Appendix 2

Lessons Learned: A Comprehensive Approach to Mine Assessment on a Watershed Scale and Guidelines for Similar Assessments

EXECUTIVE SUMMARY

In 2010, the Coalition for the Upper South Platte (CUSP) invoked on an extensive Mine Assessment Project (MAP). With financial support through the Colorado *Healthy Rivers Fund* (administered through the Colorado Water Conservation Board), CUSP was able to inventory approximately 50 selected abandoned mine sites, sample miles of river throughout 8 main tributaries, and perform a recognizance level investigation of abandoned mine lands throughout the 2,600 square mile watershed. Abandoned mine inventories had been conducted in the watershed previously by government agencies with a focus on public lands. The 2010 MAP, focused on both public and private abandoned mine lands and was particularly interested in mine lands that could be potentially impacting surface or groundwater. The 2010 MAP was the first water sampling and land inventory project of its kind completed in the 13 years of the organizations existence. The scale of the watershed and legacy of extensive historic mining made the scope of the project immense. From early literature searches, to meetings with mine property owners and local, state, and federal agencies, to ordering and determining the proper field equipment many lessons were learned. The following document highlights the process of conducting an abandoned mine inventory and includes topics such as: building positive relationships with mine owners, developing partnerships that enable funding opportunities, basic field equipment and procedures, and approaches to conducting such an inventory over a large area such as the Upper South Platte watershed. A brief history of abandoned mine inventories is provided to give a background on what has already been completed and how the numerous different agencies who deal with abandoned mines have approached inventories and management of abandoned mine lands. The intent of this document is to provide an outline of the procedures taken by CUSP and lessons learned in performing the 2010 MAP, so that similar watershed organizations who are interested in performing such an inventory not only have basic background information but can apply some of the guidance provided to enhance their projects.

INTRODUCTION

I. History of Abandoned Mine Assessment in the West

Over the last 13 years, the Department of the Interior's (DOI) Bureau of Land Management (BLM) and the U.S. Department of Agriculture's (USDA) Forest Service have been making efforts to address the impacts of hardrock abandoned mine lands (AML) throughout the west. Since 1997, the AML programs administered by the FS and BLM have addressed the physical and environmental hazards at thousands of abandoned hardrock mines. Specifically, more than 100,000 abandoned mine sites have been identified on more than 450 million acres of Federal lands managed by the BLM and USFS (USFS, 2007). Of these mine sites approximately 10 percent may be releasing toxic heavy metals, acidity, and radioactivity into rivers, lakes, and streams. The population boom in the west has added further incentive for identification of public health and safety as well as environmental degradation issues associated with AML.

In 1994, an interagency task force was formed to better address the daunting number of AML including agencies such as: the BLM, USFS, National Park Service (NPS), and DOI science bureaus including the U.S. Geological Survey (USGS) and the former Bureau of Mines. This interagency group, known as the Interdepartmental Watershed Cleanup Initiative, worked closely with the Environmental Protection Agency (EPA) to develop a "watershed approach" for cleanup of these AML. The Animas River watershed (186 square miles) was picked as the pilot area to assess AML issues on a watershed scale.

This pilot project has many similarities to the mine assessment project conducted by Coalition for the Upper South Platte (CUSP) on the Upper South Platte watershed, including: identifying priority sites in a large watershed and working to reclaim mine sites with mixed ownership. Although approximately 1,500 mine sites were identified in the Animas River watershed, only 400 were identified as priorities. The watershed partners identified these priorities through an analysis of factors such as amount of each contaminant; physical attributes; accessibility to power; and proximity to streams, wetlands, and avalanche paths. This prioritization led the Colorado Department of Public Health and Environment (CDPHE) to implement TMDL standards based on partial remediation of the priority sites.

