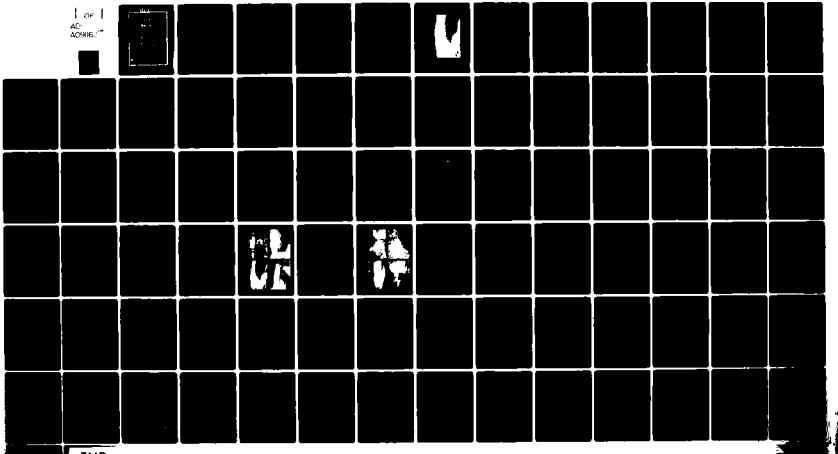
AD-A091 162 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. STEEL DAM (NDI I.D. NUMBER PA---ETC(U)
AUG 80 DACW31-80-C-0016
UNCLASSIFIED NL



END
DATE FILMED
12-80
DTIC

LEVEL IX

OHIO RIVER BASIN
CENTER BRANCH OF PIGEON CREEK, WASHINGTON COUNTY

National Dam Inspection Program

PENNSYLVANIA
STEEL DAM

NDI I.D. No. PA 00495
PENNDER ID No. 63-63

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PREPARED FOR

11 Aug 80

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

15 DACW31-80-C-0016

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146
AUGUST 1980

12 82

411004

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

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 Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

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 data available to the inspection team.

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 and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Steel Dam: NDI I.D. No. PA-00495

Owner:	Bethlehem Mines Corporation
State Located:	Pennsylvania (PennDER I.D. No. 63-63)
County Located:	Washington
Stream:	Center Branch of Pigeon Creek
Inspection Date:	22 July 1980
Inspection Team:	GAI Consultants, Inc. 570 Beatty Road Monroeville, PA 15146

The visual inspection, operational history and hydrologic/hydraulic analysis indicate that the facility is in good condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for damage to downstream structures and possible loss of life, the SDF is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass and/or store approximately 51 percent of the PMF prior to embankment overtopping at the low top of dam. Thus, the spillway system is considered to be inadequate, but not seriously inadequate. Should the embankment crest be regraded to design elevation, the spillway would be capable of passing approximately 60 percent of the PMF prior to embankment overtopping.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Remove the trees adjacent to the right spillway sidewall and regrade the right abutment crest to conform to the design top of dam elevation.

c. Remove the vegetation from within the spillway channel and fill the joints with appropriate expansion material.

d. Develop formal manuals of operation and maintenance to ensure the continued proper care of the facility.

GAI Consultants, Inc.

Bernard M. Mihalcin, P.E.

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

COMMONWEALTH OF PENNSYLVANIA
BERNARD M MIHALCIN

Date [illegible]

Date 12 Sep 80

Accession For
NTIS GRA&I
DTIC TAB
Unannounced
Justification
By
Distribution/
Availability Codes
Dist Special
A23

OVERVIEW PHOTOGRAPH

TABLE OF CONTENTS

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
STEEL DAM
(PIGEON CREEK RESERVOIR DAM)
NDI# PA-00495, PennDER# 63-63

SECTION I
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Steel Dam is an earth embankment approximately 15 feet high and 485 feet long (including spillway). The facility is provided with a centrally located concrete spillway with an ogee shaped weir 100 feet long. The spillway is flanked on both sides by earth abutments. A concrete corewall within both abutments, is founded on rock and extends to within 1-foot of the design crest of the dam. A reinforced concrete control tower is located along the upstream slope to the left of the spillway. Outlet conduits consist of a 10-inch diameter supply pipe and a 24-inch diameter blowoff pipe both encased in concrete and valved at their inlet ends.

b. Location. Steel Dam is located on the center branch of Pigeon Creek in Somerset Township, Washington County, Pennsylvania about three miles northwest of Ellsworth, Pennsylvania. The dam, reservoir and watershed are contained within the Hackett and Ellsworth, Pennsylvania 7.5-minute U.S.G.S. topographic quadrangles (see Figure 1, Appendix E). The coordinates of the dam are N 40° 07.7' and W 80° 03.9'.

c. Size Classification. Small (15 feet high, 189 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (See Section 3.1.e).

e. Ownership. Bethlehem Mines Corporation
Ellsworth Division
P.O. Box 143
Eighty Four, PA 15330

D. A. Sparks - Manager
c/o D. Patterson

f. Purpose. Water Supply.

g. Historical Data. Correspondence in PennDER files indicate that Steel Dam was designed in 1950-1951 and was constructed between July 1952 and November 1953. Neither the designer or contractor is specifically named in available correspondence; however, Morris Knowles, Inc., consulting engineers from Pittsburgh, Pennsylvania, is mentioned.

Design review by PennDER predecessors resulted in many design change recommendations, all of which were incorporated into the final design. Construction progress reports, inspection memoranda and photographs indicate that contract compliance was achieved and that all structural elements were founded on competent rock. One of the construction photographs indicates that the downstream slope was extended to its present configuration during the original construction.

No significant modifications have been made to the facility since construction and it has reportedly functioned adequately.

1.3 Pertinent Data.

a. Drainage Area (square miles). 4.1

b. Discharge at Dam Site.

Discharge Capacity of Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≅ 3590 cfs (See Appendix D, Sheet 6).

c. Elevation (feet above mean sea level). The following elevations were obtained from available drawings and through field measurements that were based on the elevation of the service spillway crest at 1002.0 feet (see Appendix D, Sheet 1).

Design Top of Dam	1007.0
Low Top of Dam	1006.5 (field).
Maximum Design Pool	1007.0
Maximum Pool of Record	Not known.
Normal Pool	1002.0
Spillway Crest	1002.0
Upstream Inlet Invert	994.0
Downstream Outlet Invert	991.5
Streambed at Centerline of Dam	992.5
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	3200
Normal Dam	2000

e. Storage (acre-feet).

Top of Dam	189
Normal Pool	89

f. Reservoir Surface (acres).

Top of Dam	29
Normal Pool	17

g. Dam.

Type	Earth.
Length	385 feet (excluding spillway).
Height	15 feet (field measured; low top of dam to invert of blowoff outlet).
Top Width	150 feet (minimum).
Upstream Slope	3H:1V
Downstream Slope	N/A (see "General Plan - Field Inspection Notes," Appendix A).

	Zoning	Homogenous earth.
	Impervious Core	Concrete corewall extends from rock to 1-foot below crest.
	Cutoff	Corewall extends to sound rock.
	Grout Curtain	None.
h.	Diversion Canal and Regulating Tunnels.	None.
i.	Spillway.	
	Type	Uncontrolled, rectangular concrete channel with an ogee shaped weir.
	Crest Elevation	1002.0 feet.
	Crest Length	100.0 feet.
j.	Outlet Conduit.	
	Type	24-inch diameter CIP encased in concrete.
	Length	180 feet (estimated; inlet to blowoff outlet).
	Closure and Regulating Facilities	Flow through conduit is controlled by a 24-inch diameter sluice gate located at the inlet

	within the concrete control tower.
Access	Steel framed, wood plank foot bridge from crest (see Photograph 7).

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No formal design reports are available for any aspect of the facility. A drawing from the owner (see Figure 6, Appendix E) contains a stability evaluation of the gravity type spillway structure. Design drawings are available from the owner and PennDER files.

b. Design Features.

1. Embankment. The original design features of the embankment are shown on Figures 2 through 6. As indicated, the embankment design consists of a homogeneous earthfill with a central concrete corewall. Correspondence and construction photographs indicate the corewall was extended into competent rock. The upstream slope is covered with 12 inches of grouted rock and the slope angle was set at 3H:1V. The design called for the crest width to be 10 feet and the downstream slope to be set at 2-1/2H:1V. Field observations revealed the upstream slope was constructed as per design. The downstream face, however, was apparently covered with excess material and now slopes very gently downstream making it hardly discernible from the embankment crest.

2. Appurtenant Structures.

a) Spillway. Details of the spillway design are shown on Figures 3 and 4. As indicated, the spillway design consists of an ogee shaped gravity section, a stilling basin and a reinforced concrete, trapezoidal shaped discharge channel. The gravity section and wall foundations are seated on rock. The concrete corewalls join the gravity section to provide a continuous seepage barrier along the dam centerline.

b) Outlet Works. The outlet works is shown in detail on Figures 3 and 5. As indicated, it consists of a 10-inch diameter supply pipe and a 24-inch diameter blowoff pipe, both encased in concrete and controlled by slide gates within a control tower situated near the upstream dam toe. The gates are operated by handwheels from atop the control tower which is accessed by a foot bridge from the embankment crest.

c. Specific Design Data and Criteria. Figure 6 shows a detailed spillway analysis for five reservoir conditions.

Results of the analysis (also shown on the figure) indicate that the design configuration is acceptable. Specifications for concrete mixes and fill placement are also presented in the notes shown on Figures 3 and 5.

2.2 Construction Records.

Bi-weekly construction progress reports are available from PennDER files in addition to seven construction photographs that confirm pertinent construction details.

2.3 Operational Records.

No formal records of operation are available for the facility.

2.4 Other Investigations.

No records of any formal investigations other than one state inspection report are available.

2.5 Evaluation.

The available data in the form of design drawings, construction progress reports and dated construction photographs are considered sufficient to make a reasonable Phase I assessment of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the facility suggests that it is in good condition.

b. Embankment. The visual inspection indicates that the embankment is in good condition and is generally well maintained with few exceptions. It was noted that the configuration of the crest and downstream slope were substantially modified, probably during construction. The crest was extended and the downstream slope virtually eliminated such that the overall appearance of the facility is that of an incised impoundment.

Deficiencies that should be corrected include: sizeable tree growth adjacent to the right spillway wingwall and noticeable crest settlement along the right abutment section.

c. Appurtenant Structures.

1. Spillway. The overall condition of the spillway is good. No significant cracking or concrete deterioration was observed. Moderate scaling of the flow surface is apparent especially near the downstream end of the spillway. An excessive amount of vegetation has rooted itself along the expansion joints in the spillway floor (see Photographs 3 and 4). The vegetation and supporting soil should be removed and the joints filled with appropriate expansion material.

2. Outlet Works. The outlet works structures and mechanisms all appear to be in good condition (see Photographs 7 and 8). No significant cracking or deterioration of the concrete elements was observed. Metal parts were adequately painted and the access bridge was in good condition.

d. Reservoir Area. The reservoir impounded by Steel Dam is surrounded by gentle to moderate slopes that are primarily wooded. No slope distress or significant sedimentation was observed.

e. Downstream Channel. The spillway discharges into the center branch of Pigeon Creek which is contained in a gently sloped, relatively wide valley. At approximately two miles downstream of the dam the center branch merges with

the south branch of Pigeon Creek. Other than the Conrail track that parallels the stream, no inhabitable structures are located within the reach from the dam to this confluence. At approximately 2,000 feet further downstream from the confluence, the combined stream flow enters the Ellsworth Reservoir, an industrial and municipal water supply impoundment. Failure of Steel Dam would probably cause overtopping and failure of the downstream dam and possibly result in loss of life within the several commercial structures adjacent to the reservoir. Consequently, the hazard classification is considered to be high.

3.2 Evaluation.

The overall condition of the facility is considered to be good. The dam and its appurtenances are reasonably well maintained and the as-built configuration of the embankment provides more than adequate stability. Deficiencies which should be corrected include: overgrowth adjacent the right spillway wingwall near the embankment crest; a low area along the dam crest to the right of the spillway; and excessive vegetation rooted within the expansion joints of the spillway floor.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The facility is self-regulating with excess inflow automatically discharged through the spillway. Under normal operating conditions the blowoff line is closed and the intake line opened within the intake tower. Valve mechanisms within the tower were not operated in the presence of the inspection team and the owner's representative did not know when they were last operated. There is no formal operations manual associated with the facility.

4.2 Maintenance of Dam.

The facility has been maintained on an unscheduled basis and there are no formal records or maintenance manual available. The left abutment section is reasonably well maintained apparently due to its easy access and use as a mine rescue practice area. The right abutment, which is not readily accessible, has become overgrown with brush and trees. The crest level of the right abutment is also noticeably low, particularly adjacent to the right spillway wingwall.

4.3 Maintenance of Operating Facilities.

The access bridge and operating mechanisms appear to be well maintained although the operability of the valve mechanism could not be confirmed during the inspection. No formal maintenance manual is available.

4.4 Warning System.

There is no formal warning system associated with the facility; however, the owner maintains communications with the downstream water treatment facility.

4.5 Evaluation.

No formal manuals of maintenance and operation are available, but, are recommended to ensure the continued proper care of the facility. Included in these manuals should be a formal emergency warning system for the notification of downstream inhabitants in the event hazardous conditions develop.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports or calculations are available. Correspondence contained in PennDER files indicate the spillway was sized to accommodate a storm runoff of 1,000 cubic feet per second per square mile of watershed.

5.2 Experience Data.

No specific records are available for this facility.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate that the spillway structure would not perform satisfactorily during a flood event, within the limits of its design capacity. Discharge through the spillway would be limited, however, by the low area along the right abutment crest.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Steel Dam ranges between the 1/2-PMF and the PMF. This classification is based on the relative size of the dam (small), and the potential hazard of dam failure to downstream developments (high). Due to its high potential for damage to downstream structures and possible loss of life, the SDF for this facility is considered to be the PMF.

b. Results of Analysis. Steel Dam was evaluated under normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of 1002.0 feet with the spillway weir discharging freely. The outlet conduit was assumed to be non-functional for the purpose of analysis, since the flow capacity of the conduit is not such that it would significantly increase the total discharge capabilities of the facility. The spillway consists of a concrete, trapezoidal, chute channel with discharges controlled by a concrete, ogee shaped weir. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix D.

