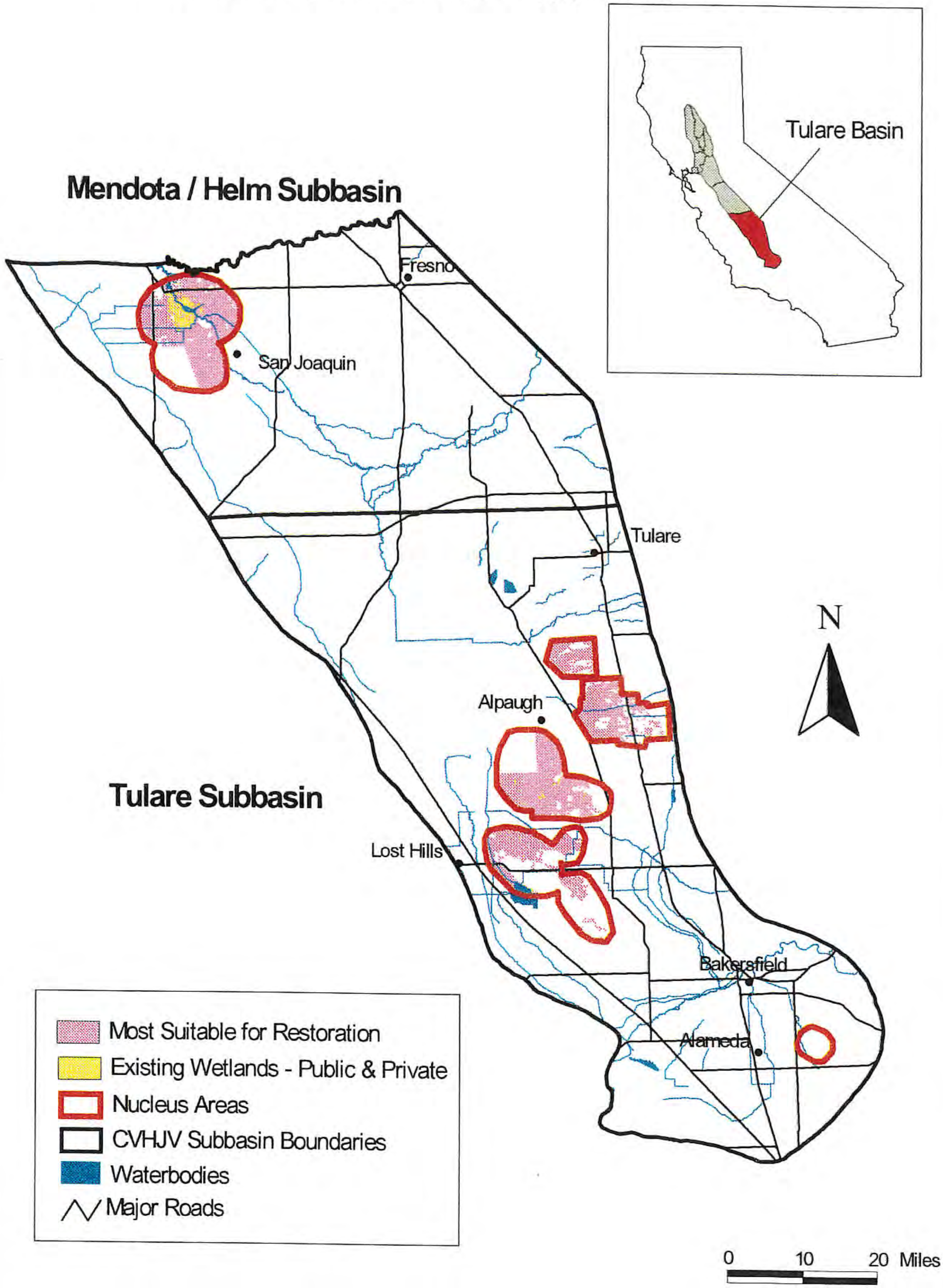
WATER SUPPLY

Local surface and groundwater supplies are not adequate for agricultural, urban, and environmental use in this basin. Surface water is imported from the Delta.

Water supply by source is 60 percent surface water (33 percent from local and 27 percent from imported surface water), 33 percent groundwater, and 7 percent groundwater overdraft. The groundwater overdraft component is not sustainable.

The stream system in this basin can be divided into major and minor streams. Major east-west streams listed north to south are the Kings, Kaweah, Tule, and Kern rivers. Minor streams on the east side include Deer, Poso, Caliente, and Tejon creeks and the White River. The water from all of these streams has been developed with most of the water being used for agriculture and groundwater recharge. West side streams provide very little water supply to the basin.

Figure 3-10. Tulare Basin – Lands Suitable for Wetlands Restoration
Central Valley Wetlands Water Supply Investigations



Two major water projects import surface water into the area: (1) the California State Water Project/Federal San Luis Canal which imports Delta water, and (2) the Friant-Kern Canal which imports San Joaquin River water.

The area's chronic water shortage forces water users to rely on groundwater to make up for surface water shortages. Consequently, groundwater overdraft is very high. This overdraft causes ground subsidence and degrades groundwater quality over time. Conjunctive use is a very important water management practice in the basin.

The water supply for most of the existing wetlands originates from agricultural runoff, winter stream flows, floodwater, and groundwater. Most of these sources vary from year to year, and groundwater use is expensive. Agricultural return flow quality sometimes can be so poor it cannot be used for wildlife habitat. Except for groundwater, these sources are adversely affected by drought, expanding implementation of on-farm water conservation measures, upstream reuse of agricultural runoff, developing water transfer opportunities and groundwater recharge practices, and the general increased competition for water by all uses.

FINDINGS

There are no CVHJV objectives for supplemental wetland restoration in this basin. Therefore, water supply and options to improve supplies for supplemental wetlands were not investigated for Tulare Basin.

Current Developments in the Tulare Basin

Federal and State agencies have identified the Tulare wetlands as the most threatened in the State. Most private wetlands occur in the extreme northern section of the basin and on the southern edge of the historic Tulare Lake bed and in the Goose Lake area. These areas contain seasonal wetlands, semi-permanent wetlands, alkali sinks, and associated uplands that are characterized by shallow open-water ponds featuring alkaline soils, swamp timothy, and in many cases, greasewood or iodine bush. The shallow wetlands provide ideal foraging opportunities for shorebirds such as dowitchers, dunlin, yellowlegs, phalaropes, and sandpipers, as well as wading birds such as white-faced ibis.

Private wetland acreage has declined dramatically in the basin since the mid-1980s, mostly due to land conversion and water supply limitations. Natural streams flow-ins are not adequate for irrigation water demand; therefore, groundwater is pumped to augment water supply, and can be very costly.

As stated in the 1990 CVHJV Implementation plan, there are no objectives for supplemental wetland restoration in this basin. However, in response to the decline of private wetlands since the signing of the Plan, the CVHJV Board agreed in 1994 to modify its protection and restoration objectives to reflect the current situation. The objectives now read, "to protect 2,000 acres (formerly 5,000 acres) of existing wetlands and to restore and protect 3,000 acres (formerly zero acres)". The CVHJV is currently in the process of updating its Implementation Plan and it is anticipated that during this process, the Tulare Basin restoration objective will be reevaluated.

Since the passage of CVPIA, firm water supplies have become available for public wetlands in the basin, allowing for additional restoration opportunities on NWRs and State Wildlife Areas. Private wetland land owners in the southern portion of the basin have also expressed interest in developing additional semi-permanent and permanent wetlands and are actively supporting efforts of the California Wildlife Conservation Board and other Joint Venture Partners to increase water delivery infrastructure to duck clubs east of Kern NWR. Restoration efforts led by Ducks Unlimited are underway in the Goose Lake area, where water supply quantity and quality are favorable. In addition, the USDA Wetland Reserve Program (WRP) alone has restored and protected a mosaic of over 6,000 acres of wetland/upland habitat in the basin since 1992. [Although landowners currently have adequate water supplies for habitat management, the WRP does not require the addition of applied water to sustain wetland habitat; consequently, in dry years these wetlands may be dry.] Other landowners have expressed interest in options for wetlands conservation in the Tulare Basin.

Chapter 4. Findings

This chapter presents the overall findings of the Central Valley Wetlands Water Supply Investigations. Individual basin findings relating to water supplies for private wetlands and for supplemental wetlands are included at the end of each basin discussion, in Chapter 2 for existing private wetlands, and in Chapter 3 for supplemental wetlands. This chapter summarizes those findings, and the issues raised that will affect improving water quality and reliability of wetlands water supplies, and gaining additional water supplies to allow optimal management of Central Valley wetlands.

FINDINGS RELATED TO PRIVATE WETLANDS

These investigations found that there are approximately 108,500 acres of private wetlands in the Central Valley. Current reliable water supplies to these private wetlands are estimated at 510,945 AF/year.

Need for Additional Water Supplies

Estimated water needs to allow optimum wetlands management of all Central Valley private wetlands are estimated at 613,760 AF/year, a shortfall valley-wide of 102,815 AF/year. By basin, the water supply needs and reliable water supply shortfalls are estimated as follows:

Basin	Water Supply Need, AF/year	Reliable Supply Shortfall, AF/year
Colusa	57,769	13,040
Butte	94,410	31,726
Sutter	622	622
Yolo	34,254	4,635
American	7,574	2,091
Delta	13,546	3,101
Suisun Marsh	161,677	0
San Joaquin	225,000	46,524
Tulare	18,908	1,076

Note: Although the vast majority of lands in the Suisun Marsh Basin are characterized by the DWR reliability analysis as having "Unknown" reliability water supply, the supply availability and reliability is good and the Reliable Supply Shortfall is zero.

Private wetlands water supply needs and reliable supply shortfalls for seasonal, semi-permanent, and permanent wetlands habitat types in each of the nine Central Valley basins are shown on **Figures 4-1 through 4-9**. Water supply needs and reliable supply shortfalls for the three habitat types in the entire Central Valley are shown on **Figure 4-10**.

