1 of 6

File ACT/015/015
Folder No. 2
copy to Lynn
Rick, Dave

0012

Consolidation Coal Company
Western Region
2 Inverness Drive East
Englewood, Colorado 80112
(303) 770-1600

November 14, 1983

JIM

NOV 21 1983

Mr. James Smith
Coordinator Mined Land Development
Division of Oil, Gas and Mining
4241 State Office Building
Salt Lake City, UT 84114

RE: Technical Review Responses
Emery Deep Mine
ACT/015/015, Folder No. 2
Emery County, Utah

Dear Mr. Smith:

Please find enclosed six copies of Consol's narrative response to technical question UMC 784.14(c) which pertains to the quantity of ground-water inflow which will enter the mine as operations continue.

As noted in Consol's letter of November 11, 1983 to you in which Consol's responses to technical questions that were identified during the Determination of Completeness Review dated October 27, 1983 were conveyed, Consol informed Mr. Lynn Kunzler of your staff on November 3, 1983 that a response to this question could not be provided by November 11, 1983. Mr. Kunzler subsequently informed Consol that the desired date for receipt of the narrative portion of this question was November 14, 1983, however, November 18, 1983 would be acceptable. The enclosed response is in accordance with the revised timetable for this question and should be added to the ACR responses contained in Volume 13 of the ACR responses.

Eight copies of this submittal are being sent to Ms. Betty Thalhofer of the Office of Surface Mining and one copy is being sent to Ms. Deborah Richardson of Richardson Associates.

Thank you for your cooperation on this matter. If you have any questions please contact Mr. Holbrook or me at our Englewood office.

RECEIVED
NOV 16 1983
DIVISION OF
OIL, GAS & MINING

Sincerely,

Dave Schouweiler

Dave Schouweiler
Regional Permit Coordinator

cc: J. Higgins w/o Encl.
S. Jaccaud w/2 Copies
D. Richardson w/1 Copy
OSM w/8 Copies

RESPONSES TO
DETERMINATION OF COMPLETENESS

Dated October 27, 1983

Consolidation Coal Company
Emery Deep Mine
ACT/015/015, Emery County, Utah

UMC 784.14 Reclamation Plan: Protection of the Hydrologic Balance

Comment:

(c) The applicant should reevaluate the quantity of ground-water which will enter the mine as operations continue. The following factors should be incorporated into the analysis:

1. increase in the fracturing of the roof material to the Ferron Sandstone due to retreat mining and increase overburden depths, and

2. increase in the hydraulic head of water in the Ferron Sandstone.

Both of these factors would lead to an increase in the quantity of flow into the mine. Extrapolation of ground-water inflows in the existing mine may not be valid.

DETERMINATION OF COMPLETENESS

The applicant makes reference to a new computer simulation of mine inflows to be anticipated over the five-year permit term. This simulation was performed using the CONOSIM model.

In order to evaluate the reasonableness of the model results, the applicant should provide a narrative which explains the assumptions, boundary conditions, calibration values and other pertinent information which were utilized in the stimulation. At this time, sufficient information to evaluate and verify the CONOSIM results has not been provided.

A similar analysis was apparently performed previously, as described on pages 7-88 to 7-91 of the permit application. Again, little documentation importance was provided in the text so that the calculations could be verified. Of importance is that fact that these same calculations were also used to project five-year water level declines in the Upper Ferron Sandstone, shown on Plate 7-5 of the permit application. It appears that the CONOSIM results presented in the applicant's ACR response (page 44) supercede the calculated inflows presented on page 7-90 of the permit application. However, the applicant did not provide a

corresponding five-year water-level decline projection map for the new CONOSIM inflow results. Since the two sets of projected inflows differ (as evidenced by the two years of overlap, 1984 and 1985) the applicant should revise Plate 7-5 to agree with the new CONOSIM inflow projections. If the applicant feels that the drawdowns shown in Plate 7-5 are still valid, he should state his reasons why and also provide all the necessary information utilized to initially prepare Plate 7-5. The brief discussion on page 7-89 is insufficient to assess the model and supporting calculations used to generate Plate 7-5.

The applicant has stated that the inflows to the mine were reevaluated using the CONOSIM model. Information must be provided on how the model handles increase in inflows due to fracturing of the roof materials and caving. Specifically, what was the height of caving anticipated and over what timeframe was the analysis done. As pillars fail, it can be expected that significant caving will occur. However, the problem is complex as is evident in the discussion on the lineament study. Three of the major roof falls were associated with "high long-term ground-water inflow areas" and other roof fall areas showed only moderate increases in inflow. How was this issue dealt with in the model? Is there any other field observations that might correlate water inflows and roof falls such as the height of the cave or the type of roof material?

