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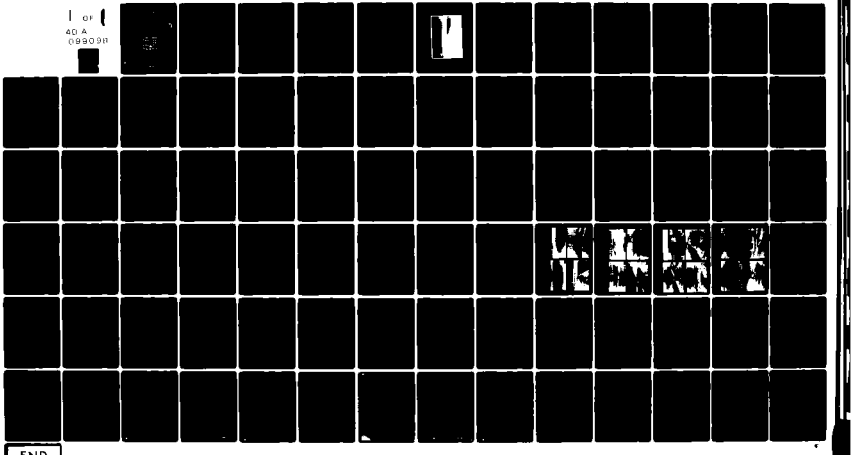

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OHIO RIVER BASIN
GLADE RUN
BUTLER COUNTY,

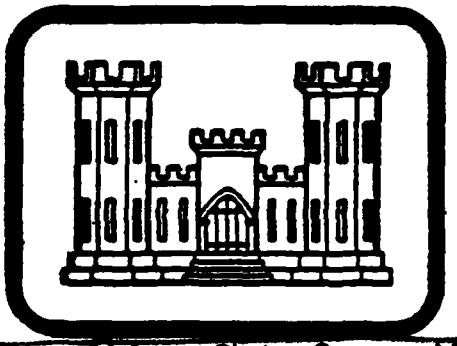
PENNSYLVANIA.

NDI No. PA 01071

PENN DER No. 10-60

National Dam Inspection Program. GLADE RUN DAM.
(NDI Number PA 01071,
PENN DER Number 10-60)
PENNSYLVANIA FISH COMMISSION.

PHASE I INSPECTION REPORT.
NATIONAL DAM INSPECTION PROGRAM



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PREPARED FOR

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

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BY

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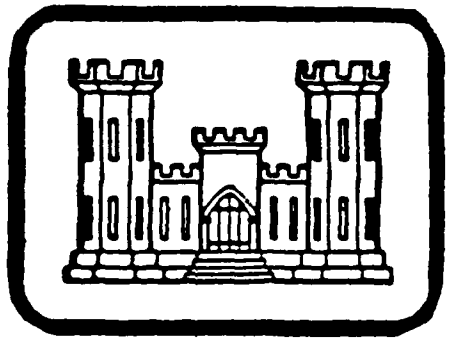
(11) MAR 81

OHIO RIVER BASIN

GLADE RUN DAM
BUTLER COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI NO. PA 1071
PennDER NO. 10-60

PENNSYLVANIA FISH COMMISSION

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

Prepared by: ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
Consulting Engineers
1000 Banksville Road
Pittsburgh, Pennsylvania 15216

Date: March 1981

PREFACE

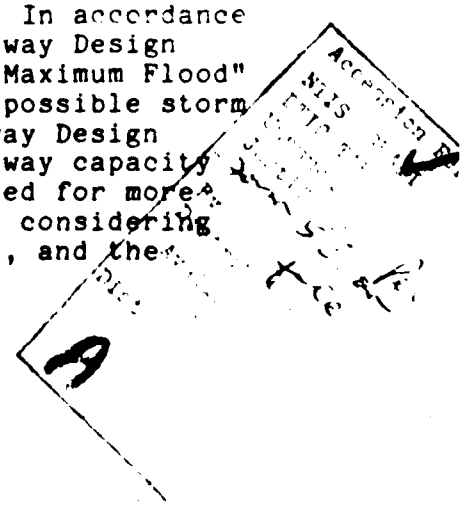
This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

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, materials testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the 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 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 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 time 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 investigations 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" (PMF) for the region (greatest reasonably possible storm runoff), or fractions thereof. The Spillway Design Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS

NAME OF DAM:	Glade Run Dam
STATE LOCATION:	Pennsylvania
COUNTY LOCATION:	Butler
STREAM:	Glade Run Tributary of Connoquenessing Creek
DATE OF INSPECTION:	2 December 1980
COORDINATES:	Lat. 40°42'59" Long. 79°53'57"

ASSESSMENT

Based on a review of available design information and visual observations of conditions as they existed on the date of the field inspection, the general condition of the Glade Run Dam is considered to be good.

This assessment is based primarily on visual observations of the embankment and appurtenant structures.

Glade Run Dam is an "intermediate" size, "high" hazard structure. Corps of Engineers guidelines recommend the Probable Maximum Flood (PMF) as the Spillway Design Flood for an "intermediate" size, "high" hazard dam. Glade Run Dam's Spillway Design Flood is the Probable Maximum Flood. Spillway capacity is "inadequate" because the non-overtopping flood discharge was found, by using the HEC-1 computer program, to be 92 percent of the PMF.

The visual inspection indicated several minor deficiencies. The deficiencies can be corrected or improved through implementation of the following recommended remedial and/or maintenance efforts.

RECOMMENDATIONS

1. Remedial Work: The Phase I investigation of Glade Run Dam disclosed several minor deficiencies which should be corrected during routine maintenance. These remedial efforts should include:

   a. Revegetation of barren areas on the embankment's upstream slope.

   b. Repair of concrete cracks, sealing of open slab joints, and removal of vegetation from slab joints.

c. Repair of the minor settlement in the concrete block pavement near the left spillway training wall.

d. Regrading of the downstream floodplain to eliminate surficial ponding of runoff.

2. Principal (and Emergency) Spillway: According to the HEC-1 Analysis the principal (and emergency) spillway is "inadequate" by Corps of Engineers' guidelines. However, the maximum embankment overtopping depth was estimated to be only 0.38 feet at the low point at the left abutment. For the observed crest profile, overtopping would occur over 165 feet of the 730 foot crest length. Duration of overtopping was calculated to be three hours.

Based on this data, and the observed well-vegetated, well-maintained embankment, it is recommended that no additional studies or embankment improvements be required.

3. Evacuation Plan: An evacuation plan should be prepared as soon as possible and incorporated into the existing warning procedure.

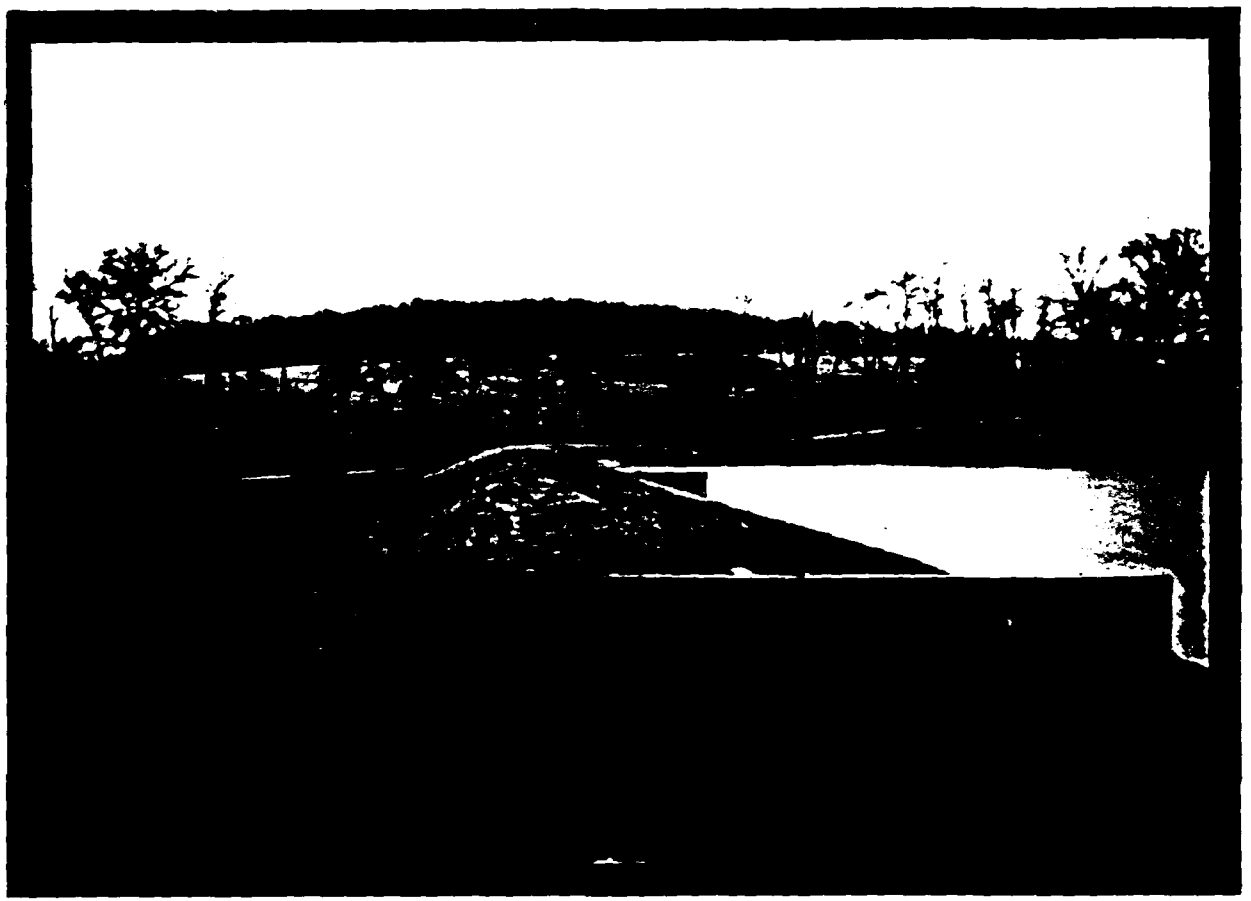
Samuel G. Mazzella — Date
Project Engineer

James P. Hannan — Date
Project Engineer

James E. Barrick, P.E. — Date
PA Registration No. 022639-E

Approved by: 5 May 81
JAMES W. PECK — Date
Colonel, Corps of Engineers
District Engineer

GLADE RUN DAM



OVERVIEW

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GLADE RUN DAM
NATIONAL I. D. No. PA 01071
PennDER No. 10-60

SECTION 1
PROJECT INFORMATION

1.1 GENERAL

a. Authority: This Phase I investigation was performed pursuant to authority granted by Public Law 92-367 (National Dam Inspection Act) to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose: The purpose of the investigation is to make a determination on whether or not the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances:

(1) Embankment: The Glade Run Dam was designed and constructed as a earthfill structure with a foundation cutoff along the centerline. The embankment (excluding spillway) is 730 feet long and has a maximum toe to crest height of 28.5 feet and a crest width of 12 feet. The embankment's upstream slope was measured to be 3.4H:1V above the waterline; the downstream slope was measured to be 2.3H:1V.

(2) Outlet Works: The outlet works consists of a 36 inch reinforced concrete box culvert with a reinforced concrete control tower. The tower is located near the center of the dam, 16 feet upstream of the axis. Flow into the conduit is controlled by white oak stop logs in the tower.

(3) Pond Drain: The reservoir can be drained by removing all of the stop logs in the outlet works control tower.

(4) Principal (and Emergency) Spillway: The principal (and emergency) spillway is a reinforced concrete open channel with ogee type weir control located near the left abutment. The weir crest is 70 feet long. The spillway discharges to a vegetated channel through a stilling basin at the downstream toe of the embankment.

(5) Freeboard Conditions: Freeboard between the principal (and emergency) spillway crest and the minimum observed elevation of the embankment crest was 5.8 feet on the date of the field inspection.

(6) Downstream Conditions: Glade Run, below Glade Run Dam, flows through a wide, moderately sloped valley for about 20.1 miles to a confluence with the Connoquenessing Creek near Zeno, Pennsylvania. The Connoquenessing Creek flows about another 47.5 miles to a confluence with the Beaver River at Ellwood City, Pennsylvania. In the first 7,000 feet below the dam, at least 10 inhabited dwellings lie on the floodplain at elevations low enough to possibly be imperiled by high flows.

(7) Reservoir: Glade Run Dam's lake is about 3,500 feet long at the operating pool elevation and has a surface area of 51 acres. When the pool is at the crest of the dam, the reservoir length increases to 6,200 feet and the surface area is about 107 acres.

(8) Watershed: The watershed contributing to Glade Run Dam's lake consistes mostly of pasture and woodland. There is also some residential development. The watershed above the dam is 3.3 square miles.

b. Location: Glade Run Dam is located in Middlesex Township, Butler County, Pennsylvania approximately 1 mile southeast of Glade Mills, Pennsylvania.

c. Size Classification: The reservoir has a maximum storage capacity of 1112 acre-feet and the dam has a toe-to-crest height of 28.5 feet. Based on the Corps of Engineers guidelines, Glade Run Dam is classified as an "intermediate" size structure.

d. Hazard Classification: Glade Run Dam is classified as a "high" hazard dam. In the event of a dam failure, at least 10 inhabited dwellings could be subjected to substantial damage and loss of more than a few lives could result.

e. Ownership: Glade Run Dam is owned by the Pennsylvania Fish Commission. Correspondence can be addressed to:

Pennsylvania Fish Commission
P. O. Box 1673
Harrisburg, Pennsylvania 17120
Attention: Mr. Ralph Abele,
Executive Director
(717) 787-6376

f. Purpose of Dam: Glade Run Dam was constructed for recreational purposes.

g. Design and Construction History: The dam was designed by T. F. O'Hara, Registered Engineer, State College, Pennsylvania in 1954. The dam was constructed by the Pennsylvania Fish Commission in 1954 and 1955.

h. Normal Operating Procedure: Glade Run Dam was designed to operate as an uncontrolled structure. Under normal operating conditions, the pool level is maintained by the ogee weir crest of the principal (and emergency) spillway.

