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NATIONAL DAM INSPECTION PROGRAM. JOHNSON'S POND (NDI-ID NUMBER --ETC(U)
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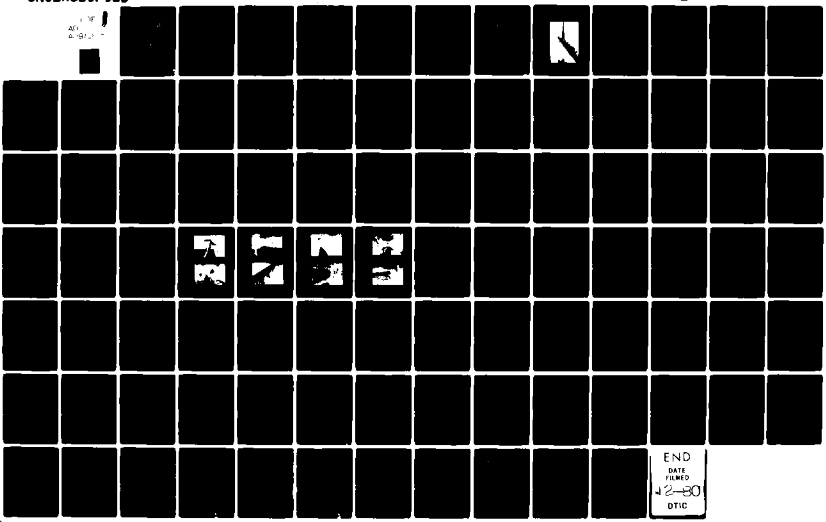

WICOMICO RIVER BASIN

WICOMICO RIVER, WICOMICO COUNTY

MARYLAND

JOHNSON'S POND

NDI ID NO. MD-11

CITY OF SALISBURY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared For

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

DACW31-80-C-0050

By

RUMMEL, KLEPPER & KAHL

Consulting Engineers

Baltimore, Maryland 21202

JULY 1980

(10) Edward J. Zeigler

(1)

WICOMICO RIVER BASIN,

WICOMICO RIVER, WICOMICO COUNTY,

MARYLAND,

(6) National Dam Inspection Program.

JOHNSON'S POND

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[redacted]

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(11) Jul 80 (15) DACW31-80-C-0050

(12) 93

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1035 N. Calvert Street
Baltimore, Maryland 21202

July 1980

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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 Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

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

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

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

WICOMICO RIVER BASIN

WICOMICO RIVER, WICOMICO COUNTY

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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

July 1980

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION AND RECOMMENDED ACTION

Name of Dam:	Johnson's Pond NDI ID NO. MD-11
Size:	Intermediate (1930 acre-feet, 16.5 feet high)
Hazard Classification:	High
Owner:	City of Salisbury P.O. Box 791 Salisbury, Maryland 21801
State Located:	Maryland
County Located:	Wicomico
Stream:	Wicomico River
Date of Inspections:	July 10, 1980 and August 5, 1980

Based on the visual inspection, available records, past operational performance, and in accordance with the guideline criteria established for these studies, Johnson's Pond dam is judged to be in good condition.

The dam is constructed across the full width of the North Prong of the Wicomico River in Salisbury, Maryland. The dam consists of a concrete and steel ogee spillway, wingwalls, and a clay fill embankment constructed on either side of the spillway. Including the lengths of clay fill embankments shown on the contract drawings of the dam, the total length of the dam is 580$\pm$ feet. The concrete and steel structure is comprised of a 300 foot long ogee spillway with wingwalls at the left and right abutments. According to the dam crest survey, the lowest point along the clay fill is elevation 14.5 and is located adjacent to the right wingwall. The crest elevation of the ogee spillway is +11.1, and a 30 foot long notch with a crest elevation of 10.6 is located in the middle of the spillway. Three sluice gates are located in the spillway directly below the notch.

The water level in Johnson's Pond is normally maintained at elevation +11, the crest elevation of the ogee spillway. The water level can be controlled by opening any of the three manually operated sluice gates. The gates are normally opened once a year during the winter to lower the water level by approximately 6 feet. This is done to expose and kill plants growing on the bottom of the pond. The water level was lowered one foot below the crest elevation for this inspection so that the condition of the ogee spillway could be checked.

Several cracks were noted in the concrete of the ogee spillway and the wingwalls, but the cracks are not considered large enough to adversely affect the structural stability of the dam at this time. The two largest cracks were noted on the wingwalls, extending through the walls from the spillway crest to the top of the wingwall. The crack in the left wingwall is approximately 0.25 inch wide and the crack in the right wingwall is approximately 0.5 inch wide. Cracking is responsible for a piece of concrete being displaced on the upstream side of the spillway along a joint located 20±' left of the spillway notch. No displacement was noted along any other cracks in the spillway, and no water was noted seeping through the cracks on the downstream side of the spillway. Minor spalling of the concrete was noted on the crest of spillway near the left wingwall.

According to the hydrologic and hydraulic analyses, the Johnson's Pond embankment will overtop by 0.4 foot for a duration of 10 hours during a flood equaling 50 percent of the Probable Maximum Flood (PMF). The analyses indicate that the Johnson's Pond spillway can pass approximately 43% of the PMF before overtopping commences. Dam breech analyses suggest that failure of the Johnson's Pond dam would raise water levels in the industrialized area between Isabella Street and U.S. Route 50 by less than one foot over the water surface that would have existed just prior to failure. It is judged that this nominal rise in flood levels would not significantly increase the hazard to loss of life than that already existing prior to dam failure. Therefore, the spillway of the Johnson's Pond dam is rated as inadequate, but not seriously inadequate.

The following remedial measures are recommended to be accomplished by the Owner:

1. Conduct a hydrologic and hydraulic study to determine what remedial measures are necessary to provide adequate capacity of the spillway.

2. Repair the cracks which extend through the right and left wingwalls from the crest of the ogee spillway to the top of each wingwall.

3. Repair the cracks noted in the ogee spillway before the cracks enlarge.

4. Raise the embankment to the design elevation.

5. Carefully inspect the ogee spillway for additional cracks, seepage through cracks or displacement of concrete along the cracks at least once a year while the water level is down.

6. Develop a formal warning system to alert downstream residents in the event of emergencies.

JOHNSON'S POND
NDI ID NO. MD-11

Submitted by:

RUMMEL, KLEPPER & KAHL

Edward J. Zeigler, P.E.
Associate

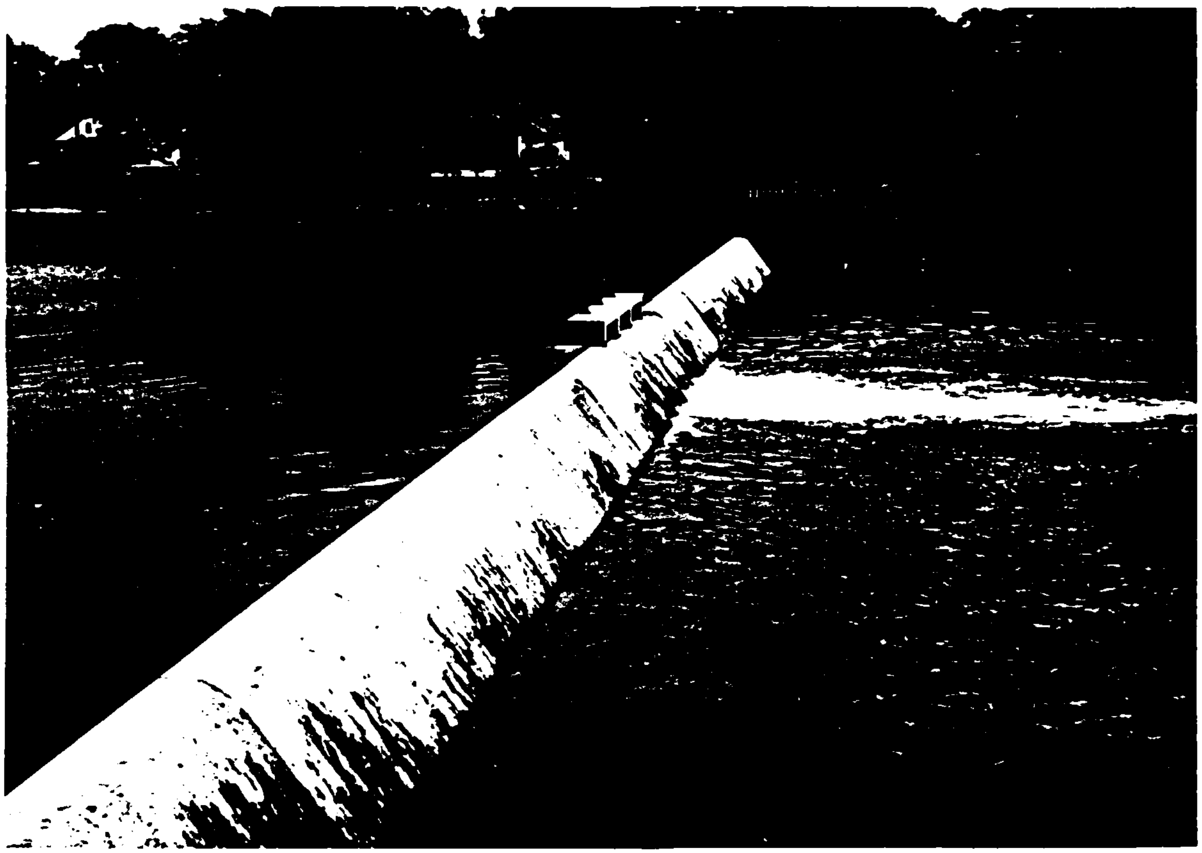
Date: August 28, 1980

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 18 Sep 80

JOHNSON'S POND



A. OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

JOHNSON'S POND
NDI ID NO. MD-11

SECTION 1
PROJECT INFORMATION

1.1 General.

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

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

1.2 Description of Project.

a. Dam and Appurtenances. Johnson's Pond dam consists of a concrete and steel ogee spillway, wingwalls, and a clay fill embankment constructed on either side of the spillway. According to the profile of the dam shown on the contract drawings, the total length of the dam, including the clay fill embankments, is 580± feet. The concrete and steel ogee spillway is 300 feet long. The low point elevation along the clay fill, noted adjacent to the right wingwall, is 14.5; the elevation of the wingwalls is 16; the crest elevation of the ogee spillway is 11.1; and the elevation of a 30 foot long notch located in the center of the ogee spillway is 10.6. The water level in Johnson's Pond is normally maintained at the crest elevation of the ogee spillway. The water level can be lowered by opening three manually operated sluice gates located below the notch in the ogee spillway.

b. Location. The dam is constructed across the North Prong of the Wicomico River in Salisbury, Maryland approximately 0.6 mile upstream of the Route 50 bridge. Johnson's Pond is shown on U.S.G.S. Quadrangle, Salisbury, Maryland, at latitude N 38° 22' 24" and longitude W 75° 36' 6". A location map is included as Plate E-1.

c. Size Classification. Intermediate (1930 acre-feet, 16.5 feet high).

d. Hazard Classification. High Hazard. There are businesses and residences along the Wicomico River downstream of the dam which could be damaged in a flood resulting from a dam failure. The embankment and bridge carrying Isabella Street over the Wicomico River 700 feet downstream of the dam could also sustain damage from a flood.

e. Ownership. City of Salisbury, P.O. Box 791, Salisbury, Maryland 21801

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was constructed in 1936 by the Federally funded Works Progress Administration. According to profiles and typical sections of the dam shown on the contract drawings, the dam is 580± feet long, including the 300 foot long ogee spillway, wingwalls, and clay fill embankments on either side of the spillway. The ogee spillway is 20 feet wide at the base and is constructed in between two lines of steel sheet piles. The steel sheet piles extend 100 feet outside the wingwalls on either side of the spillway.

h. Normal Operating Procedure. Johnson's Pond is normally maintained at the spillway crest elevation of +11. The sluice gates are usually opened during the winter to lower the water level enough to expose and kill plants growing on the bottom of the pond.

1.3 Pertinent Data.

a. Drainage Area. — 42 square miles

b. Discharge at Dam Site. — 6800 cfs (outflow at elevation 14.5)

c. Elevation (Feet above m.s.l.).

Top of Dam	16.0 (design) 14.5 (low point on clay fill embankment)
Normal Pool	11.1 (spillway crest)
Upstream Invert Outlet Works	2.5
Downstream Invert Outlet Works	2.5
Streambed at Centerline of Dam	-5.0
Maximum Tailwater	+8.0
Downstream Toe (Bottom of concrete on ogee spillway)	-8.0

d. Reservoir Length.

Normal Pool	7700 feet
Top of Dam	12400 feet

e. <u>Storage (Acre-Feet).</u>

Normal Pool	900
Top of Dam	1930

f. <u>Reservoir Surface (Acres).</u>

Normal Pool	104
Top of Dam	274

g. <u>Dam.</u>

Type	Clay fill
Length	580±'
Height	16.5' (low point on clay fill embankment)
Top Width	70±' at the wingwalls to 200±' at the natural bank
Volume of Fill	11000 cu.yds.
Side Slopes	Unknown
Zoning	None
Impervious Core	None
Cutoff	Steel Sheet Piling
Grout Curtain	None

h. <u>Outlet Works.</u>

Type	Pressure type
Pipe Size and Material	Three, 48 inch square openings formed in concrete of ogee spillway
Entrance Invert	2.5
Exit Invert	2.5
Type and Number of Gates	Three, 48 inch square sluice gates
Type of Energy Dissipator	Concrete toe of ogee spillway

i. <u>Principal Spillway.</u>

Type	Ogee Spillway
Crest Elevation of Spillway	11.1
Length of Spillway	300' (including notch)
Crest Elevation of Notch in Spillway	10.6
Length of Spillway Notch	30'
Cutoff	Steel Sheet Piling

SECTION 2
DESIGN DATA

2.1 Design.

a. Data Available. The available information was provided by the State of Maryland, Water Resources Administration. The information consists of a revised set of contract drawings dated August 1, 1936 and a limited amount of design computations and correspondence relative to design of the dam.

(1) Hydrology and Hydraulics. A limited amount of hydrologic and hydraulic computations are available.

(2) Embankment. The only information available is shown on the contract drawings.

(3) Appurtenant Structure. The only information available is shown on the contract drawings.

b. Design Features.

(1) Embankment. According to the contract drawings, the embankment on either side of the ogee spillway is comprised of clay fill. Steel sheet piling which was driven for the upstream side of the ogee spillway extends approximately 100'± from the wingwalls into the embankments on either side of the spillway. The top elevation of the sheet piling is +5 and the bottom elevation ranges from -2 to -15. The fill cannot be differentiated from natural ground, but based on the contract drawings, the clay fill extends approximately 140 feet from the wingwalls on either side of the spillway.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of the ogee spillway and the outlet works. The concrete and steel ogee spillway is 300 feet long and has a 30 foot long notch at its center. The ogee spillway is constructed in between two lines of steel sheet piling having a top elevation of +5 on the upstream side and a top elevation of 0 on the downstream side. The outlet works consist of three, 48 inch square openings equi-spaced below the spillway notch and three 48 inch square sluice gates. The gate stems are located on a deck constructed above the spillway notch. The water level in Johnson's Pond can be lowered by opening the gates.

c. Design Data.

(1) Hydrology and Hydraulics. Limited design data are included in the available design computations.

(2) Embankment and Appurtenant Structures. The only design data available are shown on the contract drawings.

2.2 Construction. Construction of the dam was completed in 1936. No dam construction records are available.

2.3 Operation. No records are kept of the operation of the dam or appurtenant structures.

2.4 Other Investigations. No records of other investigations are available.

2.5 Evaluation.

a. Availability. The contract drawings, the limited design computations, and the correspondence provided by the State of Maryland, Water Resource Administration are the only data available.

b. Adequacy. The available data, not including any construction records or detailed design calculations, is considered insufficent to evaluate the design and construction of the dam.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The on site inspection of Johnson's Pond consisted of:

(1) Visual inspection of the embankment, abutments, and embankment toe.

(2) Visual examination of the appurtenant structures.

(3) Evaluation of the downstream area hazard potential.

The specific observations are shown on Plate A-1.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features. The contract drawings indicate that the clay fill extends approximately 140 feet from the wingwalls on either side of the ogee spillway. Other than the noticeable projection of the fill into the river on the left side of the dam the clay fill cannot be differentiated from natural ground. The fill on the left side of the dam is covered primarily with grass, and trees grow along the bank. The fill on the right side is covered with grass and trees.

The crest of the clay fill embankment was surveyed and the variance in elevation was 10 inches between the high and low point on the left side, and was 36 inches between the high and low point on the right side. It should be noted that the contract drawings show that the clay fill on both sides of the ogee spillway was to be constructed even with the top of the wingwalls, or to elevation 16. The low point of the fill was elevation 14.5 noted adjacent to the right wingwall. The crest elevations measured on the left side of the dam ranged from 15.1 to 15.8. Since there is no evidence that any fill was removed from the crest by natural processes, it is presumed that either the fill was not constructed in accordance with the contract drawings, or regrading of the fill has been accomplished since construction of the dam.

Datum for the crest survey was based on a reference elevation on the crest of the ogee spillway provided by the chief surveyor for the City of Salisbury. The dam crest profile is included on Plate A-2.

c. Appurtenant Structures. Generally, the appurtenant structures were found to be in good condition. Several cracks were noted in the concrete of the ogee spillway and the wingwalls, but the cracks are not considered large enough to adversely affect the structural stability of the dam at this time. The two largest cracks were noted on the wingwalls, extending through the walls from the spillway crest to the top of the wingwall. The crack in the left wingwall is approximately 0.25 inches wide and the crack in the right wingwall is approximately 0.5 inches wide. Cracking is responsible for a piece of concrete being displaced on the upstream side of the ogee spillway along a joint located 20± feet left of the spillway notch. No displacement was noted along any other cracks in the spillway, and no water was noted seeping through the cracks on the downstream side of the spillway. Minor spalling of the concrete was noted on the spillway crest near the left wingwall.

To expose the spillway for our inspection, the pond level was lowered approximately 1 foot by opening the sluice gates the day before our visit.

During our inspection, personnel of the City of Salisbury manually closed all three sluice gates, and the gates appeared to function satisfactorily. The gates are normally opened at least once a year, and usually during the winter, to lower the water level in order to expose and kill plants growing on the bottom of the pond.