Overtopping analysis (using the Modified HEC-1 Computer Program) indicated that the discharge/storage capacity of Steel Dam can accommodate only about 51 percent of the PMF (SDF) prior to embankment overtopping. The peak PMF inflow of approximately 7075 cfs was slightly attenuated by the discharge/storage capability of the dam, as the resulting PMF peak outflow was about 7055 cfs (Appendix D, Summary Input/Output Sheets, Sheet C). Under PMF conditions, the embankment would be overtopped for approximately 6.5 hours with a maximum depth of inundation of about 1.9 feet above the low top of dam (Summary Input/Output Sheets, Sheet C). It is also noted that if the embankment crest was regraded to design elevation, the spillway would be capable of passing approximately 60 percent of the PMF prior to embankment overtopping.

5.6 Spillway Adequacy.

Although Steel Dam cannot accommodate its SDF (the PMF) without overtopping, the possible downstream consequences of embankment failure due to overtopping were not evaluated. Since the facility can safely pass a flood of at least 1/2-PMF magnitude, breaching analysis was not performed in accordance with Corps directive ETL-1110-2-234. Thus, as Steel Dam cannot accommodate a PMF-size flood, its spillway is considered to be inadequate, but not seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment is in good condition. The grouted rock riprap provides adequate upstream slope protection. Modifications (probably during construction) have resulted in a downstream configuration that virtually precludes embankment instability. The right abutment section has apparently settled with the crest being lower than the right spillway wingwall. Overtopping would therefore be concentrated over the right abutment and could cause serious erosion along the spillway. Several large trees are also located on the right abutment adjacent to the spillway wingwall. The root systems and/or toppling of these trees could eventually cause structural damage to the spillway components if not removed.

b. Appurtenant Structures.

1. Spillway. The spillway appears to be structurally well designed and currently in good condition. An unusual amount of vegetation appears to be rooted along the floor slab expansion joints providing some obstruction to flow. The vegetation should be removed and the joints filled with appropriate expansion material.

2. Outlet Works. The outlet structures and mechanisms appear to be in good condition. Routine maintenance is recommended to ensure operability of the slide gates.

6.2 Design and Construction Techniques.

Limited data indicate that the design and construction were performed in accordance with generally accepted practices.

6.3 Past Performance.

No data or other evidence is available that would indicate the facility has not performed satisfactorily since its construction.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and is subject to minor earthquake induced dynamic forces. It is believed that the static stability of the structure is sufficient to withstand such forces; however, no calculations and/or investigations were performed to confirm this belief.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection suggests that the facility is in good condition.

The size classification of the facility is small and its hazard classification is considered to be high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) for the facility ranges between the 1/2-PMF (Probable Maximum Flood) and the PMF. Due to the high potential for significant downstream economic damage and possible loss of life that would be associated with an embankment breach, the SDF for the facility is considered to be the PMF. Results of the hydrologic and hydraulic analysis indicate the facility will pass approximately 51 percent of the PMF prior to overtopping the right abutment section at low top of dam. Thus, the spillway system is considered inadequate, but not seriously inadequate. Should the embankment crest be regraded to design elevation, the spillway would be capable of passing approximately 60 percent of the PMF prior to embankment overtopping.

b. Adequacy of Information. The available data are considered sufficient to make a reasonable Phase I evaluation of the facility.

c. Urgency. The recommendations listed below should be implemented immediately.

d. Necessity for Additional Investigations. No additional investigations are considered necessary at this time.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner immediately:

a. Develop a formal emergency warning system to notify downstream residents should hazardous conditons develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

b. Remove the trees adjacent to the right spillway sidewall and regrade the right abutment crest to conform to the design top of dam elevation.

c. Remove the vegetation from within the spillway channel and fill the joints with appropriate expansion material.

d. Develop formal manuals of operation and maintenance to ensure the continued proper care of the facility.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Steel Dam STATE Pennsylvania COUNTY Washington

NDI # PA — 00495 PENNDER # 63-63

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 22 July 1980 WEATHER Overcast TEMPERATURE 75° @ 10:30 AM

POOL ELEVATION AT TIME OF INSPECTION 1002.2 feet M.S.L.

TAILWATER AT TIME OF INSPECTION _____ M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	None at site.	
D. L. Bonk		
D. J. Spaeder		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
SURFACE CRACKS	None observed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical - low area (0.8 feet below top of dam) adjacent spillway right wingwall (see "Profile of Dam Crest," Appendix A). Horizontal - Good.
RIPRAP FAILURES	None observed. Riprap consists of grouted rock covering the entire upstream face.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	No damp areas observed. Right abutment is overgrown with high brush and large trees probably because it is not readily accessible. Left abutment is well kept. Large trees are in evidence that are not detrimental to the facility.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	Staff gage attached to corner of control tower - no reference numbers on it.
DRAINS	12-inch diameter terra cotta drain observed discharging (≈ 1 gpm) through spillway left wingwall about midway along the spillway discharge channel downstream of the spillway crest.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
INTAKE STRUCTURE	Concrete control tower riser in excellent condition. No evidence of concrete deterioration.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	24-inch diameter cast iron pipe. Partially submerged.
OUTLET STRUCTURE	Concrete outlet headwall in good condition.
OUTLET CHANNEL	Discharges into stream below spillway.
GATE(S) AND OPERATIONAL EQUIPMENT	Painted and apparently well maintained. Not operated in the presence of the inspection team.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
TYPE AND CONDITION	Uncontrolled, rectangular, concrete channel with an ogee shaped weir in good condition. Beyond weir the channel is trapezoidal in cross section.
APPROACH CHANNEL	None.
SPILLWAY CHANNEL AND SIDEWALLS	Minor to moderate scaling apparent across the channel bottom. Considerable vegetation apparently rooted in expansion joints. Should remove and fill joints with expansion material. Sidewalls are in excellent condition.
STILLING BASIN PLUNGE POOL	100-foot by 10-foot by 5-foot stilling basin located at base of weir.
DISCHARGE CHANNEL	Unlined, trapezoidal shaped earth channel - natural stream.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

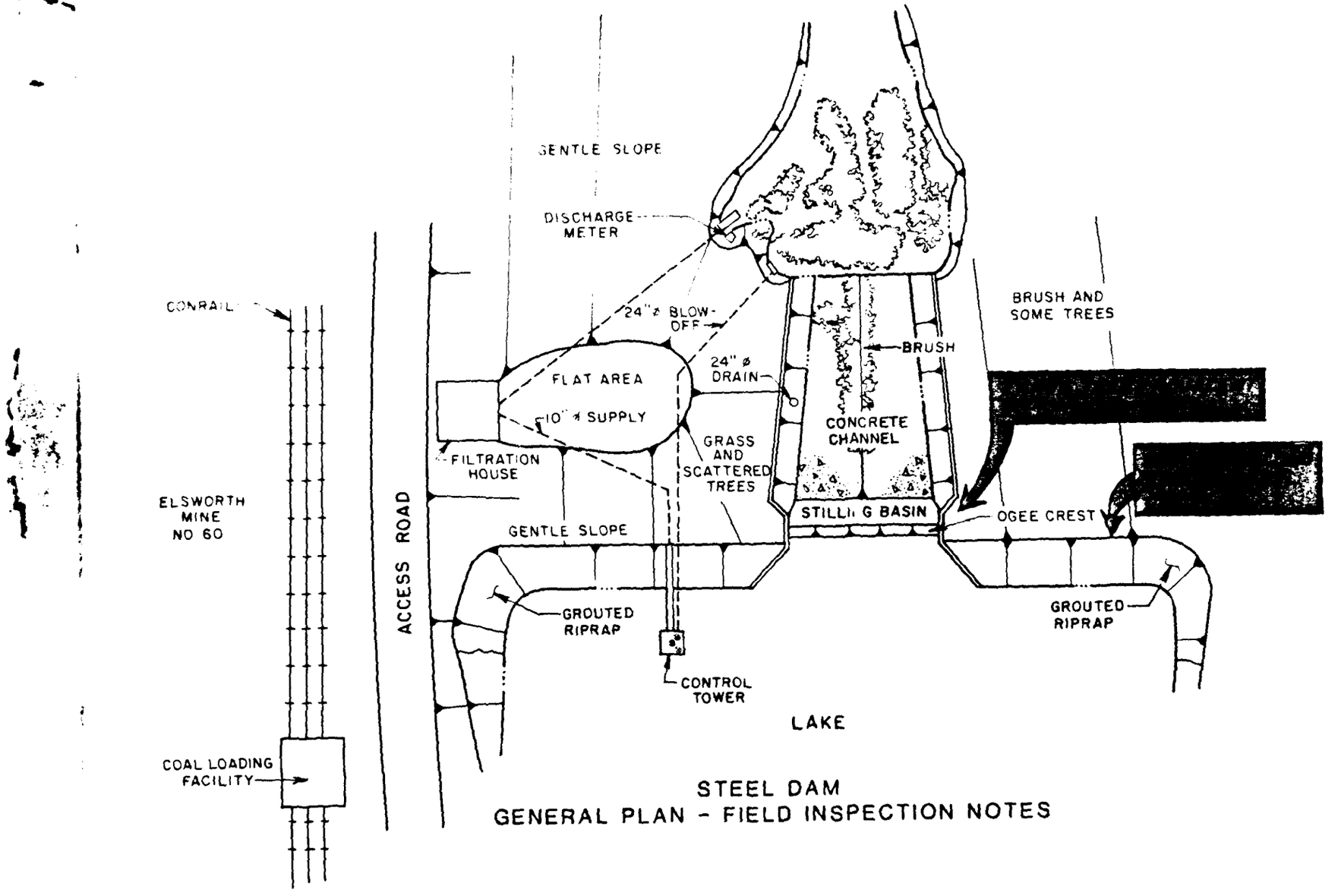
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
TYPE AND CONDITION	N/A
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
MONUMENTATION SURVEYS	None observed.
OBSERVATION WELLS	None observed.
WEIRS	Flume and automatic recording device located on a discharge line adjacent to the blowoff - not associated with embankment.
PIEZOMETERS	None observed.
OTHERS	None observed.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

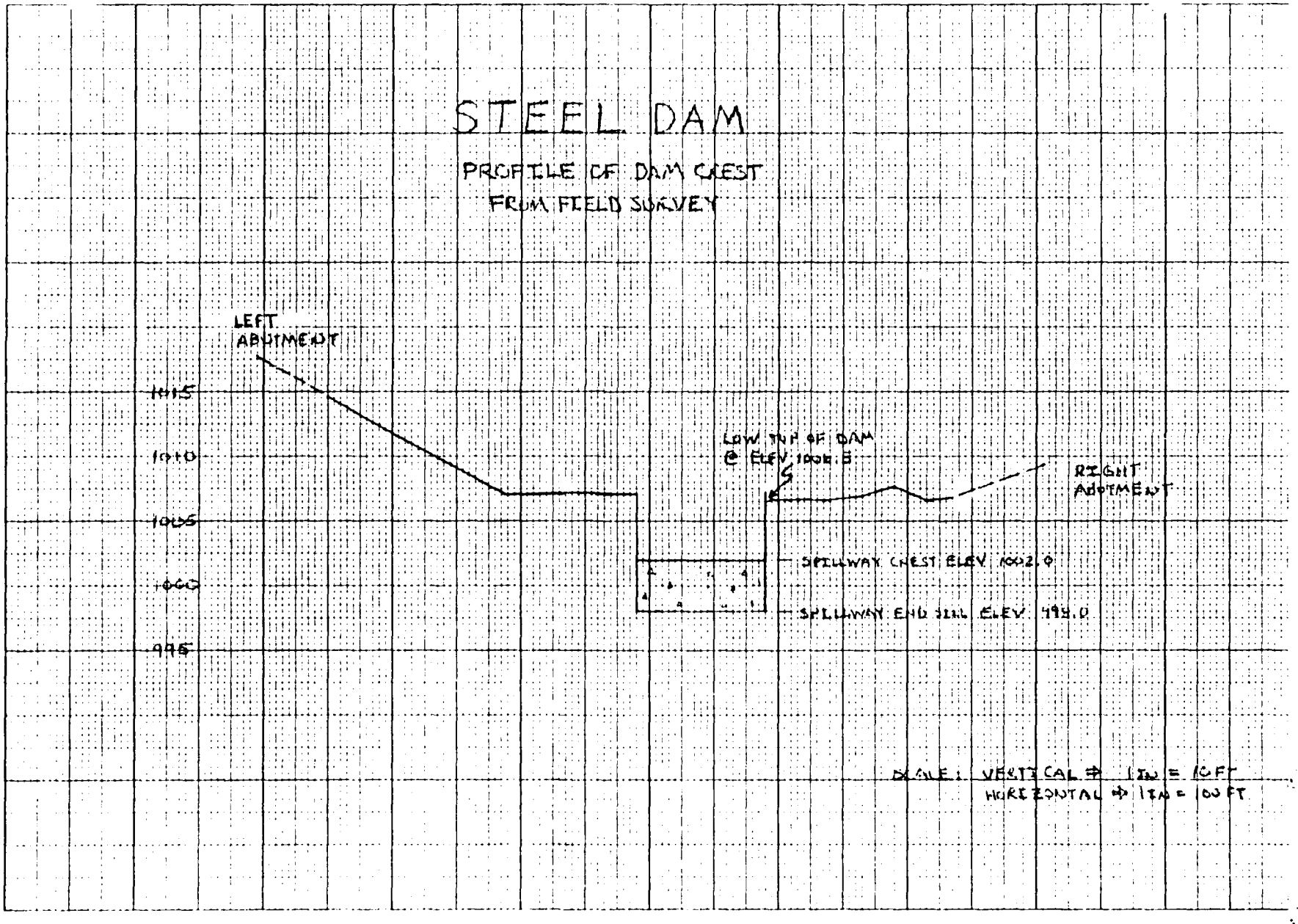
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00495
SLOPES: RESERVOIR	Right abutment - steep and heavily wooded. Left abutment - contains mining and railroad facilities.
SEDIMENTATION	None observed. Reservoir is brown in color which is indicative of a high sediment content. May be the result of heavy rainfall (≈ 3-3/4") the night prior to inspection.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel is a natural stream located in a relatively wide, gently to moderately sloped valley. Stream merges with the south branch of Pigeon Creek ≈ 2 miles from dam and enters Ellsworth Reservoir ≈ 2000 feet further downstream.
SLOPES: CHANNEL VALLEY	Channel slope is gentle to moderate. Valley slope is moderate.
APPROXIMATE NUMBER OF HOMES AND POPULATION	No houses located upstream of confluence with the south branch of Pigeon Creek. Stream enters Ellsworth Reservoir about 2000 feet downstream of confluence. Several industrial/commercial structures are located around the lower reservoir that could be damaged by a failure of Steel Dam and subsequent overtopping of the downstream reservoir. High potential for damage and loss of many lives.



