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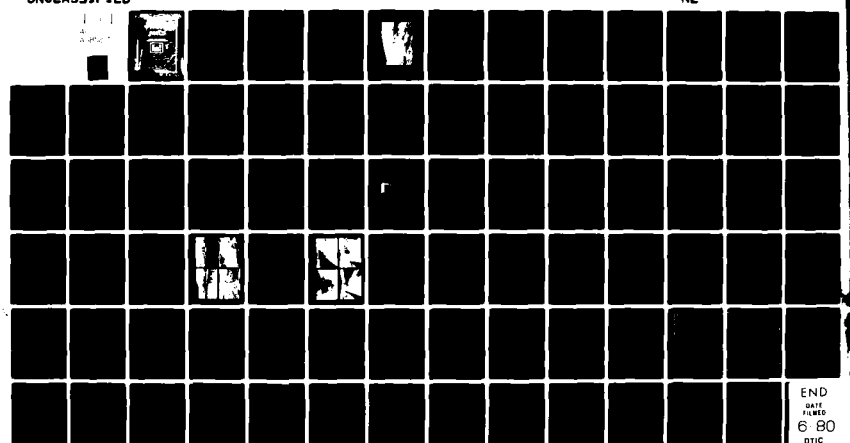

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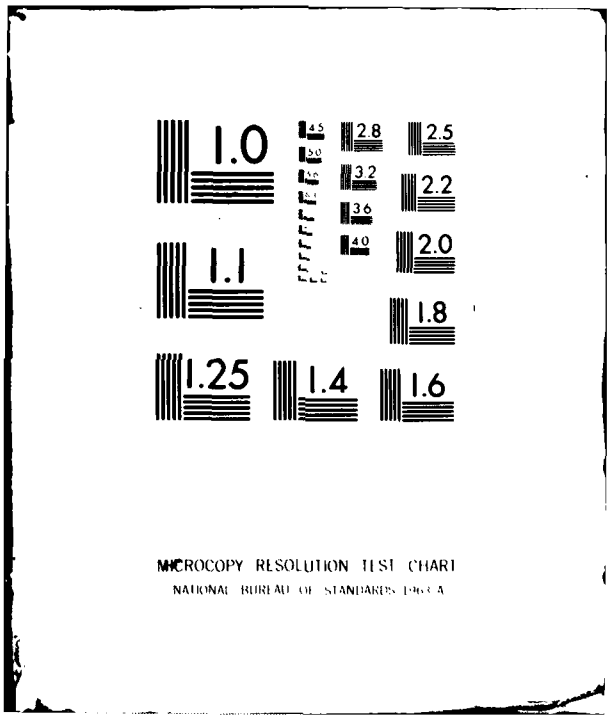
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PREFACE

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 topograhic 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 reasonably 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

Findley Run Dam: NDI I.D. No. PA-00286

Owner:	Nineveh Water Company, subsidiary of the Pennsylvania Electric Company
State Located:	Pennsylvania (PennDER I.D. No. 32-43)
County Located:	Indiana
Stream:	Findley Run
Inspection Date:	4 and 21 February 1980
Inspection Team:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on a visual inspection, operational history, and available engineering data, the dam is considered to be 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 relatively small storage capacity and the unusually stable embankment configuration the SDF for the facility is considered to be the 1/2-PMF. Results of the hydrologic and hydraulic analysis indicate the facility is capable of passing and/or storing a flood of 1/2-PMF magnitude. Consequently, the spillway is considered adequate.

It is recommended that the owner:

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. Observe the cracking in the spillway overflow wall and outlet conduit headwall in future inspections and take remedial measures if necessary.

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cont.

c. 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
REGISTERED PROFESSIONAL ENGINEER
BERNARD M. MIHALCIN
20371-E

Date 25 March 1980

Date 3 May 1980

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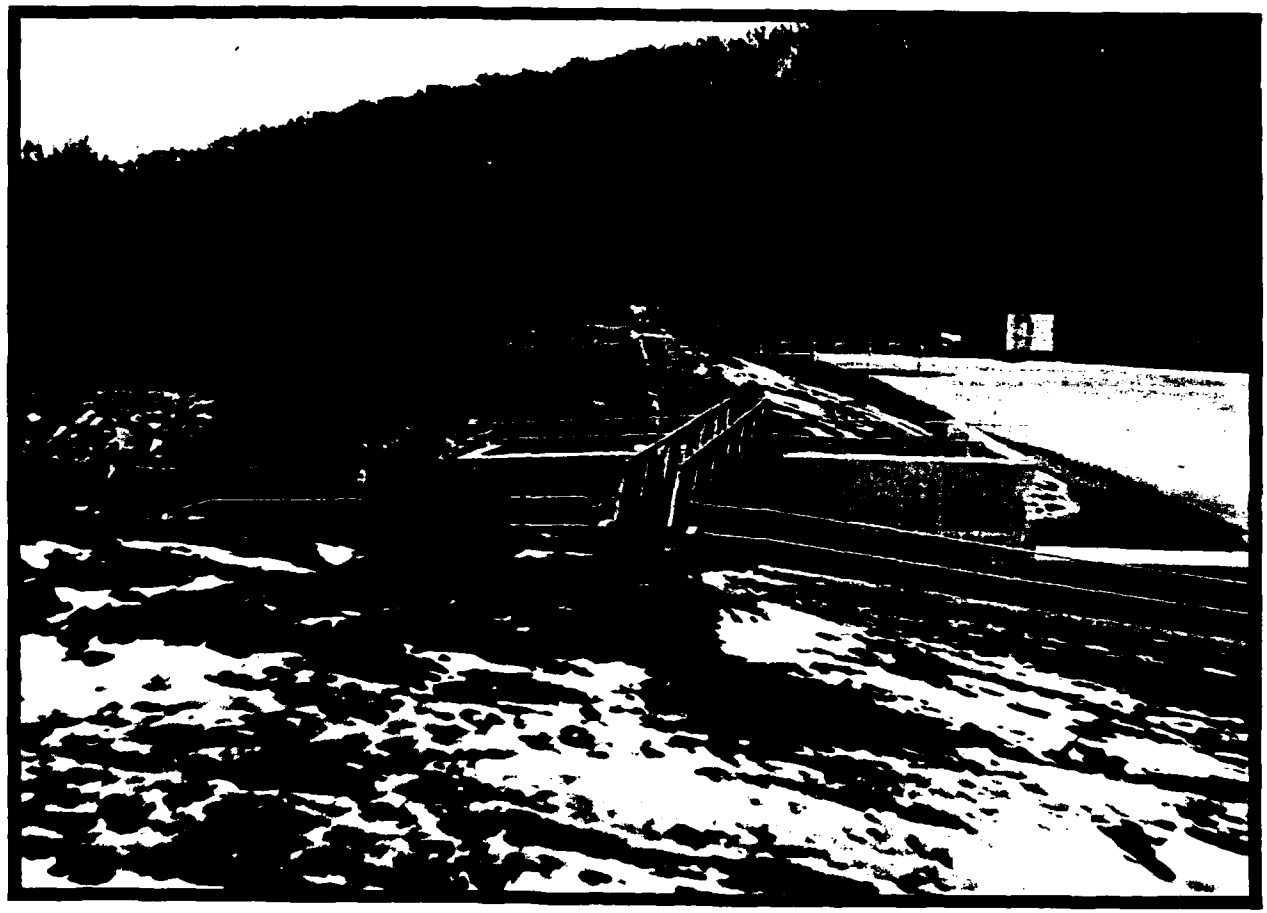

OVERVIEW PHOTOGRAPH

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
FINDLEY RUN DAM
NDI# PA-00286, PENNDER #32-43

SECTION 1
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. Findley Run Dam is a 31-foot high earth embankment approximately 380 feet long, including spillway. The facility is constructed with a 2-stage, reinforced concrete spillway, accommodating both direct and side channel flow located at the left abutment. The service weir is set at elevation 1507.3 feet and has a crest length of 20 feet. The emergency weir is set at elevation 1507.8 feet with a total crest length of 155 feet. Drawdown capacity is provided by a 4- by 6-foot concrete box culvert located about 150 feet from the right abutment. Flow through the culvert is controlled by a sluice gate located at its inlet end and manually operated from the deck of a footbridge that provides access to the mechanism from the embankment crest.

b. Location. Findley Run Dam is located on Findley Run in East Wheatfield Township, Indiana County, Pennsylvania. The site is located about 1.2 miles east of the community of Cramer, Pennsylvania, just off Pennsylvania Route 403. The dam, reservoir and watershed are contained within the Vintondale, Pennsylvania 7.5 minute U.S.G.S. topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N40° 25.3' and W78° 58.4'.

c. Size Classification. Small (31 feet high, 86 acre-feet storage capacity at top of dam).

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

e. Ownership. Nineveh Water Company
subsidiary of
Pennsylvania Electric Company
1001 Broad Street
Johnstown, Pennsylvania 15907

f. Purpose. Domestic and industrial water supply.

g. Historical Data. Findley Run Dam was constructed in 1925-1926 by the Findley Run Water Supply Company of Johnstown, Pennsylvania. The purpose of the facility was to supply domestic water to the mining villages of Cramer and Charles and industrial water to nearby mines in East Wheatfield Township. By 1929, the growing local power industry acquired the dam to supply water to its generating station at Seward. The facility is now owned by the Nineveh Water Company, a wholly owned subsidiary of the Pennsylvania Electric Company (Penelec).

Available state inspection reports contained in PennDER files reveals the facility has been adequately maintained and generally in good condition throughout its history. Minor seepage at various points across the downstream toe was consistently reported; however, no significant deficiencies were recorded.

In July 1977, the dam was overtopped by floodwaters resulting from torrential overnight rains. The watershed experienced intense rainfall reported to be approximately 11 inches in slightly more than 6 hours. The downstream embankment slope was extensively scoured; however, the dam did not fail (see Figure 2). Repairs to the facility were initiated immediately. Included were repairs to the downstream embankment slope (see Figure 3) and the design and construction of a new spillway (see Figures 4, 5 and 6). D'Appolonia Consulting Engineers, Inc., of Pittsburgh, Pennsylvania, served as project consultants for the remedial spillway work which was eventually completed in December 1979.

1.3 Pertinent Data

a. Drainage Area (square miles). 4.4

b. Discharge at Dam Site.

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

Discharge Capacity of Spillway at Maximum Pool = 11,050 cfs (see Appendix D, Sheet 7).

c. Elevation (feet above mean sea level). The following elevations were obtained from available drawings and through field measurements based on the elevation of the top of the right spillway wingwall at 1516.5 feet (see Appendix D, Sheet 1).

Top of Dam	1515.0 (design). 1515.2 (field).
Maximum Pool of Record	1516.0 (estimate July 1977).
Normal Pool	1507.3
Service Spillway Crest	1507.3
Emergency Spillway Crest	1507.8
Upstream Inlet Invert	1486.0
Downstream Outlet Invert	1484.0 (field).
Streambed at Dam Centerline	1485.0
Maximum Tailwater	Not Known.

d. Reservoir Length (feet).

Top of Dam	1600
Normal Pool	1000

e. Storage (acre-feet).

Top of Dam	86
Normal Pool	45

f. Reservoir Surface (acres).

Top of Dam	9
Normal Pool	4

g. Dam.

Type	Homogeneous earth.
Length	340 feet (excluding spillway).
Height	31 feet (field measured; downstream outlet invert to embankment crest).
Top Width	22 feet at minimum section, 200 feet at

	maximum section (see General Plan - Field Inspection Notes, Appendix A).
Upstream Slope	3H:1V.
Downstream Slope	2.5H:1V (at minimum section).
Zoning	Original embankment constructed of homogeneous fill. Repairs made to damaged portions of downstream slope in 1977 included placement of sand drains as shown on Figure 3.
Impervious Core	None indicated.
Cutoff	Clay puddle cutoff trench reportedly beneath centerline of embankment. Dimensions of trench unknown.
Grout Curtain	None indicated.
h. Diversion Canal and Regulating Tunnels.	None.
i. Spillway.	
Type	Uncontrolled, 2-stage reinforced concrete spillway, accommodating both direct and side channel flow.
Service Crest Elevation	1507.3 feet.
Emergency Crest Elevation	1507.8 feet.
Service Crest Length	20 feet.
Emergency Crest Length	155 feet.

j. Outlet Conduit.

Type	4- by 6-foot concrete box culvert located about 150 feet left of the right abutment.
Length	145 feet.
Closure and Regulating Facilities	Flow through the culvert is controlled via manually operated sluice gate.
Access	Control mechanism is accessible via footbridge from the embankment crest.

i. Supply Lines.

Type	Two 12-inch diameter cast iron pipes embedded in concrete beneath outlet conduit.
Closure and Regulating Facilities	Inlet controls in gate house near right abutment.
Access	Gate house accessible by foot from right abutment.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No formal design reports or calculations are available for any aspect of the original facility. Design drawings and miscellaneous design data are contained in PennDER files.

Design information pertaining to the reconstructed facility is available from both the owner and the PennDER. No formal design reports were obtained for review by the inspection team; however, available design information included hydrology data, spillway design calculations, design drawings and contract specifications.

b. Design Features.

1. Embankment. Available data indicate that the original embankment was constructed as a homogeneous earth structure. The embankment material was reported spread in layers not over 6 inches thick, sprinkled and rolled. A clay puddle cutoff trench was reportedly placed along the centerline.

After the damaging flood of 1977, the owner reconstructed the embankment essentially to its original configuration, but, with internal modifications. Figure 3 shows the inclusion of sand drains into the downstream embankment section. Subsequently, excess material (primarily hard sandstone) excavated to accommodate the new spillway was placed along the downstream embankment toe to both sides of the outlet conduit. The upstream embankment face is sloped at 3H:1V and is covered with a 3-foot thick layer of rock riprap. The riprap has been covered, to the left of the footbridge, by a thin layer of earth material that was mistakenly placed by the reconstruction contractor. The crest varies in width from 22 feet (above the outlet conduit) to approximately 200 feet (near spillway) where excess materials were placed. As a consequence, the downstream slope varies widely but, measures roughly 2.5H:1v at the minimum embankment section located at the outlet. The present configuration of the embankment is roughly depicted on the field sketch (General Plan-Field Inspection Notes) contained in Appendix A.

2. Appurtenant Structures.

a) Spillway. The recently renovated spillway

is an uncontrolled, 2-stage, reinforced concrete structure that accommodates a combination of direct and side channel flow. A sharp-crested, L-shaped overflow weir affords a combined crest length of 175 feet (see Figures 4 and 6). A 20-foot long section on the short leg of the L-shape is set at elevation 1507.3 feet and comprises the service overflow. The elevation of the remainder of the L-shape comprising the emergency overflow is 1507.8 feet. The emergency spillway weir is 8.7 feet below the top of the spillway channel wingwalls.

b) Outlet Conduit. The outlet conduit consists of a 4- by 6-foot concrete box culvert located about 150 feet left of the right abutment. Flow through the culvert is manually regulated by a slide gate at its inlet end. The culvert is vented at several locations (see Photograph 3).

c. Specific Design Data and Criteria.

1. Hydrology and Hydraulics. Calculations pertaining to the design of the present spillway facility, by D'Appolonia Engineers, are contained in PennDER files. The design flood hydrograph was computed by use of the U.S. Army Corps of Engineers, HEC-1 Computer Program. Included as input to the program were Snyder unit hydrograph coefficients derived from an HEC-1 runoff hydrograph, which was developed using SCS dimensionless unitgraph and runoff criteria. The peak PMF reservoir inflow computed by this method was about 20,000 cfs. As the selected project design flood ranged from the 100-year frequency to the 1/2-PMF, the spillway was designed to pass discharges in excess of the 1/2-PMF.

2. Embankment. The embankment was reconstructed with the intent of restoring it to essentially its original configuration. Excavation for the new spillway yielded excess materials (primarily rock) which were conveniently placed along the downstream embankment slope, thus, altering its cross section. No formal design data are available.

3. Appurtenant Structures. A complete set of spillway design calculations is contained in PennDER files.

No information is available pertaining to the design of the outlet conduit.

2.2 Construction Records.

Design drawings, contract specifications, several construction photographs and construction progress reports are contained in PennDER files.