Figure 4-1. Water Demands & Supplies
Existing Private Wetlands, Colusa Basin

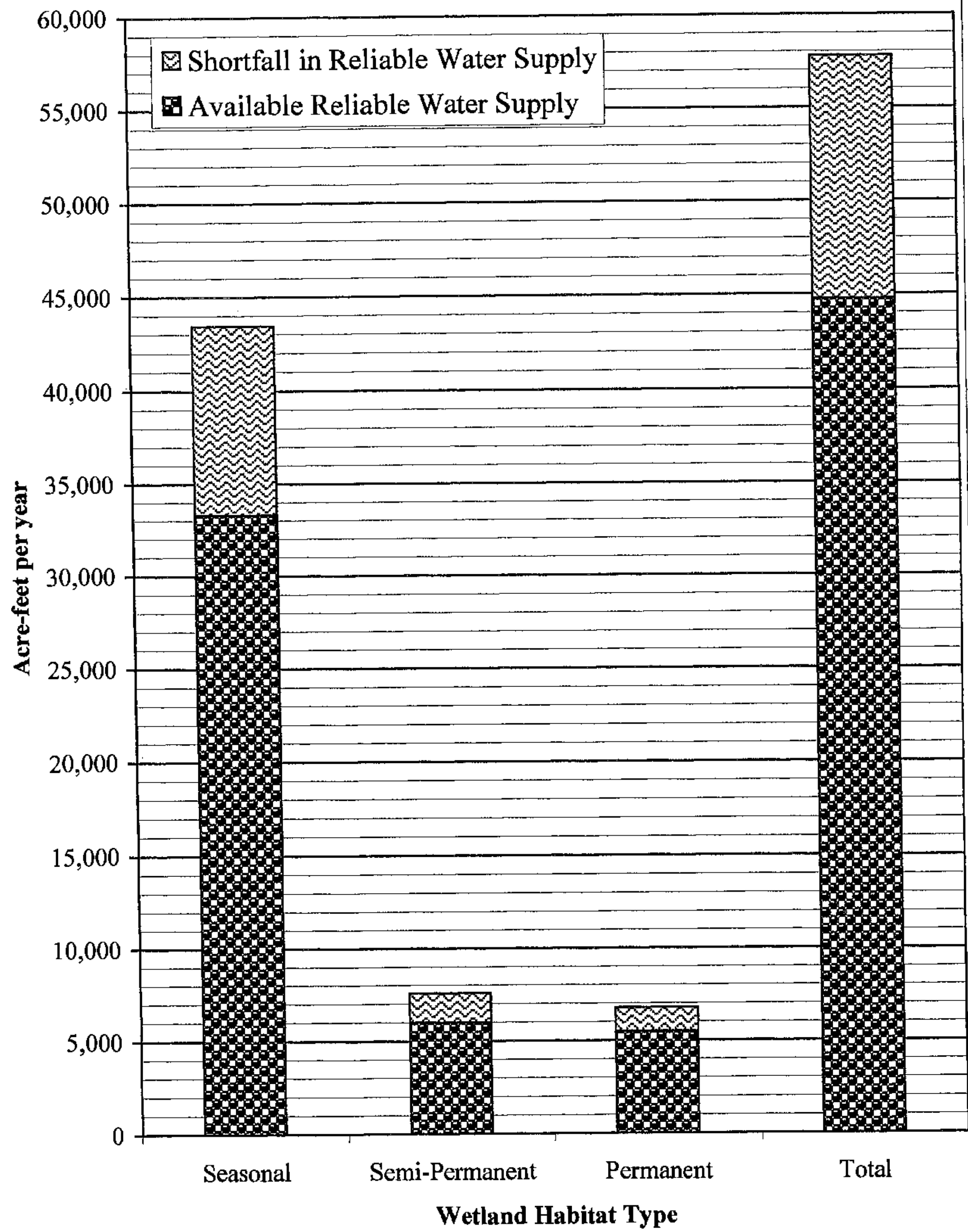


Figure 4-2. Water Demands & Supplies
Existing Private Wetlands, Butte Basin

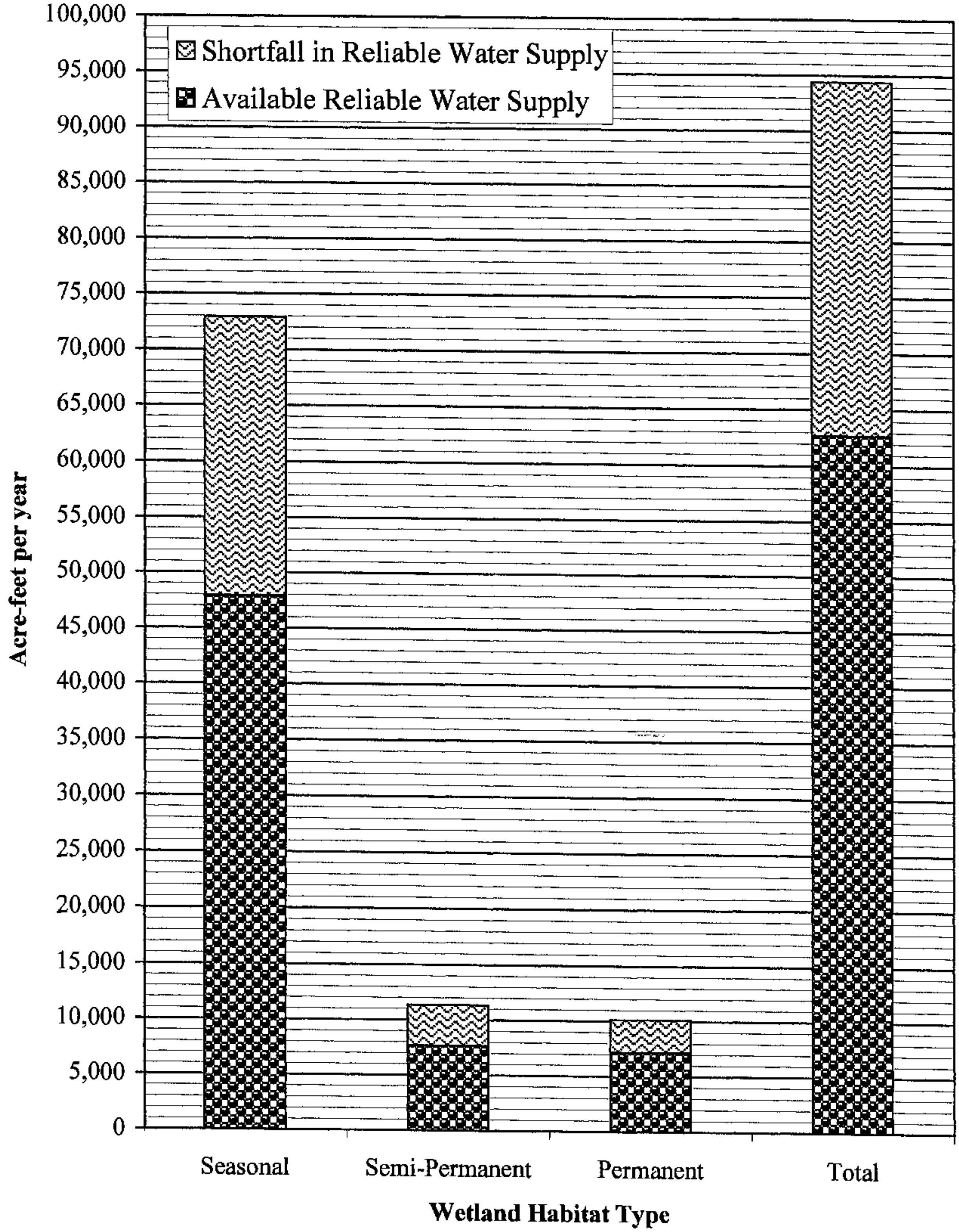


Figure 4-3. Water Demands & Supplies
Existing Private Wetlands, Sutter Basin

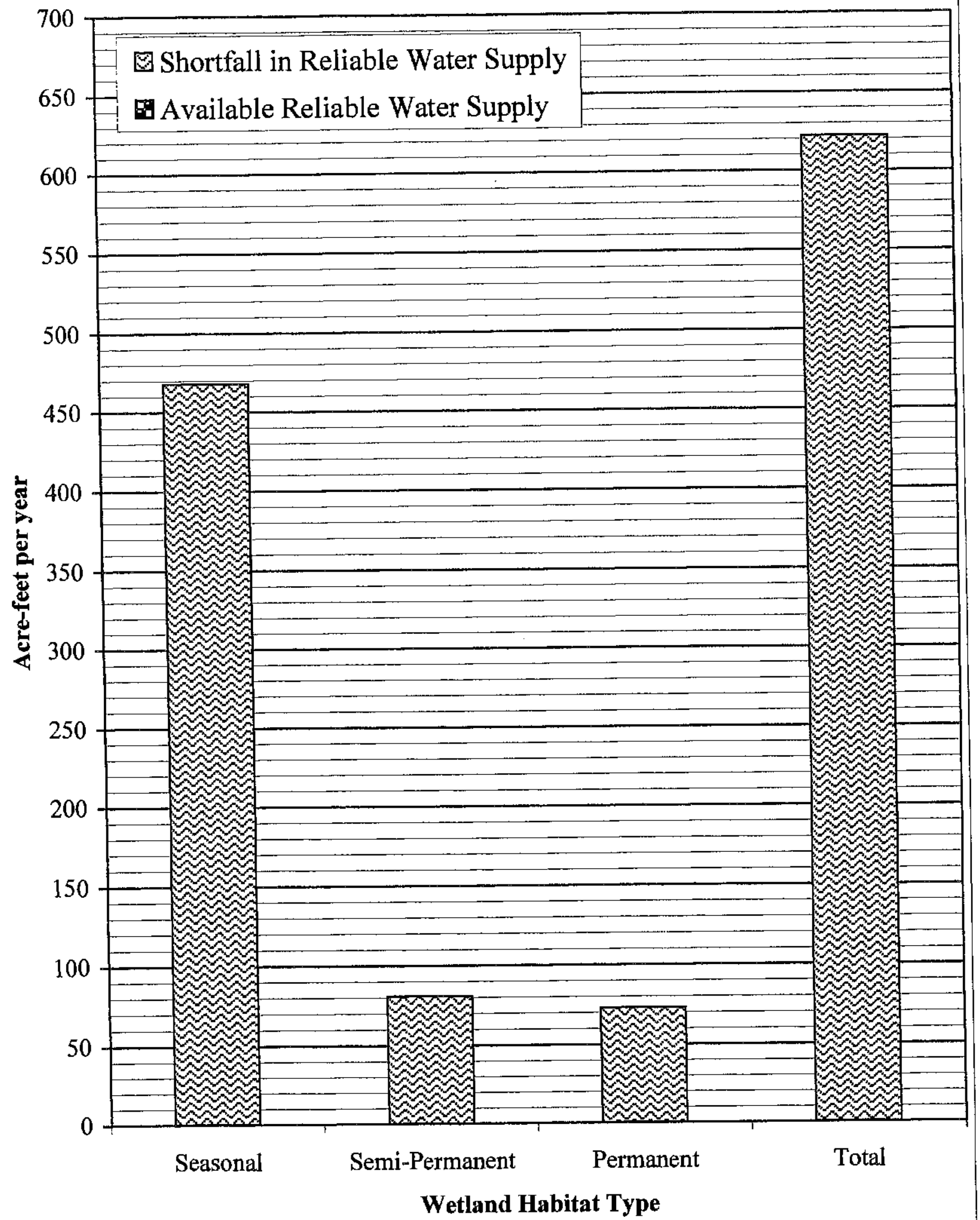


Figure 4-4. Water Demands & Supplies
Existing Private Wetlands, Yolo Basin

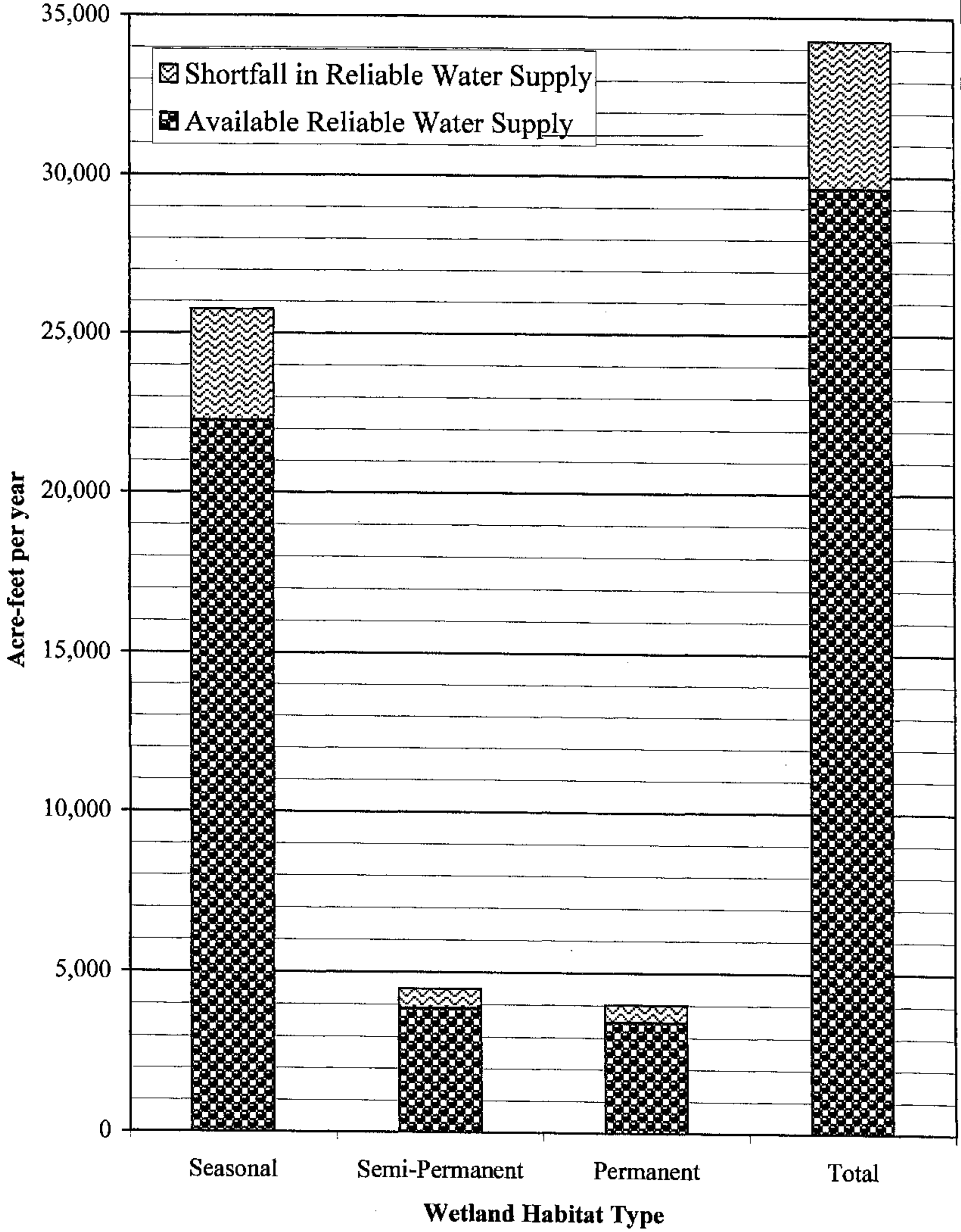


Figure 4-5. Water Demands & Supplies
Existing Private Wetlands, American Basin

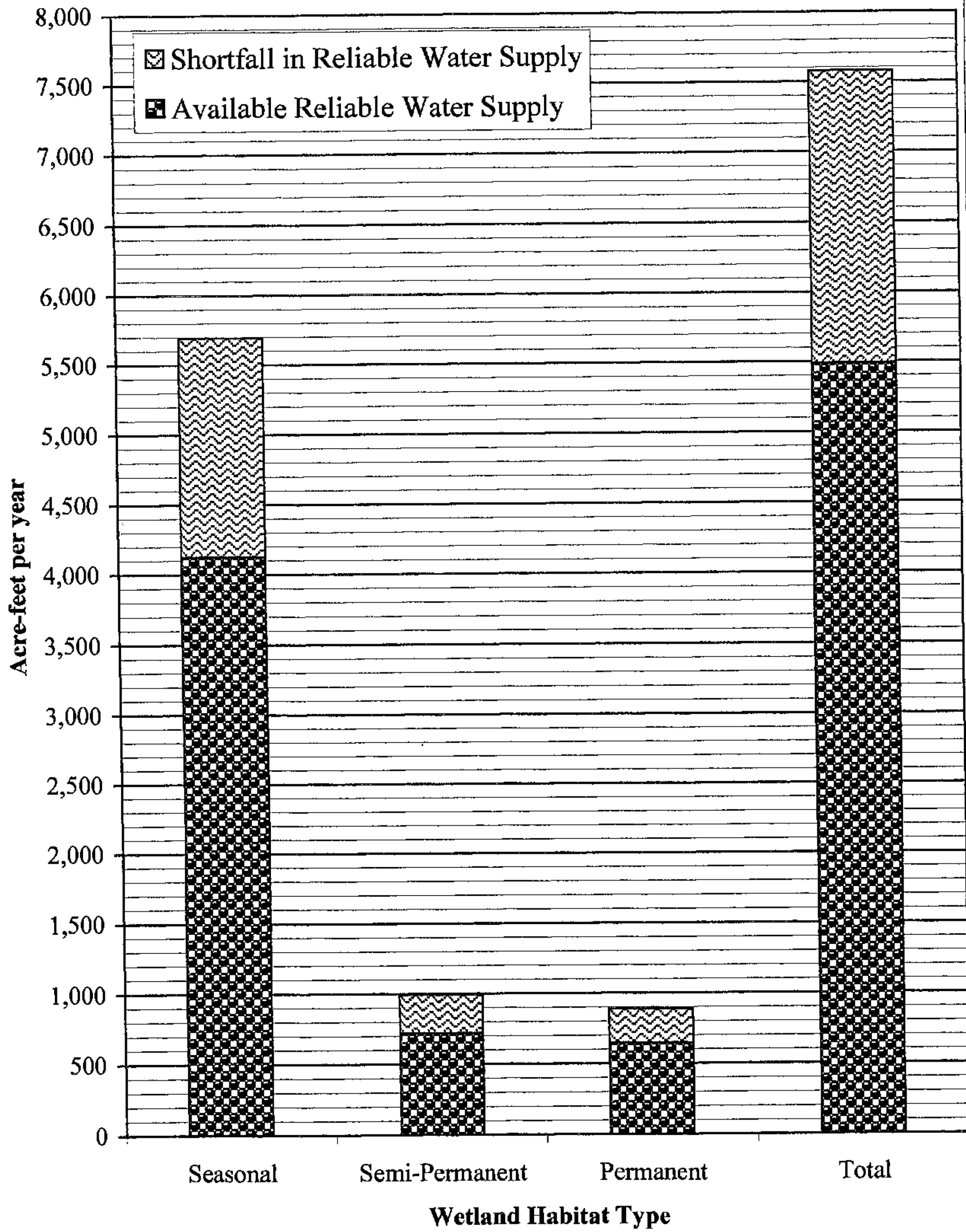


**Figure 4-6. Water Demands & Supplies
Existing Private Wetlands, Delta Basin**

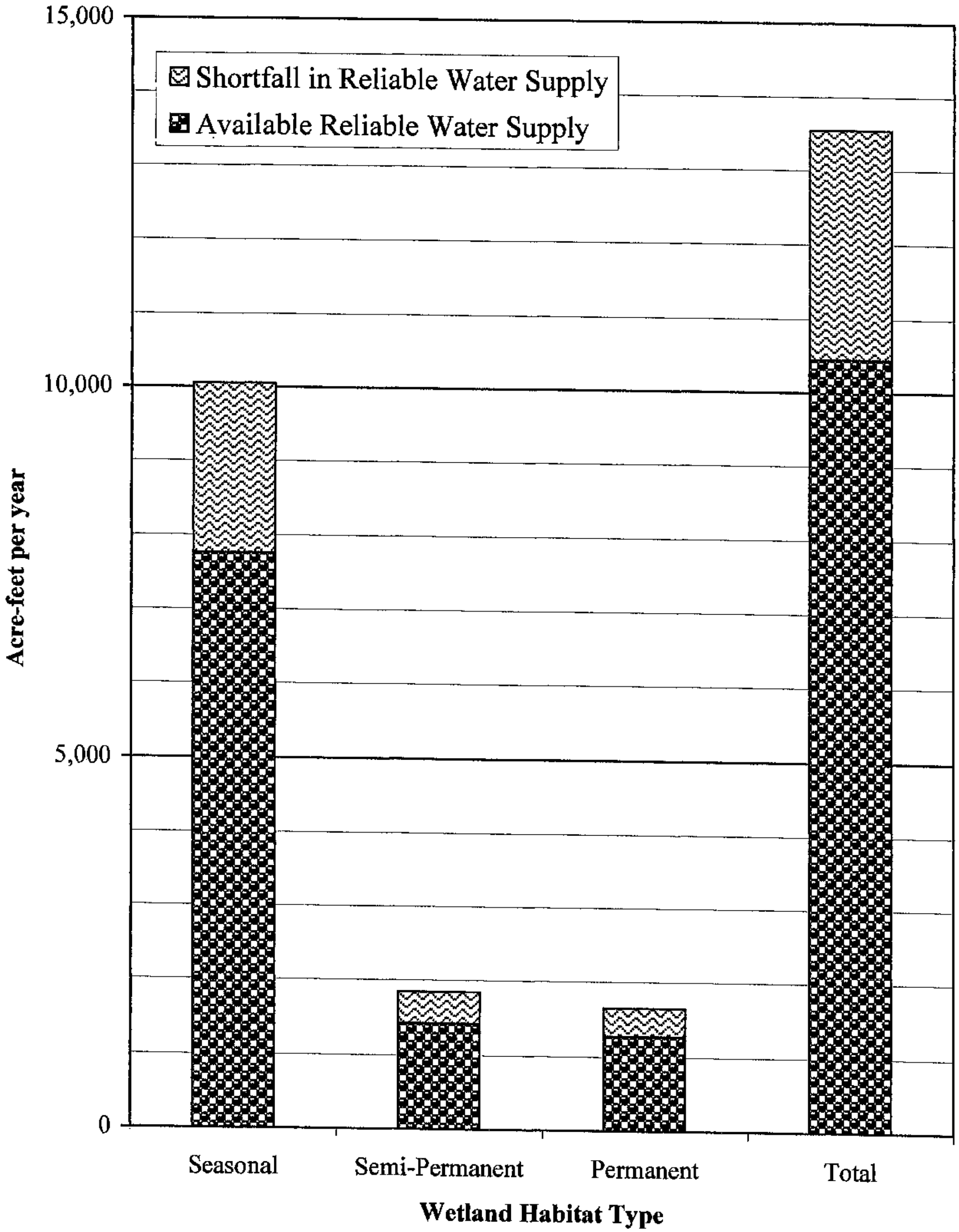
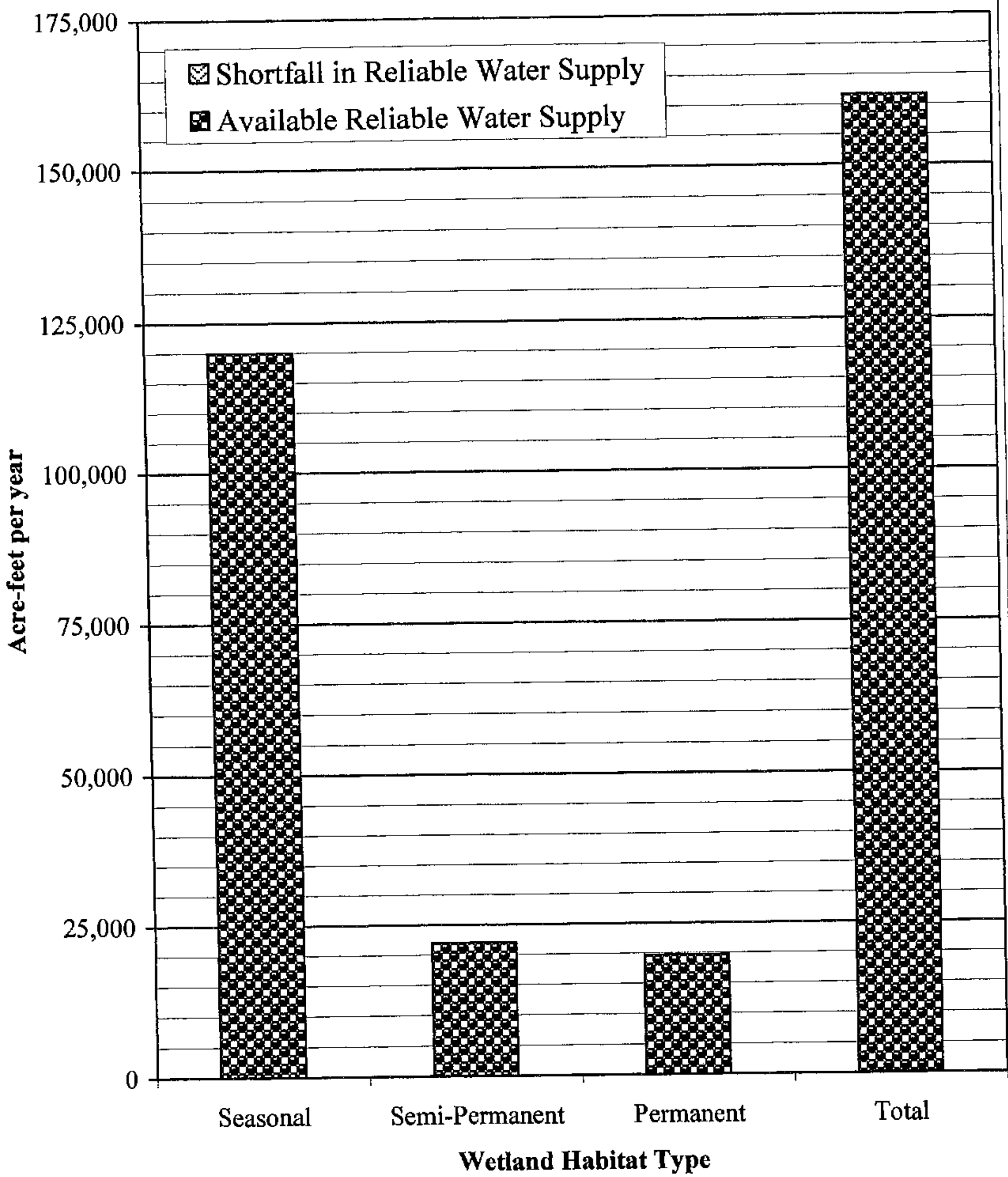


Figure 4-7. Water Demands & Supplies
Existing Private Wetlands, Suisun Marsh Basin



