

Upper South Platte Watershed Protection and Restoration Project

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Abstract—The Upper South Platte Basin is a critical watershed in Colorado. Nearly 80 percent of the water used by the 1.5 million Denver metropolitan residents comes from or is transmitted through this river drainage. The Colorado Unified Watershed Assessment identified the Upper South Platte River as a Category 1 watershed in need of restoration. Most of the river basin is located within the Pike National Forest southwest of the city of Denver. The South Platte River is also a major recreation area in Colorado and is highly regarded for its trout fishery.

The Upper South Platte Watershed Protection and Restoration Project was proposed in 1998 by Denver Water, the Colorado State Forest Service, Colorado State University, the Environmental Protection Agency, and the USDA Forest Service to respond to concerns about catastrophic disturbances in this watershed. The project is addressing these concerns by focusing on landscape vegetation patterns, soil erosion, and water quality within the Upper South Platte River Basin.

Introduction

The Upper South Platte Watershed Project was initiated in August 1998 to restore and protect the watershed. The project involves an interagency partnership between the USDA Forest Service, Colorado State Forest Service, Denver Water Board, and Environmental Protection Agency. These partners are concerned with continued soil and water problems from the Buffalo Creek Fire of 1996 and the potential for future fires to cause problems in other parts of

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the watershed. The partners intend to use watershed restoration as a guideline for management and project planning.

The Upper South Platte Protection and Restoration Project will reduce the potential for adverse effects to water quality, human life, and property by achieving the following goals:

- Reduce sediment, crown fires, and risks to property
- Create sustainable forest conditions in the Upper South Platte River Basin

The partners intend to improve water quality by reducing road and trail sediment, stabilizing stream channels, and reducing noxious weeds. Using prescribed fires, natural fires, mechanical vegetation treatments, and creating sustainable forest conditions will also reduce the risk of high intensity crown fires. Urban interface hazards will be reduced through educational programs and vegetation treatment on private lands. Sustainable forest conditions will be created by thinning stands, establishing openings, and maintaining snags and down logs. Research from the Cheesman historic forest landscape will guide the forest restoration activities.

The project will begin in three sixth-level watersheds. Restoration actions on public lands will focus in the Waterton/Deckers and Horse Creek watersheds. The USDA Forest Service, the Colorado Forest Service, and Denver Water will coordinate with other Federal and State agencies, local governments, and interested parties to plan, implement, and monitor restoration projects in the Upper South Platte River Basin. The partners involved in the Upper South Platte Project will implement new methods of doing business to protect watersheds that cross ownership or jurisdictional boundaries.

Land, Water, and Ecosystems

Characterization

The Upper South Platte Basin is a critical watershed in Colorado that encompasses about 1,000 square miles. Nearly 80 percent of the water used by the 2.5 million Denver metropolitan residents comes from or is transmitted through this river drainage. The Colorado Unified Watershed Assessment, as required in the Federal Clean Water Action Plan, identified the Upper South Platte as a Category 1 watershed in need of restoration. Most of the basin is within the Pike National Forest southwest of Denver, CO. The South Platte River is also a major recreation area in Colorado and is a highly regarded trout fishery.

The Pike National Forest portion of the protected area comprises about 500,000 acres. Private land in holdings comprise about 100,000 acres; the State of Colorado owns about 2,000 acres within the project area and manages 15,725 acres of Denver Water lands. The Bureau of Land Management and the city of Aurora also manage lands within the project area.

The Upper South Platte Project can be divided into three major vegetation zones based on elevation. The montane zone ranges from 6,500 to 10,000 feet in elevation and is made up primarily of ponderosa pine, Douglas-fir, and, in the upper portions, lodgepole pine. About 450,000 acres are in the montane zone. The subalpine zone ranges from 10,000 to 12,000 feet in elevation and comprises primarily lodgepole pine, aspen, Engelmann spruce, and subalpine fir on about 150,000 acres. The alpine zone includes the areas above tree line and primarily comprises alpine meadows, shrub land, rock and pockets of bristlecone pine on about 50,000 acres. The montane forests were intensively harvested in the late 1800s and early 1900s to supply mining needs, railroad ties, and building materials. However, a 12-square-mile area of montane forest was not logged and provides valuable information for restoration guidelines.