2.3 Operational Records.

Reservoir levels at Findley Run Dam are recorded daily and are available from the owner. No other records are maintained.

2.4 Other Investigations.

In addition to the information compiled by D'Appolonia Consulting Engineers, Inc., relative to the reconstruction of the facility, several brief state inspection reports are contained in PennDER files.

2.5 Evaluation.

The data available are considered adequate 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 indicates it to be in good condition.

b. Embankment. Observations made during the visual inspection indicate the embankment is in good condition. No evidence of sloughing, seepage, excessive settlement, animal burrows, or signs of maintenance neglect were observed (see Photograph 1). A portion of the riprapped upstream slope has been inadvertently covered with soil during recent remedial work. This condition is not considered significant.

c. Appurtenant Structures.

1. Spillway. The visual inspection revealed the spillway is in good condition. Minor shrinkage cracks and slight leakage at a construction joint were observed in the channel sidewalls but are not considered significant at present (see Photographs 1, 5, 6 and 7).

2. Outlet Conduit. The outlet conduit was observed by the inspection team to be in good condition. Slight leakage through the joints within the conduit was observed. The headwall at the discharge end has deteriorated and is in need of repair (see Photograph 4).

d. Reservoir Area. The general area surrounding the reservoir is composed of steep, heavily forested slopes. No signs of slope distress were observed.

e. Downstream Channel. From the dam, Findley Run flows in an easterly direction through a steep, narrow, wooded valley toward the village of Cramer, Pennsylvania located less than 2 miles downstream. Near Cramer, 4 homes are located sufficiently close to the stream to sustain damage in the event of a complete embankment failure. It is estimated that as many as 12 to 16 persons could be affected within this reach by such an event. Consequently, the hazard classification is considered to be high.

3.2 Evaluation.

The overall condition of the facility is considered good. Deficiencies noted by the inspection team include

general deterioration of the outlet headwall and cracking in the spillway overflow wall. These conditions are not considered significant at this time, but, should be specifically observed and assessed in future inspections.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The facility is essentially self-regulating. Excess inflow discharges over the spillway and is directed downstream. Under normal operating conditions the outlet conduit is closed. The supply lines are regulated daily from the intake structure located along the right shore just upstream of the embankment. All outlet control mechanisms are reportedly functional; however, none were operated in the presence of the inspection team. No formal operations manual is available.

4.2 Maintenance of Dam.

The facility is maintained on an unscheduled basis; however, the facility is visited and observed daily. No formal maintenance program outlining specific maintenance procedures is available.

4.3 Maintenance of Operating Facilities.

See Section 4.2 above.

4.4 Warning System.

No formal warning system is in effect; however, the owner's engineering staff is reportedly developing a system at present.

4.5 Evaluation.

No formal operations or maintenance manuals are available, but, are recommended to ensure the continued proper care and maintenance of the facility No formal warning system is in effect, but, reportedly is being developed by the owners' engineering staff.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

Calculations pertaining to the design of the present spillway facility, by D'Appolonia Engineers, are contained in PennDER files. The design flood hydrograph was computed by use of the U.S. Army, Corps of Engineers, HEC-1 Computer Program. Included as input to the program were Snyder unit hydrograph coefficients derived from an HEC-1 runoff hydrograph, which was developed using SCS dimensionless unitgraph and runoff criteria. The peak PMF reservoir inflow computed by this method was about 20,000 cfs. As the selected project design flood ranged from the 100-year frequency to the 1/2-PMF, the spillway was designed to pass discharges in excess of the 1/2-PMF.

5.2 Experience Data.

In July 1977, Findley Run Dam experienced intense rainfall reported to be approximately 11 inches in slightly more than 6 hours. The dam was overtopped by an estimated 1-foot of water. The downstream slope was extensively scoured; however, the dam did not fail. Embankment repairs were initiated immediately and a new spillway subsequently constructed to accommodate large floods not unusual to this region.

5.3 Visual Observations.

On the date of inspection, no conditions were observed that would indicate the spillway could not perform satisfactorily during a flood event, within the limits of its design capacity.

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 Findley Run Dam ranges between the 1/2-PMF (Probable Maximum Flood) 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 the relatively small storage capacity and the unusually stable embankment configuration, the SDF for this facility is considered to be the 1/2-PMF.

b. Results of Analysis. Findley Run Dam was evaluated under near normal operating conditions. That is, the reservoir was initially at its normal pool or service spillway elevation of 1507.3 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 two-stage front and side channel concrete sharp-crested weir structure which discharges into a rectangular concrete channel. All pertinent engineering calculations relative to the evaluation of this facility are provided in Appendix D.

The overtopping analysis was made using the Modified HEC-1 Computer Program. The reservoir inflow hydrograph was developed using the Snyder unit hydrograph coefficients provided in the D'Appolonia design calculations. The values of these coefficients were derived from a PMP runoff hydrograph which was developed using SCS dimensionless hydrograph and runoff criteria. The analysis indicated that the discharge/storage capacity of Findley Run Dam can accommodate storms in excess of the 1/2-PMF (the SDF), or about 55 percent of the PMF, prior to embankment overtopping (Appendix D, Summary Input/Output Sheets, Sheet C). The peak 1/2-PMF inflow of approximately 10,120 cfs was slightly attenuated by the discharge/storage capabilities of the dam, as the resulting 1/2-PMF peak outflow was about 10,040 cfs (Summary Input/Output Sheets, Sheets B and C). The maximum water surface level in the reservoir under 1/2-PMF conditions was about 1514.7, or 0.5 feet below the low top of dam elevation of 1515.2 (Summary Input/Output Sheets, Sheet C).

5.6 Spillway Adequacy.

Since the spillway at Findley Run Dam is capable of discharging the inflow resulting from a storm in excess of 1/2-PMF magnitude, the spillway is considered adequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations the embankment is in good condition exhibiting no evidence of instability.

b. Appurtenant Structures.

1. Spillway. The spillway is considered to be in good condition. Cracks observed in the side channel wall appear to be shrinkage related and are considered insignificant to the structural integrity of the spillway.

2. Outlet Conduit. The outlet conduit is in good condition exhibiting only minor leakage at construction joints. The headwall is deteriorated and in need of repair.

6.2 Design and Construction Techniques.

Based on available information, the facility (particularly recently renovated portions) appears to have been designed and constructed in accordance with generally accepted modern techniques and practices.

6.3 Past Performance.

Available records indicate the original facility had a history of leakage near the toe and suffered extensive damage from overtopping. Deficiencies and damage were corrected in remedial work performed during 1978-1979. According to discussions with the owner's representative, the facility has since performed satisfactorily.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and may be subject to minor earthquake induced dynamic forces. As the facility appears well constructed and sufficiently stable, it is believed that it can withstand the expected dynamic 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 the facility is well maintained and 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 relatively small storage capacity and unusually stable embankment configuration the SDF for the facility is considered to be the 1/2-PMF. Results of the hydrologic and hydraulic analysis indicate the facility is capable of passing and/or storing the 1/2-PMF. Consequently, the spillway is considered adequate.

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

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

d. Necessity for Additional Investigations. No additional investigations are currently deemed necessary.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner:

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. Observe the cracking in the spillway overflow wall and outlet conduit headwall in future inspections and take remedial measures if necessary.

c. 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 Findley Run Dam STATE Pennsylvania COUNTY Indiana

NDI # PA — 00286 PENNDER # 32-43

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 4 February 1980 WEATHER Cold, Clear TEMPERATURE 18° @ 12 noon

POOL ELEVATION AT TIME OF INSPECTION 1507.5 M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	Penelec	
D. J. Spaeder	R. T. Gallus	
D. L. Bonk		
Site revisited and rephotographed		
21 February 1980 by B. M. Mihalcin		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00286
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	Good-horizontal and vertical.
RIPRAP FAILURES	None observed. Riprap adjacent spillway covered with soil during recent spillway work.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition. Diversion ditch along right abutment to control surface runoff.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 00286
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None observed.
ANY NOTICEABLE SEEPAGE	None observed through embankment.
STAFF GAGE AND RECORDER	No staff gage on site. Owner intends to install one soon. Water levels are estimated and recorded daily.
DRAINS	None observed.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00286
INTAKE STRUCTURE	Concrete structure near right abutment in good condition - supply lines are regulated from within. Outlet conduit intake was submerged and not observed.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	4- by 6-foot concrete box culvert in good condition. Minor leaking through two joints near downstream end. No cracking observed.
OUTLET STRUCTURE	Headwall cracked and deteriorated. Not significant to operation.
OUTLET CHANNEL	Natural stream channel. Unobstructed.
GATE(S) AND OPERATIONAL EQUIPMENT	Four gates in intake structure are all reportedly operable.
	Slide gate on upstream end of outlet conduit. Bridge and control in excellent condition. Gate last opened to affect drawdown in late December 1979.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA-00286
TYPE AND CONDITION	Uncontrolled, 2-stage, reinforced concrete spillway. Constructed May 14, 1979 - January 2, 1980. Good condition. Minor shrinkage cracks in right sidewalls.
APPROACH CHANNEL	N/A.
SPILLWAY CHANNEL AND SIDEWALLS	Generally in good condition except for cracking in overflow wall.
STILLING BASIN PLUNGE POOL	N/A.
DISCHARGE CHANNEL	Rock cut in hard sandstone. Excellent condition.
BRIDGE AND PIERS EMERGENCY GATES	Steel footbridge across spillway. Excellent condition.

SERVICE SPILLWAY

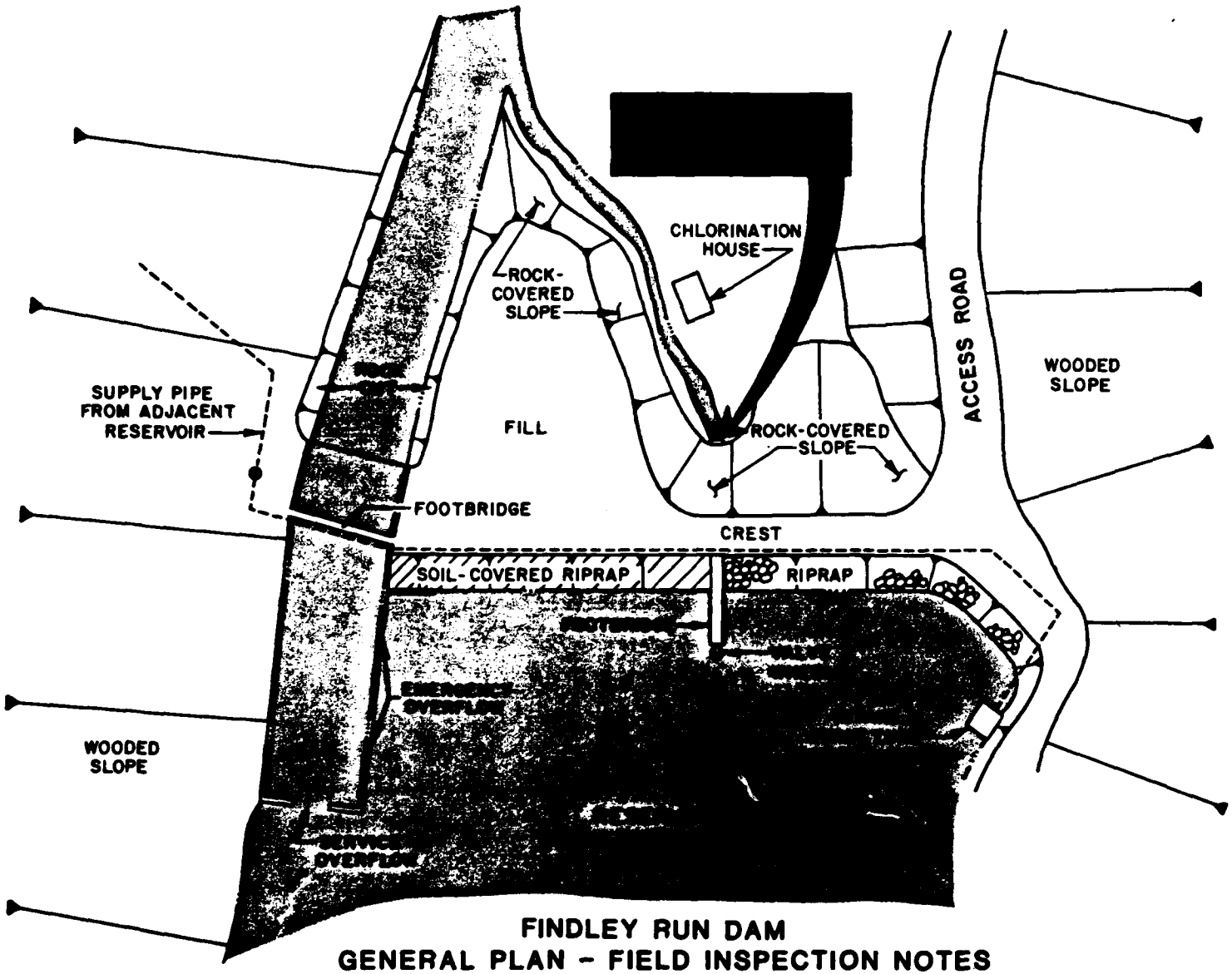
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00286
TYPE AND CONDITION	See Emergency Spillway.
APPROACH CHANNEL	N/A.
OUTLET STRUCTURE	N/A.
DISCHARGE CHANNEL	N/A.

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00286
MONUMENTATION SURVEYS	Temporary bench marks on spillway and intake house.
OBSERVATION WELLS	None.
WEIRS	None.
PIEZOMETERS	None. Owner considering installation of piezometers.
OTHERS	Metering system on water line in chlorination house.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 00286
SLOPES: RESERVOIR	Steep, heavily forested slopes.
SEDIMENTATION	Dredged in 1977. No sedimentation visible.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Natural channel, unobstructed.
SLOPES: CHANNEL VALLEY	Steep, narrow and wooded valley.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Near Cramer, about 2 miles downstream, 4 homes are located sufficiently near the stream to perhaps sustain damage in the event of an embankment breach. It is estimated that as many as 20 persons could be affected within this reach.

