

RECLAMATION PLANNING AND PERMITTING AT THE HAYDEN HILL PROJECT¹

by

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Abstract. The Hayden Hill Project is an open pit gold and silver mine located in northern Lassen County, California. The project site is composed of approximately 2,800 acres of private, BLM and USFS land. The operation utilizes conventional heap leach and milling processes to recover metal values from a shallow epithermal deposit. Ore will be processed at a rate of approximately 6 million tons per year for eight years. At project completion approximately 970 acres will be disturbed.

The reclamation permitting for the project included compliance with the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), the Surface Mining and Reclamation Act of 1975 (SMARA), and the proposed Minimum, Verifiable State-Wide Regulations Standards from the California State Mining and Geology Board. Although the project was permitted in September of 1991, prior to their adoption, a draft of the Proposed Minimum, Verifiable State-Wide Regulations Standards was used as the guideline for the planning. The project incorporated innovative reclamation practices and techniques which were beyond the requirements of the law. The reclamation plan is the latest to be permitted for a major gold mine and has received an award for excellence in reclamation from the California Mining Association. The design and permitting processes as well as the current status of reclamation at the site are discussed.

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Introduction

The Hayden Hill Project (Project) is an open pit gold mining operation with heap leach and mill processing facilities. The Project is located in northern California, west of State Highway 139, approximately 50 miles northwest of Susanville, California (Figure 1). The owner and operator of the Project is Lassen Gold Mining, Inc. (LGMI), which is a subsidiary of Amax Gold, Inc. (AGI).

The reclamation plan for the Hayden Hill Project won the California Mining Association's Excellence in Reclamation Award in 1992 and was influential in AGI's receipt of the Dupont/Conoco Environmental Leadership Award. The reclamation planning and permitting of the Project was similar to the planning and permitting of most any modern mining project. However, it was also innovative and unique in many subtle ways. Subtle, innovative and unique differences often make the difference between a well accepted, award winning plan and a simply good plan.

The Hayden Hill Project was the most recent major open pit gold mine to be reviewed and permitted under the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA) and the Surface Mining and Reclamation Act of 1975 (SMARA). This fact in itself meant that the process would be under the scrutiny of anyone interested in the evolution of these processes. The reclamation plan was written as the culmination of the CEQA/NEPA process and included all of the Environmentally Preferred Alternatives and selected mitigation measures identified in the Environmental Impact Statement (EIS).

The mine occupies land administered by the Bureau of Land Management (BLM), the United States Forest Service (USFS) and private lands which are under the permitting jurisdiction of Lassen County. Lassen County was designated as the lead agency for the combined CEQA/NEPA process.

The NEPA process for the Castle Mountain Project in California, operated by Viceroy Gold Corporation, preceded the Hayden Hill Project by a few months. Consequently, many BLM decisions and policy issues made at Castle Mountain were quickly implemented at Hayden Hill. The SMARA/state rules were also changing while the Project was being reviewed. A draft of the Proposed Minimum, Verifiable State-Wide Reclamation Standards was used to prepare the final reclamation plan. Although this draft contained requirements which would not be required in the final Reclamation Standards, it was impossible during the development of the reclamation plan to predict which would be removed or retained. Therefore, some commitments made by LGMI are beyond those required by the current Reclamation Standards and SMARA.

This paper will present a description of the Project and discuss those interesting events which controlled the creation of the Hayden Hill Reclamation Plan.

Project Description

Ownership of Land

The Project area encompasses lands which serve multiple purposes for numerous land owners and a variety of land users. Land ownership within the Project area is currently held by Federal, State, County, and private entities. Land ownership within the 1659-acre land use mine site block includes:

- 950 acres of private land;
- 512 acres of BLM-administered land; and
- 197 acres of USFS-administered land.

Access into the proposed Project area is provided by several roads cooperatively maintained by the County, USFS, and the BLM.

Mining Operation

Hayden Hill contains a shallow-level epithermal gold and silver deposit. Two distinct