a. The Colorado Geologic Survey and USFS

The Colorado Geologic Survey completed an AML inventory (AMLI) on National Forest lands in Colorado in the late 1990s. During this inventory approximately 18,000 mine-related features

were identified including about 900 features that were considered to have significant environmental problems warranting further investigation. Additionally, areas of natural water quality degradation were noted including: the upper Alamosa River, the Middle Fork of Mineral Creek, Peekaboo Gulch, and Handcart Gulch in the Upper South Platte Watershed. Water from these natural sources has been found to significantly exceed Colorado water quality standards for several metals. Information from this inventory including: water quality data, indication of draining adits or seepage at the toe of dumps and tailings, and standing water in shafts, has been critical in prioritizing abandoned mines for reclamation. The driving force behind the USFS and CGS cooperative inventory was the Federal Facilities Compliance Program, designed to bring federal facilities and lands into compliance with federal environmental laws such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and the Clean Water Act (CWA) (USFS, 2000).

b. *The Colorado Division of Reclamation and Mine Safety*

The Colorado Division of Reclamation and Mine Safety also performed AML inventories over the past 30 years. In general DRMS focuses on safety and hazards associated with AML's and since 1980 has safeguarded 6,127 hazardous openings and reclaimed 1539 acres of abandoned mined land statewide. AML inventories conducted by DRMS in 1980 were used to identify mine sites within the Upper South Platte watershed that posed potential environmental issues.

c. The Environmental Protection Agency

The Environmental Protection Agency also has an AML program whose goals are to identify ways to protect human health and the environment by using all of the non-regulatory and regulatory approaches available to the Agency including: voluntary cleanups, Agency managed emergency responses, involvement of Brownfields partners, cleanups based on redevelopment/revitalization, Superfund Alternative Site designation, and full National Priorities List listing. The EPA focuses on partnerships with other federal land management agencies, states, tribes, mine owners and operators and community stakeholders. The EPA AML Program is coordinated through the Agency's National Mining Team (NMT) and Abandoned Mine Lands Team (AMLT). These teams provide an EPA headquarters and Regional core of expertise on issues at abandoned mine sites. The teams together serve as a focal point for coordinating and facilitating national technical, policy and process issues with stakeholders on abandoned/inactive mine research, characterization, clean-up and redevelopment activities. The most common EPA regulatory process to deal with abandoned mines involves CERCLA and the National Contingency Plan (NCP) which define the criteria for

determining priorities among releases or threatened releases of hazardous substances, pollutants and contaminants for the purpose of taking remedial action. The NCP includes a list of national priorities through the United States known as the National Priorities List (NPL) or more commonly known as the superfund list. Although not every abandoned mine site qualifies for the NPL this is the most common method used by the EPA to direct remedial actions. EPA generally uses the NPL as the action list for evaluating remedial response and enforcement action under CERCLA.

d. The Colorado Department of Public Health and Environment

The Colorado Department of Public Health and Environment and Water Quality Control Division are other agencies that work with abandoned mines. In general these agencies address abandoned mines through the creation of Total Maximum Daily Loads (TMDLs) for river segments impacted by point and nonpoint pollution sources.

II. MAP BASIC OBJECTIVES

a. "To protect the water quality and ecological health of the Upper South Platte.."

Part of the Coalition of the Upper South Platte's mission is to protect the water quality and ecological health of the watershed. The MAP is designed to address the water quality impacts associated with abandoned and inactive mines within the watershed by first determining if a site is impacting surface and/or groundwater through discharge of heavy metal laden water, low pH waters, or high sediment and turbid waters. After each mine site or sub-drainage is characterized CUSP and our associated partners will be able to make better management and reclamation decisions regarding water quality in the watershed. The terminal objective of the MAP is to reduce impacts of abandoned and inactive mines on the water quality and ecological health of the watershed.

b. Emphasis on community values and economic sustainability

As CUSP seeks to protect the water quality and ecological health of the watershed there is an emphasis placed on community values and economic sustainability. Therefore the MAP project considers the economic impact of current and future mining within the watershed and all efforts are made to work collaboratively with mine owners to reduce or eliminate sources of environmental degradation while not hindering current or future mine operations. The MAP not only intends to curtail the impacts of historic mining but also encourages sustainable and responsible mining practices for the benefit of both the environment and the economy.