The crest of the ogee spillway was surveyed and the variance in elevation was 1 inch between the high and low point, not including the spillway notch at the center of the spillway. The low point elevation was 11.1, which is equal to the design crest elevation of the spillway. The Dam Crest Profile is included on Plate A-2.

d. Reservoir Area. An urban residential area surrounds the impoundment. A community beach and recreational area is located along the left shoreline of Johnson's Pond approximately 800 feet upstream from the dam. No significant amount of shore erosion was noted.

e. Downstream Channel. The downstream channel is the North Prong of the Wicomico River. Its confluence with the South Prong is 0.75 miles downstream of the dam. A railroad trestle bridge is located 400± downstream of the dam, and the bridge opening at Isabella Street is 700± feet downstream. Approximately 25 feet upstream of Isabella Street is a wooden weir which extends across the river and controls the tailwater level of Johnson's Pond. The floodplain downstream from the dam is highly industrialized, particularly between the Isabella Street bridge and the Maryland Route 50 bridge, located approximately 0.6 miles downstream of the dam. A few residences were noted in the floodplain downstream of the Route 50 bridge.

3.2 Evaluation. The visual examination and observations of the Johnson's Pond dam indicated that the structure is in good condition. We recommend that the cracks in the wingwalls be repaired the next time the sluice gates are open for an extended period of time.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating prodecures for the dam. The pond level is normally maintained at the crest elevation of the ogee spillway. During the winter, personnel of the City of Salisbury open the sluice gates to lower the water level approximately 6 feet to expose and kill plants growing on the bottom of Johnson's Pond.

4.2 Maintenance of the Dam. Maintenance of the dam is considered to be satisfactory.

4.3 Maintenance of Operating Facilities. Maintenance of the Operating Facilities is considered to be satisfactory.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available from the residences along the shoreline upstream from the dam.

4.5 Evaluation. The overall maintenance condition of the dam and its appurtenant structures is considered to be good.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. Correspondence dated January 30, 1936 and addressed to the Water Resources Commission of Maryland by the City of Salisbury indicates that the spillway for Johnson's Pond was designed to carry a peak discharge of 8400 cubic feet per second (cfs) or 200 cfs per square mile from a 42-square mile Wicomico River drainage area. Subsequent review computations by the State of Maryland suggests that the design depth of flow over the spillway crest was approximately 4 feet. Based upon the final spillway crest elevation shown on August 1, 1936 contract drawings, the apparent design high water level for Johnson's Pond was about 15 feet above mean sea level when passing 8400 cfs.

b. Experience Data. No records of maximum pool levels are available.

In August, 1933, prior to construction of the dam for Johnson's Pond at its present site, a major flood overtopped the existing bridge and embankment which formed the original dam for Johnson's Pond at Isabella Street some 700 feet downstream from the present dam site. It is reported that this flood event washed out the eastern bridge approach rendering the dam useless.

Tide data for the Wicomico River indicates a mean high tide of 2.07 feet above m.s.l. and a mean low tide of 0.93 feet below mean sea level. Driven timber sheeting forming a sharp crested weir across the Wicomico River just upstream from Isabella Street eliminates the affect of normal tidal fluctuations upon tailwater levels at the present dam for Johnson's Pond since its crest elevation exceeds mean high tide events. However, during record high tide events, the weir becomes submerged and tidewaters extend to the spillway apron at Johnson's Pond. Available data indicates that the August 1933 flood produced a record high tide of 8.07 feet above m.s.l.

c. Visual Observations. Several observations made during the visual inspection of the Johnson's Pond impoundment are particularly relevant to the hydraulic and hydrological evaluations.

(1) Embankment. The field survey of the embankments or non-overflow sections of the dam adjacent to the left and right wingwalls of the ogee spillway indicates that the crests of the existing non-overflow sections are lower than their design elevation of 16 feet above m.s.l. The low points for the left and right non-overflow sections are 15.1 and 14.5 feet above m.s.l., respectively. The data for the existing crests of the non-overflow sections was employed in subsequent hydraulic analyses.

(2) Ogee Spillway and Appurtenant Structures. The spillway crest has been constructed in accordance with the record contract drawings. The three 48-inch by 48-inch sluice gates which control discharges through openings in the ogee spillway below its crest were demonstrated during the visual inspection and operated as designed. These gates are normally closed except for a short period in the winter when the pool level is lowered to implement vegetation control measures. Subsequent hydraulic analyses assumes that these gates are in a closed position during the occurrence of a major flood event.

(3) Downstream Conditions. Failure of the dam impounding Johnson's Pond could cause significant damage to the intensely developed industrialized area downstream between Isabella Street and U.S. Route 50. Large fuel oil storage depots serving the Maryland Eastern Shore characterize the major type of industrial development in this area. Other facilities situated in this reach include a brickyard, feed supply center, automotive parts warehouse, concrete plant, and state highway maintenance yard. Because of the constricted opening at the Isabella Street bridge, a dam failure could also result in overtopping of the Isabella Street bridge approaches and severing Isabella Street, a Salisbury thoroughfare. Several shore residences situated just upstream from the dam but adjacent to and just slightly above the crest elevation of the left dam abutment could also be damaged if the dam abutments were overtopped. In keeping with the potential hazard classification criteria established by the Office of the Chief of Engineers (OCE), the downstream conditions suggest that a high hazard classification be assigned to the dam impounding Johnson's Pond.

d. Overtopping Potential. According to the criteria promulgated by the Office of the Chief of Engineers, the recommended Spillway Design Flood (SDF) for a dam classified as "intermediate" with a "high" hazard potential is 100 percent of the Probable Maximum Flood (PMF).

The Probable Maximum Precipitation (PMP) index as adjusted for the Johnson's Pond drainage area is 21.1 inches in 24 hours. Employing criteria established by the Corps of Engineers, Baltimore District, 100 percent and 50 percent PMF inflow hydrographs developed using the HEC-1 computer program have peaks of 15,800 and 7,900 cfs, respectively. The 8400 cfs discharge rate employed in the original spillway design would occur during a flood event equivalent to 54 percent of the Probable Maximum Flood.

PMF inflow hydrographs were routed through Johnson's Pond for percentages ranging from 10 to 100 percent of the PMF with each routing starting at the normal pool level of 11.1 feet above m.s.l. These initial analyses employ ogee spillway discharge ratings which neglect the affect of spillway submergence caused by downstream conditions. . Spillway submergence resulting from backwater may occur as a result of the severe downstream channel constriction caused by the approaches to the Isabella Street bridge. The initial analyses suggest that the Johnson's Pond spillway can pass approximately 43 percent of the PMF without overtopping the adjacent non-overflow sections of the dam. However, for the 50 percent PMF routing, the reservoir water level reached an elevation of 14.9 feet above m.s.l. overtopping the low point in the right dam embankment by 0.4 feet. For the 100 percent PMF routing, the reservoir water level reached an elevation of 16.9 feet above m.s.l. overtopping the embankment low point by 2.5 feet. Additional results for the initial routing analyses are found in Appendix D.

Downstream channel routings of outflow hydrographs generated by the above reservoir routings indicate that the barrier caused by the approaches to the Isabella Street bridge will produce backwater conditions extending upstream to the Johnson's Pond spillway. In addition these analyses indicate that these approaches will be overtopped if the flood event exceeds 10 percent of the PMF. If these bridge approaches fail upon overtopping, the results from the initial reservoir routing analyses for Johnson's Pond can be considered valid since backwater conditions caused by the bridge embankment would not materialize for the 50 and 100 percent PMF events. If it is assumed that the bridge approaches do not fail, this affect or resultant backwater conditions upon the spillway discharge must be considered.

Additional analyses, which consider these potential backwater conditions, were performed for Johnson's Pond using inflow hydrographs ranging from 10 to 100 percent of the PMF. Under these conditions the additional analyses suggest that the Johnson's Pond spillway can pass only approximately 11 percent of the PMF without overtopping the non-overflow sections of the dam. For the 50 percent PMF routing the reservoir water level reached an elevation of 16.9 feet above m.s.l. overtopping the embankment low point by 2.4 feet. For the 100 percent PMF routing, the corresponding water level and overtopping depth are 18.2 feet above m.s.l. and 3.7 feet, respectively. Results for intermediate routings of the alternate analyses are found in Appendix D.

e. Spillway Adequacy. It is probable that the approaches to the Isabella Street bridge would fail prior to any failure of embankments adjacent to the Johnson's Pond spillway. For this reason, the initial reservoir routing analyses, which neglect tailwater conditions caused by the constriction at Isabella Street, have been employed in evaluating the spillway adequacy. These analyses indicate that overtopping of the Johnson's Pond embankment during the occurence of a 50 percent PMF event would have a duration of 10.0 hours. It is judged that a 0.4 foot maximum overtopping depth and 10.0-hour duration could be sufficient to result in failure of the dam embankment. Dam failure analyses have been performed for two different failure configurations for a 50-percent PMF event assuming each failure begins when the dam first starts to be overtopped. (Failure configurations are identified in Appendix D). On the basis of these analyses, routing of the resultant flood wave downstream suggests that failure of the Johnson's Pond dam would raise water levels in the industrialized area between Isabella Street and U.S. 50 by only 0.5 feet to 0.7 feet over the water surface that existed just prior to failure, depending upon the breach configuration employed. It is important to note, however, that flood levels produced by passage of a 50 percent PMF flood event through this industrialized reach, assuming no dam failure, would exceed the top of the adjacent seawalls by approximately 5 feet. Such levels could cause serious damage to the industrialized development in this area and would undoubtedly pose a hazard to loss of life. It is judged that an increase of less than one foot over this flood level by a concurrent failure of Johnson's Pond would not significantly increase the hazard to loss of life already existing prior to the dam failure. Therefore the spillway is rated as inadequate but not seriously inadequate in accordance with Office of the Chief of Engineers guidelines.

f. Additional Considerations. In evaluating the overtopping potential and spillway adequacy of Johnson's Pond, it was assumed that the peak spillway discharge resulting from a 50 percent probable maximum flood event occurred when the water level in the downstream reaches was at a mean high tide level of 2.1 feet above m.s.l. Should the occurrence of such an event coincide with a high tide equal in magnitude to the 8.1 high tide of record for the Salisbury area, it follows from the previous analyses that failure of the Johnson's Pond dam would not significantly increase the hazards associated with the flood and record high tide event over those hazards already existing prior to the failure.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations.

(1) Embankment. No deficiencies were noted for the clay fill embankment on either side of the ogee crest which could adversely affect the structural stability of the dam.

(2) Appurtenant Structures. At this time, the cracks noted in the wingwalls and in the ogee spillway are not considered large enough to adversely affect the structural stability of the dam. However, the existing cracks should be repaired so that they do not enlarge and pose a potential threat to the stability of the dam.

b. Design and Construction Data.

(1) Embankment. The stability of the clay fill embankment cannot be adequately evaluated because of insufficient construction records and design calculations.

(2) Appurtenant Structures. The contract drawings include the structural details of the appurtenant structures and are sufficient to assess the adequacy of the ogee spillway, wingwalls, and sluice gates.

c. Operating Records. The structural stability of the dam is not considered to be affected adversely by its operational features of the dam.

d. Seismic Stability. Johnson's Pond dam is located in Seismic Zone 1. Based on our visual observations, the static stability of the dam appears to be adequate. Consequently, the structure should present no hazard from earthquakes.

SECTON 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Assessment. Johnson's Pond is an intermediate, high hazard impoundment. Failure of the dam embankment could cause significant damage to the intensely developed industrialized area downstream between Isabella Street and U.S. Route 50. The visual observations indicate that the embankment of Johnson's Pond is in good condition. At this time, the cracks noted in the wingwalls and the ogee spillway are not large enough to adversely affect the structural stability of the dam. However, the cracks should be repaired before they enlarge and pose a threat to the structural stability.

Hydrologic and hydraulic analyses indicate that the Johnson's Pond dam would be overtopped during a flood equaling 50 percent of the Probable Maximum Flood (PMF), but would not be overtopped by a flood event equal to or less than 48 percent of the PMF. Dam breech analyses suggest that failure of the Johnson's Pond dam would raise water levels in the industrialized area between Isabella Street and U.S. Route 50 by less than one foot over the water surface that would have existed just prior to failure. It is judged that this nominal rise in flood levels would not significantly increase the hazard to loss of life than that already existing prior to dam failure. Therefore, the spillway of the Johnson's Pond dam is rated as inadequate, but not seriously inadequate.

b. Adequacy of Information. Coupled with the visual observations, the available information, even though it does not include construction records or design calculations for the clay fill embankments, is considered to be sufficient to make the recommendations that are given below.

c. Urgency. Although there is no urgency in instituting the remedial measures recommended below, the measures should be accomplished in a timely manner.

d. Necessity for Additional Information. No additional information is needed.

7.2 Recommendations/Remedial Measures.

It is recommended that the following remedial measures be implemented by the Owner:

a. Conduct a hydrologic and hydraulic study to determine what remedial measures are necessary to provide adequate capacity of the spillway.

b. Repair the cracks which extend through the right and left wingwalls from the crest of the ogee spillway to the top of each wingwall.

c. Repair the cracks noted in the ogee spillway before the cracks enlarge.

d. Raise the embankment to the design elevation.

e. Carefully inspect the ogee spillway for additional cracks, seepage through cracks, or displacement of concrete along the cracks at least once a year while the water level is down.

f. Develop a formal warning system to alert downstream residents in the event of emergencies.

APPENDIX A

VISUAL INSPECTION CHECKLIST

PHASE I

APPENDIX A
VISUAL INSPECTION CHECKLIST
PHASE I

Name of Dam: Johnson's Pond County(or City): Wicomico State: Maryland

NDI ID. No.: MD- 11 Type of Dam: Clay fill Embankment & Concrete ogee spillway Hazard Category: High

Date(s) Inspection: 7/10/80 & 8/5/80 Weather: Partly Cloudy Temperature: 90°F

Pool Elevation at Time of Inspection: 10±' above M.S.L. Tailwater at Time of Insp. 4±' M.S.L.

Inspection Personnel:	Review Inspection Personnel:
Douglas Nauman	Edward J. Zeigler
Jim Wise	Frank H. Donaldson
	Douglas Nauman

Douglas Nauman Recorder

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Several cracks were noted in the concrete of the wing-walls and ogee spillway of the dam.	No leakage through or displacement along the cracks in the ogee spillway were noted.
USUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment satisfactory. Vertical alignment of embankment left of spillway varies 0.7', and right of spillway varies 3.0'	Vertical alignment of spillway crest varied 1 inch, and the low point elevation was equal to the design crest elev.
RIPRAP FAILURES		

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	A crack was noted through both left and right wingwalls extending from spillway crest to top of wingwall	Patch the cracks
ANY NOTICEABLE SEEPAGE	None	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The 3 outlet openings through spillway are in satisfactory condition	
INTAKE STRUCTURE	N/A	
OUTLET STRUCTURE	N/A	
OUTLET CHANNEL	N/A	
EMERGENCY GATE	Three, 48" x 48" sluice gates on upstream side of spillway at spillway notch	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	30 foot section of 300 foot ogee spillway is notched. Notch centrally located on spillway.	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	None	
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

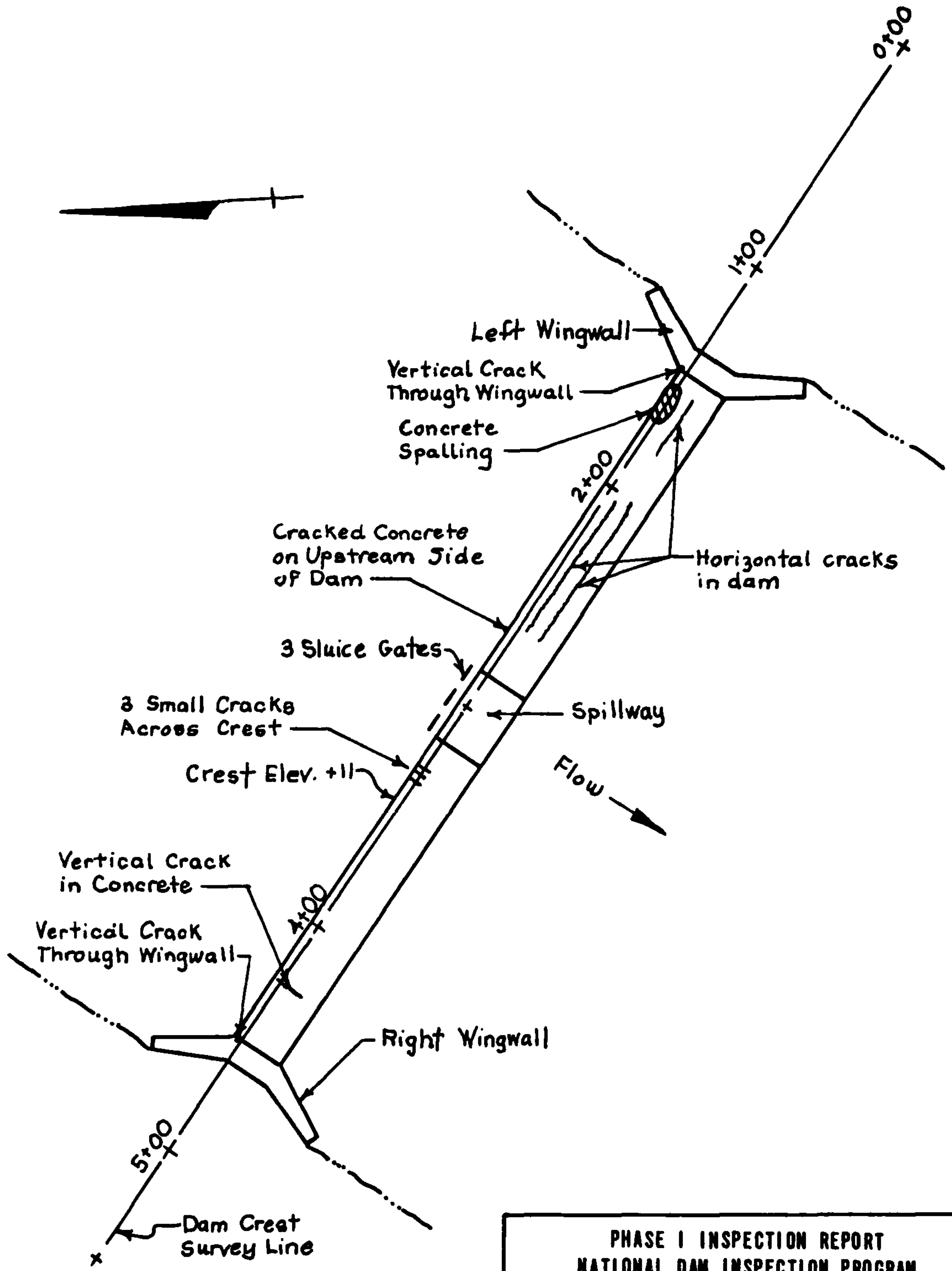
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Area surrounding reservoir is urbanized; vegetated up to bank	
SEDIMENTATION	No significant amount of sedimentation was evident	
UPSTREAM RESERVOIRS	Leonard Pond located approximately 3 miles upstream at U.S. Rte. 13	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	400±' downstream of dam is railroad trestle bridge; 700±' downstream is Isabella St. embankment and bridge.	An old wooden weir extends across channel immediately upstream of Isabella St. bridge
SLOPES	Slopes upstream of Isabella St. are generally wooded. Slopes downstream are protected by timber floodwall	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Heavily industrialized area along banks downstream of Isabella St. Some residences along banks downstream of Rte 50.	



