# MINED LAND RECLAMATION IN COLORADO: AN OVERVIEW

colorado division of minerals and geology

# Introduction

*Sunrise over Seneca Mine in Routt County.*

The State of Colorado values its natural resources, its citizens' use of those resources and its industries' right of prudent development. Regulation of mining and reclamation activities provides a framework for sound resource management and the return of land to beneficial uses. Regulation also provides a mechanism for public input before, during and after operations. This booklet provides an overview to Colorado's mine permit and reclamation process.

# Contents

# A Short Regulatory History of Mining and Reclamation in Colorado

In a land that seemed full of inexhaustible resources, settlers and miners scrabbling for their share of the gold rush demanded legal structure of rights for discovery, procedures for developing and validating mineral discovery, for settling disputes of ownership, of property boundaries and of rights of access.

The long-term environmental impact of certain mining practices, however, was rarely considered until competition for the land grew more intense. Early federal regulation targeted negative environmental and subsidence effects of coal mining in Appalachia. Colorado and other western states joined the federal trend regulating coal mining, and with growing public awareness of and concern for the impact of both past and future mining operations, **citizens enacted new guidelines for all types of mining.**

Early steps were often inconsistent. In 1965, Colorado instituted a voluntary reclamation program. Memorandums of understanding between operators and the state were signed, setting forth site-specific reclamation criteria, and the Colorado Open Cut Land Reclamation Act followed four years later; without funding for administration or enforcement of the program, though, this legislation proved ineffective. The Open Mining Land Reclamation Act of 1973 established a permitting process, requiring limited bonding and more rigid reclamation performance timelines and standards for coal mines and sand and gravel operators, though hard rock mines (such as gold and silver mines) still avoided bonding and were not required to protect the hydrologic balance, establish suitable vegetation, or dispose of toxic materials in a safe manner.

**By 1975, all western states except Arizona had adopted some form of mining and reclamation standards and regulations.** With a strong commitment from the Colorado Department of Natural Resources, the Colorado Mined Land Reclamation Division was created in early 1976 to regulate non-coal mining operations. The Colorado Mined Land Reclamation Act was passed, and a Mined Land

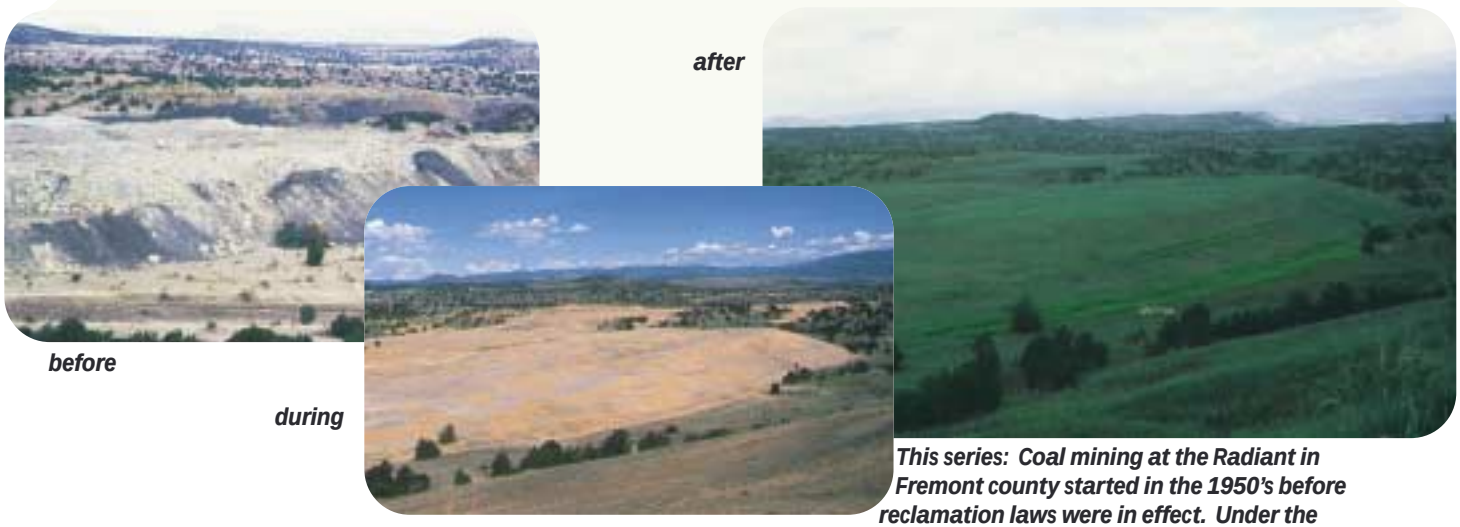
***Above: Various factors of geology, technology, economics and politics have combined to produce a diverse and fascinating history of mining in the state.***

Reclamation Board was appointed to serve in an administrative and adjudicatory capacity.