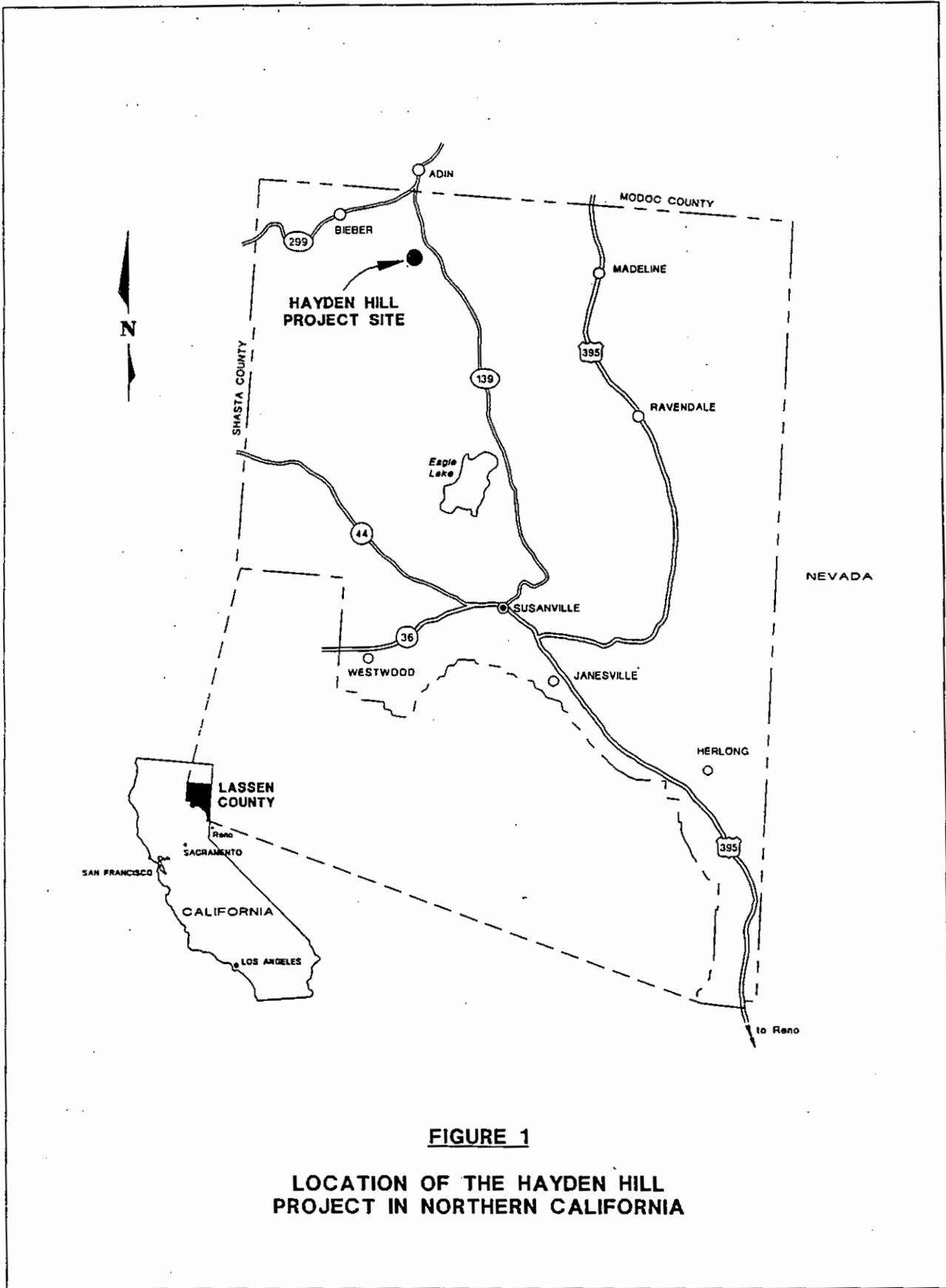


FIGURE 1

LOCATION OF THE HAYDEN HILL PROJECT IN NORTHERN CALIFORNIA

zones of economic mineralization include the Lookout Zone which extends north-south across the summit of Hayden Hill, and the Providence Zone which is approximately 1,000 feet south-west of the Lookout Zone (Figure 2).

The configuration of the ore zones necessitates the mining of the two adjacent ore zones within one open pit mine. Conventional open-pit mining methods, including drilling, blasting and a truck/loader operation, are utilized to extract ore, and remove overburden and waste material. An annual production rate of 1.3 million tons of millable material and 4.7 million tons of heap leach material will be maintained over the mine's projected eight year life. The waste rock to ore stripping ratio is approximately 1.63 to 1.

Topsoil Salvage

Topsoil and plant growth media will be stripped from the disturbed areas to a minimum depth of 12 inches and stockpiled. Waste rock will be hauled to a waste rock dump located on the north side of Hayden Hill (Figure 2).

Ore Processing Facilities

The ore processing facilities include a preparation area with crushing equipment, an ore stockpile area, one heap leach pad, a mill, solution containment ponds, one tailings impoundment, and a metals recovery system. Lower grade ore is leached while higher grade ore is milled, utilizing a carbon-in-pulp (CIP) circuit.

A dual synthetic liner system and leak detection system was designed for the heap leach facility and for the processing ponds. The cyanide heap leach facilities were designed as a zero discharge (or closed) system. Tailings from the mill are deposited in a lined impoundment located near the mill. The impoundment facility is designed to ultimately contain approximately 9.6 million tons of tailings.

Erosion Control and Detention Ponds

A detailed erosion and sediment control plan was prepared as part of the reclamation plan. Erosion control will be accomplished by source reduction and through the use of a system of diversion ditches and sediment control structures. The initial erosion control measure is to reduce erosion at the source by revegetating disturbed areas as soon as possible. Sediment which is generated from disturbed areas will be moderated by sediment control structures such as riprap, rock dikes, straw bale dikes and sediment control fences placed within diversion channels and ditches. Final sediment control will be provided by detention ponds located downgradient of the Project site.

Ancillary Facilities

Hayden Hill Road, the main access to the mine site, will be upgraded to accommodate increased traffic. Haul roads and service roads will be constructed and improved. Electrical power will be provided by a three-phase 69 kilovolt (KV) overhead transmission line extending from the Surprise Valley Electrification Corporation (SVEC) substation near Adin, approximately 17 miles to the north (Figure 1). The power demands for the Project are about 9,500 kilowatts (KW) connected load.

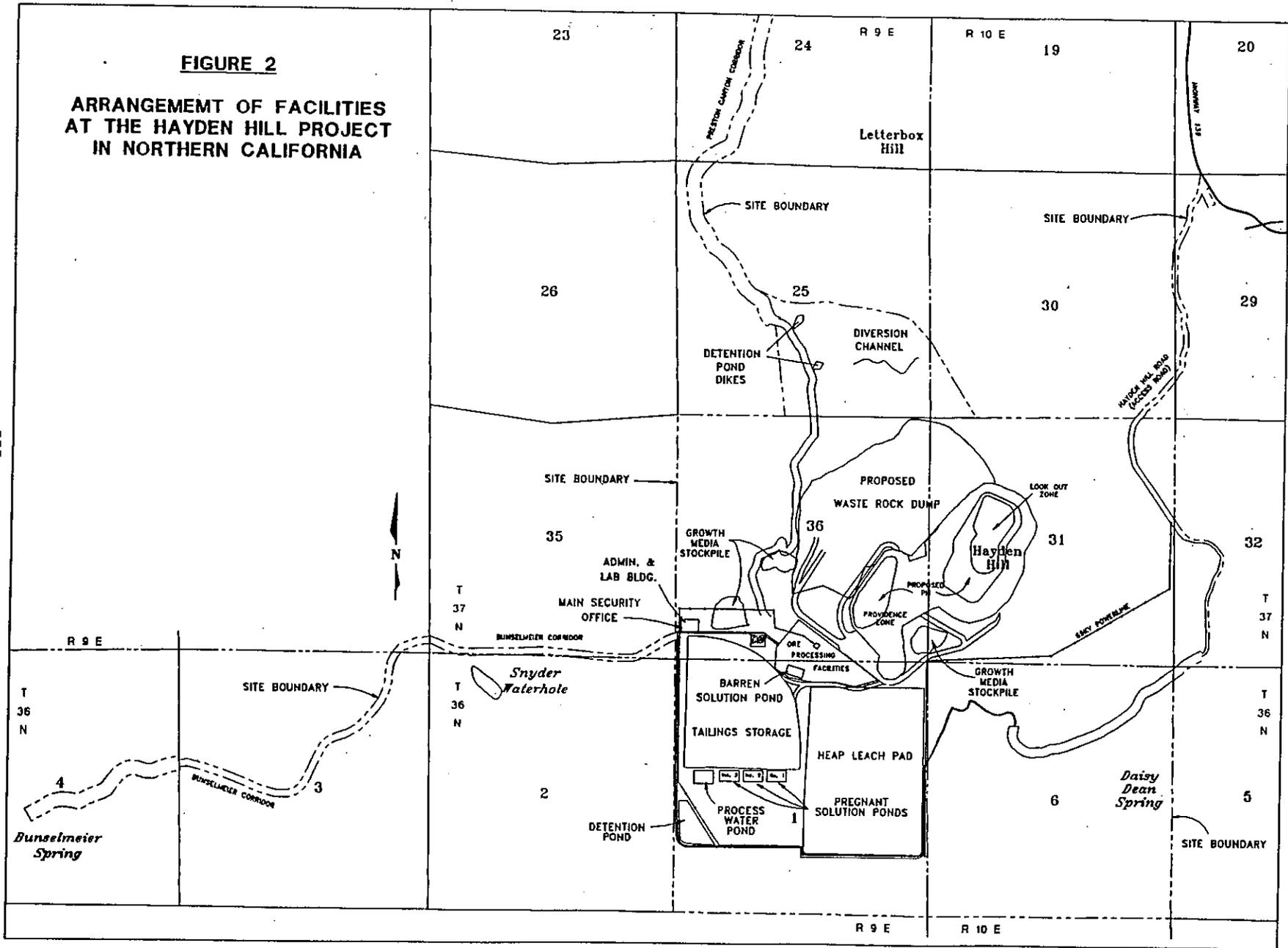
The mining and processing operations require an estimated maximum fresh water supply rate of 1,000 gallons per minute (gpm). The primary mine water supply source is groundwater from well fields to the south and west of the mine site.

