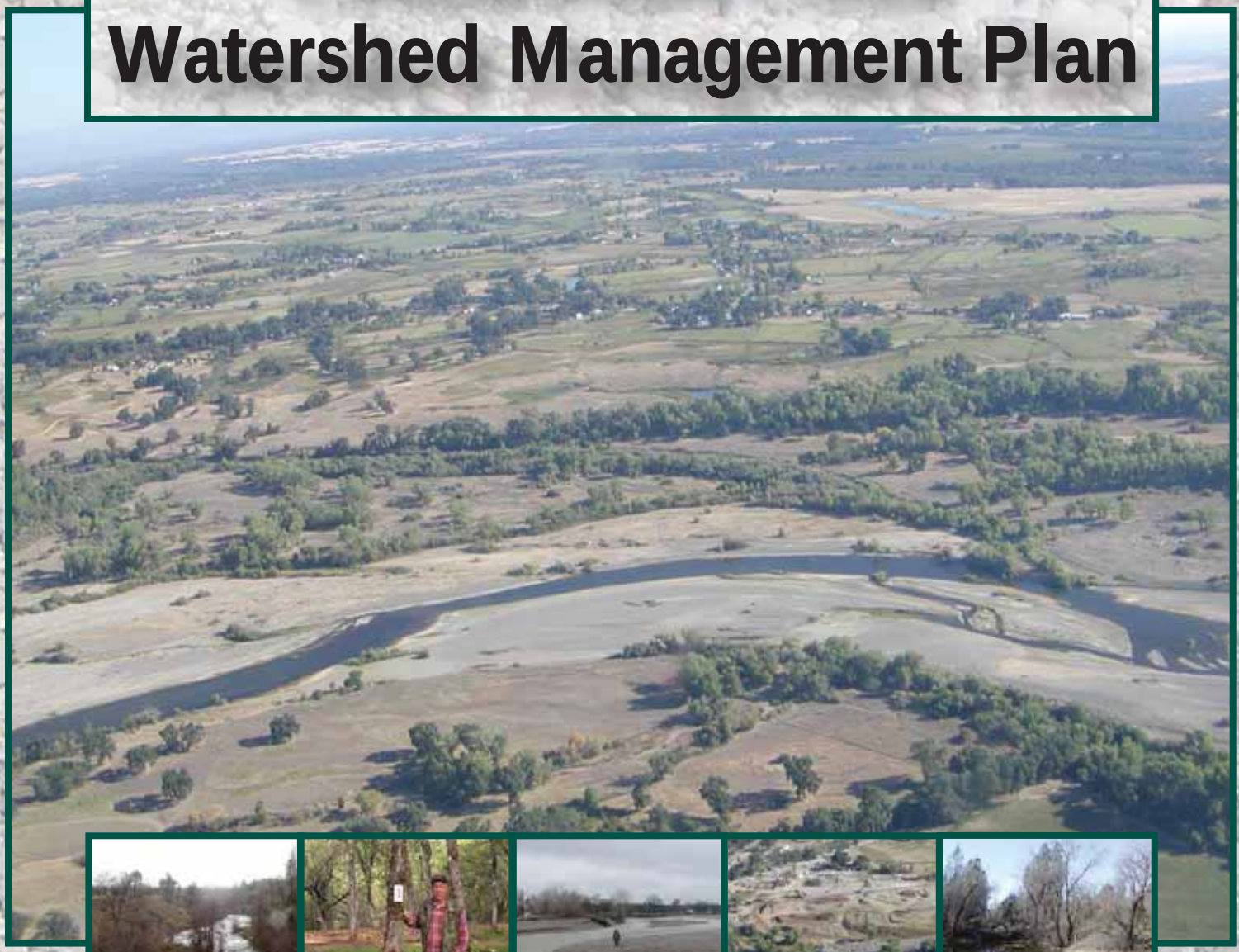
Cottonwood Creek Watershed Management Plan



Prepared for
Cottonwood Creek Watershed Group

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Cottonwood Creek Watershed Group

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Cottonwood Creek Watershed Management Plan

Prepared for

Cottonwood Creek Watershed Group

September 2007

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Preface

This Watershed Management Plan was prepared for the Cottonwood Creek Watershed Group. Funding for this Management Plan (Agreement No. 04-188-555-0) project has been provided in full or in part through an Agreement with the State Water Resources Control Board pursuant to Proposition 50 and CALFED and any amendments thereto for the Implementation of California's Non-point Source Pollution Control Program.

Acknowledgments

Many individuals contributed their time and energies to the development of this Watershed Management Plan. These include landowners from throughout the watershed, representatives of resource agencies with interest in watershed management activities and programs, business owners and their representatives, and other volunteers. Without the participation of this broad and diverse group of people, it would be impossible for the Watershed Management Plan to fulfill its intended purpose.

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Acronyms and Abbreviations

CCWG	Cottonwood Creek Watershed Group
CDFG	California Department of Fish and Game
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
ERPP	Ecosystem Restoration Program Plan
GIS	geographic information system
GRA	Graham Matthews and Associates
NRCS	Natural Resources Conservation Service
RDM	residual dry matter
SWP	Cottonwood Creek Strategic Watershed Plan
TCFCWCD	Tehama County Flood Control and Water Conservation District
TM	technical memorandum
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Watershed Assessment	Cottonwood Creek Watershed Assessment
WIM	watershed information model
WMP	Watershed Management Plan

SECTION 1.0

Introduction

1.1 What is a Watershed Management Plan?

The U.S. Environmental Protection Agency (EPA) defines a watershed plan in its *Draft Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (EPA, 2005a) as follows:

> A *watershed plan* is a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, actions, participants, and resources related to developing and implementing the plan.
>
> Although each watershed plan emphasizes different issues and reflects unique goals and management strategies, some common features are included in every watershed planning process. The watershed planning process is iterative, holistic, geographically defined, integrated, and collaborative.

With substantial input from stakeholders, the Watershed Management Plan (WMP) identifies the most pressing problems in the watershed and establishes goals, objectives, and actions for resolving them. The WMP also contains strategies for monitoring progress and financing implementation. The WMP is a living document that will be re-examined and revised by the Cottonwood Creek Watershed Group (CCWG) on a regular basis to ensure that the goals, objectives, and specific actions continue to address the most pressing problems (EPA, 2005b). This WMP is a blueprint to assist stakeholders in preserving the environment, private property and water rights, and economic resources of their watershed.

This WMP is the first iteration of a set of goals and actions that can be used to achieve those goals. There is still much to be learned about the Cottonwood Creek Watershed – it is primarily a rural watershed that has not been fully studied. Therefore, key actions outlined in this document involve gathering information required to provide a basis for future decisions and subsequent actions to meet the WMP's goals.

1.2 Cottonwood Creek Watershed Group

The CCWG was formed in 1999 under the Non-profit Public Benefit Corporation Laws of California. It was formed exclusively for public, scientific, educational, and charitable purposes within the definitions of Section 501(c) (3) of the Internal Revenue Code. The purpose of the CCWG, as described in its mission statement, is to "preserve the environment, private property and water rights and economic resources of the Cottonwood Creek Watershed through responsible stewardship, liaison, cooperation and education." The CCWG is directed by a board of five to seven members, selected from landowners within the watershed.

1.3 The Cottonwood Creek Watershed

The Cottonwood Creek drainage area lies within Shasta and Tehama Counties on the northwest side of the Sacramento Valley. The lower two-thirds of the drainage area lie in the Central Valley uplands; the upstream portion includes the east slope of the North Coast Mountain Range and Klamath Mountains, and the southern slopes of the Trinity Mountains. Cottonwood Creek flows eastward, in general, through the valley to the Sacramento River. The Cottonwood Creek Watershed has three main tributaries: North Fork, Middle Fork (flowing along the Shasta-Tehama County line), and South Fork Cottonwood Creek. The main tributaries to Cottonwood Creek within the watershed are shown on Figure 1-1 (figures are located at the end of their respective sections). The South Fork and its tributary, Cold Fork, are the main drainage ways for the southern half of the watershed; the Middle Fork and its tributary, Beegum Creek, and the North Fork are the main drainage ways for the northern half (CH2M HILL, 2002).

Table 1-1 lists some of the Cottonwood Creek Watershed's key characteristics. With an annual runoff of 586,000 acre-feet, the Cottonwood Creek Watershed, covering 938 square miles, is the third largest watershed tributary west of the Sacramento River, and the largest undammed watershed on the west side of the Sacramento Valley (CH2M HILL, 2002; Kondolf, 2000). Cottonwood Creek supplies approximately 85 percent of the Sacramento River's gravel between Redding and Red Bluff (Kondolf, 2000). The Town of Cottonwood is the most heavily urbanized area in the watershed (CH2M HILL, 2002).

TABLE 1-1
Cottonwood Creek Watershed Characteristics
Cottonwood Creek Watershed Management Plan

Characteristic	Value
Cottonwood Creek Average Annual Runoff	586,000 acre-feet
Watershed Area	938 square miles
Cottonwood Creek Stream Length	68 miles
Headwater Elevation	7,860 feet
Mean Discharge	860 cubic feet per second
10-year Flood	50,000 cubic feet per second
100-year Flood	93,000 cubic feet per second
Mean Precipitation	36 inches

The large areas of open space in the watershed provide habitats for a wide array of species, including notable threatened and endangered species such as northern spotted owl (*Strix occidentalis caurina)* and spring-run Chinook salmon (*Oncorhynchus tshawytscha*) (CH2M HILL, 2002).

Several important features distinguish the Cottonwood Creek Watershed from other watersheds in the Sacramento Valley. Watershed runoff is flashy: high in the rainy seasons and low in the dry seasons. This pattern is particularly pronounced in Cottonwood Creek because of low intra-annual storage resulting from a combination of very little recharge to

aquifers in the upper reaches of the watershed and a small amount of snow pack (CH2M HILL, 2002).

Human impacts on Cottonwood Creek began in the 1850s with gold mining operations. The gold mining in placer deposits commonly used dredge, hydraulic, and ground-sluicing techniques that resulted in the discharge of sediment to the stream. During the past 150 years, these mining effects have healed, with the possible exception of residual mercury wastes in the tailings of historical mining sites. In the early 1970s, the U.S. Army Corps of Engineers produced a draft general design memorandum for the construction of two dams and reservoirs, Dutch Gulch and Tehama Reservoirs. Water quality research within the Cottonwood Creek Watershed was initiated as a result of these proposed projects (CH2M HILL, 2002).

Today, the Cottonwood Creek Watershed is generally characterized by tracts of harvestable timber in the upper reaches, irrigated pastureland in the middle reaches, and ranches, residential housing, and gravel mining operations in the lower reaches. Approximately 70 percent of land within the watershed is privately owned (CH2M HILL, 2002). The Town of Cottonwood, with a population of approximately 3,000 people, is the most heavily developed area in the watershed, but the watershed also includes the smaller communities of Igo, Ono, Platina, Beegum, and Bowman (CH2M HILL, 2005). Figure 1-2 shows the roads and streams within the watershed.

1.4 Purpose

According to the CCWG mission statement, adopted in October 1999, "The Cottonwood Creek Watershed Group will work to preserve the environment, private property and water rights and economic resources of the Cottonwood Creek Watershed through responsible stewardship, liaison, cooperation and education."

The purpose of the WMP is to further CCWG's fulfillment of its mission statement. The WMP builds on both the work completed in the Watershed Assessment and the subsequent Watershed Management Strategy. The WMP addresses data gaps, sets goals and objectives for the watershed, and outlines actions that can be taken to provide more information on the health of the watershed and further the achievement of goals.

1.5 Watershed Management Plan Development

This WMP is a step in a process that started with the preparation of the *Cottonwood Creek Watershed Assessment* (Watershed Assessment; CH2M HILL, 2002) and continued through the development of a Watershed Management Strategy. During the Watershed Assessment, previous research was reviewed and evaluated and the history of the watershed was compiled. The Watershed Assessment, completed in 2002, represented the general state of knowledge concerning the watershed. Upon completion of the Watershed Assessment, CCWG continued the planning process by creating the *Cottonwood Creek Strategic Watershed Plan* (SWP; CH2M HILL, 2005). The SWP sought to build consensus among stakeholders on the desired condition of the watershed. The SWP was created by holding a series of workshops that allowed landowners, resource agency personnel, and other concerned citizens to voice concerns and to help identify future management strategies.

Using information from the Watershed Assessment and the SWP, this WMP provides specific techniques that can be used to address issues of concern within the watershed. Technical work groups, consisting of planners, hydrogeologists, geomorphologists, and biologists, reviewed the concerns raised in the SWP, reviewed the Watershed Assessment and other available sources of information, then identified potential actions that could be undertaken to manage the watershed. The technical work groups were staffed by CH2M HILL personnel. The work activities were divided into specific resource areas. Each technical work group produced a technical memorandum (TM) that focused on one of the resource areas. Each TM included a review of planning to date, a summary of available information, and potential next steps. Stakeholders were presented with each TM at a workshop that addressed the resource area. Comments and discussion resulting from the workshops are included in this WMP.

A series of five workshops was scheduled for late March, April, and August 2006. The first workshop, Erosion and Flood Control, was held on March 29, 2006. The goal was to arrive at a consensus among stakeholders about the desired conditions of the watershed with respect to flooding and erosion. The primary lesson that came from the initial meeting was that discussion would be more focused if specific actions were recommended.

A second workshop, Fire and Fuels Management, was held on April 6, 2006. Based on the results from the first stakeholder meeting, the information presented at this workshop focused on a small range of strategies that could be used for fire and fuels management.

Three workshops were held in August 2006. A TM was developed for each of these workshops. Each of the three TMs summarized resource concerns and projects that could be considered by CCWG to address these concerns. Each TM was distributed to the stakeholder group prior to each workshop. These meetings provided a forum to exchange ideas and promote cooperation and effective working relationships among landowners and other stakeholders. Comments and discussion resulting from the workshops are incorporated into the information and action items included in this WMP.

Watershed management is an iterative and adaptive process (EPA, 2005a). It is expected that the WMP will change as initial actions are undertaken and a better understanding of the dynamics of the watershed is achieved. The WMP should be reviewed and updated periodically as additional actions are taken and other information on the resource areas becomes available.

1.6 Watershed Management Plan Elements and Relationships

Watersheds are inherently complex, with multiple interactions and interdependencies among the resources that are present. The watershed planning process uses a holistic approach that evaluates all aspects of the watershed. Attempting to assess, evaluate, and manage every resource in the watershed simultaneously would be very difficult. To focus the assessment, evaluation, and management of the Cottonwood Creek Watershed's resources, the following individual resource areas were identified:

- Water Resources and Future Development
- Channel and Riparian Conditions

- Fishery, Vegetation, and Wildlife Resources
- Fire and Fuels Management

Each resource area consists of multiple elements, many of which are related to other resource areas. For example, because riparian habitat is an integral part of the stream channel, riparian habitat was evaluated as part of the channel and riparian conditions resource area. However, riparian habitat consists of vegetation, serves as wildlife habitat, affects fisheries, and can be affected by fire and fuels management practices. Riparian habitat can fit into the Fishery, Vegetation, and Wildlife Resources resource area. There are many resources that fit into multiple resource areas but are only discussed, for the sake of brevity, in one resource area.

Goals for the Cottonwood Creek Watershed are presented in Section 4. The goals generally apply to the entire watershed. Each goal may apply to one or more resource areas. Resource areas that influence each goal were identified and are presented in Table 1-2.

TABLE 1-2
Goals and Their Relationships to Resource Areas
Cottonwood Creek Watershed Management Plan

Goal	Primary Resource Area(s) Influencing Goal			
	Water Resources and Future Development	**Channel and Riparian Conditions**	**Fishery, Vegetation, and Wildlife Resources**	**Fire and Fuels Management**
Maintain the rural and agricultural nature of the Cottonwood Creek Watershed.	●	●		●
Address problematic bank instability and channel instability.	●	●	●	
Develop a sustainable gravel management program.		●		
Sustain existing populations of native fish, wildlife, and plant communities, and enhance where possible.	●	●	●	●
Develop an upland brush management program that reduces fire risk and enhances habitat value.		●	●	●
Sustain and expand quantity and quality of riparian habitat throughout the watershed.		●	●	●
Sustain good water quality that provides for beneficial uses, and enhance water quality where needed.	●	●	●	●
Expand watershed conditions and practices that increase storm-water infiltration, increase base flow, and reduce negative impacts of flood flows.		●		
Develop a noxious and invasive plant management program that includes control of salt cedar/tamarix and giant reed/arundo.		●	●	●
Expand the use of road maintenance and land use practices that reduce discharge of fine-grained sediment to waterways.		●		●
Continue to play an active role in the information dissemination, education, and outreach provided to stakeholders about stewardship of the Cottonwood Creek Watershed.	●	●	●	●

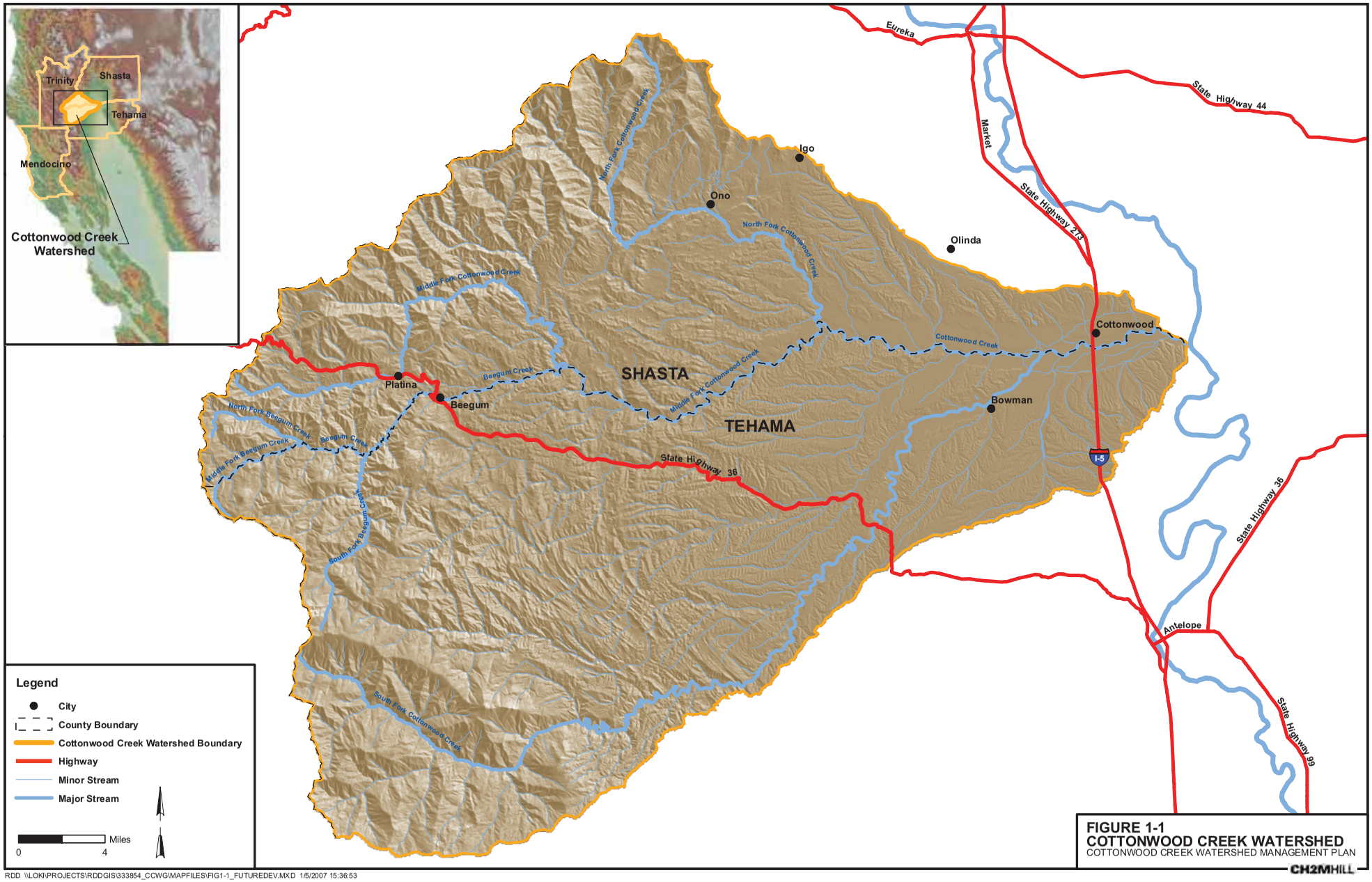

FIGURE 1-1
COTTONWOOD CREEK WATERSHED
COTTONWOOD CREEK WATERSHED MANAGEMENT PLAN

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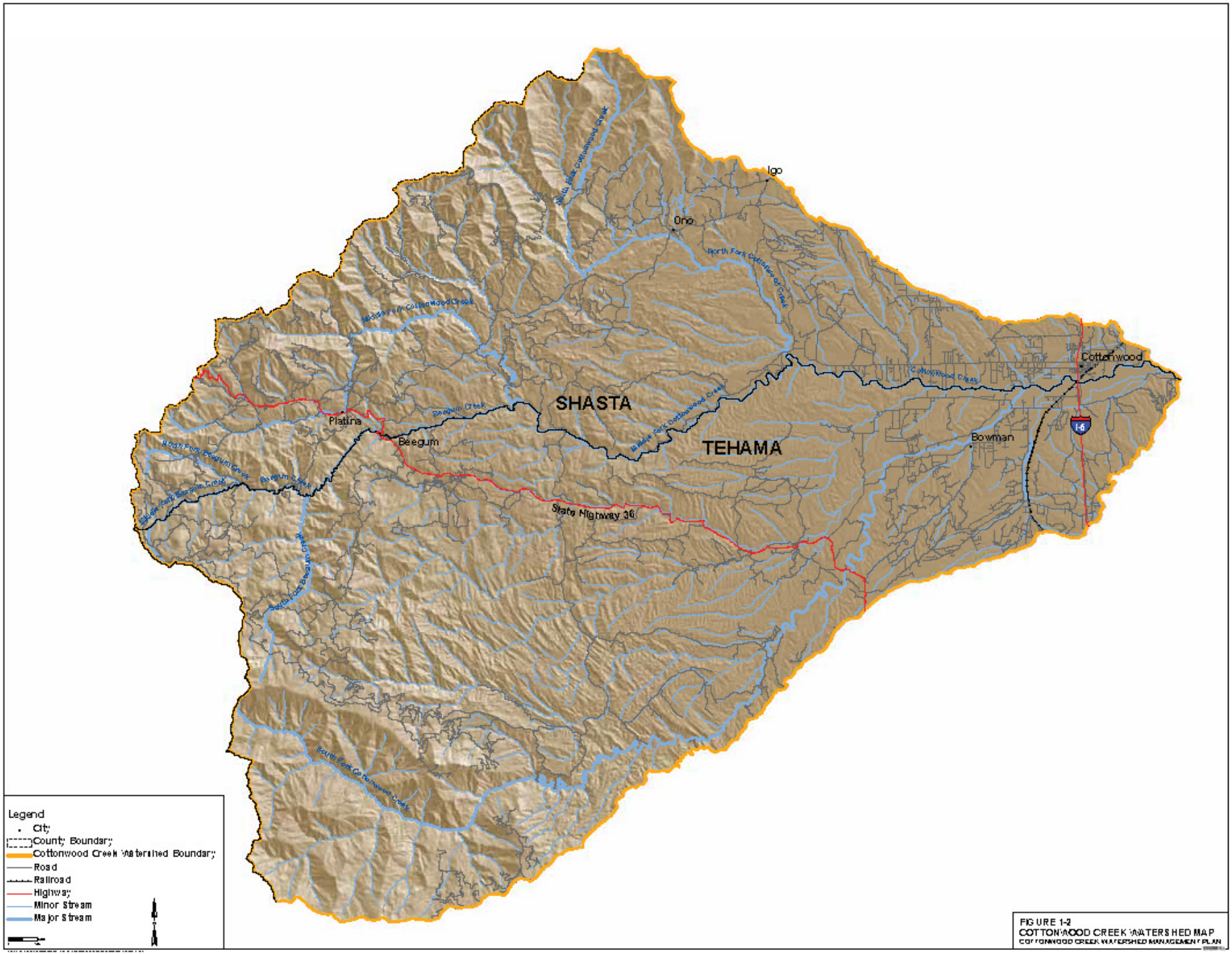

FIGURE 1-2
COTTONWOOD CREEK WATERSHED MAP
COTTONWOOD CREEK WATERSHED MANAGEMENT PLAN

SECTION 2.0

Resource Areas

This section provides information on each of the resource areas within the watershed. The current conditions of each resource area are described briefly. Current conditions include stakeholder concerns and available information. The evaluation of current conditions is followed by information of interest. The information of interest subsection presents informational resources within the watershed and information that is needed to manage the watershed. Short- and long-term actions are also provided for each resource area. The short- and long-term actions are intended to gather information needed for decision making or to correct problems that have been identified within the watershed.

2.1 Water Resources and Future Development

Appendix A contains the final TM and other information relevant to this resource area.

2.1.1 Current Conditions

Stakeholder Concerns

The SWP (CH2M HILL, 2005) documented the following concerns related to water resources and future development in the Cottonwood Creek Watershed:

- Groundwater and surface-water quantity and quality impacts of large-scale developments that are being planned in the watershed.
- Groundwater and surface-water quantity and quality monitoring activities in the watershed. Stakeholders want a better understanding of baseline (pre-buildout of planned large-scale developments) hydrologic conditions against which post-buildout hydrologic conditions can be compared in the future.
- Understanding of the linkage between the groundwater system, local streams, and the Anderson-Cottonwood Irrigation District canal and laterals.
- Groundwater levels in the Town of Cottonwood and the Rio Alto Water District area.
- Data regarding the source of turbidity in portions of South Fork Cottonwood Creek, which could affect water quality in the main stem.
- Need for an integrated geographic information system (GIS) database that could store pertinent hydrologic and other data for the watershed area and facilitate educating the public as part of community outreach programs.
- Trespassing on private land adjacent to Cottonwood Creek.

Existing Information

Several ongoing programs within the watershed provide data that could be used to educate stakeholders about past and baseline hydrologic conditions. The Water Resources and Future Development TM (Appendix A) includes a review of stakeholder concerns and sources of information available to address these concerns. Sources of information that could address stakeholder concerns are presented here.

The U.S. Geological Survey (USGS) maintains a program that focuses on streamflow and surface-water quality. A stream gauge for this program is located on Cottonwood Creek, upstream of the confluence with the Sacramento River. Streamflow has been measured consistently at this location for many years, but consistent temperature and flow information for the rest of the Cottonwood Creek Watershed is not currently available. Publications are available that contain summaries of historical data collected throughout the watershed (Rectenwald, 1999; CH2M HILL, 2002).

Several past or ongoing programs within the Cottonwood Creek Watershed focus on groundwater levels and quality. The California Department of Water Resources (DWR) monitors groundwater levels semiannually or more frequently throughout the state in a network of domestic, irrigation, industrial, municipal, and monitoring wells. The Anderson-Cottonwood Irrigation District has been working to improve the understanding of the groundwater and surface-water interactions in the Redding Groundwater Basin in response to changes in weather and pumping and irrigation practices. USGS has conducted groundwater-level and water quality monitoring programs as part of specific past studies. However, USGS does not conduct ongoing groundwater-level or quality monitoring in the Cottonwood Creek Watershed. Historical water-level and water quality measurements are available through the National Water Information System. A numerical groundwater flow model was developed for the Redding Area Water Council to examine potential impacts from implementation of various future groundwater management options in the Redding Groundwater Basin (CH2M HILL et al., 1997; CH2M HILL, 2001 and 2003). Output from the numerical model provides estimates of impacts to surrounding groundwater levels and changes in streamflow due to various groundwater management scenarios. The model has been used to evaluate impacts from projects proposed by members of the Redding Area Water Council. Municipal water suppliers are required to submit data regarding potable water-supply quality to the California Department of Health Services.

Climatic information that applies to the Cottonwood Creek Watershed is available from the Western Regional Climate Center, the Natural Resources Conservation Service (NRCS), and the Statewide Integrated Pest Management System.

Several large-scale residential developments are planned or are being built in the lower Cottonwood Creek Watershed area near the Town of Cottonwood; no large developments are planned for the upper watershed. Projections suggest that the population in the lower watershed area could more than double as a result of these new developments (CH2M HILL, 2005). Future developments planned for the Tehama County portion of the watershed include Sun City, additions to Sunset Hills Estates, and Morgan Ranch. Future developments in the Shasta County portion of the watershed include Cottonwood Hills, Oak Ranch Estates, Seal Court, the Vineyards at Anderson (in construction phase), and the Spoon Subdivision. Figure 2-1 shows the locations of these planned developments.

2.1.2 Information of Interest

Following are brief summaries of future monitoring programs in the Cottonwood Creek Watershed:

- **Sacramento Valley Water Management Program.** This collaborative regional strategy consists of multiple water management projects and actions that will ensure that local water needs are fully met while helping improve water quality and supplies in the Sacramento-San Joaquin Delta and throughout California. Additional monitoring proposed as part of the Sacramento Valley Water Management Program includes incorporating three wells that are currently monitored semiannually by DWR at an increased frequency.

- **Tehama County Flood Control and Water Conservation District (TCFCWCD)**. In its proactive approach to groundwater monitoring in Tehama County, TCFCWCD has secured funding to equip existing DWR multiple-completion monitoring wells with pressure transducers and dataloggers to provide real-time water-level data. Grant funds will be used to install additional monitoring wells in areas slated for large-scale residential developments. Hourly groundwater-level data, including hydrographs, are available at the TCFCWCD Web site. Furthermore, TCFCWCD is requiring the large-scale developers to include groundwater monitoring infrastructure in their construction plans. This would include collecting both baseline groundwater-level data before construction and real-time groundwater-level data after construction. Pre-project and post-project monitoring will allow seasonal and long-term impacts of groundwater pumping to be evaluated. An existing numerical groundwater flow model was used in the Del Webb Sun City area to predict potential impacts of that development.

- **CCWG**. A monitoring program is being implemented by CCWG to gain information on baseline water quality in the Cottonwood Creek Watershed. The program includes monitoring at 11 locations (10 along Main, North, and South Fork Cottonwood Creek and 1 along Beegum Creek). The water quality monitoring program is being conducted from September 2006 through August 2007. The main objective of this program is to document current watershed conditions to serve as a baseline from which to guide future watershed management decisions.

  The monitoring program includes monthly temperature and turbidity monitoring at 10 locations. In addition, turbidity was monitored after two storm events, with the objective of evaluating sediment flow during peak events. Macroinvertebrate monitoring occurred once during late spring 2007. *Escherichia coli* is monitored during summer months, when recreational use (e.g., swimming, rafting, and water activities) is the greatest. This monitoring occurs at two locations in the lower reaches of the watershed, one along South Fork Cottonwood Creek, and one along the main stem.

2.1.3 Short- and Long-term Actions

Groundwater-level and Quality Monitoring

As previously described, several large-scale developments are planned in the Cottonwood Creek Watershed. Significant uncertainty exists regarding the timing and construction sequencing associated with these developments. There is also uncertainty about whether

these proposed developments will be authorized and permitted as planned, or be modified. Because most of the larger-scale developments are planned in the Tehama County portion of the watershed, CCWG should take steps to coordinate groundwater monitoring efforts with TCFCWCD and DWR. Water resources staff from TCFCWCD and DWR are currently taking a proactive approach to groundwater monitoring in areas of concern to provide data that will promote a better understanding of current and future groundwater conditions. The need to seek additional funding to supplement the current and planned groundwater monitoring network should be evaluated with CCWG, TCFCWCD, and DWR to avoid duplication of efforts, foster a coordinated regional monitoring effort, and preserve the groundwater resource.

Action items for groundwater monitoring include the following:

- CCWG should coordinate groundwater monitoring efforts with TCFCWCD and DWR.
- CCWG should work with TCFCWCD and DWR to seek additional funding to supplement the current and planned groundwater monitoring network.
- CCWG should foster a coordinated regional monitoring effort.

Stream Stage and Discharge Monitoring

The existing CCWG stream monitoring program is currently funded for 1 year. Monitoring of temperature and turbidity levels throughout Cottonwood Creek should continue for more than 1 year. A routine monitoring program that extends beyond and expands the current monitoring program would provide longer-term data with which to evaluate the hydrologic changes in the Cottonwood Creek Watershed. CCWG should also seek funding to expand the monitoring program to evaluate flow and sediment changes within specific reaches of Cottonwood Creek.

Urbanization in the Cottonwood Creek Watershed will affect runoff to Cottonwood Creek. The magnitude of the effects in the watershed will vary spatially and temporally and depend on several factors, including land slope, magnitude and frequency of precipitation, geographic extent of paved areas, presence of structures such as storm drains, and presence (or absence) of vegetation. Increased urbanization could cause the watershed to exhibit a flashier response to storm events. An expanded surface water program should be created to assess impacts from urbanization. An expanded surface-water monitoring program to assess impacts from urbanization would probably focus on the lower watershed, where urbanization is more likely to occur in the future. If the existing surface-water monitoring program were extended, it should also be altered to include monitoring of runoff impacts from urbanization.

Several workshop participants believe that Cottonwood Creek has become more flashy over the last 10 to 20 years. The term flashy generally means that precipitation moves rapidly from the upper reaches of the watershed to the main stem and into the Sacramento River. This alteration in runoff is suspected, but has not been conclusively demonstrated. There is existing information on precipitation and a gauge for flow at the mouth of Cottonwood Creek. It might be possible to determine whether Cottonwood Creek is flashier in recent decades than it was historically; CCWG should find funding or a cooperative agency (California State University at Chico or DWR) to answer this question.

Action items for stream stage and discharge monitoring include the following:

- CCWG should continue the existing monitoring grogram for temperature and turbidity.
- CCWG should seek funding to expand the existing monitoring program to evaluate flow and sediment changes within specific reaches of Cottonwood Creek.
- An expanded surface-water program should be created to assess impacts from urbanization. The program should focus on the lower watershed and should include monitoring of runoff from urbanization.
- CCWG should find funding or a cooperative agency to evaluate if the watershed has become more flashy over time.

Geographic Information System Database

As monitoring programs are implemented, an integrated GIS database should be developed. The GIS database will facilitate the organization and presentation of pertinent watershed data, and it will be a useful tool for educating the public as part of community outreach programs. Data from other ongoing and past monitoring projects should also be incorporated into this database to make it more complete and to facilitate evaluations of long-term trends and impacts of urbanization through time. A watershed information model (WIM) exists for the region. It is not clear how the Cottonwood Creek Watershed fits into the WIM. CCWG should get more information about WIM.

Action items for a GIS database include the following:

- CCWG should create an integrated GIS database.
- Data from ongoing and past monitoring projects should be incorporated into this database.
- CCWG should use the database to evaluate or facilitate evaluations of long-term trends and impacts of urbanization through time.
- CCWG should get more information about WIM.

Discourage Trespassing

During the workshop, concerns were raised regarding trespassing on private land adjacent to Cottonwood Creek. Often, trespassers are recreational users of offroad vehicles and pickup trucks. Workshop participants agreed that trespassing needs to be addressed.

Fencing and gates are the most effective means of keeping trespassers off private land. Signage alone is ineffective; public education is crucial to successfully preserving private land and the resources therein. Farquhar Road, the Benson-Pine Creek area, and Eighmy Road have been identified as access points used heavily by trespassers with offroad vehicles. K-rails (concrete barriers often used in highway construction to close off or partition sections of road) were donated to CCWG and placed at Evergreen Road Bridge in September 2004. A gate was installed at this location in fall 2004 through volunteer effort and donated materials. Gates are also needed at the Farquhar Road location; however, the funding for this effort has not been secured.

Other options to discourage trespassing include the following:

- Signage
- Public service announcements on local radio stations
- Posters at local motorcycle, all-terrain vehicle, or offroad vehicle shops informing customers that motorized vehicle use on private property is illegal, or listing problems that are caused by offroad vehicle use
- Informational meetings with offroad vehicle users to educate them about harm being done to Cottonwood Creek, wildlife, and landowners from offroad vehicle use
- Interviews on local television stations
- Flights over the areas or evaluation of aerial photos to determine where fencing and gates should be located
- Working with law enforcement to issue warnings and, subsequently, citations

Trespassing, including motorized vehicle use in Cottonwood Creek, is an infringement on landowner rights. CCWG should work to preserve landowner rights. CCWG should promote information about the process of preventing trespassing, including signage, use of barriers, public education, and enforcement. CCWG should hold stakeholder meetings, keep copies of signage for distribution to interested stakeholders, and develop a public education presentation that could be shown at local schools. CCWG should also function as a point of contact for reporting areas with trespassing problems and be a repository for information about possible trespassing solutions. Part of the outreach process should include working with landowners to identify suitable public access areas.

Action items for trespassing issues include the following:

- CCWG should work to preserve landowner rights.
- CCWG should promote information about the process of preventing trespassing, including signage, use of barriers, public education, and enforcement.
- CCWG should hold stakeholder meetings, keep copies of signage for distribution to interested stakeholders, and develop a public education presentation that could be shown at local schools.
- CCWG should function as a point of contact for reporting areas with trespassing problems and be a repository for information about possible trespassing solutions.
- CCWG should work with landowners and stakeholders to identify suitable public access areas.

Land Use Planning

Several of the workshops discussed the impact of the proposed large-scale residential development on the Cottonwood Creek Watershed. CCWG views large-scale residential development as an indication of the need for more outreach and education about local and regional planning. CCWG can serve watershed landowners and the general public by acting

as a clearinghouse for information about county planning departments. CCWG should monitor planning activities in the watershed and inform interested stakeholders about current conditions and events. Updates and changes to general plans should also be monitored. CCWG should also keep information on how to get involved or participate in the planning process, for the benefit of stakeholders. By acting as a clearinghouse, CCWG would facilitate stakeholder participation in the planning process. CCWG should provide comments on environmental assessments, environmental impact reports, and public meetings. CCWG should identify potential cumulative impacts from multiple projects occurring within the watershed. CCWG should also inform members of ways to voice their opinions to the decisionmakers and regulatory agencies with authority in the watershed. By participating in the planning process, stakeholders can ensure that development issues and impacts to the watershed are addressed before projects are initiated (CH2M HILL, 2002).

Action items for land use planning include the following:

- CCWG should act as a clearinghouse for information about planning departments.
- CCWG should monitor planning activities and inform stakeholders about future developments including changes to general plans.
- CCWG should keep information about participating in the planning process.
- CCWG should provide comments on environmental assessments, environmental impact reports, and public meetings.
- CCWG should identify potential cumulative impacts from multiple projects occurring within the watershed.
- CCWG should inform stakeholders of ways to voice their opinions to decisionmakers and regulatory agencies.

2.2 Channel and Riparian Conditions

Appendix B contains the final TM and other information relevant to this resource area.

2.2.1 Current Conditions

Streambank Stability

Cottonwood Creek has high storm-related flow variations, or flashiness, which results in high-energy, high-flow events that can, in turn, result in significant streambank instability throughout the creek. Streambank instability and loss of usable land in the lower watershed are the primary concerns for many residents in the Cottonwood Creek Watershed (CH2M HILL, 2002 and 2005).

A large body of information exists for streambank stability within the Cottonwood Creek Watershed, including a Graham Matthews and Associates report (Matthews, 2003) and the Watershed Assessment (CH2M HILL, 2002). The information in these reports suggests that persistent gravel mining and Cottonwood Creek's tendency to have quick increases in flow rates from rainfall events contribute to the current channel conditions in the creek.

The California Department of Fish and Game (CDFG) identifies Cottonwood Creek as a prime source of spawning gravel for Chinook salmon entering the upper reach of the Sacramento River. Cottonwood Creek is the only tributary providing significant supplies of spawning gravel for 30 miles of the Sacramento River in Tehama County (CDFG, 1988; CALFED, 2000). It is estimated that Cottonwood Creek contributes 33 percent of the total gravel bedload to the Sacramento River (McKevitt, 1984). Next to Cache Creek, Cottonwood Creek provides the largest total sediment input to the Sacramento River (CALFED, 2000).

Previous reports have made reference to problems arising from gravel mining in Cottonwood Creek (Rectenwald, 1999; Cepello and Buer, 1995; Buer, 1994; North State Resources, Inc., 1991; State of California Resource Agency, 1988; CDFG, 1988; McKevitt, 1984; CH2M HILL, 2001; CH2M HILL, 2005; Matthews, 2003). These problems include reductions in the quantity of spawning-sized gravel reaching the Sacramento River and excessive streambank failures in Cottonwood Creek. Gravel mining, resulting in insufficient quantities of spawning-sized gravel, has been cited as one of the reasons for the reductions in salmon and steelhead populations that have been observed in Cottonwood Creek (State of California Resource Agency, 1988).

Two major gravel mines currently operate on Cottonwood Creek. The Shea Mine, which is in Shasta County, is immediately downstream of Interstate 5 and the Cottonwood Creek Sand and Gravel Mine (formerly XTRA), which is in Tehama County, is approximately 0.5 mile upstream of Interstate 5 (CH2M HILL, 2001).

Several reports have identified gravel mining as a contributing factor for the erosion rates in the Cottonwood Creek Watershed (DWR, 1992; Buer, 1994; Matthews, 2003). Gravel mining can change the slope of a riverbed. The pit created in the riverbed by the gravel removal creates a feature called a "knickpoint," where the slope of the channel bed increases drastically in the downstream direction. The velocity of the flow in the creek increases at a knickpoint as the water accelerates (falling like a waterfall) through the area of increasing slope. This acceleration imparts more energy from the flow to the channel bed, often causing scouring of the channel bed and loss of channel banks. The result is an overall lowering of the stream channel and a coarsening of the bed material (Resource Management International, Inc., 1987). Pebble counts on Cottonwood Creek's main stem show a slight coarsening trend in bed material in the downstream direction (Water Engineering and Technology, Inc., 1991). The characteristics of gravel in Cottonwood Creek are such that they are regularly fully mobilized and transported downstream by high-flow events.

GRA (2003) identified several potential effects of gravel mining on alluvial rivers, the following six of which were observed in Cottonwood Creek:

- Bed degradation caused by extraction of bed material (gravel) in excess of replenishment rates
- Bridge damage and pipeline exposure caused by bed degradation
- Removal of all gravel in the bed and exposure of other substrates in the channel, caused by bed degradation
- Reduction in overbank flooding, with accelerated bank failure caused by an absence of floodplain connectivity

- Bank failure caused by undercutting and by rapid bed degradation
- Downstream bar erosion caused by cutting off the supply of gravel to bars while the river maintains its gravel transport capacity

These effects observed in Cottonwood Creek correlate both in space and time with the extent and volume of gravel extraction in the creek. GRA (2003) discusses these effects further and argues that gravel mining is the primary cause of streambank loss and bed degradation in Cottonwood Creek.

Riparian Conditions

Riparian forests support some of the highest levels of wildlife species diversity and abundance in California. Factors contributing to the high wildlife value include the presence of surface water, the variety of niches provided by the high structural complexity of the habitat, the condition of the associated upland habitat, and the abundance of plant growth (CH2M HILL, 2002). Riparian forest habitat is used by wildlife for food, water, escape cover, nesting, migration and dispersal corridors, and thermal cover. Types of species found in this habitat type include various waterfowl species; raptors; small mammals, such as rodents, skunks, and opossums; several frog and toad species; and various reptiles, including several garter snake species (CH2M HILL, 2002).

A number of distinct riparian communities can be found throughout the Cottonwood Creek Watershed. These communities represent particularly dynamic portions of the landscape, and are shaped by disturbance characteristics of the ecosystems surrounding them, such as fire and flood. Riparian communities are also susceptible to disturbance processes unique to stream systems, including channel erosion, peak flows, and deposition resulting from floods and mass wasting events. The dynamic equilibrium that defines a riparian community can be observed in a number of locations within the watershed (CH2M HILL, 2002).

Three identifiable riparian communities provide the largest elements of riparian habitat in the Cottonwood Creek Watershed: riverine, lacustrine, and vernal pools. The predominant habitat in terms of percentage is the riverine component associated with intermittent or perennial streams. Lacustrine habitats, such as lakes, ponds, and impoundments, are a much smaller component. Vernal pools may also be found throughout the lower elevations of the watershed, depending on soil and climatic conditions (CH2M HILL, 2002).

The U.S. Forest Service (USFS) conducted riparian surveys of eight tributary headwater streams in the upper reaches of the Cottonwood Creek Watershed beginning about 1975. Because direct studies on riparian communities are limited, the information about current riparian communities reflects this time period (CH2M HILL, 2002).

CCWG was awarded an NRCS grant to initiate mapping of riparian areas in the Cottonwood Creek Watershed. The grant project includes acquiring high-resolution color aerial imagery, identifying and mapping vegetation communities along mainstem and major tributaries of Cottonwood Creek, identifying sites of non-native and noxious plants and weeds, and creating a GIS map with the survey results. Information obtained from aerial photography analysis assist in evaluating the current riparian areas for future planning, preservation, and restoration of riparian resources. In addition, the grant project

would provide opportunities for cooperative management efforts among resource personnel and landowners in the watershed.

Although results of the NRCS grant would include noxious weeds associated with riparian ecosystems, a comprehensive inventory of noxious weeds and their locations is needed to identify goals for their future management and eradication. The recommendation for a Rangeland Plan, to include comprehensive evaluation of the noxious weed issues within the watershed, is discussed in Section 2.4.

The surface-water monitoring program, which began in September 2006, includes photographic documentation of 10 monitoring locations in the Cottonwood Creek Watershed in addition to water quality monitoring. These photographs would provide 12 consecutive months of imagery (September 2006 through August 2007) from which to evaluate changes in riparian conditions and to serve as a baseline for continued riparian resource monitoring at each monitoring site.

2.2.2 Information of Interest

A variety of information is available to help the Cottonwood Creek Watershed landowners and stakeholders make best practice decisions about channel and riparian management activities. During stakeholder meetings, adaptive management has been suggested by landowners as the most desirable strategy because there is an immediate need to address streambank stabilization and the loss of private property (CH2M HILL, 2005). Under an adaptive management framework, management actions are designed as experiments to yield insights that can be used to refine existing projects and improve future project design.

Three major components influence channel and streambed conditions: the streambed, streambanks, and adjacent vegetation. The condition of the streambed is vital to fish populations in Cottonwood Creek. Failing streambanks can alter the streambed and directly impact water quality and fish populations. The vegetation adjacent to streambanks can stabilize the banks and provide shade that can cool water temperatures. Information on the current state of any of these components is of interest to CCWG. Methods to gauge impacts to these three components should be included in future CCWG projects.

A small-scale project to restore and stabilize channel banks along Cottonwood Creek has been planned on Lema Ranch property (CCWG, 2006). A gravel bar in the middle of the channel will be removed, and the excavated material will be used to stabilize the bank. The in-stream area adjacent to the bank will be reconfigured to allow for greater flow in the center of the channel. Willow trees on the gravel bar also will be relocated to the bank to reduce the potential erodibility of exposed soil. Finally, more riparian vegetation will be planted on approximately 5 acres of land adjacent to the creek. This project is expected to not only stabilize the bank, but provide additional habitat for terrestrial species in the area.

2.2.3 Short- and Long-term Actions

Adaptive Management and Bioengineering

During stakeholder meetings, adaptive management has been suggested by landowners as the most desirable strategy because there is an immediate need to address streambank stabilization and the loss of private property (CH2M HILL, 2005). Under an adaptive

management framework, management actions are designed as experiments to yield insights that can be used to refine existing projects and improve future project design.

Adaptive management is a systematic process of modeling, experimentation, and monitoring to assess the outcomes of alternative actions (Shilling et al., 2004). Actions are treated like "experiments." When an action is taken, it is recognized that hundreds of factors influence the outcome. Restoration actions are initially designed with the best available knowledge. However, much can be learned during implementation of a restoration action, and future actions are shaped by the knowledge gained from the original effort or experiment. Figure 2-2 illustrates the adaptive management process, involving a cycle of monitoring, analysis and evaluation, conceptualization, planning, decisions, actions, and more monitoring. This is the adaptive management cycle, because it implies that management decisions will be adapted to fit and respond to new information. New information is gained from monitoring and assessment of previous actions. Feedback loops that include assessing whether the problems are improving are important for gauging effectiveness (Bentrup and Hoag, 1998).

Bioengineering is the integration of living woody and herbaceous materials with organic and inorganic materials to increase the strength and structure of soil. The streambank restoration activities outlined in this section primarily focus on bioengineering techniques because these techniques could address multiple stakeholder concerns. These kinds of activities could meet the immediate need for bank stabilization to curb destructive streambank failures, could be tailored to collect data on sediment transport and flow in the area, and could enhance the riparian corridor adjacent to Cottonwood Creek.

Each bioengineering measure described in this section would require a thorough site analysis to ensure its appropriateness for a given site. These measures should not be considered permanent fixes for channel bank instability along Cottonwood Creek. Rather, they should be considered capable of limiting streambank loss during the peak of moderate flow events. And, through a monitoring and adaptive management program, these measures could provide valuable information on mechanisms of excessive streambank loss and appropriate long-term responses. The following bioengineering techniques should be used to stabilize streambanks, enhance riparian corridors, and improve aquatic habitat:

- **Installation of Willow Mattresses**. In areas where streambank loss is an immediate threat to property, mattresses composed of willows and other native riparian vegetation could be installed. Willow mattresses typically consist of a thick blanket (0.5 to 1.0 foot) of live cuttings and soil fill. Similar to the project at Lema Ranch, mattresses could be constructed of cuttings taken from existing willows in sandbars in the creek. The willow mattress approach could achieve the dual objective of channel bank revegetation and preservation.

- **Installation of Spur Dykes**. Spur dykes could be installed to provide additional protection against streambank loss. Spur dykes are transverse structures that extend into the stream from the bank and reduce streambank loss by deflecting flows away from the bank. Spur dykes can be constructed of a soil core armored with a layer of stone, or of large, woody debris with or without embedded rocks. Spur dykes constructed of large, woody debris are designed to provide biological benefits and restore habitat by creating pool habitats and increasing physical diversity (Salix Applied Earthcare, 2006).

- **Bank Shaping and Planting.** In areas where channel bank loss is accelerated as a result of oversteepened banks, bank shaping and planting could be implemented to reduce the potential for future instability. In this approach, streambanks are graded to a stable slope, prepared or improved for vegetation establishment, and planted with native riparian vegetation species. Depending on site conditions, bank shaping can be combined with slope toe stabilization (i.e., placement of erosion-resistant material, such as boulders or large logs) to improve performance during extreme high flows and to improve in-stream aquatic habitat.
- **Branch Packing.** Channel bank failures, such as slumps and gullies, could be repaired with branch packing applications, in which alternate layers of live branches and compacted fill are "packed" into the failure site. Branch packing can provide dual benefits of arresting streambank loss and enhancing riparian habitat conditions.
- **Live Fascine Installation.** Live fascines could be installed in areas with less severe streambank loss, but where conditions appear to be transitioning to a situation in which more severe streambank loss would be likely. In this approach, dormant cuttings of riparian vegetation are arranged in bundles and placed in shallow trenches excavated parallel to the bank. Wooden stakes could be used to secure the fascines to the bank, and toe erosion protection measures could be implemented along with fascines at appropriate sites. This approach could provide streambank preservation and facilitate development of new riparian vegetation.
- **Log, Rootwad, and Boulder Placement.** This approach employs large logs, rootwads, and boulders installed on channel banks along outside bends to provide robust protection against streambank loss and to provide both aquatic and riparian vegetation. In this approach, logs with attached root wads are placed on top of footer logs and interspersed with boulders placed along the bank. The rootwads are installed facing into the flow and, thereby, deflect flow away from channel banks.
- **Joint Planting.** In sensitive areas with high streambank loss rates, where the previous "softer" methods would be insufficient to provide the desired level of protection, channel banks or slope toes could be fortified with large, non-erodible rock interspersed with live riparian vegetation poles or cuttings planted in the interstitial spaces between the rocks. Although this measure would not be as conducive to the development or enhancement of riparian habitat as the previously described measures, it could be useful in extremely sensitive areas of Cottonwood Creek where continued streambank loss could not be tolerated even during extreme high flows.
- **Fencing/Livestock Management.** In situations where livestock contribute to bank erosion and damage riparian vegetation, fencing off channel watering and other techniques should be promoted to improve channel and riparian management.

Stakeholders toured the watershed in September 2006 to view problematic streambanks. Projects that were complete or were being completed to restore streambanks were also visited. Some on the tour felt that many of the bioengineering measures mentioned in this WMP will help in some areas, but that other measures need to be identified. CCWG should identify other measures and techniques to restore streambanks.

Action items for streambanks include the following:

- CCWG should promote the adaptive management cycle.
- CCWG should promote bioengineering techniques to stabilize streambanks, enhance riparian corridors, and improve aquatic habitat.
- CCWG should identify other techniques to restore streambanks.
- CCWG should identify and promote landowner practices and management options that protect stream function and habitat. CCWC should promote proper fencing and livestock management techniques that minimize streambank erosion.

