COAL BASIN & CRYSTAL RIVER AREA RESTORATION WORKSHOP

May 1-2, 2012

Town of Redstone

June 2012

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Acknowledgments

Roaring Fork Conservancy wishes to thank the nearly fifty individuals who participated in the intensive, two-day Coal Basin & Crystal River Area Restoration Workshop. We were incredibly fortunate to have such a knowledgeable and diverse group of resource experts and stakeholders attend the workshop. We would like to especially thank the technical presenters, who spent many hours before the meeting reviewing available data, studies and background information on the target restoration areas:

- Justin Anderson – U.S. Forest Service
- Kendall Bakich – Colorado Division of Parks and Wildlife
- Kate Dwire – U.S. Forest Service Rocky Mountain Research Station
- Matt Grove – U.S. Forest Servic*e*
- Andrew Harley – Biochar Solutions, LLC
- Brian McMullen – U.S. Forest Service
- Jon Proctor – U.S. Forest Service
- Steve Renner – Colorado Division of Reclamation, Mining & Safety
- Sandra Ryan – U.S. Forest Service Rocky Mountain Research Station
- Russ Walker – Colorado Mesa University

We received strong support from the White River National Forest in planning and carrying out the workshop. In addition to their attendance, Scott Fitzwilliams, Forest Supervisor, and Scott Snelson, District Ranger, Aspen-Sopris Ranger District, provided a number of their local resource experts for the two days of meetings. Mark Lacy, Fisheries Biologist, was instrumental in organizing all aspects of the workshop.

Roaring Fork Conservancy would like to express its appreciation to Kelly Burnett, U.S. Forest Service Pacific Northwest Research Station, for helping to facilitate the workshop, and to Barb Andre, for her assistance in coordinating the meeting. Rose Ann Sullivan, Kootenay Resources, LLC, also assisted with facilitation and compiled this report.

The workshop could not have taken place without the grant generously provided by the Pitkin County Healthy Rivers & Streams Board. We also wish to recognize the contribution made by the Aspen Skiing Company, which provided two of its shuttle busses and drivers for the on-site visits to the targeted restoration areas. We would like to thank the Redstone Inn, Town of Redstone, for its gracious hospitality while hosting the Coal Basin & Crystal River Area Restoration Workshop.

And most importantly, we would like to acknowledge the tremendous effort put forth by Steve Renner, Colorado Division of Reclamation, Mining & Safety, and Mike Mechau, Crystal Valley Environmental Protection Association, on the reclamation efforts to date. It has been a huge undertaking, and their creativity and passion has brought Coal Basin a long way and provided a strong foundation for future work.

Cover photo: Coal Basin - restored area of Dutch Creek near the confluence with the main stem of Coal Creek (May 1, 2012).

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The Challenge

Fifty years of large-scale coal mining in Coal Basin, a watershed characterized by naturally steep, unstable and eroding slopes, has resulted in a radically altered landscape. Erosion from partially-reclaimed mining areas, as well as sedimentation from naturally-occurring soil erosion and debris flows, are degrading water quality and stream habitat in Coal Basin and contributing to sedimentation issues in the Crystal River. Additionally, the four-mile Coal Creek Road corridor (between Coal Basin and Hwy 133) frequently impinges upon extremely active tributaries to Coal Creek, causing stream bank instability and resultant sedimentation that also impacts the Crystal River. Although the Colorado Division of Reclamation, Mining & Safety (CDRMS) was able to complete a series of restoration projects in Coal Basin from 1994-2002, nearly 650 acres of disturbed area directly connected to the Coal Creek stream system remains.

Overview of the Workshop

The Coal Basin & Crystal River Area Restoration Workshop (Workshop) was organized by Roaring Fork Conservancy (RFC) in partnership with the U.S. Forest Service (USFS). The Workshop was held over a two-day period in the Town of Redstone, Colorado, which is located on the Crystal River and minutes away from Coal Basin. The Workshop gathered nearly fifty resource experts and stakeholders together to develop a strategy for continuing the critical restoration work conducted by CDRMS in Coal Basin, and to discuss opportunities for improving the downstream confluence area where Coal Creek enters the Crystal River (the Coal Creek/Crystal River Confluence Area).

The Workshop brought hydrologists, soils scientists, geomorphologists, fish biologists, water quality analysts, plant ecologists and other technical experts together with highway engineers, mining reclamation experts, recreational planners, and other key stakeholders from multiple federal, state and local government entities, as well as local nonprofits and private interests. During a series of intensive work sessions and site visits, participants had the opportunity to engage in an open discussion about the remaining problems in Coal Basin, and the significant challenges associated with continuing the CDRMS restoration efforts. Workshop participants also had the chance to analyze the historic and current geomorphology of the Coal Creek/Crystal River Confluence Area, and to suggest opportunities to restore the function of the floodplain and enhance riparian and instream habitat in the area.

Priorities and Next Steps

Participants agreed that additional information is urgently needed to fully understand and prioritize challenges and solutions in Coal Basin. At the same time, they recognized that there was an immediate need to make some basic decisions, in order to coordinate with projects already underway or planned for the Coal Creek/Crystal River Confluence Area.

Near-term (1-2 year) projects and programs recommended by Workshop participants include:

Specific projects

- Conduct a relatively inexpensive, high-level ("Level I") GIS and limited field assessment of the Crystal River Watershed to obtain a better understanding of the dynamic natural and human-induced geomorphic processes in the Crystal River Watershed and the specific contribution of Coal Basin (especially above the Coal Creek confluence with Dutch Creek). Use this Level I assessment to guide future near-term projects in Coal Basin, Coal Creek canyon and the Coal Creek/Crystal River Confluence Area. Based on the results of the Level I assessment, conduct a more detailed resource assessment ("Level II" – "Level III") for Coal Basin and/or other areas of concern, outlining specific project designs.
- Establish a priority list of water quality parameters and sites for baseline water quality monitoring and detection of future changes. Conduct water quality sampling at regular and frequent intervals to facilitate building correlations and detecting trends. Measure stream flow and storm events (precipitation) and correlate concentrations of water quality parameters with stream discharge and magnitude of storms.
- Conduct regular macroinvertebrate sampling at previous sampling sites to develop a more robust data set for Coal Basin and the Crystal River. Correlate with various stages in the stream hydrograph.
- Collect in-channel sediment data (e.g., grain size, mineral content) at the same time as water quality sampling and macroinvertebrate sampling are being conducted.
- Support current USFS initiatives to rehabilitate sediment-producing mining-related disturbed areas with selected native plants in Coal Basin. Evaluate the efficacy of using biochar, or other soil-enhancing amendments, and selected native plant species as part of this restoration initiative.
- Modify the Coal Creek Bridge to accommodate sediment loads without excessive aggradation and to provide safe public access over/under Hwy 133 between Elk Park and the coke ovens.
- Build a visitor/discovery center and restore wetlands near Elk Park as part of Pitkin County Open Space & Trail's (OS&T) Elk Park project. Coordinate with OS&T during the Design Phase of this project to ensure Elk Park retains sufficient flexibility to accommodate future restoration initiatives in the Coal Creek/Crystal River Confluence Area.

General initiatives

- Conduct ongoing tours of Coal Basin and the Crystal River watershed to inform the general public about their history and environmental issues.
- Develop and distribute multimedia presentations and educational materials on the Coal Basin & Crystal River Area Restoration Project, including via smart phone apps, and social media.
- Develop and publish local and national newspaper and magazine articles on the restoration effort.
- Develop and implement a communications/PR plan for the Coal Basin & Crystal River Area Restoration Project.
- Develop a funding strategy for the Coal Basin & Crystal River Area Restoration Project. Coordinate and prepare appropriate grant applications.

Longer-term initiatives (2-10+ years) include the following:

- Develop Master Plans for Coal Basin and the Coal Creek/Crystal River Confluence Area to prioritize and guide future restoration activities and to determine metrics to monitor and evaluate project success. Specifically address recontouring the vertical slope in the Coal Creek/Crystal River Confluence Area as part of this planning effort.
- Expand upon USFS initiatives to rehabilitate sediment-producing mining-related disturbed areas with native plant communities in Coal Basin, targeting both public and private lands.
- Undertake channel improvements in "hot spots" along Coal Creek adjacent to Coal Creek Road from the confluence of Dutch Creek and Coal Creek down to the Coal Creek/Crystal River Confluence Area in order to reestablish natural geomorphic and ecological processes and enhance riparian and instream habitat.
- Conduct an economic study of the value of the Crystal River to the local economy and the impact of Coal Creek on that value.
- Turn Coal Basin into a restoration research and development center – a living laboratory for assessment of restoration techniques, materials and designs that can be used elsewhere.
- Develop a restoration-based economy to increase job opportunities in the Crystal River Valley and the greater Roaring Fork watershed.

RFC was selected to serve as the coordinator for the Coal Basin & Crystal River Area Restoration Project. A Working Group of technical experts and stakeholders will assist RFC with planning, funding and implementing the restoration effort. Smaller Technical Groups will form out of the Working Group to support individual projects. A Focus Group comprised of members of the general public and stakeholders will be formed for vetting specific projects and programs as they are being developed.

Background on the Targeted Restoration Areas

Introduction

Coal Basin is located just west of the historic Town of Redstone in western Colorado (Figure 1). The nearly 27-square mile (17,200 acre) watershed is drained by Coal Creek, a tributary to the Crystal River. The free-flowing Crystal River is the largest tributary of the Roaring Fork River. It was recently named one of *America's Most Endangered Rivers* by American Rivers, due to the potential development of new hydropower dams, reservoirs and water diversions. The USFS has found the Crystal River eligible for federal Wild and Scenic River designation.

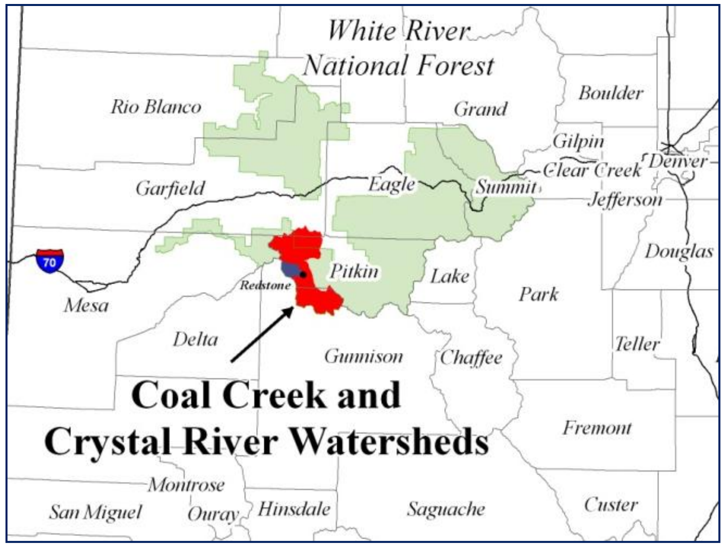


Figure 1. Location of the Coal Creek (*blue*) & Crystal River (*red*) Watersheds. The White River National Forest boundaries are indicated in *green*.

Coal Creek enters the Crystal River at the Town of Redstone – an area referred to as the Coal Creek/Crystal River Confluence Area (Figure 2). Coal Creek Road (FS 307) parallels Coal Creek, running from Hwy 133 through a narrow canyon to the upper part of the drainage.

Figure 2. Coal Creek/Crystal River Confluence Area. Note the elevated gravel bars partially blocking clearance under the bridge.

Half a century of large-scale coal mining activities on steep, inherently unstable and highly-erosive slopes has left a significantly altered landscape in Coal Basin. Some of the steep slopes below the former mine entries exhibit very little vegetative cover. Other portions of the reclaimed mine site exhibit less than optimal vegetation and may regularly be contributing to sediment loading in Coal and Dutch Creeks.

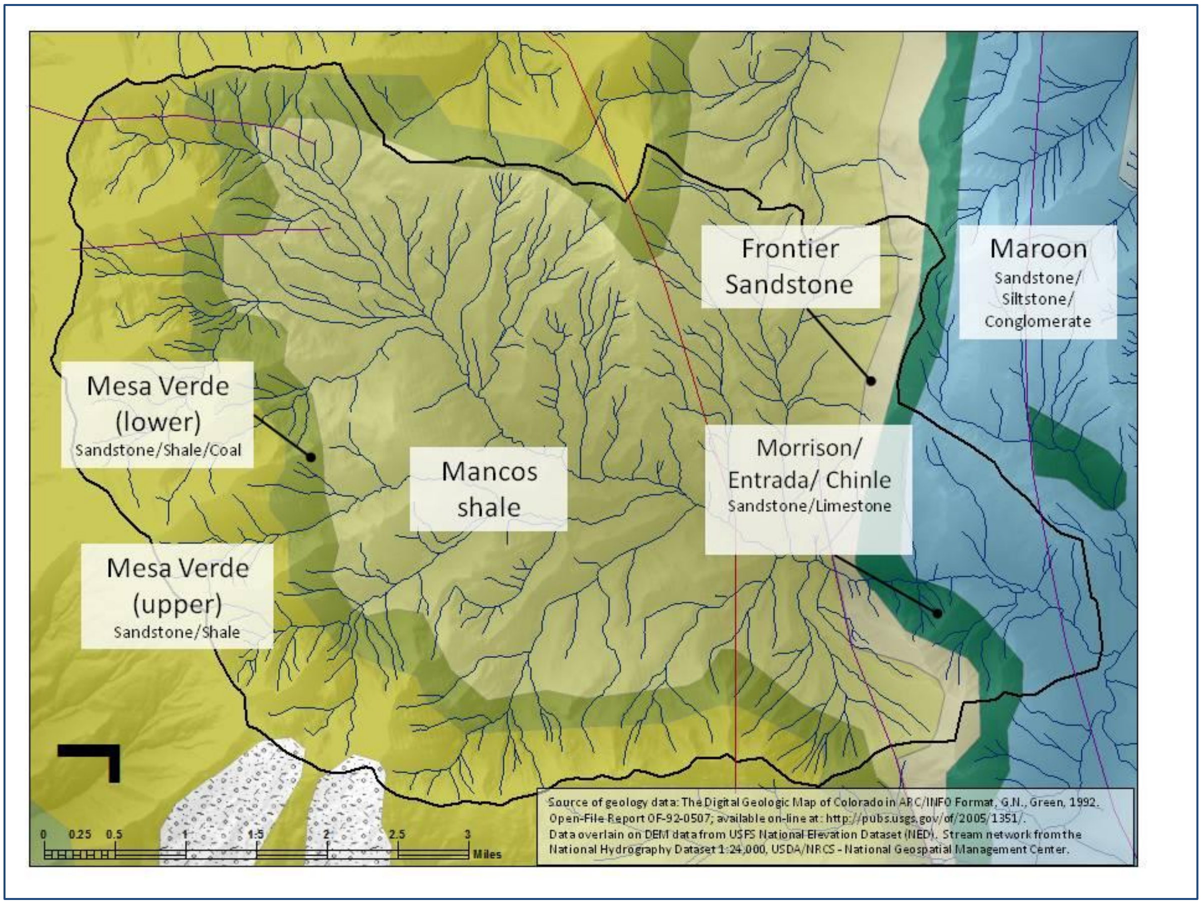


Figure 3. Geology of the Coal Creek Watershed. The solid black line indicates the drainage divide for the Coal Creek watershed. Fault lines are indicated in red and purple.

Degraded water quality and riparian and instream habitat exist today throughout the Coal Creek watershed. Sediment-loading from Coal Basin, in turn, is degrading water quality and riparian and instream habitat in the Crystal River. **However, the extent to which these environmental problems are attributable to the highly-erosive soils and dynamic geomorphology of the Coal Creek watershed, or are attributable to the former mining operations is unknown.**

Mining History

Mining in Coal Basin commenced in the late 1800s and continued until 1991, when Mid-Continent Resources (Mid-Continent) ceased operations in the area. The first mining was conducted by John Osgood, who built the company town of Redstone. These early mining operations in Coal Basin lasted for only about a decade (until about 1908), and resulted in a relatively small scar on the landscape. It wasn't until Mid-Continent's predecessor, Mid-Continent Coal and Coke Company, started mining in 1956 that several new mines were opened, an extensive network of tunnels and wide haul roads were cut into the mountainsides, and large piles of waste rock and coal refuse were created.

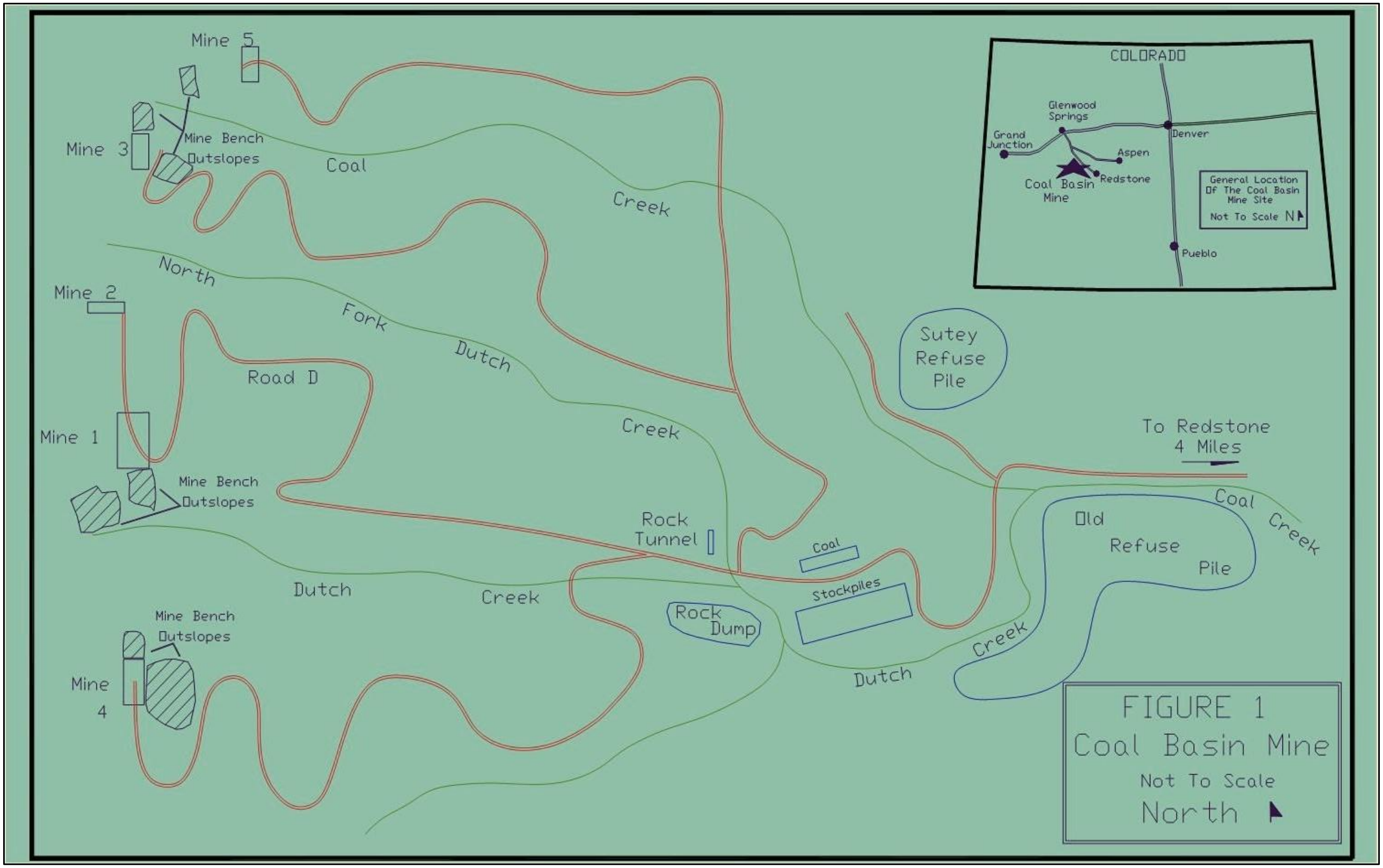


Figure 4. Illustration of the Coal Basin Mine.

Coal mining operations were conducted in a landscape dominated by highly-erosive Mancos Shale and Mesaverde Formation sandstone and shale, and in an extremely steep upper basin (Figure 3). A very high quality coal, suitable for use in the manufacture of steel, occurs in the lower member of the Mesaverde Formation exposed in Coal Basin. All of the high elevation mines enter into this formation. Significant erosion, mass-wasting and debris flows occur naturally in Coal Basin. The physical mining operations only added another layer of problems to what was already a geomorphically dynamic, eroding area.

Coal mining operations tended to disrupt natural processes in the basin by interrupting drainage patterns, depositing unconsolidated earthen materials at the angle of repose on extremely steep slopes, and through the permanent deposition of coal refuse and mining waste in inappropriate areas. Coal cleaning created large refuse piles (Figure 4) and mine water was discharged to treatment ponds. Dutch Creek, a tributary to Coal Creek, was channelized to make room for facilities and coal refuse deposition areas, causing additional instream instabilities.

Figure 5. Haul road runoff on a road located in highly-erosive Mancos Shale. The ditch has filled with eroding material and failed, causing water to run down the road.

Fifteen miles of 60'-wide (average) haul roads were built to bring the coal nearly 2,000' down to the valley floor (at approx. 8,000' elevation). The natural drainage pattern in the basin was significantly altered by this extensive road network. Roads were insloped to keep the coal trucks from sliding off the roads. Road runoff was directed to flow to a drainage ditch located on the inside margin of each road. Water flowed down the ditches to culverts periodically situated along the road network. Poor culvert spacing resulted in water cascading from the culverts onto unconsolidated material deposited on the slopes below the roads. When a drainage ditch or culvert system failed, water flowed down the roads (Figure 5), eroding the road surface and the road fill material. Gullies resulting from the road drainage system could be 6'-12' deep. Culverts periodically failed entirely due to debris flows blocking the inlets or causing the creeks to divert past the culvert system.

In 1992, Mid-Continent filed for bankruptcy protection. Subsequently, its operating permit for Coal Basin was revoked. When Mid-Continent terminated its operations in Coal Basin it left five large underground mines at high elevation (10,000'), and an extensive network of underground mining tunnels, refuse piles and miles of haul roads. In 1993, Mid-Continent's $3 Million reclamation bond was declared forfeit when it failed to carry-out the requisite site reclamation. In 1994, in the midst of all of the legal proceedings, the State of Colorado began using funds authorized by the Bankruptcy Court for reclamation work. The original bond was supplemented by over $900,000 of additional funding from a variety of sources and $500,000 of in-kind services.

Previous Reclamation Activities

CDRMS focused on five major areas of reclamation from 1994-2002: (1) road reclamation, (2) mine bench slope reclamation, (3) mine entry reclamation, (4) reclamation of the facilities area and reconstruction of the Dutch Creek channel, and (5) reclamation of refuse piles and other miscellaneous sediment control projects. (*See* Appendix II for maps and additional photos documenting the CDRMS restoration efforts.)

Road Reclamation

CDRMS worked to reestablish the natural drainage pattern in the Coal Creek watershed. Road prisms were realigned to slope outward as much as possible to encourage dispersed runoff patterns. Culverts were removed from the reclaimed road network. Rolled dips were constructed at drainage crossings to accommodate natural drainage patterns. Roads were ripped to reduce water velocity and encourage infiltration in order to reduce erosion and encourage revegetation (Figure 6).

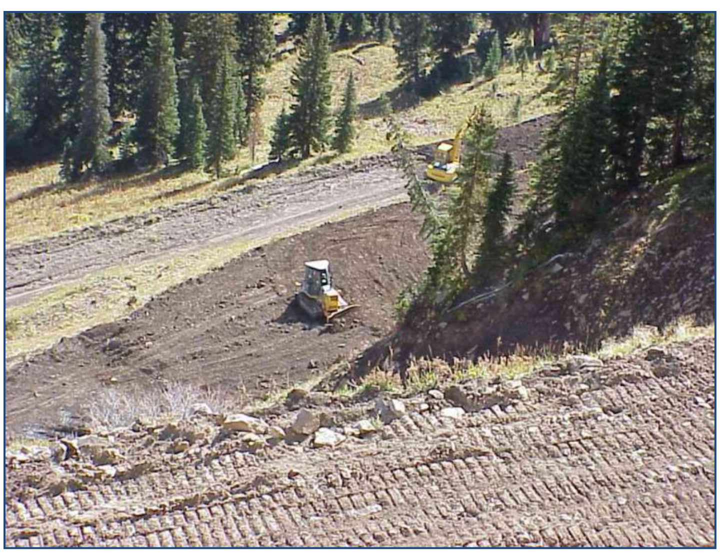


Figure 6. Road reclamation work in Coal Basin.

Mine Bench Outslope Reclamation

Mine outslopes at the mine entries (consisting of materials excavated at the mines that were dumped over the sides of benches) were considered one of the primary sources of erosion and sedimentation at the site (Figure 7). Extreme rilling and gullying of the unconsolidated slopes was occurring. Revegetation was attempted using both hand- and machine-scarification of the slope surface. Seeding was accomplished by hydroseeding and by

helicopter. Both approaches were considered too labor-intensive and too expensive for more widespread use. These original slope stabilization efforts resulted in the successful reestablishment of about 30% of the vegetative cover – with the greatest success on wetter, north-facing slopes and the least success on south-facing slopes.

Figure 7. Mine bench outslope prior to reclamation.

Mine Entry Reclamation

CDRMS created opportunities for greater sheet flow across the mine benches while eliminating confined ditch flow patterns at each of the mine entry sites in order to reduce erosion. To accomplish this, heavy equipment was used to broaden and reduce slopes and revegetate the mine entry areas. Backfilling was done at the base of the high walls, at the former locations of the underground mine entries.

Facilities Area Reclamation and Reconstruction of the Dutch Creek Channel

Mining facilities and the Dutch Creek flume were demolished and the Dutch Creek channel was reconstructed during the State's reclamation efforts (Figures 8 & 9).

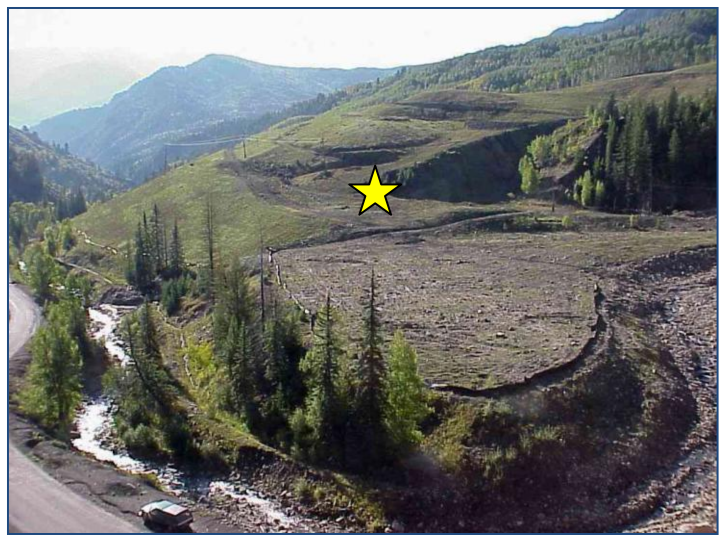
Refuse Pile and Other Sediment Control Projects

Attempts were made to revegetate refuse piles and other disturbed slopes. In many areas, mining activities had altered the entire soil profile. Revegetation efforts were hampered because minimal top soil was available for reclamation purposes. CDRMS took several actions to create a more hospitable environment for revegetation. Large earth-moving equipment was used to reshape refuse piles. The slopes on the two large refuse piles were pulled back from the angle of repose to increase infiltration and reduce erosion. Thousands of yards of road bed and mine entrance material were moved to form gentler slopes. These areas were seeded with a mixture of native and introduced grasses and forbs. The understory plantings were supplemented with various trees and shrubs.

Lessons Learned

Nearly $4 Million has been spent by the State of Colorado to-date on the Coal Basin reclamation effort. Only $1,700 currently remains from the original primary and supplementary funding.

CDRMS did a great deal of work with the funds it received under very difficult conditions. In addition to dealing with a severely altered landscape and the natural limitations of large scale revegetation in a dry, high-altitude environment with poor soil conditions, the area was repeatedly subjected to cattle grazing, as well as grazing by native ungulates during the years of reclamation efforts. The Mid-Continent bankruptcy also tied up available project funding for years – requiring CDRMS personnel to implement restoration efforts over a constantly shifting timeframe as incremental funding sporadically became available.



Figures 8 & 9. Facilities area near the confluence of Dutch Creek and the main stem of Coal Creek - before and after restoration. The star indicates the same position on the landscape.

The Coal Basin & Crystal River Area Restoration Project will build upon previous efforts by the State. It will heed the “lessons learned” (as articulated by Steve Renner, CDRMS) during the prior reclamation effort as future projects are developed and implemented:

- The natural environment at Coal Basin is an exceptionally dynamic and mobile system, in terms of frequency of hillslope failure and channel instability. It is imperative that the unique character of the environment at Coal Basin be understood and that any work undertaken reflect the location’s unique character.

- Reclamation work will be more successful if more favorable “microclimates” (e.g., using soil amendments to enhance moisture retention) are first created on site.
- Water should be dispersed at every opportunity to reduce erosion, mass-wasting and debris flows.
- “Soils” and remnant refuse on site respond favorably to the addition of organic matter.
- Cattle grazing should be permitted only after a diverse vegetative cover has been established and reached substantial maturity.

DATA & DATA GAPS

“What We Know” About the Geomorphology of Coal Basin and the Coal Creek/Crystal River Confluence Area

Geomorphology and Sources of Sediment-Loading in Coal Basin

Coal Basin is characterized by high background hillslope instability, a high connectivity to stream channel network, accelerated erosion issues due to past mining activities, and stream channels (some braided) carrying coarse sediments at high flows. Avalanche chutes are evident at higher elevations. Large and small debris flows exist and there are indications of deep-seated landslides. Surface erosion is occurring naturally from steep, exposed outcrops of shale and sandstone. Historically, the area has experienced a number of days with at least 1” of rainfall, which may occur in very short, intense summer storm events, generating significant sediment flows (Figure 10). Clearly, any restoration effort needs to consider the sources of sediment (natural and anthropogenic) in the watershed.

Sandra Ryan, USFS Rocky Mountain Research Station (RMRS), identified the following data needs for understanding the geomorphic processes causing stream sedimentation in Coal Basin:

- Identification of sediment sources and their relative contributions to Coal Basin sediment loads (natural versus mines and mine-related features);
- Quantification of in-channel sediment loads (both bed load and suspended loads);
- Assessment of the overall state of the system and ability to “stabilize” it; and
- Assessment of rainfall intensity in the area and development of a hydrograph from gage data.

She outlined a series of traditional (e.g., channel surveys) and recently-developed (e.g., LIDAR) methods for collecting this data. *See* Appendix II.

Geomorphology in the Coal Creek/Crystal River Confluence Area

The Coal Creek/Crystal River Confluence Area was significantly altered at the time the coke ovens were built outside the Town of Redstone. At the start of the Workshop many participants believed that the Coal Creek/Crystal River Confluence Area could be re-engineered and Coal Creek and the Crystal River restored to their original channels. During the Workshop presentations (which included a review and discussion of historical maps and photographs; *see* Appendix II) it became clear that the assumptions previously made about the location of the original channels may have been incorrect. Observations made during a site visit to view the area where the historical alluvial fan was located, the floodplain, nearby benches/terraces and vegetation (even-age narrow leaf cottonwoods, large older alders and dead willows) all appear to support the hypothesis that an area once thought to be the historical braided channel of Coal Creek was actually occupied by the Crystal River. Regardless of the previous locations of Coal Creek and the Crystal River, participants agreed that the focus of restoration efforts in the Coal Creek/Crystal River Confluence Area should be restoration of the natural functions and capabilities of the streams, not an attempt to achieve historical accuracy with respect to their location.

Figure 10. Coal Creek summer monsoon event (July 3, 2009).

Connected Disturbed Areas – Coal Basin

A study by the USFS, White River National Forest, has determined that 646 acres (3.8%) of the 17,215-acre Coal Creek watershed are mining-related disturbed areas that are hydrologically connected to the stream system via surface flow (referred to as Connected Disturbed Areas or CDAs) (Figure 11). Identification of these CDAs provides a first step in assessing sediment sources within Coal Basin. Another 1,038 acres (6%) of the watershed are "naturally-disturbed" outcrops (primarily within Mancos Shale and Mesaverde sandstone) and clearings. 520 acres of Connected Disturbed Areas occur on National Forest land. The remainder (126 acres) is on private land. Partially-restored roads are the largest source of CDAs, followed by old mining areas. Currently, grasses provide the main vegetative cover in the partially-restored areas.

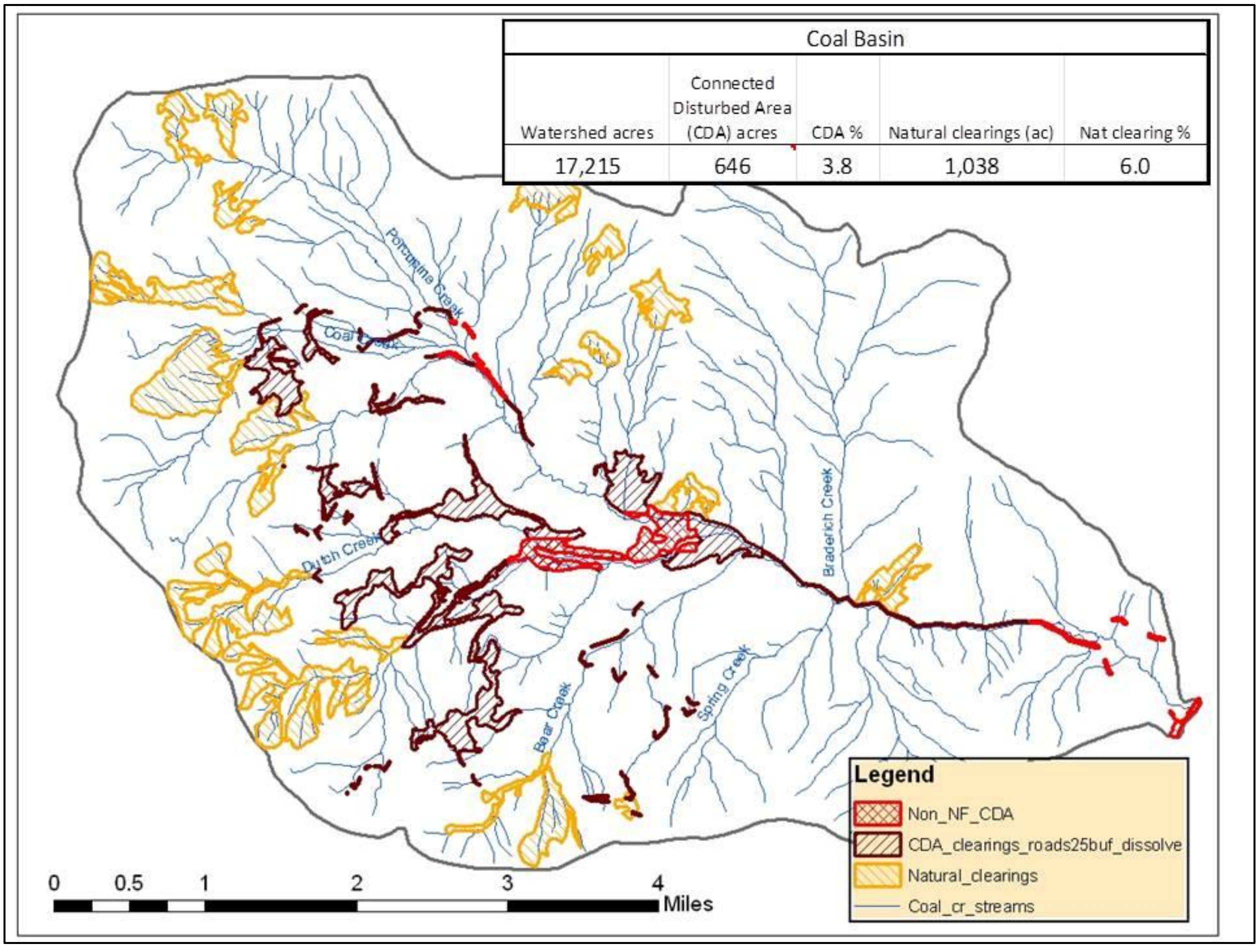


Figure 11. Coal Basin Connected Disturbed Areas (CDAs)

"What We Know" About the Natural Resources in Coal Basin and the Coal Creek/Crystal River Confluence Area

Water Quality

Available water quality data from four sites along Coal Creek, seven sites along the Crystal River, Bear Creek, and several sites with a limited number of sampling events were reviewed by Dr. Russ Walker, Head of the Department of Physics & Environmental Sciences at Colorado Mesa University (CMU). Unfortunately, the historical data was collected by a number of different entities for a variety of purposes, and the datasets are inconsistent as well as small in number of samples obtained at any one site. Thus, it was not possible to identify any overall trends from the information available, although analysis of the existing data did suggest that the high iron concentrations observed were a result of sediment-loading.

The historical water quality data is limited in its ability to meet project needs for baseline information that can be used to establish trends and patterns over time, or differences between upstream and downstream sites, and that can be compared with standards promulgated by the Colorado Water Quality Control Commission (CWQCC). Dr. Walker recommended that:

- A priority list of water quality parameters be established, as well as a prioritized list of sites for baseline water quality monitoring and detection of future changes;
- Water quality sampling be conducted at regular and frequent intervals to facilitate building correlations and detecting trends; and
- The use of multiple linear regression be explored as a replacement for some water quality sampling and analysis. (Linear regression is currently used by the U.S. Geological Survey (USGS). It allows the use of a parameter that is relatively easy to sample and analyze (e.g., conductivity) as an indicator for the presence of a parameter that is more difficult to analyze (e.g., metals)).

Specific recommendations for water quality sampling will be provided by Dr. Walker in the summer of 2012.

Fisheries

The Crystal River has been stocked with Hofer rainbow trout since 2000. The river is managed in accordance with the statewide bag and possession limit – four trout.

Limited, reliable fishery surveys have been conducted in the Crystal River watershed. One was conducted on Coal Creek in 2010 and another conducted in 2011 on the Crystal River. Sculpin constitute the greatest percentage of fish (68%) in the Crystal River, followed by Rainbow Trout (11%) and Mountain Whitefish (10%). Brook Trout, Dace and Brown Trout were also identified in limited numbers. A greater number of fish were observed above, than below, the Coal Creek/Crystal River Confluence Area.

Coal Creek has been characterized as a "flashy system" with frequent, high runoff following storms that would make it very difficult for a fishery to establish and persist, and few fish have been observed. Kendall Bakich, Aquatic Biologist for the Colorado Division of Parks and Wildlife (CDPW), finds the relatively low number of fish in the Crystal River surprising. She postulates that high sediment-loading, substantial water diversions on the Crystal River and the generally "flashy" nature of the hydrologic system are all contributing factors.

Macroinvertebrates

The composition (taxa and relative abundance) of macroinvertebrate communities is an indicator of stream health. Macroinvertebrate sampling was conducted over 6-8 years at six sites in Coal Basin during the time period 1989-1998. In 2011, four additional sites were added in Coal Basin and four sites were sampled on the Crystal River. One historical site was also sampled in Coal Basin during 2011.

Few metrics from the historical Coal Basin dataset could be interpreted and the historical data set is not comparable to current data. The limited number of reference sites located in the pervasive Mancos Shale geology is particularly problematic. No historical reference data exists for the Crystal River.

A more robust reference data set is required for macroinvertebrates, just as for water quality. Matt Grove, USFS, recommended that sampling be continued at all long-term sampling sites and that sediment particle size be collected at these sites at the same time macroinvertebrate sampling is being conducted. The following questions need to be addressed:

1. What are the main drivers impacting the macroinvertebrate community? Are they natural, anthropogenic, or both?
2. Is the presence of heavy metals in the streams influencing the macroinvertebrate community?
3. Is macroinvertebrate abundance a limiting factor for fish in Coal Basin, or do other factors regulate fish communities (e.g., flood events)?

Riparian Conditions

Riparian plant communities reflect the catchment topography, primarily stream size, gradient and underlying geology, which influence sediment dynamics and grain size of the channel and bank substrates. Watershed geomorphic processes, notably erosion, and sediment transport and deposition contribute to the formation of riparian habitats, including floodplains, channel bars and point bars, in-channel islands, and stream bank features. Hydrologic processes also exert strong controls on streamside environments. Flood frequency, magnitude, timing and duration distribute surface water and sediment to riparian areas and establish gradients that regulate surface water-groundwater exchanges and water table depths. Riparian plant species are variously adapted to exploit the spatially and temporally dynamic mosaic created by physical gradients. Because geomorphic and hydrologic processes strongly influence the distribution, development and maintenance of riparian plant communities, the success of streamside restoration efforts will require careful consideration of the reach-level physical context of each project location and the basin-level physical processes over time.

The Workshop focused on two contrasting channel types, with very different riparian environments: Coal Creek and the Crystal River. For the most part, Coal Creek is a swift, steep stream moving through a narrow canyon-like valley. Substrates are dominated by large, cobble- to boulder-sized particles. In the narrow canyon bottoms and V-shaped valleys, the

northern and protected aspects create cool microenvironments that support Douglas fir and narrowleaf cottonwood, with red-osier dogwood and willow in the shrub layer. Along stream segments with wider valley bottoms, Engelmann spruce and thinleaf alder also occur.
In contrast, the much larger Crystal River has extensive alluvial reaches where the river meanders through a wide valley bottom. Along these expansive river reaches, the multi-thread channel has created a mosaic of riparian habitats, with substrates ranging from clay-silt to cobbles. Dominant species are blue spruce, narrowleaf cottonwood and a variety of willow species and other riparian shrubs.

Planned Projects

Coal Basin – USFS Upland Restoration Project; Decommissioning of Roads under the USFS *Travel Management Plan*

Coal Basin restoration projects recently received nearly $40,000 in grant funding from the Colorado Water Conservation Board (CWCB) as a result of a proposal submitted by RFC.

An approximately three-acre Upland Restoration Project is being undertaken in cooperation with the USFS in Coal Basin. The project will focus on restoration of part of the road network in the Dutch Creek drainage, building upon the prior work by CDRMS. USFS will route drainage and strategically position boulders for grade control, build sediment traps in depositional areas, and apply a compost/biochar soil amendment (7% biochar/93% compost from the South Canyon Landfill) to four specifically-identified treatment areas. The specific goals of this effort are to:

- Increase upland vegetation in order to stabilize upland soils;
- Increase soil water storage; and
- Reduce CDAs and road-derived sediment.

The USFS will also work under its *Travel Management Plan* for the White River National Forest to decommission additional roads in the Coal Basin area.

Another USFS goal for restoration work in Coal Basin is to use native plants (grown from local seed sources) to:

- Reduce bare ground by increasing plant cover;
- Reduce the release of iron to Coal Creek from sediment by stabilizing Connected Disturbed Areas and reducing erosion;
- Reduce erosion and sediment by increasing bank armor with plant cover;
- Reduce invasive species cover by establishing resilient native plant communities; and
- Improve pollinator habitat by increasing diversity and cover of flowering plants.

USFS will be using restoration work in Coal Basin to demonstrate the utility of local native seed. Adequate supplies of genetically local native seed are currently not available for the majority of key plant species needed for large-scale restoration projects on the White River National Forest, including Coal Basin. The USFS wants to facilitate the collection and propagation of local native seed and make it available commercially.

Three replicated plots of four forbs and three grasses will be planted in a fenced area on the Sutey Refuse Piles. The demonstration planting will allow the USFS to determine the feasibility and cost/benefit of using the same tools and techniques in future restoration projects – including an expansion of the work currently underway in Coal Basin.

Coal Creek/Crystal River Confluence Area - Pitkin County OS&T Elk Park Project

Pitkin County OS&T has completed the Conceptual Design for Elk Park, which is located in the Coal Creek/Crystal River Confluence Area. The *Redstone Parks and Open Space Management Plan* (Appendix V) contains detailed information on plans for the park. OS&T recently signed a contract for development of the Detailed Design. The project has been underway for some time, and a number of Workshop participants have been involved in its development.

Coal Creek/Crystal River Confluence Area - Bridge Replacement

The South Bridge, constructed in 1947, has a current Sufficiency Rating of 54.4 out of 100, according to CDOT. The bridge is owned by Pitkin County, which is responsible for determining the timing of its replacement or rehabilitation. The County can fund the effort entirely through local funding, or it can apply for funding and assistance through CDOT.

Restoration Tools

USFS staff has mapped the natural and mining-related disturbed areas in Coal Basin in some detail (*see* Appendix II). Reforestation (with native spruce, aspen and Douglas fir) of the flatter, more accessible old mining roads in the area is being planned. Water dispersal, through the use of berms and other measures, will be key in establishing vegetative cover. USFS staff will also test the use of soil amendments (e.g., biochar) to increase moisture retention as part of site restoration.

Biochar

Biochar is an engineered carbon-rich product produced when woody biomass is heated in a closed container at high temperatures with limited oxygen (a process known as pyrolysis). Used as a soil amendment, highly-porous biochar retains moisture and soil nutrients, improves soil structure, increases microbial activity, and can be engineered to bind metals and other contaminants. It can remain stable in the soil for thousands of years. It has the additional benefit of being carbon-negative. Biochar has the dual advantage of addressing both forest health and forest management issues while providing a high-value product for restoration of highly-degraded lands, such as those found in Coal Basin.

Biochar is relatively expensive today. With increased manufacture of biofuels, it should become cheaper in the next 3-5 years.

The use of biochar for site reclamation is in the very early stages of testing and development. Andrew Harley, Biochar Solutions, LLC, made the following observations with respect to biochar reclamation work being conducted at the Hope Mine near Aspen, Colorado:

- Biochar is difficult to handle. At the Hope Mine it is being mixed with compost.
- Good results are being observed on 30-35 degree slopes. Revegetation with the biochar/compost mix is not as successful on steeper slopes.
- Application of too much biochar yields diminishing returns (i.e., too much water is retained). An application rate of 5 tons/acre (a 5-10% biochar/compost mixture) seems to be the most advantageous.

Risks currently associated with the use of biochar in site restoration include the following:

- Environmental risks are not yet fully defined;
- Biochar properties vary;
- Application of biochar onto soils can potentially mobilize metals;
- Biochar may contain toxic compounds which may accumulate in the soil when biochar is introduced as a soil amendment (although this is unlikely in the case of woody biomass obtained from beetle-killed timber on the Western Slope); and
- The long-term fate and stability of biochar in the soil is still being evaluated.

Current evaluation of the risks associated with the biochar likely to be used at Coal Basin indicates that the material is suitable for the projects outlined in this report. The data obtained from these projects will be invaluable in assessing the use of biochar in larger watershed projects.

Alluvial Fans

As you travel the wide, paved road between upper Coal Basin and the Coal Creek/Crystal River Confluence Area there is abundant evidence of the unstable nature of the Coal Creek watershed. Naturally occurring landslides, large and small, are numerous, with some generating debris flows that contribute coarse sediment to Coal Creek. An example of one of these slides can be seen on the far side of the valley downstream of the Braderich Creek

Figure 12. Debris flow near Braderich Creek trailhead with netting (at arrow) (May 1, 2012). The "toe" of the alluvial fan has been removed at the base.

trailhead. The channel was reconfigured and metal netting was installed upslope in the basin in an effort to capture large boulders that continue to threaten the roadway (Figure 12).

In many places, constriction of the channel by the main roadway has disrupted the form of these alluvial fans and altered their ability to store sediment and dissipate flow into the main channel. As a result, more suspended sediment- and bed-load reaches a relatively narrow, confined channel, at higher velocity, which causes undercutting of the stream banks and channel down-cutting and instability.

One proposed mechanism for restoration of channel form and transport regime in Coal Creek canyon may require "pulling back" the existing roadway in many locations to provide room for fan development and areas for sediment deposition and bar/back channel development. While a particularly expensive proposition, the reconfiguration of alluvial fans to reduce sediment-loading remains an option to be considered. The construction of new alluvial fans (Figure 13) is also a potential option in some areas of the upper Coal Creek drainage and at the Coal Creek/Crystal River Confluence Area. The goal of the constructed fan is to provide areas for sediment storage instead of routing it through the channel network. Data on sediment transport rates and storage capacity of fans would help determine the viability of these options.

Channel Improvements

Some basic channel improvements/modifications could be made in Coal Creek to dissipate energy and retain sediment- and bed-load so it does not reach the Crystal River. The channel could be widened in places to create flood-prone areas (bars, floodplains and back channels) and riparian vegetation could be established to increase sediment retention. Some of the existing culverts (which create high-impact, high-velocity point source flows) could be removed to alleviate head-cutting and channel incision along Coal Creek and its tributaries. Although these types of improvements require substantial road work, they warrant future consideration.

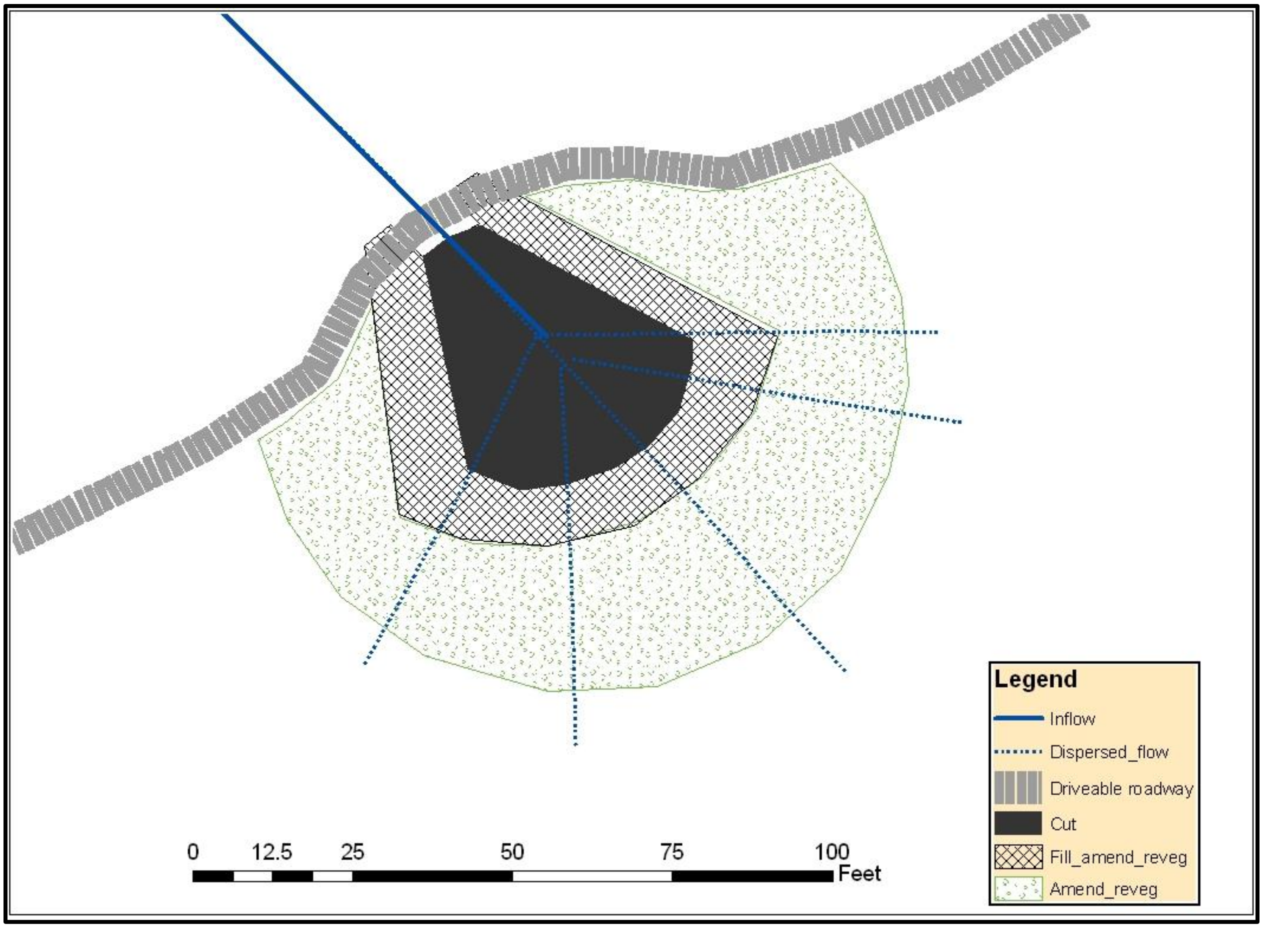


Figure 13. Sketch of a constructed alluvial fan.

Workshop Recommendations

Goals and Strategy Development

On the second day of the Coal Basin & Crystal River Area Restoration Workshop participants broke into three Working Groups to brainstorm and develop a limited list of recommended restoration projects. They were guided by the overall goals of integrating and completing projects to:

- Improve riparian area function and wildlife value;
- Address sediment issues;
- Improve upland vegetation to stabilize soils;
- Improve instream habitat and fisheries;
- Address water quality issues;

- Protect the Town of Redstone from flood flow damages; and
- Increase late summer stream flows.

For every recommended project each Working Group was asked to identify:

- A coordinating entity and key participant(s);
- Expertise needed for the project;
- Data/information needs;
- Timing;
- Approximate cost;
- Potential funding sources; and
- Indicators, metrics and measures of success to be used to report project results.

Working Groups

The recommendations made by each of the Working Groups are summarized below.

Coal Basin Projects Working Group

The Coal Basin Projects Working Group brainstormed projects for both the Coal Basin upland areas and the Coal Creek canyon riparian corridor. Potential projects ranged from traditional opportunities (e.g., drainage improvements, control of invasive weeds) to more innovative undertakings (e.g., placement of solar panels on the Sutey piles). Three general categories of projects were recommended.

1. **Rehabilitation of Sediment-Producing Mining-Related Activities**
   - **Coordinating entities:** USFS, RFC.
   - **Key participant(s):** Three private landowners, Coal Creek Watershed Group (to be formed), "Planning Sub-Group" (to be formed), all permittees, Pitkin County (OS&T, Community Development Dept, Healthy Rivers & Streams Board), CVEPA, CDRMS, AGCI, WW, BLM, ACOE, NRCS, mineral rights owners, Crystal River Caucus, Town of Redstone, CDPHE, CDOT, CDPW, CWCB, CNHP, WDWCD, Cattlemen's Association, Roaring Fork Mountain Bike Assoc., White River Forest Alliance.
   - **Expertise needed:** Drawing from the USFS, CWCB and third party consultants: project leader, quality assurance specialist, contract specialist, engineer (including expertise with drainage, steep terrain), soil scientist, geomorphologist, hydrologist, water quality specialist, plant ecologist/botanist, reclamation specialist, GIS specialist, cultural specialist, education and public information specialist, range conservationist, recreation planner/specialist, wildlife and fish biologists, and safety specialist.
   - **Data/information needs:** Inventory of all rehabilitation needs and site assessment, including assessment of all CDAs (to include hydrologic, cultural, and wildlife

assessments), followed by a ranking of priorities. Compilation of existing GIS information and future LIDAR information. Characterization of site features (e.g., slope aspect, elevation, vegetative cover, soil properties, geologic formations, noxious weeds). Determination of land ownership/surveyed property boundaries (including leases and easements). Compilation of existing climatological data for prediction of hydrologic events and stream flow and sediment transport estimation. Establishment of sources of sediment (natural and mine-related), determination of baseline sediment loads, point of compliance.

