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NATIONAL DAM SAFETY PROGRAM. MAGMONT MINE TAILINGS DAM (MO 3091--ETC(U)
APR 81 R G BERGGREEN, L M KRAZYNSKI DACW43-80-C-0066

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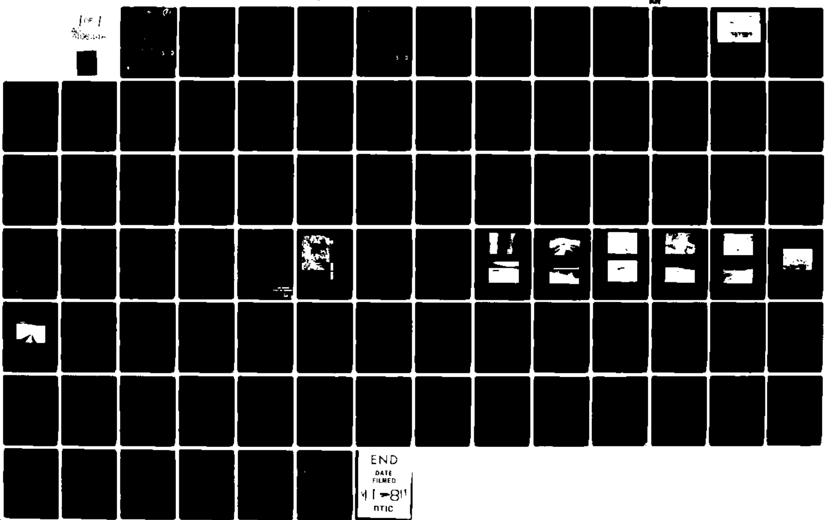

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WHITE RIVER BASIN

AD A106446

MAGMONT MINE TAILINGS DAM
IRON COUNTY, MISSOURI
MO 30917

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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St. Louis District

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National Dam Safety Program
Magmont Mine Tailings Dam (MO 30917)
Iron County, Missouri

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Richard G. /Berggreen
Leonard M. /Krazynski

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Magmont Mine Tailings Dam (MO 30917)

This report presents the results of field inspection and evaluation of the Magmont Mine Tailings Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY:	SIGNED Chief, Engineering Division	16 J N 1981 Date
APPROVED BY:	SIGNED Colonel, CE, District Engineer	18 J N 1981 Date

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MAGMONT MINE TAILINGS DAM

Iron County, Missouri

Missouri Inventory Number 30917

Phase I Inspection Report

National Dam Safety Program

Prepared by

Woodward-Clyde Consultants

Chicago, Illinois

Under Direction of

St Louis District, Corps of Engineers

for

Governor of Missouri

April 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Magmont Mine Tailings Dam
State Located	Missouri
County Located	Iron
Stream	Neals Creek
Date of Inspection	12 November 1980

Magmont Mine Tailings Dam, Missouri Inventory Number 30917, was inspected by Richard Berggreen (engineering geologist), Leonard Krazynski (geotechnical engineer), and Sean Tseng (hydrologist). The dam is a lead tailings dam.

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, US Army, Washington, DC, with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines represent a consensus of the engineering profession. They are intended to provide for an expeditious identification of those dams which might pose hazards to human life or property, based on available data and a visual inspection. In view of the limited nature of the study, no assurance can be given that all deficiencies have been identified.

The St Louis District (SLD), Corps of Engineers, has classified this dam as having a high hazard potential. The damage zone length estimated by the SLD extends approximately 19 mi downstream of the dam. Within this estimated damage zone are at least eight occupied dwellings, assorted out-buildings, several unimproved roads, and a school. The contents of a portion of the downstream hazard zone were verified by aerial reconnaissance.

Magmont Mine Tailings Dam is in the large size classification based on its maximum height of 135.5 ft. Its reservoir storage capacity is approximately 12,500 ac-ft, including both tailings and water. The large dam classification criteria are: height greater than 100 ft, or storage capacity greater than 50,000 ac-ft.

Our inspection and evaluation of available data indicate the dam and appurtenant structures are in generally good condition. No evidence was noted of slope instability such as cracking, slumping or displacement of the vertical or horizontal alignment of the dam crest. No animal burrows, sinkhole development, seepage, or detrimental settlement was noted.

Our hydraulic/hydrologic analyses indicate the decant system and/or spillway will pass the 1 percent probability-of-occurrence flood without overtopping the dam. The 1 percent flood is the flood event that has a 1 percent probability of occurring in any one year, or occurs on the average once every 100 years. These analyses also indicate the dam will not be overtopped by a flood equal to 100 percent of the Probable Maximum Flood (PMF). The guidelines require large dams to pass 100 percent of the PMF as the spillway design flood. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible for the region. The embankment is composed of medium to fine sand tailings and is judged to be highly susceptible to erosion by flowing water.

Based on our inspection and evaluation of available information, the following specific recommendations are made for this dam. Action should be taken on these recommendations as soon as practical.

1. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should be made for appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of tailings dams.

2. Evaluation should be made of the feasibility of a practical warning system to alert downstream residents and traffic in the event hazardous conditions develop at this dam.

It is also recommended that a program of periodic inspections and maintenance be developed for this dam and appurtenant structures. This program should include but not be limited to the following items.

1. Monitor the embankment for evidence of slope instability such as cracking, slumping, or settlement of the dam crest.

2. Maintain the spillway and decant inlet free of debris which could lead to reduced discharge capacity. A trash rack should be provided for the decant system.

3. Monitor the quantity and turbidity of any seepage to provide early detection of any danger of piping.

All remedial measures and maintenance should be performed by or under the guidance of an engineer experienced in the design, construction, and maintenance of tailings dams.

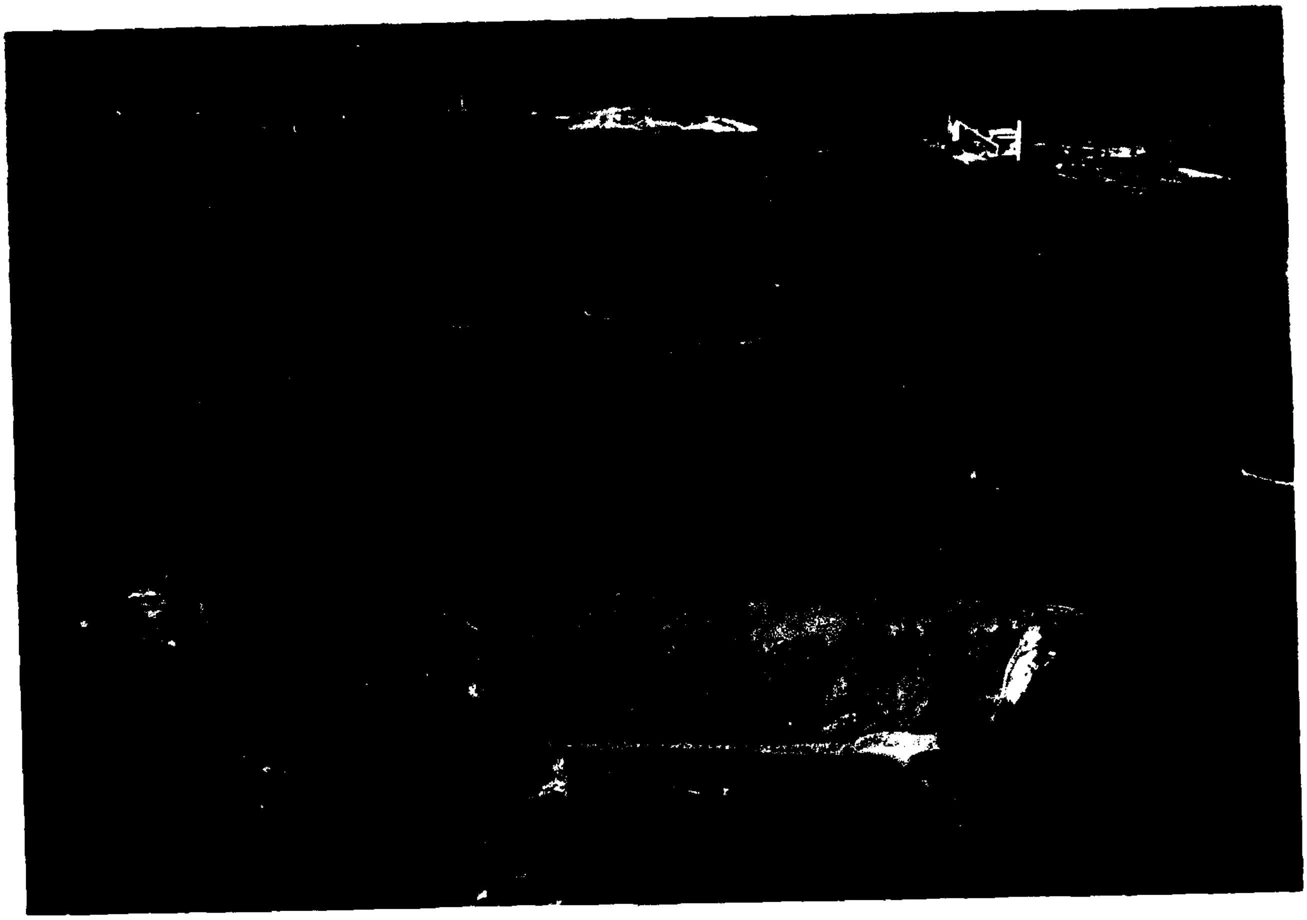
It is recommended the owner take action on these remedial measures and maintenance as soon as practical, in order to preclude development of hazardous conditions.

WOODWARD-CLYDE CONSULTANTS

Richard G. Berggreen

Richard G. Berggreen
Registered Geologist, No. 3572, CA

Leonard M. Krazynski, PE, No. C-14953, CA
Vice President



OVERVIEW

MAGMONT MINE TAILINGS DAM

MISSOURI INVENTORY NUMBER 30917

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
MAGMONT MINE TAILINGS DAM, MISSOURI INVENTORY NO. 30917

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
MAGMONT MINE TAILINGS DAM, MISSOURI INVENTORY No. 30917

SECTION 1
PROJECT INFORMATION

1.1 General

a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of the Magmont Mine Tailings Dam, Missouri Inventory Number 30917.

b. **Purpose of inspection.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").

c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams" and Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "Engineering and Design National Program for Inspection of Non-Federal Dams" prepared by the Office of Chief of Engineers, Department of the Army; and "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams," prepared by the St Louis District (SLD), Corps of Engineers. These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

a. **Description of dam and appurtenances.** Magmont Mine Tailings Dam is a lead tailings dam. Although its construction and usage are typical of other lead tailings dams in the area, it is atypical of dams constructed for the impoundment of water. The unique nature of these lead tailings dams has a significant impact on their evaluation. A brief description of their construction and usage is necessary to distinguish the differences between these dams and conventional water-retaining dams.

The lead tailings dams in southeastern Missouri have been constructed over a long period of time and include dams ranging from old abandoned dams constructed in the 1800's to modern dams still under construction. Although some construction techniques have changed, these dams share many similarities.

At the beginning of a mining operation a starter dam is frequently constructed of waste rock and residual soil. This dam is used to impound surface runoff and mine water pumped from the underground workings. The water is used in the ore processing and the transport of tailings waste. The reservoir formed by the starter dam constitutes the initial tailings disposal area.

The tailings are the waste material produced by the beneficiation and processing of the lead ore to form a high-grade lead concentrate. The coarse tailings fraction (medium to fine sand) is used to construct the dam embankment; the fine fraction (silt and fine sand) is deposited in the reservoir area. Separation of the coarse and fine fractions usually is done at a cyclone separator or a series of cyclones on the crest of the dam. The underflow or coarse fraction is deposited on the dam and the overflow or fine fraction is deposited in the reservoir, where it settles.

The dams are typically constructed using the downstream method. That is, as the tailings are added to the dam, they are deposited on the crest and downstream face. As a result, the centerline of the dam crest migrates downstream as the dam is raised.

Frequently the dam has a drainage system built into the foundation to aid in lowering the phreatic surface (water table) within the embankment. Water enters the dam both at the crest from the cyclone deposited tailings and from the upstream face where the dam is in contact with the reservoir. A clay blanket may be constructed on the upsteam face to reduce this infiltration from the reservoir.

A decant or water disposal system is typically constructed beneath the dam. This decant system consists of a vertical tower or sloping structure within the reservoir which decants or draws water from near the surface of the reservoir where the water contains the least sediment. This water is then carried beneath the dam and exits downstream of the toe of the dam. From there it may be recycled or released to the natural stream drainage. The intake level of the decant tower or structure is regulated as the tailings and reservoir level rises to maintain a balanced system of inflow and outflow. The decant system also serves as additional discharge in the event of heavy precipitation, which is generally additional to other spillway provisions.

Two characteristics are noteworthy regarding the silt and sand tailings used in the construction of these dams. First, the very uniform grain size and lack of clay or other binder makes this material extremely susceptible to erosion. It is unlikely that a dam constructed of this material could survive overtopping without dam failure. If this dam were to be overtopped, the silty sandy material composing the embankment would likely erode in a V-shaped break through which the storm water and the available water stored behind the dam would drain. A portion of the ponded tailings would be eroded and carried by flowing water through the V-shaped breach. Second, the finely ground limestone and dolomite tailings are almost barren of nutrients necessary to support vegetation. It is frequently necessary to import topsoil or fertilizer in order to successfully vegetate the dam embankment. This difficulty in vegetating the surface of the dam contributes to the potential for erosion of the dam.

Magmont Mine Tailings Dam basically follows these local practices. A clay starter dam was originally constructed and was covered with tailings using a downstream construction technique. A decant system extends from a sloping intake structure on the right bank of the reservoir (as observer faces downstream) to the discharge below the toe of the dam. A broad trapezoidal spillway has been excavated in the right abutment. No control gates or other structures are present in the spillway.

b. **Location.** The dam is located on Neals Creek, approximately 2 mi south of Bixby in Iron County, Missouri (Fig. 1). The dam is in Section 24, T34N, R2W, on the USGS Viburnum East (1967) 7.5 minute quadrangle map.

c. **Size classification.** The dam is classified large based on the height of 135.5 ft. The maximum storage capacity of both tailings and water is approximately 12,500 ac-ft. The large dam classification criteria are: height greater than 100 ft, or storage capacity greater than 50,000 ac-ft.

d. **Hazard classification.** The St Louis District (SLD), Corps of Engineers, has classified this dam as having a high hazard potential; we concur with this classification. The SLD estimated damage zone length extends 19 mi downstream of the dam. Within this estimated damage zone are at least eight occupied dwellings, assorted out-buildings, several unimproved roads and a school. Contents of a portion of the damage zone were verified by aerial reconnaissance. The potential for loss of life and property damage could be high in the event of failure of this dam.

e. **Ownership.** We understand the dam is owned by Cominco American, Inc, Magmont Mines, Bixby, Missouri, 65439. Correspondence should be sent to the attention of Art Schweizer, Mill Superintendent.

f. **Purpose of dam.** The dam was constructed to impound tailings produced in the milling and processing of lead ore from the adjacent Magmont Mine.

g. **Design and construction history.** Construction of the dam was begun in 1966. A clay starter dam was initially constructed. The dam was keyed to the top of rock according to design plans supplied by Cominco American. The tailings portion of the dam was finished in June 1979.

The starter dam was designed by Harding, Miller, Lawson and Associates, San Rafael, California. Laboratory test results on starter dam materials are included in Appendix C. The general design engineer for the tailings dam and outlet works was Arthur G. McKee and Company, San Francisco, California. Design plans prepared by the design firm are also presented in Appendix C. Typical construction practices for construction of lead tailings dams are presented in Section 1.2a.

1.3 Pertinent Data

a. **Drainage area.** 1.28 mi^2

b. **Discharge at dam site.**

Maximum known flood at damsite	Unknown
Warm water outlet at pool elevation	N/A (not applicable)
Diversion tunnel low pool outlet at pool elevation	N/A
Diversion tunnel outlet at pool elevation	N/A
Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation	11,000 ft^3/sec
Total spillway capacity at maximum pool elevation	11,000 ft^3/sec

c. **Elevations (ft above MSL).**

Top of dam	1315.5
Maximum pool-design surcharge	N/A
Full flood control pool	N/A
Recreation pool	N/A
Spillway crest (gated)	N/A
Upstream portal invert diversion tunnel	N/A
Downstream portal invert diversion tunnel	N/A
Streambed at centerline of dam	1190
Maximum tailwater	Unknown
Toe of dam at maximum section	1180

d. **Reservoir.**

Length of maximum pool	5200 ft
Length of recreation pool	N/A
Length of flood control pool	N/A

e. **Storage (acre-feet).**

Recreation pool	N/A
Flood control pool	N/A
Design surcharge	N/A
Top of dam (total storage)	12,500
Spillway crest (total storage)	9500
Decant system inlet (total storage)	6800 (includes approximately 800 ac-ft of water storage)
Tailings storage (approximate)	7000 (includes approximately 1000 ac-ft of tailings storage above elevation of decant system inlet)

f. **Reservoir surface (acres).**

Top of dam	252
Maximum pool	252
Flood control pool	N/A
Recreation pool	N/A
Spillway crest	198

g. **Dam.**

Type	Cyclone deposited lead tailings
Length	1190
Height	135.5 ft
Top width	40 ft
Side slopes	Downstream slope designed at 3(H) to 1(V) ranges from 2-1/2(H) to 1(V) at top of slope to 4(H) to 1(V) near toe. Upstream slope, exposed portion approximately 3(H) to 1(V).

Zoning	Earth starter dam to el. 1270, upstream clay blanket, fine sand tailings embankment, earth toe dam with rock fill at downstream toe. (From design plans. No record of as-built configuration).
Impervious core	None
Cutoff	Minimum 10 ft wide trench to rock (From design plans. No record of as-built configuration.)
Grout curtain	None

h. <u>**Diversion and regulating tunnel.**</u>

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating facilities	N/A

i. <u>**Spillway.**</u>

Type	Broad trapezoidal cut in right abutment. Excavated into soil and weathered rock.
Length of weir	65 ft at el. 1302 ft.
Crest elevation	1302 ft
Gates	None
Downstream channel	Steep slope down hillside below spillway. No well defined channel.

j. <u>**Regulating outlets.**</u> Decant-storm drain. Sloping intake structure on right bank of reservoir, 42 in. line below reservoir and dam, exits below toe of embankment. Discharge capacity calculated at 300 ft^3/sec. Crest elevation of decant system at time of inspection was approximately 1286 ft (MSL).

SECTION 2
ENGINEERING DATA

2.1 Design

Design drawings for the construction of the tailings embankment, prepared by Arthur G. McKee and Company, San Francisco, California, were supplied by Cominco American. Laboratory classification and strength test results on materials used in the starter dam prepared by Harding, Miller, Lawson and Associates, San Rafael, California, were also supplied to the inspection team by Cominco American.

Other data on the dam and appurtenant structures were obtained through interviews with Mr Art Schweizer, Mill Superintendent for the Magmont Mine.

2.2 Construction

Construction of the dam was begun in 1966. Initially a clay soil starter dam was constructed to an elevation of 1270 ft. Side slopes were 2.5(H) to 1(V) with a 30 ft wide crest. The dam was keyed to the top of rock by a trench, minimum width 10 ft, variable depth.

Fine sand tailings were pumped from the mill to cyclone separators at the crest of the dam. The coarse fraction from the cyclones was used to build the tailings embankment downstream of the starter dam. Slopes on this portion of the dam were designed at 3(H) to 1(V). The designed crest elevation of the tailings portion was 1310 ft. The finished crest was surveyed by Cominco American as varying from 1315.5 to 1316.4.

A clay blanket was built on the upstream face and had a minimum designed width of 14 ft at the top, tapering thicker with depth. This blanket extended from the crest of the tailings embankment to the crest of the earth starter dam.

A clay earth toe dam was constructed at the proposed toe of the tailings embankment. A filter drain extending from beneath the tailings embankment passes beneath and along the upstream slope of the toe dam. A rock dike forms the lower portion of the downstream face of the toe dam.

Construction of the dam was completed in June 1979. Completion work such as vegetation of the spillway and downstream slope of the embankment is still continuing.

2.3 Operation

Discharge from the reservoir under normal operating conditions is through the decant storm drain structure located along the right bank of the reservoir. As the lake and tailings level rises, normal procedures are to raise the intake elevation by addition of concrete plates to the top of the open flume intake structure. No records were made available to us of historical flows through the decant line.

Tailings are no longer being added to the dam but are introduced, by a pipeline from the plant, into the upstream ends of the reservoir.

No other facilities requiring operation were identified at this dam.

2.4 Evaluation

a. **Availability.** The available information on engineering and construction is as described above in Section 2.1, Design. No other records or design drawings were made available to our inspection team.

b. **Adequacy.** The available information is insufficient to evaluate the design of Magmont Mine Tailings Dam.

   Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not on record. This is a deficiency that should be rectified. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. These analyses should be performed by an engineer experienced in the design and construction of tailings dams.

c. **Validity.** There appears no reason to question the validity of information obtained from Cominco American. It is in general agreement with the observation made during the visual inspection. However, the information is incomplete.

2.5 Project Geology

The dam is located on the western flank of the Ozark structural dome. The regional dip of the bedrock is toward the west. The bedrock at the dam site is mapped on the Geologic Map of Missouri (1979) as the Potosi and Eminence Dolomite formations (Fig. 4). The Potosi Dolomite is typically a light gray, medium- to finely-crystalline dolomite with an abundance of quartz druse characteristic of chert-bearing formations. The Eminence Dolomite conformably overlies the Potosi Dolomite and likely forms the bedrock strata at the dam site. The Eminence Dolomite is similar in appearance to the Potosi Dolomite but contains less chert and quartz. Some large springs and caves have been noted in the Eminence Dolomite in parts of Missouri; however, no evidence of springs or significant solution activity was found during the visual inspection.

The soil in the vicinity of the dam site is a dark red-brown, plastic residual clay (CL-CH) characteristically developed on the carbonate bedrock in the area. The soil contains abundant quartz druse gravel typical of soils developed by weathering of the Potosi Dolomite. The soils in this area are mapped on the General Soils Map of Missouri (1979) as Captina-Clarksville-Doniphan Soil Association.

The dam is located approximately 7 mi northwest of the Black Fault (Fig. 4). The fault trends northwest-southeast and has a mapped length of approximately 16 mi, with displacement shown as northeast side up.

The Palmer Fault system is a complex branching network of faults approximately 12 mi north of the dam site. The system trends east-west for approximately 40 mi through southern Crawford and Washington Counties. Displacement on this fault is mapped as north side up.