Bioengineering Assessment and Monitoring

Channel manipulations, such as removing vegetated bars or islands in the center of the channel and applying bioengineering techniques to the channel banks, would affect channel geometry and sediment transport dynamics in Cottonwood Creek. Specific techniques should be used to assess and monitor the effects of projects on the underlying ecological and geomorphic processes that control channel form and dynamics in the creek. Assessment tools could include pre- and post-project longitudinal profile surveys, channel geometry monitoring with permanent channel cross section surveys, and bed sediment composition analyses. These assessment techniques would provide the documentation of project performance that is essential in a true adaptive management approach.

Tools for assessing and monitoring restoration projects as part of adaptive management include the following:

- Longitudinal profile surveys
- Channel geometry monitoring
- Sediment composition analyses
  - Channel bed material (pebble counts)
  - Tracer gravel study
  - Scour chains

These assessment and monitoring techniques should be used together with bioengineering or other restoration activities to gauge the effectiveness of restoration actions.

Action items for channel and streambank engineering include the following:

- CCWG should promote techniques to assess and monitor the effects of streambank restoration projects on the underlying ecological and geomorphic processes that control channel form and dynamics in the creek.

Sediment Budget

A watershed sediment budget does not exist for the Cottonwood Creek Watershed. A sediment budget takes inventory of inputs, storage, and transport of sediment in the creek. A sediment budget for the watershed would indicate the locations, quantities, and processes related to sediment entering and leaving Cottonwood Creek.

Gravel sources, replenishment rates, transport rates, and gravel extraction rates from mining activities would be useful in producing a sediment budget. The Watershed Assessment (CH2M HILL, 2002) stated that discrepancies and contradictions among the published reports regarding existing sediment transport rates in Cottonwood Creek are a major obstacle to selecting creek management solutions.

An appropriately researched sediment budget for Cottonwood Creek would provide information about the role hydrology plays in excessive erosion and better define the relationship between flow and erosion in the watershed. The sediment budget could also be used to predict performance of bioengineered structures installed along channel banks and other channel modifications designed to prevent loss of streambanks and valuable riparian habitat.

Following is an action item for a sediment budget:

- CCWG should complete or facilitate the creation of a sediment budget.

Roads Inventory

Abandoned roads in the upper watershed that have not been rehabilitated or stabilized could add significantly to erosion and sedimentation in Cottonwood Creek. Landslides along the upper section of Cottonwood Creek are common during periods of heavy rainfall and runoff in the watershed. A roads inventory should identify problem areas and roads to be revegetated and stabilized (CH2M HILL, 2005). Existing roads on public and private land, especially roads adjacent to or crossing streams, should be included in a roads inventory. CCWG should conduct or facilitate a roads inventory within the watershed.

Action items for a roads inventory are as follows:

- CCWG should conduct or facilitate a roads inventory.
- CCWG should have information available to private landowners concerning road maintenance practices that reduce erosion and sediment from dirt roads.

New Development Impact Assessment

The impact of planned large-scale developments in the lower reaches of the Cottonwood Creek Watershed on erosion, sediment loads, and, possibly, the creek's meander zone is not well known (CH2M HILL, 2005). Stakeholders are concerned that they do not have this information. The information will become more important with incipient large-scale residential development in the watershed. CCWG should conduct, facilitate, or review and comment on an impact assessment of each new large-scale development in the watershed. CCWG should also provide input to developers and planning agencies on each new development in the watershed.

Action items for new development impact assessments are as follows:

- CCWG should conduct, facilitate, or review and comment on an impact assessment of each new large-scale development.
- CCWG should determine all impacts of each new development on Cottonwood Creek including impacts to erosion, sediment loads, and the meander zone of Cottonwood Creek.

- CCWG should provide input to developers and planning agencies on each new development in the watershed.

Tributary Projects

Pilot-scale projects are recommended for tributaries to Cottonwood Creek. Their smaller and more confined scale make tributaries ideal for studying certain components (e.g., sediment delivery and transport rates to the main stem of Cottonwood Creek) of the watershed's sediment budget. For example, gradient control structures could be installed to halt head cutting and stream widening in tributaries in parallel with measuring sediment transport rates in tributary streams, which could then be extrapolated throughout the watershed to refine the sediment budget. Furthermore, the small tributaries are excellent habitat for spring-run Chinook salmon and steelhead; thus, these locations might be particularly attractive to funding agencies concerned about the salmon and steelhead in the watershed.

To determine whether incision has occurred in tributaries to Cottonwood Creek, a reconnaissance-level geomorphic assessment should be conducted for key tributaries. If incisions in tributary channels are identified by such indicators as eroding banks, undermined bridges, cut banks, exposed buried utilities, or channel scour to bedrock, the potential to reestablish floodplain connectivity and function should be evaluated. Additionally the presence of natural grade-control features and the feasibility of artificial grade control should be evaluated. Where an artificial grade control structure is deemed necessary, a pilot gradient control structure should be constructed. The structure should be designed to provide passage for migrating fish and to stop further incision of the tributary channel bed. In addition to the monitoring methods discussed previously, suspended load and bedload sediment samples should be collected in key tributaries. Measuring the sediment load of select tributaries would significantly improve the sediment budget for Cottonwood Creek. Sediment load sampling should be conducted for a range of flows to determine a sediment transport rating curve. Standard methods outlined in *A Field Calibration of the Sediment-Trapping Characteristics of the Helley-Smith Bedload Sampler* (USGS, 1980) and "Field Methods for Measurement of Fluvial Sediment" (USGS, 1999) should be followed.

Action items for tributary pilot-scale project include the following:

- Pilot-scale projects should be conducted on tributaries to Cottonwood Creek. The projects should focus on information needed for the watershed's sediment budget.
- A reconnaissance-level geomorphic assessment should be conducted to determine if incision has occurred in key tributaries.
- A gradient control structure should be constructed. The structure should be designed to provide passage for migrating fish and to stop further bed incision.
- Suspended load and bedload sediment samples should be collected in key tributaries.
- Sediment load sampling should be conducted for a range of flows to determine a sediment transport rating curve.

Conjunctive Lema Ranch Study

Before beginning the riparian restoration and bank stabilization project planned at Lema Ranch, a gravel tracer study in the area, particularly in and around the gravel bar, should be performed to provide information about gravel transport processes in Cottonwood Creek. The techniques already discussed for monitoring and assessing bioengineering should also be applied at Lema Ranch if they are not already a part of that project. Taking advantage of the bioengineering project already underway in the watershed could be a very effective way to gain a greater understanding of geomorphic processes in Cottonwood Creek, and could contribute significantly to development of best practices for this effort.

Action items for the Lema Ranch study are as follows:

- Conduct a gravel tracer study in conjunction with the Lema Ranch study.
- Apply the monitoring and assessment techniques for bioengineering at Lema Ranch.

Riparian Areas Survey

CCWG should conduct on-the-ground surveys of riparian areas identified during the GIS mapping project that is currently funded. These surveys would more accurately characterize and document habitat to more accurately determine which areas require restoration, monitoring, or preservation.

During the development of the SWP, CCWG decided to restrict the scope of recommended riparian mapping efforts to selected areas. The areas mapped should be limited to areas where landowners are agreeable, and other related projects – such as streambank stabilization – are forthcoming. CCWG should help map riparian areas where landowners have decided to prioritize riparian management or conservation. CCWG should facilitate riparian mapping or surveying by providing the technical information needed to map those areas and act as a clearinghouse, storing information on how to map riparian areas and keeping the results of past mapping. CCWG should also conduct outreach to stakeholders to provide education about riparian areas and encourage riparian mapping (CH2M HILL, 2005).

Action items for riparian surveys include the following:

- CCWG should conduct on-the-ground surveys of riparian areas.
- CCWG should provide the technical information needed to map riparian areas.
- CCWG should act as a clearinghouse, storing information on how to map riparian areas and keeping the results of past mapping.
- CCWG should conduct outreach to stakeholders to provide education about riparian areas and encourage riparian mapping.

Riparian Habitat Historical Trends Study

The Watershed Assessment recommended that CCWG initiate a study of historical and ongoing riparian habitat trends in the Cottonwood Creek Watershed. Because historical information in the Cottonwood Creek Watershed is limited, additional investigation of historical trends might require comparative studies and inferences from other watersheds in the region. Development of GIS mapping for the watershed could be conducted in conjunction with this effort. Historical aerial photographs from California Department of Forestry,

NRCS, and other sources should be evaluated to help determine the change in riparian resources over time (CH2M HILL, 2002).

Following is an action item for a riparian habitat historical trends study:

- CCWG should initiate a study of historical and ongoing trends in riparian habitat.

Promotion of Riparian Restoration Projects

CCWG should facilitate and promote restoration projects on public and private lands that focus on improving the understanding of the relationship between ecological health of riparian areas and land management practices. This recommendation was taken from the Watershed Assessment. Promoting bioengineering techniques that include riparian revegetation would help to fulfill this recommendation, but finding ways to restore riparian habitat that is not directly connected to a streambank is also important.

Action items for riparian restoration projects include the following:

- CCWG should facilitate and promote restoration projects that focus on improving the understanding of the relationship between ecological health of riparian areas and land management practices.
- CCWG should promoting bioengineering techniques that include riparian revegetation.
- CCWG should promote restoration of riparian habitat including areas presently separated from the creek.

Evaluate and Implement CALFED's Ecosystem Restoration Program. In 2000, the CALFED Bay-Delta Program released its Ecosystem Restoration Program Plan (ERPP) (CALFED, 2000). The ERPP includes information and recommendations that are specific to Cottonwood Creek. The ERPP's recommendations (called targets) and programmatic actions that are applicable to this resource area are presented here.

ERPP target – Maintain existing levels of erosion and gravel recruitment in streams in the Cottonwood Creek Ecological Management Zone, and provide for increasing the transport of these sediments to the Sacramento River by an average of 30,000 to 40,000 tons per year.

The following actions are recommended by the ERPP to achieve this target:

- Cooperatively develop and implement a gravel management program for Cottonwood Creek. The program would protect and maintain important ecological processes and functions related to sediment supply, gravel recruitment, and gravel cleansing and transport. This would involve working with state and local agencies and gravel operators to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek.
- Cooperate with the aggregate resource industry to relocate existing gravel operations on Cottonwood Creek to areas outside of the active stream channel.

ERPP target – Repair and rehabilitate spawning gravels in 10 to 20 miles of the lower south fork and main stem of Cottonwood Creek.

The following short-term action is recommended by the ERPP to achieve this target:

- Develop a cooperative program to rip and clean or reconstruct important salmon spawning riffles on the South Fork Cottonwood Creek and on lower Cottonwood Creek below the South Fork.

ERPP target – Preserve or restore the 50- to l00-year floodplain and existing channel meander characteristics of streams in the Cottonwood Creek, particularly in low-gradient areas throughout the lower 20 miles where most deposition occurs and where stream channel meander is most pronounced.

The following action is recommended by the ERPP to achieve this target:

- Cooperatively evaluate reestablishing the floodplain along the lower reach of Cottonwood Creek, and evaluate constructing setback levees to reactivate channel meander in areas presently confined by levees.
- In the short term, develop a cooperative program to mechanically create a more defined stream channel in lower Cottonwood Creek. This would facilitate fish passage by minimizing water infiltration through the streambed and maintaining flow connectivity with the Sacramento River until natural meander returns.

ERPP target – Develop a cooperative program to identify opportunities to allow Cottonwood Creek to seasonally inundate its floodplain.

The following actions are recommended by ERPP to achieve this target:

- Conduct a feasibility study to determine means by which to increase floodplain interactions on lower Cottonwood Creek.
- Minimize adverse effects of permanent structures such as bridges on floodplain processes.

ERPP target – Develop a cooperative program to establish a continuous 130-mile riparian habitat zone along upper and lower Cottonwood Creek and its tributaries through conservation easements, fee acquisition, or voluntary landowner measures.

The following actions are recommended by ERPP to achieve this target:

- Develop a cooperative program to establish, restore, and maintain riparian habitat on Cottonwood Creek through conservation easements, fee acquisition, or voluntary landowner cooperation.
- Encourage the development of long-term measures in the comprehensive watershed management plan to further improve water temperatures. Develop a cooperative approach with counties and local agencies to implement land use management to protect riparian vegetation along the streams. Develop programs to restore lost riparian vegetation.
- Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cottonwood Creek.

Action items relating to the ERPP include the following:

- CCWG should work with stakeholders to develop and implement a gravel management program.
- CCWG should cooperate with the aggregate resource industry to relocate existing gravel operations. CCWG should work with stakeholders to evaluate reestablishing the floodplain and construction setback levees to facilitate channel meander.
- As a short-term action, CCWG should develop a cooperative program to mechanically create a more defined stream channel in lower Cottonwood Creek.
- CCWG should conduct or facilitate a feasibility study to determine means by which to increase floodplain interactions on lower Cottonwood Creek.
- CCWG should work with stakeholders to minimize adverse effects of permanent structures such as bridges on floodplain processes.
- CCWG should develop a program to establish, restore, and maintain riparian habitat through conservation easements, fee acquisition, or voluntary landowner cooperation.
- CCWG should encourage the development of long-term measures to further improve water temperatures.
- CCWG should work with counties and local agencies to implement land use management to protect riparian vegetation.
- CCWG should develop programs to restore lost riparian vegetation.
- CCWG should negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cottonwood Creek.

2.3 Fishery, Vegetation, and Wildlife Resources

Appendix C contains the final TM and other information relevant to this resource area.

2.3.1 Current Conditions

Fisheries

Cottonwood Creek is known to contain many species of fish, among which are anadromous species, including the federally threatened spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*). A complete list of fish species inhabiting Cottonwood Creek is provided in Table 2-1, and more information is available in the Watershed Assessment (CH2M HILL, 2002).

Several sources of information are available concerning historical fishery and habitat conditions in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Report* (Prepared by Heather Rectenwald for CDFG, August 1999)
- *Cottonwood Creek Watershed Assessment* (CH2M HILL, 2002)

- *Working Paper on Restoration Needs. Habitat Restoration Actions to Double Natural Production of Anadromous Fish in the Central Valley of California* (USFWS, 1995)
- *Restoring Central Valley Streams: A Plan for Action* (CDFG, 1993)

Relevant data consist primarily of fish inventories or surveys conducted by resource agency personnel beginning in the 1950s. Numerous resident salmonids and warmwater species have been observed in Cottonwood Creek and its tributaries. Species recorded for Cottonwood Creek are listed in Table 2-1. Population estimates for resident species are generally unknown. No extensive stream surveys have been performed since the suspension of plans for water development in the Cottonwood Creek Watershed in the early 1980s (CH2M HILL, 2002).

TABLE 2-1
Fish Species in Cottonwood Creek
Cottonwood Creek Watershed Management Plan

Common Name	Scientific Name	Native(N)/Introduced(I)
Black bullhead	*Ictalurus melas*	I
Bluegill	*Lepomis macrochirus*	I
Brown bullhead	*Ictalurus nedulosus*	I
Brown trout	*Salmo trutta*	I
California roach	*Hesperoleucus symmetricus*	N
Carp	*Cyprinus carpio*	I
Chinook salmon	*Oncorhynchus tshawytscha*	N
Golden shiner	*Notemigonus crysoleucas*	I
Green sunfish	*Lepomis cyanellus*	I
Hardhead	*Mylopharodon conocephalus*	N
Hitch	*Lavinia exilicauda*	N
Largemouth bass	*Micropterus salmoides*	I
Mosquito fish	*Gambusia affinis*	I
Pacific lamprey	*Entosphenus tridentatus*	N
Prickly sculpin	*Cottus asper*	N
Rainbow trout	*Oncorhynchus mykiss*	N
Riffle sculpin	*Cottus gulosus*	N
River lamprey	*Lamprtra ayresi*	N
Sacramento pikeminnow	*Ptychoeilus grandis*	N
Sacramento sucker	*Catoostomus occidentalis*	N
Smallmouth bass	*Micropterus dolomieu*	I
Speckled dace	*Rhinichthys osculus*	N
Steelhead	*Oncorhynchus mykiss irideus*	N
Threespine stickleback	*Gasterosteus aculeatus*	N
Tule perch	*Hysterocarpus traski*	N
White catfish	*Ictalurus catus*	I

Source: CDFG, 1979.

Fall-, late-fall-, and spring-run Chinook salmon and steelhead are known to occupy Cottonwood Creek in the approximately 130 river miles accessible to anadromous salmonids. On average, CDFG estimates the spawner escapement for fall-run Chinook salmon in Cottonwood Creek to be approximately 1,000 to 1,600 adults annually (U.S. Fish and Wildlife Service [USFWS], 1995; CDFG, 1993). Fall-run Chinook salmon principally spawn in the main stem of Cottonwood Creek, but are know to regularly spawn in the valley reaches of the north, middle, and south forks. Annual spawner escapement estimates for late-fall-run Chinook salmon are approximately 500 adults. Similarly to fall-run, late-fall-run Chinook salmon are believed to principally spawn in the valley reaches of the main stem and South, Middle, and North Fork Cottonwood Creek.

Spring-run Chinook salmon are also known to spawn in Beegum and South Fork Cottonwood Creeks. CDFG believes that, historically, approximately 500 adult spring-run Chinook salmon spawned in Cottonwood and Beegum Creeks. Currently, less than 500 are known to spawn in the Cottonwood Creek Watershed. Although it is believed that the Cottonwood Creek Watershed is one of the major tributaries to the Sacramento River that support steelhead, there are no current population estimates for steelhead in Cottonwood Creek. Small runs of steelhead have been observed to migrate in the main stem and lower reaches of the North, Middle, and South Fork Cottonwood Creek.

Resident rainbow and brown trout are found in the South Fork Cottonwood Creek above Maple Gulch, in Beegum Creek from the Highway 36 bridge upstream, in the Middle Fork Cottonwood Creek from Platina upstream, and in the Rainbow Lake vicinity of the North Fork (CDFG, 1978). These upstream reaches provide cooler water temperatures during summer months. CDFG stocking records indicate that rainbow trout were stocked in the North, Middle, South, and Cold Fork, and brown trout in the Middle Fork (CH2M HILL, 2002).

Smallmouth bass have been observed in Cottonwood Creek from the confluence with the Sacramento to 3 miles above Maple Gulch on the South Fork Cottonwood Creek, through Beegum Gorge on Beegum Creek to Platina on the Middle Fork Cottonwood Creek, and to Rainbow Lake on the North Fork Cottonwood Creek. Smallmouth bass generally spawn on the sand when water temperatures reach 60 degrees Fahrenheit during the months of April, May, and June (CDFG, 1979).

Vegetation

Several sources of information are available concerning vegetation habitats in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Watershed Assessment* (CH2M HILL, 2002)
- *Beegum Watershed Analysis* (USFS, 1997)

The Watershed Assessment addresses overall patterns of vegetation in the Cottonwood Creek Watershed. The primary vegetation types in the watershed are blue oak / gray pine, annual grassland, chaparral, Douglas fir / true fir, and mixed conifer. The above publications contain information on these vegetation types in the watershed.

CCWG has been awarded a grant through the NRCS Partnership Initiative 2006. The grant provides for collaborative riparian and amphibian surveys to be conducted through 2007. The project includes acquiring high-resolution color imagery, identifying and mapping vegetation communities along mainstem and major tributaries to Cottonwood Creek, identifying sites of non-native and noxious plants and weeds, and creating a GIS map with the survey results. In addition, the project involves working with willing landowners on restoration and preservation options in the watershed.

Wildlife

Several sources of information are available concerning wildlife in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Watershed Assessment* (CH2M HILL, 2002).
- *Beegum Watershed Analysis* (USFS, 1997)

The Watershed Assessment addresses 10 distinct wildlife habitats in the watershed: agriculture, barren, urban, serpentine, chaparral and montaine hardwoods, annual grassland, riparian, mixed conifer forest and Douglas fir / true fir, blue oak / gray pine, and water.

Several small-scale studies have been completed that document wildlife content within the Cottonwood Creek Watershed. The 1983 USFWS study included an assessment of the wildlife habitats and resources associated with the proposed Dutch Gulch and Tehama Dam locations (USFWS, 1983). The study reported the presence and potential presence of several different species in the project area. The identified species included deer (no specific species identified), turkeys, and California quail. Additionally, federally listed bald eagles were sighted on 45 occasions during the 1-year study period. The species that were identified as potentially existing in the project area include the peregrine falcon and yellow-billed cuckoo (CH2M HILL, 2002).

DWR produced a draft environmental impact report that addressed the safety of Misselbeck Dam (DWR, 1989), located on North Fork Cottonwood Creek, northwest of the Town of Ono. Numerous game species were identified in the reservoir area, including black-tailed deer, black bear, western gray squirrel, black-tailed jackrabbit, California quail, mountain quail, mourning dove, band-tailed pigeon, and wild turkey. During the time of the study, no endangered, threatened, or rare species were known to occur within the reservoir area (CH2M HILL, 2002).

The Yolla Bolly Deer Herd Management Plan was established in 1983 as a result of the March 1976 decision by CDFG to develop "A Plan for California Deer." The plan was updated in 2001 (CDFG, 1983 and 2001). At the time of the report, the Yolla Bolly deer herd was said to occupy the western half of Tehama County and had historically produced about 30 percent of the overall county total. The plan stated that the herd contained resident and migratory Columbian black-tailed deer (*Odocoileus hemionus columbianus*) and inhabited Tehama County west of Interstate 5. Additionally, because of common summer ranges, a portion of southwestern Shasta County is included as part of the range of that herd. The Deer Herd Management Units located near Cottonwood Creek are the Beegum Subunit and the Tomhead Subunit (CDFG, 1983). Composition data are available for the herd from 1960 to 2001 (CDFG, 1983 and 2001).

2.3.2 Information of Interest

A review of the SWP and stakeholder meeting notes indicated that the CCWG stakeholders are most concerned with the following issues related to fishery, vegetation, and wildlife resources:

- Establishing a baseline fish population monitoring program
- Determining limiting conditions and creating a general fishery system model
- Mapping riparian areas of the watershed and identifying riparian habitat condition and distribution
- Creating a list of native flora and fauna, with their general habitat locations identified, in the watershed
- Assessing status and trends of native oak woodlands, particularly blue oak woodlands, in the middle and lower portions of the watershed
- Assessing the impacts of noxious weeds and non-native plants and their effect on native plants and habitat (discussed further in Section 2.5)
- Establishing basic frog monitoring, including California red-legged frog habitat and needs
- Creating a list of native species in the watershed
- Assessing deer and wildlife populations
- Mapping and preserving late successional forests
- Suppressing fires and their effects on native plants and habitat
- Habitat fragmentation
- The effects of development of vegetation and wildlife resources

The TM, the stakeholder presentation, and the following portions of this section focus primarily on these issues.

To make recommendations for the management of the fishery and habitat resources in the Cottonwood Creek Watershed, CCWG should obtain sufficient data to develop an overall understanding of fishery dynamics. Following are the primary factors affecting salmon and steelhead populations in the watershed:

- Water temperature and flow – A surface water quality monitoring program began in 2006 in the Cottonwood Creek Watershed.
- Spawning gravel availability and location – Further analysis of gravel recruitment, particle size, and locations will be necessary to properly assess current spawning habitat limitations.
- Suitable juvenile rearing habitat – The quantity and quality of juvenile rearing habitat has not been systemically mapped in the watershed.

- Water quality – The 2006 to 2007 monitoring plan includes gathering turbidity and temperature data.
- Physical barriers – There is a need to conduct a more detailed barrier assessment, including assessing the extent of anadromy at a range of flow conditions.
- Landslides and slope failures – An assessment of the extent and nature of these inputs will be necessary to understand their impacts to aquatic habitats in South Fork Cottonwood Creek.
- Impact on aquatic habitat from streambank stabilization projects – Streambank stabilization projects can affect important fisheries habitat. Assessing positive and negative impacts through monitoring habitat elements should be included in future projects.

2.3.3 Short- and Long-term Actions

Juvenile Salmonid Monitoring

CCWG should establish or facilitate a juvenile salmonid monitoring program in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG and USFWS personnel to develop and seek funding for establishing a rotary-screw trapping program.

Action items for juvenile salmonid monitoring include the following:

- CCWG should establish a juvenile salmonid monitoring program.
- CCWG should coordinate with CDFG and USFWS personnel to develop a rotary-screw trapping program.

Adult Salmonid Monitoring

CCWG should establish an adult salmonid monitoring program in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG and USFWS personnel to develop and seek funding to establish an aerial redd survey, establish an adult weir monitoring program, create a video monitoring program, or other adult monitoring program. Monitoring is needed to determine current population size and location. This information is needed to assess changes in population size or location. The monitoring will also help prioritize future actions. Knowing what parts of the creek are being used by adult salmonids will help focus future preservation efforts. The monitoring will also determine if populations are increasing or decreasing.

Action items for adult salmonid monitoring include the following:

- CCWG should establish an adult salmonid monitoring program.
- CCWG should coordinate with CDFG and USFWS personnel to develop an aerial redd survey, establish an adult weir monitoring program, create a video monitoring program, or other adult monitoring program.

Limiting Factors Analysis and Focused Investigations

CCWG should conduct or facilitate a limiting factors analysis for anadromous fishery resources in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG, National Oceanic and Atmospheric Administration Fisheries, and USFWS personnel to develop and seek funding for conducting a limiting factors analysis. A limiting factors analysis would be used to evaluate the habitat factors affecting and potentially limiting production, determine possible causes of historical population declines, and estimate production potential for the various salmonid species in the watershed. By identifying these factors, CCWG would refine the current understanding of the anadromous fishery, focus future management activities, and help prioritize restoration or enhancement actions in the Cottonwood Creek Watershed. Several focused investigations would be needed to determine the limiting factors for anadromous fish. Focused studies should include the following:

- Aquatic habitat assessment – This assessment would include basic characterization of aquatic habitats, including habitat type (pools, riffles, and runs) and geometry, channel sinuosity, residual pool depth, channel gradient, substrate character, percent cover, and an inventory and characterization of woody debris.
- Spawning gravels assessment – This assessment would include evaluating the extent (locations and volumes) and character (particle-size distribution) of gravel suitable for salmonid spawning in the watershed.
- Physical barriers evaluation – This evaluation would characterize potential barriers to migrating anadromous fish throughout the watershed and identify the extent and character of any potential barriers at varying flow conditions.
- Landslide evaluation – This would include mapping and characterizing existing landslides and hill slope failures that are affecting and have the potential to affect downstream habitat quantity and quality in the watershed.

Action items for a limiting factors analysis include the following:

- CCWG should conduct a limiting factors analysis for anadromous fishery resources.
- CCWG should conduct an aquatic habitat assessment as part of a limiting factors analysis.
- CCWG should conduct a spawning gravels assessment as part of a limiting factors analysis.
- CCWG should conduct a physical barriers evaluation as part of a limiting factors analysis.
- CCWG should conduct a landslide evaluation as part of a limiting factors analysis.

Native Plant Species Identification

A draft list of native plant species in the Cottonwood Creek Watershed has been created and is included in Appendix C. The list of native plant species includes species that could occur in the Cottonwood Creek Watershed according to information obtained through database

research. CCWG should provide information to stakeholders in the watershed about native plant species. CCWG can do this through guided tours of plants in the watershed, presentations to schools, and presentations to community organizations. The native plant species list is one tool for public education about native plants. CCWG should update the native species list twice per year, when special-status species list updates are published by CDFG and USFWS. Because comprehensive studies on native plant species have not been conducted in the watershed, CCWG should conduct surveys for special-status plant species in the watershed.

CCWG should map and assess vernal pools. CCWG should use the mapping and assessment process as the basis for prioritizing areas for preservation. CCWG should then work with stakeholders to preserve vernal pools. Part of the preservation effort would involve outreach and education of stakeholders.

CCWG should continue to work cooperatively with land management agencies, such as the California Native Plant Society, to survey for rare plants, build cooperative databases of information, and prioritize sites for native plant preservation within the watershed.

Action items for native species include the following:

- CCWG should update the native plants list twice per year, when special-status species list updates are published by CDFG and USFWS.
- CCWG should provide information to stakeholders in the watershed about native plant species.
- CCWG should conduct surveys for special-status plant species in the watershed.
- CCWG should work cooperatively with land management agencies to survey for rare plants, build cooperative databases of information, and prioritize sites for native plant preservation within the watershed.
- CCWG should map and assess vernal pools.
- CCWG should use the mapping and assessment process to prioritize vernal pools for preservation.
- CCWG should work with stakeholders to preserve vernal pools and provide outreach and education to stakeholders.

Native Wildlife Species Identification

A draft list of native species in the Cottonwood Creek Watershed has been created. A draft native wildlife species list that includes special-status species is presented in Appendix C. CCWG should update this list twice per year, when special-status species list updates are published by CDFG and USFWS. CCWG should provide information to stakeholders in the watershed about native wildlife species. CCWG can do this though guided tours of the watershed, presentations to schools, and presentations to community organizations. The native wildlife species list is one tool for public education about native plants.

Comprehensive studies on native wildlife species have not been conducted in the watershed. CCWG should conduct surveys for special-status wildlife species or site assessments

identifying potential habitat for these species in the Cottonwood Creek Watershed. The Watershed Assessment recommended that CCWG conduct mapping of habitat for special-status species in the watershed. Further planning for wildlife species of concern, including habitat identification, prioritizing habitat for preservation, and monitoring of species populations, should also be conducted. CCWG should work with stakeholders and agencies in adjacent watersheds to manage species with large home ranges. CCWG should look into using guilds for management purposes. Use of guilds has been brought up several times and should be further explored by CCWG.

Action items for native wildlife species include the following:

- CCWG should update the native wildlife list twice per year, when special-status species list updates are published by CDFG and USFWS.
- CCWG should provide information to stakeholders in the watershed about native wildlife species.
- CCWG should conduct surveys for special-status wildlife species or site assessments identifying potential habitat for these species.
- CCWG should map habitat for special-status species.
- CCWG should conduct planning for wildlife species of concern including habitat identification; prioritizing habitat for preservation; and monitoring of species populations.
- CCWG should work with stakeholders and agencies in adjacent watersheds to manage species with large home ranges.
- CCWG should look into using guilds for management purposes.

Basic Herpetological Monitoring

The current NRCS grant will establish baseline studies of California red-legged frog in the Cottonwood Creek Watershed. Information about California red-legged frog and its habitat and aerial photography analysis of frog habitat would assist in future preservation and restoration planning for frog species. Information from these studies should be used to identify areas where frog habitat preservation is needed.

Other amphibians and reptiles live in the watershed. A broader survey of amphibians (like the foothill yellow-legged frog) and reptiles (like the northwestern pond turtle or garter snake) has not been completed. CCWG should conduct or facilitate basic herpetological monitoring. CCWG should take the lessons learned from their experience studying the red-legged frog and create a broader, more inclusive herpetological monitoring program. CCWG should conduct a preliminary study to identify probable amphibian and reptilian habitat. The preliminary study should be followed by on-the-ground surveys. The results from the preliminary study should be used to identify priority areas for on-the-ground surveys. Once on the ground surveys are completed, CCWG should identify and prioritize areas for amphibian and reptilian habitat preservation or restoration.

Action items for herpetological monitoring include the following:

- CCWG should identify areas where frog habitat preservation is needed.
- CCWG should conduct or facilitate basic herpetological monitoring.
- CCWG should conduct a preliminary study to identify probable amphibian and reptilian habitat.
- The results from the preliminary study should be used to identify priority areas for on-the-ground surveys.
- CCWG should conduct or facilitate on-the-ground surveys.
- Once on-the-ground surveys are completed, CCWG should identify and prioritize areas for habitat preservation or restoration.

Status and Trends Assessment for Native Oak Woodlands

Native oak woodlands provide numerous ecological benefits. They provide a rich and diverse habitat for wildlife that includes shelter, foraging, and breeding habitat. Oak woodlands provide aesthetic value to people, forage for livestock, and serve to stabilize soil. Oak woodlands also provide recreational opportunities such as hunting, nature viewing, and birding.

Threats to oak woodlands include residential and commercial development, land conversions, fires, firewood harvest, and damage caused by grazing animals. Certain land use practices associated with development, such as construction, landscape gardening, irrigation, trenching, paving, and changes in grade and drainages are incompatible with the health and survival of oak trees.

The majority of oak woodlands in California are privately owned. Landowners and ranchers have the opportunity to preserve oak woodlands by incorporating planning and design elements into their land use objectives that take into account the basic needs of oak trees. Management guides and resources for landowners on managing oak woodlands can be obtained through several public agencies and private associations including the Tehama County Hardwood Committee, CDFG, USFWS, the University of California Cooperative Extension's Integrated Hardwood Range Management Program, the California Department of Forestry and Fire Protection, NRCS, American Farmland Trust, and the California Oak Foundation.

Comprehensive studies of native oak woodlands have not been conducted in the Cottonwood Creek Watershed. To identify areas that require management, native oak woodlands should be evaluated throughout the watershed. CCWG should coordinate with the Tehama County Hardwood Committee, CDFG, and USFWS personnel to develop and seek funding to conduct a survey that comprehensively identifies the locations and health of native oak woodland ecosystems. The results of such a study would establish baseline conditions for oak woodland habitats. After the baseline is established, areas in need of preservation or restoration could be identified and prioritized. The baseline would also be useful in assessing impacts from development, changes in land use, and changes in grazing

practices, and could better prepare the watershed for environmental crises like sudden oak death syndrome.

Action items for oak woodlands include the following:

- CCWG should help landowners preserve oak woodlands by incorporating planning and design elements into their land use objectives that take into account the basic needs of oak trees.
- CCWG should collect and distribute management guides and other resources for managing oak woodlands to landowners and stakeholders.
- CCWG should conduct a survey that comprehensively identifies the locations and health of native oak woodland ecosystems.
- CCWG should identify and prioritize oak woodlands areas for preservation or restoration.
- CCWG should assess impacts to oak woodlands from development, changes in land use, and changes in grazing practices.

Noxious Weeds Impact Assessment

The approved NRCS grant provides for GIS evaluation to identify sites of non-native and noxious plants and weeds in the Cottonwood Creek Watershed. CCWG should further evaluate the severity of non-native and noxious species in the watershed as part of an overall vegetation restoration program. The current noxious weed program should be expanded; additional effort is needed to comprehensively inventory and combat noxious weeds. Public outreach and education programs should be developed to educate land-owners in noxious weed identification as well as eradication methods. More information on noxious weed assessment and abatement is provided in Section 2.4 as part of the rangeland management plan recommendation.

Action items for noxious weeds include the following:

- CCWG should further evaluate the severity of non-native and noxious species as part of an overall vegetation restoration program.
- The current noxious weed program should be expanded.
- CCWG should comprehensively map, inventory, and combat noxious weeds.
- Public outreach and education programs should be developed to educate landowners in noxious weed identification and eradication methods.

Bank Stabilization Projects Impact Assessment

Bank stabilization projects can preserve existing riparian forests, encourage the establish-ment of new riparian areas, and improve aquatic habitat. The impact of bank stabilization projects should be assessed.

Following is an action item for bank stabilization:

- CCWG should assess the beneficial and detrimental impacts of bank stabilization projects on riparian and aquatic habitat.

Evaluate and Implement CALFED's Ecosystem Restoration Program. The CALFED ERPP includes information and recommendations that are specific to Cottonwood Creek. The ERPP's recommendations (called targets) and programmatic actions that are applicable to this resource area are presented here.

ERPP Target – Maintain and improve existing freshwater fish habitat and essential fish habitat through the integration of actions described for ecological processes, habitats, and stressor reduction or elimination.

ERPP Target - Facilitate passage of steelhead and spring-run Chinook salmon to the holding, spawning, and rearing habitat in the higher elevation reaches and tributaries.

The following action is recommended by ERPP to achieve this target:

- Begin an evaluation of structures (such as culverts, bridge abutments, grade control structures) that may be impeding or hindering migration to the high-quality upstream habitat and implement measures to facilitate upstream passage.

Action items for ERPP bank stabilization are as follows:

- CCWG should work with stakeholders to maintain and improve existing freshwater fish habitat and essential fish habitat.
- CCWG should conduct or facilitate an evaluation of structures that may be impeding or hindering migration to the high-quality upstream habitat and implement measures to facilitate upstream passage.

Create a Mitigation Library as Part of a Mitigation Bank. The EPA provides guidance on mitigation banking. This guidance includes the following description of the mitigation banking process:

> [M]itigation banking means the restoration, creation, enhancement and, in exceptional circumstances, preservation of wetlands and/or other aquatic resources expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources.
>
> The objective of a mitigation bank is to provide for the replacement of the chemical, physical and biological functions of wetlands and other aquatic resources which are lost as a result of authorized impacts. Using appropriate methods, the newly established functions are quantified as mitigation "credits" which are available for use by the bank sponsor or by other parties to compensate for adverse impacts (i.e., "debits") (EPA, 1995).

The Cottonwood Creek Watershed has areas that are fit for wetland restoration, creation, enhancement, or preservation. CCWG could work with landowners to identify areas that would be credits. CCWG could maintain a Mitigation Project Library of various projects that are potential credits. CCWG could assist in matching new projects that have adverse

impacts with credit projects that offset the impacts. The Mitigation Project Library would create a framework for approving projects as potential credits and would assist in implementation of beneficial projects.

Currently, one mitigation banking system, the Cottonwood Creek Wetland Mitigation Bank, exists within Cottonwood Creek Watershed. The existing bank sells credits for freshwater emergent wetlands. The existing bank does not offer mitigation for vernal pools, rare and endangered species, riparian areas, or other habitats. Cottonwood creek has a variety of resources that can act as credits. A mitigation banking system that includes a wider variety of potential mitigation projects would be valuable in restoring or enhancing the Cottonwood Creek Watershed. CCWG should work with the Central Valley Regional Water Quality Control Board, CDFG, U.S. Army Corps of Engineers, or NRCS to develop a new mitigation bank or to expand the current bank to include a wider range of habitats.

Action items for mitigation banking are as follows:

- CCWG should work with landowners to identify areas that would qualify as credits.
- CCWG should maintain a Mitigation Project Library of projects that are credits.
- CCWG should match new projects that have adverse impacts with credit projects.
- CCWG should create a framework for approving projects as potential credits.
- CCWG should work to develop a new mitigation bank or to expand the current bank to include a wider range of habitats.

2.4 Fire and Fuels Management

Appendix D contains the final TM and other information relevant to this resource area.

2.4.1 Current Conditions

The Watershed Assessment compiled information related to hydrology, sediment and fluvial geomorphology, soil resources, water quality, vegetative cover, fishery resources, wildlife resources and habitat types, special-status species, riparian communities, and land use (CH2M HILL, 2002). The following findings and recommendations from these topics are pertinent to fire and fuels management:

- The management and use of natural resources have affected vegetation patterns throughout the Cottonwood Creek Watershed. Fire suppression and oak woodland conversion are two factors that appear to affect the vegetation resources and patterns at the landscape level.
- Approximately 13 percent of the Cottonwood Creek Watershed is mapped as annual grassland in the CALVEG database.
- An estimated 16 percent of the Cottonwood Creek Watershed comprises chaparral habitat. Chaparral communities are fire-adapted and have reproductive methods that depend on periodic and/or recurring fires.

CCWG contracted Western Shasta Resource Conservation District to write a Strategic Fuels Reduction and Management Plan (2004) for the Cottonwood Creek Watershed, and CCWG has been working to implement the plan. The purpose of the plan was to identify areas where the construction of fuelbreaks could increase protection for residents of the watershed, protect at-risk values, provide firefighters safety when containing a blaze, allow safe transportation routes away from a fire, and encourage a maintenance plan that would continue a fuelbreak network. A list of shaded fuelbreaks, ridgetop fuelbreaks, bulldozer track fuelbreaks, and brush abatement and maintenance projects was developed based on location, vegetation, wind direction, access, and values at risk.

Following are some of the fire and fuels management projects that CCWG has facilitated to date:

- Installed Quail Ridge water tank.
- Attempted to create a fire break at Clear Creek Road; this action was not completed because of the lack of landowner cooperation. A subsequent landowner has created a fire break.
- Created a fuel break on both sides of Highway 36 near Platina.
- Completed the Cottonwood Wilds fuel break.
- Use of grazing for fuels management is ongoing and has been successful to date.

The following fire and fuels management work is being planned:

- Creation of a Hammer Loop fire break is funded, the plan is being completed, and California Environmental Quality Act documentation is ongoing.
- Creation of a fire break at R-Ranch (Wildhorse) is underway. Problems associated with this development include excessive brush on roadsides and intense four-wheel-drive activity in remote locations.
- The Bowman biomass project is in the startup phase. The project will include thinning and brush removal around residential developments. The area has dense brush near housing.
- A grant application has been submitted to perform a controlled burn and fuel reduction around Platina.

2.4.2 Information of Interest

The outcome of the workshop on fire and fuels management was that stakeholders want the information necessary to create an evacuation plan for the area, continue the fuels management plan, and develop a comprehensive rangeland management plan. Extensive information about creating a rangeland management plan and details about the components of such a plan are included at the end of this section.

2.4.3 Short- and Long-term Actions

The following actions were recommended in the Watershed Assessment. These recommendations have been reviewed by the stakeholder group and are in line with achieving one or more of CCWG's goals:

- Develop a fire management plan as a tool for habitat enhancement.
  - A fire management plan was created for the Cottonwood Creek Watershed. That plan should be updated regularly to remain relevant. The recommendations in that plan should continue to be implemented.
- Continue to evaluate and monitor the effects of fire and fire management in the watershed.
- Evaluate the effects of fire suppression on the watershed deer population.
- Assess changes in habitat use and population trends following vegetation management practices.
- With assistance from the University of California at Davis Cooperative Extension Rangeland Monitoring Program, encourage ranchers in the watershed to design grazing strategies that encourage oak recruitment and preservation of riparian habitats. This topic is discussed in further detail under Develop Rangeland Plans.
- Assess status and trends of native oak woodlands, particularly blue oak woodlands, in the middle and lower watershed.
- Evaluate the effects of fire and grazing on oak woodlands.
- Encourage sustainable harvesting of oaks in the watershed.
- Conduct livestock surveys within the watershed boundaries.
- Determine livestock types and grazing locations.
- Survey agriculture lands to determine locations, crop types, and irrigation systems used.
- Associate livestock and cropping data with county and state designated land use types and locations in the watershed.
- Promote restoration projects on public and private lands. Where appropriate, fence and plant native vegetation in degraded and nonvegetated riparian areas.
- Remove non-native species and plant native species in riparian areas.
- With assistance from the University of California at Davis Cooperative Extension Rangeland Monitoring Program, evaluate the effects of various grazing strategies on propagation of native vegetation.
- Work with landowners to establish best management practices for standard land use practices that promote cohabitation with special-status species.

The primary recommendations that were detailed in the SWP (CH2M HILL, 2005) are as follows:

- Consider grazing as a tool for fuels reduction. This recommendation is currently being used successfully in the watershed. The grazing program should be continued and expanded. Results of the grazing program should be publicized to assist stakeholders in the watershed and other interested parties outside the watershed that could benefit from the establishment of a grazing program.
- Pursue vegetation management through prescribed burning programs.
- Act as a clearinghouse for forest management information.
- Continue to eliminate or reverse fire suppression trends by implementing the fire management plan.

Other recommendations that were considered by stakeholders during the strategic watershed planning process include the following:

- Contact the California Department of Forestry concerning the two programs established to provide cost-sharing technical assistance and educational programs for timberland owners, the California Forestry Improvement Program and the Chaparral Management Program.
- With assistance from the University of California at Davis Cooperative Extension Rangeland Monitoring Program, evaluate the effects of various grazing strategies on propagation of native vegetation.
- Assess status and trends of native oak woodlands. The Tehama County Hardwood Committee has established guidelines for oak harvesting and management in the watershed. Their goal is to educate the public and landowners on the ordinances and guidelines set forth by the Committee and Tehama County.
- Establish a comprehensive rangeland management plan.
- Create a database of information on forest fuels. Start outreach to landowners and the Technical Advisory Committee to share and supplement the information in the database. The database's purpose will be to share forest management experience within the watershed.
- Develop a ranch management plan for the watershed that includes a landowner guide to grazing issues, noxious weeds, and fencing criteria.
- Develop a set of management tools. These tools should be concise and easily accessible to all stakeholders (on Web site and / or brief handout.) Tool topics could include streambank stabilization techniques, noxious weeds abatement, wildlife species, and fuels reduction / fire awareness.

The following three topics were discussed at the fire and fuels management workshop. The comments and discussion that occurred at the workshop are included in each recommendation.

Act as Clearinghouse for Fire and Vegetation Management Information

Many techniques are available for managing fire and vegetation. Information on techniques that are in practice, have been attempted, or are going to be attempted within the watershed should be listed, along with a description, in a database or other filing system at the CCWG offices. Other information, like updates that are needed for existing plans (e.g., Strategic Fuels Reduction and Management Plan), should also be kept. This would help facilitate stakeholder education.

Action items for fire and vegetation management include the following:

- CCWG should keep a database on fire and vegetation management techniques that are in practice, have been attempted or are being implemented.
- CCWG should update the Fuels Reduction and Management Plan.
- CCWG should continue to implement the existing Fuels Reduction and Management Plan.
- CCWG should facilitate stakeholder education about fire and vegetation management techniques.

Create Evacuation Plan(s) for Communities in the Watershed

The Cottonwood Creek Watershed Fire Safe Council identified the creation of an evacuation plan as one of the priorities for the watershed. The California Department of Forestry and Fire Protection created a brief guide to creating evacuation plans for communities. Personnel are available to make presentations to small communities or neighborhoods and guide residents through the process of writing an evacuation plan. CCWG should inform residents of this program and encourage them to participate in the program. CCWG should also track communities that have developed evacuation plans and can keep copies of those plans on file. CCWG should further assist stakeholders by distributing the plans to new residents and by encouraging communities to update their plans regularly. CCWG should act as a center for outreach and education for evacuation planning. This action could be undertaken fairly quickly and would be relatively inexpensive.

Action items for evacuation plans include the following:

- CCWG should inform residents of the CDF evacuation panning program and encourage them to participate in the program.
- CCWG should track communities that have developed evacuation plans and can keep copies of those plans on file.
- CCWG should assist stakeholders by distributing evacuation plans to new residents and by encouraging communities to update their plans regularly.
- CCWG should act as a center for outreach and education for evacuation planning.

Develop Rangeland Plan

There was consensus at the April 2006 stakeholder workshop to develop a rangeland management plan for CCWG. The following sections provide information on developing

rangeland management plans. The action item for CCWG is to develop a rangeland management plan. The information provided is intended to help CCWG develop a rangeland management plan. NRCS is an excellent resource for developing rangeland management plans. CCWG should coordinate with NRCS during the development of a rangeland management plan.

Summary. By addressing rangeland management issues on individual ranches in a manner that is consistent across the watershed, property owners can collectively influence the state of natural resources in the Cottonwood Creek Watershed. The proposed approach to rangeland planning for the Cottonwood Creek Watershed would occur in two phases. Phase 1 would entail developing a watershed-wide General Rangeland Plan that would serve as a reference guide for planning on individual properties, and would incorporate the management strategies identified by the SWP. Phase 2 would consist of rangeland planning for individual properties, on a volunteer basis, which would include detailed management plans for specified goals. At a minimum, both plans would include the three top-priority rangeland resource concerns identified in the SWP: a guide to grazing, noxious weed identification and eradication information, and fencing criteria. Other components of rangeland planning that would likely be useful are included in the following description of these plans.

Background and Purpose. The primary purpose of developing rangeland plans is threefold, and includes the following:

- Inventory rangeland and riparian resources.
- Document historical and present-day grazing practices.
- Develop an economically feasible plan for improving/maintaining range condition and sustaining natural resources.

Rangeland plans developed in the context of a WMP, however, fulfill a wider purpose relevant to the management of the watershed as a unit. By addressing rangeland management issues on individual ranches, property owners can collectively influence the state of natural resources in the watershed.

Approach and Rationale. The rationale for developing a General Rangeland Plan before planning for specific ranches or other grazing properties is rooted in the concept that many properties form a contiguous landscape. When information is collected and management strategies are carried out in a consistent manner across the watershed, property owners within the watershed can expect to contribute to a unified effort to preserve and enhance the natural resources in the Cottonwood Creek Watershed.

The General Rangeland Plan would serve as a reference document or set of guidelines for property rangeland plans. This approach would eliminate much of the general research and compiling of information that applies to the whole watershed and would be redundant if it were repeated for each individual property. The General Rangeland Plan would also ensure that the watershed management strategies identified in the strategic plan would be addressed. This plan would include information and inventory and watershed natural resources, including information from residents on how these resources have been managed historically.

Ideally, the research conducted in developing this plan would eliminate the need for individual landowners to perform this research every time a property rangeland plan is completed. All the information in the General Rangeland Plan would not necessarily be applicable to all properties; rather, the intent of the General Rangeland Plan would be to provide information that landowners in the Cottonwood Creek Watershed who graze livestock could use as a reference for consistency throughout the watershed.

The property rangeland plans would have different objectives. The main purpose of rangeland planning for individual properties is the reality that landowners have different management styles, budgets, goals, land types, resources, and grazing needs. These plans would address the specific goals of the landowner, but would also strive to comply with the protocols set out in the General Rangeland Plan. Ideally, site visits, field mapping, and landowner interviews would be sufficient to complete these plans. In this way, property rangeland plans could be developed by landowners themselves if an outline were developed.

An example of this approach addresses one of the priorities identified for rangeland planning through the strategic plan process – identification and eradication of noxious weeds. The General Rangeland Plan component of this subject would include the following:

- Methods of identifying noxious weeds common in Cottonwood Creek (such as growth habit, example photos, and growth environments)
- Instructions for a mapping protocol that is widely accepted by agencies and organizations concerned with invasive weeds
- Methods of eradication, such as intensive, timely grazing, burning, and chemical control, and their advantages and disadvantages
- A list of organizations that provide information and assistance in managing noxious weeds, such as Weed Management Areas
- A list of funding sources for eradication programs

The Property Rangeland Plan would include a plan to identify and/or eradicate noxious weeds compliant with the guidelines presented in the General Rangeland Plan, and would include the following:

- Identification of specific weeds on specific sites, using identification methods presented in the General Rangeland Plan.
- Maps of weeds, including location and density as described in protocol in the General Rangeland Plan.
- A method for eradicating the noxious weeds determined from methods outlines in General Rangeland Plan, and considering individual property grazing needs, other resources on the property that might be affected, budget considerations, and proven efficacy methods known to landowners from personal experience on their own property.
- A plan for implementing the eradication method, including goals for percent eradication and timelines, funding sources, and how the plan will address the watershed management strategy of eradicating noxious weeds.

Phase 1 – General Rangeland Plan

The General Rangeland Plan would include the following three main sections:

1. A list of watershed management strategies, why they are important to the watershed, recommendations to achieve them, and how they can be implemented across property boundaries
2. Documentation of watershed natural, cultural, and historic resources
3. A set of guidelines or protocols for implementing management strategies on individual grazing properties

Watershed Management Strategies. This section would outline the complete watershed management strategies, but would focus on those that are relevant to rangeland planning. For example, rangeland plans would potentially address the following four strategic areas identified by CCWG:

- Fuel reduction and vegetation management
- Inventory and mapping
- Management plan development
- Monitoring and modeling

Additionally, rangeland planning would potentially address the following management strategy recommendations:

- Consider grazing as a tool for fuels reduction.
- Pursue vegetation management through prescribed burning program.
- Bring forest fuels into balance.
- Map riparian areas.
- Develop a rangeland management plan.

Natural, Cultural, and Historic Resources. The Watershed Assessment demonstrated that there is little information on the state of the natural resources in the Cottonwood Creek Watershed, in part because of its size. Although rangeland planning is not necessarily an effort that should include a watershed-wide resource inventory, gaps in information that would be useful to rangeland planning should be noted and prioritized for further research and funding. However, some natural resource agencies have developed plans on a watershed scale for various management purposes, such as fire and fuels reduction. These plans should be consulted to enhance, not defeat, their purposes.

Cultural resources include sites of cultural significance, such as burial grounds and cemeteries, sites significant to Native American residents (past or present), and archeological sites.

Historic resources include emigrant trails, sites of significant historical events, and perhaps most importantly, residents of the watershed who hold valuable information about the historical use and management of watershed resources that are not recorded. These resources often cross present-day property boundaries, and it is important to address them in the General Rangeland Plan, because they can likely provide useful information to many of the individual property owners planning for rangeland maintenance and improvement.

Guidelines and Protocols. At a minimum, guidelines would be developed for the following components of the General Rangeland Plan, according to the priorities resulting from the management strategy process relevant to developing a rangeland management plan:

- Landowner guide to grazing issues
- Noxious weed identification and eradication information
- Fencing criteria (wildlife-friendly fencing, riparian fencing)

Other important guidelines could be developed for the following:

- Ranch management unit mapping
- Riparian mapping
- Soil stabilization
- Water developments (stock water ponds and spring development)
- Prescribed grazing
- Fire breaks and brush management
- Prescribed burning
- Streambank and shoreline protection

Conservation practice standards have been developed by the NRCS for most of these topics. Other standards developed by NRCS that could be considered include, but are not limited to, the following:

- Soil erosion potential
- Use exclusion
- Grade stabilization
- Irrigation water conveyance
- Range planting

In some cases, there are several protocols for planning, such as those for riparian mapping and invasive weed mapping. The General Rangeland Plan would specify which protocol is useful, practical, and affordable for the watershed and its landowners.