Monitoring

Monitoring to detect any chemical leakage and any adverse environmental effects will be ongoing throughout the life of the operation, during closure, and for a post closure period. Both surface water and groundwater have been monitored to develop baseline information. Sampling and monitoring stations have been established and monitoring from these stations

FIGURE 2

**ARRANGEMENT OF FACILITIES
AT THE HAYDEN HILL PROJECT
IN NORTHERN CALIFORNIA**



will be ongoing throughout the mine's life as well as during and following closure.

Reclamation Plan

Planning for reclamation of mined land at the Hayden Hill Mine was an intensive, integrated effort. The initial Reclamation Plan submitted in the Plan of Operations was greatly refined over more than two years of environmental review. Continuous interaction among the project development team and regulatory agencies resulted in a thorough and detailed reclamation plan. When completed and reviewed, the Plan was approved by the regulatory agencies in September of 1991.

The Plan is the result of a comprehensive understanding of reclamation planning and implementation. The planning process began with an intensive inventory of soil and vegetation resources, climate and landforms. Following the identification of the post-mine land uses of grazing, wildlife habitat, recreation, watershed management and minerals exploration, suitable landscapes and plant communities were designed to support those uses. Protection of environmental resources and public safety were considered in the process. Practices necessary to establish the desired plant communities were identified and scheduled, success criteria established, and a monitoring system designed. The final result was an integrated land management program presented as the Hayden Hill Reclamation Plan.

The Plan includes established practices and several innovations. While utilizing native and naturalized plant species in the program (an established practice), post-mine target or desired plant communities were designed (an innovative measure). Other innovative concepts included the vegetation monitoring program and success criteria for bond release. Rather than relying solely on pre-existing undisturbed vegetation to characterize the vegetation and establish revegetation success criteria, studies were made of old disturbances to determine natural recovery or succession patterns. These patterns were then

used to establish what level of vegetative cover was appropriate to meet land use needs and therefore bond release. Additionally, the Plan includes a schedule for interim, concurrent, and final reclamation. The following section is a summary of some of the requirements of the final plan.

Revegetation Methods

Although the revegetation methods were proposed by LGMI there was a great deal of discussion and change involved in their adoption. Each agency had a specialist who was concerned about particular aspects of the reclamation plan. Perhaps most active of the agencies were the California Departments of Mines and Geology, and Fish and Game. The following paragraphs discuss the revegetation methods which were incorporated into the plan.

Salvaging a sufficient quantity of suitable topsoil for reclamation was an issue of concern raised by the public. The soils studies indicated that most of the existing topsoil was very rocky and not suitable as topsoil according to the Wyoming standards for topsoil suitability. These standards were applied since California had no existing standards at the time. Though it was questionable that sufficient quantities would be found, the agencies did not require the importation of additional topsoil material. Instead, LGMI is required to salvage all topsoil over one foot in depth found in the areas of disturbance. Since the existing A horizon is not always suitable topsoil, suitable B horizon material will also be salvaged. Slash from the clearing of disturbed areas will be added to the stockpiles and mixed in with the topsoil. The resulting mixture, referred to as Growth Media, will be used in the reclamation of the site.

Since it was not clear that there would be sufficient topsoil, the priority of areas to receive topsoil became an issue. The post mining land use includes grazing and wildlife habitat. For this reason it was decided that growth media would be replaced at a minimum depth of 12 inches over all areas to be revegetated, except the steep walls of the pit and waste rock dump.

If sufficient growth media exists, the tailings impoundment area followed by the heap leach facility will be given top priority for additional top soil replacement because these areas are flat and conducive to grazing. The areas to receive growth media will be ripped prior to placement and compaction will be avoided. The growth media will be lightly compacted by dozer tracking to firm the seed bed.

Fertilizer will be applied at a rate determined by agricultural soils analyses and reclamation trials prior to or at the time of seeding. Agricultural soils analyses will be used in areas to be reclaimed for grazing, and the cover and species richness observations from field trials will be used in areas to be reclaimed as wildlife habitat, to determine the type and rate of fertilizer.

After the growth media has been removed from the stockpiles for replacement on other sites, LGMI will prepare a seed bed by discing any compacted surfaces and will then seed the stock pile areas.

Compacted surfaces will be loosened and left in a rough condition by ripping, followed by discing or other mechanical manipulation. Loose erodible surfaces will be "dozer-tracked" to prevent sloughing before amendments, seed, and mulch are applied.

Soils and substrate materials will be tested for fertilizer and other amendment requirements. Amendments and other seedbed materials will be applied in the amounts and rates specified by the tests. Where amendments are applied, the surfaces will be disced, raked, or treated to incorporate the amendments into the top four to six inches. Repeated applications of fertilizer will be made if indicated by the soil tests or vegetation monitorings.

Six seed mixtures were developed in response to the variety of existing vegetation and habitat types on-site. Wildlife usage was one of the main considerations in the selection of species. This issue was defended primarily by the California Department of Fish and Game. In

addition, almost every agency had at least one individual who had a favorite plant they wanted included. The resulting seed mixtures reflect some compromise. The prepared surfaces will be seeded with one of the six seed mixtures prepared for the various site locations. Seeding will either be by rangeland drill, broadcasting or hydraulic seeder depending on working area and steepness of slope.

Certified weed free straw or other protective mulch for soil cover will be applied, if necessary, and mechanically crimped or anchored with a chemical tackifier. Erosion control netting or matting may need to be applied on steep or sensitive slopes requiring additional erosion control.