STEEL DAM
GENERAL PLAN - FIELD INSPECTION NOTES

STEEL DAM

PROFILE OF DAM CREST
FROM FIELD SURVEY



APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Steel Dam

ITEM	REMARKS NDI# PA - 00495
PERSONS INTERVIEWED AND TITLE	James Loveland - Environmental Engineer
REGIONAL VICINITY MAP	See Appendix E, Figure 1 (U.S.G.S. 7.5 minute topographic quadrangles, Hackett and Ellsworth, PA).
CONSTRUCTION HISTORY	Details available from PennDER files. Designed in 1950-51. Morris Knowles, Inc., mentioned in correspondence. Constructed July 1952 through November 1953. Contractor unknown.
AVAILABLE DRAWINGS	Four prints from initial design available from PennDER files. Owner has complete set of reproducible drawings of final design at office in Eighty-four, Pennsylvania.
TYPICAL DAM SECTIONS	See Appendix E, Figure 3.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Appendix E, Figures 2, 3 and 5.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00495
SPILLWAY: PLAN SECTION DETAILS	See Appendix E, Figures 2, 3, 4 and 6.	
OPERATING EQUIP- MENT PLANS AND DETAILS	See Appendix E, Figures 3 and 5.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	None available.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	See Appendix E, Figure 6 for analysis of gravity spillway section.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA · 00495
BORROW SOURCES	Probably from within reservoir.	
POST CONSTRUCTION DAM SURVEYS	None in last four years.	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.	
HIGH POOL RECORDS	Not known.	
MONITORING SYSTEMS	None.	
MODIFICATIONS	Downstream slope modified, probably during construction.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00495
PRIOR ACCIDENTS OR FAILURES	None.	
MAINTENANCE: RECORDS MANUAL	None available.	
OPERATION: RECORDS MANUAL	None available.	
OPERATIONAL PROCEDURES	Self-regulating. Supply chamber gate apparently always open and flow controlled in treatment facility.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	Owner has communication with downstream water treatment facility at Ellsworth Reservoir. No formal warning system in effect.	
MISCELLANEOUS		

GAI CONSULTANTS, INC.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00495
PENNDER ID # 63-63

SIZE OF DRAINAGE AREA: 4.1 square miles.

ELEVATION TOP NORMAL POOL: 1002.0 STORAGE CAPACITY: 89 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: -- STORAGE CAPACITY: --

ELEVATION MAXIMUM DESIGN POOL: 1007.0 STORAGE CAPACITY: --

ELEVATION TOP DAM: 1006.5 (low spot) STORAGE CAPACITY: 189 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 1002.0 feet.

TYPE: Uncontrolled, rectangular, concrete channel with ogee shaped weir.

CREST LENGTH: 100.0 feet.

CHANNEL LENGTH: 150 feet.

SPILLOVER LOCATION: Near center of dam.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 10-inch diameter CIP supply; 24-inch diameter CIP blowoff.

LOCATION: Left of spillway.

ENTRANCE INVERTS: Blowoff - 994.0 feet.

EXIT INVERTS: Blowoff - 991.5 feet.

EMERGENCY DRAWDOWN FACILITIES: 24-inch diameter blowoff controlled by a 24-inch diameter sluice gate.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

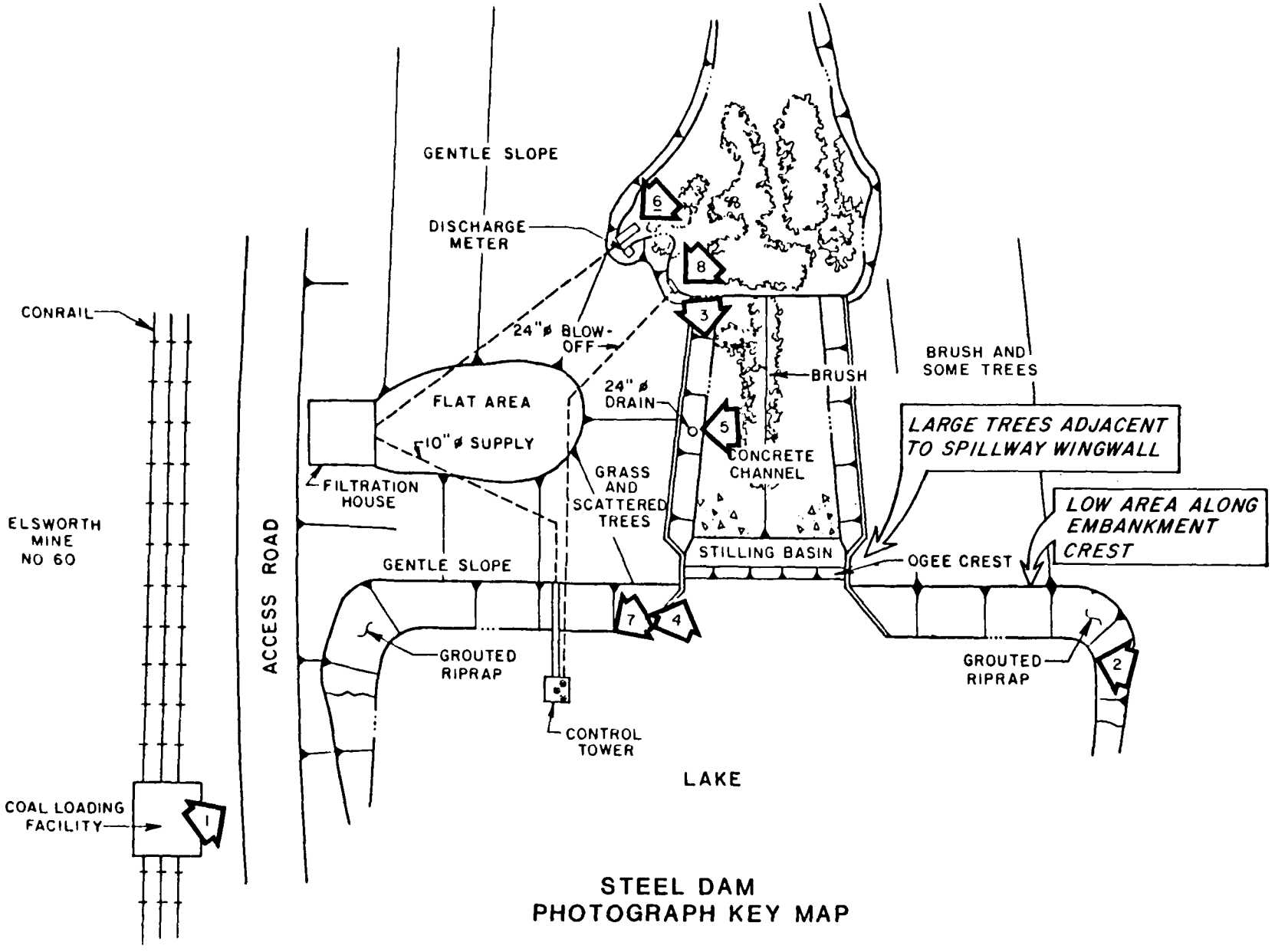
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

PHOTOGRAPHS



STEEL DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1	Overview of the embankment and reservoir from atop a building located along the left abutment hillside.
PHOTOGRAPH 2	View of the upstream embankment face to the right of the spillway.
PHOTOGRAPH 3	View, looking upstream, of the spillway weir.
PHOTOGRAPH 4	View of the spillway channel looking downstream.

1

2

3

4

PHOTOGRAPH 5 View of the 12-inch diameter terra cotta drain observed discharging (≈ 1 gpm) through the spillway left wingwall.

PHOTOGRAPH 6 View of a flume and automatic recording device located just downtream of the blowoff outlet.

PHOTOGRAPH 7 View of the control tower as seen from the upstream face of the left abutment.

PHOTOGRAPH 8 View of the outlet end of the blowoff conduit.

5

6

7

8

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevations of failure hydrographs for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: STEEL DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	STEEL DAM		
DRAINAGE AREA (SQUARE MILES)	4.1		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%)(1)	Zone 7		
6 HOURS	102		
12 HOURS	120		
24 HOURS	130		
48 HOURS	140		
72 HOURS	-		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	29		
C_p (3)	0.50		
C_t (3)	1.60		
L (MILES) (4)	4.0		
L_{ca} (MILES) (4)	2.0		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	2.99		
SPILLWAY DATA			
CREST LENGTH (FEET)	100		
FREEBOARD (FEET)	4.5		

(1) HYDROMETEOROLOGICAL REPORT - 33, U.S. ARMY CORPS OF ENGINEERS, 1956.

(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).

(3) SNYDER COEFFICIENTS

(4) L = LENGTH OF LONGEST WATERCOURSE FROM DAM TO BASIN DIVIDE.
L_{ca} = LENGTH OF LONGEST WATERCOURSE FROM DAM TO POINT OPPOSITE BASIN CENTR

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY JSC DATE 7-30-79 PROJ. NO. 79-203-495

CHKD. BY DLH DATE 8-1-79 SHEET NO. 1 OF 2

CONSULTANTS, I:
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

- HEIGHT OF DAM = 15 FT (LOW TOP OF DAM TO INVERT OF LOW LEVEL OUTLET)
- NORMAL POOL STORAGE CAPACITY = 87 AC-FT (SEE NOTE 1)
- MAXIMUM POOL STORAGE CAPACITY = 189 AC-FT (@ LOW TOP OF DAM) (HEC-1 OUTPUT)
- DRAINAGE AREA = 4.1 SQ MI. (PLANIMETERED ON 7.5' USGS TOPO QUAD, HACKETT, AND ELLSWORTH, PA)

ELEVATIONS:

TOP OF DAM (DESIGN) =	1007.0	(FIG. 3)
TOP OF DAM (FIELD) =	1006.5	
NORMAL POOL =	1002.0	(FIG. 3)
SPILLWAY CREST =	1002.0	(FIG. 3)
UPSTREAM LOW LEVEL INVERT =	994.0	(FIG. 3)
DOWNSTREAM OUTLET INVERT =	991.5	(FIG. 3)
STREAMBED @ DAM CENTERLINE =	992.5	(FIG. 3)

NOTE 1: OBTAINED FROM "REPORT UPON THE APPLICATION OF THE KITTANNING STEEL COMPANY, FOR THE CONSTRUCTION OF A DAM ACROSS CENTER BRANCH OF PLUM CREEK IN SOMERSET TOWNSHIP, WASHINGTON COUNTY, PENNSYLVANIA," JANUARY, 1952. FOUND IN ROUNDER FILES.

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY RTS DATE 7-22-80 PROJ. NO. 79-302-495

CHKD. BY [illegible] DATE [illegible] SHEET NO. 2 OF [illegible]

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM CLASSIFICATION

DAM SIZE: SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION: HIGH (FIELD OBSERVATION)

REQUIRED SDF: ½ PMF TO PMF (REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE = 4.0 MILES

LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID ≅ 2.0 MILES

(MEASURED ON USGS TOPO QUADS – HACKETT AND ELLSWORTH, ...)

$C_t = 1.60$ (SUPPLIED BY C.O.E., ZONE 29, MONONGAHELA RIVER ...)

$C_p = 0.50$

SNYDER'S STANDARD LAG: $t_p = C_t (L \cdot L_{CA})^{0.3}$

$= 1.60 (4.0 \times 2.0)^{0.3}$

$= 2.97$ HRS

(NOTE: HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH.")

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DSS DATE 7-22-80 PROJ. NO. 79-333-495

CHKD. BY DLR DATE 8-1-80 SHEET NO. 3 OF 6

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR CAPACITY

RESERVOIR SURFACE AREAS:

SURFACE AREA (S.A.) @ NORMAL POOL (EL. 1002) = 16.6 ACRES (SEE NOTE 1)

S.A. @ ELEV. 1000 = 64.0 ACRES (USGS TOPO - HACKETT, QA)

S.A. @ LOW TOP OF DAM (EL. 1006.5) = 38.5 ACRES (BY LINEAR INTERPOLATION)

"ZERO-STORAGE" ELEVATION:

BY USE OF THE CONIC METHOD,

$$\text{VOLUME @ NORMAL POOL} = \tfrac{1}{3}HA$$

WHERE H = MAXIMUM DEPTH OF RESERVOIR, IN FT,
A = SURFACE AREA @ NORMAL POOL = 16.6 AC.

$$\text{VOLUME} = \tfrac{1}{3}HA$$
$$89 = \tfrac{1}{3}H(16.6)$$
$$H = \frac{(3)(89)}{16.6}$$
$$= 16.1 \text{ FT}$$

∴ ZERO-STORAGE ASSUMED AT 1002.0 − 16.1 = 985.9 FT

NOTE: ALTHOUGH THE MINIMUM RESERVOIR ELEVATION IS IN ACTUALITY AT APPROXIMATELY ELEV. 993, THE ELEVATION COMPUTED ABOVE MUST BE USED AS INPUT IN THE HEC-1 PROGRAM, IN ORDER TO

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-23-80 PROJ. NO. 79-303-495

CHKD. BY [illegible] DATE [illegible] SHEET NO. 4 OF [illegible]

CONSULTANTS, I
Engineers • Geologists • Planners
Environmental Specialists

MAINTAIN A STORAGE OF 21 AC-FT AT NORMAL POOL.

ELEVATION-STORAGE RELATIONSHIP:

AN ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BY USE OF THE CONIC METHOD, BASED ON THE ELEVATION-SURFACE AREA DATA GIVEN HERE. (SEE SUMMARY INPUT/OUTPUT SHEETS.)