1.3 PERTINENT DATA

a. Drainage Area — 3.3 sq. mi.

b. Discharge

Maximum Flood at Dam	Unknown
Principal (and Emergency) Spillway Capacity at Design Top of Dam	3909 cfs
Principal (and Emergency) Spillway Capacity at Current Top of Dam	3710 cfs

c. Elevation (feet above MSL)

Design Top of Dam	1124.0*
Current Top of Dam (low point)	1123.8
Principal (and Emergency) Spillway Overflow Crest	1118.0
Operating Pool	1118.0
Principal (and Emergency) Spillway Weir Crest	1118.0
Outlet Works Inlet Invert	1096.6*
Outlet Works Outlet Invert	1095.3
Embankment Downstream Toe	1095.3

d. Reservoir Length

Length of Maximum Pool	6200 feet
Length of Normal Pool	3500 feet

e. Reservoir Storage

Design Top of Dam	1134 acre-feet
Current Top of Dam	1112 acre-feet
Principal (and Emergency) Spillway Crest	612 acre-feet*

f. Reservoir Surface

Design Top of Dam	108 acres
Current Top of Dam	107 acres
Principal (and Emergency) Spillway Crest	51 acres*

g. Embankment

Type	Earth*
Length	730 feet
Height	28.5 feet
Crest Width	12 feet
Slopes	
Downstream	2.3H:1V
Upstream	3.4H:1V
Zoned Embankment	Yes*
Foundation Cutoff	Yes*
Grout Curtain	None Reported

h. Principal (and Emergency) Spillway

Type	Concrete Lined Open Channel
Flow Control	Concrete Ogee Weir
Location	Near Left Abutment
Weir Crest Length	70.0 feet
Weir Crest Elevation	1118.0

i. Outlet Works

Type	Reinforced Concrete Box Culvert with Control Tower
Location	Near Center of Dam
Inlet Invert Elevation	1096.6*
Outlet Invert Elevation	1095.3
Trash Screen	At Inlet Headwall
Conduit Lengtn	132*
Anti-Seep Collars	Yes, 4*
Controls	Stop Logs in Control Tower Upstream of Dam Axis

*Taken or derived from available engineering drawings or reports.

SECTION 2
ENGINEERING DATA

2.1 DESIGN

a. Data Available: The following written information and data may be obtained from the Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania. The information reviewed for this study included:

(1) Miscellaneous correspondence related to permit application requirements and approval conditions.

(2) Application and permit for construction of a dam and concrete spillway by the Commonweath of Pennsylvania, Pennsylvania Fish Commission.

(3) Set of design drawings by T. F. O'Hara, Registered Engineer, dated for 25 February 1954 through 2 March 1954.

(4) Specifications for dam construction, undated.

(5) Construction program progress reports by state personnel.

(6) One inspection report dated 7 August 1967 by Department of Environmental Resources personnel.

(7) Miscellaneous correspondence relating to the drawdown of the lake level in 1957, 1969, 1972, 1973 and 1974.

The following information was obtained from the Pennsylvania Fish Commission, Division of Engineering:

(1) Logs of four test borings drilled at the dam site.

(2) Analytic calculations related to seepage through the embankment and dam stability.

(3) Design calculations related to the outlet works conduit, spillway, walls and footers and control tower.

(4) Relief well schematic and measurements.

b. Design Features: The embankment and appurtenances were designed in accordance with Water and Power Resources Board criteria.

(1) Field Investigation: Four diamond core borings, twelve test pits, and some hand auger borings were performed prior to construction. Logs of the four diamond drill holes are presented on Design Drawing Sheet 2 of 4. The logs showed a layer of variegated clay immediately below the top soil. Underlying the variegated clay is a layer of silty clay which extends to bedrock. Bedrock consists of dark shale grading into a fine to medium grained sandstone. Based on this information, the state dam construction engineer recommended that the cutoff walls of the 36 inch reinforced concrete box culvert, the outlet works control tower and the piers of the spillway channel be founded on rock to reduce the possibility of settlement.

(2) Embankment: The embankment was designed as a compacted earth fill. The core and upstream portions were designated to receive class "A" material. The downstream portion beyond the core was to receive class "B" material. Class "A" was defined in the specifications as selected impervious and structurally sound material, free from vegetable matter and stone greater than six (6) inches in maximum dimension. Class "B" embankment material was defined as structurally sound material sufficiently pervious to drain the embankment, containing stones, but no vegetable matter. A three foot deep and ten foot wide cutoff trench of trapezoidal section, with 1V:1H side slopes, was to be excavated the entire length of the dam at the centerline and backfilled with Class "A" material. All embankment material was to be compacted in 4 inch lifts. Concrete block paving was to be placed on the upstream slopes three feet below and three feet above the normal pool level.

(3) Outlet Works: A 36 inch square reinforced concrete box culvert with stop log type control tower was installed through the embankment. The conduit was designed with six concrete cutoffs.

(4) Principal (and Emergency) Spillway: The spillway is a reinforced concrete lined open channel with ogee type weir flow control. The weir crest is 70 feet wide. The spillway tapers to 51 feet wide at the stilling basin. The spillway is 103 feet long from the spillway crest to the stilling basin. The stilling basin is 40 feet long and approximately 3 feet deep.

2.2 CONSTRUCTION

a. Contractor: The Pennsylvania Fish Commission constructed Glade Run Dam.

b. Construction Period: The embankment and appurtenances were constructed between January 1954 and April 1955.

c. Field Changes: The only reported change in the design of the structure during construction was the installation of a pressure relief system near the second cutoff collar downstream from the control tower. The system consisted of pumping a 6 inch diameter relief well during embankment construction. The relief well was capped upon the completion of the lake filling.

d. Construction Inspection: On-site inspection was performed by representatives of the Commonwealth of Pennsylvania periodically during construction, from 14 January 1954 through completion of the structure on 6 April 1955. Throughout construction, the work was monitored by a representative of Mr. T. F. O'Hara, the design engineer.

2.3 MODIFICATION/REPAIR

There are no reports of any modifications or major repairs to this dam since its completion in 1955.

2.4 OPERATION

According to the Water and Power Resources Board, the Pennsylvania Fish Commission is responsible for the operation of Glade Run Dam.

Performance and operation records are not maintained.

2.5 EVALUATION

a. Availability: Available design information and drawings were obtained from the Pennsylvania Department of Environmental Resources and were supplemented by information and drawings obtained from representatives of the Pennsylvania Fish Commission.

b. Adequacy: The available design information supplemented by field inspection and supporting engineering analyses presented in succeeding sections, is adequate for the purpose of this Phase I Inspection Report.

c. Validity: There appears to be no reason to question the validity of the available design information and drawings.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

a. General: The field inspection of the Glade Run Dam was performed on 2 December 1980, and consisted of:

(1) Visual observations of the embankment crest and slopes, groins and abutments;

(2) Visual observations of the outlet works and spillway including intake structures, outlet structures, approach and discharge channels and stilling basin;

(3) Visual observations of the embankment's downstream toe area including drainage channels and surficial conditions;

(4) Visual observations of downstream conditions and evaluation of the downstream hazard potential;

(5) Visual observations of the reservoir shoreline and watershed;

(6) Transit stadia surveys of relative elevations along the embankment crest centerline, spillway, and across the embankment slopes.

The visual observations were made during periods when the reservoir and tailwater were at normal operating levels.

The visual observations checklist, field plan, profiles and sections containing the observations and comments of the field inspection team are contained in Appendix A. Specific observations are illustrated on photographs in Appendix C. Detailed findings of the field inspection are presented in the following sections.

b. Dam Configuration: Glade Run Dam is an earthen impounding embankment constructed across Glade Run to form Glade Run Reservoir. The dam's discharge facilities include an outlet works for lowering the lake level and a concrete open channel chute-type spillway that maintains the normal lake level and provides discharge capacity for storm flows.

c. Embankment:

(1) Crest: On the date of inspection, the embankment crest was level and of uniform width throughout its entire length. There was no indication of offsets, depressions, or other conditions that might suggest embankment distress. The embankment crest was fully vegetated and appeared to be well-maintained.

(2) Upstream Slope: The upstream slope of the embankment was generally uniform, well vegetated and appeared to be well-maintained. The erosion protection was in good condition, although numerous open joints between the elemental blocks were observed. These openings, however, did not appear to affect the integrity of the slab.

Minor settlement of the erosion protection was noted immediately to the left of the spillway's left training wall.

Bare earth, apparently the result of pedestrian traffic, was noted adjacent to both spillway training walls.

(3) Downstream Slope: The downstream slope was uniform and well-vegetated. It gave the appearance of being well-maintained. There were no bulges, scarps, or other indications of structural instability. There was no indication of a high ground water level within the embankment.

The junctions of the embankment and the abutments were generally dry and well-maintained. There were no indications of anomalous seepage or slope instabilities on either abutment. Three significant wet spots were observed on the floodplain immediately below the embankment. Two of the wet spots appeared to be the result of surface runoff ponding in topographic lows. There was no strong indication that these wet spots were the result of subsurface water. The third wet spot, approximately 200 feet downstream of the right end of the embankment, appeared to be a ground water generated swamp with soft soils and swamp-type vegetation. No discharge from the swamp was observed, and there were no indications of sediments, siltation or movement of fine soil particles anywhere in the vicinity.

Two small depressions were noted on the floodplain just below the central portion of the toe of the embankment. Neither depression appeared to be in an active state of enlargement.

d. Outlet Works:

(1) Intake Structure: The intake structure to the outlet works could not be observed because of the lake level. However, the water level within the stop log structure indicated that the intake structure was operative.

(2) Control Tower: The observed portions of the reinforced concrete control tower were in good condition. No cracks, spalling or signs of deterioration were noted. The steel stop log guides, where visible, appeared to be well-maintained. The stop logs appeared to be in good condition; only minor leakage between stop logs was noted.

(3) Conduit: The outlet works conduit could not be observed.

(4) Outlet Structure: The outlet structure, consisting of a concrete headwall and two forty-five degree wingwalls, was in good condition. No cracks, spalling or other deterioration were noted.

Some erosion of wingwall backfill was observed.

(5) Discharge Channel: The discharge channel below the outlet structure was clear of obstructions and debris, and appeared to be capable of passing outlet works flows.

Careful inspection of the discharge channel revealed no indications of ground water seepage.

e. Principal (and Emergency) Spillway:

(1) Approach Channel: The approach channel to the spillway was clear of debris and obstructions that might hinder the discharge capacity of the concrete weir.

The concrete training walls were in good condition. There were no indications of cracking, spalling or other types of deterioration at or above the waterline. Structure joints appeared to be in good condition.

(2) Concrete Weir: The concrete weir was in good condition. The crest was level, as indicated by a uniform flow over the weir. No offsets were observed, and construction joints appeared to be in good condition.

(3) Chute: The spillway chute was in good condition. No cracks were observed in training walls or slabs, and, with one exception, the joints were in good condition. The exception was an open joint between the left wingwall and the first slope slab. The opening did not appear to represent an immediate threat to the spillway structure.

Grass and patches of vegetation were noted growing from construction joints at several locations in the chute.

The chute slab drains gave no indication of excessive flows, but performance of the drains could not be assessed because of a uniform flow in the spillway.

(4) Stilling Basin: The stilling basin was operational. There were no indications of silting or sedimentation of the stilling pool area. The endwall was level and properly aligned. The condition of concrete surfaces was good. A closed, diagonal crack was noted in the final slope slab on the right side of the spillway. There were no indications of seepage in the area immediately below the stilling basin endwall.

(5) Discharge Channel: The discharge channel was in good condition and appeared to be well-maintained. There were no trees, brush or other obstructions that might hinder the discharge of flows below the stilling basin.

f. Reservoir:

(1) Slopes: The reservoir's shoreline is generally mild to moderately sloping and mostly grassed or wooded. There were no indications of serious slope instability at or above the shoreline throughout the lower portion of the reservoir.

(2) Sedimentation: There were no indications of significant sedimentation in the reservoir, although the upper end of the reservoir was not observed.

(3) Watershed: The watershed was observed to be generally as indicated by the U.S.G.S. topographic map. Considerable recent residential development has taken place within the watershed, including the construction of two mobile home parks. This development has occurred since the most recent photo-revision (1969) of the U.S.G.S. map. No other significant new construction or mining activities were observed in the watershed.

g. Downstream Conditions:

(1) Approximately 400 feet below the stilling basin, the spillway discharge channel rejoins the original Glade Run channel, which proceeds another 300 feet before entering a culvert beneath Township Road T482. A mile and a half below the dam, Glade Run passes through the village of Glade Mills and flows under State Route 8, a major north-south highway.

(2) Floodplain Development: In the first 7000 feet below Glade Run Dam, there are at least 10 inhabited dwellings on the floodplain at elevations low enough to possibly be imperiled by high flows.

3.2 EVALUATION

The following evaluations are based on the visual observations made on 2 December 1980.

a. Embankment: The condition of the Glade Run Dam embankment was considered to be good. Only very minor deficiencies were noted, and the embankment appeared to be well-maintained.

b. Outlet Works: The outlet works was in good condition and appeared to be functional, although the performance of the inlet structure and conduit could not be observed.

c. Spillway: The spillway was in good condition, with only minor deficiencies noted.

d. Downstream Conditions: The wet areas observed on the floodplain below the dam did not appear to represent serious problems. The two wet areas closest to the dam appeared to be the result of surface runoff collecting in topographic low areas. The swampy area well below the dam gave no indication of piping conditions that might threaten the integrity of the embankment's foundation. However, the origin of the swampy condition could not be determined.

e. Hazard Potential: Based on the observed height of the dam and downstream floodplain conditions, Glade Run Dam was assigned a "high" hazard potential rating.

SECTION 4
OPERATIONAL FEATURES

4.1 PROCEDURE

Reservoir pool level is maintained by the crest of the principal (and emergency) spillway. Normal operating conditions do not require a dam tender.

4.2 MAINTENANCE OF DAM

The embankment and appurtenances are maintained by the Pennsylvania Fish Commission. Maintenance reportedly consists of periodically repairing eroded areas and making miscellaneous repairs as necessary.

An inspection and maintenance manual has been prepared by the Fish Commission's Division of Engineering. The manual includes descriptions of the various appurtenances and a maintenance checklist.

4.3 INSPECTION OF DAM

The Pennsylvania Fish Commission is required by the State of Pennsylvania to inspect the dam annually and make needed repairs.

4.4 WARNING PROCEDURE

A warning procedure has been prepared by the Pennsylvania Fish Commission to provide for notification of authorities and downstream residents upon threat of a dam failure. Responsibility for developing an evacuation plan has been assigned to the Butler County Emergency Management Agency (EMA).