Note: Although the majority of lands in this basin are characterized by the DWR analysis as having "Unknown" reliability water supplies, reliability of the supplies is good and the Reliable Supply Shortfall is zero.

**Figure 4-8. Water Demands & Supplies
Existing Private Wetlands, San Joaquin Basin**

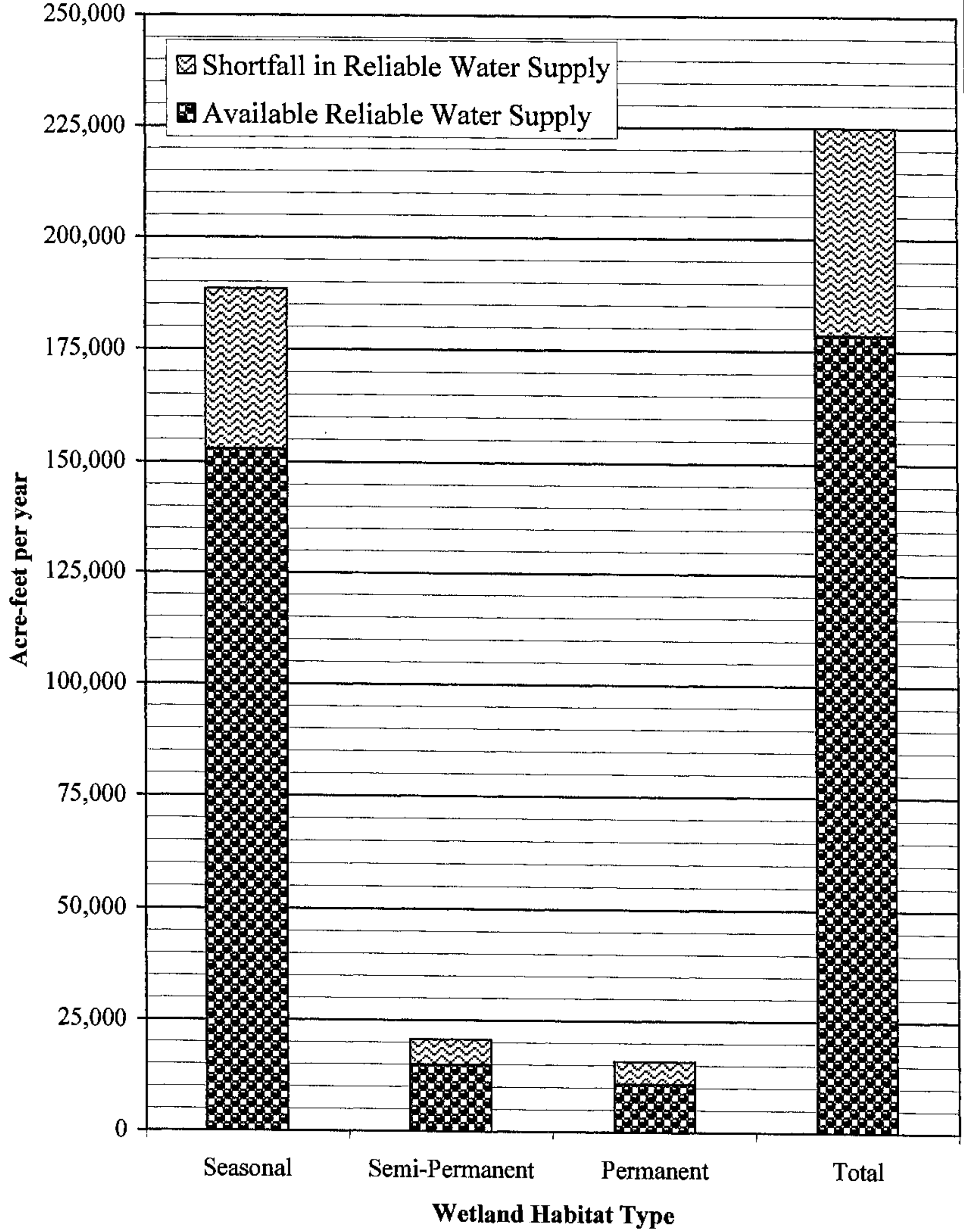


Figure 4-9. Water Demands & Supplies
Existing Private Wetlands, Tulare Basin

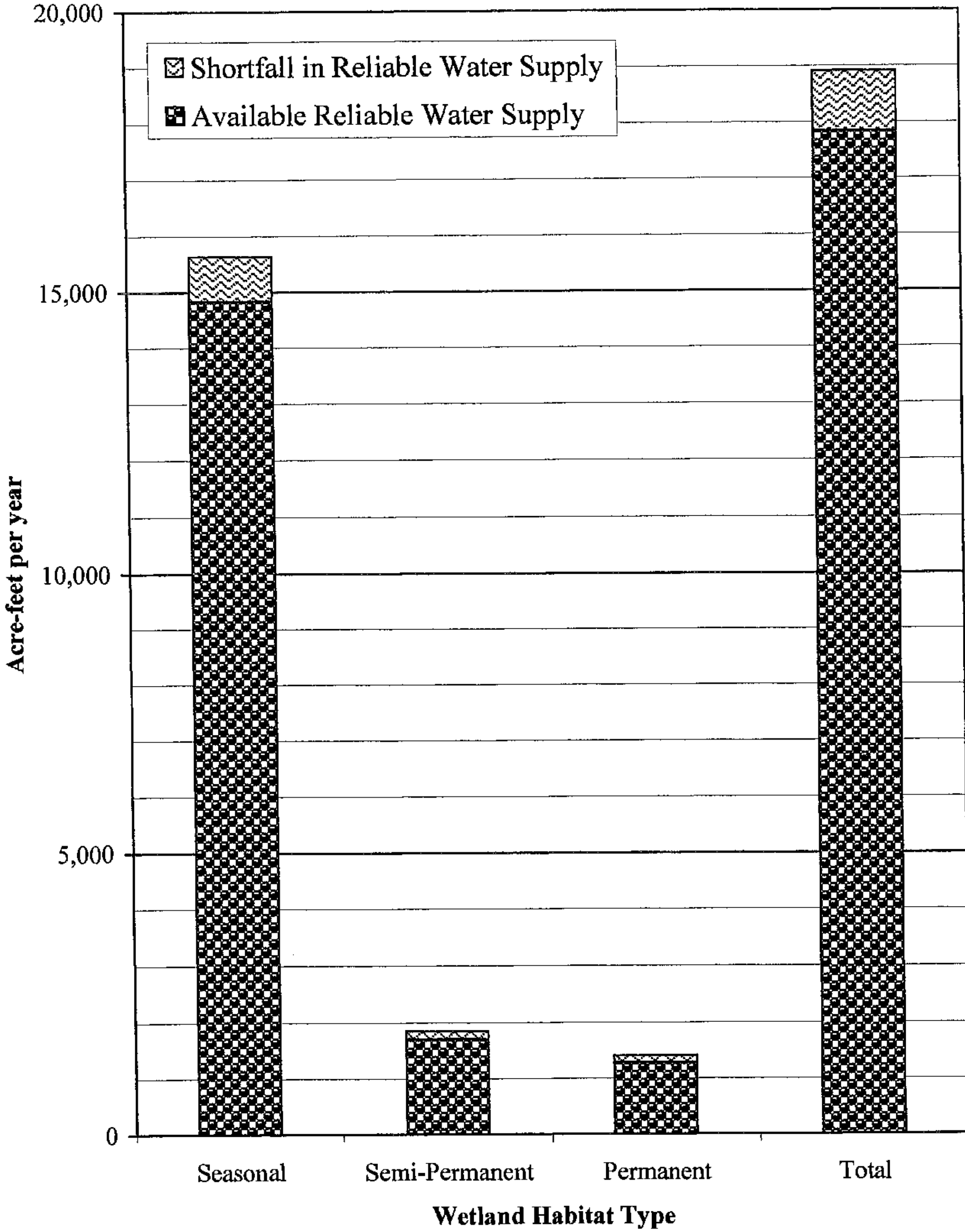
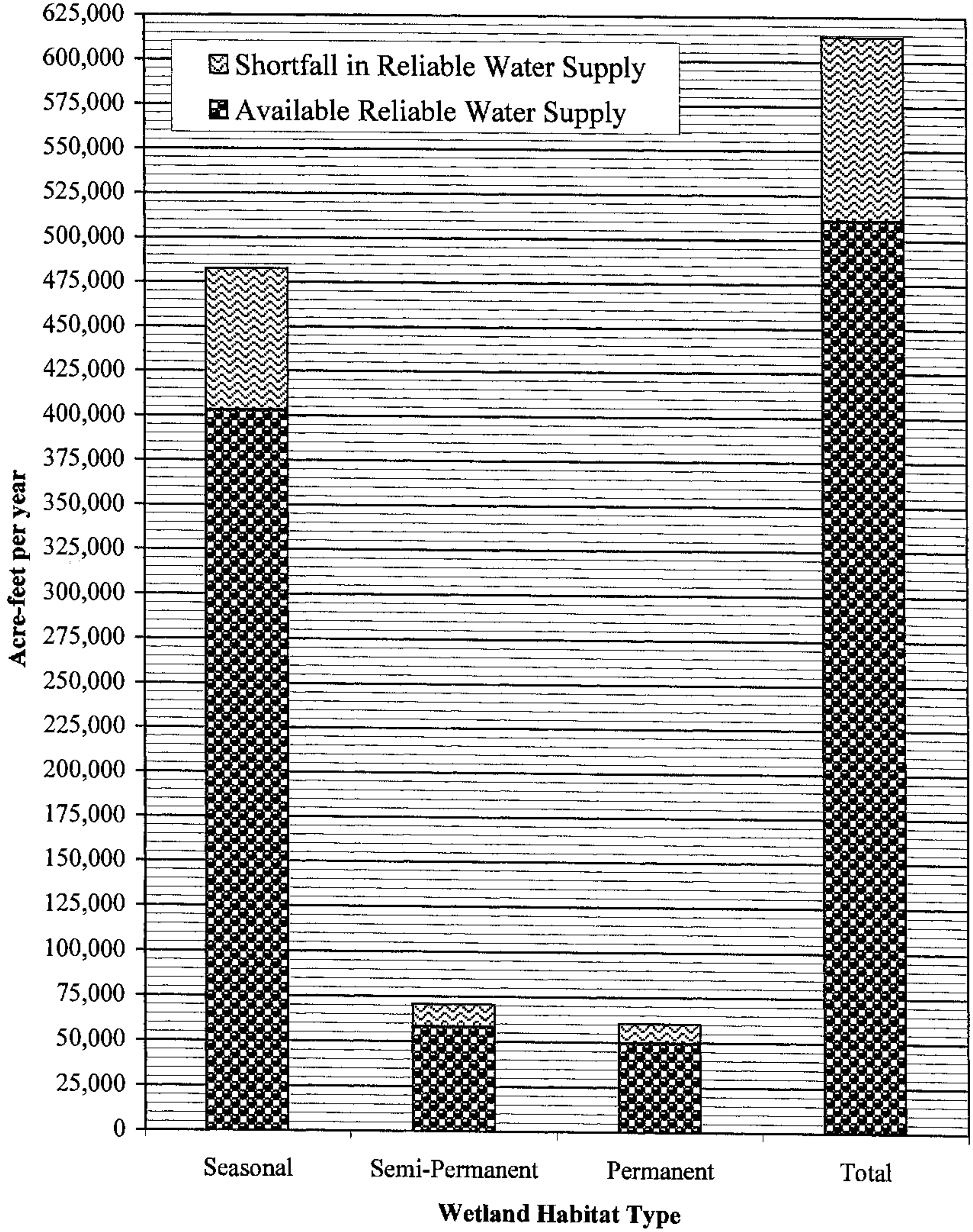


Figure 4-10. Water Demands & Supplies
Existing Private Wetlands, All Basins



Water Quality

Private wetlands in the Central Valley receive water from various sources, including surface water, groundwater, and agricultural return flows (tailwater). Generally, it appears that the quality of these water supplies is very good, particularly for surface water supplies. Water quality findings are summarized below.

