8 Using the Watershed Assessment for Decision-Making

One of the most important uses of a watershed assessment is to support watershed-scale decisions that protect or restore watershed function. This is probably one of the most difficult as well. Watershed assessments and watershed planning are the cornerstone for effective human action at the watershed-scale, but only if the findings and proposed actions are implemented and the response of the watershed monitored (Naiman, 1992; Reimold, 1998). This chapter expands on chapter 2 and describes different ways that a completed watershed assessment can be used to support watershed-scale decisions. Restoration planning, water quality regulation, land-use planning, water management, watershed planning, floodplain management, and monitoring are all activities where watershed assessment can be useful.

Chapter Outline

8.1 Watershed Planning

Watershed plans are the logical follow-up to watershed assessments. Plans take the information developed during the assessment and design a program of solutions to address the fundamental needs and problems identified in the assessment. A watershed plan consists of a series of proposed actions that seek to improve any conditions regarded as detrimental or degraded in the assessment. Information from the assessment contributes directly to the plan by providing the knowledge on which to base the proposed actions. In a recent study of watershed groups, the use of watershed plans was one of the few factors that had a high correlation with potential positive environmental outcomes (Huntington & Sommarstrom 2000).

In general, a watershed plan consists of an overall vision or set of goals for the watershed, a series of steps needed to achieve those goals, and detailed consideration of how to implement those steps. The plan should also include prioritization of the goals and actions, optimization of the sequence of actions for greatest efficiency and effectiveness, and means of monitoring the implementation and results of the actions. However, “effective plans can range in size and content from simple documents of only a few pages to multi-volume comprehensive reports” (Born & Genskow 2001).

Actions typically found in watershed plans include:

- public awareness and education programs
- agency coordination mechanisms
- proposals for changes in land use via incentives, regulations, zoning, and conservation easements
- aquatic and riparian habitat restoration
- proposals for changes in water, vegetation, and waste management
- best management practices to minimize soil loss and water-borne transport of waste materials and pollutants
- structural changes in drainage systems, storm water conveyances, bridges, dams, and diversions.

Information contained in your watershed assessment should be helpful for designing each action. Each proposed action should relate to at least one objective or goal of the watershed assessment, and contain information about:

- basis in assessment findings,
- alternatives,
- responsible parties, partners and assistants,
- public education and involvement,
- time schedules,
- costs,
- opportunities for funding,
- resources needed,
- potential impediments,
- potential jurisdictional conflicts and cooperation,
- steps for implementation, and
- measures of success.

'Good' planning processes lead to better recommendations for action (Born & Genskow 2001), so be careful about jumping into developing a "Wish List" of proposed projects and actions. It is tempting, and sometimes watershed groups need to have some relatively easy projects under their belts first in order to garner public interest to sustain a longer planning process (see "Action" type of planning in the table of concepts of schools of planning).

Your list of actions will likely exceed more than you can possibly accomplish in a 2-5 year period, or your ability to find the immediate funding to help implement. To help set priorities for the proposed actions, considering the following (Conservation Technology Information Center, 1994 and others):

- watershed assessment findings of critical causes of problems
- funds available
- opportunities for partnerships
- return on funds to be invested - "most bang for the buck"
- time and other non-financial resources
- ability to get the action done
- early successes motivate more action
- some actions rely on other actions for success
- preventative actions versus remedial ones
- ability to measure progress or success with performance indicators

8.1.1 Develop a Successful Plan

A useful assessment provides an evaluation of how well a watershed is working and how it got that way. It does not necessarily give a direction, which requires decisions. Here we are now, but where do we want to go with these helpful new findings about our watershed? Planning is a <u>process</u> that enables you to determine <u>where</u> you want to go, <u>how</u> and <u>when</u> you're going to get there, and <u>who</u> is going to do what.
First, however, you need to clearly define <u>why</u> a plan is needed. People will not participate in the planning process or accept the final plan unless they understand the need for the plan and the decisions to be made (Saul & Faast 1993). An assessment can usually make this explanation easier by identifying what needs to be improved in the watershed. The assumption (explicit or implicit) is that people will want to follow through with working on the findings of the assessment through a plan and its implementation. Do not always assume, though, that a good assessment will automatically lead to a publicly-supported plan.

> *"A key question underlying all watershed planning is: What is an effective process to relate science, policy, and public participation? Watershed planning demands integrative thinking and a coordinated approach. Perhaps the greatest contemporary concern is to provide meaningful public involvement in the process, because experience has shown that top-down planning can create a variety of implementation barriers grounded in the lack of public involvement at key points in the planning process."*
>
> ~ National Research Council (1999)

As emphasized in chapter 2, the process your group uses with your watershed community will be critical in developing the understanding and support for your plan as well as your assessment. Who makes the decisions about what goes into the plan is another key factor toward developing a sound strategy. The assessment process entails some decision-making, but the planning process involves much more. Decisions have to be made on the best strategy, and priorities have to be set. Opinions and values become more involved, and trade-offs have to be made. The primarily objective assessment process becomes transformed into an essentially subjective planning process. Science informs those decisions through the assessment, but choices still are made. Not everyone can necessarily be satisfied, though consensus should still be sought. Planning must "be seen as part of a process that strives to create a watershed community" (National Research Council, 1999).

With a credible assessment and plan having strong stakeholder support, successful implementation should be able to follow – pending funding, permitting, and other needs, of course. If monitoring and other evaluations later indicate that the plan needs to be changed, then the planning process should readily provide for adapting the plan's content and approach as needed.

8.1.2 Choose a Type of Planning

How to approach planning for watersheds will necessarily involve the different concepts or "schools of planning" that have evolved in the U.S. Each concept carries its own set of expectations as well as strengths and weaknesses. There is no ideal form of planning for all cases. Today watershed plans could be one or all of these types, depending on your needs and preferred choice.

Planning expertise can often be lacking in community-based watershed planning efforts, as it is not usually a discipline associated with watershed efforts. One suggestion is to work with your local county and city planners to help improve your own watershed planning process and product (Huntington & Sommarstrom 2000).

Remember that the key is the process - *"the process by which people of different vantage points come together, learn each others' languages, and begin to forge a common language to describe what they want to achieve with their rivers, streams, and surrounding lands*" (Environment Now & Southern California Wetlands Recovery Project, 2002).

8.1.3 Set Direction: Goals & Objectives

Your plan should be based on the direction set by a hierarchy of consistent goals and objectives. Following your group's setting of broad goals and specific objectives comes the details of your proposed strategy, which includes tasks, activities, or actions. The latter can get more and more detailed within the outline of your hierarchy. Too often,

What Helps Create Good Planning Decisions?

Your planning process will entail many decisions. Researchers have found that five key factors seem to distinguish successful decision-making processes (i.e., decisions that will be implemented) from the rest:
1. Builds trust
2. Builds understanding
3. Incorporates value differences
4. Provides opportunities for joint fact-finding
5. Provides incentives for collaboration and cooperation

Source: Wondolleck (1988) in: Saul & Faast (1993)

Concepts or 'Schools' of Planning

Type of Planning	Description	Planning Strengths	Planning Weaknesses
Comprehensive	Sytematic, step-by-step setting of goals and objectives for a number of related mgt. needs, evaluation of alternatives, adoption of implementation measures; also called "rational planning"	Can recognize the interrelationships of many issues and disciplines; emphasis on science and data collection; logical process is appealing; used by many federal agencies; needs strong laws to implement.	High costs; too broad and not site-specific enough; low implementation rates; often entails a top-down process, so little public support; may create illusion of scientific objectivity; planning is not a rational science but an art;
Incremental	Developed and implemented gradually over time through a bargaining process; Focus is on specific problems or issues & short-term results, which over time address the larger problems.	Results oriented with focus on what can be done; the public guides and makes the plan; small-scale solutions reduce risks; adopted now as "adaptive management"; little steps help map future steps	Actions may not address some of larger, more difficult issues; plans may proceed without adequate science & knowledge; implementation may or may not be coordinated; continual interaction required with clients for implementation
Consensus	Involves as many stakeholders in an area as possible; all players treated as equals; implementation based on negotiated political agreement.	Implementation rates high due to political buy-in; can be successful in resolving difficult issues; helps communities build and learn; good strategy for attracting diversified funding sources	Process can be lengthy and perceived as too "time-consuming"; plan may be a package of diverse benefits to satisfy partners but not focused and integrated; very difficult individuals can derail the process.
Advocacy	Citizens organize to advocate a position or action; plan used to strategically show alternative approach to a more traditional one.	Can be politically empowering if coalition or consensus is developed; can help with community building across formerly disparate groups; can break political impasse	Technical content of plan may be professional but may not be representative of broader community; may lack integration with other disciplines; polarization may result if consensus not reached from advocacy.
Action	Initiated by citizen groups, districts, and agencies to make something visible and positive happen on the ground in order to build public support and interest; a form of incremental planning.	Builds public awareness for the difficult Big Picture needs and watershed-wide approaches; confers credibility on planning process; can develop credibility for government programs or expertise; helps develop new community leadership	Small action projects may or may not correctly apply science or restoration methodologies; plans may not develop enough integration, coordination, or expertise; monitoring may be lacking.

(based on Riley 1998)

these plan terms are used sloppily or interchangeably and unclear expectations can result. Purported "plans" with no stated goals or objectives and only a list of recommendations do not give any measure for evaluating success in the direction you desire for your watershed.

Table 8.1 provides practical definitions for the terms most commonly applied to a plan's structure.

While your Goal statements can be long-term and somewhat lofty, your Objective statements should be more achievable

(Conservation Technology Information Center, 1994). Examples of such Objectives include: "Reduce sediment to improve habitat for trout" or "Incorporate watershed protection into county and city General Plans and Specific Area Plans". Each goal will likely have more than one objective, and each objective may have more than one strategy, which may have more than one task/action. One way to check if your draft statements for each of these terms make sense is to read them from the bottom up (tasks-strategy-objective-goal).

8.1.4 Revising & Updating Plans

Plans should be viewed as "living documents" that are assumed to change as needed, and not remain fixed to gather dust. Dog-eared pages of plans are a good sign that they are being used frequently. But even well-used plans still need regular review, updates, and revisions. This cyclical evaluation and opportunity for adjustment is a form of adaptive management, which is encouraged by the scientific community but not widely practiced (Born & Genskow 2001).

As the Washington Guide to Watershed Planning and Management states, "*A watershed plan does not need to offer all the answers. Instead, it can lay out a long-term process towards finding answers and improving solutions…"* Plan to be adaptable!

Through experience, monitoring results, and other continuing assessments, your group will evolve a greater understanding of what implementation actions work and do not work in your watershed. Restoration and ecosystem management are still in the experimental stages, and feedback is necessary for their progress. New challenges, such as rapidly increasing development in a rural sub-watershed or a recently discovered pollutant or invasive species, may stimulate your group to go back to the drawing boards and develop new strategies. Watersheds - and their social and political community - are dynamic systems with changing needs. Economic cycles may affect the availability of partners and funding sources to share costs of your plan's implementation. With stakeholders and other key decision-makers changing over time, plans will also need to reflect continually evolving priorities and practicalities.

