Community-Based Watershed Restoration in the Sierra Nevada

A Guide to Getting Started

Version 1

SIERRA NEVADA ALLIANCE

Keeping light in the range.

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"To protect your rivers, protect your mountains"
–Emperor Yu of China 1600 BC

VERSION I

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Section I
Introduction and Background

This guide is intended to assist watershed coordinators, stakeholders, and other Sierra-based conservation groups working to restore and protect their local rivers, lakes and streams. The guide is designed to provide an overview and be used as a reference when planning for watershed restoration projects in the Sierra Nevada.

Watershed

A watershed is the area that drains into a lake or a river. The land and its uses around the river or lake are connected to the quality and quantity of water. A watershed encompasses the landforms, vegetation, habitat and biological systems and communities that cover the area that eventually drains into a lake or river. A healthy watershed helps filter sediment and pollutants while supporting the many living organisms that depend on the ecosystem. Healthy watersheds improve the economy and help provide resources for everyone to use and enjoy. Healthy rivers, creeks and streams have natural flow ranges, vegetated banks, sediment movement, meandering channels, natural temperatures, in-stream habitats (e.g. pools and riffles) and have reached a dynamic equilibrium. Changes to one of these aspects of a healthy river, creek or stream will affect the **dynamic equilibrium** resulting in an unbalanced "unhealthy" system. This new or "altered" system can have detrimental affects on fish or other aquatic life and can even affect on our drinking water.

Dynamic Equilibrium:

Are the normal functions of a water body in terms of the natural ranges of flow, sediment, movement, temperature and other variables.

Sierra Nevada Watersheds

The Sierra Nevada mountain range located in California and Nevada is comprised of 24 major watersheds. Each of these in turn is made up of numerous sub-watersheds. Sierra waters are critical for the health and welfare of California and Northern Nevada. These watersheds provide over 60% of California's and almost all of Northern Nevada's developed water supply. Sierra watersheds, however, have lost much of their ability to naturally filter sediment and other pollutants. In fact, 23 out of 24 Sierra watersheds are severely polluted and impaired from 150 years of human activity. For more information on the health of Sierra Watersheds check out the Sierra Nevada Alliance's report Troubled Waters of the Sierra at www.sierranevadaalliance.org and the Sierra Nevada Ecosystem Project report at http://ceres.ca.gov/snep/

Watershed Groups can make the difference

The health of these headwater or "upper" watersheds is critical to the health and well being of the rest of California and Northern Nevada. The Sierra needs informed watershed groups, councils, and conservationists, working to protect and restore our streams, creeks and rivers if we are to continue to provide ample clean water, diverse habitat, and prime recreation in the future. The social and cultural landscape of a watershed is just as complex as its ecology. Experience has shown that watershed groups and councils provide a successful forum for developing and implementing restoration and protection projects with widespread community support. People with diverse viewpoints voluntarily, working together, find common ground as they interact with each other.

Watershed restoration planning is quite complex. Neither one guide nor one expert can provide all the answers. We encourage individuals and groups to use the experience of stakeholders in their council or group, to consult with professionals, and to review other resources to guide their restoration planning. We hope this guide will help you as you begin the planning process. This guide is designed to help you better assess what types of small scale restoration projects are feasible, what resources you will need to plan and what questions you should be asking in the planning process.

Section II
Watershed Restoration 101

Helping in the recovery of an unhealthy ecosystem.

Watershed Restoration or "Recovery" Definitions

Watershed Restoration is the preservation of and/or return of the natural functioning state of the rivers, lakes and streams in the watershed.

Additional definitions for Restoration:

- "Ecological Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed." (Society for Ecological Restoration)
- "Restoration is the process of returning a river or watershed to a condition that relaxes human constraints on the development of natural patterns of diversity. Restoration does not create a single, stable state but enables the system to express a range of conditions dictated by the biological and physical characteristics of the watershed and its natural disturbance regime." (Frissel & Ralph)

Restoration: Active vs. Passive

Restoration management strategies can be either passive or active.

Passive as the word implies allows nature to take its course. Passive restoration allows for natural adjustment processes to occur (e.g. ecological succession). Rather than actively working on the landscape passive, restoration removes human activity and allows natural processes to recover in their own time—*time can heal*. An example of passive restoration is grazing exclusion. Often the landscape can eventually recover from overgrazing if access is denied and the land is less heavily used.

Examples of passive restoration:

- Cease grazing in sensitive areas
- Cease new road construction and attempt to decommission old roads
- Stop new potential dam construction

Active restoration as the term implies are actions taken in the stream channel, riparian, or upland zones intended to improve ecological structure or function. Active restoration attempts to speed up recovery. Examples of active restoration are: planting of native vegetation, placement of woody debris or boulders, construction of in-stream structures for fish habitat, bioengineering of stream banks, channel reconstruction. (National Research Council, 1992, *Restoration of Aquatic Systems)*

Examples of active restoration:

- Implementing erosion control strategies to keep sediment on cleared slopes thereby reducing erosion
- Decommissioning or closing forest roads and trails by actively throwing slash and other material on the road, thereby reducing erosion and sedimentation into the nearby water body
- Removing artificial stream barriers to allow fish to access suitable spawning and rearing habitats
- Reconnecting streams and rivers to their flood plains
- Removing invasive or non-native plant species, and replanting native vegetation

Examples and Types of Restoration Treatments
Below are just a few examples of watershed restoration treatments that can improve watershed health. The examples come from the Forest Ecosystem Management Team. Although specific to forests it gives you a good idea of the types of projects that can be conducted in a watershed. All of the examples presented affect the overall health of a watershed. http://pnwin.nbii.gov/nwfp/FEMAT/Chapter_5/app_j.htm

Hill slope restoration
Hill slope restoration consists of activities such as upgrading roads to control and prevent erosion (e.g., larger culverts, out sloping, rocking); decommissioning or obliterating unneeded roads; controlling erosion on bare, eroding slopes; and improving derelict and degraded lands such as abandoned mines, gullied meadows, and areas where soils have become impoverished.

Riparian area restoration
Riparian restoration consists of activities such as planting and cultivating native species of vegetation, thinning and interplanting existing stands of riparian vegetation, controlling streamside land sliding, restoring riverine wetlands, controlling of grazing, correcting over-drained and gullied meadows, removing or upgrading inappropriate recreational developments, and removing or upgrading roads in riparian areas.

Stream channel restoration
Stream channel restoration consists of activities such as placing large woody material, rocks or artificial structures to catch or improve spawning gravel; improving migratory fish access; creating additional rearing habitat; and reconfiguring stream channels to improve habitat and stream channel dynamics.

Attributes of Restored Ecosystems

The information provided below taken from the Society for Ecological Restoration is a great resource for understanding what it means to restore aspects of your watershed. This information is available in its entirety at: http://www.ser.org/content/ecological_restoration_primer.asp#4

Society for Ecological Restoration
International Primer on Ecological Restoration

Section 3. Attributes of Restored Ecosystems

This section addresses the question of what is meant by "recovery" in ecological restoration. An ecosystem has recovered - and is restored - when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy. It will sustain itself structurally and functionally. It will demonstrate resilience to normal ranges of environmental stress and disturbance. It will interact with contiguous ecosystems in terms of biotic and abiotic flows and cultural interactions.

The nine attributes listed on the next page provide a basis for determining when restoration has been accomplished. The full expression of all of these attributes is not essential to demonstrate restoration. Instead, it is only necessary for these attributes to demonstrate an appropriate trajectory of ecosystem development towards the intended goals or reference. Some attributes are readily measured. Others must be assessed indirectly, including most ecosystem functions, which cannot be ascertained without research efforts that exceed the capabilities and budgets of most restoration projects.

Attributes of Restored Ecosystems continued...

Continued from previous page

1. The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.

2. The restored ecosystem consists of indigenous species to the greatest practicable extent. In restored cultural ecosystems, allowances can be made for exotic domesticated species and for non-invasive ruderal and segetal species that presumably co-evolved with them. Ruderals are plants that colonize disturbed sites, whereas segetals typically grow intermixed with crop species.

3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.

4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.

5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.

6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.

7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.

8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.

9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Other attributes gain relevance and should be added to this list if they are identified as goals of the restoration project. For example, one of the goals of restoration might be to provide specified natural goods and services for social benefit in a sustainable manner. In this respect, the restored ecosystem serves as natural capital for the accrual of these goods and services. Another goal might be for the restored ecosystem to provide habitat for rare species or to harbor a diverse gene pool for selected species. Other possible goals of restoration might include the provision of aesthetic amenities or the accommodation of activities of social consequence, such as the strengthening of a community through the participation of individuals in a restoration project.

(Society for Ecological Restoration, 3)

Sierra Nevada Alliance –Regional Council of Rural Counties Restoration Principles

In 1999, the Sierra Nevada Alliance with the Regional Council of Rural Counties developed ***Restoration Principles*** to help guide public involvement in watershed restoration and protection. These principles provide a framework for appropriate decision-making for potential watershed restoration programs and projects throughout the Sierra Nevada.

Sierra Nevada Alliance & Regional Council of Rural Counties Watershed Restoration Principles

Principle #1 Restoration must be consistent with watershed level assessment, analysis and evaluation; restoration includes protection of existing healthy conditions

Principle #2 Restoration should assure the preservation of existing healthy conditions by removing known threats and protecting from future threats

Principle #3 Restoration must include eliminating continuing causes of watershed degradation

Principle #4 Restoration should be staged, moving outward and downward generally from the top of the watershed, from core healthy or restored areas; exceptions are limited to work designed to link core healthy areas

Principle #5 Restoration projects should be prioritized within each watershed for effectiveness on the basis of maximum ecological benefit and on the benefits to sustainable local community economics and/or revitalization

Principle #6 Restoration and stewardship decisions should be based on explicit objectives and benchmarks from an approved Watershed Restoration Strategic Plan

Principle #7 Restoration that alters environments should give highest priority to project results that use natural processes

Principle #8 Progress of restoration must be effectively monitored, using explicit objectives and benchmarks, in order to evaluate ongoing restoration and stewardship efforts

Principle #9 Restoration plans and/or projects must not sacrifice one ecosystem for another

Principle #10 Restoration must be accomplished consistent with existing applicable environmental laws.

Alliance – RCRC Principles: A Closer Look

Principle #1 Restoration must be consistent with watershed level assessment, analysis and evaluation; restoration includes protection of existing healthy conditions

One of the first steps in restoring and protecting your rivers, lakes, streams and wetlands is to understand the current condition of your watershed. Watershed assessments or analyses are processes that help us better understand and interpret the current conditions of our watersheds and create recommendations and plans to manage the watershed. Assessments can illustrate cause and effect relationships between past and present natural and human activities.

Assessing your watershed or sections within your watershed will help your group better understand the current state or health of the entire system.

Assessing your watershed helps identify current and potential problems, find probable causes and creates workable solutions.

Every watershed is unique. The 24 major watersheds in the Sierra have many commonalities but also many differences. A recommended watershed management strategy used in the Feather River may not be applicable to watershed managers and advocates in the Owens River. This is why it is so important for watershed councils and other water-based advocacy groups to conduct a watershed assessment or analysis. The assessment stage is crucial to effective water resource management.

