

# Environmental Planning for a Mining Venture on Native Land

## *A Briefing Paper for the Crow Tribe of Montana*

*Prepared under the auspices of the Kennedy School of Government, Harvard University*

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Interviews with tribal officials and staff at the Bureau of Indian Affairs in Billings and Crow Agency were conducted in person. I would like to express my foremost thanks to Steve Stevens and Tyrone Ten Bears of the Crow tribe for giving me this opportunity to learn about their land and to share some of my thoughts on this mining venture. Rick Steffanic and Brenda Schief of the Bureau of Indian Affairs office in Billings and Crow Agency were very helpful in providing guidance on the regulatory aspects of mining. Carl Johnston at the Office of Surface Mining in Denver was immeasurably helpful in providing prompt replies to my Email request for information. Larry Emerson and Steve McCurdy at Arch Coal kindly provided environmental information about the company. David Conrad at the Council of Energy Resource Tribes in Denver provided information about the national lobbying efforts of Tribes with energy potential. Last but certainly not least, Joseph Kalt, Professor of Political Economy at Harvard and Manley, Begay, Director of the Harvard Project on Native American Economic Development provided guidance and support throughout the preparation of this report.

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## **Executive Summary**

### ***Introduction***

The Crow tribe has recently been approached by Arch Coal Inc. to initiate exploration and mining prospects for a large mining operation within the tribal reserve. Though the tribe has received royalties from other coal mining operations (Absalooka Mine, in particular), this will be the first full-scale mine on Crow land. Hence the tribe needs considerable planning to ensure that the project brings in much-needed funds while also preserving pristine ecosystem that constitutes the Powder River watershed. This report aims to provide background information to facilitate the environmental planning process.

### ***Mining Regulations and the Application Process***

The Federal government of the United States has promulgated a series of regulations to ensure the environmental viability of mining activities which apply to native lands as well. However, to promote native autonomy the Department of the Interior (DOI) is attempting to assist tribes in developing their own regulations. The mining regulations primarily ensue from the Surface Mining Control and Reclamation Act (SMCRA) of 1977. Memoranda of understanding between the Bureau of Indian Affairs, The Office of Surface Mining and The Bureau of Land Management provide a division of management tasks for the ongoing operations of mines on native lands

### ***Arch Coal***

Arch Coal Inc., headquartered in Saint Louis, Missouri was formed in 1997 with the combination of Arch Mineral Corporation and Ashland Coal Inc. (of Louisville, Kentucky) and now constitutes the third largest coal mining company (by revenues) in the United States. The various companies which now comprise Arch Coal each have their own environmental history. In the environmental records compendium of mining companies, *The Gulliver File*, neither Arch Minerals nor Ashland Coal are listed in any adverse category. In fact numerous awards for good citizenship have been won by these companies. However, the recent acquisition of ARCO's coal division by Arch Coal raises some significant environmental concerns since ARCO's record of environmental compliance is less satisfactory.

***Overview of Mining Activities***

All mining operations generally progress through four stages:

- (1) prospecting, or the search for mineral deposits;
- (2) exploration, or the work involved in assessing the size, shape, location, and economic value of the deposit
- (3) development, or the work of preparing access to the deposit so that the minerals can be extracted from it and
- (4) exploitation, the work of extracting the minerals.

Mining operations are a source of great economic gain on the one hand and environmental stress on the other. Inequities in the benefits gained from mining are enormous, given the historical management of such operations. The dependence of economies on mining results in tremendous leverage being granted to mining companies. Environmental criteria often get eclipsed by these broader economic goals. This ostensible opulence often leads to investment in large development projects that have their own litany of environmental damages.

***Environmental Health and Safety***

Mining can have several short-term and long-term effects on the environment which need to be considered. Mining activities generally change siltation rates in river systems and turbidity measures which may cause serious damage to fisheries. The excavation sites left by mining operations can fill with water and be a haven for mosquitoes and other undesirable pests. The siting of hydrogeochemical monitoring points is essential around mining works because of rapid and unpredictable changes in piezometric surfaces which may occur.

Mining is a hazardous occupation, and the safety of mine workers is an important aspect of the industry. Statistics indicate that surface mining is less hazardous than underground mining and that metal mining is less hazardous than coal mining.

***Ecological Concerns in the Region: The Case of Alluvial Valleys***

An environmental assessment of the Tongue River watershed within the Powder River basin was conducted by Shell in 1982 when a mine was being planned on the reservation. The Bureau of Indian Affairs will use this document as a base from which to conduct a new assessment, since the proposed mining area largely overlaps with this acreage. Alluvial valleys constitute the most significant ecological feature in the region to be protected under the SMCRA regulations of 1983 (See Appendix 3).

***Comparisons with  
Mining Operations  
on Other Tribal  
Lands***

Currently, the Navajo and Hopi tribes have the most significant mining activities as far as native groups are concerned. A conversation with staff at the Navajo Minerals Department revealed that most of the compliance concerns have been amicably resolved between the federal agencies and the mining company. The Council of Energy Resource Tribes, based in Denver is an important forum for exchanging best practices and as a lobbying group to defend native interests in energy ventures -- including mining activities.

## **Introduction**

Mining ventures on Native land can be an important source of royalty revenues for tribes but such enterprises can also have long-lasting environmental implications. The Crow tribe has recently been approached by Arch Coal Inc. to initiate exploration and mining prospects for a large mining operation within the tribal reserve. This will be the first full-scale mine on Crow land and hence the tribe needs considerable planning to ensure that the project brings in much-needed funds while also preserving pristine ecosystem that constitutes the Powder River watershed. In the early eighties Shell Corporation initiated the process to develop a mine on tribal land as well but later withdrew, partially because of a lowering in coal prices and environmental costs which made the venture economically unfeasible.

The tribe has some experience interacting with mining companies since they have property rights to mineral reserves at the Absalooka mine, a few miles north of the reservation. The tribe also collects some royalties from the Spring Creek mine and the two Decker mines adjacent to the reservation's eastern border.

My project aims to assist the tribe in planning for this important investment decision.

