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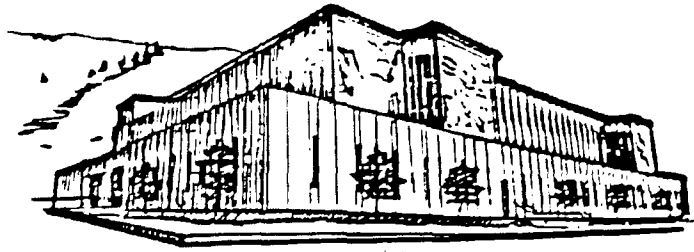
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University of  
**Montana**



**Montana's Cyanide Mining Experiment:  
Learning from Bitter Experience**

**by**

**James Barilla**

**B.A. Macalester College, 1990**

**presented in partial fulfillment of the requirements for the degree of  
Master of Science**

**The University of Montana**

**1995**

**Approved By:**

*Vicki Watson*  
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**Chairperson**

*[Signature]*  
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**Dean, Graduate School**

*July 18, 1995*  
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**Date**

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Barilla, James J. , M.S. May 1995

Environmental Studies

Montana's Cyanide Leach Experiment: Learning From Bitter Experience  
(205 pages)

Director: Vicki Watson 

The purpose of this project is to shed light on the operation and oversight of cyanide leach facilities in Montana by assimilating the heterogeneous and imposing records on file at the Department of State Lands and Department of Health and Environmental Sciences into a clear analysis of the patterns and problems associated with cyanide leach mining in the state. In doing so, I have examined the records of four of the largest cyanide leach mining operations to date: Beal Mountain, the Kendall mine, Zortman-Landusky and Golden Sunlight. A number of problematic patterns emerged from this review, including unanticipated water quality impacts, wildlife mortalities, landslides and agency enforcement lapses. This report includes a summary description of the problems encountered, followed by a series of recommendations for public citizens to affect changes in agency regulation and enforcement practices. Four appendices offer detailed analysis of the recorded history for each of the individual mines.

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## INTRODUCTION

On an early spring morning not long ago I stood in a meadow above the east fork of the Boulder River, admiring the clouds draped over the stark white peaks of the Absaroka range. I could hear Canada geese calling to one another in the slough, and elk and deer grazing near the edge of the forest. The mountains were silent, appearing immutable, while along the stream, a ribbon of faintly green cottonwoods and aspen was vibrant with birdsong.

Despite the serenity of this unfolding spring scene, I felt distinctly uneasy. Gazing up the valley, I knew I was looking at one of the largest platinum deposits in the world. Beyond the cleft where the snowy mountains converged in mist was the ghost town of Independence, now the site of a potential gold mine, and numerous mining claims by two giants of the gold mining industry, Pegasus and Noranda. Cooke City, where the New World gold mine has been proposed, was not far away. Having prepared this report, I could only imagine the giant scars and pallid, rust streaked heaps of waste rock which would mark the development of modern gold mining in the area. I could imagine this trout stream contaminated with sulfuric acid and heavy metals, its flow opaque with silt washed down off haul roads and pits.

It is my hope that citizens groups can use the information in this document to help prevent the repetition of the mistakes which have been made at four of Montana's largest cyanide leach gold mines. The report should

inform comments on mine proposals, alert groups to potential problem areas with existing operations, and assist efforts to improve DSL and DHES oversight of mining operations. Ultimately, the studies of individual mines may help make the case that some pristine and significant areas are simply inappropriate for the kinds of environmental degradation associated with these kind of operations.

### **Purpose and Organization of this Report**

Document files at the Department of State Lands and the Department of Health and Environmental Sciences have a story to tell about cyanide leach mining in Montana. The files contain correspondence between state officials and mine operators, commentary by federal officials, inspection reports, notes and memos from meetings, water quality data and letters from members of the public. For every mine there are thousands of pages of documents, hence the story they contain has remained obscured by the sheer volume of documentation.

The purpose of this project is to shed light on the operation and oversight of cyanide leach facilities in the state by assimilating the heterogeneous and imposing files into a clear analysis of the patterns and problems associated with cyanide leach mining in the state. In doing so, I have examined the records on file at the Department of State Lands and the Water Quality Division of the Department of Health and Environmental Sciences for four of the largest cyanide leach mining operations to date: Beal Mountain, the Kendall mine, Zortman-Landusky and Golden

Sunlight. I have supplemented this perusal of the documented record with interviews with personnel at the DSL and DHES.

The result is not the be-all and end-all on cyanide leach mining. I have limited this analysis to the issues raised directly by the files; there are additional legal and technical issues which are beyond the scope of this document. The Valuable Reading section at the end of this guide provides a list of additional materials which discuss some of these issues at length.

## **Overall Outline**

The report is organized into:

- \* A brief summary of heap leach mining info issues in Montana.
  
- \* Four case studies that offer detailed analysis of problems at four individual mine sites.

The summary is then divided into the following:

- i) General information on mines that use cyanide to recover gold.
  
- ii) Technical issues associated with cyanide leach mining, including land application, heap stability, liner integrity and leaks, acid mine drainage, water quality, mine expansion and wildlife fencing.

iii) Legal and enforcement issues in the permitting, bonding and oversight of mine operations.

iv) A series of recommendations on improving mine operations and oversight.

The observations and recommendations which appear in the summary are based upon the detailed appendices. Therefore readers seeking examples, document citations and a fuller treatment of the issues involved should refer to the appendices. I have divided the appendices, when applicable, into the same technical and legal issues found in the main text.

**Heap Leach and Vat Leach Mining: General Information**

Of the four mines I reviewed, three use heap leach methods to process gold deposits. The fourth, Golden Sunlight, utilizes a vat leach method. The following is a brief description of both methods.

The **heap leach** process utilizes cyanide to dissolve metals from large quantities of low grade ore. The process takes place in a number of stages.

1) The first step removes ore from the earth, often by blasting rock faces within the ore body with a blasting agent. The blasting is usually performed in levels or stages, with ore and waste rock removed between each round of blasting. The result is usually a pit, which can be thousands

of feet deep and thousands of feet across. The mine disposes of waste rock in a pile nearby.

2) The ore is sent to an agglomerator, where it is crushed to an ideal size for cyanide percolation and contact. The ore is then placed in layers on a lined surface, eventually creating a "heap" of crushed ore. The waste rock is disposed of elsewhere, often in a pile nearby.

3) Cyanide is mixed with water in a pond, then the solution is pumped through solution lines and out through sprayers onto the heap of crushed ore. The pond is called a "barren" pond because it does not contain gold. The solution, trickling down through the crushed rock, leaches out gold and other metals and collects at the bottom of the heap.

4) The gold bearing cyanide solution is pumped to a "pregnant pond" ("pregnant" with gold) and on to a refining and milling station, where the gold is removed from the solution. The solution is then pumped back to the barren pond, to be sprayed again on the next layer of ore. Solution volume lost through evaporation is replaced with "make up water," usually water from nearby streams or the underlying aquifer.

5) The mine operator may pursue reclamation activities concurrently with mining, or may wait until final shut down of the facility for some areas of the mine. Reclamation often entails contouring and reseeding of disturbed slopes to prevent erosion. Cyanide breaks down readily upon contact with sunlight and oxygen, but may remain viable for decades when trapped

beneath the surface of a heap. Reclamation activities strive to remove as much cyanide as possible from the material in the heap. Depending on the nature of the ore body, reclamation may entail rinsing heaps with water to remove metals and cyanide and ripping the tops of the heaps to promote water and oxygen penetration and circulation.

If, however, the ore body suggests a potential for sulfuric acid generation, as it has at several sites, the reclamation plan usually requires capping waste rock piles and heaps to reduce permeability to oxygen and water. Until recently, mine reclamation plans have not required that the pit be restored to its original character. A recent court case has declared this exemption for open pits illegal, hence reclamation requirements are currently in a state of flux.

6) Heap leach mining at most sites is a seasonal venture, beginning in the late spring and ending in the fall. As winter approaches, mines must initiate shutdown procedures and begin preparing for freeze up by emptying solution lines. They must prepare for spring run-off by maximizing evaporation and ensuring there is enough additional water capacity in the system to hold spring rains and snow melt.

7) Neutralization of cyanide solutions through the addition of certain chemical agents can take place at any stage of the process. Usually mines neutralize solution to prevent contamination when there is a risk of cyanide escaping the system. (see Technical Issues, Section A, below)

**Vat leach** operations utilize a slightly different leaching method. The main variation lies in the use of metal vats or containers to hold the crushed gold ore and cyanide solution while the leaching process takes place. Vats hold smaller quantities of ore and solution than heaps, but offer more efficient leaching. They are typically used with ore containing higher gold concentrations.

Once the vats have removed the gold from the ore, the spent material, a mixture of crushed rock and cyanide solution known as "tailings," travels through a pipeline system to a pond usually called the "tailings impoundment." After mining finishes and ceases to add more tailings, water in the impoundment slowly evaporates until only the cyanide treated solids are left. Reclamation plans call for the dry impoundment area to be recontoured, covered with soil and replanted.

In summary, both heap leach and vat leach operations are intended to be closed loops in which gold ore is excavated from an open pit and treated with cyanide solution, either by sprinkling on heaps or mixing in a vat. Both methods collect the gold rich solution which results for processing. Both send waste rock to dumps, and they both face reclamation requirements for disturbed areas. The two methods are similar enough to share many of the same problems. Significant differences do exist, however, and I will indicate these differences when applicable in the summary text and in the Golden Sunlight appendix. A more detailed description of the chemical and technical aspects of cyanide leach mining can be found in the resources listed in the Valuable Reading section of this report.

## **TECHNICAL ISSUES**

### **Handling Excess Water - Is Land Application Really a Solution?**

As many of the original mining permits indicate, heap leach facilities were planned as "closed loop" operations. Originally, neither the state nor the mine operators intended solution to leave the system. Evaporation was meant to be the sole reason for a decrease in solution volume, which would be replenished from fresh water sources in the area. The idea simplified water quality management considerably; since there was to be no discharge, there would be no need for MPDES permits, and no need for water degradation review.

Heap leach mines face a fundamental problem: while they must control exactly the amount of water entering the system, the vagaries of the weather are beyond their control. Mine permits have sought to cope with this situation in a number of ways. The permitting process employs rainfall data from the area to predict precipitation extremes and then stipulates a storage capacity equal to handling such an event. Thus the process circuit of heaps and ponds is supposed to allow enough space to handle water added by predicted rain events, up to a 100 year storm. During storms, diversion ditches are supposed to divert the flow of rainwater around the



actual "closed system", so that only the rainwater which falls directly on the system adds to the levels of the ponds. Winter shutdown procedures are supposed to circulate and evaporate enough water so that sufficient storage capacity exists within the system to handle spring snow melt and precipitation.

Despite these precautions, there have been leaks and massive spills from these theoretically closed systems. Perhaps the most egregious example occurred in 1985 at a heap leach facility operated by the Golden Maple Mining Company near Gilt Edge, Montana. Department of State Lands inspectors found the mine's ponds within a foot of overtopping, with a "serious head cut" threatening to breach the barren pond. Mine officials had in fact just finished repairing the dam, which had overtopped and nearly washed out at least a day before, releasing an unknown quantity of cyanide solution.

Several months later, cyanide solution once again flowed continuously over the same dam, nearly breaching it again, and releasing another unknown quantity of cyanide solution. Mine officials, in an attempt to avoid a complete dam failure, intentionally sprayed large quantities of unneutralized cyanide solution directly onto the land. Although the actual quantity is unknown and probably far higher, the company sprayed at least 77,000 gallons during a 10 day period, some of which state officials noted flowing off the permit boundary. Among the mines I reviewed, a similar series of events occurred during the spring and summer of 1985 at what is now the Kendall mine, then operated by Triad Resources.

Even when a storm does not breach the system immediately, a risky situation may still exist. As stated earlier, the mine permit requires a certain amount of storage capacity in the system at all times as a contingency against a one time, major storm, but this capacity can be incrementally exceeded by a series of modest rain events or the melting of a heavy snow blanket. Except for evaporation, which takes time and dry weather, mines originally did not have any permitted mechanism for getting rid of the excess water in order to regain the required storage capacity. Each day of operations without the required storage capacity incurs the risk of a storm event which is greater than the amount of "freeboard" available in the system to contain it.

In response to excess solution inventory, which, with additional rainfall could escalate into a Golden Maple style disaster, mine operators at the Kendall and Zortman/Landusky have first treated the excess solution with a cyanide neutralizing agent and then discharged this treated solution onto an area of land within the permit boundary. The volume of solution discharged is intended to be such that the soil absorbs the flow; no flow is intended to leave the permit boundary. Typically, the state requires monitoring in the land application area to ensure that solution borne contaminants are trapped in the soil. The state has now included land application methodology in mine permits so that what was once an emergency procedure at an accidentally underdesigned facility has become a routine part of heap leach operations. Is the excess solution volume unavoidable? Let's look at some of the causes.

## The Certain Uncertainty of the Weather

Originally, heap leach permits did not include any method for disposing of excess solution, because both mine operators and the state were confident that plans based on National Weather Service and US Geological Survey precipitation records were more than adequate to cope with the expected rainfall. Yet predicting precipitation at a given site has proven to be problematic, with weather patterns exhibiting far more variability than the historical records suggested. Regional data does not always specifically correspond to rainfall patterns in a particular drainage. As a result, mines across the state repeatedly exceeded their permitted volumes, often because the spring and summer were wetter or cooler (less evaporation) than recent regional precipitation records would have predicted. Mines whose maximum capacities were supposedly constructed to handle storms which should occur once every hundred years filled up three and four times during only a decade of operation.

## Faulty Winter Shutdown Procedures

Weather is hard to predict, but excess volume cannot be blamed exclusively on the vagaries of the weather. Mine operators head into the fall knowing that they must prepare for a surge in volume the following spring with the runoff of melting snow and rains contributing to the volume of the system. The mines are supposed to circulate process fluids through the system, spraying them onto the heaps repeatedly in order to increase

evaporation rates and make room before snow falls and the system ices up. When these procedures do not take place, the result is too little room in the system to handle the very predictable incoming rush of water at spring snow melt. In the Golden Maple case, inspectors hypothesized that the overflow occurred not because of excessive rain, but because the company had not properly completed winter shutdown procedures, leaving too little capacity in the system to absorb predictable additions in the spring. The same was true at the Kendall mine in 1986, leading to an emergency land application of solution.

#### Inadequate Diversion Ditch Maintenance

Diversion ditches are an important part of solution inventory management, since they are intended to route storm water and spring runoff around the system to maintain manageable, safe pond volumes. The ditches require constant maintenance - they often fill with silt or become blocked with branches and other debris, which must be cleared away. Failure to do so eventually leads to failure of the diversion ditches during subsequent precipitation run-off, channeling stormwater runoff directly into the system instead of around it. In 1991, for instance, Canyon Resources exceeded its freeboard capacity at the Kendall mine after a spring of slightly above average precipitation when a diversion ditch failure deposited over 1 million gallons of runoff as well as rock and sediment into the system. The solution excess had to be land applied.

When land application occurs, cyanide solution is pumped from the barren pond and sprinkled on the surrounding land. The only barrier to contamination is the neutralization process which breaks cyanide down into other, less acutely toxic, substances. There are a number of variables which can either reduce or augment the risk of contamination. Mine operators may choose to neutralize a batch of cyanide solution in a pond and then spray it on the land. Or they may add the neutralizing agent to the pipe as a pump draws the cyanide solution toward the sprinklers. Should the line feeding the neutralizing agent into the cyanide solution pipe become plugged, or the pump in the neutralizing line falter, a discharge of untreated or partially neutralized cyanide solution could occur.

In order to detect changes in the cyanide concentration or problems with the equipment, the DSL has required mine operators to test the treated CN solution periodically as it is land applied. The frequency and timing of this testing is crucial in both batch and continuous neutralization. When land application occurred with a batch method at the Kendall mine in 1987, for example, the operators found that neutralization in the pond had occurred in layers. As they reached the bottom of the pond, cyanide levels increased, necessitating the addition of more neutralizing agent. It was the testing regime, with HACH tests for cyanide conducted throughout the process, which identified the problem. The problem occurred despite DSL precautions, which required: 1) the operator to wait 48 hours before beginning to land apply in order to allow neutralization in the pond, 2) mixing of the solutions to promote even neutralization, and 3) two HACH

tests indicating less than 0.02 cyanide in the solution prior to commencing discharge. Had testing been less frequent, or implemented only at the commencement of land application, the elevated cyanide levels would not have been detected.

With continuous neutralization, testing frequency must be more frequent to be protective, since thousands of gallons may flow out through the sprinkler between tests, raising the possibility of an undetected cyanide release in the interval. When Kendall land-applied solution in 1987, 240 gallons per minute were sprinkled on the land, and tests for cyanide were conducted every eight hours, with 115,200 gallons of solution flowing out between tests. In an attempt to compensate for the risk of inadequate neutralization, some operators (like Kendall in 1991), add a larger quantity of neutralizing agent than would be necessary if complete mixing and reaction occurred prior to discharge. When calcium hypochlorite is the neutralizing agent, the treated solution damages the land application area.

#### Selecting a Neutralizing Agent: Cost versus Environmental Health

During the early 1980s, the state did not foresee the need for land application. Once that need became apparent in the mid 1980s, the compound used to neutralize the cyanide prior to land application was as bad for the environment as cyanide itself in the opinion of state officials. Calcium hypochlorite, a form of bleach, was the chemical of choice in the mid 1980s. It reacts with sodium cyanide to form ammonia and carbon dioxide, both of which are relatively benign. However, the reaction also

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produces salt and calcium chloride, both of which are sources of free chlorine ions in solution and are therefore extremely toxic to aquatic life. Even worse, if the operator adds too much calcium hypochlorite to the solution, as Canyon did when land using a continuous discharge method in 1991, the result is a highly toxic bleach solution. When land applied, as it was at the Kendall site in 1985, 1987 and 1991, the treated solution can produce a white coating over trees and grass in the area and extensive vegetative mortality. With hundreds of thousands of gallons of salty neutralized solution to apply, there is always the additional risk of ground saturation, with toxic solution draining off into area watersheds. But calcium hypochlorite was cheap and easy to store.

By 1990, an alternative neutralizing process using hydrogen peroxide had appeared on the scene. When hydrogen peroxide reacts with cyanide, the products are carbon dioxide and ammonia. This reaction did not produce toxic salt or free chlorine, making it a far better choice for the environment. On the other hand, hydrogen peroxide is considerably more expensive than calcium hypochlorite, and requires storage in special tanks. In order to land apply, the operation must invest in the storage tanks or have trucks deliver the product from the purchase point when needed. Some sites, like the Kendall mine, had already modified their permit to include land application without stipulating a neutralizing agent, and continued using calcium hypochlorite although DSL and DHES urged them to use hydrogen peroxide. Kendall continued to use calcium hypochlorite through 1991, switching to hydrogen peroxide in 1993 when the Water

Quality Division threatened to require an MPDES permit and water quality degradation review for the discharge.

### Solution Storage Capacity versus Hydrogen Peroxide Treatment

Theoretically, the destruction of cyanide with hydrogen peroxide yields products which are not considered to be as toxic as chlorine. The ability to treat and discharge solutions without severe effect has led to a rethinking of freeboard capacity among some mining officials. Maintaining sufficient volume in the system to handle a large influx of water usually means constructing larger ponds or adding contingency ponds to the system. Greater volume comes with a price: constructing ponds requires disturbance of the area involved during mine life, with the associated loss of vegetative cover, risk of erosion and stream sedimentation. Despite reclamation efforts, there is always the risk that the disturbed area will be extremely slow to return to its pre-disturbance condition, particularly at higher elevations with fragile alpine plant communities.

Alternatively, if mine operators managed solution imbalances through land application in conjunction with hydrogen peroxide neutralization, less volume would be required to retain the excess solution. Less volume would mean smaller and fewer ponds and therefore less disturbance of the surrounding environs. However, this approach represents a departure from the closed loop design, and as such entails some risks. Maintaining excess freeboard capacity is a measure of preparation which is already in place should a large scale storm occur.



In contrast, initiating land application requires some time once the need becomes apparent. For example, when Golden Sunlight neutralized two ponds with hydrogen peroxide as an emergency precaution, they had to wait for two days for the tanker trucks bearing the chemical to arrive at the site. Batch neutralization adds two more days of waiting.

Finally, if a component of the land application system were to malfunction or temporarily cease operation, the mine would not possess the same degree of extra capacity in the system to serve as a backup. The minimum storage option presumes that the land application would operate flawlessly, completely neutralizing the solution before it left the system. When solution leaves the system there is always a risk of mishap, oversight or equipment failure leading to the discharge of less than fully neutralized solutions.

Which course engenders the greater risk to the environment? In permit updates and amendments thus far, the state has appeared to pursue a middle course, with both contingency ponds and land application included in the permitted activity. The Kendall mine, for instance, constructed an additional contingency pond while also incorporating land application into the mining permit as part of an application to expand approved in 1990.

## Does Allowing Land Application Reward Poor Design and Maintenance?

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Land application began in response to a series of emergency situations; heap leaching systems were at risk of failure should additional precipitation occur. Thus land application originally occurred within the context of adherence to a closed loop design. In the wake of the repeated solution imbalances, land application was incorporated into revised mining permits, but its role remained unclear. Was it to be an emergency measure or a routine maintenance method? Would each incident of land application be subject to state approval and control, or would it be left to the mine operators discretion within the parameters of the permit? Did the treated effluent represent a point source discharge, subject to state restrictions? Ensuing land application cases demonstrated this lack of clarity over definition, necessary procedures and control. The document record indicates that at times the mine operators notified the state that they had already commenced land application under emergency circumstances, while on other occasions, the state approved land application prior to action. The state did not lower freeboard requirements, a move which might have signified a shift to fuller reliance on land application. But on the other hand it did not increase freeboard capacity to prevent the recurrence of emergencies. The DHES allowed disposal of calcium hypochlorite treated effluent on two occasions before notifying one operator, Canyon Resources, that land application would require a water quality degradation review performed by the agency.

## Site Stability

Heap and vat leach mining often occur in mountainous areas. These operations break apart millions of tons of rock and store the fragments in heaps and waste rock piles on slopes of various grades. The shifting of these vast rock quantities sometimes creates changes in pressure on these underlying rock formations. The excavation of the open pit also serves to destabilize the area, since portions of the surrounding area may slide down into the pit. Mining may also change the water flows of an area, exposing aquifers and burying surface water, which increase the chances of slippage in unstable areas.

The result of these changes can be movement along pre-existing fault lines in the ground beneath the operation, as the equilibrium of the once stable formation changes and water provides lubrication for slippage along the fault lines. When the shifting ground occurs beneath ponds and heaps containing millions of gallons of cyanide solution, it poses a catastrophic risk of liner tears or containment berm breaching.

### Assuring Heap Stability: A Shaky Science

At least until the mid 1980s, heap leach pad construction occurred without the technical analysis now considered desirable to add to the assurance of stability. The DSL assumed construction requirements ensured stability. However, as recently as 1990, the DSL approved construction on a heap

leach pad while knowing that its construction had not met those requirements.

Heaps must completely contain millions of tons of ore and CN solution. At least since 1986, the state has required the following of heap construction: 1) the operator must place ore onto the heaps in levels, 2) the overall angle along the sides of the heap must be stable for the site, 3) the berms which surround the heap leach pad must be built to certain specifications, with topsoil removed, water sources routed away from the berm area, and layers of clay, tailings and liner material used to construct the berm. The state presumed these specifications would assure stability. Thus when Grayhall Resources proposed constructing a new heap leach pad in 1986, for instance, no stability analysis was required or undertaken.

In 1990, when considering a Canyon proposal to expand Grayhall's 1986 pad, DSL discovered that Grayhall had not fulfilled the stability requirements for construction of the heap. Geotechnical analysis revealed that an unquantifiable risk of failure existed for the heap, but that expanding the heap would not increase the risk. The state could have required the operator to rectify the problem with the old heap, but instead allowed the operator to incorporate the old, improperly constructed structure into the new heap leach pad. By approving the expansion, DSL allowed the unquantified risk of failure to remain unaddressed.

Stability questions have not remained in the theoretical realm: three of the four sites I reviewed encountered major movement in the ground beneath their operations. At Beal Mountain, a plane of soil and rock began to move along old fault lines, creating a slump in the pit wall with fissures extending all the way to the heap leach pad dike, as if a giant chunk of the earth above was threatening to slide down into the pit. Mine operators responded by drilling out material at the top of the slump and placing it at the base to arrest movement and drilling into the slumping material to break up the slide plane and dewater the sliding material.

At Zortman/Landusky, the entire heap leach pad slid more than the length of a football field, covering a road. At Golden Sunlight, operations ceased after ground movement resulted in fissures which not only extended beneath cyanide tanks but cracked the concrete foundations on which they rested. The mine operators had deposited waste rock above an unstable area, creating pressure for movement along two faults in the area. By the end of 1994, the operators had removed over 14 million tons of waste rock from the unstable area.

## **Leaks**

Every heap leach operation in Montana has leaked. Any time cyanide solution leaves the permit boundary, a violation of state water quality laws has occurred because any discharge to state waters without a permit is

prohibited. Leaks can result from a variety of sources, including broken pipes, faulty drains or tears in pond liners.

You might think that cyanide in a downstream monitoring well would be enough to prove the existence of a leak. Actually, leaks may be difficult to prove. In an area of historic tailings, a leak could be taken as historic cyanide migration. Moreover, the mine operator is responsible for detecting and reporting leaks to the state, but obviously has little incentive to do so, since reporting a leak may mean a costly shutdown as well as a fine. At Beal Mountain, mine officials never reported that a cyanide leak from the barren pond had been discovered and repaired. A year later, agency personnel became suspicious when cyanide spikes appeared in water quality monitoring data, and the company then admitted to the leak. The state issued a violation and fined the company.

### Liner Perforations

Heap leach pads are currently required to have the following triple liner: a layer of clay covered with finely ground tailings material, topped with a "primary" liner of plastic-like material. All four operations I reviewed experienced perforations in the liner system which allowed cyanide solutions to escape into the environment. The causes ranged from poorly sealed seams to tears in the primary liner, caused by equipment or underlying sharp rocks. Leaks of this kind are usually discovered when testing of monitoring wells shows CN spikes (sharp increases). Depending upon the frequency of well testing, it may be as long as a month before the

operators discover a leak, and even longer before they trace it to its source. Often the quantity of lost solution cannot be precisely determined. For example, a September, 1993 leak at a Zortman/Landusky pond continued for nearly three weeks before the operators discovered the faulty seams which were allowing the solution to escape. State officials estimated that about 10,000 gallons of CN solution drained out of the system.

In more recent designs, underdrains and piezometers are typically installed beneath the liner to quickly detect and collect any flow which may indicate a leak. Such additions allow the operator to identify and locate leaks far more rapidly than in older designs. In the Zortman incident described above, the lack of piezometers contributed to the uncertainty over how much solution had been lost.

The underdrains and piezometers may be located between the synthetic primary and clay secondary liners, to collect and pump solution back into the system before it passes the secondary liner. A breach in the primary liner then becomes a gray area in terms of compliance, since solution has escaped one level of protection, but has not necessarily exited into the environment. In such cases, the question must be whether the pumps and drains collected the entire quantity of solution, or if some of the solution escaped into the environment. Ultimately, the only way of answering the question is to examine water quality data for evidence of cyanide increases downgradient of the area in question. On several occasions after 1990 at the Kendall mine, the collection system under the primary

liner of the ponds and pads captured cyanide solution, but the presence of historic cyanide in the area, coupled with inadequate baseline data, made it impossible to discern whether the entire leak had been contained.

### Drains and Pipes

Cyanide bearing pipelines connect the ponds, heaps and milling facilities. In vat leaching, cyanide treated tailings travel through pipes from the leaching vats to the tailings impoundments. Since pumps are used to move solutions through the system, the lines are usually pressurized. State permit requirements require the pathways of solution bearing pipes be lined, although this does not appear to be the case with tailings transport.

Three of the four mines I studied released cyanide into the environment through ruptures in the cyanide bearing pipelines. At Kendall, for example, employees mistakenly turned valves in cyanide solution bearing pipeline the wrong way, causing a buildup of pressure that burst the pipe. At Golden Sunlight, inspectors found that tears and ruptures in the tailings line had spilled small amounts of cyanide treated tailings onto unlined ground at numerous points along the line.

### Acid Rock Drainage



Acid rock drainage (ARD) occurs when unoxidized, sulfide bearing rock is disturbed during mining. Unoxidized material can include: ore placed on heaps, waste rock placed in piles or dumps, and the material used to create dikes, berms and other structures. When this unoxidized rock comes into contact with air and water, the reaction produces sulfuric acid. Without containment or contact with a buffering agent (such as lime or calcareous rock), the acid drains into area waters.

Prior to 1989, the state did not anticipate problems with acid rock drainage at the large cyanide leach mines I studied. In that year the state first noted evidence demonstrating a high potential for sulfuric acid drainage from Golden Sunlight operations. Subsequent investigations found that acid production was already occurring at the mine. At Zortman/Landusky, the state did not discover problems with acid rock drainage until 1992. In both cases, the original permit stated that the company did not expect to encounter unoxidized rock. This miscalculation led to the Zortman/Landusky operator constructing heap leach pad berms and other unlined structures with unoxidized material, which then began to produce ARD.

Because they did not anticipate mining unoxidized material, the reclamation plans at both Golden Sunlight and Zortman/Landusky called for actions which would increase the circulation of air and water through the heaps to promote cyanide neutralization. Such activities are the opposite of those demanded in an acid generating situation. A 1990 update of the Zortman/Landusky permit suggested that mining would

unearth unoxidized material, but that the waste rock dump would contain enough acid buffering potential to prevent acid drainage. The waste rock dump proved to have far too little neutralizing capacity, and highly acidic water began to drain into nearby streams.

Acid rock drainage now appears to be a primary concern to the state in permitting expansions of existing sites, mainly because previous mining did not undergo such rigorous analysis. Three of the four sites I reviewed now have either severe problems with acid generation or show signs of a developing problem.

#### Prediction of Acid Generating Potential: An Inexact Science

Initial attempts at ore body characterization employed by the state were cursory at best. Based on the characteristics of ore samples taken at Zortman/Landusky, for instance, the mine operators assured the state that they would not encounter any unoxidized material in the course of their operations, and the state concurred.