8.1.5 Examples of Watershed Plans

8.1.5.1 Subbasin Plans

In the huge Columbia River Basin, the Northwest Power and Conservation Council (NPCC) called in 2000 for the development of approximately 60 subbasin plans that are to guide implementation of its Columbia Basin Fish and Wildlife Program. The management plans were to help the Council prioritize projects for a limited amount of funding, through identification of past and ongoing work (the inventory) and an assessment of habitat conditions and factors that limit fish and wildlife production,. A "Technical Guide for Subbasin Planners" was prepared to assist those developing a subbasin plan (http://www.nwcouncil.org/).

The NPCC's Independent Scientific Review Panel (ISRP) reviews each draft plan to determine if it meets the Council's expectations for completeness and scientific soundness (e.g., the Program's Scientific Principles). In particular, the Panel is concerned that subbasin plans address:

- the need to adequately use available information,
- the need to clearly link the Assessment, the Inventory, and the analysis of information in these two documents to the resulting Management Plan, and
- the need to carry the planning process to scientifically justified, integrated, and prioritized conclusions in the form of realistic priorities for achievable "next steps" for managing the subbasin's fish and wildlife populations.

(http://www.nwcouncil.org/library/isrp/isrp2004-4.htm)

8.1.5.2 Water Quality Emphasis Plans

Watershed-based plans are encouraged by both the EPA and SWRCB for various water quality-related programs, such as the Nonpoint Source (NPS), storm water management, and TMDL programs. Expectations for federally-funded or required watershed management plans are described under EPA's Section 205(j) and Section 319 grant programs. Polluted runoff is also being addressed through the State and Regional Boards' Watershed Management Initiative (WMI), which promotes "integrated planning" with local stakeholder groups.

A well-developed example is the Santa Clara Basin Watershed Management Initiative (WMI) (http://www.scbwmi.org). This collaborative effort has prepared a three-volume Watershed Management Plan, composed of a Watershed Characteristics Report, a Watershed Assessment Report, and a Watershed Action Plan. Water quality is the primary focus, but other watershed values and uses are also incorporated.

Urban runoff management triggered by municipal storm water permitting helped initiate much of the San Diego watershed planning efforts (http://www.projectcleanwater.org/html/ws_efforts.html). Some of these urban runoff plans appear to have meshed or integrated with other watershed issues, some have not. As a means of complying with a regulatory program, these watershed plans and their implementation need to maintain their focus on water quality compliance.

8.1.5.3 Coastal Watershed Plans

The State Coastal Conservancy encourages the development of watershed plans through financial and technical assistance to local groups and has prepared a short *Watershed Planning Guide* outlining a step-by-step sequence of actions during the process to achieve a watershed plan. While acknowledging that every watershed will have a unique planning process, the Guide seeks to highlight the steps that are common to most planning efforts as well as the stumbling blocks: "It should be modified as much as necessary to fit the particular circumstances of your watershed." Since the Conservancy funds many projects, it sees the plans as a means of identifying and prioritizing coastal restoration projects. A variety of watershed efforts have used Conservancy assistance to prepare plans (http://www.coastalconservancy.ca.gov). These plans include, but are not limited to, the watersheds of: Tomales Bay, Pescadero Marsh, Aptos Creek, Morro Bay, Calleguas Creek / Mugu Lagoon, Arroyo Seco, and San Luis Rey River.

Some helpful hints for reviewing and revising watershed plans are:

- Have a yearly informal "here's where we are" session to update folks on plan implementation.
- Ask people to evaluate your planning process so you can do better next time.
- Issue periodic "report cards" to the public on plan implementation and monitoring results to keep them informed and to "give dignity to the plan".
- Ask yourselves, "Do we still need to do this action?"; "Has our vision changed?"; "What else can we do?"; "What has been successful, and why?"; "What has not worked, and why?"
- Celebrate your successes! You've accomplished several tasks, you've achieved an objective, or you've made significant progress towards your goal. Feel good about your progress!

Sources: Saul and Faast (1993); Conservation Technology Information Center *(1994)*

In coastal Southern California, there are “many different patterns to get watershed planning underway”, rather than a single rational sequence of events (Environment Now & Southern California Wetlands Recovery Project, 2002). A snapshot at the end of 2002 revealed that watershed management planning was “still in its infancy” in the five-county region, but many new efforts were underway. Of 20 completed plans, most were for partial watersheds and a number focused on the same region (e.g., Santa Monica Bay and Los Angeles River). Los Angeles County was the most productive for completed or in-progress watershed plans. The Santa Monica Bay, part of the National Estuary Program, region had 4 completed watershed plans, supported by over 80 studies. Water pollution and recreation concerns initially jump-started these collaborative restoration planning efforts, such as in the Malibu and Topanga Creek watersheds.

8.2 Restoration Planning and Projects

Restoration efforts are frequently an important part of a watershed plan or they can be undertaken independently of a plan as an application of a watershed assessment. California is the home to multiple state- and federally-funded restoration programs that have evolved from diverse legislative mandates, ballot initiatives, and citizen-sponsored programs. The term “restoration” offers a sense of purpose, of restoring something that has been lost, and has developed a popular following throughout the state. We seek to “restore” many natural features within the watershed: fisheries, wetlands, streams, water quality, ecosystems, and habitat, among others.

Restoration plans and projects need a solid scientific underpinning to be successful. A recent study by the State found, “Absence of useful watershed assessments and plans can result in restoration projects that don’t address priority problems and their causes” (California Resources Agency & State Water Resources Control Board, 2002). Agencies are concerned that projects may be scattered, unfocused on achieving watershed management objectives and, therefore, inefficiently using state grant funding.

The analysis contained in a watershed assessment lays the very foundation for successful restoration projects. The analysis made as part of the assessment serves to explain, based on the best available information, the likely causes of the alterations within the watershed that led to the need for the restoration activities.

More specifically, the analysis in the assessment can help to:

- Provide baseline and reference data, with which to compare restoration progress or success.
- Help understand the patterns of water and sediment transport that create and maintain the natural morphology of the channel and its associated floodplain.
- Provide information for aquatic restoration, including descriptions of upslope connections to the riparian and waterway
- Help identify the causes and not just the symptoms of problems needing correction.
- Reveal restoration opportunities, including getting beyond preconceived perceptions about problems and

“*Watershed-scale restoration should begin with an understanding of watershed structure and function and of how human activities affect and shape watershed health*.” (Williams, Wood & Dombeck 1997)

“*To achieve long-term success, aquatic ecosystem restoration should address the causes and not just the symptoms of ecological disturbance*.” (NRC 1992, p. 55) solutions.

- Coordinate with other stakeholders in developing a common understanding of how the watershed behaves
- Provide basis for a Restoration Plan, including goals and objectives.
- Help identify types of restoration methods needed to address the problem causes.
- Locate the priority sub-watersheds, stream reaches, or other areas within the watershed for restoration projects, based on the above.
- Identify priority restoration projects, based on the above

The California Department of Fish and Game's *California Salmonid Stream Habitat Restoration Manual* recommends that a 'preliminary watershed assessment' be done to get the "big picture" about present and potential fish production in a stream system <u>before</u> beginning field surveys and designing projects. However, the expectation is more of a watershed "overview" rather than a full assessment as described in this Manual. The concept still advocated is that restoration efforts need to address how the watershed works and what key processes and conditions have been altered, before prescribing the remedies. It is the physical and biological processes operating in the watershed are the mechanisms that govern the watershed's condition. Working with the natural processes in your restoration strategy will improve your chances of success. Some players tend to be more interested in the project phase than the assessment or planning phase, and they might not have been aware or interested in your assessment process. Their enthusiasm might also get ahead of them. Do a reality check with everyone on previous restoration assumptions and project ideas now that the assessment is completed.

Moving from watershed condition evaluation - your assessment - into identifying the appropriate restoration measures often involves another set of skills and approaches. Applied science and technologies tend to become more important, such as engineering, surveying, contracting, heavy equipment, and resource management skills. Experience with what works and doesn't work with certain restoration techniques, especially in your area, becomes of critical importance. Some agencies, consultants, landowners, and

An Example of a Fluvial Restoration Strategy

The Goal of fluvial restoration in _____ Watershed is to restore the river or stream to dynamic equilibrium. [The assumption is that dynamic equilibrium of the physical system establishes a dynamic equilibrium in the biological components.]

The Objectives under this broad goal are to:

1. *Restore the natural sediment and water regime*. ['Regime' refers to at least two time scales: the daily-to-seasonal variation in water and sediment loads, and the annual-to-decadal patterns of floods and droughts.]
2. *Restore the natural channel geometry, if restoration of the water and sediment regime alone does not*.
3. *Restore the natural riparian plant community, which becomes a functioning part of the channel geometry and floodplain/ riparian hydrology*. [This step is necessary only if the plant community does not restore itself upon achievement of objectives 1 and 2.
4. *Restore native aquatic plants and animals, if they do not re-colonize on their own*.

Source*:* <u>National Research Council (1992) pp. 206-207.</u>

citizen organizations may have a wealth of experience with certain methods – be sure to ask around. Use the same collaborative process applied to your assessment, but now bring in those people with the applied restoration skills. This difference in needed expertise is one of the reasons that project recommendations within the watershed assessment product can appear naïve or impractical when evaluated later by restoration practitioners (Riley 1998).

8.3 Land Use Planning

Watershed assessments are intimately tied to land use planning. The relationship between land use and watershed conditions and processes has been described in detail in this Manual. However, this relationship is not always appreciated by local planning department staff, planning commissioners, or city council members who make decisions about land uses. Usually, people in these positions are civic-minded individuals with no special knowledge of watersheds and how land uses influences the hydrological cycle as well as other potential impacts on waterways. The information generated by a watershed assessment and plan could be invaluable to local decision-makers.

California planning law requires that landowners and local planning agencies engage in the formulation of zoning and parcel-specific land use plans to guide the development of residential, commercial, and industrial areas. The most common way of doing this is through the general plan process, where a municipality or county planning agency decides which areas in the jurisdiction should fall under which zone type and what proportions of land uses would be appropriate.

> *Land use planning is the process by which public agencies, mostly local governments, determine the intensity and geographical arrangements of various land uses in a community*
>
> Fulton, 1999

There are very few instances where watershed assessments have been used explicitly to aid decision-making in land-use planning, although information contained in an assessment could be very useful for planning purposes. Orange County has conducted many watershed assessments through cooperative arrangements with the Army Corps of Engineers (ACE). These assessments are associated with restoration goals and programs and are not explicitly intended to support land-use decision-making. However, they contain information relevant for land-use decisions and could be used in that fashion.

Some of the information frequently contained in a watershed assessment that could be used to support land use planning includes:

- Data on surface and ground hydrology under natural and modified conditions
- Stream bank stability and channel characteristics which are influenced by the area of impervious surfaces and other land use modifications
- Existing and potential future surface and ground water quality under different land use and development scenarios
- Biological diversity and status of aquatic and riparian species of plants and animals

8.3.1 General Plans

Municipal and county general plans govern the development of land annexed by a city for residential, commercial, or industrial development and general or specific uses of lands within a county outside developed areas[1]General plan "elements" (e.g., land use, circulation, open space; see chapter 3.10) are used to detail the planned growth and consequences of the growth. Because

[1] These plans are required by Govt. Code 65300 *et seq.* and are implemented through policy narratives, zoning ordinances and maps (Gov't. Code 65850 *et seq.*), and subdivision maps and regulations (Gov't. Code 66410 *et seq.*; Fulton, 1999).

a general plan must be analyzed for its potential impacts to the environment (California Environmental Quality Act), there is a nexus between the plan and watershed assessment. CEQA requires that the 'best available information' be used to evaluate potential impacts of a general plan or a specific project. Many times, the best available information can be found in watershed assessments. For example, the land use element must show the location, distribution, and intensity of development and particular elements (e.g., wastewater treatment facilities) allowed under the plan. This is usually done using a map, which along with zoning and parcel maps can make the general plan process a very tangible part of watershed assessment and vice-versa. Frequently, consultants hired to perform CEQA assessments rely on incomplete databases or field assessments of limited scope. The information in a watershed assessment could be an invaluable source of data and analysis of conditions.