## **Mining Regulations: The Application Process**

The Federal government of the United States has promulgated a series of regulations to ensure the environmental viability of mining activities which apply to native lands as well. However, to promote native autonomy the Department of the Interior (DOI) is attempting to assist tribes in developing their own regulations. This process is currently in its embryonic stages and for the foreseeable future the Bureau of Indian Affairs and other units of the DOI will be involved in the environmental assessment process. Figure 1 shows the various units of the Department of Interior. The shaded units represent with direct authority over mining ventures on native land. Jurisdiction in the case of Indian land is strictly federal and state agencies only have authority through compacts which may have been signed between the tribe and the state government. In the case of mining at Crow no such compact exists.

The various units and legal applicability is as follows:

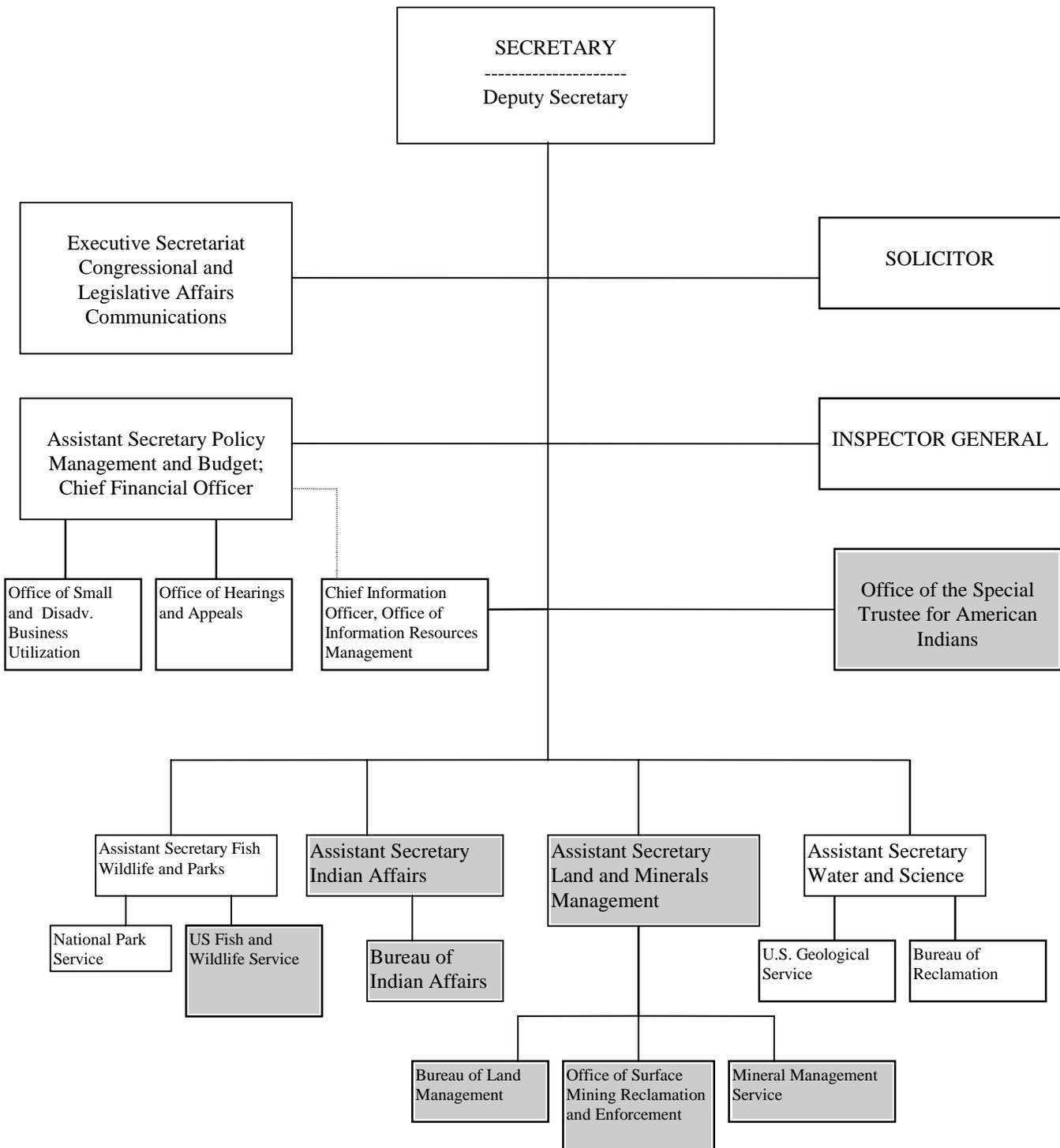
*Who reviews the applications?*

- All applications for mining are reviewed under the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and the ensuing regulations under 30 CFR Part 700 -750.

*The Exploration Plan*

- An “Exploration Plan” is to be developed in accordance with 43 CFR 3480 by the mining company, submitted to BLM under a prospecting permit or contract issued by BIA in accordance with 25 CFR 211, 212, 213 and / or 216 or a lease or license issued by BIA in accordance with 43 CFR 3480.

Figure 1: Organizational Diagram of the Dept. of Interior, highlighting offices of relevance to mining activities on Indian lands:



*Additional  
Compliance  
Obligations*

- In addition all surface coal mining and reclamation operation applications for mining on Indian land must also comply with the regulations under 25 CFR 162.

*Leasing  
Administration*

- Leasing of the coal to be mined would be administered by the Bureau of Indian Affairs as a trustee for the tribe.

*Mining Plan Review*

- Review of a “Mining Plan” would be administered by the Bureau of Land Management.

*Environmental  
Assessment*

- Compliance with the National Environmental Policy Act (NEPA) of 1969, requiring the analysis of the environmental impact of the proposed mining operation would be administered by the Bureau of Indian Affairs. A preliminary environmental assessment would be carried out by BIA and its supporting staff agencies.

*Environmental  
Impact Statement*

- A formal Environmental Impact Statement would be sanctioned by BIA but conducted by independent consultants who would be paid by the mining company. BIA would be the primary reviewing authority for this document.