The rocky terrain and soil materials at Hayden Hill may dictate broadcast seeding methodology; either cyclone seeders or, in some cases, a hydroseeder. A range drill will be used as the primary method in suitable flat terrain and broadcast methods will be used where steep slopes or rocky soils prevent the use of the drill seeder.

Jeffrey pine are common in the area and are most productive on the north facing slopes. To enhance the restoration of this ecosystem and to soften the contrast of the waste rock disposal area Jeffrey pine seedlings will be planted on the bench areas of the waste rock dump and on some of the upper benches and bottom of the pit. The seedlings will be planted at the rate of 150 containerized trees per acre. Seedling planting will follow seedbed preparation, seeding, and straw placement and crimping.

Open Pit

The reclamation of steep, open pit mines is difficult under the best of circumstances. Since the Hayden Hill pit would be large and steep, the issue of reclamation for this area received much attention. The mining plan was not changed significantly to accommodate reclamation, however, some of the minor details were changed. The main points of contention were reclaiming as much of the pit as possible in a

manner which would not put reclamation personnel in danger of rock falls or failing benches. The resulting reclamation plan allows for the safe reclamation of as much area within the pit as possible, and the placement of topsoil and Jeffrey pine seedlings on most of the benches and flat areas. As will be discussed later, the plan left some freedom for innovation which allowed better reclamation than was committed to in the plan. The following became the requirements for the reclamation of the pit.

Due to logistical constraints reclamation in and around the open pit will be limited to controlling erosion on the haul roads during active mining. During final mine closure, haul roads in and around the pit will be smoothed of all berms except those necessary for erosion control. Road cut and fill slopes will be reduced as feasible, and the road beds will be ripped and scarified where possible. Prepared seed beds will be established on select upper main benches and some flat areas, to the extent possible, by placing topsoil. The prepared seedbeds will be fertilized and broadcast seeded. The steep slopes between main benches, the remaining lower benches, and the intermediate benches will be hydraulically seeded. Jeffrey pine seedlings will be planted on selected benches near the top of the pit and in some of the bottom flat areas. Growth media placement and seedling planting will be dictated by the logistics and safety of reaching these areas. Post-reclamation contours are shown on Figure 3.

The pit will encompass 176 acres in final configuration. Except for temporary accumulation of precipitation (mostly from snowfall), the pit should remain dry. Upon final cessation of mining, the pit will be surrounded with a berm and posted with appropriate warning signs. Unstable pit highwalls will be brought down with explosives, while those areas which are stable and suitable for raptor nesting will be left in place. Disturbed areas directly around and adjacent to the pit rim will be scarified or ripped as needed, topsoiled, and seeded. The pit area will be left in a rough, coarse condition wherever possible to promote diversity of topography and to simulate existing and surrounding condi-

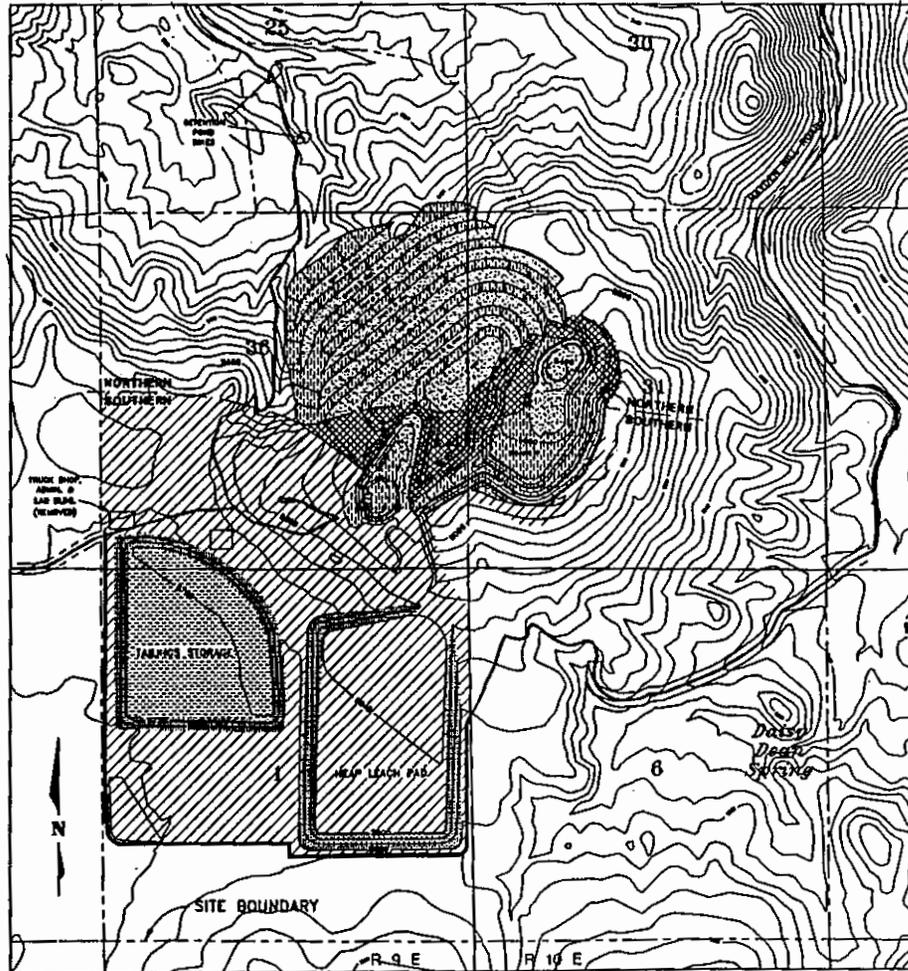
tions of the area. The resultant diverse topography is intended to provide niches and micro-environments for diverse plant and animal establishment.

Waste Rock Dump

The waste rock dump will encompass 226 acres and will lie north-northwest of the pit, sloping away from Hayden Hill at an overall slope of 3H:1V. Final contours of the waste rock dump are shown on Figure 3 and a cross section is shown on Figure 4. Due to the general sterility, lack of soil fines, amount and size of rock waste, and slope severity, waste rock dumps from hard rock mining operations typically are difficult to revegetate under the best of environmental conditions. As with the pit area, these factors led to much debate on the manner in which to reclaim the waste rock dump. Three alternatives were considered for the final grading; to leave the lowest level of the dump and the areas between benches at the angle of repose, to bench the dump all the way down to the toe, and to smooth the dump out to a 3H:1V slope at the end of mining. The three alternatives are shown on Figure 4. The final decision, to bench the dump all the way to the toe, was based on limiting the additional disturbance that smoothing the dump would cause, limiting erosion by providing benches to break the slope, and enhancing reclamation by providing flat bench areas where revegetation would be easier.