Timber management today primarily involves the harvest of dead wood for firewood. Most stands are mature, with 80 percent of the forested area in densely stocked, late seral conditions. The principal wildlife species within the project area are mule deer, elk, Merriam's turkey, Abert's squirrel and Wilson's warbler. The principal fish species are rainbow trout, brown trout, cutthroat trout, brook trout, white sucker, long nose sucker, and long nose dace. Wildlife viewing, photography, hunting, and fishing are an important part of many recreation activities.

Recreation in the Upper South Platte Project area includes sight-seeing, picnicking, camping, hiking, mountain biking, motorcycle and ATV riding, cross-country skiing, boating, fishing, and hunting. There are two designated Wildernesses within the watershed, Lost Creek and Mount Evans. Developed recreation facilities along the river corridors include 20 campgrounds. In addition to the campgrounds on the South Platte River, there are several developed picnic areas and numerous trailheads and parking sites. Use of the South Platte River and the adjacent uplands has increased annually over the past decade. Recreation use was estimated at 1,650,000 visitor days in 1995. This increase is largely attributable to the rapid population growth in the Denver metropolitan area and surrounding counties. The population has been increasing about 2.5 percent annually or 40,000 people per year. In-migrating residents tend to be active and affluent, giving rise to an increase in demand for dispersed recreation activities.

Landscape Assessment

A recent Colorado Front Range Assessment identified large areas along the Colorado Front Range where current forest conditions and urban interface are not conducive with the natural disturbance processes. The current forested landscape does not reflect the historic disturbance regime and is not sustainable. Fire suppression in the 20th century has allowed smaller, thin-barked trees to reproduce. The

Upper South Platte forests of today are denser than historic conditions, containing more small trees compared to the forests prior to 1900. These small trees serve as fire ladders, allowing ground fires to climb into the tree canopy and become crown fires. Wildfire severity and frequency have increased in recent years. These forest conditions, when combined with greater human encroachment into the forestlands, have dramatically increased the risk for loss of life and property from wildfires.

The Buffalo Creek Fire burned about 12,000 acres in 1996, destroying several homes and removing essential forest cover on highly erosive soils. Heavy rainfall and floods following the fire resulted in two fatalities and substantial erosion and sedimentation. Downstream reservoirs that supply water for the Denver metropolitan area were adversely affected. Denver Water spent nearly \$1 million on water quality cleanup and dredging operations in their reservoirs. They estimate they will spend an additional \$25 million on future cleanup, dredging, and water treatment modifications as a result of the Buffalo Creek Fire.

A landscape assessment was completed for the 645,000-acre Upper South Platte Watershed in September 1999. Key issues were identified and management recommendations were made to address catastrophic disturbances. The landscape assessment identified the dominant ecological processes and developed recommendations to restore and maintain the health of the Upper South Platte watershed.

Landscape Pattern of Vegetation—The structure, composition, and landscape pattern of vegetation have been altered from conditions found prior to the arrival of Euro-American people by the cumulative effect of human activities. Lowering the density of timber stands and creating more openings in ponderosa pine and Douglas-fir forests should reduce the risk of large-scale catastrophic fires, such as the Buffalo Creek Fire. Maintaining healthy forest stand conditions should also reduce the severity of other disturbances, including insect epidemics. Reducing existing fuel buildups by the use of prescribed fire and other treatments will reduce the threat of high-intensity wildfires and the associated risks of flooding, erosion, and downstream sedimentation.

Soil Development and Movement—Soil development and movement in the Upper South Platte Basin may be changed significantly by human influences on disturbance processes. Soil erosion hazard is correlated to road and trail density, vegetation, and drainage patterns, an especially severe problem in the highly erosive soils of the project area. Paved and unpaved roads and trails with inadequate maintenance, inadequate drainage, or improper engineering can lead to considerable erosion and increased sedimentation. Realignment or improving drainage and maintenance of existing roads and trails will reduce soil erosion and sedimentation, and improve road and trail safety. Closing and restoring unnecessary roads and trails will also reduce soil erosion and sedimentation.

Water Quality, Quantity, and Aquatic Habitats—Recent catastrophic fire and flood events have resulted in the movement of large amounts of sediment into the streams, harming water quality, aquatic habitat, and valuable municipal water systems. Water treatment plants had to be

shut down, and the tap water had a bad odor and taste. Restoring the landscape vegetation to more sustainable conditions will reduce the potential for catastrophic events. Abandoned mine reclamation and drainage control will also have a positive impact on aquatic habitat.