*Memoranda of  
Understanding*

- Specific delegation of tasks regarding the management of coal mining operations is stipulated in two different “memoranda of understanding” between the BIA, BLM and OSM and the BIA, BLM and the Mineral Management Service (MMS) respectively. The memoranda and the

relevant attachments are attached to this document as Appendices A and B.

*Special Regulations  
for Crow Tribe*

- There is a specific subsection of the regulations in 25 CFR 162.15 which addresses permits and leases on the Crow Reservation in accordance with various treaties between the tribe and the federal government.

*Plans for Tribal  
Regulation*

The Office of Surface Mining (OSM), Western Regional Coordinating Center in Denver, Colorado and the regional office in Casper Wyoming are specifically assisting the Crow tribe “in the development of their own regulations and program to regulate surface coal mining and reclamation operations on Crow Tribal lands”

**Important Contacts  
for Further  
Information on  
Regulations**

Carl Johnston, Office of Surface Mining Control and Reclamation, Denver Email: [CJOHNSTO@wscgw.osmre.gov](mailto:CJOHNSTO@wscgw.osmre.gov).

### **Arch Coal Inc.:**

Arch Coal Inc., headquartered in Saint Louis, Missouri was formed in 1997 with the combination of Arch Mineral Corporation and Ashland Coal Inc. (of Louisville, Kentucky) and now constitutes the third largest coal mining company (by revenues) in the United States. In March, 1998 Arch reached an agreement to acquire Atlantic Richfield's (ARCO) Colorado and Utah coal operations and to simultaneously combine the acquired operations and its Wyoming operations with ARCO's Wyoming operations in a new joint venture to be known as Arch Western Resources LLC, which will be 99% owned by Arch Coal and 1% owned by Atlantic Richfield (ARCO). The transaction is valued at approximately \$1.14 billion. Arch Coal will manage the joint venture.

It is important to note that 54% of Arch Coal Inc. is owned by Ashland Inc., which is a large energy and chemical company. This company has several other businesses as well. Ashland Chemical is the largest distributor of chemicals and plastics in North America. Another significant subsidiary of Ashland is Valvoline, which is a leading U.S. motor oil and automotive chemical marketer. Ashland's APAC highway construction operation is the largest highway contractor in the United States. Ashland employs approximately 37,200 people worldwide and is based in Russell KY. With sales of more than \$14 billion, Ashland ranked 109th in the Fortune 500 classification of large US companies.

### **Recent Merger with ARCO**

Through its ownership of Arch Western Resources, Arch Coal will add a powerful presence in western U.S. low-sulfur compliance coal to its leading low-sulfur coal production position in the eastern United States. Overall, Arch Coal will become the second largest U.S. coal producer with annual coal sales of close to 110 million tons, or roughly 10% of the nation's coal supply, and annual revenues of nearly \$2 billion. ARCO operates some of the largest and most productive mines in the western United States. Arch Coal is the leading producer of low-sulfur coal in the eastern United States. The alliance between these two companies is aimed to “meet the nation's growing demand for electricity; prepare to compete in a deregulated marketplace; and comply with the implementation of Phase II of the Clean Air Act in the year 2000.”<sup>1</sup>

### **Financial Status**

In 1997, on a pro forma combined basis with Ashland Coal, Arch Coal generated revenues of \$1.4 billion on the sale of 52.9 million tons of coal. Excluding a one-time merger-related charge, Arch Coal had pro forma operating income of \$111.0 million and net income of \$75.5 million. Arch Coal's domestic coal reserves are estimated at 2.1 billion tons. ARCO's U.S. coal operations, including its 65% interest in Canyon Fuel Company LLC, generated revenues of \$537 million in 1997 and after-tax operating income of \$51 million. ARCO's domestic coal reserves are estimated at 1.3 billion tons. Both companies are thus poised

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<sup>1</sup> Statement of Steven F. Leer, President and Chief Executive Officer of Arch Coal, public statement, March 23, 1998.

<sup>2</sup> Financial data derived from Arch Coal annual report and web site: <http://www.archcoal.com> and a New York State Newswire release on America Online, March 23, 1998.

for a relative secure financial future.<sup>2</sup>

**Environmental Record**

The various companies which now comprise Arch Coal each have their own environmental history. In the environmental records compendium of mining companies, *The Gulliver File*, neither Arch Minerals nor Ashland Coal are listed in any adverse category.

*Numerous awards*

Within the past few years, Arch's predecessor companies Ashland Coal and Arch Mineral Corporation have received numerous awards for their performance and reclamation work in West Virginia, and safety awards in Virginia and Kentucky. Apart from various governmental accolades, Arch's largest shareholder company Ashland Inc. has a well-recognized audit program which has been awarded the Arthur D. Little "Best of the Best" designation in 1996.

*ARCO's Environmental Record*

Atlantic Richfield (ARCO), whose domestic coal division, Arch has recently acquired has a somewhat checkered record of environmental compliance. ARCO came into existence in its present incarnation after a merger between Atlantic Refining Company and the Richfield Oil company in 1966. The former was one of the many companies that were formed after the division of the Rockefeller empire's Standard Oil corporation in 1911.

*ARCO's record with Native Tribes*

ARCO maintained a mining presence in Montana through the acquisition of Anaconda Copper Co. in 1977. Anaconda's copper mine in Butte, Montana was the subject of considerable controversy, particularly with regard to native title. Notable native American writer Winona La Duke has commented that

“basically the history of Anaconda competes in ugliness with ARCO’s history of genocide against Indian and other native people.”<sup>3</sup> Though considerable changes have occurred since La Duke, made that statement in 1979 (Anaconda no longer exists as a company), it is still important to consider the allegations of impropriety against ARCO and its subsidiaries have persisted.

In the early eighties the FBI, IRS and other government agencies investigated ARCO and a few other mineral companies for withholding over 80 million dollars in royalties from Indian tribes.<sup>4</sup> At around the same time, ARCO was taken to court by Charles White Dirt, a traditional leader of the Northern Cheyenne tribe, who accused the company of trampling on sacred sites on the reservation in search of minerals, north of it mine at Black Thunder, Wyoming. This mine(within the Powder river basin) is the largest surface coal mine in the country and is owned by ARCO and will now come under Arch Coal.