4.5 EVALUATION

The maintenance program should be continued. The operation, maintenance/inspection procedures, and warning procedure developed for this dam appear adequate. However, periodic monitoring of the swamp on the downstream floodplain should be incorporated into the proposed inspection routine.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data: The Glade Run Dam has a watershed of 2,112 acres which is vegetated primarily by woodland and pasture. The watershed is about 12,000 feet long and 8,000 feet wide and has a maximum elevation of 1,320 feet (MSL). At normal pool, the dam impounds a reservoir with a surface area of about 51 acres and a storage volume of 612 acre-feet. Normal pool level is maintained at Elevation 1118 by the overflow crest of the principal (and emergency) spillway. The impoundment has an outlet works conduit with inlet invert Elevation 1096.6. For the purpose of this hydrologic analysis, the outlet works was assumed to be inoperative.

Design spillway capacity and embankment freeboard were made sufficient to accommodate 3,909 cubic feet per second which was considered sufficient for this structure and watershed at the time of design. Glade Run Dam's spillway capacity for the observed cross-sections and existing freeboard conditions was computed to be 3,710 cfs.

No additional hydrologic calculations were found relating reservoir/spillway performance to the Probable Maximum Flood (PMF) or fractions thereof.

b. Experience Data: Records are not kept of reservoir level or rainfall amounts. There is no record or report of the embankment ever being overtopped.

c. Visual Observations: On the date of the field inspection, no serious deficiencies were observed that would prevent the principal (and emergency) spillway from functioning.

d. Overtopping Potential: Overtopping potential was investigated through the development of the Probable Maximum Flood for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. The Corps of Engineers guidelines recommend the Probable Maximum Flood (PMF) as the Spillway Design Flood (SDF) for "intermediate" size, "high" hazard dams. Therefore the Spillway Design Flood is the PMF.

Hydrometeorological Report No. 33 indicates the adjusted 24 hour Probable Maximum Precipitation (PMP) for the subject site is 19.1 inches.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version 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 and key input data for this program are discussed briefly in Appendix D.

The peak inflow to the Glade Run Dam was determined by HEC-1 to be 4,560 cfs for the SDF.

An initial pool elevation of 1118.0 was assumed prior to commencement of the storm.

e. Spillway Adequacy: The capacity of the combined reservoir and spillway system was determined to be 92 percent of the PMF by HEC-1. According to Corps of Engineers' guidelines, Glade Run Dam's spillway is "inadequate".

SECTION 6
STRUCTURAL STABILITY

6.1 AVAILABLE INFORMATION

a. Design and Construction Data: All available design documentation, calculations and other data received from the Pennsylvania Department of Environmental Resources and the Pennsylvania Fish Commission were reviewed.

Embankment stability analyses were performed by Pennsylvania Fish Commission design engineers utilizing information from test borings and assumed material parameters.

The available information indicated the following:

(1) Stability against headwater pressure, factor of safety = 3.12.

(2) Stability against downstream horizontal shear, factor of safety = 6.03.

(3) Stability against sudden drawdown upstream horizontal shear, factor of safety = 4.75.

(4) Stability against shear failure in the foundation, factor of safety = 13.3.

There was no information available on any type of circular arc stability analyses.

The embankment was designed as a homogenious compacted earth fill with cutoff core. The core and upstream portion were to be of more impervious material than the downstream portion. All embankment material was to be compacted in four inch lifts.

Inspection reports by state personnel during the course of construction did not indicate any significant changes in design plans although a relief well for dewatering the foundation was required to complete the outlet works conduit construction.

b. Operating Records: There are no written operating records or procedures for this dam.

c. Post-Construction Changes: There are no reported port-construction modifications to this dam.

d. Visual Observations: The field inspection disclosed no evidence of instability of either the embankment or spillway.

No direct embankment seepage or marked vegetal changes indicating embankment seepage were observed during the field inspection. However, swampy conditions were observed below the toe of the dam.

e. Performance: There has been no indication or report of any problem related to performance of this dam over its twenty-six year life.

6.2 EVALUATION

a. Design Documents: The design documentation was, by itself, considered inadequate to evaluate the structures. Structural and seepage calculations were reviewed.

The stability analyses performed would be inadequate by current design standards for a structure of this size and capacity.

b. Embankment: Based on results of the visual observations of embankment slopes, materials, seepage and ground water conditions, Glade Run Dam appears to have an adequate margin of safety against sliding.

c. Principal and (Emergency) Spillway: Based on the visual observations, the principal (and emergency) spillway structure appeared to be stable.

d. Underflow Pipes: On the date of the field inspection, the outlet works appeared to be structurally sound.

e. Seismic Stability: According to the Seismic Risk Map of the United States, Glade Run Dam is located in Zone 1 where damage due to earthquakes would most likely be minor.

A dam located in Seismic Zone 1 may be assumed to present no hazard from an earthquake provided static stability conditions are satisfactory and conventional safety margins exist. No calculations were developed to verify this assessment, however.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS

7.1 ASSESSMENT

a. Evaluation:

(1) Embankment: Glade Run Dam's embankment is considered to be in good condition. This is based on visual observations that revealed only minor deficiencies.

(2) Outlet Works: The condition of the outlet works is considered to be good, although the intake structure and conduit could not be inspected.

(3) Principal (and Emergency) Spillway: The condition of the principal (and emergency) spillway is considered to be fair. This is based on its "inadequate" capacity rating determined using the HEC-1 computer program and its observed satisfactory physical condition.

b. Adequacy of Information: The information available on design, construction, operation and performance history in combination with visual observations and hydrology and hydraulic calculations was sufficient to evaluate the embankment and appurtenant structures in accordance with the Phase I investigation guidelines.

c. Urgency: Recommendations should be implemented as recommended in paragraph 7.2.

d. Necessity for Further Studies: None.

7.2 RECOMMENDATIONS

a. Remedial Work: The Phase I investigation of Glade Run Dam disclosed several minor deficiencies which should be corrected during routine maintenance. These remedial efforts should include:

(1) Revegetation of barren areas on the embankment's upstream slope.

(2) Repair of concrete cracks, sealing of open slab joints, and removal of vegetation from slab joints.

(3) Repair of the minor settlement in the concrete block pavement near the left spillway training wall.

(4) Regrading of the downstream floodplain to eliminate surficial ponding of runoff.

b. Principal (and Emergency) Spillway: According to the HEC-1 Analysis, the principal (and emergency) spillway is "inadequate" by Corps of Engineers' guidelines. However, the maximum embankment overtopping depth was estimated to be only 0.38 feet at the low point at the left abutment. For the observed crest profile, overtopping would occur over 165 feet of the 730 foot crest length. Duration of overtopping was calculated to be three hours.

Based on this data, and the observed well-vegetated, well-maintained embankment, it is recommended that no additional studies or embankment improvements be required.

c. Evacuation Plan: An evacuation plan should be prepared as soon as possible, and incorporated into the existing warning procedure.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL OBSERVATIONS CHECKLIST I
(NON-MASONRY IMPOUNDING STRUCTURE)

Name Dam Glade Run County Butler State Pennsylvania National ID # PA 001071

Type of Dam Earth Hazard Category High

Date of Inspection 2 December 1980 Weather Cloudy, cool Temperature 45°F

Pool Elevation at Time of Inspection 1118.1 (MSL)
Tailwater at Time of Inspection 1095.3 (MSL)

Inspection Personnel:

J. E. Barrick, P.E.	Ackenheil & Associates, Project Manager and Hydrologist
J. P. Hannan	Ackenheil & Associates, Geotechnical Engineer
S. G. Mazzella	Ackenheil & Associates, Civil Engineer
E. J. Grindell, P.E.	Pennsylvania Fish Commission
L. Busack	Pennsylvania Department of Environmental Resources
P. Saunders	Pennsylvania Department of Environmental Resources

Recorder J. E. Barrick

GEO Project G80138 P
PennDER I.D. No. 10-60

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT SLOPES	None observed. Minor discontinuity of slope immediately above outlet works outlet structure. Vehicle access area.	
SLOUGHING OR EROSION OF ABUTMENT SLOPES	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The crest of the embankment appeared to be level. No depressions or unevenness were observed. The horizontal alignment of the embankment crest appeared to be proper. No anomalous offsets or changes in alignment were observed along the crest.	
RIPRAP FAILURES	None observed.	
SETTLEMENT	A minor amount of settlement was observed in the upstream slope's erosion protection immediately to the left of the spillway's left training wall.	

EMBANKMENT (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT	The right abutment consists of an asphalt-paved roadway that provides access from the park entrance to a parking area above the dam. The abutment area was in good condition, and showed no signs of instability or anomalous seepage. Minor erosion of the roadway's shoulder was observed. The left abutment consists of the original valley hillside. The junction of the embankment and the abutment was in good condition. There were no signs of abutment instability, erosion, or anomalous seepage.	
JUNCTION OF EMBANKMENT AND SPILLWAY	The junction of the embankment and the spillway was generally in good condition. Bare soil was exposed on the upstream slope of the embankment at both training walls of the spillway. The condition appeared to be the result of pedestrian traffic.	
ANY NOTICEABLE SEEPAGE	None observed.	
DRAINS	None observed.	
CONCRETE EROSION PROTECTION	The erosion protection on the upstream slope of the embankment consisting of concrete block paving was generally in good condition. A considerable number of open joints were observed between the cement block units that comprised the erosion protection. However, these appeared to be long standing, and did not appear to affect the durability of the erosion protection surface. Some grass was noted	

EMBANKMENT (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE EROSION PROTECTION (continued)	growing through the open joints immediately above the waterline. The grass was recently mowed, and did not appear to affect the structural integrity of the erosion protection surface. Minor separation of the concrete block paving and the outlet works control tower was observed.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	A painted benchmark was observed on the right wingwall of the outlet works outlet structure but no elevation data was available.	
OBSERVATION WELLS	None observed.	
WEIRS	The spillway contains two weirs that could be used for flow monitoring purposes if required. The two are: (1) a flow control ogee type weir at the crest of the spillway, and (2) the stilling basin endwall at the lower end of the spillway.	
PIEZOMETERS	None observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
INTAKE STRUCTURE	The outlet works intake structure was not observed because of the pool elevation of the lake.	
CONTROL TOWER	The outlet works flow control occurs at a reinforced concrete drop structure located in the upstream slope of the embankment. The structure contains removable stop logs that permit control of the reservoir surface. Concrete and steel components were in good condition. No significant cracks or deterioration were observed. Minor leakage was occurring between a few of the stop logs.	
CONDUIT	The outlet works discharge conduit could not be observed. It appeared to be operative, as stop log leakage flows were being discharged through the conduit to the discharge channel below the dam.	
OUTLET STRUCTURE	The outlet works outlet structure is a concrete headwall with 45 degree wingwalls that direct outlet works conduit flows into the discharge channel below the dam. The concrete surfaces were in good condition with no significant cracks or deterioration. Some erosion of wingwall backfill was noted on both sides of the structure. The condition was not serious.	

OUTLET WORKS (CONTINUED)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
DISCHARGE CHANNEL	The outlet works discharge channel consists of an open channel excavated into the floodplain below the dam. The channel was generally clear and free of obstructions, and appeared capable of passing flows that might discharge through the outlet works. Close examination of the channel did not reveal any indication of seepage.	
EMERGENCY GATE	None observed.	

PRINCIPAL (AND EMERGENCY) SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The principal (and emergency) spillway concrete ogee weir was in good condition. No cracks, spalling, or construction joint distress were observed.	
APPROACH CHANNEL	The principal (and emergency) spillway approach channel was clear and free of debris and obstructions that might hinder flow to the concrete ogee weir. The training walls of the approach channel were observed to be in good condition.	
DISCHARGE CHANNEL	The principal (and emergency) spillway discharge channel was in good condition. No cracking, spalling or significant joint distress were observed anywhere along the discharge channel. An open joint was observed at the junction of the left wingwall and first slope slab. The condition did not appear to represent an immediate threat to the integrity of the spillway structure. Grass and weeds were observed growing from a number of spillway construction joints. Spillway slab drains appeared to be functional, though a uniform flow of water in the spillway obscured observation of performance of these drains.	

PRINCIPAL (AND EMERGENCY) SPILLWAY (CONTINUED)