Guide to Grazing Issues. Guidelines and information would be developed for the following topics:

- **Forage Production and Use.** The General Rangeland Plan would include appropriate guidelines for estimating and managing residual dry matter (RDM) to use in stocking rate assessments on individual properties. Stocking rates are assessed to determine if the amount of RDM left on the range after the grazing season is sufficient to prevent soil instability and promote the next year's growth of forage. In some cases, landowners may see a need to change grazing practices if they observe that forage is being over or under used. Stocking rate assessments can help landowners improve the efficient use of forage on the property.

  Several guidelines exist for estimating and managing RDM. Some of these have been developed for different geographical areas and do not apply to California rangelands. Also, some of these guidelines apply or do not apply depending on the forage production potential of the site. These guidelines should be chosen with care and

presented in the General Rangeland Plan as a resource for landowners who want to conduct stocking rate assessments on their lands.

- **Complementary Grazing.** The use of native rangelands, tame pastures, and farmed forages to meet livestock nutritional needs has been termed complementary grazing. Complements mutually supply each other's lack. One forage type is used at a time when another forage fails to meet livestock nutritional needs. Complementary forage systems are likely used in the Cottonwood Creek Watershed because of the seasonality of pastures. Therefore, information on complementary grazing practices would likely be useful to many livestock producers.

- **Wildlife Considerations.** Many landowners wish to maintain or improve wildlife habitat on their land while also grazing domestic livestock. Grazing can increase or decrease plant diversity and affect bird populations. Livestock can compete with wildlife for food and transmit disease. On the other hand, livestock and wildlife can complement each other by using forage efficiently. The essentials for managing livestock with the goal of maintaining and/or improving wildlife habitat and populations would be provided in the General Rangeland Plan.

- **Grazing Sensitive Habitats.** Rangelands often include habitats that are sensitive to grazing, such as oak woodlands or riparian areas. Although overgrazing these habitats can lead to their deterioration, recent research demonstrates that moderate grazing can improve some of these habitats. The General Rangeland Plan would include information on recent research that indicates how sensitive habitats are influenced by different grazing practices.

- **Prescribed Grazing.** Prescribed grazing is the controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specific objective. The General Rangeland Plan would be a source of information for various grazing prescriptions that include intensity, timing, duration, frequency, and rotations. Grazing prescriptions would need to be modified by landowners for each site; however, this source of information would provide a starting point for livestock producers who want to maximize their use of forage while maintaining rangeland resources.

- **Monitoring.** Monitoring forms the basis for decisionmaking. Monitoring methods range from keeping farm records and taking photographs to maintaining permanent transects to measure forage production, type, and use. The General Rangeland Plan would include instructions on where to monitor (representative, critical, and treatment areas); when, what, and how to monitor; and how to develop a monitoring program. It would then be the responsibility of the landowner to determine what type of monitoring is practical and meaningful for his/her property.

Noxious Weed Identification and Eradication. The General Rangeland Plan would provide information on noxious weed identification and eradication that would be applicable in the Cottonwood Creek Watershed, including the following:

- Methods of identifying common noxious weeds in Cottonwood Creek (such as growth habit, example photos, and growth environment)

- Instructions for a mapping protocol that is widely accepted by agencies and organizations concerned with invasive weeds
- Methods of eradication, such as intensive timely grazing, burning, and chemical control, and their advantages and disadvantages
- A list of organizations that provide information and assistance in managing noxious weeds, such as Weed Management Areas
- A list of funding sources for eradication programs

Fencing Criteria. Fencing criteria in the General Rangeland Plan would include options for fencing materials, type and design, height, size, spacing, and durability. Other considerations, such as topography, soil properties, safety and management of livestock, wildlife movement, location and adequacy of water facility, development of potential grazing systems, erosions problems, flooding or fire potential, and stream crossings, would be addressed. Criteria for special considerations, such as fencing riparian areas, would also be addressed. Because of the high cost of fencing, funding sources for rangeland improvements such as fencing would be identified.

Phase 2 – Property Rangeland Plans

At a minimum, property rangeland plans would include these main sections as first priority:

1. Landowner guide to grazing issues
2. Noxious weed identification and eradication information
3. Fencing criteria (e.g., wildlife-friendly fencing, riparian fencing)

Guide to Grazing Issues. Grazing challenges are different for each property and, in many cases, different for each pasture or management unit. Grazing concerns that would be addressed include the following:

- **Forage Production and Use.** An ecological range site is a distinct type of rangeland that supports a distinct amount and type of vegetation. Range sites differ in their plant communities, soils, and hydrology. Range site classifications are general; they are approximations and may be modified as the site changes or managers acquire more knowledge about the site. Range sites have been mapped by NRCS in most areas of the state where soil surveys have been conducted, and can be used as guidelines to determine the forage production potential of a specific site. They provide information on soil depth and texture, forage production, and carrying capacity (the number of acres needed to support one animal unit equivalent for 1 year).

  Landowners that have resided on their property for several years and used it for grazing livestock likely have knowledge about the carrying capacity of their land. Range site mapping might or might not provide them with significant information that is more useful than their experiential knowledge. However, when these lands change ownership, the same may not be true of new owners. Therefore, it is important to map and document the range sites that are used for grazing to ensure that Cottonwood Creek landowners, now and in the future, have resources with which to manage range resources to the best of their ability.

Range sites could also help conduct stocking rate assessments, which are described under Phase 1 – General Rangeland Plan. Stocking rate assessments are specific to each management unit (pasture or field), and would be calculated according to the guidelines described in the General Rangeland Plan.

- **Complementary Grazing.** Complementary grazing might or might not be used on a landowner's property. If included, each property rangeland plan would describe a chosen complementary grazing system and a rationale based on factors such as efficient use of forage, animal nutrition, and practicability with ranching operations.
- **Wildlife Considerations.** Although the General Rangeland Plan would provide information on how to integrate domestic grazing with wildlife needs, the Property Rangeland Plan would describe specifically what species of domestic livestock and wildlife are managed. This plan would include maps or descriptions of wildlife vital areas and times, such as corridors or nesting periods. The plan would describe how timing and duration of grazing rotations would benefit wildlife and domestic livestock alike.
- **Grazing Sensitive Habitats.** Sensitive habitats might or might not be identified on an individual property. If identified, the landowner would consult the General Rangeland Plan on how to graze or not graze these habitats to promote effective ranch operations and maintain habitat. Each property rangeland plan would describe timing and intensity of grazing for these areas.
- **Prescribed Grazing.** Prescribed grazing describes the managed grazing practices used to graze lands with livestock. Grazing practices or prescriptions on individual properties might not have specific names, but might have been developed over years of trial and error. Descriptions of these grazing prescriptions provide valuable information.
- **Monitoring.** Specific goals, selection of monitoring sites, and selection of proper monitoring techniques are the cornerstones of monitoring programs for individual properties. Landowners would be able to use the instructions in the monitoring section of the General Rangeland Plan along with personal management preferences and individual property characteristics to determine the specifics of a monitoring program. It is important for landowners to choose their own monitoring programs so they can commit to them.

Noxious Weed Identification and Eradication. Each property rangeland plan would include a plan to identify and/or eradicate noxious weeds that complies with the guidelines presented in the General Rangeland Plan, including the following:

- Identification of specific weeds on specific sites, using identification methods presented in General Rangeland Plan
- Maps of weeds, including locations and density, as described in protocol in the General Rangeland Plan
- A method for eradicating the noxious weed determined from methods outlined in General Rangeland Plan, and considering individual property grazing needs, other resources on the property that might be affected, budget considerations, and proven efficacy methods known to landowners from personal experience on their property

- A plan for implementing the eradication method, including goals for percent eradication and a timeline, funding sources, and how the plan will address watershed management strategy of eradicating noxious weeds

Fencing Criteria. Fencing criteria described in the General Rangeland Plan would be used to determine the best type, size, and locations of fences for individual property needs. The General Rangeland Plan should provide as exhaustive a list as possible of considerations to provide a valuable reference guide for landowners considering installing new or replacing old fencing. Mapping fences in relation to management units, water sources, and roads would also be useful on ranches and other properties, for management considerations.

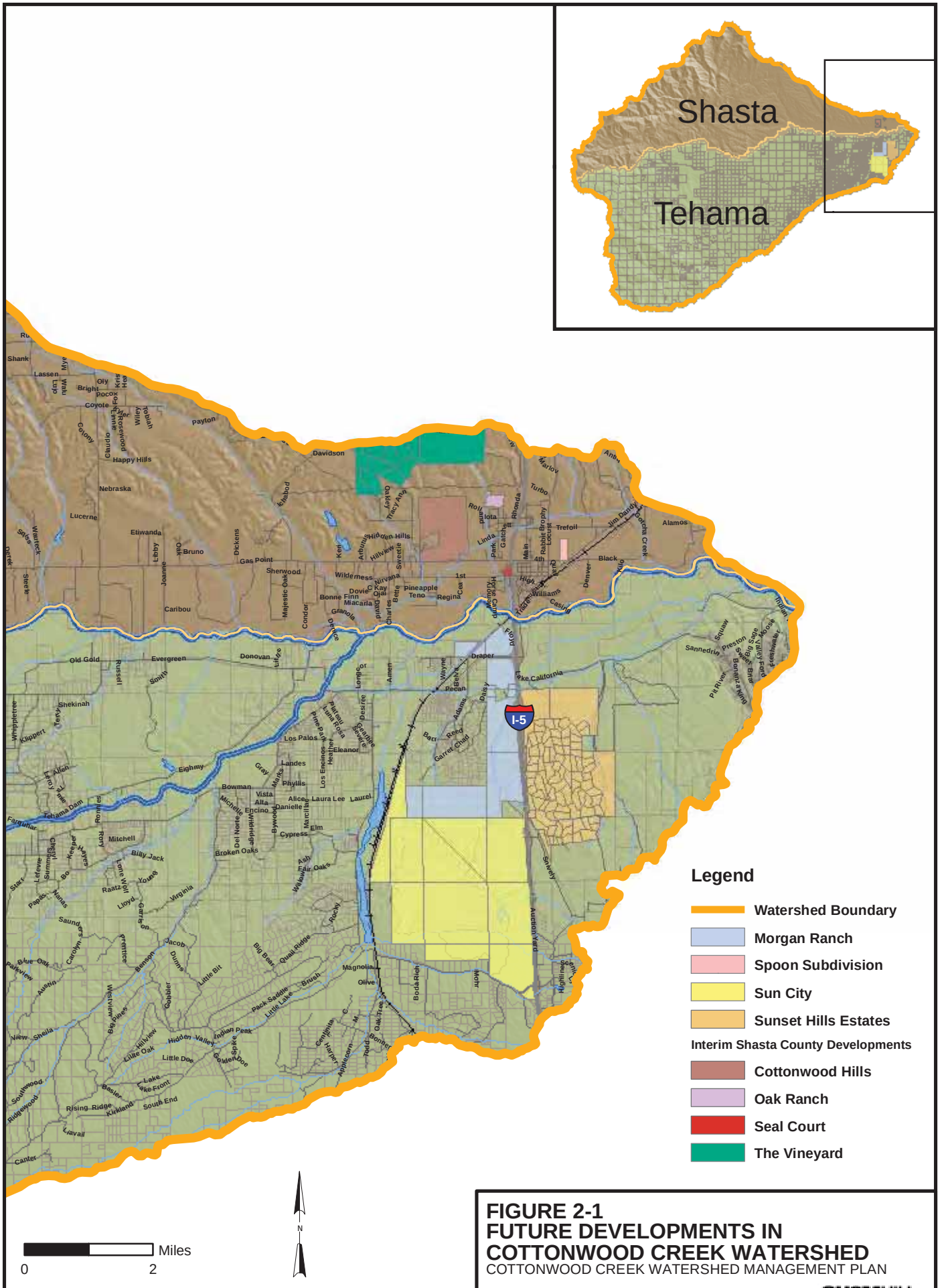

FIGURE 2-1
FUTURE DEVELOPMENTS IN COTTONWOOD CREEK WATERSHED
COTTONWOOD CREEK WATERSHED MANAGEMENT PLAN

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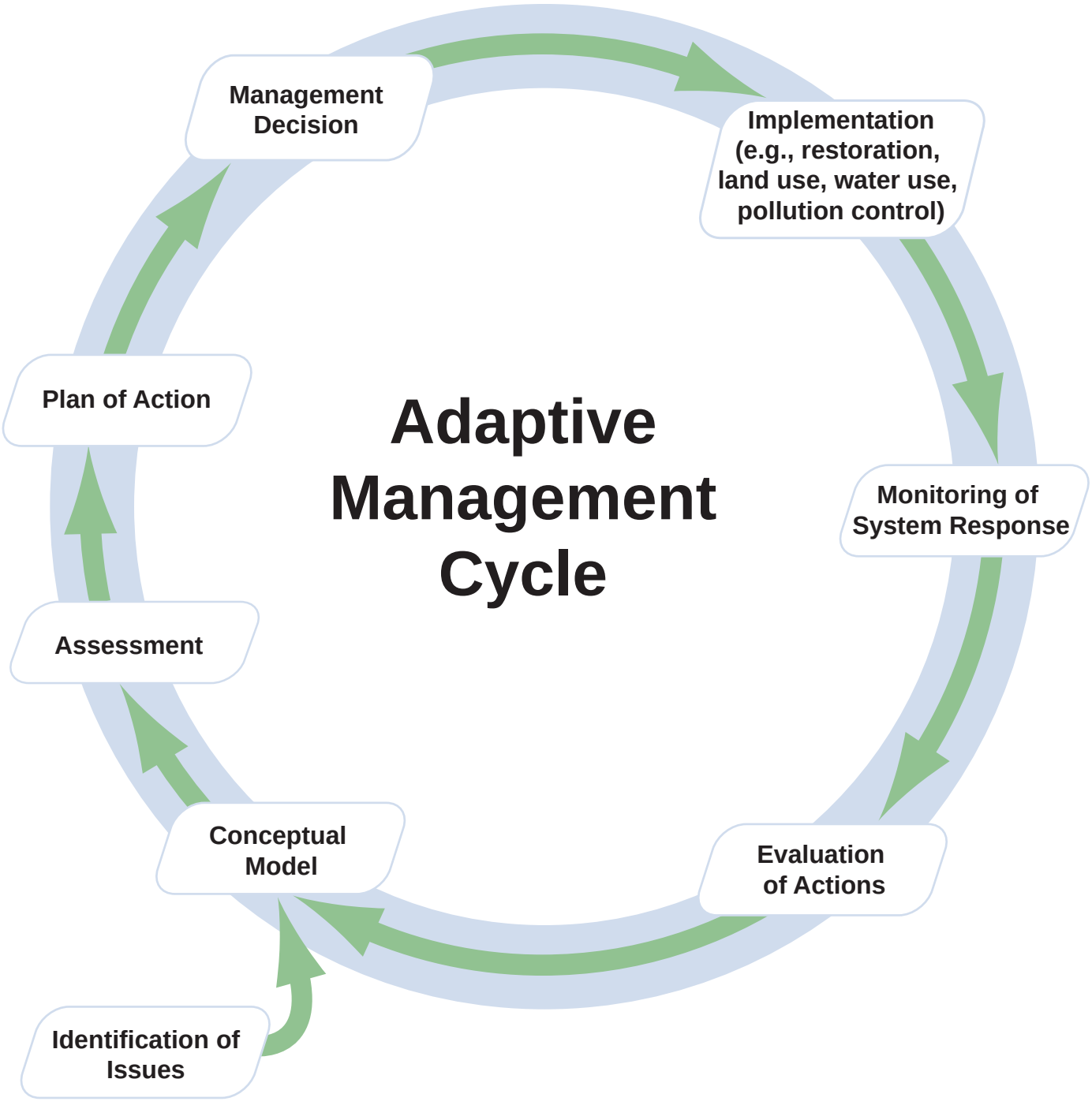

FIGURE 2-2
ADAPTIVE MANAGEMENT CYCLE
COTTONWOOD CREEK WATERSHED MANAGEMENT PLAN

SECTION 3.0

Goals and Objectives

Overall WMP goals focus on desired end products and results for the watershed. Goals are designed to be meaningful and to resonate with stakeholders. Objectives are more specific, smaller steps that are aimed at achieving the broader, long-term goals. Objectives should be measurable and achievable.

Concerns were raised at each of the stakeholder meetings. After all the meetings had been completed, stakeholder concerns were reviewed. Goals and objectives, based on stakeholder concerns, were created for the watershed. Following is a list of the goals, with their associated objectives:

- **Maintain the rural and agricultural nature of the Cottonwood Creek Watershed.**
  - Establish, improve, and maintain communication with Tehama County and Shasta County planning departments so that decisionmakers have access to CCWG expertise and management planning efforts.
  - Continue to engage stakeholders to gauge the community's desire to sustain the rural and agricultural nature of the Cottonwood Creek Watershed.
  - Inform landowners about and encourage their participation in available programs to preserve open space and agricultural lands.
- **Address problematic bank instability and channel instability.**
  - Facilitate and participate in projects that address problematic bank instability, which will also preserve riparian conditions and enhance aquatic habitat.
- **Develop a sustainable gravel management program.**
  - Promote and assist with obtaining funding for the creation of a sediment budget to determine whether gravel can be extracted from the active channel or adjacent floodplain without significant impacts to habitat and the long-term channel stability of Cottonwood Creek.
- **Sustain existing populations of native fish, wildlife, and plant communities, and enhance these where possible.**
  - Investigate limiting factors for anadromous fish in the Cottonwood Creek Watershed.
  - Enhance habitat and spawning conditions that will increase anadromous fish populations.
  - Sustain and enhance important fish, wildlife, and native plant habitat elements.
  - Maintain or improve habitat connectivity.

  - Promote and support a healthy forest ecosystem.
  - Promote preservation and/or enhancement of habitat for federal and state-listed species and species of concern known or suspected to occur within the Cottonwood Creek Watershed.

- **Develop an upland brush management program that reduces fire risk and enhances habitat value.**
  - Promote and/or implement fuels management projects, which preserve or, at a minimum, protect federally identified Communities at Risk.
  - Work cooperatively with fire management and land management agencies and landowners to sustain a fuels management program in the watershed, while also considering fuels issues/connectivity to adjacent watersheds.
- **Sustain and expand quantity and quality of riparian habitat throughout the watershed.**
  - Develop resources to support enhanced riparian vegetation and habitat projects with landowners.
  - Investigate the potential for conservation easements.
  - Pursue measures to prevent and discourage trespassing and illegal dumping.
- **Sustain good water quality that provides for beneficial uses, and enhance water quality where needed.**
  - Implement a monitoring program to establish baseline water quality conditions and periodically repeat to track long-term trends.
- **Expand watershed conditions and practices that increase stormwater infiltration, increase base flow, and reduce negative impacts of flood flows.**
  - Investigate the potential for increasing the number of ponds and wet meadows.
  - Implement projects to demonstrate feasible methods to address persistent channel entrenchment, including gullying, throughout the Cottonwood Creek Watershed.
- **Develop a noxious and invasive plant management program that includes control of salt cedar/tamarix and giant reed/arundo.**
  - Develop resources to assist landowners with removal of salt cedar *(Tamarix chinensis*) and giant reed, or arundo (*Arundo donax*).
- **Expand the use of road maintenance and land use practices that reduce discharge of fine-grained sediment to waterways.**

- **Continue to play an active role in the information dissemination, education, and outreach provided to stakeholders about stewardship of the Cottonwood Creek Watershed.**
  - Create a sustainable education and outreach plan for CCWG.
  - Obtain resources to continue implementing effective education and outreach to the Cottonwood Creek Watershed stakeholders.

SECTION 4.0

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Appendix A
Water Resources Concerns and Future Development

Introduction

A Technical Memorandum (TM) was developed that summarized local water resource concerns of stakeholders in the Cottonwood Creek Watershed. Stakeholder concerns were documented in the *Cottonwood Creek Strategic Watershed Plan* (CH2M HILL, 2005). The TM discussed projects that could be considered by CCWG to address these concerns. The TM was distributed to the stakeholder group in early August and a workshop was held on August 10, 2006, to review and discuss the content of the TM. Appendix A includes the final TM, the presentations from the workshop, the news release for the workshop and a workshop summary.

NEWS NEWS

For Immediate Release

Contact: Vieva Swearingen
Watershed Coordinator
Phone: (530) 347.6637
E-Mail: ccwg@shasta.com

August 2, 2006

COTTONWOOD CREEK MANAGEMENT PLAN DEVELOPMENT WORKSHOP- WATER QUANTITY AND QUALITY

COTTONWOOD, CA — Cottonwood Creek Watershed Group will be holding a Management Plan Development Workshop focusing on Water Quality and Quantity. The meeting will be held at Cottonwood Creek Watershed Group's office located at 3233 Brush Street in Cottonwood. The workshop will be held on Thursday, August 10th at 6:30 p.m. Copies of the Management and Restoration Plan that will be discussed during the workshop will be available at the Cottonwood Creek Watershed Group's office on Monday, August 7th. Visit us on the Web at www.cottonwoodcreekwatershed.org.

Questions? Call 347.6637 or email ccwg@shasta.com

Future Development and Water Resource Concerns in the Cottonwood Creek Watershed

PREPARED FOR: Cottonwood Creek Watershed Group

PREPARED BY: Heather Perry/CH2M HILL
Nate Brown/CH2M HILL
Ed McCarthy/CH2M HILL

DATE: August 7, 2006

PROJECT NUMBER: 333854

Introduction

This technical memorandum summarizes local water resource concerns of stakeholders in the Cottonwood Creek Watershed as documented in the *Cottonwood Creek Strategic Watershed Plan* (CH2M HILL, 2005) and discusses projects that could be considered by the Cottonwood Creek Watershed Group (CCWG) to address these concerns.

Stakeholder Concerns

The *Cottonwood Creek Strategic Watershed Plan* documented the following concerns related to water resources in the Cottonwood Creek Watershed (CH2M HILL, 2005):

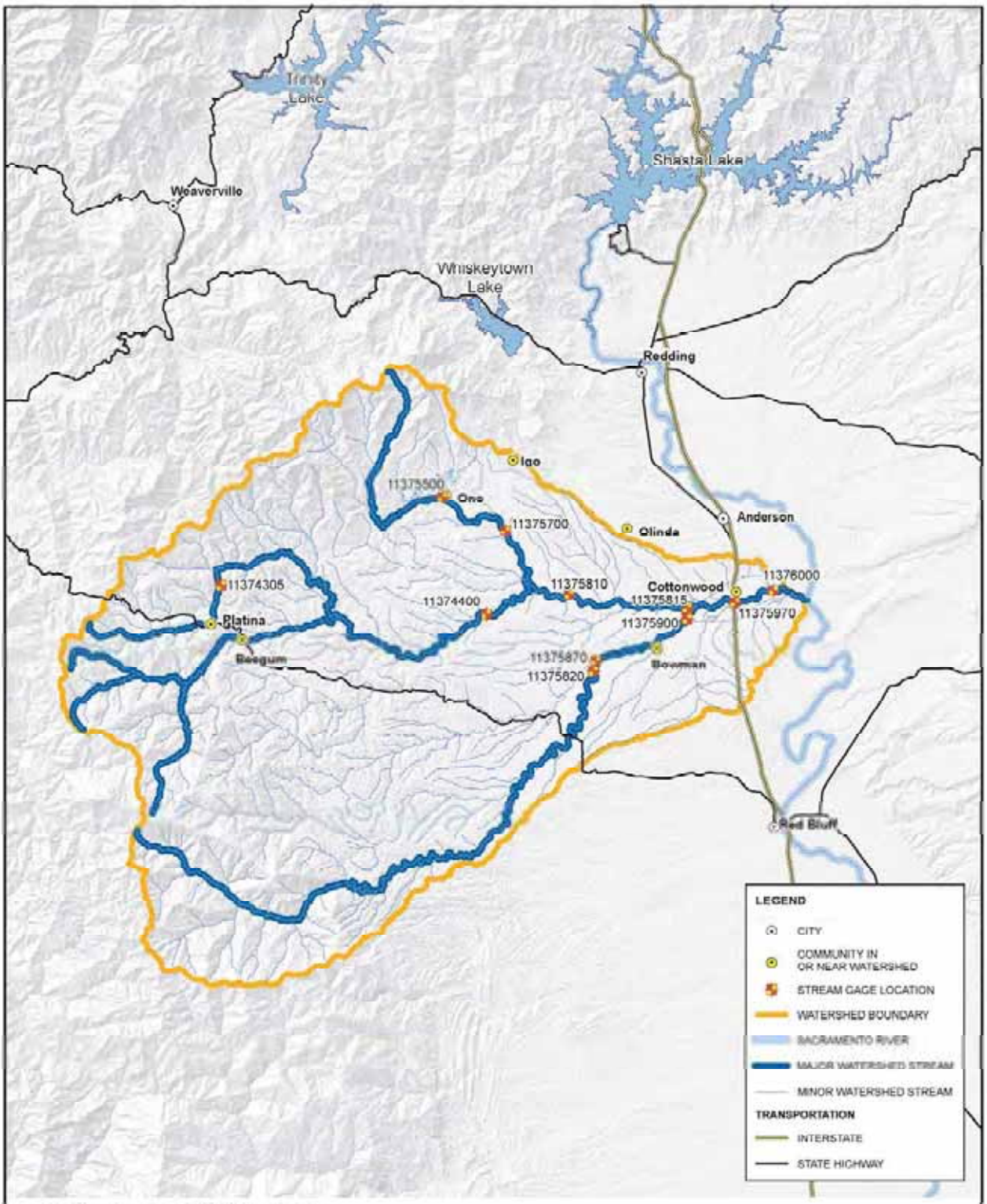
- Groundwater and surface water quantity and quality impacts of large-scale developments that are being planned in the watershed.
- Lack of groundwater and surface water quantity and quality monitoring activities in the watershed. Stakeholders want a better understanding of baseline (pre-buildout of planned large-scale developments) hydrologic conditions against which post-buildout hydrologic conditions can be compared in the future.
- Lack of understanding of the linkage between the groundwater system, local streams, and the Anderson-Cottonwood Irrigation District (ACID) canal and laterals.
- Lack of knowledge of groundwater levels in the Town of Cottonwood and the Rio Alto Water District area.
- Lack of data regarding the source of turbidity in portions of the south fork of Cottonwood Creek, which could affect water quality in the mainstem.
- Lack of an integrated geographic information system (GIS) database that could house pertinent hydrologic and other data for the watershed area and facilitate educating the public as part of community outreach programs.

Past and Ongoing Monitoring Programs

This section provides brief summaries of some ongoing and past monitoring programs in the Cottonwood Creek Watershed. The following programs provide data that could be used to educate watershed stakeholders about past and baseline hydrologic conditions:

- **Streamflow and Surface Water Quality**
  - **U.S. Geological Survey (USGS).** Figure 1 shows the locations of USGS stream gages in the Cottonwood Creek Watershed. Included on Figure 1 is a table listing the period of record for which data are available at each station. The stream gage on Cottonwood Creek upstream of the confluence with the Sacramento River is the only location at which data collection is ongoing. Stream stage and discharge data are available through both the California Data Exchange Center[1], maintained by the California Department of Water Resources (DWR), and the National Water Information System[2], maintained by USGS. Surface water quality data have been collected periodically by USGS.
- **Groundwater Levels and Quality**
  - **DWR.** DWR monitors groundwater levels on a semiannual or more frequent basis throughout the state in a network of domestic, irrigation, industrial, municipal, and monitoring wells. Figure 2 shows the locations of wells currently included in DWR's monitoring network. Groundwater-level data are available through the DWR's Water Data Library[3]. Groundwater-level monitoring locations are searchable via a map interface, by groundwater basin or township. Data are provided in both tabular and graphical form and can be exported to programs such as Microsoft® Office Excel and various text editors. DWR has periodically collected groundwater quality samples as part of past studies; historical water quality data are also available through one of the DWR's Web sites[4]. DWR does not maintain a groundwater quality monitoring program in the Cottonwood Creek Watershed.
  - **ACID.** ACID has been working to improve the understanding of the groundwater and surface water interactions in the Redding Groundwater Basin in response to changes in weather and pumping and irrigation practices. During the summer of 2003, ACID began Phase 1 of its conjunctive water management program. This phase, which was funded through a CALFED grant, included the installation of 12 new monitoring wells (5 pairs of shallow/deep wells and 2 additional shallow wells) and 2 Sacramento River stage gages (Figure 2). A 13th monitoring well, installed to a depth of 530 feet below ground surface, was added to the monitoring network in February 2005. The new monitoring locations were instrumented with pressure transducers and dataloggers; therefore, groundwater levels and Sacramento River stages have been collected hourly since 2003 (2005 for the 13th monitoring

[1] http://cdec.water.ca.gov/
[2] http://waterdata.usgs.gov/nwis
[3] http://wdl10.water.ca.gov/gw/
[4] http://wdl.water.ca.gov/wq-gst/index.cfm



Location	Agency	Date Begin	Date End
11374305	USGS	11/23/1987	05/15/2004
11374400	USGS	10/01/1950	09/30/1975
11375500	USGS	10/01/1907	09/30/1913
11375700	USGS	10/01/1956	09/30/1980
11375810	USGS	06/10/1971	09/30/1986
11375815	USGS	10/01/1981	09/30/1986
11375820	USGS	10/01/1962	09/30/1978
11375870	USGS	11/19/1976	09/30/1986
11375900	USGS	10/01/1981	09/30/1985
11375970	USGS	10/11/1974	09/24/1979
11376000	USGS	10/01/1940	09/30/2006

0 6 12

FIGURE 1
LOCATIONS AT WHICH STREAMFLOW HAS BEEN MEASURED
FUTURE DEVELOPMENT AND WATER RESOURCE CONCERNS
COTTONWOOD CREEK WATERSHED

CH2MHILL

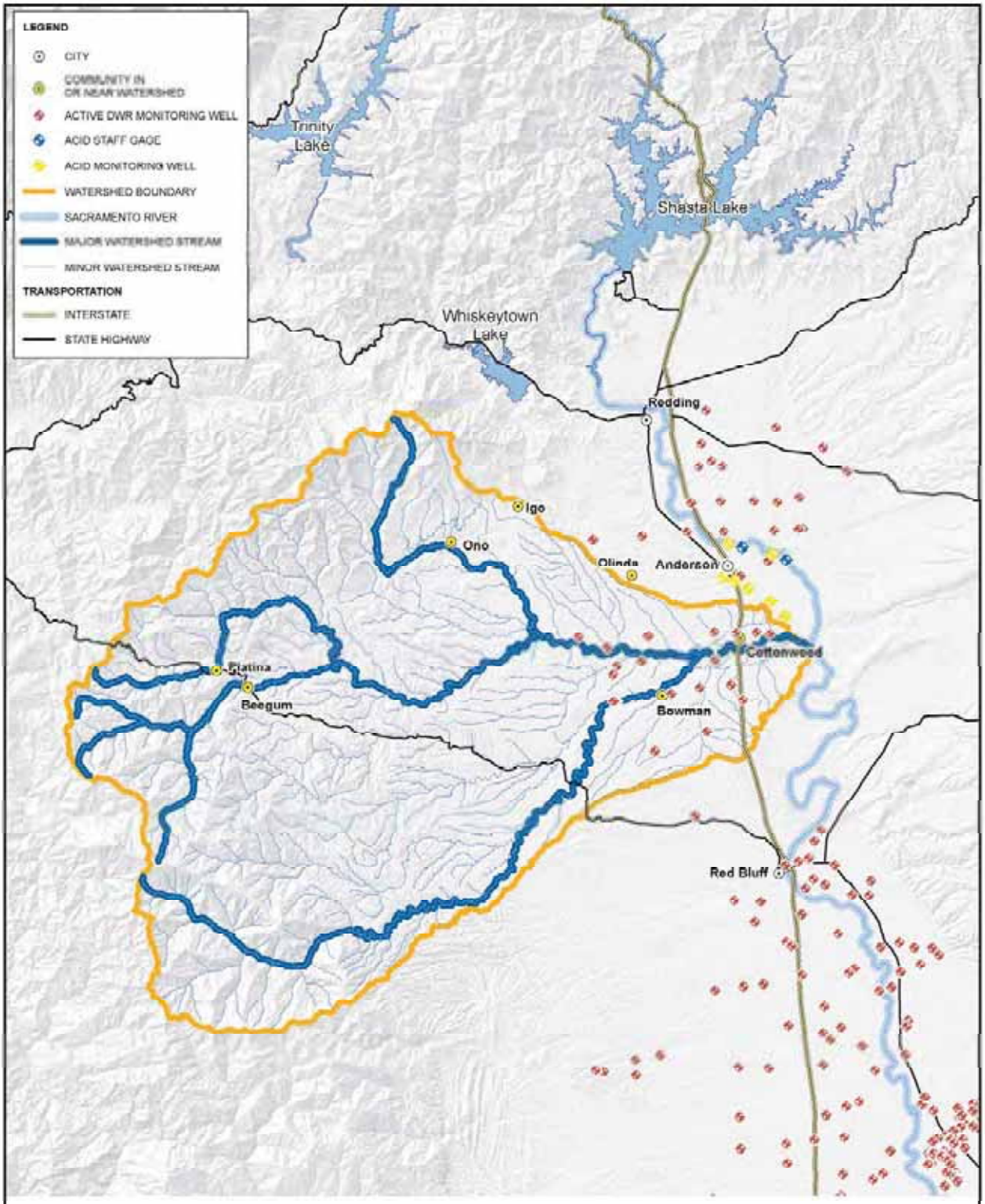


FIGURE 2
LOCATIONS OF ACID AND DWR GROUNDWATER MONITORING
FUTURE DEVELOPMENT AND WATER RESOURCE CONCERNS
COTTONWOOD CREEK WATERSHED

CH2MHILL

well). Staff from DWR's Northern District download the data from pressure transducers routinely and maintain a database of water levels.

- **USGS.** USGS has conducted groundwater-level and water quality monitoring programs as part of specific past studies. Historical water-level and quality measurements are available through the National Water Information System[5]. USGS does not conduct ongoing groundwater-level or quality monitoring in the Cottonwood Creek Watershed.

  USGS conducted a groundwater study of the Redding Groundwater Basin between 1979 and 1980 to provide a better understanding of groundwater conditions in the basin (Pierce, 1983). The study presented a discussion of basin geology and hydrogeology, the results of a groundwater-level survey (including a groundwater contour map and hydrographs from selected wells), and water quality data from groundwater samples collected in 1979.

  USGS conducted several studies in the Cottonwood Creek Watershed in the early to mid-1980s, described in Blodgett et al. (1992), Evenson and Kinsey (1985), Fogelman and Evenson (1985), and USGS (1982-1983). The purpose of these studies was to establish baseline conditions for potential installation of flood-control structures in the watershed. A network of groundwater wells and stream gages was established and monthly data were collected for a period of 1 (groundwater levels) to 3 (streamflow) years. These data were analyzed to provide a better understanding of groundwater flow and the interaction between groundwater and surface water in the watershed.

- **Shasta County Water Agency.** A numerical groundwater flow model was developed for the Redding Area Water Council to examine potential impacts from implementation of various future groundwater management options on the Redding Groundwater Basin (CH2M HILL et al., 1997; CH2M HILL, 2001a and 2003). The extent of the numerical model roughly coincides with the Redding Groundwater Basin boundary mapped by Pierce (1983), which is shown on Figure 2. Output from the numerical model provides estimates of impacts to surrounding groundwater levels and changes in streamflow due to varying groundwater management scenarios, and has been used to evaluate impacts from projects proposed by the Redding Area Water Council, ACID, and Clear Creek Community Services District.

- **Municipal and Agricultural Water Suppliers.** Water suppliers located at least partially in the Cottonwood Creek Watershed include ACID, Cottonwood Water District, Rio Alto Water District, Clear Creek Community Services District, and Igo-Ono Community Services District. Hydrologic data, such as groundwater levels, groundwater pumpage, and groundwater quality, might be available by request from these districts.

- **California Department of Health Services.** Municipal water suppliers are required to submit data regarding potable water-supply quality to the California Department

[5] http://waterdata.usgs.gov/nwis

of Health Services. Although these data are not available electronically, hardcopy reports are available for review upon request[6].

- **Other Historical Programs.** In 1975, CH2M HILL conducted a study of groundwater conditions in the Redding Groundwater Basin. As part of this study, groundwater-level data recorded on drillers logs were compiled (for wells drilled from 1951 through 1974), a depth-to-groundwater contour map was generated, hydrographs from selected wells in the Redding Groundwater Basin were presented, and the general water quality in the basin was discussed.

  In 1993, a study was conducted to quantify the impacts of expanding the water supply of Clear Creek Community Services District (Brown and Caldwell, 1993). The report provided groundwater-level data collected during a series of 24-hour aquifer tests and the model-predicted impacts resulting from the expansion of the water-supply system.

- **Climate Data**

  - **Western Regional Climate Center.** Historical climatic data, including precipitation, temperature, evaporation, and snowfall, are available for several stations in the Cottonwood Creek Watershed. Data for individual stations can be accessed online from the Western Regional Climate Center[7]. Current climate data for the Davis Ranch Station can also be accessed via the California Data Exchange Center Web site.

  - **National Resources Conservation Center.** Climatic data are available electronically, as geospatial coverages, at the National Resources Conservation Center Web site[8].

  - **Statewide Integrated Pest Management Program.** Climatic data are available electronically from the University of California at Davis Statewide Integrated Pest Management Program Web site[9].

Future Development

The Cottonwood Creek Watershed lies in Shasta and Tehama Counties, on the northwest side of Northern California's Central Valley. The Town of Cottonwood, with a population of approximately 3,000 people, is the most developed area in the Cottonwood Creek Watershed, but the watershed also includes the smaller communities of Igo, Ono, Platina, Beegum, and Bowman. Several large-scale residential developments are planned near the lower watershed area to the east; no large developments are planned for the upper watershed to the west. Projections suggest that the population in the lower watershed area could more than double as a result of these new developments (CH2M HILL, 2005). Future developments planned for Tehama County portions of the watershed include Sun City, Sunset Hills Estates, and Morgan Ranch. Future developments in Shasta County portions of

[6] http://www.dhs.ca.gov/home/contactinfo/
[7] http://www.wrcc.dri.edu/
[8] http://www.ncgc.nrcs.usda.gov/products/datasets/climate/
[9] http://www.ipm.ucdavis.edu/WEATHER/wxretrieve.html

the watershed include Cottonwood Hills, Oak Ranch Estates, Seal Court, and the Spoon Subdivision. Figure 3 shows a map of these planned developments.

Tehama County

Del Webb's Sun City would be built approximately 8 miles north of the City of Red Bluff, west of Interstate 5 (I-5). Sun City is designed to be a planned community with a mix of residential, commercial, and recreational uses, including an 18-hole golf course. The Sun City development would include 3,700 homes built on approximately 3,320 acres. Most of the housing units would be age-restricted (55 years of age and older). A 1,995-acre area is proposed to be maintained as natural habitat, and a 44-acre area is proposed to house 230,000 square feet of commercial space. Groundwater would be the water source for Sun City. Tehama County prepared and released a draft environmental impact report (EIR) for public review in December 2005 and a revised draft EIR in 2006.

Sunset Hills Estates would be located south of Lake California Drive and east of I-5. The development would include 800 homes built on approximately 4,000 acres. Average density is estimated to be one unit per 5.07 acres. The water source for this project was not identified, but groundwater is the presumed source.

Morgan Ranch would be built west of I-5 and east of the Bowman Road interchange as a master-planned, mixed-use community with residential, commercial, open space, and public facilities uses. The development would include 3,950 homes built on approximately 1,300 acres. Construction of the development would occur in 3 phases: (1) Bowman Village (mixed uses, including a life care facility for the elderly), (2) West Highlands Village, and (3) East Highlands Village. Approximately one-third of the project site would be set aside for open space and park use. Groundwater would be the water source for this Morgan Ranch. The Tehama County Planning Department released a Notice of Preparation for the Morgan Ranch Specific Plan EIR in May 2006.

Shasta County

Planned developments in the Shasta County portion of the Cottonwood Creek Watershed are generally smaller in size and scope than those in Tehama County. The largest is Cottonwood Hills, which would include as many as 610 homes built on 466 acres. Oak Ranch Estates, to be located in the northwest corner of the Town of Cottonwood, would include 144 single family homes built on approximately 70 acres. Seal Court and the Spoon Subdivision would both be built in the Town of Cottonwood and would be fairly small, with 69 and 39 houses, respectively. Information on the water source for these projects was not readily available, but it is likely to be groundwater.

Future Monitoring Programs

Following are brief summaries of future monitoring programs in the Cottonwood Creek Watershed:

- **Sacramento Valley Water Management Program (SVWMP).** This collaborative regional strategy consists of multiple water management projects and actions that will ensure that local water needs are fully met while helping improve water quality and supplies in

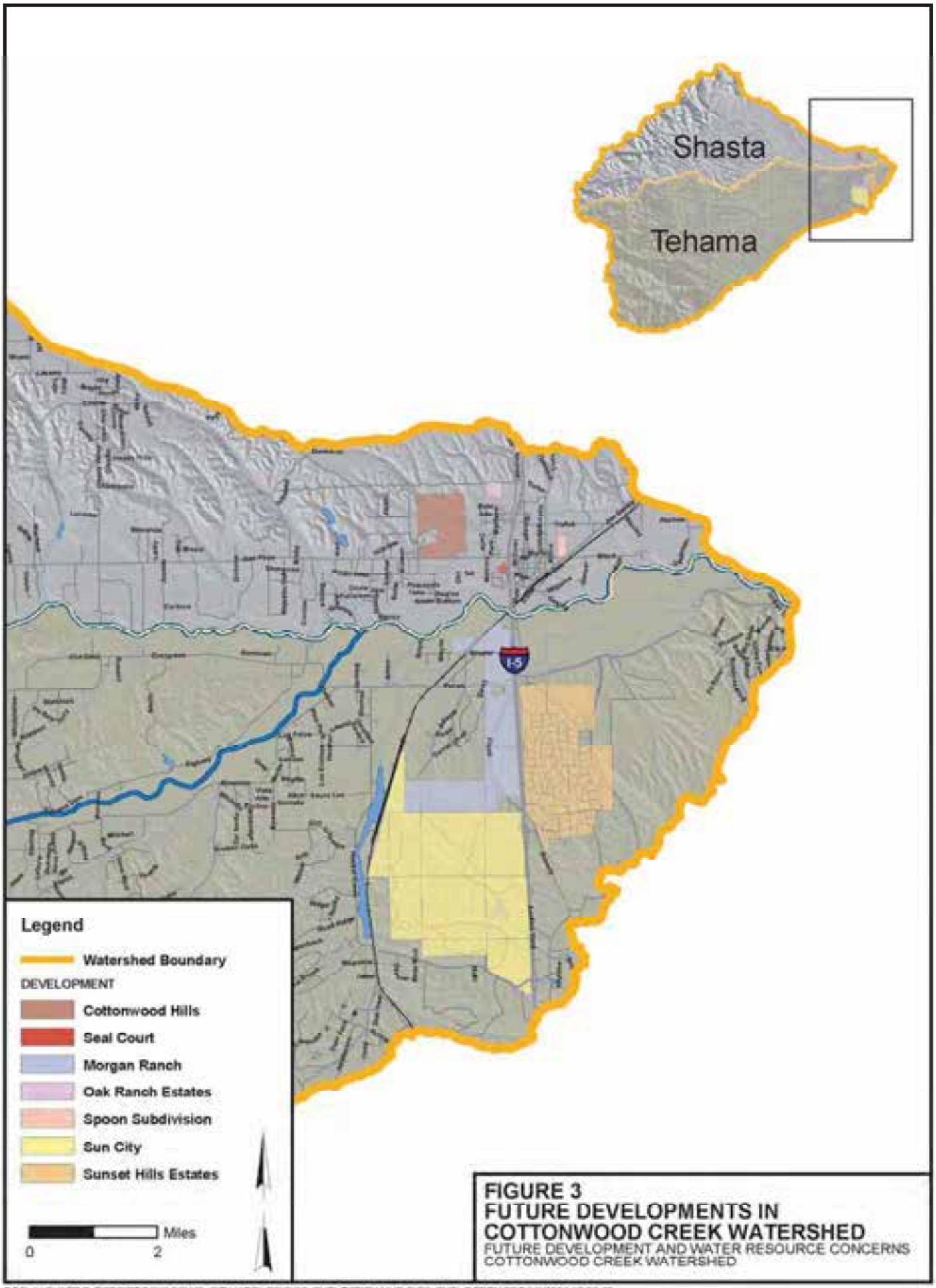


FIGURE 3
FUTURE DEVELOPMENTS IN COTTONWOOD CREEK WATERSHED
FUTURE DEVELOPMENT AND WATER RESOURCE CONCERNS
COTTONWOOD CREEK WATERSHED

RDD: \\LOKI\PROJECT\BIRDOG\SCCWG_GIS\MAPFILES\FIG3_FUTUREDEV.MXD FIG3_FUTUREDEV.PDF 8/3/2006 17:22:28

the Sacramento-San Joaquin Delta and throughout California. ACID has proposed a water management project (which would involve installation of 12 groundwater production wells) to produce 20,000 acre-feet per year and two system improvement projects (which would include canal lining and general conveyance improvements to reduce seepage losses to the underlying groundwater system) under the SVWMP. A groundwater monitoring well and stream stage monitoring network has been in place, as described previously, since 2003. Additional monitoring proposed as part of the SVWMP includes incorporating three wells that are currently monitored semiannually by DWR at an increased frequency.

- **Tehama County Flood Control and Water Conservation District (TCFCWCD).** In its proactive approach to groundwater monitoring in Tehama County, TCFCWCD has secured funding to equip existing DWR multiple-completion monitoring wells with pressure transducers and dataloggers to provide real-time water-level data. Grant funds will be used to install additional monitoring wells in areas slated for large-scale residential developments. Hourly groundwater-level data, including hydrographs, are available at the TCFCWCD Web site[10]. Furthermore, TCFCWCD is requiring the large-scale developers to include groundwater monitoring infrastructure in their construction plans. This would include installing pressure transducers and dataloggers in the monitoring wells, and collecting both baseline groundwater-level data before construction and real-time groundwater-level data after construction to allow for evaluation of drawdown impacts due to groundwater production. An existing numerical groundwater flow model was used in the Del Webb Sun City area to predict potential impacts of that development. Data collected from the groundwater monitoring wells in the Sun City area would be checked against forecasts made with this model as a verification measure[11].

- **CCWG.** A monitoring program is being planned by CCWG to gain information on baseline water quality in the Cottonwood Creek Watershed. The program would include monitoring at 11 locations (10 along the main, north, and south forks of Cottonwood Creek and 1 on Beegum Creek). The duration of the water quality monitoring program would be September 2006 through August 2007. The main objective of this program is to document current watershed conditions to serve as a baseline from which to guide future watershed management decisions.

  This planned monitoring program includes monthly temperature and turbidity monitoring at 10 locations. In addition, turbidity would be monitored after two storm events, with the objective of evaluating sediment flow during peak events. Macroinvertebrate monitoring would also occur once during the late spring of 2007 at 10 monitoring sites. *Escherichia coli* would be monitored during summer months, when recreational use (e.g., swimming, rafting, and water activities) is the greatest at two locations in the lower reaches of the watershed, one along the south fork of Cottonwood Creek and one along the mainstem.

[10] http://www.tehamacountywater.ca.gov

[11] Personal communication with Ernie Ohlin, TCFCWCD Water Resources Manager

Data of Interest for Watershed Studies

Watersheds are complex ecosystems that change over time because of seasonal and climatic variations and in response to human activities. Watershed management requires an understanding of the interrelationships between many physical attributes and processes, including climate (e.g., precipitation, timing of snowmelt), topography, soils, vegetative cover, land use, groundwater conditions, interaction between groundwater and surface water, stream morphology, riparian condition, watershed size, water quality, and hydrology/flow regime (e.g., bankfull discharge; 10-, 50-, 100-year floods; channel-shaping flow; and 10-, 50-, and 100-year low flow). It is important to have a long enough period of record and an understanding of baseline conditions so that watershed changes can be evaluated. Previous sections have described sources of available data. The following could also be helpful in understanding these interrelationships:

- A regular stream stage and discharge monitoring program that incorporates both perennial and ephemeral streams in the watershed.
- Regular surface water quality monitoring (e.g., temperature, turbidity, dissolved oxygen, nutrients, general chemistry).
- Regular groundwater-level and quality monitoring.
- A better understanding of the interaction between groundwater and surface water in the watershed, including the ability of Cottonwood Creek to replenish groundwater levels.
- A better understanding of local hydrogeology (including groundwater recharge and discharge areas) and domestic/agricultural well construction in the watershed.
- An evaluation of the effects of pumping on groundwater and surface water resources in the watershed.
- Land subsidence monitoring in the watershed.

Land subsidence caused by extraction of groundwater, oil, or gas can result in subsurface compaction of earth materials. Land subsidence has never been monitored in Shasta or Tehama Counties, but is expected to be minimal given the lack of regionally extensive clay layers or chronically depressed groundwater levels. Although significant subsidence is considered less likely in the Cottonwood Creek Watershed than in other areas of the Sacramento Valley, local subsidence monitoring would be useful in establishing baseline conditions and facilitating evaluation of future development impacts on land surface elevation. ACID has been pursing public funding to install an extensometer, which is a device used to measure changes in land surface elevation through time, in the Redding Groundwater Basin. However, public funding has not been granted for this purpose to date.

Potential Next Steps

Groundwater-level and Quality Monitoring Program

As previously described, several large-scale developments are planned in the Cottonwood Creek Watershed. Significant uncertainty exists regarding the timing and construction

sequencing associated with these developments, including the uncertainty about whether these planned developments will get through the environmental permitting process. Because most of the larger-scale developments are planned in the Tehama County portion of the watershed, CH2M HILL recommends that CCWG begin coordinating groundwater monitoring efforts with TCFCWCD and DWR. Water resources staff from TCFCWCD and DWR are currently taking a proactive approach to groundwater monitoring in areas of concern to provide data with which to better understand current and future groundwater conditions. The need to seek additional funding to supplement the current and planned groundwater monitoring network should be evaluated with CCWG, TCFCWCD, and DWR to avoid duplication of efforts, foster a coordinated regional monitoring effort, and protect the groundwater resource.

Stream Stage and Discharge Monitoring

Urbanization in the watershed will have some effect on runoff to Cottonwood Creek. The magnitude of the effect will vary spatially and temporally in the watershed and depend on several factors, including land slope, magnitude and frequency of precipitation, geographic extent of paved areas, presence of structures such as storm drains, and presence (or lack) of vegetation. Increased urbanization can cause a watershed to exhibit a flashier response to storm events. A routine monitoring program that extends beyond the currently planned CCWG 1-year stream monitoring program would provide longer term data with which to evaluate the hydrologic changes in the watershed that would result from changing land use.

Geographic Information System Database

As monitoring programs are implemented, an integrated GIS database should be developed. This will facilitate organizing pertinent watershed data and educating the public as part of community outreach programs. Data from other ongoing and past monitoring projects could also be incorporated into this database to make it more complete and to facilitate evaluations of long-term trends and impacts of urbanization through time.