There are three locations in the state where state law requires the consideration of natural resource protection at a "pseudo-watershed scale" when developing general plans. These are the Lake Tahoe basin, the California coastline, and the Sacramento and San Joaquin Rivers Delta. In all other parts of the state, there is nothing approximating a requirement to consider watershed processes when developing plans.

Three classes of regulations require that the effects of harmful actions be mitigated, though rarely is this requirement accompanied by performance measures for the evaluation of effectiveness. A watershed assessment approach could be used in conjunction with wildlife and habitat assessments to expose the environmental costs and benefits of actions proposed in a general plan, or that were not considered feasible (e.g., restoring natural processes or features). The three classes of regulations are:

- Both the federal and California Endangered Species Acts require that populations and habitats of listed species be protected from take (destruction of habitat or individuals), or if take is planned, that it be mitigated. For aquatic, wetlands, vernal pool, and riparian species this would seem to require a watershed perspective for general planning as developed areas will have direct and indirect impacts on aquatic natural processes, wildlife, and plants. *Watershed assessments can inform these decisions by showing the linkages between existing and proposed land-use decisions in the general plan and downstream habitat and populations of listed species.*

- The federal Clean Water Act and the state Porter-Cologne Act require that state regulators analyze and consider for permitting any activity that may cause harm (e.g., pollution) to California waterways and wetlands.
  Watershed assessments can inform these decisions by showing the linkages between existing and proposed land-use decisions in the general plan and downstream habitat, water quality, channel conditions, and natural processes (e.g., flooding).
  (see "Improving our Bay-Delta Estuary Through Local Plans and Programs: A Guidebook for City and County Governments (Association of Bay Area Governments, Oakland, CA), 1995, 21 pp.)

- The federal National Environmental Policy Act and the California Environmental Quality Act require that plans such as general plans be analyzed for potential impacts to human and natural environments. Alternative plans must be put forward by the lead planning agency, based in part on public input, that show different ways to achieve the plan's objectives and the potential impacts from each alternative. The lead agency must, theoretically, choose the least environmentally damaging and feasible alternative. *Watershed assessment can list the various natural and human features (e.g., streams and roads) and processes (e.g., agriculture and fire) that are important in watersheds and sub-watersheds within the general planning*

Watershed-related References in the State's General Plan Guidelines [Office of Planning & Research; http://www.opr.ca.gov]

Watershed Based flood protection , p. 12 **Safety Element**
Cities and counties should identify risks from natural hazards which extend across jurisdictional boundaries, then use any available data from watershed-based floodplain management, mapped earthquake faults, or high fire hazard areas as planning tools to address any significant issues. Each local planning agency carries a responsibility to coordinate its general plan with regional planning efforts as much as possible.

Relationships Among Elements and Issues, p. 37
General plan elements and issues interrelate functionally. For example, consideration given to the vegetation which supports an endangered wildlife species in the conservation element also involves analyzing topography, weather, fire hazards, availability of water, and density of development in several other elements. Thus, the preparation of a general plan must be approached on multiple levels and from an interdisciplinary point of view.

Ideas for Data and Analysis, Open-Space*,* p. 38
The following consists of topics which should be considered during the preparation of the general plan and, if relevant, included in a **land use element**. These subjects are based upon a close reading of the statutes and case law. When the information collected for the land use element overlaps that needed for other elements, the related element has been noted in parenthesis.

- Delineate the boundaries of watersheds, aquifer re-charge areas, floodplains, and the depth of groundwater basins (diagrams) (CO, OS, S)
- Delineate the boundaries and description of unique water resources (e.g., saltwater and freshwater marshes, wetlands, riparian corridors, wild rivers and streams, lakes). (CO)

Conservation Element
The conservation element may also cover the following optional issues:

- Protection of watersheds;

Water, p. 56-7

- Inventory water resources, including rivers, lakes, streams, bays, estuaries, reservoirs, ground water basins (aquifers), and watersheds (Map) (LU, OS)
- Identify the boundaries of watersheds, aquifer recharge areas, and groundwater basins (including depths) (Map) LU, OS)
  - Assess local and regional water supply and the related plans of special districts and other agencies
  - Analyze the existing land use and zoning within said boundaries and the approximate intensity of water consumption
- Map the boundaries and describe unique water resources (e.g., salt water and fresh water marshes and wild rivers) (LU, OS)
- Assess the current and future quality of various bodies of water, water courses, and groundwater (LU, OS)
- Inventory existing and future water supply sources for domestic, commercial, industrial, and agricultural uses (LU, OS)
- Assess existing and projected demands upon water supply sources, in conjunction with water suppliers (LU, OS)
  - Including: agricultural, commercial, residential, industrial, and public use
  - Assess the adequacy of existing and future water supply sources, in conjunction with water suppliers. (LU, OS)

area. It can describe the overall and localized condition, make linkages between human activities and condition, and serve as a major type of environmental assessment against which to judge proposed actions.

In all of the above cases, data contained in a watershed assessment can aide local municipalities in meeting these requirements. Frequently, the analysis performed by local government is incomplete and omits important information related to protecting waterways. The data and analyses contained in an assessment can play an important role in informing local decisions-makers of this important information. In cases where general plans are being adopted, community watershed groups should bring their analysis to the attention of local planning commissions and city councils to ensure that all requirements can be evaluated with the best available and most complete set of information.

Watershed-related Citations in the General Plan Guidelines [Office of Planning & Research] cont'd.

- Map riparian vegetation (LU, OS)
- Assess the use of <u>water</u> bodies for recreation purposes (LU, OS)

Forests, p. 62

- Inventory forest resources including a comprehensive analysis of conservation needs for forests, woodlands and the interrelationship they have with <u>watersheds</u> (Map) (LU, OS)
  - Describe the type, location, amount, and ownership of forests with a value for commercial timber production, wildlife protection, recreation, <u>watershed</u> protection, aesthetics, and other purposes

Fisheries, p. 62

- Identify <u>water</u> bodies and <u>watersheds</u> that must be protected or rehabilitated to promote continued recreational and commercial fishing – including key fish spawning areas
- Evaluate <u>water</u> quality, temperature, and sources of contaminates
- Identify physical barriers (man-caused or natural) to fish populations within the <u>watershed</u>, then propose alternatives and set priorities

Open-Space Element, Background, p. 68

The following topics are to be addressed, to the extent that they are locally relevant:

Open-space for the preservation of natural resources including, but not limited to:

- Areas required for ecologic and other scientific study; rivers, streams, bays and estuaries; and, coastal beaches, lake shores, banks of rivers and streams, and <u>watersheds</u>;

Open-space for public health and safety including, but not limited to:

- Areas that require special management or regulation because of hazardous or special conditions such as earthquake fault zones, unstable soil areas, flood-plains, <u>watersheds</u>, areas presenting high fire risks, areas required for the protection of <u>water</u> quality and <u>water</u> reservoirs and areas required for the protection and enhancement of air quality.
- Identify <u>watersheds</u> and key areas for the protection of <u>water</u> quality and reservoirs (map) (CO)

Safety Element, p. 77

Flood Hazard - A comprehensive approach should include mapping floodplains…, and floodplain management policies (which may include both structural and non-structural approaches to flood control using a **multi-objective watershed approach**). Flooding is often a regional problem that crosses multiple jurisdictional boundaries.

Slope instability and the associated risk of mudslides and landslides

• Identify areas that are landslide-prone by using, among other sources, Division of Mines and Geology's seismic hazard zone maps, landslide hazard identification maps, <u>watershed</u> maps, and geology for planning maps, and landslide features maps produced by the U.S. Geological Survey (map) (OS)

- [General Plan Elements: LU=Land Use; OS=Open Space; CO=Conservation; S=Safety]

When considering informing general planning with snapshot or continuing watershed assessment work, scale is an important quality to keep in mind. A fine-grained assessment is needed to judge the impacts of parcel and subdivision scales of development activities. A coarse-grained watershed-wide assessment is not an adequate substitute for this. Similarly, the right time frame for analyzing and modeling potential impacts is needed. Changes in watershed functions and outputs may be immediate, substantial, and long-lasting at the sub-watershed scale and not measurable until full general plan build-out at the river basin scale. Matching scales of assessment or monitoring activity is critical in the use of this approach in informing general planning.

8.3.2 Ordinances

Municipal or county ordinances govern certain uses of public and private property and their environmental impacts. These are binding and enforceable at that scale and tied to local problems and governance styles. For example, a rural county with natural fire ecology may be very proactive in enforcing vegetation control immediately around structures, whereas an urban county or municipality may be very active about dumping into storm drains. Information contained in watershed assessments can also be useful to local decisions makers in crafting local ordinances that might impact the health and conditions of waterways. In particular, data on the conditions of local waterways and the links to local land uses, could be used to highlight the impacts of local policies on watershed health. The development of ordinances dealing with flooding and floodplains, stormwater run-off, subdivision landscaping and design, roads and grading, and stream buffers or setbacks all could benefit from knowledge and analyses typically contained in a watershed assessment.

Examples of these ordinances are:

- Subdivision & zoning ordinances
  Data from your watershed assessment combined with information on watershed-friendly ordinances could be a powerful tool in the hands of local land use planners. Information on model ordinances, design guidelines, and other relevant guidance for local officials is available online from the Center for Watershed Protection (http:www.cwp.org), the Low Impact Development Center (http://ww.lowimpactdevelopment.org) and the NEMO Project (http://www.nemo.uconn.edu).

- Flooding and floodplain development ordinances are a useful way for local governments to reduce damage from flooding. Guidance from the State on the development of general plans to minimize flooding can be combined with data your assessment has produced to identify the need for sound development planning. The state's guidance is posted at: http://www.fpm.water.ca.gov/generalplan.html.

- Stormwater runoff and dumping into storm drains are a commonly-recognized problems in urban settings,. Because developed areas have highly impervious surfaces (e.g., roads and parking lots), water will not percolate naturally into the ground over large areas. Stormwater not only frequently contains contaminants that is harmful to aquatic life, but the increased volume associated with reduced percolation is damaging to streams. Chemicals tend to collect on impervious surfaces and attached to dust and dirt particles. When it rains, especially with the first rain of the rainy season, these chemicals can be washed into local streams. Similarly, illegal dumping of chemicals into industrial, commercial, and stormwater drains can be an occasional but major input to streams. Municipal and county ordinances can regulate the flow of water and chemicals from urbanized areas. If excessive storm flows and diffuse or localized chemical inputs are disrupting your waterways, then storm water and dumping ordinances could help. Water quality analysis, impacts to aquatic biota, diversion of surface water from natural percolation areas, and timing and volumes of flow of storm water described in your watershed assessment can help determine if this type of ordinance might be helpful.

