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DELAWARE RIVER BASIN

WIGWAM RUN, MONROE COUNTY, PENNSYLVANIA

# WIGWAM LAKE DAM

NDI ID No. PA-00990 DER ID No. 45-124

# HARRY SNOW

National Dam Inspection Program. Wigwam Lake Dam (NDI ID Number PA-00990, DER ID Number 45-124), Delaware River Basin, Wigwam Run, Monroe County, Pennsylvania. Phase I Inspection Report

# PHASE I INSPECTION REPORT

# NATIONAL DAM INSPECTION PROGRAM

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Prepared By GEO-TECHNICAL SERVICES, INC. CONSULTING ENGINEERS & GEOLOGISTS

> 851 S. 19th Street Harrisburg, Pennsylvania 17104 Contract DACW 31-81-C-0019

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For

DEPARTMENT OF THE ARMY BALTIMORE DISTRICT, CORPS OF ENGINEERS Baltimore, Maryland 21203

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### PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expediously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

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

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### PHASE I INSPECTION REPORT

### NATIONAL DAM INSPECTION PROGRAM

### BRIEF ASSESSMENT OF GENERAL CONDITION

### AND

### RECOMMENDED ACTION

Name of Dam:

Wigwam Lake Dam NDI ID No. PA-00990 DER ID No. 45-124

Size:

<u>Hazard</u> Classification:

State Located:

High

Owner:

Harry Snow R.D. #3 Stroudsburg, Pa. 18760

Small (14 feet high; 50 acre-feet)

Pennsylvania

<u>County Located</u>: Monroe <u>Stream</u>: Wigwam Run

Date of Inspection:

November 26, 1980

Based on visual inspection, the Wigwam Lake Dam is judged to be in poor condition. Based on the size and hazard classification of the dam, the recommended Spillway Design Flood (SDF) varies from ½PMF (Probable Maximum Flood) to the full PMF. Because of the small storage capacity of the reservoir, the ½PMF is selected as the SDF for the dam. Under the present conditions, the spillway will pass approximately 15 percent of the PMF without overtopping the dam. Overtopping depth of 1.2 feet was calculated for a flood magnitude of ½PMF; whereas, it was judged that the dam will begin to fail under the overtopping depth of one foot. Because failure of the dam would increase the downstream high hazard conditions, the spillway is seriously inadequate. Therefore, according to the guidelines for Safety Inspection of Dams, the dam is rated as unsafe, nonemergency.

Considering the steepness of the embankment slopes, the marshy conditions at the toe of the dam could, in time, affect the stability of the embankment.

The observed inclination of the spillway endwall from the vertical, away from the retained embankment earthfill, could, if further movement occurs, affect the integrity of the embankment.

The unknown condition and location of the valve mechanism, regulating flow through the outlet pipe, precluded assessment of the prevailing conditions of the outlet works. Ready access to an operable valve, or other method of drawing down the reservoir level during emergencies, is required. Such requirement may arise should excessive seepage or piping develop.

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### WIGWAM LAKE DAM

The present condition of the dam and appurtenances indicate that maintenance of the dam is unsuitable. There is no warning system and evacuation plan in effect at the present time.

The following investigations and comedial measures are recommended for immediate implementation by the owner:

(1) Engage a professional engineer experienced in the design and construction of dams to perform additional hydrologic and hydraulic analyses to more accurately ascertain the spillway capacity of the facility. As a result of the analyses, implement the necessary remedial measures to upgrade the present spillway capacity to the required Spillway Design Flood.

(2) Locate the valve mechanism for the outlet works, if required, and provide means to operate the valve; or develop another method of emergency drawdown in the event such action becomes necessary.

(3) Remove trees and brush from the crest and slopes of the embankment under the supervision of a professional engineer.

(4) Institute a monitoring program to detect any significant change in the conditions of the dam and appurtenant structures. As a minimum, this program shall include provision for detecting any additional movement in the spillway endwall and the rate and clarity of seepage at the toe of the dam.

In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning system to facilitate timely and orderly evacuation of the downstream population due to hazardous conditions at the dam.

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

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a professional engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

Submitted by: Approved: DEPARIMENT OF THE ARMY ERVICES, INC. GEO-T BALTIMORE DISTRICT, CORPS OF ENGINEERS а AMES W. PECK Colonel, Corps of Engineers Commander and Districe Engineer Date: 3 J4NE 1981 Date:

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# PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

### WIGWAM LAKE DAM

## NDI# PA-00990, PENNDER # 45-124

### SECTION 1

### GENERAL INFORMATION

### 1.1 Authority

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

### 1.2 Purpose.

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

### 1.3 Description of Project.

a. Dam and Appurtenances. Wigwam Lake Dam is an earthfill dam with a maximum height of 14 feet and 253 feet long, including the spillway. The spillway is located at the left abutment and consists of a concrete weir with a vertical downstream face and short rock paved apron. The spillway crest is a 57-foot long, sharp crested weir that intersects the slope of the left abutment and terminates at a vertical endwall on the earthfill dam embankment. The outlet works consist of a 16-inch diameter cast iron pipe with no visible upstream or downstream controls.

b. Location. Wigwam Lake Dam is located on Wigwam Run in Stroud Township, Monroe County, one mile east of Bartonsville, Pennsylvania. The dam and reservoir are contained within the Mount Pocono, Pennsylvania 7.5 minute series USGS Quadrangle Map at Latitude N 41°00'11" and Longitude W 75°15'36". A Location Map is shown in Exhibit E-1.

c. <u>Size Classification</u>. Small (14 feet high, 50 acre-feet storage capacity at top of dam).

d. <u>Hazard Classification</u>. High (see paragraph 3.1e).

e. Ownership. Harry Snow, R.D. #3, Stroudsburg, Pennsylvania 18760.

f. <u>Purpose of Dam</u>. The original purpose of the impounded water was for ice making and recreation. Presently, the lake is being used for recreation. g. Design and Construction History. Wigwam Lake Dam was designed by John L. Westbrook, Civil Engineer and Surveyor of Stroudsburg, Pennsylvania. Exhibits E-2 and E-3 indicate the final revised plans for which a construction permit was issued to John J. Fredericks (the original owner) by the Pennsylvania Water and Power Resources Board on August 17th, 1927. Construction started in the summer of 1927 and completed in the Spring of 1928 by Caratti (Contractor). Although "asbuilt" drawings are not available, construction history is documented in inspection reports, correspondence and photographs obtained from the Pennsylvania Department of Environmental Resources (PENNDER) files.

h. <u>Normal Operational Procedure</u>. The pool is maintained at the spillway crest elevation with excess inflow discharging over the spillway into Wigwam Run, a tributary of Pocono Creek. The outlet works was not discharging on the day of the inspection and appeared to be permanently closed. The location of regulating mechanism for the outlet works was not visible and could not be verified.

### 1.4 Pertinent Data

a.	<u>Drainage Area (square miles)</u> .	1.5
ь.	Discharge at Damsite (cfs).	
	Maximum known flood at damsite	Unknown
	Outlet works at maximum pool elevation	
	Design	Unavailable
	Computed, assuming "downstream control"	30
	Spillway capacity, prior to overtopping	
	Design	965
	Existing condition	475
c.	Elevation (feet above msl).	
	Top of Dam	
	Design conditions (top of dam)	711
	Existing conditions (lowest point)	709.8
	Maximum pool	
	Design conditions	711.0
	Existing conditions	709.8
	Normal Pool (spillway crest)	708
	Upstream Invert Outlet Works (design)	696.5, Approx.
	Downstream Invert Outlet Works	696
	Streambed at toe of dam	696
	Maximum tailwater	702.5
d.	Reservoir Length (feet).	
	Normal Pool	1500
	Maximum Pool	1800
e.	Storage (acre-feet).	
	Normal Pool	32
	Maximum Pool	
	Design conditions	58
	Existing conditions	50

f.	Reservoir Surface (acres).			_
	Normal Pool			8
	Maximum Pool			
	Design conditions			Unknown
	Existing conditions			8.3
g.	Dam.			
	Туре			Earthfill
	Length, excluding spillway (feet)	)		196
	Maximum Height (feet)			
	Design conditions			16
	Existing conditions			14
	Top Width (feet)			
	Design conditions			8
	Existing conditions		varies 7 to	14
	Side Slopes			
	Upstream			
•	Design	2H:1V		
	Existing conditions	vary	(3.6H:1V to	1.3H:1V)
	Downstream			
	Design	2H:1V		
	Existing conditions	vary	(2.6H:1V to	1.35H:1V)
	Zoning			
	Upstream	Earthf	111	
	Downstream	Earth	and rock fil	1
	Cut-off	Concre	te Core Wall	
	Impervious Core	Concre	te Core Wall	
	Grout Curtain			None
L	Deconstant and Reculations Turned			None
п.	Diversion and Regulating fumer.			none
<b>1</b> .	Snillway.			
	Type	Uncont	rolled. shar	p crested.
	-)}-	concre	te weir with	vertical
		drop o	n paved apro	n.
	Length of Weir (feet)		F	57
	Crest Elevation			708
	Upstream Channel (stone paved),	Length	(feet)	15
	Downstream Channel	Swale	to streambed	1.
j.	Outlet Works.			
-	Туре			16" dia. CIP
	Length (feet)			64 (design)
	Closure and Regulating Facilitie	S		Unknown
	Access			Unknown

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### SECTION 2 ENGINEERING DATA

### 2.1 Design.

a. <u>Data Available</u>. Design data available for review consist of the 1927 drawings, specifications, inspection reports, and photographs obtained from PENNDER files. Construction drawings are presented in Appendix E.

b. Design Features.

(1) Embankment. The dam was designed as a zoned embankment with an earth fill upstream section and an earth and rock fill downstream section. The dam has a crest width of 8 feet and side slopes of 1 vertical to 2 horizontal on both upstream and downstream faces. The upstream slope protection was to consist of 8-inch thick stone paving throughout the face of the dam. Foundation treatment was to be a 6foot wide cut-off trench along the dam axis between both abutments, including the spillway. Trench excavation was to extend to bedrock, or terminate in impervious overburden material. A concrete core wall was to be founded on a 3-foot wide concrete footing at the bottom of the cut-off trench. The 12-inch (top width) concrete core wall was to terminate one foot below the dam crest, extending from the right abutment, throughout the length of the earth embankment, to the spillway endwall.

### (2) Appurtenant Structures.

(a) <u>Spillway</u>. The spillway was to consist of a two-foot wide weir, 60 feet long, tapered on top to provide a sharper crest. The crest elevation was to be three feet below the top of the dam. An earthfill blanket was to be placed against the upstream vertical face of the weir, forming an adverse slope toward the natural ground in the reservoir. The short approach channel, formed by the earth blanket, was to be stone paved. The downstream face of the weir was to drop five feet into a sloping concrete apron in five one-foot steps. The weir was to terminate at each abutment with 18-inch thick concrete endwalls. The right endwall was to conform to the top width and side slopes of the retained earth embankment. The apron was to terminate with a concrete cut-off wall that was to extend to the depth of the endwall foundations, 4 feet below the original ground surface.

(b) <u>Outlet Works</u>. The outlet works was to consist of 16inch diameter cast iron pipe, approximately 64 feet long, and its lower half was to be embedded in a 24-inch wide concrete encasement. Two anti-scep concrete collars were to be provided along the upstream end of the pipe. Although details of the intake structure and controls for flow in the pipe

are not shown on the drawings, the existence of an upstream gate valve is referenced in correspondence, available in PENNDER files.

(c) <u>Specific Design Data and Criteria</u>. The spillway capacity was designed to meet the Pennsylvania Department of Forests and Waters criteria of 700 cubic feet per second per square mile of drainage area above the dam. The embankment was to be constructed on clay and sand or gravel from borrow areas adjoining the damsite. Fill material was to be placed in successive 6 or 8-inch layers, compacted by tamping and driven over continuously by teams and wagons after sprinkling.

### 2.2 Construction Records.

Review of inspection reports and correspondence indicates that the bottom of the cut-off trench did not extend to bedrock, or to impervious overburden material, under the entire length of the dam. Large loose boulders, rather than bedrock were encountered in the cut-off trench on the right abutment; whereas, the bottom of the trench was terminated in coarse gravel approximately 6 feet below ground surface on the left abutment and under the spillway.

### 2.3 Operational Records.

Review of correspondence between 1928 and 1965 indicates considerable water losses at the initial filling of the reservoir. Water level could not be maintained at spillway crest, although water released through the outlet works was but a fraction of the inflow into the reservoir. The downstream half of the right spillway endwall settled (observed in 1933), causing a large horizontal crack in the wall, 8 inches above the spillway crest elevation. A one inch wall separation in the vertical construction joint of the wall at the dam axis was also attributed to the settlement of the wall. Seepage and swampy conditions at the downstream toe of the maximum section were observed since the first filling of the reservoir. A six inch embankment settlement along the entire length of the dam was reported in 1941. Available records also indicate that applications were filed with the Fish Commission for a permit to draw down the reservoir for repairs in 1946 and in 1953. The 1946 repairs were attempted to reduce leakage from the dam. Repairs to the upstream gate valve were made in 1953.