Response:

Consol contacted Mr. Lyn Kunzler of the DOGM on November 3, 1983 to inform the Division that a response to this question could not be provided by November 11, 1983. After consultation with Richardson and Associates, Mr. Kunzler informed Consol on November 7, 1983 that responses to this question could be submitted in two parts, one a response to the narrative portions of the above question and the other a submittal of the requested drawdown map. The response to the narrative portion follows and the submittal of the drawdown map will be in accordance with the November 25, 1983 revised timetable as stated by Mr. Kunzler (see November 11, 1983 letter to Mr. James Smith regarding technical review responses).

Modeling Assumptions

1. Most of the water entering the mine voids is from the upper Ferron Sandstone aquifer. Minor quantities may come from leakage from the Blue Gate Shale member, but these are considered insignificant. Seepages from the lower aquifers are negligible since some coal is left in the floor and there are thin layers of shale in the immediate floor strata.

2. The mining method of room-and-pillar does not cause massive caving of the roof until after the retreat mining of the coal pillars. The extent of the mine void is considered dynamic

from one simulation time period to the next (if desired). However, during any one time step, the void is assumed static. If massive caving occurs, the model can be instructed to evaluate and update nodal or block characteristics based on the concept developed by Snow (1968).

3. Recharge to the upper Ferron Sandstone aquifer occurs along the Joe's Valley-Paradise Fault graben, and possibly from precipitation at the outcrops as well as downward leakage from the Blue Gate Shale Member of the Mancos Shale.

4. The upper Ferron aquifer is treated as a confined groundwater system with the Blue Gate Shale and the thin shale layer in the floor of the IJ Coal Seam acting as the confining strata. Since CONOSIM is a double-porosity model, both fractured and unfractured flow characteristics are considered.

MODEL PARAMETERS AND BOUNDARY CONDITIONS

The map in Figure 1 shows the modeled area bounded by heavy lines. This area is approximately three by five miles in extent and includes the present and future mining areas.

Figure 2 is a typical three-dimensional grid network for CONOSIM model. The grid block dimensions varied from 0.002 mile at the mining faces to 0.95 mile at the outermost model boundaries. For the IJ Coal Seam, which is represented by a dark layer, the fracture and matrix porosities are 25 and 3 percent, respectively; and the permeability is 0.03 foot per day (fpd). For the shale layers, the following information was used:

Fracture porosity	30%
Matrix porosity	0.5%
Permeability in the x-direction	0.00038 fpd
Permeability in the y-direction	0.00001 fpd
Permeability in the z-direction	0.00001 fpd

All of the sandstone zones designated by SAND 1, SAND 2, and SAND 3 have fracture porosity of 20 percent, matrix porosity of 1 percent, and the z-directional permeabilities of 0.074 and 0.038 fpd, respectively. However, SAND 1 had 0.0668; SAND 2 had 0.56; and SAND 3 had 0.15 fpd permeabilities in the x-direction. Both the calibration and transient-predictive simulations were run for preferential water flow conditions. The aquifer characteristics used here were determined from pump and laboratory tests.

The illustration in Figure 3 is a two-dimensional reduction of Figure 2. This is done in order to show the types of boundary conditions utilized.

BOUNDARY TYPE 1 represents constant pressures or constant flow grid nodes. With reference to Figure 1, these nodes occur along the northwestern boundary (located at the graben).

BOUNDARY TYPE II are the noflow nodes.

BOUNDARY TYPE III represents leakage or discharge grid nodes.

Calibration of CONOSIM was accomplished by comparing the computed mine discharge during a steady-state simulation with the actual measured mine inflow. The computed inflow, using the parameters outlined previously, averaged about 1.42 cubic feet per second (cfs). The current mine inflow is about 1.2 cfs.

MODEL RESULTS

The simulation quantities generated are summarized below:

Year	AVERAGE INFLOW (cfs)
1984	1.5
1985	1.8
1986	2.4
1987	2.2
1988	1.9

MODEL CAPABILITIES AND LIMITATIONS

CONOSIM has an in-built index array which is interrogated either every interation or time step to check the status or condition of each node or element. Depending upon the user specified commands or requirements, appropriate signals are generated. These signals are conveyed to appropriate sub-programs where specific actions are executed. CONOSIM model has been documented in Owili-Eger (1980).

The caving height used in this exercise was about thirty times the mining height. When an element or block fractures and caves, the model generates new characteristics based on the approach developed by Snow (1968). The fractured material zones' interactions are handled numerically by the computer through the combination of altered hydraulic and elastic properties and the resulting pressures.

