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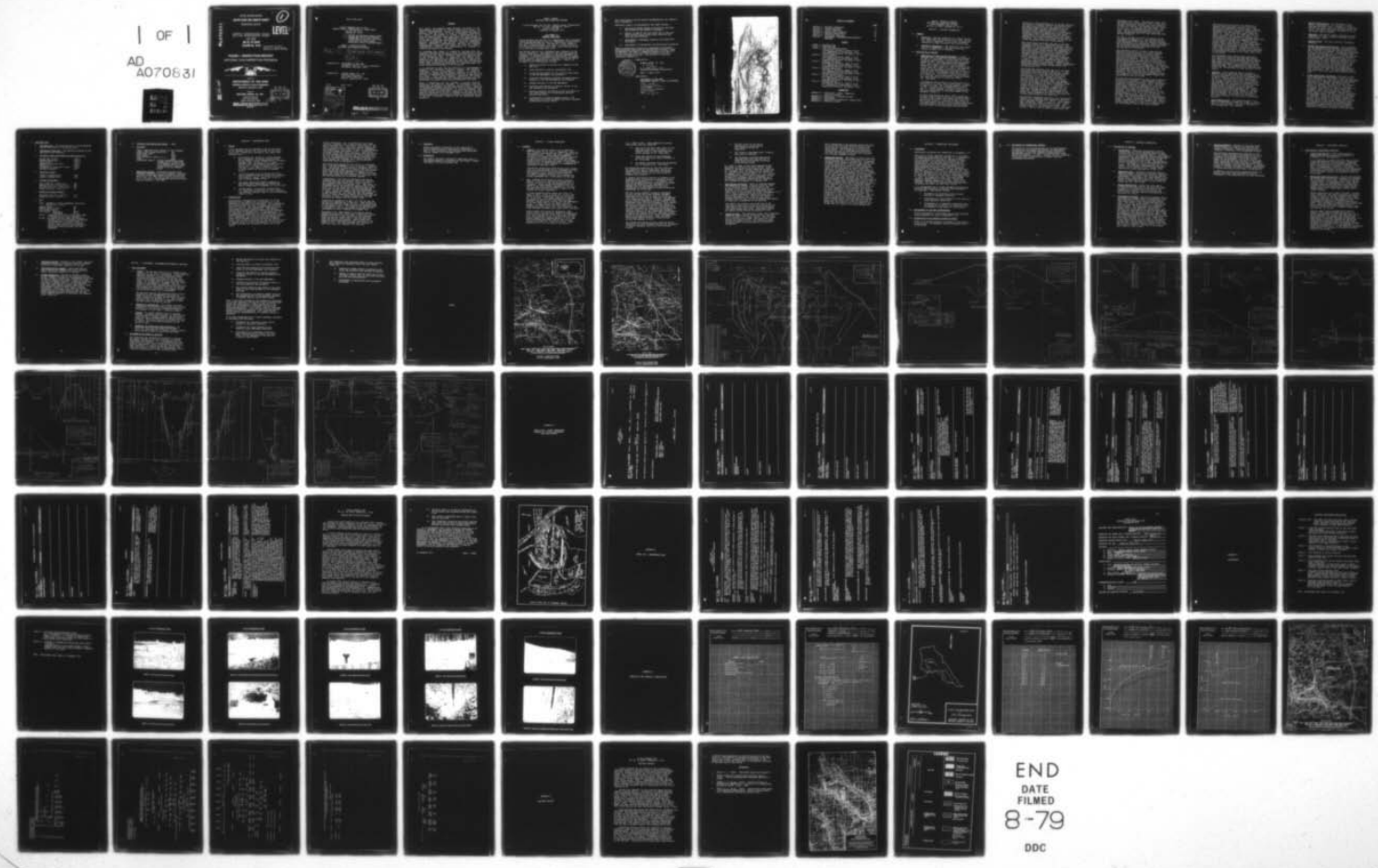

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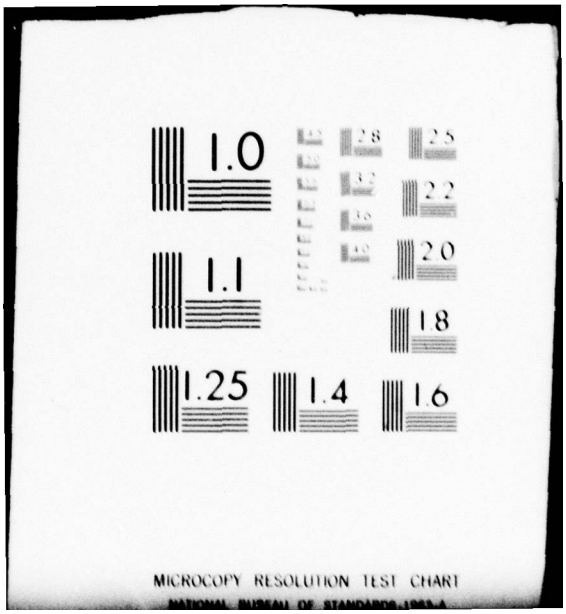
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OHIO RIVER BASIN

CALVIN CLARK RUN, MERCER COUNTY

PENNSYLVANIA

LITTLE SHENANGO DAM

(PA 490)

NDI No. PA 00246

PennDER No. 43-54

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers

4301 Dutch Ridge Road

Beaver, Pennsylvania 15009

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April 1979

OHIO RIVER BASIN

LITTLE SHENANGO DAM (PA 490)
MERCER COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI NO. PA 00246
PennDER NO. 43-54

(6) National Dam Inspection Program. Little Shenango Dam (NDI ID Number PA-00246, PennDER Number 43-54), Ohio River Basin, Calvin Clark Run, Mercer County, Pennsylvania. Phase I Inspection Report.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(11) Apr 79 (15) DACW31-79-C-0011

(12) 92 p.