- **Timing:** Unknown.
- **Approximate cost:** Unknown.
- **Potential funding sources:** CRWCD, CWCB-CWSRA, NRCS, CDPHE-Nonpoint Source Colorado, Pitkin County, private landowners, private foundations (e.g., Walton Family Fund, Aspen Skiing Company, Rocky Mountain Elk Foundation, National Forest Foundation, Gates Foundation, Peabody Coal Mining), USEPA (Brownfields) and other federal sources, CDRMS (severance tax funds, §319 CDPHE funding).
- **Indicators, metrics, and measures of success:** Confirm reductions in erosion from mining-related facilities by comparing reclaimed areas to analogous unmined areas, assessing reductions in instability and making comparisons above and below the disturbed area (mass balance). WEPP, RUSLE and empirical models. Assess contents of sediment traps (volume and sediment caliber). Assess vegetative cover (frequency, diversity, etc.). Compare pre-existing conditions (using CDRMS imagery) to post-restoration conditions (using aerial photography and LIDAR imagery).

2. **Revegetation/Enhancement of Native Plant Communities.**
    - **Coordinating entities:** USFS.
    - **Key participant(s):** See above list.
    - **Expertise & materials needed:** Silviculturalist, plant suppliers (local nurseries/greenhouses, Meeker Plant Center, USFS sources, RMRS), compost suppliers (Garfield, Mesa, Pitkin Counties), biochar supplier, volunteer field workers (Youth Corps, VOC, RFOV, VISTA volunteer to coordinate project, WW, Wildlands Restoration Volunteers, CDPHE-Nonpoint Source Colorado (local chapters), CNHP, National Audubon Society, The Xerces Society), water source for plants/back-up water supply.
    - **Data/information needs:** See above list.
    - **Timing:** Unknown.
    - **Approximate cost:** Unknown.
    - **Potential funding sources:** See above list.
    - **Indicators, metrics, and measures of success:** See above list.

3. **Coal Creek Improvements - From the Crystal River 4+ Miles up Coal Creek (Including Re-establishment of Ecological Processes).**
    - **Coordinating entities:** USFS, RFC.
    - **Key participant(s):** See above list.
    - **Expertise needed:** See above lists. Road engineers, geotechnical engineer.
    - **Data/information needs:** Sediment budget (including flow and sediment transport rates), establishment of biological indicators, and identification of reference conditions.
    - **Timing:** Unknown.
    - **Approximate cost:** Unknown.
    - **Potential funding sources:** See above list.
    - **Indicators, metrics, and measures of success:** See above list.

Confluence Area Projects Working Group

The Coal Creek/Crystal River Confluence Area presents several significant challenges for any major restoration project (such as construction of an alluvial fan to capture sediment load from Coal Creek Basin), including the following:

- It is a highly-visible area with significant local and tourist traffic;
- There are no available sediment storage areas;
- The existing infrastructure (e.g., road, buildings) limits site options;
- Some of the area is in private property ownership;
- Any project needs to be driven by community values (e.g., flood protection for the Town of Redstone); and
- The recently restored and historically significant coke ovens need to be retained and protected.

The Confluence Area Projects Working Group discussed a variety of potential projects, however it was quickly recognized that without a better understanding of upstream processes and disturbances (natural and mining- and road-related) and expected sediment loads, site-specific projects would be hard to identify and prioritize, and virtually any project planned and designed for the Coal Creek/Crystal River Confluence Area risks failure without benefit of this information. The Working Group also recognized that there is a need to make some basic decisions now, given the fact that: (i) Pitkin County's Elk Park project is already underway (and requires technical guidance during its Design Phase to improve floodplain functions and to ensure that the project is developed with sufficient flexibility to accommodate future restoration projects in the Coal Creek/Crystal River Confluence Area), and (ii) Pitkin County may soon replace the South Bridge. Pitkin County also has plans to work on a culvert near the National Forest boundary that is scheduled to begin in the summer of 2012. A coordinated, multi-jurisdictional planning effort needs to be started immediately so that these near-term projects do not compromise future work efforts.

The Confluence Area Projects Working Group ultimately recommended two significant projects, stressing the need:

- To take a geomorphic/ecological approach in all project designs (as opposed to hard engineering of structures);
- To reduce and store sediment, but also to improve fisheries, stabilize slopes and upland vegetation, and improve riparian functions, ecological diversity and aesthetics; and
- To take advantage of educational opportunities associated with projects whenever possible (using them to illustrate natural river functions).

The recommended projects were:

1. **Develop a Master Plan/Strategy for the Coal Creek/Crystal River Confluence Area.** Two immediate tasks were recommended:
   a. ***Task #1*: Recontour the Vertical Slope at the Coal Creek/Crystal River Confluence.**
      - **Coordinating entity:** Pitkin County OS&T.
      - **Key participants:** Pitkin County Public Works Dept (including the County Engineer/Floodplain Administrator), CDOT, Town of Redstone, CVEPA.
      - **Expertise needed:** Geomorphologist.
      - **Data/information needs:** Geomorphic assessment; information on how to blend sound engineering with natural channel design.
      - **Timing:** Include in the current Elk Park design activity. Try to structure as a phased activity, recognizing that design components may change as new data/information becomes available.
      - **Approximate cost:** Unknown.
      - **Potential funding sources:** Pitkin County OS&T and Healthy Rivers & Streams Board, GOCO, Scenic Byways Program, CDPW.
      - **Indicators, metrics, and measures of success:** None specified. The stream bank in question is severely undercut and continually eroding. Improvements should be evident once the bank is recontoured.

   b. ***Task #2*: Modify the Coal Creek Bridge to Accommodate Sediment Loads and Provide Safe Access Between Elk Park and the Coke Ovens.**
      - **Coordinating entities/key participants:** See above lists.
      - **Expertise needed:** Geomorphologist.
      - **Data/information needs:** Geomorphic assessment.

- **Timing:** Include in the current Elk Park design activity. Try to structure as a phased activity, recognizing that design components may changes as new data/information becomes available.
- **Approximate cost:** Unknown.
- **Potential funding sources:** See above list.
- **Indicators, metrics, and measures of success:** Improvements will be visible when complete.

2. **Conduct a Crystal River Watershed Assessment.**
   - **Coordinating entity:** USFS.
   - **Key participants:** USFS RMRS, RFC, CDPW, watershed restoration consultant to conduct the assessment (e.g., Wildland Hydrology).
   - **Expertise needed:** Geomorphologist, hydrologist.
   - **Data/information needs:** A high-level ("Level I"), relatively inexpensive assessment based primarily on GIS information with some limited field verification is needed to quickly identify and attempt to fill data gaps. The focus should be on the hydrologic system, identification of impairments, and sediment-loading from Coal Basin.
   - **Timing:** "Level I" Assessment – ASAP. A more detailed assessment may follow if major problems are identified that require further detailed study (e.g., in Coal Basin).
   - **Approximate cost:** Wildland Hydrology indicated that its "Level I" assessment could be completed in approximately 1 week for about $15,000. A "Level II – III" Assessment (which would include design work for restoration projects) requires much more time and costs approximately $140,000.
   - **Potential funding sources:** USFS (in-kind), CWCB-WSRA, Pitkin County Healthy Rivers & Streams Board.
   - **Indicators, metrics, and measures of success:** Data gaps closed and information available for future projects.

Human Dimensions Working Group

The Human Dimensions Working Group began its discussion by identifying the "audience" for the restoration effort (e.g., Town of Redstone local businesses, residents and visitors, recreational users), as well as the entities and individuals who could be expected to be "partners" in the restoration effort (e.g., CDOT, CDPW, outfitters). A communications/PR plan for the Coal Basin & Crystal River Area Restoration Project was considered critical in order to inform the public about the multiple and diverse values associated with the area (e.g., safety and flood control, wildlife habitat), and the potential benefits associated with a remediation effort (e.g., job creation, improved flood control), and to empower decision makers and stakeholders.

The Working Group confirmed that there are substantial data gaps that need to be filled; these include the need for economic information, more detailed environmental studies and the identification of specific restoration project elements (and a cost/benefit analysis for each). The Human Dimensions Working Group espoused the need for a Coal Basin Master Plan (approximate cost: $150,000) from which specific, prioritized projects would emerge.

The Working Group identified a series of potential projects that could connect the Coal Basin & Crystal River Restoration Project with the public at large:

- Build an Elk Park visitor/discovery center – This was considered to be a key opportunity. The center could include educational panels, a video showing Coal Basin's pre-history, mining history, mining impacts and its restoration potential (the Wilkerson Pass Visitor Center was cited as an example). Restoring wetlands near Elk Park would also be advantageous.
- Conduct tours of Coal Basin and the Crystal River to educate the public on both their history and environmental issues.
- Start a restoration project in a prominent, accessible location to illustrate site issues and remediation efforts. Potential sites include the Coal Creek/Crystal River Confluence Area and Braderich Creek.
- Develop and distribute multimedia presentations and educational materials on the project such as videos (e.g., the Crystal River Valley then and now), smart phone apps, and YouTube and Facebook posts. Ecoflight could be used to obtain a comprehensive image bank.
- Develop and publish newspaper and magazine articles on the restoration effort (e.g., *Outside* magazine, local papers).
- Conduct an economic study of the value of the Crystal River to the local economy and the impact of Coal Creek on that value.
- Turn Coal Basin into a restoration research and development hub – a real-world laboratory for techniques, materials and designs that could be applied elsewhere.

The Working Group saw various options for a "coordinating entity"- including, RFC, CVEPA, or a new group, akin to The Thompson Divide Coalition. It recommended that a project-specific task force be formed to help lead the process.

The Human Dimensions Working Group also noted that lack of funding currently presents a significant challenge in moving the process forward. PR/communications expertise needs to be enlisted. A long-term project plan needs to be scoped and projects prioritized. The Working Group concluded that $5,000 - $15,000 is needed to hire an individual or entity to develop a funding strategy for: (i) a communications plan, and (ii) an initial series of restoration projects.

Potential funding sources identified included: Pitkin County Healthy Rivers & Streams Board, Garfield County (particularly for seed money for a grant writer), private donors, CWCB, American Rivers, the Walton Foundation and other private foundations, local governments and institutions, the CRWCD, USFS (in-kind services), and the Cattlemen's Association.

Next Steps

The Coal Basin & Crystal River Area Restoration Project will be a multi-phase, multi-project, multi-year effort. While some pilot restoration efforts can be undertaken immediately, other projects will require further study and assessment before they can be scoped. Other tasks will require public/private land use planning and engineering designs. Securing appropriate permits and other governmental approvals, as well as adequate funding, will be part of every proposed project. Finally, a public outreach program must be successfully implemented to engage the public in this complicated, long-term effort.

At the conclusion of the Workshop, participants selected RFC as the coordinator for the Coal Basin & Crystal River Area Restoration Project. A Working Group was formed to assist RFC with project planning, to provide technical resources to support the phased restoration effort, and to ensure that the restoration plan is communicated to the larger group of participants. The Working Group will also need to help identify and secure funding for restoration projects and programs. The Working Group will be responsible for informing the larger Focus Group (described below). The initial members of the Working Group include the following individuals and entities:

- Town of Redstone/Pitkin County Healthy Rivers & Streams Board - Bill Jochems;
- USFS – representative TBD;
- Private Landowner – Dean Bacon;
- Pitkin County (OS&T/Community Development Dept/Engineer/Floodplain Administrator) – 1-2 representatives TBD (will likely include Gary Tennenbaum (OS&T);
- CVEPA/Ecologist – John Emerick;
- CDOT – representative TBD;
- ACOE – representative TBD;
- Coal Creek Cattlemen's Assoc. – representative TBD; and
- CDPW – Kendall Bakich.

It is contemplated that smaller Technical Groups will form out of the Working Group to support individual projects, as required. Finally, a Focus Group comprised of members of the general public and stakeholders will be formed for vetting specific projects and programs as they are being developed.

Participants were identified and assigned responsibility for a series of near-term "next steps" to begin organizing and carrying out the various components of this long-term restoration effort:

- John Emerick (CVEPA) – Draft article for publication in the *Crystal River Echo* – May, 2012.
- RFC –
  - Draft and issue press release on the Workshop – May 3-4, 2012;
  - Coordinate first Working Group meeting - to be held by June 2, 2012;
  - Prepare a report summarizing the results of the Workshop and disseminate the report to all participants – June, 2012;
  - Create and host a web page on www.roaringfork.org/coalbasin for posting information from the Workshop, ongoing project information (including a tracking mechanism for projects and a database for results of studies, analyses, field data collected, etc.) – May, 2012;
  - Provide PR for ongoing USFS projects in Coal Basin (with notation of endorsement by Working Group) – Ongoing;
  - Monitor the status/progress of Pitkin County OS&T's Elk Park Plan and disseminate information to the Working Group and other interested parties – Ongoing;
  - Prepare CWCB Water Supply Reserve Account (WSRA) grant application for at least a "Level I" Assessment – May, 2012;
  - Investigate feasibility of securing a VISTA volunteer to work with RFC to coordinate the overall restoration project – May, 2012; and
  - Conduct public field trip to Coal Basin and provide a one-page update with information obtained during the course of the field trip and "action items" to the Working Group and other interested parties – June, 2012.
- Steve Renner (CDRMS) –
  - Complete CDPHE §319 review and report back to Working Group on results and potential funding opportunities available under the CDPHE §319 program for Coal Basin restoration – Summer, 2012; and
  - Coordinate with USGS and Sandra Ryan (USFS RMRS) and Steve Hunter (USFS) on USFS Remote Sensing Applications Center (RSAC – Salt Lake City, UT) input, perform a LIDAR accumulation/dissemination – by October, 2012.
- Mark Lacy (USFS) – Research potential ACOE funding under the "Continuing Authorities Program" and identify who should act as the non-federal sponsor(s) to apply for such funding – May, 2012.

As of the date of this report, a number of these specifically-assigned tasks have already been completed.

APPENDICES

APPENDIX I

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Figure 14. Workshop participants (May 1, 2012).

APPENDIX II

WORKSHOP PRESENTATIONS

The Workshop began with a series of presentations on the history of the targeted restoration areas, restoration efforts to date, and "what we know" about Coal Basin's natural processes and natural resources, planned projects in the Coal Basin and Coal Creek/Crystal River Confluence Area, and potential tools for future restoration efforts. Copies of the PowerPoint presentations associated with each of these discussions are attached. They are:

1. Coal Basin History – Geology, Mining, Reclamation – presented by Steve Renner, CDRMS
2. Water Quality – presented by Dr. Russ Walker, CMU
3. Recent Fisheries Information – presented by Kendall Bakich, CDPW
4. Coal Basin Macroinvertebrate Sampling – presented by Matt Grove, USFS
5. Coal Basin Connected Disturbed Area – presented by Justin Anderson, USFS
6. Coal Creek Watershed: Geomorphic Processes and Context – presented by Sandra Ryan, USFS RMRS
7. Coal Basin Restoration Project: Native Plants – presented by Jon Proctor, USFS
8. Coal Basin Restoration Project: Riparian Vegetation – presented by Kate Dwire, USFS RMRS
9. Biochar: A Nexus for Low Value Woody Biomass and Reclamation in the Intermountain West – presented by Andrew Harley, Biochar Solutions, LLC
10. Coal Basin: USFS Pilot Upland Restoration Project – presented by Brian McMullen, USFS

APPENDIX III

ABBREVIATIONS & ACRONYMS

ACOE	U.S. Army Corps of Engineers
AGCI	Aspen Global Change Institute
BLM	U.S. Bureau of Land Management
CBRT	Colorado Basin Roundtable
CDA	Connected Disturbed Area
CDPW	Colorado Division of Parks and Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDRMS	Colorado Division of Reclamation, Mining, and Safety
CDWR	Colorado Division of Water Resources
CMU	Colorado Mesa University
CNHP	Colorado Natural Heritage Program
CRWCD	Colorado River Water Conservation District
CVEPA	Crystal Valley Environmental Protection Association
CWCB	Colorado Water Conservation Board
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
GOCO	Greater Outdoor Colorado
LIDAR	Light Detection and Ranging
NRCS	U.S. National Resource Conservation Service
OS&T	Open Space & Trails
RFC	Roaring Fork Conservancy
RFOV	Roaring Fork Outdoor Volunteers
RMRS	Rocky Mountain Research Station
RUSLE	Revised Universal Soil Loss Equation
RWAPA	Ruedi Water and Power Authority
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VISTA	Volunteers in Service to America
VOC	Volunteers Outdoor Colorado
WDWCD	West Divide Water Conservancy District
WEPP	Water Erosion Prediction Project

WW	Wilderness Workshop
WQCC	Colorado Water Quality Control Commission
WQCD	Colorado Water Quality Control Division

APPENDIX IV

PHOTO & ILLUSTRATION CREDITS

- Cover Photo: Tim O'Keefe, RFC
- Figure 1: RFC
- Figure 2: Sandra Ryan, USFS RMRS
- Figure 3: Sandra Ryan, USFS RMRS
- Figure 4: Steve Renner, CDRMS
- Figure 5: Steve Renner, CDRMS
- Figure 6: Steve Renner, CDRMS
- Figure 7: Steve Renner, CDRMS
- Figure 8: Steve Renner, CDRMS
- Figure 9: Steve Renner, CDRMS
- Figure 10: RFC
- Figure 11: Justin Anderson, USFS
- Figure 12: Rose Ann Sullivan, Kootenay Resources, LLC
- Figure 13: USFS
- Figure 14: Tim O'Keefe, RFC

APPENDIX V

REDSTONE PARKS AND OPEN SPACE MANAGEMENT PLAN

(Attached)

REDSTONE PARKS AND OPEN SPACE MANAGEMENT PLAN

December 2010

1. INTRODUCTION

The upper Crystal River Valley has some of the most spectacular scenery in Pitkin County. The community of Redstone is located in the heart of the valley where the red cliffs rise steeply off the valley floor and Coal Creek meets the Crystal River. It is here that coal was king in the early 20th century. With that valuable resource, human history has defined the architecture of Redstone, but amazingly left some parcels free from development. Several of these parcels were purchased by Pitkin County and transformed into parks and open space.

Redstone Park

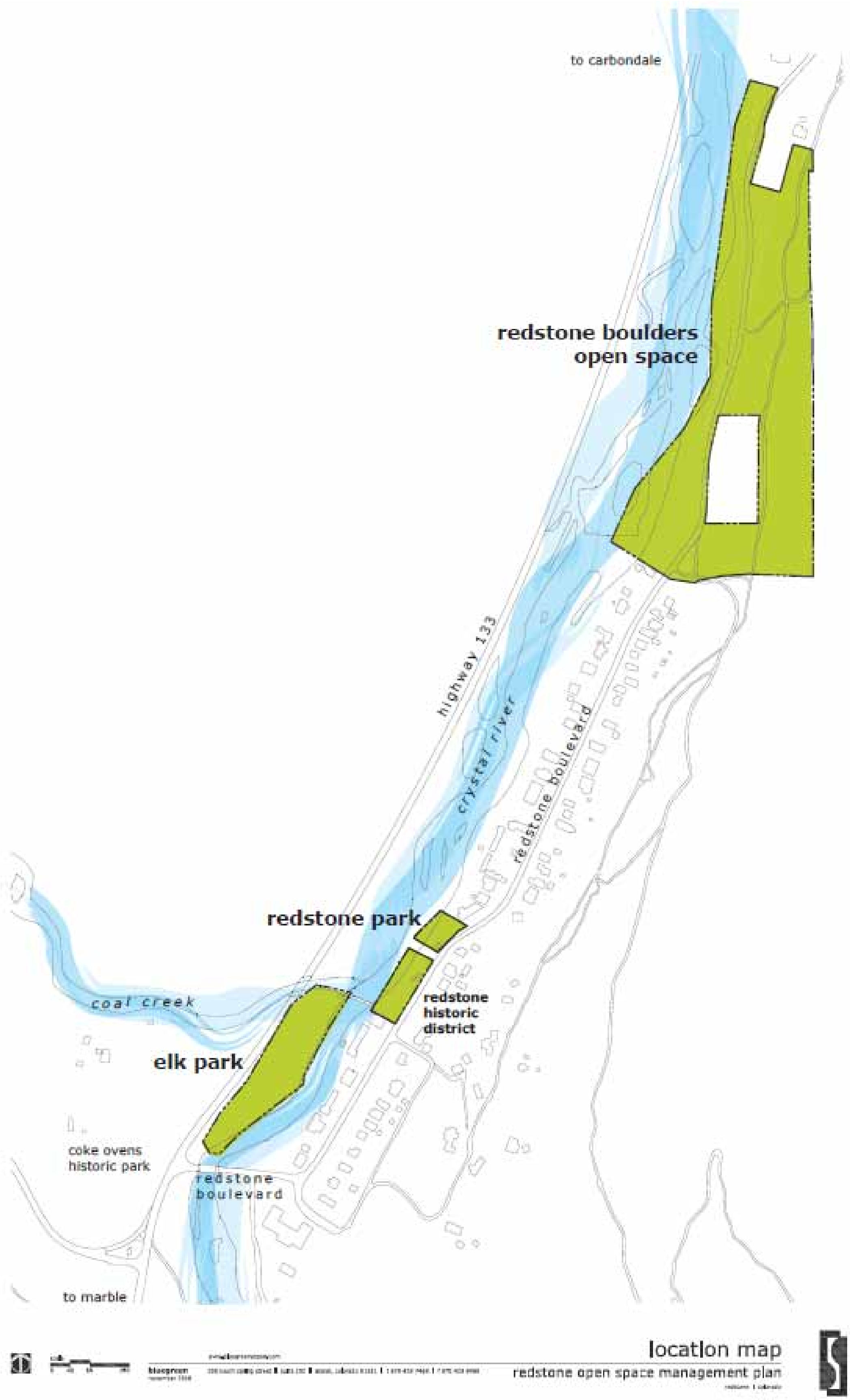
Redstone Park, Elk Park, with the adjoining Coke Ovens Historic parcel defines the south entrance to Redstone and Redstone Boulders Open Space at the north entrance providing residents and visitors with a great recreational resource. There is approximately one mile of river front connecting these properties that provides both a physical and visual connection to the river. Restoring and stabilizing key sections of the river bank, enhancing the physical and visual connection and improving wildlife and fish habitat are goals of this plan.

Redstone Park is centrally located and heavily used. The addition of a parcel on the north end, from the Meredith Family will allow Redstone Park to expand. Elk Park defines the entry to Redstone and has tremendous potential as it provides significant open space to the town but is currently underutilized. The Redstone Boulders Open Space is becoming increasingly popular due to the great trail connections and rock climbing opportunities and has great potential for riparian improvements.

The Redstone Parks and Open Space management plan is conceptual in nature. The ideas illustrated in the conceptual plans for each property not final, but will provide a basis for developing the final plans and to enable Pitkin County Open Space and Trails (OST) to seek partners and grant funding. The planning effort was community driven and facilitated by OST with the assistance of a planning and landscape architecture firm Bluegreen. As with all management plans created by OST, they are adaptive and can be updated with current information through a public process.

The Conceptual Plans are for future amenities that will need to go through further analysis and permitting to ensure the final plans comply with the Pitkin County Land Use Code along with any other State or Federal laws and regulations.

The Conceptual Plans for each property along with the Analysis Maps used to create the management plan are included in Appendix A.


to carbondale
redstone boulders
open space
highway 133
crystal river
redstone boulevard
redstone park
redstone
historic
district
coal creek
elk park
coke ovens
historic park
redstone
boulevard
to marble
location map
redstone open space management plan

2. PLANNING PROCESS

Planning Committee Meeting

Bringing together residents of the Crystal Valley to create a vision for the future of these properties has been an amazing experience in open space and park planning and is a model for Pitkin County Open Space planning in the future. The process lasted over one year and consisted of twelve monthly meetings, with some lasting three hours. A planning committee was formed of citizens that had a passion for the parks and open space in Redstone and volunteered many hours to a process that formed the foundation of this plan. Consensus was reached on almost all of the major concepts. The conceptual plans and ideas in this plan came directly from the residents on this committee and the success of this process is based on transparency and consistent community outreach. OST is grateful for the time these citizens volunteered. OST is also thankful for the time Pitkin County Community Development and Public Works dedicated to the planning effort.

The Planning Committee members are:

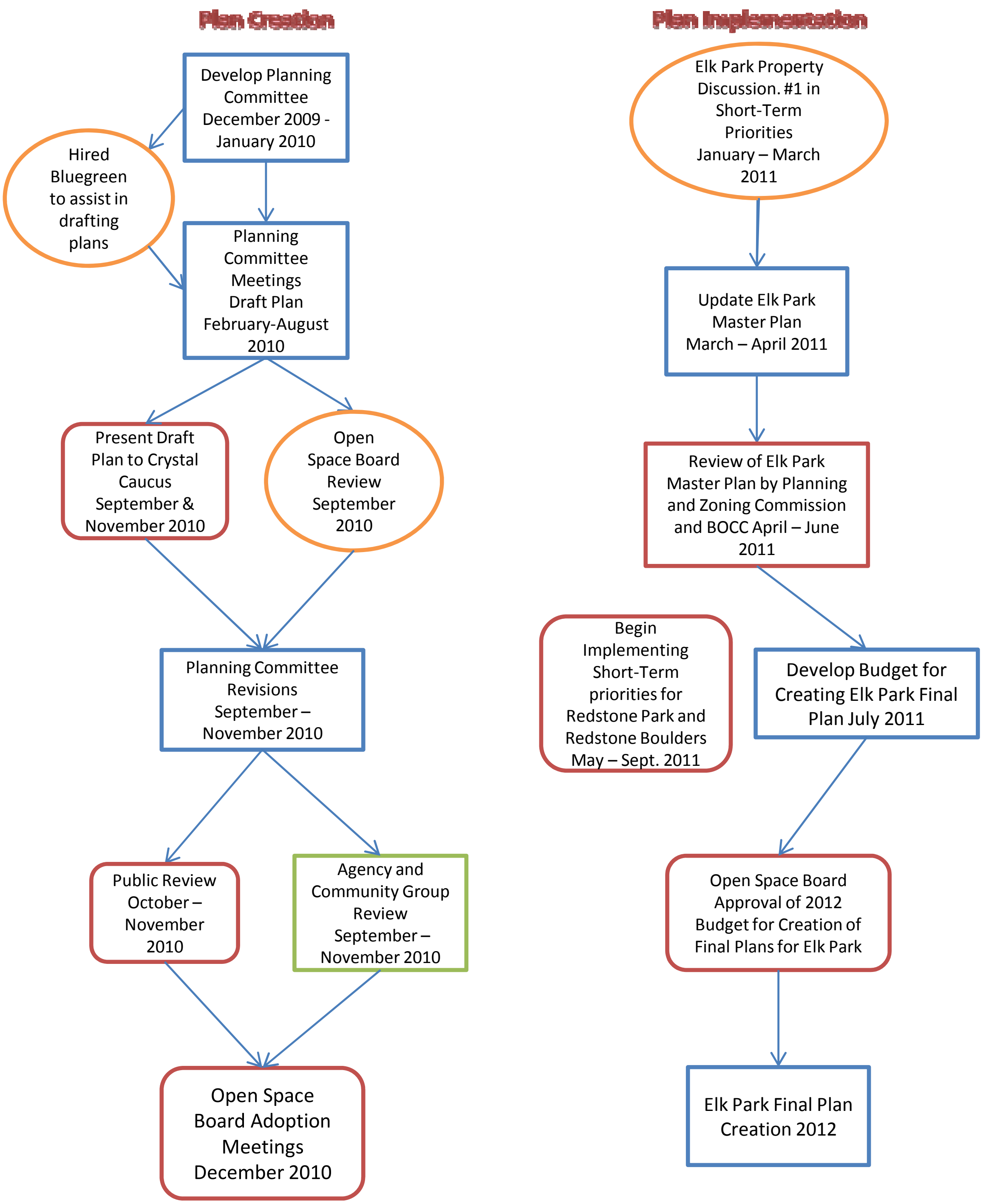
- Bob McCormick
- Chuck Downey
- Greg Meredith
- Jayson Jaynes
- Jeff Bier
- Jennifer Stanaszek
- John Emerick
- Lisa Wagner
- Melissa McBurney
- Nancy Chromy
- Ron Sorter
- Sharon Clarke

Planning and Design Consultant: Bluegreen

Next Steps

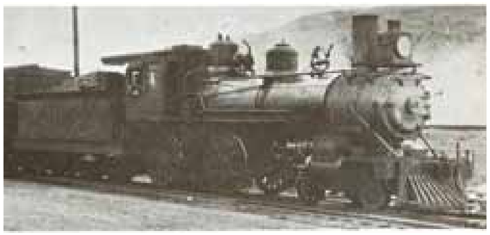
The following process map illustrates the next steps for implementation of the Redstone Parks and Open Space Management Plan:

Redstone Parks and Open Space Management Plan Process Map



3. HISTORY

OST thanks Ron Sorter for the following history of the properties. It is in the perspective of the Crystal River Railroad as it enters Redstone from the north.



Crystal Railroad

Redstone Boulders: In 1905 the Crystal River Railroad left Carbondale at 10 AM and pulled into the Redstone Depot at 11:31 AM. As it approached Redstone it passed through the Redstone Boulders parcel on a raised rail bed between Redstone Boulevard (then called the River Road) and the Crystal River. Passengers might have seen men quarrying maroon building stone here; a partially quarried specimen still remains hidden under the trees near the trail.

The maroon cliffs here are the outwash, 300 million years old, from the ancient range Uncompahgria. Those climbing the boulders here are in fact also climbing part of the Ancestral Rockies.

Pitkin County Open Space and Trails purchased the property in 2009.

Elk Park: At the south end of the Boulders, behind the first house next to the river, a switch allowed the Redstone spur and the mainline to slowly diverge. The mainline crossed the river for the first time on a bridge near the Crystal Club. As the cars approached the coke ovens, passengers could look west and see where Coal Creek had been diverted into a new northern estuary. The existing highway lies on the old rail bed and when CDOT installed the Coal Creek Bridge, it reengineered the stream to its original bed.

East of the train, passengers would alight at the Depot and also see the Doctor’s office, the Washhouse and the Carpenter’s Shop. Later, when the property was sold, these buildings were razed and the site was used for both residential and commercial purposes. When it came under development threat in the mid-nineties it was purchased by Pitkin County, renamed Elk Park, and the High Line passenger bridge was built connecting Elk Park to Redstone Park.

Redstone Park: This train, later assembled to return to Carbondale, could go north past the switch, then back onto the Redstone spur. The spur ran behind the houses next to the river, eventually onto Redstone Park where the track curved to proceed in front of the remaining buildings to the end of the line at the company store. There were never any houses built on this site.

In the seventies, a threat of development prompted the county to buy this parcel and in 1974 a patron donated funds for a two-week public works project to build Redstone Park. In the early eighties, Coal Basin’s original Lamphouse was brought to the park to serve as the Museum and the bathrooms were built then, as well. The Meredith parcel was added in 2009.

This park, with its grass, trees and open space next to the river has been a favorite gathering place for residents and visitors for longer than anyone can remember.

4. VISION

The Redstone Parks and Open Space Plan has created short and long term priorities for the management and enhancement of Redstone and Elk Park and the Redstone Boulders Open Space. While working with the Planning Committee and other residents of the Crystal Valley on the completion of this plan some major themes emerged. These themes formed the vision for the plan and were incorporated at each property.

Maintain the Culture, History, and Character of Redstone

All participants in the creation of this management plan wanted to improve the parks, but a common theme emerged that prevailed in the creation of the plans that all improvements will enhance the entire community and not change the character and culture of Redstone that everyone is so passionate about.

Accessibility

Providing parks and open space that welcomes visitors and residents was critical for the future enhancements. Increasing use of and access to Elk Park is a priority for the community. Providing safe access is also important and lead to the concepts in the Elk Park plan to look at improving the entrance to the park, coke ovens, and the entrance to Redstone Boulevard.

Ecology

Sustainable design, enhancing riparian and wildlife habitat, and improving river function to control flooding and enhance water quality were major themes that guided the design of the plans for each property.

Economy

The scenic beauty of the Crystal River Valley is a major draw for visitors. Providing places for visitors to recreate and to learn about Redstone is one theme that emerged through the planning process and everyone realized how important the parks are to the future sustainability of the economy in Redstone. Attracting more visitors while providing current and future residents with places to recreate and gather is critical to the future of Redstone. Each property plan has numerous concepts that will enhance the parks and contribute to the economy of Redstone.

5. REDSTONE PARK

Redstone Park

Redstone Park is the focal center of Redstone. From summer concerts, kids playing in the playground, to people admiring the Crystal River, the park provides an essential amenity to the community of Redstone. Through the planning process for the future use of the park, the main theme heard throughout all the meetings is that people are passionate about Redstone Park and don't want to see a large amount of change. Generally, the park is working well in its current state and any future improvements should be subtle and enhance the existing character.

Key concepts from the planning committee include:

- Improved accessibility
- Simplified spaces to reduce "clutter"
- Habitat enhancements and stabilization to the river bank and preserved views to the river and landscape beyond.

The planning committee worked through some difficult issues while deciding what is best for the future use of the park and the conceptual plan that is attached provides updates to the existing infrastructure, connects the newly acquired parcel, and provides much better access. This plan also provides a memorial, special and commercial use policy that is clear and works for both the residents and visitors.

The planning committee was also unified in requesting no artificial permanent lighting in Redstone Park.

Infrastructure

While creating the conceptual plan for future infrastructure for the park it was identified that some of the existing infrastructure could be improved in the near term to provide a better park experience. This would enhance the park while final plans were being completed and implemented.

The conceptual plan illustrates several new concepts for the park:

- Remove existing picnic structure (Gazebo) and build a larger open air pavilion to meet the needs of the community, providing a band shell for concerts/gatherings in the park. This will be clustered behind the existing restroom and museum and not obstruct any views of the river.

- Cluster existing playground equipment to allow a new access and provide better parental viewing. This area could include more seating around the playground by installing grade beams to retain the slope and function as an informal seating opportunity.
- Incorporate a Woodland Grove to the north area of the park to provide a shaded area for a future uses, such as a small theater or open grass area for weddings and picnic gatherings. Lighting was discussed on this parcel since there is existing electricity. The planning committee decided that no lighting is necessary and that the removal of the power pole will improve the aesthetics of this area. When the property was purchased from the Meredith Family it was discussed that a small memorial be developed in conjunction with the final plans for the Woodland Grove. The planning committee felt this was appropriate since this parcel truly enhances the existing park and it is a small way to recognize the former owners.
- Riparian improvements to enhance native vegetation and the natural function of the Crystal River.
- Add more dog waste stations at all access points with education signage to start addressing the current dog waste issue. It was identified in the planning process that dog waste is a problem in Redstone Park and to provide more dog waste stations at the access points with education signage as to why everyone needs to pick up the dog poop.
- During final planning explore the possibility of a dog free area on the newly acquired parcel on the north end of the park.

With all of these new uses the costs for maintaining the restrooms will be visited annually by the Open Space Board.

Access

Current access to the park is limited to the area at the restrooms and informally through private property. The conceptual plan defines four future access points:

- At the south end of the park an enlarged ADA accessible entry with direct view to the river would be created to directly connect with the pedestrian bridge to Elk Park. This will allow better pedestrian flow to Redstone Blvd. and assist with making Elk Park a true parking area and extension of Redstone Park.
- Widen the existing entrance to the playground and future pavilion. Removing the existing Gazebo would allow a better view of the park and future pavilion from Redstone Blvd.
- Provide improved access by removing existing parking spaces north of the museum. As noted in parking section 3.3, more parking will be created overall and this area is the largest open area in the park. Preserving and enlarging the open space while improving access to the river will enhance views and access to the river from Redstone Blvd.

- Create access to the new Woodland Grove on the north edge of Redstone Park. This access will open the newly acquired Meredith Parcel to pedestrian uses.

Parking

Parking along Redstone Blvd. is one of the biggest issues during the busy summer season. Redstone Park currently has approximately 8-10 spaces. The conceptual plan illustrates approximately 16 spaces. This increase is small due to the plans for Elk Park to actually capture some of the cars coming into Redstone and provide ample parking for visitors to Redstone. The conceptual plan for parking at Redstone Park will go through a much more thorough review when the final plans for each area of the park is developed.

No overnight parking will be allowed at Redstone Park.

Natural Resources

Figure 1 - Redstone Park Riparian Area

The Crystal River is the most important natural resource in Redstone Park. The focus of the park is its direct connection to the river. Enhancing the riparian area is a high priority for future improvements to the park. Nothing proposed in the Redstone Park Conceptual Plan will limit the future improvement of the riparian area. The riparian zone currently in the park does not contain much native vegetation and the structure of the levee does not provide easy access to the river (see Figure 1).

The conceptual plans call for riparian improvement and river access zones. The concept of a riparian improvement zone is:

- Areas along the riparian edge that will be restored with low native vegetation.
- River bank stabilizing materials will enhance the native vegetation and will work with the river's dynamics and variable flows.

The concept for a river access zone is:

- Provide physical access to the river.
- Incorporate natural features that provide access to the river and sandy areas when the river level is low.
- Allow the natural river dynamics to function.

There is currently a memorial garden located along the river bank and the conceptual plan allows for this to remain and be enhanced so it can be incorporated into future riparian improvements.

Existing trees will be evaluated on an ongoing basis to determine health and safety and opportunities will be sought for new trees to be planted with the park.

Trails

Surface material for access corridors, the Woodland Grove and the trail along the river will be determined during final plan creation. It is envisioned that all trails will be natural surface with very limited use of hardened surfaces like asphalt or concrete. Trails will be composed of pervious materials.

Maintenance

Incorporating the new areas to the park will increase use and maintenance responsibility. All concepts were designed to limit maintenance needs and the existing grass in the park could be changed to a low irrigation sod to reduce maintenance in the future. These concepts will be reviewed during final plan completion.

Elk Park

6. ELK PARK

In 1996, a Master Plan was created for Elk Park (Appendix B). The main uses of the park were to be parking, picnicking, potential relocation of the fire house, and use of the existing cabin for residential use by County employees. The parking area was created in 2000 with the installation of a pedestrian bridge to connect to Redstone Park. The plan was to provide an inviting parking area to reduce vehicle traffic and parking problems along Redstone Blvd.

Over the next ten years the parking area has received a limited amount of use, the cabin has been vacated by Pitkin County Public Works due to infrastructure failure, and the picnic area and the banks of Coal Creek have degraded. The conceptual plan illustrates a major change to the existing park and 1996 Master Plan. The new plan's major concepts are:

- Activate the use of the park by creating an attractive visitor information area to provide guidance to travelers along the Scenic Byway.
- Create a new entrance to Redstone by working with the Colorado Department of Transportation to slow down traffic and create safer entrances to Elk Park, Coke Ovens, and Redstone.
- Provide trails and play areas throughout the entire area of the park and a potential pedestrian bridge and connection to Redstone Boulevard next to the existing main vehicle entrance to Redstone.
- Enhance the riparian areas along the Crystal River and Coal Creek.

Infrastructure

Pitkin County Public Works manages the existing cabin. For the past 10 years the water line servicing the cabin and irrigation to the park has had major problems, which has cost the County substantial funds to repair. During the winter of 2009-2010 the water line into the cabin failed and then during a windstorm the electric lines to the cabin were knocked down. Due to these major issues, combined with the need for roof repairs, additional insulation, and upgrades to the heating system, the Public Works Department has deemed the cabin uninhabitable. Through the development of the conceptual plans the planning committee wrestled with the future of the cabin. It was determined that the concept of removing the existing cabin and preserving the existing footprint to create a visitor information area was the preferred option. On the conceptual plan for Elk Park the visitor information area is labeled the Depot to give the historical context of the Redstone train depot (see Figure 2) that existed on the property. This option will preserve the use of the structure's existing footprint on the property, but turn the use from residential to public. The planning committee would like to preserve the ability for the county to use the existing footprint for a public use and recommends OST owning the entire parcel. If the use is for a visitor information area OST will work with the Redstone Historic Preservation Commission, the Redstone Historical Society, Redstone Community Association, Scenic Byway Committee, and others to create final plans for the visitor information area.

Figure 2 - Historic Train Depot on Elk Park around 1925. Photo by Del Gerbaz

Parking

The conceptual plan proposes a major change to the existing parking area. The entire parking area would be moved to closer to the visitor information area and to a safer entrance to Elk Park. Additional parking spaces could be created along with parking areas for larger recreational vehicles and trailers. Lowering the grade for the parking area along with landscaping will provide visual mitigation.

No overnight parking will be allowed unless parking for overnight stays originating from the East Creek Trailhead are directed to Elk Park during the final plans for Redstone Boulders Open Space to keep the small parking area at the East Creek Trailhead free for day users.

Trails and Access

The conceptual plan locates many different trails through the property. All trails will be soft surface, pervious, and ADA accessible. These could include overlooks of the Crystal River. Limiting access to the Crystal River in Elk Park will protect the riparian area and leave room for riparian and floodplain improvements. Access to the Crystal River from Coal Creek can be accommodated in the final planning effort for Coal Creek. It is envisioned that in Elk Park visitors will have a visual connection to the Crystal River and to leave the physical connection to Redstone Park.

Currently, Redstone and Elk Park are connected by a pedestrian bridge that links the two parks well. There is no safe connection between Elk Park and the Coke Ovens and to the recreation corridor of Coal Creek Road. There is also not a safe pedestrian friendly connection from the south entrance of Redstone to Elk Park and the Coke Ovens. The conceptual plans show how these parks and Redstone could be connected and provide safe pedestrian access. Elk Park is the link between the coke ovens and Redstone Park and the connectivity between each of them is a critical component of the conceptual plans.

Pedestrian Bridge connecting Redstone and Elk Park

Open Space Areas

Currently in Redstone there are limited open fields for recreation and events. In the conceptual plan for Elk Park there are two new open space areas that would provide opportunities for open field play area and potentially a skating rink. These areas will be low maintenance turf grass that requires minimal and limited mowing. These new fields will maintain a natural character yet include the potential for many different activities and/or events.

Natural Resources

Crystal River

Like Redstone Park, the Crystal River is the main natural resource at the park and restoration and improvement of the riparian zone is a listed as a concept. However, the riparian improvements will not incorporate access to the river. Keeping the riparian zone intact is a concept the planning committee felt was important since there is plenty of access being contemplated at Redstone Park. Trails will be located far enough away from the riparian edge to allow the widening of the riparian corridor with limited overlooks to keep the current views of Redstone from Highway 133 and the park.

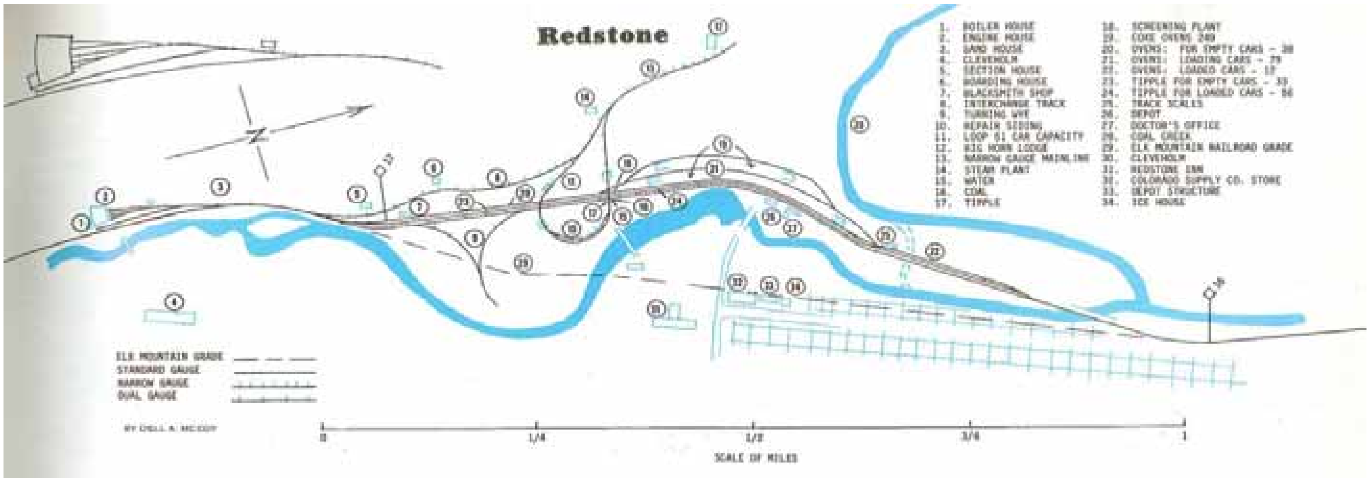


Figure 3 – Map of Redstone in early 1900's by Del McCoy.

Coal Creek

The flow of Coal Creek was dramatically changed when the coke ovens were built and the community of Redstone was planned. The community of Redstone sits in the historic floodplain for Coal Creek and the Crystal River and when the coke ovens were built, Coal Creek was diverted northward to prevent Redstone from flooding and allow the construction of the coke ovens (see Figure 3, between #25 and #22 the historic channel of Coal Creek is drawn in dashed lines). When the Colorado Department of Transportation built the Highway 133 bridge at Elk Park the creek was returned back to its original channel, but now has little floodplain due to the levee built in Redstone to prevent flooding. The absence of a floodplain allows extensive sedimentation to flow directly into the Crystal River and still poses a major flood risk to Redstone. When Coal Creek was diverted it developed an extensive floodplain west of Highway 133 before joining the Crystal River North of Redstone (see Figure 4).

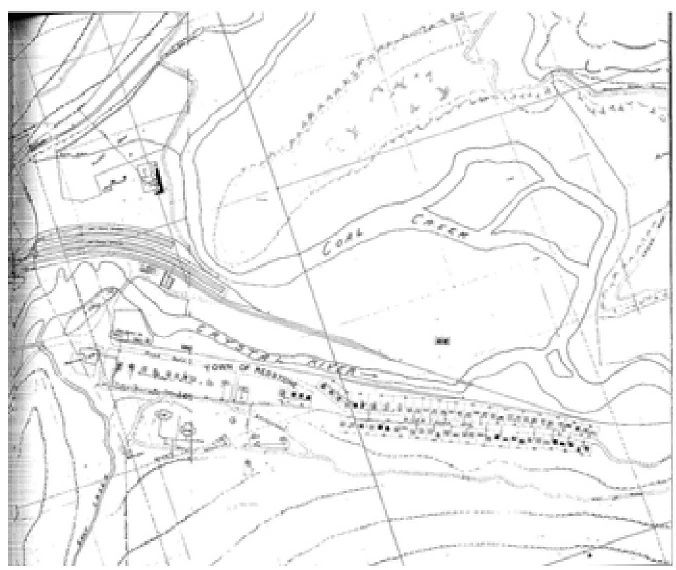


Figure 4 - Map of Coal Creek floodplain after dams were built to redirect flow away from Redstone. From the Richard A. Ronzio Collection.

OST staff has met with the Roaring Fork Conservancy, the USDA Forest Service, and the Colorado Division of Wildlife to see if it is feasible to begin a larger planning process to plan for restoration of Coal Creek. From that meeting, and with the current degradation of the creek banks and sediment loading occurring from Coal Creek to the Crystal River it is imperative to continue to work with the Roaring Fork Conservancy and other agencies to determine the scope of a planning process to restore the floodplain of Coal Creek at the junction with the Crystal River. These agencies along with the planning committee have determined some of the benefits that could be achieved with restoration planning for Coal Creek are:

- Reduce the risk of flooding for Redstone.
- Remove sediment from Coal Creek before it reaches the Crystal River.
- Creation of a floodplain for the Crystal River and Coal Creek.
- Wetland creation due to creation of a floodplain could reduce heavy metals from entering the Crystal River.
- Wildlife habitat

Maintenance

There will be an increased need for maintenance once the concepts are finalized. Increasing the use of Elk Park will increase maintenance. During the creation of the conceptual plans this increased use and maintenance that comes with it was analyzed and concepts such as native low water grasses are envisioned in the play areas and only a small increase in waste containers are envisioned. The skating rink and other winter uses of the park will be analyzed during the final plans since plowing the parking areas and providing water to create the skating rink are a change to current management.

7. REDSTONE BOULDERS OPEN SPACE

Bordering the main residential part of town and providing a natural corridor between the Forest Service lands to the west and the Crystal River, Redstone Boulders Open Space is a property that many people in Redstone are just discovering. An old trail connects the USDA Forest Service Redstone Campground to the East Creek Trailhead. This trail along with public access to the boulders climbing area is bringing more people to the property, which is creating management challenges. The East Creek Trailhead is informal and parking is haphazard with no signage or information to visitors. The existing trail is overgrown and eroded in sections and the old road into the property is in poor condition. There is also sizeable riparian habitat that has good potential and warrants some research to determine any restoration needs. Also, a concern about the amount of signing was brought up during the planning meetings and it was decided that less signage is better on this property. The following are the main concepts for Redstone Boulders Open Space:

Redstone Boulders Open Space

- Provide drainage on the main trail through the property and reduce the width of existing road to a sustainable trail and close motorized access to the property
- Provide limited informational signage.

- Work with the USDA Forest Service to create final plans for the Redstone Boulders Open Space, the surrounding National Forest lands containing the majority of the climbing boulders, riparian improvements, and trail connections.

Restrictive Covenant

OST purchased the property with OST funds after transferable development rights (TDRs) were granted to remove the development potential from the property. When the TDRs were issued a restrictive covenant was placed on the property that limits the future use of the property to only existing uses. The trails, roads, trailhead parking, and fishing access are the only prior uses that occurred on the property when the covenant was placed on the property. The conceptual plan for the property only improves the existing uses and is in compliance with the restrictive covenant.


Trail through Redstone Boulders Open Space

Trails

The current trail on the property is a great connection to the Redstone Campground and the boulders climbing area. This trail will be improved to provide better drainage. This trail will remain a natural surface without imported materials.

The existing road on the property will be closed to motorized use and realigned to sustainable grades to control erosion and provide a direct trail connection to the boulders climbing area.

Trailheads

East Creek Trailhead Parking

The existing trailhead parking for the East Creek Trail is poorly defined with no informational signage. Improvements to this trailhead are listed on the conceptual plan and will be limited in size to provide just the necessary information for users of the Redstone Boulders Open Space and National Forest Lands.

The parking area will be limited in size to approximately the current size of the parking area, but parking will be better defined using only natural materials as parking delineators and fences. It will also be designed to allow a turnaround for vehicles and community events.

There is a lot of use by people with dogs on the trails on and around Redstone Boulders Open Space and a dog waste station should be explored to reduce the amount of dog waste currently littering the site. Details on how the station will be maintained will be worked out prior to installation, but the location would be at this trailhead.

Horse trailers are not currently accommodated well in the current parking area. OST will work with the outfitters permitted on the USDA Forest Service lands to accommodate horse trailer access to the trailhead. Parking of horse trailers is conceptualized at Elk Park with accommodations at the East Creek Trailhead for unloading of pack animals and supplies. A hitching post with areas for supplies can be created in the final plan to accommodate this use. The Colorado Division of Wildlife has stated the need for providing trailer access to the East Creek Trailhead especially during hunting season. The actual use by trailers will be decided during the final planning for the property. This will also determine if overnight parking will be allowed at this trailhead. Until final plans are created overnight parking is allowed at the East Creek Trailhead.

Boulders Trailhead

A small kiosk or sign at the entrance to the trail accessing the boulders is contemplated at this site to provide Open Space and Forest Service maps and regulations. No parking is envisioned here or along Redstone Boulevard since there is parking at the East Creek Trailhead just 100 yards from the Boulders Trailhead.

Natural Resources

Redstone Boulders Open Space provides a great natural buffer to the residential area of Redstone. The riparian area along the Crystal River has great potential and a plan could be created with the adjacent USDA Forest Service and private land to restore a significant section of the Crystal River. This will be examined in the future and is allowed by the restrictive covenant.

Wildlife use of the property has not been studied, but from site visits and Division of Wildlife Maps it is within elk winter range. The amount of elk use of the property has not been analyzed, but OST will work with the Division of Wildlife as it plans for improvements to the trails. Mature vegetation is abundant on the property which support habitat for small mammals and birds.

Maintenance

The main maintenance need at Redstone Boulders Open Space will be the dog waste station. Since there is already waste removal at Redstone and Elk Park this one container should not be a large increase in cost.

8. MEMORIAL POLICY

During the planning process it was determined that limiting memorials to necessary infrastructure and natural vegetation will provide opportunities for memorials without oversaturating the park. Memorials include picnic tables, benches, plaques, naming properties or trails, or any other structures or vegetation that recognizes the memory of a person, group, or event. The conceptual plans for Redstone and Elk Park do illustrate potential locations for memorials. Until a final plan for specific locations for memorials in Redstone Park is completed, no new memorials will be allowed. The priority list for the


Memorial in Redstone Park

Redstone Parks and Open Space Plan is included in the conceptual plan and will outline the timetable for completing final plans for each property. In the final plans, designs and locations for new picnic tables, benches, and other infrastructure will be developed that meet the community desires and provide a memorial opportunity. OST encourages people wishing to memorialize people at Redstone and Elk Park to donate living memorials or funds towards infrastructure, like the pavilion or depot, riparian improvements, or the creation of new playfields at either park once final plans are complete. Memorial recognition will be consistent with the type of memorial. OST staff will work with the donors to develop appropriate recognition on the donated memorial. Conceptually, plaques could be created listing all the names of the donors for larger infrastructure like the pavilion or depot and engraving could be contemplated for benches or picnic tables. For living memorials a map will be created with every known memorial planting and this map will be updated and accessible on the OST website.

Existing memorials are identified on the conceptual plans and all will remain through their usable life. A list is being developed identifying all of the existing memorials and the condition will be evaluated.

9. SPECIAL AND COMMERCIAL USE

Redstone and Elk Park

Special Use requests for Redstone and Elk Park have increased dramatically and there are no guidelines in place to direct the types of uses the community would like to see in each park and at what times. The planning committee and OST staff agrees that some uses of the parks like the summer concert series and events like Winter Fest that are open to the public, attract community members and visitors to gather in the community center, and provide an economic benefit to the town are events that should be encouraged and accomodated. The challenge is to provide clear guidelines and coordinate events. The following policy will cover Special and Commercial Uses at Redstone and Elk Park:

- All community organized events that will occur only in Redstone and/or Elk Park will be coordinated with OST staff as soon as dates and times are finalized. Community organized events that are open and free to the public. Pending submittal and approval of a Land Use Code amendment to allow OST to administer Special Use Permits on OST properties, Special Use Permits will not be necessary for these events.
- Community organized events that are free and open to the public, but that use the parks and other non-OST locations in the area must go through the Pitkin County and/or other agency Special Use Permit process. OST will be involved in that process and ensure that the resources of Elk and Redstone Park are protected.
- Private events with over 20 participants that only use Redstone and/or Elk Park will go through the Pitkin County Open Space Special Use permit

process. Applications are available through OST staff and on the OST website. Guidelines for private use of the parks are as follows:
  - Community organized events have first priority.
  - OST Staff will consult with the Redstone Community Association on the proposed use.
  - The limit on number of participants are 75.
  - Tents or other shelters are not allowed. Use of the Gazebo or future pavilion is allowed, but must be reserved via special use permit.
  - No private events at the parks during Memorial Day weekend, July Fourth, or Labor Day weekend.
  - The future Woodland Grove can be reserved via special use permit.
  - Parking for the events will be at Elk Park since parking at Redstone Park is limited.
  - All events must end by 9 pm and be cleaned up that night.
  - No electrified lighting or amplified sound.
  - Alcohol is allowed in County Parks and Open Space unless it is provided by a public event, which would then require a liquor license be obtained from the County. For private parties or alcohol brought in to the park by individuals a liquor license is not required.
- No commercial activity is allowed on Redstone or Elk Park.

Redstone Boulders Open Space

For Redstone Boulders Open Space there is a restrictive covenant on the property that limits the amount of use on the property. No special or commercial use is allowed on the property except for the following:

- Environmental education programs approved by OST.
- Research on the property approved by OST.
- Commercial outfitters accessing the East Creek Trail. Details on parking commercial horse trailers will be worked out with OST staff.