**The Federal government passed the Surface Mining Control and Reclamation Act, specific to coal mining, in 1977,** and as an equivalent to the federal law, the Colorado Surface Coal Mining Reclamation Act was passed in 1979, approved at the federal level in 1980, and placed under the administration and adjudication of the Colorado Mined Land Reclamation Board.

**Colorado has continued to operate under these two programs, amending them as necessary.** Since 1980, the greatest changes have been in incorporating environmental protection provisions, protecting adjacent properties and water resources, improving bonding procedures, and addressing higher risk operations by creating specific regulations for operations posing a higher degree of risk to persons, property, or the environment.

The Division of Mined Land Reclamation merged with several other divisions within the Department of Natural Resources to create the Division of Minerals and Geology (DMG) in 1992. Within DMG, the Office of Mined Land Reclamation (OMLR) administers rules and regulations through the Coal Program and the Minerals Program. In 1993, DMG amended the Minerals Act to give the Division and Board greater authority in bonding requirements and environmental engineering design and protection, and earlier grandfather protections were modified to retrofit old permits with the necessary new environmental requirements.




*This series: Coal mining at the Radiant in Fremont county started in the 1950's before reclamation laws were in effect. Under the abandoned mine land program reclamation activities included regrading and revegetation to create wildlife habitat and rangeland.*

# Colorado's Mined Land Reclamation Board

**The Mined Land Reclamation Board (MLRB) consists of seven members.** Five are appointed by the governor with confirmation by the Colorado State Senate as follows: two with substantial experience in the mining industry, two with substantial experience in conservation and environmental resources, and one with substantial experience in agriculture. The remaining two seats are filled by the executive director of the Department of Natural Resources (or the executive director's appointee) and a member of the State Soil Conservation Board.

**Board members' terms are staggered, each serving a term of four years.** Subsequent terms are subject to reappointment and Senate confirmation. MLRB rotates the position of chairperson among its appointed members. A chair and vice-chair serve for a period of six months at a time.

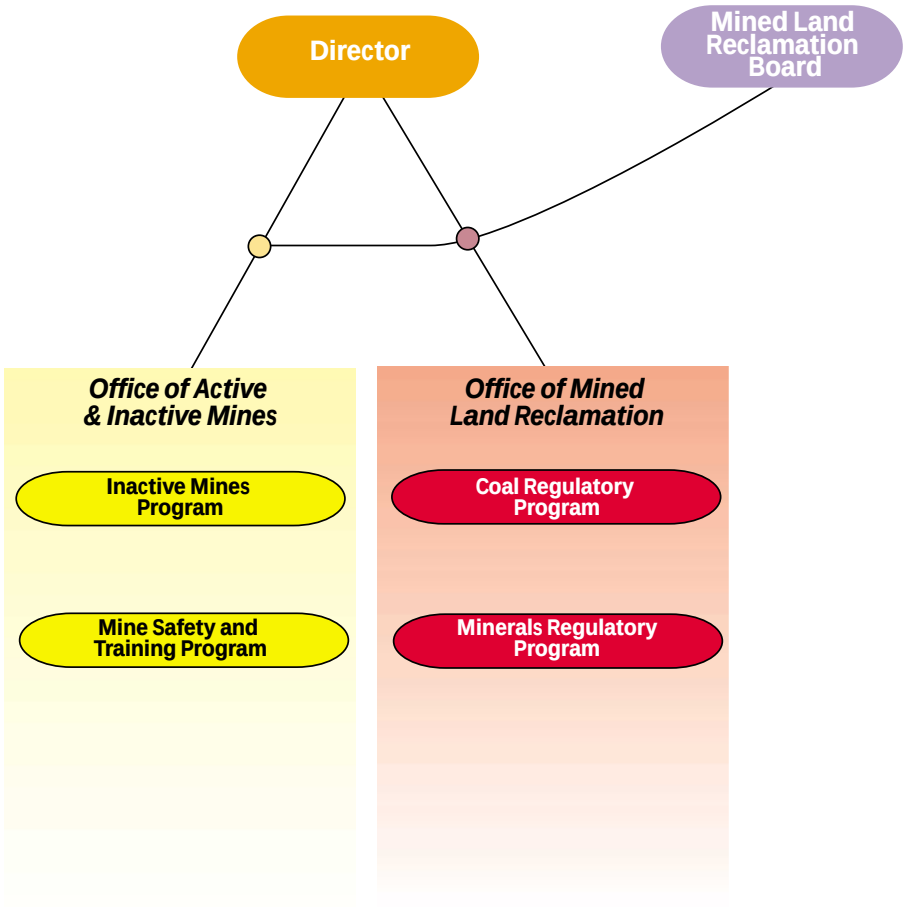
MLRB must have four members present to conduct regular business, although three members may continue to conduct business if one of the convening members is recused or abstaining. Five members are required for MLRB to conduct an Executive Session. The affirmative vote of the majority of MLRB members present is needed to carry a vote, with two exceptions: rule-making adoption requires four affirmative votes, and votes after the question has been called by a member require a two-thirds majority vote.

