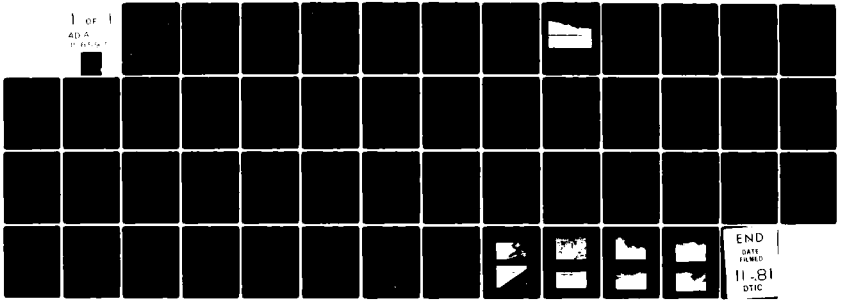
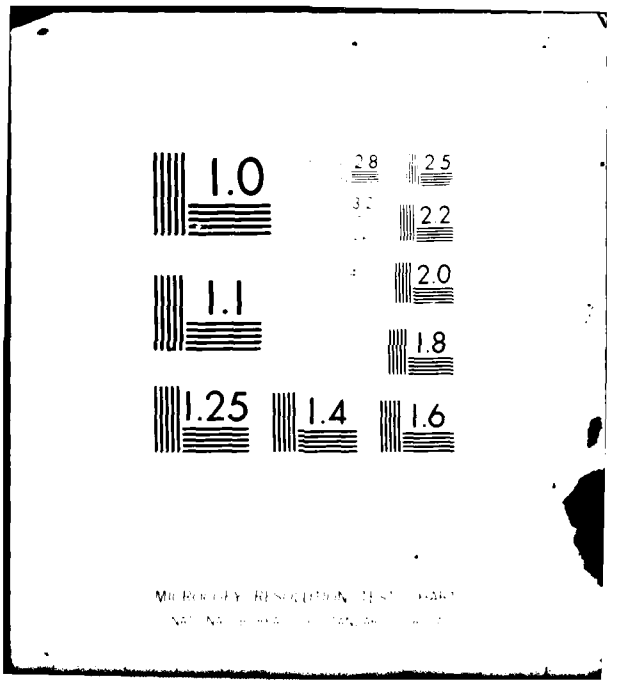
AD-A106 597 INTERNATIONAL ENGINEERING CO INC SAN FRANCISCO CA F/G 13/13
NATIONAL DAM SAFETY PROGRAM. CADET NUMBER 1 DAM (MO 30704), MIS--ETC(U)
AUG 79 K B KING, J H GRAY, D E WESTCOTT DACW43-79-C-0037
UNCLASSIFIED NL




1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

LEVEL

MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

AD A

CADET NO. 1 DAM
WASHINGTON COUNTY, MISSOURI
MO 30704

DTIC
ELECTE
NOV 5 1981
H

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DTIC FILE COPY

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

"Original contains color plates: All DTIC reproductions will be in black and white"

St. Louis District

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1979

81 11 02 027

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD A106597	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Cadet No. 1 Dam (MO 30704) Washington County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) International Engineering Company, Inc.	8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0037
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	12. REPORT DATE Aug[illegible]979
	13. NUMBER OF PAGES Approximately 60
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

Kenneth B. /King James H. /Gray
Donald E. /Westcott

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if di

18. S

National Dam Safety Program. Cadet Number 1 Dam (MO 30704), Mississippi - Kaskaskia - St. Louis Basin, Washington County, Missouri. Phase I Inspection Report.

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.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

412587

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

LMSED-FI

22 August 1979

SUBJECT: Cadet No. 1 Dam (MO 30704) Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Cadet No. 1 Dam:

It was prepared under the National Program of Inspection of Non-Federal dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1. Dam cannot contain 50 percent of the Probable Maximum Flood.

2. Dam failure significantly increases the hazard to loss of life downstream.

3. Excessively steep downstream embankment slope.

4. Excessive seepage and interrupted drainage observed at the dam toe.

SUBMITTED BY: SIGNED
Chief, Engineering Division

21 Sep 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

21 SEP 1979
Date

CADET NO. 1 DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30704

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

AUGUST 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Cadet No. 1 Dam
State	Missouri
County	Washington
Stream	Offstream from unnamed Mill Creek Tributary
Date of Inspection	10 April 1979

Cadet No. 1 Dam, owned by Baroid Division of NL Industries, Inc. Potosi, MO, was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. of San Francisco, California. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment was based on an evaluation of the available data, a visual inspection, and an evaluation of the hydrology and hydraulics of the site to determine if the dam poses hazards to human life or property. The purpose of the dam is to provide impoundment for barite ore tailings.

Cadet No. 1 Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these Guidelines, this dam is classified as being of intermediate size. The St. Louis District Corps of Engineers has classified this dam as having high downstream hazard potential. Failure of this dam could threaten life and property. The estimated damage zone provided by the St. Louis District Corps of Engineers extends approximately four and one half miles downstream of the dam. There are two dams, 11 dwellings, and 11 mobile homes within this damage zone.

The results of the inspection indicate an absence of facilities for discharging floodwater, inadequate freeboard, and failure of the dam to meet the criteria given in the Guidelines for a structure with the size and hazard potential of Cadet No. 1 Dam. As an intermediate size dam with a high hazard potential, the Guidelines specify that the discharge capacity and/or storage capacity should be capable of safely handling the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. It was calculated that the impoundment can retain the 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. It was also estimated that the impoundment can retain 45 percent of the PMF without overtopping the crest; however, the impoundment cannot retain 50 percent of the PMF without overtopping the embankment.

Adequate overflow facilities and/or freeboard should be provided so that the impoundment can handle the PMF without overtopping the crest and without significant erosion of the embankment.

Seepage and interrupted drainage observed at the dam toe should be drained to reduce the possibility of weakening foundation materials by saturation.

Seepage and stability analyses of this dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

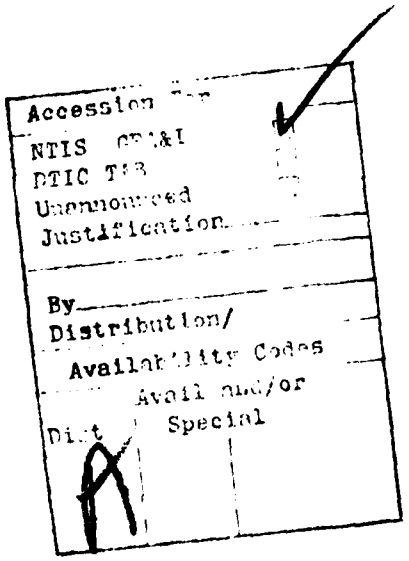
An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

James H. Gray, P.E.

Donald E. Westcott



Overview of Cadet No 1 Dam,
ID No 30704

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
CADET NO. 1 DAM
ID NO. 30704

TABLE OF CONTENTS

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

LIST OF PLATES

PHOTOGRAPHS

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

CADET NO. 1 DAM - ID NO. 30704

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Cadet No. 1 Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and visual inspection, to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These Guidelines were developed with the help of several Federal agencies, many professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Type of dam - Cadet No. 1 Dam is an earthfill dam that was used to impound barite ore tailings. The impoundment is formed by a dam which closes a drainage area next to the mill site.

(2) Spillway - There is no active spillway at the dam.

b. Location. The dam is located in Washington County, Missouri, as shown in Plate 1. The dam is shown in Plate 2 and is located in Section 21, Township 38 North, Range 3 East.

c. Size Classification. Cadet No. 1 Dam is greater than 40 feet and less than 100 feet high and therefore is classified as an intermediate size dam in accordance with "Recommended Guidelines for the Safety Inspection of Dams".

d. Hazard Classification. This dam is classified as having a high hazard potential by the St. Louis District Corps of Engineers. The estimated damage zone, as provided by the St. Louis District Corps of Engineers, extends approximately four and one half miles downstream. There are two dams, 11 dwellings, and 11 mobile homes within this damage zone.

e. Ownership. This dam is owned by:

Baroid Division
N. L. Industries
P.O. Box 8
Potosi, Missouri 63664

f. Purpose of Dam. The dam impounds tailings resulting from a barite separation and benefication process. Tailings are no longer conveyed to the impoundment. Reactivation of tailings disposal activities is not expected.

g. Design and Construction History. There is no written design or construction data available for this dam. Information obtained from Mr. Clarence Houk, General Superintendent for Baroid, indicated that the starter dam was built in 1955. The impoundment was enlarged subsequently during mine operations until 1967-8, when the impoundment was deactivated.

h. Normal Operating Procedures. No operating records are known to exist. Runoff into the pond is removed by seepage into the tailings and by evaporation. The facility is inactive in that tailings are no longer conveyed to the impoundment.

1.3 PERTINENT DATA

a. General. Field surveys were made by Booker Associates, Inc. of St. Louis, Missouri on 19 April 1979. Measurements are valid as of the dates of inspection and survey.

b. Drainage Area. 66 acres (from ASCS air photograph #BMH-3MM-233).

c. Discharge at Damsite.

(1) Outlet Pipe - Not applicable.

(2) Total spillway capacity at maximum pool elevation - No spillway for this dam exists.

d. Elevation (Feet Above M.S.L.).[1/]

(1) Top of dam (Maximum Pool) - 907.5 to 912.0 feet.

(2) Toe of dam - 852.6 feet.

(3) Operating pool - 903.5 feet on 19 April 1979.

(4) Spillway crest - Not applicable.

(5) Overflow pipe - Not applicable.

(6) Intake structure (flashboards) - Not applicable.

d. Reservoir.

(1) Length of maximum pool - 2000 feet ± (from ASCS airphoto BMH-3MM-233).

(2) Length of operating pool - 1200 feet ±.

e. Storage above Tailings Surface.

(1) Maximum - 92 acre-feet at El. 907.5 feet.

(2) Operating - 16 acre-feet at El. 903.5 feet.

f. Reservoir Surface Area.

(1) Top of dam (Maximum Pool) - 30 acres at El. 907.5 feet.

(2) Operating pool - 10 acres at El. 903.5 feet.

(3) Spillway crest - Not applicable.

g. Dam.

(1) Type - Earthfill.

(2) Crest Length - 3200 feet.

(3) Height - 55 feet at Station 11+28.

(4) Crest width - Variable; from 25 to 35 feet.

[1/] Elevations are based on an arbitrary reference elevation of 912.50 feet at the temporary benchmark. This datum was estimated from topographic data presented on the Mineral Point 7.5-minute quadrangle sheet.

(5) Side Slopes -

(a) Downstream: 1.5(H):1(V)

(b) Upstream: Unknown.

(6) Zoning - It is not known if the dam was built as a zoned structure. The dam appears to be constructed consistent with the prevailing practice. This consists of a clay starter enlarged using ~7/8-inch barite gravels.

(7) Cutoff - There is no written information available to indicate that a cutoff was designed or constructed.

h. Spillway. There is no spillway at Cadet No. 1 Dam.

i. Regulating Outlets. Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design drawings or data are known to exist.

2.2 CONSTRUCTION

a. Information. According to Mr. Clarence Houk, General Superintendent of Baroid Division of NL Industries, the starter dam was built in 1955 and the dam was enlarged during operations until cessation of tailings disposal operations in 1967-8. There are no written records concerning construction methods.

According to Mr. Houk, the foundation for the starter dam was stripped, and a core trench was excavated with scrapers to a depth of 10 feet and then refilled with residual clay soil. Residual clay soil was compacted in lifts of unknown thickness with sheepsfoot rollers to construct the starter dam. The dam was raised by dumping gravel in windrows on the crest and spreading the gravel to raise the crest approximately 6 inches. Gravel raveled down upstream and downstream slopes. Residual clay soil was placed against the upstream slope to seal the dam against seepage. The starter dam was also extended along the abutments as the operation progressed.

b. Assessment of Construction Method and Materials. Procedures used to build this dam were developed by local miners using trial and error techniques over the last 60 years. After construction of the starter dam, sand and angular gravels (finer than 7/8-inch) were hauled to the crest of the dam, end-dumped, and spread; and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The centerline of the dam remains approximately at the same position as the embankment is raised. Compaction of the material on the crest was by construction equipment.

The 7/8-inch gravels were used to enlarge this tailings dam. They are free draining, angular, and relatively well-graded through the gravel and coarse sand range. The gravel appears to function well as a drain material, and it also functions fairly well as erosion protection from rainfall; however, it is inadequate to prevent erosion from channeled surface flow with a velocity greater than 4 to 6 feet per second.

Foundation preparation for the downstream foundation zone appears to be nonexistent, as buried trees in the downstream face tend to indicate.

2.3 OPERATION

No records of operation are known to exist.

2.4 EVALUATION

a. Availability. No design or construction records were available. The only information made available to the inspection team was provided during conversations with Mr. Clarence Houk, General Superintendent of Baroid Division of NL Industries of Potosi, Missouri owner of the facility.

b. Adequacy. The field surveys and visual inspections documented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for the Safety Inspection of Dams" are not available, and this lack of data is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earth-quake loads, and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The inspection team consisted of a civil engineer and an engineering geologist from International Engineering Company, Inc. Mr. Clarence Houk, mill general superintendent for Baroid met the inspection team at Baroid's office near the site. A Baroid employee escorted the team to the damsite. The facility is an abandoned barite tailings impoundment. Photographs taken during the inspection are included in this report; locations are shown on Plate 7.

b. Project Geology. Bedrock in the area and underlying the dam is composed of the gray dolomite of the Cambrian Age Potosi formation. Isolated outcrops are found over much of the surrounding area; these outcrops have been exposed by mining activities. Soil cover ranges from about 10 to 15 feet in thickness. The residual overburden soil consists of dark red and brown barite-rich clays derived from weathering of the dolomite. Intermixed with the clays are rock fragments consisting of barite, quartz, chert, and dolomite, which grade from fine gravel to boulders.

c. Dam. The plan of the dam is shown on Plate 3; a profile and sections are presented on Plates 4, 5, and 6. Little vegetation is growing on the slopes of the dam. Some trees were buried during the dam enlargement process, and these were exposed in places on the downstream slope of the dam.