**Important Contacts  
for Further  
Information**

Lawrence D. Emerson, Director of Environmental Performance,  
Arch Coal Inc., P.O. Box 6300, Huntington, WV 25771-6300,  
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lemerson@archcoal.com

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<sup>3</sup> Quoted in Moody, 1992. Anaconda also had longstanding dispute with the Laguna tribe over a uranium mine on its reserve which led to severe health problems for tribal members and a reclamation case which was settled with a \$50 million plan in 1987.

<sup>4</sup> The company eventually settled at the Supreme Court level to pay over \$400 million in dues to the government, particularly with regards to its Alaskan operations.

## **Overview of Mining Activities**

All mining operations generally progress through four stages:

- (1) prospecting, or the search for mineral deposits;
- (2) exploration, or the work involved in assessing the size, shape, location, and economic value of the deposit
- (3) development, or the work of preparing access to the deposit so that the minerals can be extracted from it and
- (4) exploitation, the work of extracting the minerals.

### ***Prospecting***

In the past, ore bodies were discovered by prospectors in areas where veins were exposed on the surface, or by accident, as when gold was discovered in California in 1848. Today, however, prospecting and exploration are skilled occupations involving expert scientific personnel. Teams of geologists, mining engineers, geophysicists, and geochemists work together to discover new deposits. Modern prospecting methods include regional geological studies to define areas where mineralization is likely to have occurred; broad surveys by sophisticated instruments mounted in airplanes and artificial earth satellites (remote sensing) to discover anomalies in the earth's magnetic field, electrical fields, or radiation patterns in order to define the most promising locations; visual examinations of the surface area for coloring, rock formations, and plant life; chemical analyses of soil and water in the area; and surface work with geophysical instruments.

### ***Shafts and Pits***

These modern techniques can reveal deep-seated as well as near-

surface prospects, and they serve as a basis for preliminary estimates of the economic potential of the prospect. The subsequent exploration work includes digging pits, sinking exploration shafts, and core-drilling operations, all of which tend to define the physical limits of the ore body and permit a more reliable estimate of its economic value. The findings may dictate the method used to reach the ore body, the extent of the development work, and the best method of exploitation.

*The Decision-making Process*

The decision to develop an ore body is reached as soon as sufficient information is available to indicate a profitable return on the financial investment. Complete certainty about the full potential of the mineral is not crucial at this point; exploration work can continue over many years while the deposit is being mined.

*The Mode of Entry*

After the decision is made to mine an ore deposit, the mode of entry and the extent of lateral or subsidiary development must be determined. If the ore body lies at or near the surface and extends to a depth of no more than a few hundred feet, it may be developed by an open-pit excavation, using power shovels and large trucks. If, however, it is deep or steeply inclined, access may be made through a vertical or inclined shaft, an adit, or crosscut tunnels.

*The Topography*

The topography or landscape of the region, the geometry and physical nature of the ore body, and the proposed method of exploitation have a bearing on this decision. When the terrain is nearly flat, entry must be made through a shaft. In mountainous regions, access to the ore body may be gained through an adit, a

nearly horizontal tunnel from which crosscuts may be driven at right angles to reach the ore. Shaft sinking involves a larger outlay of capital and higher operating costs than an adit or crosscut opening. A shaft requires hoisting equipment to raise the ore and rock to the surface, pumping equipment to dispose of any water present, and structural support for the rock and the mechanical equipment operating in the shaft. In an adit, drainage occurs naturally in all workings above the adit as a result of gravity, and structural support is usually not as costly or extensive.

*Water as a Hindrance* The problems encountered in the sinking of a shaft may be great, especially if water-bearing strata need to be pierced. The water-bearing strata must be cemented or frozen before excavation begins, and lining the shaft with concrete becomes necessary. Even in dry strata, deep shafts are often lined in order to withstand the lateral pressures in the rocks through which they are sunk. After the shaft or adit is completed, lateral development takes place, and crosscuts are driven to reach the ore deposit at different levels. An extensive mine may have a main hoisting shaft and one or more auxiliary shafts or adits for supplies and ventilation. Many state mining laws require mines to be equipped with at least two points of entry and egress to improve the degree of safety for miners.

### *The Choice of Method*

The method chosen for mining will depend on how maximum yield may be obtained under existing conditions at a minimum cost, with the least danger to the mining personnel. The conditions include the shape, size, continuity, and attitude of the ore body; the mineralogical and physical character of the ore, and the character of the wall rock or overlying material; the relation of the deposit to the surface, to other ore bodies, and to existing shafts on the same property; the skill of available labor; and regional economic conditions. These variables are interdependent and of varying importance, but maximum profit and maximum extraction are closely related, because a method that sacrifices part of the ore body often yields maximum profit. In view of these considerations, open-pit mining tends to be more economical than underground mining, except in regions where climatic conditions are so severe that surface mining is often impossible.

### **Coal Mining**

Coal has been mined for more than 1000 years, and large-scale mining was practiced as early as the 18th century. The first coal mine in America was opened in Virginia, in the Appalachian bituminous field, during the 1750s; the mining of anthracite began in the late 1700s. Extensive mining in the United States commenced about 1820; until 1854 more than half of all the coal that was produced in the U.S. was Pennsylvania anthracite. In 1989, anthracite production was about 2.72 million metric tons, compared to about 980 million metric tons of bituminous coal and lignite.

## **Systems of Coal Mining**

Two principal systems of coal mining are used: surface, or strip, mining and underground, or deep, mining. Strip mining, which is a form of quarrying, is possible only when the coal seam is near the surface of the ground. In large surface mines, huge power shovels and draglines are used to remove the earth and rock (overburden) from above the seam; modern shovels have bucket capacities of as much as 290 metric tons. Smaller shovels then load the coal directly into trucks. The chief advantage of strip mining over underground mining is the enormous saving of time and labor. The daily output per person in strip mines is many times that in underground mines.