### 2.4 Other Investigations.

After completion of construction (December 1928), available reports indicate that on-site inspections were made in June 1929, May 1931, June 1933, June 1934, May 1935, June 1938, May 1941, May 1950, and in January 1957. These inspections were made as part of the Pennsylvania State mandated inspection program. Additionally, inspections were made by engineers from the Pennsylvania Department of Forests and Waters (presently PENNDER) to investigate property owners' complaints. The complaints were related to reduction in the flow of Wigwam Run, downstream of the constructed dam, during periods of low flow.

## 2.5 Evaluation.

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(a) <u>Availability of Data</u>. Although "as built" plans for Wigwam Lake Dam are not available, data obtained from PENNDER files provide information relative to the chronology of construction, operation and repairs of the dam and appurtement structures.

(b) <u>Adequacy</u>. The available data is limited and the assessment must be based primarily on the visual inspection and hydrologic and hydraulic analysis, presented in Section 5.

(c) <u>Validity</u>. With the exceptions noted on Exhibit E-3, there is no reason to question the validity of the available data.

### SECTION 3 VISUAL INSPECTION

### 3.1 Observations.

(a) General. The overall appearance of the dam and its appurtenant structures is considered to be poor. The locations of observed deficiencies are shown on the Sketch Plan, presented in Exhibit A-1, Appendix A. The profile and typical sections of the dam are presented in Exhibits A-2, A-3, and A-4 and are based on field survey made on the day of inspection. The survey datum for this inspection was an approximate elevation obtained for the spillway crest from a USGS map. The construction drawings for the dam and appurtenant structures are shown in Exhibits E-2 and E-3, Appendix E. The elevations shown on the construction drawings are based on a different datum than that of the USGS map. Therefore, to convert the elevations shown on the appended construction drawings to the elevations used in this report, it is necessary to add 609 feet to the elevations shown on the appended drawings. On the inspection date (11/26/80), the lake level was 0.1 foot above the spillway crest (elevation 708 above mean sea level). Deficiencies observed during the field inspection are described-below, and further illustrated in Exhibits A-1, Appendix A. Visible features of the dam are depicted in photographs, presented in Appendix C.

Embankment. Observations made during inspection indicate that ь. the embankment is in poor condition. The upstream slope, above the lake level varies from 1V:3.6H (1 vertical to 3.6 horizontal) near the left abutment to 1V:1.3H near the maximum section (see Exhibits A-3 and A-4). The 8-inch thick stone pavement on the upstream face of the embankment, shown on the construction drawing (Appendix E), does not exist above the lake level (see photographs 1 and 2, Appendix C). The top width of the dam varies from 7 feet at the left abutment to 14 feet at the maximum dam section, as shown on Exhibits A-1, A-3, and A-4. The crest of the dam, upstream of the core wall, settled approximately 4 inches, exposing the upstream face of the core wall (see Section B, Exhibit A-4, and photographs 5 and 6, Appendix C). The crest of the dam at the junction with the spillway endwall on the left abutment is 0.6 foot lower than the top of the wall (see photograph 10, Appendix C). The top of the dam elevations vary as indicated in Exhibit A-2. The lowest point on the top of the dam is at elevation 709.8', which is 1.3 feet lower than the design elevation for the top of the dam. The abundance of brush and trees on the top of the embankment slopes and at the toe of the dam are illustrated in photographs 1, 2, 5, 6, and 8, Appendix C. The downstream slope of the embankment varies from 1V:2.6H on the left abutment to 1V:1.35H at the maximum section, near the right abutment (see Exhibits A-3 and A-4). Clear seepage at a total estimated rate of 2 gallons per minute (GPM) was observed immediately to the right of the outlet pipe and at a point

50-feet left of the outlet works. The entire downstream area near the toe of the maximum section is marshy. Approximate limits of the marshy area are shown in Exhibit A-1. The right abutment of the dam is at the toe of a near-vertical cliff, as shown on photographs 4 and 6, Appendix C, and further discussed in Appendix F, Geology. A gully shaped depression begins downstream of the right abutment of the dam and extends to the toe of the dam, as shown in Exhibit A-1 and photograph 7, Appendix C. The top of the dam near the right abutment and the beginning of the depression is at elevation 709.9, which is 1.1 feet lower than the design elevation for the top of the dam.

### (c) Appurtenant Structures.

(1) Spillway. The overall appearance of the spillway is poor. The left spillway endwall and the stepped drops, shown in Exhibit E-3, do not exist. The concrete weir intersects the present slope of the left abutment; and the downstream face of the concrete weir is vertical, as shown in Exhibits A-2 and A-3. The present spillway length is 57 feet, or 3 feet shorter than the design length. The top 4 inches of the weir near the right endwall of the spillway has been lifted by about 2 inches for a distance of approximately three feet, resulting in a near-horizontal joint (see photographs 1, 2, and 10, Appendix C). Flow of water through this joint is illustrated by the icicle formation in photograph 10. The spillway endwall is leaning slightly away from the retained earth embankment. A vertical crack at the center of the wall terminates above the top of the weir, where patching with mortar was previously attempted. The bottom of the spillway outlet channel between the weir and the toe of the endwall has an accumulation of debris, as shown on photograph 10, Appendix C. The spillway concrete apron, shown on the construction drawing (Exhibit E-3), was not visible on the day of inspection. Verification of its existence was hampered by the frozen ground conditions on the day of inspection. The spillway discharge channel, shown in Exhibit E-2, is eroded at the downstream end of the spillway endwall. The present alignment of spillway channel, downstream of the dam, is illustrated in Exhibit A-1.

(2) <u>Outlet Works</u>. The outlet of the 16-inch diameter cast iron pipe appears to be in good condition. The invert of the outlet pipe is located at the maximum section of the dam and is at stream level (see photograph 8, Appendix C). The end of the concrete cradle shown in Exhibit E-2 was not visible. There was no flow through the outlet pipe on the day of the inspection. The upstream gate valve (see Engineering Data, Section 2) was not visible and its location or existence could not be verified.

(d) <u>Reservoir Area</u>. The watershed is predominantly wooded, rising from elevation 708 to elevation 1020 feet above mean sea level. The immediate area along the left bank of the lake is flat to moderately sloped (less than 5%). The right bank of the lake rises from elevation 708 feet to elevation 800 feet, sloping from 20% along the shore line to nearvertical cliff at the right abutment of the dam. There was no evidence of slide activity on the steep slopes that can endanger the safety of the dam. Both permanent and seasonal homes are located along the entire eastern shore of the lake, as well as on the upstream half of the western shore. A residential developement is located on the lower part of the watershed, approximately 1000 feet west of Wigwam Lake and above elevation 820 feet. The drainage pattern from this development is in southeasterly direction toward the lake. The northern half of the watershed is characterized by wider valleys and milder slopes. Pertinent watershed features are presented in Exhibit E-1, Appendix E. Geologic features of the area are described in Appendix F.

(e) Downstream Channel. The average slope of the stream channel between the dam and State RTE 611 is 0.007 foot per foot (0.7%). Computer printouts of typical sections, located 800 feet and 2100 feet downstream of the dam, are presented in Appendix D. Each section represents the downstream end of the stream reach where existing residences may be subject to inundation, should Wigwam Lake Dam fail. Present stream encroachments within the aforementioned reaches consist of a box culvert and a bridge, a distance of 500 to 1900 feet from the dam, respectively. The 3-foot high by 5-foot wide box culvert is shown in photographs 11 and 12; and the 4-foot high bridge, spanning 18 feet across the stream, is shown in photographs 13 and 14, Appendix C. Development within the first reach of the stream and below the top of dam elevation consists of five permanent and seasonal dwellings that are located on the east side of Wigwam Run. Development within the second stream reach consists of five permanent dwellings, residential garages, a trailer court, a grocery store, and a restaurant (see photographs 11, 12, 13, and 14, Appendix C). The survey indicates that more than a few lives can be lost and a significant amount of property damage incurred should the dam fail when the cited structures are occupied. Consequently, the Wigwam Lake Dam is classified as a high hazard structure.

### SECTION 4 OPERATIONAL PROCEDURES

### 4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with the excess inflow discharging over the spillway into the downstream channel. The upstream control for the outlet pipe was not visible and does not appear operational.

### 4.2 Maintenance of Dam.

Maintenance activities by the present owner could not be verified during the inspection and appear to be minimal. Past history of the dam indicates that maintenance was infrequent and consisted of brush and tree removal from the top and downstream toe of the dam. The removal of trees by the previous owners was ordered by the Pennsylvania Department of Forests and Waters, following inspection by the Department's personnel (see paragraph 2.4, Section 2). In 1966, the Department instructed the present owner to remove trees and brush growing on the dam embankment as well as the removal of debris from the wasteway channel. The conditions on the top of the dam on 11/26/80 are shown in photographs 1, 2, and 5. The debris downstream of the spillway weir on the day of the inspection is shown in photograph 10, Appendix C.

### 4.3 Maintenance of Operating Facilities.

The condition of the upstream operating facilities for the outlet pipe could not be verified during the site inspection. Past history of the dam indicates that valve repair work in 1953 necessitated a permit to draw down the reservoir for an estimated depth of 10 to 15 feet.

### 4.4 Warning System in Effect.

There is no emergency operation and warning system in effect at the present time.

### 4.5 Evaluation.

The maintenance of the outlet pipe control facilities is inadequate. The owner should institute regularly scheduled maintenance inspections. Operational control facilities to lower the water level in the reservoir may be required for emergency repairs at the downstream toe of the dam. Institution of a **surveillance** and warning system and plan of evacuation for the downstream population is necessary to detect adverse conditions at the dam and to prevent loss of life should the dam fail.

### SECTION 5 HYDROLOGY AND HYDRAULICS

### 5.1 Design Data.

The permit given by the Pennsylvania Water and Power Resources Board stipulates that the spillway design meets the criteria to pass 700 cfs per square mile of the drainage area above the dam. Consequently, the spillway design capacity for the 1.5-square mile drainage area above the dam was 1050 cfs. To obtain this capacity for the design head and spillway length shown in Appendix E, it appears that a spillway discharge coefficient of 3.37 was adopted for spillway design. Hydraulic analysis presented in Appendix D employed a discharge coefficient of 3.1, which better represents the conditions of the constructed spillway. The drainage area above the dam was verified to be 1.5 square miles.

### 5.2 Experience Data.

The probable flood of record in Wigwam Run is the August 1955 flood. Flood stages or flow records at the damsite or above the mouth of the stream are not available. No records are available on the maximum stage of the reservoir nor to indicate past overtopping of the Wigwam Lake Dam.

### 5.3 Visual Observations.

Based on the visual inspection and field survey, described in Section 3 of this report, the observations relevant to hydrology and hydraulics are evaluated below:

a. <u>Embankment</u>. The present low point on top of the dam is at 709.8, or 1.2 feet below the design elevation for the top of the dam. The low top of dam elevation on the right abutment, the existing gully between that abutment and the toe of the dam, and the steep downstream embankment slope of the maximum dam section suggests that the Wigwam Lake Dam may have been overtopped at least one time since 1928.

b. <u>Spillway</u>. The spillway crest is at elevation 708.0 feet and the top of the spillway endwall at the left end of the dam is at elevation 711.1. The length of the spillway crest is 57 feet, or 3 feet shorter than the design length. In the absence of the left spillway endwall shown in Appendix E, the present spillway has a trapezoidal cross-sectional area with the top width of overflowing water surface varying from 57 feet at elevation 708 feet to approximately 78 feet at elevation 711. Should the top of the dam be restored to elevation 711 throughout its entire length, the maximum capacity of spillway discharge will increase from the present 475 cfs to approximately 965 cfs.

c. <u>Reservoir Area</u>. There are no upstream structures of significant influence on the rate and time of flood inflow into Wigwam Lake. Land use changes within the watershed, resulting from residential development since the construction of the dam, are described in Paragraph 3.1d, Section 3. Although this residential development increases the runoff from the watershed, the extent of this development is not expected to alter significantly the rate of reservoir inflow during extreme floods. d. <u>Downstream Conditions</u>. The present and the design spillway capacity are not affected by tailwater conditions. Two stream stretches were selected for the determination of flood stage elevations resulting from Dam Break analysis. The location of the selected stretches are shown on Exhibit E-1. Computer printouts of typical channel sections for each stream reach are presented in Appendix D. Each section was selected with due consideration given to the backwater effect from bridges or other stream encroachments. Hazard to life and property, resulting from dam failure, is limited to the flood plain of Wigwam Run along the first 2100 feet of the stream below the dam.

### 5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis, is presented in Appendix D.

### 5.5 <u>Summary of Analysis</u>.

a. <u>Spillway Design Flood (SDF)</u>. According to criteria established by the office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of the Wigwam Lake Dam is between the one-half Probable Maximum Flood (½PMF) and the full PMF. Because of the small storage capacity of the reservoir, the ½PMF is selected as the SDF for the Wigwam Lake Dam.

b. Results of Analysis. Pertinent results are tabulated in Appendix D. The analysis reveals that under the prevailing top of dam elevations, the spillway discharge is 475 cfs when the water surface in the reservoir reaches the low point on the dam crest. This condition is equivalent to a flood magnitude of approximately 15 percent of the PMF. The insignificant difference between Peak Inflow and Peak Outflow from the reservoir indicates that the effect of reservoir storage on flood reduction is minimal. Should the top of the dam be restored to its design elevation, the spillway could pass approximately 30 percent of the PMF without overtopping the dam. The maximum rates of inflow and outflow from the reservoir, corresponding to a flood magnitude of PMF, are 3340 cfs and 3320 cfs, respectively. For a flood magnitude of 4PMF, the derived inflow and outflow peak rates are 1670 cfs and 1660 cfs, respectively. The dam is overtopped by 0.3 foot, 1.2 feet and 2.2 feet during peak outflow resulting from flood magnitudes of 20%, 50% and 100% of the PMF. The duration of overtopping that corresponds to the aforementioned floods is 3.25, 7.75 and 10.75 hours, respectively.