No detrimental settlement, depressions, sinkholes, animal burrows, or evidence of past embankment overtopping was observed. Gravel placed on the downstream slope is probably near the angle of repose for the material.

Several springs and ponds were observed at the dam toe near Stations 10+00 to 12+50. Estimated flow quantities and turbidity were as follows:

Station	Flow (gpm)	Turbidity
9+95	2	Clear
10+18	20	Clear
11+70	1	Clear

Several ponds were also observed in this area; and the ground is marshy and soft in spots (Photo 2).

The spring at Station 10+18 shows some evidence of having piped fine embankment material or tailings some time in the past. This piping does not appear to be extensive or continuing (Photo 3).

Some seepage and marshy ground at the dam toe were observed near Stations 20+00 to 22+00. No flow was observed, but the ground is marshy and soft in spots.

Freeboard, defined here as the height difference between the effective crest elevation and the adjacent tailings elevation, varies between 0.5-foot at Station 15+00 to greater than 4 feet. The effective crest elevation was surveyed on the crest roadway between the dumped gravel windrows (Photo 4).

For the purpose of setting a crest elevation for the overtopping analysis, a gravel berm with a height of 1.5 feet over the dam crest roadway was estimated (Plate 4). Overtopping would probably occur near the left abutment near Stations 2+00 to 2+86, where no gravel windrows are present to back up reservoir water. The elevation of this low area varies from 908.2 feet to 907.5 feet.

There is no erosion or slope protection at the dam. Both abutments for the L-shaped impoundment are composed of residual soil. Baroid's mill is located on the right abutment; the left abutment consists of undisturbed ground.

d. Appurtenant Structures. No spillway exists at the damsite. The impoundment would probably overflow somewhere between Stations 2+00 and 2+86 and would drain into a ditch, which runs along the toe of the dam to Station 10+00.

A ditch carrying mill tailings slurry to Dam No. 30707 flows within 10 feet of the dam toe from Station 33+40 to approximately Station 26+00.

A dike and an abandoned diversion structure were observed in the southeast corner of the impoundment. The area behind the dike has been mined out and would impound water if the reservoir overflowed. Behind this area is the mill access road that would also impound reservoir water.

e. Reservoir Area. No landslide activity or excessive erosion was observed in the reservoir area. Little sedimentation occurs at this site because of the small drainage basin, and there are no upstream hazards that might be subject to backwater flooding.

The impoundment consists of red silty clays deposited by hydraulic methods during active mine operations. No deposition has occurred for approximately 11 years. Some consolidation of the tailings has probably occurred, primarily immediately adjacent to the dam where drainage can occur. Also, the surface zones have dessicated, and small trees and grasses transpire some water from near the surface of the tailings.

Approximately 90 percent of the watershed area consists of tailings covered by small trees and grass and 10 percent is undisturbed forest land.

f. Downstream Channels. The primary downstream channel consists of the ditch along the dam toe to Station 10+00. It then crosses Highway E into a heavily mined out area. The channel is not well defined and is covered with brush and mining debris. The area immediately downstream of the dam is not normally flood prone.

3.2 EVALUATION

No functional spillway was observed. The lack of a spillway increases the possibility of overtopping. Flows of water in the ditch along the toe of the dam could cause erosion and movement of the embankment gravels at the dam toe.

Seepage and interrupted drainage were observed at the dam toe near the maximum section at Stations 10+00 to 12+50. No adequate means of draining this water was evident. This could result in weakening of the clay foundation soil by saturation and could adversely affect the stability of the dam.

The embankment is a relatively porous granular structure above the tailings surface. If the water level were to rise above the tailings surface due to flood runoff, there could be significant seepage through the embankment which may have an adverse effect on the stability of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures exist for the structure. No means of passing runoff water has been provided for this dam.

4.2 MAINTENANCE OF DAM

According to the owner's representative, the dam is inspected by the shift foremen daily. Information available to the inspection team indicates that the dam is not maintained.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities at this dam. Not applicable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

To our knowledge there is no warning system in effect at this dam.

4.5 EVALUATION

A periodic inspection program should be established so that indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam, or an increase in the volume or turbidity of water from the springs or seeps, can be monitored. Maintenance of the dam is inadequate.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam are presented in Section 1 - Project Information and are also presented in the accompanying field survey drawings, Plates 3 through 7. Hydrologic or hydraulic design information are not available.

For this evaluation, the watershed drainage area and reservoir area-elevation data were measured using 1971 U.S. Agricultural Stabilization and Conservation Service airphoto enlargements and survey data.

The total drainage area including the reservoir at Cadet No. 1 Tailings Dam, I.D. No. 30704, is almost enclosed by the embankment and secondary dikes and is approximately 66 acres (0.1-square mile). The watershed location and drainage boundary are shown on Plate 2. The entire drainage area was occupied by the dumped tailings from barite mining. Field surveys of the tailings behind the embankment (see Plate 3) showed the tailings profile was irregular and at different elevations. To obtain the active storage capacity, the spot surveys of the tailings elevations were transferred to the aerial photograph and used as a guide to develop contours of the tailings.

For computations of "basin" characteristics, a lag time of 0.1-hour and antecedent moisture conditions (AMC) reflected by a runoff curve number (CN) of 100 were assumed for the computations of flood runoff for the tailings within the reservoir.

The input data and computed parameters, such as basin lag time, unit hydrograph, probable maximum precipitation, and the reservoir elevation-area-capacity data are in Appendix A. As shown in the computer printouts, the reservoir surface areas are actual surface areas corresponding to the elevations shown. The capacities shown, as computed in the computer program by the Conic Method, are the active capacities at the given elevation adjusted for the tailings. No spillway was present at the damsite. Computations of the discharge rating curve for flows over the dam crest were made by using the weir flow formula with a weir coefficient of C=2.7 for the dam crest. The discharge rating curve for flows over the dam crest is in Appendix A, under the input data listing on the Y4 and Y5 cards. The overtopping analysis was based on the effective crest elevations as surveyed on the dam crest. The effective crest elevation for overtopping was assumed to be at El. 907.5, the lowest point along the dam crest at about Sta. 2+00 to Sta. 2+86.

b. Experience Data. Rainfall, streamflow, and flood data for the entire watershed are not available.

c. Visual Observations. Visual observations are discussed in Section 3 - Visual Observations.

During the field inspection, it was observed that the low points of the tailings were submerged in water. The pond water surface elevation was about El. 903.5 (see Plate 3).

d. Overtopping Potential. The 100-year flood, probable maximum flood (PMF), and floods expressed as a percentage of PMF were computed and routed into and through the reservoir. The probable maximum flood is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible at a particular location or region.

The computed floods were routed through the project reservoir using the Modified Puls Method of flood routing. For all cases of the reservoir flood routing, the starting water surface elevation was set at El. 903.5, the observed water surface elevation behind the embankment.

Results of the overtopping analyses indicate that the dam is able to retain the 100-year flood. The studies indicate that the dam cannot pass the 50 percent PMF. It can handle about 45 persent of the PMF without overtopping the minimum dam crest.

The primary effect of overtopping would be an increased flow of water into the ditch along the toe of the dam. This flow would probably cause erosion and movement of the embankment gravels at the dam toe.

Results of the overtopping analyses are reported in Appendix A and summarized below.

Flood	Peak Inflow (cfs)	Peak Outflow (cfs)	Max WS Elev (ft)	Max Depth Over Min. Dam Crest (ft)	Duration Overtopped (hrs)
40% PMF	578	0	907.2	0	-
45% PMF	651	0	907.5	0	-
50% PMF	723	8	907.7*	0.2	6.6
75% PMF	1084	179	908.0*	0.5	8.4
PMF	1446	666	908.4*	0.9	9.0

* Dam overtopped (Minimum Dam Crest El. 907.5).

Note: Water surface elevations include the velocity heads corresponding to the velocities computed for the various flow depths for the overtopping section.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions that adversely affect the structural stability of the dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions, including earthquake loads, and made a matter of record.

c. Operating Records. No appurtenant structures are operable at this dam; no records of operations were located.

d. Post-Construction Changes. The dam has been enlarged during active mine operations, but no records are available concerning dates of enlargements, design, or materials used. No other post-construction changes were evident.

e. Seismic Stability. The dam is located in Seismic Zone 2, to which the 1976 Uniform Building Code assigns a "moderate" damage potential. There appears to be a potential for instability caused by ground shaking during earthquakes where the dam overlies soft saturated clay foundation soil. Some crest settlement and ravelling of the embankment gravels could also occur during seismic shaking because the gravels are in a loose state and the downstream slope is at or near the gravel's natural angle of repose.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several deficient conditions at the dam should be corrected to improve the margin of safety. The absence of an operable spillway to safely remove storm runoff is the most serious deficiency. Other deficiencies noted are: soft foundation materials resulting from ponded seepage and springs at the dam toe and insufficient freeboard. The soft foundation conditions caused by seepage could reduce the stability of the dam. Suggested remedial measures are discussed in Section 7.2 Remedial Measures.

b. Adequacy of Information. No design or construction data were available. Seepage and stability analyses meeting the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information is considered a deficiency.

Topographic data for this dam are inadequate. This is due primarily to the fact that the dam enlargement activity occurred subsequent to the publication of USGS 7.5-minute quadrangle map. The drainage area measurement was made after locating the dam on the original topography. Reservoir area-capacity data and slopes were developed using survey measurements and constructing topographic contours on a 1 inch = 660 feet air photo enlargement showing the reservoir and watershed areas. This data is considered adequate for a Phase I analysis; however, the evaluation of overtopping potential is approximate due to the available data.

c. Urgency. The lack of a spillway is a serious deficiency. Corrective measures should be initiated without delay.

d. Necessity for Phase II. Additional studies are not required with the exception of seepage and stability analyses as described in Section 7.2.

7.2 REMEDIAL MEASURES

a. Spillway. A spillway should be designed to safely pass the PMF without causing erosion of the embankment under the Guidelines established by the Corps of Engineers. An engineer experienced in the design of dam spillways should be retained for the design and supervision of construction of the spillway.

b. Drainage of Seepage. Seepage that presently ponds at the dam in various locations between Stations 10+00 and 12+50 should be drained to remove water, which saturates and weakens foundation soil.

c. Inspection Program. The dam should be inspected periodically by an engineer who will observe and record the performance of the dam. The springs and seeps should be monitored as part of the inspection program. Records of these inspections should be maintained, and all maintenance or remedial measures performed at the site should be documented.

d. Seepage and Stability analyses. These analyses should be performed by an engineer experienced in the design and construction of tailings dams. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam. Based on the results of these analyses, remedial measures may become necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, Jul 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Reservoir Area-Capacity - Areas were measured from U.S.G.S. topographic maps and from aerial photographs. Reservoir elevations and corresponding surface areas were input into the computer program, which determined the reservoir capacities by the Conic Method.

- Flood Routing - The Modified Puls Method was used for all flood routing and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, and pertinent computer printouts of results. Definitions of all input and output variable names are presented in the September 1978 computer program "Users Manual", and are not explained herein.

```
A1          CADET NO. 1 TAILINGS DAM MO. NO. 30704
A2          HEC-1  PHASE 1  DAM SAFETY INVESTIGATIONS
A3          RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     288                   5
B1      5
J       1         5         1
J1    .40       .45       .50       .75       1.0
K       0   INFLOW                              1         1
K1    PMF INFLOW TO CLOSED SYSTEM
M       1         2        .1                             1                                        1
P       0      25.8       102       120       130
T                                                                          -1       -100
A2                .1
X    -.01      -.01       1.0
K       1   LAKE                                1         1         1
K1 ROUTING THROUGH CLOSED SYSTEM
Y                                               1         1
Y1      1                                                            -903.5        -1
Y4  900.0     907.5     907.7     908.1     908.6     909.2     909.7     910.3
Y5      0     0.001        10       218       872      2503      4823      8008
$A      0        10        17      27.5        34        42        50
$E    900     903.3       905       907       908       909       911
$S  907.5
$D  907.5
K      99
A
A
A
A
A
```

```
********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
********************************

RUN  DATE* 79/07/23.
     TIME* 15.57.00.


                       CADET NO. 1 TAILINGS DAM MO. NO. 30704
                       HEC-1  PHASE 1  DAM SAFETY INVESTIGATIONS
                       RATIOS OF PMF ROUTED THROUGH RESERVOIR

                                          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= 5 LRTIO= 1
          RTIOS=     .40      .45      .50      .75    1.00


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

                                          SUB-AREA RUNOFF COMPUTATION

          PMF INFLOW TO CLOSED SYSTEM

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

                                             HYDROGRAPH DATA
          IHYDG     IUHG    TAREA      SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
              1        2      .11      0.00      .11     1.00    0.000        0        1        0

                                               PRECIP DATA
                   SPFE      PMS       R6       R12      R24      R48      R72      R96
                   0.00    25.80   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  -100.00     0.00     0.00

          CURVE NO = -100.00  WETNESS =   -1.00  EFFECT CN =  100.00

                                        UNIT HYDROGRAPH DATA
                                  TC=  0.00      LAG=   .07

                                             RECESSION DATA
                          STRTQ=    -.01    QRCSN=    -.01    RTIOR= 1.00

          TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

          UNIT HYDROGRAPH  A END OF PERIOD [illegible] TC=  [illegible]  LAG=  .10  VOL= [illegible]
```

	219.	324.	142.	55.	21.	8.	3.	1.

