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NATIONAL DAM INSPECTION PROGRAM. TOBYHANNA NUMBER 2 DAM (NDS ID--ETC(U)
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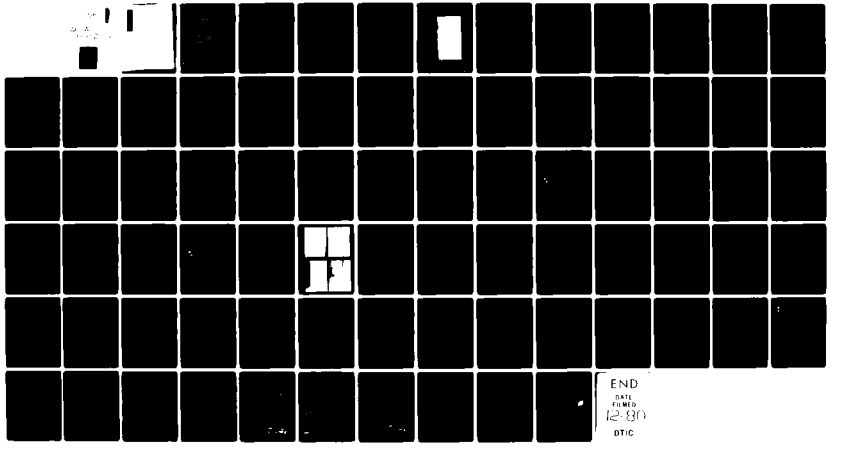

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DELAWARE RIVER BASIN
TOBYHANNA CREEK, MONROE COUNTY
PENNSYLVANIA

(1) National Dam Inspection Program

TOBYHANNA NO. 2 DAM

NDS ID No. PA-779
DER ID No. 45-36

~~COMMONWEALTH OF PENNSYLVANIA~~

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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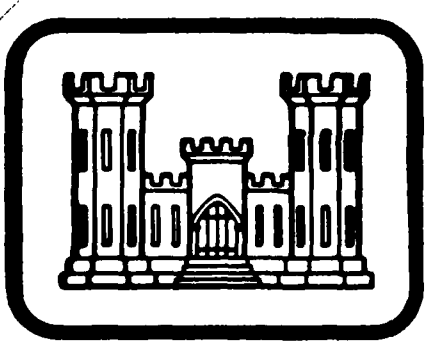


Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

(15) DACW31-80-C-0010

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

SEPTEMBER, 1980

711059

PREFACE

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

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

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

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

PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Tobyhanna Lake No. 2 Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Monroe
STREAM	Tobyhanna Creek
DATE OF INSPECTION	May 22, and July 30, 1980
COORDINATES	Lat: 41° 12.5' Long: 75° 24.5'

ASSESSMENT

The assessment of Tobyhanna Lake No. 2 Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance. The inspection and review of data of Tobyhanna Lake No. 2 Dam did not reveal any problems which would require emergency action. The dam and spillway appear to be in good condition and are adequately maintained.

Tobyahanna Lake No. 2 Dam is a high hazard-intermediate size dam. The spillway design flood (SDF) for a dam of this size and classification is the PMF. The spillway and reservoir are capable of controlling approximately 58% of the PMF. Based on criteria established by the Corps of Engineers, the spillway is termed inadequate.

The following recommendations and remedial measures should be instituted immediately.

1. The warning system or program for this dam should be located and kept on file at the park office and made readily accessible should an emergency situation arise requiring its need.

2. Replace missing riprap on the upstream slope adjacent to the right spillway approach wingwall. Riprap should be replaced on the upstream slope as required.

3. A regular safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

4. Due to past settlement in the area (Section 2.2) immediately adjacent to the concrete gravity spillway structure, particular attention should be given to continued monitoring of conditions in the area. In addition, the cracks in the spillway walls should be monitored on a regular basis.

5. Low areas on the embankment crest should be filled to the design elevation. The work should be completed and conform to current engineering practice.

TOBYHANNA LAKE NO. 2 DAM
PA 779

SUBMITTED BY:

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

Date

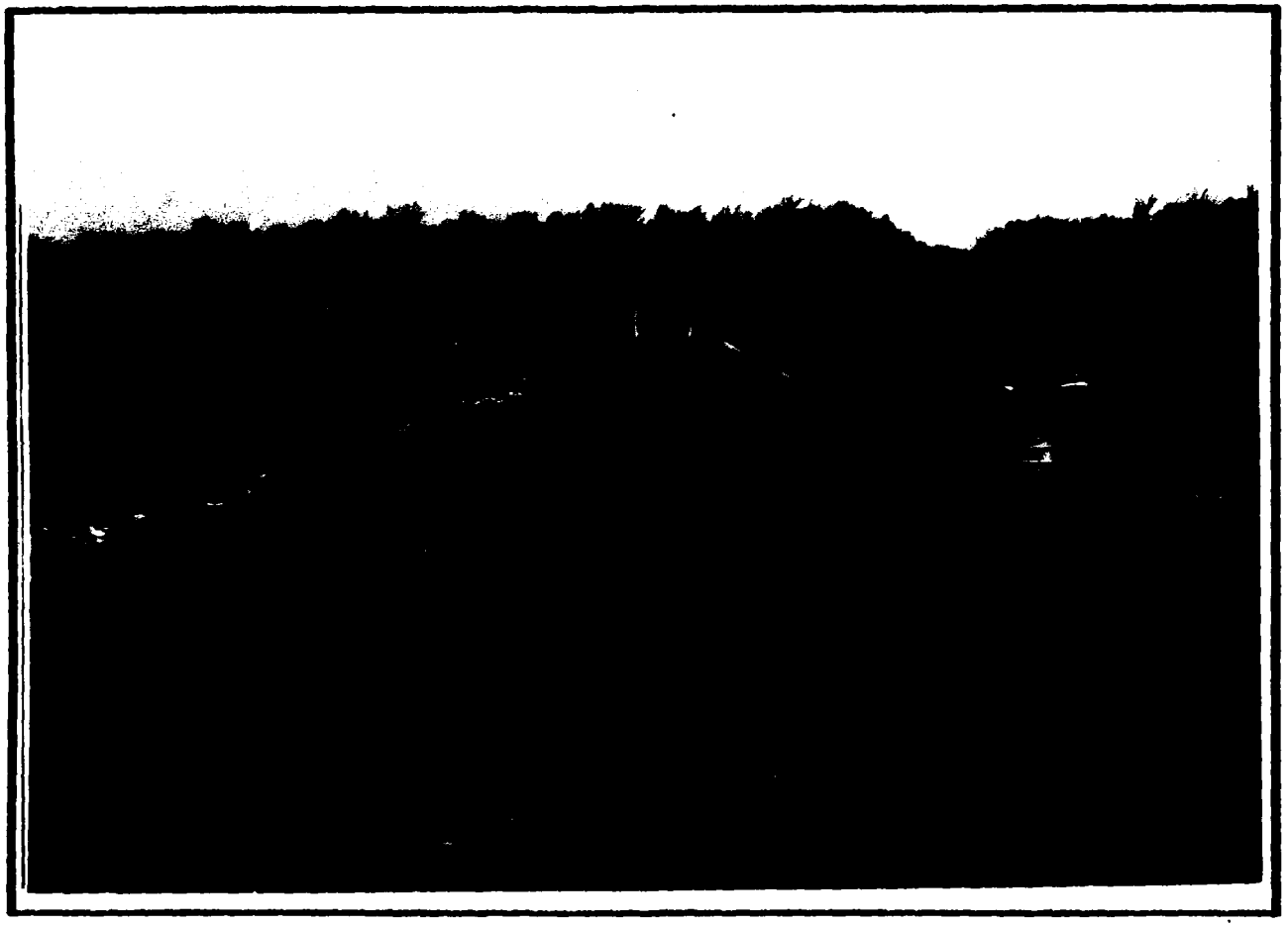
R. Jeffrey Kimball, P.E.

APPROVED BY:

24 Sep 1980

Date

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer



Overview of Tobyhanna Number 2 Dam.

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APPENDICES

PHASE I
NATIONAL DAM INSPECTION PROGRAM
TOBYHANNA LAKE NO. 2 DAM
NDI. I.D. NO. PA 779
DER I.D. NO. 45-36

SECTION 1
PROJECT INFORMATION

1.1 General.

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

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

1.2 Description of Project.

a. Dam and Appurtenances. Tobyhanna Lake No. 2 Dam is an earthfill dam, 860 feet long and 18 feet high. The crest width of the dam is 11 feet. The upstream slope is 2.5H:1V and protected with dumped riprap. The downstream slope varies from 2H:1V to 2.5H:1V and is grass covered.

The spillway is located approximately 200 feet from the right abutment and consists of an ogee gravity section having a length of 61 feet between abutments. A 10 foot wide concrete foot bridge spans the spillway crest. On the right abutment of the spillway there exists a 5 foot by 5 foot concrete structure which houses an inactive gaging station. An 18" concrete pier is located midway across the span and provides support for the concrete foot bridge. A valve for the reservoir drain is located immediately upstream of this concrete pier.

b. Location. Tobyhanna Lake No. 2 Dam is located approximately 1.7 miles northeast of Tobyhanna, Monroe County, Pennsylvania. Tobyhanna Lake No. 2 Dam can be located on the Tobyhanna, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Tobyhanna Lake No. 2 Dam is an intermediate size dam (18 feet high, 2489 acre-feet).

d. Hazard Classification. Tobyhanna Lake No. 2 Dam is a high hazard dam. Downstream conditions indicate that the loss of more than a few lives is probable should the structure fail. Several dwelling are located approximately 0.75 miles downstream and the village of Tobyhanna is located approximately 1.75 miles downstream of the dam.

e. Ownership. Tobyhanna Lake No. 2 Dam is owned by The Pennsylvania Department of Environmental Resources. Correspondence should be addressed to:

Commonwealth of Pennsylvania
Bureau of State Parks
Evangelical Press Building
3rd & Reily Street
Harrisburg, PA 17120
717-787-6640

f. Purpose of Dam. Tobyhanna Lake No. 2 Dam is used for recreation.

g. Design and Construction History. Tobyhanna Lake No. 2 Dam was originally constructed during the late 1800's by the Mountain Ice Company. The original earthfill dam was approximately 500 feet long. Approximately 230 feet of the crest length had a crest width of approximately 20 feet. The balance of the crest for the remaining distance of the dam was between 5 and 10 feet in width. The maximum height of the dam was about 15 feet. The spillway was located about 200 feet from the right abutment and constructed of rock filled timber cribbing. A sluiceway was located 40 feet west of the spillway. A side track of DL & W Railroad ran across the crest for a distance of 150 feet, crossing the spillway and sluiceway to the ice house. The dam was in a deteriorating condition and attempts were made during 1920 to repair the embankment and spillway structure.

Construction for the modifications was completed around November, 1919. The new spillway crest had a length of approximately 20 feet and a pier was located at mid span to support a railroad which crossed the spillway. A new 8' wide sluiceway contained two 36" diameter pipes encased in concrete and running underneath the sluiceway. The water level in the reservoir was controlled by flashboards in the spillway and sluiceway.

Early in 1950 the firm of Gannett, Fleming, Corddry and Carpenter was authorized to conduct a survey of the Tobyhanna Lake No. 2 Dam and to furnish location plans and cross-sections thereof. The Gannett, Fleming study led the way to construction of the present Tobyhanna Lake No. 2 Dam.

The plans of the new structure show an earth dam with a concrete gravity spillway located 200 feet from the right abutment. The earth embankment had a total length of 860 feet, exclusive of the spillway section. The maximum height of the dam was 12 feet and a crest width of 10 feet was proposed. The plan shows that the old embankment was to be removed where necessary and a cutoff trench constructed the entire length of the dam. A proposed trench was to have a bottom width of 10

feet and side slopes of 1H:1V and extending to a satisfactory foundation. The dam was designed to have an impervious core of select material. The sideslopes of the impervious core were specified to be 1/2H:1V. Less impervious material (random fill) was to be similarily placed on both sides of the impervious core and to be built simultanously with the clay core. The upstream finished slope was to be 2.5H:1V and the downstream slope was to be 2H:1V.

The upstream face was protected by 6" gravel filter upon which there was placed 2 feet of dumped rock riprap. The crest was to be protected with a layer of rolled gravel or crushed stone. The downstream face was to be protected by planting grass.

The spillway was designed as an ogee gravity section having a length of 62 feet between abutments, a height of 12.5 feet and a effective base width of 18 feet. The spillway depth was 8 feet.

The ogee section was founded on a three foot thick concrete slab 23 feet long. The base was provided with a cutoff wall 4 feet thick and extending 12 feet below the bottom of the base slab at the upstream edge of the section. The downstream end of the slab was provided with a 3 foot deep cutoff, 2 foot wide at the base and 3.6 feet wide at the top. The downstream end was provided with a bearing seat and construction joint to carry the upstream end of the stilling basin bottom slab. The downstream face of the ogee section was reinforced along the lower 2/3 of its surface.

The stilling basin was designed to be 17 feet long to the upstream face of the toe water stop. The bottom slab was 2 feet thick and reinforced with 5/8" bars on 12" centers. The stilling basin pool was provided with 15 energy dissipating piers located 15 feet downstream of the toe of the spillway section.

