2005
Supplement
to the

2000 Colorado Nonpoint Source Management Program

August 8, 2005

prepared by the
Water Quality Control Division
Colorado Department
of
Public Health and Environment

in cooperation with the
Colorado Nonpoint Source Council

Colorado Department
of Public Health
and Environment

Colorado's Nonpoint Source Program has evolved over the years from one of outreach and demonstration to one focused on restoring waters impaired by nonpoint sources of pollution and preventing future impairments. Within the overall goal, the following long-term goals are identified:

By 2025, using an integrated approach on a watershed basis, waters on the 2004 List of Waters Still Needing Total Maximum Daily Loads impaired due to nonpoint sources will attain applicable water quality standards that support the designated uses.

By 2025, nonpoint sources will no longer be a cause of water impairments in Colorado.

This update to the 2000 Nonpoint Management Program is intended to provide the near-term framework for program actions over the next five years. The actions identified in this document will lay the foundation to accomplish the long-term goals of the program.

Acknowledgements:
This update would not have been possible without significant assistance and input from a number of members of the Colorado Nonpoint Source Council and others, in particular:

Julie Annear, Colorado Division of Minerals and Geology
Russ Clayshulte, Chatfield Watershed Authority
Barb Horn, Colorado Division of Wildlife
Randal Ristau, Colorado Water Quality Control Division
Ed Rumbold, Bureau of Land Management
Loretta Lohman, Colorado State University Cooperative Extension

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I. INTRODUCTION

Colorado's nonpoint source (NPS) program was initiated in 1987, shortly after the Clean Water Act became law. The US Environmental Protection Agency (US EPA) Region 8 approved the original Nonpoint Source Management Program in 1989. A major update was completed in January 2000, based on guidance from US EPA that included nine key elements for nonpoint source management.

Colorado's program has evolved over the years from one of outreach and demonstration to one using a watershed approach to restore waters impaired by nonpoint sources of pollution and prevent future impairments. That approach, though, has its own set of challenges.

Challenges for NPS Management in Colorado

The voluntary nature of NPS management is also its greatest challenge. With few regulatory requirements, improvements to streams impaired by nonpoint source pollutants are dependent upon a group of local stakeholders recognizing a problem and voluntarily acting upon it. A strong local stakeholder group can make a measurable difference in the streams of their watershed. The resources of those volunteers are strained, however. It is becoming increasingly difficult to find either funding or time to make the match required for a nonpoint source grant.

In addition, the amount of available funding is far over-shadowed by the magnitude of the water quality impact. For example, Colorado's allocation of the national nonpoint source appropriation was approximately $1.9 million. However, the estimate to cleanup the Upper Animas River Basin is $30 million dollars. The cost to restore water quality impacted by legacy mining issues statewide is estimated to cost nearly $314 million.

Similarly, an analysis conducted by Colorado State University found that upgrading all agricultural irrigation management, including nutrient and pest management, would cost $45 million annually. Yet in 2005, Colorado's federal allocation was approximately $1.9 million for nonpoint source projects. Even if the program could focus all funds toward an area such as the Upper Animas, it would still take 10 years to implement the necessary measures.

Funding in general since 2000 has been in crisis:

- State budget issues. Many states in the country, including Colorado, faced serious budget shortfalls in the early 2000s. General funds appropriated by the Colorado legislature for water quality management were eliminated in state fiscal year 2003-04. Fee-for-service replaced the general funds, but since nonpoint source management is largely a voluntary effort, it was not possible to assess a fee that could be appropriately allocated to nonpoint source activity. Consequently, nonpoint source program management remains entirely federally funded.

- Federal funding cuts. As a result of the program evaluation tools utilized by the federal Office of Management and Budget, funding for the nonpoint source program at the national level was reduced by nearly 16% in federal fiscal year 2005. This caused a commensurate reduction in Colorado's funding, all of which came from the base grant allocation.

Despite the disproportion of restoration needs to actual funding, greater expectations were placed on the program at the same time funding was reduced. Through the OMB evaluations, the national program was criticized for having no description or expectation of "measurable results." In response, the national program at the US Environmental Protection Agency developed a series of "program activity measures" (PAMs), intended to demonstrate the accomplishments of nonpoint source management. Draft PAMs for the nonpoint source program include:

- Number of watershed-based plans and water miles/acres covered that are under development.
- Number of watershed-based plans and water miles/acres covered that are being implemented.
- Number of watershed-based plans and water miles/acres covered that have been substantially implemented.
- Number of waterbodies identified in 2000 as being impaired by nonpoint sources or by both point and nonpoint sources that are fully restored.
- Annual load reductions in pounds/tons of nitrogen, phosphorus, and sediment from nonpoint sources to waterbodies.

These PAMs are incorporated into the Performance Partnership Agreement between US EPA Region 8 and the Colorado Department of Public Health and Environment.

The interaction between nonpoint sources and point sources of pollution (those that require a discharge permit) also is more apparent, in particular with stormwater runoff and inactive mine sites. In a watershed such as the Upper Animas or Willow Creek, it likely is not possible to restore streams without active treatment of draining adits and mine tunnels. Active treatment, however, requires a discharge permit and therefore falls outside the purview of the nonpoint source program.

Finally, the need for data continues to challenge the program. In many instances, it may be possible to develop a total maximum daily load for an impaired stream segment using existing data. But the data may be insufficient to prioritize the specific actions necessary to restore the segment.

Update to Colorado's NPS Management Program

This update to Colorado's Nonpoint Source Management Program is, in part, to position the program to address more fully the national performance expectations. In addition, the program has moved from the targeting provided by the Unified Watershed Assessment to priorities linked specifically to a state's List of Waters Still Needing Total Maximum Daily Loads (TMDLs), also known as the 303(d) list. More than half of the funds allocated to Colorado in the past three years can be used only to implement watershed-based plans in watersheds where streams are identified on the 303(d) list.

The long-term goal of the Colorado's nonpoint source program is to restore to full use those waters, both surface and ground water, impaired by nonpoint sources, and to prevent future impairments to Colorado's waters, using an effective, efficient and open process that fully involves the public and brings together the necessary regulatory and non-regulatory authorities, agencies and programs.

A short-term goal for this update is to reposition the Colorado Nonpoint Source Program from one focused on implementation based on pollutant categories to one where the categories are

integrated on a sub-river basin basis. This will allow the program to address NPS needs on a watershed basis, regardless of pollutant category.

Water Quality in Colorado

The Status of Water Quality in Colorado – 2004 also known as the 305(b) report, provides a current and accurate assessment of all surface waters of the state that have been assessed in the past six years. It also reports the extent of which these waters provide protection for the propagation of aquatic life ("fishable") and primary contact recreation ("swimmable") in and on the water. The tables excerpted below from the 305(b) report highlight the sources and predominant causes of impairments in Colorado.

Table 1: Surface Water Quality Summary for Degree of Use Support

Degree of Support	**Assessed River Miles**	**Assessed Lake Acres**
Fully supporting all uses	53,748	61,025
Not supporting at least one use	7,705	12,094
Total assessed	61,453	73,119

Note: Total assessed miles and acres include assessments conducted in the last six years.

Table 2: Summary of Sources Affecting Water Bodies Not Fully Supporting Classified Uses

Source Category	**Colorado Rivers (Miles Affected)**	**Colorado Lakes (Acres Affected)**
Municipal Point Sources	24	0
Urban Runoff / Storm Sewers	7.5	0
Highway/Road/Bridge Runoff	7.5	0
Resource Extraction	699	142
Natural Sources	699	0
Sources Unknown	6,812	11,952

"Source" means the activities, facilities, or conditions that contribute pollutants or stressors.
Sum of the acres or miles affected does not equal the total non-attained acres or miles since non-attainment

Table 3: Five Predominant Causes Affecting Water Bodies Not Fully Supporting Classified Uses

Cause Category	**Colorado River Miles Affected**	**Cause Category**	**Colorado Lake Acres Affected**
Metals	7,031	Metals	6,799
Selenium	6,225	Mercury	5,819
Iron (total recoverable)	835	pH	3,825
Zinc	603	Ammonia and organic enrichment; low dissolved oxygen	1,006
Pathogens	410	Algal Growth/ Chlorophyll *a*	916

"Cause" means the pollutants and other stressors that contribute to the non-attainment of classified uses in a water body.

II. STRATEGIES AND LINKAGES FOR MANAGING NONPOINT SOURCES

The Watershed Approach in Colorado

The watershed approach has increased in significance in water quality management. US EPA has issued various pieces of guidance in the past five years that promote a watershed approach, including:

- Watershed-based National Pollutant Discharge Elimination System Permitting Implementation Guidance, December 2003, including NPDES Permitting for Environmental Results Strategy, August 2003
- US EPA Final Water Quality Trading Policy, January 2003
- Nonpoint Source Program and Grant Guidelines for States and Territories, October 2003

It is envisioned that by 2010 Colorado's Nonpoint Source Program will have moved from a categorical approach to an integrated watershed approach. The action plan described in Section IV provides the framework for this effort. The foundation of the integrated watershed approach is the watershed plan.

Watershed Partnerships

Nonpoint source issues impact a wide array of programs from federal to local levels, for both public agencies and private organizations. The NPS Program will provide qualified support to agencies and organizations pursuing nonpoint source water quality issues in their program activities.

The NPS Program champions the collaboration of key organizations and agencies to address emerging environmental issues that include nonpoint source water quality impacts by promoting and implementing BMP systems. For example, the NPS Program partners with lead agencies in responding to wildfire area treatment, especially in implementing BMPs to protect public water systems source water areas.

Watershed Planning

The emphasis on watershed-based plans in US EPA's NPS program activity measures has raised the awareness and increased the need for a coordinated effort to manage the resources of a geographic locale. Watershed planning has been a major component of NPS activity since the 1998 Clean Water Action Plan, which required a watershed restoration action strategy prior to using incremental NPS funds.

A watershed plan is a living document, developed in an iterative process that includes a wide variety of watershed stakeholders, such as land owners and managers, local governments and special interest groups, as well as land users such as recreationists. The planning process usually begins with a group of concerned citizens who come together around a particular resource issue.

US EPA has identified nine minimum elements of a watershed plan, which need to be addressed before NPS funds can be used. It should be noted that the nine elements alone do not comprise a

total watershed plan. A watershed-based plan should address not only the sources of water quality impairment, but also any pollutants and sources of pollution that need to be addressed to assure the long-term health of the watershed. In addition, a comprehensive watershed plan will recognize other natural resource-related needs that are important to the community, such as recreation, air quality, endangered species habitat needs, and cultural and historic resources. For nonpoint source project purposes, though, the plan should focus on water quality needs.

US EPA's Nine Elements of a Watershed Plan

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, USDA's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Watershed planning is not new. Planning for water quality purposes was established with Section 208 of the Clean Water Act in 1972. The US Department of Agriculture has used watershed planning for years in its Small Watershed Program. There are many similarities between the minimum NPS planning elements and other planning efforts. Those efforts can compliment planning for nonpoint source purposes.

USDA Area-wide Plan

Area-wide conservation planning focuses on providing conservation planning assistance to local stakeholders in a locally led effort to develop area-wide conservation plans or assessments. Area-wide conservation planning involves multiple ownerships within a watershed or other geographically defined area.

US Water Resources Council Principles and Guidelines

The planning process consists of a series of steps that identifies or responds to problems and opportunities associated with the Federal objective and specific State and local concerns, and culminates in the selection of a recommended plan. The process involves an orderly and systematic approach to making determinations and decisions at each step so that the interested public and decision makers in the planning organization can be fully aware of: the basic assumptions employed; the data and information analyzed; the areas of risk and uncertainty; the reasons and rationales used; and the significant implications of each alternative plan.

Table 4: Planning Elements Comparison

EPA's Key Elements of a NPS Watershed-based Plan	**Components of a USDA area-wide plan**	**Source Water Protection Plan (draft)**	**Section 208 Regional water quality management plans**	**US Water Resources Council Principles and Guidelines**
Identification of pollutant causes and sources	Description of planning area	Describe the source water protection area (SWPA) to which the source water protection plan will apply.	Facility needs, location, service area, and capacity Timing of facility expansion	Identify water resources problems in the study area
NPS management measures to be implemented	Problems and opportunities	Identify which potential sources of contamination (PSOCs) and water sources will be prioritized for the implementation of source water protection measures	Demographics of the area Social, environmental and economic impacts of implementing the plan	Collect data on the problems identified
Estimate of load reductions to results from mgt. measures	Local objectives	Describe the criteria used to prioritize the PSOCs and the water sources	Level of treatment by the facility	Develop alternatives to solve the problems
Estimate of financial/technical assistance	Resource inventory	Describe the different contaminant categories associated with the prioritized PSOCs	Permit conditions	Evaluate the effects of the alternatives
Outreach	Alternatives	Describe criteria used to identify/ select the acceptable source water protection approaches to be implemented	TMDLs/wasteload allocations Nonpoint source and stormwater information	Compare alternatives
Implementation schedule	Record of decisions	Summarize the recommended source water management approaches and identify the implementation tasks, costs, funding source, and schedule	Management agency review Watershed restoration plans Source water assessment and protection	Select a plan for recommendation or decide to take no action

Interim milestones	Implementation	Describe how to track and report on the effectiveness of the source water management approaches that have been implemented	Links to other water quality related programs Partnerships	
Evaluative criteria	Evaluation		Water quality analysis and assessment; standards and classifications	
Monitoring and evaluation plan			Regional water quality policies	

All on-the-ground improvements or restoration activities, including stream restoration projects, funded with NPS grant funds must be identified and prioritized within a watershed plan, whether or not the watershed contains impaired waters. Watershed plans should integrate Colorado's NPS categorical programs and consider potential pollutants generated from the broad categories of agriculture, silviculture, mining, urban, construction and hydrologic modification.

Monitoring

The Nonpoint Source Program requires determination of measurable results for all on-the-ground activities funded by NPS grant money. Measurable results enable the Water Quality Control Division (WQCD) to evaluate the success of on-the-ground activities by comparing pre- and post restoration conditions. Coordination between the WQCD and project proponents is important in collecting the appropriate data to obtain measurable results, as well as determining the measurable results of the project. Whenever practical, monitoring should be conducted through a cooperative arrangement among the various local stakeholders, state and federal agencies. In some cases, state or federal agencies may have data that could supplement data collected per requirements in a project implementation plan.

The WQCD Surface Water Quality Assurance Project Plan will form the basis for all data collection efforts. The WQCD and stakeholders need to collaborate on selecting monitoring approaches, measurement and sampling methods, and overall monitoring design, including frequency and locations of sampling and measurements to evaluate success. Quality control and data quality will also be addressed in quality assurance project plans. It is recommended that project sponsors consult with the WQCD prior to submitting an on-the-ground project proposal to improve project objectives, design, and monitoring guidelines and ensure the approach is appropriate for the watershed.

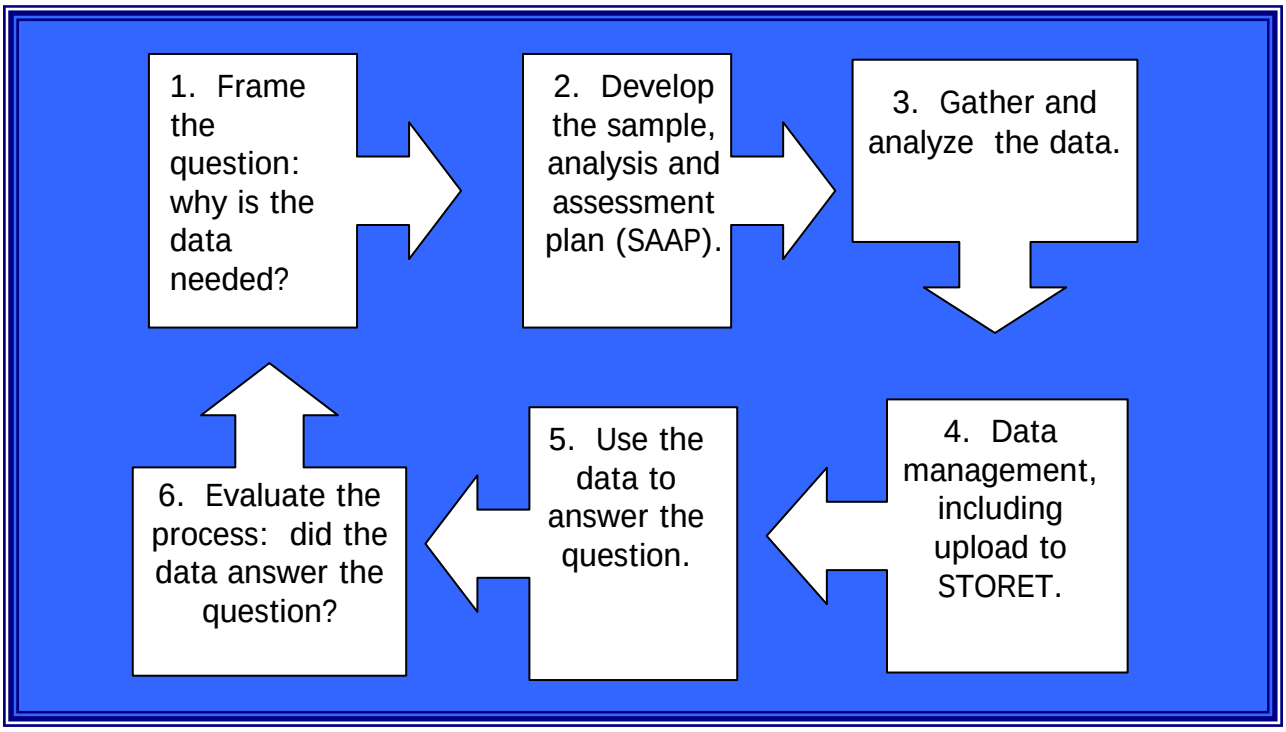

Figure 1: Generalized Monitoring and Assessment Process

The process shown in Figure 1 depicts a generalized monitoring and assessment process. The steps comprise an overall strategy or approach that is followed regardless of the underlying purpose for the monitoring.

Wildfire and other catastrophic events

Colorado's landscape changed significantly in 2002 with a massive wildfire season. More than 379,287 acres burned in Colorado; an estimated 6.9 million acres burned in the western states. It was Colorado's most extensive wildfire season in recorded history.

Colorado's NPS program responded in two ways. First, part of the 2002 grant was reallocated immediately from selected projects to burn area restoration activities in watersheds where additional work was needed to protect public drinking water supplies and systems. More than $700,000 was allocated to protect water supplies in Douglas County and La Plata County.

Second, beginning with the 2004 grant, part of the grant is set aside annually as a "rapid response" fund, which will allow the program to respond to catastrophic events more quickly than through the regular grant cycle. The funds can be used first to remediate catastrophic events that create conditions considered to be an imminent threat to the public health. A second use of the funds would be to repair recently installed best management practices installed with NPS grant funds but that had not yet been established and become fully functional. The Division and Commission may identify other uses of the funds.