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.01	0.00	3.	1.01	12.05	145	.22	.22	-.00	84.
1.01	.10	2	.01	.01	.00	8.	1.01	12.10	146	.22	.22	-.00	134.
1.01	.15	3	.01	.01	.00	10.	1.01	12.15	147	.22	.22	-.00	156.
1.01	.20	4	.01	.01	-.00	11.	1.01	12.20	148	.22	.22	-.00	165.
1.01	.25	5	.01	.01	.00	11.	1.01	12.25	149	.22	.22	-.00	168.
1.01	.30	6	.01	.01	.00	11.	1.01	12.30	150	.22	.22	.00	169.
1.01	.35	7	.01	.01	.00	11.	1.01	12.35	151	.22	.22	-.00	170.
1.01	.40	8	.01	.01	-.00	11.	1.01	12.40	152	.22	.22	.00	170.
1.01	.45	9	.01	.01	.00	11.	1.01	12.45	153	.22	.22	-.00	170.
1.01	.50	10	.01	.01	.00	11.	1.01	12.50	154	.22	.22	-.00	170.
1.01	.55	11	.01	.01	.00	11.	1.01	12.55	155	.22	.22	.00	170.
1.01	1.00	12	.01	.01	.00	11.	1.01	13.00	156	.22	.22	.00	170.
1.01	1.05	13	.01	.01	.00	11.	1.01	13.05	157	.26	.26	-.00	179.
1.01	1.10	14	.01	.01	.00	11.	1.01	13.10	158	.26	.26	-.00	194.
1.01	1.15	15	.01	.01	.00	11.	1.01	13.15	159	.26	.26	-.00	200.
1.01	1.20	16	.01	.01	.00	11.	1.01	13.20	160	.26	.26	-.00	202.
1.01	1.25	17	.01	.01	.00	11.	1.01	13.25	161	.26	.26	-.00	203.
1.01	1.30	18	.01	.01	.00	11.	1.01	13.30	162	.26	.26	.00	203.
1.01	1.35	19	.01	.01	.00	11.	1.01	13.35	163	.26	.26	-.00	204.
1.01	1.40	20	.01	.01	.00	11.	1.01	13.40	164	.26	.26	-.00	204.
1.01	1.45	21	.01	.01	-.00	11.	1.01	13.45	165	.26	.26	-.00	204.
1.01	1.50	22	.01	.01	.00	11.	1.01	13.50	166	.26	.26	-.00	204.
1.01	1.55	23	.01	.01	.00	11.	1.01	13.55	167	.26	.26	-.00	204.
1.01	2.00	24	.01	.01	.00	11.	1.01	14.00	168	.26	.26	-.00	204.
1.01	2.05	25	.01	.01	-.00	11.	1.01	14.05	169	.33	.33	-.00	218.
1.01	2.10	26	.01	.01	.00	11.	1.01	14.10	170	.33	.33	-.00	230.
1.01	2.15	27	.01	.01	.00	11.	1.01	14.15	171	.33	.33	.00	240.
1.01	2.20	28	.01	.01	.00	11.	1.01	14.20	172	.33	.33	-.00	252.
1.01	2.25	29	.01	.01	.00	11.	1.01	14.25	173	.33	.33	.00	254.
1.01	2.30	30	.01	.01	-.00	11.	1.01	14.30	174	.33	.33	-.00	254.
1.01	2.35	31	.01	.01	.00	11.	1.01	14.35	175	.33	.33	.00	255.
1.01	2.40	32	.01	.01	.00	11.	1.01	14.40	176	.33	.33	-.00	255.
1.01	2.45	33	.01	.01	-.00	11.	1.01	14.45	177	.33	.33	-.00	255.
1.01	2.50	34	.01	.01	.00	11.	1.01	14.50	178	.33	.33	-.00	255.
1.01	2.55	35	.01	.01	.00	11.	1.01	14.55	179	.33	.33	-.00	255.
1.01	3.00	36	.01	.01	.00	11.	1.01	15.00	180	.33	.33	-.00	255.
1.01	3.05	37	.01	.01	.00	11.	1.01	15.05	181	.20	.20	-.00	226.
1.01	3.10	38	.01	.01	.00	11.	1.01	15.10	182	.40	.40	.00	228.
1.01	3.15	39	.01	.01	.00	11.	1.01	15.15	183	.40	.40	-.00	275.
1.01	3.20	40	.01	.01	.00	11.	1.01	15.20	184	.60	.60	.00	340.
1.01	3.25	41	.01	.01	-.00	11.	1.01	15.25	185	.70	.70	.00	435.
1.01	3.30	42	.01	.01	.00	11.	1.01	15.30	186	1.70	1.70	-.00	718.
1.01	3.35	43	.01	.01	.00	11.	1.01	15.35	187	2.80	2.80	.00	1309.
1.01	3.40	44	.01	.01	.00	11.	1.01	15.40	188	1.10	1.10	.00	1466.
1.01	3.45	45	.01	.01	.00	11.	1.01	15.45	189	.70	.70	-.00	1023.
1.01	3.50	46	.01	.01	.00	11.	1.01	15.50	190	.60	.60	.00	713.
1.01	3.55	47	.01	.01	.00	11.	1.01	15.55	191	.40	.40	-.00	518.
1.01	4.00	48	.01	.01	.00	11.	1.01	16.00	192	.40	.40	-.00	394.
1.01	4.05	49	.01	.01	-.00	11.	1.01	16.05	193	.31	.31	-.00	322.
1.01	4.10	50	.01	.01	.00	11.	1.01	16.10	194	.31	.31	-.00	271.
1.01	4.15	51	.01	.01	.00	11.	1.01	16.15	195	.31	.31	-.00	249.
1.01	4.20	52	.01	.01	-.00	11.	1.01	16.20	196	.31	.31	-.00	242.
1.01	4.25	53	.01	.01	.00	11.	1.01	16.25	197	.31	.31	-.00	239.
1.01	4.30	54	.01	.01	-.00	11.	1.01	16.30	198	.31	.31	-.00	238.
1.01	4.35	55	.01	.01	.00	11.	1.01	16.35	199	.31	.31	-.00	238.

1.01	4.40	56	.01	.01	.00	11.	1.01	16.40	200	.31	.31	.00	238.
1.01	4.45	57	.01	.01	.00	11.	1.01	16.45	201	.31	.31	-.00	238.
1.01	4.50	58	.01	.01	.00	11.	1.01	16.50	202	.31	.31	.00	238.
1.01	4.55	59	.01	.01	.00	11.	1.01	16.55	203	.31	.31	.00	238.
1.01	5.00	60	.01	.01	-.00	11.	1.01	17.00	204	.31	.31	-.00	238.
1.01	5.05	61	.01	.01	.00	11.	1.01	17.05	205	.24	.24	.00	223.
1.01	5.10	62	.01	.01	.00	11.	1.01	17.10	206	.24	.24	.00	202.
1.01	5.15	63	.01	.01	.00	11.	1.01	17.15	207	.24	.24	-.00	193.
1.01	5.20	64	.01	.01	.00	11.	1.01	17.20	208	.24	.24	.00	189.
1.01	5.25	65	.01	.01	-.00	11.	1.01	17.25	209	.24	.24	.00	188.
1.01	5.30	66	.01	.01	.00	11.	1.01	17.30	210	.24	.24	.00	187.
1.01	5.35	67	.01	.01	.00	11.	1.01	17.35	211	.24	.24	.00	187.
1.01	5.40	68	.01	.01	.00	11.	1.01	17.40	212	.24	.24	.00	187.
1.01	5.45	69	.01	.01	-.00	11.	1.01	17.45	213	.24	.24	.00	187.
1.01	5.50	70	.01	.01	.00	11.	1.01	17.50	214	.24	.24	.00	187.
1.01	5.55	71	.01	.01	.00	11.	1.01	17.55	215	.24	.24	.00	187.
1.01	6.00	72	.01	.01	-.00	11.	1.01	18.00	216	.24	.24	.00	187.
1.01	6.05	73	.06	.06	.00	22.	1.01	18.05	217	.02	.02	.00	139.
1.01	6.10	74	.06	.06	-.00	38.	1.01	18.10	218	.02	.02	-.00	67.
1.01	6.15	75	.06	.06	-.00	45.	1.01	18.15	219	.02	.02	-.00	36.
1.01	6.20	76	.06	.06	.00	48.	1.01	18.20	220	.02	.02	-.00	24.
1.01	6.25	77	.06	.06	-.00	49.	1.01	18.25	221	.02	.02	-.00	19.
1.01	6.30	78	.06	.06	.00	50.	1.01	18.30	222	.02	.02	-.00	18.
1.01	6.35	79	.06	.06	-.00	50.	1.01	18.35	223	.02	.02	-.00	17.
1.01	6.40	80	.06	.06	.00	50.	1.01	18.40	224	.02	.02	-.00	17.
1.01	6.45	81	.06	.06	-.00	50.	1.01	18.45	225	.02	.02	-.00	17.
1.01	6.50	82	.06	.06	-.00	50.	1.01	18.50	226	.02	.02	.00	17.
1.01	6.55	83	.06	.06	.00	50.	1.01	18.55	227	.02	.02	-.00	17.
1.01	7.00	84	.06	.06	-.00	50.	1.01	19.00	228	.02	.02	-.00	17.
1.01	7.05	85	.06	.06	-.00	50.	1.01	19.05	229	.02	.02	-.00	17.
1.01	7.10	86	.06	.06	.00	50.	1.01	19.10	230	.02	.02	-.00	17.
1.01	7.15	87	.06	.06	-.00	50.	1.01	19.15	231	.02	.02	-.00	17.
1.01	7.20	88	.06	.06	.00	50.	1.01	19.20	232	.02	.02	-.00	17.
1.01	7.25	89	.06	.06	.00	50.	1.01	19.25	233	.02	.02	-.00	17.
1.01	7.30	90	.06	.06	.00	50.	1.01	19.30	234	.02	.02	-.00	17.
1.01	7.35	91	.06	.06	.00	50.	1.01	19.35	235	.02	.02	-.00	17.
1.01	7.40	92	.06	.06	.00	50.	1.01	19.40	236	.02	.02	-.00	17.
1.01	7.45	93	.06	.06	.00	50.	1.01	19.45	237	.02	.02	-.00	17.
1.01	7.50	94	.06	.06	.00	50.	1.01	19.50	238	.02	.02	-.00	17.
1.01	7.55	95	.06	.06	.00	50.	1.01	19.55	239	.02	.02	-.00	17.
1.01	8.00	96	.06	.06	.00	50.	1.01	20.00	240	.02	.02	-.00	17.
1.01	8.05	97	.06	.06	-.00	50.	1.01	20.05	241	.02	.02	-.00	17.
1.01	8.10	98	.06	.06	.00	50.	1.01	20.10	242	.02	.02	-.00	17.
1.01	8.15	99	.06	.06	.00	50.	1.01	20.15	243	.02	.02	-.00	17.
1.01	8.20	100	.06	.06	.00	50.	1.01	20.20	244	.02	.02	.00	17.
1.01	8.25	101	.06	.06	.00	50.	1.01	20.25	245	.02	.02	-.00	17.
1.01	8.30	102	.06	.06	.00	50.	1.01	20.30	246	.02	.02	-.00	17.
1.01	8.35	103	.06	.06	-.00	50.	1.01	20.35	247	.02	.02	.00	17.
1.01	8.40	104	.06	.06	.00	50.	1.01	20.40	248	.02	.02	-.00	17.
1.01	8.45	105	.06	.06	.00	50.	1.01	20.45	249	.02	.02	-.00	17.
1.01	8.50	106	.06	.06	.00	50.	1.01	20.50	250	.02	.02	-.00	17.
1.01	8.55	107	.06	.06	.00	50.	1.01	20.55	251	.02	.02	-.00	17.
1.01	9.00	108	.06	.06	.00	50.	1.01	21.00	252	.02	.02	-.00	17.
1.01	9.05	109	.06	.06	.00	50.	1.01	21.05	253	.02	.02	-.00	17.
1.01	9.10	110	.06	.06	.00	50.	1.01	21.10	254	.02	.02	-.00	17.
1.01	9.15	111	.06	.06	-.00	50.	1.01	21.15	255	.02	.02	.00	17.
1.01	9.20	112	.06	.06	.00	50.	1.01	21.20	256	.02	.02	-.00	17.
1.01	9.25	113	.06	.06	.00	50.	1.01	21.25	257	.02	.02	-.00	17.
1.01	9.30	114	.06	.06	.00	50.	1.01	21.30	258	.02	.02	.00	17.
1.01	9.35	115	.06	.06	.00	50.	1.01	21.35	259	.02	.02	-.00	17.