### *Supplementary augers*

As a supplement to strip mining, or when other mining techniques are not adequate, augers are used to bore horizontally into exposed coal seams. The loosened coal then flows into a conveyor for loading into trucks. A newer development is a boring machine, called a push-button miner, that can tunnel as deep as 300 m (1000 ft) into the coal seam, dumping the coal into mobile conveyors pulled by the machine.

### *Underground Mining*

In underground, or deep, mining, the coal seam is reached through vertical or inclined shafts, or, if the deposit is located in a mountain, through level or nearly level tunnels. The coal deposit is usually marked out in “rooms,” which vary in size according to local conditions. The coal is cut and blasted away, with pillars of coal left to support the roof. In the longwall system of working, a machine with steel teeth is raked along the face, and the broken coal drops onto a conveyor belt. As the machine moves forward, steel supports are advanced to support

the roof directly over the working face. The roof behind the coal face is allowed to collapse.

### *The Drilling*

In the conventional method of mining, power cutters have supplanted the traditional tool of the miner, the pick. The miner makes an undercut with these cutters about 15 cm (about 6 in) wide and as much as 2.7 m (9 ft) deep across the face of the coal seam, often close to the floor of the room. Deep holes are then drilled at the top of the face, and charges of safety-approved explosives or cartridges of compressed air are tamped into them. The explosive blast brings down and partially shatters a large chunk of the coal face, which is then loaded by machines into low, electrically propelled shuttle cars that bring the coal to a central loading point. From there it is hauled to the surface by either rail cars or giant conveyor belts. Most of the U.S. underground production of bituminous coal is mined by so-called continuous-mining machines, which eliminate the separate steps of cutting, drilling, blasting, and loading. These huge machines, capable of mining up to 10.8 metric tons of coal per minute, tear coal from the face and load it onto built-in conveyor belts. The belts transport the coal to waiting shuttle cars or mine conveyor belts that carry it to the surface. The coal is then transferred to a preparation plant, where it is screened, washed, sorted into various sizes, and sometimes crushed before shipment.

### *The Shortwall System*

A recent development, called the shortwall system, combines the continuous-mining machine with the use of longwall steel supports at the face. The continuous miner operates under the protective canopy of the supports and the roof is allowed to cave in as in the longwall system. Among the chief problems in

underground mines are ventilation and roof support. Ventilation is important because of the presence in coal mines of dangerous gases such as methane and carbon dioxide. Large fans and blowers must be used to maintain the circulation of pure air. In order to prevent the spread of coal dust, which can be highly explosive, mine interiors are frequently sprayed with limestone dust, a process known as rock-dusting. To provide support for the roofs of tunnels and work spaces, steel roof bolts that bind together the overlying rock layers are inserted into the mine ceiling.

### ***Coal Distribution***

Great Britain, which led the world in coal production until the 20th century, has deposits in southern Scotland, England, and Wales. In western Europe, important coalfields are found throughout the Alsace region of France, in Belgium, and in the Saar and Ruhr valleys in Germany. Central European deposits include those of Poland, the Czech Republic, and Hungary. The most extensive and valuable coalfield in the former Soviet Union is that of the Donets Basin between the Dnepr and Don rivers; large deposits have also recently been exploited in the Kuznetsk Coal Basin in western Siberia. The coalfields of northwestern China, among the largest in the world, were little developed until the 20th century.

*Coal Reserves of the United States*

The coal reserves of the United States are divided into six major regions. Only three of these regions, however, are mined extensively. The most productive region is the Appalachian field, which includes parts of Pennsylvania, West Virginia, Kentucky, Tennessee, Ohio, and Alabama. In the Midwest one large field covers most of Illinois and sections of Indiana and Kentucky. A thick field extends from Iowa through Missouri, Kansas, and Oklahoma. These three regions produce a majority of the coal mined in the United States. There are large deposits of lignite and subbituminous coal in North Dakota, South Dakota, and Montana. Subbituminous and bituminous coal deposits are scattered throughout Wyoming, Utah, Colorado, Arizona, and New Mexico. The Pacific Coast and Alaska have small reserves of bituminous coal. Almost all the anthracite in the United States is in a small area around Scranton and Wilkes-Barre, in Pennsylvania. The best bituminous coal for coking purposes comes from the Middle Atlantic states.

*Estimates of World Coal Reserves*

Estimates of world coal reserves vary widely. According to the World Energy Council, recoverable world reserves of anthracite, bituminous, and subbituminous coal in the late 1980s exceeded 1.2 trillion metric tons. Of this recoverable coal, China held about 43 percent, the United States 17 percent, the former Soviet Union 12 percent, South Africa 5 percent, and Australia 4 percent.

**Coal Production**

Before World War II, coal production in the United States had gradually declined, mainly because of the increasing use of other

fuels, particularly oil. War-industry needs stimulated mining, however, and in 1947 production reached a high of nearly 624 million metric tons, of which nearly 572 million metric tons were bituminous. Production dropped in the 1950s but rose again in later decades because of the large market provided by the electric utilities, events such as the Arab oil embargo of the mid-1970s, and an overall rise in energy needs. The geographic distribution of coal production also shifted greatly in the 1970s and early 1980s. More than 90 percent of U.S. coal production was distributed east of the Mississippi in 1970, but by 1990 the western states accounted for nearly 40 percent of the total. In general, the trend in the United States has been toward an increasing percentage of total production being provided by larger mines.

*US Mining  
Employment*

In the U.S., mining employment generally declined through the late 1960s. In the early 1970s, however, with the Arab oil embargo, coal reemerged as an important fuel. As production increased, so did employment—to more than 200,000 men and women in the early 1980s. In 1990 the coal industry employed 146,000 workers.

