CITIZEN'S GUIDE TO

COLORADO WATER QUALITY PROTECTION

Prepared by
Colorado Foundation for Water Education

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Citizen's Guide to Colorado Water Quality Protection

This Citizen's Guide to Colorado Water Quality Protection (2003) is the second in a series of educational booklets designed to provide Colorado citizens with balanced and accurate information on a variety of subjects related to water resources.

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About the cover: Colorado's varied landscape is seen in the waters of Molas Lake in the Grenadier Range of the San Juan Mountains and Little Dutch Girl Lake near the Pawnee National Grasslands.

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Mission Statement

The mission of the Colorado Foundation for Water Education is to promote better understanding of water resources through education and information. The Foundation does not take an advocacy position on any water issue.

Colorado Foundation for Water Education

Preface

Water quality determines how our water resources can be used. Abundant surface water supply is of no use to the farmer if that water is salty and brackish. An expensive new well is of no use to the homeowner if that water is contaminated with bacteria and viruses.

Similarly, the quality of our water reflects the health of our natural environment. Aquatic life of all sorts -fish, insects, and birds- need good quality water to grow and thrive. Wildlife relies on the healthy ecosystems created by our rivers and lakes.

High quality water in Rocky Mountain streams is a cornerstone of Colorado's image and identity. This unique resource is an important feature in the more than 40 Wilderness Areas throughout the state, as well as Rocky Mountain National Park and other national parks and monuments.

Water quality and water quantity are intertwined. *The Citizen's Guide to Colorado Water Law* describes our state's water quantity use and management systems. Colorado water law allows for the establishment of water use rights for a variety of purposes, including farming, drinking, manufacturing, recreation, and protection of the environment.

However, poor water quality can destroy the use and value of water for any or all of these purposes. A well-considered and effective water quality protection program is essential to our state's economy and the health of its citizens and environment.

The Citizen's Guide to Colorado Water Quality Protection is designed to provide an overview of water quality issues important to Colorado. It also summarizes the water quality protection framework currently in place on a national, state, and local level to help ensure that we protect, restore, and maintain the quality of this important natural resource.

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Urban areas produce large quantities of domestic wastewater which must be treated before it is discharged into local streams.

In contrast, stormwater is not actively treated before being discharged into rivers and lakes. Stormwater pollution control depends on management plans that focus on sources of pollution, such as construction sites.

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Ten Mile Peak (above) is reflected in the Blue River Ranch Lakes. Cold-water fisheries in the San Miguel River (below) attract anglers from around the world.

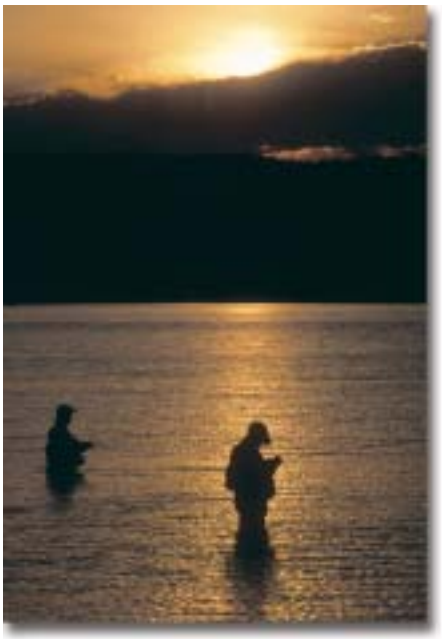
Surface Water and Groundwater

Water resources are categorized into surface water and groundwater. Surface water includes lakes, reservoirs, rivers, and streams. Groundwater refers to water located beneath the surface of the earth in aquifers, typically withdrawn through wells.

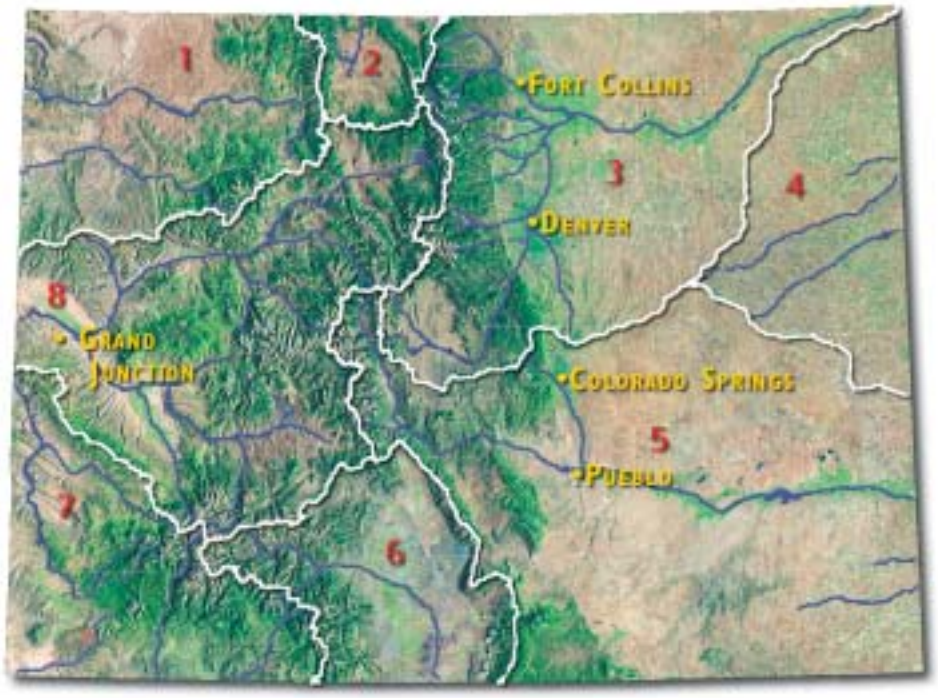
Surface streams in Colorado range from large perennial rivers to small ephemeral tributaries, totaling over 100,000 miles in length. Of the over 70,000 stream miles that have been evaluated by monitoring, over 90 percent meet or exceed their water quality goals.

Surface water supplies the majority of Coloradans with their drinking water, generally through a municipal water system. It also supplies the majority of agricultural irrigation across the state. Because of surface water's importance for drinking, recreation, agricultural and industrial use, as well as the maintenance of aquatic ecosystems, it is the primary focus of Colorado's water quality management and regulatory system.

Groundwater extracted from Colorado's aquifers provides some 18 percent of the water withdrawn for use in Colorado, primarily for domestic use and agricultural irrigation. Approximately 96 percent of this extracted groundwater is used for agricultural purposes. Groundwater supplies drinking water to roughly 500,000 Coloradans, mostly in small communities and rural areas.



Fishermen test their skills at Trinidad Reservoir.



Colorado's Major River Basins
1 – Green River Basin, 2 – North Platte River Basin, 3 – South Platte River Basin, 4 – Republican River Basin, 5 – Arkansas River Basin, 6 – Rio Grande Basin, 7 – San Juan River and Dolores River Basins, 8 – Colorado and Gunnison River Basins

Major Factors Affecting Water Quality

Natural Factors	Geology	Formations with varying amounts of minerals or metals Different soil types
	Climate	Mountainous areas with considerable snowmelt runoff vs. arid areas with minimal runoff
	Vegetation	Dense or sparse vegetation of varying types
	Wildlife	Fecal bacteria
	Wildfires	Erosion Sedimentation from burned areas
Human-induced Factors	Point source pollutants	Industrial and municipal wastewater discharges Stormwater runoff
	Nonpoint source pollution	Polluted runoff or leaching from areas disturbed by human activity
	Structural changes	Modified stream channels Reservoir storage Diversion of water from streams Drainage of wetlands

Water Pollutants and Pollution

A "pollutant" is broadly defined by federal and state law to include any substance that will adversely affect water quality or impair the desired uses of that water. Examples of common pollutants include metals, nutrients (phosphorus and nitrogen), ammonia, pathogens (disease-causing bacteria, viruses), sediment, and salinity. Metals or ammonia can kill fish, nutrients can cause a reservoir to fill with algae, pathogens can cause human illness, and sediments can smother aquatic habitat. Even heat is considered a pollutant, since elevated temperatures can harm aquatic life.

"Pollution" is defined even more broadly, as the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.

Point Source Pollutant Discharges

Point source discharges are contaminated discharges that flow into a water body from "any discernible, confined, and discrete conveyance." Point sources are often referred to as "end-of-pipe" discharges. However, they also may include overflows from impoundments, or runoff concentrated in some manner, for example in urban stormwater drains. In general, if pollutants are under someone's direct control, then released to a water body, this is considered a point source discharge. The largest continuous point source discharges in Colorado and nationwide are from municipal sewage and industrial wastewater treatment plants.

"The largest continuous point source discharges in Colorado and nationwide are from municipal sewage and industrial wastewater treatment plants."

Colorado law exempts agricultural stormwater runoff, irrigation return flows, and certain water management activities associated with the storage or delivery of water from regulation as point source discharges.

Nonpoint Source Pollution

Nonpoint source pollution is diffuse, rather than coming from one fixed location. Any source of pollution that does not meet the definition of a point source is considered to be a nonpoint source. Examples of nonpoint sources include runoff from agricultural lands, inactive mine sites, construction sites and urban development.

Nonpoint sources are considered the largest remaining source of pollution, contributing to both state and national water quality problems.

Safe water to play in is easy to take for granted. Behind the scenes, an extensive system of water quality standards and regulations works to protect human health and the environment.

Historical Perspective

Early Efforts

Our first water quality laws were adopted before Colorado became a state. In 1868, Colorado's territorial legislature adopted a law that addressed pollution from mining activities, stating that it was "the duty of every miner to take care of his own tailings, upon his own property, or become responsible for all damages that may arise therefrom."

Other laws soon followed, including an 1874 statute prohibiting the discharge to streams or ditches of "any obnoxious substances, such as refuse matter from slaughterhouse or privy, or slops from eating houses or saloons, or any other fleshy or vegetable matter which is subject to decay in the water…"

Early on, Colorado courts also determined that owning water rights under Colorado's prior appropriation system did not include the right to pollute in a manner harming other water uses. In 1897, the Colorado Court of Appeals ruled in the Suffolk Gold Mining case that owning an upstream water right did not entitle that user to pollute such that the water could not be used downstream. This protection applies even to junior water rights established later than the upstream use.

However, early efforts to protect water quality were only partially successful. Direct discharge of raw sewage and industrial byproducts was still common, if not the norm, throughout much of the last century. Even in metropolitan Denver, the first sewage treatment plant did not begin operations until 1938. And, although wastewater treatment continued to expand and improve over time, as recently as the early 1970s raw sewage was still found entering the South Platte River in the Denver area.

Colorado's continually growing population, combined with a lack of technology and enforcement, left some rivers and streams with significant pollution problems. However, Colorado's experience was far from unique. Nationally, concerns about the health of our rivers and lakes were increasing by the second half of the 20th century.