1.01	9.40	116	.06	.06	-.00	50.	1.01	21.40	260	.02	.02	-.00	17.
1.01	9.45	117	.06	.06	.00	50.	1.01	21.45	261	.02	.02	-.00	17.
1.01	9.50	118	.06	.06	.00	50.	1.01	21.50	262	.02	.02	-.00	17.
1.01	9.55	119	.06	.06	.00	50.	1.01	21.55	263	.02	.02	-.00	17.
1.01	10.00	120	.06	.06	-.00	50.	1.01	22.00	264	.02	.02	-.00	17.
1.01	10.05	121	.06	.06	-.00	50.	1.01	22.05	265	.02	.02	-.00	17.
1.01	10.10	122	.06	.06	-.00	50.	1.01	22.10	266	.02	.02	-.00	17.
1.01	10.15	123	.06	.06	-.00	50.	1.01	22.15	267	.02	.02	-.00	17.
1.01	10.20	124	.06	.06	-.00	50.	1.01	22.20	268	.02	.02	-.00	17.
1.01	10.25	125	.06	.06	-.00	50.	1.01	22.25	269	.02	.02	-.00	17.
1.01	10.30	126	.06	.06	.00	50.	1.01	22.30	270	.02	.02	-.00	17.
1.01	10.35	127	.06	.06	-.00	50.	1.01	22.35	271	.02	.02	-.00	17.
1.01	10.40	128	.06	.06	-.00	50.	1.01	22.40	272	.02	.02	-.00	17.
1.01	10.45	129	.06	.06	-.00	50.	1.01	22.45	273	.02	.02	-.00	17.
1.01	10.50	130	.06	.06	.00	50.	1.01	22.50	274	.02	.02	-.00	17.
1.01	10.55	131	.06	.06	-.00	50.	1.01	22.55	275	.02	.02	.00	17.
1.01	11.00	132	.06	.06	-.00	50.	1.01	23.00	276	.02	.02	-.00	17.
1.01	11.05	133	.06	.06	-.00	50.	1.01	23.05	277	.02	.02	-.00	17.
1.01	11.10	134	.06	.06	.00	50.	1.01	23.10	278	.02	.02	-.00	17.
1.01	11.15	135	.06	.06	-.00	50.	1.01	23.15	279	.02	.02	-.00	17.
1.01	11.20	136	.06	.06	-.00	50.	1.01	23.20	280	.02	.02	-.00	17.
1.01	11.25	137	.06	.06	-.00	50.	1.01	23.25	281	.02	.02	-.00	17.
1.01	11.30	138	.06	.06	-.00	50.	1.01	23.30	282	.02	.02	-.00	17.
1.01	11.35	139	.06	.06	-.00	50.	1.01	23.35	283	.02	.02	-.00	17.
1.01	11.40	140	.06	.06	-.00	50.	1.01	23.40	284	.02	.02	-.00	17.
1.01	11.45	141	.06	.06	-.00	50.	1.01	23.45	285	.02	.02	-.00	17.
1.01	11.50	142	.06	.06	-.00	50.	1.01	23.50	286	.02	.02	-.00	17.
1.01	11.55	143	.06	.06	-.00	50.	1.01	23.55	287	.02	.02	-.00	17.
1.01	12.00	144	.06	.06	.00	50.	1.02	0.00	288	.02	.02	-.00	17.
									SUM	33.54	33.54	.00	25972.
										(852.)(	852.)(	0.)(	735.45)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1446.	281.	90.	90.	25930.
CMS	41.	8.	3.	3.	734.
INCHES		26.14	33.50	33.50	33.50
MM		663.95	850.95	850.95	850.95
AC-FT		139.	179.	179.	179.
THOUS CU M		172.	220.	220.	220.

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

HYDROGRAPH ROUTING

ROUTING THROUGH CLOSED SYSTEM

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

ROUTING DATA

QLOSS	CLOSS	AVG	IPES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-904.	-1

STAGE	900.00	907.50	907.70	908.10	908.60	909.20	909.70	910.30
FLOW	0.00	.00	10.00	218.00	872.00	2503.00	4823.00	8608.00
SURFACE AREA=	0.	10.	17.	28.	34.	42.	66.	
CAPACITY=	0.	11.	34.	78.	103.	146.	253.	
ELEVATION=	900.	905.	905.	907.	908.	909.	911.	

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
907.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
907.5	0.0	0.0	0.

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)

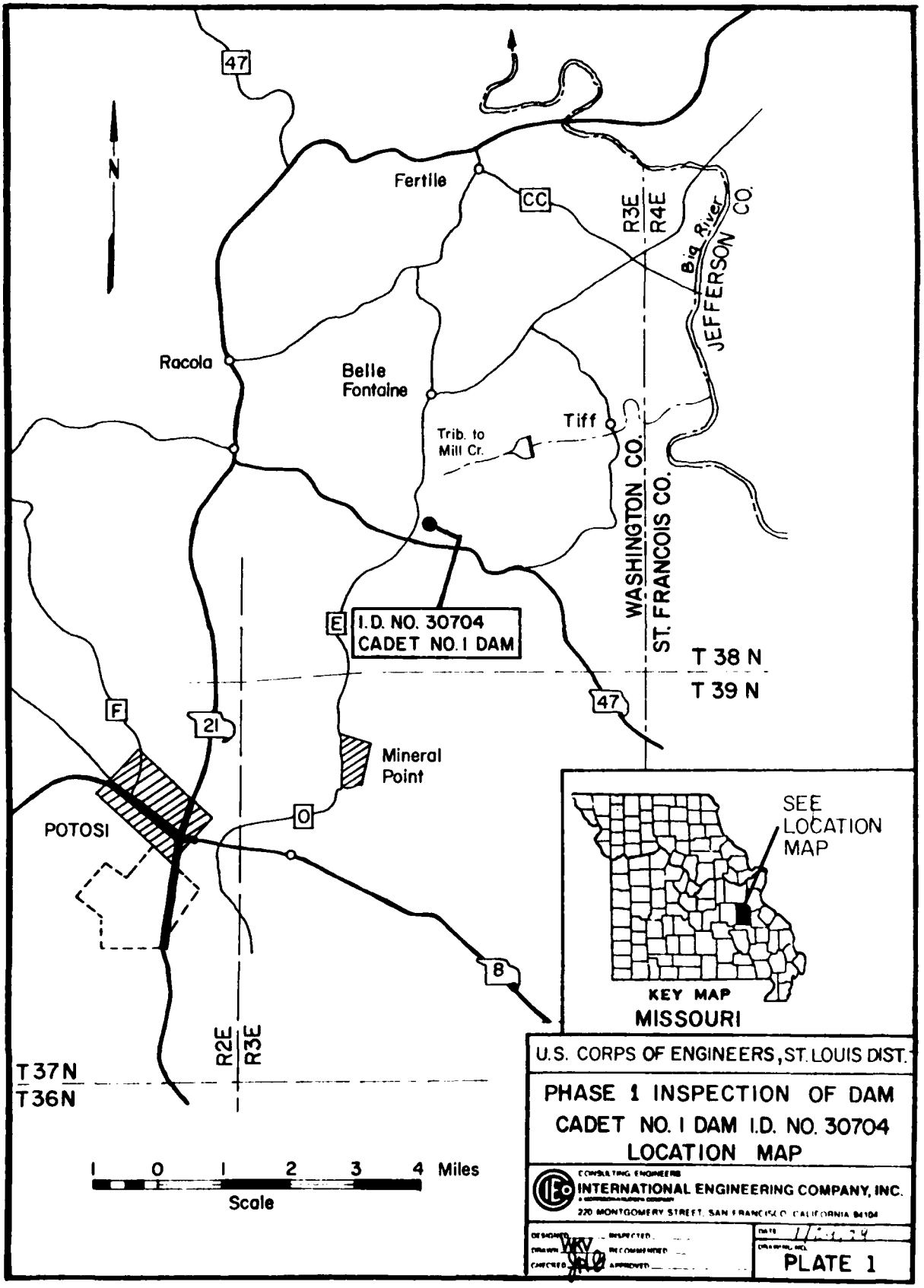
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .40	RATIO 2 .45	RATIO 3 .50	RATIO 4 .75	RATIO 5 1.00
HYDROGRAPH AT	INFLOW	.10	1	578.	651.	723.	1084.	1446.
		(.26)	(	16.39)(	18.43)(	20.47)(	30.71)(	40.95)(
ROUTED TO	LAKE	.10	1	0.	0.	8.	179.	666.
		(.26)	(	.00)(	.01)(	.23)(	5.05)(	18.86)(

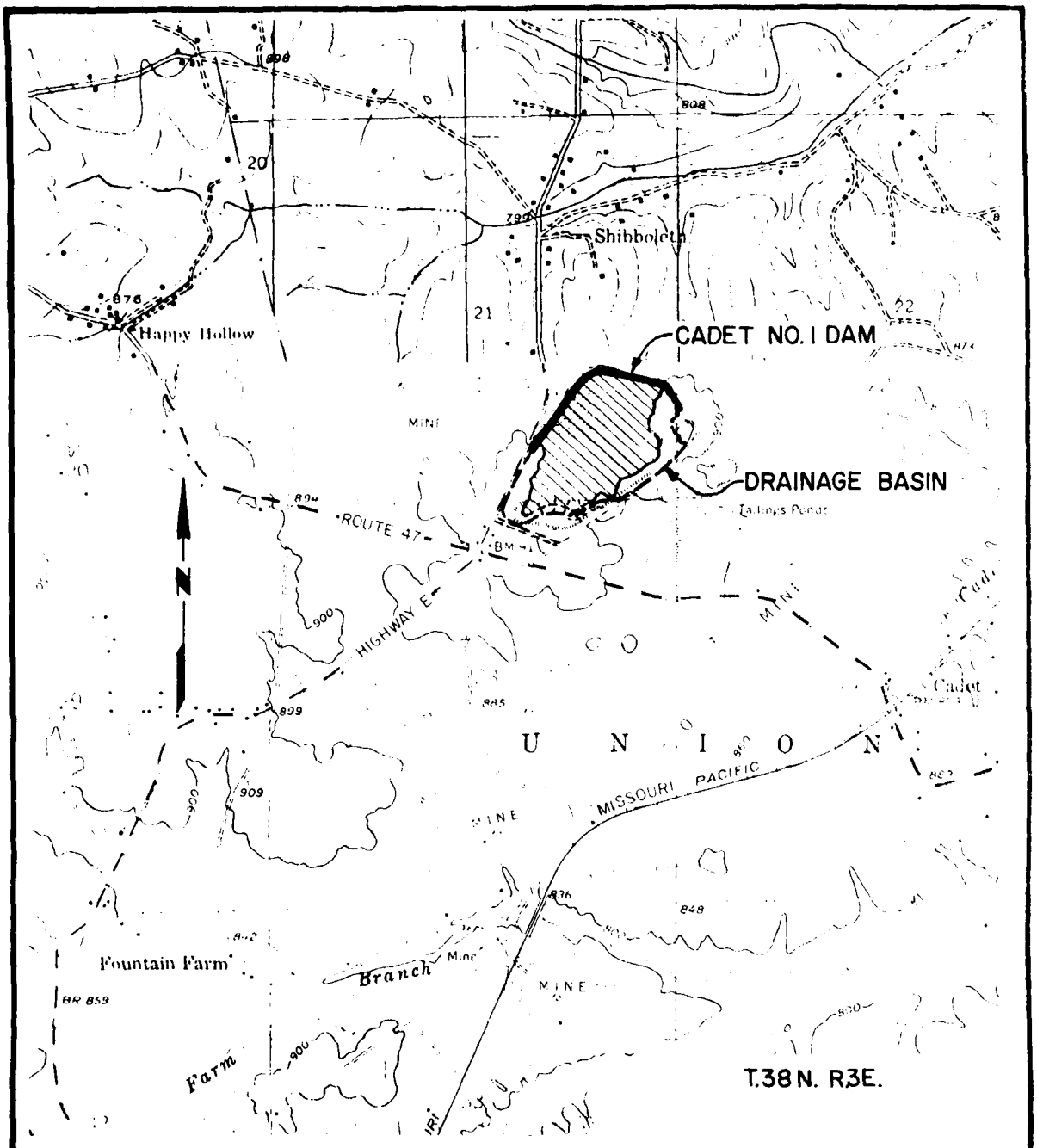
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	903.50	907.50	907.50
STORAGE	13.	92.	92.
OUTFLOW	0.	0.	0.