- Landscaping and water conservation ordinances can regulate the rate of pesticide application and irrigation in order to reduce the input of chemicals and excessive water into streams. Pesticides can cause direct mortality of aquatic biota, excessive nutrients can cause potentially harmful algae blooms, and summer irrigation in arid areas can upset the ecology of seasonally dry streams in the arid West. The state of Vermont and the cities of Sebastopol (CA), Buffalo (NY), and Burlington (VT) limit the application of pesticides to residential and forestry landscapes to reduce impacts to human and ecosystem health. If pesticides and excessive nutrients from fertilizer applications are a problem in your waterways, then municipal ordinances restricting these chemicals could be appropriate. Water quality analysis and the condition of aquatic communities described in your watershed assessment could inform local government officials about the development of landscaping ordinances.

8.4 Public Lands Management

On federally-managed lands, watershed assessments are usually termed watershed analyses. Some people believe the term “analysis” implies more detail at a finer spatial scale than typical “assessments”, but “analysis” is the usual term used by the Forest Service and Bureau of Land Management for their process.

These watershed analyses on federal lands became institutionalized during the development of the Northwest Forest Plan (FEMAT 1993, USDA-Forest Service 1994). Among the recommendations of the Northwest Forest Plan was an aquatic conservation strategy intended to improve stream conditions for anadromous fish. A major part of this strategy was an assessment process that became known as watershed analysis. Although it was initially designed to focus on riparian issues, federal watershed analysis was soon recognized to be useful for evaluating a broad range of issues throughout a watershed (Grant 1994). During the 1990s, watershed analysis evolved as a tool for describing watershed attributes, issues, and capabilities that would form the basis of future land management on National Forests and Bureau of Land Management properties (Reid, et al. 1994).

Individual National Forests and some BLM offices have been conducting watershed analyses for the past decade using the protocol outlined by USDA-Forest Service (1995). In the federal context, watershed analysis is a tool for description and assessment of watershed processes and ecological conditions. It is based on processes, ecosystem components, and locations, but not on projects or proposals as is typical of other Forest Service planning processes. Watershed analysis on federal lands is not designed to produce a decision document and is not subject to the National Environmental Policy Act. Instead, the information generated from a watershed analysis can be used to inform and guide the projects that eventually implement a forest plan.

The basic parts of watershed analysis as described in the Federal Guide to Watershed Analysis (USDA-Forest Service 1995) include the following: The usual scale of analysis is for watersheds of 20 to 200 mi^2. A particular watershed is selected for analysis on the basis of regional interests, controversies, and opportunities for management. Public input is sought to identify critical issues, locate contributing information, and provide reality checks. The federal approach includes the following steps:

1) Characterization of the watershed
2) Identification of issues and key questions
3) Description of current conditions
4) Description of reference conditions
5) Synthesis and interpretation of information
6) Recommendations (usually including desired future conditions and potential strategies for moving the landscape toward those conditions)

The resulting report of a federal watershed analysis usually includes:

1) Description of the watershed including its natural and cultural features
2) Description of the beneficial uses and values associated with the watershed and, when supporting data allow, statements about compliance with water quality standards
3) Description of the distribution, type, and relative importance of environmental processes
4) Description of the watershed's present condition relative to its associated values and uses
5) Maps of interim and potential riparian reserves
6) Description of the mechanisms by which environmental changes have occurred and description of specific land-use activities in generating change
7) Description of likely future environmental conditions in the watershed, including discussion of trends and potential effects of past activities
8) Interpretations and management recommendations

Much of the federal guide covers various analysis methods for describing key processes and conditions and their possible causes. These topics include fire history, existing and potential vegetation, roads, mass movements, surface erosion, channel erosion, sediment yield, streamflow characteristics, runoff generation, stream temperature, channel conditions, aquatic and terrestrial habitat, and water supply. Descriptions of these methods include generic goals, data needs, assumptions, products, and procedures at both a cursory level and a more quantitative level depending on the needs of a study (USDA-Forest Service 1995). Another related set of procedures that focus on watershed hydrology is found in the publication, *A Framework for Analyzing the Hydrologic Condition of Watersheds* (McCammon, et al. 1998).

If your watershed includes some National Forest land, looking at the approaches and techniques of the federal guide is certainly worthwhile. The "analytic modules" will provide some guidance for a variety of measurements and analyses that may be appropriate for your situation. Just decide on your objectives first and see if any of the federal procedures would help meet those objectives, rather than charging into a measurement program just because the Forest Service finds it useful.

Within the National Forests of California, a variety of watershed analyses have been conducted. In general, the forests in the northern part of the state that were part of the Northwest Forest Plan have had a more active (and better funded) watershed analysis program. This program has been driven by northern spotted owl and salmon issues. The Shasta-Trinity National Forest has produced more than a dozen watershed analyses. Other forests are still working on their first analysis. The quality and level of detail of the initial round of watershed analyses is quite inconsistent, depending on the issues and local support for a particular analysis. Many of the watershed analyses have had their scope expanded somewhat by also incorporating guidance from the Region 5 (California) guide to ecosystem management (Manley et al. 1995).

Reduction of the risk of catastrophic wildfires through management of fuels is the primary focus of many of the recent watershed analyses. At least one analysis has incorporated hydroelectric project re-licensing as the principal issue. The ultimate utility of the wide range of watershed analyses is yet to be determined. The Sierra Nevada Framework for revising the Forest Plans of the National Forests of the Sierra Nevada includes a major component of watershed analyses, but few had been completed to date within the Sierra Nevada. Web sites for most of the National Forests include the completed reports as well as progress of ongoing efforts.

Perhaps the most comprehensive watershed analysis completed to date on federal land in California and Nevada was for the Lake Tahoe Basin (USDA-Forest Service 2000). The national significance and public visibility of the Lake Tahoe Basin allowed an investment of about $2 million in this assessment. The document is a good source of ideas and approaches to watershed assessment, even if your budget is on a somewhat smaller scale.

You can take advantage of watershed analyses done by the National Forest in your region for a variety of background material relevant to your own watershed assessment. Check the web site of your local National Forest for completed watershed analyses. They may be found under resource management, watersheds, or publication or by using the web site's search engine. Alternatively, call the nearest ranger district or supervisor's office and ask about watershed analyses that have been completed or are in progress. The basic descriptions of climate, hydrology, vegetation, management, and disturbance history may be directly applicable to your watershed if the analysis area is close enough or may provide some good leads for pursuing information about your watershed.

We recommend that you use Forest Service watershed analyses as information sources and not as templates or models for your assessment. Your fundamental goals and driving issues are likely to be quite different than the motivations behind the federal analyses.

8.5 Water Management

A consideration of watershed conditions is part of an integrated water management plan. In previous eras, water management was viewed primarily from an engineering perspective – how to deliver and dispose of water. More recently, however, the structure and function of the overall watershed is considered as another important factor in water management. Integrated water management has the potential to go beyond watershed management which focuses on conditions in the waterway and the processes that influence them. Science-based integrated water management considers the best way to develop/retrofit infrastructure in coordination with land use planning and protection of the aquatic ecosystem. The term "best way" reflects the development of a plan that includes the wise use of water, the environmental sound disposal of stormwater and wastewater, land use plans, and ecosystem protection and restoration. To address all these issues successfully involvement of critical stakeholders is essential. **Watershed assessments can provide an important source of information and analysis that is required for the development of an integrated water management plan.**

In 1998, the Washington State legislature passed the Watershed Planning Act to set a framework for addressing the State's water resource issues… When lawmakers passed the Act, they stated that the primary purpose of the statute was "…**to develop a more thorough and cooperative method**

of determining the current water situation in each water resource inventory area of the state and to provide local citizens with the maximum possible input concerning their goals and objectives…". This statement identifies the purpose and issues associated with water management. To manage water, issues of surface and groundwater water supply and quality need to be evaluated**.**

In 2002, several acts were passed in California that were aimed at achieving similar goals as Washington state. The statutes added to the Water Code are:

- **Integrated Regional Water Management Planning Act of 2002** (Water Code sections 10530-10537) was created by SB 1672 (Costa). This act's implementation is to lead to the development of integrated regional water management plans, as a means of "maximizing the quality and quantity of water available to meet the state's water needs by providing a framework for local agencies to integrate programs and projects that protect and enhance regional water supplies." A "regional water management group" is defined as "three or more local public agencies, at least two of which have statutory authority over water supply." Groundwater management and grant-funded projects are also to be tied into such plans (section 10753.7)

- **The Integrated Water Management Program** (IWMP) (sections 79560-63) was created by Proposition 50 as a grant program operated by two state agencies: the Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB). It requires that eligible projects are consistent with an adopted integrated regional water management plan, or such a plan is in progress. Such a plan under the DWR grant program is to address, at a minimum: water-related objectives and conflicts in the watersheds of the region, including: 1) water supply, 2) groundwater management, 3) ecosystem restoration, and 4) water quality.

The details and coordination of these new programs are being worked out by the departments and the California Watershed Council, a state-supported collaborative partnership effort (http://cwp.resources.ca.gov/cwc_about.html). Under the SWRCB program, the integrated plan must be designed "to improve regional water supply reliability, water recycling, water conservation, water quality improvement, storm water capture and management, flood management, recreation and access, wetlands enhancement and creation, and environmental and habitat protection and improvement."

In addition to contributing to sounder land use planning, a watershed plan and the assessment on which it is based, can also inform the integrated water management effort. The analysis of the effects of human activities on watershed components and processes needs to be integrated into a water management plan. The impacts of water conveyance and discharge must be evaluated in this plan as well. This analysis usually part of watershed assessments and therefore, has direct relevance and use in water management plans.

Integrated water management might include some or all of the following:

- Balancing water use with water supply
- Connecting water supply protection with watershed management.
- Utilizing low impact development methods[2] to improved groundwater

[2] Low impact development methods utilize swales, rain gardens, pervious pavement, landscaped bioretention structures, and other integrated management practices to reduce imperviousness and the production of stormwater.

recharge, reduced stormwater volume, and protection and enhancement of instream habitat
- Integrating land use planning with water management and ecosystem protection
- Coordinating water supply infrastructure and planning among water agencies within a region
- Affecting inter-basin water transfer and delivery decisions, and/or
- Linking regional water availability with future land use development
- Balancing viewpoints of diverse societal interests into decisions about water resource allocation.

A well-developed watershed assessment has a number of important uses for water management (Washington Department of Energy, 1998):

- Identifying the water supply and demands within the watershed,
- Analyzing the relationship between surface water and ground water,
- Analyzing the connection between water quality and water quantity,
- Integrating short-term and long-range water planning,
- Addressing and integrating water quantity, quality, and habitat needs,
- Providing part of the information that is crucial to making water-right decisions.
- Providing information the facilitates decisions that protect and enhance the aquatic ecosystem.

The following section reviews some of the key components of an integrated water management plan and identifies how information generated in a watershed assessment is useful for decision-making around each of these issues.

8.5.1. Water Supply

A key part of a water management plan is identifying and planning for water supply. Interestingly, the first watershed assessments in California were conducted to evaluate potential for water resources development. Thorough field studies were conducted early in the 20th century to evaluate whether different watersheds had the capability to serve as a reliable water source for San Francisco (Freeman, 1912) and Sacramento (Hyde, et al., 1916). These studies included detailed descriptions of watershed conditions.