A New Federal Role

Until the middle of the 20th century, environmental protection efforts were largely left to state and local governments. Changing societal values and increasing concern about the preservation of our natural environment precipitated landmark federal environmental legislation in the 1960s and 1970s.

In 1972, Congress substantially expanded a previously limited federal role in protecting the water quality of the nation's lakes and streams by adopting what is now known as the Clean Water Act. In 1974, Congress adopted the Safe Drinking Water Act to protect public drinking water supplies. Both federal acts establish a set of minimum requirements that must be met by public and private entities. These requirements are the basis for the majority of Colorado's water quality laws and regulations.

The objective of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Act even established a timetable for improvements, setting a "national goal that the discharge of pollutants into navigable waters be eliminated by 1985."

The act also established a goal that by July 1, 1983, the quality of all navigable waters should be suitable for "the protection and propagation of fish, shellfish, and wildlife" and for "recreation in and on the water." This is commonly referred to as the "fishable, swimmable" goal of the Clean Water Act.

Although fully attaining these goals proved unrealistic in practice, they exemplify the ambitious water quality program established by the Clean Water Act.

State Waters vs. Waters of the United States

The federal Clean Water Act applies to "navigable waters" defined as "waters of the United States," which includes surface water but not groundwater. There is ongoing debate whether some waters, such as isolated wetlands, are protected by the Act. Colorado's water quality program applies to "state waters," which are defined more broadly to include both surface and ground water.

There is additional debate regarding the legal status of water in diversion ditches and other man-made conveyance structures under state and federal water quality law. In Colorado, permits are required for point source discharges into ditches, but water quality standards do not apply to these waters.

Protected by a gas mask, a worker on the Denver sewer crew circa 1920, is extracted from a manhole.

Water Quality From the Headwaters to the Plains

Rocky Mountains

Colorado is a headwaters state. All the major rivers flowing out of the state originate high in the Rocky Mountains, created principally by snowmelt that soaks into the ground and runs off into streams. Although in recent years there has been increasing concern about pollutants transported to remote areas by air currents (e.g., acid rain), generally water bodies in the mountains have not yet been affected by the majority of human development and land use activities.

This is the central feature of Colorado's water quality: it originates as a relatively pristine resource, not yet used (and reused) by others. Although Colorado's water is used several times within the state before its rivers flow into adjacent states, Colorado has a unique opportunity to define its water quality goals and expectations without inheriting problems that others have created.

Still, not all water flowing from the mountains is pristine. The natural geology of Colorado plays an important role. Geological formations containing metals and acid-forming minerals found in the mountainous regions of the state can produce naturally elevated concentrations of metals, minerals and acidity in nearby streams.

Although current mining operations in Colorado are subject to extensive regulation, mining in the late 19th century and first half of the 20th century left substantial, continuing water quality impacts in the headwaters of the state's major river basins. There are an estimated 23,000 abandoned mines in Colorado, several hundred of which adversely affect water quality.

A range of impacts other than mining can occur in Colorado's high country. Although the majority of Colorado's development occurs at lower elevations, activities such as logging, grazing, mountain towns, off-road vehicle use, and ski areas can all impact water quality.

Uncompahgre Peak, Gunnison River Basin

Mining Impacts in the Animas River Basin

The Upper Animas River Watershed is located at high elevations in the San Juan Mountains of southwestern Colorado, formed by three streams originating in a highly mineralized volcanic caldera – Mineral Creek, Cement Creek and the Upper Animas River. The last active mine in the basin closed in 1992, but water quality in the basin continues to be impacted by more than 130 years of mining.

Mine waste piles and drainage from old mines add metals such as aluminum, copper, cadmium, iron and zinc to local streams, resulting in severe adverse impacts to aquatic life ranging from a reduced number and variety of fish to a complete elimination of aquatic life from some streams. Although there are nearly 1,500 historic mine sites in the watershed, it is estimated that 34 draining mines and 33 waste piles account for 90 percent of all metal pollution from this area.

Metals and Acidity

Metals such as copper, arsenic, cadmium, mercury, zinc, and lead occur naturally in rock and can be toxic to aquatic life and humans. Waste rock from mining and waste material left from mineral processing (known as "tailings") can expose large quantities of metals to erosion and runoff, resulting in potential contamination of nearby surface waters.

Sulfide minerals exposed by mining can react with water and oxygen to produce acid, which further leaches metals from rock and increases the toxicity of metals to aquatic life.

In the Animas River Basin, mineralized waters stain the rocks with iron.

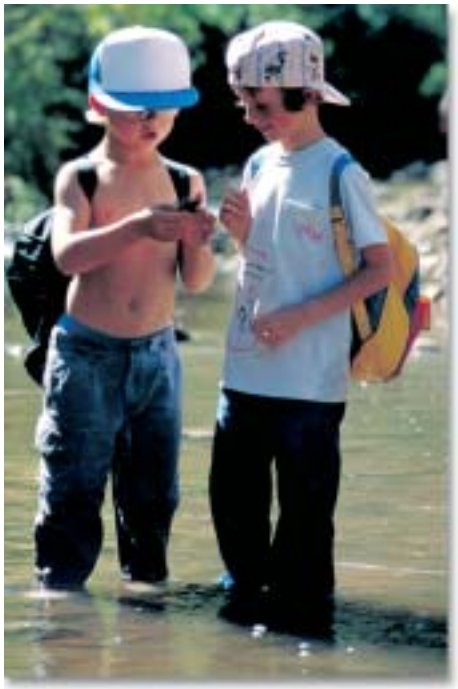
Impacts from Road Maintenance

Straight Creek parallels I-70 from the west side of the Eisenhower Tunnel to Silverthorne in Summit County. Winter road maintenance in this mountain corridor requires an application of approximately 10,000 tons of road traction sand each year. The cumulative effects of 30 years of these practices caused substantial adverse impacts to Straight Creek, reducing fish habitat and inundating wetlands. Starting in the 1990s, the Colorado Department of Transportation installed control structures and changed a number of practices in an effort to minimize these impacts.

Black Gore Creek, which runs from the west side of Vail Pass down to the town of Vail, also has been negatively affected by substantial sedimentation from road traction sand washed into the creek from highway maintenance. Work is currently underway by the Eagle River Watershed Council, state agencies, and others to remediate the problem.

Paralleling I-70 near Vail Pass, Black Gore Creek shows the impacts of sedimentation from road traction sand.

Sedimentation Excessive sediments deposited on stream and lake bottoms can damage spawning habitat (reducing fish survival and growth rates), impair fish food sources, and fill in pools and shallow, slow-water habitats that provide important cover and refuge for aquatic life. Sediment can also inundate and harm wetlands.



Two young explorers find plenty to investigate along the banks of the Colorado River.

Roads go hand-in-hand with development and can alter water quality. Without proper design and maintenance, including "best management practices" such as silt fences, adequate setbacks, drainage filters, or sufficient design for maximum runoff, road construction can increase erosion, clog streams with debris, and smother aquatic life with sediment. Roads built right next to streams may narrow and straighten the stream channel increasing risks of erosion, and remove the diversity of habitat needed for healthy stream ecosystems. Particularly in remote locations, road construction may greatly increase the risk of negative impacts to otherwise high quality waters.

Highways open year-round through the Colorado mountains require large quantities of road traction sand to mitigate winter driving conditions. This sand can then run off and cause excessive sedimentation of nearby streams.

Interstate 70 crosses the heart of the Rocky Mountains in Colorado. In two areas, runoff of road traction sand from I-70 has resulted in water quality problems severe enough for these streams to be placed on Colorado's list of polluted waters (see Impacts from Road Maintenance, *left*).

Colorado's high country is a favorite recreation area for many, providing excellent fishing, skiing, rafting, kayaking, and hiking opportunities. Although most mountain waters are of high quality, people recreating in the high country should be aware of natural water quality concerns that make some streams unfit for drinking.

Giardia is a microscopic organism that can be present in natural streams – even clear, cold, free-running mountain streams whose water looks, tastes, and smells good. Drinking untreated water with giardia can cause people to become ill several days later with symptoms that include nausea, diarrhea, cramps and loss of appetite. Since giardia comes from animal feces, it can be present even in streams in wilderness areas with little or no human development. Giardia can be removed from water by boiling, filtration or chemical disinfection.

Urban Areas

As Colorado streams flow to lower elevations, human activities and impacts increase. In particular, urban development results in several types of potentially significant water quality impacts.

Cities and towns with high concentrations of people must treat and dispose of large quantities of human sewage. Today, before domestic wastewater is discharged into Colorado streams, it typically receives substantial treatment. However, wastewater treatment plant discharges have the potential to increase stream concentrations of ammonia (which can be toxic to fish), nutrients (nitrogen and phosphorus compounds), and pathogens (disease-causing bacteria or viruses), as well as reducing oxygen levels in the receiving water. In addition, researchers are investigating the potential impacts associated with very small quantities of pharmaceutical chemicals such as hormones or over-the-counter medications, which find their way into rivers through wastewater treatment plant discharges.

Excessive levels of nutrients in an aquatic system – especially a standing water body – can lead to an undesirable level of algae growth known as eutrophication. Eutrophication is a natural process but it can be accelerated by wastewater treatment plant discharges, fertilizer-enriched runoff, and other activities that increase nutrient loadings to a water body.

Eutrophication is a common water quality problem in Colorado's urban reservoirs. Excess algae growth reduces water clarity and can make it less desirable for swimming or boating. Algae blooms can

Ammonia (NH_3) A nitrogen compound that can be toxic to many forms of aquatic life even at low levels.

Biochemical Oxygen Demand (BOD) A measure of the oxygen-consuming material present in wastewater. Higher BOD results in greater depletion of oxygen in a water body, which can be harmful to aquatic life.

Whether taking a tour along the Pueblo River Walk (top) or water skiing on Sloan's Lake (below), Coloradans are increasingly demanding access to clean and healthy waterways in urban areas.

Rocky Mountain Arsenal

The Rocky Mountain Arsenal is a federal Superfund site encompassing 27 square miles of land on the outskirts of Denver, north of the former Stapleton Airport and west of Denver International Airport. From 1952 to 1982, the U.S. Army used this site to manufacture chemical warfare agents. In addition, during this period Shell Oil Company manufactured agricultural pesticides on the Arsenal property. Manufacturing and waste disposal practices used during these years resulted in contamination of soil, surface water, sediments, and groundwater at the site.