CONOSIM can handle up to 400 inflow nodes with either constant or time varying rates. Thus, the "high long-term groundwater inflow areas" and others, do not present any modeling difficulties.

Although CONOSIM is a powerful three-dimensional model, the complex nature of a dynamic mining environment coupled with geologic uncertainties cannot be overlooked. The hydrologic parameters generated are at best approximations. However, they have been obtained via the best available technology and are far too superior to analytical or empirical techniques. As additional data are obtained from actual inflows and water level monitoring (seasonal), our predictions can then be refined and upgraded.

REFERENCES

Owili-Eger, A. S. C., 1980. "Modeling Immiscible Gas-Water Flow in Deforming Mining Environments," paper presented at the SME-AIME Fall Meeting and Exhibit, Minneapolis, Minnesota, October 22-24, 1980, SME Preprint No. 80-312.

Snow, D. T., 1968. "Fracture deformation and changes of permeability and storage upon changes of fluid pressure," in Quarterly of the Colorado School of Mines, v63, ni, pp. 201-244.

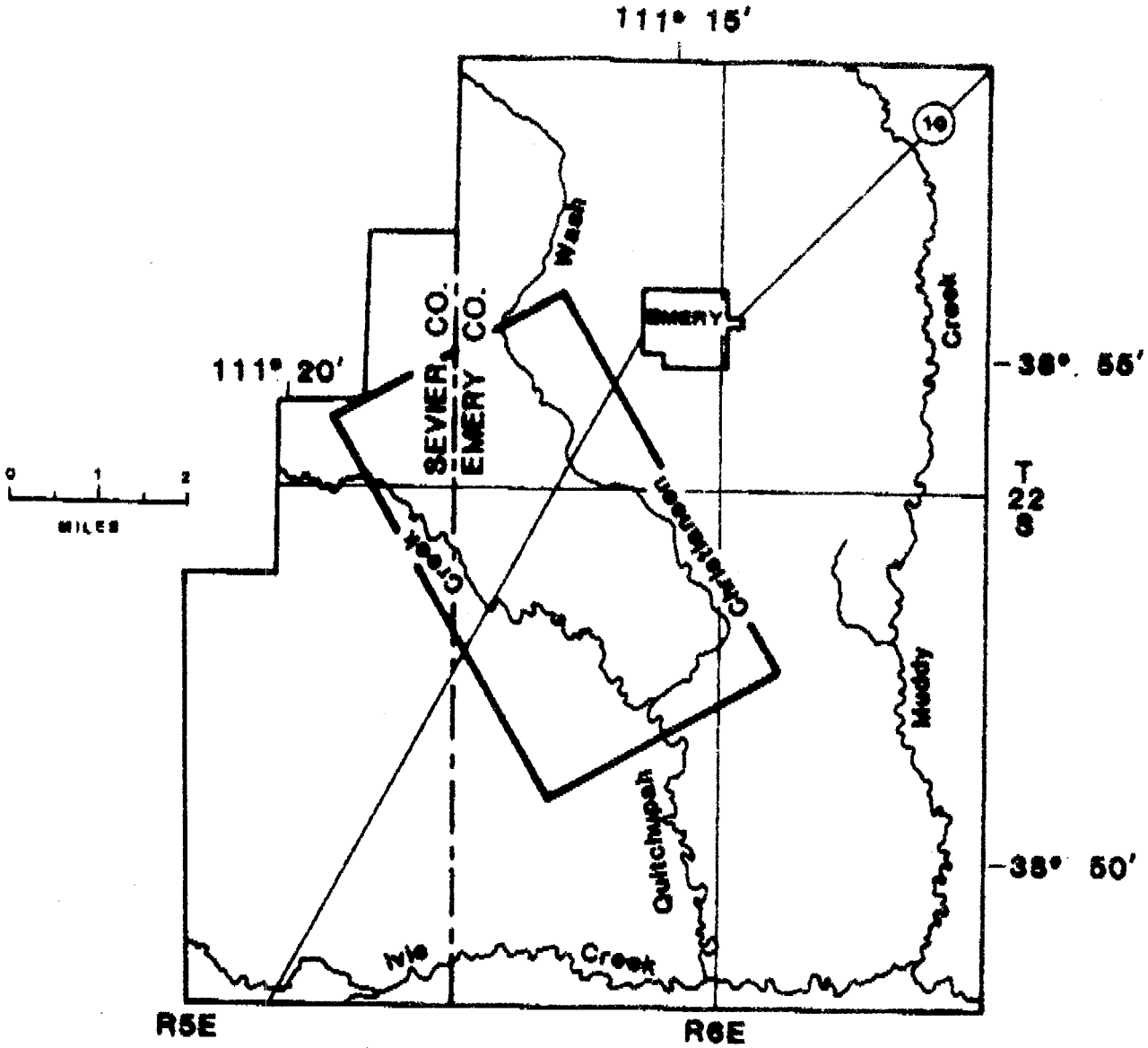


FIGURE 1.
AREAL OVERVIEW OF THE EMERY
MINE SHOWING CONOSIM REGION

Geologic Material	Young's Modulus ($x10^6$ psi)	Poisson's Ratio
Shale	1.30	0.05
Sandy Shale	1.48	0.06
Coal	0.37	0.16
Sandstone	1.33	0.06