Surface Water

Surface water in most areas is from direct diversion from rivers or streams, or from water service agencies receiving water from the same rivers or streams or storage facilities of the CVP or SWP or local agencies. In most areas of the Central Valley the surface water is of excellent quality for wetlands and agricultural use. In areas where surface streams are constituted heavily of agricultural runoff, there may be water quality problems. These problems are monitored by the SWRCB and Regional Water Quality Control Boards, and by local agencies. The problems are being addressed in various ways, often by blending lower quality water with higher quality supplies, and in some instances by increasing dam release flows to the water sources. Overall, the quality of surface water supplies to private wetlands is very good, and no serious problems were identified that are not already being addressed.

Groundwater

Groundwater supplies to existing private wetlands are generally of good quality. There are localized groundwater quality problems in every basin, and in certain areas groundwater is not used to supply wetlands because of quality problems. However, the private wetlands now using groundwater appear to have supplies of adequate quality for that use.

Agricultural Return Flows

Some private wetlands are dependent on agricultural return flows (tailwater) for their water supplies. Most of this tailwater in the Sacramento Valley is runoff from rice fields, and is of very good quality. Agricultural return flows in the San Joaquin Valley are more likely to be of poor quality and in some cases unsuitable for wetlands.

Improving Reliability and Increasing Water Supplies

These investigations identified alternative means of improving the reliability of water supplies of private wetlands, and potential ways of securing additional supplies.

There are few possibilities for private wetlands landowners to improve the reliability or quantity of their water supplies without incurring significant added expense. It is unlikely that private wetlands owners will be motivated to incur high costs for increased reliability or for more water in order to better manage their wetlands

For small areas of private wetlands, it may be impractical to develop incentives or funding assistance to encourage improved wetlands management. Local water supply agencies seeking additional water supplies or system improvements may be interested in agreements to firm up wetlands water supplies in exchange for funding or other incentives.

Options that may be available for improving reliability and increasing water supplies include:

- obtaining additional water from the current water source,
- obtaining additional water from a new water source, and
- modifying the timing of water availability.

1. Obtain Additional Water from Current Source:
   - Some private wetlands may not be receiving their full allocation from their water supplier, and a few districts have more water available if landowners ask for it and pay for it. Taking full advantage of available supplies is probably the least-cost alternative to gain supplies where it is an option.
   - Pumping groundwater may be the next best alternative to gain reliability, but pumping costs may be too expensive if large amounts of water are needed.
   - Negotiating agreements for agricultural return flows could improve the reliability of this source. Most supplies are fully utilized, however, the timing of wetlands needs may provide opportunities that do not compete with agricultural irrigation demands. Wetlands might gain additional supplies by agreeing to take water in August when rice lands are drained for harvest, as 1922 Agreement Lands in the Butte Basin do.

2. Obtain Additional Water from New Source:
   - Investigate annexation to local water district. Feasibility will depend on whether the district has water available, annexation policies, and other district policies and landowner concerns. Conveyance facilities may be required, and the district could not be expected to bear this cost; it would probably be too expensive for the private wetlands owner.
   - Develop a groundwater supply, if feasible. This depends on local groundwater quality and availability, and on groundwater management for the area. This may be cost-prohibitive for private wetlands owners, and is not an option in areas of groundwater overdraft.
   - Investigate availability of agricultural return flows.
   - Investigate buying water from a willing seller. This also may be cost-prohibitive for the private wetlands owner, and may also require wheeling and/or conveyance facilities.

3. Modify Timing of Water Availability:
   - Apply to SWRCB for appropriative rights to divert water in fall and winter. USBR has applied to SWRCB for rights to supply CVP water in fall and winter, and a few water agencies interviewed have made similar applications. Private wetlands owners holding appropriative water rights may be limited to diverting water during the irrigation season, as many water right holders and contractors for CVP water are.
   - Surplus natural flows may be available during December to March of most years in the Sacramento River and Sacramento-San Joaquin Delta, and could be used for winter wetlands maintenance. Private wetlands with riparian water rights can already divert natural flows for beneficial uses, but others would need to apply to SWRCB for permits to divert surplus natural flows. This would be an option for wetlands if conveyance facilities or wheeling could be arranged, and if permits were granted. SWRCB considers wetlands a beneficial use under its category of fish and wildlife enhancement purposes, but quantities of use for wetlands would have to be deemed "reasonable" for permits to be granted. There is a possibility of public interest/public trust protests, as well as protests from other water users. Whether any water is "surplus" may be protested or contested by other water users, in view of current shortages and environmental water requirements in the Delta.

EXPECTED WATER NEEDS OF SUPPLEMENTAL WETLANDS

These investigations found that Central Valley wetlands restoration remaining to meet the 120,000-acre objective is 90,813 acres. Reliable water supplies to allow optimum wetlands management of these 90,813 acres are expected to total 521,894 AF/year. Existing reliable water supplies are estimated to total 342,887 AF/year , a shortfall valley-wide of 179,007 AF/year. By basin, water supply needs and reliable water supply shortfalls are estimated as follows:

Basin	Water Supply Need, AF/year	Reliable Supply Shortfall, AF/year
Colusa	66,727	15,065
Butte	149,692	50,277
Sutter	58,899	58,899
Yolo	33,543	4,724
American	55,568	15,345
Delta	94,406	21,611
San Joaquin	63,059	13,086

Supplemental wetlands water supply needs and reliable supply shortfalls for seasonal, semi-permanent, and permanent wetlands habitat types in each of these seven basins are shown on **Figures 4-11 through 4-17**. Water supply needs and reliable supply shortfalls for the three habitat types in the entire Central Valley are shown on **Figure 4-18.**

Figure 4-11. Expected Water Demands & Supplies
Supplemental Wetlands, Colusa Basin

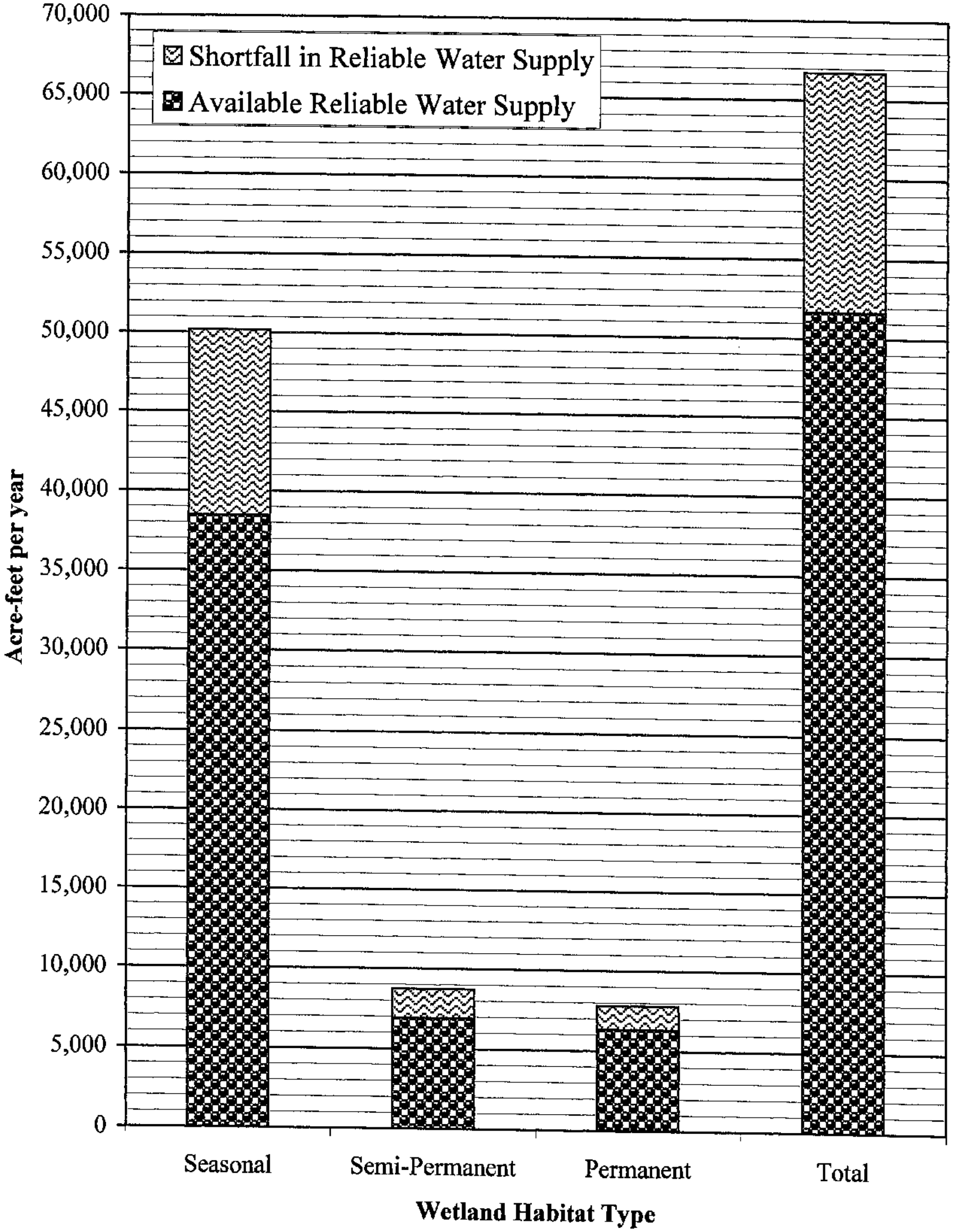


Figure 4-12. Expected Water Demands & Supplies Supplemental Wetlands, Butte Basin

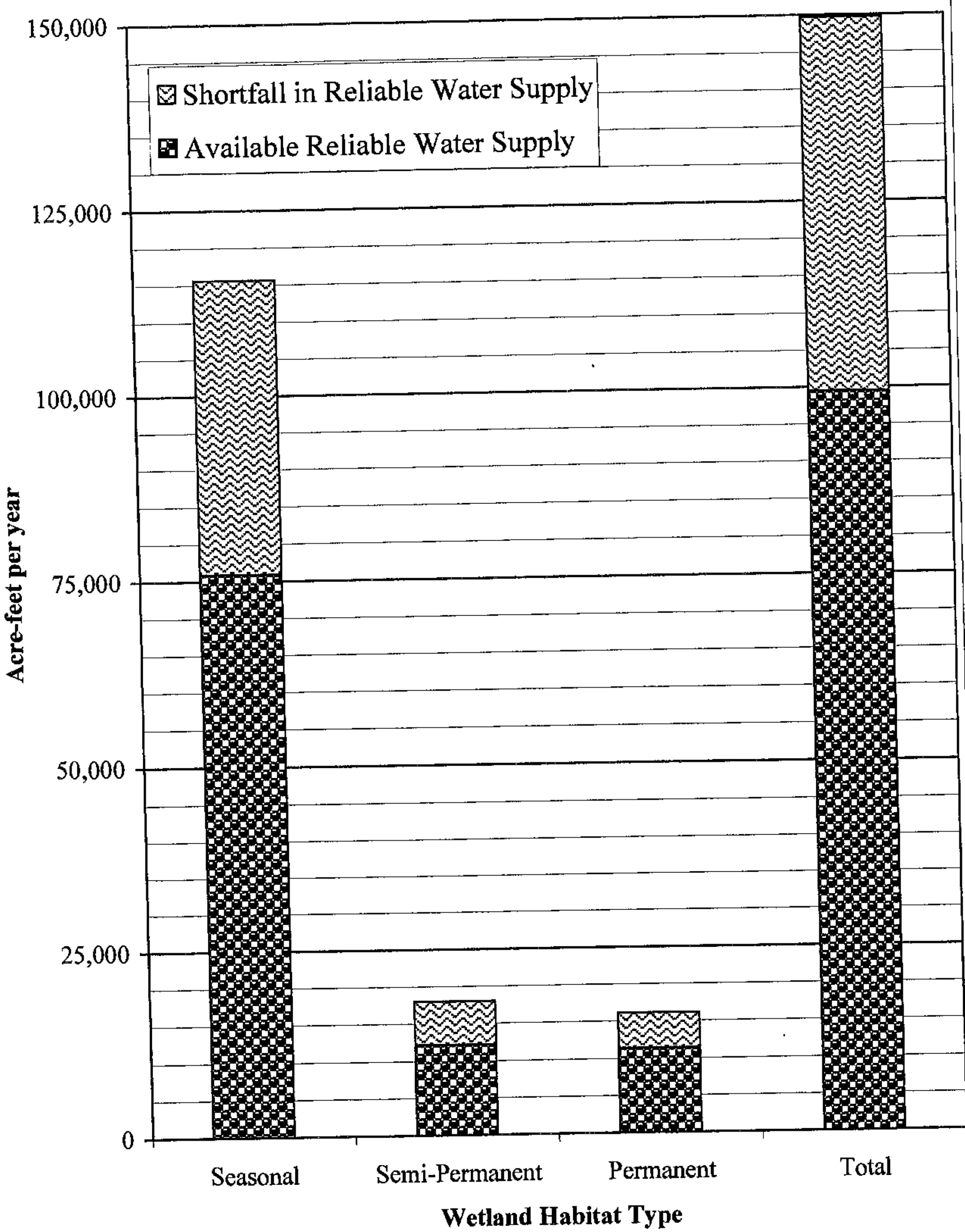


Figure 4-13. Expected Water Demands & Supplies Supplemental Wetlands, Sutter Basin