PMP CALCULATIONS

- APPROXIMATE RAINFALL INDEX = 24 INCHES
  (CORRESPONDING TO A DURATION OF 24 HOURS, AND A DRAINAGE AREA OF 200 SQUARE MILES.)
  (REF 3, FIG. 1)
- DEPTH-AREA-DURATION ZONE 7 (REF 3, FIG. 1)

- ASSUME DATA CORRESPONDING TO A 10-SQUARE MILE AREA MAY BE APPLIED TO THIS 4.1 SQUARE MILE BASIN:

DURATION (HRS):	6	12	24	48
PERCENT OF INDEX RAINFALL:	108	133	100	140

(REF 3, FIG. 2)

ADD BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 4.1 SQUARE MILES IS 0.80

(REF 4, P. 49)

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

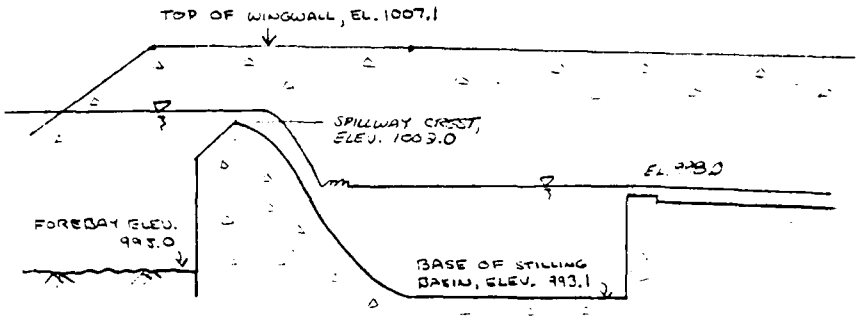
BY DJS DATE 7-27-80 PROJ. NO. 79-353-495

CHKD. BY [illegible] DATE 8-1-80 SHEET NO. 5 OF [illegible]

CONSULTANTS, II
Engineers • Geologists • Planners
Environmental Specialists

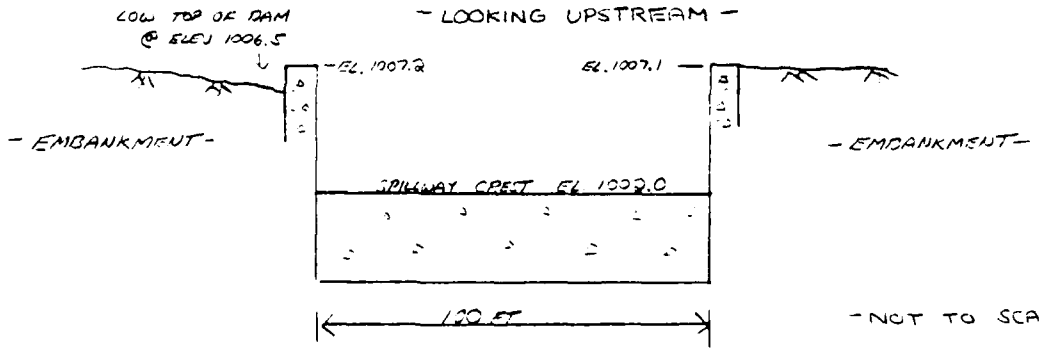
SPILLWAY CAPACITY

PROFILE:



- NOT TO SCALE -

CROSS-SECTION:



- NOT TO SCALE -

(SKETCHES BASED ON FIELD SURVEY AND DESIGN DRAWINGS.)

THE SPILLWAY CONSISTS OF A RECTANGULAR CONCRETE CHUTE CHANNEL, WITH DISCHARGES CONTROLLED BY A CONCRETE OGEE-TYPE WEIR. DISCHARGE OVER THE WEIR CAN BE ESTIMATED BY THE EQUATION

$$Q = CLH^{3/2}$$ (REF 4, p. 373)

WHERE Q = DISCHARGE OVER THE WEIR, IN CFS,
C = COEFFICIENT OF DISCHARGE,

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-24-79 PROJ. NO. 79-303-135

CHKD. BY [illegible] DATE [illegible] SHEET NO. 6 OF 10

CONSULTANTS, I
Engineers • Geologists • Planners
Environmental Specialists

L = WEIR LENGTH = 100 FT,
H = HEAD, IN FT.

THE DESIGN COEFFICIENT OF DISCHARGE IS 3.80. AS THE HEAD ON THE WEIR BECOMES SMALL, DISCHARGE IS REDUCED DISPROPORTIONATELY, DUE TO THE ROUGHNESS AND THE CONTACT PRESSURE BETWEEN THE WATER AND THE WEIR SURFACE. THUS, THE DISCHARGE COEFFICIENT TAKES ON A VALUE LOWER THAN THAT OF DESIGN (DESIGN HEAD IS ASSUMED TO BE 5.0, OR AT THE DESIGN TOP OF WINGWALL ELEVATION). THE OPPOSITE TREND OCCURS FOR HEADS GREATER THAN THAT OF DESIGN. THEREFORE, FOR HEADS LESS THAN 5.0 FT, THE DISCHARGE COEFFICIENT WILL BE REDUCED, ACCORDING TO FIG. 250, REF. 4. FOR HEADS GREATER THAN 5.0, THE COEFFICIENT WILL REMAIN CONSTANT AT 3.80 — DUE TO THE MINOR COUNTER-ACTING EFFECTS OF TAILWATER INTERFERENCE AND INCREASING HEAD (TAILWATER EFFECTS ARE MINOR FOR THE RANGE OF DISCHARGES CONSIDERED HERE).

SPILLWAY RATING CURVE:

	RESERVOIR ELEVATION (FT)	H (FT)	H/Ho	C/Co ①	C ②	Q ③ (CFS)
	1002.0	0	—	—	—	0
	1003.0	1.0	0.2	0.85	3.23	330
	1004.0	2.0	0.4	0.90	3.42	970
	1005.0	3.0	0.6	0.94	3.57	1860
	1006.0	4.0	0.8	0.97	3.69	2950
(FLOW TOP OF DAM)	1006.5	4.5	0.9	0.99	3.76	3570
	1007.0	5.0	1.0	1.00	3.80	4250
	1007.5	5.5	1.1	—	3.80	4700
	1008.0	6.0	1.2	—	3.80	5580
	1009.0	7.0	1.4	—	3.80	7040
	1010.0	8.0	1.6	—	3.80	8600

① FROM FIG. 250, REF 4 (p. 378)
② $C = \frac{C}{C_o} \times 3.80$
③ $Q = 100 \times CH^{3/2}$

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-24-80 PROJ. NO. 79-803-445

CHKD. BY DJS DATE 8-1-80 SHEET NO. 7 OF 12

CONSULTANTS, I
Engineers • Geologists • Planners
Environmental Specialists

EMBANKMENT RATING CURVE

DISCHARGE OVER THE DAM CREST WILL ESSENTIALLY CONSIST OF OPEN CHANNEL FLOW, DUE TO THE NATURE OF THE ENCROACHMENT. DISCHARGE WILL BE ESTIMATED BY USE OF MANNING'S EQUATION FOR FLOW AT NORMAL DEPTH:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad \text{(REF 5, p. 7-17)}$$

WHERE Q = DISCHARGE, IN CFS,
n = ROUGHNESS COEFFICIENT,
A = FLOW AREA, IN FT^2,
R = HYDRAULIC RADIUS, IN FT,
S = AVERAGE CHANNEL SLOPE, IN FT/FT.

DUE TO THE DIFFERENT CONDITIONS ON THE RIGHT SIDE AND LEFT SIDE PORTIONS OF THE EMBANKMENT, FLOW OVER EACH SIDE WILL BE COMPUTED SEPARATELY.

LENGTH OF DAM INUNDATED VS RESERVOIR ELEVATION:

ELEVATION (FT)	LENGTH - LEFT SIDE (FT)	LENGTH - RIGHT SIDE (FT)	
1006.5	0	0	
1006.7	0	65	
1006.9	0	105	
1007.1	25	120	
1007.5	110	145	(FROM FIELD SURVEY
1008.0	120	155	USGS TOPO-MAP
1009.0	135	165	AT DAM CENTERLINE
1010.0	155	175	

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-24-80 PROJ. NO. 79-302-495

CHKD. BY [illegible] DATE [illegible] SHEET NO. 8 OF 10

CONSULTANTS, I
Engineers • Geologists • Planners
Environmental Specialists

ASSUME THAT INCREMENTAL DISCHARGES FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $D_i[(L_1+L_2)/2]$, WHERE L_1 = LENGTH OF EMBANKMENT OVERTOPPED AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, D_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW AREA-WEIGHTED" DEPTH (D_w) CAN BE SET EQUAL AS (TOTAL FLOW AREA / L_1). THIS "WEIGHTED DEPTH" WILL BE ASSUMED AS AN ADEQUATE ESTIMATE FOR H_w IN THE MANNING EQUATION.

CHANNEL SLOPE : $S = 2.5\%$

(ASSUME THAT EMBANKMENT SLOPE IN THE AREA FAR DOWNSTREAM OF RESERVOIR IS ROUGHLY THE SAME AS THAT OF THE MAIN AND SMALL CHANNEL SIDE-WALLS → FIG 1.)

$n_{\text{RIGHT PORTION}} = 0.160$ (SEE 7, p 3-[illegible])

$n_{\text{LEFT PORTION}} = 0.050$ ([illegible])

SHOULD THE ABOVE METHOD PROVIDE DISCHARGES WHICH ARE FOUND TO BE SUPERCRITICAL, THEN CRITICAL FLOW WILL CONTROL, AND DISCHARGES CAN BE ESTIMATED AS

$$Q = 3.087 L H_w^{3/2}$$ (REF 5, p 5-24)

WHERE L = LENGTH OF DAM INUNDATED, IN FT,
H_w = WEIGHTED HEAD ABOVE CREST = D_w (SEE ABOVE).

THE EMBANKMENT RATING TABLE IS PROVIDED ON SHEET 9.

SUBJECT DAM SAFETY INSPECTION

BY 225 DATE [illegible] STEEL DAM

CHKD. BY [illegible] DATE [illegible] PROJ. NO. 79-[illegible]-495

SHEET NO. 9 OF [illegible]

	LEFT SIDE PORTION							RIGHT SIDE PORTION							
ELEV (FT)	L_1 (FT)	L_2 (FT)	D_L (FT)	A_L ① (FT^2)	A_T (FT^2)	D_W ② (FT)	Q_L ③ (CFS)	L_1 (FT)	L_2 (FT)	D_L (FT)	A_L ① (FT^2)	A_T (FT^2)	D_W ② (FT)	Q_R ③ (CFS)	Q_{TOTAL} (CFS)
1006.5	0	–	–	–	–	–	0	0	–	–	–	–	–	0	0
1006.7	0	0	0.2	–	–	–	0	65	0	0.2	7	7	0.1	0	0
1006.9	0	0	0.2	–	–	–	0	105	65	0.2	17	24	0.2	10	10
1007.1	25	0	0.2	3	3	0.1	0	120	105	0.2	23	47	0.4	40	40
1007.5	110	25	0.4	27	30	0.3	60	145	120	0.4	53	100	0.7	120	180
1008.0	120	110	0.5	58	88	0.7	220	155	145	0.5	75	175	1.1	270	490
1009.0	135	120	1.0	128	216	1.6	840	165	155	1.0	160	335	2.0	780	1620
1010.0	155	135	1.0	145	361	2.3	1670	125	165	1.0	170	505	2.9	1510	3180

① $A_L = D_L \left[\frac{L_1 + L_2}{2}\right]$

② $D_W = \frac{A_T}{L_1}$

③ $Q = \frac{1.49}{n} A_T R^{2/3} \sqrt{S}$ OR $Q = 3.087 L_1 D_W^{3/2}$, THE LOWER OF THE TWO VALUES. THE HYDRAULIC RADIUS, R, IS APPROXIMATED AS D_W FOR THE WIDE SHALLOW FLOW AREAS USED HERE.

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-24-80 PROJ. NO. 79-203-495

CHKD. BY [illegible] DATE [illegible] SHEET NO. 10 OF [illegible]

gai CONSULTANTS, I
Engineers • Geologists • Planners
Environmental Specialists

TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$

RESERVOIR ELEVATION (FT)	$Q_{SPILLWAY}$ ① (CFS)	$Q_{EMBANKMENT}$ ② (CFS)	Q_{TOTAL} (CFS)
1002.0	0	–	0
1003.0	320	–	320
1004.0	970	–	970
1005.0	1860	–	1860
1006.0	2950	–	2950
(TOP OF DAM) 1006.5	3590	0	3590
1007.0	4250	30*	4280
1007.5	4900	180	5080
1008.0	5580	490	6070
1009.0	7040	1620	8660
1010.0	8600	3180	11,780

* - LINEARLY INTERPOLATED.
① FROM SHEET 6.
② FROM SHEET 9

OVERTOPPING ANALYSIS

SUBJECT DAM SAFETY INSPECTION
STEEL DAM
BY DJS DATE 7-29-99 PROJ. NO. 79-203-435
CHKD. BY DLA DATE 8-1-99 SHEET NO. A OF C

SUMMARY INPUT/OUTPUT SHEETS

DAM SAFETY INSPECTION
STEEL DAM ***** INFLOW HYDROGRAPH *****
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1
RTIOS= .50 .60 1.00

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

SUB-AREA RUNOFF COMPUTATION

RESERVOIR INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	4.10	0.00	4.10	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	102.00	120.00	130.00	140.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA (INITIAL & CONSTANT RAINFALL LOSS (COE.))

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.99 CP= .50 NTA= 0

RECESSION DATA (BASEFLOW PARAMETERS (COE))

STRTQ=	-1.50	QRCSN=	-.05	RTIOR=	1.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=10.69 AND R=24.60 INTERVALS

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 2.97 HOURS, CP= .50 VOL= .97

6.	21.	41.	70.	101.	134.	169.	206.	245.	284.
322.	355.	384.	408.	427.	442.	452.	455.	449.	434.
417.	400.	384.	369.	354.	340.	327.	314.	301.	289.
277.	267.	256.	246.	236.	227.	218.	209.	201.	193.
185.	177.	170.	164.	157.	151.	145.	139.	134.	128.
123.	118.	113.	109.	105.	100.	96.	93.	89.	85.
82.	79.	76.	73.	70.	67.	64.	62.	59.	57.
55.	52.	50.	48.	46.	45.	43.	41.	39.	38.
36.	35.	34.	32.	31.	30.	28.	27.	26.	25.
24.	23.	22.	21.	21.	20.	19.	18.	17.	17.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
								SUM	26.88	24.46	2.42	3210RS.	

CONSULTANTS
Engineers • Geologists • Environmental Specialists

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 2-30-80 PROJ. NO. 79-203-495

CHKD. BY DLA DATE 2-1-80 SHEET NO. 8 OF C

CONSULTA
Engineers • Geologists •
Environmental Specialists

RESERVOIR INFLOW HYDROGRAPHS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	3537.	2857.	1080.	555.	159894.	
CMS	100.	81.	31.	16.	4528.	
INCHES		6.48	9.80	10.08	10.08	0.50 PM
MM		164.64	248.97	255.96	255.96	
AC-FT		1417.	2142.	2202.	2202.	
THOUS CU M		1747.	2642.	2717.	2717.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	4245.	3428.	1296.	666.	191873.	
CMS	120.	97.	37.	19.	5433.	
INCHES		7.78	11.76	12.09	12.09	0.60 PM
MM		197.57	298.77	307.15	307.15	
AC-FT		1700.	2571.	2643.	2643.	
THOUS CU M		2097.	3171.	3260.	3260.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME	
CFS	7075.	5714.	2160.	1110.	319788.	
CMS	200.	162.	61.	31.	9055.	
INCHES		12.96	19.60	20.15	20.15	PMF
MM		329.28	497.94	511.92	511.92	
AC-FT		2833.	4285.	4405.	4405.	
THOUS CU M		3495.	5285.	5433.	5433.	