The waste channel was paved with a 1 foot thick reinforced concrete slab for a distance of 11 feet below the stilling basin. This paving was terminated in a reinforced concrete cutoff wall 1.5 feet thick and extending to a minimum of 5 feet below the top surface of the slab.

The spillway abutments are concrete gravity sections having a base width of 44% of their height and a top width of 1.6 feet. The abutments were provided with 1 foot thick reinforced

concrete cutoff walls extending 4 feet outside the abutments. The abutment footings were 14 feet deep adjacent to the ogee section and 7 feet deep at the outside. The width of the footing was 15 feet 7 inches.

A 36" diameter blow-off pipe was to extend through the gravity section. This blow-off opening was to be closed by a hand operated sluice gate on the upstream face of the spillway. The approach channel was paved for a distance of 9 feet upstream from the sluice gate. The spillway was provided with a 10 foot wide foot bridge of concrete construction. The spillway was also equipped with a recording pool stage recorder to provide data for hydraulic studies.

Prior to August, 1950, the Willis Construction Company of Branchville, New Jersey was awarded the contract to complete the work.

h. Normal Operating Procedures. No operations are conducted at the dam.

1.3 Pertinent Data.

a. Drainage Area. 8.78 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site (1995)	1185
Drainline capacity at normal pool	Unknown
Spillway capacity at top of dam	4683

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on principal spillway crest elevation 1952.3 feet obtained from design drawings.

Top of dam - low point	1959.8
Top of dam - design height	1960.3
Maximum pool - design surcharge	Unknown
Full flood control pool	N/A
Normal pool	1952.3
Emergency spillway crest	None
Upstream portal - 36" drainline	Unknown
Downstream portal - 36" drainline	Unknown
Tailwater	1942.2
Maximum tailwater	Unknown
Toe of dam (concrete apron)	1942.0

d. Reservoir (feet).

Length of maximum pool	1300 feet
Length of normal pool	6500 feet

e. Storage (acre-feet).

Normal pool	436
Top of dam	2489

f. Reservoir Surface (acres).

Top of dam	393
Normal pool	172
Spillway crest	172

g. Dam.

Type	Earthfill
Length (excluding spillway)	860 feet
Height	18 feet
Top width	11 feet
Side slopes - upstream (field measurement)	2.5H:1V
- downstream	2H:1V to 2.5H:1V
Side slopes - upstream (design)	2.5H:1V
- downstream	2H:1V
Zoning	Yes
Impervious core	Yes
Cutoff	Partial
Grout curtain	None

h. Reservoir Drain.

Type	36" RCP
Length	Unknown
Closure	Sluice gate
Access	Upstream face of ogee section
Regulating facilities	On concrete walkway which spans the spillway crest

i. Spillway.

Type	Ogee gravity section
Length (crest, field measurement)	60 feet
Crest elevation	1952.3
Upstream channel	Lake (unrestricted)
Downstream channel	Concrete channel to natural streambed

SECTION 2
ENGINEERING DATA

2.1 Design. Review of available information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources, revealed that some correspondence, design drawings, construction inspection memos, laboratory concrete compression test reports and pertinent information were available for review. Some information was supplied by personnel from the Pennsylvania Parks Service. Design drawings and an engineering report prepared by Gannett, Fleming, Corddry and Carpenter were reviewed for the purposes of this report.

2.2 Construction. Reconstruction of Tobyhanna Lake No. 2 Dam was begun on August 8, 1950. Periodic construction inspection report memos are located in the Pennsylvania Department of Environmental Resources files. A September 21, 1950 memo notes the removal of the entire left end of the original dam. Comments concerning the cutoff trench excavation were also mentioned and it was reported that no relatively impervious layer had been reached at the bottom of the cutoff. Information in the memo notes that the location of the borrow area for construction of the embankment was located a couple of miles from the site, behind the military buildings. Continuation of the cutoff trench excavation was questioned since the material with which it will be backfilled was perhaps less impervious than the material removed. Further comments in the memo relative to the cutoff trench excavation make note of the fact that no serious trouble was encountered in the old dam due to seepage losses. It was noted that conservative calculations of possible seepage losses might disclose that the cutoff is unnecessary and that a sand embankment would be all right. Based on information contained in the DER files it appears as though borrow had been obtained from several sites in the area of construction. Further review of the finals show no mention of any major problems being encountered during the construction phase.

During mid 1951, construction was completed and a final inspection was slated to occur on July 10, 1951. Approximately 8 months after construction on April 29, 1952, the embankment crest in the area of the spillway experienced some damage due to heavy rains which had occurred during the previous week. There is no indication in the files as to the exact cause of the damage. An inspection of the structure was conducted the following day on April 30, 1952 by state officials. Information obtained from the inspection report makes note of embankment settlement of approximately 4 inches. It appears as though the embankment settlement occurred in an area directly adjacent to the spillway structure.

A June 25, 1952 memorandum contained in the DER files makes note of a June 24, 1952 meeting which was held at the dam site to discuss what work, if any, was to be done by the contractor under the maintenance bond which was to expire on July 13. Remarks in the memo make note of the fact that levels were run over the entire crest of the dam and it had not appeared as though any appreciable settlement had occurred except at the spillway abutments. Discussions relative to the settlement near the spillway structure make note of the deep fills in the area of the spillway. Fill in the area was approximately 30 feet deep and a settlement of 4 inches was remarked to have represented approximately 1% of the height of the fill. Remarks contained in the memo state that it could not be definitely determined that the contractor was at fault in regards to the settlement. It was further noted that since most of the damage had been repaired by park employees that the park foreman should complete the rest of the work. Later correspondence contained in the DER files make note of the settlement damage and repair as being considered a park maintenance problem.

2.3 Operation. The drainline sluice gate is operated and lubricated each spring and fall.

2.4 Evaluation.

a. Availability. Engineering data were provided by PennDER, Bureau of Dams and Waterways Management. The owner of the dam is the Commonwealth of Pennsylvania. The Tobyhanna park superintendent, Mr. Ken Fultz, was interviewed in regards to operation and maintenance of the dam. Mr. Fultz did not accompany the inspection team during the inspection.

b. Adequacy. The Phase I Report was based on visual inspection and hydrologic and hydraulic analysis. Sufficient information exists to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Tobyhanna Lake No. 2 Dam was conducted by personnel of L. Robert Kimball and Associates on May 22, and July 30, 1980. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to be in good condition. From a brief survey conducted during the inspection, it was noted that a low spot exists on the embankment crest adjacent to the left spillway wingwall. The low area noted during the field survey corresponds somewhat to previous settlement in the area as previously noted in Section 2.2. The difference in elevation is not noticeable to the naked eye and there is no immediate concern due to the depression. It should be noted that the low area does exist in an area where previous settlement has occurred and it may be possible that settlement is as yet incomplete.

The crest of the dam had just been seeded prior to the inspection and the downstream slope of the dam was grass covered. The upstream slope of the dam is riprapped for its entire length. A portion of the upstream slope on either side of the spillway structure is protected with slush grouted riprap with signs of minor deterioration. The crest width is 11 feet, the downstream slope was measured to be 2H:1V to 2.5H:1V. The upstream slope is 2.5H:1V. It was noted during the inspection that a small area on the upstream slope immediately adjacent to the right spillway wingwall was in need of some additional riprap. No erosion or seepage was observed during the inspection.

c. Appurtenant Structures. The concrete structure, the spillway weir and the concrete walkway which spans the spillway crest appeared to be in good condition. Some cracking of the concrete was noted on the right wall of the discharge channel. The reservoir drain was not observed during the inspection.

d. Reservoir Area. The watershed consists of forested lands as well as many large swamp areas. The storage potential of the swamp areas are unknown. A more indepth analysis would be required to determine what storage potential, if any exists, in the areas. The reservoir slopes are gentle to moderate and do not appear to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping by displacing water.

e. Downstream Channel. The downstream channel of Tobyhanna Lake No. 2 Dam consists of Tobyhanna Creek. The stream channel is relatively broad for its entire distance of approximately 1 mile at which point Tobyhanna Creek discharges into Mill Pond #1 near the village of Tobyhanna.

3.2 Evaluation. The embankment, spillway structure, walkway and spillway crest appear to be in good condition. The upstream slope adjacent to the right spillway wingwall requires additional riprap. No seepage was observed during the inspection. The cracks observed in the right wall of the discharge channel do not appear significant enough to effect the stability of the structure. Information contained in the DER files indicate that the cracks have been monitored on a regular basis.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. No operations are conducted at this dam. The gaging station located on the right abutment of the spillway structure has not been in operation since January, 1978. The water level in the reservoir is maintained at the spillway crest elevation, 1952.3.

4.2 Maintenance of the Dam. No planned maintenance schedule exists for Tobyhanna Lake No. 2 Dam. Mowing of the embankment crest and downstream slope is completed on an unscheduled basis. The dam is inspected twice each year by state officials and recommendations as per maintenance or repairs are completed as required.

4.3 Maintenance of Operating Facilities. The drainline sluice gate is operated each spring and fall. The operation of the gate includes lubrication of the regulating facilities.

4.4 Warning System in Effect. The park superintendent, Mr. Ken Fultz, reported that a warning system or program existed to warn downstream residents of a potential dam emergency. The warning system or program was not available for review since the park administration had just moved into a new office and the file was temporarily misplaced.

4.5 Evaluation. The condition of the dam is considered good. Discussions with the park superintendent indicated that the maintenance program at the dam as well as the maintenance of operating facilities was adequate. A warning system or program exists to warn downstream residents of a possible downstream emergency but this program was not available for review at the time of the inspection. Mr. Fultz informed the inspection team that a staff gauge is planned to be installed in the near future and would be read during periods of high water levels in the reservoir.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. Preliminary calculations relative to the hydrologic and hydraulic design were contained in the DER files. This information was reviewed for the purposes of this report. Information contained in the file indicates that the computed capacity of the spillway is 5200 cfs. A design inflow for the reservoir is reported in correspondence to be 10,800 cfs. The design calculations and drawings show the spillway length to be approximately 62 feet. A pier located mid span of the crest which supports the concrete walkway is approximately 1.5 feet in width. This agrees with data collected during the time of inspection.

b. Experience Data. No rainfall or runoff data were available. The gaging station at the dam has not been in operation since January, 1978. Review of available data relative to reservoir water levels were reviewed for the purposes of this report.

c. Visual Observations. The spillway appeared to be in good condition. Several cracks were noted on the right spillway discharge channel wall but it appears as though they present no problems relative to the stability of the structure. Remarks made by the park superintendent as well as information contained in the DER files indicates that several attempts had been made to repair the cracks but they have not been successful. It was reported by the park superintendent that the cracks will continue to be monitored by park personnel as well as members of the semi-annual inspection team. A state highway bridge is located approximately 100 feet downstream of the spillway crest. Correspondence located in the DER files indicate that the bridge designer made contact with appropriate state officials relative to the design capacity of the spillway and potential peak inflow to the lake.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. Pool elevation prior to the storm was at the spillway crest elevation, 1952.3.

2. The storage potential of the several large swamp areas located in the watershed was not considered in this analysis.

3. The top of dam was considered the low spot elevation, 1959.8.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	13044 cfs
Spillway capacity	4683 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for a dam of this size and classification is the PMF. Based on the following definition provided by the Corps of Engineers, the spillway is rated as inadequate as a result of our hydrologic analysis.

> Inadequate - All high hazard dams which do not pass the Spillway Design Flood (PMF).

The spillway and reservoir are capable of controlling approximately 58% of the PMF without overtopping the embankment.

5.4 Summary of Dam Breach Analysis. As the subject dam is capable of passing at least 50% of the PMF it was not necessary to perform the dam breach analysis and downstream routing of the flood wave.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. No erosion was observed on the embankment crest or slopes at the time of inspection. No seepage or wet areas were observed on the downstream slope or along the toe of the dam. No structural deficiencies were observed during the time of the inspection. Several cracks were observed on the right spillway discharge channel wall. Some riprap was missing on the upstream slope adjacent to the right spillway approach wingwall. The upstream slope on either side of the spillway structure is protected with slush grouted riprap for a distance of about 1/2 the length to either abutment. Review of past inspection reports conducted by state officials did not disclose any problems relative to the structural stability of the dam.

b. Design and Construction Data. Some design and construction data were available in the DER files and were reviewed for the purposes of this report. The review of design information, did not contain any information relative to a stability analysis on the dam. The file contains considerable test results relative to concrete compression tests conducted on materials (concrete) used in construction of the spillway structure. Some test results are available relative to field density testing. Based on correspondence contained in the PennDER files, it appears as though the embankment material consists of sand and gravely type soils.

c. Operating Records. No operations are conducted at the dam. The gaging station recorder has not been operated since January of 1978.

d. Post Construction Changes. Approximately 4 inches of settlement is noted to have occurred adjacent to the spillway structure and correspondence contained in the DER files suggest that some repairs were made in the area immediately adjacent to the spillway structure. The work was performed by park personnel. A question was noted in correspondence relative to attempting to have the construction company responsible, make the repairs but later correspondence made note of the fact that after several meetings the contractor was not held responsible for this settlement. The repair work relative to the settlement was completed by park personnel and the work was considered a maintenance type problem. The settlement and subsequent repairs were performed less than one year after construction of the dam was completed.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in good condition and adequately maintained. No erosion or seepage were observed during the inspection. A section of riprap is missing on the upstream slope adjacent to the right spillway approach wingwall. No deficiencies were observed which would affect the structural stability of the embankment or spillway structure. The visual observations, review of available data, hydrologic and hydraulic calculations and past operational performance indicate that the Tobyhanna Lake No. 2 Dam is capable of controlling approximately 58% of the PMF. Based on the hydrologic and hydraulic calculations the spillway at Tobyhanna Lake No. 2 Dam is considered inadequate.

b. Adequacy of Information. Sufficient information is available to complete a Phase I report.