Prepared for: DEPARTMENT OF THE ARMY
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Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

Date: April 1979

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PREFACE

This report was 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 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 REPORT
NATIONAL DAM INSPECTION PROGRAM

Little Shenango Dam (PA 490), Mercer County, Pennsylvania
NDI No. PA 00246, PennDER No. 43-54
Calvin Clark Run
Inspected 6 December 1978

ASSESSMENT OF GENERAL CONDITIONS

Little Shenango Dam (PA 490) is a homogeneous earth floodwater retarding dam designed by the U.S. Department of Agriculture, Soil Conservation Service. The dam has a crest length of 430 feet, a maximum height of 45 feet, a storage volume of 472 acre-feet at spillway crest level, and a storage volume of 19 acre-feet at normal pool level.

The dam was found to be in generally poor condition at the time of inspection. The inspection did disclose potential problems with seepage and piping in the dam embankment and abutments. A detailed engineering investigation of seepage, piping, erosion, and structural stability of the dam should be initiated as expeditiously as possible. Items to be included in the investigation include:

1) Nature and extent of glacial soil deposits at the dam site.

2) Local patterns of natural groundwater flow.

3) Locations and extents of silt and fine sand zones in the dam embankment and abutments.

4) Locations and extents of piping (internal erosion) conduits in the dam embankments and abutments.

5) Seepage patterns in the dam embankment.

6) Condition and efficacy of granular drains in the dam foundation and abutments.

7) Erosion potential and safety of the silty knoll at the right abutment of the emergency spillway during flood flows.

8) Installation of properly bedded riprap at the downstream end of the emergency spillway to prevent erosion from surface runoff.

This investigation should develop recommendations for remedial work as necessary.

Additional items to be performed by the owner include:

1) Cleaning of animal guards on outlets of the three dam foundation and abutment drainpipes.

2) Removal of debris from the trash rack of the low-level orifice inlet in the riser structure and from the pond perimeter.

3) Development of emergency operation and evacuation procedures.

4) Development of operational and maintenance procedures.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is therefore considered "adequate."

Submitted by:

MICHAEL BAKER, JR., INC.

C. Y. Chen

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 5 April 1979

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer
Date: 22 Apr 79

LITTLE SHENANGO DAM

Overall View

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LITTLE SHANANGO DAM (PA 490)
NDI NO. PA 00246, PennDER No. 43-54

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

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

b. Purpose of Inspection - 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. Description of Dam and Appurtenances - Little Shenango Dam, a floodwater retarding dam designed by the U.S. Department of Agriculture, Soil Conservation Service (SCS), is also known by its SCS number PA 490. The homogeneous earth embankment has a crest length of 430 feet and a maximum height of 45 feet (Plate 4). The dam crest at El. 1192.6 feet has a width of 16 feet. The upstream slope has an inclination of 3H:1V (horizontal: vertical) and the downstream slope has an inclination of 2H:1V. The upstream slope has a 6-foot wide berm at El. 1162 feet, a 4-foot wide berm at El. 1159 feet, and riprap between these two berms for slope protection at normal pool level (El. 1160 feet).

A foundation cutoff trench was constructed with a base width of 12 feet, 1H:1V side slopes, a length of about 100 feet, and a maximum depth of about 10 feet to glacial till or bedrock (Plates 4, 6, and 7). Cutoff trenches of similar cross-section were also constructed to shallower depths in the abutments (Plate 7).

A 4-foot wide foundation drain trench containing granular material was installed to a maximum depth of about 8 feet beneath the downstream toe of the dam (Plates 4 and 8). Sections of this trench in the valley bottom contain 12-inch diameter perforated corrugated metal collector pipes which discharge from the sides of the reinforced concrete outlet

structure at the downstream toe of the dam (Plate 8). Toe drains of granular material and rockfill were provided along portions of the contacts of the downstream slope with both abutments (Plate 8). The right (west) abutment drain has a 4-inch diameter plastic pipe leading to a 6-inch diameter bituminous coated corrugated metal pipe which discharges in the right (west) side of the outlet channel about 25 feet downstream from the outlet structure. The outlets of the two 12-inch and one 6-inch drainpipes have small animal guards.

The outlet works (principal spillway in SCS terminology) consist of a reinforced concrete riser connected to a 30-inch diameter reinforced concrete pipe which is approximately 208 feet long (Plate 5). This outlet pipe located beneath the embankment in the valley bottom (Plate 3) has a concrete cradle and seven reinforced concrete anti-seep collars (Plates 5 and 6). The downstream end of the outlet pipe with invert El. 1144 feet discharges into a reinforced concrete impact basin (Plates 3, 5, and 6). The 12-foot wide outlet channel is paved with riprap for a distance of about 25 feet downstream from the impact basin. Further downstream, the outlet channel extends through dense, well graded glacial till.

The reinforced concrete riser unit is a two stage drop-inlet structure about 30 feet high. It has an overflow weir with trash rack and anti-vortex device at El. 1177 feet and a low-level inlet consisting of a 1.0- by 3.25-foot orifice at El. 1160 feet (Plate 5). Normal pool level is controlled by this low-level inlet. At normal pool El. 1160 feet, the pond, which was designed to provide storage for 50 years of sediment accumulation, has a surface area of 4.1 acres and a volume of about 19 acre-feet. A pond drain consisting of 34 feet of 21-inch diameter iron or steel pipe extends upstream from the riser unit (Plate 5). According to Mr. James Mondok of the Mercer County Conservation District, this pipe has a steel plate bolted on its inlet end.