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
.40	907.21	0.00	84.	0.	0.00	24.00	0.00
.45	907.50	.00	92.	0.	.25	24.00	0.00
.50	907.66	.16	97.	8.	6.58	24.00	0.00
.75	908.02	.52	109.	179.	8.42	16.50	0.00
1.00	908.44	.94	124.	666.	9.00	15.83	0.00


47
N
Fertile
CC
R3E
R4E
Big River
JEFFERSON CO.
Racola
Belle Fontaine
Tiff
Trib. to Mill Cr.
WASHINGTON CO.
ST. FRANCOIS CO.
E
I.D. NO. 30704
CADET NO. 1 DAM
T 38 N
T 39 N
47
F
21
Mineral Point
POTOSI
O
8
R2E
R3E
T37N
T36N
1 0 1 2 3 4 Miles
Scale
SEE LOCATION MAP
KEY MAP
MISSOURI
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.
PHASE 1 INSPECTION OF DAM
CADET NO. 1 DAM I.D. NO. 30704
LOCATION MAP
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104
DESIGNED
DRAWN
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
PLATE 1

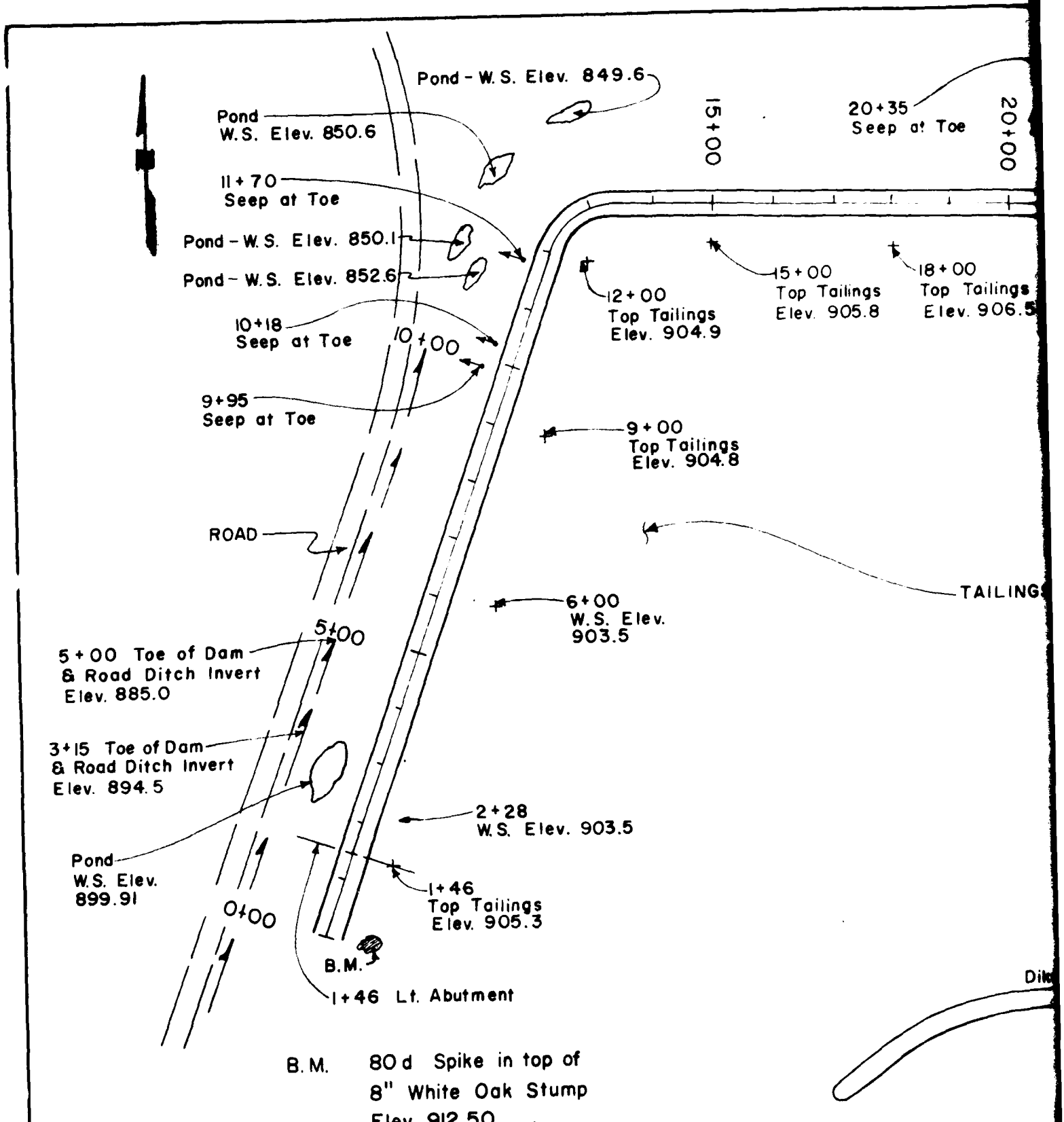


U.S. CORPS OF ENGINEERS, ST. LOUIS DIST

PHASE I INSPECTION OF DAMS
CADET NO. 1 DAM I.D. NO. 30704
VICINITY TOPOGRAPHY

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED — INSPECTED —
DRAWN BB RECOMMENDED —
CHECKED JWH APPROVED —
DATE 7/24/79
DRAWING NO. PLATE 2


Pond - W.S. Elev. 849.6
Pond
W.S. Elev. 850.6
11+70
Seep at Toe
Pond - W.S. Elev. 850.1
Pond - W.S. Elev. 852.6
10+18
Seep at Toe
10+00
9+95
Seep at Toe
ROAD
5+00
5+00 Toe of Dam
& Road Ditch Invert
Elev. 885.0
3+15 Toe of Dam
& Road Ditch Invert
Elev. 894.5
Pond
W.S. Elev.
899.91
0+00
B.M.
1+46 Lt. Abutment
15+00
20+35
Seep at Toe
20+00
12+00
Top Tailings
Elev. 904.9
15+00
Top Tailings
Elev. 905.8
18+00
Top Tailings
Elev. 906.5
9+00
Top Tailings
Elev. 904.8
TAILINGS
6+00
W.S. Elev.
903.5
2+28
W.S. Elev. 903.5
1+46
Top Tailings
Elev. 905.3
Ditch
B.M. 80d Spike in top of
8" White Oak Stump
Elev. 912.50

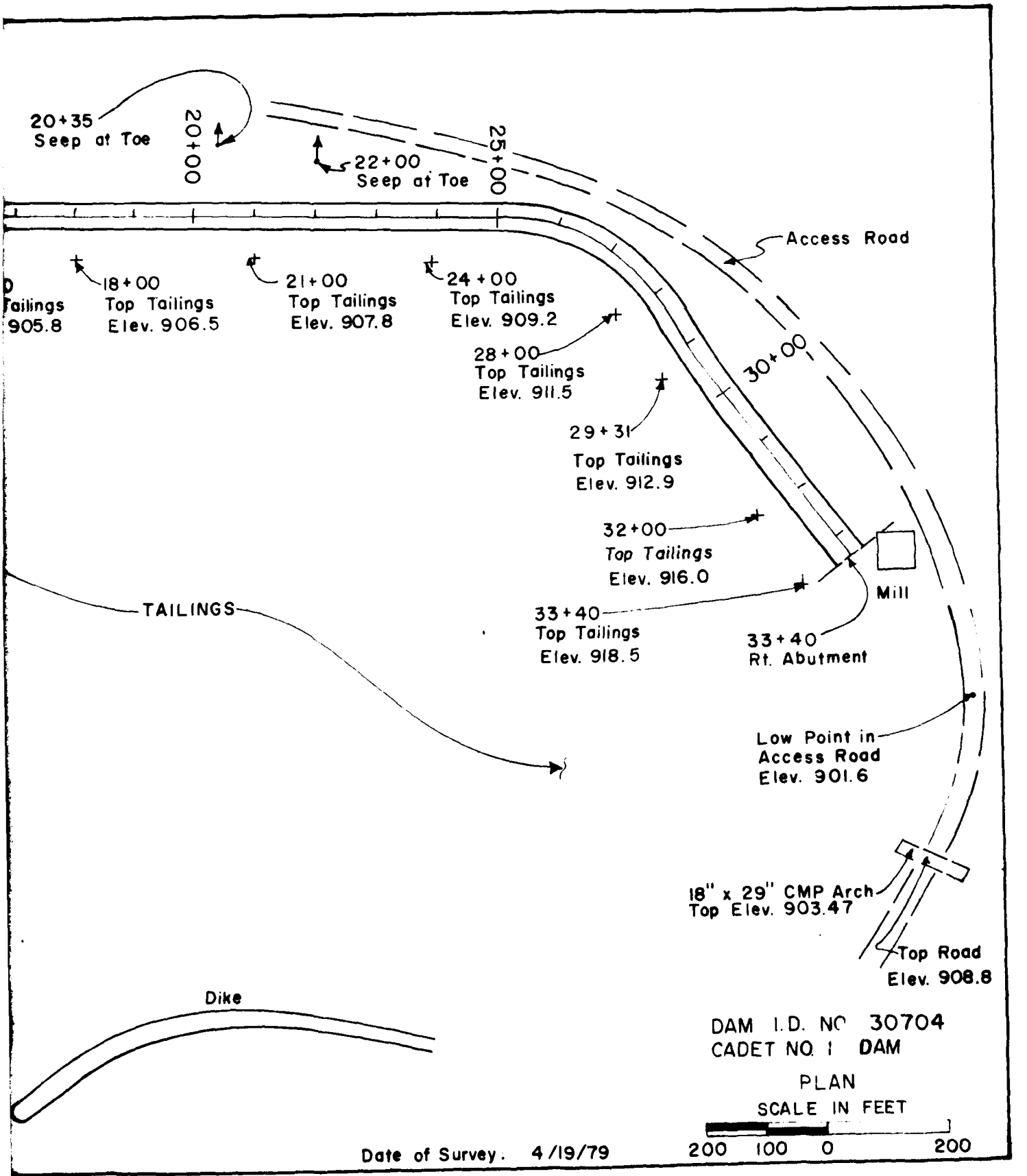
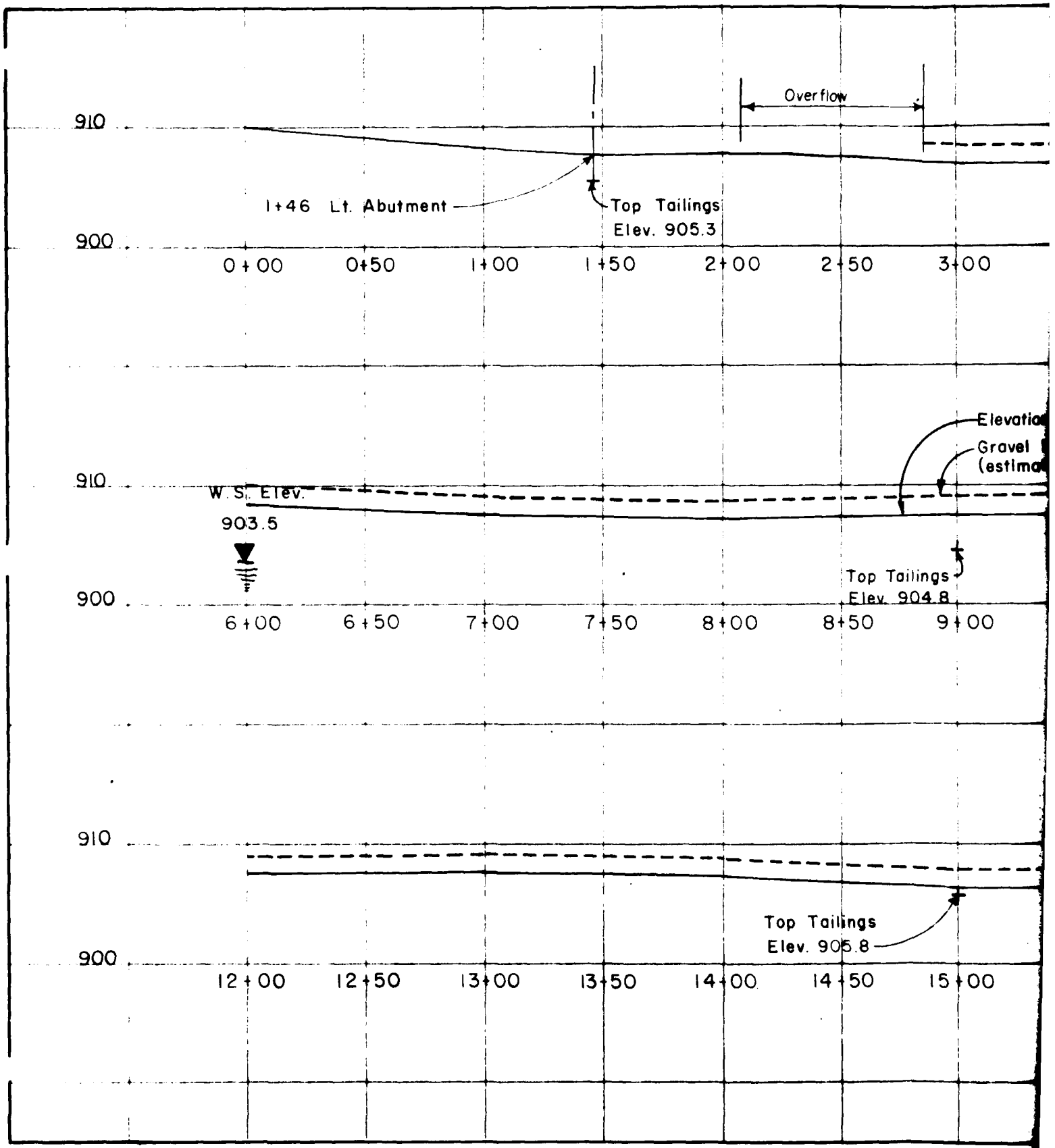
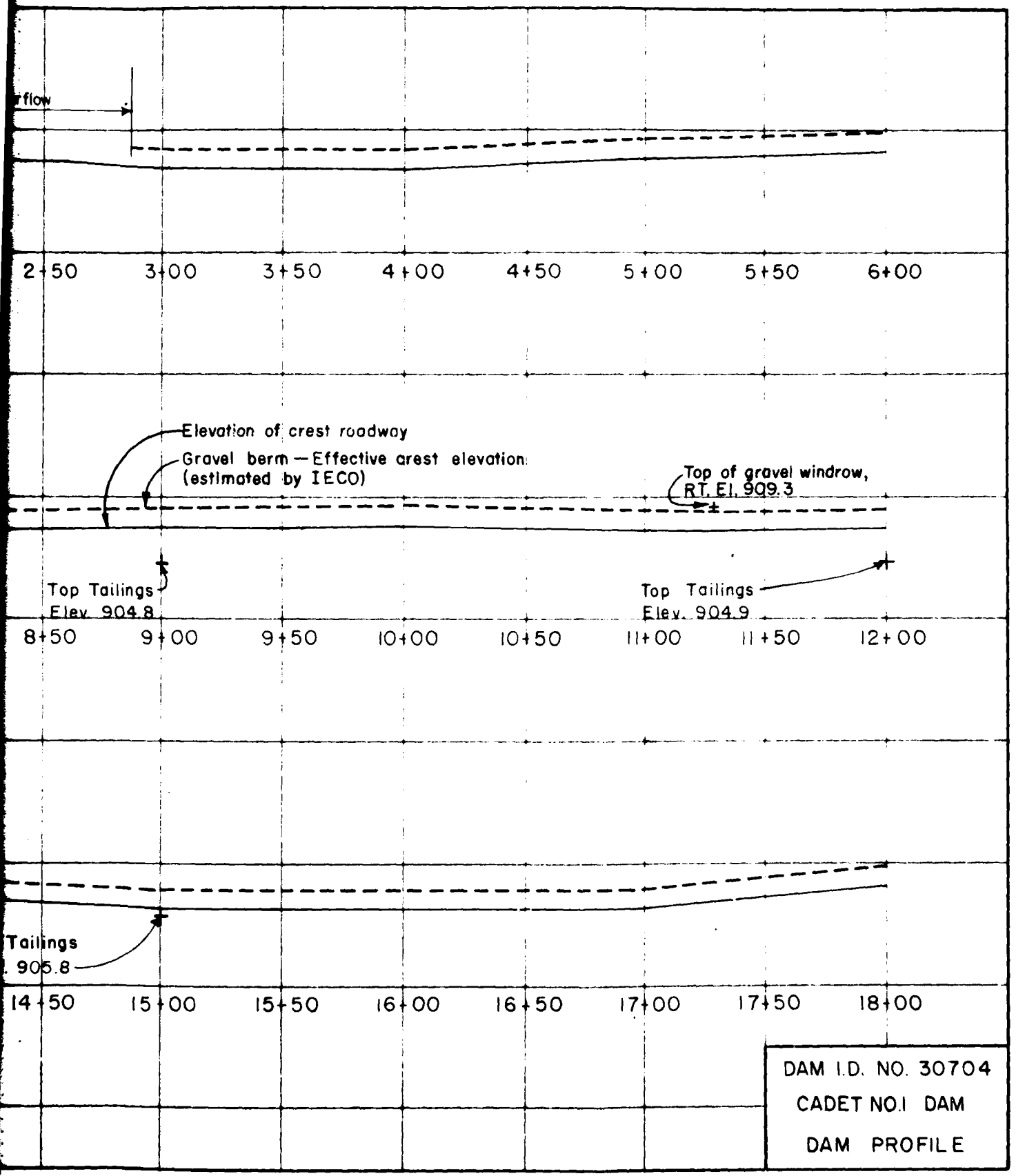