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

HYDROGRAPH ROUTING

ROUTE INFLOW HYDROGRAPH THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	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	-1002.	-1

STAGE	1002.00	1003.00	1004.00	1005.00	1006.00	1006.50	1007.00	1007.50	1008
	1010.00								
FLOW	0.00	320.00	970.00	1860.00	2950.00	3590.00	4280.00	5080.00	6070
	11780.00								
SURFACE AREA=	0.	17.	29.	64.					
CAPACITY=	0.	89.	189.	798.					
ELEVATION=	986.	1002.	1007.	1020.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1002.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1006.5	0.0	0.0	0.

SUBJECT DAM SAFETY INSPECTION
STEEL DAM

BY DJS DATE 7-30-80 PROJ. NO. 79-203-495

CHKD. BY DLB DATE 8-1-80 SHEET NO. C OF C

CONSULTA
Engineers • Geologists • Environmental Specialists

RESERVOIR OUTFLOW HYDROGRAPHS

PEAK OUTFLOW IS 3509. AT TIME 42.83 HOURS

0.50 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3509.	2848.	1057.	543.	156359.
CMS	99.	81.	30.	15.	4428.
INCHES		6.46	9.59	9.85	9.85
MM		164.13	243.67	250.30	250.30
AC-FT		1412.	2097.	2154.	2154.
THOUS CU M		1742.	2586.	2657.	2657.

PEAK OUTFLOW IS 4213. AT TIME 42.83 HOURS

0.60 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4213.	3418.	1270.	652.	187811.
CMS	119.	97.	36.	18.	5318.
INCHES		7.76	11.52	11.84	11.84
MM		197.00	292.70	300.65	300.65
AC-FT		1695.	2519.	2587.	2587.
THOUS CU M		2091.	3107.	3191.	3191.

PEAK OUTFLOW IS 7055. AT TIME 42.67 HOURS

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7055.	5700.	2129.	1090.	313812.
CMS	200.	161.	60.	31.	8886.
INCHES		12.93	19.76	19.78	19.78
MM		328.47	489.12	502.35	502.35
AC-FT		2826.	4209.	4322.	4322.
THOUS CU M		3486.	5191.	5332.	5332.

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1002.00	1002.00	1006.50
STORAGE	89.	89.	189.
OUTFLOW	0.	0.	3590.

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	1006.44	0.00	188.	3509.	0.00	42.83	0.00
.60	1006.95	.45	202.	4213.	2.83	42.83	0.00
1.00	1008.38	1.88	247.	7055.	6.50	42.67	0.00

(OVERTOPPING OCCURS @ ≈ 0.51 PMF)

LIST OF REFERENCES

1. "Recommended Guidelines for Safety Inspection of Dams," prepared by Department of the Army, Office of the Chief of Engineers, Washington, D. C. (Appendix D).

2. "Unit Hydrograph Concepts and Calculations," by Corps of Engineers, Baltimore District (L-519).

3. "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Duration of 6, 12, 24, and 48 Hours," Hydrometeorological Report No. 33, prepared by J. T. Riedel, J. F. Appleby and R. W. Schloemer, Hydrologic Service Division Hydrometeorological Section, U. S. Department of the Army, Corps of Engineers, Washington, D. C., April 1956.

4. Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation, Washington, D. C., 1973.

5. Handbook of Hydraulics, H. W. King and E. F. Brater, McGraw-Hill, Inc., New York, 1963.

6. Standard Handbook for Civil Engineers, F. S. Merritt, McGraw-Hill, Inc., New York, 1968.

7. Open-Channel Hydraulics, V. T. Chow, McGraw-Hill, Inc., New York, 1959.

8. Weir Experiments, Coefficients, and Formulas, R. E. Horton, Water Supply and Irrigation Paper No. 200, Department of the Interior, United States Geological Survey, Washington, D. C., 1907.

9. "Probable Maximum Precipitation Susquehanna River Drainage Above Harrisburg, Pennsylvania," Hydrometeorological Report 40, prepared by H. V. Goodyear and J. T. Riedel, Hydrometeorological Branch Office of Hydrology, U. S. Weather Bureau, U. S. Department of Commerce, Washington, D. C., May 1965.

10. Flood Hydrograph Package (HEC-1) Dam Safety Version, Hydrologic Engineering Center, U. S. Army, Corps of Engineers, Davis, California, July 1978.

11. "Simulation of Flow Through Broad Crest Navigation Dams with Radial Gates," R. W. Schmitt, U. S. Army, Corps of Engineers, Pittsburgh District.

12. "Hydraulics of Bridge Waterways," BPR, 1970, Discharge Coefficient Based on Criteria for Embankment Shaped Weirs, Figure 24, page 46.

13. Applied Hydraulics in Engineering, Morris, Henry M. and Wiggert, James N., Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.

14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.

15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C. 1969.

16. Water Resources Engineering, R. K. Linsley and J. B. Franzini, McGraw-Hill, Inc., New York, 1972.

17. Engineering for Dams, Volume 2, W. P. Creager, J. D. Justin, J. Hinds, John Wiley & Sons, Inc., New York, 1964.

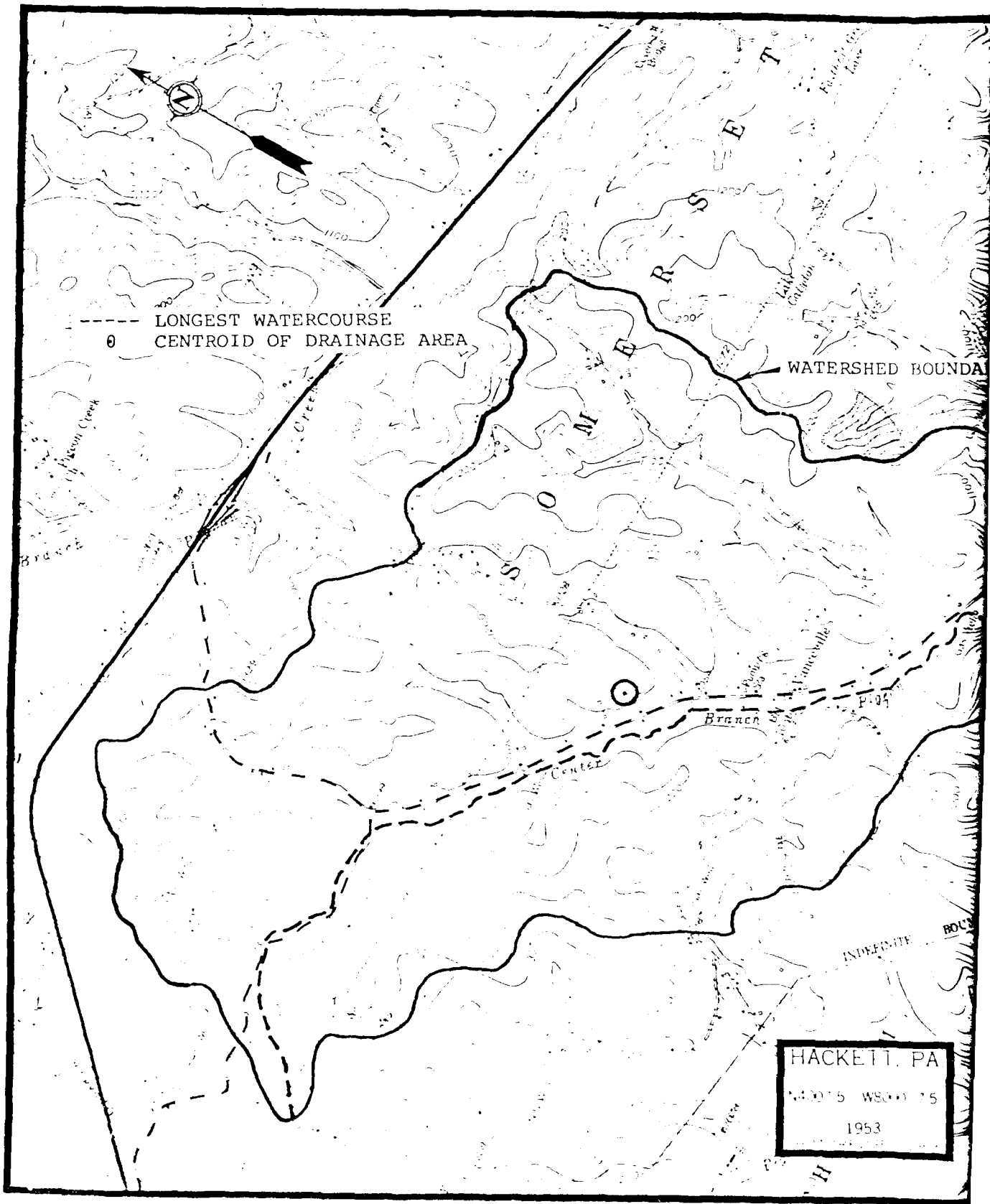
18. Roughness Characteristics of Natural Channels, H. H. Barnes, Jr., Geological Survey Water-Supply Paper 1849, Department of the Interior, United States Geological Survey, Arlington, Virginia, 1967.

19. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, Bureau of Public Roads, Washington, D. C., 1965.

