EA# MT065-063-93

SUPPLEMENTAL
ENVIRONMENTAL ASSESSMENT

for

STATE OPERATING PERMIT 00095 AND
FEDERAL PLAN OF OPERATIONS MTM-77779

LANDUSKY MINE
OPERATING AND RECLAMATION PLAN MODIFICATIONS
ACID ROCK DRAINAGE CONTROL AND REMEDIATION

PREPARED BY:

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LEWISTOWN DISTRICT OFFICE

PURSUANT TO THE NATIONAL AND
MONTANA ENVIRONMENTAL POLICY ACTS

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DOCUMENT SUMMARY

Water resources monitoring reports from the Landusky Mine show the development of acid rock drainage (ARD) from several of the mine facilities (waste rock dumps and ore heap retaining dikes). The current operating and reclamation plans are not designed to address ARD concerns in detail. Modifications to these plans have been proposed by the mine operator, Zortman Mining, Inc. (ZMI) to corredt the ARD problems. ZMI proposes to change reclamation practices for the Mill Gulch waste rock dump, teh Sullivan Park leach pad dike and the Gold Bug pit. ZMI also proposes to identify and selectively handle material with a high ARD generation potential as well as to conduct long-term reclamation studies.

ZMI's proposed modifications have been reviewed by the permitting agencies, the Montana Department of State Lands (DSL) and the Bureau of Land Management (BLM). The agencies have developed an alternate modification plan which expands the ZMI proposal to address all mine facilities that could potentially generate ARD. This alternative would increase the reclamation capping thickness on all heaps and waste rock dumps, reduce the slopes to ensure stability, and move the approved Montana Gulch leach pad expansion to an existing disturbed area. This is the agencies' preferred alternative. Other alternatives considered include the no action alternative and suspension of mine operations.

The Landusky Mine is located in the Little Rocky Mountains, Phillips County, Montana. The mine consists of seven leach pads, four waste rock dumps, three open pit mining areas, a processing plant and associated infrastructure. The mine is permitted to disturb a total of 814 acres for mining and mining related activities.

The major rock types associated with the mine have varying degrees of acid generating and acid neutralizing ability depending on their origin and subsequent weathering patterns. Rock types which contain sulfide mineralization, mainly pyrite (FeS_2), oxidize over geologic time and are categorized as "oxide". Rock which has not oxidized is termed "unoxidized" or sometimes "sulfide." Other rock types in the deposit such as limestones, dolomites and shales have a natural ability to neutralize acid.

Acid rock drainage can occur when either unoxidized or partially oxidized material that contains sulfides comes in contact with oxygen and water. The reaction between oxygen, water and the sulfide mineral forms acid. This reaction is accelerated by the presence of a naturally occurring bacteria. The overall process is similar to natural weathering but occurs at a much faster rate due to the increased surface area in the rock created by mining activity. Once generated, the acidic water may come in contact with adjacent minerals that have the ability to neutralize acid. If this neutralizing ability is exceeded the resulting discharge would be acidic. ARD may contain levels of dissolved metals or other constituents that degrade water quality and are harmful to aquatic life.

Efforts to prevent ARD are aimed at preventing water and oxygen from coming in contact with potentially acid forming materials. This involves: identification of acid forming materials, selective handling of those materials to place them away from possible contact with either infiltrating surface waters or groundwaters, capping of rock piles with low permeability liners to prevent precipitation from infiltrating and limit air circulations, and diverison of runoff away from the rock disposal area.

The efforts proposed by ZMI are consistent with this approach but may not be extensive enough to ensure existing conditions are abated and future ARD development prevented. As a result there is still the potential for negative impacts to both water resources and relcamation revegetation under this alternative.

The regulatory agencies' approach is to assume that all the facilities have the potential to produce some acid until proven otherwise. As a result the reclamation cap has been enhanced to prevent infiltration of precipitation on not only the Mill Gulch and Gold Bug waste rock dumps, but on all the unreclaimed leach pads and mine pits. The result is that subsequent discharge from these facilities would be of acceptable water quality and have only a negligible impact on water resources. Surface reclamation success is likely with the lower slopes and cap of neutral material for a capillary break. This alternative also includes increased monitoring and trend analysis to detect any change in water quality that would require further remediation efforts.

Impacts from the no action alternative would result from continued mining under the approved operating and reclamation plans. These plans have already been demonstrated inadequate and intermim corrective measures have been taken. To date, impacts have not been severe; however, continued operations under existing permits would most likely result in increased degradation to water resources and partial failure of surface reclamation. Impacts from suspending current mining permits would be very similar to those that would occur under the no action alternative. There would be less overall mining but there would be inadequate material for reclamation. Continued mining is necessary to achieve an adequate source of neutral cap rock. This alternative was dropped from consideration.

Implementation of corrective measures at the Landusky Mine does not require nor depend on approval of the proposed Zortman Mine expansion.

It is the agencies' belief that implementation of the agency modified alternative would provide the most effective means for correcting existing ARD problems and for insuring longterm relamation success at the Landusky Mine.

Technical staff from the Montana Department of HEalth and Environmental Science, Water Quality Bureau and the U.S. Environmental Protection Agency have provided input in the preparation of this environmental analysis. BLM and DSL appreciate their comments.

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CHAPTER I - INTRODUCTION

A. PURPOSE AND NEED FOR ACTION

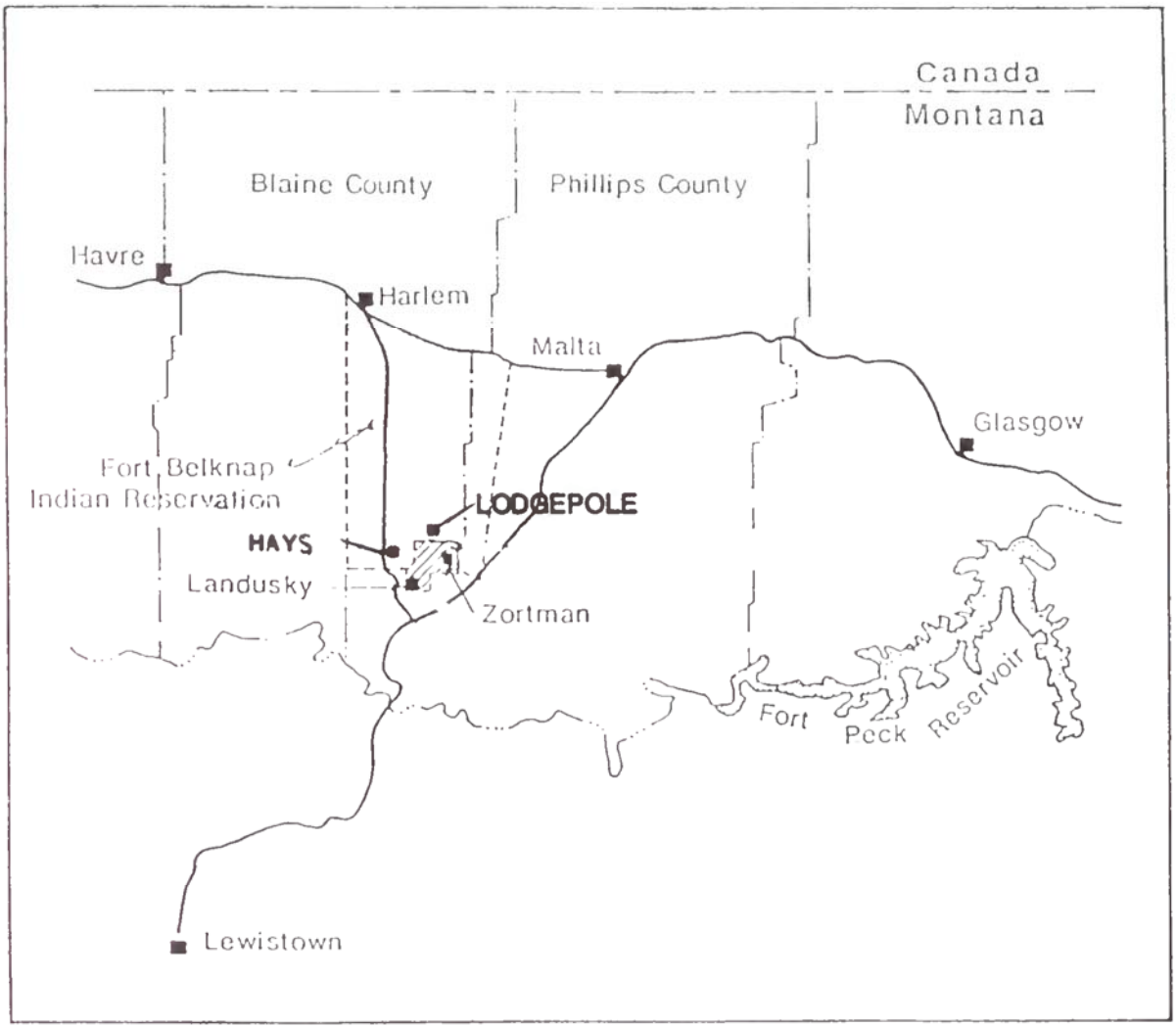
Zortman Mining Inc. (ZMI) has proposed to modify the approved operating and reclamation procedures in State Operating Permit 00095 and Federal Plan of Operations MTM-77779 for the Landusky Mine (ZMI, 1993 and ZMI letters to Montana Department of State Lands (DSL) and the Bureau of Land Management (BLM), dated November 19, 1992, February 22, March 15, April 26 and July 23, 1993). Facilities for which modified proposals have been submitted include all Landusky heap leach pads, the Gold Bug pit, Mill Gulch waste rock dump, and the Sullivan Park leach pad dike.