Drought and water quality

In a semi-arid environment, drought is a regular occurrence. Colorado's worst wildfire season coincided with a severe drought that has continued in varying degrees, depending on the part of Colorado in question. Drought reduces the available dilutional flows in streams, rivers, lakes and reservoirs, which may increase the concentration of various pollutants in those water bodies. Drought can also cause pollutants typical in storm water flows to build up on the ground surface, which then may increase the initial concentrations when precipitation finally does occur. In addition, prolonged drought reduces aquifer recharge, which increases the drawdown and may cause some water systems to reduce output. Well failure is possible if pumping continues in a depleted aquifer.

The impacts to the NPS Program are observed in project implementation, especially in those projects that involve irrigation and nutrient management, and those that involve revegetation. Project implementation may be delayed when precipitation and stream flows are reduced.

Source Water Assessment and Protection Program

The 1996 Safe Drinking Water Act Amendments required each state to develop a Source Water Assessment and Protection (SWAP) Program. The SWAP program uses a two-phase process.

The assessment phase involves understanding where each public water system's source water comes from, what contaminant sources potentially threaten the source, and how susceptible each water source is to potential contamination. A source water assessment consists of delineation of source water assessment areas, inventory of potential sources of contamination, susceptibility analysis and reporting the assessment results to the public. The assessment methodology may be found at http://www.cdphe.state.co.us/wq/sw/pdfs/SW_SWAPAssessmentMethodology_v6.pdf.

The protection phase is a voluntary, ongoing process where the public water system and local community initiate preventive measures to protect the water supply from the potential sources of contamination. State and federal law do not require the development or enforcement of source water protection measures, though some protection measures may fall under other existing state or federal laws.

Source water protection is an important consideration in any watershed plan, as nonpoint sources have the potential to impact drinking water. NPS funds may be used for on-the-ground activities that reduce potential sources of contamination, within the context of other program priorities. Source Water Protection and nonpoint source planning activities will contain similar components, which make them candidates for a coordinated development and implementation approach.

Stormwater Management

An objective of the urban and construction nonpoint source management is to link the efforts of the NPS program to those of the phase I and II municipalities or others working under Colorado Discharge Permit System stormwater permits. Linking these programs to the maximum extent practicable provides for more effectiveness since both deal with the problems of precipitation

related (stormwater) pollution. Most water quality issues, including stormwater management, will benefit from watershed based solutions.

The following six objectives of the urban and construction NPS program parallel the six program elements of the stormwater permit:

1. Support public education efforts regarding the impacts of stormwater pollution on receiving water bodies and steps that can lessen or eliminate those problems.
2. Support public involvement efforts in watersheds that include urbanized areas.
3. Support a reduction of illicit discharges to urban waterways.
4. Support the control of construction site runoff from construction activities on a state wide basis.
5. Support the control of runoff from developed lands post construction activities.
6. Support efforts of entities to improve runoff quality from facilities and processes used in performing their work..

Permits for stormwater runoff from municipal separate storm sewer systems (MS4's) require the six programs above to control the discharge of pollutants to the maximum extent practicable. In meeting permit requirements owners of municipal storm sewer systems have flexibility in defining the measurable goals for each of these six programs. While supportive of the stormwater program elements, NPS funds may be used only for stormwater management activities not specified in a stormwater permit, within the context of annual program and funding priorities.

Animal Feeding Operations

Colorado is a significant beef producing state, generally ranking fourth in the nation for the number of beef cattle on feed. There are approximately 13,300 farms in Colorado with cattle (2002 Census of Agriculture), including 981 with "cattle on feed." The vast majority of farms, nearly 10,000, carry fewer than 100 head of cattle. Slightly more than 41% of Colorado's cattle and calves are considered to be "on feed."

An animal feeding operation (AFO) is defined by CDPHE WQCC Regulation No. 81, June 30, 2004 as a lot or facility (other than an aquatic animal production facility where:

- Animals (other than aquatic animals) have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over ay portion of the lot or facility.

A concentrated animal feeding operation (CAFO) means an AFO that is defined as a large or medium CAFO or that is designated by the WQCD as a CAFO, pursuant to Regulation 81, Section 81.4. CAFOs are determined by the number and type of animals stabled or confined on the facility, or if either of the following are met:

- Pollutants are discharged into surface waters of the state through a man-made drainage system; or

- Pollutants are discharged directly into surface waters of the state which originate outside of and pass over, across or through the facility or otherwise come into direct contact with the animals confined in the operation.

NPS interaction with AFOs is limited to those that fall outside concentrated animal feeding operations (CAFOs). The livestock feeding industry is active in providing their membership with both technical and financial assistance for those facilities not identified as CAFOs. Also, the off-site management of wastes that have been generated by a CAFO and then transported to an off-site facility that is not subject to discharge permit requirements is considered part of Colorado's NPS program.

NPS grant funding used to assist AFOs may only be used with those facilities that have and will implement a comprehensive nutrient management plan (CNMP). Aspects of a CNMP that are not directly related to water quality, for example dust or odor suppression, are not eligible for grant funding.

Onsite wastewater systems

Onsite wastewater systems, also known as septic systems or individual sewage disposal systems, are used to treat and dispose of domestic wastes in relatively small volumes of wastewater, usually from houses and businesses that are not served by central wastewater treatment plants. The installation of septic systems normally is regulated at the local level, except that systems with a design capacity of 2,000 gallons or more per day must obtain site location approval and a discharge permit from the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division.

Septic systems generally are considered potential nonpoint sources. In Colorado, 33% of all homes are served by onsite wastewater systems, a trend that continues to grow. Millions of gallons of septic tank effluent percolate into the soils of the state annually. Ensuring compliance with wastewater treatment performance requirements that protect human health, surface waters, and ground water resources is difficult due to the dispersed nature of septic systems. Proper placement, operation, and maintenance of onsite wastewater systems are critical to minimize potential pollutant problems.

A recommendation of the (CDPHE) Individual Sewage Disposal System Steering Committee, (2/14/2002) states "Additional education is needed for homeowners and owners of small commercial systems regarding the importance of ongoing maintenance of these systems. Informational literature and communication strategies for getting information to system owners need to be developed." There also is "a need to provide adequate training of those involved with the regulation and oversight of onsite wastewater systems, the design and installation of such systems, and those involved with inspection and/or maintenance of such systems."

The Water Quality Control Division proposes to team up with professional organizations to provide education, training, and technical assistance to the various industry professionals as well as homeowners. The goal of this initiative is to minimize septic system failures by ensuring that

systems are appropriately managed, perform effectively, and protect human health and the environment with proper operation and maintenance.

Mining and draining adits

The legacy of hard rock mining is obvious in many Colorado streams. Heavy metals leach from mine waste piles or drain from old mine tunnels and adits. Many of the impaired stream segments identified on Colorado's 303(d) list are impacted by inactive mines. For NPS purposes, an inactive mine is one that has not operated since the passage of the 1972 Clean Water Act.

Inactive mine land reclamation projects that are designed to restore water quality are eligible for Section 319 funding except where funds are used to implement specific requirements in a draft or final discharge permit. NPS funds may not be used to build treatment systems required by a discharge permit for an inactive mine, but they may be used to fund a variety of other remediation activities at the same mine. Examples of activities that could be eligible for funding include:

- Mapping and planning remediation at inactive mine land sites.
- Monitoring needed to design and evaluate the effectiveness of implementation strategies.
- Technical assistance to State and local abandoned mine land programs.
- Information and education programs.
- Technology transfer and training.
- Development and implementation of policies to address inactive mine lands.

Other projects that may be funded in Colorado include moving, consolidating, capping and revegetating tailings piles, and diverting clean water around waste piles. Mine reclamation projects must be prioritized in a local watershed plan. NPS funds in Colorado may not be used for construction of any treatment system that ultimately will require a discharge permit.

Source controls show promise in dealing with acid mine drainage and also may be eligible for funding. Source control eliminates the creation of polluted mine drainage by intercepting and diverting clean water away from contact with heavily mineralized zones.

Lakes and Reservoirs

By using the watershed approach, Colorado's NPS Program recognizes all surface waters. The same set of targeting tools may be applied to streams, rivers, lakes or reservoirs. Lake protection and restoration activities are eligible for nonpoint source funding to the same extent, and subject to the same criteria, as activities to protect and restore other types of waterbodies from nonpoint source pollution. For instance, Phase One Clean Lakes Studies are eligible for funding to the extent the study is supportive of the development and/or implementation of a TMDL. Lake protection and restoration activities must be identified and prioritized in a local watershed plan.

Section 314 of the Clean Water Act describes the Clean Lakes Program, which was reauthorized in 2000. Clean Lakes activities should be funded only in lakes that are publicly owned and that have public access, consistent with the Clean Lakes regulations at 40 CFR 35.1605-3.

Ground Water and NPS Management

Ground water quality in Colorado varies significantly, depending on geography and geology. Shallow, unconfined aquifers in Colorado are susceptible to contamination from surface activities. Overall, ground water provides 18% of the water beneficially used in the state. However, in some localities it is the sole source of domestic and irrigation water.

Ground water protection in Colorado has been delegated to a number of state agencies through legislation and statutory responsibilities. The ground water standards and classifications adopted by the Water Quality Control Commission are implemented through the rules and regulations of the individual agencies.

In 1990, the Legislature adopted Senate Bill 126, which established new provisions in the Colorado Water Quality Control Act to address potential ground water quality contamination from agricultural chemicals (pesticides and commercial fertilizers). Section 25-8-205.5 of the Act gives the Department of Agriculture authority to develop voluntary best management practices and, if necessary, mandatory agricultural management plans to control this potential pollution source, subject to ultimate authority of the Water Quality Control Commission to adopt regulatory requirements if necessary.

The NPS Program interaction with ground water issues is primarily through the Agricultural Chemicals and Ground Water Protection Program of the Colorado Department of Agriculture. The best management practices developed through SB-126 are appropriate management measures to reduce the ground water impact of nutrients and pesticides in agricultural use.

Coordination with the NPS Council

As the advisory group and work group for the program, the Council reviews all management program updates, BMP recommendations, and applications for NPS grant funding. The Council's committees provide the technical review necessary to assure that the actions and BMPs in the management program, as well as applications for funding, are technically sound and represent the current knowledge in each pollutant category.

Working in concert, the committees, Council and Division represent the path a project must travel to obtain a recommendation for funding and approval by the Water Quality Control Commission. Likewise, the committees, Council and Division represent the process for updating the management program, prior to approval by the Commission and submission to the Environmental Protection Agency.

Federal Consistency

Section 319(k) of the 1987 Clean Water Act states that Federal entities shall allow states to review efforts and shall accommodate state concerns regarding consistency of such efforts with a state NPS management program. The review opportunity is based on Executive Order 12372, which discusses the intergovernmental review process for federal assistance programs and development projects. However, Colorado no longer participates in the "single point of contact" process

described in the executive order. Therefore, a somewhat informal process has evolved with several federal partners.

Federal agencies own, manage or otherwise influence a significant portion of Colorado's land area. In fact, nearly 37 percent of the surface land of the state is federally owned, largely in headwaters areas. The Nonpoint Source Program in Colorado currently does not have the resources to review each forest plan, grazing allotment plan and other routine management tools developed by the different agencies.

The WQCD does not aggressively pursue review opportunities for most federal programs. The Division has found it to be more effective to work with individual agencies on the ground, rather than reviewing documents in a formal, anonymous manner. Since 2000, the NPS Program has conducted field reviews in nearly all US Department of Agriculture, Forest Service and US Department of Interior, Bureau of Land Management offices. The field reviews typically included both a document review and field visit to determine:

- Was water quality addressed in the planning stage?
- What BMPs were to be implemented?
- Were they implemented properly?
- Were the BMPs effective in reducing erosion or protecting the stream from nonpoint source pollution?
- If not, what changes can be made to protect water quality?

In nearly all instances, the NPS program has observed an increase in planning documents of the consideration of water quality standards. In the near term, the program will evaluate the field reviews conducted between 2000 and 2005 to develop an appropriate strategy for assuring continuing federal consistency.

The following table identifies the federal programs that could have water quality impacts in Colorado.

Table 5: Federal Assistance Programs or Actions with Potential Water Quality Impacts

U.S. Department of Agriculture	Department of Transportation
Emergency Conservation Program	Highway Planning and Construction
Environmental Quality Incentive Program	
Forestry Incentive Program	
Wildlife Habitat Incentive Program	U.S. Department of Interior
Wetland Reserve Program	Abandoned Mine Reclamation Program
Conservation Reserve Program	Mineral Development
Watershed Protection and Flood Prevention	Revisions or Amendments to Land and Management Programs, including timber sales and grazing allotments
River Basin Surveys	
Revisions or Amendments to Land and Management Programs, including timber sales and grazing allotments	Irrigation Systems Rehabilitation or Development
Colorado River Salinity Control Program	Management of National Wildlife refuges and proposed acquisitions
Department of Defense	National Park Management Plans and proposed acquisitions
Flood Plains Management Services	Colorado River Salinity Control Program
Flood Control Projects	
Planning Assistance to States	
Defense Installations Land Management Plans	

Stream Restoration

Properly functioning stream and riparian areas are critical in maintaining water quality, water quantity, riparian habitat, fish populations and species diversity, downstream beneficial uses, and social and economic viability of Colorado. For the purposes of the NPS program, stream restoration/rehabilitation can be defined as the measurable improvement of stream and riparian ecosystem processes. Following restoration and rehabilitation activities, streams must be able to convey the sediment and flow produced by the upstream watershed to attain the designated uses without excessive aggradations or degradation of bed and banks.

A rigorous scientific approach is necessary for stream/riparian rehabilitation activities to meet objectives and enhance the chances for long-term success. These projects can be very expensive and sound scientific principles and engineering techniques must be applied. Planning of stream and wetland restoration to ensure that the project is conducted in a timely and cost-efficient manner and that the ecological and/or NPS pollution goals are met are critical steps.

The stream restoration activities must be put into the context of the upstream contributing watershed, which can be accomplished in an overall watershed plan. A risk assessment should be conducted downstream of the restoration activity.

Knowing the past, current and potential development in a watershed will improve chances for success in restoring streams and avoid temporary approaches to stream restoration/rehabilitation. It is also important to implement a watershed approach for calculating flow and sediment

discharge, impervious areas, diversions, identification of soils and geologic types, localized climate, etc.

Funding Opportunities

Through the watershed planning process, local stakeholders can identify and integrate a variety of funding options that may be appropriate to assist in implementing a watershed plan. The following list is not all-inclusive, but provides examples of funding sources used to implement NPS projects.

Targeted Watershed Grants

The Targeted Watersheds Grant Program is a relatively new US EPA program designed to encourage successful community-based approaches and management techniques to protect and restore the nation's waters. This grant program was first proposed in 2002; US EPA has awarded nearly $30 million the first two years. Targeted Watershed Grants support projects that protect watersheds valued for drinking water, fisheries, recreation, and other important uses. The watershed organizations receiving grants generally exhibit strong partnerships with a wide variety of support; creative, socio-economic approaches to water restoration and protection; and explicit monitoring and environmentally-based performance measures.

Water Pollution Control Revolving Fund

The Water Pollution Control Revolving Fund (WPCRF) was created in 1988 within the Colorado Water Resources and Power Development Authority by the General Assembly under Senate Bill 50. Colorado was required by the Federal Clean Water Act Amendments of 1987 to convert the wastewater grant program to a revolving loan program. The Authority issues bonds to fund leveraged loans and provide the State's required 20% match on each federal dollar. Through December 2004, the Authority has provided approximately $35 million to match over $187.6 million in federal grants. The subsidized loans are provided to local governments finance wastewater infrastructure (plants, sewers, etc.) and nonpoint source pollution abatement projects.

Great Outdoors Colorado

Great Outdoors Colorado (GOCO) was established by voter approval in 1992, and is funded from 50% of the proceeds from the Colorado Lottery, which is the only source of funding. The program now includes seven different grant opportunities related to wildlife, outdoor recreation, parks and open lands. Several NPS project sponsors have been successful in obtaining GOCO grants.

US Department of Agriculture

USDA has a variety of financial assistance programs for use on private working lands, including several new programs resulting from the 2002 Farm Bill. Most notable is the Environmental Quality Incentive Program; Colorado was allocated more than $39 million in federal fiscal year 2005. Other programs include the Farm and Ranchland Protection Program, Conservation Security Program, Conservation Reserve Program, Wetland Reserve Program, and the Wildlife Habitat Incentive Program.

Energy and Mineral Impact Assistance Fund

Energy and Mineral Impact Assistance (EMIA) program assists communities affected by the growth and decline of energy and mineral industries in the state. Funds come from the state severance tax on energy and mineral production and from a portion of the state's share of royalties paid to the federal government for mining and drilling of minerals and mineral fuels on federally owned land. The program was created by the legislature in 1977.

Entities eligible to receive grants and loans include municipalities, counties, school districts, special districts and other political subdivisions and state agencies. By statute, eligible activities consist of the "planning, construction and maintenance of "public facilities" and "the provision of public services." Several nonpoint source projects have used this fund to provide the required match for a nonpoint source grant. Examples include funds to implement a stormwater infrastructure program and partial funding for a local watershed coordinator.

Nonpoint Source Grant Funds

Each year Colorado receives an allocation from the federal appropriation to implement its Nonpoint Source Management Program. Based on a formula, Colorado ranks 36th among the states and territories that receive the appropriation.

The allocation is divided into two parts: base funds, which may be used for any NPS program purpose, and incremental funds, which may only be used in watersheds with impaired waters. Guidance is issued periodically by US EPA headquarters to provide direction on the use of the grant funds.

Colorado's funding priorities are established annually, depending on program needs and program guidance from US EPA. Deadlines and procedures may change from year to year. Current information is provided on the NPS Website.

What is eligible for NPS grant funding?

NPS funds are appropriated by Congress for the express purpose of implementing a state's Nonpoint Source Management Program. All applications for funding must address objectives and action items found later in this document. In addition, the emphasis on measurable water quality improvements necessitates the funds be focused toward on-the-ground remediation and restoration activities. However, in the course of watershed plan implementation, other activities frequently are proposed for funding.

Watershed coordinators

One key to success for a local stakeholder group is a dedicated local watershed coordinator. The NPS program recognizes the importance of these individuals, especially for a fledgling group, and will provide limited financial support.

- NPS grant funds may be used to support a local watershed coordinator on a part-time basis (half-time), for up to two years, with NPS funds contributing up to 60% of a half-time coordinator.
- In the event a local stakeholder group is implementing a watershed plan, and has four or more open contracts (regardless of funding source) that will lead to measurable water quality improvement, NPS funding may be used to provide

administrative support and contract management beyond the two-year limit for coordinators.

Technical assistance

Technical assistance is critical to the success of any on-the-ground project, to assure the management measures are properly designed, implemented, operated and maintained. NPS funding may be used to provide technical assistance for active, on-the-ground NPS-funded projects, for the duration of an active NPS contract. Other requests for technical assistance will be considered on a case-by-case basis, taking into consideration the annual priorities and action items in the NPS Management Program.