**MLRB serves in several capacities.** It presides as an adjudicatory council over the regulatory affairs of the Coal and Minerals Programs. MLRB also functions as MLRB of Trustees of the Coal Mine Subsidence Protection Program, and it serves in an administrative oversight capacity, approving budgets and overseeing activities of the various offices within DMG.

MLRB's jurisdiction is limited to the provisions of the legislative authority delegated by the Acts and Rules and Regulations governing the Coal and Minerals Programs. MLRB operates according to the Colorado Administrative Procedures Act, and generally follows Robert's Rules of Order for the conduct of its meetings.

**MLRB does not have jurisdiction over local land use issues** such as: planning, zoning, traffic, visual impacts, quality of life, noise, dust, and use of public roads. Issues that are regulated by other permitting agencies, such as fugitive dust, water rights, noise, and compliance with air quality and surface water quality standards, are referred to the agency with regulatory authority for that area. DMG maintains agreements with other agencies on how overlapping oversight and enforcement will be communicated and handled.

## The Division of Minerals and Geology



# Prospecting, Mining and Reclamation Regulation in Colorado

## Prospecting and Exploration

Prospecting and exploration are terms used interchangeably in DMG regulations, referring to the activity of searching for, discovering, and characterizing coal or mineral deposits. Techniques may vary from visual observation and hand sampling, to remote sensing and drilling extensive hole patterns, to driving exploration adits or shafts.

Notice of Intent to Conduct Prospecting permits are treated on a case-by-case basis. Reclamation plans and bonding are required for prospecting permits. In the Minerals Program, all information provided in the Notice of Intent to Conduct Prospecting is protected as confidential information by state statute, unless otherwise released in writing by the operator or by a finding of MLRB that reclamation is satisfactory. A prospecting permit does not give a legal right of entry.

*Above: Gravel mining along the South Platte River.*
*Above Right: Queens Quarry near Colorado Springs.*

The permit allows the operator to conduct prospecting within the rules and regulations of DMG. Other permits and right of entry may be required before prospecting can commence.

## Reclamation of Mined Lands

**All mining operations are required to file reclamation permit applications to the DMG, post a reclamation bond to guarantee reclamation and obtain a permit prior to mining.**

Any operation on federal land is additionally subject to regulation and bonding by the federal land management agency in charge, as well as compliance with county governments' local land-use regulations.

**During the application review process, DMG reviews applications to ensure the following types of concerns are addressed to the extent required by the Acts and Regulation: Location, Material and Processing**

**Location:** Activities located adjacent to streams and lakes or with potential to impact ground and surface water quality and quantity generally require more detailed information in reclamation plans. Other major concerns of project sighting include protection of property and structures within 200 feet, and minimizing impacts to wildlife and wildlife habitat.

**Material:** Prospected or mined materials may potentially impact public health and the environment when removed from original geologic locations. As material is removed and exposed to weather and oxidation, care should be taken to stockpile the material in ways that prevent transport and erosion from wind and water. Many materials are inert, however, metal-bearing ores and associated country rock may be acidic, creating low pH solutions with soluble metals when contacted by moisture and runoff water. Other types of materials may be alkaline and create similar concerns at high pH levels.

**Processing:** Many materials are mined and shipped without product upgrading like crushing, screening, washing, separation, or leaching. Others may require minimal or complex preparation at the mine site or nearby facilities. The type of material, type of processing, and facilities required for processing must be taken into account when considering reclamation permits. Care must be exercised in projecting the long term stability of facilities, type of reclamation proposed, and protection of adjacent resources, public health, safety, and property.

***From Top: Coal crushing facility in Gunnison County; Cripple Creek and Victor Gold Mining Company near Victor; Overburden spoil ridges at a surface coal mine in Northwest Colorado.***

# Types of Reclamation Permits

Applications for mining and reclamation permits can be obtained from DMG. A copy of current rules and regulations and bond forms should also be obtained and reviewed to prepare the application.

## Coal Program

The Coal Program issues **one type of permit for coal mining and reclamation, regardless** of the size of operation or amount of material mined.

## Minerals Program

The Minerals Program does not grant permission to mine. The Program issues **four different types of reclamation permits** based on the type of operation, characterization of the material being mined, and in one case the exclusive use of the mined material for highway or utility projects under government contracts.