The spillway (emergency spillway in SCS terminology) consists of a vegetated earth channel in the left (east) abutment (Plates 3, 6, and 7). This channel has a centerline length of about 320 feet, a base width of 235 feet, and 3H:1V side slopes. The control section of the spillway is at El. 1186 feet (Plates 3 and 6); this is some 6.6 feet below the

embankment crest level. The spillway crest level was selected by routing runoff from a storm with a 100-year recurrence interval and 6 hour duration through the reservoir with maximum conduit outflow of 114 c.f.s. At the spillway crest level, the total volume of floodwater storage is 472 acre-feet. The spillway discharges down the left (east) stream bank about 100 feet downstream from the dam (Plate 3).

The dam is located in an area of complex glacial soil deposits (Appendix E). Boring and test pit information obtained by the SCS, geologic information presented in the references listed in Appendix E, and field observations during dam inspection yield the following simplified description of site geology and soil conditions.

Both abutments consist of kame or kame terrace deposits overlying glacial till and/or bedrock. The valley bottom has recent alluvium and/or glacial outwash overlying glacial till which in turn overlies bedrock. The top of sandstone bedrock is at about El. 1144 feet in the valley bottom beneath the upstream toe of the dam and the top of shale bedrock is at about El. 1134 feet in the valley bottom beneath the dam axis. No bedrock was encountered in a boring extending to El. 1126 feet in the valley bottom about 40 feet downstream from the downstream toe of the dam, but the boring log indicates that bedrock was not far below this elevation. This limited boring information therefore suggests a buried valley segment beneath the downstream portion of the dam.

The spillway was excavated in kame terrace deposits along the left abutment. These deposits consist of partially water sorted silts, sands, and gravels. Subsurface information (Plates 6 and 7) and field observations indicate an abundance of silts and silty sands in this area from which most of the borrow material used in dam construction was obtained. No bedrock was encountered in a boring extending to El. 1179 feet in the spillway or in a boring extending to El. 1153 feet in the left abutment, but sandstone bedrock was encountered at El. 1167± feet in two borings in the right abutment (Plate 7). These limited boring data, plus topographic information and field observations, indicate a much greater extent of glacial soil deposits on the left abutment than on the right abutment.

Relatively pervious glacial soil deposits on uplands along both sides of Calvin Clark Run function as groundwater recharge areas. This is particularly true for the area of kame and kettle topography east and northeast of the dam site (Plate 1). Calvin Clark Run loops through this area at El. 1180 feet to El. 1250 feet. It is highly probable that groundwater recharge from this reach of the stream is a significant contributor to the extensive spring flow observed on both valley walls at the dam site. Infiltration of surface water, particularly in kettle-type depressions on the hilltop east of the dam (Plate 1), contributes to groundwater discharge on the left (east) side of the valley. Surface water infiltration in the upland west of the dam site contributes to groundwater discharge on the right (west) side of the valley.

The groundwater flow patterns described above, plus the silty nature of the kame-type glacial soil deposits in the dam abutments and dam embankment, give rise to situations favorable for the development of piping, i.e., internal erosion of fine soil particles, irrespective of pool levels behind the dam. Field observations indicated this to be true, as described in later sections of this report.

b. Location - Little Shenango Dam is located on Calvin Clark Run about 1000 feet upstream (north) from its confluence with the Little Shenango River in Perry Township, Mercer County, Pennsylvania (Plate 1). The dam is about 0.75 mile north of the village of Clarks Mills which is situated on the southwest bank of the Little Shenango River upstream from the confluence of Calvin Clark Run. Normal access to the dam is via an unpaved secondary road extending northerly from Clarks Mills across the Little Shenango River. During periods of high flood flows, access to the dam may be necessary via a route from the north or west of the dam. Clarks Mills is located on Pa. Route 358 about 1.5 miles east of Interstate Route 79.

c. Size Classification - The maximum height of the dam is 45 feet and the reservoir volume to the dam crest is 790 acre-feet. The dam is therefore in the "Intermediate" size category.

d. Hazard Classification - As discussed in more detail in paragraph 3.1.d., failure of Little Shenango Dam might result in damage to a feed mill and several houses, plus loss of "more than a few" lives. The dam is therefore considered to be in the "High" hazard category.

e. Ownership - The dam is owned by the Mercer County Commissioners, Mercer County Courthouse, Mercer, Pennsylvania 16137.

f. Purpose of Dam - The dam is used for floodwater detention.

g. Design and Construction History - Little Shenango Dam was designed by the SCS under the authority of the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. The dam was constructed by Kirila Contractors, Inc. of Brookfield, Ohio from May 1970 through May 1971. No work except for some spillway excavation was done over the winter from mid-November 1970 through mid-April 1971. According to Mr. James Mondok of the Mercer County Conservation District, three small slides with a total breadth of about 75 feet occurred in the excavated slope on the left (east) side of the spillway soon after the dam was constructed. These slides were repaired and drainage measures were installed in 1973. No other problems have occurred in this area since this remedial work was done.

h. Normal Operational Procedures - The pond is typically maintained at the low-level inlet of the riser structure, El. 1160 feet. There has reportedly been no major flood since the dam was constructed. According to Mr. Mondok, the maximum pool of record was probably near the top of the straight portion of the riser structure, El. 1170± feet. Operational information is scanty as the dam is in a somewhat remote location, has no operating equipment, and is only occasionally visited by Mercer County or SCS personnel. Mercer County and SCS personnel inspect the dam each year according to procedures for annual inspections of SCS dams of this type. Copies of all annual inspection reports are available in the Mercer office of the SCS and copies of most annual inspection reports are available in the files of the Pennsylvania Department of Environmental Resources (PennDER). Routine maintenance of the dam and spillway is performed as necessary by Mercer County personnel.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area of Little Shenango Dam is 2100 acres or 3.29 square miles.