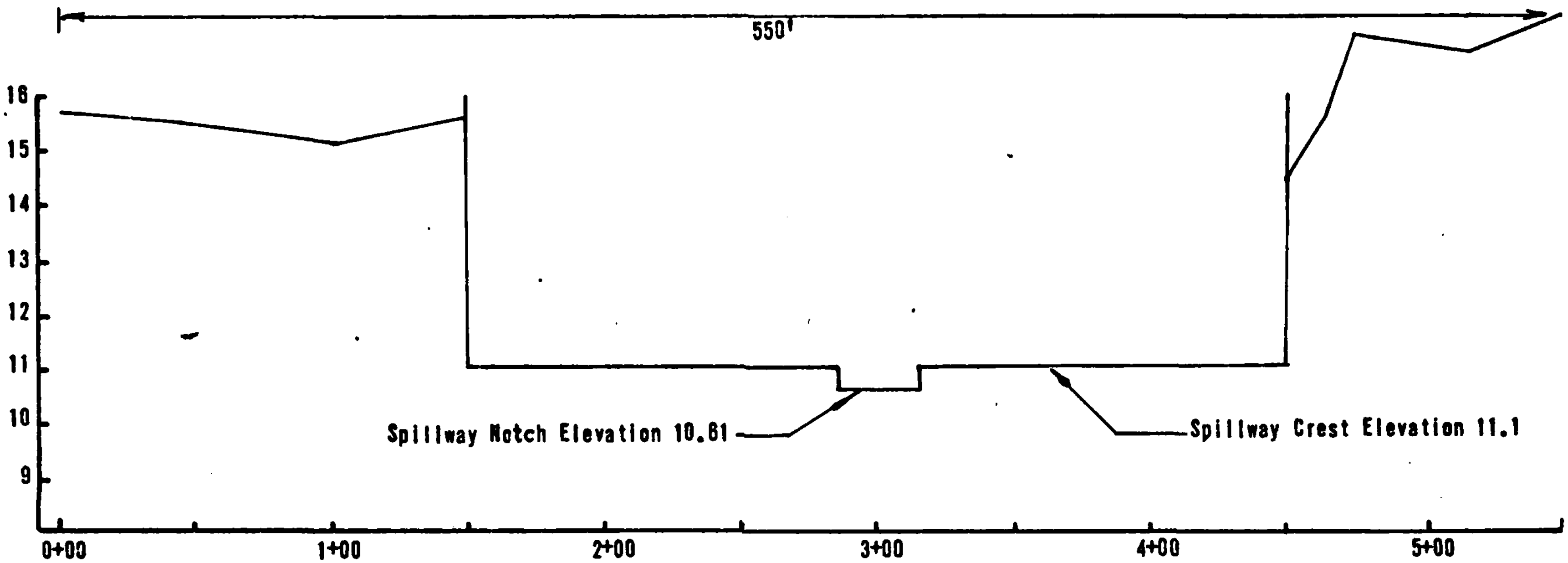
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

JOHNSON'S POND

CITY OF SALISBURY

RESULTS OF VISUAL INSPECTION

JULY 1980 PLATE A-1



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTE:

DAM CREST SURVEY STATIONS ARE SHOWN ON PLATE A-1.

DATUM ELEVATION WAS PROVIDED BY THE CHIEF SURVEYOR FOR THE CITY OF SALISBURY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

JOHNSON'S POND

CITY OF SALISBURY

DAM CREST SURVEY

JULY 1980 PLATE A-2

APPENDIX B

ENGINEERING DATA CHECKLIST

PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Johnson's Pond

ID# NDI ID No. MD-11

ITEM	REMARKS
AS-BUILT DRAWINGS	Contract Drawings entitled, "Proposed Steel and Concrete Dam at Johnson's Pond" by Mayor and Council, Salisbury, Md., dated January 10, 1936, and revised August 1, 1936.
REGIONAL VICINITY MAP	Refer to Location Map, Plate E-1 in Appendix
CONSTRUCTION HISTORY	No construction records available
TYPICAL SECTIONS OF DAM	Included on Contract Drawings and as Plate E-2 in Appendix
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	For outlet plan and details, refer to Plate E-2 in Appendix

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None
DESIGN REPORTS	None
GEOLOGY REPORTS	None
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Limited design computations and correspondence relative to design of dam are available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

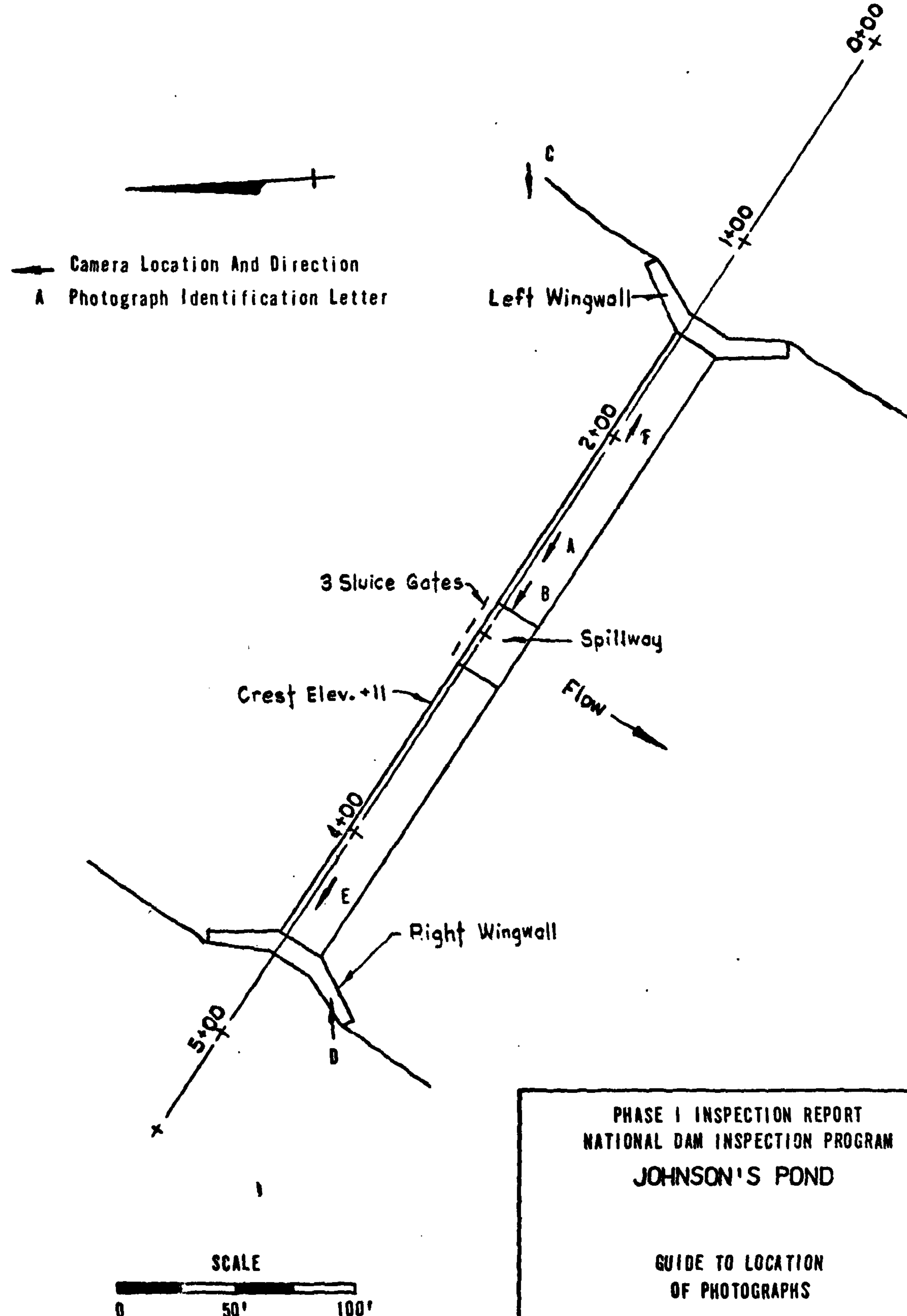
ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	No data available
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	None

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	None
SPILLWAY PLAN SECTIONS DETAILS	Sections and Details included on Contract Drawings. Refer to Plates E-2 and E-3 in Appendix
OPERATING EQUIPMENT PLANS AND DETAILS	Plans and Details included on Contract Drawings. Refer to Plate E-2 in Appendix

APPENDIX C

PHOTOGRAPHS



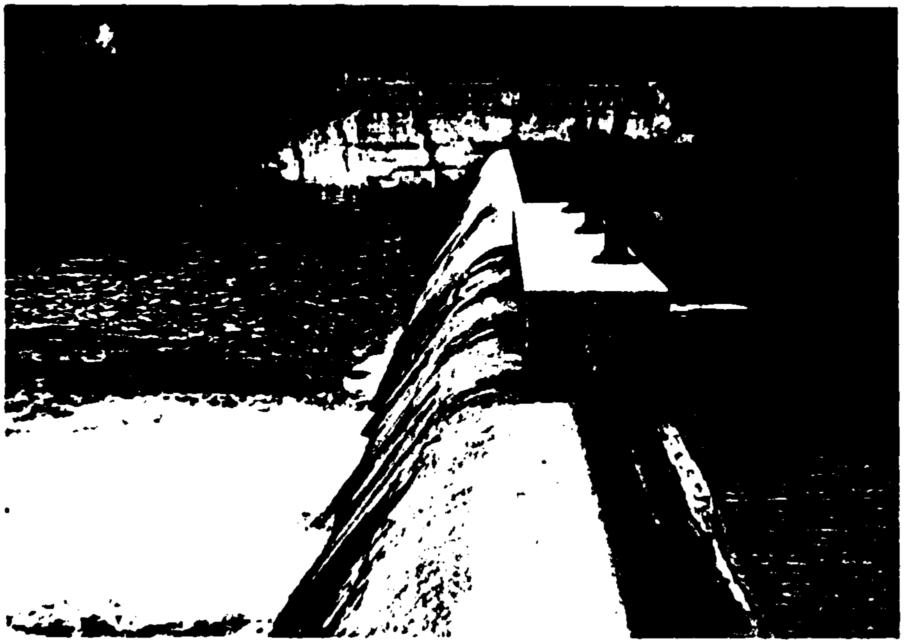
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

JOHNSON'S POND

GUIDE TO LOCATION
OF PHOTOGRAPHS

JULY 1980

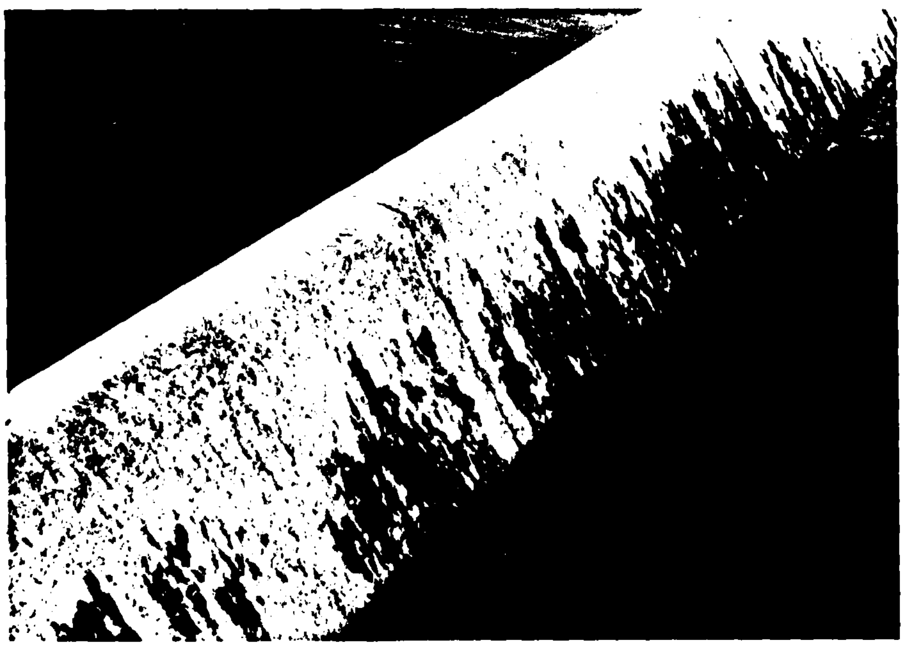
PLATE C-1



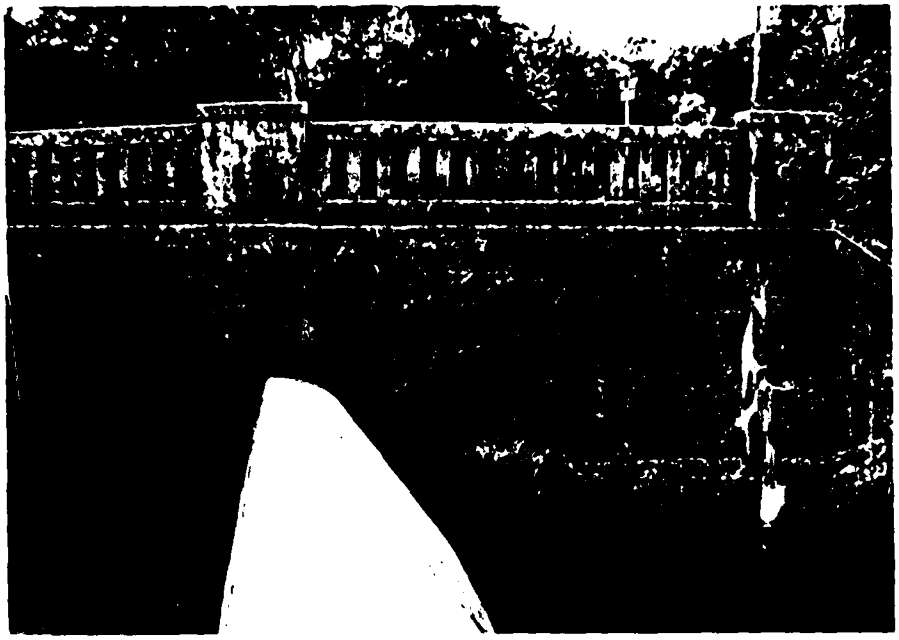
A. Dam with sluice gates open

B. City of Salisbury personnel closing sluice gates

C. Upstream side of dam



D. Vertical crack in dam near left end of dam



E. Structural crack in retaining wall above dam crest at left end of dam

F. Structural crack in retaining wall above dam crest at right end of dam

G. Isabella Street Bridge crossing river downstream of dam

H. Downstream of Isabella Street Bridge

APPENDIX D

HYDROLOGY AND HYDRAULICS

BASE DATA FOR DETERMINATION OF PROBABLE MAXIMUM FLOOD, UNIT HYDROGRAPH AND INFLOW HYDROGRAPHS

Name of Dam: Johnson's Pond Dam NDI-ID MD-11

Unit Hydrograph Parameters

Watershed Drainage Area	42 sq. miles
Main Channel Length, L	11.18 miles
Main Channel to Centroid Length, Lca	4.94 miles
Lag Time $tp = Ct\ (L \times Lca)^{0.3}$	13.6 hours
Basin Zone Location from Unit Hydrograph Coefficient Map	37
Basin Coefficients	
Cp[1]	0.35
Ct[1]	4.07

Inflow Hydrograph Parameters[1]

Base Flow at Start of Storm	1.5 c.f.s./sq. mile
Initial Rainfall Loss	1 inch
Uniform Rainfall Loss	0.05 inches/hour
Ratio of Peak Discharge Used to Compute Base Flow which Deviates from Hydrograph Falling Limb	0.05
Ratio of Recession Flow occuring 10 Tabulation Intervals Later	2.0

Rainfall Data[2]

Probable Maximum Precipitation Index for 24 hours and 200 square miles	25 inches (Zone 6)
Percentage Adjustments of PMP for Drainage Area	
6 hour storm	99%
12 hour storm	108%
24 hour storm	118%

---

[1] Basin Coefficients and Hydrograph Data established by Corps of Engineers Baltimore District.
[2] Hydrometeorological Report 33, Corps of Engineers, 1956

Tabulation of Reservoir Area and Storage Vs. Elevation

Name of Dam: Johnson's Pond Dam, NDI-ID MD-11

Pool Elevation feet above m.s.l.	Surface Area acres	Reservoir Storage acre-feet
-5 (Bottom of Pool)		0
11.1 (Normal Pool)	104[3]	904[1]
14.5 (Top of Dam)	274[2]	1930[2]
15.0 (Maximum Design Flood Level)	300[2]	2070[2]
20.0	550[4]	3562[1]

Comments:

Actual bottom pool elevation equals - 5 feet m.s.l. However a bottom pool elevation of -15 feet m.s.l. was used in employing the HEC-1 "Conical Storage" computer analysis to reflect the bowl shape of Johnson's Pond for a more accurate storage capacity determination.

---

1 Computed by HEC-1 Computer Analysis

2 Interpolated by Rummel, Klepper and Kahl

3 Source "Watershed Construction Permit Activity Record," Johnson's Pond Dam

4 Area planimetered from 2000 scale USGS maps, dated 1942

SPILLWAY RATING CURVE TABLE[1]

Name of Dam: Johnson's Pond Dam, NDI-ID MD-11

Reservoir Water Elevation ft.	Spillway Capacity Without Tailwater c.f.s.	Spillway Capacity With Tailwater c.f.s.
10.6	0	0
10.81	7.74	7.74
11.0	21.8	21.8
11.07	27.0	27.0
12.0	949	200
13.0	2837	700
14.0	5306	1450
15.0	8243	2500
16.0	11581	4250
17.0	-	7400

Calculation Basics

Ogee Spillway Capacity Without Tailwater:

$Q = CLH^{1.5}$

$= 3.6 \times (300\text{ ft} - 6\text{ ft})\ H^{1.5}$

$= 1058\ H^{1.5}$, where H = Reservoir Water Elevation minus 11.07

Ogee Spillway Capacity With Tailwater:

$Q = Cs\ LH^{1.5}$

$= Cs \times 294\ H^{1.5}$, where H is as defined above and Cs varies with tailwater levels[2].