Groundwater underneath the Rocky Mountain Arsenal is contaminated with multiple pollutants, including diisopropyl methylphosphonate (DIMP) as well as several pesticides (dieldrin, chlordane, dichloropropane, and DDT) and industrial chemicals (benzene, TCE, carbon tetrachloride and chloroform). Over time, a plume of contaminated groundwater has moved north of the Arsenal property, contaminating a number of private wells in the area. Remedial actions implemented under the Superfund program include removal of waste piles and contaminated soils, ongoing treatment of contaminated groundwater, provision of a new permanent water supply for nearby residents living north of the Arsenal, and creation of the Rocky Mountain Arsenal National Wildlife Refuge, with associated restrictions on future land use in this area.

A worker sprays water to prevent dust emissions during demolition of the "north plants" at the Rocky Mountain Arsenal. Workers demolished more than 150 structures throughout the Arsenal's 17,000 acres. Monitoring groundwater quality is an important part of Superfund efforts to remove contamination and transform the site into a national wildlife refuge. Today, the U.S. Fish and Wildlife Service estimates there are more than 300 different species of wildlife found within the Arsenal boundaries.

Diisopropyl Methylphosphonate (DIMP) A liquid chemical generated as a by-product of the manufacture and detoxification of the nerve agent Sarin, which was produced at the Rocky Mountain Arsenal by the U.S. Army in the 1950s. After lengthy debate regarding the human health risks posed by this chemical, the Water Quality Control Commission established water quality standards for DIMP in 1993.

cause taste and odor problems for reservoirs supplying municipal drinking water. Decomposition of algae by bacteria can consume oxygen, lowering dissolved oxygen to levels potentially harmful to fish and other aquatic life.

Reservoir releases and operations can have a positive or negative effect on water quality and quantity downstream of the dam and in the reservoir, potentially changing water temperature, dissolved oxygen, and sediment levels in the system.

Urban areas pose other water quality challenges. Oil, grease, and other materials from automobile operation and maintenance are deposited on driveways, streets, and parking lots. Sand, salts, and other chemicals are applied to roadways for winter maintenance. Excess fertilizer can run off from lawns. Pet wastes and improperly maintained septic systems are sources of pathogens and pollutants such as nitrogen and phosphorus. Litter, debris, and occasional spills of chemicals used in commercial or industrial activities can be washed into streams and lakes.

Urban areas have many impervious surfaces (roofs, streets, parking lots), in contrast to undeveloped areas where more infiltration into natural soils can occur. Therefore, during rainfall or snowmelt, pollutants deposited on urban surfaces are more easily carried into streams, lakes and reservoirs through municipal stormwater runoff systems or as diffuse, nonpoint source pollution. The numerous small and diverse sources of polluted urban runoff present a substantial water quality protection challenge (see Stormwater Discharges, p. 24).

Industrial activities also can result in water quality impacts. Today, wastewater generated by industrial operations must be adequately treated prior to discharge to surface waters or the municipal sewer system (see Municipal and Industrial Wastewater Treatment Plant Discharges, p. 23).

However, in some locations, previous industrial activities have resulted in ongoing contamination of local groundwater. Several of these sites, such as the Rocky Mountain Arsenal, have been designated for clean-up under the federal Superfund program.

Metro Wastewater Reclamation District

Created in 1961, the Metro Wastewater Reclamation District provides centralized treatment for the majority of the domestic wastewater generated in the Denver metropolitan area. The District, located on the South Platte River near the northern end of the metropolitan area, is by far the largest wastewater treatment facility in Colorado, treating more than 160 million gallons of wastewater per day. The District provides service to 57 local governments, with a population of 1.5 million people in a 380 square mile area.

The District provides primary, secondary and advanced wastewater treatment before its effluent is discharged to the South Platte River (see Domestic Wastewater Treatment Technologies, p. 23). The goals of treatment are to remove ammonia, disinfect the wastewater to eliminate pathogens, and lower the biochemical oxygen demand of the materials that end up in the receiving stream. The District also has constructed a series of drop structures in the South Platte River that create turbulent forces to introduce more oxygen into the water, which is beneficial to aquatic life and the downstream ecosystem.

The semi-solid materials removed from the wastewater by the treatment process—referred to as biosolids—are applied as fertilizer and soil conditioner to crop lands in eastern Colorado (see Biosolids Management, p. 26).

Clockwise from top: The Metro Wastewater facility is the largest in Colorado. Raw sewage from municipalities across the Denver metro area enters the plant. The aeration pond, part of primary treatment, is sampled and monitored. The water moves to a secondary clarification pond. Chlorination ponds are the next to last stage before the effluent is discharged to the river.

Pesticides and Fertilizers in Northeastern Colorado

Irrigated agriculture has a long, productive history in Colorado's river valleys. In Weld County, Nathan Meeker's Union Colony began diverting water from South Platte River tributaries in 1870 for corn, hay, oats, sugarbeets, and livestock. Following World War II, commercial fertilizers and pesticides first became available to farmers, and by the 1960s were commonly used in conjunction with irrigation to optimize crop yields. The herbicide atrazine, for example, became widely used for controlling weeds in corn fields beginning in 1960 with very little concern for water quality impacts.

Thirty years later, Colorado passed the Agricultural Chemicals and Groundwater Protection Act, authorizing groundwater monitoring in areas of the state deemed vulnerable to fertilizer and pesticide leaching. Studies in Weld County in the early 1990s first alerted the state that more than 25 percent of rural domestic wells and more than 75 percent of irrigation wells in the alluvial aquifer along the South Platte River contained detectable levels of atrazine. Fortunately, most of these pesticide detections were below the established EPA standard of 3 parts per billion. Nitrate levels, however, were found to exceed the EPA drinking water standard of 10 parts per million nitrate-nitrogen (NO_3-N) in more than 30 percent of wells tested in the alluvial aquifer.

Since the early 1990s, intensive education efforts, restrictions upon atrazine use, use of environmentally safer new chemicals, and increased care by farmers and professional applicators have resulted in documented reductions in the levels and frequency of pesticide detections in Weld County groundwater.

Chemigation systems meter calculated quantities of fertilizer and pesticides into center pivot irrigation systems. Precise application helps reduce input costs and potential water quality impacts.

Plains, Plateaus and Valleys

The water quality of streams and lakes across Colorado's diverse plains, plateaus and valleys varies widely. Generally, streams in these areas are warmer, slower and more nutrient-enriched than mountain streams. Rather than trout, reservoirs may support catfish and bass. In warmwater streams, suckers, minnows and darters are common. Along with these differences in natural conditions, land use activities change.

Across the eastern plains, on the west slope's Colorado Plateau, and in the San Luis Valley in southern Colorado, the most widespread human activities are agricultural. While agricultural production results in environmental benefits such as the preservation of open space, it also can affect water quality.

The most common water quality concerns associated with agricultural crop production involve the application of pesticides and fertilizers, particularly in areas predominated by irrigated agriculture. Pesticides are widely used to control insects that may damage crops (insecticides), to control undesirable weeds (herbicides), and to control crop diseases (fungicides). Both animal wastes (manure) and commercial fertilizers are applied to croplands to facilitate plant growth and increase crop yields. Excess applications of either pesticides or fertilizers can infiltrate into the ground and contaminate underlying groundwater or run off over the surface and enter streams or lakes.

In certain areas of Colorado, soils naturally contain materials that can create water quality problems. Activities such as irrigation, livestock grazing, or urban development can accelerate leaching of these materials into surface and ground waters. In western Colorado, infiltration and runoff from irrigated lands on marine sedimentary deposits like the Mancos Shale have exacerbated naturally elevated levels of selenium and salinity in some local streams.

Concerns regarding selenium levels in western waters increased following the discovery in the 1980s that selenium toxi-

city had caused mortality, deformities, and decreased reproduction in fish and aquatic birds at the Kesterson Wildlife Refuge in California's San Joaquin Valley. The Kesterson problem was tied to irrigation drainage waters with high concentrations of selenium and led to closer scrutiny of irrigation drainage at other locations in the West. In western Colorado, several stream segments do not meet current water quality standards for selenium for the protection of aquatic life. A number of local cooperative efforts such as the Gunnison Basin Selenium Task Force, are currently addressing these concerns.

High salinity levels have received substantial attention throughout the Colorado River Basin and in Mexico. In 1973, the Colorado River Basin Salinity Control Forum was established by the seven basin states, including Colorado. Since then, the federal government has spent approximately $400 million on salinity control efforts throughout the basin. More recently, it has been recognized that salinity and selenium impacts often occur at the same locations, due to leaching from the same shale-derived soils. To address the problem, Colorado water users and federal agencies have undertaken demonstration projects – such as replacing earthen canals with piped laterals to carry irrigation water – exploring the potential multiple-pollutant benefits of different control measures.

Concentrated animal feeding operations (CAFOs) also have the potential to adversely affect water quality if the large quantities of animal manure generated by these facilities are not properly managed. There are approximately 400 CAFOs in Colorado, with the majority of these operations located on the eastern plains. This includes 12 active "Housed Commercial Swine Feeding Operations." These large confined swine feeding operations are subject to special permitting and regulatory requirements. Unlike all other water quality laws, which are created by the state legislature, in 1998 these requirements were established as a result of voter approval of a citizen's initiative known as Amendment 14.

Selenium An essential trace element that occurs naturally and can be present at high concentrations in certain geologic formations. In surface waters, elevated levels of selenium have been shown to cause reproductive failure and deformities in fish and aquatic birds.

Salinity A measure of the total amount of dissolved salts in water. High levels of salinity can significantly reduce crop yields and can cause more frequent replacement of industrial or water treatment facilities' plumbing and other equipment.

Irrigation water helps turn the Uncompahgre Valley (above) into productive farm ground. However, irrigation-related leaching of salts and selenium from some areas of Mancos Shale have raised concerns that elevated concentrations of selenium in the rivers may be harming aquatic life.

Large quantities of manure generated by CAFOs can provide valuable fertilizer for farmland, but must be properly handled, stored, and applied to avoid contamination of ground or surface waters.

Concentrated Animal Feeding Operation (CAFO) An operation where large numbers of livestock (including cattle, swine, chickens, turkeys, horses or sheep) are confined for 45 days or more per year in an area with no grass or other vegetation during the normal growing season.

Coalbed Methane Production

Coalbed methane is the name given to methane gas present in underground coal seams. Since the late 1980s, new technology has resulted in increasing amounts of coalbed methane production in Colorado. Typically, large amounts of water are removed from coal formations to allow extraction of methane gas. This produced water, the quality of which can vary substantially from site to site, may be re-injected underground beneath the production zone, or it may be used or disposed of on the surface. Surface use or disposal can present water quality concerns due to elevated salinity levels. Due to coalbed methane production, the San Juan Basin in southwestern Colorado is now the fourth largest gas field in the United States.

A drill rig prepares a new well. Oil and gas pumped from the well is also likely to bring up large quantities of "produced water" high in salts. Preventing cross-contamination of fresh groundwater aquifers, aquifer drawdown, and appropriate surface disposal methods are some of the water quality concerns associated with production of coalbed methane.