b. Discharge at Dam Site - The maximum discharge at the dam site is not available.

c. Elevation [feet above Mean Sea Level (M.S.L.)] -

Design Top of Dam -	1192.6
Maximum Design Pool -	1190.4
Riser Crest -	1177.0
Emergency Spillway Crest -	1186.0
Normal Pool -	1160.0
Streambed at Centerline of Dam -	1147±
Maximum Tailwater -	N.A.

d. Reservoir (feet) -

Length of Maximum Pool -	3700
Length of Normal Pool -	1000

e. Storage (acre-feet) -

Top of Dam (El. 1192.6 ft.) -	790
Maximum Pool (El. 1190.4 ft.) -	680
Spillway Crest (El. 1186.0 ft.) -	472
Normal Pool (El. 1160.0 ft.) -	19

f. Reservoir Surface (acres) -

Spillway Crest (El. 1186 ft.) -	37.5
Normal Pool (El. 1160 ft.) -	4.1

g. Dam -

Type - Homogeneous earth embankment containing 54,200 c.y. of fill	
Length (feet) -	430
Maximum Height (feet) -	45
Crest Width (feet) -	16
Side Slopes - Upstream -	3H:1V
Downstream -	2H:1V

Cutoff - Compacted earth with 12-foot base width in foundation and lower abutments.

Drains - Foundation drain trench with granular material and 12-inch diameter perforated corrugated metal collector pipes in valley bottom; toe drains of granular material and rockfill along portions of downstream slope junctions with both abutments.

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type - vegetated earth channel in left abutment	
Length (feet along centerline) -	320
Base Width (feet) -	235
Side Slopes -	3H:1V
Crest Elevation (feet M.S.L.) -	1186
Gates -	None
Downstream Channel -	Slightly meandering stream channel about 20 feet wide in floodplain about 200 feet wide extends 1000 feet downstream to Little Shenango River.

j. Regulating Outlets - Reinforced concrete riser structure connected to 30-inch diameter reinforced concrete outlet pipe beneath the dam has overflow weir at El. 1177 feet and low-level orifice inlet at El. 1160 feet. The downstream end of the outlet pipe has invert El. 1144 feet.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Little Shenango Dam was designed by the SCS according to its standard practice for structures of this type, circa 1960. Design data included in this report were obtained from:

1) SCS Drawings No. PA-490-P, "Little Shenango River Watershed, Floodwater Retarding Dam PA 490, Mercer County, Pennsylvania," 20 sheets Designed 1967, "As Built" 1971; 1 Sheet (Bronze Plaque and Monument) Designed and "As Built" 1971. (Copies of Sheets 3-8 are included in this report as Plates 3-8; prints of other sheets are available in PennDER files.)

2) "Little Shenango River Watershed Work Plan," report prepared by Mercer County Soil Conservation District, et al., April 1963 (copy in file of Mercer office of SCS).

3) Dam Permit Application Report prepared by the Pennsylvania Department of Forests and Waters (predecessor of PennDER) on 5 April 1968.

4) "Design Report, Site PA-490, Pennsylvania," U.S. Department of Agriculture, Soil Conservation Service, undated (copy in file of Harrisburg office of SCS).

2.2 CONSTRUCTION

Chronological information on construction of Little Shenango Dam was summarized in paragraph 1.2.g. and additional information is given below. This information was obtained from the files of PennDER and the Mercer office of the SCS. The SCS provided essentially full-time inspection of dam construction. Semi-monthly construction progress reports prepared by SCS personnel are available in PennDER files. A representative of the Pennsylvania Department of Forests and Waters (now PennDER) made periodic visits to the dam during construction. Memoranda, and black and white photographs of construction progress are also available in PennDER files. SCS "as built" drawings for the dam are available in PennDER files as noted in paragraph 2.1 and several of these drawings are included as Plates 3-8 of this report.

Kirila Contractors, Inc. of Brookfield, Ohio began clearing, grubbing, and foundation excavation for the dam in late May 1970. The riser, outlet conduit, and outlet structure were constructed and the embankment was completed to within about 10 feet of finished grade during the Summer and Autumn of 1970. Construction proceeded relatively slowly throughout this period due to rainy weather and resultant wet ground conditions. Much of the embankment borrow material excavated from the left abutment spillway was extremely wet due to rainy weather and, probably also, the groundwater conditions noted in paragraph 1.2.a.

Dam construction ceased for the winter on 13 November 1970, with the embankment fill at a height of about 35 feet. Excavation of waste material (probably wet silt) from the spillway began on 21 January 1971 when frozen ground permitted heavy equipment to operate in the area. This work continued until 17 February 1971 when operations ceased for the remainder of the winter with the spillway excavation 95 percent complete.

A memorandum in the files of the Mercer SCS office indicates that rain and snowmelt from 19-22 February 1971 produced heavy runoff with a flood crest at approximately 5 PM on 20 February 1971. The height of floodwater behind the partially completed dam is not given, but it was noted that the flood storage was 75 acre-feet and the flood pool covered approximately 10 acres. These data suggest that the flood crest was at approximately El. 1167 feet and that the maximum height of water temporarily behind the 35-foot high dam was about 20 feet. It seems unlikely that the dam sustained any damage from this minor flood.

Construction resumed on 14 April 1971 and the dam was essentially completed by 27 May 1971. Some erosion of the dam and spillway slopes occurred during heavy rains in the Summer of 1971. This erosion was repaired prior to seeding the area in late Summer to Autumn of 1971. Impoundment of water commenced in November 1971.

According to Mr. James Mondok of the Mercer County Conservation District, three small slides with a total breadth of about 75 feet occurred in the excavated slope on the left (east) side of the spillway soon after the dam was constructed. These slides were repaired and drainage measures were installed in the Summer of 1973. No other problems have occurred in this area since this remedial work was done.