20+35
Seep at Toe
20+00
22+00
Seep at Toe
25+00
Access Road
18+00
Top Tailings
Elev. 906.5
21+00
Top Tailings
Elev. 907.8
24+00
Top Tailings
Elev. 909.2
28+00
Top Tailings
Elev. 911.5
30+00
29+31
Top Tailings
Elev. 912.9
32+00
Top Tailings
Elev. 916.0
Mill
TAILINGS
33+40
Top Tailings
Elev. 918.5
33+40
Rt. Abutment
Low Point in
Access Road
Elev. 901.6
18" x 29" CMP Arch
Top Elev. 903.47
Top Road
Elev. 908.8
Dike
DAM I.D. NO 30704
CADET NO. 1 DAM
PLAN
SCALE IN FEET
200 100 0 200
Date of Survey: 4/19/79

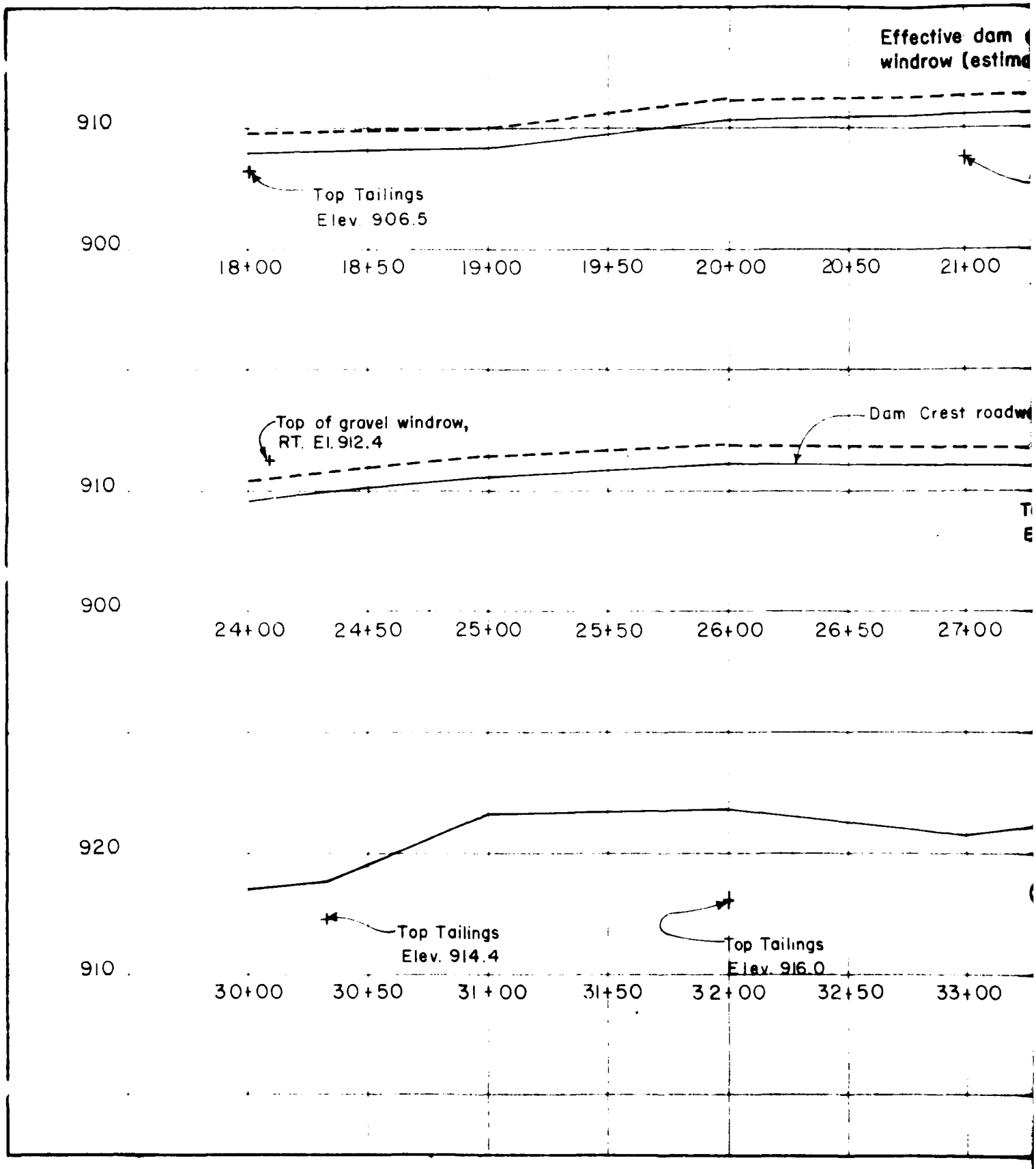
PLATE 3

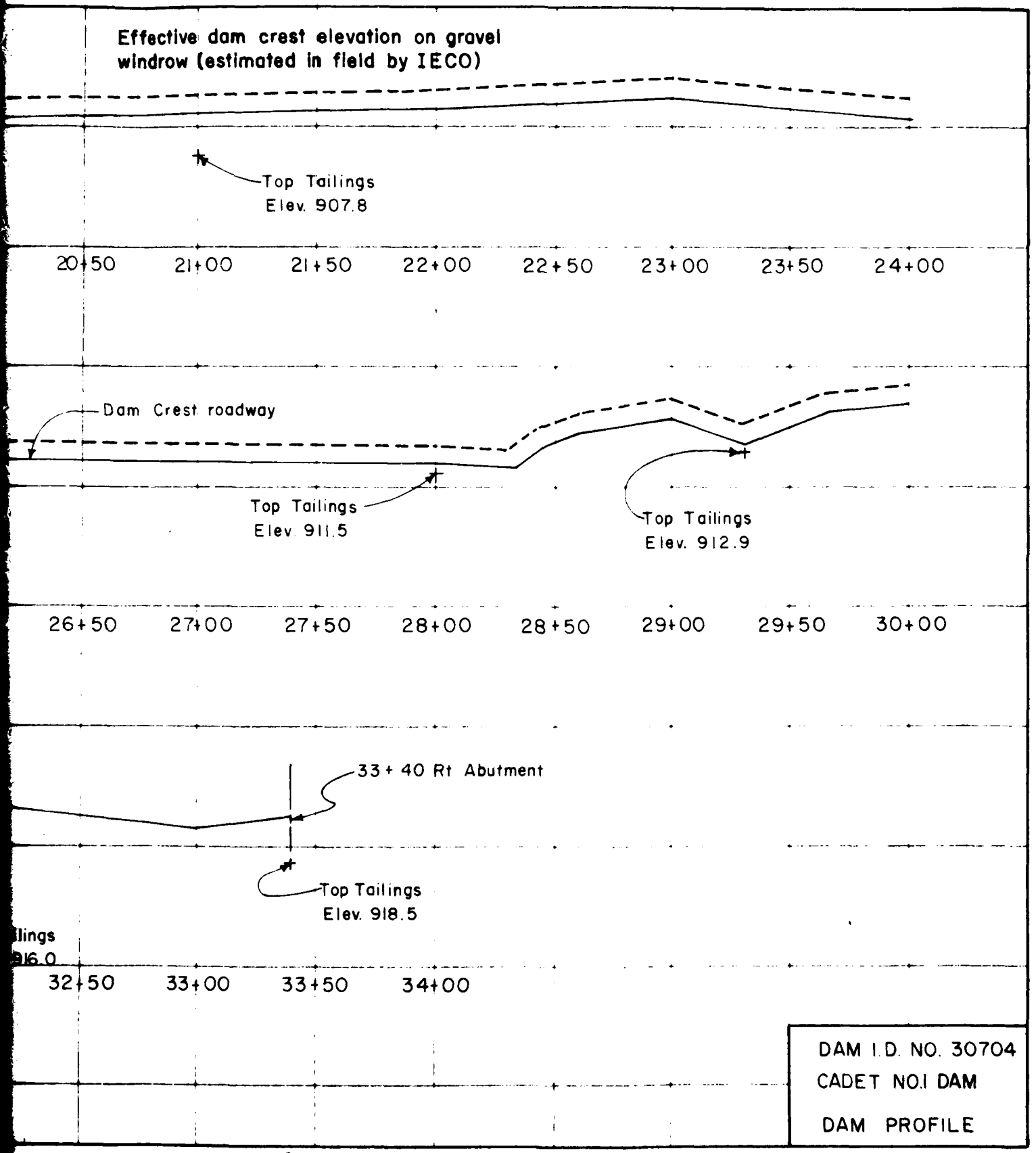

Overflow
910
1+46 Lt. Abutment
Top Tailings
Elev. 905.3
900
0+00
0+50
1+00
1+50
2+00
2+50
3+00
910
W.S. Elev.
903.5
900
6+00
6+50
7+00
7+50
8+00
8+50
9+00
Top Tailings
Elev. 904.8
910
900
12+00
12+50
13+00
13+50
14+00
14+50
15+00
Top Tailings
Elev. 905.8