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

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. The warning system or program for this dam should be located and kept on file at the park office and made readily accessible should an emergency situation arise requiring its need.

2. Replace missing riprap on the upstream slope adjacent to the right spillway approach wingwall. Riprap should be replaced on the upstream slope as required.

3. A regular safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

4. Due to past settlement in the area (Section 2.2) immediately adjacent to the concrete gravity spillway structure, particular attention should be given to continued monitoring of conditions in the area. In addition, the cracks in the spillway walls should be monitored on a regular basis.

5. Low areas on the embankment crest should be filled to the design elevation. The work should be completed and conform to current engineering practice.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Tobyhanna Lake No. 2 Dam COUNTY Monroe STATE Pennsylvania ID# PA 779

TYPE OF DAM Earthfill and rockfill HAZARD CATEGORY High

DATE(s) INSPECTION May, 22, 1980 WEATHER Overcast, cool TEMPERATURE 50°
July 30, 1980 Hot and humid 85°

POOL ELEVATION AT TIME OF INSPECTION 1052.2 M.S.L. TAILWATER AT TIME OF INSPECTION 1042.3 M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

Cameron R. Mock - L. Robert Kimball and Associates

James T. Hockensmith
RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted at time of inspection. DER files make note of approximately 4 inches of settlement adjacent to the concrete spillway structure during mid-1952.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appears adequate.	
RIPRAP FAILURES	Small section of riprap missing on upstream slope immediately adjacent to the right spillway wingwall.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Crest seeded at time of inspection. Downstream grass covered.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Low spot on dam noted approximately adjacent to the left spillway abutment. No other deficiencies noted.	
ANY NOTICEABLE SEEPAGE	None.	
STAFF GAUGE AND RECORDER	Reservoir level recorder located on right abutment of spillway. Has not been operable since January of 1978.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	Not applicable.	
OUTLET STRUCTURE	Not applicable.	
OUTLET CHANNEL	Not applicable.	
EMERGENCY GATE	Not applicable.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete ogee gravity section. The weir appeared to be in good condition and well maintained.	
APPROACH CHANNEL	Unrestricted - lake.	
DISCHARGE CHANNEL	Concrete discharge channel to Tobyhanna Creek.	
BRIDGE AND PIERS	Concrete foot bridge spans the spillway crest. One pier is located at mid span.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

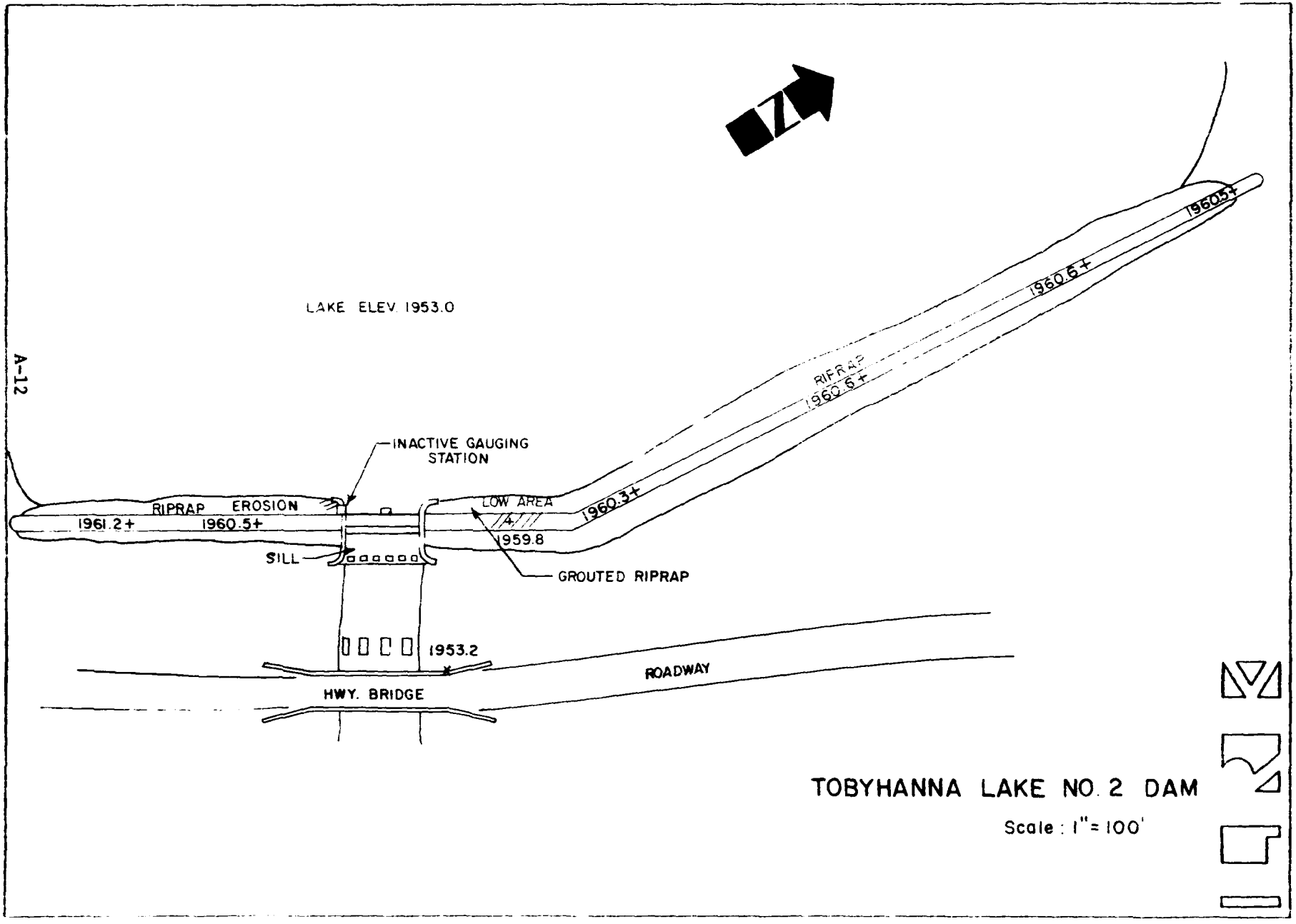
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Tobyhanna Creek provides the downstream channel for Tobyhanna Lake No. 2 Dam. The downstream channel is relatively broad for a distance of one mile below the dam at which point the stream flows into Mill Pond No. 1 located in the village of Tobyhanna.	
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Several homes are located approximately 1 mile downstream and are located along the headwaters of Mill Pond No. 1 in Tobyhanna. It is estimated that approximately 6 homes/25 people are located in this area.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle to moderate slopes. Appear to be stable.	
SEDIMENTATION	Unknown.	

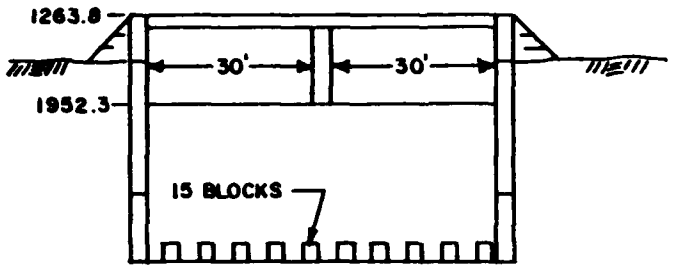
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Correspondence located in the DER files suggest that several benchmarks - temporary - are located on the state highway bridge located approximately 100 feet downstream of the spillway structure.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

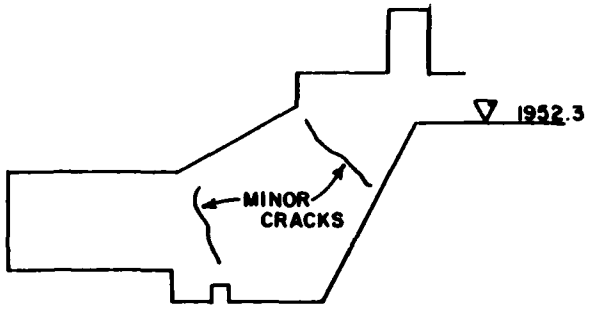


TOBYHANNA LAKE NO. 2 DAM

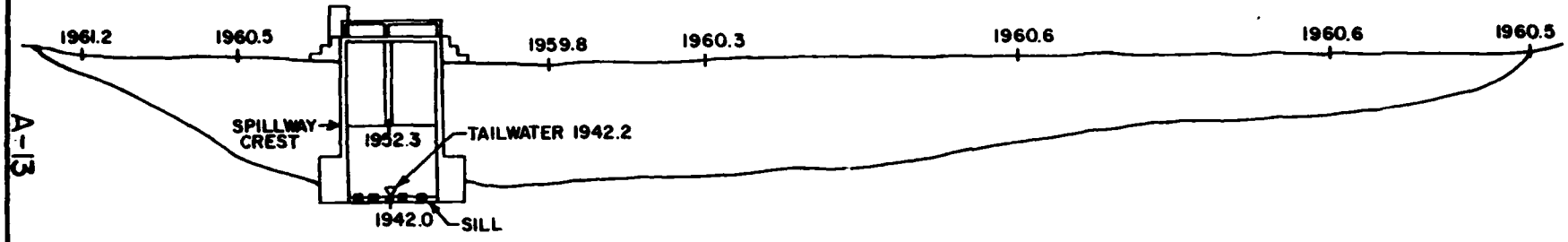
Scale : 1" = 100'



SPILLWAY PROFILE
(No Scale)



SPILLWAY SECTION
(No Scale)



PROFILE
LOOKING UPSTREAM

Scale: Horiz. 1"= 100'
Vert. 1"= 20'

TOBYHANNA LAKE NO. 2 DAM

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Tobyhanna Lake ~~No. 2 Dam~~

ID# ~~779~~

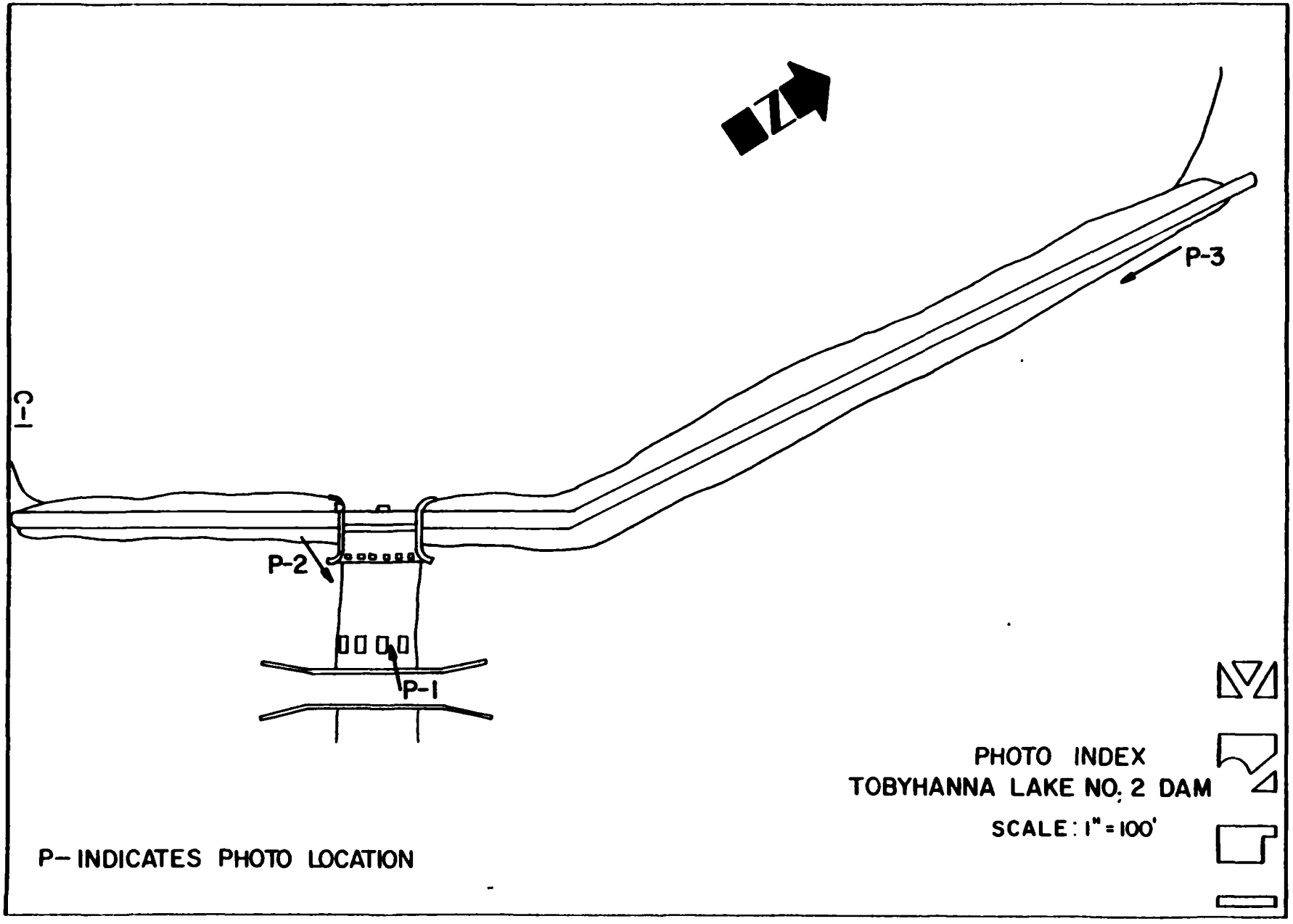
ITEM	REMARKS
AS-BUILT DRAWINGS	Unknown. Correspondence in the DER files suggests that as build drawings were submitted.
REGIONAL VICINITY MAP	U.S.G.S. quadrangle.
CONSTRUCTION HISTORY	DER files reviewed and park superintendent Ken Fultz interviewed during the inspection.
TYPICAL SECTIONS OF DAM	On construction drawings.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	DER files. DER files. None. None. Some information as to reservoir levels are located in the DER files.

