2. EXECUTIVE SUMMARY

2. EXECUTIVE SUMMARY

Introduction

The following chapter provides a summary of the contents of the *Technical Studies and Recommendations For The Lower Cache Creek Resource Management Plan.* It gives the reader a brief synopsis of each subsection presented in the three technical studies, and assists the reader in locating particular areas of interest covered in the document. Table 6-1 at the end of this chapter contains, in its entirety, a summary of recommendations from Chapter 6. This table summarizes the stated objectives for resource enhancement and management in the lower Cache Creek study area and recommendations for accomplishing those objectives. These recommendations were prepared by the study team in cooperation with County staff.

Purpose of the Technical Studies

Lower Cache Creek possesses valuable natural resources which should be preserved and managed to maximize their overall benefit in to the people of Yolo County. Valuable resources provided by the creek include: surface water supply, groundwater recharge, construction-grade aggregate, riparian forest and riparian-dependent wildlife and fish. It has long been recognized that a comprehensive plan is needed to manage the many resources provided by Cache Creek so that the good of the public is best served and the viability of the creek protected. Previous attempts to develop and implement such a plan have met with limited success, in part, because they lacked a solid base of technical information and data which is necessary to develop effective policies and accurately evaluate the expected effects of those policies.

Yolo County is currently in the process of developing a Cache Creek Resources Management Plan (CCRMP) for lower Cache Creek. This plan will rely on strong factual information to support its conclusions and policies. To provide this factual basis, the County contracted with EIP Associates in association with Northwest Hydraulic Consultants and David Keith Todd Consulting Engineers to prepare three technical studies for the streamway covering the areas of fluvial geomorphology, groundwater resources, and riparian habitat. Results from these three studies are contained in this report entitled *Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan.*

The purpose of this report is to:

- provide a comprehensive evaluation of existing relevant data on Cache Creek resources;

- provide a thorough review of historic conditions on and adjacent to the creek;

- provide a scientific, process-based evaluation of changes in the nature of the creek and its resources over time and why those changes have occurred;

- provide a general understanding of the interrelationship between streamway geomorphology, groundwater conditions, and riparian habitat characteristics of Cache Creek and how conditions are likely to change in the future under various approaches to resource management; and

- provide a basis for the County of Yolo to develop Cache Creek Resource Management Plan (CCRMP).

Based on the results of the three technical studies, resource management and policy recommendations were prepared that, in the opinion of the technical studies preparers, best serve the public good and protect and enhance the long-term viability of the Creek. These recommendations are provided for consideration by the County during their preparation of the upcoming CCRMP. These recommendations, along with public input, results from the technical studies themselves, and any other relevant information available to the County will be used to formulate the CCRMP.

Primary Study Area

The primary study area for the three technical studies is an approximately 16,000-acre area defined by the presence of minable aggregate resources in or adjacent to lower Cache Creek. This area extends approximately 1 to 1.5 miles on either side of Cache Creek for about 14.5 miles from the Capay Dam downstream to a leveed section of the creek near the town of Yolo (see Figure 1-1). This area provides the focus for all three technical studies although the scope of discussions for the groundwater evaluation and, to an extent, the streamway geomorphology study extend to areas beyond this in order to give a regional perspective to those evaluations.

Contents Of The Technical Studies and Recommendations Report

The contents of the technical studies report include:

Chapter 1: Introduction describes the general scope, content, and background of the report.

Chapter 2: Executive Summary provides a summary of the key findings of each of the three technical studies and the resource management and policy recommendations developed from these studies.

Chapter 3: Streamway Study was prepared by Northwest Hydraulic Consultants and analyzes the fluvial geomorphology and hydraulic characteristics of Cache Creek. It provides a description of how the physical nature of the creek has changed over time in response to various natural and artificial elements and discusses the current state of the creek and likely prospects for future changes under various management approaches.

Chapter 4: Groundwater Study was prepared by David Keith Todd Consulting Engineers, Inc. The groundwater study quantifies historical groundwater quantity and quality, documents the hydrogeologic context, describes surface water/groundwater interactions, and evaluates potential impacts of mining and reclamation on groundwater in and near lower Cache Creek.

Chapter 5: Biological Resources Study was prepared by EIP Associates. This chapter describes historical changes and trends in riparian vegetation, wildlife and fisheries in the lower Cache Creek area and discusses likely factors responsible for those changes. Current habitat conditions along the creek are discussed in terms of their interrelationship with stream hydraulics, fluvial morphology, land use practices, groundwater availability and surface water availability.

Chapter 6: Recommendations synthesizes the results of all three studies and formulates recommendations to be considered by the County during its preparation of guidelines and policies for the upcoming Cache Creek Resource Management Plan and/or mining-related ordinances.

Chapter 7: Report Preparation catalogues all participants responsible for creating this document.

Chapter 8: Bibliography consolidates all references used throughout the three technical studies in alphabetical order.

Chapter 9: Glossary provides definitions for technical terms that are used throughout.

CACHE CREEK STREAMWAY STUDY

Chapter 3 analyzes the fluvial geomorphology and hydraulic characteristics of Cache Creek. It provides a description of how the physical nature of the creek has changed over time in response to different natural and artificial elements, discusses the current state of the creek, and examines likely prospects for future changes under various management approaches. The chapter contains the following six subsections:

- 3.1: Introduction
- 3.2: Basin Geology and Geomorphology
- 3.3: Hydrology, Hydraulics, and Sediment Yield
- 3.4: History of Human Influences
- 3.5: Changes in Channel Geomorphology
- 3.6: Channel Dynamics

Section 3.1: Introduction describes the study area and establishes the purpose, objectives and scope of the Streamway Study. This section states that:

- the purpose of the streamway study is to provide an understanding of the hydrologic and geomorphic processes affecting Cache Creek and to provide the technical foundation for development of the CCRMP;

- the objectives of the streamway study are to: 1) develop a systems understanding of the hydrologic and geomorphic behavior of the Cache Creek study area over time; 2) develop an understanding of sediment processes (supply, transport, and loss), hydrology, and hydraulics under present and historical conditions; and 3) apply this understanding of "physical processes of the Creek as an integrated system" to develop recommended management concepts; and

- the scope of this study was to summarize relevant existing information, collect additional data, and perform additional analyses needed to provide the technical basis for the County to develop a resource management plan for Cache Creek.

Section 3.2: Basin Geology and Geomorphology describes the general geology and geomorphology of the Cache Creek drainage basin and alluvial fan. Existing information was evaluated in association with the results of field work conducted as part of the Streamway Study to assess: 1) lithologic make-up of channel bed material, 2) sources of gravel recruitment, 3) geomorphic and hydraulic controls of the channel, and 4) influences on stream-groundwater interactions (e.g. groundwater extraction) within the study area. Key conclusions from Section 3.2 include:

- The geology of the Cache Creek drainage basin is extremely complex and the result of recent tectonic adjustment, volcanism and ongoing processes of structural deformation, geothermal activity, faulting, and sedimentation.