Principle #2 Restoration should assure the preservation of existing healthy conditions by removing known threats and protecting from future threats

The truth is that if you do not understand your watershed problems and how the system functions, you could restore one area only to have a problem upstream destroy your downstream work later. Or you could fix what you perceive is the problem, but in reality you did not fix the real problem but only a symptom. Or you could use resources in one area of your watershed, only to find those same resources could have fixed a bigger problem elsewhere. Assessing the overall health of your watershed so that you can design effective restoration projects and prioritize where you put your resources is very important.

***Principle** #3 Restoration* must include eliminating continuing causes of watershed degradation

The information that your group gathers in an assessment will identify the causes of degradation in your watershed. This information will assist your group in creating management plans that will deal with the sources of degradation.

> *Address ongoing causes of degradation. Restoration efforts are likely to fail if the sources of degradation persist. Therefore, it is essential to identify the causes of degradation and eliminate or remediate ongoing stresses wherever possible. While degradation can be caused by one direct impact such as the filling of a wetland, much degradation is caused by the cumulative effect of numerous, indirect impacts, such as changes in surface flow caused by gradual increases in the amount of impervious surfaces in the watershed. In identifying the sources of degradation, it is important to look at upstream and up-slope activities as well as at direct impacts on the immediate project site. Further, in some situations, it may also be necessary to consider downstream modifications such as dams and channelization. (US EPA)*

Principle #4 Restoration should be staged, moving outward and downward generally from the top of the watershed, from core healthy or restored areas; exceptions are limited to work designed to link core healthy areas

When conducting any type of watershed restoration project it is critical that you attempt to restore the function at the top of the watershed. Remember water flows downstream. Restorative actions implemented downstream of degraded headwaters will seriously compromise the success of the project. It is very wise to restore function at the top of the watershed first and then move downstream. Your group may not always be able to start at the top of the watershed, but it is definitely the place you should attempt to start. If you must conduct a project downstream, make sure that you consider all the potential factors that could occur upstream that could affect your projects integrity.

Also, when conducting a project incorporate human and social elements. For instance if you restore a major section of a creek and five years down the road the land upstream is developed into a large subdivision, your restored creek will be forced to deal with increased sediment loads. We encourage you to get involved with your local city and county planning officials to find out where the potential residential and/or commercial build-out possibilities exist. Make your restoration planning as inclusive and collaborative as possible. It is impossible for one person to identify all potential factors but simpler for a multi-stakeholder collaborative group.

Principle #5 Restoration projects should be prioritized within each watershed for effectiveness on the basis of maximum ecological benefit and on the benefits to sustainable local community economics and/or revitalization

The basic premise for restoring health to a river, creek, stream, lake or wetland ecosystem is to restore proper function in the system.

Proper Functions & Reference Ecosystems

As noted above, you must assess and understand your watershed before beginning restoration. This will help you not only identify problem areas, but also identify "reference ecosystems." Reference ecosystems can illustrate how a healthy ecosystem functions. Before your watershed group can begin "recovery or restoration," analyze and evaluate a proper functioning system (creek, stream, meadow) within your watershed so that you may have a "reference site."

"A reference ecosystem can serve as the model for planning an ecological restoration project, and later serve in the evaluation of the project. In its simplest form, the reference is an actual site, its written description or both."
(Society for Ecological Restoration, 8)

The only real way we can measure success is if we have an idea what success looks like. So make sure you put time into finding a reference site for your project.

In addition, all systems should have proper hydrologic function, energy capture and nutrient cycling.
(For more information on these concepts see Section III)

Sources of information that can be used in describing the reference ecosystem include:

- Ecological descriptions, species lists and maps of the project site prior to damage
- Historical and recent aerial and ground-level photographs; remnants of the site to be restored, indicating previous physical conditions and biota;
- Remnants of the site to be restored, indicating previous physical conditions and biota;
- Ecological descriptions and species lists of similar intact ecosystems
- Herbarium and museum specimens
- Historical accounts and oral histories by persons familiar with the project site prior to damage;
- Paleoecological evidence, e.g. fossil pollen, charcoal, tree ring history, rodent midens.

(Society for Ecological Restoration, 6)

Principle #6 Restoration and stewardship decisions should be based on explicit objectives and benchmarks from an approved Watershed Restoration Strategic Plan,

A watershed restoration strategic plan establishes goals and objectives. For a watershed restoration project to be successful the project must address a goal or certain set of goals.

> **"Much like a watershed assessment, a properly planned restoration project will be a response to a question or goal**." (Society for Ecological Restoration, 10)

To determine appropriate goals for your project discuss what functions you are intending to restore to your watershed. During this discussion goals will most likely present them self.

> **Setting goals for management and restoration is perhaps one of the most important steps in designing and implementing a project or program, and yet it is often either overlooked entirely or not done very well. There is a tendency to jump straight to the 'doing' part of a project without clearly articulating the reasons why things are being done and what the outcome should be. Ensuring that goals are both explicit enough to be meaningful and realistic enough to be achievable is a key to the development of successful projects.** (Hobbs, S2)

Goals vs. Objectives

Goals should be general and non-specific yet inclusive and flexible enough to persist over time.

Examples of Goals:

- Control erosion and establish native plant communities
- Ensure and/or restore stream and riparian functions and processes that contribute to fish habitat

Objectives are more specific, measurable, realistic and attainable. Objectives have a direct relation to the problem and are time specific. (Hogan, 7)

Examples of Objectives:

- Establish infiltration rate similar to reference site (within X %) and establish a native plant community of X% vegetative cover within the next X years.
- Establish stream bank vegetation cover by X% within the next X years. Reestablish native fish population by X% within the next X years.

Principle #7 Restoration that alters environments should give highest priority to project results that use natural processes

> *Use natural fixes and bioengineering techniques, where possible**.** Bioengineering is a method of construction combining live plants with dead plants or inorganic materials, to produce living, functioning systems to prevent erosion, control sediment and other pollutants, and provide habitat. Bioengineering techniques can often be successful for erosion control and bank stabilization, flood mitigation, and even water treatment. Specific projects can range from the creation of wetland systems for the treatment of storm water, to the restoration of vegetation on riverbanks to enhance natural decontamination of runoff before it enters the river*. **(***US EPA)*

Principle #8 Progress of restoration must be effectively monitored, using explicit objectives and benchmarks, in order to evaluate ongoing restoration and stewardship efforts

> *Monitoring is systematic data collection that provides information on changes that can indicate problems and/or progress towards target criteria or performance standards which, when met, indicate that established ecological goals have been reached. Thus, monitoring provides data on whether a site is developing in a way that will achieve the project goals.* (EPA, 35)

When developing a project-monitoring plan make sure that the type of monitoring you conduct directly correlates to the goals and objectives of what you are trying to restore. Monitoring strategies should consist of pre-project monitoring, during the project, and post-project monitoring. The duration of the post-project monitoring will be dependent upon the type of project that you conduct.

See section IV for more information on monitoring

Principle #9 Restoration plans and/or projects must not sacrifice one ecosystem for another

It is very important to not sacrifice one ecosystem for another. Make sure that you cleanup the staging area of your restoration project and its surroundings. The objective is to restore function into the landscape not destroy one area to restore another.

Principle #10 Restoration must be accomplished consistent with existing applicable environmental laws

There are often numerous permits and other documentation required for conducting a restoration project in or adjacent to a waterbody. There are federal, state, county and even city laws that you should investigate to make sure that you are in compliance. See section IV for more specifics on which permits exist and tips for getting them.

Section III
Key Watershed Concepts and Terms

The following section contains key watershed concepts and terms that you should have a clear understanding of when entering the world of watershed restoration. The information provided below is just a brief overview. For more in-depth information, a great resource on the hydrology, geomorphology, physical, chemical and biological processes of streams, rivers and creeks is the Federal Interagency Stream Corridor Restoration Working Group's Stream Corridor Restoration: Principles, Processes, and Practices guide at **http://www.nrcs.usda.gov/technical/stream_restoration/**

Adaptive Management

Adaptive management will assist you in conducting meaningful steps in watershed restoration planning, implementation, monitoring, evaluation and maintenance.

> *Adaptive management is the process of establishing checkpoints to determine whether proper actions have been taken and are effective in providing desired results. Adaptive management provides the opportunity for course correction through evaluation and action*. (Stream Corridor Restoration, 9-32)

Adaptive Management Cycle

For this guide the Sierra Nevada Alliance has decided to highlight an adaptive management model developed for the California Alpine Resort Environmental Cooperative (CAREC) by Michael Hogan, Integrated Environmental Restoration Services, Lahontan Regional Water Quality Control Board, participating ski areas in the Tahoe Basin, and the Sierra Business Council.

From 2003 to 2005 members of CAREC came together to agree upon a process for planning and implementing erosion control projects for ski areas in the Sierra Nevada. Sediment remains the leading contributor to polluted waters in the area of concern. Keeping soils on the land is crucial to maintaining healthy watershed systems.

The following information is taken straight from the document CAREC created: the California Alpine Resort Handbook-Ski Guidelines http://www.waterboards.ca.gov/lahontan/AvailDocs.htm#sschndbk

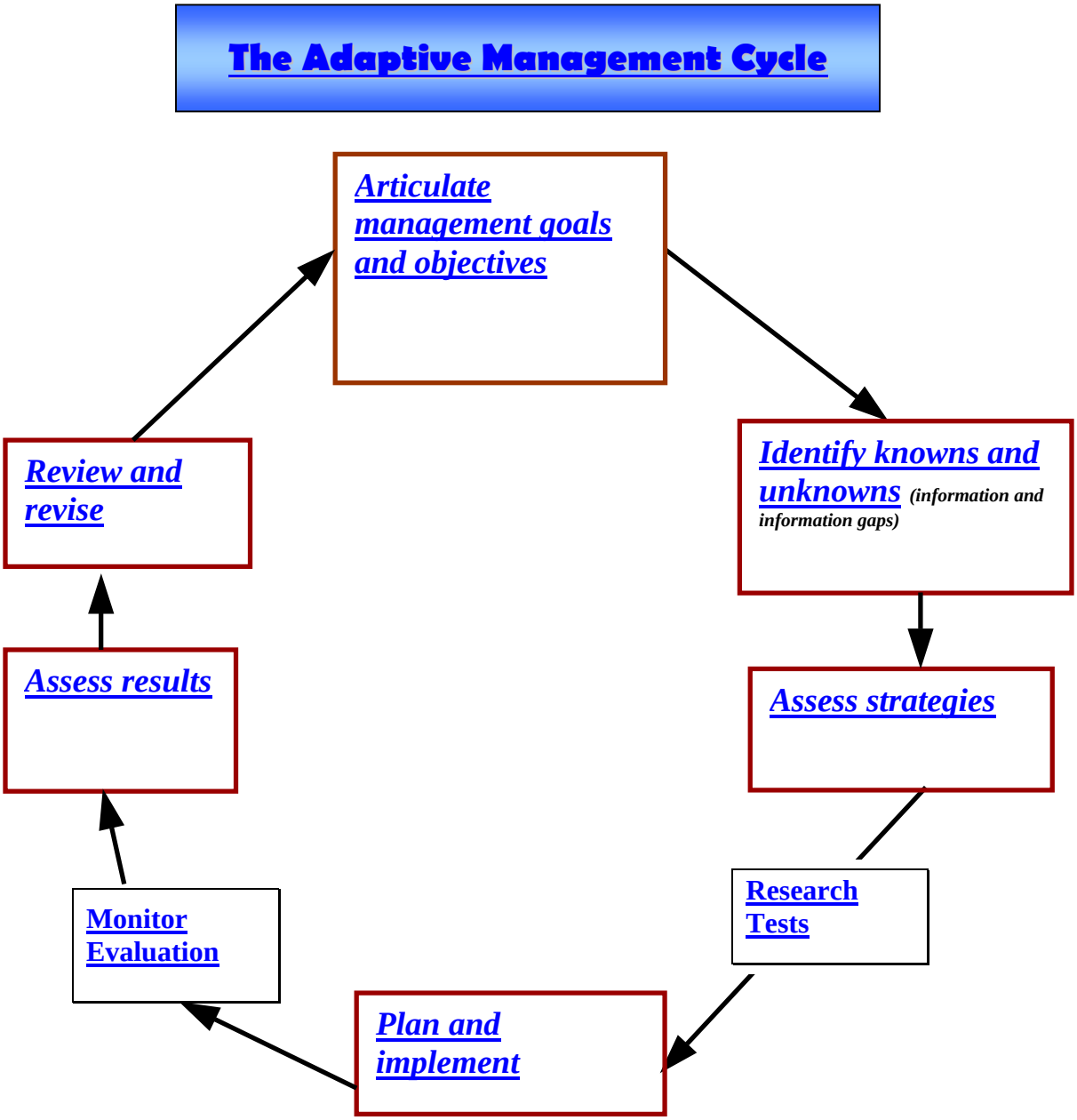
Framing the Program: The Adaptive Management Model