ITEM	REMARKS
DESIGN REPORTS	Pre-design and construction reports are located in DER files.
GEOLOGY REPORTS	Unknown.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Some information relative to hydrologic and hydraulic calculations available in DER files. No reference made as to a stability being conducted on the dam. Correspondence located in the DER files make reference to the need for seepage studies prior to construction but no information was available for review.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	DER files. Unknown - correspondence in the DER file notes test pits being done prior to construction. DER files. DER files.
POST-CONSTRUCTION SURVEYS OF DAM	Unknown.
BORROW SOURCES	Several borrow source area were mentioned in the DER files. It appears as though the initial borrow area for construction of the dam was located in an area behind the military buildings located near the site.

ITEM	REMARKS
MONITORING SYSTEMS	Gage recorder not operated since January, 1978.
MODIFICATIONS	Repairs require an area of the spillway structure due to settlement 1952.
HIGH POOL RECORDS	DER files.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None noted.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None noted.
MAINTENANCE OPERATION RECORDS	DER files page B-4.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	DER files.
OPERATING EQUIPMENT PLANS & DETAILS	DER files.

APPENDIX C
PHOTOGRAPHS


N
C-1
P-3
P-2
P-1
PHOTO INDEX
TOBYHANNA LAKE NO. 2 DAM
SCALE: 1" = 100'
P- INDICATES PHOTO LOCATION

TOBYHANNA LAKE NO. 2 DAM
PA 779

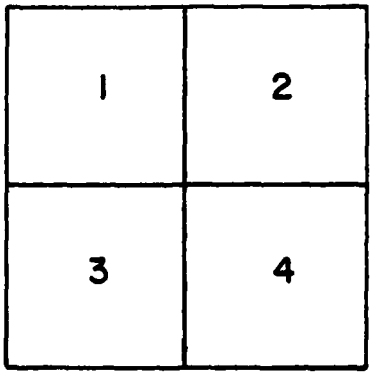
Photograph Description

Sheet 1

Front

(1) Upper left - Spillway crest.
(2) Upper right - Discharge channel (note highway bridge).
(3) Lower left - View of embankment from left abutment.
(4) Lower right - Downstream exposure.

TOP OF PAGE



APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 40" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Tobyhanna Lake No. 2 Dam (Delaware River Basin)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 21.80 inches

STATION	1	2	3	4
Station Description	Subarea 1	Subarea 2	Subarea 3	Subarea 4
Drainage Area (square miles)	.98	1.8	3.8	2.2
Cumulative Drainage Area (square miles)	.98	2.78	6.58	8.78
Adjustment of PMF for Drainage Area (%)(1)				
6 hours	111	111	111	111
12 hours	121	121	121	121
24 hours	131	131	131	131
48 hours	142	142	142	142
72 hours				
Snyder Hydrograph Parameters		(Zone 1)		
Zone (2)	2	2	2	2
Cp (3)	.45	.45	.45	.45
Ct (3)	2.1	2.1	2.1	2.1
L (miles) (4)	1.89	2.79	3.0	2.08
Lca (miles) (4)	.90	1.47	1.59	.99
tp = Ct(LxLca) 0.3 hrs.	2.46	3.21	3.36	2.61
Spillway Data				
Crest Length (ft)		60'		
Freeboard (ft)		7.5'		
Discharge Coefficient		3.8		
Exponent		1.5		

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army Corps of Engineers, 1965.

(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).

(3) Snyder's Coefficients.

(4) L=Length of longest water course from outlet to basin divide. L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: D.A. = 8.78 mi^2 gentle to moderate

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 436 ac-ft

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 2489 ac-ft

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1959.8

SPILLWAY CREST:

a. Elevation 1952.3
b. Type Ogee gravity section
c. Width Unknown
d. Length 60 feet
e. Location Spillover Approximately 200 feet from right abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type None
b. Location None
c. Entrance inverts None
d. Exit inverts None
e. Emergency draindown facilities 36" diameter concrete pipe

HYDROMETEOROLOGICAL GAUGES:

a. Type Gage recorder
b. Location Right spillway abutment
c. Records DER files and park office - use discontinued January, 1978

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME TOBYHANNA No. 2
I.D. NUMBER 773
SHEET NO. 1 OF 3
BY CAB DATE 7-[illegible]

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY CORPS OF ENGINEERS BALTIMORE DISTRICT.

STRTL = 1 INCH

CNSTL = .05 IN/HR

STRTQ = 1.5 CFS/MI^2

QRCSN = .05 (5% OF PEAK FLOW)

RTIOR = 2.0

ELEVATION - AREA RELATIONSHIP

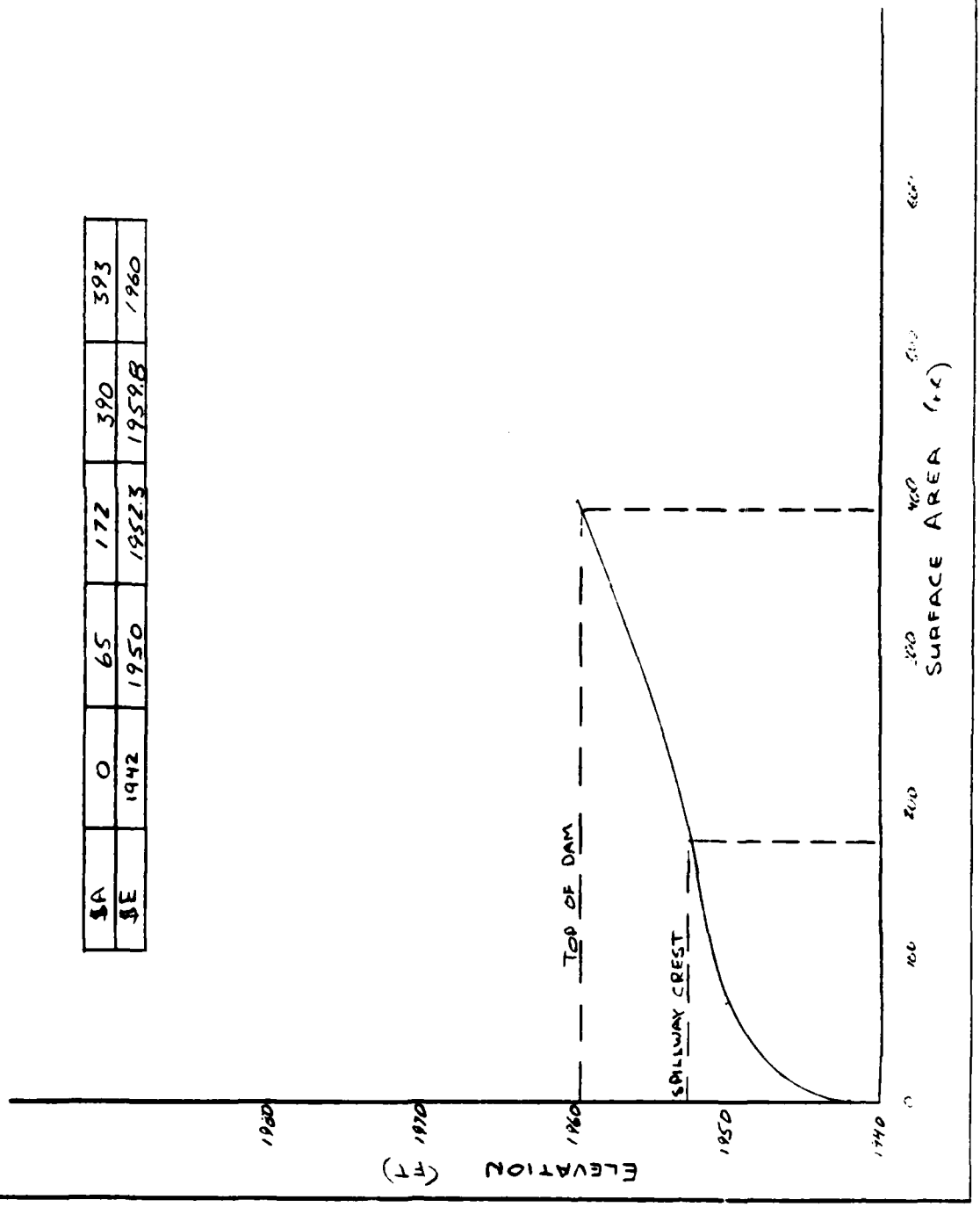
FROM U.S.G.S. 7.5 MIN QUAD., DER FILES AND FIELD INSPECTION DATA.

SPILLWAY CREST ELEV. = 1952.3
POND SURFACE AREA = 172 AC.
ELEV. WHERE AREA EQUALS ZERO = 1942
AREA AT ELEV. 1950 = 65 AC.
AREA AT ELEV 1960 = 393 AC

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME TOBYHANNA No. 2
I.D. NUMBER 778
SHEET NO. 2 OF 3
BY CAC DATE 7-1-80

$A	0	65	172	390	393
$E	1942	1950	1952.3	1959.8	1960



L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME TOMPKINS No. 2
I.D. NUMBER 779
SHEET NO. 5 OF 3
BY CAR DATE

OVERTOP PARAMETERS

TOP OF DAM ELEV. = 1959.8
LENGTH OF DAM (EXCLUDING SPILLWAY) = 660
COEFFICIENT OF DISCHARGE = 3.1

EL	10	38	85	280	650	815
EV	1959.8	1960	1960.2	1960.4	1960.6	1960.8

665	995	1060
1961	1962	1963

DISCHARGE RATING CURVE

CALCULATED BY HEC-1 COMPUTER PROGRAM

SPILLWAY CREST ELEV. = 1952.3
CREST LENGTH L = 60'
COEFFICIENT OF DISCHARGE = 3.8

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
    2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF TOBYHANNA DAM NO. 2
    3          A3      RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (779)
    4          B   288       0      10       0       0       0       0       0       0       0
    5          B1    5
    6          J     1       5       1
    7          J1  .4      .5      .6     .75       1
    8          K     0       1                                       1
    9          K1     INFLOW FROM SUBAREA 1
   10          M     1       1     .98                                                       1
   11          P           21.80     111     121     131     142
   12          T                                                   1.0     .05
   13          W  2.46     .45
   14          X  -1.5    -.05     2.0
   15          K     0       2                                       1
   16          K1     INFLOW FROM  SUBAREA 2
   17          M     1       1     1.8                                                       1
   18          P           21.80     111     121     131     142
   19          T                                                   1.0     .05
   20          W  3.21     .45
   21          X  -1.5    -.05     2.0
   22          K     2       3                                       1
   23          K1     COMBINING TWO HYDROGRAPHS
   24          K     1       4                                       1
   25          K1     ROUTING THROUGH CHANNEL REACH NO. 1
   26          Y                                 1       1
   27          Y1    1
   28          Y6  .06     .05     .06    1974    2000    6400   .0025
   29          Y7    0    2000    1300    1980    1450    1976    1454    1974    1460    1974
   30          Y7 1464    1976    1810    1980    1990    2000
   31          K     1       5                                       1
   32          K1     ROUTING THROUGH CHANNEL REACH NO. 2
   33          Y                                 1       1
   34          Y1    1
   35          Y6  .06     .05     .06    1953    1980    3200    .007
   36          Y7    0    1980     110    1960     400    1955     404    1953     410    1953
   37          Y7  414    1955    1030    1960    1880    1980
   38          K     0       6                                       1
   39          K1     INFLOW FROM SUBAREA 3
   40          M     1       1     3.8                                                       1
   41          P           21.80     111     121     131     142
   42          T                                                   1.0     .05
   43          W  3.36     .45
   44          X  -1.5    -.05     2.0
   45          K     0       7                                       1
```

```
46              K1      INFLOW FROM SUBAREA 4
47              M     1       1     2.2                                                   1
48              P           21.80     111      121      131      142
49              T                                                          1.0      .05
50              W   2.61     .45
51              X   -1.5    -.05     2.0
52              K     3        8                                                    1
53              K1      COMBINING THREE HYDROGRAPH
54              K     1        9                                                    1
55              K1      ROUTE THROUGH RESERVOIR
56              Y                                  1        1
57              Y1    1                                                  -1952.3
58              SA    0       65      172      390      993
59              SE  1942     1950   1952.3   1959.8     1960
60              SS1952.3       60      3.8      1.5
61              SD1959.8      3.1      1.5      860
62              SL    10       38       85      280      680      815      865      995     1060
63              SV1959.8     1960   1960.2   1960.4   1960.6   1960.8     1961     1962     1963
64              K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 80/07/03.
TIME= 10.23.58.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF TOBYHANNA DAM NO. 2
RATIOS OF THE PMF ROUTED THROUGH THE RESERVOIR (779)

JOB SPECIFICATION

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

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .40 .50 .60 .75 1.00

****

SUB-AREA RUNOFF COMPUTATION

INFLOW FROM SUBAREA 1

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

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.98	0.00	.98	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	121.00	131.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.46 CP= .45 NTA= 0

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=15.29 AND R=23.62 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 2.45 HOURS, CP= .45 VOL= .98

2.	7.	15.	24.	34.	45.	57.	69.	81.	91.
101.	108.	113.	117.	118.	116.	112.	107.	103.	98.
94.	90.	87.	83.	80.	76.	73.	70.	67.	64.
62.	59.	57.	54.	52.	50.	48.	46.	44.	42.
40.	39.	37.	36.	34.	33.	31.	30.	29.	28.
26.	25.	24.	23.	22.	21.	21.	20.	19.	18.
17.	17.	16.	15.	15.	14.	13.	13.	12.	12.
11.	11.	10.	10.	10.	9.	9.	8.	8.	8.
7.	7.	7.	7.	6.	6.	6.	6.	5.	5.
5.	5.	4.	4.	4.	4.	4.	4.	3.	3.