- Surficial geology of Cache Creek Basin consists of marine and non-marine deposits dating from the Paleocene to Eocene and continental deposits that include sedimentary rocks of the Tehama, Modesto, and Red Bluff Formations dating from Pliocene to Holocene age. The geomorphic importance and characteristics of each of these formations are detailed in Section 3.2.

- The gravels of Cache Creek in the study reach can be classed into four major lithologic groups, based on the results from pebble counts by NHC and Klein and Goldman in 1958: (1) sandstone and metasandstone, (2) chert, (3) volcanic, metavolcanic, and ultramafic rocks, and (4) vein quartz.

- North Fork Cache Creek and Bear Creek supply approximately 30 percent of the total suspended sediment load transported down Cache Creek. The remaining 70 percent of the total suspended load is supplied by the main stem of Cache Creek.

- Historical geomorphic characteristics of Cache Creek from Capay Dam downstream to the Cache Creek Settling Basin were considerably different from today. Through this 28-mile reach the pre-mining natural channel of Cache Creek underwent a transition in the downstream direction from a wide, relatively steep, braided channel on the upstream end of the alluvial fan (with active deposition of gravels and sands) to a narrow channel incised into fine-grained overbank deposits and Tule marsh areas downstream from Yolo.

- The present day active channel (narrowed from 19th century widths) displays additional variations in width associated with constrictions of the channel at bridges. It also displays considerable differences in depth and therefore channel conveyance (flow carrying capacity, or cross section area) resulting from the cumulative effects of aggregate extraction for the past 100 years.

- Moving from downstream to upstream within the study area, there are at least four major physiographic provinces (geomorphic units) with distinctly different morphologic, hydraulic, and sediment characteristics. Additionally, the consultant team identified six "subreaches" within the study area with distinct characteristics including mean width, mean depth, slope, reach length and stationing.

- Cache Creek experiences tremendous seasonal and year-to-year variability in flow and sediment discharge.

- Sediment load and the grain size distribution of sediment materials associated with that load can vary greatly with changing river discharge. Periodic transport of sediment (especially the sand and gravel fractions) largely shapes the form and dimensions of the channel relating to the channel's stability or instability.

Section 3.3: Hydrology, Hydraulics, and Sediment Yield describes the hydrologic and hydraulic characteristics of the Cache Creek Basin such as stream discharge, water diversions, climate, channel vegetation and flow variability. The section also evaluates sediment yield in relation to aggregate extraction. Key conclusions from this section include:

- Flow (water discharge in cfs) in Cache Creek has large seasonal and annual variability. Because of water diversions, there is also a significant spatial variation in flow along the creek. The variability in discharge is amplified below Capay Dam, where irrigation diversions are made to the West Adams and Winters Canals. Water diversions from the Capay Dam may account for more than fifty percent of the annual flow past the dam during drought periods to less than ten percent of the annual flow in a wet year. While 10 to 50 percent of the total annual runoff is diverted, the diversions are concentrated during the irrigation season, with 100 percent of runoff diverted in many summer months, resulting in zero flow below Capay for extended periods in most years.

- Cache Creek can experience large floods during winter and spring months and rapid changes in discharge in relatively short periods of time (less than 24 hours). This type of system is extremely "flashy", or "episodic" in that it responds quickly to periods of intense precipitation in the upper basin, producing flow increases from a small base flow to a raging flood in a few hours.

- The average annual total sediment supply to the study reach above Capay is estimated to be approximately 927,600 tons, of which about 114,000 tons is sand and 49,000 tons is gravel. Summing the estimated sand and gravel loads in Cache Creek near Capay from 1943-1995 indicates that the cumulative total loads of sand and gravel over the past 53 years is approximately nine million tons.

doesn't add up?

- An estimated 90 million tons of aggregate have been mined from Cache Creek in the 75-year period since 1919. Less than 5 million tons of extraction was reported prior to 1943, however actual values may have been greater.

- Recorded extraction volumes exceed estimated sand and gravel yields amounting to a volume deficit of several hundred years.

- The expanding cumulative aggregate deficit (allowed under the current interim mining ordinance) between supply and extraction prevents the re-establishment of the dynamic equilibrium between river flow and sediment load. A prolonged imbalance of this magnitude can contribute to severe local as well as regional (reach averaged) channel changes (e.g., streambed lowering, bridge undermining, stream bank instability and impacts to riparian habitat). Consequently, it may not be practical or possible to "manage" Cache Creek back to geomorphic conditions similar to those observed fifty years ago. Realizing these limitations is important for the development of future management practices.

Section 3.4: Cache Creek History of Human Influences establishes a historical context for tracing significant changes in channel morphology over time using historical writings, aerial photography and mapping focusing on significant human influences. Section 3.4 presents a detailed history of settlement, agricultural development, water diversion and irrigation development, flood control, aggregate excavation, and bridge construction, and discusses their effects on the nature and behavior of lower Cache Creek. Key conclusions from Section 3.4 include:

- Channel response is extremely complex, and it is usually impossible to isolate the effects of a single variable. However, it is possible to draw general conclusions regarding channel response to a variety of influences, and to predict channel changes based on current conditions and historical trends. In order to understand current conditions of a stream, it is necessary to review the historical influence of changes along the stream channel and in the watershed.

- Cache Creek plays a prominent role in the history of Yolo County and the State of California.

- The Spanish and Mexican grants of *ranchos* inspired settlement of much of California's best agricultural lands and establishment of traditional Mexican patterns of *rancho* life. The Rancho Canada de Capay included the land shown on Bidwell's map as Rancho de Davis and Rancho de Mateo, extending along both sides of Cache Creek into the upper part of Capay Valley. These three ranchos encompassed nearly 76,000 acres of land along approximately 40 miles of Cache Creek, including the entire study area.

- During the 1850s, agriculture began to blossom in Yolo County, and the valleys of Putah and Cache Creek were the centers of farming and stock raising.

- The Cache Creek Valley was one of the first areas in the state to develop irrigated agriculture. Development of diversion systems on Cache Creek began in 1856 with the initial construction of Moore's Ditch. In 1871, the Clear Lake Water Company constructed a dam at the head of the Capay Valley above Rumsey.

- The Yolo County Flood Control and Water Conservation District was created by the legislature in 1951. In 1967, the district acquired the Clear Lake Water Company. In 1972, the district succeeded in passing a $4.4 million bond issue for construction of Indian Valley Reservoir. The dam was completed in 1976 and impounds 300,000 acre-feet of water.

- Although not well documented prior to about 1940, the history of gravel mining extends back into the late 1800s.

- As early as 1936, Yolo County began to regulate extraction of gravel from Cache Creek with the Yolo County Mining Ordinance, but use permits were not universally required, and many operations functioned without permits.