However, in the 21st century, a primary use for information from watershed assessments related to water supply projects will be in identifying alternatives for operation of existing or proposed projects. Such information can be used to identify opportunities for alternative management of facilities to serve new uses not recognized during initial project design and construction. A recent example is the July 2000 settlement agreement on the operation of Pacific Gas and Electric Company's hydropower facilities on the Mokelumne River. Detailed evaluations of natural hydrology and system operation contributed to the settlement agreement and relicensing of the project (McGurk and Paulson, 2000). About 30 hydroelectric projects in California will go through the relicensing process during this decade. Proposals for "re-operation" of these and other water projects will require much of the basic hydrologic and operational hydraulic information that might be contained in a watershed assessment. However, the data and analysis needs related to these projects and proposals for different management will usually be far more detailed than in a typical watershed assessment.

<u>Watershed assessment data useful for water supply management</u>

- Surface and ground water - present and available in the watershed
- Surface and ground water - use, by type (agriculture, municipal, etc.)
- Water rights summary, by source (ground, surface)

- Water storage, by source (natural, artificial)
- Streamflow (max /min / mean acre-feet per year)
- Land use summary, by Type & % cover
- Vegetation cover, by Type & % cover
- Impervious surface area, % cover

Water information developed in a watershed assessment can also help local land use agencies in their decision-making. Connecting water supply availability to land use planning was required in recent state legislation (e.g., SB 610 and SB 221 in 2001). While focused on large development approvals, the new laws demand an assessment of the water supply situation. In Washington State, the legislature wanted water rights decisions to be influenced by a good watershed assessment and plan.

8.5.1.1 Drinking Water Source Assessment and Protection Program (DWSAP)

Watershed assessment can provide useful information for drinking water source protection efforts. Protecting sources of drinking water is the purpose of the federal and state Drinking Water Source Assessment and Protection Program (DWSAP). The initial part of this effort is the Source Water Assessment Program (SWAP), which is where watershed assessments become directly relevant. Each of California's 15,000 active public water systems must delineate the boundaries of the area around their drinking water source(s) through which contaminants might move and reach that drinking water supply. They next must inventory "possible contaminating activities" (PCAs) that might lead to the release of microbiological or chemical contaminants within that delineated area. This inventory allows for a determination of the water source's vulnerability to contamination. After the assessment and vulnerability analysis are completed, the water source protection approaches, including protection zones, are identified. Local protection programs are enacted voluntarily, while the assessments are mandatory.

For surface water sources, the watershed boundaries above the point of diversion for drinking water use delineate the logical assessment area. Previously, a "watershed sanitary survey" of the drinking water source(s) was required at least every five years, but the vulnerability ranking was not a component. For ground water sources, the source areas and protection zones are delineated based on "readily available hydrogeologic information on ground water flow, recharge and discharge, and other information deemed appropriate by the State" (California Department of Health Services, 1999). This ground water portion of the DWSAP also serves as the State's wellhead protection program.

8.5.1.2 Groundwater Management Planning

Your watershed assessment may also be able to contribute to a groundwater management plan that is independent or part of an integrated water management plan, by improving an existing one or helping to create a new one. A California groundwater law, Assembly Bill 3030 (Water Code section 10750-10756), provides a systematic procedure for an existing local agency to develop a groundwater management plan. This section of the code provides such an agency with the powers of a water replenishment district to raise revenue to pay for facilities to manage the basin (extraction, recharge, conveyance, quality). About 150 water agencies have developed groundwater management plans in accordance with AB 3030, which then allows them to qualify for certain state grants and loans for groundwater management (posted at: http://www.groundwater.water.ca.gov). Public water systems that have performed evaluations under AB 3030 requirements may satisfy all or part of the DWSAP (see 8.4.1.3).

In developing groundwater management plans, one important consideration is the effects of these plans on the conditions in the waterway. For example, depletion of the groundwater could cause perennial streams to become ephemeral. Springs that historically have fed a river might no longer do so if groundwater supplies are over-utilized. Information from your watershed assessment might lend insight into the potential impacts of groundwater management plans on the aquatic ecosystem.

8.5.1.3 Water Quality Considerations

Watershed assessments can be very useful in management of water quality by providing basic information about the various factors that affect the constituents of water. A comprehensive watershed assessment should include information about:

- the climate and hydrology of the watershed that will determine the water availability during different seasons and at different places in the watershed and the consequent capacity for dilution of introduced materials;
- the geochemistry of parent material and soils that will determine natural contributions of dissolved constituents;
- soil properties, terrain features, vegetative cover, land use, and climatic factors that control potential for sediment production;
- hydraulic and geomorphic properties of channels that influence sediment transport;
- riparian vegetation properties that influence energy input to streams and consequent water temperature;
- known and suspected sources of pollution (both point and non-point); past measurements of water quality parameters; and
- changes in watershed conditions over time.

These types of information will provide the general context of water quality and allow identification of problems that should be addressed. While some polluters will voluntarily reduce their sources of contamination once these problems are brought to their attention through the information of the watershed assessment, some form of regulation is often necessary. A detailed watershed assessment may incorporate modeling results from models such as the EPA's Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) and Stormwater Management Model (SWMM). Such models can aid in identifying sources and factors subject to control and estimate the effectiveness of various controls and practices on downstream water quality.

Considerations of water quality issues is an essential part of any integrated water management plan. Data and analysis from a watershed assessment can make significant contributions to the understanding of water quality conditions and the stressors in the watershed that pose a risk to maintaining high water quality and meeting the beneficial uses of the waterways.

8.6 Floodplain Management

Another aspect of integrated water management is floodplain management. Planners need to consider how the management of water produced by large rain events fits into the overall water management plans. City and County general plans must evaluate flood hazards and develop strategies for floodplain management, as noted in the **OPR General Plan Guidelines**:

> "Cities and counties should identify risks from natural hazards which extend across jurisdictional boundaries, then use any available data from **watershed-based** floodplain management…as planning tools to address any significant issues. Each local planning agency carries a responsibility to coordinate its

general plan with regional planning efforts as much as possible. " (p. 77)

The safety element must also identify flood hazard areas and establish policies which will avoid unreasonable flood risks. A comprehensive approach should include mapping floodplains, establishing general policies to keep intensive new development out of floodplains or to mitigate and protect against flood impacts if development is to be located in such areas, minimizing impacts on existing development where possible, establishing policies regarding capital improvements or acquisitions necessary to ensure flood protection, and floodplain management policies (which may include both structural and non-structural approaches to flood control using a **multi-objective watershed approach**). Flooding is often a regional problem that crosses multiple jurisdictional boundaries. Policies should be developed cooperatively with local, state, and federal agencies, including special districts, to create feasible solutions, Guidelines for the preparation of an optional floodplain management element are provided in Appendix C. http://www.fpm.water.ca.gov/generalplan.html. The Department of Water Resources' Division of Flood Management can provide floodplain management and flood control information, including floodplain maps, where available.

In addition, the state Cobey-Alquist Floodplain Management Act encourages local governments to plan, adopt, and enforce floodplain management regulations through an ordinance or other means(Water Code §8400, et seq.). Where a federal flood control project report has been issued which designates floodway boundaries, the Department of Water Resources or the State Reclamation Board will not appropriate money in support of the project unless the applicable agency has enacted floodplain regulations. Those regulations must provide that: (1) Construction of structures in the floodway which may endanger life or significantly reduce its carrying capacity shall be prohibited; (2) Development will be allowed within the "restrictive zone" between the floodway and the limits of the floodplain as long as human life and the carrying capacity of the floodplain are protected.

As a result of the above, local government and special districts can be both a contributor to and user of your watershed assessment where it addresses flooding and floodplains.

8.6.1 Floodplain Processes and Ecology

In our channel-centric view of rivers, the floodplain is often a neglected component of the fluvial system. This view has been prevalent historically in developed areas of California, where attempts to convey flood flows within existing channels are common. There are several problems with this approach:

1) Prior to development, natural alluvial channels evolved to accommodate the dominant discharge, or bank full flow (flows with a range of recurrence intervals of about 1 to 5 years) while higher magnitude floods inundated the adjacent floodplain riparian zone on average every few years. The current assumption that the channel itself, without its floodplain, can convey a full range of flood flows is unrealistic, and has led to considerable flood hazards. Moreover, the hazard worsens incrementally with increases in watershed development that reduce infiltration and increase runoff and peak discharges
2) Floodplain development has led to a situation where there is often no riparian buffer between the top of the channel bank and the adjacent development.   In this case, attempts are made to prevent the natural processes of bank erosion and channel migration, processes integral to the storage and transfer of sediment within a fluvial system, as well as to vegetation succession. Levees and bank protection are employed to prevent geomorphic

processes acting between channels and their floodplains, thus creating static river morphology. Such attempts to arrest erosion, and in some cases sediment deposition, has led to extensive channelization efforts throughout California

3) Relatively short hydrologic records are used in statistical methods to predict future flood magnitudes and recurrence intervals. However, high magnitude floods change the flood statistics, and lower the recurrence interval associated with specific magnitude floods—otherwise stated, the occurrence of a high magnitude flood may increase the discharge of the design flood, such as the 100-year event commonly used for floodplain management.

Floodplain riparian ecosystems are sustained by the very disturbances that our past floodplain management efforts often try to eliminate: flooding and erosion. In California, as in most of the developed world, over 90% of riparian ecosystems have been lost. Agricultural and urban development often extends all the way to the top of the channel bank, leaving only a single line of trees. In creeks where cattle or other livestock graze, vegetation may be completely absent. In order to minimize flood and erosion hazards, and to sustain or restore floodplain ecosystems, floodplain management should:

- Accommodate physical processes, or the "natural disturbances" that create and maintain processes and functions of floodplain ecosystems (flooding, channel migration, avulsion, overbank flow, sediment erosion and deposition);
- Expect and accommodate change in the relation between the river channel and floodplain boundary (e.g. erosion, deposition, and migration);
- Preserve longitudinal and lateral connectivity between the channel and floodplain (e.g. dam releases to maintain geomorphic processes, vegetation succession, overbank flow, and fish use of floodplain areas);
- Preserve flood storage function of floodplain;
- Preserve floodplain riparian zone as a buffer between developed areas and the fluvial system.

8.6.2 A Watershed Approach to Floodplain Management

A watershed approach to reduce flood hazards must consider cumulative effects of past and proposed floodplain changes. The most successful approach to minimize flood hazards it to minimize floodplain development, and to instead preserve the natural flood storage capacity of the floodplain. Flood hazard reduction and floodplain management is encouraged by many, including the California Department of Water Resources (DWR; http://www.fpm.water.ca.gov) and the professional, non-profit educational organization, the Floodplain Management Association (FMA; http://www.floodplain.org). Flooding often crosses multiple jurisdictional boundaries for ownerships and responsibilities: county, city, special district (water, flood control, community services, etc.), state, federal, and tribal.