The concept of adaptive management has been applied for centuries under a number of different names. Physical engineers have used this approach since the first structure or bridge was constructed to continually learn from mistakes and successes and improve designs. Adaptive management has a dual nature.

First, adaptive management is a philosophical approach toward resource management that acknowledges that we do not completely understand the system that we are dealing with. It acknowledges that we will proceed with a project or program using existing information while we gather the knowledge that we lack.

Second, adaptive management is a structured decision-making process that includes the following components, usually in stepwise and cyclical fashion:

- Articulate project goals, outcome or success criteria
- Collect existing knowledge and practices relative to achieving the goals
- Identify information gaps and related research needs
- Develop a strategy and apply knowledge and relevant practices towards achieving the clear goals
- Develop a clearly-defined and defensible monitoring program to determine whether the goals are being achieved
- Negotiate a pre-defined management response if the goals are not met.
- Reassess and improve practices and reconsider the goals or outcomes



Web Sites for additional information on Adaptive Management

California Alpine Resort Handbook-Ski Guidelines
http://www.waterboards.ca.gov/lahontan/AvailDocs.htm#sschndbk

Society for Ecological Restoration-Restoration Primer
http://www.ser.org/content/ecological_restoration_primer.asp

California Society for Ecological Restoration
http://www.sercal.org/

Ecological Processes

Ecological processes functioning within a normal range of variation support a diverse mixture of plant and animal communities. These ecological processes include:

The water cycle—the capture, storage, and redistribution of precipitation;

Energy flow—conversion of sunlight to plant and animal matter; and

Nutrient cycles—the cycle of nutrients such as nitrogen and phosphorus through the physical and biotic components of the environment http://fresc.usgs.gov/products/fs/fs-125-02.pdf

Energy Flow and Nutrient Cycling

"An initial emphasis on repairing water and nutrient cycles, and increasing energy capture, will initiate and direct positive feedback repair systems that drive continuing autogenic recovery." (Whisenant).

The priority strategy of repairing hydrology, energy flow, and nutrient cycling into your proposed restoration project will allow for the system to initiate autogenic restoration or the process of self-recovery.

Nutrient Cycling~ Once nutrients enter a riparian area, they are exposed to mechanisms that may use or change them. Some nutrients, especially nitrogen, phosphorus, calcium, magnesium, and potassium, are taken up by shallow-rooted riparian vegetation. Dissolved nutrients moving with the ground water and those that are leached from the soil may be taken up by deeper-rooted riparian vegetation. Some nutrients pass through without being detained, and some that are taken up by riparian vegetation may be reintroduced into the water column when the vegetation dies and decomposes.

Energy transfer~ The uniqueness of riparian areas derives from the fact that litter-fall produced within the riparian ecosystem may be transported laterally and made available to in-stream animal communities as well as those downstream from the source of organic matter production. As compared with purely aquatic or terrestrial ecosystems, riparian organic matter has the potential of supporting a diversity of food webs within both habitats. *NRCS Riparian Areas Environmental Uniqueness, Functions, and Values* http://66.102.7.104/search?q=cache:eAZstMgEfUsJ:www.nrcs.usda.gov/technical/land/pubs/ib11text.html+hydrologic+function+and+nutrient+cycling&hl=en

Hydrologic Cycle

The transfer of water from precipitation to surface water and ground water, to storage and runoff, and eventually back to the atmosphere is an ongoing cycle. http://www.nrcs.usda.gov/technical/stream_restoration/PDFFILES/CHAPTER2.pdf

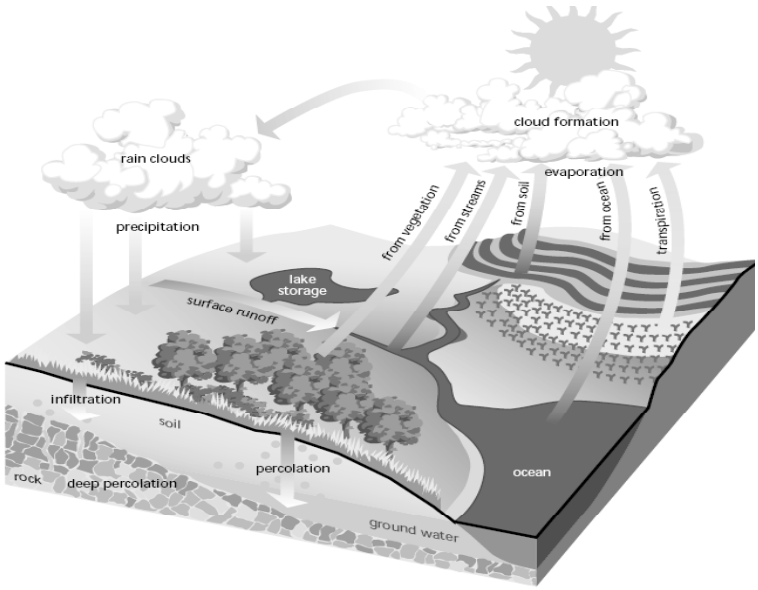


Figure 2.2: The hydrologic cycle. *The transfer of water from precipitation to surface water and ground water, to storage and runoff, and eventually back to the atmosphere is an ongoing cycle.*

Hydrologic Function

The capacity of the site to **capture**, store, and safely release water from rainfall, run-on, and snowmelt (where relevant), to resist a reduction in this capacity, and to recover this capacity following degradation.
http://fresc.usgs.gov/products/fs/fs-125-02.pdf

Infiltration and Runoff

- In the Sierra Nevada one of the major causes of impaired water is bare (under-vegetated) or mismanaged slopes contributing increased runoff carrying sediment and pollutants into nearby waterways. The lack of vegetation and poor soil condition on the slope means that there is poor infiltration and more water than natural is running off the slopes. This increased runoff carries higher levels of sediment and pollutants into streams, creeks and lakes.
- Detailed below is a model of infiltration v. runoff from the NRCS Stream Corridor Restoration Guide: http://www.nrcs.usda.gov/technical/stream_restoration/PDFFILES/CHAPTER2.pdf

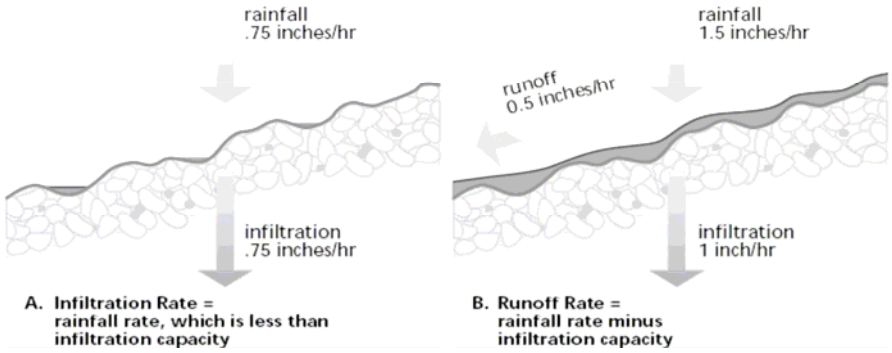


Figure 2.6: Infiltration and runoff. *Surface runoff occurs when rainfall intensity exceeds infiltration capacity.*

Sediment and Erosion

- Sediment is a solid fragment of inorganic or organic materials that come from the weathering of rock and are carried and deposited by wind, water, or ice.
- Sedimentation is the settling of sediments from water as velocity decreases.
- Erosion is the wearing away of land surface by wind or water, intensified by land-clearing practices related to farming, residential or industrial development, road building, or logging.

SECTION IV
Steps to Watershed Restoration

Before Getting Started--

Assess your watershed and determine priority projects

The Sierra Nevada Alliance strongly suggests that you put some time into researching why the watershed is not functioning properly. Put some time into figuring out what is wrong with the ecosystem, are the soils too compacted and water is not infiltrating, is there an aggressive invasive species making it to difficult for the native to survive, is there no natural system to filter out the pollutants before they reach the downstream creek or stream. If you have not conducted any type of assessment in your watershed it is going to be quite difficult to know what you should or should not restore.

Conducting a watershed assessment before starting any potential restoration project will allow your group to gather information on and analyze *in-water conditions, adjacent and upland conditions and other social, cultural and economic conditions* that exist in your watershed. Gathering this existing information on your watersheds health will allow your group to best interpret and determine what your group should think about restoring. The assessment will help you decide when to use passive restoration or active restoration.

The following are examples of components of a watershed that could be assessed.

In-Water Conditions

- Groundwater
- Surface water: locate and document where existing streams and rivers flow, lakes and wetlands are found, and status of riparian areas, flow regime--histogram
- Water Quantity
- Water Quality: chemical (e.g. DO, pH), physical (riparian habitat), and biological (bugs and other aquatic life)
- Temperature and precipitation: current and historical

Adjacent and Upland Conditions

- Climatic patterns and changes
- Dams, diversions, and flumes (wet and dry)
- Filter/buffer strips: grassy areas located at the borders of fields adjacent to lakes, wetlands and streams.
- Forest conditions: old, middle and young growth, fuels and fire, historical and contemporary logging practices, animal or insect issues, disease, wildfire history
- Plants: existing species, native, introduced species, presence and absence, impacts
- Geology and geomorphology of stream channels
- Hydrology
- Land Uses: Historical and contemporary. Define the landscape's location, ownership, size, and use (farming, ranching, recreation, urban)
- Recreation: Trails, OHV's, mountain biking, horses, developed campgrounds, dispersed camping, parking areas for trailheads, pit toilets
- Roads: Un-maintained, undeveloped, failing roads, old and still-used logging roads. Determine all other impervious surfaces: parking lots, abandoned buildings (etc.)
- Riparian areas: vegetation and land adjacent to banks
- Soil types: Also document major areas where erosion has been an issue, and may be an issue in the future.
- Vegetation and cover type: major tree and shrub species and % of each

- Wildlife and Wildlife Habitat: present habitat and species on landscape; historical native fisheries and wildlife habitats, introduced fish and wildlife species (presence and absence), and threatened and endangered species

Other Social, Cultural, and Economic Factors

- Cultural resources
- Historical resources
- Economic/tax/ zoning issues
- GIS and other mapping: What maps are available to you? What maps do you need?
- Future residential and commercial development within your community.