Customers and the Public Benefit

The Upper South Platte River Basin is southwest of Denver, CO. The area includes portions of Park, Jefferson, Douglas, Teller, and Clear Creek Counties. Residential land use in the Upper South Platte Basin is primarily rural; recreation, mining, and agriculture form the economic base. The watershed is sparsely populated, with several small towns located near historic mining and recreation areas. Many of the small communities have a mixture of permanent and seasonal residents. The communities of Bailey (population 9,100) and Woodland Park (population 9,000) are the largest urban areas within the watershed. Other small communities include Shawnee, Pine, Trumbull, Oxyoke, Nighthawk, and Deckers. Many homes are located in unincorporated areas adjacent to the South Platte River and its tributaries.

Stakeholders

The stakeholders include local and county governments, fire departments, landowners, and the business and environmental communities. The Upper South Platte Watershed Protection Association is a stakeholder group that shares similar interests with the Upper South Platte Watershed Protection and Restoration Project. The project will seek to develop a partnership with the association.

The Upper South Platte Project will benefit watershed stakeholders in several ways. Reducing wildfire severity will also reduce the risk of large, disastrous fires and the resulting home and property damage in the urban interface. Many of the residents' livelihoods are dependent on the surrounding natural resources. Sustainable forest conditions would support continued recreation and employment opportunities in the natural resource-related jobs.

Customers

Customers include horseback riders, hikers, mountain bikers, motorcycle, ATV and four-wheel drive enthusiasts, campers, anglers, hunters, and guides, Denver Water consumers, and downstream irrigators. The Upper South Platte Basin supplies about 80 percent of the water needs of Denver and the surrounding communities (50 percent from the South Platte and 30 percent from the North Fork). The current demand on the Denver Water system averages 265,000 acre-feet per year. The supply is about 345,000 acre-feet per year. Water resource development interests have identified the Upper South Platte Basin as the most efficient supply with the least costly storage sites for the Denver metropolitan area's future water.

The Denver metropolitan area residents also benefit from the Upper South Platte Project in several ways. Reducing sediment transport will minimize impacts on water quality. Denver Water will save money on maintaining reservoir capacity and water treatment. Water bills will remain low for Denver Water customers, and they will continue to have quality drinking water. The Denver metropolitan area residents comprise the majority of the recreation users in the Upper South Platte River Basin. Sustainable forest conditions will permit continued high quality forest recreation opportunities.

The Public

As a result of the Upper South Platte Restoration Project, the forest will be less prone to catastrophic wildfire. This will save suppression costs on large wildfires and create more sustainable landscape conditions for soil, water, fish, wildlife, and recreation.

Controversies

Fire Risks

A report prepared by the Federal General Accounting Office in 1999 describes the seriousness and problems that now exist from the threat of catastrophic wildfires to forest resources and communities in the following statement:

Uncontrollable wild fires should be seen as a failure of land management and public policy, not as an unpredictable act of nature. The size, intensity, destructiveness and cost of wildfires are no accident. It is an outcome of our attitudes and priorities. The fire situation will become worse rather than better unless there are changes in land management priority at all levels.

The early logging from 1870 to 1900, grazing of domestic livestock, and fire suppression effects on the Upper South Platte Watershed have resulted in conditions that differ markedly from pre-Euro-American settlement conditions, especially in the ponderosa pine, Douglas-fir forests. These forests have changed from a mosaic of patches with different aged trees and tree densities to a more uniform, dense forest. The fire regimes have changed over time from mixed severity fires to crown fires.

In the last 150 years, no extensive fires have occurred in the drainage. A low-intensity fire that occurred in the 1850s was extensive. A similar fire should have reoccurred in 60 years. These "natural" fires and tree recruitment periods following the fires resulted in considerable spatial and temporal heterogeneity. There are four components to this type of forest. The first component is forested patches with a distinct age cap. The second component includes patches of old-growth ponderosa pine with no evidence of past stand-replacing fires. In these patches, ponderosa pine and, often, Douglas-fir trees range widely in ages and states of health and decline. The third component is nonforested openings created by fire. The fourth component is the riparian system. These components proportions have changed significantly in the Upper South Platte Watershed, which increases the likelihood of a catastrophic fire.