### 5.6 Spillway Adequacy.

It was judged that Wigwam Lake Dam would begin to fail during the <sup>1</sup>/<sub>2</sub>PMF when the pool level reaches elevation 710.8, which is one-foot above the low point on the dam. Because the selected SDF of <sup>1</sup>/<sub>2</sub>PMF would result in overtopping and probable failure of the dam, a dam breach analysis was performed. Reservoir outflow resulting from the breach was routed through the downstream reaches represented by channel sections 3 and 4, described in Appendix D. Failure of the dam at <sup>1</sup>/<sub>2</sub>PMF would raise water levels by 3.9 feet and 3.6 feet over the levels that existed just prior to the dam failure at stations 3 and 4, respectively. This would increase the downstream hazard to property and to loss of life. As a result of the hydro-

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logic and hydraulic analysis and the downstream hazard, the present spillway capacity is rated as seriously inadequate.

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### SECTION 6 EVALUATION OF STRUCTURAL STABILITY

### 6.1 Visual Observations.

The visual inspection of Wigwam Lake Dam is described in Section 3. Observations that are relevant to structural stability of the dam and the appurtenant structures are evaluated below:

(a) Embankment. Field surveys indicate that both upstream and downstream slopes of the dam at its maximum section are steeper than the design slopes. The upstream slope of the dam above the normal level of the reservoir is 1V:1.3H. Rock pavement over the upstream face is shown on the Construction Drawings, Appendix E, and in a 1928 post-construction photograph of the dam. No rock pavement was visible on the upstream face of the embankment on the day of the inspection. Small seeps and marshy areas at the downstream toe of the dam are shown in Exhibit A-1. The steepness of the embankment slopes at the maximum section of the dam, the absence of upstream slope protection against wave action and the marshy conditions at the toe of the dam are of some concern; but there is no evidence of instability of the dam.

(b) Spillway. Additional investigations and analysis are required to assess the stability of the inclined endwall. This wall should be closely monitored and any additional movement recorded. If further movement of the wall toward the spillway should occur, internal cracking can develop in the earth embankment, as well as in the concrete core wall. Extensive cracking could cause concentration of seepage from the reservoir toward the downstream toe and could possibly cause internal erosion of the earth embankment (piping) and potential failure of the dam. An opening in the vertical joint on the top of the spillway endwall was first observed in 1933. This opening was reported to cause a one-inch separation of the joint and was attributed in the 1933 inspection to settlement of the downstream part of the wall. The present elevations on the downstream top of wall are approximately  $\frac{1}{2}$ -inch lower than those on the upstream edge, thus supporting the previous observations. However, no significant wall settlement has taken place since 1933 which would affect the structural stability of the wall beyond that previously mentioned. The separation of the top portion of the concrete weir along approximately 3 feet near the endwall does not appear to affect the structural stability of the weir. Frequent inspection of the spillway weir will be necessary to insure that the present condition has not worsened and remedial measures should be taken as required.

(c) <u>Outlet Works</u>. The 16-inch cast iron pipe was constructed in 1928, indicating a period of service for more than fifty years. This length of service approaches the normal expected useful life of cast iron pipe. There was no flow at the pipe outlet on the day of the inspection, indicating that the pipe was not subjected to hydrostatic pressure. Since the reported upstream gate valve could not be located and operated, the effect of pressure flow on the pipe and on the rate of seepage at the toe of the dam could not be verified. Therefore, it is necessary to locate and operate the reported gate valve to evaluate the condition of the outlet works.

### 6.2 Design and Construction Data.

Available design and construction data are inadequate to assess the present stability of the dam; thus, the evaluation is based on visual inspection.

### 6.3 Past Performance.

With the exception of the settlement observed in the spillway endwall in 1933 (see Paragraph 6.1b), the available data does not indicate any previous occurrences of structural problems in the dam and appurtenances.

### 6.4 Seismic Stability.

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The dam is located in Seismic Zone 1 and may be subject to minor dynamic forces induced by earthquakes. Normally, it can be considered that if a dam is stable under static loading conditions, it can be assumed safe for minor earthquake loading. However, no computations were made to evaluate this condition. SECTION 7 ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. <u>Safety</u>.

(1) Based on visual inspection, the Wigwam Lake Dam is judged to be in poor condition. Based on the size and hazard classification of the dam, the recommended Spillway Design Flood (SDF) varies from ½PMF (Probable Maximum Flood) to the full PMF. In view of the relatively small reservoir storage, it was judged that the SDF of ½PMF is appropriate for this class of structure. Under the present conditions, the spillway will pass approximately 15 percent of the PMF without overtopping the dam. Overtopping depth of 1.2 feet was calculated for a flood magnitude of ½PMF; whereas, it was judged that the dam will begin to fail under an overtopping depth of one foot. Because failure of the dam would increase the downstream high hazard condition, the spillway is seriously inadequate, and the dam is rated as unsafe, non-emergency.

(2) Considering the steepness of the embankment slopes and marshy conditions at the toe of the dam, the stability of the embankment could, in time, be affected.

(3) The observed cracks and inclination of the spillway endwall away from the retained embankment earthfill, could, if further movement occurs, affect the integrity of the embankment.

(4) The unknown condition and location of the valve mechanism, regulating flow through the outlet pipe, precluded assessment of the prevailing conditions of the outlet works. Ready access to an operable valve, or other method of drawing down the reservoir level during emergencies, is required. Such requirement may arise should excessive seepage or piping develop.

(5) The present condition of the dam and appurtenances indicates that maintenance of the dam is inadequate.

(6) There is no warning system and evacuation plan in effect at the present time.

b. <u>Adequacy of Information</u>. The data collected from previously cited dam inspection reports, past performance, visual inspection and computations performed as part of this study are sufficient for Phase I dam safety assessment.

c. <u>Urgency</u>. The recommendations in Paragraph 7.2 should be implemented immediately.

d. <u>Necessity for Further Investigations</u>. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by a professional engineer, experienced in the design and construction of dams, will be necessary.

### 7.2 Recommendations and Remedial Measures.

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a. The following investigations and remedial measures are recommended for immediate implementation by the owner:

(1) Engage a professional engineer experienced in the design and construction of dams to perform additional hydrologic and hydraulic analysis to more accurately ascertain the present spillway capacity. As a result of the analysis, implement the necessary remedial measures to upgrade the present spillway capacity to the required Spillway Design Flood.

(2) Locate the valve mechanism for the outlet works facilities and provide means to operate the valve; or develop another method of emergency drawdown, in the event such action becomes necessary.

(3) Remove trees and brush from the crest and slopes of the embankment, under the supervision of a professional engineer.

(4) Institute a monitoring program to detect any significant change in the conditions of the dam and appurtenant structures. As a minimum, this program shall include provision for detecting any additional movement in the spillway endwall and the rate and clarity of seepage at the toe of the dam.

b. In addition, it is recommended that the owner take the following precautionary operational and maintenance measures:

(1) Develop a detailed emergency operation procedure and warning system to facilitate timely and orderly evacuation of the downstream population if any hazardous conditions at the dam are observed.

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

(3) After satisfactory implementation of the remedial measures resulting from the recommended additional investigations, institute a formal inspection and maintenance program for the dam. As presently required by the Bureau of Dams and Waterway Management of PENNDER, the program shall include an annual inspection of the dam by a professional engineer, experienced in the design and construction of dams. Deficiencies found during annual inspections should be remedied as necessary.

APPENDIX A

# VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES







TYPICAL DAM SECTIONS



11:00 A.M. High TEMPERATURE 41 E & OTHERS HAZARD CATEGORY COUNTY Monroe M.S.L M.S.L STATE Pennsylvania 45-124 **OWNER REPRESENTATIVES** WEATHER Clear/cold CHECK LIST VISUAL INSPECTION PHASE 1 Small PENNDER# SIZE \_ 696.0 708.1 DATE(S) INSPECTION November 26, 1980 Earth (concrete core) POOL ELEVATION AT TIME OF INSPECTION NDI # PA - 990 TAIL WATER AT TIME OF INSPECTION. Wigwam Lake Dam NAME OF DAM TYPE OF DAM

None (three attempts to contact Mr. Harry Snow: reported to be on leave in Florida) Gerald Branthoover - Geologist INSPECTION PERSONNEL Ronald Mather - Surveyor Gideon Yachin - Engineer Wayne Himes - Surveyor

RECORDED BY Gideon Yachin, P.E.

PAGE 1 ()1 -

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 990
SURFACE CRACKS	None Observed
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None Observed
SLOUGHING OR ERO SION OF EMBANK MENT AND ABUTMENT SLOPES	Evidence of over-topping at right abutment on natural ground. The downstream slope of the maximum dam section near the right abutment is much steeper than the downstream slope of the balance of the dam. (see Exhibit A-4).
VERTICAL AND HORI- ZONTAL ALIGNMENT OF THE CREST	Horizontal - good Vertical - settlement of embankment upstream of concrete core wall (4" <sup>±</sup> ) on right end of dam. Top of dam elevations vary along the crest of the dam. For top of dam profile, see Exhibit A-2.
RIPRAP FAILURES	None Observed (Thin rock riprap on downstream slope of embankment). No upstream riprap above the water surface in the reservoir.
JUNCTION OF EMBANK- MENT AND ABUT- MENT, SPILLWAY AND DAM	Top of dam lower than spillway endwall (6"±) on left dam abutment. Top of dam at right abutment is 1' lower than the design elevation

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EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 990
DAMP AREAS IRREGULAR VEGETA- TION (LUSH OR DEAD PLANTS)	Marshy area along toe of dam.
ANY NOTICEABLE SEEPAGE	Seepage (estimated 2 <sup>±</sup> GPM) on right side of outlet conduit (16" dia. C.I.P.) and approximately 50 feet to the left of the outlet pipe near the toe of the dam. (see Exhibit A-1).
STAFF GAGE AND RECORDER	None
DRAINS	None Observed
ROCK OUTCROPS	Metamorphic Siltstone, Dark Gray exposed on right abutment. Highly jointed; cleavage pronounced; bedding undefined.
DAM FOUNDATION TREES, OTHER	Trees (4" dia.) on top of dam and at the toe (+8" dia.). Small break in natural spillway channel diverting flow to main stream near the right abutment (away from the toe of the dam).
	PAGE 3 CH #

**OUTLET WORKS** 

Intake si INTAKE STRUCTURE	
	submerged. Method and type of upstream control could not be verified.
OUTLET CONDUIT (CRACKING AND SPALLING OF CON CRETE SURFACES)	meter CIP. No evidence of concrete cradle or encasement.
OUTLET STRUCTURE None	
None Vis	isible. Apparent original stream channel is to the right of outlet pipe
GATE(S) AND OPERA- TIONAL EQUIPMENT upstrear	nstream gate. Apparent control at inlet to the pipe, or on the am section of the conduit.
CONCRETE SURFACES Not App CRACKS, SPALLING JOINTS	plicable

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ITEM	<b>OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA</b> · 990
TYPE AND CONDITION	Concrete Weir (slight adverse slope toward upstream; 2' horizontal width) in fair condition with noted exception.
APPROACH CHANNEL	Earth fill with stone paving between upstream cutoff wall and spillway weir.
SPILLWAY CHANNEL AND SIDEWALLS	No evidence of left spillway wall. Right spillway wall cracked with slight lean to the left (off vertical). Evidence of patched concrete along vertical wingwall strip, adjacent to the weir.
STILLING BASIN PLUNGE POOL	None
DISCHARGE CHANNEL	Channel flows perpendicular to the weir to the end of the apron, overflows and runs downslope to the right to join the main stream.
BRIDGE AND PIERS EMERGENCY GATES	None
	PAGE 5 OF N

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# **EMERGENCY SPILLWAY**

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SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDIA	PA.	066
TYPE AND CONDITION	МА		
APPROACH CHANNEL	NA		
OUTLET STRUCTURE	NA		
DISCHARGE CHANNEL	NA		
			PAGE 6 OF 8

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INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA-	066
MONUMENTATION SURVEYS	None	
<b>OBSERVATION WELLS</b>	None	
WEIRS	None	
PIEZOMETERS	None	
OTHERS	None	
OPERATION AND MAINTENANCE DATA	None available	

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ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA 990
SLOPES: RESERVOIR	Steep, from vertical to IV on 3H slopes along and upst <b>re</b> am of right dam abutment; mild to flat slope along and upstream of left abutment.
SEDIMENTATION	Glacial outwash; swampy valley. No evidence of sedimentation.
DOWNSTREAM CHAN- NEL (OBSTRUCTIONS, DEBRIS, ETC.)	No obstructions until 0.25 mile downstream of dam. Box culvert under township road. Small bridge on Route 611 between grocery store and restaurant.
SLOPES: CHANNEL VALLEY	Channel - swampy, braided stream - flat, 100 yard wide valley - steep slopes 1:1.
APPROXIMATE NUMBER OF HOMES AND POPULATION	10 homes, trailer court, restaurant and a grocery store. Population 50 to 100.
WATERSHED DESCRIPTION	Mostly wooded. Steep slopes in lower half. Wider valleys and moderate slopes in upper half. Strip development along lake and above right abutment of dam.
	PAGE B OF B