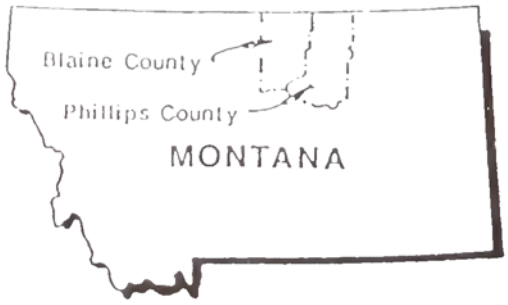
The proposed modifications have been submitted in response to the development of acid rock drainage (ARD) discharge from several of the mine facilities. Measures to prevent, control and mitigate ARD need to be incorporated into the current operating and reclamation plans in order to comply with federal and state environmental protection requirements.

B. BACKGROUND AND PROJECT LOCATION

ZMI operates the Landusky gold mine in the Little Rocky Mountains of central Montana, Phillips County. The mine area is located east of Mission Peak and north of the town of Landusky, 45 miles south of Malta, 5 miles southeast of Hays, and 8 miles southwest of Lodgepole (Figure 1). ZMI's state Operating Permit 00095 was originally issued June 6, 1979, in accordance with the Montana Metal Mine Reclamation Act (MMRA). That permit application (ZMI, 1978) was evaluated in an Environmental Impact Statement (EIS) prepared by the Montana Department of State Lands (MDSL) in 1979 (MDSL, 1979). When the BLM Surface Management regulations (43 CFR 3809) went into effect in 1981, the existing operating permit was accepted by BLM as an approved plan of operations. Subsequent revisions to the operating and/or reclamation plans have been analyzed pursuant to the Montana National Environmental Policy Acts (MEPA and NEPA) in MDSL et al 1986, 1988, 1990a, 1990b, and 1991.

The Landusky mining operation (Figure 2) is located on 1,287 acres of land of which 382 acres are patented mining claims. The remaining acreage is unpatented lands controlled by ZMI and administered by the BLM. A total of 814 acres are currently permitted for disturbance. The mine area currently contains 764 acres of disturbed land. Approximately 98 acres have been partially revegetated. The mine pits are primarily located on patented claims controlled by ZMI, while heaps, waste rock dumps and other facilities are primarily located on unpatented claims where the BLM manages the surface.





NORTH

Figure 1

General Project Location Map

FIGURE 1.

Surrounding BLM lands are managed for wildlife habitat and recreational uses (BLM, 1992). The mine area, in sections 15 and 22 of T25N, R24E, is also near the Fort Belknap Indian Reservation. At its closest, Mission Peak, the reservation is 725 feet from the mine property. The boundary is approximately 1,250 feet from the nearest mine-related disturbance, the Montana Gulch waste rock dump.

At Landusky, ore is mined from open pits, and is placed on a composite plastic polyvinyl chloride (PVC) and clay-lined heap leach pad to extract the gold from the ore. In heap-leaching, gold ore is sprinkled with a weak cyanide solution which dissolves the precious metals. The solution percolates through the ore and is collected by the liner. The collected process solution is piped to a plant where the gold is recovered, and the solution is adjusted for cyanide concentration and pH, and recycled back to the heap. Heap leaching uses cyanide to extract gold from the ore in a "closed circuit" where solution is recycled and used many times over.

Under the existing approvals 120 million tons of ore have been permitted for heap leaching at the Landusky mine. The majority of ore is contained, or being loaded, on the Mill Gulch and the Sullivan Park leach pads.

At the Landusky mine the oxidation of iron disulfides found in waste rock has produced acidity and associated metals mobility in effluent from the various mine facilities (Hydrometrics, 1992). A previous environmental review (MDSL et al, 1990b) had concluded that the acid producing potential of some rock types mined at the Landusky operation would be buffered by the neutralizing capacity of other rock types which occur within the deposits. Water resource monitoring required as a part of mine operation has provided data which documents that this has not occurred to the degree anticipated and ARD has resulted (see Chapter III).

Based on field inspections in 1992 and review of water quality monitoring data gathered from 1988 to date, the Bureau of Land Management and the Montana Department of State Lands determined in December 1992, that ZMI's approved operating and reclamation plans were not preventing ARD. Inspections showed that modifications to the plan were necessary. The proposed modifications analyzed in this document are in response to agency requirements sent to ZMI November 5, 1992 (BLM), and January 15, 1993 (DSL and BLM), and in response to a decision of the BLM State Director dated April 13, 1993.

ZMI's preliminary proposed corrective actions were submitted on November 19, 1992, February 22, and March 15, 1993. The agencies reviewed the proposals and requested further details and specific changes including revised capping scenarios for various facilities. On July 23, 1993 the final proposal (ZMI, 1993a) was submitted to the agencies.

Contingency ponds and pumpback systems are in place and functioning below problem leach pad underdrains and waste rock dumps. Recently, several large precipitation events have

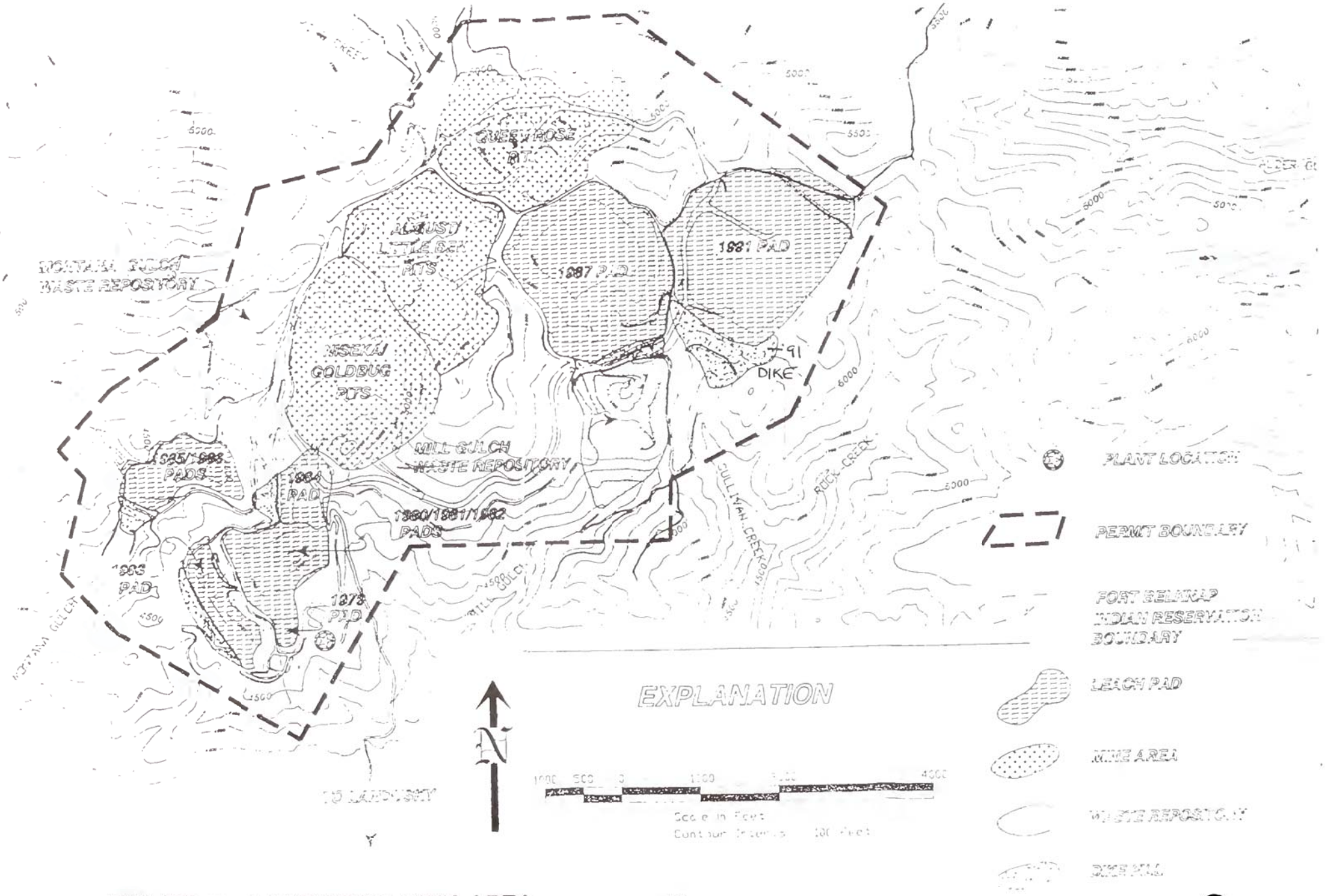


FIGURE 2. LANDUSKY MINE AREA

occurred in the Little Rocky Mountains which resulted in high flows in all drainages. Because of these precipitation events, pumpback systems at the Landusky mine were not able to capture all discharge of acidic water downgradient of certain facilities. Captured discharges were routed back to the process circuit. These short-term measures are marginally effective and demonstrate the need for mine plan modification.