2.3 OPERATION

Readily available information on the operation of Little Shenango Dam was summarized in paragraph 1.2.h. Most of this information was obtained from interviews with Mr. Mondok on 6-8 December 1978.

2.4 EVALUATION

The readily available information summarized above is considered adequate for purposes of this Phase I Inspection Report on Little Shenango Dam.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The dam was found to be in generally poor condition at the time of inspection. Most of the problems noted during the visual inspection are considered minor. Items requiring immediate attention are seepage and piping features observed in several locations on the upstream and downstream slopes of the dam, and along both abutment contacts with the downstream slope. A more detailed investigation of these features is recommended as discussed in Sections 6 and 7.

Significant observations made during visual inspection of Little Shenango Dam on 6 December 1978 are presented briefly in the following paragraphs. The complete visual inspection check list is included in Appendix A along with a Seepage and Piping Supplement and a field sketch of the dam.

b. Dam - Seepage and evidence of piping (internal erosion of fine soil particles) was observed at several locations in the dam embankment and its abutments. These seepage and piping areas are shown in the field sketch (Appendix A), and they are described briefly below and in detail in the Seepage and Piping Supplement.

A 3-inch diameter piping tunnel was noted at a depth of about 1 foot in silty fill on the right (west) side of the upstream slope of the dam at El. 1174± feet. This tunnel appeared to extend horizontally some 50 feet left from the right abutment contact before turning into the embankment in an area where the fill is denser and well graded. It seems likely that this tunnel was produced by piping due to flow from springs in the right abutment as normal pool level is El. 1160 feet.

Surface water flow along the downstream right (west) side of the spillway, perhaps in combination with flow from springs in the left (east) abutment area, has produced a line of erosion gullies and piping tunnels with maximum depths of 2 to 3 feet from the downstream right side of the spillway toward the stream (El. 1180-1170± feet). These features are in silt of glacial ice contact

(i.e., kame) origin. Minor seepage and piping indications were also observed:

1) Some 50 to 100 feet right (west) of the above-mentioned area in similar silt deposits lower on the downstream left (east) abutment at El. 1163± feet.

2) Along the contact of the downstream slope with the right (west) abutment at El. 1172± feet.

3) At several locations along the downstream toe of the dam at El. 1155-1160±.

No significant migration of fine soil particles was observed at any of these areas during the inspection but numerous "ratholes" and tunnels from a fraction of an inch to a few inches in diameter were observed.

It appears that piping features in abutment soils resulted mainly from natural groundwater flow as described in paragraph 1.2.a. Groundwater flow from the abutments probably contributed to piping indications observed in the embankment fill. Seepage from the impoundment may also have contributed to piping features observed along the downstream toe of the dam.

The two 12-inch diameter foundation drainpipe outlets and the one 6-inch diameter abutment drainpipe outlet (Plate 8) were all trickling clear water at the time of inspection and appeared to be functioning properly. However, seepage and piping features observed along the contacts of the downstream slope with both abutments (field sketch) generally correlate with the granular drains on the abutment contacts (Plate 8). The possibility of partial plugging or other malfunctioning of the granular drains in the foundation and abutments requires attention in the recommended investigation of seepage and piping features. The small animal guards on the outlets of all three drainpipes were partially plugged with moss, slime, and debris. These animal guards should be cleaned during routine maintenance in 1979.

The seepage and piping situation observed during inspection of Little Shanango Dam was not considered to require emergency action for the following reasons:

1) The pool level is low and no indications of active piping were observed during the inspection.

2) The volume of impounded water is small--less than 20 acre-feet.

3) The floodwater retarding dam seldom impounds much water and the pool is drawn down fairly quickly following flood storage events.

Dr. James V. Hamel of the field inspection team discussed the situation briefly with Mr. James Mondok of the Mercer County Conservation District on 7 December 1978, and again with Mr. Mondok and Mr. Richard Crowley of the Mercer SCS office on 8 December 1978. Michael Baker, Jr., Inc. advised the Baltimore District Corps of Engineers of the situation by telephone shortly thereafter and a preliminary assessment memorandum was submitted for information purposes on 2 January 1979.

c. Appurtenant Structures - Minor to moderate seepage was observed at several locations along the toes of the excavated slopes on both sides of the spillway (field sketch), and piping features were observed in the silt along the downstream right (west) side of the spillway as noted in paragraph 3.1.b. All of these seepage and piping areas are well above normal pool level. They are attributed to natural groundwater flow from the left (east) abutment area and they are not considered detrimental to stability or operation of the spillway.

Some debris was noted on the trash rack of the low-level orifice inlet in the riser structure and other debris was noted around the pond perimeter just above normal pool level. This debris should be removed during routine maintenance in 1979.

d. Reservoir Area - The moderately steep, well vegetated, reservoir slopes consist of glacial soil deposits of ice contact (i.e., kame) origin. Most of these soils are sands and gravels, but there are local pockets and zones of silt. The reservoir slopes are quite stable from geotechnical and hydraulic standpoints.

