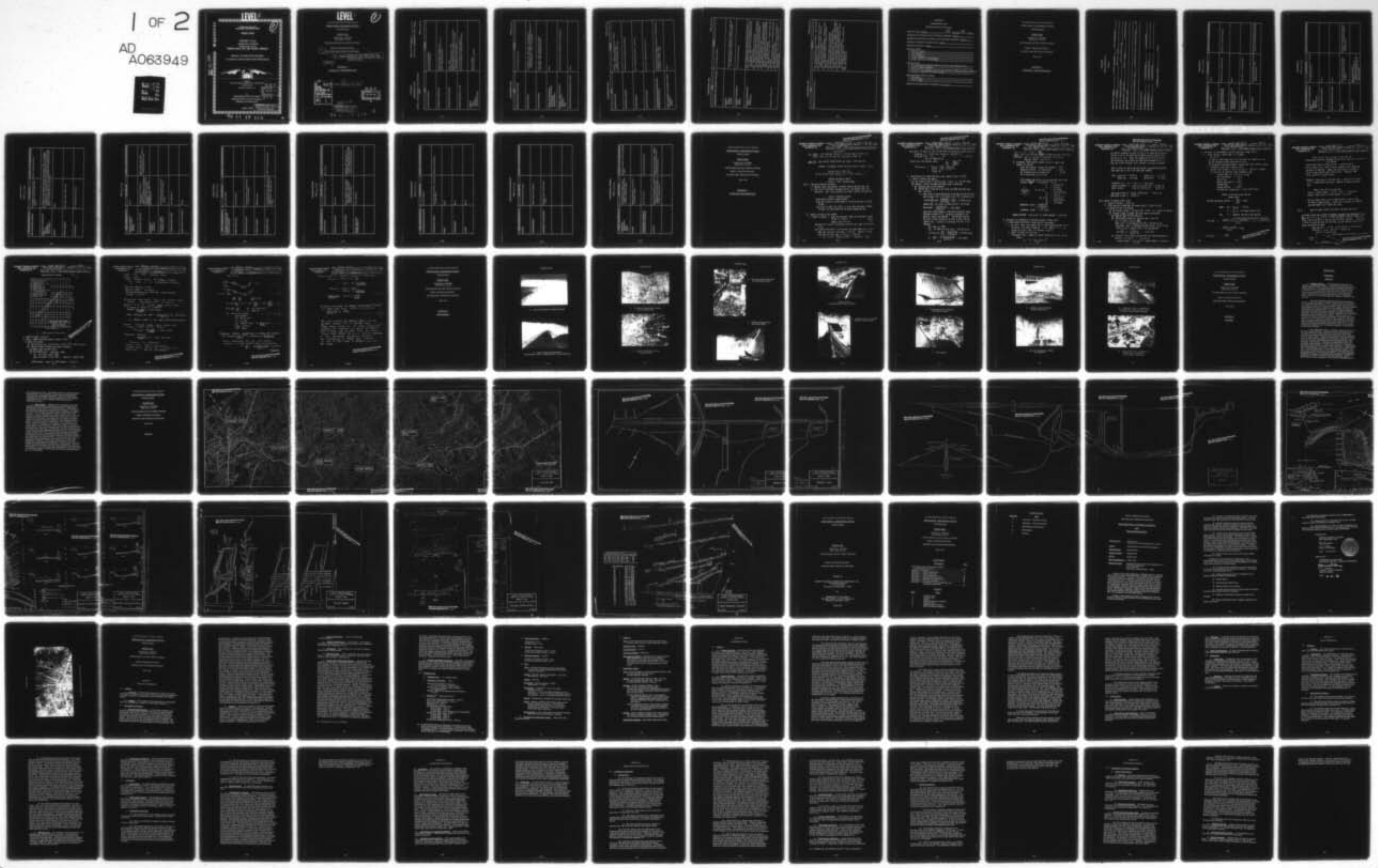
AD-A063 949 GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. NESBITT DAM (NDS PA-00449/DER --ETC(U)
JUL 78 DACW31-78-C-0046

UNCLASSIFIED NL

1 OF 2
AD
A063949



SUSQUEHANNA RIVER BASIN
SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID NO. PA-00449

DER ID NO. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

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

JULY 1978

LEVEL II

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM.

JUL 1978

Nesbitt Dam (NDS PA-00449/DER 35-15), Susquehanna River Basin, Spring Brook, Lackawanna County, Pennsylvania. Phase I Inspection Report.

200p.

APPENDIX A

CHECKLIST - ENGINEERING DATA

Contract No. DACW31-78-C-0046

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Nesbitt

NDS ID NO.: PA-00449 DER ID NO.: 35-15

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	Only for modifications. No original drawings.
REGIONAL VICINITY MAP	Project is shown on Avoca, PA Quadrangle Sheet N 4115-W 75 37.5/7.5 1946. Photorevised 1969.
CONSTRUCTION HISTORY	Built - 1903. Grouting below masonry - 1920. Spillway extended and dam raised - 1931 to 1932. Apron, outlet works, and downstream channel modifications - 1945 to 1947.
TYPICAL SECTIONS OF DAM	One in DER files for masonry spillway. One of embankment in modification drawings.
OUTLETS: Plan Details Constraints Discharge Ratings	Plans available. No other details available.

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	No systematic records.
DESIGN REPORTS	By designer - Mr. John Lance - Published in "Transactions of the Association of Civil Engineers of Cornell University - 1903" - No analyses.
GEOLOGY REPORTS	1914 survey - Brief geologic description. Other data in DER correspondence file.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	Some boring data (not detailed) for modifications.
POSTCONSTRUCTION SURVEYS OF DAM	None.

ITEM	REMARKS
BORROW SOURCES	Masonry - Quarry on northeast side of valley, 3 miles downstream of dam. Embankment - from east end of dam.
MONITORING SYSTEMS	Monuments for monitoring right hillside.
MODIFICATIONS	See "Construction History" - Sheet A-1.
HIGH POOL RECORDS	May 1942 - Raised from 11" to 5'-3".
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	Pennsylvania Water Supply Commission - 1914 and 1917. Frederick P. Stearns - 1918. Consultants - 1918 to 1920.
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	None.

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	No systematic records.
SPILLWAY: Plan Sections Details	Plans and Details of 60' extension available. Other data for original spillway available but not as detailed.
OPERATING EQUIPMENT: Plans Details	None, except outlet works.
PREVIOUS INSPECTIONS Dates Deficiencies (Continued on Sheet A-5)	1919 - Leakage through spillway masonry at left end. 1921 - Crack at downstream end of retaining wall - about 1/2 inch open. Also notes crack at junction wall and nonoverflow section. 1922 - Slope moving about 1/4 inch/year. 1923 - Seepage at left abutment rock face. Cracks in retaining wall as noted above. Hillside moving as before. 1924 - Slight seepage at right downstream wingwall. Hillside same as previous year. 1925 - Leakage in left hill. Few masonry joints need repointing. Large crack in downstream end of retaining wall and two small cracks at junction with nonoverflow section. Hillside still moving. 1926 - Hillside moving 2 inch/year. Masonry joints need repointing. 1927 - Some repointing needed. Old spillway deflecting - probably from moving hillside. 1928 - Repointing needed. Notes survey information on hillside movement. Cracks in retaining wall as previously noted.

ITEM	REMARKS
PREVIOUS INSPECTIONS (Cont'd.)	1929 - Slope movement to left of channel. Total movement of right hillside - 2.9 feet. 1930 - Seepage at toe to right of spillway and at left of spillway, as well as through masonry. Cracks in retaining wall as noted above. 1932 - Some seepage through masonry. Seepage at other points (description cannot be matched to existing features). 1933 - Small flow of water from 3-inch drain. Displacement of right waste channel wall. 1934 - Considerable erosion of downstream face. Seepage from rocks at left end. Seepage in nonoverflow section, through face. Displaced waste channel wall. 1941 - Erosion of earthfill near nonoverflow section. Seepage through face of nonoverflow section. Cracks in retaining wall as noted above. 1943 - Seepage as noted above. Apron washed out. 1953 - No deficiencies. 1965 - No deficiencies.

CHECKLIST

ENGINEERING DATA

HYDROLOGY AND HYDRAULICS

NAME OF DAM: Nesbitt NDS ID NO.: PA-00449 DER ID NO.: 35-15

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1156.0

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1166.0

ELEVATION MAXIMUM DESIGN POOL: 1166.0

ELEVATION TOP DAM: 1166.0

SPILLWAY CREST:
- a. Elevation 1156.0
- b. Type Ogee weir
- c. Width 5 feet
- d. Length 200 feet
- e. Location Spillover Left abutment
- f. Number and Type of Gates None

OUTLET WORKS:
- a. Type Two 30-inch diameter pipes with 14-inch line tapped off one.
- b. Location Right of spillway.
- c. Entrance Inverts 1071.4
- d. Exit Inverts One 30-inch - 1067.8; other 30-inch - 1068.6, 14-inch - 1072.9
- e. Emergency Draindown Facilities Above

HYDROMETEOROLOGICAL GAGES:
- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 19,540 cfs

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1978

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Nesbitt County: Lackawanna State: Pennsylvania

NDS ID No.: PA-00449 DER ID No.: 35-15

Type of Dam: Masonry and Earthfill Hazard Category: High

Date(s) Inspection: 7 June 1978 Weather: Overcast Temperature: 65° F.

Soil Conditions: Moist

Pool Elevation at Time of Inspection: 1156.1 msl/Tailwater at Time of Inspection: 1064.9 msl

Inspection Personnel:

J. Crouse (GFCC)	D. Kaufman (PG&W)	E. Hosier (PG&W)
D. Ebersole (GFCC)	J. Skoritowski (PG&W)	
W. Seip (GFCC)	J. Powell (PG&W)	

A. Whitman, Jr. (GFCC) Recorder

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Depression at retaining wall.	Wall has cracked and moved.
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	None.	
CREST ALIGNMENT: Vertical Horizontal	From survey - no deficiencies.	
RIPRAP FAILURES	Few stones missing near retaining wall. One 3' x 3' bulge. Stumps in riprap.	Missing stones probably caused by vandals. Bulge probably from ice.

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	See unusual movement or cracking at toe (Sheet B-2).	
ANY NOTICEABLE SEEPAGE	None.	
STAFF GAGE AND RECORDER	None.	
DRAINS	Near outlet works drain (about 4-inch diameter) observed seeping.	Another 2-inch diameter drain was seeping. This drain extends to unknown point.
VEGETATION	Near right abutment. 9± trees (up to 2 inches in diameter) in downstream slope. One 6-inch diameter tree in upstream slope.	

MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Nonoverflow section from 12 feet below the top, the entire face is wet.	Brown leaching over face.
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	At junction of nonoverflow section and retaining wall - two cracks. One starts at toe of both structures and extends 20 feet vertically through blocks. The second is 3 feet downstream, extends 20 feet vertically through blocks, and then deflects 45° downstream along joints. Both are fine - no movement.	
DRAINS	None.	
WATER PASSAGES	See outlet works (Sheet B-6).	
FOUNDATION	No deficiencies observed.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY SURFACES: Surface Cracks Spalling	None.	
STRUCTURAL CRACKING	(See junction of structure - Sheet B-4.) Crack 26' upstream of downstream toe of retaining wall. Horizontal separation - 8.5", vertical separation - 5", offset - 9".	Batter appears the same Wet area 36' long by 3' wide by 3' deep; adjacent to crack.
ALIGNMENT: Vertical Horizontal	No deficiencies.	
MONOLITH JOINTS (Masonry Joints)	Nonoverflow section near right - 2' x 2' area with grass in mortar.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAGE OR RECORDER	None.	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None (iron pipe).	
INTAKE STRUCTURE	Not observable.	
OUTLET STRUCTURE	Control structure - missing pane of glass in skylight.	
OUTLET CHANNEL	Spillway apron.	
EMERGENCY GATE	Four 30-inch valves could not be operated with four men and bars. 10-inch valve - operation was good.	10-inch valve packing leaks.

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY WEIR	Eroded mortar in lower joints.	Not severe.
APPROACH CHANNEL	Reservoir.	
DISCHARGE CHANNEL	Apron - eroded mortar in joints (fairly severe). Downstream edge eroded. Wire mesh corroded and broken.	Auxiliary apron and wall - no deficiencies, except trees close to wall. Seepage from rock face which acts as left abutment.
BRIDGE AND PIERS ACROSS APRON	Good condition.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	On right hillside.	
OBSERVATION WELLS	Two near right abutment, upstream of core wall.	Apparently abandoned.
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Fairly steep with outcrop.	
SEDIMENTATION	Owner reports no problem.	
WATERSHED DESCRIPTION	Mostly wooded. PG&W owns 50%±.	

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	Soil deposited in right side of channel, about 100 feet downstream of spillway apron.	Channel narrows to 30% of upstream width.
SLOPES	Being monitored by Owner (see "Seepage" below).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Over 100 homes.	Not observable from dam.
SEEPAGE	About 45' downstream of retaining wall and at same elevation (approximate). Clear seepage of 25 gpm in swampy area.	Stream leads from area. Hillside below area is wet with some seepage observed.

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1978

APPENDIX C

HYDROLOGY AND HYDRAULICS

CLASSIFICATION

HIGH HAZARD, SINCE DOWNSTREAM POPULATION IS 500, AND FAILURE OF THE DAM COULD RESULT IN MORE THAN A FEW LIVES LOST AND EXCESSIVE ECONOMIC LOSS.

LARGE SIZE, SINCE SURVEYED HEIGHT = 101 FEET AND CAPACITY = 5,034 ACRE-FEET

REFERENCE: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS," p. D-8.

SPILLWAY DESIGN FLOOD (SDF)

THE SDF SHOULD BE THE PMF (FROM p. D-12 OF "REC. GUIDELINES...")

HYDROLOGY AND HYDRAULICS ANALYSIS

REFERENCE: PHASE I PROCEDURE PACKAGE

II. A. 2. PMF INFLOW HYDROGRAPH NOT AVAILABLE

a. BALTIMORE CONTACT, MIKE KANOWITZ, RECOMMENDS OBTAINING PMF PEAK FROM CURVE
b. FROM CURVE OF SUSQUEHANNA RIVER BASIN, REGION 2, AND DRAINAGE AREA = 37.1 SQUARE MILES, PMF = 1,380 CFS/SQ.MI. x 37.1 SQ.MI. = 51,198, SAY 51,200 CFS

EFFECT OF UPSTREAM RESERVOIRS

DO NOT NEGLECT THE EFFECT OF WATRES RESERVOIR

ASSUME THAT THE EFFECT OF COMPTON RESERVOIR IS REFLECTED IN THE EFFECT OF WATRES RESERVOIR

CHECK EFFECT OF MAPLE LAKE (D.A. = 1.1 SQ. MI. AND SURFACE AREA = 35 ACRES)
SEE SHEET 6 FOR STORAGE VOLUME CHECK FOR FAILURE OF MAPLE LAKE DAM

B. ABILITY OF SPILLWAY TO PASS THE PMF

1. CAPACITY OF SPILLWAY — DESIGN TOP OF DAM ELEV. = ACTUAL TOP OF DAM ELEV. = 1,166.0'
SPILLWAY CREST ELEVATION = 1,156.0'
AVAILABLE HEAD ON SPILLWAY = 10.0'

FROM WATER SUPPLY COMMISSION OF PENNSYLVANIA COMPUTATION SHEETS DATED 29 OCTOBER 1942, C = 3.09

FROM "REPORT UPON THE APPLICATION OF THE SCRANTON-SPRING BROOK WATER SERVICE COMPANY," WATER SUPPLY COMMISSION OF PENNSYLVANIA, 27 JUNE 1945, CAPACITY OF SPILLWAY WITH A HEAD OF 10 FEET AND C = 3.09 IS 19,540 CFS

$$Q = CLH^{3/2} = (3.09)\ 200\ (10)^{3/2} = 19,540 \text{ CFS} \quad (OK)$$

SP 11860A

CHECK ABILITY OF SPILLWAY TO PASS THE PMF FROM THE UNCONTROLLED DRAINAGE AREA ALONE

UNCONTROLLED D.A. = NESBITT D.A. − WATRES D.A. − MAPLE LAKE D.A.

UNCONTROLLED D.A. = 37.1 − 15.4 − 1.1 = 20.6 SQ.MI.

PMF FOR UNCONTROLLED D.A.

GENERAL FORMULA FROM BALTIMORE CONTACT: $\frac{Q_1}{Q_2} = \left(\frac{D.A._1}{D.A._2}\right)^{0.8}$

$$Q_{\text{UNCONTROLLED D.A.}} = Q_{\text{TOTAL D.A.}} \left(D.A._1 / D.A._2\right)^{0.8}$$
$$= 51{,}200 \left(20.6 / 37.1\right)^{0.8}$$
$$= 31{,}980 \text{ CFS}$$

3. THE PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY (31,980 > 19,540)

b. ROUTING OF THE PMF IS NOT AVAILABLE

(1.) THE SPILLWAY WILL PASS (19,540/31,980) = 0.611 = p = 61.1 % OF PEAK

(2.) INCLOSURE 3 METHOD TO ESTIMATE THE STORAGE EFFECT OF THE RESERVOIR

(a) TRIANGULAR SHAPE FOR PMF HYDROGRAPH

(b) FROM THE GRAPH OF TOTAL TIME VS. D.A. FOR THE SUSQUEHANNA RIVER BASIN, TOTAL TIME = 41.4 HOURS

— CHECK INCHES OF RUNOFF PRODUCED BY THE PMF PEAK AND THE TOTAL TIME —

RUNOFF VOLUME = $\frac{1}{2}bh = \frac{1}{2}$ (41.4 HOURS)(51,200 CFS) = 1,059,840 CFS-HRS

$$1{,}059{,}840 \frac{FT^3}{SEC} \times HOURS \times \frac{3{,}600 \text{ AC-SECS}}{43{,}560 \text{ FT}^2\text{-HRS}} \times \frac{12 \text{ IN}}{1 \text{ FT}} = 1{,}051{,}081 \text{ AC-IN}$$

DRAINAGE AREA = 37.1 SQ.MI. × (640 ACRES / SQ.MI.) = 23,744 ACRES

$$\text{RUNOFF AMOUNT} = \frac{1{,}051{,}081 \text{ AC-IN}}{23{,}744 \text{ AC}} = 44.3 \text{ INCHES}$$

SINCE 44.3 INCHES OF RUNOFF IS A HIGH VALUE FOR THE PMF, REDUCE THE INCHES OF RUNOFF TO 26, AS PER THE INSTRUCTIONS OF THE BALTIMORE CONTACT, MIKE KANOWITZ. FROM THE PMF PEAK AND THE VOLUME OF RUNOFF PRODUCED BY 26 INCHES OF RUNOFF OVER THE DRAINAGE AREA, CALCULATE THE EQUIVALENT TOTAL TIME OF PMF HYDROGRAPH.

$VOL = \frac{1}{2}bh;\ b = \frac{2\,VOL}{h}$

VOL = 26" RUNOFF × 23,744 ACRES = 617,344 AC-IN

$$617{,}344 \text{ AC-IN} \times \frac{1 \text{ FT}}{12 \text{ IN}} \times \frac{43{,}560 \text{ FT}^2\text{-HRS}}{3{,}600 \text{ AC-SECS}} = 622{,}489 \text{ CFS-HRS}$$

$$b = \frac{2\,VOL}{h} = \frac{2 \times 622{,}489 \text{ CFS-HRS}}{51{,}200 \text{ CFS}} = 24.3 \text{ HOURS}$$

SP 11860A

$1-p = 1 - 0.611 = 0.389 = \frac{\Delta AOC}{\Delta AOB}$

$\Delta AOB = \frac{1}{2} bh = VOL = 20.6 \text{ SQ.MI.} \times \frac{640 \text{ ACRES}}{1 \text{ SQ.MI.}} \times 26'' \text{ RUNOFF} \times (1 \text{ FT}/12 \text{ IN}) = 28,565 \text{ AC-FT}$

SUBSTITUTING, $\Delta AOC = (1-p)\,\Delta AOB = (0.389)(28,565) = 11,110$ AC-FT

REQUIRED STORAGE = 11,110 AC-FT

(c) INCREMENTAL STORAGE AVAILABLE BETWEEN NORMAL POOL ELEVATION AND MAXIMUM POOL ELEVATION

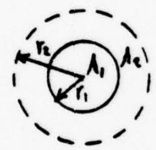
NORMAL POOL ELEVATION = SPILLWAY CREST ELEVATION = 1156.0'
MAXIMUM POOL ELEVATION = TOP OF DAM ELEVATION = 1,166.0'
AREA OF RESERVOIR WITH W.S @ SPILLWAY CREST = 116 ACRES
AREA OF RESERVOIR WITH W.S. @ TOP OF DAM = ?

ASSUME RESERVOIR SIDE SLOPES OF 4H ON 1V AND ASSUME CIRCULAR SHAPE

$116 \text{ ACRES} \times \frac{43,560 \text{ FT}^2}{1 \text{ ACRE}} = 5,052,960 \text{ FT}^2 = \pi r_1^2$

$r_1^2 = 1,608,407 \text{ FT}^2$

$r_1 = 1,268.2 \text{ FT}$



$r_2 = r_1 + \Delta H = r_1 + 4(\Delta V)$

$r_2 = 1,268.2 \text{ FT} + 4(10')$

$r_2 = 1,308.2 \text{ FT}$

$A_2 = \pi r_2^2 = \pi (1,308.2')^2$

$A_2 = 5,376,728 \text{ FT}^2$

$A_2 = 123.4 \text{ ACRES}$

$\text{INCREMENTAL STORAGE} = \left(\frac{A_1 + A_2}{2}\right) \Delta V = \left(\frac{116 + 123.4}{2}\right) 10'$

INCREMENTAL STORAGE = 1,197 AC-FT

STORAGE REQUIRED = 11,110 AC-FT >> STORAGE AVAILABLE = 1,197 AC-FT

C. PROCEDURES FOR DETERMINATION OF ADEQUATE/INADEQUATE SPILLWAY CAPACITY

2. STORAGE REQUIRED FOR THE PMF IS GREATER THAN THE STORAGE AVAILABLE

a. ETL 1110-2- STATES THREE CONDITIONS THAT MUST EXIST BEFORE THE SPILLWAY CAPACITY IS CONSIDERED TO BE SERIOUSLY INADEQUATE. CHECK CONDITION "C." (IS THE SPILLWAY ABLE TO PASS ½ PMF W/O OVERTOPPING FAILURE?)

b. REPEAT CALCULATIONS FOR ½ PMF PEAK

FROM BALTIMORE CONTACT, DETERMINE THE TRIBUTARY DISCHARGES FOR THE PMF FROM THE FORMULA:

$$Q_1 = Q_2 \left(D.A._1 / D.A._2 \right)^{0.8}$$

SP 11860A

AN ASSUMPTION IS REQUIRED TO ESTIMATE THE OUTFLOW FROM WATRES DAM AND FROM MAPLE LAKE DAM TO ADD TO THE RUNOFF FROM THE UNCONTROLLED AREA BELOW THOSE DAMS AND ABOVE NESBITT DAM. ASSUME VERY CONSERVATIVE CONDITIONS FOR THE OUTFLOWS FROM THE UPSTREAM DAMS, AND IF NESBITT DAM CANNOT PASS THE CONSERVATIVE INFLOW TO IT, THEN THE SPILLWAY OF NESBITT CAN BE CONSIDERED TO BE UNABLE TO PASS ½ PMF.