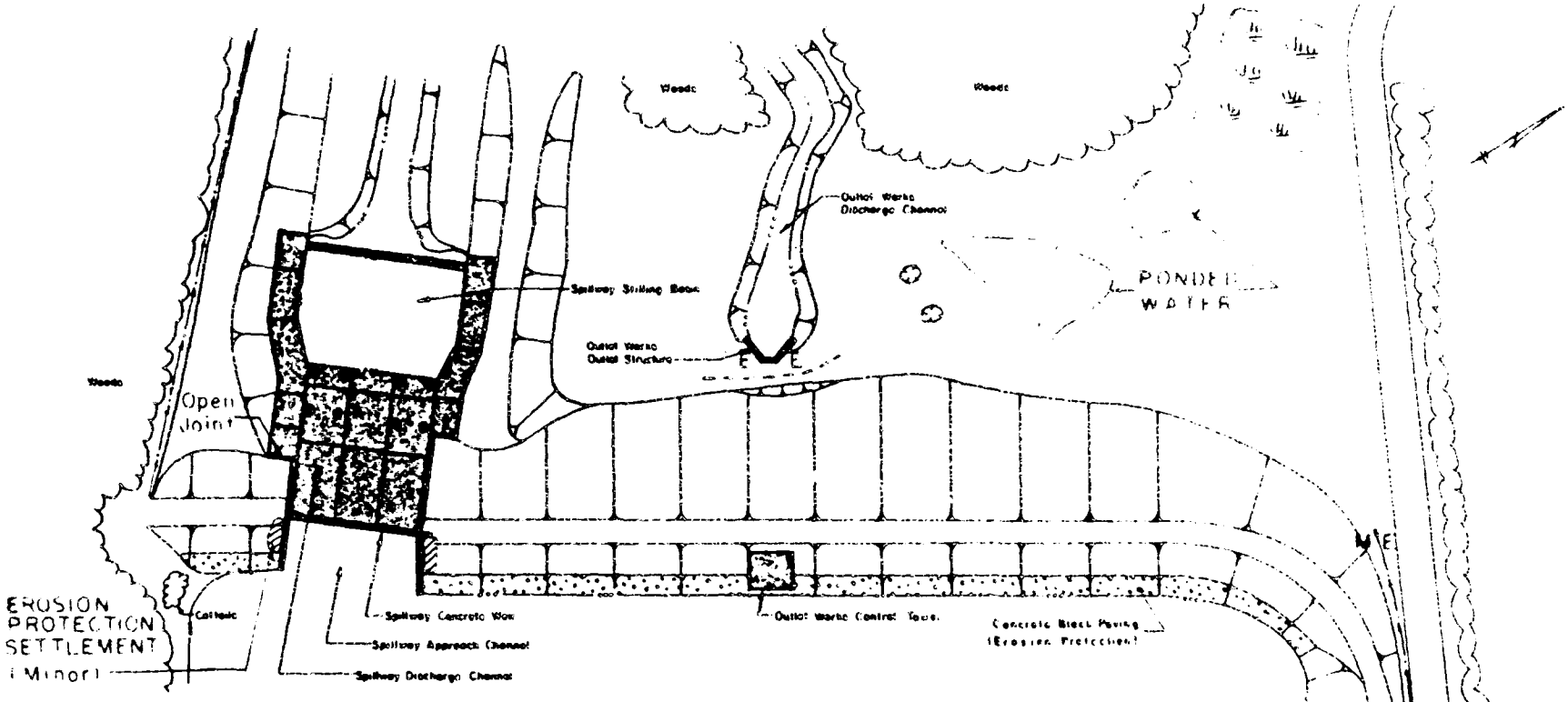
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STILLING BASIN	The principal (and emergency) spillway stilling basin appeared to be in functional condition. No significant amounts of sediment or debris were observed in the stilling basin, and the endwall was level and properly aligned. A closed, diagonal crack was observed in the last slope slab on the right side of the spillway. No strong evidence of seepage was noted in the spillway discharge channel immediately below the stilling basin endwall.	
DISCHARGE CHANNEL	The principal (and emergency) spillway discharge channel, below the stilling basin, was in good condition. No obstructions were observed in the channel that would hinder discharge of spillway flows. Discharge channel slopes were well vegetated, and there were no signs of slope instability.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes of the reservoir range from mild to moderate, and were generally tree and grass-covered. No significant signs of reservoir slope instability were observed.	
SEDIMENTATION	Extent unknown.	
WATERSHED	The watershed was observed to be generally as indicated by the U.S.G.S. topographic map. No significant new construction or mining activities were noted anywhere in the watershed. However, a considerable number of new, single-family dwellings were observed throughout the watershed that were not shown on the latest photo-revised U.S.G.S topographic map (1969). Also, two new mobile home subdivisions were observed in the watershed.	

DOWNSTREAM CONDITIONS

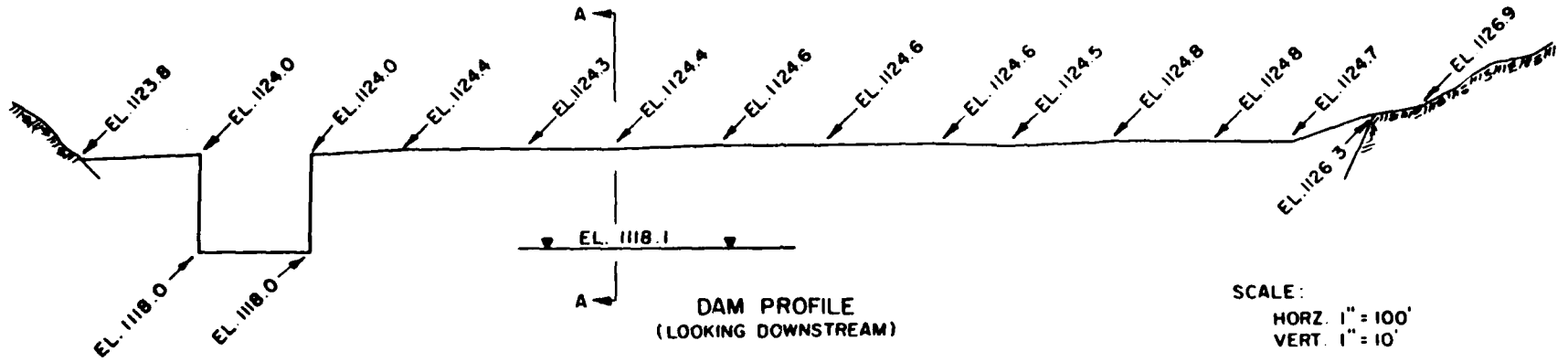
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CHANNEL CONDITIONS (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel below the spillway is an excavated trapezoidal open channel that has grassed slopes and appeared to be well maintained. Approximately 400 feet below the stilling basin, the discharge channel returns to the original Glade Run stream channel, which passes beneath Township Road T482 approximately 700 feet below the stilling basin.	
EMBANKMENT TOE AREA	Three significant wet spots were observed on the floodplain immediately below the embankment. Two of the wet spots (those closest to the embankment) appeared to be the result of surface runoff collecting in topographic low areas. There were no strong indications that these wet spots were the result of foundation seepage. The third wet spot, approximately 200 feet downstream from the embankment, appeared to be the result of ground water conditions rather than surface drainage conditions. However, origin of the swampy conditions could not be determined. Two small depressions were noted on the floodplain immediately below the embankment. Neither appeared to be an active condition.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	At least ten inhabited dwellings lie on the Glade Run floodplain at elevations low enough to possibly be imperiled by high flows in the first 7,000 feet below the dam.	



LEGEND

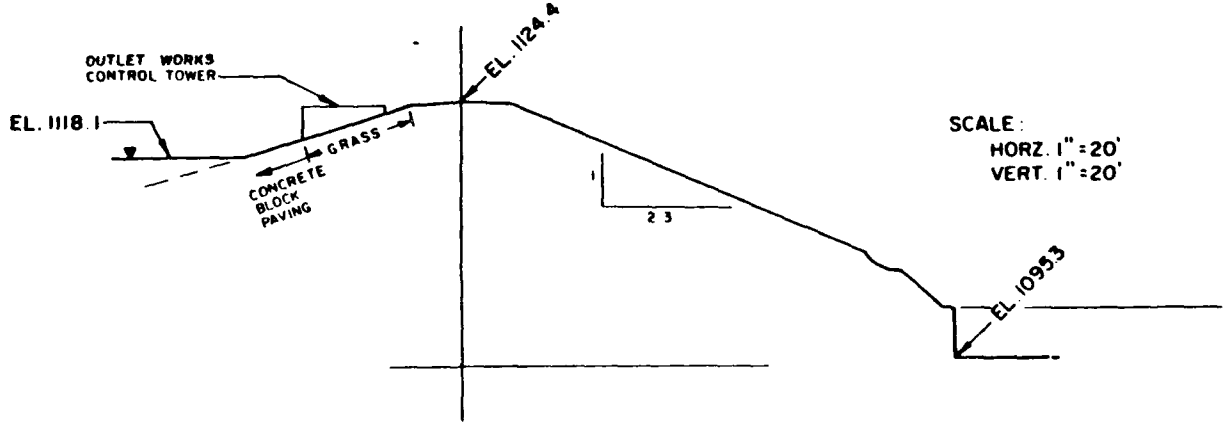
Y	IMPOUNDING EMBANKMENT SLOPE	E	EROSION
Y	OTHER SLOPE	ME	MINOR EROSION
—...—	STREAM OR SHORELINE		DEPRESSION
—→—	SURFACE DRAINAGE COURSE		SPILLWAY DRAIN
	BARREN AREA		CONSTRUCTION JOINT VEGETATION
	CONCRETE STRUCTURE		EROSION PROTECTION
— — —	FOOT PATH OR TRAIL		SWAMP OR MARSH

DATE: MARCH 1981	GLADE RUN DAM NATIONAL DAM INSPECTION PROGRAM	FIELD SKETCH
SCALE: NONE		
DR: JF CK: JEB	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS GEO SYSTEMS, INC. 1000 RANKSVILLE RD PITTSBURGH PA 15216	
DWG. NO. 80138P-1		



DAM PROFILE
(LOOKING DOWNSTREAM)

SCALE:
HORZ. 1" = 100'
VERT. 1" = 10'



SCALE:
HORZ. 1" = 20'
VERT. 1" = 20'

SECTION A-A

DATE: MARCH 1981		GLADE RUN DAM NATIONAL DAM INSPECTION PROGRAM	FIELD PROFILE and SECTION
SCALE: AS SHOWN			
DR: JF	CK:	ACKENHEIL & ASSOCIATES CONSULTING GEO SYSTEMS, INC. ENGINEERS 1000 BANKSVILLE RD./PITTSBURGH, PA. 15216	
DWG. NO. 80138P-2			

A13

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Glade Run Dam
NDI. No. PA 01071

ITEM	REMARKS
*Design Drawings	Design drawings by T. F. O'Hara, Registered Engineer, State College, Pennsylvania including: Sheet No. 1 Topographic Map Sheet No. 2 General Plan and Sections Sheet No. 3 Spillway Details Sheet No. 4 Outlet Tower and Culvert
As-Built Drawings	None available.
Regional Vicinity Map	U.S.G.S. 7-1/2 Minute Valencia, Pennsylvania Quadrangle Map.
*Construction History	Constructed between January 1954 and April 1955; Contractor not reported. Periodic progress reports available in PennDER files by state personnel. See Miscellaneous, below.
*Typical Sections of Dam	See Design Drawings.
*Outlets-Plan Details Constraints Discharge Ratings	See Design Drawings.

ITEM	REMARKS
Rain/Reservoir Records	None reported.
*Design Reports	"Report upon the Application of the Commonwealth of Pennsylvania, Pennsylvania Fish Commission", dated 12 March 1954, prepared by the Chief, Division of Dams, for the Water and Power Resources Board.
**Geology Reports	Test Boring Records for Holes 1 through 4, Pennsylvania Drilling Company, Pittsburgh, Pennsylvania, 5 - 8 January 1954.
**Design Computations	Structural design of conduit, footer under weir wall, weir wall at end of stilling basin, control tower, retaining walls.
**Hydrology and Hydraulics	Spillway capacity and outlet works box culvert capacity calculations.
**Dam Stability	Stability calculations - headwater pressure, downstream horizontal shear, sudden drawdown, upstream horizontal shearing, shearing stress in foundation, sliding of spillway paving.
**Seepage Studies	Seepage analysis, indicating flow of 0.00001 cubic feet per lineal foot of dam.
*Materials Investigations, Borings Records, Laboratory, Field	Twelve test pits, seven hand auger holes and four diamond core borings: See Sheet Nos. 1 and 2, Design Drawings.

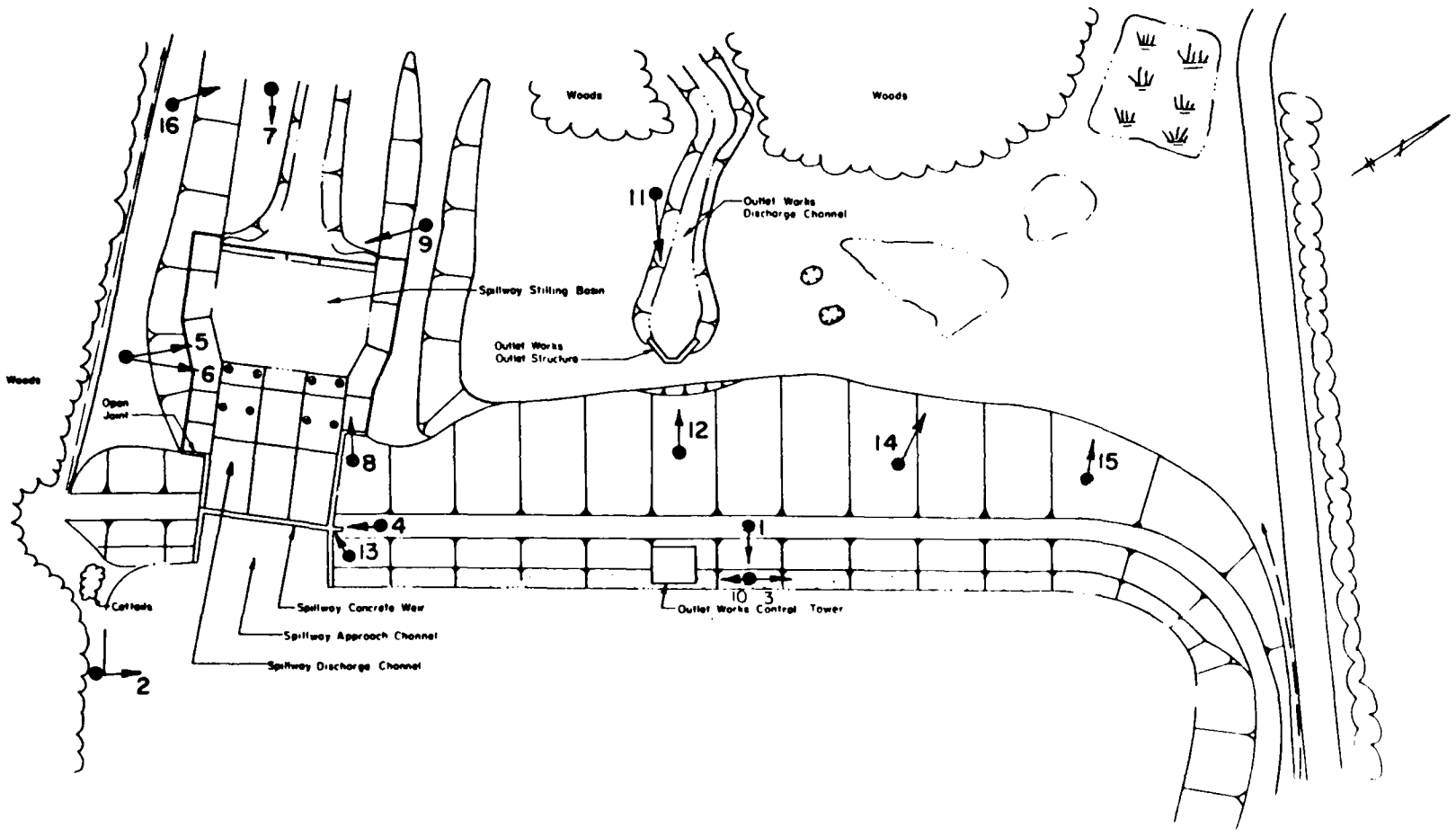
ITEM	REMARKS
Post-Construction Surveys of Dam	None available.
*Borrow Sources	On site.
Monitoring Systems	None reported.
Modifications	None reported.
High Pool Records	None reported.
Post-Construction Engineering Studies and Reports	None available.
Maintenance, Operation Records	None available.
*Spillway-Plan Sections Details	See Design Drawings above.
*Operating Equipment Plans and Details	See Design Drawings above.
*Specifications	"Specifications for Construction of Glade Run Lake and Dam, Middlesex Township, Butler County, Pennsylvania."