Air Quality

Wildland fire is a major source of air pollutants that have the potential to create high concentrations of fine particulates. The Environmental Protection Agency 24-hour standard for these particulates with a diameter of less than 10 microns is 150 micrograms per cubic meter. Concentrations of 5,000 micrograms per cubic meter have been measured on some wildland fires.

The emissions vary significantly between flaming and smoldering combustion. Six to 10 times more particulates are produced by smoldering combustion compared to flaming combustion. Most small fuels are consumed by flaming combustion and have a relatively small emission factor. About 40 percent of the larger fuels, those materials 6 inches in diameter and larger, burn by smoldering combustion, which results in large emissions. By removing larger materials before the ignition, the potential for large amounts of smoke and larger fuels to smolder for long periods of time is reduced. This smoldering often occurs after ideal meteorological conditions have passed and an inversion has set in. We are working to develop markets for small diameter materials so they can be removed by methods other than prescribed fire.

Prescribed fires are scheduled during periods when meteorological conditions will prevent violating air quality standards. Of course, it is not possible to schedule a wild fire. Prescribed fire can be an excellent technique to prevent extreme emission from being generated from a wild fire. Agencies in Colorado are working hard to improve monitoring and predicting the impacts of fire emissions to the ambient air quality and visibility.

Water Quality

The Upper South Platte watershed is a valuable drainage system to Denver and surrounding communities. Of particular concern is the quality and quantity of water produced by this watershed. Shortly after the Buffalo Creek Fire, a strong thunderstorm occurred over the burned area. Flooding from this storm moved large amounts of sediment, destroyed homes and bridges, and decreased soil stability. Following the fire there were efforts to rehabilitate the burned area. Although some of the rehabilitation was successful, another flood caused two human fatalities and moved tremendous quantities of sediment. Much of the sediment settled in the Strontia Springs Reservoir, which supplies municipal water. Aquatic habitat was also damaged as a result of the fire and floods.

This project is now making a concentrated effort to protect and restore the landscape to a more sustainable condition to reduce the potential for future catastrophic events that would dramatically affect water quality and aquatic habitat. The intent of these efforts is to move watershed conditions and functions towards more sustainable conditions.

Erosion

Human activities have affected soil development and movement during the past 100 years, primarily by influencing disturbance processes. Alterations to natural disturbance

processes may increase catastrophic events, such as a fire. Soil development and movement depend on several factors: climate, parent material, time, vegetation, and disturbance. Granite is the parent material of most of this watershed. Granite weathers to gruss, which is a coarse gravel to fine sand crystalline regolith. Gruss and the soils that develop on it are highly erodible when exposed to direct impacts of rain, overland flow, or removal of vegetation by fire. Consequently, soil development and soil movement may be much different spatially and temporally during the past 100 years than the 1,000 years before Euro-American influence. An imbalance of soil development processes that may have potential long-term detrimental effects to the health and vigor of the watershed has likely occurred.

Land uses, such as suburban and rural development, are activities that can increase the surface erosion and soil loss. For a period, these activities may expose detrimentally compacted, displaced or fragmented surface organic and mineral layers to erosion. The net effect of these conditions may leave the surface soil layers in an unstable or unprotected state that can erode and deposit in streams and reservoirs.

Road construction, home construction and recreation use are on the rise in the Upper South Platte watershed, fueled by population growth in Denver. The Buffalo Creek Fire burned homes and forest cover on about 12,000 acres of highly erosive soils. Fortunately, this fire did not burn in a heavily populated area. While the homes were quickly rebuilt, ecological recovery has been slow. Hillsides are still barren of woody vegetation, and soil erosion continues. The soils are being transported to a storage reservoir for Denver Water. Denver Water estimates it will take \$25 million to dredge this reservoir.

Marketing

Marketing that involves the public and organizations has been designed to help develop a desired image of the watershed and the project. The objectives include:

- Providing timely and accurate information about the Upper South Platte Project to interested parties, media, public officials and others.
- Preparing and issuing news releases from the partners pertaining to the Upper South Platte Project in coordination with the Pike National Forest, Rocky Mountain Regional Office, Colorado State Forest Service and Denver Water.
- Informing the public and affected interests of the importance of healthy watersheds and the disturbances that can affect them.
- Emphasizing partner's commitment to implementing the Upper South Platte Project and completing activities on the ground.
- Offering opportunities for individuals and affected interests to contribute to the project—support, comments, ideas, assistance.
- Building and strengthening relationships with community leaders as well as interested individuals and organizations.
- Gaining recognition of and support for the project.