---

[1] Calculated by Rummel, Klepper and Kahl

[2] Refer to "Modified Discharge Coefficient, Cs, Computations" on Page D-4

TRIAL NO.	PERCENT OF P.M.F	Q_1 DISCHARGE AT ISABELLA STREET c.f.s.	TAILWATER ELEVATION AT Johnson's Pond feet above m.s.l.	ASSUMED ELEVATION UPSTREAM FROM DAM feet above m.s.l.	H_d ASSUMED ELEVATION MINUS TAILWATER ELEVATION	H_e ASSUMED ELEVATION MINUS 11.1 ft.	$\frac{H_d}{H_e}$ DEGREE OF SUBMERGENCE	$\frac{C_s}{C_o}$ [1,2] Ratio of MODIFIED COEFFICIENT TO FREE DISCHARGE COEFFICIENT	C_s MODIFIED DISCHARGE COEFFICIENT	$Q_2 = C_s L H_e^{1.5}$ DISCHARGE AT DAM ADJUSTED FOR SUBMERGENCE	REMARKS [3]
1	10	1570	13.8	13.9	0.1	2.8	0.036	0.375	1.35	1859	TOO HIGH USE 13.85
1	20	3130	15.6	15.9	0.3	4.8	0.0625	0.5	1.8	5565	TOO HIGH
2	20	3130	15.6	15.7	0.1	4.6	0.022	0.22	0.792	2297	TOO LOW
3	20	3130	15.6	15.8	0.2	4.7	0.042	0.4	1.44	4313	TOO HIGH USE 15.75
1	40	6275	16.5	16.7	0.2	5.6	0.036	0.36	1.30	5064	TOO LOW
2	40	6275	16.5	16.8	0.3	5.7	0.052	0.47	1.70	6800	TOO HIGH USE 16.75
1	50	7843	16.8	17.2	0.4	6.1	0.066	0.5	1.80	7972	TOO HIGH
2	50	7843	16.8	17.1	0.3	6.0	0.05	0.46	1.65	7129	TOO LOW
3	50	7843	16.8	17.15	0.35	6.05	0.058	0.49	1.764	7718	ok USE 17.15
1	70	10,910	17.3	17.9	0.6	6.8	0.089	0.62	2.23	11,625	TOO HIGH
2	70	10,910	17.3	17.8	0.5	6.7	0.075	0.55	1.98	10,100	TOO LOW USE 17.85
1	100	15,673	17.8	18.3	0.5	7.2	0.069	0.53	1.91	10,848	TOO LOW
2	100	15,673	17.8	18.5	0.7	7.4	0.095	0.64	2.3	13,612	TOO LOW
3	100	15,673	17.8	18.7	0.9	7.6	0.118	0.685	2.47	15,214	TOO LOW USE 18.75

1. For C_s/C_o refer to figure 194 from Design of Small Dams
2. C_o = 3.6
3. Assumed elevation upstream from dam is correct when $Q_1 = Q_2$

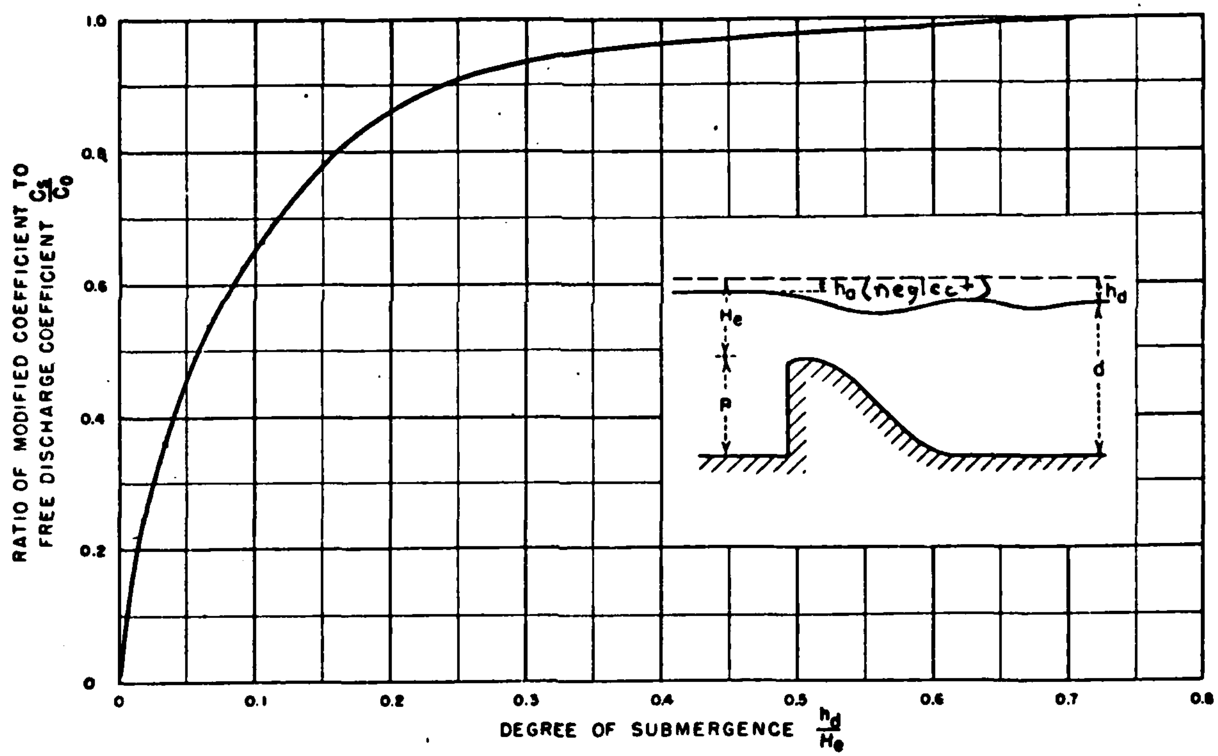
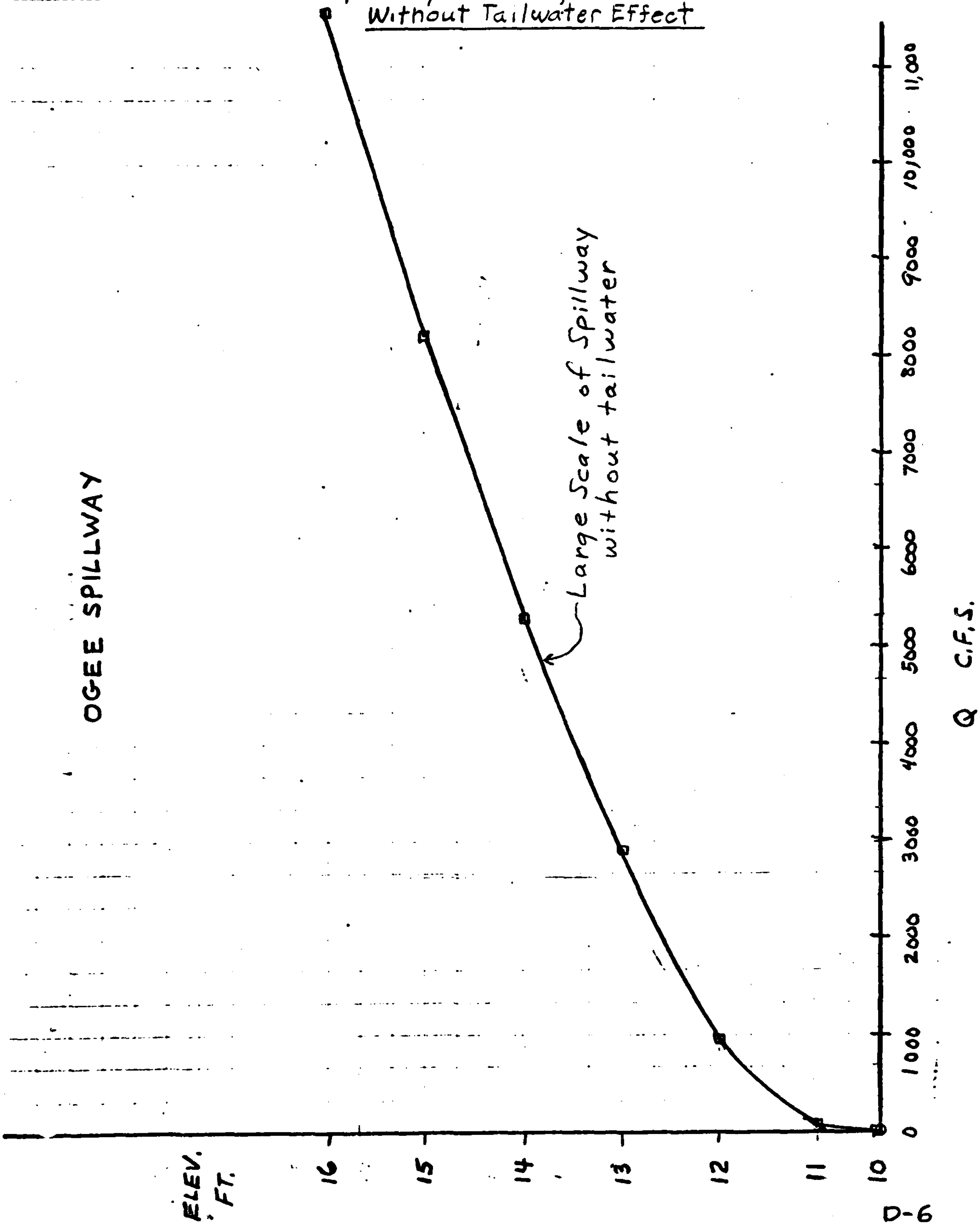


Figure 194. **Ratio of discharge coefficients due to tailwater effect.**

BY GFS DATE 7/28/30 SUBJECT Johnson's Pond SHEET NO. 10 OF

CHKD. BY DATE JOB NO. 580-21-10

Spillway Rating Curve
Without Tailwater Effect

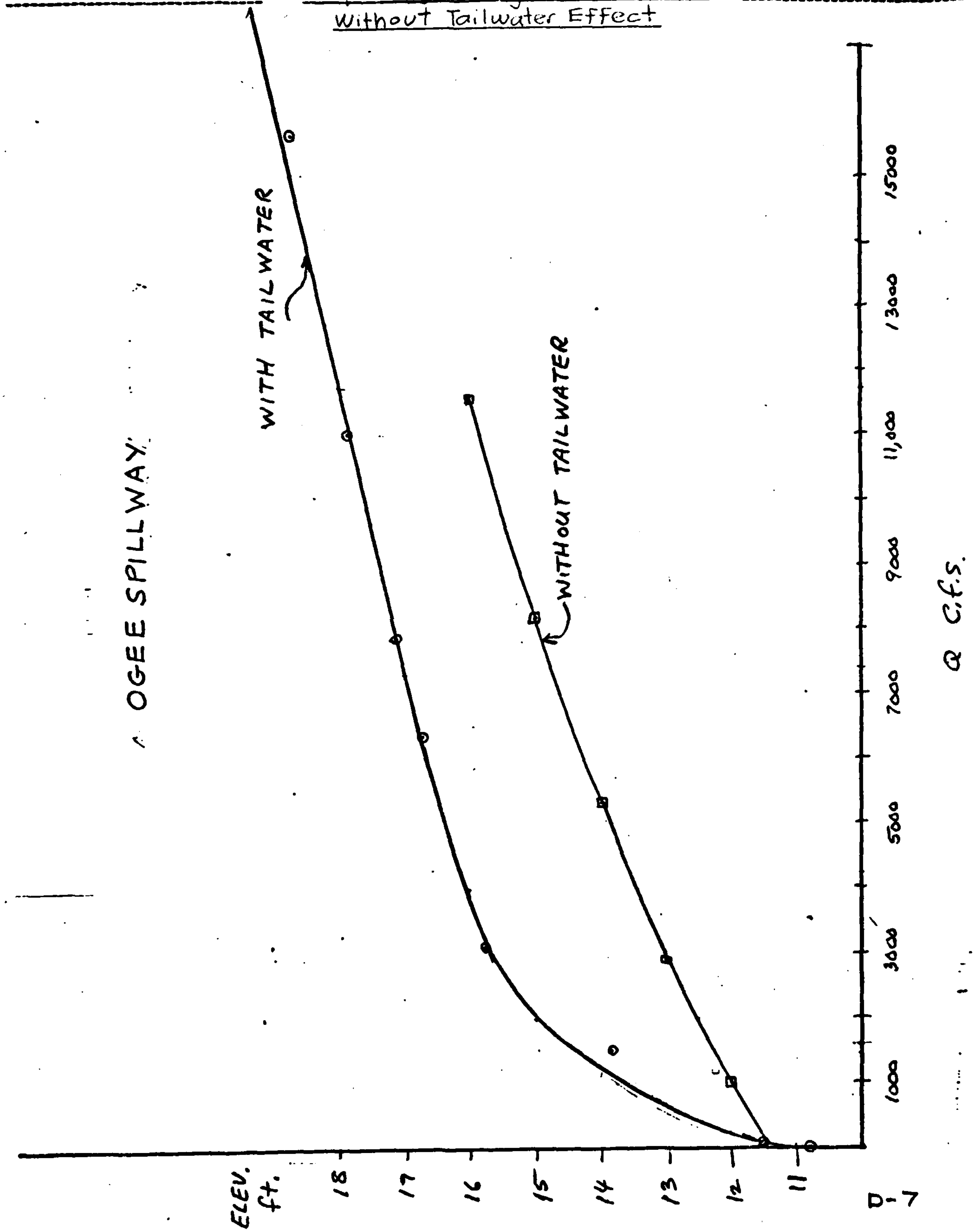


D-6

BY GFS DATE 8/5/80 SUBJECT Johnsons Pond SHEET NO. ___ OF ___

CHKD. BY ___ DATE ___ JOB NO. 580-21-1D

Spillway Rating Curves With And Without Tailwater Effect

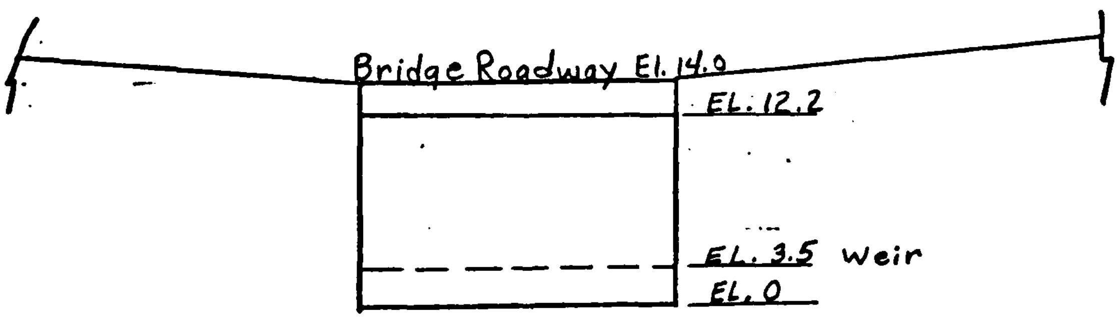


D-7

BY GES DATE 8/6/80	SUBJECT Johnson's Pond Dam	SHEET NO. ____ OF ____
CHKD. BY ____ DATE ____	Phase 1 Dam Inspection Program	JOB NO. 580-21-1D
	Reach I Isabella St.	

OUTLET CURVE DATA [1]

Elevation ft.	Storage Data ac.ft.	Outflow Rate c.fs.
3.5		0
4.0	11.53	54
4.5		150
5.0	16.89	191
7.0	28.28	420
9.0	40.84	701
11.0	55.7	1027
12.2	68.0	1242
14.0		1600
15.0		1821
16.0		3995
17.0		8528
19.0	158.0	27541



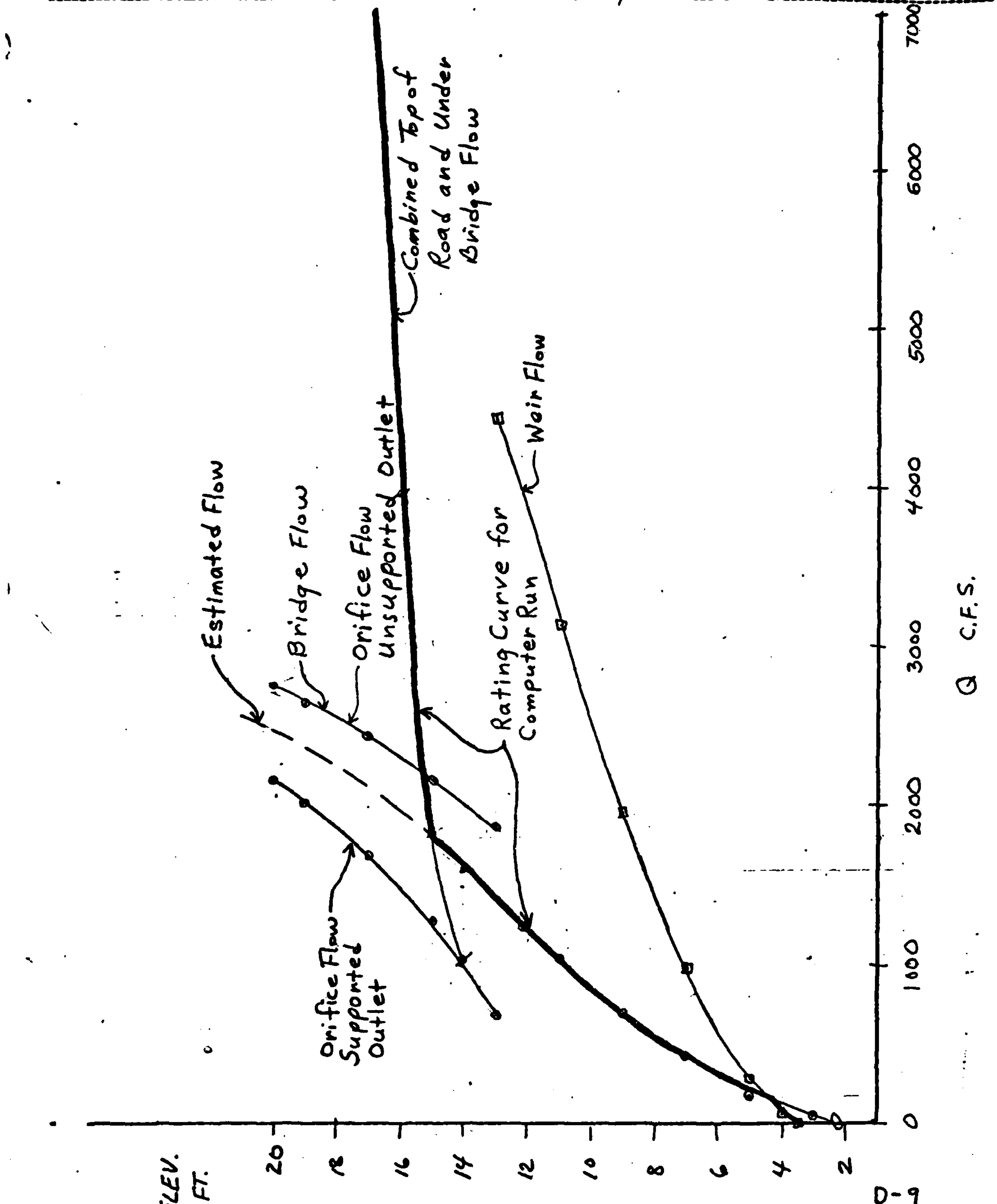
[1] Refer to Page D-10 for Isabella Street Rating Curve Computations.