A watershed assessment that evaluates upslope-downstream hydrologic effects and causes of alterations can provide a very useful tool for floodplain management. Downstream communities will likely have more interest in a watershed assessment addressing flooding and floodplain issues than upstream ones, often driven by recent or continuous experience with damaging floods. Urbanizing areas tend to discover that previous "flood control" channels and reservoirs, as well as road culverts, are not sized to withstand the flood peaks ("peak discharge") estimated when the watershed was more rural, with less paved and covered (impervious) surfaces.

Some examples of downstream California communities (and their watershed) actively working with partnerships on watershed assessments and plans with floodplain management and flood protection as a major focus include:

- City of Newport Beach – San Diego Creek watershed
- City of Santa Cruz – San Lorenzo Creek watershed
- City of Napa – Napa River watershed
- Marine Corps Base Camp Pendleton – Santa Margarita River watershed
- City of San Jose / Santa Clara County – Guadalupe River watershed [http://www.scbwmi.org]
- City of East Palo Alto – San Francisquito Creek watershed

8.7 Regulation

Regulations influence water quality, land uses, resources extraction (e.g., timber) and integrated planning. Federal, state and local regulations define the environment in which all of the issues are considered. There are many state and local regulatory processes where watershed assessment and management are either required or are useful tools to achieve regulatory goals.

8.7.1. Water Quality Regulation

The federal Clean Water Act and the state Porter-Cologne Act are the two primarily water quality statutes (Table 8.2). These acts prescribe that permits be issued to regulate the release of contaminants into waterways and that reports are prepared to evaluate the conditions and status of waterways, among other requirements. Before discussing how information from your watershed assessment might be useful in this regulatory context, the following section reviews basic background information

8.7.1.1. Major categories of water pollution

Water pollution is grouped into two major categories – point source and nonpoint source (NPS). Point source pollution is defined as anything that is regulated by the National Pollution Discharge Elimination System (NPDES) and generally comes out of the end of a pipe. This includes most urban stormwater run-off, which, now in large part is regulated through NPDES Storm Water programs.
Although urban runoff is collected from a large geographical area, it is regulated by NPDES, and is generally released into a waterway via a pipe so is considered a point source. NPS pollution includes all other sources of pollution, including run off from agriculture, rural areas, most abandoned mines, and forested areas. In particular, data and analysis from a watershed assessment could provide useful information in the development of non point source pollution regulations.
In reality, almost all NPS pollution is really point source pollution because contaminants and other disruptors of watershed function originate from points on the landscape. Typically, however, the term point source pollution is applied only to focused human activities that discharge contaminants or modify physical or chemical qualities of a waterway (e.g., an industrial operation).

As a watershed assessor, you will find that there is a gray area between permit-regulated and unregulated pollution that can be associated with a type of land-use. For example, agricultural operations in the Central Valley have been given a conditional waiver by the state for the pollutants originating from agricultural lands in the Valley. In exchange, the growers monitor water quality at the sub-basin level and employ “best management practices” to reduce pollutant runoff to waterways. A watershed assessment can still be very useful in this setting as one aspect of the conditional waiver is to understand watershed conditions for a given planning area.

8.7.1.2 Point Source Pollution Regulation

Point sources may have a wide-range of potential impacts, from minor to being drivers of waterway function. Stormwater permits are given to local municipalities for point source discharges under the National Pollutant Discharge Elimination System (NPDES) and are called NPDES permits. These permits contain a list of criteria that cities and counties must comply with regarding stormwater effluent. Large cities fall under the Phase I permits and are required to monitor waterways. Monitoring data collected in the course of preparing a

Table 8.2 State statutes that deal with water quality

Name of Law	Key provisions
Clean Water Act (federal, 1972)	• Regulations to meet the goal of zero discharge of pollutants. • Includes sections on water standards (303) and TMDLs (303d); assessment of water quality (305b); nonpoint source management (319); NPDES permits (402), and wetlands (404).
Porter-Cologne (state, 1990)	• Established the State Water Resources Control Board and 9 Regional Boards to control water rights and water quality in California. • Empowers the regional boards to prepare water quality control plans (Basin Plans) to ensure that beneficial uses of water are being met and actions are taken to control point and nonpoint source pollution. • Authorizes the Boards. to issue NPDES permits under the federal CWA
California Toxics Rule	• In 2000, the US EPA finalized the California Toxics Rule to reinstate water quality criteria for toxic pollutants in the state's rivers, streams, lakes, enclosed bays and estuaries. The EPA promulgated this rule to fill a gap in California water quality standards that was created in 1994 when a State court overturned the State's water quality control plans containing water quality criteria for priority toxic. • The final rule promulgated: 1) freshwater and saltwater criteria for 22 toxics; 2) ambient aquatic life criteria for 23 priority toxics; 3) ambient human health criteria for 57 priority toxicsThe State of California must use the criteria together with the State's existing water quality standards when controlling pollution in inland waters and enclosed bays and estuaries. The numeric water quality criteria contained in the final rule are identical to the EPA's recommended CWA §304(a) criteria for these. However, the EPA did not include the proposed acute and chronic criteria for mercury to protect freshwater and saltwater aquatic life or the proposed acute criteria for selenium to protect freshwater aquatic life. Also, the final rule does not contain numeric criteria for chloroform.

watershed assessment could be very valuable for those involved in overseeing compliance with the permits (e.g., Regional Water Quality Control Boards). Within the Public Works or Utilities departments of each Phase I city, a "Stormwater Quality" division oversees monitoring of selected waterways for a variety of conventional and toxic water quality constituents to comply with their permit. Data from a watershed assessment could aid the effort to prioritize pollutant monitoring. This prioritization process involves identifying key locations for monitoring and key constituents that are most toxic and most prevalent. Data generated as part of an assessment could identify stream reaches where particular pollutants were problematic. Additionally, the assessment will contain an analysis of the impacts of contaminants, sediment, and total water volume on habitat conditions. These impacts need to be evaluated during the permitting process and would be useful to the staff at the Regional Boards.

Watershed assessments should at least include the location of point sources and estimated discharge of pollutants, or other effects on watershed function. These points sources may have a wide range of potential impacts, from minor to being drivers of waterway function. Assessment of watershed function can also inform future permitting of point source discharge. If waterways within a watershed are already impacted by point or non-point sources of pollution, the future permitted discharges would be inadvisable.

There are various ways that you can deal with point source information:

1) Point source dischargers and the state regulatory agency must monitor the pollution originating from the permitted facility and also the potential impacts of the pollution. This information is an important local source of information for the water quality part of your assessment.

2) Information about single point sources, or a combination of point and non-point sources of pollution can be combined to give an assessment of existing impacts. This combined impact should be assessed for ecosystem and other impacts and the information presented and summarized in a way that is useful for future permits.

3) Types of pollution that are covered by permits include those listed in chapter 3.6 (e.g., organic compounds, metals, high temperature). Contaminants may have their effects in isolation from each other, but often they have their negative impacts in concert. This is where watershed assessment, which is by definition integrative, can have a valuable role in decision-making. For example, future land-use decisions could impact the volume and composition of municipal waste discharge, the timing and volume of managed storm-water runoff, and suppress natural processes. When existing conditions and impacts are compounded with future possible scenarios, then the combined impacts can be assessed.

4) Ultimately, the regulatory agency, the State Water Resources Control Board, must accept the finding of a negative impact to deny a pollution discharge permit, or accept a finding of no net impact to allow a permit. There is not always a clear role for watershed groups in this process, though local agencies may be able to bring forward watershed assessment information to the decision-making process.

8.7.1.3 Non-Point Source Pollution Regulation

The problem of non-point source pollution has contributed to the widespread application of watershed assessment and management. Widely distributed and occasional appearance of water pollution across a watershed is a product of the combination of the natural environment and human actions. It is possible in some cases to attribute responsibility for NPS pollution to individual actions, land uses, or parcels.

Non-point source pollution enters waterways at non-specific places as a consequence of the movement of water across the landscape. When the beneficial uses of the waterbodies are impaired as a consequence of this pollution, total maximum daily loads (TMDLs) can be established to reduce the contaminant(s). TMDLs have been established in waterways for pesticides, nutrients, sediment, and other types of contaminants.

The TMDL process is a framework of assessing a watershed, but with a water quality emphasis. Each TMDL has five general objectives, quite similar to the watershed assessment process described in this Manual:

1. To assess the condition of a waterbody, and determine/confirm cause(s) / source(s) of pollutant;
2. To quantify the sources of the pollutant;
3. To determine how much of a particular pollutant a waterbody can handle and still meet desired conditions;
4. To identify whether and how much the different sources need to be reduced in order to support desired conditions;
5. To develop a plan which, when implemented, will restore waterbody health.

TMDLs are determined by state agencies for pollutants impacting specific waterways. For example, in the Newport Bay watershed (Southern California), San Diego Creek has a TMDL established by the US-EPA for organic and inorganic pollutants originating from residential, commercial, industrial, and agricultural lands. The Garcia River has a TMDL for sediment (posted at: http://www.krisweb.com/biblio/garcia_usepa_regix_1998_finaltmdl.pdf).

TMDLs can consider and allocate loads (amounts) for contaminants originating from both non-point and point sources. Natural loads are calculated and are often considered the background for a particular substance (e.g., sediment or nutrients). TMDL reports describe the data analysis and modeling used to determine likely or actual sources of pollutants and eventually "waste load allocations", or the amount of pollution each polluter or area may contribute to the waterway.

There are no fixed protocols for the determination and allocations of pollutant loads under individual TMDLs. Like watershed assessments, they are tailored to the watershed and the sources of pollution. The San Diego Creek TMDL used the proportion of sub-watersheds in different land use categories and measurements or estimates of loads originating from land-use types to determine loads for each pollutant in each sub-watershed.

Watershed assessment approaches are more general than TMDL calculations and might provide more detail about natural processes and human activities in the same sub-watersheds. This additional detail would help the TMDL process and potentially inform the implementation of the waste load allocation and reduction.

1) TMDLs being carried out in watersheds

A TMDL identifies the maximum amount of a pollutant that may be discharged to a water body without causing exceedences of water quality standards and impairment of the uses made of these waters. The federal Clean Water Act requires development of TMDLs for polluted waters to assist in identifying pollutant control needs and opportunities.
(Total Maximum Daily Loads For Toxic Pollutants San Diego Creek and Newport Bay, California; US-EPA, Region 9, 2002)
http://www.epa.gov/region09/water/tmdl/nbay/summary0602.pdf

with assessments or similar analyses should explicitly take into account the watershed characteristics and processes described in the assessment.

2) Watershed assessments should describe historic, present, and likely future conditions, which is all useful information for determining a TMDL.

3) Watershed management plans based on watershed assessments in TMDL watersheds should take into account the source calculations and waste load allocations in the TMDL when describing management recommendations.

8.7.2 Timber Harvest Plans

Developing and implementation of timber harvest plans (THPs) are required by the Board of Forestry under the California Forest Practices Act. It is the intention of the state that these THPs not result in non-point source pollution to the state's waterways. Watershed assessment can provide several types of information for THP development:

1) The physical and biological setting for THP activities should be described at several watershed scales. For example, the impacts of logging and grading under a THP will be most apparent at the smallest sub-watershed scale. It is most valuable to collect data at this fine scale on many watershed processes in order to provide an appropriate description of the natural environment. However, some impacts of the project may work their way downstream into the stream and river system meaning that processes should be measured there as well.