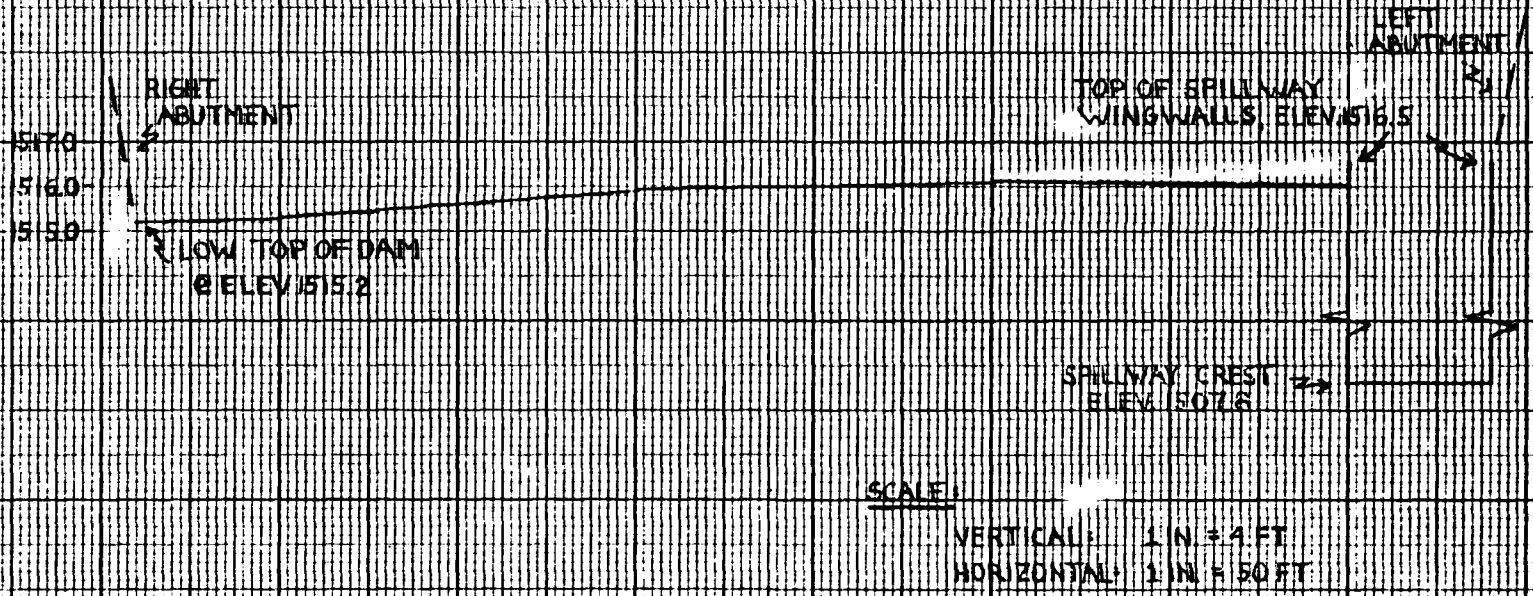


FINDLEY RUN DAM
GENERAL PLAN - FIELD INSPECTION NOTES

FINDLEY RUN DAM

PROFILE OF DAM CREST

FROM FIELD SURVEY



SCALE:

VERTICAL: 1 IN = 4 FT

HORIZONTAL: 1 IN = 50 FT

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Findley Run Dam

ITEM	REMARKS NDI# PA - 00286
PERSONS INTERVIEWED AND TITLE	Pennsylvania Electric Company R. T. Gallus - Generation Engineering Supervisor.
REGIONAL VICINITY MAP	See Appendix E, Figure 1.
CONSTRUCTION HISTORY	Originally constructed in 1925 - 1926. Overtopped during July 1977 Flood. Extensive repairs completed in 1979 (see Section 1.2.g).
AVAILABLE DRAWINGS	Drawings of original design are contained in PennDER files. Drawings of remedial work performed since July 1977 are available from both the owner and the PennDER.
TYPICAL DAM SECTIONS	See Appendix E, Figure 3.
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Appendix E, Figure 4. Discharge curves are not available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00286
SPILLWAY: PLAN SECTION DETAILS	See Appendix E, Figure 4. See Appendix E, Figure 5. See Appendix E, Figure 6.
OPERATING EQUIP- MENT PLANS AND DETAILS	None available.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	Hydrology and hydraulics computations as per D'Appolonia Consulting Engineers, Inc. pertaining to the new spillway design are contained in PennDER files.
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None available.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00286
BORROW SOURCES	From within reservoir and most recently from the area excavated for the new spillway.
POST CONSTRUCTION DAM SURVEYS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	D'Appolonia Consulting Engineers, Inc. of Pittsburgh, Pennsylvania, served as project consultants for the post 1977 reconstruction. No formal reports are available.
HIGH POOL RECORDS	Overtopped in July 1977 by an estimated 1-foot of water. New spillway constructed in late 1979.
MONITORING SYSTEMS	None. Owner plans to install staff gage and possibly piezometers in near future.
MODIFICATIONS	Major remedial work performed since 1977.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00286
PRIOR ACCIDENTS OR FAILURES	Overtopped in July 1977. Extensive damage incurred. Repairs completed in 1979.
MAINTENANCE: RECORDS MANUAL	Maintained as-needed. No formal records or manual are available.
OPERATION: RECORDS MANUAL	Site visited daily. Pool level recorded daily. No formal records or manual are available.
OPERATIONAL PROCEDURES	Self-regulating.
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None presently in effect. A system is currently being developed by the owner's engineering staff.
MISCELLANEOUS	

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CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00286
PENNDER ID # 32-43

SIZE OF DRAINAGE AREA: 4.4 square miles.

ELEVATION TOP NORMAL POOL: 1507.3 STORAGE CAPACITY: 45 acre-feet

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 1515.2 STORAGE CAPACITY: 86 acre-feet

SPILLWAY DATA

CREST ELEVATION: 1507.3 feet (service); 1507.8 feet (emergency).

TYPE: Uncontrolled, 2-stage, reinforced concrete, direct and side channel overflow.

CREST LENGTH: 20 feet (service); 155 feet (emergency).

CHANNEL LENGTH: Approximately 200 feet.

SPILLOVER LOCATION: Left abutment.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 4- by 6-foot concrete box culvert.

LOCATION: About 150 feet left of right abutment.

ENTRANCE INVERTS: 1486.0 feet.

EXIT INVERTS: 1484.0 feet.

EMERGENCY DRAWDOWN FACILITIES: Sluice gate at inlet.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

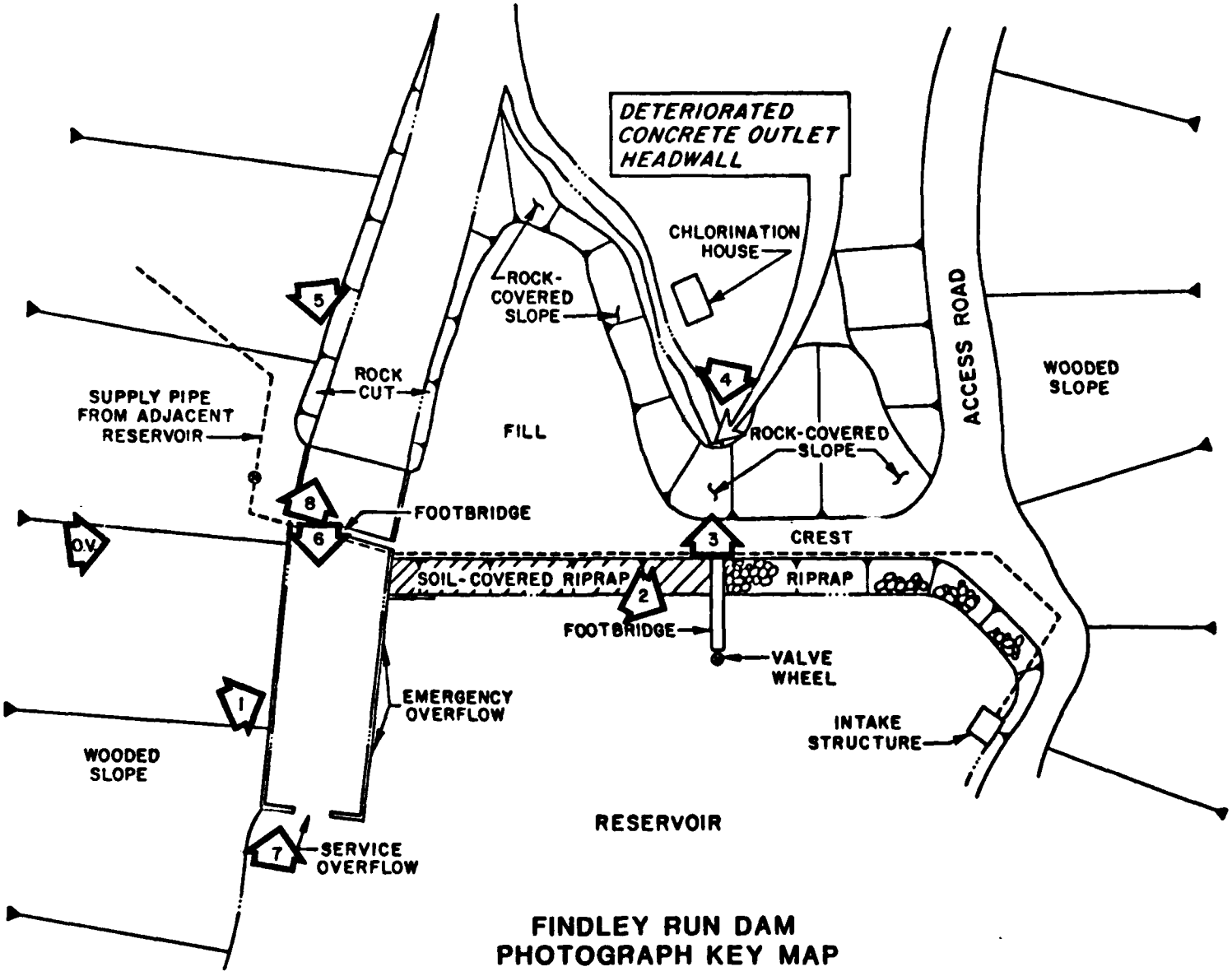
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

PHOTOGRAPHS



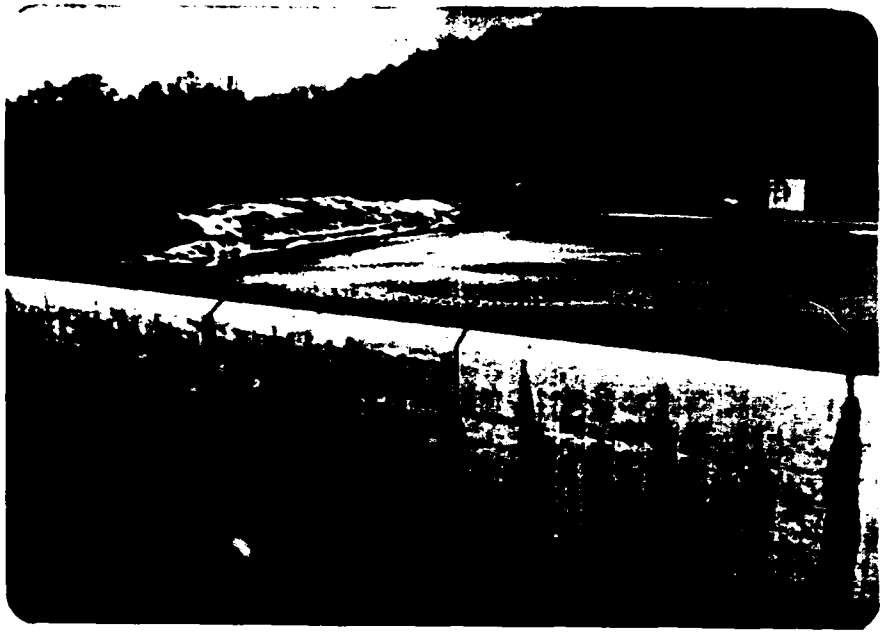
FINDLEY RUN DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1 View of the emergency spillway overflow and upstream embankment face as seen from the left abutment.

PHOTOGRAPH 2 View of the valve wheel, located at the end of the footbridge, that operates the gate at the inlet end of the outlet conduit. The structure in the background houses control mechanisms for the supply line system.

PHOTOGRAPH 3 View of the outlet conduit discharge channel as seen from the embankment crest.

PHOTOGRAPH 4 View of the deteriorated outlet headwall.



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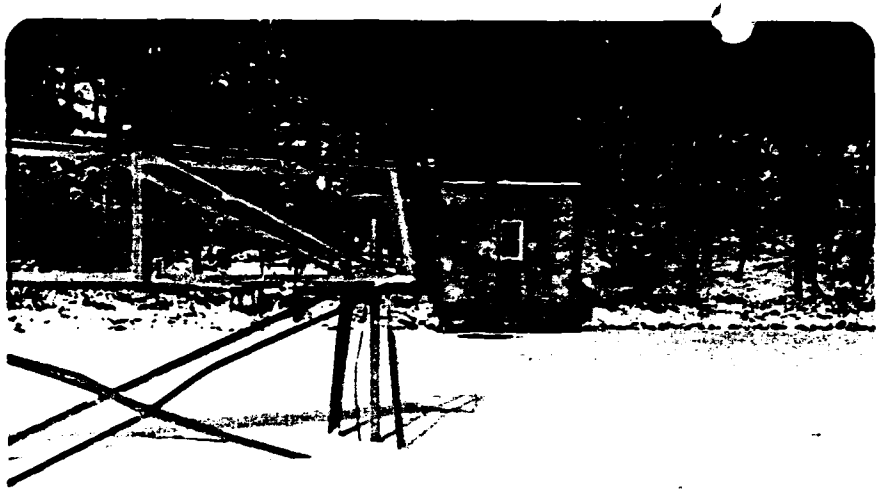

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3

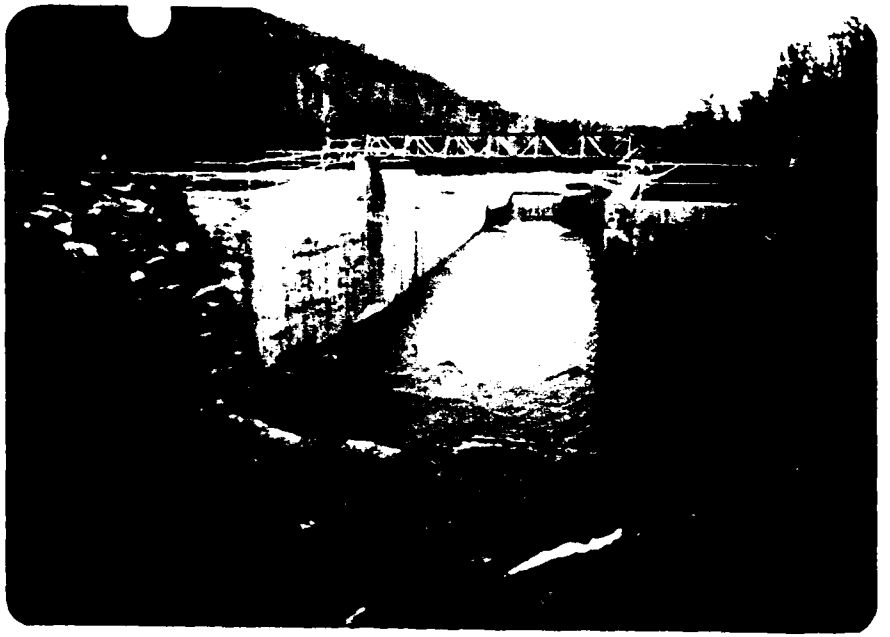
4

PHOTOGRAPH 5 View, looking upstream, of the spillway discharge channel.

PHOTOGRAPH 6 View of the spillway as seen from the footbridge that spans the channel from the embankment crest to the left abutment.

PHOTOGRAPH 7 View of the spillway channel as seen from the wingwall adjacent the service overflow weir.

PHOTOGRAPH 8 View of the rock-cut channel located immediately downstream of the spillway channel.