C. SCOPE OF ANALYSIS

This environmental assessment (EA) is a supplement to the EA prepared for ZMI's Application for Amendment 10 to State Operating Permit 00095 and Federal Plan of Operations MTM - 77779 (MDSL et al, 1990b, and MDSL et al, 1991). This analysis evaluates the effectiveness of various operational control measures, reclamation capping scenarios, and other ARD mitigation. Thus the analysis focuses on reclamation procedures and impacts to water resources. For more information concerning other environmental aspects of the Landusky mine the reader is referred to MDSL et al, 1990b and to MDSL et al, 1991. These documents were prepared by the Montana Department of State Lands and the U.S. Department of the Interior - Bureau of Land Management and provide the most recent assessment of environmental effects from the Landusky mine.

Amendments to the Zortman mine reclamation plan, (Operating Permit 00096 and MTM 77778) east of the Landusky mine, will be evaluated in a Zortman Mine Expansion EIS currently in progress. Issues and concerns identified by the agencies and the public prior to preparation of this document are summarized in Appendix 1.

D. AGENCY RESPONSIBILITIES

A number of agencies have participated in a joint review of this proposal. The following is a description of the cooperating agencies and each agency's responsibilities.

1. Montana Department of State Lands (MDSL)

The Commissioner of State Lands must decide whether to approve Zortman Mining Inc's proposal, to modify their proposed reclamation plan, or to deny the proposed change pursuant to the Montana Metal Mine Reclamation Act (MMRA) Title 82, Chapter 4, Part 3, MCA.

The MDSL administers the MMRA which applies to state, federal, and private lands within Montana. The purpose of the act is to provide that the usefulness, productivity, and scenic values of all lands and surface waters involved in mining and exploration receive the greatest reasonable degree of protection and reclamation to beneficial use. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps to be taken in the issuance of an operating permit for and the reclamation of the applicant's proposed mine expansion. When a previously approved plan becomes impractical or impossible to implement or maintain, or when environmental problems are identified,

the MMRA also provides that the Department may require an operating or reclamation plan to be changed so that it will not conflict with existing laws (82-4-337, MCA).

MDSL's rules (ARM 26.2.601 et seq.) implementing the Montana Environmental Policy Act (MEPA) Title 75, Chapter 1, MCA, then require preparation of an environmental analysis of the actions proposed under MMRA.

The Commissioner may deny a permit modification only when it can be demonstrated that air and water statutes cannot be complied with and/or the reclamation plan as proposed is not feasible (82-4-351, MCA). A permit may also be denied if a person, or any firm or business association of which that person was a principal or controlling member has a bond forfeited (82-4-360, MCA) or for failure to reclaim an operation (82-4-341(6), MCA). ZMI has not forfeited any bonds under the MMRA and has not failed in its reclamation obligations.

The Department of State Lands also has authority to enforce the Metal Mine Reclamation Act. It may not, however, enforce statutes delegated to other agencies.

Specific to the corrective actions under evaluation in this EA and the circumstances surrounding those actions, the Department has issued a Notice of Noncompliance for failure to handle sulfide materials properly. Penalties will be assessed as soon as the Department has completed the processing of the corrective action and this MEPA/NEPA analysis.

2. United States Department of the Interior Bureau of Land Management (BLM)

The BLM is responsible for the evaluation and regulation of mineral activities on public lands. The BLM uses the 43 CFR 3809 regulations to prevent unnecessary or undue degradation of the public lands with respect to locatable mineral activities. The BLM evaluates the activity through the National Environmental Policy Act of 1969 (NEPA), and the Federal Land Policy Management Act of 1976 (FLPMA). Federal regulation 43 CFR 3809.3-1 provides for a joint federal-state regulatory program. Such a program was initiated May 9, 1984, by a Memorandum of Understanding (MOU) between the BLM and MDSL. This agreement allows for joint agency NEPA analysis.

The BLM has issued a Notice of Noncompliance for improper waste handling for Mill Gulch Waste Dump on May 27, 1993. On August 9, 1993, another Notice of Noncompliance was issued for failure to comply with other federal laws specifically the Clean Water Act.

3. Montana Department of Health and Environmental Sciences (DHES)

Water Quality Bureau (WQB)

The WQB of DHES is responsible for administration of the Montana Water Quality Act (Title 75, Chapter 5, MCA), providing for the classification of surface waters, establishing surface water quality standards, and administering permit programs to control the discharge of pollutants into state waters. This program includes delegated responsibilities from the U.S. Environmental Protection Agency (EPA) for implementation of the Federal Clean Water Act. Any water treatment needed, beyond passive measures such as constructed wetlands, would be imposed by the WQB.

A Montana Pollutant Discharge Elimination System (MPDES) permit must be obtained before any discharge to state water may occur. The MPDES permit contains water quality limitations and requires self-monitoring of effluent by the permittee. Mining operations must also comply with Montana groundwater standards.

On April 13, 1993, the DHES notified ZMI of apparent Montana Water Quality Act violations, and requested additional information to determine the extent of these apparent violations.

On August 24, 1993, DHES filed a complaint and application for injunction against ZMI. This complaint requires that ZMI take corrective actions to ensure that the mine is in compliance with the Montana Water Quality Act. The complaint also requires ZMI to obtain an MPDES permit(s) for all state waters which may be impacted by mining disturbances. ZMI's application for such permits was received on August 30, 1993 (ZMI, 1993b).

4. United States Environmental Protection Agency (EPA)

The EPA Region VIII has jurisdiction or special expertise regarding protection of water quality pursuant to the Clean Water Act and mined-land restoration pursuant to the Solid Waste Disposal Act. The EPA Region VIII may also be designated as a cooperating agency pursuant to 40 CFR 1501.6. This code provides that the lead agency may request any other federal agency to serve as a cooperating agency, if the agency has jurisdiction or special expertise regarding an environmental issue or issues that should be addressed in a NEPA document. The EPA has both jurisdiction and expertise.

On April 22, 1993, the EPA issued a letter to ZMI requesting more information on facilities siting, topography, and drainages pursuant to Section 308 (33 U.S.C. 1318) of the Clean Water Act. The EPA has inspected the site numerous times and is currently coordinating with the DHES-WQB to assure compliance with the Clean Water Act. On July 28, 1993, the EPA issued a notice of violation to ZMI for discharge without a permit (per Section 301(a) (33 U.S.C. 1251 et. seq.) Clean Water Act). The EPA has delegated authority to issue National Pollutant Discharge Elimination System (NPDES) permits in Montana to the Montana DHES. The EPA and DHES are taking joint actions to ensure compliance with the Clean Water Act and Montana Water Quality Act.

E. THE PERMITTING PROCESS

The permitting process usually begins with an applicant's submission of a plan of operations to the appropriate State and Federal agencies. In this case, the process began when the BLM and the MDSL identified a need for a corrective action or change in the reclamation plan in December 1992. The agencies received ZMI's proposal (ZMI, 1993a, etc.) to amend their operating and reclamation plans to incorporate segregation of potentially acid generating material, as requested by the MDSL and the BLM. Subsequently the plan must be evaluated pursuant to MEPA and NEPA.

The NEPA and the MEPA are Federal and State laws which direct the BLM, the MDSL and DHES to evaluate and disclose effects of proposed activities on Federal and State lands to the public and to officials making decisions concerning the proposal. Under the NEPA and MEPA, issues and alternatives are developed based on both public and agency input gathered during scoping. These issues are then tracked through the environmental analysis phase of the document. See also, Appendix 1.

The deciding officials review the alternatives, weigh the possibilities for positive and negative impacts, and reach a decision. A decision document is then prepared which outlines the major points of the decision and the rationale used to reach the decision. The activities outlined in the decision document are then approved to be implemented on the ground. State decisions can be challenged in district court and BLM decisions are appeable to the Interior Board of Land Appeals (IBLA).

This chapter identifies ZMI's proposed plans and identifies other alternatives to be considered in decision making.

A. ZMI PROPOSED MODIFICATIONS

This section describes ZMI's proposed modifications to the approved mining and reclamation plans. ZMI has proposed these modifications to address the potentially acid-generating character of some mined ore and waste rock. The modifications described below are contained in documents (ZMI, 1993a) and letters submitted to the MDSL and BLM dated November 19, 1992, February 22, March 15, April 26 and July 23, 1993.