The Ellington Fault is located approximately 20 mi southwest of the dam, has a mapped length of 22 mi, and is mapped as northeast side up.

These faults, like most others in the Ozark region, are within Precambrian and Paleozoic bedrock and are likely Paleozoic in age. They are not considered to pose an unusual hazard to the dam.

The dam is located approximately 110 mi northwest of the line of epicenters for the very large New Madrid earthquakes which occurred in 1811 and 1812. A recurrence of an earthquake of the magnitude of the New Madrid event could cause damage to the dam, but an assessment of this risk is beyond the scope of this Phase I investigation.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. **General.** Magmont Tailings Dam was inspected 12 November 1980. Mr Art Schweizer of Cominco American accompanied the inspection team throughout the inspection. The results of the inspection indicate the dam and appurtenant structures are in generally good condition.

b. **Dam.** The dam is a lead tailings embankment, constructed as described in Sections 1.2a and 2.2. The material comprising the bulk of the embankment consists of medium to fine sand (Photo 1), the coarse tailings fraction from cyclone separation. The fine fraction was discharged into the tailings reservoir. The embankment materials are considered highly susceptible to erosion by flowing water.

The upstream face of the dam is covered by a clay blanket with a designed minimum thickness of 14 ft to limit water infiltration into the embankment. This face of the dam has a well developed cover of grass (Photo 2) and is considered to have a moderately low erosion potential. No riprap for erosion protection has been installed.

The crest of the dam is crossed by an unpaved gravel road. Gravel berms have been placed along the shoulders of the road (Photo 3) to prevent precipitation runoff from the crest of the dam causing erosion on the embankment slopes.

A program of vegetating the downstream slope of the embankment had just begun prior to the inspection visit (Photo 4). A portion of the downstream slope had been seeded with grass, covered with straw, and overlain with netting to control erosion (Photo 5). It was too early, at the time of the visual inspection visit, to evaluate the success of the vegetation program. However, no evidence of significant erosion was noted on the embankment.

No evidence of cracking, slumping, detrimental settlement, or disruption of the vertical or horizontal alignment of the dam crest was noted. No evidence of sinkhole development or animal burrows was noted.

Abutment drains, composed of river gravel, have been placed at the junction of the embankment and abutments (Photo 6) to prevent runoff from the abutments causing gullying on the embankment. These drains appear to be functioning well and no erosion was noted in these areas.

No seepage was noted at the toe of the dam or through the abutments.

No evidence or record of prior overtopping of the embankment was noted during the inspection.

A decant system from the reservoir passes beneath the dam and exits below the toe of the dam. This system was flowing an estimated 2 to 3 ft^3/sec at the time of the inspection (Photo 7 and 8). The flow appeared clear.

A rock and soil toe dam (at the toe of the tailings embankment) is exposed in the lowest portion of the downstream face (Photo 9 and Overview). This dam is constructed of gravelly residual soil. Portions of this dam are sparsely vegetated with grass and weeds; other portions are barren. Some erosion gullying has occurred on this material but does not appear at this time to be significant with regards to the structural stability of the embankment.

c. **Appurtenant structures.**

1. Spillway. The spillway at this dam is a broad trapezoidal cut (Photo 10) in the right abutment (as the observer faces downstream). The spillway is excavated into undisturbed soil and weathered rock. The relatively flat slope indicates that erosional deepening of the spillway during flood flows should not be great enough to pose an unusual hazard to the safety of the dam. Footings have been excavated in the spillway for the construction of a concrete weir but construction had not begun at the time of the visual inspection. The floor and slopes of the spillway were planted with grass which has developed an incomplete cover. This will contribute to limiting the erosion potential in the spillway during moderate flows.

No flow was occurring through the spillway and no evidence or record of flow was found during the visual inspection. There did not appear to be any potential for obstructing this spillway during flood flows.

2. Decant-Storm drain system. In addition to the spillway, a discharge facility consisting of a decant system storm drain is present at this dam. The facility consists of a sloping intake structure on the right bank of the reservoir, a 42-in. pipeline beneath the reservoir and dam, and a concrete outlet below the toe of the dam (Photos 7 and 8). The intake structure consists of sloping concrete flume, partly open at the top. In order to control flow through this outlet as the lake and tailings level rises, concrete plates are added to cover the top of the flume to a selected elevation. Storm runoff or additional discharge into the reservoir will be passed through this structure until the reservoir reaches the elevation of the spillway crest. Flow passes through a 42-in. concrete pipe, approximately 1400 ft long. The discharge point is a box structure below the toe of the dam (Photo 7). This decant-storm drain was flowing approximately 2 to 3 ft^3/sec at the time of the visual inspection. The flow appeared clear.

d. **Reservoir area.** The reservoir serves as a storage impoundment for lead tailings produced at the Magmont Mine. Much of the reservoir is currently filled with tailings. The reservoir has been separated into two small and one large impoundments by two dikes which cross arms of the reservoir (Overview Photo and Photo 8). Elevations of the crests of the dikes are such that the dikes will be submerged prior to overtopping of the main dam and they have been disregarded in the overtopping analysis (Section 5).

Slopes surrounding the reservoir are for the most part densely wooded and are relatively flat, 5(H) to 1(V), or flatter. No evidence of unstable slopes were noted during the inspection visit.

e. **Downstream channel.** The downstream channel is a steeply sloping hillside, estimated at 3(H) to 1(V), downstream of the spillway (Photo 11). This steep slope indicates the control section for discharge is in the spillway. Erosion can be anticipated in this downstream channel during flood flows, as the channel consists of residual soil and weathered rock. However, the location of the channel well away from and downstream of the embankment indicates erosion in this channel is not likely to adversely impact the safety of the dam. No evidence or record of flow in the channel, other than surface runoff, was noted during the visual inspection.

3.2 Evaluation

The visual inspection indicated the embankment and appurtenant structures are in generally good condition. The tailings portion of the embankment is considered highly susceptible to erosion by flowing water. However, a program to vegetate the downstream face has been initiated to reduce this erosion potential. No evidence of significant erosion was noted during our field inspection. The upstream face is already vegetated with a well developed cover of grass. No evidence was noted during the visual inspection of slumping, cracking, detrimental settlement or disruption of the vertical or horizontal alignment of the dam crest. No animal burrows or development of sinkholes was noted. No seepage was noted at either the toe of the dam or along the abutments. The spillway did not appear subject to significant erosion. The discharge channel downstream of the spillway may be subject to erosion, but erosion is not anticipated to pose a significant safety hazard to the dam due to the distance from the main embankment. The decant storm drain system appeared to be in generally good condition, and was flowing an estimated 2 to 3 ft^3/sec at the time of the visual inspection.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

There are no operating facilities on the dam. Within the reservoir, operating procedures consist of periodically raising the intake level of the decant system as tailings are deposited and the reservoir level rises. This is achieved by adding concrete plates to the open top of the sloping flume which carries water from the reservoir to the pipe which runs beneath the dam. No other gates or controls are present on the decant system or within the spillway.

4.2 Maintenance of Dam

Following completion of the dam in June 1979, a program of vegetation was initiated at this facility to reduce the potential for erosion of the tailings embankment. The upstream face has been vegetated and has developed a good covering of grass. Vegetation of the downstream face has only recently begun. The program consists of seeding the embankment, covering the seed with straw, and a netting which is designed to decompose and contribute fertilizer. At the time of the visual inspection, the success of this vegetation program could not be assessed.

The road across the dam crest and the erosion control gravel berms on the shoulders of the road appeared to be in a good state of repair.

4.3 Maintenance of Operating Facilities

There are no mechanical facilities requiring maintenance at this dam. The ungated spillway has been seeded to limit erosion. The decant system should be provided with a trash rack to prevent clogging and obstruction of flow.

4.4 Description of Any Warning System in Effect

The visual inspection did not identify any warning system in effect at this facility.

4.5 Evaluation

The embankment and appurtenant structures appear to be well maintained. A trash rack is recommended for the decant inlet to prevent clogging and obstruction of flow.

It is recommended that a program of regularly scheduled maintenance be initiated to assure the necessary maintenance is continued. Records of the maintenance should be kept on file.

The feasibility of a practical warning system should be evaluated to alert downstream residents in the event potentially hazardous conditions develop at this dam.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. **Design data.** Some preliminary hydrologic analyses for the Magmont Mine Tailings Dam and appurtenant structures were performed by Mr Art Schweizer of Cominco American. These analyses were provided to the inspection team and pertinent analyses include:

1. Maximum Probable Flood Calculations,

2. Storage Capacity Calculations,

3. Decant Line Capacity,

4. Spillway Capacity, and

5. A Summary Fact Sheet on the Dam and Appurtenant Structures.

A comparison of the results of the analyses performed by Cominco American and the hydraulic/hydrologic analyses performed for this Phase I investigation indicate a fairly good correlation. Values for reservoir water surface, spillway capacity, decant line capacity, and overtopping potential were in rough agreement for both analyses. The results presented in this report, however, refer only to the Phase I analyses, following the format presented in the SLD guidelines for hydraulic/hydrologic analyses.

b. **Experience data.** No records of historical rainfall, runoff, discharge, or pool stage data were found for this reservoir.

c. **Visual observations.**

1. Watershed. The watershed is forested with mixed hardwoods and softwoods. The area of the reservoir is approximately 23 percent of the total drainage area of 1.28 mi^2.

2. Reservoir. The reservoir and dam are described in Section 3 of this report and by the maps and photographs enclosed herewith. The reservoir is used for storage of tailings.

3. Spillway. The ungated spillway is located at the south end of the dam. The steep discharge channel below the spillway indicates that the spillway acts as the control section for flow. A 42-in. diameter decant pipe, about 1400 ft long, also discharges water below the toe of the dam. This pipe was assumed to be operative in the hydraulic/hydrologic analyses.

d. **Overtopping potential.** One of the considerations in the evaluation of Magmont Mine Tailings Dam is the assessment of the potential for overtopping and consequent failure of the embankment by erosion. Since the spillway of this dam is grass-lined earth and weathered rock, some erosion at the control section of the spillway due to high velocity discharge is expected to occur during significant flood flows through the spillway. However, the spillway is located away from the dam embankment and erosion is not anticipated to pose an unusual hazard to the safety of the dam. The lowest portion of the dam crest, which is near the north end of the embankment, was considered to be the top of the dam for the purpose of determining the overtopping potential.

Hydrologic analysis of this dam for the 1 and 10 percent probability-of-occurrence and Probable Maximum Floods (PMF) were all based on initial water surface elevations equal to the spillway crest elevation. The results of the analysis indicate that a flood of 100 percent of PMF will not overtop the dam. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The analysis also indicates that the 1 percent probability-of-occurrence (100 year) flood event will be stored in the reservoir and passed by the decant pipe and spillway without overtopping the dam. The 1 percent probability-of-occurrence flood event is the precipitation event that has a 1 percent chance of occurring in any year, or occurs on the average of once every 100 years.

The following data were computed for various flood events, assuming no erosion of the spillway or the embankment.

Precipitation Event	Max. Reservoir WS Elev., ft, MSL	Max. Depth Over Dam, ft	Max. Outflow, ft^3/sec	Duration of Overtopping, hrs
1% Prob	1302.0	0	300	0
50% PMF	1304.2	0	1000	0
100% PMF	1307.0	0	2900	0

Input data and output summaries for the hydrologic and hydraulic analyses are presented in attached Appendix B.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual inspection. Results of the visual inspection of the dam are given in Section 3.1b. There were no indications of structural instability such as displacement, cracking, or slumping. The vertical and horizontal alignment of the dam crest was undisturbed by deformation. No evidence was noted of excessive settlement, sinkhole development, animal burrows, or erosion. No evidence was noted of detrimental seepage through the embankment or abutments.

b. Design and construction data. Design and construction data were available for review. The data supplied by Cominco American to the inspection team included:

1. Laboratory classification and strength tests on proposed starter dam materials by Harding, Miller, Lawson and Associates;

2. Compaction and permeability tests of tailings used in the dam construction; and

3. Plans of the tailings pipeline and tailings dam, drawing numbers 926-603G and 926-610G, prepared by Arthur G. McKee and Company.

As-built construction records were not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating records. No operating records were available for this facility.

d. **Post construction changes.** Construction is currently underway for installation of a concrete spillway weir. A program of vegetation of the spillway and downstream face of the dam is also underway. No other post construction changes were noted during the visual inspection.

e. **Seismic stability.** The dam is located in Seismic Zone 2, to which the guidelines assign a moderate damage potential. As no static or seismic stability analyses are available for review, the seismic stability cannot be evaluated.

The uniform sand and silt size tailings are probably quite susceptible to liquefaction if the tailings are comparatively loose and saturated. No information is available on the relative density of the material or the phreatic surface (water table) within the tailings, but substantial deformation and possibly failure of the embankment could occur during a severe seismic event.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. **Safety.** Based on our visual inspection and evaluation of available data, Magmont Mine Tailings Dam is judged to be in generally good condition.

There is no evidence of disruption of the vertical or horizontal alignment of the dam crest, no sinkhole development, cracking, slumping, erosion or animal burrows noted. The upstream slope is vegetated with grasses and a program is underway to vegetate the downstream slope.

Hydraulic/hydrologic analyses performed on this dam indicate the reservoir, spillway, and decant line are sufficient to store and pass 100 percent of the Probable Maximum Flood (PMF) without overtopping the embankment. These analyses were in general agreement with similar analyses performed by Cominco American.

Seepage and stability analyses for this dam were not available, which is considered a deficiency under the requirements of "Recommended Guidelines for Safety Inspection of Dams."

b. **Adequacy of information.** The visual inspection and information obtained from Cominco American provided sufficient information to support the conclusions presented in this Phase I report. Seepage and stability analyses as required by the guidelines are not on record, which is considered a deficiency which should be rectified.

c. **Urgency.** The deficiencies described in this report could affect the safety of the dam. The recommendations for further analyses and remedial work presented in Section 7.2b and 7.2c should be performed as soon as practical.

d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspection of Dams," the subject investigation was a minimum study. This study revealed that additional in-depth investigations are needed to complete the assessment of the safety of the dam. Those investigations which should be performed as soon as practical are described in Section 7.2b. It is our understanding from discussions with the St Louis District that any additional investigations are the responsibility of the owner.

7.2 Remedial Measures

a. **Alternatives.** There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Remove the dam, or breach it to prevent the storage of water.

2. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy.

3. Provide a highly reliable flood warning system (generally does not prevent damage but decreases the chances for loss of life).

b. **Recommendations.** Based on our inspection and evaluation of data for Magmont Mine Tailings Dam, it is recommended the following topics be evaluated as soon as practical.

1. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should consider appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of tailings dams.

2. Evaluation should be made of the feasibility of a practical warning system to alert downstream residents and traffic, in the event hazardous conditions develop at this dam.

c. <u>O & M procedures.</u> It is recommended that a program of periodic inspections and maintenance be developed for this dam and appurtenant structures. This program should include but not be limited to the following items.

1. Monitor the embankment for evidence of slope instability such as cracking or slumping, or settlement of the dam crest.

2. Maintain the spillway and decant inlet free of debris which could lead to reduced discharge capacity. The decant system should be provided with a trash rack to prevent clogging.

3. Monitor the quantity and turbidity of any seepage to provide early detection of any danger of piping.

All remedial measures and maintenance should be performed by or under the guidance of an engineer experienced in the design, construction, and maintenance of tailings dams.

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McCracken, M. H., 1971, Structural Features Map of Missouri: Missouri Geological Survey, scale 1:500,000.

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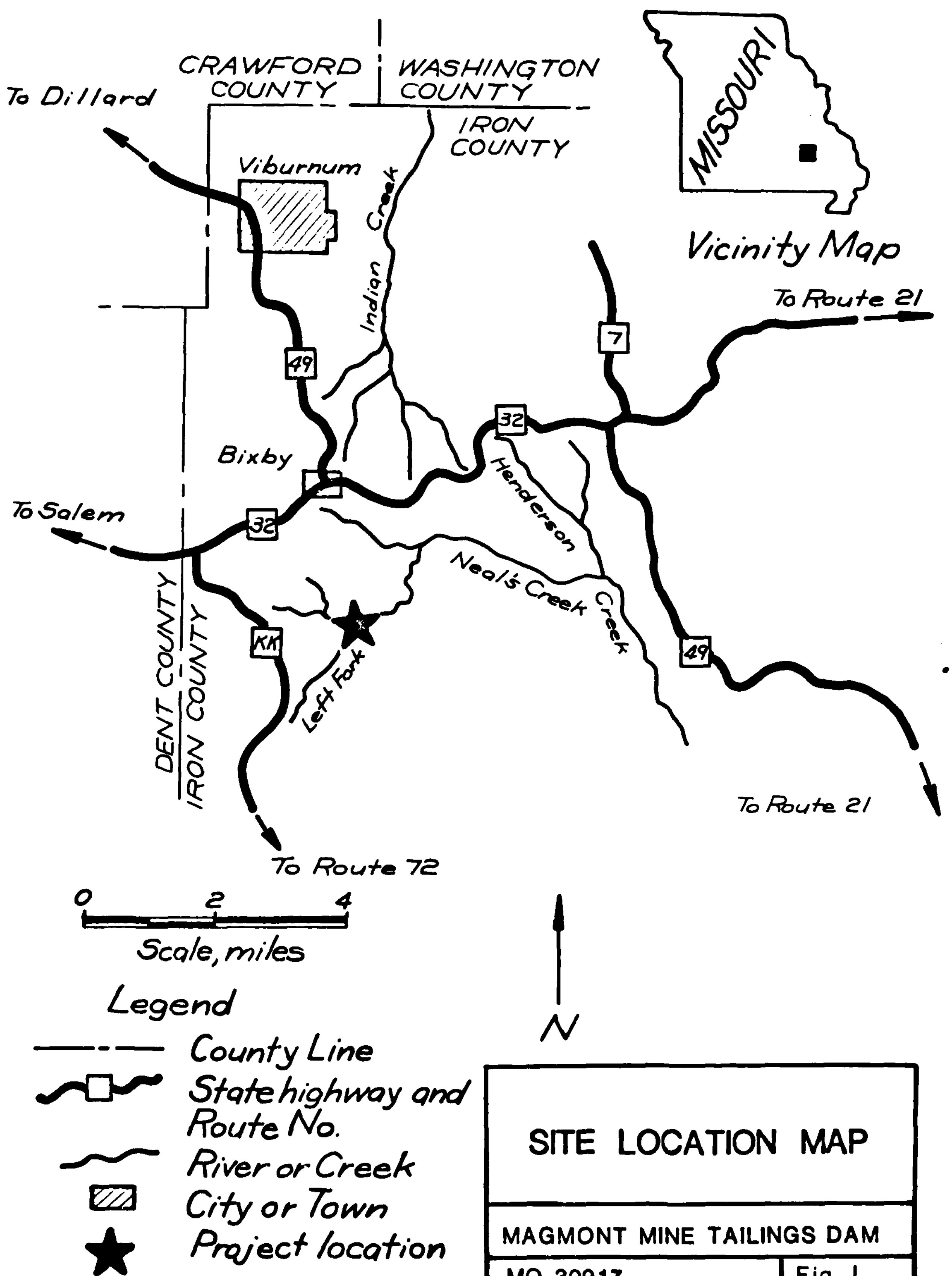
US Department of Commerce, US Weather Bureau, 1956, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours, Hydrometeorological Report No. 33.