The potential for the waste rock to be acid generating could not be conclusively determined without extensive drilling and testing. Therefore, LGMI is required to geochemically test waste rock as it is placed in the dump. If waste rock is identified which has a potential to produce acid drainage or toxic pollutants, this waste rock will be handled as described in a Geochemical Sampling and Contingency Plan which was produced with the Final EIR/EIS.

Upon final mine closure, the dump top and sides will be contoured to prevent erosion, pooling, ponding or slope failure. Large rock will be strategically placed along the benches and slopes to promote topographic diversity.



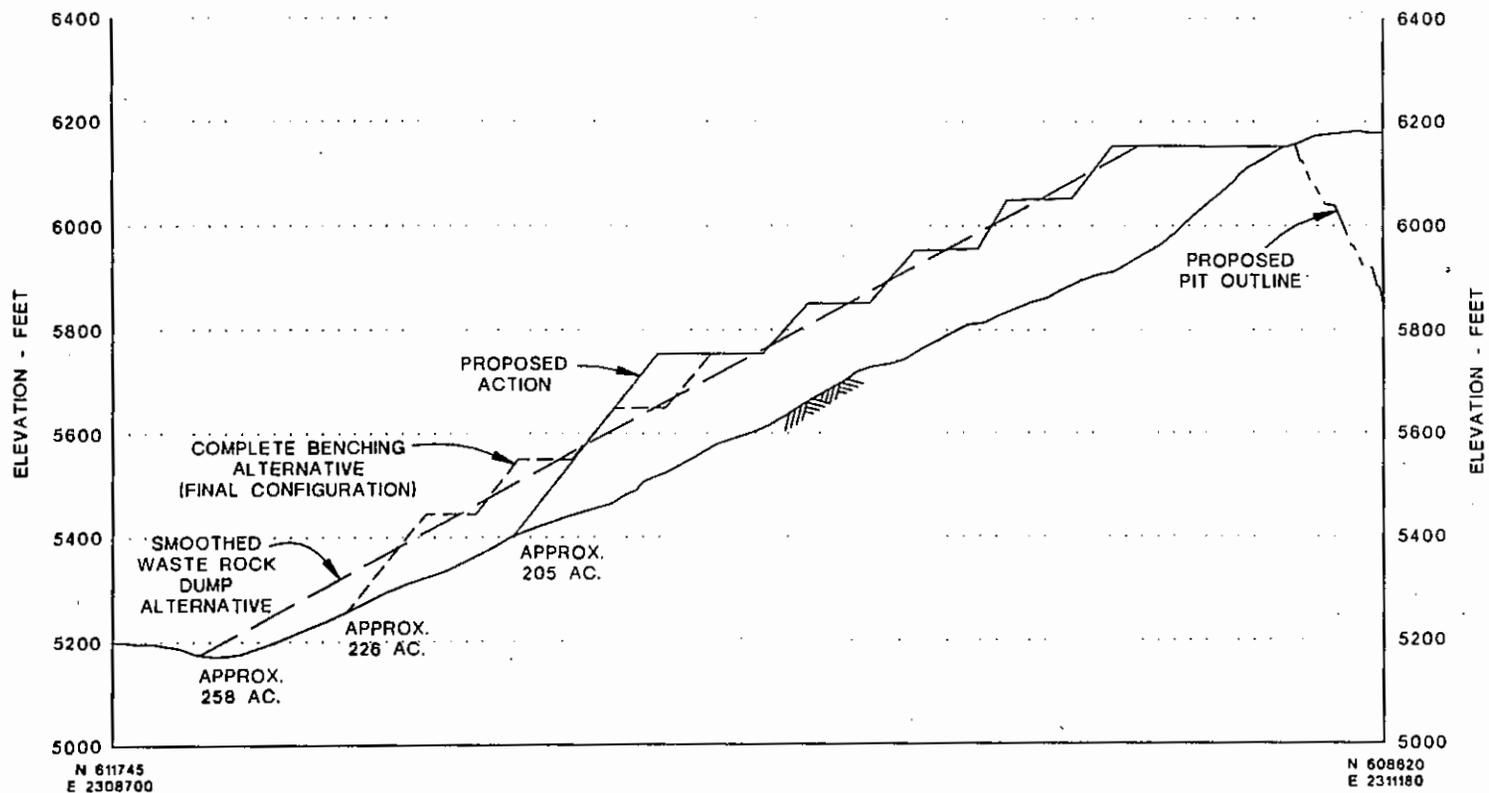
LEGEND

- (1A) 'DRY SITE - MODERATE TO COARSE TEXTURE' SEED MIX (TAILINGS AND HEAP LEACH PAD SLOPES)
- (1) 'DRY SITE - MODERATE TO COARSE TEXTURE' SEED MIX (GRASSLAND LOW-GRADIENT AREAS)
- (2) 'DRY SITE - FINE TO MODERATE TEXTURE' SEED MIX (TAILINGS SURFACE)
- (3) 'INTERMEDIATE SITE' SEED MIX (UPLAND-LOW GRADIENT, NORTH ASPECT WITH JEFFERY PINE)
- (3) 'INTERMEDIATE SITE' SEED MIX (UPLAND-LOW GRADIENT, SOUTH ASPECT W/O JEFFERY PINE)
- (4) 'SHRUB SITE' SEED MIX (UPLAND SLOPES)

FIGURE 3

**GENERAL PLANTING PLAN
FOR THE HAYDEN HILL PROJECT**

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EXPLANATION

- PROPOSED ACTION - BENCHED FROM TOP TO 5750' CONTOUR; ANGLE OF REPOSE BELOW 5750' CONTOUR
- - - - - COMPOSITE BENCHING ALTERNATIVE - BENCHED TO BOTTOM
- · - · - SMOOTHED WASTE ROCK DUMP ALTERNATIVE - BENCHES GRADED OUT AFTER DUMP COMPLETION
- · · · · PROPOSED PIT OUTLINE
- /////// ORIGINAL GROUND

NOTES: CROSS SECTION IS LOOKING NORTH
 APPROX. VERTICAL SCALE: 1"=250'
 APPROX. HORIZONTAL SCALE: 1"=400'

FIGURE 4
CROSS SECTION OF THE FINAL CONFIGURATION OF THE WASTE ROCK DUMP FOR THE HAYDEN HILL PROJECT

Stockpiled growth media material will be distributed on the dump top and benches prior to seeding with the proposed seed mixtures. Jeffrey pine seedlings will be planted on the top and flat bench areas of the dump as shown on Figure 3. Logs will be placed for wildlife habitat as they become available from stripping operations.