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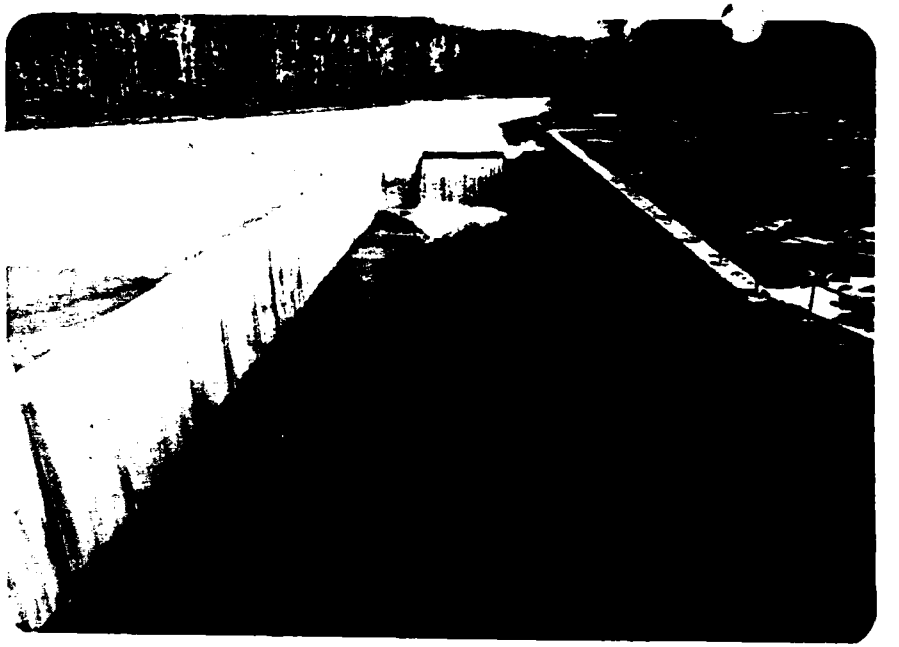

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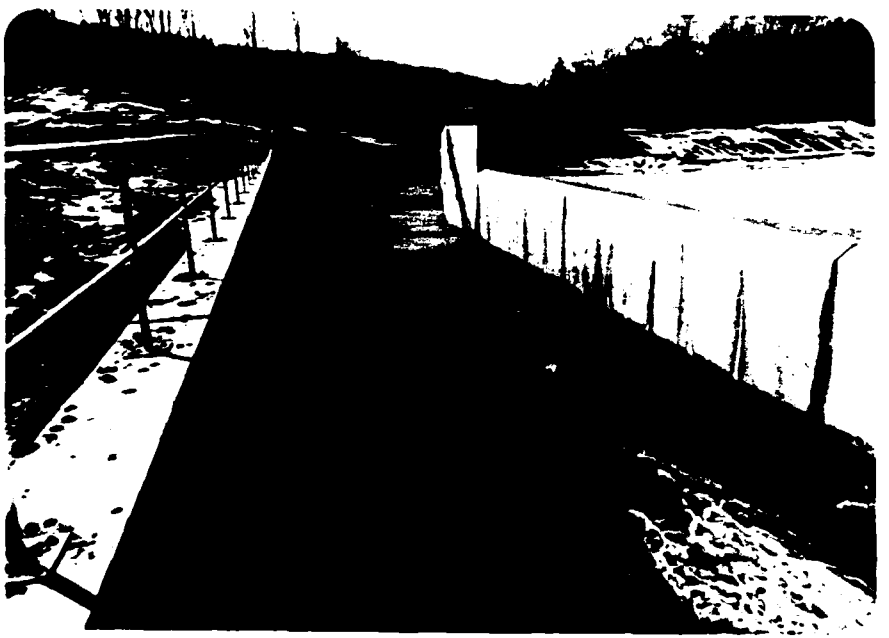

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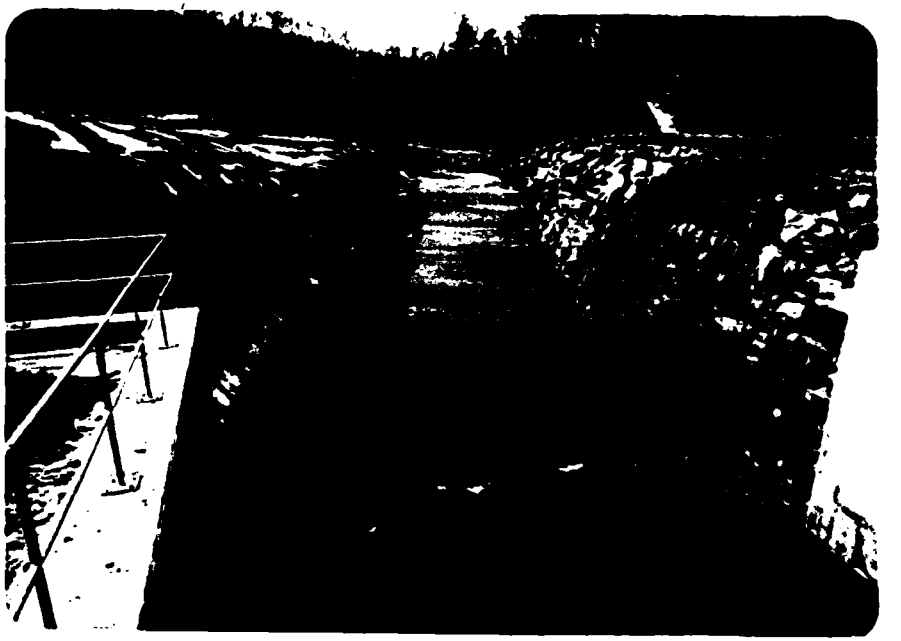

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APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: FINDLEY RUN DAM

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

STATION	1	2	3
STATION DESCRIPTION	FINDLEY RUN DAM		
DRAINAGE AREA (SQUARE MILES)	4.4		
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)	N.A.		
C_p (3)	0.80		
C_t (3)	0.45		
L (MILES) (4)	3.6		
L_{ca} (MILES) (4)	1.9		
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (HOURS)	0.80		
SPILLWAY DATA			
CREST LENGTH (FEET)	175		
FREEBOARD (FEET)	7.4		

(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 CENTROID.

PROJECT DAM SAFETY ANALYSIS
FINDLEY RUN DAM

BY JJS DATE 2-17-82 PROJ. NO. 79-203-336
CHKD. BY DLB DATE 3-5-80 SHEET NO. 1 OF 10

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DAM STATISTICS

- HEIGHT OF DAM = 31 FT (FIELD MEASURED)
- NORMAL POOL STORAGE CAPACITY = 45 ACRE-FT (SEE NOTE 1)
- MAXIMUM POOL STORAGE CAPACITY = 86.1 ACRE-FT (@ TOP OF DAM) (SEE SHEET 4)
- DRAINAGE AREA = 4.4 SQUARE MILES (PLANIMETERED ON USGS 7.5 MINUTE TOPO QUAD: VINTONDALE, PA)
- ELEVATION OF TOP OF DAM (DESIGN) = 1515.0 (FIGURE 3)
- ELEVATION OF TOP OF DAM (FIELD) = 1515.2
- NORMAL POOL ELEVATION = 1507.3 (FIGURE 4)
- EMERGENCY SPILLWAY CREST = 1507.3 (FIGURE 6)
- TOP OF SPILLWAY WINGWALL = 1516.5 (FIGURE 5)
- CONCRETE STOP JOINT ELEVATION = 1486.0 (SEE NOTE 2)
- DOWNSTREAM OUTLET INVERT = 1484 (FIELD MEASURED)
- STREAMBED AT DAM CENTERLINE = 1485 (ESTIMATED; SEE FIG 2)

NOTE 1: THESE VALUES WERE OBTAINED FROM "REPORT UPON THE APPLICATION OF THE NINEVEH WATER COMPANY," FINDLEY RUN DAM — CONSTRUCTION OF NEW SPILLWAY, APRIL, 1979; FOUND IN REMUDER FILES.

NOTE 2: OBTAINED FROM DRAWING CONTAINED IN REMUDER FILES ENTITLED "CONSTRUCTION DETAILS FOR DAM FOR WATER SUPPLY STORAGE ON FINDLEY RUN," BY [illegible] ENGINEERING COMPANY, DATED 10-8-34 (NOT INCLUDED IN APPENDIX E).

SUBJECT DAM SAFETY ANALYSIS
FINDLEY RUN DAM

BY DJS DATE 1-24-80 PROJ. NO. 79-303-396
CHKD. BY DLB DATE 3-5-80 SHEET NO. 2 OF 10

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DAM CLASSIFICATION

DAM SIZE : SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION : HIGH (FIELD JUSTIFICATION)

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

HYDROGRAPH PARAMETERS

- LENGTH OF LONGEST WATERCOURSE : $L = 3.6$ MILES
- LENGTH OF LONGEST WATERCOURSE FROM DAM TO A POINT OPPOSITE BASIN CENTROID : $L_{CA} = 1.9$ MILES

{ MEASURED ON USGS 7½' QUAD : VINTONDALE, PA }

$C_p = 0.30$
$C_t = 0.45$
} SNYDER COEFFICIENTS. (SEE NOTE 3)

SNYDER'S STANDARD LAG : $t_p = C_t (L \cdot L_{CA})^{0.3}$
$= 0.45 (3.6 \times 1.9)^{0.3}$
$= 0.80$

NOTE 3: THESE VALUES OF THE SNYDER COEFFICIENTS WERE USED IN THE SPILLWAY DESIGN CALCULATIONS, BY DAMJUNIA ENGINEERS. THE VALUES WERE DERIVED FROM AN HEC-1 PMP RUNOFF HYDROGRAPH, WHICH WAS DEVELOPED USING SCS RUNOFF AND DIMENSIONLESS UNIT GRAPH CRITERIA. THESE VALUES DIFFER GREATLY WITH AND ARE MORE CONSERVATIVE THAN THOSE PROVIDED BY THE C.O.E. (ZONE 34, $C_p = 0.45$, $C_t = 1.6$), BUT IT IS FELT THAT THEY ARE MORE APPLICABLE TO THIS AREA, AND THEREFORE ARE USED IN THE ANALYSIS.

PROJECT DAM SAFETY INSPECTIONS
FINDLEY B LK DAM

BY DJS DATE 2-27-80 PROJ. NO. 79-223-2.5

CHKD. BY DLB DATE 3-5-80 SHEET NO. 3 OF 10

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RESERVOIR CAPACITY

RESERVOIR SURFACE AREAS:

- SURFACE AREA (S.A.) @ NORMAL POOL (EL. 1507.3) = 4 ACRES (SEE NOTE 1)
- S.A @ ELEV. 1520 = 12 ACRES (PLANIMETERED ON U.S.G.S. 7½' QUAD, VINTONDALE, PA)
- S.A. @ ELEV. 1540 = 33 ACRES

RESERVOIR VOLUMES:

KNOWN VOLUMES:

- STORAGE @ ELEV 1507.3 = 45 AC-FT
- STORAGE @ ELEV 1516.3 = 92 AC-FT (SEE NOTE 1)

- SINCE THE UPSTREAM INLET INVERT ELEVATION = 1486.3 FT (SHEET 2), "ZERO-STORAGE" VOLUME WILL BE ASSUMED HERE.

STORAGE CAPACITIES BELOW NORMAL POOL:

- ASSUME THAT THE MODIFIED PRISMOIDAL RELATIONSHIP ADEQUATELY MODELS THE SURFACE AREA - STORAGE RELATIONSHIP FOR THE RESERVOIR. SINCE THE STORAGE AT NORMAL POOL IS KNOWN, A CORRECTION FACTOR MAY BE APPLIED TO THE CALCULATED VOLUMES. (REF: IH, p. 15)

$$\Delta V_{1-2} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

WHERE ΔV_{1-2} = INCREMENTAL VOLUME BETWEEN ELEVATIONS 1 & 2, IN ACRE-FT,
h = ELEVATION 2 − ELEVATION 1, IN FEET
A_1 = S.A. @ ELEV 1, IN ACRES,
A_2 = S.A. @ ELEV 2, IN ACRES.

SUBJECT	DAM SAFETY INSPECTION		
	FINDLEY RUN DAM		
BY DJS	DATE 2-27-80	PROJ. NO. 79-303-386	
CHKD. BY DLB	DATE 3-5-80	SHEET NO. 4	OF 10

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ELEVATION - STORAGE RELATIONSHIP:

ELEVATION (FT)	A_i (AC)	ΔV_{1-2} (AC-FT)	INITIAL CALCULATED TOTAL VOLUME (AC-FT)	CORRECTED TOTAL VOLUME ** (AC-FT)
1486.0	0	—	0	0
1490.0	0.8 *	1.1	1.1	1.2
1495.0	1.7 *	6.1	7.2	7.7
1500.0	2.6 *	10.7	17.9	19.2
1505.0	3.6 *	15.4	33.3	35.7
1507.3	4.0	8.7	42.0	45.0

* - LINEARLY INTERPOLATED ; BASED ON THE ASSUMPTION OF A [illegible] FOR SURFACE AREAS BELOW NORMAL POOL ELEVATION.

** - CORRECTED VOLUME = $\left(\frac{\text{ACTUAL VOL. @ NORMAL POOL}}{\text{COMPUTED VOL. @ NORMAL POOL}}\right) \times$ INITIAL CALC. TOTAL VOLUME

$= \frac{45.0}{42.0} \times$ INITIAL CALCULATED TOTAL VOLUME.

STORAGE CAPACITIES ABOVE NORMAL POOL:

AGAIN, USE THE MODIFIED PRISMOIDAL RELATIONSHIP WITH A CORRECTION FACTOR:

	ELEVATION (FT)	A_i (AC)	ΔV_{1-2} (AC-FT)	INITIAL CALC. TOTAL VOLUME (AC-FT)	CORRECTED ** TOTAL VOLUME (AC-FT)
	1507.3	4.0	—	45.0	45.0
	1508.0	4.4 *	2.9	47.9	47.3
	1510.0	5.7 *	10.1	58.0	55.4
	1512.0	7.0 *	12.7	70.7	65.6
	1514.0	8.2 *	15.2	85.9	77.8
([illegible])	1515.0	9.0 *	10.3	96.2	86.1
	1516.0	9.5 *	7.4	103.6	92.0
	1518.0	10.7 *	20.2	123.8	108.2
	1520.0	12.0	22.7	146.5	130.4

* - LINEARLY INTERPOLATED

** - CORRECTED TOTAL VOLUME = $\left[\left(\frac{\text{ACTUAL VOL. @ 1516 - ACTUAL VOL. @ NORMAL POOL}}{\text{CALC. VOL. @ 1516 - ACTUAL VOL. @ NORMAL POOL}}\right) \times (\text{CALC. VOL.} - \text{ACTUAL VOL. @ NORMAL POOL})\right] +$ [ACTUAL VOL. @ NORMAL POOL] $= \left[\left(\frac{92-45}{103.6-45}\right) \times (\text{CALC. VOL.} - 45)\right] + 45$

SUBJECT Dam Safety Inspection
Findley Run Dam

BY DTS DATE 1-24-80 PROJ. NO. 79-302-326

CHKD. BY DLB DATE 3-5-80 SHEET NO. 5 OF 10

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PMP Calculations

- Approximate Rainfall Index = 24.0 inches (Ref 3 Fig. 1)
  (corresponding to a duration of 24 hours and an area of 200 square miles)

- Depth - Area - Duration Zone 7 (Ref 3, Fig. 1)

- Drainage Area = 4.4 square miles; assume flat data corresponding to a 10-square mile area is representative of the basin:

Duration (hrs)	Percent of Index Rainfall
6	102
12	120
24	130
48	140

(Ref 3, Fig. 2)

- Hub Brook Factor (adjustment for basin shape and for the lesser likelihood of a severe storm centering over a small basin) corresponding to a drainage area of 4.4 square miles is 1.30.

(Ref 4, p. 73)

SUBJECT DAM SAFETY INSPECTION

EVERETT FIRE DAM

BY DJS DATE 2-19-82 PROJ. NO. 79-833-XXX

CHKD. BY DLB DATE 3-5-80 SHEET NO. 6 OF 16

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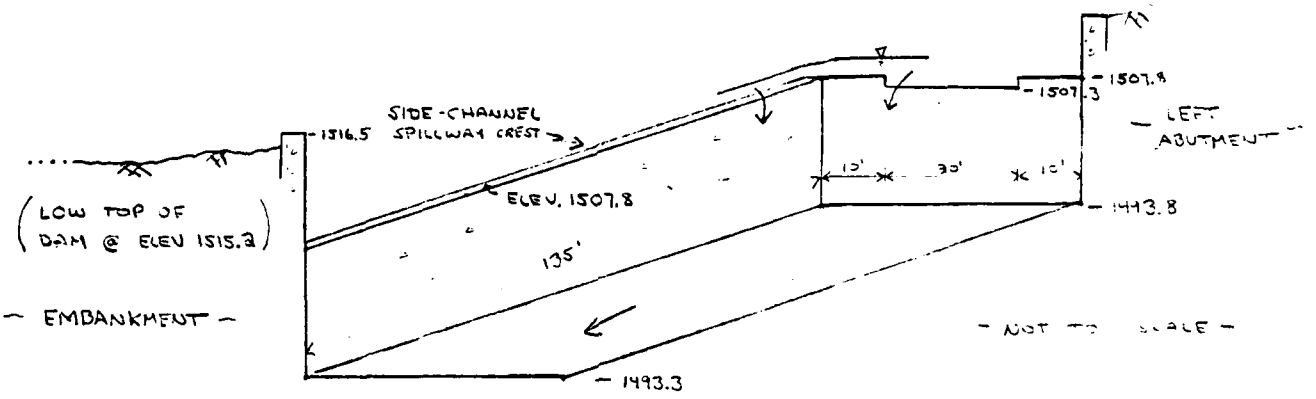
SPILLWAY CAPACITY



- BASED ON FIELD NOTES AND AS-BUILT DRAWINGS.

THE SPILLWAY CONSISTS OF A TWO-STAGE FRONT- AND SIDE-CHANNEL SPILLWAY WHICH DISCHARGES INTO A RECTANGULAR CONCRETE CHANNEL. FLOWS ARE CONTROLLED BY THE SHARP-CRESTED WEIR STRUCTURE. DISCHARGE CAN BE ESTIMATED BY THE EQUATION

$$Q = CLH^{3/2} \qquad \text{(Ref 5, p 5-3)}$$

WHERE Q = DISCHARGE OVER WEIR, IN CFS,
L = LENGTH OF WEIR CREST, IN FEET,
H = HEAD ON WEIR, IN FEET, AND
C = DISCHARGE COEFFICIENT.