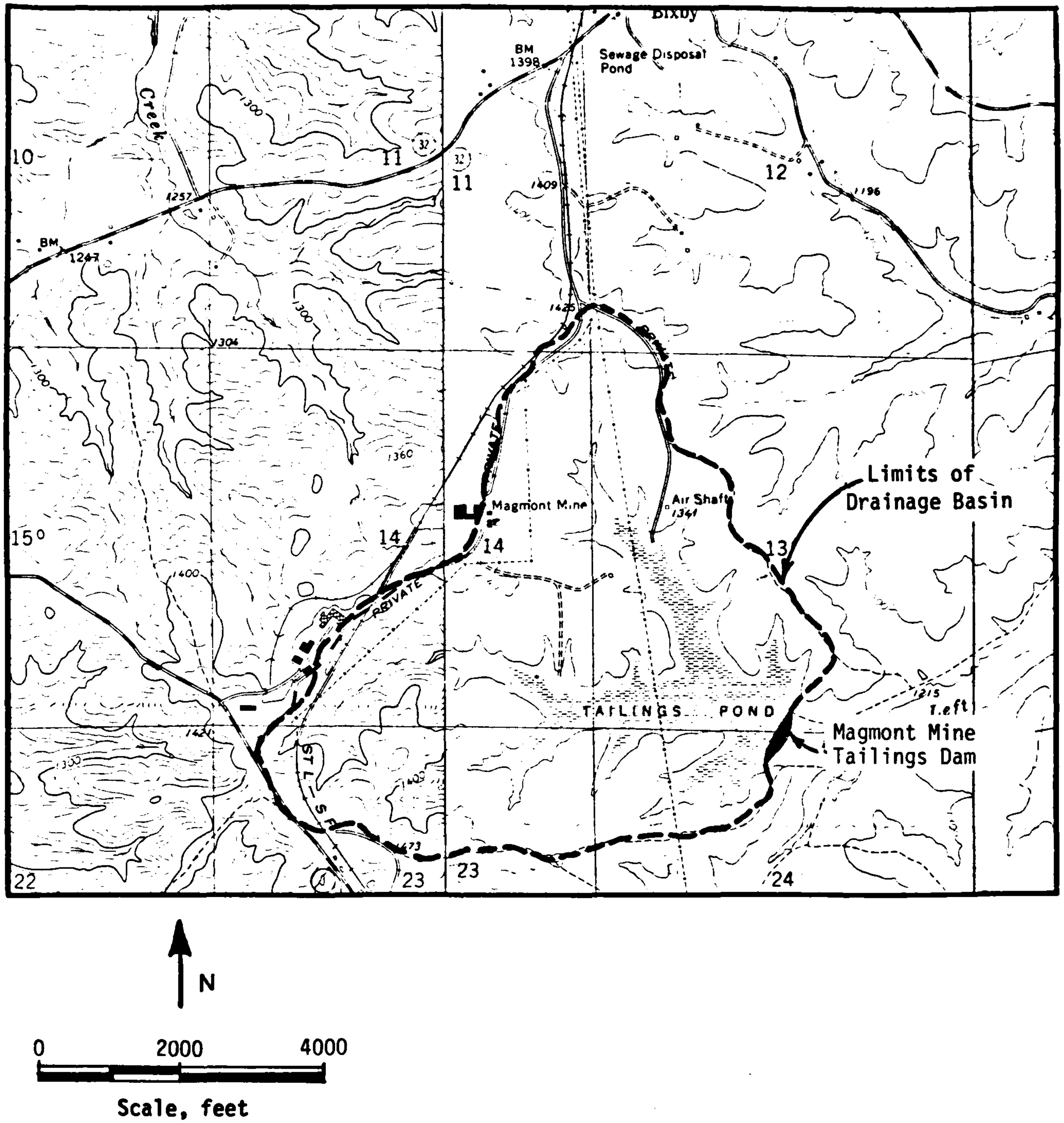


SITE LOCATION MAP

MAGMONT MINE TAILINGS DAM

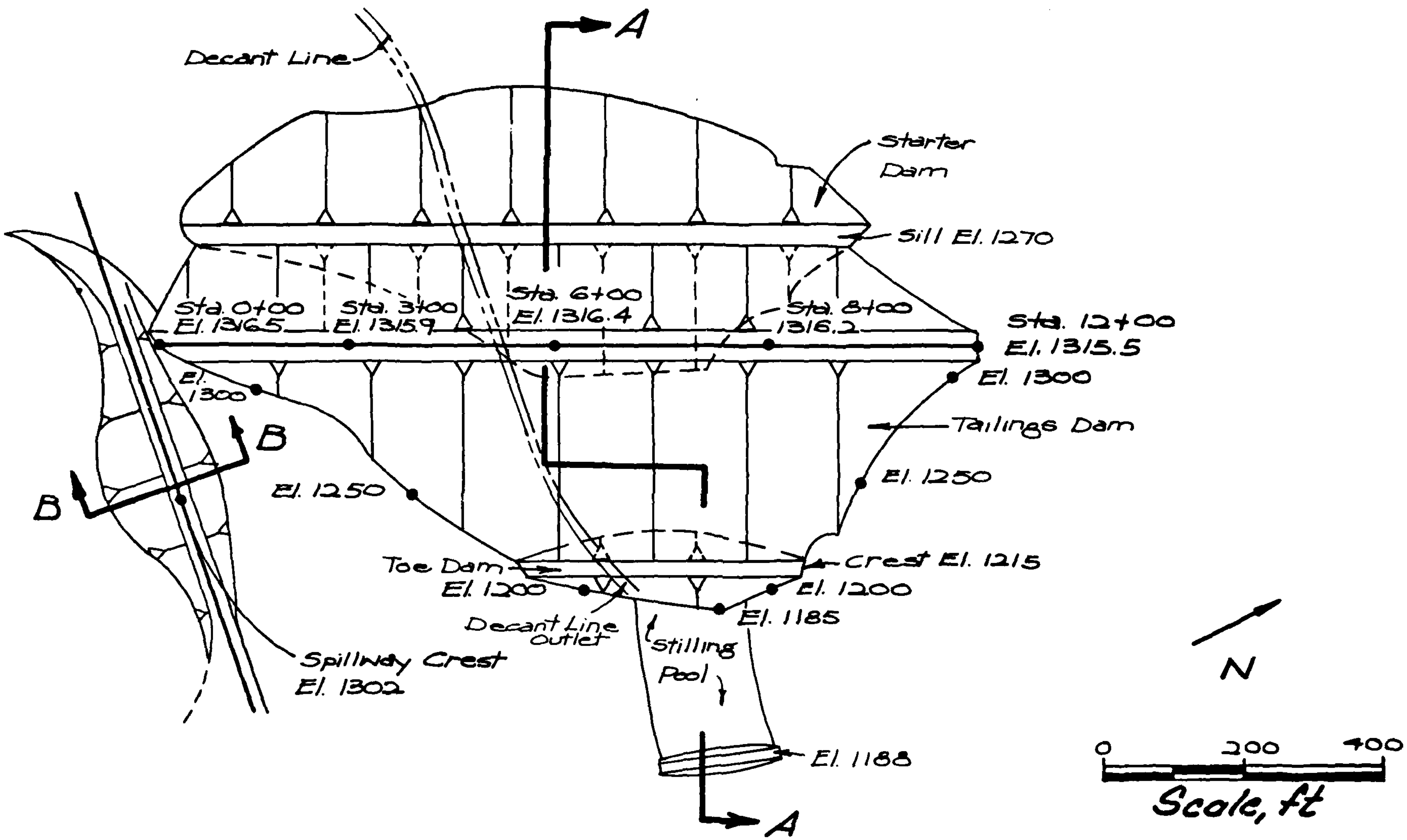
MO 30917

Fig. 1



Notes:
1. Topography from USGS Viburnum West and Viburnum East 7.5-minute quadrangle maps (1967).

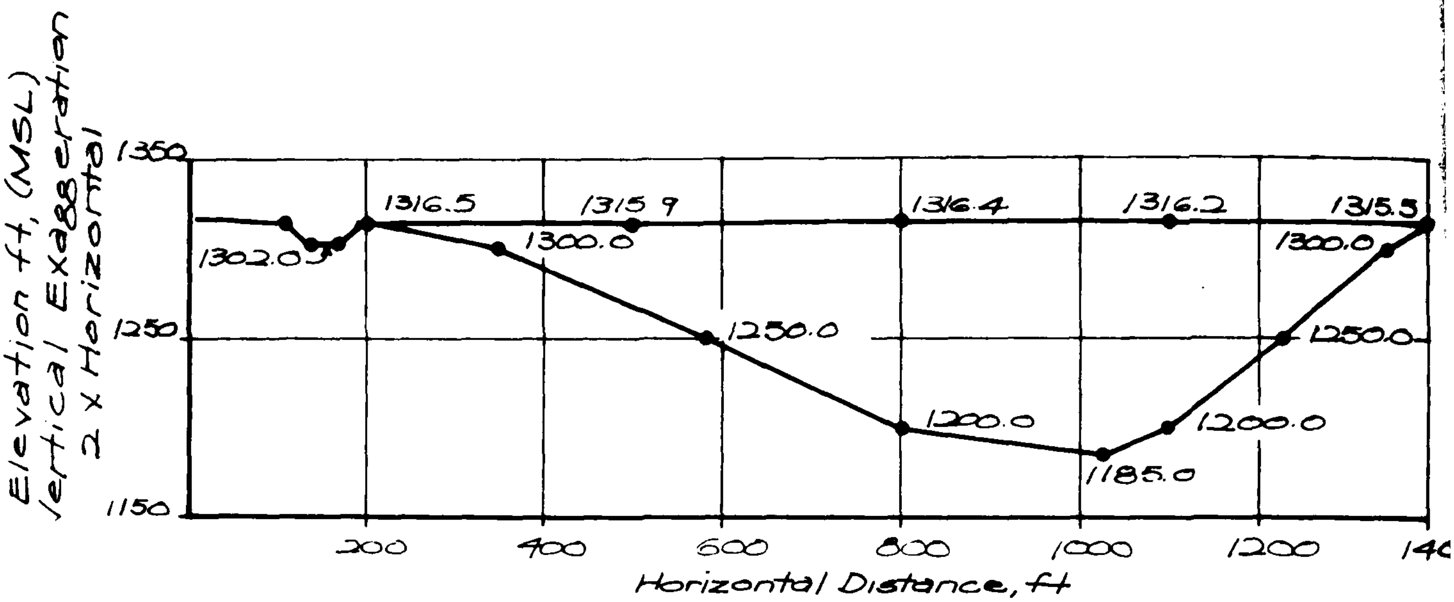
DRAINAGE BASIN AND SITE TOPOGRAPHY	
MAGMONT MINE TAILINGS DAM	
MO 30917	Fig. 2



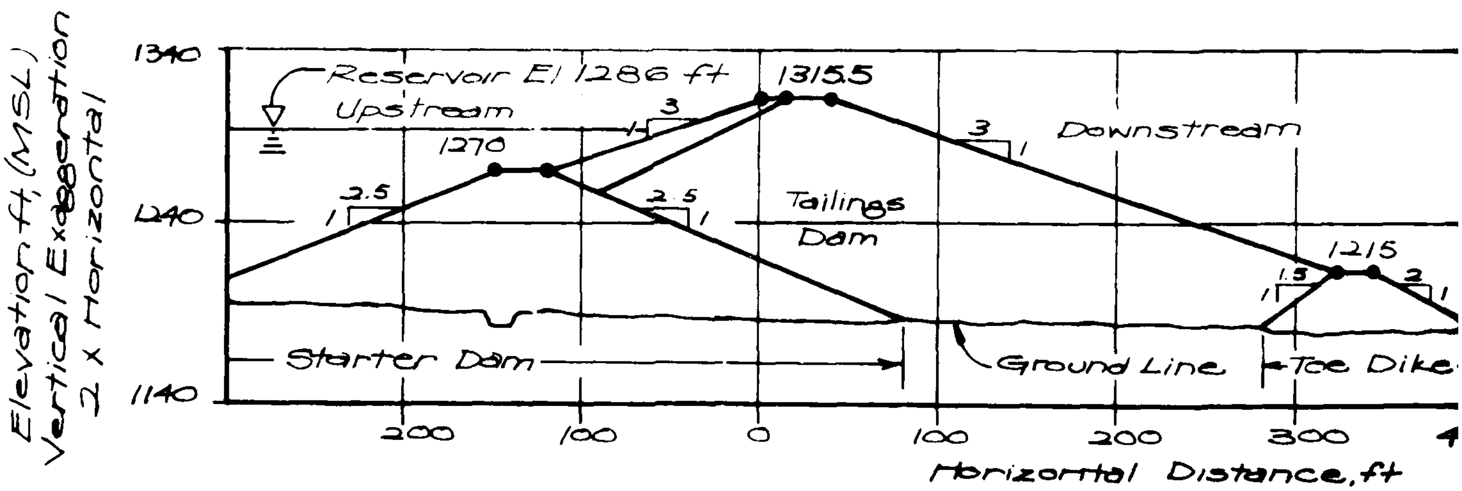
Notes:

1. From Arthur G. Mekee Drawing No. 926-603G dated 6 October '66
2. Elevations of Spillway and Dam Crest Surveyed by Cominico American for this report.

PLAN OF DAM	
MAGMONT MINE TAILINGS DAM	
MO 30917	Fig. 3-A

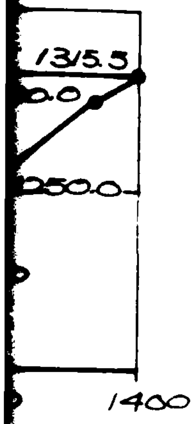


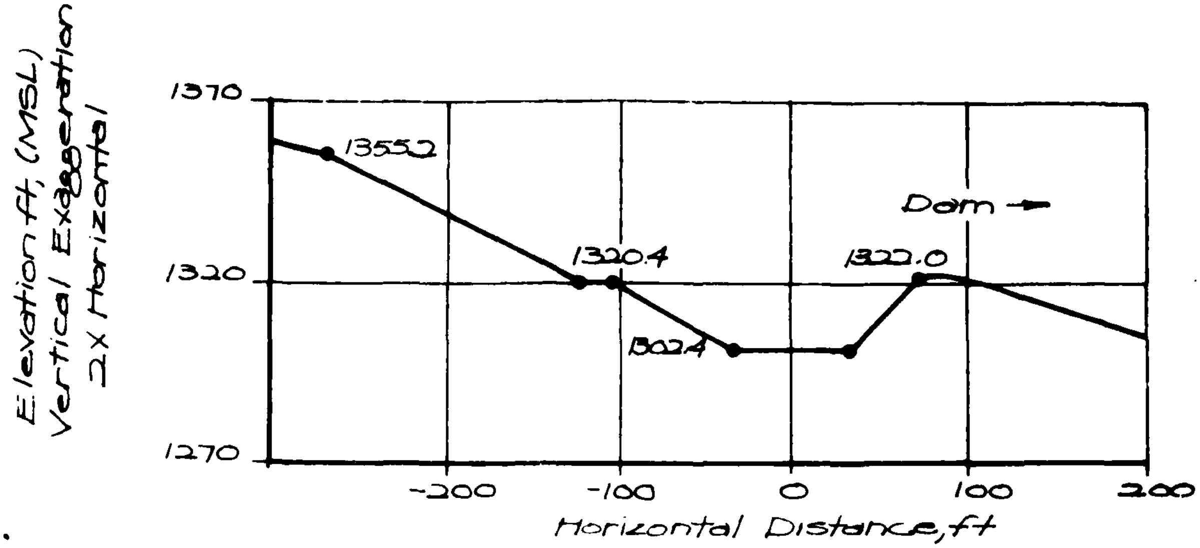
DAM PROFILE



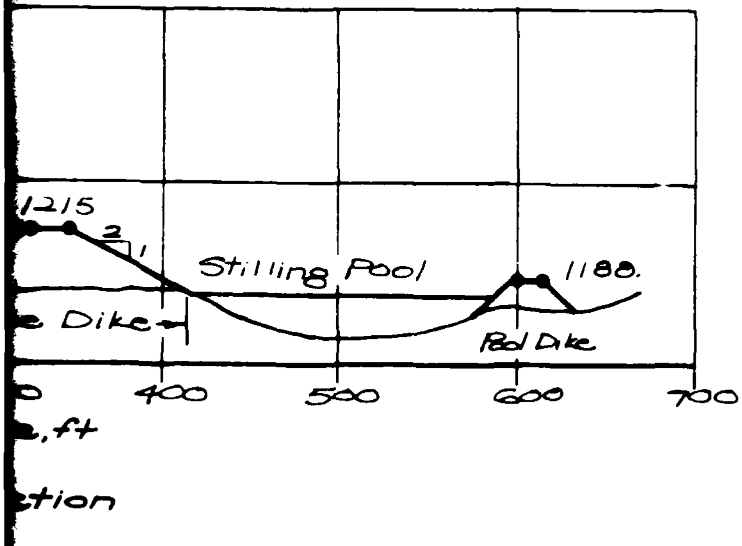
SECTION A-A

Maximum Dam Section

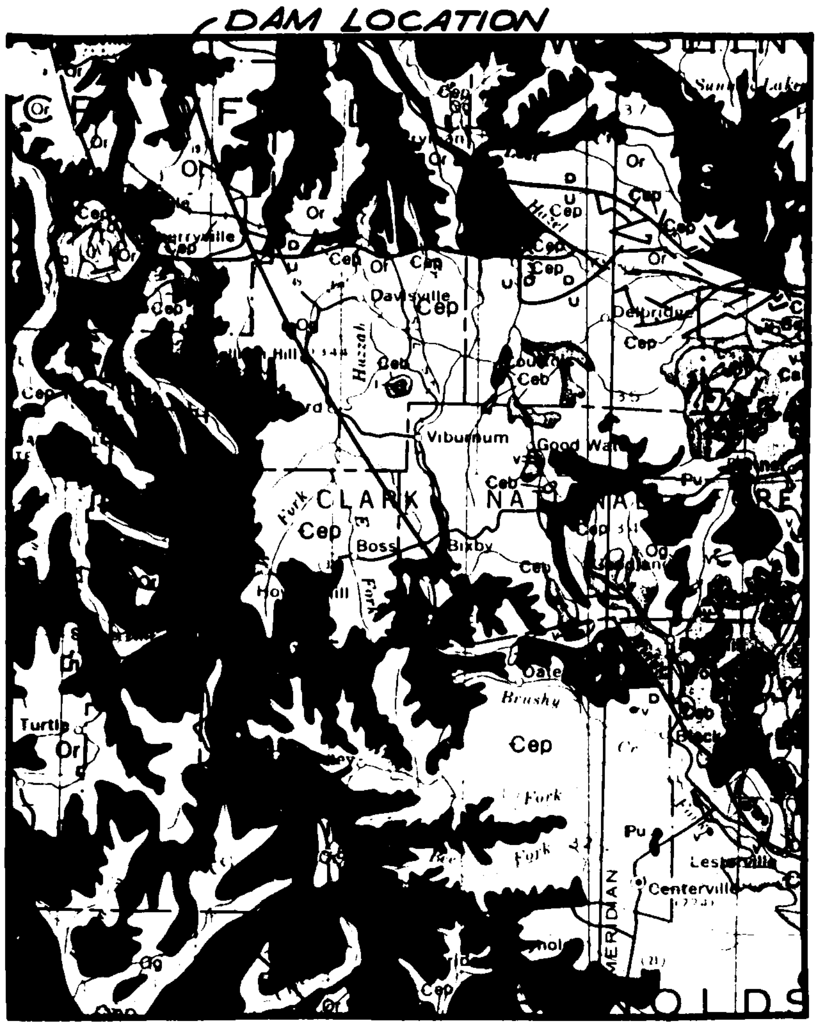


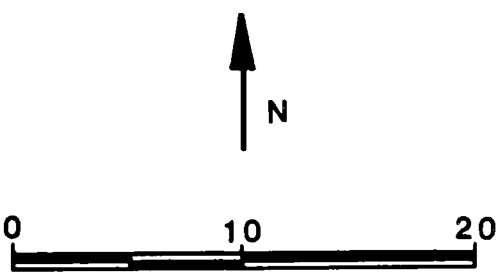


SECTION B-B
Spillway Section



DAM
PROFILE AND
MAGMONT MINE TAILINGS DAM
MO 30017





Scale, mile

Legend

OJC	Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite
Or	Roubidoux Formation
	Gasconade Dolomite Gunter Sandstone Member
Cep	Eminence Dolomite Potosi Dolomite
Ceb	Derby-Doerun Dolomite Davis Formation Bonneterre Formation Whetstone Creek Member Sullivan Siltstone Member
	Reagan Sandstone (subsurface, western Missouri) Lamotte Sandstone
	Diabase (dikes and sills) St. Francois Mountains Intrusive Suite St. Francois Mountains Volcanic Supergroup

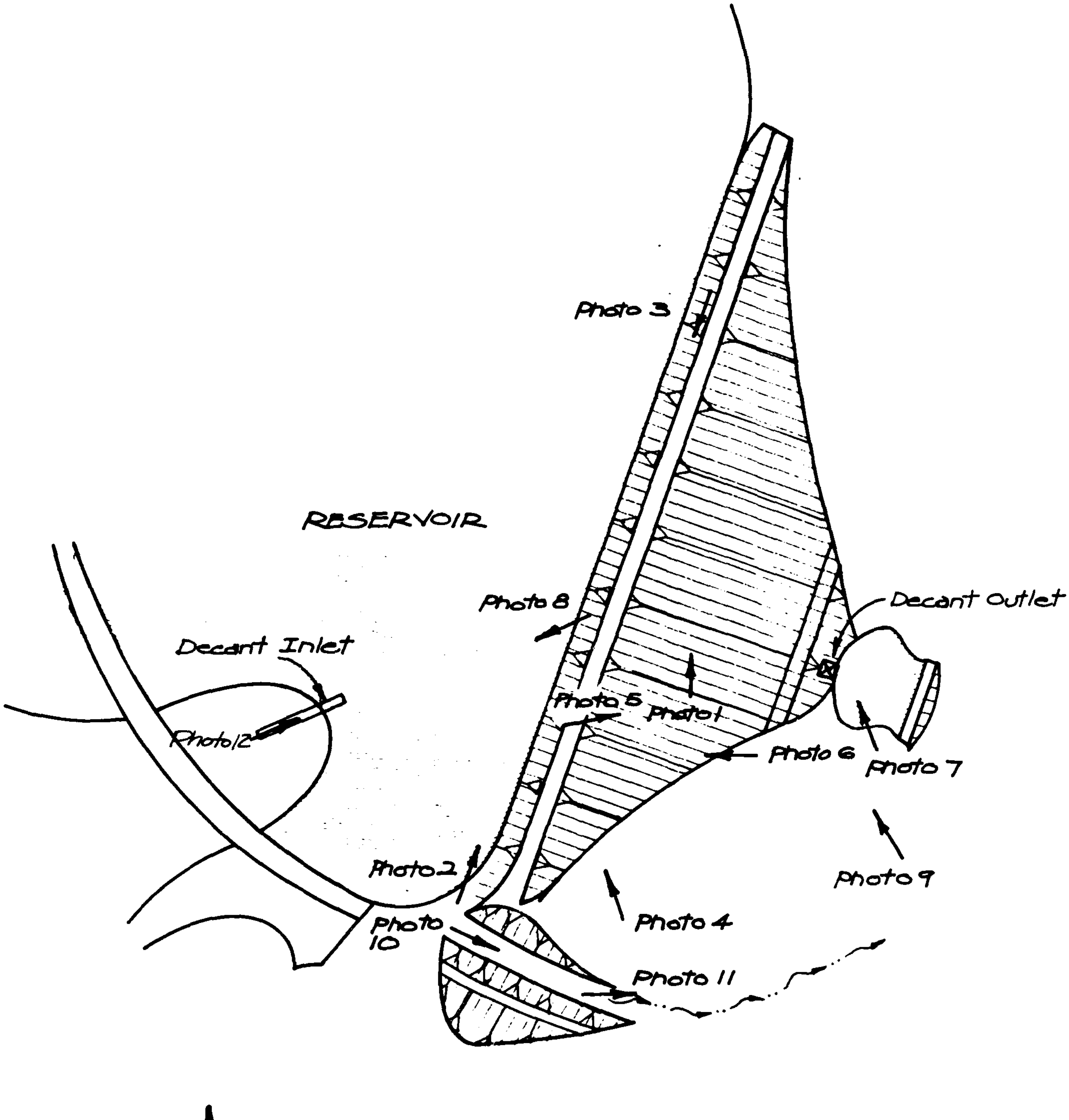
REGIONAL GEOLOGIC MAP

MAGMONT MINE TAILINGS DAM

MO 30917 | Fig. 4

APPENDIX A

Photographs



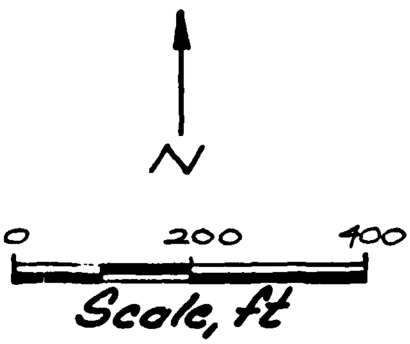
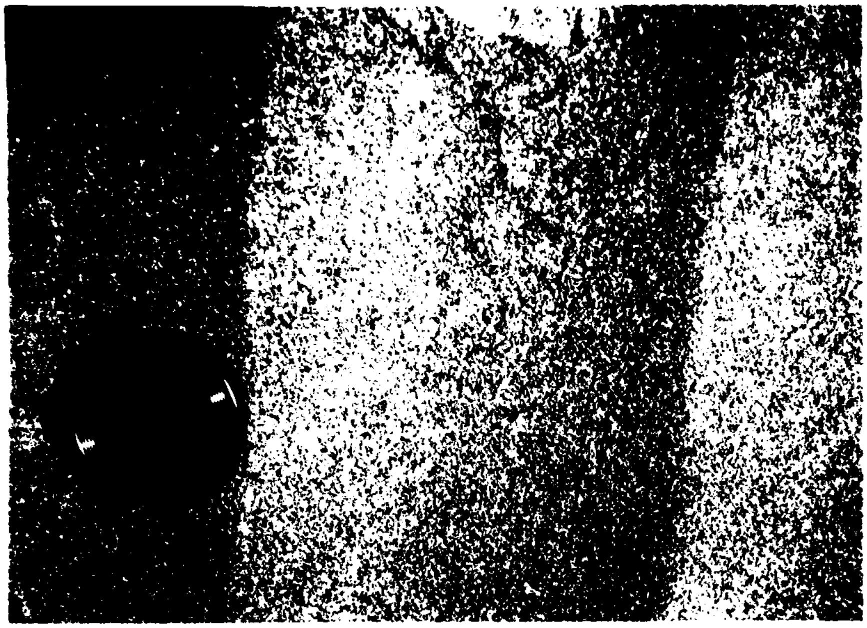


PHOTO LOCATION SKETCH	
MAGMONT MINE TAILINGS DAM	
MO 30917	Fig. A-1



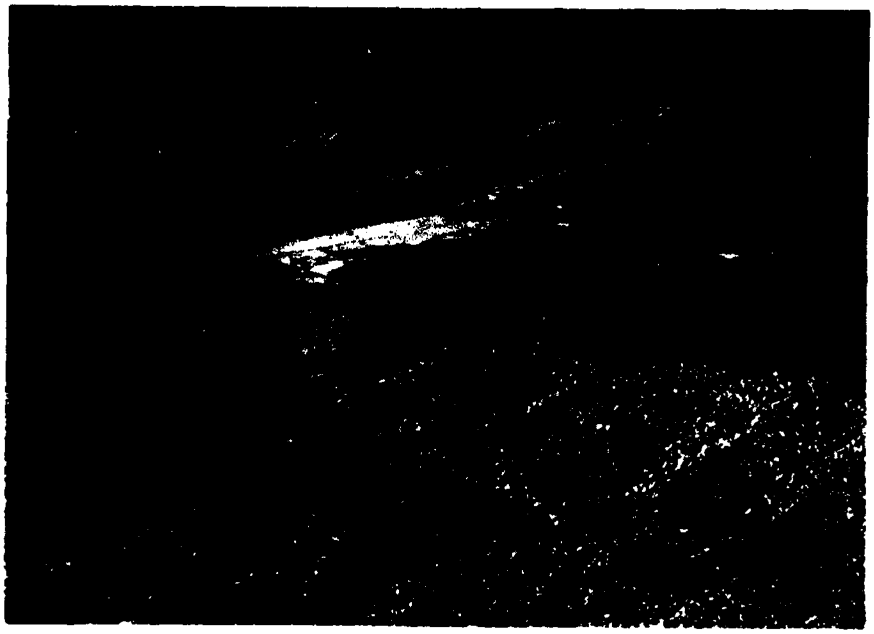
1. Fine sand tailings on downstream slope of embankment.