RUMMEL, KLEPPER & KAHL · ENGINEERS

BY GES DATE 8/5/80 SUBJECT Johson's Pond SHEET NO. ____ OF ____

CHKD. BY ____ DATE ____ JOB NO. 580-21-10

Reach 1 Outlet Rating Curve



D-9

BY GFS DATE 8/29/80 SUBJECT Ivanson's Pond SHEET NO. OF
CHKD. BY DATE Isabella Street JOB NO. 530-21-1D
Rating Curve Computations

Water Surface Elevation feet	Flow Under Bridge c.f.s	Orifice Flow at Bridge c.f.s.	Flow Over Bridge c.f.s.	Discharge at Isabella Street c.f.s.
3.5	0			0
4.0	54			54
4.5	150			150
5.0	191			191
7.0	420			420
9.0	701			701
11.0	1027			1027
12.2	1242			1242
14.0	(transition flow derived from graph)			1600
15.0		1295	526	1821
16.0		1696	2477	3995
17.0		2018	6832	8528
19.0		2162	25,523	27,541

Calculation Basics

Flow Under Bridge

$Q = CLH^{1.5}$
$= 2.63 \times 14.7\ H^{1.5}$
$= 38.7\ H^{1.5}$

H = Water Surface Elevation − 2.1 feet above m.s.l.

Orifice Flow at Bridge

$Q = CA\sqrt{2gH}$
$= 0.6 \times 161\ \sqrt{2gH}$
$= 774H^{.5}$

H = Water Surface Elevation − 12.2 feet above m.s.l.
(orifice flow with "supported outlet" conservatively assumed in rating curve derivation)

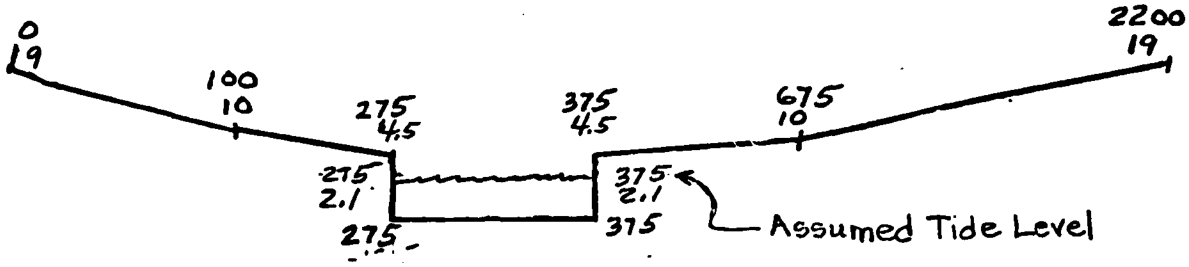
Flow over Bridge

$Q = CLH^{1.5}$
$= 2.63 \times L \times H^{1.5}$

H = Water Surface Elevation − 14.0 feet above m.s.l

L becomes larger as the elevation increases.

BY GFS DATE 8/7/80 SUBJECT Johnson's Pond SHEET NO. ___ OF ___
CHKD. BY ___ DATE ___ JOB NO. 580-21-1D
Reach Data Rt. 50



REACH DATA

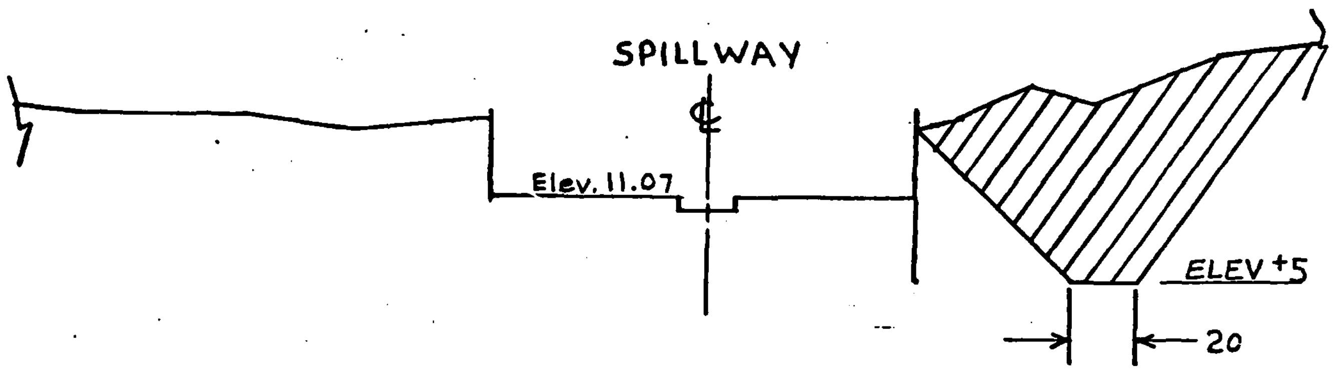
n. of 0.1 to account for buildings on side slope area

QN (1)	0.1
QN (2)	0.02
QN (3)	0.1
ELNVRT	2.1
ELMAX	19.0
RLNTH	2800
SEL	0.001

BREACH DATA

Shape of Breach	Trapezoid
Bottom Width of Breach	20 feet
Maximum Depth of Breach	5 feet
Side Slope of Breach	1 to 1
Water Level at Beginning of Breach	11.07 feet above m.s.l.
Time to Maximum Size	1 hour

BREACH DIAGRAM

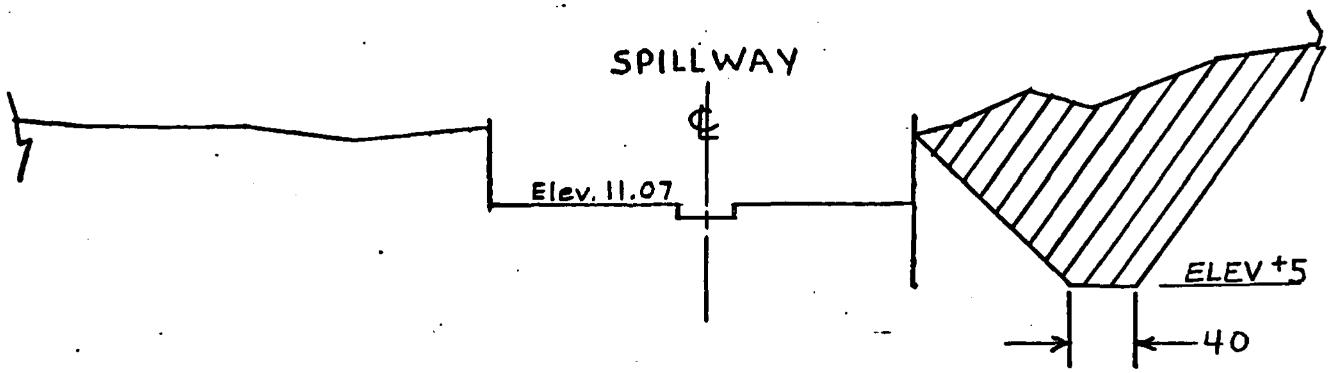


NOT TO SCALE

BREACH DATA

Shape of Breach	Trapezoid
Bottom Width of Breach	40 feet
Maximum Depth of Breach	5 feet
Side Slope of Breach	1 to 1
Water Level at Beginning of Breach	11.07 feet above m.s.l.
Time to Maximum Size	1 hour

BREACH DIAGRAM



NOT TO SCALE

Comment: Analysis assumes free-flow over spillway weir

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
*********************************
A1      SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES FOR
A2      JOHNSONS POND DAM
A3      NDI-I.D. MD11   COMM. NO. 580-21-1D
B      150       1       0       0       0       0       0       0      -4       0
B1       5
J        1       9       1
J1     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     1.0
K        0       1                       0       0       1       0
K1      CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
M        1       1      42              42       0                       1
P        0      25      99     108     118
T                                                        1    0.05
W     13.6    0.35
X     -1.5   -0.05     2.0
K        1       2
K1      ROUTED FLOWS THROUGH JOHNSONS POND DAM.
Y                                1       1
Y1       1                                          -11.07      -1
Y4    10.6   10.81    11.0   11.07    12.0    13.0    14.0    15.0    16.0
Y5       0    7.74    21.8      27     949    2837    5306    8243   11581
$A       0     104     550
$E   -15.0   11.07      20
$$   11.07
$D    14.5    2.63     1.5      10
$L      80     185     309     452     605     800
$V    15.5      16      17      18      19      20
K        1       3
K1      ROUTED FLOW MOD PULS REACH1
Y                                1       1
Y1       1
Y2   11.53   16.89   28.28   40.84    55.7      64     158
Y3      54     191     420     701    1027    1200   27541
Y4     3.5     4.0     4.5     5.0     7.0     9.0    11.0   12.20    14.0    15.0
Y4    16.0    17.0    19.0
Y5       0      54     150     191     420     701    1027    1242    1600    1821
Y5    3995    8528   27541
K        1       4
K1      FLOOD ROUTING MOD PULS REACH 2
Y                                1       1
Y1       1
Y6     0.1    0.02     0.1     2.1    19.0    2100   0.001
Y7       0      19     100      10     275     4.5     275     2.1     375     2.1
Y7     375     4.5     675      10    2200      19
K       99
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  06 FEB 80
**********************************
                          SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES FOR
                          JOHNSONS POND DAM
                          NDI-I.D. MD11    COMM. NO. 980-21-1D

                                        JOB SPECIFICATION
             NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
            150        1        0        0        0        0        0        0       -4        0
                                      JOPER      NWT    LROPT    TRACE
                                          5        0        0        0

                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                     NPLAN= 1 NRTIO= 9 LRTIO= 1
            RTIOS=     0.10     0.20     0.30     0.40     0.50     0.60     0.70     0.80     1.00


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

                                   SUB-AREA RUNOFF COMPUTATION

                         CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
                             ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                 1        0        0        0        0        0        1        0        0

                                            HYDROGRAPH DATA
            IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                1        1    42.00     0.00    42.00     0.00    0.000        0        1        0

                                               PRECIP DATA
                          SPFE      PMS       R6      R12      R24      R48      R72      R96
                          0.00    25.00    99.00   108.00   118.00     0.00     0.00     0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.845

                                                LOSS DATA
            LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
                0     0.00     0.00     1.00     0.00     0.00     1.00     1.00     0.05     0.00     0.00

                                            UNIT HYDROGRAPH DATA
                                       TP= 13.60      CP=0.35       NTA=  0

                                               RECESSION DATA
                               STRTQ=    -1.50     QRCSN=    -0.05     RTIOR= 2.00

            UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=  13.56 HOURS, CP= 0.35  VOL= 0.95
          12.        46        96.       156.       224.       299.       379.       459.       532.       595.
         646.       686       711.       717.       702.       679.       657.       635.       615.       595.
         575.       557.       538.       521.       504.       487.       472.       456.       441.       427.
         413.       400        387.       374.       362.       350.       339.       328.       317.       307.
         297.       287.       277.       268.       260.       251.       243.       235.       227.       220.
         213.       206.       199.       193.       186.       180.       174.       169.       163.       158.
         153.       148        143.       138.       134.       129.       125.       121.       117.       113.
         110        106        103.        99.        96.        93.        90.        87.        84.        81.
          79         76         74         71         69.        67.        65         62.        60.        58
          57.        55         53.        51.        50.        48.        46.        45.        43.        42.
```

```
     0                                                END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q        MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q

                                                                                   SUM  24.92   23.05    1.88   605328.
                                                                                       ( 633.)( 585.)(  48.)(17140.97)


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

                                              HYDROGRAPH ROUTING

                          ROUTED FLOWS THROUGH JOHNSONS POND DAM.
                                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                     2       1       0       0       0       0       0       0       0
                                                      ROUTING DATA
                          QLOSS  CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                            0.0  0.000    0.00       1       1       0       0               0

                                 NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                     1       0       0   0.000   0.000   0.000    -11.      -1

     STAGE      10.60     10.81     11.00     11.07     12.00     13.00     14.00     15.00     16.00

      FLOW       0.00      7.74     21.80     27.00    949.00   2837.00   5306.00   8243.00  11581.00

 SURFACE AREA=       0.     104.     550.

     CAPACITY=       0.     904.    3562.

    ELEVATION=     -15.      11.      20.

                                  CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                                  11.1     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                       DAM DATA
                                               TOPEL    COQD    EXPD  DAMWID
                                                14.5     2.6     1.5     10.

    CREST LENGTH        80.      185.      309.      452.      605.      800.
    AT OR BELOW
    ELEVATION          15.5      16.0      17.0      18.0      19.0      20.0

 PEAK OUTFLOW IS      1564.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS      3132.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS      4692.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS      6260.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS      7814.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS      9382.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS     10944.  AT TIME   30.00 HOURS

 PEAK OUTFLOW IS     12512.  AT TIME   30.00 HOURS
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PEAK OUTFLOW IS    15646. AT TIME  30.00 HOURS


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

                                          HYDROGRAPH ROUTING

                        ROUTED FLOW MOD PULS REACH1
                                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                    3       1       0       0       0       0       0       0       0
                                                          ROUTING DATA
                          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                            0.0   0.000    0.00       1       1       0       0               0

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

 STORAGE      11.53      16.89      28.28      40.84      55.70      64.00     158.00

 OUTFLOW      54.00     191.00     420.00     701.00    1027.00    1200.00   27541.00

   STAGE       3.50       4.00       4.50       5.00       7.00       9.00      11.00      12.20      14.00      15.00
              16.00      17.00      19.00

    FLOW       0.00      54.00     150.00     191.00     420.00     701.00    1027.00    1242.00    1600.00    1821.00
            3995.00    8528.00   27541.00

MAXIMUM STAGE IS      13.8

MAXIMUM STAGE IS      15.6

MAXIMUM STAGE IS      16.2

MAXIMUM STAGE IS      16.5

MAXIMUM STAGE IS      16.8

MAXIMUM STAGE IS      17.1

MAXIMUM STAGE IS      17.3

MAXIMUM STAGE IS      17.4

MAXIMUM STAGE IS      17.8


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

                                          HYDROGRAPH ROUTING

                        FLOOD ROUTING MOD PULS REACH 2
                                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                    4       1       0       0       0       0       0       0       0
                                                          ROUTING DATA
                          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                            0.0   0.000    0.00       1       1       0       0               0