Assessment and Monitoring

US EPA limits the amount of grant funds that may be used for monitoring and assessment, which includes the development of TMDLs and watershed plans. NPS funds may be used only to:

- Collect data in direct support of the development and implementation of a total maximum daily load.
- Determine measurable results from on-the-ground NPS projects.
- Develop watershed plans, when identified as a priority in the annual proposal guidance.

NPS funds may not be used to determine "baseline" conditions. For example, they cannot be used to capture current conditions outside the development of a TMDL. Collecting data to evaluate current water quality classifications and standards or to conduct a use attainability analysis also are not eligible for NPS funding.

Any proposal to fund assessment in watersheds where water bodies are identified as impaired must be coordinated through the TMDL program at the WQCD prior to submittal of the proposal.

Use of NPS funds on private land

One requirement for NPS grant funding is long-term operation and maintenance of any best management practice implemented with NPS funds. Long-term O&M is best assured when the landowners and/or operators (for instance, lessees) in a watershed are active participants both in the stakeholder organization and in voluntarily implementing BMPs.

Landowners and/or operators will be required to commit to a minimum period of operation and maintenance, which will be determined on a project-by-project basis, and is based on the expected life of the project. Several organizations, including USDA, have developed BMP practice life span guidelines, which will be used, in part, to determine an appropriate project life span.

Landowners and/or operators will also be required to participate financially in implementing BMPs on their land. The expected contribution is at least 25% of the cost of BMP implementation on their properties. Their contribution can be either by direct cost contributions, i.e., cash, or through in-kind services, e.g., labor.

In appropriate circumstances the program will ask affected landowners to execute an environmental covenant in exchange for the use of nonpoint source grant funds on their property. An environmental covenant is a mechanism by which current and future owners of a property agree to maintain and/or not interfere any institutional controls (such as a cap, fencing, access requirements, diversion ditches, water well prohibitions, etc.) that are part of an approved remedy and are necessary to protect public health and the environment. The Department believes that an environmental covenant is appropriate where nonpoint source grant funds are used on a project that results in residual contamination at levels that have been determined to be safe for one or more specific uses, but not all uses; or that include the incorporation of an engineered feature or structure that requires monitoring, maintenance, or operation or that will not function as intended if it is disturbed.

If the landowner obtains the benefit of nonpoint source grant funds, the Department believes that it is fair as a matter of policy to attach reasonable conditions that help ensure that the remedy paid for with such funds remains effective. In appropriate circumstances the Department will thus give priority to projects where the landowner agrees to a covenant.

Public access to lands restore/improved with NPS grant funds

There is precedent in the Clean Lakes Program to require public access to those water bodies improved or restored with the use of public funds:

> *The Clean Lakes Program will only address publicly owned lakes with public access to the lake through publicly owned contiguous land so that any person has the same opportunity to enjoy nonconsumptive privileges and benefits of the lake as any other person. If user fees are charged for public use and access through State or substate operated facilities, the fees must be used for maintaining the public access and recreational facilities of this lake or other publicly owned freshwater lakes in the State, or for improving the quality of these lakes (40 CFR 35.1605-3).*

When NPS grant funds are used for stream restoration/improvement projects, the watershed plan that prioritized the stream project must also describe how public access will be provided to the improvements gained by the project. Proposals for nonpoint source grant funding that provide public access will be given priority for funding, assuming all other criteria are met. NPS funds may not be used on projects that could improve a fishery used for private or exclusive purposes, private or personal gain or benefit.

III. DESCRIPTION OF THE POLLUTANT CATEGORIES

Section 319(a)(1)(B) of the 1987 Clean Water Act requires each state to identify the categories and subcategories of nonpoint sources that contribute pollutants in amounts such that water quality standards are not met. Colorado's original NPS assessment report identified the following major categories of nonpoint sources:

Agriculture	Resource Extraction
Silviculture	Land Disposal
Construction Runoff	Hydrologic Modification
Urban Runoff	Other

These categories also represent the primary committees of the Colorado Nonpoint Source Council. The committees and Council assisted the Division develop the original NPS Management Program. Several categories were combined in the original program, as many of the most appropriate management measures (best management practices) to control pollutants were similar between categories. Those combinations are maintained in this update as noted by section headings.

This section of the NPS Management Program update describes the impact of each category on Colorado's waters and the areas of focus for the next five years. Focus areas are incorporated into the action plan in Section IV.

Agriculture – Silviculture

Agriculture and silviculture account for a majority land use in Colorado and are significant potential sources of NPS pollution. Successful implementation of a system of BMPs has shown to minimize this potential of pollution.

Agriculture and silviculture includes the cultivation of cropland (including grains, vegetables, and orchards), the raising of livestock and the management of forests. Related activities include irrigated and dryland farming, grazing, animal feeding operations, and timber harvesting including related road construction on public and private lands.

The Colorado NPS Program values the partnerships that have developed with the land stewarding organizations and agencies. Colorado's conservation districts have willingly worked on water quality related BMPs in program planning and project implementation.

Urban growth projections continue to show an increase in the next twenty years. This trend adds a strong potential influence for agricultural as a downward trend on agricultural acreage. These projections also indicate an increased urban need for water posing a further impact on agricultural, especially irrigated agricultural production. The forestlands have also shown impacts from growth related issues. Wild fires have been a significant issue in recent years.

Table 6: Agriculture Statewide Statistics

	1993	1996	1998	2002
Number of farms	25,500	25,000	24,500	31,369
Land in Farms, million acres	32.8	32.7	32.5	31.1
Average farm size, acres	1286	1308	1327	991
Cropland acreage, million acres	11.0	10.9	10.9	11.5
Irrigated acreage, million acres	3.0	3.2	3.2	2.6
Total cattle operations, (includes feedlots)	14,000	13,000	13,000	13,311
Sheep operations	1800	1300	1,200	1613
Hog operations	1600	1400	1,000	989

Note: Recent statistics have been affected by new farm classifications that could impact perceived trends.

Colorado has approximately 22.6 million acres of forestland, with nearly 68 percent in federal ownership. An estimated 200,000 private landowners control 28 percent of the state's forest; the remaining forest is owned by other units of government or other non-federal entities. (2001 Report on the Condition of Colorado's Forests)

Impacts on Surface Water Quality

The 2004 303(d) list (CDPHE WQCC Regulation #93)details over 40 surface stream segments in the state with selenium impairment. Agriculture is a possible contributor to these pollutant loads in many situations and locations. Impairments due to pH and bacteria also may have an association to agriculture.

Other pollutants often associated with agriculture and silviculture are sediment and nutrients. Over 85 listings for sediment occur on the Monitoring and Evaluation list (CDPHE WQCC Regulation #94). These pollutants occur naturally due to erodible soils and an arid climate. Human activities can greatly increase the rate of erosion and lead to siltation of streambeds, as well as lakes and reservoirs. Siltation can lead to loss of aquatic habitat in both streams and standing water bodies.

Phosphorus and nitrogen are used commonly in agriculture and can pose a threat to water quality. Over-application of fertilizers and animal waste to cropland can lead to runoff and/or leaching problems. Increased nitrate levels in ground water drinking water sources, as in, pose health concerns. Nutrient-enriched surface runoff may stimulate the growth of algae or nuisance weeds in lakes and reservoirs.

Silvicultural activities can impact the flow and sediment delivery process through the removal of forest canopy and road construction. Wild fires can have similar impacts with the addition of greater landslide potential. The actual impact of silvicultural activities on water quality has not been well quantified. However, forest health is an important feature of watershed management. In 2002, the US Forest Service in cooperation with the Colorado State Forest Service began a five-year inventory of Colorado's forest health as part of the Forest Inventory and Analysis

Program. Once the five-year cycle is complete, a comprehensive report on Colorado's forests will be published.

High levels of nitrate (in excess of 10 mg/l nitrate nitrogen) are present in a limited number of drinking water supplies, in particular several communities in the lower South Platte Basin that depend on alluvial ground water and San Luis Valley residents that depend on the unconfined aquifer. Recreational activities in lakes and reservoirs have been restricted by over enrichment of standing waters, in addition to impacting drinking water and irrigation supplies.

Impacts to Ground Water

Nitrate-nitrogen is the primary impact from agriculture to ground water impairment in Colorado. Nitrate leached from fertilizer and manure has significantly impacted ground water quality in several basins. This impairment has been measured by several entities including: the Agricultural Chemicals and Ground Water Program at Colorado Department of Agriculture, US Geological Survey National Water Quality Assessment (NAWQA), Northern Front Range Water Quality Planning Association, the USDA-Agricultural Research Service, Colorado Division of Water Resources, public water suppliers and several ground water management districts.

The South Platte alluvial ground water system has been found to have more frequent and higher levels of nitrate-nitrogen than other parts of Colorado. Monitoring has found roughly one-third of the wells from Denver to Julesburg exceeding the 10 milligrams per liter drinking water maximum contaminant level (MCL). The most impaired portion of the aquifer exists in Weld County from Brighton to Greeley. In this area, up to 70 percent of wells sampled from 1989 to 2004 exceed the drinking water standard. Recent trend analyses conducted on nitrate data in this portion of aquifer shows no trend in nitrate concentrations over a ten-year period.

The San Luis Valley unconfined aquifer is next in impairment due to nitrate as approximately 30 percent of ground water samples from monitoring wells sampled in 2000 were above the MCL. Sampling in the Lower Arkansas River valley alluvium showed five percent of monitoring wells and 13 percent of domestic well samples exceeding the drinking water MCL. Other sporadic nitrate drinking water samples exceeding the drinking water MCL have been found on the High Plains and along the Urban Front Range.

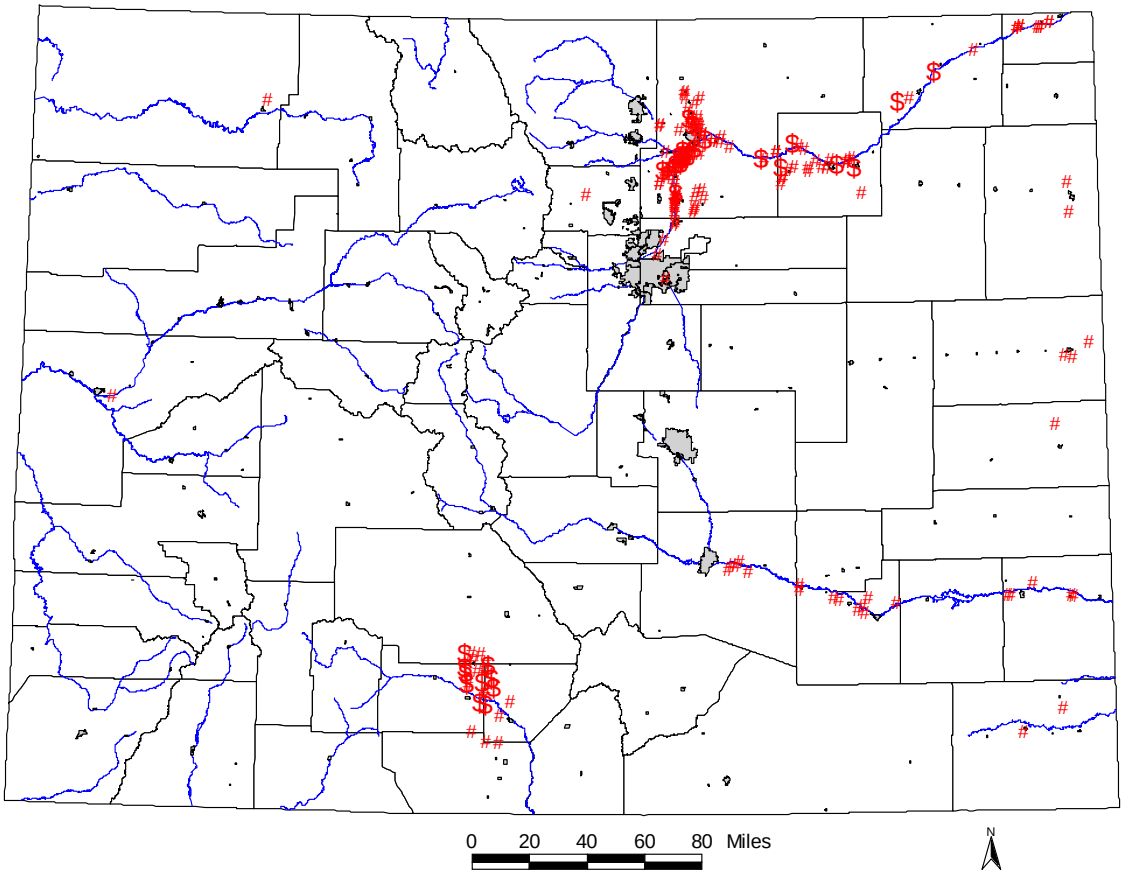

Figure 2: Samples exceeding 10 milligrams per liter drinking water standard

Sampled by the Agricultural Chemicals and Ground Water Protection Program (Source: Brad Austin, Colorado Department of Agriculture).

Monitoring also indicates a few locations with pesticide detections in the ground water, but no widespread contamination. For instance, in the South Platte alluvial aquifer, atrazine and its breakdown products have been frequently detected at low levels (less than one microgram per liter). However, one monitoring well in 2001 registered a level above the maximum contaminant level for atrazine of 3.0 microgram per liter.

It is worth noting the both the frequency and concentration of atrazine and prometone in the Weld County portion of the South Platte alluvial aquifer is decreasing. The next most frequently detected pesticide throughout Colorado is prometone, followed by metolachlor, alachlor, 2,4-D, and metribuzin. In 14 years of sampling by the Ground Water Program, less than one percent of over 1,600 samples have exceeded an established water quality standard.

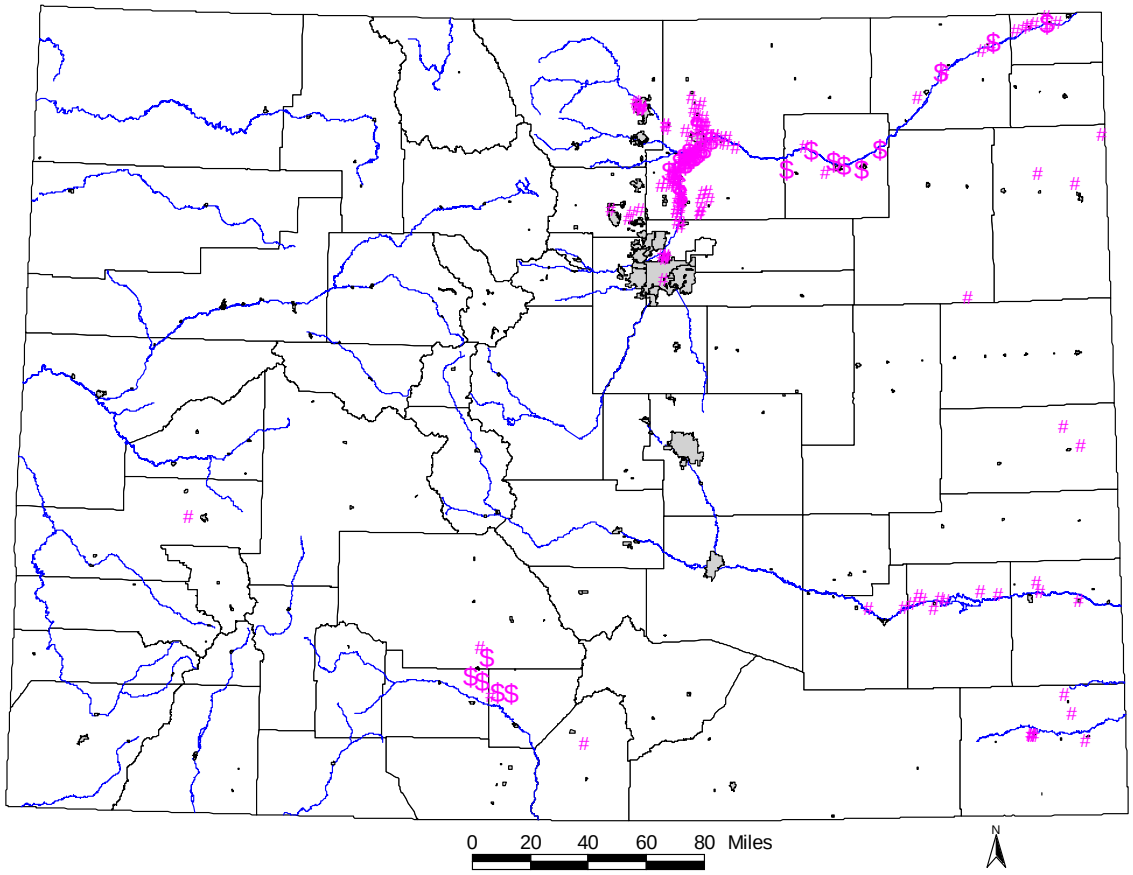

Figure 3: Pesticide detections in wells

Sampled by the Agricultural Chemicals and Ground water Protection Program (Source: Brad Austin, Colorado Department of Agriculture).

In summary, pesticide contamination in Colorado ground water is infrequent and at very low concentrations. Nitrate contamination, however, exists in concentrated hot spots in several basins, largely around animal confinement facilities (past and present) and intensively farmed irrigated crop lands. The South Platte basin between Brighton and Greeley has the most complex and significant ground water contamination from both nitrate and pesticides as a result of the length and intensity of human activity.

<u>Agriculture – Silviculture Focus Areas</u>

- Implement selenium management efforts (including related salinity reduction practices) to reduce loading in the lower watersheds of the Arkansas, Gunnison, Colorado and South Platte Rivers.

- Support animal agriculture in managing adverse animal impacts to water quality

- Reduce sediment loads that impair surface waters or posing a significant threat to public drinking water supplies, e.g. wildfire burn area rehabilitation.

- Prevent impairment of ground and surface water due to nonpoint source contamination by agricultural chemicals.

- Partner with organizations and agencies to promote the inclusion of water quality management in their programs; support technology transfer and implementation related activities through grant and technical assistance.

Hydrologic Modification

In 1992, the US EPA Region 8 approved a separate NPS management program for Hydrologic Modification. The program described a process to assist an individual or entity in identifying and developing programs to minimize nonpoint source water quality impacts resulting from hydrologic modifications.

Many of the concepts identified in the 1992 program, in particular the consideration of a watershed as a whole, have been incorporated into Colorado's overall program. The 1992 program has been used rarely in Colorado.

The exercise of a water right in Colorado is protected in the state constitution and reinforced in numerous state statutes. The NPS program shall not supersede, abrogate, impair or cause material injury to water rights in accordance with 25-8-104 C.R.S. or be inconsistent with U.S.C. 33-1251(g).

Hydrologic Modification Focus Area

- Evaluate the existing hydrologic modification program process in the context of a watershed integration of the NPS pollutant categories, and revise and update as necessary.