The facilities and supporting roads addressed by ZMI's initial proposal (Figure 2) are located in three drainages: Montana Gulch, Mill Gulch and Sullivan Creek. Table 1 summarizes the approved reclamation plan and the proposed changes for the facilities which exist in each drainage. Mill Gulch and Sullivan Creek drainages are upgradient of the small town of Landusky. The Montana Gulch drainage enters Rock Creek downgradient of Landusky. All three drainages report to the Rock Creek drainage which eventually discharges to the Missouri River.

All Landusky Heap Leach Pads

The proposed reclamation plan would delay perforation of the liner systems beneath the heaped ore until ZMI provided the agencies with 90-days notice of its intent to puncture the liner.

Mill Gulch Waste Rock Dump

Placement of waste rock has not been authorized on the Mill Gulch dump since February 1993. The existing dump (Figure 3) would be reclaimed as follows. A 6-to 12-inch clay liner on the top of the dump would be covered by a 15 mil synthetic PVC liner. On top of the PVC liner a protective geofabric layer would be placed to prevent puncture of the PVC liner. A 20 mil PVC liner would be used in critical drainage areas. Three feet of non-acid generating waste would be placed above this liner to serve as a capillary break (to prevent penetration of roots into the synthetic liner). The dump top would then be covered with 12 to 18 inches of soil. Runoff from precipitation which falls on the dump face would be routed into clay and PVC lined, rip-rapped side ditches along the dump perimeter via similarly designed drains constructed on 15 to 30 foot wide benches which would transect the dump face every 100 feet of vertical slope length. Drainage from the backsloped dump top would be routed into the main Landusky drainage system rather than the side ditches, to reduce the flow in these steeper side ditches. The overall slope of the dump face and benches would be 2.5 horizontal to 1 vertical (2.5:1).

Table 1: Summary of Approved and Proposed Reclamation Plans for the Existing Landusky Facilities by Drainage

DRAINAGE	FACILITIES	SUMMARY OF PROPOSED RECLAMATION PLAN	SUMMARY OF APPROVED RECLAMATION PLAN	WATER QUALITY STANDARD CLASSIFICATION
Montana Gulch	'83, '84, and '85/'86 Leach Pads	same as approved plan except to delay liner perforation until agencies have received 90 days notice	rinse to <0.22 WAD CN^-, reduce slopes to 2H:1V, cap with 8-12" soil, revegetate, perforate liner	C-3
Montana Gulch above '86-'86 Leach Pad	Montana Gulch Waste Dump	no change (this has already been implemented)	reduce to 2H:1V slope, cap with 8-12" soil, revegetate	C-3
Montana Gulch east upper reach	Gold Bug Pit/ Waste Dump	continue waste disposal in the Gold Bug pit, salvage soil, install limestone/lime underdrain, backfill in 5' lifts with 11 million tons of segregated waste rock to the 4900' level, high sulfur material isolated in the interior, at 4740' level a 6" compacted clay barrier to separate the upper dump from the lower dump, 25' wide clay and synthetic lined benches with lined ditches every 100 vertical feet, lined side ditches, dump top would be covered with 6" of clay or >10 mil synthetic liner to form an impermeable cap, dump slopes would be covered with 6" of compacted clay and 12-18" of non-acid generating waste rock for use as a capillary break, at final reclamation 30-40 percent of the slopes would be covered by non-acid generating waste scree and 60-70 percent would be 12 -18" of soil; at 4900' level decision to backfill with additional waste would be made; the final overall slope would be 2.25:1	cover with 8-12" soil on benches, vegetate with grasses and trees	C-3

DRAINAGE	FACILITIES	SUMMARY OF PROPOSED RECLAMATION PLAN	SUMMARY OF APPROVED RECLAMATION PLAN	WATER QUALITY STANDARD CLASSIFICATION
Montana Gulch and Mill Gulch above the waste dump	'79,'80-'81-'82, and '87 Leach Pads	same as approved plan except to delay liner perforation until agencies have received 90 days notice	rinse to <0.22 WAD CN*, reduce slope to 2:1, cover with 8-12" soil, revegetate, perforate liner	C-3
Mill Gulch below the '87 Heap Leach Pad	Mill Gulch Waste Dump	discontinue waste disposal in Mill Gulch, reduce overall slope to 2.5:1, every 100 vertical feet install 15-30' wide clay lined benches with synthetic lined ditches, synthetic lined sideline ditches, cover the entire dump slope with 6" clay cap overlain by 12-18" non-acid generating waste scree, cover 60-70 percent of the surface area with 12-18" soil and revegetated, 30-40 percent remains rock scree; cap dump top by first backsloping with 36-84" neutral waste followed by a 6" clay/15 mil PVC liner/geofabrick, cover with 36" non-acid generating waste capillary break with 12-18" soil, install instrumentation to evaluate infiltration and chemical reactions.	reduce slopes to 2:1 with 25' benches every 200' of slope length (for diversions), cover with 8-12" soil, revegetate	C-3
Sullivan Creek above dike	'91 (Sullivan Park) Heap Leach Pads	same as approved plan except to delay liner perforation until agencies have received 90 days notice.	rinse to <0.22 WAD CN*, reduce slopes to 3:1, cover with 8-12" soil, revegetate, perforate liner	C-3
Sullivan Creek below the '91 Leach Pad	Sullivan Park Dike/'91 Leach Pad Contingency Pond	salvage soil, reduce to average 2.5:1 slope, cover entire surface with 6" compacted clay cap overlain by 12-18" non-acid generating waste scree, cover 60-70 percent of surface area with 12-18" soil and revegetate, 30-40 percent remains rock scree, install diversion benches every 100 vertical feet	reduce to 2:1 slope, cover with 8-12" soil, revegetate	C-3

* <0.22 WAD CN = less than 0.22 parts per million weak acid dissociable cyanide.

In order to spread and compact clay on the dump slopes, the slope must be reduced to a more gradual slope than the currently permitted 2 horizontal to 1 vertical (2:1). ZMI proposes to reduce the slopes of this facility to an overall 2.5:1. The actual slopes would vary from 2.5:1 to 2.75:1, in the upper region of the dump to more steep, and from 2.25:1 to 2.5:1 in the lower region. All dump slopes would be covered by 6 inches of clay. Subsequently a 12 to 18 inch layer of non-acid generating waste would be added. Finally, 12 to 18 inches of soil will be placed on 60 to 70 percent of the slope surface. If the reclamation surface performance study (ZMI, 1993a) indicates that a different capping sequence would be more effective, the capping sequence would be modified for reclamation of this and other facilities determined to have the potential to produce ARD.

All Landusky Pits

ZMI has not proposed any changes to the pit reclamation plans other than for the Gold Bug pit.