THE DISCHARGE COEFFICIENT IS ASSUMED TO BE ON THE ORDER OF 3.0, BASED ON D'APPOLONIA DESIGN CALCULATIONS CONTAINED IN OUR FILES. ALTHOUGH THIS VALUE MAY BE SOMEWHAT CONSERVATIVE, IT WILL BE USED IN LIGHT OF THE FACT THAT ANY EFFECTS DUE TO THE RIGHT ANGLE JOINT IN THE WEIR CREST ARE ASSUMED TO BE NEGLIGIBLE.

SUBJECT Dam Safety Inspection
Findley Run Dam

BY DTS DATE 2-27-81 PROJ. NO. 77-223-286

CHKD. BY DLB DATE 3-5-80 SHEET NO. 7 OF 10

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THE "SERVICE SPILLWAY" PORTION OF THE STRUCTURE IS 20 FT LONG, AT ELEVATION 1507.3. THE "EMERGENCY SPILLWAY" SECTION IS 155 FT IN TOTAL LENGTH, AT ELEVATION 1507.8

SPILLWAY RATING TABLE:

	RESERVOIR ELEVATION (ft)	SERVICE H_s (ft)	SERVICE Q ① (cfs)	EMERGENCY H_e (ft)	EMERGENCY Q ② (cfs)	Q_{TOTAL} ③ (cfs)
(NORMAL POOL)	1507.3	0	0	—	—	0
	1507.8	0.5	20	0	0	20
	1508.0	0.7	40	0.2	40	80
	1509.0	1.7	140	1.2	630	770
	1510.0	2.7	280	2.2	1570	1850
	1511.0	3.7	440	3.2	2750	3190
	1512.0	4.7	630	4.2	4140	4770
	1513.0	5.7	840	5.2	5700	6540
	1514.0	6.7	1080	6.2	7420	8500
	1515.0	7.7	1320	7.2	9250	10,600
(TOP OF DAM)	1515.2	7.9	1380	7.4	9670	11,050
	1516.0	8.7	1590	8.2	11,280	12,870
	1517.0	9.7	1870	9.2	13,410	15,280
	1518.0	10.7	2170	10.2	15,250	17,380
	1519.0	11.7	2480	11.2	18,310	20,790
	1520.0	12.7	2810	12.2	20,480	23,290

① $Q_{service} = (20)(3.0)(H_s)^{3/2}$

② $Q_{emergency} = (C_w)(155)(H_e)^{3/2}$

③ $Q_{total} = Q_{service} + Q_{emergency}$

SUBJECT DAM SAFETY INSPECTION
FINDLEY RUN DAM

BY DTS DATE 2-27-80 PROJ. NO. 79-352-226

CHKD. BY DLB DATE 3-5-80 SHEET NO. 9 OF 10

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EMBANKMENT RATING CURVE

- ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2} \qquad \text{(Ref 5, p. 5-13)}$$

WHERE Q = DISCHARGE OVER THE EMBANKMENT (CFS),
L = LENGTH OF EMBANKMENT OVERTOPPED (FT),
H = HEAD ON WEIR; IN THIS CASE IT IS THE AVERAGE "FLOW-AREA" WEIGHTED HEAD ABOVE THE LOW TOP OF DAM,
C = DISCHARGE COEFFICIENT, DEPENDENT ON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION.

RESERVOIR ELEVATION (FT)	EMBANKMENT LENGTH (FT)
1515.2	0
1515.3	40
1515.5	70
1516.0	190
1516.5	345
1517.0	355
1518.0	375
1519.0	430
1520.0	480

(BASED ON FIELD MEASUREMENTS AND USGS TOPO MAP.)

PROJECT DAM SAFETY INSPECTION
FINDLEY RUN DAM

BY [illegible] DATE 2-22-80 PROJ. NO. 79-323-[illegible]

CHKD. BY DLR DATE 3-5-80 SHEET NO. 9 OF 16

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ASSUME THAT INCREMENTAL DISCHARGES (BETWEEN SUCCESSIVE RESERVOIR ELEVATIONS) OVER THE EMBANKMENT ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i[(L_1+L_2)/2]$, WHERE L_1 = LENGTH AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW-THRU" WIDTH OVER A HEAD, H_w, CAN BE ESTIMATED AS (TOTAL FLOW AREA / L_1).

EMBANKMENT RATING TABLE:

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL H (FT)	① INCR. FLOW AREA, A_i (FT²)	② TOTAL FLOW AREA, A_T (FT²)	③ WEIGHTED FLOW H_w (FT)	④ $\frac{H_w}{L_1}$	⑤ C	⑥ Q (CFS)
1512.2	0	-	-	-	-	-	-	-	0
1513.0	40	0	0.1	2	2	0.1	0.00	2.93	0
[illegible]	70	40	0.2	11	13	0.2	0.002	2.97	30
1514.0	140	70	0.5	65	78	0.4	0.004	3.01	140
[illegible]	345	140	0.5	134	212	0.6	0.006	3.03	490
[illegible]	355	345	0.5	175	387	1.1	0.01	[illegible]	1950
[illegible]	375	355	1.0	365	752	2.0	0.02	[illegible]	[illegible]
[illegible]	420	375	1.0	388	1140	2.9	0.03	[illegible]	[illegible]
[illegible]	490	420	1.0	410	1550	3.7	0.04	[illegible]	[illegible]

① $A_i = H_i\left(\frac{L_1+L_2}{2}\right)$

② $H_w = A_T/L_1$

③ [illegible] = [illegible] EMBANKMENT CREST = 33 FT

④ C [illegible] FROM FIG. 15, HDS 24.

⑤ $Q = CL_1H_w^{3/2}$

JECT DAM SAFETY INSPECTION
FINDLEY RUN DAM

BY DJS DATE 2-28-80 PROJ. NO. 79-203-236

CHKD. BY DLB DATE 3-5-80 SHEET NO. 10 OF 10

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TOTAL FACILITY RATING CURVE

	RESERVOIR ELEVATION (FT)	$Q_{SPILLWAY}$ (CFS)	$Q_{EMBANKMENT}$ (CFS)	Q_{TOTAL} (CFS)
	1507.3	0	—	0
	1507.8	20	—	20
	1508.0	80	—	80
	1509.0	770	—	770
	1510.0	1850	—	1850
	1511.0	3190	—	3190
	1512.0	4770	—	4770
	1513.0	6540	—	6540
	1514.0	8500	—	8500
	1515.0	10,600	—	10,600
(LOW TOP OF DAM)	1515.2	11,050 *	0	11,050
	1515.5	11,730 *	20	11,790
	1516.0	12,870 *	140	13,010
	1516.5	14,080 *	490	14,570
	1517.0	15,380	1150	16,530
	1518.0	17,820	3230	21,050
	1519.0	20,490	6580	26,570
	1520.0	23,290	9130	32,410

* - BY LINEAR INTERPOLATION

SUBJECT DAM SAFETY INSPECTION / FINDLEY RUN DAM / OVERTOPPING

BY DTS DATE 3-4-80 PROJ. NO. 79-203-286

CHKD. BY DLB DATE 3-4-80 SHEET NO. A OF C

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SUMMARY INPUT/OUTPUT SHEETS

DAM SAFETY INSPECTION
FINDLEY RUN DAM *** OVERTOPPING ANALYSIS ***
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LKOPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .50 .60 .70 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	4.40	0.00	4.40	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

INITIAL AND CONSTANT RAINFALL LOSSES AS PER C.O.E.

LOSS DATA

LKOPT	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= .80 CP= .80 NTA= 0

BASE FLOW PARAMETERS AS PER C.O.E.

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.17 AND R= 2.38 INTERVALS

UNIT HYDROGRAPH 17 END-OF-PERIOD ORDINATES, LAG= .80 HOURS, CP= .79 VOL= 1.00

471.	950.	1765.	2465.	2803.	2683.	2097.	1388.	905.	591.
385.	251.	164.	107.	70.	46.	30.			

END-OF-PERIOD FLOW

HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.88	24.46	2.42	41610.
										(683.)(621.)(61.)(11.62.78)			

SUBJECT DAM SAFETY INSPECTION

FINDLEY RUN DAM

BY RTS DATE 3-4-80 PROJ. NO. 79-203-286

CHKD. BY DLB DATE 3-4-80 SHEET NO. B OF C

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RESERVOIR INFLOW HYDROGRAPHS:

		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
0.5 PMF	CFS	10124.	4409.	1400.	722.	207945.
	CMS	287.	125.	40.	20.	5888.
	INCHES		9.32	11.84	12.21	12.21
	MM		236.78	300.80	310.18	310.18
	AC-FT		2186.	2778.	2864.	2864.
	THOUS CU M		2697.	3426	3533.	3533.
		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
0.6 PMF	CFS	12148.	5291.	1680.	866.	249534.
	CMS	344.	150.	48.	25.	7066.
	INCHES		11.19	14.21	14.65	14.65
	MM		284.13	360.96	372.22	372.22
	AC-FT		2624.	3333.	3437.	3437.
	THOUS CU M		3236.	4111.	4240.	4240.
		PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
PMF	CFS	20247.	8818.	2801.	1444.	415890.
	CMS	573.	250.	79.	41.	11777.
	INCHES		18.64	23.69	24.42	24.42
	MM		473.55	601.60	620.37	620.37
	AC-FT		4373.	5555.	5729.	5729.
	THOUS CU M		5394.	6852.	7066.	7066.

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

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAO	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	45.	-1

STAGE	1507.30	1507.80	1508.00	1509.00	1510.00	1511.00	1512.00	1513.00	1514.00
	1515.20	1515.50	1516.00	1516.50	1517.00	1518.00	1519.00	1520.00	
FLOW	0.00	20.00	80.00	770.00	1850.00	3190.00	4770.00	6540.00	8500.00
	11050.00	11790.00	13010.00	14570.00	16530.00	21040.00	26510.00	32410.00	
CAPACITY=	0.	1.	8.	19.	36.	45.	47.	55.	66.	78.
	86.	92.	108.	126.					
ELEVATION=	1486.	1490.	1495.	1500.	1505.	1507.	1508.	1510.	1512.	1514.
	1515.	1516.	1518.	1520.					

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1507.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1515.2	0.0	0.0	0.

SUBJECT DAM SAFETY INSPECTION

BY DTS DATE 7-4-79 FINDLEY RUN DAM

CHKD. BY DLB DATE 3-4-80 PROJ. NO. 79-203-286

SHEET NO. C OF C

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RESERVOIR OUTFLOW HYDROGRAPHS:

OVERTOPPING OCCURS AT APPROXIMATELY 0.55 PMF

PEAK OUTFLOW IS 10043. AT TIME 40.33 HOURS

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10043.	4408.	1399.	721.	207749.
CMS	284.	125.	40.	20.	5883.
INCHES		9.32	11.83	12.20	12.20
MM		236.70	300.54	309.89	309.89
AC-FT		2180.	2775.	2862.	2862.
THOUS CU M		2690.	3421.	3530.	3530.

PEAK OUTFLOW IS 12080. AT TIME 40.33 HOURS

0.6 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12080.	5289.	1679.	866.	249324.
CMS	342.	150.	48.	25.	7060.
INCHES		11.18	14.20	14.64	14.64
MM		284.04	360.69	371.91	371.91
AC-FT		2623.	3331.	3434.	3434.
THOUS CU M		3235.	4108.	4236.	4236.

PEAK OUTFLOW IS 20166. AT TIME 40.33 HOURS

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	20166.	8816.	2799.	1443.	415607.
CMS	571.	250.	79.	41.	11769.
INCHES		18.64	23.67	24.41	24.41
MM		473.43	601.26	619.95	619.95
AC-FT		4372.	5552.	5725.	5725.
THOUS CU M		5392.	6848.	7061.	7061.

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1507.30	1507.30	1515.20
STORAGE	45.	45.	86.
OUTFLOW	0.	0.	11050.

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	1514.73	0.00	83.	10043.	0.00	40.33	0.00
INTERPOLATED VALUES → .55	1515.20		86.	11050.	—	—	—
.60	1515.62	.42	89.	12080.	.50	40.33	0.00
.70	1516.35	1.15	95.	14116.	.67	40.33	0.00
1.00	1517.81	2.61	107.	20166.	1.33	40.33	0.00

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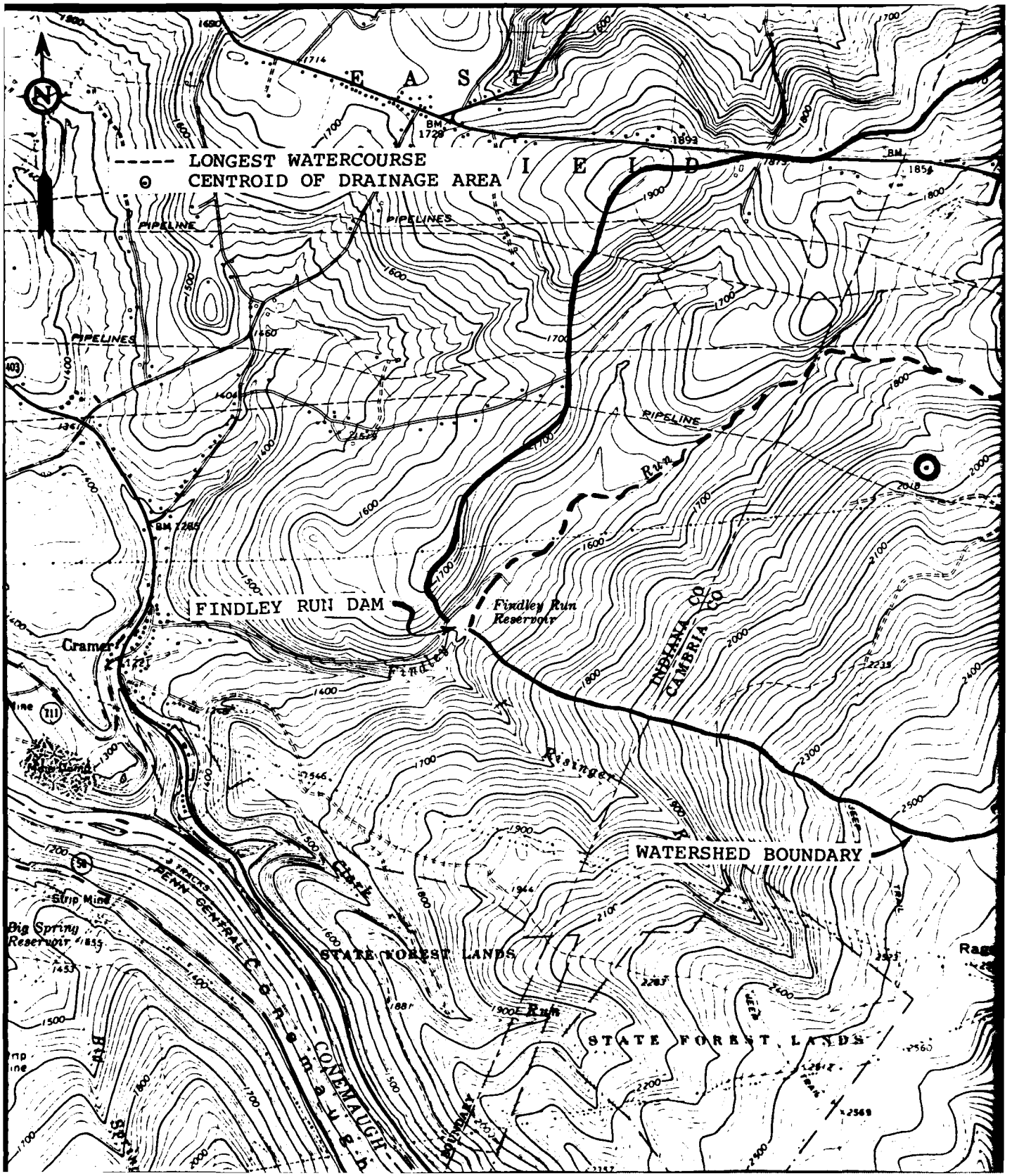
APPENDIX E