Information and Education

NPS Information and education efforts to date have been successful in increasing the awareness and knowledge of the general public. More citizens know that pollution from diffuse sources can impair waterways just as pollution from a point source can. However, at the same time a survey by the League of Women Voters of Colorado Education Fund found less than 25% of urban residents knew they lived in a watershed. Clearly, additional efforts are needed.

It takes time for awareness to evolve into action or behavior change, which in turn will result in a direct water quality improvement. Many changes are generational, that it, the small changes take a full generation or more to have a cumulative, measurable impact. This is difficult to measure in a five to 10 year time span.

As Colorado's NPS Program moves toward an integrated watershed approach to NPS management, new I & E work will be focused on achieving NPS program goals. The core I & E

program activities will be retained, for instance, the coordination of outreach activities, electronic distribution of news, and Website maintenance.

Information and Education Focus Areas

- The I & E program content and activities will be integrated with all other categorical areas.

- I & E efforts and projects will focus new efforts on those that will achieve the larger NPS Program goals while maintaining the Outreach Grant Program, being a NPS resource and clearinghouse, hosting a forum and producing NPS information products (such as project fact sheets, web page, etc.)

Mining

Although the original NPS assessment identified the category of resource extraction in general, the issues have been refined to address mainly the historic and inactive hard rock mine sites. The mining NPS program is designed to deal with mining water quality impacts that result from mining activities that occurred previous to the passage of the Clean Water Act in 1972. These issues present some of the most difficult challenges to water quality improvement in Colorado.

Mining operations occur in areas that have significant reserves of metals such as gold, silver, lead, zinc and copper. The majority of adverse impacts from mining occur in historic mining districts within the mineral belt of Colorado, which extends from Boulder south and southwest to Silverton. These same areas typically have high concentrations of materials such as sulfur, arsenic and other elements that can contribute to the release of heavy metals.

A statewide inventory of abandoned mines estimates that over 23,000 abandoned mines exist in Colorado. Approximately 400 of these mines are adversely impacting, or have the potential to impact, rivers and streams. Sediment related to past mining and milling activities also contributes to the contamination of the state's waters. Many stream segments on the state 303(d) list are impaired by heavy metals from inactive and legacy mines. Pollutant metals include zinc, cadmium, manganese, iron, and lead.

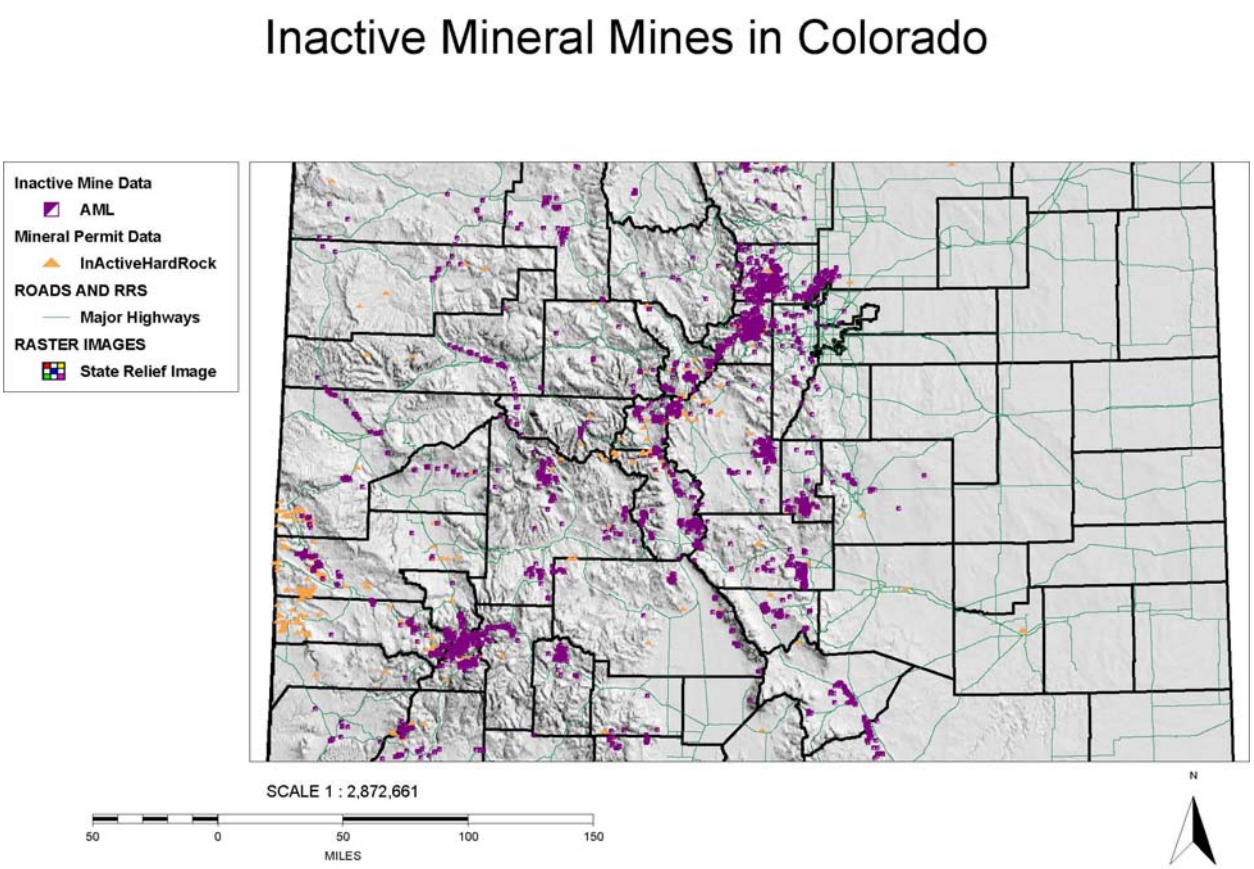

Figure 4: Inactive Mines of Colorado

<u>Mining Focus Areas</u>

- Continue a watershed approach to remediation. This includes creating a plan that targets all sources of pollution in a watershed through the collection of data, setting goals for remediation efforts, determining clean up strategies, using appropriate regulatory and nonregulatory mechanisms to implement those strategies, and providing follow-up monitoring to determine if the efforts are successful.

- Watersheds with approved TMDLs and existing watershed plans will be prioritized for implementation activities.

Urban and Construction

The State of Colorado faces significant challenges due to pressures of increased employment and population. Colorado experienced inward migration over several decades, and this pattern is forecasted to continue into the near-term future. The Colorado population was estimated to be 4,691,250 in 2005. The Denver metropolitan region population was estimated at 2,611,500 during the same time period. The Colorado population is projected to reach over 7,156,500 people in the year 2030 with over 3.875 million people in the Denver metropolitan region for an average growth rate of 1.8 percent.

Erosion and sedimentation are still the primary source of pollution associated with development in Colorado. A number of stream segments affiliated with urban watersheds are on Colorado's 303(d) list. The effects of substantial steps to reduce pollutant potential in urban areas and on construction sites over the last five-years are generally evident. Major site development projects affecting one acre or more of land area require a National Pollutant Discharge Elimination System (NPDES) stormwater permit. These construction activities have the greatest potential to cause nonpoint source pollution. Both structural and nonstructural best management practices are used to reduce water quality degradation from construction sites. While not every construction site is inspected for compliance, the threat of inspection and possible fines has altered the construction industry in Colorado. Many large-scale construction activities associated with both urban development and road construction have been inspected and fines levied in cases of negligent application of best practices.

Construction practices associated with development have the potential to cause sediment erosion beyond natural conditions. Runoff from construction sites also has the potential to carry other chemical pollutants and biological pollution. The deposition of sediments in receiving waters in Colorado is a major nonpoint source problem. Construction debris carried in runoff water has also been identified as a potentially significant nonpoint pollutant source. In relation to potential water quality degradation, there are two levels of construction activity occurring in Colorado that can produce varying degrees of nonpoint source pollution and specific runoff pollutants:

- • Site development or highway construction that disturbs over five acres of land area (medium to high potential for runoff pollutant generation); and
- • Site development or roadway improvements on one to five acres of land (low potential for runoff pollutant generation).

Construction activities on sites with less than one acre of disturbance are not currently regulated and generally pose a limited threat to receiving water quality in Colorado. The phase II stormwater regulation regulates construction activities on lots larger than one acre.

An urban watershed protection approach is an integrated, holistic strategy to protect or attain the desired beneficial uses of waters within an urban area. The approach is more effective than isolated efforts under existing programs that do not consider the watershed as a whole. Nonpoint source or stormwater runoff control at a watershed level can have a significant impact on the protection of beneficial uses. A watershed protection approach addresses point source discharges along with nonpoint source and stormwater pollutant loads. An urban watershed approach also considers other human activities that may affect the uses and quality of the water resources.

Urban and Construction Focus Areas

The long-range target of the urban and construction management program in Colorado is to reduce the pollution potential from urbanized regions of the state and at construction sites within a watershed and/or urbanshed framework. The near-term focus areas include:

- • Support TMDL efforts in urbanized areas associated with or caused by large-scale construction efforts.

- • Support nonpoint and stormwater source prevention and control programs, urban and construction pollutant reduction, pollution prevention or other preventative programs in urban watersheds.
- • Develop and disseminate categorical urban and construction best management practice guidance documents and manuals.

IV. COLORADO'S 2005 – 2010 NONPOINT SOURCE ACTION PLAN

The intent of this section is to identify those items that reasonably can be accomplished over the next five years, assuming level federal grant funding. Action items from the pollutant category areas are included in this section.

All action items will operate under the following overall program goal.

> *The Nonpoint Source Program will strive to restore to full use those waters, both surface and ground water, impaired by nonpoint sources, and to prevent future impairments to Colorado's waters, by using an effective, efficient and open process that fully involves the public and brings together the necessary regulatory and non-regulatory authorities, agencies and programs.*

In addition, the program activity measures established by the US Environmental Protection Agency will be used, in part, to guide actions and evaluation of the program. As of April 1, 2005, the draft PAMs for the nonpoint source program include:

- Number of watershed based plans and water miles/acres covered that are under development.
- Number of watershed based plans and water miles/acres covered that are being implemented.
- Number of watershed based plans and water miles/acres covered that have been substantially implemented.
- Number of water bodies identified in 2000 (1998 in Colorado's case) as being impaired by nonpoint sources or by both point and nonpoint sources that are fully restored.
- Annual load reductions in pounds/tons of nitrogen, phosphorus, and sediment from nonpoint sources to water bodies.

These measures may change from year to year, and will be updated and incorporated into the action plan as necessary.

In addition to the national program activity measures, the Colorado NPS Program will track other load reductions important to Colorado waters, such as the reduction of heavy metals from restoration activities at inactive mines.

The action plan will be reviewed annually and updated as needed to reflect completed actions as well as emerging needs. Progress in accomplishing PAMs also will be reviewed annually.

Table 7: NPS Action Plan

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Objective 1: Stakeholder support. *Nonpoint source projects are conducted on a voluntary basis, which generally requires an active and involved group of concerned citizens. The NPS Program will provide qualified support to those local organizations actively involved in restoring water quality.*			
Action 1.1: Support watershed stakeholder organizations through initial financial support of local watershed/stakeholder coordinators in important watersheds, following guidelines established in Section II of this document.	2005 – 2010	Initiation grants/coordinator grants to key stakeholder organizations	Watershed plans and remediation actions initiated in important watersheds
Action 1.2: Provide technical assistance to NPS-funded remediation projects.	As needed through 2010	Funding provided in conjunction with on the ground remediation actions	Watershed plans and remediation actions initiated in important watersheds
Action 1.3: Increase the funding foundation of watershed stakeholder organizations in high priority watersheds by providing financial development technical assistance to those groups.	2005 - 2008	Key watershed groups have a finance plan for their operations	Sustainably funded watershed groups
Action 1.4: Build long-term partnerships to enhance cooperation between industry, environmental groups, and government in restoration of inactive mined lands and other lands.	2005 – 2010	Collaboration, coordination and cooperation for on-the-ground projects	Watershed plans and remediation actions initiated in important watersheds

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Objective 2: Prioritizing Data Collection. *Limited resources and national emphasis require a limited but strategic approach to funding monitoring and evaluation activities.*			
Action 2.1: Annually, in consultation with the Water Quality Control Division TMDL program and others, establish priorities for monitoring and evaluation activities to support the total maximum daily load program needs with a substantial nonpoint source component.	By September 1 each year	Annual guidance for potential project sponsors	Sufficient data to develop approvable TMDLs or to delist stream segments
Objective 3: Watershed planning.			
Action 3.1: Increase the number of important watershed plans developed by funding up to eight planning efforts each year.	Eight plans approved for funding by March 1 of each year	Watershed plans that integrate across NPS pollutant categories and include both restoration of impaired streams and protection of unimpaired streams in the watershed	Prioritized implementation of restoration/protection actions leading to improved water quality

Watersheds for which a watershed plan should be developed by 2015, based on 303(d) lists to date:

- Upper San Miguel River
- Dolores River
- Mancos River and tributaries above US Highway 160 East
- Uncompahgre River, from Montrose to confluence with Gunnison River
- Gunnison River, below Blue Mesa Reservoir
- North Fork of the Gunnison
- Colorado River, from confluence with Gunnison River to state line
- Barr Lake and Milton Reservoir
- Kerber Creek
- Alamosa River
- Upper Arkansas, above Buena Vista
- Arkansas River, Pueblo Reservoir to John Martin Reservoir
- Arkansas River, John Martin Reservoir to state line
- Blue River above Dillon Reservoir
- North Fork of the South Platte
- Middle Fork of the South Platte
- Rio Blanco River

The list above is not all-inclusive, and is subject to bi-annual review and update.

<table>
<tr><th>Objective/Action Item</th><th>Time Frame</th><th>Output or Product</th><th>Outcome or Result</th></tr>
<tr><td>Action 3.2: Increase the proficiency of local stakeholder organizations to develop watershed plans through hands-on training opportunities.</td><td>Annually provide training</td><td>• Local watershed groups understand the planning process and plan content needs
• Local groups have a strategy to complete their plans</td><td>Higher quality watershed plans which prioritize implementation of restoration/protection actions that lead to improved water quality</td></tr>
<tr><td colspan="4"><u>Objective 4: Implementation of Restoration and Prevention Measures.</u> All on-the-ground activities must be identified in a local watershed-based plan. Watershed plans are expected to integrate priority activities across NPS pollutant categories, as appropriate for the local watershed.</td></tr>
<tr><td>Action 4.1: Identify those watersheds with adequate watershed plans and encourage stakeholders to implement those plans; provide financial support to those stakeholders implementing water quality restoration measures.</td><td>Annually</td><td>Project implementation plans funded to implement important watershed plans</td><td>Prioritized implementation of restoration/protection actions leading to improved water quality</td></tr>
<tr><td colspan="4">Watersheds that have already completed or will complete watershed plans by 2007, and which would be eligible for implementation funding, depending on annual priorities:</td></tr>
<tr><td colspan="4">▪ Animas River above Silverton*
▪ Lake Fork of the Gunnison, Palmetto Gulch
▪ Snake River
▪ Slate River
▪ Coal Creek and tributaries from Crested Butte water supply intake to Slate River
▪ Upper Rio Grande, including Willow Creek, to Alamosa County line
▪ Straight Creek*
▪ Cherry Creek*
▪ Clear Creek, above the mouth of the canyon
▪ Big Thompson River, Rocky Mountain National Park to Home Supply Canal
▪ Lefthand Creek, including James Creek and Little James Creek*
▪ Eagle River, including Black Gore Creek
▪ North Fork of the Republican River
▪ Big Thompson River
▪ Fountain Creek
▪ Bear Creek

* Indicates watershed with completed TMDL.</td></tr>
</table>

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Action 4.2: Secure maintenance agreements with landowners and/or operators for on-the-ground restoration activities prior to initiation of work, to assure long-term operation and maintenance of NPS funded best management practices and continuance of protection accomplished by the work.	Prior to initiating on-the-ground activities in each project area	Maintenance agreements	Long-term operation and maintenance of restoration/protection actions leading to improved water quality
Action 4.3: Partner with lead agencies in responding to emergency wildfire area treatments to implement BMPs to protect public water systems.	As needed through 2010	Rapid implementation of emergency BMPs	Public water supplies protected
Action 4.4: Implement selenium management efforts, including partnerships with other programs, to reducing loading in the lower watersheds of the Arkansas Colorado, Gunnison, Uncompahgre, and South Platte Rivers.	2005 – 2010	Project implementation plans and coordination/cooperation with partners	Prioritized implementation of restoration/protection actions leading to improved water quality
Objective 5: Evaluation and monitoring for success. *Measurable results require collection of data and evaluation of that data to document change in water quality and effectiveness of the BMPs implemented through NPS projects and others.*			
Action 5.1: Identify, develop or modify evaluation tools for both the program and for water quality as impacted by nonpoint sources.	By January 1, 2007	Appropriate tools that can be used by project sponsors and others to measure activity results	Documented water quality improvements
Action 5.2: Identify, develop or modify other indicators of success, including scientific, social, and political indicators.	By January 1, 2007	Appropriate tools that can be used by project sponsors and others to measure activity results, recognizing not all success results in a direct water quality improvement	Documented improvement measured in other indicators

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Action 5.3: Develop standard sample, analysis and assessment plan template for NPS-funded projects to use.	By July 1, 2006	Consistent sample, analysis and assessment plans for collection of NPS data	Documented changes in water quality
Action 5.4: Train project sponsors in data management, including STORET.	By July 1, 2008	Project sponsors and other watershed partners manage data through STORET	Documented water quality improvements; data collected by NPS projects fulfills grant conditions and is considered in WQCD assessment programs
Action 5.5: Provide monitoring technical assistance to project sponsors, as needed.	2005 – 2010	Request for proposals to monitor key watershed implementation projects	Documented changes in water quality
Action 5.6: Assess the impacts of BMPs in those areas where significant restoration and protection efforts have occurred, including selenium management and heavy metal mitigation from mining.	2005 – 2010	• Produce data from key projects • Report to EPA progress in attaining PAMs	Documented changes in water quality
Objective 6: Outreach and education. *The increased emphasis on measurable results places outreach activities in the context of on-the-ground water quality improvements. While outreach activities are not subject to the same requirements to demonstrate water quality improvements, outreach needs to be strategic and contextual. Maintenance of overall state-wide efforts is necessary to achieve the program goal; local efforts should be initiated in the context of watershed priorities.*			
Action 6.1: Increase the knowledge level of partner organizations, stakeholder groups and other interested entities on the technical aspects of water quality management, including topics such as water quality standards and the development of TMDLs by developing and producing a "Colorado water quality academy."	By July 1, 2007	Water quality workshop(s)	Key stakeholders, partners and others understand and can appropriately apply Colorado water quality principles in their locales.