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

SUB-AREA RUNOFF COMPUTATION

INFLOW FROM SUBAREA 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.80	0.00	1.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	121.00	131.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.21 CP= .45 NTA= 0

RECESSION DATA

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=19.82 AND R=30.48 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 3.23 HOURS, CP= .45 VOL= .95

2.	7.	14.	23.	33.	44.	56.	68.	81.	95.
109.	121.	132.	142.	151.	158.	163.	167.	169.	168.
163.	158.	153.	148.	142.	139.	134.	130.	126.	122.
118.	114.	110.	107.	103.	100.	97.	94.	91.	88.
85.	82.	79.	77.	74.	72.	70.	67.	65.	63.
61.	59.	57.	55.	54.	52.	50.	49.	47.	45.
44.	43.	41.	40.	39.	37.	36.	35.	34.	33.
32.	31.	30.	29.	28.	27.	26.	25.	24.	24.
23.	22.	21.	21.	20.	19.	19.	18.	18.	17.
16.	16.	15.	15.	14.	14.	14.	13.	13.	12.

COMBINE HYDROGRAPHS

COMBINING TWO HYDROGRAPHS

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	2	0	0	0	0	1	0	0

HYDROGRAPH ROUTING

ROUTING THROUGH CHANNEL REACH NO. 1

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QR(1)	QR(2)	QR(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1974.0	2000.0	6400.	.00250

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 2000.00 1300.00 1980.00 1450.00 1976.00 1454.00 1974.00 1460.00 1974.00
1464.00 1976.00 1810.00 1980.00 1950.00 2000.00

STORAGE	0.00	1.78	9.40	47.64	120.00	223.77	348.40	492.84	657.09
841.15	1045.02	1268.69	1512.18	1775.48	2058.58	2361.49	2684.22	3026.75	3389.09
3771.24									
OUTFLOW	0.00	17.65	93.86	516.78	1624.60	3800.29	7159.88	11682.81	17438.44
24503.29	32955.89	42874.94	54338.62	67424.16	82207.74	98764.43	117168.18	137491.82	159807.10
184184.77									
STAGE	1974.00	1975.37	1976.74	1978.11	1979.47	1980.84	1982.21	1983.58	1984.95
1986.32	1987.68	1989.05	1990.42	1991.79	1993.16	1994.53	1995.89	1997.26	1998.63
2000.00									
FLOW	0.00	17.65	93.86	516.78	1624.60	3800.29	7159.88	11682.81	17438.44
124503.29	32955.89	42874.94	54338.62	67424.16	82207.74	98764.43	117168.18	137491.82	159807.10
184184.77									

HYDROGRAPH ROUTING

ROUTING THROUGH CHANNEL REACH NO. 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QR(1)	QR(2)	QR(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1953.0	1980.0	3200.	.00700

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1980.00 110.00 1960.00 400.00 1955.00 404.00 1953.00 410.00 1953.00
414.00 1955.00 1030.00 1960.00 1880.00 1980.00

STORAGE	0.00	.92	7.06	37.89	95.60	180.14	280.27	387.52	501.89
184623.38	751.99	887.72	1030.58	1180.55	1337.65	1501.86	1673.20	1851.66	2037.24
182229.94									
OUTFLOW	0.00	31.68	206.08	1341.61	4346.44	10015.40	19744.29	32293.18	47594.58
65637.03	86439.01	110036.76	136477.64	165816.39	198112.67	233429.55	271832.46	313388.45	358165.67
406233.01									
STAGE	1953.00	1954.42	1955.84	1957.26	1958.68	1960.11	1961.53	1962.95	1964.37
181965.79	1967.21	1968.63	1970.05	1971.47	1972.89	1974.32	1975.74	1977.16	1978.58
181980.00									
FLOW	0.00	31.68	206.08	1341.61	4346.44	10015.40	19744.29	32293.18	47594.58
465637.03	86439.01	110036.76	136477.64	165816.39	198112.67	233429.55	271832.46	313388.45	358165.67
406233.01									

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SUB-AREA RUNOFF COMPUTATION

INFLOW FROM SUBAREA 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.80	0.00	3.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	121.00	131.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.36 CP= .45 NTA= 0

RECESSION DATA

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

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=20.67 AND R=31.97 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 3.35 HOURS, CP= .45 VOL= .94

3.	13.	27.	44.	63.	84.	106.	130.	155.	181.
207.	232.	255.	276.	293.	309.	321.	331.	337.	340.
337.	328.	318.	308.	299.	290.	281.	272.	264.	256.
248.	240.	233.	226.	219.	212.	205.	199.	193.	187.
181.	176.	170.	165.	160.	155.	150.	146.	141.	137.
133.	128.	125.	121.	117.	113.	110.	106.	103.	100.
97.	94.	91.	88.	86.	83.	80.	78.	75.	73.
71.	69.	67.	65.	63.	61.	59.	57.	55.	54.
52.	50.	49.	47.	46.	44.	43.	42.	40.	39.
38.	37.	36.	35.	33.	32.	31.	30.	30.	29.

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SUB-AREA RUNOFF COMPUTATION

INFLOW FROM SUBAREA 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.20	0.00	2.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.80	111.00	121.00	131.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.61 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.30 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC=16.28 AND R=29.09 INTERVALS

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 2.61 HOURS, CP= .45 VOL= .97

4.	14.	28.	46.	65.	87.	110.	134.	159.	181.
201.	218.	232.	242.	249.	251.	246.	237.	227.	219.
210.	202.	194.	186.	179.	172.	165.	159.	153.	147.
141.	135.	130.	125.	120.	115.	111.	107.	102.	98.
94.	91.	87.	84.	81.	77.	74.	71.	69.	66.
63.	61.	59.	56.	54.	52.	50.	48.	46.	44.

43.	41.	39.	38.	36.	35.	33.	32.	31.	30.
29.	27.	26.	25.	24.	23.	22.	22.	21.	20.
19.	18.	18.	17.	16.	16.	15.	14.	14.	13.
13.	12.	12.	11.	11.	11.	10.	10.	9.	9.

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COMBINE HYDROGRAPHS

COMBINING THREE HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
8	3	0	0	0	0	1	0	0

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
9	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1952.	0

SURFACE AREA=	0.	65.	172.	390.	393.
CAPACITY=	0.	173.	436.	2689.	2567.
ELEVATION=	1942.	1950.	1952.	1960.	1960.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1952.3	60.0	3.8	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1959.8	3.1	1.5	860.

CREST LENGTH AT OR BELOW ELEVATION	10.	38.	85.	280.	680.	815.	865.	995.	1060.
	1959.8	1960.0	1960.2	1960.4	1960.6	1960.8	1961.0	1962.0	1963.0

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 .40	RATIO 2 .50	RATIO 3 .60	RATIO 4 .75	RATIO 5 1.00
HYDROGRAPH AT	1	.98	1	677.	846.	1016.	1270.	1693.
		(2.54)		(19.17)(	23.97)(	28.76)(	35.95)(	47.93)(
HYDROGRAPH AT	2	1.80	1	1057.	1322.	1586.	1983.	2644.
		(4.66)		(29.94)(	37.43)(	44.91)(	56.14)(	74.86)(
2 COMBINED	3	2.78	1	1715.	2144.	2573.	3216.	4288.
		(7.20)		(48.57)(	60.71)(	72.85)(	91.06)(	121.42)(
ROUTED TO	4	2.78	1	1633.	2074.	2495.	3122.	4195.
		(7.20)		(46.25)(	58.73)(	70.65)(	88.39)(	118.80)(
ROUTED TO	5	2.78	1	1626.	2064.	2485.	3110.	4172.
		(7.20)		(46.05)(	58.46)(	70.36)(	88.06)(	118.13)(
HYDROGRAPH AT	6	3.80	1	2162.	2702.	3243.	4053.	5404.
		(9.84)		(61.21)(	76.52)(	91.82)(	114.77)(	153.03)(
HYDROGRAPH AT	7	2.20	1	1467.	1833.	2200.	2750.	3667.
		(5.70)		(41.53)(	51.91)(	62.29)(	77.87)(	103.82)(
3 COMBINED	8	8.78	1	5130.	6479.	7792.	9750.	13044.
		(22.74)		(145.49)(	183.47)(	220.65)(	276.08)(	369.35)(
ROUTED TO	9	8.78	1	3200.	4016.	4830.	6031.	10905.
		(22.74)		(90.62)(	113.71)(	136.78)(	193.43)(	308.80)(

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.40	1633.	1979.5	43.50
.50	2074.	1979.8	43.33
.60	2495.	1980.0	43.33

.75	3122.	1980.4	43.33
1.00	4195.	1981.0	43.17

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW.CFS	MAXIMUM STAGE.FT	TIME HOURS
.40	1626.	1957.4	43.67
.50	2064.	1957.6	43.50
.60	2485.	1957.8	43.50
.75	3110.	1958.1	43.50
1.00	4172.	1958.6	43.50

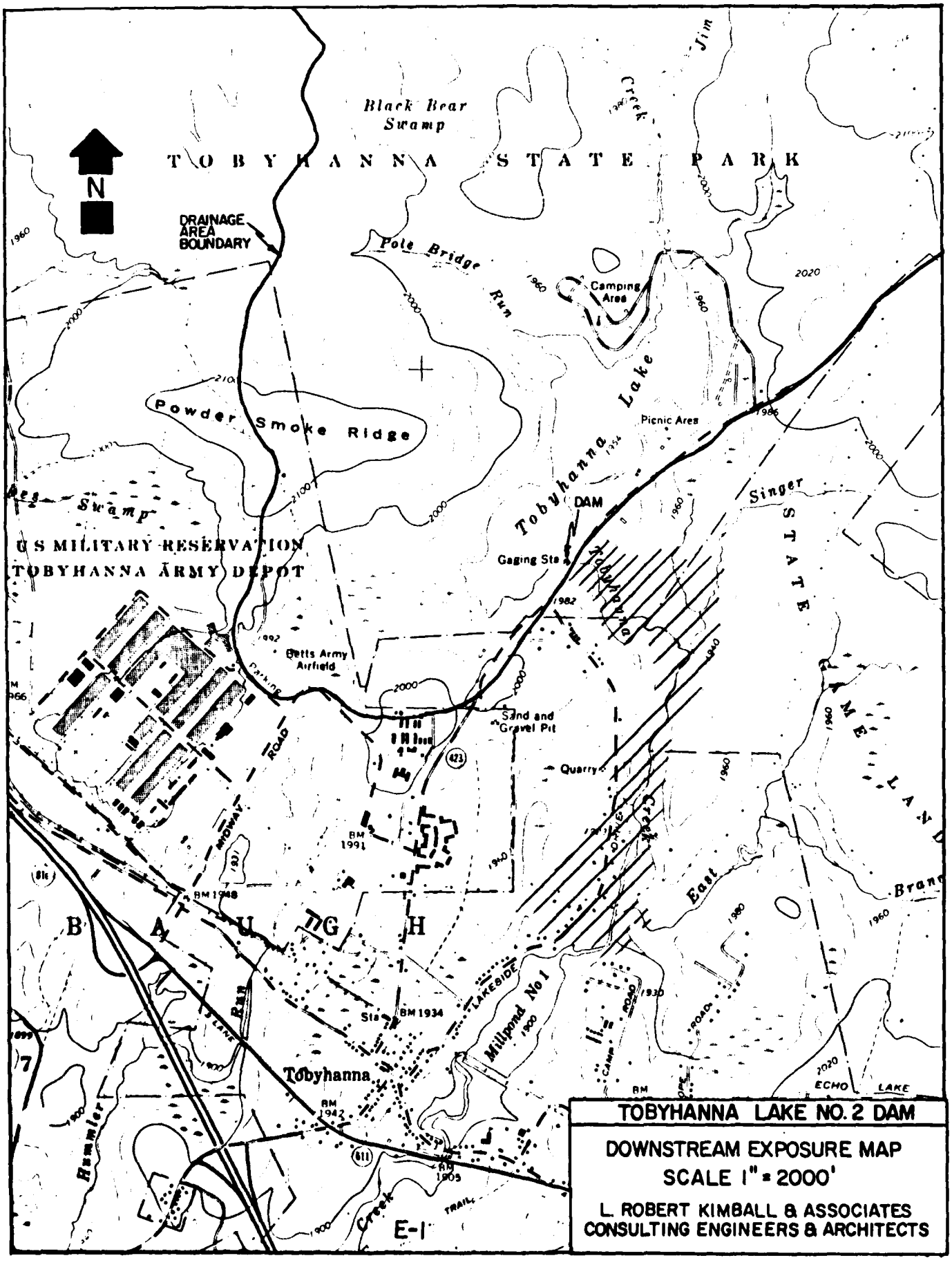
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1952.30	1952.30	1959.80
STORAGE	436.	436.	2489.
OUTFLOW	0.	0.	4683.