2. Upstream face of embankment showing well developed grass erosion protection. Looking north-northeast from right abutment.

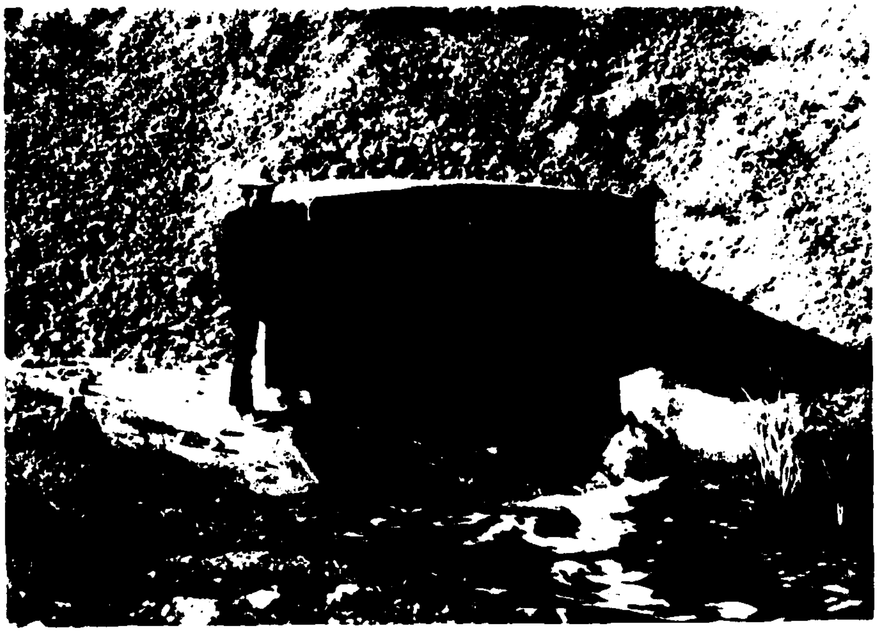
3. Gravel road on crest of dam. Note gravel berms along the shoulders of the road to prevent erosion on the slopes of the dam. Looking southwest from near the center of the dam crest.

4. Erosion control measures on downstream face of tailings embankment. Area near crest of dam has been seeded, covered with straw and netting to prevent erosion. See Photo 5. Looking north from right abutment.

5. Close-up of erosion control straw and netting to aid in vegetation of downstream face of dam.



6. Abutment drain at junction of embankment and right abutment. Designed to prevent erosion of the embankment by runoff from the abutment. Looking west from downstream face of dam.



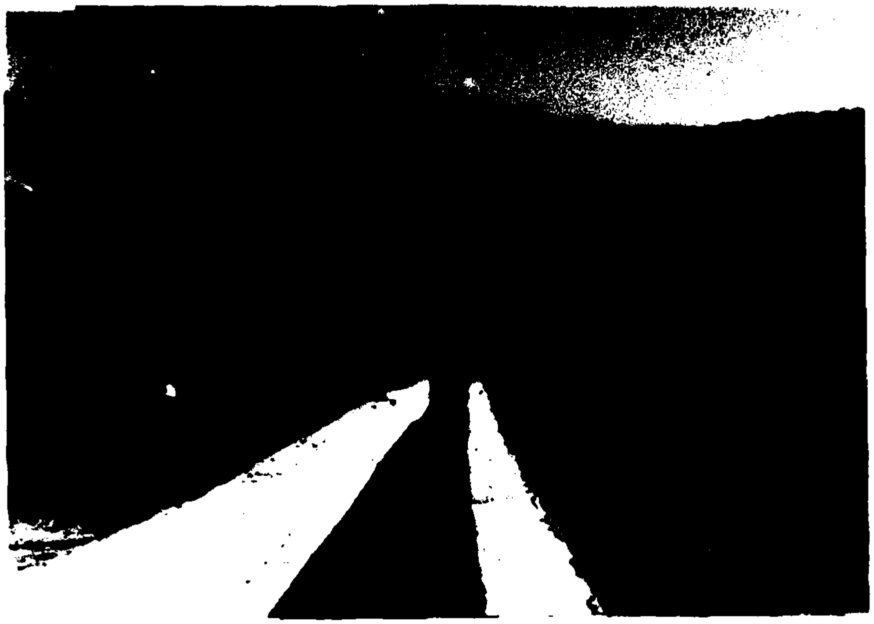
7. Outlet for decant system at toe of dam. Flow estimated at time of visual inspection to be 3 to 4 ft^3/sec.

8. Sloping inlet flume for decant system along right (south) side of reservoir. Looking west from crest of dam. Also note dikes within the reservoir to left and right of decant inlet structure.

9. Toe dam composed of gravelly soil at base of tailings embankment. Note rilling erosion and sparse vegetation cover. Looking northwest from lower right abutment.

10. Spillway cut into residual soil and weathered rock of right abutment. Slopes and floor partially covered with grass planted to control erosion. Looking southeast (downstream in spillway).

11. Discharge channel below spillway. Excavated in soil and weathered rock. Some erosional deepening has occurred from normal precipitation runoff. Looking east (downstream in discharge channel).



12. Sloping inlet flume for decant system on south side of reservoir. Looking northeast.

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

APPENDIX B
Hydraulic/Hydrologic Data and Analyses

B.1 Procedures

a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.

b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District, Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956).

c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (SCS, 1971, Hydrology: National Engineering Handbook, Section 4) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi^2, and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{\ell^{0.8}\,(s+1)^{0.7}}{1900\ Y^{0.5}} \qquad \text{(Equation 15-4)}$$

where:
L = lag in hours
ℓ = hydraulic length of the watershed in feet = 2800
$s = \frac{1000}{CN} - 10 = 4.3$

CN = hydrologic soil curve number as indicated in Section B.2e.
Y = average watershed land slope in percent = 5.3.

This empirical relationship accounts for the soil cover, average watershed slope and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_c = \frac{L}{0.6} \qquad \text{(Equation 15-3)}$$

where: T_c = time of concentration in hours

L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was estimated utilizing the following relationship:

$$\Delta D = 0.133T_c \qquad \text{(Equation 16-12)}$$

where: ΔD = duration of unit excess rainfall
T_c = time of concentration in hours.

The final interval was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, a time interval of 5 minutes was used.

d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS curve number method. The curve numbers were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) degree of development, (d) vegetative cover and (e) present land usage in the watershed.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

(1) 1 and 10 percent probability events - spillway crest elevation of 1302 ft.

(2) Probable Maximum Storm - spillway crest elevation of 1302 ft.

f. Spillway Rating Curve. The HEC-2 computer program was used to compute the spillway rating curve using spillway channel cross sections and assuming critical depth over the spillway. In addition, flow through the 42-in. decant line was also calculated.

B.2 Pertinent Data

a. Drainage area. 1.28 mi^2

b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 24 hours duration was divided into 5-minute intervals in order to develop the inflow hydrograph.

c. Lag time. 0.4 hours

d. Hydrologic soil group. C

e. SCS curve numbers.

1. For PMF- AMC III - Curve Number 85
2. For 1 and 10 percent probability-of-occurrence events - AMC II - Curve Number 70

f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Viburnum East and Viburnum West 7.5 minute quadrangle maps. The data were entered on the $A and $E cards so that the HEC-1 program could compute storage volumes.

(Storage volume calculated by HEC-1 did not include dead storage between elevation 1180 (zero storage) and elevation 1280. Storage figures in text of report include 6000 ac-ft storage between elevations 1180 and 1280. This change in dead storage volume does not affect overtopping or flood routing analysis.

g. Outflow over dam crest. Analyses indicate the dam will not be overtopped.

h. Outflow capacity. The spillway rating curve was developed from the cross section data of the spillway assuming critical flow over the spillway, using the HEC-2 backwater program. Flow through the 42-in. decant pipe was calculated and a combined spillway rating curve was calculated. The results of the above were entered on the Y4 and Y5 cards of the HEC-1 program.

i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 1302 ft, the spillway crest elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 1302 ft, the spillway crest elevation.

B.3 Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the results summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1              A1     DAM NO. 30917, MAGMONT MINE DAM, IRON COUNTY, MO.
    2              A2     WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
    3              A3     PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS
    4              B    288       0       5       0       0       0       0       0       0       0
    5              B1     5
    6              J      1       2       1
    7              J1   .50     1.0
    8              K      0    LAKE                                       1
    9              K1     INFLOW HYDROGRAPH ANALYSIS
   10              M      1       2    1.28                         1.0
   11              P     0.     26.    102.    120.    130.
   12              T                                                     -1     -89               .23
   13              W2           .40
   14              X     -1    -.05       5
   15              K      1     DAM                                       1
   16              K1     PROBABLE MAXIMUM FLOOD ROUTING AND OVERTOPPING ANALYSIS
   17              Y                              1       1
   18              Y1     1                                        -1302.00      -1
   19              Y41302.0  1302.4  1303.0  1304.4  1305.6  1306.3  1307.5  1308.5  1309.5
   20              Y5 300.0   350.0   500.0  1100.0  1800.0  2300.0  3300.0  4300.0  5300.0
   21              SA 120.0   155.0   170.0   190.0   230.0   252.0   270.0
   22              SE1280.0  1290.0  1300.0  1302.0  1310.0  1315.5  1320.0
   23              $$1302.0
   24              $D1315.5
   25              SL    0.   180.0   330.0   650.0  1170.0  1220.0
   26              $V1315.5  1315.9  1360.0  1316.2  1316.4  1316.6
   27              K     99
```

Input Data
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B4

Output Summary
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B5

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************

RUN  DATE* 81/02/17.
     TIME* 08.06.54.

                    DAM NO. 30917, MAGMONT MINE DAM, IRON COUNTY, MO.
                    WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
                    PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS

                                      JOB SPECIFICATION
          NQ      NHR     NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         288        0        5       0       0       0       0       0       0       0
                                 JOPER     NWT   LROPT   TRACE
                                     5       0       0       0

                             MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 1 NRTIO= 2 LRTIO= 1
          RTIOS=      .50    1.00

            *********      *********      *********      *********      *********

                                 SUB-AREA RUNOFF COMPUTATION

                 INFLOW HYDROGRAPH ANALYSIS

                       ISTAQ    ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                        LAKE        0       0       0       0       0       1       0       0
                                            HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              1       2    1.20    0.00    1.20    1.00   0.000       0       0       0
                                              PRECIP DATA
                SPFE     PMS      R6     R12     R24     R48     R72     R96
                0.00   26.00  102.00  120.00  130.00    0.00    0.00    0.00
                                               LOSS DATA
        LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -85.00    0.00     .23

             CURVE NO =  -85.00  WETNESS =   -1.00  EFFECT CN =   85.00

                                        UNIT HYDROGRAPH DATA
                                   TC=  0.00     LAG=   .40

                                          RECESSION DATA
                            STRTQ=   -1.00    QRCSN=   -.05    RTIOR= 5.00

             UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=    .40  VOL= 1.00
         129.      396.      834.     1233.     1392.     1399.     1181.      936.      647.      473.
         354.      263.      191.      141.      103.       75.       55.       41.       30.       22.
```

Output Summary
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B6

16. 13. 10. 7. 4. 1.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	2.	1.01	12.05	145	.22	.21	.01	629.
1.01	.10	2	.01	.00	.01	3.	1.01	12.10	146	.22	.21	.01	689.
1.01	.15	3	.01	.00	.01	5.	1.01	12.15	147	.22	.21	.01	814.
1.01	.20	4	.01	.00	.01	9.	1.01	12.20	148	.22	.21	.01	999.
1.01	.25	5	.01	.00	.01	14.	1.01	12.25	149	.22	.21	.01	1208.
1.01	.30	6	.01	.00	.01	18.	1.01	12.30	150	.22	.21	.01	1413.
1.01	.35	7	.01	.00	.01	22.	1.01	12.35	151	.22	.21	.01	1592.
1.01	.40	8	.01	.00	.01	25.	1.01	12.40	152	.22	.21	.01	1735.
1.01	.45	9	.01	.00	.01	27.	1.01	12.45	153	.22	.21	.01	1839.
1.01	.50	10	.01	.00	.01	29.	1.01	12.50	154	.22	.21	.01	1909.
1.01	.55	11	.01	.00	.01	30.	1.01	12.55	155	.22	.22	.01	1988.
1.01	1.00	12	.01	.00	.01	31.	1.01	13.00	156	.22	.22	.01	2008.
1.01	1.05	13	.01	.00	.01	31.	1.01	13.05	157	.27	.26	.01	2048.
1.01	1.10	14	.01	.00	.01	32.	1.01	13.10	158	.27	.26	.01	2087.
1.01	1.15	15	.01	.00	.01	32.	1.01	13.15	159	.27	.26	.01	2142.
1.01	1.20	16	.01	.00	.01	32.	1.01	13.20	160	.27	.26	.01	2209.
1.01	1.25	17	.01	.00	.01	33.	1.01	13.25	161	.27	.26	.01	2281.
1.01	1.30	18	.01	.00	.01	33.	1.01	13.30	162	.27	.26	.01	2349.
1.01	1.35	19	.01	.00	.01	33.	1.01	13.35	163	.27	.26	.00	2407.
1.01	1.40	20	.01	.00	.01	33.	1.01	13.40	164	.27	.26	.00	2454.
1.01	1.45	21	.01	.00	.01	33.	1.01	13.45	165	.27	.26	.00	2497.
1.01	1.50	22	.01	.00	.01	33.	1.01	13.50	166	.27	.26	.00	2512.
1.01	1.55	23	.01	.00	.01	33.	1.01	13.55	167	.27	.26	.00	2539.
1.01	2.00	24	.01	.00	.01	33.	1.01	14.00	168	.27	.26	.00	2546.
1.01	2.05	25	.01	.00	.01	33.	1.01	14.05	169	.33	.33	.00	2569.
1.01	2.10	26	.01	.00	.01	33.	1.01	14.10	170	.33	.33	.00	2599.
1.01	2.15	27	.01	.00	.01	33.	1.01	14.15	171	.33	.33	.00	2660.
1.01	2.20	28	.01	.00	.01	33.	1.01	14.20	172	.33	.33	.00	2748.
1.01	2.25	29	.01	.00	.01	34.	1.01	14.25	173	.33	.33	.00	2842.
1.01	2.30	30	.01	.00	.01	35.	1.01	14.30	174	.33	.33	.00	2934.
1.01	2.35	31	.01	.00	.01	35.	1.01	14.35	175	.33	.33	.00	3019.
1.01	2.40	32	.01	.00	.01	37.	1.01	14.40	176	.33	.33	.00	3079.
1.01	2.45	33	.01	.00	.01	38.	1.01	14.45	177	.33	.33	.00	3124.
1.01	2.50	34	.01	.00	.01	39.	1.01	14.50	178	.33	.33	.00	3157.
1.01	2.55	35	.01	.00	.01	41.	1.01	14.55	179	.33	.33	.00	3182.
1.01	3.00	36	.01	.01	.01	42.	1.01	15.00	180	.33	.33	.00	3201.
1.01	3.05	37	.01	.01	.01	43.	1.01	15.05	181	.20	.20	.00	3199.
1.01	3.10	38	.01	.01	.01	45.	1.01	15.10	182	.40	.40	.00	3184.
1.01	3.15	39	.01	.01	.01	46.	1.01	15.15	183	.40	.40	.00	3184.
1.01	3.20	40	.01	.01	.01	48.	1.01	15.20	184	.60	.60	.00	3204.
1.01	3.25	41	.01	.01	.01	49.	1.01	15.25	185	.71	.70	.00	3358.
1.01	3.30	42	.01	.01	.01	51.	1.01	15.30	186	1.71	1.70	.01	3811.
1.01	3.35	43	.01	.01	.01	52.	1.01	15.35	187	2.82	2.81	.01	4883.
1.01	3.40	44	.01	.01	.01	53.	1.01	15.40	188	1.11	1.10	.00	6377.
1.01	3.45	45	.01	.01	.01	55.	1.01	15.45	189	.71	.70	.00	8329.
1.01	3.50	46	.01	.01	.01	56.	1.01	15.50	190	.60	.60	.00	9933.
1.01	3.55	47	.01	.01	.01	57.	1.01	15.55	191	.40	.40	.00	10690.
1.01	4.00	48	.01	.01	.01	58.	1.01	16.00	192	.40	.40	.00	10887.
1.01	4.05	49	.01	.01	.01	59.	1.01	16.05	193	.31	.31	.00	9880.
1.01	4.10	50	.01	.01	.01	61.	1.01	16.10	194	.31	.31	.00	8699.
1.01	4.15	51	.01	.01	.01	62.	1.01	16.15	195	.31	.31	.00	7428.
1.01	4.20	52	.01	.01	.01	63.	1.01	16.20	196	.31	.31	.00	6397.
1.01	4.25	53	.01	.01	.01	64.	1.01	16.25	197	.31	.31	.00	5579.
1.01	4.30	54	.01	.01	.01	65.	1.01	16.30	198	.31	.31	.00	4930.
1.01	4.35	55	.01	.01	.01	66.	1.01	16.35	199	.31	.31	.00	4435.