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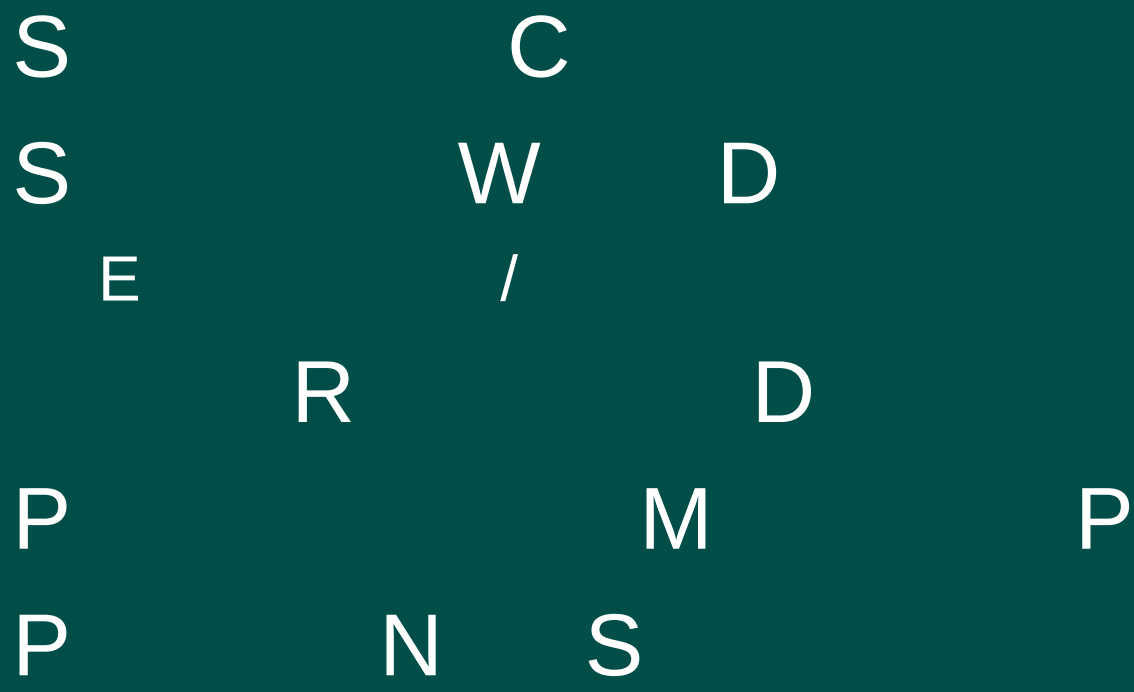
Water Resources and Future Residential Developments

Presented to

Cottonwood Creek Watershed Group

August 10, 2006

Presentation Topics



Stakeholder Concerns

Stakeholder Concerns

L

- Lack of understanding of the linkage between groundwater (GW) and surface water (SW) systems
- Future impacts from planned large-scale residential developments to GW and SW quantity and quality

Sources of Water Data

Online Sources of Water Data

- limate ata

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  http www wrcc dri edu

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  http www ncgc nrcs usda gov products datasets climate

  Statewide ntegrated est anagement rogram
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Online Sources of Water Data (cont)

- Streamflow and SW quality
  - SGS http waterdata usgs gov nwis
  - W http cdec water ca gov
- GW levels and quality
  - W http wdl water ca gov gw
  - W http wdl water ca gov wq-gst inde cfm
  - ehama ounty Flood ontrol and Water onservation istrict
    http www tehamacountywater ca gov

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Other Sources of Water Data

- S Geological Survey studies

  ierce *Groundwater in the Redding Basin, Shasta and Tehama Counties, California.* S Geological Survey Water- esources nvestigations eport -

  Fogelman F and venson *Water-Resources Monitoring in the Cottonwood Creek Area, Shasta and Tehama Counties, California, 1982-83.* S Geological Survey Water- esources nvestigations eport -

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  lodgett Walters and W orchers *Streamflow Gains and Losses and Selected Flow Characteristics of Cottonwood Creek, North-Central California, 1982-85.* S Geological Survey Water- esources nvestigations eport -

Other Sources of Water Data (cont)

- nderson- ottonwood rrigation istrict ( ) (with assistance from W)
  - GW level monitoring at monitoring wells in nderson area north of ottonwood
  - SW level monitoring at stage gages in Sacramento iver in nderson area upstream of ottonwood reek confluence
- Shasta ounty Water gency (S W)
  - GW flow model of edding asin developed for W to aid in forecast potential impacts from implementing various future GW management options

Other Sources of Water Data (cont)

- unicipal and gricultural Water Suppliers

  Water data (e g ag waiver data or onsumer onfidence eports) might be available upon request

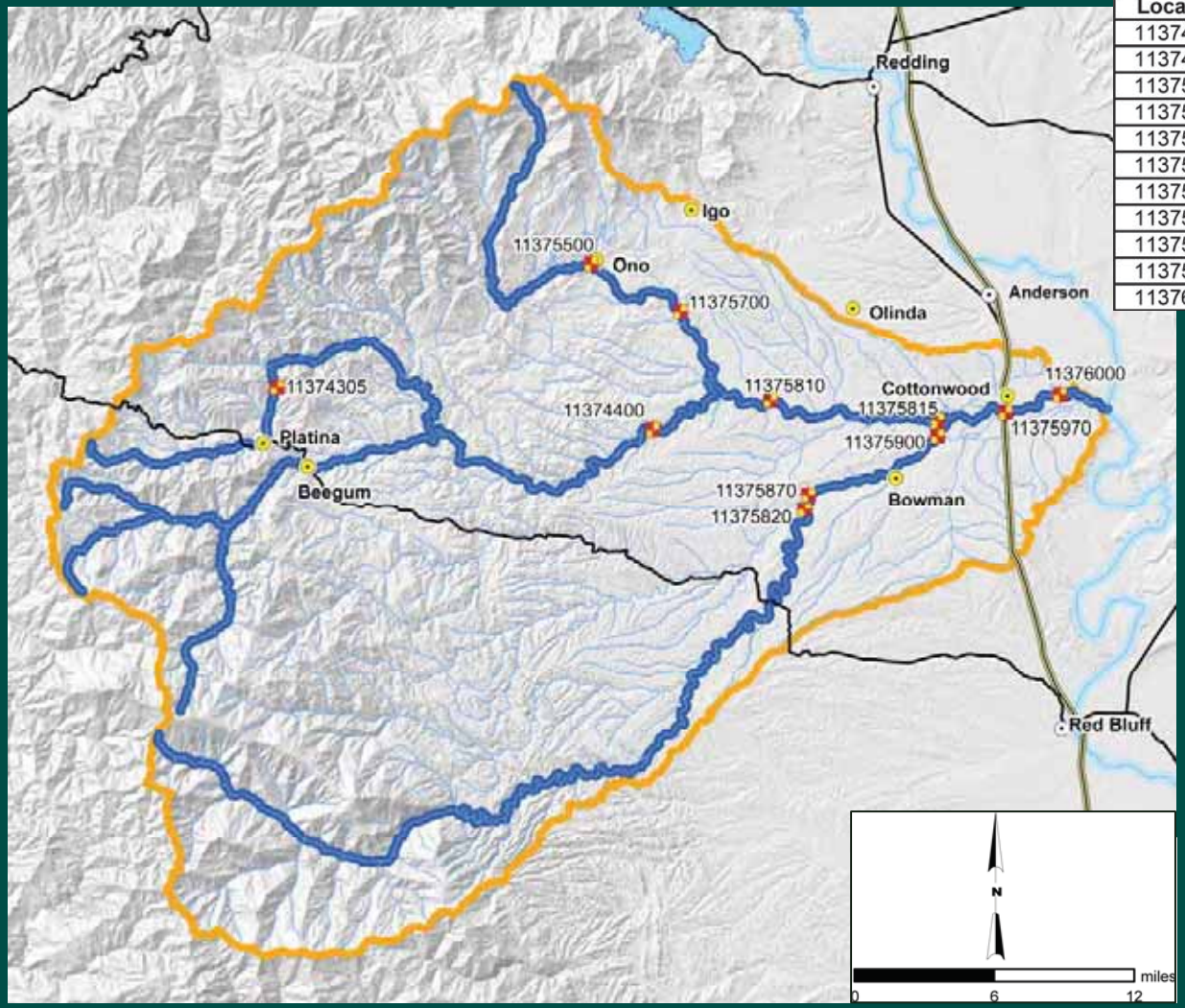
  - *ACID*
  - *Cottonwood Water District*
  - *Rio Alto Water District*
  - *Clear Creek Community Services District*
  - *Igo-Ono Community Services District*

Other Sources of Water Data (cont)

- epartment of ealth Services (S)
  - unicipal water suppliers required to submit water quality data to S
  - ardcopy reports available for review upon request

Example Surface Water Data

Stream Gage Locations



Location	Agency	Data Begin	Data End
11374305	USGS	11/23/1997	05/15/2004
11374400	USGS	10/01/1956	09/30/1975
11375500	USGS	10/01/1907	09/30/1913
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11375810	USGS	08/10/1971	09/30/1986
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11375820	USGS	10/01/1962	09/30/1978
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11375900	USGS	10/01/1981	09/30/1985
11375970	USGS	10/11/1974	09/24/1979
11376000	USGS	10/01/1940	06/20/2006

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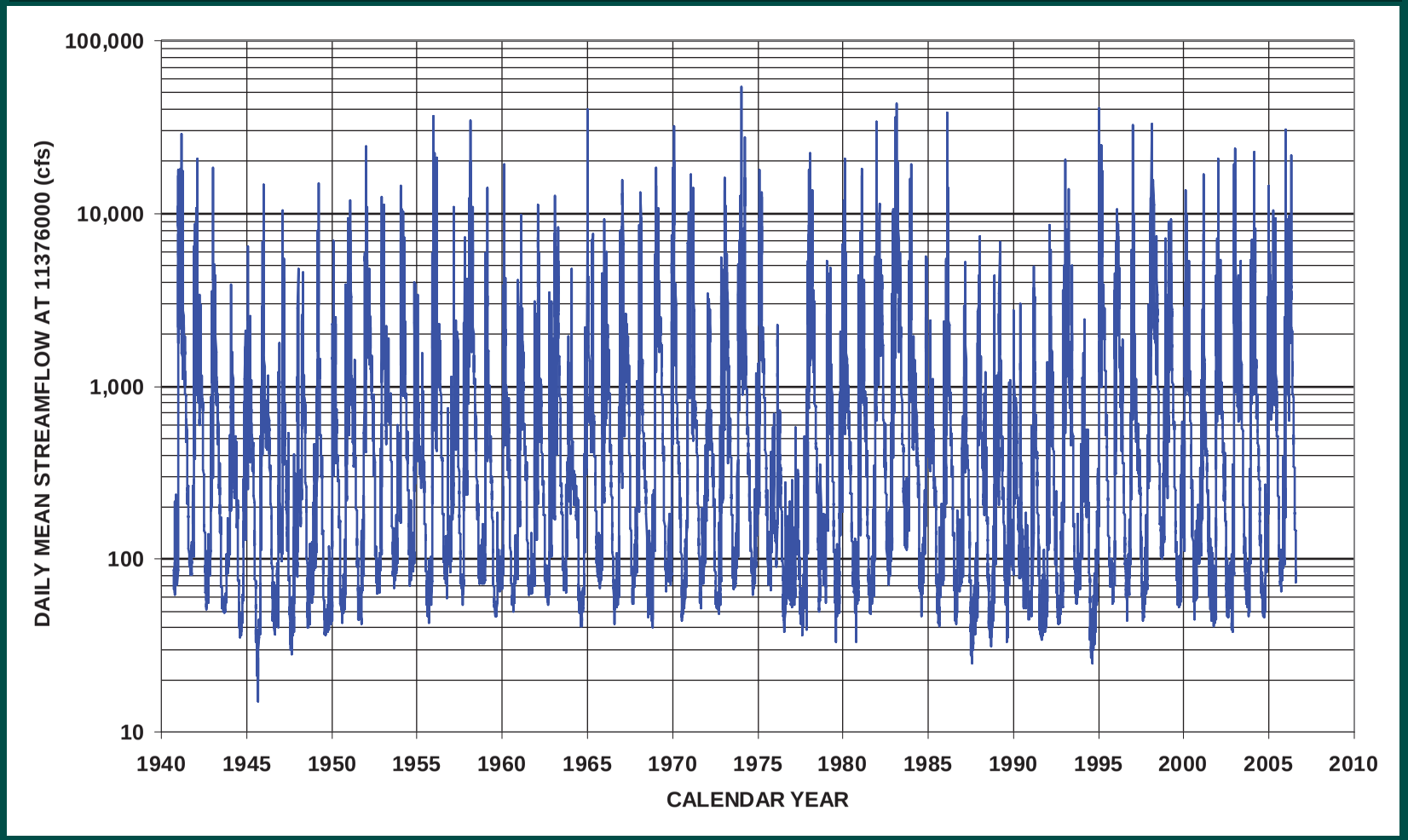
Daily Mean Streamflow at 11376000



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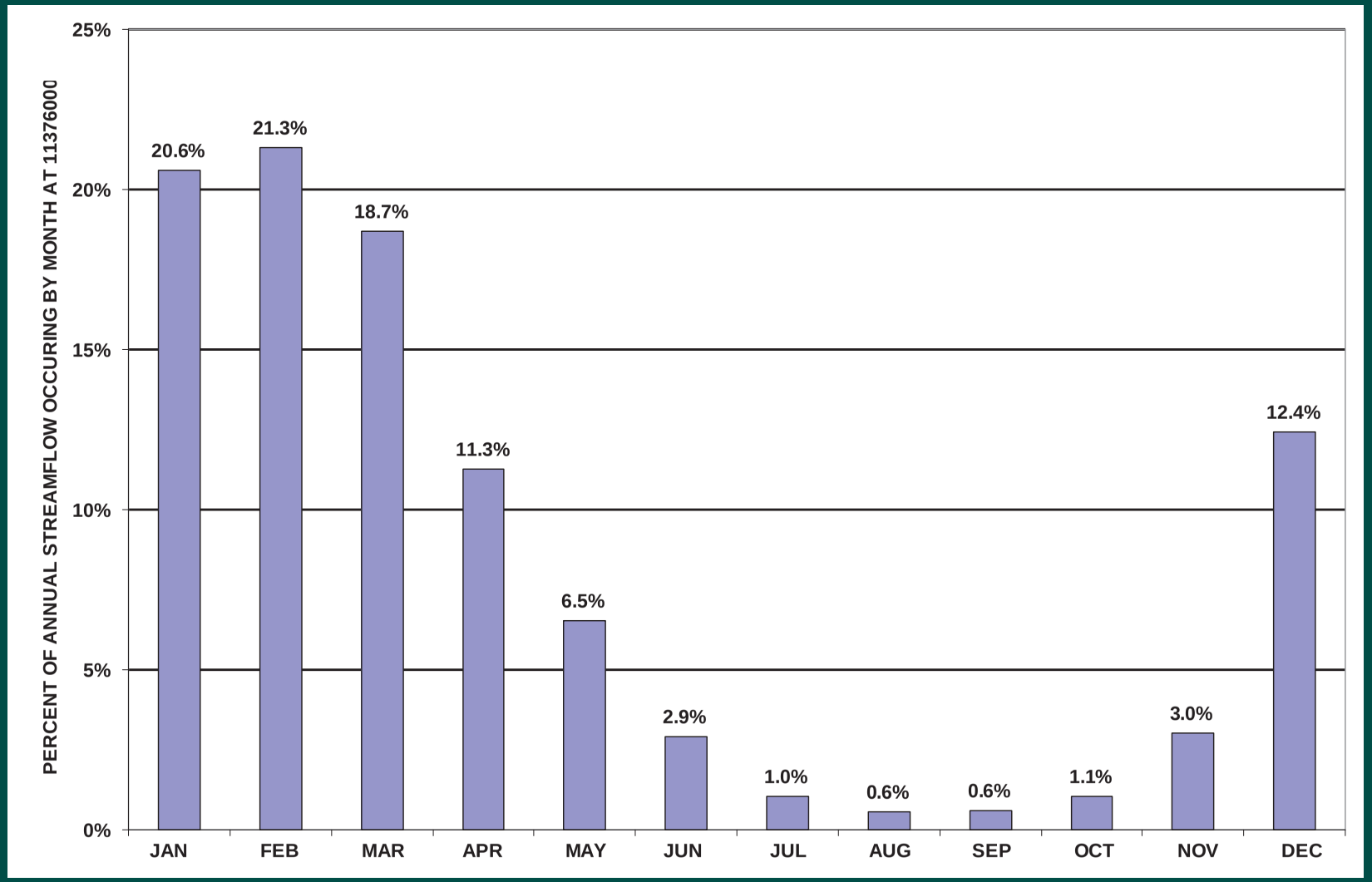
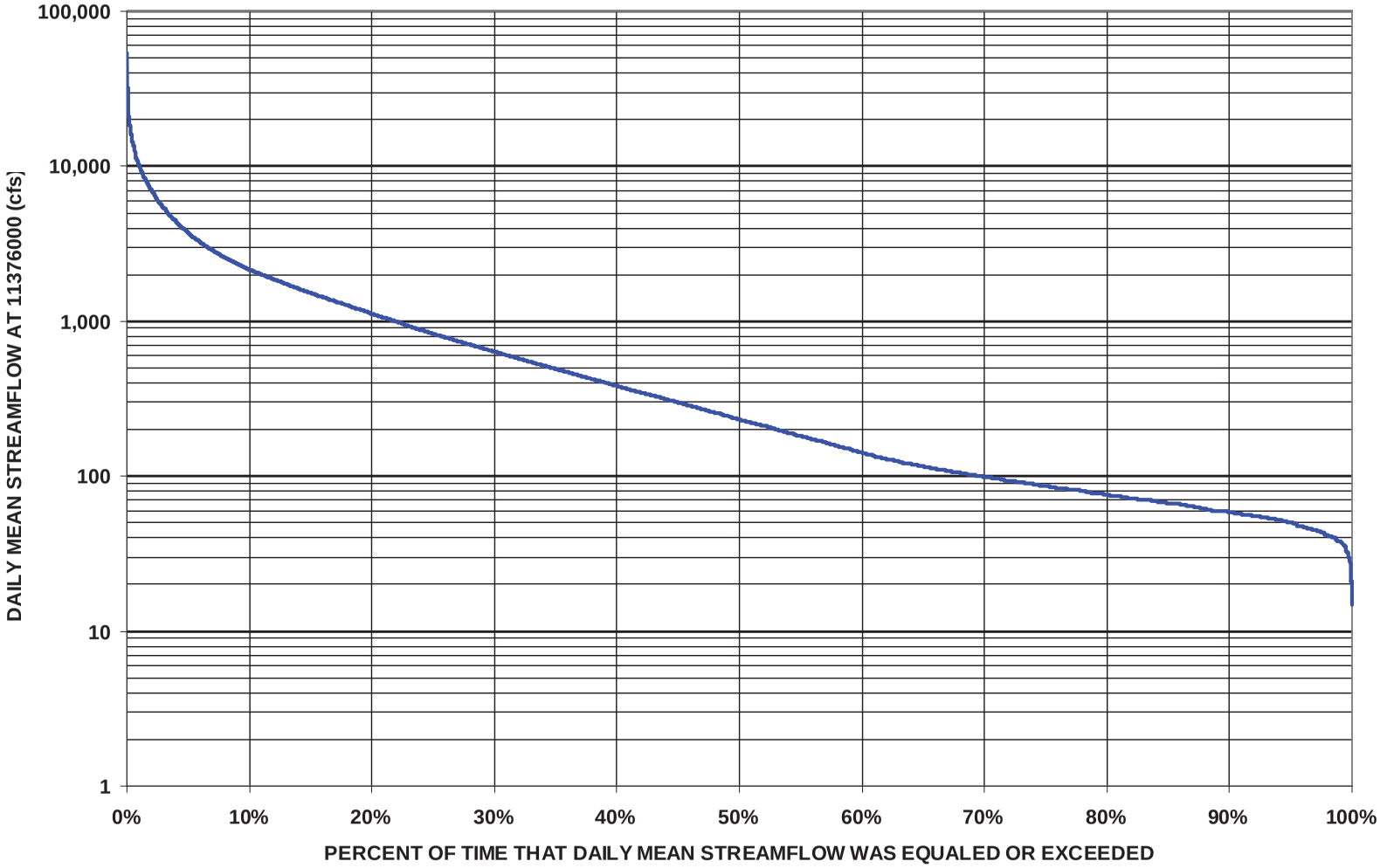
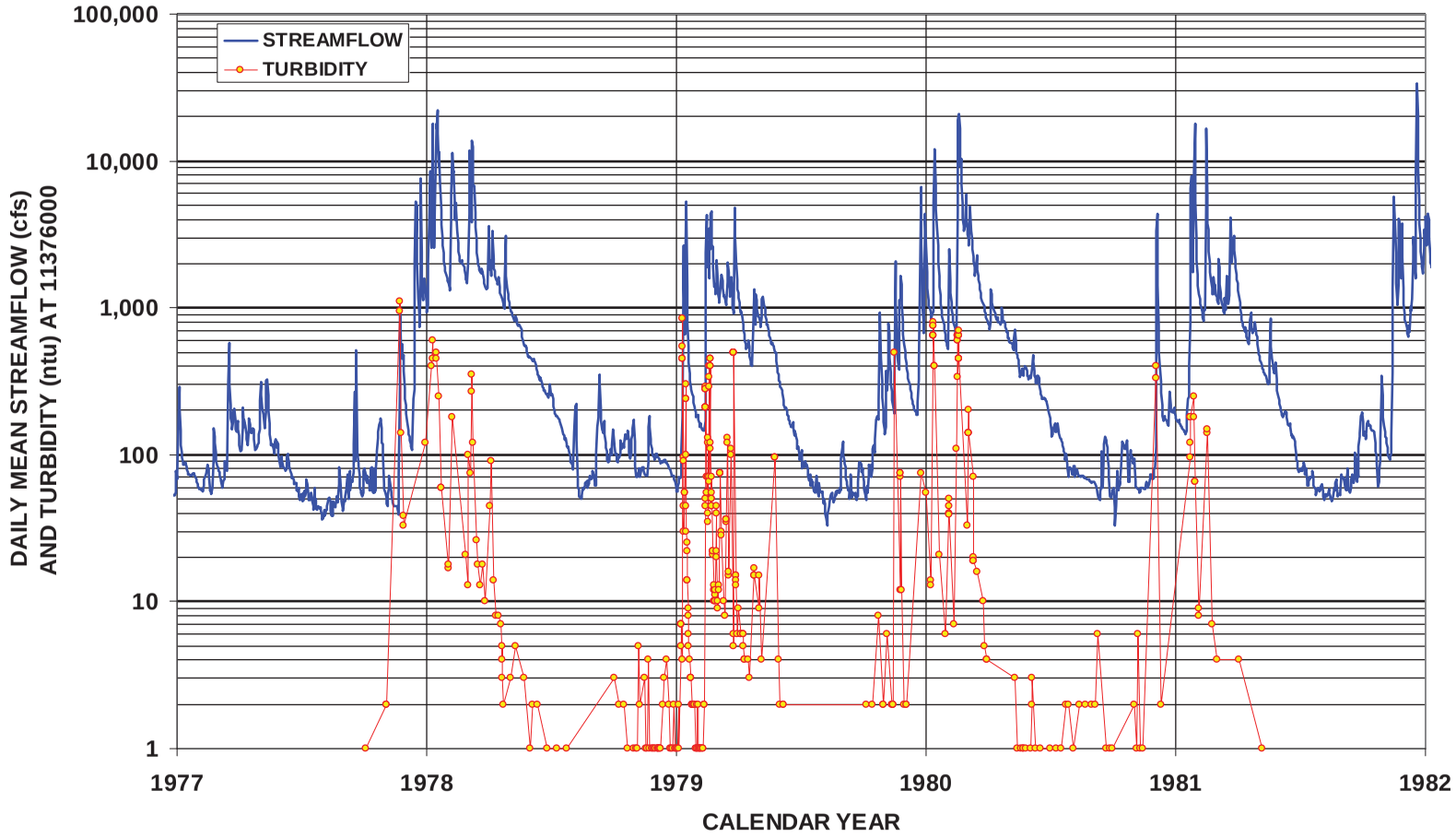
Monthly Streamflow at 11376000



Streamflow Summary at 11376000



Streamflow and Turbidity 11376000



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Streamflow Summary

- Streamflow measurements from SGS available on non-continuous basis from stream gages since

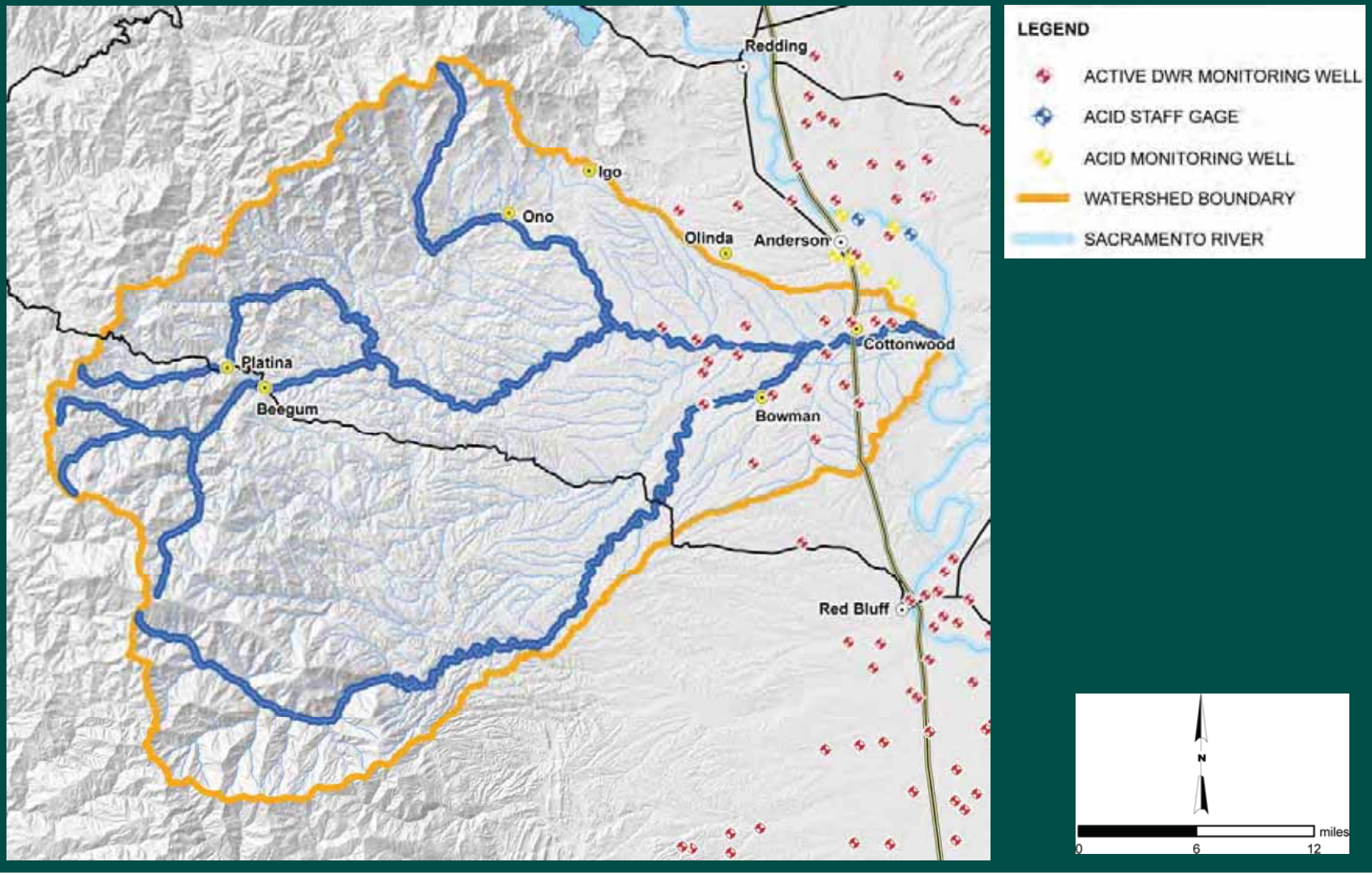
- Stream gage is only gage at which streamflow has been measured routinely on long-term basis (ct- to present)

SW Quality Summary

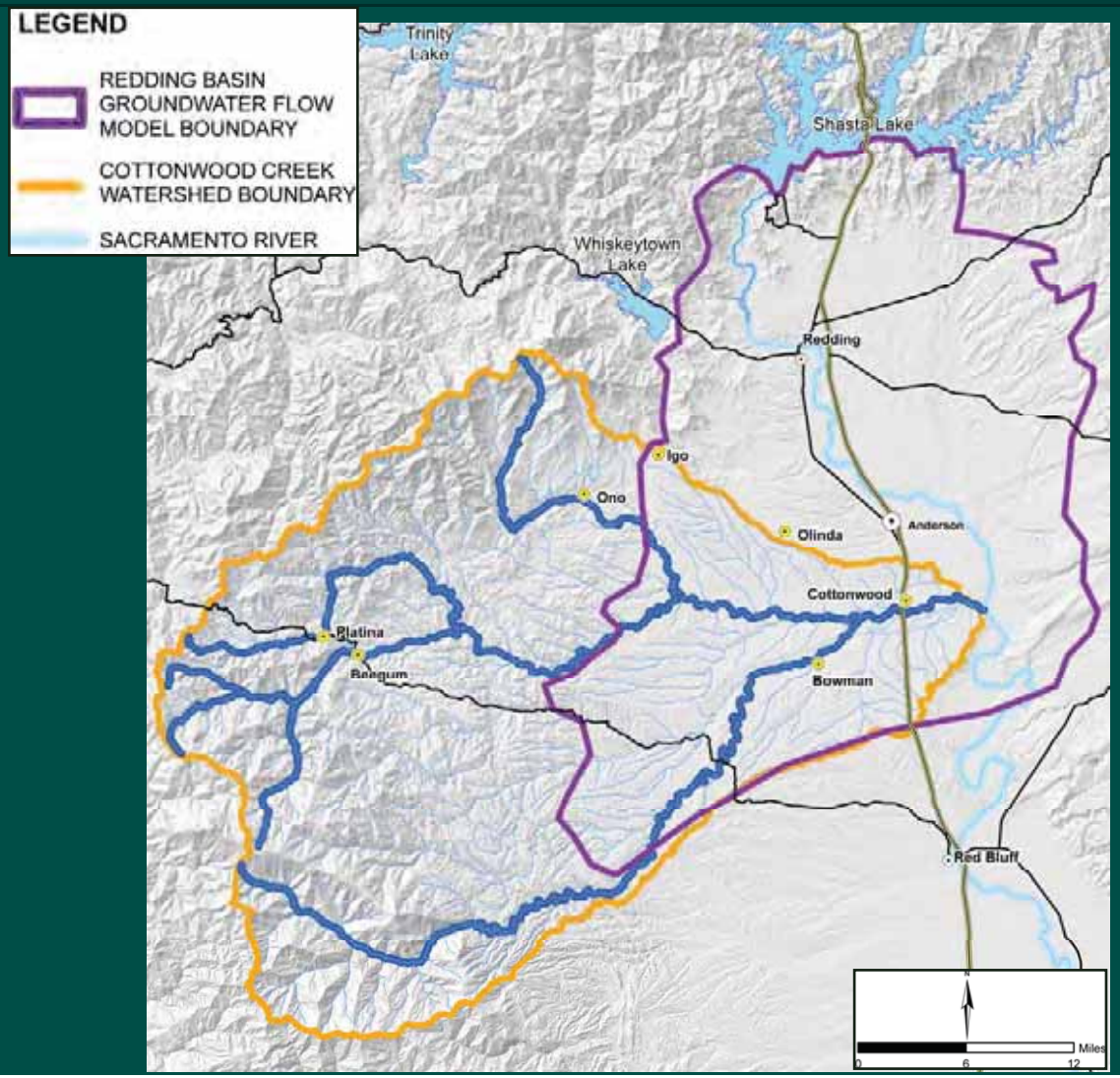
- SGS studies indicate that SW quality in ottonwood reek Watershed is good when compared to drinking water and agricultural standards
- SW quality in ottonwood reek and S Fork ottonwood reek similar to GW quality on ehama ounty side of ottonwood reek (SGS)

Example Groundwater Data

Groundwater Monitoring Locations



Redding Basin Model Boundary



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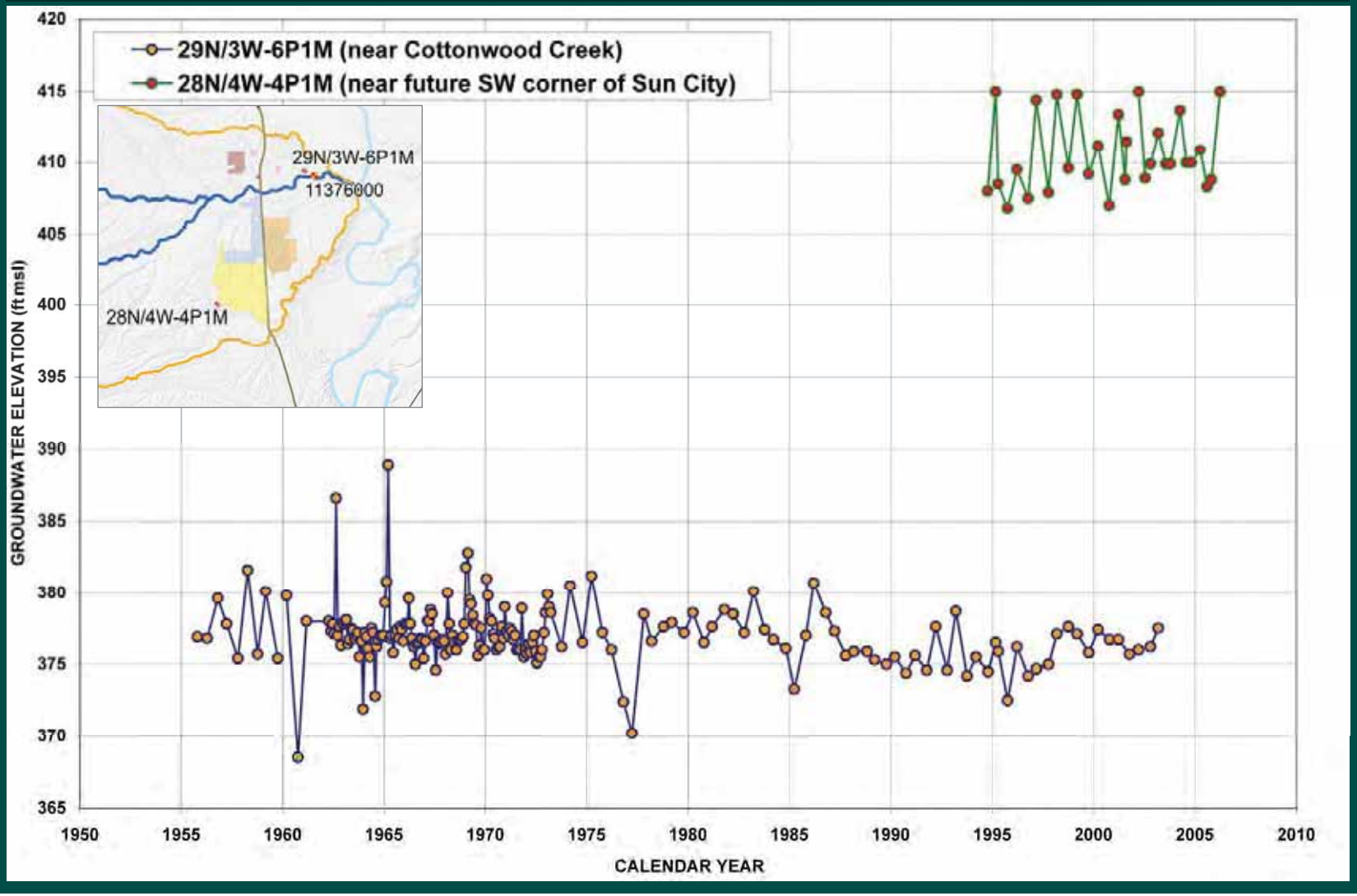
Groundwater Levels



Groundwater Level Summary

- outine GW monitoring being conducted by W and F W
- Generally seasonal fluctuation in GW levels is within to feet per year
- o indication of long-term increasing or decreasing trends in GW levels

Groundwater Quality Summary

- outine GW quality monitoring conducted by municipal water suppliers

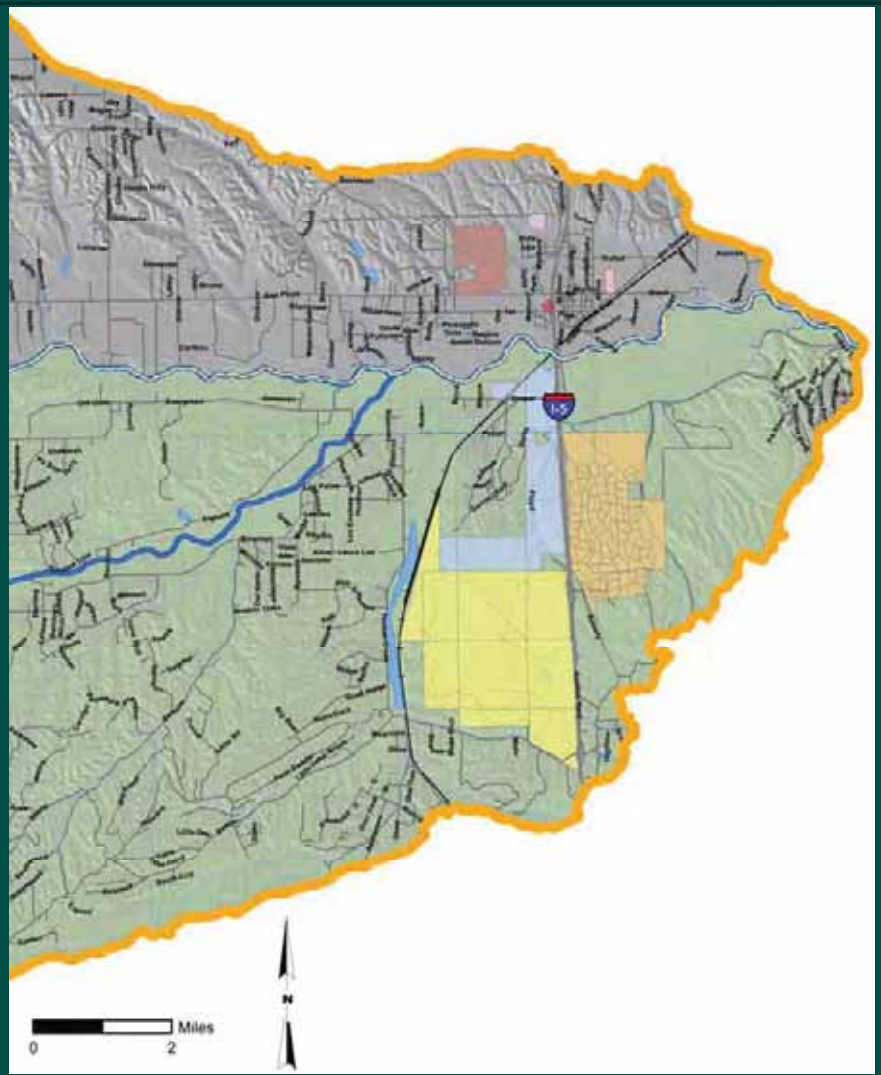
  equest onsumer onfidence eports

- SGS studies indicate that GW quality in ottonwood reek Watershed is good when compared to drinking water and agricultural standards

  owever elevated oron has been detected in locali ed areas (W)

Future Residential Developments

Future Residential Developments



Legend

- Watershed Boundary

DEVELOPMENT

- Cottonwood Hills
- Seal Court
- Morgan Ranch
- Oak Ranch Estates
- Spoon Subdivision
- Sun City
- Sunset Hills Estates

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Shasta County Portion of Cottonwood Creek Watershed

Development	Planned Homes
ottonwood ills	
ak anch states	
Seal ourt Subdivision	
Spoon Subdivision	

Tehama County Portion of Cottonwood Creek Watershed

Development	Planned Homes
organ anch	
el Webb s Sun ity	
Sunset ills	

Tehama County Portion of Cottonwood Creek Watershed (cont)

- organ anch

  lanned community with mi of residential commercial open space and public facilities uses

  onstruction would occur in phases

  - *Bowman Village*
  - *West Highlands Village*
  - *East Highlands Village*

  ehama ounty lanning epartment released a otice of reparation for the organ anch Specific lan in ay

Tehama County Portion of Cottonwood Creek Watershed (cont)

- el Webb s Sun ity
  - lanned community with mi of residential commercial and recreational areas (including -hole golf course)
  - ost housing units will be age-restricted (at least years of age)
  - ehama ounty released raft for public review in late and a revised raft in early
- Sunset ills states
  - Some construction has already taken place
  - lanned average density of one unit per acres

Water Resource Implications

- Several plans on drawing board with significant uncertainty regarding the phasing of each development

  omplete build-out would eventually create water demands for over new homes commercial facilities and irrigated areas

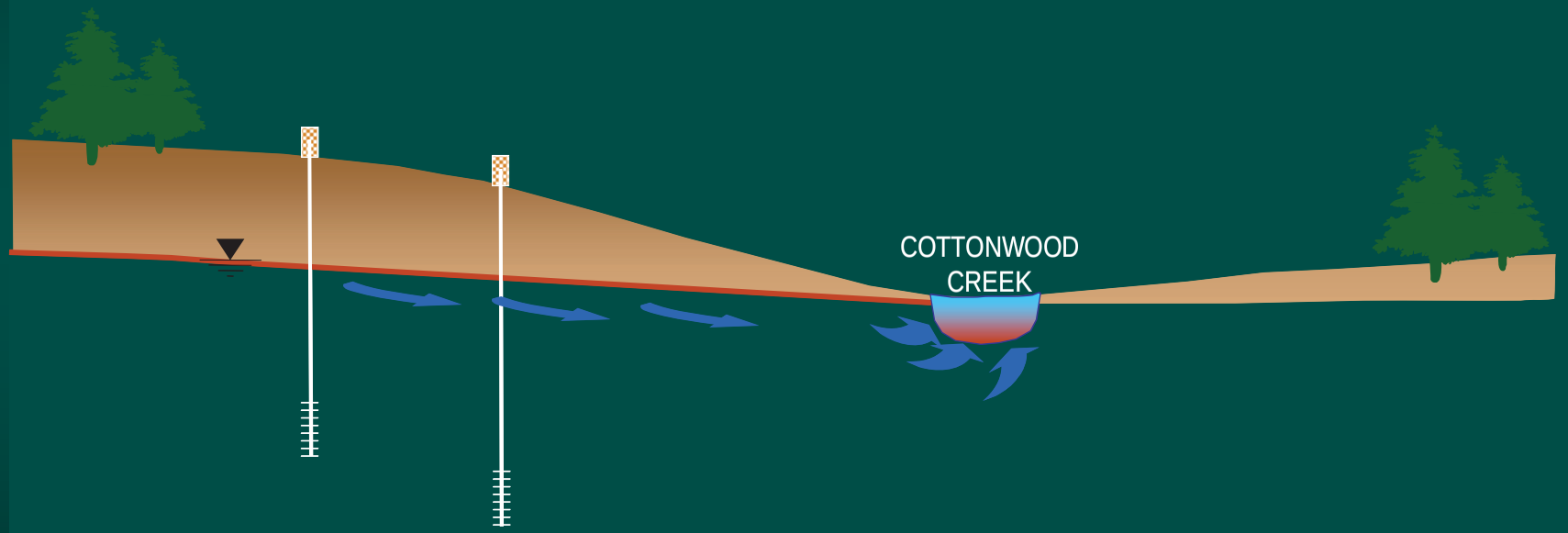
  Source of water supply would be groundwater

  Lowering of GW levels will occur in some areas as new GW demands are imposed on the GW system

  - *Need to be proactive with regard to forecasting cumulative multi-year effects on the GW and SW systems from additional GW demands, supported with monitoring data to confirm forecasts*

GW–SW Interaction

GW–SW Interaction: Pumps Off



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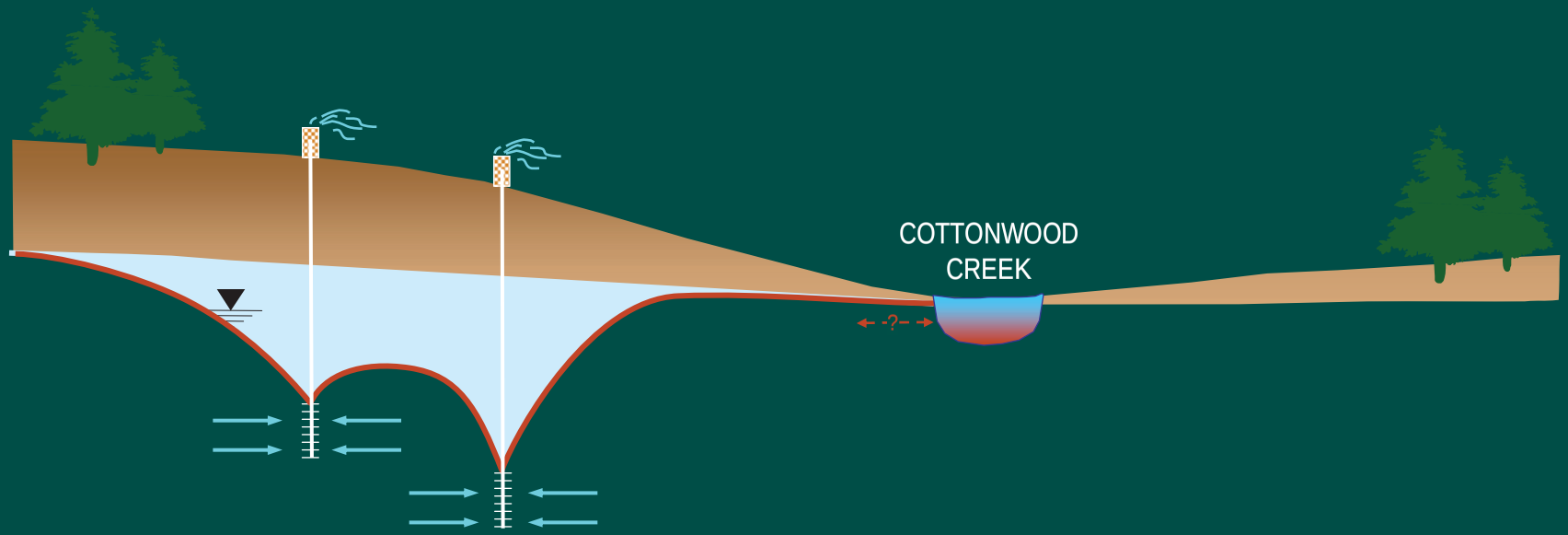
GW–SW Interaction: Pumps On



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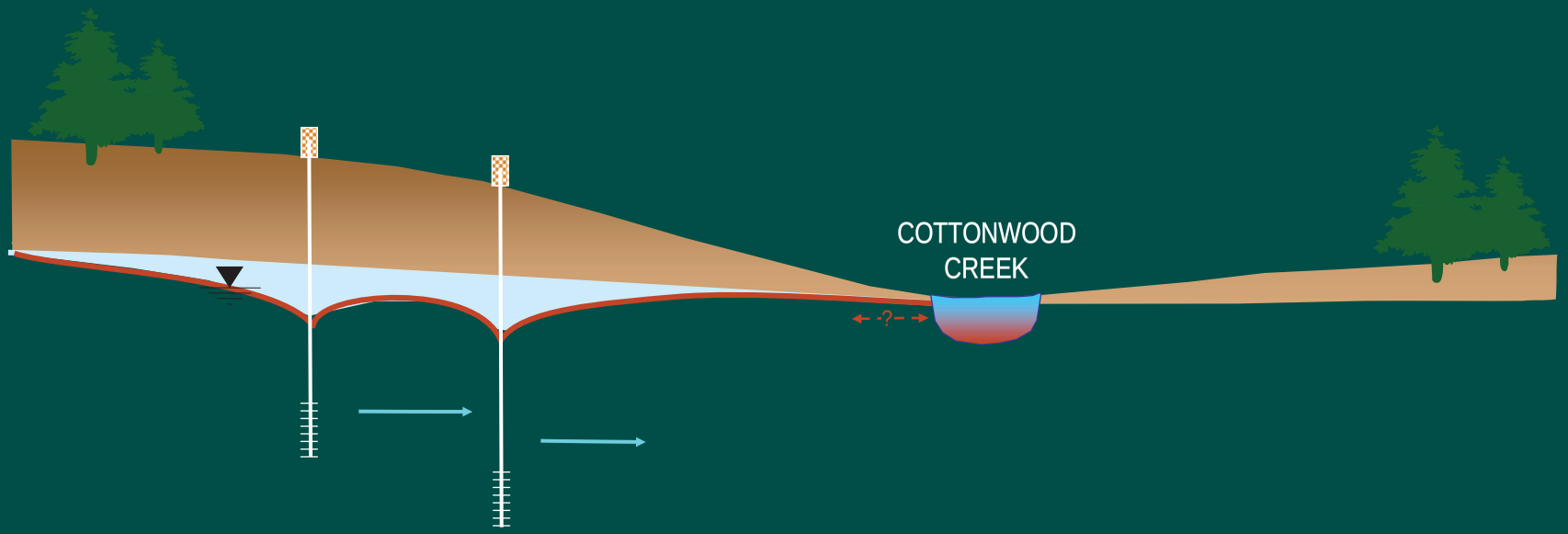
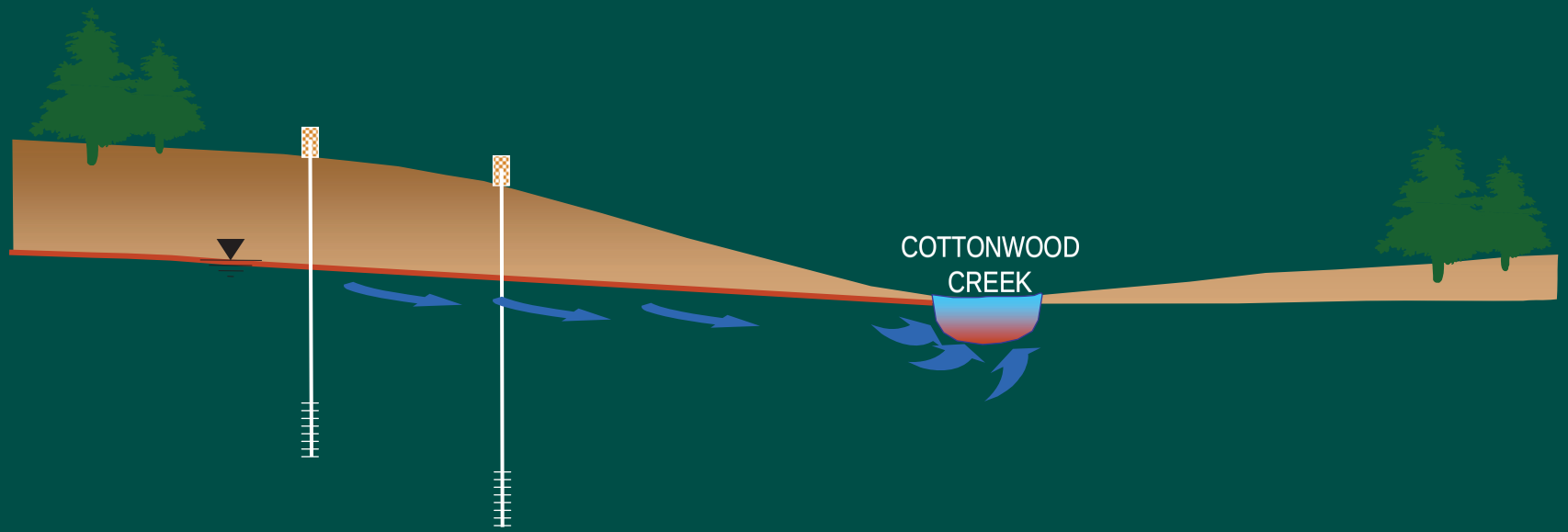
GW–SW Interaction: End of Irrigation Season Prior to Winter Rains



CH2MHILL

GW–SW Interaction: End of Winter (full recovery shown)



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Planned Future Monitoring Programs

Planned Future Monitoring Programs

- Sacramento alley Water anagement rogram (S W)
  - ollaborative regional strategy of increasing GW use in-lieu of SW diversions from Sacramento iver and its ma or tributaries to make local water supply more reliable while improving SW quality in Sacramento-San oaquin elta
  - dditional monitoring locations (both wells and stage gages in streams) throughout alley are being proposed to establish baseline conditions and provide monitoring infrastructure with which to evaluate impacts as program e pands
    - is a participant in S W
  - Selected wells currently monitored by W on a semi-annual basis might be monitored at an increased frequency

Planned Future Monitoring Programs (cont)

- F W

  his district is working closely with W installing new monitoring wells in ehama ounty near areas slated for future large-scale residential developments

  - *Goal is to establish baseline conditions and provide ongoing GW level data with which to evaluate GW impacts from implementation of planned large-scale developments.*
  - *Modeling forecasts were made for Del Webb's Sun City development and these data could be checked against the forecasts as a verification measure*

  s new monitoring wells are installed and GW level measurements are recorded these data will be made available via F W s website (http www tehamacountywater ca gov)

Planned Future Monitoring Programs (cont)

- ottonwood reek Watershed Group

  lanned monitoring program to getter understand baseline surface water quality conditions

  ncludes monitoring locations

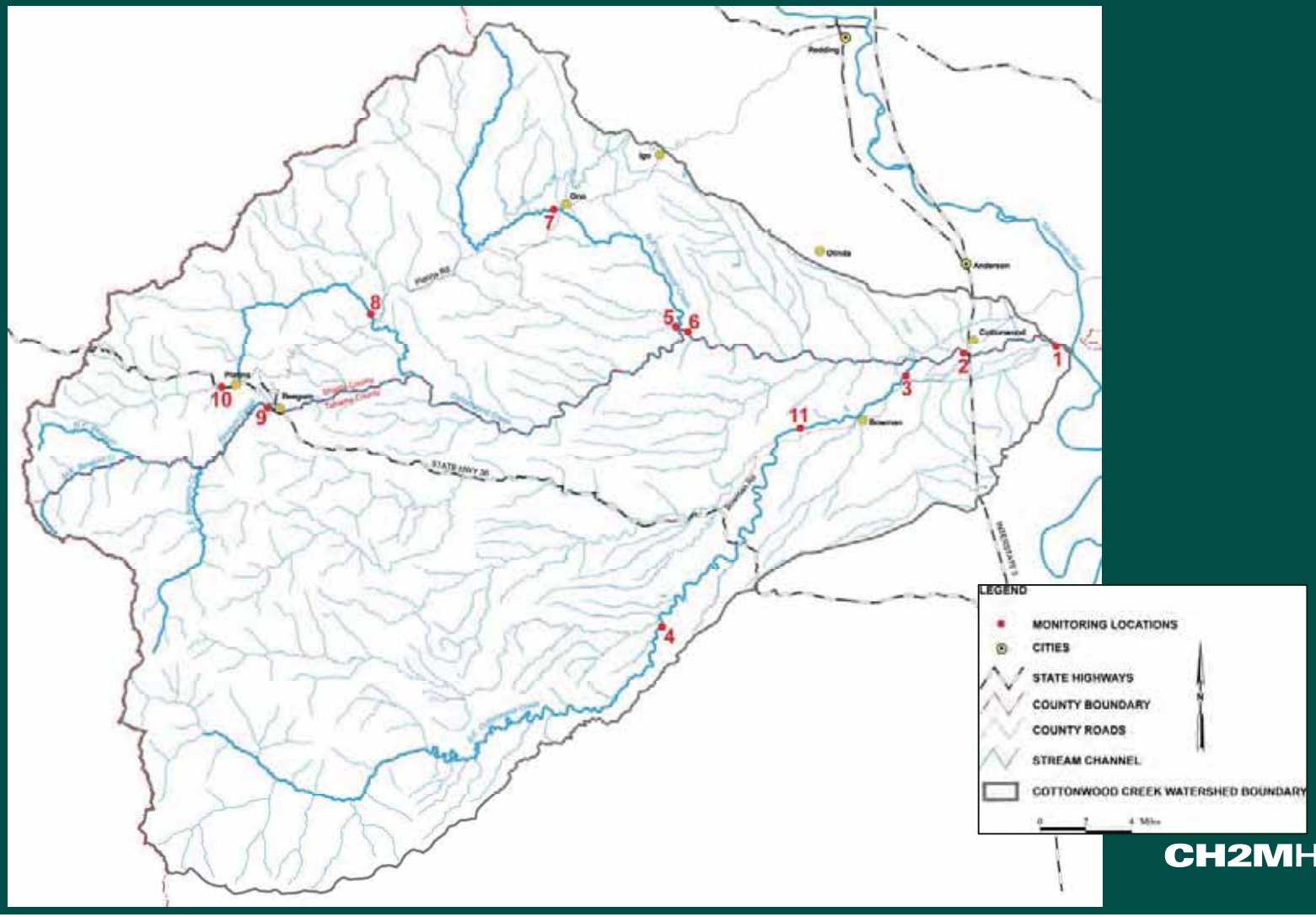
  - *10 along main, north, and south forks of Cottonwood Creek*
  - *1 on Beegum Creek*

  ncludes

  - *Monthly water temperature and turbidity monitoring at 10 locations*
  - *Event-oriented monitoring after 2 storm events*
  - *Macroinvertebrate monitoring at 10 locations during late Spring 2007*
  - *Escherichia coli monitoring during summer months at 2 locations (1 on S.Fork Cottonwood Creek and 1 on the mainstem)*

  urrent funding will carry monitoring program from Sep through ug

CCWG's Planned Monitoring Locations



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Potential Next Steps

Stakeholder Concerns

- Lack of ongoing monitoring in the watershed
- Lack of understanding of the linkage between groundwater (GW) and surface water (SW) systems
- Future impacts from planned large-scale residential developments to GW and SW quantity and quality

Potential Next Steps

- oordinate with F W W and on their ongoing monitoring programs
- Seek future funding to supplement current and planned monitoring networks
  - o avoid duplication of efforts
  - o foster a coordinated regional monitoring effort
  - o protect the GW and SW resource against inevitable changes in land and water use

Potential Next Steps (cont)

- evelop integrated Geographic nformation System (G S) database
  - o house pertinent hydrologic monitoring and land use data
  - o facilitate organi ation and interpretation of monitoring data for watershed
  - o facilitate educating the public as part of community outreach programs

Questions?