                                  NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
```

1	0	0.	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	ELNVT	ELMAX	RLNTH	SEL
0.1000	0.0200	0.1000	2.1	19.0	2100.	0.00100

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	19.00	100.00	10.00	275.00	4.50	275.00	2.10	375.00	2.10
375.00	4.50	675.00	10.00	2200.00	19.00				

STORAGE	0.00	4.29	8.58	13.01	19.94	30.17	43.68	60.50	80.60	104.03
	132.94	168.74	211.43	261.00	317.47	380.81	451.05	528.17	612.18	703.07
OUTFLOW	0.00	191.55	601.14	1172.60	1912.32	2832.95	3948.21	5270.71	6812.52	8569.54
	10512.58	12801.46	15449.20	18479.71	21919.26	25794.32	30130.96	34954.61	40290.08	46161.56
STAGE	2.10	2.99	3.88	4.77	5.66	6.55	7.44	8.33	9.22	10.11
	10.99	11.88	12.77	13.66	14.55	15.44	16.33	17.22	18.11	19.00
FLOW	0.00	191.55	601.14	1172.60	1912.32	2832.95	3948.21	5270.71	6812.52	8569.54
	10512.58	12801.46	15449.20	18479.71	21919.26	25794.32	30130.96	34954.61	40290.08	46161.56

MAXIMUM STAGE IS 5.2

MAXIMUM STAGE IS 6.8

MAXIMUM STAGE IS 7.9

MAXIMUM STAGE IS 8.9

MAXIMUM STAGE IS 9.7

MAXIMUM STAGE IS 10.5

MAXIMUM STAGE IS 11.2

MAXIMUM STAGE IS 11.8

MAXIMUM STAGE IS 12.8

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

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.10	RATIO 2 0.20	RATIO 3 0.30	RATIO 4 0.40	RATIO 5 0.50	RATIO 6 0.60	RATIO 7 0.70	RATIO 8 0.80	RATIO 9 1.00
HYDROGRAPH AT	1	42.00	1	1577.	3155.	4732.	6310.	7887.	9465.	11042	12620	15774
	(	108.78)	(	44.67)(	89.34)(	134.00)(	178.67)(	223.34)(	268.01)(	312.68)(	357.35)(	446.69)
ROUTED TO	2	42.00	1	1564.	3132.	4692	6260	7814.	9382.	10944	12512	15646
	(	108.78)	(	44.30)(	88.68)(	132.85)(	177.25)(	221.28)(	265.66)(	309.89)(	354.29)(	443.04)
ROUTED TO	3	42.00	1	1566.	3130.	4701.	6275	7843.	9371.	10910	12491	15673
	(	108.78)	(	44.34)(	88.64)(	133.10)(	177.68)(	222.08)(	265.37)(	308.93)(	353.71)(	443.81)
ROUTED TO	4	42.00	1	1562	3135.	4704	6257.	7804	9383	10953	12518	15638
	(	108.78)	(	44.23)(	88.78)(	133.21)(	177.17)(	220.98)(	265.70)(	310.16)(	354.46)(	442.83)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	11.07	11.07	14.50
STORAGE	904.	904.	1468.
OUTFLOW	27.	27.	6775.

RATIO OF PMF	MAXIMUM RESERVOIR W.S ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	12.33	0.00	1060.	1564.	0.00	30.00	0.00
0.20	13.12	0.00	1187.	3132.	0.00	30.00	0.00
0.30	13.75	0.00	1306.	4692.	0.00	30.00	0.00
0.40	14.32	0.00	1428.	6260.	0.00	30.00	0.00
0.50	14.85	0.35	1554.	7814.	10.00	30.00	0.00
0.60	15.34	0.84	1681.	9382.	17.00	30.00	0.00
0.70	15.79	1.29	1810.	10944.	23.00	30.00	0.00
0.80	16.20	1.70	1936.	12512.	28.00	30.00	0.00
1.00	16.93	2.43	2181.	15646.	35.00	30.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.10	1566.	13.8	30.00
0.20	3130.	15.6	29.00
0.30	4701.	16.2	29.00
0.40	6275.	16.5	30.00
0.50	7843.	16.8	30.00
0.60	9371.	17.1	30.00
0.70	10910.	17.3	29.00
0.80	12491.	17.4	30.00
1.00	15673.	17.8	30.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.10	1562.	5.2	30.00
0.20	3135.	6.8	30.00
0.30	4704.	7.9	30.00
0.40	6257.	8.9	30.00
0.50	7804.	9.7	30.00
0.60	9383.	10.5	30.00
0.70	10953.	11.2	30.00
0.80	12518.	11.8	30.00
1.00	15638.	12.8	30.00

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*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
*********************************
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Comment: Analysis assumes spillway weir submerged as a result of high tailwater

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A1      SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES FOR
A2      JOHNSONS POND DAM
A3      NDI-I.D  MD11   COMM.NO. 580-21-1D
B      150       1       0       0       0       0       0       0      -4       0
B1       5
J        1       9       1
J1     0.1     0.2     0.3     0.4     0.5     0.6     0.7     0.8     1.0
K        0       1                       0       0       1       0
K1      CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
M        1       1      42              42       0                       1
P        0      25      99     108     118
T                                                        1    0.05
W     13.6    0.35
X     -1.5   -0.05     2.0
K        1       2
K1      ROUTED FLOWS THROUGH JOHNSONS POND DAM.
Y                                1       1
Y1       1                                          -11.07      -1
Y4    10.6   10.81    11.0   11.07    12.0    13.0    14.0    15.0    16.0    17.0
Y4    18.0
Y5       0    7.74    21.8      27     200     700    1200    2000    4000    7400
Y5   11700
$A       0     104     550
$E   -15.0   11.07      20
$$   11.07
$D    14.5    2.63     1.5      10
$L      80     185     309     452     605     800
$V    15.5      16      17      18      19      20
K        1       3
K1      ROUTED FLOW MOD PULS REACH1
Y                                1       1
Y1       1
Y2   11.53   16.89   28.28   40.84    55.7      64     158
Y3      54     191     420     701    1027    1200   27541
Y4     3.5     4.0     4.5     5.0     7.0     9.0    11.0   12.20    14.0    15.0
Y4    16.0    17.0    19.0
Y5       0      54     150     191     420     701    1027    1242    1600    1821
Y5    3995    8528   27541
K        1       4
K1      FLOOD ROUTING MOD PULS REACH 2
Y                                1       1
Y1       1
Y6     0.1    0.02     0.1     2.1    19.0    2100   0.001
Y7       0      19     100      10     275     4.5     275     2.1     375     2.1
Y7     375     4.5     675      10    2200      19
K       99
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
**********************************
                         SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM OVERTOPPING ANALYSES FOR
                         JOHNSONS POND DAM
                         NDI-I D  MD11    COMM NO. 580-21-1D

                                    JOB SPECIFICATION
           NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
          150       1       0       0       0       0       0       0      -4       0
                                 JOPER     NWT   LROPT   TRACE
                                     5       0       0       0

                              MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 9 LRTIO= 1
           RTIOS=   0.10   0.20   0.30   0.40   0.50   0.60   0.70   0.80   1.00


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

                                   SUB-AREA RUNOFF COMPUTATION

                 CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
                      ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                          1       0       0       0       0       0       1       0       0

                                        HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              1       1   42.00    0.00   42.00    0.00   0.000       0       1       0

                                          PRECIP DATA
                      SPFE     PMS      R6     R12     R24     R48     R72     R96
                      0.00   25.00   99.00  108.00  118.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.845

                                          LOSS DATA
        LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.05    0.00    0.00

                                      UNIT HYDROGRAPH DATA
                                  TP= 13.60     CP=0.35     NTA=  0

                                         RECESSION DATA
                           STRTQ=    -1.50    QRCSN=    -0.05    RTIOR= 2.00

             UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=  13.56 HOURS, CP= 0.35  VOL= 0.95
          12.       46.       96.      156.      224.      299.      379.      459.      532.      595.
         646.      686.      711.      717.      702.      679.      657.      635.      615.      595.
         575.      557.      538.      521.      504.      487.      472.      456.      441.      427.
         413.      400.      387.      374.      362.      350       339.      328.      317.      307.
         297.      287.      277.      268.      260.      251.      243.      235.      227.      220.
         213.      206.      199       193.      186.      180.      174.      169.      163.      158.
         153.      148.      143.      138.      134.      129.      125.      121.      117       113.
         110.      106.      103.       99        96        93.       90.       87        84.       81
          79.       76        74        71.       69        67.       65.       62.       60.       58.
          57        55.       53.       51        50.       48.       46        45.       43        42
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    0                                        END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
                                                                         SUM   24.92  23.05   1.88  605328.
                                                                             ( 633.)( 585.)(  48.)(17140.97)


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

                                          HYDROGRAPH ROUTING

                      ROUTED FLOWS THROUGH JOHNSONS POND DAM.
                               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                   2       1       0       0       0       0       0       0       0
                                                    ROUTING DATA
                       QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                         0.0   0.000    0.00       1       1       0       0               0

                               NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                   1       0       0   0.000   0.000   0.000    -11.      -1

 STAGE        10.60      10.81      11.00      11.07      12.00      13.00      14.00      15.00      16.00      17.00
              18.00

  FLOW         0.00       7.74      21.80      27.00     200.00     700.00    1200.00    2000.00    4000.00    7400.00
           11700.00

SURFACE AREA=       0.       104.       550.

    CAPACITY=       0.       904.      3562.

   ELEVATION=     -15.        11.        20.

                            CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                            11.1     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                     DAM DATA
                                          TOPEL    COQD    EXPD  DAMWID
                                           14.5     2.6     1.5     10.

   CREST LENGTH       80.        185.       309.       452.       605.       800.
   AT OR BELOW
   ELEVATION          15.5       16.0       17.0       18.0       19.0       20.0

PEAK OUTFLOW IS      1422.  AT TIME   33.00 HOURS

PEAK OUTFLOW IS      3049.  AT TIME   31.00 HOURS

PEAK OUTFLOW IS      4680.  AT TIME   30.00 HOURS

PEAK OUTFLOW IS      6257.  AT TIME   30.00 HOURS

PEAK OUTFLOW IS      7824.  AT TIME   30.00 HOURS

PEAK OUTFLOW IS      9404.  AT TIME   30.00 HOURS

PEAK OUTFLOW IS     10972.  AT TIME   30.00 HOURS
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PEAK OUTFLOW IS    12540.  AT TIME  30.00 HOURS

PEAK OUTFLOW IS    15676.  AT TIME  30.00 HOURS


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

                                          HYDROGRAPH ROUTING

                      ROUTED FLOW MOD PULS REACH1
                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  3       1       0       0       0       0       0       0       0
                                                    ROUTING DATA
                       QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                         0.0   0.000    0.00       1       1       0       0               0

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

  STORAGE      11.53      16.89      28.28      40.84      55.70      64.00     158.00

  OUTFLOW      54.00     191.00     420.00     701.00    1027.00    1200.00   27541.00

    STAGE       3.50       4.00       4.50       5.00       7.00       9.00      11.00      12.20      14.00      15.00
               16.00      17.00      19.00

     FLOW       0.00      54.00     150.00     191.00     420.00     701.00    1027.00    1242.00    1600.00    1821.00
             3995.00    8528.00   27541.00

MAXIMUM STAGE IS      13.1

MAXIMUM STAGE IS      15.6

MAXIMUM STAGE IS      16.1

MAXIMUM STAGE IS      16.5

MAXIMUM STAGE IS      16.8

MAXIMUM STAGE IS      17.1

MAXIMUM STAGE IS      17.3

MAXIMUM STAGE IS      17.4

MAXIMUM STAGE IS      17.8


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

                                          HYDROGRAPH ROUTING

                      FLOOD ROUTING MOD PULS REACH 2
                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  4       1       0       0       0       0       0       0       0
                                                    ROUTING DATA
                       QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                         0.0   0.000    0.00       1       1       0       0               0
```

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.1000	0.0200	0.1000	2.1	19.0	2100.	0.00100

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

```
  0.00   19.00  100.00   10.00  275.00    4.50  275.00    2.10  375.00    2.10
375.00    4.50  675.00   10.00 2200.00   19.00
```

STORAGE	0.00	4.29	8.58	13.01	19.94	30.17	43.68	60.50	80.60	104.03
	132.94	168.74	211.43	261.00	317.47	380.81	451.05	528.17	612.18	703.07
OUTFLOW	0.00	191.55	601.14	1172.60	1912.32	2832.95	3948.21	5270.71	6812.52	8569.54
	10512.58	12801.46	15449.20	18479.71	21919.26	25794.32	30130.96	34954.61	40290.08	46161.58
STAGE	2.10	2.99	3.88	4.77	5.66	6.55	7.44	8.33	9.22	10.11
	10.99	11.88	12.77	13.66	14.55	15.44	16.33	17.22	18.11	19.00
FLOW	0.00	191.55	601.14	1172.60	1912.32	2832.95	3948.21	5270.71	6812.52	8569.54
	10512.58	12801.46	15449.20	18479.71	21919.26	25794.32	30130.96	34954.61	40290.08	46161.58

MAXIMUM STAGE IS 5.1

MAXIMUM STAGE IS 6.7

MAXIMUM STAGE IS 7.9

MAXIMUM STAGE IS 8.9

MAXIMUM STAGE IS 9.7

MAXIMUM STAGE IS 10.5

MAXIMUM STAGE IS 11.2

MAXIMUM STAGE IS 11.8

MAXIMUM STAGE IS 12.8

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

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.10	RATIO 2 0.20	RATIO 3 0.30	RATIO 4 0.40	RATIO 5 0.50	RATIO 6 0.60	RATIO 7 0.70	RATIO 8 0.80	RATIO 9 1.00
HYDROGRAPH AT	1 (	42.00 108.78)	1 (	1577. 44.67)(	3155. 89.34)(	4732. 134.00)(	6310. 178.67)(	7887 223.34)(	9465. 268.01)(	11042. 312.68)(	12620. 357.35)(	15774. 446.68)
ROUTED TO	2 (	42.00 108.78)	1 (	1422. 40.25)(	3049. 86.33)(	4680. 132.53)(	6257. 177.19)(	7824. 221.54)(	9404. 266.28)(	10972. 310.69)(	12540. 355.09)(	15676. 443.89)
ROUTED TO	3 (	42.00 108.78)	1 (	1427. 40.40)(	3077. 87.12)(	4675. 132.37)(	6295. 178.27)(	7821. 221.47)(	9414. 266.57)(	10972. 310.68)(	12573. 356.03)(	15693. 444.39)
ROUTED TO	4 (	42.00 108.78)	1 (	1423. 40.31)(	3046. 86.25)(	4687. 132.73)(	6244. 176.80)(	7826. 221.61)(	9419. 266.72)(	10981. 310.95)(	12542. 355.14)(	15685. 444.15)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	11.07	11.07	14.50
STORAGE	904.	904.	1468
OUTFLOW	27.	27.	1600

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.10	14.28	0.00	1417.	1422.	0.00	33.00	0.00
0.20	15.52	1.02	1732.	3049.	30.00	31.00	0.00
0.30	16.14	1.64	1916.	4680.	44.00	30.00	0.00
0.40	16.52	2.02	2038.	6257.	54.00	30.00	0.00
0.50	16.87	2.37	2158.	7824.	62.00	30.00	0.00
0.60	17.17	2.67	2267.	9404.	67.00	30.00	0.00
0.70	17.43	2.93	2366.	10972.	73.00	30.00	0.00
0.80	17.68	3.18	2464.	12540.	77.00	30.00	0.00
1.00	18.15	3.65	2660.	15676.	85.00	30.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.10	1427.	13.1	34.00
0.20	3077.	15.6	31.00
0.30	4675.	16.1	31.00
0.40	6295.	16.5	30.00
0.50	7821.	16.8	30.00
0.60	9414.	17.1	29.00
0.70	10972.	17.3	30.00
0.80	12573.	17.4	30.00
1.00	15693.	17.8	30.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.10	1423.	5.1	33.00
0.20	3046.	6.7	32.00
0.30	4687.	7.9	30.00
0.40	6244.	8.9	30.00
0.50	7826.	9.7	30.00
0.60	9419.	10.5	30.00
0.70	10981.	11.2	30.00
0.80	12542.	11.8	30.00
1.00	15685.	12.8	30.00

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
*********************************
A1       SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM FAILURE ANALYSES FOR
A2       JOHNSONS POND DAM
A3       NDI-I.D. MD11   COMM. NO. 580-21-1D
B     150       1       0       0       0       0       0       0      -4       0
B1      5
J       2       1       1
J1    0.5
K       0       1                       0       0       1       0
K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
M       1       1      42              42       0                       1
P       0      25      99     108     118
T                                                       1    0.05
W    13.6    0.35
X    -1.5   -0.05     2.0
K       1       2
K1       ROUTED FLOWS THROUGH JOHNSONS POND DAM
Y                               1       1
Y1      1                                          -11.07      -1
Y4   10.6   10.81    11.0   11.07    12.0    13.0    14.0    15.0    16.0
Y5      0    7.74    21.8      27     949    2837    5306    8243   11581
$A      0     104     550
$E  -15.0   11.07      20
$$  11.07
$D   14.5    2.63     1.5      10
$L     80     185     309     452     605     800
$V   15.5      16      17      18      19      20
$B     20       1       5     1.0   11.07    14.5
$B     40       1       5     1.0   11.07    14.5
K       1       3
K1       ROUTED FLOW MOD PULS REACH1
Y                               1       1
Y1      1
Y6    0.1    0.02     0.1     2.1    19.0    2800   0.001
Y7      0      19     100      10     275     4.5     275     2.1     375     2.1
Y7    375     4.5     675      10    2200      19
K      99
```

Comment: Analysis assumes Isabella Street bridge fails prior to failure of Johnson's Pond Dam. Routing reach extends from Station 2 to Station 4.

```
*******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
*******************************
                          SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM FAILURE ANALYSES FOR
                          JOHNSONS POND DAM
                          NDI-I.D. MD11    COMM.NO. 580-21-1D

                                        JOB SPECIFICATION
            NQ       NHR      NMIN      IDAY       IHR      IMIN     METRC      IPLT      IPRT     NSTAN
           150         1         0         0         0         0         0         0        -4         0
                                        JOPER       NWT     LROPT     TRACE
                                            5         0         0         0

                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                       NPLAN= 2 NRTIO= 1 LRTIO= 1

            RTIOS=    0.50

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

                                         SUB-AREA RUNOFF COMPUTATION

            CALCULATION OF SNYDER INFLOW HYDROGRAPH TO JOHNSONS POND DAM
                         ISTAG     ICOMP     IECON     ITAPE      JPLT      JPRT     INAME    ISTAGE     IAUTO
                             1         0         0         0         0         0         1         0         0

                                          HYDROGRAPH DATA
            IHYDG      IUHG     TAREA      SNAP     TRSDA     TRSPC     RATIO     ISNOW     ISAME     LOCAL
                1         1     42.00      0.00     42.00      0.00     0.000         0         1         0

                                             PRECIP DATA
                     SPFE       PMS        R6       R12       R24       R48       R72       R96
                     0.00     25.00     99.00    108.00    118.00      0.00      0.00      0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.845

                                                LOSS DATA
           LROPT     STRKR     DLTKR     RTIOL     ERAIN     STRKS     RTIOK     STRTL     CNSTL     ALSMX     RTIMP
               0      0.00      0.00      1.00      0.00      0.00      1.00      1.00      0.05      0.00      0.00

                                          UNIT HYDROGRAPH DATA
                                    TP= 13.60      CP=0.35      NTA=  0

                                             RECESSION DATA
                          STRTQ=    -1.50      QRCSN=    -0.05      RTIOR= 2.00

        UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=  13.56 HOURS, CP= 0.35  VOL= 0.95
```

12.	46.	96.	156.	224.	299.	379.	459.	532.	595.
646.	686.	711.	717.	702.	679.	657.	635.	615.	595.
575.	557.	538.	521.	504.	487.	472.	456.	441.	427.
413.	400.	387.	374.	362.	350.	339.	328.	317.	307.
297.	287.	277.	268.	260.	251.	243.	235.	227.	220.
213.	206.	199.	193.	186.	180.	174.	169.	163.	158.
153.	148.	143.	138.	134.	129.	125.	121.	117.	113.
110.	106.	103.	99.	96.	93.	90.	87.	84.	81.
79.	76.	74.	71.	69.	67.	65.	62.	60.	58.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

```
                                          END-OF-PERIOD FLOW
      0
   MU DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                          SUM  24.92  23.05   1.88   605328.
                                                                             ( 633.)( 585.)(  48.)(17140.97)


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

                                               HYDROGRAPH ROUTING

                         ROUTED FLOWS THROUGH JOHNSONS POND DAM.
                                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                    2       1       0       0       0       0       0       0       0

                                              ALL PLANS HAVE SAME
                                                  ROUTING DATA
                         QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                           0.0   0.000    0.00       1       1       0       0               0

                                NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                    1       0       0   0.000   0.000   0.000    -11.      -1

 STAGE       10.60       10.81       11.00       11.07       12.00       13.00       14.00       15.00       16.00

  FLOW        0.00        7.74       21.80       27.00      949.00     2837.00     5306.00     8243.00    11581.00

SURFACE AREA=        0.       104.       550.

    CAPACITY=        0.       904.      3562.

   ELEVATION=      -15.        11.        20.

                              CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                              11.1     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                        DAM DATA
                                              TOPEL    COQD    EXPD  DAMWID
                                               14.5     2.6     1.5     10.