Partnerships

Partners in the Upper South Platte Watershed are those agencies and organizations contributing funds or services to the Restoration Project. The Upper South Platte Restoration Project is coordinating with and seeking the involvement of stakeholders, customers, and the public. The project is also developing additional stakeholder partners. The partners are concerned with water quality issues and fire risks within the Upper South Platte River Basin.

The partners agree to use watershed restoration as a guide for management and project planning within the Upper South Platte River Basin. The partners agree to the following collaboration principles: no one is the center of a network; keep commitments; communicate in a candid and tactful manner; honor each others' interests and contributions; and keep shared work products visible.

Rocky Mountain Region and Pike National Forest

The USDA Forest Service manages about 500,000 acres of the Pike National Forest within the Upper South Platte Basin. National forest management occurs within a framework set by Federal laws and regulations. The agency's ultimate responsibility is to manage National Forest lands for multiple benefits on a sustainable basis. The USDA Forest Service operates within the annual budgets appropriated by Congress. Individual projects are planned with public input using the National Environmental Policy Act (NEPA) process. The Federal budget, acquisition, and planning processes result in the USDA Forest Service moving slower than the other partners.

The Rocky Mountain Region and the Pike National Forest entered into the partnership to facilitate meeting landscape objectives. Although the agency manages nearly 80 percent of the lands within the Upper South Platte River Basin, it cannot hope to achieve the landscape objectives without partners. The partners will provide resources to improve conditions adjacent to the largest streams and in the urban interface where private lands predominate. The partnerships provide a means to increase efficiencies in planning and implementing projects on a landscape basis. The partners provide a collaboration to leverage funds to achieve shared objectives.

The management branch of the USDA Forest Service has a three-person team assigned full time to the Upper South Platte Project. The team is involved in all aspects of the project, including public involvement, partner recruitment, restoration projects, and coordination with other Forest Service projects and programs. The team has identified numerous specific restoration projects to improve terrestrial and aquatic conditions. The planning for these projects began in 2000. The majority of the projects described in the Business Plan will occur on the Pike National Forest.

Rocky Mountain Research Station

The research branch of the USDA Forest Service focuses on academic issues in forest management. Peer-reviewed research provides tools and context for National Forest

management. The research branch is relatively independent of the land management branch to minimize any scientific bias. The Rocky Mountain Research Station entered the partnership to assure the relevance of research to land management by formalizing the feedback loop to the knowledge base. Monitoring by the research community assures research conclusions can be tested on a landscape basis, and management practices can be adapted accordingly.

The Upper South Platte Project is based on science. It is not a pilot or test. It will rely heavily on research being conducted at Cheesman Lake, an intact historical landscape that can serve as a model for restoration activities in the lower montane zone for the Colorado Front Range.

A great deal is known about the natural disturbance history of this historical landscape and about the structure of the landscape components. Management actions will be based on this knowledge without compromising options. Research during the first years of the project will improve knowledge about the overall landscape and the structure and processes regulating it. New information can be incorporated into project planning and implementation. However, technical limitations may prevent new research information being implemented in a timely way.

The Forest Service research branch will conduct the research for the restoration activities, at an annual cost to the project of \$175,000. We are using the Forest Vegetation Simulator and Stand Visualization System with existing data. A GIS layer of forest structure at the landscape scale has been developed for the historical Cheesman Lake landscape. Fire behavior is being evaluated for several landscape scenarios using the FARSITE model. Additional research for fiscal year 2000 included: (1) developing an integrated landscape Historical Range of Variability for the historical landscape; (2) testing this Historic Range of Variability elsewhere in South Platte Basin; and (3) preparing three-dimensional visualizations of various landscape scenarios.

After the first year, subsequent research will focus on tightening the description of the historical landscape and natural variation in the processes affecting landscape patterns, with the overall goal of extending results to the larger montane zone of the Front Range. This will include refining restoration scenarios for the project landscape and evaluating crown fire potential and water balance, comparing the project area and historical landscape. Subsequent research also will assess pretreatment and posttreatment understory plant diversity in the project area, including noxious weeds.