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# **RESERVOUR AREA AND DOWNSTREAM CHANNEL**

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## APPENDIX B

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## ENGINEERING DATA - CHECKLIST

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CHECK LIST ENGINEERING DATA PHASE I

NAME OF DAM Wigwam Lake Dam

ITEM	REMARKS NDIM PA · 990
PERSONS INTERVIEWED AND TITLE	None. Owner in Florida. No response from residents immediately downstream of the dam.
REGIONAL VICINITY MA <sup>E</sup>	See Exhibit E-1, Appendix E
CONSTRUCTION HISTOR1	Construction design by John L. Westbrook, Civil Engineer and Surveyor. Constructed in 1927 - 1928 by Caratti (Contracter), Pennsylvania
AVAILABLE DRAWINGS	Original and revised (two sheets) drawings and specifications on file with PennDER.
TYPICAL DAM SECTIONS	For typical Design Section, see Exhibit E-3, Appendix E. Present condition is depicted in Exhibits A-3 and A-4, Appendix A.
OUTLETS PLAN	See Exhibit E-2
DETAILS DISCHARGE RATINGS	Not available

CHECK LIST ENGINEERING DATA

· · ·	PHASE I
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ITEM	REMARKS NDI# PA · 990
SPILLWAY PLAN SECTION DETAILS	See Exhibit E-2, Appendix E See Exhibit E-3, Appendix E
OPEHATING EQUIP MENT PLANS AND DETAILS	Not shown on origianl drawings (Appendix E)
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS. HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None available
MATERIAL MATERIAL INVESTIGATIONS BORING RECORDS LABORATORY TESTING FIELD TESTING	Description not available Description of depth to rock available for cutoff trench on file with PennDER; see also Exhibit E-4, Appendix E. None Not known

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CHECK LIST ENGINEERING DATA PHASE I (CONTINUED)

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ITEM	REMARKS NDI# PA · 990
BORROW SOURCES	Adjacent to construction site (from construction specifications, PennDER files)
PUS1 CONSTRUCTION DAM SURVEYS	None available prior to 1980. For conditions on 11/26/80, see top of dam profile and typical sections, Appendix A
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection Reports (1929, 1931, 1933, 1934, 1935, 1938, 1941, 1950 and 1957) on file with PennDER.
HIGH POOL RECORDS	No formal records are available.
MONITORING SYSTEMS	None
MODIFICATIONS	None

PAGE 311

PAGE 4 04 % NDI# PA - 990 PHASE I (CONTINUED) REMARKS Self-regulating. Not available Not available Not available Not reported **PRIOR ACCIDENTS OR** COMMUNICATION FACILITIES WARNING SYSTEM AND/OR MISCELLANEOUS MAINTENANCE RECORDS MANUAL **OPERATIONAL PROCEDURES** OPERATION RECORDS FAILURES MANUAL ITEM

## **ENGINEERING DATA CHECK LIST**

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## CHECK LIST HYDROLOGIC AND HYDRAULIC ENGINEERING DATA

NDI ID # \_\_\_\_\_00990 PENNDER ID # 45-124

SIZE OF DRAINAGE AREA: <u>1.5 square miles</u>	
ELEVATION TOP NORMAL POOL _708_0STORAGE CAPACITY32_Acre-feet	
ELEVATION TOP FLOOD CONTROL POOL NA STORAGE CAPACITY NA	+ \
ELEVATION MAXIMUM DESIGN POOL 711 STORAGE CAPACITY 56 Acre-feet (Desi	gn)
ELEVATION TOP DAM: 711 (Design STORAGE CAPACITY: 56 Acre-feet (Design) 709.8 (Exist.) 47 Acre-feet (Exist.)	
CRILLINAY DATA	

### SPILLWAY DATA

CREST ELEVATION: 708.0 Feet
TYPE:Uncontrolled, rectangular concrete weir (Design)
CREST LENGTH:60 feet (Design) 57 feet (Exist.)
CHANNELLENGTH:15_feet (Design apron)
SPILLOVER LOCATION:left_abutment
NUMBER AND TYPE OF GATES: <u>None</u>
OUTLET WORKS
TYPE:16" diameter C.I.P.
LOCATION: At maximum dam section near right abutment
ENTRANCE INVERTS: Elevation 696.5, approximately (Design)
EXIT INVERTS:Elevation_696.0

EMERGENCY DRAWDOWN FACILITIES: <u>None visible (reported upstream valve)</u>

## HYDROMETEOROLOGICAL GAGES

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LOCATION: None

RECORDS. None\_\_\_\_\_

MAXIMUM NON-DAMAGING DISCHARGE: \_\_\_\_\_\_500\_cfs\_\_\_\_\_

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PAGE 5 OF 5

APPENDIX C

**PHOTOGRAPHS** 





WIGWAM LAKE DAM DOWNSTREAM PHOTOGRAPHS LOCATION MAP

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EXHIBIT O-C







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9. DOWNSTREAM SLOPE , LOOKING TOWARD LEFT ABUTMENT



10. DOWNSTREAM SLOPE AT SPILLWAY WALL

8 OUTER PIEC 16 DIA CIE



## 12. LOOKING UPSTREAM AT CULVERT









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11. TRAILER COURT AT WIGWAM RD. BOX CULVERT

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## APPENDIX D

## HYDROLOGY AND HYDRAULICS

## SUMMARY DESCRIPTION OF FLOOD HYDROGRAPH PACKAGE (HEC-1) DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.

- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

GEO-TECHNICAL SERVICES Consulting Engineers & Geologists	SHEET NU CALCULATED BY CHECKED BY SCALE	UF
METHODOLOG	<u>y</u>	
I.) MULTI-RATIO OVER	TOPPING ANALYSIS	
2.) ROUTE TO DOWNSTR	EAM SECTIONS	
3.) DUE TO DOWNSTREI \$ OVERTOPPING 1	AM HAZARD CONDITION MALYSIS A DAM BRE	IS EACH
ANALYSIS WAS PA	FRFORMED.	1
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A STATE AND A CARACTER AND AND AND AND AN	500 630 640			01
Consulting Engineers & Goologists	CALLULATED	u G.Y.	·	UATE 1/19/1981
	CHECKED BY	<b>-</b> .		DATE
	SCALL .			

## UPSTREAM DAMS : None

## DOWNSTREAM DAMS: Not applicable

NOTE: Downstream dam: (DER #45-63; 45-29 \$ 45-28) are located on Pocono Cr. McMichael Cr. and Brochead Creek, respectively (see Sheet 1). These are nonqualifying claims for Phase 1 inspection program and are located a great distance clownstream from Wigwam Lake Dam.

## SNYDER'S UNIT HYDROGRAPH PARAMETERS

SUB- AREA	DRAINAGE AREA SCIMI	Ср	Ce	L MILES	LCa MILES	L'	To	REFEREN
	Jan	$\omega$	(2)	(3)	(4)	(5)	(6)	• • • • • •
ABOVE DAM	1-50	0.45	1.23	2.12	1.14	NA	1.60	· · ·

(1) (2) Snyder's Unit Hydrograph Coefficients; Supplied by the Baltimore District, U.S. Army Corps of Engineers: Delaware River Basin Zone Map (Zone 1) and Tabulated Values

 (3) (4) Length of Moin watercourse from outflow point to the drainage divide and to the Centroic of the drainage area, respectively.
 (6) Tp = Ct x (LxLca)<sup>0.3</sup>

RAINFALL DATA (REF. - HYDROMETEROLOGICAL REPORT#33)

PMP Rainfall Index 21.8 inches (24-hour duration over 200 mi<sup>2</sup> drainage area); Zone 1. Adjustment for drainage area above dam (Hup Brook reduction factor 0.8) is included in HECIDB computer program

RAINFALL DISTRIBUTION

DURATION	6-HOUR	12-HOUR	24-HOUR	48-HUUR
PERCENT	111	123	/33	142

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WIGWAM LAKE DAM. PA0990 JOD SHEET NO **GEO-TECHNICAL SERVICES** DATE 1/19/1981 G.Y. **Consulting Engineers & Geologists** CHECKED B SCALE RATING CURVES A. SPILLWAY Negligible, length of approach channel, resulting El 71300 - SPILLWAY DAM 200 ASSUME D 90 EI. 7120 110 OWEST 4 CREST. 7098 E. 1. 710 El. 708.0) SPILLWAY CREST Use general equation for flow at critical depth (REF. - KING'S HANDBOOK OF HYDRAULICS - SECTION 8) Substituting Drn = - 7 Q = Discharge in cfs where  $Q = \partial_{1}\sqrt{g}D_{m}$ g = 32.2 ft/sec = a = Cross sectional area of flow T= Top width of flow Head over crest Hm = Dc + Dm where De = Critical depth (fl) At El. 708.5' De= 0.5; T= 57 + 0.5 (70-57) = 59.7/ a: 57+59.71 x 0.5 = 29.18 ft 2; Dm = 29.18 = 0.49' Q= 29.18 x \32.2x0.49 = 116 cfs; Hm = 0.5 + 0.49 = 0.75 0-6

WIGWAM LAKE DAM; PA0990 JOB SHEET NO **GEO-TECHNICAL SERVICES** DATE 1/19/1981 G.Y. CALCULATED BY .... **Consulting Engineers & Geologists** CHECKED BY 8CALE RATING CURVES (CONTINUED) T= 70'+ ADe x 12.5 (see shetch, sheet ... ) Above El. 710:4' a = 152ft + TO+T + ADe where A De is the incremental critical depth above El, 710.4 Similarly, above El. 712.0' T= 90'+ A Dex 110' 2-280 ft2 + 90+1 + a De where a De is the incremental critical depth above El. 712.0 Dc 7 Dm Ø a Hm W. 5. ADe f12 ft ft. cfs 4 ft. ELEV 59.71 29.18 0.49 0.5 116 a.75 708.75 1.48 59.71 1.0 62.42 331 709.48 64.04 495 191 1.3 7868 709.91 65.13 91.59 616 710.20 1.5 2.20 1.6 65.67 98.13 680 2.35 710.35 1.7 66.21 104.73 747 2.49 710.49 67.83 2.0 124.83 961 2.92 710.92 2.4 70.00 152.40 3.49 711.49 1276 3.0 3:6 4:0 77.50 4.21 |778 2366 2808 712:27 713:04 713:56 196.65 2.54 0.6 2.89 280.40 16 556 145. 339.15 2.34 2943 0.5 4.5 5.67 713.67 5.0 200 425.40 3521 6.06 1.0 2.13 714.06

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JOB WIGWAM LAKE DAM: PA 0990 SHEET NO **GEO-TECHNICAL SERVICES** CALCULATED BY \_\_\_\_\_ **Consulting Engineers & Geologists** CHECKED BY 8CALE RESERVOIR AREA-CAPACITY DATA Use Storage Per Bulletin 5 of 24.5 acre-feet (8MG) @ Elev. 708.0 and surface area = 8 acres Applying the Conic Method for Rescucir Volume, h = 3 × 24.5 / 8 = 9.2' .: Elev. @ O Aren = 708.0-9.2.698.8 Since the derived elevation is above the streambed elevation 696 and in order to comply with the dam break analysis criteria (see D-11), Elev. 69.6.0 was selected for the zero area and storage capacity. AREA (Acres)\* ELEVATION 696.0 70.8.0 709.8 8.3 8.5 711.1 28.7 720·0 \* Planimetered Areas From 7.5' USGS Map RM 204 Available from (NEBS) Inc. Townsond, Mass 01470 D-9