Remember that an Assessment or Analysis is not!

- Monitoring and data collection only
- A list of data only
- A consolidation or summary of existing information only
- Historical conditions or "baseline" only
- An identification of symptoms of problems only
- A plan
- An endpoint

(Taken From CWAM http://cwam.ucdavis.edu/)

This guide is focused on restoration and not intended to review the watershed assessment process. The Sierra Nevada Alliance provides on our website a useful guide to the different types of watershed assessments, steps to conducting an assessment and resources required. Please review this guide if you are not already familiar with watershed assessments for more information: www.sierranevadaalliance.org

Stakeholder Tip:
Be inclusive. The more people you have joining in and making decisions at the beginning, the fewer problems you will have later on down the road. Gathering information about your area and potential sites will require you to involve many different people with many different agendas. The more community ownership of your watershed plans the better. Include public and private stakeholders and hired experts. Create a Technical Advisory Committee (TAC) comprised of different experts to help plan, implement, monitor and evaluate the project. Potential members of the committee could be:

- Local biologist
- Local chemist
- Watershed Coordinator
- Large landowner in area
- City and County reps.
- Local geologist
- Local hydrologist
- Regional Water Quality Control Board Rep.
- Local Water Agency/Purveyor
- Any other major player in your watershed

Prioritizing your projects

After completing a watershed assessment, determine which areas of your watershed need repair. The assessment will give you a pretty good idea of potential project sites. The first thing to do is to acknowledge that you cannot possibly take on all the potential projects at once. Determine which projects are necessary to tackle first. Does one site have an impact on others? Is the project at the top of the watershed? After you have made a list of priority projects consider the following checklist to decide which project is feasible for your group to do at this point in time.

Checklist before moving forward on a Site and Project

A comprehensive understanding of the site that you choose is needed before you can embark on any restoration project. Consider the following:

Site Assessment Information:

- Has an in-depth assessment been conducted on the prospective site?
- What do you know about the site?
- What natural function are you trying to restore to the system? And, do you have the knowledge or expertise to restore that function to the system?
- Did you choose an upstream site? If not, what is above this site? Is the site you chose an appropriate location?
- What additional information do you need to know before starting a project on this site?
- Do the goals of your restoration project address the pollution problems at this site?

Access and Permission:

- Who owns or manages the land?
- Do you have permission to do work on the site?
- Who do you need to talk to get permission to use the site?
- What type of access is there to the site?
- What type of access will you need? Will the work be done by hand or will you need to get heavy machinery equipment into the site?
- Do you need to get permission to use heavy equipment at the site?

Future Management Considerations:

- What are the surrounding land uses?
- Will neighboring land uses threaten the survival and integrity of the project?
- How much use will this site get in the future?
- Is there potential for land use changes to occur upland from your restoration site? What is the area zoned for? Is there potential for development?
- Does the site you choose address the goals of your restoration project and watershed program?

Group Capacity:

- What skills and expertise are required for this project? Do you have the skills and expertise in your group? Will you need to hire outside experts?
- What level of funding is required? Do you have the funds? What are potential sources of funding? Can you raise the funding?
- How motivated are people in your group on this particular project? Is it a good idea, but no one is motivated to lead or work on this effort?
- What other resources will the project require that exist in or outside your community?
- What type of monitoring is your group capable of conducting?

Recommended Watershed Restoration Steps in light of Adaptive Management

I. Articulate project goals, outcomes and success criteria
   a. *Collect existing knowledge and practices relative to achieving the goals and identify information gaps and related research needs*
   b. *Negotiate a pre-defined management response if the goals are not met*
   c. *Develop an implementation plan*

II. Get landowner permission and all necessary permits

III. Set up a monitoring plan

IV. Gather resources: materials, volunteers & liability insurance, funding, methods, experts (consultants) and other potential resources

V. Implement project

VI. Evaluate, reassess, improve practices and reconsider the goals or outcomes

Once you have conducted an analysis of your watershed, created a list of priority projects, and chosen a potential project site, the following steps can help you through the planning and implementing stages. This guide, however, will not tell you exactly what to do. This guide is only intended to be a reference to help you through the process.

Any quick or in-depth literature review on watershed restoration, ecological restoration, erosion control guides and handbooks will demonstrate that there is no uniformity to steps in conducting a restoration project. There are, however, a lot of commonalities between many of the steps that are used.

The Sierra Nevada Alliance feels the Adaptive Management model discussed on page 13 is a very successful model to use in watershed restoration planning and implementation. This model continually gives you the opportunity for evaluation, change, feedback and decision-making. The following steps are the Sierra Nevada Alliance's adaptation of CAREC's model *(see page 13)* for community-based watershed restoration.

I. Articulate project goals, outcomes and success criteria

Once you have assessed the capacity of your organization to conduct the restoration project, gather the needed stakeholders to the table to begin the planning process. The first step is asking: "What is your intention, goal or intended outcome of your project?" Set clear and measurable goals, objectives, outcomes and success criteria for your restoration project. For more information on goals and objectives *see page 12*.

Stakeholder tip: Remember to be inclusive. At this point in time you have finally reached the true project planning stage and will be moving along much quicker. You don't want any hiccups now. Make sure that everyone in the project-planning group agrees upon and fully understands the goals, the objectives, what you hope the outcomes to be and what you will use as your success criteria. Don't proceed to the next step until everyone in your group is on the same page.

a. Collect existing knowledge and practices related to achieving the goals and identify information gaps and related research needs

A lot of information will come out of your watershed assessment. However, further detail on the specific project site is useful. A good focused assessment of your project area will supply you with the needed information to restore function back into the degraded watershed. *For more information on watershed assessments please visit Section II: Alliance –RCRC Watershed Restoration Principles.*

b. Negotiate a pre-defined management response if the goals are not met

As a group it is extremely wise to come up with a set of responses or strategies in case your goals are not being met. This is the beauty of the adaptive management cycle—it allows you to continually evaluate what you are doing while you are doing it. Do not be afraid of failure! If the techniques you are using are not meeting your goals, feel confident in your decision to cease the current method in order to find a more appropriate technique.

Deciding on how you are going to deal with and manage particular responses to certain situations beforehand will help your group in case something goes awry. Determine alternative tactics and strategies you will put in place in the instance of your first management strategy failing.

c. Develop implementation plan

As a group, develop a written implementation plan. The plan should contain the following elements:

I. **Identify the site.** Give a written description of the health of the site, where the information was taken from and the site location

II. **State the problem.** Describe what functions you are trying to restore to the system

III. **Determine goals and objectives.** Clearly state and write the goals and objectives for your project, identify your biological, physical and hydrological goals and objectives

IV. **Create success criteria.** Clearly state what you will use as criteria for success of the project. Keep your reference site in mind when developing success criteria. Only when we know what success looks like can we begin to measure it.

V. **Develop a Strategy for Implementation.**

a. Clearly write out **what you are actually going to do** to restore function to the system

b. Clearly state **how your group will conduct the needed work**

   i. Will you be using test or research plots to make sure that the method you intend to use is the best possible method for that site?

c. **Specify if you will hire consultants.** Clearly define and write what the specific roles and responsibilities of the consultant(s) will be in the implementation of the project

d. **Identify key partners and stakeholders.** Clearly state what individuals will be involved in the project with specific roles and responsibilities

e. **Clarify who does the work**. Who will actually do the project implementation? Will the workers be paid or volunteer? If paid—do you need to comply with labor laws? If volunteer—what kind of volunteer liability will you provide? Clearly define and state in your plan.

f. **Permits.** What permits will you need? Who will go through the process to make sure that they are completed in a timely manner? Make sure that you have all needed permits in place before breaking ground.

g. **Materials.** What materials will you need for the project? When will you need them by and where will you get them?

VI. **Develop a Budget.** After assessing your implementation plan, determine the costs of the materials, consultants, workers and other resources. Include expenditures and sources of revenue to cover the expenditures.

VI. **Make a timeline for implementation.** How long will it take to implement the project? How much time do you have? Will weather and seasons affect the length of the project?

VII. **Design a monitoring plan.** Clearly state and write your pre, during, and post monitoring plan. How will you use this monitoring information to determine the success of your project? Gather any existing monitoring or assessment data to be included in a final analysis report.

VIII. **Determine how you will share information.** How will your group share the project plans, implementation and results with the larger community? Will you be posting informative signs at the restoration site? Will your group conduct public forums or field tours to explain the restoration project? Will your group be notifying nearby landowners and/or businesses about the project? Will you be inviting media to write stories about your plans, implementation and results?

II. Get landowner permission and all necessary permits

Landowner Permission

Before embarking on any project make sure that you check with all applicable landowners and land managers to make sure that you have their permission to enter their property and/or perform work on their property. If you are planning on doing restoration on a privately owned site make sure that you sign an agreement with the owner to allow access for monitoring, implementing the project and maintaining and restoring the site into the distant future.

Quick and Useful Permitting Tips

Often restoration projects that involve waterways and the adjacent land require city, county, state and/or federal permits.

Tip #1: Make personal contact with agencies prior to sending in your permit application. Agency staff are often more helpful if they know you and your project. Ask the permit reviewers to look at your project plans and incorporate their feedback into your project proposal. This will increase your chances of getting the permit approved and improve the quality of your restoration project. It should be noted that some permitting agencies do not give feedback unless they see a hard plan from an engineer. *You may want to choose a different restoration project if an elaborate permit is required or allow yourself more time in completing the project.*

Tip #2: A good way to gather all of the necessary information for the permits is to create a matrix of information needed for all permits and then prioritize what information will be the hardest to acquire. Tackle this information first and then move on to the more easily attained information.

A list of permitting agencies and necessary documentation needed for streambank restoration projects follows. Additional permits may be needed depending on the scope of your project.

California Environmental Quality Act (CEQA)

Everyone must comply with the California Environmental Quality Act when they undertake a project that may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. The lead agency or organization in the project must perform an *Initial Study* to determine if their

project causes a significant environmental impact. The areas that are evaluated to determine if there will be an impact include aesthetics, biological resources, hazards/hazardous materials, mineral resources, public service, utilities/service systems, agricultural resources, cultural resources, hydrology/water quality, noise, recreation, air quality, geology/soils, land use/planning, population/housing, and transportation/traffic.

There is an Environmental Checklist to aid in making the *Initial Study*. It is a checkbox document on which you check off whether your project will have certain kinds of significant impacts or not. If you indicate that your project will have any significant impacts you are required to write a paragraph on what measures you will use to mitigate the impact. The checklist is reviewed by the lead agency of the project to determine: if the project will require an Environmental Impact Statement, if the project will qualify for an exemption, or if the project will receive a negative declaration stating that there will be no adverse impact on the environment. You can get the checklist from http://ceres.ca.gov/theme/env_law/ceqa/rev/appg_102698.pdf.