## Minerals Program/Limited Impact Operations

Referring to section 34-32-110 of the Mined Land Reclamation Act, a 110 Limited Impact Permit denotes an operation limited in size of acreage that can be disturbed, and for hard rock operations, the tons of material that can be mined on a yearly basis. It also implies that the material being mined and disturbed is not toxic or acid producing. **Several types of limited impact permits are issued.**

## Minerals Program/Special Mining Operations

Special permits are issued only for use on projects where the material is sand, gravel, or aggregate and such material is used exclusively on a government contracted highway or utility project. Allowing commencement of mining without unduly delaying construction projects, **these expedited permits are often called 111 permits**, after section 34-32-111 of the Act.

## Minerals Program/112 Regular Mining Operations

A 112 Regular Permit is a permit issued for operations disturbing more than 10 acres, and for hard rock operations mining more than 70,000 tons per year. **Award of a 112 permit implies that the material being mined and disturbed is not toxic or acid producing.** It gets its title from section 34-32-112 of the Mined Land Reclamation Act.

## Minerals Program/Designated Mining Operations

The category of Designated Mining Operations deals with **permits issued to operations considered to be of higher environmental risk** than 110 Limited Permits or 112 Regular Permits. They generally mine and disturb materials that are toxic or acid producing, and may include toxic chemicals in on-site processing. Permitting and bonding requirements are more rigorous. There are several types of Designated Mining Operations–110d, 112d-1, 112d-2, and 112d-3–based on size of disturbance and amount of material mined in any one year.

# The Permitting Process

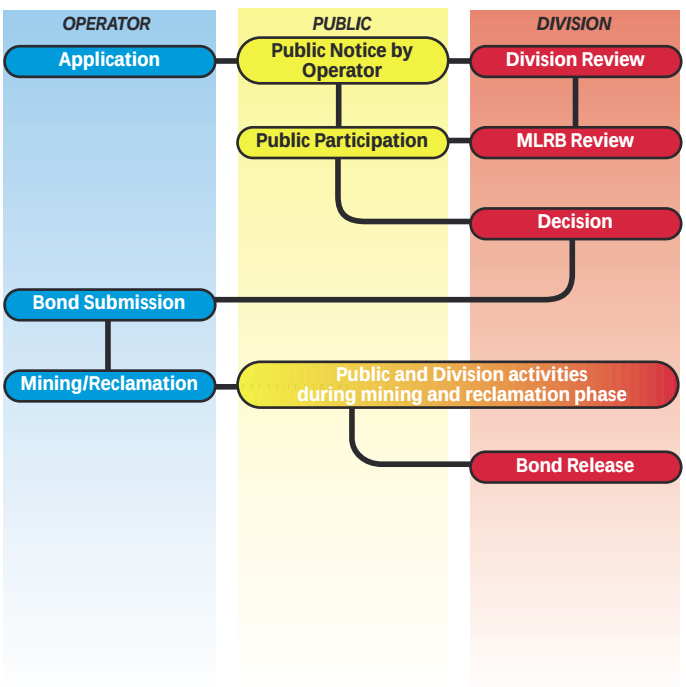
## Pre-application Information

Persons wishing to apply for reclamation permits are advised to obtain current copies of the Mined Land Reclamation Act, Rules and Regulations, and the appropriate permit application form. DMG reclamation staff are available to discuss proposed operations and explain the type of information that will be required for particular operations.

## Submitting a Permit Application

Reclamation permit applications are considered "filed" when all required information has been submitted in sufficient detail for DMG to begin its in-depth evaluation of the proposed mining activity. If application information is inadequate, applicants have several options: immediately submit the information required to complete adequacy; withdraw the application; or ask for an extension of the review period, if more time is needed to complete adequacy.

## The Review and Decision Process




# Public Involvement in Permitting

**Comments from the public supporting or opposing proposed operations are always welcome by DMG** and may result in permits that incorporate stipulations addressing their concerns. Interested members of the public are encouraged to obtain current copies of the Rules and Regulations and to subscribe to the DMG mailing list for notices of permit activities by the Division.

The public comment and participation requirements vary with different permit application procedures. Refer to the Rules and Regulations for the proper procedure to follow. Persons who wish to participate as parties to actions by DMG or MLRB have a more formal involvement than those who wish to limit their participation to writing letters and commenting during the public comment portion of the process, and they have both privileges and responsibilities. They become part of the hearing process, and they may exercise their privilege to submit exhibits, make presentations, and cross-examine witnesses. Their responsibilities include appearing at all hearings, delivering their written submissions and exhibits to all other parties, and following the hearing process in the allotted time specified by MLRB. They also may be named in lawsuits brought by a party concerning matters decided by MLRB.

# Intergovernmental Coordination and Mining

## Local Governments (Land Use Planning)

**Through land use planning and zoning, local governments establish uses for areas within their boundaries.** Generally speaking, mining can only be conducted on land approved for mining by special use permit or zoned for mining by local governments. Applicants and interested persons should contact local planning and zoning departments for specific requirements.