GEO.TECHNICAL SERVICES Consulting Engineers & Geologists ESTIMATED OUTLET WOAN DISCHARGE Invert of outlet end, 16" \$ CIP, El. G96.0' Normal pool at spillway crest El, 708.0' High pool at /sw point on dam EL 709.8' Head at normal pool in prifice formula G= Ca [235 708-(GW-067) 1267' G = 0.7* 139 + [644-1267 = 28 cfs G. at Low, point on dam = 30 cfs			JOB Wigwam Lak	<u>Dam; PA0990</u>
ESTIMATED OUTLET WOAK DISCHARGE Invert of Outlet end, 16"¢ CIP, El. G96.0' Normal pool at spillway crest El. 708.0' High pool at /ow point on dam El. 709.8' Head at normal pool in orifice formula Q= Ca [235 708-(640-067) 1267' 19= TD'14= TT*A33'14=139 fl*], C=07. Q= 0.7x A39* [64071207 = 28 cfs Q. at Low point on dam= 30 cfs.		GEO-TECHNICAL SERVICES Consulting Engineers & Geologists	CALCULATED BY	DATE 1/21/1981
ESTIMATED OUTLET WANN DISCHARGE Invert of Outlet end, 16" & CIP, El. G96.0' Narmal pool at spillway crest El. 708.0' Nigh pool at low point on dam El. 709.8' Head at normal pool in orifice formula Q= Carator 10 CG (GK-067) 1267' A= TD'14 = TT+M33'4=139 ft <sup>2</sup> ; C=0.7. Q = 0.7x H39+ (GAA-1267 = 28 cfs) Q. at Low point on dam = 30 cfs			8CALE	
Invert ef outlet end, 16" $\phi$ CIP, El. G96.0' Narmal pool at spillway crest El. 708.0', High pool at /aw point on dam El. 709.8' Head at normal pool in orifice formula $Q = Ca [23h - 708-(646-067) - 1267']$ Q = 0.7n + 339 + (644-1267 = 28 efs) Q = 0.7n + 39 + (644-1267 = 30 cfs)		ESTIMATED OUTL	ET WOAK DISCHAI	PGE
Normal pool at spillway crest El. 708.0' High pool at low point on Jam El. 709.8' Head at normal pool in orifice formula $Q = C = 2 \overline{g} \overline{b} = 708-(696-067) = 1267'$ $Q = T \overline{D}^2/4 = T + 133^2/4 = 139 \text{ pl}^*; C = 0.7.$ $Q = 0.7 \times 139 \times 1644 = 1247 = 28 \text{ cfs}$ Q = at Low point on dam = 30  cfs		Invert of outlet end, 1	6"¢ CIP, El.	696.0'
Head at normal pool in prifice formula $G = Ca [2gh   108-(GH6-0G7)   1267' G = TD^2/4 = T+133^2/4 = 139 pt^{3}; C = 0.7. G = 0.7x   139 + [and-1207 = 28 cfs] G. at Low point on dam = 30 cfs$		Normal pool at spillway High pool at /ow point on	crest El. dam El.	708.0' 709.8'
$Q = 0.7 \times 139 \times 1644 \times 1207 = 28 cfs$ $Q at Low point on dam = 30 cfs$	· · ·	Head at normal pool i formula $Q = C \cap \sqrt{2gh}$ $Q = T O^2/4 = T + \sqrt{33^2/4} = 1$	n orifice 708-(696-067) 3988 <sup>2</sup> 1 C=07	12.67
Q. at Low point on dam = 30 cts	•	Q = 0.7x 1.39 + 164.4 + 1267 =		28cfs
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GEO-TECHNICAL SERVICES Consulting Engineers & Geologists

JOB WIGWAM DAM	PA 0990
SHEET NO _	OF
CALCULATED BY	DATE_ <u>3/21/81</u>
CHECKED BY	DATE
SCALE	

DUE TO THE DOWNSTREAM HAZARD CONDITIONS & THE RESULTS OF THE OVERTOPPING ANALYSIS, A BREACH ANALYSIS WAS MADE.

THE DAM WAS CONSTRUCTED WITH A FULL DEPTH, 13" THICK CONCRETE CORE WALL AT THE & OF THE EMBANKMENT. FOR A BREACH TO OCCUR, A PART OF THIS WALL MUST FAIL, WHICH WOULD HAPPEN IF THE DOWNSTREAM EARTH TOE WAS ERODED. THE WALL WOULD PROBABLY FAIL IN SECTIONS. BETWEEN JOINTS. ASSUMANG A MONOLITHIC LENGTH OF 30', ANALYZE THE DAM FOR BREACH WIDTH'S OF 30', 60'\$ 90' SINCE I' OF OVERTOPPING MAY BE ENOUGH TO ERODE THE EARTH TOE, BEGIN BREACH FAILURE WHEN THE WATER SURFACE REACHES I' OVER THE WALL = ELEV. 710.8. ASSUME THE BREACH WOULD BE FULL DEPTH TO STREAM BED = ELEV. 696.0, HAVE VERTICAL SIDE SLOPES, \$ 000000 OCCUR QUICKLY \$ 15 MMI.

THE SPILLWAY DESIGN FLOOD SELECTED FOR THIS DAM 13. 0.5 PMF WHICH CAUSES AN OVERTOPPING DEPTH OF 1.2 "+

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NI         Route         Table         Constraint	K     K     K     1     0 <td><math display="block"> \begin{array}{c ccccccccccccccccccccccccccccccccccc</math></td> <td>x     x<td>K       I</td><td><math>K_1</math>       RUTE       <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <th< td=""><td>XI       Route T       Route T       Nour       Nour</td><td>x       1       Route       x       1       0       0       0       0       1       0       <th0< th="">       0</th0<></td></th<><td>•</td><td>×</td><td>-1.5</td><td></td><td>10</td><td></td><td>•</td><td>0</td><td><b>0</b> 1</td><td>• • •</td><td></td><td>0</td></td></td>	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	x     x <td>K       I</td> <td><math>K_1</math>       RUTE       <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_2</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <math>T_1</math> <th< td=""><td>XI       Route T       Route T       Nour       Nour</td><td>x       1       Route       x       1       0       0       0       0       1       0       <th0< th="">       0</th0<></td></th<><td>•</td><td>×</td><td>-1.5</td><td></td><td>10</td><td></td><td>•</td><td>0</td><td><b>0</b> 1</td><td>• • •</td><td></td><td>0</td></td>	K       I	$K_1$ RUTE $T_2$ $T_1$ $T_2$ $T_1$ $T_2$ $T_1$ $T_1$ $T_2$ $T_1$ $T_2$ $T_1$ $T_1$ $T_2$ $T_1$ $T_1$ $T_2$ $T_1$ $T_1$ $T_1$ $T_2$ $T_1$ $T_1$ $T_1$ $T_2$ $T_1$ $T_1$ $T_1$ $T_1$ $T_1$ $T_1$ $T_1$ $T_1$ <th< td=""><td>XI       Route T       Route T       Nour       Nour</td><td>x       1       Route       x       1       0       0       0       0       1       0       <th0< th="">       0</th0<></td></th<> <td>•</td> <td>×</td> <td>-1.5</td> <td></td> <td>10</td> <td></td> <td>•</td> <td>0</td> <td><b>0</b> 1</td> <td>• • •</td> <td></td> <td>0</td>	XI       Route T       Route T       Nour	x       1       Route       x       1       0       0       0       0       1       0 <th0< th="">       0</th0<>	•	×	-1.5		10		•	0	<b>0</b> 1	• • •		0
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W11110h     T1110h     T1156     T1166     T116     T111     T20     T0     T0 <tht0< th="">     T0     T0     T0</tht0<>	(1113, 0) $(113, 55)$	Y Y 113.64       T 13.65       T 14.66       6 0       7 4       961       1276       1176         Y Y       256       208       293       351       656       600       747       961       1276       1176         Y Y       256       708       793       711.15       720       0	V1113-0     T13-5     T23-5	$\gamma$	$\gamma$ <td>Y = 13.6       713.65       713.65       713.65       713.65       616       77       61       77       61       177       61       177       61       177       61       177       61       177       61       177       61       177       61       177       61       173       52       28       70       61       70       61       71       13       52       28       70       61       71       51       61       71       51       61       71       51       61       71       61       71       61       71       61       71       72       72       72       72       72       72       72       72       72       72       72       72       73       72       73       73       74       74       74</td> <td>Y 113.60       113.67       113.67       113.67       113.65       113.67       113.65       113.67       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.75       28.7       96.1       <t< td=""><td>. 0</td><td></td><td>708</td><td>708.7</td><td>5 709.41</td><td>109.91</td><td>710.20</td><td>710.35</td><td>710.49</td><td>710.92</td><td>711.49</td><td>712.27</td></t<></td>	Y = 13.6       713.65       713.65       713.65       713.65       616       77       61       77       61       177       61       177       61       177       61       177       61       177       61       177       61       177       61       177       61       173       52       28       70       61       70       61       71       13       52       28       70       61       71       51       61       71       51       61       71       51       61       71       61       71       61       71       61       71       72       72       72       72       72       72       72       72       72       72       72       72       73       72       73       73       74       74       74	Y 113.60       113.67       113.67       113.67       113.65       113.67       113.65       113.67       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.65       113.75       28.7       96.1 <t< td=""><td>. 0</td><td></td><td>708</td><td>708.7</td><td>5 709.41</td><td>109.91</td><td>710.20</td><td>710.35</td><td>710.49</td><td>710.92</td><td>711.49</td><td>712.27</td></t<>	. 0		708	708.7	5 709.41	109.91	710.20	710.35	710.49	710.92	711.49	712.27
1 $173$ $660$ $747$ $961$ $1276$ $1778$ 2 $75$ $616$ $785$ $264$ $680$ $747$ $961$ $1276$ $1778$ 2 $875$ $796$	1       7 $5.5.6$ 2016 $5.33$ $5.5.6$ $5.16$ $5.60$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $5.61$ $7.7$ $7$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	111       13       531       532       616       680       747       661       1276         111       111       12       0       0       0       0       0       0         111       12       111       12       0       0       0       0       0       0         111       111       12       0<	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0	7471	3.04	713.56	5 713-6	714.06	0	0	0	0	•	•
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$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	3       5       65       70       8.5       28.7       0	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	3       54       0       8 $6.5$ $7.6$ $7.6$ $7.5$ $2.5$ $7.6$ $0$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	2	Y5	2366	2808	3 2943	5521	•	•	c	•	0	0
*       636       708       709.8       711.1       720       0	*       6 56       708       709.8       711.1       720       0	*     565     708     709.8     711.1     720     0 <td>**     &lt;</td> <td>*       696       708       711.1       720       <t< td=""><td><math>\mathbf{x}</math> <math>\mathbf{x}</math> <math>\mathbf{x}</math></td><td>35 <math>636</math> <math>708</math> <math>708</math> <math>711.1</math> <math>720</math> <math>0</math> <math>0</math></td></t<><td>35       696       708       708       701       720       &lt;</td><td>Ð</td><td>8 A</td><td>0</td><td>3</td><td>8. 8.</td><td>8.5</td><td>28.7</td><td>0</td><td>0</td><td>0</td><td>•</td><td>0</td></td>	**     <	*       696       708       711.1       720       0 <t< td=""><td><math>\mathbf{x}</math> <math>\mathbf{x}</math> <math>\mathbf{x}</math></td><td>35 <math>636</math> <math>708</math> <math>708</math> <math>711.1</math> <math>720</math> <math>0</math> <math>0</math></td></t<> <td>35       696       708       708       701       720       &lt;</td> <td>Ð</td> <td>8 A</td> <td>0</td> <td>3</td> <td>8. 8.</td> <td>8.5</td> <td>28.7</td> <td>0</td> <td>0</td> <td>0</td> <td>•</td> <td>0</td>	$\mathbf{x}$	35 $636$ $708$ $708$ $711.1$ $720$ $0$	35       696       708       708       701       720       <	Ð	8 A	0	3	8. 8.	8.5	28.7	0	0	0	•	0
55       53       708       2.7       1.5       196       0 <t< td=""><td>55       55       700       0<td>57     57     70     0</td><td><math display="block">\begin{array}{c ccccccccccccccccccccccccccccccccccc</math></td><td>55       5708       0</td></td></t<> <td>5       7       708       0</td> <td>51       703       <math>2 \cdot 1</math> <math>1 \cdot 5</math> <math>190</math> <math>0</math> <math>0</math></td> <td><math display="block">\begin{array}{c ccccccccccccccccccccccccccccccccccc</math></td> <td></td> <td>SE</td> <td>969</td> <td>106</td> <td>1002 8</td> <td>1.117</td> <td>720</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>	55       55       700       0 <td>57     57     70     0</td> <td><math display="block">\begin{array}{c ccccccccccccccccccccccccccccccccccc</math></td> <td>55       5708       0</td>	57     57     70     0	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	55       5708       0	5       7       708       0	51       703 $2 \cdot 1$ $1 \cdot 5$ $190$ $0$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		SE	969	106	1002 8	1.117	720	0	0	0	0	0
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KI       RUITE       TO	KI       RUUTE TO STREAM SECTION AT STA         Y       0         Y       10         Y	KX     K1     RUTE T0 STREAM SECTION AT STA 3     0     0     0     0       Y     0     00     00     00     0     0     0     0       Y     0     00     00     00     0     0     0     0       Y     0     00     00     00     0     0     0     0       Y     0     00     0     0     0     0     0     0       Y     0     00     0     0     0     0     0     0       Y     0     00     0     0     0     0     0     0       Y     0     00     0     0     0     0     0     0       Y     0     0     0     0     0     0     0       Y     1     1     1     0     0     0       Y     1     1     1     0     0     0       Y     1     1     0     0     0     0       Y     1     1     1     0     0     0       Y     1     1     0     0     0     0       Y     1     1     0     0     0 <td>x       x</td> <td>X       X       X       X       X       X       Y</td> <td>KI       Route To Stream Section AT STA       State Section AT STA       State</td> <td>KI       Route       0       1       0<!--</td--><td>Ki       Route T       Stream Section AT SIA       Stream Secti</td><td>9</td><td><b>\$</b>D 7</td><td>9.60</td><td>2.1</td><td>1.</td><td>196</td><td></td><td>0</td><td>•</td><td>•</td><td>••</td><td>•</td></td>	x       x	X       X       X       X       X       X       Y	KI       Route To Stream Section AT STA       State	KI       Route       0       1       0 </td <td>Ki       Route T       Stream Section AT SIA       Stream Secti</td> <td>9</td> <td><b>\$</b>D 7</td> <td>9.60</td> <td>2.1</td> <td>1.</td> <td>196</td> <td></td> <td>0</td> <td>•</td> <td>•</td> <td>••</td> <td>•</td>	Ki       Route T       Stream Section AT SIA       Stream Secti	9	<b>\$</b> D 7	9.60	2.1	1.	196		0	•	•	••	•
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$x_1$ $x_1$ $x_0$ $x_1$ $x_0$ $0$	M1     ROUTE     TO STREAM SECTION AT STA       M1     1     1     1       M2     V1     1     0     0       M3     V1     0     0     0       M3     V1     0     0     0       M3     V1     0     105     100       V1     0     105     100     0       V1     0     105     100     0       V1     0     105     0     0       V1     0     105     100     0       V1     0     105     0     0       V1     0     105     0     0       V1     0     10     10     0       X     10     10     0     0       X     10     10     10       X     10<	x1     ROUTE TO STREAM SECTION AT SIX A       x1     1       x2     1       x3     1       x4     1       x5     1       x6     1       x6     1       x7     1       x6     1       x7     1       x8     1 <td>************************************</td> <td>x     x     x     x     x     x     x       x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y<td>KI     ROUTE TO STREAM SECTION AT SIA +       V     0     0     0       V     1     1     0     0       V     V1     1     0     0       V     V6     06     0     0       V7     0     06     06     0       V7     0     06     06     0       V7     20     06     06     0       V7     29     682     314     700       V7     29     682     314     700</td><td>X1       ROUTE TO STREAM SECTION AT STA       0</td><td>N1       RUTE       TO       TO       D       <thd< th="">       D       <thd< th="">       D       D       <thd< td="" th<=""><td>•</td><td>×</td><td> `</td><td>•</td><td></td><td></td><td></td><td>0</td><td>-</td><td>D</td><td>D</td><td>Ð</td></thd<></thd<></thd<></td></td>	************************************	x     x     x     x     x     x     x       x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     x     x     x     x     x     x     x       x     x     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y     y       y     y     y     y     y     y <td>KI     ROUTE TO STREAM SECTION AT SIA +       V     0     0     0       V     1     1     0     0       V     V1     1     0     0       V     V6     06     0     0       V7     0     06     06     0       V7     0     06     06     0       V7     20     06     06     0       V7     29     682     314     700       V7     29     682     314     700</td> <td>X1       ROUTE TO STREAM SECTION AT STA       0</td> <td>N1       RUTE       TO       TO       D       <thd< th="">       D       <thd< th="">       D       D       <thd< td="" th<=""><td>•</td><td>×</td><td> `</td><td>•</td><td></td><td></td><td></td><td>0</td><td>-</td><td>D</td><td>D</td><td>Ð</td></thd<></thd<></thd<></td>	KI     ROUTE TO STREAM SECTION AT SIA +       V     0     0     0       V     1     1     0     0       V     V1     1     0     0       V     V6     06     0     0       V7     0     06     06     0       V7     0     06     06     0       V7     20     06     06     0       V7     29     682     314     700	X1       ROUTE TO STREAM SECTION AT STA       0	N1       RUTE       TO       TO       D <thd< th="">       D       <thd< th="">       D       D       <thd< td="" th<=""><td>•</td><td>×</td><td> `</td><td>•</td><td></td><td></td><td></td><td>0</td><td>-</td><td>D</td><td>D</td><td>Ð</td></thd<></thd<></thd<>	•	×	`	•				0	-	D	D	Ð
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$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	M     M     M     M     M     M     M       M     M     M     M     M     M     M     M     M       M     M     M     M     M     M     M     M     M     M     M       M <td>1     1     1     0<!--</td--><td>1     1     0<td>1     1     0     0     0     0     0     0       1     1     1     0     0     0     1300     .0069       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0       1     1     1     1     1     0     0       1     1     1     1     1     0       1     1     1     1     0     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     &lt;</td><td>x     x<td>VI       I       0</td><td>Y       1       0</td><td></td><td><b>•</b></td><td></td><td></td><td>_</td><td>_</td><td></td><td></td><td></td><td>•</td><td></td><td></td></td></td></td>	1     1     1     0 </td <td>1     1     0<td>1     1     0     0     0     0     0     0       1     1     1     0     0     0     1300     .0069       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0       1     1     1     1     1     0     0       1     1     1     1     1     0       1     1     1     1     0     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     &lt;</td><td>x     x<td>VI       I       0</td><td>Y       1       0</td><td></td><td><b>•</b></td><td></td><td></td><td>_</td><td>_</td><td></td><td></td><td></td><td>•</td><td></td><td></td></td></td>	1     1     0 <td>1     1     0     0     0     0     0     0       1     1     1     0     0     0     1300     .0069       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0       1     1     1     1     1     0     0       1     1     1     1     1     0       1     1     1     1     0     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     &lt;</td> <td>x     x<td>VI       I       0</td><td>Y       1       0</td><td></td><td><b>•</b></td><td></td><td></td><td>_</td><td>_</td><td></td><td></td><td></td><td>•</td><td></td><td></td></td>	1     1     0     0     0     0     0     0       1     1     1     0     0     0     1300     .0069       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0     0       1     1     1     1     1     1     0       1     1     1     1     1     0     0       1     1     1     1     1     0       1     1     1     1     0     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     1     0       1     1     1     <	x     x <td>VI       I       0</td> <td>Y       1       0</td> <td></td> <td><b>•</b></td> <td></td> <td></td> <td>_</td> <td>_</td> <td></td> <td></td> <td></td> <td>•</td> <td></td> <td></td>	VI       I       0	Y       1       0		<b>•</b>			_	_				•		
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	AM NG ANALYSIS) ECIFICATION ECIFICATION METRC IPLT IPRT HSTAN MANN METRC IPLT IPRT HSTAN LROPT TRACE D 0 0 -4 0	YSES TO EF PERFORMED RTIO= 7 LPTIO= 1 40 -50 -75 1.00	VOFF_ COMPUTATION	ITAPE JPLT JPRT INAME ISTAGE IAUTO 0 0 0 1 0 0	GPAPH DATA Da trspc ratio isnow isame local 50 0.00 0.000 0 1 1 c	CIP DATA 2 R24 R48 R72 R96 0 133.00 142.00 0.00 0.00	SS DATA Strks rtick strtl cnstl alsmx rtimp 0.00 1.00 1.00 .05 0.00 0.00	DROGRAPH CATA CP= .45 NTA= 0
FLOOD HYDROUMAPH FACKAGE (HEC-1) DAM SAFETY VERSION JULY 1976 Last Modification 01 AFH 20 Fun Date 81/03/19. Time 09.07.33.	NATIONAL CAM INSPECTION PROGR NATIONAL CAM INSPECTION PROGR VIGWAM DAMPA0990 COVERTOPPI STROUD TUP, MONROE CO, PA JOB SF JOB 0 150 0 150 0 150 000 0 150 0 150 000 0 150 0 150 0 150 0 150 0 150 0 150 0 0	RTIOS= •10 •20 •30	SUB-AREA RU	W INFLOW TO RESERVOIR W ISTAO ICOMP LECON	HYDG IUHG TAREA SNAP TRS	PRE SPFE PMS R6 R1: 0.00 21.60 111.00 123.0	LROPT STRKR DLTKR RTIOL ERAIN 0 0.00 1.00 1.00 0.00	HH 10901 = 41