FIGURES

LIST OF FIGURES


E A S T
F I E L D
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
PIPELINE
PIPELINES
FINDLEY RUN DAM
Findley Run Reservoir
Findley Run
INDIANA CO
CAMBRIA CO
Cramer
Strip Mine
Big Spring Reservoir
3 TRACKS
PENN CENTRAL
Conemaugh
Creek
STATE FOREST LANDS
WATERSHED BOUNDARY
Fisinger Run
BM 1720
BM 1854
BM 1285

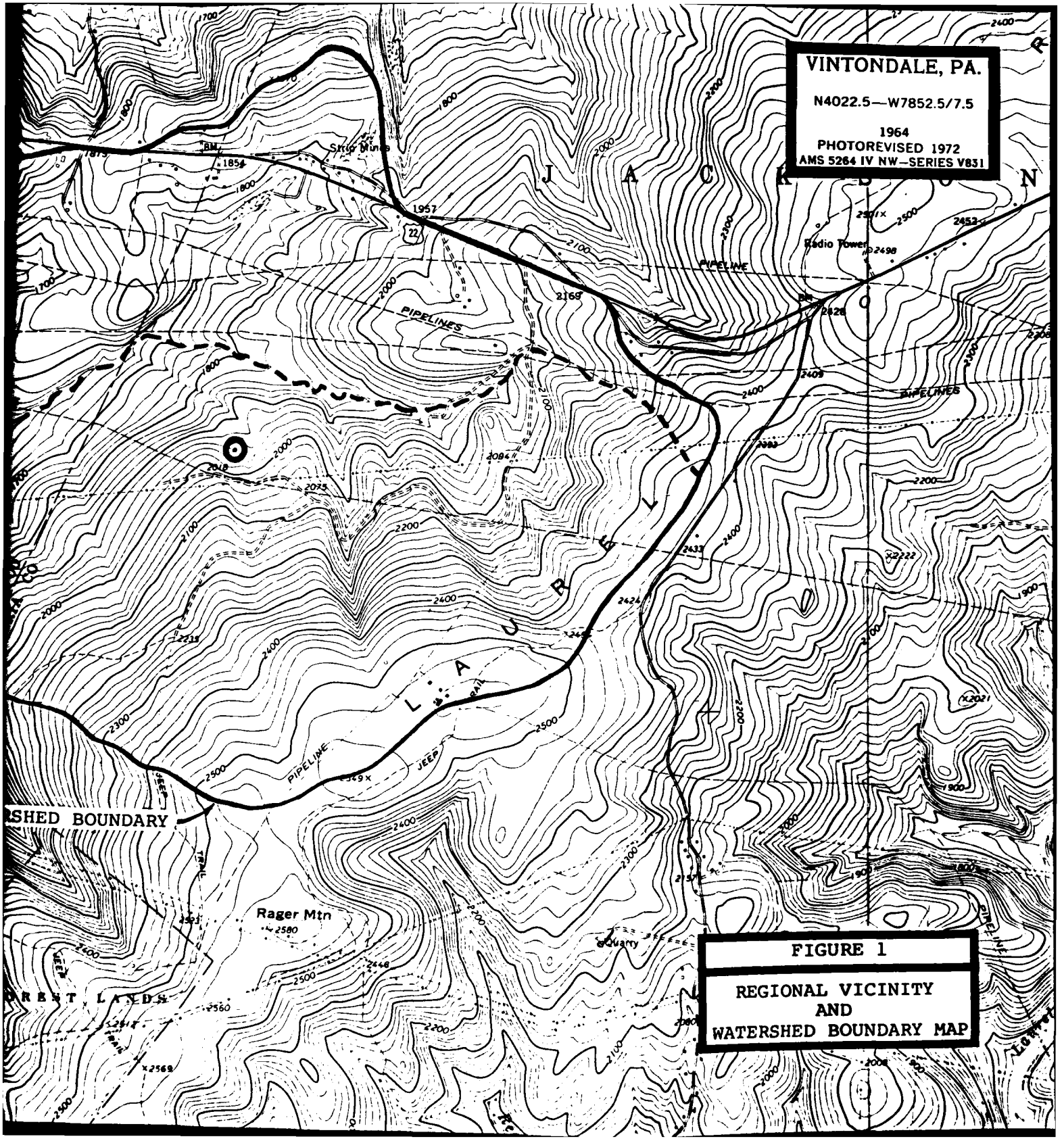
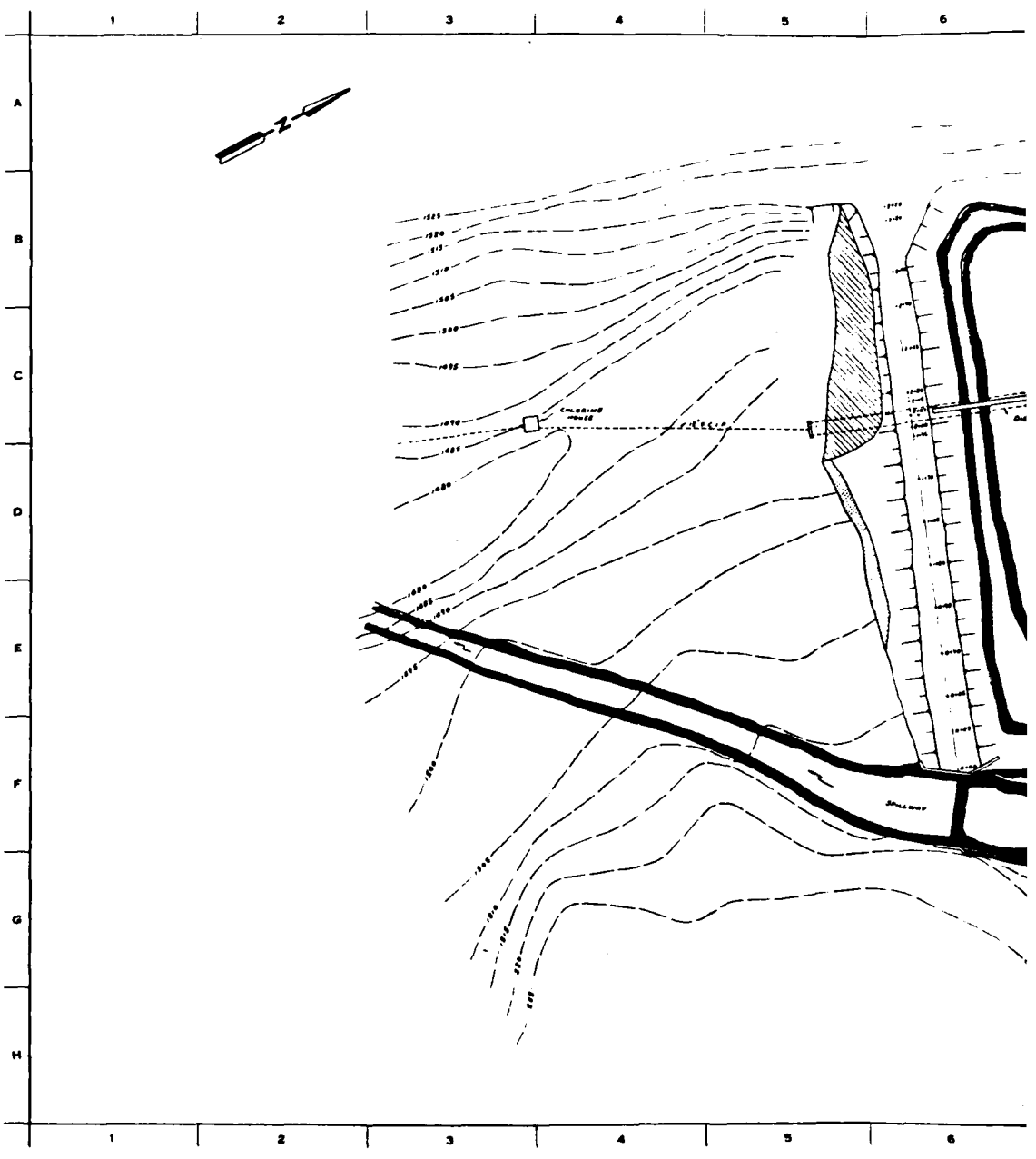


FIGURE 1

REGIONAL VICINITY AND WATERSHED BOUNDARY MAP


1
2
3
4
5
6
A
B
C
D
E
F
G
H
N

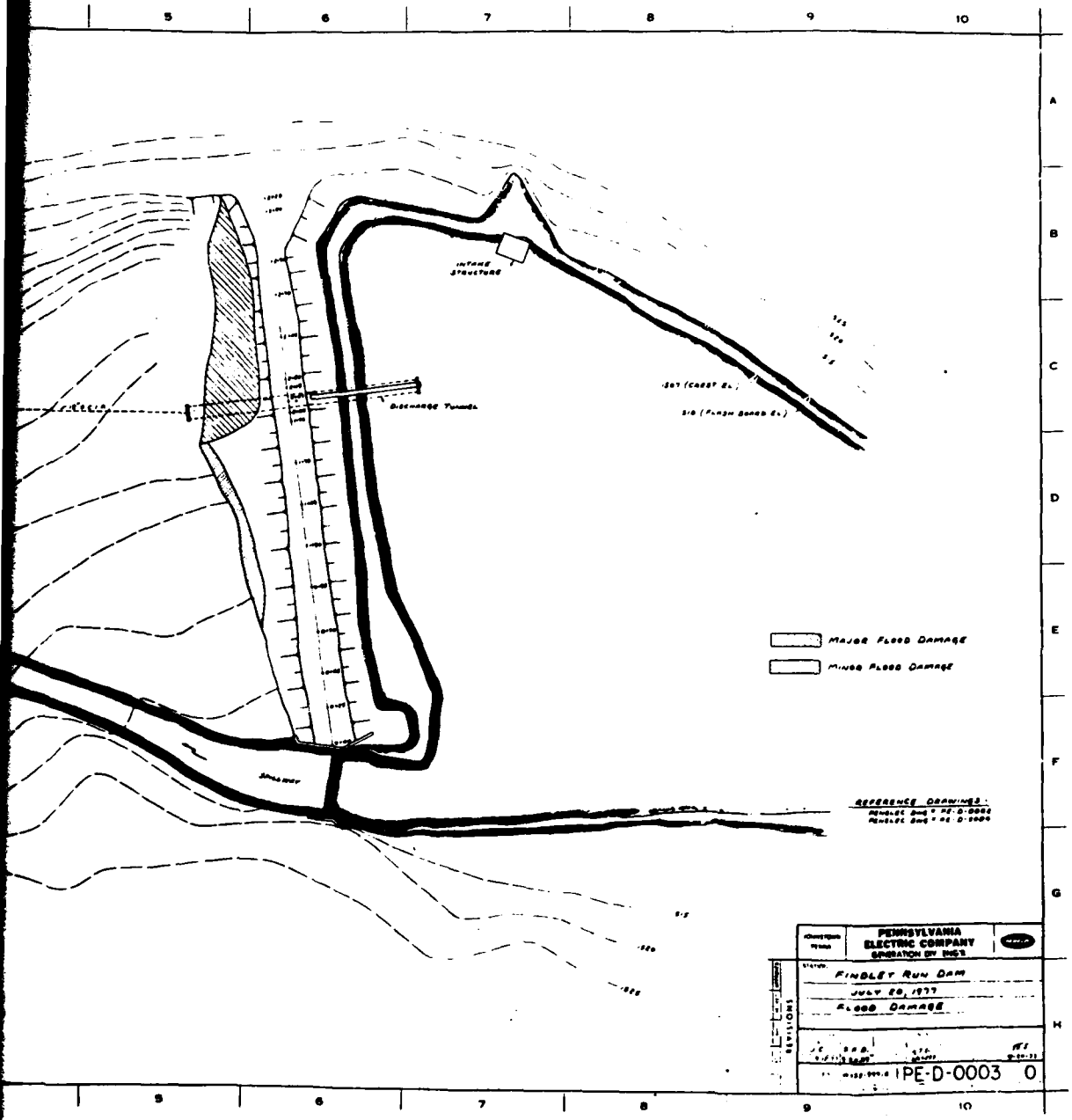


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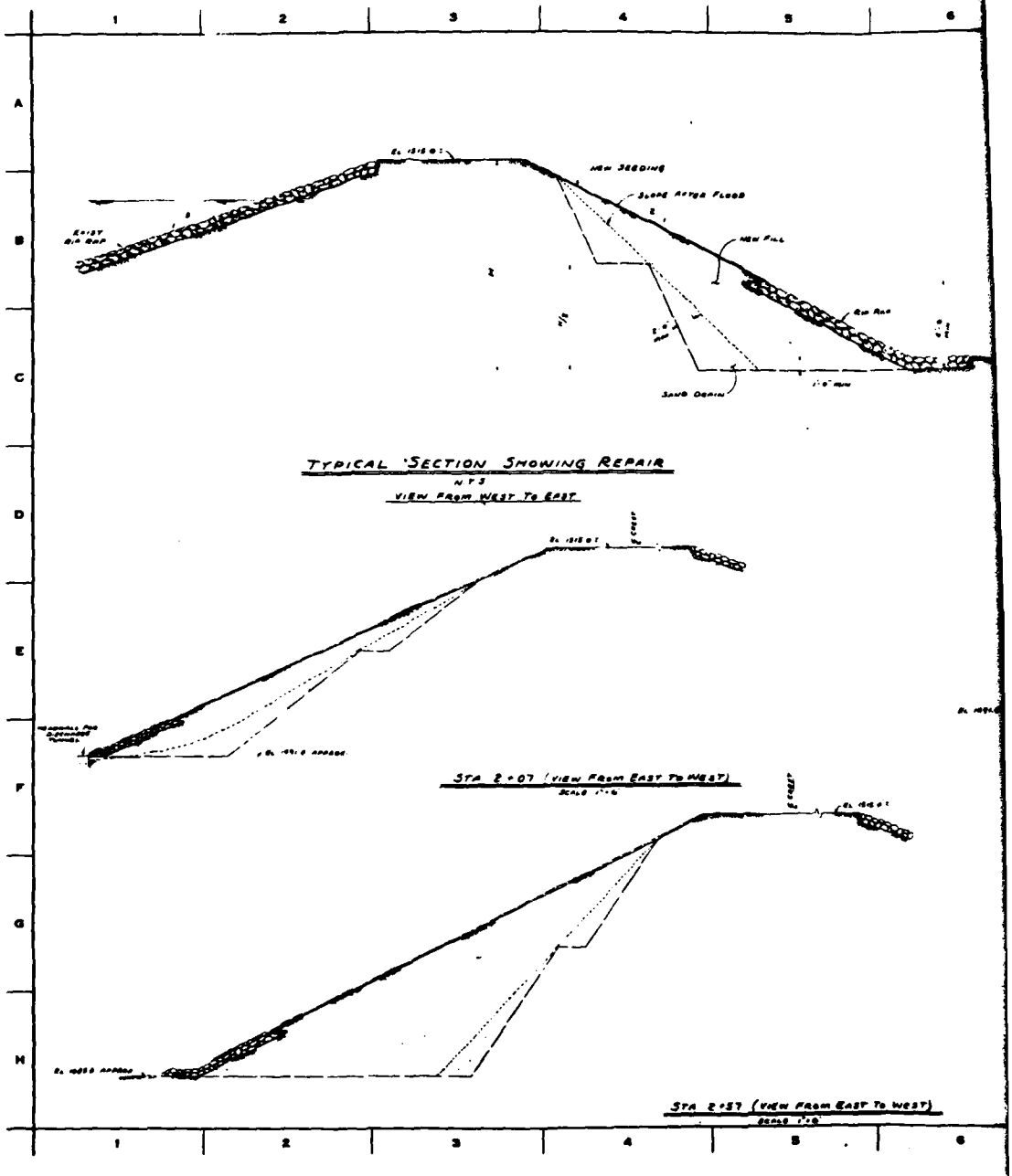
FIGURE 2


1
2
3
4
5
6
A
B
C
D
E
F
G
H
NEW SEEDING
NEW FILL
SLOPE DRAIN
TYPICAL 'SECTION SHOWING REPAIR
N F 3
VIEW FROM WEST TO EAST
STA 2+07 (VIEW FROM EAST TO WEST)
STA 2+57 (VIEW FROM EAST TO WEST)