**Important Contacts  
for Further  
Information**

- Mineral Policy Center, 1612K St., NW, Suite 808, Washington DC 20006, Ph: 202-887-1872, Email: mpc-us@msn.com, Web: <http://www.mineralpolicy.org>
- Montana Environmental Information Center, PO Box 1184, Helena MT 59624, Ph: 406-443-2520, Fx: 406-443-2507, Email contact Andrew Dunn: [adunn@desktop.org](mailto:adunn@desktop.org). Billings affiliate office Ph: 406-248-1154, Email: [jbarber@desktop.org](mailto:jbarber@desktop.org)

## **Environmental Health and Safety**

Retrieving rocks and minerals from the Earth's crust changes the most basic structure of an ecosystem by disrupting the substrate on which life may develop. The environmentally deleterious effects of mining were noticed as early as 1556, when Georgius Agricola wrote his seminal text on mining:

### *Agricola's Quotation*

“The strongest argument of the detractors [of mining] is that the fields are devastated by mining operations...When ores are washed, the water which has been used poisons the brooks and streams. Therefore the inhabitants of these regions, on account of the devastation of their fields, woods, groves, brooks and rivers find great difficulty in producing the necessities of life.”<sup>5</sup>

### *Waste Material Generated*

Enormous quantities of waste material is generated since minerals are generally a rare appendage to huge quantities of worthless sediment. A study conducted by UNESCO specifically

### *Hydrogeological Impact*

highlighted 9 hydrogeological processes which are affected by mining. Underground mining often involves rock dewatering and the lowering of piezometric head. This may in turn lead to compaction of sand and clay, alteration in rock mass, and the

### *Surface Subsidence*

development of major jointing and surface subsidence. Mining activities are also likely to cause extensive chemical pollution and sedimentation in river channels because detergents and petroleum powered machinery are often used in the mining processes. Chemical engineers have described mines, specially abandoned ones, as “arsenic factories.”<sup>6</sup>

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<sup>5</sup> Agricola, Georgius. *De Re Metallica* (1556). Translated by Herbert Clark Hoover and Lou Henry Hoover 1912 Reprint, New York: Dover Publications. Quoted in Eggert, 1994.

<sup>6</sup> Henk Coetzee and David Cooper. “Wasting Water: Squandering a Precious Resource.” in Cock & Kosh eds., 1991, pp. 136.

*Dredge Mining*

Dredge mining, a process in which unconsolidated mineral-rich sedimentary material is removed by suction from a water-covered area is extremely deleterious for wetland areas. Water within a mine has been traditionally considered a hindrance to mining and hence draining programs from the mining site have caused major disruptions in groundwater regimes. The direction of groundwater movements may easily change due to mining, thus leading to disruptions in recharge regimes and the drying up of certain springs. There may also be a rise in groundwater in certain mining areas where geotechnological methods are used. Contamination of springs due to seepage of mine wastes may exacerbate the problem of water quality. Highly mineralized water may be very damaging to the organisms residing in rivers, not to mention the deleterious effects on humans.

*Change in Siltation Rates*

Mining activities generally change siltation rates in river systems and turbidity measures which may cause serious damage to fisheries. The excavation sites left by mining operations can fill with water and be a haven for mosquitoes and other undesirable pests. This has been a particular problem in the Brazilian mining region, where reported malaria cases increased from 52,469 in 1970 to 577,520 in 1989.<sup>7</sup>

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<sup>7</sup> Cleary, D and I. Thornton. "The Environmental Impact of Gold Mining in the Brazilian Amazon." in Hester and Harrison eds., 1994.

<sup>8</sup> Kelinman, 1985.

**Mitigation  
Measures**

Technological improvement is the main means of preventing depletion and pollution of water resources due to mining. One of the main means to prevent or limit the depletion of aquifers is to make use of the drainage waters by closely linking them with the general water supply for the mining operations and the surrounding district.

*Protecting  
Groundwater*

There should be an on site facility to retreat mineralized drainage and water-tight curtains in mining tunnels to prevent contaminated drainage and flooding. The siting of hydrogeochemical monitoring points is essential around mining works because of rapid and unpredictable changes in piezometric surfaces which may occur. In some cases artificial recharge or controlled discharge may be required to keep the aquifer levels stable.

*Bacterial Treatment  
for Acid Mine  
Drainage*

Acid mine drainage may be controlled by having sufficiently oxygenated water, through rotating biological contractors (a wastewater treatment device) and by using catalytic bacteria, most notably *Thiobacillus ferrooxidans*. Sphagnum-dominated natural wetlands may also be a natural means of filtering out impurities and buffering small amounts of mine water.<sup>8</sup> For mines which have already been polluted and need rehabilitation, there are also several methods which have been devised, based on previously discussed mitigation regimes.

**Table 1: Environmental Effects of Various Methods of Mineral Extraction**  
(after Ripley et al., 1996)

| <b>Mining Method</b>       | <b>Environmental Advantages</b>   | <b>Environmental Disadvantages</b>  |
|----------------------------|---|---|
| <i>Underground</i>         |   |   |
| Open stopping              | less waste rock than with surface mining                                      | high subsidence potential<br>oxidation of exposed materials   |
| Filled stopping            | lower risk of subsidence; disposes of some waste material                     | possibility of oxidation and combustion of backfill; slurry drainage and water disposal<br>aquifer impact                 |
| <i>Surface</i>             |   |   |
| Open pit                   | accessibility and lower worker risk than underground                          | waste rock and dust; noise; mine drainage; ore oxidation  |
| Alluvial                   | relatively easy to control damage although rarely done                        | high potential for particulate emissions to atmosphere and hydrosphere; surface disturbance                               |
| <i>Non-entry</i>           |   |   |
| Auger                      | minimum surface disturbance and low worker risk                               | low extraction efficiency   |
| <i>in-situ</i> leaching    | reduction of solid wastes, mill tailings, surface disturbance and worker risk | requires disposal of large amounts of soluble salts, possible groundwater contamination and surface subsidence            |
| <i>in-situ</i> utilization | minimal surface disturbance, worker risk and solid residuals                  | difficulty in containing and controlling underground process; high potential for underground contamination and explosions |