## State Agencies

Although DMG is the responsible state agency for mining or prospecting, **many other state agencies have regulations that may pertain to mining or prospecting.** For example, the Colorado Department of Public Health and the Environment has jurisdiction in enforcing air and surface water quality standards, and mining operations must obtain the necessary permits from this agency.

## Federal Land Managers

Federal land management agencies include the Bureau of Land Management (BLM), U.S. Forest Service (NFS), and Indian Reservation Lands. **Permission to mine must be obtained from these agencies for most mining or prospecting activities on land under federal management,** and often additional permits are required as well. In all cases, a DMG permit must be obtained for mining or prospecting on any land in Colorado, regardless of federal, private, or state ownership, unless otherwise exempted from the need for a permit by the Act and Rules or a Declaratory Order issued by MLRB.

## Federal Environmental Protection Regulations

**All mining and prospecting operations in Colorado are subject to federal environmental laws.** Some federal regulations are administered and enforced by state agencies, while others may be directly implemented by federal agencies. DMG can assist applicants, operators, and interested persons in identifying which agencies may have jurisdiction in a particular situation.

## Inter-agency Agreements

Colorado's coal mining and reclamation permitting process generates from a federally mandated program implemented at the state level by a state agency, in this case DMG. The federal agency, the Office of Surface Mining, provides funding, policy and oversight, including intervention and enforcement authority if necessary. Conversely, Colorado's mineral reclamation permitting process does not have a federal counterpart program.

Agencies with overlapping or conflicting regulations usually enter into written agreements called Memorandums of Understanding (MOU) or Memorandums of Agreement (MOA). For example, Stormwater Regulation is a federally mandated requirement of EPA, administered by CDPHE and delegated to DMG for application to mining and prospecting activities.

***Left: Inspections are often coordinated with local and federal land managers. Above: Mining and reclamation plans are reviewed on site.***

## DMG coordinates with the following agencies:

**United States Government:**

- Army Corps of Engineers
- Bureau of Land Management
- Environmental Protection Agency
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- National Park Service
- Mine Safety & Health Administration
- Office of Surface Mining

**State Government:**

- Department of Public Health and the Environment
  - Air Pollution Control Division
  - Water Quality Control Division
- Division of Wildlife,
- State Engineer
- Soil Conservation Board
- State Historical Preservation Office
- State Land Board
- Geological Survey

**Local Government:**

- County Commissioners, County Planners
- City and Town Governments
- Regional Planners
- Sewage & Water Treatment Agencies
- Water Conservation Associations

# Inspections and Enforcement; Modifications to Existing Permits

## Coal Program

### Inspection and Enforcement

At least one complete inspection is conducted each quarter at all coal mines, including an on-site review of a permittee's compliance with all permit conditions and requirements within the entire disturbed area. At least one partial inspection is conducted each month at active coal mines, an on-site or aerial review of a permittee's compliance with some of the permit conditions and requirements.

A Notice of Violation is issued when an inspector determines that any condition or practice in violation of the Act, Rules, or the approved permit exists. A Cessation Order is issued if the violation creates an imminent danger to the health or safety of the public or is causing or can reasonably be expected to cause significant environmental harm to land, air, or water resources. DMG reviews each Notice of Violation and Cessation Order in accordance with regulatory criteria to determine whether a civil penalty will be assessed.

Penalized operators can request an assessment conference in which all relevant information concerning the violation and penalty is reviewed by a conference officer, an authorized representative of DMG. If the issues are not resolved, the operator can request a hearing before the MLRB.

MLRB has the authority to revoke a permit and forfeit the reclamation bond, where a pattern of violations exists.

### Permit Renewal

Coal permits are issued for five years and have the right to successive renewal if a complete permit application for renewal is submitted at least 180 days prior to the expiration date.

### Permit Revision

Revisions to coal permits can be requested when necessary. The type of revision depends upon the modification that is requested.

Minor revisions are minor changes within the permit area. Examples include minor alterations in the location of roads or other facilities or minor alterations in the timing or sequencing of mining or reclamation plans.

Technical revisions do not cause a significant alteration to the reclamation plan. Examples include incidental permit boundary revisions, increases in coal production, reduction or termination of approved environmental monitoring programs, or design changes for regulated structures or facilities.

Permit revisions are significant modifications to the terms or requirements of the approved permit. Examples include significant changes to the mining and reclamation plan and increases to the permit boundary.

***Left: Inspections include sampling for vegetative cover. Above: This photo shows the stages of mining and reclamation in a surface coal mine. From left to right: revegetation after two growing seasons; revegetation after one growing season; replaced topsoil; regraded spoil; spoil ridge; open pit; disturbed lands where topsoil has been salvaged. Right: Sampling mine discharge is often part of the monthly inspection routine.***

## Annual Reclamation Reports

A reclamation report is filed each year for all areas covered by a reclamation bond. The report and maps include the number of acres newly disturbed, backfilled and graded, replaced topsoil, and seeded. Subsidence, revegetation and wildlife monitoring data may also be included.