- Yolo County kept records of excavation of gravel from Cache Creek after 1960. These records generally reflect excavation within the channel, but after 1981 would include excavation (about 600,000 tons per year) in off-channel areas.

- Figure 3.3-14 in Section 3.3 presents the results of research into extraction rates for the period 1929 to 1994. This figure provides a general overview of gravel extraction from Cache Creek using both production and excavation records.

- In 1979, the County adopted the Yolo County Mining and Reclamation Ordinance, establishing a 'theoretical thalweg' and setting maximum production amounts for each operator. The Yolo County Board of Supervisors also formed the Aggregate Technical Advisory Committee (AGTAC) to prepare the resource management plan recommended by the Aggregate Resources Committee.

- In 1984, AGTAC completed their Draft Resource Management Plan for the creek, recommending that a floodway be maintained along Cache Creek, and that mining be permitted off-channel in deep pits. A Draft EIR was prepared by Dames and Moore to evaluate the impacts of the proposed AGTAC Draft Resource Management Plan. The Draft EIR was released in 1989, but was rejected by the Board of Supervisors as inadequate in 1991 after extended discussion and comments.

- The history of bridges in the study area includes failures or problems at nearly every crossing on the creek. In 1995, the Capay Bridge was substantially damaged during high flows in January and March. The left approach was eroded in January, and substantial bank loss occurred on the left bank upstream from the bridge. During the March event, settlement of one of the piers became substantial, and the bridge was closed to all traffic. The County is in the process of designing bridge and river training (stabilization) improvements for this bridge site. Table 3.4-4 summarizes key points in the history of bridges in the study area.

- The morphology and riparian vegetation of the Cache Creek channel prior to the influence of significant human disturbance is of interest in analyzing morphologic changes over time and as a baseline for stream restoration concepts. This study utilized a series of historical aerial photographs to quantify channel changes since 1937.

- Although the historic descriptions and map information are sketchy at best, they are helpful in forming an impression of the Cache Creek Channel prior to extensive human disturbance. In general, the creek was much shallower in relation to surrounding ground than it is today, and possibly had already begun some incision by the time the 1905 topographic maps were completed by the U.S. Geological Survey. Section 3.5 summarizes the morphologic changes that have occurred in the study reach since the 1930s. The width of the creek appears to have been variable, although in places where riparian vegetation was present, the active channel may have been only 150 to 200 feet wide. Overflow into riparian areas or onto alluvial fan surfaces would have occurred at relatively low depths of flow in the main channel.

- Major influences on the creek during the late 19th century include stock grazing, clearing of the land for agriculture, diversion of the creek's water for irrigation, and gravel extraction for road and railroad construction. The influence of humans on the creek has continued to increase in the 20th century due to more extensive and intensive farming practices, groundwater pumping for irrigation, increased diversions, substantially increased gravel extraction after about 1950, and flood control.

Section 3.5: Changes In Channel Morphology focuses on specific characteristics of the study reach and discusses the significant geomorphic changes that have occurred over time. Key conclusions from Section 3.5 include:

- Plan form changes in the channel were mapped from historical aerial photographs and topographic maps. The edge of active channel was defined by an escarpment clearly visible on the aerial photographs viewed stereoscopically and typically corresponding with a significant vertical change in bank elevation and often, in vegetative cover. The active channel was redefined for each year mapped, i.e., as formerly active portions of the channel bed were changed by avulsion, incision or other activities. The long-term trend observed was that the former extent of the active channel became smaller with time due to agricultural encroachment, levee building, road and bridge construction, installation of irrigation diversion structures and aggregate extraction.

- Between 1937 and 1964 the stream continued to narrow and incise. Gravel extraction contributed to localized channel incision; however, in the period from 1900 to about 1953, the construction of all-weather roads and bridge crossings may have contributed more to the narrowing and confinement of Cache Creek than did gravel extraction. Construction of the Capay, Esparto, Madison and Stevens Bridges greatly reduced the channel width at the bridge crossings as indicated in the early plans for the construction of the new all-weather road and bridge at Esparto (see Figure 3.4-12).

- Average channel widths since 1905 were reduced by approximately 85 percent in some reaches, from 3,500 feet wide to approximately 500 feet wide. Associated with channel narrowing is also an appreciable channel bed lowering (incision) as shown in Figure 3.5-9 which shows the change in thalweg elevation recorded at the bridge locations since 1905. At Stevens Bridge (Road 94B) as much as 30 feet of bed lowering was observed from the period 1953 to 1981. The channel invert (bottom) at Yolo has also lowered by approximately 24 feet since 1905. Figure 3.5-10 presents historical longitudinal profiles of Cache Creek developed from historical topographic maps, along with the County's "theoretical thalweg" which has been used since 1979 as the vertical limit for in-channel mining in the creek.

- Figure 3.5-11 shows historical channel cross section changes measured along the upstream face of the Highway 505 bridge in the years 1956, 1959, 1966, 1970 and 1974. Note that within 18 years the channel thalweg went down approximately ten feet and the overall cross section shape changed to a wider, more uniform cross section. Over time the bridge pier footings were exposed forcing Caltrans to conduct emergency bridge repairs to protect the footings (see Table 3.4-4 in Section 3.4). Since 1974, the bottom elevation near the Highway 505 bridge has lowered an additional three to five feet.

- Figures 3.5-12 through 3.5-16 show historic channel cross section changes since 1905 at typical subreach locations in the reaches between the bridges. They show the dramatic channel shape adjustment that has occurred over time in the reaches between the bridges. While the bottom has gone down, the channel has also narrowed. This has led to the overall adjustment of the creek's bed slope, plan and profile, and hydraulic characteristics. The ramifications of these changes discussed in Chapter 3.6.

- Figures 3.5-2 through 3.5-9 summarize the primary channel changes obtained from mapping the historic channel boundaries and mining operations over time.

- A GIS data base was used to compare changes in total channel area and mined areas within the active channel boundary and 1979-designated mining limits for time periods from pre-1937 to 1994. Results show a gradual increase in mining activity from 1937 to 1964 with a significant increase in the spatial extent of mining from 1964 to 1994. Present mining has expanded to fill 71 percent of the 1979 interim mining ordinance boundary (see Table 3.5-3).

Section 3.6: Channel Dynamics assesses the relative hydraulic capacity, sediment transport, and channel and bridge stability characteristics in each reach of the study area. Because of the variation in width and slope, there is considerable variability in local depth and velocity resulting in different sediment transport capacities from subreach to subreach. This chapter provides a quantitative basis for recommendations in Chapter 6 by running various simulations to characterize changes in the creek and probable stream response over time.

Key conclusions from Section 3.6 include:

- Today's creek from Capay Dam to Yolo is dramatically different in its geomorphic, hydraulic and sediment carrying characteristics compared to pre-1930 conditions. Historically, overbank flow during floods was more common in most reaches of the study area. Channel incision and levee construction have significantly reduced the frequency of these events.