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
.40	1958.12	0.00	1881.	3200.	0.00	46.67	0.00
.50	1959.07	0.00	2213.	4016.	0.00	46.50	0.00
.60	1959.95	.15	2548.	4830.	2.67	46.50	0.00
.75	1960.96	1.16	2952.	6831.	4.67	45.83	0.00
1.00	1961.79	1.99	3296.	10905.	5.67	44.83	0.00

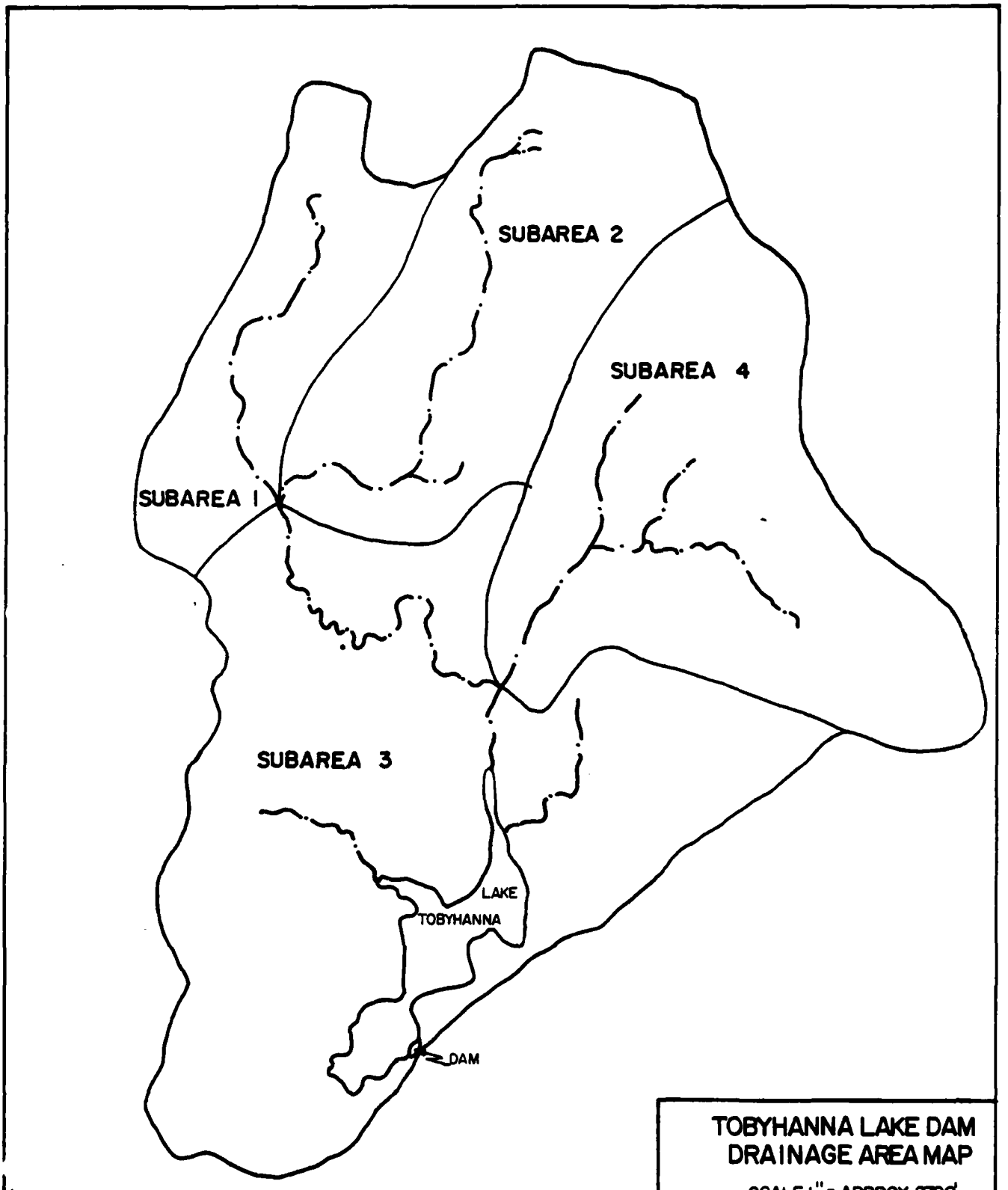
APPENDIX E
DRAWINGS



TOBYHANNA LAKE NO. 2 DAM

DOWNSTREAM EXPOSURE MAP
SCALE 1" = 2000'

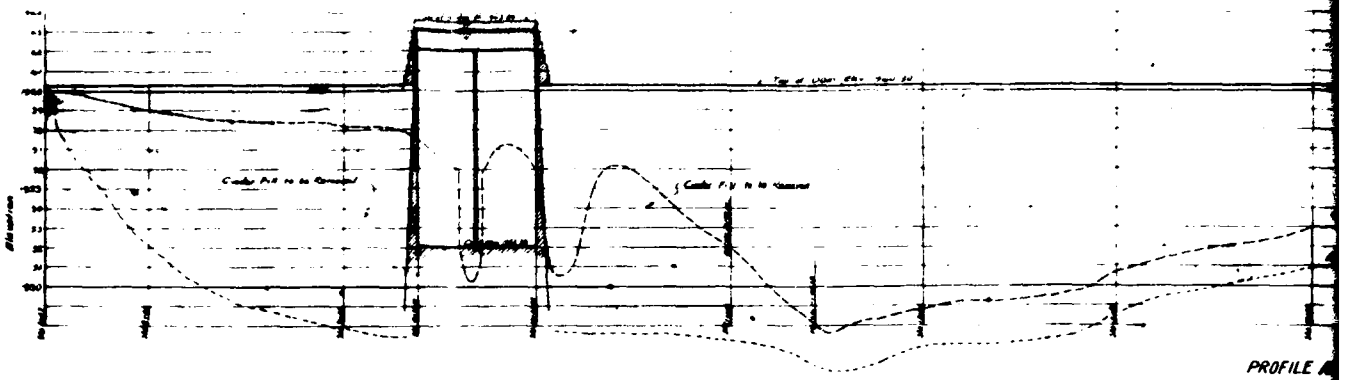
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



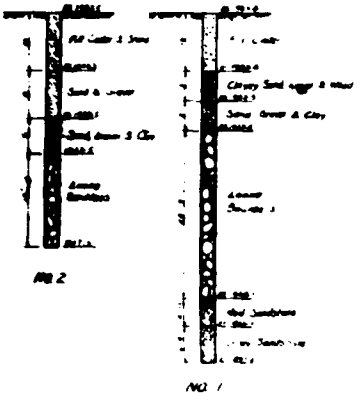
TOBYHANNA LAKE DAM
DRAINAGE AREA MAP

SCALE 1" = APPROX. 2700'