THAT IS, ASSUME NO OUTFLOW FROM MAPLE LAKE DAM, AND ASSUME THE CONTRIBUTION FROM WATRES DAM IS 40% OF THE WATRES DAM COMPONENT.

GIVEN: NESBITT PMF = 51,200 CFS — WATRES D.A. = 15.4 SQ.MI.
NESBITT D.A. = 37.1 SQ.MI. — MAPLE LAKE D.A. = 1.1 SQ.MI.

UNCONTROLLED D.A. = 37.1 − 15.4 − 1.1 = 20.6 SQ.MI.
UNCONTROLLED COMPONENT = 51,200 CFS $(20.6/37.1)^{0.8}$ = 31,980 CFS
WATRES COMPONENT = 51,200 CFS $(15.4/37.1)^{0.8}$ = 25,340 CFS

PMF INFLOW TO NESBITT ≥ 31,980 + (0.4) 25,340 = 42,116 CFS
½ PMF INFLOW TO NESBITT ≥ 21,060 CFS

II. B. ABILITY OF SPILLWAY TO PASS ½ PMF
1. CAPACITY OF SPILLWAY = 19,540 CFS
3. ½ PMF PEAK FLOW IS GREATER THAN THE SPILLWAY CAPACITY (19,540 > 21,060)
b. ROUTING OF ½ PMF IS NOT AVAILABLE
(1.) THE SPILLWAY WILL PASS (19,540/21,060) = 0.928 = p = 92.8 % OF ½ PMF PEAK
(2.) INCLOSURE 3 METHOD TO ESTIMATE THE STORAGE EFFECT OF THE RESERVOIR
(a) TRIANGULAR SHAPE FOR ½ PMF HYDROGRAPH
(b) SAME AS BEFORE, EXCEPT THAT THE PEAK IS NOW 21,060 CFS
$1-p = 1-0.928 = 0.072 = \frac{\Delta ADC}{\Delta ACB}$
$\Delta ACB = \frac{1}{2}bh = \frac{1}{2}$ (24.3 HOURS)(21,060 CFS) = 255,879 CFS-HRS
SUBSTITUTING, ΔADC = (0.072)(ΔACB) = (0.072)(255,879) = 18,423 CFS-HRS
∴ 18,423 CFS-HRS IS REQUIRED TO PASS ½ PMF W/O OVERTOPPING
$18{,}423 \frac{FT^3}{SEC} \times HRS \times \frac{3{,}600\ AC\text{-}SEC}{43{,}560\ FT^2\text{-}HRS}$ = 1,523 AC-FT
(c) INCREMENTAL STORAGE AVAILABLE BETWEEN NORMAL POOL ELEVATION AND MAXIMUM POOL ELEVATION − SEE SHEET 3 − = 1,197 AC-FT
STORAGE REQUIRED = 1,523 AC-FT > STORAGE AVAILABLE = 1,197 AC-FT

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT NESBITT DAM (35-15) FILE NO. 763.1N
HYDROLOGY AND HYDRAULICS ANALYSIS SHEET NO. 5 OF 7 SHEET
FOR USCE - BALTIMORE DISTRICT
COMPUTED BY JRC DATE 6/20/78 CHECKED BY PvdG DATE 7/5/..

C. PROCEDURES FOR DETERMINATION OF ADEQUATE / INADEQUATE SPILLWAY CAPACITY

2. STORAGE REQUIRED IS GREATER THAN STORAGE AVAILABLE

a. ETL 1110-2-

① THERE IS A HIGH HAZARD OF LOSS OF LIFE FROM LARGE FLOWS DOWNSTREAM OF DAM

② CHECK TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS

③ THE DAM AND SPILLWAY ARE NOT CAPABLE OF PASSING ½ PMF WITHOUT OVERTOPPING FAILURE

b. TAILWATER AT INSTANT BEFORE OVERTOPPING OCCURS

SPILLWAY CAPACITY DISCHARGE = 19,540 CFS (CASE 1). FROM HEC-2 COMPUTER RUN USING A USGS TOPO SHEET CROSS-SECTION DOWNSTREAM OF DAM,

TAILWATER DEPTH @ Q = 19,540 CFS IS 14.5 FEET

TOP OF DAM ELEVATION	=	1,166.0'
HEIGHT OF DAM	=	101.1'
BOTTOM OF DAM ELEVATION	=	1,064.9'
TAILWATER DEPTH	=	14.5'
TAILWATER ELEVATION	=	1,079.4'

TOP OF DAM ELEV. − TAILWATER ELEV. = 1,166.0' − 1,079.4' = 86.6'

PERCENT OF PMF THAT SPILLWAY CAN PASS
GENERAL FORMULA

$$\text{\% OF PMF THAT SPILLWAY CAN PASS} = \frac{Q_T}{Q_{PMF}} \times 100\%,$$

WHERE $Q_T = Q_{SPILLWAY} + 2S/\Delta t$,

$S = \sum_{i=1}^{n} S_i$ FOR UPSTREAM RESERVOIR CASES,

AND T = EQUIVALENT TOTAL TIME OF PMF HYDROGRAPH

$$\text{\% OF PMF} = \frac{19{,}540 + \left(\frac{2 \times (1{,}197 + 2{,}284 + (4')(35\text{ A}))\text{ AC-FT}}{24.3\text{ HOURS}} \times \frac{43{,}560\text{ FT}^2\text{-HR}}{3{,}600\text{ AC-SEC}}\right)}{51{,}200} \times 100$$

$$= \frac{19{,}540 + 3{,}606}{51{,}200} \times 100\%$$

$$\text{\% OF PMF} = 45\%$$

SP 11860A

STORAGE VOLUME CHECK FOR FAILURE OF MAPLE LAKE DAM

FAILURE CAPACITY OF MAPLE LAKE = NORMAL POOL VOL.* + SURCHARGE VOL. − NATURAL LAKE VOL. = 657 + 140 − 140
= 657 ACRE-FEET

SURCHARGE STORAGE CAPACITY OF NESBITT RESERVOIR = 1,197 AC-FT (SHEET 3)

SINCE THE SURCHARGE STORAGE CAPACITY OF NESBITT RESERVOIR IS MUCH GREATER THAN THE CAPACITY OF MAPLE LAKE, NESBITT DAM SHOULD BE ABLE TO WITHSTAND A FAILURE OF MAPLE LAKE DAM WITHOUT BEING OVERTOPPED, DISREGARDING OTHER INFLOW AND OUTFLOW TO NESBITT RESERVOIR.

* REFERENCE: "DAMS, RESERVOIRS, AND NATURAL LAKES," WATER RESOURCES BULLETIN NO. 5, COMMONWEALTH OF PENNSYLVANIA, DEPARTMENT OF FORESTS AND WATERS, 1970.

STORAGE VOLUME CHECK FOR WATRES DAM

CAPACITY OF WATRES RESERVOIR = 8,655 + 2,284 = 10,939 AC-FT

SURCHARGE STORAGE CAPACITY OF NESBITT RESERVOIR = 1,197 AC-FT

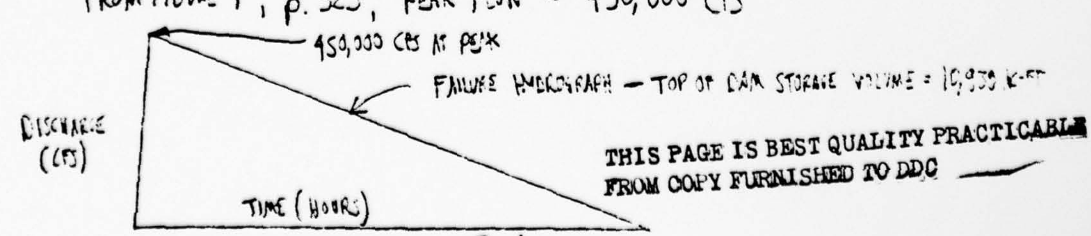
SINCE THE SURCHARGE STORAGE CAPACITY OF NESBITT RESERVOIR IS MUCH LESS THAN THE CAPACITY OF WATRES RESERVOIR, NESBITT DAM WOULD PROBABLY BE OVERTOPPED AND WOULD PROBABLY FAIL IF WATRES DAM FAILED.

II. B. ABILITY OF NESBITT SPILLWAY TO PASS RELEASE FROM WATRES DAM FAILURE

AN ATTEMPT HAS BEEN MADE BY BERTLE IN <u>INSPECTION, MAINTENANCE, AND REHABILITATION OF OLD DAMS</u>, ASCE, 1973, pp. 328-336 TO PRESENT AN ESTIMATE OF PEAK FLOW FROM A DAM FAILURE BASED ON THE HEIGHT OF DAM AND ACTUAL DAM FAILURE EXPERIENCE. ASSUME THAT A FAILURE OF WATRES DAM WOULD FOLLOW THIS TREND, AND THAT THE TOTAL STORAGE VOLUME BEHIND THE DAM WOULD BE RELEASED.

WATRES DAM HEIGHT = 101 FEET (WATRES DAM PHASE I INSPECTION REPORT)

FROM FIGURE 1, p. 329, PEAK FLOW = 450,000 CFS



SELECTING SPILLWAY FLOODS 329

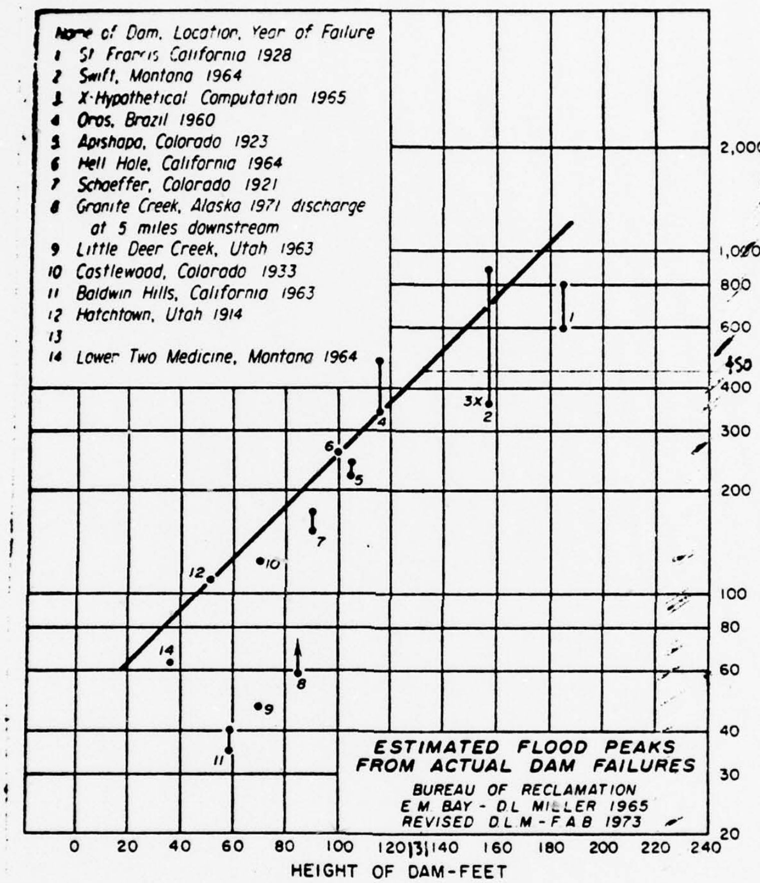


FIG. 1. -- ESTIMATED FLOOD PEAKS FROM ACTUAL DAM FAILURES

1. CAPACITY OF SPILLWAY = 19,540 CFS
3. INFLOW IS GREATER THAN SPILLWAY CAPACITY (450,000 > 19,540)
   b. ROUTING IS NOT AVAILABLE
      (1) THE SPILLWAY WILL PASS (19,540/450,000) = 0.043 = p = 4.3% OF THE PEAK
      (2) INCLOSURE 3 METHOD TO ESTIMATE STORAGE EFFECT OF RESERVOIR
         (a) TRIANGULAR SHAPE FOR FAILURE HYDROGRAPH
         (b) FAILURE HYDROGRAPH VOLUME = 10,939 AC-FT = ΔAOB

$1-p = 1.0-0.043 = 0.957 = \frac{\Delta AOC}{\Delta AOB}$

$\Delta AOC = (1-p)\, \Delta AOB = (0.957)\, 10,939 = 10,469$ AC-FT = REQUIRED STORAGE

STORAGE REQUIRED = 10469 >> STORAGE AVAILABLE = 1,197 AC-FT

SP 11840A

FROM PA DAM SURVEY BOOK

MAPLE LAKE:

NOTE PG&W OWNS 2 MAPLE LAKES
THIS ONE IS IN LACKAWANNA COUNTY

DRAINAGE AREA = 1.1 mi^2
SURFACE AREA = 35 ACRES
STORAGE (NORMAL POOL) = 214 MG = 657 ACRE-FT
HEIGHT = 15 FT

DETERMINE EQUIVALENT RADIUS AT NORMAL POOL

$A = \pi r^2$ $\quad 35 \times 43560 = \pi r^2 \quad r \approx 697$ FT

ASSUME 1V ON 1H SLOPES BELOW NORMAL POOL

$r_{\text{AT BOTTOM}} = 697 - 15 = 682$ FT

$$\text{AREA} = \frac{\pi \times 682^2}{43560} = 33.5 \text{ ACRES}$$

$$\text{POOL RETAINED BY DAM} = \left(\frac{35 + 33.5}{2}\right) \times 15 = 514 \text{ ACRE-FT}$$

$\therefore$ NATURAL LAKE IS AT LEAST (657 − 514) = 143 ACRE-FT

ASSUME 1V ON 3H SLOPES ABOVE NORMAL POOL

$r_{\text{EQUIV.}} = 697 + 3 \times 4 = 709$ FT

$$A_{\text{AT TOP}} = \frac{\pi \times 709^2}{43560} = 36.3 \text{ ACRES}$$

SURCHARGE STORAGE:

$$\frac{36.3 + 35}{2} \times 4 = 143 \text{ ACRE-FT}$$

SUMMARY OF STORAGE:

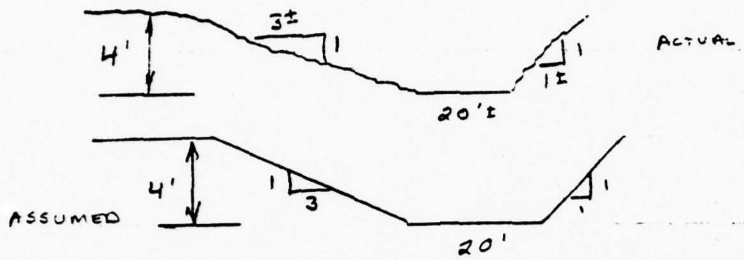
NATURAL LAKE:	143 A.F.	Δ = 514 A.F.
NORMAL POOL:	657 A.F.	Δ = 143 A.F.
TOP OF DAM:	800 A.F.	

Δ = 657 A.F. (natural lake to top of dam)

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT: MAPLE LAKE — HYDRAULICS AND HYDROLOGY
FILE NO. ______ SHEET NO. ____ OF ____ SHEETS
FOR: NESBITT
COMPUTED BY: AAW DATE 6/27/78 CHECKED BY ______ DATE ______

SPILLWAY



$$\frac{A^3}{T} = \frac{Q^2}{g} \qquad \frac{gA^3}{T} = Q^2$$

$$H = d + V^2/2g = 4' = d + \frac{Q^2}{2gA^2} = d + \frac{\frac{gA^3}{T}}{2gA^2}$$

$$4' = d + \frac{A}{2T} \qquad A = d(20+2d)$$

$$T = 4d+20$$

BY TRIAL AND ERROR

$d = 2.84$ FT

$A = 72.93$ FT^2

$T = 31.36$

$Q = 630.9$ CFS $\approx$ 630 CFS

$V^2/2g = 1.16$ FT

$H = 4$ FT

TRANSPOSE NESBITT HYDROGRAPH FOR MAPLE LAKE COMPONENT

$$Q = 51{,}200\left(\frac{1.1}{37.1}\right)^{0.8} = 3068 \text{ CFS} \approx 3070 \text{ CFS}$$

ADJUST HYDROGRAPH FOR 26 INCHES RUNOFF

$$\text{VOLUME} = 1.1 \times 640 \times 43560 \times 26/12 = 66{,}443{,}520 \text{ CF}$$

$$T = \frac{2S}{Q} = \frac{2 \times 66{,}443{,}520}{3070} = 43{,}286 \text{ SEC}$$

$$= 12.02 \text{ HRS}$$

6315

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT: MAPLE LAKE
HYDRAULICS AND HYDROLOGY
FOR: NESBITT
COMPUTED BY: AHW DATE: 6/29/78 CHECKED BY: ______ DATE: ______
FILE NO. ______ SHEET NO. ____ OF ____ SHEETS

DETERMINE % OF NESBITT COMPONENT OF PMF PASSED

$$Q_{INFLOW} = Q_{SPILLWAY} + \frac{2S}{T}$$

$$= 630 + 2 \times \frac{143 \times 43560}{12.02 \times 3600}$$

$$Q_{INFLOW} = 630 + 288$$

$$= 918 \text{ CFS} \approx \underline{\underline{920 \text{ CFS}}}$$

$$\frac{920 \times 100}{3070} = 29.96 \approx \underline{\underline{30\%}}$$

STORAGE AVAILABLE AT NESBITT (SURCHARGE) = 1,197 A.F.

IF MAPLE LAKE FAILS 657 A.F. WILL FLOW OUT

$$\frac{657 \times 100}{1,197} \approx 55\%$$

IN THE ANALYSIS OF NESBITT DAM FOR THE ½-PMF STORM. IT IS ASSUMED THAT MAPLE LAKE STORES ALL ITS INFLOW. WHILE NOT CORRECT, THIS "IMPROVES" THE ABILITY OF NESBITT DAM TO PASS THE ½-PMF. SINCE THE RESULTS INDICATE THAT NESBITT SPILLWAY IS SERIOUSLY INADEQUATE, A MORE REASONABLE ASSUMPTION CONCERNING THE CONTRIBUTION OF MAPLE LAKE OUTFLOWS TO THE ½-PMF STORM AT NESBITT WILL NOT BE MADE.

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

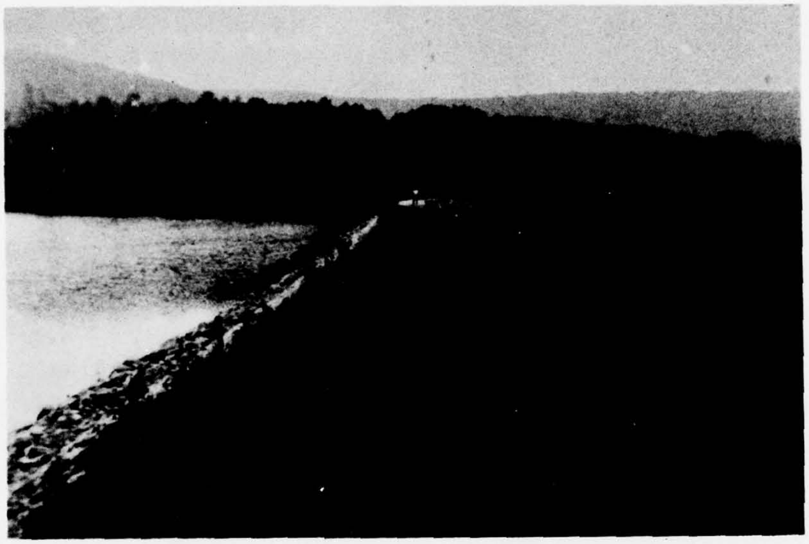
NATIONAL DAM INSPECTION PROGRAM

JULY 1978

APPENDIX D

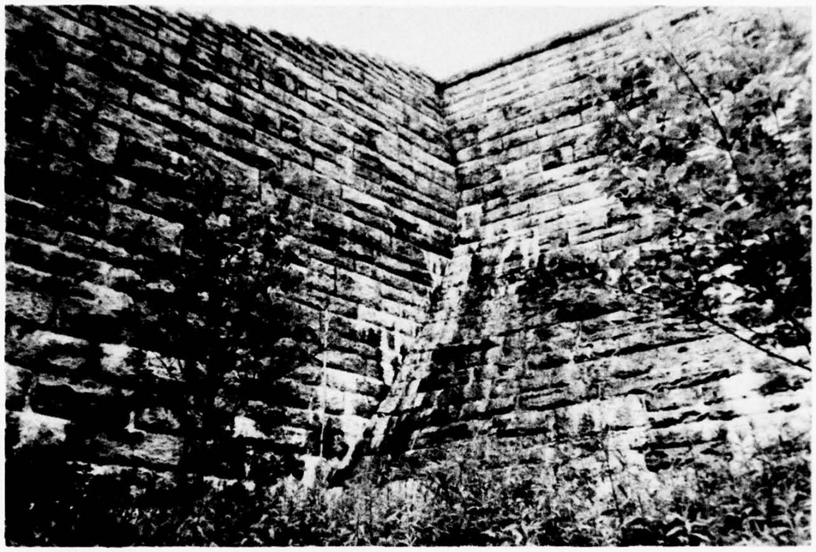
PHOTOGRAPHS

NESBITT DAM

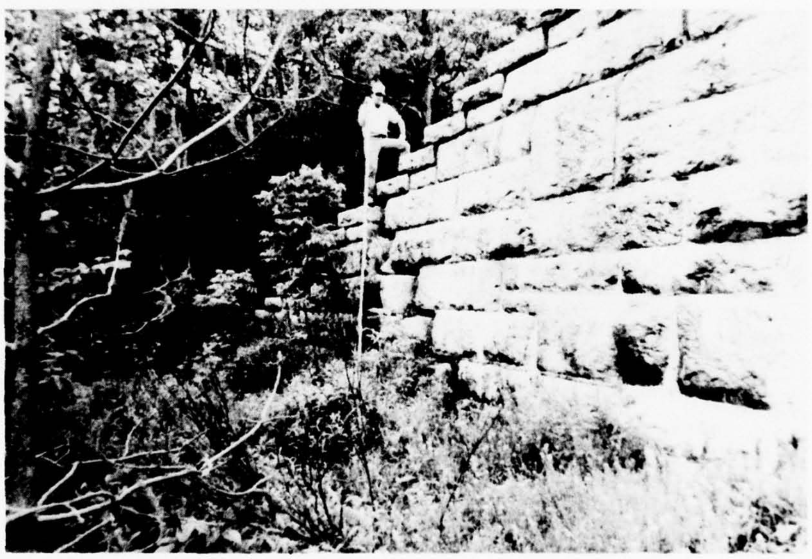


A. View of Embankment at Right Abutment

B. View Towards Right Abutment.
Nonoverflow Section, Retaining Wall, and Embankment.



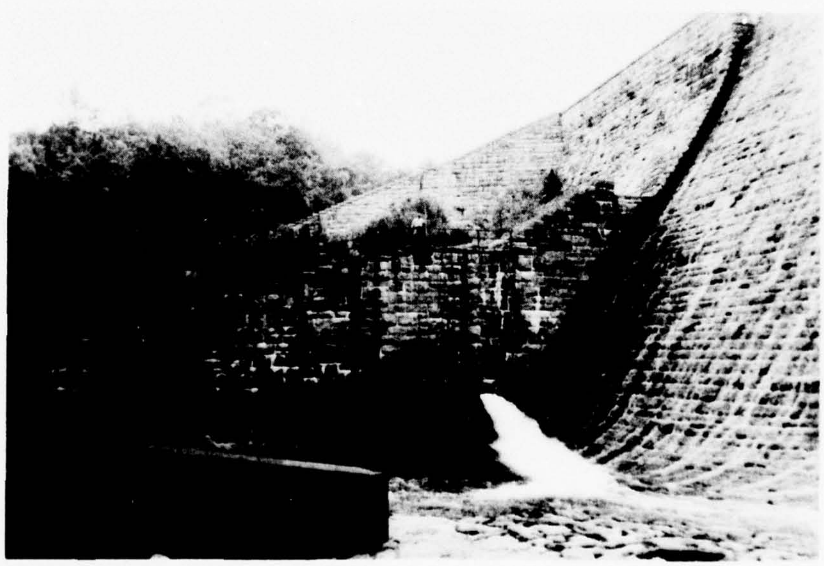
C. Junction of Nonoverflow Section and Retaining Wall