- Construction of water diversions and bridges initially contributed to the alteration of the creek's plan and profile, and its ultimate flow characteristics.

- The present Cache Creek channel system is out of balance with the flow and sediment loads entering it.

- Bridges create significant hydraulic controls (constrictions) in the system.

- The bridges upstream from the Jesus Maria subreach (Subreach 2 near the I-5 bridge) are, in general, sediment starved (degradational). The Capay subreach (Subreach 8, upstream of the Capay bridge) is sediment starved and experienced significant incision during the 1995 floods.

- Channels typically respond to incision by trying to widen. Therefore, in future years we may see increased bank erosion in those reaches that experienced general bed lowering this year.

- The Madison and Hungry Hollow subreaches (6 and 7) tend to be depositional. Annual bar skimming to an arbitrary elevation (the theoretical thalweg) eliminates the long term accumulation of sediment, thus affecting the gradient through the reach and the availability of sediment loads to subreaches downstream from reaches 6 and 7. This can initiate nick point migration upstream and channel incision downstream.

- Annual bar skimming removes vegetation and disrupts the formation of armor materials and renders the bed surface more erosion prone during subsequent flood events.

- Reduction of floodplain storage and blockage of natural flood water escape routes has altered the local hydrology (flood peaks and travel time) in the study area.

- In most subreaches, the channel wants to be much wider than it is presently. Channel flows, depths and velocities have increased through the study area since the early 1900; affecting channel stability, vegetation and riparian characteristics.

- Increased hydraulic stresses within the channel may limit the type and survivability of some vegetative species formerly found in the creek.

- Continuous long-term (100-years) sediment transport simulations indicate that the creek will work on its own toward a more stable configuration (channel slope and compound-shaped cross section).

- Long-term sediment transport simulations indicate substantial aggradation in some subreaches.

- The long-term simulations demonstrated that there are opportunities through alternate river management practices to improve today's channel conditions. These opportunities are presented in Chapter 6 and summarized in Table 6.1.

CACHE CREEK GROUNDWATER STUDY

Chapter 4 of the Technical Studies Report serves as the factual foundation for groundwater resources in the upcoming Cache Creek Resources Management Plan. The chapter contains six subsections including:

4.1: Introduction
4.2: Available Data

4.3: Hydrogeologic Setting
4.4: Historical Perspective on Groundwater
4.5: Aggregate Mining and Groundwater Resources
4.6: Conclusions

Section 4.1: Introduction presents the purpose and scope of the groundwater study. Key conclusions from this section include:

- Major objectives of the groundwater study are the quantification of historical groundwater quantity and quality, documentation of the hydrogeologic context, determination of surface water/groundwater interactions, evaluation of potential impacts of mining and reclamation, and identification of recommendations for management and monitoring of aggregate extraction.

- The groundwater study focuses on the vicinity of Cache Creek from near Capay to Yolo, extending outward to encompass the mining resource zones that are the subject of the Cache Creek Resource Management Plan. However, the regional nature of the groundwater resource necessitates consideration of the overall groundwater basin shown in Figure 4.1-1.

Section 4.2: Available Data documents the available data compiled for this study and provided to Yolo County. Basic data reviewed in this section include rainfall, streamflow, irrigation diversions, land use, groundwater levels, groundwater use, groundwater quality, and aggregate excavation and production. Key conclusions from this section include:

- The rainfall record at several sites is incomplete, but a fairly complete record exists at Davis, and rainfall data overall are adequate for water resource studies.

- Although a long historic streamflow record exists for the Yolo gage, the Capay gage was discontinued in the mid-1970's.

- Irrigation diversion data are available extending back to 1929, but have not been compiled for specific canal diversions in useful form for 1978-1988.

- Numerous geologic logs and extensive groundwater level data exist, compiled by the California DWR and local aggregate mining companies.

- Although municipal pumping is documented, data on amounts of agricultural groundwater pumpage are not available.

- A master database of groundwater quality has now been compiled. However, the quality data often consists only of selected constituents and sampling has tended to be episodic, so that few long records exist. Due to the lack of complete ion analyses, the value of this data base is questionable.

- Information on historic aggregate extraction and production have been compiled; current record-keeping by the County monitors annual excavation by each aggregate company.

Section 4.3: Hydrogeologic Setting summarizes the groundwater characteristics of the study and surrounding areas which share the groundwater basin. Specific topics are the geologic setting, occurrence of groundwater, aquifer properties, groundwater storage, and groundwater quality. Key conclusions from Section 4.3 include:

- The geologic structure of the area is dominated by the Dunnigan Hills anticline, expressed as the Dunnigan Hills and Plainfield Ridge, and Madison syncline, the site of thick deposits of alluvium.

- The major aquifers in the area are the alluvium and Tehama Formation. Of these, the alluvium is more permeable.

- The contact between the alluvium and Tehama Formation has been the subject of considerable investigation. This "contact" represents the boundary between the permeable alluvium and the less permeable Tehama Formation. A revised contact is presented in this study.

- The alluvium is locally separable into two units--a shallower unconfined unit and deeper confined unit. The alluvium can be treated as one unit on a regional basis, but may need to be considered as two units on a local basis.

- Well construction and water level data are not sufficient for preparation of groundwater level maps distinguishing shallow and deep aquifer zones.

- No formal pumping tests apparently have been conducted to evaluate aquifer parameters such as transmissivity and storativity.

- Groundwater storage capacity of the basin is approximately five million acre-feet.

Section 4.4: Historical Perspective provides a historical review of groundwater resources along Cache Creek. The purpose of this review is to document trends in groundwater levels and quality, evaluate factors affecting groundwater resources, and provide a realistic perspective for groundwater management in the future. This historical perspective is divided into three major periods: Early History (to 1940), Middle History (1941 - 1977), and Recent History, (1978 - 1995). Each of these includes a discussion of agriculture, water development, aggregate mining, and groundwater resources and ends with a summary of the period. The key conclusions from this section include:

- Prior to significant water development in the Cache Creek area, the groundwater basin generally was full, with groundwater levels sloping gently from west to east.

- Natural recharge to groundwater under pre-development conditions occurred primarily from rainfall; streamflow in Cache Creek and overland flooding. Discharge of groundwater occurred through flow into creeks, evapotranspiration by riparian vegetation, and subsurface flow.

- The development of irrigation represents the most significant source of change in the groundwater system, resulting even before the 1940's in reduction of in-channel streamflow and recharge because of irrigation diversions, and in creation of a new avenue of groundwater discharge (well pumpage and subsequent consumptive use by crops).

- The period 1941 to 1977 was marked by substantial change in the groundwater system, including groundwater level declines to record lows in 1977, development of broad depressions in groundwater levels and convergent groundwater flow into major pumping areas, reduced groundwater discharge to streams and increasing recharge of streamflow.

- In the mid-1970's, the expansion of irrigated agriculture slowed and Indian Valley Reservoir, a major improvement to surface water irrigation facilities, was completed. By the late 1970's, irrigation wells also were largely in place.