Colorado State Forest Service

The mission of the Colorado State Forest Service is to achieve stewardship of Colorado's environment through forestry outreach and service. The mission includes protecting natural resources from damaging elements and increasing public understanding of forestry's role and value in a healthy environment. The State owns about 2,000 acres within the Upper South Platte River Basin. The Colorado State Forest Service has a contract to manage Denver Water lands in addition to the State lands. The State will work closely with private landowners to reduce the fire risk in the urban/forest interface. The partnership provides the State

with demonstration areas for other landowners on Colorado's Front Range. The partnership also provides a mechanism to leverage funds and improve communication with the public.

Denver Water

Denver Water owns 15,725 acres within the Upper South Platte River Basin. The forest management is under contract to the Colorado State Forest Service. They manage dams and reservoirs within the basin, which provide 80 percent of the water used by Denver metropolitan residents. Strontia Springs Reservoir was adversely affected by sediment following the Buffalo Creek Fire. Denver Water wants to reduce the risk of future events like the Buffalo Creek Fire by proactively managing its lands and the public lands within the basin. Denver Water can communicate the partners' objectives to nearly one million residential water customers.

USDI Geological Survey

The U.S. Geological Survey maintains stream gauges and monitors water quality across the United States. The U.S. Geological Survey collected water quality and soil erosion data in the Upper South Platte River Basin following the Buffalo Creek Fire. The U.S. Geological Survey has GIS data available for the landscape. Their monitoring experience has resulted in well-established monitoring protocols for soil and water parameters. They will help develop and implement the monitoring plan.

USDA Natural Resource Conservation Service

The Natural Resource Conservation Service provides soil and conservation technical assistance to private landowners. They provide an additional avenue of public outreach and have a close working relationship with the local Soil Conservation Districts (local officials appointed by county commissioners). The Natural Resource Conservation Service may be a source of potential cost-share funding for private landowners. They have soil inventories for the area and can provide water quality testing.

Trout Unlimited

The Trout Unlimited Cutthroat Chapter is concerned about road- and trail-related sediment that is adversely affecting fish habitat in the South Platte River. They are interested in identifying potential restoration projects to reduce sediment and can provide volunteers to help complete the work. Trout Unlimited has expressed an interest in reconstructing the Gill Trail.

Elk Creek Fire Protection District

The Elk Creek Fire Protection District provides fire protection in the urban/forest interface. The district is interested in creating defensible space to fight forest fires before

homes become engulfed in flames. The district will work with the Colorado State Forest Service to raise public awareness and educate homeowners on how to create defensible space.

Landscape Restoration

Mechanical Vegetation Treatment

The Landscape Assessment identified the Cheesman, Trout Creek, and Waterton/Deckers and Horse Creek watersheds as high priority for forest vegetation and wildlife habitat restoration. The ponderosa pine/Douglas-fir forests are at high risk of catastrophic fire because of dense, even-aged, closed-crown forest conditions. These forests have very little down wood to permit low intensity ground fires. Under extreme fire conditions (hot, dry, and windy), fire will carry as a high intensity crown fire. Mechanical treatment is needed to reduce the canopy density and create openings. The objective is to reduce canopy density to 30 percent or less on up to 80 percent of the ponderosa pine/Douglas-fir landscape. Openings of 1–40 acres will be created on up to 25 percent of this landscape. The mechanical vegetation treatments will include commercial timber sales, stewardship/service contracts, noncommercial thinning, and chipping or shredding to masticate the trees on site. Prescribed fire will be used in conjunction with mechanical vegetation treatments.

About 2,000 acres will have mechanical vegetation treatment on an annual basis. The operational costs vary considerably based on the method used. Monitoring plan that includes vegetation plots and landscape mosaics will measure accomplishments.

Generally, lands with existing road access and slopes less than 35 percent may use commercial timber sales to meet the vegetation objectives. The timber value in the basin is relatively low; therefore, some flat areas with roads may require stewardship/service contracts to meet the vegetation objectives. Noncommercial hand felling, shredding, or chipping will be used in steep or limited access areas.