Output Summary
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B7

1.01	4.40	56	.01	.01	.01	67.	1.01	16.40	200	.31	.31	.00	4067.
1.01	4.45	57	.01	.01	.01	68.	1.01	16.45	201	.31	.31	.00	3740.
1.01	4.50	58	.01	.01	.01	69.	1.01	16.50	202	.31	.31	.00	3600.
1.01	4.55	59	.01	.01	.01	70.	1.01	16.55	203	.31	.31	.00	3458.
1.01	5.00	60	.01	.01	.01	71.	1.01	17.00	204	.31	.31	.00	3371.
1.01	5.05	61	.01	.01	.01	72.	1.01	17.05	205	.24	.24	.00	3265.
1.01	5.10	62	.01	.01	.01	73.	1.01	17.10	206	.24	.24	.00	3182.
1.01	5.15	63	.01	.01	.01	74.	1.01	17.15	207	.24	.24	.00	3088.
1.01	5.20	64	.01	.01	.01	75.	1.01	17.20	208	.24	.24	.00	2919.
1.01	5.25	65	.01	.01	.01	76.	1.01	17.25	209	.24	.24	.00	2859.
1.01	5.30	66	.01	.01	.01	77.	1.01	17.30	210	.24	.24	.00	2749.
1.01	5.35	67	.01	.01	.01	77.	1.01	17.35	211	.24	.24	.00	2694.
1.01	5.40	68	.01	.01	.01	78.	1.01	17.40	212	.24	.24	.00	2619.
1.01	5.45	69	.01	.01	.01	79.	1.01	17.45	213	.24	.24	.00	2528.
1.01	5.50	70	.01	.01	.01	80.	1.01	17.50	214	.24	.24	.00	2494.
1.01	5.55	71	.01	.01	.01	81.	1.01	17.55	215	.24	.24	.00	2468.
1.01	6.00	72	.01	.01	.01	81.	1.01	18.00	216	.24	.24	.00	2450.
1.01	6.05	73	.07	.04	.03	86.	1.01	18.05	217	.02	.02	.00	2409.
1.01	6.10	74	.07	.04	.02	99.	1.01	18.10	218	.02	.02	.00	2312.
1.01	6.15	75	.07	.04	.02	127.	1.01	18.15	219	.02	.02	.00	2121.
1.01	6.20	76	.07	.04	.02	167.	1.01	18.20	220	.02	.02	.00	1849.
1.01	6.25	77	.07	.04	.02	214.	1.01	18.25	221	.02	.02	.00	1532.
1.01	6.30	78	.07	.05	.02	261.	1.01	18.30	222	.02	.02	.00	1229.
1.01	6.35	79	.07	.05	.02	304.	1.01	18.35	223	.02	.02	.00	966.
1.01	6.40	80	.07	.05	.02	341.	1.01	18.40	224	.02	.02	.00	758.
1.01	6.45	81	.07	.05	.02	364.	1.01	18.45	225	.02	.02	.00	614.
1.01	6.50	82	.07	.05	.02	392.	1.01	18.50	226	.02	.02	.00	519.
1.01	6.55	83	.07	.05	.02	411.	1.01	18.55	227	.02	.02	.00	428.
1.01	7.00	84	.07	.05	.02	427.	1.01	19.00	228	.02	.02	.00	373.
1.01	7.05	85	.07	.05	.01	441.	1.01	19.05	229	.02	.02	.00	329.
1.01	7.10	86	.07	.05	.01	453.	1.01	19.10	230	.02	.02	.00	298.
1.01	7.15	87	.07	.05	.01	463.	1.01	19.15	231	.02	.02	.00	275.
1.01	7.20	88	.07	.05	.01	473.	1.01	19.20	232	.02	.02	.00	258.
1.01	7.25	89	.07	.05	.01	481.	1.01	19.25	233	.02	.02	.00	244.
1.01	7.30	90	.07	.05	.01	489.	1.01	19.30	234	.02	.02	.00	237.
1.01	7.35	91	.07	.05	.01	495.	1.01	19.35	235	.02	.02	.00	230.
1.01	7.40	92	.07	.05	.01	502.	1.01	19.40	236	.02	.02	.00	225.
1.01	7.45	93	.07	.05	.01	508.	1.01	19.45	237	.02	.02	.00	222.
1.01	7.50	94	.07	.05	.01	513.	1.01	19.50	238	.02	.02	.00	219.
1.01	7.55	95	.07	.05	.01	518.	1.01	19.55	239	.02	.02	.00	217.
1.01	8.00	96	.07	.06	.01	523.	1.01	20.00	240	.02	.02	.00	215.
1.01	8.05	97	.07	.06	.01	527.	1.01	20.05	241	.02	.02	.00	215.
1.01	8.10	98	.07	.06	.01	531.	1.01	20.10	242	.02	.02	.00	214.
1.01	8.15	99	.07	.06	.01	535.	1.01	20.15	243	.02	.02	.00	214.
1.01	8.20	100	.07	.06	.01	539.	1.01	20.20	244	.02	.02	.00	214.
1.01	8.25	101	.07	.06	.01	543.	1.01	20.25	245	.02	.02	.00	214.
1.01	8.30	102	.07	.06	.01	546.	1.01	20.30	246	.02	.02	.00	214.
1.01	8.35	103	.07	.06	.01	549.	1.01	20.35	247	.02	.02	.00	214.
1.01	8.40	104	.07	.06	.01	552.	1.01	20.40	248	.02	.02	.00	214.
1.01	8.45	105	.07	.06	.01	555.	1.01	20.45	249	.02	.02	.00	214.
1.01	8.50	106	.07	.06	.01	558.	1.01	20.50	250	.02	.02	.00	214.
1.01	8.55	107	.07	.06	.01	560.	1.01	20.55	251	.02	.02	.00	214.
1.01	9.00	108	.07	.06	.01	563.	1.01	21.00	252	.02	.02	.00	214.
1.01	9.05	109	.07	.06	.01	565.	1.01	21.05	253	.02	.02	.00	214.
1.01	9.10	110	.07	.06	.01	567.	1.01	21.10	254	.02	.02	.00	214.
1.01	9.15	111	.07	.06	.01	570.	1.01	21.15	255	.02	.02	.00	214.
1.01	9.20	112	.07	.06	.01	572.	1.01	21.20	256	.02	.02	.00	214.
1.01	9.25	113	.07	.06	.01	574.	1.01	21.25	257	.02	.02	.00	214.
1.01	9.30	114	.07	.06	.01	576.	1.01	21.30	258	.02	.02	.00	214.
1.01	9.35	115	.07	.06	.01	577.	1.01	21.35	259	.02	.02	.00	214.

1.01	9.40	116	.07	.06	.01	579.	1.01	21.40	260	.02	.02	.00	214.
1.01	9.45	117	.07	.06	.01	581.	1.01	21.45	261	.02	.02	.00	214.
1.01	9.50	118	.07	.06	.01	582.	1.01	21.50	262	.02	.02	.00	214.
1.01	9.55	119	.07	.06	.01	584.	1.01	21.55	263	.02	.02	.00	214.
1.01	10.00	120	.07	.06	.01	586.	1.01	22.00	264	.02	.02	.00	214.
1.01	10.05	121	.07	.06	.00	587.	1.01	22.05	265	.02	.02	.00	214.
1.01	10.10	122	.07	.06	.00	588.	1.01	22.10	266	.02	.02	.00	214.
1.01	10.15	123	.07	.06	.00	590.	1.01	22.15	267	.02	.02	.00	214.
1.01	10.20	124	.07	.06	.00	591.	1.01	22.20	268	.02	.02	.00	214.
1.01	10.25	125	.07	.06	.00	592.	1.01	22.25	269	.02	.02	.00	214.
1.01	10.30	126	.07	.06	.00	594.	1.01	22.30	270	.02	.02	.00	214.
1.01	10.35	127	.07	.06	.00	595.	1.01	22.35	271	.02	.02	.00	214.
1.01	10.40	128	.07	.06	.00	596.	1.01	22.40	272	.02	.02	.00	214.
1.01	10.45	129	.07	.06	.00	597.	1.01	22.45	273	.02	.02	.00	214.
1.01	10.50	130	.07	.06	.00	598.	1.01	22.50	274	.02	.02	.00	214.
1.01	10.55	131	.07	.06	.00	599.	1.01	22.55	275	.02	.02	.00	214.
1.01	11.00	132	.07	.06	.00	600.	1.01	23.00	276	.02	.02	.00	214.
1.01	11.05	133	.07	.06	.00	601.	1.01	23.05	277	.02	.02	.00	214.
1.01	11.10	134	.07	.06	.00	602.	1.01	23.10	278	.02	.02	.00	214.
1.01	11.15	135	.07	.06	.00	603.	1.01	23.15	279	.02	.02	.00	214.
1.01	11.20	136	.07	.06	.00	604.	1.01	23.20	280	.02	.02	.00	214.
1.01	11.25	137	.07	.06	.00	604.	1.01	23.25	281	.02	.02	.00	214.
1.01	11.30	138	.07	.06	.00	605.	1.01	23.30	282	.02	.02	.00	214.
1.01	11.35	139	.07	.06	.00	606.	1.01	23.35	283	.02	.02	.00	214.
1.01	11.40	140	.07	.06	.00	607.	1.01	23.40	284	.02	.02	.00	214.
1.01	11.45	141	.07	.06	.00	608.	1.01	23.45	285	.02	.02	.00	214.
1.01	11.50	142	.07	.06	.00	608.	1.01	23.50	286	.02	.02	.00	214.
1.01	11.55	143	.07	.06	.00	609.	1.01	23.55	287	.02	.02	.00	214.
1.01	12.00	144	.07	.06	.00	610.	1.02	0.00	288	.02	.02	.00	214.
									SUM	33.80	32.24	1.56	318142.
										(859.)(	819.)(	40.)(	9008.78)

Output Summary
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B8

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2
				RATIOS APPLIED TO FLOWS	
				.50	1.00
HYDROGRAPH AT	LAKE	1.28	1	5345.	10690.
	(	3.32)	(	151.35)(	302.69)(
ROUTED TO	DAM	1.28	1	1013.	2868.
	(	3.32)	(	28.70)(	81.21)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1302.00	1302.00	1315.50
STORAGE	3481.	3481.	6517.
OUTFLOW	300.	300.	11300.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1304.20	0.00	3926.	1013.	0.00	18.25	0.00
1.00	1306.98	0.00	4516.	2868.	0.00	17.42	0.00

Output Summary
Various PMF Events
Magmont Mine Tailings Dam
MO 30917
B9

Input Data
1% Probability Event
Magmont Mine Tailings Dam
MO 30917

B10

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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
LAST MODIFICATION  01 APR 80
**************************************
             A1     DAM NO. 30917, MAGMONT MINE DAM, IRON COUNTY, MO.
             A2     WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
             A3     PROBABILISTIC FLOOD 100-YEAR
             B    288      0      5      0      0      0      0      0      0      0
             B1     3
             K      0   LAKE                                   1
             K1  RAIN STA--18-LESTRVL -- FREQ=100.0;-- INTERVAL=   5MIN -- DURATION=  24HR
             M      0      2   1.28                      1.0
             B    288  7.394                 DA =    .50
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .014   .014   .025   .025
             01  .025   .025   .025   .025   .025   .025   .025   .025   .025   .025
             01  .025   .025   .025   .025   .025   .025   .033   .033   .033   .033
             01  .033   .033   .058   .058   .058   .058   .059   .059   .140   .140
             01  .140   .267   .267   .552   .817   .384   .267   .140   .140   .140
             01  .059   .059   .058   .058   .058   .058   .033   .033   .033   .033
             01  .033   .033   .025   .025   .025   .025   .025   .025   .025   .025
             01  .025   .025   .025   .025   .025   .025   .025   .025   .025   .025
             01  .014   .014   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .014   .014   .014   .014
             01  .014   .014   .014   .014   .014   .014   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
             01  .007   .007   .007   .007   .007   .007   .007   .007
             T                                           -1    -70                .23
             W2            .40
             X     -1    -.05      5
             K      1   DAM                                    1
             K1     100-YEAR FLOOD ROUTING AND OVERTOPPING ANALYSIS
             Y                               1
             Y1     1                                 -1302.00     -1
             Y41302.0  1302.4  1303.0  1304.4  1305.6  1306.3  1307.5  1308.5  1309.5
             Y5 300.0   350.0   500.0  1100.0  1800.0  2300.0  3300.0  4300.0  5300.0
             SA 120.0   155.0   190.0   198.0   230.0   252.0   270.0
             SE1280.0  1290.0  1300.0  1302.0  1310.0  1315.5  1320.0
             SS1302.0
             SD1315.5
             SL    0.   180.0   330.0   650.0  1170.0  1220.0
             SV1315.5  1315.9  1360.0  1316.2  1316.4  1316.6
             K     99
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Output Summary
1% Probability Event
Magmont Mine Tailings Dam
MO 30917
B11

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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**************************************

RUN  DATE* 81/02/17.
     TIME* 07.46.13.
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DAM NO. 30917, MAGMONT MINE DAM, IRON COUNTY, MO.
WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
PROBABILISTIC FLOOD 100-YEAR

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
3	0	0	0

**********   **********   **********   **********   **********

SUB-AREA RUNOFF COMPUTATION

RAIN STA--10-LESTRWL -- FREQ=100.0;-- INTERVAL= 5MIN -- DURATION= 24HR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	1.28	0.00	1.28	1.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
288	7.39	0.00	0.00

PRECIP PATTERN

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.06	.06	.06	.06	.06	.06	.14	.14
.14	.27	.27	.55	.82	.38	.27	.14	.14	.14
.06	.06	.06	.06	.06	.06	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-70.00	0.00	.23

CURVE NO = -70.00 WETNESS = -1.00 EFFECT CN = 70.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .40

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .40 VOL= 1.00

129.	396.	834.	1233.	1392.	1359.	1181.	936.	647.	473.
354.	263.	191.	141.	103.	75.	55.	41.	30.	22.
16.	13.	10.	7.	4.	1.				

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	1.	1.01	12.05	145	.82	.60	.21	983.
1.01	.10	2	.01	.00	.01	2.	1.01	12.10	146	.38	.30	.09	[illegible]
1.01	.15	3	.01	.00	.01	3.	1.01	12.15	147	.27	.21	.06	1829.
1.01	.20	4	.01	.00	.01	5.	1.01	12.20	148	.14	.11	.03	2227.
1.01	.25	5	.01	.00	.01	7.	1.01	12.25	149	.14	.11	.03	2442.
1.01	.30	6	.01	.00	.01	9.	1.01	12.30	150	.14	.11	.03	2459.
1.01	.35	7	.01	.00	.01	11.	1.01	12.35	151	.06	.05	.01	2307.
1.01	.40	8	.01	.00	.01	12.	1.01	12.40	152	.06	.05	.01	2094.
1.01	.45	9	.01	.00	.01	13.	1.01	12.45	153	.06	.05	.01	1794.
1.01	.50	10	.01	.00	.01	14.	1.01	12.50	154	.06	.05	.01	1483.
1.01	.55	11	.01	.00	.01	15.	1.01	12.55	155	.06	.05	.01	1257.
1.01	1.00	12	.01	.00	.01	15.	1.01	13.00	156	.06	.05	.01	1082.
1.01	1.05	13	.01	.00	.01	15.	1.01	13.05	157	.03	.03	.01	906.
1.01	1.10	14	.01	.00	.01	15.	1.01	13.10	158	.03	.03	.01	781.
1.01	1.15	15	.01	.00	.01	16.	1.01	13.15	159	.03	.03	.01	680.
1.01	1.20	16	.01	.00	.01	16.	1.01	13.20	160	.03	.03	.01	593.
1.01	1.25	17	.01	.00	.01	16.	1.01	13.25	161	.03	.03	.01	519.
1.01	1.30	18	.01	.00	.01	16.	1.01	13.30	162	.03	.03	.01	458.
1.01	1.35	19	.01	.00	.01	16.	1.01	13.35	163	.02	.02	.00	409.
1.01	1.40	20	.01	.00	.01	16.	1.01	13.40	164	.02	.02	.00	369.
1.01	1.45	21	.01	.00	.01	16.	1.01	13.45	165	.02	.02	.00	338.
1.01	1.50	22	.01	.00	.01	16.	1.01	13.50	166	.02	.02	.00	311.
1.01	1.55	23	.01	.00	.01	16.	1.01	13.55	167	.02	.02	.00	287.
1.01	2.00	24	.01	.00	.01	16.	1.01	14.00	168	.02	.02	.00	267.
1.01	2.05	25	.01	.00	.01	16.	1.01	14.05	169	.02	.02	.00	250.
1.01	2.10	26	.01	.00	.01	16.	1.01	14.10	170	.02	.02	.00	237.
1.01	2.15	27	.01	.00	.01	16.	1.01	14.15	171	.02	.02	.00	229.
1.01	2.20	28	.01	.00	.01	16.	1.01	14.20	172	.02	.02	.00	223.
1.01	2.25	29	.01	.00	.01	16.	1.01	14.25	173	.02	.02	.00	219.
1.01	2.30	30	.01	.00	.01	16.	1.01	14.30	174	.02	.02	.00	216.

Output Summary
1% Probability Event
Magmont Mine Tailings Dam
MO 30917

B12

Output Summary
1% Probability Event
Magmont Mine Tailings Dam
MO 30917

813

1.01	2.35	31	.01	.00	.01	16.	1.01	14.35	175	.02	.02	.00	214.
1.01	2.40	32	.01	.00	.01	16.	1.01	14.40	176	.02	.02	.00	213.
1.01	2.45	33	.01	.00	.01	16.	1.01	14.45	177	.02	.02	.00	212.
1.01	2.50	34	.01	.00	.01	16.	1.01	14.50	178	.02	.02	.00	211.
1.01	2.55	35	.01	.00	.01	16.	1.01	14.55	179	.02	.02	.00	211.
1.01	3.00	36	.01	.00	.01	16.	1.01	15.00	180	.02	.02	.00	211.
1.01	3.05	37	.01	.00	.01	16.	1.01	15.05	181	.01	.01	.00	209.
1.01	3.10	38	.01	.00	.01	16.	1.01	15.10	182	.01	.01	.00	206.
1.01	3.15	39	.01	.00	.01	16.	1.01	15.15	183	.01	.01	.00	196.
1.01	3.20	40	.01	.00	.01	16.	1.01	15.20	184	.01	.01	.00	186.
1.01	3.25	41	.01	.00	.01	16.	1.01	15.25	185	.01	.01	.00	173.
1.01	3.30	42	.01	.00	.01	16.	1.01	15.30	186	.01	.01	.00	161.
1.01	3.35	43	.01	.00	.01	16.	1.01	15.35	187	.01	.01	.00	150.
1.01	3.40	44	.01	.00	.01	16.	1.01	15.40	188	.01	.01	.00	141.
1.01	3.45	45	.01	.00	.01	16.	1.01	15.45	189	.01	.01	.00	135.
1.01	3.50	46	.01	.00	.01	16.	1.01	15.50	190	.01	.01	.00	131.
1.01	3.55	47	.01	.00	.01	16.	1.01	15.55	191	.01	.01	.00	127.
1.01	4.00	48	.01	.00	.01	16.	1.01	16.00	192	.01	.01	.00	125.
1.01	4.05	49	.01	.00	.01	16.	1.01	16.05	193	.01	.01	.00	123.
1.01	4.10	50	.01	.00	.01	16.	1.01	16.10	194	.01	.01	.00	122.
1.01	4.15	51	.01	.00	.01	16.	1.01	16.15	195	.01	.01	.00	121.
1.01	4.20	52	.01	.00	.01	16.	1.01	16.20	196	.01	.01	.00	121.
1.01	4.25	53	.01	.00	.01	16.	1.01	16.25	197	.01	.01	.00	120.
1.01	4.30	54	.01	.00	.01	16.	1.01	16.30	198	.01	.01	.00	120.
1.01	4.35	55	.01	.00	.01	16.	1.01	16.35	199	.01	.01	.00	120.
1.01	4.40	56	.01	.00	.01	16.	1.01	16.40	200	.01	.01	.00	119.
1.01	4.45	57	.01	.00	.01	16.	1.01	16.45	201	.01	.01	.00	119.
1.01	4.50	58	.01	.00	.01	16.	1.01	16.50	202	.01	.01	.00	119.
1.01	4.55	59	.01	.00	.01	16.	1.01	16.55	203	.01	.01	.00	119.
1.01	5.00	60	.01	.00	.01	16.	1.01	17.00	204	.01	.01	.00	119.
1.01	5.05	61	.01	.00	.01	16.	1.01	17.05	205	.01	.01	.00	119.
1.01	5.10	62	.01	.00	.01	16.	1.01	17.10	206	.01	.01	.00	119.
1.01	5.15	63	.01	.00	.01	16.	1.01	17.15	207	.01	.01	.00	119.
1.01	5.20	64	.01	.00	.01	16.	1.01	17.20	208	.01	.01	.00	119.
1.01	5.25	65	.01	.00	.01	16.	1.01	17.25	209	.01	.01	.00	119.
1.01	5.30	66	.01	.00	.01	16.	1.01	17.30	210	.01	.01	.00	119.
1.01	5.35	67	.01	.00	.01	16.	1.01	17.35	211	.01	.01	.00	120.
1.01	5.40	68	.01	.00	.01	16.	1.01	17.40	212	.01	.01	.00	120.
1.01	5.45	69	.01	.00	.01	16.	1.01	17.45	213	.01	.01	.00	120.
1.01	5.50	70	.01	.00	.01	16.	1.01	17.50	214	.01	.01	.00	120.
1.01	5.55	71	.01	.00	.01	16.	1.01	17.55	215	.01	.01	.00	120.
1.01	6.00	72	.01	.00	.01	16.	1.01	18.00	216	.01	.01	.00	120.
1.01	6.05	73	.01	.00	.01	16.	1.01	18.05	217	.01	.01	.00	119.
1.01	6.10	74	.01	.00	.01	17.	1.01	18.10	218	.01	.01	.00	117.
1.01	6.15	75	.01	.00	.01	18.	1.01	18.15	219	.01	.01	.00	112.
1.01	6.20	76	.01	.00	.01	20.	1.01	18.20	220	.01	.01	.00	109.
1.01	6.25	77	.01	.00	.01	22.	1.01	18.25	221	.01	.01	.00	90.
1.01	6.30	78	.01	.00	.01	25.	1.01	18.30	222	.01	.01	.00	88.
1.01	6.35	79	.01	.00	.01	26.	1.01	18.35	223	.01	.01	.00	81.
1.01	6.40	80	.01	.00	.01	28.	1.01	18.40	224	.01	.01	.00	75.
1.01	6.45	81	.01	.00	.01	29.	1.01	18.45	225	.01	.01	.00	71.
1.01	6.50	82	.01	.00	.01	30.	1.01	18.50	226	.01	.01	.00	66.
1.01	6.55	83	.01	.00	.01	30.	1.01	18.55	227	.01	.01	.00	66.
1.01	7.00	84	.01	.00	.01	31.	1.01	19.00	228	.01	.01	.00	64.
1.01	7.05	85	.01	.00	.01	31.	1.01	19.05	229	.01	.01	.00	63.
1.01	7.10	86	.01	.00	.01	31.	1.01	19.10	230	.01	.01	.00	62.
1.01	7.15	87	.01	.00	.01	31.	1.01	19.15	231	.01	.01	.00	62.
1.01	7.20	88	.01	.00	.01	32.	1.01	19.20	232	.01	.01	.00	61.
1.01	7.25	89	.01	.00	.01	32.	1.01	19.25	233	.01	.01	.00	61.
1.01	7.30	90	.01	.00	.01	32.	1.01	19.30	234	.01	.01	.00	61.