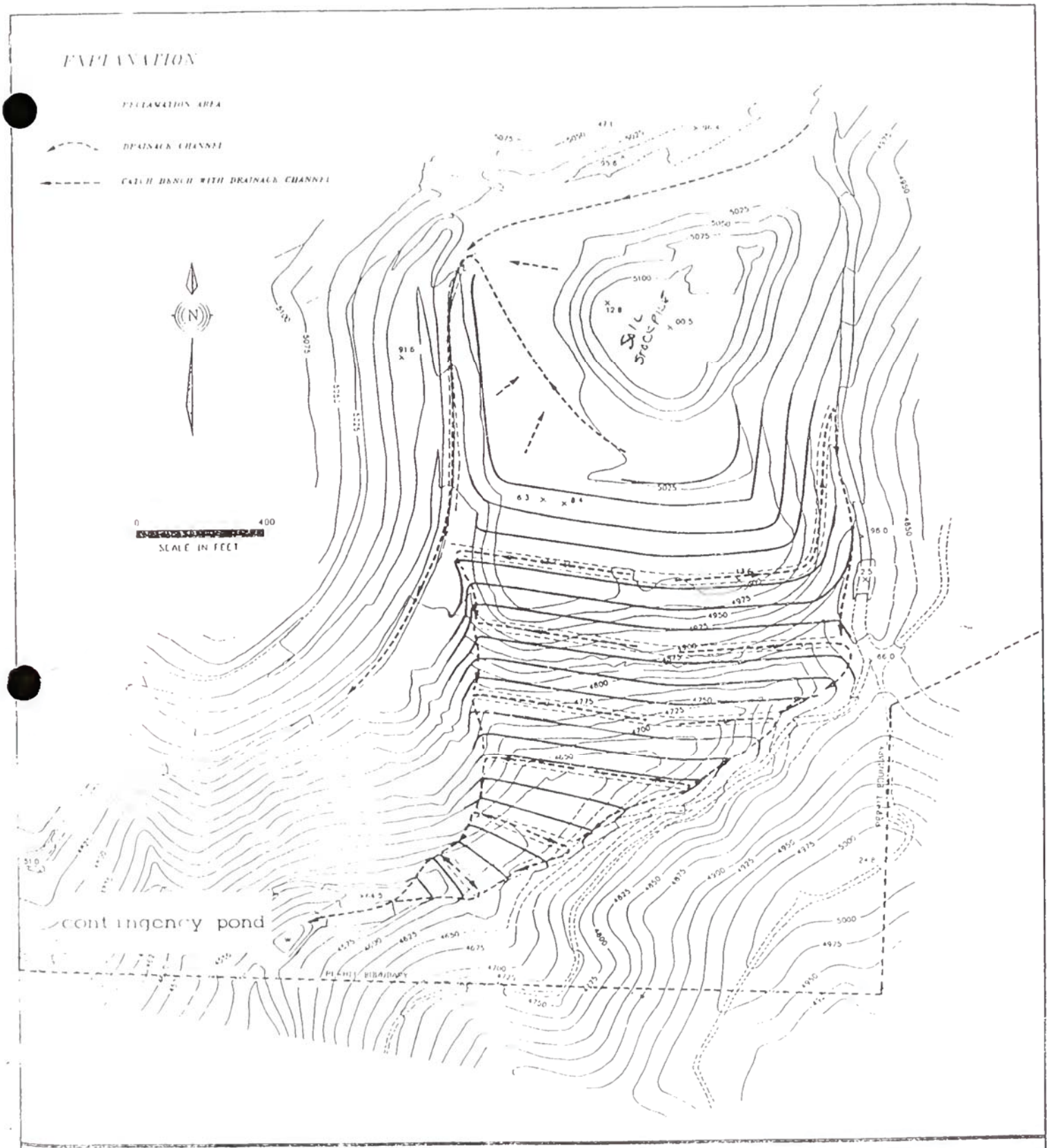
Gold Bug Pit/Waste Dump

Waste rock which was to report to the Mill Gulch waste rock dump has been placed in the Gold Bug pit (BLM, April 13, 1993). Dump construction in the pit is proposed to progress in 25-foot lifts until the entire pit has been backfilled to the 4900 foot level as depicted in Figure 4 for a total of 11 million tons of waste. The pit has the capacity to hold 50 million tons of waste rock if completely backfilled to the 5325 foot elevation. However, ZMI has neither proposed nor been approved to mine enough material to backfill the pit above the 4900 foot elevation. ZMI would construct the dump with an overall slope of 2.25:1. Waste in the dump would be segregated based upon total sulfur content, so that reactive waste would be isolated in the interior of the facility.

The Gold Bug waste dump would be reclaimed similar to the Mill Gulch waste dump, except that the waste dump would be capped and revegetated concurrently with dump construction. Rather than covering the entire reclaimed top with soil, ZMI proposes to reclaim to a 60 to 70 percent vegetation and 30 to 40 percent rock scree mosaic pattern (Figure 5), similar to that which naturally occurs on many hillsides within the Little Rocky Mountains. Lined ditches would be constructed on benches across the dump every 100 vertical feet.

Sullivan Park Dike/'91 Leach Pad Contingency Pond

The retention dike which holds the Sullivan Park leach pad in place was partially constructed with acid generating waste rock. The slope of this structure is 2:1 and would have to be reduced to 2.5:1 to facilitate the placement of a clay infiltration barrier on the dike slopes.



MILL GULCH RECLAMATION AND DRAINAGE

ZORTMAN MINING INC.

DRAWN BY: Melissa J. Hall 6/21/93

FIGURE 3.

EXPLANATION

BLUE WASTE REPOSITORY

STAGE 2
4900 ELEVATION

DRAINAGE DITCH

FIGURE 4.

400 800

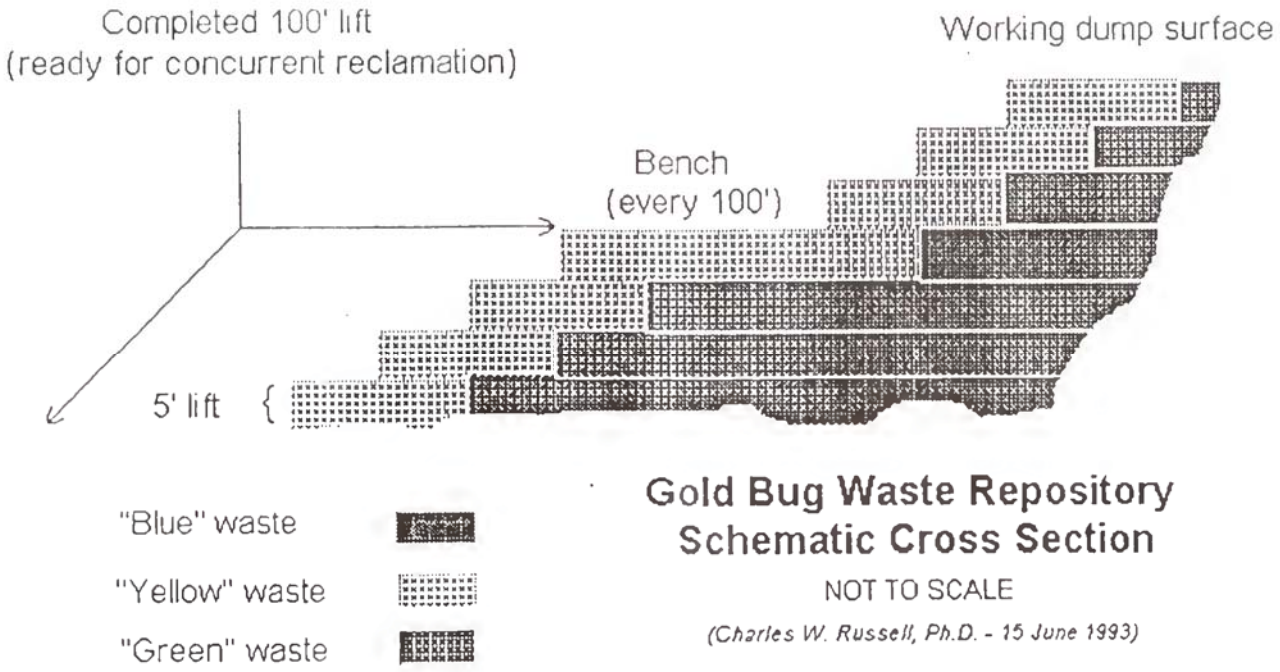
scale in feet

GOLD BUG WASTE REPOSITORY
PLAN VIEW OF 4900 ELEVATION

ZORTMAN MINING INC.

DRAWN BY: Michael J Hall 06/15/93

MATERIALS PLACEMENT

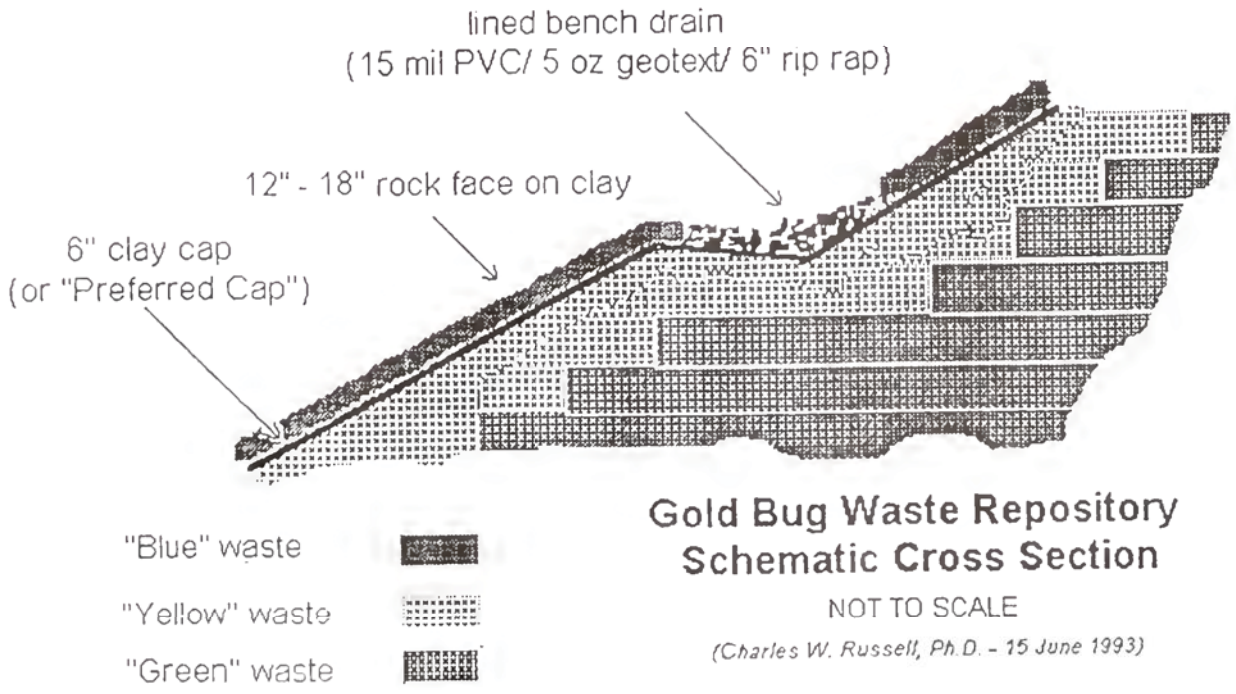


Gold Bug Waste Repository
Schematic Cross Section

NOT TO SCALE

(Charles W. Russell, Ph.D. - 15 June 1993)

INFILTRATION CONTROLS



Gold Bug Waste Repository
Schematic Cross Section

NOT TO SCALE

(Charles W. Russell, Ph.D. - 15 June 1993)

FIGURE 5.