Most of the mechanical vegetation treatments will occur on National Forest lands managed by the USDA Forest Service. The Colorado Forest Service will manage State and Denver Water lands and provide assistance to private landowners. Costs for mechanical vegetation treatment vary from commercial value for some timber sales to several hundred dollars per acre for hand felling. An average cost of \$137.50 per acre is planned for mechanical treatment. The actual cost could be considerably different if the treatment mix differs significantly from the assumed 50–75 percent in commercial removal.

Reforestation

A portion of the Buffalo Creek Fire area requires reforestation to provide vegetation diversity. The USDA Forest Service will plant about 1,000 acres with ponderosa pine widely spaced. Standard reforestation survival and growth protocol will be used to measure accomplishments. The seed inventory is currently insufficient to provide an adequate

number of seedlings. Seeds will be sowed in 2000 to plant 100 acres of container seedlings in 2001. Cones will be collected in 2000–2002 to replenish the seed inventory. Additional seed will be sowed in 2001–2003 to plant 300 acres per year the following years. Reforestation costs are expected to be \$500 per acre.

Noxious Weeds

Leafy spurge, diffuse knapweed, yellow and Dalmatian toadflax, and Canada and musk thistles are noxious weeds along 25 miles of the South Platte River. These noxious weeds are less palatable to wildlife, are less effective in stabilizing soil, and often out compete native vegetation. The goal is to reduce the infested acres. About 200 acres will be treated annually using chemical, biological, mechanical, and manual methods. Accomplishments will be measured by surveying the river corridor annually to determine if the infestation zone is shrinking, remaining constant, or growing.

The USDA Forest Service, Colorado Division of Wildlife, Colorado Department of Agriculture, and county weed boards are working with private landowners and volunteer groups to manage the noxious weed problem. County weed management departments will assist in developing integrated weed management plans for all land ownerships. The National Fish and Wildlife Foundation and the USDA Forest Service have provided grants for noxious weed treatments in previous years. A contribution of \$20,000 annually will be used to leverage an additional \$40,000 in grants from partners.

A noxious weed prevention strategy will require treating an additional 200 acres annually prior to mechanical and prescribed fire treatments. The additional 200 acres will require \$40,000, for a total of \$60,000 funds annually.

Roads

Many roads are poorly located and poorly maintained. Roads are the major source of anthropogenic erosion and sedimentation. The Pike National Forest plans to inventory its roads and update the information during the next 3 years. The project will accelerate the inventory within the basin and supplement the collected information to include site-specific erosion and sedimentation concerns. The updated information will be used to assess and prioritize roads for maintenance, closure, and obliteration. The cost in fiscal year 2000 cost will be \$55,000.

Road maintenance in the basin costs about \$100,000 annually. Currently, several roads not normally maintained are in obvious need of maintenance or need more effective closure devices installed. In fiscal year 2000, \$45,000 will be used to place effective water bars or closure devices on 100 miles of priority roads known to be contributing high amounts of sediment. The road assessment is anticipated to identify \$120,000 of road maintenance, \$73,000 of road reconstruction improvements from funds, and \$57,000 of road obliteration annually in fiscal years 2002–2005. Accomplishments will be measured by visual inspection to assure best management practices are implemented and effective. The monitoring plan identifies the protocols to evaluate if roads are affecting water quality.

Trails

The goal of the following trails projects is to create a safe, sustainable trail system in the South Platte watershed to meet the needs of hikers and other trail users while minimizing environmental impacts.

Cheesman Canyon is one of Colorado's treasures. The Gill Trail travels through the Cheesman Canyon and accesses a nationally known fishery along the Platte River. The trail is used by many hikers interested in seeing one of Colorado's major canyons absent roads, railroads, and residential development. Views of the historic Cheesman Dam and rugged canyon scenery also attract trail users. The Gill Trail was constructed about 40 years ago, stopping short of Cheesman Reservoir. No major trail improvements have occurred since then. An estimated 25,000 visitors per year use the trail and their effects are clearly evident. Crumbling side-slope trails have caused numerous braided routes and excessive erosion. Many social trails have been created to try to access the South Platte River, and some sections of this route are unsafe. The excessive and braided trails also cut through habitat used by the Federally listed Pawnee montane skipper, killing the plants on which they depend.