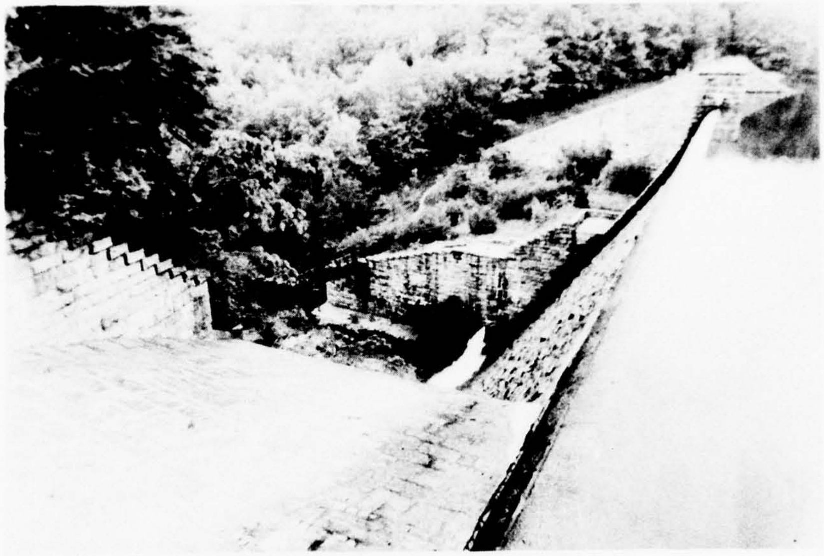


D. Crack at Downstream Toe of Retaining Wall

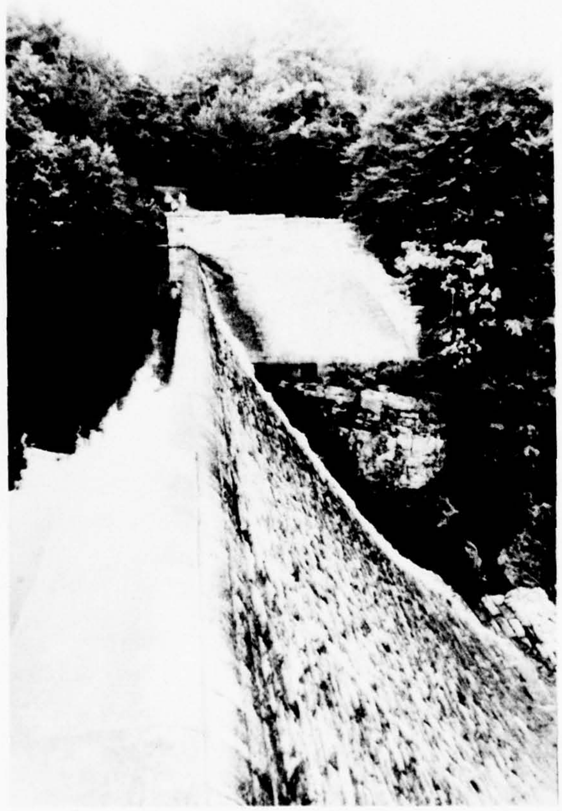
E. Wet Spot Near Downstream Toe of Retaining Wall

F. Spillway Training Wall and Outlet Pipes



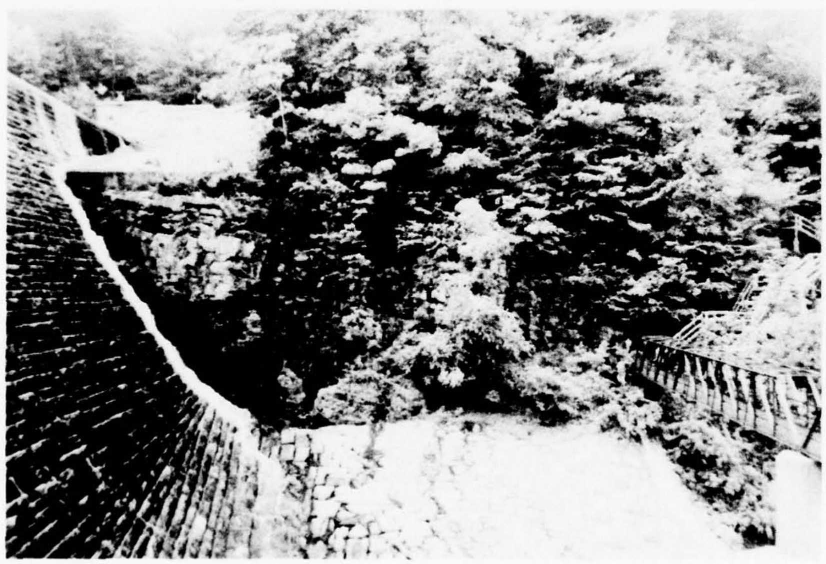


G. Spillway Crest
Looking Towards Right Abutment



H. Spillway Crest — Looking Towards Left Abutment

I. Downstream Face of Spillway and Spillway Apron



J. Left Abutment

K. Spillway Apron and Bridge
Looking Downstream

L. View of Downstream Channel
from Spillway

M. Maple Lake Dam — Upstream of Nesbitt Dam — View of Top of Dam Looking Towards Right Abutment

N. Maple Lake Dam — Upstream of Nesbitt Dam — Spillway, View Looking Downstream

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1978

APPENDIX E

GEOLOGY

NESBITT DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35°-40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. Northwest of Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country to the northwest. Consequently, most of the drainage in this part of the County flows westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. Nesbitt Dam is founded in the sandstone and shales of the Catskill group to the southeast of the Lackawanna Syncline and the Lackawanna River. The effect of the syncline on the rocks in this area is very great. The dip of the rock strata changes from being almost horizontal to a sharp dip of 30° to 40° to the northwest, normal to the axis of the syncline. It was determined by borings, made in 1920, that the 250 feet of masonry gravity nonoverflow at the left, or southeastern end of the dam, is founded on red and green sandstone. Under the 140 feet of masonry spillway, the sandstone strata begins to dip to the right, or northwest, and is overlain by red shale. Near the right end of the spillway, 30 feet of red clay shale overlays the sandstone. Beyond this point the sandstone strata begins to dip very sharply and the red shale transitions into red sandy clay. The right, or northwest, end of the dam consists of 250 feet of earthen embankment resting on clay. The sandstone strata is located from 50 to 150 feet below the clay foundation surface in this area. Investigation during construction revealed the existence of several thin seams of gravel in the thick layer of clay that rested over the sandstone. The concrete core wall, in the middle of the embankment, was founded on a gravel seam located an average of 35 feet below top of ground. The clay foundation is obviously the decomposed red shale and it had contained thin stratifications of sandstone or sandy shale. Decomposition probably occurred after the shale formation was fractured from folding. A short distance below the damsite, the stream turns to the left and begins to cut through the Pocono sandstone formation as a deep gorge.

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

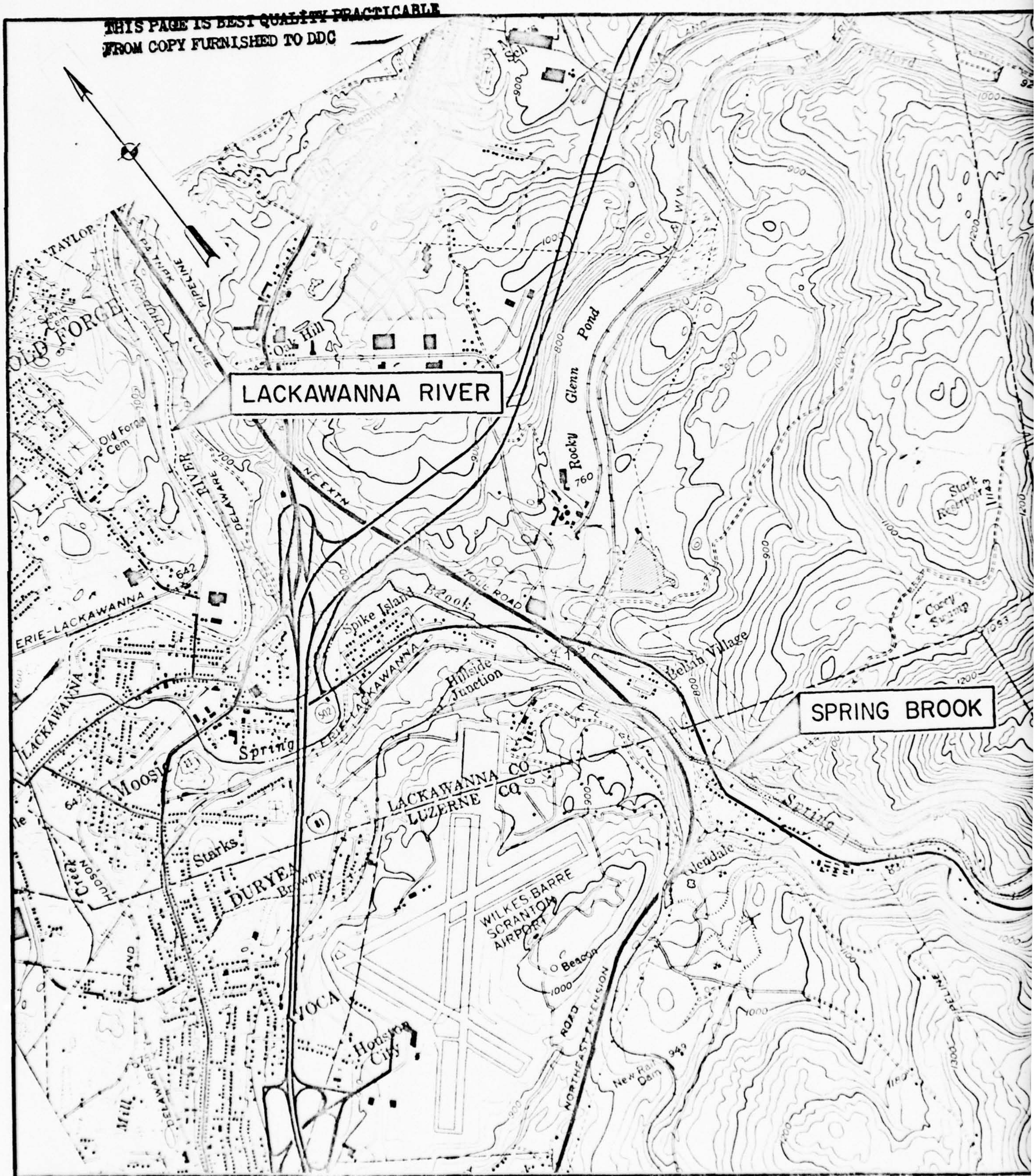
PENNSYLVANIA GAS AND WATER COMPANY

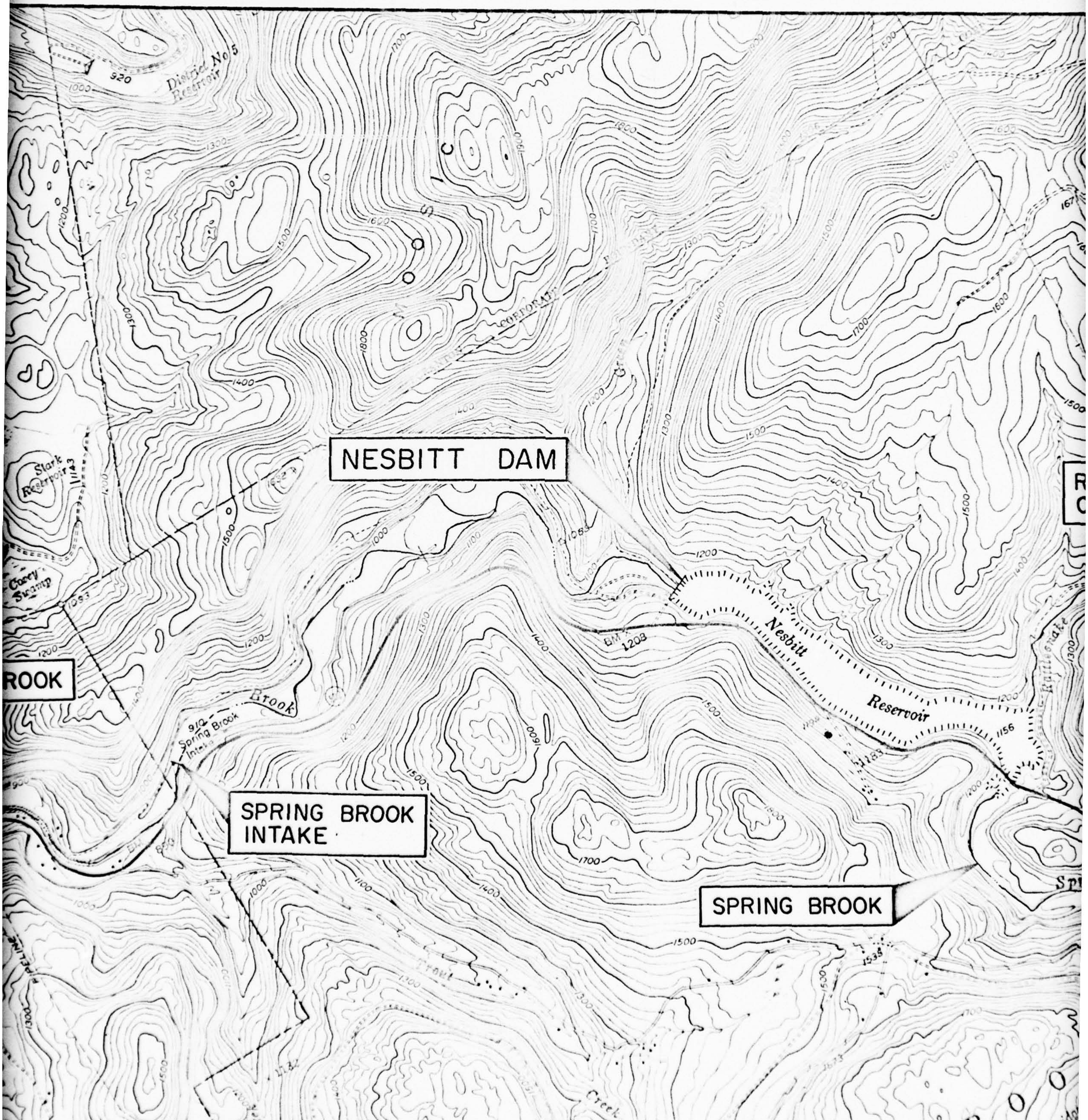
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

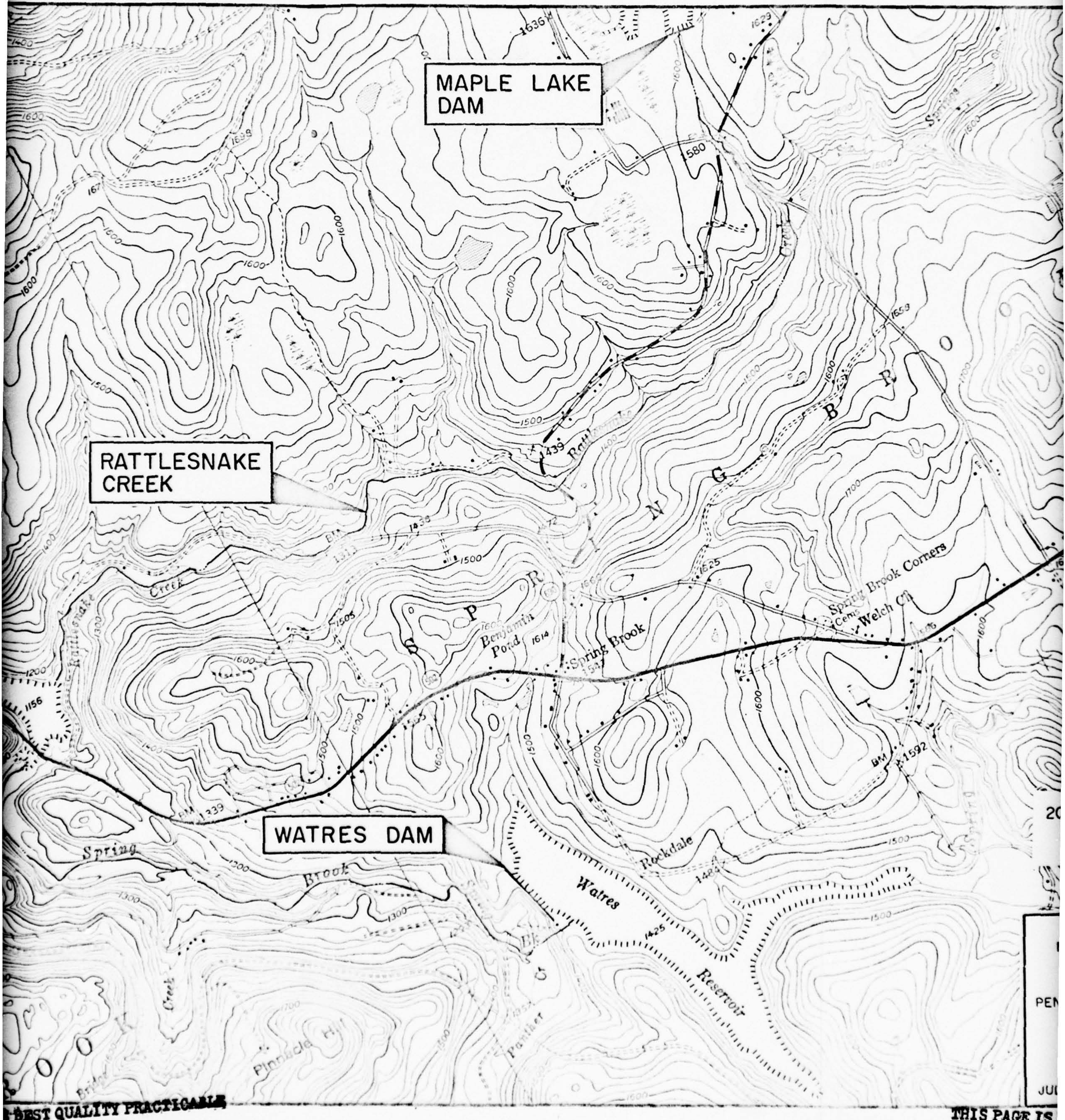
JULY 1978

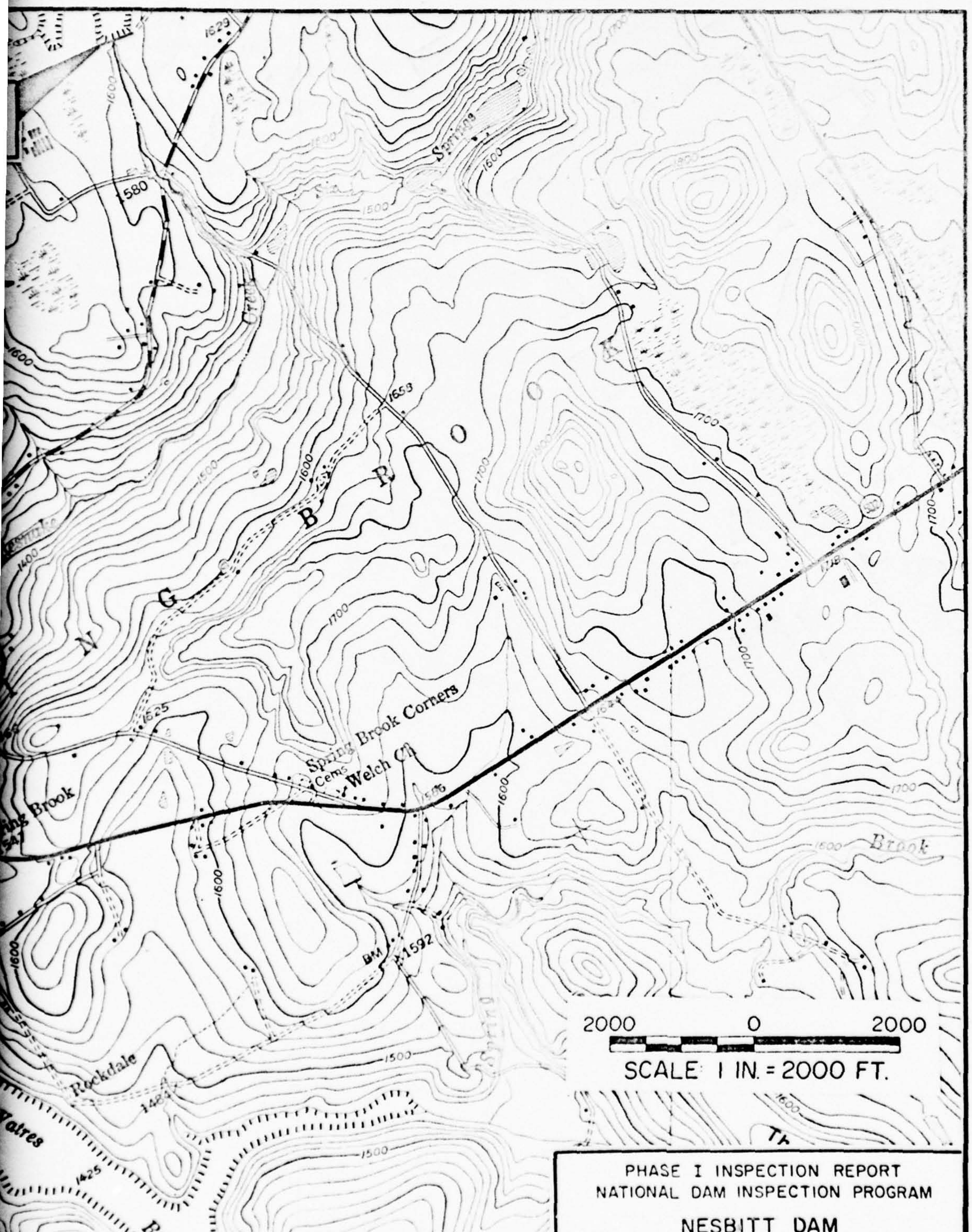
PLATES


LACKAWANNA RIVER
SPRING BROOK
OLD FORGE
TAYLOR
Old Forge Cem
RIVER
DELAWARE
PIPELINE
ERIE-LACKAWANNA
LACKAWANNA
Moosic
Spring
Starks
DURYEA
Browns
Creek
Mill
Oak Hill
Spike Island
Brook
Hillside Junction
LACKAWANNA CO
LUZERNE CO
WILKES-BARRE SCRANTON AIRPORT
Beacon
NORTHEAST EXTENSION
New Rail Dam
Houston City
Rocky Glenn Pond
NE EXTN
TOLL ROAD
Stark Reservoir
Stafford
Glendale
Spring