Cottonwood Creek Watershed Management Plan Management Plan Development Workshop: Future Development and Water Resources August 10, 2006

FROM: Ed McCarthy / CH2M HILL
Nate Brown / CH2M HILL

DATE: August 15, 2006

Attendees:

Tricia Bratcher / CDFG	Dee Swearingen / Consultant
Guy Chetelat / RWQCB	Vieva Swearingen / CCWG
Lon Currey / CCWG Board	Ed McCarthy / CH2M HILL
Dennis Heiman / RWQCB	Nate Brown / CH2M HILL
Tom Harrinton / CCWG Board	Susan Lukso / CH2M HILL

COPIES: Vieva Swearingen / CCWG

Introductions and Meeting Purpose

Vieva Swearingen / CCWG started the meeting at 6:30 p.m. and introduced the presenters.

The purpose of this workshop, and the two workshops in subsequent weeks, is to expand upon the primary areas of concern for the Cottonwood Creek Watershed (CCW) as identified in the Watershed Strategic Plan (WSP). The workshops are an elaboration on the CH2M HILL Technical Memoranda on future development and water resources; fish, vegetation, and wildlife resources; and channel and riparian conditions. Stakeholders and the general public are encouraged to participate in the reviews and discussions as the outcomes will impact the direction of the Cottonwood Creek Watershed Management Plan (WMP). Comments and questions on the workshops and technical memorandums can be submitted to Ed McCarthy / CH2M HILL up until September 15, 2006.

Ed McCarthy / CH2M HILL facilitated introductions.

Nate Brown / CH2M HILL began the discussion of the Management Plan Development Workshop: *Future Development and Water Resource Concerns in the Cottonwood Creek Watershed [Technical Memorandum]* (CH2M HILL, August 7, 2006) findings with the usage of a PowerPoint presentation (Water Resources and Future Residential Developments, August 10, 2006). A copy of the presentation was emailed to Vieva Swearingen on Friday, August 11, 2006.

Discussion

Topics of discussion:

Comment: Guy Chetelat / RWQCB recommended that the final two workshops be rescheduled so that they are not in August 2006. He believes that the workshop attendance would be increased if they were after the vacation season.

Comment: Stakeholder turnout at workshops has been fairly light. In order to increase stakeholder participation, it was recommended that the CCWG newsletter contain an announcement about the current status of WMP development and a request for comments. This would be done in an attempt to ensure full disclosure to the stakeholders during the final stages of the WMP development.

Response: Vieva Swearingen has announced the development of the WMP in several past editions of the newsletter. Meetings also have been and will be announced in the local paper. She will include a notice for "final opportunity for input" in the next newsletter edition to encourage participation. The WMP draft will be available for public comment in October 2006.)

Response: Dennis Heiman / RWQCB stated that CCWC has preformed their due diligence in providing notice of the Watershed Management Plan to the stakeholders, and that one final notice could be sent when a draft is available.

Comment: The Technical Memorandum titled *Future Development and Water Resource Concerns in the Cottonwood Creek Watershed* focused on residential developments and water quantity rather than water quality. There are no continuous water quality data available over a long period of time.

Response: The CCWG will begin monitoring water quality in October 2006 until October 2007 due to a recently awarded grant. They will use some of the grant to purchase monitoring equipment so that they can continue to monitor turbidity after the grant period ends.

Question: Has a precipitation and flow analysis been done? Public perception is that a problem exists. The problem that is perceived is that the watershed has become more "flashy" (the time from precipitation to higher flows is short) over time. Is this warranted by the data available?

Response: One could compare magnitudes and frequencies of streamflow peaks in earlier periods with those during later periods after normalizing with respect to precipitation (so comparisons are apples-to-apples). This combined with comparison of total flow volumes over different periods may provide insights into whether the surface water system runoff versus infiltration characteristics are changing over time. However, this kind of analysis would not provide "cause-effect" information, just "effect" information. Some changes in land use can counteract each other with regard to runoff. For example, urbanization in some areas may be balanced by changes in vegetative cover in other areas. Further, you may get more runoff in an urbanized area, but may have more rainfall interception storage (from the

canopy of certain vegetation) in other areas which could result in less runoff. Because the only long-term stream gage is located near the outlet of the watershed, one would not be able to accurately discern the cause of changes to streamflow. To evaluate cause-effect relationships for streamflow, a computer model should be developed for the watershed for this purpose.

Question: Why is the addition to Lake California and Shasta County Vineyards, not included on the future developments map? Where is the water runoff going? In Lake California, where is the ground water for Rio Alta Water Company coming from?

Response: The impact will depend on the phase and type of development and the source of water supply. This has not been specifically evaluated by CH2M HILL at this time. Lake California is in its second phase of development but it is unknown by the attendees what the impact will be. Shasta County Vineyards located north of the creek appears to have its current runoff going north away from the creek, north of the CCW boundary. This may change, however, if the development expands into the CCW.

With regard to groundwater impacts to existing wells, this will depend on the proximity of each development and the depth of active wells nearby. Shallow active wells located close to the developments will be most impacted.

A forecast of the cumulative effects of planned residential developments needs to be made over a multi-year period to adequately address the question of impacts to water resources resulting from planned developments. This, coupled with monitoring data to confirm the forecasts, would provide the basic information that one would need to avoid / mitigate water resource problems associated with large-scale residential developments.

Question: How does the Tehama County Ground Water Ordinance affect the developments?

Response: There is no affect because the developments are not transferring any water out of the county.

Question: Can we identify an adequate level of groundwater for the aquifers in order to protect the resource from over development and pumping?

Response: Some counties have Basin Management Objectives (BMOs) which define groundwater level conditions. Neither Shasta nor Tehama County has rigid BMOs. Selection of such levels for this area would need careful thought. There is no indication of long-term increasing or decreasing trends in groundwater levels based on available data. Groundwater levels temporarily decrease due to seasonal or drought conditions; however, they typically rebound to pre-drought conditions after rainfall returns to normal or above-normal conditions. This suggests that there is capacity for additional groundwater development in the area. Coordination at a regional level between Shasta and Tehama Counties is needed to ensure that adequate technical evaluations (i.e., forecasts) are being conducted along with ongoing monitoring programs to confirm the forecasts.

Question: Is there any cooperation between the Shasta and Tehama Counties' on water monitoring?

Response: CH2M HILL does not know the current level of coordination between the counties. CCWG could serve as a liaison between the counties.

Question: What is the affect of the development on Gas Point Road?

Response: That is not known.

Question: If CCWG allied with other groups that are interested in groundwater and water quality, what would be the reasoning and result?

Response: Such an alliance could provide for greater funding opportunities (i.e., increase relevance, joint applications), reduce duplication of services and efforts, and expand public interest in the watersheds.

Question: An increasing population near the watershed will increase trespassing on private property and habitat. Will this topic be discussed in a technical memo?

Response: Trespassing was discussed in the WSP. Within the WSP, recommendations were made for how to legally handle trespassing on private property. At a Spring 2006 meeting stakeholders did not identify trespassing as a primary concern warranting additional coverage. The WSP was viewed as sufficient coverage for that topic.

Since trespassing has now been deemed a topic of concern by the stakeholders, the WMP will include a restatement of the WSP recommendations. It was agreed upon that the WMP will include a synopsis of topics of concern that repeatedly arose in stakeholder meetings.

Question: Will the planned developments remove the rural lifestyle and open space that currently exists in Cottonwood? Should urbanization management be a central theme for the mission of the CCWG?

Response: CCWG could work for the preservation of the existing lifestyle in relation to the creek and work toward minimizing the loss of habitat resulting from urbanization. This is a decision for CCWG and its stakeholders.

Response:

A discussion was held regarding trespass in the creek area with the consultants doing the EIR plans on the Morgan Ranch project, and a suggestion by them that a park could possibly be added in the plan.

Question: How will development affect riparian habitats?

Response: The August 17, 2006 presentation by CH2M HILL on Recommendations for Fishery, Wildlife, and Vegetation Resources will discuss the creek and riparian habitats.

Question: Should the WMP include contact information of agencies and individuals who are involved in the development of recreation resources? The community could use that information to develop its community action activities.

Response: Such information should not be included in the WMP.

Response: The majority of the CCWG focus could be on the pursuit of conservation easements and not recreational development.

Meeting ended at 8:35 pm

Appendix B
Channel and Riparian Conditions

Introduction

A Technical Memorandum (TM) that focused on channel and riparian conditions was developed that summarized the concerns of stakeholders in the Cottonwood Creek Watershed. Stakeholder concerns were documented in the *Cottonwood Creek Strategic Watershed Plan* (CH2M HILL, 2005). The TM discussed projects that could be considered by CCWG to address these concerns. The TM was distributed to the stakeholder group in mid-August and a workshop was held on August 24, 2006, to review and discuss the content of the TM. Appendix B includes the final TM, the presentations from the workshop, the news release for the workshop and a workshop summary.

An initial stakeholder meeting was held on March 29, 2006, that focused more specifically on erosion and flooding. The goal was to arrive at a consensus among stakeholders about the desired conditions of the Cottonwood Creek Watershed with respect to flooding and erosion. The workshop participants attempted to outline a vision for the watershed, including conceptual strategies for environmental management, long-term monitoring, and education.

No consensus was reached at the initial meeting. The primary lesson that came from the initial meeting was that discussion would be more focused if specific actions were recommended. The second stakeholder meeting on channel and riparian conditions was more focused and included more detailed techniques that could be implemented within the watershed.

NEWS NEWS

For Immediate Release

Contact: Vieva Swearingen
Watershed Coordinator
Phone: (530) 347.6637
E-Mail: ccwg@shasta.com

August 17, 2006

COTTONWOOD CREEK MANAGEMENT PLAN DEVELOPMENT WORKSHOP- CHANNEL AND RIPARIAN CONDITIONS

COTTONWOOD, CA — Cottonwood Creek Watershed Group will be holding a Management Plan Development Workshop focusing on channel and riparian conditions within the watershed. The meeting will be held at Cottonwood Creek Watershed Group's office located at 3233 Brush Street in Cottonwood. The workshop will be held on Thursday, August 24th at 6:30 p.m. Copies of the Management and Restoration Plan that will be discussed during the workshop will be available at the Cottonwood Creek Watershed Group's office on Monday, August 21th. Visit us on the Web at www.cottonwoodcreekwatershed.org.

Questions? Call 347.6637 or email ccwg@shasta.com

Channel and Riparian Conditions in the Cottonwood Creek Watershed

PREPARED FOR: Cottonwood Creek Watershed Group

PREPARED BY: Laura Elliott/CH2M HILL
Ed McCarthy/CH2M HILL
Mark Tompkins/CH2M HILL
Anthony Falzone/CH2M HILL

DATE: August 21, 2006

PROJECT NUMBER: 333854

Introduction

This technical memorandum (TM) presents existing watershed data, notes data of interest for future watershed studies, and discusses potential next steps that would be beneficial to channel and riparian conditions in the Cottonwood Creek Watershed. This TM suggests strategies to mitigate the detrimental effects of erosion along Cottonwood Creek, and opportunities both to learn more about critical processes operating in and along the creek and to add to the body of watershed knowledge for improved future management and implementation of best practices.

The Cottonwood Creek Watershed lies in Shasta and Tehama Counties on the northwest side of the Sacramento Valley. The lower two-thirds of the drainage area lie in the Central Valley uplands; the upstream portion includes the east slope of the North Coast Mountain Range and Klamath Mountains and the southern slopes of the Trinity Mountains. Cottonwood Creek generally flows eastward through the valley to the Sacramento River. With an annual runoff of 586,000 acre-feet from its 938-square-mile drainage, Cottonwood Creek is the third largest west-side tributary to the Sacramento River and the largest undammed watershed in the Sacramento Valley. Mean daily flow in Cottonwood Creek is 860 cubic feet per second (cfs) (CH2M HILL, 2001). Mean daily flow in Cottonwood Creek ranges from 71 cfs in late summer/early fall to 2,480 cfs in winter. The Log-Pearson Type III 2-, 10-, 50-, and 100-year peak flows are 21,600, 53,460, 84,360, and 97,600, respectively (data from U.S. Geological Survey [USGS] Gage 11376000, Cottonwood Creek, near Cottonwood, California). The community of Cottonwood is the most developed area in the watershed, but several large-scale housing developments have been completed or are planned for the near future. Projections suggest that the population in the lower watershed could more than double as a result of these new developments (CH2M HILL, 2005).

The Cottonwood Creek Watershed has a large amount of open space and provides habitats for a wide array of species, including threatened and endangered species, such as northern spotted owl (*Strix occidentalis*) and spring-run Chinook salmon (*Oncorhynchus tshawytscha*)

(CH2M HILL, 2005). Several important features distinguish Cottonwood Creek Watershed from other watersheds in the valley. Generally, surface water runoff in neighboring watersheds is very flashy, with peaks typically occurring in the winter and spring from rainfall, and low base flows in the summer and fall. This pattern is particularly pronounced in Cottonwood Creek because its watershed receives a relatively small amount of snowpack and little recharge to aquifers occurs in the upper reaches of the watershed. These two factors also reduce the potential for intra-annual storage in Cottonwood Creek. The lack of elevation along the upper rim of the watershed limits the amount of snowpack that can accumulate in any given year. Thus, there is less time between precipitation events and subsequent runoff than there might be in watersheds with greater intra-annual storage capacity. The overall lack of storage in the watershed results in flashy seasonal runoff. The baseflow component of runoff is generally small, and the majority of flows are directly attributable to storm events (CH2M HILL, 2005).

The high storm-related flow variations, or flashiness, of the watershed results in high-energy, high-flow events, which can, in turn, result in significant stream bank erosion throughout the creek. Erosion control and loss of usable land in the lower watershed have been concerns for many residents in the watershed (CH2M HILL, 2001).

Existing Information

A large body of information exists for the Cottonwood Creek Watershed. A Graham Matthews and Associates (Matthews) report (2003) and CH2M HILL's *Cottonwood Creek Watershed Assessment* (2001) are particularly useful sources of information about erosion in the watershed. The information in these reports suggests that persistent gravel mining coupled with Cottonwood Creek's tendency to have quick increases in flow rates from rainfall events contribute to the current channel conditions in the creek. In addition, existing information about past and planned work in the watershed at Lema Ranch provides insights and guidance for future channel management actions.

Gravel Mining

Two major gravel mines operate on Cottonwood Creek. The Shea Mine is immediately downstream of Interstate 5 and the Cottonwood Creek Sand and Gravel Mine (formerly XTRA) is approximately 600 feet upstream of Interstate 5 (CH2M HILL, 2001).

Previous reports have made reference to problems arising from gravel mining in Cottonwood Creek (Rectenwald, 1999; Cepello and Buer, 1995; Buer, 1994; North State Resources, Inc., 1991; State of California Resource Agency, 1988; California Department of Fish and Game [CDFG], 1988; McKevitt, 1984; CH2M HILL, 2001; CH2M HILL, 2005; Matthews, 2003). These problems include reductions in the quantity of spawning-sized gravel reaching the Sacramento River and excessive erosion in Cottonwood Creek. It is estimated that Cottonwood Creek contributes 33 percent of the total gravel bedload to the Sacramento River (McKevitt, 1984). Next to Cache Creek, Cottonwood Creek provides the largest total sediment input to the Sacramento River (CALFED, 1997). The high natural sediment and gravel yield is a result of recent tectonic uplift combined with erodible geologic formations in the Cottonwood Creek Watershed.

CDFG names Cottonwood Creek as a prime source of spawning gravel for Chinook salmon entering the upper reach of the Sacramento River; Cottonwood Creek is the only tributary providing significant supplies of spawning gravel for 30 miles of the Sacramento River in Tehama County (CDFG, 1988). Gravel mining, resulting in insufficient quantities of spawning-sized gravel, has been cited as one of the reasons for the reductions in salmon and steelhead populations that have been observed in Cottonwood Creek (State of California Resource Agency, 1988).

Several reports have determined that gravel mining has exacerbated erosion rates in the Cottonwood Creek Watershed (California Department of Water Resources, 1992; Buer, 1994; Matthews, 2003). Gravel mining changes the slope of a riverbed. The pit created in the riverbed by the gravel removal creates a feature called a "knickpoint," where the slope of the channel bed increases drastically in the downstream direction. The velocity of the flow in the creek increases at a knickpoint as the water accelerates (falling like a waterfall) through the area of increasing slope. This acceleration imparts more energy from the flow to the channel bed, often causing scouring of the channel bed and erosion of channel banks. The result is an overall lowering of the stream channel and a coarsening of the bed material (Resource Management International, Inc., 1987). Pebble counts on Cottonwood Creek's mainstem show a slight coarsening trend in bed material in the downstream direction (Water Engineering and Technology, Inc., 1991). The characteristics of gravel in Cottonwood Creek are such that they are fully mobilized and transported downstream regularly by high flow events.

Matthews (2003) identified several potential effects of gravel mining on alluvial rivers, the following six of which he observed in Cottonwood Creek:

- Bed degradation caused by extraction of bed material (gravel) in excess of replenishment rates
- Bridge damage and pipeline exposure caused by bed degradation
- Removal of all gravel in the bed and exposure of other substrates in the channel caused by bed degradation
- Reduction in overbank flooding with accelerated bank erosion caused by a lack of floodplain connectivity
- Bank erosion caused by undercutting and bank failure resulting from rapid bed degradation
- Downstream bar erosion caused by cutting off the supply of gravel to bars while the river maintains its gravel transport capacity

These effects observed in Cottonwood Creek correlate both in space and time with the extent and volume of gravel extraction in the creek. Matthews (2003) discusses these effects further and argues that gravel mining is the primary cause of erosion and bed degradation in Cottonwood Creek.

Lema Ranch

A small-scale project to restore and stabilize channel banks along Cottonwood Creek has been planned on Lema Ranch property (Cottonwood Creek Watershed Group [CCWG], 2006). A gravel bar in the middle of the channel will be removed, and the excavated material will be used to stabilize the bank. The in-stream area adjacent to the bank will be reconfigured to allow for greater flow in the center of the channel. Willow trees on the gravel bar also will be relocated to the bank to reduce potentially erodible exposed soil. Finally, more riparian vegetation will be planted on approximately 5 acres of land adjacent to the creek. This project is expected to not only stabilize the bank, but also to provide additional habitat for terrestrial species in the area.

Data of Interest for Watershed Studies

A variety of information is available to help Cottonwood Creek Watershed landowners and stakeholders make best practice decisions about channel and riparian management activities. During stakeholder meetings, adaptive management has been suggested by landowners as the most desirable strategy because there is an immediate need to address erosion and the loss of private property (CH2M HILL, 2005). Under an adaptive management framework, management actions are designed as experiments to yield insights that can be used to refine existing projects and improve future project design. The following sections describe projects that have been designed to fit an adaptive management approach.

Sediment Budget

A watershed sediment budget does not exist for Cottonwood Creek. A sediment budget, analogous to a financial budget, takes inventory of inputs, storage, and transport of sediment in the creek. A sediment budget for the watershed would indicate the locations, quantities, and processes related to sediment entering and leaving the creek.

Gravel sources, replenishment rates, transport rates, and gravel extraction rates from mining activities would be useful in producing a sediment budget. *Cottonwood Creek Watershed Assessment* (CH2M HILL, 2001) stated that discrepancies and contradictions among the published reports regarding existing sediment transport rates in Cottonwood Creek are a major obstacle to selecting creek management solutions.

An appropriately researched sediment budget for Cottonwood Creek would provide information about the role hydrology plays in excessive erosion and better define the relationship between flow and erosion in the watershed. The sediment budget could also be used to predict performance of bioengineered structures installed along channel banks and other channel modifications designed to prevent loss of usable land.

Roads Inventory

Abandoned roads in the upper watershed that have not been rehabilitated or stabilized could add significantly to erosion and sedimentation in Cottonwood Creek. Landslides along the upper section of Cottonwood Creek are common during heavy rainfall runoff periods in the watershed. Landslide zones add significant amounts of gravel, mud, and

other fine sediment to the creek. A road inventory could identify problem areas and roads so that they can be revegetated and stabilized (CH2M HILL, 2005).

Impact Assessment of New Developments

The impact of planned large-scale developments in the lower reaches of the Cottonwood Creek Watershed on erosion, sediment loads, and, possibly, the creek's meander zone is not well known (CH2M HILL, 2005). Stakeholders have expressed concern about this lack of information, and it will only become more important with incipient large-scale residential development in the watershed.

Potential Next Steps

Restoration Using Bioengineering

Stakeholders have expressed concerns about stream bank erosion and the loss of riparian habitat along Cottonwood Creek. Applied in an adaptive management framework, pilot-scale bioengineering projects could be used to limit channel migration and erosion in highly sensitive areas and to enhance native riparian habitat. A similar approach is planned and has been funded for Lema Ranch. Projects similar to the one planned for Lema Ranch might be the most appropriate for individual landowners along Cottonwood Creek. Each bio-engineering measure described in this section would require a thorough site analysis to ensure its appropriateness for a given site. These measures should not be considered permanent fixes for channel bank erosion along Cottonwood Creek. Rather, they should be considered capable of limiting erosion during the peak of moderate flow events and, through a monitoring and adaptive management program, providing valuable information on mechanisms of excessive bank erosion and appropriate long-term responses.

The stream bank restoration activities outlined in this section could address multiple stakeholder concerns. Activities could meet the immediate need for bank stabilization to curb destructive erosion, could be tailored to collect data on sediment transport and flow in the area, and could enhance the riparian corridor adjacent to Cottonwood Creek. Restoration activities should be designed as experiments that contribute to the body of knowledge about the watershed, providing additional data for sediment budget calculations and contributing information to the adaptive management process – a value-added approach. In the long term, this learning component of the stabilization projects could allow CCWG to produce better long-term restoration strategies for Cottonwood Creek. In addition, similar to the solutions proposed for Lema Ranch, bioengineering solutions could provide and enhance valuable riparian habitat.

Willow Mattress

In areas where erosion is an immediate threat to property, mattresses composed of willows and other native riparian vegetation could be installed. Willow mattresses typically consist of a thick blanket (0.5 to 1.0 foot) of live cuttings and soil fill. Willows are chosen because they root easily from cuttings. Similar to the project at Lema Ranch, mattresses could be constructed of cuttings taken from pre-existing willows in sandbars in the creek. The willow mattress approach could achieve the dual objective of channel bank revegetation and protection. Willow mattresses protect channel banks by increasing the roughness of the

channel bank, reducing flow velocities at the bank face, and protecting channel banks from scouring action. In addition, willow mattresses trap some sediment and facilitate development of riparian habitat along the edge of the creek. This type of environmentally sensitive bank stabilization scheme is attractive for prospective grant funding because it provides beneficial habitat while simultaneously protecting the bank from erosion. However, this approach might not prevent bank erosion during extreme peak flows in the creek.

SOURCE: HTTP://WWW.COASTALRCD.ORG/CFIMAGE14.GIF

FIGURE 1
WILLOW MATTRESS EXAMPLE

Spur Dykes

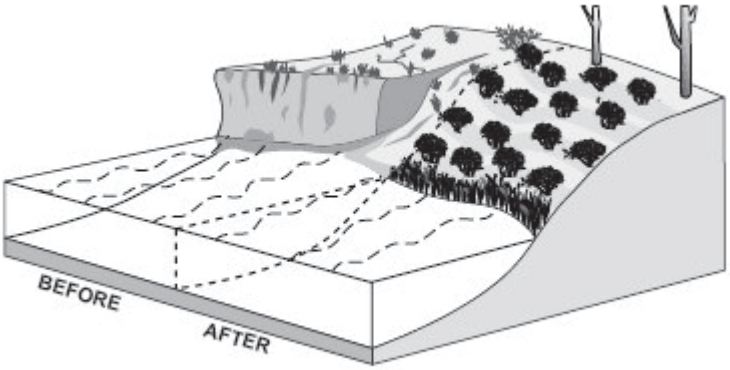
Spur dykes could be installed to provide additional protection against bank erosion. Spur dykes are transverse structures that extend into the stream from the bank and reduce erosion by deflecting flows away from the bank. Two to five structures are typically placed in series along the bank. Spur dykes can be constructed of a soil core armored with a layer of stone, or of large, woody debris with or without embedded rocks. Spur dykes constructed of large, woody debris are designed to provide biological benefits and restore habitat by creating pool habitats and increasing physical diversity (Salix Applied Earthcare, 2006).

SOURCE: HTTP://WWW.WHITEWATER.ORG/RIAC/EFFORTS/SEYMOUR_WOODY_DEBRIS_OVER.JPG

FIGURE 2
SPUR CONSTRUCTED FROM WOODY DEBRIS

Bank Shaping and Planting

In areas where channel bank erosion is accelerated as a result of oversteepened banks, bank shaping and planting could be implemented to reduce the potential for future erosion. In this approach, stream banks are graded to a stable slope (based on site soil, geotechnical, and hydraulic characteristics), prepared or improved for vegetation establishment, and planted with native riparian vegetation species. Depending on site conditions, bank shaping can be combined with slope toe stabilization (i.e., placement of erosion-resistant material, such as boulders or large logs) to improve performance during extreme high flows. However, extreme high flows in Cottonwood Creek could damage or destroy areas of bank shaping and planting.

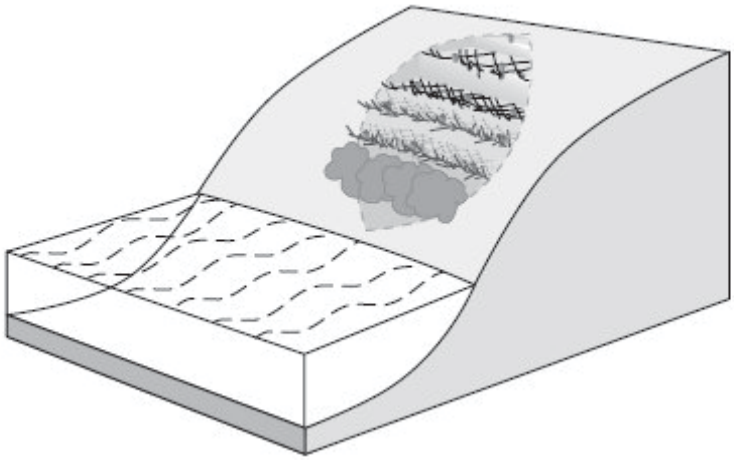


SOURCE: HTTP://WWW.NRCS.USDA.GOV/TECHNICAL/STREAM_RESTORATION/PDFFILES/APPENDIX.PDF

FIGURE 3
BANK SHAPING AND PLANTING

Branch Packing

Channel bank failures, such as slumps and gullies, could be repaired with branch packing applications, in which alternate layers of live branches and compacted fill are "packed" into the failure site. Similar to willow mattresses and bank shaping and planting, branch packing can provide dual benefits of arresting bank erosion and enhancing riparian habitat conditions. However, this approach could also be vulnerable to extreme high flows.



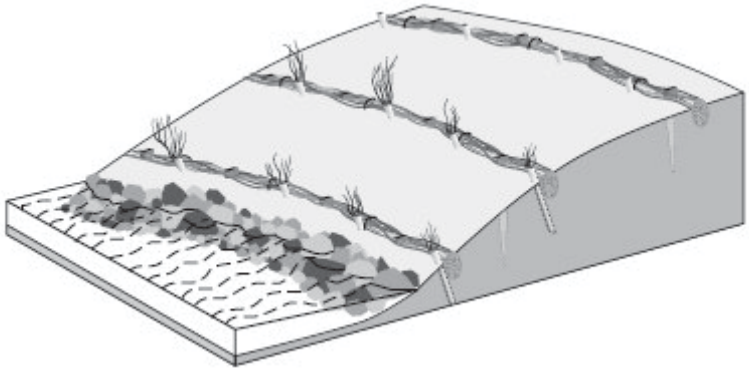
SOURCE: HTTP://WWW.NRCS.USDA.GOV/TECHNICAL/STREAM_RESTORATION/PDFFILES/APPENDIX.PDF

FIGURE 4
BRANCH PACKING

Live Fascine Installation

Live fascines could be installed in areas with less severe bank erosion, but where conditions appear to be transitioning to a condition in which more severe erosion would be likely. In this approach, dormant cuttings of riparian vegetation are arranged in bundles and placed in shallow trenches excavated parallel to the bank. Wooden stakes can be used to secure the fascines to the bank, and toe erosion protection measures can be implemented along with

fascines at appropriate sites. This approach can provide erosion protection and facilitate development of new riparian vegetation, but should not be applied at sites with extensive ongoing erosion. In addition, this approach could be vulnerable to extreme high flows in Cottonwood Creek.

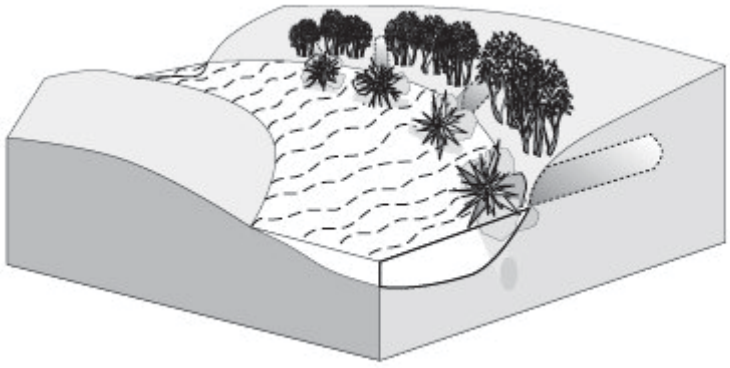


SOURCE: HTTP://WWW.NRCS.USDA.GOV/TECHNICAL/STREAM_RESTORATION/PDFFILES/APPENDIX.PDF

FIGURE 5
LIVE FASCINE INSTALLATION

Log, Rootwad, and Boulder Placement

This approach employs large logs, rootwads, and boulders installed on channel banks along outside bends to provide robust protection against bank erosion and to provide both aquatic and riparian vegetation. In this approach, logs with attached root wads are placed on top of footer logs and interspersed with boulders placed along the bank. The root wads are installed facing into the flow, and thereby deflect flow away from channel banks. The logs, rootwads, and boulders can be cabled together in sites with high erosion potential. Although this approach can be very effective when designed and sited appropriately, it can also be expensive in comparison to other approaches and can induce localized scour and erosion.

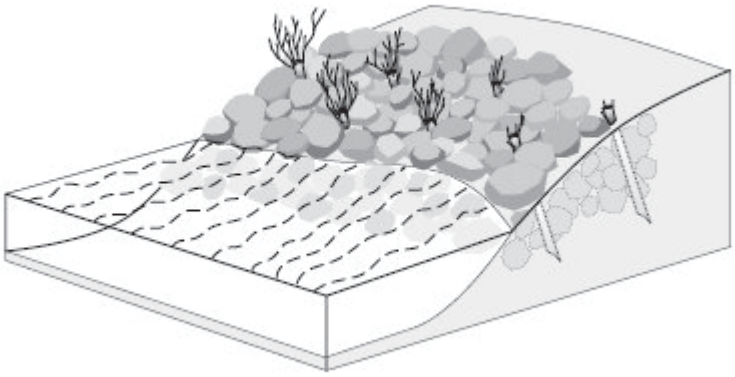


SOURCE: HTTP://WWW.NRCS.USDA.GOV/TECHNICAL/STREAM_RESTORATION/PDFFILES/APPENDIX.PDF

FIGURE 6
LOG, ROOTWAD, AND BOULDER PLACEMENT

Joint Planting

In sensitive areas with extremely high bank erosion rates, where the previous "softer" methods would be insufficient to provide the desired level of protection, channel banks or slope toes can be fortified with large, non-erodible rock interspersed with live riparian vegetation poles or cuttings planted in the interstitial spaces between the rocks. Although this measure would not be as conducive to the development or enhancement of riparian habitat as previously described measures, it could be useful in extremely sensitive areas of Cottonwood Creek where continued erosion could not be tolerated even during extreme high flows.



SOURCE: HTTP://WWW.NRCS.USDA.GOV/TECHNICAL/STREAM_RESTORATION/PDFFILES/APPENDIX.PDF

FIGURE 7
JOINT PLANTINGS

Tools for Assessing, Monitoring, and Adaptively Managing Restoration Projects

Channel manipulations, such as removing vegetated bars or islands in the center of the channel and applying bioengineering techniques to the channel banks, would affect channel geometry and sediment transport dynamics in Cottonwood Creek. Specific techniques can be used to assess and monitor the affects of projects on the underlying ecological and geomorphic processes that control channel form and dynamics in the creek. Assessment tools could include pre- and post-project longitudinal profile surveys, channel geometry monitoring with permanent channel cross-section surveys, and bed sediment composition analyses. These assessment techniques, which are discussed in more detail in the following subsections, would provide the documentation of project performance that is essential in a true adaptive management approach.

Longitudinal Profile Surveys

A longitudinal profile survey is a survey of channel bed elevations along the deepest part of the channel. Longitudinal profiles are used to visualize changes in the depth of the river and river slope. Paired with cross-section surveys, a longitudinal profile survey provides data showing how the shape of the river changes with time and how those changes are related to implemented channel and bank treatments.

A detailed longitudinal profile should be produced for a defined study reach under existing conditions and at regular intervals after project implementation. A longitudinal profile should be surveyed before project construction to record the current condition of the reach immediately after construction to document the as-built condition. Additional longitudinal profiles should be produced after peak 2-year, 5-year, and 10-year flow events and after any flow above the peak 10-year flow during the first 15 years of the project. A longitudinal profile shows the deepest part of the channel over a given distance, and repeat surveys can show changes in channel features (i.e., riffles, runs, and pools) and areas of sediment deposition or channel incision. Study reaches should include the area of active channel manipulation and bank stabilization for a given project and extend at least 20 channel widths in length upstream and downstream of the manipulation. The longitudinal profile could be surveyed using a survey-grade global positioning system (GPS) or a total station. Elevations would be surveyed at the upstream and downstream extents of major geomorphic channel features (e.g., riffles, runs, and pools) and other channel-influencing features (e.g., bedrock outcrops and in-channel structures). If the depth of a pool exceeded the capacity of the GPS rover, an elevation would be taken at the water surface, and the depth of the pool would be estimated using a stadia rod or weighted fiberglass tape. Water-surface elevation, bearing, and distance to the thalweg point would be recorded. Profile survey points would be downloaded as MicroStation files and output as text files for analysis and presentation.

Longitudinal profiles have been surveyed in previous studies of Cottonwood Creek by the U.S. Army Corps of Engineers, USGS, and the Xtra Power Company (Matthews, 2003). Matthews surveyed a detailed longitudinal profile of the lower part of Cottonwood Creek in 1999. Similar to the cross section surveys, future profiles should be compared with past results to illustrate changes through time.

Channel Geometry Monitoring

Surveys of Cottonwood Creek could be conducted to provide a view of cross sections of the creek at a given location. Changes in the location, width, and depth of the channel, as well as changes in the steepness of the banks, shape of the riverbed, and shape of the banks, are illustrated in a cross section. Cross-section surveys should be conducted prior to implementation of any channel manipulation or bank treatment and could be analyzed to identify areas that are losing or gaining sediment, areas that are being eroded, and areas that are prone to future erosion. In addition, repeat surveys of permanently marked cross sections should be conducted to document and quantify changes in channel geometry such as bank erosion, deposition, and migration of the thalweg. Repeat surveys should be conducted immediately after construction to document the as-built condition, and again after peak 2-year, 5-year, and 10-year flow events and after any flow above the peak 10-year flow in the first 15 years of the project.

As in the longitudinal profile surveys, permanently marked cross sections should be surveyed in the vicinity of any proposed channel bank treatment or manipulation. A minimum of three cross sections should be surveyed at the proposed manipulation, and at least three cross sections should be distributed upstream and downstream of this location. Cross sections should be selected to capture representative characteristics in each reach, including important features of any channel manipulations and natural channel features such as riffles, runs, and meander bends. Cross section surveys should capture all signifi-

cant slope breaks, and changes in geomorphic channel features. Ground photographs would be taken at each cross-section end point, looking across the channel from both banks, and looking upstream and downstream of the cross section. Cross-section points surveyed in the field would be attributed with the following information:

- Estimated bankfull stage (right and left bank)
- Water surface edges (right and left bank)
- Thalwegs
- Substrates
- Vegetation types
- Terraces
- Riparian vegetation characteristics
- Large, woody debris characteristics

Cross-section survey points would be downloaded as MicroStation files and output as text files for analysis and presentation.

Previous studies have established permanent cross-section locations on Cottonwood Creek. Reoccupying these sites (where appropriate) in the future is suggested to document changes in the creek's shape through time. USGS established 28 cross sections along lower Cottonwood Creek in 1982 and 1983 (Matthews, 2003). Matthews mapped 16 of the USGS cross sections again in 1999 and 2000. Mapping the cross sections again in the future is recommended to provide the most information about how creek morphology changes with time.

Sediment Composition Analyses

Channel Bed Material. Pebble counts should be collected throughout the study reach to record the dominant facies, and changes in facies in the study reach and at each tracer gravel site (see following discussion on tracer studies). Pebble counts document the surface size distribution of channel bed. Pebble counts would be collected along the stream channel throughout the study reach. At least one pebble count would be collected at each cross section location and at each tracer gravel site. Pebble count data would be collected from streambed surfaces that appear to have been recently active (e.g., relatively fresh, unvegetated gravel or cobble bars). The same location types (e.g., head of riffle or upstream edge of bar) would be sampled throughout the study reach to compare data at points that are geomorphically similar. Standard methods described by Wolman (1954) and Kondolf (2000) would be used for pebble counts.

Pebble counts should be collected before project construction to record the current condition and immediately after construction to document the as-built condition. Pebble counts should be repeated at the same locations after a peak flow event that mobilizes the channel bed surface and after any flow above the peak 10-year flow in the first 15 years of the project.

Tracer Gravel Study and Scour Chains. As part of any implemented bank restoration measures or other channel manipulations, CH2M HILL recommends a set of tracer gravel studies to improve understanding of bank erosion and bed scour processes. Tracer gravel studies show how bed mobility is affected by channel or bank manipulations (i.e., moving willows from a sandbar in the middle of the creek to the bank walls), and should be instructive with respect to best management practices for bank erosion protection.

Tracer gravel transects would be placed in the project reach as well as upstream and downstream of the project reach. Tracer particles would be placed at approximately 2-foot intervals along the transect. Native rocks would be removed from the bed of the active channel and the hole from which each rock was drawn would be marked. The intermediate axis and general shape of each removed rock would be measured and recorded. A tracer stone of similar size and shape would be carefully fit into the hole from which the native rock was drawn, and the size and shape of the tracer recorded. Tracer gravel would consist of river rocks similar in shape and specific gravity to the native rocks of Cottonwood Creek and could be painted with a "safety red" or "safety yellow" epoxy-based paint, which is easily visible in the bed, resistant to algae growth, and persistent for at least 2 years. Tracer gravels could also be fitted with radio transmitters. This approach typically yields more and better data about sediment transport during high flows, but is also more expensive than the painted rock approach. Regardless of the rock marking technique, each placed tracer would be surveyed in place (i.e., on the channel bed) with a survey-quality GPS or total station. Surveyed changes in bed elevation could provide evidence of scour or burial in the event that tracer particles could not be located. Pebble counts at each tracer study site would be used to select the appropriate distribution of tracer sizes for each site. In addition, where feasible, 2-foot by 2-foot (or 1-foot by 1-foot) squares would be painted in place on dry portions of tracer transects with spray paint and surveyed to permanently document their locations. The intent of the squares would be to allow observation of the movement of native gravel and to test whether this movement occurred under different conditions than for the tracer gravel. A pebble count on the facies of the painted square would be collected to document the gravel sizes on the bar where the square was painted. Photographs would be taken of the painted squares perpendicular to the ground surface after painting and during tracer resurveys.

Tracer transects would be checked for movement after any discharge that exceeds the expected threshold of mobility, which would be calculated using the results of the pebble count and cross-section survey. Tracers would be placed upstream and downstream of the project reach at initiation of the project. Tracers would be placed in the project reach after construction of channel or bank features. Tracers would only be placed in the project reach before construction if it were estimated that at least one flood season would pass between project initiation and construction. When documenting tracer particle movement, the distance downstream and the general direction of movement would be measured and recorded.

In addition to tracer gravels, scour chains would be placed at each tracer transect. Scour chains are used to measure the maximum scour and deposition during a given flow event. A scour chain is a chain or strong cord that is buried vertically into the channel bed. The chain is buried in the bed using pipes pounded into the channel bed below the expected maximum depth of scour (Lisle and Eads, 1991). The amount of chain draped over the bed is

measured and the location of the chain surveyed with a survey-quality GPS or total station. The elevation of the horizontal chain segment indicates the maximum scour depth and the depth of burial indicates the amount of deposition. Two rows of scour chains would be installed at each tracer gravel site at 6-foot intervals. Scour chains would be checked when the tracer gravel transects are resurveyed.

Tributary Projects

Similar pilot-scale projects are recommended for tributaries to Cottonwood Creek. Although not an immediate erosion concern, their smaller and more confined scale make tributaries ideal for studying certain components (e.g., sediment delivery and transport rates to the mainstem of Cottonwood Creek) of the watershed's sediment budget. For example, gradient control structures could be installed to halt head cutting and stream widening in tributaries in parallel with measuring sediment transport rates in tributary streams, which could then be extrapolated throughout the watershed to refine the sediment budget. Further, the small tributaries are essential habitat for spring run salmon; thus, these locations might be particularly attractive to funding agencies concerned about the salmon in the watershed.

To determine whether incision has occurred in tributaries to Cottonwood Creek, a reconnaissance-level geomorphic assessment could be conducted on key tributaries. If incision in the tributary channels is identified by such indicators as eroding banks, undermined bridges, cut banks, exposed buried utilities, or channel scour to bedrock, a pilot gradient control structure could be constructed. The structure would be designed to provide passage for migrating fish and to stop further incision of the tributary channel bed. In addition to the monitoring methods discussed previously, suspended load and bedload sediment samples would be collected in key tributaries. Measuring the sediment load of select tributaries would significantly improve the sediment budget for Cottonwood Creek. Sediment load sampling would be conducted for a range of flows to determine a sediment transport rating curve. Standard methods outlined in *A Field Calibration of the Sediment-Trapping Characteristics of the Helley-Smith Bedload Sampler* (USGS, 1980) and *Field Methods for Measurement of Fluvial Sediment* (USGS, 1999) would be followed.

Conjunctive Lema Ranch Study

Before beginning the riparian restoration and bank stabilization project planned at Lema Ranch, a gravel tracer study in the area, particularly in and around the gravel bar, could be performed to provide information about gravel transport processes in Cottonwood Creek. The techniques discussed in this TM, including mapping channel bed forms, installing permanent monitoring cross sections, and surveying a longitudinal profile, could also be applied at Lema Ranch if they are not already a part of that project. Taking advantage of the bioengineering project already underway in the watershed could be a very effective way to gain a greater understanding of geomorphic processes in Cottonwood Creek, and could contribute significantly to development of best practices for this effort.