- Groundwater levels since the late 1970's have been marked by a pattern of successive increase, decrease, and increase again. This pattern reflects the dynamic interplay of rainfall, surface water supply, and groundwater use.

- The impact on groundwater of thalweg decline along Cache Creek has not been as great as suggested in the late 1970's, but may have resulted in groundwater level declines of about ten feet in close proximity to the creek between Madison and Stephens Bridge.

Section 4.5: Aggregate Mining and Groundwater Resources presents an evaluation of potential effects of mining on the quantity and quality of groundwater resources along Cache Creek.

Potential effects on groundwater quantity include evaporation losses from quarries reclaimed as wet pits or lakes; impacts on groundwater levels and flow due to fines disposal, backfilling, and pit sedimentation; potential effects on groundwater recharge; and impacts of dewatering. Potential impacts on groundwater quality include exposure of the water table to surface contamination, loss of aquifer filtration capacity, and concentration of salts due to water table exposure to evaporation.

Section 4.5 recognizes that aggregate mining presents the potential for not only adverse impacts but also beneficial opportunities for groundwater management, including water storage and conveyance, and artificial recharge. The section concludes with a discussion of mining, monitoring, and groundwater management.

Key conclusions from Section 4.5 include:

- Evaporation losses from a wet pit are within the range of evapotranspiration losses of local crops and landscaping turf, but are essentially irreversible and exceeded only by well-tended turf.

- Wet pits are transfer mechanisms for groundwater flow, and can be designed and maintained to preserve groundwater quality and minimize sedimentation.

- Inappropriate handling and disposal of fine sediments generated by mining can result in loss of recharge capacity and hindrance of groundwater flow. Adverse impacts can be lessened through use of fine sediments in reclamation for agriculture or habitat, or in the case of localized disposal of fine sediments, minimizing the depth and extent to which the fine sediment deposit penetrates the water table.

- Backfilling of a pit with fine sediments introduces a zone of lower permeability in the aquifer, causing a downgradient decline in groundwater levels and an upgradient rise. Potential adverse impacts can be minimized through pit siting and design.

- Pits can be used for temporary clean water storage, and can be designed and maintained to preserve water quality. Adverse impacts on wells, streamflow, and riparian vegetation can be minimized through pit siting and design, and operational guidelines.

- Release of fine sediments to the Cache Creek channel could result in loss of recharge capacity. Benefits of intentional placement of fine sediments to establish vegetation may offset localized adverse impacts on recharge capacity.

- Intentional distribution of fine sediments to create substrate and soils for agriculture has no significant effect on groundwater recharge.

- Localized disposal of fine sediments typically involves small acreage and negligible impacts on recharge.

- Aggregate mining can create opportunities for artificial recharge through provision of shallow basins situated above the water table.

- Design of recharge basins above the water table provides an unsaturated zone for filtration, and allows drying of basins and sediment removal to maintain recharge rates.

- Potential areas for artificial recharge include the forebay or recharge reaches near Esparto and below Stevens Bridge near Woodland.

- Dewatering involves significant impacts on groundwater levels and supply.

- Thalweg lowering results in small localized groundwater level declines and loss of storage capacity. Such impacts can be minimized by limitations on in-channel mining.

- Entry of contaminants into a wet pit can adversely impact groundwater quality. Such impacts can be reduced through provision of a setback to wells, determined on a site-specific basis through capture zone analysis, and site design and maintenance to protect lake quality.

- Creation of a wet pit involves local reduction of filtration capacity by removing the gravel that acts as a natural filter for percolating water. The impact of this reduction can be minimized through provision of a setback to wells, determined on a site-specific basis through capture zone analysis, and site design and maintenance to protect lake quality. Creation of a wet pit also results in a small concentration of salts in groundwater, comparable to that associated with groundwater irrigation of high water demand crops. Site-specific monitoring at sites with backfilling or wet pit mining involve installation or selection of monitoring wells, measurement of water levels in wells and pits, and water quality sampling for wells and pits. Evaluation of wellhead protection areas will aid in development of specific guidelines for siting and design of wet pits. Simplified, small-scale computer models may be applied for such analysis.

- Specific monitoring requirements should be determined on a site basis, and may change through time.

- Water-related monitoring of mining and reclamation sites is best achieved when embedded in an overall regional water monitoring program, as responsibility for mining areas reclaimed for water management will ultimately rest with the water management agency.

- The Cache Creek region currently lacks a comprehensive water resources monitoring and data analysis program conducted by a single, responsible water management agency.

- Specific monitoring tasks to be incorporated into such a comprehensive program are enumerated, and entail collection of basic water resources information, ranging from continued compilation of rainfall data, to conduct of pumping tests, to revision of the groundwater quality monitoring program.

- Regional computer models are useful in simulating the cumulative or regional impacts of mining and reclamation, as well as water management alternatives. However, construction and application of such a model requires data, time, expertise, and a long-term commitment to use of the model. A regional model is best used in the context of regional water management.

Section 4.6: Conclusions presents the salient conclusions of the report in their general order of appearance in the report, beginning with Section 2, Available Data and ending with Section 5, Aggregate Mining and Groundwater Resources. Many of these conclusions are presented in this Summary under sections 4.2 through 4.5 above and in Chapter 6.

CACHE CREEK BIOLOGICAL RESOURCES STUDY

Chapter 5 of the Technical Studies report discusses the history and present conditions of the biological resources of the study area. The chapter begins with brief descriptions of the regional setting and general ecology of riparian systems in the central Great Valley of California. Interrelationships between biological resources and the water and mineral resources that are described in the streamway and groundwater studies are discussed qualitatively where appropriate, and opportunities and constraints related to identified possible management concepts are presented.

The chapter has seven subsections including:

5.1: Introduction
5.2: Ecology of Riparian Habitat
5.3: History of Habitat and Human Influences
5.4: Existing Conditions
5.5: Special Status Species
5.6: Weeds
5.7: Habitat Restoration: Limitations and Opportunities

Section 5.1: Introduction describes the contents and purpose of the biological resources study.

Key conclusions from the Section 5.1 include:

- Riparian systems in general are important for conservation planning for many reasons: they tend to support higher diversity of habitat subtypes and of species than do other habitats; they inherently constitute migration and dispersal corridors, thereby biologically connecting the inhabitants of otherwise separated habitat areas into larger population associations; and the tall trees and other dense cover that is found in many riparian systems provide breeding sites and daily refuge for many species of wildlife that forage in surrounding agricultural areas or other types of upland habitats.

- Riparian systems often represent good conservation opportunities for simply practical reasons. The most practical and economical method of accommodating regular flooding regimes involves leaving sufficient undeveloped space to permit unimpeded high water flows. Also, the aesthetic and recreational values associated with biologically well-developed riparian systems are high: fishing, nature observation, and recreational trail development are generally compatible with maintenance of riparian habitat of high biological value.