Output Summary
1% Probability Event
Magmont Mine Tailings Dam
MO 30917

B14

1.01	7.35	91	.01	.00	.01	32.	1.01	19.35	235	.01	.01	.00	41.
1.01	7.40	92	.01	.00	.01	32.	1.01	19.40	236	.01	.01	.00	41.
1.01	7.45	93	.01	.00	.01	32.	1.01	19.45	237	.01	.01	.00	40.
1.01	7.50	94	.01	.00	.01	32.	1.01	19.50	238	.01	.01	.00	40.
1.01	7.55	95	.01	.00	.01	32.	1.01	19.55	239	.01	.01	.00	40.
1.01	8.00	96	.01	.00	.01	32.	1.01	20.00	240	.01	.01	.00	40.
1.01	8.05	97	.01	.00	.01	32.	1.01	20.05	241	.01	.01	.00	40.
1.01	8.10	98	.01	.00	.01	32.	1.01	20.10	242	.01	.01	.00	40.
1.01	8.15	99	.01	.00	.01	32.	1.01	20.15	243	.01	.01	.00	40.
1.01	8.20	100	.01	.00	.01	32.	1.01	20.20	244	.01	.01	.00	40.
1.01	8.25	101	.01	.00	.01	32.	1.01	20.25	245	.01	.01	.00	40.
1.01	8.30	102	.01	.00	.01	32.	1.01	20.30	246	.01	.01	.00	40.
1.01	8.35	103	.01	.00	.01	33.	1.01	20.35	247	.01	.01	.00	40.
1.01	8.40	104	.01	.00	.01	33.	1.01	20.40	248	.01	.01	.00	40.
1.01	8.45	105	.01	.00	.01	33.	1.01	20.45	249	.01	.01	.00	40.
1.01	8.50	106	.01	.00	.01	34.	1.01	20.50	250	.01	.01	.00	40.
1.01	8.55	107	.01	.00	.01	34.	1.01	20.55	251	.01	.01	.00	40.
1.01	9.00	108	.01	.00	.01	35.	1.01	21.00	252	.01	.01	.00	40.
1.01	9.05	109	.02	.01	.02	36.	1.01	21.05	253	.01	.01	.00	40.
1.01	9.10	110	.02	.01	.02	38.	1.01	21.10	254	.01	.01	.00	40.
1.01	9.15	111	.02	.01	.02	41.	1.01	21.15	255	.01	.01	.00	40.
1.01	9.20	112	.02	.01	.02	46.	1.01	21.20	256	.01	.01	.00	40.
1.01	9.25	113	.02	.01	.02	51.	1.01	21.25	257	.01	.01	.00	40.
1.01	9.30	114	.02	.01	.02	57.	1.01	21.30	258	.01	.01	.00	40.
1.01	9.35	115	.02	.01	.02	62.	1.01	21.35	259	.01	.01	.00	40.
1.01	9.40	116	.02	.01	.02	66.	1.01	21.40	260	.01	.01	.00	40.
1.01	9.45	117	.02	.01	.02	70.	1.01	21.45	261	.01	.01	.00	41.
1.01	9.50	118	.02	.01	.02	73.	1.01	21.50	262	.01	.01	.00	41.
1.01	9.55	119	.02	.01	.02	76.	1.01	21.55	263	.01	.01	.00	41.
1.01	10.00	120	.02	.01	.02	78.	1.01	22.00	264	.01	.01	.00	41.
1.01	10.05	121	.02	.01	.02	81.	1.01	22.05	265	.01	.01	.00	41.
1.01	10.10	122	.02	.01	.02	83.	1.01	22.10	266	.01	.01	.00	41.
1.01	10.15	123	.02	.01	.02	85.	1.01	22.15	267	.01	.01	.00	41.
1.01	10.20	124	.02	.01	.02	87.	1.01	22.20	268	.01	.01	.00	41.
1.01	10.25	125	.02	.01	.02	88.	1.01	22.25	269	.01	.01	.00	41.
1.01	10.30	126	.02	.01	.01	90.	1.01	22.30	270	.01	.01	.00	41.
1.01	10.35	127	.03	.01	.02	92.	1.01	22.35	271	.01	.01	.00	41.
1.01	10.40	128	.03	.01	.02	95.	1.01	22.40	272	.01	.01	.00	41.
1.01	10.45	129	.03	.01	.02	100.	1.01	22.45	273	.01	.01	.00	41.
1.01	10.50	130	.03	.01	.02	106.	1.01	22.50	274	.01	.01	.00	41.
1.01	10.55	131	.03	.01	.02	112.	1.01	22.55	275	.01	.01	.00	41.
1.01	11.00	132	.03	.01	.02	119.	1.01	23.00	276	.01	.01	.00	41.
1.01	11.05	133	.06	.03	.03	126.	1.01	23.05	277	.01	.01	.00	41.
1.01	11.10	134	.06	.03	.03	136.	1.01	23.10	278	.01	.01	.00	41.
1.01	11.15	135	.06	.03	.03	150.	1.01	23.15	279	.01	.01	.00	41.
1.01	11.20	136	.06	.03	.03	169.	1.01	23.20	280	.01	.01	.00	41.
1.01	11.25	137	.06	.03	.03	189.	1.01	23.25	281	.01	.01	.00	41.
1.01	11.30	138	.06	.03	.03	210.	1.01	23.30	282	.01	.01	.00	41.
1.01	11.35	139	.14	.07	.07	235.	1.01	23.35	283	.01	.01	.00	41.
1.01	11.40	140	.14	.08	.06	270.	1.01	23.40	284	.01	.01	.00	41.
1.01	11.45	141	.14	.08	.06	321.	1.01	23.45	285	.01	.01	.00	41.
1.01	11.50	142	.27	.16	.11	400.	1.01	23.50	286	.01	.01	.00	41.
1.01	11.55	143	.27	.17	.10	509.	1.01	23.55	287	.01	.01	.00	41.
1.01	12.00	144	.55	.38	.18	681.	1.02	0.00	288	.01	.01	.00	41.
									SUM	7.39	4.74	2.65	46829.
										(188.)(	120.)(	67.)(	1326.59)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2495.	507.	162.	162.	46588.

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	LAKE	2455.	507.	162.	162.	1.28
	(	69.53)(	14.37)(	4.58)(	4.58)(	3.32)
ROUTED TO	DAM	300.	300.	299.	299.	1.28
	(	8.50)(	8.50)(	8.47)(	8.47)(	3.32)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1302.00	1302.00	1315.50
STORAGE	3481.	3481.	6517.
OUTFLOW	300.	300.	11300.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1301.99	0.00	3481.	300.	0.00	0.00	0.00

Output Summary
1% Probability Event
Magmont Mine Tailings Dam
MO 30917

B15

APPENDIX C

Laboratory Test Results
and Design Plans

HARDING • MILLER • LAWSON & ASSOCIATES
SOIL MECHANICS ENGINEERS

RICHARD S. HARDING, CIVIL ENGINEER
EUGENE A. MILLER, CIVIL ENGINEER
OLIVER E. MERWIN
ROBERT T. LAWSON, CIVIL ENGINEER
HENRY T. TAYLOR, CIVIL ENGINEER

64 WOODLAND AVENUE • P.O. BOX 1169
SAN RAFAEL, CALIFORNIA 94902

TELEPHONE (415) 454-1720

September 19, 1966
2956.2

Arthur G. McKee and Company
650 Fifth Street
San Francisco, California

Attention: Mr. Erik Rettig

Gentlemen:

Laboratory Test Results
Embankment Materials - Starter Dam
Missouri Lead Operating Company
Tailings Dam
Salem, Missouri

This letter transmits the results of laboratory classification and strength tests we have performed on the proposed embankment materials for the starter dam for the Missouri Lead Operating Company's Tailings Dam, Salem, Missouri.

Initially, classification tests were performed on three soil samples submitted by you, labeled Sample No. 1, No. 2 and No. 3. The results of these classification tests, consisting of sieve analyses and plasticity index tests, are presented on Plates 1 and 2. The three samples were then combined, equally by weight, to be used for the required strength testing.

The composite sample was compacted to form four 2.5 inch diameter cylindrical specimens to a density 95 percent of the maximum obtainable by the ASTM D698-58T (C) method at a water content 1% to 2% wet of optimum. The results of the compaction test are presented on Plate 3. This compaction method is generally referred to as the "Standard A.S.T.M." method and is equivalent to a compactive effort of 12,375 foot-pounds per cubic foot. As discussed with you, this compactive effort and water content is believed realistic for the planned construction and is in keeping with a recognized standard test procedure.

These specimens were subsequently tested in the triaxial compression apparatus (with pore pressure measurements) to determine the shearing strength parameters for the various conditions required for embankment design. The results of the laboratory strength tests are presented below and are shown graphically on Plate 4.

Condition	Shearing Strength
Unconsolidated - Undrained (Total Stresses)	c = 750 psf ø = 0
Consolidated - Undrained (Total Stresses)	c = 500 psf ø = 13 degrees
Effective Stress (Computed Drained Strength)	c' = 250 psf ø' = 32 degrees

The detailed results of the individual tests are presented on Plates 5 and 6.

Classification tests were also performed on a sample of coarse tailings proposed as the main dam embankment materials and the results of these tests are presented on Plate 7. We understand that you desire to obtain an approximate value of the permeability of this material to aid in your seepage analysis. Based on the Unified Soil Classification System, the coarse tailings are a SM type material which is a silty sand or a poorly graded silt-sand mixture. Using the 20 percent size criterion, the coefficient of permeability is estimated to be in the range of 1000 to 3000 feet per year. ?

We trust that these test data results are sufficient for your needs. We would be pleased to consult with you further regarding this project.

Yours very truly,

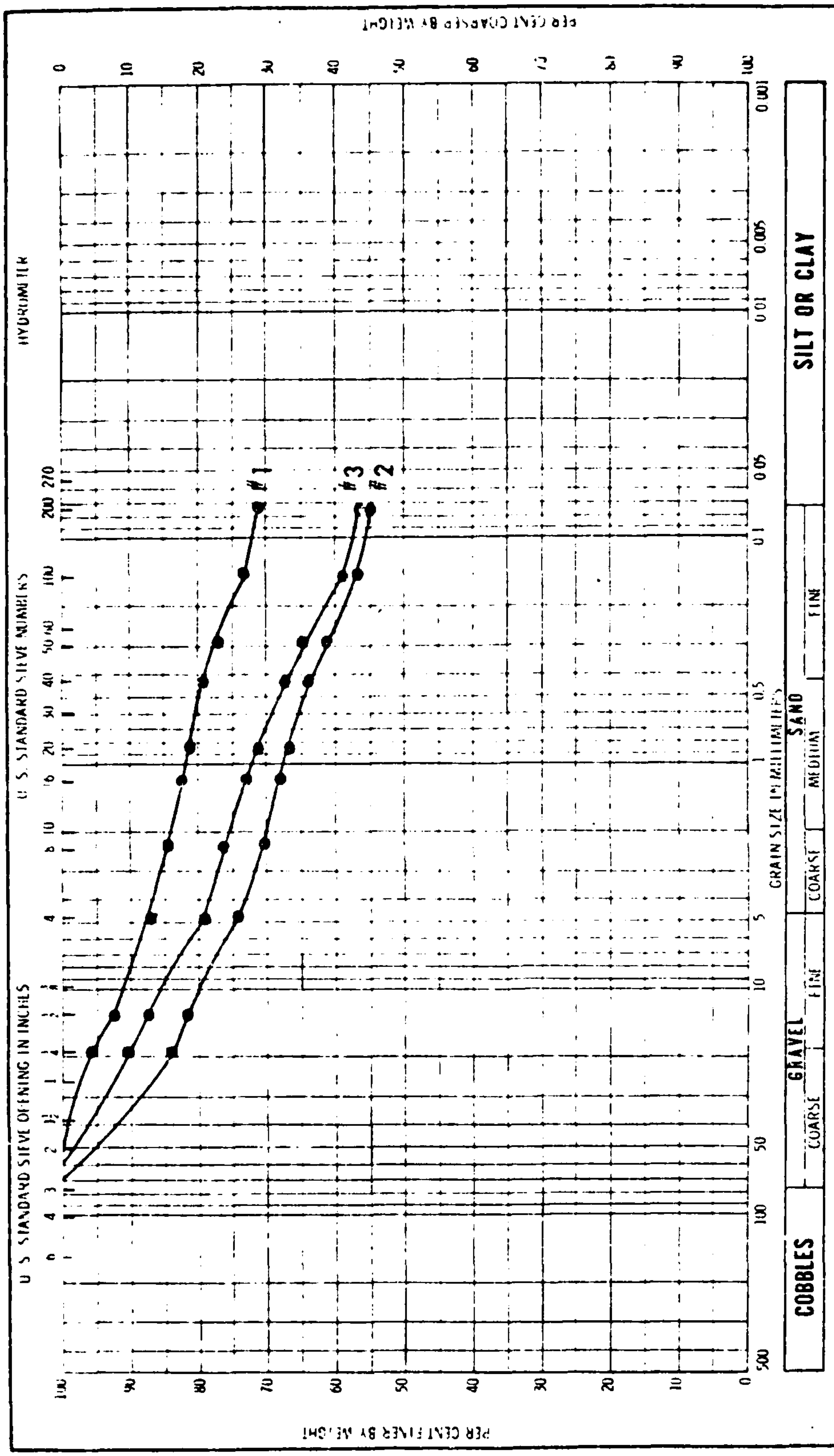
HARDING-MILLER-LAWSON & ASSOCIATES

Robert T. Lawson

Robert T. Lawson
Civil Engineer - 9715

KHB/EBH/RTL/leo

3 copies submitted



Sample No.	Elev. or Depth	Soil Name and Symbol	Nat w %	LL	PL	PI
1		GRAVELLY SANDY CLAY (CL)		39	20	19
2		GRAVELLY SANDY CLAY (CL)		32	20	12
3		GRAVELLY SANDY CLAY (CL)		32	17	15

Project Missouri Lead Tailings Dam
Area
Hole No
Date

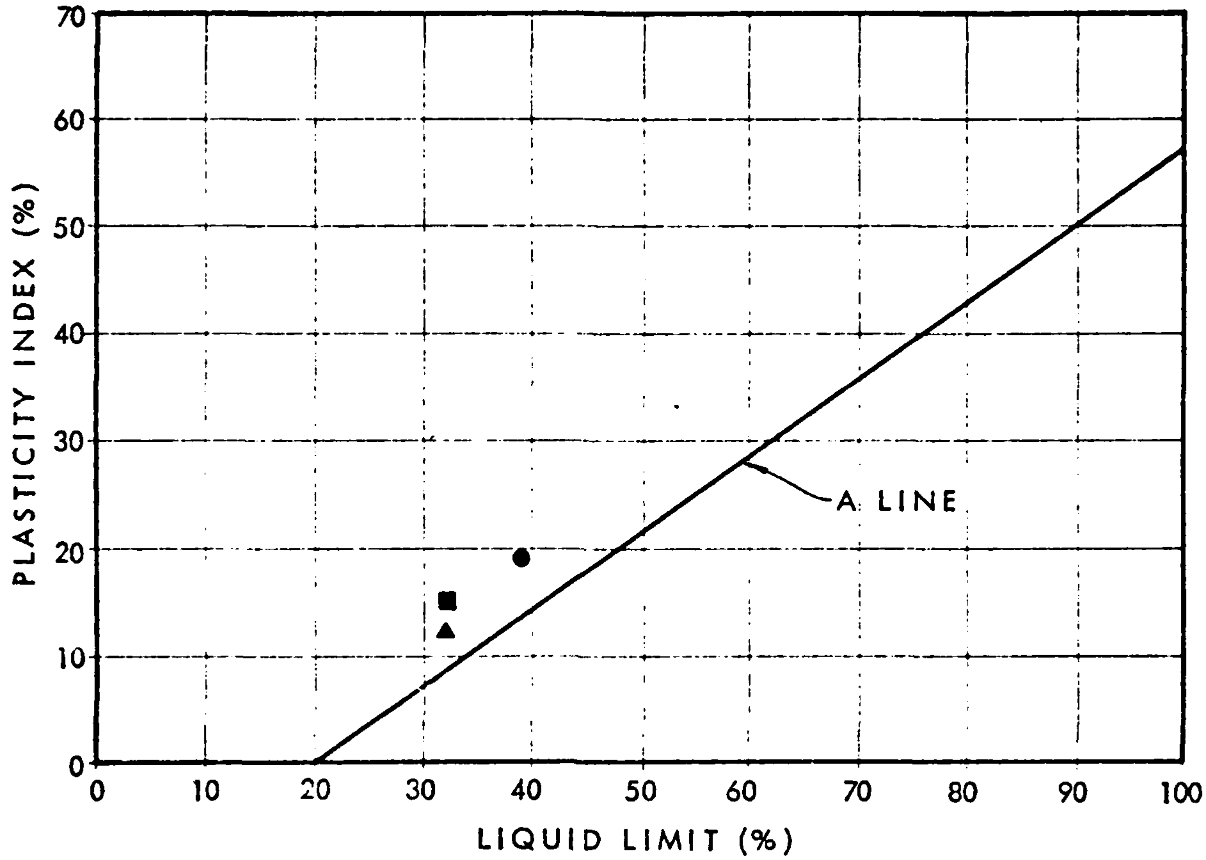
PARTICLE SIZE ANALYSIS

HARDING MILLER LAWSON & ASSOCIATES
soil mechanics engineers

Job No: 2956.2 Appr: WP/rr Date: 9/19/66

PARTICLE SIZE ANALYSIS
Missouri Lead Tailings Dam

PLATE
1



SYMBOL	CLASSIFICATION & SOURCE	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SCREEN
●	GRAVELLY SANDY CLAY (CL) (sample #1)	39	20	19	
▲	GRAVELLY SANDY CLAY (CL) (sample #2)	32	20	12	
■	GRAVELLY SANDY CLAY (CL) (sample #3)	32	17	15	

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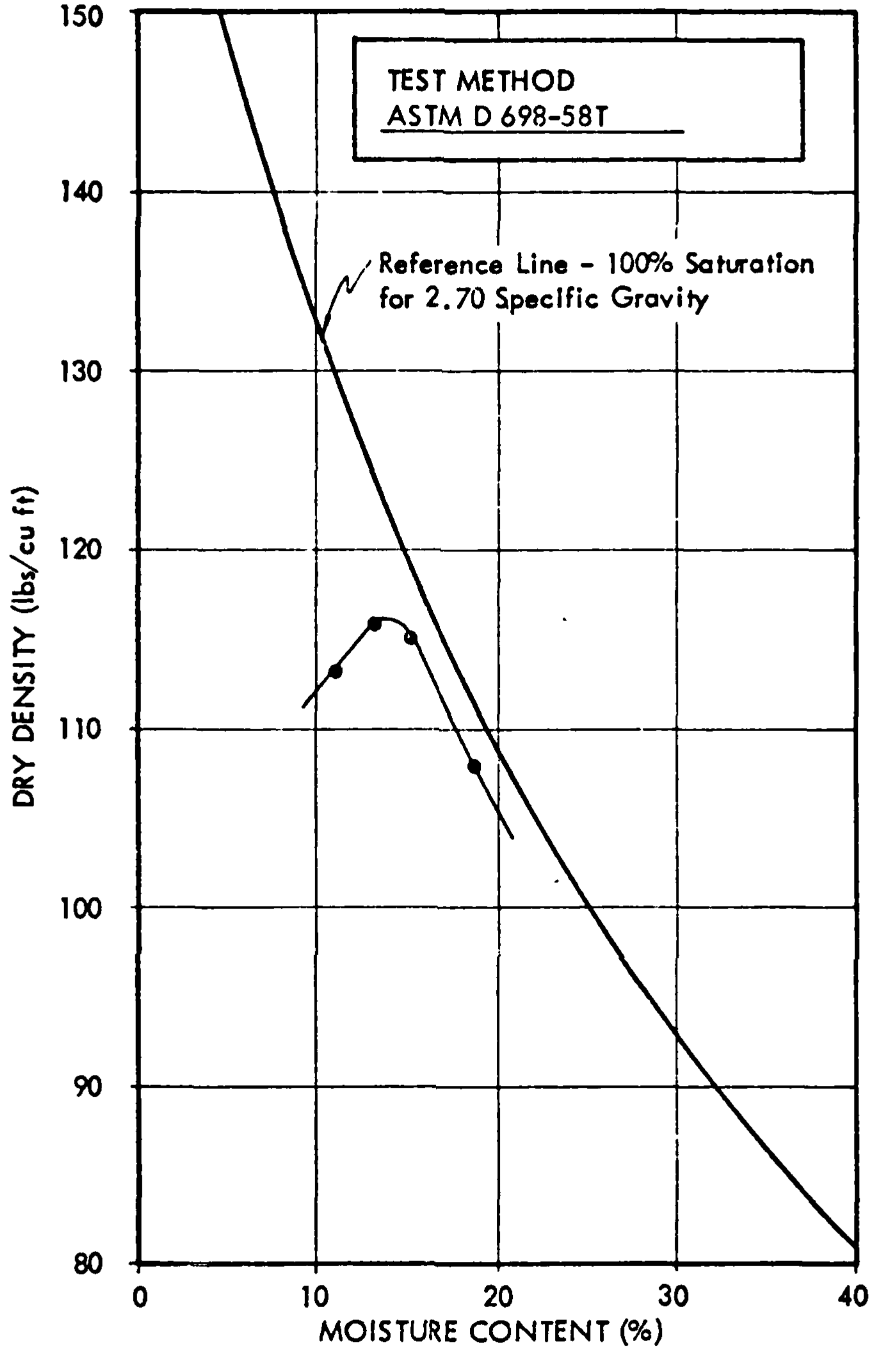
soil mechanics engineers

Job No: 2956.2 Appr: 1/7/rr Date: 9/19/66

PLASTICITY CHART

Missouri Lead Tailings Dam

PLATE 2



Symbol	Sample Source	Classification	Optimum Moisture (%)	Maximum Dry Density (pcf)
●	Combined Samples 1, 2, &3	GRAVELLY SANDY CLAY (CL)	14	116