Oil and gas production activities throughout the state also present potential water quality concerns for Colorado's plains, plateaus and valleys. Colorado has approximately 23,000 producing oil and gas wells located in 42 of its 63 counties. Weld County alone has more than 10,000 active wells. Oil and gas operations are regulated by the state Oil and Gas Conservation Commission.

Several aspects of oil and gas production pose potential water quality risks. First, wells must be properly constructed to prevent cross-contamination of pollutants from hydrocarbon-bearing zones into fresh groundwater zones. Wells also must be properly closed when they are no longer used.

When oil and gas is pumped from production wells, most wells bring up groundwater from the same formation. Handling of this "produced water," which often has high salinity levels, presents another potential water quality concern. Most produced water is re-injected deep underground, either to improve recovery of oil and gas or simply for disposal. In areas with little or no shallow groundwater, produced water may be stored in surface pits and allowed to evaporate or percolate into the ground. A small percentage of produced water is clean enough that it can be discharged to surface streams pursuant to a state discharge permit.

An additional water quality risk is that oil, gas, and/or produced water can be accidentally spilled in a location where it adversely affects surface or ground water quality.

Organizations and Agencies

Federal Agencies

The United States Environmental Protection Agency (EPA) is the federal agency responsible for water quality protection. The EPA's Office of Water develops national water quality criteria, specifies scientific methods and data collection requirements, and oversees state water quality standards and regulations. Ten regional EPA offices work with states and stakeholders to implement these programs. Colorado is located in EPA Region 8.

Other federal agencies, such as the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Department of Agriculture (including the Forest Service), Bureau of Land Management, and the National Park Service also have an interest in water quality.

For example, the U.S. Geological Survey collects and analyzes a significant amount of data to evaluate the quantity, quality, and use of the nation's water resources. The U.S. Fish and Wildlife Service works to protect endangered species whose recovery may be impacted by poor water quality. Federal land management agencies (such as the Forest Service and Bureau of Land Management) address water quality issues as part of their management and planning duties.

State Agencies

The Colorado Department of Public Health and Environment is the umbrella agency in charge of public health and environmental concerns, including water quality protection. The Water Quality Control Commission and Division, Operators Certification Board, and Board of Health are all part of the Department of Public Health and Environment.

The Colorado Water Quality Control Commission develops the rules for water quality management in Colorado. The Governor-appointed Commission holds hearings in each of the state's major river basins to set water quality classifications and standards, and develops regulations to ensure compliance.

The Colorado Water Quality Control Division implements and enforces water quality management policies established by the Water Quality Control Commission and the Board of Health. The Division is Colorado's lead agency for surface and ground water quality monitoring, protection, and restoration. It regulates the discharge of pollutants into the state's surface and ground waters and enforces the Colorado Primary Drinking Water Regulations.

The Colorado Board of Health sets regulations and policies that administer the public health laws of the state. This includes state drinking water standards, minimum standards for individual sewage disposal systems (septic tanks), and land application of water treatment plant sludges.

The Colorado Water and Wastewater Facility Operators Certification Board licenses operators of facilities that treat and manage drinking water and domestic sewage. In addition, the Colorado Division of Wildlife provides input to the Water Quality Control Commission and Division regarding the health of the state's aquatic life.

Inter-Governmental Organizations

Section 208 of the Clean Water Act requires states to develop regional water quality management plans. A principal function of these plans is to identify domestic wastewater treatment needs and plan for the appropriate size and location of new facilities. For most of the state, this planning is done by the Water Quality Control Division. However, in the central mountains and along the Front Range six regional agencies conduct this planning:

- Denver Regional Council of Governments
- North Front Range Water Quality Planning Association
- Northwest Colorado Council of Governments
- Pikes Peak Area Council of Governments
- Pueblo Area Council of Governments
- Upper Arkansas Area Council of Governments (pending)

Non-Governmental Organizations

A wide variety of non-governmental organizations are involved with water quality protection efforts, including a growing number of local watershed groups. Three statewide non-governmental organizations specifically address water quality issues.

The Colorado Water Quality Forum was created to increase statewide coordination between diverse interests in water quality management. For example, Forum work groups help resolve complex water quality standards issues before they go to the Water Quality Control Commission. First convened in 1992, participants include water suppliers, industrial and municipal dischargers, environmental groups, and federal, state and local government agencies. The Forum is a volunteer group, open to all interested persons. More information about the Forum is available on its web site at www.cwqf.org.

The Colorado Nonpoint Source Council advises the Water Quality Control Division on implementation of the state's nonpoint source pollution program. The Council is a voluntary assembly of federal, state and local agencies, as well as public and private interest groups. It reviews nonpoint source projects for funding, and promotes voluntary and cooperative nonpoint source management efforts. The Council encourages the public to attend its meetings and share concerns about local nonpoint source pollution issues (see Resources and Contacts, p. 31).

The Colorado Water Quality Monitoring Council is a statewide organization, open to all, working to helping standardize monitoring techniques, and increase cooperation among the many entities monitoring the state's water quality. The Council includes more than 50 organizations representing local, state and federal agencies, universities, watershed groups, consultants, industry, and professional organizations. For more information, refer to its web site at cwqmc.colostate.edu.

How Clean is Clean? Surface Water Quality Goals and Limits

How a water resource is used determines the water quality standards applied. The state has four main water use classifications: water supply (drinking), aquatic life, recreation, and agriculture.

Given Colorado's diverse water resources, from clear mountain streams to rivers rich with silt, from huge fluctuating reservoirs to small urban ponds: how does the state set goals and limits to either protect or restore water quality in each water body?

Colorado's water quality protection framework has three main components:

- Use classifications
- Water quality standards
- Antidegradation provisions.

The regulation creating this framework for the state is called the *Basic Standards and Methodologies for Surface Water*, often referred to as the *Basic Standards*. In addition, each of Colorado's major river basins has its own separate water quality regulation. Complete versions of these regulations are available on the Colorado Water Quality Control Commission website or may be requested by calling the Commission directly (see Resources and Contacts, p. 31).

In these regulations, lakes, reservoirs and rivers are divided into separate numbered segments. For example, the South Platte River Basin contains 145 different segments reflecting changes in use and water quality.

To find out what water quality classifications and standards apply to a local river or stream, one must first refer to the correct regulation for that area (e.g, Upper Colorado River Basin Regulation #33), then look up the sub-basin and specific stream segment of interest.

Use Classifications

When deciding the appropriate level of water quality for a particular river or stream, the Water Quality Control Commission's first step is to determine how those waters are currently used and what beneficial uses are desired in the future. The Commission then adopts "use classifications" for each current or future use to be protected. By law, use classifications must be adopted for the highest water quality attainable. The state classifies Colorado's surface waters as appropriate for the following uses: recreation, aquatic life, agriculture, water supply, and wetlands.

Recreational uses are distinguished by whether a stream or lake can support primary contact recreation, such as swimming, rafting, kayaking, tubing, windsurfing and water skiing. Situations where children frequently play in shallow water are also considered primary contact. Primary contact uses are divided into class 1a (existing use) and class 1b (potential use) recreation classifications. Streamside recreation uses, where ingestion of small quantities of water is unlikely, receive a recreation class 2 designation.

On some streams, primary contact recreation may occur only during certain seasons of the year. In these cases, streams may have different use classifications and standards for summer and winter.

Surface waters with aquatic life are classified by their ability to support diverse aquatic life, and by the temperature of the water. Class 1 waters are capable of sustaining a wide variety of aquatic life, including sensitive species. Class 2 waters are not. Class 1 waters are further divided into cold or warm water streams. Generally, cold water aquatic life classifications are appropriate for mountain streams, whereas warm water classifications apply to plains streams. Cold water standards are designed to protect the relatively sensitive trout species, and are therefore more stringent than the warm water standards protecting the somewhat less sensitive species found in those waters.

Agricultural classifications are intended to protect the quality of water used for either crop irrigation or livestock watering.

The domestic water supply classification most commonly applies to water that will be treated by a municipality and used as its drinking water source. This classification can also be used to protect shallow drinking water wells hydrologically connected to nearby streams.

The *Basic Standards* regulation provides a number of distinct classifications for wetlands, although application of these classifications has been limited.

Identification of the appropriate classification of waters is sometimes based upon a scientific assessment called a use attainability analysis (UAA). Some use attainability analyses can be completed quickly and easily; others may be very expensive and take years to complete.

Narrative and Numerical Standards

To protect a water body's classified uses, the state sets both numerical and narrative water quality standards.

Narrative standards describe the water quality goals for all state surface waters in a list of six general statements. For example, state waters are to be free from pollutants "harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life." Narrative standards provide protection against pollutants that do not have specific numerical standards.

Numerical standards set the maximum acceptable concentrations of specific pollutants in streams, lakes, and reservoirs. These concentrations are often based on criteria established by the EPA, taking into account available scientific research. Standards based on research-based criteria are referred to as "table value standards."

Alternatively, the Commission can adopt standards based on site-specific studies of what water quality will protect the classified uses of a particular stream. These studies may consider factors such as the specific aquatic species needing protection in that stream and their vulnerability to pollutants. Site-specific standards generally are less stringent than table value standards.

In some cases, the findings of a use attainability analysis help determine appropriate standards. For example, after an extensive UAA looking at the feasibility of cleaning up Animas River Basin streams adversely affected by past mining, site-specific standards were adopted for metals such as aluminum, cadmium, copper, iron, and zinc.

Numerical water quality standards are typically expressed in parts per billion (micrograms per liter) or parts per million (milligrams per liter). Recent advances in laboratory analysis have permitted assessment at the parts per billion level or even the parts per trillion level for many pollutants. For some pollutants, this has contributed to the development of more stringent standards.

Many complexities are involved when setting accurate water quality standards that adequately protect without being overly restrictive. For example, when assessing impacts to aquatic life, different numeric limits are set to avoid acute (instantaneous or short-term) and chronic (long-term) pollution impacts. Metals standards also can vary depending on water hardness, because metals are less toxic to fish in harder water.

On segments not meeting their stated water quality goals, the Water Quality Control Commission may adopt temporary modifications to those standards. Temporary modifications allow poorer water quality for a period of time, where it is recognized that water quality improvement is needed but it may take several years to achieve the desired long-term, underlying standard.

Units of Measure

1 part per billion (ppb) =
1 penny in $10,000,000

1 part per million (ppm) =
1 penny in $10,000

Hardness A measure of the level of calcium and magnesium in water.

How Clean is Clean? Surface Water Quality Goals and Limits

Antidegradation

In addition to use classifications and water quality standards, Colorado has adopted antidegradation provisions. The primary purpose of antidegradation provisions is to protect current water quality, especially where that quality is better than necessary to protect a water body's classified uses. Particularly because Colorado is a headwaters state with high quality water resources, antidegradation provisions are important in protecting the highest quality waters.