ITEM	REMARKS
*Miscellaneous	Miscellaneous correspondence involving application requirements and approval conditions including: Application for permission to "construction a new earth dam with concrete spillway" by the Pennsylvania Fish Commission, dated 8 March 1954. Requests for permission for lake drawdown in 1957, 1969, 1972, 1973 and 1974. One inspection report by Division of Dams and Encroachments personnel, dated 7 August 1967.
*Construction Reports	One preconstruction report and three construction reports by Bureau of Dams personnel, dated from 19 January 1954 through 12 April 1955.
Prior Accidents or Failure of Dam Reports	None reported.

*Information and data may be obtained from the PennDER, Harrisburg, Pennsylvania
**Information and data may be obtained from the Pennsylvania Fish Commission, Division of Engineering, Bellefonte, Pennsylvania

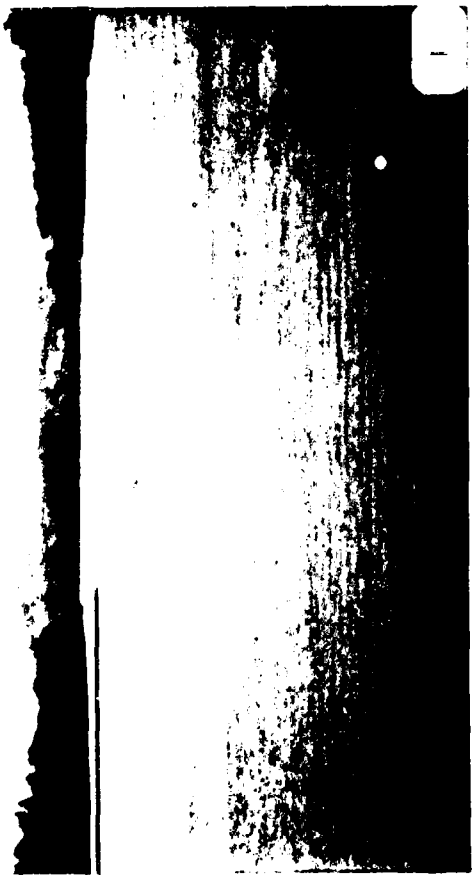
APPENDIX C

PHOTOGRAPHS



DATE: MARCH 1981	GLADE RUN DAM NATIONAL DAM INSPECTION PROGRAM	
SCALE: NONE		
DR: JF CK: JFR	A. C. ACKENHEIL & ASSOCIATES, INC CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD	
DWG NO. ROVMP 4		

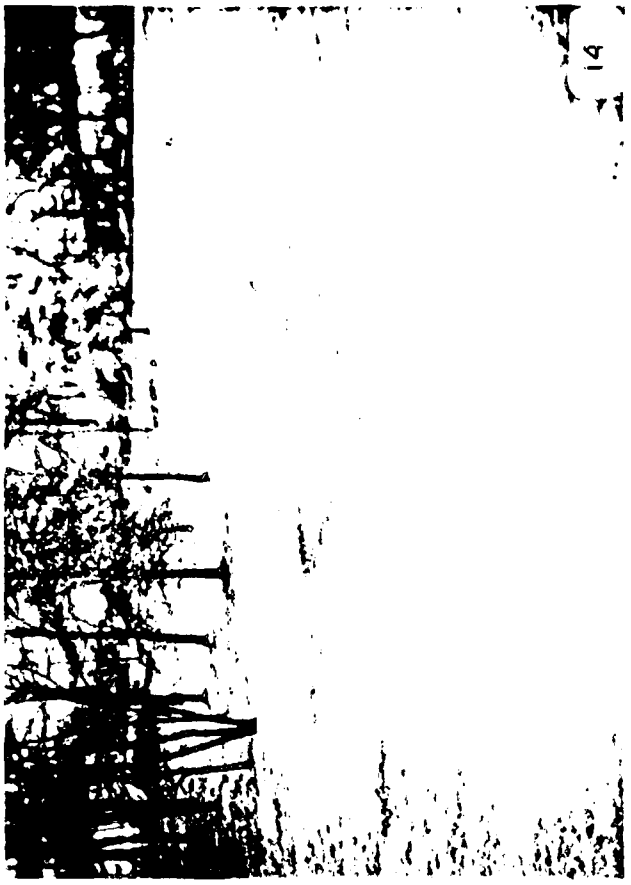
GLADE RUN DAM



GLADE RUN DAM

GLADE RUN DAM

GLADE RUN DAM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PHOTOGRAPH DESCRIPTIONS

Photo 1 Reservoir Overview taken from embankment crest.

Photo 2 Upstream Embankment Slope Overview showing right portion of Principal (and Emergency) Spillway entrance, concrete block paving, and outlet works control tower.

Photo 3 Upstream Embankment Slope with close-up of grass cover and concrete block paving (erosion protection).

Photo 4 Embankment Crest and Spillway showing portion of the embankment to the left of the Principal (and Emergency) Spillway. Also note the Spillway weir, left Spillway training wall, and concrete block paving on upstream slope.

Photo 5 Downstream Floodplain Note stilling basin's slope slabs, outlet works discharge channel (center), and embankment toe (right).

Photo 6 Downstream Embankment Slope Note transition between vertical spillway training wall (right) and slope slab in foreground.

Photo 7 Principal (and Emergency) Spillway Overview.

Photo 8 Principal (and Emergency) Spillway Discharge Channel Overview

Photo 9 Stilling Basin Endwall and Weir.

Photo 10 Outlet Works Control Tower. Note separation between concrete block paving and right corner of tower.

Photo 11 Downstream Embankment Slope and Outlet Works Outlet Structure Note slope discontinuity above outlet structure.

Photo 12 Outlet Works Discharge Channel

Photo 13 Spillway Training Wall Key Note slight erosion of upstream slope's grass cover (lower right corner).

Photo 14 Downstream Floodplain Showing one of three wet spots beyond the toe of the embankment.

Photo 15 Downstream Floodplain Showing swampy conditions beyond the toe of the embankment.

Photo 16 Downstream Floodplain including houses and Township Road T482. Principal (and Emergency) Spillway discharge channel is in foreground.

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology: The dam overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version, July, 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. 33" 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 to estimate 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 analyses.

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

3. Routing: Reservoir routing is accomplished by using Modified Puls 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 Probable Maximum Flood (PMF)** the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

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

**Runoff estimated to occur as result occurrence of a PMP.

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominately woodland and pasture with some residential development.

ELEVATION-TOP NORMAL POOL (STORAGE CAPACITY): 1118 (612 acre-feet)

ELEVATION-TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1123.8 (1112 acre-feet)

ELEVATION-MAXIMUM DESIGN POOL: 1124

ELEVATION-TOP DAM: Design=1124, Observed Minimum=1123.8

OVERFLOW SECTION

a. Elevation 1118.0*
b. Type Concrete Ogee Weir
c. Width 2 feet
d. Length 70 feet
e. Location Spillover Left Abutment
f. Number and Type of Gates None

OUTLET WORKS

a. Type 36 inch x 36 inch (inside dimensions) RC box culvert
b. Location Through center of dam
c. Entrance Invert 1096.6*
d. Exit Invert 1095.3
e. Emergency Drawdown Facilities Stop logs in Control Tower

HYDROMETEOROLOGICAL GAGES

a. Type None
b. Location N/A
c. Records None

MAXIMUM REPORTED NON-DAMAGING DISCHARGE None reported

*Elevation 100.0 on the drawings in Appendix C is estimated to be approximately U.S.G.S. El. 1120.

HEC-1 DAM SAFETY VERSION
HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Glade Run Dam NDI ID NO. PA 01071

Probable Maximum Precipitation (PMP)	23.9*
Drainage Area	3.3 sq. mi.
Reduction of PMP Rainfall for Data Fit	0.8 (23.9)
Reduce by 20%, therefore PMP rainfall =	19.1 inches

Adjustments of PMF for Drainage Area (Zone 7)

6 hrs.	102%
12 hrs.	120%
24 hrs.	130%
48 hrs.	140%

Snyder Unit Hydrograph Parameters

Zone	27**
C_p	0.4
C_t	2.7
L	2.3 mile
L_{ca}	0.8 mile
$t_p = C_t (L \cdot L_{ca})^{0.3}$ =	3.2 hours

Loss Rates

Initial Loss	1.0 inch
Constant Loss Rate	0.05 inch/hour

Base Flow Generation Parameters

Flow at Start of Storm	1.5 cfs/sq.mi=4.95 cfs
Base Flow Cutoff	0.05 x Q peak
Recession Ratio	2.0

Overflow Section Data

Crest Length	70 feet
Freeboard	5.8 feet
Discharge Coefficient	3.04-3.95
Exponent	1.5
Discharge Capacity	3710 cfs

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* Hydrometerological Report 33

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

ACKENHEIL & ASSOCIATES
GEO Systems, Inc.
1006 Banksville Road
PITTSBURGH PA 15216
(412) 531-7111

Sheet _____ of _____

Job GLADE RUN DAM Job No 80138-P

Subject DATA INPUT

Made By, SKM Date 25 Feb 81 Checked _____ Date _____

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT

STRTL = 1 INCH
CNSTL = 0.05 INCHES/HOUR
STRTQ = 1.5 CFS/mi^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

ELEVATION - AREA - CAPACITY RELATIONSHIPS

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

AT ELEVATION 1118.0

INITIAL STORAGE = 612 ACRE-FEET

POND SURFACE AREA = 51 ACRES

AT ELEVATION 1120 AREA = 85.4 ACRES

AT ELEVATION 1140 AREA = 229.6 ACRES

FROM THE CONIC METHOD OF RESERVOIR VOLUME

FLOOD HYDROGRAPH PACKAGE HEC-1

DAM SAFETY VERSION (USERS MANUAL)

$$H = \frac{3V}{A} = \frac{3(612)}{51} = 36$$

ELEVATION WHERE AREA EQUALS ZERO

1118 - 36 = 1082.

$A	0	51	85.4	229.6
$E	1082	1118.0	1120	1140

ACKENHEIL & ASSOCIATES
GEO Systems, Inc.
1000 Banksville Road
PITTSBURGH PA 15216
(412) 531-7111

Sheet _____ of _____

Job GLADE Run Dam Job No 60139.7

Subject DATA INPUT

Made By JDH Date 11/19/82 Checked SGM Date 2/[illegible]/83

Overtop Parameters

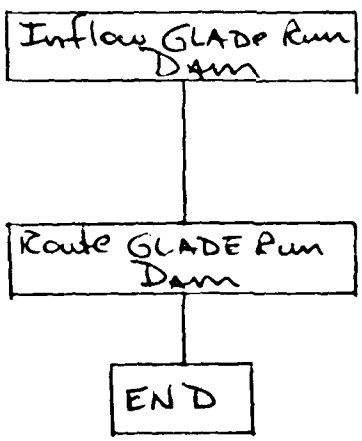
Top of Dam Elevation (minimum) = 1123.8

Length of Dam (Excluding Spillway) = 736

Coefficient of Discharge = 3.1

L_{max} = 826 V_{max} = 1126.5

Program Schedule



Sheet _____ of _____

ACKENHEIL & ASSOCIATES
GEO Systems, Inc.
1000 Banksville Road
PITTSBURGH PA 15216
(412) 531-7111

Job GLADE RUN DAM Job No 80138P

Subject SPILLWAY RATING CURVE

Made By JPH Date 11/18/80 Checked SEM Date 2/9/81

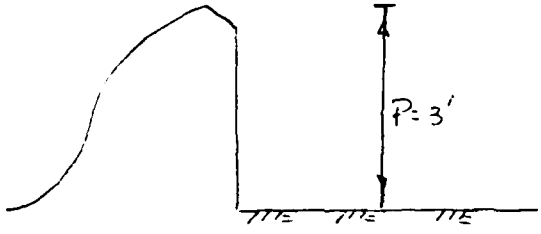
$Q = CLH^{1.5}$

$H_o = 6'$

$C_o = 3.8$

$P/H_o = 3/6 = 0.5$

$L = 70'$



NOT TO SCALE

ANALYSIS TAKEN FROM DESIGN OF SMALL DAMS, USBR

ELEVATION	HEAD	H_e/H_o	C_o	C/C_o	C	Q
1118.0	0	0	3.8	0	0	0
1118.5	0.5	0.08		0.800	3.04	75.2
1119.0	1.0	0.17		0.842	3.20	224.0
1119.5	1.5	0.25		0.866	3.29	423.1
1120.0	2.0	0.33		0.884	3.36	665.2
1120.5	2.5	0.42		0.904	3.44	951.8
1121.0	3.0	0.50		0.920	3.50	1273.1
1121.5	3.5	0.58		0.936	3.56	1631.7
1122.0	4.0	0.67		0.950	3.61	2021.6
1122.5	4.5	0.75		0.965	3.67	2452.4
1123.0	5.0	0.83		0.978	3.72	2911.4
1124.0	6.0	1.00		1.000	3.80	3909.4
1125.0	7.0	1.17		1.023	3.89	5043.1
1126.0	8.0	1.33		1.040	3.95	6256.5