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Action 6.2: Cooperate with CSU Cooperative Extension to provide a staff coordinator for I & E Core Responsibilities.	Through 2010	• NPS staff outreach coordinator with Cooperative Extension • Increased coordination of outreach activities with NPS projects	Increased public awareness of polluted runoff issues as measured by statewide survey conducted in 2006 and 2010
Action 6.3: Support specific NPS outlets/approaches with proven success (NPS annual forum, Webpage, electronic newsletter, NPS message consistency and mascot use, I&E BMP guidance/training, NPS information clearing house/resource, targeted youth education, manage outreach grant and cultural diversity).	Through 2010	• Annual NPS Forum • www.npscolorado.com • Database management/ clearing house maintenance	Increased public awareness of polluted runoff issues as measured by statewide survey conducted in 2006 and 2010
Action 6.4: Hold an animal agriculture summit to communicate resources and methods available to reduce animal impact to water quality.	By July 1, 2008	Communication/coordination between animal agriculture projects with NPS emphasis	Improved/protected water quality as related to animal agriculture operations
Action 6.5: Manage Outreach Mini-Grant to support overall NPS objectives.	Through 2010	Outreach guidance reflects program priorities	Increased public awareness of polluted runoff issues as measured by statewide survey conducted in 2006 and 2010
Action 6.6: Compile existing guidance for urban BMP needs into relevant guides for Colorado use.	Through 2010	BMP guides	Improved/protected water quality as related to urban and construction activities
Action 6.7: Conduct a statewide symposium on urban and construction practices, updates and implementation strategies, as well as advances in sediment and erosion control specific to Colorado hydrologic conditions.	By 2010	Symposium and proceedings	Improved/protected water quality as related to urban and construction activities

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Action 6.8: Continue support for the development and dissemination of low impact development technology	Through 2010	AWARE Colorado	Improved/protected water quality as related to urban and construction activities and land use decisions
Objective 7: Program Integration. *To implement a watershed-based approach for nonpoint source management, the NPS program will move toward program integration on a sub-river basin basis by 2010*			
Action 7.1: Identify and describe the initial sub-river basins for Colorado NPS management.	By July 1, 2006	Identification of sub-river basins	Watershed approach to NPS management that results in prioritized actions to protect/improve water quality
Action 7.2: Initiate program integration activities in two basins by developing a strategy for integration for those basins, including feasibility assessment.	By July 1, 2006	Outline of an integration strategy and feasibility assessment	Watershed approach to NPS management that results in prioritized actions to protect/improve water quality
Action 7.3: Evaluate structure, composition and functions of the NPS Council, and implement Council operations and processes that are supportive of pollutant integration on a basin basis.	By July 1, 2006	NPS Council organized to support program integration	Watershed approach to NPS management that results in prioritized actions to protect/improve water quality
Action 7.4: Based on the feasibility assessment in Action 7.2, continue to develop integration strategies for each sub-river basin.	80% developed by 2010	Integration strategies developed and initiated for 80% of the sub-river basins identified in Action 7.1.	Watershed approach to NPS management that results in prioritized actions to protect/improve water quality

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Objective 8: Program accountability.			
Action 8.1: Assure the Grant Reporting and Tracking System (GRTS) is up-to-date for all 319-funded projects. GRTS will be used to track project progress reports, reimbursement requests, match accrual, and overall project management items.	January 1 and July 1 each year	Database up to date	Fulfillment of grant conditions and continuing funding from US EPA
Action 8.2: Provide contract and project management training to all new project sponsors each year. Work with project sponsors to assure their semi-annual reports are submitted on time, and loaded into GRTS by the Division.	Spring/early summer each year	Workshop plus contracting and project management tools	NPS projects are accountable and able to accurately fulfill contract requirements
Action 8.3: Provide the NPS Annual Report to US EPA Region 8; report will include progress toward accomplishing PAMs.	January 1 each year, unless otherwise negotiated	Report	Fulfillment of grant conditions and continuing funding from US EPA
Action 8.4: Annually assure public notification of the NPS grant availability and process occurs in a timely manner, based on the overall schedule, which may change from year to year.	September 1 each year, subject to change depending on outside influences on the process	Proposal guidance for potential project sponsors	Prioritized implementation of restoration/protection actions leading to improved water quality through targeted projects
Action 8.5: Draft contracts for NPS projects.	Within 14 days of grant award	Contracts/purchase orders ready for approval	Prioritized implementation of restoration/protection actions leading to improved water quality through targeted projects
Action 8.6: Reimbursement requests from projects are approved and submitted for processing within seven days of receipt from the project sponsor, assuming accurate submittal by the sponsor.	Within seven days of accurate submittals from sponsors	Timely reimbursement to project sponsors	Prioritized implementation of restoration/protection actions leading to improved water quality through targeted projects

Objective/Action Item	Time Frame	Output or Product	Outcome or Result
Action 8.7: Evaluate the list of watersheds in Objectives 3 and 4 and modify as necessary, either by adding newly identified watersheds or deleting those that no longer have NPS water quality concerns.	July 1, 2007 July 1, 2009	Revised priority target lists	Prioritized implementation of restoration/protection actions leading to improved water quality through targeted projects

V. BEST MANAGEMENT PRACTICES

Best management practices (BMPs) for this management program are defined as:

> *A practice or combination of practices, as determined by a responsible group after examination of alternative practices and appropriate public participation, to be the most effective, practicable means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water/stream quality goals.*
>
> *They include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures.*

Implementation of BMPs to correct nonpoint source water quality problems, where such BMPs are identified solely as part of the nonpoint source program, is voluntary in Colorado. Thus, in the absence of independent statutory or regulatory authority, reference in other state and federal enactments to Colorado's NPS program, including BMPs developed thereunder, shall not establish an enforceable requirement that BMPs be implemented other than voluntarily.

The recommendation of BMPs is a complex issue, due to the interaction between various natural resources. A watershed as a whole must be considered, to determine true cause and effect for a nonpoint source concern and identify the most appropriate BMP for the situation. Off-site impacts of BMP implementation must also be considered.

In addition, the selection of specific BMPs will require the involvement and coordination of many parties and interests. Prior to selecting BMPs, a decision must be made on the level of land management to be continued after treatment. Complex systems with high maintenance requirements, although they may be effective initially, will be useless if they are not maintained in the long term.

BMP implementation conducted with NPS grant funds must be prioritized in a local watershed plan. Selected BMPs may not control all nonpoint loading, but will be installed as necessary to reduce nonpoint loading to the goal level. Reasonableness of implementation costs must be considered with each proposed application of BMPs but cost will not be used as a sole determining factor to preclude BMPs in a particular location.

The information on the best management practices in the 2000 NPS Management Program is largely still valid. The information presented here provides an update to the 2000 descriptions.

Contacts for Assistance in Planning and Implementation

The best source of assistance for planning and implementing any best management practice will be in the locality where the BMP's are used. Local offices of the various natural resource management agencies, whether local, state, or federal, can develop site-specific recommendations or designs that account for the local climate, soils, hydrology, etc., as well as any social or cultural considerations. In addition, topic-related professional organizations may have the resources to

provide assistance. There also are environmental resources consulting firms that provide stream restoration services.

Planning and Implementation Tools

The NPS Program recognizes a variety of technical references and guides that provide guidance in site-specific planning, design, implementation or construction, operation and maintenance of a practice or components of a practice. The following list is not all-inclusive, but provided for information. Additional tools may be found in the categorical chapters of the 2000 program document.

- USDA Natural Resources Conservation Service Field Office Technical Guide
- U.S. Forest Service Watershed Conservation Practices Handbook and other technical references
- USDI Bureau of Land Management Technical References
- Colorado State University Cooperative Extension
- Urban Drainage and Flood Control District, Urban Storm Drainage Criteria manual: Volume 3
- Stream Corridor Restoration: Principles, Processes and Practices (The Federal Interagency Stream Restoration Working Group, 1998). See http://www.nrcs.usda.gov/technical/stream_restoration
- Colorado Timber Industry Association Silviculture BMPs
- Colorado Division of Minerals and Geology Best Practices in Abandoned Mine Land Reclamation.

Table 8: Agriculture and Silviculture BMPs

BMP	Description	Use	Purpose
Riparian Area Management	Vegetation and/or structures in-stream, on banks, and on immediately adjacent areas of streams or constructed channels	Riparian areas to stabilize and protect against stream bank erosion	1. Reduce sediment loads which cause downstream or in-stream damage 2. Improve or restore a stream for recreation or to enhance fish and wildlife habitat 3. Prevent the loss of land or damage to utilities, roads, buildings, or other facilities adjacent to the channel banks 4. Minimize impacts of human activities within riparian, sensitive and wet areas
Irrigation Water Management	Determining and controlling the rate, amount, and timing of irrigation water application to achieve the most effective irrigation possible based on environmental conditions	All irrigated lands	1. Manage and control the moisture environment of crops to promote the desired crop response 2. Minimize soil erosion and loss of plant nutrients and agri-chemicals 3. Control undesirable water loss either through runoff or leaching 4. Reduce degradation of water resource due to salinity
Soil Stabilization in Croplands	Utilizing existing plant residues, temporary or permanent vegetative cover and/or structures to reduce erosion and minimize sediment transport	All agricultural lands with the potential for wind and water erosion	1. Prevent sediment and soil-borne pollutants from entering surface water 2. Improve soil health 3. Improve water use effectiveness 4. Improve wildlife habitat 5. Break reproduction cycles of plant pests
Nutrient Management	Application of nutrients based on crop needs, and accounting for all sources of nutrients (commercial fertilizer, manure or sludge, irrigation water, atmospheric sources, composted products, etc.)	All lands where nutrients are applied	1. Minimize availability of nutrients for transport by eliminating over-application 2. Reduce nutrient loading to surface and ground water

BMP	Description	Use	Purpose
Integrated Pest Management	Evaluate all options to determine the appropriate treatment to deal with target pests. Utilize integrated pest management strategies. Select the appropriate chemical, using the minimum effective rate, timing the application for the targeted pest, considering proximity environmentally sensitive conditions including surface water	All lands impacted by pests	1. Reduce reliance upon chemicals by integrating all pest management options, considering biological, cultural, and mechanical means as appropriate 2. Minimize pesticide loss to surface and ground water by eliminating over-application
Forest Management	Managing multiple uses on forestlands in a manner that will maintain or improve forest health	Any managed public or private forestland to reduce erosion and minimize sediment transport due to the activity of man	1. Maintain sufficient vegetation to reduce erosion and sedimentation 2. Maintain litter and mulch necessary to reduce erosion and sedimentation 3. Maintain natural beauty and visual quality 4. Maintain and protect existing uses 5. Minimize hazard of dangerous wildfires 6. Maintain or improve habitat conditions for fish and wildlife 7. Minimize soil loss, and maintain or improve soil quality 8. Minimize or eliminate degradation of water quality 9. Establish stream buffers sufficient to protect water quality. 10. Rehabilitate areas where an unacceptable level of erosion and/or stream/lake sedimentation is already occurring 11. Restore and maintain fisheries that have been damaged or destroyed by sedimentation 12. Maintain or improve the quality and

BMP	Description	Use	Purpose
			integrity of sensitive areas such as, but not limited to, research, natural, scenic, and unstable geologic areas.
Animal Waste Management	Handling animal waste in a manner that minimizes impacts or potential impacts to surface or ground water, including issues such as collection, storage, transport, and land application	Small to medium size confined animal feeding operations not categorized as a point source	1. Prevent ground and surface water contamination 2. Properly apply animal waste to cropland

Table 9: Mining BMPs

Note: BMPs used to treat acid mine drainage, whether active or passive systems, likely are not eligible for nonpoint source grant funding.

BMP	Description	Use	Purpose
Diversion ditches	Ditch diverting water away from mine waste or mine workings.	Waste rock piles Mill tailings Draining mine openings	Effective where the quality of rainwater, snowmelt or surface flow is degraded by flowing over or through mine waste, tailings or into mine workings. Diversion ditches can also be used to intercept shallow groundwater that may enter a mine waste or tailings pile.
Mine waste rock/tailings removal and consolidation	Move the reactive material in the waste rock dump or tailings pile away from water sources	Waste rock located in direct contact with flowing water or pond mill tailings located in direct contact with flowing water or pond	Reduces the potential for water flow through the dump or pile. Will decrease the formation of contaminants, thereby reducing contamination to nearby water sources.
Stream diversion	Stream diversion involves relocating a stream away from a waste rock dump or tailings pile.	Waste rock pile in direct contact with flowing stream with no place to remove and consolidate pile; mill tailings in direct contact with flowing stream with no place to remove and consolidate pile	Stream diversion involves relocating a stream away from a waste rock dump or tailings pile. Reducing the potential for water flow through the reactive materials in the dump or tailings pile will decrease the input of contaminants into the stream

BMP	Description	Use	Purpose
Erosion control by regrading	Preparing disturbed area for revegetation by grading to appropriate slope.	Waste rock piles Mill tailings	Generally, slopes with less than three feet horizontal to one foot vertical are stable from erosion and conducive to vegetation growth.
Capping	Capping of waste rock or tailings is a protective layer of soil, graded to promote runoff rather than infiltration into the reactive materials.	Waste rock piles Mill tailings	Prevent disturbance of the contaminated waste rock or tailings.
Vegetation	Vegetation planted on a waste rock or tailings pile	Waste rock piles Mill tailings	Contain the reactive material by protecting the pile from erosion and reducing the amount of water that can infiltrate into the pile. In addition, vegetation growth provides nutrients to the soil cover and improves the wildlife habitat.
Aeration and settling ponds	Aeration is accomplished by channeling the mine drainage over a series of small waterfalls or drops, which will increase the oxygen content of the water into a quiet settling pond, where the metals will drop out	Treating drainage from a mine opening	Aeration and settling ponds promote the precipitation of heavy metals such as iron, zinc and manganese through oxidation processes
Sulfate-reducing wetlands	The sulfides combine with heavy metals in the drainage to form relatively insoluble metal sulfides, which precipitate or drop out. The bacteria derive their energy from a carbon source, most commonly cow manure or mushroom compost.	Treatment of drainage from waste rock piles; from mill tailings; from a mine opening	Sulfate-reducing wetlands will improve the quality of acid mine drainage using common bacteria found in decomposing organics to remove the heavy metals. Sulfate-reducing bacteria (SRBs) utilize the oxygen in sulfates for respiration, producing sulfides
Oxidation wetlands	Metals, such as iron, manganese, and arsenic are precipitated through oxidation by aquatic plants and algae.	Treatment of drainage from waste rock piles; from mill tailings; from a mine opening	The plant materials provide aeration and, when they die, provide adsorption surfaces for the metals and sites for algal growth. Algae help in the manganese removal process.

BMP	Description	Use	Purpose
Other BMPs to treat acid mine drainage	Diversion of surface waters, dilution, land application, bulkhead seals, anoxic limestone drains, aqueous limestone injection and mechanical injection of neutralizing agents	Treatment of contaminated drainage from mine openings	These BMPs must be designed and engineered to take into account the volume of water, water chemistry, and mine configuration, are expensive and require ongoing maintenance

Table 10: Stream Restoration BMPs

BMP	Description	Use	Purpose
Plant vegetation	Plant vegetation where appropriate; however, there may be exceptions, such as ephemeral streams, high gradient boulder or bedrock dominated channels where vegetation may not have existed historically.	Any stream with unstable banks or potentially degraded due to construction or development pressure	To prevent impairment of streams from construction activities and storm water run off; stabilize banks, improve aquatic habitat. Others include energy dissipation, protect banks, maintain water table and stream/riparian processes.
Reconfigure channel	Change stream morphology; add flow-steering structures and /or root wads and sinuosity.	Any channelized or degraded stream channel	Dissipate stream energy and power associated with high streamflows, minimizing erosion; filter sediment, capture bedload,, aid in floodplain development and increase sinuosity where appropriate.
Filter runoff	Plant vegetation, protect riparian buffer	Any stream with high sedimentation or pollutant runoff	Decrease sediment concentration
Improve habitat	Add root wads, boulders, trees to improve cover, vegetate banks	Any stream needing increased habitat	Decrease stream temperature
Decrease stream temperature	Decrease channel width/depth ratio; add vegetation canopy; add boulders, root wads or snags for cover and energy dissipation.	Any stream too warm to support native species	Improve fish habitat
Slow stream velocity	Add drop structures and/or increase sinuosity	Any stream with high sediment concentration where excessive aggradation is apparent.	Decrease sediment concentration

BMP	Description	Use	Purpose
Weed treatments	Mechanical, chemical or biological agents to eradicate weeds. Plant native vegetation	Any stream chocked with phreatophytes and other water using weeds.	Improve species composition and water quality/quantity by removing weeds.

Table 11: Urban and Construction BMPs

BMP	Description	Use	Purpose
Mountain Driveways	BMPs appropriate for driveways compiled in a concise manner with engineering sketches	Construction that causes sediment and erosion products that reach streams and other waterbodies	Driveways in mountainous areas
High Altitude	Vegetation may not mature until the third growing season, requiring additional time	Where construction of roads, mines, pipelines, and ski areas have left earth bare	Revegetation and restoring land high in the Rocky Mountains
Green Industry	Design, installation and maintenance practices relevant to the Green Industry and the public that they serve	Any new or renovating landscaped area	Conservation of water resources and protection of water quality
Golf Courses	28 key BMPs for use during design, construction, and operation of golf courses	Golf courses in Colorado	Standard erosion and sediment control practices, key regulatory considerations, and lists of additional references
Low Impact Development	A series of best management practices that address reduction of impervious surfaces	To show decision-makers impacts of land use choices on water quality	Provide land use decision makers with research-based, non-advocacy information so they can make informed land use decisions

VI UPDATES TO BACKGROUND INFORMATION

Much of the background information for Colorado's Nonpoint Source Program was developed in the 2000 NPS Management Program document, which continues to serve as a reference document for NPS issues. Consequently, this supplement to the 2000 document only contains new information or significant updates to previous pollutant category information. This supplement supersedes all previous action items and priority watershed or issue designations.

New information in this supplement includes a significant discussion regarding the relationship between stream restoration and water quality. In addition, an additional update was necessary for the Urban and Construction aspect of the program, which follows the stream restoration discussion

Nonpoint Source Stream Restoration Strategy

Introduction to Stream Restoration

The NPS Program over the years has received many proposals to fund various forms of stream restoration. In order to provide technical guidance to future project sponsors and the public, the Division requested the Stream Restoration Committee of the Colorado Nonpoint Source Council to provide input on a new section of the NPS Management Program. The Stream Restoration Committee advocates adaptive management in improving aquatic and riparian habitat to prevent impairment, as well as maintaining or improving beneficial uses of water. Stream restoration activities may be a necessary part of implementing a watershed plan.

Properly functioning stream and riparian areas are critical in maintaining water quality, water quantity, riparian habitat, fish populations and diversity, downstream beneficial uses, social and economic viability of Colorado. Wetlands and riparian areas are critical in ameliorating impacts from upland nonpoint source pollution, and may decrease the need for costly stormwater controls and flood protection structures. Other benefits of streams, wetlands and riparian areas include habitat for nesting, feeding, cover and breeding of birds, fish, reptiles, amphibians, and mammals.