State officials utilize a procedure called "acid-base accounting" to determine the acid generating potential of rock in the area to be mined. The procedure involves taking core samples from different locations around the ore body and characterizing the rock according to the balance of minerals that tend to form acids versus those that tend to buffer acids. Each sample receives a score, with positive numbers indicating rock with a net buffering capacity, zero representing neutral rock and negative

values signifying a net acid generating potential. Based on the characterization of the different strata of rock surrounding the ore body, state officials have attempted to quantify the amounts of buffering and acid generating rock to be produced during mining and make predictions about acid generation based on them.

The process has not met with much success. In the case of Zortman/Landusky, acid based accounting predicted a net buffering potential for waste rock in a 1990 environmental assessment on extending the mine life at the site. Instead, the waste rock generated such large quantities of acidic seepage that the company attempted and failed to contain all seepage from the vicinity of the waste rock dump. Acid destroyed trout streams in the area, which during 1993 were running more acid than vinegar. Golden Sunlight has also experienced acid drainage problems, and evidence of acid-generating potential, in the form of rising sulfate levels, has appeared in the springs downgradient of the Beal Mountain waste rock dump.

### Waste Rock Segregation is not Microsurgery

In response to the realization that unoxidized waste placed in dumps already posed an acid drainage threat at several heap leach mines, the state attempted to prevent the creation of additional problems by requiring that "all sulfide bearing materials disturbed during mining" be placed on the heaps along with the ore. This approach was used in the 1990 amendment to the Zortman/Landusky permit. The presumption was that

putting the unoxidized material on the lined heaps would not prevent acid generation but would contain any effluent produced. Implicit in the requirement was the belief that the amount of sulfide material to be encountered would be relatively small, since burdening the heaps with large quantities of waste would render the leaching of ore inefficient. However, the company did not abide by the DSL edict, interpreting the DSL requirement to include only sulfide bearing ore, not waste rock. DSL allowed them their interpretation. They continued to place unoxidized waste rock in uncovered, unlined dumps until fumaroles of hot sulfuric gas began to appear at the top of the waste rock piles.

The next attempt at waste rock management appears in Zortman/Landusky's current application to expand, as well as in the Beal Mountain expansion amendment approved in 1993. In an attempt to prevent unoxidized waste contact with air and water, procedures call for the company to identify areas of unoxidized rock in the ore body prior to mining by drilling core samples at regular intervals in the pit face to be mined. Once the company removes the rock, unoxidized waste must be separated from oxidized waste material. Finally, the company must place the unoxidized or "hot rock" in a special dump, with the unoxidized material layered in tiers and surrounded on all four sides by enough acid neutralizing material to buffer the acid. A clay cap is to cover the pile at the end of the mine's life, preventing water and air from reaching the unoxidized material.

At Zortman/Landusky, the procedures are to be used as a preventative; the presumption being that acid generation will probably occur unless the measures are taken. At Beal Mountain, on the other hand, the procedures are to be taken only in response to evidence of water quality deterioration due to acid drainage from the waste.

Evidence from the files suggests that the requirement for waste rock segregation may not be easily implemented. When dealing with tons of rock, some unoxidized material, possibly through misidentification or insufficient separation, inevitably slips through and enters the oxidized waste rock pile. At Zortman in 1993, for instance, mine inspectors watched two dump truck loads of unoxidized waste empty into the waste rock dump, in spite of explicit demands that all waste be segregated and no sulfide bearing rock be placed in the dump.

The question of whether or not the quantity that slips through would be sufficient to generate acid drainage depends upon a number of variables, most prominently the buffering capacity of the site and the amount of "hot rock" involved. In the Zortman/Landusky incident, the operator characterized the amount of "hot rock" as miniscule, exclaiming that "mining is not microsurgery".

#### Reclamation Plan Alterations for Unoxidized Rock

None of the four mines I surveyed included any reclamation measures for unoxidized waste in their original permits. In fact, waste rock had already

been mined and placed in dumps before the state realized that the reclamation plans in place were doomed to fail.

The mining of unoxidized rock demands a stringent set of reclamation procedures in order to reclaim waste rock piles, heaps and other disturbed areas to some semblance of stable, pre-mining conditions in the area. Acid generation can not only pollute water but it can kill vegetation as well. The reaction which produces acid rock drainage can also acidify and heat up the overlying topsoil, making revegetation difficult. Once started, acidification feeds itself: revegetation failure triggers erosion, exposing more "hot rock" to water and air, which then drives the acid generating reaction.

The measures needed to prevent this cycle from beginning have been the source of controversy within the DSL and a lawsuit brought against one of the mines I studied. To reclaim unoxidized areas, mine operators must seal off the "hot rock" beneath layers of buffering material, so that no contact with topsoil occurs. The material cannot rest at a slope too steep for grading equipment to operate effectively and spread buffering layers evenly. Nor can the recontoured slopes above the unoxidized material be so steep that they encourage erosion of the buffering rock and topsoil.

At Golden Sunlight, the controversy centered on two questions: the thickness of the buffering and topsoil layers, and the slope at which the unoxidized areas must be reclaimed. The company wanted to reclaim using thinner layers of soil and buffering rock than recommended for acid

generating conditions. They also wanted to reclaim at slopes far steeper than the DSL's own technical staff believed would work. Thinner layers and steeper slopes require a lot less soil and a lot less work. The DSL approved the company's plan on a trial basis, stating that if the company's measures failed then they would be required to reclaim to DSL specifications. However, the DSL decision to approve the mine's "reclamation test plots" was struck down in 1994 in a lawsuit brought by several environmental organizations against the state and the mine.

### **Water Quality Problems**

Several of the original mine permits I reviewed repeated the frequently made claim: cyanide leach systems are closed loop systems, and therefore water quality impacts should be minimal. Neither the state nor the mines expected degradation to result from mining. However, water quality impacts at several sites have been severe, with drinking water supplies contaminated with cyanide, some trout streams running more acidic than vinegar and other streams flowing so full of sediment that they resembled chocolate milk. Water quality problems extend beyond the cyanide used in leaching, several operations have exceeded state limits for metals, nitrates, sulfates, pH and turbidity. Identifying and reducing these impacts has been hampered to some extent both by the nature of the sites and by inadequate baseline characterization of water quality.

Historic versus New Contamination

Water quality monitoring data is very difficult to interpret due to the nature of the mine sites. Many cyanide leach mines exploit old mining sites, where traditional mining methods were no longer profitable but new, efficient methods can exploit the low grade ore that remains. Old tailings piles and historic cyanide contamination often characterize these sites, yet the quantities, and the behaviour of the contaminants during weather events or spring run-off, is unpredictable. Any cyanide level might show up in a well or stream and be blamed on past contamination. Without a series of water quality measurements taken before the commencement of all mining activity, there is no reference point for future monitoring results.

For instance, a rainstorm may leach cyanide out of old tailings piles and into the groundwater, which will then show up as elevated readings in the monitoring wells. On the other hand, the rainstorm may have caused a breach in the containment wall of the current heap leach pad, causing cyanide contamination to appear in the monitoring wells. In this situation, only a witness to the actual breach would be able to state conclusively that the contamination was due to a leak and not due to historic cyanide migration. Thus heap leach operators consistently argue that elevated readings are due to construction shifting historic tailings or weather events causing cyanide migration through the underlying strata, rather than the result of a leak. Without witnessing the leak, it is difficult to prove otherwise.

Inadequate Baseline Required of Sites With Incremental Expansion



Some small mines evolve into large operations, and this incremental expansion may result in poor regulation if the limited expectations for a small mine are incorporated into the management plan for the larger mine. This is particularly true for baseline data, which can confuse interpretations of water quality monitoring in a manner similar to that of historic mining. For baseline data to be effective, it must include a number of parameters in addition to cyanide, such as heavy metals, nitrates and sulfates. It must include wells and surface stations in different areas of the site, and it must occur over a long enough period to establish averages and account for seasonal fluctuations in the parameters involved.

Review of baseline data included in the permits for these four sites indicate that baseline data has not been gathered in this manner, resulting in ambiguity and numerous operator claims that elevated contamination levels were the result of natural, seasonal nitrate flushing from the soil or historic cyanide migration - claims which the baseline was inadequate to address.

At the Kendall site, for example, baseline data up until 1990 consisted of one test at one monitoring well near the site which revealed less than 0.02 cyanide. No other parameters were tested. The baseline data was originally incorporated into the permit for Triad Resources. The mine was then sold to Grayhall Resources, which amended the permit to expand without providing additional water quality data to establish a new baseline. Canyon Resources took over in 1987, maintaining the same set of ridiculously inadequate baseline data until 1989, when an expanded list of

parameters appeared in an amendment to expand. However, the more complete data set still represented the results of a single day of testing.

### Self Monitoring (Fox Guards Hen House)

Heap leach mines conduct their own water quality monitoring, and the state currently has no policing arm to ensure that the results are valid. The state argues that it does not have the funds to pay for the water quality monitoring of all the mines in the state. Hence state policy requires the mining company to conduct its own water quality monitoring and to submit the results to the state for review. When a leak or other event occurs, the state may request an increase in monitoring frequency, but it is still the company which monitors itself. An independent lab is supposed to analyze the water samples. The problems with self-monitoring are obvious; providing evidence of leaks cost the company money, while submitting acceptable results allows business to continue as usual. The "independent" lab which analyzes samples is in fact paid by the mining company to conduct the testing. Without some form of state policing mechanism (e.g. unannounced water quality testing), a mining company may provide data which are unrepresentative of the site. At one site wells which have shown elevated cyanide readings in the past were reported to be dry or caved in. In other incidents, suspicious holes in a list of otherwise innocuous data make one wonder if the wells were not tested because of a suspected leak nearby.

The potential for water quality impacts does not reside in the toxic solution alone. Since cyanide possesses a poisonous cachet, it has received the lion's share of attention until very recently. In reality, water quality problems have originated from a variety of sources at cyanide operations, including fertilizers used in reclamation, chemicals used in land application, blasting agents, waste rock piles and haul roads. While cyanide has been a major contributor to ground and surface water contamination, these other contaminants and their sources cannot be overlooked. These pollutants, their sources and effects, include:

Sediments - Beal Mountain has encountered the greatest problems with sediment laden storm water flowing down off eroding reclamation areas and haul roads and into nearby streams. The sediment problem existed in 1992, but intensified with the mine's 1993 expansion into an area of clay soils - a problem which the permit failed to anticipate. During the fall of 1994, turbidity levels in German Gulch were 10,000 times the state limit. The increase in turbidity and total suspended solids happened in spite of an increase in sediment trapping structures mandated by the expansion permit. The state did not fine the company, despite the fact that high sediment levels can suffocate aquatic life and degrade habitat.

Metals - Gold is usually not the only metal present in the ore body; mining typically uncovers a number of metals which can be mobilized with the percolation of water through rock. Waste rock dumps, which are often

unlined and uncapped during mining, are often the source of a variety of metals which emerge in seeps and springs downgradient. Stormwater running over slopes exposed during mining can also deliver high concentrations of metals to area drainages. At Beal Mountain and Zortman/Landusky, springs and seeps downgradient from waste rock dumps contain high concentrations of metals, some exceeding Montana water quality standards. At Beal Mountain, the metals involved include iron, zinc and manganese, while at Zortman they included cadmium, lead, nickel and chromium. Both mines attempted to counter the problem by collecting the flow of contaminated springs and pumping it into the lined system of ponds and heaps. However, this in effect removes the spring's flow from a creek and reduces surface water contamination by obliterating streams.

Nitrates - Mines provide three potential sources of nitrate contamination: nitrogen based fertilizers used in reclamation, blasting agents and the compounds resulting from the breakdown of cyanide. Nitrate pollution in surface waters may result in nuisance algae growth which changes the ecological character of the surface water involved. Nuisance river algae is not usually a human health hazard, hence the state standard for nitrates is 10.0 mg/L, the drinking water standard set to protect human health. Preventing nuisance algae growth would require much lower levels. Nonetheless, cyanide operations have exceeded the state standard for nitrates in springs affected by mining. At Beal Mountain, nitrate levels in some springs in 1993 reached 12 mg/L, and biological monitoring of area streams indicated that pollution tolerant algae had replaced sensitive

algae species in the biotic community of German Gulch, a stream populated by west slope cutthroat trout. The cause of the nitrate problem remains inconclusive; mine operators maintain that nitrogen based fertilizers were to blame, whereas the state still considers blasting agents a potential or partial culprit. The mine operators diverted five springs contaminated not only with nitrates but with sulfates and metals. They pumped the springs' water into the process circuit instead of flowing into German Gulch, reducing by half the flow in this important trout stream.

Sulfates - Sulfates are a warning sign of potential acid drainage problems, since they signify the presence of sulfide rich pyrite in excavated material. Sulfate values for a site can be high while the pH values remain stable. In such a case the "hot rock" may be encountering enough buffering capacity in surrounding material that the result is sulfates instead of sulfuric acid, but no one can be certain how long the buffering capacity will last. At Beal Mountain, where sulfate levels have exceeded state standards, the sulfates have appeared in springs downgradient from the waste rock dump, suggesting the presence of sulfide-bearing waste in an unlined and uncapped pile.

### **Wildlife Death**

Two of the four mines under review have caused wildlife deaths during mining operations. The primary culprits are the ponds which contain pregnant and barren cyanide solutions at heap leach facilities, and the

tailings ponds containing cyanide solution and tailings at vat leach operations. These ponds pose a threat to waterfowl which land in the poisoned water and to big game animals such as deer, elk and bighorn sheep which come to drink.

Montana is not the only state to encounter these problems. In Nevada, for instance, over 6000 waterfowl and shorebird deaths were documented in cyanide bearing impoundments prior to 1992 (GAO REPORT). Nevada mines experimented with various hazing techniques such as propane cannons and blaring rock music designed to scare away birds, but eventually discovered that the most effective method of preventing mortality was to prevent access to the water by draping a layer of netting above the surface. Since these ponds have been covered with nets, bird mortality has dropped precipitously. In Montana, both Zortman/Landusky and the Beal Mountain mine utilize netting over their barren pond. .

Similarly, preventing deer access to the ponds with fencing prevents deer from drinking poisoned water or drowning in the slippery lined ponds which are difficult to escape. Despite the deaths at Montana mines, the document record suggests some mine operators have been slow to erect fences, even when required to do so by their permit.

#### Wildlife fencing

Fences and nets are only effective when they are complete, closed and in place. But limiting access to wildlife also limits access to mine personnel,

bulldozers and haul trucks busy with construction, maintenance, and transporting ore and waste.

At the Kendall mine, a 1992 Inspection Report states that after repeated state requests, wildlife fencing still had not been completed at the mine as mandated by the permit. At the Golden Sunlight mine in 1988, an inspector noted numerous deer tracks passing through an open gate to the tailings pond; a subsequent inspection found a dead deer floating in the impoundment. The state warned the mine that exclusion of wildlife from the impoundment was a condition of the operating permit, but took no further action. In 1992, three deer died at the Golden Sunlight impoundments. The deer may have entered via a 100 yard section in which fencing had been removed for construction purposes, but state documents warning the mine once again cite gates which are periodically left open. Despite these incidents, the document record includes no evidence of Notices of Noncompliance concerning wildlife at the four mines I studied.

## Netting

Two of the four mines have experienced significant waterfowl mortality: Golden Sunlight and Zortman/Landusky. The most severe problems occurred Golden Sunlight, which is located near the Jefferson River in a migratory flyway. While the highest number of birds have died during migration periods, significant numbers of birds have also died during non-migratory periods of the summer. Concerns include the loss of birds

landing in the impoundments and the possibility that threatened and endangered raptors, such as bald eagles and peregrine falcons known to frequent the area, might feed on poisoned waterfowl. 40

The mine has pursued a variety of mitigation options but has stopped short of netting the impoundments, which the operators contend would not be feasible due to the changing size and shape of the impoundment. The mine fired propane cannons, blared rock music and predatory raptor calls, hired two "duck guards" to haze away incoming birds with shotguns and "various pyrotechnics" and purchased a \$20,000 houseboat, a radio controlled aircraft and a \$30,000 hovercraft to chase birds away from the impoundments. While these hazing methods may have reduced avian mortality at the mine, bird deaths occurred despite their use.

Zortman/Landusky's ponds have caused far fewer deaths, but after 30 seagulls died in a pond in 1992, the BLM required the company to net all CN bearing ponds. With netting in place, six eared grebes died in a single incident in which three birds got tangled in the netting and three more squeezed through the netting and died in the pond beneath.

### Wildlife Death Toll

The exact number of wildlife deaths which have taken place since the four mines opened cannot be ascertained from the document record, because no adequate reporting mechanism for wildlife mortality exists. Mine permits do not require operators to report wildlife deaths to the Department



of State Lands, and the recording of wildlife deaths has typically been left to the operator's discretion. Wildlife affairs fall under the jurisdiction of the Department of Fish, Wildlife and Parks, but the personnel inspecting the mines for permit compliance are attached to the Department of State Lands. Inspection reports tend to focus on the technical aspects of mining and associated physical impacts to land and water; wildlife issues often appear tangential. Thus the document file records at least three inspections at the Golden Sunlight mine where inspectors discovered wildlife related incidents while conducting an investigation into other aspects of the mine. In two separate cases, inspectors found dead deer floating in the impoundment. 4 1

In 1989, Golden Sunlight voluntarily began to keep records of wildlife deaths at the site and to report those deaths periodically to the Department of State Lands. From 1990 to 1992, the company reported 194 ducks, geese, shore birds and gulls as having perished in the Golden Sunlight impoundments. Yet with the exception of the death of three swans mentioned in 1988, the document record contains no evidence of bird mortality from the time the impoundment was commissioned in 1982 until the mine began recording and reporting the deaths in the fall of 1989. No enforcement activities or investigations of bird deaths appear in the record for the six year period.

### **Least Cost, Less Effective Strategies**

The document record is replete with examples of best available technologies and strategies for dealing with environmental problems which operators chose not to use and the state chose not to require. In many cases these alternatives would have reduced or eliminated the cause of a problem or risk instead of mitigating the effects. But these options were often more costly, and thus the companies chose the less effective, but less costly option of dealing with the problem. Sometimes this choice paid off; the operation exposed the environment to a higher risk without the catastrophic event occurring. Yet on other occasions the less costly option caused environmental damage which could have been avoided.

Zortman/Landusky, for instance, chose to cope with acid rock drainage by dealing with the effects, not by confronting the source of the problem. The company had made a bad decision in constructing buttresses, dikes, under drains and retaining walls out of acid generating material. Instead of removing and replacing all suspect material and capping it to prevent drainage, the company chose to remove some structures and install less costly pumpback facilities to catch acid drainage before it reached a nearby drainage. The strategy was a complete failure, as area streams wound up running more acidic than vinegar during the summer of 1993.

The continued use of calcium hypochlorite at the Kendall mine, the refusal to net the Tailings Impoundment at Golden Sunlight and the diversion of contaminated springs at Beal Mountain are all additional examples in

which more expensive options existed but were not pursued. In all three cases, the environment suffered as a result.

## **LEGAL AND ENFORCEMENT ISSUES**

The state is charged with ensuring that a heap leach mine operates within the provisions of the permit and abides by state law. Technically, when the mine is not in compliance with the terms of the permit, the mine is operating in violation of the permit. The state should respond to a violation of the permit with a notice of noncompliance, which assesses a monetary penalty for the violation and requires remedial action. Depending upon the nature of the violation, the state may also suspend operations or revoke the permit. Yet violations often do not result in Notices of Noncompliance. Some flagrant violations resulting in large scale environmental damage have gone unpunished by the state. Consider, for instance, the glaring lack of any enforcement action against the Golden Sunlight mine for leaking 19 million gallons of cyanide solution into the groundwater from an unlined tailings pond. Even more common are instances in which enforcement actions are warranted but not pursued for violations which do not result in cyanide solution leaving the permit boundary. In addition, the files indicate that on several occasions the DSL issued a Notice of Noncompliance without assessing a fine. Without a fine, a Notice of Noncompliance has no teeth.

How many warnings should a mine operator be allowed before receiving a notice of noncompliance, given the nature of the substances involved and the risk of gross contamination if failure occurs? A closed system, by design, should tolerate no leaks or conditions which create the risk of a leak. However, because all the mines leak, it is easy to view problems which are not immediately catastrophic as relatively minor and not deserving a notice of noncompliance or fine.

Another problem concerns the division of responsibility for enforcement within the state between the Department of State Lands and the Water Quality Division of the Department of Health and Environmental Sciences. The two are supposed to work in conjunction with one another, but the Water Quality Division is charged with enforcing violations of the state's water quality laws, whereas DSL's responsibility lies in enforcing the provisions of the permit. Thus DHES becomes directly involved when a discharge off the property occurs, but does not have the authority to regulate the operation to prevent such a discharge. The conditions under which the mine is operating, which may present an imminent risk of a discharge to state waters, are within the jurisdiction of the Department of State Lands.

### **Permitting Process: EA versus EIS**

With incremental expansion common among the largest mines, the preparation of Environmental Assessments and Environmental Impact Statements has become a regular feature of cyanide leach permitting.

The Montana Environmental Protection Act requires preparation of an environmental review document for any state action which might impact the environment. An Environmental Assessment determines whether the impact of the proposed action is environmentally significant. If it is not, then the EA is sufficient consideration. If the impact is expected to be significant, then the agency must prepare a far more comprehensive review, the EIS. 45

With some frequency, and limited success, the state has attempted to confine its consideration of environmental impacts to the preparation of the EA. The state has argued that the impacts of expansion at several mines are insignificant, or that mitigation measures required in the approved permit will reduce significant impacts to a negligible level. In approving major expansions at Golden Sunlight and Kendall in 1990, the state contended that Environmental Assessments prepared for both proposals were adequate consideration of environmental impacts. However, in 1994 their argument failed to sway a District Court judge, who deemed the Golden Sunlight EA inadequate and ordered DSL to perform an EIS for the expansion.

### **Negligence, Accident, Intent**

Human error and resulting accidents are perhaps inevitable in any kind of enterprise. However, when dealing with large quantities of extremely toxic chemicals such as cyanide, or more generally, when managing an operation that impacts a large area, the margin for error is small and the potential for environmental harm great. Presumably a key issue in

determining how to prevent accidents must be whether a pattern exists and similar events occur repeatedly. Thus the situation in which Canyon employees mistakenly altered the pressure in pressurized solution lines, causing the lines to rupture, may be anomalous since it occurred only once, but it would be a different matter if it happened again.

At all four mines, negligence in the operation of vehicles either caused environmental damage or created the potential for it. A bulldozer drove out on a pond liner at Canyon's Kendall mine, tearing the liner. A similar incident happened at Beal Mountain. At Zortman, a bulldozer slipped off the road and drove down a streambed, uprooting vegetation and destroying the streambed. Mistaken instructions resulted in the construction of a road and the bulldozing of another streambed at Zortman. On this scale, relatively minor mistakes can have a major environmental impact. When patterns of accidents emerge at a site, DSL's enforcement activities should intensify, even if the individual infractions are minor. Repeated accidents could eventually result in a significant problem and should be called negligence.

### **Bankruptcy and Bonding**

The rights of a bankrupt company may interfere with the state's ability to enforce the mine's operating permit and state water quality laws.

Bankruptcy has prevented the DSL from collecting fines from Notices of Noncompliance, and it has also stopped the state from revoking the bond of a bankrupt operator who continued to violate the permit and endanger

state waters. In 1986, Grayhall Resources, the operator of what is now the Kendall mine, was bankrupt and without the wherewithal to fix a host of problems at the site. The DSL obtained legal advice from its staff attorney that shutting down the company and revoking its bond to clean up the site would probably result in a legal battle that the state might lose. Collection of fines for the continuing violations was even less certain in the legal arena, due to the protection afforded bankrupt companies. The state chose to allow Grayhall to continue operating.

Estimating adequate bonds for CN leach mines is a tricky business. Bond amounts are calculated to cover the cost of reclaiming a site should the operator declare bankruptcy and walk away. But there are few mines to serve as reclamation cost examples, because most of the mines are still operating. Bond calculation for cyanide leach mines in Montana is therefore a kind of informed speculation. Problems with acid rock drainage and water quality contamination have required dramatic changes in the nature of these operations and the bonding amounts needed to cover them.

At Golden Sunlight, for example, mine operators anticipate treating poor quality water forever, something never envisioned when cyanide leach mining came to the state. The company will post a bond, with the interest expected to pay for treatment 400 years from now. The ability to predict what treatment will cost generations from now is questionable at best.

### **Expansion by Increment**

All of the mines under review have expanded beyond the limits of their original permit through incremental increases in the mining area, the life of the mine and the amount of rock to be mined and processed. After ten years of operation, the mine may bear only passing resemblance in its size and scope to the operation approved in the initial permit. Yet frequently, an environmental impact statement accompanies only the initial permit application, with the additional expansions reviewed under an environmental assessment procedure. Environmental review thus acquires an incremental focus, which typically has resulted in a finding of no significant impact, rather than considering the impact of the mine in its totality. This approach favors mines which divulge modest intentions in the original stage of permit approval, then expand incrementally in subsequent years without undergoing the same rigorous environmental review which they would have received had they revealed the full scope of their intentions at the start.

#### Mining Faster Than Permitted Rate

Another form of expansion which occurred at one of the sites under study involves an increase in the rate of mining. Instead of mining the one million tons per year projected in the permit, a company now admits it may mine two million tons per year. Effectively, the total quantity of mined material should be the same, with the life of the mine shortened as the operation reached the limit more rapidly. Yet when combined with incremental expansions, the result is a larger operation than originally



permitted. At Beal Mountain, operators more than doubled the rate of 49  
production, then applied for two life of mine amendments to dig an  
additional pit and mine deeper into the existing pit. All the while, cyanide,  
nitrate producing blasting agents, water, dump trucks and diesel fuel must  
all be utilized in quantities much higher than would be required at the rate  
projected in the permit, producing a greater risk of negative environmental  
consequences.

### Expansion versus Closure at Troubled Sites

When trouble occurs at a cyanide leach mine, expansion instead of  
closure is often the preferable option for the state, particularly when the  
problems stem from unanticipated causes or shortcomings in the permit.  
Cyanide leach operations have encountered unanticipated problems with  
acid rock drainage, process solution management, ground movement,  
impoundment construction and perpetual water quality degradation.  
Closure of a troubled site may mean the state must take responsibility for  
clean-up. Expanding operations gives the state leverage; it can update  
permit requirements and compel the mine to abide by new restrictions or  
clean-up old messes.

Most of Beal Mountain's expansion amendment, for example, addressed  
water quality problems previously generated by the mine, rather than the  
expansion itself. Extending mine life buys time for the operator to deal with  
problems. To deal with water degradation at Beal, the amended permit set  
water quality restoration goals which gradually reduced impacts in the

direction of baseline levels. In its approval of the Beal amendment, DSL identified the expansion as the environmentally preferred alternative, even to the no additional mining option. According to DSL, the expansion would include numerous mitigation measures for already existing mining, while the no action option would only prevent additional mining.

Had the state not approved the expansion amendment, it would have been left to pursue corrective actions in the context of the original permit and original bond. With an unanticipated problem like acid rock drainage, reclamation requirements and the potential clean-up costs to be covered by a bond would both change dramatically. A statement by a member of DSL's technical staff to the Beal Mountain illustrates how costly the problem could prove to be: "I appreciate your early grasp of the problem we face with mine waste management in the future. I'm afraid that the true cost of reclaiming marginal mineral deposits with the potential for eventual acid rock drainage will come back to haunt some mining companies in Montana." (Plantenberg to Dale, Letter, 1/29/91) Should the mine close with a permit which predicates reclamation measures and bond requirements on the belief that no unoxidized rock will be encountered, then the true cost might come back to haunt the state rather than the company.

At Golden Sunlight, for instance, DSL staff welcomed the Golden Sunlight expansion because the mine was expected to close in 1993 and potentially severe, long term water quality problems had just been identified. Reclamation efforts included in the original permit were either

inadequate or counter productive, leading agency officials to conclude that reclamation according to the existing permit would fail. In addition, the state had not based bond requirements on the potential for acid rock drainage or the need for perpetual treatment of seepage from chronically leaking tailings impoundments. Mine closure would have left the agencies scrambling to force the mine to change its reclamation practices and come up with a bigger bond before it finished operating. Expansion, on the other hand, offered the chance to make reclamation succeed by requiring perpetual water quality treatment and a completely different reclamation regime in the amended permit, state officials claimed.

Expansion gives the state time and options, and keeps responsibility on the shoulders of the mining company. But at a troubled site, expansion may only compound existing problems instead of correcting them. At Golden Sunlight, water quality problems could only grow more complicated and severe by digging deeper into a pit expected to fill with contaminated water should excavation continue. When the state allowed Grayhall Resources to expand their troubled operations (at what is now the Kendall mine), the result was shoddy construction, a dangerously overloaded process circuit and additional cyanide contamination of ground water.

## **CONCLUSION**

Cyanide leach mining returned to Montana in the late 1970s with the procedures for gold extraction clearly defined, but without an equally clear

definition of the practices necessary to safeguard the state's environment. As a result, state agencies and mine personnel have had to learn from costly mistakes and unanticipated problems, many of which have proven costly to the environment. DSL may argue, for instance, that agency knowledge and experience have improved dramatically since Zortman/Landusky began operating in 1979, and that the permit for the recently proposed McDonald Meadows project, for example, will reflect enhanced agency know how and include state of the art technology.

In truth, agency regulation and mining technology both continue to improve, but the impacts associated with cyanide leach mining have become more pronounced as well. State mining policy has continued to play catch up with developing environmental problems. Recent DSL correspondence indicates that DSL technical staff now believe that acid rock drainage will be a concern at many Montana sites, that water treatment forever will be required at many Montana mines, and that the cost of reclaiming marginal sites may exceed the profits gleaned from mining. The industry continues to sail onward into uncharted regulatory waters, where unanticipated problems are likely to develop. DSL may now have a handle on land application, and be in the process of developing strategies for dealing with acid rock drainage. But perpetual water treatment represents a whole new experiment, with Montana's environment as the testing ground.

How will the agency cope with the yet to be identified implications of this untested technology? Rather than approve first and react later, the DSL

must take a far more cautious approach to the permitting and management of these mines. The fundamental lesson of these documents must be that far too often, the DSL allowed untested assumptions to pass for conclusive, research supported findings. Emergencies and environmental degradation occurred when actual operation did not conform to these flawed assumptions. The agency must be held partially accountable for the results. The agency must learn to err on the side of caution, which may mean preparing an EIS instead of an EA, requiring larger bond amounts and rejecting an expansion if the potential impacts cannot be quantified.