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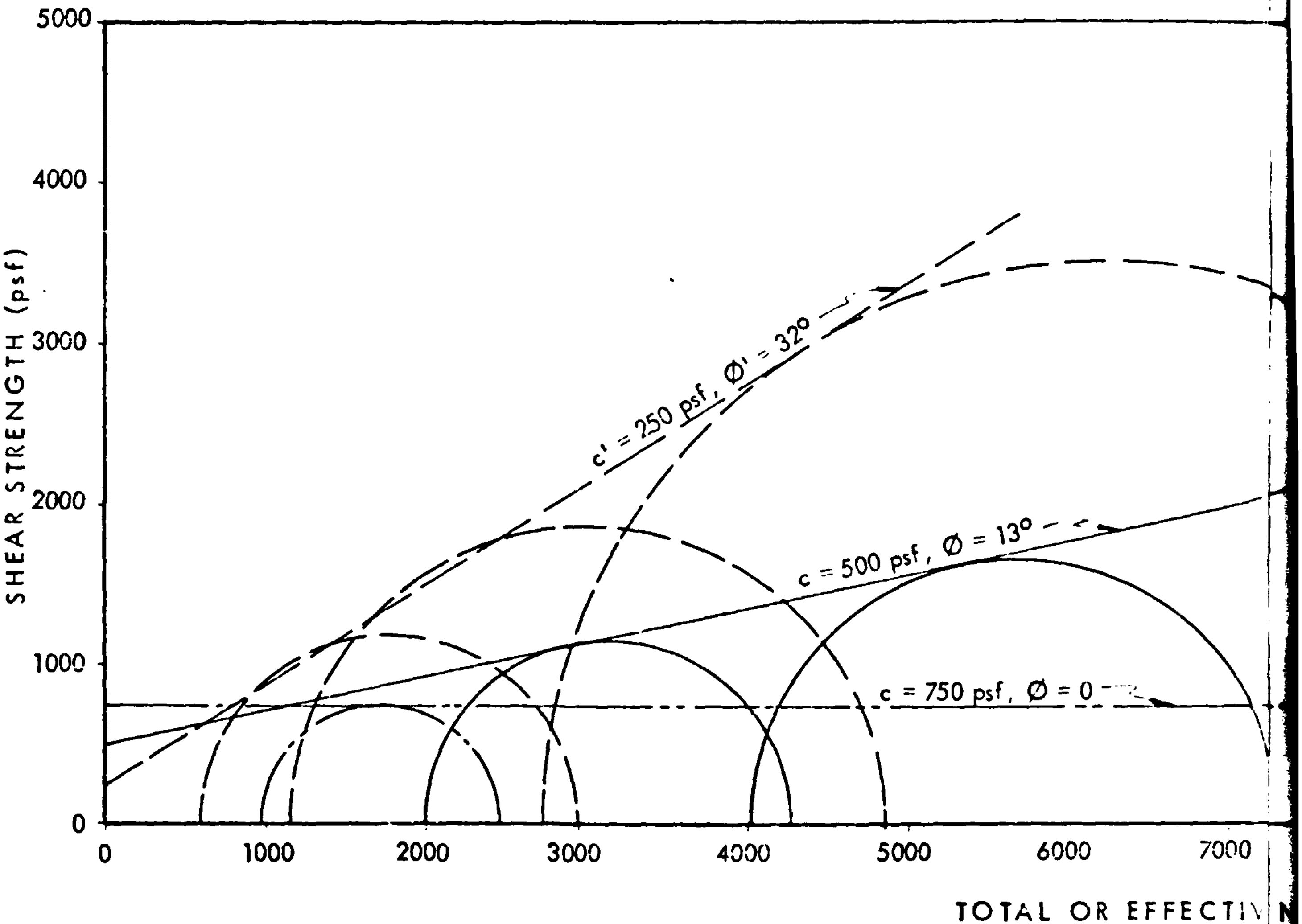
soil mechanics engineers

Job No: 2956.2 Appr: [illegible] /gr Date: 9/16/66

COMPACTION TEST DATA

Missouri Lead Tailings Dam

PLATE
3

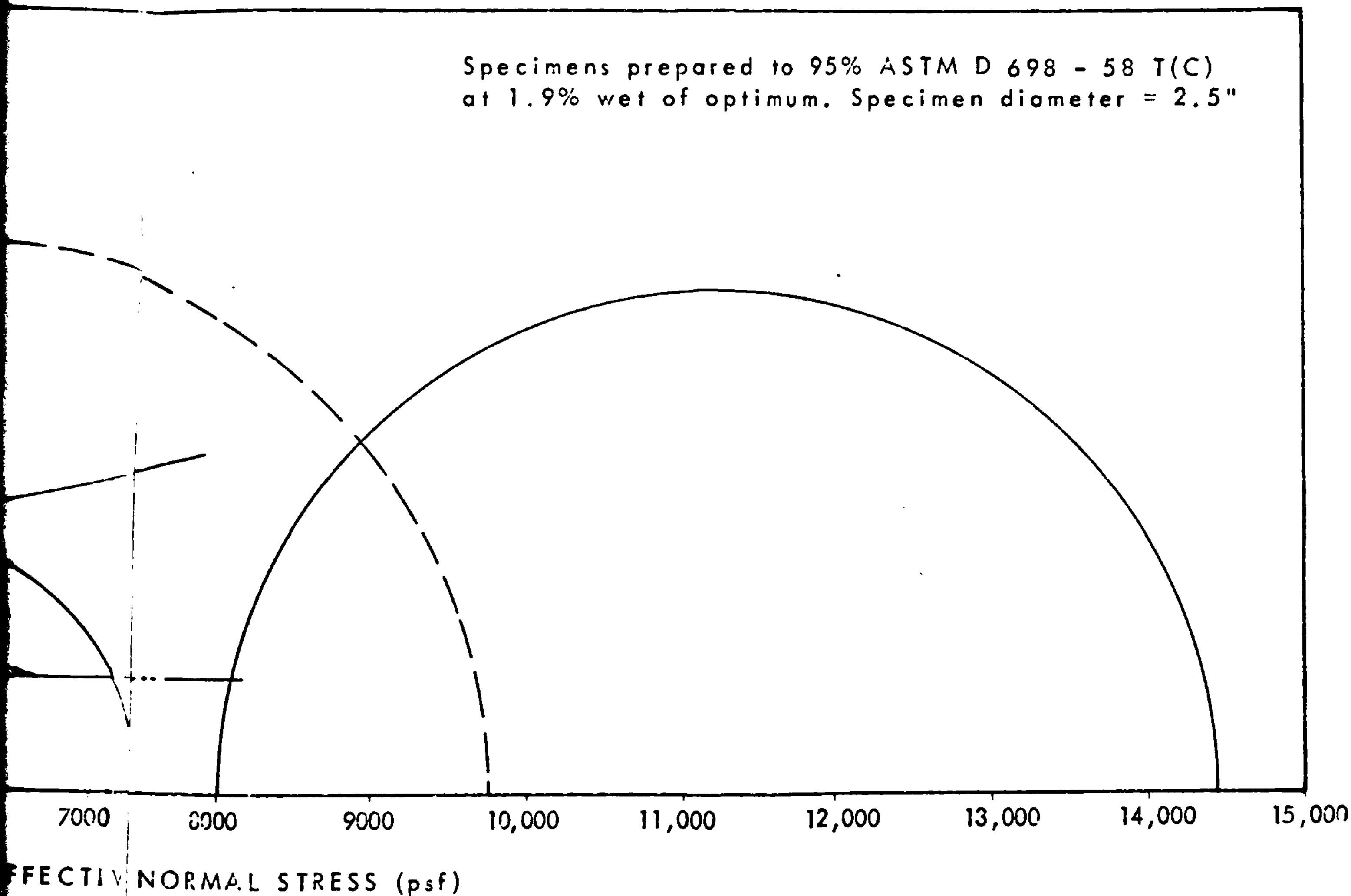


KEY:

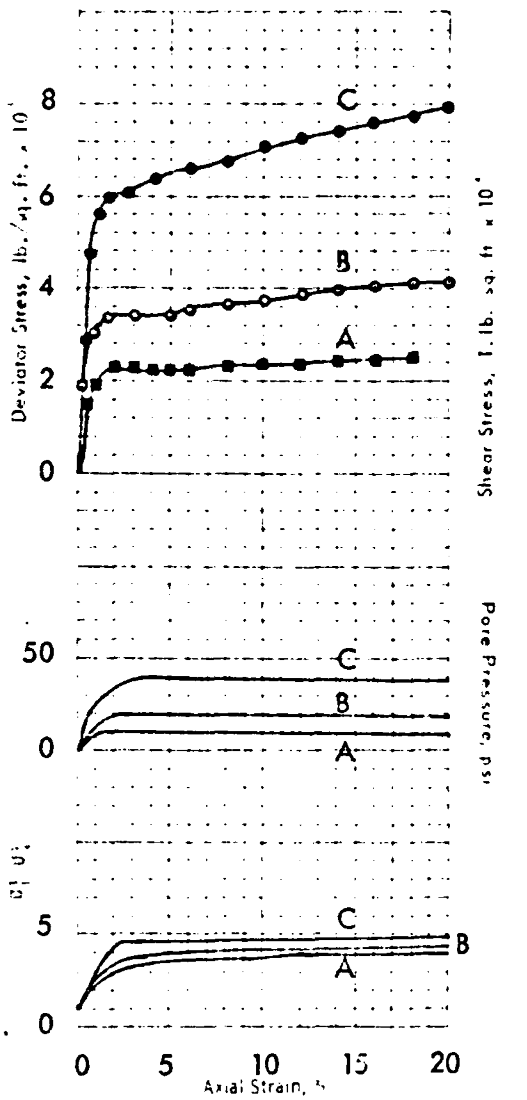
A. Unconsolidated - Undrained Triaxial Test ————-·-·—————-·-·

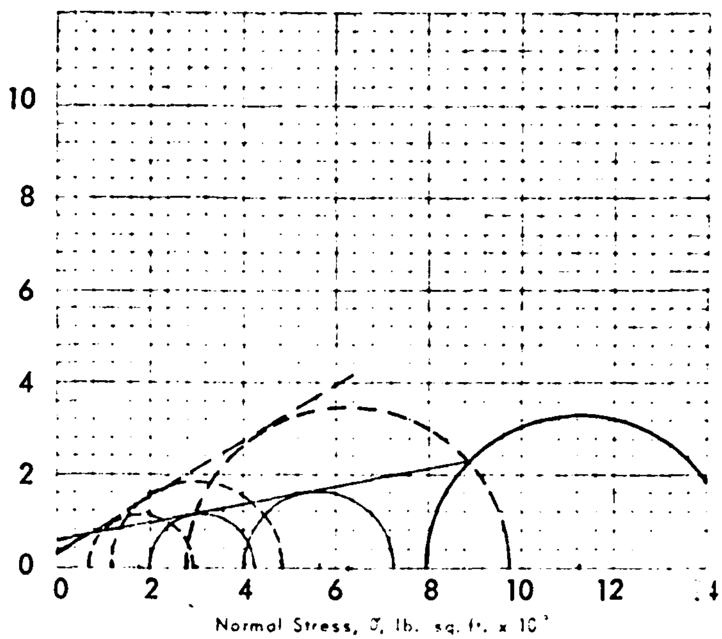
B. Consolidated - Undrained Triaxial Test ————————————

C. Effective Stress Circles and Envelope — — — — — — — — —
(Computed from Consolidated - Undrained Triaxial Tests with Measurement of Pore Water Pressures)



HARDING - MILLER - LAWSON & ASSOCIATES *soil mechanics engineers*	SHEARING STRENGTH TEST RESULTS EMBANKMENT MATERIALS STARTER DAM Missouri Lead Tailings Dam	PLATE 4
Job: 2956.2 Appr: K.E./rr Date: 9/19/66		





Test No.			A	B	C
Initial	Water content	w_o	16.2	15.9	15.5
	Void ratio	e_o	.537	.534	.519
	Saturation	S_o	81	80	80
	Dry density, lb/cu ft	γ_d	108.8	109.0	110.1
Before Test	Water content	w	18.6	17.4	15.7
	Saturation	S	100+	100+	100
	Consolidation press., lb/sq ft		2000	4000	8000
	Void ratio	e	.488	.462	.422
Final	Water content	w_f	18.6	17.4	15.5
	Void ratio	e_f	.488	.462	.422
Major principal stress, lb/sq ft		σ_1	5110	9670	14,530
Minor principal stress, lb/sq ft		σ_3	2000	4000	8000
Time to failure, min			12	8	35
Initial diameter, cm			6.35	6.35	6.35
Initial height, H_o, cm			14.60	14.60	14.60

Shear Values

ϕ = 13

tan ϕ = .231

c = 500 lb./sq. ft.

Type Test CU

Method of Saturation Back Pressure

☐ Controlled Stress ☒ Controlled Strain

Type of specimen Remolded   Rate of strain .011 in./min.

Classification GRAVELLY SANDY CLAY (CL)

LL --   PL --   PI -- G_s 2.68 (assumed)

Remarks

Boring   Depth

Area

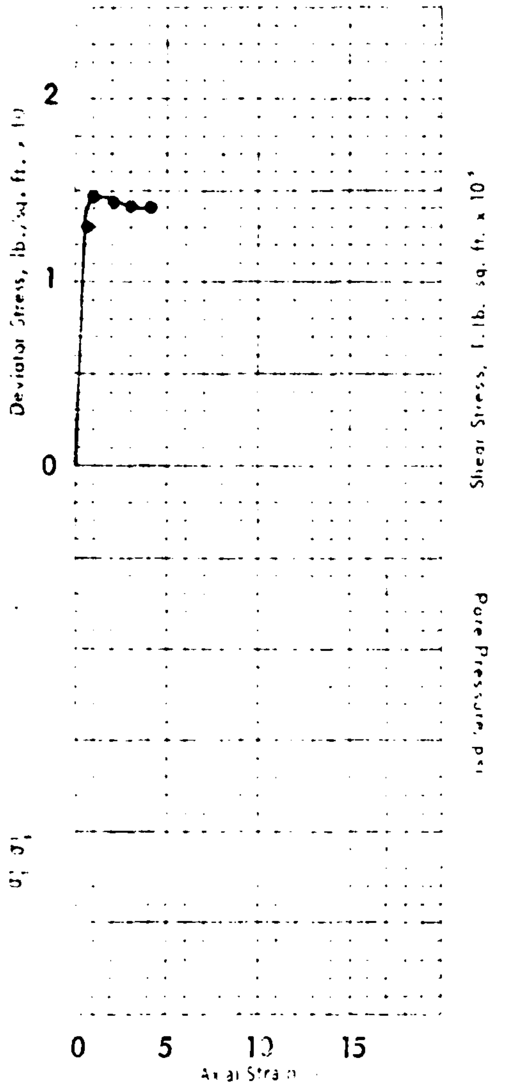
HARDING MILLER LAWSON & ASSOCIATES
soil mechanics engineers

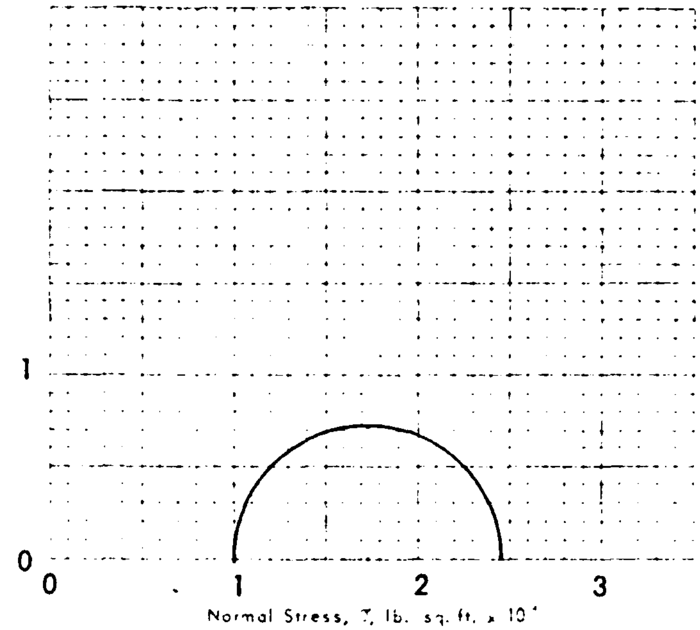
Job No: 2956.2 Appr: /rr Date: 9/19/66

TRIAXIAL COMPRESSION TEST

Missouri Lead Tailings Dam

PLATE 5





Shear Values

	Test No.				
Initial	Water content	w	15.5		
	Void ratio	e	.535		
	Saturation	S	78		
	Dry density, lb/cu. ft.	γ_d	109.0		
Before Test	Water content	w	19.0		
	Saturation	S	99		
	Consolidation pressure		--		
	Void ratio	e	--		
Final	Water content	w	19.0		
	Void ratio	e	.513		
	Max. deviator stress		2440		
	Minor principal stress		1000		
	Time to failure, min.		1.0		
	Initial diameter, cm		6.36		
	Initial height, cm		14.58		

Type Test UU

Method of Saturation Back Pressure

Controlled Stress X Controlled Strain

Type of specimen	Remolded	Rate of strain	1.0 %/min
Classification	GRAVELLY SANDY CLAY (CL)		
LL --	PL --	PI --	G_s 2.68 (assumed)

Remarks Back Pressure = 59 psi (8496 psf)

Boring Depth

Area

HARDING MILLER LAWSON & ASSOCIATES
soil mechanics engineers

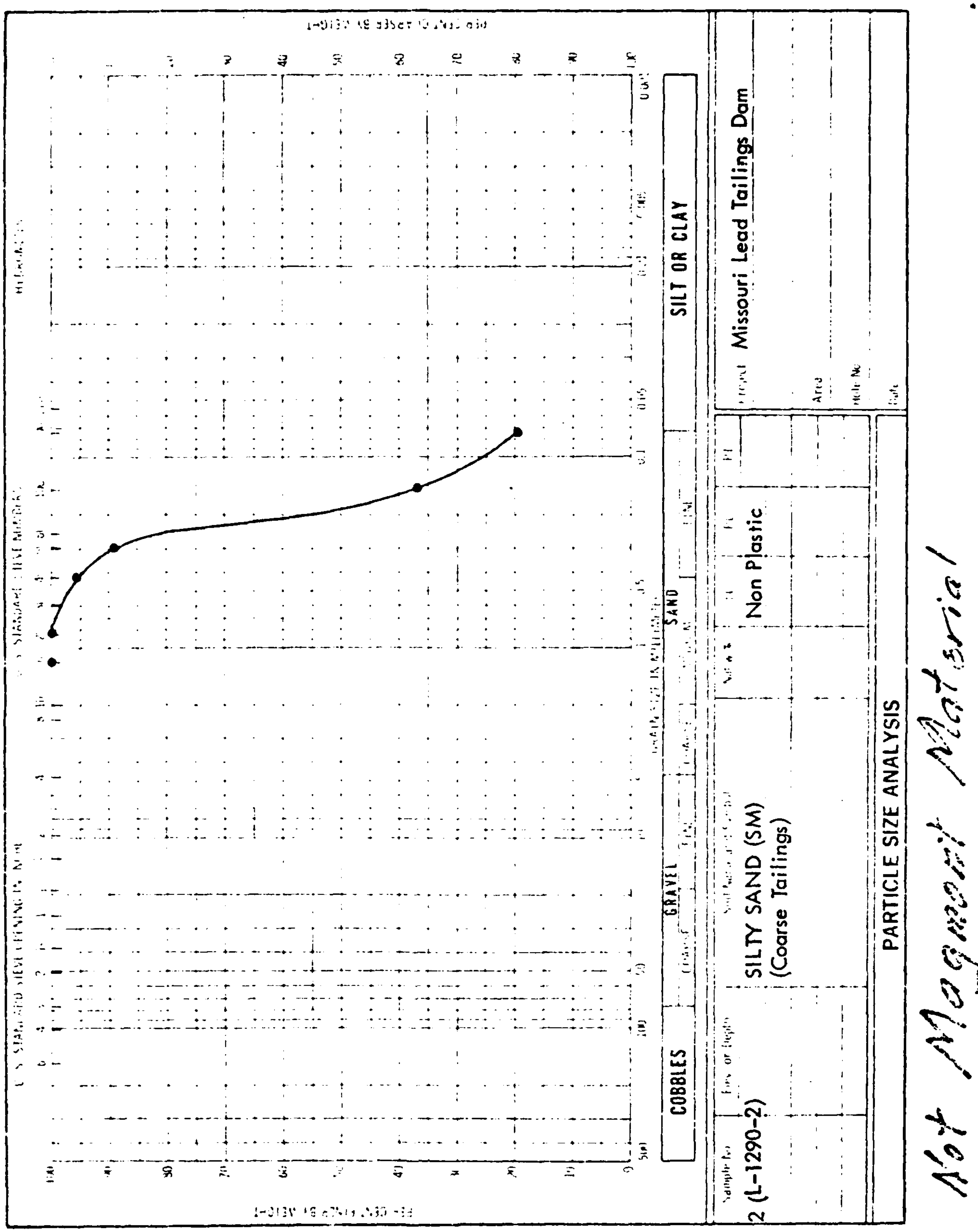
Job No: 2956.2 Appr: [illegible] /rr Date: 9/19/66

TRIAXIAL COMPRESSION TEST

Missouri Lead Tailings Dam

PLATE

6



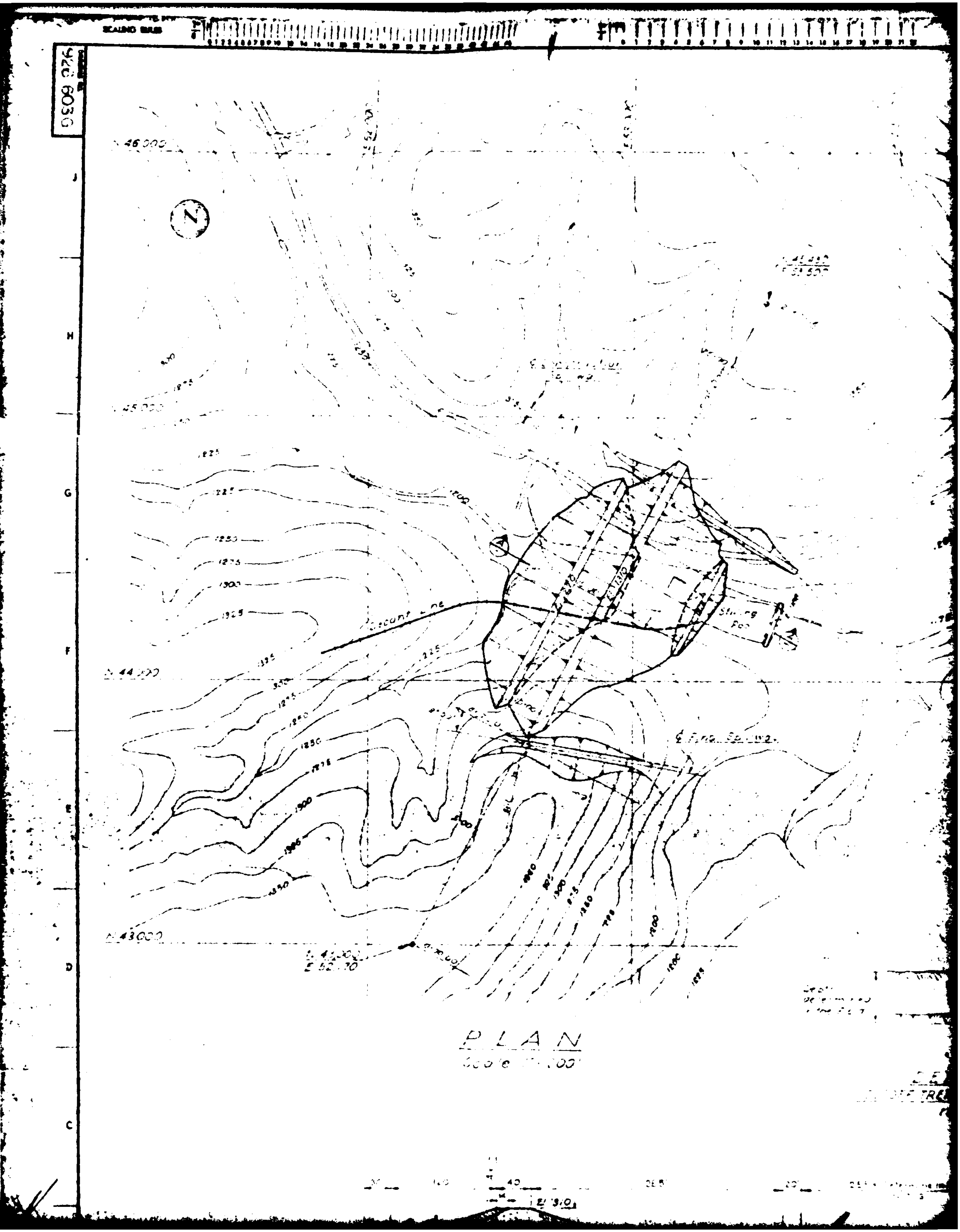
HARDING MILLER LAWSON & ASSOCIATES
soil mechanics engineers