Maroon Bells Wilderness Area near Aspen (top) is an example of an "outstanding waters" designation, while the South Platte River near Kersey is an example of a "use protected" water resource.

Three results are possible under Colorado's antidegradation provisions:

1) Outstanding waters designation: no degradation is allowed.
2) Use-protected waters designation: degradation is allowed, so long as water quality standards are still met.
3) Reviewable waters: if there are no reasonable alternatives available, degradation is allowed so long as water quality standards are still met; if alternatives are available, degradation is not allowed.

Outstanding waters designations apply to high quality waters that constitute an outstanding natural resource. No degradation of outstanding waters is allowed. In large part due to this restriction, to date the Commission has applied this designation only to headwaters streams in federal wilderness areas and in Rocky Mountain National Park.

At the opposite end of the spectrum, the Commission designates water bodies as use-protected if they have a class 2 aquatic life classification (not capable of sustaining a wide variety of aquatic life) or poor water quality (worse than table value standards) for three or more pollutants. Most plains streams in Colorado are designated use-protected. Water quality in these streams is allowed to worsen, so long as their classified uses and water quality standards are still met.

By default, all remaining surface waters, without a use-protected or outstanding waters designation, are referred to as reviewable waters. Reviewable waters receive an intermediate level of protection since they are required to undergo an antidegradation review before any new or increased water quality impacts from point sources. The first step in the review determines whether degradation for the activity in question is considered significant. If it is, the review also must determine whether reasonable alternatives are available that would result in less degradation. If such alternatives are not available, the activity may proceed as proposed.

Review and Revision

Review and revision of water quality classifications and standards is an ongoing process. State and federal law require this review at least once every three years, through what is known as the "triennial review process."

Under Colorado's triennial review process, the statewide Basic Standards regulation, as well as the regulations for each individual river basin, rotate through a three-step review process. For example, in October of year one, an Issues Scoping Hearing is held for a particular basin's classifications and standards, to provide an opportunity for early identification of potential changes to be considered in the next major rulemaking hearing for this regulation. An Issues Formulation Hearing is then held in November of year two, to identify the specific issues to be addressed in the rulemaking hearing. Finally, in July of year three, a Rulemaking Hearing is held to formally consider adoption of any changes to the water quality classifications and standards. Three years after the Rulemaking Hearing for a particular regulation, a new Issues Scoping Hearing is held to start the review cycle again.

Anyone interested may participate in these hearings and propose that existing classifications and standards be made more restrictive or less restrictive. Detailed explanations of each step in the process and information about how to participate are available on the Commission's web site or from the Commission Office (see Resources and Contacts, p.31).

All new or revised water quality classifications and standards must be approved by the EPA before they become effective under federal law. If EPA rejects (disapproves) state standards, it has authority to adopt federal standards that will apply in Colorado. EPA has disapproved some Colorado standards. However, to date it has not adopted federal standards, preferring to afford the state an opportunity to revise its standards to address EPA's concerns. Nevertheless, the possibility of federal action is an important consideration in the Commission's development of Colorado classifications and standards.

Triennial Review Schedule

Year	**October** *Issues Scoping Hearing* Provide an opportunity for early identification of potential issues	**November** *Issues Formulation Hearing* Identify the specific issues to be addressed	**July** *Rulemaking Hearing* Formally consider and adopt any revisions to water quality classifications and standards
2003	**Basic Standards (#31)**	South Platte (#38)	Upper Colorado (#33) Lower Colorado (#37)
2004	San Juan (#34) Gunnison (#35)	**Basic Standards (#31)**	South Platte (#38)
2005	Arkansas (#32) Rio Grande (#36)	San Juan (#34) Gunnison (#35)	**Basic Standards (#31)**
2006	Upper Colorado (#33) Lower Colorado (#37)	Arkansas (#32) Rio Grande (#36)	San Juan (#34) Gunnison (#35)
2007	South Platte (#38)	Upper Colorado (#33) Lower Colorado (#37)	Arkansas (#32) Rio Grande (#36)
2008	**Basic Standards (#31)**	South Platte (#38)	Upper Colorado (#33) Lower Colorado (#37)

When researching a regulation, refer to the Commission's number for each regulation (#).

Are the Goals Met? Water Quality Monitoring & Assessment

Monitoring provides data that measure various aspects of water quality. Assessment is the process of organizing, analyzing and interpreting data to reach conclusions about water quality. In short, assessment is the process by which water quality data is transformed into useful information.

State-Sponsored Monitoring

The Water Quality Control Division uses several different types of monitoring to evaluate the health of the state's waters, focusing on chemical and biological monitoring of streams, lakes and reservoirs. Chemical monitoring refers to sampling of chemical constituents such as ammonia, copper or bacteria in surface water. Biological monitoring assesses fish populations, aquatic insects, algae, and aquatic habitat.

The state funds routine water quality monitoring at approximately 75 permanent sites throughout the state, generally collecting monthly samples for metals, nutrients and other basic water quality parameters. Monitoring is also periodically conducted at approximately 150 additional sites, for example prior to regular review of a basin's water quality classifications and standards.

Permitted point source (end-of-pipe) dischargers must routinely monitor the quality of their own discharges and report the results to the Water Quality Control Division (see Permits for Point Source Discharges, p. 23). Data from this monitoring is used to determine if dischargers are in compliance with permit requirements or if the state needs to take legal action to ensure compliance. The Division also performs limited spot checks to verify monitoring results.

In addition, monitoring or some other project evaluation is required for nonpoint source (diffuse pollution) control projects funded by federal grants (see Nonpoint Source Pollution Controls, p. 26). This

STORET

The EPA maintains a national database of all the water quality monitoring data collected in the United States that meets certain quality control criteria. It received the nickname STORET based on its purpose of data STOrage and RETreival. STORET recently underwent significant revision to make it more accessible and user-friendly. All water quality monitoring data collected in Colorado by the Water Quality Control Division is entered into STORET. Other public and private entities are encouraged to submit their water quality data to STORET. For more information on STORET see the EPA web site www.epa.gov/storet. Monitoring data for a specific watershed can be found in STORET in a variety of ways, including by searching for the name of the county, stream, latitude and longitude, or by sampling organization.

Permitted point source dischargers such as the Metro Wastewater Reclamation District regularly sample, test and monitor their effluent.

evaluation is important to determine whether nonpoint source control projects are improving water quality.

Once every two years, the Water Quality Control Division compiles all water quality monitoring information received (whether collected by the Division or others) into a report called The Status of Water Quality in Colorado. Section 305(b) of the Clean Water Act requires that this report be prepared and submitted to EPA by April 1 of every even-numbered year. EPA uses this information to prepare a national water quality report.

Other Monitoring

Federal agencies, including the U.S. Geological Survey, conduct monitoring as part of national research projects such as the National Water Quality Assessment (NAWQA) program. This program monitors long-term changes in water quality in more than 50 major river basins and aquifers nationwide.

Many other groups and organizations also conduct monitoring. These include universities, watershed groups, municipalities and private industry. Coordination of these multiple efforts is an ongoing challenge that led to the creation of the Colorado Water Quality Monitoring Council (see Non-Governmental Organizations, p. 15).

Any monitoring data provided to the Division and Commission that is adequately documented and judged to be reliable can be used to help determine appropriate water quality classifications and standards and to identify impaired waters (see Section 303(d) List of Impaired Waters, p. 22).

If monitoring shows that a lake, reservoir or stream segment is not meeting water quality standards, the Water Quality Control Division targets that water body for review and action. Although the state monitors only a portion of Colorado's surface waters each year, streams with suspected water quality concerns receive a higher priority.

River Watch

For more than a decade, the River Watch program (also known as Rivers of Colorado Water Watch Network) has provided resources and training for schools and local watershed groups to monitor the quality of waters in their local watersheds. The objectives of the program are to provide useful water quality data to regulatory agencies and other interested entities and to provide an educational opportunity for students and citizens.

The River Watch program is sponsored by the Colorado Division of Wildlife and administered by the Colorado Watershed Network, a non-profit organization. Approximately 125 schools and 15 local watershed groups participate. These groups regularly sample a total of about 220 separate locations throughout the state for metals, nutrients and other basic water quality parameters, resulting in over 70,000 individual data points generated annually. For more information, contact the Division of Wildlife or look on the Internet at wildlife.state.co.us/riverwatch.

Students from Rocky Mountain High School in Fort Collins collect water quality samples from Spring Creek and the Poudre River.

Cleaning Up Polluted Waters

Section 303(d) List of Impaired Waters

Water segments that do not meet water quality standards are placed on a list of polluted waters called the Section 303(d) List. The list gets its name from section 303(d) of the federal Clean Water Act, which requires states to periodically submit to EPA a list of impaired waters. The EPA requires that this list be updated every two years.

The first step in the listing process is development of a listing methodology, which describes the criteria that will be used to determine if waters are impaired. Over time, Colorado's listing methodology has become increasingly more specific regarding the type and amount of information required to place a water body on the list. The Water Quality Control Commission adopts revisions to the methodology following a public hearing.

Next, the Water Quality Control Division uses the listing methodology to prepare a proposed Section 303(d) List. Following a formal rulemaking hearing to receive public comment, a final prioritized list of impaired waters is adopted by the Commission and submitted to the EPA for approval. Should the EPA determine that the state's list is incomplete, it has authority to publish a list of additional impaired waters.

Colorado also maintains a Monitoring and Evaluation List. If a reservoir, lake, or stream has suspected water quality problems, but there is inadequate information to reach a conclusion about whether it meets standards, it will be placed on the Monitoring and Evaluation List. Further assessment of the waters on this list occurs as resources allow.

Total Maximum Daily Loads (TMDLs)

The Clean Water Act requires that for all waters on Colorado's Section 303(d) List, the state must develop what are known as total maximum daily loads (TMDLs). The TMDL concept was introduced in the 1972 Clean Water Act. However, substantial effort was devoted to TMDLs only after various environmental groups successfully sued the EPA in the 1990s to force such action.

A TMDL is a calculation that identifies the total quantity of pollutants that can be added to a water body from all sources (plus a margin of safety), and still meet water quality standards. The TMDL must evaluate all pollutant sources, including point sources (discharges from the end of a pipe), nonpoint sources (diffuse sources such as runoff), and natural sources. The TMDL report identifies all such sources in the affected area and calculates how much the pollutant loadings must be reduced to meet standards.

In some cases, after a water body is on the Section 303(d) List, questions may arise as to whether current use classifications or water quality standards are appropriate for that water body. If available information or new studies suggest that the current standards are overly stringent, dischargers or other stakeholders can ask the Commission to adopt less stringent site-specific standards (see Numerical and Narrative Standards, p. 17) before a TMDL is developed. Then, if the water body can meet these less stringent classifications or standards, no TMDL will be required.