Leach Pad Complex

Laboratory tests show that the spent ore material on the pad may be detoxified by washing in place with fresh water at the end of the leach pad life.

Spent ore which has been left on the pads or which will be removed from a pad must first be rinsed until:

- Weak Acid Dissociable (WAD) cyanide levels in effluent rinse water are less than 0.2 mg/l;
- The pH level of the effluent rinse water is between 6.0 and 9.0; and
- Contaminants in any effluent from the processed ore which would result from meteoric waters would not degrade surface or ground water.

If the above requirements cannot be achieved, LGMI can be granted a variance to those conditions if they can demonstrate that:

- The remaining solid material, when representatively sampled, does not contain levels of contaminants that are likely to become mobile and degrade the waters of the State under the conditions that exist at the site; or
- The spent ore is stabilized in such a fashion as to inhibit meteoric waters from migrating through the material and transporting contaminants that have the potential to degrade water.

The requirements listed above are stipulations of the reclamation plan, however, the California Water Quality Control Board (CRWQCB) permit requirements will take precedence over the reclamation plan. A representative from the CRWQCB participated in the reclamation plan preparation and provided these requirements as minimums that they would require.

Due to the amount of fresh water required, the wash solution from the heap will be detoxified and reused. Detoxifying processes and reagents, such as chlorine, peroxide, and sulfur dioxide, will be evaluated prior to closure; however, at this time, it is anticipated that the INCO process and facilities at the mill will be used.

The process water ponds will remain intact until the residual cyanide level in the heap meets the CRWQCB requirements. When this level is achieved, water remaining in the pregnant and barren solution ponds will be detoxified (if necessary) to meet California Waste Discharge Permit stipulations and evaporated by spray irrigation on the heap. Any sediment remaining in the ponds will be analyzed and handled accordingly.

There will be no discharge from the ponds unless authorized by the CRWQCB staff. The pond liners will be left in place following the heap rinsing process for two years or until the CRWQCB approves their removal. At this time, the pond liners will be punctured and buried within the ponds. The ponds will then be modified to function as sediment control structures. The pond areas will be graded and contoured for surface drainage and reseeded.

The spent heap leach material will be reclaimed in place. The 199-acre heap will be contoured and physically manipulated for stabilization, to control drainage and to prevent surface ponding. The slopes of the heap will be pushed out to a slope of 2H:1V. Certain benches will remain. The heap will be covered with a minimum of 12 inches of growth media material prior to seeding and revegetated. The slopes

of the heap will receive a seed mixture specifically designed to quickly stabilize the slopes. The upper flat areas of the heap will be sown to a mixture which will facilitate grazing as a post-mining land use.

The process water remaining after rinsing and detoxifying the heap, which will have been detoxified in preparation for evaporation over the heap, will be available for temporary irrigation of the heap revegetation efforts. The feasibility of preparing and seeding the heap before this water is evaporated will be investigated prior to mine closure. Having irrigation for the vegetation establishment phase of the heap reclamation would help to eliminate the possibility of reclamation failure due to drought or excessive precipitation. If irrigation proves feasible, LGMI will need to submit a written request to the involved agencies for approval.

Tailings Impoundment

As with the heap, the final detailed closure and Reclamation Plan for the 131-acre tailings impoundment will be based on requirements and stipulations of the CRWQCB permit based on input from the BLM and other surface landlords.

The mill tailings will be continuously detoxified before deposition using the INCO SO₂ process. The anticipated tailings solution WAD cyanide level after the INCO process is 10 ppm or less. Natural degradation in the tailings pond will lower the concentration further. Tailings effluents will be detoxified to 0.2 mg/l WAD cyanide. The pH levels must be between 6.0 and 9.0. Measurements are to be made of the effluent at a point where the impoundment discharge waters could/would enter the adjacent environment. Reduction in order constituents such as metals must meet the Federal minimum containment levels (for drinking water) or applicable State requirements.

If the above requirements cannot be achieved, LGMI can be granted a variance to those conditions if they can demonstrate, as with the heaps, that:

- The remaining solid material, when representatively sampled, does not contain levels of contaminants that are likely to become mobile and degrade the waters of the State under the conditions that exist at the site; or
- The tailings are stabilized in such a fashion as to inhibit meteoric waters from migrating through the material and transporting contaminants that have the potential to degrade water.

Since the impoundment will be designed and constructed to minimize water pooling, drying should be accomplished in a reasonably short period. Following dewatering and drying, the impoundment will be contoured and the outboard dike slopes may be moderated.

During the contouring phase, the impoundment will be engineered to direct storm water run-off away from the top of the impoundment in an efficient fashion without causing surface erosion. This will be accomplished using riprap channel/armored spillway techniques.

The outside slopes of the tailings impoundment will be revegetated concurrently with construction. The top and any disturbed areas of the slopes of the impoundment will be topsoiled and prepared for seeding at closure. Prior to seeding, measures will be taken to develop an adequate seed bed (dragging, discing, etc.). Growth media placement activities usually produce such a seedbed if planting occurs soon after construction is completed. Those areas not conducive to seed germination will be scarified, harrowed, or ripped prior to topsoiling and seeding. The slopes will be seeded with a mixture specially designed for quick stabilization of the soil. The top of the impoundment will be seeded with a mixture prepared for this specific location.

Mill, Crushing, Process Plant, and Building Sites

Buildings and structures (administration, process facility, crusher and mill site, storage

and shop facilities, etc.) will be dismantled and removed from the site following final closure. Concrete foundations and any paved areas will be reduced to rubble and buried on site. The remaining disturbances will be ripped and scarified, as needed, smoothed, and contoured for surface drainage control, covered with a minimum of 12 inches of growth media, and reseeded.

Roads, Fences, Miscellaneous Areas

Following final mine closure, LGMI will consult with the BLM, USFS, and the Lassen County Public Works Department to determine whether any site roads and fences on public land will be left intact in the public interest. Those roads not designated to remain will be blocked to prevent access, graded for drainage, erosion control, and slope stability, scarified or ripped, and then reseeded.

Several fencelines will remain following final cessation of mining at Hayden Hill: The overall site boundary fence; plant site security fences; the tailings impoundment fence; and the solution pond fencing. The security fences will be removed when the plant buildings have been dismantled. The tailings impoundment fencing will remain until reclamation has been completed and vegetation has become established to a level which can sustain wildlife use. Fencing around the solution ponds and the wildlife protective netting will be removed after cyanide levels have been tested and shown to be within the Waste Discharge Requirement stipulations. The future of the site boundary fence will be based upon discussions with the BLM, USFS, and the Lassen County Planning Department. Since this fence will be stock proof, there may be merit in leaving it in place until revegetated areas have become established well enough to withstand moderate grazing pressure.