- Near the mined reach of Cache Creek, an as-yet undetermined amount and nature of riparian habitat restoration will be required within the study area as an element in aggregate mining reclamation. Coordinated advance planning will maximize the habitat values that will be achieved within the space and economic constraints of that reclamation.

Section 5.2: Ecology of Riparian Habitat presents a summary of the ecological processes of riparian habitats and provides an introduction to the historical changes and present conditions in the lower Cache Creek study area. Key conclusions from this chapter include:

- When applied to species or ecosystems, the term "riparian" refers to all those species and systems that are associated with flowing water.

- Major relevant characteristics of the Cache Creek riparian system include the occurrence of an extremely wide range of flow rates from very low or no flow in summer to discharges of many thousands of cubic feet per second (cfs) under flood conditions when sediment transport and deposition are correspondingly large. Flow conditions may also vary on a reach-by-reach basis. Some reaches of the creek tend to lose water to relatively deep aquifers below the channel. These are called "losing reaches." Some reaches gain water from relatively shallow aquifers and these area called "gaining reaches." Under some conditions, losing reaches may be dry while gaining reaches contain flowing water.

- The character (grain size) and hydrologic regime of substrate determines the plant community that initially becomes established.

- Several interrelated parameters of the physical environment control most of the biological character of any particular riparian area. These include the pattern of water flow, the nature of the substrates (which is to some extent a consequence of surface hydrology), and the depth and seasonal fluctuation of the groundwater which, in part, affects the pattern of surface flow.

- The most critical aspect of stream hydrology for vegetation is the duration of the post-flood and low-flow period, as it is during the late spring and summer that nearly all growth of riparian vegetation occurs. The enormous influence that the duration of flow has on vegetation can easily be seen in Cache Creek: even in the limited areas within losing subreaches that are not subject to frequent surface disturbance from aggregate mining, the development of high quality riparian vegetation is slow or limited in potential structure, whereas the perennial-flow subreaches support dense and diverse riparian vegetation.

- One of the most prominent characteristics of riparian habitat is its dynamic character, both short- and long-term. This continual change results from a variety of causes, primarily the fluvial geomorphological processes such as those discussed in this study. As a result of all of these dynamic processes, riparian ecosystems are composed of a variety of very different habitat types, closely juxtaposed; this concentrated diversity is one of main reasons for the high biodiversity and habitat values of these communities.

Section 5.3: History of Habitat and Human Influences discusses the conditions of Cache Creek riparian habitat during three historic periods: the period prior to human influence, the early stages of human influence, and the twentieth century when intensive modification to the creek and surrounding areas occurred. Key conclusions from this section include:

- The habitats present in and around Cache Creek prior to significant human influence would have been much more mesic (water-dependent) than at present, and facultative-wetland plant communities, primarily willow thickets, would have extended across most of the flood plain lying between the multiple channels. The high ground to either side of the creek system, which would have been in the form of natural levees lying slightly above the annual flood plain, would have been forested primarily by oaks. It is possible that low areas outside the creek system might have supported some non-oak-dominated riparian forest, but an extensive forest of mixed valley and blue oak was present far beyond the present limits of the riparian system.

- The two most important alterations of the biological resources of Cache Creek that were carried out by early settlers were the introduction of huge populations of livestock and the felling of the majority of the oak forests. Water diversions were also initiated at this time, although their relatively small scale would have had only a limited effect on the riparian system as a whole.

- From the perspective of effects on biological resources, the defining event of the modern period of the history of Cache Creek is the construction of the Capay Dam in 1914. Although high flows are not substantially impeded by this dam, and the regular flooding and sediment processes that sustain riparian ecology continued (and continue, to some extent), the dam facilitates the diversion of most or all of the early growing season water flow that is important in sustaining the area and character of riparian vegetation in the losing reaches (areas where creek flow is lost to groundwater) of the creek. Vegetation in the gaining reaches (areas where groundwater contributes to creek flow) is affected to a much lesser extent.

Section 5.4: Existing Conditions provides a reach-by-reach description of riparian habitat conditions found along lower Cache Creek. These habitat types are illustrated in Figure 5.4-1. Total acreage of riparian vegetation types that occur within the study area are shown in Table 5.4-1.

Cache Creek fisheries resources are also described in Section 5.4. Though anadromous species (species that spend most of their lives in salt water but migrate to fresh water to spawn) are virtually absent from the creek, the creek supports a diverse "warm-water" fishery made up of both native and introduced species that reside in the study area.

Section 5.5: Special Status Species discusses species that are listed or proposed for listing as rare, threatened, or endangered by either the California Department of Fish and Game (CDFG) or the U.S. Fish and Wildlife Service; most species that are candidates for either state or federal listing; and species designated as "fully protected" or "species of special concern" by CDFG. Key conclusions from the section include:

- Within the study area, only three special-status species are recorded in the Natural Diversity Data Base (NDDB) maintained by the California Department of Fish and Game: Swainson's hawk, bank swallow, and tricolored blackbird.
- Designated critical habitat for a fourth species, valley elderberry longhorn beetle (VELB), has been mapped within the study area.

Section 5.6: Weeds discusses plant species that were introduced to the Cache Creek area within historic times, have become naturalized, and are invasive. Of particular interest are tamarisk and giant reed. The natural history of these species and their status along Cache Creek are detailed in the section, as are potential methods for control of these species.

Section 5.7: Habitat Restoration - Potential Limitations and Opportunities describes the opportunities available and existing constraints for the improvement of riparian habitat within the study area. Key conclusions from this section include:

- The enhancement and/or expansion of riparian habitat within the study area depends upon the creation and maintenance of a channel morphology and hydrology that are conducive to the development of desired habitat types or mosaics. Specifically, frequent flooding is necessary to create seasonal saturation and to deposit fine-grained sediments, and near-surface ground water is necessary to sustain woody vegetation through dry seasons and years. Wherever surface flow is not perennial, the duration of the seasonal flow is very important in determining the character of the vegetation that can develop. Active habitat restoration efforts, such as removal of undesired weedy species or planting of desired native species, are only successful in the context of other actions that will maintain the proper soils and hydrologic regimes. Thus, achievement of habitat goals is realized primarily by improving the physical character of the streamway, and secondarily by specific vegetation-directed actions. The limitations imposed on re-establishment of extensive riparian habitat include narrowing of the floodway, diversion of surface flows, and surface disturbance due to aggregate mining. In general, the recommendations for establishing a wider channel morphology more similar to historical conditions and modifying aggregate extraction operations significantly would provide opportunities for establishment of riparian habitat (Recommendations 1, 2, 3, 6, and 7 ~~above~~ below). Changes in flow-duration characteristics described in Recommendation 9 may also benefit riparian communities, although additional summertime flow may be required to support vegetation (see Chapter 5).