## Annual Hydrology Reports

Permitted coal mines monitor ground and surface water quantity and quality. Data from the previous year's hydrologic monitoring is submitted in an annual hydrology report. These reports are used to evaluate impacts on the hydrologic balance.

## Minerals Program

MLRB has directed the Minerals Program to inspect each permitted mine site at least once every four years. High priority sites, such as hardrock and in-stream gravel extraction operations, should be inspected annually. Operations that use toxic or hazardous material should be inspected monthly. MLRB has also directed the Program to respond to written citizen complaints within 30 days of receipt.

In the Minerals Program, only MLRB may find an operator in violation of the Act, Regulations, or the provisions of an operator's approved permit. The Minerals Program, upon determining an operator is in violation, will send notice that the Division has "Reason to Believe" that the operator may be in violation and schedule the matter for a Formal Board Hearing before MLRB. At the Formal Board Hearing, MLRB may find a violation, issue a civil penalty, specify corrective actions, and revoke or suspend the permit and forfeit the reclamation bond.

### Permit Renewal

Permits issued under the Construction Materials Act or the Hardrock Act in the Minerals Program are issued for the life of the operation. There are provisions in the two Acts for operators to enter two five-year periods of temporary cessation; however, by the end of the second five-year period, operators must reinitiate operations or begin reclamation. Once an operator has completed a phase of mining, the operator has five years to complete reclamation for that phase.

### Permit Revision

Operators may make revisions to their approved permits at any time through the appropriate revision process.

However, there are certain limits placed on operations dependent upon the particular type of permit issued and the statute under which the site was permitted, i.e. construction material vs. hardrock.

Technical Revision is a change in the permit or an application for a permit, which has only a minor effect upon the approved or proposed Reclamation plan.

Amendment is a change in the permit or an application for a permit which increases the acreage of the affected land or which has a significant effect upon the approved or proposed Reclamation Plan.

### Annual Fees and Reports

Each operator must submit to the Division an annual report and fee, which funds the Minerals Program in part. The remaining money used to run the Minerals Program comes from a General Fund appropriation and Severance Tax. The annual report must describe, in general terms, the mining and reclamation activities conducted over the preceding year.

***Over 1,000 inspections are performed on mineral operations annually***

# The Oxide Tailing Pond Conversion to the Eagle Park Reservoir

## The Climax Mine

The Climax Mine is a molybdenum mining and milling operation located 13 miles north of Leadville, Colorado at the summit of Fremont Pass (11,318 ft.). The Climax Molybdenum Company was formed in 1916 and by 1980, the Climax Mine and Mill were processing from 45,000 to 50,000 tons of ore per day with a total historic production through 1980 of approximately 360 million tons. In 1989 the Climax Mine reclamation permit was amended and the post mining land use designated for the Oxide Pond was changed to develop water resources.

***Far Left: These tailings were highly acidified as a result of the acid leaching process used in the Molyoxide plant. A limestone milling circuit was initiated in 1971 and 1972 to neutralize Oxide Pond water for use in the mill.***

***Middle: In 1993 an agreement was forged with Vail Associates to complete tailing removal and reclamation of the Oxide Pond to a fresh water reservoir, now known as Eagle Park Reservoir.***

***Right: Climax recognized the long term value of their water rights and existing water storage and conveyance infrastructure in the planning and development of the Eagle Park Reservoir reclamation project. The completed reservoir stands as a model for future reclamation efforts that involve water delivery to highly sensitive receiving waters.***

# Reclamation Bond Release

## Coal Program

Permittees can request release of coal reclamation bonds as stages of reclamation are completed, a three-phase process based upon specified criteria. At phase I, up to 60% of the bond may be released when the mined land has been backfilled and graded to approximate original contour and drainage control has been reestablished. Up to 85% of the bond may be released at phase II with topsoil replacement, successful establishment of vegetation that supports the post-mining land use, and documentation that the reclaimed lands do not contribute suspended solids to streamflow or runoff outside the permit area in excess of premining levels. The remaining bond may be released at phase III, characterized by termination of the liability period and successful completion of the reclamation plan.

Coal permits are terminated when all requirements of the Rules and the Act have been successfully completed and all requirements for bond release have been achieved.

## Mineral Program

The DMG may release an operator from reclamation liability when the operator demonstrates through an on-site inspection and other relevant information that the operator has met the conditions of the approved Reclamation Plan, the Rules and Regulations, and the Act. If a site is releasable, DMG will terminate the approved permit and return the reclamation bond to the financial warrantor. Once a site is released by MLRB or DMG, MLRB no longer has jurisdiction over the site.