Miscellaneous areas include such small sites as pump stations and electrical substations scheduled for removal. These sites will be treated and reclaimed in the same fashion as building sites.

The power supply line will be removed from the site to the junction of County Road A2 and Highway 139 (Figure 1). The disturbances associated with the removal of these utilities will be reclaimed in the same manner as other areas.

Post-Reclamation Topography

The post-reclamation contouring for the site was designed for the control of erosion and sediment, with the post-mining land use in mind. Wildlife habitat areas such as the waste rock dump and pit areas will be contoured for topographical diversity and cover. Certain areas will be modified for raptor nest sites as possible. The lower flat areas which will be reclaimed as grazing areas will be contoured for pasture land. The post-reclamation topography is shown on Figure 3. The mining, waste rock deposition, heap leach ore placement, and tailings deposition will be accomplished to minimize the amount of post-mining re-contouring required to meet the individual area needs. This can be accomplished with a high level of efficiency since detailed drainage control and post-mining contours were designed prior to the start of mining.

Management of Reclaimed Areas

Reclaimed areas will be managed by excluding all unnecessary traffic and personnel, implementing practices to manage grazing by domestic animals, and undertaking a monitoring program to determine reclamation success. Grazing will be managed to control undesirable and desirable species. The intent of the grazing management will be to attain the desired plant communities by timing grazing to either encourage desirable species or to remove undesirable species. Personnel will be managed by fencing, signs, and/or communication and education of the reclamation program. Livestock will be controlled by fencing until reclamation is proven successful. Grazing management will be determined by the property owner. Monitoring to determine reclamation success will continue as described above until an area is proven successful.

Research

Development of the research program will begin following project approval. The first item of research will be to identify suitable comparison areas for the success evaluation and transition curve data acquisition, which will be discussed later. The next step will be to evaluate these areas and produce the transition curves for Upland Shrub and Jeffrey Pine/Mountain Shrub vegetation. The curves will be modified as additional research is done.

In addition to the above research, site-specific reclamation trials will be conducted to test and further refine the proposed treatments, fertilization rates and seed mixes. Vegetation communities which have extensively colonized the Fischer-Watt leach pad since 1986 will be analyzed in an effort to promote similar colonization and succession on the Hayden Hill leach pad. Other items of research will include analyses geared toward using the tailings pond to model a duripan soil and produce a Low sagebrush community type. A detailed experimental design will be developed during the first few years of project operation.

Monitoring Program

The monitoring program will be an integral part of the Mitigation Compliance Program. At a minimum, an annual report summarizing the findings of the monitoring program will be submitted to the BLM, USFS, and Lassen County. The report will include the acreage disturbed and reclaimed to date, as well as acreage to be disturbed and reclaimed.

Reclamation Permitting

Culmination of the NEPA/CEQA Process

The reclamation plan was the culmination of the NEPA/CEQA process. During the process numerous improvements and changes had been made to the original plan of operations. Mitigation measures had been proposed and discussed. A great many of these measures became stipula-

tions for approval of the reclamation plan. The process of incorporating these changes and additional requirements into the plan required a significant effort.

Adding a mitigation measure to a reclamation plan is not necessarily a large task. However, if the mitigation measure is still an issue of negotiation within the NEPA/CEQA process, and is still evolving itself, the complications and work involved increase. Mitigation measures can have far reaching consequences which cause changes in a plan that aren't readily apparent. An example would be the requirement of placing topsoil and revegetating the pit benches. One would think this would be simple enough. In reality it may cause the re-design of the mining method to produce benches which are wide enough and stable enough for the required equipment. At the very least, the stability analyses must be checked to verify the safety of this level of work on the benches. The best of circumstances would be to complete the NEPA/CEQA process and then simply write the reclamation plan. This would, however, add additional time to an already long permitting process.

Number of Agencies Involved

Perhaps the single most influencing factor in the reclamation planning was the number of agencies involved and the regulations they were bound by. In order to be in full compliance the reclamation plan had to comply with the Federal Land Policy and Management Act (FLPMA), the Forest Management Act, SMARA and County requirements. The intent of this compliance was to provide for the Project while minimizing water degradation, air pollution, damage to aquatic or terrestrial wildlife habitat and erosion, while at the same time providing for a continuation of existing uses including livestock grazing, watershed protection, wildlife habitat and upland recreation. The State of California measured the compliance of the reclamation plan in accordance with Title 14, California Code of Regulations (CCR), Section 3502. The USFS evaluated the reclamation plan with respect to Title 2800 of the Forest Service Manual, Chap-

ter 2840. It is the BLM's responsibility to ensure mining operations are completed in conformance to the 36 Code of Federal Regulations (CFR) 228 Subpart A and 43 CFR 3809 regulations. Lassen County, having little experience in the reclamation of mining projects of this size, yielded to the California Department of Mines and Geology in most of the reclamation plan review process.

Since the plan was re-written at the end of the NEPA process, all of the agencies and their personnel which had contributed to the EIR/EIS became involved in the reclamation plan. This included: the BLM- Alturas Resource Area; the BLM-Susanville District Office; the USFS-Modoc National Forest Supervisors Office, Alturas; the USFS-Modoc National Forest, Big Valley Ranger District, Adin; the Lassen County Planning Department; the California Department of Fish and Game (CDFG), the California Central Valley Regional Water Quality Control District; and, the California Department of Mines and Geology. The process was completed by submitting drafts prepared by LGMI and SRK to the committee of agencies for review. After the periods of review, meetings were held to discuss and modify the document. The difficulties involved in coming to a consensus with such a large and diverse group of people and policies were enormous.

Future projects would benefit by limiting the decision making personnel present in meetings. This requires that the representative from each agency or company is of a high enough rank to make most of the necessary decisions. It does not mean they have to make all of the decisions in a vacuum. Meetings can be scheduled and structured so that information is distributed at one meeting, some time is provided for review, and then a second meeting is held to discuss the material and come to the decisions. Well organized and structured meetings with definite goals and deadlines are essential. The methods of accomplishing this goal are not clear cut. However, the benefits are a shortened permitting time period which benefits all parties involved. Encouragement towards this end from

any involved party should not be met with resistance.