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

```
    1              A1       NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLADE RUN DAM
    3              A3       PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD
    4              B    300       0      30       0       0       0       0       0      -4       0
    5              B1     5
    6              J      1       3       1
    7              J1    1.      .5      .4
    8              K      0       1                                       1
    9              K1       INFLOW HYDROGRAPH FOR GLADE RUN DAM
   10              M      1       1     3.3             3.3                                       1
   11              P             23.9     102     120     130     140
   12              T                                                     1.0     .05
   13              W    3.2    0.40
   14              X   -1.5   -0.05     2.0
   15              K      1       2                                       1
   16              K1       ROUTING AT GLADE RUN DAM
   17              Y                                       1       1
   18              Y1     1                                             612.      -1
   19              Y4 1118.0  1118.5  1119.0  1119.5  1120.0  1120.5  1121.0  1121.5  1122.0  1122.5
   20              Y4 1123.0  1124.0  1125.0  1126.0
   21              Y5     0.    75.2   224.0   423.1   665.2   951.8  1273.1  1631.7  2021.6  2458.4
   22              Y5 2911.4  3909.4  5043.1  6256.5
   23              $A     0.    51.    85.4   229.6
   24              $E  1082.  1118.   1120.   1140.
   25              $$  1118.
   26              $D 1123.8    3.09    1.5   730.
   27              $L    54.   134.    165.    357.    614.    751.    774.    792.    816.    828.
   28              $V 1123.8  1124.0  1124.2  1124.4  1124.6  1124.8  1125.0  1125.0  1126.0  1126.5
   29              K     99
   30              A
   31              A
   32              A
   33              A
   34              A
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
ROUTE HYDROGRAPH TO 2
END OF NETWORK


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


RUN DATE: 23 FEB 81
RUN TIME: 12. 7.21

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLADE RUN DAM
PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	30	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1
RTIOS= 1.00 0.50 0.40

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR GLADE RUN 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	3.30	0.0	3.30	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.90	102.00	120.00	130.00	140.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 3.20 CP=0.40 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 68 END-OF-PERIOD ORDINATES, LAG= 3.19 HOURS, CP= 0.40 VOL= 1.00

14.	52.	107.	168.	221.	257.	266.	252.	230.	2[illegible].
197.	181.	167.	153.	141.	130.	120.	110.	101.	93.
86.	79.	73.	67.	62.	57.	52.	48.	44.	41.
37.	35.	32.	29.	27.	25.	23.	21.	19.	18.
16.	15.	14.	13.	12.	11.	10.	9.	8.	8.
7.	7.	6.	6.	5.	5.	4.	4.	4.	3.
3.	3.	3.	2.	2.	2.	2.	2.		

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	26.77	24.35	2.42	104252.
										(680.)	(619.)	(61.)	(2952.09)

****

HYDROGRAPH ROUTING

ROUTING AT GLADE RUN DAM

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

ROUTING DATA

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

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	612.	-1

STAGE	1118.00	1118.50	1119.00	1119.50	1120.00	1120.50	1121.00	1121.50
	1122.00	1122.50	1123.00	1124.00	1125.00	1126.00		
FLOW	0.0	75.20	224.00	423.10	665.20	951.80	1273.10	1631.70
	2021.60	2452.40	2911.40	3909.40	5043.10	6256.50		

SURFACE AREA=	0.	51.	85.	230.
CAPACITY=	0.	612.	747.	3780.