Despite DSL assurances that their oversight has improved, it is important to ensure that state agencies do learn from the past, and incorporate past lessons into current mining permit stipulations, better enforcement practices and reclamation requirements. The recent Golden Sunlight court case indicates that pressure from the mining industry can weaken DSL's resolve to learn from past mistakes. Within the current framework of mining laws and regulation, there is vast room for improvement. Most of the recommendations I have to make suggest changes within this existing framework.

## **RECOMMENDATIONS**

What follows are a series of recommendations intended to improve the operation and regulation of cyanide leach mines in Montana. I have tried to organize the recommendations according to three stages of mine

operation: the permitting stage prior to actual operation or expansion, the regulation and enforcement stage, when active mining is underway, and the reclamation stage after mining is complete. Many of the recommendations call for DSL to take action, since this agency usually takes the lead in permitting and regulating mining operations. Citizens groups face several obstacles to ensuring proper regulation of cyanide mines, the most prominent of which is a lack of access to the mine site. It is difficult for groups to take water samples, observe the condition of pads and dumps or monitor diversion ditch conditions when the gates are locked and entry denied to non-employees.

The primary goal of the citizens groups in this case should be to pressure DSL into adopting these recommendations as administrative rules to be followed as standard procedures whenever they prepare a mine permit or inspect a site. For those recommendations which the state chooses not to adopt, citizens groups should still request these changes when commenting on individual mine permits, mine amendments, environmental assessments and environmental impact statements.

While many of the recommendations will help improve environmental protection at existing and future operations, the case studies also suggest that the suitability of potential mining sites must be carefully reviewed. However, changes within the existing framework may not be enough to protect environmentally important areas. One of the policy implications which emerges from this study is the need to assess the environmental value and fragility of a particular site more fully than the current NEPA

process allows. The process should allow a determination that environmental values outweigh mineral values, and therefore a site is unsuitable for mining. Similar provisions currently exist in Montana's coal mining law, and citizens groups should push for their adoption in the hard rock mining rules as well. However, these kind of policy changes may be difficult to achieve in the current political climate.

## **Permitting**

The permitting stage is a crucial opportunity to define the practices, procedures and environmental safeguards by which the mining operation must abide. The documents for all four mines offer numerous examples of inadequate permit requirements. Sometimes vague permit language allowed polluting mines to escape enforcement activity. In other cases, the mine permit omitted consideration of environmentally dangerous practices altogether. Judging from previous DSL permitting efforts, citizens should demand that DSL:

*1) Define annual quantity of material to be mined and require annual reporting of quantity mined in previous year. In order to provide the company with some flexibility, define in the original permit the maximum quantity foreseeable to be mined in the future, even if it is well above current levels. If the mine had to define possible future increases at the start, and undergo environmental review for that level, then the current repetition of expansion amendments could be avoided. If the mine proposes to expand beyond the maximum outlined in the permit by more*

than 5%, then an amendment to the permit must be prepared with an environmental review which fulfills Montana Environmental Policy Act (MEPA) guidelines. This will prevent situations like that at Beal Mountain, where operators doubled the mining rate without agency notification, an amendment to the permit or an environmental review of the consequences. The DSL took no enforcement action because the permit failed to define the maximum annual quantity of material to be mined. The Legislative Audit of DSL offered a similar recommendation.

*2) Define quantity of cyanide, ANFO, water and diesel fuel to be used annually, and require annual reporting of their usage levels.* Once again, if the mine proposes to increase the use of these beyond the maximum originally defined in quantities greater than 5%, then an amendment must be prepared to reflect the changes, and the amendment must undergo an environmental review as required by MEPA. This will address cases like that at Beal Mountain, where the company increased substantially their use of these substances without agency notification or review. Once again, the permit failed to define maximum annual quantities of these substances, and the DSL took no enforcement action as a result. The Legislative Audit of DSL also made a similar recommendation.

*3) Define annual schedule of mining at the site which indicates months of active mining and leaching as well as months when the mine must remain dormant. Any departure from the schedule must require an amendment to the permit, with an environmental review in accordance with MEPA.* This recommendation will address situations like that at Beal Mountain, where



operators switched from winter closure to year round leaching without any modification of the permit or environmental review of the change. The DSL did not pursue a noncompliance because a Forest Service official overseeing the mine had given verbal approval of the change. The Legislative Audit of DSL also made a similar recommendation.

*4) Require baseline water quality testing over an extended period of 2-4 years, particularly across seasons, to characterize fluctuations and migration patterns of contaminants due to historic or predecessor mining.*

The set of baseline data currently required is too ambiguous; it has allowed companies to successfully argue that they are not responsible for water pollution. Better baseline data will allow the state to distinguish between cyanide readings which are due to spring run-off moving through old tailings, and cyanide contamination which has been caused by spills during current mining operations.

*5) Specify at least quarterly submittal of water quality monitoring reports.*

Water quality data can be an important tool in identifying problems at a mine, but to be useful the information must be timely. The files indicate that spills have occurred and gone unreported for over a year before the company submitted annual water quality monitoring reports revealing the leak to DSL and DHES. At Beal Mountain, the permit did not specify when the company had to submit annual hydrologic reports, and the company did not submit three previous years worth of data until 1993. The Legislative Audit also made this recommendation.

6) *Require geotechnical analysis of area surrounding projected mine site to characterize potentially unstable areas. The fault lines and movement blocks which lie beneath the mine area must be characterized before mining begins, and waste rock dumps, mine facilities and open pits located accordingly.* This will help prevent a Golden Sunlight situation, in which geotechnical analysis described ancient planes of movement beneath waste rock dumps only after the dumps had already triggered a slide.

7) *Require use of hydrogen peroxide as a neutralizing agent, and require sufficient quantity to be stored on site to neutralize at least two days of worth of land application (or however long shipment of additional hydrogen peroxide would take by tanker truck).* Treating cyanide with calcium hypochlorite produces salt and bleach, which when land applied have killed vegetation and threatened ground and surface water at the Kendall mine. The use of hydrogen peroxide instead of calcium or sodium hypochlorite will reduce the harmful impact of land application, but it must be present on site to be ready for an emergency.

8) *Specify the use of a batch treatment method for cyanide solution neutralization, with three HACH tests to ensure neutralization of cyanide below 0.02 before beginning land application and periodic testing during application.* Batch treatment offers far more security than a continuous system which treats and land applies solution almost simultaneously. Testing before application begins ensures that the cyanide has been neutralized; subsequent testing will determine whether any stratification of

cyanide levels exists in the pond. Hence the testing intervals must be at least frequent enough to accompany and characterize significant changes in the pond's volume. The actual testing frequency will depend on the overall pond volume and the rate of application.

9) *Require enough storage capacity in the system to hold a 100 year storm for the period of time it takes to neutralize solution, get land application equipment in place and functioning, and begin land applying.* The safest form of neutralization, batch treatment, typically requires 48 hours for complete neutralization of a pond, indicating that the system must be able to hold the additional volume from a major storm for at least that amount of time without spilling.

10) *Resolve uncertainty over control of land application by specifying the protocols for authorizing the process.* If an imminent threat of overtopping exists, then the operator must take whatever measures are necessary to deal with the problem. If there is too much solution in the system but no emergency exists, then the operator must consult with DSL and gain permission to commence neutralization and land application.

11) *If an expansion increases the amount or duration of disturbance at a site by more than 25% of the original permit levels, then require an EIS which considers cumulative impacts and provides alternatives to expansion.* Hopefully, better anticipation of maximum mining quantities in the original permit will render these kind of changes less frequent.

Incremental expansion demands a re-evaluation of the mine's impacts, not

just of the additional environmental burden, but of the overall impact to the area. Additional disturbance may push the mine past a threshold where significant effects might appear, which may not have been identified by consideration of the expansion alone. Requiring alternatives helps identify other options for the site, some of which might prove superior to the original expansion proposal.

## **Regulation and Enforcement**

The document records suggest that DSL needs to significantly improve enforcement activities in order to protect the environment. Rules and regulations on the books are meaningless unless the agency identifies violations and assesses stiff fines to dissuade operators from making the same mistake again. I offer the following suggestions for both the construction and operation stages of mine activity:

### Construction

12) *Require diversion ditch construction prior to or concurrent with creation of waste rock dumps, roads, heaps and other sediment generating disturbance.* This will help prevent sediment loading of streams like German Gulch, a cutthroat stream near Beal Mountain which looked like chocolate milk after a rain because the mine built roads without adequate diversions. It will also protect recently reclaimed slopes from erosion after rains.

13) *Increase inspection frequency during construction of pads, laying of pond liners and building of berms to ensure adherence to permit requirements.* This measure is intended to identify shoddy construction before it gets covered up with ore. At the Kendall mine, no inspectors were around to notice the faulty construction of a leach pad foundation before it was completed and the company placed cyanide and ore onto it. The Legislative Audit of DSL offered a similar recommendation.

14) *Ensure integrity of fencing during construction periods through the use of temporary fencing of downed areas when work is not in progress.* At Golden Sunlight, deer gained access to the impoundments even after fencing was complete, because a 100 yard section was down due to construction.

## Operation

15) *Require fall inspection to ensure that winter shutdown procedures have been initiated and that the company has ceased adding water to the system.* Many emergency land application episodes occurred not because of an inordinate amount of rain, but because the operator failed to shutdown properly or kept adding water to the system too late into the year. A fall inspection would insure that the mine initiated appropriate procedures at the right time.

16) *Require DSL to estimate the amount of money required to perform a proper fall shutdown, repair a liner, fix broken pipes, conduct reclamation and whatever else might be required should an operator walk away from the mine. DSL should then require a contingency fund to cover these costs which could be used by the state to bring the site into compliance even after the company has filed for bankruptcy.* This measure is needed to avoid situations like that at Kendall, where the mine was in terrible shape, the company, Grayhall, was in bankruptcy and the DSL could not revoke the company's bond, which was inadequate to cope with the problems regardless.

17) *Require reporting of all wildlife deaths within a week of discovery to DSL and FWP. The report should include the species, number, date discovered, likely cause of death and the company's remediation response.* Reporting of wildlife mortality has been haphazard at two mines. The federal agency with jurisdiction over Zortman operations demanded monthly reporting after bighorn sheep and birdlife died there in 1992, while Golden Sunlight volunteered to report all deaths in 1989. The General Accounting Office made a similar recommendation.

18) *Conduct unannounced water quality monitoring inspections, take samples and substantiate reported data.* Consultants paid by the company conduct water quality monitoring, although at times company personnel actually take the samples. Verification of results should be part of the regulation regime, particularly since suspicious holes and dry wells have

occasionally appeared in the water quality data at troubled mines.

The Legislative Audit of DHES recommended similarly.

19) *Inspect fences for gaps and open gates allowing wildlife access as part of regular inspection process. Include wildlife fencing in Inspection Checklist.* Wildlife mortalities have often been observed by accident while inspecting other aspects of the mine. The Inspection Checklist does not currently include wildlife fencing in its checklist of areas to consider during an inspection. This measure would attach greater importance to wildlife and increase awareness of wildlife issues among inspection personnel.

20) *The agencies should consider patterns of "accidents" in determining whether a negligent or gross violation of the permit has occurred. Patterns of minor infractions should receive a Notice of Noncompliance.* The extent to which violations with minor environmental consequences receive warnings instead of notices of noncompliance must be reduced. Minor mishaps can translate into big problems; several of the cyanide leaks which occurred at various mines resulted directly or indirectly from accidents involving heavy equipment. The DSL must consider the context of a minor error and take action before a major problem develops.

21) *Fine amounts must be increased.* The DSL often fines multi-million dollar operations too little to encourage companies to avoid violations. When calculating fines, DSL could assess a penalty for each day in violation of the permit, with the resulting fine amounting to thousands of

dollars. Instead, the fine amounts I observed in the files rarely exceeded \$2000, and fines of \$500 or less were most common.

*22) Fines must be assessed and paid after Notices of Noncompliance are issued.* There are too many examples of notices of noncompliance which are never finalized; the company receives the notice but the state never fixes a penalty and the company never pays a fine. The Legislative Audit of DSL includes a similar recommendation.

## **Reclamation**

None of the four mines have finished operation, and therefore complete reclamation has yet to occur. However, problems like acid rock drainage demand reclamation planning prior to closure. There are a number of steps which DSL can take to improve the chances that reclamation will succeed, including:

*23) Treatment of water in perpetuity must be studied thoroughly before it is approved at any sites.* The duration and scope involved in permanent water treatment demand rigorous testing and experimentation before it can be relied upon to mitigate the potentially enormous impacts associated with the infilling of an open pit with water. In addition, the legality of the concept must be clarified before it can be approved. Permanent disturbance appears to contradict the reclamation requirement of the Montana Constitution.



24) *Require a full ore and waste rock characterization of acid generating potential before mining begins, and as part of subsequent expansion amendments. At several mines, the state has only recently discovered that previous ore and waste characterizations unoxidized rock were woefully insufficient and have greatly underestimated the extent of the problem. As a result, the operators have already placed unsorted waste rock in dumps on top of springs and have contaminated topsoil stockpiles to be used in reclamation. Thorough, independent study, not company assurances, must be undertaken to prevent similar situations at mines in the future.*

25) *If acid generating potential exists, then a series of steps must be initiated before the appearance of signs that oxidation is occurring within waste dumps. The assurance that enough buffering waste exists to prevent acid drainage is not sufficient. The waste rock must be sorted and the "hot rock" placed in separate dumps where no springs will be encountered. The unoxidized waste must be surrounded with buffering rock, capped with clay and at least 18 inches of topsoil. Diversion ditches must route storm water around the dumps, and underdrains must collect seepage from underneath the dumps and prevent contact with the waste. Two mines have claimed that they had enough neutral waste to buffer acid production in their waste dumps and hence special precautions were unnecessary. One mine now has severe problems with acid rock drainage, and the other shows signs of developing the same problem. The steps must be taken before signs of acid production begin to appear, not after, as the state chose to require in regulating waste rock dumps at Beal*

Mountain. The signal that acid rock drainage has begun is deteriorating water quality; state waters should not have to suffer degradation before the state requires preventative measures.

*26) Require at least 3:1 slopes on reclamation of unoxidized waste rock dumps and heaps.* DSL's own technical staff recommended this ratio of horizontal to vertical angles on the reclaimed slopes of waste rock dumps and impoundments to ensure reclamation success. Anything steeper makes equipment operation and the even spreading of topsoil difficult. Erosion also increases on the steeper slopes, leading the DSL technical staff to state that anything steeper than 3:1 was likely to fail.

### **Glossary of Terms**

**Acid Rock Drainage (ARD):** Sulfuric acid tainted water draining from areas in which unoxidized rock has been exposed to air and water. Typical areas include waste rock dumps and old mining tunnels.

**Acid Base Accounting:** Method used to evaluate the sulfuric acid generating potential of an unmined ore body and associated waste rock. The method attempts to quantify and assess the balance between rock which can neutralize acid and rock which will produce acid. A positive value, such as +20, means the rock can neutralize acid, whereas a negative value indicates an acid generating potential. The assigned

number corresponds to the number of tons of lime needed to neutralize 1000 tons of rock. A value of - 20 means 20 tons of lime must be applied to 1000 tons of the rock in order to neutralize it.

Acid Generating Potential: Any rock containing unoxidized sulphide material has the potential to generate sulfuric acid if it contacts air and water.

Agglomeration: The process by which gold bearing ore is prepared for leaching. The ore is crushed to size and then sprinkled with cyanide solution.

ANFO: A nitrogen based blasting agent used to excavate rock from the open pit in mining operations. Breaks down into nitrates in the environment.

Angle of Repose: Angle at which a pile of rock placed on an incline will cease motion and become stable.

Aquifer: An underground spring or source of water table recharge for an area.

Barren pond: In the heap leaching system, a pond which contains cyanide bearing solution, but no gold or other metals. Precedes application to the heaps.

Baseline: A series of data intended to characterize the environmental quality of a site prior to anticipated impacts. Baseline data allows the state, for instance, to compare water quality data over time, identify trends and quantify impacts to water.

Berm: An earthen wall intended to contain water. Berms typically surround pond areas, or collection points for storm run-off.

Closed Loop: Heap leach mines were originally permitted to rule out any discharge of highly toxic cyanide to the environment by prohibiting any discharge of solution whatsoever. The system formed a closed loop: pipes connected ponds, heaps and processing facilities. The only sanctioned way for solution to escape was through evaporation.

Cyanide: A highly poisonous chemical used to dissolve gold from rock in the leaching process. Abbreviation: CN.

Downgradient: A relative term used to characterize the direction of water flow between two sites. For instance, the permit boundary may be downgradient of the waste rock dump, indicating that water will tend to flow from the dump to the boundary.

Environmental Assessment (EA): An environmental review required for all state actions which are not expected to have a significant impact on the

environment. The EA identifies potential environmental impacts and discusses why they will not be significant. It does not consider alternatives to the proposed action. This review may be undertaken as a precursor to an EIS if the agency is unsure whether potential impacts will be significant. A less comprehensive review than an Environmental Impact Statement.

Environmental Impact Statement (EIS): An environmental review required for all state actions which may significantly impact the environment. The review identifies impacts and considers the benefits of a number of alternatives course of action, including the no action alternative in which the desired alternative does not take place. A more comprehensive review than an Environmental Assessment.

Freeboard Capacity: In order to be prepared for storm water running into ponds and heaps, mines must maintain a specified quantity of extra volume in their systems at all times. The difference between the capacity of the system and the actual amount of solution in the system is the freeboard capacity.

Fumarole: A fissure spouting hot sulfur dioxide gas. Sometimes observed in waste rock dumps, where sulfides in the rock are undergoing an oxidizing reaction.

Geotechnical Analysis: Analysis of the underlying rock formations and fault lines of a particular site, associated with identifying potential ground related stability problems.

HACH Test: A field test used for measuring cyanide levels in water.

Results are immediate but less precise than lab testing of water samples.

(WAD or total?)

Head Cut: A breach or gouge near the top of an earthen berm caused by water running over the berm from the pond behind it.

Heap: A layered mound of ore used to extract gold with cyanide. Gold bearing rock is placed on the heap in layers and sprinkled with cyanide, which dissolves the gold. A collection system under the heap collects the cyanide solution for processing.

Incremental Expansion: Mine expansion by amendment, in which the life of the mine and the quantity of excavated material increases in stages. The ultimate size and scope of the project may bear little resemblance to the initially approved mine.

Leach: Process by which cyanide mixed with water trickles through rock and dissolves metals into the solution. Processing removes the gold from the solution.

Leaching Vats: The vat leaching process uses large steel containers, or vats, to contain gold bearing ore and cyanide solution during the leaching process.

Level stages: Refers to the elevation of a heap or pile in equal layers. 7 1

A pile of unoxidized waste rock, for instance, may be built up in step-like layers like a pyramid to inhibit contact with air and water.

Life of Mine Amendment: An amendment to a mine's operating permit, issued by the Department of State Lands, granting an extension of mine life and an expansion of mine operations.

Liners: Mine facilities often include a layer of impervious material beneath areas containing cyanide such as heaps and ponds. Liners may be made of clay or synthetic materials.

MPDES permit: A permit, issued by the Water Quality Bureau, allowing the discharge of waste water which may degrade state surface waters. The permit application must undergo a non-degradation review which justifies the degradation of state surface waters.

Neutralization: A chemical process typically involving hydrogen peroxide or sodium hypochlorite or calcium hypochlorite which breaks cyanide down into other substances such as carbon dioxide and ammonia. The reaction between cyanide and calcium or sodium hypochlorite is given by:  $\text{Ca}(\text{OCl})_2 + \text{NaCN} \rightarrow \text{CaCl}_2 + \text{NaCl} + \text{CO}_2 + \text{NH}_3$ . The reaction between hydrogen peroxide and cyanide is given by:  $\text{H}_2\text{O}_2 + \text{NaCN} \rightarrow \text{CO}_2 + \text{NH}_3$ .

Neutralizing Potential (Buffering capacity, Buffering potential): Any rock type which has the capacity to neutralize a quantity of acid. Often mentioned in this capacity are calcareous rock types, and lime.

Non-degradation Review: A permit for waste water discharge from a mine must undergo a non-degradation review conducted by the Water Quality Bureau, which considers whether or not degradation will occur, whether adequate consideration has been given to means of preventing degradation, and whether the degradation is justified by economic or other factors.

Notice of Noncompliance (NON): A notice sent by the Department of State Lands which informs a mine of an operating permit violation.

Ore: Rock bearing economically recoverable gold deposits, which is excavated and placed on heaps for leaching.

Pad: see Heap.

Permit Amendment: A major change in the mining permit, affecting such factors as the life of the mine, the quantity of material to be mined or the location of mining activities. Significant environmental impacts may result, necessitating the preparation of an Environmental Assessment or Environmental Impact Statement.



Permit Boundary: The area in which the mine permit allows mining activities to occur. The boundary also represents the physical limit for impacts to such factors as ground and surface water. Any impacts beyond the permit boundary are a violation of the permit.

Permit Revision: A minor change in the permit which will result in no greater land disturbance or environmental impact. No environmental review required.

Piezometer: Device used to measure flow of water. Often used to measure the efficiency of underdrains and leak collection systems in leaching operations.

Pregnant pond: In the heap leaching system, a pond which contains cyanide solution and gold or other metals. Collects solution after it has leached through the heaps.

Primary Liner: A layer, usually of synthetic material, placed beneath a pond or heap to prevent contact with the underlying ground. The primary liner will typically be placed over a secondary liner made of clay.

Pyrite: A type of rock containing sulphides, a form of sulfur. If the sulphides present in the rock are unoxidized, they could generate sulfuric acid upon contact with air and water.

Secondary liner: A back-up layer, usually of clay, placed beneath a pond or heap to prevent contact with the underlying ground. The secondary liner underlies the primary liner and is intended to contain any solution which escapes the primary liner.

Stability Analysis: Study conducted to determine the stability of a given structure, such as a heap leach pad.

Sulphide Bearing: Rock types, such as pyrite, which contain sulphides, a form of sulphur. The sulphides, if present in an unoxidized state, have the potential to react with air and water to produce sulfuric acid.

Tailings Impoundments: Large ponds store tailings, the mixture of ore and cyanide solution, after processing has extracted the gold.

Underdrain: A system of coarse rock channels constructed underneath a waste rock dump or heap leach pad to drain groundwater or springs away from the area and prevent contact with the material above.

Unoxidized: A term used to describe rock which has the potential to generate acid. The sulphides in the rock are in an unoxidized state, meaning contact with air and water will bring about an oxidizing reaction and produce sulfuric acid.

Waste Rock: Sometimes referred to as overburden, waste rock contains no gold but must be removed to access the gold bearing ore bodies.

Waste Rock Dump: Pile of waste rock created by mining.

Winter Shutdown: A set of procedures which a mining operation undertakes in the fall to prepare for winter. Typically the mine shuts down for the winter months. The procedures include reducing cyanide solutions in the system to make room for spring run-off.

### **Valuable Reading**

Babamento, Rasim, "Regulating Mining in Montana: Stealing the Common from the Goose," Unpublished Master's Thesis, University of Montana, 1993.

Offers an examination of the history of state and federal laws governing hard rock mining in the state. Critiques the existing legal framework and offers recommendations for improving mine regulation.

Chamberlin, Peter G., and Pojar, Michael G. "Gold and Silver Leaching Practices in the United States," U.S. Department of the Interior, Bureau of Mines, 1983. 47 pages.

Describes leaching methods, technology and regulations for potential miners.

Erickson, Lil, Olsen, R. Dennis and Black, Anne, Reclaiming the Wealth: A Citizen's Guide to Hard Rock Mining in Montana, Northern Plains Resource Council, 1990. 107 pages.

Good introduction to hard rock mining terms, processes and laws. Useful sections on organizing principles and opportunities for influencing mining decisions. Describes different mining processes for different minerals, explains the relationship of state and federal laws to mining practices and offers a step by step discussion of the environmental review process for mines.

Grove, Angie, "Performance Audit Report: Enforcement of the Water Quality and the Public Water Supply Acts, Water Quality Division, Department of Health and Environmental Sciences", Office of the Legislative Auditor. September 1994. 65 pages.

The Legislature requested a review of DHES operations, and the Office of the Legislative Auditor performed a review of agency files. The audit did not focus on mining operations, but it did utilize the files to track enforcement activities. The report describes a lack of sufficient enforcement activity, and makes recommendations for improving DHES procedures.

McClelland, G.E., and Eisele, J.A., "Improvements in Heap Leaching to Recover Silver and Gold From Low-Grade Resources," U.S. Department of Interior, Bureau of Mines, 1981. 26 pages.

Prepared during James Watt's tenure as Secretary of Interior, presents the results of a study which determined cyanide heap leaching to be an effective means of gaining profitable gold quantities from low grade ores.

U.S. General Accounting Office, "Increasing Attention Being Given to Cyanide Operations," GAO: June 1991. 38 pages.

Report to Congress which describes impacts of cyanide mining in California, Nevada and Arizona. Included is information on wildlife deaths and cyanide leaks. Recommends improvements in federal management of sites.

Wingard, Mike, "Performance Audit Report: Hard Rock Mining Regulation, Reclamation Division, Department of State Lands", Office of the Legislative Auditor, December 1994. 83 pages.

At the behest of the Montana legislature, the Office of the Legislative Auditor reviewed the files of 23 mines for the period of January 1989 to December 1993. The examiners looked specifically at DSL performance

in fulfilling its regulatory duties. The report identifies a number of administrative and procedural shortcomings and makes a series of recommendations. Some of the problems discussed in the audit report also appear in the enforcement section of my report.

#### A Note on the Documents Used in This Report

The documents from the DSL and DHES files which I used to prepare this report have been bound and are available in the special collections room of the University of Montana's Mansfield Library in Missoula, Montana.

### Overview

The Golden Sunlight mine, owned by Placer Dome, is a vat leaching operation near the Jefferson River and Whitehall, Montana, that received its first permit from DSL in 1975. The state prepared an EIS for the first of six permit amendments in 1981. The additional amendments approved the mining of 20 million tons of ore and 90 million tons of waste rock. In 1988, the company submitted a seventh amendment to expand operations. The amendment, approved in 1990, permitted the excavation of a 209 acre pit and the construction of a tailings impoundment of 250 acres. Total ore production increased by 30 million tons, and waste rock by 210 million tons. The amendment doubled the area of disturbance, with waste rock dumps expanding to cover 750 acres alone, making the mine the state's largest.

However, in 1994, a District Court judge overturned the DSL's approval of the expansion, citing the state's insufficient review of environmental impacts. In 1994 the ground beneath the mine began to move, halting operations for nearly a year. The mine has a history of significant environmental problems, from the loss of approximately 19 million gallons of cyanide solution to the recent identification of large quantities of unoxidized rock in waste rock piles and tailings impoundments. The water quality problems associated with the mine may require treatment into perpetuity.

## 1) Ground Movement

On June 13, 1994, the Golden Sunlight mine notified the DSL that some type of ground movement was occurring beneath the vats and tanks used in the leaching process. The following night, one of the leaching vats inside the mill building shifted 4 - 8 inches, causing cracks in the mill floor, buckling catwalks and damaging equipment. The mine shut down operations immediately. (DSL, Written Findings, 1/30/95) Neither the state nor the company knew what was causing the movement (which continued, albeit slowly) or what might develop next. In the weeks following the shutdown of the mine, consultants hired by the operators identified two major blocks (geological formations) associated with a landslide situated beneath the mine facilities.

The Rattlesnake Block, an area of movement which had gone unnoticed until the events in June, either underlies or is adjacent to the GSM mill complex and a portion of Tailings Impoundment I. Thousands of years before mining commenced, the "ancestral" Rattlesnake Block had experienced significant movement, but had remained relatively stable since mining began until the 1994 events. Movement in the Rattlesnake area totaled 1-1.5 feet by July, 1994. (BLM, Meeting Notes, 7/7/94)

Geotechnical investigations revealed that the Rattlesnake Block began to move as it was dragged along a fault line by an adjacent block of movement, the Sunlight Block. (Golder Associates, Memo, 10/21/94)



The Sunlight Block is another reactivated ancestral area of sliding material located to the west of the Rattlesnake Block and the mining complex. Geological analysis identified this block as the primary cause of movement during the 1994 episode.

The June ground movement was not the first stability problem the mine had encountered. The mine had previously experienced problems with landslides and slumping material, neither of which were related to the ground movement which occurred in the spring of 1994.

The Swimming Pool slide, which the DSL termed a "minor" area of movement between the pit and the mill complex had caused ground cracking and movement problems near the GSM operations in the past. (Clinch to Marx, Memo, 8/2/94) In 1989, The Swimming Pool slide caused a failure in the highwall of the pit. (Creek to DSL, Report, 6/24/94) DSL reports describe the movement in the pit as ongoing, with the extent of the slide appearing to end above the fire water tank and the mill complex. (Williams, Inspection Report, 6/20/94) On April 6, 1994, the slide had demonstrated increased movement on the hillside above the mill. (Creek to Olsen, Letter, 6/24/94)

The Midas Slump, located in the North Dump area, extended approximately 1/10 of a mile. (Clinch to Marx, Memo, 8/2/94) There has been a history of waste dump instability related to sliding on weak foundation materials and the flow of an intermittent spring underneath the dumps. A 1990 DHES Inspection Report described the slump visually:

"The "Midas slump" at the toe of the north waste dump was seen next.

We were quite a distance away, on a dump to the south, but the amount of mass movement and soil fracturing was very apparent." (Bugosh, Inspection Report, 3/20/90) The sliding dump "dozed" weak foundation materials ahead of its movement southward. (Golder Associates, Memo, 10/14/94)

The ground movement in the area of the mine associated with the Swimming Pool slide and Midas slump made recognition of the movement caused by the Rattlesnake and Sunlight blocks difficult. In fact, mine personnel first noticed cracks in the mill foundation and in soils near the mill in April, 1994, several months before the events which shut down the mill. But they assumed these cracks were associated with a variety of causes other than the mile long and half mile wide landslide which was slowly beginning to move. On April, 8, 1994, a consultant evaluating the Swimming Pool slide found a crack near the mill complex and assumed it was the result of movement in that slide. (Clinch to Marx, Memo, 8/2/94) Subsequent cracks in facilities, roads and dump surfaces were deemed suspicious, but were thought to be the possible result of heavy traffic or adjacent construction. Mine operators attributed a crack in the foundation near a leach tank, for instance, to construction of a pit water treatment facility nearby. (Creek to Olsen, Letter, 6/24/94) However, by early June cracks running several thousand feet in length had appeared in the ground and continued to widen. When the vat containing 45,000 gallons of cyanide sank and tilted several inches due to movement in the concrete

foundation beneath, it marked the end of three months of steadily more pronounced signals that the mine was on unstable ground.