III. Developing Partnerships for a Comprehensive Approach

a. CUSP Partnerships

Abandoned mine issues are most effectively addressed through a collaborative approach requiring a network of partnerships with government agencies, nongovernmental organizations, and both mine owners and surrounding property owners. Any group that intends to perform an AMLI should consider developing these partnerships early in the process. Creating a network of partnerships will help leverage funding for both site investigations and cleanup. Partnerships can help achieve a number of objectives in the mine assessment and reclamation process including: gaining early and consistent involvement of stakeholders; incorporating local knowledge of economic, social, and environmental conditions; avoiding duplication of effort among partners; determining practical cleanup solutions for mixed ownership sites; and building relationships of trust and cooperation.

Early in the MAP planning process a stakeholder meeting was held to discuss the goals of the project from CUSP's view and to incorporate stakeholder suggestions. Stakeholder representation included: CUSP, the U.S. Forest Service, U.S. Fish and Wildlife Service, the Colorado Division of Reclamation and Mine Safety, EPA, the Colorado Geologic Survey, and the Colorado Water Conservation Board a division of the Colorado Department of Natural Resources. These agencies have all had some involvement with abandoned mines within the watershed and were critical in obtaining previous reports and providing direction regarding planning, goals, and objectives for the MAP. In addition to these stakeholders, the CUSP board of directors is comprised of a diverse number of individuals including representatives from Park County, City of Aurora, the Wilderness Society, the Center of Colorado Water Conservancy District, Jefferson Conservation District, Douglas County, Trout Unlimited, Teller County, Upper South Platte Water Conservancy District, Denver Water, and Jefferson County. Utilizing the partnerships above CUSP was able to get 50 water quality samples analyzed for an in-kind donation by Denver Water, project advice and support from the USFS and EPA, and background research assistance from DRMS and the USFS.

IV. Developing a Monitoring Plan

a. Previous Abandoned Mine Inventories, geologic reports, and literature search

When developing an abandoned mine inventory project obtaining all the previous reports done in the study area is a necessity. Additionally, obtaining reports of mine assessments done in other parts of the state or with similar site conditions can provide valuable planning information. The

EPA and BLM also have a plethora of guidance documents available on-line that address almost all aspects of conducting an abandoned mine inventory or performing monitoring projects. For the MAP, CUSP used the USFS Abandoned Mine Lands Inventory Field Guide as a check list to make sure all aspects of the site were investigated in the same manor. The USFS-AMLI field guide also has a preliminary guidance table to help categorize the degree of environmental degradation.

Often researching the previous reports done in the study area will require direct contacts with the department or division that conducted the study, again this is where partnerships can be utilized. Good places to start are to determine if there is a river or water body in the study area with an established TMDL or if it has been listed on a 303(d) list of impaired waters. It is important to begin the literature search for the area of interest well in advance of performing field work. CUSP started this process a year before the field work, and that allowed ample time to search for pertinent information.

When planning for field work, the reports acquired during the literature review phase can help determine some of the sampling protocols. Taking samples in similar locations to previous studies will help develop seasonal and annual trends for a site. Geological and geochemical reports of the mines of interest also provide valuable information about the underground workings and extent of the mine; the type of deposit and host rock composition; and the type of ore processing that was conducted on site; all of this information can help identify the primary pollution source at a site and provide valuable information needed for developing a successful remediation alternative.

b. Watershed / sub-drainage scale vs. individual mine inventory approach

The Upper South Platte Watershed encompasses approximately 2,600 square miles, a significantly larger watershed than the Animas Watershed highlighted for its AMLI. The size of the watershed and history of intense mining made the CUSP MAP a daunting task. Early in the history of Abandoned Mine Inventories and remediation actions, each mine site was considered individually in a piece-meal approach. This approach has often resulted in less than stellar results when projects were finally completed. As a result, CUSP proposed a true reconnaissance level inventory completed at the watershed level. However, due the size of the watershed, it was logical for the CUSP MAP to inventory the watershed by sub-drainage. This sub-drainage watershed approach was necessary to get a general idea of the mining impacts throughout the watershed. This approach was also more cost- and time-efficient than conducting in-depth investigations at each mine site in the watershed. Using the watershed approach will indicate sub-drainages with multiple mine sites or individual mine

sites that need further investigation, possibly on a site-by-site basis. Conducting a site-by-site inventory initially may result in missed sites and take significantly longer.