ELEVATION=	1082.	1118.	1120.	1140.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1118.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PEAK OUTFLOW IS [illegible] AT TIME [illegible]

PEAK OUTFLOW IS [illegible] AT TIME [illegible]

PEAK OUTFLOW IS [illegible] AT TIME [illegible]

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	RATIO 1	RATIO 2	RATIO 3
				RATIOS APPLIED TO FLOWS		
HYDROGRAPH AT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ROUTED TO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1118.	1118.00	1123.80
STORAGE	612.	612.	[illegible]
OUTFLOW	0.	0.	[illegible]

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
1.00	1124.18	0.38	1154.	4197.	3.00	44.50	0.0
0.50	1122.01	0.0	929.	2001.	0.0	44.50	0.0
0.40	1121.45	0.0	877.	1594.	0.0	44.50	0.0

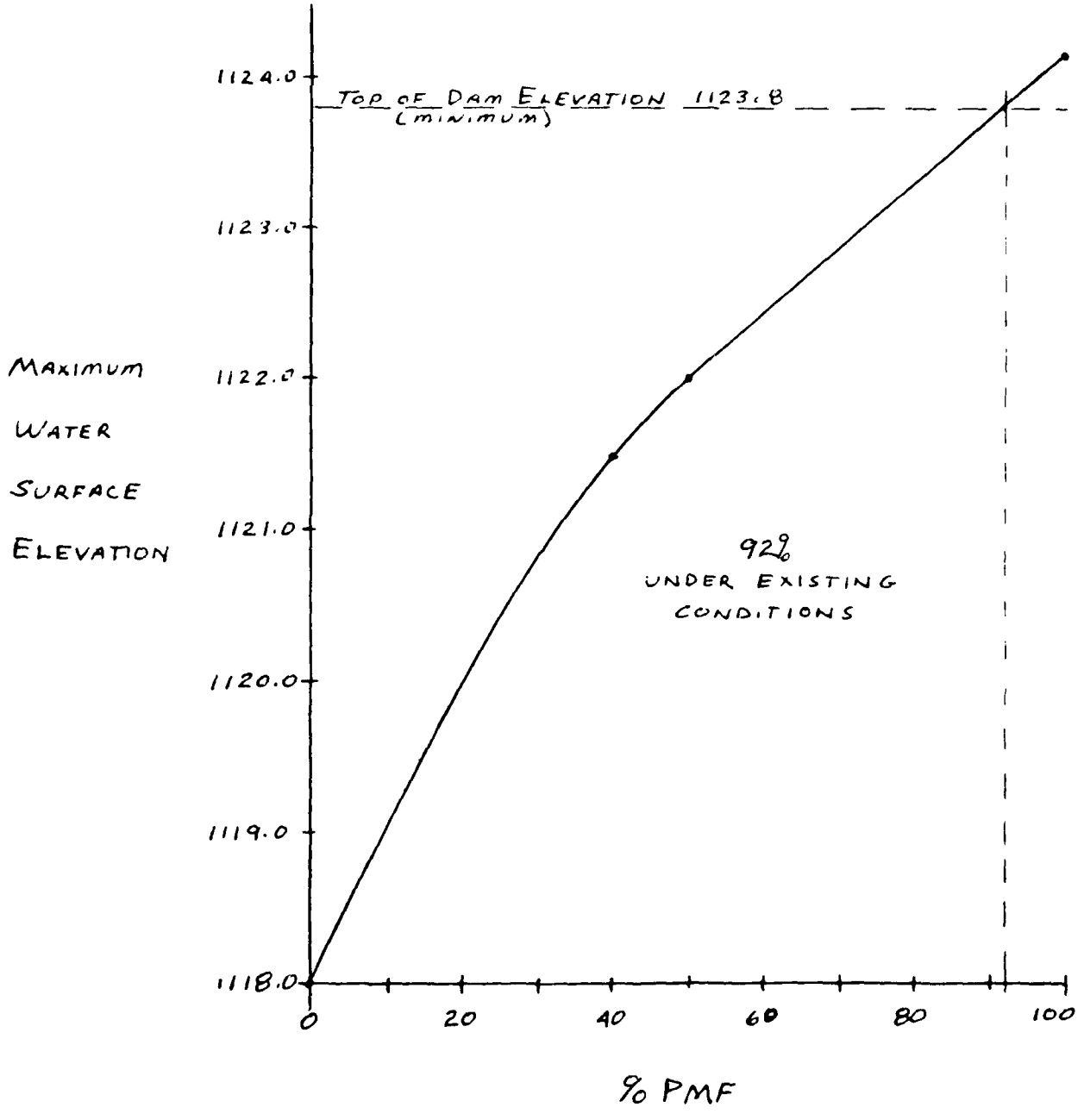
Sheet _____ of _____

ACKENHEIL & ASSOCIATES
GEO Systems, Inc.
1[illegible] Banksville Road
PITTSBURGH PA 15216
(412) 531-7111

Job GLADE RUN DAM Job No 80138-P

Subject SPILLWAY/RESERVOIR RATING CURVE

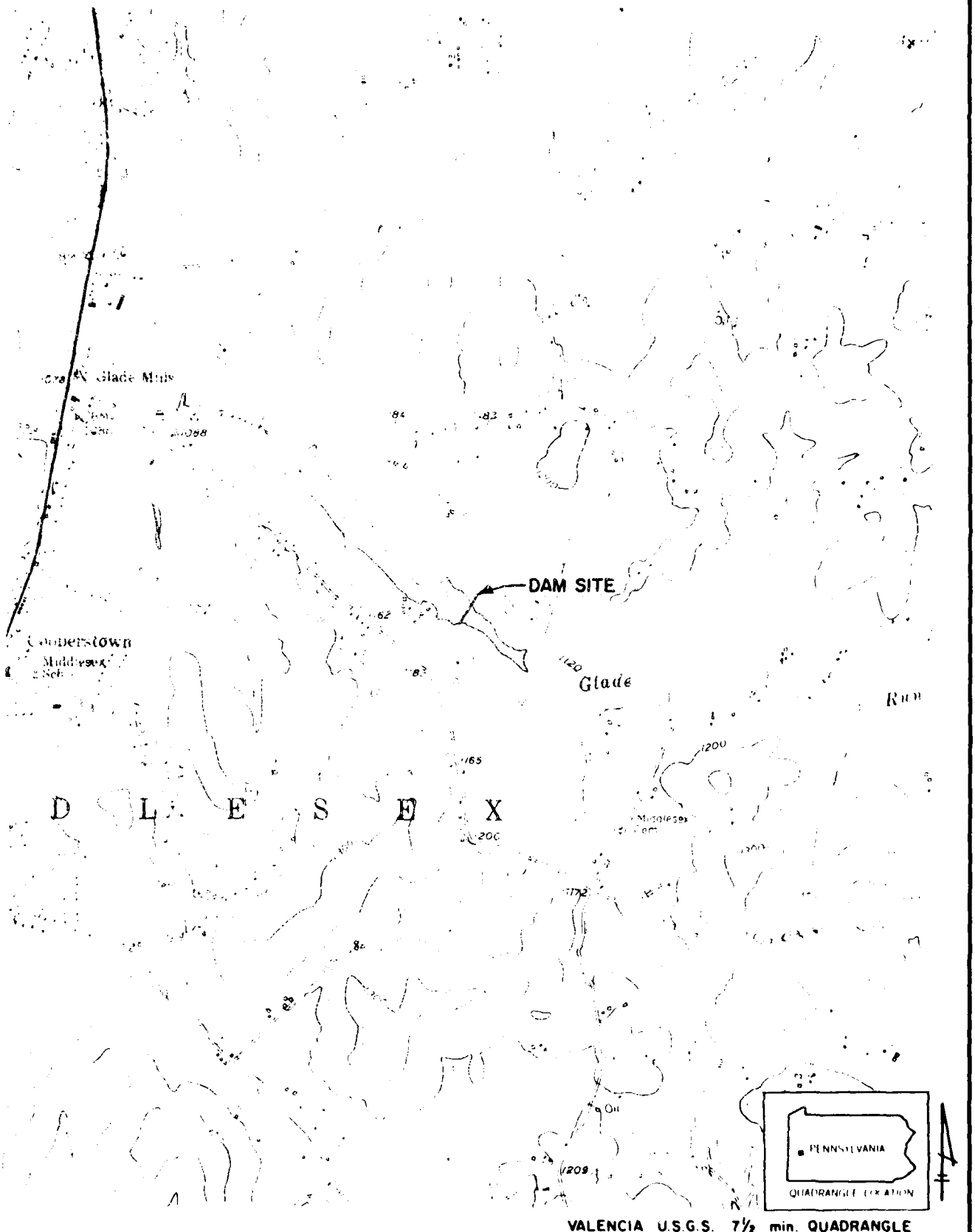
Made By SGM Date 24 FEB 81 Checked _____ Date _____



APPENDIX E

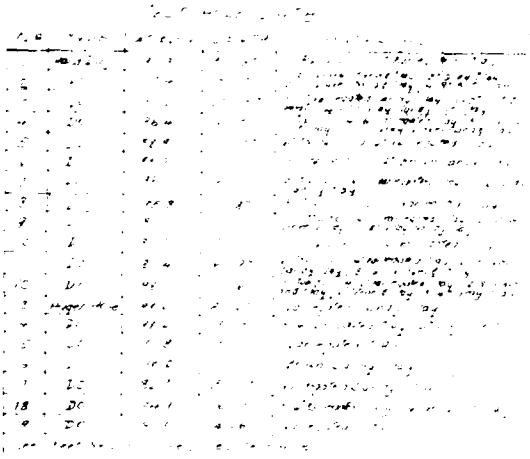
PLATES

LIST OF PLATES

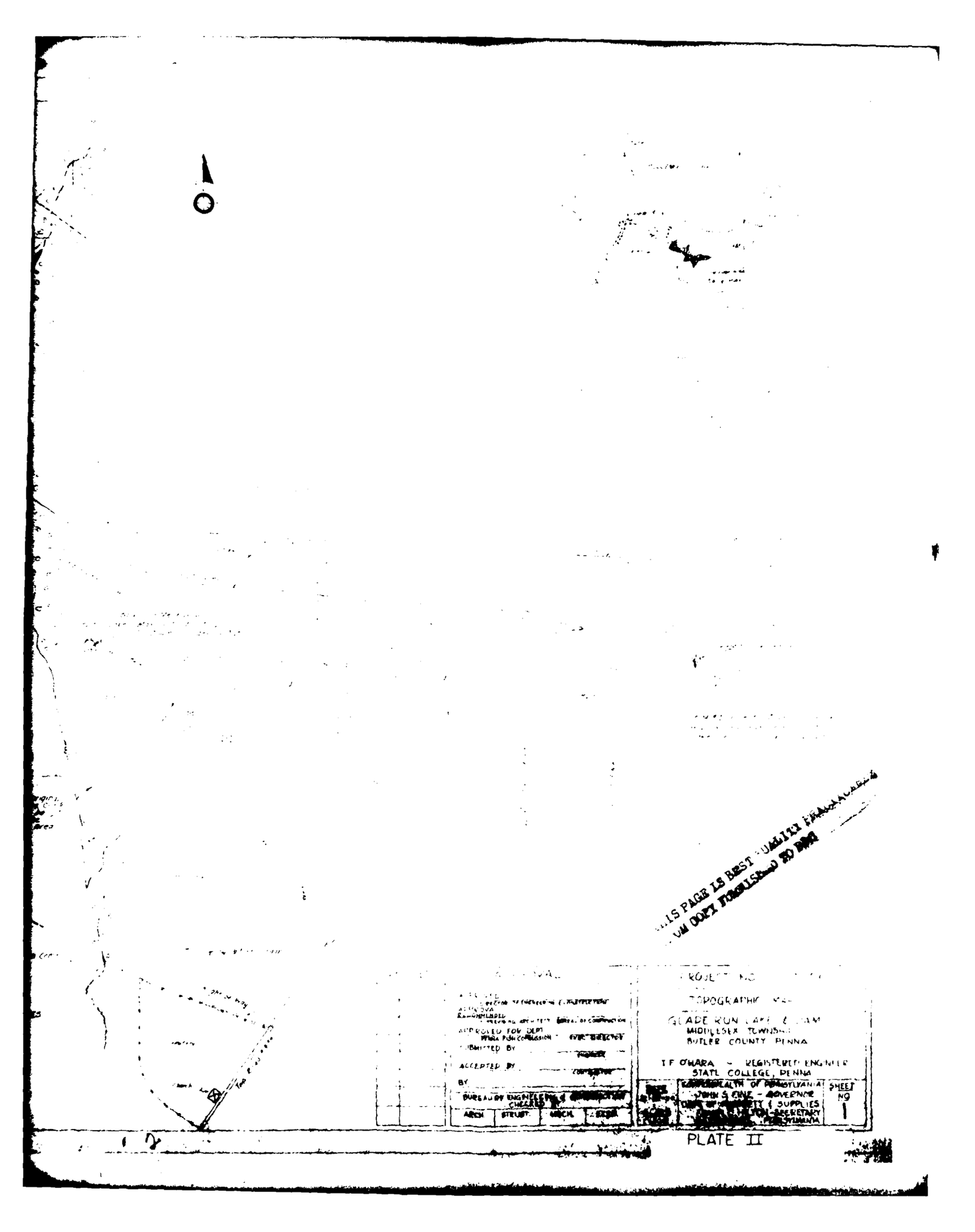


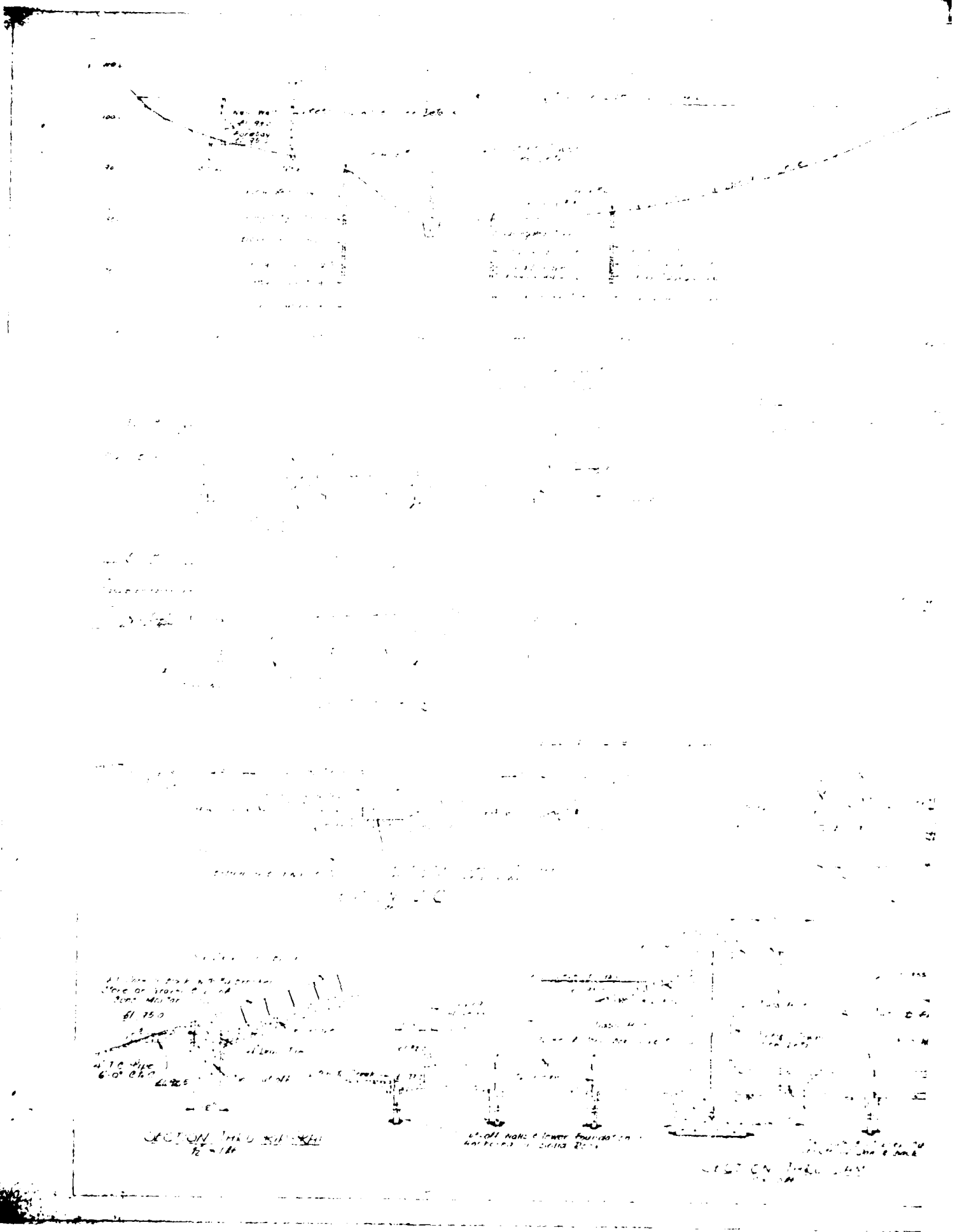
VALENCIA U.S.G.S. 7½ min. QUADRANGLE

DATE: MARCH 1981	GLADE RUN DAM	REGIONAL VICINITY MAP
SCALE: 1" = 2000'	NATIONAL DAM INSPECTION PROGRAM	
DR: JF CK:	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS	
PLATE I	GEO SYSTEMS, INC. 1000 BANKSVILLE RD./PITTSBURGH PA. 15216	



- Test Holes - Hand Dug
- Test Holes - Core Drilled
- ● Auger Holes - Hand Drilled
- Wooded Area


TOPOGRAPHIC MAP
GLADE RUN LAKE DAM
MIDDLESEX TOWNSHIP
BUTLER COUNTY PENNA
I F O'HARA - REGISTERED ENGINEER
STATE COLLEGE, PENNA
COMMONWEALTH OF PENNSYLVANIA
JOHN S. FINE - GOVERNOR
SHEET NO
1
PLATE II



APPROVALS

APPROVED FOR THE ENGINEERING ADMINISTRATION	
RECOMMENDED	BUREAU OF ENGINEERING
APPROVED FOR DEPT.	EXEC. DIRECTOR
SUBMITTED BY	ENGINEER
ACCEPTED BY	CONTRACTOR
BY	

BUREAU OF ENGINEERING & CONSTRUCTION
CHECKED BY
ARCH | STRUCT | MECH | ELEC

GENERAL PLAN & SECTIONS

BLADE RUN LAKE DAM
MARLESON TOWNSHIP
BUTLER COUNTY, PENNA.

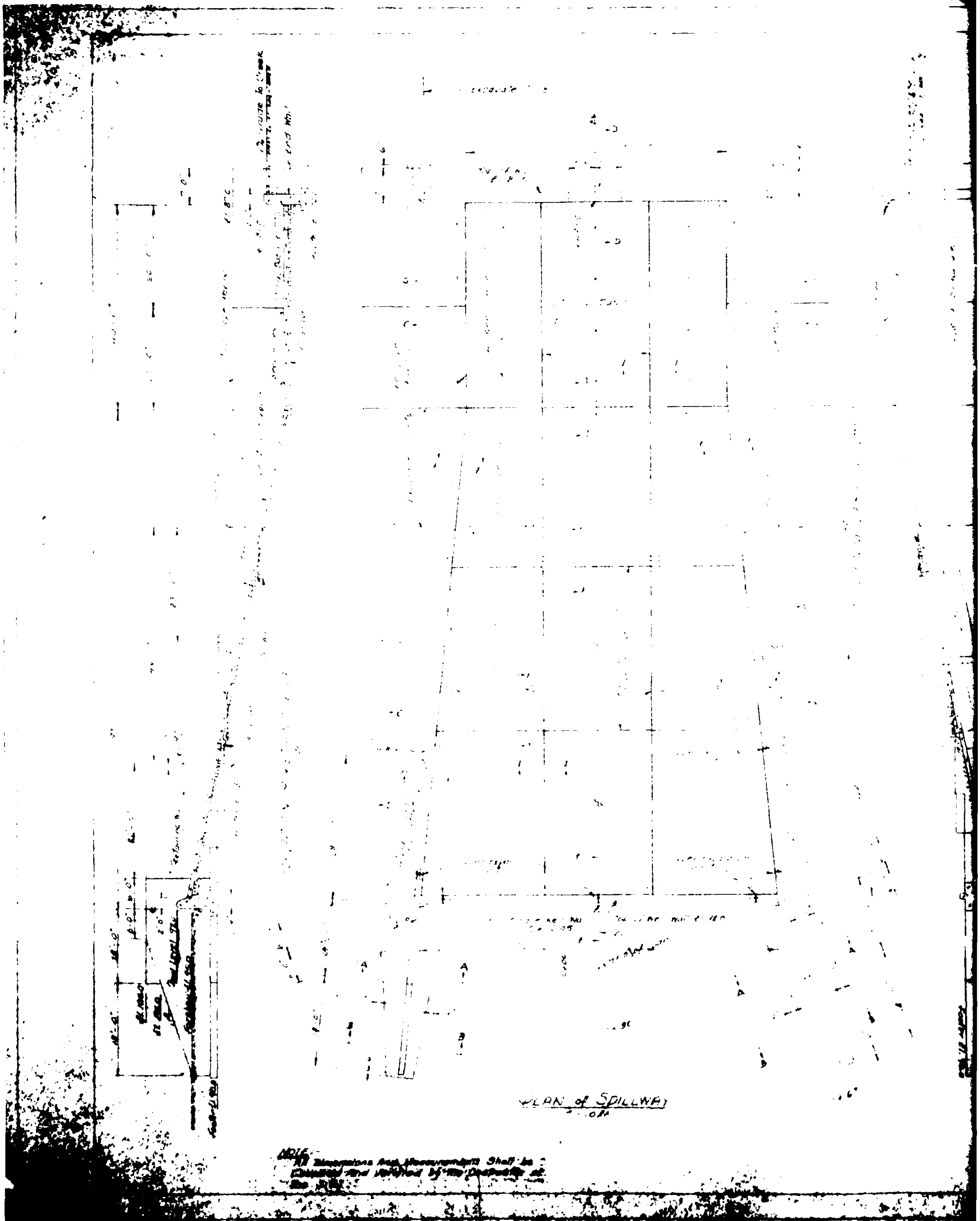
T. F. O'HARA — REGISTERED ENGINEER
STATE COLLEGE, PENNA.

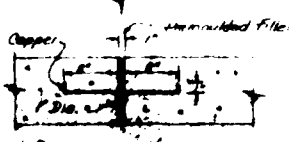
DATE 9/24/64
SCALE AS NOTED

COMMONWEALTH OF PENNSYLVANIA
JOHN S. FINE — GOVERNOR
DEPT. OF PROPERTY & SUPPLIES
FRANK C. HILTON SECRETARY
HARRISBURG, PENNSYLVANIA

SHEET NO. 2

PLATE III


PLAN of SPILLWAY



REVISED

APPROVALS

APPROVED
APPROVED AS AMENDED
APPROVED FOR DEPT.
SUBMITTED BY
APPROVED BY
BY
BUREAU OF ENGINEERING & CONSTRUCTION
CHECKED BY
ARCH. | PROJECT | MECH | ELEC.

PROJECT NO. [illegible]707

SPILLWAY DETAILS

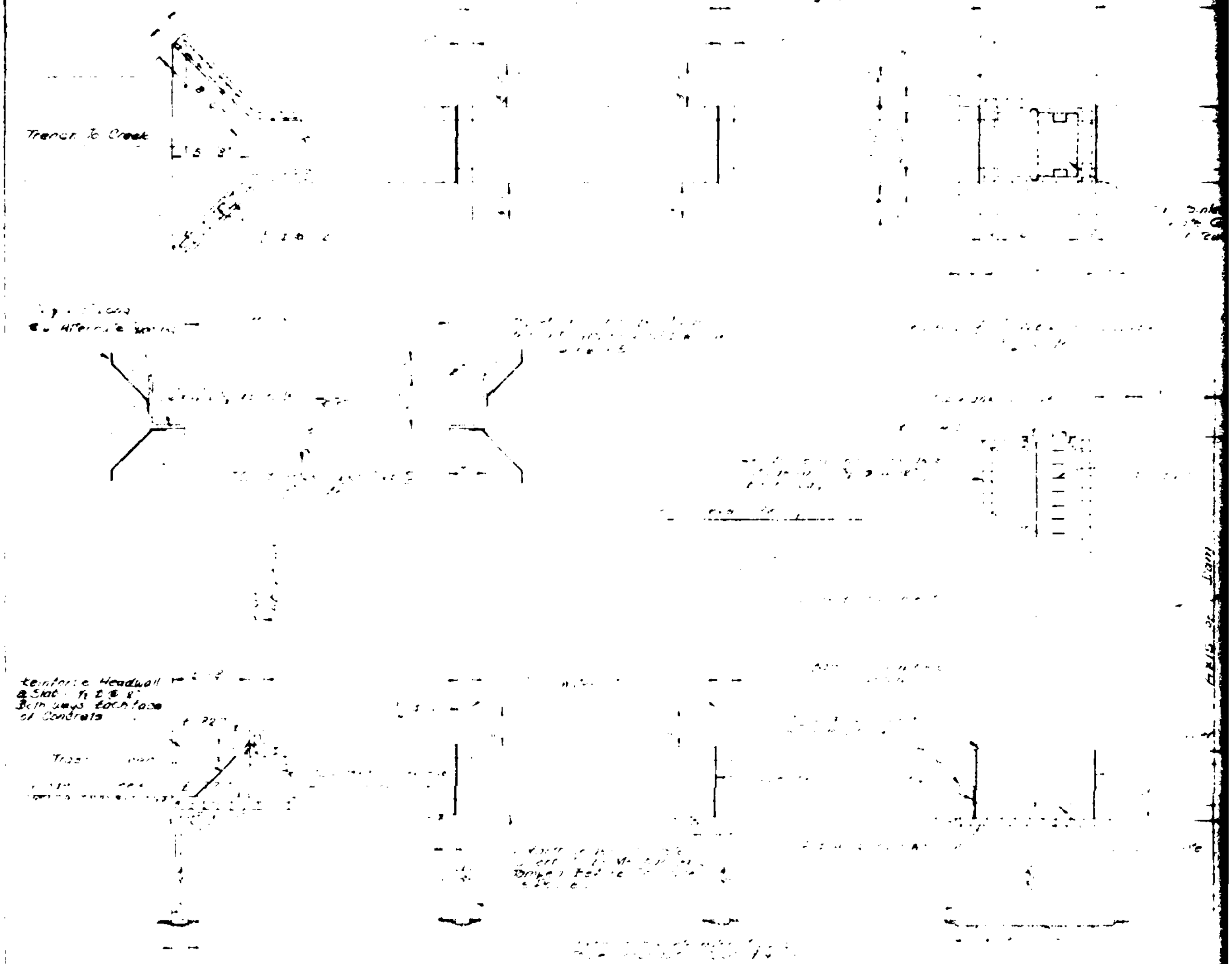
GLADE RUN LAKE & DAM
MIDDLESEX TOWNSHIP
BUTLER COUNTY, PENNA

T. P. O'HARA — REGISTERED ENGINEER
STATE COLLEGE, PENNA

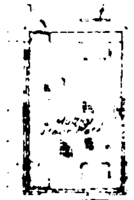
COMMONWEALTH OF PENNSYLVANIA
WILLIAM S. FINE — GOVERNOR
DEPT. OF PROPERTY & SUPPLIES
FREDRIC POSNER — SECRETARY
HARRISBURG, PENNSYLVANIA

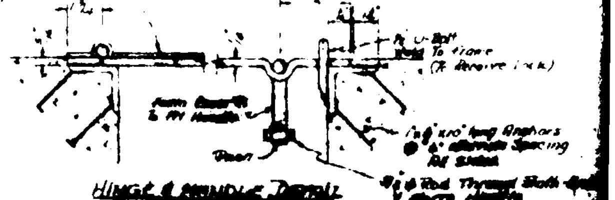
SHEET 3

PLATE IV



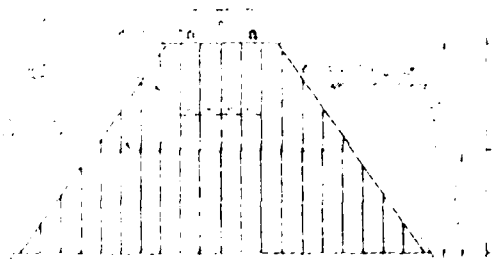
1. [illegible] and Unless Otherwise Noted [illegible] 2½" Deep and ⅓ Section Width
2. Square Bars and Spacing Noted [illegible]
3. [illegible] Bars and [illegible]
4. Steel Wire Fabric Noted Thus [illegible]
5. Dowels Bars Shall be the Same Size as [illegible] Bars Unless Otherwise Noted
6. Stress Steel [illegible] Shall [illegible] the [illegible] the Walls, [illegible] Slabs and [illegible] have the [illegible] Center of Stress Bar [illegible]
   - 3" Where Footers or Slabs [illegible]
   - 2" Where After Removal of Forms the Concrete [illegible] Exposed To The Weather [illegible] for Bars More than ⅝ Diameter