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



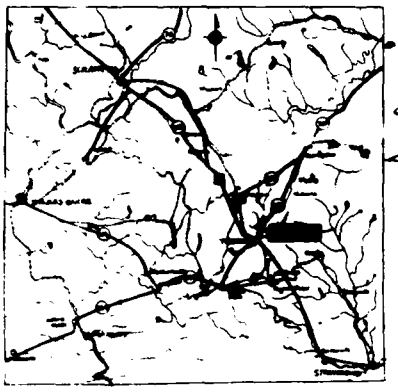
PROFILE A
SCALE



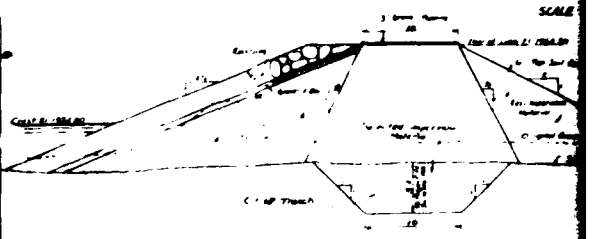
NO 2

NO 1

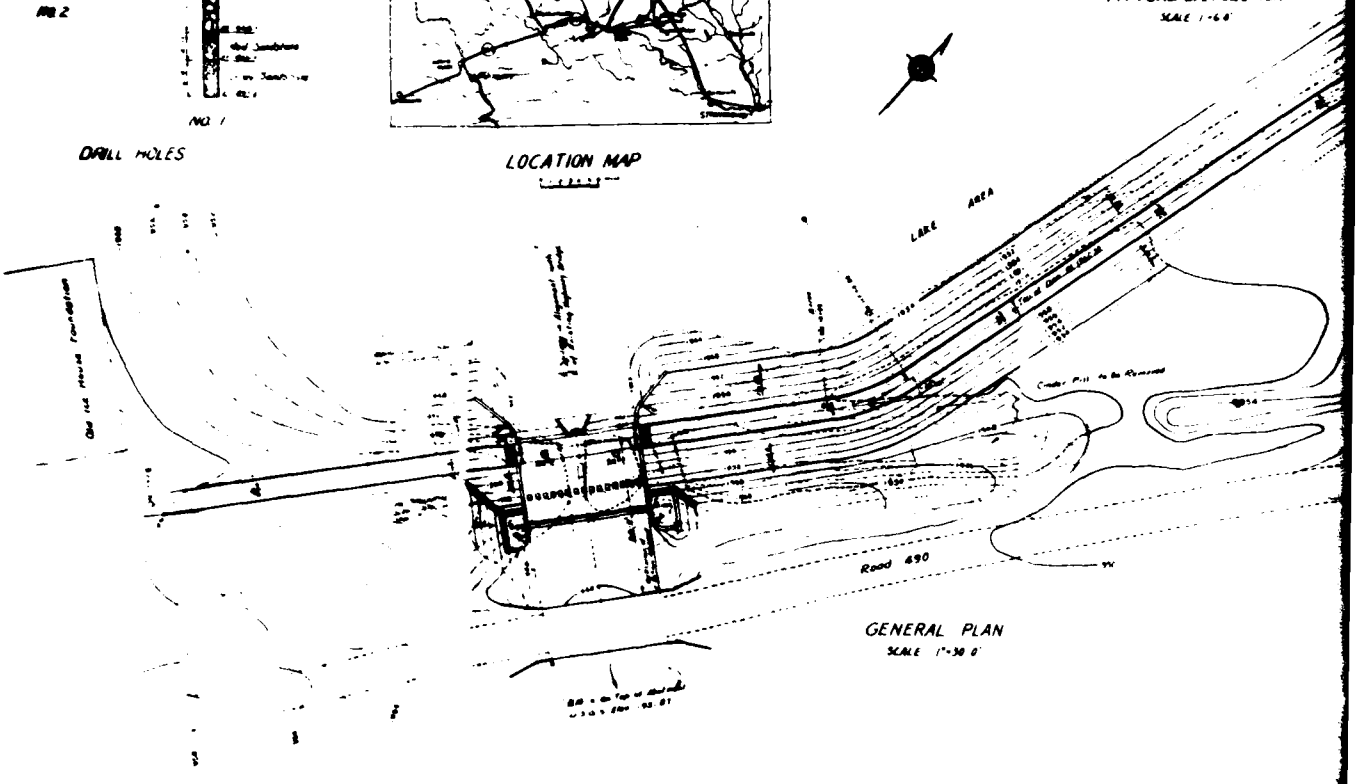
DRILL HOLES



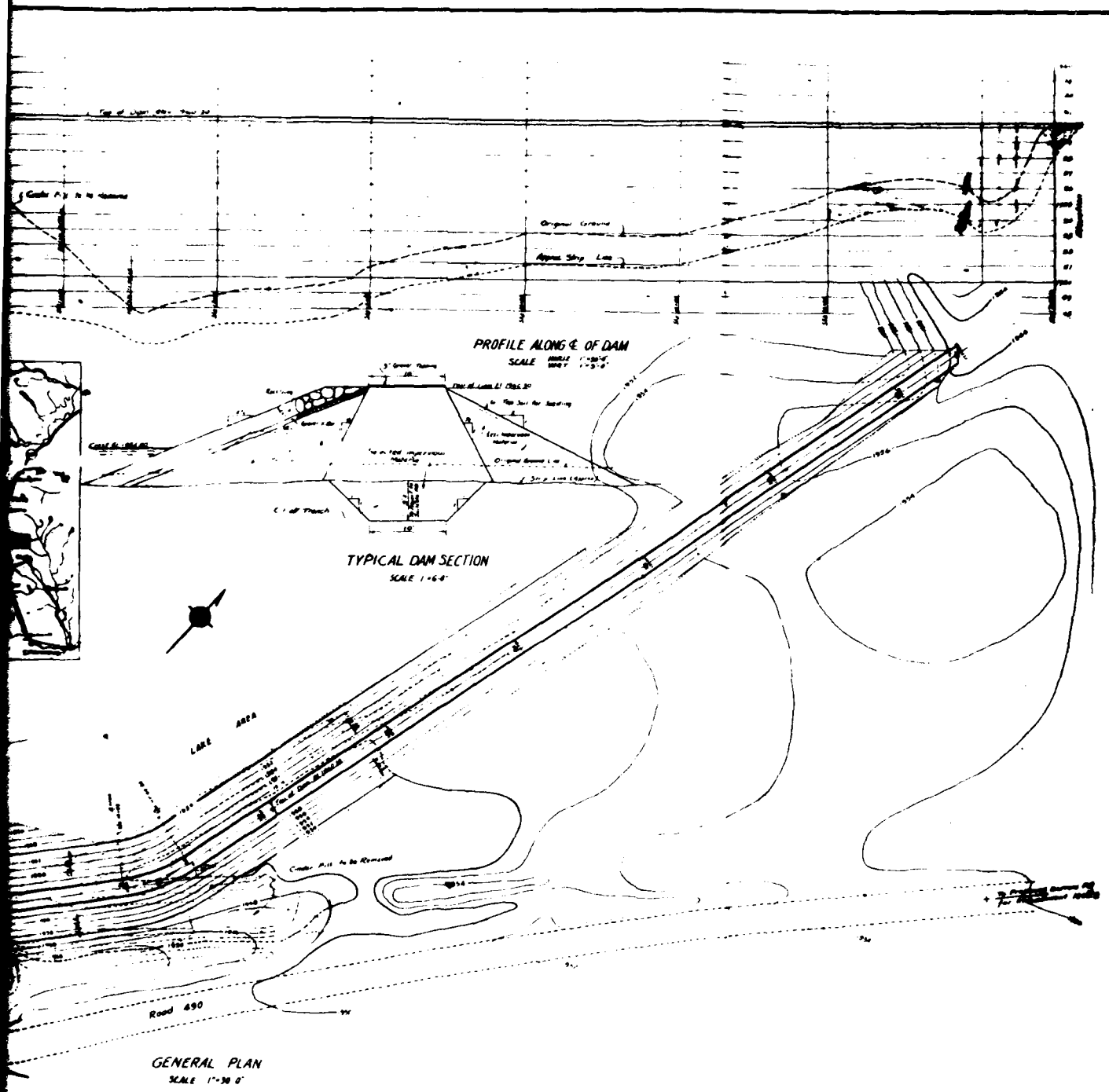
LOCATION MAP

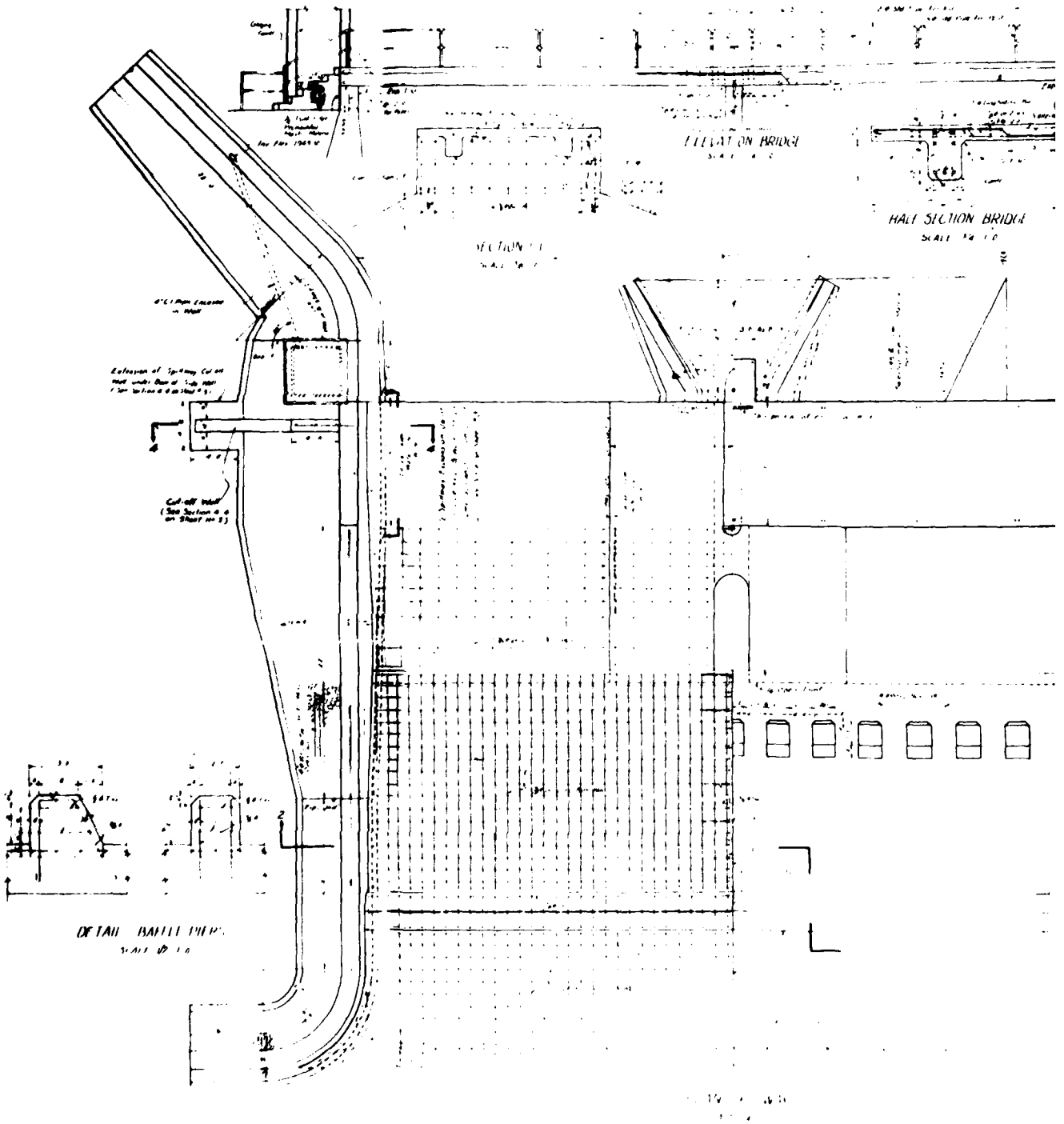


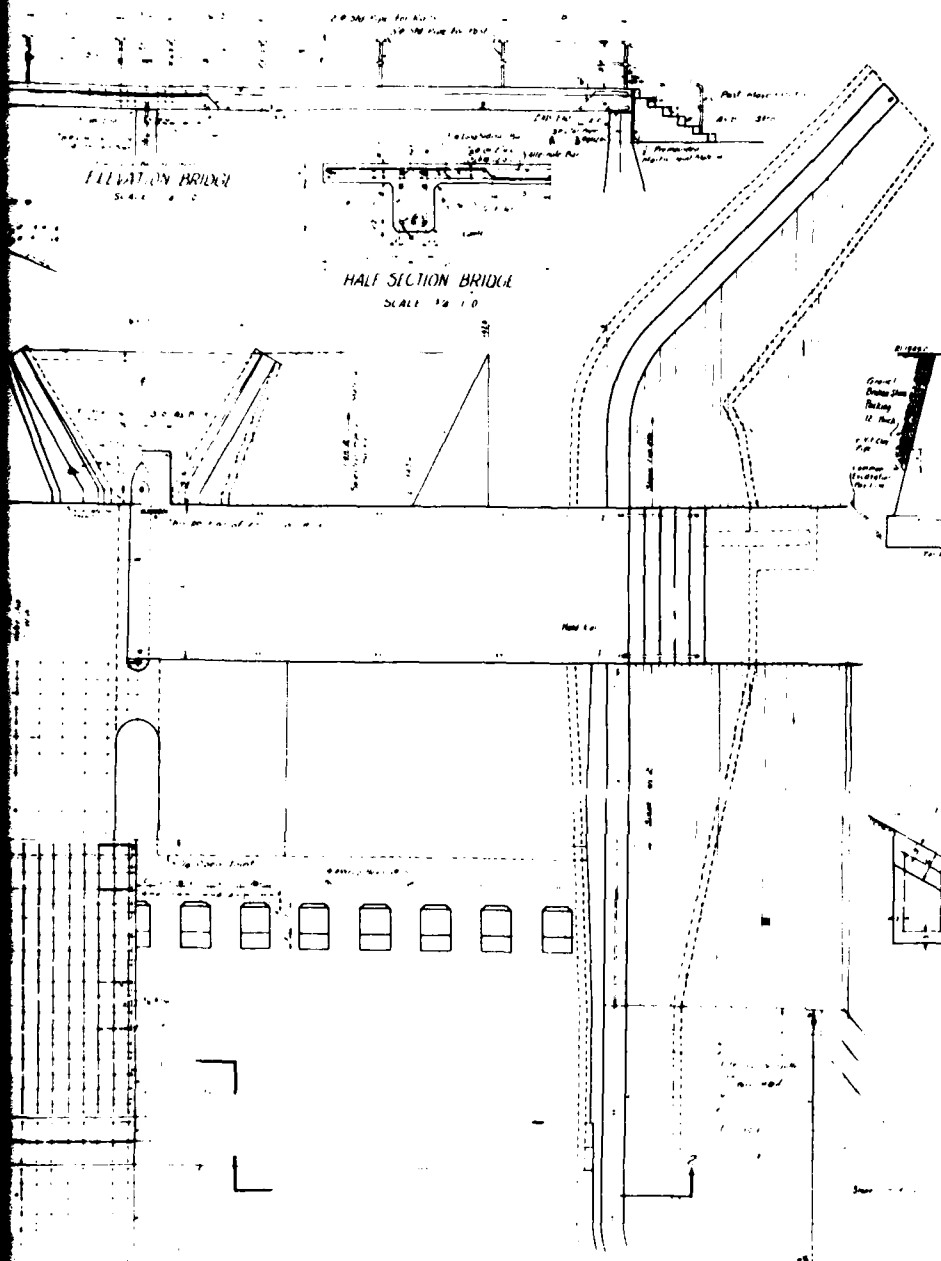
TYPICAL DAM SECTION
SCALE 1"=6'

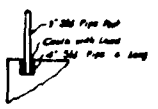


GENERAL PLAN
SCALE 1"=30'