#### A) Cause of the June, 1994 Ground Movement

At first neither the company nor the state knew what was causing the movement, but they both became convinced from geologic testing that the slide was occurring along an ancient series of fault lines, similar to a slide that had happened thousands of years before. At that time, a buildup of eroded material located at the top of the Rattlesnake block had put downward pressure on the unstable material beneath, pushing the block into a slide. Mine managers unwittingly recreated the same conditions which caused the ancient slide by loading the top of the unstable Rattlesnake block with 30 million tons of waste rock in the North Dump Complex. (Ludwick, Missouliau, 8/3/94) They also removed tons of rock from the bottom of the slide area in order to construct a second tailings impoundment, thereby increasing the pressure at the top of the unstable material while decreasing the support at the base.

Mine managers and the agencies involved in permitting the mine were quick to attribute the inability to predict the movement to a lack of information. "Sometimes, there are things that come up that you haven't thought about that cause problems," BLM geologist Dave Williams told the Missouliau in response to the ground movement. (Ludwick, Missouliau, 8/3/94) Yet the question remains: why were no stability analyses performed before the siting of the waste dumps that caused the slide? Of

course, hindsight attaches great importance to underlying stability in this case, but a thorough understanding of area stability should be part of any permitting process. Certainly these analyses should have been performed once the Midas slump and Swimming Pool slide occurred. It should not take a major landslide to trigger analysis of underlying fault lines and slippage areas. Earlier stability analyses would have saved the company a great deal of money and eliminated risks to the environment.

Omission of stability analysis may be one more example of the problems which develop with incremental expansion. The Golden Sunlight mine first began operations in the late 70s, expecting to process far less ore and produce far less waste rock than the operation which encountered problems in 1994. Yet the decisions regarding siting of waste rock dumps had already been made under earlier, smaller incarnations. Unlike the siting of a new mine or new facilities, the state does not have the same latitude after the disturbance, be it waste rock dump or open pit, is already there. The state must anticipate the change in stability resulting from a change in scale for the site, despite the appearance of stability under current loads.

#### B) Response to the June, 1994 Ground Movement

As a first response to the settling of the cyanide leaching vat inside the mill, the company began draining all the vats in the process circuit, pumping the material to the tailings impoundments and then neutralizing the tailings impoundments with hydrogen peroxide. The mine also constructed earthen containment berms around the mill to contain

potential cyanide leaks and sealed cracks in the mill's concrete foundation with bentonite clay to prevent water entry into the foundation (which would have further destabilized the foundation).

The response serves as a measure of how long an emergency shutdown and neutralization takes to complete. The draining of the vats required a week to 10 days, while the company continued to run the solution through the gold recovery processing equipment before sending it on to the impoundments. (Winegar, Inspection Report, 6/15/94) During this period, cyanide contaminated tailings and solutions continued to travel down to the impoundments through pipes exposed to shifts and shears in the sliding ground. Two water lines ruptured and several monitoring wells sheared, but no tailings lines broke as a result of the movement. (Scholz to Olsen, Letter, 11/18/94) While the vat movement occurred on the 14th of June, the company had to order hydrogen peroxide and did not begin neutralization of the tailings impoundments until the 17th. Thus it took several days to begin neutralizing the impoundments and even longer to drain the leaching vats, a period in which the system remained vulnerable to ground movement.

In order to slow the ground movement, the mine began removing waste from the dumps at the slide's top and began construction of a buttress at the base to restrain movement. The removal needed to be conducted quickly, in order to arrest further cracking in the area of the mill. The company first requested to remove 7.3 million tons, or 24 percent of the total waste placed in the dumps. Later, they upped it to 12.5 million tons,

then to 15 million. Movement of the slide slowed as the waste was removed and stopped in October when about 8.8 million tons had been transferred. (Foster to Olsen, Letter, 12/4/94) But geotechnical analysis suggested that additional unloading would provide a margin of safety from movement in the future, and the company continued to unload to the full 15 million tons.

The removal commenced while stability analyses were ongoing, with limited proof that the area where the material would be relocated was stable. The initial GSM request for waste rock removal states, "In the unlikely event foundation problems are encountered [at the relocation site], GSM is prepared to relocate waste rock from this area to a more suitable site." (Creek to Olsen, Letter, 6/29/94) Relocation proceeded under the aegis of preliminary reports suggesting stability. (Stacey to Creek, Preliminary Report, 7/23/94) The final stability analysis for the waste rock relocation area northeast of the Midas slump was submitted to DSL on December 23, 1994, after the bulk of the material had already been placed there. The analysis concluded that the foundation materials at the site were sufficiently stable to support 12 million tons of material, although correspondence between the mine and DSL from the same time mention 15 million tons. (DSL, Written Findings, 1/30/95)

When relocation began, mine operators did not know how much rock needed to be removed, nor did they know how much could be removed safely. The material at the top of the slide served to buttress the Midas slump. Mine operators were faced with a situation in which removing

material was necessary to halt one landslide, but the removal of too much of the very same material might trigger another landslide. The northernmost waste dumps had been built on the Midas slump material. Waste dumps further to the south served to buttress these dumps against movement. In fact, mine operators had constructed a "Midas Capture Dump" at the southernmost extent of the waste dump area, a waste rock depository intended to serve as a buttress to prevent the other dumps from sliding. But portions of both the southern dumps and the Midas Capture Dump were located at the headscarp, or crest, of the Sunlight Block, thus creating the downward pressure that caused the June 14 movement.

Based on their geotechnical analysis of the site, consultants to GSM concurred with the decision to unload portions of the Midas Capture Dump and backfill behind it. Some of the transfer would result in additional loading to the Sunlight Block, whereas other portions would provide the chance to unload material from it. (Stacey to Creek, Memo, 10/14/94) The final amount transferred represented a compromise between the two landslides. The analysis suggested that 14.6 M tons of relocation would provide some margin of safety for the Sunlight Block without triggering movement in the Midas Slump. According to the technical report prepared by the consultants: "Substantial unloading beyond the 14.6 M tons within the Sunlight Block headscarp area could possibly lead to relatively shallow surface instability of the waste dumps north of the headscarp area. Prevention of such shallow failures would require additional unloading north of the Sunlight Block headscarp." (Stacey to Creek, Memo, 12/1/94) In other words, removing more of the material causing Sunlight Block

instability would also require removal of unstable waste associated with the Midas slump.

The Rattlesnake Buttress constructed at the base of the Rattlesnake Block also had its share of stability related questions. The mine used waste rock known to have acid generating potential to construct the buttress, with the DSL stipulating that net neutralizing material be employed at the toe of the buttress where any acidic seepage would collect. The company constructed a drain system underneath the buttress to separate the flow of the Bunkhouse spring from the sulfide rich rock. However, both the company and the state expected the buttress to continue moving for some time after its completion, raising the possibility of a failure in the integrity of the buttress, its clay cap, or the drain system (If the buttress moved significantly then cracks might appear, allowing air and water access to the pyrite, or the drain system might rupture, causing the Bunkhouse Spring to trickle through the acid generating rock. The situation would then resemble that which occurred at Zortman/Landusky, where a buttress constructed of acid generating material developed a myriad of contaminated seeps known as the "Weeping Wall").

Once construction was complete, the buttress continued to move, at first more rapidly than either of the blocks, then slowed. As of January 1995, no cracks or failures in the integrity of the buttress had been reported. Movement in the Rattlesnake block also slowed.



The DSL found that the mine had fulfilled all state stipulations for reopening at the end of January, 1995. Before allowing the mine to reopen, the DSL delineated the following goals: 1) Halting of ground movement and reasonable assurances that the movement would not resume 2) A plan for continued monitoring 3) Shutdown criteria and procedures in case of resumed movement, and 4) Procedures for prevention of all environmental effects if movement resumes. These four goals in turn led to the formulation of the seven stipulations which GSM had to fulfill in order to reopen. In addition to the movement of waste material described above, the DSL required the company to replace pumpback wells below the impoundments should movement shear them and provide an emergency containment and detoxification plan for cyanide solutions in the mill and impoundments.

It remains to be seen whether or not the mine's responses to these stipulations will actually prove successful in preventing future movement and effectively dealing with any movement which does occur. However, the stipulations and the mine's responses do illustrate the areas in which both the mine and the state saw the need for improvement. The primary shortfalls resulted from the fact that neither had planned for ground movement. When the first incident occurred, there was no planned threshold at which the mine should shut down, thereby allowing potential signals of instability to appear for months before closure. There was no plan for containment of solutions lost due to ground movement; the mine hastily dug an earthen berm around the mill. No detoxification procedure

had been mapped out for the system, and the one implemented took several days to complete.

The updated plan established criteria for identifying the point at which operations must cease due to renewed ground movement. It included construction of higher concrete containment walls in the mill, rerouting pipelines and laying pipes in lined ditches. (DSL, Written Findings, 1/30/95) It required a quantity of the neutralizing agents sodium hypochlorite, calcium hypochlorite and hydrogen peroxide to be stored in sufficient quantities on site to neutralize the 6 million gallons of cyanide bearing material in the process circuit. The process solutions would be pumped down to the impoundments, which would then be neutralized by truckloads of neutralizing agents.

While the development of emergency plans undoubtedly represents an improvement over the lack of planning which characterized the first event, certain shortcomings remain. The final stipulation dealing with the detoxification of process materials and impoundments retains some apparent contradictions and inadequacies. For instance, the plan requires the company to keep enough neutralizing agent on site to cope with the entire volume of the process solution. Yet it also stated that these solutions would drain to the impoundments where "detoxification can be initiated." (DSL, Written Findings, 1/30/95) The on site reagent quantity called for by the plan is not sufficient to neutralize the ponds, yet the document does not specify any other point, such as the mill, where the process solution would be neutralized prior to emptying into the ponds. If detoxification is to be

initiated in the ponds and not before, then presumably the mine should keep sufficient quantity on site to detoxify the ponds instead of just the process solutions.

This is especially true since 2 days are required for additional truckloads of neutralizing material to reach the site. Although the previous incident did not involve the impoundments, this is no guarantee that future movements will spare the ponds. In the first case, the toe of the slide appeared just above a diversion near the top of Impoundment II. (Foster to Olsen, Letter, 7/29/94) Should movement cause a breach in the impoundments' walls or liner, a great deal of CN solution could drain away before neutralization could begin.

In addition, DSL incorrectly states that sodium and calcium hypochlorite convert cyanide into "inert, stable and harmless compounds." (DSL, Written Findings, 1/30/95) The products of the reaction between cyanide and these neutralizing agents include highly reactive free chlorine ions and salt, both of which are potentially damaging to the environment. DSL staff have indicated to other mines (such as the Kendall mine) that they consider the products of these reactions to be more toxic to the environment than low levels of cyanide, and have requested the use of hydrogen peroxide instead. (Frazier, Inspection Report, 5/29/91) The issue is relevant since neutralization in essence signifies preparation for a release. Were the solution treated with hypochlorite, the released solution would not be benign.

## 2) Acid Rock Drainage

### A) Waste Rock Characterization

The EIS for the Golden Sunlight mine, prepared for Amendment 001 in 1981, identified sulfide bearing materials in the material to be mined, but neither the state nor the company anticipated problems with this material oxidizing and producing sulfuric acid. The few permit requirements designed to prevent oxidation from occurring were not strictly followed. For instance, while the company was supposed to keep sulfide materials separate from oxidized waste rock dumps and topsoil stockpiles, they failed to do so, resulting in the acidification of the oxidized rock and topsoil needed for reclamation of the disturbed areas. (Plantenberg to Foster, Comments on 1990 Annual Report, 8/26/91) At least 80% of the oxidized dumps were contaminated with sulfides. (Plantenberg, Inspection Report, 3/19/91)

No references to the acidification issue appear in the document record until after the company submitted a proposal for expansion in 1988. In preparing the EA on the expansion proposal, DSL requested more information on the rock types to be encountered during mining.

(Plantenberg to Olsen, Memo, 1/31/90) The result was a 1989 report by consultant Doug Dollhopf, cited by both Plantenberg and the BLM (I was unable to locate it in the records) which concluded that the material to be mined had a far greater potential to generate sulfuric acid than either the mine or the state had previously believed. Soon after the Dollhopf report appeared, DSL inspections began to detail the extent of sulfide oxidation occurring in the waste rock dumps. A 1989 inspection, for example,

observed mine operators moving material in a waste rock dump. The inspector stated, "Sulfide oxidation was observed to be actively occurring in the top 10-12 feet of the dump in what appeared to be a zone of moisture retention, and was evidenced by considerable heat and release of sulfur dioxide." (Pagel to Walther, Memo, 4/27/89)

Based on the Dollhopf report, both the BLM and DSL technical staff declared the GSM reclamation plan which was included as part of the expansion proposal to be inadequate. (Hadley to Olsen, Letter, 12/12/89) However, the DSL had already declared the amendment application to be complete, and was already nearing completion of the mitigated EA for the expansion. The extent to which revisions to the reclamation plan should be made prior to approving the expansion became the focus of disagreement within DSL and ultimately one of the central issues in a lawsuit filed against the state and the company.

#### B) Problems with Acidic Seepage

Acidic seepage related to mining activities appeared in three locations at the mine: the Midas seep, West Dump seep and Ohio adit. Two of the seepage areas occurred at the base of unreclaimed waste rock dumps loaded with unoxidized pyrite. Mine officials claimed the two waste dump seeps only occurred after precipitation events. The seeps include:

Midas Seep - Seepage appeared in this area after the mine began dumping waste rock there in 1984. Prior to 1984, according to mine officials, no seeps or surface flow were apparent in the area. (Foster to

Frazier, Letter, 8/26/93) Although the seepage from the dumps was of poor quality, with low pH, high TDS, iron and sulfate concentrations suggesting acid rock drainage from the dump, mine officials contended that the discharge did not contact state surface or ground waters and did not require an MPDES permit. Foster states in a letter to the DHES that there are no receiving waters in the vicinity and that any seepage which does not evaporate enters the vadose zone, with groundwater levels 200 feet below the surface.(Foster to Frazier, Letter, 8/26/93)

The first DSL acknowledgment of the Midas seep's existence and poor water quality appears in a 1989 Inspection Report, in which the Inspector sampled the seep at the dump toe and found the pH to be 2.7. (Inspection Report, 5/4/89) According to mine personnel, the operators had dealt with the seepage by constructing earthen retention berms below the dump to collect and retain the seepage. (Foster to Frazier, Letter, 8/26/93) The issue did not come to the fore, however, until a 1993 inspection revealed retention berms to be inadequate. The DSL inspector found about 20 gallons per minute flowing from seeps at the base of the dump, over a soil stripped area and down a dirt road before infiltrating into the ground about 200 yards away. The acidic discharge was effervescing due to contact with carbonate rich soil. A water sample found the pH to be 2.77 and the specific conductivity 13,000. (Gurrieri, Inspection Report, 7/29/93) The operators responded first by digging additional dozer trenches to retain more water and treating the collected seepage with milk of lime. (Foster to Frazier, Letter, 8/26/93) As Gurrieri's inspection indicates, however, their attempts were not completely successful in containing the acidic seepage.

In the wake of these events, the mine constructed several underdrains at the waste dump to collect the Midas seepage and route it to Tailings Impoundment No.2. (DHES Field Investigation Report, 6/7/94)

On August 10, 1993, the DHES informed the mine that the Midas seep, along with three other seeps at the mine, might require MPDES permits for discharge to state waters and requested information about the seeps.

(Fraser to Wilson, letter, 8/10/93) Yet the agency did not inspect the site to make a determination until the following June, after several environmental organizations sent a notice of intent to file a citizen suit for unpermitted discharge at the mine. (DHES Field Investigation Report, 6/7/94) The inspection found that the Midas seep drained to ground water, not to state surface waters, and therefore no MPDES permit was required.

Contamination of ground water was a potential concern according to the report, but ground water was not the subject of the inspection.(DHES Field Investigation Report, 6/7/94) The document record does not indicate any further DHES analysis of the contamination question.

West Dump Seep - In July, 1993, mine operators noted a 1-2 gallon per minute seep draining from the toe of the southwest dump complex. Ice was present in the temperature stratified dump, and the source of the seepage appeared to be melting ice created by a combination of springs buried by the dump and high precipitation infiltrating into the dump. The operators' 1993 report claimed that retention berms below the dump toe contained the seepage, and reported the water quality of the discharge to be "near neutral pH, low Fe and other metals, and relatively low solids and sulfate."

(Foster to Frazier, Letter, 8/26/93) However, a July, 1993, DSL inspection found that the pond collected the seepage from the dump, which then seeped through the retention berm and continued downstream. (Gurrieri, Inspection Report, 7/29/93) Gurrieri's follow-up, August 3, 1993 inspection found 10-15 gallons per minute flowing down an iron stained gully from a pond at the base of the dump, suggesting flows much greater than company estimates and a viable connection between the gully and the contaminated pond. (Gurrieri, Inspection Report, 8/3/93)

Subsequent evaluations of the West Dump seep offer a more complicated view of water quality. The DSL account of the June, 1994 inspection describes two water sources at the base of the dump: one a spring "flowing as it has been for the past year," and a "small amount of ARD (1/10 gpm) contained behind a berm." (Gurrieri, Inspection Report, 6/20/94) The spring, according to Gurrieri, possessed relatively good water quality while the seepage water quality was "quite bad." The DHES account of the same inspection described the ponded seepage as orange in color, with a pH of 2.5-3.5, TDS of 75,000 mg/L, sulfate 51,000 mg/L and nitrate 11.2 mg/L, although evaporation in the pond may have affected concentrations. (DHES Field Investigation Report, 6/7/94) A series of springs issued immediately below the pond from an orange stained area which fed into an intermittent drainage. Chemical analysis of this water revealed a pH of 6.9, sulfates at 2180 mg/L and TDS at 3510 mg/L.

The DHES inspection report states that the West Dump seep involved an area where state surface waters (i.e., the springs) flowed; such waters are



subject to water quality standards and the discharge permit requirement. Yet the DHES report does not state that an MPDES permit for the seepis required, nor does it recognize any violation of water quality standards which might be occurring as a result of the acid rock drainage from the mine.

By the time DHES inspectors arrived, no connection between the pond and the springs was visible, and thus the agency could only state, "the toe pond is at a higher elevation than the spring and could reasonably be expected to affect the quality of this spring through seepage." (DHES Field Investigation Report, 6/7/94) The sulfate and TDS levels of the springs were eight and seven times higher than the state water quality standards of 250 mg/L and 500 mg/L respectively (The report presumably refers to Federal Drinking Water Standards, since secondary MCLs for these two contaminants are not explicitly stated in Montana Water Quality Standards). But no baseline data for the spring had ever been collected by the company, and therefore the DHES report states that "given the lack of baseline data it may not be possible to determine, with any certainty, the impact to these springs." Complicating matters, the report cites the poor quality of other springs in the area which may not be impacted by mining and may therefore approximate a baseline for the West Dump springs. Sulfate and TDS levels in the West Dump spring, the report states, may be consistent with normal levels for the area.

Ohio Adit -The Ohio adit discharged acid rock drainage from historic underground mining in the GSM permitted area. A capture system

collected the discharge and routed it to the impoundment until 1994, when mining in the pit intersected and continued below the adit, causing the discharge to dry up at the previous location.

### C) Causes of Seepage Problems

The Failure of Capture and Pumpback Systems The history of the Ohio adit's capture system illustrates the inadequacy of collecting seepage, using systems intended to collect and pump the contaminated water into the mine circuit. On separate occasions in 1990 and 1993, mine inspectors found the Ohio adit system plugged with sediment and the contaminated water running over land. In March 1990, DHES inspectors reported that the culvert which normally routed the acid mine drainage to the tailings line had been plugged with adit material several weeks earlier. (Bugosh, Inspection Report, 3/20/90) Again on May 3, 1990, DSL inspectors found the collection system plugged and the discharge flowing into an unplugged exploration drill hole 25 feet from the portal. The drill hole, the report states, could have the potential to discharge to the underlying aquifer. (DSL Inspection Report, 8/22/90) In both cases the operators cleaned out the collection system, but not before contaminated water had discharged, and the problem recurred. Gurrieri's July, 1993 inspection found the Ohio Adit discharge containment system inoperable due to a clogged pipe under the road. About 30 gallons per minute of acidified water were flowing over land. (Gurrieri, Inspection Report, 7/29/93)

The Midas seep collection system, completed in 1994, has encountered similar problems. An August, 1994 inspection found mine operators mucking out the Midas Capture System. (DSL Inspection Report, 8/4/94) After a storm, the capture system had plugged with sediment and overtopped. The inspector, having arrived some time after the storm, observed the flow escaping the capture system at 6 gallons per minute.

No Stormwater Diversions - In a 1993 letter to DHES, GSM suggests abnormally high levels of precipitation are the cause of seeps which appeared beneath the waste dumps and the tailings impoundment. (Foster to Frazier, Letter, 8/26/93) However, the blame for seeps and sediment problems lies squarely with the mine, not wet weather. Numerous field inspection reports document the mine's failure to adequately divert storm water and control sedimentation in the area through 1994. Undiverted storm water ponded on the top of waste rock dumps and infiltrated into the piles of rock to react with the acid generating waste. (Gurrieri, 7/29/93) It washed away topsoil and mulch placed on top of the waste dump in an attempt at reclamation. (DSL Inspection Report, 9/15/94) Seeps appeared at the toes of the waste dumps after heavy rains, in part because storm water was flowing into the waste dumps. (Plantenberg, Annual Tour Report, 8/13/93)

The August, 1993 DHES letter characterizing these seeps as potential discharges in need of MPDES permits triggered an interest in diversion construction. (DHES Field Investigation Report, 6/7/94) An August, 1993

DSL report states, "GSM has finally realized the need to control runoff water. They are reviewing the overall mine drainage patterns and have begun to divert water to manage some operational drainage problems. Runoff water from recent rainfall may have a direct correlation with the seeps because of the lack of operational diversions." (Plantenberg, Annual Tour Report, 8/13/93) Yet by 1994, these operational diversions were only partially in place, and the waste rock dumps which the mine operators had re-soiled in preparation for seeding rilled badly and spread sediment down the drainages below the dumps. (DSL Inspection Report, 9/15/94) The inspector observed other, similar problem areas "visible by the trails of sediment spread down the hills by the storm event."

The sediment flowed freely because the mine had not installed any sediment capture structures or implemented any sediment control best management practices. (DHES Field Investigation Report, 6/7/94) The clogging of the Midas Capture System, therefore, should not be blamed on the storm. The system clogged because a storm predictably produced runoff and the mine had no structures in place to prevent erosion and sedimentation.

### 3) Cyanide leaks

The Golden Sunlight mine leaked approximately 19 million gallons of cyanide solution from Tailings Impoundment I between 1983 and 1984. Neither DSL nor DHES took any action against the company for contaminating groundwater. In fact, company documents indicate that both the company and DSL expected relatively small amounts of seepage from

the impoundment from the start. The cyanide plume has continued to spread underground, and the impoundment has continued to leak. State officials and mine personnel now plan to treat seepage from the impoundment forever. 101

A) Unlined Impoundment Leaks Cyanide In February, 1983, GSM commissioned the use of Tailings Impoundment I. The unlined impoundment was constructed on supposedly impermeable bedrock, but the cyanide solution immediately began to leak down through underground alluvial gravel channels, under a cut-off wall intended to prevent groundwater migration out of the impoundment, and out into the surrounding aquifer. April, 1983 monitoring reports indicated a significant rise in cyanide levels down gradient of the cut-off wall. (GSM, Plan of Action, 7/85) Subsequently, cyanide began to appear in wells used by two ranch families down gradient from the mine. The mine provided an alternative water supply, but in January, 1987 the families threatened to sue. (Hemmer to Black, Findings, 5/22/87) The mine company decided to avoid further complaint by purchasing the family ranches.

In a 1985 Plan of Action, the company attributed the leak to "errors made during the initial construction of the bentonite slurry cut-off wall" which "resulted in portions of the wall not being properly keyed into the underlying relatively impermeable Bozeman Foundation." (GSM, Plan of Action, 7/85) The Plan of Action indicates that the company and DSL expected the wall to leak one to five gallons per minute of groundwater

contaminated by cyanide, but that when the impoundment was filled, far larger quantities began bypassing the wall. 102

In response, the company installed a series of pumpback wells downstream of the cut-off wall and along the eastern edge of the impoundment. Water levels declined in monitoring wells down gradient of the eastern flank of the impoundment. But another monitoring well, to the south of the impoundment, began to show a rise in water quantity and cyanide concentrations. The company stated that the cyanide tainted water could still be migrating through the buried channel, or " a more direct pathway may exist from the impoundment." (GSM, Plan of Action, 7/85) The company did not determine the actual cause of the seepage. The plan of action stated that despite company dewatering and pumpback efforts, "it is not certain that an absolute physical and hydraulic barrier to southward groundwater movement exists." (GSM, Plan of Action, 7/85)

The problem in determining the cause or causes of seepage lay in the fact that most of the area involved was already covered with tailings. Rather than identify and rectify the cause of the problem, the company chose to control contamination through pumpback. GSM did not propose tailings removal to rectify construction problems with the cut-off wall and identify other potential pathways. Nor did it propose constructing another, lined impoundment and moving the tailings there. DSL concurred with the company's plan of action, and did not pursue a Notice of Noncompliance for the possibly faulty construction of the cut-off wall. The DHES did not pursue any fines for the contamination of groundwater. To date, no

hydrologic study of the movement of the cyanide contaminated ground water has been completed.

Unfortunately, the 1985 Plan of Action was inadequate, and cyanide continued to migrate via unknown pathways out of the impoundment and into the surrounding groundwater. Both the DSL and DHES noted probable leakage areas in inspection reports, but no enforcement actions were ever taken against the company. For example, an August, 1993 DSL inspection report states "CN seepage [from the impoundment] has probably been occurring for awhile. Cetails at impoundment toe prove this theory." (Gurrieri, Inspection Report, 8/13/93) Similarly, a 1992 inspection report describes a visit to the "leaking" impoundment. During the visit, Fess Foster described two alluvial channel systems beneath the impoundment, one consisting of old river channels in the upper section of the impoundment, and the other a larger and more distinct channel in the lower portion called the Bozeman Formation. Both had created cyanide plumes in the groundwater, but the Bozeman cyanide plume remained uncontrolled and the extent of the contamination remained unclear. (Snyder, Inspection Report, 1/27/92) To date, no hydrogeologic studies have been completed to characterize the movement of cyanide in the groundwater surrounding the mine.

#### B) Groundwater Seepage Mixes with Permeable Impoundment

On August 2, 1993, mine operators discovered two seeps issuing just downgradient from the Tailings Pond No.1 embankment. The water flowed down to a man made catchment pond in the drainage, which was

discharging into an overflow pipe down into an intermittent stream which runs into the Jefferson River. Hach tests found the cyanide content of the water in the pond to be 3 ppm, but the cyanide content of the seeps ranged from 10-89 ppm total cyanide. (Foster to Fraser, Letter, August 26, 1993) The state water quality standard for cyanide is 0.02 ppm total. In response, the mine plugged the overflow pipe, added sodium hypochlorite to the catchment pond to neutralize cyanide in the trapped solution and installed a pump to move water back to a lined pond intended to collect seepage. (Foster to Fraser, Letter, August 26, 1993) However, the seeps had been flowing down into the catchment pond and then on into the intermittent drainage at a rate of 10 gallons per minute for an undetermined length of time before these measures were taken.

Initially, mine operators suspected a break in the pipes designed to pump seepage back into the impoundment. (Foster to Fraser, Letter, August 26, 1993) However, no ruptures were found in the excavated pipes. The mine's 1993 report to the DHES describes the source as "shallow ground water movement in alluvial material coming in contact with the southwest corner of the embankment." "Abnormally high" precipitation recharged seeps and caused the water movement, the report claims, but it also mentions "the abnormally high water volume and head in the tailing impoundment may have also contributed to the seepage." (Foster to Fraser, Letter, August 26, 1993)

A 1993 DSL report states the probable cause as storm water inundating a cyanide contaminated area of ground and then flowing through the ground



to the embankment. (Plantenberg, Inspection Report, 8/13/93) The area had been used for tailings storage for one day in 1986. The report also suggests that although mine operators downplayed the Impoundment as a seepage source because its water levels remained at expected (as high as expected given the abnormal amount of precipitation) levels, "a rocky outcrop area near the west end of the impoundment is probably also a major leak area from the impoundment which could be feeding the seep area." Presumably the rocky outcrop within the unlined impoundment served as a conduit for solution to seep down beneath the impoundment, mix with groundwater and flow out under the impoundment berms.

When the DHES inspected the seepage area the following year, they did not mention the tailings storage area, instead citing high groundwater levels in the area mixing with solutions in the tailings impoundment and then flowing out at the base of the embankment. (DHES Inspection Report, 6/7/94) Rather than an isolated incident, this situation resembles previous episodes in which cyanide solutions migrated through the permeable ground beneath the unlined impoundment. The problem, once again, was that ground water could enter and exit the impoundment. The mine installed another series of pumpback wells near the Southwest corner of the impoundment, lowering the water table and drying up the seeps. But the discharge had already impacted not only ground water, but state surface waters as well.

During the 1994 inspection, DHES staff found 3-5 gallons per minute flowing in the intermittent drainage downstream of the impoundment,

enough to constitute a state surface water. Thus, as the report states, <sup>106</sup> the seepage from the impoundment during the previous summer represented a discharge to state waters, since cyanide contaminated water exited the containment pond through the overflow pipe and flowed down the drainage. According to the DHES report, "the impacts of these discharges are unknown." (DHES Inspection Report, 6/7/94)

Yet the DHES recommended no violation for the escape of cyanide solution from the impoundment. The report states that GSM's pumpback measures corrected the problem and "should prevent future discharges in this location." (DHES Inspection Report, 6/7/94) The pumpback wells may have stopped seepage in that section of the embankment, but the fact remains that they were not the first instance of cyanide migrating from the impoundment. Since 1983, the mine had installed pumpback wells near other parts of the impoundment to control contamination in those areas as well, only to have seepage occur in yet another portion of the impoundment. The more intractable problem which the agency failed to address was not the particular seeps but the lack of an adequate liner. The discharge of cyanide solutions to state waters without an MPDES permit was a violation of Montana water quality laws, and should have resulted in prompt enforcement action.

In a similar vein, no violation appears in the DSL records in connection with leaks from the impoundment caused by the rocky outcropping, nor do any requests for remediation appear. No DSL violation appears for the storage of cyanide contaminated tailings on unlined ground, which DSL

inspectors hypothesized as a source of contamination in ground water. Both are clear violations of the DSL administered mining permit, and should have caused the agency to issue notices of noncompliance.