   - 1½" Where after Removal of Forms The Concrete [illegible] To The Weather or in contact with the Ground [illegible] ⅝ or Less Diameter
7. The Amount of Steel Shown [illegible] be Doubled [illegible] Joints and for a Distance [illegible] Each Side of The Joint
8. All Bars Where Spliced Shall be Lapped [illegible] Diameter [illegible]
9. Splices Shall Not be Made at Points of Maximum Stress
10. All Reinforcing Steel Shall be Bent as Noted in Accordance With A.C.I. Building Code Requirement (A.C.I. 318-41)
11. All Expansion Joints Where Concrete Joins Concrete Surface Shall be Painted With Asphalt Paint





HINGE & HANDLE DETAIL

NOTE:— All Dimensions and Measurements Shall be Checked and Verified by The Contractor at The Site.



LADDER TANK DETAIL
1" = 1'-0"

APPROVALS

APPROVED
DIRECTOR OF BUREAU OF ENGINEERING & CONSTRUCTION
RECOMMENDED
SUPERVISING SECURITY, BUREAU OF CONSTRUCTION
APPROVED FOR DEPT
STATE INSPECTION
SUBMITTED BY
ENGINEER
ACCEPTED BY
CONTRACTOR
BY

BUREAU OF ENGINEERING & CONSTRUCTION
CHECKED BY

ARCH	STRUCT	MECH	ELEC.

PROJECT NO. [illegible]

OUTLET TOWER & CULVERT

GLADE RUN LAKE & DAM
MIDDLESEX TOWNSHIP
BUTLER COUNTY, PENNA

T F O'HARA — REGISTERED ENGINEER
STATE COLLEGE, PENNA

COMMONWEALTH OF PENNSYLVANIA
JOHN S. FINE - GOVERNOR
DEPT OF PROPERTY & SUPPLIES
FRANK C. MILTON - SECRETARY
[illegible] - PENNSYLVANIA

DATE 9/6/64
SCALE [illegible]

SHEET NO. 4

PLATE V

APPENDIX F

GEOLOGY

GEOLOGY

Geomorphology

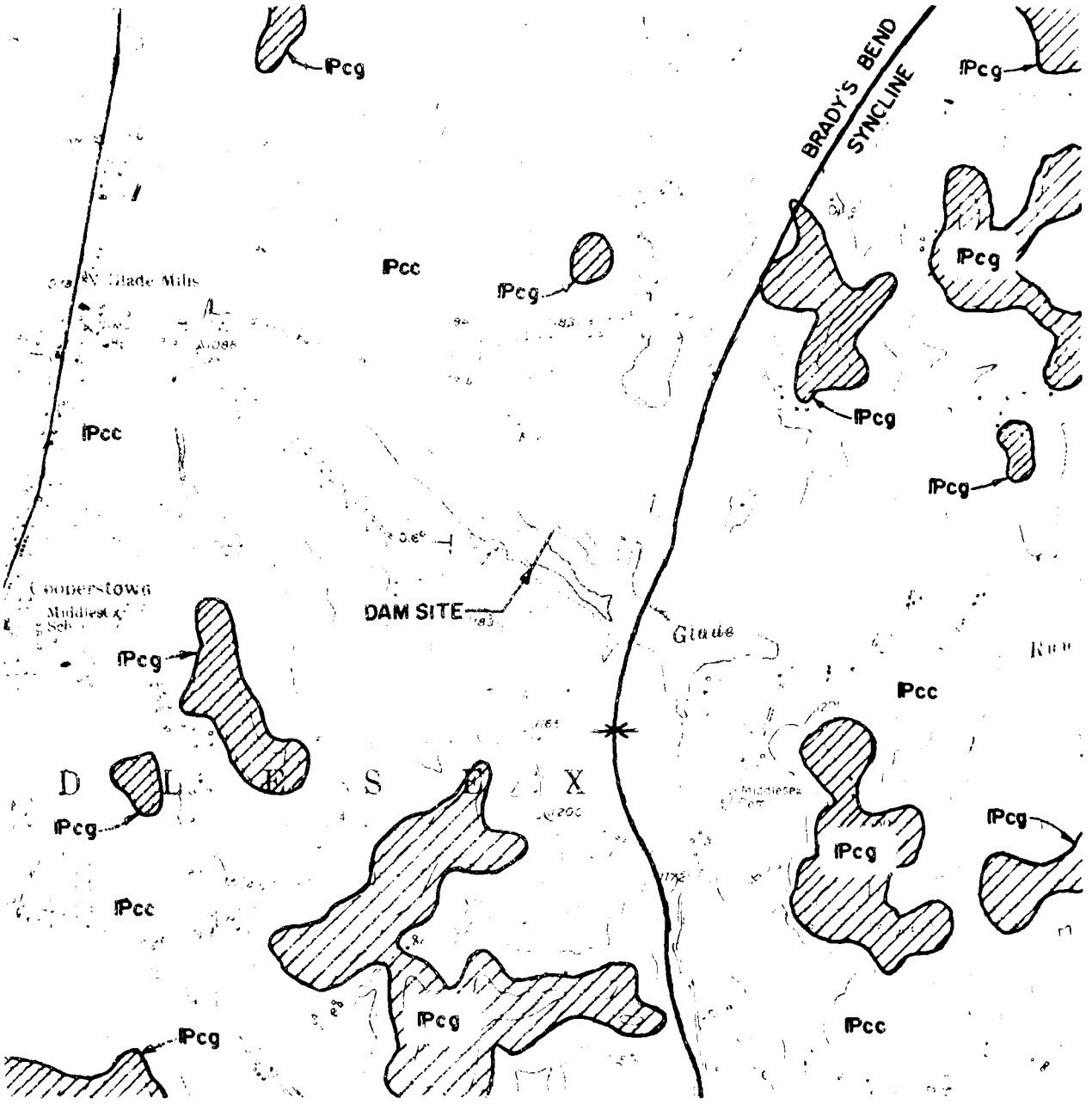
Glade Run Dam is located within the Pittsburgh Plateau section of the Appalacian Plateau Physiographic Province. This area is characterized by gently folded sedimentary rocks which have been deeply cut by streams to form steep sided valleys. The valley bottom of Glade Run is about 280 feet below the highest adjacent hilltops. These rounded hilltops are at Elevation 1300 to 1400 feet, and in a regional sense are part of a broad, undulating plateau.

Structure

The axis of the Brady's Bend Syncline passes directly through the Glade Run Lake vicinity. This syncline trends northeast to southwest and plunges to the southwest. Strata in the vicinity of the dam dip to the northwest at a rate of less than 1°. No faults have been documented in the vicinity of the dam and no observations were made that would indicate faulting in the rocks outcropping around the dam site.

Stratigraphy

Rocks outcropping in the area of the dam belong to the Casselman and Glenshaw Formations of the Conemaugh Group and are of Pennsylvanian Age. Both the Casselman and Glenshaw Formations consist of cyclic sequences of sandstone, shale, red beds, thin limestone, and coal. The Ames Limestone marks the top of the Glenshaw Formation and, because of its highly fossiliferous nature, is a well-known marker bed. The most notable rock type present in both formations, but mainly below the Ames Limestone, is the landslide-prone red clay shales, known locally as the "Pittsburgh Red Beds."



VALENCIA QUADRANGLE, BUTLER COUNTY, PENNSYLVANIA

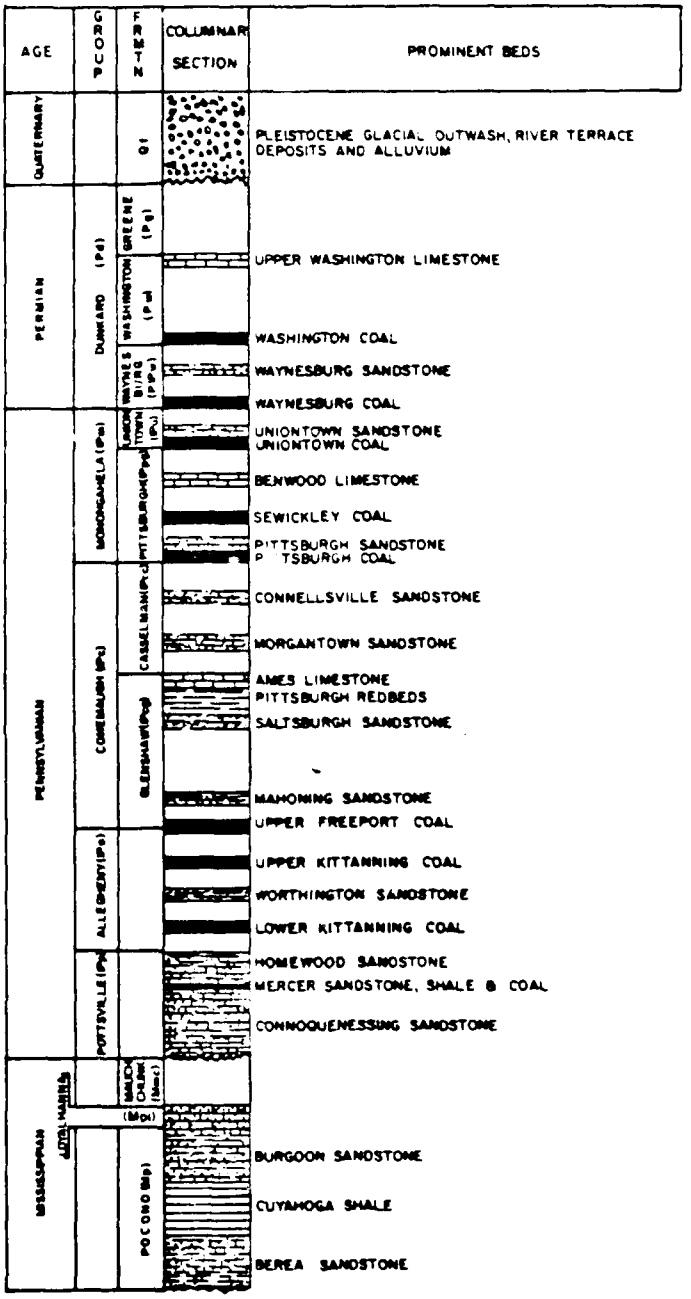
SCALE: 0 ½ MILE 1:24000

CONTOUR INTERVAL 20 FT DATUM IS MEAN SEA LEVEL

——— FORMATION CONTACT

DATA OBTAINED FROM PENNSYLVANIA TOPOGRAPHIC AND GEOLOGIC SURVEY GREATER PITTSBURGH REGION GEOLOGIC MAP AND CROSS SECTIONS, 1975 and GREATER PITTSBURGH REGION STRUCTURE CONTOUR MAP, 1975

DATE: MARCH 1981	GLADE RUN DAM NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC MAP
SCALE: 1"=2000'		
DR: JF CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	



DATE: MARCH 1981	GLADE RUN DAM NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC COLUMN
SCALE: 1"=360		
DR: JF CK:	ACKENHEIL & ASSOCIATES CONSULTING ENGINEERS GEO SYSTEMS, INC. 1000 BANKSVILLE RD / PITTSBURGH PA 15216	
DWG. NO.		


END
DATE
FILMED
6-81
DTIC