However, the dike supports the leach pad and its slope cannot be simply reduced to facilitate capping. Therefore, additional material, approximately 0.3 million tons of less than 0.5 percent total sulfur waste rock would be placed on the existing dike slope to produce the desired slope of 2.5:1. After resalvaging of soil material, this additional material would fill in an area of previous disturbance, including a portion of the existing contingency pond below the dike (reducing its capacity by approximately 350,000 gallons).

To reduce infiltration, ZMI proposes to cap the dike with a 6-inch layer of compacted clay. A 12- to 18-inch layer of neutral/non-acid generating waste would be placed over this clay cap. Finally, 60 to 70 percent of the non-acid generating waste would be covered with 12 to 18 inches of soil and revegetated.

To limit runoff velocities, to facilitate drainage off of the main dike face, and to protect soils from erosion, benches would be placed every 100 vertical feet. Benches would be from 15 to 30 feet wide, and sloped back into the dike with grades of 5 to 10 percent (Figure 6). These benches would be capped with clay and a synthetic liner and would serve as access roads to maintain a 10- to 20-foot wide drainage ditch. This drainage ditch would be lined with a synthetic impermeable liner, which would be held in place with neutral rocks greater than 6 inches in size.

Side ditches would be installed to collect the runoff from the top and slopes of the reclaimed dike. The liner for these ditches would be a synthetic impermeable barrier which is bedded upon 6 inches of clay to gravel-sized material (Figure 7). The liner would be secured in place with 6 to 18 inches of sized neutral material. Drainage from the upper portion of the dike would be diverted into the drains on the dike east and west flanks. A plan view of the reconfigured Sullivan Park dike is shown in Figure 8.

Mine Products Characterization Program

Effective implementation of the reclamation plan requires that certain mine facilities be geochemically characterized, resloped, and capped to allow identification and isolation of this reactive waste and to decrease water infiltration into the waste rock dumps. Due to the manifestation of acid rock drainage (ARD) associated with various waste rock piles, and at the request of the BLM and the MDSL, ZMI has completed the preliminary phase of a mine products characterization program (ZMI, 1993a and ZMI letter dated July 30, 1993). This has allowed the company to reach a preliminary determination that a relationship exists between the rock's total sulfur content and its net neutralizing potential (NNP). The mine products characterization program directs the segregation and isolation of waste in the Gold Bug pit/waste rock dump and provides for sampling and geochemical testing of all unreclaimed heap leach pads.

Cross-Section
of Bench Drain Ditches

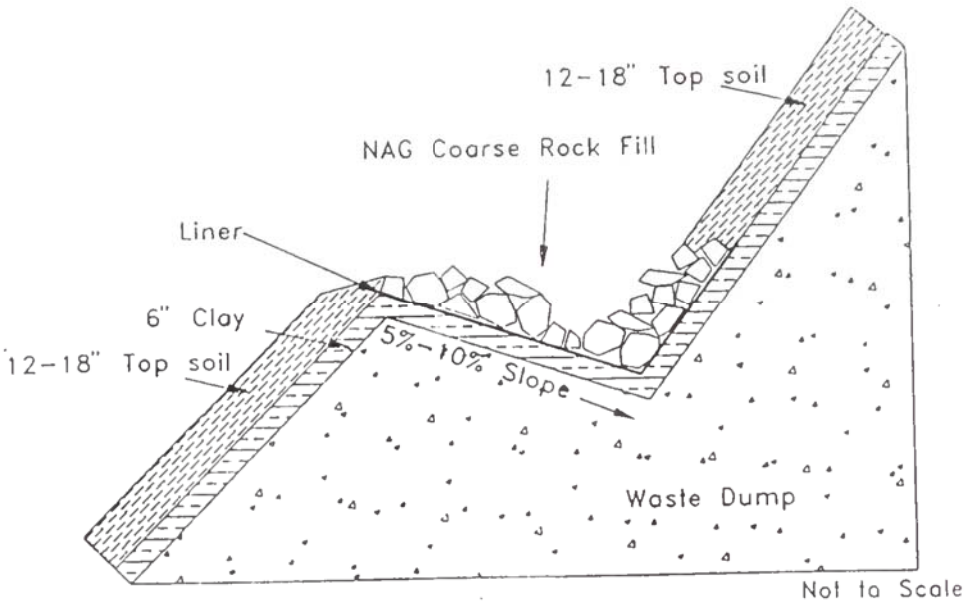


FIGURE 6.

Cross-Section
of Side Drain Ditches

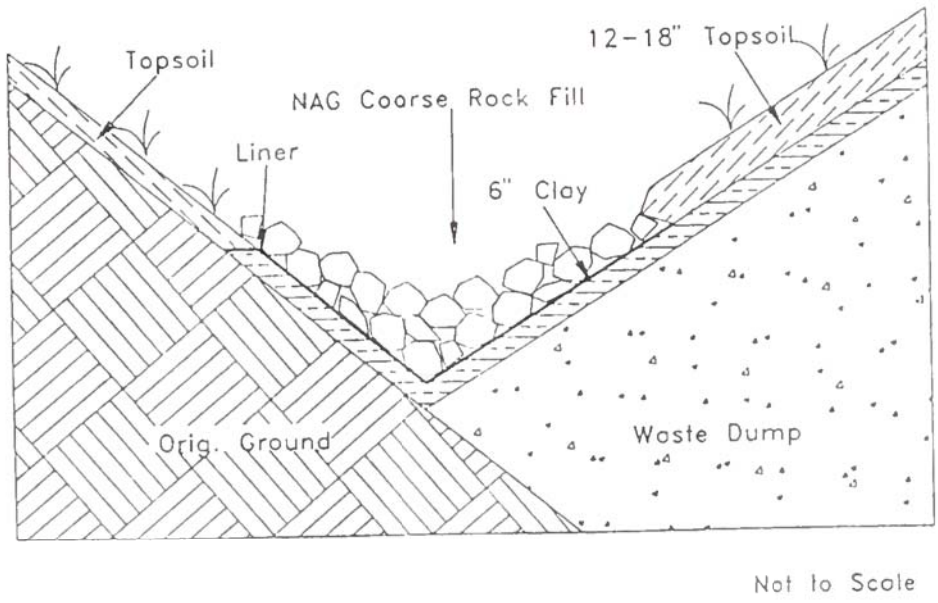


FIGURE 7.


SULLIVAN PARK DIKE
5100
5075
5050
5025
5000
4975
4950
4925
4900
4875
4850
4825
5050
5025
5000
4975
RESLOPED DIKE
contingency pond
410,624 SQ FT. 9.43 ACRES
400

FIGURE 8.

For the Landusky ore and waste rock, ZMI has determined a correlation exists between the total sulfur content of the rock and the NNP, which was evaluated by the Sobek method (Sobek et al, 1978) as modified by Schafer and Associates (ZMI, 1993a- Table 2, Figures F-1 and F-2). Seven hundred and forty one blasthole samples from the Little Ben/August and Queen Rose pits have been analyzed for NNP and total sulfur. Based upon these data, waste categories have been defined for material which has low risk for acid production (0 to 0.2 percent total sulfur), material which has moderate risk for acid production (0.2 to 0.5 percent total sulfur), and those which are expected to be acid generating (> 0.5 percent total sulfur). These materials are delineated with color-coded flagging at the excavation site to assist in the isolation of reactive rock and stockpiling of nonreactive capping material. Also, the loaders are fitted with colored lights to signal to the haul truck drivers where to deliver their loads of waste rock.

Table 2: Characterization Of Waste Based On Total Sulfur And NNP Analyses Of 741 Samples

Category	Blue waste	Yellow waste	Green waste
Total sulfur (%)	0.0 - 0.2	0.2 - 0.5	greater than 0.5
Average sulfur (%)	0.10	0.32	0.78
Average NNP	22.30	1.11	-20.95
Number of samples	345	227	169
Placement in Facilities	reclaimed exterior	between interior and exterior	interior

ZMI is analyzing a composite of every third to fifth blasthole for total sulfur content. After blasting, ore grade material is marked with red flagging and trucked to the leach pad. Waste of greater than 0.5 percent total sulfur content has been determined to be potentially acid generating. This material is marked with green flagging, and is placed in an isolated location in the center of the Gold Bug waste dump. Waste rock having a total sulfur content between 0.2 percent and 0.5 percent is flagged yellow, and is used for construction of the waste rock dump around the green waste. Waste having less than 0.2 percent total sulfur is marked with blue flagging and stockpiled for capping and construction material (ZMI, 1993a. Table 3).

