Watershed Management

Photo caption. Carmel River Estuary.

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Chapter 27. Watershed Management

Watershed management is the process of creating and implementing plans, programs, projects, and activities to restore, sustain, and enhance watershed functions. These functions provide the goods, services and values desired by the community affected by conditions within a watershed boundary. In California, the practice of community-based watershed management has evolved as an effective approach to natural resource management practiced in hundreds of watersheds throughout the state. These community-based efforts are carried out with the active support, assistance, and participation of numerous State agencies and programs.

A primary objective of watershed management is to increase and sustain a watershed's ability to provide for the diverse needs of the communities that depend on it, from local to regional to State and federal stakeholders. Using watersheds as an organizing unit has proven to be an effective scale for natural resource management. The watershed is an appropriate scale to coordinate and integrate management of the numerous physical, chemical, and biological processes that make up a river basin ecosystem (Box 27-1). It serves well as a common reference unit for the many different policies, actions, and processes that affect the system. Using the watershed as a basic management unit also provides a basis for greater integration and collaboration among those policies and actions.

Watershed Management in California

Significant efforts to better manage natural resources using a watershed approach are occurring in all regions of California. Several hundred structured efforts involving organizations, local governments, landowners/users, and stewardship groups along with State and federal agencies are active in the state.

Many of these efforts are working to blend community goals/interests with the broader goals of the state as a whole. They are carrying out management that helps achieve these goals in a manner consistent with environmental, social, institutional, and economic conditions in the watershed. Emphasis at the community level has brought about a broader understanding of compatible and shared interests and has created innovative management approaches to meet these diverse interests. The need to address environmental justice and social equity has been recognized and addressed effectively, along with more traditional project management approaches.

In many communities, these organized efforts serve as forums to bring about collaborative management involving the public and private sector, the academic community, and other people working at the local, regional, State, and national level, taking advantage of the inherent capabilities of each. Benefits of watershed-based

Box 27-1 Watershed Defined

What is a Watershed?

In its historical definition, a watershed is the divide between two drainage streams or rivers separating rainfall runoff into one or the other of the basins. In recent years, the term has been applied to mean the entirety of each of the basins, instead of just the divide between them. The Continental Divide is a watershed according to the earlier definition, where rainfall runoff is directed toward the Gulf of Mexico or toward the Pacific Ocean. The Mississippi River basin and the Colorado River basin are watersheds under the new definition. Other parts of the world use the terms catchment, or river basin, to describe the drainage area between (historical) watersheds. It is from the earlier definition of watershed that we derive the phrase "watershed event"—an occurrence that changes the pattern of all that follows, moving the flow of events toward a different outcome.

A watershed includes all natural and artificial (manmade) features, including its surface and subsurface features: climate and weather patterns, geologic and topographic history, soils and vegetation characteristics, and land use. A watershed may be a small area or as large as the Sacramento, San Joaquin or Klamath River basins.

Using watersheds as organizing units for planning and implementation of natural resource management means that:

- Large regions can be divided along topographic lines that describe a natural system more accurately than typical jurisdictional lines.
- Condition and trends analysis can be done on the basis of the entire natural system, in concert with economic and social conditions.
- Communities, including resource management and regulatory agencies, within and outside a particular watershed can better track and understand the cumulative impacts of management activities on the watershed system.
- Managers within each watershed can more effectively adjust their measures and policies to meet management goals across scales, including regional and statewide goals.
- Multi-objective planning is facilitated by inclusion in, and reference to, a whole-system context.

Effective management recognizes the mutually dependent interaction of various basic elements of a watershed system including the hydrologic cycle, nutrient and carbon cycling, energy flows and transfer, soil and geologic characteristics, plant and animal ecology and the role of flood, fire and other large scale disturbance.

Each must be considered in context with the others, because change in one spurs changes in the others, creating a different system outcome.

management are being realized in such diverse locations as the upper Feather River, the Los Angeles River Basin, and the Napa River, to name a few.

In addition to these local efforts, a number of regional, statewide, and national initiatives have been and continue to be carried out to help improve our overall ability to practice watershed management. A chronology of some notable initiatives in California follows.

State Watershed Management Chronology – Key Dates

1997 – Ten Lessons Learned. A summary of key experiences implementing the watershed management efforts from the US Environmental Protection Agency Office of Wetlands, Oceans and Watersheds (OWOW). The EPA initiative that prompted the State to begin addressing resource management from a watershed perspective.