712.27 1778.00 711.49 1276.00 SUM 24.76 22.38 2.39 81560. ( 629.)( 568.)( 61.)( 2305.52) COMP 6 212. 79. 30. • • • LOSS 961.00 710.92 \*\*\*\*\*\*\*\*\* IAUTO 0 1.59 HJURS, CPC .45 VOL= 1.00 274. 256. 234. 106. 96. 87. 40. 36. 355. Excs 12. LSTR JPRT INAME ISTAGE 0 TSK STORA ISPRAT 0.000 -708. -1 MO.DA HR.MN PERIOD RAIN 710.49 747.00 EXPL 0.0 \*\*\*\*\*\*\*\*\* FTIOR= 2.00 CAREA 0.0 710.35 680.00 000000 15. 6. 2. **dhq**I C00L 0.0 IOPT TECON TAPE JPLT LAG AMSKK X 264. 117. -.05 710.20 616.00 • 📢 58 END-OF-PERIOD ORDINATES, LAC= 110. 173. 224. 264. 158. 143. 130. 117. 59. 53. 46. 44. \*\*\*\*\*\*\* END-OF-PERIOD FLOW Comp Q MO.D HYDROGRAPH ROUTING RECESSION DATA Grcsn= -•D ELE VL 0.0 ROUTING DATA Ires Isame 1 1 1 214. 720. 29. 1 18. ..... EXP4 0.0 \$521.00 58. 709.91 **6** 711. C004 -1.50 20. LOSS I COMP NSTPS NSTOL \*\*\*\*\*\*\* 0000 709.48 331.00 2943.00 SPUID 0.0 710. ROUTE THRU RESERVOIR . 80 47. STRT0= RAIN EXCS 0.00 0.000 0.00 0.000 ISTAG • • • • • • • • ; CREL 708.0 UNIT HYDROGRAPH 80 32. 708. 708.75 116.00 2808.00 ; 54. 174. 65. 47 • 6 F ; MO.DA HR.MN PERICO ..... 696. • \*\*\*\*\*\*\* 713.04 ł 0.00 2366.00 15. 192. 72. 27. SURFACE AREA= CAPACITY= ELEVATION= 0 FLOU STAGE ÷ • • • i D-14 111 2121 IN STARS 331 7.7 11-11

	I SPRAT D	STORA 0.	15K 0.000	×000°0	AMSKK 0.000	00 L 4	NSTDL	NSTPS		
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				l NG	APH ROUTI	HYCROGR				
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							HOURS	41.25	3323° AT TIME	EAK OUTFLOW IS
		•					S enon	41.25	2492. AT TIME	EAK CUTFLON IS
							HOURS	11.25	1661. AT TIME	PEAK OUTFLOW IS
							HOURS	41.56	1328. AT TIME	PEAK OUTFLOW IS
					•		HOURS	41.50	996. AT TIME	PEAK OUTFLOW IS
							HOURS	+1.50	664. AT TIME	PEAK OUTFLON IS
							HOURS	41.75	324° AT TIME	PEAK OUTFLOW IS
			DAM4! 196 -	0474 Expd 1.5	044 C000 2.7	10PFL 709.8				