The watershed or sub-drainage approach includes synoptic sampling starting at the headwaters of each primary tributary that experienced mining. Through this approach background water quality conditions can be determined and sources of natural water quality degradation can be identified. If an inventory is conducted site-by-site natural springs, headwaters, and non-impacted tributaries are not evaluated leaving gaps in the overall picture of the hydrogeochemistry of the drainage. It is also important to consider placement within the watershed or sub-drainage when prioritizing mine sites for remediation. Although there may be one priority mine site in need of reclamation, if there are five smaller sites polluting up stream, remediating that one mine site may not significantly improve the overall water quality.

c. Basic field equipment

The early AMLI conducted by the CGS, USFS, and DRMS evaluated sites based on very basic field parameters such as conductivity and pH. Mine sites were described by field notes and hand drawn maps. Although these inventories are extremely valuable for future inventories, modern GIS technology and water quality testing equipment can provide a more in-depth and accurate picture of each site. Some basic field equipment essential for an AML inventory includes: a multi-parameter probe that collects pH, conductivity, temperature, and dissolved oxygen; flow measuring devices such as pigmy flow meters and flumes, both are preferable for measuring flow across a wide range of conditions; a digital camera; and hand held GPS units that are accurate to one meter with differential correction.

For the CUSP MAP, a Hanna HI 98280 meter was used to collect basic field parameters such as pH, conductivity, and DO, the Hanna meter also has built in GPS so the coordinate of each reading was recorded; a pigmy flow meter was used to determine discharge at each sampling location but could only be used on streams with adequate depths and widths, often small tributaries or mine discharge were too low to be measured with the pigmy meter and a flume would have been appropriate but was not obtained for the 2010 field season; a digital cameral with GPS capabilities was also used in the 2010 field season, having a coordinate assigned to each photograph will allow CUSP to link photographs to the GIS map of each mine site; lastly a DR2800 Hach Spectrophotometer was purchased for the CUSP MAP, this unit was used for water sample analysis for additional samples that could not be analyzed by Denver Water laboratories, one of the partners in the project.

The spectrophotometer is an exceptional piece of equipment that should be considered for any group interested in water quality, often laboratory analysis is cost prohibitive for each sample therefore, after the initial purchase cost, the spectrophotometer can be used for cost effective small scale sample analysis. CUSP can also use the spectrophotometer and multi-probe for environmental education programs, monitoring water quality in response to fire mitigation projects, and monitoring water quality prior, during, and after river restoration projects. Although the initial investment to obtain all the necessary field equipment is great, non-profit and watershed groups can make use of the equipment for other projects and it is more cost effective for long term projects than equipment rental. Partnerships may become very important if purchasing this equipment is not possible by providing trained personnel to help conduct the inventory. Higher education institutions are also great partners for both equipment and personnel support.

When purchasing, nonprofit groups should specifically ask suppliers about discounts. In CUSP's case, these requests resulted in significant savings — for example, the Hanna company charged us full price for the meter, but supplied all the reagents at wholesale pricing.

V. Mining Claims and Mixed Ownership

a. Determining if a mine is on public or private lands

Previous mine inventories conducted by the USFS or BLM focused on mines located on public lands. In the Upper South Platte Watershed the majority of mines are located on private mining claims and ownership is not only mixed between public and private but also mixed between different private parties. To truly evaluate the mining impacts to water quality within the entire watershed it is a necessity to evaluate both public and private lands; this can represent one of the biggest challenges of a project. With modern GPS and GIS technology it is easier to determine if a mine site is located on public or private lands but can still be a challenge.

During the initial literature search, CUSP representatives mapped the approximate location of each mine of interest using the given township and range information provided in the original inventory and GIS software. This gave approximate coordinates for each mine site of interest. Then the county parcel data was used to determine the schedule number of each parcel surrounding the mine site. This schedule number was searched in the county assessors database to determine the ownership. This gave us a basic idea of ownership but is only a start in determining the mine owners.