Colorado's current schedule contemplates developing TMDLs for all waters on the Section 303(d) List within 10 years after the segment is added to the list. The Water Quality Control Division develops TMDLs, sometimes with substantial assistance from local groups. The Division makes draft TMDLs available for public comment. It then finalizes the TMDL and submits it to the EPA for approval. From 2000 to 2002, the Division submitted and EPA approved 48 TMDLs. If the EPA does not approve a state submission, it has the authority to establish a TMDL for that polluted waterbody.

Currently, implementation of a TMDL depends on the nature of the pollutant sources. Point source discharges of pollutants are reduced through enforceable discharge permits (see Permits for Point Source Discharges, p.23). Nonpoint source pollution may be reduced through voluntary, non-regulatory control efforts (see Nonpoint Source Pollution Controls, p.26).

Ammonia TMDL for Boulder and St. Vrain Creeks

In 2003, the Water Quality Control Division completed a TMDL for the amount of ammonia discharged to Boulder Creek and St. Vrain Creek from 13 municipal wastewater treatment plants. Complex computer modeling, considering factors such as pH and temperature, evaluated the contributions of each source. As a result of this TMDL, the two largest wastewater treatment plants in the area are expected to need advanced wastewater treatment technology.

Boulder Creek flowing east to the plains.

Total Maximum Daily Load (TMDL)
A calculation of the total amount of pollutants that can be added to a water body from all sources and still meet water quality standards.

Pollution Controls

Once water quality classifications and standards have been set, current water quality has been monitored and assessed, and needed improvements in water quality have been identified, how does the state assure that appropriate water quality controls will be put in place?

The state uses three primary mechanisms to control water pollution: discharge permits for point source discharges, control regulations, and voluntary nonpoint source controls. In addition, section 404 of the federal Clean Water Act requires that certain activities impacting wetlands receive a permit from the U.S. Army Corps of Engineers. Further, section 401 of the Act gives states authority to review these and other federal permits to assure that state water quality requirements are met.

Permits for Point Source Discharges

Discharge permits regulate point source discharges of municipal and industrial wastewater and stormwater. These permits are required by the Clean Water Act National Pollution Discharge Elimination System (NPDES).

The Water Quality Control Division issues discharge permits for most point sources in Colorado, although EPA can veto individual permits and may enforce state-issued permits. EPA issues permits for discharges from federal facilities and on American Indian reservations. Dischargers must renew their permits every five years.

Municipal and Industrial Wastewater Treatment Plant Discharges

Discharge permits limit the amount of pollutants that may be released into state waters. The primary requirements in municipal and industrial wastewater treatment plant discharge permits are called effluent limits, of which there are two major types: technology-based and water quality-based.

Technology-based effluent limits require that a discharger achieve a certain minimum level of pollution control that EPA has determined to be technologically achievable. Congress created technology-based requirements so that dischargers across the nation would have an equal obligation to treat their wastewater irrespective of the quality of receiving waters.

Throughout the United States, municipal sewage and industrial wastewater treatment plant discharges constitute the greatest volume of continuous point source discharges into rivers, lakes, and reservoirs. Congress' decision in 1972 to require nationally consistent

"…nationally consistent effluent limits for discharges are the principal factor in the nation's substantial progress in improving water quality during the last 30 years."

Domestic Wastewater Treatment Technologies

Primary Treatment The initial stage of sewage treatment, which uses screens to remove floating material from the wastewater and settling tanks to remove heavy material.

Secondary Treatment Biological treatment where bacteria consume the organic waste. All municipal dischargers are now required to utilize at least secondary treatment. This reduces the wastewater's oxygen demand, which lessens the impact of the discharge on the receiving stream.

Tertiary or Advanced Treatment Additional treatment steps beyond secondary treatment, such as filtration, or a combination of additional biological and chemical treatment to remove phosphorus, nitrogen compounds, toxic substances or other pollutants. For example, all of the wastewater treatment plants in the Dillon Reservoir watershed use advanced treatment to remove phosphorus.

Water flows through the primary treatment area at the Metro District.

Septic Tanks

In many areas of Colorado, wastewater from individual homes does not go to a central wastewater treatment facility. Rather, it is treated on the homeowner's property in an underground septic tank and leach field – commonly referred to as an individual sewage disposal system (ISDS) or on-site wastewater system. It is estimated that there are over 600,000 such systems in Colorado, serving about one-fourth of the state's population. Individual household septic systems do not require point source discharge permits.

When it rains, dense urban neighborhoods of buildings and pavement create impervious surfaces which don't allow stormwater to infiltrate. Instead, stormwater washes over these surfaces, potentially moving a variety of pollutants into the storm drain system. Water flowing into storm drains (above) is not treated, and may flow directly into rivers and lakes.

effluent limits for discharges is the principal factor in the nation's substantial water quality improvements in the last 30 years.

Water quality-based effluent limits require a discharger to treat its effluent so that water quality standards will be met in the receiving stream, even during low flow conditions. In Colorado, water quality-based effluent limits often are more stringent than technology-based limits because so many of the state's streams provide little or no dilution flows at certain times.

A discharge permit may also include whole effluent toxicity (WET) testing requirements. This type of testing measures the potential toxicity of a discharge by exposing aquatic organisms (e.g., fathead minnows) to varying concentrations of effluent. Most industrial facilities and cities with greater than 10,000 people are required to conduct WET testing.

Before a permit is finalized, the Water Quality Control Division issues a draft permit to allow for public comment. Notice of permit actions is published in the Denver Post and in a monthly Water Quality Information Bulletin prepared by the Division. Any interested person may subscribe to the Bulletin for $40 per year.

Under state law, permit violations are subject to potential civil penalties of up to $10,000 per day. In addition, the EPA can issue federal civil penalties of up to $27,500 per day. Finally, under the federal Clean Water Act, citizens have a right to bring a lawsuit against a discharger not meeting applicable requirements if the state and federal agencies have failed to act.

Stormwater Discharges

Stormwater runoff is rainfall or snowmelt that runs over the land surface potentially carrying pollutants into streams and lakes. Pet waste, excess lawn fertilizer, motor oil, cigarette butts, and trash can result in polluted stormwater runoff.

Point source discharges of stormwater runoff (e.g., storm sewers) are subject to a separate set of permit requirements than municipal and industrial wastewater discharges, largely due to the different nature of this discharge. Rather than discharging continuously at a relatively consistent volume, stormwater runoff can be extremely erratic. Therefore, stormwater management focuses principally on control and minimization of the pollution sources, rather than on treatment prior to discharge.

Colorado's Phase I stormwater permit program was adopted in 1993. The Phase I program requires each municipality with over 100,000 people (i.e., Denver, Aurora, Lakewood and Colorado Springs) to obtain one permit covering all of its stormwater discharges. These permits require an inventory of all stormwater discharge points and development of a Stormwater Management Program. Stormwater management programs address activities such as street sweeping, road deicing, and construction. They also establish long-term monitoring plans, as well as educational programs to raise public awareness regarding the negative impacts of improper waste disposal practices such as dumping used oil or

antifreeze on the ground, where it can wash into storm drains and eventually into Colorado's waterways.

Colorado's Phase II stormwater permit program was adopted in 2001. This phase includes most municipalities in Colorado with a population of 10,000 or greater, as well as smaller municipalities within a larger metropolitan area, and construction sites that disturb at least one acre. Phase II permittees are required to meet six minimum requirements similar to many elements of Phase I. However, unlike Phase I, Phase II permittees are not required to conduct sampling during storm runoff events or to regulate industrial stormwater discharges.

The six Phase II stormwater minimum requirements are:

1) Public education and outreach on stormwater impacts
2) Public participation and involvement
3) Detection and elimination of illicit connections and discharges
4) Construction site stormwater runoff control
5) Post-construction stormwater management in development/redevelopment
6) Pollution prevention/good housekeeping for municipal operations

Industrial stormwater dischargers are regulated under a general permit. Under this general permit, industrial facilities must develop individual stormwater management plans.

Groundwater Discharge Permits

The Water Quality Control Division requires a groundwater discharge permit for unlined sewage treatment lagoons or other impoundments containing wastewater, and for the application of wastewater to land. In general, a groundwater discharge permit from the Division is not required if the discharge is already regulated by a separate state or federal program. Because the federal Clean Water Act applies only to surface water, Colorado groundwater discharge permits are not subject to EPA review or approval.

Chatfield Reservoir (above) serves many functions, including recreational opportunities.

Pretreatment Control Regulation

Because wastewater generated by industry may not be treated effectively by the city's wastewater treatment plant, state law requires some facilities to treat their wastewater before discharging it into the city system. The primary focus of pretreatment requirements is to avoid discharges that may (1) interfere with the treatment performed by the municipal wastewater treatment plant, (2) pass through the municipal plant untreated, or (3) contaminate the biosolids material removed from the wastewater by municipal treatment.

More than 25 municipalities in Colorado have developed their own pretreatment programs. Indirect industrial dischargers in towns without a pretreatment program are regulated directly by the state Water Quality Control Division.

Biosolids Management Control Regulation

Biosolids are semi-solid organic materials remaining after the treatment of sewage at municipal wastewater treatment plants. Approximately 80 percent of the biosolids generated by treatment plants in Colorado are applied to agricultural lands as fertilizer.

Biosolids management requirements are designed to protect human health or surface water quality from harmful levels of pollutants, such as metals or pathogens in the biosolids. For example, regulations require that biosolids be applied at rates based upon the nutrient requirements of the growing crops, so the organic materials in the biosolids will be beneficially used and will not result in ground or surface water contamination.

Wastewater Reuse Control Regulation

In order to help conserve water resources, a number of municipalities have begun reusing their treated wastewater for landscape irrigation – e.g. for parks, greenbelts, golf courses and other public areas. This water is referred to as reclaimed domestic wastewater. Regulations have been adopted by the Water Quality Control Commission to protect public health while encouraging the beneficial reuse of treated wastewater.

Materials removed from treated wastewater are called biosolids. Full of nutrients, biosolids may be used as fertilizer on farm fields. Due to human health concerns, application of biosolids is subject to strict control regulations.

Control Regulations

"Control regulation" is a general term for any regulation, not including discharge permits, that the Water Quality Control Commission determines is needed to regulate specific activities or to protect water quality in certain water bodies. The Commission has adopted the following activity-specific control regulations:

- Industrial pretreatment before discharge to municipal sewers
- Biosolids application
- Wastewater reuse for landscape irrigation
- Passive treatment of mine drainage

It also has adopted control regulations to protect the following water bodies:

- Dillon Reservoir
- Cherry Creek Reservoir
- Chatfield Reservoir
- Bear Creek Watershed
- Cheraw Lake

Nonpoint Source Pollution Controls

Nationally, nonpoint source pollution is the largest remaining source of water quality problems. In contrast to the mandatory permit program established for point sources, the current approach to nonpoint source pollution in Colorado is voluntary and non-regulatory. The principal focus of nonpoint source control is to prevent pollution from occurring at the source, rather than treating water after it is contaminated.