1998 – Draft CALFED Watershed Strategy. Assembled by State and federal agency representatives to respond to public comment regarding early expenditures by CALFED that largely left out projects above major dams or below Carquinez Strait. This evolved

to the development of the CALFED Watershed Program as part of the overall CALFED Bay-Delta Program.

1997-99 – Watershed Protection and Restoration Council (WPRC). Established by Governor's executive order to develop statewide watershed management policies focused on fostering and supporting community-based watershed management activities along with coordination among State agencies—largely on salmonid species recovery in California.

1999 – Watershed Management Council (WMC) Forums. A series of public meetings to generate recommendations for improving coordination among State agencies and between the State and federal governments and local management programs. Created the *12 Steps to Watershed Recovery* document.

1999 – California Biodiversity Council Watershed Work Group (CBC-WWG). Formed to carry on the work begun by the WPRC and to develop principles and guidelines for coordinating State agency activities related to watershed management. Developed a set of management principles for watershed management activities and programs.

1998-2000 – Development of the CALFED Watershed Program. Established to aid in achieving the overarching goals of the CALFED Bay-Delta Program by working with the community at watershed level. The Program Plan was published in 2000. The plan was developed in close partnership with the Bay-Delta Advisory Committee's (BDAC) Watershed Work Group, the Inter-Agency Advisory Team (IWAT), and the CBC-WWG.

2000 – California Coastal Salmon and Watersheds program. Established to "recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

2000 – Formation of California Watershed Network (CWN). A nonprofit organization with the mission to help people protect and restore the natural environments of California watersheds while ensuring healthy and sustainable communities. CWN worked to develop a coordinated network of community-based watershed management in California.

2000 – AB 2117 (Wayne). Established to evaluate a sample of locally led watershed management partnerships and produce a report to the Legislature.

2001 – Joint Task Force on California Watershed Management. Established to oversee the report required by AB 2117. The report, *Addressing the need to protect California's watersheds,* was published in 2002. It lists the results of the investigation and makes recommendations to State government. Among the recommendations is to develop a watershed management strategic plan for the State.

2001 – Memorandum of Understanding. Established between State and federal government agencies to provide a framework for implementing the CALFED Watershed Program. The MOU identified implementing and coordinating agencies, outlined their roles, and established a formal means to conduct the business of the CALFED Watershed Program element. The MOU expired in 2003.

2002 – Watershed, Clean Beaches and Water Quality Act (Pavley). Authorizes the establishment of an Integrated Watershed Management Program to develop coordinated and complementary strategies and solutions for watershed management across landownership and agency jurisdictional boundaries.

2003 – Memorandum of Understanding. MOU between the Natural Resources Agency and California Environmental Protection Agency (Cal/EPA) to implement the Integrated Watershed Management Program from the Pavley bill. Established the California Watershed Council as an advisory group.

2003 – California Watershed Council. Designed to provide advice and recommendations to agency secretaries regarding watershed management policy and programs. The group generated several work products that included a set of basic principles, and a series of recommendations for funding processes, technical assistance, communications, information sharing, and coordination processes.

2003 – AB 1405 (Wolk) California Watershed Protection and Restoration Act. Enacted the California Watershed Protection and Restoration Act to encourage Cal/EPA and the Natural Resources Agency to provide assistance and grants to those who choose to participate in watershed restoration and enhancements, and declared that local collaborative watershed partnerships are in the State's interest in terms of effectiveness, citizen involvement and community responsibility. This bill authorizes certain State agencies to provide technical assistance to local watershed partnerships, and requires that State guidelines adopted for use by local watershed partnerships provide flexible mechanisms to achieve quantifiable watershed objectives.

2003 – California Agency Watershed Program Strategic Plan. Developed by a consultant group after interactions with members of the Joint Task Force on California Watershed Management.

2004 – Memorandum of Understanding between Cal/EPA and the Natural Resources Agency (revised). Rewrote the 2003 MOU. It was designed to emphasize and implement the Governor's Environmental Action Plan and the Ocean Action Plan, using stakeholder advisory processes and inter-agency collaboration

2005 – California State Agency Watershed Management 18-month Action Plan. Designed to replace the strategic plan with a more action-oriented approach for agencies to pursue watershed management.

2007 (Nov) – Establishing a Statewide Watershed Program. The Secretary for Natural Resources called for the transition of the CALFED Watershed Program to a statewide watershed program and assigns the Department of Conservation to administer this effort.