#### 4) Spills of Contaminated Tailings

In the weeks following the 1994 ground movement which shut down the mine, the state conducted several inspections of the site. While inspecting potential rerouting lines for surface water, DSL inspectors discovered numerous areas where the lines which conveyed tailings to the tailings impoundments had broken or spilled finely ground ore and cyanide contaminated solution onto the ground. (Plantenberg, report, 6/21/94)

Tailings from several of the spills had migrated downhill along two minor drainages for as far as a quarter mile. None of the spills had been reported to the state.

Inspectors identified one major spill of 45 tons of tailings and an equal amount of solution from the line. The spill appeared to have occurred during the preceding fall or early spring, but the mine had not cleaned up the spill by June, 1994, when inspectors discovered it. The state issued a Notice of Noncompliance to the company both for failing to notify the state and for not cleaning up the spill immediately. A GSM press release, responding to the notice, called the spill an "isolated incident," caused by a truck gouging the pipe. Yet follow-up DSL inspections revealed numerous, recurring spills at different points all along the line. For instance, inspectors found areas such as the "bleed off air riser," which "obviously spills a small amount of tailings every time the line is bled."

(DSL Inspection Report, 6/28/94) At another spot along the line, inspectors found "a little spill that had occurred since last week's visit." Overall, inspectors found nine areas where spills had taken place, several repeatedly over time. They found areas where tails had been partially cleaned up with a backhoe and grader, but tailings remained under the pipe where the equipment couldn't reach.

Thus the Notice of Noncompliance inadequately addressed the spills as a single incident when in fact the problem had occurred repeatedly without the company notifying the state or cleaning up the spills. A BLM rendering of the June 28, 1994 inspection calls managing the spills a "housekeeping/education undertaking," since the quantities of cyanide contaminated material are relatively small and can be shoveled up and taken down to the impoundment. (BLM Inspection Report, 6/28/94) An article on the spill quotes the mine's environmental manager as stating that the largest spill could not have contaminated groundwater because it was upgradient of the tailings pond, which would have captured any downhill flow. (Whitehall Ledger, Article, 7/21/94)

However, these spills may not be as innocuous as these statements suggest. In 1993, the company investigated cyanide contaminated seepage issuing from the containment wall of the Impoundment. Ultimately, they attributed the seeps to cyanide migration under and around the impoundment from the temporary storage of cyanide laced tails on unlined ground upgradient of the tailings impoundment. (Plantenberg, Memo, 8/11/93) In other words, the situation was very similar to the spills

of tailings onto the ground under the tailings lines. The path of cyanide contaminated material along unlined routes cannot be strictly controlled or predicted, so we should question the view that repeated, neglected and unreported tailings spills should be regarded as routine maintenance events unworthy of enforcement actions or fines.

#### 5) Wildlife deaths

Environmental Impact Statements on mining proposals often scrutinize the expected impacts to local wildlife populations, so one might expect wildlife mortalities to be a top state priority and the focus of stringent enforcement. Yet the Golden Sunlight mine's record indicates that the state responded to wildlife deaths with lax enforcement, no reporting requirements and inadequate prevention measures. The agency expected to identify wildlife problems during inspections is not the same agency charged with protecting wildlife, the Dept. of Fish, Wildlife and Parks, but the agency expected to ensure compliance with the mining permit, the Department of State Lands.

In approving Golden Sunlight's expansion in 1981, the state apparently concluded that fencing of the proposed Tailings Impoundment would be sufficient to protect wildlife. The state did not anticipate wildlife mortality and therefore neglected to include any requirement to record, report and redress wildlife mortality. As a result, no reports of wildlife deaths appear in the record for six years after the mine commissioned Tailings

Impoundment No. 1 in 1982 to store cyanide contaminated rock and solution.

Not only does the state not compel the company to report wildlife deaths, but the state agency charged with inspecting the site does not look for wildlife mortalities. The Department of State Lands standard inspection form includes a checklist of areas to be evaluated during an inspection, including reclamation, disturbance, water quality and road construction, but no wildlife related issues such as fencing or mortalities. Consequently, when the state discovered dead wildlife it was by accident while inspecting other aspects of the mine. In 1988, Pat Plantenberg requested an inspection of the reclamation trials at the mine. His two page report notes at the very end that "a dead deer was observed floating in the impoundment adjacent to the reclamation trials." (Inspection Report, Plantenberg, 5/27/88)

No Notices of Noncompliances have been filed regarding wildlife mortalities at the site, despite clear evidence of negligence on the part of the operator. Plantenberg's report requests a statement from the mine indicating what was done about the dead deer, but does not mention the possibility of a Notice of Noncompliance for failing to comply with mine fencing requirements. Yet a DSL letter to the mine from the same period refers to an August, 1988 inspection by another state agency, the Solid and Hazardous Waste Bureau, which found numerous deer tracks passing through an open gate leading to the impoundment, a clear violation of the

requirement that the impoundment be enclosed with fencing.

(Strazdas to GSM, letter, 8/31/88)

Subsequent documents suggest that the gates continued to be left open until three more deer drowned in the mine's impoundments during the fall of 1992. The company, not the state, discovered and voluntarily reported the mortalities, to which DSL responded by calling for a joint inspection with FWP for October 22, 1992. The two agency accounts of that inspection offer two different perspectives on the mine's wildlife protection measures. The DSL inspection report mentions two problems: a 200 meter gap in the fence removed due to construction in the vicinity and a gate with too great a gap between it and the ground. (Plantenberg to File, Memo, 10/23/92) The group found that in response to the deaths, the mine had installed a single strand of electric fence around the pond, placed an additional water trough outside the fence and added a strip of rug on top of the pond's synthetic liner to help deer scramble out of the impoundment. The DSL report notes that the group concluded these measures would probably be ineffective, and instead suggested closing the gap in the fence with temporary fencing. Yet the DSL report went on to say that the group found the mine had taken adequate measures in response to the deaths and thus no compliance violations were warranted. The DSL memo does not refer to the previous deer death, nor does it mention gates left open as a potential source of deer access.

On the other hand, the FWP version of the same inspection takes an entirely different tone. The FWP letter to the mine states that "this [the three

deaths] is not the first time an incident of this nature has occurred" 112  
and concludes that the deaths occurred due to company negligence in  
three areas. (Wells to Scharf, letter, 11/2/92) The letter mentions not only  
the missing fence and gap beneath the gate, but also states, ". . . gates  
entering the impoundment area are apparently periodically left open." The  
letter also asserts that unless the company corrects these areas, the  
leaching ponds could be subject to civil penalties as a public nuisance,  
and the failure to prevent more deaths could be prosecuted as criminal  
mischief under the law. The operator responded by installing temporary  
fencing and sealing the gap beneath the gate. (Scharf to Carlsen, letter,  
10/30/92)

Bird mortality in the impoundment only comes to light in the files when the  
mine volunteers to submit reports of bird deaths to the DSL. In a 1991  
letter, mine manager D.J. Wilson states that although no official permit  
stipulation requires it, he will record and report bird deaths to the DSL.  
Wilson relates that he has been recording mortalities at the impoundment  
since 1989. (Wilson to Plantenberg, 9/19/91 letter) The letter lists 131 bird  
deaths occurring between the Fall of 1989 and the Fall of 1991, all of  
which occurred without DSL acknowledgment or response. During the 10  
year period beginning with the Impoundment's commissioning through the  
company's decision to report bird deaths, state inspectors did not note a  
single bird mortality at the mine.

Even after the company began to report continuing bird deaths to the state,  
the state did not demand that the company take the step known to ensure



prevention: netting the impoundment. The state had the opportunity to<sup>113</sup> address bird poisonings in the 1990 permit amendment allowing expansion to a second tailings impoundment. The National Wildlife Federation lawsuit makes two valid points on this issue: 1), that the state was aware of three swan deaths in the impoundment as early as 1988, and 2), that netting tailings impoundments had proven successful at providing zero mortality at similar mines in Nevada (Knowles, Affidavit) Instead, the state accepted the mine position that "because of the constantly changing size and shape of the impoundment, we do not believe this [netting] is feasible. It is not a question of cost but a question of effectiveness. The problem with shorebirds would probably remain." (Wilson to Plantenberg, letter, 9/19/91) The state allowed the company to continue experimenting with various hazing techniques, a strategy the company had been pursuing for an unspecified length of time.

Despite intensified efforts, birds continued to die in the impoundment. Up until 1989, the mine used loud rock music and propane cannons. Although the files do not contain evidence of avian mortality, the company chose to hire a "duck guard" in 1989 to patrol the pond area and haze away birds with a shotgun and fireworks. The following year the company hired a second duck guard and commissioned a houseboat to haze birds away and retrieve poisoned birds to be revived. Fifty birds died during the year that the state released its Record of Decision approving an additional impoundment without netting; 83 died in the following year. None of the hazing methods employed were able to reach shallow areas and shorelines where shorebirds landed and died. The mine continued to

experiment, purchasing first a radio controlled aircraft and then a hovercraft to patrol the shallows. With sixty two bird deaths occurring in impoundment I in 1992, the company stated in its 1992 Annual Report that "the plan for Impoundment No. 2 bird and wildlife access control will be similar in most respects to the current plan for Impoundment No. 1 which was modified after the recent bird mortalities." (GSM Annual Report, 3/92) The 1992 deaths occurred after the state requested "immediate action" and a remedial action plan "as soon as possible," going so far as to mention a "potential noncompliance." (Plantenberg to Foster, comments, 8/26/91)

The trouble with hazing techniques is that they do not offer blanket, constant prevention. In order to drive away the birds, the equipment must be working and the staff must be present to operate it. When the equipment breaks, or the staff is not there because no migratory activity is predicted, birds can still land and perish. According to GSM, the sixty two bird deaths in 1992 occurred during the late summer when the operator, anticipating little bird activity in the area, pulled the houseboat out of the pond for repairs. (Scharf to Plantenberg, letter, 3/26/93) In addition, hazing techniques rely on the staff seeing birds before they land on the pond, which might prove difficult at night.

## 6) Expansion

The Golden Sunlight mine received its first permit in 1975. In 1980 the mine proposed to expand operations significantly, which the agencies (DSL and BLM) approved after preparing an Environmental Impact

Statement. In 1988, GSM submitted an expansion proposal which would extend the life of the mine, scheduled to conclude in 1993, through the year 2005. Plans indicated the mine would produce 50 million tons of tailings and 300 million tons of waste rock during the additional life of the mine. The expansion also called for increasing the size of the pit and building a second tailings impoundment. (BLM, Draft Statement, 3/26/92)

The agencies (DSL and BLM) chose to prepare an Environmental Assessment for the expansion instead of the more comprehensive Environmental Impact Statement. The Environmental Assessment recognized that significant impacts to the environment would result from the expansion as proposed. Therefore the agencies, when issuing their Record of Decision granting the expansion, attached 31 stipulations intended to mitigate the potential impacts and reduce them to insignificance. DSL retroactively changed the conclusions of the final EA to state that significant impacts would occur unless the state required mitigation. The mine completed construction of the second tailings impoundment and began mining under the expanded terms of the amended permit.

Several environmental groups, including the National Wildlife Federation and the Montana Environmental Information Center, first appealed the BLM's role in the decision to the Interior Board of Land Appeals, then filed suit in district court against the mine and DSL claiming violations of state mining laws, MEPA regulations and the Montana constitution. (NWF vs. DSL and GSM, Complaint, 3/30/92) In September, 1994, Judge Thomas

Honzel ruled that the state had violated Montana mining law, MEPA 116 regulations and the state constitution. (Honzel, Memorandum and Order, 9/1/94) Honzel remanded the permit back to DSL for preparation of an EIS and compliance with Montana Mining law, although he stopped short of compelling the mine to comply with the Montana constitution by reclaiming their already extant open pit.

#### A) Reclamation

The reclamation plan proposed by GSM as part of the proposed expansion sparked controversy both within the agency charged with permitting the mine and among environmental groups fighting the expansion. The state allowed the mine to use increasingly steep slopes in its site reclamation. A more gentle slope angle requires a great deal more grading, soil cover and work on the part of the company, but it lessens the chance of topsoil erosion, mine waste exposure and reclamation failure. By 1989, initially proposed slope angles of 6.7 horizontal to 1 vertical had been reduced to 2:1 in successive mine permit revisions. (Honzel, Memorandum and Order, 9/1/94)

In the initial EIS and the first expansion EIS, acid generation was not anticipated to be a problem. As part of the EA for the proposed second expansion, the mine commissioned a study of the waste rock. Meanwhile, the DSL completed a draft EA for the proposal based on the expectation that waste rock and ore for the site were pH neutral. (Hard Rock Technical Staff to Olsen, Memo, 1/23/90) The Dollhopf report on waste rock characteristics, which appeared in October, 1989, showed that the

assumptions upon which the DSL had based reclamation requirements were completely wrong. Waste rock and tailings at the site had far more acid generating potential than previously thought, and would require a number of measures to prevent acid mine drainage and fulfill vegetative reclamation requirements.

As a result, the previously amended and approved reclamation plan for both waste rock dumps and tailings impoundments, was doomed to fail. (Hadley to Olsen, Letter, 12/12/89) In the opinion of the DSL's own technical staff, the proposed reclamation plan for the expansion included in the draft EA would fail also. (Hard Rock Technical Staff to Olsen, Memo, 1/23/90) DSL inspectors had already found waste rock oxidizing in the waste rock dumps, generating hot sulfur dioxide gas and steam. (Pagel to Walther, Memo, 4/27/89) Now the observed conditions were known to be only preliminary indications of far worse to come in the dumps. The technical staff recommended a revised waste rock dump plan with at least 3:1 slopes, a cap of neutral waste rock and accurate inventories of oxidized and unoxidized soil and rock at the site in addition to previous requirements. (Plantenberg, 1/31/90)

Yet the DSL administration continued to negotiate with the company over reclaimed slope angles, since the company held firm to the desire to reclaim slopes to a 2:1 angle. The administration position met with internal resistance. A letter signed by six DSL technical staff expressed strong disagreement with the administration's position and stated, "to permit reclamation of 2h:1v slopes, either outright or by "test plot" permitting,

would not be responsible representation of both industry and public interests." (Hard Rock Technical Staff to Olsen, Memo, 1/23/90) The memo concluded with a recommendation that the agency abandon discussion of 2:1 slopes with the company. Patrick Plantenberg in a subsequent memo states, "we don't allow other operations to test the feasibility of reclamation without an acceptable reclamation plan in hand. It is time to insist on a stringent, detailed reclamation plan." (Plantenberg, 2/21/90) According to Plantenberg, the mine has a history of failed test plot reclamation. Since 1984, the sole reclamation effort on GSM waste rock dumps consisted of one test plot, which was hydromulched and seeded in 1986. The reclamation effort failed, and the company applied no further research to resolve the problem. (Plantenberg, 2/21/90) 118

The final EA for the expansion contains numerous references to the expected failure of the 2:1 reclamation as proposed, including statements that the reclamation of Impoundment 2 is "bound to fail," and that reclamation failure of the waste rock dumps "can be assumed." (Wilson, Brief in Support of Alternative Writ of Mandate, 3/30/92) Despite predicting reclamation failure in the final EA, and over the repeated objections of its own technical staff, DSL allowed the mine to conduct reclamation using 2:1 test plots while bonding for 3:1 plots in case of failure. However, the state did attach 31 stipulations to its Record of Decision approving the plan, many of which required additional monitoring and research to evaluate the effectiveness of the approved reclamation methods.

Several environmental organizations filed suit against the DSL, arguing in part that the agency's failure to abide by its own staff's professional reservations, coupled with a reliance on a post approval study, violated MEPA. This issue will be discussed at length in the section below. The groups also alleged that the omission of the pit from reclamation consideration was a violation of the Montana constitution, which states that "all lands disturbed by the taking of natural resources must be reclaimed to a beneficial and productive use." (Honzel, Memorandum and Order, 9/1/94)

Judge Honzel found in favor of the plaintiffs. Both the Montana Constitution and the MMRA require the reclamation of all lands disturbed during mining to the extent feasible. DSL should therefore have at least considered whether or not reclamation of the open pit was feasible, Honzel said, but no discussion of the feasibility matter appears in the EA. Honzel went one step further, however, in declaring the MMRA in conflict with the Montana Constitution. The Constitution requires all lands to be reclaimed, while the MMRA makes an exception for unfeasible cases, and specifically mentions open pits. The judge stopped short of interpreting the implications of this conflict, which might include ordering all mines to abide by the Constitution. Honzel acknowledged that mines like Golden Sunlight had been operating for years under the assumption that their open pits would not have to be reclaimed, and reclamation of the GSM pit might not be feasible at the time of the his decision.

One of the central issues of the lawsuit involved the requirements of the state law known as Montana Environmental Protection Act, MEPA, which is modeled on the federal National Environmental Protection Act.

Argument focused on whether DSL, in its preparation of an Environmental Assessment instead of an Environmental Impact Statement, had violated MEPA. As the plaintiff's counsel put it: "Whether the EA in this instance met the requirements for mitigated EAs is at the heart of this mandamus action." (Wilson, Brief for Alternative Writ of Mandate, 3/30/92) The state contended that its preparation of a "mitigated EA" precluded the need for an EIS. The plaintiffs argued that the state's mitigated EA inadequately addressed the environmental issues involved and therefore failed to fulfill MEPA.

State and federal agencies must initiate the NEPA process for any proposed government action with potential environmental impacts. The requirements are strict; under MEPA, when the agency considers an action "which may significantly impact the environment," it must prepare an EIS. (Honzel, Memorandum and Order, 9/1/94) An EIS must include a detailed statement on the environmental impact of the action, any adverse environmental effects which cannot be avoided, alternatives to the proposed action, a consideration of short term uses versus long term interests and any irreversible commitments of resources involved. Justice Honzel described the EA, on the other hand, as a "less exhaustive environmental review" prepared for activities which do not constitute major



state actions significantly affecting the quality of the human environment. (Honzel, Memorandum and Order, 9/1/94)

In this case, the agencies sought to utilize what is known as a "mitigated EA" instead of an EIS. The plaintiff's side described the mitigated EA as follows:

"The agency may, as an alternative to preparing an EIS, prepare an EA whenever the action is one that might normally require and (sic) EIS, but effects which might otherwise be deemed significant appear to be mitigable below the level of significance through design, or enforceable controls or stipulations or both imposed by the agency . . . . For an EA to suffice in this instance, the agency must determine that all of the impacts of the proposed action have been accurately identified, that they will be mitigated below the level of significance, and that no significant impact is likely to occur." (Wilson, citing ARM 26.2.643 (4), Brief for Alternative Writ of Mandate, 3/30/92)

The plaintiff's counsel argued that the state should have included its stipulations for public review in the final EA rather than attaching them to the Record of Decision allowing the expansion. They also maintained that the state's stipulations were in fact requirements for monitoring problems and evaluating ways to alleviate impacts, whereas MEPA requires a concrete description of actual steps to be taken to reduce impacts to insignificance. (Honzel, Memorandum and Order, 9/1/94) A BLM description of the Record of Decision substantiates their claim. "The environmental assessment did not resolve some of the questions related

to the issues. Consequently, the operating permit, which was issued on July 9, 1990 included stipulations for monitoring many of the parameters which will enable the mine and regulatory agencies to determine measures which prove effective in assuring ultimate reclamation is successful." (BLM, Draft Statement, 03/26/92) Without knowing what the mitigating actions would be, the plaintiffs asserted, the state could not guarantee that the impacts would be mitigated.

Justice Honzel agreed with the environmental organizations that the stipulations did not necessarily alleviate significant environmental impacts, and therefore the mitigated EA was insufficient in replacing the EIS. The attachment of stipulations to the final EA was not in itself a violation of law, but their insufficiency constituted an "arbitrary and capricious" action on the part of the state. In his decision, Honzel cited the DSL's own lack of conviction: "In this case, DSL stated merely that the 31 permit stipulations were 'believed to preclude' significant environmental impacts, and that potential impacts 'have been minimized to the extent reasonable and feasible.' (Honzel, Memorandum and Order, 9/1/94) He said the agency had failed to offer sufficient explanation of how the stipulations could be expected to render impacts insignificant. According to Honzel, the DSL could not legally substitute post licensing study for the analysis and proof of insignificance MEPA requires before activities may proceed. "MEPA does not permit this kind of approve-now, ask-questions-later kind of approach."(Honzel, Memorandum and Order, 9/1/94)

C) Pit Fills with Water and Requires Treatment Forever

One controversial aspect of the expansion application involved the disposal and treatment of water flowing into the open pit, possibly forever. In the EA, GSM predicted that water quantity and quality in the open pit would stabilize after 400 years, creating a 40 acre lake with an inflow of two gallons per minute. DSL calculated that the inflow figure might be closer to four gallons per minute, and stated in the EA that GSM's assumptions regarding water flows were not substantiated by data. (Honzel, Memorandum and Order, 9/1/94) In order to deal with the accumulation of potentially contaminated water in the pit, the mine committed to constructing a water treatment facility and treating water from the pit into perpetuity if necessary. The DSL, using a high end estimate of outflow quantities, estimated the treatment of an anticipated 95 gpm inflow once mining ceased would require a water treatment plant, a 9 acre evaporation pond and a 70 acre landfill. (Honzel, Memorandum and Order, 9/1/94) The operation and repair of the treatment facility would be paid for out of a trust fund supported by interest from a bond posted by the company. (Casey to Wilson, Affidavit Response, 3/23/92)

In their lawsuit, the environmental organizations contended that the water treatment plan violated both the MMRA and MEPA. They alleged that the EA had failed to consider the effectiveness of water treatment in preventing ground water contamination, failed to contemplate the environmental impacts associated with the facility, and failed to provide a reclamation plan for the ponds and plant. (Honzel, Memorandum and Order, 9/1/94)

In reply, the state argued that the plan as approved would capture and treat contaminated waste waters, and therefore no groundwater contamination would occur. The facilities required no reclamation plan, according to DSL, because treatment would be perpetual.

Judge Honzel sided with the plaintiffs. He said the state could not guarantee groundwater protection without knowing how much water would have to be treated. Since the EA acknowledged that the actual volumes of seepage from the pit and the tailings impoundments "are not known with any certainty," the state could not assure treatment of the contaminated effluent. In addition, Honzel said the plan called for treatment of waste water from the pit and tailings impoundments, but did not provide measures to prevent seepage from occurring. Providing a treatment facility did not guarantee the capture and treatment of all contaminated effluent. (Honzel, Memorandum and Order, 9/1/94)

Honzel agreed with the environmental organizations on reclamation of the facilities as well. He said the construction of the waste water treatment facilities required consideration in the EA of the potential environmental impacts which might result. Regardless of whether or not the facility might always remain open, he said, a reclamation plan should have been drawn up to facilitate clean-up after its possible closure. (Honzel, Memorandum and Order, 9/1/94)

The key question which Honzel's ruling addressed was not whether the state should allow a perpetual treatment facility, but how the state should

go about permitting it. However, the permitting of a permanent treatment facility is itself a precedent setting issue. DSL officials acknowledged that the MMRA fails to address such facilities, and that the GSM case may represent the first of many more to require water treatment into perpetuity. (Plantenberg, Draft Comments, 1/16/92) The state included no bond estimates for the trust fund in the final EA, because officials were still developing the procedures for creating a fund of this kind and purpose, which they had never done before. (Plantenberg, Draft Comments, 1/16/92)

As the first of its kind, the GSM proposal demanded closer technical and legal scrutiny. The MMRA and associated administrative rules require the state to develop measures to prevent objectionable effluent from mined lands. (Plantenberg, Draft Comments, 1/16/92) But they also require reclamation of lands disturbed during mining. Acceptance of perpetual treatment means reclamation of the site will never be complete. As a result of mining, the GSM site will retain a 70 acre hazardous waste landfill, a 9 acre evaporation pond filled with contaminated water and a treatment plant. Disturbance of the site remains; hence the intent of reclamation remains unfulfilled and an irretrievable commitment of resources has occurred. One must also wonder how the DSL can calculate a bond amount now which will be valid for treatment in 400 or 1000 years.

Ultimately, the state's options may be limited at already extant sites. Inflows to the GSM pit began at the rate of 45-57 gallons per minute in 1991. Contaminated seepage under the tailings impoundments continues

at the mine. Currently, the mine pumps the seepage into the process circuit. However, at the end of mine life, mine officials expect the contaminated water to continue flowing. If the flow cannot be stopped, then treatment for as long as contamination persists (and possibly even longer, during intermittent or periodic water contamination) would appear to be the only response at existing mines. 1 2 6

At mines in the permitting stage, on the other hand, contaminated seepage into the pit or through tailings impoundments has yet to occur. Should treating effluent forever become a standard part of the state-of-the-art mining permit, or is this institutionalizing inadequate reclamation? If the reality of mining is that most sites will require treatment into perpetuity, then we must ask in an EIS whether a permanent mining presence is appropriate for an area before the mine gains approval. If the area cannot really be reclaimed, should the mining be allowed? Mine permitting should also consider the risks and costs associated with treatment left to future generations.

## Case Study 2: Beal Mountain Mine

Pegasus' Beal Mountain mine near Butte, Montana received its initial permit to process 1.64 million tons of ore using cyanide heap leach methods in 1988. In approving the mine, the state hailed its future as a "showcase" operation which would utilize state of the art technology and expertise to avoid the environmental problems encountered by older mines. The DSL granted an expansion of mine operations in 1993 which approved mining two additional open pits for one million more tons of ore. At its inception and during the first four years of mine life, mine operations did not include any MPDES water discharge permits. While the mine has been in operation for only 6 years (compared to 19 at Golden Sunlight), it has already developed significant water quality problems and violated the terms of its operating permit. The mine has applied for MPDES permits for storm water discharge and to allow discharge of water from dewatering wells in the open pit.

### Slumping in the Pit Wall

The slumping of material in the walls of the open pit is not necessarily a major environmental concern. The area surrounding the open pit is already subject to heavy disturbance as excavation proceeds. Slumping material which slides down into the open pit may make the miner's job

more difficult since it can bury the active mining area of the pit floor, but it becomes a serious environmental concern only in terms of the risk it poses to mining facilities nearby. Obviously, the closer the process circuit is to the open pit, the shorter the hauling distance for the tons of excavated ore. Hence heap leach pads tend to be located close to the open pit. When the pit walls begin to fail, there is always the chance that the unstable chunk of ground extends to the area beneath the pad. Ground movement could cause the liner to tear and discharge cyanide solution, or in the worst case, the pad could slide down into the pit along with the slumping material and release massive quantities of cyanide solution which could enter groundwater.

Mine personnel first observed slumping in the wall of the Main Beal pit in April, 1991. Movement of wall material ceased in November, 1991, after the operator drilled dewatering drains into the slipping material and blasted the plane along which the slide was occurring to increase friction. (LeLacheur, Inspection Report, 9/1/92) However, in June 1992, following snowmelt and spring rains, slumping began again in the same area but lower in the pit, and continued for several months, sometimes moving as much as a foot a day.

The heap leach pad and other facilities at Beal rested above the wall of the pit. What was termed a "wedge block failure" by officials meant that a portion of the pit wall was in the process of breaking away from the surrounding pit walls and sliding down into the pit, with the potential to carry with it any structures on the wrong side of the fault line. As early as



August, 1991, a Forest Service inspection indicated that the slump had reached the SW corner of the containment dike for the heap leach pad, although the inspector stated that "it looks like it's far enough away that it's not a big hazard." (Bump, Inspection Report, 8/15/91)

By August, 1994, the slide was still moving at about 1 inch per day. The mine operators were mining out the material which had slid down and were re-depositing the material as backfill after keying the backfill into the substrate, in order to halt the slide. (DSL, Inspection Report, 8/5/94) The leach pad cell nearest the slide was drained and deactivated while the slump block was removed. (Jepson, Inspection Report, 9/30/94) Mine officials relocated plans for the Stage III leach pad to the northeast of the fault line as a result of the ground movement. (LeLacheur, Inspection Report, 9/1/92)

The mine's response served to slow down the slide and reduce immediate threats of leach pad failure. Over the long term, however, the risk of ground movement beneath the leach pad remains, particularly after mining ceases. A September, 1992, DSL Inspection Report states, "Over the long term, it is possible that after the end of mining, slumping may reactivate even if motion is arrested during the life of the operation." (LeLacheur, Inspection Report, 9/1/92) The report identifies the potential for movement in another layer of unstable material beneath the two already sliding layers, which could begin to move as the pit deepens. It also states that dewatering efforts which have halted movement so far will cease after mining finishes, increasing the danger of leach pad failure.

### Cyanide Leak

In May, 1992, the mine submitted water quality monitoring results for 1991 as part of the 1991 Annual Monitoring Report. The data indicated that during the spring of 1991, cyanide appeared in a collection drain beneath the leach pad, evidence that a leak had occurred over a year before without any notification of DSL or DHES. (Jepson, Inspection Report, 5/20/92) Cyanide levels peaked in May, 1991 at 0.281 mg/L. When inspectors arrived at the site in May, 1992 to inquire about the cause of the elevated readings, the mine operators reported that one year previously they had detected a leak in the barren pond and had drained and replaced the pond lining. Inspectors took water samples, which indicated that the cyanide was still present at some of the monitoring stations, although concentrations were lower than those in the report. (Spano to Rife, Letter, 6/25/92)

DSL issued a Notice of Noncompliance and ordered the company to increase the frequency of testing in downgradient monitoring wells to a biweekly rate. DSL also directed the mine to submit hydrologic data quarterly instead of annually, to provide "more timely results for compliance purposes." (Spano to Rife, Letter, 6/25/92) As the discussion below will demonstrate, however, the state never actually required

submission of water quality monitoring reports on even an annual basis prior to the leak.

### Water Quality

Beal Mountain did not submit annual hydrologic data reports for 1988, 1989 and 1991 until April, 1992, three years after the commencement of mining, in conjunction with their proposal to expand. One might presume that an annual report which reviews the events of the preceding year would be available soon after that year ended. But DSL decided the company's failure to submit the reports was not a violation, because the mining permit did not specify a time frame for submitting the annual reports. (DSL staff to Olsen, Memo, 1/12/93) The oversight in the original permit is bad enough, but even worse is the fact that nobody at DSL noticed that three years worth of information about water quality was missing. It took a cyanide leak for the state to compel the mine to submit quarterly monitoring reports, which are the standard for most other mines in the state. (Spano to Rife, Letter, 6/25/92) Initially requiring quarterly reports was only an emergency requirement. Ultimately, DSL decided to modify the permit and require periodic submittal of water quality monitoring reports as part of the South Beal amendment .