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	0060°	GN(2) .0900	0060°	ELN 689	1 1 0	ELMAX A 709.0	3LNTH 800.	SEL 00750						
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	STORAGE	21.52	52	• 49	N	1.39 9.00	2.71 32.91	0-1	4 • 42 36 • 94	6.53 41.06	8 <b>•</b> 97 45 <b>•</b> 19	11.69 49.33	14.69 53.47	57.6
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n-1	STAGE	689.00	069	.05 58	69	11.11 11.63	692 • 11 702 • 61	ഹണ	693.21 703.74	694.26 704.79	695.32 705.84	696.37 706.89	697.42 707.95	698.4 709.0
6	FLOU	0.00 5751.12	31 7420	•60 •43	11 927	51.20 1.39	320.5 11303.4	17 17	620.08 .3516.22	1058.44 15921.58	1665.13 18497.66	2416.78 21231.64	3321.63 24117.34	4388.1 27149.5
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NOMAL DEPTH CAMMUL ROUTING         LIG         LIG <thlig< th=""> <thlig< th="" th<=""><th>1</th><th></th><th>1</th><th></th><th>0-0 0-0</th><th>CL0SS 0.000</th><th>AVG 0.00</th><th>ROUT IRES 1</th><th>ING DATA ISAME</th><th>10PT 0</th><th>0 dwdI</th><th></th><th>LSTR 0</th><th></th><th>۲</th></thlig<></thlig<>	1		1		0-0 0-0	CL0SS 0.000	AVG 0.00	ROUT IRES 1	ING DATA ISAME	10PT 0	0 dwdI		LSTR 0		۲
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QN(1)         GN(2)         GN(2) <th< td=""><td>ži</td><td>DRMAL DEPTH</td><td>CHANNEL</td><td>ROUTI</td><td>9 I V C</td><td></td><td></td><td>     </td><td></td><td></td><td>•</td><td></td><td></td><td></td><td></td></th<>	ži	DRMAL DEPTH	CHANNEL	ROUTI	9 I V C			   			•				
C         CROSS SECTION COORDINATESSTATELEV-ETC         207.00         680.00         227.01         272.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703.01         703	ı ļ	- 20 •	1) QNC 00 • 06	• 0 0 0 0	N ( 3 ) 0600	ELNVT 680.0	ELMAX 705.0	LNTH 1300	SEL 30690						
Notice       0.00       .64       1.43       2.69       4.47       6.77       9.60       12.95       92.         0UTFLOW       0.00       48.52       163.75       44.01       51.01       58.54       67.29       76.72       92.         0UTFLOW       6670.48       85.75.52       165.77       15971.482       19126.47       1844.64       2702.11       3780.         0UTFLOW       6670.48       8537.53       10594.38       13166.74       15971.482       19126.40       20829.87       23467.42       27337.         0UTFLOW       6670.48       8537.53       10594.38       13166.74       15971.482       19126.40       20829.87       23467.42       2702.11       3780.         699.474       699.4711       699.4711       699.4711       699.474       701.07       1844.64       2702.11       2702.11       2703.17       703.43         FLOW       6670.48       859.45       15166.74       15971.482       19126.40       208.2987       23467.482       2702.11       2703.11       2703.11       2703.14         MAXINUM STAGE       15       689.47       15971.482       19126.40       20829.87       23467.482       2702.11       2702.11       2703.14	0-1	CR0:	SS SECTI 0.00 7	0N COO 05.00 82.00	RDINATE 113.00 314.00	SSTA. 700.01 700.01	ELEV.STA. 0 205.00 0 464.00	ELEVET( 682.00 705.00	C 207.00	68 <b>0</b> •80	222.00	680.00			
OUTFLOW         6678-48         5531.52         155.75         1551.42         710.45         1591.66.7         1591.66.7         2366.74         2702.11         3780.           STAGE         6690.00         681.35         10694.36         13166.74         15971.82         19126.40         20829.87         23667.42         27337.           STAGE         6890.00         681.32         683.45         683.45         683.45         691.67         19126.40         20829.87         23667.42         27337.           FLOW         693.16         694.47         695.79         697.11         571.82         19126.40         208.97.52         703.37           FLOW         6678.48         8537.55         10694.38         13166.74         15971.82         19126.40         20829.87         702.31         703.40           MAXINUM STAGE         IS         6837.55         10694.38         13166.74         15971.82         19126.40         20829.87         23467.42         27357.           MAXIMUM STAGE         IS         683.7.55         10694.38         13166.74         15971.82         19126.40         20829.87         23467.42         27357.7           MAXIMUM STAGE         IS         683.5         15971.82         19126.40 </td <td>7</td> <td>STORAGE</td> <td>0.0</td> <td>0 10</td> <td>.64 31.56</td> <td></td> <td>1.43 37.52</td> <td>2.69 44.01</td> <td>ب ت ا</td> <td>•47 •01</td> <td>6.77 58.54</td> <td>Ŀ</td> <td>9.60 7.29</td> <td>12.95 76.72</td> <td>16.6; 92.86</td>	7	STORAGE	0.0	0 10	.64 31.56		1.43 37.52	2.69 44.01	ب ت ا	•47 •01	6.77 58.54	Ŀ	9.60 7.29	12.95 76.72	16.6; 92.86
STAGE     680.00     681.52     683.95     685.26     686.58     661.89     659.21     690.       FLOW     693.16     693.47     697.11     694.42     697.74     701.05     702.37     703.       FLOW     0.00     48.52     153.72     371.92     703.43     1166.07     1844.64     2702.11     3740.       MAXINUM     STAGE     15     683.65     13166.74     15971.62     19126.40     2702.11     3740.       MAXINUM     STAGE     15     683.65     13166.74     15971.62     703.43     1166.07     3746.42     2702.11     3740.51       MAXINUM     STAGE     15     683.65     13166.74     15971.62     19126.40     20029.687     23467.42     27337.70       MAXINUM     STAGE     15     686.9     13166.74     15971.62     27337.70     23467.42     27337.70       MAXINUM     STAGE     15     686.9     13166.74     15971.62     27337.70     23467.42     27337.70       MAXINUM     STAGE     15     686.9     13166.74     15971.60     20029.487     23467.42     27337.70       MAXINUM     STAGE     15     686.9     13166.74     15971.60     20029.487     23467.42     27337.70<		OUTFLOW	0 • 0 6 6 7 8 • 4	0 00	48.52 8537.53	106	63.72 94.38	371.92 13166.79	703 15971	• <del>4</del> 3 • 8 2 1	1186.07 9126.40	184 2082	4.64 9.87	2702.11 23467.42	3780.04 27337.89
FLOW         0.00         48.52         163.72         371.92         703.43         11f6.07         1844.64         2702.11         3740.           MAXIAUM STAGE IS         6678.48         8537.55         10694.38         13166.74         15971.62         19126.40         20629.87         23467.42         27337           MAXIAUM STAGE IS         683.6         13166.74         15971.62         19126.40         20629.87         23467.42         27337           MAXIAUM STAGE IS         686.1          685.1         33467.42         23467.42         27337           MAXIMUM STAGE IS         686.1           646.1          23467.42         233467.42         27337           MAXIMUM STAGE IS         686.9            20629.87         23467.42         27337           MAXIMUM STAGE IS         686.9              20629.687         23467.42         27337         27337           MAXIMUM STAGE IS         686.9              20629.687         27667.42         273347           MAXIMUM STAGE IS         687.5	,	STAGE	680 • 0 693 • 1	e 0	681 • 32 694 • 47	ف ف	82 • 63 95 • 79	683.95 697.11	6 8 5 6 9 5 7 9	• 26	696•58 699•74	6 b 7 0	7.89 1.05	659.21 702.37	690-53 703-68
MATIAUM STAGE IS       683.6         MAXIMUM STAGE IS       685.1         MAXIMUM STAGE IS       686.9         MAXIMUM STAGE IS       686.9         MAXIMUM STAGE IS       687.5         MAXIMUM STAGE IS       687.5         MAXIMUM STAGE IS       6.97.5         MAXIMUM STAGE IS       550.6	1	FLOU	0.0	0.0	48.52 8537.53	106	63•72 94•38	371.92 13166.74	703. 15971.	• 4 3 • 8 2 1	1166.07 9126.40	184 2022	4.64 9.87	2702+11 23467+42	3760.04 27337.89
MAXIMUM STAGE IS       685.1         MAXIMUM STAGE IS       686.9         MAXIMUM STAGE IS       686.9         MAXIMUM STAGE IS       687.5         MAXIMUM ST IS       687.5         MAXIMUM ST IS       690.6	Ē.	ACTAUN STAGE	E 1S	683•6											
MAXIMUM STAGE IS         686.1           NAXIMUM STAGE IS         686.9           MAXIMUM STAGE IS         687.5           MAXIMUM ST         1S         64.9           MAXIMUM ST         1S         64.9           MAXIMUM ST         1S         64.9	Ĩ	<b>LXIMUM STAGE</b>	E IS	685.1	ł										
MAXIMUM STAGE IS       686.9         MAXIMUM STAGE IS       687.5         MAXIMUM ST       IS         F42.9         MAXIMUM STAGE IS       687.5         MAXIMUM ST       IS         F42.9         MAXIMUM STAGE IS       590.6	Ē	IXIMUM STAGE	E IS	686.1											
MAXIMUN STAGE IS 687.5 Maximum St IS F42.9 Maximum Stage IS 590.6	Ì	AXIMUM STAG	E 1S	686.9											
MAXIMUM ST IS F48.9 MAXIMUM STAGE IS 59.6	ž	AXIMUM STAGI	E IS	687.5	•										
MAXIMUM STAGE IS 650.6	<b>T</b> .	- IAXIMUM ST	IS	5*3*4	•										
	1	AXIMUM STAG	3E 1S	650 <b>.</b> C											

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WYDROGRAPH AT       1       1.50       1       334.       667.       1001.       1335.       1668.       2503.       33         WYDROGRAPH AT       1       3.88)       1       9.45)       18.90)       28.35)       37.79)       47.24)       70.87)       94.         ROUTED TO       2       1.50       1       324.       664.       996.       1329.       1661.       2492.       33         ROUTED TO       2       1.50       1       325.       664.       996.       1331.       1661.       2495.       33         ROUTED TO       3       1.50       1       325.       664.       996.       1331.       1664.       2495.       33         ROUTED TO       3       1.550       1       9.19)       18.80)       28.26)       37.69)       47.12)       70.65)       94.         ROUTED TO       4       1.550       1       9.19)       18.80)       28.26)       37.69)       47.12)       70.65)       94.         ROUTED TO       4       1.550       1       9.16)       18.80)       28.25)       37.71)       47.15)       70.65)       94.       94.       94.       94.       94.       <	HYDROGRAPH AT       1       1.50       1       334.       667.       1001.       1335.       1668.       2503.       33.         HYDROGRAPH AT       1       3.480       1       334.       664.       995.       1335.       1661.       2492.       33.         ROUTED TO       2       1.50       1       324.       664.       995.       1329.       1661.       2492.       33.         ROUTED TO       2       3.480       1       524.       664.       995.       1329.       1661.       2492.       33.         ROUTED TO       2       1.50       1       325.       664.       995.       1331.       1664.       2495.       33.         ROUTED TO       3       1.50       1       9.191(       18.800)(       28.261)(       37.69)(       47.120)(       70.55)(       94.5         ROUTED TO       3       3.54.       663.       2996.       1332.       1666.       2498.       31.5         ROUTED TO       4       1.501       18.400       28.225)(       37.600       47.120       70.650(       94.5         ROUTED TO       4       1.500       1       9.1601       18.780       1	OPERATION	STATION	AFEA	PLAN	RATI0 1 •10	6.ATIO 2 •20	RATIOS API Patic 3 •30	PLIED TO F P≠TI0 4 •40	LO45 Ratio 5 •50	FATIO 6 •75	PATIO 1.C
ROUTED TO         2         1.50         1         324.         664.         996.         1329.         1661.         2492.         31           ROUTED TO         2         3.881         1         9.1816         18.8016         28.2116         37.6216         47.0216         70.5716         94.           ROUTED TO         3         1.50         1         325.         664.         99P.         1331.         1664.         2495.         31           ROUTED TO         3         1.50         1         9.1916         18.8016         28.2616         47.1216         70.65516         94.           ROUTED TO         4         1.50         1         324.         663.         998.         1332.         1665.         2498.         31.           ROUTED TO         4         1.550         1         324.         663.         998.         1332.         1665.         2498.         31.	ROUTED TO       2       1.50       1       324.       664.       996.       1329.       1661.       2492.       333         ROUTED TO       3       1.50       1       325.       664.       997.       1331.       1661.       2495.       333         ROUTED TO       3       1.50       1       325.       664.       997.       1331.       1664.       2495.       333         ROUTED TO       3       1.50       1       325.       664.       2997.       1331.       1666.       2495.       333         ROUTED TO       4       1.50       1       324.       663.       998.       1332.       1665.       2498.       333         ROUTED TO       4       1.50       1       324.       663.       298.       1332.       1665.       2498.       333         ROUTED TO       4       1.550       1       9.160.       18.780.       26.250.       37.710.       47.150.       70.740.       94.23         ROUTED TO       4       3.680.       1       3.24.       66.3.       26.250.       37.710.       47.150.       70.740.       94.24.	HYDROGRAPH	AT 1 (	1.50 3.88)		334 <b>.</b> 9 • 45 ) (	667• 18•90)(	1001. 28.35)(	- 1335. 37.79)(	1668. 47.24)(	2503. 70.87)(	3337 94 <b>.</b> 49
ROUTED TO         3         1.50         1         325.         664.         99P.         1331.         1664.         2495.         31           ROUTED TO         1         3.68)         1         9.19)         18.80)         28.26)         47.12)         70.65)         94.           ROUTED TO         4         1.50         1         324.         663.         998.         1332.         1665.         2498.         31           ROUTED TO         4         1.50         1         324.         663.         998.         1332.         1665.         2498.         31	ROUTED TO       3       1.50       1       325.       664.       99P.       1331.       1664.       2495.       333         Conted       3.680       1       9.190       18.800       28.260       37.690       47.120       70.6550       94.2         RouteD       4       1.50       1       324.       663.       998.       1332.       1665.       2498.       333         RouteD       4       3.880       1       324.       663.       2998.       1332.       1665.       2498.       333         RouteD       4       3.880       1       9.160       18.780       26.250       37.710       47.150       70.740       94.0	ROUTED TO	2	1.50 3.881		324.	664. 18.80)(	996. 28.21)(	1329. 37.62)(	1661. 47.02)(	2492. 70.57)(	3327 94 <b>•0</b> 9
ROUTED TO 4 1.50 1 324. 663. 998. 1332. 1665. 2498. 3 ( 3.88) ( 9.16)( 18.78)( 28.25)( 37.71)( 47.15)( 70.74)( 94.	ROUTED TO 4 1.50 1 324, 663, 998, 1332, 1665, 2498, 33 ( 3.88) ( 9.16)( 18.78)( 26.25)( 37.71)( 47.15)( 70.74)( 94.1	ROUTED TO	3	1.50 3.68)		325.	664. 18.80)(	998. 28.26)(	1331. 37.69)(	1664. 47.12)(	2495. 70.65)(	3327 94•21
		ROUTED TO	•	1.50 3.88)		324 . 9 . 16) (	663. 18.78)(	998 <b>.</b> 26.25) (	1332. 37.71)(	1665 <b>.</b> 47.15)(	2498. 70.741(	3331 94•33
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TY ANALYSIS SUMMARY OF DAM

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TCF ハF いよく 705-50 47-453-5FILLWAY CREST 706.00 32. 0. I:.ITI\*L VALUE 708.06 32. 0. ELEVATION Storage Outflou PLAN 1 ...... I