10.PLAN IMPLEMENTATION PRIOIRTIES

The following list details the priority the Planning Committee has placed on action items in the conceptual plans for the properties.

Short Term Priorities 1-3 years

<u>Redstone Park</u>

1. Remove existing picnic tables that are in poor condition.
2. Repair fence around park.
3. Explore the possibility of locating the existing trash dumpster to a less visible location.

4. Work with Pitkin County Community Development on amending the land use code to allow OST to administer special use permits on OST property.
5. Identify all existing memorials and evaluate condition.
6. Adopt memorial policy for Redstone and Elk Park.
7. Remove utility pole and exposed water lines. OST will keep water tap for future irrigation.
8. Continue mechanical noxious weed management.
9. Remove concrete slab and revegetate area with native vegetation on the Meredith Parcel.

Elk Park

1. Determine the fate of the cabin, historical significance, and future ownership of the parcel. The planning committee recommends removing the existing cabin, OST assuming ownership of the parcel, and OST reserving the existing cabin footprint for future public use.
2. Develop a funding recommendation for the 2012 budget for creating the final plans for Elk Park. This will include working with CDOT on the access plan to the park and defining the improvements to Highway 133.
3. Continue to collaborate with the Roaring Fork Conservancy, the USDA Forest Service, and the Colorado Division of Wildlife on the future of the Coal Creek floodplain.

Redstone Boulders Open Space

1. Close motorized access at the Boulders Access Trailhead.
2. Explore the potential for placing a dog waste station at the East Creek Trailhead. This will determine how this station would be maintained.
3. Work with the USDA Forest Service and Division of Wildlife on the trail connecting to the campground and to place limited visitor information signage.

Long Term Priorities 3-10 years

Redstone Park

4. Develop final plans for the park. This will refine the pavilion and woodland grove concept and create an access plan.

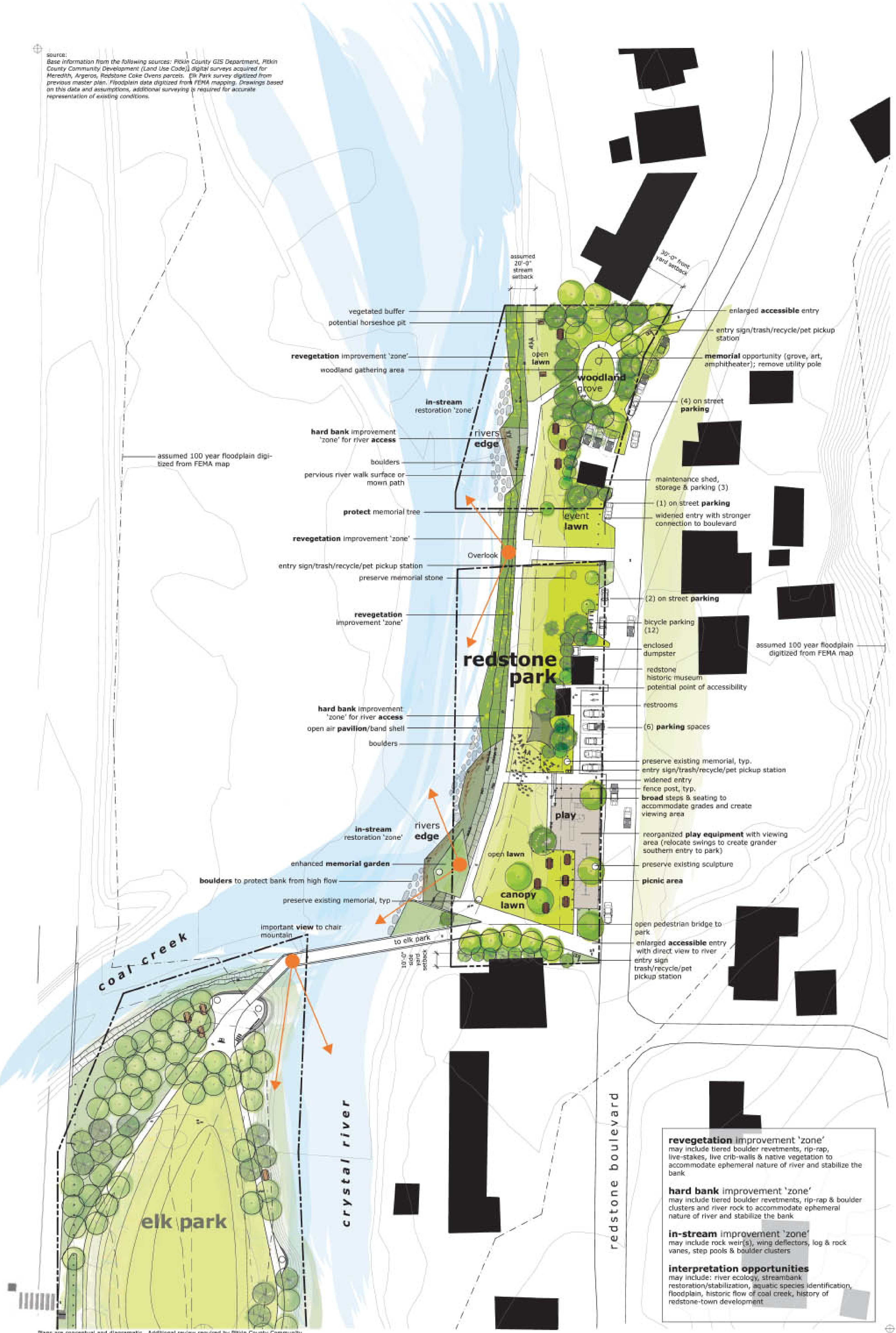
Elk Park

5. Implement final plans.
6. Continue working on solving the floodplain issues on Coal Creek.

Redstone Boulders Open Space

7. Begin a collaborative planning process with the USDA Forest Service and the community for the trails, trailheads, riparian area, and recreational resources of the Redstone Boulders area.

APPENDIX A



Plans are conceptual and diagramatic. Additional review required by Pitkin County Community Development, CDOT, Army Corps of Engineers, U.S. Forest Service and other agencies. Plans may be revised per comments from these and other agencies.

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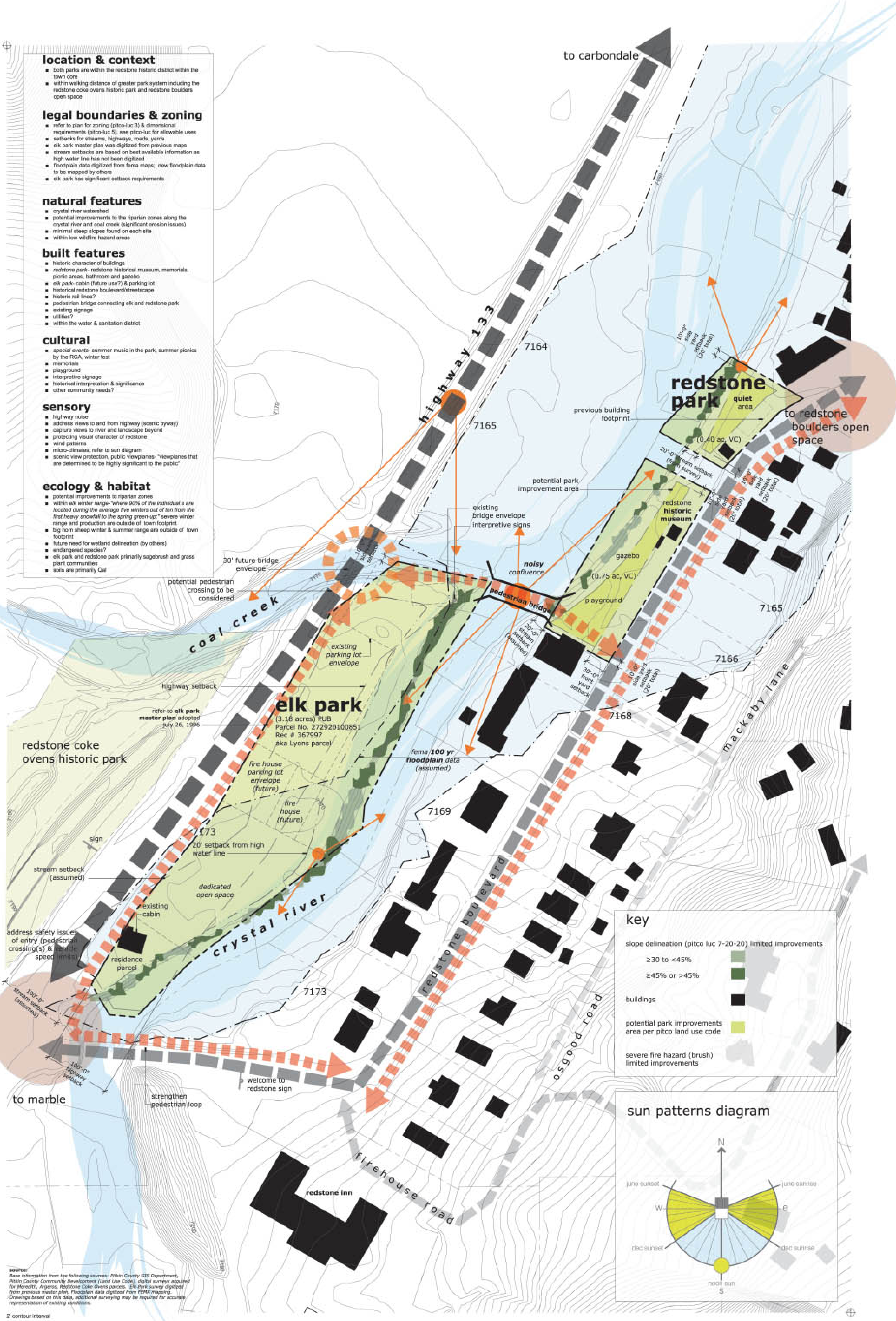
redstone park | conceptual site plan

redstone open space management plan

redstone | colorado

Appendix A
Redstone Park and Open Space Management Plan



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elk park & redstone park

redstone open space management plan

redstone | colorado

Appendix A
Redstone Park and Open Space Management Plan

redstone park
source:
Base information from the following sources: Pitkin County GIS Department, Pitkin County Community Development (Land Use Code), digital surveys acquired for Meredith, Argeros, Redstone Coke Ovens parcels. Elk Park survey digitized from previous master plan. Floodplain data digitized from FEMA mapping. Drawings based on this data and assumptions, additional surveying is required for accurate representation of existing conditions.
signage—reduced speed limit, provide indicator signage beyond town limits
riverbank stabilization with boulders and live staking
wayfinding signage trash/recycling/pet pickup station
picnic grove; opportunity for memorial trees
signage—pedestrian crossing zone ahead
historic coal creek diversion
coal creek
signage—pedestrian crossing zone
pedestrian crosswalk
assumed 100 year floodplain digitized from FEMA map
small hill for highway separation
native grasses, shrubs & perennials
pervious trail to coke ovens
wayfinding signage trash/recycling/pet pickup station
dedicated turn lane
assumed 100 year floodplain digitized from FEMA map
signage for parking
signage—parking entrance
wayfinding signage trash/recycling/pet pickup station (12) bicycle parking
coke ovens turnoff
dedicated turn lane
redstone coke ovens historic park
pedestrian crosswalk
future pedestrian path connection to coal creek through coke ovens property
signage—pedestrian crossing zone
improvements to be discussed with CDOT signage (northbound)
—public parking ahead
—pedestrian crossing zone ahead
—reduced speed limit
—provide indicator signage beyond town limits
Plans are conceptual and diagramatic. Additional review required by Pitkin County Community Development, CDOT, Army Corps of Engineers, U.S. Forest Service and other agencies. Plans may be revised per comments from these and other agencies.
highway 133
100'-0" highway setback
10'-0" side yard setback
in-stream restoration 'zone'
to redstone park
gateway opportunity to make bridge more inviting
overlook
confluence overlook
preserve existing signage
(8) bicycle parking
in-stream restoration 'zone'
multi-purpose trail, pervious material, typ
informal recreation field
flexible play/event field (native turf) nordic skiing, snowshoeing, skijoring (winter) floodplain overflow, frisbee, soccer, football (summer)
overlook
revegetation improvement 'zone'
preserve existing tree stand, typ
elk park
wildflowers
floodplain improvement 'zone'
flexible play/event field skating (winter) floodplain overflow, amphitheater and play, potential opportunity for pond (summer)
stormwater improvement 'zone'
crystal river
floodplain improvement 'zone'
stormwater improvement 'zone' for parking lot runoff
parking (depressed)
32 spaces
4 recreational vehicle/trailer spaces (overflow)
further review with community development required
overlook, typ; minimal regrading & no impact materials, pervious
revegetation improvement 'zone'
interactive coke oven (play structure, education, interpretation to enforce gateway concept)
the depot (information, education, interpretation, open air shelter in the same footprint of the existing cabin)
depot
overlook
in-stream restoration 'zone'
fence post, typ.
gateway
50'-0" stream setback
100'-0" stream setback
10'-0" side yard setback
100'-0" highway setback
redstone boulevard
new ice sculpture opportunity
new pedestrian crossing over river
revegetation & floodplain improvement 'zone'
revegetation improvement 'zone'
may include tiered boulder revetments (minimal), rip-rap (minimal), live-stakes, live crib-walls & native vegetation to accommodate ephemeral nature of river and stabilize the bank
floodplain improvement 'zone'
may include regrading for floodplain overflow zones and revegating with native plants that can accept seasonal flows
in-stream improvement 'zone'
may include rock weir(s), wing deflectors, log & rock vanes, step pools & boulder clusters
stormwater improvement 'zone'
may include vegetated depressed areas to accept and treat parking lot runoff during major storms
interpretation opportunities
may include: river ecology, streambank restoration/stabilization, aquatic species identification, floodplain, historic flow of coal creek, history of redstone-town development, historic depot site and additional coke oven interpretation.
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elk park | conceptual site plan
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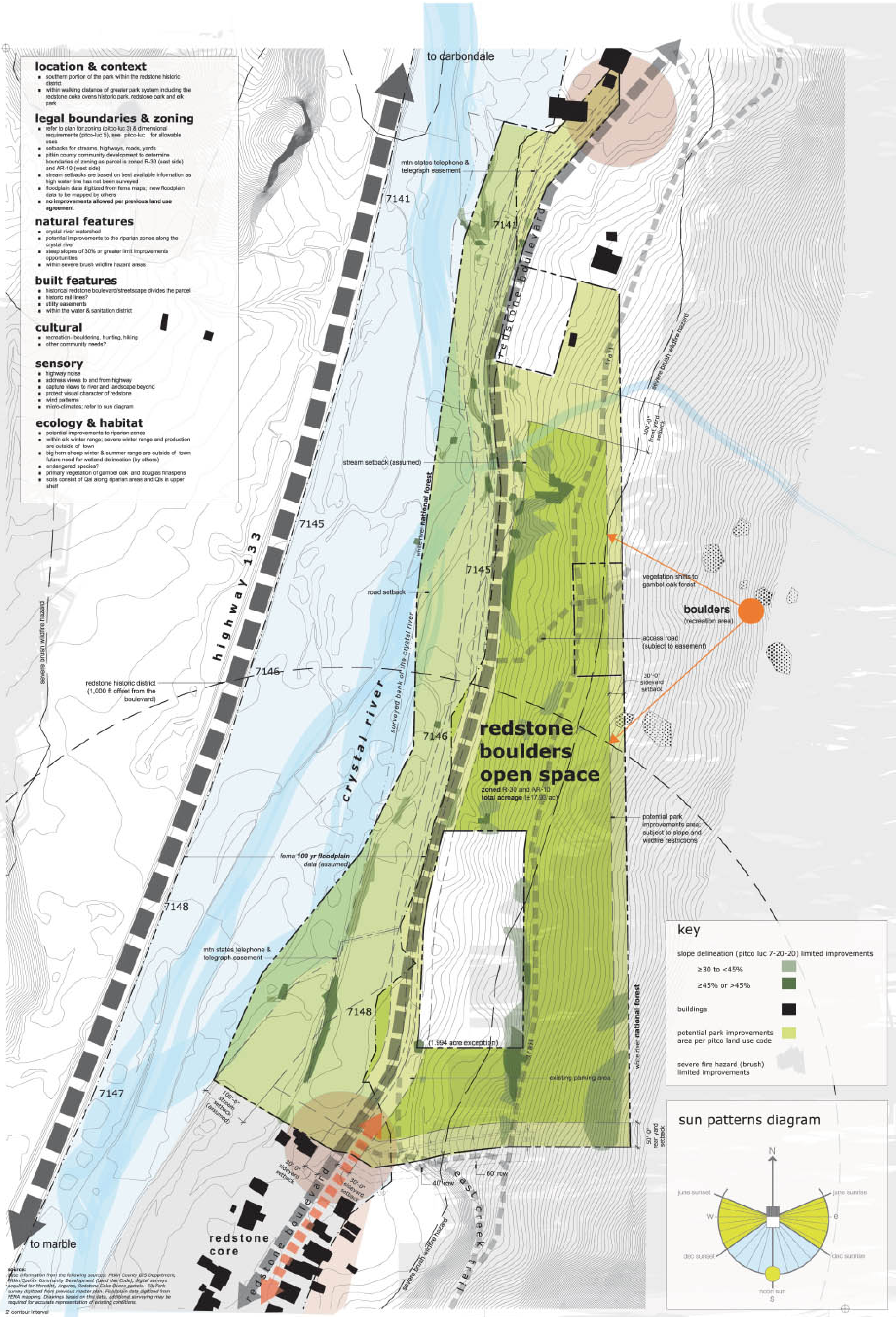

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redstone boulders open space

redstone open space management plan

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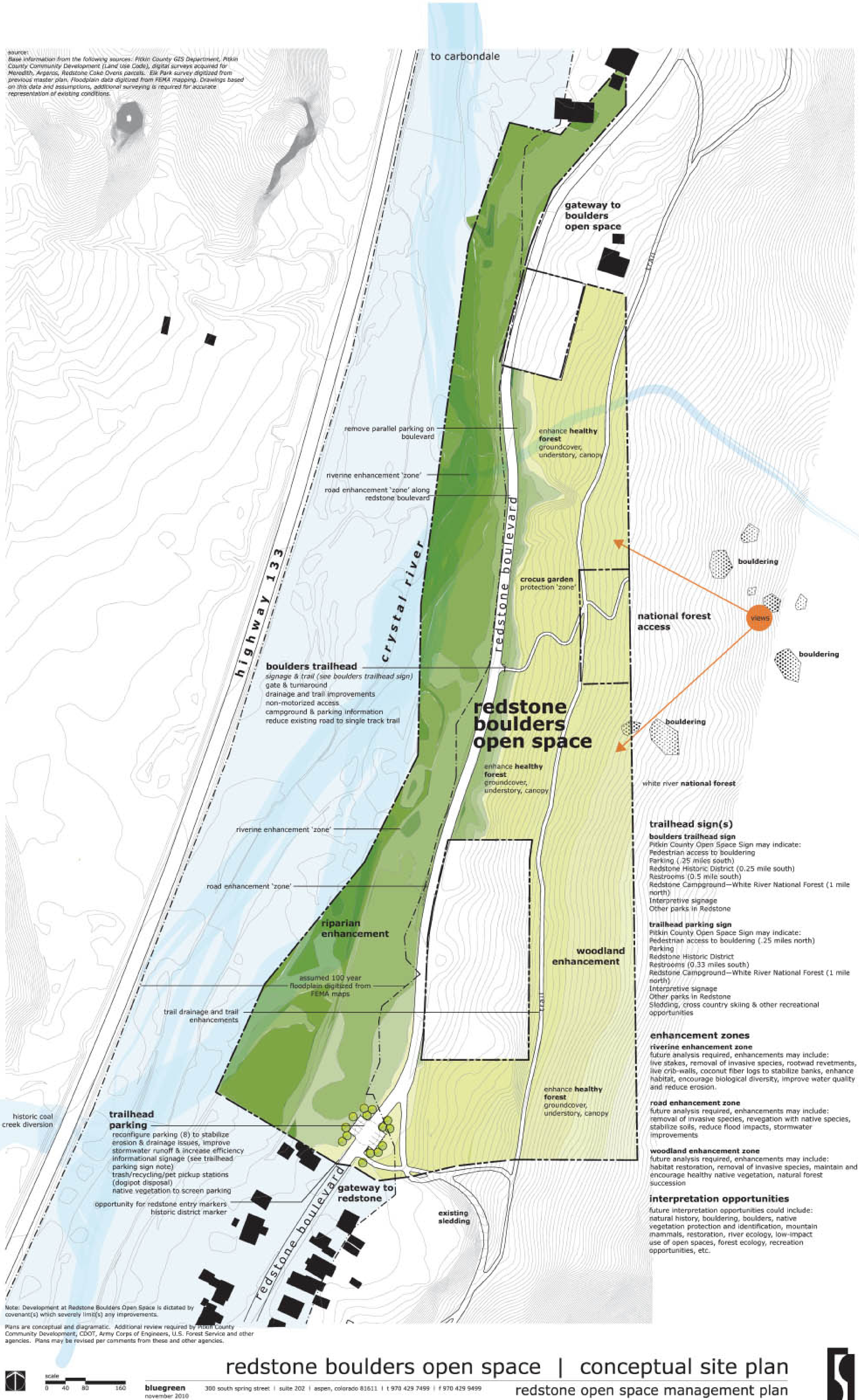
Appendix A
Redstone Park and Open Space Management Plan



Appendix A
Redstone Park and Open Space Management Plan

APPENDIX B

Elk Park Master Plan

Final Draft
As Adopted by the Pitkin County Commissioners
July 24, 1996

Prepared by Mark Fuller
Fuller Consulting Services

With Assistance From:
Rick Magill, Aspen/Pitkin County Planning Office
Amy Amidon, Aspen/Pitkin County Historic Preservation
Dorothea Farris, Crystal River Caucus
Jim Spencer, Redstone Community Association
and
the residents of Redstone, Colorado

Elk Park Master Plan
November 7, 1996

I. PROPERTY DESCRIPTION AND HISTORY

The Elk Park Property, formerly known as the Lyon Property, is 2.94 acres in area and is located just south of the Coal Creek-Crystal River confluence on the west bank of the Crystal River at Redstone, Colorado. A Master Plan Plat, including a location map, and a Conceptual Site Plan are included as Exhibits to this Master Plan. The approximate center line of the Crystal River defines the eastern boundary line of the property and Colorado State Highway 133 is contiguous to the western property line. The south Redstone Boulevard bridge into Redstone across the Crystal River is immediately south of the property. Elk Park lies partially within the 100 year floodplains of the Crystal River and Coal Creek. Although there is no record of flooding on the property, its banks have been built up in some locations to reduce flood hazard. The property is generally flat and unobstructed with an average elevation of 7,170 feet. There are a number of mature narrowleaf cottonwood and Colorado blue spruce trees along the Crystal River shoreline and near the residence at the south end of the property. Other vegetation consists of grasses, forbs and occasional native shrubs (i.e. serviceberry, willow, chokecherry). In the past the property has been used as a railroad depot and siding site, a Colorado Department of Transportation equipment yard, an equipment and construction yard for Mid-Continent Resources, and, most recently, a construction company and real estate office site.

The property was purchased for $465,000 by Pitkin County in 1994 using funds from the County's general fund and from the Pitkin County Open Space and Trails Program. Further information on the respective contributions of these parties and the resulting restrictions on property use are discussed below. Since 1994 the property has been planned, with the participation of the residents of Redstone, for a variety of uses. The planning process is described and the Master Plan for future use and development of the property is presented herein.

II. PLANNING PROCESS

Pitkin County took title to the property in March of 1994. Of the total price of $465,000, $140,000 was contributed by the County Open Space and Trails Program. This contribution was made on the assumption that approximately 30% of the property would remain in open space and that the part of the property attributable to permanent open space would be subject to the restrictions and requirements of open space acquired through the Open Space and Trails Program. The balance of the property acquired through general fund contribution would not be subject to restrictions on future uses except by the requirements of the Master Plan and Public Zoning classification.

A public meeting was held in May of 1994 to discuss potential uses of the property with interested members of the Redstone community. This meeting included a brainstorming session to list all conceivable uses of the property, and a decision-making session to prioritize the proposed uses according to public sentiment. The Carbondale and Rural Fire District made a proposal regarding the relocation of their Redstone Fire House to the Elk Park Property. This meeting was successful in determining a clear set of priorities for the property based on local needs and desires.

The public meeting also endorsed a Task Force, made up of Mark Fuller, County Open Space and Trails Director, Rick Magill, County Planner, Amy Amidon, County Historic Preservation Officer, Dorothea Farris, Crystal Valley Resident and Jim Spencer, President of the Redstone Community Association, to follow up the meeting's findings with more detailed planning. This group met a number of times between May and October of 1994 to refine the results of the initial meeting into specific proposals. Included in Task Force discussions were a fire house location, size and design, bridge location and design, use of the old real estate office building, size and design of a parking area, and long-term management issues. These meetings resulted in a sketch plan of the site (see Exhibits), which were taken back to Redstone for a second public meeting in October of 1994. At that meeting the site plan and accompanying narrative were reviewed and endorsed by those in attendance.

This Master Plan has been subjected to discussion, review and public hearing by the Pitkin County Planning Department, the Pitkin County Planning and Zoning Commission and the Pitkin County Commissioners. Any restrictions, requirements or conditions contained within Resolution No. 96-31 (adopted 7/24/96) formally approving this Master Plan or Resolution No. 96-212 (adopted 7/24/96) granting approval of the 1041 Hazard Review for the property are hereby incorporated into this Master Plan. Every effort has been made to make this Master Plan consistent with that Resolution and Ordinance. To the extent that there are any conflicts between the two, the Resolution and Ordinance shall take precedence.

This Master Plan, based on the Redstone meetings and subsequent discussions with the Open Space and Trails Board, the Pitkin County Commissioners, and other interested parties, is intended to formalize the planning process and to guide future development, use, permitting procedures and management of the Elk Park Property.

III. PROPERTY FACILITIES AND FEATURES

1. LAND

The property is 2.94 acres in size and is generally flat although there is a small rise along the western property boundary adjacent to Highway 133. The property is vegetated with grass and scattered trees and shrubs along the Crystal River and around the residence. The banks of Coal Creek along the property's northern boundary are made up of raw boulders, bare dirt and fill material. There are extensive unvegetated areas that were previously used as driveways, storage, parking and equipment areas. The property immediately surrounding the dwelling unit has been improved with shrubs, grasses, wildflowers and other typical landscape plantings. The garage building that stood on the site previously has been removed but the cement floor of the garage is still in place as of this date. There are no known obstacles, geologic hazards, unstable soils or other physical conditions on the property that would hinder or complicate development. A Phase 1 Environmental Assessment of the property was done prior to County purchase and no hazardous materials or contaminated soils were identified.

2. DWELLING UNIT

This 950 square-foot building is located at the southern end of the property. It was originally a residence and was later converted to a real estate office. It is a single story wood-frame building with a fireplace, two bedrooms, storage closet, living-dining area, kitchen and one bathroom. Water is supplied by the Redstone Water and Sanitation District, heat is electric baseboard and there is an individual septic system. There is no garage nor are there other outbuildings. The unit is suitable for occupancy and is currently occupied by a Pitkin County Sheriff's deputy. The septic system, insulation, roof and heating systems have been identified as priorities for upgrading. If the County Environmental Health Department determines that the existing septic system requires a permit, the County will take responsibility for obtaining that permit.

3. OTHER FEATURES

As of the date of this Master Plan, the property is bounded by a chain-link fence along Highway 133. There is also a small footbridge over a drainageway between the dwelling unit and the Redstone Boulevard bridge over the Crystal River into Redstone. This footbridge is currently closed pending a safety inspection and possible repairs. There is a water standpipe near the former garage site and a working hand pump. Water meters are also located near this standpipe. There is no fire hydrant on the property. There is electric service to the dwelling unit and a utility pole near the garage site that previously carried service to the garage. A footbridge, salvaged from the Colorado Department of Transportation is currently stored on the property at its northern end. Other than these features, the property is vacant.

IV. PROPOSED FACILITIES AND DEVELOPMENTS

1. PARKING AREA

A parking area of approximately 13,000 square feet is proposed for the area previously occupied by the construction firm equipment yard and garage in the north-central portion of the property. The conceptual design of this parking area is shown on the attached Site Plan. The parking area has been sized to accommodate 25-30 automobiles parked at an angle around an oval shape and divided by a landscaped median. The area is intended to provide an alternative to parking on Redstone Boulevard and to accommodate special event traffic. The parking area is also intended to provide room for a future loading/unloading area for Roaring Fork Transit Agency (RFTA) vans or buses. The parking area design will provide for parking while leaving room for landscaping and landforms to mitigate visual impacts. The parking area will also allow for easy access to the bridge over the Crystal River to the Redstone Town Park (see below) The existing entry drive, which served both the residence and the garage, will be relocated to the north to accommodate the parking area and the firehouse, and to the south to maintain a private access to the dwelling unit (see below). Those parts of the existing access road that will not be used under this Master Plan, such as the section of road that crosses the Natural Area described under paragraph 5, below, will be scarified and revegetated by the County in the course of construction of the Parking Area. The County will be responsible for obtaining a Highway Access Permit from the Colorado Department of Transportation prior to development of a new access road. The County will also be responsible for the design and construction of the parking area, including landscaping and revegetation.

2. BRIDGE OVER THE CRYSTAL RIVER

The bridge site has been selected to take advantage of the location of the Redstone Town Park. The Town Park, located across the Crystal River to the east and slightly north of Elk Park, will allow for the location of both bridge abutments on public land. It will also guarantee that no private land will need to be acquired and that conflicts with private landowners, residences or businesses will be minimized. Both bridge abutment sites will be located on previously disturbed land so bridge construction will cause very little disruption of vegetation, natural areas, wetlands or other natural features. The bridge structure itself may cross private property adjacent to and immediately south of the Town Park. If so, the County may need to acquire an access easement from that landowner prior to construction. The bridge abutment on the Elk Park property will be located immediately north and east of the parking area, so pedestrian access from the parking area to the bridge and back will be convenient and efficient. Persons crossing the bridge into Redstone will be deposited in a central location, allowing for easy access to businesses and residences on either side of the Town Park.

The current plan for bridge construction calls for the recycling and re-installation of the bridge being stored on the site. This bridge was salvaged from the Colorado Department of Transportation and was originally built in Glenwood Canyon to carry highway construction traffic. It is a laminated wood structure which is unsightly but sturdy and long enough to span the Crystal River in the identified location. The bridge will consist of a 103' central span and two 60' spans at either end. The spans will rest on stringers which will be set on new abutments. A sketch of the bridge location and general design is attached. No center support is required and no significant disturbance of the riverbed is anticipated. A letter is attached from the Army Corps of Engineers (ACE) confirming that no ACE permit will be required as long as the bridge design and location is consistent with that described in this Master Plan. The bridge will remain 1'-2' above the identified 100-year floodplain of the Crystal River and therefore no floodwater impedance is anticipated. Preliminary engineering information developed by Patillo and Associates of Glenwood Springs on the bridge design and site is attached for further reference. Abutment installation will require some earthmoving and vegetative disturbance but no permanent impacts are anticipated except for the loss of a nominal amount of grassy area.

The bridge will be subject to site-specific engineering and design when installation proceeds. In addition, the County is required to develop, review and approve a 1041 application dealing specifically with the bridge prior to the issuance of any building permits for the bridge. This Master Plan specifically does not include approval for bridge installation. Bridge design, materials and construction methods may be subject to further discussion and modification prior to project-specific 1041 application, review and construction. Although this Master Plan identifies the bridge being stored on-site as the structure now planned for installation, this issue is still being debated as of this date and a significantly modified or new bridge may be proposed by the project-specific development application.

3. DWELLING UNIT

No significant modifications in physical status or use is anticipated for the dwelling unit in the immediate future. The dwelling unit is approved for rental under Category 3 of the affordable housing guidelines in place as of this date. Rental income is intended to go to upgrading and maintenance of the unit and to funding improvements to the balance of the property.
Responsibility for renting and managing the property will remain with Pitkin County in cooperation with the Housing Authority. Dogs are prohibited from residing in the dwelling unit or within the dwelling unit property or anywhere else within the Elk Park Property.

A number of possible alternative uses of the dwelling unit building were discussed during the planning process. Future use of the dwelling unit for residence purposes may be restricted to persons directly involved in maintenance or management of the property as a whole. Other possible uses of the dwelling unit building included a visitor's information center or other public/office function. Conversion of the dwelling unit to these purposes will require specific amendment of this Master Plan.

4. FIREHOUSE

The Carbondale and Rural Fire District which serves the Redstone and Crystal River Valley had expressed an interest in relocating their fire house facilities from the northern end of Redstone Boulevard to the Elk Park property. The existing facility is too small and has access problems due to its location. The Elk Park property has been identified by the Fire District as the best available alternative site. The local community endorsed this relocation during the planning process and a footprint which will allow for a new building of 2,500 square feet has been reserved for future firehouse relocation. The building will be designed and built to be compatible with local architecture and will occupy the minimum space necessary to accommodate essential functions. The building will share the entryway off Highway 133 with the parking area discussed above. In addition, an area sufficient for parking 7-9 cars and parking emergency vehicles for washing, etc., is set aside. The location and area of this reservation is shown on the attached Site Plan.

The review, approval and construction of site-specific firehouse plans will be separate from this Master Plan and will be the sole responsibility of the Fire District when they are prepared to pursue relocation. This Master Plan simply reserves an appropriate building site but does not authorize any transfer of property ownership to the Fire District, nor does it require that site-specific plans be approved once they are submitted. Those plans may be rejected by the County if they are in any way incomplete, inadequate or in conflict with the requirements of the Land Use Code without such rejection constituting a violation of this Master Plan. The County anticipates that the Fire District will purchase or otherwise acquire access to the appropriate land area through a transaction (i.e. lease) with the County and that the proceeds from that transaction will be used to repay the County general fund and/or Open Space and Trails funds as may be appropriate at the time. Compliance with all applicable regulations and requirements at the time of application will be the responsibility of the Fire District.

While the reserved area remains undeveloped, this Master Plan calls for it to remain more or less in its current state, as a grassy lawn. No plantings or structures that would interfere with future fire house development are permitted. A sign designating the area as the future site of a relocated fire house is recommended pending confirmation from the Fire District that their plans have not changed. This Master Plan does not put a time limit on the reservation described. Should the Fire District change their plans or should new circumstances lead to reconsideration of this reservation, this Master Plan shall be formally amended to remove the reservation and establish other priorities for the reserved area.

5. NATURAL AREA, TRAILS AND FISHERMAN ACCESS POINTS

The undeveloped portion of the property will be left in a natural state or enhanced to restore it to a natural state. The management objective for the undeveloped portion of the property will be to manage it as a natural area with an emphasis on native plants and passive recreation. Existing vegetation may be removed to the extent that it is not native or compatible with this management objective but no such removal is required and any vegetation removed must be replaced with vegetation which is more in keeping with the objective. No major landscaping or earthmoving in this area is anticipated or authorized by this Master Plan. However, a landscaping and vegetation plan for the area may be necessary in the course of restoring this area to a more natural condition. The Pitkin County Open Space and Trails Program will oversee the production of such a plan if it is found to be necessary.

The attached Master Plan Plat designates a portion of the property as open space. This part of the property is within and a part of the Natural Area/Arboretum described above. This part of the property is attributable to the contribution of the Pitkin County Open Space and Trails Program to the original purchase. In exchange for that contribution, this portion of the property is set aside as open space under the terms, restrictions and conditions of the Open Space and Trails Program. This Master Plan has been reviewed and approved by the Open Space and Trails Program and constitutes the management plan for the open space portion of the property. This portion of the property may not be sold, exchanged or otherwise disposed of by the County without the consent of the Open Space and Trails Program and without following the procedures dictated by the policies and procedures of that Program. Moreover, any proposed changes to the open space part of the property for other purposes is prohibited unless specifically reviewed and approved by the County Open Space and Trails Board prior to implementation.

The undeveloped portions of the property may be the location of foot trails to allow for access through and around the property. These trails are conceptually located on the attached site plan. Trails will be designed and built to the lowest reasonable standard to allow for safe pedestrian access and trail maintenance. Trails will not be paved and will not be any wider than necessary to allow for safe and convenient use so as to minimize soil and plant disturbance and visual impacts. Trails are to be restricted to pedestrian use and horses, bicycles or other wheeled vehicles are to be prohibited. Trails may be sited and designed to provide for fisherman access to the Crystal River and Coal Creek but will not adversely impact riparian vegetation and habitat. Trails will not encroach on the area set aside for the dwelling unit so as to minimize conflict and preserve privacy on that portion of the property. Trails may be extended into and through the dwelling unit area if the dwelling unit and the surrounding area are converted to other uses through amendment to this Master Plan. The Open Space and Trails Program may take responsibility for the siting, design and development of trails and fisherman access points as described below, at its discretion. In any case, the Open Space and Trails Program will review and approve trails for location and design suitability prior to their installation.

One or more fisherman access points to the Crystal River may be developed simultaneously and in conjunction with trail development. These access points will be located and designed on-site in such as way as to minimize vegetation loss, erosion and loss of bank stability. That portion of the property within the Crystal River bed will be fully accessible to the public for fishing by way of the designated access points.

The undeveloped part of the property between the parking area, Coal Creek and the proposed bridge abutment may be the site of a small amphitheater sculpted into landforms from native or natural materials. This amphitheater will be designed so as to blend into, rather than overwhelm the site and to provide a small and informal gathering place rather than as a theatrical facility. The specific design and location of this feature is subject to further 1041 review prior to installation. It is recommended that if this feature is installed, it be done simultaneously with the bridge to the Redstone Town Park, in that the excavation for bridge abutments will also disturb the area identified as appropriate for the amphitheater.

The undeveloped area, with the exception of the area reserved for Open Space, may be the site of landscaping, minor earthmoving, plantings, picnic tables, trash containers, informational or directional signs, and low-key lighting to provide guidance to and from important facilities such as the parking area and the bridge. Overall, improvements to this area are to be compatible with, or to enhance, the natural setting.

6. BRIDGE OVER COAL CREEK

There is a possibility that the property along the Crystal River to the north of the Elk Park Property and north of Coal Creek may be accessible to the public in the future. This property is currently privately owned but its proximity to Highway 133 to the west and the Crystal River to the east minimize its development potential. This property is the site of a valuable and attractive native riparian area. If it is acquired by a public entity in the future or if a private owner makes it available for public use and access, it would be appropriate to provide for pedestrian access to this area from Elk Park. This Master Plan authorizes the installation of a bridge over Coal Creek to provide this access in a manner that is free from conflicts with traffic along Highway 133 subject to project-specific review and approval. No site specific investigations have been made regarding this bridge due to the current unavailability of the downstream property, but this Master Plan designates and reserves an appropriate area at the northwestern corner of the Elk Park property for a potential future bridge abutment site.

V. DESIGN and USE STANDARDS

The Master Plan process revealed a strong concern in the community of Redstone that the development of Elk Park enhance and compliment the unique architectural and scenic qualities that characterize the Redstone area. For that reason, the following design guidelines are suggested to assure that development and use of Elk Park is consistent with existing community and natural features.

1. Firehouse

There have been suggestions that the firehouse be designed in a manner consistent with the old railroad depot that once stood on the site. A photo of this depot is attached for reference. The architecture of this depot was consistent with that of the Redstone Inn, the Osgood Mansion and many other buildings dating from Redstone's origin. While this design may not be completely compatible with the needs of a modern firehouse facility, it is strongly suggested that the architecture of a new firehouse echo, to the extent possible, the architectural theme and scale of the historic community. It is clear that a completely functional facility, such as the one in use on Redstone Boulevard, would be inconsistent with the community's priority for making Elk Park an attractive gateway to the community.

The Community has expressed a strong interest in making a new fire house facility available and useful to the public for gatherings and activities. This Master Plan endorses such use on the condition that such uses do not compromise fire house utility and on the condition that the footprint and overall bulk of the fire house are not significantly enlarged to accommodate such uses. The central location of the fire house via the bridge to the

Town Park, its large size and public status would make it a reasonable location for such activities as town meetings or other local group gatherings. It would not be appropriate, however to design the building for those uses rather than for the primary public safety use to such uses must be limited to those which clearly do not interfere with that primary use.

2. Parking Area:

While it will probably not be possible to completely shield this facility from passers-by, it is important to include extensive landscaping and earthwork into its design to mitigate visual impacts. These mitigating measures are suggested in the attached site plan. A moderate berm, planted with native vegetation, along Highway 133 is suggested, as is a landscaped median within the lot. Landforms and plantings on the periphery of the parking area are also suggested as a means of softening the visual impact and improving the environment immediately surrounding the parking area. The County will developing a landscaping plan as an element of specific engineering and construction plans for the Parking Area. This landscaping and revegetation plan is to be submitted for review by the Community Development and Land Management Departments prior to issuance of a building permit.

The Parking Area includes an area suitable for future expansion if necessary. The County will be responsible for approving and implementing this expansion if and when the use of the parking area dictates. The Parking area also allows room for a RFTA pickup spot, and a dumpster/trash container location. See the attached Conceptual Site Plan for specific suggested locations of these features. This Master Plan approves the installation of such features but their final location and design may be varied depending on site conditions.

3. Bridge(s)

The bridge which is being stored on site as of the date of this Master Plan is acknowledged to be functionally adequate but physically unattractive. There have been discussions in the Redstone community regarding the potential to modify this bridge to make it more attractive. Among the suggestions are to sandblast or paint the surface of the bridge, to cut out portions of the sidewalls to reduce the bridge's solid and opaque profile,and to put a roof or railings on the bridge to improve safety and visual charm. Any of these suggestions would need to be evaluated to assure that they would not compromise the structural integrity of the bridge. Also some or all of these modifications may make the bridge more expensive than a completely new bridge built and designed to specifications. The location of the bridge will make it a significant visual feature as it will be fully visible to passers-by on Highway 133 and to users of the Town Park. Despite the utilitarian nature of the bridge and its importance to the utility of the Parking Area as an effective traffic-reduction feature, it is important to recognize its scenic importance and to assure that it is physically attractive.

4.Natural Area, Trails and Fisherman Access Points

These features are discussed above in terms of their compatibility with native vegetation and low-impact facilities. At the same time, it is important that designs and installation be pursued with an eye towards low maintenance costs and low use impacts. The Pitkin County Trails Design and Management Handbook can be of use in making site-specific trails location and design decisions. All vegetation and trail improvements should be consistent with the maintenance of a natural and self-sustaining environment and should not require permanent new investment in irrigation systems, lawn or garden care equipment, weed or pest control, drainage structures, traffic control facilities or safety equipment.

It is anticipated that the trails on the property will be built to the lowest reasonable standard for pedestrian use and that all other uses by bicycles, equestrians, in-line skates or other non-motorized means will be forbidden. Also, it is anticipated that access to and use of the open areas and trails will be limited to daylight hours and that camping, open fires, organized sports or other high-impact uses will also be forbidden. This Master Plan approves minor improvements and amenities aimed at maintaining and improving low - impact uses, such as botanical labels, drainage and erosion-control improvements, picnic tables, trash containers, and placement of rocks or vegetation to define pathways or use areas.

5. Dwelling Unit

No significant changes or modifications to the dwelling unit are contemplated or approved by this Master Plan. It is anticipated that minor and cosmetic modifications to the unit for maintenance purposes will be made, but no changes to the floor plan, exterior footprint, exterior color, existing vegetation or basic structure are permitted. To the extent that maintenance is required, it will be consistent with these restrictions except insofar as it may be required to maintain the safety and habitability of the unit. Major changes to the unit, such as upgrading of the septic system, electrical system or insulation, will be the responsibility of the County.

The dwelling unit will be deed restricted to Category 3 from the Affordable Housing Guidelines applicable as of the date of this Master Plan. A deed restriction confirming this status will be submitted to the Housing Office prior to the commencement of any project construction. Occupancy of the residence may, at the County's discretion, be limited to a person or persons employed by the County or another public agency with the responsibility for safety, maintenance or other public service functions in the Elk Park, Redstone or Crystal River Valley areas. The lease, and management of the lease to the unit and relations with the occupants of the unit shall be the responsibility of the County. In addition, in recognition of the location of the dwelling unit within the 100-year floodplain, the County will obtain and carry flood insurance for the unit. Documentation of adequate flood insurance will be provided by the County prior to any construction on the property. The dwelling unit shall be used as a residence until such time as that use is changed through an amendment to this Master Plan.

5. Miscellaneous

A. Signs: The Elk Park Property has been identified as an appropriate location for signs which would provide a map of Redstone and describe the social and environmental history of the Crystal River Valley. These signs have been designed and manufactured with the cooperation of the U.S. Forest Service and the Scenic Byway Committee of the Colorado Department of Transportation. The Scenic Byway Committee is charged with overseeing the development of Scenic Byway features for Colorado State Highway 133. One site near the bridge to the Redstone Town Park has been identified as appropriate for sign placement (see Conceptual Site Plan Map). Others may be identified as Park development proceeds. All signs will be placed so as not to be visible from travelers on Highway 133. Signs will be screened from highway view through the use of vegetation and landforms. All signs will be designed and installed in conformance with the Pitkin County sign code or in conformance with officially authorized variances to that code. Applications for any variances that might be required pursuant to sign design and placement will be the responsibility of the Scenic Byway Committee.

B. Lighting : Lighting of the site will be the minimum necessary to allow for safe access to and from Elk Park features. Lighting is approved for ingress and egress points which will include driveways into the property and into such features as the Parking Area and Bridge(s). Trails, fisherman access points, natural areas or other undeveloped areas will not be lit. All lights will be low to the ground and shielded from the Highway 133 Right of Way. No landscape or facade lighting will be installed. Exterior lights in and around the dwelling unit are likewise restricted and limited to those necessary to provide for safe access to and from the unit.

C. Footbridge: The small footbridge at the southern end of the property is within the dwelling unit envelope and is not open to public use. This footbridge is currently closed to all traffic due to structural instability. The County Risk Manager will inspect this footbridge and evaluate its safety prior to the issuance of any construction permits for the property. Following this findings of the Risk Manager, a determination will be made regarding rehabilitation or demolition of the footbridge. In the interim, signage and the Master Plan Plat will indicate that the footbridge is not open for public use.

VI. EXHIBITS

1. Resolution No. 96- 212 Granting Approval of a 1041 Hazard Review for Elk Park

2. Ordinance No. 96- 31 Granting Approval of a Master Plan and Rezoning of Elk Park From Village Commercial to Public

3. Conceptual Site Plan

4. Master Plan Plat

5. Crystal River Bridge Preliminary Engineering, Army Corps of Engineers Correspondence and Flood Plain Data.

COAL BASIN AND CRYSTAL RIVER CONFLUENCE AREA WORKSHOP

Coal Creek Restoration
ROARING FORK WATERSHED PLAN was here

PITKIN COUNTY
Healthy Rivers and Streams Board

Thank You

Colorado Division of Reclamation Mining & Safety

CVEPA

Open Space and Trails
Pitkin County

Roaring Fork Conservancy

Kootenay Resources, LLC

Pitkin County
Healthy Rivers and Streams Board

Forest Service
U S
Department of Agriculture

BIOCHAR SOLUTIONS

Colorado • Parks • Wildlife

Colorado Mesa University

ASPEN SNOWMASS
THE DIFFERENCE IS NIGHT & DAY

Upland, Riparian, Instream Restoration Project

Overall project goal is to integrate and complete projects to:

- Improve riparian area function/wildlife value
- Balance sediment budget
- Improve upland vegetation to stabilize soils
- Improve instream habitat and fisheries
- Address water quality issues
- Protect Redstone from flood flow damages
- Increase late summer flows


Confluence of Coal and Dutch Creek
July 3, 2009

Coal Basin History;
Geology, Mining, Reclamation

You have to know the past to understand the future

- Carl Sagan

Geology and Coal Basin

- Welcome to planet Earth, a wonderful but not entirely stable place to live."
  -Craig Childs

- Mancos Shale; Cretaceous deep ocean, fine grained sediment;
- MesaVerde Formation
  - Late Cretaceous inter-coastal and near coast inter-bedded coal, sandstone shale development
- Nearby Elk Mountains mountain building pushes sediments upwards

Geology and Coal Basin

- -Following mountain building episodes, erosion and mass wasting become dominant land-forming processes in Coal Basin.
  - Dutch Creek debris flows
  - Incised creeks
  - Sediment laden runoff

- Physical geography and geology are inseparable scientific twins. Sir Roderick Murchison, 1857

Coal Basin History

- Late 1800's
  - John Osgood develops Coal Basin Mine
    - Located near headwaters of Coal Creek
  - Coal Basin Mine operates until about 1908
    - Rail and town site remnants still visible
    - Coal refuse located in and adjacent to Coal Creek floodplain

Coal Basin History

- 1956 Mid Continent Coal and Coke Company begins operations;
- Underground mining and coal cleaning operations;
- Five underground mines developed over span of about 10 years;
- Operations cease in 1991

Coal Basin History

- Each mine built at about 10,000 elevation;
- Each mine had about 4 entries and fan entries;
- Entry areas (face-up) developed by excavating mountain to create highwalls;
  - waste downcast over slope;
- Coal mined by room and pillar and longwall methods;

Coal Basin History

- Coal hauled from entries to preparation plant for cleaning;
- Need for facilities space and coal refuse deposition results in channelization of Dutch Creek;
- About 15 miles of haul roads;
- Over-the-road hauling substantially replaced by Rock Tunnel beltline system in mid-’80’s;

Coal Basin History

- Continued coal cleaning requires construction of (second large) Sutey Coal Refuse Disposal Facility;

- Mine makes water. In later years mine water discharged at Rock Tunnel entry to treatment ponds;

Coal Basin History

- 1977 Federal Surface Mining Control and Reclamation Act (SMCRA) enacted;
  - State Primacy;
- About 1984 Mid-Continent Resources issued a permit by Colorado;
- Numerous operational and environmental issues;
- Numerous citizen complaints

Coal Basin History

- From late ‘80’s through 1993, lots of Federal / State / Company / Local Public Interest Group jostling to resolve site issues.
- A story unto itself, the upshot is:

Coal Basin History

- MCR files bankruptcy in February, 1992;
- The operating permit is revoked in August, 1992, MCR ordered to complete reclamation;
- Reclamation bond is forfeit by Colorado in September, 1993;
- First of a number of lawsuits between State and MCR initiates in September, 1993;
- State begins reclamation work in 1994.