Once the agencies got their hands on the 1988-91 reports, they found the data indicated a trend of increasing surface water contamination over the course of mining. The state responded with an inspection which found

high levels of contaminants in a spring which originated beneath a waste rock pile and drained into German Gulch. High concentrations of contaminants in the spring were diluted by the waters of the stream, but still represented elevated levels relative to the pre-mining condition. For instance, the inspection stated that sulfates and nitrates in the spring exceeded state water quality standards (Presumably, this refers to Federal Drinking Water Standards for sulfates). They found elevated levels of iron, zinc and manganese, with manganese at the standard. (Reid, Inspection Report, 7/9/92)

In January, 1993, the DSL drafted a Notice of Noncompliance for the unpermitted use of nitrogen-based fertilizer (the Beal permit expressly forbid its use) which led to the excessive nitrate levels; the rationale for the citation states that nitrate levels peaked at 12.5 mg/L in the spring and reached 2.6 mg/L downstream on German Gulch. (Jepson, NON 203, 1/7/93) The Forest Service sent a memo stating that the mine had exceeded state water quality standards for nitrates and sulfates, thereby jeopardizing the original 1987 Environmental Assessment's finding of no significant impact to state waters. (Ewing to Rife, Letter, 2/17/93) The issuance of a Notice of Noncompliance indicates that DSL regarded the nitrate contamination levels in the stream as significant degradation and a violation of the Metal Mine Reclamation Act, although the notice's rationale describes the nitrate levels in this case as the cause of "slight environmental harm." (DSL, Rationale for NON 203, 1/7/93) At this point in time, the state used the original baseline water quality in German Gulch to make comparisons and determine that degradation due to nitrates had

occurred. Yet with the approval of the South Beal amendment, the state departed from the original stream quality as a baseline reference and began using what it called "trigger levels."

In approving the South Beal Amendment, the state required the mine to meet certain "trigger levels" for water quality parameters in German Gulch. The trigger levels, generally set below state water quality standards (also known as Maximum Contaminant Levels or MCLs) for each potential contaminant, would force the mine to divert upstream springs and withhold the contaminated water from the stream until the pollution had abated for three consecutive weeks or the contamination source was identified and mitigated. If the exceedance of the trigger levels could not be rectified and concentrations continue to rise, the company would be forced to suspend operations or treat all German Gulch water.

While the trigger levels and associated activities appear to be attempts to protect German Gulch water quality, they in fact represent de-facto acceptance of mining related water quality degradation in the drainage. The 1987 EA predicted no impact to water resources. (Reid, Inspection Report, 7/9/92) The state selected trigger levels for nitrate, sulfate, total dissolved solids, pH, copper, selenium and arsenic because the mine had already demonstrated that these parameters were or could prove to be pollution problems. The 1988 mining permit recognized the pre-mining quality of German Gulch as the standard to which the mine must adhere. The 1993 amendment, on the other hand, acknowledges the areas in which the company has degraded German Gulch, accepts this

degradation as a new status quo, and recommends trigger levels for most parameters which are higher than the highest levels yet measured in the already degraded water quality found in the stream. (DSL, Amendment 002 Approval, 7/20/93) Exceptions are nitrates and selenium. In addition, some of the water quality standards have since changed.

Beal Mountain Water Quality Degradation\*

Parameter	NO3+NO4 as N	SO4	TDS	pH	Cu	Se	As
<b>1988 Permit Levels</b>	<0.05 mg/L	29 mg/L	119 mg/L	7.5		.005 mg/L	
<b>In Stream Levels 1993</b>	3.37 mg/L avg. 5.3 mg/L high	116.7 mg/L avg. 159 mg/L high	260 mg/l avg. 367 mg/L high	7.88 avg.	.006 mg/L avg. .008 mg/L high	.020 mg/L avg. .027 mg/L high	.014 mg/L avg. .018 mg/L high
<b>Trigger Levels</b>	2.0 mg/L	200 mg/L	400 mg/L	<6.5 or >8.5	0.025 mg/L	0.025 mg/L	0.025 mg/L
<b>1994 Standard</b>	10.0 mg/L human health	250 mg/L secondary MCL	500 mg/L secondary MCL	7.76 - 8.03 secondary MCL	1 mg/L human health .012 mg/L aquatic life	0.05 mg/L human health .005 mg/L aquatic life	0.018 ug/L human health .19 mg/L aquatic life

\*The in stream levels and trigger levels values come from the 1993 amendment and the 1988 permit levels appear in the 1988 permit and are based on pre-mining levels.

The amendment approval does require a reduction in the levels of some of these contaminants, but begins with the status quo and does not demand a return of the stream to its pre-mining condition or the quality required by the original permit. According to the amendment approval, sulfates must be reduced to 150 mg/L by 1995, and 100 mg/L by 1998; nitrates to 1.0 mg/L and 0.8 mg/L; TDS to 300 mg/L and 250 mg/L and selenium to 0.1 mg/L and .006 mg/L. The approval does not explain why these levels were

chosen as restoration goals, and does not justify their selection over baseline values. The document neither discusses nor defends the apparent sanctioning of state surface water degradation.

The increased monitoring and trigger levels included in the plan did little to abate the pollution. Almost immediately after the amendment was approved, in July, 1993, the mine exceeded the trigger levels for nitrates and selenium in German Gulch. Water in the contaminated spring below the waste rock dump exceeded federal or state water quality standards for nitrate, sulfate, selenium, and total dissolved solids. (Ewing to Olsen, Letter, 9/22/93) The mine operators responded by diverting the spring's flow into the process circuit and away from the stream, in accordance with the amendment. The spring contributes over half the flow of German Gulch during the summer months. (Reid, Inspection Report, 7/9/92)

Since nitrate and selenium levels had approached the trigger levels in the past, the South Beal amendment had anticipated the spring's contamination, and called for the diversion of the contaminated spring water to prevent it from reaching German Gulch. In actuality, the amendment's mitigation option merely ratified the status quo. The springs had shown chronic contamination for several years prior to the expansion, and mine operators had already attempted their diversion. A year prior to the South Beal approval, in June, 1992, DSL inspectors found the company in the process of constructing ditches to divert three contaminated springs in the drainage. DSL issued a Notice of Noncompliance, stating that the diversion had been undertaken without

state consultation, and that the diverted springs make up a large portion of the flow in upper German Gulch. (DSL, NON 202, 4/7/93) A February, 1993 Forest Service memo indicates the same concern over flow rates in German Gulch, and suggests that the mine not only continued to construct the diversions after the 1992 DSL inspection, but had diverted four contaminated springs in the drainage months before the approval of the South Beal amendment. (Ewing to Rife, Letter, 2/17/93)

The South Beal amendment codified these concerns into contradictory requirements, since it required the diversion of contaminated springs while also requiring the operators to maintain sufficient flow in German Gulch to sustain the west slope cutthroat trout population (without quantifying sufficient flow). As the company had already constructed and employed diversions, it was the easiest mitigation option to approve, even if flow rates were compromised as a result.

Despite the diversion of contaminated spring water during part of 1992 and 1993, a DHES analysis of hydrologic data found that from the fall of 1987 to the fall of 1993, upper German Gulch waters had undergone a 218 % increase in TDS, 268% in sulfates, 2,300% in nitrates and a 460% increase in selenium levels. (Reid to Winegar, Memo, 8/12/93) Either diversions were not an effective means of preventing contamination, or the water quality of German Gulch was already so degraded that diverting the springs for only the last year of the seven year period showed little overall impact.



In July, 1992, just after receiving Annual Hydrologic Data reports indicating elevated cyanide levels in monitoring wells, DSL and DHES conducted a joint inspection of the Beal site. While their primary concern was to evaluate the sources of the elevated cyanide and nitrate levels indicated by the data, they discovered another water quality issue upon arrival.

At monitoring Site 3A on German Gulch, located 100 yards above the permit boundary, the inspectors found the cobble and pebble stream bottom heavily embedded with fine particulate material. The water itself was visibly turbid. (Reid, Inspection Report, 7/9/92) At Spring 5, which drained from the toe of the waste rock pile into German Gulch (contributing half the stream's volume) , fine sediment covered most of the substrate, although the water was clear at the time of inspection. The inspectors noted that diversion ditches around the waste rock pile had not been constructed according to permit specifications, resulting in erosion of reclaimed surfaces and fresh sediment deposits below the waste rock pile after heavy rains. In addition, the inspectors noted unpermitted road construction occurring near spring 5, without any sediment control structures such as straw bales or silt fences in place.

The situation did not, however, result in a Notice of Noncompliance. Tom Reid of DHES sent the mine a follow-up memo in September of 1992 which stated that German Gulch Creek is classified as a B-1 stream with turbidity limited to 5 NTUs, and that the turbidity observed in July likely

exceeded the standard. Reid informed the company that the increase <sup>138</sup> in turbidity was probably a violation of Montana Water Quality Standards, but that the activity creating the disturbance was probably already complete and therefore DHES would not pursue the matter further. (Reid to Rife, Letter, 9/30/92) Thus the state did not undertake any testing to quantify the stream's turbidity and define the extent to which the company was violating state water quality laws.

The DSL did not issue a Notice of Noncompliance for the failure to construct diversion ditches around the waste rock pile to permitted specifications. DSL inspectors had noted the shortcoming in an earlier April, 1992 inspection, but the permit stated that the diversions must be constructed to meet specifications within five years of beginning to mine. Since mining began in 1988, the diversions did not have to stop storm water from flowing over reclaimed areas of the waste rock pile and depositing the sediment in German Gulch Creek until 1993, according to the permit. By 1993, the diversions had been completed to specification. (DSL Staff to Olsen, Memo, 1/12/93) In essence, the DSL permitted the company to foul the creek for five years before putting the protective diversions in place.

The construction of the unpermitted road without proper siltation prevention or DSL consultation did not receive a Notice of Noncompliance. A meeting of DSL technical staff in early 1993 stated that the mine operators, concerned about storm water moving sediment in German Gulch, built the road in order to access the waste rock dump and

construct diversions around it to the permit specifications. Regardless <sup>139</sup> of motivation, the company's activity occurred without safeguards against silt movement and created rather than solved sediment problems. The need for haste without consultation is suspect, since four years of apparent unconcern preceded the construction. Yet the DSL technical staff concluded that the company's activity was undertaken in an emergency and thus did not warrant a Notice of Noncompliance. (DSL Staff to Olsen, Memo, 1/12/93)

Throughout the permitting process, both DSL and DHES appeared to believe that sediment problems would disappear, either through the completion of the diversion ditches required in the original permit or through additional Best Management Practices to be included in the South Beal permit amendment. The technical staff meeting report, written in January 1993, states that although the company had utilized the BMPs it committed to in the 1987 permit, the BMPs were insufficient to prevent sediment from entering German Gulch. (DSL Staff to Olsen, Memo, 1/12/93) The additional BMPs included in the South Beal Amendment were more of the same, and they failed to adequately control movement in the underlying clay soils of the South Beal area. (DSL, Record of Decision, 7/20/93)

As a result, instead of alleviating the problem, the South Beal amendment intensified sediment problems in German Gulch. An August 1994 inspection report describes a number of new erosion control and sediment runoff control structures which the mine put into place after the

commencement of South Beal mining. (DSL, Inspection Report, 8/5/94) In October, 1994, mine inspectors from DSL and DHES returned to the site to find the new sediment control structures overwhelmed. The mine's environmental director explained that the bedrock on the south side of German Gulch contained much more clay than the north side where the operation began, and that sediment control had become more difficult since the development of the South Beal pit and haul roads. (Jepson, Inspection Report, 10/27/94) He stated that turbidity in the stream increased after the South Beal operation opened. (Bugosh, Inspection Report, 10/27/94)

Inspectors found sediment laden water flowing down along haul road diversions, over and through sediment traps, and into German Gulch at several locations at the site. As the DHES inspector states in his report, "The storm water was routed through a series of settling basins, yet the discharge resembled chocolate milk." (Bugosh, Inspection Report, 10/27/94) The sediment traps appeared ineffective given the volume of storm water, for as the DSL inspector states in his report, "These [sediment traps] may have been catching a lot of sediment, yet the apparent turbidity of the storm water remained unchanged." (Jepson, Inspection Report, 10/27/94) As a result, German Gulch was extremely turbid at several sampling points, from the center of mining activity down to the permit boundary. Above the active mining area, however, the inspectors found German Gulch to be "quite clear." The inspectors took samples, which revealed the following:

	<u>TSS(mg/L)</u>	<u>Turbidity (NTU)</u>
<u>German Gulch upstream of mine:</u>	64	13
<u>German Gulch in mine area:</u>	40,490	10,500

(Bugosh, Inspection Report, 10/27/94) As Reid's memo indicated above, the legal standard for German Gulch is 5 NTU.

Despite turbidity levels over 2000 times greater than the legal limit, the mine did not receive a NON. Both inspectors declared the mine in compliance with all the requirements of the Storm water Pollution Prevention Plan, devised in consultation with both agencies. Both reports indicate that the operators had installed all the BMPs required by both the main permit and the South Beal amendment. Since all aspects of the approved permit were fulfilled, the company was not at fault. The inspectors concluded that the sediment prevention efforts were overwhelmed by drainage from the recently installed South Beal haul roads, and that new methods for contending with the sediment drainage would have to be adopted.

The two agencies emphasized different approaches when discussing mitigation of the problem. The DHES report discussed the transferal of storm water discharge coverage from the general operating permit to an individual storm water permit with MPDES provisions, thereby transferring

responsibility to DHES and allowing the construction of an "elaborate, engineered system" to cope with the storm water. (Bugosh, Inspection Report, 10/27/94) The DSL report mentioned the construction of large settling and containment ponds, but stated that with mine life expected to last only a couple more years, the increased disturbance necessary to construct the ponds would render this option less than worthwhile. (Jepson, Inspection Report, 10/27/94) By this logic, speeding up mining and shortening mine life becomes an excuse not to correct problems. Instead of ponds, the DSL report recommended more of the same: additional straw bales in the ditches to be replaced after every storm event.

### Nitrates

As indicated by the water quality discussion above, mining activity at the site has had a significant impact on nitrate levels, which have exploded by several thousand percent over the course of mining. The source of the nitrates, however, was also the source of some uncertainty. The company increased the rate of mining, which also increased the usage rate of the blasting agent ANFO which produces nitrates. One potential source for elevated levels, therefore, was the blasting agent residues on waste rock and ore. Another potential source was the ongoing reclamation activity at the site, including reseeding with nitrogen based fertilizers on exposed dike faces.

Neither the increased mining rate nor the use of nitrogen-based fertilizers was approved by DSL; in fact, the permit expressly prohibits the use of nitrogen based fertilizers. DSL issued a Notice of Noncompliance for the

fertilizer use, which the company acknowledged in a 1992 report on the sources of nitrogen pollution. (DSL, NON 200, 3/22/93) While DSL officials suspected blasting residues as the source, the company report fingered reclamation activities. (Fitzpatrick to Olsen, Letter, 7/15/92) The mitigation requirements depended upon the source; identifying fertilizers meant ceasing to use nitrogen based materials, digging ditches to intercept seepage and placing the ditch which collects water from beneath the heap in a culvert to prevent seepage infiltration. (Fitzpatrick to Olsen, Letter, 7/15/92) Fingering the blasting agents would have meant a reduction in the mining rate and construction of a seepage collection system around the waste rock dumps. A report on nitrogen contamination at the Golden Sunlight mine also appeared in the document record. Wells drilled in response to a cyanide leak at the mine had elevated nitrate levels as well. The report claimed a "natural reservoir" of nitrogen in the soil was the source of contamination at that site, freeing the mine operators from culpability. (DSL, Report on Well Investigations, undated) 143

A DSL review of Beal's report remained critical of the contention that fertilizers were the sole contamination cause. The report's conclusion was based on a single waste rock sample rather than samples from different areas of the waste rock pile. The report stated that if ANFO were the primary source of the pollution, then all areas containing waste rock would show elevated nitrate levels, which was not the case. Yet the same logic, the report stated, defeats the notion that fertilizers were responsible, since many of the waste rock areas that failed to produce elevated nitrate levels were also hydromulched with nitrogen based fertilizers. (Jepson to Olsen,

Memo, 7/23/92) "Blasting residue on waste rock as a potential nitrate source cannot be discounted so easily," the report states. (Jepson to Olsen, Memo, 7/23/92) 144

Regardless of the source, the most recent hydrologic data reviewed in the fall of 1994 indicated that nitrogen levels remained elevated in the springs which flow into German Gulch. The fact that sulfates and heavy metals are also elevated in the waters which originate under the waste rock dump suggests that the contamination is not limited to fertilizer alone.

### Sulfates

Elevated sulfate levels in the spring which originates beneath the waste rock pile indicate a potential for acid rock drainage which was not anticipated in the original permit. The pH levels in monitoring wells and surface waters have remained fairly constant, but sulfate levels have increased dramatically. The increase in sulfates suggests unoxidized rock in the waste rock dumps is oxidizing to form sulfuric acid, but that the acid is then being neutralized by the buffering capacity of some of the waste rock types. (Spano to Rife, Letter, 6/25/92) At the time of the South Beal expansion, and the proposal to mine deeper into the Main Beal pit, there was no acid rock drainage, but an unaccountably high sulfate level in surface waters. As early as January, 1991, the DSL informed the mine of the need to test rock types on site and determine their potential for acid production. (Plantenberg to Dale, Letter, 1/29/91) Subsequently, a DSL inspector in September 1991 took two rock samples from the Main Beal pit, stating, "Obviously the potential for acid production is indicated by



these first samples from the mine." (Plantenberg, Inspection Report, 8/22/91) The inspector went on to state that the reclamation plan for the mine, and the eventual seepage from the heap and waste rock dump, would have to be re-evaluated "with the new concern for potential acid production." (Plantenberg, Inspection Report, 8/22/91) The company responded with a complaint to the DSL Commissioner, claiming that the inspector's comments were unsubstantiated personal opinions.

(Fitzpatrick to Casey, Letter, 10/8/91) The DSL responded by instructing all employees to limit inspection report comments to compliance issues.

(Olsen to Fitzpatrick, Letter, 2/26/92)

Ultimately, the South Beal deposit demonstrated little potential for acid rock drainage, but the amendment addressed concern over rock already mined in the Main Beal pit. State officials, in preparing the amendment, were already aware of elevated sulfate levels in waters directly downgradient of the waste rock dump. Yet the amendment states that the operator must monitor the waste rock dump for temperature, pore gas composition and other parameters necessary to detect oxidation of sulfide bearing rock. (DSL, Record of Decision, 7/20/93) While the amendment states that the mine cannot dispose of excess water by spraying it onto the waste rock dump, it does not demand a waste rock segregation program unless the dump begins to indicate oxidation of sulfides. The document states that if water quality parameters, such as sulfates, continue to deteriorate, then the mine must segregate waste and mix lime into the higher sulfide rock. Yet water quality parameters, as indicated by the levels included in the very same document, had already deteriorated since

the commencement of mining. (DSL, Record of Decision, 7/20/93) 146

The Record of Decision approving the amendment does not specify the levels of deterioration which would cause waste segregation and lime mixing to begin.

### Year Round Operation

Mining at the Beal Mountain site began as a seasonal affair. The 1988 Environmental Assessment which evaluated the Beal Mountain mine proposal identified the mine site as elk winter range. The company believed average winter temperatures were too cold to feasibly operate (Davis to Olsen, Letter, 2/23/93). As a result, the original permit allowed the mine to operate only between March and November.

During the first year of operation, the company initiated winter shutdown procedures as the permit required, but during the next season the company came up with a method of leaching year round. They never shut down again. Potentially significant impacts to the environment resulted, including an increase in the annual use of cyanide. Continual activity and traffic around the mine no longer spared the time when elk needed the site for winter range. Indirectly, continual leaching allowed the company to process greater quantities of rock than the permit allowed, another violation with significant environmental impacts (see below).

Four years passed before these changes generated concern at DSL. In September, 1992, DSL staff drafted a Notice of Noncompliance for the mine's apparent departure from the operating permit (Snyder, NON 202,

9/28/92) The Notice of Noncompliance was never sent. According to the Forest Service ranger in charge of overseeing the operation in 1989, both the DSL and Forest Service staff verbally approved the change (Davis to Olsen, Letter, 2/23/93). Agency staff never documented the change or their approval, however. They did not even require a formal modification of the operating permit. Subsequent staff turnover led to a situation in which DSL personnel were unaware that their predecessors had approved the switch, or even that the change had taken place. A situation which on the surface appeared to be company malfeasance was in actuality an agency blunder.

The change to year round operations represents a significant departure from the operating permit, with the potential for significant environmental impacts. The mine operators should have applied for an amendment to the operating permit, but even that would not have been sufficient. No formal consideration of the potential environmental impacts of the change ever took place. No formal evaluation of the safety and effectiveness of applying cyanide to leaching pads during the winter months occurred. In a department memo discussing the change, DSL staff note that the switch never received an environmental review as required under the Montana Environmental Protection Act (DSL Staff to Olsen, Memo, 1/12/93). They suggest that the change should be retroactively considered as part of the South Beal Expansion Environmental Impact Statement.

#### Mining Rate Increase

The rate at which mining proceeds is an important factor in determining the intensity of environmental impacts to the area. Even when the total quantity of excavated material remains the same, mining faster means blasting more often, driving more trucks and equipment through the site and using more ANFO blasting agent, more cyanide, more water and more diesel fuel. The pit grows deeper more rapidly than permitted, and waste rock dumping occurs at a more rapid rate than permitted. These kind of significant changes typically require the company to submit an amendment to the operating permit for DSL review. In evaluating the amendment, the state must fulfill Montana Environmental Protection Act requirements, usually through preparation of an Environmental Assessment or Environmental Impact Statement.

At Beal Mountain, however, the company dramatically increased the quantity of ore being mined at the site without DSL knowledge or any kind of administrative review. The DSL drafted a Notice of Noncompliance after the company submitted replacement pages to their permit application reflecting the change. (Miller, NON, 1/6/93) Replacement pages are intended to reflect minor changes in operation which do not alter dramatically the conditions of the mine. In this case, the replacement pages indicated that the mine had increased yearly production from 1.64 million tons per year to 3-4 million tons per year. (Miller, NON, 1/6/93) Diesel fuel usage increased from 80,000 gallons to 800,000 gallons per year. The replacement pages did not constitute a request for a change in practices; the increase in mining had already been in place for at least a year.

Initially, the DSL response was clear; the increased rate was a violation. A memo from the DSL technical staff to the Hard Rock Bureau Chief defined the rationale for a Notice of Noncompliance: "Impacts from the doubling of production have not been evaluated. The change may cause greater environmental effects than those disclosed in the original EA. The staff has had no opportunity to analyze the effects of increased blasting on ground water and surface water. . . . Although it would be difficult to pinpoint the effects of doubling production, the doubling of production and associated increases are clearly not permitted and a violation should be issued." (DSL Staff to Olsen, Memo, 1/12/93). In effect, the state recognized that the company had circumvented the environmental review process and deserved to be penalized.

DSL never sent the Notice of Noncompliance. A meeting of DSL technical staff concluded that the permit had only established estimates of average annual production, not maximum annual volumes or a maximum mining rate. In this case, the mine had not increased the total amount of waste and ore to be mined, only the rate at which they would be excavated and processed. (DSL Staff to Olsen, Memo, 2/19/93) Thus the DSL decided that the company could double production and still remain in compliance with the operating permit.

The DSL staff also indicated that a violation might not be justified because the philosophy governing production rates had changed only recently. The mine's submission of replacement pages was consistent with the state's

old way of thinking, in which changes in production rates were "not considered major changes, and did not require review." (DSL Staff to Olsen, Memo, 1/12/93) It may be that the shift in management philosophy was not made clear to the mining company, and therefore a violation in this instance may have been inappropriate. Yet if current DSL guidance required environmental review of production rate changes, then the DSL should have demanded an amendment to the permit which defined annual production rates. If the rates were significantly different from those used to prepare the original Environmental Assessment, then the state should have required a new environmental review of the mine's impacts. Instead, the state allowed the mine to continue at the increased rate.

### Bulldozer Accident

In October, 1988, a bulldozer dropped off the road onto Cell #1 of the heap leach pad, catching the leach pad with a ripper tooth of the blade and tearing the liner. The company responded by unloading the ore from the pad with hand tools, causing a number of additional tears in the liner. The company then replaced the 30 mil PVC liner. The entire episode cost \$250-300,000. Bulldozers at the site no longer have ripper teeth. (DSL, Note, 10/25/88) The document record offered no indication whether or not cyanide leaks had occurred due to the multiple tears in the liner.

## Case Study 3: Zortman/Landusky

### Overview

Pegasus Gold's cyanide heap leach facilities at Zortman/Landusky in <sup>151</sup> the Little Rocky Mountains, which began operating in 1979, are among the oldest of their kind in the state; they are also among the worst when it comes to pollution of the state's surface and groundwaters. The mine, which abuts the Rocky Boy Reservation in central Montana, has a long history of permit violations, water degradation and cyanide spills, and the mitigation measures employed have often served to compound old problems and create new violations.

The summer of 1993 serves as a case in point. Inspectors found an unpermitted road filling one streambed; another stream had been destroyed by a bulldozer "walking down" the drainage. EPA inspectors found 7 separate discharges of polluted seepage draining into streams, as well as a chlorine "feed shack" where, to cope with the lingering effects of a previous cyanide spill, the company added highly toxic chlorine directly to a stream. Rapidly worsening problems with acid rock drainage (ARD) finally came to a head as above average rainfall overwhelmed all attempts to contain highly acidic and heavy metal contaminated seepage, which flowed in high volume into area streams. The summer ended with a 10,000 gallon cyanide leak upgradient of the domestic water supply for the town of Zortman.

In August, the state Department of Health and Environmental Sciences filed suit against the mine for the unauthorized discharges to state waters, seeking thousands of dollars in penalties. The case is still pending. Yet despite the array of problems, the mine has continued to seek an

expansion of its operations with the Department of State Lands. The expansion would mine still deeper into sulfide bearing ore bodies, increasing the likelihood of even greater acid generation in the future. 152

### Acid Rock Drainage

Of the four mines I reviewed, Zortman/Landusky has developed the most severe problems with acid rock drainage. Yet the recognition of the problem, which took years to develop, has only recently been recognized by the state agencies. The problems at this site may serve as a warning of the potential for similar problems at other mines.

#### a) Recognizing the ARD Problem

What is most interesting about the problems with acid generation at the Zortman/Landusky mines is that the problem appears to come out of nowhere at the end of 1992. In reality, however, even such documents as an Environmental Assessment for a mine expansion first drafted in 1988 noted declines in water quality associated with acid rock drainage. But as recently as 1990, nobody at ZMI or DSL appeared to think acid rock drainage would be a problem at the Zortman and Landusky sites.

The acid rock drainage problem at ZMI arose after DSL approved a Landusky amendment to expand operations in 1989. The amendment indicated an awareness of non-oxidized material to be mined without any



recognition of the potential for acid rock drainage to occur. The amendment reads:

Due to the low-grade mineralization of Zortman and Landusky ore and waste rock, the acid generating potential of waste material going to the depositories is quite low. In review of previous baseline and operational monitoring material for the Montana Gulch and Mill Gulch waste areas, no significant changes in pH values have been detected. Any sulfide materials disturbed during oxide ore mining operations will be loaded, transported and leached on existing leach pad facilities along with mined oxide materials.

(DSL, Landusky Life of Mine Amendment, 12/6/89) The amendment commits to sorting all sulfide bearing material, including waste rock and ore from the rest of the mined material and placing the sulfide bearing rock onto heap leach pads with the oxidized ore, where it will be contained in a closed system. Before the approval of this amendment in 1990, acid generating waste material had already been dumped in two other locations (the Alder Gulch Waste Dump and the OK pit) and used for the construction of the 85/86 leach pad dike buttress and an unspecified and probably unknown number of other construction projects. The reclamation plan for the mine called for ripping the waste dump tops to improve air and water movement, the exact opposite of the procedures used to prevent air and water access in an acid generating situation. (Jepson, Memo, 12/30/92)

Despite the warning signs of deteriorating water quality found in both an August 13, 1991 inspection and 1991 water quality monitoring data, it was

not until a December 17, 1992 inspection startled state inspectors that the ARD problem gained recognition. At Zortman, inspectors viewed an acidic seep from the 85/86 buttress and took a sample of sulfide bearing rock from the buttress. At Landusky, inspectors observed sulfur dioxide fumaroles venting in the Mill Gulch Waste Dump, where the life-of-mine amendment stated that no net acid generation would occur. (Jepson, Memo, 12/30/92) As Jepson states, "Landusky waste probably contains lower sulfide content than Zortman waste," and "if waste observed in the Landusky Mill Gulch Waste Dump and in the walls of the Zortman OK pit and 85/86 buttress are indicative of the waste buried in the Alder Gulch waste dump, this (Alder Gulch) reclamation is likely to fail over the next few years."

Suddenly the problem was both widespread and severe. The BLM explained the lack of foresight by stating that the most recent EA (1990) for the Landusky life of mine amendment analyzed rock types and concluded that more acid neutralizing capacity existed than acid generating potential in the rock, and that this constituted "due consideration of the matter." (Lawton to ZMI, Letter, 4/13/93) The BLM letter goes on to require ZMI to cease disposing of waste rock in the Mill Gulch Waste Dump while modifications are made to the existing Plan of Operations and these modifications undergo scrutiny to determine whether they are significant under NEPA. The document record does not indicate any company objections, and the BLM and DSL therefore expected no more waste to enter the Mill Gulch Waste Dump.

b) More "Hot Rock" in the Dump

On April 16, however, a BLM inspector watched as mine waste hauling trucks deposited two trucks loads of unoxidized, sulfide bearing waste in the dump. Rock along a side slope indicated that these were not atypical loads. (Haight, Memo, 5/18/93)

At this point, company actions veer away from the intent of DSL and BLM instructions. The inspector, Scott Haight, told Jim Geyer, the Mine Manager, that it looked like sulfide bearing waste rock was being deposited in the dump, contrary to the Plan of Operations and the April 13 BLM letter. Geyer stated that they were not putting waste in the Mill Gulch dump but "merely building up the backslope and sideslope to prepare drainageways that would be needed at final reclamation." Haight saw the mine operator putting more waste rock in the dump; Geyer claimed they were performing slope reconfiguration in the dump using waste rock. Haight concluded that the mine operators had failed to segregate sulfide bearing material as called for in the amended Plan of Operations, and that this waste material was placed in the dump in contradiction to the April 13 letter.