THIS PAGE IS BEST QUALIT
FROM COPY FURNISHED TO


MAPLE LAKE DAM
RATTLESNAKE CREEK
WATRES DAM
Rattlesnake
Creek
Benjamin Pond
Spring Brook
Spring Brook Corners
Welch Ch
Rockdale
Watres
Reservoir
Spring
Brook
Pinnacle Hill
Panther



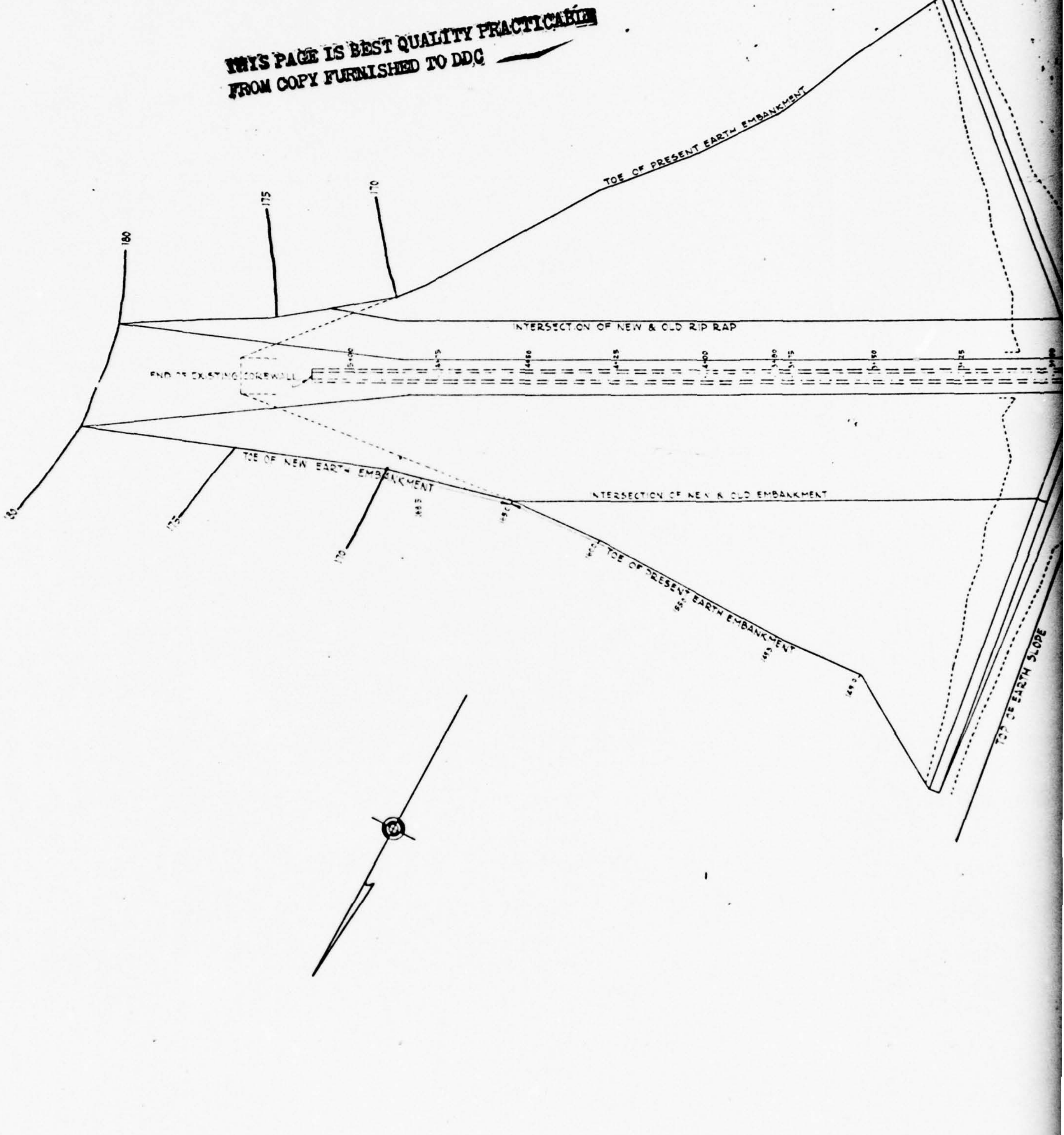
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NESBITT DAM

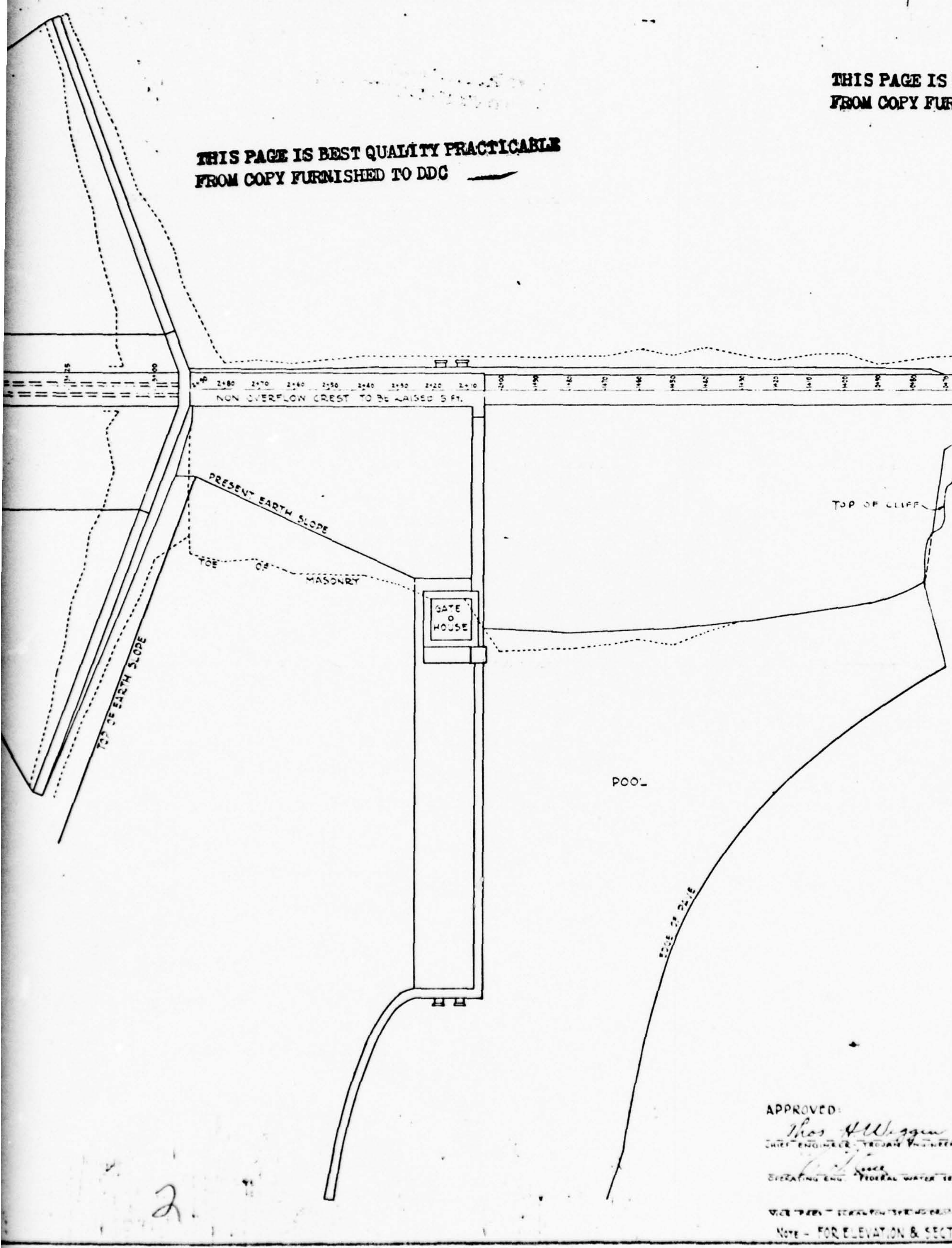
PENNSYLVANIA GAS AND WATER COMPANY

LOCATION MAP

JULY 1978 PLATE 1


TOE OF PRESENT EARTH EMBANKMENT
180
175
170
INTERSECTION OF NEW & OLD RIP RAP
END OF EXISTING COREWALL
TOE OF NEW EARTH EMBANKMENT
INTERSECTION OF NEW & OLD EMBANKMENT
180
175
170
TOE OF PRESENT EARTH EMBANKMENT
TOE OF EARTH SLOPE

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC



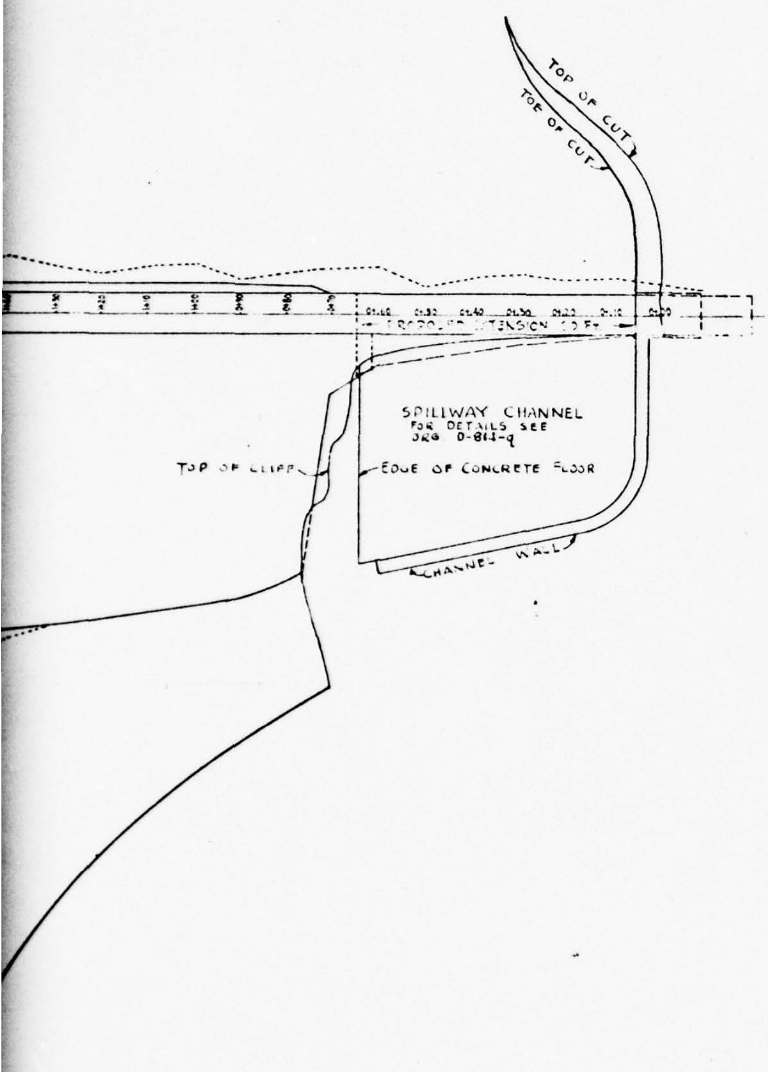
PHASE I INSPECTION
NATIONAL DAM INSPECTIO

NESBITT DA

PENNSYLVANIA GAS AND WA

GENERAL PL

JULY 1978



3

APPROVED:

Note - FOR ELEVATION & SECT

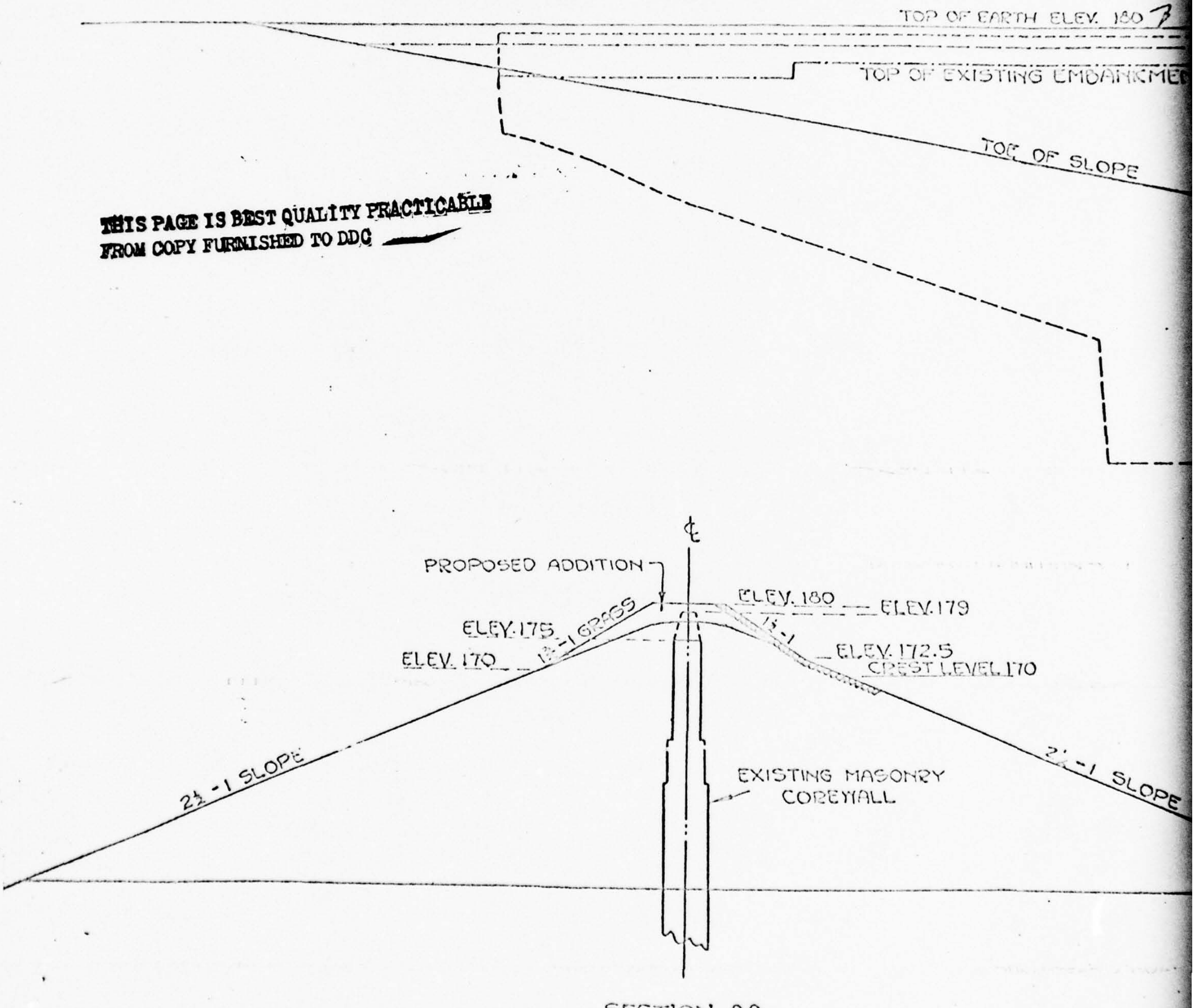
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NESBITT DAM