The USDA Forest Service, the National Park Service, consultants, and partners have prepared preliminary trail plans that address the issues described above. Key partners in this project include the Cutthroat Chapter of Trout Unlimited, Denver Water, and the USDA Forest Service. The final trail plan will be refined and evaluated under the National Environmental Policy Act planning process by the end of fiscal year 2000. Trail and restoration work will include safe rerouting and repair of existing trail, building a new safe sustainable trail from the original alignment to Cheesman Reservoir, expanding parking areas, eliminating braided trails, rehabilitating damaged side slopes, and restoring native vegetation that can be used by the skipper. All work will be completed by fiscal year 2004. Expected project benefits include improved safety, hiking experience, and visual quality along the trail, restored skipper habitat, and reduced sediment input from eroding trails. Local economic benefits may result from expenditures for goods and services by anglers and hikers attracted to the improved South Platte River access.

The estimated total cost for this project is \$400,000 over the next 5 years. The trail design, construction, and maintenance portion is estimated at about \$355,000, restoration about \$30,000, and monitoring at \$15,000. Besides the USDA Forest Service's contribution, Trout Unlimited and Denver Water will contribute about \$126,000 (32 percent of the project total cost). Trout Unlimited and the USDA Forest Service have also applied for grants totaling \$145,000 (36 percent of the project total) from the Colorado State Trails Program and Fishing is Fun. This project will make extensive use of volunteers from Trout Unlimited and Volunteers for Colorado Outdoors to perform trail work.

Prescribed Fire

Fire has been suppressed in the Waterton-Deckers and Horse Creek watersheds for more than 100 years. Therefore, the natural fuels have been building up over time and have

the potential for large catastrophic stand-replacing fires. These stands are generally dense, even-aged, with closed crown conditions. Extreme fire conditions (low humidity, low fuel moistures, high temperatures and wind) allow fire ignitions to result in high-intensity crown fire. The objective of this project is to treat 2,000 acres annually with prescribed fire to reduce natural and activity fuels and, where possible, create openings in the ponderosa pine-Douglas-fir stands. The areas to be treated will be companion areas to those being treated by mechanical methods.

The operational costs should not vary from costs experienced over the past 5 years in the prescribed fire program. Accomplishments will be measured based on the monitoring plan. Prescribed fire can be used to treat lands with little or no access and slopes greater than 35 percent. The slopes greater than 35 percent are on the upper limit for mechanical treatment. There may be a need to return to the stands treated by prescribed fire to supplement the prescription by hand felling trees not killed by fire to enlarge openings. Mechanical treatments will generally be followed by prescribed fire on lands managed by the Colorado State Forest Service and the USDA Forest Service.

Monitoring

Monitoring will serve as the quality control aspect of this restoration project. Data collection and observations of activities will provide a basis for evaluation of the overall restoration project. Data collection and analysis will follow established scientific procedures. Data collected will be analyzed and evaluated. Monitoring will be designed to determine if activities are being carried out in compliance with the project plan and existing Forest Plan. Objectives, long-term relationships, and the ability of the project to adapt to the research findings from the Cheesman research project will be evaluated. Also, the effectiveness of management activities in moving the vegetation and water quality toward desired conditions and in reducing the threat of catastrophic wild fires and their associated effects on soil, water and the human environment will be evaluated.

Monitoring will be completed annually and it will be based on the *Upper South Platte Watershed Protection and Restoration Project Monitoring Strategy* developed by a subcommittee of the Steering Committee. The monitoring will determine whether project activities are meeting the goals of reducing fuel hazards and associated catastrophic fire risk while maintaining soil productivity, minimizing erosion, and improving water quality. The monitoring strategy is designed to be dynamic and will be changed as new information becomes available. Monitoring stations will be established in the upper portion of the watershed, as well as in the lower portion of the watershed. Activity-level monitoring will be determined during project planning. Where possible, the Denver Water lab will be used for water analysis. The USDA Forest Service will provide data storage, and information will be shared with all partners on a regular basis.

The USDA Forest Service will take the lead in funding the monitoring activities and will work with partners to secure additional funding. The USDA Forest Service will work with partners to assign personnel to conduct the monitoring activities. A monitoring report will be done annually and presented to the partners and Steering Committee. The Middle East Regional Cooperation Program will contribute some data to the monitoring process. This project may also contribute some funds toward the overall project but this remains to be seen.

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