On June 1, 1993, DSL issued a Notice of Non-Compliance which addresses both issues. (DSL, NON 207, 1/6/93) The Notice of Noncompliance states that observation of fumaroles at Mill Gulch makes clear that "sulfide material was disturbed during mining, and that this

material, if not of ore grade, was placed in the waste rock dump rather <sup>156</sup> than on the leach pad." The violation refers to the commitment in the Landusky amendment, which appears straightforward: "Any sulfide material disturbed during oxide ore mining operations will be loaded, transported and leached on existing leach pad facilities . . . ." The intent of the statement would appear to be that any sulfide bearing material encountered while mining be dealt with in such a way that it does not contact the surrounding environment and produce deleterious environmental effects. Yet ZMI successfully refined the above statement after the fact. Just as "slope reconfiguration" using sulfide bearing waste rock was not, according to ZMI, placing waste rock in the Mill Gulch waste dump, so "overburden stripping is not oxide ore mining." A letter from ZMI to DSL argues that the life-of-mine amendment did not deal with waste rock produced during excavation to get to the ore body. (Fitzpatrick to North, Letter, 6/29/93) Sulfide bearing waste rock might be removed to get to the oxide ore body, but this is "overstripping," and this material would go to the waste rock dumps, not the heaps. "At no time has Zortman Mining, Inc. ever committed to placing only oxide materials in the waste rock depositories," the letter states.

The letter also cites the 1990 EA, which the BLM and DSL approved, as indicating recognition and acceptance of acid rock drainage from the Mill Gulch waste dump:

Monitoring of downgradient surface water has shown some impacts which are attributable to seepage from waste rock dumps, i.e. Mill Gulch . . . Surface water in upper Mill Gulch, immediately below the contingency pond (station

L-18) has shown changes between 1986 and 1988 which correspond 157  
with construction of the Mill Gulch waste rock dump . . . including decreases  
in pH from 7 to 3.2 and increases in sulphate from 8 mg/l to 268 mg/l.

The letter then cites an additional EA passage which indicates recognition that "such changes are 'the result of the generation of acid from waste rock.'" (Fitzpatrick to North, Letter, 6/29/93) These statements in the EA are in direct contradiction to the statement made in the Landusky life-of-mine amendment itself, namely, that "in review of previous baseline and operational monitoring material for the Montana and Mill Gulch waste areas, no significant changes in pH values have been detected." (DSL, Landusky Life of Mine Amendment, 12/6/89)

Based on the statements in the EA, ZMI claimed that the BLM and DSL knew about and approved the placement of sulfide bearing rock in the waste dump, and that they were aware that doing so would create the potential for acid rock drainage. Amazingly, DSL concurred. Wayne Jepson, writing for DSL, states that despite ZMI's life-of-mine amendment assertion that impacts to water quality from waste rock seepage would be minimal, this could not be taken as a commitment that acid drainage from the dump would not occur. (Jepson, Memo, 9/29/93) Jepson could have interpreted the Landusky Life of Mine Amendment requirement that all sulfide ores be placed on the heap as a refusal to accept water quality deterioration and an attempt to prevent further water quality declines. Instead, he agrees with ZMI that the 1988 and 1989 Environmental Assessments did not compel ZMI to maintain pre-existing water quality,

and that, in fact, the EAs acknowledged already extant declines in water quality. Jepson continues by stating that after a review of the life-of-mine amendment, he agrees with ZMI that the statement actually did refer solely to ore grade sulfide materials, not waste rock. In issuing its Notice of Noncompliance, Jepson claims, DSL had made the faulty assumption that this statement referred to any sulfide material. He speculates that, contrary to the BLM inspector's opinion, the two loads of sulfide waste were probably atypical of the waste being placed, and that this waste was being used for slope reconfiguration, and was therefore exempt from the BLM's April 13 prohibition of "waste disposal" in Mill Gulch waste dump. Pursuit of the non-compliance, he writes, "would be extremely time-consuming and unrewarding." (Jepson, Memo, 9/29/93)

Thus it appears that the DSL assumed responsibility for the failure to permit the mine in such a way as to avoid acid drainage. Jepson states that

the acid drainage problem has arisen not because ZMI has mined more sulfide waste rock than predicted in the 1990 EA, but rather because the method (Acid-Base Accounting) used by the agencies to determine whether or not acid rock drainage would occur is not an appropriate predictive method for run-of-mine waste rock. The science of predictive geochemistry, and the regulatory agencies' familiarity with it, has improved considerably in the last few years.

No doubt the acid-base accounting system contributed to the problem; the agencies may have acknowledged the potential for acid rock drainage and misjudged its likelihood or intensity of impact. But with the benefit of

hindsight the agency's permitting of the expansion appears a colossal blunder, unless the intent of the agency stipulations were such as to prevent this situation from occurring. Indeed, imprecision in acid-base accounting does not exonerate the dumping of sulfide waste on a pile instead of a lined heap. A straightforward reading of the statement, "Any sulfide material disturbed during oxide ore mining operations will be loaded, transported and leached on existing leach pad facilities along with mined oxide materials," suggests to me that any sulfide material disturbed during the mining process will be placed on the leach pads. This is exactly the assumption DSL made in issuing the notice-of-noncompliance. If there was a distinction to be made between overburden stripping and oxide ore mining, or a distinction between the fate of sulfide bearing ores and sulfide waste, why did they fail to appear in the text? One must also consider the responsibility of the company for its assurances that the acid generating potential of rock going into the dump would be quite low, and balance agency recognition in the EA of acid caused changes in Mill Gulch with the contradictory assurances in the life-of-mine amendment that no changes had been detected in the same drainage. ZMI's statement that the agencies were aware of the potential for acid rock drainage also indicates that the company too must have been aware of it. The agency allowed ZMI to place the rock in such a manner that it created ARD, but ZMI placed the rock. Both are responsible for the problem, and both must accept the need for changes in procedures to deal with it.

In the wake of these problems, the company and the state agreed to a segregation and disposal strategy which identified, separated and

disposed of "hot rock" in a specially designed dump. The sulfide bearing rock would be surrounded by layers of neutralizing material and capped with clay to limit water infiltration. The plan addresses the issue of overburden dumping, since sulfide waste would have its own dump. But it does not address the issue of construction with waste versus dumping waste. Haight's observation of sulfide bearing rock heading for the wrong dump calls into question the efficacy of these measures.

When reading the current mine expansion proposal, therefore, it is important to remember how apparently straightforward statements became extremely vague and contentious when problems occurred. Can this happen again, and can the problems be anticipated, or does environmental degradation have to occur to provide the necessary insight? Changes may be made as a result of the previous experience, as Jepson indicates above, but a review of ZMI's proposed amendment for mine expansion again shows a recognition of "the potential to produce ARD if not handled properly." And the waste rock is still characterized by Acid-Base Accounting, a method previously described by Jepson as an inappropriate predictive method. (Completeness Review, 6/7/1993, #74)

#### c) The Result: Stream Contamination

Waste rock dumps and heaps at ZMI have been the source of seepage and leaks so egregious that one heap leach pad buttress has even been nicknamed the "Weeping Wall" for the numerous contaminated seeps which originate there. The company has tried to identify sources and



prevent discharges, but severe contamination of area streams has resulted nonetheless.

With contaminated water seeping from various points around the mine, the operators found themselves in the curious circumstance of being in compliance with their DSL permit while producing acid effluent in violation of Montana Water Quality laws administered by the Water Quality Division. ZMI attempted to cope with the acid drainage problem by collecting the contaminated seepage before it entered on-site drainages and pumping it back into the closed circuit. But contamination had already occurred, and it continued. DSL analysis of groundwater data at the end of 1992 concluded that groundwater below both Ruby Gulch and Alder Gulch showed significant deterioration of water quality during mine life with Total Dissolved Solids and Sulfates increasing while pH decreased in monitoring wells. Data for the Rock Creek drainage showed "undesirable impacts to groundwater" below the Sullivan Park Pad, with sulfate values increasing and pH decreasing. In Montana Gulch, most of the drainage showed no ARD effects except below the 79-84 Pad, where TDS concentrations increased dramatically. (Gurrieri, 12/31/92)

This is the context in which the EPA inspected the mine in May of 1993. They found that in seven separate locations, the pumpback was insufficient to collect and return all the contaminated effluent back into the process circuit. Seepage flowed past the pumpback stations and entered the area streams, which then left the property boundary. These point source discharges had no NPDES permits; they were unauthorized under

the Montana Water Quality Act and violated the Clean Water Act. The 162  
contaminated waters flowed not only from waste dumps containing  
unoxidized waste, but also from leach pads and other structures on site,  
such as the "Alder Spur Pads," the "Weeping Wall," the "85/86 Landusky  
Pad" and the "Gold Bug adit." (DHES, Civil Complaint, 8/24/93). The  
seepage called into question the integrity of the supposedly closed  
process circuit. Given that heap leach pads are part of the closed loop,  
cyanide solution should not have "migrated" and continue to "migrate  
through this (85/86) heap leach pad," and should not have "seeped to the  
base of the pad and discharged to surface and groundwater." (DHES, Civil  
Complaint, 8/24/93)

EPA found the pumpback system in violation about a month before  
unusually severe summer rains overwhelmed the various stations and  
emphasized their inadequacy. On July, 15, A BLM inspector arrived at the  
mine to find that rains the night before had completely washed out the  
pumpback station at Carter Gulch, which in May when the EPA inspected  
had only allowed about 1-2 gallons per minute to seep past. (Mitchell,  
Inspection Report, 7/15/93) At this location, the drainage was filled with  
sediment and over 1000 gallons per minute were flowing past the point  
where the pumpback facilities used to stand. The inspector drove to Ruby  
Gulch, where during the May EPA inspections surface flow below the  
"weeping wall" pumpback and a secondary pumpback was minimal;  
approximately 5000 gallons per minute were flowing past both inoperable  
pumpback stations. (Mitchell, Inspection Report, 7/18/93) The inspector then  
drove to Alder Spur, where a pumpback station was installed to collect

seepage from the 83/84 leach pads. He found 1000 gallons per minute flowing past the pumpback station.

The Department of Health and Environmental Sciences filed suit against the mine on August 24, 1993, for the unauthorized discharges to state waters. But the dramatic overflows of contaminated effluent which occurred after the rains observed by the BLM in July did not receive differentiated attention in the suit. No acknowledgement of these events as a violation appears in a Notice of Noncompliance or any other state document except the Inspection Reports. In fact, the document record does not indicate any effort by DSL or DHES to address the summer situation directly by requiring changes in pumpback location or construction. The lawsuit, like the EPA inspections, seeks to require the company to end the discharges or obtain MPDES permits for them.

The company immediately sent the Water Quality Bureau a list of outfalls increasing their number of permitted discharges from three to seven. (ZMI to Reid, Letter, 8/26/93) Probably because the inadequacy of the pumpback system to deal with storm events was never addressed after the summer storm events, the company reconstructed the washed out facilities with minor changes but in a manner which would still render them inoperable during and after a storm event. An August 17 DSL inspections report states:

The pumpback system which collects effluent from the dump toe and returns it to the processing circuit has been replaced. The original system was washed away during the storms of July. The new tank is located out of the

channel and is secured to trees to prevent a similar event from recurring. The tank is filled from small synthetic-lined collection ponds within the drainage which would still be washed away during storm events. Therefore, retention of acidic solution during storm runoff remains unlikely. The redesigned system does allow for more rapid repair of the pumpback system after storms, however. (Jepson, Inspection Report, 8/17/93)

The document record does not contain any indication that Jepson's comments resulted in changes in the pumpback system. By recognizing the problem without demanding change, DSL is setting itself up for a scenario in which it must again claim at least partial responsibility when pumpback problems re-emerge. Despite the lesson of the July events, another storm will blow out the pumpback station. Acidic solution will once again leave the permit boundary in the flow of an area stream.

### Land Application and Solution Inventory Excess

The original Zortman/Landusky permit adhered to the closed loop design and allowed for no solution discharge. The mine had a stipulated freeboard capacity thought to be able to handle a 100 year event, which it was not allowed to exceed. Yet the mine has exceeded the freeboard requirements repeatedly in the last decade, and wound up discharging treated solution to the environment.

The problem at ZMI first appears in the document record as an unanticipated, emergency situation in 1986, when over 6 inches of rain fell overnight and two leach pads neared solution capacity. In order to prevent a catastrophic failure of heaps and impoundments, the operators neutralized and land applied 30 million gallons of cyanide solution with hypochlorite. They did so in cooperation with DSL and BLM, but without any permit authorizing the discharge, bypassing the mandate of the WQD to regulate water quality degradation.

The discharge created an interagency conflict between DHES and DSL. The company was violating water quality laws in order to comply with freeboard capacity stipulations in their DSL permit. A December 1986 letter from DHES advises ZMI that "continuing discharges would appear to represent further violation of the Montana Water Quality Act. Pending application for permits or amendments to permits with this Department or any other state agency does not relieve this company from responsibility pursuant to the Montana Water Quality Act." (Pilcher to Banning, Letter, 12/23/86) DHES follows with a January, 1987 letter to ZMI reiterating that "this Department cannot endorse unauthorized discharges in order to comply with stipulations in your DSL operating permit" despite the emergency conditions. (Pilcher to ZMI, Letter, 1/16/87) Yet DHES never pursued the discharges as a violation of state law, and allowed ZMI to apply for a permit authorizing similar discharges in the future, although the discharge did result in cyanide contamination beyond the permit boundary. A 1993 inspection report states that levels of cyanide within health advisory limits have been commonly detected in the Alder Gulch

drainage, and attributes the cyanide to the emergency land application of 1986. (DSL, Inspection Summaries, 5/12/93)

After the 1986 episode, the mine's operating permit changed to acknowledge the problem and define a response. But the changes did little to prevent reoccurrence. DSL revised the ZMI mining permit to allow land application when solution inventory exceeds freeboard capacity. DSL did not require increased solution capacity or other measures to prevent excessive solution inventory, however. Not surprisingly, solution imbalances occurred again within a few years of the 1986 problems.

DSL inspectors made an interesting comment on the 1986 episode in May of 1993, about three days before the rains of an unusually wet summer began. "Today, more solution capacity exists [than in 1986] because there are more leach pads and solution can be transferred via pipeline between the Zortman and Landusky mines. The total solution capacity for the leach pads at both mines is 340 million gallons; the pads do not operate over 60% capacity. Therefore approximately 136 million gallons of contingency capacity is available in the event major storms occur in the future." (DSL, Inspection Summaries 5/12/94) In spite of the additional capacity, by August of 1993, the company found itself in a position similar to the one it faced in 1986. "The water balance situation at Zortman is currently at a point where the excess solution in our system must be reduced . . . . Zortman Mining cannot go into winter with the current process solution load. Our leach system would likely be stretched beyond capacity if high

precipitation levels continue and next year's spring runoff contains significant moisture." (ZMI to Winegar, Letter, 8/19/93) 167

ZMI states that although they are permitted to land apply, it would not be an effective strategy due to soil saturation caused by the wet weather. The company proposed constructing two lined solution containment ponds on the top of a flat section of a leach pad. Engineering reports stated that doing so would reduce the factor of safety by about 5 percent, due to a reduction in the stability of the heap. (Sitka Corp. to Geyer, Letter, 8/20/93) Surprisingly, the issue disappears from the record until December, when DSL expresses concern that land application may be necessary in the spring and no short term LAD site has been proposed. (Winegar to Geyer, Letter, 12/28/93) The company gambled with the weather and won. Winter precipitation and spring run-off proved to be less than normal in 1994, and neither pond construction nor land application occurred as a result.

What these events make clear is the difficulty of predicting precipitation at the site. State officials applauded ZMI's capacity to handle storms just days before summer rains filled the system. The 1993 episode illustrates how the system can handle a stretch of above average rainfall, but then be vulnerable to any additional storms. One rainfall event builds upon another; a number of smaller events can fill up a system just as easily as one big 100 year event, and this cumulative effect is difficult to assess or predict, yet seems more likely. The solution capacity required to contain a 100 year event may be very different from that needed to contend with a

fairly wet precipitation year or season, in which no single precipitation event is extraordinary. 168

The degree of uncertainty which these calculations entail can be seen in ZMI's description of their water balance in an August, 1993 letter. ZMI calculates various contingencies, given their solution balance of 250 million gallons. They state that at the moment of writing the system could handle an additional 100 year precipitation event of 6" and still be able to handle an additional 2.9" of precipitation. Were this series of events to occur, however, then the system could not handle normal precipitation in the ensuing fall months. The letter states that, given solution balances at the time of writing, normal precipitation calculations for the winter months would bring a 12 million gallon solution surplus by May of 1994. The letter concludes by stating that if Zortman were to experience a 100 year wet year from August 1993 through April 1994, 18" of precipitation would enter the system and render land application necessary even with the proposed storage ponds on top of the Mill Gulch heap. (ZMI to Haight, Letter, 8/23/93)

### Cyanide Leaks

In September of 1993, a liner installed in a caustic pond was improperly sealed, but operators failed to notice the problem until the pond had been leaking for 20 days. Discovery occurred only after cyanide showed up in monitoring wells near the processing plant. Investigators could only approximate the solution loss as between 5000 and 10000 gallons,



because the leakage occurred over such a long period. The cyanide 169 travelled down into the fractured bedrock aquifer under the processing facility. The same aquifer served the town of Zortman's municipal water supply, raising the possibility of renewed contamination of the town's drinking water. (DSL to ZMI, Penalty Notice, 1/28/94)

According to the Notice of Noncompliance, "the underlying clay liner was not able to retain the solution. As a result, cyanide solution could not be contained, and was released into the environment." (DSL to ZMI, NON #224, 1/6/94) Thus not only the faulty primary liner but the presumably intact secondary liner failed to prevent the release of solution. Despite the secondary liner's failure, ZMI continued to display confidence in its function when proposing to utilize the same liner system in its proposed expansion: "The pond design is expected to provide superior environmental performance due to the low intrinsic leakage rate of composite clay/synthetic liners and due to the low permeability of natural clay foundation materials below the ponds which will be compacted during construction for optimum density." (ZMI Completeness Responses, 4/5/93, #73)

Unfortunately, this leak is only one of many at the Zortman/Landusky facilities, and the mine must be viewed in the context of repeated cyanide releases to groundwater. In 1983, the company experienced cyanide leaks on six separate occasions, prompting a lawsuit by the DHES which resulted in over \$20,000 in fines. (DHES vs. ZMI, Stipulation and Agreement, 8/11/93) The cyanide leaks polluted the Zortman public water

supply, which came to light when a mine employee turned on a tap in <sup>170</sup> his home several days after a spill had occurred at the mine and smelled cyanide in the water. (Greene to Keenan, Memo, 11/9/82)

### The Zortman Expansion: Expanding a Troubled Mine?

The proposed expansion at the Zortman site represents a radical departure from the operation which was permitted in 1979. The company has scraped away the surface ore bodies and now must dig deeper to find more. But digging deeper at this site means increasing the environmental danger. The original mine was expected to encounter oxide ores; the amendment for the proposed expansion acknowledges that more than half the waste rock to be produced, or 43 million tons out of a total of 54-60 million tons, will be "non-oxidized material" capable of generating acid. (ZMI, Completeness Review, 4/5/93) The company's responses to a review of their permit amendment indicate that the waste rock produced will also have acid formation potential: "Static tests of waste rock indicates that a portion of the waste has the potential to produce ARD if not handled properly. Although the average Acid-Base Accounting (ABA) score of the waste is approximately -18, most of the waste has an ABA score of -10 and higher. (ZMI, Completeness Review, 4/5/93)."

The proposal must be seen in terms of the results of past mining practices at the site, which have resulted in the large scale and continuing contamination detailed below. It should be noted that previous expansions recognized the potential for ARD related problems while either misjudging their likelihood for development or proposing inadequate mitigation

measures. Given current circumstances, before ZMI should be granted permission to expand in a way that increases the risk of ARD it should first prove it can completely resolve its current acid rock problems. Further, the problems which have occurred leave a great deal of doubt as to whether the company, despite assurances, can mine increasingly risky ore without creating new acid problems. Given the damage to the area which has already occurred, the surrounding environs should not have to endure that risk.

### Accident, Negligence and Intent

At Zortman-Landusky, a mine inspection on May 12, 1993 found two different drainages had been severely impacted by heavy equipment. Inspectors found the road leading from the Alder Gulch Waste Rock Dump had been extended down into Carter Gulch, and then down the Carter Gulch stream bed. The inspection Report states, "No erosion control was evident . . . and no effort had been made to minimize disturbance. Within Carter Gulch the road completely filled the drainage bottom, and flow within the gulch infiltrated into the rock fill, then discharged from this fill several hundred feet downstream . . . ." (DSL, Inspection Summaries, 5/12/93) In writing to the BLM, ZMI contends that an equipment operator misunderstood his instructions, and instead of unblocking an already extant road, inferred that a new road needed to be created. (Geyer to Olsen, Letter, 6/27/93)

The May 11 inspection also discovered that a bulldozer had "walked down" the creek bottom of Mill Gulch, displacing rock and uprooting vegetation. While the May DSL Inspection Summary describes the disturbance as "minimal," a BLM report of the same date describes workers stacking cleared vegetation and moving rock in order to re-establish the stream channel. (BLM, Inspection Report, 5/11/93) Mine officials reported that the dozer slipped off a snowy road during the winter and then attempted to find a way out of the creek bottom by travelling along the gulch with the blade up.

To label these incidents accidental may be a convenient recourse, given the DSL system of assessing penalties for breaches of the operating permit. An accident tends to deflect responsibility from the company to the hapless worker, and indeed, the penalty for an "accident" is less than for "negligence." The "Definitions of Conduct" which accompany the assessment of a penalty for a violation read: "Accidental: not reasonably foreseeable or within the control of the operator; Negligent: failing to meet the level of care reasonably required by the nature of the activity; Gross: conscious and voluntary act or omission which is likely to result in injury, reckless indifference to the results; Intentional: acting on purpose and in disregard of consequences, intending to violate the law; Aggravated: wanton violation of the law, knowing the effect would be to cause serious environmental or personal harm." (DSL to ZMI, Penalty, 1/28/94)

Thus an accident is the least serious of the offenses listed, yet when considering the unauthorized construction of a road or a bulldozer driving

across a pond, the lines are less clear. When instructions are unclear,<sup>173</sup> is the operator responsible, and does this constitute negligence? Would a lack of clear rules for equipment operation constitute a gross violation if the above events ensued as a result? Interestingly, the company response in each of these situations is to deflect blame toward the individual worker instead of the operator, thereby avoiding the question of company negligence by implying that the actions of a single worker are beyond the operator's control.

Yet heavy equipment operation was involved in environmental mishaps on more than one occasion, and that faulty communication resulting in environmentally damaging construction occurred more than once as well. Such patterns, even if they are patterns of accidents, would appear to have more significance and accrue more responsibility than the term "accident" suggests.

### Wildlife Deaths

The Zortman/Landusky facilities have been responsible for a number of wildlife deaths, including bighorn sheep, deer and migratory birds. Soon after the mine began operation, bighorn sheep began using the cyanide sprayed heaps as salt licks. Despite permit requirements, the heaps and ponds had not been fenced, allowing the animals easy access. In January, 1983, the Dept. of Fish, Wildlife and Parks surveyed the bighorn population in the area, found them to be in good health, and recommended the placement of salt licks around the mine perimeter to

discourage the animals and spare the company the expense of the fencing required in the permit. (Wentland to Geyer, Letter, 1/13/83) By August, 1983, however, several sheep had been found dead on the heaps, and the DFWP required the company to fence the heaps and ponds.

The completion of fencing did not prevent wildlife mortalities from continuing. Mule deer died from drinking process waters, sometimes gaining access during construction, when the fence was down, and leaping the fencing on other occasions. On one occasion, a dead deer was found outside the fence, near a cracked pipe that transported cyanide solution. (Lyle to DSL, Report, 12/31/91)

In June, 1991, a flock of 40 gulls landed in the barren pond at the Zortman site. 30 perished; mine personnel rescued and revived the rest. (Fitzpartick to Olsen, 6/14/91) The mine responded by ordering netting for the ponds at both the Zortman and Landusky sites. The BLM required modifications to the Operating Plan, which included monthly reporting of wildlife mortalities. (Miller to ZMI, Letter, 6/17/91) Prior to July, 1991, the company was not required to report wildlife mortalities and an accurate assessment cannot be made.

## Case Study 4: The Kendall Mine

### Overview

Ownership of the Kendall mine near Lewistown, Montana has undergone several changes since heap leach operations began under Triad Resources in 1984. Ownership transferred to Grayhall Resources in 1986 following a state lawsuit against Triad. Grayhall went bankrupt in 1986, and operation was taken over in 1987 by Canyon Resources in 1987. Canyon increased the operating area by 400 percent, including expansion of an existing heap leach pad and development of four more open pits in an amendment approved by DSL in 1990. The mine serves as an example of how financial difficulties can lead to poor management, enforcement limitations and environmental problems. Since the mine required land application on three separate occasions, it demonstrates the evolution in state attitudes towards cyanide neutralization and discharge.

### Land Application

Excess solution problems at the Kendall site began soon after Triad obtained its permit. Twice in 1985, the cyanide bearing ponds filled to capacity and then overflowed onto the ground. No land application took place; the operator just tried to contain as much solution as possible. Land application began under duress in 1986, as a bankrupt Grayhall Resources disregarded winter shutdown requirements and allowed the system to fill up to the brink of disaster. Canyon managed the land application during that episode, and during two subsequent episodes in 1991 and 1993 as well. The following is an exploration of the issues involved with land application at the mine.

#### a) Overflowing Ponds Before Land Application

The Triad experience in 1985 with excess solution could serve as a model for the problems to come at other sites. All the factors which have resulted in land application were involved: faulty diversion ditches, inadequate storage capacity, unfulfilled winter shutdown procedures and excessive precipitation. But land application was not yet an option.

In April, 1985, mine inspectors found all the ponds in the system "brim full," with the pregnant pond overflowing into an unlined emergency catchment pond. The mine plan called for the mine to neutralize excess solution with hypochlorite and pump it to the emergency catchment pond, but the mine was diverting run-off to the catchment pond instead. (Baltzer, Inspection Report, 4/16/85)

Later inspection reports list the causes of the solution excess. The company had not constructed diversion ditches to permit specifications. The pregnant pond capacity was not large enough to accommodate potential runoff. The company did not draw down ponds sufficiently prior to winter shutdown, and continued to add water to the system past the point in October when evaporation ceased. (Lewis, Inspection Report, 4/18/85)

In May, 1985, the mine pumped the contaminated water in the unlined emergency catchment pond to the heap leach pads, where evaporation of excess solution could take place. (Lewis, Note, 5/2/85) The mine also began planning construction of three additional, lined ponds to handle excess solution. Before the company completed the ponds, however, storms overwhelmed the system again. In an August, 1985 letter to the



state, the mine's manager described the situation before the storm: 177

"Prior to the rainstorm of August 2, 1985, the barren pond had three feet of freeboard, the preg [nant] pond two feet of freeboard, and for all intents and purposes, the lower pregnant pond was empty." (Dugdale to Lewis, Letter, 8/28/85) After the storm, all the ponds were full. When a light rainstorm hit on August 16, the mine had no additional capacity. The mine's barren pond overflowed. (Lewis, Note, 8/5/85) The pregnant pond also overtopped. (Lewis, Inspection Report, 8/16/85) The company dug an unlined emergency pond to hold excess solution and reduce pressure on the system. The operator estimated that at least 20 pounds of cyanide escaped in an unquantified volume of solution. (Lewis, Note, 8/5/85)

The DHES had already filed a lawsuit against the company on August 1, requesting \$10,000 in fines as a result of repeated losses of cyanide and associated contamination of ground and surface waters. (DHES, Civil Complaint, 8/1/85) No Notices of Noncompliance appear in the document record against the company, although DSL inspections recognize numerous breaches of the mining permit. The DHES collected \$2000 in fines when Grayhall Resources took over the mine. The company agreed to a series of requirements meant to put an end to cyanide losses from the site.

#### b) Faulty Winter Shutdown Procedures

Unfortunately, Grayhall failed to improve management of the mine, and by the spring of 1987 there was once again a dangerous excess of solution in the system. The situation which developed at the Kendall mine in 1986

again illustrates how solution imbalances can occur through operator negligence, leaving few options but overflowing, digging unlined emergency ponds or land application. Winter shutdown requires the operator to begin to reduce solution inventory as fall approaches in anticipation of the typically large volume of flows entering the system with spring snowmelt and rains. Yet at the Kendall mine, when solution volume should have been decreasing, the inventory remained over a million gallons above that needed to handle a typical spring runoff (Dennis Smith, Meeting Memo, 10/29/86). Despite several warnings from the state, the company did nothing to alleviate the excess water in the system until it was too late to take any action. In August, DSL officials sent a list of 15 areas along diversion ditches needing to be cleaned out and rerouted to prevent the continued flow of run-off into the closed system (Smith to Mountjoy, Letter, 8/13/86). The letter also requested continual spraying of solution from the ponds onto the heaps to aid in evaporation before winter shutdown. An inspection report dated September 11 states that there is no question that the ponds don't have adequate storage capacity for winter shutdown (Baltzer, Inspection Report, 9/11/86). 178

Three days later, the company sent a letter committing to winter shutdown conditions in which one pad and two ponds full of cyanide solution would be empty by the onset of winter. Nothing happened. At the end of October, with winter fast approaching, DSL officials met with DHES personnel in an attempt to find a rapid means of solution disposal and thereby "prevent an uncontrolled discharge in the spring." (Smith, Meeting Memo, 10/29/86) The parties agreed to land application as the best option in an emergency

situation, with DHES stating that it would not continually issue administrative orders to allow discharge. However, no such action occurred before the ground froze and land application was no longer an option according to the agencies. A December 15 inspection found the supposedly empty ponds and pad approaching capacity, and the system under ice. (Spano, Inspection Report, 12/15/86)

The state was left with no mitigation options, other than waiting to see what happened in the spring. In fact, the December inspection report requests the installation of a spillway on one of the ponds, (Pond 5) "to prevent the dike from washing out next spring should the pond overtop." (Spano, Inspection Report, 12/15/86) A memo dated January 5, 1987 states that the DSL issued a Notice of Noncompliance because, despite numerous cautionings, "Management at the mine chose to maintain the facility at "status quo." As a result, there is a good chance that a discharge of process water will occur in the spring as snow melts and rain accumulates exceeding the small capacity left (Smith to Amestoy, Memo, 1/5/87)."