Environmental Setting

Land management activities or land disturbance, either alone or in combination, have affected the timing, magnitude and duration of streamflow, as well as sediment delivery processes from contributing watersheds. These changes in streamflow and sediment routing from the aforementioned activities (alone or in combination) have altered stream stability and caused erosion of some streams, and aggradations of sediment in others. Changes in stream stability can trigger changes in aquatic habitat including substrate, embeddedness, temperature and ultimately, aquatic macroinvertebrate communities. Stream chemistry can be affected by urbanization, mining, atmospheric deposition, and agricultural runoff.

Definition

For the purposes of the NPS program, stream restoration/rehabilitation is defined as the measurable improvement of stream and riparian ecosystem processes that will allow all designated

uses of the water to be attained. Following restoration and rehabilitation activities, streams must be able to convey the sediment and flow produced by the upstream watershed without excessive aggradations or degradation of bed and banks to attain the designated uses.

Colorado's Approach to the Improvement of Stream and Riparian Systems

Colorado's Nonpoint Source Pollution program is designed to address impacts to streams and riparian systems from a multitude of activities, such as mining, urban growth, stormwater, return flows, hydrologic modification, agriculture and silviculture. Stream rehabilitation actions are likely to overlap with the NPS pollutant categories

A rigorous scientific approach is necessary for stream/riparian rehabilitation activities to meet objectives and enhance the chances for long-term success. These projects can be very expensive, and sound scientific principles and engineering techniques must be applied. Planning stream and wetland restoration are critical steps to ensure that the project is conducted in a timely and cost-efficient manner and that the ecological and/or NPS pollution goals are met.

Watershed Approach

The stream restoration activities must be put into the context of the upstream contributing watershed. A risk assessment should be conducted downstream of the restoration activity. The watershed (sometimes referred to as a catchment or drainage) is defined as the area of land that drains water, sediment, and dissolved materials to a common point along a stream. The common point will be the area along a stream being restored. Knowing the past, current and potential development in a watershed will greatly improve chances for success in restoring streams and avoid "band-aid" approaches to stream restoration/rehabilitation. It is also important to implement a watershed approach for calculating flow and sediment discharge, impervious areas, diversions, identification of soils and geologic types, localized climate, etc. Watersheds can be delineated on aerial photos, USGS 7 ½ minute quadrangle maps, or other topographic maps.

Identification of Impacted Areas and Stream Rehabilitation Priorities

Stream restoration is part of an overall watershed plan to improve habitat and water quality. A watershed plan will assist watershed groups and other local entities in prioritizing restoration needs, with the most critical needs addressed first. To ensure success at the least cost, careful planning and consultation with professionals with the appropriate expertise is necessary.

Reference Sites and the Concept of Expected Condition

The stream morphology data collected at the reference site is applied to the impacted site to achieve desired restoration goals and stream conditions. The reference stream reaches that define the "*Expected Condition*" need not be located in pristine/pre-European settled areas, because these streams may not available, nor have similar stream morphology, geology, climate, range of streamflow, soils, precipitation, or land use history. The Aquatic Life Workgroup and WQCD developed the concept of *Expected Condition* when comparing a potential impaired stream reach to another stream of interest. *Expected Condition* is defined as: the condition of a water body resulting from the best biological, physical and chemical conditions attainable (considering past,

present and future beneficial uses) given reasonable and appropriate land, soil and water quality management practices and avoiding material injury to water rights. "Where feasible, the expected condition for a water body, or group of water bodies, will be determined based on the best conditions that can be attained by an aggregate of similar water bodies within a regionally partitioned framework (i.e. ecoregions, elevation, and stream size)." *Expected Condition* is determined on a site-specific basis and is based upon several acceptable reference sites (if available), to design stream restoration projects properly for the impacted stream of interest. The reference reaches chosen may be minimally impacted (non-urban areas), but must represent the stable form of the impacted channel within a similar valley type, stream type and physiographic characteristics.

In some settings, streams have been highly altered over time by check dams, diversions, canals, "hardening" with riprap and concrete, and straightening of stream channels. Locating a stream to represent an *expected condition* in these settings may prove to be problematic. Professional engineers or water resources professionals may have to focus on locating streams (expected condition) with similar streamflow, particle size distribution, bankfull width and depth, and gradient characteristics.

Reference Site Selection

Reference site locations include sites directly upstream from the nonpoint source problem and sites in comparable watersheds. The selection of sites may be made from areas that have the least anthropogenic influences, and represent the best attainable conditions that can be achieved by similar stream types within the watershed, or adjacent watersheds. Moreover, reference sites must be representative of the stream and habitat types of interest. Examples include:

- Physical characteristics typical of the region (e.g., ecoregion (Hughes et al 1986) climate, topography, geology, and soils).
- Similar stream morphology typical of the region (e.g., Rosgen (1996) channel type, pools, riffles, runs, backwaters, and glides). For urban settings, the best attainable expected condition may be significantly altered from pre-development times.
- Representative diversity of substrate materials (fines, gravel, cobbles, boulders, and woody debris) appropriate to the region.
- Similar streamflow characteristics - in some cases, the flow patterns display large seasonal differences in response to rainfall and snowmelt; in other cases, diversions, irrigation return flows, and stream alterations (in urban settings) will have to be analyzed.
- Banks representative of undisturbed streams in the region (generally covered by riparian vegetation with little evidence of bank erosion, or undercut banks stabilized by root wads). Banks should provide cover for aquatic biota.
- Natural color and odor - in some area, clear, cold water is typical of the water body types in the region; in others, such as the Colorado River, the water may be more turbid.
- Natural riparian vegetation representative of the region.

Ideal considerations for good reference sites are:

- No upstream impoundments or significant diversions.
- No known point source discharges or contaminants in place.

- No known spills, pollution incidents, or hazardous waste sites.
- Low human population density, agricultural activities, and low road densities.
- Minimal nonpoint source problems.

Impaired sites displaying channel instability occur in a variety of ecosystems, from effluent dominated streams and streams receiving stormwater runoff in urban areas to high elevation streams in forested areas. The processes that determine the dimension, pattern and profile can be very different for varying geology, soils, precipitation, as well as, urban, agricultural and forested watersheds. The project proponents must also understand the streams stage of degradation or aggradation.

Stream Channel Hydraulics and Processes

Streams are constantly adjusting to the water and sediment produced by the upstream watershed. It is important to understand the range of flows produced by the upstream watershed, as well as the role of bankfull discharge in moving sediment and shaping stream channels.

The bankfull stage corresponds to the discharge at which channel maintenance is most effective; moreover, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the morphologic characteristics of channels (Dunne and Leopold, 1978). The bankfull stage is the most effective or dominant channel forming flow over time. Bankfull flows typically occur every other year and may occur several times within a water year. Rosgen suggests the importance of bankfull morphologic features and identifying stream types in applying the correct restoration technique.

Regional curves and hydraulic geometry relations are useful to gain some understanding of how bankfull channel dimensions change in the downstream direction for a particular watershed, and the potential design criteria for a stream restoration project. The curves relate independent variables, such as discharge or drainage area, to dependent variables such as width, depth, slope, and velocity.

Regional curves for a particular area in Colorado can be developed by visiting current and past US Geological Survey gauging stations and gathering bankfull dimensions, as well as analyzing discharge data collected by the USGS. Regional curves should only be used as indicators to help identify the channel geometry at a restoration site, because of the large degree of natural variability in sites. The field collection of channel morphology data for several cross sections at both the reference and design reaches is necessary.

Stream Classification

Stream classification can be useful in better understanding complex relationships between flow, sediment and stream morphology. Although following a stream classification is not necessary to design a restoration project, it does provide a step-wise process for collecting geomorphic field data that is important prior to implementing a stream restoration project.

Channel Succession

To implement a successful restoration plan it is important to assess the attributes and processes occurring in a stream and riparian area. An example of an alluvial/non-graded valley bottom type riparian/wetland area is provided in Figure 4 along with brief explanations.

State A is in properly functioning condition with adequate bank stability, stream – floodplain connectivity, and plant community development. State A is characterized by the floodplain being accessible by moderate flow events, floodplain storage and release, width/depth ratio, gradient sinuosity in balance. Plant communities are able to withstand a range of flow events and maintain bank stability.

State B – the stream is incising and widening, and is beginning to lose connectedness with the floodplain. The water table has lowered and vegetation is still present to dissipate energy associated with higher flows. There probably is not a significant change in water quality, but in-stream aquatic habitat is likely being affected.

State C – the stream has continued to downcut and the stream bottom is down to bedrock. The stream is no longer connected to the adjacent floodplain (except during high flows), or the water table. Stream substrate has been scoured to bedrock, there is a loss of in-stream aquatic habitat, and no hydraulic controls exist to dissipate stream energy. Bank stabilizing vegetation is nonexistent and the channel will continue to widen to varying degrees depending on the magnitude of flows, amount and size of sediment, and type of soils.

State D would be considered non-functional. The stream has no bank stabilizing vegetation, and probably no aquatic life. The floodplain has been scoured away, and the stream temperature regime has likely been altered significantly due to increase in width/depth ratio, loss of stream shade, and no groundwater – surface water interactions to moderate fluctuations. State A will be reached again over time as the stream aggrades and builds a floodplain within the incised reach. Vegetation will begin to re-establish as the stream aggrades and the floodplain develops over time. As vegetation becomes established, the stream will begin to narrow and the complexity of the riparian area and aquatic habitat will increase.

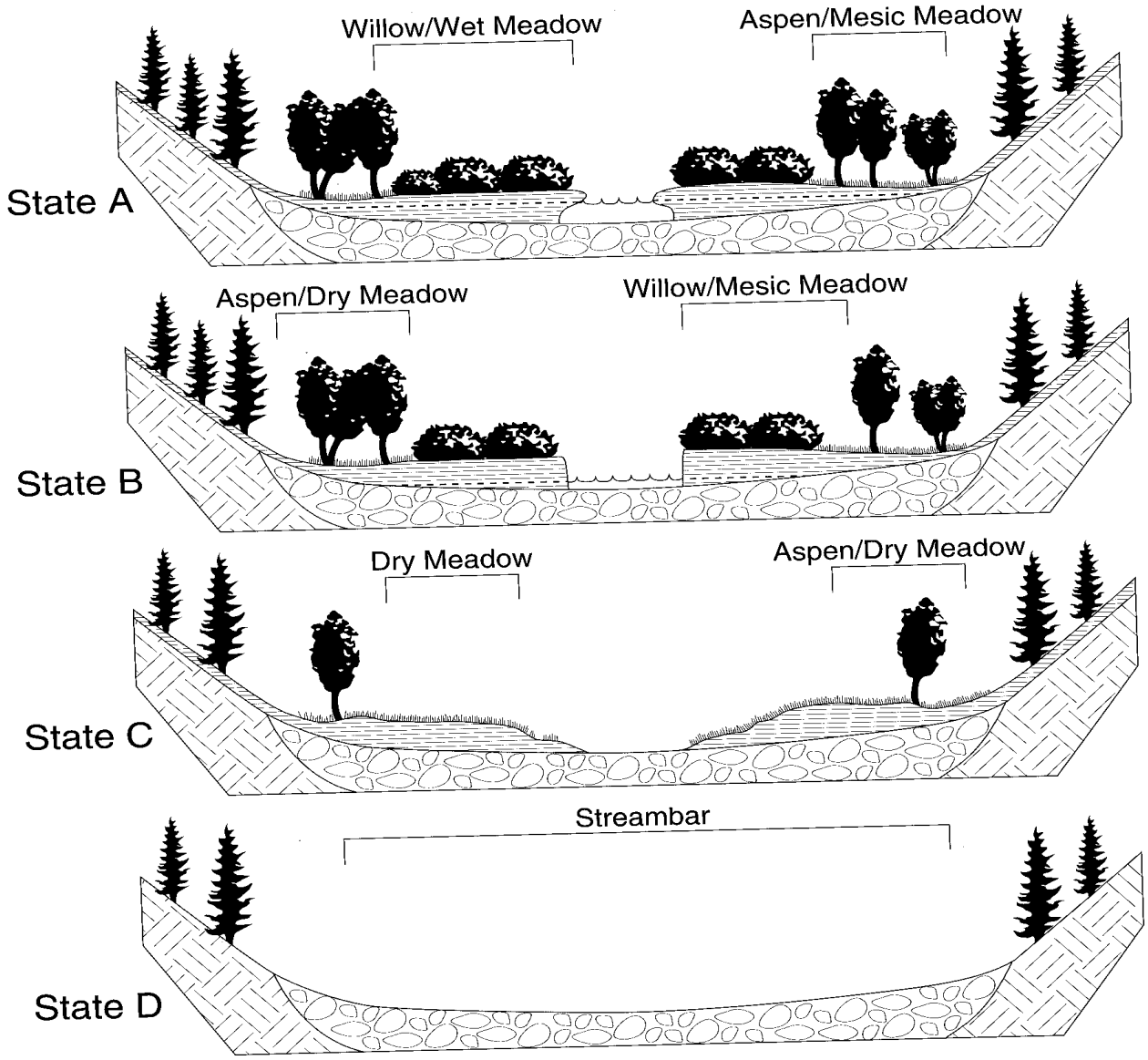

Figure 5: Succession of States for Fluvial/V-Shaped Depositional Valley-Bottom Type

US Department of Interior, Bureau of Land Management. 1998. Riparian Area Management, A User Guide To Assessing Proper Functioning Condition And The Supporting Science For Lotic Areas. Technical Reference 1737-15, p.13

Riparian Vegetation

The role of vegetation in a stream restoration project cannot be understated. Riparian areas are lands directly influenced by the presence of flowing water – creeks, streams, rivers, ponds, lakes, and other bodies of surface or sub-surface water (Naiman, 1992). Riparian areas are typically only a small portion of the overall watershed acres, but the diversity of vegetation and ecological processes therein are important for aquatic and wildlife species. Riparian vegetation provides the following benefits to stream channels:

- Dissipate stream energy and power associated with high streamflows, minimizing erosion and maintaining existing water quality.
- Filter sediment, capture bedload (material transported downstream by rolling or bouncing along the stream bottom), and aid in floodplain development.
- Improve flood-water retention and ground water recharge.
- Provide shade that maintains or reduces temperature regime and marked fluctuations.
- Reduces nutrient loads to streams.
- Stabilize stream banks with vegetation.
- Reduce erosion from uncontrolled runoff.
- Protect fish habitat.
- Maintain ground water and surface water interactions, which are important to aquatic macroinvertebrates.

Vegetation is a fundamental controlling factor in stream corridor function, and restoration designs should protect existing native vegetation and restore native vegetation structure whenever possible. This may be challenging in deeply incised streams or in urban stream corridors, but every opportunity should be explored to improve vegetative cover along streams. Examination of reference reaches is a good way to determine the plant community composition and distribution needed at the disturbed site. The current trend in establishing vegetation is to plant a variety of species for improved habitat conditions. Numerous species have been used in stream restoration, including willows, alder, serviceberry, oceanspray, vine maple, cottonwood, poplar, and others. However, historical accounts of the area, as well as information from the reference reach, may suggest only one species is planted rather than a mosaic of species. Introduced/non-native species should be avoided.

Some streams flow through areas that receive very little precipitation, and the geology is such that little to no riparian vegetation is to be present. Intermittent and ephemeral streams have little to no riparian vegetation due to short periods of flow. Restoration objectives for these streams will be very different than perennial streams. Intermittent (or seasonal) streams flow at certain times during a year when they receive water from springs or snowmelt. Intermittent streams may flow longer than 30 days (+/-) as groundwater continues to recharge the channel, whereas ephemeral streams are likely to flow for very short periods (depending on the physiographic region) in direct response to convective thunderstorms, snowmelt runoff or overland flow. The amount and composition of vegetation in these streams depends on the period of flow, as well as the connectedness of the stream to the riparian area and water table. Ephemeral streams generally are above the water table. Given the importance of riparian vegetation, bioengineering must be considered in any stream bank restoration project. Even in urban settings where riprap has been used routinely for bank protection, willow (or other species) plugs can be installed between the rocks (Gray and Sotir, 1996).

Best Management Practices and Planning

Nonstructural BMP's, such as preventative maintenance or preserving native vegetation, are components of operational or managerial techniques. There also are structural BMP's to consider such as diversion structures, silt fences and retention ponds. Such activities should be applied

before, during and after activities to reduce or eliminate sedimentation. Since restoration/ rehabilitation activities are considered construction activities, a review of the NPS *Urban/Construction* BMPs is suggested. Although the use of BMP's is voluntary, they are necessary to maintain or improve water quality over the long term. The following references and guides provide the specific information necessary for identifying the appropriate components. Many of these references are available on the Internet.

Planning and Implementation Tools

- Stream Corridor Restoration: Principles, Processes and Practices (The Federal Interagency Stream Restoration Working Group, 1998). http://www.nrcs.usda.gov/technical/stream_restoration
- National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (June 2001) EPA 841-B-01-001 (www.epa.gov/owowtr1/NPS/wetmeasures/wetmeasures.pdf
- Applied River Morphology (Rosgen, 1996).
- Reconfigured Channel Monitoring and Assessment Program. (co.water.usgs.gov/projects/rcmap/rcmap.html)
- Colorado Riparian Association, 2001. Colorado Stream Corridor Guide. (www.coloradoriparian.org)
- An Introduction and User's Guide to Wetland Restoration, Creation and Enhancement. Interagency Workgroup on Wetland Restoration (www.epa.gov/owow/wetlands/restore/finalinfo.html)
- Principles for the Ecological Restoration of Aquatic Resources (US EPA, 2000) EPA 841-F-00-003 (www.epa.gov/owow/wetlands/restore)
- US Forest Service, Natural Resources Conservation Services and US Bureau of Land Management, 1998. A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. (www.blm.gov/nstc/library/techref.htm)
- USDA Forest Service Watershed Conservation Practices Handbook (FSH 2509.25) and other technical references (www.fs.fed.us/im/directives/dughtml/fieldfsh2000.html)
- Colorado Association of Stormwater and Floodplain Managers, Habitat Assessment Field Data Sheet, 2pp.

Contacts for Assistance in Planning and Implementation

The best source of assistance for planning and implementing any best management practice will be in the locality where the BMP's are used. Local offices of the various natural resource management agencies, whether local, state, or federal, can develop site-specific recommendations or designs that account for the local climate, soils, hydrology, etc., as well as any social or cultural considerations. In addition, topic-related professional organizations may also have the resources to provide assistance. There are also environmental resources consulting firms that provide stream restoration services.

Examples of BMPs and other project design features

- Conduct activities during dry periods to minimize runoff and sediment delivery downstream. State and/or Federal permit(s) should have guidance on periods of operation.

- Comply with all requirements in permits. Projects may require a Phase II stormwater permit, and/or Corps of Engineer's 404 permits, respectively.
- Use silt fences and/or mulch to maintain sediment on site during construction activities.
- Complete the work in a reasonable time frame, or as designated in the permits.
- Minimize the amount of ground disturbance at the site.
- New access roads and drainage must be built to acceptable State and Federal engineering standards and reclaimed once work is completed.
- Comply with all applicable State and Federal Statutes.
- If fish are present at the site or downstream, conduct activities during periods when fish are not spawning, or when sediment delivery will not affect egg survival.
- Avoid activities near raptor nest sites or other critical habitat.
- Determine if drinking water sources downstream may be affected and notify the appropriate authorities.
- Revegetate or otherwise stabilize disturbed sites as soon as practicable following disturbance.