APPENDIX E

FIGURES

LIST OF FIGURES


N
----- LONGEST WATERCOURSE
θ CENTROID OF DRAINAGE AREA
WATERSHED BOUNDA
SOMERSET
HACKETT, PA
1953

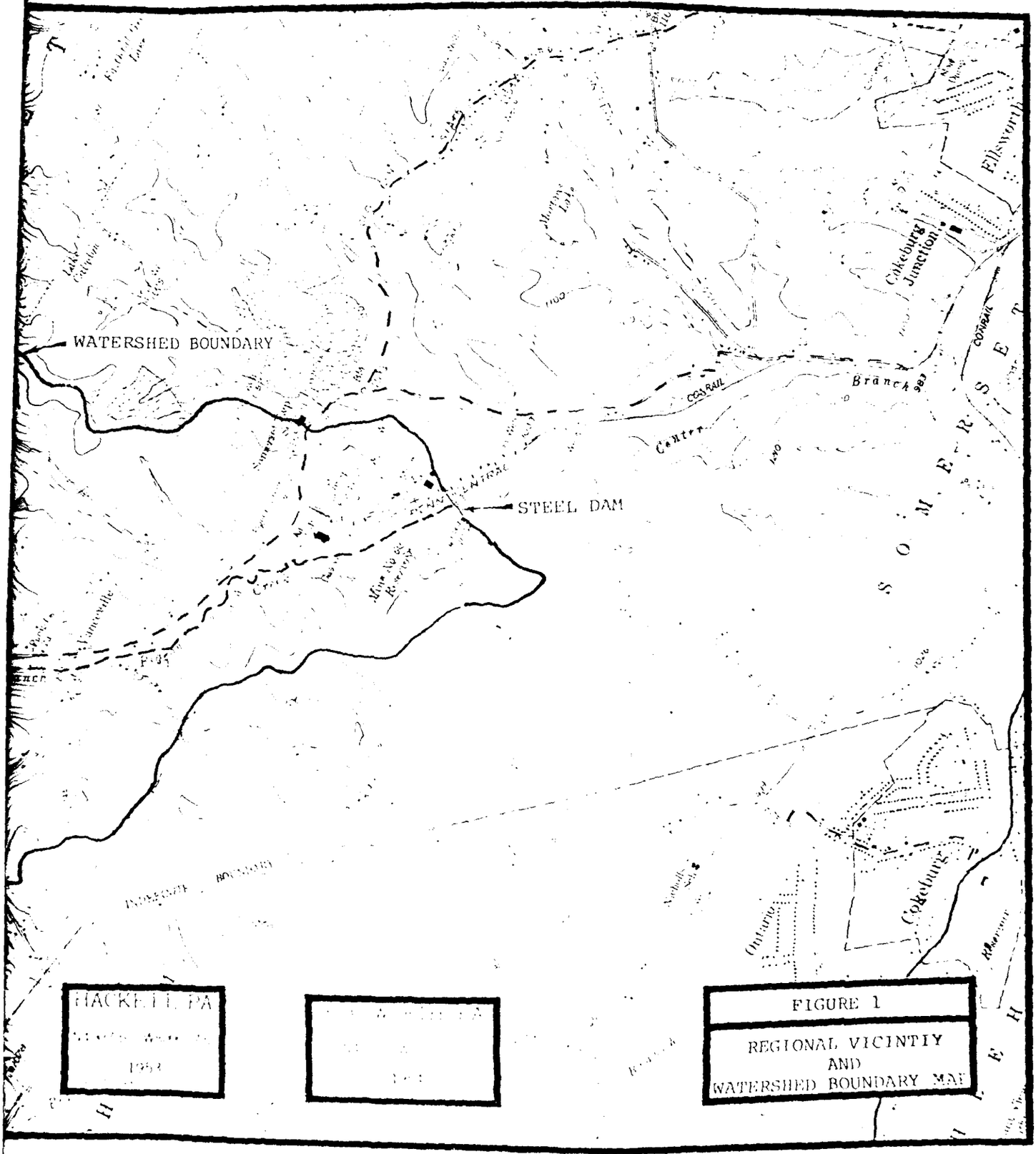
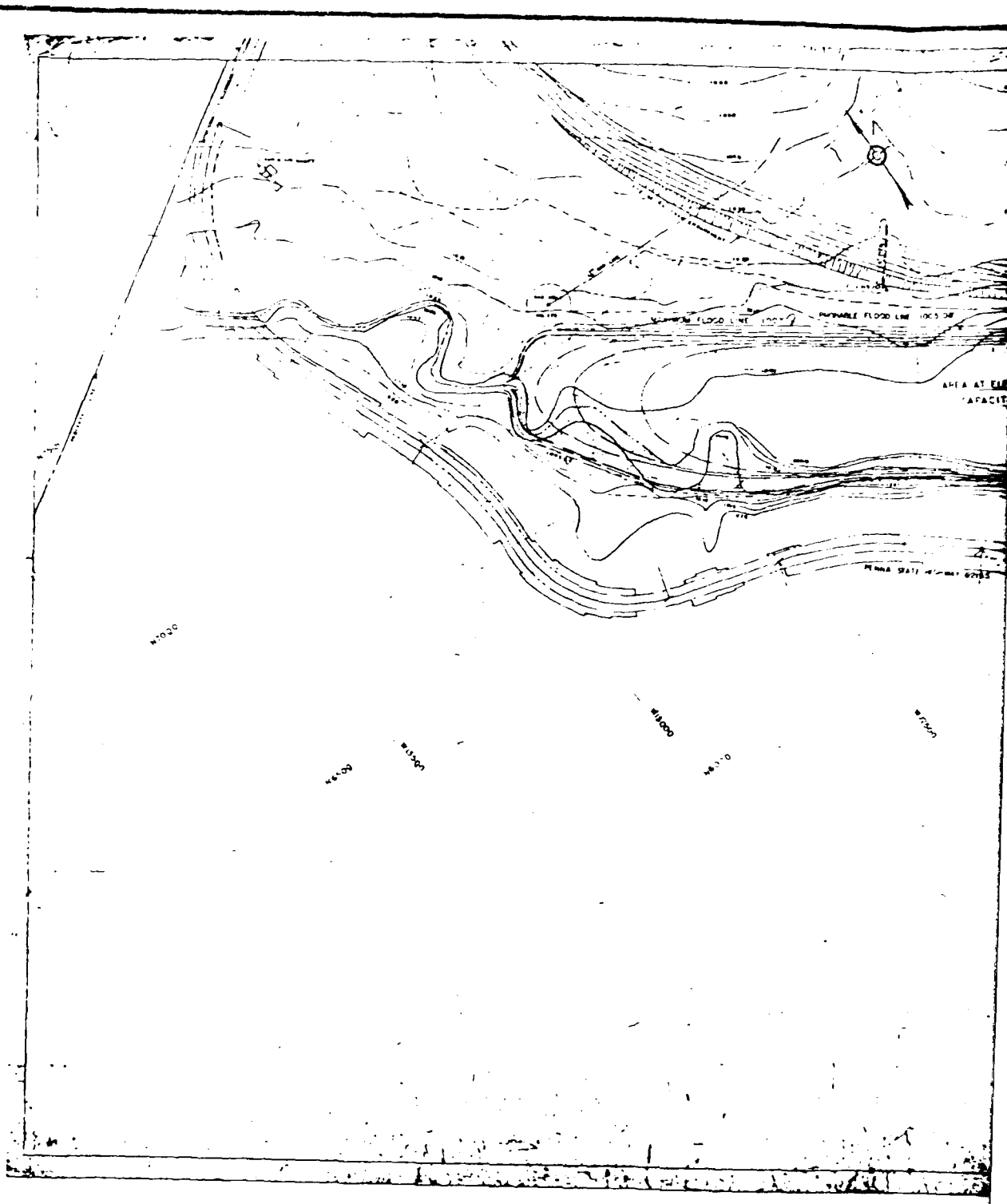
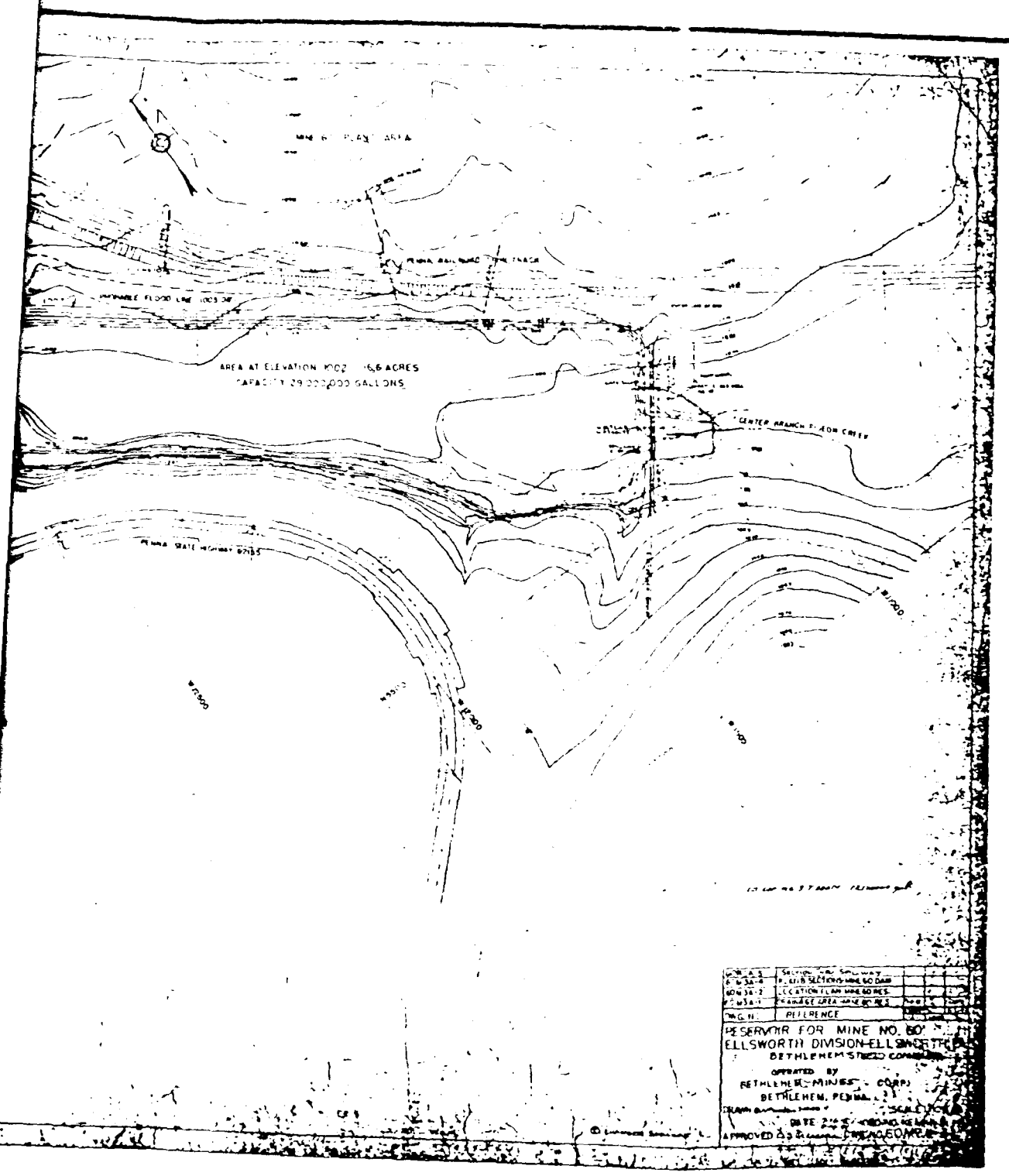


FIGURE 1

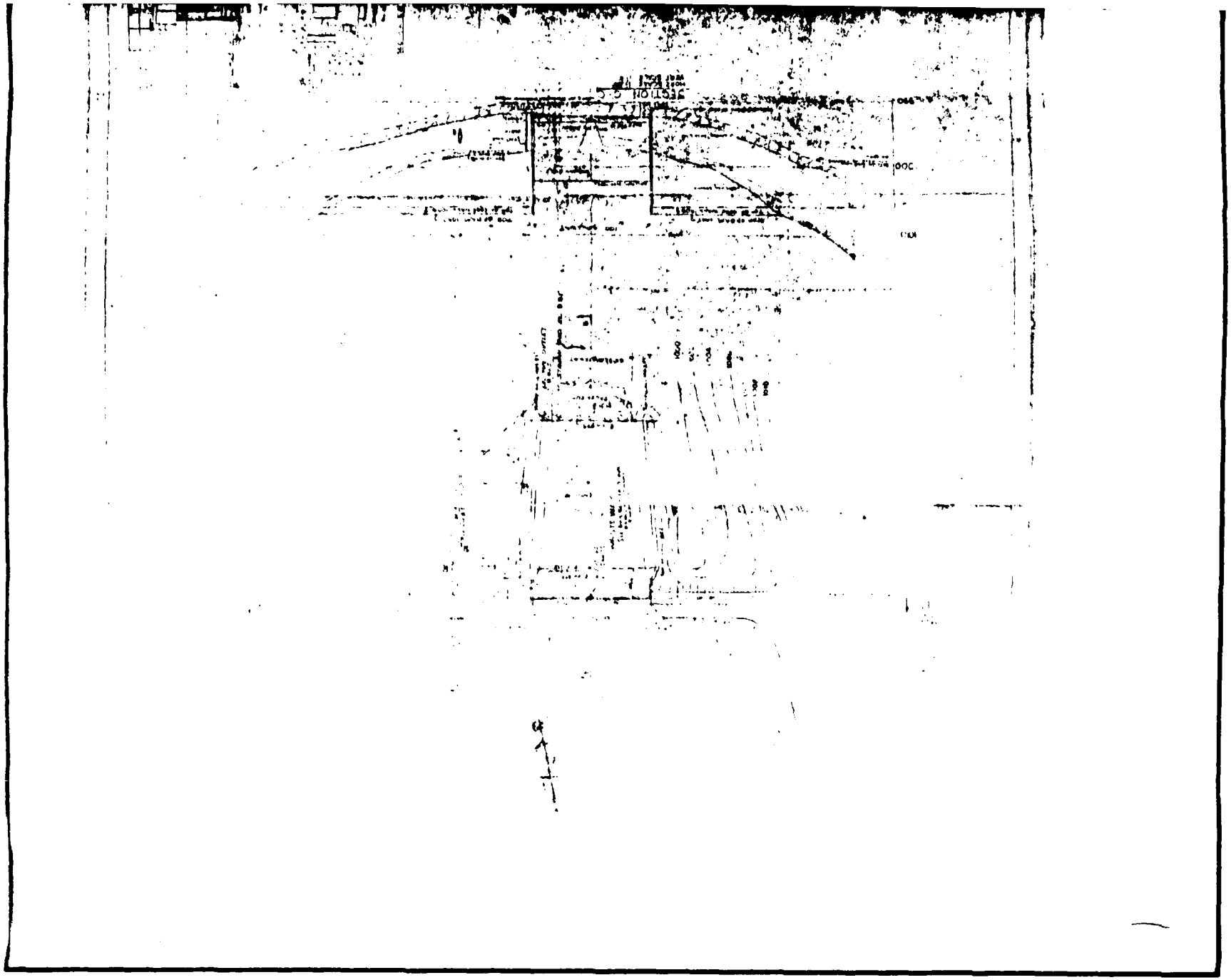
REGIONAL VICINTIY
AND
WATERSHED BOUNDARY MAP

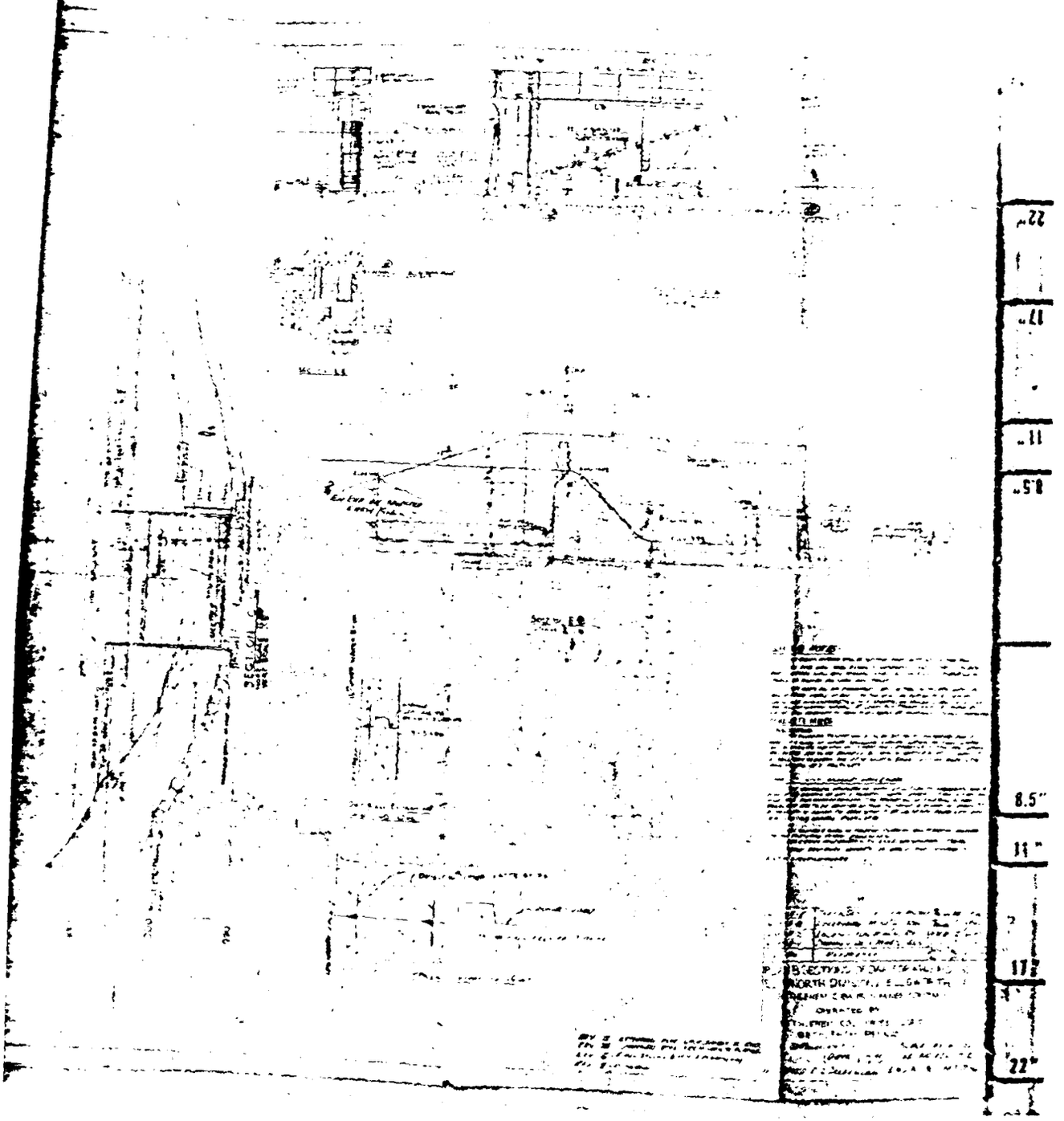




GAI CONSULTANTS, INC.