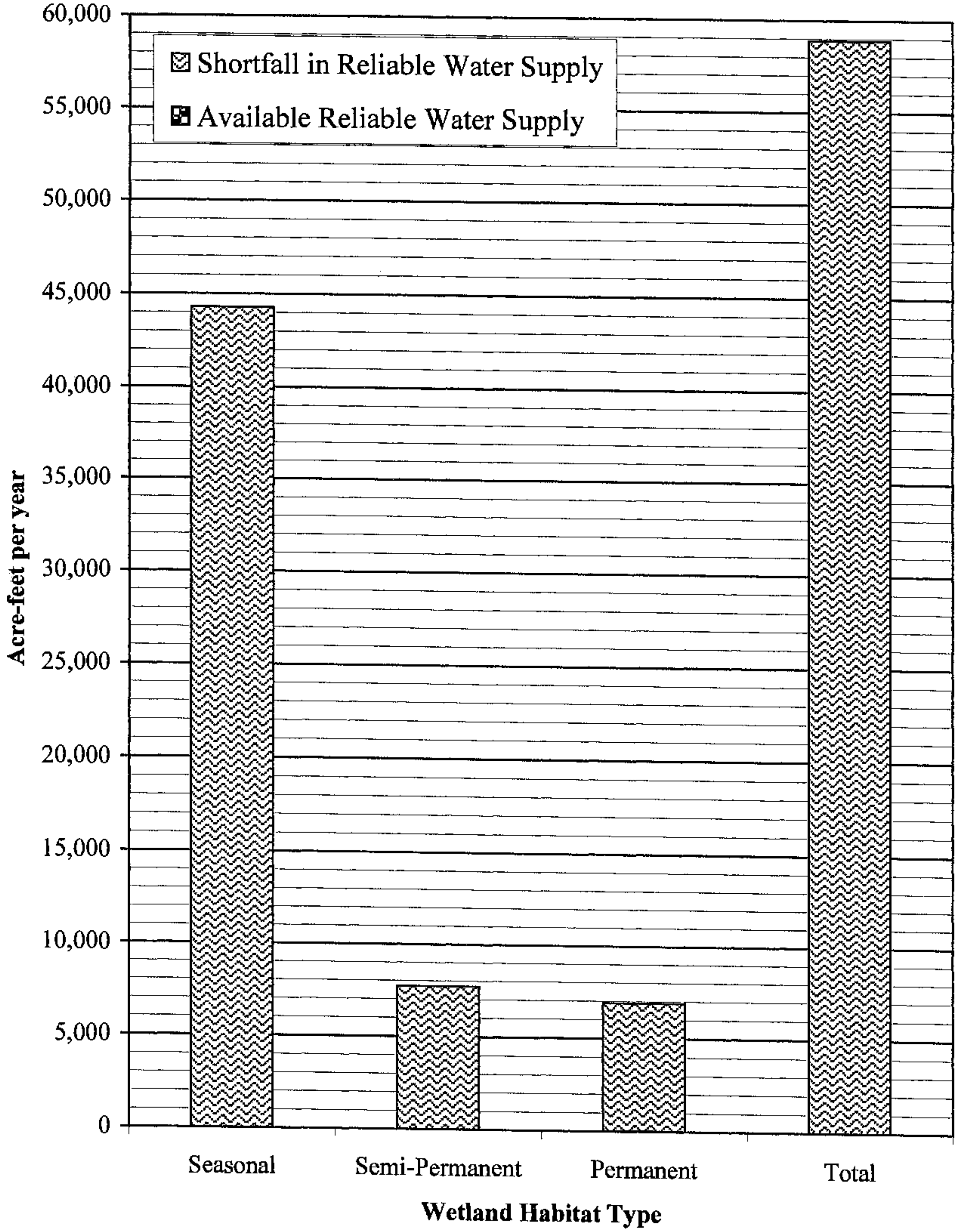


Figure 4-14. Expected Water Demands & Supplies Supplemental Wetlands, Yolo Basin

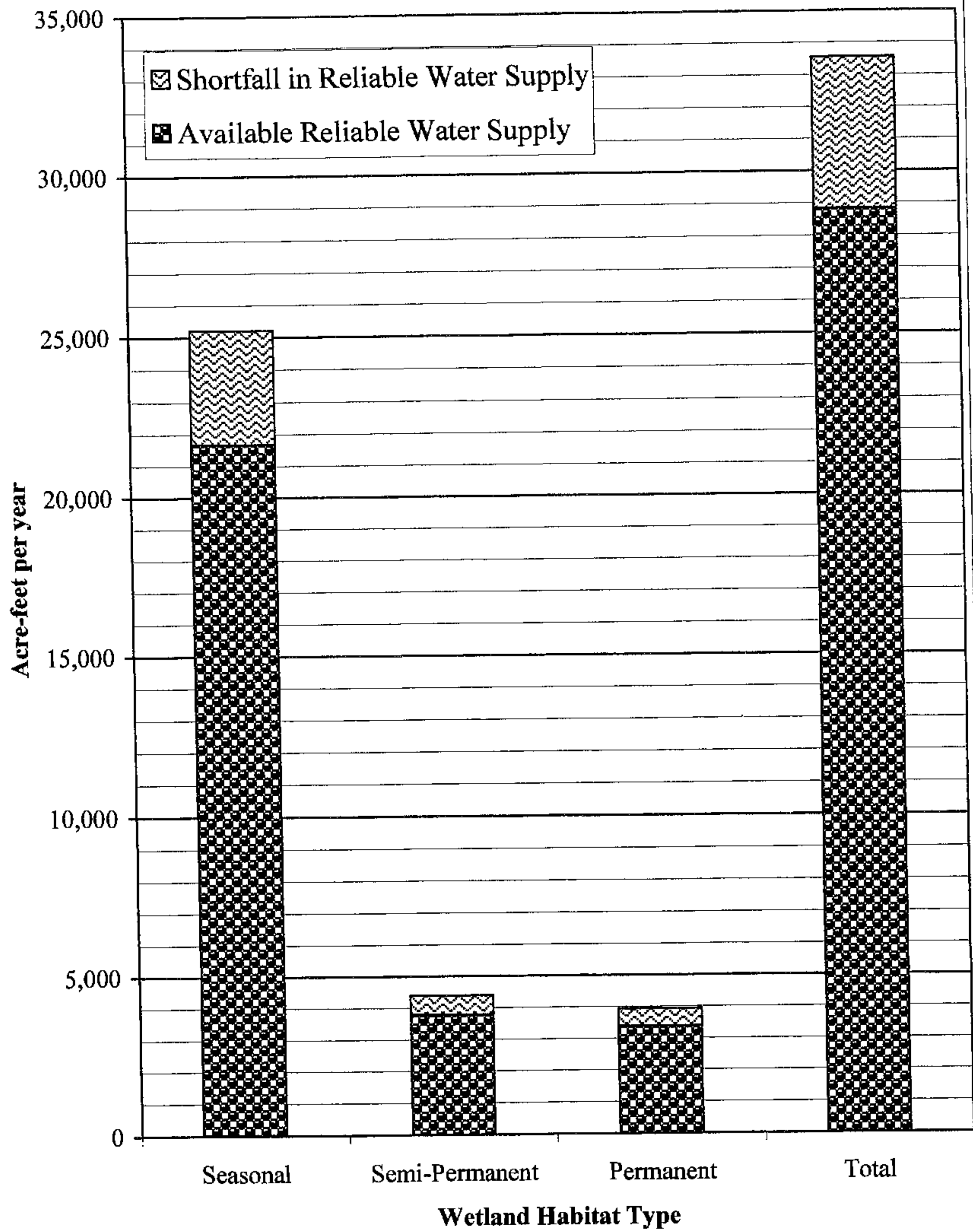


Figure 4-15. Expected Water Demands & Supplies
Supplemental Wetlands, American Basin

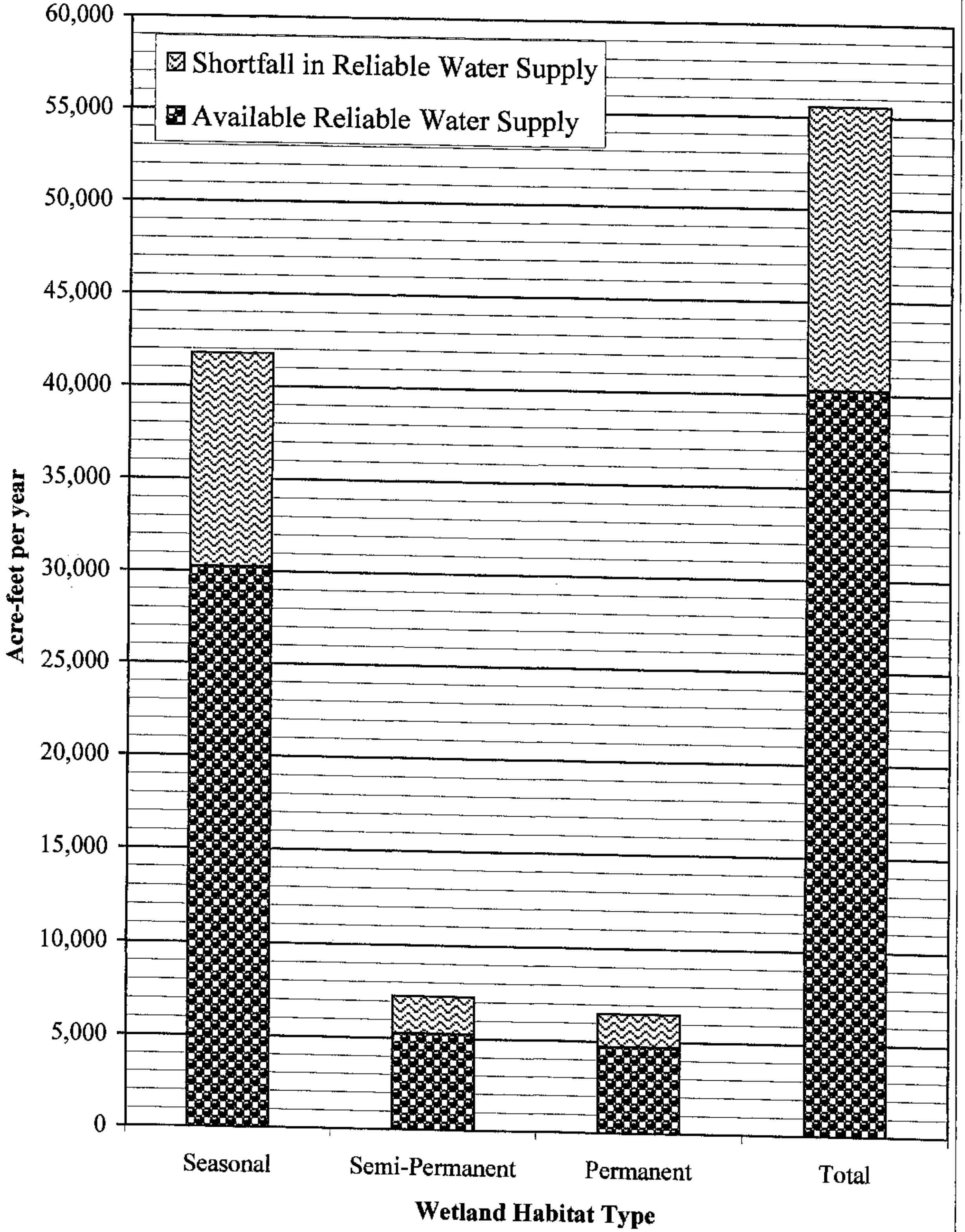


**Figure 4-16. Expected Water Demands & Supplies
Supplemental Wetlands, Delta Basin**

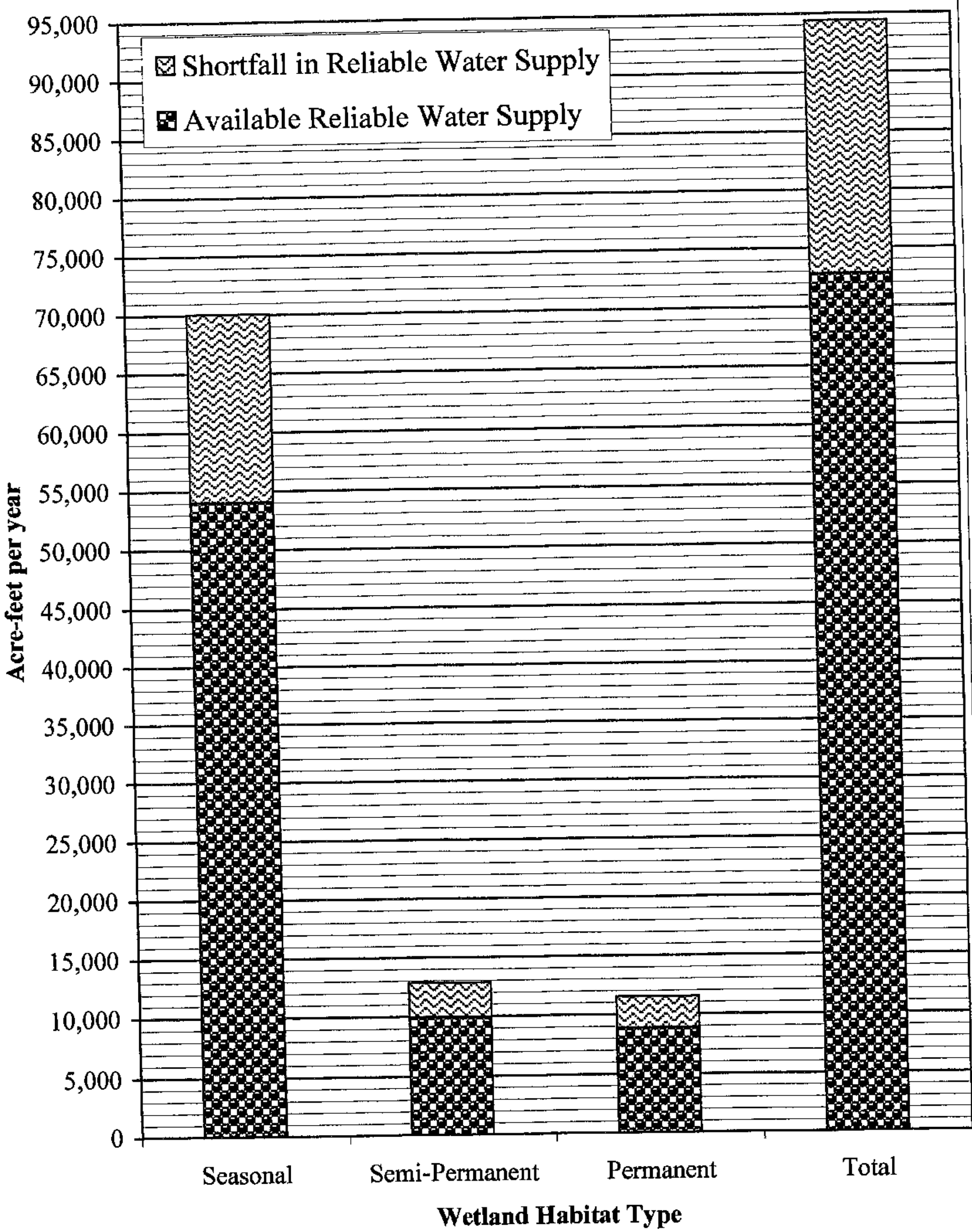


Figure 4-17. Expected Water Demands & Supplies Supplemental Wetlands, San Joaquin Basin