Job No: 2956.2 Appr: ___ Date: 9/19/66

PARTICLE SIZE ANALYSIS

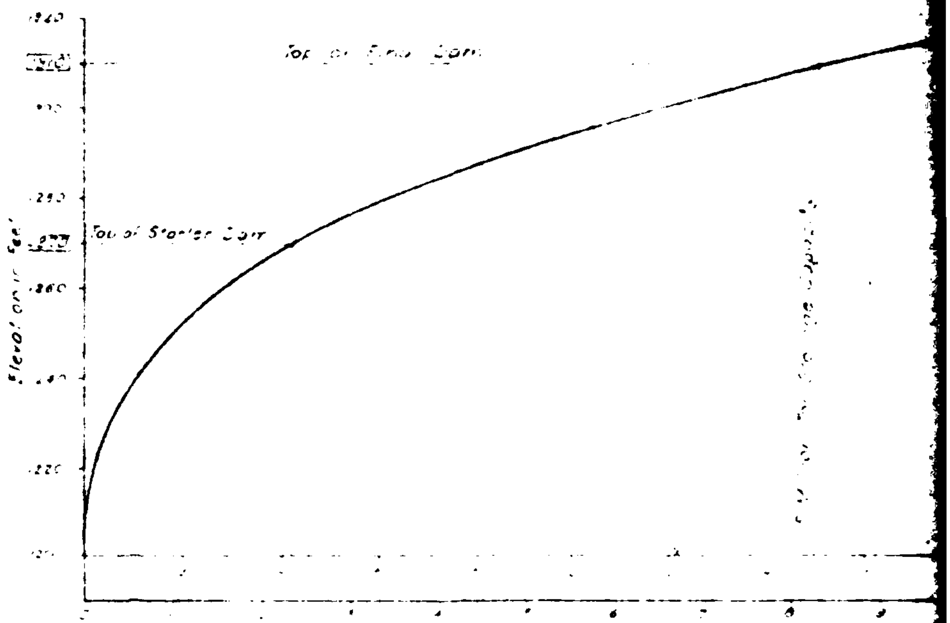
Missouri Lead Tailings Dam

PLATE 7

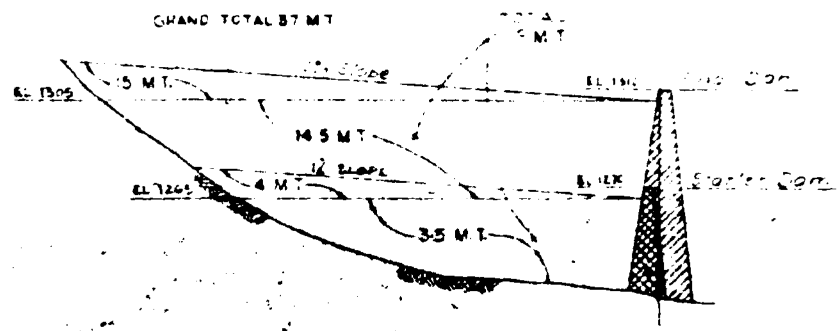


PLAN

Scale 1"=100'

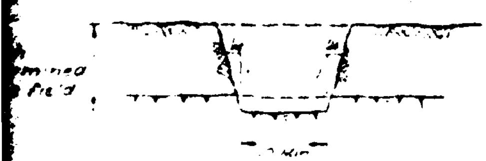


STORAGE CAPACITY - LEVEL SURFACE



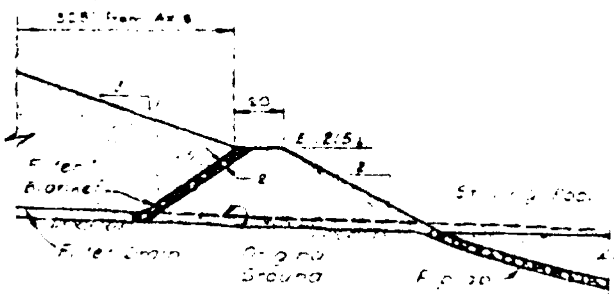
STORAGE CAPACITIES ; TAILINGS

SCHEMATIC SKETCH



DETAIL A

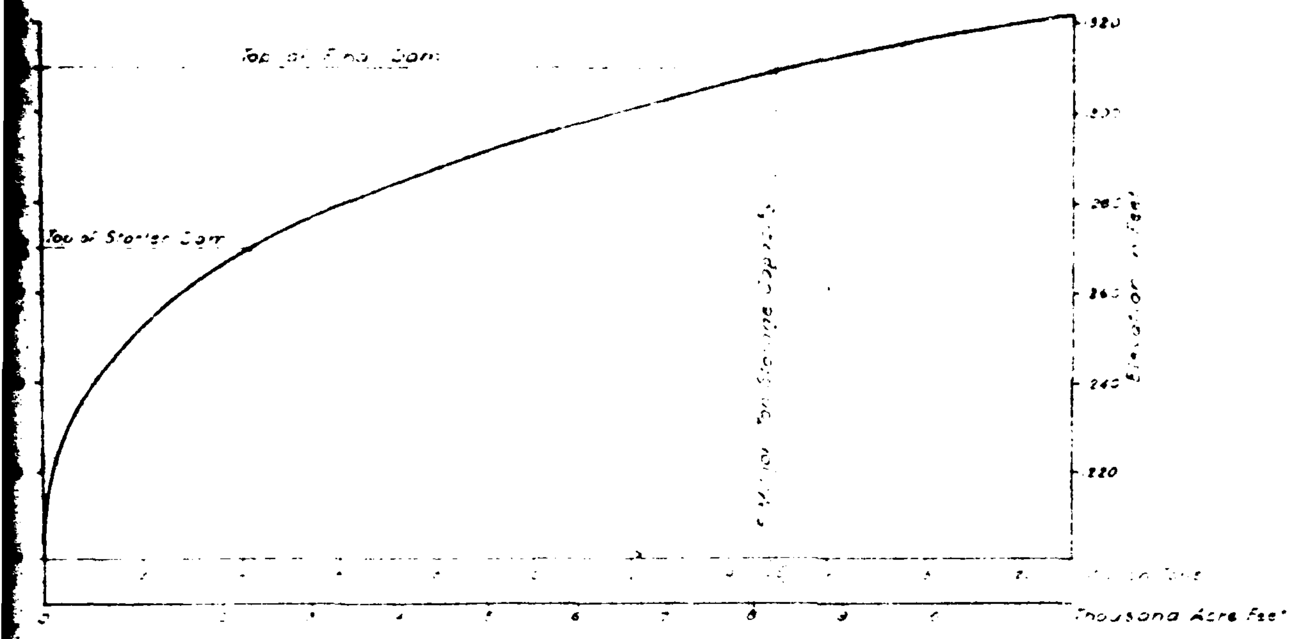
CUTOFF TRENCH, TYPICAL SECTION



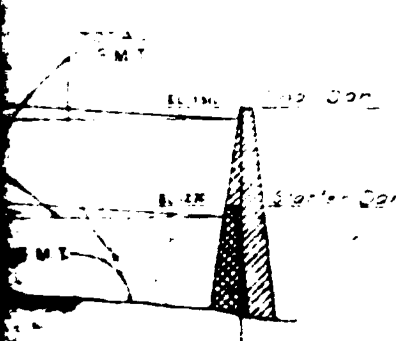
DETAIL B

TOE DIKE, TYPICAL SECTION

Scale 1"=40'

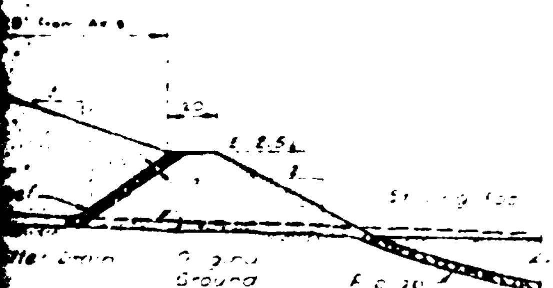


STORAGE CAPACITY-LEVEL SURFACE



ES ; TAILINGS

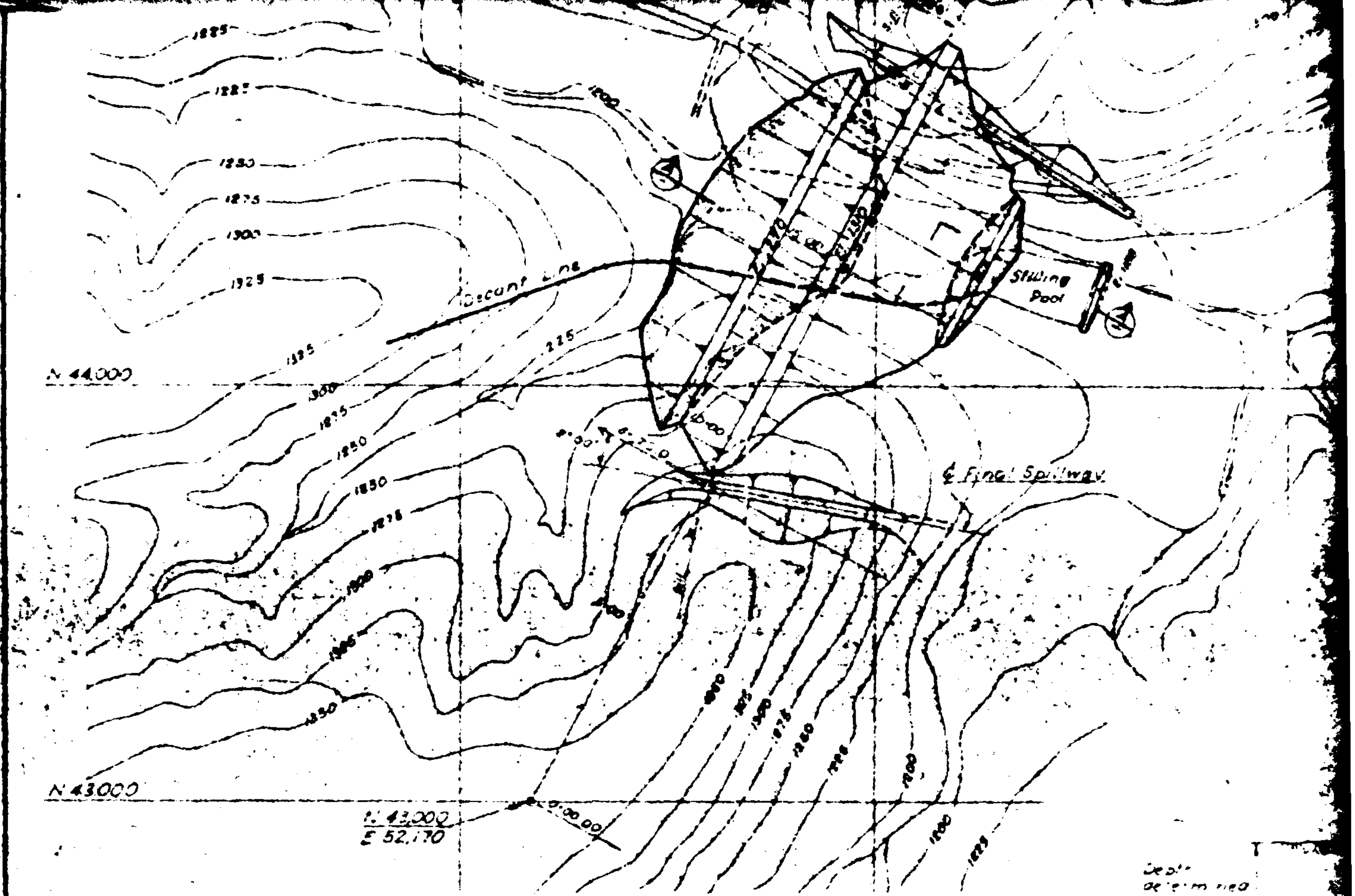
TCH



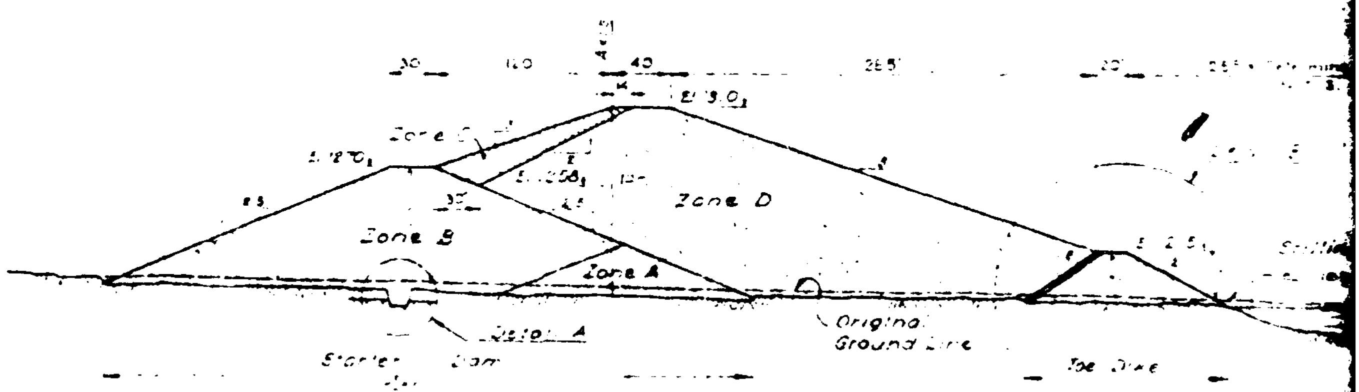
DETAIL B

DIKE TYPICAL SECTION

Scale 1 · 40'



PLAN
Scale 1" = 200'

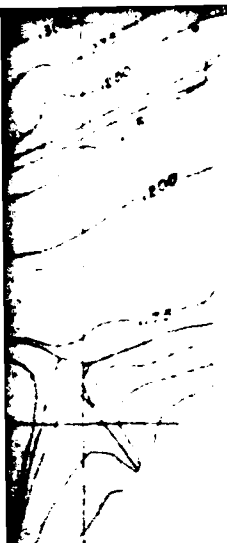


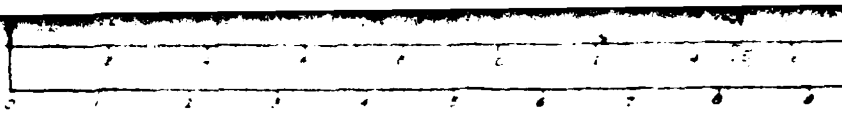
SECTION (A)
Scale 1" = 60'

REVISIONS	NO.	DESCRIPTION	BY	CK.	APPROVED	DATE	REVISIONS	NO.	DESCRIPTION	BY	CK.	APPROVED	DATE

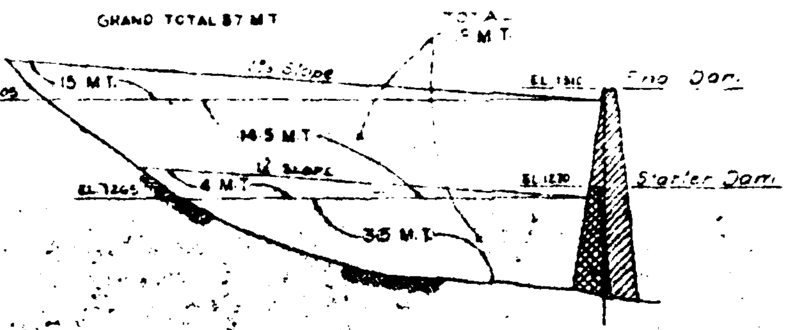
1 2 3 4 5

174



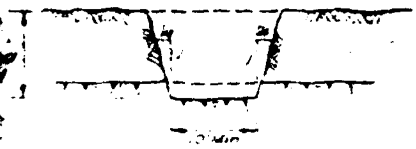


STORAGE CAPACITY-LEVEL SURFACE



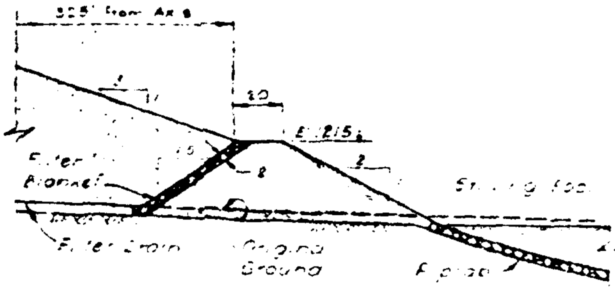
STORAGE CAPACITIES ; TAILINGS

SCHEMATIC SKETCH



DETAIL A

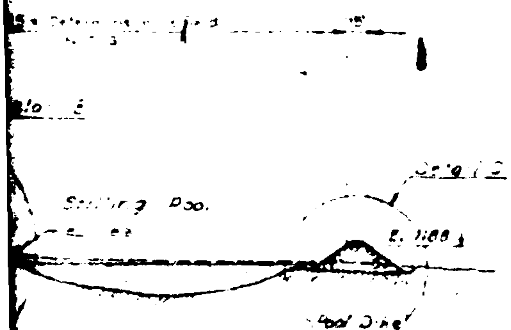
CUTOFF TRENCH, TYPICAL SECTION

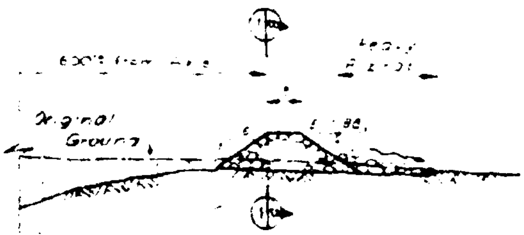


DETAIL B

TOE DIKE, TYPICAL SECTION

Scale 1"=40'

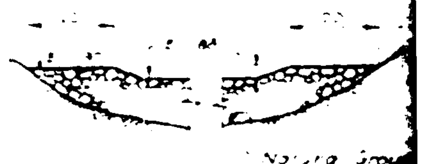




DETAIL C

POOL DIKE, TYPICAL SECTION

Scale 1"=40'



SECTION E

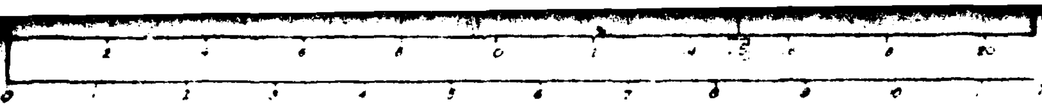
ARTHUR G. MCKEE & COMPANY

NONFERROUS METALS & MINERALS DIVISION

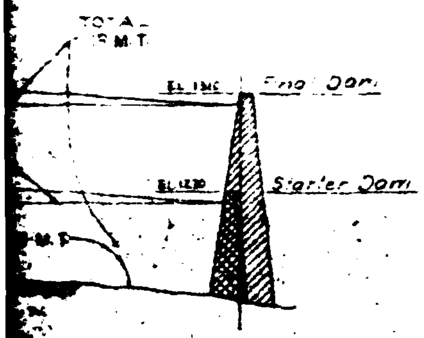
ENGINEERS CONSTRUCTORS

SAN FRANCISCO CALIFORNIA

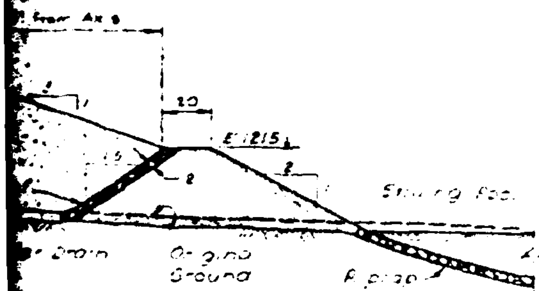
204-B Tailings Dam Details



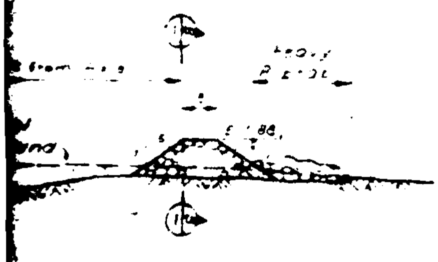
STORAGE CAPACITY-LEVEL SURFACE



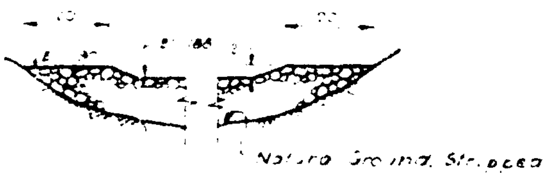
S - TAILINGS



DETAIL B
TOE DIKE TYPICAL SECTION
Scale 1"-40'



DETAIL C
DIKE TYPICAL SECTION
Scale 1"-40'



SECTION

TAILINGS DAM
GENERAL PLAN & SECTIONS

ARTHUR G. MCKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION
ENGINEERS CONSTRUCTORS
SAN FRANCISCO CALIFORNIA

COMINCO AMERICAN INCORPORATED
MAGMONT PROJECT
BIXBY MISSOURI

SCALE As Shown

926-603 G A

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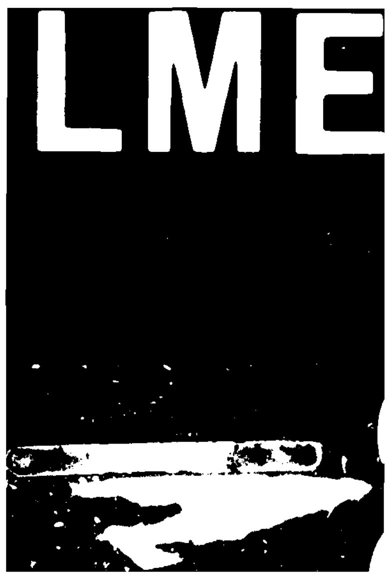
LME