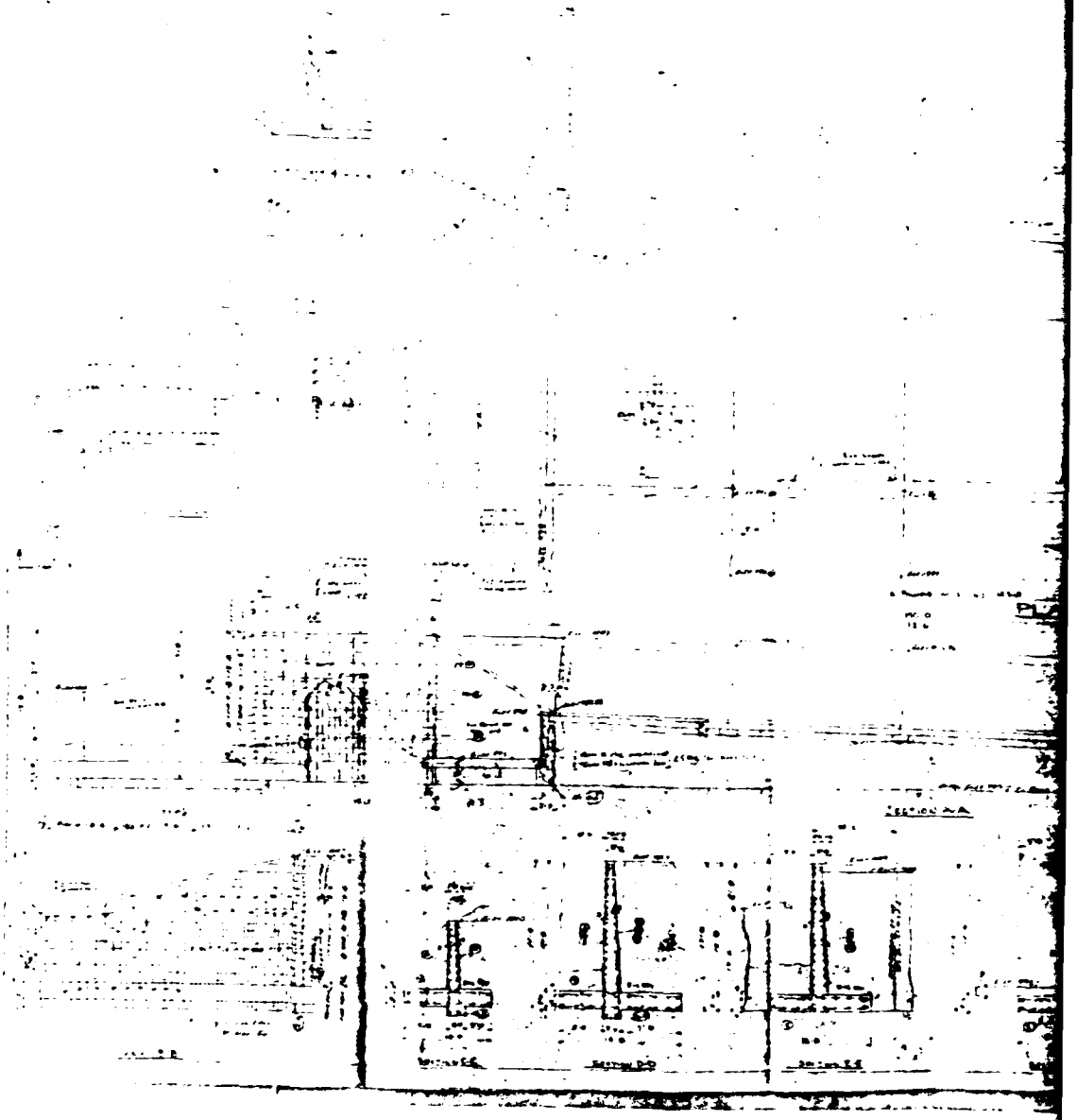
FIGURE 2

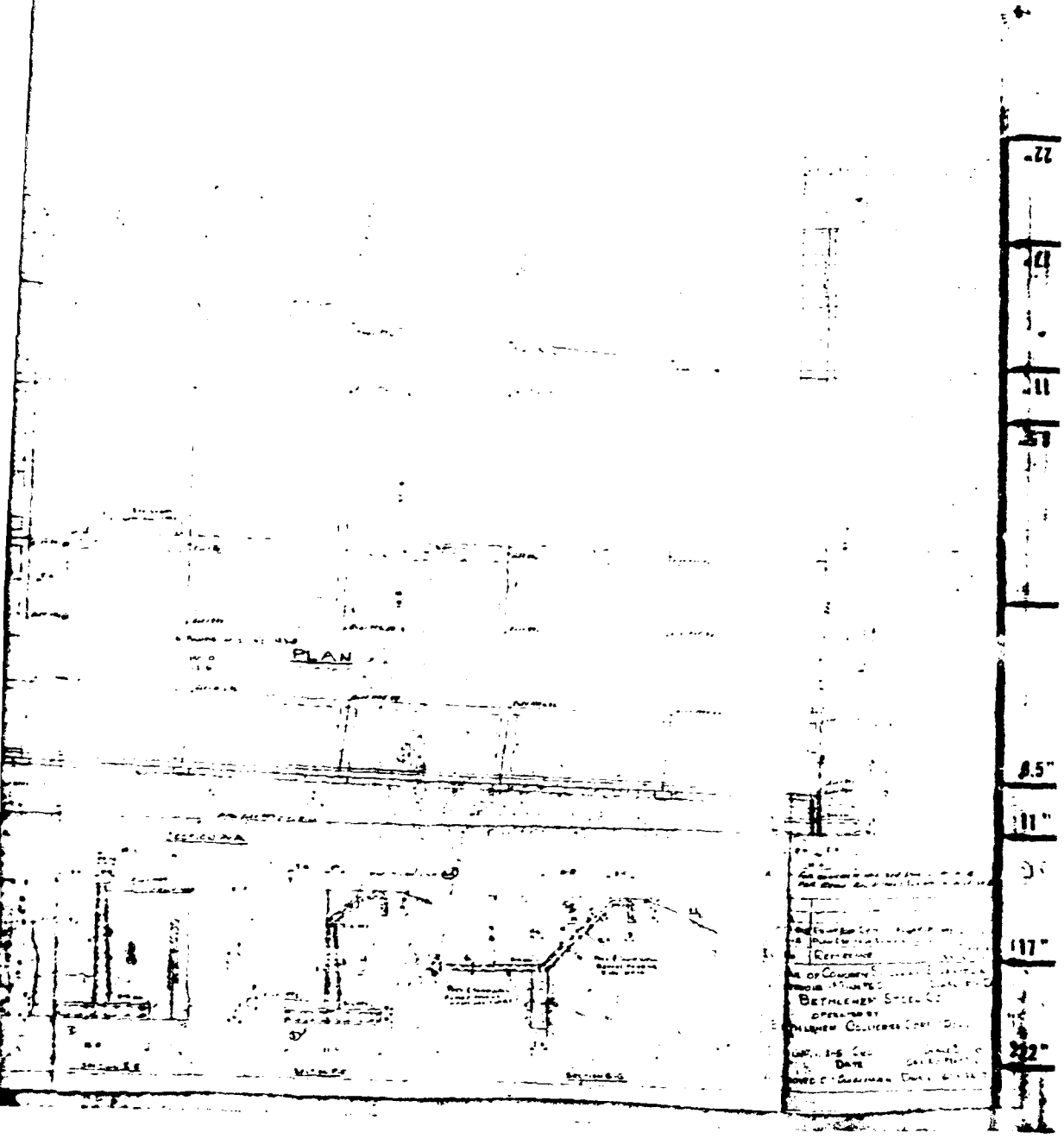




gai CONSULTANTS, INC.

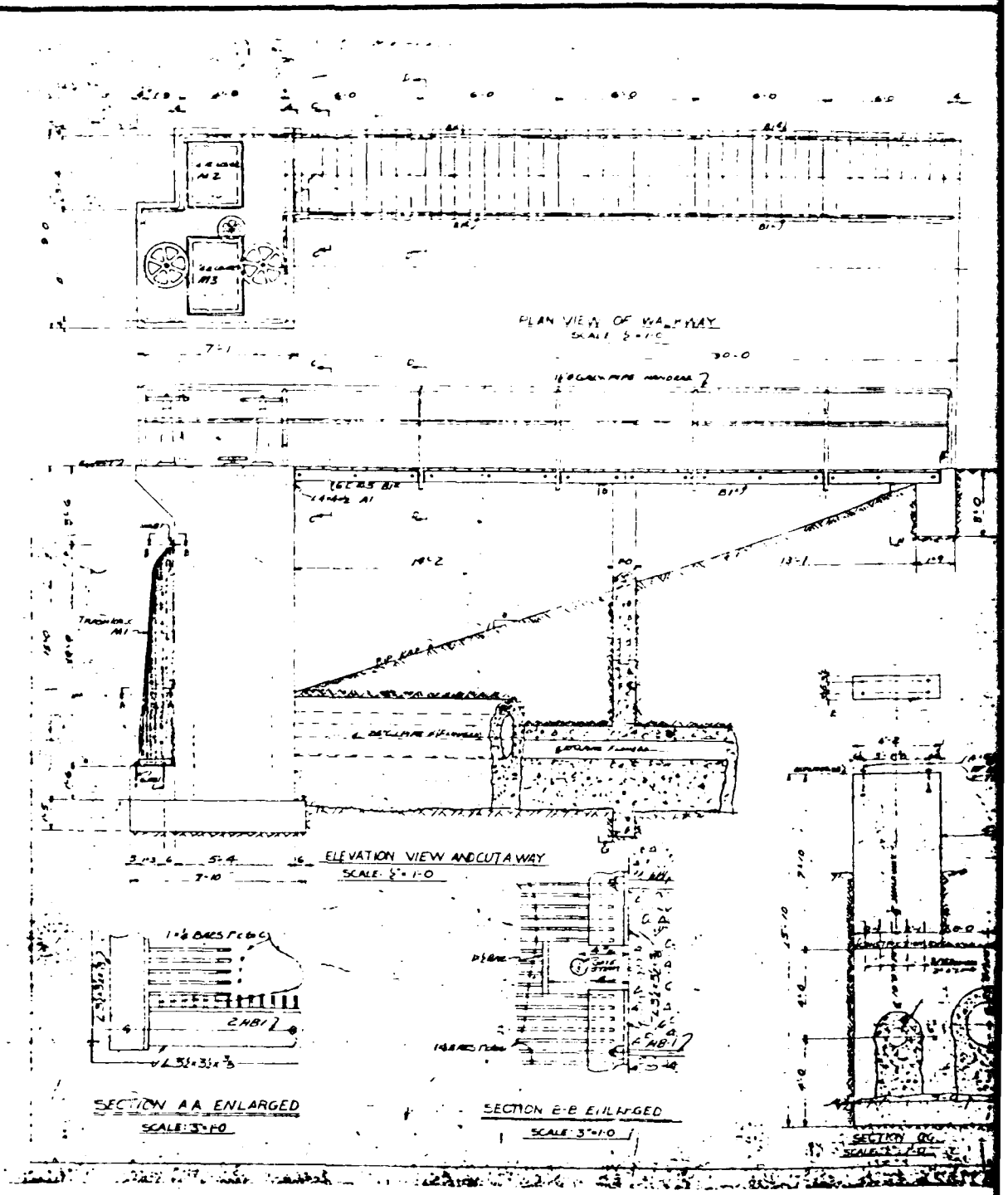
FIGURE 3

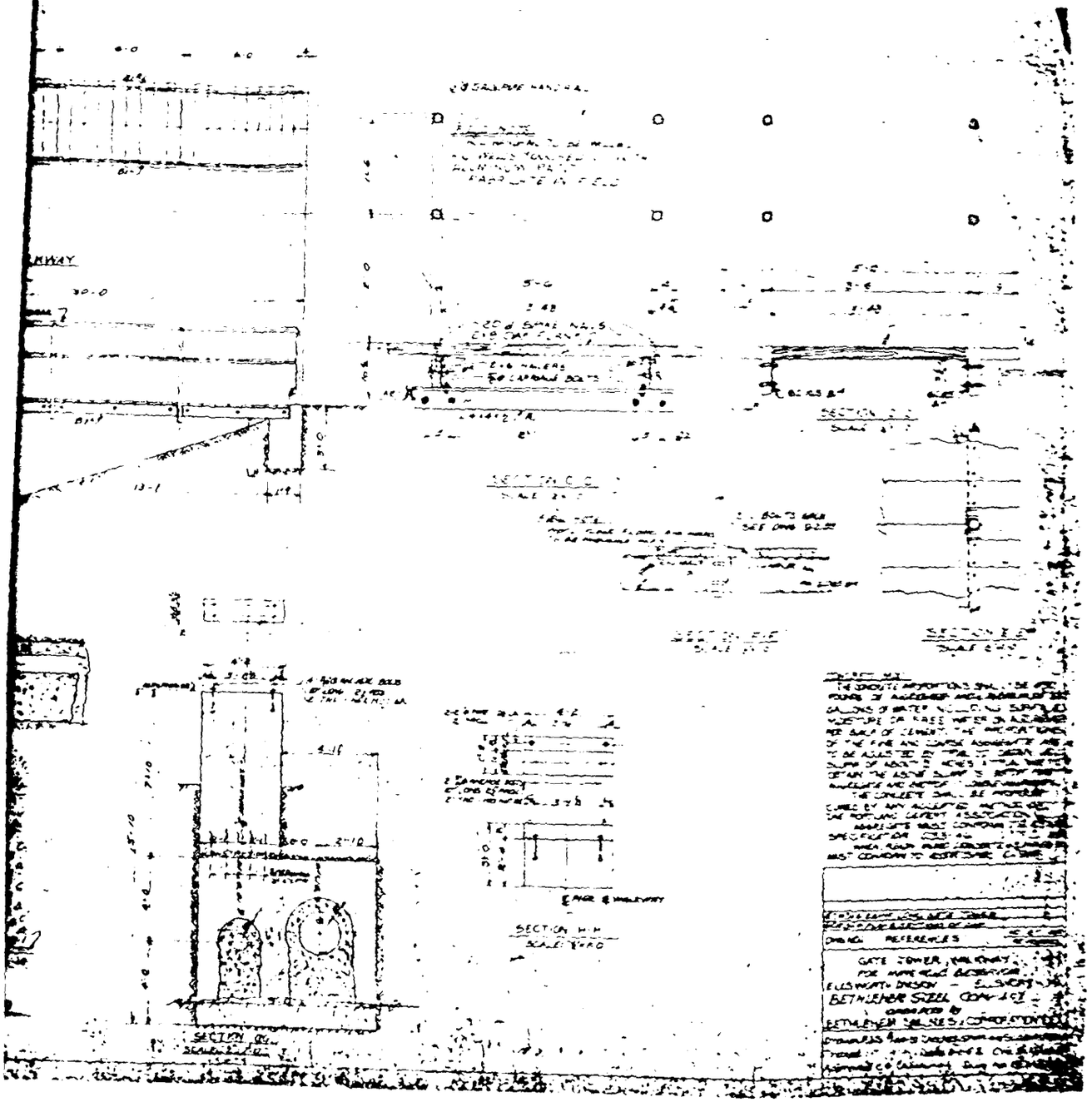




gai CONSULTANTS, INC.