***This site along Clear Creek (left) was restored (above) during reclamation.***

*Phased reclamation of the Tomahawk Strip Mine in Delta County. This photo shows the early stages of reclamation grading.*

*Phase I bond release was granted following backfilling and grading of the mine site and drainage reestablishment. Topsoiling and revegetation are in process.*

*Phase II bond release was approved after topsoil was replaced and vegetation was established to control erosion and support the post mining land use.*

*This is a close-up view of the juniper/bitterbrush stand established on the reclaimed mine after ten years. Phase III bond release was granted after the 10-year liability period was completed; native vegetation was established; and the land was returned to a beneficial land use.*

# Returning Land to a Beneficial Use

*Above: Reclaimed lands provide valuable wildlife habitat in northwest Colorado. right: Sharp tail grouse reestablish leks and nesting sites on reclaimed mines in Moffat and Routt Counties.*

*Above: Rangeland is often improved during reclamation.*

*Mayflower Mill was preserved as a historic museum in Silverton.*

*Right: Archeological sites are left undisturbed. This teepee ring was identified during pre-mining surveys.*

# The Inactive Mine Reclamation Program

The Inactive Mine Reclamation Program was established in 1980 to address the hazards and environmental problems that arise from abandoned mines. Over 23,000 hazardous mines and 1,300 miles of streams are impacted by past mining. The program is funded through the Department of the Interior by reclamation fees paid by current coal mine operations. Since 1980, the program has safeguarded 5600 hazardous openings and reclaimed 1539 acres of abandoned mined land statewide. Project activities include: field investigations, project development, project design, realty work, construction contract bidding and management, site construction and reclamation, construction inspection, site monitoring and maintenance of prior project work.

***Far Left: Inactive Mines are often historic mines—the DMG not only keeps the public safe from old mines but also protects Colorado's heritage by preserving them. Left: Steel doors and drainage pipes like the ones shown here ensures public safety at over 5,600 mines statewide.***

# Mine Safety and Training Program & the Coal Mine Board of Examiners

**The Mine Safety and Training Program** is charged with protecting the health and safety of the public and the mining community from mining-related hazards. The services which the Mine Safety and Training Program provides include: lending assistance to miners through education, training and safety auditing to ensure their health and safety; inspecting tourist mines to ensure the health and safety of the public; assisting operators in establishing safety and rescue training; regulating safety and security in the use of mining explosives and diesel equipment; and collecting and preserving mining information. This mission is accomplished through a cooperative and coordinated effort between the federal government, local government, the mining industry, and the Mine Safety and Training Program.

*Top: On-site mine safety training includes field exercise as well as classroom instruction. Bottom: Mine rescue training is conducted at the Edgar Mine in Idaho Springs*

**The Coal Mine Board of Examiners** is responsible for the examination, training and certification of mine foremen. firebosses, surface mine foremen, shotfirers, blasters and electricians in coal mines. The Board meets quarterly and holds examinations quarterly. The Board is appointed by the Governor and confirmed by the legislature and serve four-year terms.

### Recreational and Hobby Mining

Weekend rock hounds, specimen collectors and gold panners are generally not required to obtain mining permits if their surface disturbance is minimal and falls under a total surface disturbance of less than 1600 square feet. There is no official category of recreational or hobby mining, and the total surface disturbance is not the only criteria considered. Anyone entering on other's lands should seek permission prior to entry. Also, **abandoned mines are very hazardous! Do not enter mines; stay out and stay alive.**

### Placer Mining

Placer mining is an activity that simultaneously extracts and upgrades a mineral product from wet or dry alluvial gravel. It can be as simple as gold panning and sluicing, or as complex as an operation involving excavators, dredges, and concentrating equipment. Two significant environmental concerns pertain to placer mining: suspended sediments created by the placer mining method can impact water quality and aquatic species; and the displacement or relocation of gravel and other materials may destroy in-stream and stream bank habitat. Agencies such as the Colorado Water Quality Control Division may require discharge permits, and the Army Corps of Engineers may require a cut and fill or other type of permit for the activity.

### Surface and Open-Pit Mining

The techniques of surface and open-pit mining extract a shallow coal or mineral resource by excavating from the surface downward, enlarging the size of the opening as overburden and the resource are removed. High walls may be created as the excavation deepens, but all activities remained exposed at the surface. Reclamation and environmental concerns for surface and open-pit mining are site specific and depend upon the size of the operation, depth of excavation, method and location of stockpiled materials, exposure or proximity to ground water tables, and potential impacts to surface water quality and quantity.