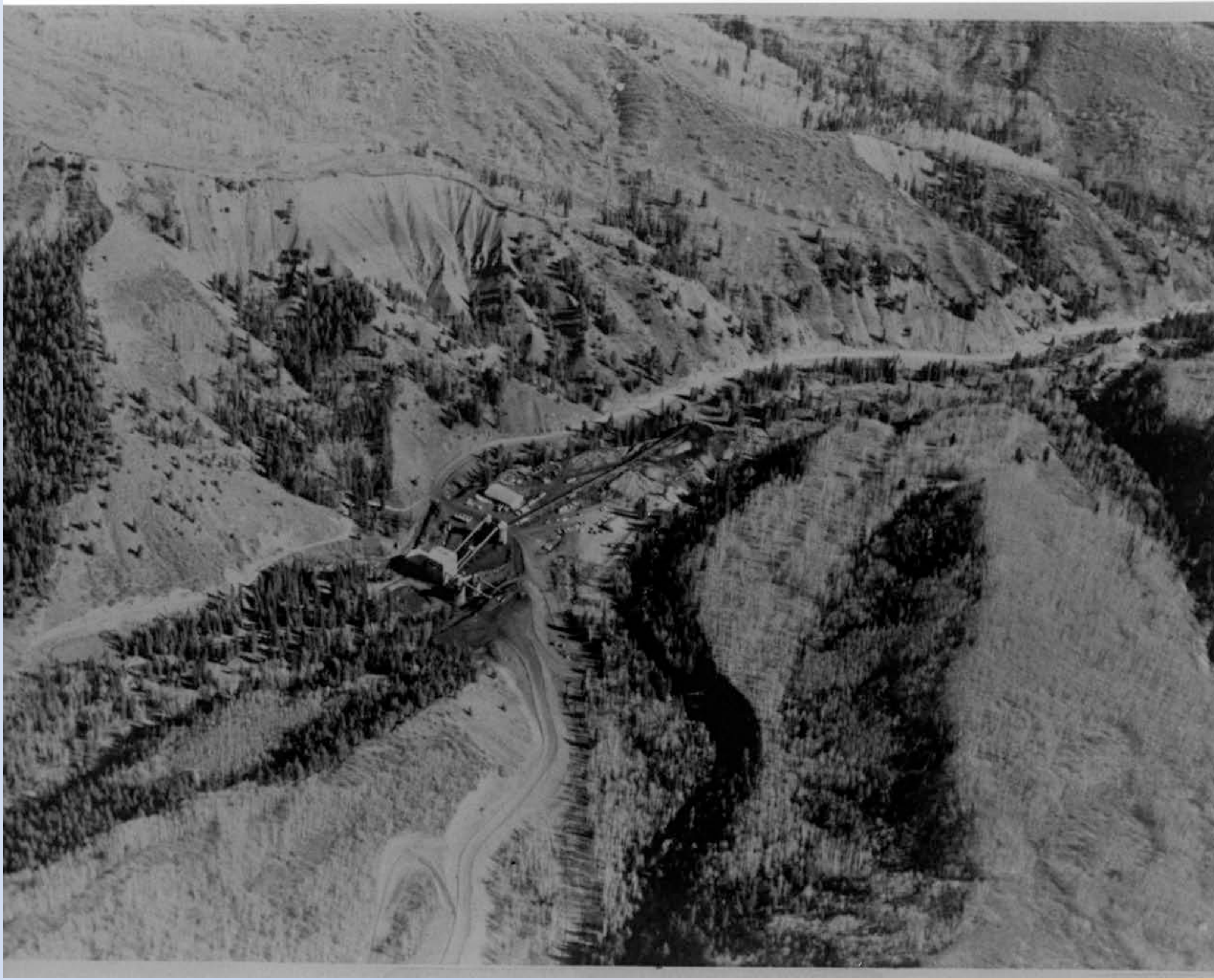
Coal Basin Environmental History

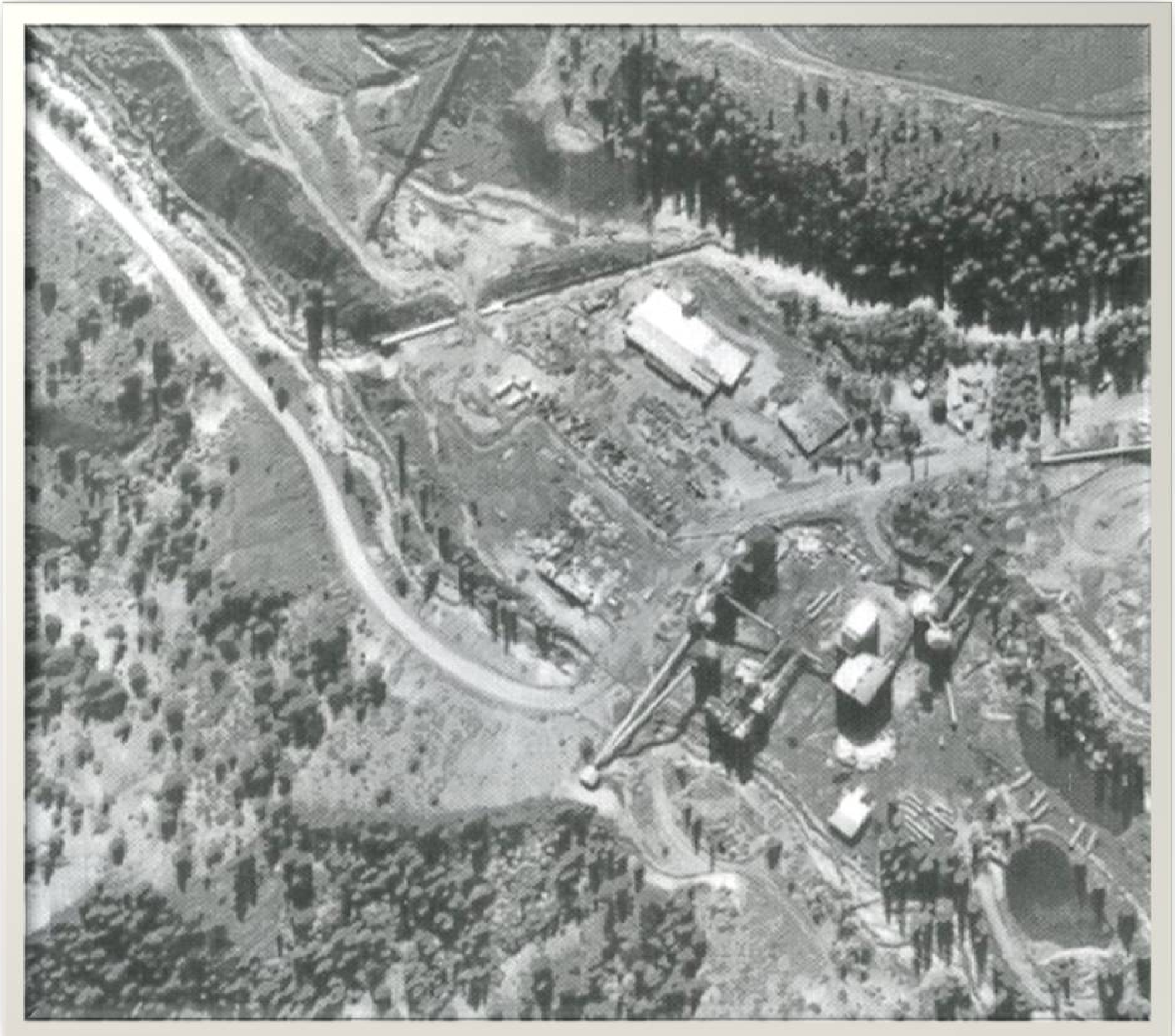
Environmental Issues Driving Reclamation

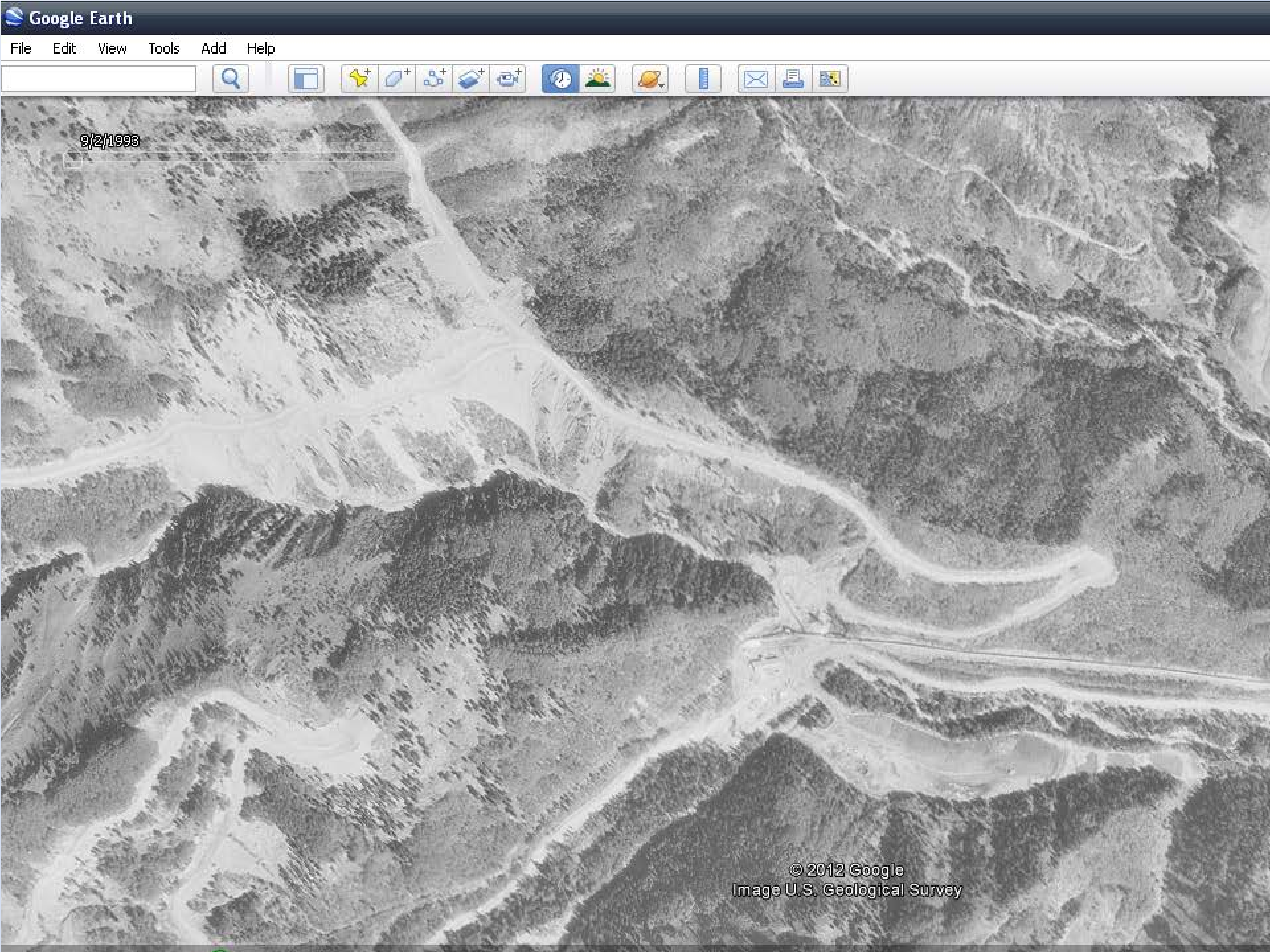
- Sedimentation from Mining Related Facilities
  - Road System
  - Facilities Area (Confluence Coal and Dutch Creeks)
  - Mine Bench Outslopes
  - Coal Basin Town Refuse

Coal Basin Environmental History Environmental Issues Driving Reclamation

- ‘Contaminants’
  - Underground Storage Tanks
  - Diesel Stained Soils;
- Old Refuse Pile Instability (Confluence Coal and Dutch Creeks);
- Dutch Creek Diversion Instability






Google Earth
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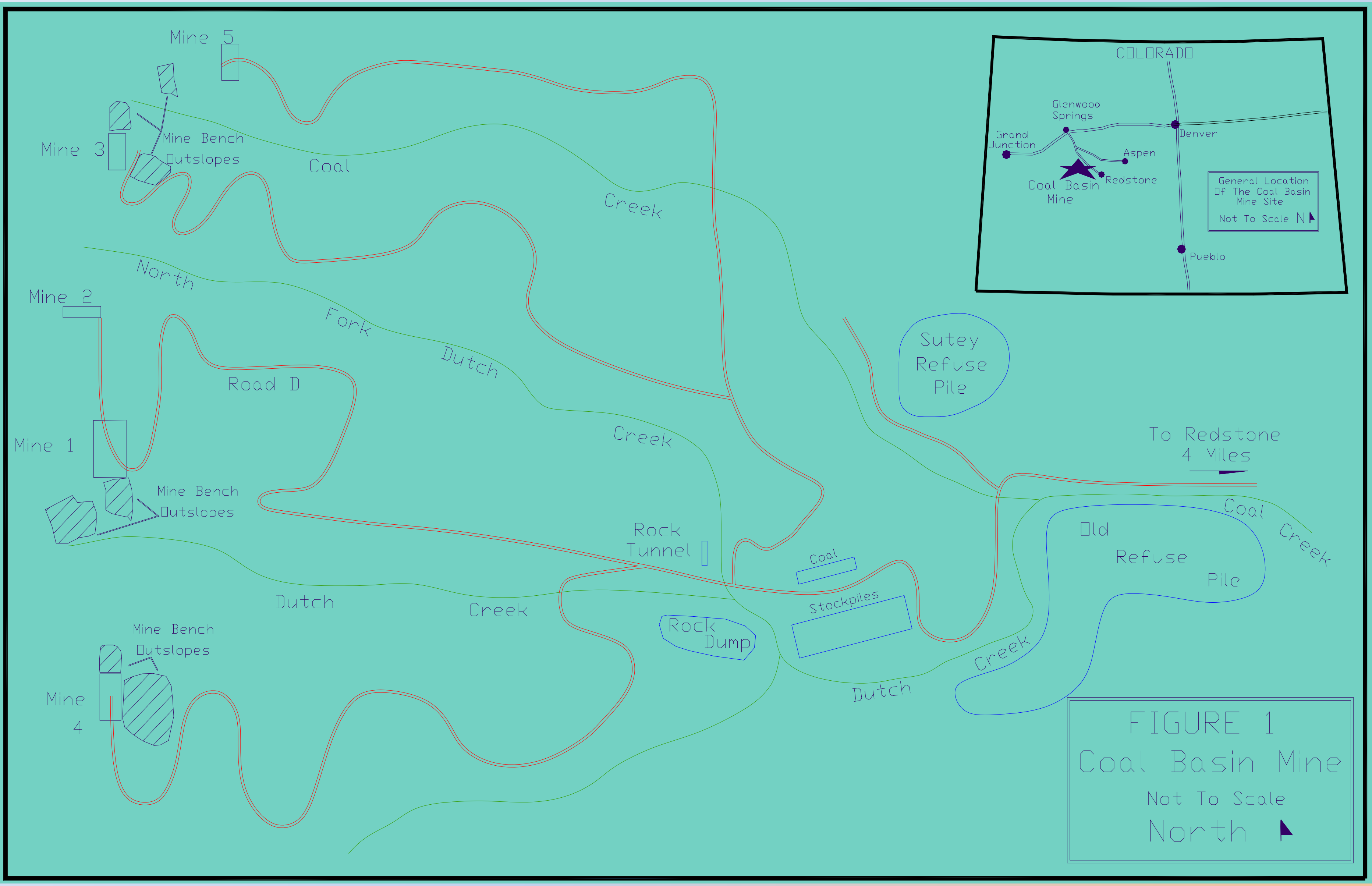
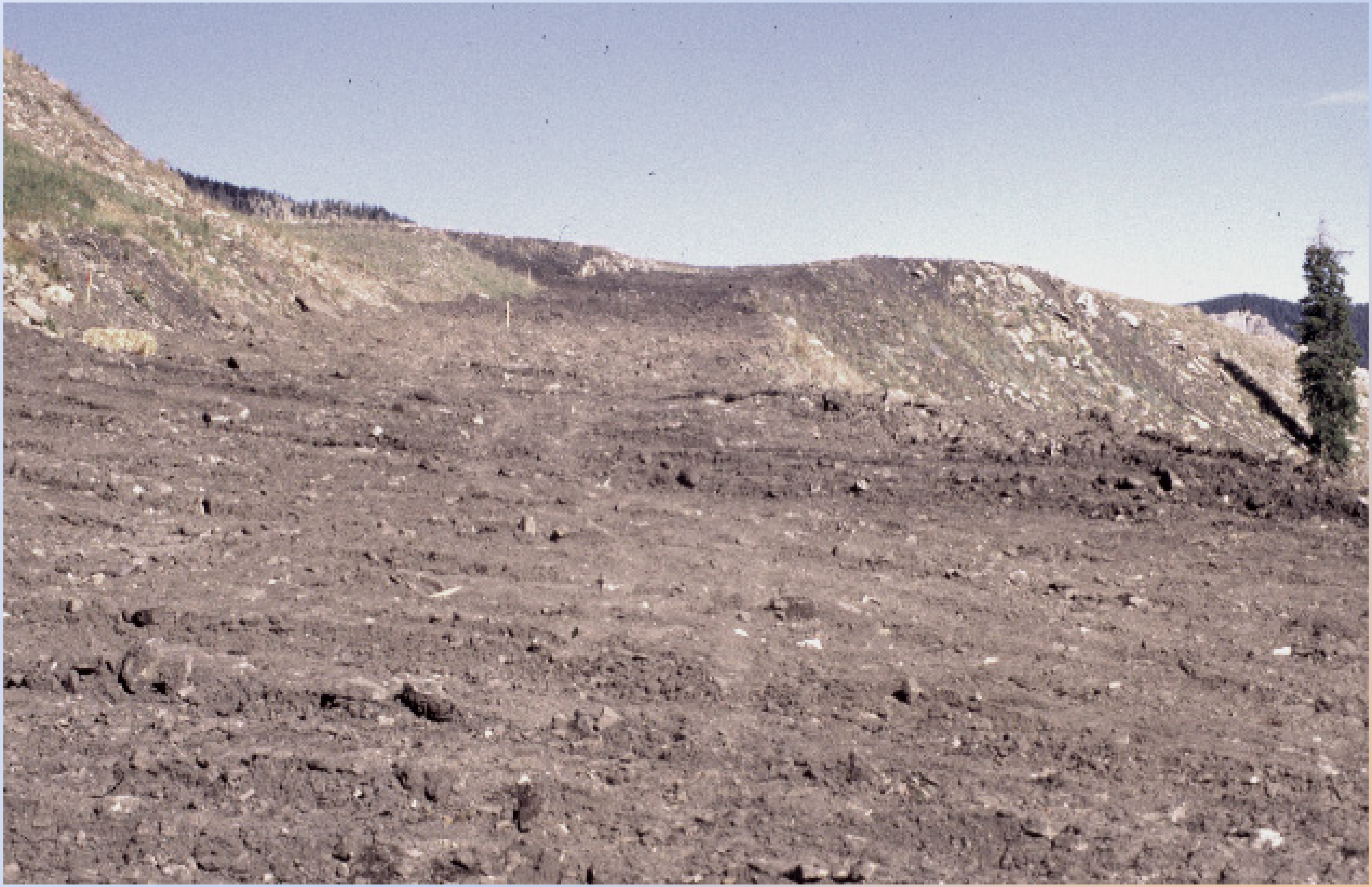
9/2/1993
© 2012 Google
Image U.S. Geological Survey

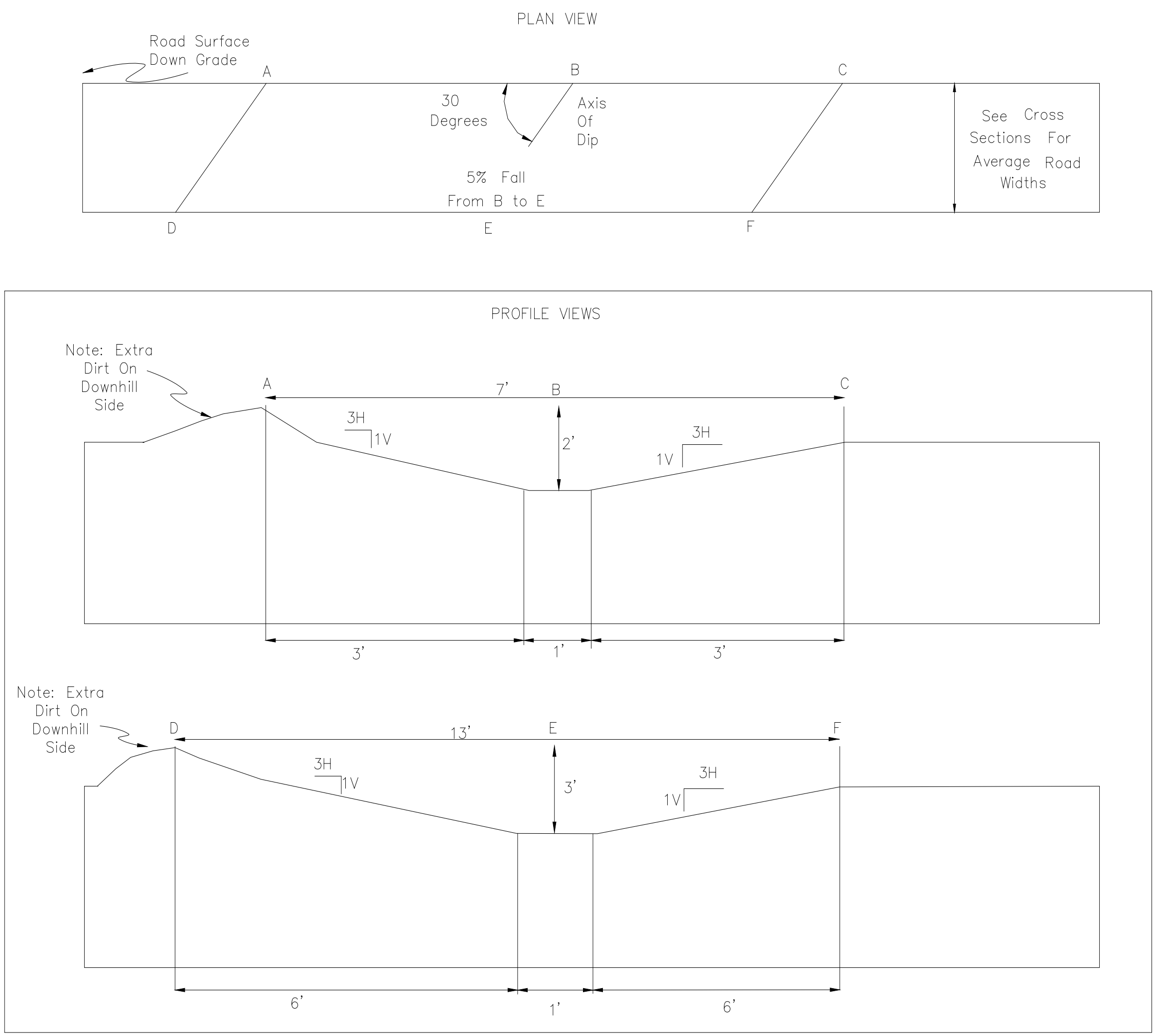

COLORADO
Glenwood Springs
Grand Junction
Denver
Aspen
Redstone
Coal Basin Mine
Pueblo
General Location Of The Coal Basin Mine Site
Not To Scale N
Mine 5
Mine 3
Mine Bench Outslopes
Coal
Creek
North
Fork
Dutch
Creek
Mine 2
Road D
Mine 1
Mine Bench Outslopes
Sutey Refuse Pile
To Redstone 4 Miles
Rock Tunnel
Coal
Stockpiles
Old Refuse Pile
Coal
Creek
Dutch
Creek
Rock Dump
Creek
Dutch
Mine Bench Outslopes
Mine 4
FIGURE 1
Coal Basin Mine
Not To Scale
North

Coal Basin Environmental History

- Road Reclamation



Rolled Dip Construction



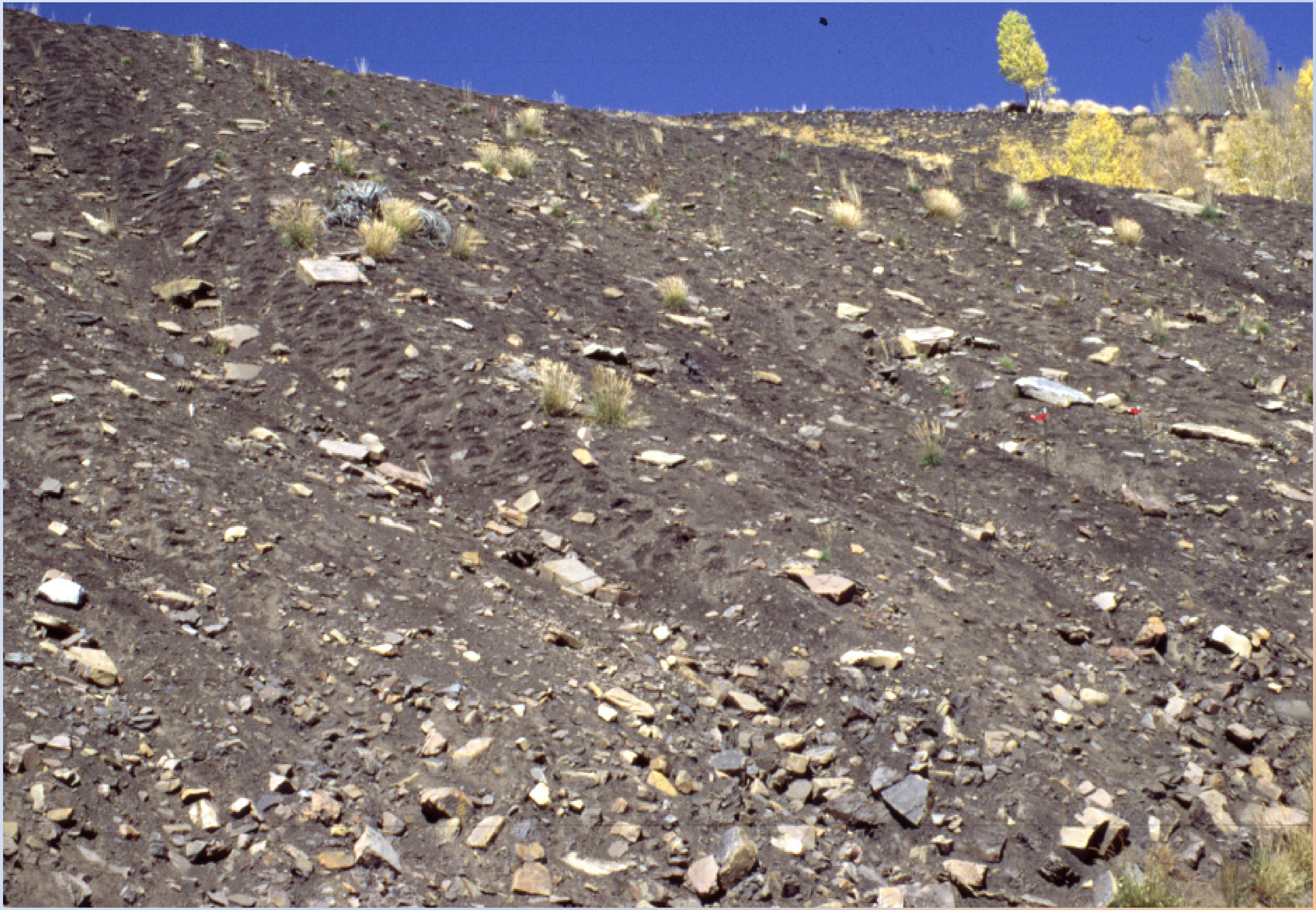
Coal Basin Environmental History

- Mine Entry Area Reclamation

Coal Basin Environmental History

- Mine Bench Outslope Reclamation


WESTERN
STATES

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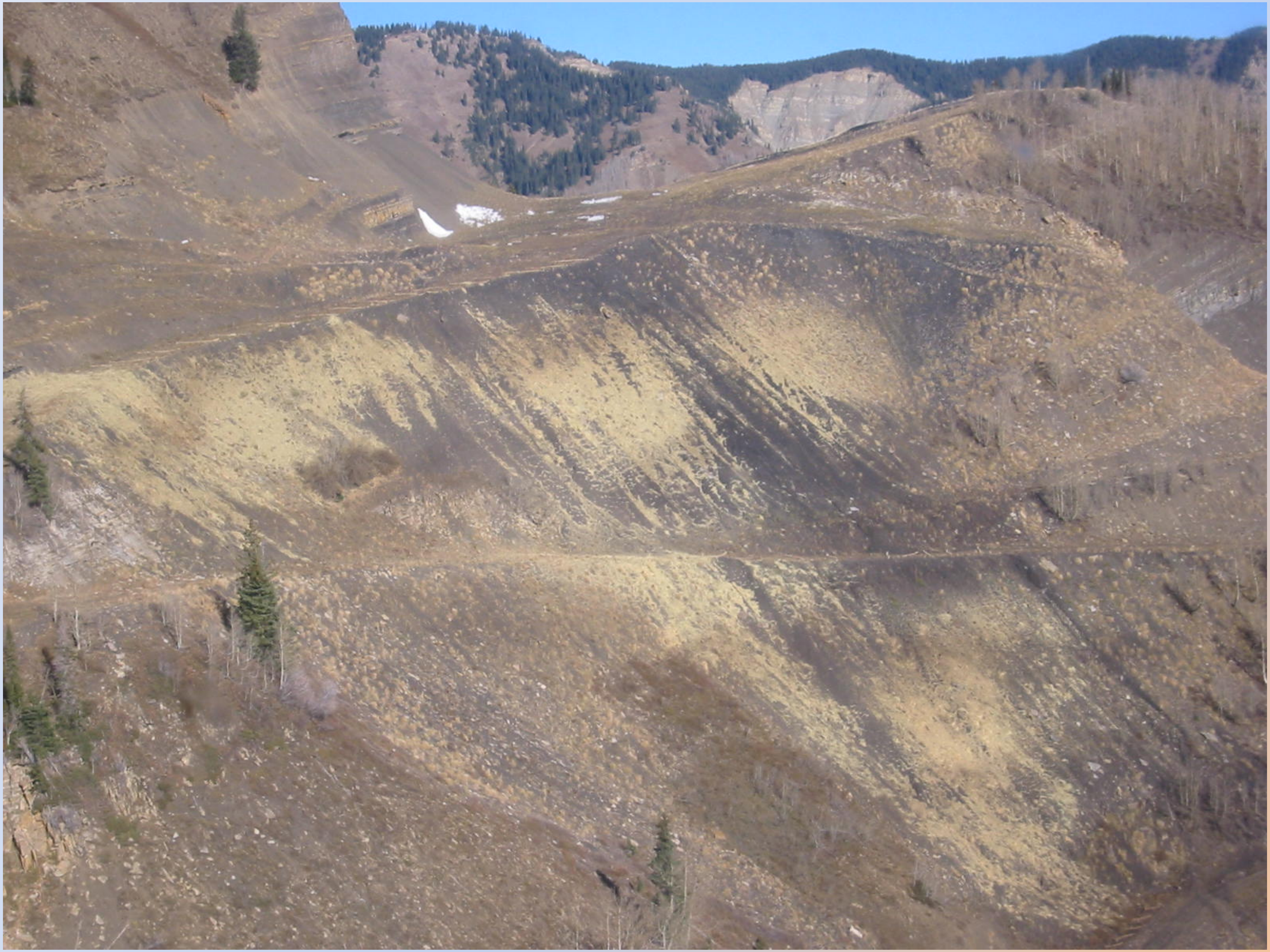
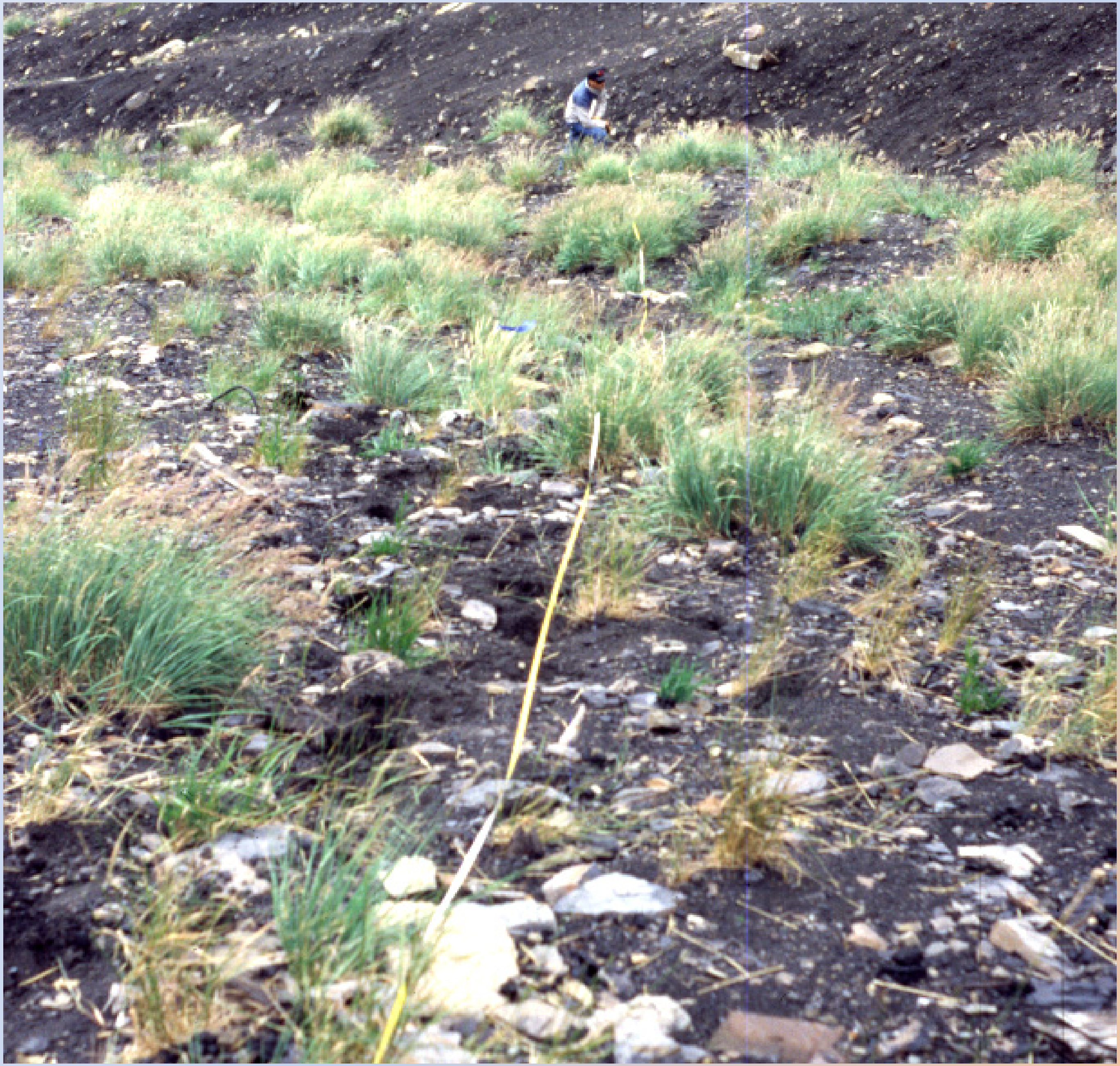




Coal Basin Environmental History

- Facilities Area and Dutch Creek Diversion Reclamation

Coal Basin Environmental History

- Refuse Pile and Other Sediment Control Reclamation Projects

Reclamation Funding

Primary Reclamation Funding

- Reclamation Bond @ $2.5 Million
- Work in Lieu of Cash @ $500,000

- TOTAL @ $3,000,000

Supplemental Funding

- OSM Civil Penalty Grant (Dutch Creek Diversion) @ $110,000;
- AML Fund (Old Refuse Pile) @ $437,000;
- AML Fund (Coal Basin Town Refuse Pile) @ $135,000;
- CWA (319) Fund (Outslopes) @ $196,000;
- USFS, WRNF (Outslopes) @ $50,000;
- Colo. Dept. Ag (Weed Control) @ $ 6,000

- TOTAL @ $934,000

Coal Basin Environmental History

- My Soap Box (What I’ve Learned):
  - Understand the Environment at Coal Basin and Work With its Unique Character;
  - Exceptionally Dynamic and Mobile System;
  - Graze Only After Substantial Maturity and Diversity Established;

Coal Basin Environmental History

- My Soap Box (What I’ve Learned), Cont’d:
  - Build Micro Climates;
  - Disperse Water at Every Opportunity;
  - “Soils” and Remnant Refuse Respond to Addition of Organic Matter;

Water Quality

Russ Walker, Ph.D.
Professor , Environmental Science
Head, Dept. of Physical & Environmental Sciences
Colorado Mesa University

Evaluation of Water Quality

- Approach
  - Compare observations with standards promulgated by the Colorado Water Quality Control Commission
  - Look for trends in time
  - Look for differences between sites
  - Look for other patterns
  - Look for consistency with expectations

Evaluation of Water Quality

- Available data
  - Bear Creek
  - Four sites on Coal Creek
  - Seven sites on Crystal River
  - Several sites with few observation dates
  - ~196,000 cells in spreadsheet (but many are blank)
- Data collected by USGS, USFS, CDPHE, and CDOW

Evaluation of Water Quality

- Tools for analysis
  - Excel for calculation of hardness-dependent, pH-dependent, and temperature-dependent standards
  - WQSTAT+ for time series, histograms, box plots, Mann-Kendall trend, Wilcoxon rank sum, seasonality

Evaluation of Water Quality

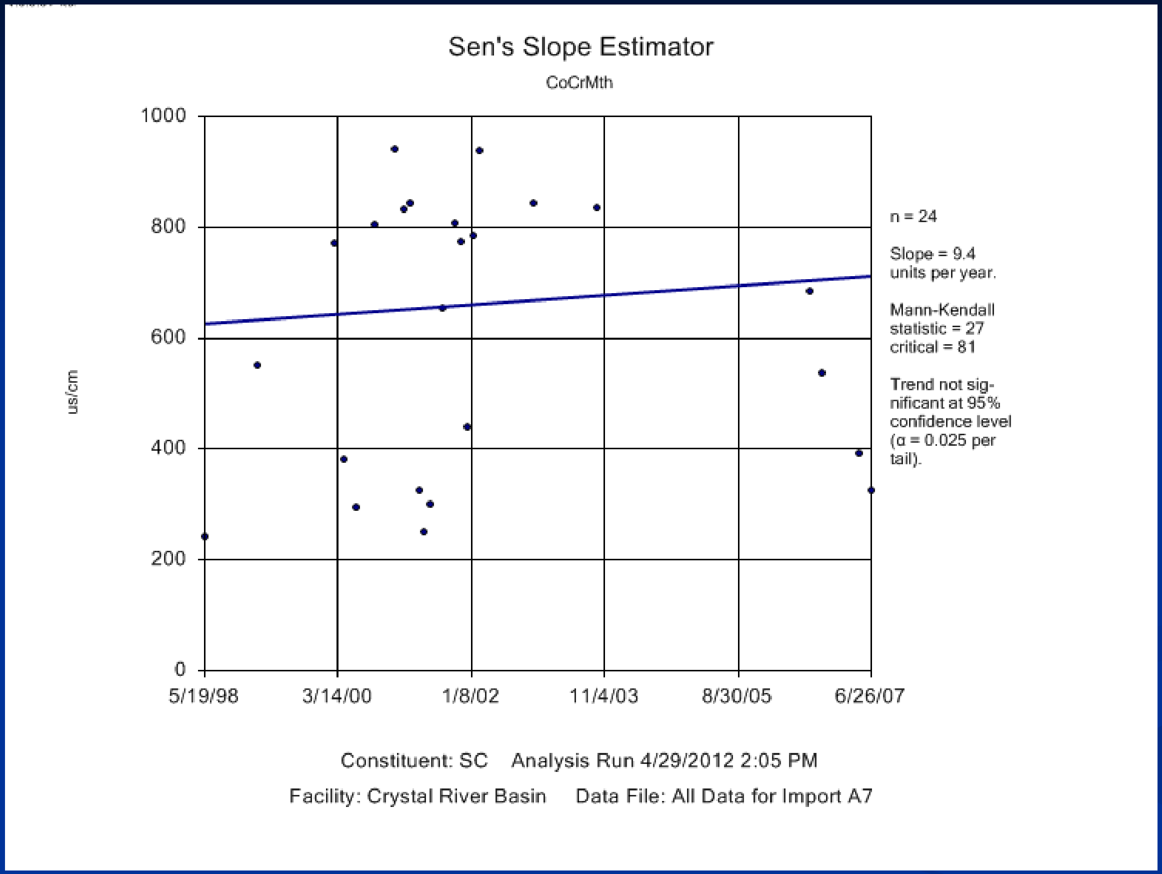
- What determines water quality?
  - Geochemistry of the watershed
  - Point source discharges directly to streams
  - Non-point sources anywhere in watershed

Water Quality Standards

- Notable observations:
  - DO < 6 mg/L on 25 dates from 1995-1997 in Crystal River at Penny Hot Springs
  - 7 pH values > 9 on 5 dates at 5 sites
  - 57 values of iron > 1000 µg/L
    - 5 in Crystal River above Coal Creek
    - 10 in Coal Creek above Redstone
    - 42 in Crystal River downstream of Coal Creek

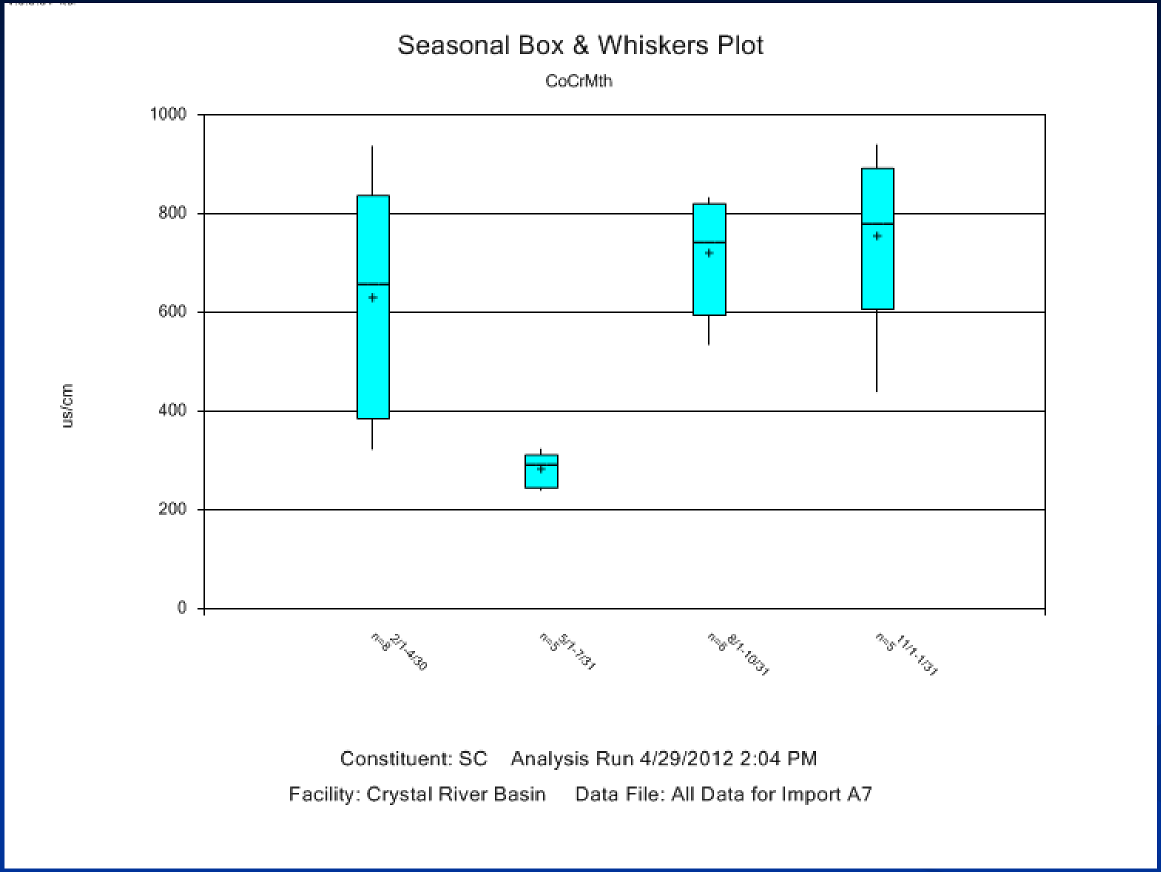
Water Quality Standards

- Notable observations:
  - Copper > hardness-dependent standard of 8 µg/L in Coal Creek on one date
  - Selenium > chronic standard of 4.8 µg/L in Coal Creek on 2 dates (1995-1996) and in Crystal River below Redstone on 4 dates in 2000