Colorado's nonpoint source program primarily uses federal grants (under section 319 of the Clean Water Act) to implement voluntary nonpoint source pollution reduction projects. In recent years, Colorado has received between $2-$2.5 million in federal grant funds annually for nonpoint source projects. In the past, these projects were largely designed to demonstrate and test the feasibility of specific best management practices (BMPs). More recently, Colorado's nonpoint source program has narrowed its focus toward projects that will clean up polluted waters, specifically high-priority waters on the

Section 303(d) List.

The U.S. Department of Agriculture's Environmental Quality Incentive Program (EQIP) provides cost-share funds for BMPs to reduce water quality degradation from soil erosion, grazing, irrigation, confined animal feeding and other nonpoint sources.

Another option for increasing control of nonpoint sources is "pollutant trading," also called "water quality trading." The Commission has applied this concept by adopting control regulations that allow point source dischargers to receive "credits" to discharge a greater quantity of a pollutant, if they implement nonpoint source remediation projects that eliminate a larger quantity of that pollutant.

Section 404 Permits

Section 404 of the federal Clean Water Act requires a permit prior to the "discharge of dredged or fill material" into waters of the United States. Because waters of the United States include wetlands, this program primarily regulates activities that fill in wetlands for development. However, activities such as the construction of dams and diversions or river crossings also generally require a permit.

The basic principle of the section 404 permit program is that no discharge of fill material is allowed if a practical alternative exists that is less damaging to the aquatic environment. Although the U.S. Army Corps of Engineers issues section 404 permits, EPA is responsible for developing the environmental criteria for evaluating permit applications. EPA also has authority to veto individual section 404 permits and authority to enforce permit requirements.

Section 401 Certification

Section 401 of the federal Clean Water Act requires that, prior to issuance of a federal license or permit that may result in a discharge to waters of the United States, the state in which the discharge occurs must certify that the discharge will not result in a violation of state water quality standards. The state may attach conditions to its certification to protect water quality.

In Colorado, this requirement generally applies to activities needing the following federal approval: (1) an Army Corps of Engineers section 404 permit (see Section 404 Permits, above), (2) a Federal Energy Regulatory Commission hydropower license, and (3) EPA issuance of permits for discharges from federal facilities or on American Indian reservations.

Dillon Reservoir Pollutant Trading Program

Dillon Reservoir, constructed in the 1960s, is a 254,000 acre-foot reservoir located in Summit County and owned by the Denver Water Department. In addition to serving as a major component of Denver's water supply, the reservoir is heavily used for recreation.

To help prevent eutrophication of Dillon Reservoir, a water quality standard for phosphorus was established in 1984, along with a control regulation limiting the amount of phosphorus that the wastewater treatment plants in this basin may discharge. All of these treatment plants have installed advanced treatment facilities that limit phosphorus discharges to very low levels.

The Dillon Reservoir Control Regulation established an innovative pollutant trading program to control nonpoint source phosphorus pollution. Under this program, the Copper Mountain Consolidated Metro District paid to convert about 100 homes in the Frisco area from old, marginal septic systems to central sewer service. It was estimated that these septic systems used to contribute 120 pounds of phosphorus to Dillon Reservoir. This trade resulted in a credit of an additional 60 pounds of phosphorus allowed to be discharged by Copper Mountain, leaving a net reduction of 60 pounds in phosphorus loading to the reservoir.

Reducing inputs of phosphorous into Dillon Reservoir helps prevent excessive algae growth that can make the water less desirable for recreation.

Groundwater Quality Goals & Limits

Basic Standards

In a regulation called the *Basic Standards for Ground Water,* the Water Quality Control Commission sets statewide water quality standards for certain radioactive materials and organic chemicals in groundwater. In addition, the Commission has adopted site-specific groundwater quality classifications and standards for over 40 locations around the state, mostly to protect water quality in municipal well fields.

It also has adopted an interim narrative standard intended to protect existing groundwater quality until site-specific classifications and standards can be established. This standard provides important protection since the state has not yet had adequate resources to adopt site-specific groundwater quality classifications and standards for the majority of the state.

Private Wells

The state's water quality program does not regulate the quality of water in private wells. Homeowners with private domestic wells are responsible for monitoring their own drinking water quality. Just because a well permit is obtained for new home construction does not guarantee that good quality water will be available.

Agricultural Chemicals Program

An "agricultural chemicals program" was established in the Colorado Water Quality Control Act to protect groundwater quality from contamination from agricultural pesticides and commercial fertilizers. Implemented principally by the Colorado Department of Agriculture, this program focuses primarily on voluntary "best management practices" (BMPs) agricultural producers can utilize to minimize the risk of groundwater contamination. The Colorado Department of Agriculture established mandatory rules for proper containment of bulk quantities of pesticide and fertilizer under this program.

Drinking Water Quality Goals & Limits

The Safe Drinking Water Act was adopted by Congress in 1974 to protect public health by regulating the quality of the nation's public drinking water supply. Unlike the Clean Water Act, it controls the quality of water "at the tap" rather than addressing water quality in-stream or regulating pollution sources.

Major Elements of the Safe Drinking Water Act

- EPA national drinking water standards apply to all public water systems – i.e., systems with at least 15 service connections or which provide drinking water to an average of at least 25 people daily for at least 60 days out of the year. These systems are further classified as either "community" or "non-community" depending upon whether they serve residents year-round.
- Public water systems must conduct regular monitoring and notify the public of monitoring results, including any violations of drinking water standards.
- Community systems must provide Consumer Confidence Reports to the public, highlighting the results of their monitoring.
- Water system operators must be certified, to assure they have adequate education and experience for the operation of public water systems or states will lose substantial federal funding.
- Every state must develop a source water assessment program to identify potential contamination threats to public water supplies.

Drinking Water Standards

The EPA develops national drinking water standards known as maximum contaminant levels (MCLs). These standards set numerical limitations for many of the most significant contaminants that may be present in drinking water provided by public water systems. Secondary drinking water standards set limits on chemicals that cause aesthetic problems with drinking water, such as taste and odor problems. Colorado has adopted state drinking water standards identical to the MCLs established by the EPA.

In addition to meeting numerical drinking water standards, public water systems must comply with specific treatment requirements. For example, most public water systems in Colorado are required to provide disinfection, typically by chlorination, to control organisms such as bacteria and viruses. In addition, facilities using surface water must filter their water to remove microorganisms, such as giardia, that cannot be controlled by disinfection.

Source Water Protection

To implement the 1996 amendments to the federal Safe Drinking Water Act, Colorado developed the Source Water Assessment and Protection Program (SWAP) to evaluate the vulnerability of public drinking water systems to possible contamination. This program begins by delineating watersheds that contribute to the public water system, and then identifying potential sources of drinking water contamination in those areas. The susceptibility of public water supplies to these contamination sources is then evaluated. Colorado is required to complete these assessments for approximately 2,100 public water systems in the state.

Public education and public participation are key components of the source water assessment and protection process. However, recent concern about potential terrorism threats to public water systems has raised questions regarding how much information about drinking water sources should be made public. All levels of government are currently weighing the trade-offs between the public's need to know about the susceptibility of its drinking water sources to contamination and the security risks created by making too much information publicly available.

Water Quality / Water Quantity

Natural Tensions

A major physical constraint affecting Colorado's water quality is water scarcity. Colorado is a semi-arid state, with statewide annual average precipitation of some 16 inches. Many Colorado streams have naturally low flows much of the year. Natural stream flows may be increased or decreased at different locations and different times of the year by water management activities such as reservoir releases and diversions from streams, as well as return flows. In many instances, Coloradans' substantial use of water for agricultural, municipal, and other important beneficial purposes results in less water flowing in streams.

While it is generally accepted that "dilution is not the solution" to water quality problems, the reality is that less water flowing in Colorado streams and rivers makes impacts from human development more pronounced than in less arid parts of the country. Thus, a natural tension exists between our extensive use of water resources and our desire to maintain a high level of water quality.

A natural tension also exists between Colorado's water quantity and quality laws. Water quantity law has developed over nearly a century and a half, principally at the state level, and has been shaped largely by numerous individual court cases interpreting statutes and resolving state and local disputes.

Water quality law, on the other hand, was created primarily in the last quarter of the 20th century. Developed mostly at the federal level through the Clean Water Act and the Safe Drinking Water Act, it consists of very specific requirements contained in detailed "rules and regulations" developed by state and federal administrative agencies.

Cooperation

So how do Colorado's water quantity and quality management systems interact? There is no simple answer to this question. Federal and state laws relate in a complex manner depending on varying individual circumstances.

State law dictates part of the interaction. For example, although the Water Quality Control Commission and Division prescribe and enforce water quality standards, they are prohibited by state statute from requiring instream flows to dilute pollution. Neither can they take any legal action to impair the exercise of a water right.

Colorado's prior appropriation system recognizes the importance of leaving flowing water in streams for beneficial use. It allows instream flow rights held by the Colorado Water Conservation Board to benefit the natural environment. Water rights for instream recreational diversions by governmental entities are permissible. However, water rights for dilution of pollution are not.

Beyond these legal provisions, cooperation and collaboration among interested parties plays a key role in finding better solutions to water quantity/quality problems. Over the last decade, there has been increasing collaboration within state government to find better solutions to these problems. For example, the managers of the principal state water quality and quantity management agencies (Water Quality Control Commission and Division, Colorado Water Conservation Board, and the Division of Water Resources) hold regular quarterly meetings to discuss and work through issues with cross-cutting water quality and water quantity considerations.

At the local level there has been an increasing trend toward the formation of local watershed groups. Although the specific issues and concerns addressed by local watershed groups vary widely, a common theme of these efforts is achieving an appropriate integration of the quantity and quality aspects of water resources management. The Colorado Watershed Assembly (www.coloradowater.org) is the umbrella organization for local watershed groups in Colorado.

"...a natural tension exists between our extensive use of water resources and our desire to maintain a high level of water quality."

Colorado Watershed Protection Fund

In 2002, the Colorado General Assembly added the Colorado Watershed Protection Fund to the state's voluntary income tax refund check-off program. Monies contributed to the fund are to be used "to assist in the restoration and protection of lands and natural resources within watersheds in the state." Decisions regarding how the funds will be distributed are made jointly by the Water Quality Control Commission and the Colorado Water Conservation Board, in cooperation with the Colorado Watershed Assembly.

Fly fishing along the White River near Meeker.