   CREST LENGTH       80.      185       309.       452.       605.       800.
   AT OR BELOW
   ELEVATION         15.5      16.0       17.0       18.0       19.0       20.0

                                                     DAM BREACH DATA
                                     BRWID        Z     ELBM   TFAIL     WSEL  FAILEL
                                       20.     1.00     5.00    1.00    11.07   14.50

BEGIN DAM FAILURE AT 26.00 HOURS

PEAK OUTFLOW IS     9101.  AT TIME  27.00 HOURS

                                                     DAM BREACH DATA
                                     BRWID        Z     ELBM   TFAIL     WSEL  FAILEL
                                        40     1.00     5.00    1.00    11.07   14.50

BEGIN DAM FAILURE AT 26.00 HOURS
```

```
'EAK OUTFLOW IS    10358. AT TIME  27.00 HOURS

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

                                  HYDROGRAPH ROUTING

                ROUTED FLOW MOD PULS REACH1
                          ISTAG   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                              3       1       0       0       0       0       0       0       0

                                         ALL PLANS HAVE SAME
                                            ROUTING DATA
                  QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP                   LSTR
                    0.0   0.000    0.00       1       1       0       0                      0

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

NORMAL DEPTH CHANNEL ROUTING
----------------------------

         QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
        0.1000  0.0200  0.1000     2.1    19.0   2800.  0.00100

         CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
            0.00   19.00  100.00   10.00  275.00    4.50  275.00    2.10  375.00    2.10
          375.00    4.50  675.00   10.00 2200.00   19.00

  STORAGE       0.00       5.72      11.43      17.35      26.59      40.22      58.25      80.66     107.47     138.70
              177.25     224.99     281.91     348.01     423.29     507.75     601.40     704.23     816.24     937.43

  OUTFLOW       0.00     191.55     601.14    1172.60    1912.32    2832.95    3948.21    5270.71    6812.52    8569.54
            10512.58   12801.46   15449.20   18479.71   21919.26   25794.32   30130.96   34954.61   40290.08   46161.58

    STAGE       2.10       2.99       3.88       4.77       5.66       6.55       7.44       8.33       9.22      10.11
               10.99      11.88      12.77      13.66      14.55      15.44      16.33      17.22      18.11      19.00

     FLOW       0.00     191.55     601.14    1172.60    1912.32    2832.95    3948.21    5270.71    6812.52    8569.54
            10512.58   12801.46   15449.20   18479.71   21919.26   25794.32   30130.96   34954.61   40290.08   46161.58

MAXIMUM STAGE IS      10.2

MAXIMUM STAGE IS      10.5

        **********      **********      **********      **********      **********
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 0.50
HYDROGRAPH AT	1	42.00	1	7887
		(108.78)		(223 34)(
			2	7887
				(223.34)(
ROUTED TO	2	42.00	1	9101.
		(108.78)		(257.71)(
			2	10358.
				(293.30)(
ROUTED TO	4	42.00	1	8687.
		(108.78)		(245 99)(
			2	9440
				(267.32)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	11.07	11.07	14 50
STORAGE	904	904	1468
OUTFLOW	27.	27	6775

RATIO OF PMF	MAXIMUM RESERVOIR W S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	14 56	0.06	1483	9101	1 88	27 00	26.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	11.07	11 07	14 50
STORAGE	904	904	1468
OUTFLOW	27	27	6775

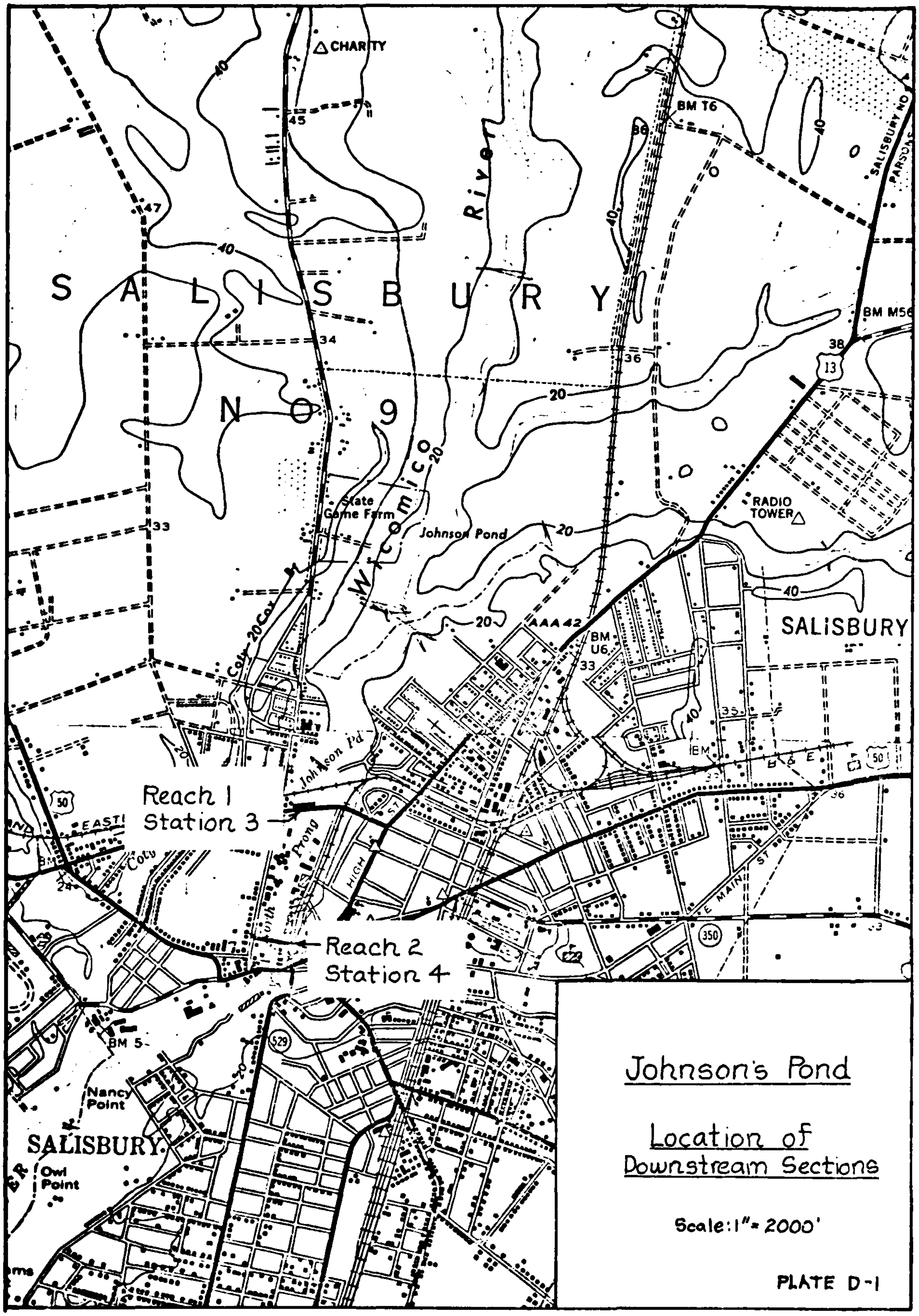
RATIO OF PMF	MAXIMUM RESERVOIR W. S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	14.55	0.05	1480.	10358	1 70	27 00	26 00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	8687.	10.2	28.00

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	9440.	10.5	28.00



Johnson's Pond

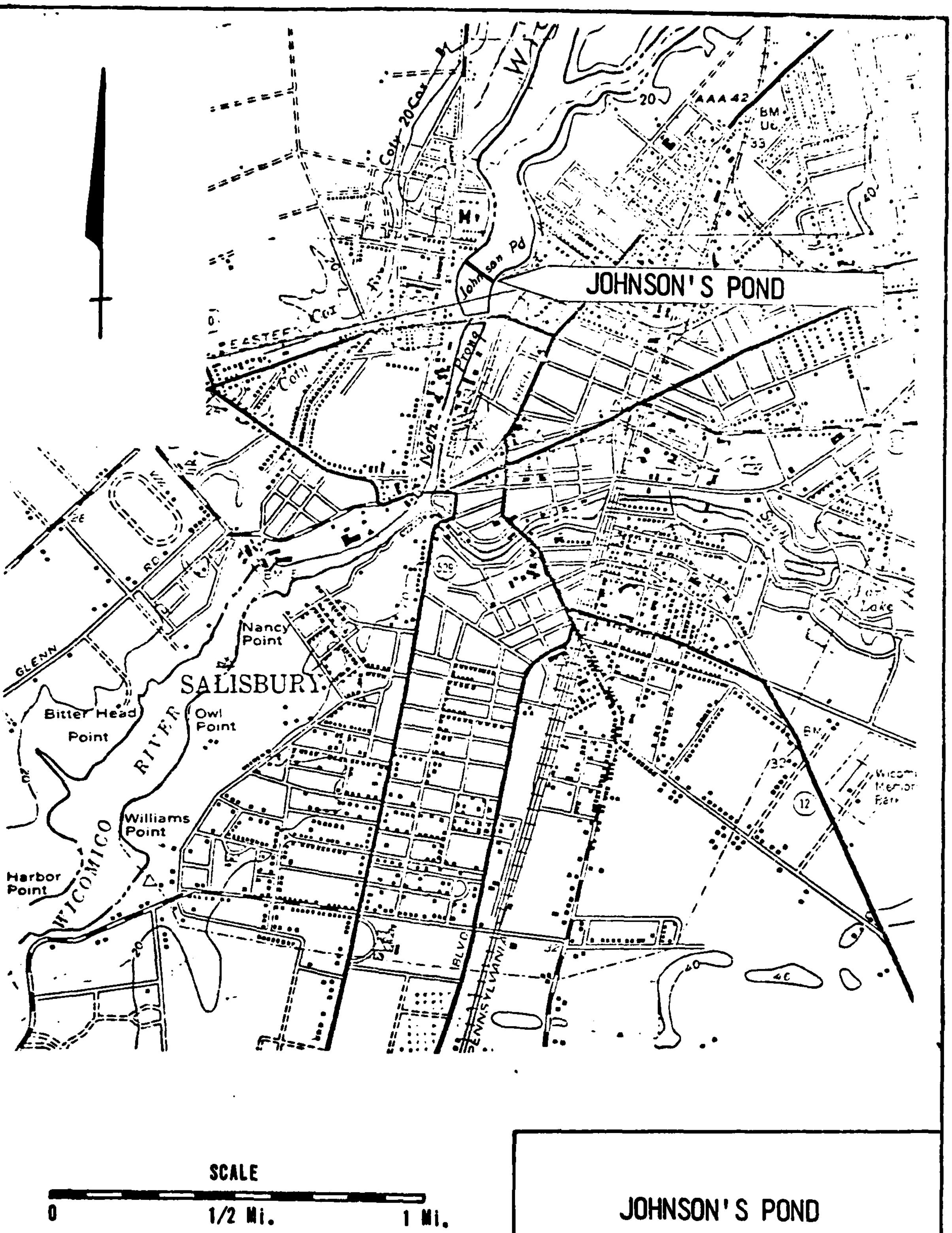
Location of Downstream Sections

Scale: 1" = 2000'

PLATE D-1

APPENDIX E

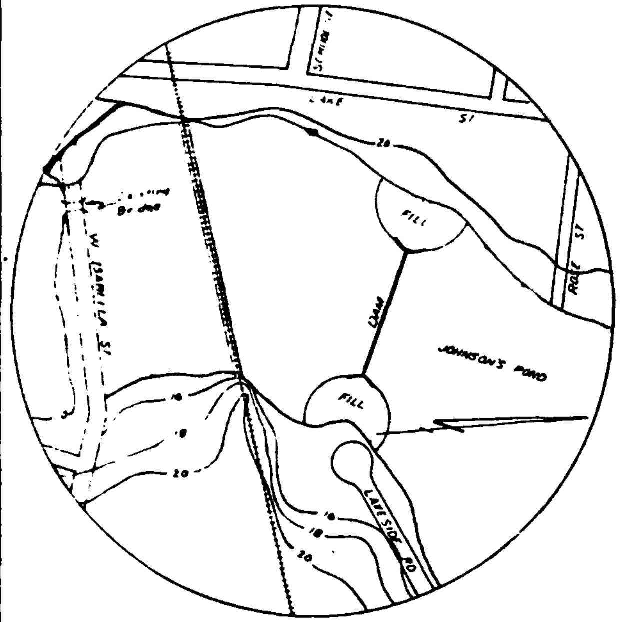
PLATES



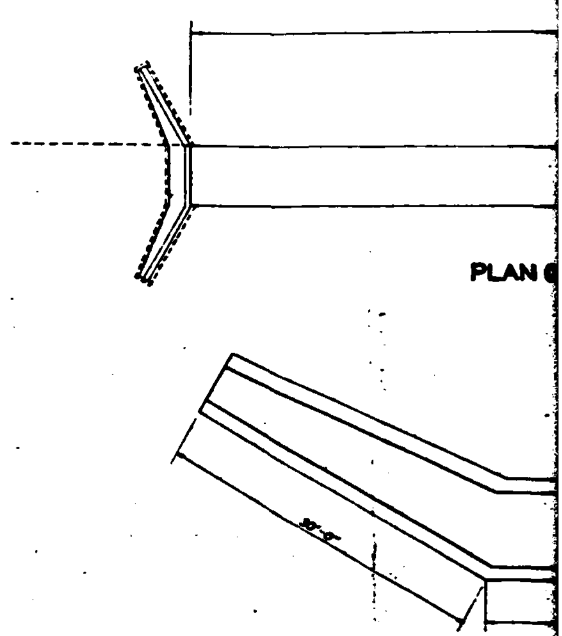
JOHNSON'S POND

LOCATION MAP

PLATE E-1

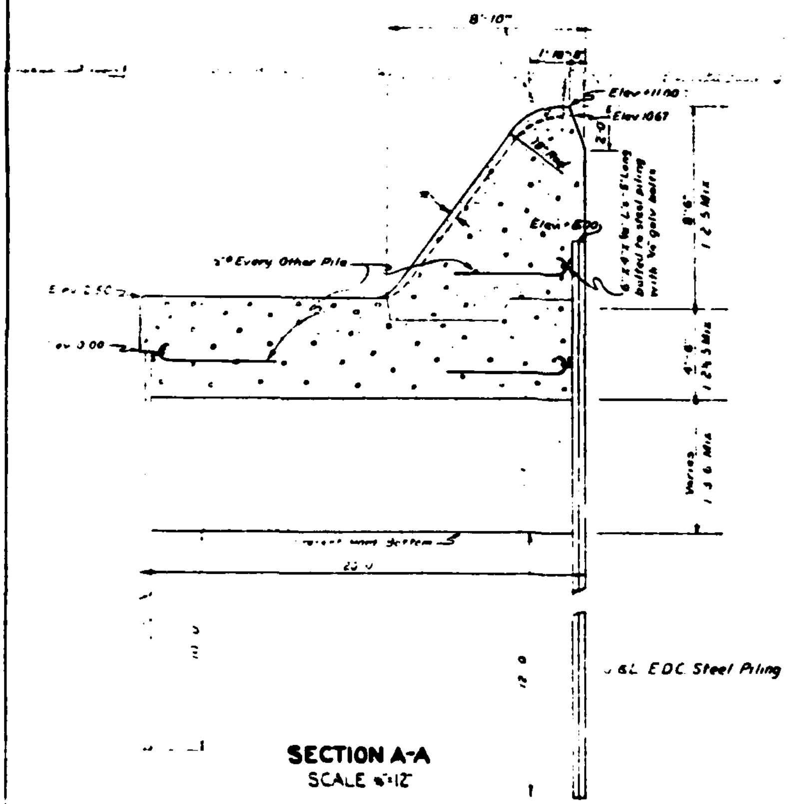


PLOT PLAN
SCALE 1" = 200'

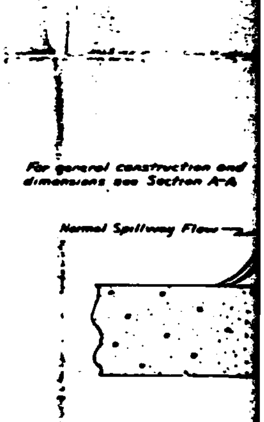


PLAN O

PLAN O
SC



SECTION A-A
SCALE ¼"=1'



SECTION TI
SCA

PROJECT SPONSOR'S PROPOSAL NO 2

MAYOR & COUNCIL SALISBURY, MD.	APPROVED: January 10, 1936 CITY ENGINEER	Revised August 1, 1936	PROPO