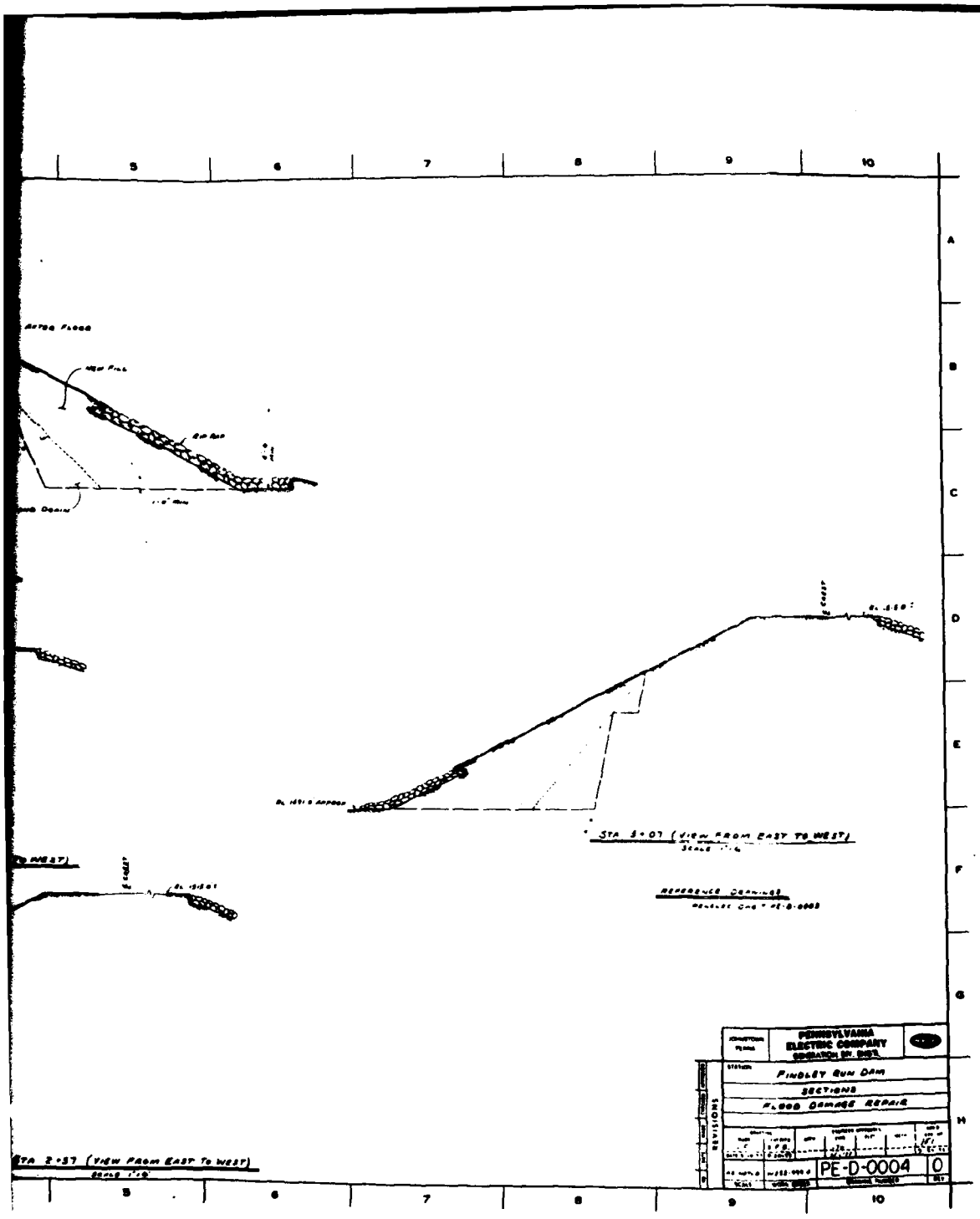


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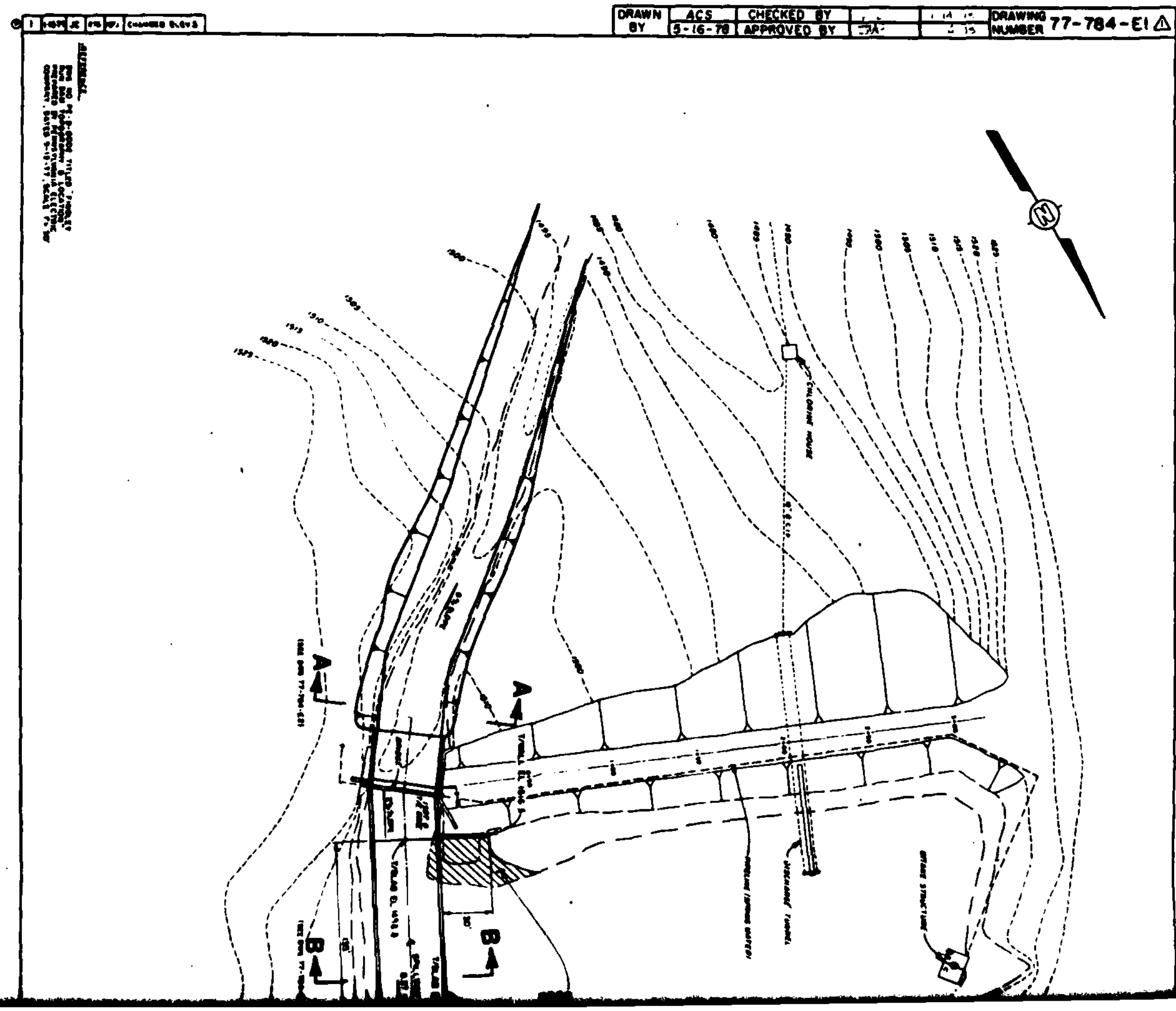
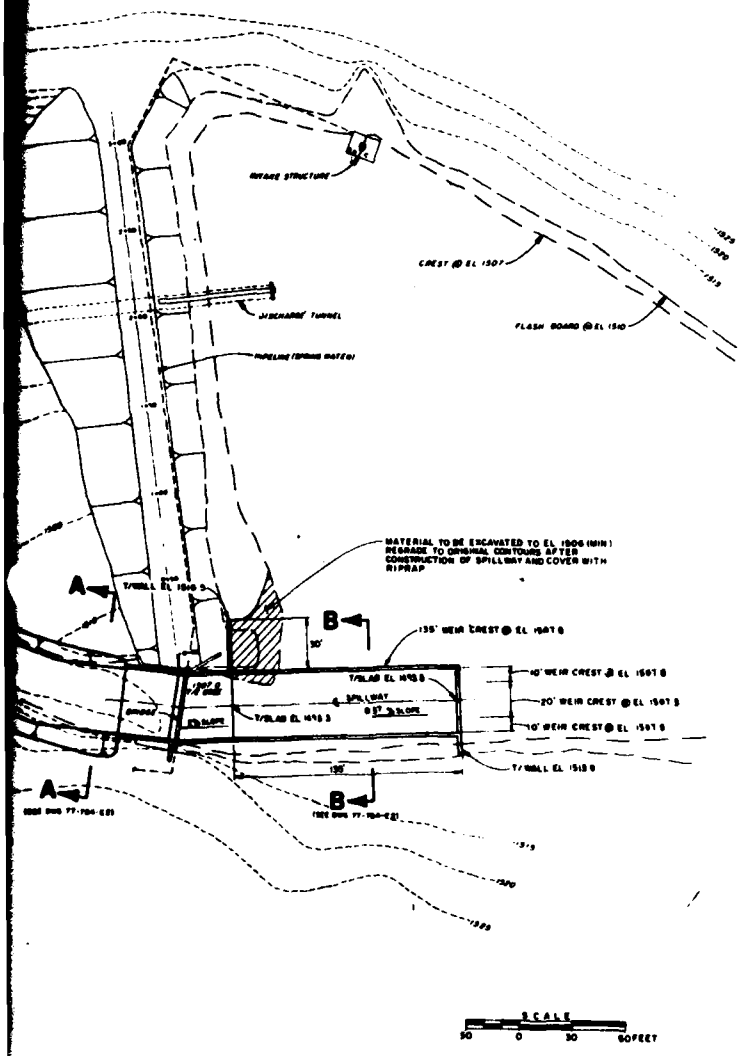
FIGURE 3


DRAWN BY
ACS
5-16-78
CHECKED BY
APPROVED BY
DRAWING NUMBER 77-784-E1
CHLORINE HOUSE
DISCHARGE TUNNEL
INTAKE STRUCTURE
A
A
B
B



NOTES

1. FOOT BRIDGE ACROSS EXISTING SPILLWAY TO BE REMOVED DURING CONSTRUCTION AND REINSTALLED ON NEW SPILLWAY
2. SPRING WATER PIPELINE CARRIED ACROSS THE SPILLWAY BY THE FOOT BRIDGE TO BE TEMPORARILY RELOCATED AROUND THE CONSTRUCTION SITE AND THEN REINSTALLED IN ITS ORIGINAL CONFIGURATION AFTER REPLACEMENT OF THE FOOTBRIDGE
3. EXISTING CONCRETE OGEE AND EXISTING CONCRETE SPILLWAY WALLS TO BE REMOVED.
4. CONCRETE COUNTERFORT SUPPORTING THE EASTERN WEST WALL OF THE SPILLWAY TO BE LEFT IN PLACE AND INCORPORATED INTO THE NEW SPILLWAY STRUCTURE. SEE DWG 77-704-E3, DETAIL (2)
5. SPILLWAY CHANNEL DOWNSTREAM OF THE NEW CONCRETE SPILLWAY STRUCTURE TO BE RAKE DEEPER AND WIDER AS SHOWN ON DWG 77-704-E2.
6. ALL ELEVATIONS GIVEN FOR THE NEW SPILLWAY STRUCTURE ARE REFERENCED TO THE TOP OF THE EXISTING CONCRETE OGEE WHICH IS AT ELEVATION 1507.0 PER THE ORIGINAL CONSTRUCTION DRAWINGS. AFTER THE REMOVAL END OF THE OGEE AS A BENCH MARK. THE CREST OF THE DAM WAS ASSUMED TO BE AT ELEVATION 1516.0.
7. HANDRAIL TO BE INSTALLED ALONG THE TOP OF ALL OF THE WALLS OF THE SPILLWAY STRUCTURE EXCEPT FOR THE TAPERED WEIR CREST AT ELEVATIONS 1501.0 TO 1501.0.

3279802

FINDLEY RUN DAM
PROPOSED SIDE CHANNEL SPILLWAY

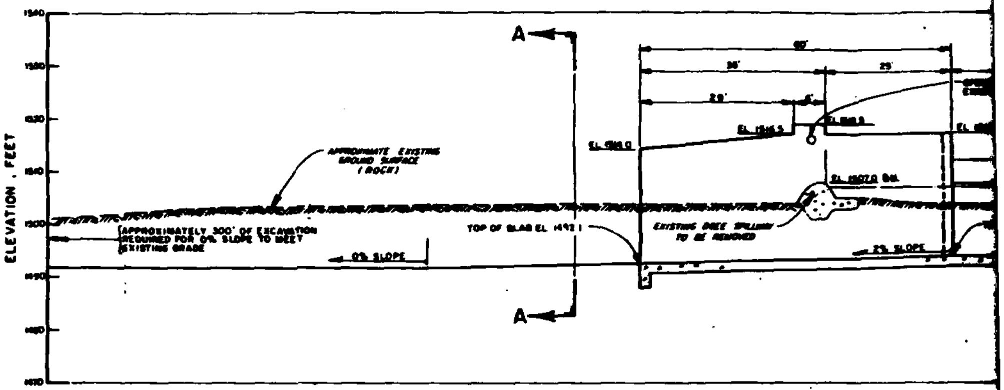
PREPARED FOR
NINEVEH WATER CO
SUBSIDIARY OF
PENNSYLVANIA ELECTRIC COMPANY
JOHNSTOWN, PENNSYLVANIA

D'APPOLONIA

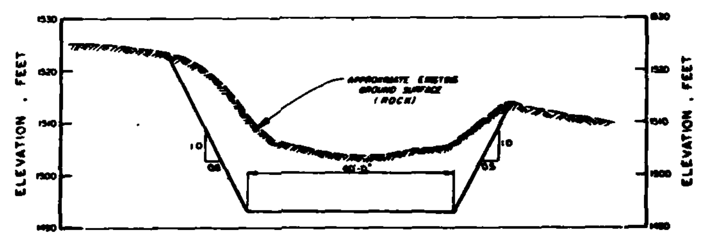
9

GAI CONSULTANTS, INC.