Army Corps of Engineers

This agency requires a Nationwide Army Corps Permit which applies to restoration projects that "serve the purpose of restoring 'natural' wetland hydrology, vegetation, and function to altered and degraded non-tidal wetlands and 'natural' functions of riparian areas." This permit is needed if your project includes any of the following:

- Construction of piers, wharves, bulkheads, dolphins, marinas, ramps, floats, intake structures, and cable or pipeline crossings
- Dredging and excavation
- Depositing of fill or dredged material in waters of the U.S. or adjacent wetlands
- Site development fills for residential, commercial, or recreational developments
- Construction of revetments, groins, breakwaters, levees, dams, dikes, and weirs
- Placement of riprap and road fills

The Nationwide Permit application can be acquired on the Army Corps Website: http://www.usace.army.mil/inet/functions/cw/cecwo/reg/index.htm.

State and Regional Water Quality Control Board

There are two permits required for the Water Quality Control Board: the Water Quality Certification (401) and the NPDES Waste Discharge Permit. The first is a 401 permit under the Federal Clean Water Act protecting the beneficial uses of the waters of the United States and regulating discharge. You need this permit if you are proposing to conduct activities that may result in a discharge to surface waters including dredging and filling. This permit application can be mailed to you from your Regional Water Quality Control Board office. The NPDES Waste Discharge permit is needed if there will be a discharge to surface waters. This permit and additional information can be found at: http://www.swrcb.ca.gov/.

Department of Fish and Game

The permits required by this agency are the Form FG 2023 Notification of Lake or Streambed Alteration and the Form FG 2024 Project Questionnaire. This permit and questionnaire were formed to protect California's threatened and endangered species and fish habitat. They are needed for any project that will substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake or use materials from a streambed. It is best to let this agency know about your plans very early in your project to increase your chances of getting your permit approved. These permits can be downloaded at http://www.dfg.ca.gov/1600/notification_pkg.html

Navigating the permitting process is not necessarily that easy. However, there are organizations that can help you through the process.

- *Sustainable Conservation:* Sustainable Conservation, a nonprofit environmental organization, in partnership with the Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCD), has designed and implemented a unique and innovative one-stop permitting program to improve water quality, enhance wildlife habitat and preserve agricultural resources. Dubbed Partners in Restoration (PIR), this

program is for farmers and ranchers interested in implementing voluntary conservation projects to control erosion and sedimentation, as well as enhancing the natural resource values on their lands. Farmers and ranchers need only work with the NRCS and Sustainable Conservation to navigate through the entire permitting process. PIR includes special conditions, developed in cooperation with regulators, on the timing, location, and methods of installing these projects to minimize and avoid potential negative impacts on water quality, sensitive species and important habitat. For more information on Sustainable Conservation contact: Carolyn Remick, Program Director, Restoration on Private Lands cremick@suscon.org or visit www.suscon.org

- *California Association of Resource Conservation Districts:* CA RCD has created a guide to Watershed Project Permitting for the State of California. This helpful guide can be found at: www.carcd.org/permitting/main.html

III. Set up a monitoring plan

Setting up a pre, during, post and ongoing monitoring strategy

Your monitoring plan should directly correlate to what you are trying to restore. Determine what to monitor based on your project goals, objectives and success criteria. For example, if a goal of your project is to reduce sedimentation coming from an eroded slope, you will want to monitor sediment loading. If a goal were to restore fish habitat, ideally you would monitor the fish population at the project site. Sometimes you may not have the expertise, technology or resources to directly monitor for your goals. Then you will want to monitor other indicators related to your goal. For example, if your goal is to improve fish health and you cannot afford to hire a fish biologist, perhaps you can monitor water temperature, macro invertebrates, and other indicators that inform you if there is adequate habitat and conditions for fish.

As noted above, your monitoring program needs to be within the capacity of your group. Ask yourself:

- What expertise is required to do this type of monitoring?
- Do you have staff, partners or volunteers with this expertise?
- Do you need to hire outside consultants, and do you have the resources for this?
- Do you have the time to do this monitoring? Does this require daily, weekly or periodic monitoring?
- Do you have the equipment and technology?
- And if you do not have any of the above, can you raise the resources to fill the gaps?
- What type of monitoring protocols do you need to follow? Are there specific QA/QC (Quality Assurance/Quality Control) documents that you need to have set in place before starting the project?

For more information on monitoring contact Sierra Nevada Alliance and the Clean Water Team:
Sierra Nevada Alliance: 530.542.4546, sna@sierranevadaalliance.org
Clean Water Team: http://www.swrcb.ca.gov/nps/volunteer.html

IV. Gather resources: materials, volunteers & liability insurance, funding, methods, experts (consultants) and other potential resources

Materials: when and where to get them

Knowing not only what materials you need for your restoration project, but also when and where to get them is important. If you have a local nursery in your area that grows native vegetation, consult them early in your

planning so that you can find out how long it will take to get certain materials. You may need to give a local nursery six months to a year notice to grow the proper amount of plants or collect the right amount of seeds for your project. This is one of the reasons why the planning stage is so important.

Below is a partial list of potential businesses and/or organizations that can help you with your restoration materials:

- **Bitterroot Restoration:** In the past decade, BRI has built two of the most advanced native plant nursery operations in North America. Our Montana and California nurseries include greenhouses, propagation houses and shade houses designed to grow site-adapted plants for a wide range of ecosystems, including wetlands, arctic, desert, montane, grasslands and forested regions. All plants are source identified and guaranteed.

  BRI maintains a variety of source-identified native plants suitable for site-specific application. Over 350 species from multiple seed sources are propagated annually with a total production of over two million. Our plants are categorized by moisture requirements and include xeric, mesic upland, mesic riparian and wetland species. http://www.revegetation.com/

- **California Native Grasslands Association:** Each year the California Native Grasslands Association produces a products and services guide. The guide is a comprehensive list of businesses, agencies, consultants, and other organizations working on restoring native grasslands. You will be able to find plenty of businesses in this directory for native vegetation. http://www.cnga.org/psd.php?version=text

- **California Native Plant Society:** Originally formed in 1965 in the east bay region, the California Native Plant Society (CNPS) is a statewide non-profit organization of amateurs and professionals with a common interest in California's native plants. The Society, working through its local chapters, seeks to increase understanding of California's native flora and to preserve this rich resource for future generations. Membership is open to all. Our members have diverse interests including natural history, botany, ecology, conservation, photography, drawing, hiking, and gardening. They have regular Plant Sales through different CNPS chapters. Check with your local chapter or visit: http://www.cnps.org/plant_sales.htm

- **California Straw Wattles:** Straw Wattles are an economical and efficient Best Management Practice for: Stormwater Pollution Control on all Construction Projects, Fire Burn Rehabilitation, Timber Harvest Erosion Control, Revegetation Projects, Streambank Restoration, Mine and Land Reclamation, Vineyard Management, Ski Slope Maintenance, and anywhere Erosion and Sediment Protection is required. http://www.strawwattles.com/

- **GreenWood Resources** maintains a private nursery of native cottonwood and hybrid species that can be used to enhance and rebuild watersheds. Cottonwoods are suitable for planting along creeks, streams and rivers that need additional shade as well as buffers to agricultural and pasture lands. Mature cottonwoods and hybrids have deep roots and high nitrate uptake that make them favorable natural filters in the riparian zone. Portland, Oregon http://www.greenwoodresources.com/resource/management/watershed.html

- **Your own Backyard! Pine needles:** Get in touch with Michael Hogan from Integrated Environmental Restoration for more information on the use of pine needles as ground cover. Michael Hogan, Integrated Environmental Restoration Services *Phone: 530-525-1335 Email: revegetate@earthlink.net*

Volunteer Liability

All volunteers who will work on the restoration project need some form of volunteer liability insurance. One option is to get coverage and liability forms from the Natural Resource Conservation Service (NRCS). They have a program called Earth Team Volunteers, which provides liability insurance for volunteers at restoration projects. Contact your local NRCS office. Please see their website: http://www.nrcs.usda.gov/feature/volunteers/
Some groups helping organize the event may also have liability insurance that will cover the event. Ask your organizing committee.

Funding

Currently, most projects are funded through government grants. However, projects have been supported through a variety of fundraising strategies such as individual donors, major gifts, community events, and in-kind donations. There are many guides and resources to diverse fundraising tactics and we will not repeat the basics of non-foundation fundraising in this guide. But contact the Sierra Nevada Alliance if you would like more information on diverse fundraising strategies and training.

Given that currently the majority of restoration projects are government and private foundation funded, we encourage you to take advantage of news services that alert you to these opportunities. There are a few good news services that provide ongoing updated notices about watershed private foundation and government grant funding opportunities. These include:

- **Sierra Nevada Alliance Currents**: This electronic news bulletin includes funding notices, as well as other resources and news articles related to Sierra watershed efforts. To subscribe to this monthly electronic news service email Megan at ***megan@sierranevadaalliance.org*** and put in the subject line subscribe to Currents. Include in the body of the email your name, address, phone number, and email address.
- **River Network: River Advocate's Fundraising Guide**: Diversify and strengthen your fundraising base with these "how to" materials, samples, case studies and resources. http://www.rivernetwork.org
- **California Watershed Funding Database:** The California Watershed Funding Database is a great resource to search government and private foundations grants that fund watershed restoration or similar projects. For more information and to search the database please visit: *www.calwatershedfunds.org*

Methods

There are numerous restoration methods that can be used to reach a particular restoration goal. We cannot provide a menu of the full universe. However, given that Sierra Nevada watersheds have significant problems with excess sedimentation and erosion, we are offering some examples in Appendix I to provide you some ideas of bio-technical approaches to address erosion. Please see Appendix I for *Bioengineering for Hill slope, Streambank and Lakeshore Erosion Control by Thomas* G. Franti, Surface Water Specialist Note: Also visit the website to view diagrams for bio-technical approaches http://ianrpubs.unl.edu/Soil/g1307.htm - bioeng

Experts (Consultants)

Working with experts in the fields such as hydrology, biology, geomorphology, soils and/or plants can provide a better understanding of the processes and functions that need to be restored to a proposed restoration site. A number of consultants also specialize in conducting assessments and designing and implementing restoration projects. Working with experts or consultants, however, can be tricky if you don't establish clear objectives, goals and work plans. Please see Appendix III for more information on how to effectively work with consultants.

V. Implement the project

A great resource for understanding the major elements of restoration implementation is **Stream Corridor Restoration: Principles, Processes, and Practices—1998**. Below is an excerpt of the information that can be found in the guide. For more in depth information consult the guide.
http://www.nrcs.usda.gov/technical/stream_restoration/

Major Elements of Restoration Implementation
- Review of Plans
- Site Preparation
- Site Clearing
- Installation and Construction
- Site Reclamation/Cleanup
- Inspection
- Maintenance

Review Plans: A successful restoration project requires detailed, manageable and confident work plans. Before implementing your project spend some time reviewing and analyzing what your strategy. Who knows--you may have overlooked some important piece of information. If you realize that you have forgotten something or have left a particular stakeholder out, now is the perfect time to fix any of these future potential problems.