**Table 2: Abatement Procedures for Some Environmental Effects of Mineral Exploitation**  
(after Ripley et al., 1996)

| <b>Effect</b>                                   | <b>Traditional Abatement</b>  | <b>Advanced abatement</b>   |
|---|---|---|
| <i>Surface disturbance and Waste Dumps</i>      | reclamation, backfilling and slope engineering<br><br>physical stabilization: covering with inert material such as slag, soil, concrete<br>chemical stabilization: spraying with oil-resin emulsion;<br>vegetative stabilization                  | greater use of waste material for mine backfilling, roads, construction<br>greater use of non-entry methods of mining and alternative methods of disposal<br>better waste-dump siting |
| <i>Hydrospheric effluents (water pollution)</i> | settling ponds, recycling, lime neutralization<br><br>chemical treatment: neutralization, coagulation, precipitation, oxidation, reduction, oil exchange<br>chemical stabilization: spraying with oil-resin emulsion;<br>vegetative stabilization | use of wet drilling or enclosure and dust collection, more recycling<br>biological polishing<br><br>better waste-dump siting  |

*Balancing Costs and Benefits*

Mining operations are thus a source of great economic gain on the one hand and environmental stress on the other. Inequities in the benefits gained from mining are enormous, given the historical management of such operations. The dependence of economies on mining results in tremendous leverage being granted to mining companies. Environmental criteria often get eclipsed by these broader economic goals. This ostensible opulence often leads to investment in large development projects that have their own litany of environmental damages.

***Occupational  
Health and Safety***

Mining is a hazardous occupation, and the safety of mine workers is an important aspect of the industry. Statistics indicate that surface mining is less hazardous than underground mining and that metal mining is less hazardous than coal mining. A study of the frequency and severity of accidents shows that the hazards stem from the nature of the operation. In all underground mines, rock and roof falls, flooding, and inadequate ventilation are the greatest hazards. Large explosions are characteristic in coal mines, but more miners suffer accidents from the use of explosives in metal mines. Accidents related to the haulage system constitute the second greatest hazard common to all types of mines.

*Long-term Hazards*

A number of debilitating hazards exist that affect miners with the passage of time and that are related to the quality and nature of the environment in the mines. Dust produced during mining operations is generally injurious to health and causes the lung disease known as black lung, or pneumoconiosis. Some fumes generated by incomplete dynamite explosions are extremely poisonous. Methane gas, emanating from coal strata, is always hazardous although not poisonous in the concentrations usually encountered in mine air, and radiation may be a hazard in uranium mines. A tight and active safety program is usually in operation in every mine; where special care is taken to educate the miners in safety precautions and practices, accident rates are lower.

*Legislative Action*

Federal and state legislation has set numerous operating standards regarding dust and gas concentrations in the mines, as

well as general rules regarding roof support. Despite this, local conditions can suddenly change the atmosphere in the mines and render it hazardous. The Federal Coal Mine Health and Safety Act, passed in December 1969 and expanded in 1977, provided health compensation to miners and set strict controls regarding coal dust, methane gas, escapeways, roofing, wiring, and other mining hazards.

### *Localized Hazards*

Some hazards are related to the local geology and the state of stress in the rocks in the mine. The mining operation results in the shifting of loads on the strata, and in extreme cases such shifts may apply pressures on a critical section of rock that exceed the strength of the rock and result in its sudden collapse. This phenomenon, which is known as a rockburst, occurs particularly in deep mines, and research is under way to eliminate the danger.

*Accident Statistics*

Education, experience, research, social consciousness, and government regulation have contributed to lowering the accident rates in the mining industry. In coal mining in the U.S., for example, 346 miners lost their lives in 1930 for every 100 million tons of bituminous coal produced, but in 1990, the number of fatalities was less than one for the same amount of coal. The estimate has been made that 60 to 75 percent of all mining accidents are avoidable and are the result of human error.

*Social Awareness*

Mining operations are considered one of the main sources of environmental degradation and a dangerous occupation. Social awareness of this problem is of a global nature and government actions to stem the damage to the natural environment have led to numerous international agreements and laws directed toward the prevention of activities and events that may adversely affect the environment.

**Ecological Concerns in the Region: The Case of Alluvial Valleys**

An environmental assessment of the Tongue River watershed within the Powder River basin was conducted by Shell in 1982 when a mine was being planned on the reservation. The Bureau of Indian Affairs will use this document as a base from which to conduct a new assessment, since the proposed mining area largely overlaps with this acreage. Arch Coal has asked for an unusual arrangement whereby they would like to have exploration rights over a very large expanse of land and then select the federally allowable acreage within this land on which to start mining. The scope of the exploration assessment would thus be very large. Rick Steffanic, the environmental office at the BIA Billings office, feels that the company should give some indication of where exactly they want to drill within the acreage so that localized assessment studies can be carried out for those sites. The terms of this arrangement are being worked out.

***Ecological Profile***

The details regarding the ecological profile of the region have already been established in the Shell study. Suffice it to say that the ecology of the region is relatively resilient and should be able to sustain mining activity without any devastating consequences. There are no endangered or threatened plant species in the area. The bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrinus anatum*) are classified as endangered by the US Fish and Wildlife Service. The range of both these species of birds fall within the proposed mining area but no nesting sites have been observed. The black-footed ferret (*Mustela nigripes*) is an endangered species which may use prairie dog burrows, which are fairly common in the region. However, no black-footed ferrets have been reported within the

***Endangered Species***

proposed site area.

### ***Alluvial Valleys***

Alluvial valleys constitute the most significant ecological feature in the region to be protected under the SMCRA regulations of 1983 (See Appendix 3). The floor of an alluvial valley contains rich sediment which are an important agricultural resource and also an essential part of the ecosystem. According to a guidance document prepared by the Office of Surface Mining and Reclamation Enforcement, “an alluvial valley floor is defined by the existence of flood plains and terraces underlain by unconsolidated stream-laid deposits, the availability of water by flood irrigation or subirrigation and the use, or potential use, of that water and land for agricultural purposes.” Figure 2 shows the regulatory process involved in alluvial valley identification and resulting prohibitions.

### ***Creeks within Reservation that constitute alluvial valley floors***

Several creeks within the reservation constitute alluvial valley floors. The representation of one of these creeks, Squirrel Creek is shown in Figure 3. Note how the valley floor has filled over time above the bedrock. The depositional layers are the primary feature that the law aims to protect. The hydrology of alluvial valleys is particularly important.