- Active habitat restoration efforts, such as removal of undesired weedy species or planting of desired native species, are only successful in the context of other actions that will maintain the proper soils and hydrologic regimes for riparian vegetation establishment.

- Achievement of habitat goals can be realized primarily by improving the physical character of the streamway, and secondarily by specific vegetation-directed actions.

- General guidelines for riparian vegetations directed actions are presented in Section 5.7.

CHAPTER 6: RECOMMENDATIONS

The three studies presented in Chapters 3, 4, and 5 of the Technical Studies Report provide the technical basis from which a Cache Creek Resources Management Plan (CCRMP) can be developed. The following chapter discusses the proposed objectives of the CCRMP as described in the June 1994 Yolo County Statement of Goals, Objectives, and Polices for the Cache Creek Resources Management Plan and presents recommendations designed to assist the County in creating the means to achieve those objectives.

Chapter 6 describes objectives for creek management, provides specific recommendations for achieving these objectives, and briefly discusses implementation options. All recommendations are tabulated in Table 6-1. In that table, each recommendation is given a priority ranking indicating the relative importance and effectiveness of the specific recommendation to achieve the stated objective with "1" having the highest priority and "3" having the lowest.

Table 6-1 is presented below:

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Increase Channel Stability	1. Define a regulatory boundary for streamway influence utilizing the historical extent of the channel as defined by early topographic mapping.	1
	2. In the long term, limit in-channel aggregate extraction to approximately the volume of sand and gravel delivered annually to the study reach. Vary extraction to match supply on an annual basis.	1
	3. In the near term, allow aggregate extraction greater than the supply to the study reach to return the channel to a form more similar to its historical morphology.	1
	4. Discontinue mining activities within active low flow channel areas to avoid disturbance to the armor layer. Recommended width of protection is 300 feet for single thread channels and 250 feet for multiple thread channels.	1
	5. Abandon the theoretical thalweg concept and 1979 in-channel mining boundary. Utilize valley slope and historical sinuosity to establish management targets for bed gradients.	1
	6. Restrict aggregate extraction using general or reach-specific cross section templates (see Figures 6-2 to 6-5).	1
	7. Synthesize individual in-channel mining reclamation plans into a single regional plan. Utilize the regional reclamation plan to reduce changes in hydraulic and sediment transport capacities between reaches.	1
	8. Develop regular and emergency channel bank maintenance and repair agreements with aggregate operators, land owners, and government agencies.	1
	9. Modify Capay Dam operation to provide channel forming flows during the Spring and Fall. If feasible based on annual precipitation, release flows of 1,000 cfs or more for a period of at least 1 week and flows of 2,000 cfs or more for a period of at least 1 day.	3
	10. Consider the benefits of bank protection and bridge protection in economic analyses of upstream storage dams, if a dam is reconsidered for flood control and water supply purposes.	3
	11. Integrate riparian vegetation into overall hydraulic and sedimentation management.	2
	12. Use riparian vegetation, where appropriate, to create smoother transitions between reaches with differing hydraulic capacities.	1

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Increase Channel Stability (cont)	13. Selectively remove vegetation where its establishment threatens channel stability.	1
	14. Encourage vegetation in newly established terrace areas within the channel near the banks.	2
Improve Riparian Habitat	15. Promote habitat stability by improving channel stability. Smooth the channel banks by lowering the high banks at constrictions, as shown in Figure 6-1. In the stream segment including the Dunnigan Hills subreach and the upstream portion of Hoppin subreach, create terraced cross-sectional topography with gradual (10:1) transitions. Longitudinally smoothed, terraced creek topography will reduce erosion/sedimentation instability and promote the development of a variety of different riparian habitats.	1
	16. Once the desired channel configuration is achieved in the restoration reach(es), terminate in-channel mining in those areas in order to preserve the highest quality riparian habitat resources.	1
	17. Apply treatments similar to those presented in Recommendations 15 and 16 to the Capay reach.	2
	18. Promote the development of stable habitat along losing reaches. Establish a low flow channel with an initial configuration similar to that seen in aerial photographs taken after the 1995 flood events. Discontinue all mining-related surface disturbance within a corridor 200 feet wide centered on this channel. Modify the width and location of the no-disturbance zone as the low-flow channel migrates and evolves. Require that no large piles of mined materials be left within the channel in places where they would tend to create highly erosive flows in the no-disturbance zone.	2
	19. In gaining reaches of the riparian system, plant species appropriate to the substrate and hydrologic regime of each microsite (terrace, transition slope, etc.).	1
	20. In all reaches where mining occurs, require that bar skimming be limited to the downstream portion (up to 3/4 of the length) of the bar, and require salvage of topsoil and woody plant material and their use in restoration planting.	1

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Improve Riparian Habitat (cont)	21. Configure abandoned off-channel pits designated for habitat creation so as to favor the establishment and long-term survival of a diverse mixture of woody species, emphasizing those comprising mixed riparian forest. Place topsoil and plant abandoned pits to be reclaimed with appropriate zones of riparian species.	1
	22. Control weed invasion primarily by improving channel characteristics as described above.	1
	23. Remove individual large clumps of giant reed in areas of highest flow velocities (in or near the thalweg).	1
	24. Remove or exterminate tamarisk only where it competes with native species which would otherwise form closed vegetative communities.	2
Protect Groundwater Resources	25. Protect groundwater from overdraft by discouraging dewatering of wet pits to facilities mining.	1
	26. Encourage minimization of lake area, especially shallow lake areas.	3
	27. Protect groundwater recharge by encouraging disposal of fine sediments in reclamation to agriculture and habitat.	1
	28. Where localized disposal of fine sediments is proposed, encourage minimization of the footprint of the deposit.	3
	29. Discourage releases of fine sediments to the Cache Creek channel. This recommendation recognizes that intentional placement of fine sediments to provide suitable substrate for vegetation may provide benefits that offset localized losses of recharge capacity.	1
	30. Protect aquifer transmissivity by adopting procedures to determine appropriate site-specific size limitations and setbacks for backfilled pits. These procedures would include identification of potentially impacted wells, water level monitoring, documentation of aquifer characteristics, and application of analytical methods or small scale modeling to determine limitations and setbacks.	1
	31. Minimize penetration into the water table of deposits resulting from localized disposal of fine sediments.	3
	32. Maintain wet pits and lakes in a clean condition to minimize clogging and prevent sedimentation of wet pits.	2