PENNSYLVANIA GAS AND WATER COMPANY

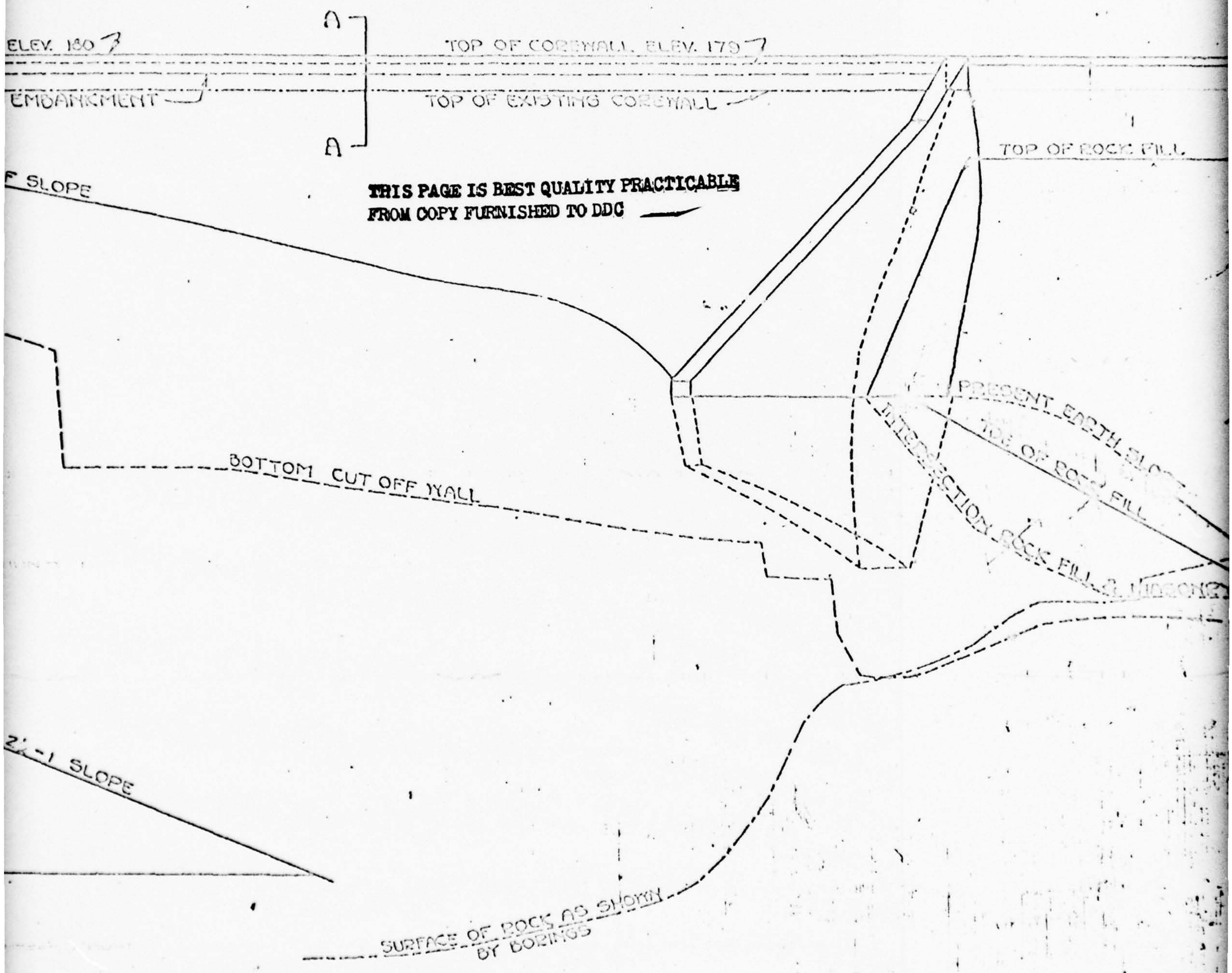
GENERAL PLAN

JULY 1978 PLATE 2



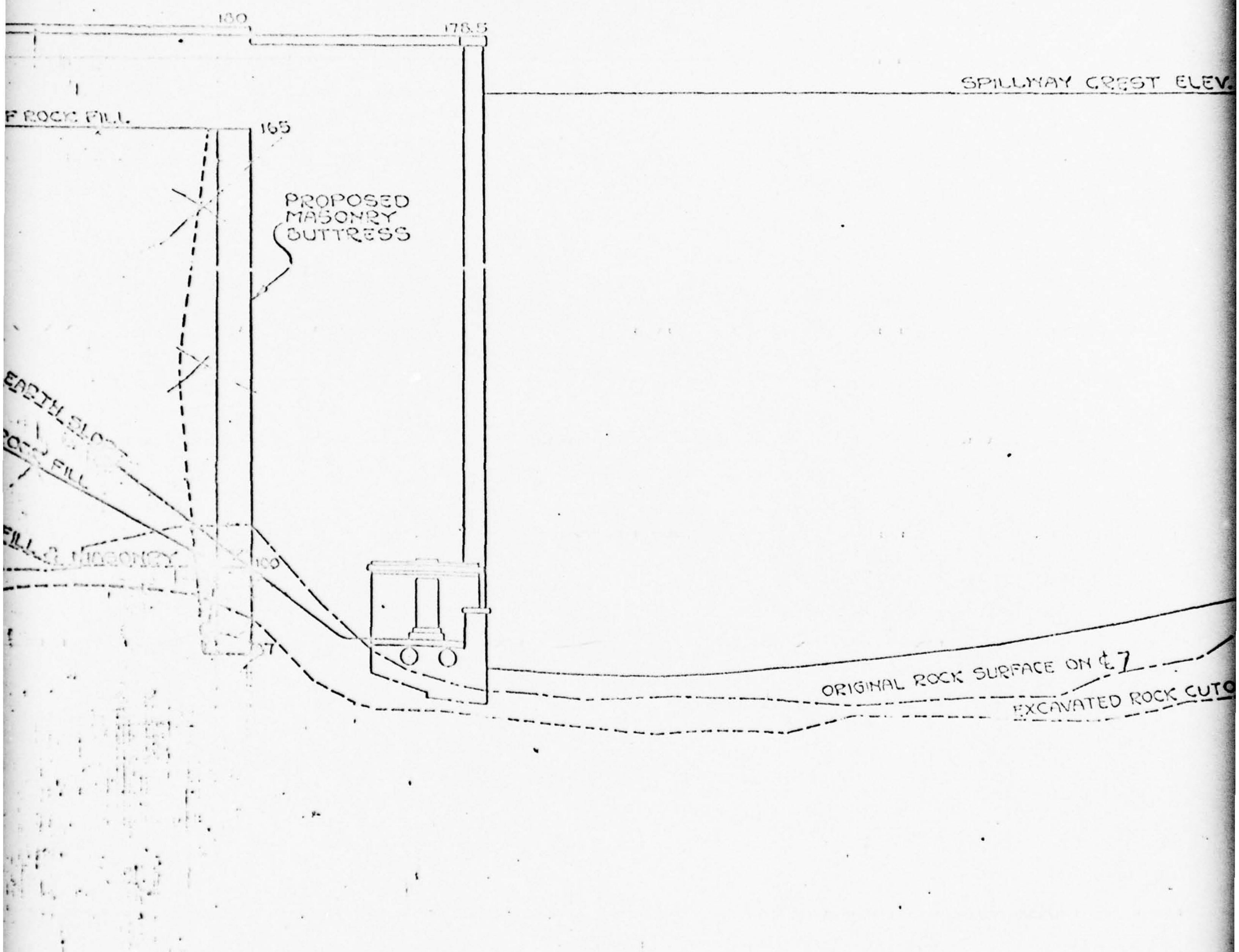
SECTION AA

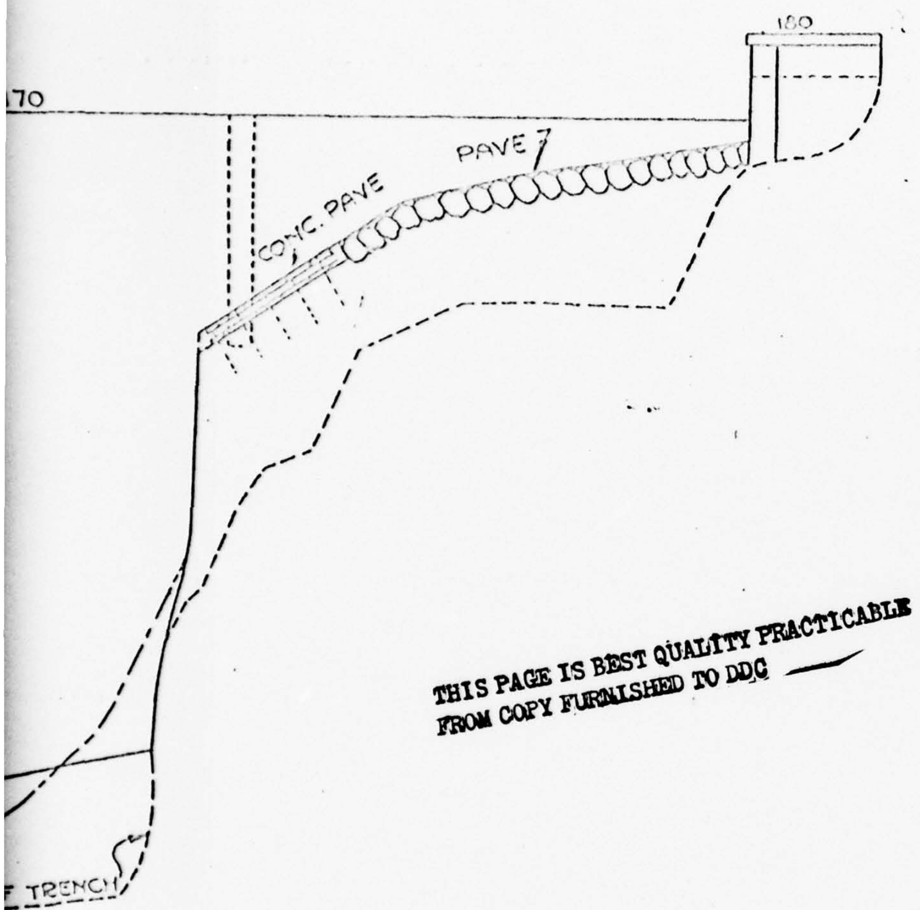
STA. 3180


ELEV. 180
EMBANKMENT
A
A
TOP OF COREWALL, ELEV. 179
TOP OF EXISTING COREWALL
TOP OF ROCK FILL
F SLOPE
BOTTOM CUT OFF WALL
TOP OF ROCK FILL
2:-1 SLOPE
SURFACE OF ROCK AS SHOWN
BY BORINGS

2

THIS PAGE IS BEST QUALITY
FROM COPY FURNISHED TO DDC





PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

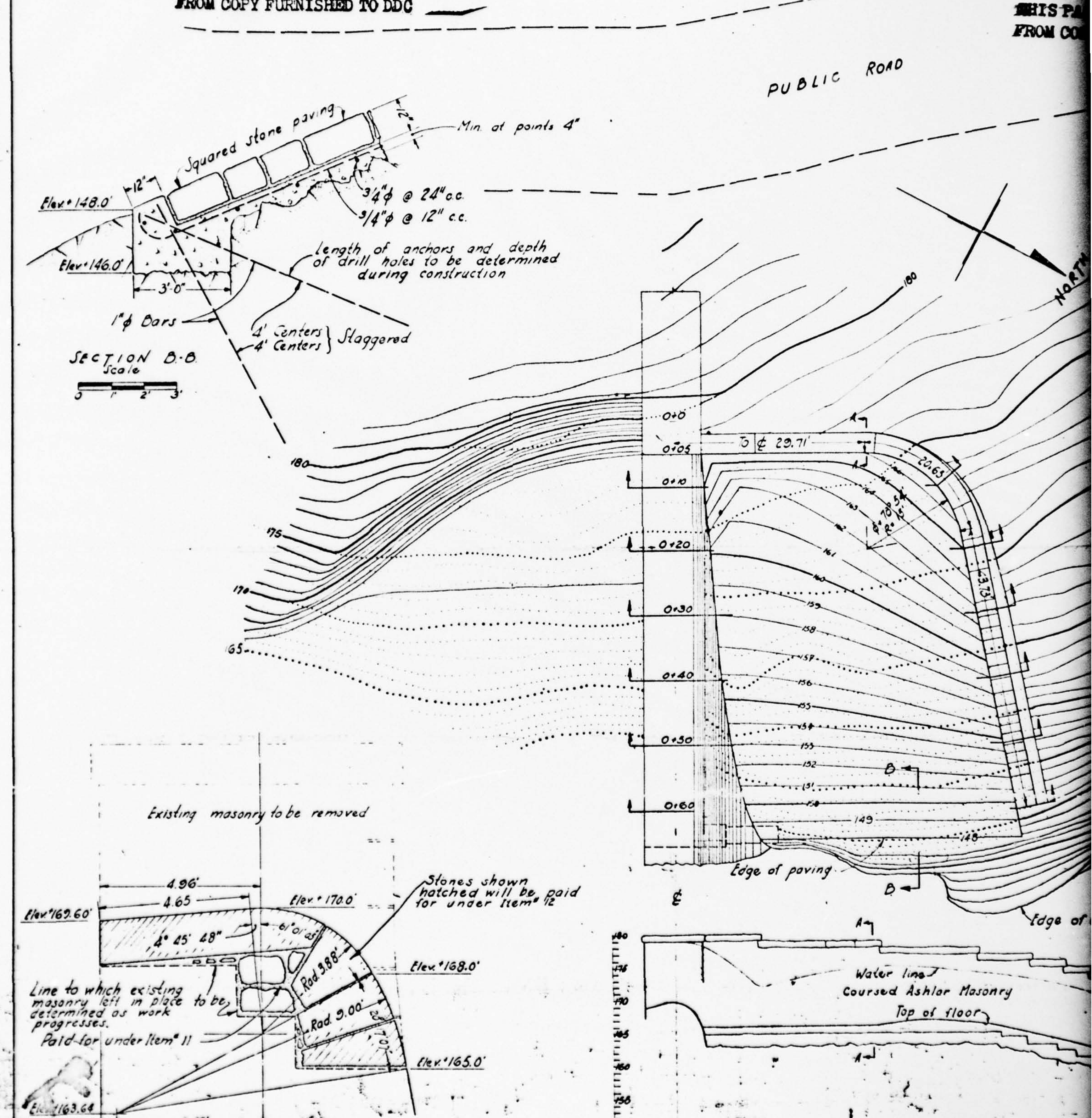
NESBITT DAM

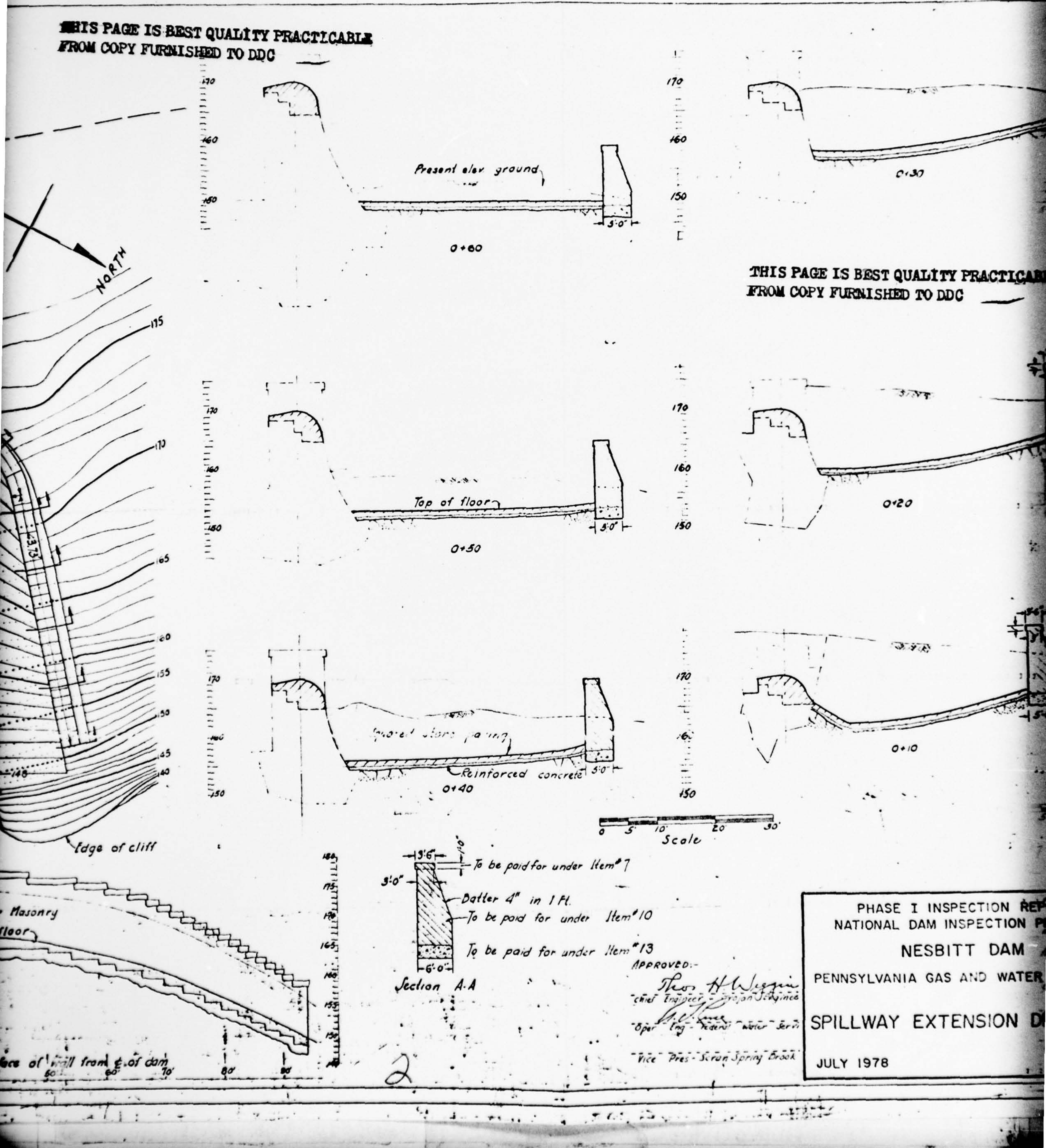
PENNSYLVANIA GAS AND WATER COMPANY

PROFILE

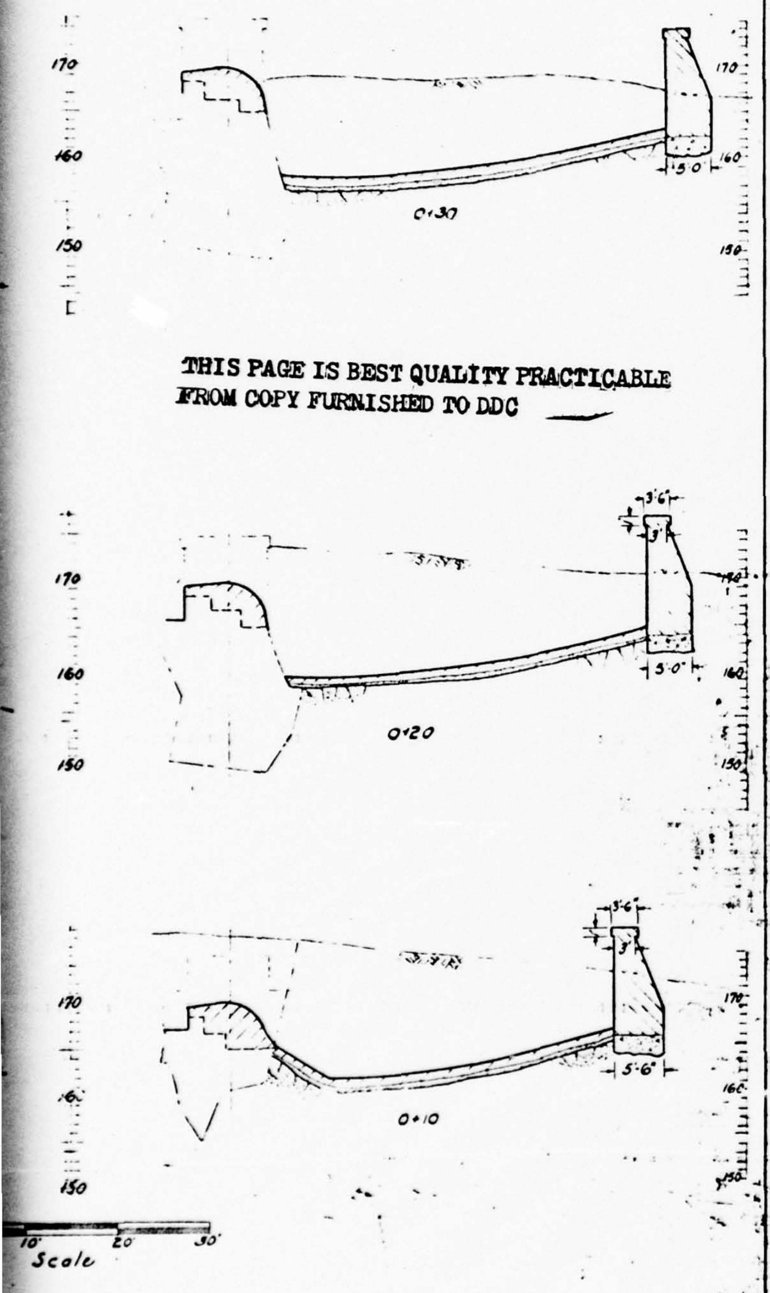
JULY 1978 PLATE 3

4


PUBLIC ROAD
Squared stone paving
2'
Min. at points 4"
12"
Elev. 148.0'
Elev. 146.0'
3'-0"
3/4"φ @ 24" c.c.
3/4"φ @ 12" c.c.
length of anchors and depth of drill holes to be determined during construction
1"φ Bars
4' Centers
4' Centers
Staggered
SECTION B-B
Scale
0 1' 2' 3'
NORTH
180
175
170
165
0+0
0+05
0+10
0+20
0+30
0+40
0+50
0+60
To ℄ 29.71'
20.65
A
B
Edge of paving
℄
Edge of
Existing masonry to be removed
4.96'
4.65
Elev. 169.60'
Elev. 170.0'
4° 45' 48"
Stones shown hatched will be paid for under Item 12
Rad. 3.88'
Rad. 9.00'
Elev. 168.0'
Line to which existing masonry left in place to be determined as work progresses.
Paid for under Item 11
Elev. 165.0'
Elev. 163.64
4.48'
TYPICAL SECTION - SPILLWAY CREST
Scale
Water line
Coursed Ashlar Masonry
Top of floor
Distances along face of wall from ℄
0' 10' 20' 30' 40' 50' 60'



THIS PAGE IS BEST QUALITY PRACTICABL
FROM COPY FURNISHED TO DDC



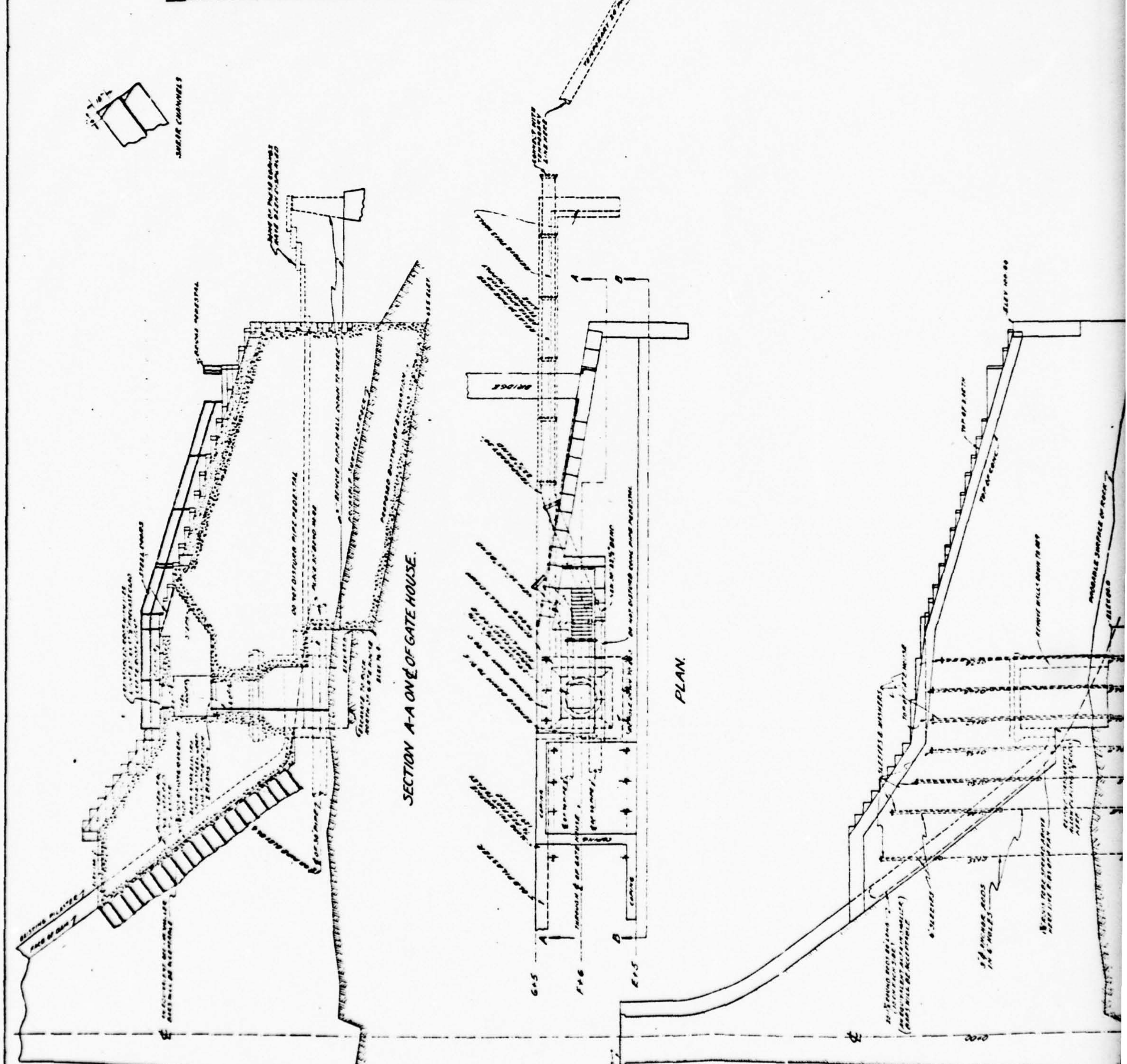
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