Bond measures have brought significant funding to assist with maintenance and restoration work needed in many of the state's watersheds. Recent bond measures (Propositions 50 and 84) stressed the need for integrated planning that includes objectives at the watershed and regional scales, and provide incentives to carry out work consistent with these plans.

Potential Benefits of Watershed Management

Managing our interactions with and impacts on natural systems have resulted in a number of significant benefit when using a watershed approach with emphasis on maintaining, restoring, or enhancing the many functions associated with these natural systems. Many of these benefits are described using typical economic terms such as a product, goods, or service and are readily valued in the traditional marketplace. Reliable quantities of clean water, agricultural or forest products, and biofuel production are good examples. Avoided costs such as reduced flood or fire damages can also frequently be quantified. Other values associated with our natural systems such as biological diversity, disease suppression, and climate moderation are more difficult to quantify monetarily because these values are not routinely traded in the marketplace. As a result, the term "ecosystem services" is often used to better describe and equate the monetary and non-monetary values or benefits provided to society by healthy watersheds. See Table 27-1 Typical list of watershed products, goods and services.

Potential Costs of Watershed Management

Costs associated with watershed management depend on many factors, such as the size of the watershed; the land and water use activities occurring in the watershed; the condition and trends of the watershed; and the values, goods, and services demanded from the watershed.

Much of the cost of watershed management in California is associated with the specific land or water use activities occurring within the watershed on a recurring basis and is coincidental with these uses. Additional or external costs of watershed management discussed in this chapter tend to be associated with interventions designed to influence management or improve the results of management, to offer specific protection for certain functions and values, or to restore the functional conditions and associated uses of a watershed. These interventions may come from various levels of government or

Table 27-1 Typical list of watershed products, goods and services

Typical watershed products, goods and services (also described as ecosystem services)	Benefit of Service
Provision of water supplies	Agriculture, municipal, industrial, and other beneficial uses
Provision of food, fiber, fuel	Sustainable production of agricultural and forest products that are dependent on healthy productive soils, favorable climate and water conditions, and the availability of pollinators
Water purification/waste treatment	Well managed watersheds produce clean, cool water generally useful for a broad range of beneficial uses. Virtually all fresh water used in California originates as precipitation that is intercepted, captured, routed, and released from watersheds in California and the Colorado River Basin.
Flood mitigation	Healthy watersheds with adequate distributed wetlands and functional floodplains moderate the volume and timing of surface runoff reducing flood damage.
Drought mitigation/flow attenuation	A healthy watershed works like a sponge to store and release water to both streams and groundwater. In California, healthy watersheds increase the residence time of water, and tend to store and release water longer into the dry season.
Provision of aquatic and terrestrial habitat	Uplands, rivers, streams, floodplains, and wetlands provide necessary habitats for fish, birds, mammals, and countless other species, and generally sustain a strong level of biological diversity that provides wide benefits to society.
Soil fertility, health, productivity	Soil health and fertility is an essential component of primary ecosystem production, and is critical for maintenance of important terrestrial, floodplain, riparian, and wetland components and processes.
Nutrient, mineral cycling and delivery, carbon sequestration	Cycling of nutrients is necessary to maintain healthy, diverse biological systems, to sustain biological diversity that mediates disease, and to sustain populations of native species.
Biodiversity maintenance	Diverse assemblages of species work to provide the services (including all those listed in this table) upon which societies depend. Conserving genetic diversity preserves options for the future and increases the resilience of ecosystems in the face of the impacts of a changing climate.
Recreational opportunities	Swimming, fishing, hunting, boating, wildlife viewing, hiking, and skiing are all delivered or enhanced in healthy watersheds, often resulting in concurrent economic improvements in local communities reliant on recreation as a source of economic sustenance or growth.
Climate moderation/buffering	Generally, a diversified watershed ecological system is more robust and resilient to rapid climate changes or other types of disturbance. Maintaining a resilient watershed ecosystem will be of critical importance in the face of a changing climate. That adaptation will better ensure that watershed ecosystem functions will continue to provide the goods, services, and values of the systems we experience today.
Aesthetics	Quality of life is a major, but difficult to quantify, benefit of watershed conditions. Pleasant surroundings, with clean air, clean water, and adequate recreational opportunities have been shown to be beneficial across a broad spectrum of social structures.
Managing salinity gradients	Freshwater flow regimes can determine salinity gradients in deltas, coastal estuaries and near-shore marine environments, a key to biological richness and complexity.