2) Different geographic scales will be appropriate for different potential impacts (Ziemer, 2000). For example, road crossings may change stream channel properties for only a few hundred meters up and down stream of the crossing. In contrast, skid trails and road cuts may contribute excess sediment, nutrients, and surface water to downstream channels for many miles.

3) Cumulative effects of past, proposed, and future activities are also best measured at several scales, from the sub-watershed to watershed. Smaller watersheds may respond more quickly and to fewer actions than larger watersheds as well as in different ways.

4) Effects of the proposed actions and cumulative effects should be analyzed over appropriate time scales for the processes in question. For example, if the logging will impact shade on upland slopes, what will the change in subsurface water temperature be and how will that change affect the immediate stream reach? At another scale: how will the combined actions change natural disturbance processes and population dynamics on the landscape and in the waterways of the larger watershed over decades?

8.7.3 Federal and State Endangered Species Acts

Both the Federal and California Endangered Species Acts (FESA and CESA, respectively) require that federal and/or state agencies consider and regulate the impacts of land and water use actions on imperiled plant and wildlife species and their habitats. For certain species, e.g., salmon, these impacts are often considered at the watershed scale in order to include landscape impacts on waterways. Many watershed assessments have been done because of the presence in the watershed of endangered or threatened species.

Watershed assessments can be used to inform decisions for managing impacts to endangered species in the following ways:

1) Identify potential and actual impacts to endangered species that may originate

from single or multiple sources that are best measured at the watershed scale.
2) Identify the spatial and temporal scales at which potential and actual impacts should be measured within the watershed.
3) Use the conceptual model approach from the assessment planning stage (see chapters 2 and 6) to identify human and other actions and processes that influence the well-being of endangered species.
4) Give relative weights to the human and natural influences on endangered species habitats and populations. Use these relative weights to prioritize the influences for remedial action.
5) Describe protection or restoration strategies that could be implemented at the watershed scale for the benefit of endangered species or their habitats.
6) Identify data and knowledge gaps specific to the species and their habitats that are needed prior to making decisions that are based on knowledge of ecosystem and population dynamics.

8.8 Voluntary Private Lands Management

In general, most landowners have intimate knowledge of their property, so it is unlikely that a watershed assessment will tell them much that they don't already know about general condition. Scientific aspects of the assessment may be more revealing to them. Perhaps the principal benefit of a watershed assessment to a private landowner is setting the context of their property within the entire watershed. For some people, this perspective will be of interest and benefit and may lead to alterations in management practices. For others, a watershed perspective and associated information will not affect their established way of doing business. A watershed assessment may contain substantial resources such as aerial photographs, satellite imagery, and GIS layers of their land and adjoining properties that an individual may not have ready access to. These types of information may be of value to some owners in their planning and decision-making.

Some landowners have partnered with neighbors to restore a waterway. One example is Murphy's Creek in San Joaquin County, where landowners obtained a CALFED grant to remove a non-functioning earthen dam, which had prevented migration of anadramous fish. Landowners such as this group could benefit from the data and analysis contained in a watershed assessment.

Regional information on geology, climate, soil productivity, erosion risk, land capability, and vegetation may be useful for operations of some farmers and ranchers or for planning construction and other development. These general types of information would be necessary for environmental analysis of development proposals. Watershed information could also be useful in complying with regulations and as background in applications for grants from state and federal agencies for soil conservation and habitat restoration projects.

Watershed assessments should be helpful to owners of forest-land in scheduling of logging, road construction, and road maintenance to minimize impacts on streams. Information from watershed assessments should also assist in complying with California's Forest Practice Rules and preparing Timber Harvest Plans, Sustained Yield Plans, or Non-industrial Timber Management Plans. Watershed assessments probably have the greatest direct applicability to evaluating cumulative watershed effects as required for Timber Harvest Plans. If the Board of Forestry adopts the recommendations of the University of California Committee on Cumulative Watershed Effects (Dunne, et al. 2001), then watershed assessments could become an integral part of planning for forest operations.

8.9 Monitoring Programs

Monitoring is an important part of adaptive management and the implementation of watershed plans, restoration programs, regulation, and land and water use decisions. Monitoring is closely tied to watershed assessment. The results of monitoring should be useful to assessment and assessment in turn should be used to design and implement monitoring programs.

Two important ways that watershed assessment can inform monitoring program design and implementation are: 1) by exposing gaps in knowledge and data about watershed conditions and 2) by showing geographically areas that are at risk or have actual impacts from human activities.

Knowledge and Data Gaps

Part of your watershed assessment should involve identifying gaps in information about systems in your watershed and deficiencies in knowledge about how the systems work (see chapter 2.4.2). These gaps should be separated into these two major categories, data and knowledge, and a monitoring and research program recommended to address deficiencies. Obviously implementation of the program will depend on factors beyond the control of the assessment project. In addition, not all data and knowledge gaps can be readily filled, even by the most advanced watershed groups. However, it will help your own, or someone else's, future understanding of the watershed if you go through this exercise.

Data gaps

Monitoring is conducted to find out how a system works or is changing over time. The term is typically applied to water quality monitoring programs, but you could just as easily use it to refer to wildlife or ground water monitoring. There are a wide variety of things you could conceivably monitor in response to findings in your watershed assessment. Here are some things to keep in mind:

1) The spatial scale and resolution of your monitoring program (e.g., location and distribution of monitoring sites) should be determined by the nature of your monitoring/assessment question or the information gap. For example, if there are particular land-uses of concern distributed throughout your watershed (e.g., roads), then you should monitor enough of them closely to statistically determine whether or not an impact is occurring, as well as the extent of the impact throughout sub-watersheds.

2) The temporal scale and resolution of your program is as important as the spatial resolution. If your data gaps are related to storm event impacts (e.g., large movements of sediment or contaminants), then monitoring should occur intensively during and after storms and for several storms. Between storms, you would want to determine non-storm related impacts in order to provide a "baseline" against which to compare storm impacts. Frequency of sampling is a critical issue here as it both determines whether or not you can tell something about individual events, changes during a water-year, and/or trends over decades.

Knowledge gaps

Data gaps are different from knowledge gaps. Knowledge gaps refer to things you don't know about a system or thing you are interested in. To address gaps in your knowledge about how your watershed is working, changing over time, or responding to stress from human activities, you may need to implement monitoring that is basically research. An example of a knowledge gap is the contribution of nutrients to waterways from different land use and cover types. Addressing this knowledge gap would demand collecting data about nutrients upstream, adjacent to, downstream, and in sub-surface water for each land use or cover type of interest. The data would need to be collected over a reasonable time and space resolution and for long enough to establish any trends. Along the way you might fill data gaps (e.g., nutrient concentration in a certain waterway), but the knowledge gap filling occurs when you find statistically-significant relationships between land-uses and nutrient conditions under a range of climate and other conditions. This obviously requires specialized analytical skills that you may or may not find in your current assessment team or watershed group.

Here are some things to keep in mind when designing programs to address knowledge gaps:
1) Differentiate between data gaps and knowledge gaps. Data gaps require the collection of information about a system about which you already have some knowledge. Knowledge gaps occur where you may or may not have data, you just aren't sure how processes and things are interacting with each other, or occurring over space and time.
2) Approach knowledge gaps in the same way you went after conceptual modeling (chapter 2). Think of how a system might work based on your knowledge of how similar systems work. Draw or describe a conceptual model of the system including where the gaps occur. Pencil in possible ways that things might work and use this exercise to come up with targeted questions for future monitoring or research.

8.10 Watershed Adaptive Management

Watershed adaptive management is a continuous procedure, broken up occasionally by planning and watershed assessment. Monitoring and evaluation of the effects of intentional and inadvertent changes to your watershed is a critical part of watershed adaptive management. Watershed adaptive management is defined here as "monitoring or assessing the progress toward meeting management objectives and incorporating what is learned into future conceptual models, management plans and actions, and monitoring (figure 8.1). "Learning while doing," acknowledges that many management actions (e.g. restoration) are experiments. Assessment plays a key role in both the planning of management activities and the evaluation of past activities. It relies on monitoring information collected before, during and after actions and during the coming and going of seasons and years. This section builds upon early chapters and emphasizes watershed assessment as part of the continuous process of watershed adaptive management, with periodic stops to measure and evaluate ecosystem responses.

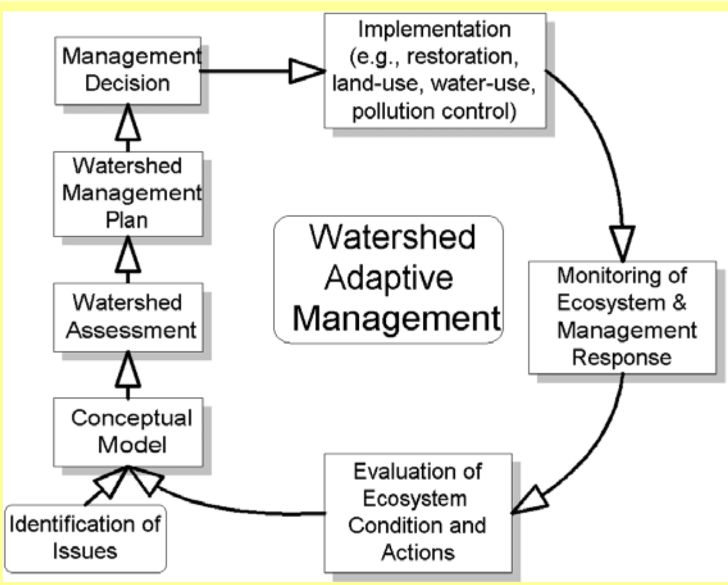

Figure 8.1 Watershed adaptive management

The monitoring data collected, analyzed, and interpreted as part of the watershed assessment will provide information that may alter the watershed's original conceptual model, the management activities, and the monitoring program itself. One important question is how to make the connection between the "evaluation of ecosystem condition and actions" stage and the "conceptual model" and "management decision" stages. If the original questions and issues driving the monitoring and evaluation/assessment were derived from the conceptual model and are related to the management decisions, then this loop should close easily.

Probably the best way to close the loop on watershed adaptive management is to make clear at the outset the policies, processes, and actions that are being monitored and evaluated. Also, the people and organizations that are involved in the management and other decisions should be aware at the outset of the monitoring and evaluation. Although they should probably not evaluate their own actions, they can provide valuable input into the actions they take and processes they affect.

Clear identification at the beginning of the monitoring program of the policies and management actions that will be informed will theoretically facilitate the entry of new information into subsequent decision-making. The actual use of well-collected monitoring data and scientifically-rigorous evaluations will depend on social and political forces outside the scope of this Manual.

8.10.1 Continuing Assessment

Even as you finish one watershed assessment, you should be looking forward to updating it as you gain new information and knowledge. Periodically assessing watershed conditions is an essential component of adaptive management at the watershed scale because of the continual changes occurring in watersheds. The threads connecting one assessment to the next are a combination of the kinds of problems you identified in the first assessment and the watershed processes and conditions you decide to monitor. There are two primary ways to structure monitoring programs that lead to assessments: 1) ambient monitoring, which involves measuring physical, chemical, and biological characteristics of the watershed to assess the status and trends of these conditions and processes. No assumptions are made regarding cause-and-effect relationships and 2) stress-based or strategic monitoring, which focuses on connections between the current conditions and known or suspected sources of stress. This second type of monitoring will allow you to more readily draw conclusions about what actions affect certain natural processes in the watershed, but may be less informative about the natural functioning of the system. A combination of these approaches will allow the greatest flexibility in monitoring ambient natural conditions and fluxes, while also facilitating conclusions about correlations among watershed compartments and potentially leading to the discovery of new connections among compartments.