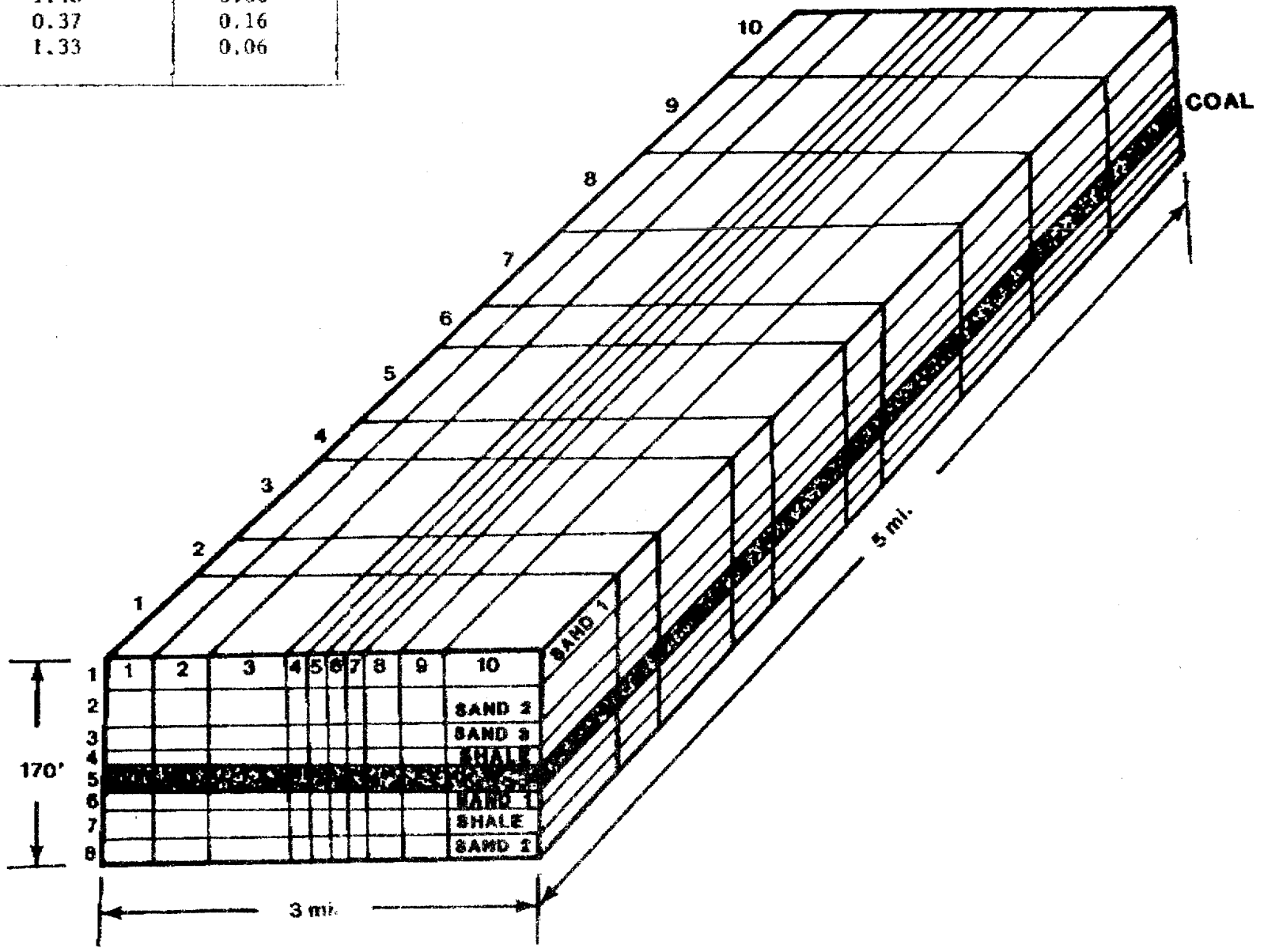
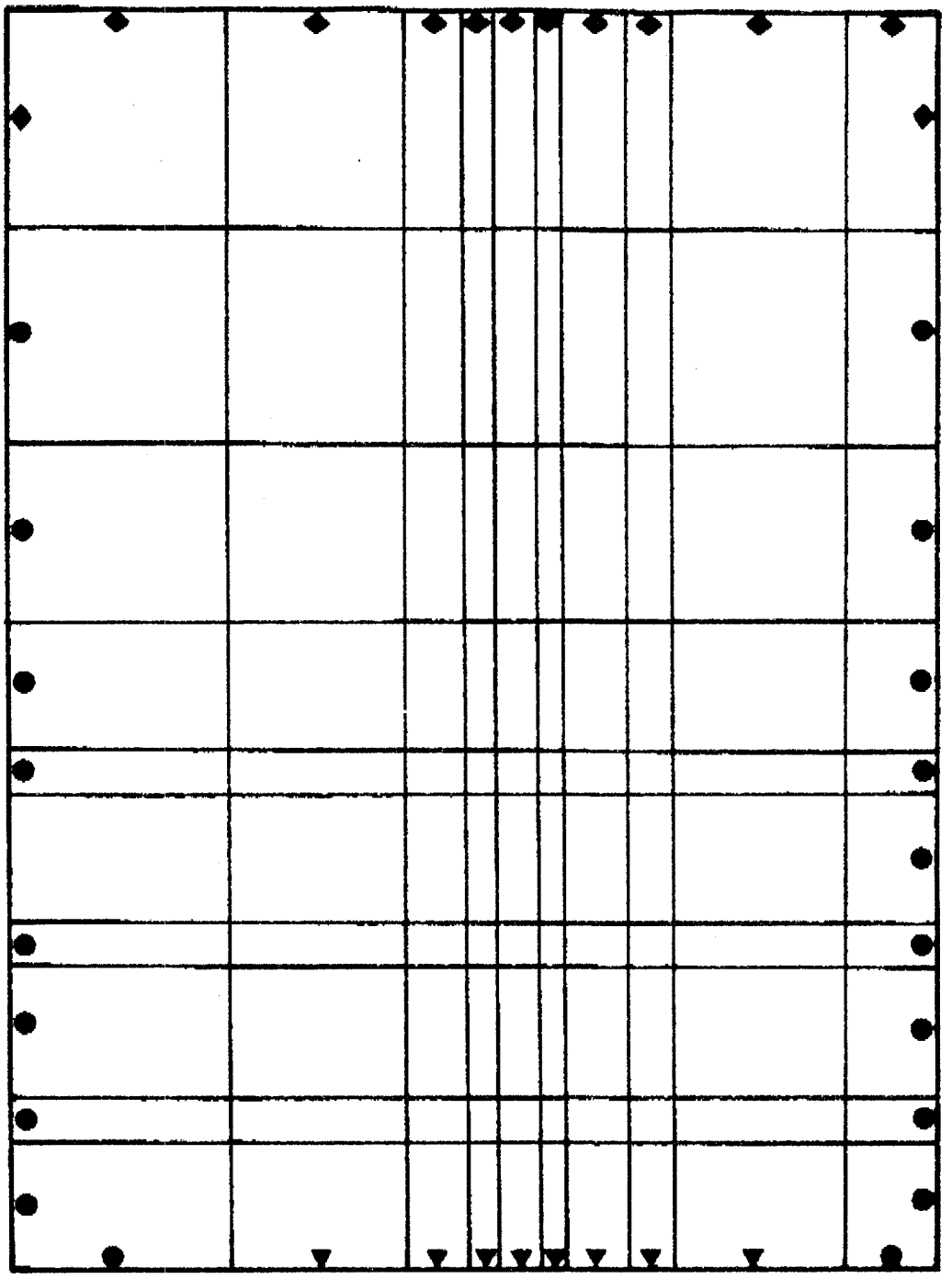


FIGURE 2.
THREE-DIMENSIONAL GRID FOR THE EMERY MINE INFLOW SIMULATION



◆ BOUNDARY TYPE I

● BOUNDARY TYPE II

▼ BOUNDARY TYPE III

FIGURE 3.
TWO-DIMENSIONAL GRID SHOWING THE TYPES OF BOUNDARY CONDITIONS IMPOSED FOR CONOSIM SIMULATION AND CALIBRATION