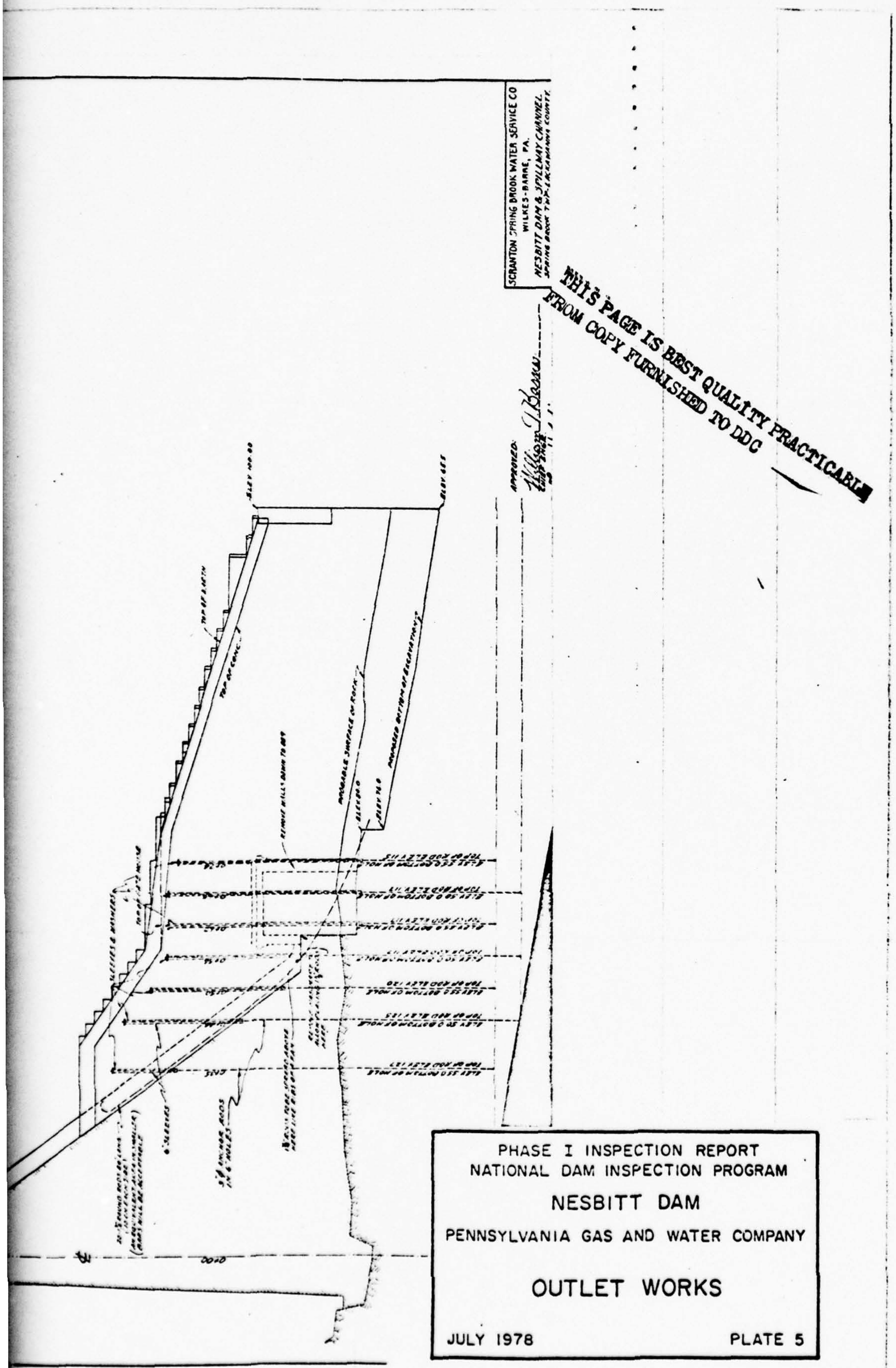
NESBITT DAM

PENNSYLVANIA GAS AND WATER COMPANY

SPILLWAY EXTENSION DETAILS

JULY 1978 PLATE 4


SHEAR CHANNELS
BRIDGE
SECTION A-A ON ℄ OF GATE HOUSE
PLAN



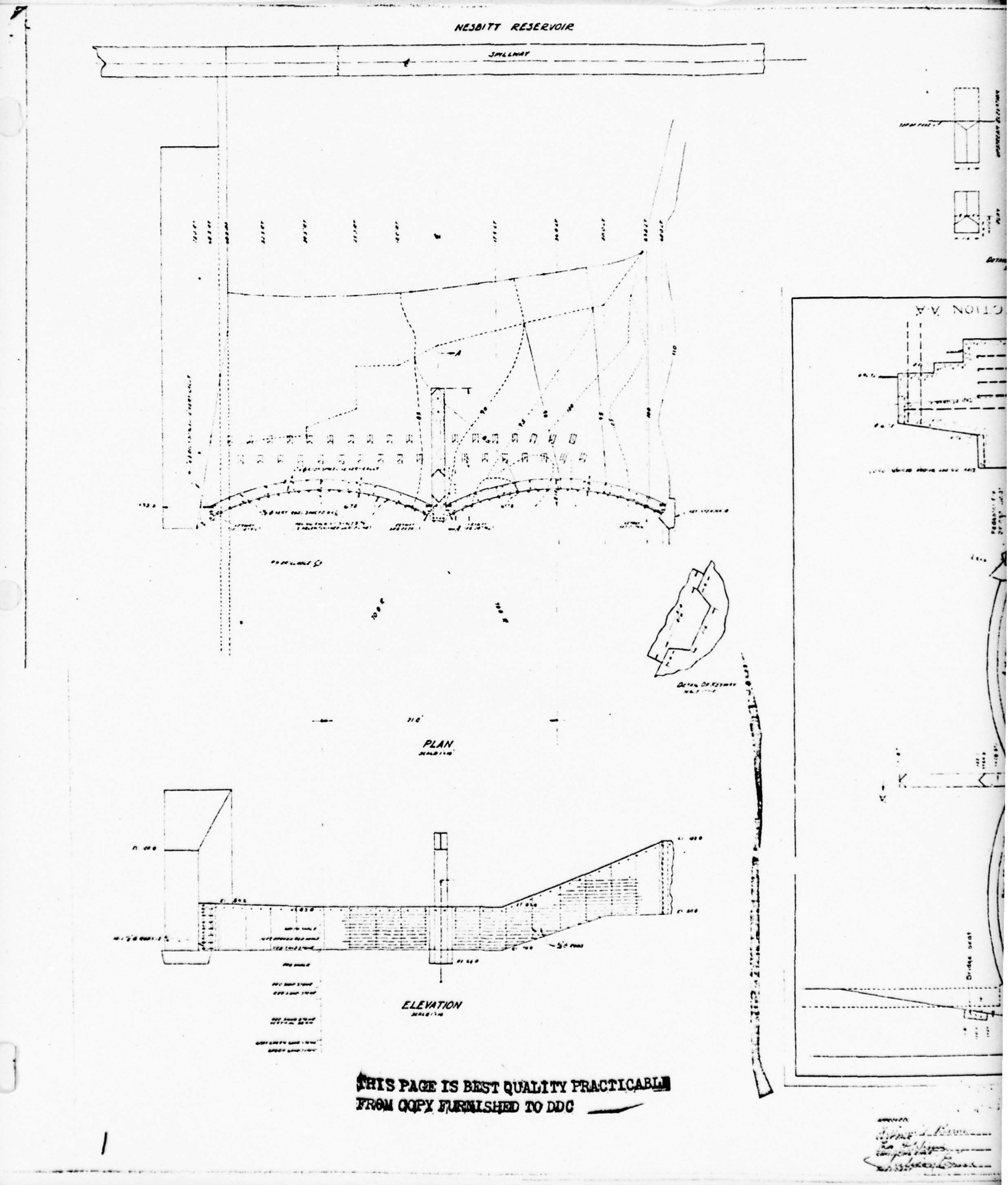
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

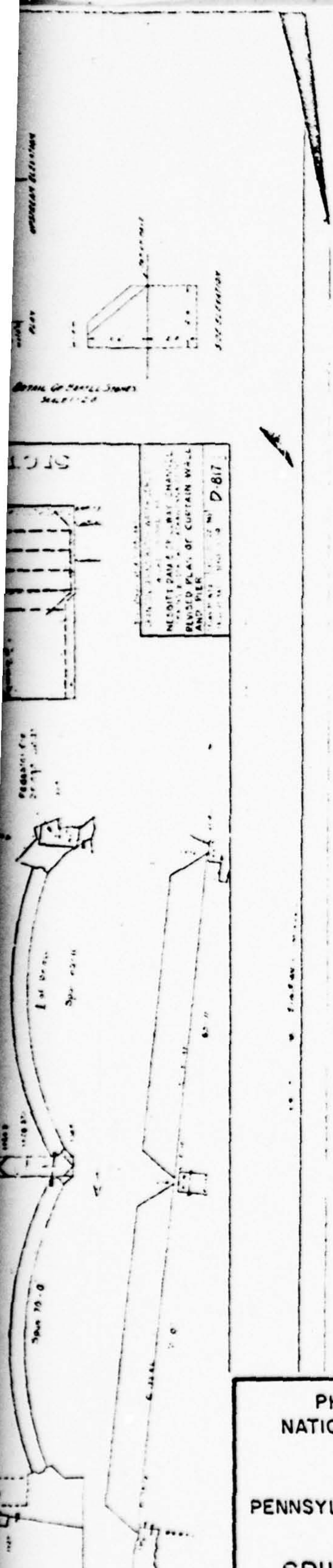
NESBITT DAM

PENNSYLVANIA GAS AND WATER COMPANY

OUTLET WORKS

JULY 1978 PLATE 5


NESBITT RESERVOIR
SPILLWAY
SECTION A-A
PLAN
ELEVATION
DETAIL OF KEYWAY
Bridge seat



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

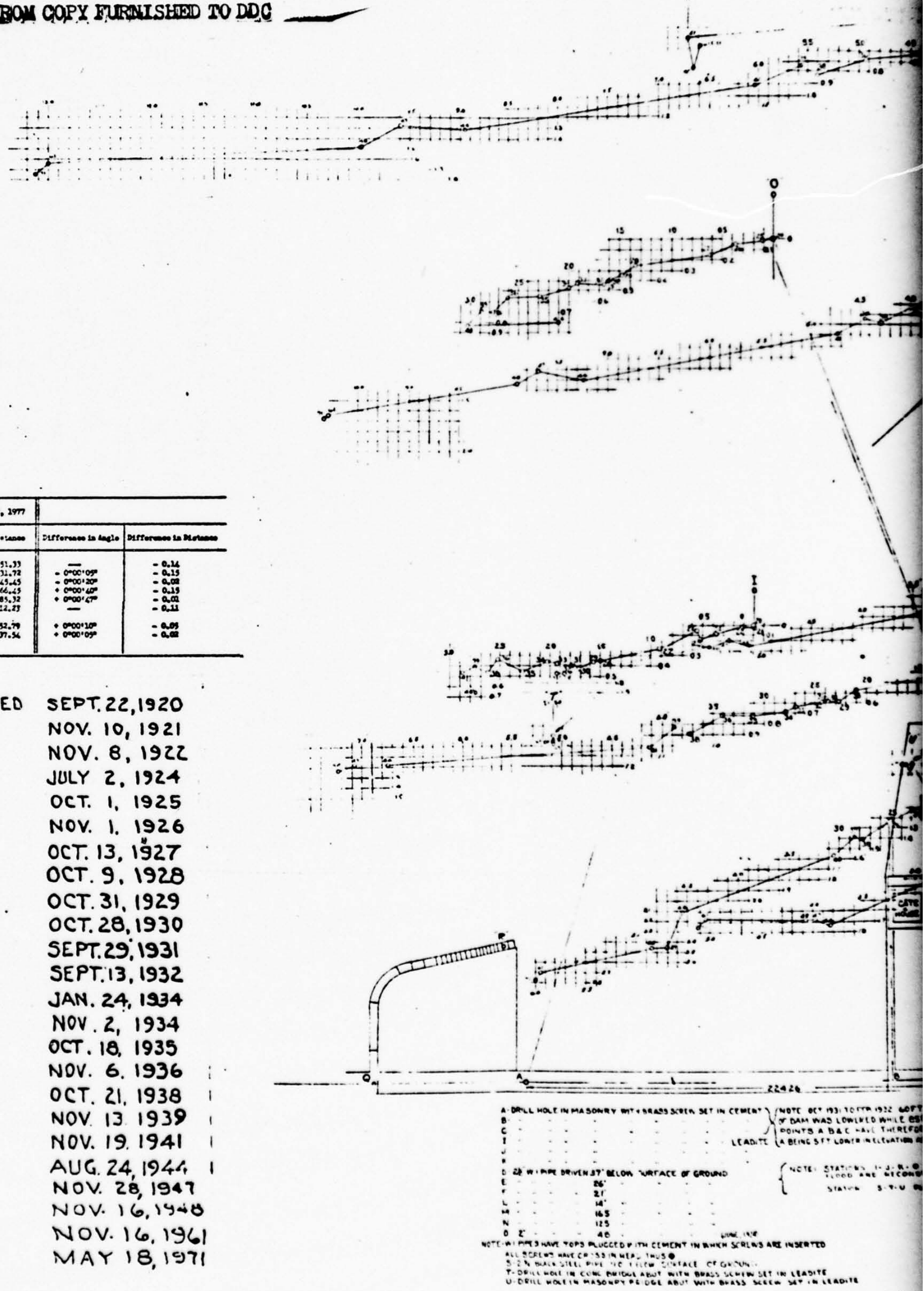
NESBITT DAM

PENNSYLVANIA GAS AND WATER COMPANY

SPILLWAY APRON DETAILS

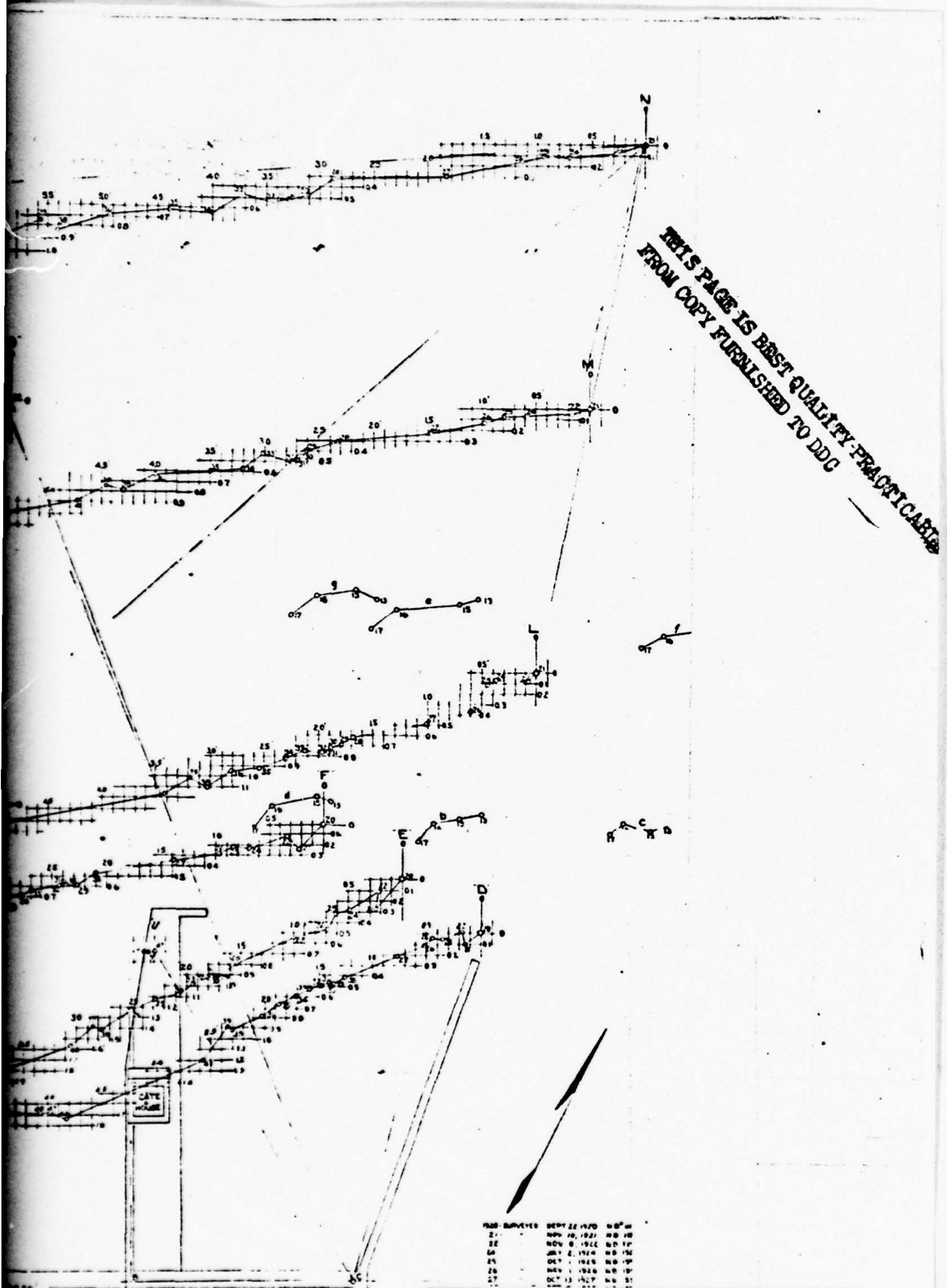
JULY 1978 PLATE 6

2



	SURVEY DATED MAY 18, 1971		SURVEY DATED NOV. 9, 1977			
Stations	Average Angle	Distance	Average Angle	Distance	Difference in Angle	Difference in Distance
C-Q-D	21°30'00"	351.47	21°30'00"	351.33	—	- 0.14
C-Q-E	26°26'45"	331.87	26°26'40"	331.72	- 0°00'05"	- 0.15
C-Q-U	30°17'50"	245.43	30°16'30"	245.45	- 0°00'20"	- 0.02
C-Q-B	48°13'50"	566.60	48°14'30"	566.45	+ 0°00'40"	- 0.15
C-Q-H	42°00'40"	485.33	42°01'27"	485.32	+ 0°00'47"	- 0.01
C-Q-I	33°20'00"	412.34	33°20'00"	412.23	—	- 0.11
Q-C-T	32°27'20"	252.84	32°27'30"	252.79	+ 0°00'10"	- 0.05
Q-C-S	68°19'25"	437.56	68°19'30"	437.54	+ 0°00'05"	- 0.02

1920 -	SURVEYED	SEPT. 22, 1920
21 -	"	NOV. 10, 1921
22	"	NOV. 8, 1922
24	"	JULY 2, 1924
25	"	OCT. 1, 1925
26	"	NOV. 1, 1926
27	"	OCT. 13, 1927
28	"	OCT. 9, 1928
29	"	OCT. 31, 1929
30	"	OCT. 28, 1930
31	"	SEPT. 29, 1931
32	"	SEPT. 13, 1932
33	"	JAN. 24, 1934
34	"	NOV. 2, 1934
35	"	OCT. 18, 1935
36	"	NOV. 6, 1936
38	"	OCT. 21, 1938
39	"	NOV. 13 1939
41	"	NOV. 19. 1941
44	"	AUG. 24, 1944
47	"	NOV. 28, 1947
48	"	NOV. 16, 1948
61	"	NOV. 16, 1961
71	"	MAY 18, 1971



NOTE: OCT 1931 TO FEB 1932 60 FT OF NON OVERFLOW CREST AT WEST END OF DAM WAS LOWERED WHILE 85 FT AT EAST END WAS RAISED 5 FT. POINTS A B & C HAVE THEREFORE BEEN RESET WITH SAME CO-ORDINATES ... BEING 5 FT LOWER IN ELEVATION AND B & C BEING 5 FT HIGHER THAN FORMERLY

NOTE: STATIONS I-J-K-O REMOVED DUE TO FLOOD AND RECONSTRUCTION
STATION S-T-U PLACED NOV 19, 1967

...INSERTED

...LEADITE
...SET IN LEADITE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

WATRES DAM

PENNSYLVANIA GAS AND WATER COMPANY

SLOPE MOVEMENT SUMMARY

JULY 1978 PLATE 7

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

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

JULY 1978

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1978

CONTENTS

PLATES

APPENDICES

Appendix	Title
A	Checklist - Engineering Data.
B	Checklist - Visual Inspection.
C	Hydrology and Hydraulics.
D	Photographs.
E	Geology.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Nesbitt Dam NDS ID No. PA-00449/DER ID No. 35-15
Owner:	Pennsylvania Gas and Water Company
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Spring Brook
Date of Inspection:	6 June 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on the visual inspection, available records, calculations and past operational performance, Nesbitt Dam is judged to be in good condition. However, the spillway will not pass the Probable Maximum Flood (PMF) or one-half of the PMF without overtopping the dam. If Nesbitt Dam should fail due to overtopping, the hazard to loss of life downstream from the dam would be significantly increased from that which would exist just prior to overtopping. Based on criteria established for these studies by the Department of the Army, Office of the Chief of Engineers (OCE), the spillway capacity is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 45 percent of the PMF peak inflow.

In view of the concern for safety of Nesbitt Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for Maple Lake and Nesbitt Dam system. A similar warning system has already been recommended for Watres Dam.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Nesbitt Dam, as well as the nature and extent of mitigation measures required to make the spillway hydraulically adequate. The effects of Maple Lake Dam and Watres Dam should be included in the study.

(3) Monitor the slope movement on the downstream right hillside. In this regard, eight observation wells or other instrumentation should be provided. The wells should be placed at selected locations in the hillside and be founded in a gravel strata. Core boring should be performed to ascertain the type, location, extent, and engineering properties of the gravel strata and other right hillside soil. Inclinometers should be placed in the hillside to ascertain the nature of the movement. The purpose of the investigation and study should be to devise a method to stop slope movement by either sealing off the water intake into the hillside or of relieving its pressure head.

(4) Repair 30-inch gate valves and provide proper maintenance for them.

In order to correct operational, maintenance, and repair deficiencies, and to more accurately assess the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Visually monitor seepage on the downstream face of the nonoverflow section and at the left abutment. If changes are noted, take appropriate action.

(2) Remove trees growing in the embankment and behind spillway auxiliary training wall.

(3) Repair riprap.

(4) Fill burrowing animal hole.

(5) Repair leaking valve packing.

(6) Visually monitor mortar for further signs of erosion. Severely eroded mortar should be repaired.

(7) Replace missing pane of glass in outlet works skylight.

(8) Repair downstream edge of spillway apron and re-anchor wire mesh.

The following operational measures are recommended to be undertaken by the Owner:

(1) During periods of unusually heavy rains, provide round-the-clock surveillance of Nesbitt Dam.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date: 31 July 1978

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
ALBERT CHARLES HOOKE
ENGINEER
No. 2201-E

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date: 31 Jul 78

NESBITT DAM

View from Downstream of Left Abutment

SUSQUEHANNA RIVER BASIN

SPRING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

NESBITT DAM

NDS ID No. PA-00449
DER ID No. 35-15

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1978

SECTION 1

PROJECT INFORMATION

1.1 General.

a. 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.