Prepare the Site:
- Delineate work zones. Make sure to clearly mark and explain to all potential workers the different zoning areas (e.g. private land, permitted areas, access and restrictions, land contours). Use temporary fencing, flags or stakes to designate zoned areas.
- Prepare access and staging areas.
- Take precautions to minimize disturbance. Consider: sensitive habitat and existing vegetation, erosion, water and air quality, cultural resources, noise, solid waste disposal and worker sanitation.
- Use appropriate equipment

Clear the Site: Clearly mark and define the restoration area. Make sure to mark all large trees, stumps and/or rocks that will remain after restoration work has been completed. Remove non-native plant species. Consider potential issues with drainage and extremely wet sites.

Install and Construct: Make sure that the individuals installing and constructing the project understand the goal and intent of the restoration project.

Reclaim and Cleanup the Site: It is very important to not sacrifice one ecosystem for another. Make sure that you cleanup the staging area and its surroundings. Your objective is to restore the landscape, not destroy one area to restore another.

Project Tip:
If a contractor is conducting your project—make sure that you put into your contract that it is their responsibility to conduct thorough and regular site inspections

Inspect the Site: Remember that just because you completed your project and it went well doesn't mean that you don't have to check up on it. Schedule times to monitor the site after completion. Refer back to the adaptive management cycle—have you restored the function into the system? If it looks like you have, make sure that you have checked with your monitoring data to reconfirm. Visual restoration is very different from actually restoring function. If you have not restored function back into the system, revisit your goals and objectives and re-evaluate whether or not you were addressing the problem or just one of the symptoms.

Maintain the Site: Reassess and improve practices. The best long term management and maintenance that you can conduct is adaptive management. Adaptive management enables your group to manage the evolving complexity of the project by continuing to monitor, evaluate and improve your particular restoration site. Listed below are a few items to consider in reassessing and maintaining the ecological function of your site as you have designed it to do:

- Maintain existing structures such as berms, water control structures, or retention basins
- Maintain a specific desirable plant community by removing (pulling), burning, mowing, or otherwise managing the vegetation on a periodic basis
- Address problems such as invasive species or excessive sediment deposition
- Address unexpected events such as structural failure
- Address unexpected recreational or human use issues

VI. Evaluate, reassess, improve practices and reconsider the goals or outcomes

As a group use the adaptive management cycle to evaluate your success criteria and consider:

- Did you restore ecological processes (hydrologic function, nutrient cycling, and energy flow) back into the system?
- Did you meet your goals? Were they the right goals for the project?
- Did you address the problem or the symptoms?
- Has your monitoring strategy been effective? Did you monitor the right parameters?
- What kind of comparisons can you make to your reference site? What conclusions can you make by comparing both sites?

Section V
Resources

Technical Resources

California Society for Ecological Restoration: http://www.sercal.org/
SERCAL is a non-profit membership based organization dedicated to the purpose of bringing about the recovery of damaged California ecosystems. To this end, the organization's activities are focused on the presentation of conferences, symposia, workshops, field trips and other educational activities dealing with the many different aspects involved in restoration of California native habitats. SERCAL also publishes a quarterly newsletter, Ecesis, available to all current members. SERCAL's educational programs and activities are planned and implemented by a volunteer Board of Directors, elected by the organization's membership. Membership is open to anyone practicing, teaching or simply interested in the field of ecological restoration.

Center for Watershed Protection http://www.cwp.org/
Founded in 1992, the Center for Watershed Protection is a non-profit 501(c) 3 corporation that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources: our streams, lakes and rivers. The Center has developed and disseminated a multi-disciplinary strategy to watershed protection that encompasses watershed planning, watershed restoration, stormwater management, watershed research, better site design, education and outreach, and watershed training.

Central Valley Regional Water Quality Control Board http://www.waterboards.ca.gov/centralvalley/
Mission Statement: Our mission is to preserve and enhance the quality of California's water resources for the benefit of present and future generations. *Function:* The primary duty of this Regional Board is to protect the quality of the waters within the Central Valley Region for all beneficial uses. This duty is performed by formulating and adopting water quality control plans for specific ground and surface water basins and by prescribing and enforcing requirements on waste discharges. Specific responsibilities and procedures of the Regional Boards and the State Water Resources Control Board are contained in the Porter-Cologne Water Quality Control Act ,

DWR Urban Streams Restoration Program http://www.watershedrestoration.water.ca.gov/urbanstreams/
The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community.

Izaak Walton League Save Our Streams: www.iwla.org
Izaak Walton League Watershed Literacy Assistance Center: Anyone who is involved in conserving watersheds is invited to call our Watershed Literacy Assistance Center and ask our staff questions related to their specific organization and watershed conservation efforts. Give us a call at 800.BUG.IWLA! or email: sos@iwla.org

Lahontan Regional Water Quality Control Board http://www.waterboards.ca.gov/lahontan
The primary responsibility for the protection of water quality in California rests with the State Water Resources Control Board (State Board) and nine Regional Water Quality Control Boards. The State Board sets statewide policy for the implementation of state and federal laws and regulations. The Regional Boards adopt and implement Water Quality Control Plans (Basin Plans), which recognize regional differences in natural water quality, actual and potential beneficial uses, and water quality problems associated with human activities. The jurisdiction of the California Regional Water Quality Control Board, Lahontan Region (Regional Board) extends from the Oregon border to the northern Mojave Desert and includes all of California east of the Sierra Nevada crest. The name of the Region is derived from prehistoric Lake Lahontan, which once covered much of the State of Nevada. Most of the waters of the North Lahontan Basin drain into closed basins, which were

previously part of Lake Lahontan. Waters of the South Lahontan Basin also drain into closed basin remnants of prehistoric lakes.

Natural Resource Conservation Service: Soil Survey Manual http://soils.usda.gov/technical/manual/
The Soil Survey Manual provides in a single volume the major principles and practices needed for making and using soil surveys and for assembling and using data related to them. The Manual is intended primarily for use by soil scientists engaged in the classification and mapping of soils and in the interpretation of soil surveys. Although the Manual is oriented to the needs of those actively engaged in preparing soil surveys for publication, workers and students who have limited soils experience or are less familiar with the soil survey process also will be able to use the information.

Natural Resources Projects Inventory (NRPI) http://endeavor.des.ucdavis.edu/nrpi/
This is a collaborative effort between the California Biodiversity Council and the University of California at Davis Information Center for the Environment. The signatories of the California Biodiversity Council joined forces to gather information on thousands of conservation, mitigation and restoration projects being developed and implemented throughout California. The result, the Natural Resource Project Inventory (NRPI), has become a comprehensive electronic database searchable on the Internet. NRPI is an expansion of previous inventories including 1) the Watershed Projects Inventory (WPI), 2) the California Ecological Restoration Projects Inventory (CERPI), and 3) the California Noxious Weed Control Projects Inventory. Contact: UC-Davis Kevin Ward, NRPI Coordinator, Information Center for the Environment, Phone: (530) 752-2378 Fax: (530) 752-3350, Email: kcward@ucdavis.edu

Society for Ecological Restoration International http://www.ser.org/
The Society for Ecological Restoration International is a non-profit organization infused with the energy of 2300 members – individuals and organizations who are actively engaged in ecologically-sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets and cultural perspectives. They are scientists, planners, administrators, ecological consultants, first peoples, landscape architects, philosophers, teachers, engineers, natural areas managers, writers, growers, community activists, and volunteers, among others.

US EPA Top 10 Watershed Lessons Learned http://www.epa.gov/owow/lessons/

US EPA River Corridor and Wetland Restoration http://www.epa.gov/owow/wetlands/restore/

Recommended Reading

- *Bioengineering for Land Reclamation and Conservation*, by Dr. Hugo M.Schiechtl. The University of Alberta Press 1980. This is a masterwork in the field of restoration, with an enormous bibliography and great appendices of useful plants. It is, however, out of print and difficult to find, but well worth tracking down. The following two books are currently available and very useful, only lacking the full appendices of the original.
- *California Environmental Handbook*-- USDA-NRCS California State Office, 430 G Street #4164, Davis, CA 95616-4164. (530) 792-5600. This document is available online for download on the following website: http://www.ca.nrcs.usda.gov/rts/ENVHNB/environhandbook1.html
- *California Salmonid Stream Habitat Restoration Manual*
  CA Dept of Fish & Game, 1807 13th Street, Suite 104, Sacramento, CA 95814. (916) 324-6903. This document is available online for download on the following website:
  http://www.dfg.ca.gov/fishing/manual3.pdf
- *Ecological management and restoration: Assessment, setting goals and measuring success.* Richard J. Hobbs. Ecological Management and Restoration Volume 4 Supplement, February 2003.
- *Evaluation of Geomorphic Restoration Techniques Applied to Fluvial Systems* (2001) http://www.feather-river-crm.org/publications/preports/georest/cover.html

- *Field Office Technical Guides (FOTGs)*FOTGs are the primary technical reference for NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources. Technical guides used in each field office are localized so they apply specifically to the geographic area for which they are prepared. These documents are referred to as Field Office Technical Guides. You can find the FOTG for your specific geographical area online at your state NRCS office website or by contacting your local NRCS office. http://www.ca.nrcs.usda.gov/rts/fotgintro.htm

- *Ground Bioengineering Techniques for Slope Protection and Erosion Control* H.M. Schiechtl and R. Stern Blackwell Science 1996

- *Gully Formation and Control: the status of our knowledge.* Burchard H Heede. USDA Forest Service 1976. Research Paper RM-169 Excellent theory and practice, best used in conjunction with the Kraebel Pillsbury document.

- *Handbook of Erosion Control In Mountain Meadows.* Charles J Kraebel and Arthur F. Pillsbury USDA Forest Service 1934. Republished as GUIDELINE FOR WATERSHED IMPROVEMENT MEASURES, by USDA Forest Service Region 5, 1980 Emphasis on repair of gullies. A very practical guide.

- *Handbook for Forest and Ranch Roads: A guide for planning, designing, constructing, reconstructing, maintaining and closing wildland roads.*William E. Weaver, Ph.D. and Danny K. Hagans, Pacific Watershed Associates for the Mendocino County Resource Conservation District, June 1994. $25 including shipping. Available from: Mendocino County RCD, 405 Orchard Ave., Ukiah, CA 95482. (707) 468-9223.

- *Keeping the Academics in Service Learning Projects, or Teaching Environmental History to Tree Planters.* Mark Stemen, California State University, Chico. The History Teacher Volume 37 No.1, November 2003.

- *Keeping Water on the Land Longer*. Dennis Doncaster, Bureau of Land Management's Rock Springs Field Office, Wyoming. *http://www.wrds.uwyo.edu/wrds/wsc/dtf/wateronthеland.pdf*

- *Man's Effect On California Watersheds:* A study of the management of natural resources within California watersheds---Assembly Committee On Natural Resources, Planning, And Public Works---Full report of the Institute of Ecology, University of California at Davis. This is an excellent work, produced in response to the devastating effects of the 1964 flood. It examines the causes and possible solutions to the problem of destabilized landscapes. You can find it in the government documents section of any large library.

- *New Concepts for Meadow Restoration in the Sierra Nevada*: Donna S. Linquist and Jim Wilcox. http://www.feather-river-crm.org/pdf/ieca.pdf

- *Restoration of Aquatic Ecosystems* - science, technology, and public policy, National Research Council. This book presents a national strategy for aquatic restoration. National Academy Press 1992

- *Stream Corridor Restoration: Principles, Processes and Practices*, USDA: NRCS, Published October 1998, revised August 2001. This document is available online for download on the following website: http://www.usda.gov/stream_restoration

- *U.S. EPA River Corridor and Wetland Restoration***:** http://www.epa.gov/owow/wetlands/restore/

- *Using process-oriented parameters to assess degradation.* Jason Cummings (Ecosystem Management, University of New England, Armidale NSW 2351, Australia, Email: jcummin2@metz.une.edu.au) Ecological Management & Restoration Volume 4 Supplement February 2003.