### Underground Mining

Underground mining is normally used to extract vein-type mineral deposits or deep high quality coal deposits. The deposits are accessed by shafts driven downward from the surface and/or adits driven horizontally, which in turn branch out into other mine workings. Reclamation and environmental concerns for underground mines are site-specific based upon ground stability, hydrologic balance, and geologic characterization. Underground mining creates voids that expose remaining materials to oxidation and leaching by moisture and percolating waters. Underground mines that encounter and pump water to the surface must obtain a discharge permit from the Water Quality Control Division.

### In-Situ Mining

In-situ mining combines extraction and processing from a permeable geological structure containing a soluble ore, while the ore remains resident in the ground. This relatively new technology has been successfully used to extract uranium, trona, and copper utilizing a central recovery well surrounded by a pattern of injection wells. An extractant solution is pumped under pressure through the injection wells, passes through the pore spaces of the geological structure,

dissolving the soluble mineral as it goes, and is then withdrawn from the recovery well and further processed in surface facilities. Once the soluble mineral is removed from the solution, the solution can be reconstituted and recycled through the system. After the soluble minerals' resource has been depleted, detoxifying and rinse solutions are circulated through the same system to remove and residual extractant. Reclamation and environmental concerns focus upon potential contamination of aquifers and types of chemicals used in the extraction process.

### Heap Leaching

Leaching and processing of mined ores at or near mine sites employs a variety of techniques used individually or in combination. In all cases, mined ore is contacted with extracting solutions that selectively remove minerals of interest.

In heap leaching, mined ores are first crushing to a specific top size, then mixed with a neutralizing agent such as quick lime and an agglomerating agent such as portland cement. The ore is then stacked on lined leaching pads to create a heap. Drip lines or sprinklers are used to distribute the extracting solution slowly and uniformly across the surface area of the heap. The extractant percolates down through the heap, collecting minerals on the leaching pads liner, then drains into a collection pond where minerals are recovered. After the heap has been leached, rinse solutions are circulated through it to detoxify the material and remove and residual extractant. The detoxified heap is then recontoured, covered with subsoil and topsoil, and revegetated.

### Vat Leaching

Vat leaching employs a similar technique to heap leaching with the exception that it is performed in a reusable contained area. Flat cement vats are often used for coarse material that can be added and removed with front-end loaders. Fine material is usually leached in large cylindrical vats, where the material can be agitated or stirred to enhance leaching. Leached and detoxified coarse ore is usually placed on a synthetic or soil liner, or back in the pit for reclamation. Fine ore from agitated leaches is pumped as slurry to lined tailings-deposition areas that are eventually capped and reclaimed. Reclamation and environmental concerns focus on containment of solutions during processing, complete detoxification of materials and solutions after processing, exclusion of wildlife from affected areas until reclamation is performed, and protection of ground and surface water resources.

### Chemical Processing

Chemical processing is a catch-all term that defines flotation processing, thermal pretreatment, solvent extraction, and other metallurgical processes employing additional chemicals to advance or enhance metal separation from host material. Reclamation and environmental concerns relative to chemical processing are similar to those for heap leaching. Operations that create and impound tailings add additional concerns of long geotechnical stability and wind erosion of dry tailings before capping. Long-term monitoring of groundwater in areas adjacent to and down gradient of the facilities is usually required.

### Physical Benefication, Up-Grading and Milling Activities

Physical (non-chemical) techniques are often used to upgrade products at the mine site. Differences in specific gravity, particle size, magnetic field, static charge, and other physical characteristics allow for physical separations of one material from another and concentration of the desired material as it is separated from its host material. Physical separations may be performed wet or dry, depending on the technique. Reclamation and environmental concerns are generally focused on materials handling and storage, water discharge for wet processing, and the characteristics of the rejected material.

### Cement and Asphalt Batch Plants

Cement and asphalt plants may or may not be included in reclamation permits, depending on many factors. Portable plants and plants that process material from many sources generally fall under the definition of a custom mill, and are regulated by the CDPHE.

Reclamation and environmental concerns focus on good housekeeping issues and protection of surface and ground water that may be contacted if batching materials are spilled and not cleaned up.

### Remining and Reclamation Mining

Remining and reclamation mining are terms that deal with reworking previously wasted materials to recovery secondary mineral resources and complete site reclamation. In some cases the objective is profitable mineral recovery, and in others the objective is environmental restoration where mineral recovery may help to significantly defray reclamation costs.

These activities are generally welcomed and encouraged because they help to take already disturbed areas and return them to productive or beneficial uses.

**For More Information, such as:**

- ***DMG Mailings and Publications***
- ***Examining Permit Applications and Documents***
- ***Board Meetings and Hearings***
- ***Contacting Mining Operations Directly***

**call us at 303.866.3567**

**or write to us:**

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**Room 215**
**Denver, CO 80203**

**visit us online at www.mining.state.co.us**

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**text and photos by dmg staff**
**additional photos: Alan Berger, university of colorado at denver; Rick Hoffman, division of wildlife; Roy Karo, seneca coal company**