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

1.2 Description of Project.

a. Dam and Appurtenances. Nesbitt Dam consists of an earthen embankment with masonry core wall and masonry gravity nonoverflow and spillway sections. The 260-foot long earthen embankment at the right abutment has a top width of 10 feet and slopes which average about 1V on 2H both upstream and downstream. The left end of the embankment ends at a retaining wall which extends upstream and downstream of the axis of dam. The embankment reaches its maximum height of 76 feet adjacent to the retaining wall. A masonry gravity nonoverflow section extends for 88.5 feet to the left of the retaining wall. The 8-foot wide top of the nonoverflow section is at the same elevation as the top of embankment. The nonoverflow section is about 100 feet high, but an earthfill is placed along the downstream face such that only the upper 50 feet is visible. At the left end of the nonoverflow section, a spillway training wall extends downstream for about 135 feet. The training wall also contains the earthfill at the toe of the nonoverflow section. It is constructed of concrete and has a masonry facing on the exposed vertical faces. The outlet works control structure is integral with this wall. Two 30-inch diameter cast-iron pipes extend through the nonoverflow section to the gate valves in the control structure, which is essentially a hollow area in the spillway training wall. The pipes then extend through the wall and terminate at the face of the wall. A 14-inch diameter cast-iron pipe branches off from one of the 30-inch pipes and terminates at the face of the wall. The spillway is 200 feet long and extends along the axis of the dam from the left end of the nonoverflow section. In cross section, the spillway is similar to the nonoverflow section except for the crest, which is 10 feet lower than the top of the nonoverflow section. From the nonoverflow section, the first 140 feet of the spillway discharge onto an apron 85 feet below. The last 60 feet of the spillway is founded on top of the rock ledge which forms the left abutment of the dam. In this section, the spillway discharges onto an auxiliary apron about 14 feet below. Discharge from the auxiliary apron drops over the ledge to the spillway apron beneath. Masonry gravity training walls extend along the left and downstream sides of the auxiliary apron. The spillway apron is a warped mortared-masonry surface which extends about 60 feet downstream of the exposed spillway toe. Masonry baffle blocks extend along the downstream side of the apron. At the downstream end of the apron, a reinforced concrete cutoff wall, with bridge pier in the center, extends below the apron. A two-span footbridge, supported by a pier and bridge seats, crosses the apron near the downstream edge. The channel downstream of the apron is rock-lined for about 400 feet. A wire mesh covers this rock. Various features of the dam are shown on the plates at the end of the report and on the photographs in Appendix D.

b. Location. The dam is located on Spring Brook approximately 4.5 miles southeast of Moosic, Pennsylvania. Nesbitt Dam is shown on USGS Quadrangle, Avoca, Pennsylvania, with coordinates N41°19'35" and W75°39'15" in Lackawanna County, Pennsylvania. The dam is southeast of the Scranton/Wilkes-Barre Airport. Watres Dam is located upstream of Nesbitt Dam on Spring Brook 1.7 miles southeast of Nesbitt Reservoir. Maple Lake Dam is located upstream of Nesbitt Dam on Rattlesnake Creek, a tributary to Spring Brook, about 2.9 miles east of Nesbitt Reservoir. A location map is shown on Plate 1.

c. Size Classification. Large (101 feet high, 5,034 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Nesbitt Dam (Paragraph 5.1e.).

e. Ownership. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water supply for the communities of Avoca, Duryea, Kingston, Moosic, Old Forge, Pittston, West Pittston, and Wyoming, Pennsylvania.

g. Design and Construction History. Nesbitt Dam was designed by John Lance, Chief Engineer of the Spring Brook Water Supply Company, and built by Force Account in 1903 under his supervision. In 1914, the dam was studied by the Pennsylvania Water Supply Commission. No recommendations were forthcoming from that report. In 1917, the dam was studied again by the Pennsylvania Water Supply Commission. The report recommended that the freeboard available for the spillway design flood of 7,790 cfs(1) be increased to prevent overtopping by wave action. In 1918, Frederick P. Stearns, consulting engineer, Boston, Massachusetts, issued a report in conjunction with the Pennsylvania Water Supply Commission report. The recommendations in the Stearns' report were to either strengthen the dam or lower the spillway crest. Between 1919 and 1920, Leonard Metcalf, of Metcalf and Eddy, consulting engineers, Boston, Massachusetts, and Daniel Moran, of Moran and Proctor, foundation consultants, New York City, were retained by the Owner to consult on Nesbitt Dam. During this period, movement of the right hillside downstream of the dam had been noted. Arthur Morgan of Dayton-Morgan engineering companies was retained by the Pennsylvania Water Supply Commission to consult on Nesbitt Dam. A preliminary drilling and grouting program along the top of the masonry sections had been instituted by the Owner in 1920. Mr. Morgan reviewed the results of the grouting and recommended that additional holes be drilled and grouted. These recommendations were implemented by the Owner. Mr. Morgan also recommended increasing the spillway capacity of Nesbitt Dam. In 1926, Watres Dam, which controls about 42 percent of the drainage area of Nesbitt Dam, was completed. The Water Supply Commission still believed that the spillway capacity of Nesbitt Dam should be increased, and they so requested. A contract was awarded in 1931 to the B. G. Coon Construction Company of Kingston, Pennsylvania, for making modifications to the dam. The work was completed in 1932. It consisted of raising the embankment

(1) 210 csm x 37.1 xm = 7,790 cfs.

by 3 feet, raising the core wall 4 feet, and raising part of the nonoverflow section 1.5 feet so that the embankment, core wall, and nonoverflow section would have a constant top elevation. The work also consisted of replacing a 60-foot long nonoverflow section on the left with a 60-foot long spillway section having the same crest elevation as the existing spillway. The spillway auxiliary apron and auxiliary training walls were also constructed under this contract. The outlet channel was apparently eroded by the flood of May 1942. In 1945, a contract was awarded to construct the spillway training wall, relocate the outlet works, construct the spillway apron and footbridge, and protect the downstream channel. The Contractor, B. G. Coon Construction Company, completed the work in 1947.

h. Normal Operational Procedure. The pool is maintained at spillway crest with excess inflow discharging over the spillway. Releases from the outlet works, as well as spillway discharges, flow downstream to Spring Brook Intake Dam, where water enters the distribution system. Flows into Nesbitt Reservoir can be augmented by releases from either Maple Lake Dam or Watres Dam.

1.3 Pertinent Data.

a. Drainage Area. 37.1 square miles.

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite -
11,450 (estimated - August 1955).
Outlet works at maximum pool elevation -
550 (approximate).
Spillway capacity at maximum pool elevation -
19,540.

c. Elevation.(1) (Feet above msl.)

Top of dam (nonoverflow section) - 1166.0.
Top of dam (embankment) - 1166.0.
Maximum pool - 1166.0.
Normal pool - 1156.0.
Upstream invert outlet works -
30-inch pipe - 1071.4.
30-inch pipe - 1071.4.
14-inch pipe - none (tapped into 30-inch pipe).
Downstream invert outlet works -
30-inch pipe - 1067.8.
30-inch pipe - 1068.6.
14-inch pipe - 1072.9.
Streambed at centerline of dam - 1065.2.

(1) An approximate datum for elevations was taken from the reservoir level on the USGS Quadrangle. The Owner also uses this datum elevation. The datum used on the Owner's drawings is Elevation 100.0. The equivalence is Elevation 1156.0 (USGS) equals Elevation 170.0 (Drawings).

d. Reservoir Length. (Miles.)

Normal pool - 1.5.
Maximum pool - 1.6.

e. Storage. (Acre-feet.)

Normal pool (spillway crest) - 3,837.
Maximum pool (top of dam) - 5,034.

f. Reservoir Surface. (Acres.)

Normal pool (spillway crest) - 116.
Maximum pool (top of dam) - 123.

g. Dam.

Type - Combination masonry gravity nonoverflow section and earthfill embankment with central masonry core wall.

Length - Masonry gravity nonoverflow - 88.5 feet.
Embankment - 267 feet.

Height - 101 feet.

Top Width - Masonry gravity - 9 feet.
Embankment - 10 feet.

Side Slopes - Upstream - 1V on 1.5H above Elevation 1156.0.
Upstream - 1V on 2.5H below Elevation 1156.0.
Downstream - 1V on 1.75H above Elevation 1156.0.
Downstream - 1V on 2.5H below Elevation 1156.0.

Zoning - Homogeneous earthfill with masonry core wall.

Cutoff - Masonry spillway and masonry nonoverflow section founded on bedrock. Core wall in embankment founded 20 feet to 40 feet below original ground on gravel. Core wall stops 35 feet from right abutment.

Grout Curtain - None, some post-construction grouting under spillway and nonoverflow section.

h. Diversion and Regulating Tunnel. None other than regulating outlets.

i. Spillway.

Type - Broad-crested with rounded nose and 6-inch adverse slope (width 5.0 feet) with free overfall.

Length of Weir - 200 feet.

Crest Elevation - 1156.0.

Upstream Channel - Reservoir.

Downstream Channel - Variable bottom sloped masonry apron extending 60 feet from toe of spillway. Downstream of the apron the channel bottom and sides are rock-lined for 400 feet. The stone is held in place with a continuous layer of wire mesh.

j. Regulating Outlets.

Type - Cast-iron pipes - 30-inch diameter blowoff, right.
30-inch diameter blowoff, left.
14-inch diameter blowoff.

Length - 30-inch diameter blowoff, right - 110 feet.
30-inch diameter blowoff, left - 103 feet.
14-inch diameter blowoff - 10 feet.

Closure - 30-inch diameter blowoff, right - two manually operated nonrising stem, 30-inch gate valves with 2.8 exposed gear reducers and 21-inch diameter handwheel mounted horizontally on gate stand.

30-inch diameter blowoff, left - two manually operated nonrising stem, 30-inch gate valves with 2.8 exposed gear reducers and 21-inch diameter handwheel mounted horizontally on gate stand.

14-inch diameter blowoff - one manually operated nonrising stem 10-inch gate valve operated by T-bar on exposed operating nut recessed in roof of gate structure.

Access - Only to control structure with valves therein via stairs at spillway training wall. Downstream end of pipes accessible from spillway apron.

Regulating Facilities - None other than outlet works.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Design Available. Some design data was available for review. The design engineer, John Lance, Chief Engineer of the Scranton-Spring Brook Water Supply Company, prepared an article on Nesbitt Dam entitled "Some Dams Recently Constructed by the Spring Brook Water Supply Company". The article was published in the "Transactions of the Association of Civil Engineers of Cornell University - 1901". In a study performed in 1914 by the Pennsylvania Water Supply Commission, an account of design concepts, geology, construction materials and methods, and design features was prepared for the components of the dam from interviews with the Owner, visual inspection, and other sources. The 1914 study also included analyses for hydrology, hydraulics, and stability of the principal features. Load assumptions and a summary of the results of the analyses are on file.

b. Design Features. Nesbitt Dam consists of an earthfill embankment with masonry core wall, a masonry gravity non-overflow section, and a masonry gravity spillway. A plan of the dam is shown on Plate 2. A profile is shown on Plate 3. A discussion on geology is presented in Appendix E.

The earthfill embankment extends for 260 feet from the right abutment (Photographs A and B and Plate 3). The embankment earthfill consists of a homogeneous mixture of clay and gravel. The top of embankment is 10 feet wide and is at Elevation 1166.0. The upstream slope is covered with riprap. The downstream slope is covered with grass. Below Elevation 1156.0, both upstream and downstream slopes are 1V on 2.5H. Above Elevation 1156.0, the downstream slope is 1V on 1.75H and the upstream slope is 1V on 1.5H. The maximum height of embankment is about 48 feet.

The masonry gravity core wall extends along the axis of the embankment. It terminates about 35 feet from the right end of the embankment. The core wall is founded on gravel strata within the right abutment hillside which is mostly sandy clay. The core wall trench was extended down on an average of 35 feet below original ground surface. About 120 feet from the end of the earthfill at the right abutment, the trench steps up to a higher gravel strata such that the average depth of trench is about 15 feet. The top of the core wall is at Elevation 1165.0 and is 3 feet wide. The wall is vertical down to Elevation 1161.0 where both the upstream and downstream sides commence being stepped, with an average batter of 2V on 1H. The maximum height of the core wall is about 76 feet at the left end of the embankment.

Where the core wall trench steps up sharply, a 4-inch diameter iron pipe is provided. This pipe extends to the spillway channel and acts as a drain. The core wall is shown on Plates 2 and 3.

The left end of the embankment and core wall terminate at a masonry gravity retaining wall which extends both upstream and downstream of the dam axis (Photographs B and C and Plate 2). Both the upstream and downstream sections of the wall make about a 70-degree angle with the dam axis such that the upstream and downstream ends are closer to the right abutment. The tops of both sections are stepped. The back, or earthfill, face of the wall is stepped on an average of 3V on 1H. The front face of the wall has a continuous batter of 12V on 1H. The wall is founded on rock, except at its downstream end.

A masonry gravity nonoverflow section, founded on rock, extends for 88.5 feet left of the earthfill embankment along the same axis (Photographs C and F). The top of this section is at Elevation 1166.0 and is 9 feet wide. The upstream face abuts the reservoir and is vertical above Elevation 1126.0. Below this elevation, the upstream face has a batter of 24V on 1H. The downstream face is vertical above Elevation 1151.0. Below this elevation, the section curves on a 156-foot radius until the curve is at Elevation 1126.0. Below this elevation, the downstream face has a 1V on 0.75H batter, which extends to the toe of the section. Along the left end of the nonoverflow section, a masonry lip protrudes downstream about 3 feet to contain spillway flows. The section, at its maximum height, rises about 102 feet over its foundation. An earthfill partially covers the downstream face of this section. This earthfill has a 10-foot top width at Elevation 1116. The earthfill curves around and generally maintains this elevation along the toe of the exposed retaining wall front face. The top 10 feet of the earthfill has an approximate 1V on 2H slope. The remaining portion has an approximate 1V on 4H slope.

A masonry spillway training wall at the left end of the nonoverflow section extends 76 feet downstream normal to the axis of the dam (Photograph F and Plate 5). The wall is constructed of concrete but it looks like a masonry wall and is so termed. The training wall then deflects right about 9 degrees and extends downstream another 60 feet. It then deflects 81 degrees right and extends 20 feet until it meets existing ground. This wall is used to contain spillway flows and to retain the earthfill extending from the toe of the nonoverflow section. Part of this wall also serves as the outlet works control structure. In profile, the upstream end of the wall, where it joins the nonoverflow section, has a top elevation of 1119.0 (Plate 5). The wall is level for 18 feet beyond this point and then slopes downward on a 2V on 3H slope for

12 feet, vertically. It then slopes downward on a 1V on 7H slope for 3 feet vertically and then on a 1V on 3.33H slope for 18 feet, vertically. Masonry steps are provided along all the sloping top. There is a 3-foot deep notch extending 13 feet along the top at the upstream end of the wall. Its purpose is unknown, but is probably to allow water that has splashed from the spillway to enter the spillway channel. In cross section, the wall is rectangular and 20 feet wide at the upstream end for a length of 76 feet. The back, earthfill side, remains normal to the dam axis, while the front side defects toward the right creating a varying top width over a length of 60 feet. The wall is founded on rock, except where it abuts the nonoverflow section. There it is anchored into the masonry of the nonoverflow section with steel rods which extend into the rock below the masonry (Plate 5). Apparently the wall is constructed monolithically of concrete with all exposed vertical sides having a masonry facing. A 3-foot wide by 3-foot high concrete section extends along the front face of the wall.

The outlet works control structure was formed in this wall (Plate 5). The control structure is in the center of the wall and about 65 feet downstream of the axis of the dam. The floor of the control structure is at Elevation 1066 and is 12 feet square. The control structure walls, which are essentially a hollow area in the spillway training wall, extend vertically for about 15 feet. The structure walls then transition to a circular shaft which extends to the working floor at Elevation 1094. A skylight with frosted glass panes held in concrete is provided on the roof over the working floor. This roof is also the top of the spillway training wall. Steps formed in the training wall concrete extend from an opening in the top of the training wall to the working floor. Metal doors cover the opening. A grating covers the circular shaft opening on the working floor. A ladder extends from the working floor to the bottom of the control structure. Two 30-inch diameter cast-iron pipes extend from the reservoir through the masonry nonoverflow section to the bottom of the control structure. The upstream invert of both pipes is 1071.4. Two 30-inch gate valves, connected in series, are connected to each pipe. The pipes then deflect left and extend through the spillway training wall. Both pipes terminate at the front face of the wall. The downstream invert of the left pipe is 1067.8, while that of the right pipe is 1068.6. Operators for each 30-inch valve are provided on the working floor. A 14-inch diameter cast-iron pipe is tapped off the left 30-inch diameter pipe upstream of both valves. The 14-inch diameter pipe extends to a 10-inch gate valve and then through the spillway training wall. The pipe terminates on the front face of the wall at invert Elevation 1072.9. The 10-inch gate valve is operated by a portable T-bar which connects to an exposed operating nut on the top of the spillway training wall.

The masonry gravity spillway extends left of the nonoverflow section (Photographs G, H, and I and Plate 3). The spillway is 200 feet long. In cross section, it is identical to the nonoverflow section, except as described hereafter. The crest elevation is 1156.0, which is 10 feet lower than the nonoverflow section. Downstream of the crest, the section is rounded with compound arcs to form an approximate ogee shape. The top of the spillway section, upstream of the crest, slopes on a 1V on 10H slope until it meets the vertical upstream face. The exposed downstream toe of the spillway is rounded on a 20-foot radius to direct discharge onto the spillway apron. The spillway extends left from the nonoverflow section 140 feet until it meets a near-vertical rock ledge, which forms the left abutment of the dam. For this 140 feet, the spillway discharges onto the spillway apron about 85 feet below. Left of this 140-foot section, the top of the rock ledge has been excavated. The spillway maintains the same crest elevation and upper cross section for an additional 60 feet left of the rock ledge face. For this 60 feet, the spillway discharges onto the spillway auxiliary apron which, in turn, discharges over the rock ledge to the spillway apron beneath.

The highest elevation on the spillway auxiliary apron is near the left abutment of dam and is about 1151 (Photographs G, H, and J and Plate 4). The lowest elevation is near the overfall at the face of the rock ledge and is about 1134. The entire spillway auxiliary apron is warped. It is constructed of mortared-stone masonry placed over a reinforced-concrete paving that is founded on rock. Masonry gravity training walls are provided on the left side and downstream side of the auxiliary apron. The wall extends downstream from the left end of the spillway until it is about 30 feet from the dam axis. The wall then deflects right for about 79 degrees along a 15-foot radius curve. The wall then extends straight for 44 feet until it terminates near the top of the rock ledge. The top of wall elevation decreases, with the highest elevation of 1166 being at the left end of the spillway. The height of wall is about 15 feet at the spillway and about 11 feet where the wall terminates at the top of the rock ledge. In section, the wall has a 1-foot thick and 3.5-foot wide capstone. Beneath the capstone, the wall has a vertical front face and 3-foot wide top. The back, or landside face, has a 3V on 1H batter for the upper 9 feet and then is vertical below. The wall is founded on concrete about 2 feet thick. The concrete is founded on rock.

A 12-foot long masonry wall extends along the axis of the dam left of the spillway. The dimensions of the wall, which acts as a cutoff, are unknown.

Along the 140-foot length of the high section of spillway extends a mortared masonry spillway apron (Photographs I and K and Plate 6). The apron extends from the vertical rock ledge on the left to the spillway training wall on the right. Discharges over the spillway, some of which drops from the spillway auxiliary apron, as well as discharges from the outlet, pass over the apron. The apron is a warped surface with lower areas near the spillway training wall. The apron extends about 60 feet downstream of the exposed toe of the spillway. Two rows of stone masonry baffle blocks are provided near the downstream side of the apron. A concrete bridge pier is situated in the middle of the apron near the downstream edge. The pier, which is founded on rock, is 40 feet long, 4 feet wide, and about 30 feet high. The pier acts as the center support for a double-arch, reinforced-concrete cutoff wall. Details of this cutoff wall are shown on Plate 6. The arches are on a 70-foot radius. The left end of the left arch is keyed into the vertical rock ledge with a concrete pedestal that also acts as the left bridge abutment. The right end of the right arch is keyed into the downstream end of the spillway training wall, which also acts as the right bridge abutment. The top of the cutoff wall is flush with the downstream end of the spillway apron. The wall is founded on sound rock at Elevation 1066, except near the left end where the sound rock elevation rises.

The bridge abutments and pier support a two-span steel truss bridge whose low chord is at Elevation 1091.4 (Photographs J, K, and L). Wooden stairs extend from the left abutment of the dam down to the left end of the bridge.

The channel downstream of the spillway apron is excavated and rock-lined for about 400 feet (Photograph L). The channel is about 70 feet wide on the average. The rock lining is covered with a galvanized wire mesh which extends over the bottom of the channel and up the banks. The wire mesh at the upstream end of the channel is anchored into the mortar of the spillway apron.

2.2 Construction.

a. Data Available. Construction data available for review for Nesbitt Dam was limited to information contained in the 1914 report prepared by the Pennsylvania Water Supply Commission. The information in this report was obtained from interviews with the Owner, and it gives some details of foundation conditions encountered during construction. Very little construction data for subsequent modifications was available for review.

b. Construction Considerations. Since the available construction data is limited, construction methods cannot be assessed. The 1914 report by the Pennsylvania Water Supply Commission describes the core wall as being constructed of concrete.

2.3 Operation. No formal records of operation were reviewed. Based on information from the Owner and the caretaker of the dam, all structures have performed satisfactorily with some exceptions. The right hillside downstream of the dam is being monitored for movement. The downstream end of the retaining wall is cracked and is being monitored. A detailed description and evaluation of these conditions are covered in Section 3, Visual Inspection.

2.4 Other Investigations. No known investigations other than those previously described were reviewed.

2.5 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania and by the Owner, Pennsylvania Gas and Water Company. The Owner made available an engineer, a caretaker, and a valve crew for information and operation demonstrations during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data is limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The general appearance of Nesbitt Dam is good, with the exceptions noted below.

b. Embankment. The embankment is in generally good condition. The sod is in excellent condition. The riprap on the upstream slope is in good condition. The riprap has an area, about 3-foot square, which is bulged. A few stones were missing from the top of slope near the retaining wall. Small stumps were observed in the upstream slope. Trees were growing in the embankment near the right abutment (Photograph B). One tree, about 6 inches in diameter, was growing in the upstream slope. About nine small trees, up to 2 inches in diameter, were growing in the downstream slope. The embankment has a depression near the downstream toe at the retaining wall.

c. Nonoverflow Section. This section is in generally good condition. Except for the top 12 feet, seepage was observed along the downstream face of the masonry (Photograph C). The seepage was not localized. Near the right end, a 2-foot square area was observed to have grass growing in the joints. Also in this area, brown-colored material was leaching from the nonoverflow section. The area of leaching was up high on the face and could not be closely inspected. A 4-inch diameter hole was observed in the earthfill at the exposed downstream toe of masonry.

d. Appurtenant Structures.

(1) The spillway was in good condition. The masonry in some of the joints near the exposed toe had eroded slightly.

(2) The spillway auxiliary apron and auxiliary training wall were in excellent condition. Trees were growing close behind the auxiliary training wall (Photograph H).

(3) The spillway apron was in good condition. Mortar had eroded from some of the joints in the apron. The downstream edge of apron was slightly eroded. The wire mesh, which originally was anchored to this edge, was corroded and no longer anchored. Seepage was occurring over the entire rock face that is to the left of the apron. This seepage extended from the spillway to about 100 feet downstream of the apron. It was not localized.

(4) The retaining wall at the junction of the nonoverflow section and the embankment had three cracks. One crack started at the exposed toe of the wall at the junction of the nonoverflow section. It extended vertically through the masonry blocks for about 20 feet, which is about one-half the height of wall at this point. There was no evidence of relative movement. The second crack started at the exposed toe of wall about 3 feet downstream of the first crack. The second crack extends through the masonry blocks vertically for about 20 feet, then it deflects 45 degrees downstream and extends along the masonry joints to top of wall. There was no evidence of relative movement at this crack. Both of these first two cracks were very fine, generally less than 0.1 inch wide. The third crack starts at the exposed toe of wall 26 feet upstream of the downstream end. This crack extends to the top of wall on a 45-degree angle towards the downstream end along the masonry joints. The downstream end of the wall has moved such that the crack measures 0.7 foot horizontally and 0.4 foot vertically. The downstream end is displaced towards the spillway channel about 0.75 foot. The wall batter upstream and downstream of the crack was about the same. At the toe of this third crack, there is a wet area which extends 10 feet downstream and 26 feet upstream. The area is 3 feet wide. It was possible to insert a surveying rod 3 feet into this wet area (Photograph E). The earthfill bounded by the spillway training wall, the retaining wall, and the nonoverflow section is overgrown with small trees.

(5) The spillway training wall contains the outlet works. The wall was in generally good condition. One pane of frosted glass was missing from the skylight at the outlet works control structure. The operation of the outlet works valves was observed. The 10-inch valve connected to the 14-inch diameter pipe was operated easily by two men from its partially open position to its fully open position. No problems were observed with this line except a leaking valve packing. The Owner attempted to operate the four 30-inch valves. Four valve operators equipped with lever bars attempted to turn each valve. Although some of the valve stems rotated slightly, the valves could not be opened. The Owner became concerned that, if the valves were opened, they could not be closed again. This would have seriously affected the Owner's distribution system. The caretaker could not recall the 30-inch valves being operated since they were installed in 1945.

e. Reservoir Area. The reservoir slopes are wooded. No evidence was visible of creep, rockslides, or landslides. Pennsylvania Gas and Water Company owns and posts about 50 percent of the watershed. The Owner indicated that sedimentation is not a problem from the standpoint of reduced reservoir capacity. Maple Lake Dam and Watres Dam are located upstream of Nesbitt Reservoir. These upstream dams are discussed in Paragraphs 5.1a.(5) and 5.1a.(6).

f. Downstream Conditions. The right abutment hillside immediately downstream of the dam has iron pipes used as surveying monuments. These pipes are used to monitor movement in the hillside. About 100 feet downstream of the spillway apron, the channel narrows suddenly to about 30 percent of its upstream width. The right side of the channel is filled and overgrown (Photograph L). Clear seepage of about 25 gpm was observed in a swampy area 45 feet downstream of the end of the retaining wall. This swampy area was at approximately the same elevation as the wet area near the retaining wall. A small stream flowed from this area. The hillside below the swampy area was generally wet with many small seeps observed.