Note: Table content adapted from *Rivers for Life: Managing Water for People and Nature* (2003) written by Sandra Postel and Brian Richter.

interests either within or outside the watershed. The potential costs associated with these interventions are estimated here by:

- Extrapolating costs based on other program expenditures (See Table 27-2 from California Water Plan Update 2005, Volume 2 Resource Management Strategies, Chapter 25 Watershed Management. Estimates are based on CALFED watershed management estimates scaled up for statewide coverage.)

Table 27-2 Estimates of watershed management costs to year 2030, from Water Plan Update 2005 and CALFED program estimates

Period (years)	Assessment-planning [1] ($ millions)	Public process[2] ($ millions)	Projects[3] ($ millions)	Total for period ($ millions)
2004-2009	$10-$37.5	$8-$16	$14-$80	$160-$667
2010-2015	$10-$30	$8-$16	$14-$88	$160-$804
2016-2030	$10-$25	$8-$16	$14-$100	$160-$2,115
Total				**$480-$3,586**

[1] CALFED service area estimated as 40% of statewide need. Therefore, statewide assessment and planning = 2.5 x CALFED values from draft CALFED Finance Plan (2004)

[2] The service area for public process estimated as 25% of the statewide need. Therefore, statewide public process = 4x CALFED values

[3] For projects, CALFED service area is estimated to be 25% of the statewide need. Therefore, statewide projects = 4x CALFED values

Note: The CALFED service area is defined as the Sacramento and San Joaquin River basins, the Tulare Lake Basin, The Delta and San Francisco Bay Area, and that portion of central and Southern California serviced by the State Water Project

Table source: *California Water Plan Update 2005,* Volume 2 Resource Management Strategies, Chapter 25, Watershed Management.

- Applying a "willingness to pay" approach based on existing examples (using CALFED Watershed Program analysis as part of Program Finance Plan development)

In addition to the more easily quantified benefits of well functioning watersheds, effective watershed management can also result in significant avoided costs such as lessened fire and flood damage, erosion and sediment loss reduction, water quality maintenance, reduced illnesses and treatment costs, and control of agricultural pests. An example is shown in Box 27-2 Watershed Degradation and Water Treatment Costs.

Willingness to Pay

To estimate the approximate external costs to fully implement the watershed management strategy, an analysis developed by the CALFED Watershed Program is used. This analysis examined areas where communities have chosen to provide quantifiable financial support for watershed management, thus demonstrating "a willingness to pay" for the services provided by a well managed watershed.

This analysis has been written using methods described by the US Department of Energy (Natural Resource Valuation, 1997), and the US Congressional Research Service (RL30242 Report for Congress, 1999). It is an attempt to describe a monetary value to effective watershed management.

The Napa County community was used as a basis for this comparison for several reasons. One is its similarity to state demographics as a whole. Another is that the

Box 27-2 Watershed Degradation and Water Treatment Costs

The development of watershed and aquifer recharge lands results in increased contamination of drinking water. With increased contamination come increased treatment costs. The costs can be prevented with a greater emphasis on source protection. A study of 27 water suppliers conducted by the Trust for Public Land and the American Water Works Association in 2002 found that the more forest cover in a watershed, the lower the treatment costs. According to the study:

> *Approximately 50 to 55 percent of the variation in treatment costs can be explained by the percent of forest cover in the source area. For every 10 percent increase in forest cover in the source area, treatment and chemical costs decreased approximately 20 percent, up to about 60 percent forest cover.*

The study did not gather enough data on suppliers with over 65 percent forest cover to draw conclusions; however, it is suspected that treatment costs level out when forest cover is between 70 and 100 percent. The 50 percent variation in treatment costs that cannot be explained by the percent forest cover in the watershed is likely explained by varying treatment practices, the size of the facility (larger facilities realize economies of scale), the location and intensity of development and row crops in the watershed, and agricultural, urban, and forestry management practices. The table shows the change in treatment costs predicted by this analysis, and the average daily and annual cost of treatment if a supplier treats 22 million gallons per day.