Future Challenges

What We Know

We can be certain that future challenges to Colorado water quality protection efforts will result from added pressure on our finite water resources caused by increasing population and development. More people means more demand for water resources, including competing desires for water flowing in streams or diverted out, as well as increasing groundwater withdrawals. At the same time, more development means more waste and pollution that will need to be adequately treated or managed to maintain the quality of our receiving streams.

What We Don't Know

Perhaps even more daunting than the inevitable challenges resulting from increased population and development are the challenges resulting from what we do not know. In spite of tremendous advances in scientific information during the last 30 years, additional research continues to refine what constitutes "safe" levels of pollutants for various water uses. As research advances, standards adopted in the past may prove to be under-protective or overly stringent. In addition, many pollutants do not yet have water quality standards because we know little about their risks.

One example is the recent and growing speculation about the potential impacts of pollutants known as pharmaceuticals and personal care products. This term refers to a wide range of prescription and over-the-counter medicines, fragrances, cosmetics, and other substances. Recent research indicates that these chemicals are finding their way from our homes into our rivers through wastewater treatment plant discharges. Existing wastewater treatment plants are not designed to remove these substances from domestic sewage. Preliminary information indicates that these pollutants may adversely affect human endocrine systems, which produce hormones that affect human growth and development. However, little is yet known about the presence of these substances in our streams and rivers or about what levels of these substances become detrimental to human health or other water uses.

This example illustrates a central challenge of ongoing water quality protection efforts: What should we do in the face of uncertainty? Recognizing limitations on what is known, what goals and strategies are appropriate to protect, maintain, and restore the quality of Colorado's water resources? These questions involve an inevitable trade-off between more stringent controls to assure protection in the face of uncertainty, and the costs of additional monitoring, research, and new control technology.

Water quality is important because it determines how our water resources can be used and because it reflects the health of our environment. Making the best choices regarding how to manage the quality of Colorado's water resources will require the ongoing and active involvement of a wide range of Colorado citizens. Participation at all levels is important, whether becoming involved in the opportunities described in this guide or by simply being aware of what we pour down the drain or into storm sewers. We all live downstream.

Resources and Contacts

State water quality classifications and standards, regulations

Water Quality Control Commission
4300 Cherry Creek Drive South
Denver, Colorado 80246
303-692-3469 www.cdphe.state.co.us/op/wqcc/wqcchom.asp

State water quality protection programs

Water Quality Control Division
4300 Cherry Creek Drive South
Denver, Colorado 80246
303-692-3500 www.cdphe.state.co.us/wq/wqhom.asp

Drinking water quality or which water system serves a particular area	*Compliance Assurance and Data Management Unit*
Nonpoint source programs and funding	*Outreach and Assistance Unit or Nonpoint Source Coordinator*
Point source discharge permits	*Permits Unit*
Stormwater management programs	*Stormwater Coordinator*
Water quality monitoring and current water quality in specific streams, lakes and reservoirs	*Assessment Unit*
Water and wastewater treatment financial assistance	*Outreach and Assistance Unit*
Watershed-specific issues	*Watershed Coordinators*

Local drinking water quality

Your local public water treatment facility

Local watershed groups

Colorado Watershed Assembly
970-484-3678 www.coloradowater.org/cwa_main.asp

Water quality monitoring opportunities

Colorado Water Quality Monitoring Council
cwqmc.colostate.edu

Rivers of Colorado Water Watch Network
6060 Broadway Street
Denver, Colorado 80215
303-291-7412 wildlife.state.co.us/riverwatch

Federal water quality protection programs

Environmental Protection Agency (EPA) – Region 8
999-18th St. Suite 300
Denver, CO 80202-2466
1-800-227-8917 (Region 8 states only)
303-312-6312 www.epa.gov/region8

State water quantity management

Colorado Division of Water Resources
1313 Sherman Street, Room 818
Denver, Colorado 80203
303-866-3581 water.state.co.us

Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203
303-866-3441 www.cwcb.state.co.us

Glossary

Ambient water quality The existing quality of water in the environment, such as in a stream, lake or reservoir.

Ammonia A nitrogen compound present in domestic wastewater. Even low levels of ammonia can be toxic to many forms of aquatic life.

Antidegradation Provisions intended to protect the existing quality of a water body.

Aquifer A subsurface water-bearing geological structure capable of storing and yielding water to streams, springs, or wells.

Best management practices (BMP) Structural and/or management techniques determined to be the most effective practices for controlling nonpoint sources of pollution.

Biochemical oxygen demand A measure of the oxygen-consuming material present in wastewater. Higher BOD results in greater depletion of oxygen in a water body, which can be harmful to aquatic life.

Biosolids The semi-solid material, sometimes referred to as "sludge," removed from domestic wastewater as the result of treatment by a municipal wastewater treatment facility.

Concentrated Animal Feeding Operation (CAFO) An operation where livestock (including cattle, swine, chickens, turkeys, horses or sheep) are confined for 45 days or more per year in an area with no grass or other vegetation during the normal growing season, and which exceeds certain size thresholds or is determined to be contributing pollutants to state waters.

Diisopropyl Methylphosphonate (DIMP) A liquid chemical generated as a by-product of the manufacture and detoxification of the nerve agent Sarin, which was produced at the Rocky Mountain Arsenal by the U.S. Army in the 1950s.

Effluent limits Limitations on the concentration and/or mass of specific pollutants that a facility is allowed to discharge.

Eutrophication Enrichment of an aquatic system with nutrients (nitrogen and phosphorus compounds) increases growth of algae and aquatic weeds. Eutrophication is a natural process, but can be accelerated by human activities that increase nutrient loadings to a water body.

Giardia A microscopic organism that can be present in natural streams – even clear, cold, free-running mountain streams whose water looks, tastes and smells good. Drinking untreated water with giardia can cause people to become ill several days later, with symptoms that include nausea, diarrhea, cramps, and loss of appetite.

Groundwater Water located beneath the surface of the earth, typically withdrawn for use through wells.

Headwaters The small streams, generally in the mountains, that are the sources of a river; the first and smallest tributaries of a river.

Nonpoint source A diffuse source of water pollution, such as general runoff over the land surface; a pollution source that does not meet the definition of a "point source."

Nutrients Primary elements necessary for plant growth. The principal nutrients of concern for water quality protection are nitrogen and phosphorus compounds. In surface waters, elevated levels of nutrients can cause algae blooms, oxygen depletion, and adverse impacts to aquatic life.

Organic chemicals A class of mostly man-made, carbon-containing chemical compounds, such as pesticides and industrial solvents.

Outstanding waters Very high quality surface water that constitutes an outstanding natural resource and which is not allowed to be degraded.

Pathogens Microscopic organisms, such as bacteria and viruses, which can produce disease in humans if ingested.

Point source A pipe, channel, conduit or other discrete conveyance from which pollutants are discharged.

Pollutant Any waste or other contaminant that adversely affects water quality.

Pollution The man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.

Pretreatment The treatment of non-domestic, industrial wastewater before it is discharged into a municipal sewer system.

Public Water System A system with at least 15 service connections, or which provides drinking water to an average of at least 25 people daily for at least 60 days out of the year.

Reviewable waters Colorado surface waters that have not been designated "outstanding waters" or "use-protected", and which are subject to an anti-degradation review before new or increased contamination is allowed.

Salinity A measure of the total amount of dissolved salts in water. High levels of salinity can significantly reduce crop yields and can cause more frequent replacement of industrial or water treatment facilities' plumbing and other equipment.

Selenium A trace element that occurs naturally and can be present at high concentrations in certain geologic materials. In surface waters, elevated levels of selenium have been shown to cause reproductive failure and deformities in fish and aquatic birds.

Stormwater runoff Rainfall or snowmelt that runs off over the land surface, potentially carrying pollutants to streams, lakes, or reservoirs.

Table Value Standards Numerical water quality standards based on general scientific research, rather than on site-specific conditions.

Temporary modification A temporary relaxation of numerical water quality standards, to allow time for actions to improve water quality and achieve a long-term standard.

Total Maximum Daily Load (TMDL) A calculation of the total amount of pollutants that can be added to a water body from all sources and still meet water quality standards.

Use Attainability Analysis (UAA) A structured, scientific assessment of factors that may affect the ability to achieve a particular use of water. The analysis may consider physical, chemical, biological and economic factors that affect whether a use can be attained.

Use classification A formal designation of the uses (e.g. aquatic life, recreation, water supply and agriculture) for which the water quality in a stream, lake or reservoir will be protected.

Use-protected waters Water bodies that are not subject to antidegradation review, but rather are protected only for their classified uses.

Water quality standards Numerical or narrative criteria that specify allowable water quality conditions in a water body.

Waters of the state All surface and subsurface water in Colorado, except water withdrawn from the environment for use.

Wetlands Areas near the margin between water and land (such as swamps and marshes) that are wet enough to support plant growth typically found in saturated soil conditions.

Books

Thomas V. Cech, *Principles of Water Resources – History, Development, Management and Policy,* John Wiley & Sons, Inc (2003).

Don Elder, Gayle Killam, and Paul Koberstein, *The Clean Water Act: An Owner's Manual,* River Network (1999).

Richard Helmer and Ivanildo Hespanhol, *Water Pollution Control – A guide to the use of water quality management principles,* World Health Organization and United Nations Environment Program (1997).

Carol Wekesser (Editor), *Water – Opposing Viewpoints,* Greenhaven Press, Inc. (1994).

Other Publications

Colorado Water Quality Management and Drinking Water Protection Handbook, Colorado Water Quality Control Commission (Updated October 15, 2002).

Water Quality in Colorado – 2000, Colorado Water Quality Control Division (2000)

Colorado Water, League of Women Voters of Colorado (2001)

Gregory J. Hobbs, Jr. and Bennett W. Raley, *Water Quality Versus Water Quantity: A Delicate Balance,* Mineral Law Institute (1988)

Lawrence J. MacDonnell, *Water Quality and Water Rights in Colorado,* Colorado Water Resources Research Institute (1989)

Medano Creek, Great Sand Dunes National Monument

Spring runnoff cascades off the Needle Mountains in the Animas River watershed.

The Importance of Water Quality

Early inhabitants of Colorado grew to know the value of water – safe, clean water – in a semi-arid place. The Pueblo people built reservoirs and other water works as did the early European settlers. Towns and cities grew around rivers, streams, water holes and lakes.

Homesteaders and miners needed water for crops and industry, but also a reliable source of drinking water for survival. A dry well, even in the good years, could spell the end of a homestead.

Consider life without a reliable source of clean water, as much of the third world experiences – a life spent carrying and boiling water to protect against illness and disease.

Or consider the inability to grow food safely, swim in our lakes and rivers, or maintain the environment.

As a headwaters state, Colorado enjoys a unique opportunity and responsibility for the guardianship of our most precious resource – water.

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