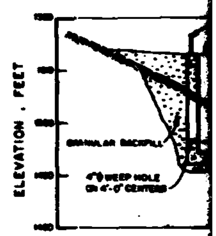
FIGURE 4



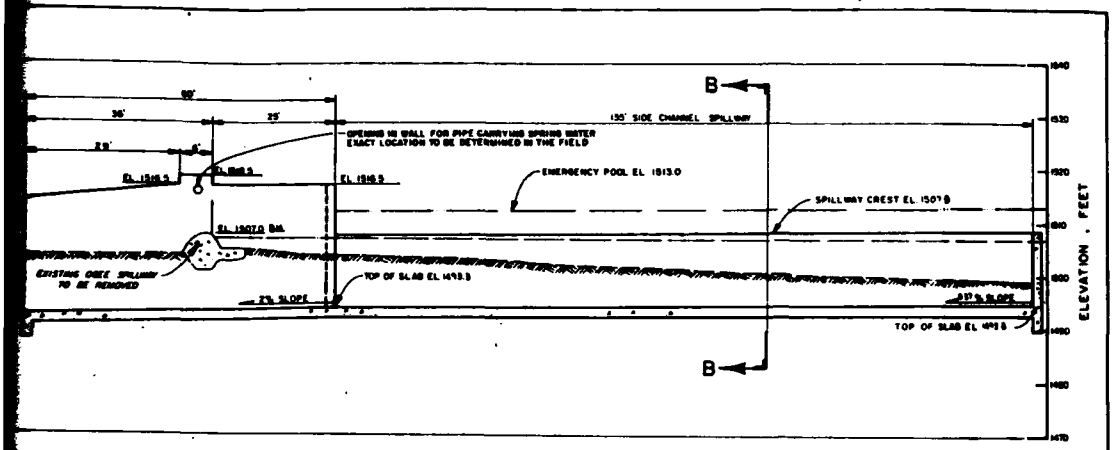
PROFILE ALONG ℄ OF PROPOSED SP



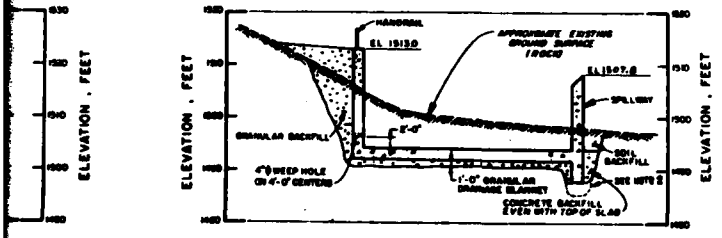
SECTION A-A
(LOOKING DOWNSTREAM)



DRAWING NUMBER 77-784-E2



ILE ALONG ℄ OF PROPOSED SPILLWAY CHANNEL



SECTION B-B
(LOOKING DOWNSTREAM)

NOTE
1 FOR PLAN AND LOCATION OF SECTIONS SEE DWG 77-784-E1
2 GROUT CURTAIN IF REQUIRED
3 SLAB TO BE ANCHORED TO ROCK AS REQUIRED

SCALE
10 0 10 20 FEET

FEB 06 1979
327960A

FINDLEY RUN DAM
PROPOSED SIDE CHANNEL SPILLWAY

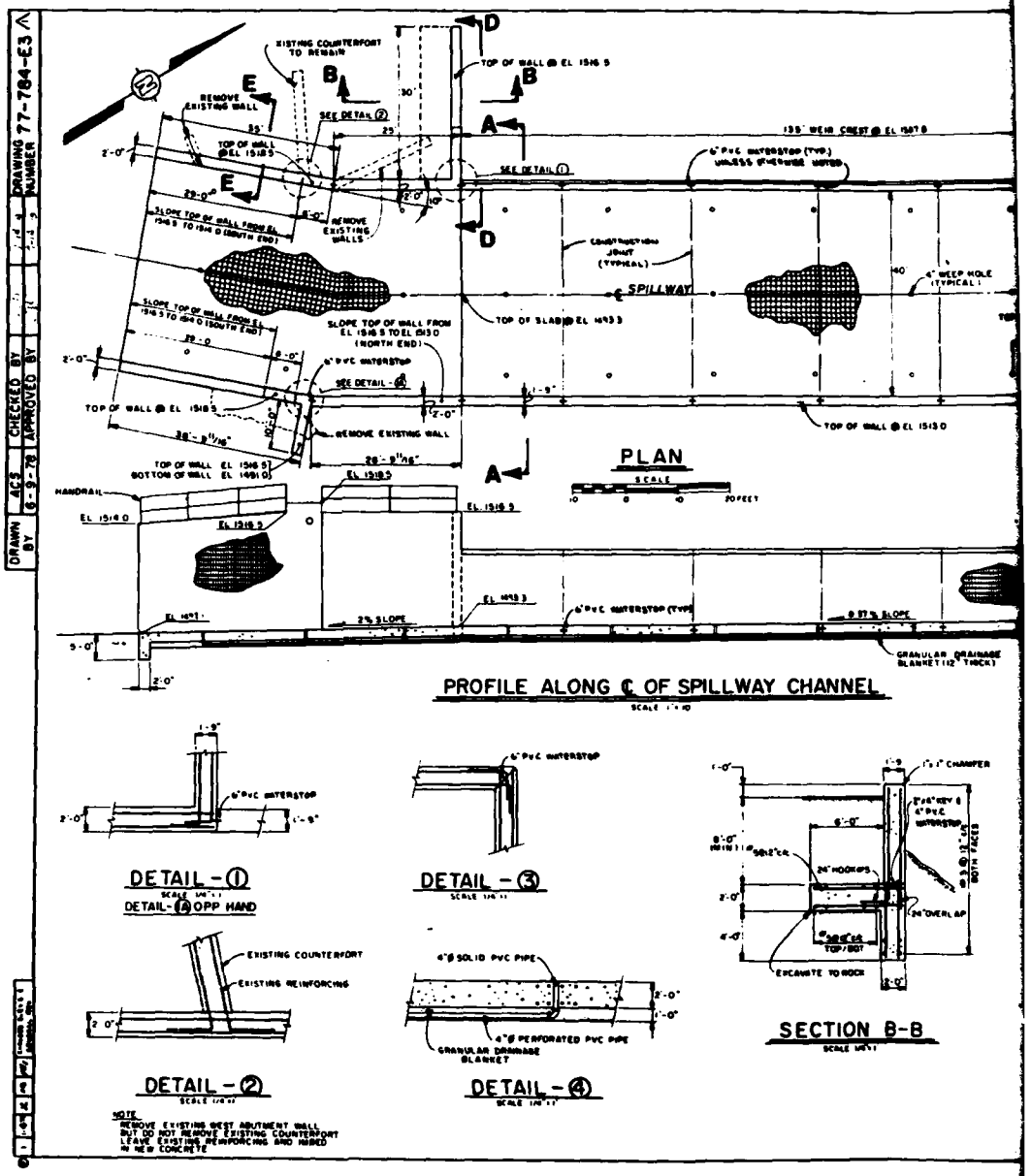
PREPARED FOR
NINEVEH WATER CO
SUBSIDIARY OF
PENNSYLVANIA ELECTRIC COMPANY
JOHNSTOWN, PENNSYLVANIA

D'APPOLONIA

2

GAI CONSULTANTS, INC.

FIGURE 5


DRAWN BY
CHECKED BY
APPROVED BY
DRAWING NUMBER 77-784-E3
EXISTING COUNTERFORT TO REMAIN
REMOVE EXISTING WALL
SEE DETAIL ②
TOP OF WALL @ EL 1516.5
135' WEIR CREST @ EL 1507.8
SEE DETAIL ①
6" PVC WATERSTOP (TYP.) UNLESS OTHERWISE NOTED
CONSTRUCTION JOINT (TYPICAL)
SPILLWAY
4" WEEP HOLE (TYPICAL)
TOP OF SLAB @ EL 1493.3
SLOPE TOP OF WALL FROM EL 1516.5 TO EL 1513.0 (NORTH END)
SEE DETAIL ③
TOP OF WALL @ EL 1513.0
REMOVE EXISTING WALL
TOP OF WALL EL 1516.5
BOTTOM OF WALL EL 1491.0
HANDRAIL
EL 1516.0
EL 1515.9
EL 1493.3
2% SLOPE
0.57% SLOPE
GRANULAR DRAINAGE BLANKET (12" THICK)
PLAN
SCALE
PROFILE ALONG ℄ OF SPILLWAY CHANNEL
DETAIL - ①
DETAIL - ① OPP HAND
DETAIL - ③
EXISTING COUNTERFORT
EXISTING REINFORCING
DETAIL - ②
4"ϕ SOLID PVC PIPE
4"ϕ PERFORATED PVC PIPE
GRANULAR DRAINAGE BLANKET
DETAIL - ④
24" HOOKUPS
24" OVERLAP
EXCAVATE TO ROCK
SECTION B-B
NOTE
REMOVE EXISTING WEST ABUTMENT WALL BUT DO NOT REMOVE EXISTING COUNTERFORT LEAVE EXISTING REINFORCING AND KEYED IN NEW CONCRETE

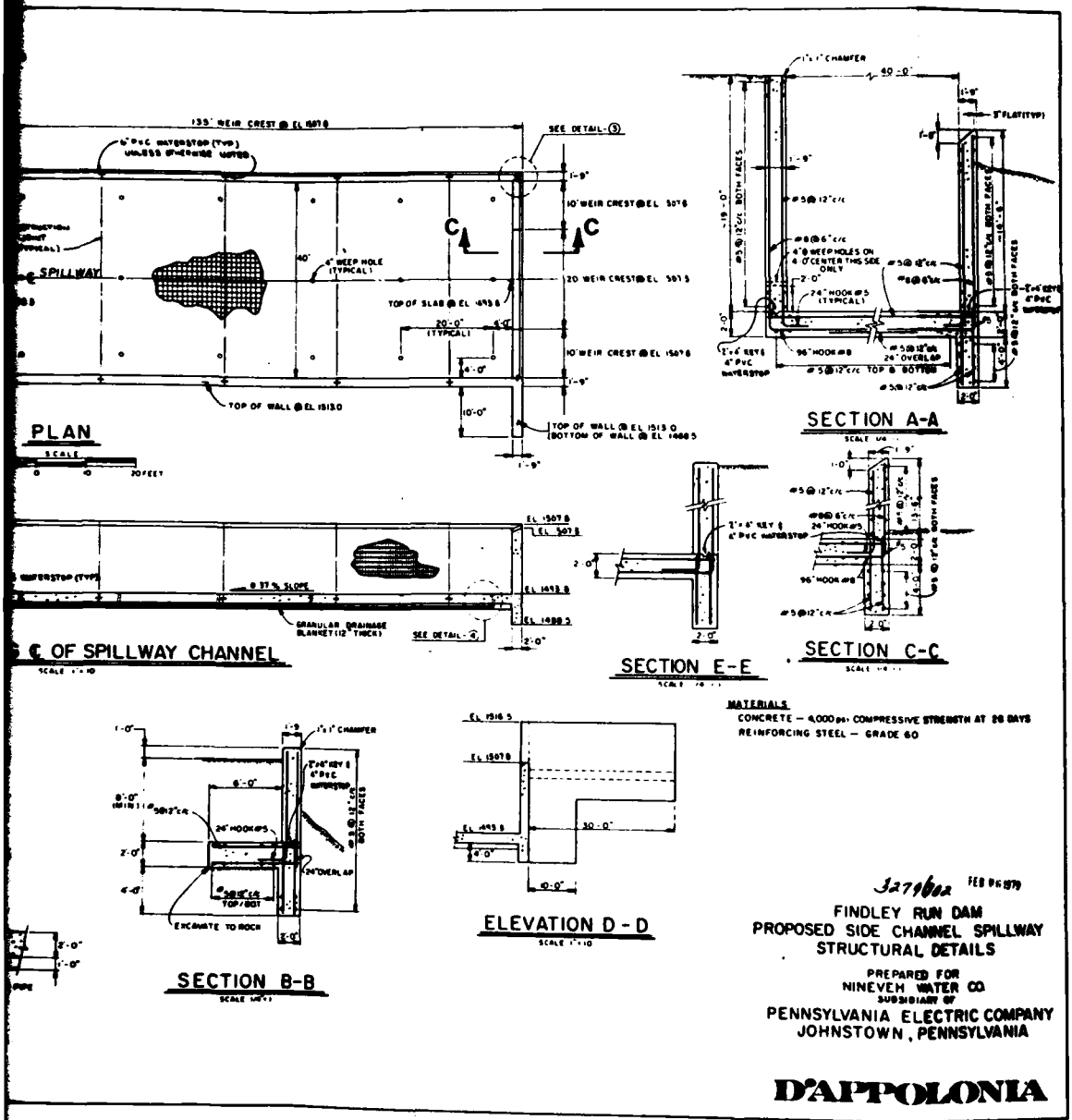


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FIGURE 6

APPENDIX F

GEOLOGY

Geology.

Findley Run Dam is located in the Allegheny Mountain section of the Appalachian Plateau Province of west central Pennsylvania. In this area, the Allegheny Mountain section is characterized by gently folded sedimentary rock strata of middle Pennsylvanian age. Major structural axes strike from southwest to northeast with flanking strata dipping northwest and southeast.

Structurally, the dam and reservoir lie about one mile southeast of the Ligonier syncline, whose axis strikes in a southwest to northeast regional trend.

The sedimentary rock sequences at the dam site are members of the Allegheny Group of Pennsylvania age. The rocks of this group typically exhibit the rapid vertical and lateral lithologic changes characteristic of cyclic sedimentation. "The Allegheny series is characterized by repeated depositional sequences, some of which locally are complete cyclothems. Shale is the dominate rock type in the section throughout the area, but sandstone is present locally in approximately equal amounts."

Economically, "the Allegheny series in western Pennsylvania contains at least seven economically important coal beds. They are in downward stratigraphic order as follows: Upper Freeport "E", Lower Freeport "D", Upper Kittanning "C Prime", Middle Kittanning "C", Lower Kittaning "B", Clarion "A Prime", and Brookville "A". Only the Upper Freeport, Lower Freeport and Lower Kittanning coals have importance in the New Florence quadrangle and have been exploited commercially. Clay deposits of variable thickness and quality usually underlie the coal beds, as occassionally do argillaceous freshwater limestones. Minor ores of limonite and siderite also are present."

A report contained in PennDER files dated October 10, 1924 discusses, in part, the subsurface conditions at the dam site. "Five diamond drill holes along the centerline of the dam varing in depth from 28 to 70 feet were drilled. These drill holes indicate a depth of from 5 to 16 feet of soil and earth under which is found on the left side of the valley, a layer of conglomerate from 7 to 27 feet thick, under which in turn, are layers of sandstone, conglomerate, slate, clay and thin coal beds. On the right side of the valley, under the surface materials, is found a 9 foot

stratum of impure fire clay, under which is 13.5 feet of shale and sandstone."

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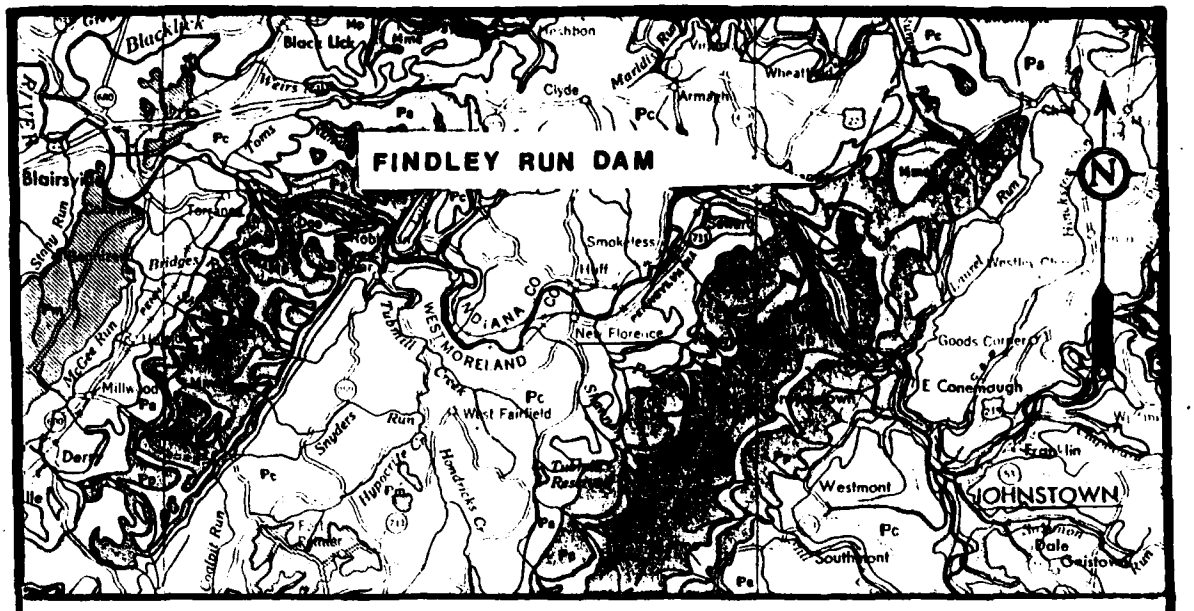
[1]Commonwealth of Pennsylvania, Department of Forests and Waters, Water and Power Resources Board Permit, File No. 32-43, October 10, 1924.

[2]Shaffner, M.N. Topographic and Geologic Atlas of Pennsylvania, New Florence Quadrangle, Pennsylvania Geological Survey, Fourth Series, A57, 1958.



LEGEND

PENNSYLVANIAN

APPALACHIAN PLATEAU

Monongahela Formation
Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

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.

Allegheny Group
Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals, limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pottsville Group
Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

MISSISSIPPIAN

Mauch Chunk Formation
Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group
Predominantly gray, hard, massive, cross-bedded conglomeratic and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

DEVONIAN

Oswayo Formation
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Catskill Formation
Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.

Scale

0 2 4 6 8 10 MILES

REFERENCE:
GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

GEOLOGY MAP

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