DAM I.D. NO. 30704
CADET NO.1 DAM
DAM PROFILE

PLATE 4A

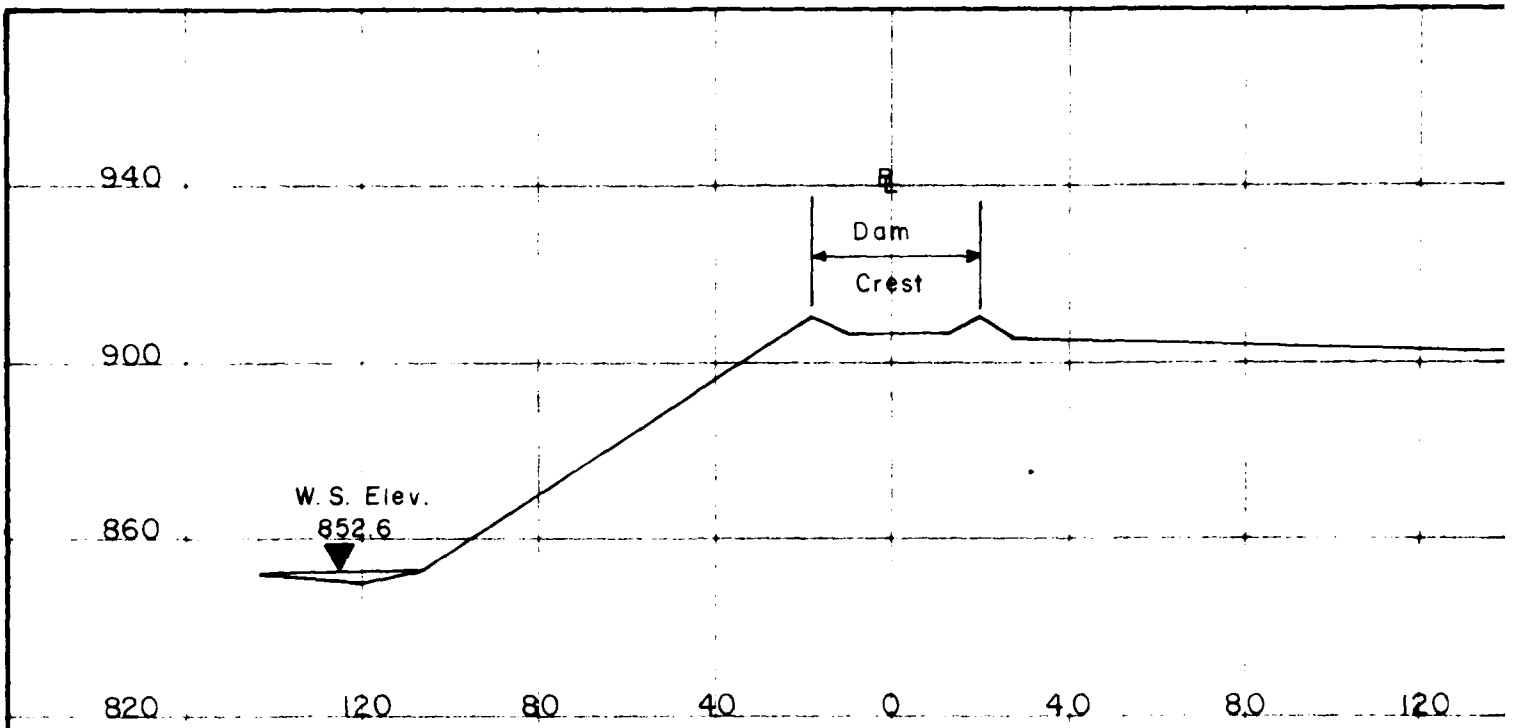

Effective dam
windrow (estima
910
900
Top Tailings
Elev. 906.5
18+00
18+50
19+00
19+50
20+00
20+50
21+00
Top of gravel windrow,
RT. El. 912.4
Dam Crest roadw
910
900
24+00
24+50
25+00
25+50
26+00
26+50
27+00
920
910
Top Tailings
Elev. 914.4
Top Tailings
Elev. 916.0
30+00
30+50
31+00
31+50
32+00
32+50
33+00