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Cottonwood Creek Watershed

Cottonwood Creek Watershed Geomorphology and Bank Stabilization

resented to ottonwood reek Watershed Group

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Cottonwood Creek
Purpose

- Introduction
- Cottonwood Creek Background
- Basic geomorphology conceptual models
- Summary of recommended watershed studies
- Summary of Bioengineering techniques
- Questions

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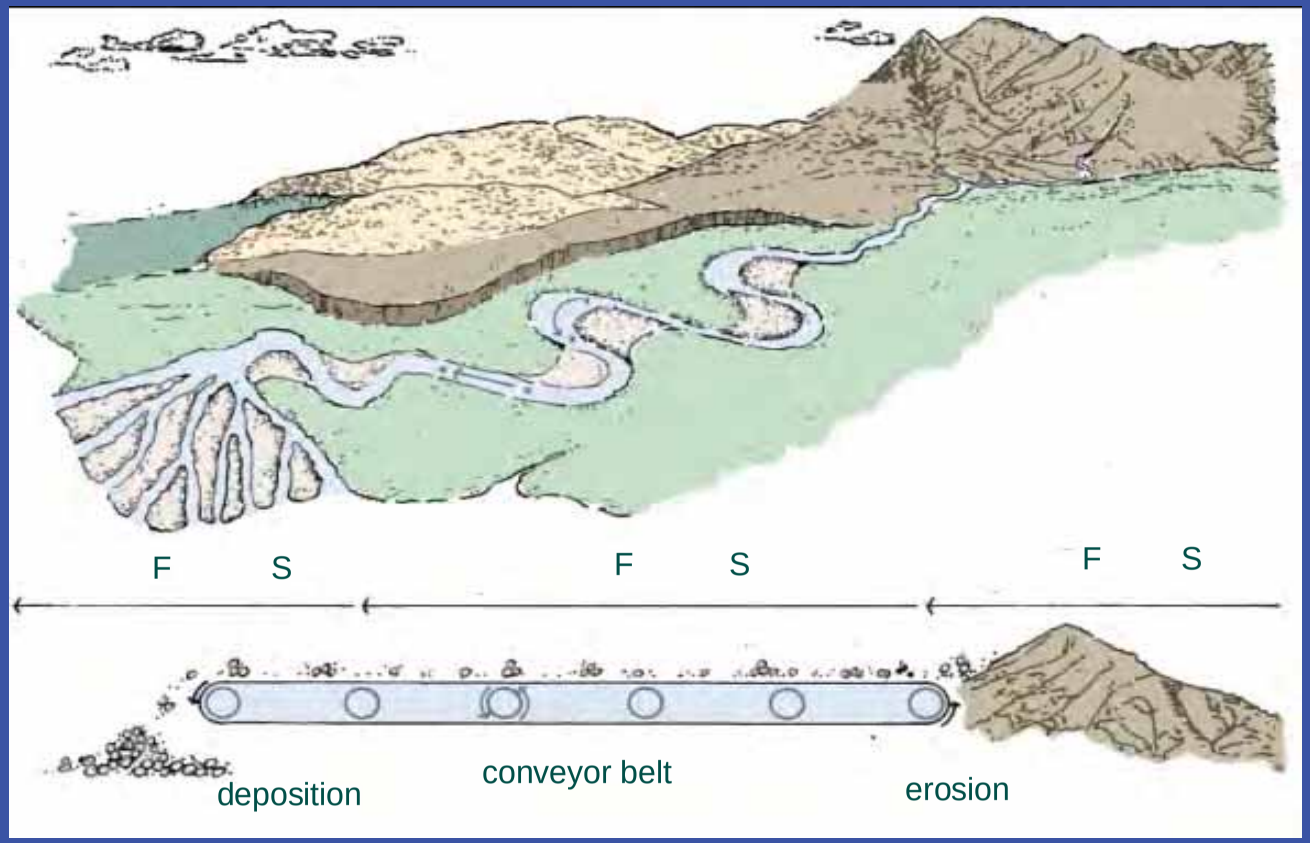
Cottonwood Creek
Background Information

- Largest undammed watershed in the Sacramento Valley
- 3rd largest Westside tributary to the Sacramento River
- 938 square-mile drainage area
- 586,000 acre-feet annual runoff
- Q_2 21,600 cfs
- Mean daily discharge for the winter 2,480 cfs
- Mean daily discharge for the summer 71 cfs

Cottonwood Creek
Connection to the Sacramento/San Joaquin Bay Delta

- Cottonwood Creek contributes 33% of the total gravel bedload to the Sacramento River
- Provides second largest sediment input to the Sacramento River
- Prime source of spawning gravel for Chinook Salmon in the Upper Sacramento River
- Only tributary providing significant supplies of spawning gravel to 30 miles of the Sacramento River

Basic Geomorphology
Sediment Transport



Sediment transport at the watershed scale. (Stillwater Sciences 2002 modified from Kondolf and Matthews 1993)

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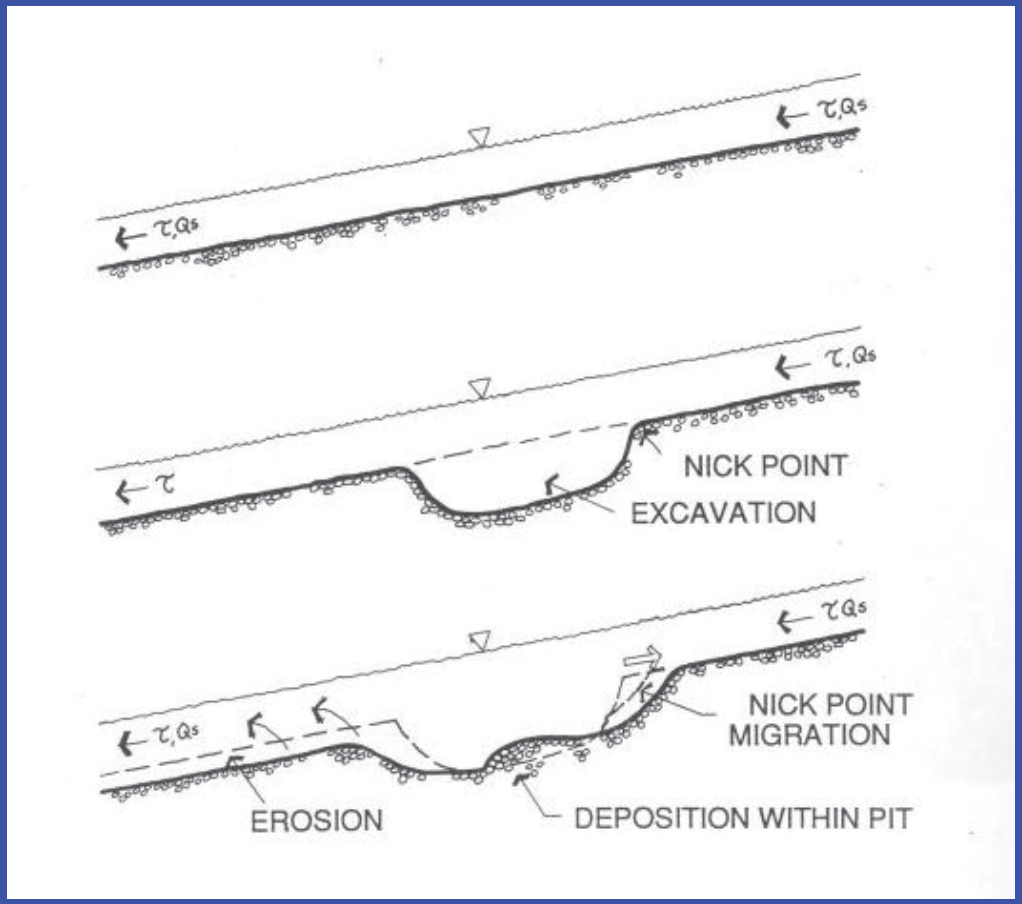
Basic Geomorphology
Knick point Migration



Incision produced by gravel mining. (Kondolf et al. 1996)

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Watershed Studies

- **Sediment Budget**
  - nventory of inputs storage and transport of sediment in the creek
  - eed to determine sediment transport rate to select management solutions
  - sed to predict performance of bioengineered structures in the channel and along the banks
- **Roads Inventory**
  - bandoned roads in the upper watershed have not been stabili ed or rehabilitated and could be impacting the sediment dynamics of the creek
  - etermine if landslides in upper watershed are the result of road building activity

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Bioengineering Tools
Purpose

- Bank stabilization to limit erosion
- Enhance riparian corridor
- Collect data on sediment transport and discharge
- Require site analysis before implementation

Cottonwood Creek Watershed Group

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Bioengineering
Willow Mattress

- Composed live cuttings and soil fill
- Willows root easily and cuttings can be taken from existing willows along the creek
- Creates riparian habitat and protects the bank
- Susceptible to scour during high flow events

Cottonwood Creek Watershed Group

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Bioengineering
Willow Mattress

Cottonwood Creek Watershed Group

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Bioengineering
Spur Dykes

- Structures that extent into the channel to deflect flows away from the bank
- Can be constructed with a soil core and planted
- Typically armored with rock or large woody debris, which provide habitat
- Two to five structures are typically placed along a bank

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Bioengineering
Spur Dykes

Cottonwood Creek
Watershed Group

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Bioengineering
Bank Shaping and Planting

- **Applicable to steep or cut banks where there is room to re-grade the channel bank**
- **The bank is graded based the following characteristics:**
  - geotechnical
  - soil
  - hydraulic
  - channel geometry
- **Re-grade slope is planted with native vegetation**
- **Toe of the slope can be further stabilized with boulders or logs**

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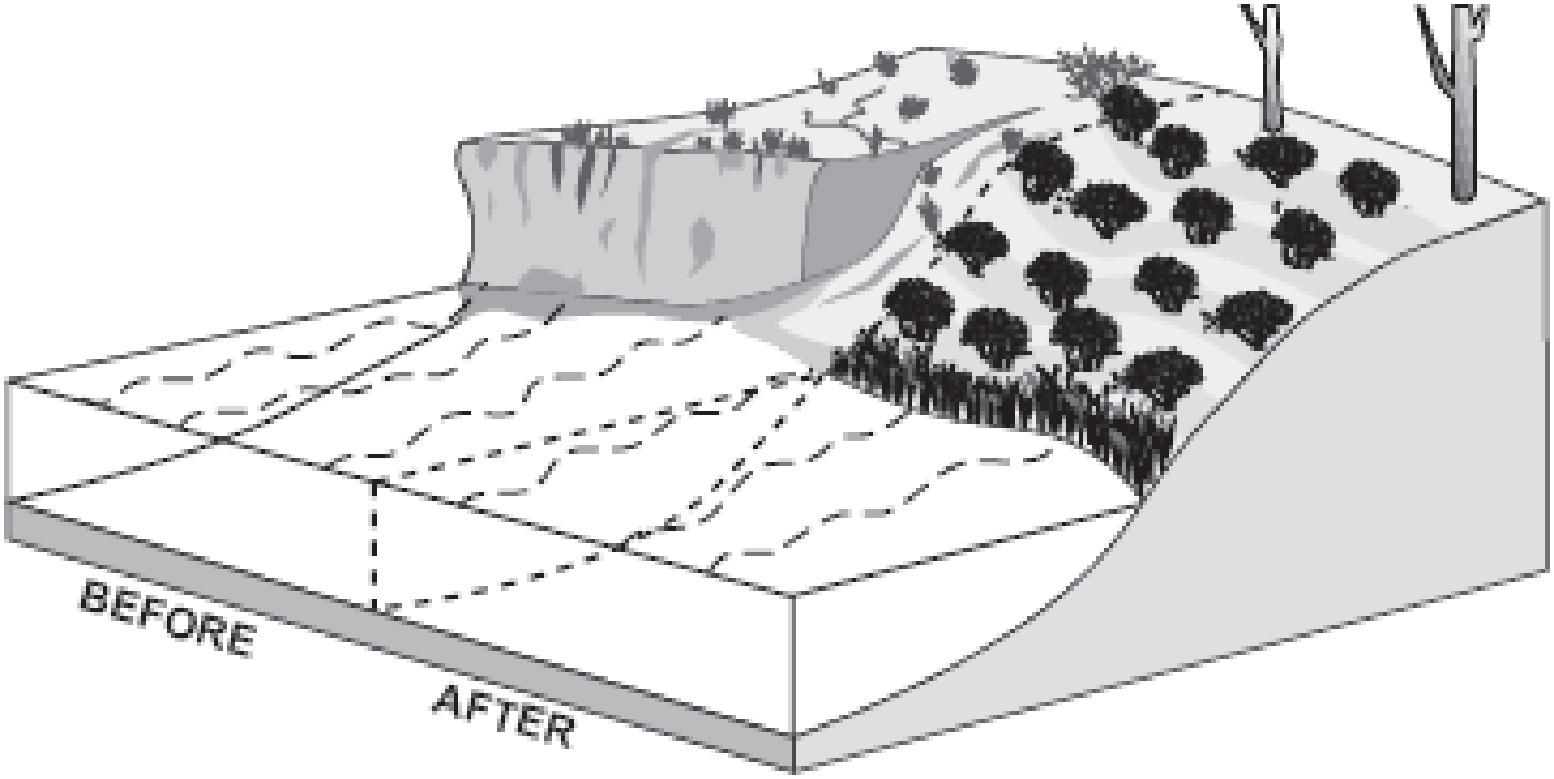
Bioengineering
Bank Shaping and Planting



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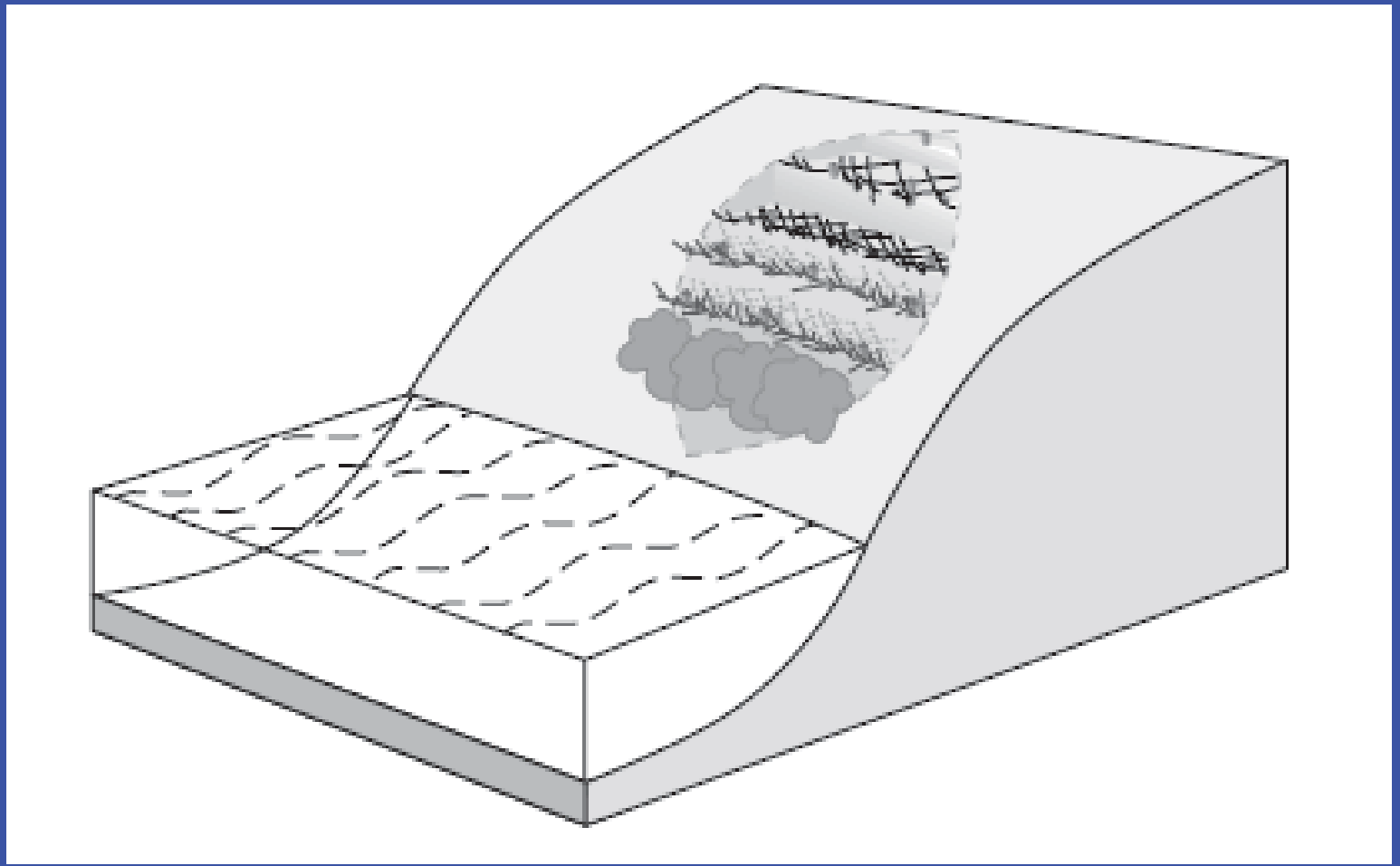
Bioengineering
Branch Packing

- Applied to channel bank failures
- Alternating layers of live branches and compacted fill are “packed” into the failure site
- Susceptible to high flow events
- Similar to willow mattresses
-

Bioengineering
Branch Packing



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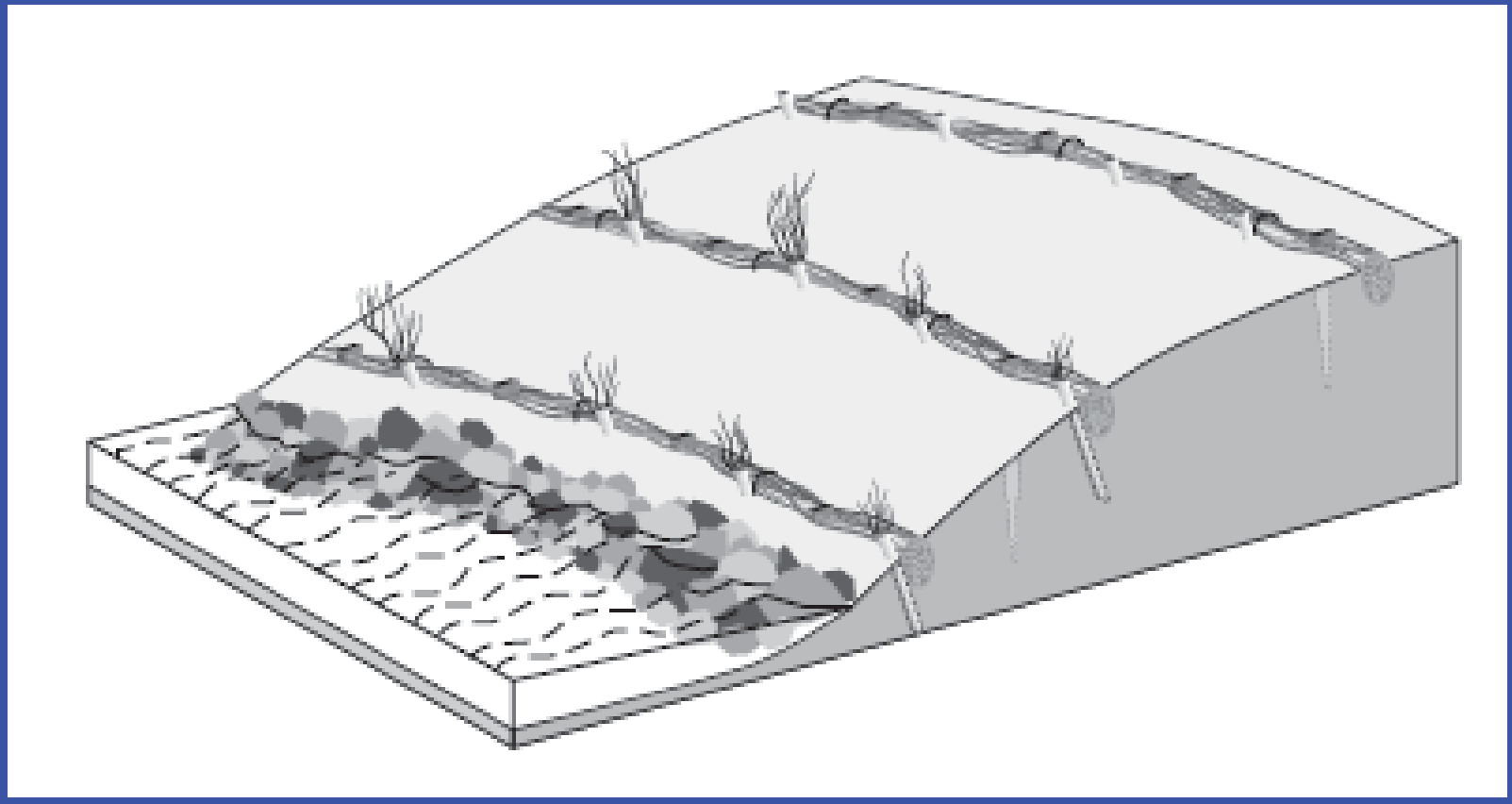
Bioengineering
Live Fascine Installation

- Bundles of riparian cuttings are placed in shallow trenches parallel to the bank
- wooden stakes or riparian vegetation cuttings are used to secure the fascines to the bank
- Toe of the bank can be further protected with boulders or logs
- Not applicable for severely eroded banks
- provides riparian habitat

Bioengineering
Live Fascine Installation



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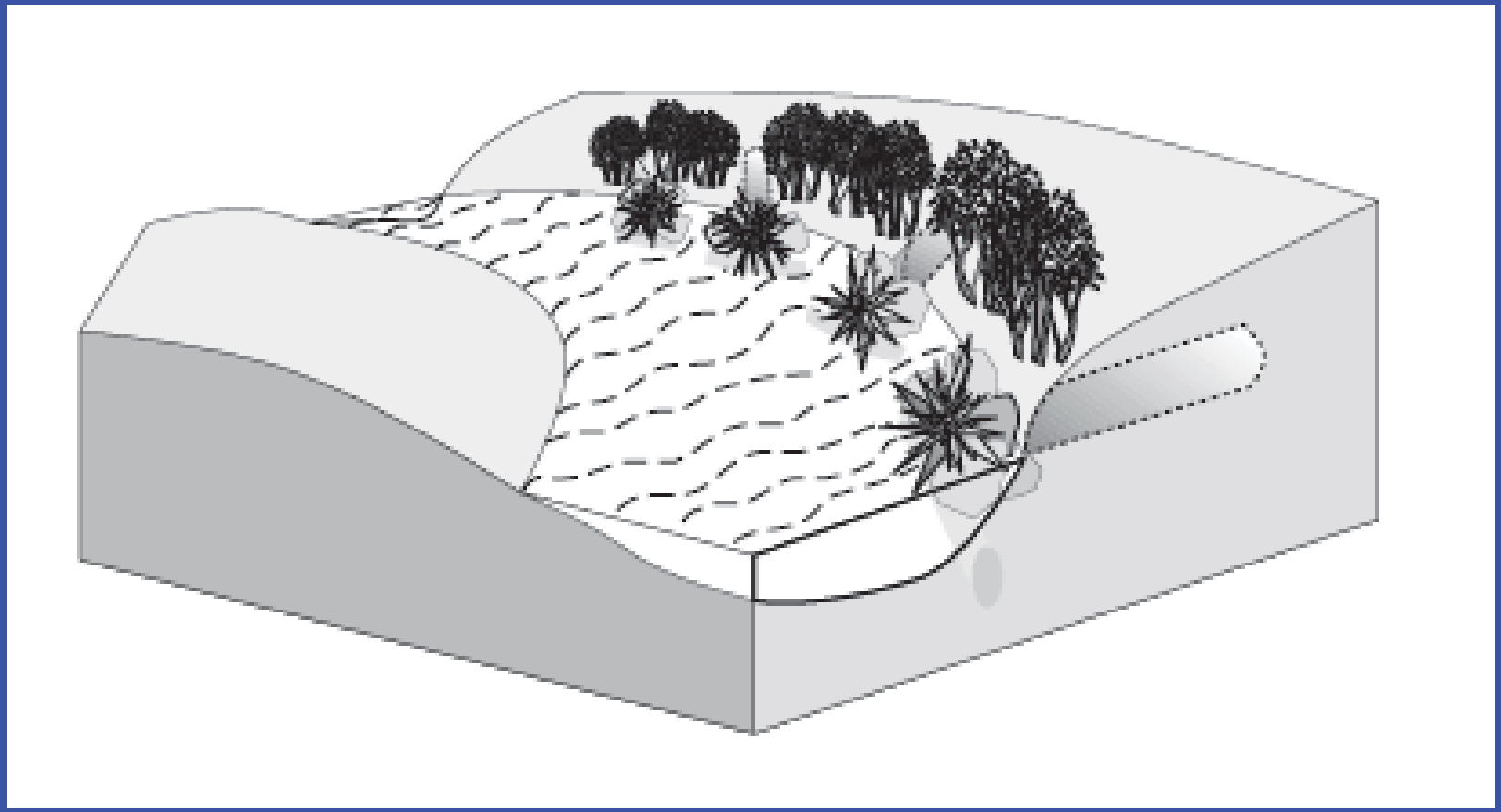
Bioengineering
Log, Rootwad, and Boulder Placement

- Used on the outside bend to stop bank erosion
- Provides aquatic and riparian habitat
- rootwads are faced into the channel to difect the flow from the bank
- Boulders are placed along to bank
- Often logs and boulders are cabled together to prevent mobilization during high flows
- Expensive and can induce localized scour

CH2MHILL

Bioengineering
Log, Rootwad, and Boulder Placement



Cottonwood Creek Watershed Group

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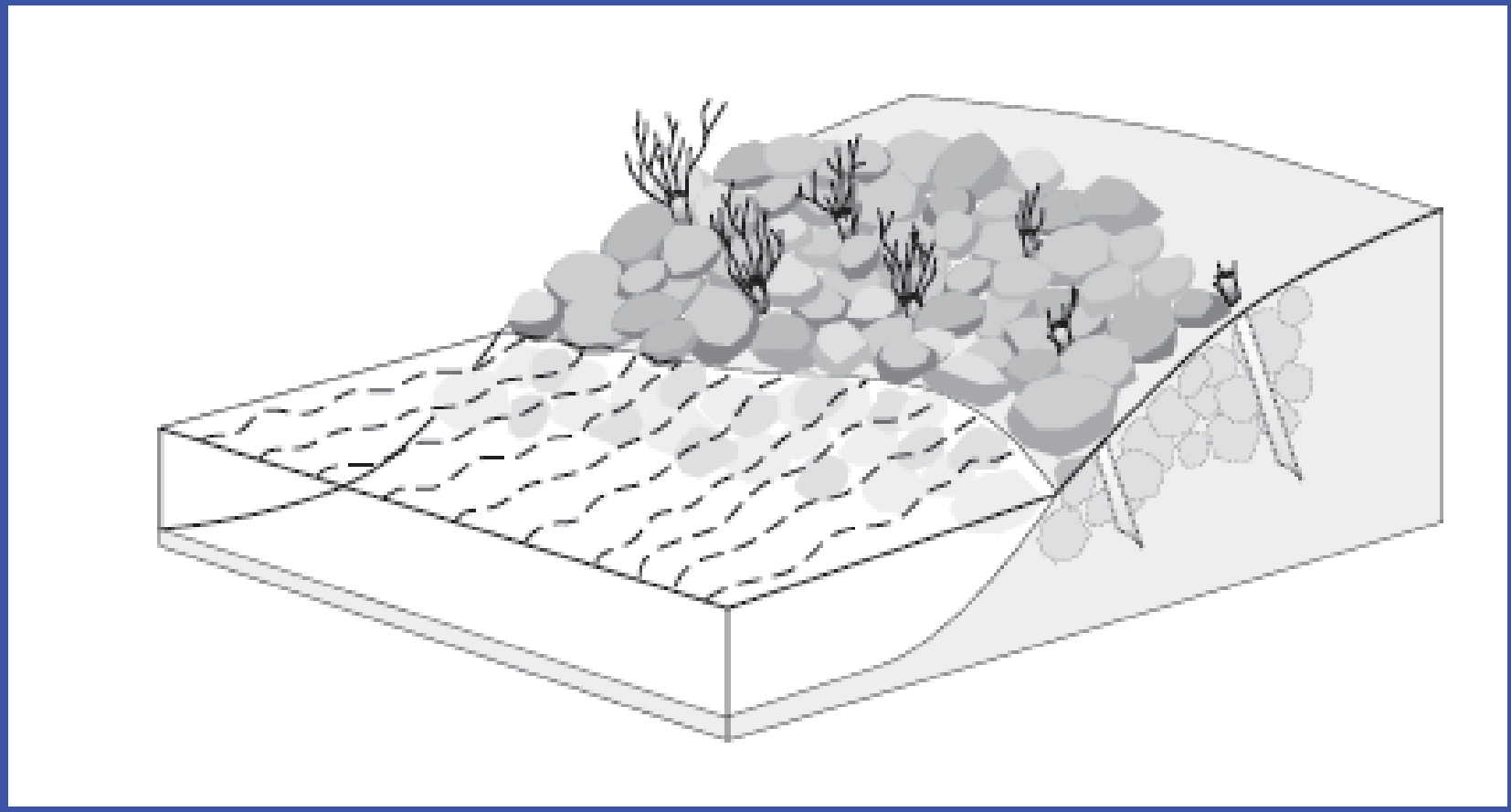
Bioengineering
Joint Planting

- Used in areas with high bank erosion rates
- Bank is lined with large boulders
- Live cutting poles are planted in between boulders
- Provides the highest level of bank protection
- Limited habitat value
-

CH2MHILL

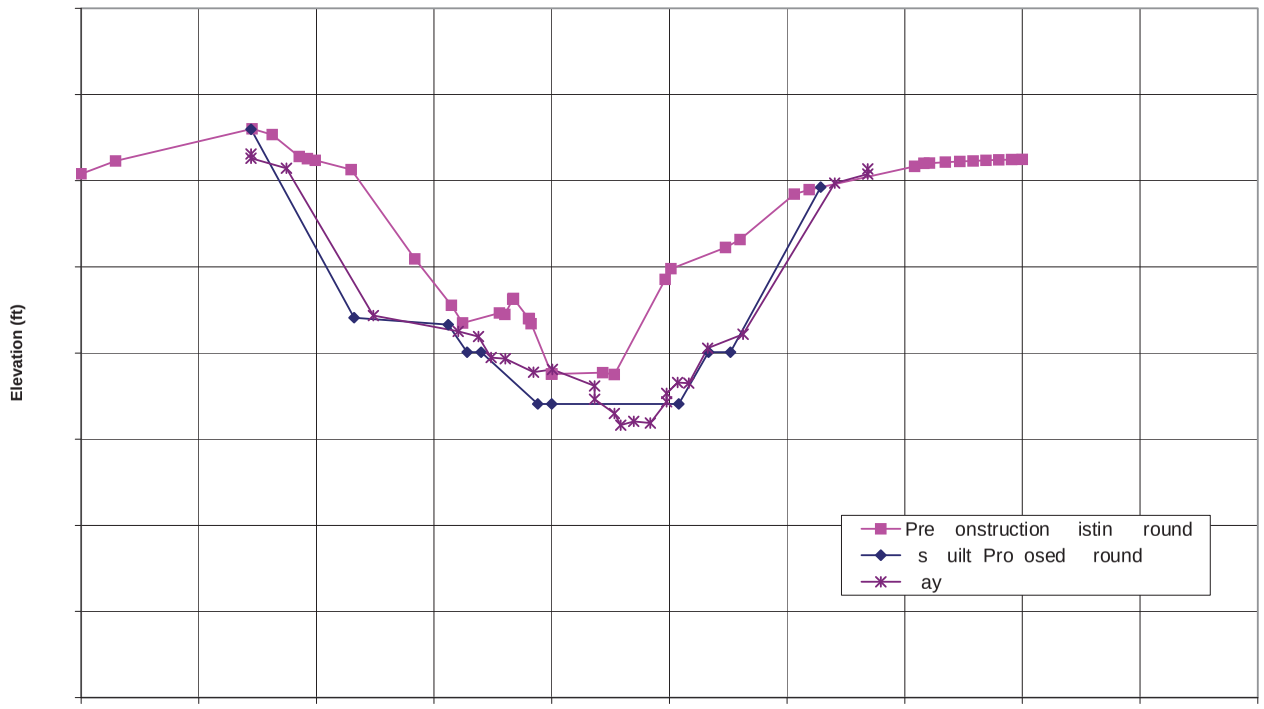
Bioengineering
Joint Planting



Monitoring Tools
Channel Geometry

- **Channel and bank manipulation will have an impact on the channel**
- **Channel impacts and project performance can be monitored and assessed by the following methods:**
  - Longitudinal profile survey
    - *Survey of the bed elevation along the deepest part of the channel*
    - *Shows how the shape of the channel changes with time*
    - *Shows the change in location of channel features (pools, riffles, runs)*
  - Permanently monumented cross sections
    - *Survey across the channel*
    - *Shows changes in location, width, and depth of the channel and steepeness and shape of the channel banks*

Monitoring Tools
Re-surveyed Cross Sections



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Monitoring Tools
Bed material Composition and Sediment Transport

- **Alteration of the channel or banks will have an impact of the bed material composition and sediment transport characteristics of the study site**
- **Determining the bed material composition is important for sizing bank stabilization material**
  - et ods
    - *Pebble counts*
    - *Facies mapping*

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Monitoring Tools
Bed material Composition and Sediment Transport

- **Understanding sediment transport will guide the design of potential bank stabilization treatments**
- **Methods:**
  - racer ra el studies
    - *Placement of surveyed, painted rocks in the channel*
    - *Re-survey of tracer transects after high flows*
  - cour ains
    - *Placement of chains buried in the channel bed*
    - *measurement of the exposed length of chain and survey of chain location*
    - *Re-measurment of chains after high flows*

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Monitoring Tools
Pebble Count

Cottonwood Creek Watershed Group

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Monitoring Tools
Tracer Gravel Study

Cottonwood Creek Watershed Group

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Tributary Projects
Purpose

- **Processes affecting the main channel will have a similar impact on the tributaries to Cottonwood Creek**
- **The smaller size of tributary channel makes then easier to study and the information can be applied to the mainstem**
- **Example projects include:**
  - radient control structures to alt eadcuttin and c annel incision
  - edload sediment trans ort monitorin to de elo sediment trans ort ratin cur e
  - econnaissance le el eomor ic assessment to determine c annel condition

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Questions

Cottonwood Creek Watershed Group

CH2MHILL

Cottonwood Creek Watershed Management Plan Management Plan Development Workshop: Channel and Riparian Conditions in the Cottonwood Creek Watershed
August 24, 2006

FROM: Ed McCarthy / CH2M HILL
Anthony Falzone / CH2M HILL
Susan Lukso / CH2M HILL

DATE: August 30, 2006

Attendees:

Julia Arnold / CCWG	Chuck Lema / Landowner
Jan Lopez / CCWG	Jennifer Williams / Landowner
Vieva Swearingen / CCWG	Guy Chetelat / RWQCB
Tricia Bratcher / CDFG	Brenda Olson / USFWS
Curt Howitt / CDFG	Aric Lester / DWR
Tom McCubbins / CDFG	Ed McCarthy / CH2M HILL
Dee Swearingen / Consultant	Anthony Falzone / CH2M HILL
Joe & Ellen Coil / Landowner	Susan Lukso / CH2M HILL

COPIES: Vieva Swearingen / CCWG

Introductions and Meeting Purpose

Vieva Swearingen / CCWG started the meeting at 6:40 p.m. and introduced the presenters and attendees.

In 2001 CH2M HILL did a Watershed Assessment of the most current data on the Cottonwood Creek Watershed (CCW). In 2005 they developed a Watershed Strategic Plan (WSP) in consultation with stakeholders that detailed the desired conditions for the CCW. These two plans, as well as the five stakeholder workshops held in March, April, and August 2006, will be the basis of the Watershed Management Plan (WMP). A draft version of the WMP will be made available for public comments in October 2006. Copies will be given to the directors and the technical advisory committee. Additional copies will be obtainable from the CCWG office.

The Channel and Riparian Workshop is a continuation of the Fire and Fuels Management Workshop held in April 2006. CH2M HILL also welcomes feedback on the presentations and technical memoranda.

Anthony Falzone / CH2M HILL began the discussion of the Management Plan Development Workshop: *Channel and Riparian Conditions in the Cottonwood Creek Watershed [Technical Memorandum]* (CH2M HILL, August 21, 2006) findings with the usage of a PowerPoint presentation (*Cottonwood Creek Watershed Geomorphology and Bank Stabilization*, August 24, 2006). A copy of the presentation was emailed to Vieva Swearingen on Tuesday, August 29, 2006.

Discussion

Topics of discussion:

Question – Guy Chetelat / RWQCB: How can the gravel miners claim that there has been no change in the elevation of Cottonwood Creek where they have removed sediment?

Response – Anthony Falzone: The Knick Point Migration theory explains how the miners can be correct in their assessment. However, even if there is not elevation change, there can still be bank erosion.

Question – Brenda Olson / USFWS: What other types of factors besides gravel removal can cause bank erosion?

Response – Anthony Falzone: Overgrazing of vegetation and urbanization of neighboring land can contribute to erosion.

Comment – Dee Swearingen / Consultant – The gravel companies' initial permits were for in stream gravel mining. This allowed for more invasive cutting into the creek beds. The current permits are for skimming of gravel beds.

Response – Anthony Falzone: This has less of an elevation impact than the mining that took place in the past. The use of the geologic scale operational method on the creek would show the effect of changes many years after a disturbance to the creek.

Question: How is a willow mat constructed?

Response – Anthony Falzone: They are made by weaving willow cuttings and anchoring them along the bank. It's a cheap solution since the cuttings can be taken from neighboring trees.

Comment: A toe trench is needed to provide water for the cuttings. It can be backfilled once the willows are established. The creek is diverted into the trench.

Comment: Spur dykes can do damage to creeks if installed improperly or in incorrect areas.

Response – Anthony Falzone: All of the bioengineering methods that are to be discussed can cause damage if improperly placed. A survey should be done prior to implementation of bioengineering tools.

Comment – Brenda Olson: Using wood is preferable in the construction of spur dykes. They need to be submerged a large portion of the year in order to preserve the wood, but it provides more of a natural habitat than other construction materials.

Question: Are there any examples of spur dykes in the area?

Response – Anthony Falzone: There are no known examples nearby. In the Sonoma County Dry Creek spur dykes have been successfully used. CCW might need multiple spur dykes installed.

Question: Are there any examples of bank shaping and vegetation planting in the area?

Response – Ed McCarthy: Sulphur Creek near Turtle Bay has had this technique employed.

Question: Can the banks be refilled with soil or gravel instead of being shaped?

Response – Anthony Falzone: Yes, it could be, but armor still needs to be installed. Create a pilot channel. Refilling the banks might narrow the creek, and there could be other changes from this narrowing.

Question – Dee Swearingen: What about narrowing the creek to its historic width?

Response – Anthony Falzone: The creek has been adjusting to external changes by changing its flow pattern. That is why erosion is happening. Eventually the river would reach a new equilibrium and stop eroding the banks. If the creek is narrowed back to its historic width, it will need to be studied to observe the affects down river. In-stream structures could be installed to stop incising. Refilling is not typically done.

Comment – Dee Swearingen: The banks are eroding to the hard pan where there is no gravel. In order for the riparian habitat to be reestablished, the gravel needs to be replaced.

Comment – Chuck Lema / Landowner: Why is the creek bending so much and consuming so much land? The willows and dirt are present in the creek in the areas with the most extreme erosion. If the CH2M HILL consultants go to those sites, they will see it for themselves. Gravel needs to be added to the banks, not dirt or willows. This was done along the Lema Ranch creek banks with great success. Erosion has stopped.

Response – Ed McCarthy: A sediment budget needs to be done. In addition to gravel additions, spur dykes would help to reduce sediment erosion. Different tools for different locations could be implemented only after evaluating the entire creek to determine possible impacts of the structures up and down stream.

Comment – Dee Swearingen: Landowners had done bioengineering in the past without consultation or studies. They'd removed willows and stumps up until the requirement and enforcement of permits.

Question – Ed McCarthy: What has been the experience of landowners who have asked for stream bank alteration permits fromCDFG? Were they rejected?

Response – No one knows of anyone that had a permit application denied. But there was concern about funding for stream bank alteration work and some general fear about applying for permits.

Response – Dee Swearingen: Chuck Lema obtained such funding but others have not been successful. The lack of match money is a big reason for funding refusal. The cost of equipment and hiring bioengineering services on their own impedes self-contracting work. The landowners may have better success if they approach the funding proposals with the

angle that fixing the bank erosion problems would aid riparian, fish and wildlife habitats. The technical memoranda are missing that recommendation.

Question – Brenda Olson: What kind of creek flow would allow sediment to flow in a healthy pattern? Sediment transportation and bank stabilization need to be in the WMP. It's too late to reverse the creek condition to exactly the way it was without management. More drastic and invasive measures need to be utilized and those can only be done with management.

Response – Ed McCarthy: To know what a stable creek should be, a sediment budget and additional studies about the current creek status need to be done. Funding needs to be obtained. Graham Mathews broached this subject, but it still needs to be done.

Response – Anthony Falzone: More studies need to be done to understand how the channel can be fixed. Bioengineering is just a Band-Aid.

Question: Will Cottonwood Creek be managed or unmanaged creek?

Response – Dee Swearingen: Adaptive management is recommended as it would allow for keeping both the stakeholders and habitat protection agencies interests in mind.

Comment: A sediment budget needs to be done first.

Comment – Brenda Olson: Objectives and goals need to be determined first.

Comment – Ed McCarthy: As long as there is work in the creek, like gravel mining or the work Mr. Lima is doing, the creek is managed.

Comment – Chuck Lema: Have a channel for the water to go into other than widening the creek through erosion. Clear the channel of willows in most parts.

Response – Vieva Swearingen: The group needs to walk the creek to determine what parts need to be managed. It needs to be known in its year-round states. Stakeholders need to determine if it should be managed or unmanaged. A sediment budget should be done but funding agencies had discouraged that in the past by saying it was unnecessary. Vieva will email the consultants and stakeholders to arrange a Saturday tour led by Tricia Bratcher and Brenda Olson.

Comment – Anthony Falzone: A sediment budget would be unnecessary if flood control measures are done in the channel (i.e., removing willows, reinforcing and armoring banks).

Response – Dee Swearingen: Armoring the banks is not an option. Management with natural materials must be the plan.

Comment – Ed McCarthy: Suggestions for tools and techniques have been requested by the stakeholders.

Question – Jan Lopez: The watershed needs to have its flash floods slowed down in the upper tributaries so that the aquafers to the West can be recharged. What can we do to manage a little to make water more beneficial and less intrusive?

Comment – Chuck Lema: At the Lema Ranch, the gravel was removed from the channel and placed along the banks. During the high water season, the water is calm along that

section of the creek bank and rapid in the center. There has been no additional erosion since the bank work was done. Based on this example increasing sediment is not needed in the creek.

Response – Anthony Falzone: Sediment budgeting will answer the question of what is happening to the creek now in terms of where the sediment is entering and exiting. Why is it eroding? What is it trying to do or where is it trying to go? Is the creek bed being scoured or is sediment being deposited?

The Cottonwood Creek situation is unique because there are no dams.

There are different types of sediment depending on size. Coarse sediment is good for fish and the hardest to observe. Fine sediment is harmful to fish and the easiest to be transported.

Question: Will the sediment budget answer whether the stream is in balance?

Response – Anthony Falzone: Yes. It will tell us whether a delta is being created or if the creek is sediment starved.

Comment – Ed McCarthy: The steeper the stream, the quicker it is. The increase in speed can cause bank erosion.

Question – Aric Lester: What is done after the sediment budget?

Response – Anthony Falzone: The sediment budget will determine what would need to be done to make the creek health. Consistent and appropriate behavior will be sought. Most likely a pilot channel will be created. Hopefully it will be self-maintaining but can be maintained with adaptive management.

Question – Aric Lester: What will be done if the creek is becoming a depositional zone?

Response – Anthony Falzone: That is unknown at this time.

Response – Ed McCarthy: Graham Mathews did not think that the creek is becoming a depositional zone.

Comment – Dee Swearingen: It is a waste of money if we only do a sediment budget. We also need to know the current condition of vegetation. Studies on the impact of willows along the shore and piles of gravel and willows mid-stream need to be done.

Comment – Vieva Swearingen: Aerial photos would show erosion around the areas that willows and gravel have built-up. We have a landowner that takes aerial photos of the creek every year. We should be able to use those photos to answer some of these questions.

Comment: The sediment budget should assist in the development of a self-sustaining creek management system with occasional assistance through management. Active management would be necessary initially. Access to the creek through permitting is still an issue.

Comment: - Aric Lester: There have been coordinated efforts for obtaining permits on Stony Creek. It's probably a parallel to the Cottonwood Creek project.

Response – Vieva Swearingen: CCWG cannot do permit coordination because it is a non-profit. Stony Creek is part of an RCD (Resource Conservation District). The sediment

budget recommendation should be in the WMP but still list action items like removing willows.

Comment – Anthony Falzone: The geomorphic assessment will include the sediment budget and the goal of designing a self-sustaining creek.

Comment – Dee Swearingen: We need to know the scouring velocity. Would a 2' shot rock move?

Response – Anthony Falzone: The channel will continue to widen until it reaches its own equilibrium.

Question – Ed McCarthy: How is a scouring velocity determined?

Response – Anthony Falzone: A tracer gravel study or scourer trains study can be done. Bedload sediment transfers are done in smaller tributaries. A lot of data is needed to study sediment because it moves in pulses. It will take a considerable amount of effort to do the study.

Question: Would a sediment budget help to identify a sustainable amount for gravel mining?

Response – Anthony Falzone: Yes it can but those findings have been contested in other places in the past.

Comment: CCWG would like more long-term, sustainable tools and less short-term tools.

Response: Initially the studies and tools were intended for the middle fork, however, if the smaller creeks are identified as having significant flow issues, than they could be included. Stakeholders could help to identify the relevant creeks.

Comment: The WMP should include baseline information on creek confluence and slides of upreach creeks. As a data-point include data from other creek slides.

Response – Vieva Swearingen: The CH2M HILL consultants have never been at the creek. A tour for the consultants and stakeholders will be planned.

Comment – Dee Swearingen: CH2M HILL consultants have been at the creek for other projects.

Response – Ed McCarthy: I have driven along the creek to become acquainted with it for this project. I looked at as much as I could but most of the creek isn't open for public access, as the stakeholders know.

Response – Anthony Falzone: The ideas presented in the technical memoranda are generalized. Bioengineering studies would require extensive presence on the creek.

Comment: Touring the creek would have a community outreach affect. By walking the creek the consultants would know the problems more thoroughly and help the stakeholders understand the reason for the pattern changes.

Question – Anthony Falzone: Is there a way to fund conceptual design field work?

Question – Tricia Bratcher / CDFG: What about the Integrated Regulation Water Management Plan funding status?

Response: The funding is still available. More will be known in November.

Comment – Vieva Swearingen: Collaborate to obtain the funding so it can be used to finance the geomorphic conceptual design field work.

Response: The basic scientific study of the CCW needs to be pursued. The sediment budget and geomorphic design plan would be the beginning.

Comment – Dee Swearingen: The CCWG grant applications should focus on the CCW's status as providing 33% of the Sacramento River's spawning fish.

Response – Ed McCarthy: There is still a lot to be learned about the fish in the watershed.

Comment – Tricia Bratcher: The AFRP (Anadromous Fish Restoration Program) is not a likely source for funding. Private property grants typically require recipient match of the funding and studying the affects up and down stream of the bioengineering.

Comment – Dee Swearingen: Shot rocks, not round rocks, are necessary for bioengineering; however, they are more costly. Equipment for placing the gravel is costly. These factors and points Tricia made make bioengineering efforts too expensive to achieve by a single landowner. The WMP has to show the value of all possible options so landowners have choices that they can afford and achieve.

Question – Guy Chetelat: Has anyone done preemptive planting of trees to prevent erosion?

Response: The trees did not stop the erosion from happening. It is not the act of rising or running water that causes the erosion. It is when the water recedes that the soil sloughs off.

Comment – Anthony Falzone: When the water recedes, the water in the soil goes to the lowest point. The saturated soil, down to the bedrock, goes with the water back into the creek.

Question: If funding agencies and consultants recommended not doing a sediment budget in the past, how can we expect to obtain funding for it?

Response – Jan Lopez: We can focus the application on the contribution of the watershed to the Sacramento River and delta. The CCWG needs to increase statewide knowledge and attention about the watershed. It is not widely known how significant the watershed is to the Sacramento River. Studies need to be done to shape and strengthen the CCWG's arguments and actions.

Comment: The CCWG should increase its presence among the politicians and agencies in Sacramento.

Meeting ended at 9:00 pm

Cottonwood Creek Watershed Management Plan: Background Information for Workshop on Erosion and Flooding – Workshop 1, March 29, 2006

Objective

The purpose of this workshop is to bring together stakeholders to determine the direction of the Cottonwood Creek Watershed Management Plan. The goal is to arrive at a consensus among stakeholders about the desired erosion and flooding conditions of the watershed. The workshop discussions will be instrumental in developing a comprehensive Watershed Management Plan and, ultimately, providing a rational, science-based approach to cooperatively managing the Cottonwood Creek Watershed with a diverse set of stakeholders. The workshop participants will outline a vision for the watershed including conceptual strategies for environmental management, long-term monitoring, and education.

Project Introduction

One workshop will be held for landowners, resource agency members, and other stakeholders on erosion and flooding. This will provide an opportunity for stakeholders to receive information on present watershed conditions and discuss and prioritize desired watershed conditions. This workshop on erosion and flooding will help to develop strategies for achieving the desired erosion and flooding conditions of the watershed. Four additional workshops are scheduled to cover the topics of Fire and Fuels Management, Fish Ecosystems, Water Supply, and Public Education and Outreach.

Watershed Assessment (CH2M HILL, 2002)

This watershed assessment compiled information related to hydrology, sediment and fluvial geomorphology, soil resources, water quality, vegetative cover, fishery resources, wildlife resources and habitat types, special-status species, riparian communities, and land use. Findings and recommendations from these topics that are pertinent to erosion and flooding issues are presented below.

Findings

- Hydrology of Cottonwood Creek is extremely variable.
- There is very little naturally occurring water storage in the watershed.
- Sediment and gravel resources in Cottonwood Creek provide economic and environmental benefits.
- The current land use and sediment resources of Cottonwood Creek are not mutually compatible.

- There is little information available on the relationship of the soil resources to site productivity and/or erosion issues.
- There are discrepancies and contradictions among published reports on the existing sediment transport rates in Cottonwood Creek.
- A comprehensive mapping effort is being conducted for U.S. Forest Service lands that will provide additional information on soil and geomorphic relationships. To date, geomorphic mapping (landforms such as landslide and fluvial areas) has been conducted; however, the U.S. Forest Service is currently in the process of completing the work that will make the mapping data useful in Geographic Information System (GIS) databases. This effort will likely be completed within the next year. Soils mapping is planned for the future, and none (other than the Order 3 soil survey mapping) has been conducted to date.

Previous hydrologic analyses include the following:

- U.S. Army Corps of Engineers (1977)
- USGS McCaffrey et al. (1988)
- Water Engineering & Technology, Inc. (1991)

Recommendations

1. Real-time flow data would be useful for correlating storm events to flooding and implementing flood control projects
2. Additional study is necessary to understand the linkage between the ACID canal and Cottonwood Creek.
3. Additional hydrologic studies are needed to better define the relationship between flow and erosion, especially in the alluvial reaches of the watershed.
4. Develop a study to rectify the discrepancies and contradictions among the published reports on the existing sediment transport rates in Cottonwood Creek.
5. Review and optimize current land uses in light of sediment sources.

Hydrology, Geomorphology, and Historical Channel Changes of Lower Cottonwood Creek (Graham Matthews & Associates, 2003)

The scope of this project was to develop an updated understanding of geomorphic changes that have occurred along the lower 15 miles of Cottonwood Creek through a field-based investigation. The report includes:

- Geomorphic and hydrologic analyses
- Re-surveys of historical data
- Channel geometry information from cross sections and profiles
- Information on bed material composition from field data collection
- Comparison of field data to historical data sets

Findings

Hydrology Results

- Largest flood during 63 years of record was in 1983, with peak discharge at 86,000 cubic feet per second (cfs) (likely a 45-year event)
- Flood frequency analysis indicated 100-year flood at 94,400 cfs and 2-year flood at 21,500 cfs
- Flow duration analysis indicated that all of the geomorphic development accomplished by the creek occurs in less than 5 percent of the time, with most concentrated in 1 percent of the time when flows exceed 10,000 cfs

Geomorphology and Historical Channel Changes

- The sequence of events (i.e., the number of years between significant events) is often as important as the peak magnitudes in determining geomorphic significance.
- Planform analysis, primarily using aerial photographs, resulted in the following conclusions:
  - Channel alignments were quite stable in the 1939 to 1966 period despite a number of large flood events (50,000- to 60,000-cfs flood peak range)
  - It appears that beginning in 1972, some event, sequence of events, or human activity initiated a series of changes that resulted in greater channel instability; more frequent and rapid shifts in the channel alignments occurred, but not all during large floods
  - Since the end of the 1987 to 1992 drought, substantial channel change and bank erosion have occurred at many sites despite no storm flows exceeding an 8-year event
  - Channel migration diminishes with distance upstream
  - Several of the alignment changes appear to have been initiated by activities associated with instream aggregate extraction
- Trends in channel length changes are different for the reach of the creek from the mouth to the South Fork confluence and the reach from the South Fork confluence upstream to the end of the surveys.
- The results of the gaging station analysis that indicated periods of degradation and aggradation were different from those in three other documents: WET (1991); USGS (1983); DWR (1992). This discrepancy is likely because of the time at which the studies were conducted; more significant degradation has occurred since those studies were conducted, and trends are now more apparent.
- Cross section and profile analysis indicated that, relatively speaking, a large amount of channel bed degradation has occurred in a small amount of time. Channel geometry data prior to 1982 is limited to one study (U.S. Army Corps of Engineers, 1977).

- Substrate investigations indicated fair quality salmonid spawning substrate.
- Sediment transport evaluation indicated that computed bedload is approximately 1 percent of the suspended sediment load. The bedload transport values seem quite low, as the literature typically predicts bedload as 5 to 10 percent of suspended sediment load.

Overall Conclusions

Geomorphic changes to lower Cottonwood Creek, 1939 to 2002, are characterized as follows:

- Substantial geomorphic change over past 63 years, especially since 1960s
- Channel lengths and sinuosity have increased by 20 to 25 percent
- Bank erosion is prevalent and has increased substantially in extent and rate in the last two decades

Changes since 1983 USGS study are as follows:

- Substantial changes that are generally deleterious to stream health are likely caused by instream aggregate extraction far in excess of annual replenishment rates.

Effects of instream gravel mining including the following:

- Of 12 potential effects of instream gravel mining, there is evidence that six of these have already occurred or are occurring, including:
  - Bed degradation
  - Bridges affected or pipelines exposed
  - Exposure of other substrates
  - Reduction in overbank flooding
  - Bank erosion increase from bank height increase
  - Reduction in height of gravel bars potentially leading to bank erosion

Recommendations

Future monitoring should include the following:

- At a minimum, re-investigation of the cross sections and portions of the profile established in this study for comparison of existing and future channel conditions
- Optimally, add cross sections to provide improved resolution of changes in channel geometry

Restoration approaches outlined but not recommended:

- **Limited Action** – limited action to protect structural development; generally passive approach resulting in a new equilibrium channel, bank erosion, and floodplain.
- **Moderate Stabilization** – bioengineering solutions, such as channel shaping and extensive revegetation, responding to individual erosion problems; sediment management approach.
- **Extensive Stabilization** – traditional engineering approach resulting in extensive stabilization.

Other recommendations are as follows:

- In-channel gravel extraction should be ended immediately.

Questions Pertinent to Erosion and Flooding Arising from the Watershed Assessment

Members of the Watershed Assessment Technical Advisory Committee posed the following questions. Some of the information provided in the GMA report that was completed subsequently is pertinent to these questions, and is provided below where applicable. The information in the GMA report is not considered definitive; however, it is information on Lower Cottonwood Creek that is available for discussion and critical consideration.

1. Is there any apparent change in annual hydrologic regime for the period of record?

GMA did not recognize a change in annual hydrologic regime when monthly flows were analyzed. At present, no studies indicate that a change in annual hydrologic regime has occurred.

2. Is flood control an important issue – both in Cottonwood Creek and in the Sacramento River?

GMA did not address this topic specifically. However, CALFED priorities for Cottonwood Creek include streamflow regulation and floodplain management plans (CALFED Record of Decision, 2000).

3. What is the relationship between current geomorphic characteristics and historical characteristics? (Assume this means geomorphology of the river channel.)

GMA analyzed geomorphology using a number of methods; however, little quantitative data describing channel geometry were found prior to 1982. As a result, most of these conclusions arise from planform changes and inferences from sequential aerial photography.

Channel alignments were quite stable in the 1939 to 1966 period despite a number of large flood events (50,000- to 60,000-cfs flood peak range). It appears that beginning in 1972, some event, sequence of events, or human activity initiated a series of changes that resulted in greater channel instability; more frequent and rapid shifts in the channel alignments occurred, but not all during large floods. Since the end of the 1987 to 1992 drought, substantial channel change and bank erosion have occurred at many sites despite no storm flows exceeding an 8-year event (GMA, 2003).

The channel is far less braided than it was historically, and is now a single-thread channel in the lower creek study area (mouth to 5 miles upstream of the South Fork confluence). Most of this change has occurred since the 1960s. Channel lengths and sinuosity have increased by 20 to 25 percent over the period of study (1941 to 1999).

4. Is Cottonwood Creek aggrading or degrading?

GMA (2003) compared historical profiles of lower Cottonwood Creek from the South Fork to the mouth. No profile data were located for the reach above the South Fork confluence. Historical profiles from U.S. Army Corps of Engineers (1977), USGS (1982), and the Xtra

Power EIR (1987) were available for comparison. GMA also surveyed a detailed profile from the mouth to 2,000 feet upstream of the South Fork confluence (8.9 miles).

Since about 1975, there appears to be approximately 3 feet of degradation at the USGS streamflow gage. Analyses by the USGS (1983), WDR (1991), and DWR (1992) did not report degradation; however, the mean bed elevation had not changed enough by the time those studies were conducted to warrant findings of degradation. Since 1990, a much more pronounced decline has occurred, and the trend since 1975 is much more readily apparent.

5. What is the current state of gravel extraction and how does this affect channel bed elevation and gravel transport to the Sacramento River?

Presently, in-stream gravel extraction is not allowed in Cottonwood Creek in Shasta County; however, it is allowed in Tehama County. GMA found that profile and cross section surveys demonstrate that significant bed degradation has occurred since 1977 over long reaches of Lower Cottonwood Creek, and is likely attributable to instream gravel extraction. Gravel transport was not specifically addressed.

6. What do the cross section data indicate about the effect of gravel mining?

In 1999 to 2002, GMA re-visited 16 of the mainstem cross sections established by USGS along lower Cottonwood Creek and established seven more (five on the mainstem and two on the Lower South Fork). GMA determined that the channel has incised a considerable amount since 1983 at most of the cross sections. In many cases, the cross sectional areas have also increased 100 to 200 percent as a result of the incision.

> "The primary causes of channel bed degradation include dam construction, urbanization, channelization, and gravel extraction. In extreme cases, vegetation conversion could possibly also trigger incision, through a substantial increase in runoff. Of these, only gravel extraction appears to be involved in Cottonwood Creek at a scale necessary to have caused the observed changes. There is a remarkable correlation in space and time between the presence of gravel mining in the vicinity of Interstate 5 and upstream to the South Fork confluence and a substantial amount of streambed degradation" (GMA, 2003).