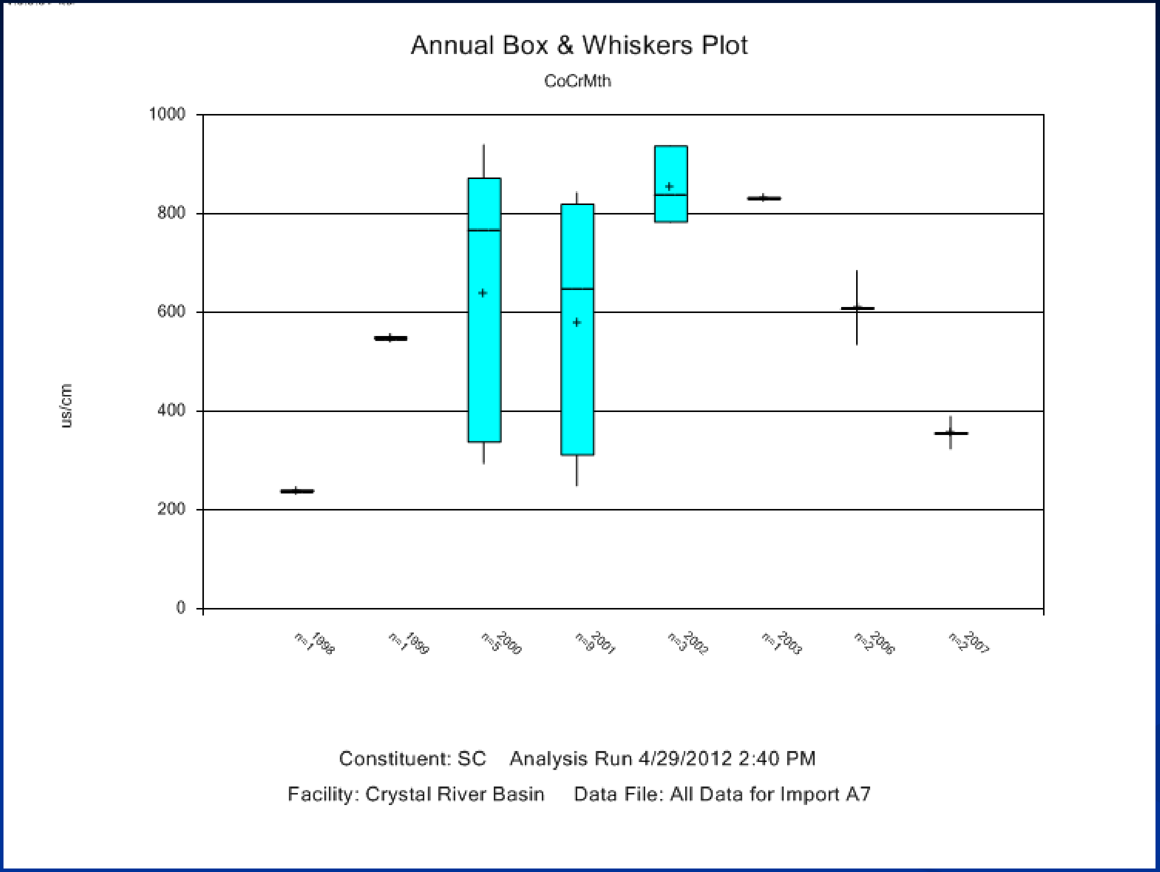
Coal Creek above Crystal River

Specific conductance over time



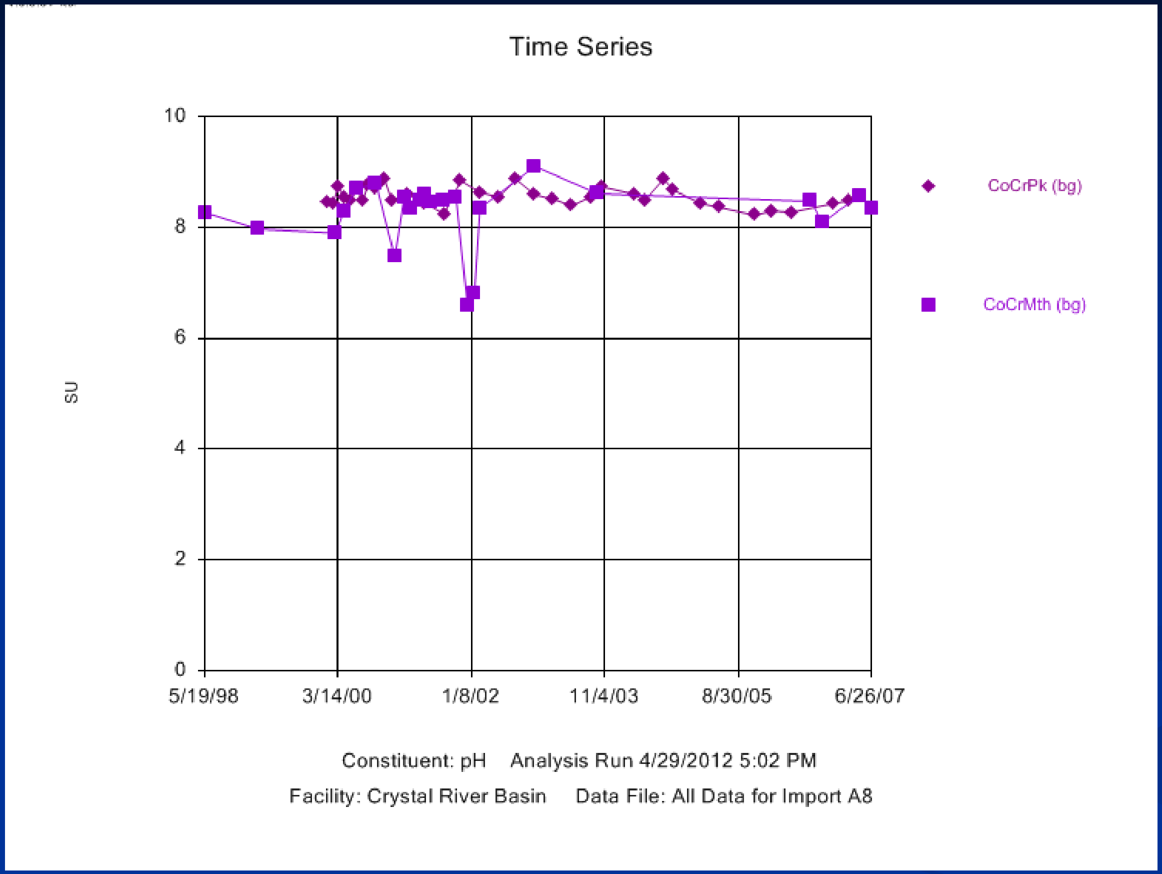
Coal Creek above Crystal River

Specific conductance by season



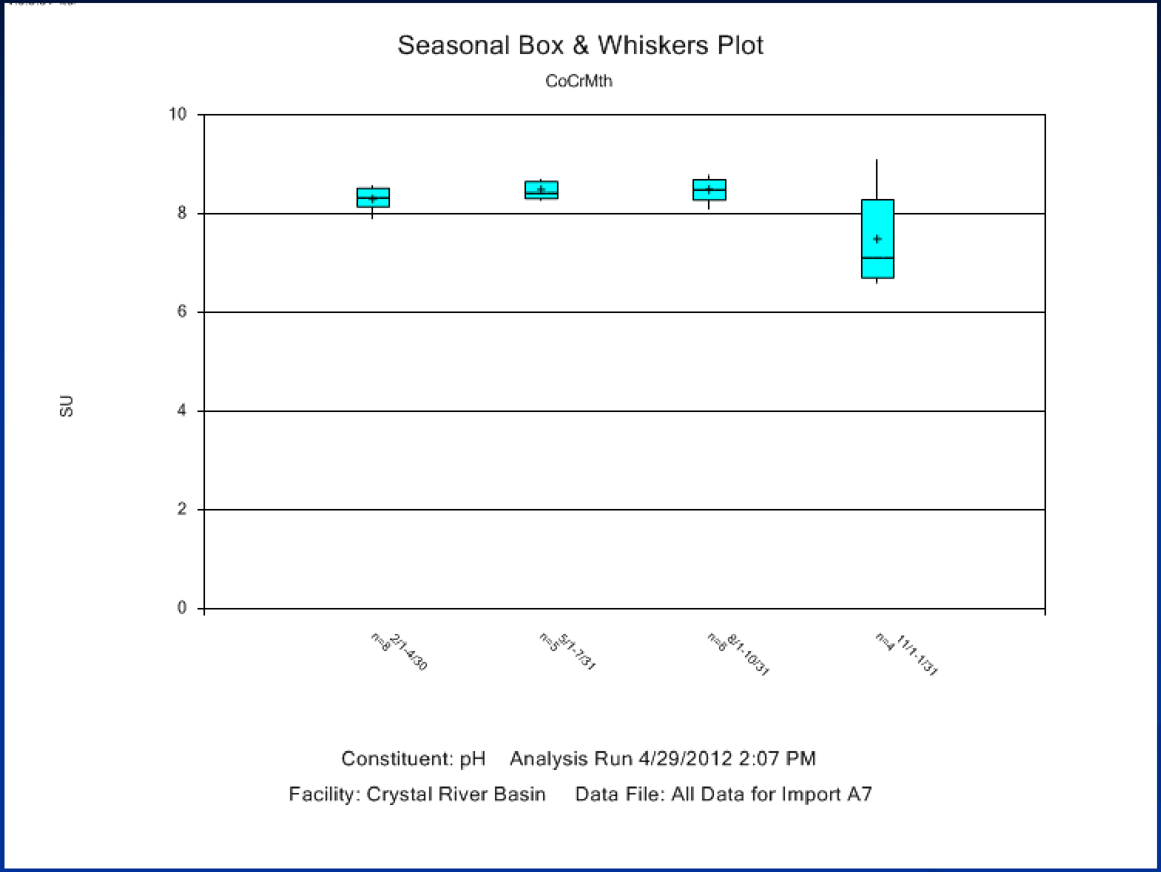
Coal Creek above Crystal River

Specific conductance by year



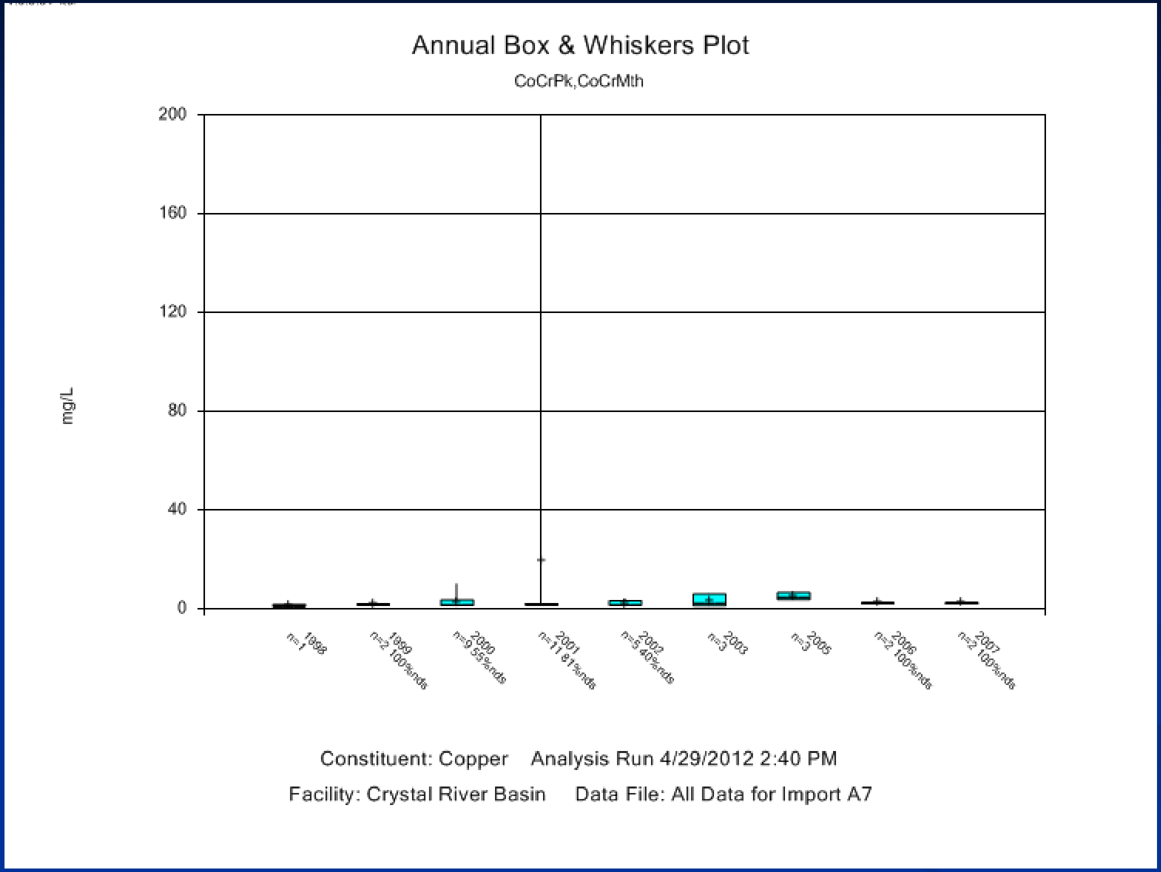
Coal Creek above Crystal River

pH over time



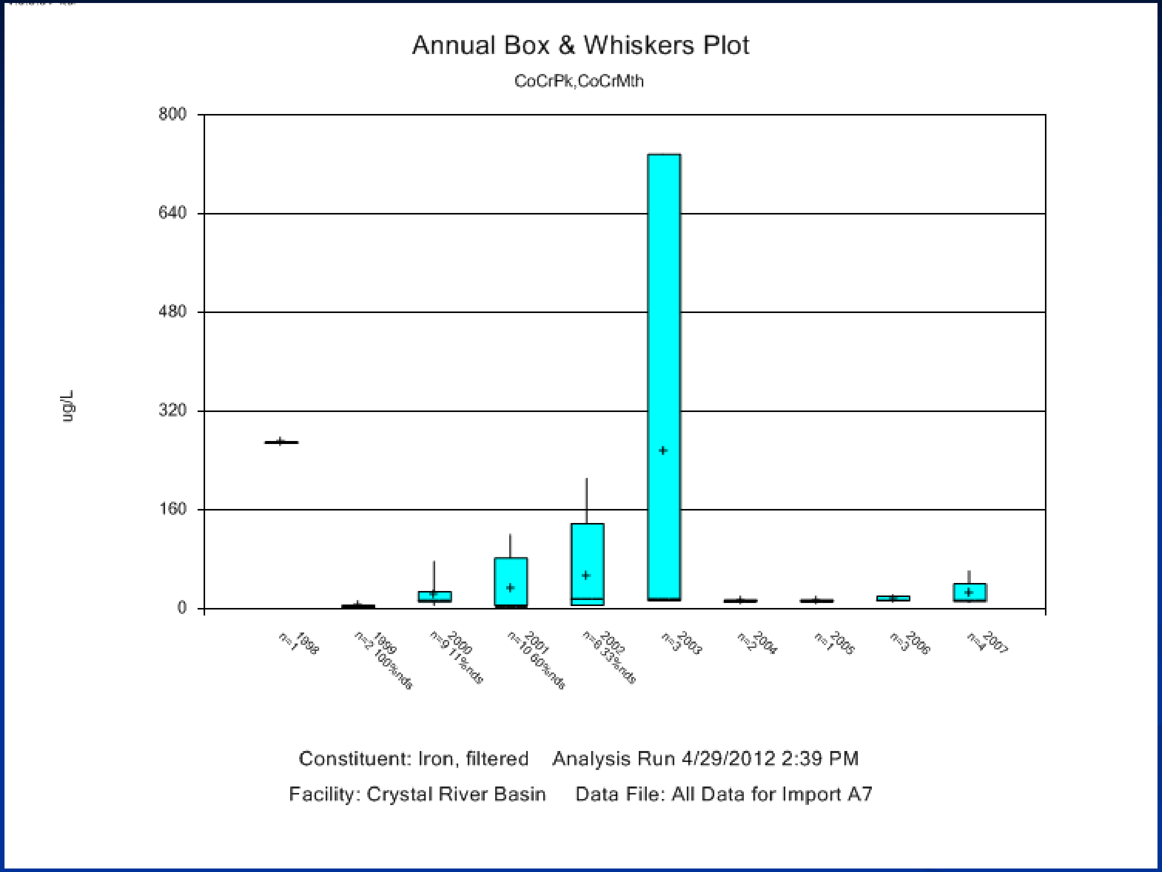
Coal Creek above Crystal River

Seasonal pH



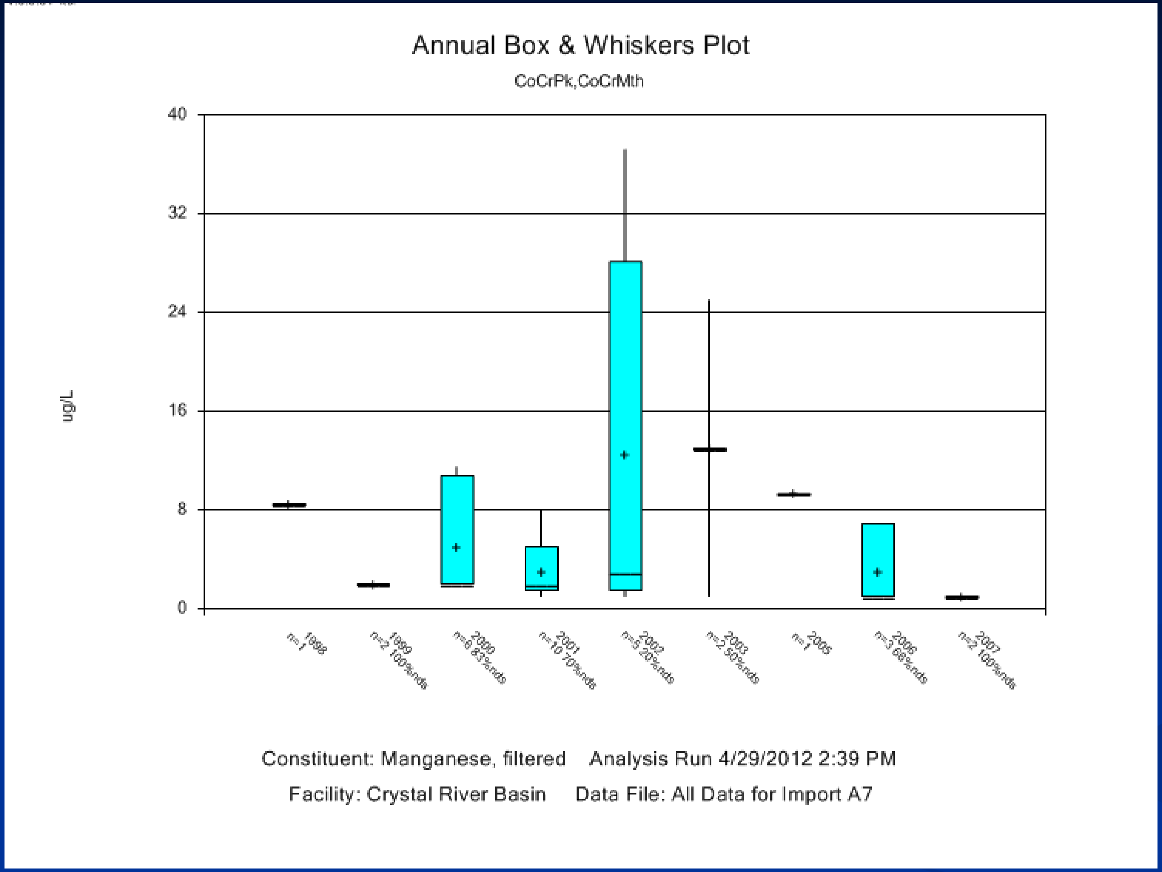
Coal Creek above Crystal River

Copper by year



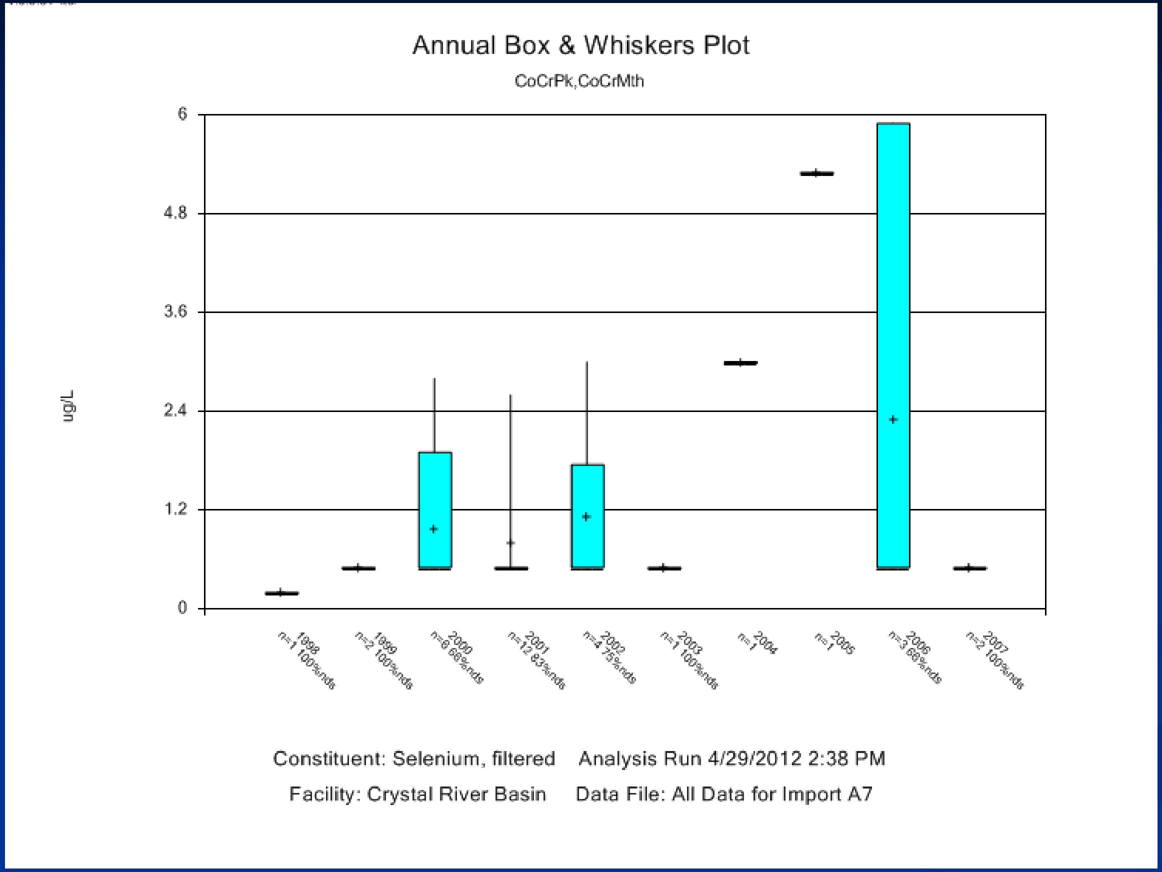
Coal Creek above Crystal River

Iron by year



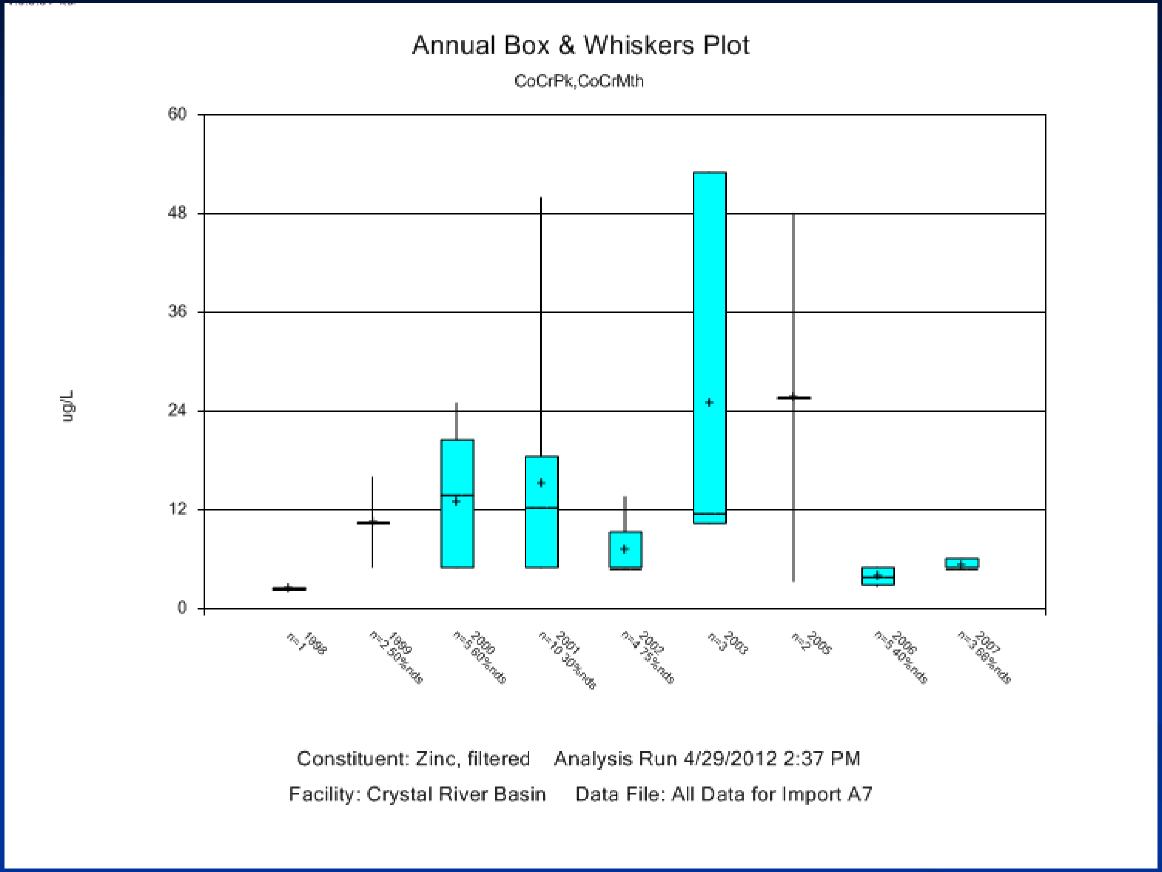
Coal Creek above Crystal River

Manganese by year



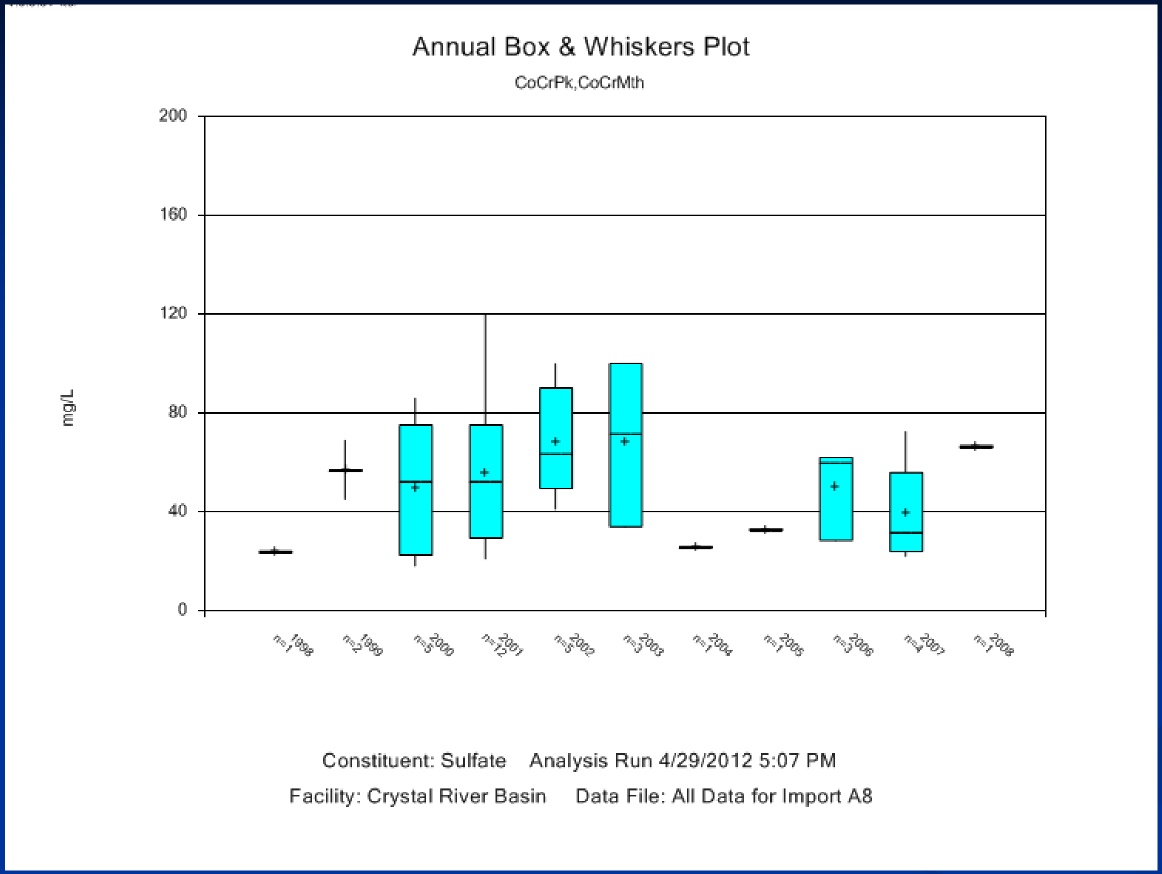
Coal Creek above Crystal River

Selenium by year



Coal Creek above Crystal River

Zinc by year

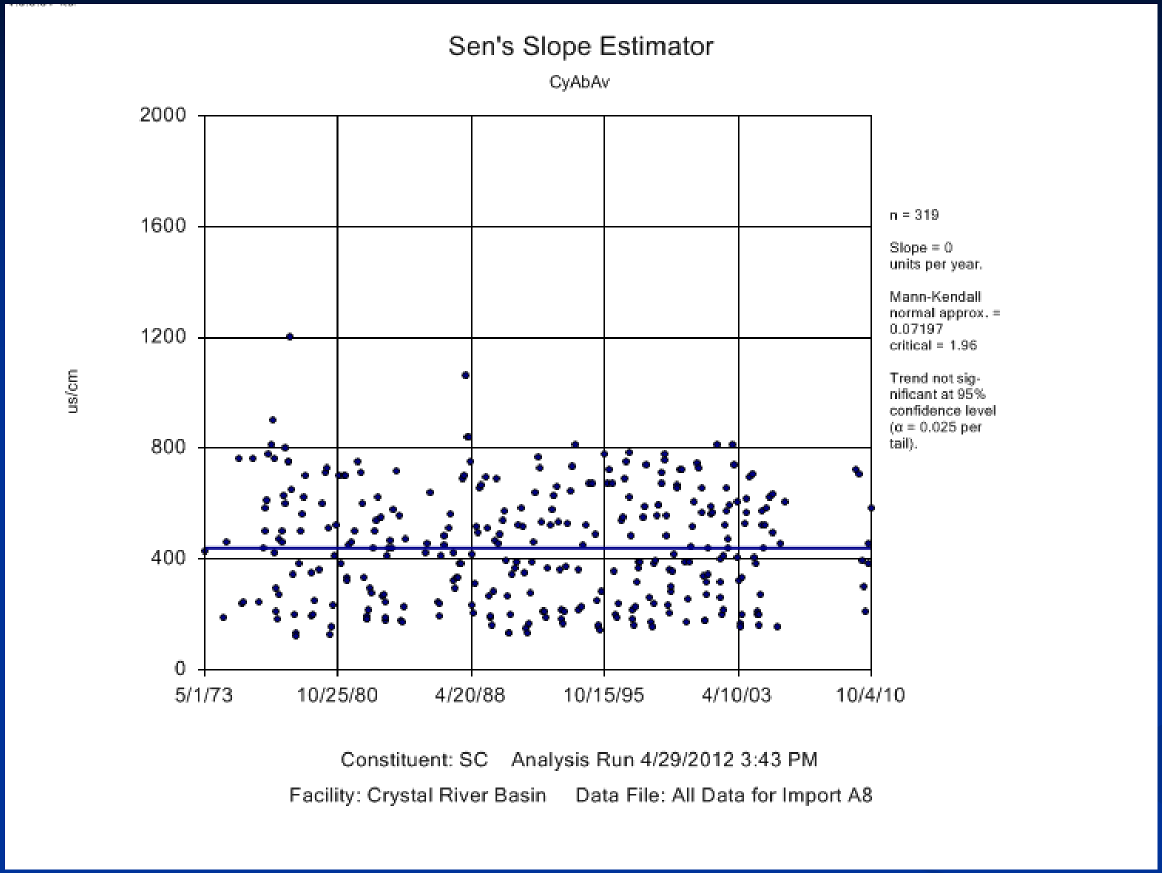


Coal Creek above Crystal River

Sulfate by year

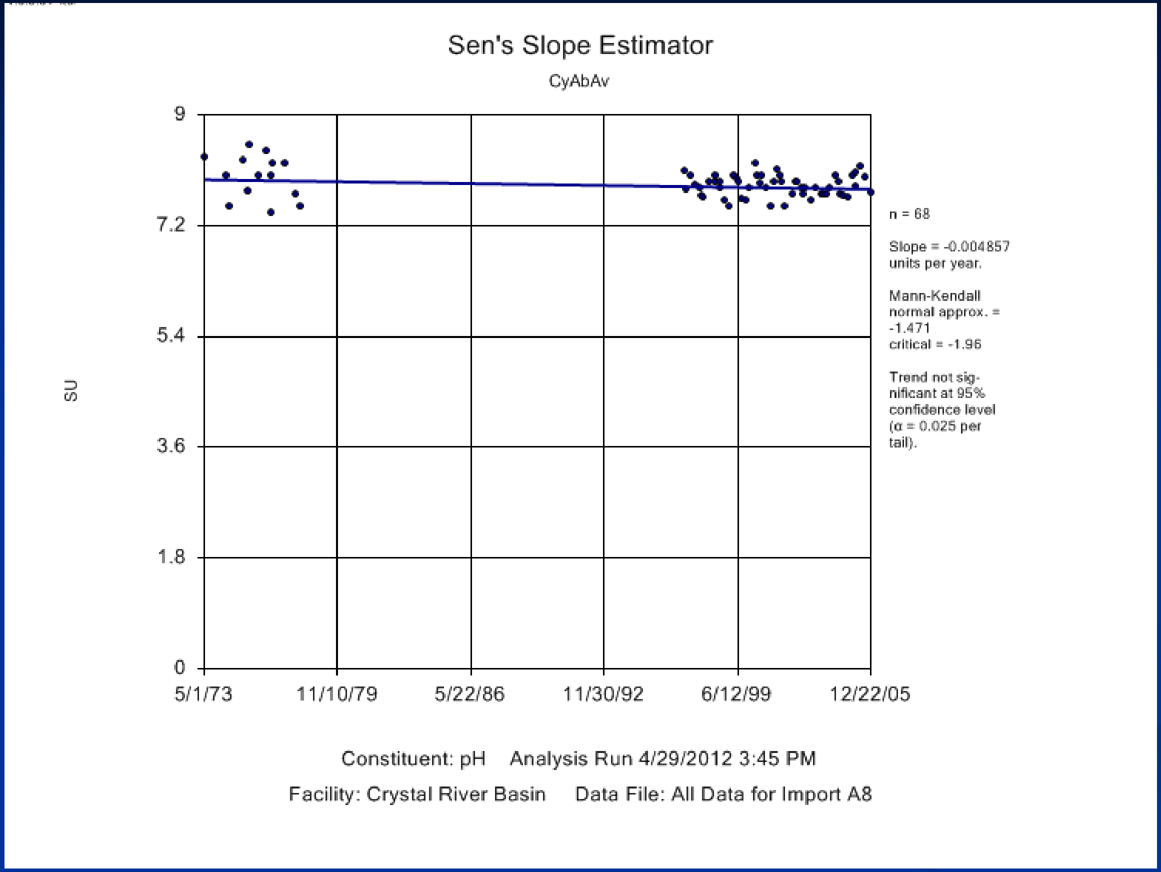
Coal Creek

- Notable observations:
  - Do iron and zinc concentrations spike in 2003? May be artifact of small sample numbers.
  - Similar for manganese in 2002 and 2003, and selenium in 2004-2006
  - pH, specific conductance, and sulfate don’t show spikes



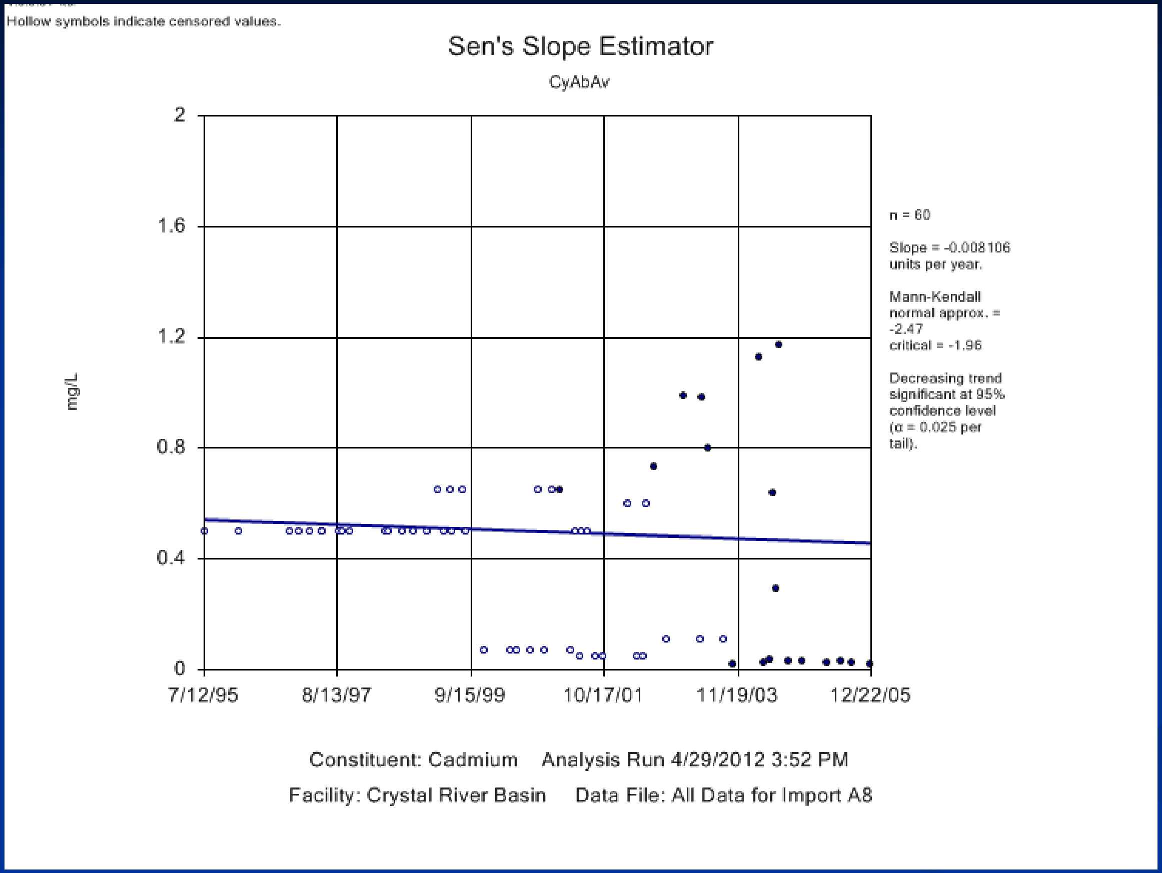
Crystal River above Avalanche Creek

Specific conductance over time: no trend



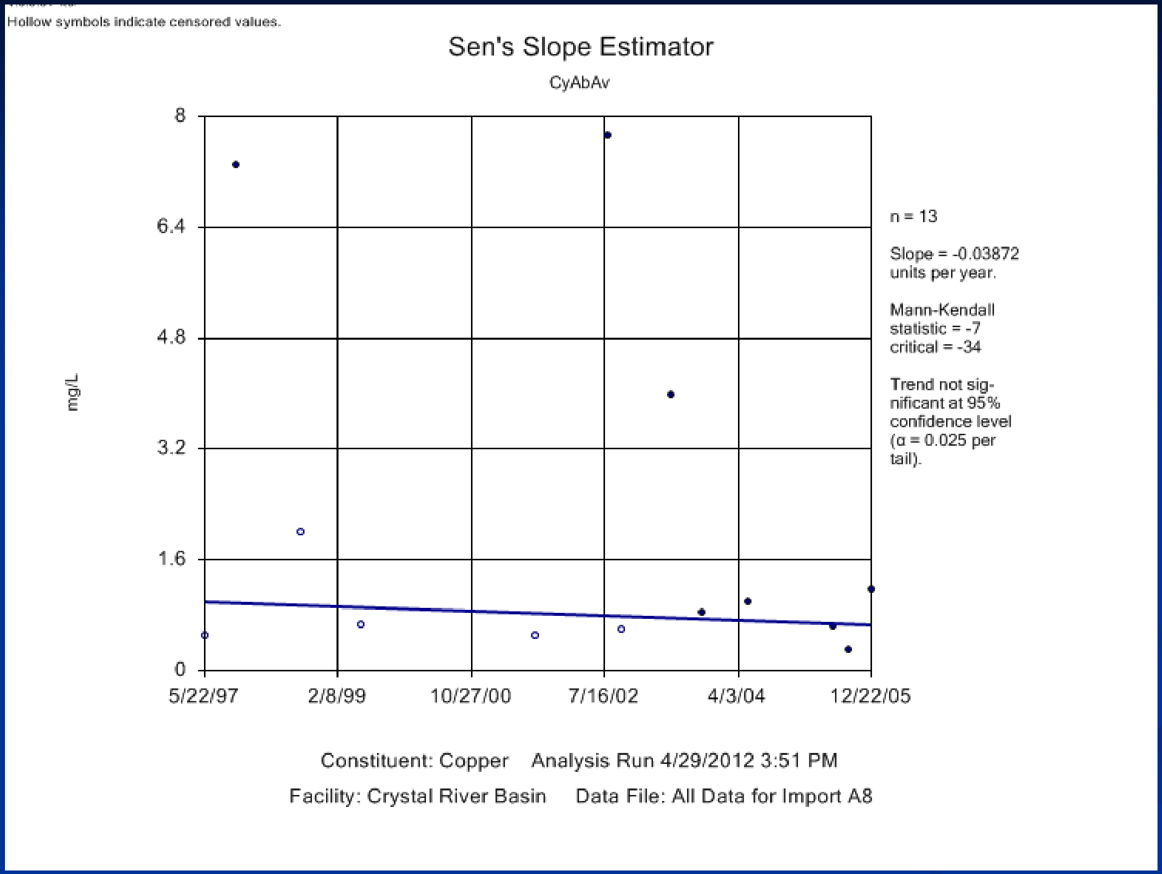
Crystal River above Avalanche Creek

pH over time: no trend



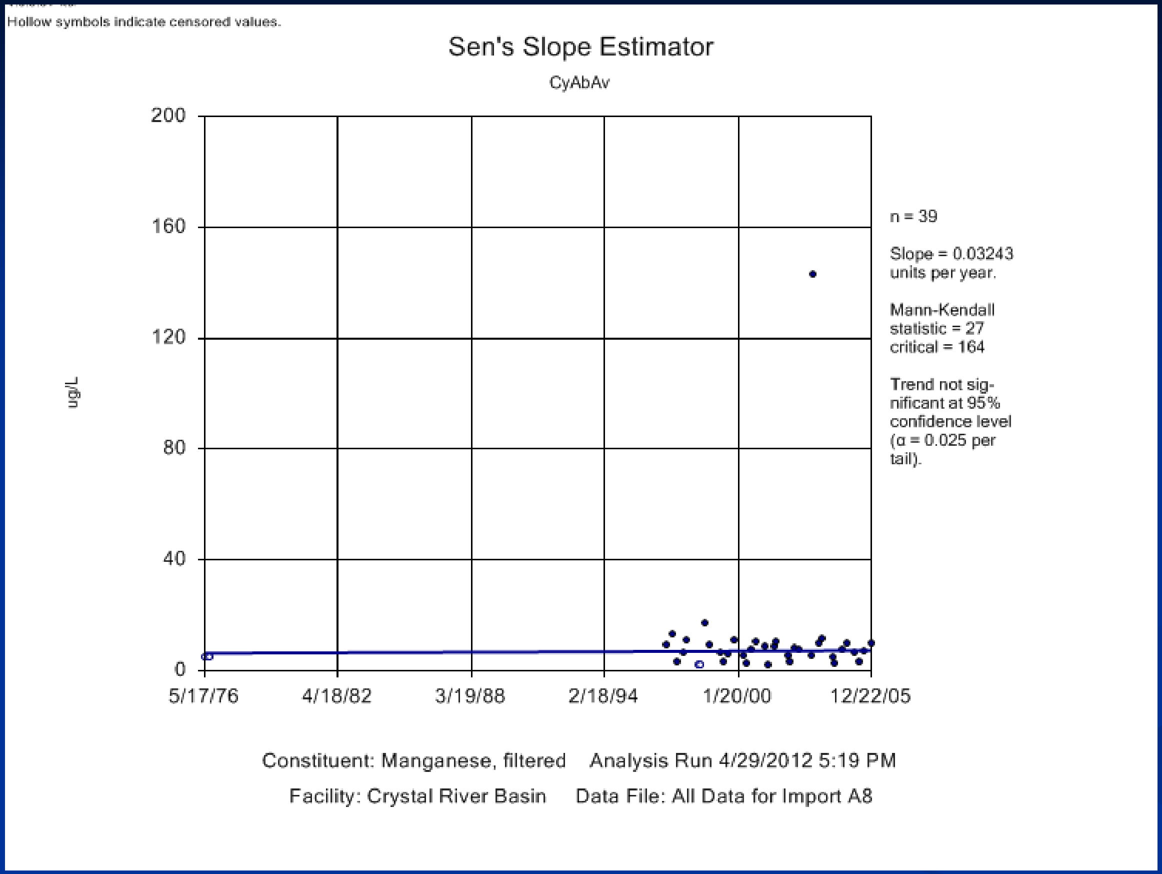
Crystal River above Avalanche Creek

Cadmium over time: decreasing trend



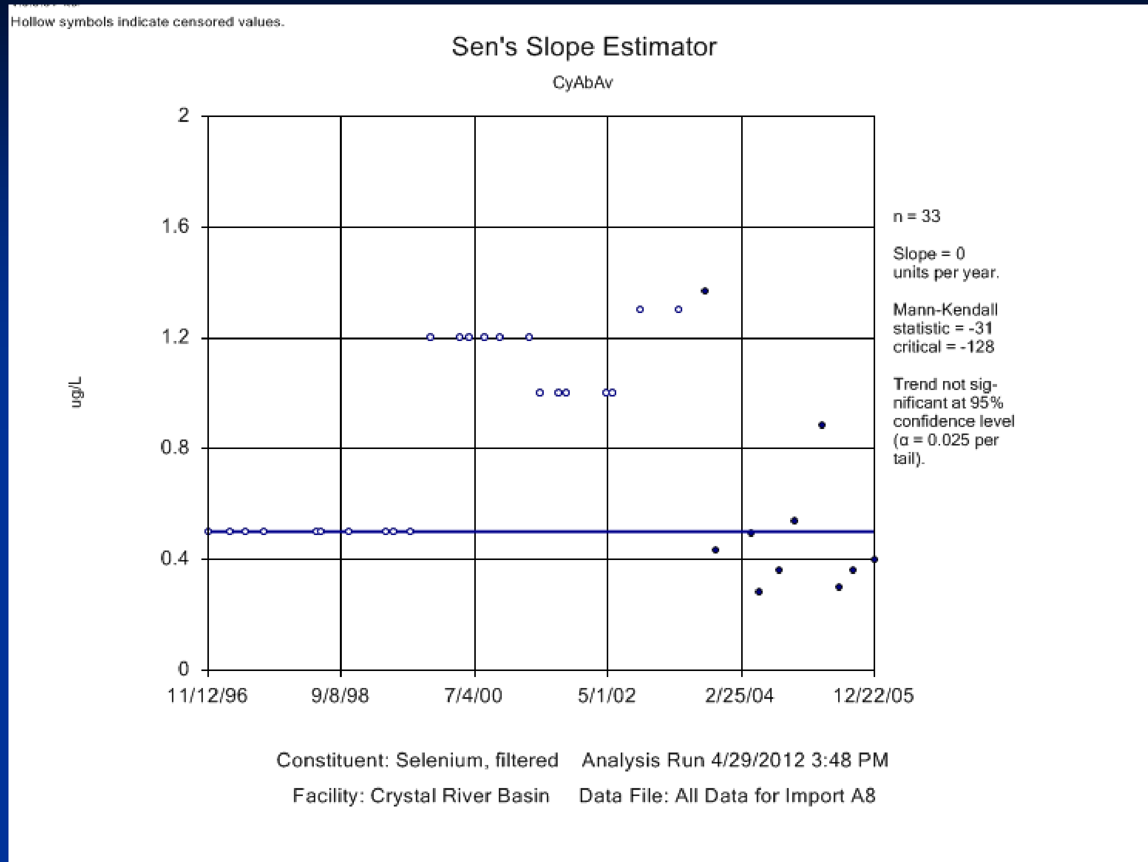
Crystal River above Avalanche Creek

Copper over time: no trend



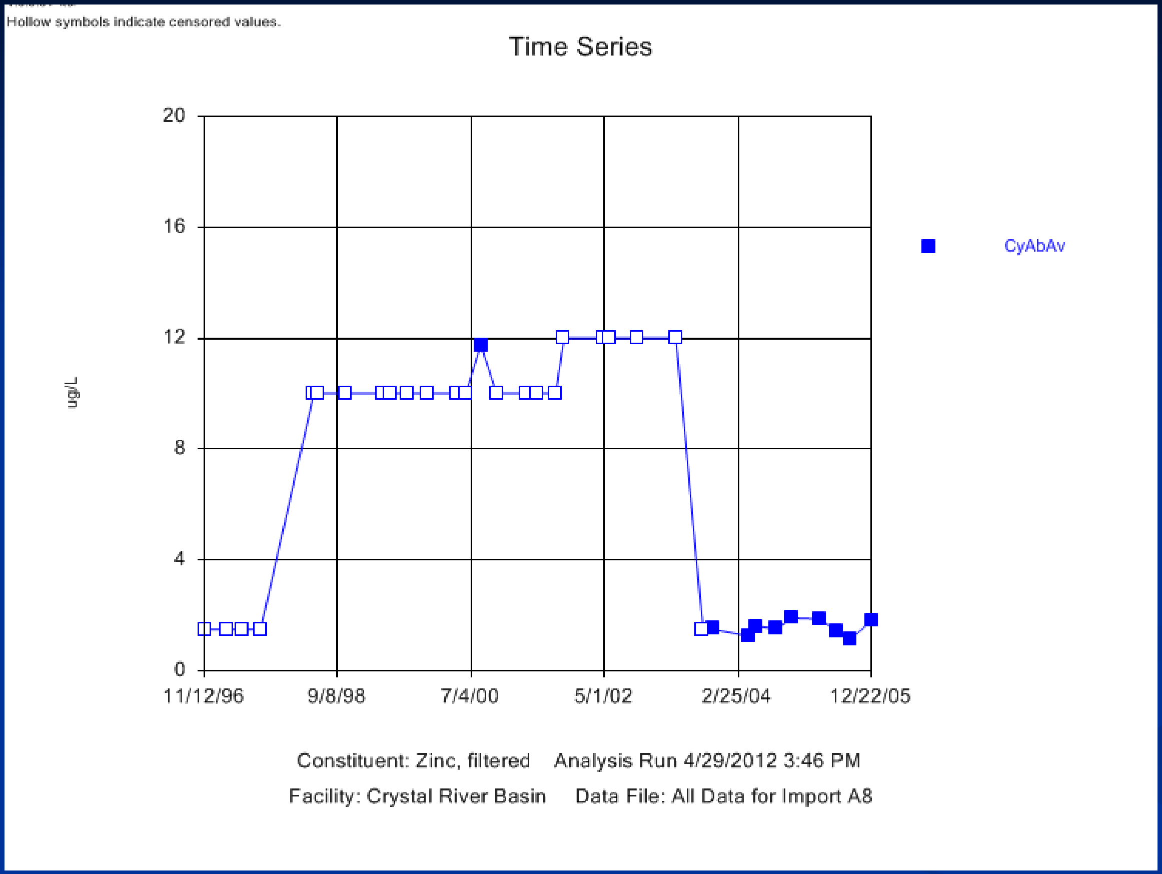
Crystal River above Avalanche Creek

Manganese over time: no trend



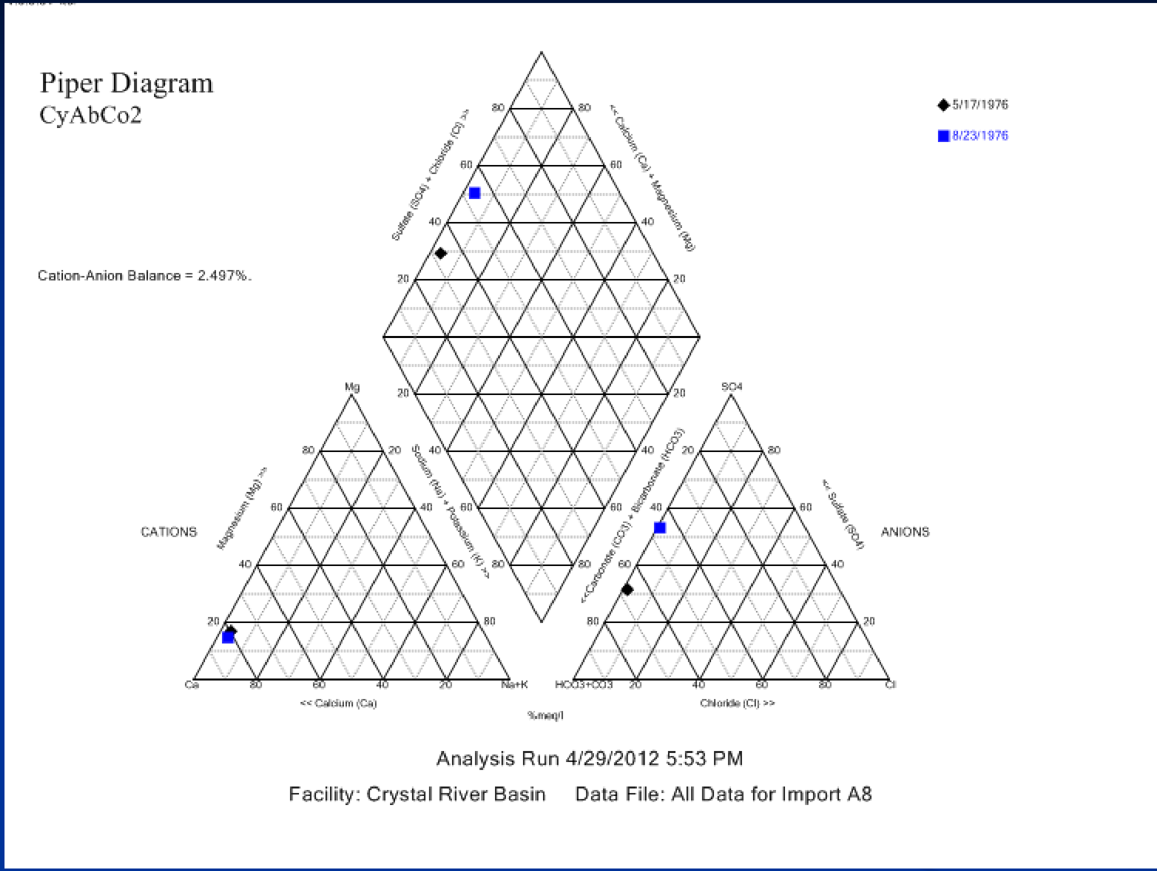
Crystal River above Avalanche Creek

Selenium over time: no trend



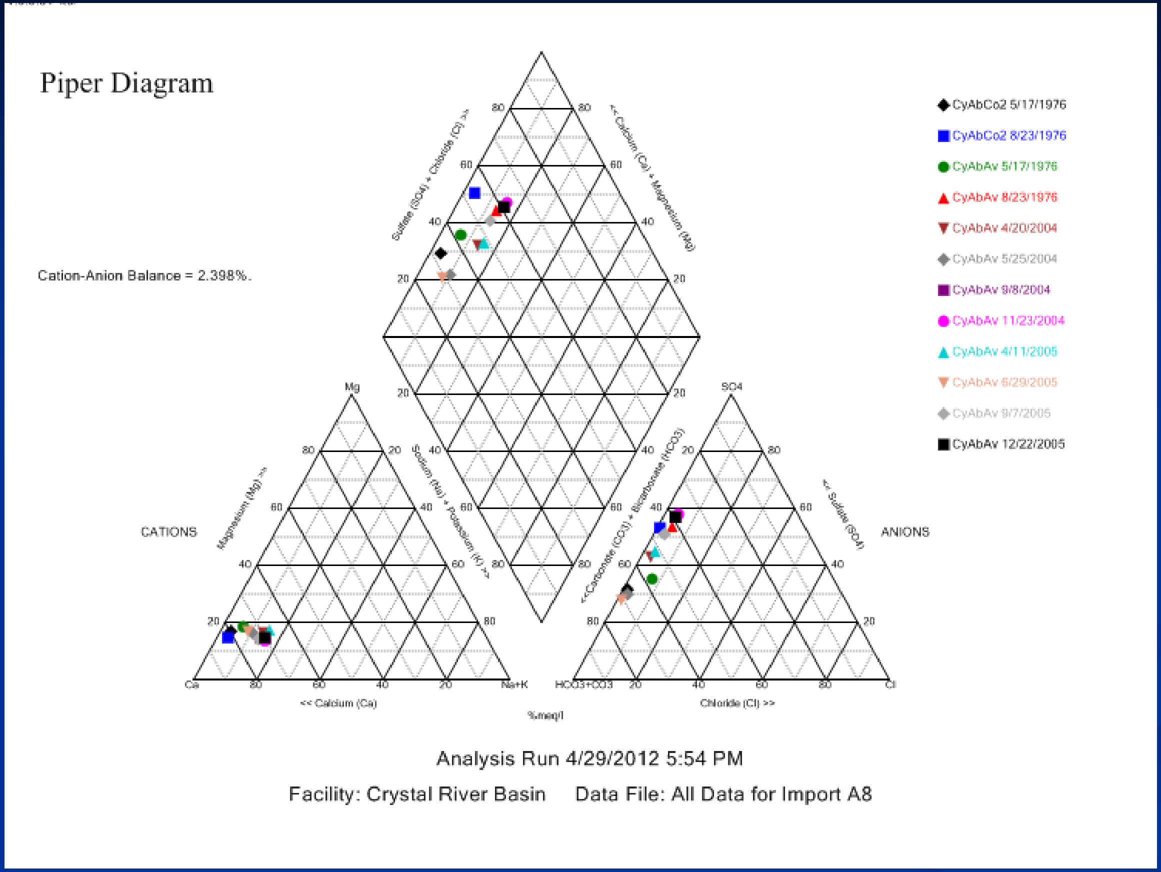
Crystal River above Avalanche Creek

Zinc over time: no trend



Crystal River above Coal Creek

Profile of major ions



Crystal River above Avalanche Creek

Profile of major ions

Crystal River at Avalanche Creek

- Notable observations
  - No trend: specific conductance, pH, copper, manganese, selenium, zinc
  - Decreasing trend: cadmium
  - Major ion chemistry unchanged relative to Crystal River above Coal Creek

Crystal River Above and Below Coal Creek

- Significant increases (α=0.05) occurred for pH, cadmium, iron, manganese, selenium, zinc
- However, for comparison of Crystal River above Coal Creek with Coal Creek above Crystal River, only pH and specific conductance showed significant difference
- No significant differences for specific conductance and copper

Recommendations

- Develop prioritized list of water quality parameters and sites for baseline monitoring and detection of future changes
- Sample at regular and frequent intervals to build correlations and detect trends
- Explore use of multiple linear regression as replacement for sampling and analysis

What Next?

Acknowledgments: Brita Lancaster, a CMU Environmental Science major, for her assistance in analyzing data

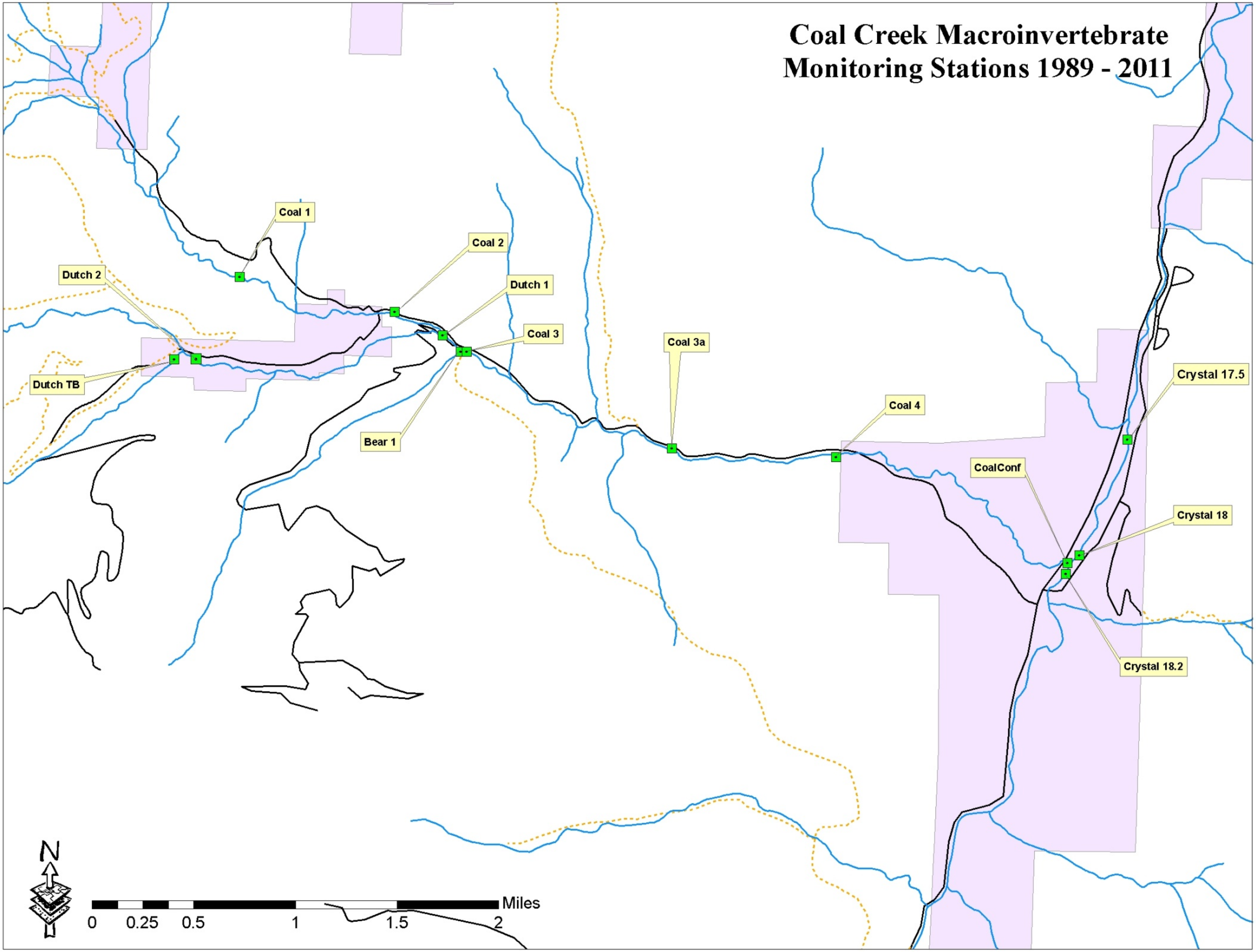
Coal Basin Macroinvertebrate Sampling

Coal Basin Historic Data

- Macroinvertebrates collected from six sites in the watershed from 1989 to 1998.
  - Coal 1: 1989, 1990, 1992, 1994, 1995, 1997
  - Coal 2: 1989-1992, 1994, 1995, 1997, 1998
  - Coal 3: 1989-1992, 1994, 1995, 1997
  - Coal 4: 1989-1992, 1994, 1995, 1997, 1998
  - Dutch 1: 1990-1992, 1994, 1995, 1997
  - Bear 1: 1990-1992, 1994, 1995, 1997, 1998

2011 Monitoring

- In 2011 four new sites were added in Coal Basin and four sites were sampled on the Crystal River
  - Dutch 2, Dutch Tb, Coal 3b, Coal Confluence
- One historic site (Coal 2) was sampled in 2011



Coal Creek Macroinvertebrate
Monitoring Stations 1989 - 2011
Coal 1
Coal 2
Dutch 2
Dutch 1
Coal 3
Coal 3a
Dutch TB
Bear 1
Coal 4
Crystal 17.5
CoalConf
Crystal 18
Crystal 18.2
N
Miles
0
0.25
0.5
1
1.5
2

Macroinvertebrate Metrics

Metric	Response to Impacts	Description	CV
No. EPT Taxa	Decrease	Number of mayfly, stonefly, and caddisfly taxa; taxa considered to be generally sensitive to pollutants.	0.09
No. Ephemeroptera Taxa	Decrease	Number of mayfly species in a sample.	0.12
Benthic Condition Index (BCI)	Increase	Index used for evaluating stream sediment impacts (Winget and Magnum 1979).	0.09
No. Metal Intolerant Taxa	Decrease	Number of taxa considered to be intolerant of high metals concentrations.	0.14
WRNF Sediment Intolerant Taxa	Decrease	Number of intolerant EPT taxa selected using White River National Forest substrate and aquatic insect data.	0.16

Robust Stream Health

Stream Health Class	% of Reference	Habitat Condition
Robust	> 74 or < 126*	Stream exhibits high geomorphic, hydrologic and/or biotic integrity relative to its natural potential condition. Physical, chemical and/or biologic conditions suggest that State assigned water quality (beneficial, designated or classified) uses are supported.
At Risk	59 to 73 or 125 to 141*	Stream exhibits moderate geomorphic, hydrologic and/or biotic integrity relative to its natural potential condition (as represented by a suitable reference condition). Physical, chemical and/or biologic conditions suggest that State assigned water quality (beneficial, designated or classified) uses are at risk and may be threatened.
Diminished	< 58 or > 142*	Stream exhibits low geomorphic, hydrologic and/or biotic integrity relative to its natural potential condition (as represented by a suitable reference condition). Physical, chemical and/or biologic conditions suggest that State assigned water quality (beneficial, designated or classified) uses may not be supported.

*For metrics that increase with decreasing stream health, such as BCI, fine sediment and unstable stream banks.