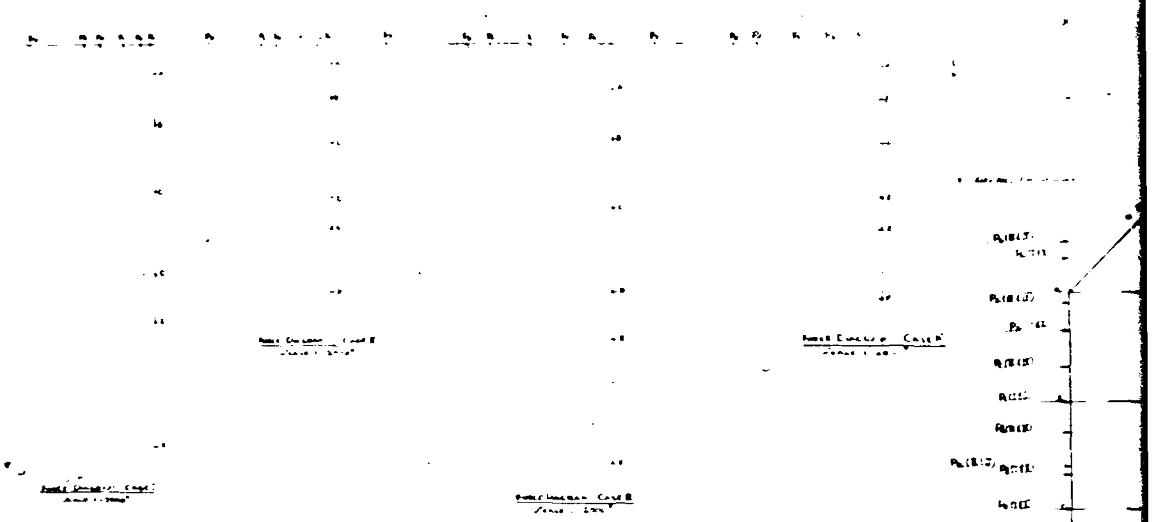
FIGURE 4


PLAN VIEW OF WALKWAY
SCALE 3"=1'-0"
ELEVATION VIEW AND CUTAWAY
SCALE: 3"=1'-0"
SECTION A-A ENLARGED
SCALE: 3"=1'-0"
SECTION B-B ENLARGED
SCALE: 3"=1'-0"
SECTION CC
SCALE: 3"=1'-0"



CONSULTANTS, INC.

FIGURE 5



Sections	Forces … Used in Determining Pressure Lines … Spillway													
	Vertical Forces and Arms										Horiz. Forces and Arms			
	Case I		Case II		Case III		Case IV		Case V		Case I, II, III		Case IV & V	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total P	[illegible]	Total P	[illegible]
A	1063	2.40	735	2.65	1688	1.98	598	2.00	978	2.63	125	0.66	350	.54
A-B	2938	2.88	2031	3.08	3565	2.54	2032	2.65	2813	2.98	500	1.33	1750	1.5
A-B-C	5413	3.45	3676	3.63	6038	3.20	3656	3.27	5288	3.52	1125	2.00	3000	2.64
A-B-C-D	8469	4.07	5678	4.11	9113	3.84	5673	3.92	8363	4.12	2000	[illegible]	4500	3.42
A-B-C-D-E	10250	4.48	6810	4.51	10655	4.18	6555	4.24	10125	4.42	[illegible]	[illegible]	[illegible]	3.80
A-B-C-D-E-F	14825	5.36	9105	5.06	15450	5.20	9570	5.30	14700	5.42	4500	4.00	8250	4.91

Forces in Pounds, Arms in Feet

Case	Summary of Results					
	[illegible]	Total W	Total P	Ecc.	[illegible]	[illegible]
I	6.58	14825	4500	1.045	1560	8300*
II	7.01	9165	4500	0.615	745	5100*
III	7.82	15450	8250	0.195	1090	8650*
IV	9.65	9570	8250	1.83	1055	5250
V	5.41	14700	0	2.41	1662	8220*
Ice	9.16	14700	8120	1.53	1545	8220*

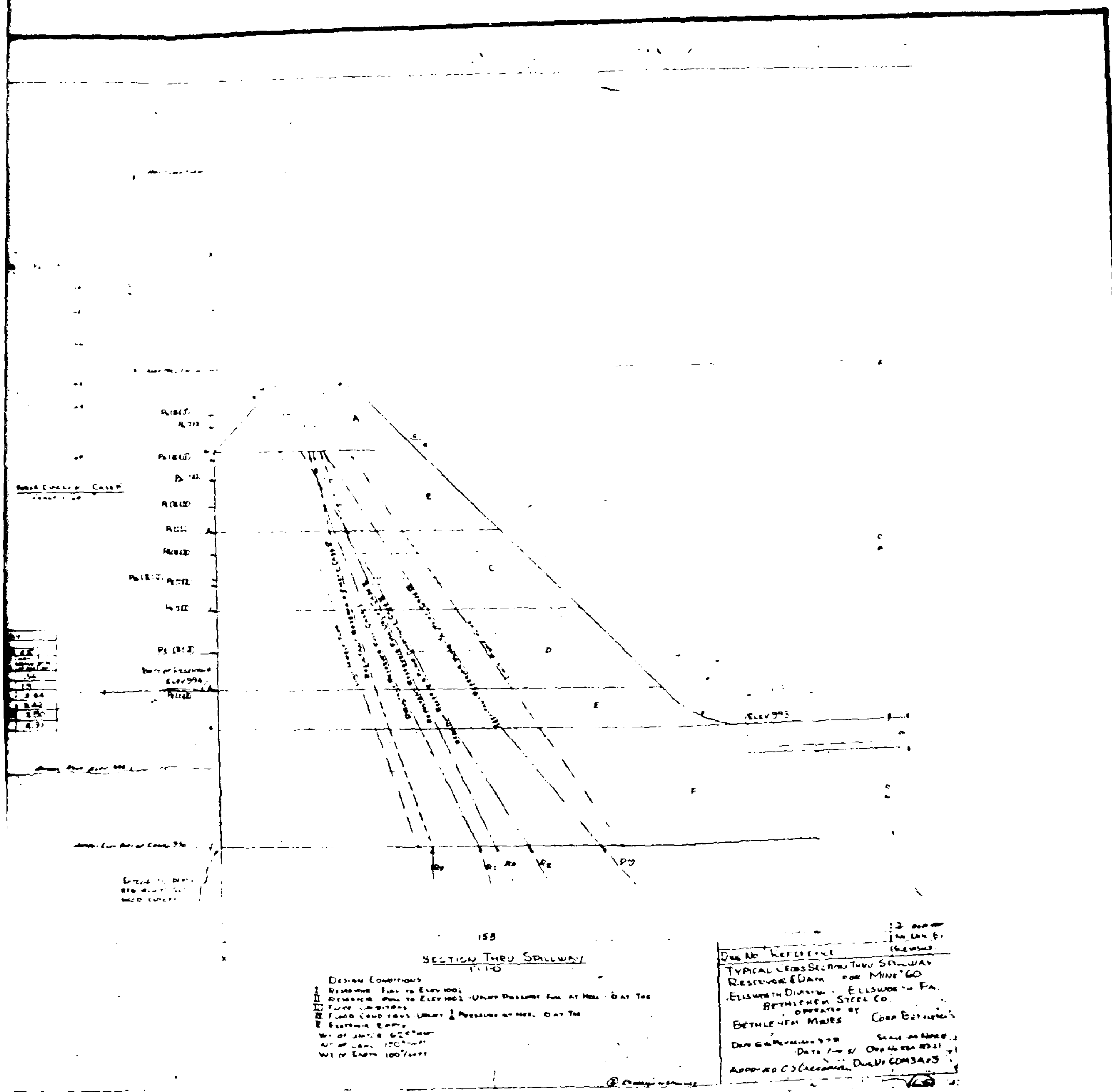
Coef of Friction = .56

For Ice Pressure of 5000# acting 9.5 from bottom

	F	Arm	Mom
Water	9120	× 3.83	= [illegible]
Ice	5000	× 9.5	= 47500
Wt	14700	× 5.42	= 77002

14700) 134900

[illegible] 9.16 ft



CONSULTANTS, INC.

FIGURE 6

APPENDIX F

GEOLOGY

Geology

Steel Dam is located in the Pittsburgh Plateaus section of the Appalachian Plateaus province of southwestern Pennsylvania. In this area, the Pittsburgh Plateaus section is characterized by flat-lying to very gently folded sedimentary rock strata of upper Pennsylvanian age. Major structural axes strike from southwest to northeast with flanking strata gently dipping northwest and southeast.

Structurally, the dam and reservoir lie about one mile east of the axial trace of the southwestward plunging Amity anticline. In the vicinity of the dam and reservoir, the bedrock dips gently to the southeast or downstream at approximately one-half degree.

The sedimentary rock sequence contained in the abutments and underlying the embankment is the lower member of the Uniontown Formation, Monongahela Group, of Pennsylvanian age. The rocks of this group typically exhibit the rapid vertical and lateral lithology changes characteristic of cyclic sedimentation. Rock types to be expected immediately underlying the dam and reservoir are: "limestone; silty mudstone; siltstone; sandstone; mudstone; and locally impure coal (the Uniontown Coal)". The Uniontown Coal horizon lies about 40 feet beneath the dam. Underlying the Uniontown Formation is the Pittsburgh Formaton, the base of which is delineated by the Pittsburgh Coal. The Pittsburgh Coal, therefore, lies approximately 300 feet beneath the dam embankment and about 280 feet below the upstream inlet to the reservoir. According to the Geologic Map of the Hackett Quadrangle, Washington County, Pennsylvania, "the Pittsburgh Coal largely has been removed by mining" around the dam and reservoir and, possibly, beneath same.

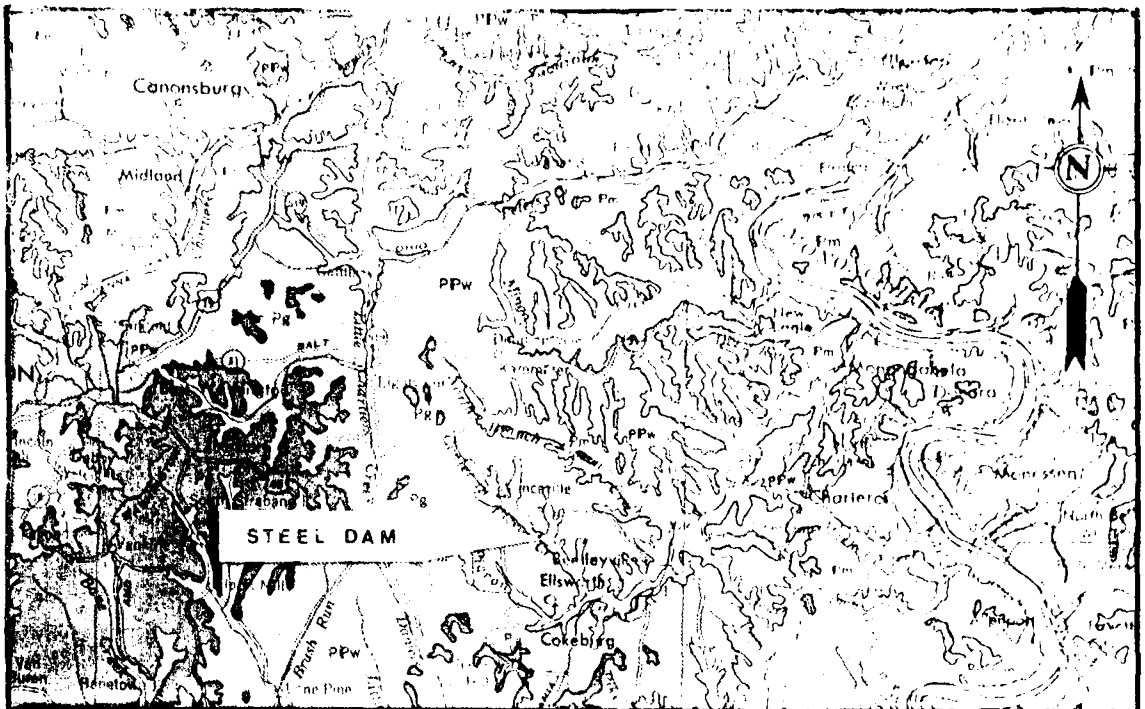
Alluvial materials in the valley consist of "unconsolidated silt, sand, gravel, and cobbles. These have been removed from beneath the core cutoff wall within the dam embankment.

REFERENCES

Clapp, Frederick G., "Geologic Atlas of the United States - Amity Folio," No. 144, U. S. Geological Survey, Washington, D. C., 1907.

Kent, Bion H., "Geologic Map of the Hackett Quadrangle, Washington County, Pennsylvania," Map No. GQ-630, U. S. Geologic Survey in cooperation with the Commonwealth of Pennsylvania, 1967.

Wallace, Joseph J., et al., "Estimate of Known Recoverable Reserves of Coking Coal in Washington County, Pennsylvania," Bureau of Mines Report of Investigations 5109, U. S. Department of the Interior, Washington, D. C., 1955.



LEGEND

PERMIAN

Pg — Greene Formation

[illegible]

PERMIAN AND PENNSYLVANIAN

PPw — Washington Formation

[illegible]

PENNSYLVANIAN

APPALACHIAN PLATEAU

Pm — Monongahela Formation

Cyclic sequences of sandstone, shale, [illegible] stone and coal; limestone prominent in northern outcrop areas; shale and [illegible] stone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal

P — Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section

Scale

0 2 4 6 8 10 MILES

GEOLOGY MAP

GAI CONSULTANTS, INC.


DATE
FILME
2-8