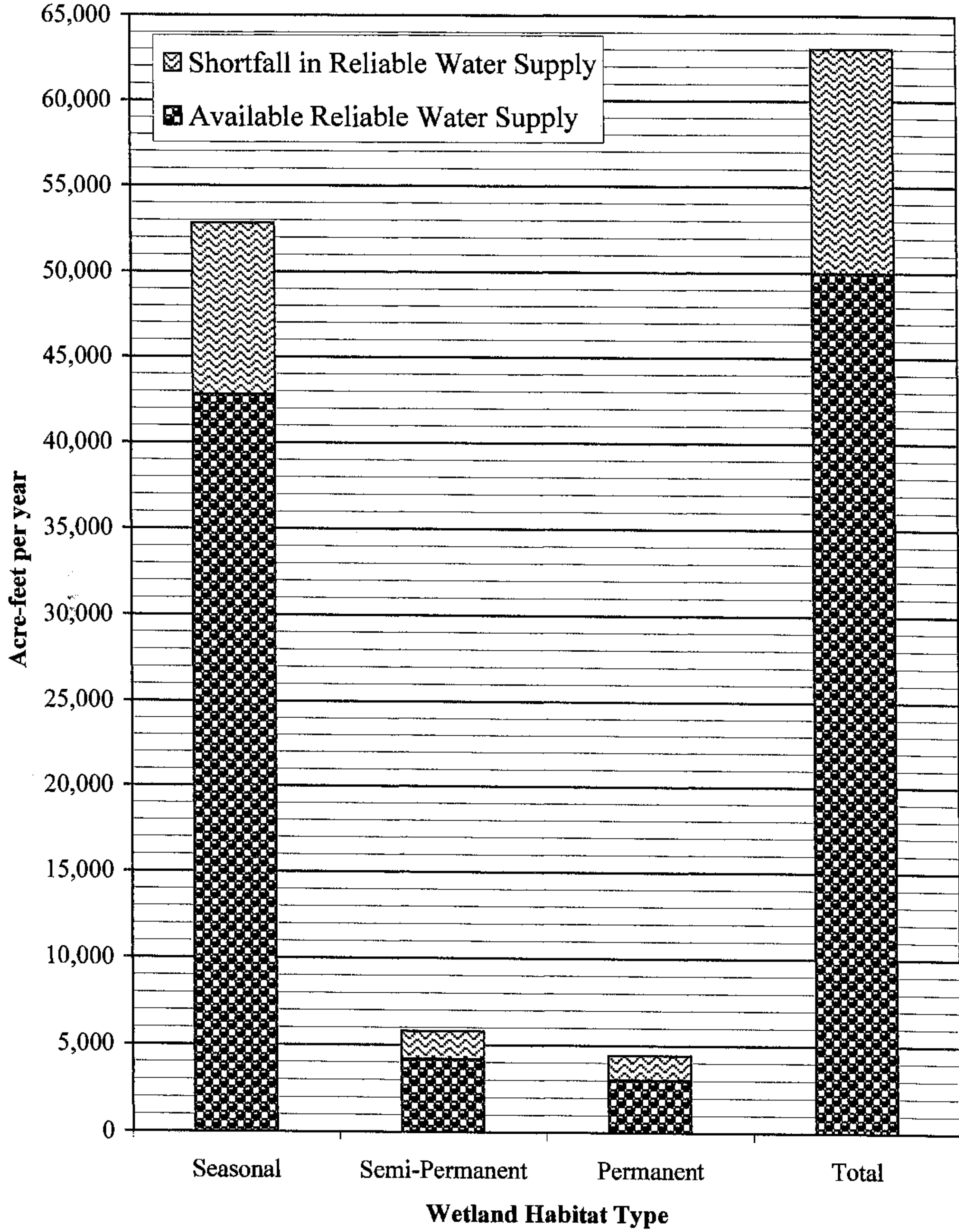
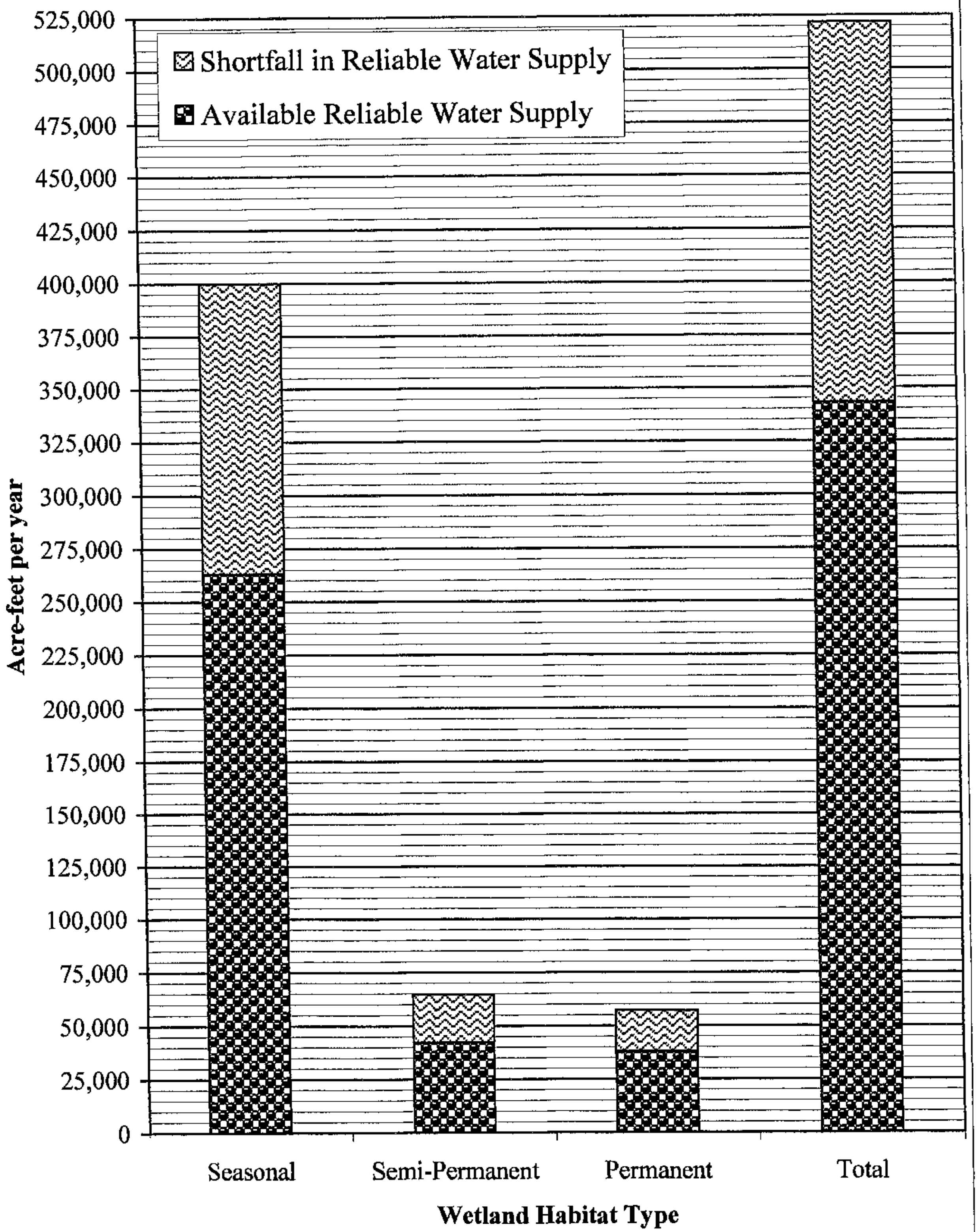


Figure 4-18. Estimated Water Demands & Supplies
Supplemental Wetlands, All Basins



FINDINGS RELATED TO BOTH PRIVATE AND SUPPLEMENTAL WETLANDS

The interviews conducted with private wetlands water suppliers provide information which is valuable for both investigations. In each case it is necessary to identify means of providing reliable water supplies. The interviews helped to identify issues and conditions which are likely to affect the reliability of present and future wetlands water supplies. Information from the water suppliers interviewed may also help wetlands managers to improve the reliability of their water supplies.

The comments of individual agencies made in the interviews and reported here represent their own perceptions and views, and do not necessarily reflect the views of other agency managers interviewed. They are included in this report as results of the interviews, and not endorsed or presented as fact in the report. Where any such comments are critical of the actions of Federal, State or local agencies, it should be recognized that these agencies have statutory requirements, rules and regulations that they are required to meet in carrying out their duties.

Issues of Concern to Interviewed Wetlands Water Suppliers

The issue of greatest concern to all water suppliers interviewed was the uncertain reliability of their own water supplies. Those with CVP contracts were in the process of negotiating renewal contracts, and were reluctant to make any definitive statements about their availability of water for wetlands until their renewal contract amounts and terms were known. All were concerned about statewide shortages, lack of new water development, loss of Colorado River supplies, reduction of Trinity River flow in the Sacramento River, and increasing environmental and urban water demands reducing supplies for agriculture.

Water suppliers with water from all sources, whether from CVP, SWP, other agencies, or landowner water rights, were equally concerned about the reliability of their future water supplies. They were all concerned about SWRCB flow requirements for the Delta, possible CALFED decisions, and pumping restrictions or dam removals due to ESA and fish restoration programs. Suppliers in rice-growing areas were concerned about the impact on their water supplies of a CALFED proposal for flushing flows in the rivers at a time when rice fields are being flooded.

Agency Policies for Supplying Water to Lands Converted to Wetlands

Many water suppliers said that if agricultural lands were converted to wetlands, the same water supplies would remain available for the wetlands. This was true of most agricultural water suppliers in the Sacramento Valley, with a few exceptions, who said that in a shortage the highest priority was given to agricultural needs. (These agencies do not supply water for municipal or industrial use.) Most said the lands had a certain allocation, and it was up to the landowner how the water was used, as long as it was a beneficial use and not wasteful. In water-short areas of the San Joaquin Valley, however, suppliers said that agricultural needs would have priority, and the water would not be available for wetlands use; or that this would depend on meeting the objectives of their agency's water management plan.

A few agencies said that "agricultural and municipal uses" are specified in their SWP contract, and said there might be a legal question as to whether or not water could be used for wetlands. Others were not sure wetlands would be considered a "beneficial use" by SWRCB, and therefore covered under their water rights.

Despite these comments, SWRCB approval of the beneficial use of water for wetlands does not appear to be an unsettled legal question. Wetlands are not specifically mentioned as a beneficial use of water in SWRCB Regulations pertaining to Appropriation of Water in California. However, Section 666 of the Regulations specifies "Fish and Wildlife Preservation and Enhancement Use" as a beneficial use of water. The SWRCB regularly processes applications that request appropriation of water for wildlife refuges and wetland areas, and considers this a non-consumptive, beneficial use.

Agency Ability to Serve Wetlands

Water supply availability was the most significant factor in the ability of most suppliers to provide water to wetlands. Some were constrained by a lack of water, others by limitations on time of use or system operations. In some cases, there were constraints because certain areas were not covered by distribution systems.

There were only a few cases where specific needs for improvements in delivery systems could improve service to wetlands. In most cases, systems were adequate for delivering the entire water supply, and the only constraints were timing of deliveries. Scheduling or small delays were common when all the agricultural users wanted water at the same time, but these problems were temporary. Wetlands managers could improve their reliability by working with agency managers to time their deliveries for maximum system efficiency.

Agency managers emphasized that the source of their water supply must be reliable so they can provide water to wetlands. Several interviewed asked that the Joint Venture help to assure that there is consideration of water for wetlands in CVP contract renewals and in CALFED decisions. One agency manager said similar efforts are needed for private wetlands such as those being made to provide districts with a water supply to furnish water for refuges.

Trades and Transfers/Water Rights

Many of the agencies had participated in trades and transfers within their own basins during droughts, and a few had some experience with water transfers and water marketing. All who commented about water transfers were critical of the regulatory processes involving both State and Federal agencies. Most said that the State wants to encourage transfers, and has passed legislation to make it happen, but actually trying to do it is very complicated. One commented that the agency had done several transfers to habitat for refuges and those got through easily, "but we can't get a transfer through if somebody down the street wants it for habitat." This agency's perception is that private wetlands get less consideration than public refuges in approval of transfers.

The California Legislature recently passed SB 970 which is intended to expedite SWRCB processing time for water transfers, and other legislation is pending designed to protect area of origin water rights in water marketing and transfers. Information on water rights and water transfers is available on the Internet from SWRCB's Division of Water Rights at WWW.waterrights.CA.gov. The information includes a water right application form and other information about applying for water rights. Selection of "water transfers" gives access to a July 1999 draft of "A Guide to Water Transfers" prepared by the Division of Water Rights. CVPIA Section 3405 outlines further conditions for CVP water transfers.

Rice Culture Influence on Wetlands Water Supplies in the Sacramento Valley

Rice fields require flooding when the crop is planted in the spring, and this provides important tailwater supplies to private wetlands in this region. Rice growers in the Sacramento Valley also provide winter wildlife habitat by flooding their rice fields for rice straw decomposition. Many of the water suppliers interviewed said that landowners often flood in alternate years, and burn rice stubble every other year. Rice field burning has been restricted in recent years because of air quality, and is expected to be entirely prohibited eventually. Water suppliers said that if this does happen, all rice fields will have to flood in winter, greatly increasing the demand for water. This could have a significant influence on water supplies available to wetlands.

Effects of Water Conservation on Sacramento Valley Wetlands

Water district managers in the Sacramento Valley commented that CALFED policies of water conservation, resulting in pressures to recycle water and reduce diversions, are potentially damaging to wildlife and reduce water supplies to wetlands. For example, Glenn-Colusa Irrigation District (GCID) recycles up to 130,000 AF/year. This replaces water that would otherwise be diverted from the river, and costs the district more than diverting it from the river. GCID does this recycling because they are under pressure to keep diversions to a minimum, but it has the effect of reducing return flows for downstream users and drying up habitat that would otherwise receive return flows. All GCID return flows drain to the Colusa Drain, and water users along the Drain now have their supplies reduced. GCID believes dialogue is needed to strike a balance between the pressure to reduce diversions and recognition of the effects it has on habitat.

Legal and Institutional Issues

As mentioned under "Agency Policies for Supplying Water to Lands Converted to Wetlands" above, a few agencies said that "agricultural and municipal uses" are specified in their SWP contract, and raised a legal question of whether or not water could be used for wetlands. Others were not sure wetlands would be considered a "beneficial use" by SWRCB, and therefore covered under their water rights. None of the agencies interviewed reported any instances of water supplies being denied to wetlands on this basis. However, if that situation were to arise, a clarification would be needed from DWR regarding SWP authorized water use for wetlands. The position of SWRCB appears clear that they consider wetlands a non-consumptive beneficial use.

Wetlands water managers may deal with various types of agencies in connection with their water supplies. Some agencies are water suppliers; others may be primarily concerned with flood control or water quality, with incidental involvement in water supply.

These agencies are primarily water districts, irrigation districts, reclamation, flood control, or water conservation districts, and are formed under a variety of codes or special legislation. Their powers differ, and they have various funding mechanisms, and different ways of charging for water. These differences can affect their willingness or ability to serve water to wetlands, and need to be considered when seeking wetlands water supplies.

Two matrix charts (**Tables 4-1 and 4-2**) are provided to illustrate the various powers and financing capacity of water-related agencies which could supply water to wetlands. [For more detail on specific agencies formed before 1994, a DWR publication, General Comparison of Water District Acts", Bulletin 155-94, is available from DWR.] **Table 4-1** (Powers of California Local Agencies) lists the relevant governmental units and the powers granted by law to each type. **Table 4-2** (Revenue and Financing Methods of California Local Agencies) lists the same units and their respective financing devices. Consideration of any individual entity as a part of any individual wetlands project would require consideration of that entity's status under:

- California Proposition 13's property tax limitations,
- California Proposition 4's expenditure limits, and
- California AB8 property tax distribution agreements.

With regard to assessments and fees, consideration should also be given to the possible applicability of California Proposition 218 election requirements (although there are specific exceptions which exempt water).

Most of the agencies interviewed said that wetlands posed no economic problems to the agency, because wetlands would pay for their water like anyone else. However, agencies that depend on assessments per acre for revenues noted that public wetlands don't pay assessments. In some cases they are able to work out "in lieu" agreements to eliminate this problem for the agencies. One agency noted that they do not always get paid, even if there is an agreement, because the money may not be appropriated for it.