### ***Reclamation***

Reclamation work after the mining stops must also be considered carefully when in planning. The Spring Creek mine located adjacent to Crow land has had considerable experience in this regard. In 1981, the Montana Department of State Lands determined that 90 acres of undeveloped rangeland adjacent to the Spring Fork Creek is subirrigated, and that 87 acres of land is potentially flood irrigable. The South Fork Spring Creek was

thus designated and alluvial valley floor and further deemed to be insignificant to farming. NERCO was thus obliged to submit a conceptual mining plan for the mine which provides for the restoration of essential hydrologic functions of the area.

*Compensation for  
Environmental  
Protection*

If such an eventuality were to occur on the proposed Arch Coal mine, the company would of course be accountable to the enforcement authorities and this may reduce the area which could be mined (depending on an economic assessment which the company would conduct). However, the BIA has in the past compensated the tribe for any coal which could not be mined due to environmental concerns by a revenue sharing arrangement from federal coal reserves.

Figure 2: Flowchart of alluvial valley floor regulatory process:

Figure 3

**Comparisons  
with mining  
operations on  
other tribal  
lands:**

The distribution of coal mining reserves across the country are shown in Figure 4. Currently, the Navajo and Hopi tribes have the most significant mining activities as far as native groups are concerned. A conversation with staff at the Navajo Minerals Department revealed that there most of the compliance concerns have been amicably resolved between the federal agencies and the mining company. The tribe has some concerns about water quality because of the scarcity of the resource in the region but overall the mining investment has been a largely beneficial activity for the tribes. There is a separate office which deals with abandoned mines and their reclamation. his is coordinated by the Office of Surface Mining and Reclamation.<sup>9</sup>

A list of all the mining ventures on native land and the respective mining companies is given in Table 3:

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<sup>9</sup> Personal communication via phone with Ram Das, Mining Engineer, Navajo Mining Dept., Window Rock, AZ: Ph: 520-871-6587, Fx: 520-871-7190.

**Table 3: Mines on Native Land in the United States, 1998**

| <b>Mining Company and Mines</b>  | <b>Tribe</b>  | <b>Mineral</b> | <b>Status</b>            |
|--|---------------|----------------|--------------------------|
| Amcord Inc.<br>• Amcoal Mine   | Navajo        | Coal           | Inactive<br>reclamation  |
| BHP Navajo Mining Company<br>• Navajo Mine                             | Navajo        | Coal           | Active                   |
| Consolidation Coal Company<br>• Burnham mine                           | Navajo        | Coal           | Inactive/<br>Reclamation |
| National King Coal LLC<br>• King Coal mine                             | Ute Mountain  | Coal           | Under<br>Construction    |
| Peabody Western Coal Co.<br>• Black Mesa / Kayenta                     | Navajo / Hopi | Coal           | Active                   |
| Pittsburgh & Midway Coal Mining Co.<br>• McKinley North                | Navajo        | Coal           | Active                   |
| San Juan Coal Company<br>• La Plata Haulroad                           | Ute Mountain  | Coal<br>(Road) | Active                   |
| Westmoreland Coal Company<br>• Absaloka mine (Montana land, Crow coal) | Crow          | Coal           | Active                   |
| Yampa Mining Company<br>• De-Na-Zin mine                               | Navajo        | Coal           | Inactive/<br>Reclamation |

***The Council of  
Energy Resource  
Tribes***

The Council of Energy Resource Tribes, based in Denver is an important forum for exchanging best practices and as a lobbying group to defend native interests in energy ventures -- including mining activities. The Council is a non-profit organization founded in 1975 with the goal to “support member tribes as they develop their management capabilities and use their energy resources as foundation for building stable balanced self-governed economies.” the following services are provided by the organization:

- Natural and Energy Resource Development
- Environmental Protection
- Policy Analysis and Advocacy
- Negotiations
- Enterprise Development / Financial Management
- Strategic Planning
- Communications and Publications
- Workshops and Conferences

*Environmental  
Protection  
Opportunities*

The Environmental Protection Department of CERT provides environmental needs assessments; environmental audits; workshops and training for Tribal environmental staff; internships and management assistance (particularly in hazardous wastes management). There is a year-long internship for Tribal staff co-sponsored by the Environmental Protection Agency, Region VIII available for Tribal staff.

*Internship*

**Important Contacts  
for Further  
Information**

David Conrad, Director, Environmental Program, Council of Energy Resource Tribes, 1999 Broadway, Suite 2600, Denver, Colorado, 80202-5726, Ph: 303-297-CERT, Fax: 303-296-5690, Email: CERT1975@AOL.COM

Figure 4:

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# **Appendix 1: Important Regulations on Alluvial Valleys**

# **Appendix 2: Memoranda of Understanding**

Environmental impacts of mining is related with its surroundings. Levels of impact on the human environment different from the mining location, topography, and climate. Environmental damage close to the number of people affected, for example, A city with annual mine output of 50000 tons will receive more complaints than a remote deserted island with an annual output of 5 million tons when it comes to the environmental problems caused by mining. Local terrain and climate characteristics have an enormous impact on the mining environment. In the flat area, the river flows slowly, with less sediment in it. Environmental planning is urban and regional planning with a focus on sustainability. It aims to analyze and minimize the environmental impacts of proposed construction projects and make sure they meet all environmental regulations. It essentially deals with "shaping" or improving construction projects to make them easier on the earth. Environmental Damages of Mining. Open pit mining. Open pit mining, where material is excavated from an open pit, is one of the most common forms of mining for strategic minerals. Underground mining has the potential for tunnel collapses and land subsidence (Betournay, 2011). It involves large-scale movements of waste rock and vegetation, similar to open pit mining. Additionally, like most traditional forms of mining, underground mining can release toxic compounds into the air and water. ISL mining has environmental and safety advantages over conventional mining in that the ore body is dissolved and then pumped out, leaving minimal surface disturbance and no tailings or waste rock (World Nuclear Association, 2012).