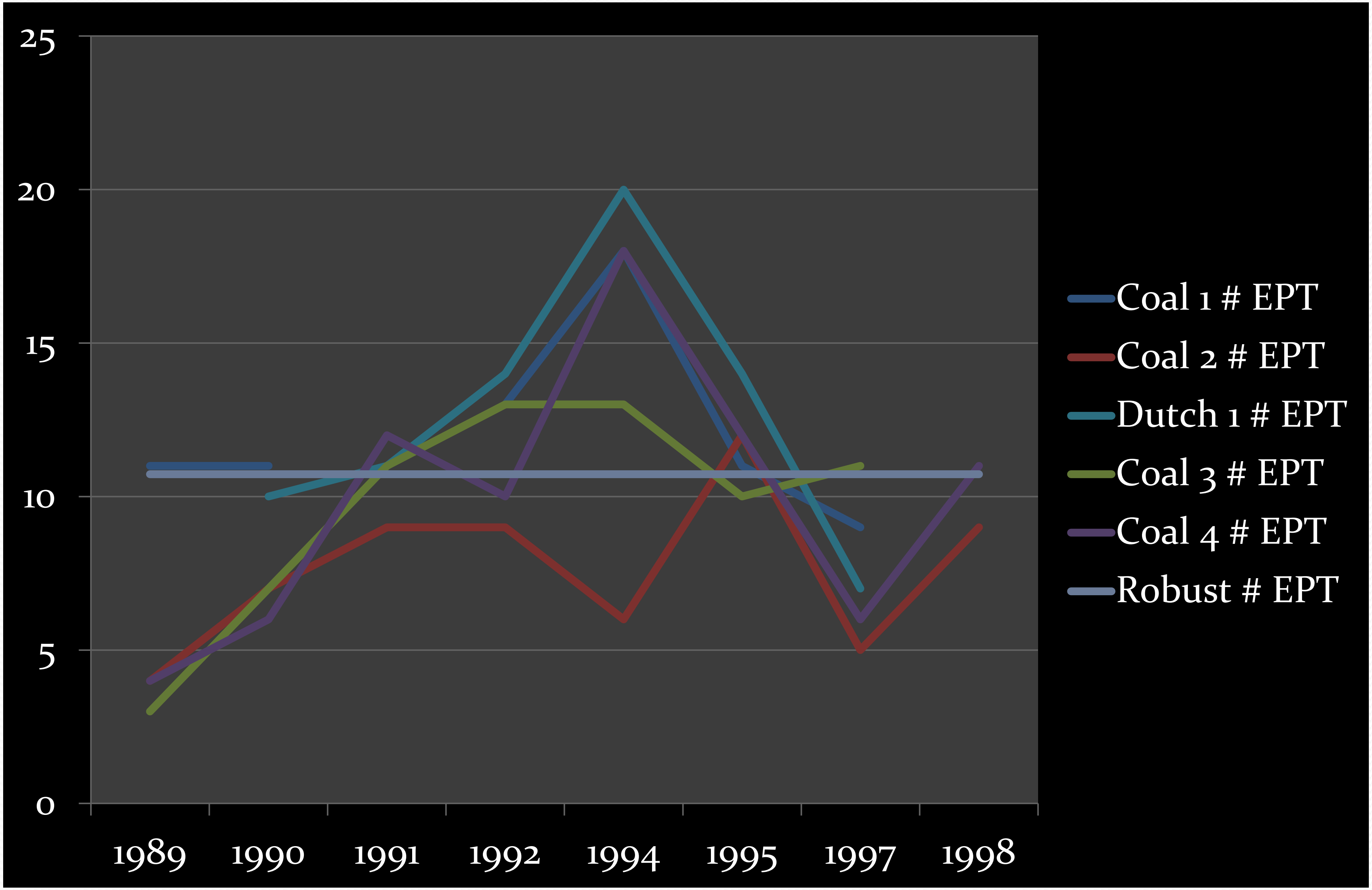
Historic Data Limitations

- Only a few metrics from historic data set could be interpreted.
- Metrics include: Number of EPT taxa, Number of Ephemeroptera taxa, and density

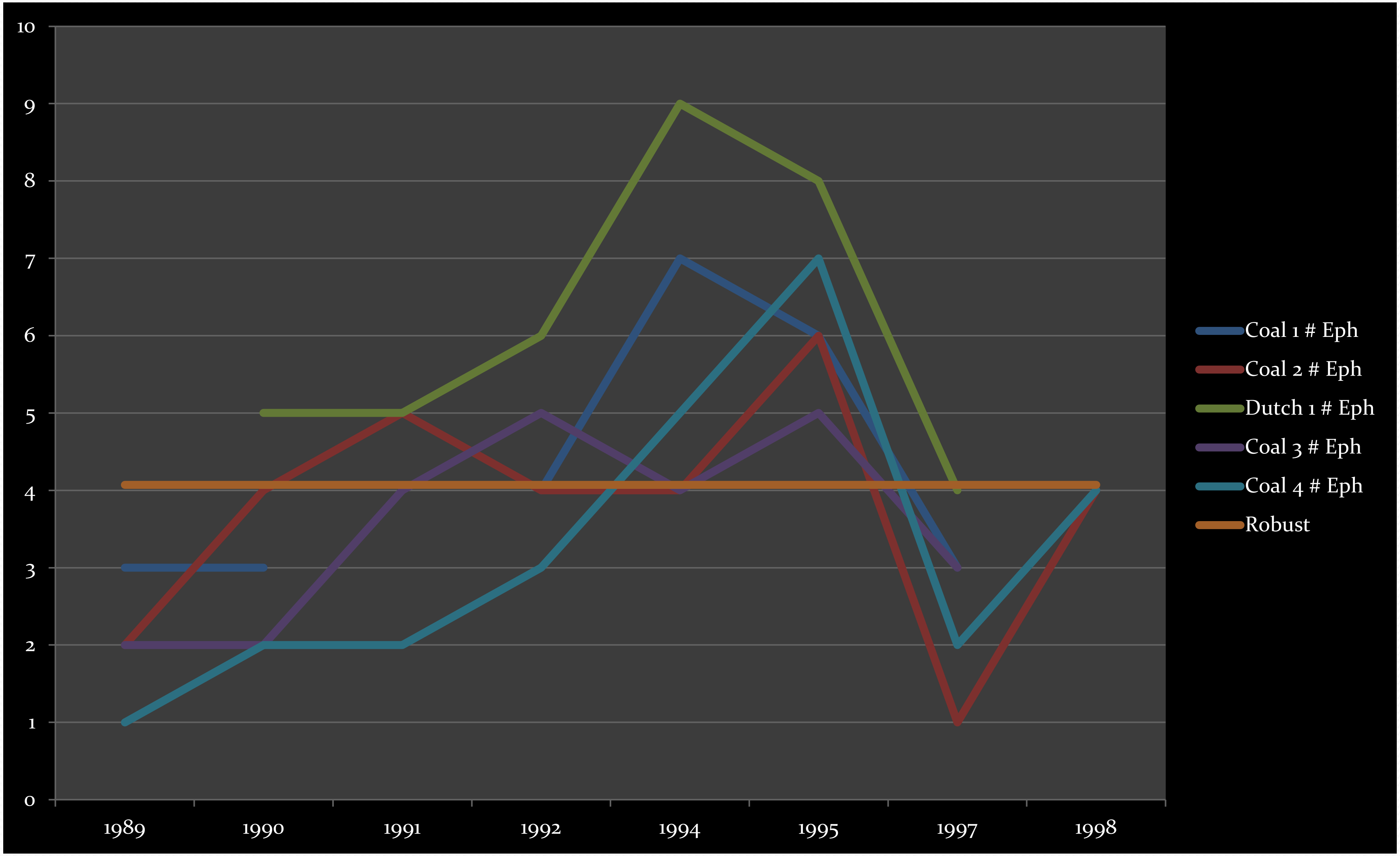
Reference Sites

- Limited
- Coal Basin geologically unique: Mancos Shale
- Current database contains limited sites in Mancos Shale geology
- Historic data is not comparable to current data set
- For Historic data, Bear Creek showed least impacted macroinvertebrate communities and was used for reference condition
- One site is not a robust data set
- 2011 Reference set limited by geology; may influence inflated reference values

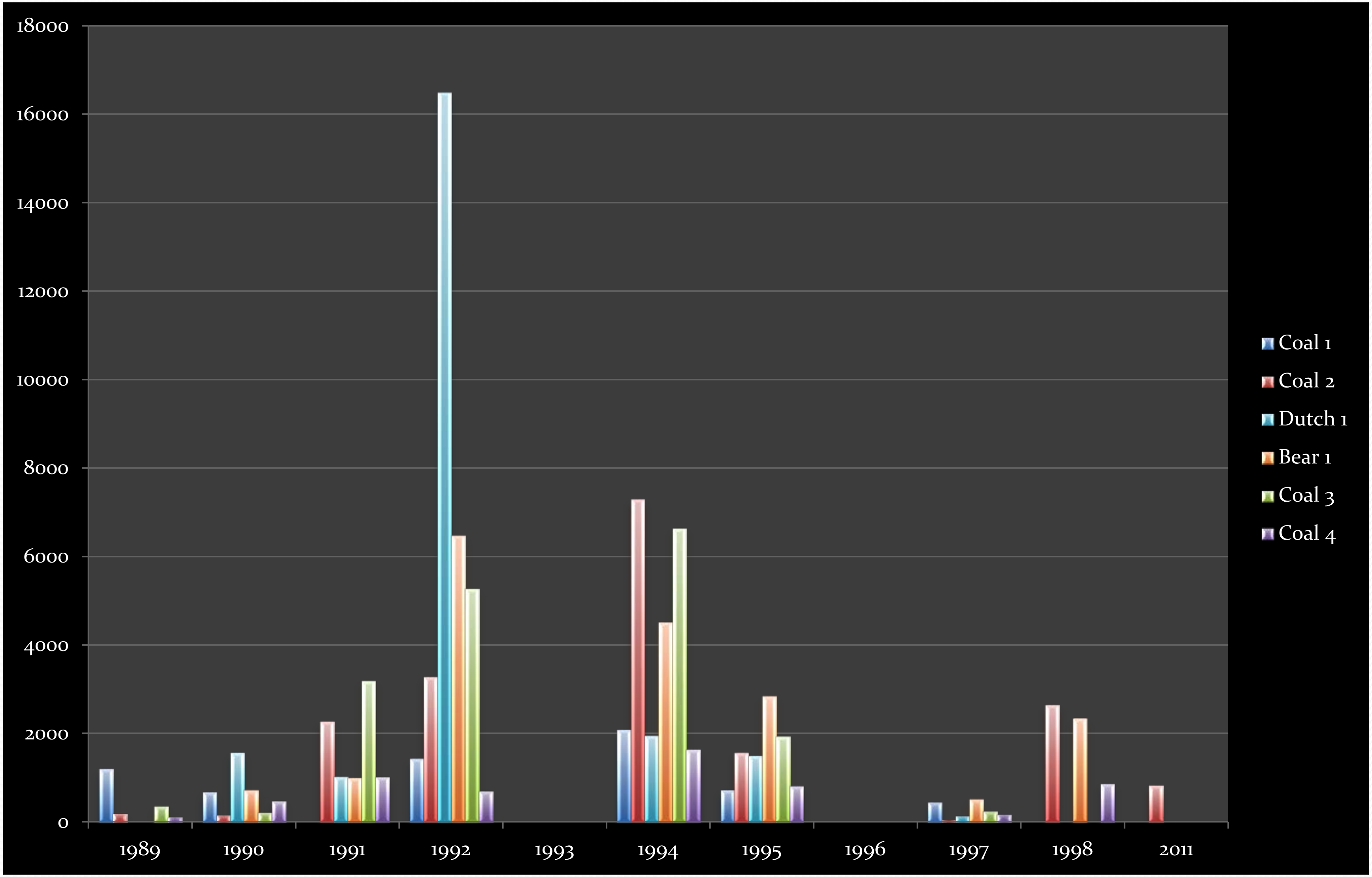
Historic Coal Basin EPT taxa



Historic Coal Basin Ephemeroptera Taxa



Historic Coal Basin Density



2011 Monitoring Results Dutch and Tributaries

	BCI	WRNF Intolerant Taxa	No. EPT Taxa	No. Eph Taxa	Metal Intolerant Taxa
		Reference Data			
Number of Sites	3	3	3	3	3
Number of Samples	10	10	10	10	10
% of Reference (Robust Stream Health)	<6.17	>5.18	>14.25	>5.18	>6.1
% of Reference (Diminished Stream Health)	>6.95	<4.06	<11.17	<4.06	<4.8
		Dutch Tb			
2011	**6.20**	**6**	**11**	**6**	**4**
		Reference Data			
Number of Sites	5	5	5	5	5
Number of Samples	13	13	13	13	13
% of Reference (Robust Stream Health)	<6.82	>4.44	>13.32	>4.44	>5.9
% of Reference (Diminished Stream Health)	>7.68	<3.48	<10.44	<3.48	<4.6
		Dutch 2			
2011	**8.95**	**5**	**12**	**4**	**3**

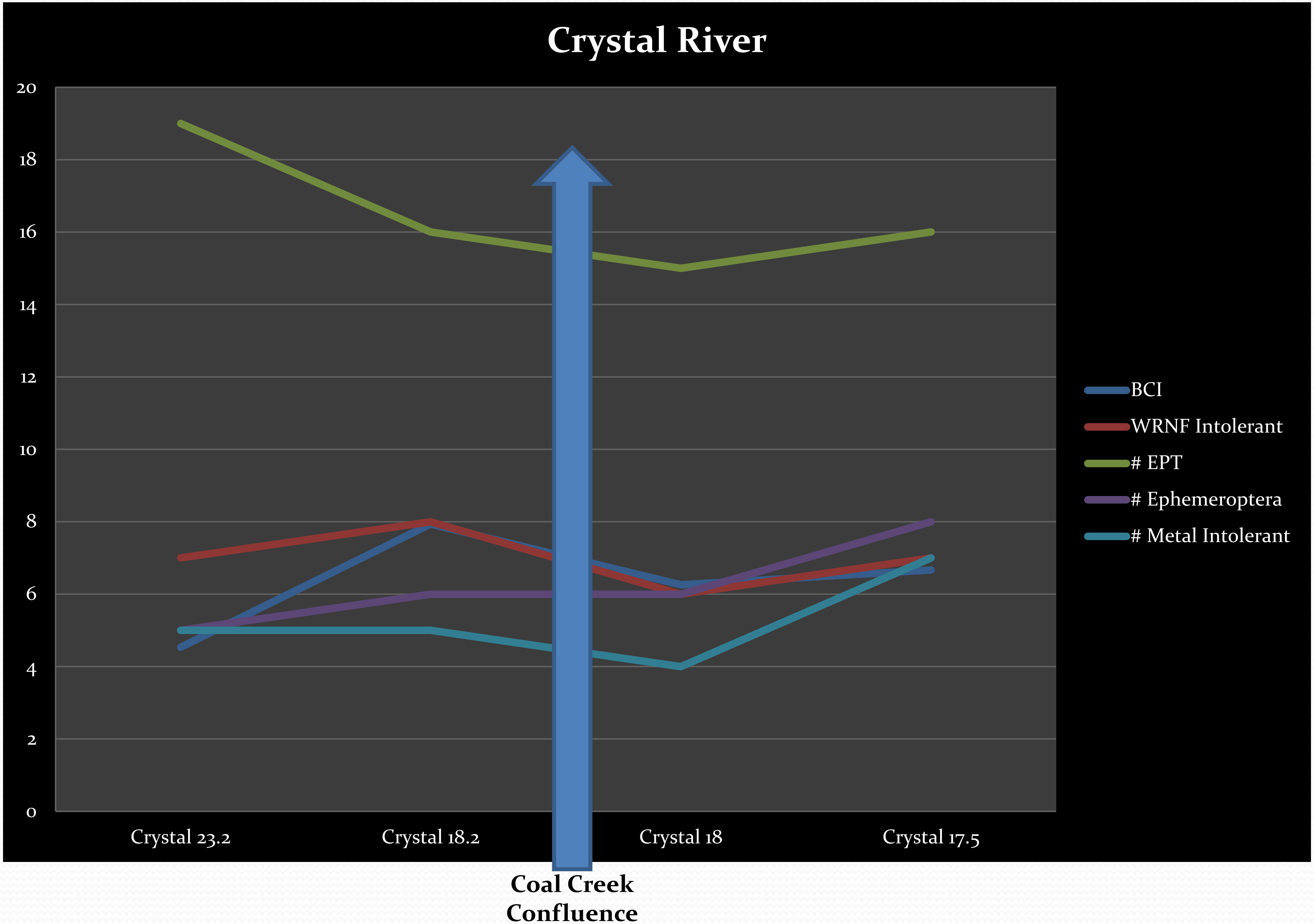
2011 Monitoring Results Coal Creek

	BCI	WRNF Intolerant Taxa	No. EPT Taxa	No. Eph Taxa	Metal Intolerant Taxa
		Reference Data			
Number of Sites	4	4	4	4	4
Number of Samples	10	10	10	10	10
% of Reference (Robust Stream Health)	<7.05	>5.37	>14.06	>5.18	>5.9
% of Reference (Diminished Stream Health)	>7.94	<4.21	<11.02	<4.06	<4.6
		Coal 2			
2011	**7.61**	**2**	**12**	**4**	**2**
		Reference Data			
Number of Sites	2	2	2	2	2
Number of Samples	6	6	6	6	6
% of Reference (Robust Stream Health)	<4.6	>5.18	>15.73	>6.66	> 6.8
% of Reference (Diminished Stream Health)	>5.19	<4.06	<12.33	<5.22	< 5.4
		Coal 3a			
2011	**8.04**	**3**	**8**	**4**	**2**
		Coal Confluence			
2011	**6.38**	**4**	**9**	**4**	**4**

2011 Crystal River Sampling

- No reference data in WRNF Macroinvertebrate Data Base
- Looked at longitudinal analysis using Placida site as “reference” and Coal Creek as limiting Factor

2011 Crystal River Metrics



2011 Monitoring Results Crystal River

	BCI	WRNF Intolerant Taxa	No. EPT Taxa	No. Eph Taxa	Metal Intolerant Taxa
Reference Data (Placida)					
Number of Sites	1	1	1	1	1
Number of Samples	1	1	1	1	1
% of Reference (Robust Stream Health)	< 5.71	> 5.18	> 14.06	> 3.7	> 3.7
% of Reference (Diminished Stream Health)	> 6.43	< 4.06	< 11.02	< 2.9	< 2.9
Crystal 18.2 (Upstream Coal Creek)					
2011	7.94	8	16	6	5
Crystal 18 (Downstream Coal Creek)					
2011	6.26	6	15	6	4
Crystal 17.5 (Downstream Coal Creek)					
2011	6.67	7	16	8	7

Questions/Monitoring Needs

- What is the main driver for macroinvertebrate impacts: natural, anthropogenic, or both?
- Are macroinvertebrates a limiting factor to fish in Coal Basin?
- Are heavy metals influencing macroinvertebrate communities?
- Sediment data at all long term sites
- Continue sampling long term sites
- Need for a more robust reference site data set

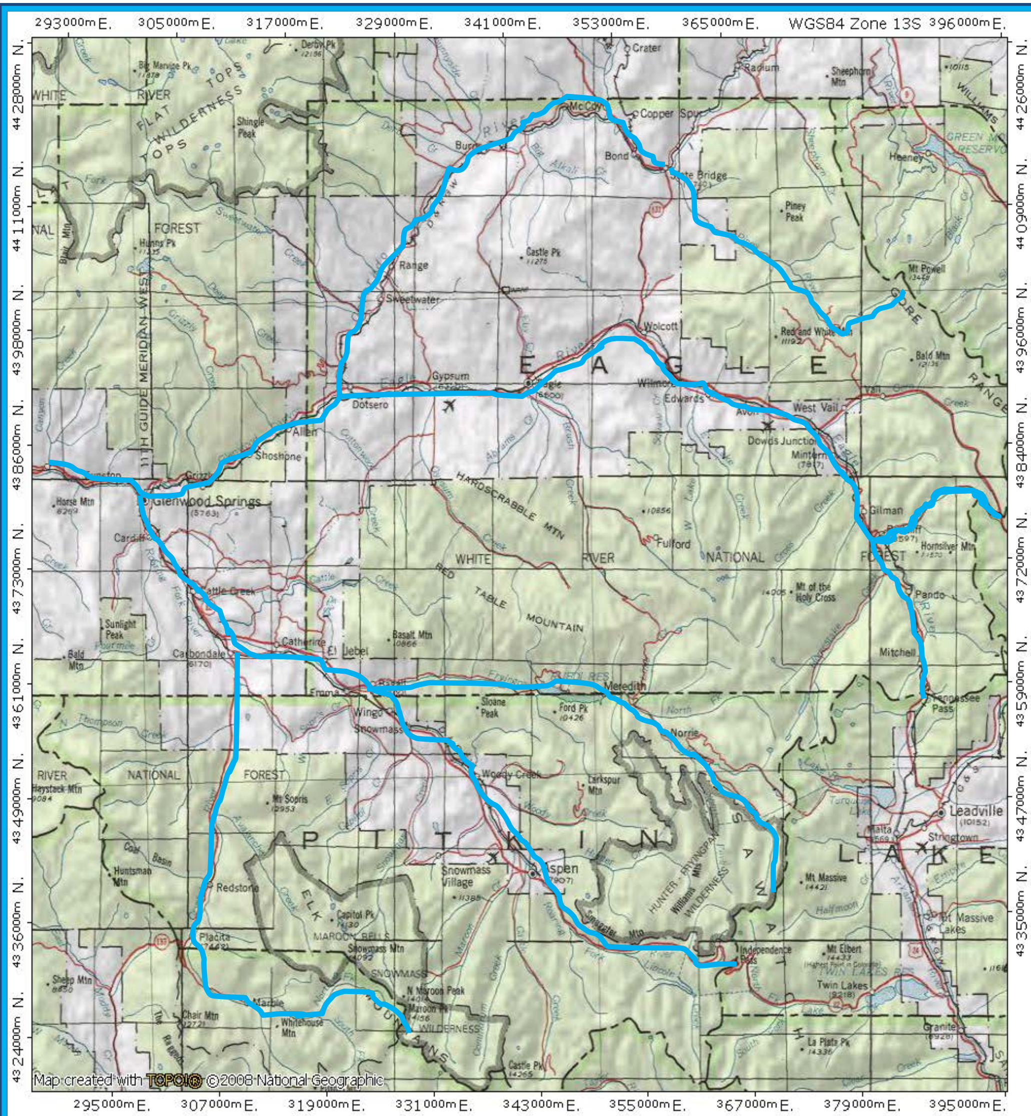
CRYSTAL RIVER/COAL CK

RECENT FISHERIES INFO

Kendall Bakich - Glenwood Area Aquatic Biologist

Area 8 Aquatic Biologist

- Kendall Bakich
- Glenwood Spgs, Area 8
  - Watersheds:
    - Colorado River (Canyon Creek to State Bridge)
      - Piney River
    - Eagle River
    - Roaring Fork
      - Crystal River
      - Fryingpan River



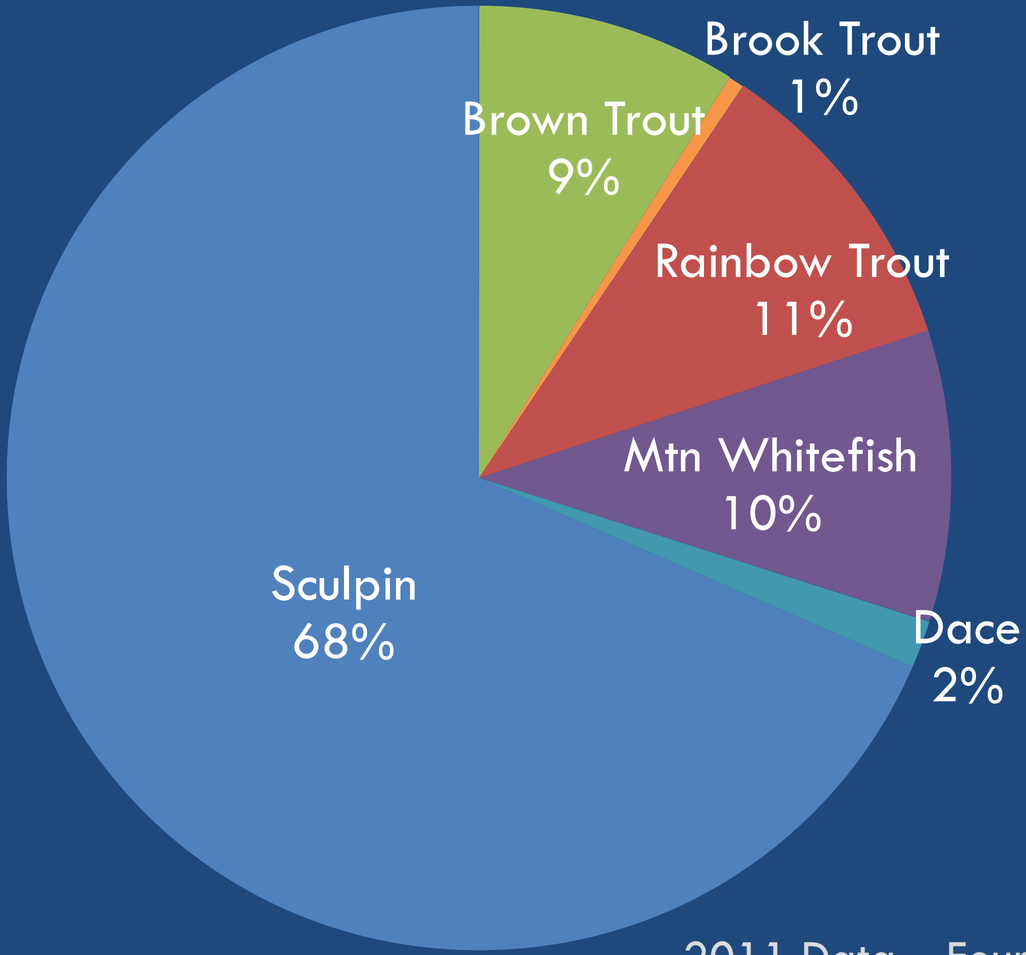
Presentation Summary

- Management
  - Fishing Regulations
  - Stocking
- Fisheries Data Collection Efforts
  - Past
  - Present
  - Future
- Discussion/Questions

Crystal River

- Management
  - Stocked with HOFER rainbow trout - catchables and fingerlings since 2000
  - Harvest regulation: Bag and possession limit – statewide limit: 4 trout
- Fishery Surveys
  - Coal Creek
    - 2010
  - Crystal River
    - 2011: four stations, alternating years: Carbondale, Blw Redstone, Abv Coal Creek, Placita

Crystal River: Species Diversity



2011 Data – Four sample stations

Crystal River: Native Fish

Speckled Dace

Sculpin

Crystal River: Sportfish

Rainbow trout

Mountain whitefish

Crystal River: Data Summary

	2011 CR Hatchery	2011 Blw Redstone	2011 Abv Coal Ck	2011 Placita	2004 RVR	2004 1mi. Abv Hatchery
Rainbow Trout per acre	**13** (11-15)	**8**	**21** (20-22)	**10** (3-17)	**2**	*2 collected*
Rainbow Trout lbs/acre	**9** (6-12)	**3**	**14** (13-15)	**5** (2-8)	**1**	
Mtn Whitefish per acre	**1**	**2**	**37** (35-39)	**5**	**5**	*1 collected*
Mtn Whitefish lbs/acre	**1**	**1**	**30** (28-32)	**5**	**10**	
Brown Trout per mile	**13** (10-16)	**8**	**6** (4-8)	**3** (0-8)	**30** (6-54)	**16** (14-18)
Brown Trout lbs/acre	**8** (6-10)	**7**	**4** (2-6)	**15** (12-18)	**18** (3-33)	**13** (11-15)

Discussion and Comments

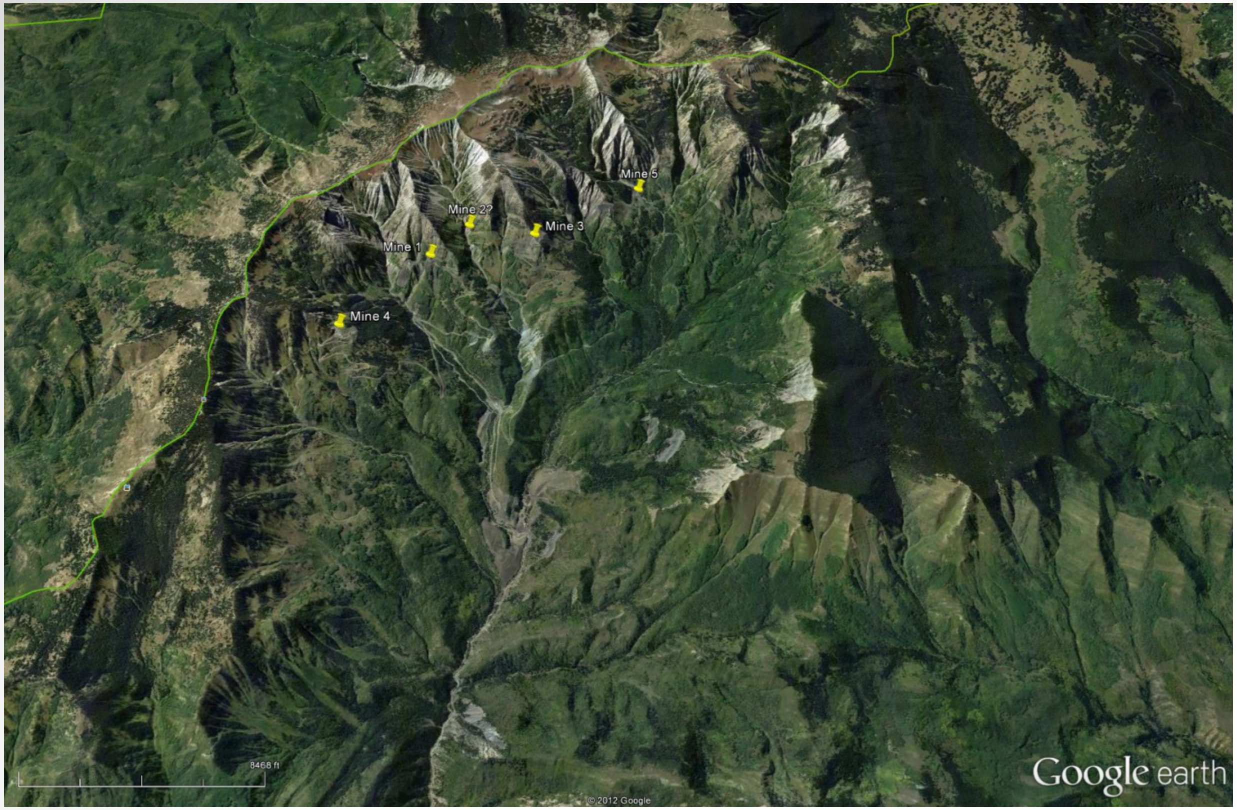
THANK YOU!

Coal Creek Watershed: Geomorphic Processes and Context

Sandra Ryan
Research Geomorphologist
Rocky Mountain Research Station
Fort Collins, Colorado

Outline

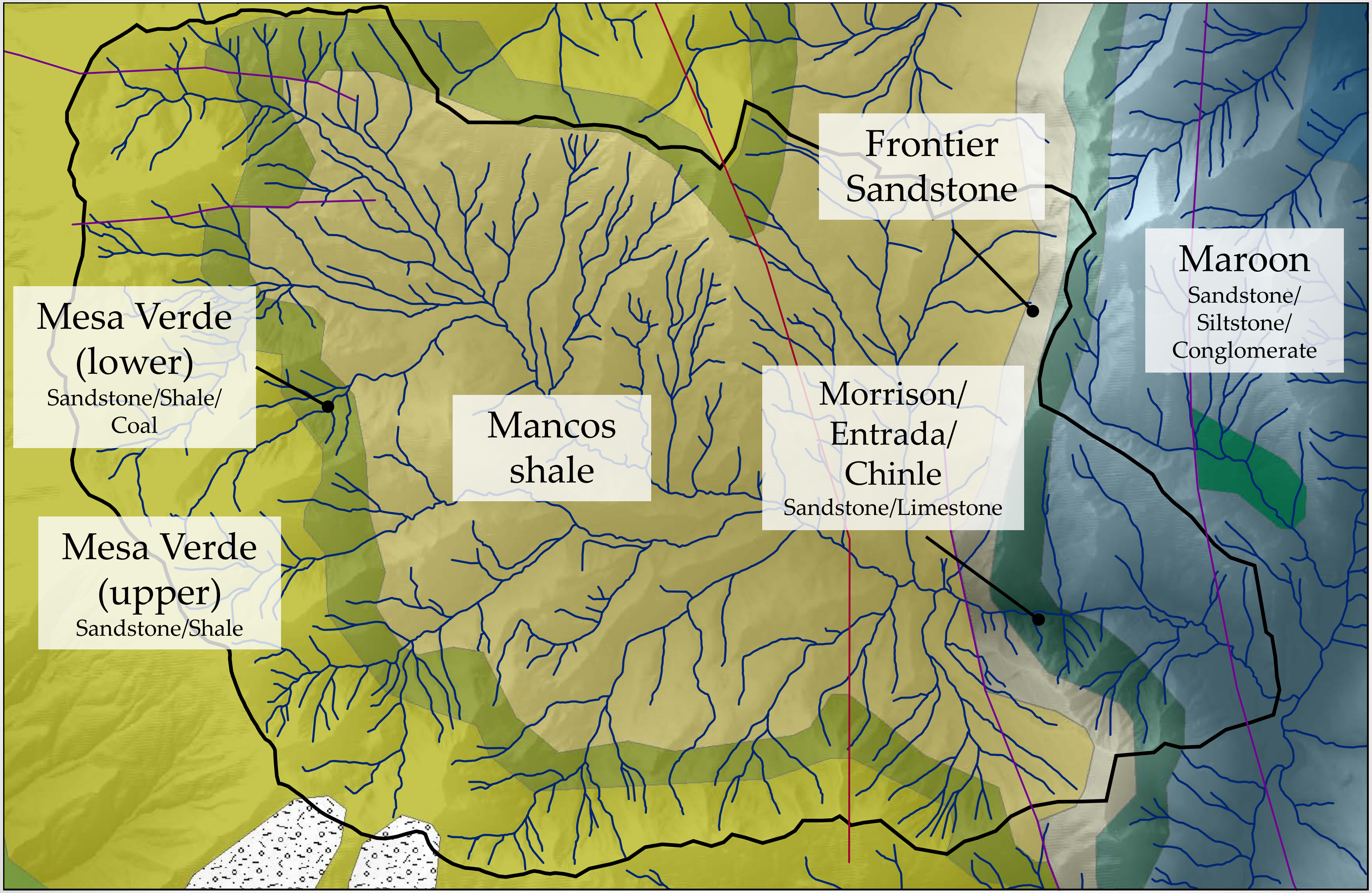
1. Geomorphic characteristics of Coal Creek watershed
2. Data needs
3. Methods to obtain data – feasibility, reliability, and safety
4. Confluence of Coal Creek and Crystal Rivers



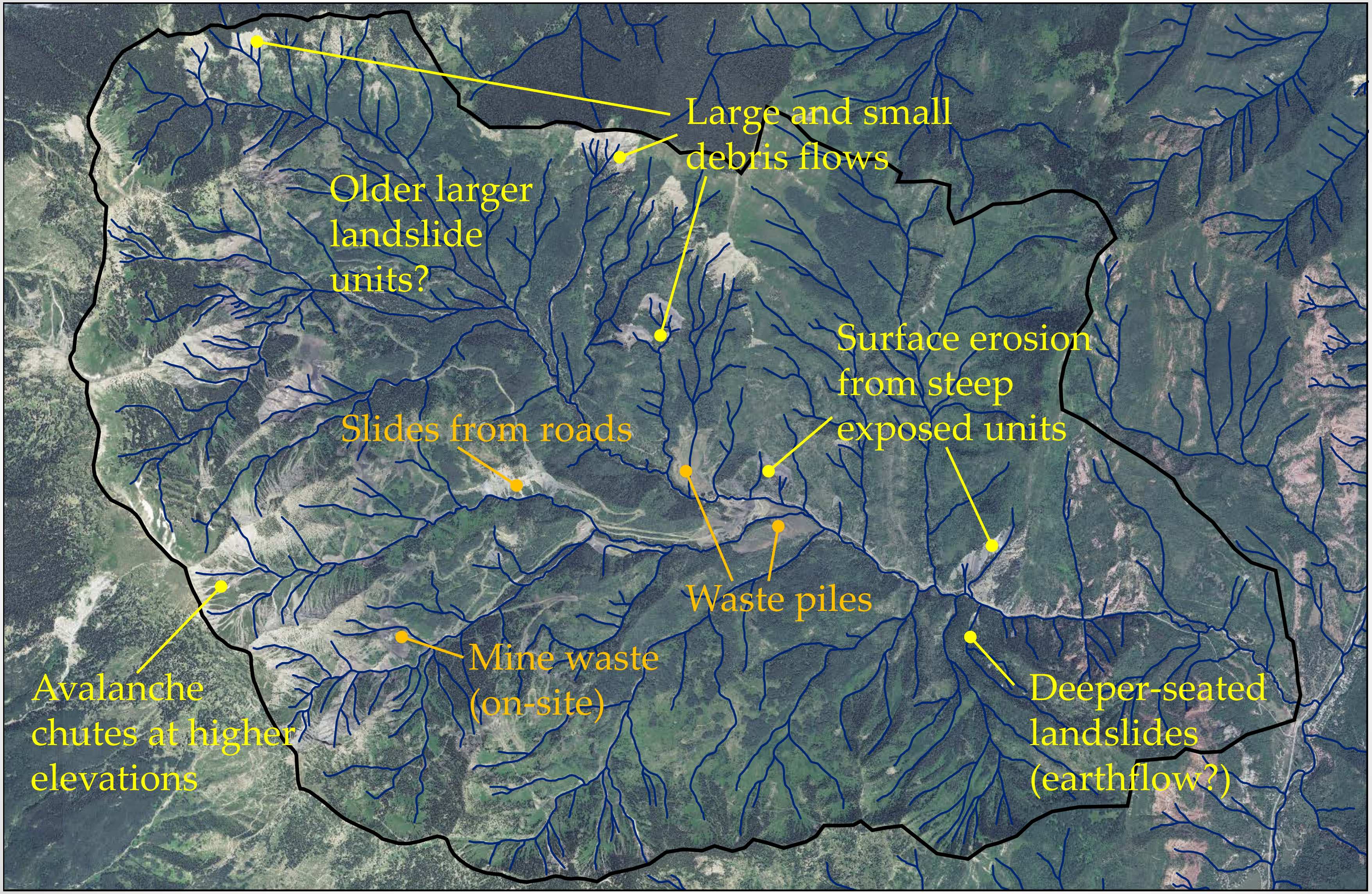
Coal Creek Watershed

- 69.2 km^2 (26.7 sq mi)area
- High background hillslope instability
- High connectivity to channel network
- Accelerated erosion issues due to past mining – 2 entries into watershed
- Channels have coarse sediments that are transported at high flows. Braided in some sections

Geology, Coal Creek Watershed

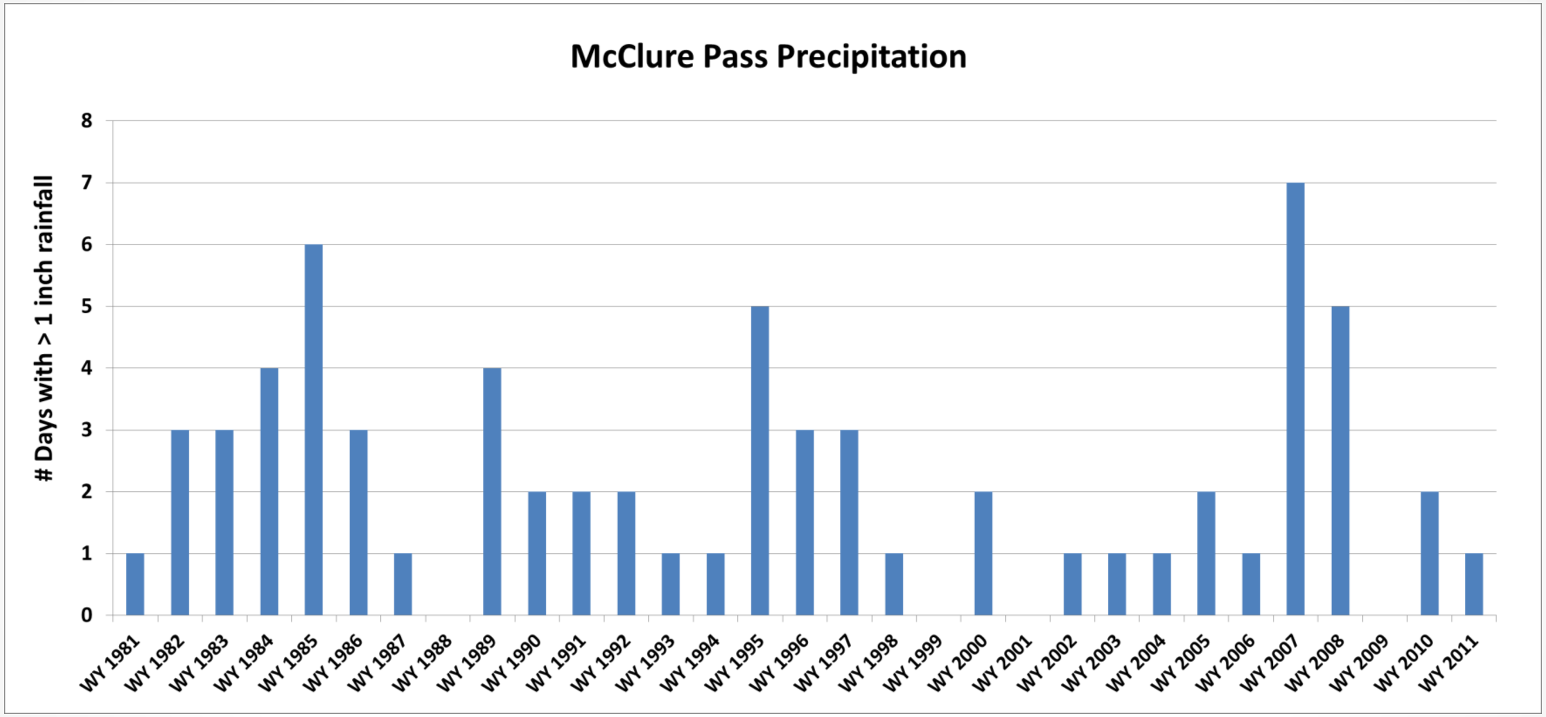


Landscape Instability



Precipitation/Flow

- MAP for Coal Creek is about 33 inches - ranges from 21inches near Redstone to 50 inches (based on PRISM estimates)



- Primarily a snowmelt driven system
- Snowmelt peak in late May or June.
- Summer storms can be significant. Potential for high intensity rainfall in summer months

Data needs

Coal Creek Watershed

Data Needs

for Understanding Stream Sedimentation

- Sediment sources
- Contribution of mines and mining related features
- Sediment loads (bedload and suspended loads)
- State of the system (ability to "stabilize")
- Rainfall intensity and hydrograph (gage data)

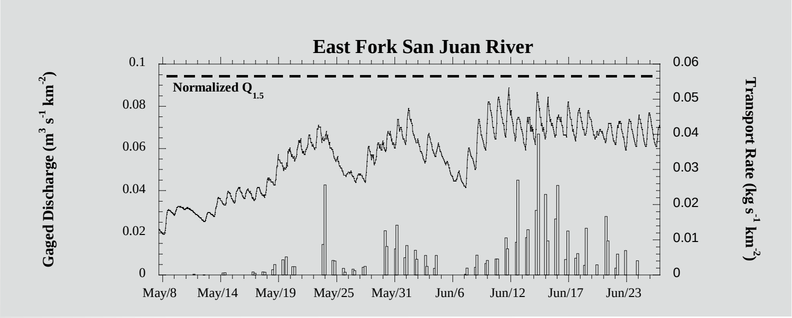
How much of a reduction in sediment load might be expected if the restoration of significant sediment sources is achieved?

How much mine related sediment is in channel that is still moving through the system and may impact restoration effort?

Potential Methods

Characterize Geomorphic Processes in Coal Creek Watershed

Sediment load: Bedload

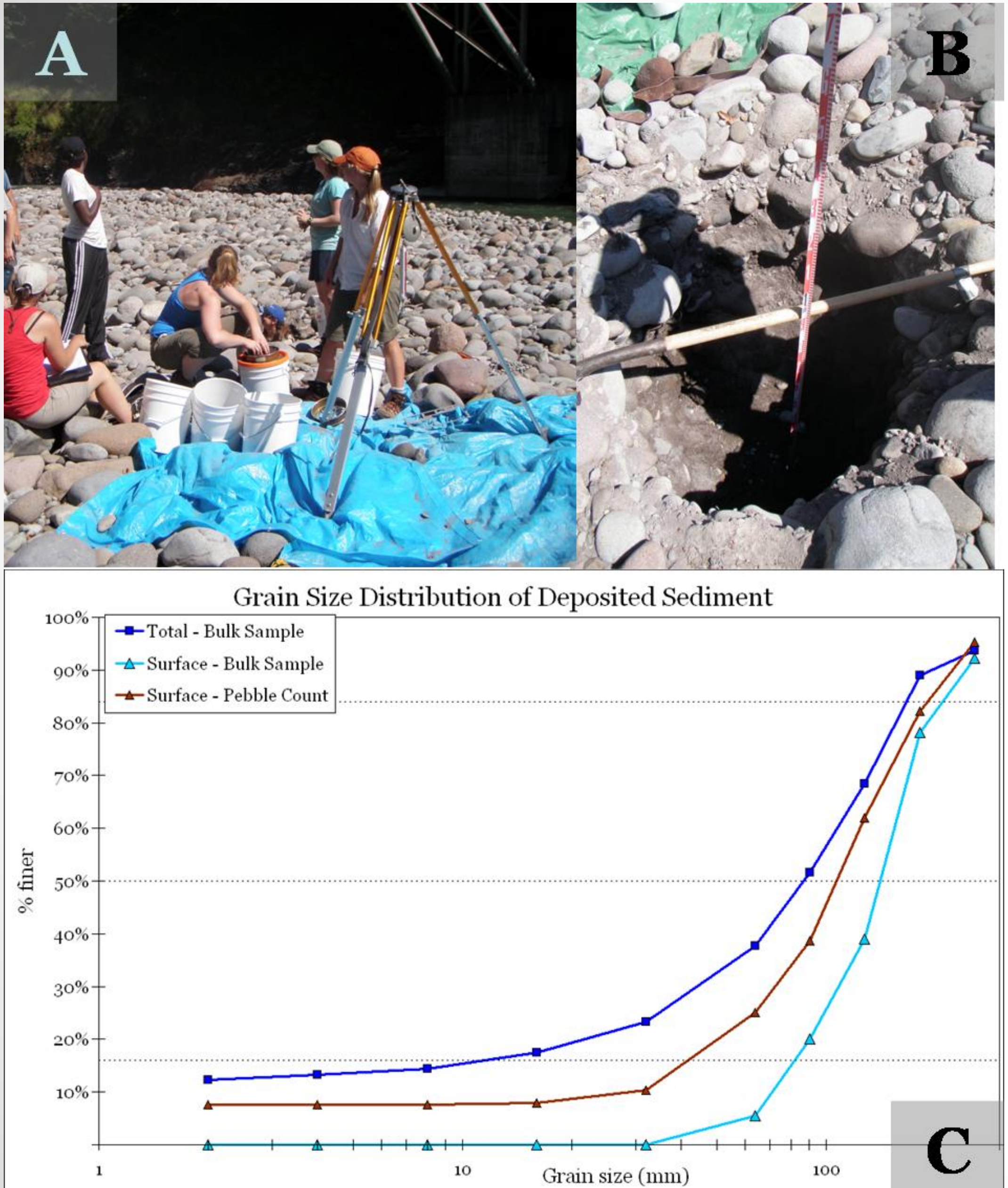


- Involves collecting physical samples of coarse sediment moving along the bed of the channel
- Samples are collected over a range of flows, including floods
- Provides information on the amount and type of sediment moved under different conditions of flow
- Useful for calibrating transport models
- Particularly challenging to collect (feasibility in Coal Creek? Expense?)

Sediment loads: SSC

Crystal River downstream of Coal Creek during summer storm (July 3, 2009)

- Physical samples are collected using a variety of pressure-difference type or automated intake samplers
- Turbidity measurements can be used as a surrogate measure for SSC
- Regression relationship developed between turbidity and physical samples



Channel Bed Materials

- Grain size
  - Pebble counts
  - Bulk samples (subsurface)
- Sediment type (source)

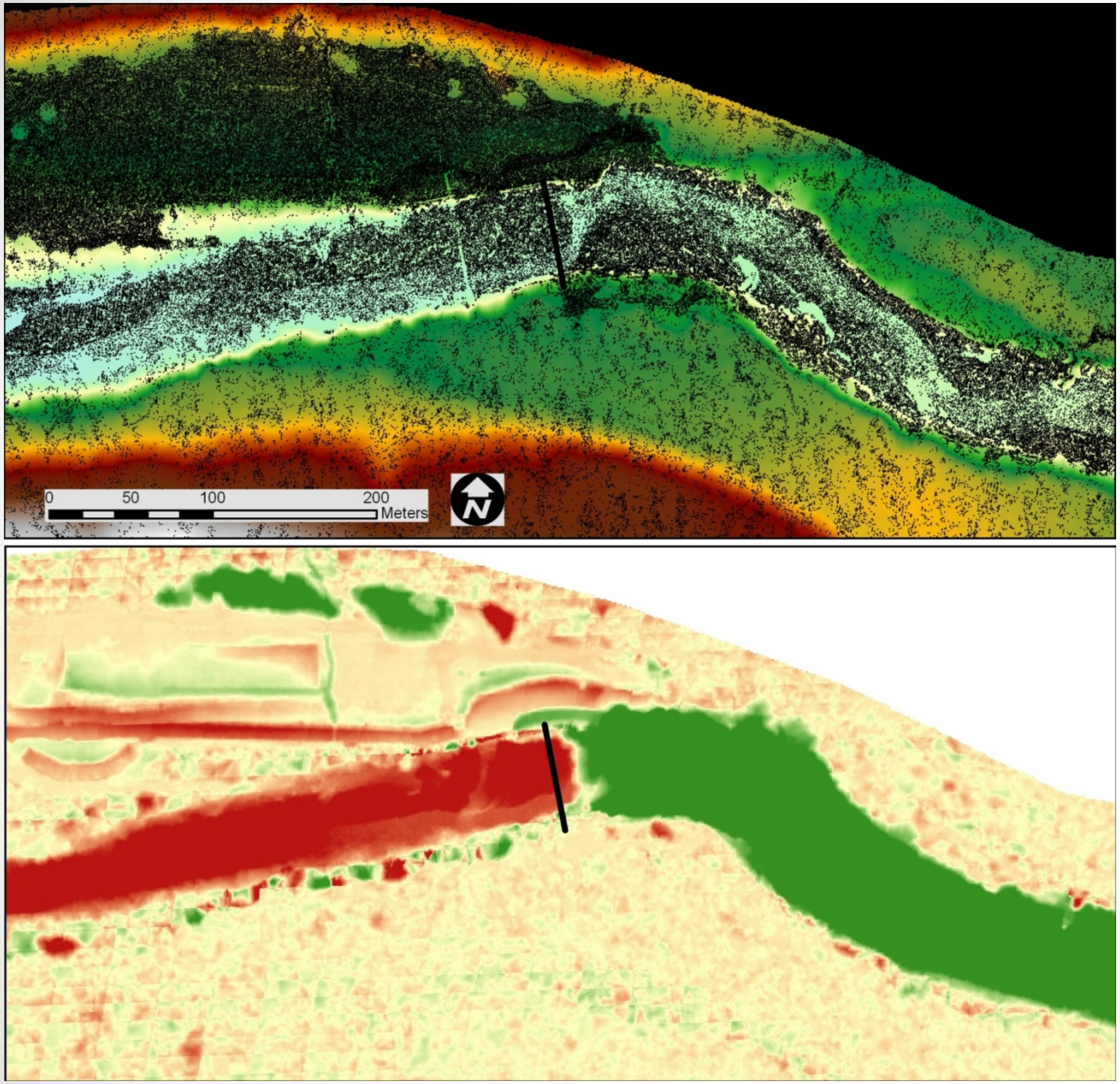
http://serc.carleton.edu/vignettes/collection/37752.html

Channel Surveys

- Channel hydraulic geometry (width, depth, area)
- Roughness estimates
- Slope (local)
- Channel type (step-pool, plane-bed, braided, pool-riffle)
- Gravel bar size/ volume
- Relatively labor intensive. Identify reaches of interest for monitoring

Topography via LiDAR

(Light Detection and Ranging)

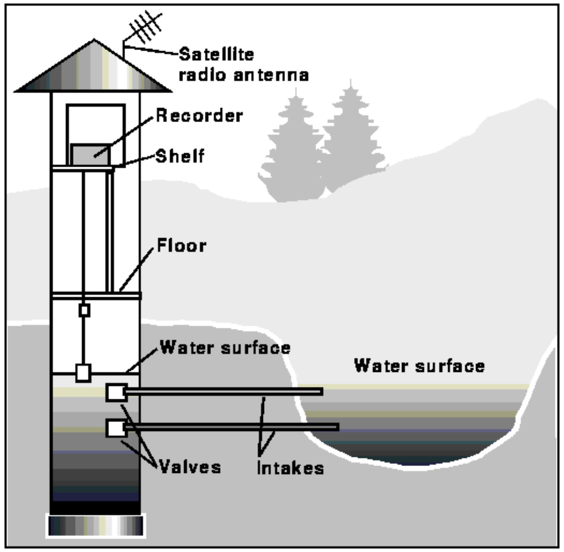


http://serc.carleton.edu/vignettes/collection/37752.html

- Detailed sampling of ground elevations over large areas
- Aerial or ground systems in use
- "Cloud Points" are used to generate DEMs
- Useful for detecting changes in surface elevation
- For Coal Creek – LiDAR may be used to map large areas and detect areas of significant change over time

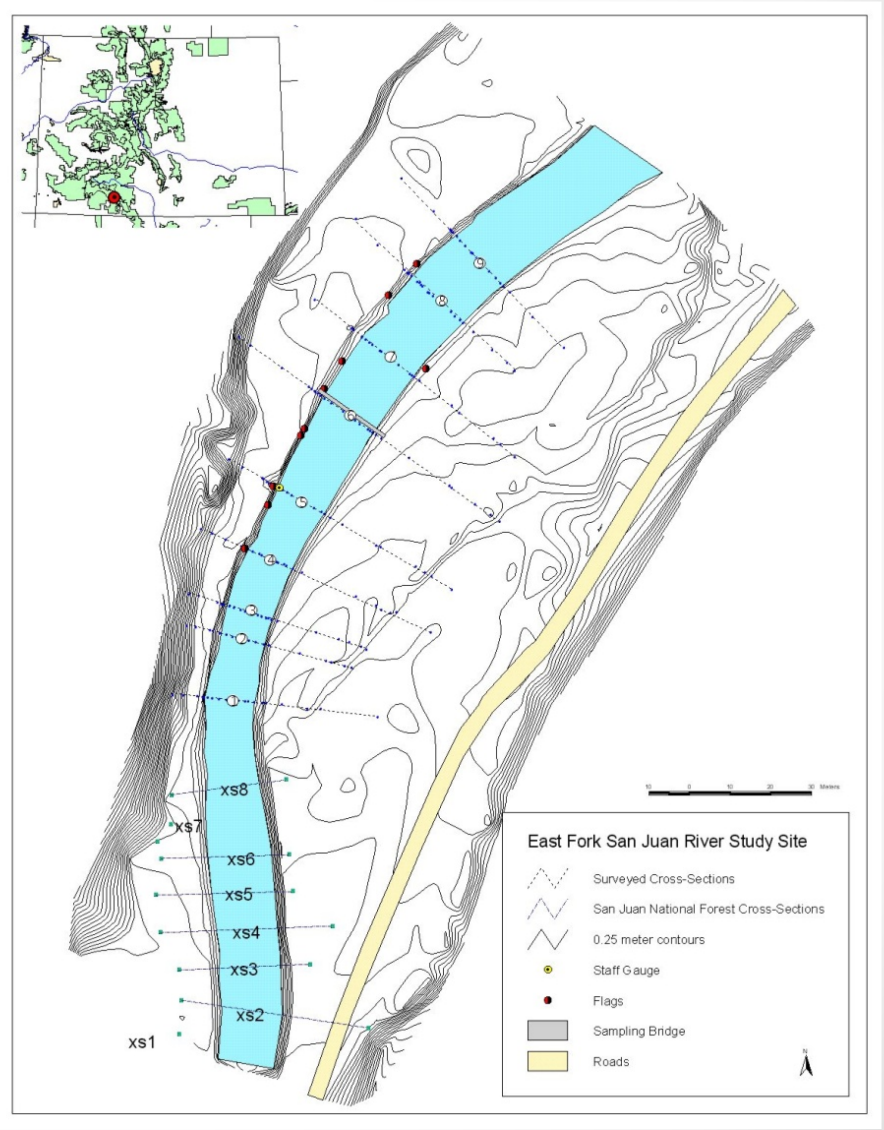
Meteorological/ Hydrological Monitoring

- Precipitation – total and instantaneous (tipping bucket)
- Temperature
- Stage monitoring
- Discharge measurements (current meters or ADV)



Sediment and Hydrologic Modeling

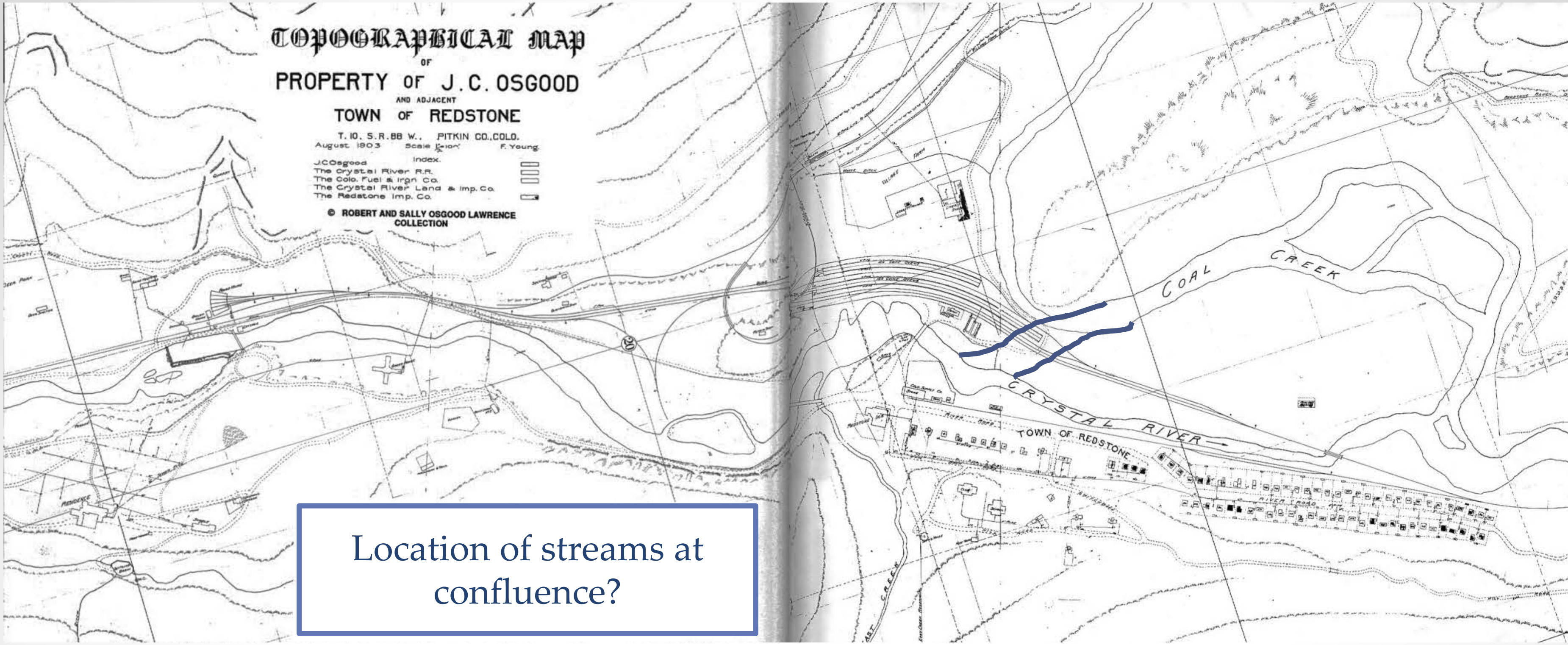
- Need stream survey data to run hydrologic and transport models
- Bedload measurements used to calibrate transport models
- Landslide/ sediment source data used to quantify sediment supply
- Models provide further insight into processes and highlight watershed areas of particular concern



Confluence

Coal Creek and

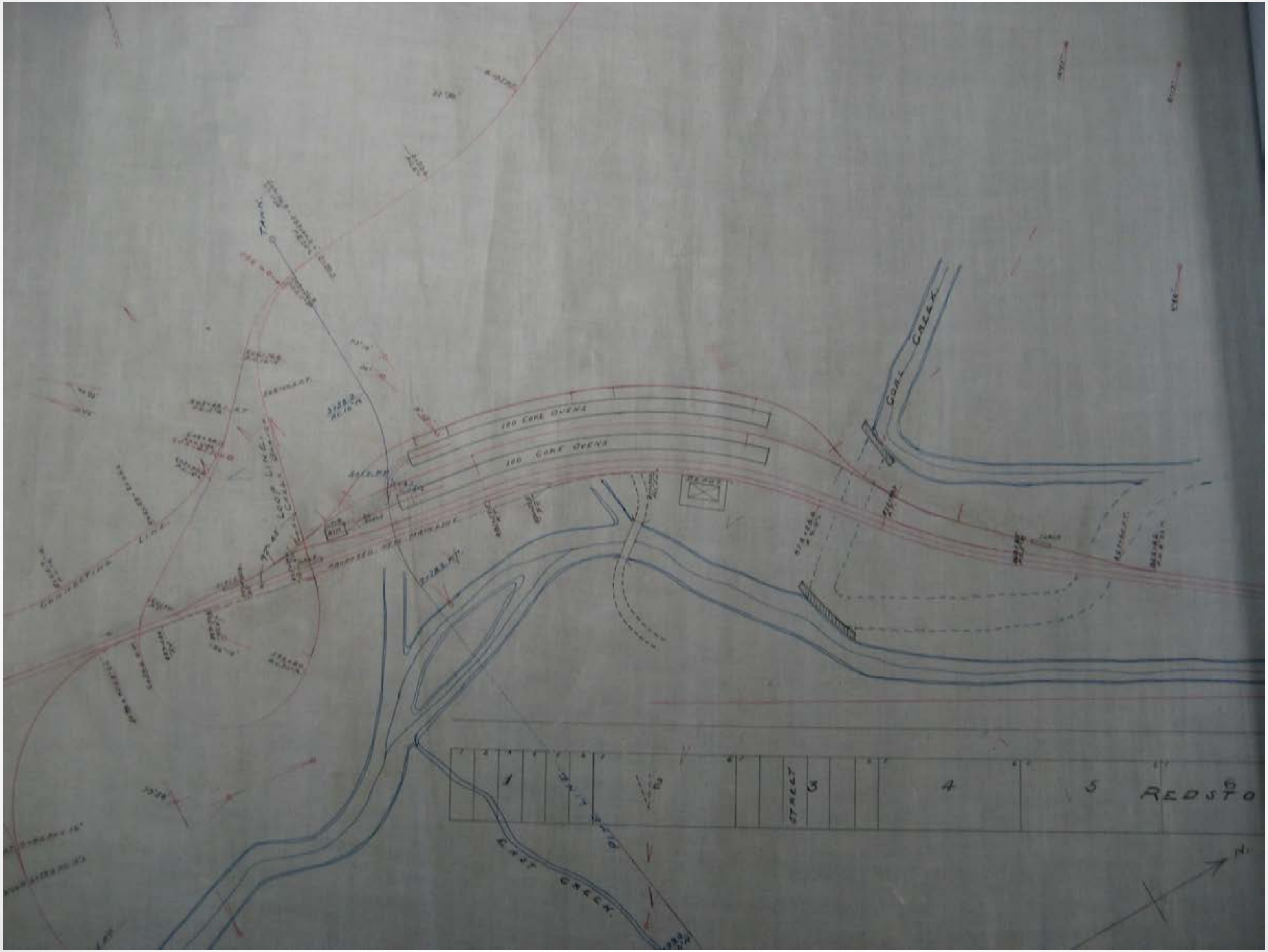
Crystal River



Location of streams at confluence?