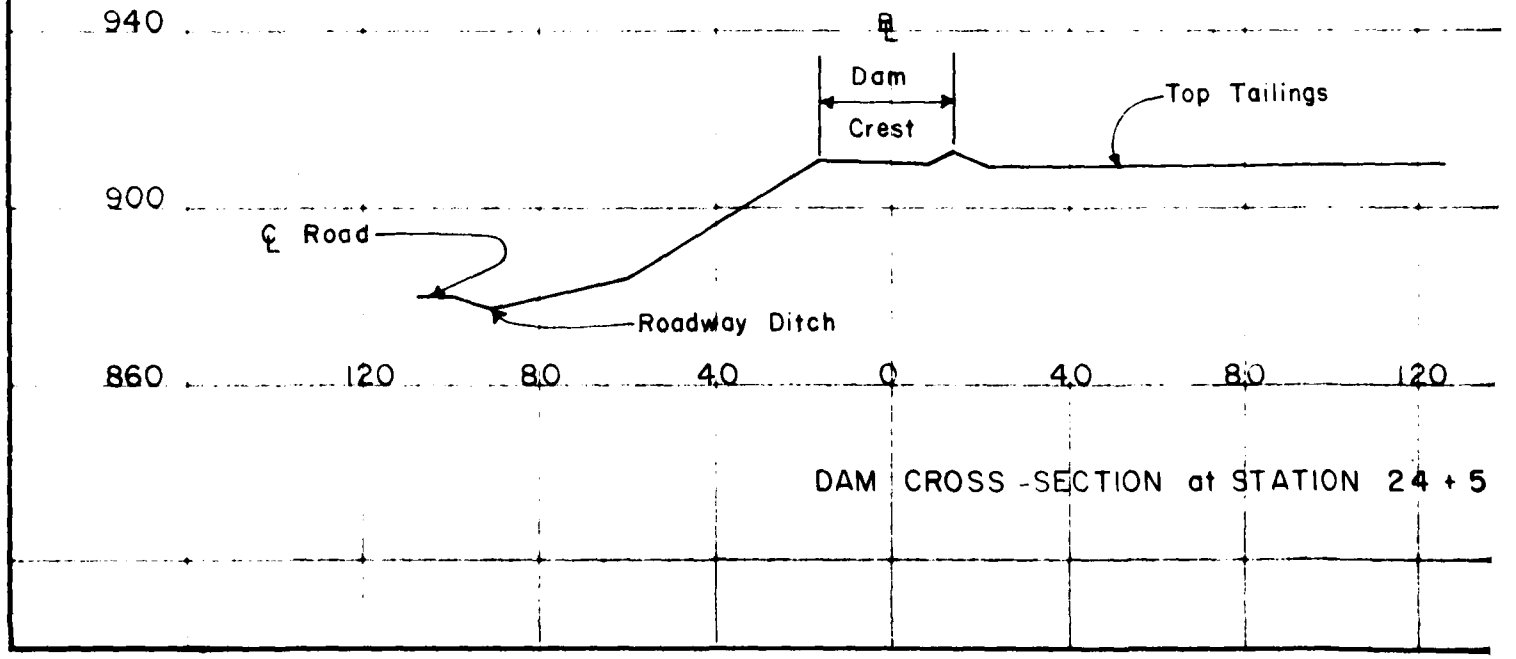
DAM I.D. NO. 30704
CADET NO.1 DAM

DAM PROFILE

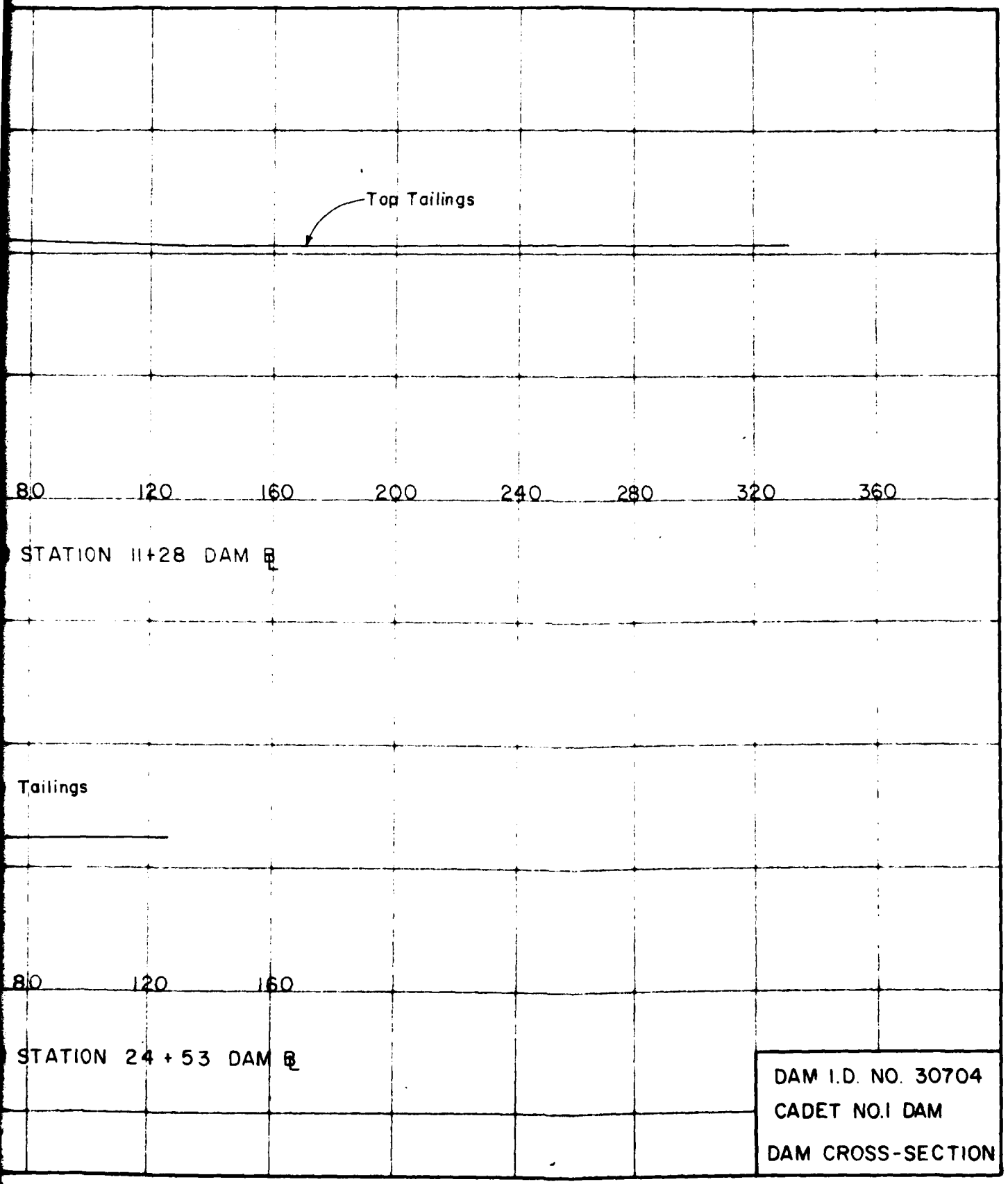
PLATE 4B



DAM CROSS - SECTION at STATION 11+28 [



DAM CROSS - SECTION at STATION 24 + 5



DAM I.D. NO. 30704
CADET NO.1 DAM
DAM CROSS-SECTION

PLATE 5

12

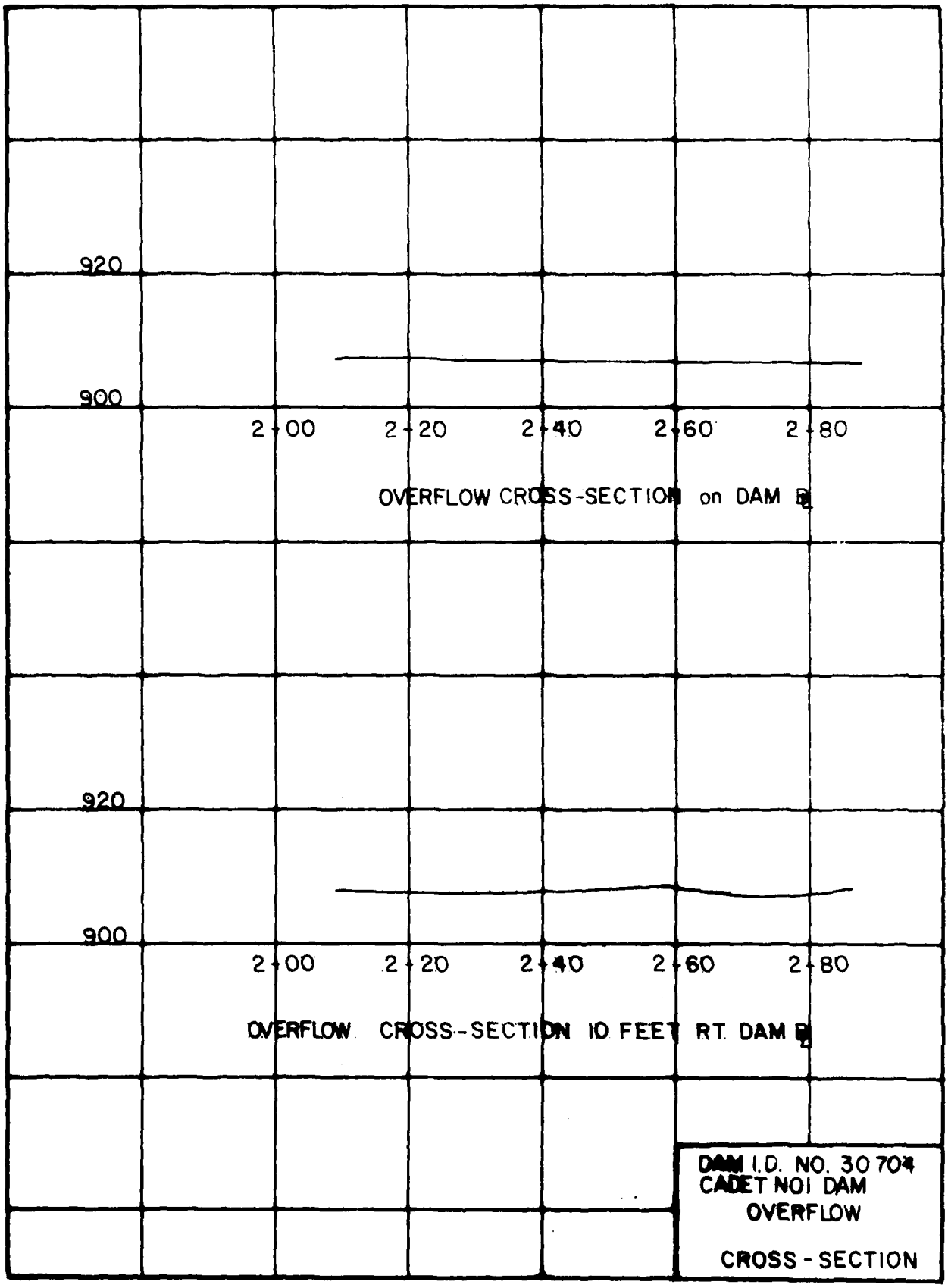
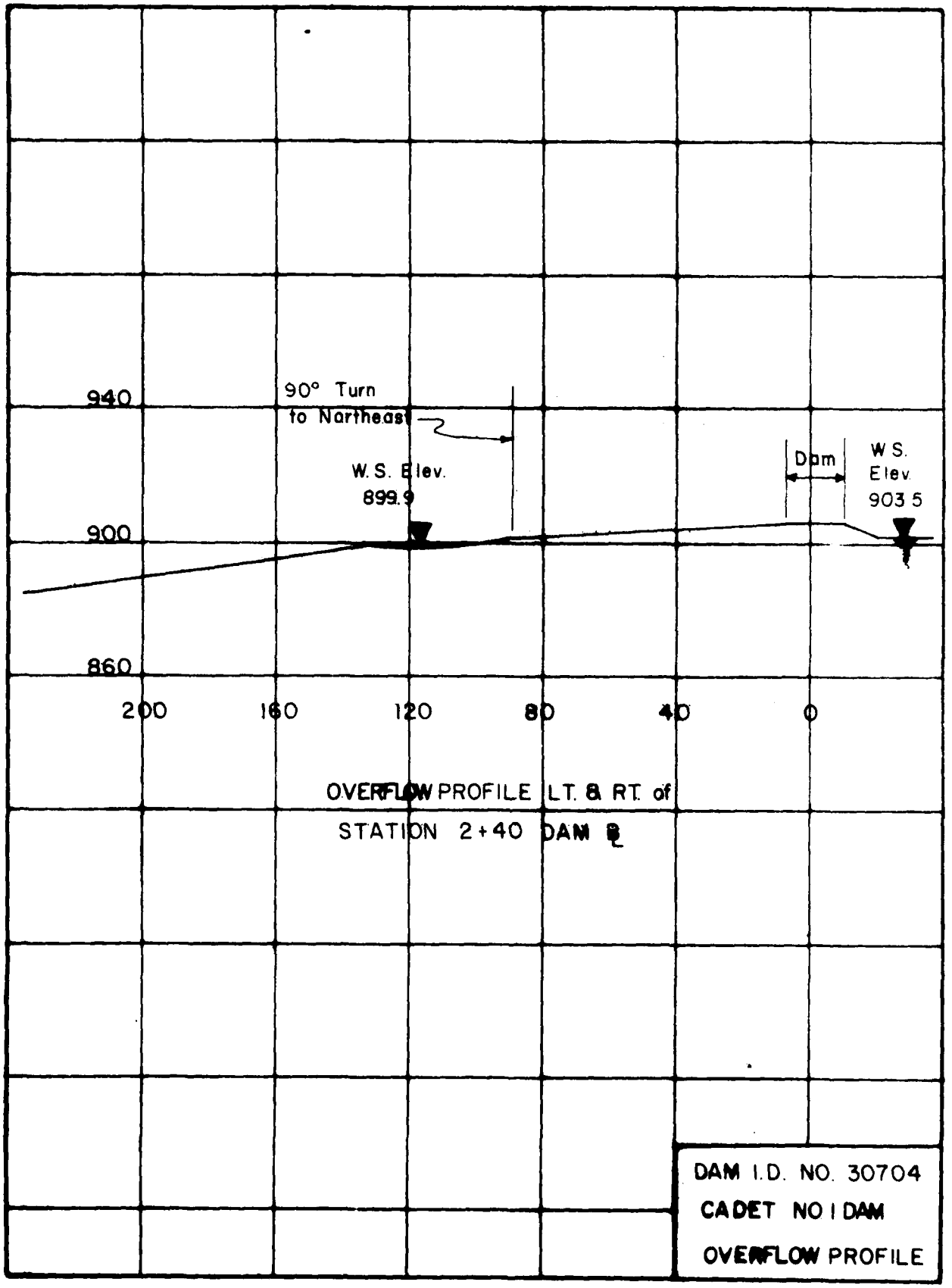

920
900
2+00
2+20
2+40
2+60
2+80
OVERFLOW CROSS-SECTION on DAM ℄
920
900
2+00
2+20
2+40
2+60
2+80
OVERFLOW CROSS-SECTION 10 FEET RT. DAM ℄
DAM I.D. NO. 30704
CADET NOI DAM
OVERFLOW
CROSS-SECTION

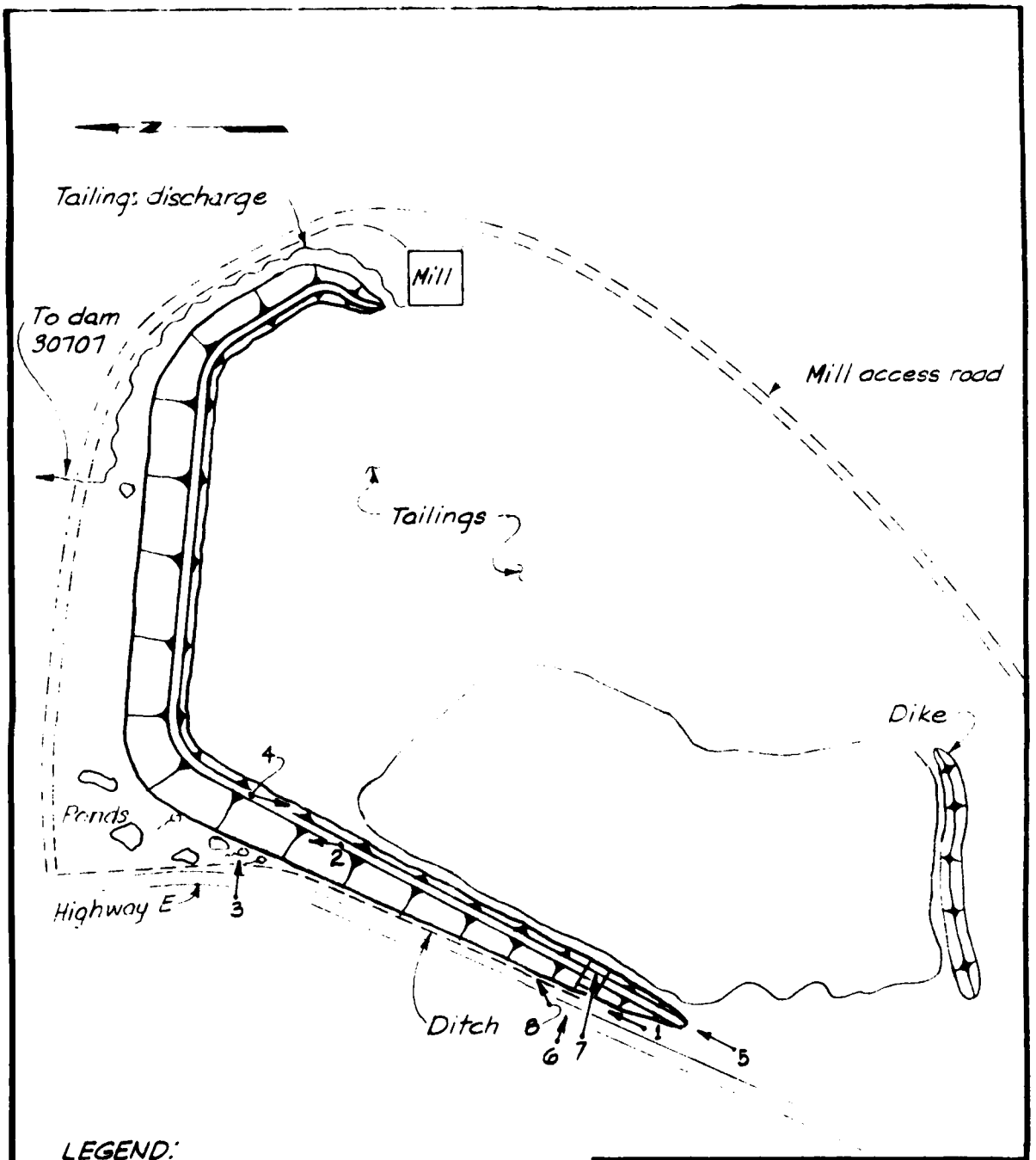
PLATE 6



OVERFLOW PROFILE LT. & RT. of
STATION 2+40 DAM ℄

DAM I.D. NO. 30704
CADET NO 1 DAM
OVERFLOW PROFILE

PLATE 7



LEGEND:

← 4 Photo No. and view direction

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
CADET NO. 1 DAM NO. 30704
PHOTOGRAPH LOCATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO CALIFORNIA 94104

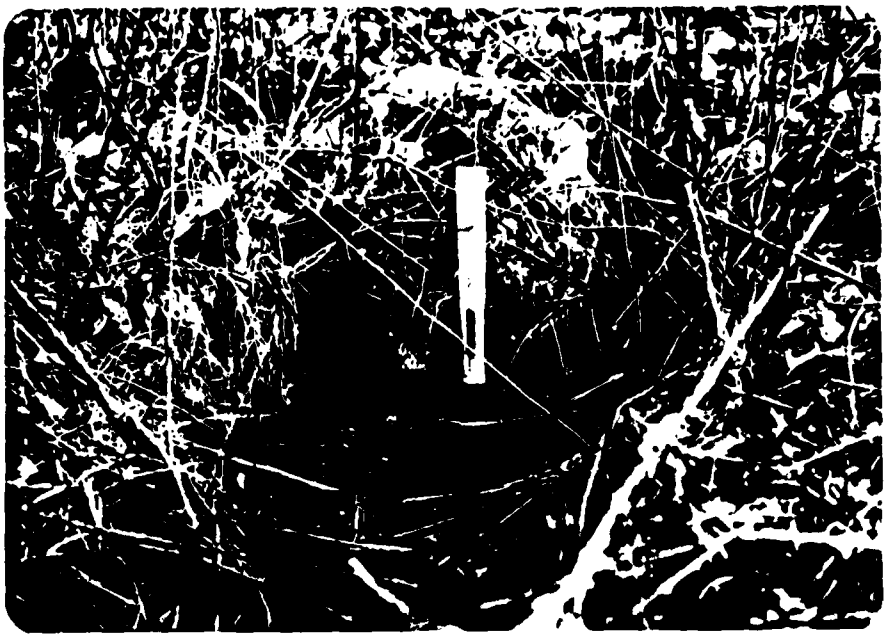
DESIGNED ____ INSPECTED ____
DRAWN WKV RECOMMENDED ____
CHECKED ____ APPROVED ____

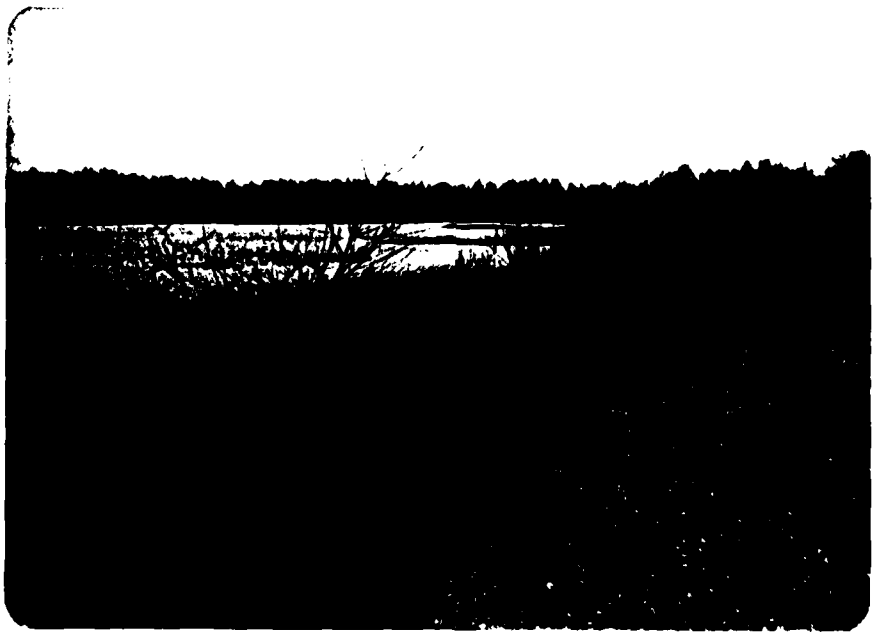
DATE 7-24-79
DRAWING NO. PLATE 8

PHOTOGRAPH RECORD

Cadet No. 1 Dam I.D. No. 30704

Photograph No.	Description
1.	View north along dam and ditch at dam toe.
2.	Ponds at dam toe in vicinity of Station 12+00.
3.	Spring at Station 10+18 flowing at 20 gpm. Clean sediment in channel indicates piped materials were deposited here.
4.	View south along dam crest and pond in impoundment. Note windrows of gravel on crest.
5.	View north from left abutment. Low spot in front of car is likely overtopping point.
6.	View east of low area of dam. Flow would overtop dam in background and break through gravel in foreground, then flow north of the ditch along the dam toe.
7.	View of low spot on dam crest near left abutment.
8.	View north along ditch at dam toe.





7

5

200

E 3

END

DATE
FILMED

11-8

DTIC