3.2 Evaluation.

a. Embankment. The bulged riprap was probably caused by ice action the previous winter. The missing stones were probably caused by trespassers. The Owner reports that, although the area is posted, persons swim in the reservoir. Trees on the embankment are undesirable. The depression in the embankment is probably caused by the movement of the downstream end of the retaining wall.

b. Nonoverflow Section. The seepage observed on the face of the nonoverflow section was not sufficient enough to be of more than slight concern. The deterioration of mortar in one localized area may have been caused by a poor mix during construction. It presents no immediate hazard. The hole which was observed was probably made by a burrowing animal. It did not appear to be active.

c. Appurtenant Structures.

(1) The eroded mortar in the spillway joints is caused by long-term exposure to flowing water. It presents no hazard at present.

(2) Trees close behind the spillway auxiliary training wall are undesirable.

(3) The erosion observed in the masonry joints and at the downstream edge of the spillway apron is caused by long-term exposure to flowing water. If the wire mesh is not anchored to the spillway apron, it could unravel during high spillway discharges and therefore not contain the small stones beneath the mesh. The seepage from the rock face has been reported in the various inspections by the Commonwealth. It has apparently existed ever since the dam was built. None of the conditions observed at the spillway apron presented an immediate hazard to the dam.

(4) The two cracks in the retaining wall that are near the exposed toe of the nonoverflow section may have been caused by the wall deflecting at some previous time. They may also be related to the crack at the downstream end of the retaining wall. The Pennsylvania Water Supply Commission believed that these cracks were related to the crack at the downstream end of the wall, as noted in the inspection reports of 1921 and later. The crack at the downstream end and the adjacent wet area are evaluated in Paragraph 3.2e. Tree growth on the earthfill is undesirable.

(5) The 30-inch gate valves are inoperable. The valve maintenance procedures are not adequate. The missing pane of glass presents no hazard to the dam. It is a slight hazard to personnel. Leaking valve packings are undesirable.

d. Reservoir Area. No conditions were observed in or near the reservoir which might present significant hazard to the dam.

e. Downstream Conditions. The narrowing of the channel downstream of the dam is undoubtedly due to the monitored movement of the right hillside toward the stream. As noted in Appendix E, the bedrock in this hillside is well below streambed and from 50 to over 150 feet below natural ground surface. The overburden consists of sandy clay with stratifications of gravel running through it. The gravel strata apparently follows the right and downstream dip of the underlying rock. The construction reports indicate that the foundation for the right core wall was excavated through the sandy clay in order that the core wall could rest upon gravel strata. Plate 3 indicates the location of the core wall foundation. The gravel strata below the core wall foundation, probably outcrops into the reservoir and carries water into the downstream hillside. This would account for the saturated condition of the downstream hillside below Elevation 1115, which is about 50 feet above streambed, and the clear flow of about 25 gallons per minute from the hillside. The hillside itself has been moving downstream ever since the dam was first filled in 1902 at an average rate of about 0.25 feet per year. The movement has been monitored by the Owner since 1902. Monuments were installed in 1920 and surveys made at irregular intervals between 1920 and 1971. Results of this monitoring is shown on Plate 7. A total horizontal movement of 13 feet is indicated during this period at one monument that is about 400 feet downstream of the axis of dam. Movement nearer to the dam is generally less, but is still more than 5 feet near the downstream end of the embankment retaining wall. The crack in the downstream end of the retaining wall is probably related to this tendency to move. It might be noted that the two largest increments of movement occurred during the periods when the two largest floods and rainfall of record occurred. Failure of the retaining wall would present an immediate hazard to the dam.

The natural slope of the downstream hillside is now about 1V on 2H, which is still very steep for saturated sandy clay, so the hillside has been trying to gain equilibrium by flattening its own slope over the past 76 years. Additional discussion on downstream conditions is presented in Paragraph 5.1e.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest Elevation 1156.0 with excess reservoir inflow discharging over the spillway. The downstream valves on both 30-inch diameter cast-iron blowoff lines are normally closed and both upstream valves are normally open. The 10-inch diameter valve connected to the left 30-inch conduit is operated in the throttled position to increase discharge from the reservoir as required by demand and pool elevation at the Spring Brook Intake Dam located 2 miles downstream of Nesbitt Dam. Water taken from Spring Brook intake flows by gravity to the distribution lines of Avoca, Duryea, Kingston, Moosic, Old Forge, Pittston, West Pittston, and Wyoming, together. These communities consume 18 mgd, on the average. The 30-inch blowoff lines have the potential for augmenting the inflow at Spring Brook intake.

4.2 Maintenance of Dam. The dam is visited daily by two caretakers, who throttle the 10-inch gate valve as required to maintain a full pool at Spring Brook intake. Daily pool elevations are recorded and sent to the Owner's Engineering Department weekly. This information is used by the Owner's Engineering Department to regulate flows in the distribution system. The caretakers are also responsible for observing the general condition of both the dam and appurtenant structures, and reporting any changes or deficiencies to the Owner's Engineering Department. The downstream hillside is surveyed irregularly to check for movement. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and records are kept on file and are used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. Special problems, such as condition of seepage and displacement of downstream end of right embankment retaining wall, are monitored at intervals as determined by the Owner's Engineering Department. The embankment is mowed at regular intervals and brush is cut annually. The caretakers also visit Spring Brook intake, Watres Dam, Maple Lake Dam, Covey Swamp Dam, and Fort Tuna Creek Dam, daily.

4.3 Maintenance of Operating Facilities. There is no regular maintenance program. Maintenance is apparently performed when deemed necessary.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a chain of command diagram for Nesbitt Dam and a generalized emergency notification list that is applicable for all the Pennsylvania Gas and Water Company dams.

The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions. Company vehicles are usually equipped with radios so that the personnel can communicate with each other and with a central control facility. The truck used by the caretaker on the day of inspection had no radio. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Nesbitt Dam but are as directed by the Owner's Engineering Department.

4.5 Evaluation. As was noted in Section 3, Visual Inspection, both 30-inch valves on each of the two 30-inch diameter lines were inoperable, and trees were observed on the right end of the embankment. Other than for these items, the maintenance appeared to be satisfactory. The inoperable valves leave the dam with no emergency drawdown facilities. The procedures used by the Owner to inspect the dam are adequate, but some needed repairs have not been made. In general, the warning system is adequate, but it would be more effective if it were more detailed.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data.

(1) No hydrologic and hydraulic analyses for the original Nesbitt Dam design were available for review. The spillway capacity was estimated in 1914 by the Pennsylvania Water Supply Commission. The spillway capacity was also estimated after the 1933 modifications to the dam.

(2) In the recommended guidelines for safety inspection of dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended spillway design flood for the size (large) and hazard potential (high) classification of Nesbitt Dam is the Probable Maximum Flood (PMF). If the dam and spillway are not capable of passing the PMF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

(3) The 1945 "Report upon the Application of the Scranton-Spring Brook Water Service Company" by the Pennsylvania Water Supply Commission shows a spillway capacity, with reservoir at top of dam, of 19,540 cfs. Calculations were performed to check the accuracy of the spillway capacity estimate. The estimate is reasonable (Appendix C).

(4) The Owner estimated that approximately half of the watershed belongs to the Pennsylvania Gas and Water Company. Most of the watershed is undeveloped. Hydrologic analysis for this study was based on existing conditions and the effects of future development of the watershed were not considered.

(5) Maple Lake Dam is 2.9 miles northeast of Nesbitt Reservoir. It is a natural lake whose water surface was raised by construction of a dam. Maple Lake Dam is on a tributary to Rattlesnake Creek, which flows into Nesbitt Reservoir, 4.0 stream miles downstream. The drainage area at the damsite is 1.1 square miles. During the inspection of Nesbitt Dam, a brief field visit was made to Maple Lake Dam. The spillway is the natural channel with a trapezoidal control section, that has a bottom width of 20 feet and an average of 1V on 2H side slopes. The spillway invert is 4.0 feet below top of dam. There had apparently been, at some previous time, a different control structure in the spillway. Rotten wooden planks are aligned vertically across the bottom of the spillway control section. The dam is an earthfill embankment. At normal pool elevation, the reservoir has a surface area of 35 acres and it contains 657 acre-feet. Except for the spillway dimensions, data for Maple Lake was obtained from Bulletin No. 5, "Water Resources Bulletin; Dams, Reservoirs, and Natural Lakes", published by the Bureau of Engineering, Pennsylvania Department of Forests and Waters. Calculations (Appendix C) indicate that the natural lake at the site contains at least 143 acre-feet and that the reservoir would contain 800 acre-feet at top of dam elevation. The spillway discharge capacity was estimated at 630 cfs. The peak inflow into Maple Lake from the component of the Nesbitt PMF was estimated at 3,070 cfs. The volume of the hydrograph was adjusted to approximate 26 inches of runoff occurring over the Maple Lake drainage area. Considering the effects of surcharge storage, Maple Lake Dam can pass a storm equal in duration to its component of the Nesbitt PMF and with a peak inflow of 920 cfs. This is 30 percent of the peak inflow from its component of the Nesbitt PMF. If Maple Lake should fail, a maximum of 657 acre-feet would be released into Rattlesnake Creek. This is 55 percent of the available surcharge storage in Nesbitt Reservoir. Therefore, the failure of Maple Lake would not, by itself, cause overtopping of Nesbitt Dam.

(6) Watres Dam is 2.5 stream miles upstream of Nesbitt Reservoir and is on Spring Brook. A Phase I Inspection Report has been prepared for Watres Dam. At the damsite, the drainage area is 15.4 square miles. The total storage capacity of Watres Reservoir is 8,241 acre-feet, of which 2,284 acre-feet are surcharge storage. The spillway at Watres Dam has a discharge capacity of 10,000 cfs; it is rated as seriously inadequate.

(7) Watres Dam and Maple Lake Dam would both affect flood inflows to Nesbitt Reservoir. They are relatively far upstream of the reservoir and the peak inflow from the intervening drainage area would most probably reach the reservoir before the peak outflow from the dams arrived. The method of analysis used in this report does not lend itself to hydrograph routings. Better data than was available, as well as a more sophisticated analysis, would be required to ascertain the inflow hydrograph

to Nesbitt Reservoir. For this study, the component of the PMF peak flow for Maple Lake Dam, Watres Dam, and the intervening drainage area was transposed from the PMF peak flow at the Nesbitt Damsite. A peak inflow to Nesbitt Reservoir was then estimated using the sum of the peak inflow from the intervening drainage area plus 40 percent of the peak inflow to Watres Dam. It was assumed that outflows from Maple Lake Dam would not increase the peak inflow to Nesbitt Reservoir. These estimates were based solely on engineering judgment.

(8) The caretaker of the dam reported that, during Tropical Storm Diane in August 1955, the tailwater from the downstream channel reached the low chord of the footbridge. The low chord is approximately 26 feet above the stream. The cause of the water being this high is unknown. It is assumed that there was some sort of channel blockage downstream. For this report, tailwater was computed at normal depth for an average cross section. The results indicate a lower tailwater depth for a higher discharge than occurred during Tropical Storm Diane.

b. Experience Data. For this study, the PMF was obtained from the curve of PMF peak flow versus drainage area for Region 2 of the Susquehanna River Basin.(1) The PMF peak was estimated to be 51,200 cfs. The volume of the inflow hydrograph was adjusted to approximate 26 inches of runoff from the entire watershed.

In May 1942, a head of 5.25 feet was reported on the spillway crest. The estimated discharge is 8,020 cfs. During Tropical Storm Diane in August 1955, a head of 7 feet was reported on the spillway crest. The estimated discharge is 11,450 cfs.

c. Visual Observations. On the date of the inspection, no conditions were observed that would indicate that the spillway capacity would be significantly reduced during a flood occurrence.

d. Overtopping Potential. For an occurrence of the PMF, the peak inflow of 31,980 cfs from the uncontrolled drainage area below Watres and Maple Lake Dams alone is greater than the spillway capacity of Nesbitt Dam. A check of the surcharge storage effect of Nesbitt Reservoir shows that the storage available is insufficient to contain an inflow with a peak flow of 31,980 cfs without overtopping the dam (Appendix C).

e. Downstream Conditions. Spring Brook flows from Nesbitt Dam 2.1 stream miles to Spring Brook Intake Reservoir along an uninhabited reach with a relatively wide flood plain, as shown on Plate 1. Spring Brook Intake Reservoir is sufficiently

(1) Obtained from the Baltimore District, Corps of Engineers.

small that its failure would not add a significant amount of water to the stream. However, it would provide no significant mitigating effect to floods originating upstream. Spring Brook then flows 1.9 stream miles along a reach with at least 80 houses in the flood plain. The stream then passes under the large and high Pennsylvania Turnpike Bridge and flows for 1.5 stream miles past a development with at least 60 houses in the flood plain. The stream then crosses under the large and high Interstate Route No. 81 Bridge and flows for 0.8 stream mile, through the highly populated community of Moosic, to its confluence with the Lackawanna River. Downstream conditions indicate that a high hazard classification is warranted for Nesbitt Dam.

f. Spillway Adequacy.

(1) The spillway will not pass the PMF from the uncontrolled drainage area without overtopping the dam. The PMF peak discharges for Maple Lake Dam, Watres Dam, and the uncontrolled drainage area below those dams were estimated by transposition of the PMF peak discharge for Nesbitt Dam. One-half of the PMF inflow to Nesbitt Reservoir was assumed to be at least one-half of the PMF peak discharge for the uncontrolled drainage area plus 40 percent of one-half of the PMF peak discharge for Watres Dam. A check of the surcharge storage effect of Nesbitt Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 21,060 cfs without overtopping the dam (Appendix C).

From the Phase I Inspection Report for Watres Dam, an occurrence of one-half of the PMF for the Watres Dam watershed would overtop and would probably cause the failure of Watres Dam. Based on actual dam failures (Appendix C), a failure hydrograph with a peak inflow as high as 450,000 cfs could rush into Nesbitt Reservoir. The spillway capacity of 19,540 cfs is much smaller than the peak inflow of 450,000 cfs. A check of the surcharge storage effect of Nesbitt Reservoir shows that the surcharge storage available is insufficient to contain an inflow with a peak flow of 450,000 cfs without overtopping Nesbitt Dam.

(2) The maximum tailwater is estimated to be Elevation 1079 at the spillway capacity of 19,540 cfs. At maximum pool elevation, there is a difference of about 90 feet between headwater and tailwater. If Nesbitt Dam should fail due to overtopping, the hazard to loss of life downstream from the dam will be significantly increased from that which would exist just prior to overtopping.

(3) Based on established OCE criteria, as outlined in Paragraph 5.1a.(2), the spillway capacity of Nesbitt Dam is rated as seriously inadequate. Considering the effects of the

combined surcharge storage of Maple Lake Dam, Watres Dam, and Nesbitt Dam of 3,621 acre-feet, the spillway discharge capacity of 19,540 cfs can accommodate a flood with a peak inflow of 23,150 cfs for a storm of the same duration as the PMF. This is 45 percent of the PMF peak inflow.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of the dam resulted in a number of observations relevant to structural stability. These observations are listed herein for various features.

(2) Nonoverflow Section. Slight seepage was observed over most of the downstream face. The description and evaluation are presented in Paragraphs 3.1c. and 3.2b., respectively.

(3) Appurtenant Structures. Eroded mortar was observed in the downstream face of the spillway and in the spillway apron. The description and evaluation are presented in Paragraphs 3.1d.(1), 3.1d.(3), 3.2c.(1), and 3.2c.(3). The retaining wall is cracked in three locations. The description and evaluation are presented in Paragraphs 3.1d.(4), 3.2c.(4), and 3.2e.

(4) Downstream Channel. Movement has been observed on the right downstream hillside. The description and evaluation are presented in Paragraphs 3.1f. and 3.2e., respectively.

b. Design and Construction Data. No record of stability analysis for the original structures was available for review. However, a stability study for the nonoverflow section was performed in 1914 by the Pennsylvania Water Supply Commission. The results of the analysis are on file.

The 1914 analysis for the nonoverflow section was reviewed to assess the stability of the section. The maximum loading condition that was used included the following: full hydrostatic pressure on the upstream face from reservoir level at the top of embankment, no tailwater, and uplift varying uniformly from two-thirds of the headwater pressure at the heel to zero at the toe. The results of this analysis, as presented in the 1914 report, show that the resultant falls 1.4 feet outside the middle third of the section from the top of structure to level of foundation. Toe pressure, as well as resistance to overturning and sliding, were found to be satisfactory. The top of dam has subsequently been raised 3 feet. Stability considerations for the spillway were not mentioned in the 1914 report.

Between 1918 and 1920, various consultants were retained to advise on the stability of Nesbitt Dam, as described more fully in Paragraph 1.2g.

Stability analyses for both the spillway and the nonoverflow were performed in this study. Only the bottom sections were considered. The loading assumptions for both sections were as follows: reservoir level at the top of the embankment, full hydrostatic pressure on upstream face and uplift varying uniformly from full tailwater at the toe to full tailwater at the heel plus two-thirds of the difference between the headwater and tailwater also at the heel.

The results of the stability analysis performed for the nonoverflow section showed that the toe pressure and sliding factor are within acceptable limits and the resultant is outside the middle third, but within the base, about 13.4 feet from the toe. OCE guidelines on overturning recommends that the resultant be within the middle third. Although the resultant is outside the middle third, it is within the base. Considering that the nonoverflow section is on a rock foundation and the toe pressure is within acceptable limits, the resultant being outside the middle third is not considered to be a significant deviation from the recommended guidelines.

The results of the stability analysis performed for the spillway showed that the toe pressure and sliding factor are within acceptable limits and the resultant is outside the middle third, but within the base, about 12.1 feet from the downstream toe. OCE guidelines on overturning recommended that the resultant be within the middle third. Although the resultant is outside the middle third, it is within the base. Considering that the spillway is on a rock foundation and the toe pressure is within acceptable limits, the resultant being outside the middle third is not considered to be a significant deviation from the recommended guidelines.

The retaining wall at the downstream side has cracks as previously discussed.

c. Operating Records. Based on the operating records, there is no evidence that any stability problems have occurred for the embankment, the upstream retaining wall, the spillway, or the nonoverflow section.

d. Post-Construction Change. No modifications have been made to Nesbitt Dam since its construction.

e. Seismic Stability. Nesbitt Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected loading. However, since there are no formal static stability analyses, and since there is the potential of earthquake forces moving or cracking the masonry core wall, the theoretical seismic stability of the dam cannot be assessed.

AD-A063 949 GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. NESBITT DAM (NDS PA-00449/DER --ETC(U)
JUL 78 DACW31-78-C-0046

UNCLASSIFIED NL

2 OF 2

AD A063949

END
DATE FILMED
3-79
DDC

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on the visual inspection, available records, calculations and past operational performance, Nesbitt Dam is judged to be in good condition. However, some maintenance and repair deficiencies were noted. A summary of features and observed deficiencies are listed below:

Feature and Location	Observed Deficiencies
Embankment:	
Near right abutment	Trees in slopes.
Upstream slope	Bulged riprap and stones missing.
Toe near retaining wall	Depression.
Nonoverflow Section:	
Downstream face	Seepage and area with deteriorated mortar.
Downstream toe	Burrowing animal hole.
Spillway:	
Downstream face	Eroded mortar.
Spillway Auxiliary Training Wall:	
Behind auxiliary wall	Trees adjacent.
Spillway Apron:	
Apron	Eroded mortar.
Left abutment	Seepage.
Downstream edge	Eroded edge and corroded wire mesh.
Retaining Wall:	
Downstream toe	Cracks, movement, and wet area.
Near nonoverflow section	Cracks.
Earthfill at toe	Brush.

Feature and Location	Observed Deficiencies
Outlet Works:	
10-inch valve	Leaking valve packing.
30-inch valves	Inoperable.
Skylight	Missing glass pane.
Downstream Channel:	
Right hillside	Movement.
Channel	Deposition.

(2) The overtopping potential analysis shows that Nesbitt Dam will be overtopped by the PMF and by one-half the PMF. Based on OCE criteria, as outlined in Paragraph 5.1a.(2), the spillway capacity is rated as seriously inadequate. The existing spillway can accommodate a flood with a peak inflow of 45 percent of the PMF peak inflow.

(3) Watres Dam and Maple Lake Dam are both upstream of Nesbitt Reservoir. A Phase I Report was prepared for Watres Dam. Its spillway is rated as seriously inadequate. Failure of Watres Dam would cause overtopping of Nesbitt Dam. Failure of Maple Lake Dam would not, by itself, cause overtopping of Nesbitt Dam.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented as noted therein.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations will be required.

7.2 Recommendations and Remedial Measures.

a. In view of the concern for the safety of Nesbitt Dam, the following measures are recommended to be undertaken by the Owner as soon as practical:

(1) Develop a detailed emergency operation and warning system for Maple Lake and Nesbitt Dam system. A similar warning system has already been recommended for Watres Dam.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Nesbitt Dam, as well as the nature and extent of mitigation measures required to make the spillway hydraulically adequate. The effects of Maple Lake Dam and Watres Dam should be included in the study.

(3) Monitor the slope movement on the downstream right hillside. In this regard, eight observation wells or other instrumentation should be provided. The wells should be placed at selected locations in the hillside and be founded in a gravel strata. Core boring should be performed to ascertain the type, location, extent, and engineering properties of the gravel strata and other right hillside soil. Inclinometers should be placed in the hillside to ascertain the nature of the movement. The purpose of the investigation and study should be to devise a method to stop slope movement by either sealing off the water intake into the hillside or of relieving its pressure head.

(4) Repair 30-inch gate valves and provide proper maintenance for them.

b. In order to correct operational, maintenance, and repair deficiencies, and to more accurately assess the condition of the dam, the following measures are recommended to be undertaken by the Owner in a timely manner:

(1) Visually monitor seepage on the downstream face of the nonoverflow section and at the left abutment. If changes are noted, take appropriate action.

(2) Remove trees growing in the embankment and behind spillway auxiliary training wall.

(3) Repair riprap.

(4) Fill burrowing animal hole.

(5) Repair leaking valve packing.

(6) Visually monitor mortar for further signs of erosion. Severely eroded mortar should be repaired.

(7) Replace missing pane of glass in outlet works skylight.

(8) Repair downstream edge of spillway apron and reanchor wire mesh.

c. The following operational measures are recommended to be undertaken by the Owner:

(1) Provide round-the-clock surveillance of Nesbitt Dam during periods of unusually heavy rains.

(2) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.