- *Water Bioengineering Techniques; for Watercourse, Bank, and Shoreline Protection.* H.M. Schiechtl and R. Stern Blackwell Science 1997.

Section VI
Glossary

Aquatic habitat: Areas suited for fish and other creatures, which live in wet conditions.

Abiotic: Pertaining to the non-living part of an ecosystem or to an environment where life is absent.

Acre-foot: A unit for measuring the volume of water, equal to the quantity of water required to cover 1 acre to a depth of 1 foot and equal to 43,560 cubic feet or 325,851gallons. The term is commonly used in measuring volumes of water used or stored.

Active restoration: Actions in the channel or riparian zone intended to improve ecological or geomorphic structure or function. Examples: vegetation planting, placement of woody debris or boulders, construction of in-stream structures for fish habitat, bioengineering of stream banks, channel reconstruction.

Autotrophs: An organism able to build all the complex organic molecules that it requires as its own food source, using only simple inorganic compounds. Plants, and some bacteria are autotrophs.

Bank: The margins of a channel. Banks are called right or left as viewed facing in the direction of the flow.

Bank storage: The water absorbed into the banks of a stream channel, when the stages rise above the water table in the bank formations, then returns to the channel as effluent seepage when the stages fall below the water table.

Base runoff: Sustained or fair weather runoff. In most streams, base runoff is composed largely of groundwater effluent.

Best management practices (BMPs): Methods that have been determined to be effective, practical means of preventing or reducing pollution from nonpoint sources.

BOD (Biochemical Oxygen Demand): A measure of the amount of oxygen necessary to decompose organic materials in a volume of water. As the amount of organic waste in water increases, more oxygen is used, resulting in a high BOD.

Bioengineering: Practice of combining living plant material with natural and synthetic construction material to provide measurable engineering properties.

Biota: Plants, animals, and microorganisms.

Braiding of river channels: Successive division and rejoining (of river flow) with accompanying islands is the important characteristic denoted by the synonymous terms, braided or anastomosing stream.

Channel (watercourse): An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. River, creek, run, branch, anabranch, and tributary are some of the terms used to describe natural channels. Natural channels may be single or braided. Canal and floodway are some of the terms used to describe artificial channels.

Channelization: Straightening and deepening streams so water will move faster – a tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.

Discharge: The quantity of water flowing past a particular point on a stream, usually measured in cubic feet per second (cfs).

Drainage basin: The area that contributes surface water to a particular stream system.

Damage: Refers to acute and obvious changes in an ecosystem.

Degradation: Pertains to subtle or gradual changes that reduce ecological integrity and health.

Destroyed: is an ecosystem where degradation or damage has removed all macroscopic life, and commonly has ruined the physical environment as well.

Detritus: Particles from decaying plants and animals.

Dynamic Equilibrium: Are the normal functions of a waterbody in terms of the natural ranges of flow, sediment, movement, temperature, and other variables.

Ecological Trajectory: is one that describes the developmental pathway of an ecosystem through time. In restoration, the trajectory begins with the unrestored ecosystem and progresses towards the desired state of recovery that is expressed in the goals of a restoration project and embodied in the reference ecosystem. (Society for Ecological Restoration, 5)

Ecosystem: Consists of biota within a given area, the environment that sustains it, and their interactions.

Ecosystem Health: is the state or condition of an ecosystem in which its dynamic attributes are expressed within 'normal' ranges of activity relative to its ecological stage of development.

Effluent: Any material that flows outward from something; examples include waste water from treatment plants and water discharged into streams from abandoned coalmines.

Enhancement: any improvement of a structural or functional element.

Ephemeral: Water flow only during or immediately after periods of precipitation. The flow is generally less than 30 days.

Ground water: The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Heterotrophs: Organisms that, unlike autotrophs, cannot derive energy directly from light or from inorganic chemicals, and so must feed on other life forms. They obtain chemical energy by breaking down the organic molecules they consume. Heterotrophs include animals, fungi, and some types of bacteria.

Hydrograph: A graph showing the water level (stage), discharge, or other property of a river volume with respect to time.

Hydrology: the study of surface and subsurface water.

Infiltration: is the term used to describe the movement of water into soil pores.

Intermittent: Water flow during only certain times of the year, seasonal flow normally lasts longer than 30 days.

Macro invertebrate: refers to crustaceans (such as crayfish), insects (without backbone) and worms, which assemble in semi-permanent populations. Study of the presence of various macro invertebrates provides a good environmental indicator of stream health because many species are known to be either pollution tolerant or intolerant.

Mitigation: actions taken to avoid, reduce or compensate for environmental damage.
Example: create or restore wetlands in a new site to compensate for the destruction of an existing wetland at another site.

Nonpoint source: Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet).

Passive restoration: remove stressors and allow natural adjustment processes (geomorphic adjustment, ecological succession) to operate. Example: grazing exclosure.

Perennial: Continual water flows during both wet and dry periods of the year.

Point source: Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Photosynthesize: The process by which plants convert water and carbon dioxide into carbohydrates, using sunlight as the source of energy and with the aid of chlorophyll.

Preservation: maintenance of an existing aquatic system that is in good or excellent condition with ecological structure and function intact.

Reclamation: changing an ecosystem or site to a new or altered use, typically to serve a utilitarian function. Example: draining wetlands for agricultural use.

Reference ecosystem: can serve as the model for planning an ecological restoration project, and later can serve in the evaluation of the project.

Rehabilitation: putting back into good conditions or working order; used primarily to refer to visual improvements.

Resistance: Is the term describing an ecosystem's ability to maintain its structural and functional attributes in the face of stress and disturbances.

Resilience: Is the ability of an ecosystem to regain structural and functional attributes that have suffered harm from stress or disturbance.

Riparian area: Lands that occur along watercourses and water bodies. Examples include: streambanks and floodplains. Unique soil and vegetation comprise this landscape characterized by the presence of water.

Runoff: Is the process when the rate of rainfall or snowmelt exceeds infiltration capacity, excess water collects on the soil surface and travels down slope.

Sediment: Soil, sand, and minerals washed from land into water, usually after rain. Sediment can accumulate in reservoirs, rivers and lakes, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Sustainable cultural practices: Traditional human land uses that maintain biodiversity and productivity.

Trophic: Relating to processes of energy and nutrient transfer from one or more organisms to others in an ecosystem.

Watershed: The land area that drains into a stream. An area of land that contributes runoff to one specific delivery point; large watersheds may be composed of several smaller "subsheds," each of which contributes runoff to different locations that ultimately combine at a common delivery point.

Endnotes

Federal Interagency Stream Corridor Restoration Working Group's Stream Corridor Restoration: Principles, Processes, and Practices guide at **http://www.nrcs.usda.gov/technical/stream_restoration/**

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APPENDIX I
Bioengineering

Bioengineering for Hillslope, Streambank and Lakeshore Erosion Control
by Thomas G. Franti, Surface Water Specialist

Contour Wattling

This method is used to control surface erosion by breaking long slopes into shorter slopes. Bundles of branches, called wattles or fascines, are placed in shallow trenches along the slope or streambank contour. Trenches are excavated by hand to half the diameter of the bundles. Wattles are typically 8 to 10 inches in diameter and branches secured with twine. After the wattle is staked in place, the trench is backfilled until only the top of the bundle is exposed and no air pockets remain around the bundle. Wattles can be used for hillslope restoration, road embankments, wide gullies, or slump areas.

Brush Layering

This method is used to restore slopes by constructing a fill-slope consisting of alternating layers of live branches and soil, creating a series of reinforced benches. Large quantities of dormant willow branches are often used. While about 75 percent to 80 percent of the branch is buried, the tips are left exposed. The layers of branches help reinforce the fill, which improves as the branches develop roots throughout the fill area. Brush layering can be used to place new fill or repair old fill areas, restore shallow slumps, repair narrow gullies and stabilize loose soil slopes.

Trench Packing

This method is used to slow or spread water by placing live plants in a trench perpendicular to the flow. To reduce wave impact, live plants are placed in trenches running parallel to the shoreline. Several trenches may be used with different plants in each, depending on the distance to water. Generally, a wide planting area is needed to dissipate wave energy. In upland areas, trench packing serves to slow water and spread it over the soil surface, reducing its erosion potential. Trench packing can also be used to control shallow seeps, protect wetland construction and renovation and protect abandoned roads.

Brush Matting

This method protects streambanks by placing a mattress-like layer of branches over it to protect soil and slow water velocity. The mat is composed of interwoven, usually dead, branches secured to the soil by live stakes, wire, twine or live branches. Live stakes are often cut from dormant willow. Brush matting helps collect sediment and enables establishment of vegetation on banks. Like brush layering, this method requires large quantities of branches, pine needles, and other organic nutrients.

Coir Fascines

Coir fascines stabilize banks and help establishment of wetland plants. The coconut fiber accumulates sediment and biodegrades as plant roots develop and become a stabilizing system. (From Bestmann-Green Systems)

Coir fascines are wattles made from the fibrous outer husk of coconuts. Coir is denser than water so it won't float and is very slow to decay. Coir fascines are a readily available manufactured product and are popular for streambank and wetland restoration where a natural look is desired. Coir fascines are placed with their tops at the water surface. Live plants can be placed into coir fascines to create a natural look.

Prevegetated Mats

Prevegetated mats are live plants grown on a movable mat of organic material. They come in many sizes and materials and are moved and installed in one piece. They are generally 4 by 8 feet in size for easy handling. Mats are grown in nurseries for up to a year or more to provide a good plant stand. Thin mats can be rolled up and shipped without special packing. Thick mats are handled with heavy equipment because of their weight. Prevegetated mats are made of coir or other slowly degradable material and can use many types of plants. Mats are usually used in wetland or lakeshore environments so wetland plants are the most common. Currently, most prevegetated mats are custom ordered one to two years in advance.

Interplanting Rip Rap

Rip rap is often used to protect streambanks and lakeshores. Rip rap is composed of various size large stones placed on the soil surface where the water contacts the soil. Live cuttings can be interplanted in rip rap to provide additional slope stability. Root growth below the rip rap will improve soil strength and live vegetation will hide the rocks, presenting a more natural look.

Continued on Next Page

Continued From Previous Page Bioengineering for Hillslope, Streambank and Lakeshore Erosion Control

Live Cuttings
Live cuttings can be used to secure materials in place and to increase plantings on a slope. Live cuttings can be from 18 inches to 4 feet in length. Longer cuttings are used for live staking of wattles, while shorter cuttings are used for plantings.

Staking
Staking is used extensively in bioengineering practice. Stakes can be live or dead. Live staking is often done with willows to stabilize soil or to stake other materials in place. Manufactured timber stakes, 2 to 3 feet long, are used to secure wattles and coir fascines. Timber stakes for upland application need to have a bias, or angle, cut making them easier to install. For wetland or streamside applications, stakes need straight parallel sides to prevent heaving from water pressure.