Monitoring and Measurable Results

The Colorado Nonpoint Source Program requires measurable results for all stream-restoration activities funded by NPS grant money. Measurable results are numeric, and calculations for tons of sediment saved from the stream, or percent decreases in sediment load or sediment concentration must be determined. Restoration activities, such as fish structures, riparian plantings, or gravel placement in streams for fish typically are not sediment related and other measurable results would be valid. In these cases, pool habitat created, feet of bank restored, or acres of riparian habitat restored are reasonable measurable results. Measurable results enable the Water Quality Control Division to evaluate the success of the stream restoration activities by comparing pre- and post stream restoration conditions. Coordination between the WQCD and project proponents is important in collecting the appropriate data to obtain measurable results, as well as determining the measurable results of the project. Whenever practical, monitoring should be conducted through a cooperative arrangement among the various stakeholders, state and federal agencies. In some cases, state or federal agencies may have data that could supplement data to be collected per requirements in a project implementation plan.

The WQCD and stakeholders need to collaborate on selecting monitoring approaches, measurement and sampling methods, and overall monitoring design, including frequency and locations of sampling and measurements to evaluate success. Quality control and data quality will also be addressed in quality assurance plans. It is recommended that project sponsors consult with the Division prior to submitting a stream restoration/rehabilitation project to improve project objectives, design, and monitoring guidelines to ensure the approach is appropriate for the specific stream reach.

Selection of a particular monitoring approach will depend on the following factors:
- Monitoring Objectives – determining the objective is critical.
- Site and reach characteristics
- Scope of the project
- Cost
- Time available for the study
- Resources available

Geomorphology measurements (Elliott and Parker, 1999; Harrelson and others, 1994):

- Surveying channel cross sections and longitudinal profile surveys of the streambed and channel banks to determine channel morphology through the monitoring reach
- Comparing aerial photographs to determine previous channel position, pattern, and depositional areas. After restoration to estimate improved stability of channel (channel pattern, width, sediment bar size, headcutting distance, area of vegetation) to determine sediment saved from erosion
- Conducting cross section and longitudinal surveys to:
  - Measure from bank pins to bank edge to calculate sediment saved from or lost to channel erosion
  - Measure changes in stream-bank height on bank pins or other reference point
  - Measure vertical distance from top of bank to streambed
  - Measure stream-bank angles
- Measuring the volume or mass of sediment removed from or deposited in an area of the stream.

Stream-bottom-substrate measurements **(CDPHE, Water Quality Control Commission, 2002):**

- Measuring the extent that large particles are embedded or buried by fine sediment (MacDonald et. al., 1991, p. 121).
- Measuring the salmonid living space available in coarse-particle substrate (Burton and Harvey, 1990).
- Measuring the percent of streambed composed of fines <2mm (CDPHE, WQCD, not dated).
- Measuring the percent of pool bottom affected by sediment deposition (CDPHE, WQCD, not dated).
- Measuring the volume of pool occupied by fine sediment (Lisle and Hilton, 1992).
- Measuring the accumulation of fine particles in interstitial spaces of coarse-particle substrate (Carling and McCahon, 1987; Frostick et. al., 1984).
- Measuring the subsurface particle-size distribution in cores (Petts, 1988; Lisle, 1989)
- Measuring the subsurface particle-size distribution through an in-situ sample of known volume (Lambert and Walling, 1998; MacDonald et. al., 1991, p. 119; Platts et. al., 1983, p. 17).
- Measuring the particle-size distribution in a specific area of stream bank, streambed, or bar by measuring the intermediate axis of gravels, pebbles, cobbles, or boulders (Wolman, 1954; Bevenger and King, 1995).

***Bioassessment measurements (Colorado Water Quality Forum, 1995; Plafkin et. al., 1989; Colorado Division of Wildlife*)**:

- Counting or measuring growth in vegetation planted to stabilize stream banks.
- Counting the number (population) or biomass of each key aquatic species.
- Counting the number of species at key locations (diversity measure).
- Calculating indices of community structure from benthic macroinvertebrate data.
- Testing for the presence and quantity of trace elements or organic contaminants (Shelton and Capel, 1994).

Hydrologic measurements:

- Measuring streamflow at key locations (Carter and Davidian, 1968; Buchanan and Somers, 1969)

The measurements made to determine the success of the stream-restoration activity should be appropriate for the goal of that stream-restoration activity. The matrix below is a guide to assist in determining the appropriate monitoring for various water quality goals.

Table 12: Determining measurable results

Water-quality goal	**Stream-restoration activity**	**Task**	**Baseline information**	**Post-activity information**	**Calculation of result**
Decrease sediment concentration in stream or downstream	Stabilize bank	• Plant vegetation • Add root wads • Flow-steering structures (J-Hooks, cross vanes)	• Bank geometry • Vegetated area Channel surveys (cross section, longitudinal survey)	• Bank geometry • Vegetated area Channel surveys (cross section, longitudinal survey)	Estimate mass of sediment saved out of the stream
Decrease sediment concentration in stream or downstream	Change stream morphology	Reconfigure channel	• Sediment concentration in stream • Stream depth, velocity Channel surveys	• Sediment concentration in stream • Stream depth, velocity Channel surveys	Difference in sediment concentration, depth, and velocity in stream
Decrease sediment concentration in stream or downstream	Filter runoff	Plant vegetation	Vegetated area Turbidity of stream	Vegetated area Turbidity of stream	Difference in vegetated area, turbidity
Decrease sediment concentration in stream or downstream	Slow stream velocity	Add drop structures and/or increase sinuosity	• Stream velocity • Sediment concentration • Channel surveys	• Stream velocity • Sediment concentration • Channel surveys	Difference in stream velocity, sediment concentration
Improve fish habitat	Decrease stream temperature	• Increase channel depth to width ratio • Add vegetation canopy • Add boulders or snags for cover	• Stream temperature • Bioassessment measurements	• Stream temperature • Bioassessment measurements	Difference in stream temperature, bioassessment measurements

Table 13: Biological Component of Restoration

Water-quality goal	Stream-restoration activity	Task	Baseline information	Post-activity information	Calculation of result
Increase the abundance and diversity of aquatic macroinvertebrates	• Change stream morphology • Vegetate stream banks • Add root wads, boulders, trees to improve cover.	• Decrease width/depth ratio, increase sinuosity • Reduce fine sediment • Reduce fine sediment and increase pool habitat.	• Sediment concentration in stream, stream depth, velocity • Channel surveys • Bank geometry, channel cross sections • Channel surveys, streamflow characteristics	• % of vegetated area and determination of mortality. • Channel surveys • Macroinvertebrate surveys and lab results • - # of structures that moved or transported downstream	• # of feet or acres treated • Differences in fine sediment, vegetative cover, pool – riffle habitat • #'s of structures in-place and functioning
Improve stream corridor vegetation composition and water availability through weed treatments	Mechanical, chemical and/or utilize biological agents to eradicate weeds. Plant native vegetation	Improve species composition and water quantity and quality by removing weeds. Tamarisk and Russian Olive are phreatophytes that use more water than native plants	Establish plots and conduct weed inventory along stream corridors	Re-visit plots to determine effectiveness of treatments	• # of feet or acres treated. • % reduction in weeds.

2005 Urban and Construction Update

Introduction

Urban development and associated construction activities both within the urban context and for infrastructure development (e.g., roadway network) are significant elements contributing to nonpoint source pollution in Colorado. Consequently, Colorado's nonpoint source management program identifies urban and construction as a major categorical pollutant area requiring specific management planning and both restorative and preventive implementation strategies. Urban development and associated construction activities affect all four river basins with the greatest urban development impact to the South Platte River system. Highway construction throughout the state can cause nonpoint source pollution, although the Colorado Department of Transportation has successfully implemented extensive best management practices to lessen this impact on the state transportation system. Sedimentation and erosion remains the biggest pollutant problem associated with urban and construction activities.

The State of Colorado faces significant challenges due to pressures of increased employment and population. Colorado experienced in-ward migration over several decades, and this pattern is forecasted to continue into the near-term future. Migrant populations continue to grow into the Denver metropolitan region. Colorado's in-ward migration pattern should remain constant over the next ten-years at approximately 50,000 person per year. At the same time, natural population growth (births minus deaths) continues to increase. The Colorado population was estimated to be 4,691,250 in 2005. The Denver metropolitan region population was estimated at 2,611,500 during the same time period. The Colorado population is projected to reach over 7,156,500 people in the year 2030 with over 3.875 million people in the Denver metropolitan region for an average growth rate of 1.8 percent.

Based on an average household size of 2.5 people, 2.46 million more housing units (over 98,000 housing units per year) are needed to support this population increase. About 82 percent of Colorado's population lives in or around major urban centers, with 56 percent of the state's population living in the Denver Metropolitan region. This development pattern has concentrated the construction activities into these discrete areas, and increased the nonpoint source and stormwater loading potential within urban centers.

Status of Urban Development Practices In Colorado

The Urban and Construction Chapter 6 of the 2000 Colorado Nonpoint Source Management Plan (WQCD January 2000) contains a detailed listing and summary discussion of best management practices appropriate to Colorado hydrology. Chapter 6 also includes many practices requiring refinement under semi-arid conditions. This 2005 update to the management program does not duplicate that information, but rather builds from that document and summarizes current practices, identifies new or modified practices, changes in regulatory programs affecting practices (stormwater phase II program), and current water quality conditions associated with urban development and associated construction activities.

Erosion and sedimentation are still the primary source of pollution associated with development in Colorado. A number of stream segments affiliated with urban watersheds are on the Colorado 303(d) List of impaired waters. Substantial strides to reduce pollutant potential in urban areas and on construction sites over the last five years generally are evident. All construction activities that disturb one or more acres require a stormwater permit.

Nutrient management in lakes and reservoirs near urban centers remains a concern. Nutrient loads from urban or construction activities potentially can degrade water quality and preventive programs are far more cost effective than restoration programs. Consequently, new watershed efforts in Colorado are underway to manage these critical resources.

Status of Construction Practices in Colorado

Construction practices associated with development have the potential to cause erosion beyond natural conditions. Runoff from construction sites also has the potential to carry other chemical pollutants and biological pollution. The deposition of sediments in receiving waters in Colorado is a major nonpoint source problem. Construction debris carried in runoff water has also been identified as a potentially significant nonpoint pollutant source. In relation to potential water quality degradation, there are two levels of construction activity occurring in Colorado that can produce varying degrees of nonpoint source pollution and specific runoff pollutants:

- Site development or highway construction that disturbs over five acres of land area (medium to high potential for runoff pollutant generation); and

- Site development or roadway improvements on one to five acres of land (low potential for runoff pollutant generation).

Major site development projects affecting one acre or more of land area require a National Pollutant Discharge Elimination System (NPDES) stormwater permit. These construction activities have the greatest potential to cause nonpoint source pollution. Both structural and nonstructural best management practices are used to reduce water quality degradation from construction sites. Construction activities on sites with less than one acre of disturbance are not currently regulated and generally do not pose a threat to receiving water quality in Colorado. The phase II stormwater regulation regulates construction activities on lots over one acre.

Urban and Construction Nonpoint Source Assessment

Surface Water Quality Assessment

Urban Landscape and Water Quality Issues

Urban landscape in Colorado broadly defines a built environment influenced by different combinations of land uses. Residential and commercial development, industrial areas, parks, open space, and roadways are examples of urban land uses. The construction of wastewater, water and stormwater pipelines and power lines, generally called utility infrastructure, also change the natural environment and help shape the urban landscape. Land use patterns strongly influence surface water quality and to a lesser extent groundwater. Land use choices are interactive parts of water quality management, restoration or enhancement programs. Urban land use decisions must

consider water quality management strategies and goals. Conversely, water quality should be considered in zoning and platting processes used by local governments..

Scale affects how water quality is managed and often who is responsible for this management. Water quality management targets overall health and quality of water and environmental resources. Management also provides direction at fixing specific water quality problems in targeted waterbodies. Consequently, water quality management in urban settings occurs at two basic levels. Macro-scale landscapes include all combined urban land uses for a single city or a combination of cities and towns. Water quality management at the macro-scale is often linked to watershed restoration or protection efforts.

Micro-scale landscapes can include smaller urban watersheds, drainages or other limited geographic areas where site-specific water quality management is necessary to control targeted urban-caused pollution. Macro-scale watersheds often are measured in square miles, while micro-scale landscapes are identified in acres. The near-term goals for urban NPS management in Colorado focus on the micro-scale, while the long-term goal is to resolve urban pollution at the macro or watershed level.

An urban watershed protection approach is an integrated, holistic strategy to protect or attain the desired beneficial uses of waters within an urban area. The approach is more effective than isolated efforts under existing programs that do not consider the watershed as a whole. Nonpoint source or stormwater runoff control at a watershed level can have a significant impact on the protection of beneficial uses. A watershed protection approach addresses point source discharges along with nonpoint source and stormwater pollutant loads. An urban watershed approach also considers other human activities that may affect the uses and quality of the water resources.

Water quality management programs in urban landscapes are divided into three general source categories: point sources, nonpoint sources and stormwater runoff. Point sources are discrete discharges that go from a pipe source (e.g., wastewater treatment plant discharge) back into the environment and are excluded from the Colorado nonpoint source management program. Nonpoint sources are a type of diffuse pollution not introduced into the environment from a single pipe. Stormwater runoff is a type of nonpoint source runoff usually associated with urban landscapes, which is subject to permitting requirements for medium and large cities. Stormwater and other nonpoint sources associated with urban landscapes are collectively called urban runoff.

Urban runoff can flow across residential and urban streets, roofs, lawns, open space, hard (impervious) surfaces and other areas. Urban runoff occurs under both wet and dry weather conditions. Dry-weather runoff from irrigation practices and leaky pipes contribute various amounts of polluted runoff. Urban runoff carries many different types of chemicals, sediments, debris and pathogens. An excessive amount of urban pollution impairs water quality in wetlands, streams, rivers, lakes, reservoirs or groundwater (receiving waters). Construction activities or other development activities introduce large amounts of sediments and other pollutants into receiving waters. Increased pollutant loads can harm fish and wildlife populations, kill native vegetation, reduce or limit recreational uses, and contaminate drinking water supplies.

Development patterns change the natural landscape and replace it with hard or impervious surfaces (i.e., concrete, asphalt or hard-packed dirt), which in turn changes the hydrologic or flow patterns from surfaces and into receiving waters. Urbanization causes increased stormwater runoff, which is more intense, has a higher volume and has less residual runoff than natural runoff conditions. A typical city block characterized by pavement and rooftops generates over nine times more runoff than a woodland area of equal size. Less water gets into underlying groundwater and more water enters receiving waters as runoff flow. Aquifers under urban areas are called "starved" since water recharge is minimized.

Natural runoff from an area without any kind of disturbance is called background or sometimes baseflow. Urbanization activities altering runoff patterns can decrease baseflow and increase runoff flow. In most urban landscapes, lawn irrigation practices or other forms of dry weather discharge can greatly increase runoff flow.

Changes in flow regimes also cause increased frequency of flooding and peak flow volumes in receiving waters. These flooding events cause loss of aquatic or riparian habitat and changes in stream physical characteristics (channel width and depth). Stormwater management requires urban areas to develop stormwater drainage systems to avoid flood damage. These systems accumulate runoff from storms and send these flows away from the urban area.

Phase II Stormwater Rule

The Phase II Stormwater regulations specify six program elements that must be addressed by permit holders. The regulations also imply that additional things will need to be done but the lack of specific requirements gives permit holders a great deal of flexibility about what to do about some aspects of stormwater management, chiefly monitoring. The six required stormwater program elements include:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Runoff Management
- Pollution Prevention/Good Housekeeping Practices for All Municipal Operations.

Highway And Road Construction

The Colorado Department of Transportation (CDOT) has an erosion control manual for contractors to use on all state highway and road construction projects. Major highway or road construction projects affecting one or more acres of disturbed land area require a NPDES stormwater permit.

Runoff controls are mechanisms to prevent potentially polluted runoff associated with roads, highways and bridges from reaching surface waters in Colorado. Erosion during and after construction of highway infrastructure can contribute large amounts of runoff pollutants. Metals, oils and other potentially toxic materials, along with construction debris, can be transported with runoff waters and deposited in adjacent waterways.

The use of best management practices during and after construction of highway infrastructure prevents highway related nonpoint source pollution. Table 9 lists some typical pollutants associated with highway runoff.

Table 14: Typical Pollution from Highway Runoff in Colorado

Category	Pollutant	Source
Sedimentation	Sediment, particulate, dust	Pavement wear, vehicles, atmospheric deposition, maintenance activities, sanding operations, construction activities
Nutrients	Nitrogen	Fertilizer application, atmospheric deposition, construction activities
	Phosphorus	Fertilizer application, atmospheric deposition
Pesticides & Insecticides	Accumulations of pesticides & insecticides	Applications along roadways
Metals and Major Cations	Lead	Auto exhausts, gasoline and tire wear
	Zinc	Tire wear, motor oil and grease
	Iron	Auto body rust, steel highway structures and moving engine parts
	Copper	Metal plating, moving engine parts and brake lining wear, bushing wear, fungicides and insecticides
	Cadmium	Tire wear and insecticide application
	Chromium	Metal plating, moving engine parts and brake lining wear
	Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, bushing wear, brake lining wear and asphalt paving
	Manganese	Moving engine parts
	Cyanide	Anti-cake compounds used to keep deicing salts granular
	Sodium, Calcium & Chloride	Deicing salts
	Sulfates	Roadway beds, fuel and deicing salts
Hydrocarbons	Petroleum	Spills, leaks, antifreeze and hydraulic fluids, asphalt surface leachate
	Rubber	Tire wear from vehicles

Lakes and Reservoirs

Nutrients (nitrogen and phosphorus) are generally present in urban runoff and have impaired water quality in lakes and reservoirs throughout Colorado. Nutrient loading of lakes and reservoirs is a growing water quality concern because urban development is often associated with these waterbodies. Consequently, clean lake studies will be considered as part of the urban and construction management program for those lakes and reservoirs identified on the 303(d) list.

Nutrients in urban runoff may accelerate eutrophication problems and severely limit recreational uses, especially in lakes and reservoirs. National Urban Runoff Program lake projects indicate the degree of beneficial use impairment varies widely, as does the significance of the urban runoff

component. To a lesser extent, a hydrologic watershed approach has been used in many Colorado locations (e.g., Bear Creek Watershed, Big Thompson River, Clear Creek, Chatfield Watershed, Cherry Creek Watershed, Dillon Reservoir, and Fountain Creek).