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Protect Groundwater Resources (cont.)	33. Protect usable groundwater storage capacity by continuing limitations on in-channel mining to prevent thalweg lowering within the context of streamway restoration.	2
	34. Preserve groundwater quality by developing wet pit design parameters to protect lake and groundwater quality. Such parameters should include perimeter berms to prevent intrusion of local runoff into the lake. Promote design of wet pits with relatively steep slopes along a portion of the perimeter to minimize clogging and promote throughflow of water, while recognizing the offsetting riparian and recreational benefits of gentler slopes along a portion of the perimeter.	1
	35. Define appropriate site use and maintenance. Wet pits reclaimed as lakes provide opportunities for natural habitat and recreation. If the site is to be remain private property, consider the maintenance of security, aesthetics, and habitat benefits of the site and lake. If accessible to the public, consider the ultimate ownership and responsibility for the site. In addition, define restrictions on site access and activities. Such restrictions may include fencing and gating of the site, establishment of site hours or curfew, regular inspection, security, and even policing of the site. Sanitary facilities will be required for public access. Restriction of site activities should include prohibition of motorized vehicles and watercraft to prevent erosion and pollution. Appropriate site activities may range from those including significant access to the water and site (e.g., non-motorized boating, windsurfing, swimming) to those prohibiting water access and allowing, for example, only picnicking, pier fishing, and perimeter hiking in designated areas.	1
	36. To ensure that nearby wells are provided protection through aquifer filtration and attenuation, outline procedures to identify and describe potentially affected wells, to evaluate wellhead protection areas, and determine appropriate setback. These procedures would include identification of nearby wells, documentation of local hydrogeologic conditions, and analysis of wellhead protection areas, likely using small scale modeling.	1
	37. Provide for detection of a groundwater quality problem through installation and sampling of two or more monitoring wells downgradient of the wet pit or lake. Establish a site monitoring program that includes upgradient and downgradient wells, water level measurements, and regular sampling.	1

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Protect Groundwater Resources (cont)	38. Improve riparian habitat by considering evapotranspiration demands of restored riparian habitat as an appropriate demand on groundwater supply. Promote establishment of shoreline vegetation along the perimeter of wet pits.	3
	39. If a wet pit is to be reclaimed for recreational uses or riparian habitat, document the range of expected water level fluctuations and adjust siting and design of the pit accordingly.	1
	40. Enhance Yolo County water supply by considering establishment of a comprehensive, basin-wide water resources monitoring and data analysis program.	1
	41. Integrate site-specific monitoring of mining sites into a comprehensive, basin-wide water monitoring program. Recognize that this integration will be incremental: beginning initially with data sharing by mining companies, developing into a program of quarry area monitoring by an agency, and eventually including full responsibility by a water management agency for sites reclaimed with water management functions.	1
	42. Use of a wet pit for clean water storage should include careful consideration of adverse impacts. Adopt procedures to determine appropriate setbacks for storage pits and operational limitations. These procedures would include identification of potentially impacted wells, water level monitoring, documentation of aquifer characteristics, and application of analytical methods or small scale modeling to determine limitations and setbacks.	2
	43. Discourage use of pits for retention of poor quality water.	1
	44. Consider dedication to artificial recharge of areas in and beyond the Cache Creek channel that are permeable, situated above the high water table, relatively flat, and accessible by equipment.	1
	45. Implement a regional or County-wide water management program, including identification of the suitable water agency, initiation of comprehensive regional monitoring and management, and development of a regional computer model.	1
	46. Consider the implications on channel stability of any future diversions from the creek associated with groundwater recharge.	2

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Protect Groundwater Resources (cont)	47. Consider in-channel recharge basins in appropriate reaches of the creek as one component of a more intensively managed section of the creek. Compatible uses might include managed aggregate extraction and development of seasonal wetland habitat.	3
Provide Opportunities For Aesthetic, Recreational, and Educational Enhancement	48. Develop a continuous corridor along Cache Creek accessible to the public as part of regional reclamation plans. In the near term, public access may be incompatible with many existing land uses. However, as reclamation plans are developed in phases, limited public access may be feasible, and could help to financially support additional reclamation and restoration. Increased public access, with a continuous parkway corridor, may be a feasible long term goal.	3
Preserve Flood Carrying Capacity	49. Limit changes in channel form (compound shape) and establishment of vegetation to levels that will not result in overtopping of historical channel banks (in-channel mining boundary) in the 100-year flood.	1
	50. Perform annual maintenance based on a monitoring program to maintain flood capacities (see Recommendation 8 for channel maintenance, and monitoring recommendations below).	1
	51. Request that the Corps of Engineers make appropriate sedimentation and channel stability assessments in conjunction with development of flood control alternatives near the downstream end of the study area.	1
Provide For Managed Aggregate Extraction	52. Utilize managed extraction to promote and maintain channel stability and flood capacity. Aggregate extraction would primarily be from shallow excavations located on in-channel bars and terraces. Extraction would be guided by annual monitoring. Because extraction may be necessary outside the limits of mining rights of individual operators, the County may wish to take bids for these removals under a new permit program	1
	53. Extract the aggregate presently located in levees constructed or remaining within the channel limits to create a wider channel with a compound form more similar to historical channel cross sections (see Recommendation 6).	1
	54. In the long term, promote the development of off-channel aggregate extraction to replace the present supply from in-channel mining. Maintain a setback distance between the present bank line and the edge of off-channel pits. A setback of 700 feet is recommended unless engineering analysis indicates that a smaller setback will not adversely affect channel stability or groundwater resources. A minimum setback of 200 feet is recommended.	2

TABLE 6-1

SUMMARY OF RECOMMENDATIONS

Objective	Recommendation	Priority Class
Protect County Infrastructure	55. Widen or eliminate existing bridges to reduce hydraulic constrictions in the channel and the potential for scour damage at the bridges. (This recommendation, while technically sound for protection of the bridges, may not be justifiable or practical based on cost.)	1
	56. In lieu of Recommendation 55, construct smooth transitions in channel capacity upstream and downstream from the bridges and construct guide banks and grade control structures at the bridges where determined necessary in a monitoring program. Transitions may use spur dikes, berms, vegetation or other means to gradually change channel capacity in the longitudinal direction. Transitions should be at least five times as long as the change in channel width at the bridge. Monitor and maintain transition areas.	1
Promote A Self Sustaining Fluvial System	57. Institute a focused creek monitoring program to collect data necessary to make management decisions. This data collection should include water and sediment discharge data at the Capay and Yolo gage sites, water and sediment discharge data collection during high flows at additional sites, and topographic data collection twice annually in areas of aggregate extraction and once annually in other areas. Substantial monitoring could be accomplished through a combination of forces, including federal and state government agencies (USGS, Corps of Engineers, DWR), local agencies (Yolo County, YCFCWCD), local residents and interest groups, and aggregate operators. The monitoring program could become a part of public education programs associated with the creek. The monitoring results should be integrated and maintained in the County's GIS database.	1
	58. Establish a Technical Advisory Committee (TAC) composed of members with sound technical backgrounds to make management decisions on the creek. Provide monitoring data to the TAC to be used as the basis for decisions and recommendations to the Board of Supervisors. Synthesize annual monitoring data and TAC recommendations into scientifically-based management actions.	2
	59. Allow for flexibility in management of the creek over time as conditions change. Establish desirable trends rather than fixed plans or specific dimensions. Monitor changes to confirm trends.	1