Percent of watershed forested	Treatment and chemical costs per million gallons	Change in costs	Average treatment costs	
			Daily	Per year
10%	$115	19%	$2,530	$923,450
20%	$93	20%	$2,046	$746,790
30%	$73	21%	$1,606	$586,190
40%	$58	21%	$1,276	$465,740
50%	$46	21%	$1,012	$369,380
60%	$37	19%	$814	$297,110

Extracted from Land Conservation and the Future of America's *Drinking Water - Protecting the Source* (2004). Published by the Trust for Public Lands and the American Water Works Association

taxes levied are directly tied to implementation of community-generated watershed management plans. The levies also demonstrate strong local support among voters and elected officials for the values inherent in improved management. Finally, the funds are generated and dispersed locally by locally responsive government entities.

Valuations from three different Napa County tax measures were investigated. One is a half-cent sales tax passed by 68 percent of voters in the late 1990s that generates approximately $10 million in revenue per year specifically for watershed management (the "Living River" program). Another is a parcel tax of $12.70 per parcel supported and levied within the City of Napa for watershed management. That is accompanied by an additional parcel tax of $12 per year specifically for storm water runoff management inside the city's watersheds. The range of value then is from nearly $14,000 per square mile for the sales tax revenue, to just under $1,600 per square mile for the parcel tax.

Table 27-3 Cost estimate to fully implement the strategy – willingness to pay

Napa County	Less 10%	Bay-Delta watershed area (mi^2)	Southern California area (mi^2)	Total value estimated
$1,572 per mi^2	$1,414 per mi^2	48,050		$67,942,700
			30,000	$42,420,000
			Total Valuation:	**$110,362,700**

For the purposes of this value estimate, the lower amount of $1,572 per square mile area is used. That in turn is adjusted to account for the slight difference in demographic statistics between Napa and California at large (Table 27-3).

The value estimates in Table 27-3 represent annual, external cost to fully implement the watershed management strategy over approximately half the surface area of California, including all or part of the following hydrologic regions: Sacramento River, San Joaquin River, Tulare Lake, San Francisco Bay, South Coast, and South Lahontan. A simple extrapolation of this value to the entire land area of the state would result in an estimated annual cost of $221 million to "fully implement" the strategy. For this example, fully implement suggests extensive application within the regions of the Policy Level and Strategic Practices recommendations in this chapter. It should be noted here that an as yet undetermined, but likely significant, portion of that cost is not an added cost, but existing expenditures applied differently. For instance, permits and stream alteration agreements issued by watershed boundary instead of jurisdictional boundary could result in considerable added benefit and positive effect without adding to the real cost of implementation. Also, land use planning done on the basis of watershed impact may yield higher beneficial results without increasing costs.

Major Issues Facing Watershed Management

Managing land and water resources for selected products, services, and values has altered the conditions and functions of many watersheds in California.

Land Uses Alter Hydrologic Cycles

The hydrologic cycle includes snow or rain, the flow of water over and beneath the land, and the evaporation of water into the atmosphere. How the land is managed can reduce rainwater infiltration and the timing and, in some cases, the volume of runoff. Storms, especially in urban areas but also in some rural areas, are now marked by high intensity runoff over short periods. This creates greater flood risk and reduces the ability to capture water for needs during dry times. From an ecological perspective, this compression of runoffs robs the streams and landscape of groundwater. This leads to dry land, a shift in vegetation types, lower and warmer streams, and deterioration of stream channels, all of which lead to shifts in the plants and animals that can be supported.

In some areas, the diversion of water from streams in the watershed to other regions outside the watershed, or the application of water imported from outside the watershed, has changed ecological functions or altered the flow of water through the watershed.

Human Activities Alter Nutrient Cycles

Another important natural cycle is the nutrient cycle. As watersheds are developed, the ambient amount of water-soluble nutrients is increased, often from concentrations in fertilizers or biosolids. These concentrated forms of nutrients can trigger dramatic changes in water bodies, vegetation, and animal communities. Many native plants evolved under fairly low nutrient conditions. Increasing the available nutrients often allows invasive plants to overrun the native vegetation. This can reduce the infiltration capacity of the land and diminish the habitat quality. We often export nutrients from the location that they are generated, frequently from inappropriate use or application rates. In some cases, this carries the nutrients to a point where they can support algae or other plant growth that impairs the usability of water. In other cases, this is through the transport of waste materials, or the application of fertilizers. In any event, the result is an increase in nutrient loads that often diminish the ecological quality in water bodies.

Disrupting habitats and migration corridors is a frequent result of development within a watershed. Elimination of large amounts of dendritic drainage through culverts and other diversions, increase of impervious surfaces, disruption of corridors by transportation and development, and reduction of riparian forest areas are examples of changes that have far reaching impacts on watershed hydrological and ecological conditions.