Minor sedimentation was observed around the edges of the normal pool pond upstream from the dam. This pond acts essentially as a sediment and debris basin. The sedimentation is relatively insignificant due to watershed characteristics. The pond was designed by the SCS with allowance for a 50-year sediment storage.

e. Downstream Channel - The reach of Calvin Clark Run extending 1000 feet downstream from the dam to the Little Shenango River is uninhabited. An unpaved secondary road extends along the right (west) side of Calvin Clark Run to a small bridge over the Little Shenango River about 200 feet downstream (west) of the confluence of Calvin Clark Run. A feed mill is located on the left (south) bank of the Little Shenango River just east of the bridge. The only house in the immediate vicinity is located on the left (south) bank of the Little Shenango River, about 300 feet southwest of the feed mill. From the bridge near the house and feed mill, the Little Shenango River extends about 4 miles westerly through a fairly wide, uninhabited valley to the village of Hadley which has an estimated population of 500 persons, most of whom reside well above river level. The village of Clarks Mills with an estimated population of 200 persons lies about 0.5 mile southeast of the feed mill and upstream from the confluence of Calvin Clark Run. Most of Clarks Mills lies more than 10 feet above the floodplain of the Little Shenango River. Some six houses are located in the Little Shenango River valley between Calvin Clark Run and Clarks Mills. Some of these houses, plus the feed mill and the house near the feed mill, might be subjected to damage and "more than a few" lives might be lost in the event of failure of Little Shenango Dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures are summarized in paragraph 1.2.h.

There are no formal emergency procedures in the event of impending catastrophe for the dam. It is understood that the condition of the dam is checked by Mercer County personnel following each occurrence of heavy precipitation. The spillway and outlet works are uncontrolled and the pond drainpipe reportedly has a steel plate bolted on its inlet (paragraph 1.2.a.). Rapid emergency drainage of the pond is therefore impossible. The time required to lower the pond from spillway crest (El. 1186 feet) to riser weir (El. 1177 feet) is estimated to be 1.4 days and the time required to lower the pond from riser weir to normal pool level at the riser orifice (El. 1160 feet) is estimated to be 3.7 days. At normal pool level, the pond storage volume is approximately 19 acre-feet. Additional emergency drawdown capability is never likely to be required. One method of draining the pond completely is pumping the water into the riser orifice.

It is recommended that a formal emergency procedure be prepared and prominently displayed, and furnished to all personnel. This should include:

1) Procedures for evaluating inflow during periods of emergency operation.

2) Procedures for rapid drawdown of the reservoir under emergency conditions.

3) Development of an emergency evacuation plan, including who to notify, for areas which will be affected in the event of a dam failure.

4.2 MAINTENANCE OF DAM AND APPURTENANCES

Routine maintenance is performed periodically by Mercer County personnel as noted in paragraph 1.2.h.

4.3 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of a dam failure. An emergency warning procedure should be developed.

4.4 EVALUATION OF OPERATIONAL ADEQUACY

The nature of Little Shenango Dam and its appurtenances are such that the present operational and maintenance procedures are considered adequate pending results of the seepage, piping, and stability investigation recommended in Sections 3, 6, and 7. Results of that investigation could lead to modification of operational and maintenance procedures.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - Hydrologic and hydraulic design calculations for Little Shenango Reservoir were obtained from the SCS "Design Report." According to SCS criteria, the emergency spillway and freeboard hydrographs were developed and routed through the reservoir to establish the elevations of the design high water and top of dam. The emergency spillway hydrograph, with a peak discharge of 5285 c.f.s., was based on a 6-hour rainfall of 9.4 inches. The freeboard hydrograph was developed using a 6-hour rainfall of 18.7 inches, which resulted in a peak discharge of 10,180 c.f.s.

b. Experience Data - Although no detailed reservoir stage or rainfall records are available, there has reportedly been no major flood since the dam was constructed. According to Mr. James Mondok of the Mercer County Conservation District, the maximum reservoir stage has been about 10 feet above the normal pool El. 1160.0 feet.

c. Visual Observations - Except for minor debris located on the trash rack of the low-level inlet, no condition was observed at the time of the inspection to indicate that the spillway and outlet works could not operate satisfactorily in the event of a flood.

d. Overtopping Potential - The Little Shenango Dam is classified as a "High" hazard-"Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the Probable Maximum Flood (PMF). The outlet works consist of a typical SCS concrete riser and the spillway is a vegetated earth channel. The hydrologic and hydraulic capabilities of the reservoir, outlet works, and spillway were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The PMF hydrograph developed as a part of this analysis had a peak discharge of 3829 c.f.s. based on a peak 6-hour rainfall of 27.1 inches. The results of the flood routing indicate that the reservoir, outlet works, and spillway are capable of passing the PMF with a maximum reservoir level of El. 1187.7 feet, which is about 4.9 feet below the minimum top of dam El. 1192.6 feet.

e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing the PMF without overtopping. Therefore, the spillway is "adequate" according to the recommended criteria.

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slope, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed, however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - Visual observations of seepage and piping features were presented in paragraph 3.1.b. and Appendix A.

It is impossible to assess from the type of visual inspection performed for this Phase I Inspection Report the extent to which observed seepage and piping features affect structural stability of the dam. As recommended in Section 7, the Mercer County Conservation District should seek engineering assistance in performing a more detailed investigation of seepage, piping, and structural stability of the dam.

b. Design and Construction Data - The dam was designed and constructed according to standard SCS procedures for structures of this type. According to the SCS "Design Report," the upstream slope of the dam has a safety factor of approximately 2.1 under rapid drawdown conditions and the downstream slope has a safety factor of approximately 1.6 under steady seepage conditions. These safety factors are of course adequate.

General experience with slopes of heights, inclinations, materials, and overall hydraulic conditions similar to those of the dam indicates that, under ordinary conditions, the dam slopes could be shown to satisfy the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." This inference is supported by SCS experience and by empirical guidelines given by the U.S. Bureau of Reclamation (1973) Design of Small Dams, 2nd edition, pp. 261-267.