With the arrival of spring, the situation, in the words of DSL inspector Scott Spano, was "critical." (Spano, Inspection Report, 4/8/87) Spano's report states that Pond 5 had 16 inches of freeboard before a discharge occurred, with a 70% chance of rain, snow on the hillsides above and unmelted ice covering most of the ponds. The operator responded by preparing to discharge neutralized solution on south-facing slopes. Spano states, "Although this not an approved discharge by DSL/DHES, there is

no other choice. Failure to do so would result in an uncontrolled, untreated discharge from Pond 5 down the valley."

#### b) From Closed Loop to Permitted Discharge

The Grayhall permit committed to winter shutdown with adequate capacity to allow for spring run-off, without entertaining the possibility of what might ensue if the company or the weather failed to live up to permitted specifications. It made no mention of land application procedures in the case of emergency and therefore allowed for no discharge. In the fall of 1986 the problem became clear when Grayhall Resources failed to reduce solution levels in the system to a safe volume. Under the circumstances, a regulated discharge, if possible, was preferable to an uncontrolled discharge, and DSL and DHES set about approving an emergency permit to discharge by land application.

The state issued the permit in 1987 with a number of stipulations. With Grayhall in bankruptcy, Canyon Resources carried out the land application under the rules of the permit approved by the state. The rules included: 1) batch treatment of cyanide solution in a pond dedicated to the purpose, with a 24 hour waiting period during which time the solution would be circulated to ensure complete neutralization throughout; 2) three consecutive tests of the batch indicating that cyanide levels were lower than the state standard; 3) testing of the solution as it was applied every two hours to ensure that the solution was meeting the state standard; 4) a maximum of 1 million gallons applied.

The emergency permit to discharge was intended to be a one time affair, but the DSL's response to the emergency was to modify the permit to allow land application, converting the closed loop system to a system that discharges to the environment. Kit Walther, in an early 1987 letter, reports Canyon's Bob Perry as stating that he wants a permanent amendment so that in the future, controlled land application discharges can occur if the operation cannot attain the required freeboard through evaporation. (Walther to Eckles, Letter, 4/1/87) In essence, the operator wanted land application to become a routine management tool, not an emergency measure subject to DSL incident by incident approval. Even after a 1990 amendment authorized land application, the question of whether land application was an emergency or routine measure remained unresolved.

Canyon's 1990 amendment to their operating permit expanded the mine's operations dramatically. Since the amount of solution in the system also increased dramatically, the expansion should have necessitated increased storage capacity. But the amendment contended that previously constructed ponds would provide adequate storage capacity to meet the permit requirements. The only addition to the excess solution management system was a land application plan designed to handle a 100 year storm. Land application went from an unpermitted emergency measure to become an integral part of excess solution management.

Agency comments on the amendment application recommended that Canyon consider 1) switching from Calcium hypochlorite to hydrogen

peroxide, due to the toxicity of the Chlorine produced; and 2) increase storage capacity given that actual precipitation in the area does not seem to coincide with the average measurements on which the original storage capacity calculations were based. These were only recommendations, however, not requirements, which Canyon perhaps considered but decided not to pursue.

The terms of the 1990 amendment allowed Canyon to land apply whenever a lack of storage capacity rendered it necessary. The amendment committed to batch detoxification with a 24 hour holding period and three negative tests for cyanide levels before discharging onto land. However, testing of the discharge from the batch pond, according to the amendment, must occur every eight hours, not every two hours as the state required earlier in 1987 when issuing the emergency permit to discharge. Circulation of the solution within the batch pond, a requirement for the emergency discharge, is not mentioned in the amendment.

Thus the amendment clearly delineated the procedures for land application to take place without settling the crucial issue of who controlled land application, the company or the state. Land application began as a last ditch, emergency option; the amendment approved its use whenever a solution budget imbalance rendered it necessary, an undefinitive phrase open to multiple interpretations. In fact, both the permitting process and the amendment's final terms appear to diminish the state's power to exert control over land application and solution management. The state recommends, but does not require, design improvements which later

events suggest might have spared the environment. The non-emergency land application process requires less care from Canyon in ensuring complete neutralization before discharge than the emergency process. It wasn't long before these issues, implicit in the permitting stage, became regulatory and enforcement problems.

### c) Diversion Ditch Maintenance

Less than two years later, during the summer of 1991, Canyon again employed the land application system. What caused the land application? A 100 year storm? No. The BLM, in a July, 1991 letter, points out the following: 1) the amount of rainfall in and around Lewistown has been heavy but not extraordinary; 2) the land application areas are intended for emergency use only, not routine solution inventory management, and 3) the freeboard requirement means that considerably more freeboard than was available in Canyon's system must be present in the fall to accommodate spring run-off and still maintain the required storage capacity throughout. The BLM concludes by requesting Canyon to recalculate its water solution inventory (Miller to Benbow, Letter, 7/3/91).

The letter implies that inadequate facilities or a problem with procedures have created the necessity for land application, not extraordinary weather. A site inspection in June, in the midst of land application, revealed that a diversion ditch had failed near Pond 7, adding 1 million gallons of run-off to the system as well as rock and sediment to the pond (Pagel, Inspection Report, 6/27/91). These documents indicate that in spite of the 1989 amendment's assurances, the system either lacked the capacity to

maintain freeboard requirements in an above average year and/or that poor adherence to winter shutdown procedures failed to prepare for the possibility of a more wet than normal spring. Yet the system was supposed to be designed to cope with a 100 year event at all times, and Canyon had the opportunity, in 1989, to construct the capacity to do so. The situation was exacerbated by the failure of the diversion ditch, which was more a maintenance problem than a weather problem. An October 1991 list of problems at the mine, compiled by DSL, states that land application became necessary because "1) company did not meet required freeboard going in to winter shutdown; 2) diversion ditch was not adequate to divert runoff and failed adding ~ 1, 000, 000 gallons to the system (DSL, Meeting List, 10/24/91)." The memo suggests that the company, not the weather, is to blame.

#### c) Continuous vs. Batch Application

On May 10, 1991, Canyon called DSL to report that they had only 2.9 feet of freeboard instead of the 6.3 feet required by the permit, and were batch treating 700, 000 gallons of solution with calcium hypochlorite for land application. Three days later they called again, this time to report that they had begun continuous land application at 4:15 AM after receiving a heavy rain. They committed to returning to batch treatment "about Wednesday." As for the state's response, a June, 1991 Inspection Report inquired belatedly, "Do they get to land apply when they want?" (Pagel, Inspection Report, 6/27/91)



The permit specifically required that the company use a batch method<sup>185</sup> of treatment before land applying; continuous application is a violation of the permit. Worse, the company did not return to batch application on Wednesday or throughout the land application process. On July 22, 1991, Canyon's Robert Vine informed DSL that the company had disposed of over 6.2 million gallons of solution and over 280,000 pounds of calcium hypochlorite using "direct injection of calcium hypochlorite into the intake side of the land application pump (Vine to Spano, Letter, 7/22/91)." Thus there was no 24 hour holding time to ensure neutralization of the batch, making it all the more likely that an oscillation in the rate of calcium hypochlorite introduction or a variation in the solution's cyanide levels would bring about a cyanide discharge. The company tested the discharge every two hours during the day and every six hours at night. This is more frequent than the eight hours required by the permit, but the permit presumed a batch treatment which had already undergone three negative tests for cyanide before being released. The eight hour tests were therefore an additional precaution. In the case of continuous discharge, no preliminary testing had been done to determine the cyanide level. The testing occurred as the solution left the system at 280 gallons a minute. A review of the testing data shows two tests with levels of 12.5 mg/L free cyanide and 5.0 mg/L free cyanide, respectively. (Kendall, Table of Land Applied Solutions, 1991) All sorts of cyanide variation could have occurred during the intervals between tests, and even if a test detected high cyanide, some quantity of the solution would have already left the system before it could be turned off.

Canyon attempted to counter this possibility by adding additional calcium hypochlorite to the discharge to more than account for any variation in the cyanide level. However, direct injection required overchlorination, which in turn damaged the environment. Scott Spano, in a July 1991 reply to Vince's letter, informed Canyon that direct injection usually leads to overchlorination and that a batch treatment method is preferable, but does not mention that the permit compels Canyon to utilize batch treatment (Spano to Vine, Letter, 7/31/91). An October 1991 DSL list of problems at the site includes "Water treated during land application was overchlorinated, probably as a result of direct injection of chlorine instead of batch treatment, as was required by their permit (DSL, Meeting List, 10/24/91)."

The environmental result of the land application is best described by two inspection reports by the DSL's Joe Frazier. In May, 1991, Frazier notes "white precipitate coats surface of spray area and standing vegetation (Frazier, Inspection Report, 5/29/91) ." A month later, Frazier's inspection reports "some of the understory (grasses and forbs) is currently dead or dying. The coniferous vegetation shows no effect although most is coated with a white precipitate up to 3' to 4' above ground level . . . . Water was seeping at several locations below and downgradient of the spray area. Foam was present at the largest seep (Frazier, Inspection Report, 6/25/91)." Spano's July, 1991 letter implies that overchlorination, particularly without the 24 hour wait to dissipate free chlorine ions, leads to application of a solution that is extremely toxic to plants and aquatic life. As a result of Canyon's activities, vegetative mortality can be expected to

take place. (Spano to Vine, Letter, 7/31/91) A year later, in 1992, a DSL memo indicates that Canyon had requested to move their land application area because the "application of +6,000,000 gallons last year caused the silty clay soil on LAD 3 area to slip toward Leach Pad 4 and permanent diversion ditch (Snyder, Memo, 6/3/92)." In viewing these facts, it should be remembered that the heap leach operation began as a closed system without any discharge, and that the state recommended in 1989 that Canyon use hydrogen peroxide, not calcium hypochlorite, in any future discharges.

In sum, Canyon land applied in a way that was not only detrimental to the environment but was in clear violation of their 1989 permit. The company, not the state, dictated the terms of land application, telling the DSL when and how the process would proceed. Even when these steps violated the amended permit, the DSL complained but did not issue a Notice of Noncompliance. Amending the permit was apparently interpreted by both parties as a relinquishment of state control.

#### d) Calcium Hypochlorite versus Hydrogen Peroxide

In the summer of 1993, Canyon once again found itself without enough freeboard. In correspondence sent to DSL during the 1991 episode, the company stated its intention to increase the size and storage capacity of Pond 8 in order to alleviate the need for future discharges. No evidence appears in the document record that the increase took place, and whatever the remedial steps taken in the wake of 1991, they were not enough.

At the end of July, 1993, the company informed the state that they did not have adequate freeboard capacity and intended to land apply, using a batch method. They further stated that testing would be conducted as outlined in the Plan of Operations. In spite of state recommendations and the vegetation mortality which occurred in 1991, the company proposed to continue using calcium hypochlorite (Vine to DSL, Letter, 7/27/93).

The DHES responded with a letter stating that Canyon, in order to comply with the Montana Water Quality Act, needed a permit to discharge wastewaters into state waters, and such a permit must be issued, as in 1987, before the mine could begin land applying (Fraser to Vine, Letter, 8/10/93). Canyon maintained, however, that DHES was involved in the permitting process which resulted in the DSL approved Plan of Operations and allows Canyon to discharge whenever necessary without a separate permit (Ryan to Reid, Letter, 8/13/93). Canyon states that "we will continue to coordinate land application at the Kendall Mine with the DSL and the BLM in the approved manner specified by our permit," and commences with the application of calcium hypochlorite neutralized solution.

Meanwhile, DHES meeting notes indicate that the application of calcium hypochlorite treated solution in such quantities constitutes a point source discharge, for which state law requires a permit, and that the state's non-degradation rules may also be applicable. The notes show the state considering options under non-degradation, including a non-degradation review and authorization, a decision to consider the discharge insignificant, and a compliance order (Reid, Meeting Notes, 8/24/93). A

September, 1993 letter from Canyon to DHES, reporting Canyon's understanding of the state's position, suggests that DHES and DSL planned to "remodel" permit requirements for the mine without continuing to press the issue on the need for a separate permit.

Perhaps anticipating the changes, Canyon switched to hydrogen peroxide in September, 1993. But the company also switched again to continuous discharge, which was not approved in their plan of operations. A September 14, 1993 letter informed DSL that the company plans to pump treated water to Pond 3, from which the same volume of water would be constantly drained to the land application area (Vine to Winegar, Letter, 9/24/93). While the switch may have represented an improvement, and the methodology may have been appropriate, they were not part of the approved permit, and do not appear to undergo any review or approval process. It seems somewhat ironic that the company stated its strict adherence to the existing permit when DHES requested an additional discharge permit, and yet less than a month later the company was defining its own land application regime without a process of review and approval.

#### Inadequate Baseline and Degradation Uncertainty

In order to determine whether a leak has occurred at the site, current cyanide levels in groundwater must be compared to baseline data - data collected before the operation in question began. At Canyon's Kendall mine, current cyanide levels have been attributed to a combination of historic cyanide seeping through old tailings and spills from the previous

operator, Grayhall. It is not possible to distinguish between the two sources, because Grayhall's original permit included only one test at one groundwater monitoring well and revealed the results only as  $< .02$  m/l total cyanide. No other parameters were tested. What little baseline data was gathered did not indicate the presence of any historic cyanide before Grayhall. Thus it is not possible to characterize the movements of cyanide beneath the surface, or attribute elevated monitoring well readings to underground cyanide migration. The baseline data for groundwater which are contained in Canyon's 1989 amended permit of operations include more parameters but are still based on only one day's testing. Given the unpredictable movement of unknown quantities of solutions beneath the surface, one day's result may be very different from the next, and may be far higher or far lower than the average for the well.

Thus when a tear in the primary liner leaked solution out of the system, as occurred in April 1993, the only way of knowing if the secondary liner contained the solution entirely was to look at the monitoring well results downgradient. The downgradient well had no detectable CN, and the detection limit of the method used was  $.005$  ppm. Hence there was either no CN present or less than  $.005$  ppm. DSL assumed that  $.005$  ppm was the ambient level, concluding there was no degradation. If they said there was no measurable degradation, their conclusion would be quite acceptable and the problem would be the detection limit.

Canyon exploited similar uncertainty in arguing against responsibility for elevated readings at a number of wells. A summary of 1989 data, which

included high cyanide readings at several wells, states, "Cyanide in groundwater appears to reach maximum concentrations during the spring and early summer months. According to a Canyon report, increased volume of water moving through the alluvial material during the spring months could liberate weakly bound cyanide in the alluvium. Naturally occurring cyanide, the report continues, occurring in concentrations up to .39 mg/l total cyanide in nearby areas undisturbed by current mining, could also enter the hydrologic cycle during spring thaw and runoff (Kendall, Water Quality Summary Report, 1989)." Nick Bugosh, commenting for DHES, reached an opposite, and equally plausible conclusion: "Perhaps the rise is attributable to spring start -up discharging more solution over pads and ponds . . . ." (Bugosh to Brown, Memo, 1/29/90) In other words, tears or leaks in the system may have occurred over the winter, and the addition of new solution may have caused the elevated spring readings. Either explanation could be valid.

In a similar vein, Canyon responded to a nearby rancher's contention that Pad 3 is leaking and showing cyanide in monitoring well TMW - 6 by blaming elevated cyanide readings on spills committed by their predecessor, Grayhall. "We believe it is leakage prior to 1988 that is showing up in TMW-6 on June 6, 1989, that has been mobilized by the heavy spring run off and rains. . . . [Canyon] believes that cyanide solution seeped into the Pad 3 area between the time Grayhall began leaching and the time Canyon Resources arrived in 1987. . . . The entire pad and pond complex has a history of prior cyanide contamination . . . ." (Kendall, Question Responses, 6/28/89) Canyon's contention could have been

correct. Given the unpredictable nature of the situation and the lack of <sup>192</sup> long term baseline data to characterize fluctuation prior to their operation, it would be difficult to prove otherwise unless an actual breach in the system was observed. But the opposing contention might also be valid.

### Liner Integrity and Cyanide Leaks

Canyon has had two documented leaks of solution from the permit boundary since assuming responsibility. Yet one leak may reveal a number of problems. Such was the case with a leak which occurred for an unknown length of time early in 1991. Mine officials first suspected a problem when they detected water flowing from a sub-drain pipe near solution Pond 3B. Inspection of 3B found small tears in the liner, but the quantity and sewage smell of the solution found in a collection pond downstream of Pond 3B suggested another leak. Canyon traced the flow of this solution to a seep in a hillside above Pond 3B. Tests indicated the presence of high cyanide levels in the seep. Canyon then proceeded to the processing plant uphill from the seep, where they found that the grouting around the drains had cracked.

However, the cyanide solution should have been contained by Pond 1, since the floor drains drained into it. But Pond 1 also had a leak, allowing the solution to drain down the hillside, bypass Pond 3B and flow into the collection pond and a ditch which led into Pond 6. Pond 6 should have contained the solution, but a bulldozer had driven out onto the pond liner, tearing it, and had pushed a quantity of sharp, coarse fragments onto the liner, causing additional punctures. The solution then drained out of Pond



6 and into the surrounding environment. One apparent leak turned out to be many. 193

In the second incident, in September 1991 employees cleaning part of the process system failed to equalize pressure by closing the proper valves in the pressurized cyanide solution lines. A pipe inside the metal recovery plant ruptured under the resulting excess pressure, releasing 2500-3000 gallons of solution into a diversion ditch outside. Emergency drains which were supposed to catch any release and funnel it into a lined pond were plugged because the pond was in the process of receiving a new liner. Pumpback captured some of the cyanide solution, but the rest flowed past the permit boundary in storm water contaminated by the spill. (DSL, News Release, 10/1/91)

#### Heap Stability: A Known and Unanswered Question

In the spring of 1986, Grayhall filed for bankruptcy protection, and DSL inspectors found Grayhall's operations in a state of disarray. A March 1986 report describes most of the problems as relating to the recent construction of Leach Pad 3 (Smith, Inspection Report, 3/28/86). They found the diversion ditch constructed above Pad 3 had almost filled completely with sediment. They found Grayhall had not disposed of the plastic which covered the Pad for the winter; it remained on the top of the heap, indicating that the company had not been actively pursuing preparations for the spring. They found that the company had proceeded with leaching on Pad 3 even though it had not completed constructing the parts of the

heap designed to protect the environment. The March report cites the need to finish lining the pad, place bentonite over all exposed PVC and extend the liner up to the top of the dike. In addition, spillways to Pad 3 had not been constructed, so that the pressurized solution lines ran outside of lined spillways. 194

A July, 1986 follow-up inspection states, "I don't see where any significant work has been completed since the last inspection almost three months ago (Spano, Inspection Report, 7/29/86)." The construction work on Pad 3 was still incomplete; the liners had not been pulled up to the top of the dike, and in many places were covered with cyanide bearing ore.

Leachate had ponded on the east side of the pad and was 5 inches away from spilling beyond the liner and contacting the soil. An August 1, 1986 letter from DSL informed Grayhall that the entire pad must be lined with PVC and a cover of fine tailings, in accordance with the permit (Manley to Mountjoy, Letter, 8/1/86).

The written record indicates that Pad 3 construction did not proceed in a satisfactory manner, and it contains little evidence that Grayhall made construction modifications to Leach Pad 3. An August 13, 1986 letter to Grayhall quotes Steve Mountjoy, Grayhall's operator, as stating there is no more PVC on site and no money to buy more and finish lining the pad (Smith to Mountjoy, Letter, 8/13/86). Yet in a July 17, 1986 letter, Mountjoy stated that the spillways had been completed and the pressurized lines placed in them (Mountjoy to Manley, Letter, 7/17/86). He also claimed that

Pad 3 construction has been completed according to permit

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requirements. No further specific references to Pad 3 construction appear in the record.

Thus Canyon inherited Leach Pad 3, whose construction was already suspect. In 1989, Canyon proposed to expand Leach Pad 3 and combine it with Leach Pad 4 into one big pad. In early 1989, the company submitted a proposed amendment, and the state completed an environmental assessment. A public hearing was held on the amendment on June 19, 1989. What was not available to the public for comment during the hearing were the results of an auger drilled core sample of the Leach Pad 3 dike, which indicated that the pad's lack of completion was more than superficial. The core sample was taken because DSL decided a stability analysis of the pad was needed. Originally, no stability analysis of the expansion was planned. Craig Pagel of DSL, after a review of Leach Pad 3's history which revealed that it was designed and permitted without simulation or geotechnical stability analysis, requested a stability analysis for the expansion (Pagel to Walther, Memo, 6/5/89). The stability analysis, performed by a consultant to Canyon before the hearing, concluded that the pad was stable, based on "conservative" assumptions and "assuming the subsurface conditions are as described by others." These assumptions turned out to be wrong.

An auger hole drilled into the dike face revealed that Grayhall did not construct the Leach Pad according to the permitted conditions upon which the stability analysis was based. Leach Pad 3 construction was supposed

to include topsoil removal, foundation preparation and compaction of <sup>196</sup> a six inch clay liner, placement of a tailings layer over the clay liner and installation of a smooth PVC liner. The auger hole encountered roots and topsoil at the dike base; the topsoil was not stripped and the clay and tailings layers were not implemented. In addition, the stability analysis assumed drained foundation conditions, when in fact the foundation was constructed without underdrains and limited foundation preparation and showed evidence of seepage in the dike face (Pagel to Cole, Memo, 8/2/89). Not only was the heap lacking two of its three liners, but its potential lack of stability raised the possibility of the heap sliding down over the dike and off the PVC liner, releasing huge quantities of cyanide.

The results of the core sample, which called into question the conclusion of stability, appeared after the public comment period had ended and therefore were not disclosed at the public meeting on the expansion. Pagel, in a August 2, 1989 interdepartmental memo, disagreed with the "truncation" of the review process and stated his belief that more thorough review and the inclusion of the core sample results would have changed the environmental assessment conclusions which approved the expansion (Pagel to Cole, Memo, 8/2/89).

Canyon's response was to conduct further stability analyses which concluded that while the poor construction resulted in an unquantifiable risk of failure, expanding the pad would not increase the likelihood of dike failure. The company also agreed to install a meter to measure slope movement and thus deformation of the pad's walls. However, neither of

these actions addressed the question of whether or not the Pad was actually stable given its dubious foundation. The slope indicator might tell if the dike was failing, but it wouldn't stop the failure. Based on the additional analysis performed by Canyon's consultants, Pagel concluded on August 16, 1989, that "the stability of the toe area is marginal, and an unquantified environmental risk does exist. However, given the conservative assumptions for unknown foundation conditions, and the demonstration that pad expansion will not increase driving forces in the toe area, the risk is considered reasonable and practical (Pagel to Cole, Memo, 8/16/89)."

Yet proceeding with already constructed Leach Pad 3 was not the only option open to the company. The company could have taken remedial construction action, or removed the old pad and reconstructed the new pad entirely. These options would have cost far more. While Pagel may have concluded that the risk was reasonable and practical, the fact remains that DSL chose to take the risk rather than require the company to incur the extra expense of starting from scratch on Leach Pad 3 and doing the job right. The company knew from Grayhall's history as well as the core sample that the pad was shoddily constructed; they chose to build upon the mistake rather than correct it.

#### Enforcement: Violations but no Notice of Noncompliance

Canyon Resources took over a mine with severe problems in the spring of 1987. Grayhall Resources had filed for bankruptcy the year before while continuing to operate the mine in a haphazard and dangerous manner. In

March of 1986, inspectors found Grayhall actively spraying cyanide solution on recently constructed Pad 3 without having constructed lined spillways for the pad and all connected ponds. The company had been warned of the deficiency twice, and had committed to constructing the spillways on two other occasions. The same inspection also revealed that pressurized solution lines from the barren pond to Pad 3 were not placed in lined channels, so that a rupture would leak instantly into the ground. Once again, the company had been warned and had agreed to line the channels, prior to start-up. The state issued a Notice of Noncompliance (Smith to Grotbo, Memo, 4/3/86).

Yet the number of Notices of Noncompliance which the DSL issued in no way matched the number of leaks and other problems occurring at the site. As the year continued, Grayhall admitted to cyanide losses due to leaks in the fall of 1986 while their pond system filled to far above the level required to accommodate anticipated spring run-off. The number and quantity of the losses were never substantiated, as Grayhall never specified the number of leaks or spills and the state never pursued specification. A DHES letter dated April 17, 1987, states, "Company representatives have freely admitted to such losses during the Fall of 1986 and have attributed dramatic increases in cyanide concentration in the monitoring well system to that/those spills (DHES, Letter, 4/17/87)."

Not only was the state aware of the cyanide losses, but the record indicates that the DSL appears to have been aware of the possible sources of continuing leaks under Grayhall, which resulted in the elevated

cyanide readings. But these possible leak sources only appear in the <sup>199</sup> documents after Canyon takes over operations and begins to rectify the problems. For instance, an inspection report on March 18, 1987 describes Canyon's remedial activities: ". . . - this includes draining Pond 5 to examine for leaks. Although this pond has been repaired, it is still under suspicion of adding to CN - groundwater problem. Also, the small pond below the lab/office building, which is used to collect lab effluent, should be drained and at least checked for leaks. This is also under suspicion of adding to groundwater problem (Spano, Inspection Report, 3/18/87)." Similarly, a May 6, 1987 report states: "The spillway between Ponds 4 & 5 has been glued, and may go a long way towards eliminating the groundwater problem." The "groundwater problem" was occurring throughout Grayhall's 1986 operations; it did not simply appear with the Canyon assumption of responsibility. A March, 1986 letter from Grayhall informed DSL that TMW#4 was showing elevated levels of cyanide, and surmised that the readings might be due to a leak in the Pond 5 liner (Mountjoy to Grotbo, Letter, 3/27/86).

Grayhall's statements may only prove that, given the company's bankruptcy, the state had no real enforcement tools to bring Grayhall into compliance, did not expect any response to notices since other warnings went unheeded, and therefore allowed these possible leaks to continue unannounced until Canyon took over. Yet unquestionably, they also represent a failure on the part of the state to fulfill its enforcement duties. The DSL knew that leaks were occurring, they had a good idea of their source, and they did not issue a Notice of Non-Compliance or take action

to prevent these losses from continuing to occur. Not until April, 1987, <sup>200</sup> after Canyon has taken over the mine's management and begun remedial action, did the DHES sends Grayhall's trustee a letter demanding a compliance plan and an expanded monitoring well network to "document and control the losses." (Keenan, letter to Eckles, 4/17/87) By the time DHES sent their letter, cyanide had already been exiting the system for at least six months.

### C) Immunity Under Bankruptcy

Meanwhile, bankruptcy law prevented the state from pursuing the Notices of Noncompliance against the company or revoking the company's cash performance bond, despite the repeated and continuing violations of the permit. A memo from the Department of State Lands' staff attorney indicates that the state intended to pursue a Notice of Noncompliance and considered revoking Grayhall's cash bond, but a lack of clear court opinion on the legality of assessing fines or removing resources from a bankrupt entity, reported in the attorney's memo, stopped DSL from pursuing any fines (Butler to Amestoy, Memo, 11/19/86). The resulting Notice of Noncompliance, dated December 9th, 1986, therefore had no teeth, because, as the DSL notes in a letter to Grayhall, they did not intend to collect the fines for as long as Grayhall was in bankruptcy (Manley to Eckles, Letter, 4/30/87). Nor did the state intend to shut the mine down, for even if the state chose to rescind the permit, it would be left cleaning up the site with funding from a bond of only \$71,000. Thus December of 1986 found the mine without adequate capacity to handle spring run-off and



without any means of attaining the capacity before spring, and the state without enforcement or remediation options.

### EA vs EIS: The Canyon Expansion

In 1989 the state prepared an Environmental Assessment for the Canyon expansion. The DSL Commissioner concluded that the EA provided sufficient consideration of environmental issues associated with the expansion, stating, "The department's check-list environmental assessment considered the direct, indirect, and cumulative impact of the proposed pad expansion. The environmental impacts are not considered to be significant." (Casey to Jensen, Letter, 7/12/89) However, at least one vocal DSL technical staff member complained that the EA assumptions were flawed and the review process inadequate. (see Heap Stability above) Bolstering his opinion, both the EPA and the BLM concluded that the state should have prepared an Environmental Impact Statement in order to comply with National Environmental Protection Act requirements.

The EPA said the EA lacked quantitative support for qualitative assurances that no significant impacts to the environment would occur. The agency stated that while some of the proof may have been provided in the permit application, the EA should have referenced or included the data. The agency listed four concerns: 1) Permanent alterations to 400 acres of land, 2) Increased production of ore and waste, 3) Concerns about short and long-term impacts from cyanide heap leach systems, and 4) Topographic and vegetative changes visible for extended distances. As a result of these significant issues, the EPA believed "the proposed

expansion could have supported preparation of an EIS." (Wardell to Casey, Letter, 10/30/89) In addition, the EPA's letter supports the development of alternative actions. Only an EIS would have required consideration of alternatives to the two options considered in the EA: mine closure and expansion. (Sundby, Billings Gazette Article, 11/1/89) 202

The BLM, in a July 1989 letter to the state, states that "it is difficult to definitely conclude that this EA does or does not fully meet NEPA requirements." The letter reiterates EPA concerns that there are no alternative actions considered, and that "generic statements" assess potential impacts instead of quantitative analysis. In addition, the BLM found the EA deficient in its analysis of the cumulative impacts of "piece-meal" expansion. The letter concludes that with only 10% of the proposed expansion on BLM land, the agency can state that the EA "barely" meets NEPA requirements. Were the BLM area greater, however, the agency could not support the state's position that the EA is sufficient. (BLM to DSL, Memo, 7/11/89)

### Heavy Equipment Accidents

Two incidents which occurred during Canyon's tenure demonstrate the risk of cyanide release posed by negligent vehicle operation. In February, 1991, DSL inspectors on site to inspect a cyanide leak watched as a bulldozer operator drove out onto a pond liner. The bulldozer tore the liner badly and pushed coarse, sharp fragments onto the liner which created additional punctures. The pond served as an overflow pond which normally did not contain cyanide, but cyanide solution was present as a

result of the January 1991 leak from the floor drains in the ore processing plant. The inspectors watched as the cyanide trapped in the pond drained through the tear and out into the surrounding environment. (Spano to Casey, Memo, 2/14/91)

In August, 1992, a company pickup rolled into another pond containing cyanide when an employee taking water samples left the truck out of gear. The company drained the pond, removed the truck and inspected the liner. They did not observe any damage to the pond liner. (Spano, Memo, 6/8/92)

While driving a bulldozer out onto a pond intentionally may seem more egregious than forgetting to leave a parked vehicle in gear, both accidents involved negligence on the part of company personnel, which either caused a cyanide release or created the danger of one. Yet neither incident received a notice of noncompliance from the state.