<u></u>	RATIO	MUMIXAM	MUMIXUM	MUMIXM	MUMIXAM	DURATICN	TIME OF	TIME CF
	OF	RESERVOIR	DEPTH	STOR AGE	OUTFLON	OVER TOP	MAX OUTFLG.	FAILUFE
	PNF	N. S.ELEV	OVER DAM	AC-FT	CFS	HOURS	HOUSS	SPUOH
	•10	709-46	0.00	44	324.	0000	41.75	U 0 • 0
	.20	710.10	02.	49.	654.	3.25	41.50	0.00
	.30	710.44	•64	52.	996.	5.25	41.50	00.00
		710.72	• <del>•</del> •	54.	1326.	6.75	41.50	0.00
	.50	710.97	1.17	56.	1661.	7.75	41.25	0000
	.75	711.52	1.72	61.	2492.	9.75	41.25	0.00
	1.00	712.00	2.20		3323.	10.75	41.25	00*0
			ľď	LAN 1	STATION	s.		
				MUMIXAM	MUMIXEM	TIME		
			RATIO	FLOWCFS	STAGE .FT	HOUPS		
			.10	325.	692.2	41.75		
			-20	664 •	693.3	41.50		
			0.0	998 •	694.1	41.50		
E -1			.40	1331.	694.7	41.50		
			• 50	1664.	695.03	41.50		
ク,			.75	2495.	696.5	41.50		
			1.00	3327.	697.4	41.50		
19	!	•						
			1d	LAN 1	STATION	\$		
				MAXIMUM	MUMIXAM	TIME		
			RATIO	FLON•CFS	STAGE•FT	HOUPS		
			•10	324 .	683•6	41.75		
			•20	663.	685.1	41.50		
			• 30	- 998°	686.1	41.50		
			.40	1332.	666.9	41.50		
			• 50	1665.	687.5	41.50		
			- 75	2498.	688°9	41.50 41 50		
	•		T • C C	• 1000	0100			

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cococ 40000 000000 . 00000 CALCULATION 710-708 749 747 747 00 00 10 155 1 0069 2079 2070 00000 00000 680 680 0 0 0 0 710.8 710.8 710.8 710.8 1300 1300 682 705 0 NETWORK 00000 7 1 8000 7099 7099 00000 00 710.35 CRAM ANALYSIS) 00000 00000 H 1 0 710.20 616 616 720 720 720 708 708 708 708 708 708 708 10 2125 105 2125 205 205 464 0 STREAM TAPH AT TPH TO TPH TO STA STA °ECTION ' 0 (BREA 0 CO, PA 0 0 0 0 0 0 SECTION A SECTION A 680 700 700 UENCE OF 5 AT HYDROGRAP HYDROGRAP HYDROGRAP HYDROGRAP 709.91 714.06 3521 3521 3521 711.1 196 196 .25 .25 1230 70490 70490 70490 SECTION OF SEQUENCE RUNOFF ROUTE H ROUTE H ROUTE H ROUTE H END OF 214 214 214 214 214 214 0 0 113 314 315 STREAM ЮM MMG 1. 11 DAI-10 TUP-10 10 10 10 10 10 21.88 21.88 21.88 21.88 21.88 21.88 21.88 21.88 21.88 21.88 22.98 JTE TO ST 0 0 705 682 682 Preview RU ROUTE THR 116 2808 708 2.7 2.7 13.5 **FROUD** NPLOW ROUTE ROUTE 709.8 709.8 30 30 90 051 ьсодно<sup>,</sup> .0010 220610 

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 END-OF-PERIOD ORDINATES, LAG 

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RECESSION DATA QRCSN- -.05 JOB SPECIFICATION IHR IMIN MI 0 0 NWT LROPT TF HYDROGRAPH DATA TRSDA TRSPC 1.50 0.00 \*\*\*\*\*\* ITAPE 0 NATIONAL DAM INSPECTION PR. AM WICKAM DAM--PA0990 (BRLACH AMALYSIS) STROUD TWP, MONROE CO, PA I ECON E PMS R6 0 21.80 111.00 .800 OO.O -1.50 IDAY 0 JOPER ICOMP 0 TP= RTIOL 1.00 \*\*\*\*\*\* INFLOW TO RESERVOIR TAREA 1.50 STRTQ= NMIN 15 ISTAQ 1 DLTKR 0.00 .50 LOSS UNIT HYDROGRAPH 54. 54. 1744. 55. 24. 24. 3. I UHG SPFE 0.00 TRSPC COMPUTED BY THE PROGRAM IS NHR 0 RTIOS= EXCS STRKR 0.00 I HYDG 1 1 50 1 \*\*\*\*\*\*\*\* RAIN LROPT 0 DATE\* 81/04/08. 192. 192. 107. MO.DA HR.MN PERIOD RUN C C ¢

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								HYDROG	RAPH ROUT	LING				
	C				ROUTE	THRU RESI	ERVOIR							
	C					ISTAQ 2	I COMP 1	1 ECON	ITAPE 0	174r 0	JPRT 0	I NAME 1	ISTAGE 0	0 0
	C				3.0 32019 32019	CL055	AVC 00.0	ALL PLA Rou Ires 1	NS HAVE ? TING DAT/ Isame 1	SAME A IOPT 0	0 0		LSTR 0	
	ι					NSTPS 1	0 0	0 TYC	AMSKK 0.000	0000.0	1SK 0.000	STORA -708.	I SPRAT	
	۰ <b>,</b> ۰	STAGE	708.00	708.75	709.48 713.67	709.91 714.06	710.20	710.	35 710	. 49	10.92	711.49	712.2	2
~	L	FLOW	0.00 2366.00	116.00 2808.00	331.00 2943.00	495.00 3521.00	616.00	680.	00 747	00.	961.00	1276.00	1778.0	0
	•													
			SURFACE	AREA-	.0	80	е. В	9.	29.					
	•		CAP.	ACITY-	.0	32,	47.	58.	214.					
, .	•		ELEV	ATION-	. 696 .	708.	710.	711.	720.					
D					7	CREL SI 08.0	PUID C	0.00 E	XPW ELE	1 C C	0.0 0.0	XEA E)	141	
-22	ł							TOPEL 709.8	DAM COQD 2.7	DATA EXPD 1.5	DAMVID 196.			
•	•						BRWID 30.	20°0	DAM BREAC Elbm 696.00	H DATA TFAIL 25	VSEL 708.00	FAILEL 710.80		
			BECIN DAM	FAILURE A	VT 40.75 HOUR	s								
			PEAK OUTFI	SI NOT	4331. AT TI	ME 41.00	D HOURS							
	à					·	BRWID 60.	00 °0	DAM BREAC Elbm 696.00	TFAIL TFAIL .25	VSEL 708.00	FAILEL 710.80		
	1		BECIN DAN	PAILURE A	NT 40.75 HOUR	S1 07	S enca							
			LEAN VULL	PT M07	** ** *****	N	J RUUNG							

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FAILEL 710.80

WSEL 708.00

DAM BREACH DATA Z ELBM TFAIL 0.00 696.00 .25

> ERWID 90.

BEGIN DAM FAILURE AT 40.75 HOURS Peak outflow is 6734. At time 40.99 Hours

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\*\*\*\*\* IAUTO 0 LSTR 0 INAME ISTAGE 1 0 \*\*\*\*\*\*\* JPRT 0 AM41 0 JPLT 0 0 1401 ALL PLANS HAVE SAME ROUTING DATA IRES ISAME IO I I HYDNUCRAPH ROUTING \*\*\*\*\*\* ITAPE 0 ROUTE TO STREAM SECTION AT STA 3 IECON 0 ICOMP 1 AVG 0.00 \*\*\*\*\*\* ISTAQ 3 CL055 0.000 QL055 0.0 \*\*\*\*\*\*\*

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NORMAL DEPTH CHANNEL ROUTING

QN(1) QN(2) QN(3) ELNVT ELMAX RLNTH SEL .0900 .0900 .0900 689.0 709.0 800. .00750

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	-	CROSS SECTIC 0.00 70 205.00 69	00 COORDINA 09.00 1. 04.00 214.	TESSTA,E 00 704.00 00 704.00	LEV STA, EI 25.00 215.00	EVETC 699.00 709.00	155.00	689.0	0 170.0	0 689.00	
STORAGE	0.00	0.49 25.20	1.39 29.00	2.70 32.91	4.42 36.94	6.53 41.06	в. 45.	97	11.69 49.33	14.69 53.47	17.97 57.62
DUTFLOW	0.0( 5751.12	0 31.60 2 7420.43	131.20 9271.39	320.52 11303.43	620.08 13516.22	1058.44 15921.58	1665	. 13	2416.78 21231.64	3321.63 24117.34	4388.15 27149.60
STAGE	689.0( 699.53	0 690.05 3 700.58	691.11 701.63	692.16 702.68	693.21 703.74	694.26 704.79	692	. 32	696.37 706.89	697.42 707.95	698.47 709.00
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CR055 SECTION GOORDINATES-STA, ELV - TETC      0.00    705,00    113,00    700,00    464,000    .05.00    680.00    222.00    680.00      224.00    682.00    114,00    700.00    464.000    .05.00    113.95    16.80    1      AGE    26.13    31.56    37.52    44.01    51.01    58.34    9.60    12.95    92.86    1      LON    6678.48    8537.53    10694.38    13166.74    15971.82    19126.40    20829.56    78.72    2703.11    2789.04    50      LON    6678.48    8537.53    10694.38    13166.74    15971.82    19126.40    20829.56    2763.14    2703.11    27337.69    323      AGE    699.00    691.32    13166.74    15971.82    19126.40    20829.56    2703.11    2703.11    2703.12    2703.13    2703.16    500.04    50    50    50    51    56    56    56    56    56    56    56    56    56    57    703.69    323    500.04    500.04    50    50    50 <td></td> <td>1)ND</td> <td>0 0600</td> <td>QN(3) 0600</td> <td>ELNVT 680.0</td> <td>ELMAX R 705.0 1</td> <td>LNTII 3000</td> <td>SEL 0690</td> <td></td> <td></td> <td></td> <td></td> <td></td>		1)ND	0 0600	QN(3) 0600	ELNVT 680.0	ELMAX R 705.0 1	LNTII 3000	SEL 0690					
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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS Plows in cubic feet per second (cubic meters per second) Area in square miles (square kilometers)

RATIOS APPLIED TO PLOWS

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S" HMARY OF DAM SAFETY ANALYSIS

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TOP TOP	DURATION OVER TOP HOURS 2.70	EST TOP	DURATION OVER TOP HOURS 2.66	EST TOP	DURATION OVER TOP BOURS 2.64
SPILLWAY CR1 708.00 32. 0.	MAXIMUM Outflow CFS 4331.	SPILLWAY CRI 708.00 32.	MAXIMUM Outflow CFS 6325.	SPILLWAY CR1 708.00 32.	MAXIMUM OUTFLOW CFS 6734.
VALUE .00 32.	MAXIMUM Storage Ac-Pt 55.	VALUE .00 32.	MAXIMUM Storage AC-FT 55.	VALUE .00 32.	MAXIMUM Storage AC-FT 55.
INITIAL 708	MAXIMUM DEPTH Over DAM 1.04	1NIT1AL 708	MAXIMUM DEPTH Over D <b>an</b> 1.04	INITIAL 708	MAXIMUM DEPTH OVER DAM 1.04
ELEVATION Storage Outplow	MAXIMUM Reservoir 4. S. Elev 710.84	ELEVATION Storage Outflow	MAXIMUM Reservoir W.S.Elev 710.84	ELEVATION Storage Outflow	AAXIMUM Riservoir W.S.Elev 710.84
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APPENDIX E

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EXHIBITS

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EXCAVATION OF CUTOFF TRENCH (6/24/1927)



VIEW OF UPSTREAM FACE, DURING CONSTRUCTION (7/26/1927)



DOWNSTREAM FACE OF DAM AND SPILLWAY (3/29/1928)

( NOTE FLASHBOARDS IN SPILLWAY AND THAT CREST OF DAM LOWER THAN TOP OF ENDWALL )



SPILLWAY ENDWALL AND UPSTREAM FACE OF DAM LOOKING TOWARD RIGHT ABUTMENT (12/13/1928)

( NOTE ROCK PROTECTION ON UPSTREAM FACE )



## CONDITION ON 6/20/1938

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APPENDIX F

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GEOLOGY

## WIGWAM LAKE DAM

## APPENDIX F

## GEOLOGY

The Wigwam Lake Dam is located within the glacial low plateaus section of the Appalachian Plateaus Province of east-central Monroe County, Pennsylvania. The bedrock unit present at the dam site is the Mahantango Formation of Middle Devonian age. The soils present downstream and on the eastern side of the reservoir are derived from alluvium and ice contact, stratified drift. The bulk of this stratified material was originally deposited during the stagnation and melting phase of the Woodfordian Glacier in contact with a melting ice lobe south of Camelback Mountain.

The Mahantango Formation is present along the stream valley west of the dam and reservoir. The bedrock outcrops on the right abutment and is comprised of a dark-gray siltstone and silty shale. It displays a well-developed cleavage which has a near-vertical dip striking parallel to the dam centerline. Bedding dips to the northwest at 18° to 20°.

The alluvian and woodfordian ice contact stratified drift are undifferentiated and take the form of subtle sheetlike deposits and terrace filled valley deposits, such as in the Wigwam Run Valley. This material is stratified, unconsolidated sand and gravel with some boulders. The thickness of this material is measured to be 17 feet in a water well along the Wigwam Valley. This material surrounds the reservoir upstream, downstream, on the eastern shore dam abutment and the reservoir bottom.

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