Success Evaluation

The revegetation success evaluation is an innovative method inspired by Dr. Hugo A. Ferchau of Western State College in Colorado. The success of the revegetation will be determined by monitoring vegetation parameters such as cover, density, and species richness and comparing these values to curves developed for each vegetation type. The curves will be developed by monitoring areas of similar vegetation that were disturbed at known time intervals in the past. The cover, density, and species richness data will be plotted against time. This will produce a curve that represents the transition from newly revegetated land to a specific vegetation type as determined by cover, density, and species richness. Curves will be developed for each vegetation type. The comparison areas will be determined and agreed upon with the lead agencies within the first year of operations.

The monitoring technique will be similar for all community types to be reclaimed. Observations will be made of each area prepared and seeded as a unit. For example, if the entire waste rock dump were prepared and seeded at one time, the success of the reclamation would be determined based on one set of observations for the whole dump. In reality, the waste rock dump will be reclaimed bench by bench as deposition moves down the slope, and observations will be made for each bench individually. Plots for herbaceous cover observations will be 20 centimeters (cm) by 50 cm. Plots for shrub and tree observations will be belt transects not less than 16 square meters (m²) for shrub, and 100 m² for tree species. The initial sample size for the cover evaluation will be 20 quadrats per reclaimed unit. The sample size for species richness will be determined statistically, by the use of species area curves, during the observations. Density of woody species will be measured within the belt transects used for species richness. Sample sizes will be modified after analysis, with approval by the County, to ensure adequate sample size to meet the established

precision level of 80% plus or minus 20%. The methods used for cover, density, and species richness will be consistent with those stated in Daubenmire (1959, 1968), and Mueller-Dombois and Ellenberg (1974), or an equivalent method. Observations will be completed for each reclaimed unit once each year, during an appropriate plant development stage so that plant identification is possible. The observations will be done at approximately the same time each year. Observations of an individual unit will continue until the requirements for success are reached or exceeded. Photographic points will be established to document vegetation dynamics.

The observations will continue each year until the area meets or exceeds the target curve values. Areas where the first revegetation attempt does not meet the values listed below will be investigated for the reason of failure, the problems rectified, and the area re-seeded. Observations of failed areas will be noted and recorded as such. Problem areas will be handled on a case-by-case basis according to the Mitigation Compliance Plan. The comparison areas will be agreed to by the lead agencies during the first year of operations.

The goals for cover, density, and species richness will be based on reaching a percentage of a comparison area value or a transition curve point for a given parameter. For direct comparison areas, the goals vary by year to allow establishment of the vegetation. Cover will be observed for herbaceous vegetation only. Density will be observed only in those areas where tree and shrub seed Mixtures are used. Species richness will include only those perennial species comprising greater than 3 percent cover. Observations will continue until all areas are accepted for bond release. Until the curves are developed the following revegetation goals will be used.

<u>Parameter</u>	<u>1-Yr Goal</u>	<u>5-Yr Goal</u>
Cover (% of control) herbaceous species only	10%	80%
Density (% of control) woody species only	5%	60%
Species richness (% of control)	5%	60%

Measurements will be made of perennial species comprising >3% cover only.

If a reclaimed area does not meet the goals or does not appear to be nearing the goals, LGMI will investigate the reasons for failure. If warranted, the area will be fertilized, irrigated, reseeded, or otherwise corrected in order to achieve successful reclamation.

Vegetation is always in transition. Commonly, disturbed areas, whether disturbed naturally or artificially, transition through competition among annual species and communities, through perennial grasses and forbs to shrubs and coniferous trees. Revegetation generally attempts to short circuit this natural transition by establishing perennial grasses, forbs and shrub species immediately following the disturbance. Often the attempt is considered to be a failure if the cover, density and diversity are not some high percentage of the original vegetation in a relatively short period of time. The problem is that each transition stage has it's own set of values for these parameters and they are not always higher for a higher level on the transitional ladder. For example, a poorly established perennial grass meadow may have higher cover, density and species richness values than a well established Jeffrey pine forest. Conversely, a well established revegetation job, during the first growing season, may have high cover values yet be composed of only one or two nurse species. The success evaluation for the Hayden Hill Project is unique in that the comparison is made to a curve rather than a fixed value. The curve

is based on the value which can be realistically expected and desired at the time of the comparison. This evaluation technique relies on experienced ecologists making statistically sound comparisons. It should not be attempted by those who are not comfortable with statistics and ecological techniques. For the Hayden Hill Project which has a wide variety of vegetation types, a well documented history of disturbance, and is staffed with experienced reclamation ecologists, the curve method is preferable.

Early Operating Results

The Project was fully permitted and operational by the Summer of 1992. Though the bridge over Willow Creek was not widened due to the possibility of impacts to Modoc sucker habitat, the access road was upgraded significantly. The cut and fill slopes were revegetated by grading, spreading topsoil and hydro-mulching. Silt fences were used extensively to control sedimentation into Willow Creek and an organic agent was used to control dust. There appears to be little or no sediment or dust movement along the access road.

Growth media was stripped from the disturbed areas. It appears that there will be sufficient growth media to meet the requirements of the reclamation plan and possibly to place extra in some critical locations following the priorities laid out in the plan.

The processing facilities, tailings impoundment, heap leach pad, office building and shop were constructed during the Spring of 1992. Other disturbances, which were constructed to their final configurations, were revegetated.

During the construction of the pit an improvement over the planned reclamation was developed. Growth media is placed about 10 feet out from the base of the highwalls of each successive cut of the pit. This area is then seeded and fertilized. The next lower cut is stopped when growth media is observed to fall over the edge. With this method the problems of maintaining safe access to the benches is

eliminated and the revegetation is completed at the earliest possible time. The freedom to be innovative was included in the reclamation plan. Without this freedom the concurrent reclamation of the pit benches would not be possible and the vegetation in these areas would be approximately eight years behind the current schedule.

The wetlands mitigation area was also constructed and filled during the Summer of 1992. Sage grouse and Pronghorn have been observed at the wetland in numbers far greater than expected.

Summary and Conclusions

From conception to the completion of the permitting process, culminating with the approval of the reclamation plan, the Hayden Hill Project required over three years. Could this period have been reduced and the project put in operation any quicker? Given hindsight, certainly it could have. Assumptions, and agreement among agencies, on impact to habitat and plant and animal species could have been made early, eliminating additional research and negotiation. A more intense effort could have been made to make and meet established deadlines. These items may have reduced the over all permitting time. But, would these factors lower the over all cost of permitting? Probably not. The savings in time would most likely have been off set by over conservatism in design.

Some commitments of the reclamation plan were beyond those required by the law. These included the preparation of the detailed erosion and sediment control plan, the use of the curve method for a revegetation success evaluation, and the seeding of the steep slopes of the pit and waste rock dump. These commitments were made by LGMI in an effort to produce the best possible reclamation of the Project. A commitment to good reclamation is insurance toward lower liabilities in the future.

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