Combinations *(This is preferable and usually produces the quickest results)*
Combinations of the above practices are usually used for most bioengineering designs. For example, brush wattles and live staking is a common combination used to stabilize slopes. A coir fascine can be used with live plantings, brush matting and trench packing to restore wetlands or stream channel. New combinations of existing methods, and the use of new materials, will provide creative applications of bioengineering techniques.

Plantings
Bioengineering involves the use of live plants to add structural strength to soil. Many different plant materials are used. Live cuttings should be soaked in cold water for at least 24 hours before they are used. This not only provides the cuttings with needed moisture but also improves rooting. Live potted plants are often used. Care of live plants before and during planting is critical for success. Live plants raised indoor need to be acclimatized to the outdoor environment before planting. Planting should be done during the wet season, which typically in the Sierra Nevada is in the fall.

Plants can be planted directly into coir fascines, coir pots or mats. Prevegetated mats, as described earlier, are another method used to transplant live plants. Wrapping several live plants in a roll of degradable material and placing the roll in the ground like a wattle can develop a plant roll. This method also can be used for trench packing.

Seeding can be used where appropriate. Seeding and mulching are not appropriate in areas of flooding, high water flow or rapid changes in water depth, as the mulch and seed will be washed away. Proper seedbed preparation, fertilization and irrigation may be needed to assure seedling survival.

Expect some failure of plantings in all bioengineering application. A 75 percent to 80 percent survival rate is considered very good. Replanting is generally inexpensive and often the plants will reestablish themselves in time. Some loss of vegetation does not seriously impact a project as long as most of the soil stays in place and the structural features of the design are sound.

Protect Plantings
Protect live plantings from animals, especially ducks and geese along lakeshores and streamsides. Deer, muskrats, beaver, dogs and humans can also pose a threat. Signs may keep people away, but fencing may be needed if animals are a problem. For lakeshore or streamsides, an enclosed fencing layout is best to keep waterfowl away. One fence should be placed 1 to 2 feet into the water away from the shoreline plantings with a parallel fence 2 to 3 feet upslope from the plantings. Also, protection from flooding or excess water flowing across the planting is important to establish all bioengineering plantings. Be sure surface drainage and water flow is directed away from the new plantings or protected slope.

Vegetation Type
Selection, procurement and installation of the proper plant material is essential for a successful design. In the case of lakeshore and streambank protection, both herbaceous and woody plants are needed. Herbaceous plants, or wetland plants, will be needed at and near the water's edge. These plants can grow with their roots underwater. This root growth adds considerable strength to the soil. Generally, using several different wetland plant species increases the chance of a successful planting. However, woody plants placed too near the water or water table will not provide good structural strength and may not survive. Woody plants should be used on the upper slope and upland areas where their roots can grow in soil above the water table.

Native vegetation existing at or near the site will give good guidance concerning plant selection. As mentioned, willow cuttings are often used for wattles and live cuttings. Proper species selection is important. Nurseries can be contracted with in advance to grow native plants that are found in project site.

APPENDIX II
Sample Contract

Organization {Insert Name} and Consultant/Contractor {Insert Name}
INDEPENDENT CONTRACTOR AGREEMENT

This agreement is entered into in city location, State as of the date set forth in Exhibit A to this agreement between the (Insert name of organization) and (Insert name of Consultant/Contractor), for the purpose of engaging (Insert name of Consultant/Contractor) to perform services for the (Insert name of organization) as described herein. In consideration of the mutual promises herein, the parties agree, as follows:

Services. Contractor shall perform the services described in Exhibit A to this agreement. Contractor shall determine the method, details and means of performing these services.

Term. The term of this agreement shall be set forth in Exhibit A to this agreement. Either party may terminate this agreement earlier for any reason upon thirty days written notice.

Compensation. For the satisfactory performance of services under this agreement, the (Insert name of organization) shall pay the (Insert name of Consultant/Contractor) the fees specified in Exhibit A to this agreement. Payment will be made upon presentation of (Insert name of Consultant/Contractor's) monthly invoice(s) containing descriptions of work.

Expenses: (Insert name of Consultant/Contractor) shall be responsible for all costs and expenses incurred in performing services under this agreement, including, but not limited to, costs of transportation, office, telephone, supplies, equipment, and all other costs of doing business, except as indicated in Exhibit A to this agreement.

Independent Contractor. The relationship between (Insert name of Consultant/Contractor) and the (Insert Name of Organization) established by this agreement is that of an independent contractor, not one of employment, agency, partnership, or joint venture, and nothing in this agreement shall be construed otherwise. (Insert name of Consultant/Contractor) shall determine his or her schedule for performing services and shall retain the right to perform services for others during the term of this agreement. (Insert name of Consultant/Contractor) shall provide all tools and instrumentalities required to perform the services under this agreement. (Insert name of Consultant/Contractor), shall be solely responsible for its employees' health and medical coverage, Social Security, workers' compensation, and other taxes and withholdings. If (Insert name of Consultant/Contractor) has employees, (Insert name of Consultant/Contractor) shall provide the (Insert Name of Organization) with its worker's compensation certification.

Liability. (Insert name of Consultant/Contractor) agrees to defend, indemnify and hold the (Insert Name of Organization) harmless against all claims and damages arising from (Insert name of Consultant/Contractor performance of services under this agreement.

Ownership Rights. Programs, documents, and other materials developed by (Insert name of Consultant/Contractor) pursuant to this agreement will belong to the (Insert Name of Organization), unless specified otherwise. Programs, copyrighted works and other materials belonging to the (Insert Name of Organization) shall remain the sole property of the (Insert Name of Organization). (Insert name of Consultant/Contractor) agrees not to use or copy materials belonging to the (Insert Name of Organization) without prior permission except in connection with the services performed under this agreement, and (Insert name of Consultant/Contractor) agrees to hold the (Insert Name of Organization) harmless against any charge of copy infringement arising out of the use of materials supplied by (Insert name of Consultant/Contractor).

Confidentiality. (Insert name of Consultant/Contractor) agrees that it will not disclose any confidential or proprietary information belonging to the (Insert Name of Organization) to any other party or use such information for the benefit of any party other than the (Insert Name of Organization) without the express written consent of the (Insert Name of Organization).

Miscellaneous. This is the entire agreement between the parties on the subject and may not be modified except in writing signed by both parties. The rights and obligations of the parties are to be governed by and construed in accordance with California law. Neither party shall assign this agreement or any obligations there under without the express written consent of the other. In any action to enforce or interpret this agreement, the prevailing party will be entitled to recover reasonable attorney's fees from the other party.

(Insert Name) **Organization**	**DATE**
(Insert Name) **Organization**	**DATE**

{See Exhibit A, Next Page}

{Insert Name of Organization} and {Insert Name of Consultant/Contractor}

EXHIBIT A

SCOPE OF SERVICES
for Agreement between {INSERT NAME OF ORGANIZATION} and {INSERT NAME OF CONSULTANT/ CONTRACTOR}

Purpose {Insert intent of contract—why will you be working together?}

Contract {Insert length of contract, location, dates, and any other pertinent temporal or spatial issues}

Work Plan {Insert scope of work. This can get very detailed with specific tasks, deliverables, and due dates}

Expected Budget {Insert agreed upon budget}

Invoices {Example}

- Invoices will be issued at the end of each month or upon the Work plan's completion, whichever is sooner.
- Consultant requires prompt payment of invoices. Consultant will stop work if payments are past due.
- (Insert Name of Organization) will reimburse Consultant within X days of receipt of invoice.
- Consultant tracks and records project time in hour increments

Timeline {Insert detailed timeline with deliverable due dates if desired}

The (Insert Name of Organization) must approve changes to the contract in writing.

Agreed to by both parties:

_____	_____
{Insert Name}	**{Insert Name}**
{Insert Title}	**{Insert Title}**
{Name of Organization}	**{Name of Organization}**
_____	_____
Date	**Date**

APPENDIX III
Working with Consultants

When would you need to work with a consultant

- No one at your organization has the knowledge, time or desire to conduct the work or project needed
- Your group wants a consultant to lend credibility to the project
- The groups members continue to disagree about how to meet the need and bring in a consultant to provide expertise or facilitation skills to come to consensus

Tips for Success

- Know exactly what you want
- Create a mutually beneficial contract with specific, clearly defined goals and objectives, deliverables, work plan, and timeline

Tip:
Before starting any work with a consultant, make sure you explain exactly who you are and what your group's mission and goals are. If the consultant does not understand the nature of your organization—you probably don't want to invest your time in them.

Creating Contracts

Why set up a contract with a consultant? Contracts help ensure clear communication between the contractor and the contracting organization. They make sure you and the contractor are on the same page about what strategy or tactics will be performed, what the budget is, and what the schedule is. Contracts are the first step towards a good working relationship.

Contracts also ensure the work gets done if the main contacts change in the consulting firm or organization. Contracts are often between consulting firms and organizations, and employees and primary contacts can change due to unforeseen factors such as illness. A great way to think of a contract is "what would happen if the individual you are contracting with becomes sick and someone else takes his or her place?" Will the replacement person know what to do? Likewise, what if the primary organizational person who sets up the contract needs to step out – can someone else in the organization takeover managing the consultant and know what is going on?

Contracts are legal documents and will also protect your group from negligence. They will also ensure your group will not have to pay a contractor if they are not meeting the obligations of the contract. Clear communication can help prevent ending up in court and they can also help protect the organization in the worse case situation if you do end up in court.

The following bullets are potential components to include in creating a contract with a consultant.

- **Timeline**: Include a timeline with specific checkpoints to make sure that work is staying on schedule.
- **Communications and Correspondence**: Include information to ensure your consultant keeps in touch with you on a daily, weekly, monthly, bimonthly, quarterly, or yearly basis.
- **Scope of Work**
- **Deliverables**
- **Invoice schedule** (payment methods and timeline): When should the contractor invoice you – monthly, quarterly, half the amount up front and half upon completion? Also clearly state when the organization will send the check after the invoice is received. Will it take 10 days for reimbursement, a month?
- **Expenses:** Clearly state how you will deal with specific expenses such as travel, copies, mailings and equipment purchases. For restoration projects, are materials (such as willow wattles) and equipment (such as renting of a back hoe) purchased and covered by the organization or contractor. Are general operating costs for the consultant covered under a lump fee, or are there other operational costs that are in addition to their primary fee? Is there a cap or ceiling you want to state on these other costs?

- **Permitting:** Clarify in the contract who will be responsible for obtaining permits and landowner permission. Ensure that the contract states that the contractor can perform no fieldwork until all necessary permits and landowner permission is obtained.
- **Roles:** Who will be doing the actual work? Clarify roles and responsibilities of all parties in the work plan.
- **Labor clauses:** Make sure that you have a clause stating it is up to the consultant to make sure that they are complying with all state laws regarding labor, wages, unions and safety.
- **Budget:** Make sure that the budget is agreed upon and all potential expenses are included.
- **Authority:** Clearly state in the contract who has authority to approve expenditures, invoices, and changes.
- **Cancellation:** Make sure that you put in a statement that the Contract Manager (you and your organization) have the right to pull out of the contract at any time.
- **Changes:** Include in the contract a statement that any changes desired by the contractor/consultant must be requested of the Contract Manager in writing and approved by the Contract Manager in writing before any changes can be made.

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