From: Marble: A Town Built on Dreams. Oscar McCollum, Jr. 1992.

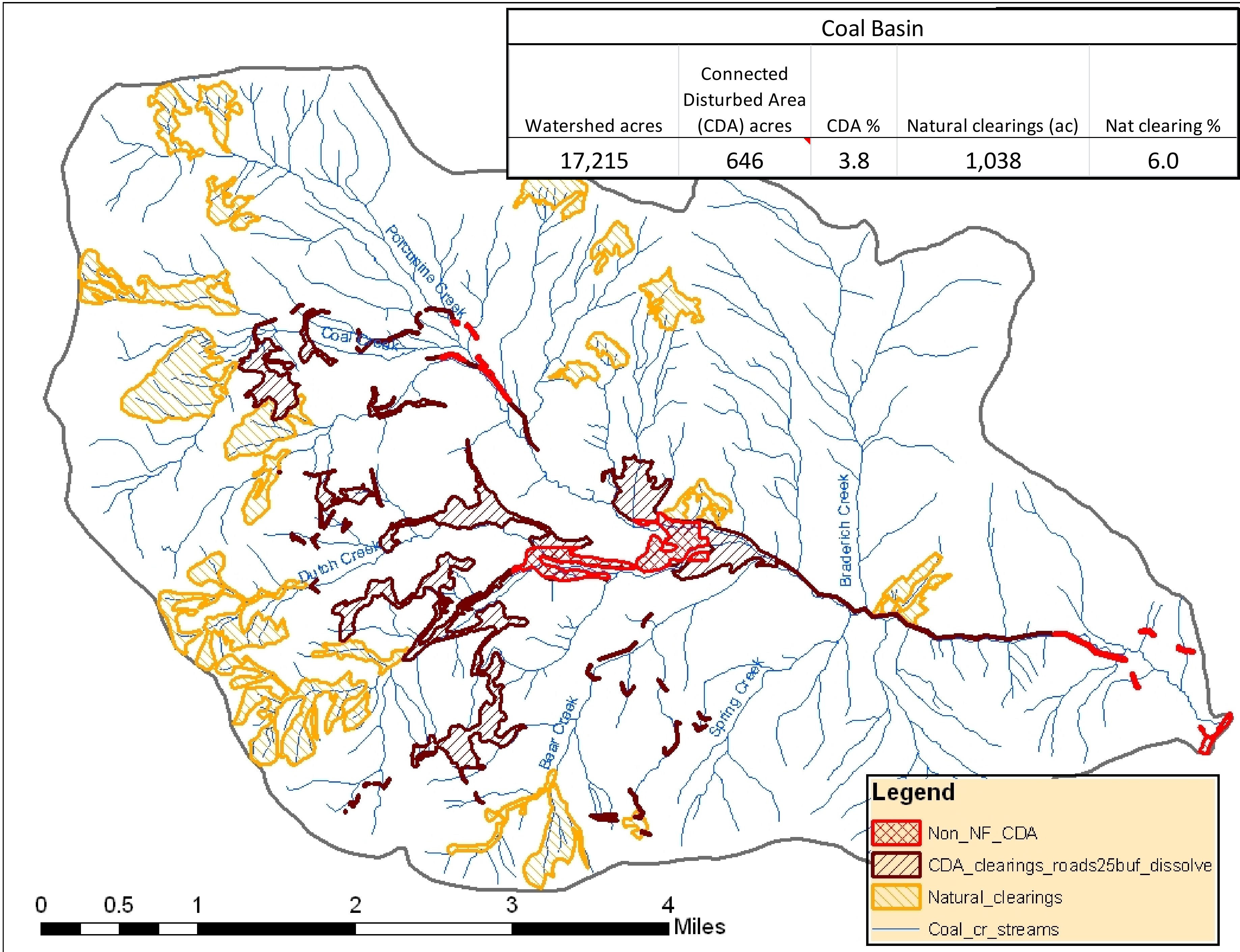
Bessemer Rist Ovens Drawings



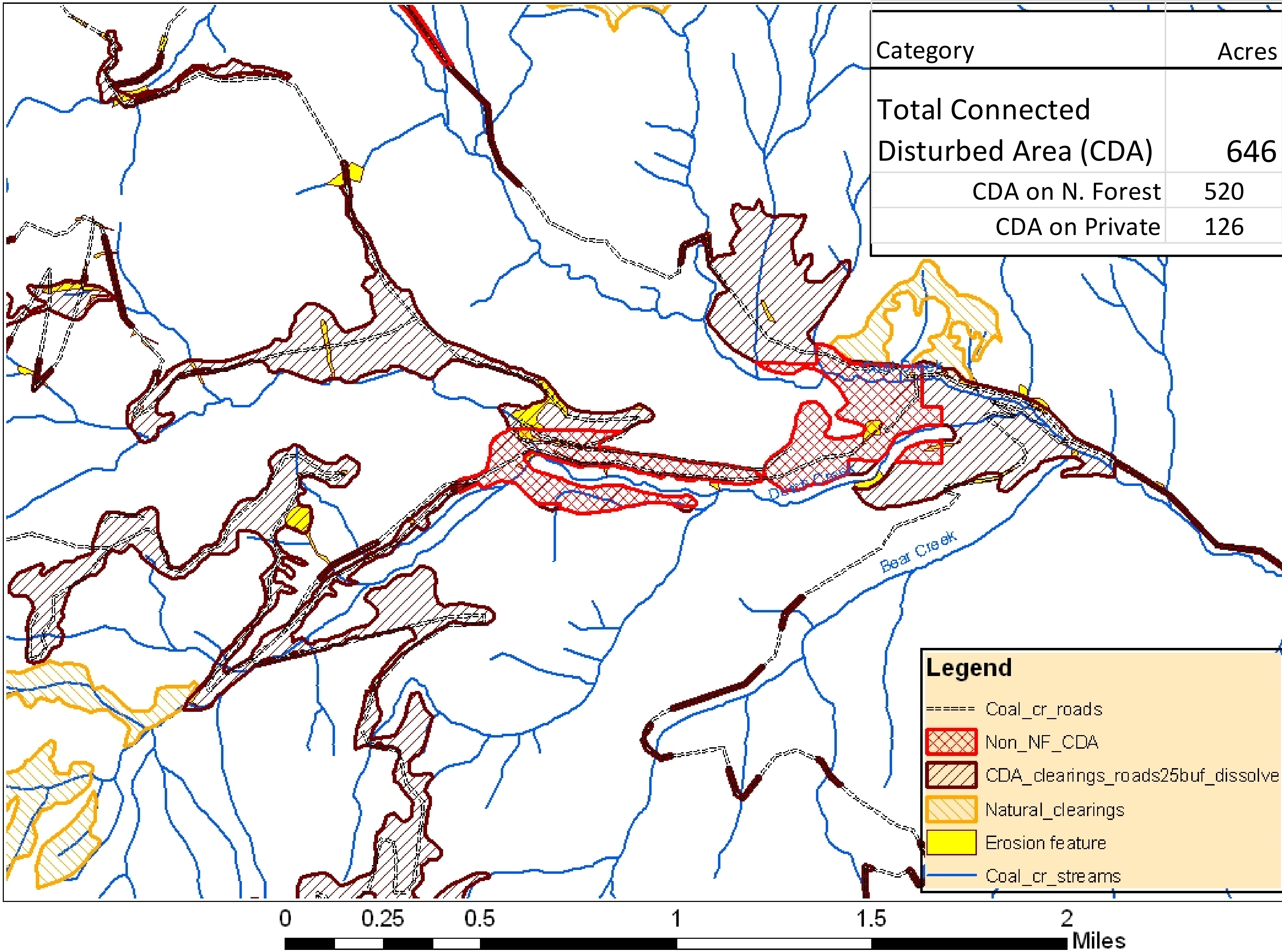
Old Channel at Confluence


Questions?

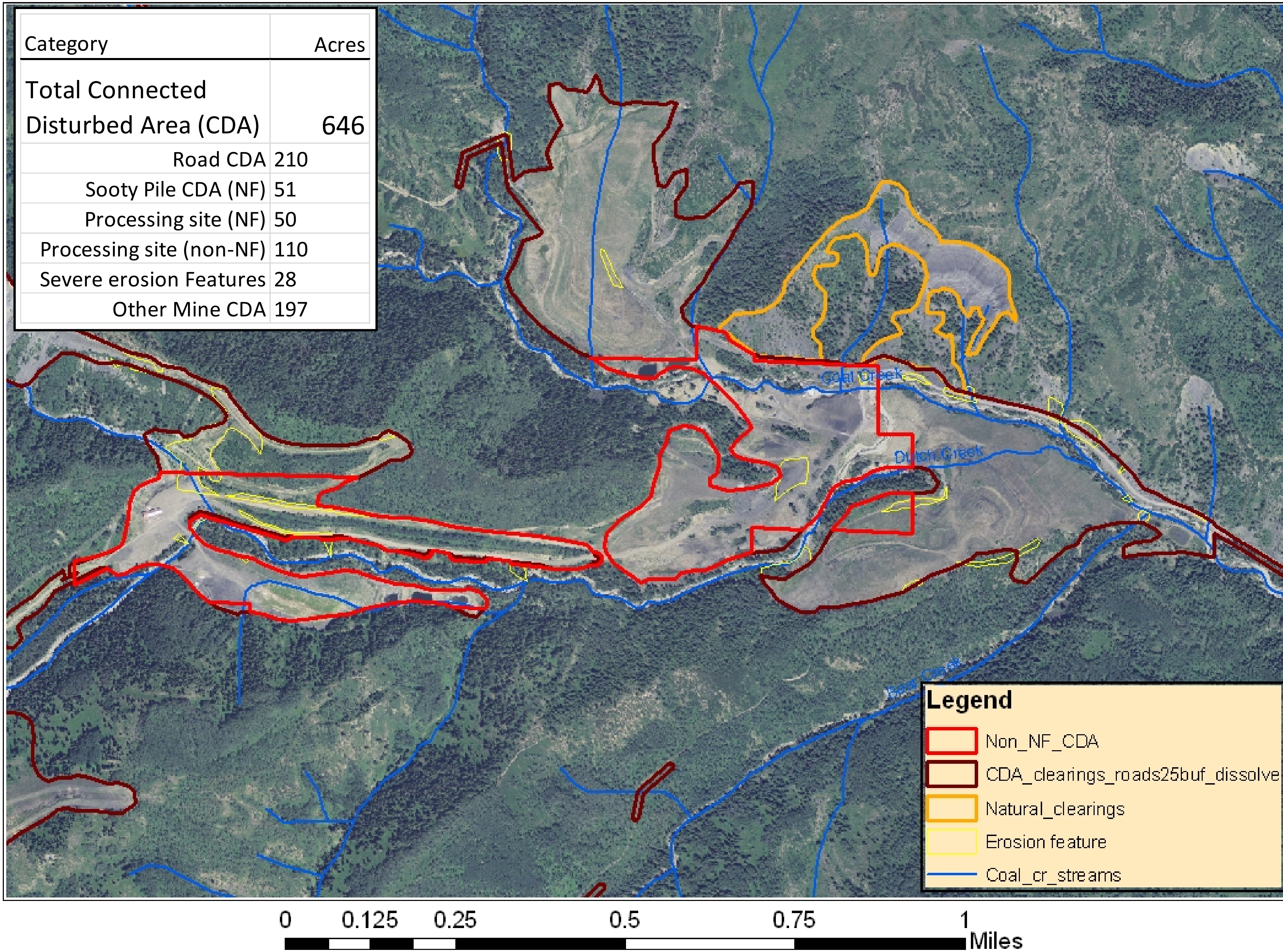
Coal Basin				
Watershed acres	Connected Disturbed Area (CDA) acres	CDA %	Natural clearings (ac)	Nat clearing %
17,215	646	3.8	1,038	6.0



Coal Basin Connected Disturbed Area

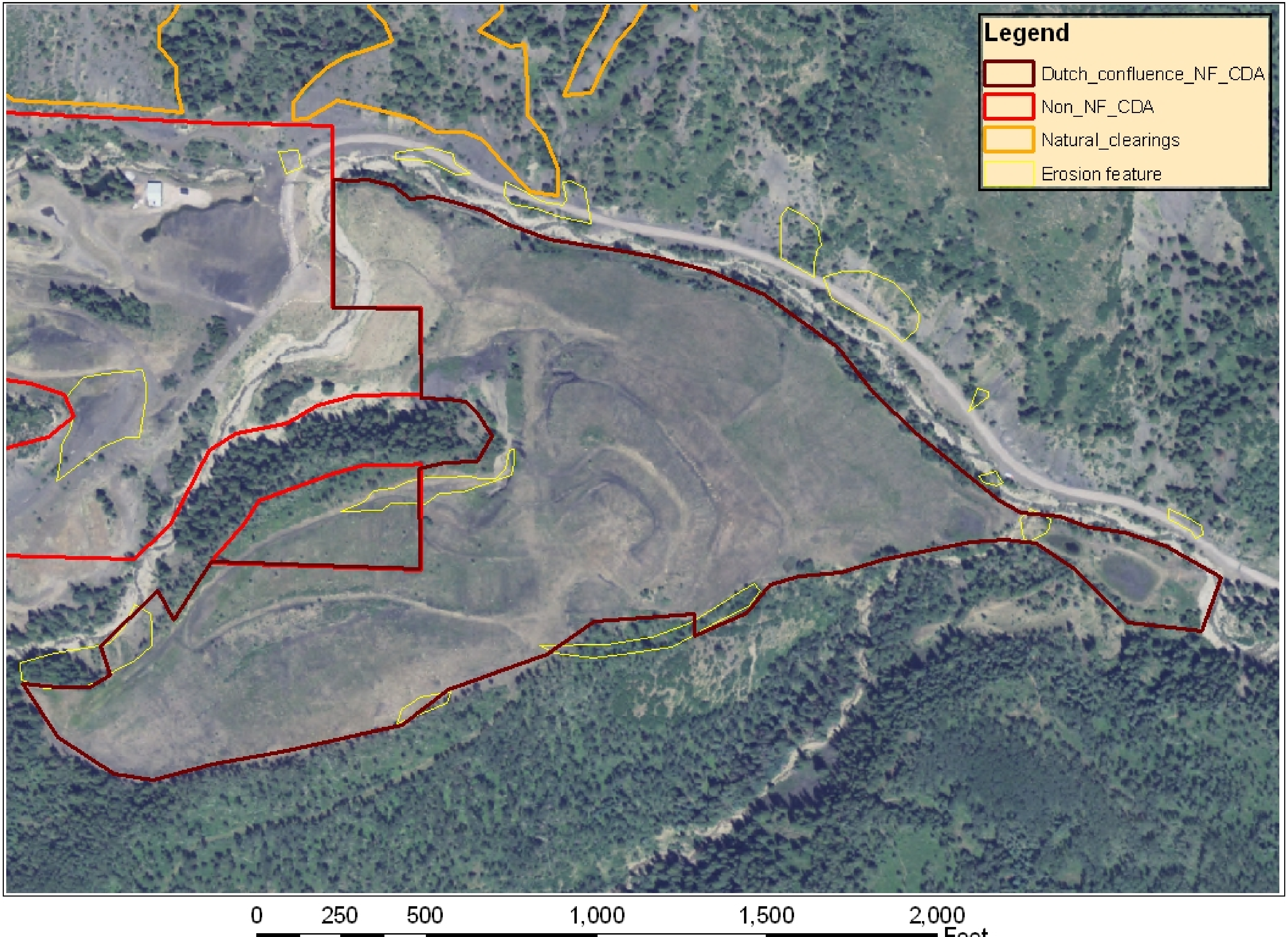


Coal Basin Connected Disturbed Area

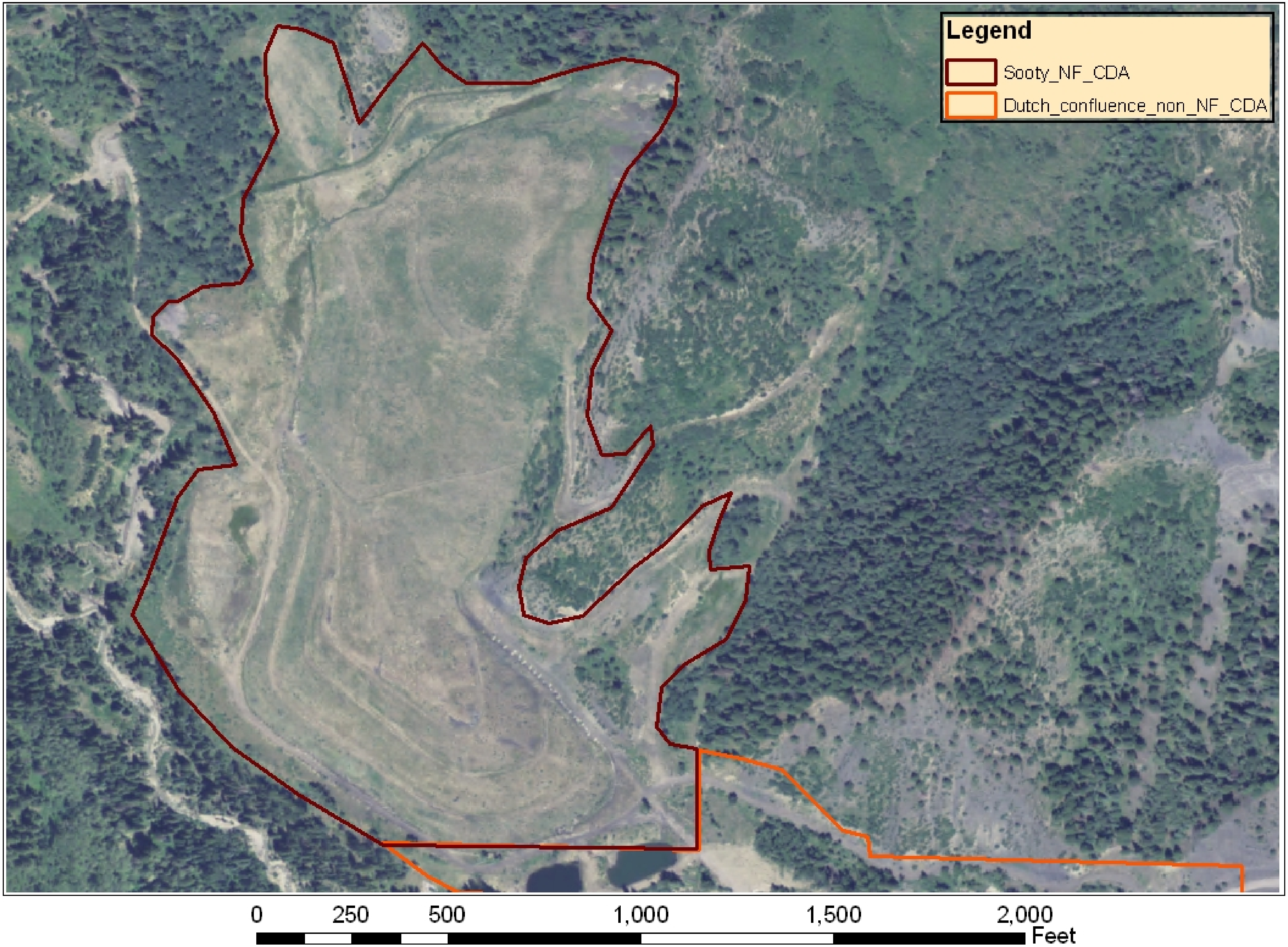


Category	Acres
Total Connected Disturbed Area (CDA)	646
Road CDA	210
Sooty Pile CDA (NF)	51
Processing site (NF)	50
Processing site (non-NF)	110
Severe erosion Features	28
Other Mine CDA	197

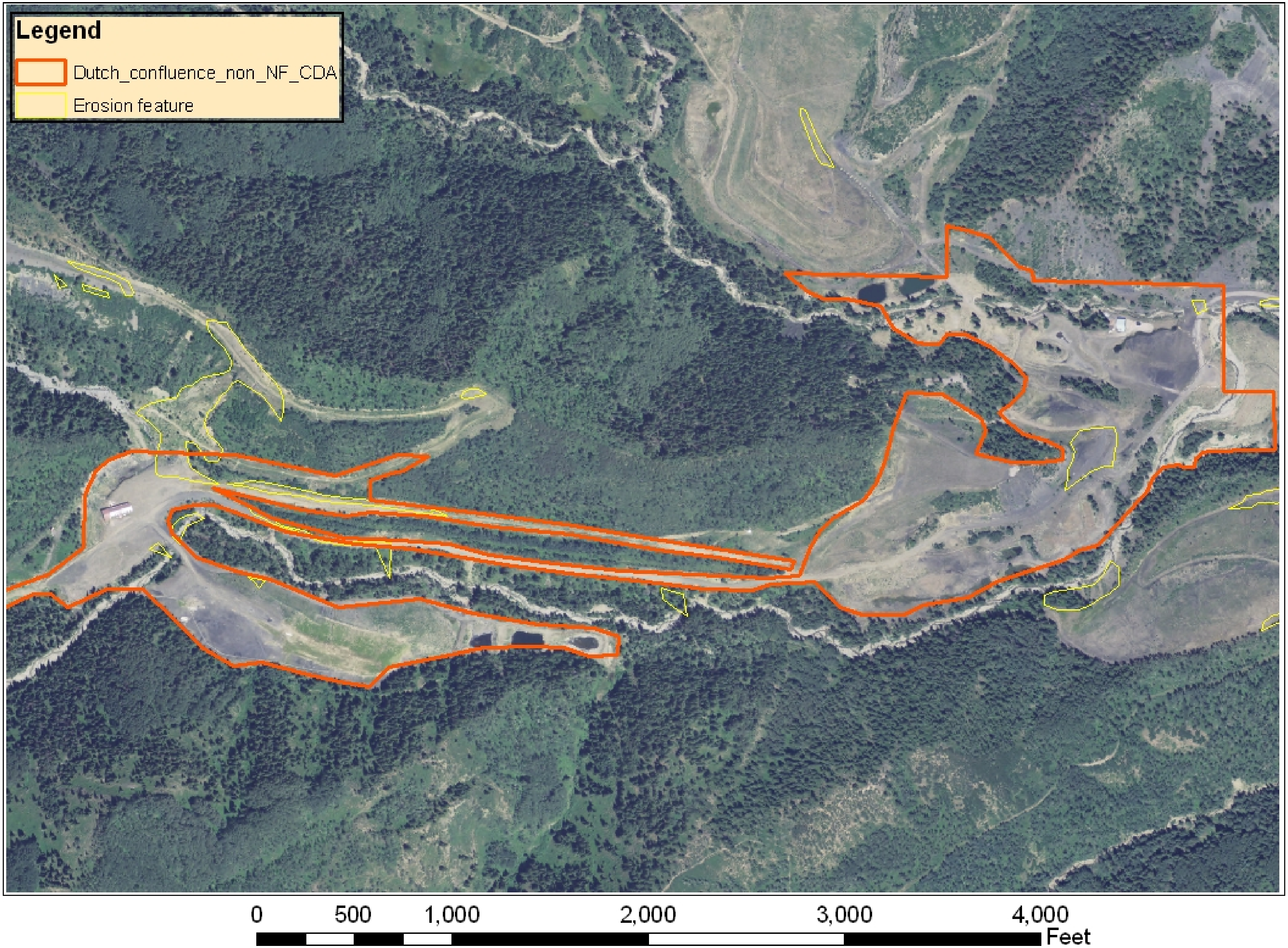
Coal Basin Connected Disturbed Area

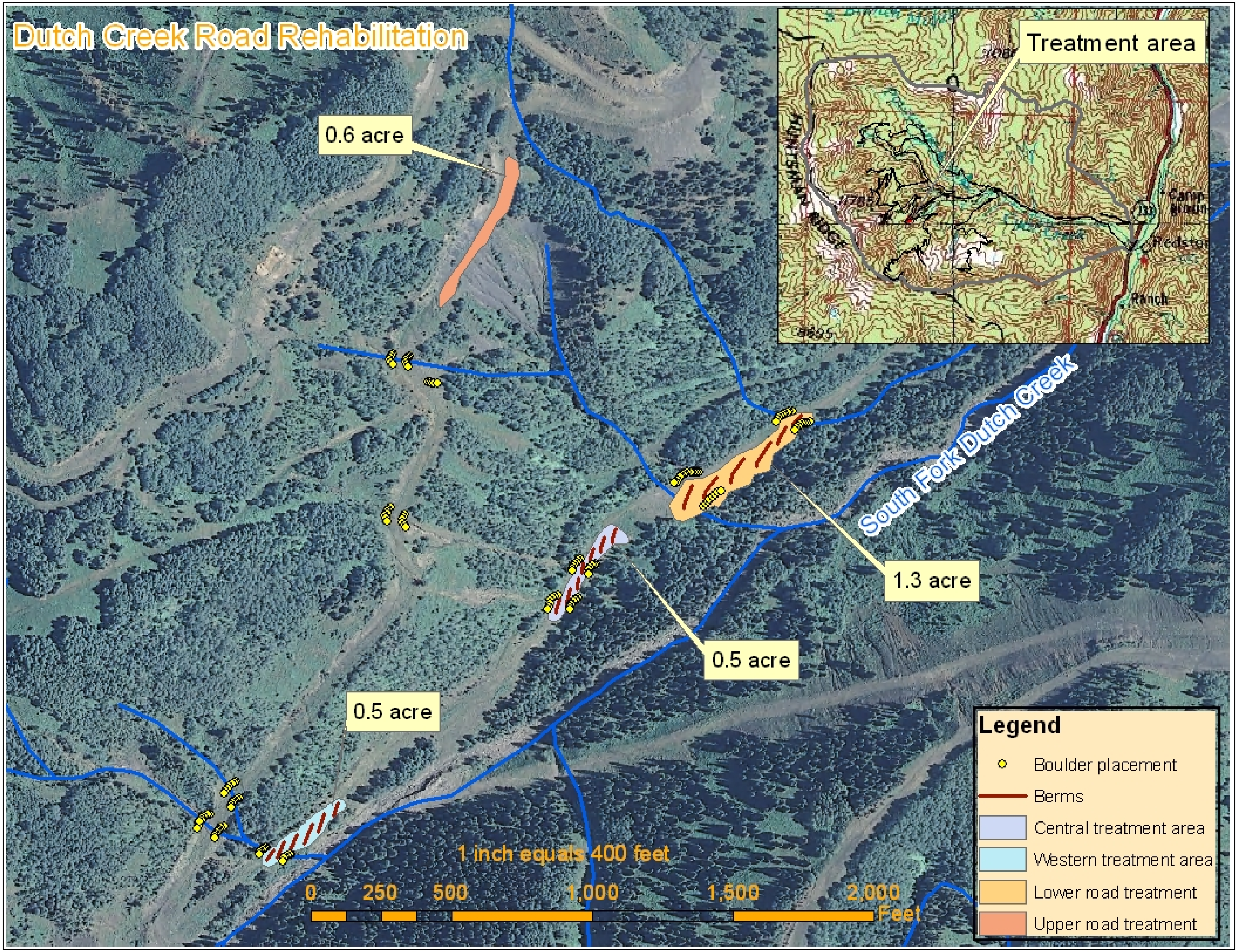


Coal Basin Connected Disturbed Area



Coal Basin Connected Disturbed Area





Dutch Creek Road Rehabilitation
Treatment area
0.6 acre
1.3 acre
0.5 acre
0.5 acre
South Fork Dutch Creek
1 inch equals 400 feet
0
250
500
1,000
1,500
2,000
Feet
Legend
Boulder placement
Berms
Central treatment area
Western treatment area
Lower road treatment
Upper road treatment

Acreage	Char Volume in Cubic Yards (5 tons/acre)	Char Volume in Cubic Yards (10 tons/acre)	Compost Volume (cubic yards)	Compost Cost @ $30/yd^3$	Char Cost (5T/ac)	Char Cost (10T/ac)
0.6 acres	30	60	240	$34,800	???	???
1.3 acres	65	130	520			
0.5 acres	25	50	200	**Compost Cost @ $25/yd^3$**		
0.5 acres	25	50	200	$29,000		
	145	**290**	**1160**			
Pueblo to Coal Basin (Redstone)	298 miles	Pueblo to Glenwood Springs (South Canyon landfill)	269 miles			
Glenwood (South Canyon) to Redstone	31 miles					

Coal Basin Restoration Project: Riparian Vegetation

Kate Dwire

US Forest Service

Rocky Mountain Research Station

Fort Collins, CO

kadwire@fs.fed.us

Coal Creek: Riparian Vegetation

- Reflects physical setting and processes;
- Coal Creek= swift, steep stream; narrow valley & channel;
- Large substrates – cobble to boulder-sized;
- Well-established, older trees occur on narrow benches

Coal Creek: Riparian Vegetation

Douglas Fir (*Pseudotsuga menziesii*)
Narrowleaf cottonwood *(Populus angustifolia)*
Red-osier dogwood (*Cornus sericea*)
Willow spp. (*Salix spp.*)

Carsey et al. 2003. Field Guide to the Wetland and Riparian Plant Associations of Colorado

Coal Creek: Riparian Vegetation

Revegetation requires consideration of:

- establishment requirements of species;
- distribution of substrates & geomorphic surfaces;
- channel processes.

Crystal River: Riparian Vegetation

- Reflects physical setting and processes;
- Crystal River: wide valley, meandering, multi-thread channel;
- Substrates: wide-range of sizes; clay-silt, sands, cobbles.


Crystal River: Riparian Vegetation
Blue spruce (*Picea pungens*)
Narrowleaf cottonwood (*Populus angustifolia*)
Willow spp. (*Salix spp.*)

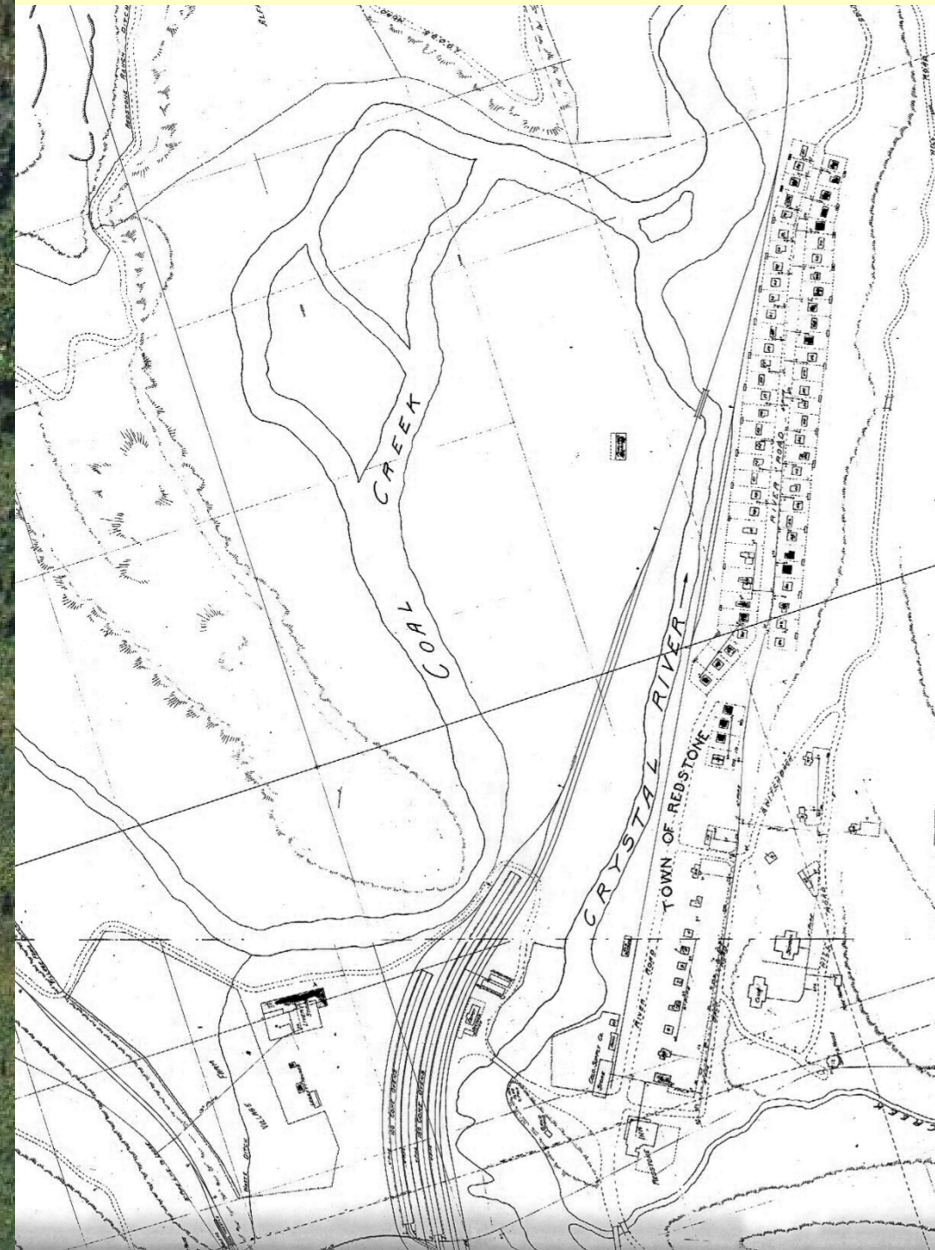
Crystal River - Placita Area

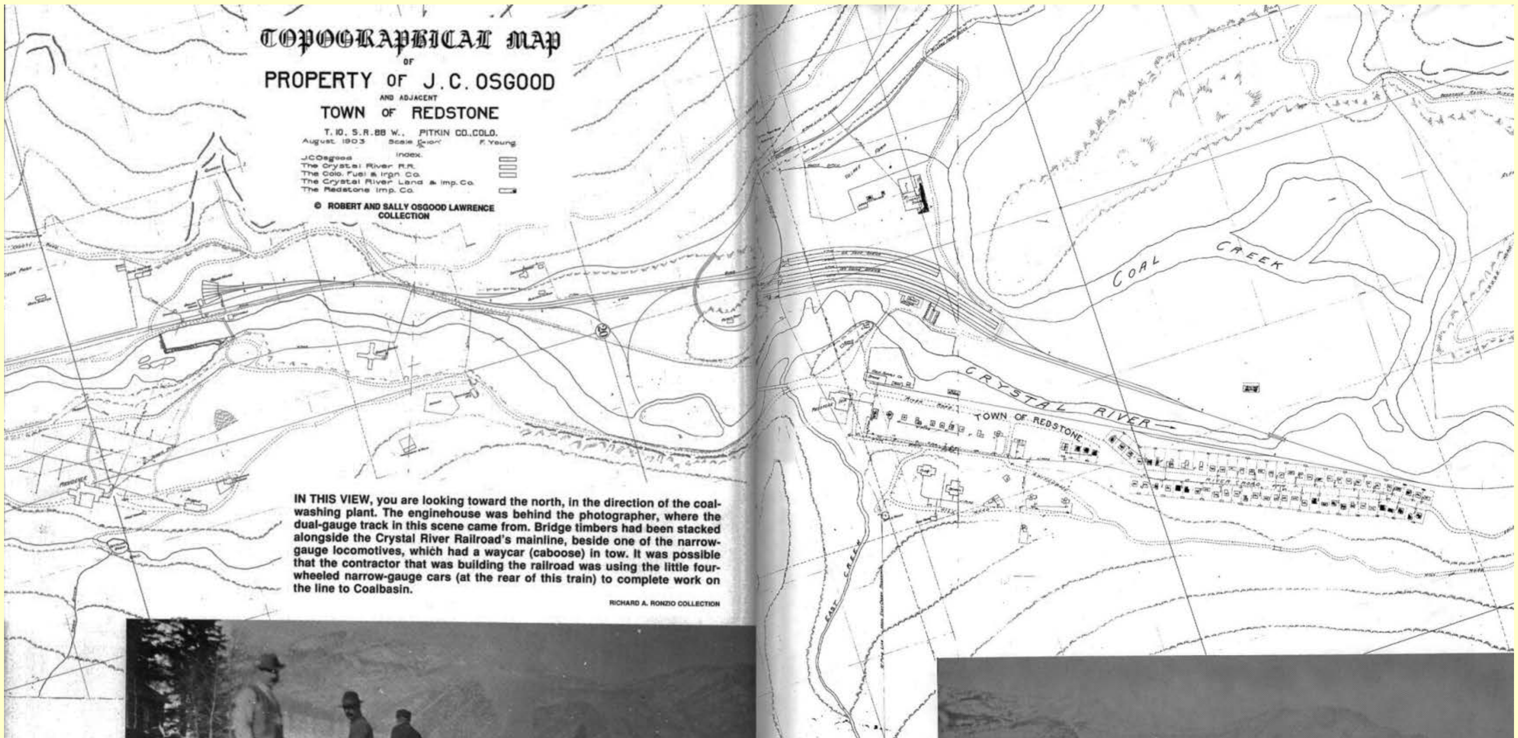
- Complex meandering channel within wide valley bottom
- Hydrologically connected floodplain
- Diverse riparian vegetation reflects geomorphic surfaces

Crystal River - Redstone Area

- Simplified channel, constricted on each side
- High width to depth ratio (shallow and wide)
- Narrowing of historic floodplain (Hwy 133 and Redstone)
- Narrow band of riparian vegetation

1903 Plan Form





© ROBERT AND SALLY OSGOOD LAWRENCE COLLECTION

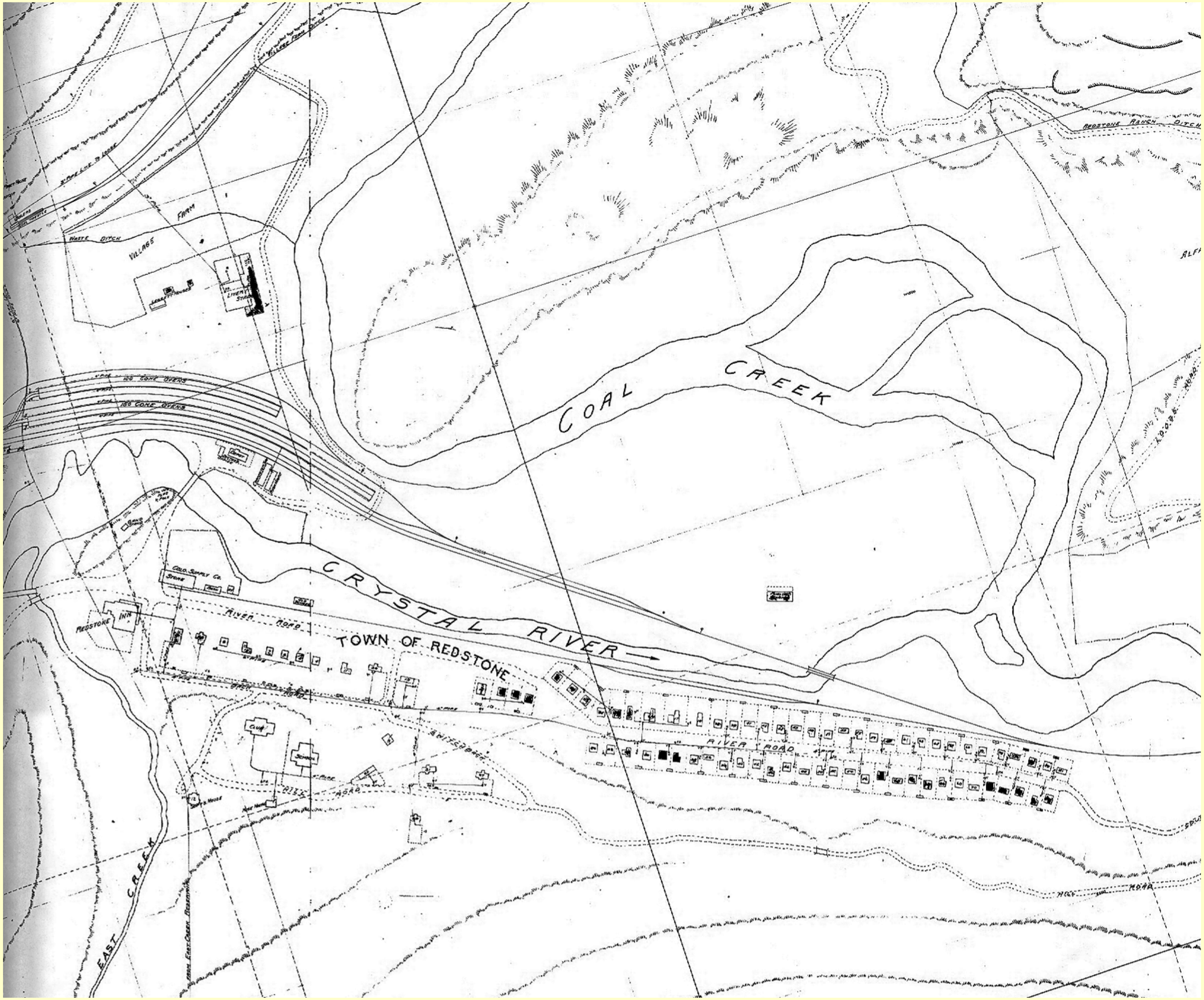
IN THIS VIEW, you are looking toward the north, in the direction of the coal-washing plant. The enginehouse was behind the photographer, where the dual-gauge track in this scene came from. Bridge timbers had been stacked alongside the Crystal River Railroad's mainline, beside one of the narrow-gauge locomotives, which had a waycar (caboose) in tow. It was possible that the contractor that was building the railroad was using the little four-wheeled narrow-gauge cars (at the rear of this train) to complete work on the line to Coalbasin.

RICHARD A. RONZIO COLLECTION

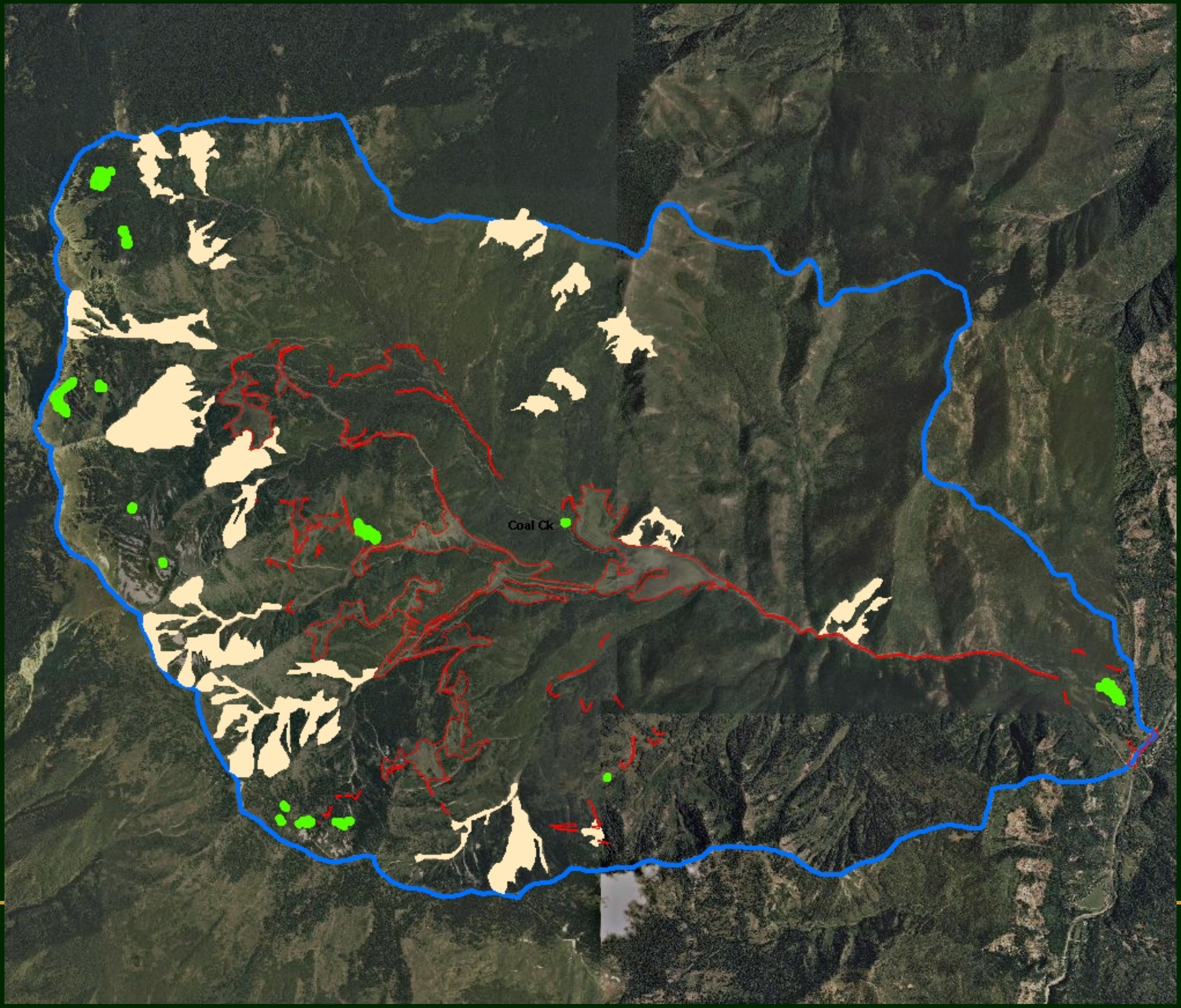
RICHARD A. RONZIO COLLECTION

IN THIS VIEW, the narrow-gauge train being used by the tracklaying contractor was on the Redstone interchange track. The train was near the coal tipple and coal-washing plant (in view at the right).

Confluence: Coal Creek & Crystal River


COAL CREEK
CRYSTAL RIVER
TOWN OF REDSTONE
RIVER ROAD
EAST CREEK
REDSTONE INN
REDSTONE RANCH DITCH

Coal Basin Watershed. Connected Disturbed and Natural Clearings in relation to Potential Fen



Goals for Coal Basin Restoration Area

- Reduce Bare Ground = Increase Plant Cover
- Reduce Release Iron to Coal Creek = Stabilize Connected Disturbed Areas
- Reduce Erosion and Sediment = Increase Bank Armor with Plant Cover
- Reduce Invasive Species Cover = Encourage Resilient Plant Community
- Improve Pollinator Habitat = Increase Diversity & Cover of Flowering Plants
- Restore Fen Function = Verify Fen within Watershed. Determine Condition.

Goals of this Presentation

- Introduce WRNF Native Plant Materials Program.
- Discuss how the Program is working to meet the WRNF Vision and Forest Plan Direction.
  - Implementing Landscape Restoration
  - Connecting People to the Land
  - Stimulating a Restoration Economy
- Discuss the Program’s contribution to Coal Basin Restoration.

The Vision of the WRNF

- We are a 21st century organization, leading the nation in innovative landscape conservation, connecting citizens to the land through world-class recreation, restoring and enhancing resilient ecosystems, and contributing to sustainable economies.

Forest Plan Direction

- **BioDiversity Standard #1.** Use genetically local (at the ecological subsection level) native plant species for revegetation efforts when technically and economically feasible. Use seed mixtures and mulch that are noxious weed-free. To prevent soil erosion, non-persistent, non-native annuals or sterile perennial species may be used while native perennials are becoming established.

- **BioDiversity Guideline #1.** Favor native and desirable non-native plant and animal species over undesirable exotic species during management plan implementation activities. Within designated wilderness, use genetically local native species preferentially.

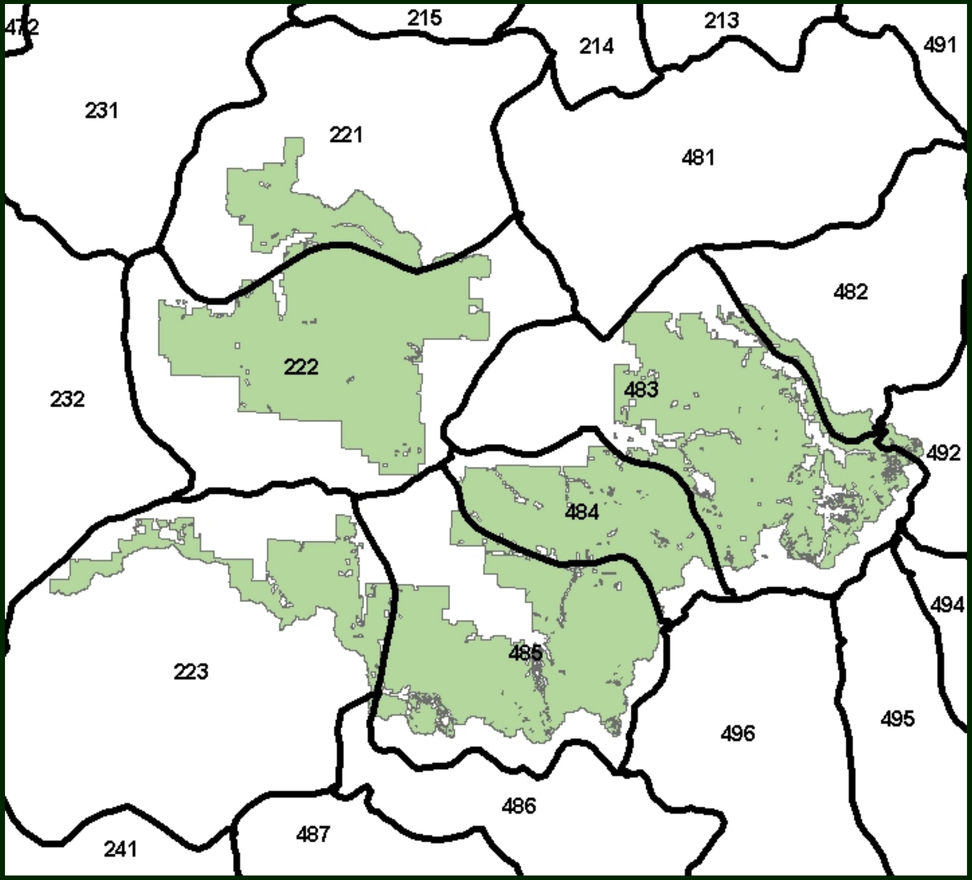
The PROBLEM

- Adequate supplies of genetically local native seed are currently not available for the majority of key plant species needed for large-scale restoration projects on the WRNF

The GOAL of WRNF Plant Program

- Facilitate the Collection and Propagation of local native seed and make them available through the Commercial Seed Industry, to agencies and private land owners for large scale restoration work and to help stimulate restoration economy.