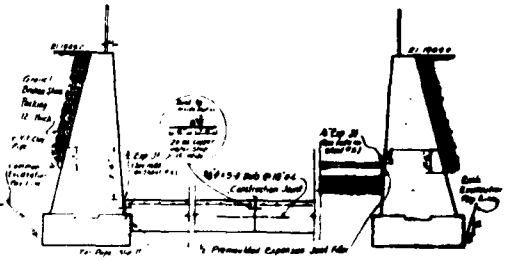



ELEVATION BRIDGE
HALF SECTION BRIDGE

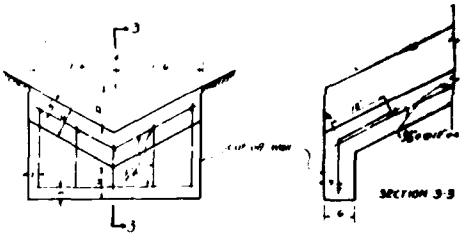




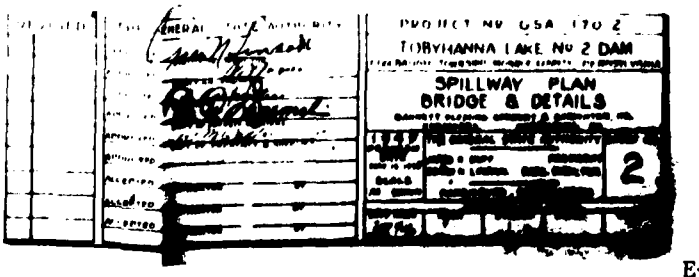
RAILING POST
NO SCALE

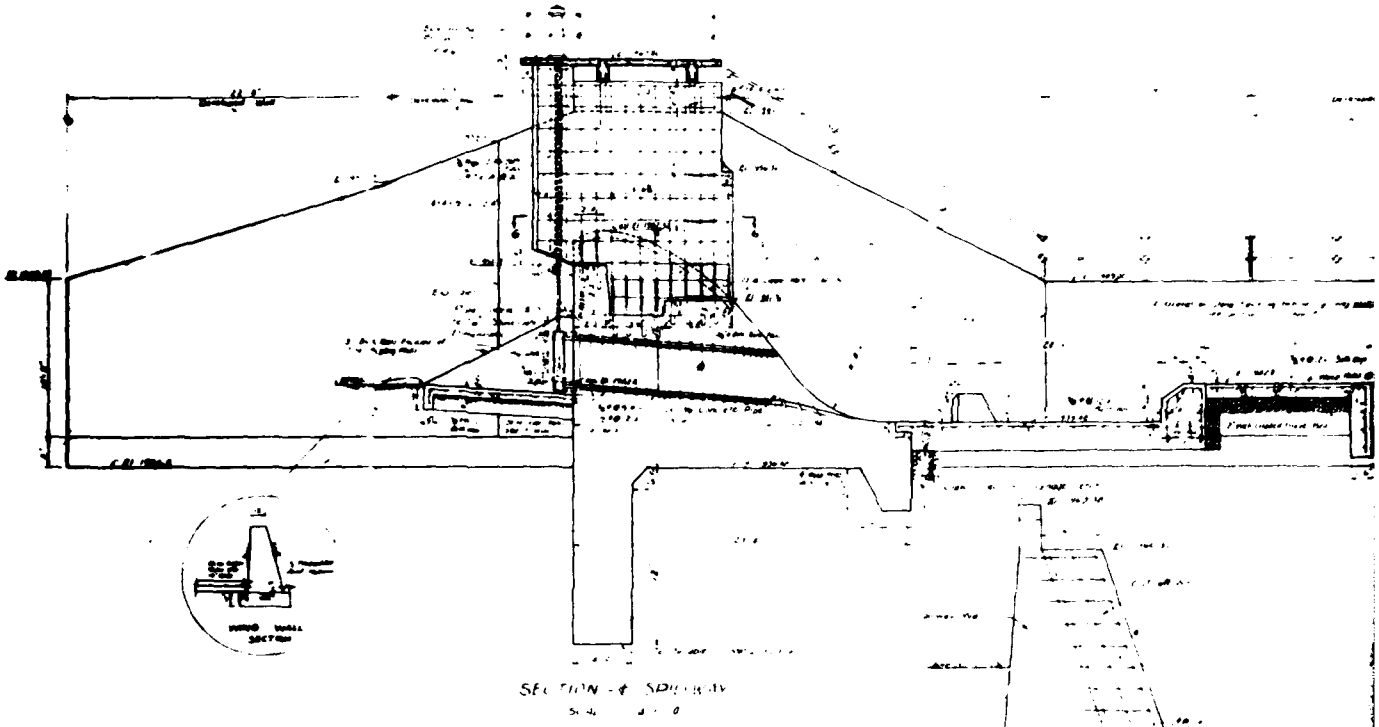


SECTION 2-2

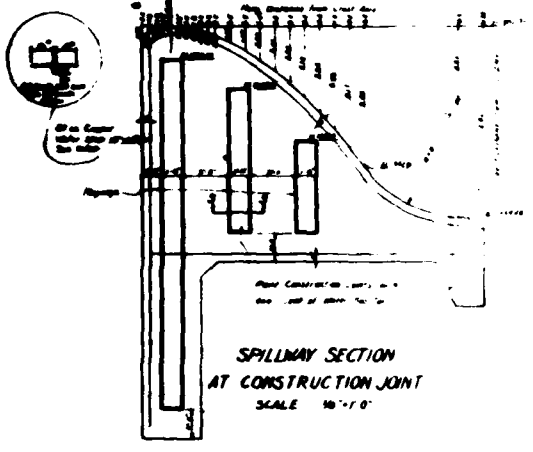


DETAIL INTERCEPTING GUTTER

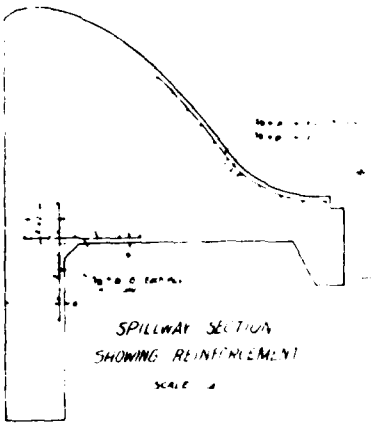




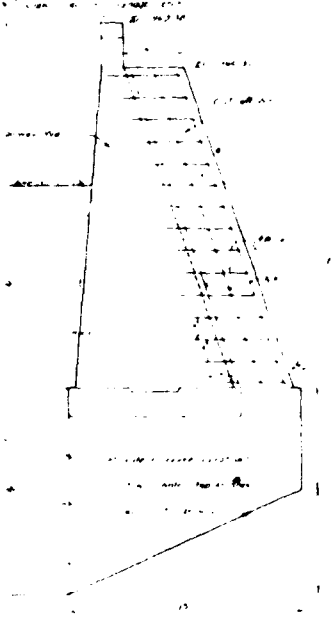
SECTION - 4 SPILLWAY



SPILLWAY SECTION
AT CONSTRUCTION JOINT
SCALE

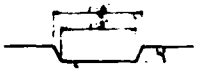


SPILLWAY SECTION
SHOWING REINFORCEMENT
SCALE

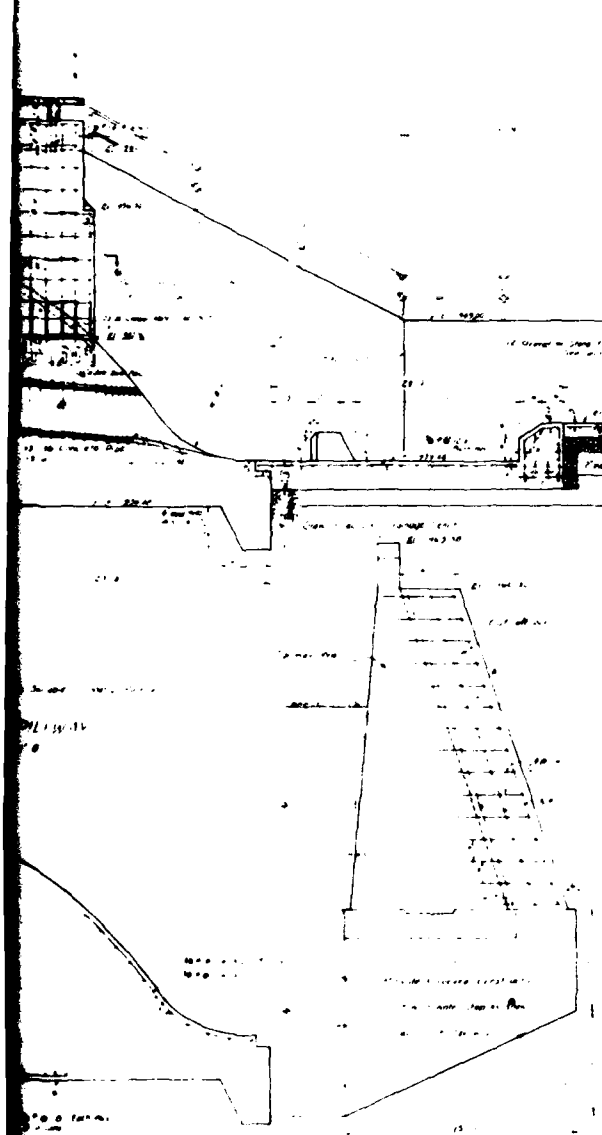


SECTION 4-4

TYPIC

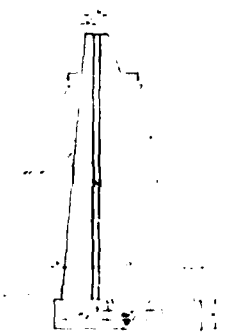


SECTION 5-5
SCALE

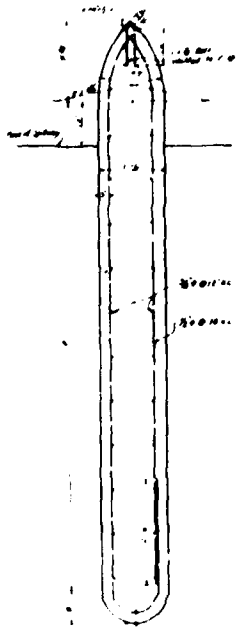


SPILLWAY SECTION
SHOWING REINFORCEMENT
SCALE

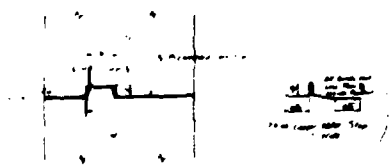
SECTION 4-4
PLAN VIEW ON SHEET NO
SCALE



TYPICAL SPILLWAY WALL SECTION
SCALE



SECTION 6-6
SCALE



SECTION 7-7
SCALE

Note

All Expansion Joints Shall be Filled to within One Inch of Exposed Face with ½ Inch Premolded Joint Material and Place One Inch Seal with Asphalt Cement Impregnated with Mineral Fiber

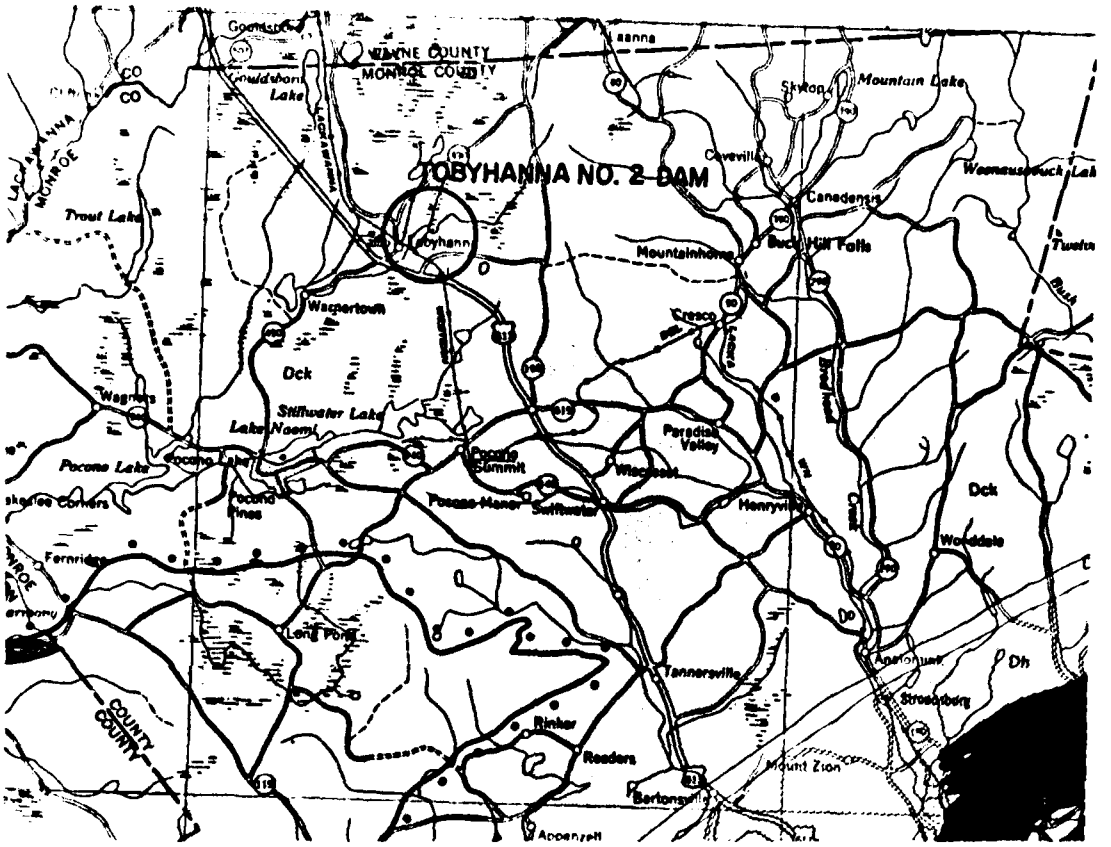
REVISED	THE GENERAL STATE AUTHORITY	PROJECT Nº GSA-170-2
		TOBYHANNA LAKE Nº 2 DAM
		SECTIONS - SPILLWAY, WALLS & BRIDGE PIER
		1950 THE GENERAL STATE AUTHORITY SHEET NO 3

APPENDIX F
GEOLOGY

General geology

Tobyhanna Lake No. 2 Dam lie within the Pocono Plateaus Section of the Appalachian Plateaus Physiographic province. This region is characterized by both broad and narrow anticlines and synclines. While drag folds and minor faulting may be common in this area, no major faulting is indicated in the area of the dam.

The bedrock underlying the lake and dam consists of the Devonian aged Catskill Formation. This is a cmoplex unit of conglomerate, sandstone, siltstone and shale. The normally well developed beds range in thickness from less than one to over fifteen feet. The usually well developed joints are closely spacead and steeply dipping. The shales disintegrate rapidly, but the sandstones, siltstones and conglomerates are fairly resistant. The rocks can form a good foundation for heavy structures if excavated to sound material and the shales and siltstones are kept water free. The interstitial porosity is low in the coarser rocks, but the joint development creates a medium overall effective porosity.



GEOLOGIC MAP OF THE AREA AROUND TOBYHANNA LAKE NO. 2 DAM

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

SCALE 1:250,000