7. For all resource areas, what data are lacking?

Data gaps may include, but are not limited to: gravel transport, tons of available gravel, soil resources related to flooding results, and consistent monitoring data.

8. What is the current state of spawning gravel?

GMA conducted bulk sampling at seven sites along pool tail-riffle crest features near the Bengard Ranch. Size distribution indicated that percent fines less than 0.85 mm in diameter, often used to evaluate the quality of spawning substrate for salmonids, ranged from 4.5 to 10.4 percent. These figures indicate fair quality spawning substrate.

9. What is causing the recent episodes of bank erosion in the lower watershed?

GMA suggests that bank erosion has occurred at several locations as a result of geomorphic changes to the Lower Cottonwood Creek stream channel, such as bank height increase and

reduction in height of gravel bars. More erosion seems to be occurring at smaller flood magnitudes in the last 20 years; the rate and extent of erosion has increased substantially in this period.

Cottonwood Creek Watershed Strategic Plan (December 2005)

Summary of Erosion and Flooding Workshops

The Erosion and Flooding workshop included discussion of topics ranging from trespass to erosion. Some landowners expressed concerns about motorized vehicles driving on the dry creek bed. Others mentioned that trespass in the creek offers access for theft of private property. The appropriate course of action to control erosion in the watershed, particularly in the lower watershed, was discussed in depth. Some participants preferred a proactive solution of adaptive management including stream alteration and bank stabilization in heavily eroded areas. This approach would use both aggregate materials and replanting techniques to reinforce eroding banks. Some participants felt that the adaptive management approach was not the best solution and might add to the problem. The Group recommended further investigation of the adaptive management process.

Other erosion considerations included the added sediment load from landslides in the watershed. Landslide zones add significant amounts of mud and sediment to Cottonwood Creek during heavy rainfall runoff periods. Abandoned roads in the upper watershed that have not been rehabilitated or stabilized can also add significantly to erosion and sedimentation. A road inventory and analysis should be completed to identify problem areas and abandoned roads so that they can be replanted and stabilized.

Erosion and Flooding-related Recommendations from WSP

Strategic Area 1: Fuel Reduction and Vegetation Management

- Establish a comprehensive rangeland management plan to address erosion and flooding issues

Strategic Area 2: Inventory and Mapping

- Map riparian areas – floodplain management is related to riparian health

Strategic Area 3: Outreach and Education

- Increase public awareness of trespass
- Address use of motorized vehicles in creek
- Investigate RPD trespass deterrence
- Encourage good riparian habitat stewardship through stakeholder participation
- Develop a set of management tools for stakeholders (handout and website) relating to erosion control, noxious weed abatement, wildlife species, and fuel reduction

Strategic Area 4: Management Plan Development

- Research the Adaptive Management approach
- Develop a floodplain management plan (similar to Clear Creek / Deer Creek)

Strategic Area 5: Monitoring and Modeling

- Develop an ecosystem monitoring plan / watershed monitoring plan
- Develop a monitoring plan to track in-stream changes in the unstable reach of the Cottonwood Creek mainstem (geomorphic monitoring program)

Cottonwood Creek Watershed Management Plan Erosion and Flooding Workshop March 29, 2006

FROM: Mike Urkov / CH2M HILL
Ed McCarthy / CH2M HILL

DATE: March 30, 2006

INVITEES:

Tricia Bratcher / CDFG
Guy Chetelat / RWQCB
Lee Delaney / Landowner
Clarissa Hale / Landowner
Dennis Heiman / RWQCB
Chuck Lema / Landowner
Roy H. Richards, Jr. / CCWG Board
Karen Scheuernan / Landowner
John Schoonover / CH2M HILL
Dee Swearingen / Consultant
Vieva Swearingen / CCWG
Mike Urkov / CH2M HILL

COPIES: Vieva Swearingen / CCWG

Introductions and Meeting Purpose

The meeting began at 2:00 p.m.

The purpose of this workshop was to bring together stakeholders to determine the direction of the Cottonwood Creek Watershed Management Plan. The goal is to arrive at a consensus among stakeholders about the desired erosion and flooding conditions of the watershed. Workshop discussions will be instrumental in the development of a comprehensive watershed management plan (WMP), and ultimately provide a rational, science-based approach to cooperatively managing the Cottonwood Creek Watershed with a diverse set of stakeholders.

Mike Urkov / CH2M HILL facilitated introductions and reviewed the agenda.

Mike opened the group discussion with a reminder that the intent of the Watershed Management Plan (WMP) is to provide a road map for the watershed. Ultimately the WMP will be a working document that will not only guide the decisions and direction of future studies and monitoring, but also lead to real projects being implemented on the ground in the watershed. Mike expressed the group sentiment that the watershed had been studied "to death" over the past twenty years concerning erosion and flooding. The CH2M HILL consulting team has heard is seeking input from this group about the exact direction that

Discussion

Topics of discussion:

Comment: Vieva had a recent high water photo of Evergreen Bridge to share with the group.

Comment: There has been speculation that the South Fork may be backing up from the main stem of the creek. The Sacramento River probably doesn't have a direct effect on the South Fork because there is so much room for the creek to widen out below the I-5 Bridge. There is some indication that runoff may be occurring almost instantaneously.

Question: Is anyone in the watershed having real issues with flooding? I know there are things that back up when fences catch debris. The water comes up out of the creek and fills the fences with debris, and that causes some flooding issues, but is anyone having actual property damage because of flooding issues? I know that we're combining these two topic now, but they are each unique and they're all related.

Comment: Loss of land is an issue. The riparian health and floodplain management all goes into the big picture of how fast the creek rises and erosion and all.

Comment: Cottonwood creek didn't used to flood. The problem is that the willows are allowed to grow in the creek, and then the creek floods and the water is pushed around the willows. The willows are the problem. We need to fix the creek. The creek has been studied to death. Everyone used to be able to clear their section of the creek before so many rules. It is like forest fires now. In the old days, the last cowboy out would take a handful of matches and start some fires. The low intensity fires would burn up the grass, maybe a rat nest, maybe scar a tree, but it didn't kill the tree. They were taking care of the forest. Now the environmentalists come along and worry about endangered species. Every year there are huge forest fires. Do the environmentalists ever worry about how many species are burning up in the forest fires? These do-gooders think they know the problems. They say the creek needs to meander. Davis lost 35-40 acres from the creek meander. We can't keep on losing this good topsoil to the creek. We can fix the creek. I did it up on my property. If we don't leave some good dirt for our children or grandchildren to grow something, raise something to eat. This good dirt doesn't come back once it washes down the river. We just need to start doing something at some point.

Comment: As the creek recedes, it takes the banks topsoil with it.

Comment: I have a tree that washed off into the middle of the creek. I can't get permission to fix the tree…take the tree out of the channel. The tree is forcing the water in another direction and now it is eroding the other side. I got the permit….but then what? How does the landowner afford to get equipment out there to fix it now?

Comment: One of the biggest hurdles for landowners now is being able to afford to fix the problems. Even if you can get through the permitting process, there is no money out there to help the landowners. The government isn't going to pay for your erosion problem. They don't see it as being in the public interest, so you're on your own. We all know that the

erosion adds to the fishery problems and ecosystem degradation, but they don't see it that way.

Comment: All of the in stream work has to be done in August or September.

Question: Why can't the work be done during other months?

Response: The time restrictions of the DFG 1600 permit are mostly based on whether anadromous fish are migrating through, or have the potential to be present in the creek during the time when projects are taking place. Spring-run Chinook salmon may be present or moving through between about March and June. Out-migrating fry can be hanging out during certain times of the year. There is also the issue of the federally listed Red-legged frog. It is possible to do an inventory of the frog to prove that none are present. The inventory can be used to justify that no impacts would be possible and maybe open up the working time frame somewhat. You still have to consider when the fry are present. Once the creek has warmed above the temperature threshold where spring-run could survive, then they will not move into Cottonwood Creek.

Question: Who determines when or what temperature threshold is for Salmon?

Response: The temperature threshold is already determined for each species of Salmon. DFG can make the determination of exactly what temperature would be necessary to allow work to proceed.

Comment: There has been some discussion about doing a programmatic 1600 permit written through the CCWG for landowners to use as a group for erosion issues.

Comment: Tehama County RCD is doing a programmatic type of program, but it is becoming complicated. I would say it would be difficult.

Response: I spoke to Carl Harral and Donna Cobb at DFG 1600. Carl doesn't actually work in 1600 any longer; Donna now works in his old position. I also have a call into Bruce Webb, but haven't spoken to him yet. The bottom line is that there is probably no way that CCWG will ever get a programmatic 1600 permit for landowners to work from. DFG wants to have a specific project with specific time line in order to determine possible impacts of the project. Donna Cobb indicated that such a programmatic permit may be possible if it were within the context of a programmatic EIR/EIS that had already evaluated some sort of creek enhancement program, but otherwise would need to be handled on an individual basis.

Comment: DFG 1600 is the only office that handles streambed alterations for the entire northern 1/3 of the state. That office is inundated with work, occasionally doing triage type permitting where they only take the cases where impacts seem likely. Sometimes you may even get a form letter that says we just don't have time to deal with your request.

Comment: There was a time when the warden would just come out and go over what you're doing and write the permit on the spot. That was some time ago.

Comment: I believe that DFG is still willing to take the time to work with you on the 1600 issues. They really do want to help you through the process; they just have to find the time.

Comment: One of the main things that we need from the agencies is a list of approved materials for use in these projects. Agencies get really nervous when you take things out of

the stream. If you mention rip rap you'll get the door shut on you. We need to discuss riparian habitat restoration and fish protection. It also might be possible to develop project design standards of good techniques that DFG would allow.

Comment: The main thing that changes Cottonwood Creek is the willows. You can go out there anywhere in the creek and see where there are a bunch of willows and the creek will have moved around them.

Comment: I believe we need to do some sort of a conceptual plan as the first step. Clear creek had a conceptual plan in the beginning. Next, we need to identify specific projects.

Comment: We need to focus on the problems, the causes of the problems as well. I'm concerned that we're just fixing the symptoms instead of figuring out what is really going on in the watershed. On one hand, we say that the gravel mining (GMA Report) is causing the problems in the creek. Others think that the willows are the problem. Any specific plan at this point is just treating the symptoms rather than addressing the cause.

Question: In this management plan, can't we do both? Can't we come up with some on the ground-type projects and still address the cause of the problems?

Comment: The government isn't going to pay for private property protection. We all know that.

Comment: All we need to do is move the willows out of the creek and back on to the banks. We already know what the hydrologists say about how the channel has moved through history. It's been here and back time and again.

Question: Are you suggesting that we pick a year, a historical flow path and plan for the channel to be in that path?

Response: Well no. The channel is where it is. We can pick some hard points where bridges exist, confluences, whatever. If you've been working in the creek, you now exactly where the fixing need to take place. We have aerial photos to look at and just figure out what needs to be done in each area.

Comment: We have the 2001 aerial photos, and other could be taken of specific project sites.

Comment: I think it is important to just state in this plan that the creek is "flashy". Flashiness is not a good thing, and we need to figure out why it happens. Do we know whether it is flashier now than ever?

Comment: Any alterations made to one landowner property will effect another upstream or down.

Comment: On Chuck's property, for instance, we need to move some large gravel bars.

Comment: What we're really describing here is a floodplain management plan.

Comment: CCWG could play a role as facilitator between landowners and agencies so that projects are integrated and don't interfere with one another.

Question: Is there a way to actually develop a plan for the entire watershed? The system is very complex. Things that you do in the lower watershed will be felt in the upper

watershed. It is possible to create a model to determine what these changes will be. Is there another way to quantify what we're looking for? If we use air photos, where do we start? It seems like we would need to start at the mouth and work up in the photos.

Response: You don't need to start at the mouth and you don't need a model. I don't have a pedigree, but all you need to do is get the air photos and layout where the channel should be to see what needs fixing. You can start at the hard points and work back up in the photos. (Example given on air photo).

Question: So where would we start?

Response: The logical place seems to be at Little Dry Creek downstream to the South fork confjuence. Chuck's project has been holding up there for 4 years. A hard point exists there.

Question: How long is that stretch?

Response: 4-5 miles. We have two willing landowners here. Chuck and Clarissa are the owners of the land at Little Dry Creek. We could do a reach management project there. Concet would be 2 to 3 foot shot rock to protect from high and fast water. Project would also consider riparian and fish benefits, and contribution of gravel to the Sacramento River and soil conservation.

Comment: If we do end up with a straighter channel, what will we have accomplished? I would really like us to look at the historical conditions of the watershed and determine if it is more flash now than in the past.

Question: Has a study like that been done in any other watershed?

Response: Not that I'm aware of.

Comment: What we will accomplish is riparian health improvement. We need to stress riparian health, lowering the water temperature for the fish by improving bank planting.

Comment: So what I'm getting here from the group a two part plan. One part is to get moving on an actual reach management pilot project near the Little Dry Creek area, and the other is to develop a watershed conceptual plan to build off upon, using the concept of an aerial photo layout and conceptual drawing as long as it goes to the TAC for review. CH2M HILL would develop a conceptual plan for TAC review and concurrence. The project will also need to focus on ecological rationale. Examples include Butte Creek and Rogue River. Aesthetics are also an important consideration.

Comment: There are other references out there that should be check into. I believe that Graham Mathews did some cross-sectional work in that area. There was existing cross-sectional data from USGS prior to that. GMA actually reoccupied some of the old USGS sites, or tried to at least. He also created some of his own. There are other aerial photos. Check out the Clear Creek conceptual plan. CH2M HILL did some work on the Deer Creek plan.

Comment: Now let's talk about how you stop a head cut. I want to know if anyone knows how to stop a head cut. I've heard many ideas that don't work, but none that do. Gabions won't work.

Comment: A statistical analysis of the flashiness of the creek would be valuable, particularly in comparison with other west-side streams.

Response: You might want to try cobbles. Maybe old hay bales, but that won't last that long.

Comment: One of the problems in the watershed is the hardness of the soils. Some parts of the watershed have extremely hard soils and the rain cannot infiltrate resulting in an instantaneous response to storms.

Comment: You might want to take a field trip over to Alamanor Ranger station to see what they've done. They've been working extensively with head cuts.

Comment: We didn't really address the "sponge" effect in the upper watershed. Issues and management techniques to increase basin retention.

Comment: We also need to include in the plan a set of desired conditions about the watershed. General recommendations for management of erosion.

Comment: I think we should also look at adjacent watersheds to see if they are flashy, and possible reasons for increased flashiness. We definitely need to look at the historical peak flow record.

Appendix C
Fishery, Vegetation, and Wildlife Resources

Introduction

A Technical Memorandum (TM) that focused on fishery, vegetation, and wildlife resources was developed that summarized the concerns of stakeholders in the Cottonwood Creek Watershed as documented in the SWP (CH2M HILL, 2005). This TM discussed projects that could be considered by CCWG to address these concerns. The TM was distributed to the stakeholder group in mid-August and a workshop was held on August 17, 2006, to review and discuss the content of the TM. Appendix C includes the final TM, the presentations from the workshop, the news release for the workshop, and a workshop summary.

NEWS NEWS

For Immediate Release

Contact: Vieva Swearingen
Watershed Coordinator
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August 10, 2006

COTTONWOOD CREEK MANAGEMENT PLAN DEVELOPMENT WORKSHOP- FISHERIES, VEGITATION, AND WILDLIFE RESOURCES

COTTONWOOD, CA — Cottonwood Creek Watershed Group will be holding a Management Plan Development Workshop focusing on fisheries, vegetation, and wildlife resources. The meeting will be held at Cottonwood Creek Watershed Group's office located at 3233 Brush Street in Cottonwood. The workshop will be held on Thursday, August 17th at 6:30 p.m. Copies of the Management and Restoration Plan that will be discussed during the workshop will be available at the Cottonwood Creek Watershed Group's office on Monday, August 14th. Visit us on the Web at www.cottonwoodcreekwatershed.org.

Questions? Call 347.6637 or email ccwg@shasta.com

Recommendations for Fishery, Vegetation, and Wildlife Resources in the Cottonwood Creek Watershed

PREPARED FOR: Cottonwood Creek Watershed Group

PREPARED BY: Tim Hamaker, CH2M HILL
Julie Rochlitz, CH2M HILL
John Schoonover, CH2M HILL
Ed McCarthy, CH2M HILL

DATE: August 17, 2006

PROJECT NUMBER: 333854

Introduction

This technical memorandum provides a synopsis of existing information for fishery, vegetation, and wildlife resources in the Cottonwood Creek Watershed, identifies data of interest for watershed studies, then identifies potential next steps for furthering resources management.

Existing Information

Fisheries

Cottonwood Creek is known to contain many species of fish, among which are anadromous species, including the federally threatened spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*Oncorhynchus mykiss*). A complete list of fish species inhabiting Cottonwood Creek is provided in the Cottonwood Creek Watershed Assessment.

Several sources of information are available concerning historical fishery and habitat conditions in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Report* (Prepared by Heather Rectenwald for the California Department of Fish and Game [CDFG], August 1999)
- *Cottonwood Creek Watershed Assessment* (Prepared by CH2M HILL, November 2001)

Relevant data consist primarily of fish inventories or surveys conducted by Resource Agency personnel beginning in the 1950s. Stream gage (hydrology) information varies spatially and temporally throughout the Cottonwood Creek Watershed. Streamflow has been measured consistently near the Sacramento River confluence for many years, but consistent temperature and flow information for the reaches is not currently available. The

above publications contain summaries of many years of existing data collected throughout the watershed.

Fall-, late-fall-, and spring-run Chinook salmon and steelhead are known to occupy Cottonwood Creek in the approximately 130 river miles accessible to anadromous salmonids. On average, CDFG estimates the spawner escapement for fall-run Chinook salmon in Cottonwood Creek to be approximately 1,000 to 1,500 adults annually. Fall-run Chinook salmon principally spawn in the mainstem of Cottonwood Creek, but are know to regularly spawn in the valley reaches of the north, middle, and south forks. Annual spawner escapement estimates for late-fall-run Chinook salmon are approximately 500 adults. Similar to fall-run, late-fall-run Chinook salmon are believed to principally spawn in the valley reaches of the mainstem and south, middle, and north forks.

Spring-run Chinook salmon are also known to spawn in Beegum and South Fork Cottonwood Creeks. CDFG believes that, historically, approximately 500 adult spring-run Chinook salmon spawned in Cottonwood and Beegum Creeks. However, many fewer that that number are known to spawn in the Cottonwood Creek Watershed currently. Although it is believed that the Cottonwood Creek Watershed is one of the major tributaries to the Sacramento River that support steelhead, there are no current population estimates for steelhead in Cottonwood Creek. Small runs of steelhead have been observed to migrate in the mainstem and lower reaches of the North, Middle, and South Fork Cottonwood Creek.

Vegetation

Information Sources

Several sources of information are available concerning vegetation habitats in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Watershed Assessment* (Prepared by CH2M HILL, November 2001; includes information from the California Native Plant Society's Inventory of Rare and Endangered Vascular Plants, CDFG Natural Diversity Database [CNDDB], and the CALVEG Database)
- *Beegum Watershed Analysis* (Prepared by the Yolla Bolla Ranger District, South Fork Management Unit, Shasta-Trinity National Forests, 1997)

The watershed assessment addresses overall patterns of vegetation in the Cottonwood Creek Watershed. The primary vegetation types in the watershed are blue oak / gray pine, annual grassland, chaparral, Douglas fir / true fir, and mixed conifer. The above publications contain information on these vegetation types in the watershed.

Current Program

Cottonwood Creek Watershed Group (CCWG) has been awarded a grant through the Natural Resource Conservation Service (NRCS) Partnership Initiative 2006. The grant provides for collaborative riparian and amphibian surveys to be conducted through 2007. The project includes acquiring high-resolution color imagery, identifying and mapping vegetation communities along mainstem and major tributaries to Cottonwood Creek, identifying sites of non-native and noxious plants and weeds, and creating a geographic

information system (GIS) map with the survey results. In addition, the project involves working with willing landowners on restoration and preservation options in the watershed.

Wildlife

Several sources of information are available concerning wildlife in the Cottonwood Creek Watershed. The most relevant information is summarized in the following documents:

- *Cottonwood Creek Watershed Assessment* (Prepared by CH2M HILL, November 2001). The Watershed Assessment includes information from the California Wildlife Habitat Relationships (WHR) model and, CDFG Natural Diversity Database (CNDDB)
- *Beegum Watershed Analysis* (Prepared by the Yolla Bolla Ranger District, South Fork Management Unit, Shasta-Trinity National Forests, 1997)

The watershed assessment addresses 10 distinct wildlife habitats in the watershed: agriculture, barren, urban, serpentine, chaparral and montaine hardwoods, annual grassland, riparian, mixed conifer forest and Douglas fir / true fie, blue oak / gray pine, and water.

Data of Interest for Watershed Studies

To make a scientific recommendation for the management of the fishery and habitat resources in the Cottonwood Creek Watershed, CCWG should obtain sufficient data to develop an overall understanding of fishery dynamics. Following are the primary factors affecting salmon and steelhead populations in the watershed:

- **Water temperature and flow** – Salmon and steelhead life stages require water temperatures below a specific threshold to survive and successfully reproduce. Adult fish will not migrate into Cottonwood Creek until the temperature of the water has dropped below this threshold. For the most part, there are no major dams to limit flow and affect water temperature in the watershed. When seasonal rains in fall and early winter cool the water and increase flows, anadromous salmonids are able to move into the watershed. *A water temperature monitoring program will begin in 2006 in the Cottonwood Creek Watershed.*
- **Spawning gravel availability and location** – Information from studies conducted in the 1970s indicated that spawning gravel might be available in the appropriate size range throughout most of the watershed*. However, further analysis of gravel recruitment, particle size, and locations will be necessary to properly assess current spawning habitat limitations.*
- **Suitable juvenile rearing habitat** – Depending on species, salmonid juveniles remain in the watershed for varying lengths of time before they emigrate to the Sacramento River and the ocean. These fry, juvenile, and parr life stages need suitable summer and winter habitat of the appropriate temperatures and flows, an adequate food supply, and cover habitat to survive and grow. *The quantity and quality of juvenile rearing habitat has not been systemically mapped in the watershed.*
- **Water quality** – Aquatic habitats can be adversely affected by poor water quality, of which water temperature, dissolved oxygen, turbidity, and pollutants are of major

concern. Water quality issues other than temperature may be a limiting factor in fish survivability and growth. Water quality conditions for much of the watershed are not known at this time. *The 2006-2007 monitoring plan includes gathering turbidity and temperature data.*

- **Physical barriers** – Physical barriers prevent upstream migration of adult salmon and steelhead. Large physical barriers (a waterfall on the North Fork, low flows and large boulders in Beegum Creek, and a constructed barrier on the South Fork) prevent upstream migration in Cottonwood Creek. The extent of anadromy is discussed in the watershed assessment and other publications. *There is a need to conduct a more detailed barrier assessment, including assessing the extent of anadromy at a range of flow conditions.*

- **Landslides and slope failures** - Off-channel sediment sources adversely affect habitat quality and quantity for salmon and steelhead. Large upslope sediment sources are present in the South Fork Cottonwood Creek. Landslides and slope failures continue to adversely affect habitats downstream of their input into the channel. *An assessment of the extent and nature of these inputs will be necessary to understand their impacts to aquatic habitats in the south fork of Cottonwood Creek.*

Potential Next Steps for Resources Management

Fisheries

Reviews of the Cottonwood Creek Strategic Watershed Plan and stakeholder meeting notes indicated that the CCWG stakeholders are most concerned with the following issues related to aquatic resources:

- Establishing a baseline fish population monitoring program
- Determining limiting conditions and creating a general fishery system model

The following subsections discuss methods and approaches to address those concerns.

Juvenile Salmonid Monitoring

CCWG should establish a juvenile salmonid monitoring program in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG and U.S. Fish and Wildlife Service (USFWS) personnel to develop and seek funding for establishing a rotary screw trapping program.

Similar programs currently monitor juvenile salmonid populations on Deer, Mill, and Butte Creeks and the Sacramento River (CDFG), and in Battle and Clear Creeks and the Sacramento River (USFWS). Rotary screw trapping is the preferred method for monitoring juvenile salmonids in Cottonwood Creek for several reasons. Screw trapping could provide annual index of the number of migrant smolts to establish baseline and future populations. The population indices would be useful in determining responses of salmonid populations to environmental conditions or management actions in the watershed. CDFG representatives were consulted for this recommendation, and agreed that establishing a juvenile trapping program is likely the best solution for monitoring juvenile salmonid populations in the Cottonwood Creek Watershed.

Adult Salmonid Monitoring

CCWG should consider establishing an adult salmonid monitoring program in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG and USFWS personnel to develop and seek funding to establish or re-establish an aerial redd survey or establish an adult weir monitoring program or other adult monitoring program.

Similar CDFG and USFWS programs currently monitor adult salmon populations in many of the tributary creeks and the mainstem Sacramento River. Establishing an adult monitoring program might be more problematic than establishing a juvenile trapping program because of seasonal water clarity variations, access limitations to large areas of private land, and the specific life histories of the species of interest. If these obstacles could be overcome, it would be desirable to monitor adult salmonids in Cottonwood Creek Watershed and establish baseline population information using one or more of these methods. CDFG representatives were consulted on this recommendation, and agreed that if the obstacles to establishing an aerial or weir monitoring program could be overcome, it would be desirable to monitor adult salmon populations in the Cottonwood Creek Watershed.

Limiting Factors Analysis and Focused Investigations

CCWG should consider conducting a limiting factors analysis for anadromous fishery resources in the Cottonwood Creek Watershed. CCWG should coordinate with CDFG and USFWS personnel to develop and seek funding for conducting a limiting factors analysis.

Concept

To determine which factors limit andromous salmonid production and populations in the watershed, CCWG needs to conduct a limiting factors analysis. This analysis would be used to evaluate the habitat factors affecting and potentially limiting production, determine possible causes of historical population declines, and estimate production potential for the various salmonid species in the watershed. By identifying these factors, CCWG could refine current understanding of the anadromous fishery, focus future management activities, and help prioritize restoration or enhancement actions in the Cottonwood Creek Watershed.

A limiting factors analysis is a process that generally is accomplished by conducting a structured, multi-step evaluation such as the following:

1. Assemble and review available information.
2. Identify additional information needs.
3. Develop and refine a conceptual model, hypothesis, and work plan for any necessary focused studies.
4. Conduct focused investigations (monitoring, inventory, remote imaging, and or on-the-ground evaluations).

5. Conduct limiting factors evaluation.

6. Develop recommendations and actions.

Focused Investigations

Prior to conducting the final evaluation of factors that are adversely affecting populations of salmonids in the Cottonwood Creek Watershed (Step 5), it would be necessary to conduct several habitat investigations (Step 4). To fully evaluate species-specific conceptual models and hypotheses of limiting factors, several investigations designed to obtain habitat information crucial to the limiting factors evaluation would be necessary. These investigations would include the following:

- **Aquatic habitat assessment** – This would include basic characterization of aquatic habitats, including, but not limited to, habitat type (pools, riffles, and runs) and geometry, channel sinuosity, residual pool depth, channel gradient, substrate character, percent cover, and an inventory and characterization of woody debris.
- **Spawning gravels assessment** – This would evaluate the extent (locations and volumes) and character (particle-size distribution) of gravel suitable for salmonid spawning in the watershed. The evaluation should focus on the areas identified as temperature suitable, as determined by the water temperature monitoring program being implemented in 2006.
- **Physical barriers evaluation** – This would evaluate and characterize potential barriers to migrating anadromous fish throughout the watershed and identify the extent and character of any potential barriers at varying flow conditions.
- **Landslide evaluation** – This would include mapping and characterizing existing landslides and hill slope failures that are and have the potential for adversely affecting downstream habitat quantity and quality in the watershed. This evaluation should focus on existing, known areas of problematic landslides (e.g., Slide Creek vicinity in South Fork Cottonwood Creek).

Limiting Factors Evaluation – Summary

All of the data and information obtained in these focused investigations would need to be reviewed to evaluate the conceptual models and hypotheses of factors limiting to salmonids in the Cottonwood Creek Watershed. The end product of a limiting factors analysis for Cottonwood Creek should provide the following types of key information:

- Factors affecting the present extent, quality, and quantity of adult holding and spawning habitats
- Factors affecting the present extent, quality, and quantity of juvenile rearing habitats
- Factors affecting adult and smolt migrations
- Estimates of potential production for the various anadromous salmonids occupying the watershed

There would likely be a large overlap and a common set of data required for a conducting a fishery limiting factors analysis and for evaluating riparian vegetation, aquatic, and terrestrial habitats and stream channel geomorphic processes. The rapidly evolving nature of GIS technology, aerial photography, and remote sensing technologies might make it possible to obtain valuable data on stream habitat conditions (e.g., stream sinuosity) even in inaccessible locations.

It is recommended that CCWG use the services of an environmental consultant with specific experience conducting stream habitat assessments and performing limiting factor analyses for anadromous fish species. Furthermore, the other Cottonwood Creek Strategic Watershed Plan recommendations and the information necessary for implementing those resource programs should be reviewed in conjunction with and prior to planning the limiting factors analysis. Stillwater Sciences (Berkeley, California) and Jones & Stokes (Sacramento, California) are two experienced fishery consultants that have recently performed limiting factor analyses for anadromous salmonids in watersheds of the Central Valley and other parts of California.

Vegetation

Review of the Cottonwood Creek Strategic Watershed Plan and stakeholder meeting notes indicated that CCWG stakeholders are most concerned with the following issues related to vegetation resources:

- Mapping riparian areas of the watershed
- Creating a list of native flora and fauna, with their general habitat locations identified, in the watershed
- Assessing status and trends of native oak woodlands, particularly blue oak woodlands, in the middle and lower portions of the watershed
- Assessing the impacts of noxious weeds on vegetative resources

Mapping Riparian Areas

The current NRCS grant would initiate mapping of riparian areas in the watershed. The grant project includes acquiring high-resolution color imagery, identifying and mapping vegetation communities along mainstem and major tributaries of Cottonwood Creek, identifying sites of non-native and noxious plants and weeds, and creating a GIS map with the survey results.

Information obtained from aerial photography analysis under the NRCS grant and from California red-legged frog (CRF) surveys would assist in evaluating the current riparian areas for future planning, preservation, and restoration of riparian resources. In addition, the grant project would provide opportunities for cooperative management efforts among resource personnel and landowners in the watershed.

The long-term monitoring program, to be implemented beginning in September 2006, will include photographic documentation of 10 monitoring locations in the watershed. These

photographs would provide 12 consecutive months of imagery (September 2006 through August 2007) from which to evaluate changes in riparian conditions and to serve as a baseline for continued riparian resource monitoring at each monitoring site.

CCWG should consider conducting surveys of riparian areas identified during the GIS mapping project that require restoration, monitoring, or preservation.

Identifying Native Plant Species

A list of native plant species in the watershed has been created using information obtained from the California Native Plant Society's Inventory of Rare and Endangered Vascular Plants, CNDDB, and the CALVEG Database, as evaluated in the watershed assessment. The list of native plant species is based on those that could potentially occur in the watershed according to information obtained through database research. It is recommended that CCWG update this list twice per year, when special-status species list updates are published by CDFG and USFWS.

Comprehensive studies on native plant species have not been conducted in the watershed. CCWG should consider conducting surveys for special-status plant species in the watershed.

A draft native plant species list that includes special-status species is provided as Attachment 1. The list has been updated to indicate current special-status species listings as of August 2006 and was provided to the Technical Advisory Committee for review during a previous resource management workshop.

Assessing Status and Trends of Native Oak Woodlands

CCWG should consider conducting a comprehensive evaluation of native oak woodlands in the Cottonwood Creek Watershed. CCWG should coordinate with the Tehama County Hardwood Committee, CDFG, and USFWS personnel to develop and seek funding to conduct a survey that comprehensively identifies the locations and health of native oak woodland ecosystems that serve as habitat for native plant and wildlife populations.

Assessing Impacts of Noxious Weeds

The primary adverse effects of noxious weeds in a watershed include domination of habitat that leads to displacement of native species, promotion of non-native wildlife, and ecosystem effects (e.g., nutrient cycling and water uptake). Examples of invasive plants in the Cottonwood Creek watershed are giant reed (*Arundo donax*), star thistle (*Centaurea solstitialis*), tamarisk (*Tamarix spp.*), and medusahead (*Taeniatherum caput-medusae*).

The approved NRCS grant provides for GIS evaluation to identify sites of non-native and noxious plants and weeds in the watershed. CCWG should further evaluate the severity of non-native and noxious species in the watershed as part of an overall vegetation restoration program.

Wildlife

Reviews of the Cottonwood Creek Strategic Watershed Plan and stakeholder meeting notes indicated that the CCWG stakeholders are most concerned with the following issues related to wildlife resources:

- Establishing basic frog monitoring
- Creating a list of native species in the watershed

Establish Basic Frog Monitoring

The current NRCS grant would continue studies of CRF in the watershed. Information about CRF and its habitat and aerial photography analysis of frog habitat would assist in future preservation and restoration planning for frog species. Information from the study could be used to identify areas where frog habitat preservation is needed.

Identifying Native Wildlife Species

A list of native species in the watershed has been created using the information obtained through the CNDDB and the Wildlife Habitat Relation Model, as listed in the watershed assessment. The list of native wildlife species is based on those that could potentially occur in the watershed according to information obtained through database research. It is recommended that CCWG update this list on a bi-yearly basis in accordance with special-status species list updates published by CDFG and USFWS.

Comprehensive studies on native wildlife species have not been conducted in the watershed. CCWG should consider conducting surveys for special-status wildlife species or site assessments identifying potential habitat for these species in the watershed.

A draft native wildlife species list that includes special-status species is included as Attachment 2. The list was provided to the Technical Advisory Committee for review during a previous resource management workshop and has been updated to indicate current special-status species listings as of August 2006.

Potential Sources of Funding

Following is a list of federal and state conservation programs that might be used to fund resources recommendations:

- USFWS
  - Partners for Fish and Wildlife
  - Anadromous Fish Restoration Program
  - Private Stewardship Grant Program
  - Central Valley Project Improvement Act
- California Bay Delta Authority / CALFED
  - Ecosystem Restoration Program
  - Watershed Program
- State Water Resources Control Board
  - Proposition 13, 40, and 50 Consolidated Grants Program

- California Department of Water Resources
  - Integrated Water and Resource Management Program
  - Proposition 40 and 50 Consolidated Grants Program
- NOAA Fisheries
  - American Rivers Grant Program

Works Cited

CH2M HILL. 2001. *Cottonwood Creek Watershed Assessment*. November.

Rectenwald, Heather. 1999. *Cottonwood Creek Report*. Prepared for California Department of Fish and Game. August 18.

Yolla Bolla Ranger District. 1997. *Beegum Watershed Analysis*. South Fork Management Unit, Shasta-Trinity National Forests. March.

Attachment 1
Draft Native Species List – Vegetation

Common Name	Scientific Name	Status
Conifers		
ou las ir	*Pseudotsuga menziesii*	
ray Pine	*Pinus sabiniana*	
od e ole Pine	*Pinus contorta var. murrayana*	
eat er a	*Quercus durata*	
ncense edar	*Calocedrus decurrens*	
e rey Pine	*Pinus jeffreyi*	
no cone Pine	*Pinus attenuata*	
re er ruce	*Picea breweriana*	
ountain emloc	*Tsuga mertensiana*	
o le ir	*Abies procera*	
Ponderosa Pine	*Pinus ponderosa*	
Port r ord edar	*Cupressus lawsoniana*	
ed ir	*Abies magnifica*	
asta ir	*Abies magnifica var. shastensis*	
ite ar Pine	*Pinus albicaulis*	
u ar Pine	*Pinus lambertiana*	
estern ite Pine	*Pinus monticola*	
ite ir	*Abies concolor*	
Oaks		
re er a	*Quercus garryana var. breweri*	
lac a	*Quercus kelloggii*	
lue a	*Quercus douglasii*	
anyon i e a	*Quercus chrysolepis*	
oast i e a	*Quercus agrifolia*	
nterior i e a	*Quercus wislizenii*	
uc le erry a	*Quercus vaccinifolia*	
re on ite a	*Quercus garryana*	
ar anoa	*Lithocarpus densiflorus var. echinoides*	
adler a	*Quercus sadleriana*	
ru anyon i e a	*Quercus chrysolepis var. nana*	
ru nterior i e a	*Quercus wislizenii var. frutescens*	
anoa	*Lithocarpus densiflorus var. densiflorus*	
alley a	*Quercus lobata*	
Broad-leaf trees		
i lea a le	*Acer macrophyllum*	
irc lea ountain a o any	*Cercocarpus betuloides*	
lac otton ood	*Populus trichocarpa*	
o elder	*Acer negundo*	
ali ornia ay	*Umbellifera californica*	
ali ornia uc eye	*Aesculus californica*	
ali ornia a elnut	*Corylus cornuta*	
ali ornia oneysuc le	*Lonicera hispidula*	
ali ornia uc le erry	*Vaccinium ovatum*	
o ood	*Cornus spp.*	
remont otton ood	*Populus fremontii*	
adrones	*Arbutus menziesii*	
ountain a le	*Acer glabrum*	
ountain or inlea lder	*Alnus incana ssp. tenuifolia*	
Paci ic adrone	*Arbutus menziesii*	
ed lder	*Alnus rubra*	
ite lder	*Alnus rhombifolia*	
illo s	*Salix spp.*	
Shrubs		
itter erry	*Prunus emarginata*	
lac erry	*Rubus spp. (native and introduced species may occur)*	
o lea ar	*Silktassel Garrya buxifolia*	
ali ornia o ee erry	*Rhamnus californica*	
ali ornia escue	*Festuca californica*	
ali ornia a elnut	*Corylus cornuta var. californica*	
ali ornia ild ose	*Rosa californica*	
amise	*Adenostoma fasciculatum*	
ree in ar erry	*Berberis aquifolium var. repens*	
ree in no erry	*Symphoricarpus mollis*	
urrant	*Ribes spp*	
eer rus	*Ceanothus integerrimus*	
remont il tassel	*Garrya fremontii*	
reenlea an anita	*Arctostaphylos patula*	
airy oneysuc le	*Lonicera hispidula*	
oary an anita	*Arctostaphylos canescens*	
oneysuc le	*Lonicera spp.*	
e son eanot us	*Ceanothus jepsonii*	
emmon eanot us	*Ceanothus lemmonii*	
a ala at	*Ceanothus prostratus*	
an anitas	*Arctostaphylos spp.*	
ountain itet orn	*Ceanothus cordulatus*	
ule at	*Baccharis viminea*	
ceans ray	*Holodiscus discolor*	
Pinemat an anita	*Arctostaphylos nevadensis*	
Poison a	*Toxicodendron diversilobum*	
ododendron	*Rhododendron spp.,*	
oc iraea	*Holodiscus microphyllus*	
alal	*Gaultheria shallon*	
er ice erry	*Amalenchier spp.*	
is iyou at	*Ceanothus pumilus*	
no erry	*Symphoricarpus mollis*	
tic y urrant	*Ribes viscosissimum*	
anoa s ru orm	*Lithocarpus densiflorus var. echinoides*	
oyon	*Heteromeles arbutifolia*	
ree in ua in	*Chrysolepis chrysophylla*	
ed elea	*Ceanothus Ceanothus cuneatus*	
estern alea	*Rhododendron occidentale*	
estern ed ud	*Cercis occidentalis*	
itelea an anita	*Arctostaphylos viscida*	
Herbaceous Plants		
ed es	*Carex spp.*	
lue rass	*Poa spp.*	
rodiaea	*Brodiaea spp.*	
rome	*Bromus spp.*	
ulrus es	*Scirpus spp.*	
ulrus es	*Scirpus spp.*	
attails	*Typha latifolia T. domingensis T. angustifolia*	
ec er allo	*Sidalcea spp.*	

alse elle ore	*Veratrum spp.*
escue	*Vulpia spp.*
entian	*Gentiana spp.*
ily	*Lilium spp.*
ouse ort	*Pedicularis spp.*
ari osa ily	*Calochortus spp.*
eedle rass	*Nassella spp.*
at rass	*Danthonia spp.*
nion rass	*Melica spp.*
eed rass	*Calamagrostis spp.*
us es	*Juncus spp.*
ed e	*Carex athrostachya*
ootin tar	*Dodechatheon spp.*
ule	*Scirpus acutus*
m rella latsed e	*Cyperus eragrostis*
ild yacint	*Dichelostemma spp.*
am a	*Perideridia spp.*
Palmate racted ird s ea	*Cordylanthus palmatus*
o s a e ed e yso	*Gratiola heterosepala*
lender orcutt rass	*Orcuttia tenuis*

Key to Status Codes:

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Additional resources on habitat types within Cottonwood Creek Watershed can be found within the Watershed Assessment at the following website:

Cottonwood Creek Watershed Group
http://www.cottonwoodcreekwatershed.org/

Resources to include photographs and information on native species can be found at the following websites:

U.S. Fish and Wildlife Service
http://www.fws.gov/species/

California Department of Fish and Game
http://www.dfg.ca.gov/hcpb/species/species.shtml

Cal Photos
http://calphotos.berkeley.edu/

California Native Plant Society
http://www.cnps.org/

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Cottonwood Creek Watershed Group

Native Plant Species List

Cottonwood Creek Watershed Group

Cottonwood Creek Watershed encompasses approximately 938 square miles and contains many native plant species within its diverse habitats. The unique climate, geographic, and topographic conditions within the watershed provide a large diversity of habitat types for native species to reside. Habitats within the watershed include agriculture, barren, urban, serpentine, chaparral and montaine hardwoods, annual grassland, riparian, mixed conifer forest, blue oak/grey pine woodland, and mountainous terrain.

Attachment 2
Draft Native Species List – Wildlife

Reptiles

ali nia ntain in sna e	*Lampropeltis zonata*	
n a te sna e	*Thamnophis sirtalis*	
iant a te sna e	*Thamnopsisi gigas*	S
p e sna e	*Pituophis melanoleucus*	
in nec sna e	*Diadophis punctatus*	
e a	*Charina bottae*	
St ipe ace	*Masticophis lateralis*	
este n a atic a te sna e	*Thamnophis couchii*	
este n p n t tle	*Clemmys marmorata*	S
este n s in	*Eumeces skiltonianus*	

Amphibians

ll	*Rana catesbeiana*	
ali nia ne t	*Taricha torosa*	
ali nia e le e	*Rana aurora draytonil*	S
asca es	*Rana cascadae*	
t ill ell le e	*Rana boylii*	S
L n t e sala an e	*Ambystoma macrodactylum*	
ntain ell le e	*Rana muscosa*	
N t e n le pa	*Rana pipiens*	
e le e	*Rana aurora*	
S asta sala an e	*Hydromantes shastae*	S
aile	*Ascaphus truei*	S
este n spa e t t a	*Scaphlopus hammondii*	S

Insects

alle el e e l n n eetle	*Desmocerus californicus dimorphus*	

Mammals

e ican a e	*Taxidea taxus*	
e ican a ten	*Martes americana*	
e ican in	*Mustela vison*	
lac ea	*Ursus americanus*	
lac taile ac a it	*Lepus californicus*	
cat	*Lynx rufus*	
a te le	*Scapanus latimanus*	
s a it	*Sylvilagus bachmani*	
ali nia an a at	*Dipodomys californicus*	
ali nia v le	*Microtus californicus*	
ali nia lve ine	*Gulo gulo luteus*	S
n s at	*Ondatra zibethicus*	
te	*Canis latrans*	
ee se	*Peromyscus maniculatus*	
ese t c tt ntail	*Sylvilagus audubonii*	
las s i el	*Tamiasciurus douglasii*	
s te at	*Neotoma fuscipes*	
aste n s i el	*Sciurus niger*	
l	*Cervus elaphus*	
nsatina	*Ensatina eschscholtzii*	
ine	*Mustela erminea*	
e al at	*Capra hircus*	
in e tis at	*Myotis thysanodes*	S
a	*Urocyon cinereoargenteus*	
L ep le c ip n	*Tamias speciosus*	
L n ea e tis at	*Myotis evotis*	S
L n le e tis at	*Myotis volans*	S
L n taile easel	*Mustela frenata*	
ntain eave	*Aplodontia rufa*	
ntain li n	*Puma concolor*	
le ee	*Odocoileus hemionus*	
N t e n l in s i el	*Glaucomys sabrinus*	
N t e n ive tte	*Lontra canadensis*	
Paci ic is e	*Martes pennanti pacifica*	S
Paci ic este n i ea e at	*Corynorhinus townsendii townsendii*	S
Pale t nsen s i ea e at	*Corynohinus toensendii pallescens*	
Palli at	*Antrozous pallidus*	
P n n	*Antilocapra americana*	
acc n	*Procyon lotor*	
e	*Vulpes vulpes*	
in tail	*Bassariscus astutus*	
San a in p c et se	*Perognathus inomatus inomatus*	
S all te tis at	*Myotis ciliolabrum*	S
Sn s e a e	*Lepus americanus*	
Sp tte at	*Euderma maculatum*	
St ipe s n	*Mephitis mephitis*	
nsen s i ea e at	*Corynorhinus townsendii*	
a ant s e	*Sorex vagrans*	
i inia p ss	*Didelphis virginiana*	
este n a s i el	*Sciurus griseus*	
este n asti at	*Eumops perotis*	
este n e at	*Lasiurus blossevillii*	
este n sp tte s n	*Spilogale gracilis*	
ite taile ac a it	*Lepus townsendii*	
il pi	*Sus scrofa*	
lve ine	*Gulo gulo*	S
a tis at	*Myotis yumanensis*	S

Fish

ent al valle steel ea	*Oncorhyhcuhs mykiss*	
in sal n	*Oncorhyhchus tshawytscha (winter run)*	S
in sal n	*Oncorhyhchus tshawytscha (fall run)*	S
in sal n	*Oncorhyhchus tshawytscha (spring run)*	
elta s elt	*Hypomesus transpacificus*	S
een st e n	*Acipenser mendirostris*	
la at ts P vince Steel ea	*Acipenser medirostris*	
L n in s elt	*Spririnchus thaleichthys*	S
N t e n ali nia Steel ea	*Onchorhynchus mykiss*	
ive La p e	*Lamprtra ayresi*	

Crustaceans

e nal P l a p le S i p	*Lepidurus packardi*	
e nal P l ai S i p	*Branchinecta lynchi*	

Key to Status Codes:

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P e e al P p se n an e e

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S e e al Species nce n

e e al an i ate Species

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State

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S ali nia Species Special nce n

S Species nce n

t e

NPS ali nia Native Plant S ciet Liste

P ll P tecte a e

Additional resources on habitat types within Cottonwood Creek Watershed can be found within the Watershed Assessment at the following website:

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Cal Photos
http://calphotos.berkeley.edu/

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Cottonwood Creek Watershed Group

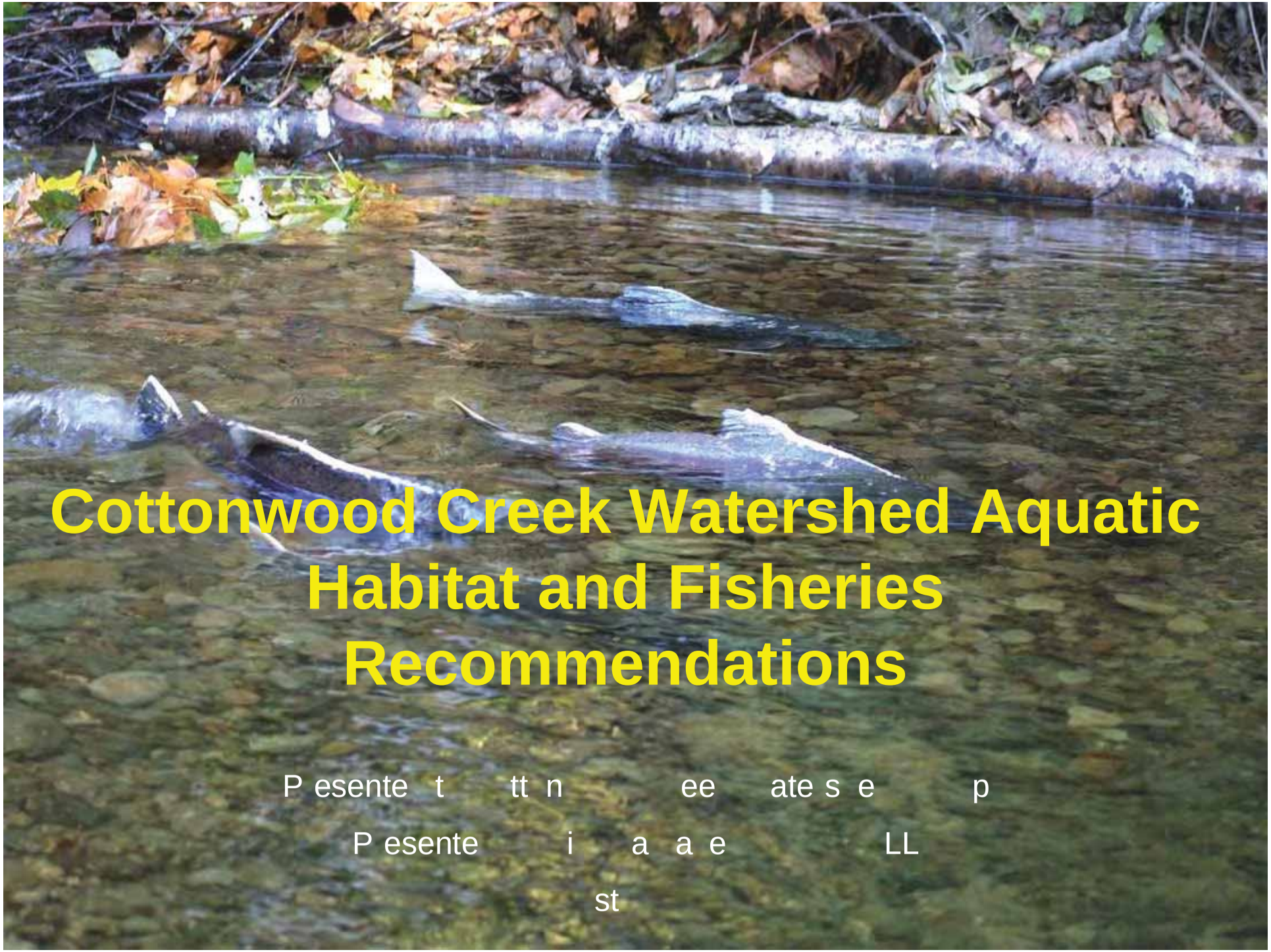
Native il li e Species List

Cottonwood Creek Watershed encompasses approximately 938 square miles and contains several native wildlife species within its diverse habitats. The unique climate, geographic, and topographic conditions within the watershed provide a large diversity of habitat types for native species to reside. Habitats within the watershed include agriculture, barren, urban, serpentine, chaparral and montaine hardwoods, annual grassland, riparian, mixed conifer forest, blue oak/grey pine woodland, and mountainous terrain.

Native wildlife species occurring or potentially occurring within the Cottonwood Creek Watershed are based on habitat types identified within the Cottonwood Creek Watershed Assessment.