Seed Transfer Zones for the WRNF

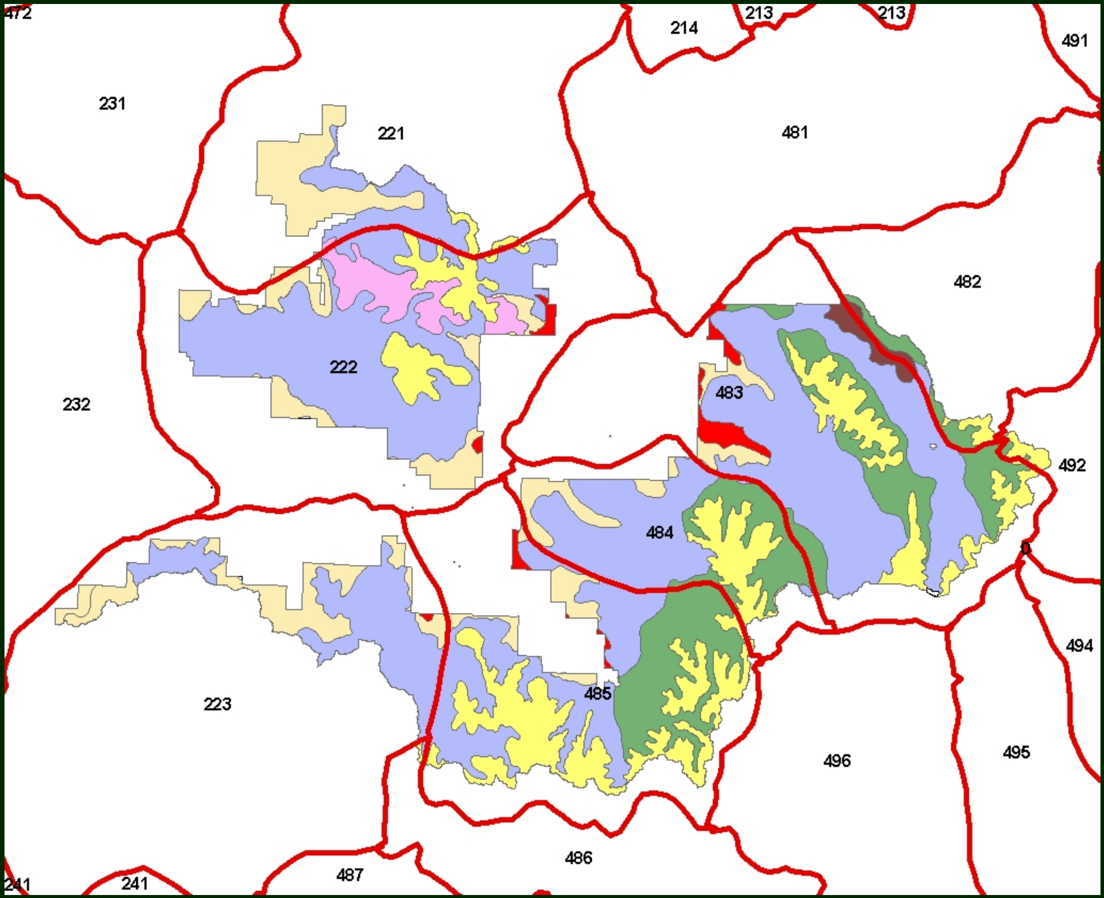


Seven Seed Zones Overlap the WRNF. These Zones Derived by Ecological, Physiographic and Climatic Environmental Gradients.

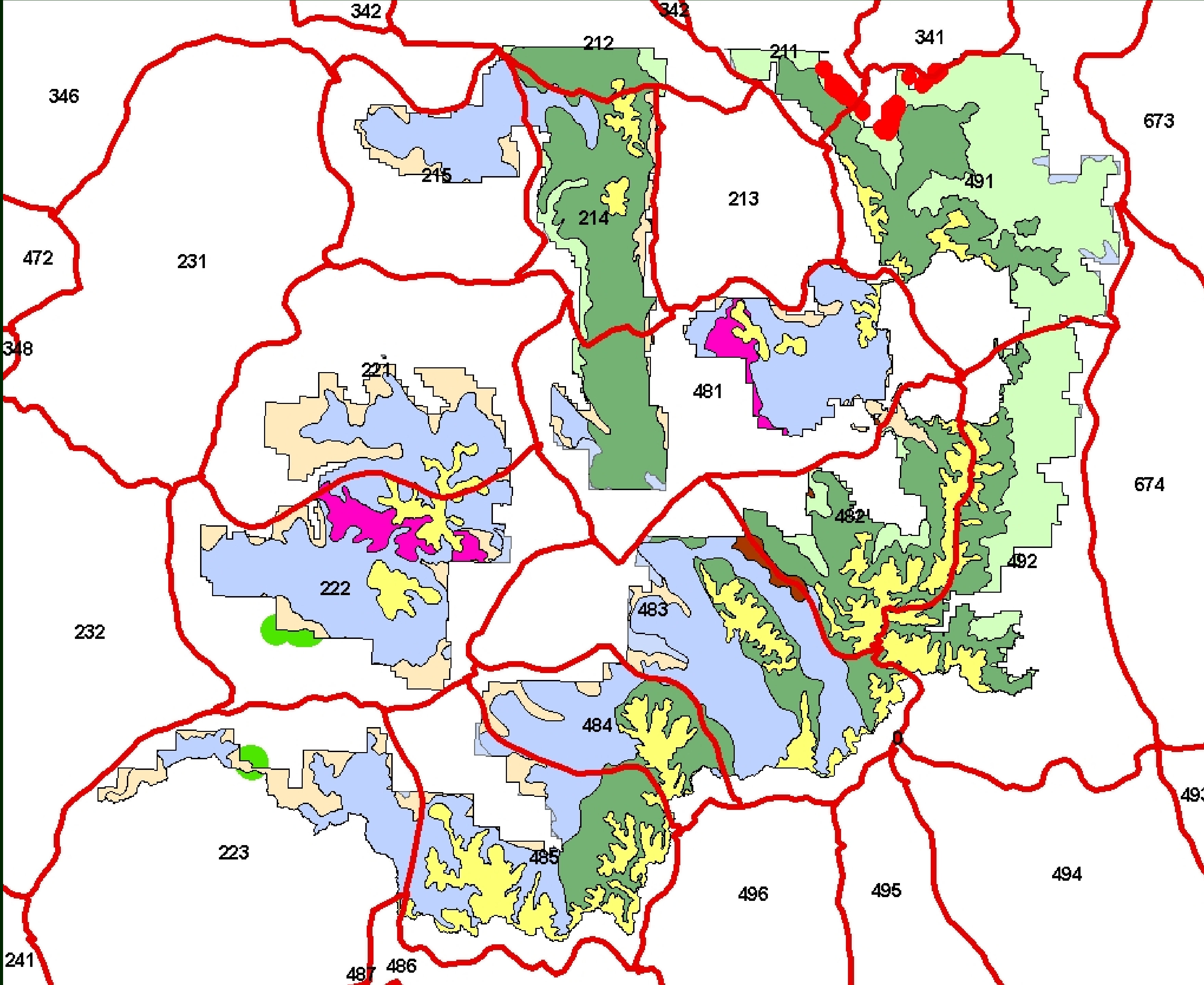
Seed Zones Mitigate Negative Consequences:

- Avoid Out-right failure
- Poor performance over time (geographic and elevational impacts)
- Contamination of native gene pools
- Non-natives behaving as noxious weeds or overly competitive natives

Ecological Subsections for the WRNF



Level 4 Eco-Region Subsections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484
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496
495
241
487
486

#1 Mountain District Broad Spectrum Upland Mix

Suggested for the following sites: disturbed ground in aspen or coniferous cover types, mesic to dry mountain meadows, and sagebrush or mixed mountain shrub sites with at least moderately deep soils; montane and subalpine zones.

Species	Percent of Mix by Weight
Sandberg bluegrass (*Poa secunda)*	4
Mountain bromegrass (*Bromus marginatus*)	40
Blue wildrye (*Elymus glaucus)*	33
Slender wheatgrass (*Elymus trachycaulus*)	23
Total	100

How Do we Get There?

- To make a species ready for commercial production, 100 – 300 lbs of quality seed stock are needed.

Seed Collections

- In 2009 and 2010 viable seed for the species listed above were collected from the WRNF.

USFS Lucky Peak Nursery (Boise, ID)

Blue Wildrye – 2011 Yields

- 76 pounds harvested in July 2011. Two more acres will be planted at LPN

Sandberg Bluegrass – 2011 Yields

Great Establishment but No Seed Yields in 2011. Typically Year 2 and 3

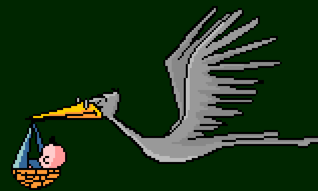
Slender Wheatgrass – 2011 Yields

This one acre plot yielded 450 pounds of raw material in July 2011!

Mountain Brome – 2011 Yields

- This one acre plot yielded 415 pounds of raw material in July 2011!

First Yields = Additional Production and Field Trials



Does it make sense to use ecotypic sources in areas previously seeded with Cultivars?

1st Production Contract (IDIQ) SW Seed in Delores, Colorado

Second Step Increase Mountain Brome and Slender Wheatgrass

Tutelage from Randy Mandel
How to Collect, Process and Grow Various Forbs

- Species easy to collect, easy to grow and colonize early seral habitats

Tech Transfer toVolunteers and Forest Employees




Despite Multiple Challenges

We Succeeded at Collecting Viable Seeds for 4 forbs and 2 shrubs

- The seeds were planted at USFS Bessie Nursery, Halsey NB

Demonstration Planting to Evaluate Utility in Increasing Forb Diversity on Suety Piles

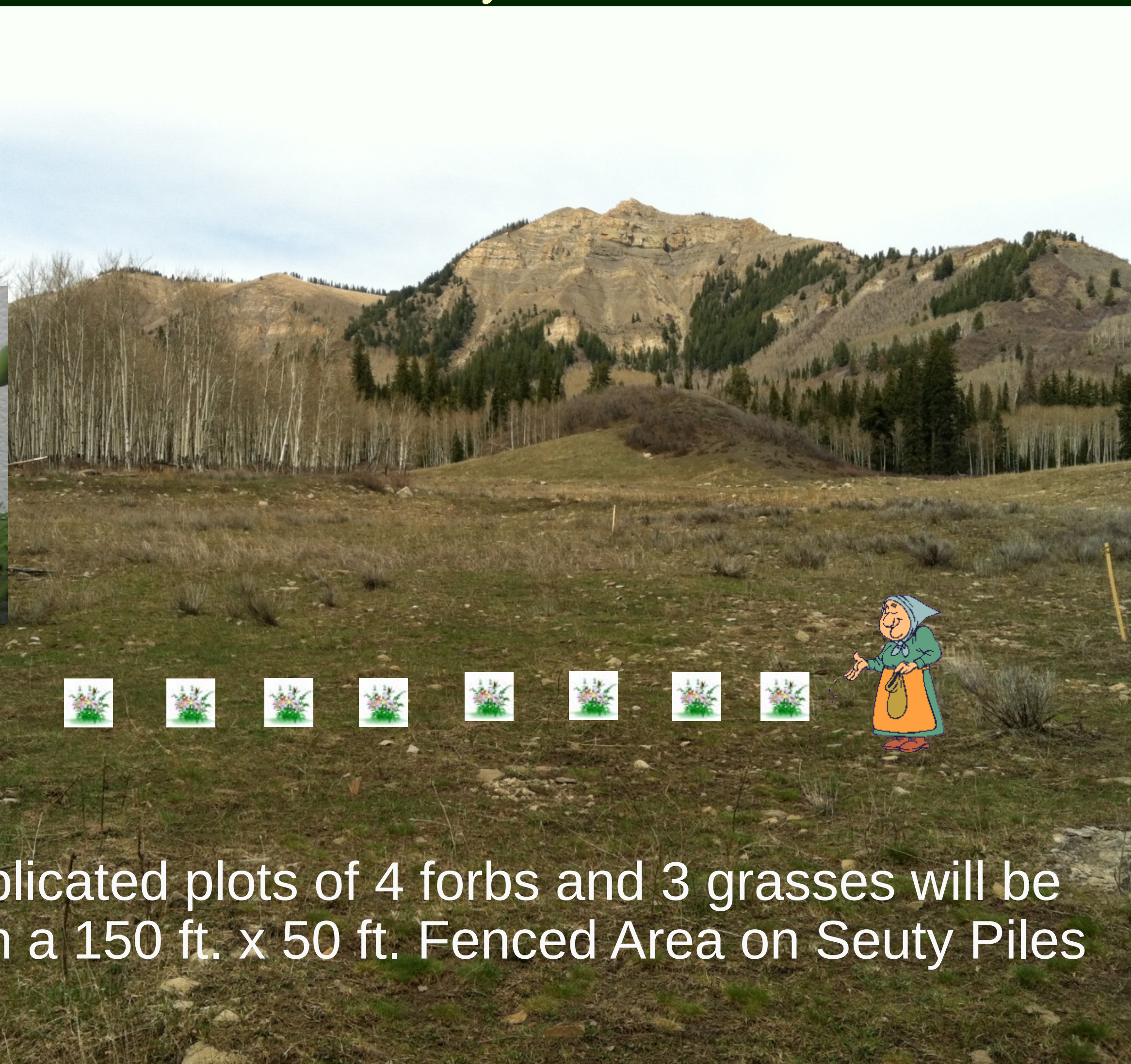
- Columbine

- Geranium

- Jacob's Ladder

- Smooth Aster

Common Garden Study/ Field Demonstration On Suety Piles:



Three replicated plots of 4 forbs and 3 grasses will be planted in a 150 ft. x 50 ft. Fenced Area on Seuty Piles

Demonstration Planting Suety Pile

- The goals of the common garden study are :
  - Provide a demonstration and field evaluation planting area for local native materials.
  - Demonstrate tools and techniques for the USFS to determine the cost-to-benefit ratio for potential future projects.
  - Reduce the release of iron into the Coal Creek Watershed.
  - Increase pollinator habitat with forb diversity.
  - Serve as a genetic repository and increase for site-specific ecotypes.

Long Stem Planting Technique

To Armor and Enhance Stream Banks

Goals of Longstem Riparian Demo

- Provide a demonstration and field evaluation planting area for local native materials.
- Reduce erosion and mass wastage by armoring and enhancing the stream bank.
- Create wildlife and plant habitat.
- Demonstrate tools and techniques as well as the cost-to-benefit ratio fo future projects.
- ☐Reduce iron and sediment flow into the Coal Creek Watershed.
- Serve as a genetic repository and increase for site-specific ecotypes.

- specific techniques to be employed at this site are as follows:
- 1. The utilized plant species will include Salix exigua, Salix monticola, Salix drummondiana, Salix lasiandra, Salix geyeriana, Alnus incana, and Populus angustifolia.
- 2. 8 species x 25 plants per species equals 200 plants. A. 200 plants x $12 per plant equals $2400 for plants plus estimated 10% shipping cost.
  - B. Therefore, $2640 before consulting
  - C. Plant materials need to be approximately 12-ft long and should be grown for 3 years.
  - D. Materials chould be installed internally with USFS personnel.
- 3. Equipment: $500/day x 4 days equals $2000.
- 4. The total cost is estimated at $4640 before consulting services from Mr. Randy Mandel, Senior Restoration Ecologist, Golder.
- 5. Equipment necessary for installation will be a tractor with minimum of 65 horsepower and a 4-ft auger of 6-in. to 9-in. diameter plus a 4-ft extension.
- 6. The USFS will need to identify a nursery to grow out the material. This task will also include a technology transfer from USDA NRCS Los Lunas Plant Materials Center.
- 7. The utilized spacing will be on **3-ft centers,** hence 80 plants per each side of the stream.

Questions?

In Closing:

#2 Mountain District Shallow Soil Foothill/Montane Upland Mix

Suggested for the following sites: shallow soil non-forested sites (such as sagebrush or mixed mountain shrub ridgetops or sideslopes).

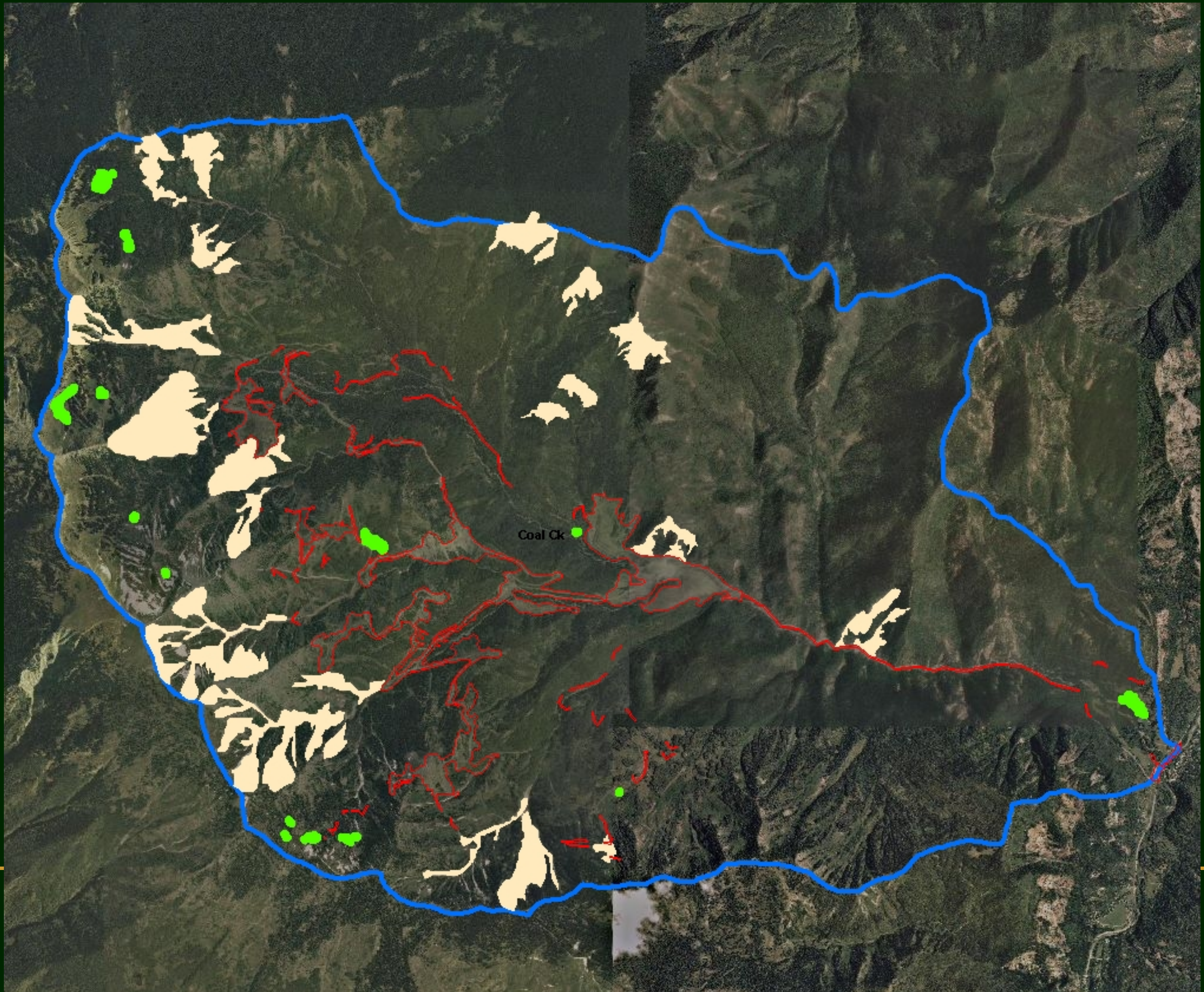
Species	Percent of Mix by Weight
Sandberg bluegrass (*Poa secunda*), or Canby bluegrass (*Poa canbyi*)	5
Prairie junegrass (*Koeleria macrantha,* formerly *Koeleria cristata*)	2
Bottlebrush squirreltail (*Elymus elymoides*, formerly *Sitanion hystrix*)	22
Western wheatgrass (*Pascopyrum smithii*, formerly *Apropyron smithii*)	40
Bluebunch wheatgrass (*Pseudoroegneria spicata)*	31
Total	100

Alpine Meadow Mix

Suggested for the following sites: moderately moist alpine meadows and slopes (for soils that are perennially wet see the Riparian Seed Mix below.) **Suggested seeding rate:** 10-15 lbs/ac

Species	Percent of Mix by Weight
Alpine timothy (*Phleum alpinum*)	40
Alpine bluegrass (*Poa alpina*)	40
Tufted hairgrass (*Deschampsia cespitosa*)	20

Coal Basin Watershed – Connected Disturbed Areas, Natural Disturbed Areas and Fens



WRNF Native Plant Material Program


ACE
The helpful place
ACE
The helpful place

Common Gard

The project will establish a common garden study at t

Common Garden Demonstration

This project will field evaluation planting area for local native plant materials.

The Seed Sources Would Be Used To Accomplish:

- Burned Area Recovery
- Soil Stabilization
- Wildlife Habitat Improvement
- Weed Control
- Campground Rehab
- Landscape Restoration
- Other Projects on Federal, State and Private Lands.

Native Plant Materials Demonstration Cost = $

- This project will establish a common garden study at the new trail head

Seed Transfer Zones
Are Developed Considering;

- Latitude and longitude
- Elevation
- Climatic variables,
- Ecologic and Physiographic
- Zones can be Refined for individual species
  - Based on known patterns of genetic variation
    - Often determined from Common Garden Studies
    - Genetic Modeling

Sandberg Bluegrass – One Acre in 2010

Expect Seed Yields in 2011, 2012 and 2013.   Up to 200Lbs. Total

Blue Wildrye – 1/3 Acre

Expect Yields in 2011, 2012 and 2013. Up to 300 Lbs. Total.

Slender Wheatgrass, One Acre in 2010

Expect Yields in 2011, 2012 and 2013. Up to 600 LBS Total

Mountain Brome – One Acre in 2009

Yielded 20 LBS in 2010. Additional Yields in 2011 and 2012. Up to 600#








8 BRMA4. 15090094

The Seed Sources Would Be Used To Accomplish:

- Burned Area Recovery
- Soil Stabilization
- Wildlife Habitat Improvement
- Weed Control
- Campground Rehab
- Landscape Restoration
- Other Projects on Federal, State and Private Lands.

Biochar: A Nexus for Low Value Woody Biomass and Reclamation in the Intermountain West

www.biocharsolutions.com

So What is Biochar?

Biochar is an engineered carbon-rich product produced when biomass is heated in a closed container with limited air and is intended for use as a soil amendment.

BIOCHAR SOLUTIONS

So What is Biochar?

Forest biomass

Biochar is an engineered carbon-rich product produced when biomass is heated in a closed container with limited air and is intended for use as a soil amendment.

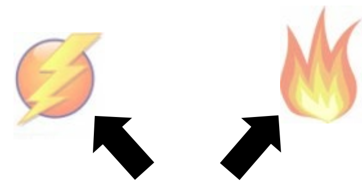
So What is Biochar?

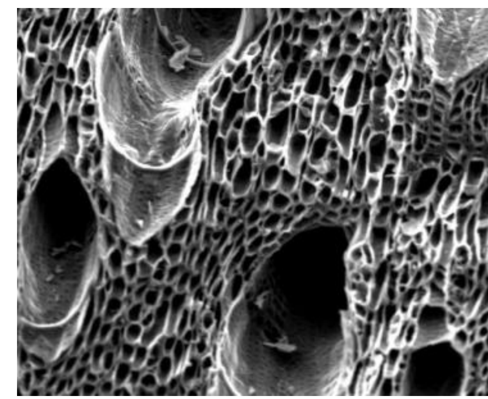
Forest biomass

Pyrolyzer

Biochar is an engineered carbon-rich product produced when biomass is <u>heated in a closed container with limited air</u> and is intended for use as a soil amendment.

So What is Biochar?





Forest biomass

Pyrolyzer

Biochar

Biochar is an engineered carbon-rich product produced when biomass is heated in a closed container with limited air and is intended for use as a soil amendment.

So What is Biochar?

Fixed Carbon

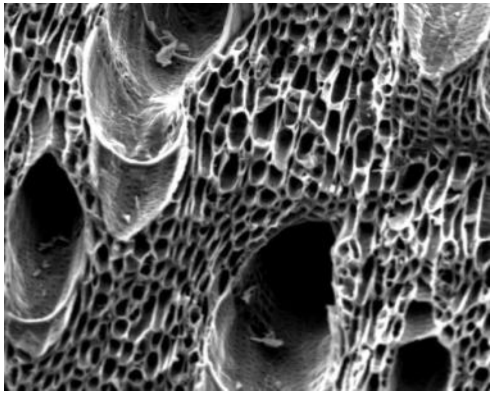
90%

BET Surface Area

$\leq$ 400 m^2 per 1 gram

Forest biomass

Pyrolyzer



Biochar

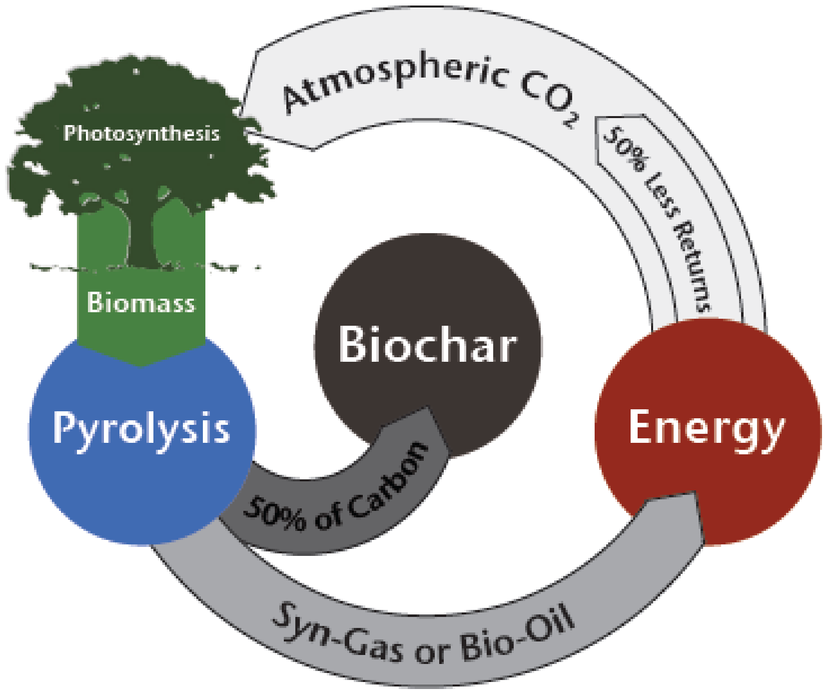
Biochar is an engineered carbon-rich product produced when biomass is heated in a closed container with limited air and is intended for use as a soil amendment.

Biochar In Brief

- retains soil moisture and nutrients
- increases microbial activity
- can be engineered to bind metals and contaminants

More of a Mineral than Organic

Biochar is Carbon Negative



~4 Tons of biomass makes 1 Ton of biochar + energy

~1 Ton of biochar = <u>3.67 Tons of CO_2</u>

Biochar can be stable in soil for 1000's of years

Carbon Perspective

Modified From Dr. Werner Kurz, Canadian Forest Service, Natural Resources Canada

BIOCHAR SOLUTIONS

Turning the problem into the solution

In the mountain west, USA

Regional Carbon Liabilities

- 100,000 trees fall, per day, in CO and S. WY (mtn. pine beetle)
- 1-telephone pole contains 1-ton of CO_2 (so >1.5 T CO_2 per tree)

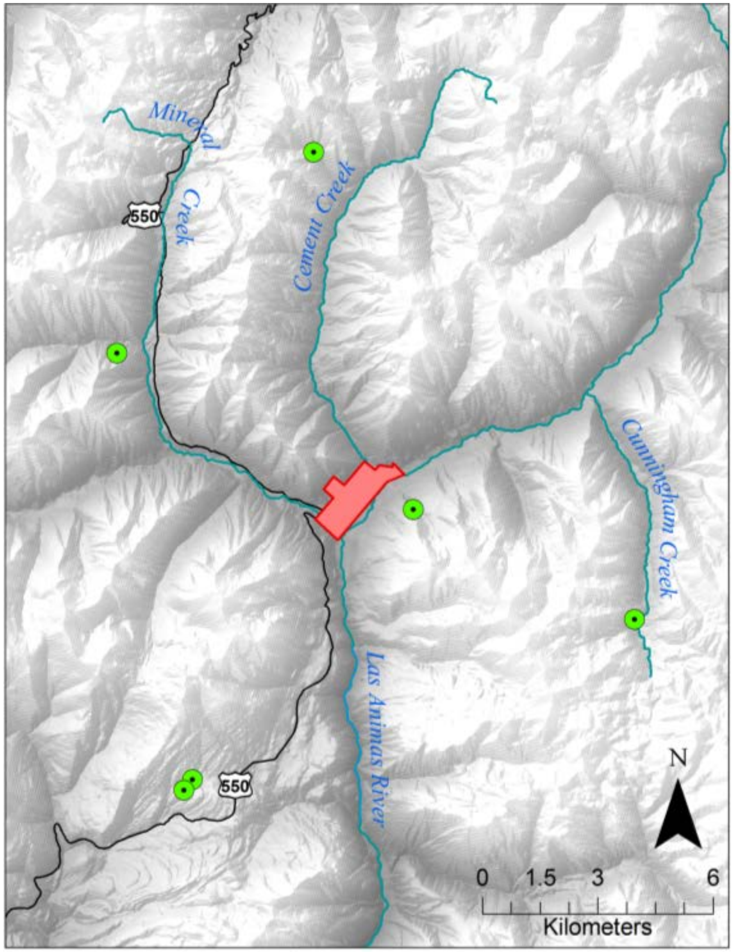
= +/-**150,000 T of CO_2 per day and 55M T CO_2 per year**

Legacy Mining Sites

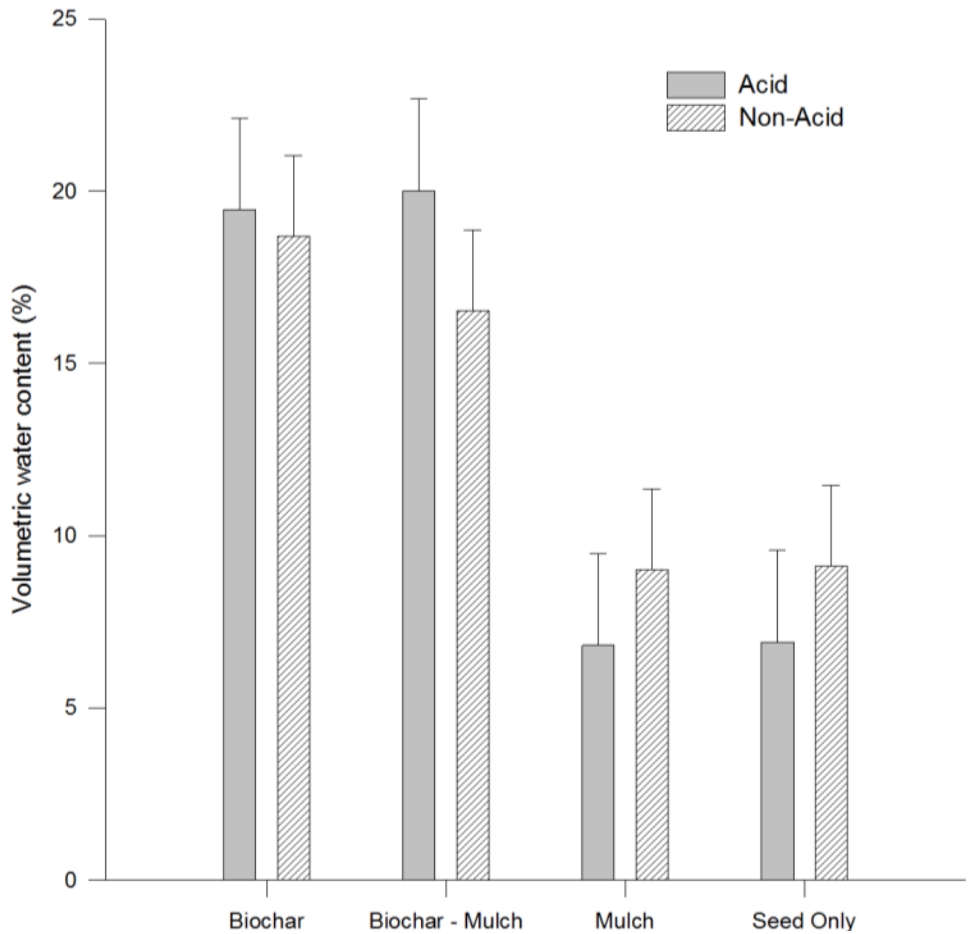
- There are over 150,000 mines in the mountain west
- The headwaters of 40% of western rivers are contaminated
- 1,300 miles of streams and rivers in Colorado alone

- Expensive to engineer, and very difficult to re-vegetate

BIOCHAR SOLUTIONS



	0	1	2	3
pH	>6.0	4.5-6.0	3.5-4.5	<3.5
Σ(As+Cd+Cu+Pb+Zn)	<500 μg/L	500-1,000 μg/L	1,000-5,000 μg/L	>5,000 μg/L



Volumetric water content (%)
25
20
15
10
5
0
Acid
Non-Acid
Biochar
Biochar - Mulch
Mulch
Seed Only

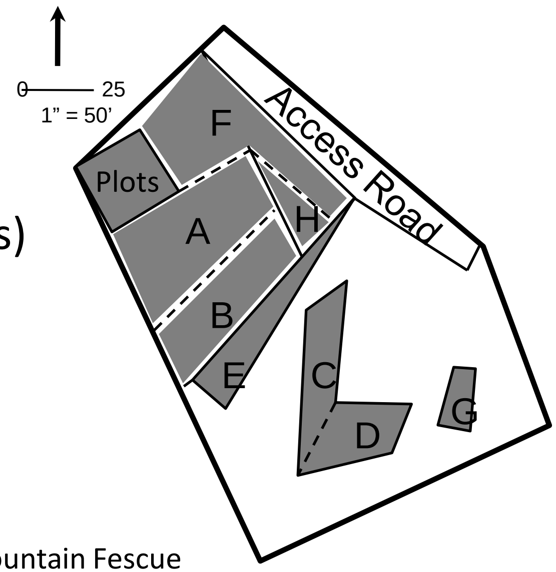
Reclamation Project Design

Objectives

-Evaluate materials handling
-Rates of biochar application
-Biochar blends (compost and others)

Logistics

-Erosion control netting
-Material blending
-Seed Mix
Slender Wheatgrass, Mountain Brome, and Rocky Mountain Fescue
-Application by high-speed conveyor



	Replicated Plot Treatment
1	Control (seed only)
2	Compost
3	Biochar 2.5 t/ac + Compost
4	Biochar 5.0 t/ac + Compost
5	Biochar 10.0 t/ac + Compost
6	Biochar 20.0 t/ac + Compost

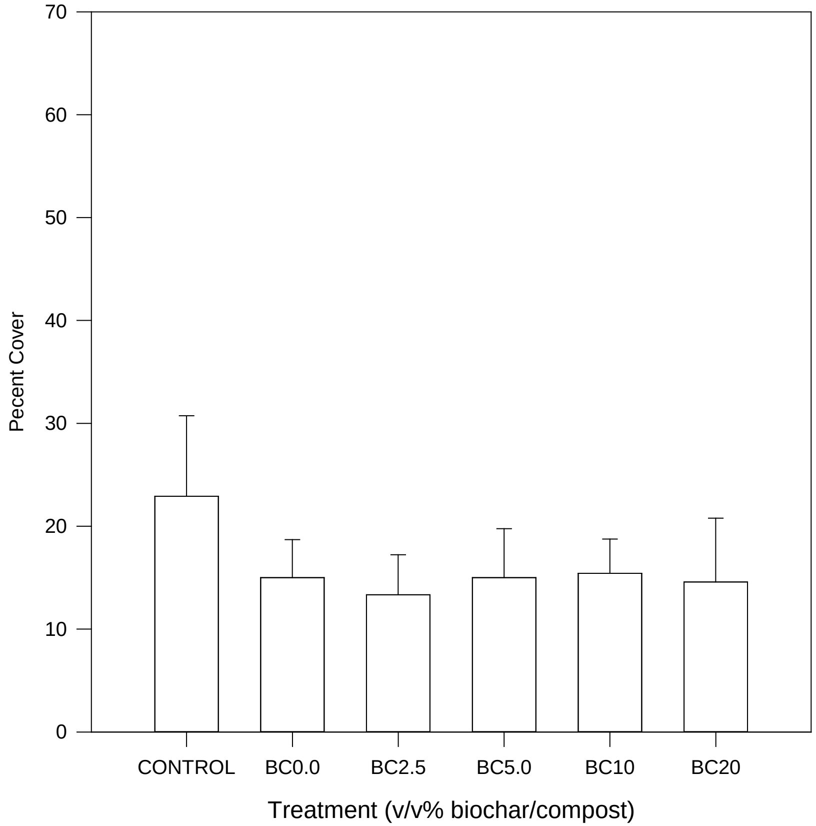
Monitoring

-Seedling emergence
-Persistence through the growing season
-Soil moisture and temperature
-Total biomass at end of YR1, YR2, YR3

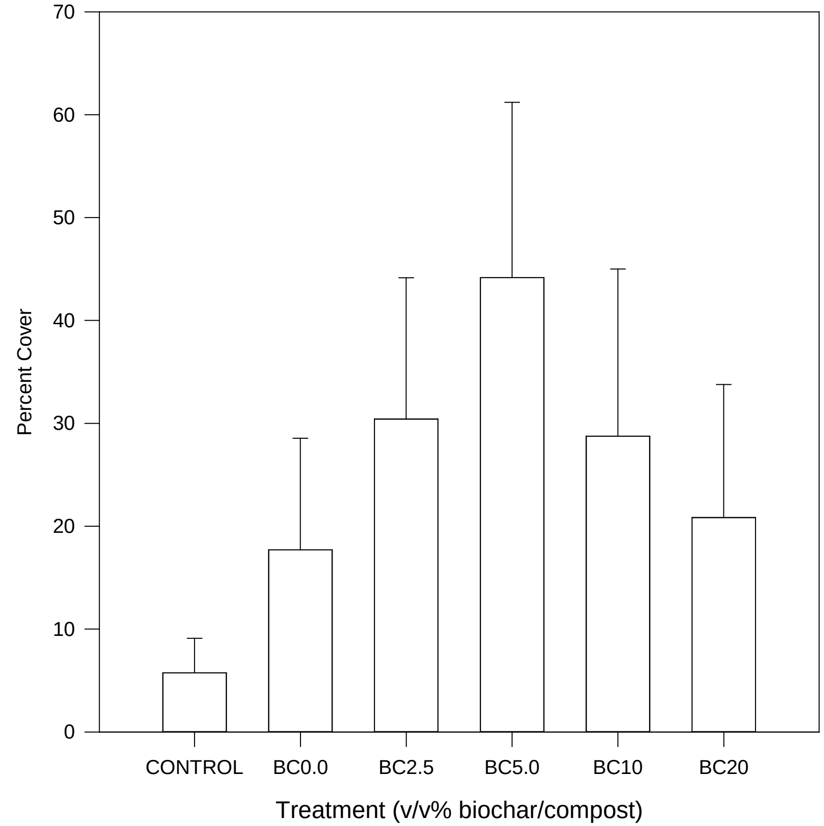
BIOCHAR SOLUTIONS

HOPE MINE RECLAMATION

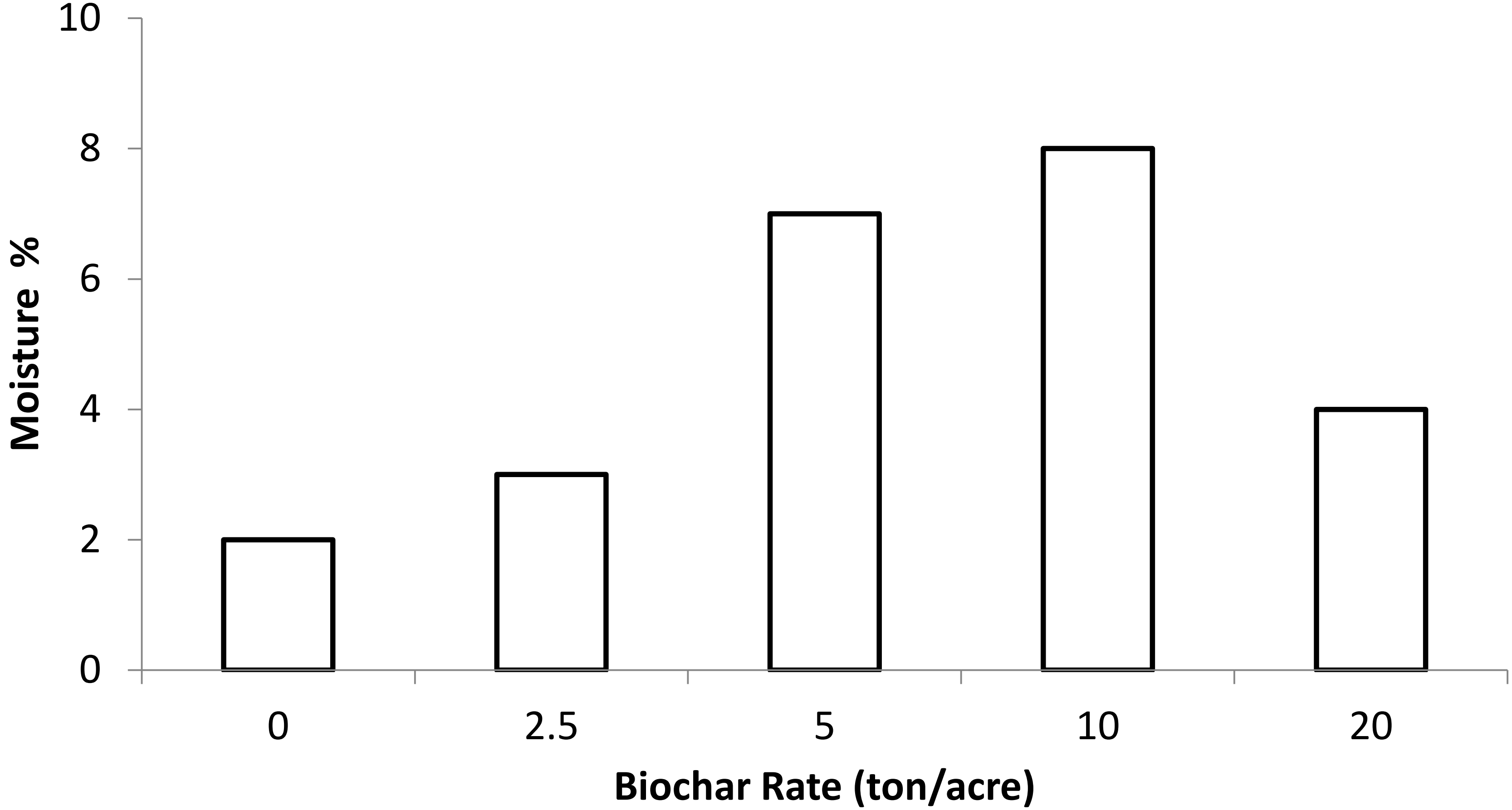
Spring, 2011



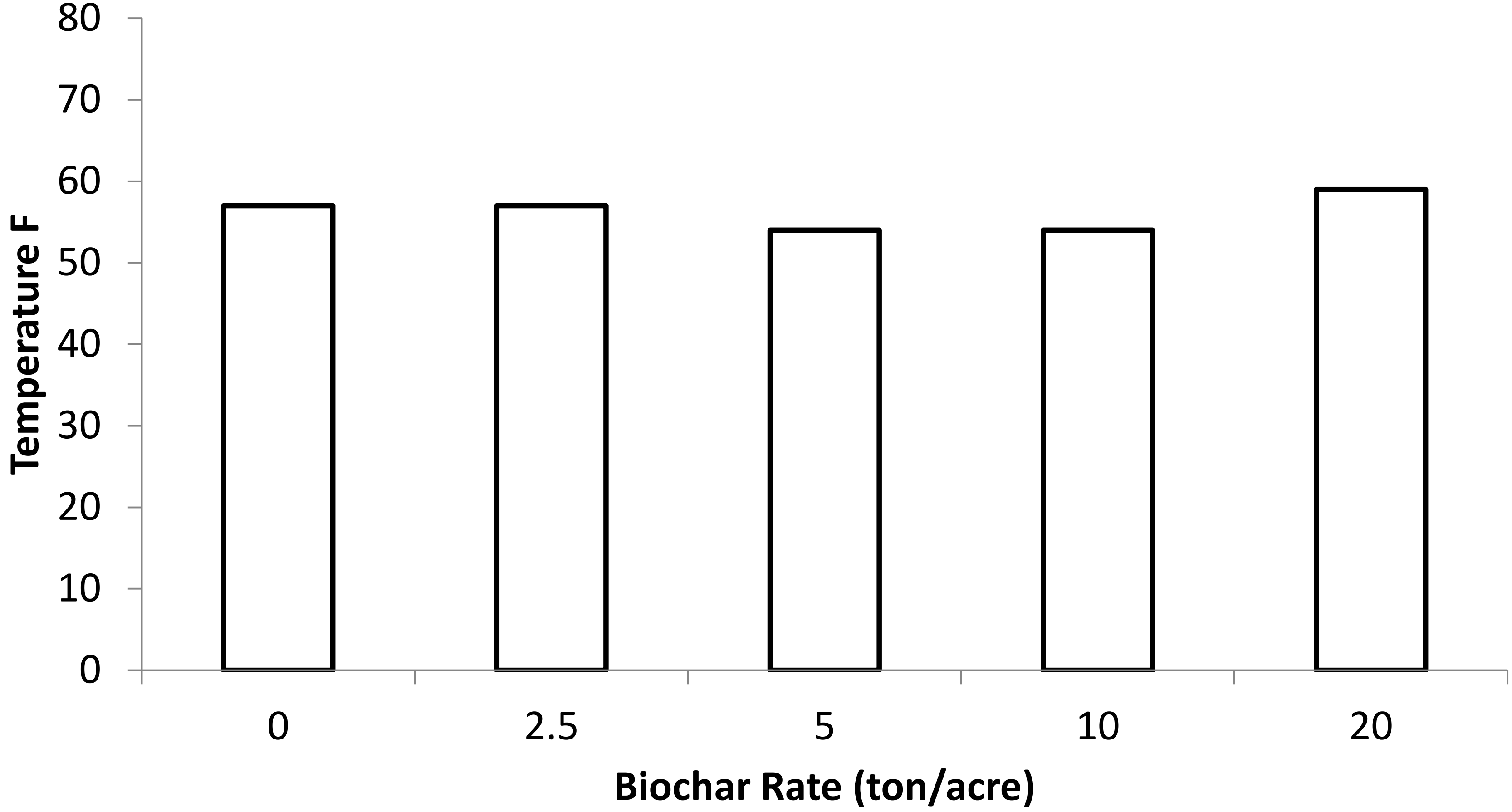
Fall, 2011



Moisture Content - Fall



Temperature - Fall



Topsoil → Amendments → Biochar → Soil Minerals

Risks

- Environmental risks not fully defined
- Variable biochar properties
- Application of biochar to soil mobilizes metals
- Potential presence of toxic compounds
- Potential accumulation of toxic compounds introduced into soil
- Long-term fate and stability of biochar in soil

BIOCHAR SOLUTIONS

www.biocharsolutions.com

Crystal River Caucus
May 1, 2012
Pilot Restoration Project
Brian McMullen, USFS

Upland Restoration Project

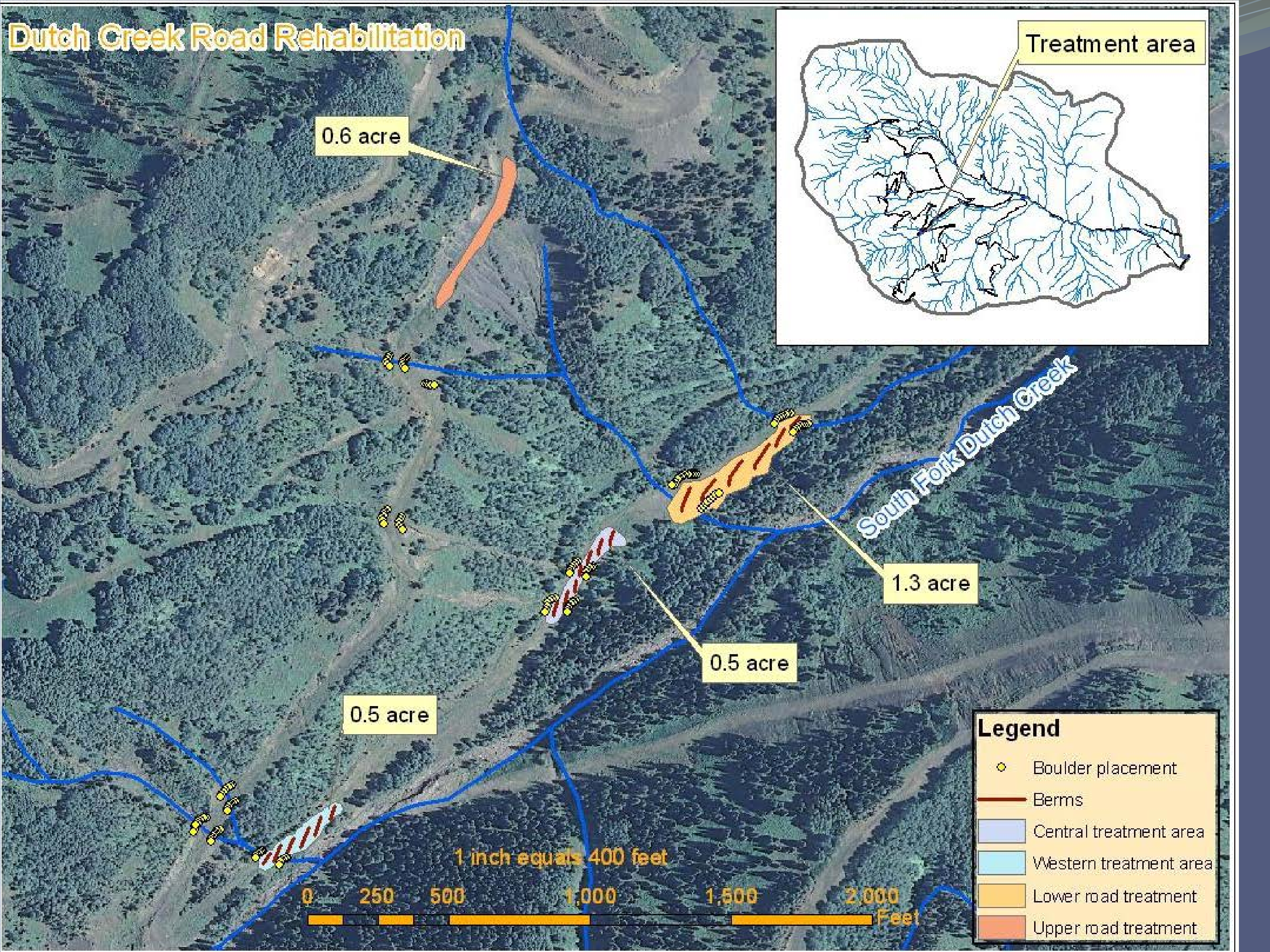
Overall project goal is to integrate and complete projects to:

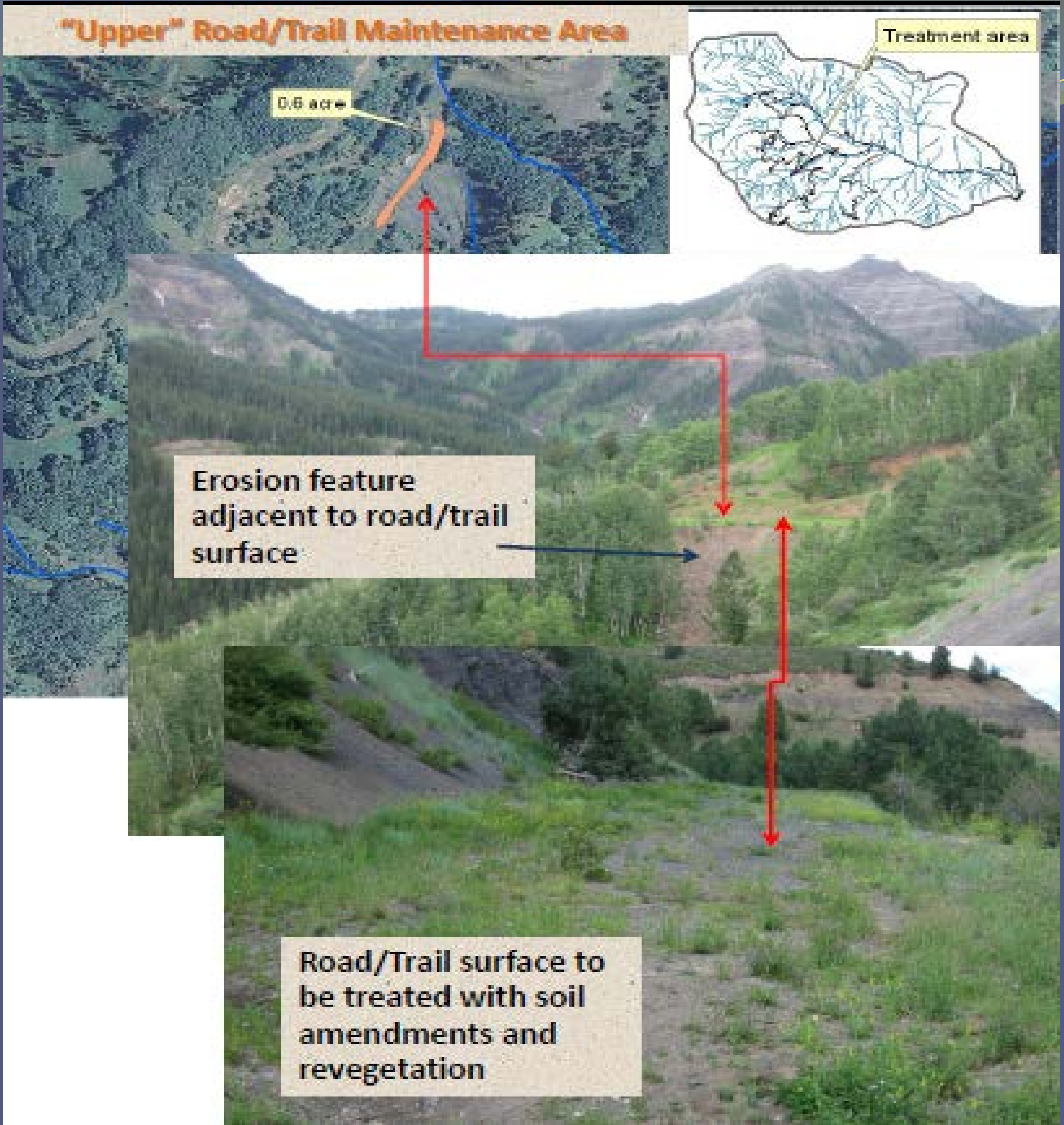
- Improve upland vegetation to stabilize upland soils
- Increase soil water storage
- Reduce CDA and road-derived sediment

USFS Proposed Work

Building on previous restoration efforts continue to address the impact of roads in Coal Basin by:

- **Route drainage and place boulders for grade control**
- **Create sediment traps in depositional areas**
- **Amend soils in the treatment areas**


Dutch Creek Road Rehabilitation
Treatment area
0.6 acre
1.3 acre
0.5 acre
0.5 acre
South Fork Dutch Creek
1 inch equals 400 feet
0
250
500
1,000
1,500
2,000
Feet
Legend
Boulder placement
Berms
Central treatment area
Western treatment area
Lower road treatment
Upper road treatment


"Upper" Road/Trail Maintenance Area
0.6 acre
Treatment area
Erosion feature adjacent to road/trail surface
Road/Trail surface to be treated with soil amendments and revegetation