Designing monitoring that leads to an assessment based on goals, questions, or issues in the watershed necessarily means simplifying the systems so a conceptual model can be constructed (see CWAM chapter 2). This conceptual model will reflect what is known about influences and connections among parts of the system. It should also show which influences are natural and which are of human origin and thus most open to change through adaptive management. It should also show which aspects of the systems are appropriate for monitoring (indicators) and how knowing about them will improve knowledge and decision-making. Finally, it should show which influences are natural and which are of human origin and thus most open to change through adaptive management.

The conceptual models for the watershed monitoring program and periodic assessment should be nearly identical. Monitoring may lead to interim changes in the conceptual model as new knowledge is gained about the system. The conceptual model will also remind people and organizations within and outside the monitoring program why particular parameters or indicators were selected and invested in. Finally, the conceptual model will serve as a common frame of reference as monitoring and re-assessments are done over time.

Once you have connected the watershed conceptual model and proposed monitoring actions, you should consider describing the context for the monitoring. In some cases, you will only be monitoring features (e.g., wildlife populations) and fluxes (e.g., precipitation and discharge of surface water) in the watershed regardless of their context of human actions. Usually, you will be trying to understand the system from an adaptive management viewpoint and thus will need to include monitoring of human actions and system responses to these actions.

Restoration Effectiveness

Hopefully your watershed management activities will result in restoration or rehabilitation of watershed conditions and processes. This could consist of efforts to change land-use practices and zoning in order to reduce impacts, implementing "best management practices, removing harmful infrastructure, or removing exotics and re-vegetating with native species in riparian and upland areas. The role of watershed assessment in restoration planning is described in chapter 8.2 The effectiveness of these restoration activities can be measured by monitoring and evaluating watershed processes and human activities. One way of measuring performance or effectiveness is to choose indicators of condition or change in condition in the system. Indicators are measures that reflect key changes in the status and trends of important watershed processes and conditions. Examples of indicators are: change in the number of native fish species in a reach, upland and riparian forest cover in a sub-watershed, bank armoring or rate of bank erosion, number of miles of roads in a sub-watershed, proportion of sub-watershed protected by a conservation easement. The idea is that you would measure change in the indicators over time and space in a place where restoration is

Adaptive Management in the City of Los Angeles

In the face of mounting pressure to clean up storm water runoff, river channels, and beaches, the City of Los Angeles passed a $500 million bond measure in 2004 to address these problems. Key to this measure is the requirement to use an adaptive management approach to monitoring project effectiveness and modifying the program in response to new information.

Clean Water, Ocean, Rivers, Beaches, Bay Through Storm Water Projects General Obligation Bond Program

Excerpt: *All projects shall provide water quality benefits and have as their primary purpose the reduction of pollutant loads to the impaired waters of Los Angeles to meet water quality standards. Wherever feasible projects shall be designed (1) to provide multiple benefits and purposes including water supply, flood management, open space, habitat, and recreation benefits, (2) with consideration of source control measures and leveraging of funds and collaboration with other agencies, and* ***(3) shall utilize a strategic adaptive management approach that incorporates assessment, feedback, adaptation, and flexibility****. In order to protect public health, improve water quality, conserve water and reduce flooding, the types of projects include storm water cleanup, control and diversion; water quality, pollution and bacteria control; trash capture; urban lakes and bay improvements; habitat/wetlands restoration and development; storm water retention.*

http://www.lacitysan.org/irp/documents/PropOFactSheet3.pdf taking place and compare the change to the condition prior to restoration or to a reference condition. The reference condition could be a positive reference (e.g., historic or desired condition) or a negative reference (e.g., violable water quality standard or no reproducing fish). Environmental indicators are discussed in more detail in CWAM Volume II.

Some indicators change slowly and so are measured very seldom (e.g., forest cover), others change rapidly over hours or days, but it is the trend over time that you are really interested in (e.g., water temperature or sediment load). To measure effectiveness of restoration actions requires that you have 1) control conditions (e.g., reference un-treated sites and/or natural condition sites or in some cases knowledge of historical conditions), 2) dedicated monitoring and evaluation over appropriate time frames (years to decades), 3) a solid theoretical understanding of experimental design, sampling, and statistics, and 4) a desired condition toward which you would like your watershed to head.

The California Department of Fish and Game has developed a manual for assessing salmon habitat restoration effectiveness (Harris et al., 2005; http://nature.berkeley.edu/forestry/comp_proj/dfg.html). This manual includes detailed monitoring protocols for evaluating restoration of stable banks, culvert fish passage, instream habitat, instream substrate, riparian and upland vegetation, and upgraded roads. It has been field-tested by the authors and has guidance relevant beyond just restoration for salmonids.

Land and Water Management Effects

Some management actions will be "restoration", while others will be the usual land and water uses which may damage the watersheds. The role of watershed assessment in land use and management is described in sections 8.3 to 8.8 above. Most watersheds have multiple human demands placed upon them and it is reasonable to periodically assess them in order to understand their condition and how conditions can change in response to particular actions. This can be done in much the same way as you measure restoration effectiveness, except that restoration is more like an experiment in that you can control change in the system. Because you can't easily control the water and land management actions, measuring and assessing change in watershed condition will consist of comparing your indicators with a reference condition or recognized standards (e.g., water quality standards). Your ability to conclude that certain actions lead to certain effects will be based on correlation between action and effect, which is different from direct "cause and effect" relationships.

Continuing assessment in this case is a combination of measuring restoration effectiveness and "ambient monitoring". There are a few guidelines to keep in mind when designing an assessment program that is intended to evaluate management effects:

- Be very clear about what you want to assess; what are the questions?
- Initiate monitoring as long as possible before the management action occurs to strengthen the evaluation of effects.
- Make sure the indicators that you will monitor and evaluate are very closely linked to the likely effects of the management actions so that your "linkage analysis" consists of only one or two steps.
- Try to have a broad range of conditions that you are evaluating. This will make your statistical analysis and conclusions much more robust.
- Be sure that the spatial extent and time frames of your data collection and assessment match the scale of activity you are evaluating.

- Consider monitoring the management actions themselves as well as environmental or ecological indicators.
- Consider inviting the organizations or individuals responsible for the management actions into the monitoring process so that they can trust the data and adapt their decision-making.

8.10.2 Collecting Monitoring Data

Just as watershed assessment informs monitoring programs (section 8.9), new monitoring will be used in future watershed assessments. Although there are no standard return intervals for watershed assessment, there are certainly guidelines to use to decide when the information on which you have relied has expired. Continuing assessment requires the collection of new data for parameters identified as important for measuring natural change and the effects of restorative and non-restorative management (e.g., urban development). There are many potential types of data that you could collect. The sections below describe some examples of commonly-collected information in the context of assessment as part of an adaptive management cycle. More detailed descriptions of data collection are given in chapter 4 and CWAM Volume II.

Geographic information

An up-to-date geographic information system (GIS) is an invaluable tool for identifying places needing regular or periodic monitoring and for keeping track of certain types of monitoring data. How well your GIS reflects current conditions in the watershed depends on how regularly you update your spatial data. Expiration depends on the scale of your study area. For small watersheds (10,000 acres), disturbances can result in dramatic changes over short time periods, thus your data collection intervals should be shorter (1-5 years). For the large watershed-scale (>100,000 acres), change will be gradual when averaged over the whole area, thus data collection intervals for the whole watershed could be longer (5-10 years).

Hydrology

Without gaging stations, basic waterway hydrology cannot be directly measured. Without basic waterway hydrology, aquatic habitat conditions, pollutant loads, water supplies, and other properties and functions of watersheds cannot be determined. Measuring flows is one of the most critical things that can be done in a continuing monitoring program. However, flow monitoring requires a long-term commitment because short-term data do not reflect the natural variability of California's climate.

Geomorphology

Landforms change in response to human activity and natural processes. At the scale of channel banks, hillslopes, and stream-beds, the change may be rapid enough to measure among years and between assessments. There may be specific indicators of landform change that you can measure as part of a monitoring program to address questions that were raised in your assessment. These could be things that change rapidly and will be discussed in your next assessment, or indicators of long-term change appropriate for someone to analyze decades later. The choice of specific indicators will depend on the questions you have about the watershed.

Water Quality

Water quality is literally always changing. Temperature, pH, and dissolved oxygen can fluctuate over hours, suspended sediment and toxic contaminants over hours to days, and seasonal conditions or annual loads over decades. Ideally, you will have a database of water quality data for your watershed that shows daily, seasonal, and annual fluctuations in various parameters. Continuing assessment in the case of water quality could consist of the periodic collection of data from other organizations conducting monitoring.

Biological Information

Most collection of "biological data" will take place through specialists and specialized agencies. You may be in the position to collect some yourself (e.g., benthic macroinvertebrate sampling). Either way, the questions you have about the watershed and potential impacts to the watershed should drive your decisions about collecting and analyzing these data.

Aquatic organisms are a common target for monitoring and assessment because they are thought to integrate the effects of terrestrial and aquatic ecosystem management. This is partly true. It is also true that communities of aquatic organisms go through their own cycles and have responses to natural fluctuations in the environment independent of anything humans are doing at the watershed scale.

Social Conditions

There are aspects of human communities in your watershed that may change within years and decades and are important to watershed management. There may be changing economic conditions associated with evolving local and regional economies. There may be changing demographics that will impact how you communicate with watershed communities. Changes in economics and demographics will be difficult to monitor over annual timescales, but there are indicators of social well-being and social valuation that can be monitored over shorter timeframes.

8.10.3 Cost-Effective Assessment

One consideration for the design of monitoring and assessment programs is the cost of continued implementation. The expense often leads to inadequate sampling intensity. There are several types of considerations for cost that may help you to determine how much you need and how to keep costs down:
1) Spatial extent – how far do your concerns extend through the watershed? Are there certain places you could focus on more than others?
2) Sampling intensity – how often do you need to sample? How many samples do you need to take for each parameter?
3) Indicators/parameters needed – how many and which indicators will tell you the most about the processes in the watershed you are concerned about? Are there cheaper, adequate alternatives to the best indicators?
4) Frequency and intensity of assessment – do you need to assess everything at a regular interval? Can some components be monitored only after channel changes during a flood? Are there certain components and actions/processes in the watershed that should be assessed less often than others? Are there other things that should be assessed very frequently (e.g., annually)?
5) Monitoring management – are there ways to encourage people influencing the watershed to do part of the monitoring and provide you with the data?

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Using the Assessment in Decision-Making Checklist

- ❑ Watershed planning
- ❑ Restoration Projects
- ❑ Integrated Water Management Projects
  - o Water Supply Projects
  - o Drinking Water Protection Efforts
  - o Groundwater Management Planning
  - o Water Quality Protection
  - o Floodplain Management
- ❑ Regulations relating to:
  - o Water quality
  - o Timber harvesting
  - o Federal and state endangered species
  - o Local land-use planning
- ❑ Voluntary Private Lands Management
- ❑ Monitoring and Adaptive Management