The sulfur values of the blasthole samples are plotted on the same map as the gold assays when ore and waste blocks are discriminated (ZMI, 1993a-Figure F3). All ore, regardless of total sulfur content is taken to the '91 heap leach pad. The remaining waste is assigned to blocks

which are classified on the basis of the most restrictive waste category which is included in any given block (i.e. if a block of predominantly "yellow" waste contains some "green" class waste, the entire block would be handled as "green" waste (Table 3). The following waste classification procedures are used.

To ensure the validity of these classification schemes, every year 300 to 500 check samples would be analyzed for total sulfur and NNP. For already existing, still unreclaimed facilities, such as all the heap leach pads, total sulfur determinations are proposed to be made from surface samples collected on a surveyed 100 foot grid. Results would be reported to the agencies on topographic maps and contoured according to the color-code given in Table 3.

Table 3: Mine Products Characterization Program

Mined Material	Color of Flagging	Location of Placement
ore	red	heap leach pads
waste - greater than 0.5 per cent total sulfur content	green	isolate in center of waste rock dump
waste - greater than 0.2 percent but less than 0.5 per cent total sulfur content	yellow	layer over green waste isolated in center of waste rock dump
waste - less than 0.2 percent total sulfur content	blue	used for unrestricted construction and for reclamation and capping over yellow waste

Water Monitoring Plans

Two water monitoring programs are in place at Landusky: an operational plan and a general plan. ZMI has expanded their operational water resources monitoring plan (ZMI 1993b) to include additional monitoring sites and to monitor for additional parameters. New surface water locations are now being monitored, sumps of reclaimed leach pads are being monitored, and ZMI's laboratory is developing the ability to analyze water samples for metals and sulfate. ZMI has not proposed any modifications to the general water resources monitoring plan (Hydrometrics, 1993a).

B. AGENCY MODIFIED ALTERNATIVE

This alternative is the same as the ZMI proposed action with additional operating, reclamation and monitoring measures imposed by the MDSL and BLM. The mitigating measures described below have been developed by the agencies in order to further reduce impacts and prevent unnecessary or undue degradation. If this alternative was selected these measures would become stipulated conditions of approval.

ZMI's proposals to date have focused on the Mill Gulch waste rock dump and the Gold Bug pit. Other facilities would require revised reclamation procedures. The agencies have developed conceptual plans for the leach pads, waste dumps, dikes and pits, for this EA. Prior to final reclamation, some adjustments in these plans would be necessary.

All Landusky Pits

ZMI would map all pits using visual analysis of sulfide percentages (especially the iron uslifdes), oxidation, and particle size distribution and using analytical measurements of paste PH and total sulfur, to identify areas of potential acid production. As final benches are mined, surfaces would be tested for acid generating potential. Areas with the potential to acidify runoff would be capped with 6 inches of compacted clay prior to reclamation. Depending upon final pit configurations and locations of sulfide zones, and other factors, final pit reclamation would include partial backfilling with waste and/or spent ore to bury exposed sulfides and to cause reclaimed pits to be free-draining rather than draining internally. After pit backfilling, a channel would be constructed to route pit runoff from all pit areas ultimately to Montana Gulch. The surface of this backfilled material would require capping to minimize infiltration prior to soil replacement and revegetation. Sources of backfill would include waste from further mining, from the Gold Bug waste rock dump, or from neutral spent ore from the Mill Gulch leach pad.

Testing of pit highwalls and benches above the backfilled zone for acid generating potential would be required. Testing would include total sulfur analyses, static and leachate extraction tests, and in-place testing of highwall material. If it is not feasible to bury and cap all acid generating portions of the pit walls, then reclamation must provide for neutralization of acidic runoff from the highwalls and diversion of runoff around acid generating areas. Where possible, diversions above pits would prevent storm water run-on. Construction of diversions lined with limestone or other neutralizing material below highwalls and construction of wetland areas to remove dissolved metals from runoff, or alternate reclamation designs of equal or greater effectiveness, would be required.

All Landusky Heap Leach Pads and Waste Disposal Facilities

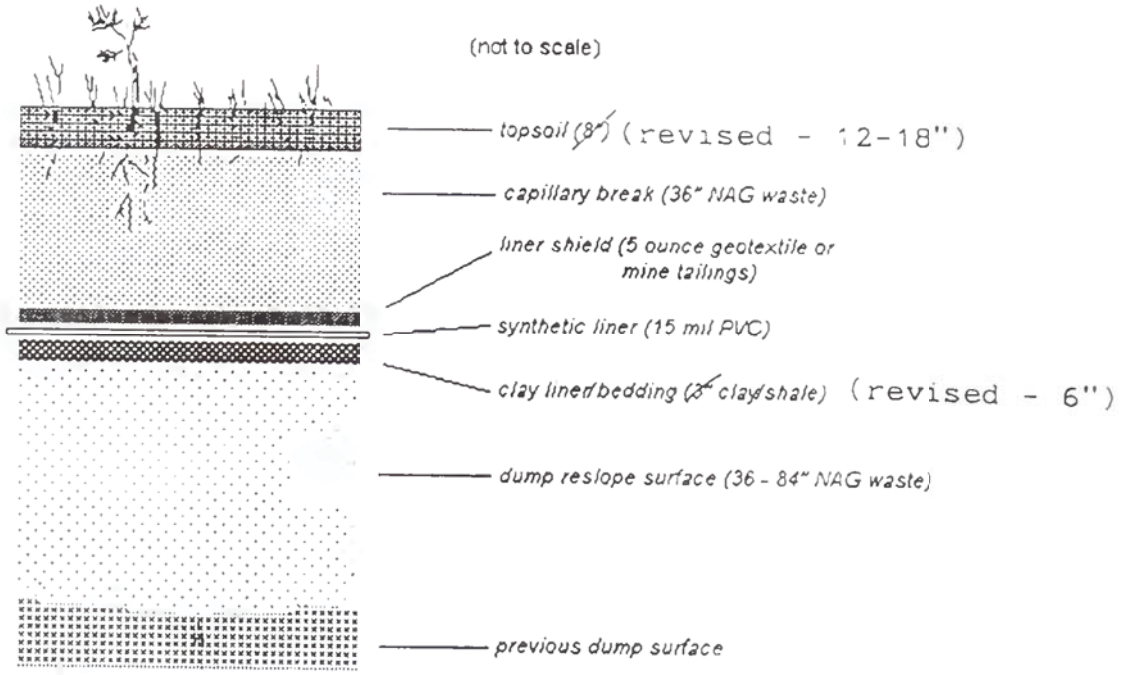
Unless the rock within a facility is demonstrated to the agneicies' satisfaction to not be acid generating, ZMI would be required to reslope all facilities to an overall 3:1 slope or flatter where topographic considerations allow or as determined technically feasible by the agencies. After slope reduction, ZMI would be required to conduct grid sampling, on 100-foot centers, of surficial material for total sulfur content. ZMI would be required to place at least 36 inches of < 0.5 percent total sulfur ("yellow waste") rock over any areas which contain exposed material of greater sulfur content. On top of this surface, a 12-inch clay layer would be compacted in two lifts. ZMI would be required to place 15 mil synthetic liners on crest surfaces flatter than 5 percent grade. A liner shield, such as geofabric or screened tailing material, would be placed over the synthetic liner to prevent perforation. A capillary break using non-acid-generating waste would be installed above the synthetic and/or clay liner. This capillary break would be 36 inches on the dump tops and at least 18 inches on the side slopes. Finally, 12 to 18 inches of soil would be placed above the capillary break (Figure 9). No rock scree would be allowed.

The non-acid generating capillary break to be installed in the capping sequence above the compacted clay liner would be constructed with material having the following characteristics: 1) a neutralization potential 3 times greater than the acidification potential (NP>3AP), and 2) a net neutralization potential greater than +20. Not all "blue waste" would meet this criteria. Segregation of material suitable for the capillary break portion of the reclamation cap would be made based primarily on lithologic unit character and total sulfur content. This would necessitate segregation and stockpiling during mining of rock units such as bighorn dolomite, Emerson shale, etc. from the color-coded blue, yellow, or green waste rock. Blue waste may be used to meet the performance objective of a non-acid generating cap, but only after results from long-term leachate extraction testing in the field have demonstrated, to the satisfaction of the agencies, its non-acid generating character.

ZMI would be required to sample the water which collects in the sumps within reclaimed leach pads, and to measure phreatic surface elevations within each leach pad. From the rate of phreatic surface rise, the rate of infiltration into a reclaimed leach pad would be estimated. If the rate of water infiltration and accumulation within each pad is kept sufficiently low for 10 years such that no degradation would occur, liner perforation could be allowed. If water quality or quantity problems are identified through monitoring, water recovery systems would be required. If water levels within the leach pads would reach such drains the water would flow out of the leach pads.