Table 4-1. Powers of California Local Agencies
Central Valley Wetlands Water Supply Investigations

Powers	Agencies										
	County Water District	Irrigation District	Reclamation District	City	County Water Authority	Flood Control District	Resource Conservation District	County Service Area	Community Services District	Municipal Utility District	Public Utility District
Enabling Act (see notes)	A	B	C	D	E	E	F	D	D	G	H
Urban Water Supply	X	X		X				X	X	X	X
Sewer Appurtenances and Maintenance	X	X		X				X	X	X	X
Rural Irrigation		X	X	X			X		X	X	
Flood Control and Maintenance		X	X	X	X	X	X	X	X	X	X
Agricultural Drainage		X	X	X	X	X	X	X	X	X	X
Drainage Construction				X	X		X	X	X	X	X
Soil Conservation				X			X		X	X	
Sewer Construction	X			X				X	X	X	X

A: California Water Code §30,000 et. seq.	E: Special Legislation
B: California Water Code §20,500 et. seq.	F: California Public Resources Code §50,000 et. seq.
C: California Water Code §50,000 et. seq.	G: California Public Utilities Code §11,501 et. seq.
D: California Government Code	H: California Public Utilities Code §15,501 et. seq.

Table 4-2. Revenue and Financing Methods of California Local Agencies
Central Valley Wetlands Water Supply Investigations

Revenue and Financing Methods	Agencies										
	County Water District	Irrigation District	Reclamation District	City	County Water Authority	Flood Control District	Resource Conservation District	County Service Area	Community Services District	Municipal Utility District	Public Utility District
Enabling Act (see notes)	A	B	C	D	E	E	F	D	D	G	H
Valuation Property Tax	X	X	X	X	X			X	X	X	X
Area Special Assessment	X	X	X	X	X	X	X	X	X	X	X
User Fee Quantity Service Charge	X	X	X	X	X			X	X	X	X
User Fee - Standby	X	X	X	X	X			X	X	X	X
Grants	X	X	X	X	X	X	X	X	X	X	X
Conventional Loans	X	X	X	X	X			X	X	X	X
Bonded Debt (General Obligation Bonds)	X	X	X	X	X			X	X	X	X
Impounds (Benefit-Based)	X	X	X	X	X			X	X	X	X

A: California Water Code §30,000 et. seq.	E: Special Legislation
B: California Water Code §20,500 et. seq.	F: California Public Resources Code §50,000 et. seq.
C: California Water Code §50,000 et. seq.	G: California Public Utilities Code §11,501 et. seq.
D: California Government Code	H: California Public Utilities Code §15,501 et. seq.

Economic Issues

Most water suppliers interviewed said there were no economic problems posed by serving wetlands (except public wetlands, where they were dependent on assessments, as noted above), Most managers said that there would be no problem with serving wetlands "as long as the district is kept whole" financially. There were some specific concerns about loss of revenue for the district if too many lands in the district were converted to wetlands and used groundwater, rather than district water; or used less water than agriculture. Some mentioned the need for additional personnel if they had to operate their delivery systems when they were not in normal operation, and other operating and maintenance costs that might be involved.

Most believed that there would be economic problems for the communities, rather than the district, if too many lands were taken out of agricultural production to be converted to wetlands. There would be loss of employment for the community as a whole, and particularly with those who sold farm equipment, and other goods and services to farmers and farm workers.

The CALFED Program

Since 1995, this consortium of Federal and State agencies and other water stakeholders has been meeting to negotiate consensus on a plan to balance the use and maintenance of the San Francisco Bay-Delta as both a water supply system and a healthy ecosystem for fish and wildlife. In the summer of 2000, CALFED released its plan, "California's Water Future: A Framework for Action," and a Record of Decision, outlining Stage I of an $8.7 billion program of projects to be completed in the first seven years of a 30-year program to solve Bay-Delta problems and improve water quality, ecosystem health, water supply reliability and levee system integrity.

The program includes Delta and upstream projects to increase storage, conserve more water, improve water quality, and restore the ecosystem. CALFED emphasizes a comprehensive approach that will result in multiple benefits and consider all water users, with the goal that "everyone gets better together." CALFED's water conservation programs will include conjunctive use programs with elements such as groundwater recharge and storage and water banking. The CALFED program includes increasing existing storage and new off-stream storage.

The CALFED plan proposes to establish an environmental water account (EWA) that will share existing and new storage. A key purpose of the EWA is to make water available for species protection for use when it is needed, and reduce conflicts with other water users. By giving the environment its own water supply, CALFED planners hope to minimize the need for releases or other interference with operations of the CVP and SWP, and effects on other diverters and water users.

At this stage in the CALFED program, it is too early to predict the effects the program might have on Central Valley wetlands water supplies. CALFED will need a formal structure, such as the Federal-State commission proposed in the framework agreement, and additional funding, to fully implement the program. However, CALFED leaders intend to start implementing the program with funding that is now available. The CALFED program includes a number of projects that could improve water quality and reliability for all water users.

RESPONSE TO COMMENTS ON THE AUGUST 2000 DRAFT REPORT

The August 2000 Draft Report was distributed for review to all the agencies and organizations that contributed information and to other interested parties. Comments on the August 2000 Draft Report were received from two water agencies and several CVHJV participants.

All specific comments noting errors or needed clarification have been addressed by revisions to this report. There were also general comments relating to the way the investigations were conducted, and to issues which were beyond the scope of this report. The general comments are summarized below with responses.

Comments Subject: The report's use of goals for wetlands development based on the CVHJV's "Implementation Plan" dated April 19, 1990.

Response: Congress [CVPIA Section 3406(d)(6)] was specific in directing use of this plan as a basis for the investigations, and the plan has not been updated in the interim.

Comments Subject: The age of the 1990 CVHJV "Implementation Plan" goals, and the age of the data for this report.

Response: Aging of the data over the course of investigations and report preparation is unavoidable. After the passage of CVPIA October 30, 1992, mandating these investigations, a number of actions were required to produce this report. These included developing administrative procedures to implement the CVPIA, assigning responsibility and forming teams to conduct the investigations, and developing a GIS database and model for the investigations. It was also necessary to identify water suppliers to wetlands throughout the Central Valley, and to interview them and present results of the interviews.

By the time all these steps were completed, some of the initial data (e.g., identification of private wetlands from satellite imagery and field verification) was as old as 1993. Since then some private wetlands areas have been added, and significant progress has been made through voluntary programs to increase supplemental wetlands toward the CVHJV goals.

The need to produce a report has made it necessary to accept a cut-off date and use existing data to complete the investigations. While it is acknowledged that all the data is not current, this report represents a valid snapshot in time of the status of water supplies for wetlands, and has produced a GIS model that can be easily updated and used for future planning by federal, state, and local agencies and private organizations.

Comments Subject: The report addresses managed private wetlands, but excludes flooded agricultural land and natural wetlands within this definition.

Response: The definition of wetlands adopted by the CVHJV does not include flooded agricultural land. Lands may be flooded periodically for the primary purpose of decomposing rice straw, but these lands are not committed to seasonal wetlands use, and may not be flooded every year. The report acknowledges the importance of flooded rice lands in providing significant seasonal habitat. However, these lands are not appropriately part of the wetlands water supply investigations conducted for this report. Natural wetlands are also logically excluded from the investigations because they receive water from natural sources and don't require applied water.

Comments Subject: The report does not address the impacts of land use conversion.

Response: The scope of this report is to define water needs for existing private wetlands and additional supplemental wetlands, and to identify potential means to provide the water necessary for their full habitat development. Recommendations--on land use issues, impacts, or any other issues that might arise from any specific program or project--are beyond the scope of this report.

The options for providing water discussed in this report are the reasonable possibilities that could be identified, not recommendations. Similarly, the report's discussion of land retirement or conversion from one land use to another as means to achieve wetlands goals are not recommendations. They are observations, or findings, of what has been happening throughout the Central Valley through various voluntary programs, thus they are identified as the most likely means to reach the goals for supplemental wetlands.

Consideration of any impacts would be appropriate if specific actions or projects were proposed, but no recommendations or actions are proposed in this report. Cumulative impacts of land conversion are addressed through county land use planning, and may be included in the CALFED planning efforts, but it is not the purpose of this report, nor within its scope, to address them.

Comments Subject: Potential use of this report as a blueprint for targeting land and water use.

Response: The only purpose of this report is to respond to the Congressional directive of CVPIA Section 3406(d)(6). Wetlands data derived from the GIS analysis and presented in this report should in no way be interpreted as wetland data for any regulatory purpose.

Interior's policy in implementing the requirements of the CVPIA has been to coordinate and form partnerships with other federal agencies and state and local agencies, and to assure that the investigations and studies required by CVPIA will allow sharing of information and data. It is anticipated that the GIS model developed for this report will serve as a tool for Federal, State and local government agencies, conservation organizations, water districts, and individual landowners interested in further investigation of wetland water needs and supplies on a site-specific basis. Any such use of the model or this report will need to take into account the age and limitations of the data, conduct site-specific investigations, and assess the specific issues and potential impacts.

Appendix A
Development of the Central Valley Wetlands Geographic Information System Model

The geographic information system (GIS) database used for these investigations was the California Wetland and Riparian GIS database developed by Ducks Unlimited, Inc. (DU) under contract with the California Department of Fish and Game (CDFG), the California Wildlife Conservation Board (WCB), and the U.S. Bureau of Reclamation (USBR). The goal of the California Wetland and Riparian GIS was to develop a wetland and riparian GIS database for four key regions in California: 1) the Sacramento Valley, 2) the San Francisco Bay and Delta, 3) the San Joaquin Valley, and 4) the South Coast to support cooperative conservation planning and wetland resource protection efforts of State, Federal, and local governments and private organizations. The development of this database is reported in the "California Wetland and Riparian Geographic Information System Project Final Report, January 17, 1997."

This GIS model was used to combine, store, edit, and display the large quantities of data crucial to the investigation. The GIS model served this report (and future investigations) by:

- simplifying analysis of the large study area—the 400-mile-long Central Valley and the intensive data collection over about 1.8 million acres
- storing and rapidly retrieving large amounts of data for analysis
- presenting map data and tabular information visually for simplicity, clarity, and ease of understanding
- providing an objective means of analysis
- expanding to include additional data as it becomes available
- enabling replication of the analysis process using adjustable criteria and complete data sets
- making data accessible in a format for ready distribution to others.

Pertinent GIS information used for this report is available for review in formats compatible with Arc/View 2 software at a scale not less than 1:24,000.

The following information, displayed in this report in GIS map format, was used to obtain information about private wetlands for Chapter 2 of this report.

a. Acreage of each private wetland ownership greater than 2 acres to the nearest acre.

b. Ownership and location map of each wetland.

c. Land use within the period of the most recent California Department of Water Resources (DWR) land use survey (generally within the last 5 years) including wetland easements, long-term habitat retention agreements, and participation in various wetland programs (e.g., Water Bank--tabular data, Wetland Reserve Program, Williamson Act--tabular data, Partners for Wildlife--tabular data, California Waterfowl Habitat Program--tabular data)

d. Water supply quantity by month, past and current (tabular data)
e. Existing water delivery infrastructure and system capacity in cfs (USBR)
f. Water budget by wetland parcel in acre-feet per month (tabular data)
g. Water rights (tabular data)
h. Water quality and reliability of groundwater and surface water supply
i. Alternative water supply sources and opportunities and related costs
j. Power availability and source for wells
k. Staff knowledge of existing and potential constraints affecting protection and restoration of wetlands and other habitats (e.g., endangered species and urban development concerns)
l. Benefits of reliable water supply to specific species of wildlife

The following CVHJV partner-protected lands (those parcels which have been purchased in fee or have been protected in perpetuity with a conservation easement) are included in this report in GIS map format:

a. Federal Conservation Easements held by USFWS and U.S. Natural Resources Conservation Service (NRCS) Wetland Reserve Program
b. State Conservation Easements held by WCB and CDFG
c. Private Conservation Easements such as those held by The Nature Conservancy
d. Federal lands owned in fee by USBR, U.S. Bureau of Land Management (USBLM), USFWS, U.S. Army Corps of Engineers (USCOE) or other agency
e. State Lands owned in fee by WCB, Reclamation Board, State Lands Commission, or other agency
f. Private lands owned by DU, The Nature Conservancy, National Audubon Society, or other land trustees

The following GIS data layers and sources were used to help identify lands suitable for wetlands restoration (supplemental wetlands) for Chapter 3 of this report:

a. Soil series/type (NRCS)
b. Water supply source/infrastructure information (DWR)
c. Water supply reliability (DWR)
d. Crop history/land cover (DWR, CDFG staff field verification)
e. Land ownership by parcel (commercial vendors and county records)
f. Water district (data from USBR not fully georeferenced, but referred to)
g. Publicly- and privately-owned or easement ownership information from CVHJV public or private partners
h. Basin boundary and nucleus areas determined by special knowledge of CVHJV partners

The GIS model prepared for this study used the CDFG wetland mapping model developed by DU in 1996 along with tabular data gathered to identify and provide information about wetlands. The DU model depicts the location of all Central Valley wetland habitat (public and private) detectable from aerial imagery. This model used satellite imagery collected in the summer of 1993 and January of 1994. Using this satellite imagery, data for winter and summer wetland acreage were delineated. The distribution of wetlands found by DU was compared with the distribution of natural vegetation types in DWR land use inventories. The result was an assemblage representing all wetlands.

Publicly-owned wetlands were eliminated from the total wetlands to delineate existing private wetlands and to form the basis for Chapter 2 of this report. To identify private wetlands considered in this report (private wetlands larger than 2 acres) the DU model was refined to exclude Federal and State wildlife refuges, flooded agricultural land, vernal pools, riparian vegetation along the waterways and canals, and wetlands less than 2 acres. CDFG and USFWS personnel reviewed and edited the resulting land cover map using the International Tracking System (ITS) data, CDFG records, and field staff verification to tabulate private wetland acreage in the Central Valley. The identified wetlands may be owned by a CVHJV partner, enrolled in a CVHJV easement program, or may be private wetlands not affiliated with any program.

To use available resources most efficiently, the Focus Group narrowed the investigation of supplemental wetlands by identifying "nucleus areas" (those areas within each basin near existing managed wetlands where it seemed wetland restoration could most likely occur). These areas form the basis for Chapter 3 of this report. Using criteria agreed upon by the focus group, attributes within individual data layers were chosen for their importance to wetland restoration.

Appendix B
Time Line of Actions to Protect Suisun Marsh

The following is a time line of the actions taken in the period 1974 through 1995 to protect this ecologically sensitive marsh:

Year	Action
1974	The California Legislature recognized the threat of urbanization to the marsh and enacted the Suisun Marsh Preservation Act, which required a protection plan to be developed for the marsh.
1976	The Suisun Marsh Protection Plan proposed primary and secondary management areas, policies, a local protection program, acquisitions, and funding programs.
1977	The California Legislature added the Suisun Marsh Preservation Act to the Public Resources Code and legislated the protective measures outlined in the plan.
1978	Channel water salinity standards for the Suisun Marsh from October through May were set through State Water Resources Control Board (SWRCB) Water Right Decision 1485. Decision 1485 placed operational conditions on water right permits from the federal Central Valley Project and the State Water Project requiring that channel salinity standards be met.
1984	California Department of Water Resources (DWR) published the *Plan of Protection for the Suisun Marsh including Environmental Impact Report.*
1986	Federal legislation authorized funding for U.S. Bureau of Reclamation (USBR) to participate in protecting the Suisun Marsh.
1987	USBR, DWR, California Department of Fish and Game and Suisun RCD signed the Suisun Marsh Preservation Agreement (SMPA). Completed components of the Plan of Protection include Phase I, or Initial Facilities (Morrow Island Distribution System, Roaring River Distribution System, and Goodyear Outfall), and Phase II (Suisun Marsh Salinity Control Gates, also known as "Montezuma Slough Control Structure").
1995	SWRCB replaced the Suisun Marsh standards in Decision 1485 with standards contained in Order WR 95-6, which are based on the objectives in the 1995 Bay/Delta Plan. The purpose of these objectives is to provide water of sufficient quality to achieve soil water salinities capable of supporting the plants characteristic of a brackish marsh (SWRCB Environmental Report, 1995 Bay/Delta Plan, Appendix 1, page IX-15, et seq.). SWRCB suggested implementing measures to appropriately control Suisun Marsh soil and channel salinities, including those actions identified in the SMPA, and recommended using water and land management practices and employing a water manager to provide more consistent protection for the managed wetlands than currently done.