1

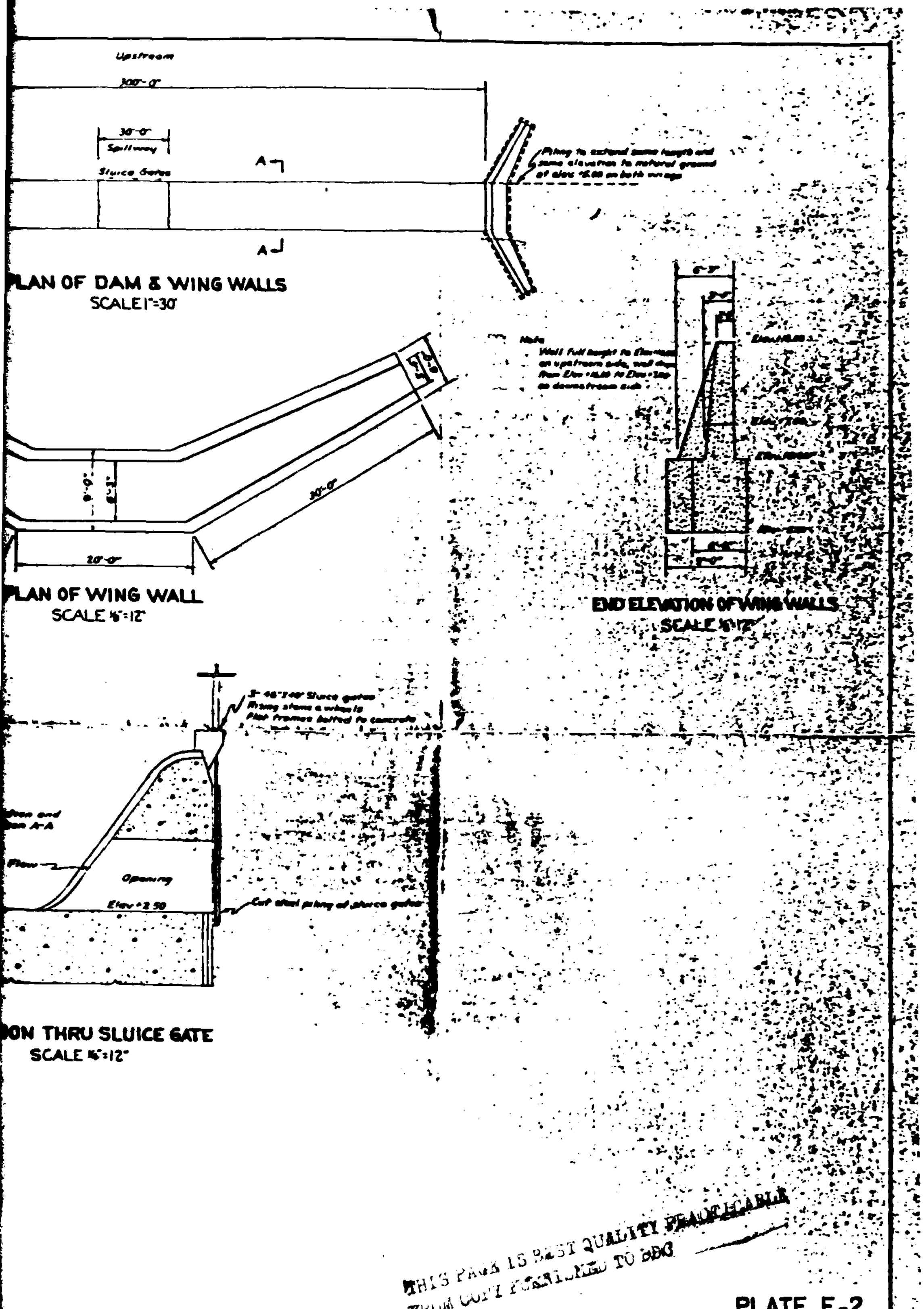
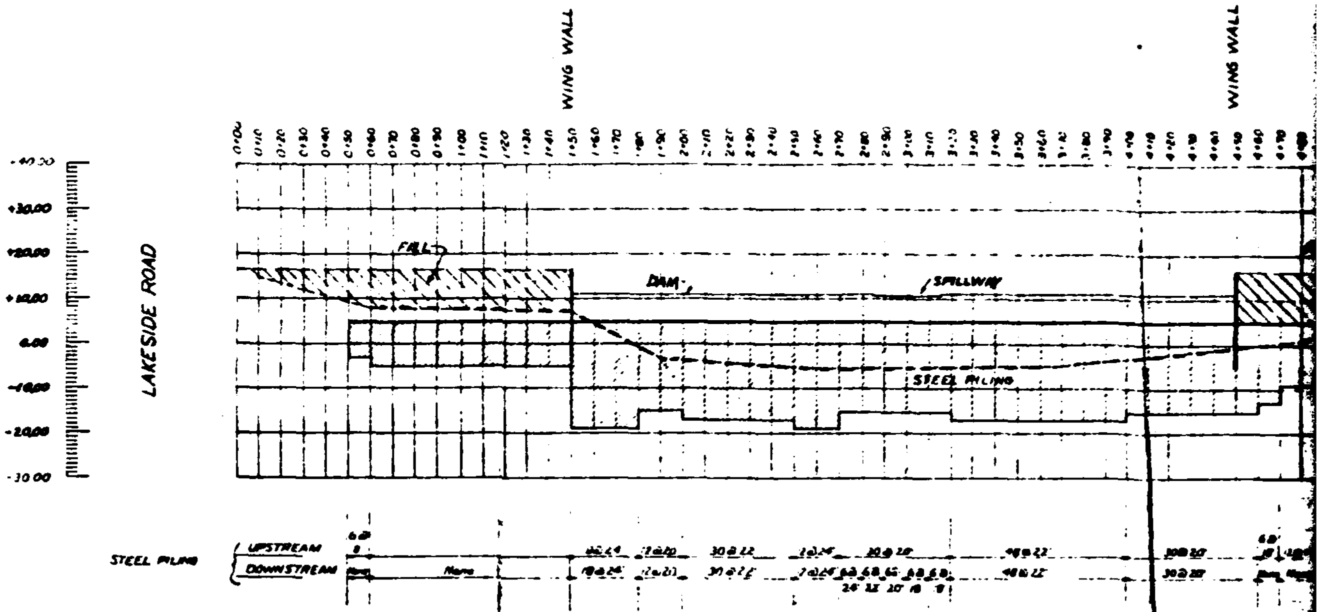
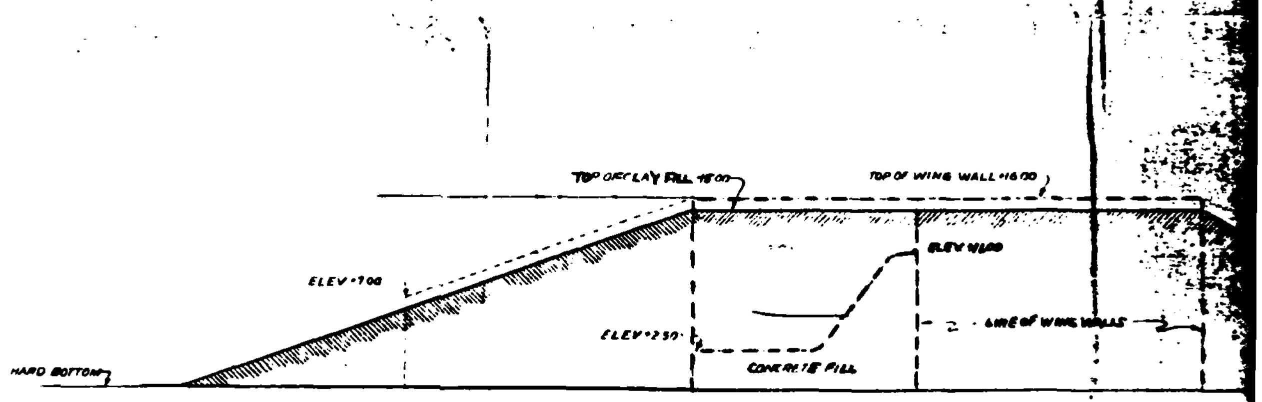


PLATE E-2

OPOSED STEEL & CONCRETE DAM AT JOHNSON'S POND	SHEET NO. 1 OF 2	SCALE AS SHOWN	1-4 B-36-21 Q



PROFILE OF DAM STANDING ABOVE DAM & LOOKING DOWNSTREAM
VERTICAL SCALE 1" = 20.0'
HORIZONTAL SCALE ¼" = 10.0'



CROSS SECTION OF FILL AT WING WALL
SCALE ⅛" = 1'2"

W P A PROJECT SPONSOR'S PROPOSAL NO 2

MAYOR & COUNCIL SALISBURY, MD.	APPROVED: January 10, 1936 CITY ENGINEER	Revised August 1, 1936	PROF

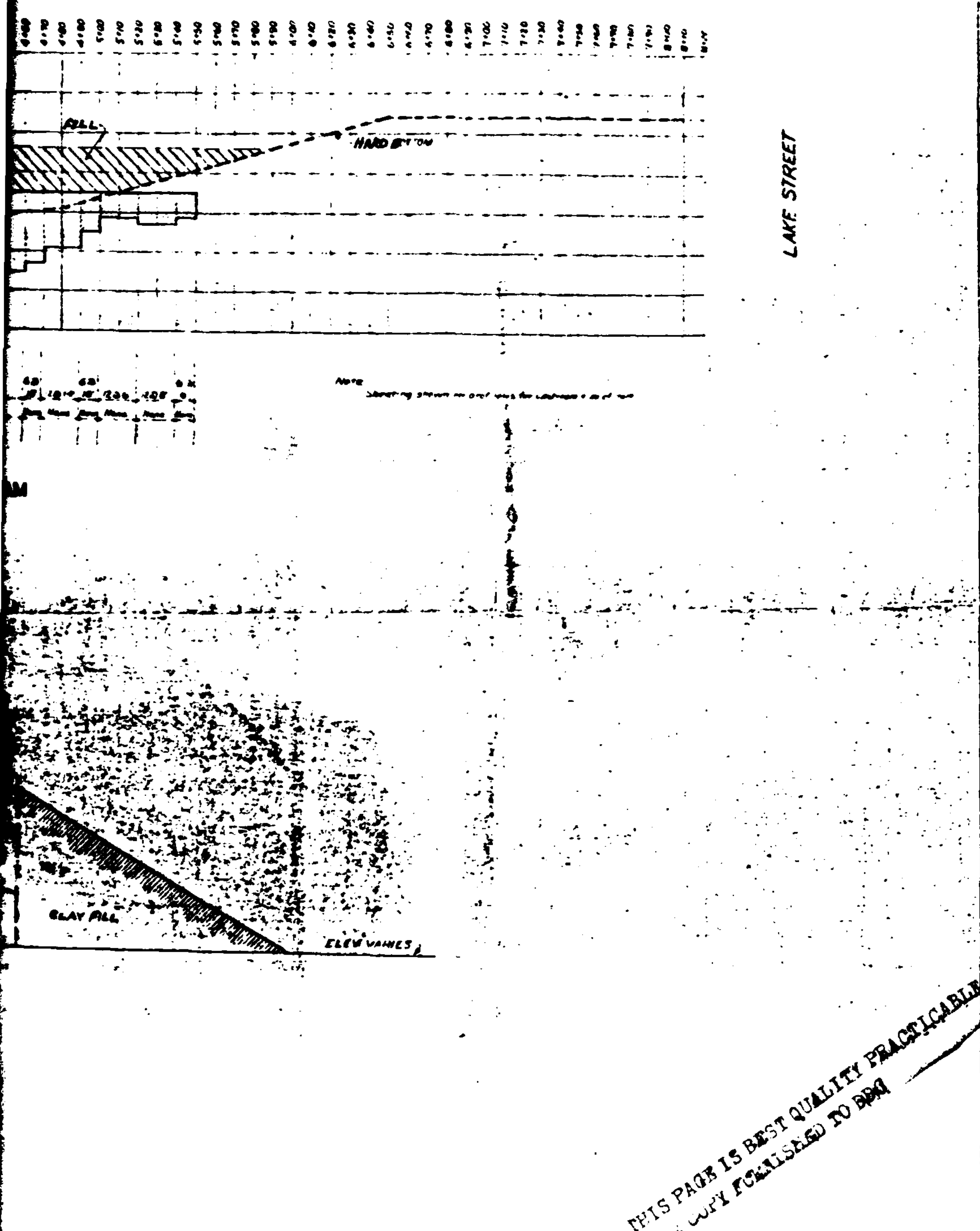


PLATE E-3

OPOSED STEEL & CONCRETE DAM AT JOHNSON'S POND	SHEET NO.2 OF.2	SCALE AS SHOWN	1-4 B-36-21 Q

APPENDIX F

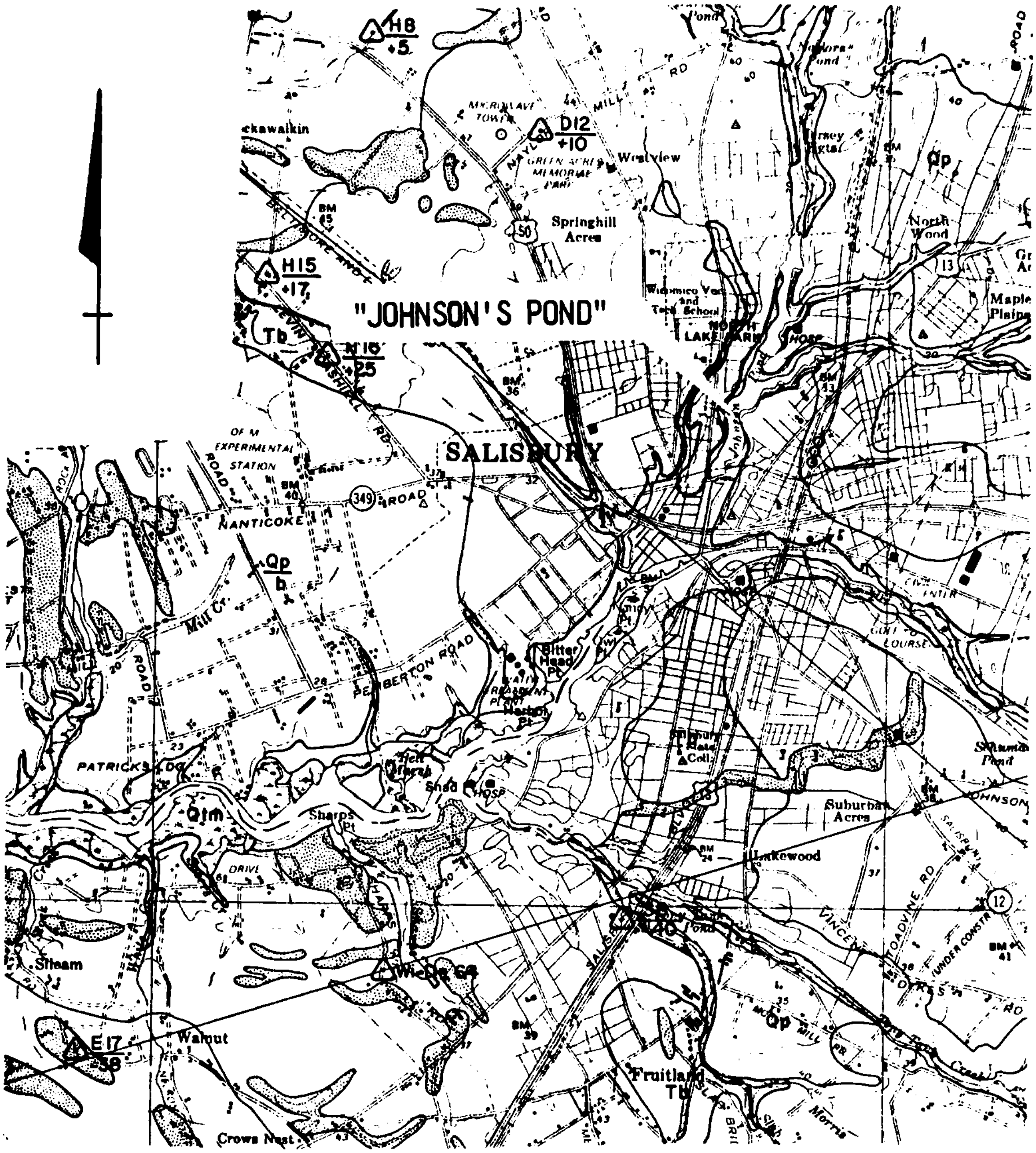
GEOLOGY

JOHNSON'S POND

APPENDIX F

REGIONAL GEOLOGY

The Johnson's Pond dam is situated on the sediments of the Pliocene Beaverdam Sand and the Pleistocene Parsonsburg Sand, which include sand and silty sand which is locally interbedded with gravelly sand and clayey silt. These sediments of the Coastal Plain Provience lie unconformably on the Upper Miocene deposits of the Yorktown Cohansey and the Pensaulken Formations. The Parsonsburg Sand is a relatively thin deposit in the area, rarely exceeding a depth of 10 feet. The thickness of the Beaverdam Sand is approximatley 30 feet, and the deposits generally thicken to the northwest and to the southeast.



SCALE

0 1 Mi. 2 Mi.

JOHNSON'S POND

GEOLOGY MAP

RUMMEL, KLEPPER & KAHL

REFERENCE:

GEOLOGIC MAP OF WICOMICO COUNTY,
PREPARED BY STATE OF MARYLAND,
MARYLAND GEOLOGICAL SURVEY,
DATED 1979.

Tw

WALSTON SILT (UPPER(?) AND MIDDLE(?) PLIOCENE) - Clay and silt, interstratified with poorly sorted clayey sand. Orange, brown, or mottled red and white in upper weathered part of Formation, grading to greenish gray and dark gray in unweathered lower part of Formation. Most of the formation is deeply weathered, hence brightly colored. Locally, thin, light-colored, horizontally stratified, burrowed sand overlies the clay-silt beds and may be part of the Formation. The Walston Silt underlies the highlands (elevations as much as 24 m or 80 ft) in the central and eastern parts of the County. Despite the rolling topography of this highland region, the Formation is for the most part poorly exposed. Extensive outcrops of this unit are found, however, in the road cuts just east of Powellville on Md. Route 350. Here, as much as 6.0 m (20 ft) or nearly half the total thickness of the Formation is exposed. At these locations the Formation consists of pale-gray massive clayey silt (typically 1.3 m or 4 ft thick) and white to pale-gray sequences of thinly bedded poorly sorted sand and clay (typically 3.0 m or 10 ft thick). The basal contact with the Beaverdam Sand is sharp but undulatory. Gravel, mostly weathered chert as much as 6 cm (2.5 in) in diameter, is found locally along this contact.

Tb

BEAVERDAM SAND (UPPER(?) AND MIDDLE(?) PLIOCENE) - Sand and silty sand locally interbedded with gravelly sand, clay-silt, and rare peaty sand or clay. Aquamarine, pale green or white where unweathered; orange or red brown where weathered.

REFERENCE:

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JOHNSON'S POND

GEOLOGY MAP LEGEND

RUMMEL, KLEPPER & KAHL

Qal	ALLUVIUM (HOLOCENE) - Largely sand, gravelly sand or clay. Narrow deposits fill most stream valleys, particularly in the eastern half of the County; generally thin and poorly exposed. The headward part of a typical valley is swampy and underlain by peaty sand or clay. Downstream, the alluvium is mainly sand or gravelly sand, depending upon the texture of the formation traversed by any given stream.
Qtm	TIDAL MARSH DEPOSITS (HOLOCENE) - Silty clay to fine sand, dark gray to gray-brown, largely muck. Woody debris and finely comminuted organic matter abundant.
Qp	PARSONSBURG SAND (UPPER WISCONSIN) - Mostly sand, loose and light colored; pale yellow, yellowish orange, pale red-brown, or white. Locally at base where peaty, the sands are dark gray-brown. Most of the sand is medium-grained, although coarse sand and sand containing granules is locally common. Sorting varies in vertical cuts from good to poor. In outcrop the upper few meters of the Formation are red-brown, slightly clayey, and appear to be extensively burrowed. The material is laced with numerous cylindrical burrows about 3 cm (1 in) in diameter and 5-15 cm (2-6 in) long. Below the massive reddened zone, thin bands of red-brown clayey sand are common in the thicker sections to a depth of as much as 3 m (10 ft). In some of the thickest sections, the lower part of the Parsonsburg Sand is well stratified with small scale cross beds. Concentrations of black minerals are common in the cross-bedded portion.
Qk	KENT ISLAND FORMATION (MIDDLE WISCONSIN OR UPPER SANGAMON) - Predominantly sand, white, yellow, brown, or pale to medium gray, interstratified with thin beds of dark-gray silt or silty fine-grained sand. Light-gray to white gravelly sands common at the base of the Formation. Underlies a broad lowland in the western part of the County between hilly topography of the Parsonsburg Sand along the east side of the Nanticoke River and a sandy terrain about 5 miles east of the river along a highly dissected northwest-trending scarp extending from Crows Nest on the southeast to Mardela Springs on the northwest. Most of the land surface here is at elevations ranging from 3.0-7.6 m (10 to 25 ft). Small dune-shaped sand bodies which rise above this general level are scattered across the lowland. North of Mardela Springs, a small area of lowland deposits flanks the east side of the lower Nanticoke River as far as the northern part of the County.

REFERENCE:

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JOHNSON'S POND

GEOLOGY MAP LEGEND

RUMMEL, KLEPPER & KAHL

LMED

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