FIGURE 9. CAPPING SEQUENCE

CAPPING SEQUENCE



Montana Gulch Leach Pad Expansion

ZMI would be requred to not proceed with the approved expansion plans for the Montana Gulch leach pad. Instead, ZMI would be allowed to utilize areas in and adjacent to the current Sullivan Park and Mill Gulch leach pads for placement of the ore that would have gone on the Montana Gulch leach pad expansion. The rationale for this mitigating measure is to reduce further disturbance in the Montana Gulch drainage, to place material with acid generating potential away from surface waters, and to utilize the mined ore to fill in low areas to facilitate reclamation.

Sullivan Park Dike/'91 Leach Pad Contingency Pond

Resloping of the Sullivan Park dike would decrease the capacity of the contingency pond located below it. Thus, construction of additional ponds would be required to return the capacity to the permitted 1,300,000 gallon capacity (ZMI, 1989; MDSL and BLM, 1990b) or to an approved design storm event if appropriate.

Mine Products Characterization Program

In ZMI's mine product characterization program, a static, modified acid-base accounting (ABA) method (Sobek et al, 1978) was used, as modified by Schafer and Associates, to determine the net neutralizing potential (NNP) of the rock material to be mined. This method assumes that all neutralizing minerals will be available for reaction. For the experimental procedure, this is true because the sample is ground to a very fine grain size and more surface area is exposed. However, when applying this analytical method to determine the potential for acid production for waste rock or spent ore, the assumption is not always valid because the true availability of the neutralizing minerals can be much less.

Because of the variability in interpreting results derived using a static method, ZMI would conduct long-term leachate extraction testing in the field to validate the 0.2 percent total sulfur cutoff used for waste segregation. Also, when "blue" waste is being characterized ZMI, would sample and test every blasthole for total sulfur. If any sampled blasthole has a total sulfur value of greater than 0.2 percent the waste would be classified as reactive "yellow or green" waste (ZMI, 1993a; Chapter II, ZMI Proposed Modification, Mine Products Characterization Program).

Mine Facilities' Monitoring

ZMI has reclaimed almost 43 acres of other mine waste dumps and heap leach pads. For these reclaimed facilities, ZMI would be required to characterize the surface material on a 100-foot grid as was proposed for the unreclaimed leach pads. Based on the sampling results and continued water monitoring results, the agencies would decide if the reclamation must be redone.

For unreclaimed facilities, ZMI would be required to conduct 2 years of monitoring using best available technologies (BAT) for instrumentation of each heap leach pad, waste rock dump, and any other structure built with potentially acid producing material to evaluate the extent of and/or potential for acid rock drainage release into existing drainages. The data collected would be used to establish baseline conditions within each facility so that future monitoring results can be accurate.

All Watershed Diversion Structures

Diversion structures for final reclamation need to be designed to withstand large storm events. The minimum size design storm that would be used at Landusky is the 6-inch, 100-year, 24-hour storm.

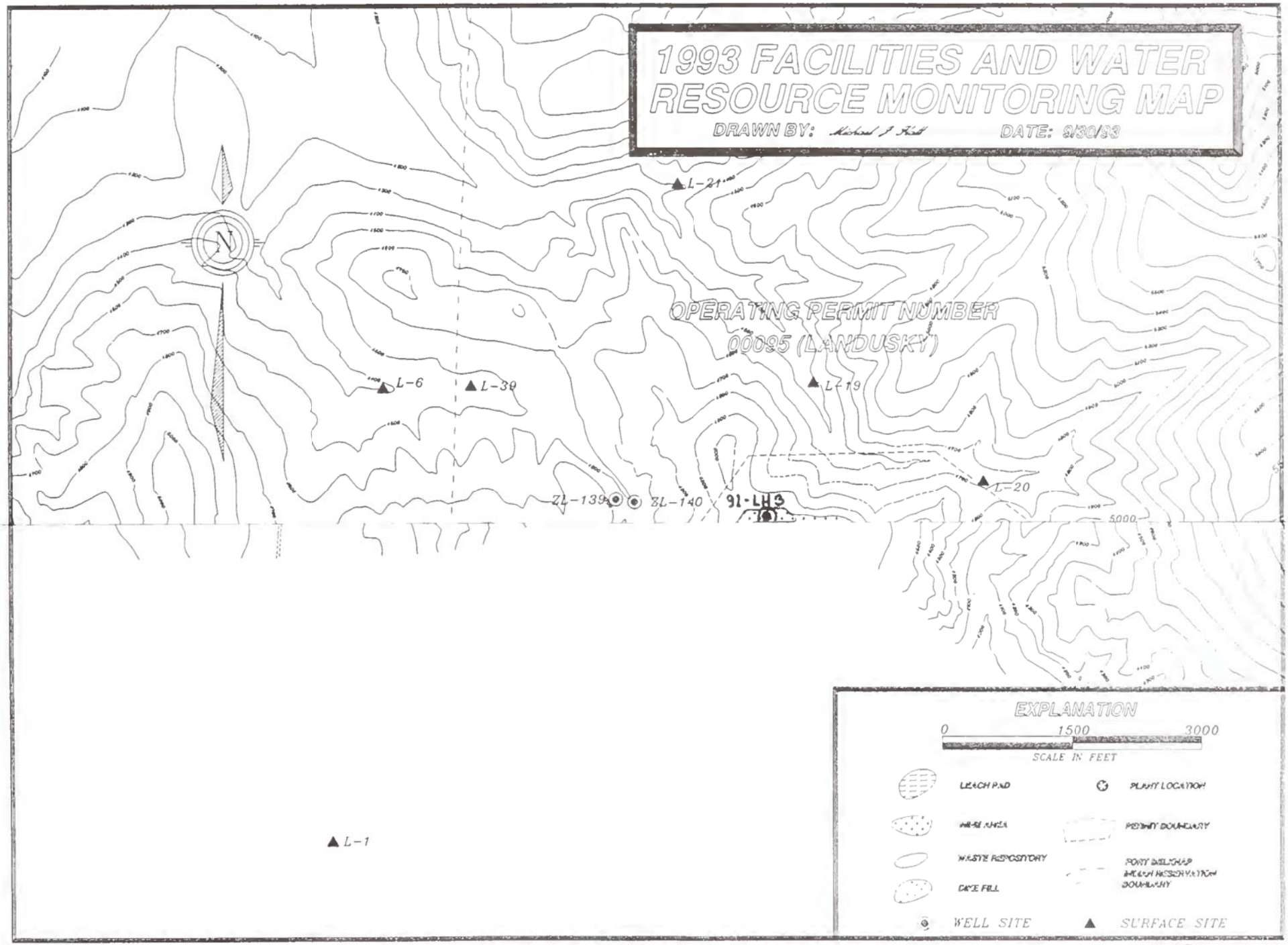
Sizing of diversions would be based upon the risk to the environment or public health, associated with failure of a particular diversion. Diversions intended to prevent erosion of, or infiltration into, facilities containing acid generating material after final reclamation must be designed to withstand a 7-inch, 24-hour storm event. Other diversions would be required to meet MPDES discharge requirements.

The agencies would require ZMI to place geotextile or other cushion material between the synthetic liner and the coarse rock rip rap in the diversion structures. This would be done to prevent damage to the synthetic liner.

Water Monitoring and Pumpback Systems

The agencies would require additions to the operational and general water resources monitoring plans, including installations of the following monitoring wells: one well on the west side of the Landusky processing yard (west of ZL-108 and ZL-118), a bedrock monitoring well in Montana Gulch below the '85/'86 leach pad contingency pond, and two wells (alluvial/bedrock contact and deep bedrock) at the head of King Creek, immediately below the reclaimed waste rock disposal area (Figure 10). Also, ZMI would be required to monitor 91LH-3, a 600-foot deep well located northwest of the Queen Rose pit. ZMI installed this well in 1991, but it has not been included in past monitoring plans.

In addition, frequency of general water resources monitoring would be increased from twice yearly to three times yearly by adding a sampling event in July. The agencies consider this additional monitoring necessary to aid in the evaluation of water quality trends. Raw data from ZMI's three annual sampling events would be submitted to the agencies within six weeks of each sampling event to facilitate rapid review of the data. ZMI would present quality assurance and trend analysis studies of these data sets, rather than just raw data in their annual reports.


1993 FACILITIES AND WATER RESOURCE MONITORING MAP
DRAWN BY: Michael J. Kiff
DATE: 9/30/93
OPERATING PERMIT NUMBER 0095 (LANDUSKY)
N
L-21
L-6
L-39
L-19
L-20
ZL-139
ZL-140
91-LH3
5000
L-1
EXPLANATION
0
1500
3000
SCALE IN FEET
LEACH PAD
PLANT LOCATION
WASTE ROCK
PERMIT BOUNDARY
WASTE REPOSITORY
PORT DISCHARGE MEANS RECEIVATION BOUNDARY
CAVE FILL
WELL SITE
SURFACE SITE