Reservoirs and some altered lakes are hydrologic modifications of historic flow patterns. Most reservoirs constructed in Colorado are for agricultural and flood control purposes. Many flood control reservoirs and altered natural lakes upstream of urban areas have recreational uses. Reservoirs can have use classifications ranging from agricultural use alone to a mix of aquatic life, recreation, water supply and agricultural use.

Hydrologic modifications and structures may produce unique water quality problems when associated with reservoirs. Hydrologic modifications of waterways associated with urban areas or affected by construction and development projects can be addressed through the urban and construction management program. Water quality limited lakes, reservoirs, and those waterbodies with control regulations require monitoring in Colorado

Groundwater Quality Assessment

National data shows urban areas can significantly alter groundwater regimes in both quantity and quality. Colorado data is limited in predicting the relationship between urbanized activities on groundwater quality. Recent studies by the US Geological Survey strongly suggest urban development has degraded aquifer quality in site-specific regions. The identification recommended BMPs specific to groundwater protection or restoration still requires research and further evaluation. A concern about the impact of development, particularly the structural practices, to groundwater is noted by many agencies. Any evaluation of these practices must take into consideration design features and monitoring programs to determine groundwater impacts, if any caused by the practice. This information, as it is generated, may then be used to update the structural practices.

Urban And Construction Objectives and Action Steps

Long-Range Program Target

The Colorado urban and construction management program identifies appropriate urban runoff and construction related best management practices, implementation strategies and control programs. Consequently, the long-range target of the urban and construction management program in Colorado is to:

> *Significantly reduce the pollution potential from urbanized regions of the state and at construction sites within a watershed and/or urbanshed framework.*

The urban and construction program has two levels of targeting: 1) five-year action plan, which defines near-term objectives and action strategies; and 2) long-term targets for changing behavior and development practices so as to greatly reduce the potential for nonpoint and stormwater pollution. The near-term goals are translated into a five-year action plan as outlined previously. The long-term program targets emphasize mechanisms to educate a broad range of groups, test the effectiveness of best management practices under Colorado hydrologic conditions, update practices as appropriate and encourage implementation of urban watershed implementation

programs. The long-term goals are identified in the Urban and Construction Chapter 6 of the *Colorado Nonpoint Source Management Plan* (WQCD January 2000.

Best Management Practices

The best management practices (BMPs) in the Urban and Construction Nonpoint Source Management Program directed toward improving water quality falls into two categories:

1) Erosion control BMPs intended to prevent discharge of pollutants or provide improved water quality in runoff from construction sites; and
2) Urban stormwater BMPs intended to reduce loads after the construction phase is complete (e.g. phosphorus and nitrate which stimulate aquatic weeds and algae.)

Stormwater BMPs supplement existing urban runoff and flood control practices. Model ordinances for erosion control and stormwater quality are also part of the management program. The Colorado recommended BMP list requires periodic updating, since demonstration or application of BMPs under Colorado conditions can prove the merit, or conversely prove the flaws of various BMPs. While most of the general best management practices apply throughout Colorado, some of these management practices are generally untested under Colorado hydrology conditions. Detailed descriptions of these practices are contained in the Urban and Construction Chapter 6 of *The Colorado Nonpoint Source Management Plan* (WQCD 2000).

Best management practices (BMPs) are management tools. Erosion control practices prevent discharge of pollutants or provide improved water quality in runoff from construction sites or development areas. Urban stormwater practices reduce loads in the built urban environment. Similar best management practices are applicable to both stormwater runoff in urban areas and construction site runoff. BMPs include structural and non-structural methods, measures or practices, which help prevent, reduce or mitigate adverse water quality problems caused by urbanization.

Structural BMPs passively treat runoff before it enters receiving waters. Such BMPs when used on a construction or development site can be either temporary or permanent and are designed to reduce sediment load or other runoff waste products for the life of the project. These practices protect aquatic or riparian environments.

Nonstructural BMPs include prevention practices and source control activities that minimize or eliminate a problem before it occurs. Source control BMPs are often referred to as “good housekeeping practices.” Site planning and design of BMPs is a nonstructural BMP.

The protection of surface and groundwater resources from urban growth and development activities is best approached through application of BMPs at a watershed level. Water quality management in urban landscapes is an evolving and dynamic effort of pollution and pollutant abatement involving a growing number of groups, agencies and governments. Land use decision makers should consider growth and development impacts on urban water resources when adopting offsetting mitigation strategies.

Specialty Best Management Practices

Mountain Driveway Best Management Practices

Driveways in mountainous areas can be a significant source of sediment and erosion products that reach streams and other waterbodies. While BMPs appropriate for secondary roads and highways exist, BMPs appropriate for driveways are not specifically defined. The *Mountain Driveway Best Management Practices* includes a limited number of BMPs appropriate for driveways compiled in a concise manner with engineering sketches (Wright Water Engineers, Inc. and DRCOG 1999).

High Altitude Best Management Practices

Erosion control specialists face challenges when revegetating and restoring land high in the Rocky Mountains where construction of roads, mines, pipelines, and ski areas have left earth bare. Vegetation may not mature until the third growing season, requiring additional time in the implementation of best management practices. In addition to a short construction and growing season high-altitude erosion control projects must contend with realities such as less availability of nutrients. Plant roots can take up food only when the soil is free of frost. Cold temperatures reduce activity of microorganisms that convert organic debris and inorganic matter to soil; and less photosynthesis occurs. The thinner atmosphere at high-elevation sites filters out less ultraviolet radiation from the sun. These rays can damage leaf surfaces, disrupting photosynthesis and even killing plants. The Colorado Department of Transportation has experimented with high-altitude BMPs and incorporated these features in their construction projects.

Green Industry

The *Green Industry Best Management Practices (BMPs) for the Protection and Conservation of Water Resources in Colorado* (GreenCO February 2003) manual consolidates and improves upon Green Industry Best Management Practices (BMPs) for the conservation of water resources and protection of water quality. These BMPs include a variety of design, installation and maintenance practices relevant to the Green Industry and the public that they serve. This document is an initial building block for the Green Industry to use in further developing common industry-wide standards

Guidelines for Water Quality Enhancement at Golf Courses

In December 1996, Wright Water Engineers, Inc. and Denver Regional Council of Governments released *Guidelines for Water Quality Enhancement at Golf Courses Through the Use of Best Management Practices*, which had input from golf course managers, architects, consultants, and Colorado State University Cooperative Extension representatives. The guidance documents 28 key BMPs for use during design, construction, and operation of golf courses. The guidance summarizes standard erosion and sediment control practices, key regulatory considerations, and lists of additional references. A quick-reference one-page summary of these BMPs was distributed to golf courses throughout Colorado.

Low Impact Development

The AWARE Colorado (Addressing Water and Natural Resources Education) is a new statewide program to educate local decision-makers about the impacts of land use choices on water quality. Through education, AWARE Colorado will provide land use decision-makers with research-based, non-advocacy information so they can make informed land use decisions. AWARE promotes low impact development and identifies a series o best management practices that address reduction of impervious surfaces.

VII. REFERENCES

The following references either are new to the NPS Management Program or have updated the references in the 2000 Colorado Nonpoint Source Management Program. Please refer to the individual chapter references in the 2000 document for additional information.

Agriculture and Silviculture

Austin, B., R. Waskom, M. Yergert. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 1995. Denver: Colorado Department of Agriculture, 1995.

Austin, B., R. Waskom, M. Yergert. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 1996. Denver: Colorado Department of Agriculture, 1996.

Austin, B., R. Waskom, M. Yergert. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 1997. Denver: Colorado Department of Agriculture, 1997.

Austin, B., R. Waskom, M. Yergert. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 1998. Denver: Colorado Department of Agriculture, 1998. http://www.ag.state.co.us/csd/groundwater/publications/old/gwreport98.html

Austin, B., R. Waskom, M. Yergert. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 1999. Denver: Colorado Department of Agriculture, 1999. http://www.ag.state.co.us/csd/groundwater/publications/old/gwreport99.html

Austin, B., R. Wawrzynski, and R. Waskom. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 2000. Denver: Colorado Department of Agriculture, 2000.

Austin, B., T. Bauder, R. Wawrzynski, and R. Waskom. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 2001. Denver: Colorado Department of Agriculture, 2001.

Austin, B., T. Bauder, R. Wawrzynski, and R. Waskom. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 2002. Denver: Colorado Department of Agriculture, 2002.

Austin, B., T. Bauder, and R. Wawrzynski. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 2003. Denver: Colorado Department of Agriculture, 2003.

Austin, B., T. Bauder, and R. Wawrzynski. 2003. *Status of implementation of senate bill 90-126 the agricultural chemicals and ground water protection act.* Annual Reports for 2004. Denver: Colorado Department of Agriculture, 2004

Becker, Mark F., et. al. *Ground-Water Quality in the Central High Plains Aquifer, Colorado, Kansas, New Mexico, Oklahoma, and Texas, 1999.* US Geological Survey Water-Resources Investigations Report, 02-4112. Reston, VA: USGS. 2002. http://permanent.access.gpo.gov/waterusgsgov/water.usgs.gov/pubs/circ/circ1167/circ1167.pdf

Dennehy, K.F., et. al. *Water Quality in the South Platte River Basin, Colorado, Nebraska, and Wyoming, 1992-95.* US Geological Survey Circular 1167. Reston, VA: USGS, 1998. http://permanent.access.gpo.gov/waterusgsgov/water.usgs.gov/pubs/circ/circ1167/

US Environmental Protection Agency. *National Management Measures to Control Nonpoint Source Pollution from Forestry.* EPA 841-B-05-001. Washington: US EPA, 2001, 2005. http://www.epa.gov/nps/forestrymgmt/index.html

Mining

Colorado Department of Natural Resources, Division of Minerals and Geology. *Best Practices in Abandoned Mine Land Reclamation: the remediation of past mining activities.* Denver: Colorado Department of Natural Resources, 2002. http://www.mining.state.co.us/bmp.pdf

Stream Restoration

Bevenger, G. and King, R. *A pebble count procedure for assessing watershed cumulative impacts*. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, 1995. Report RM-RP-319. http://stream.fs.fed.us/news/streamnt/jul95/jul95a1.htm

Buchanan, T.J. and Somers, W.P. "Discharge measurements at gaging stations." In *Techniques of Water-Resources Investigations*. Arlington: U.S. Department of the Interior, U.S. Geological Survey, Book 3, Chapter A8, 1969. http://water.usgs.gov/pubs/twri/twri3a8/

Burton, T.A. and Harvey, G.W. *Estimating intergravel salmonid living space using the cobble embeddedness sampling procedure*. Boise: Idaho Department of Health and Welfare, Division of Environmental Quality, Water Quality Monitoring Protocols Report, 1990.

Carling, P.A. and McCahon, C.P. "Natural siltation of Brown Trout (Salmo Trutta L.) spawning gravels during low-flow conditions." In *Regulated Streams,* edited by Craig, J.F. and Kemper, J.B., 229-244. New York: Plenum Publishing Corporation, 1987.

Carter, R.W. and Davidian, Jacob. "General procedure for gaging streams." In *Techniques of Water-Resources Investigations*, Book 3, Chapter A7. Arlington: U.S. Department of the Interior, U.S. Geological Survey, 1968. http://water.usgs.gov/pubs/twri/twri3a7/

Colorado Department of Public Health and Environment, Water Quality Control Commission. *Provisional implementation guidance for determining sediment deposition impacts to aquatic life in streams and rivers.* Commission Policy 98-1, 2002. http://www.cdphe.state.co.us/op/wqcc/MeetingsandHearings/HearingNotices/AAH/SedGuide.pdf

Colorado Department of Public Health and Environment, Water Quality Control Division. *Standard operating procedures for habitat analysis.* No date.

Colorado Division of Wildlife, (methods for inventory and population estimates)

Colorado Riparian Association. *Colorado Stream Corridor Guide.* Boulder: Colorado Riparian Association, 2001. http://www.coloradoriparian.org

Colorado Water Quality Forum. *Water quality monitoring in Colorado*. Water Quality Control Division, Colorado Department of Public Health and Environment, 1995.

Edwards, T.K. and Glysson, G.D. "Field methods for measurement of fluvial sediment." In *Techniques of Water-Resources Investigations*, Book 3, Chapter C2. Arlington: U.S. Department of the Interior, U.S. Geological Survey, 1999. http://water.usgs.gov/pubs/twri/twri3-c2/

Elliott, J.G., and Parker, R.S. *Reconfigured-channel monitoring and assessment program.* Arlington: U.S. Department of the Interior, U.S. Geological Survey Fact Sheet WRIR 99-4111, 1999.

Frostick, L.E., Lucas, P.M., and Reid, I. "The infiltration of fine matrices into coarse-grained alluvial sediments and its implications for stratigraphical interpretation." In *Journal of the Geological Society of London* 141 (1984): 955-965. http://www.ingentaconnect.com/content/geol/jgs/1984/00000141/00000006/14160955

Habitat Assessment Field Data Sheet derived from Zuellig, R. Macroinvertebrate and Fish Communities Along the Front Range of Colorado and Their Relationship to Habitat in the Urban Environment Spring. MA Thesis, Colorado State University, 2001. Thesis modified US Environmental Protection Agency, Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. EPA 841-B-99-002.

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. *Stream channel reference sites and illustrated guide to field technique.* Fort Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-245, 1994. http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF

Interagency Workgroup on Wetland Restoration. *An Introduction and User's Guide to Wetland Restoration, Creation and Enhancement*. Washington: U.S. Environmental Protection Agency, no date. www.epa.gov/owow/wetlands/restore/finalinfo.html

Lambert, C.P. and Walling, D.E. "Measurement of channel storage of suspended sediment in a gravel-bed river." *Catena* 15 (1988): 65-80.

Lisle, T.E. "Sediment transport and resulting deposition in spawning gravels, North Coastal California." *Water Resources Research* 25(6): 1303-1319. http://216.48.37.142/pubs/viewpub.jsp?index=7852

Lisle, T.E., and Hilton, Sue, 1992. "The volume of fine sediment in pools—an index of sediment supply in gravel-bed streams." *Water Resources Bulletin* (28): 371-383. http://www.treesearch.fs.fed.us/pubs/viewpub.jsp?index=7860

MacDonald, L.H., Smart, A.W., and Wissmar, R.C.E. *Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska*. Seattle, WA: U.S. Environmental Protection Agency, Region 10, Water Division, EPA 910/9-91-001, 1991.

Petts, G.E., 1988, "Accumulation of fine sediment within substrate gravels along two regulated rivers." *Regulated Rivers—Research and Management* (2): 141-153.

Plafkin, J.L., et.al. *Rapid bioassessment protocols for use in streams and rivers: Benthic Macroinvertebrates and Fish.* Washington, D.C.: U.S. Environmental Protection Agency, Office of Water, EPA 444/4-89-001, 1989. http://www.epa.gov/owow/monitoring/rbp/

Platts, W.S. et.al. *Methods for evaluating stream, riparian, and biotic conditions*. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report INT-138, 1983.

Rosgen, David L. "Applied River Morphology." Pagosa Springs, CO: Wildland Hydrology, 1996. http://www.wildlandhydrology.com/html/applied.htm

Shelton, L.R., and Capel, P.D. *Guidelines for collecting and processing samples of streambed sediment for analysis of trace elements and organic contaminants for the National Water-Quality Assessment program*. Arlington: U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 94-458, 1994.

The Federal Interagency Stream Restoration Working Group. *Stream Corridor Restoration: Principles, Processes and Practices.* Washington: GPO, 1998. http://www.nrcs.usda.gov/technical/stream_restoration

US Department of Agriculture, Forest Service. *Watershed Conservation Practices Handbook.* FSH 2509.25 series. Denver: Rocky Mountain Region, no date. www.fs.fed.us/im/directives/dughtml/fieldfsh2000.html

US Department of the Interior and Bureau of Land Management. *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas*. Tech. Ref. 1737-15 Denver: BLM National Science & Technology Center, 1998. http://www.ecbarranch.com/adeq%204004/rrip/tech%20ref.htm

US Environmental Protection Agency, Office of Water. *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution*. EPA 841-B-01-001. Washington: EPA, June 2001. http://www.epa.gov/nps/wetmeasures/wetmeasures.pdf

US Environmental Protection Agency. *Principles for the Ecological Restoration of Aquatic Resources*. EPA 841-F-00-003. Cincinnati: NSCEP , 2000. http://www.epa.gov/owow/wetlands/restore/principles.html

US Geological Survey. *Reconfigured Channel Monitoring and Assessment Program*. Denver: USGS, 1999. http://co.water.usgs.gov/projects/rcmap/rcmap.html

US Geological Survey. "National field manual for the collection of water-quality data." In *U.S.Geological Survey Techniques of Water Resources Investigations*, Book 9, Chapters A1-A9. Arlington: U.S. Department of the Interior, U.S. Geological Survey, various dates. http://pubs.water.usgs.gov/twri9A

Wolman, M.G., 1954. "A method for sampling coarse river-bed material." *Transactions of the American Geophysical Union* (35:6): 951-956.

Urban and Construction

AWARE Colorado. *Water Protection Toolkit For Local Officials: Connecting Land Use With Water Quality*. Denver: League of Women Voters of Colorado Education Fund, 2004. http://awarecolorado.org/toolkit.html

Center for Watershed Protection. Urban Subwatershed Restoration Manual Series. *Manual #1: An Integrated Framework to Restore Small Urban Watersheds.* Ellicott City, MD: Center for Watershed Protection March, 2004. http://www.cwp.org/USRM_verify.htm

Colorado Department of Public Health and Environment, Water Quality Control Division. "Urban and Construction Nonpoint Source Management Program." In *Colorado Nonpoint Source Management Program.* Denver: CDPHE, 2000. http://www.cdphe.state.co.us/op/wqcc/NPS/cnpsmpu.html

Colorado Department of Public Health and Environment, Water Quality Control Commission. *Regulation No. 82, 401-certification regulation, 5 CCR 1002-82.* Denver: WQCC, 2003. http://www.cdphe.state.co.us/op/regs/waterregs/100282wqcc401certification.pdf

Green Industries of Colorado. *The Green Industry Best Management Practices (BMPs) for the Protection and Conservation of Water Resources in Colorado.* Denver: GreenCO, 2003. http://www.greenco.org/bmp_list.htm

US Environmental Protection Agency. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas (draft).* Washington: US EPA, 2002. http://www.epa.gov/owow/nps/urbanmm/

Wright Water Engineers, Inc. and Denver Regional Council of Governments. *Guidelines for Water Quality Enhancement at Golf Courses Through the Use of Best Management Practices.* Denver: Wright Water Engineers, 1996. http://www.wrightwater.com/wwe/aboutWWE.html

Wright Water Engineers, Inc. and Denver Regional Council of Governments. *Mountain Driveway Best Management Practices Manual.* Denver: Wright Water Engineers, 1999. http://www.wrightwater.com/wwe/aboutWWE.html

Colorado's Nonpoint Source Program

www.npscolorado.com

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and Environment

www.cdphe.state.co.us/wq/nps/npshom.asp