Appendix C
Abbreviations, Acronyms and Definition of Terms

LIST OF ABBREVIATIONS AND ACRONYMS

AF .... Acre-foot (or Acre-feet)
CDFG ..... California Department of Fish and Game
cfs .... cubic feet per second
CVHJV .... Central Valley Habitat Joint Venture
CVP .... Central Valley Project
CVPIA ..... Central Valley Project Improvement Act (Public Law 102-575)
CWA ...... California Waterfowl Association
DU .... Ducks Unlimited, Inc.
DWR ...... California Department of Water Resources
EPA .... U.S. Environmental Protection Agency
ESA .... Endangered Species Act
EWA ...... Environmental Water Account
gpm .... gallons per minute
GIS .... Geographic Information System
ICP .... Interagency Coordinated Program for Wetlands Water Use Planning, Central Valley, California
ID .... Irrigation District
ITS .... International Tracking System
MAF ...... Million acre-feet
MOU ...... Memorandum of Understanding
NAWMP ... North American Waterfowl Management Plan
NRCS ...... U.S. Natural Resources Conservation Service
P.L. .... Public Law
RCD .... Resource Conservation District
RD .... Reclamation District
SWP .... California State Water Project
SWRCB .... California State Water Resources Control Board
TDS .... Total Dissolved Solids
USFWS .... U.S. Fish and Wildlife Service
USBLM .... U.S. Bureau of Land Management
USBR ...... U.S. Bureau of Reclamation
USCOE .... U.S. Army Corps of Engineers
USDA ...... U.S. Department of Agriculture
WCB ...... California Wildlife Conservation Board
WD .... Water District

DEFINITION OF TERMS

AB 3030: Assembly Bill 3030, California's Groundwater Management Act, passed by the State Legislature and effective beginning January 1, 1993. This law provides for voluntary groundwater management at the local level. The law was designed as a means to retain local control over groundwater management while allowing the State to comply with EPA's Comprehensive State Ground Water Protection Programs to protect water quality.

Acre-foot (AF): The amount of water that will cover one acre to a depth of one foot; equal to 43,560 cubic feet or 325,851 gallons. This amount would supply a family of four with all household and landscape uses, or irrigate one acre of almond trees, for a year. Water demands are often measured in acre-feet annually, and reservoir capacities are reported as thousands or millions of acre-feet.

Anadromous Fish: Fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.

Appropriative Right: A water right based on physical control of water. The SWRCB permit system was established in 1914. Generally, diversions commenced prior to 1914 do not require a permit from the SWRCB. Diversions commenced after 1914 require a permit. Typically referred to as "pre-1914 right" and "post-1914 right", respectively.

Appropriator: A party that diverts or extracts water for use on nonriparian or nonoverlying land or for nonriparian or nonoverlying uses.

Area of Origin: In an interbasin transfer, the region exporting water.

California Department of Fish and Game (CDFG): Administers and enforces the California Fish and Game Code, and the regulations promulgated by the California Fish and Game Commission.

California Department of Water Resources (DWR): Oversees the State Water Project (SWP) and has the ability to implement, promote and encourage statewide water conservation. DWR also has the responsibility for investigating groundwater conditions and recommending protective actions and the safety of non-federal dams.

California State Water Resources Control Board (SWRCB): Administrative agency with the primary responsibility for regulating and determining rights to surface water and groundwater occurring within known and defined channels and as subsurface flow. In addition, the SWRCB has primary responsibility for enforcing the constitutional reasonable use requirement.

CALFED: The CALFED Bay-Delta Program is a cooperative effort by State and Federal agencies to solve water quality and reliability problems in California's Bay-Delta system. Working in partnership with urban and agricultural water users, environmental organizations, the business community and others, the CALFED Bay-Delta Program's mission is to develop a long-term, comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system.

Central Valley: The area from Red Bluff at the north end of the Sacramento Valley, to Bakersfield at the south end of the Tulare Valley. The Central Valley generally corresponds to the areas between the toe slopes (300-foot contour) of the Sierra Nevada and Coast Ranges, including the San Joaquin Valley, Sacramento Valley, and the Delta including Suisun Marsh, west to the Benicia-Martinez Bridge.

Central Valley Habitat Joint Venture (CVHJV): A consortium of public and private agencies and organizations united to restore sensitive wetland habitats. There are 16 partners in the CVHJV, which was formed in 1988 to implement the North American Waterfowl Management Plan in the Central Valley.

Central Valley Habitat Joint Venture Basins: The CVHJV Implementation Plan divided the Central Valley into nine drainage basins.

Basins within the Sacramento River watershed are:

- Butte
- Colusa
- Sutter
- Yolo
- American

Basins within the San Joaquin River watershed are:

- San Joaquin

Tulare Basin is an enclosed basin (and subbasin) that functions as a sink, although historically in wet cycles, it overflowed into the San Joaquin River.

Delta Basin is at the convergence of the Sacramento and San Joaquin rivers southwest of the City of Sacramento.

Commingled water from the Sacramento and San Joaquin rivers and their central Sierra Nevada tributaries flows west through the extensive **Suisun Marsh** Basin to San Francisco Bay.

Central Valley Project (CVP): This is a major water resource development project originally authorized by an Act of Congress in 1937, and managed by the U.S. Bureau of Reclamation. Facilities extend from Shasta and Clair Engle lakes in Northern California to Millerton Lake on the San Joaquin River. These reservoirs, with pumping plants and aqueducts, serve much of the Sacramento, San Joaquin and Tulare valleys. Important water distribution systems include the Tehama-Colusa Canal, Delta-Mendota Canal, and Friant-Kern Canal.

Central Valley Project Improvement Act (CVPIA): This Act of Congress, P.L. 102-575, signed October 30, 1992, gave significant new authority and policy direction to the U.S. Bureau of Reclamation for operating the Central Valley Project. The CVPIA authorized protection, restoration, and enhancement of fish and wildlife as a CVP project purpose. The law established as a policy that the CVP would achieve a reasonable balance between competing water demands among fish and wildlife, agricultural, municipal, and industrial water users and power contractors.

Conjunctive use, Conjunctive Operation: Operation of a groundwater basin in combination with a surface water supply and conveyance system to maximize water supply. Water is stored in the groundwater basin for later use by intentionally recharging the basin when a supply is available.

Consumptive Use: Use of water in a manner making it unavailable for use by others, generally because of absorption, evaporation, transpiration or incorporation in a manufactured product.

Crop Substitution: Most farm land in California can grow several different crops. Land managers may choose to plant and harvest crops that are economically productive, help control pests, or change the nutrients being extracted from or added to the soil. If a different crop is selected, one that reduces the irrigation water needed compared to a former crop, that crop substitution can make water available for other uses, including wetland restoration.

Deep Percolation: The percolation of water through the ground and beyond the lower limit of the root zone of plants into a groundwater aquifer.

Delta Inflow: The combined water flow entering the Delta at a given time from the Sacramento River, San Joaquin River, and other tributaries.

Delta Islands: Islands in the Sacramento-San Joaquin Delta protected by levees. Delta Islands provide space for numerous functions including agriculture, communities, and important infrastructure such as transmission lines, pipelines, and roadways.

Delta Outflow: The net amount of water (not including tidal flows) at a given time flowing out of the Delta towards the San Francisco Bay. The Delta outflow equals Delta inflow minus the water used within the Delta and the exports from the Delta.

Diversions: The action of taking water out of a river system or changing the flow of water in a system for use in another location.

Drainage Problems: Irrigated land may have impermeable layers underground. Irrigation water that percolates below the crop root zone may accumulate at the impermeable layer and slowly fill the soil profile until it reaches the root zone. The crop roots may be damaged by suffocation, or salts in the groundwater may rise to the soil surface by capillary action and accumulate as alkali deposits. Drainage problem lands may become unproductive for agriculture, in which case water that would have been used on them may be applied elsewhere. Alternatively, under some conditions these lands may be developed as wetlands.

Drought: A prolonged period of dry weather characterized by absence of or deficiency in precipitation. There is no measure for determining a drought, but qualitatively it usually causes a partial crop failure, a hydrologic imbalance, or an interference with the ability to meet established water demands.

Evapotranspiration: The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces. Quantitatively, it is usually expressed in terms of depth of water per unit area during a specified period of time. Land surfaces covered by wetland plants generally have high rates of evapotranspiration.

Environmental Water Account (EWA): A CALFED program to provide fish protection through environmentally beneficial changes in the operations of the SWP and CVP, at no uncompensated water cost to the project's water users. The EWA is intended to provide sufficient water, combined with the Ecosystem Restoration Program and the regulatory baseline, to address CALFED's fishery protection and restoration/recovery needs.

Endangered Species Act (ESA): Federal (FESA) and California (CESA) laws to protect the ecosystems upon which endangered and threatened species depend; and to protect and conserve such threatened and endangered species.

Firm Water Supply: The maximum annual water supply of a given water development that is expected to be available on demand, with the understanding that lower yield will occur in accordance with a predetermined schedule or probability.

Fish Screens: Physical structures placed at water diversion facilities to keep fish from being drawn into the facilities.

Focus Group: A steering committee for the Central Valley Wetlands Water Supply Investigations, drawn from interested members of the CVHJV.

Full Habitat Development: This is the result of implementing an optimum management strategy for any particular parcel. An optimum management strategy considers the unique combination of physical and biological factors affecting the site and the desires of the land owners.

Geographic Information System (GIS): A computerized system for storing, retrieving, and displaying data related to geography. The system can be imagined as a stack of maps marked with resource information that can be overlaid in layers to consider relationships between several resources at once.

Groundwater: Water that occurs beneath the land surface, in the saturation zone, and completely fills all pore spaces of the alluvium soil, or rock formation, in which it is situated.

Groundwater Overdraft: Intentional or inadvertent withdrawal of water from an aquifer in excess of the amount of water that recharges the basin over a period of years during which water supply conditions approximate average, and which, if continued over time, could eventually cause the underground supply to be exhausted, cause land subsidence (i.e., lowering of land surface in response to lowering of fluid pressure), cause the water table to drop below economically feasible pumping lifts, or cause a detrimental change in water quality.

Hydric Soil: A soil saturated, flooded, or ponded in the upper layer long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

Imported Water: Water transported into a watershed from a different watershed. Native water is water that occurs naturally within a watershed.

Irrigation: Distribution of water to land through artificial means to enhance crop production, either where natural water sources are so deficient as to make crop production impossible or where it is advantageous to supplement the natural water supply at certain critical stages in the development of crops.

Irrigation Tailwater, Irrigation Return Flow: Applied water that is not transpired, evaporated or deep-percolated into a groundwater basin, but returns to a surface water supply.

Land Fallowing/Retirement: Allowing previously irrigated agricultural land to temporarily lie idle (fallowing) or purchasing such land and allowing it to remain out of production for a variety of purposes for a long period of time. In both cases, the water formerly used to irrigate the land is available for use elsewhere. Fallow and retired land may be grazed or sometimes a crop grown with only rainfall.

Nucleus Area: As used in this report, a nucleus area comprises those areas near existing managed wetlands where the Focus Group thought wetland restoration would most likely be feasible. Nucleus areas are within one of the nine basins identified in the CVHJV Implementation Plan.

North American Waterfowl Management Plan (NAWMP): An agreement signed by Canada and the United States, and later co-signed by Mexico. It provides a broad cooperative framework for wetland and waterfowl conservation. The plan identifies 32 high priority focus areas critical to long-term conservation of North American waterfowl. The Central Valley of California is one of those priority areas.

Optimum Management Strategy: This is an empirical estimate of the percent coverage of the mixture of habitat types found on well-managed wetland complexes, as determined by waterfowl specialists in the wildlife agencies. For example, in northerly, better-watered basins, the percentage in seasonal and permanent wetland habitat types is higher than in more arid basins of Tulare or San Joaquin Valley basins.

Permanent Pasture: A land use of irrigated grass and forage plants maintained for livestock grazing. Permanent pasture is similar in some respects to wetland in water consumption. It may have considerable wildlife habitat value.

Permanent Wetland: In California, permanent wetlands historically occurred in areas near major waterways where river meanders created oxbow lakes or where sediment deposits would block off drainages from their outlet. Enormous permanent wetlands were at the terminus of Sierra Nevada drainages such as Tulare Lake and parallel to the Sacramento River and its tributaries.

Privately-Owned Wetlands: Managed wetlands, (minimum of 2 acres), owned by a private individual(s), or private organization(s). These lands may be under Federal or State easement.

Pumping Level: The position of the water surface in a groundwater source during pumping.

Pumping Lift: The distance water is lifted in a well from the pumping level to ground surface.

Riparian Land: The land adjacent to a natural water course such as a river or stream.

Riparian Right: A right to use the natural flow of a river or stream for beneficial purposes on riparian land without a permit from the SWRCB. The right is based on ownership of land, and attaches to the smallest parcel of land bordering a stream, lake, or pond. A riparian right generally has a higher priority than most appropriative rights.

Salinity: Generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids), electrical conductivity or osmotic pressure. Where sea water is known to be the major source of salt, salinity is often used to refer to the concentration of chlorides in the water. See *total dissolved solids.*

Seasonal Wetland: Lands that flood or become saturated during the fall, winter, or spring produce seasonal wetlands. Traditionally, most seasonal wetlands are along major waterways.

State Water Project (SWP): A water storage and conveyance system built and operated by the State of California. It has storage facilities at Lake Oroville on the Feather River, tributary to the Sacramento River, and conveyance facilities that extend to southern California. The SWP and CVP are operated in cooperation with each other, and share some of the same facilities.

Supply Augmentation Alternatives: Water management programs (such as conjunctive use, water banking or water project facility expansion) that increase water supply.

Supplemental Wetland Habitat: Refers to those restored or potentially restorable wetlands that are part of the 120,000-acre goal of additional wetland habitat identified in the CVHJV Implementation Plan.

Total Dissolved Solids (TDS): The quantity of minerals (salts) in solution in water, usually expressed in milligrams per liter (mg/L) or parts per million (ppm).

Water Banking: A water conservation and use optimization system whereby water is allocated for current use or stored in surface water reservoirs or in aquifers for later use. Water banking is a means of handling surplus water resources.

Water Conservation: Reduction in applied water through more efficient water use such as implementation of Urban Best Management Practices or Agricultural Efficient Water Management Practices. The extent to which these actions actually create a savings in water supply depends on how they affect net water use and depletion.

Water Marketing: The selling or leasing of water rights in an open market.

Water Right: A legally protected right to take possession of water occurring in a natural waterway and to divert that water for beneficial use.

Water Transfer: Conveyance of groundwater or surface water from one area to another that involves crossing a political or hydrologic boundary. A voluntary change in a point of diversion, place of use, or purpose of use that may involve a change in water rights. A long-term transfer shall be for any period in excess of one year (California Water Code Section 1735).

Wetland: Land where water-saturated soil is the dominant factor determining soil development and the types of plants and animal communities living on the soil and its surface. (Note: Riparian areas are excluded from the scope of study for this report, except where riparian values occur in conjunction with, or as part of, managed wetlands.)

Wetland Restoration: Developing hydrological, topographical, geochemical, and biological components necessary to support and maintain a wetland, principally where a wetland previously existed. Occasionally, development could occur on lands that were not formerly or not recently wetlands.