Birds

le tian ana a se	*Branta Canadensis leucopareia*	
e ican c t	*Fulica americana*	
e ican c	*Corvus brachyrhynchos*	
e ican pe e ine alc n	*Falco peregrinus anatum*	S
e ican ite pelican	*Pelecanus erythrorhynchos*	
e ican i e n	*Anas americana*	
ai s san pipe	*Calidris bairdii*	
al a le	*Haliaeetus leucocephalus*	S
an taile pi e n	*Columba fasciata*	
an s all	*Riparia riparia*	S
ell s sa e spa	*Amphispiza belli belli*	S
lac s i t	*Cypseloides niger*	
l e se	*Dendragapus obscurus*	
l e in e teal	*Anas discors*	
le ea	*Bucephala albeola*	
ali nia ll	*Larus californicus*	
ali nia ail	*Callipepla californica*	
ali nia t as e	*Toxostoma redivivum*	
ali nia t ee	*Pipilo crissalis*	
ana a se	*Branta Canadensis*	
inna n teal	*Anas cyanoptera*	
n l ene e	*Bucephala clangula*	
n e anse	*Mergus merganser*	
n en	*Gallinula chloropus*	
n snipe	*Gallinago gallinago*	
n ell t at	*Geothlypis trichas*	
pe s a	*Accipiter cooperii*	
a e e nc	*Junco hyemalis*	
le c este c ant	*Phalacrocorax auritus*	
asi n i e n	*Anas penelope*	
e in s a	*Buteo regalis*	S
is e	*Martes pennanti*	
a all	*Anas strepera*	
l en ea le	*Aquila chrysaetos*	
eat l e e n	*Ardea herodias*	
eat e et	*Ardea alba*	
eate ite nte se	*Anser albifrons*	
een in e teal	*Anas crecca*	
e e anse	*Lophodytes cucullatus*	
ne la	*Eremophila alpestris*	
Lesse sca p	*Aythya affinis*	
Little n tis	*Myotis lucifugus*	
Little ill l catc e	*Empidonax trailil brewsteri*	S
L e ea s i e	*Lanius ludovicianus*	
L n ille c le	*Numenius americanus*	
L n ea e l	*Asio otus*	
alla	*Anas platyrhynchos*	
e lin	*Falco columbarius*	
ntain ail	*Oreortyx pictus*	
nin ve	*Zenaida macroura*	
N t e n lic e	*Colaptes auratus*	
N t e n s a	*Accipiter gentilis*	S
N t e n a ie	*Circus cyaneus*	
N t e n pintail	*Anas acuta*	
N t e n s vele	*Anas clypeata*	
N t e n sp tte l	*Strix occidentalis caurina*	
sp e	*Pandion haliaetus*	S
Pe e ine alc n	*Falco peregrinus*	
P ai ie alc n	*Falco mexicanus*	
P ple a tin	*Progne subis*	
in nec e p easant	*Phasianus colchicus*	
ss se	*Chen rossii*	
c	*Oxyura jamaicensis*	
e se	*Bonasa umbellus*	
s c ne spa	*Aimophila ruficeps*	
Sa e spa	*Centrocercus urophasianus*	
San ill c ane	*Grus Canadensis*	
Savanna spa	*Passerculus sandwichensis*	
S a p s inne a	*Accipiter striatus*	
S t ea e l	*Asio flammeus*	
Sn se	*Chen caerulescens*	
S n spa	*Melospiza melodia*	
Sp tte t ee	*Pipilo maculatus*	
S ains n s a	*Buteo swainsoni*	S
ic l e lac i	*Agelaius tricolor*	
a s s i t	*Chaetura vauxi*	
este n in l	*Athene cunicularia hypugea*	S
este n sc a	*Aphelocoma californica*	
ite ace is	*Plegadis chihi*	S
ite taile ite	*Elanus leucurus*	
il t e	*Meleagris gallopavo*	
ill l catc e	*Empidonax traillii*	S
c	*Aix sponsa*	
ell a le	*Dendroica petechia*	
ell ille c c	*Coccyzus americanus*	
ell easte c at	*Icteria virens*	



Cottonwood Creek Watershed Aquatic Habitat and Fisheries Recommendations

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Cottonwood Creek Strategic Watershed Plan (Dec, 2005)

2005 Stakeholders Workshops Resulted in Recommendations related to Aquatic Habitat:

(1) Establish baseline water quality monitoring

(2) Establish baseline fish and frog monitoring

(3) Determine limiting conditions for fish species

Recommendation 1:

"Establish baseline water quality monitoring"

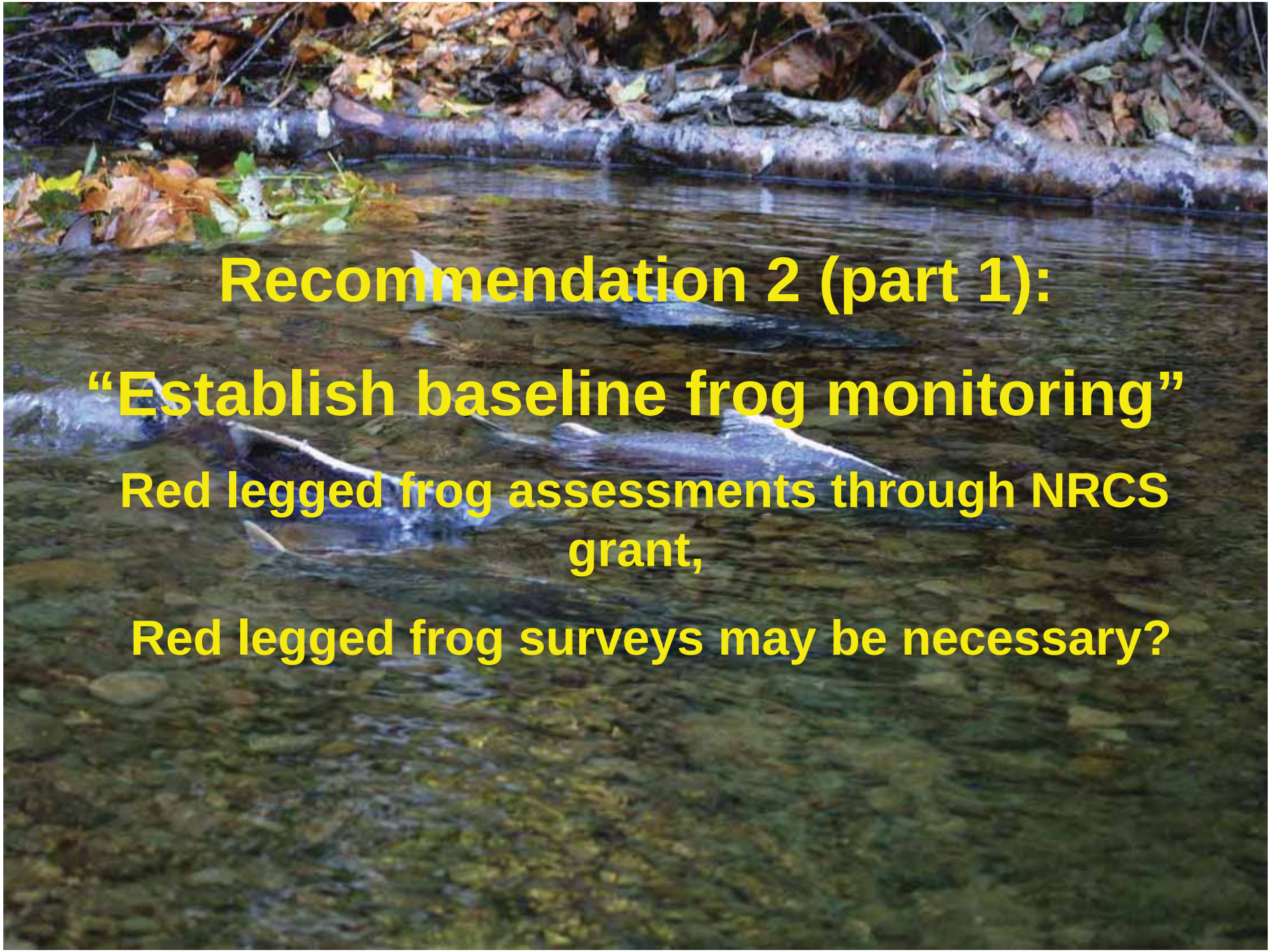
Parameters:

Water temperature, turbidity, *E. coli, b*enthic macro Invertebrates.

10 locations in watershed,

Begin September, 2006,

Year round for one year



Recommendation 2 (part 1):

"Establish baseline frog monitoring"

Red legged frog assessments through NRCS grant,

Red legged frog surveys may be necessary?

Recommendation 2 (part 2):

"Establish baseline fish monitoring"

Monitor juvenile populations:

Monitor adult populations:

Establish Baseline Juvenile salmonid monitoring program:

Baseline Juvenile salmonid monitoring program:

Recommend using Rotary Screw Traps

Results: Annual index juvenile (smolts) numbers

Recommendation 2 (cont.):

"Monitoring Adult Salmonid Populations"

Adult Population Survey Methods:

Carcass surveys (boat and wading),

Aerial Redd surveys (fixed wing or helicopter),

“On-the-ground” Redd surveys (boat/wading),

Snorkel surveys (underwater observations),

Weir counts (video or other technology)

Developing Adult salmonid monitoring program:

Evaluate various methodologies,

Determine feasibility of each,

Select & prioritize reaches for monitoring.

Carcass surveys

(likely feasible)

Carcass (creamer) surveys

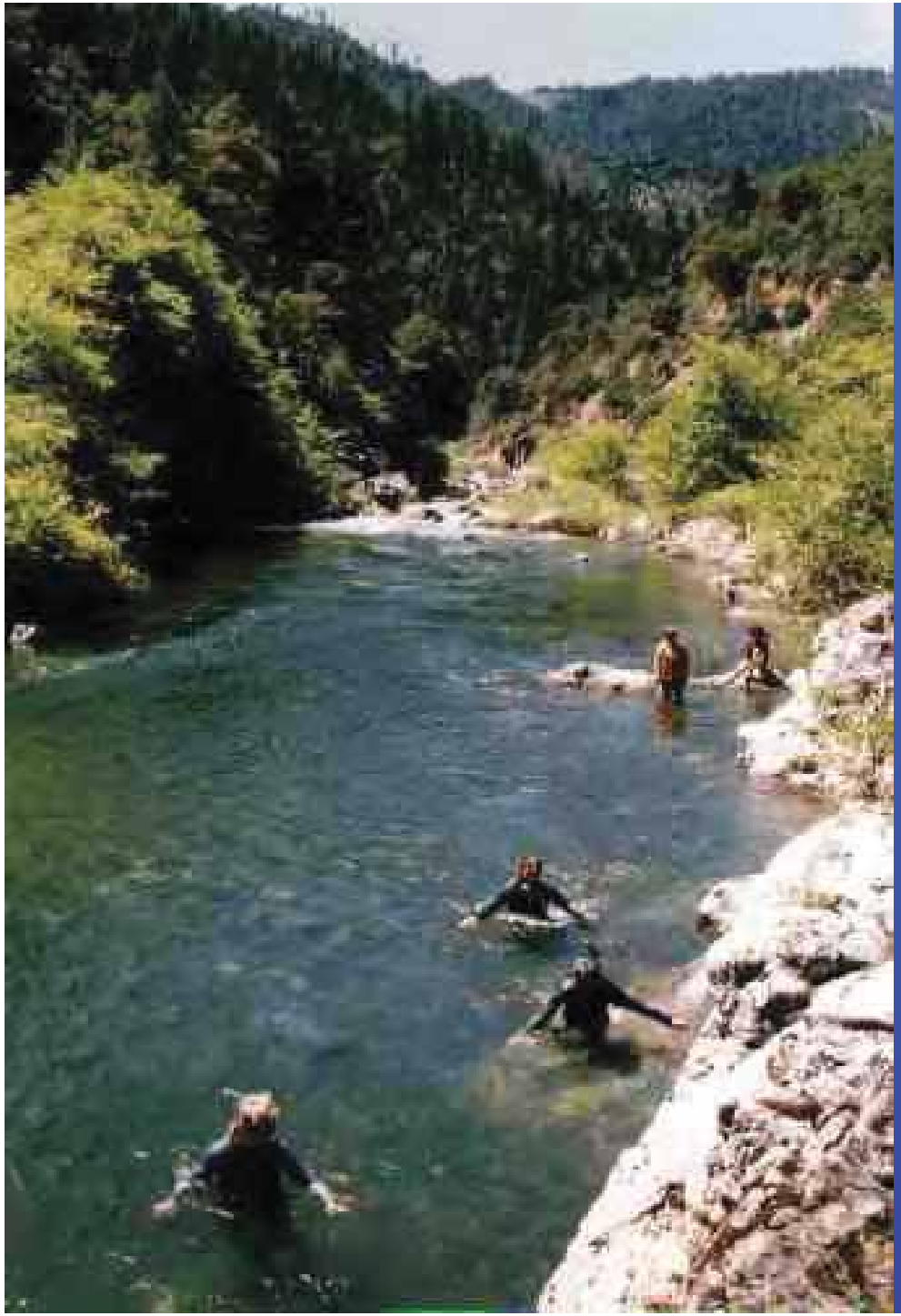

Redd Surveys
(may be feasible)

Aerial Redd Surveys

(CDFG has conducted in CC Watershed)

Snorkel surveys

(may feasible in some circumstances)



Snorkel Surveys:

observation-counts

CDFG presently conducts Spring Chinook snorkel surveys in Beegum Creek

Weir counts

(feasible)

Alaskan Resistance Board Weir


Assembly of fish trap
on Alaskan Weir

Recommendation 3 :

“Determine Factors Limiting to Fish Populations”

Steps in Determining Limiting Factors to Fish Populations:

1. Assess existing data.
2. Determine data gaps,
3. Develop conceptual models & hypothesis,
4. Plan & conduct focused studies to fill gaps,
5. Conduct limiting factors analysis,
6. Make recommendations

"Plan and conduct focused investigations to fill gaps"

Aquatic habitat assessment needs:

a. Habitat typing (pool, riffle, run),

b. Unit characterization (width, depth, length),

c. Stream gradient, sinuosity, aspect,

d. Substrate characterization

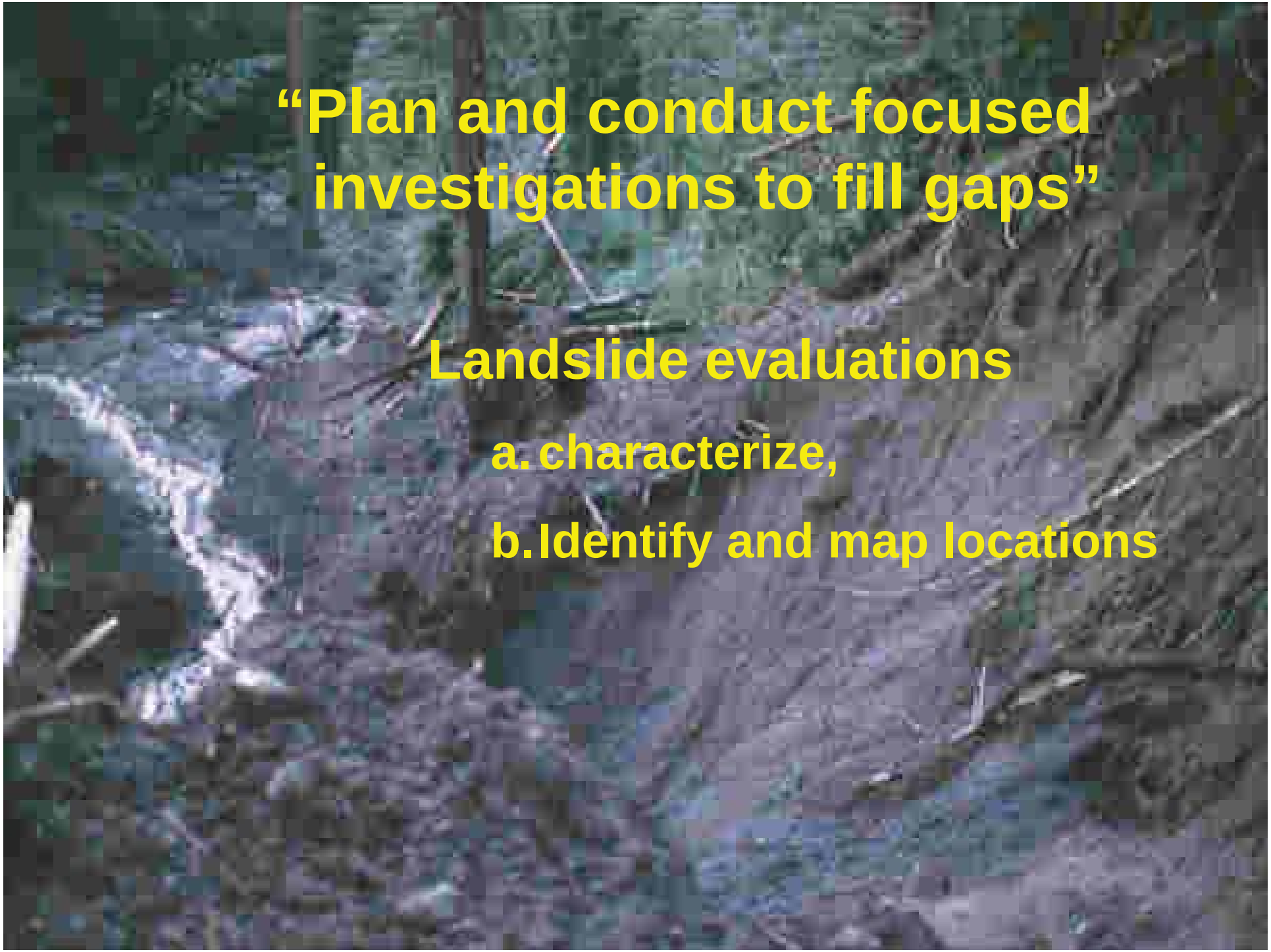
“Plan and conduct focused investigations to fill gaps”

Detailed fish barrier assessments:

a. Identify locations,

b. characterize at varying flows,


"Plan and conduct focused investigations to fill gaps"
Spawning Gravel assessments:
a. Identify locations and volume (area),
b. characterize (particle size, embeddedness)


“Plan and conduct focused investigations to fill gaps”
Landslide evaluations
a. characterize,
b. Identify and map locations

Next Steps:

Consult with Cal Fish and Game and USFWS,

Seek funding programs,

Develop detailed proposals,

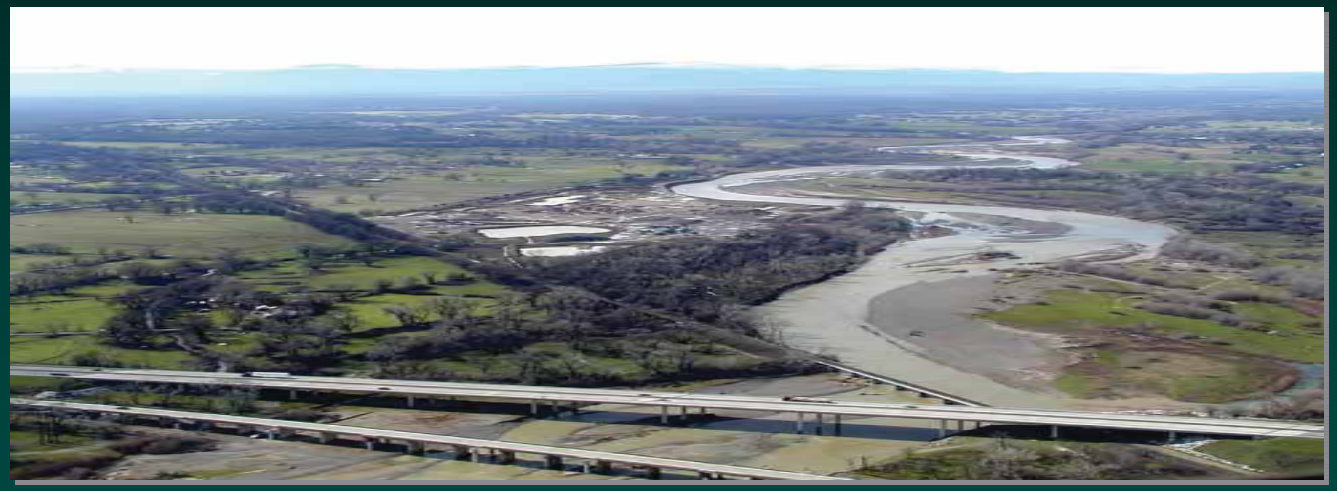
Sponsor investigations,

Conduct analyses,

Plan and implement projects to solve limiting factors.


Questions?

Cottonwood Creek Watershed



Cottonwood Creek Watershed Vegetation and Wildlife Resources Workshop

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CH2MHILL

Vegetation
Cottonwood Creek Strategic Watershed Plan Recommendations

1. **Mapping riparian areas of the watershed**
   Stat s ipa ian a itat in t e ate s e
2. **Creating a list of native plants, with their general habitat locations identified in the watershed**
3. **Assessing status and trends of native oak woodlands, particularly blue oak woodlands, in the middle and lower portions of the watershed**
4. **Assessing the impacts of noxious weeds on vegetative resources**

Vegetation
Mapping Riparian Areas

Riparian mapping is scheduled to be initiated through NRCS Cooperative Conservation Partnership Initiative 2006 grant that includes:

- c i in i es l ti n c l i a e
- enti in an appin ve etati n c nities al n ain ste tt n ee an a t i ta ies
- enti in sites n n native an n i s plants an ee s ipa ian a eas
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Information from NRCS study will be useful in filling data gaps identified within the Watershed Strategic Plan

Monitoring program will provide photographic documentation of 12 sites for one year

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Recommended that CCWG continue photographic documentation of these sites after completion of the monitoring program.

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Vegetation
Identify Native Plant Species

List of native-species for review

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Recommend initiation of surveys for special-status species

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Vegetation

Assess Status and Trends of Native Oak Woodlands

- **Identify location of native oak woodlands within watershed**
- **Recommend evaluation of habitat of native oak woodlands and establish baseline conditions**
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- **Prioritize areas for protection**
- **Work with landowners on management of oak woodlands**

Vegetation
Noxious Weeds

Noxious weeds associated with riparian areas would be evaluated by NRCS (tamarix, giant reed and pampas grass)

Recommend comprehensive noxious weed inventory and management plan

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Recommend noxious weed education and outreach plan

Wildlife
Cottonwood Creek Strategic Watershed Plan Recommendations

1. Establish basic fish and frog monitoring
2. Create a list of native species in the watershed
3. Develop management goals for terrestrial wildlife habitat

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Wildlife
Basic Frog Monitoring

California red-legged frog inventory is scheduled to be initiated through NRCS Cooperative Conservation Partnership Initiative 2006 grant that includes:

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Wildlife

Identify Native Wildlife Species

List of native-species for review

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Initiate surveys for special-status species

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Wildlife
Manage Terrestrial Wildlife Habitat

Assess terrestrial wildlife resources within the watershed

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Continue public education and stewardship for protection of wildlife habitat

- Native ipa ian an a lan a itat p ese vati n an est ati n

Questions

CH2MHILL

Noxious Weed Management

Adaptive approach for noxious weed management

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CH2MHILL

Noxious Weed Education

- Provide information on how noxious weeds spread
- Provide information on native species that could be planted following noxious weed abatement
- Identify methods of minimizing future noxious weed invasion within watershed

Cottonwood Creek Watershed Management Plan Management Plan Development Workshop: Fish, Vegetation, and Wildlife Resources August 17, 2006

FROM: Ed McCarthy / CH2M HILL
Tim Hamaker / CH2M HILL
Julie Rochlitz / CH2M HILL
Susan Lukso / CH2M HILL

DATE: August 22, 2006

Attendees:

Tom Harrington / CCWG	Ed McCarthy / CH2M HILL
Vieva Swearingen / CCWG	Tim Hamaker / CH2M HILL
Dee Swearingen / Consultant	Julie Rochlitz / CH2M HILL
Guy Chetelat / RWQCB	Susan Lukso / CH2M HILL
Brenda Olson / USFWS	

COPIES: Vieva Swearingen / CCWG

Introductions and Meeting Purpose

Vieva Swearingen / CCWG started the meeting at 6:40 p.m. and introduced the presenters.

The purpose of this workshop series has been to expand upon the primary areas of concern for the Cottonwood Creek Watershed (CCW) as identified in the Watershed Strategic Plan (WSP). The workshops are an elaboration on the CH2M HILL Technical Memoranda on future development and water resources; fish, vegetation, and wildlife resources; and channel and riparian conditions. Stakeholders and the general public are encouraged to participate in the reviews and discussions as the outcomes will impact the direction of the Cottonwood Creek Watershed Management Plan (WMP).

Vieva Swearingen / CCWG facilitated introductions.

Tim Hamaker / CH2M HILL began the discussion of the Management Plan Development Workshop: *Recommendations for Fishery, Vegetation, and Wildlife Resources in the Cottonwood Creek Watershed [Technical Memorandum]* (CH2M HILL, August 17, 2006) findings with the usage of a PowerPoint presentation (*Cottonwood Creek Watershed Aquatic Habitat and Fisheries Recommendations*, August 17, 2006). Julie Rochliz / CH2M HILL continued the discussion with her presentation (*Cottonwood Creek Watershed Vegetation and Wildlife Resources Workshop*, August 17, 2006). A copy of the presentation was emailed to Vieva Swearingen on Friday, August 18, 2006.

Discussion

Topics of discussion:

Comment: In the *Recommendations* Technical Memorandum, the physical barriers section identifies the North Fork as having a waterfall and the South Fork as having a constructed barrier. Vieva Swearingen and other attendees believe that these features are reversed. The South Fork has a waterfall and the barrier has been deconstructed there while the North Fork does not have a waterfall. Other attendees said that the description in the TM was correct, that there is a waterfall on the North Fork and a constructed barrier on the South Fork. Mike Berry, Correne Harvey, Bill Guros, and / or the Harveys can confirm these features.

Question: What is the proposed time duration of study of juvenile salmonid (smolts)?

Response: The first step is to identify the baseline of fishery resources. After that has been established, the CCWG can pursue the recommended long-term study program with additional funding.

Question: Are the screw traps stable and the information they collect valid during the high flow periods?

Response: The screw traps must be monitored more frequently or even removed during high flow periods. Placement must allow for ease of removal or access to empty of the traps. Each trap costs approximately $40,000 so in terms of cost of information for cost of the device there is a high return rate.

Question: Is it recommended to set screw traps at the South Fork and Beegum Creek?

Response: Ease of access for maintenance is an issue. A joint program could be developed with Brenda Olson / USFWS and Tricia Bratcher / CDFG. Beegum Creek has never been studied while the other creeks have. Consistent monitoring goals need to be established.

Response: According to Brenda Olson / USFWS the AFRP (Anadroumous Fish Restoration Program) have monitoring goals.

Response: CH2M HILL recommends an adult monitoring program. The split beem, hydrocustic, or ditsen could be used for this purpose.

Comment: Brenda Olson noted that the Weir count method is going to be tried on Cow Creek despite it being flashy like Cottonwood Creek.

Comment: The recommended “assessing existing data” and “determining data gaps” steps for determining of limiting factors to fish population are nearly done.

Question: Is it important to study non-natal rearing?

Response: It is important. The baseline study will help to determine the relevance.

Response: The geomorphic study will be discussed at the Thursday, August 24, 2006 Management Plan Development Workshop: Channel and Riparian Conditions.

Question: Will temperature be monitored?

Response: Temperature will be a focus in the long term surface water monitoring program. If the temperatures are known, than the timing of fish migration up the creek becomes more predictable which is useful for additional future salmon monitoring.

Questions: Will gravel recruitment be studied?

Response: Yes. The channel conditions technical memorandum will discuss gravel recruitment and make recommendations for studies for evaluating where the gravel is coming from and, if the budget allows, the particle size.

Question: Are there other fish in the creek? Will the WMP include a diverse representation of the fish species in the creeks? The technical memorandum focuses on salmon but if other fish are in the WMP, then CCWG can cite it in the future when pursuing species specific funding.

Response: There are multiple species in the watershed along with native and non-native species such as pike minnows, trout, and lampreys. Recently salmon is the high priority for most restoration activities so most of the existing data is on them. Also, by having data on the presence of other species, the data can be used anecdotally for salmon research.

Comment: Dee Swearingen requests that at least one paragraph in the WMP be devoted to other fish species.

Comment: Small mouth stripers are also viewed as a problem fish in the watershed.

Question: Brenda Olson views the technical memoranda as restatements of the WSP. She wanted more solutions presented for the known problems.

Response: The technical memoranda are elaborations on the primary concerns identified by the CCWG and stakeholders in the WSP. Each memorandum provides technical understanding and possible solutions that the group may choose from. The workshops are the forum in which the group can identify the solutions they want to seriously consider utilizing. The WMP will synthesize the chosen solutions into what and how the group and individuals can proceed.

The Channel and Riparian Conditions workshop will include information on stopping bank erosion and methods for habitat restoration.

Comment: The migration of the fish in the watershed is abnormal.

Comment: Temperature is the primary issue affecting the migration pattern of the fish. Gravel in the middle of the stream bed and silt removal also impact migration. Channel restoration will be very important to restoring the migration pattern.

Comment: Dee Swearingen suggested that if the streambed is restored, than the gravel will move naturally on its own.

Comment: Brenda Olson suggested that the meandering is a result of the gravel in the middle of the stream and presence of the willows.

Comment: Ed McCarthy recommends that a map of the good areas for habitat study be developed. The basics need to be done.

Comment: Brenda Olson does not want the WMP to minimize the study options and management recommendations for the watershed.

Comment: The WMP will be broad. That is the reason for the technical memoranda.

Question: What is the sustainability level of non-endangered wildlife in the habitat? Can this information be included in the wildlife section of the WMP?

Response: A biologist would need to determine the sustainability level.

Comment: Funding would be an issue for such a study.

Question: What is the objective of the turbidity study if it is monthly?

Response: The measurements will be taken the same date each month as well as within 8-12 hours of two storms. The data will help to determine which creek forks are contributing to the flow and if there are any force problems.

Comments: The WMP needs to address that long-term data monitoring is needed pending additional funding. Distinguish between the upcoming baseline data gathering study and a long-term study.

Comment: Brenda Olson suggested that Cottonwood Creek be included in the USGS temperature gathering study that is already planned for Deer and Mill Creeks.

Comment: Vieva Swearingen acknowledged that in the future the USGS and CCWG temperature collections could be a joint effort thus assisting with funding.

Comment: Data logs are fairly cheap for the quantity of data they provide.

Comment: Include an assessment and recommendations on continuing temperature data gathering in the WMP.

Comment: The WMP needs to be more than a recommendation to fill data gaps.

Comment: Ed McCarthy asked Tim Hamaker to include suggestions and methods for how to approach data gaps.

Comment: Vieva Swearingen asked for the WMP to include a list of recommendations that could be fulfilled eventually if funding becomes available.

Comment: For Brenda Olson habitat restoration is the priority. There needs to be a wildlife baseline established before recovery goals are established. Establishing funding for additional studies and efforts can then be made. Incorporate funding analysis from Mill and Cow Creeks into Cottonwood Creek efforts.

Comment: On slide 2 in Julie Rochlitz's PowerPoint show, she should reverse the order of her recommendation to map and survey the watershed.

Comment: The Native Species List – Vegetation should include a section on beneficial range species (i.e., native grasses) for range managers.

Comment: The list should also include "ice cream plants", those that are highly prone to being overgrazed by cattle.

Question: Would landowners allow a vegetation survey on their property?

Response: Vieva Swearingen's past experience with requests for private property access for surveys lead her to think that few would allow such access for vegetation survey. However, the WMP should still include this recommendation. It is important for the public to understand the positive impact such a survey could have on the watershed and their property.

Question: What native vegetation should people plant if attempting restoration on their property? That information should be in the WMP.

Response: A list of that sort can be obtained through the Native Plant Society and the University of California, Davis website. The WMP can cite those sources in the Native Species List – Vegetation.

Response: Include what the species are good for.

Question: Is there a tree cutting problem in the watershed?

Response: In Tom Harrington's experience there had been a problem a while back so there is fear of a reoccurrence. Tehama County has a plan for how to handle resurgence of the cutting, but Shasta County does not. The cutting of trees does affect wildlife.

Comment: Counties are working on oak woodland preservation.

Question: Address large wildlife so that the WMP is comprehensive.

Response: The WSP set concerns to be expanded upon in the technical memoranda and recommended in the WMP.

Comment: Wildlife had been mentioned previously. Comments that had been mentioned at a previous meeting have not always been reiterated or continuously advocated but that should not be used to judge their value.

There is a large amount of hunting in the watershed so people will want to manage it for the wildlife. Include strategies for landowners to encourage and sustain the wildlife.

Question: Include the development of off-channel water reservoirs. Can they be connected to the channel?

Comment: The wording in the WMP should be "management" or "assisting in the preservation" of the watershed and not the "protection" of the watershed. Protection has a negative connotation that implies a superseding of the watershed's interest over the landowners. Since the landowners are vital in carrying out the recommendations of the WMP, they should know what they interests are respected.

Comment: A clear statement of the goals of the management plan should be included.

Response: A style guide will be developed for the preparation of the WMP.

Meeting ended at 8:45 pm

Appendix D
Fire and Fuels Management

Introduction

A Technical Memorandum (TM) was developed that summarized fire and fuels management concerns of stakeholders in the Cottonwood Creek Watershed as documented in the SWP (CH2M HILL, 2005). The TM discussed projects that could be considered by CCWG to address these concerns. The TM was distributed to the stakeholder group at a workshop that was held on April 6, 2006, to review and discuss the content of the TM. Appendix D includes the final TM, the presentations from the workshop, the news release for the workshop, and a workshop summary.

This workshop was held 1 week after the initial workshop on erosion and flooding. The workshop was an opportunity to present details on the development of a rangeland management plan. The information presented at this workshop was meant to focus on a small range of strategies that could be used for fire and fuels management. The result of the workshop was that CCWG would like to move forward with the creation of a rangeland management plan and that such a plan would be two-phased – a broad watershed-scale document followed by a more focused plan that would target a smaller set of priorities within the watershed. Although this focused workshop generated a consensus, participants were not satisfied with the breadth of discussion of this topic. After this workshop was completed, future workshops were put on hold while the structure of the workshops was evaluated. The TM format that was used during August meetings was a result of re-evaluating the workshop format.

Cottonwood Creek Watershed Management Plan: Background Information for Workshop on Fire and Fuels Management – Workshop 2, April 6, 2006

Objective

The purpose of this workshop is to bring together stakeholders to determine the direction of the Cottonwood Creek Watershed Management Plan. The goal is to arrive at a consensus among stakeholders about the desired conditions for fire and fuels within the watershed. The workshop discussions will be instrumental in developing a comprehensive Watershed Management Plan and, ultimately, providing a rational, science-based approach to cooperatively managing the Cottonwood Creek Watershed with a diverse set of stakeholders. The workshop participants will outline a vision for the watershed including conceptual strategies for management, monitoring, and education.

Project Introduction

One workshop will be held for landowners, resource agency members, and other stakeholders on Fire and Fuels Management which will provide an opportunity for stakeholders to receive information on present watershed conditions and discuss and prioritize desired watershed conditions. This workshop on fire and fuels management will help to develop strategies for achieving the desired fire and fuels conditions within the watershed. Additional workshops are scheduled to cover the topics of Fish Ecosystems, Water Supply, and Public Education and Outreach.

Watershed Assessment (CH2M HILL, 2002)

This watershed assessment compiled information related to hydrology, sediment and fluvial geomorphology, soil resources, water quality, vegetative cover, fishery resources, wildlife resources and habitat types, special-status species, riparian communities, and land use. Findings and recommendations from these topics that are pertinent to fire and fuels management are presented below.

Findings and Recommendations

- The management and utilization of natural resources have affected vegetation patterns throughout the watershed. Fire suppression and oak woodland conversion are two factors that appear to affect the vegetation resources and patterns at the landscape level.
- Conduct livestock surveys within the watershed boundaries. Determine livestock type and location of grazing. Survey agriculture lands to determine location, crop type and irrigation system used. Associate livestock and cropping data with county and state designated land use type and location in the watershed.

- In general, agriculture, timber, and federal lands cover the largest percentage of the land area within the watershed.
- Approximately 13 percent of the Cottonwood Creek watershed is mapped as annual grassland in the CALVEG database.
- An estimated 16 percent of the Cottonwood Creek watershed is comprised of chaparral habitat. The chaparral communities are generally distributed on harsh sites with rocky substrates in the foothills and montane portions of the watershed, and consist of short-statured shrubs and trees (less than 15 feet tall). Chaparral communities are fire-adapted and have reproductive methods that are dependent on periodic and/or recurring fires.
- Promote restoration projects on public and private lands. Where appropriate, fence and plant native vegetation in degraded and nonvegetated riparian areas. Remove non-native species and plant native species in riparian areas.
- Assess status and trends of native oak woodlands, particularly blue oak woodlands, in the middle and lower watershed. Evaluate the effects of fire and grazing on oak woodlands. Encourage sustainable harvesting of oaks in the watershed.
- With assistance of U.C. Davis Cooperative Extension Rangeland Monitoring Program, encourage ranchers within the watershed to design grazing strategies that encourage oak recruitment and preservation of riparian habitats.
- Develop a fire management plan as a tool for habitat enhancement. Evaluate the effects of fire suppression on the watershed deer population. Assess changes in habitat usage and population trends following vegetation management practices.

Strategic Fuels Reduction and Management Plan for the Cottonwood Creek Watershed (Western Shasta Resource Conservation District, 2004)

The purpose of the plan was to identify areas where the construction of fuelbreaks and could increase protection for residents of the watershed, protect at risk values, provide firefighters safety when containing a blaze, allow safe transportation routes away from a fire, and encourage a maintenance plan that would continue a fuelbreak network. A list of shaded fuelbreaks, ridgetop fuelbreaks, dozer track fuelbreaks, brush abatement and maintenance projects were developed based on location, vegetation, wind direction, access, and values at risk.

Recommendations

Table 1, taken from the Strategic Reduction and Management Plan, provides a summary of recommendations.

TABLE 1
Summary of Recommendations

Project	Area of Water-shed	Project Location	Length	Type	Other Information
A	Bowman	Benson Rd	3 miles	Ridge-top Shaded FB	5.5 mile road
B	Bowman	Basler Rd	2 miles	Ridge-top Shaded FB	8.3 mile road
C	Bowman	Quail Ridge Rd	5 miles	Ridge-top Shaded FB	
D	Bowman	Quail Ridge Rd		Man-made cistern for H2O storage	Multiple willing landowners
E	Igo	Gas Point Rd, just S of Placer Rd	2 to 3 miles	Ridge-top Shaded FB	19 mile road
F	Igo	Clear Creek Rd, Gas Point Rd to CCW boundary	2 miles	Shaded FB	Majority of road east of CCW boundary
G	Igo	Cloverdale Rd, S – tie in with existing FB N of Clear Creek Rd	2.2 miles	Shaded FB	Ridge road, along CCW NE boundary
H	Ono	Rainbow Lake Rd	5 miles	Shaded FB for foothill protection	Road is ~5 miles from Ono to Rainbow Lake
I	Pettyjohn Rd	Pettyjohn Rd, ~2 miles W of Reeds Creek Rd	1.8 miles	Shaded FB	Remote area
J	Platina	Cottonwood Wilds – tie in with BLM & USFS	Multiple FB lines	Maint. of ~11 existing FBs	Range of existing FBs: 0.2 – 1.4 miles; BLM sections interspersed
K	Platina	Cottonwood Wilds		Controlled burn	Conversion of Brush/ Chaparral to Grass/Oak Savannah
L	Platina	Beegum Gorge Rd – tie in with USFS	1 miles	Shaded FB	Roadside, some ridge top
M	Platina	SR 36, section of road east of Platina Rd	0.8 miles	Shaded FB	Roadside
N	Platina	Harrison Gulch Rd	3 miles	Shaded FB	SR 36 to USFS line
O	Platina	Surrounding hillsides, Platina		Controlled burn	Fuel reduction of dense chaparral areas
P	Platina	Between Platina & Beegum		Water source	Year-round availability needed
Q	Central Watershed	Vestal Rd	~6.5 miles mostly grazing land	Education	SR 36 south to Weemasoul Rd
R	Central Watershed	Bland Rd	~8 miles ranch areas	Education	MF Cottonwood Creek to SR 36
S	Central Watershed	Ball Rd	~2.5 miles	Dozer track	SR 36 to end, combating E-W wind
T	Central Watershed	R Wild Horse Ranch on SR 36	Area around ranch	Shaded FB	Protection of rural, seasonal community
U	State Route 36	SR 36	~35 miles	Dozer track or Shaded FB as needed	Length of Hwy through CCW

TABLE 1
Summary of Recommendations

Project	Area of Water-shed	Project Location	Length	Type	Other Information
V	Platina Rd	Platina Rd	~23 miles	Dozer track or Shaded FB as needed	Length of road from Gas Point Rd to SR 36
W	Platina Rd	MF Cottonwood Creek	~2 miles	Fuel break -to protect riparian habitat	~ 1 miles upstream & ~1 miles downstream of Platina Rd
X	Platina Rd	Smith Ranch		Brush abatement	Around Smith Ranch & Trinity Wilderness
Y	Lake California	Lake California Dr	~3 miles	Maint.	I-5 to Lake CA gate
Z	All Areas			Maint. of burned areas	Eliminates decadent brush fields to benefit wildlife
A1	All Areas			Regenerate from chaparral to grass/ oak areas	Eliminates decadent brush fields to benefit wildlife

Also included in the plan were recommendations from the Cottonwood Creek Watershed Fire Safe Council. The priority list of activities that can help create a fire safe watershed include:

1. Develop strategic locations for cisterns throughout the watershed.
2. Install cisterns in strategic areas previously identified.
3. Illustrate all large ranches, and subdivisions, etc. within the Cottonwood Creek Watershed on a map.
4. Locate and illustrate all existing water sources such as ponds, pools and streams and access routes for fire engines.
5. Install signs at major road intersections to indicate the location of existing water sources within the watershed.
6. Install reflective road signs on private and county roads to help firefighters and other emergency response teams locate and communicate target destinations.
7. Develop and disseminate educational information about fire prevention and emergency planning to all residents in the watershed.
8. Develop an evacuation plan for the watershed to provide residents with information regarding evacuation procedures, emergency shelters, and safe escape routes.
9. Continue CDF's VMP program within the watershed, concentrating on larger ownerships with an emphasis on noxious weed eradication and converting chaparral to annual grasslands.

10. Build or improve road access to existing and developed water sources.
11. Identify and map the location of landowners with water hookups for fire engines.
12. Provide property owners with the means to develop defensible space around homes.

Cottonwood Creek Watershed Strategic Plan (December 2005)

The Cottonwood Creek Strategic Watershed Plan (Strategic Plan) was completed through a process of issue-area specific stakeholder meetings designed to arrive at a consensus about the desired conditions in the Cottonwood Creek watershed. This Strategic Plan was intended to form the foundation for a comprehensive Watershed Management Plan (WMP).

Summary of Fuel Reduction and Vegetative Management Workshops

Fuel reduction and vegetation management were discussed in three of the five issue-area workshops. The Rangeland and Timber workshop focused most heavily on fuel reduction and vegetation management. It was noted that any action-oriented objectives set by CCWG, such as fuel reduction and vegetation management plan implementation, must be supported by a base of information about resources in the watershed and their locations. Without inventories of watershed resources, it will be difficult for CCWG to recommend how best to manage resources.

The CCWG, together with CDF, U.S. Forest Service (USFS), Bureau of Land Management, and local timber companies, could play a large role in fire prevention and safety by creating safe zones and educating landowners in the watershed area about ways to help minimize fire hazard.

Fuel Reduction and Vegetative Management Recommendations

Strategic Area 1: Fuel Reduction and Vegetation Management

The primary recommendations that were detailed in the Strategic plan are:

- Consider Grazing as a Tool for Fuels Reduction
- Pursue Vegetation Management Through Prescribed Burning Programs
- Act as a Clearinghouse for Forest Management in the Watershed
- Eliminate or Reverse Fire Suppression Trends by Implementing a Watershed Fire Management Plan

Other recommendations that were considered by stakeholders include:

- Contact CDF concerning the two programs established to provide cost-sharing technical assistance and educational programs for timberland owners. These two programs include the California Forestry Improvement Program and the Chaparral Management Program.

- With assistance from the University of California - Davis Cooperative Extension Rangeland Monitoring Program, evaluate the effects of various grazing strategies on propagation of native vegetation.
- Assess status and trends of native oak woodlands. The Tehama County Hardwood Committee has established guidelines for oak harvesting and management within the watershed. Their goal is to educate the public and landowners on the ordinances and guidelines set forth by the committee and Tehama County.
- Establish a comprehensive rangeland management plan.
- Create a database of information on forest fuels. Start outreach to landowners and Technical Advisory Committee (TAC) to share the information in the database and also to find more information to add to the database. The database's purpose will be to share forest management experience within the watershed.

Strategic Area 2: Inventory and Mapping

- Map riparian areas.

Strategic Area 5: Monitoring and Modeling

- Develop ranch management plan for watershed that includes helpful landowner guide to grazing issues, noxious weeds, and fencing criteria.
- Develop a set of management tools. These tools should be concise and easily accessible to all stakeholders. (Put on Web site and/or brief handout.) Tool topics include erosion control, noxious weeds abatement, wildlife species, fuels reduction/fire.

Recent Activities

Work to implement the Strategic Fuels Reduction Plan is ongoing.

Recent work includes:

- Quail Ridge water tank (Project D in Table 1) was installed.
- Creating a fire break at Clear Creek Rd (Project F in Table 1) was attempted but not completed because there was no land owner cooperation. There is currently a new land owner who has created a fire break on his own.
- Platina Fuel Break on both sides of Highway 36. (Project M in Table 1)
- Cottonwood Wilds fuel Break. (Project J in Table 1)
- Use of grazing for fuels management project is ongoing and has been successful to date.

Current work in the planning stage includes:

- Hammer Loop fire break has funding and has started the process of completing the plan and CEQA documentation. Currently looking funding to do the project.

- Applied for a grant to create a fire break at R-Ranch (Wildhourse) (Project T in Table 1). Problems associated with this development include excessive brush on roadsides and more four-wheel-drive activity in remote locations.
- Bowman Biomass project is getting ready to start. Will do thinning and brush removal around residential developments. Getting landowner participation will be important. Area has dense brush near housing. A grant application has been submitted to perform a controlled burn and fuel reduction around Platina (Project O in Table 1).

Action Items to be Included in the WMP:

The following three strategies should be included in the WMP. These items will be discussed by the stakeholders and any decisions made about these items will be carried forward into the WMP.

1. Cottonwood Creek should Act as a Clearinghouse for Fire and Vegetation Management within the watershed.

There are many techniques available for managing fire and vegetation. Information on techniques that are in practice, have been attempted, or are going to be attempted within the watershed would be listed, along with a description, in a database or other filing system at the CCWG offices. Other information, like updates that are needed for existing plans (e.g. Strategic Fuels Reduction and Management Plan), would also be kept. This will help facilitate stakeholder education. The WMP will include further recommendations for how to implement and maintain the database.

2. Create a Rangeland or Vegetation Management Plan.

Create a Rangeland or Vegetation Management Plan (plan). A plan can be developed in a number of ways. Determining the specific approach for creating a plan is one of the goals of this workshop. A single plan for the watershed could be created. This single plan would be limited because of the size and diversity of the watershed. Multiple smaller plans could be produced for targeted areas. Generally, a plan or plans would help landowners manage natural resources like riparian zones, grasslands, invasive species, and chaparral. The plan can document existing conditions including vegetation type, habitat type, and BMPs in use in the watershed or at a specific location within the watershed.

The process of creating a plan would involve reviewing the available data, conducting field work or interviews to collect information that is not available currently, and then combining the information to develop specific goals for maintaining or improving range. One example of a component of a management goal would be a Star Thistle Management Goal. To create the plan for this goal, a watershed wide inventory of locations with star thistle would have to be conducted and a map created. Methods for Star Thistle eradication would be collected and complied. Then a list of priority eradication sites would be made with specific recommendations for methods of eradication. Funding sources or volunteers from the community could be found to help implement the management plan.

3. Create an Evacuation Plan

The Cottonwood Creek Watershed Fire Safe Council identified the creation of an evacuation plan as one of the priorities for the watershed. If this is a priority for the stakeholders, recommendations for creating an evacuation plan for the watershed can be more fully explored in the WMP. The WMP would identify the major players who would be involved in creating the plan and would attempt to identify funding sources for creation of the plan.

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Rangeland and Riparian Management Plans for Cottonwood Creek Watershed

Presented to

Cottonwood Creek Watershed Group

April 6, 2006

Purpose

1. Inventory rangeland and riparian resources
2. Document historical and present day grazing practices
3. Develop economically feasible plan for improving/maintaining range condition and sustaining natural resources

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Strategic Areas

Range plans would address four out of the five strategic areas identified in the Watershed Management Strategy

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Watershed Strategy Recommendations

Range plans would address the following watershed strategy recommendations

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Develop rangeland management plan that includes

Helpful landowner guide to grazing issues

- ***Noxious weed identification and eradication***
- ***Fencing criteria***

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Approach

- **Develop a watershed range plan**
  - *Several properties form a contiguous landscape*
- **Develop a site-specific plan**
  - *Land owners have different management styles, budgets, goals, land types, and grazing needs*

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Guide to Grazing Issues

Example Issues:

1. Stocking rates
2. Complementary grazing
3. Grazing sensitive habitats
4. Prescribed grazing

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Grazing

Grazing Issue	Watershed Plan	Site Plan
Stocking Rates		
Complementary Grazing		
Sensitive Habitats		
Prescribed Grazing		

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Noxious Weed Identification and Eradication

Example Strategies:

1. **Identification**
2. **Eradication**
3. **Mapping**
4. **Funding sources**

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Noxious Weeds

Strategy	Watershed Plan	Site Plan
Identify		
Map		
Eradicate		
Fund		

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Fencing Criteria

Example Information Needs:

- Types of wildlife-friendly fencing
- Wildlife species
- Map

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Fencing Criteria for Wildlife

Information Need	Watershed Plan	Site Plan
Types of Fencing		
Wildlife Species		
Map		

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Other Goals

- *Document historical grazing practices*
- *Document historical and cultural resources*
- *Inventory resources*
- *Recognize best management practices already in use*
- *Address current research in rangeland management*
- *Develop plan that is consistent with management style and responsive to economic returns*
- *Take photographs; characterize land*
- *Find practices that work and apply to them to other parts of the watershed*

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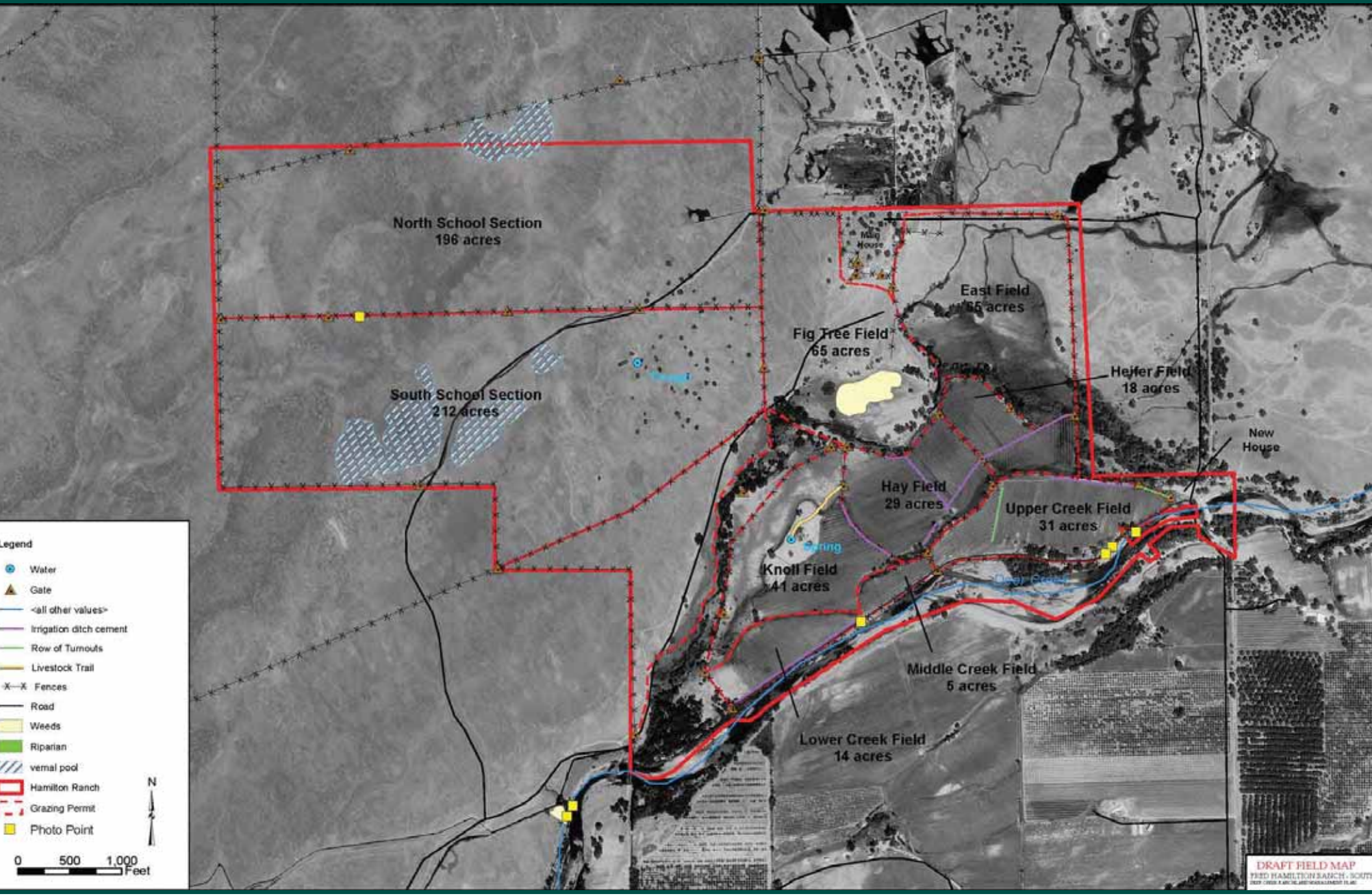
North School Section
196 acres
South School Section
212 acres
East Field
55 acres
Fig Tree Field
65 acres
Heifer Field
18 acres
New
House
Hay Field
29 acres
Upper Creek Field
31 acres
Spring
Knoll Field
41 acres
Middle Creek Field
5 acres
Lower Creek Field
14 acres
Legend
Water
Gate
<all other values>
Irrigation ditch cement
Row of Turnouts
Livestock Trail
Fences
Road
Weeds
Riparian
vernal pool
Hamilton Ranch
Grazing Permit
Photo Point
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500
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Feet
DRAFT FIELD MAP