Life Cycles and Migration Patterns of Animals

Many projects built in the past, several prior to environmental laws such as CEQA and NEPA, have disrupted migration corridors or destroyed or impoverished habitat that is critical for certain life stages of animals. Coastal wetlands that support breeding, nursery, and rearing habitat for many ocean species have been particularly affected. Dams on most significant California waterways have blocked access to spawning and rearing habitats for anadromous fish. Riparian forests that support migration of Arctic and South American birds and inland wetlands that support the Pacific Flyway species have all been measurably impacted.

An example is when steepening of riverbanks through down-cutting or construction, such as creating levees, has changed the gradient of shorelines, and diminished the gradual gradients necessary for many aquatic semi-aquatic species (especially plants and insects) to complete their life cycles. This in turn affects larger life forms that rely on those specific species and diminishes the buffering impacts of near-shore vegetation.

Fire and Water

The management of our forest and wildlands over the past few generations has created a risk of very large, very intense fires that do much more damage to watersheds than

fires of historical intensities. The result is that watersheds are not capable of rapidly recovering from these fires. These fires create periods of accelerated soil erosion and diminish the productivity and diversity of plant communities that cover the land. They displace animals and limit the subsequent human use of the lands. Severe wildfires result in more water quality problems, more surface runoff and less infiltration, and increased operations and maintenance costs for reservoirs and canal systems and may create more frequent and severe downstream flood events, unstable lands, and large economic losses, including significant alterations of natural biological cycles.

Recommendations to Better Manage Watersheds in California

Policy Level Recommendations:

1. Establish a scientifically valid means of tracking and reporting change in the state's major watersheds that may provide reliable, current information to local communities, State agencies and others regarding the net effects of management against the background of external change.

2. Support adaptive management programs that regularly assess the performance and condition of projects and programs to determine if they are satisfying ecological and community needs compatibly. Adjust the operations or re-design existing projects or programs as needed.

3. Clearly define expected products, goods and services from the State level, to provide a large scale basis from which to apply local variations and additions.

4. As appropriate and feasible, coordinate State funding and support within watersheds and between programs to generate more focused, measurable results.

5. More effectively align agency goals and methods to reflect coordinated approaches to resource management using watersheds as the context for implementation and effectiveness measurement.

6. Provide a means of easy access to technical information such as geographic information system (GIS) layers, monitoring data, planning models and templates, assessment techniques, from multiple sources that is useful at multiple levels of decision-making.

7. Conduct present management activities in a manner, and within a context, that is consistent with watershed dynamics and characteristics.

8. Provide local land use decision-makers with watershed education and information access to better inform local decision making to maintain and improve watershed functions.

Strategic Practices Recommendations:

9. Use a watershed approach to coordinate forest management; land use; agricultural land stewardship; integrated resources planning and other appropriate resource strategies and actions.

10. Design and select projects with ecological processes in mind and with a goal of making the projects as representative of the local ecology as possible.

11. Increase the ability for precipitation to infiltrate into the ground; reduce surface runoff to a point where it better reflects a natural pattern of runoff retention. This practice is often described as reducing impervious surfaces within a watershed. Retain floodplain and other wetlands intact to the extent possible, in order to maintain or increase residence time of water in the watershed.

12. Decrease the amount of irrigated landscaping in the watershed, and increase the use of native vegetation in landscaping and agricultural buffer lands.

13. Design appropriate wildlife migration corridors and biological diversity support patches by watershed when planning fire-safe vegetation alteration.

14. Support the installation and maintenance of stream flow gauges in major drainages.

15. Maintain and create habitat around stream and river corridors that is compatible with stream and river functions. Provide as much upslope compatibility with these corridors as possible.

16. Design drainage and storm water runoff controls to maximize infiltration into local aquifers, and minimize immediate downstream discharges during runoff.

17. Provide regionally appropriate, regular and dependable educational materials to encourage water conservation, water re-use, and water pollution prevention.

18. Restore and preserve stream channel morphology to allow access of flood waters to the floodplain and to provide for stable banks and channel form.

19. Work to restore the characteristics and functions of native grasslands, woodlands, forests and other wildlands.

20. Carryout invasive weed planning and removal when needed as a part of overall resource management efforts.

21. Protect soil resources and restore the functions of drastically disturbed soils, to slow run off and increase rainfall infiltration

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