A map of historic mining claims can look like a pile of rectangles overlapped and crisscrossing, additionally the surface rights and mineral rights may be owned by different parties. When performing a site investigation it is important to acquire information regarding property boundaries as soon as possible, the private lands shown on topographic maps are not adequate to determine if a property is private or public. CUSP places a strong emphasis on community values and respects the property rights of the miners in the watershed, therefore no samples were deliberately collected on private lands without permission. By respecting the private lands and wishes of the mine owners CUSP will be able to establish trusting relationships with owners leading to a more collaborative and successful mine inventory and remedial action. The following list is a good place to start to determine if mine sites are public or private lands:

- County assessor database
- Historic mine reports and maps
- Previous reports and AMLIs
- GIS and parcel data, there is free open source GIS software available on-line and many counties have interactive GIS databases and maps

b. Building Positive Relationships with Mine Owners

Once the owners have been identified through the methods described above it is important to contact them regarding the inventory and to make positive connections. Historically, agencies have used regulatory actions to reduce environmental impacts and reclaim mine lands. This has been in the form of fines and lawsuits, therefore many mine owners are hesitant to work with environmental groups. Today agencies are more interested in solving the problem through cooperative non-regulatory actions ("carrots"), rather than expensive lawsuits and fines ("sticks"). Again because of our focus on community values, many locals have found CUSP to be a middle of the road organization that strives to better the environment without detrimental effects for the property owner. The following list represents good ways to make contacts with the mine owners and community:

- Contact mine owners with a letter or phone call describing both the organization and project
- Attend the local mining association meetings
- Have owners involved in the stakeholders meetings so they feel that they are represented and involved

- Have a release of liability waver for the owners to sign to obtain access to the site
- Respect private property and never trespass

If mine owners are un-willing to cooperate leave it up to the regulatory agencies. An inventory can still be done up stream and down stream of the site where access is on public lands or can be obtained from other owners. Focus on developing relationships with owners who have multiple properties or are leaders in the mining community; their involvement and cooperation may encourage others.

VI. Peaks and Valleys: Successes and Failures

The size of the watershed, extensive mining legacy, short field season, and mixed ownership made the 2010 Upper South Platte Abandoned Mine Assessment a daunting project. Overall, the project could be considered a success because many of the goals were accomplished. Almost the entire watershed was inventoried except for two remote drainages where access issues and time constraints limited investigation (our intention is to access these in the 2011 field season). Water quality samples were collected on all the major tributaries and sub-drainages that experienced historical mining, where as past sampling only focused on specific stream segments or individual mine sites.

The biggest success of the 2010 season was not only the number of mines inventoried or miles of streams sampled, but was the connections made with mine owners and collaboration with partners. Mine inventories in the past have generally been implemented by individual agencies on the public lands that they manage; the CUSP MAP brought together different land management agencies and regulatory agencies in a collaborative process with a focus on the watershed as a whole, not segmented by ownership. This approach has the potential to generate funding for further investigations and reclamations from many different sources without having to use strict regulatory actions against property owners. Although only a handful of private mine sites were thoroughly investigated in the 2010 season, the building blocks of positive and collaborative relationships have been laid for future work in the watershed.

One of the biggest challenges faced in the 2010 season, other than the mixed ownership of the mining claims, was obtaining all the necessary field equipment. Fortunately, funding through the Colorado *Healthy Rivers Fund* (administered by the Colorado Water Conservation Board), made possible the purchase of the multi-probe and spectrophotometer. The pigmy flow meter was borrowed by our Office of Surface Mining intern from her environmental science program at

Denver University. During field work it was determined that a flume was also necessary for discharge measurements but was not obtained for the 2010 season.

During the field season we learned that the day does not begin and end in the field, it begins the night before by charging all the equipment; the morning of the instruments need to be calibrated, bottles labeled and appropriate maps be reviewed; the end of the day requires proper chain of custody paperwork be filled out and samples readied for delivery to the laboratory; and most importantly entering all the field data into electronic form and typing of field note summaries. None of these things are revolutionary or unexpected, but it is imperative that the paperwork of the field day be updated before conducting additional field work no matter how short the field season. Data collected during the 2010 season has helped identify priority mine sites, but review of this data has also lead to more questions and the need for additional data collection. Mine inventories and future remediation requires motivation, patience, and strong partnerships. CUSP will continue to monitor the water quality in the watershed and work diligently to develop collaborative solutions to water degradation associated with historic mine properties in the future.