Like all dams, Little Shenango Dam is unique because of site-specific geologic details. At Little Shenango Dam, critical geologic details are those related to the glacial soil deposits and groundwater flow system described in paragraph 1.2.a. These details, plus the standard SCS design and construction procedures used for the dam, have produced the localized seepage and piping features described in paragraph 3.1.b. and Appendix A. As noted in paragraph 6.1.a., a more detailed engineering investigation is necessary to evaluate structural stability of the dam.

c. Operating Records - Nothing in the readily available operating information indicates cause for concern relative to structural stability of the dam.

d. Post-Construction Changes - There have been no post-construction changes which would adversely affect structural stability of the dam.

e. Seismic Stability - The dam is located in Zone 1 on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is an area of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. There will be no need for further consideration of seismic stability once the recommended engineering investigation shows the dam (with remedial measures, if necessary) has adequate static stability.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - The dam was found to be in generally poor condition at the time of inspection. Items requiring immediate attention are the seepage and piping features observed in several locations on the upstream and downstream slopes of the dam, and along both abutment contacts with the downstream slope. It is impossible to assess from the visual inspection performed on 6 December 1978 the extent to which these seepage and piping areas may have reduced the structural stability of the dam. A more detailed investigation of seepage, piping, and structural stability is recommended.

The spillway capacity was analyzed using criteria presented in the "Recommended Guidelines for Safety Inspection of Dams" and according to procedures outlined in paragraph 5.1.d. This analysis indicates that the spillway is adequate to pass the PMF without overtopping the dam.

b. Adequacy of Information - The readily available information and the observations made during field inspection of the dam are considered sufficient for purposes of this Phase I Inspection Report.

c. Urgency - No urgent remedial work is required. However, procedures and personnel for the detailed investigation of seepage, piping, and structural stability should be determined as expeditiously as possible. This investigation should begin as soon as weather and field conditions permit in the Spring of 1979.

d. Necessity for Additional Data/Evaluation - As indicated above and discussed in more detail below, an investigation of seepage, piping, erosion, and structural stability should be performed.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection has revealed the existence of seepage and piping features at several locations in the dam embankment and abutments. It is recommended that the owner retain the services of a registered professional engineer experienced in the design and construction of dams; especially in regards to seepage, piping, and stability aspects of earth dams; to immediately conduct a detailed investigation of the following items.

1) Nature and extent of glacial soil deposits at the dam site.

2) Local patterns of natural groundwater flow.

3) Locations and extents of silt and fine sand zones in the dam embankment and abutments.

4) Locations and extents of piping (internal erosion) conduits in the dam embankments and abutments.

5) Seepage patterns in the dam embankment.

6) Condition and efficacy of granular drains in the dam foundation and abutments.

7) The erosion potential and safety of the silty knoll at the right abutment of the emergency spillway.

8) The installation of properly bedded riprap at the downstream end of the emergency spillway to prevent erosion from surface runoff.

Some of the above information can probably be determined, or at least inferred, from review of SCS records on dam design and construction. Other information in the above list can probably be developed from detailed field reconnaissance. It is likely, however, that some subsurface exploration involving test pits and perhaps borings will also be required. This investigation should develop recommendations for remedial action as necessary.

It is also recommended that a formal emergency procedure be developed soon including:

1) Procedures for evaluating inflow during periods of emergency operation.

2) Procedures for rapid drawdown of the reservoir under emergency conditions.

3) Development of an emergency evacuation plan, including who to notify, for areas which will be inundated in the event of a flood or dam failure.

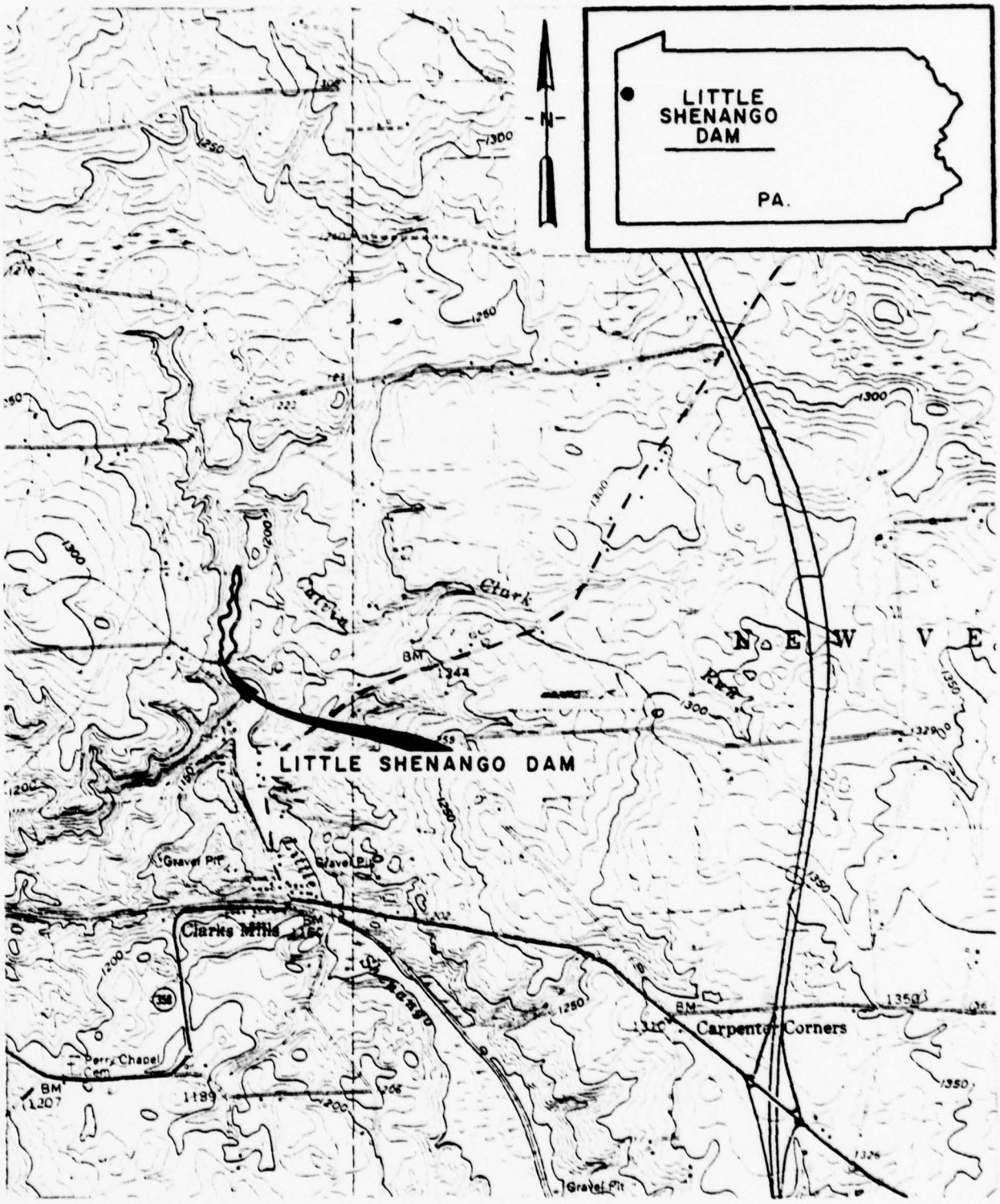
The inspection also disclosed items of lower priority which should be completed within the near future. These are:

1) Cleaning of animal guards on outlets of all three dam foundation and abutment drainpipes.

2) Removal of debris from the trash rack of the low-level orifice inlet in the riser structure and from the pond perimeter.

3) Development of operational and maintenance procedures.

PLATES



SCALE 1:24000

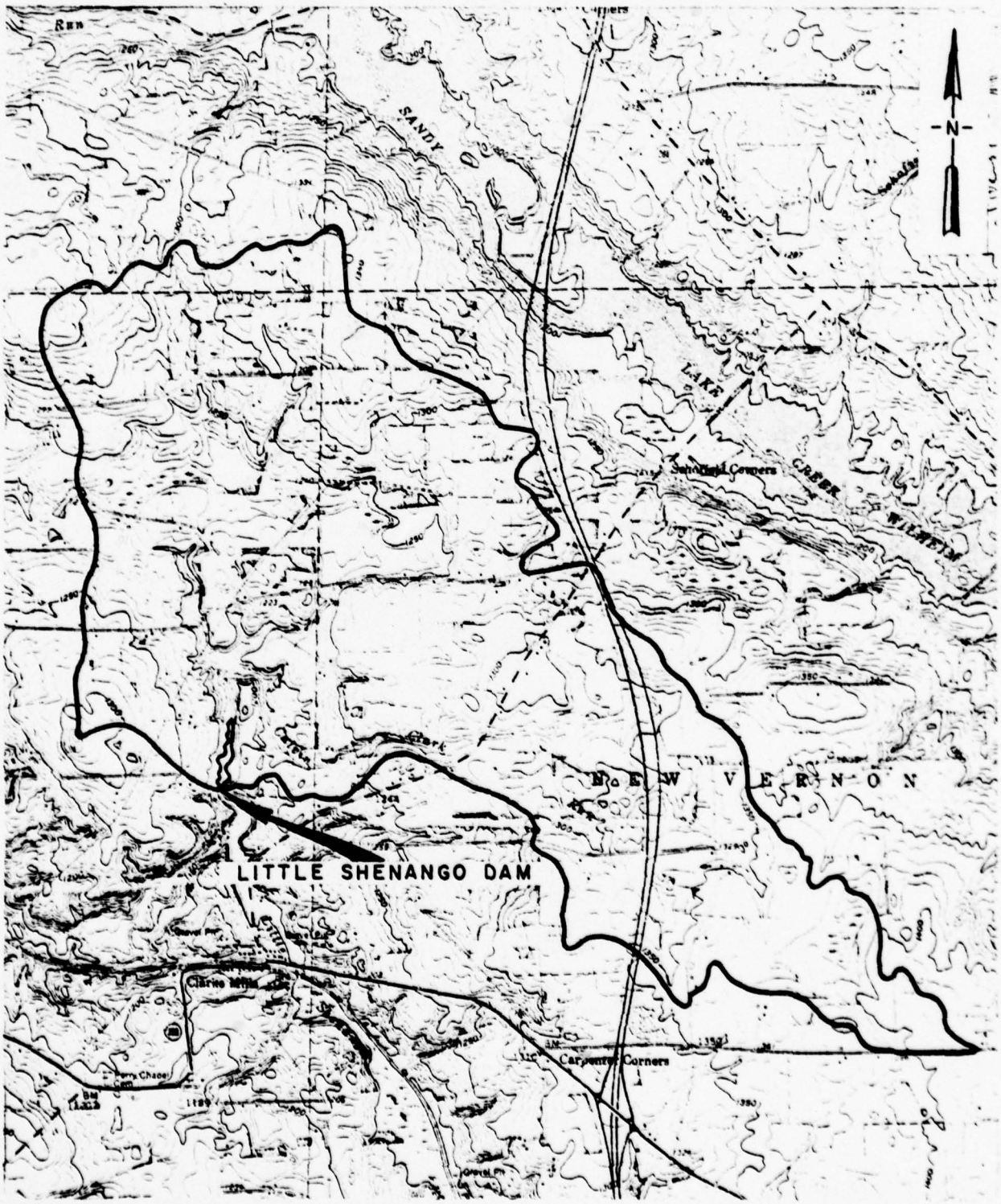
1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

PLATE 1 LOCATION PLAN

LITTLE SHENANGO DAM



SCALE 1:24000

1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

PLATE 2 WATERSHED MAP

LITTLE SHENANGO DAM

LEGEND

Stream

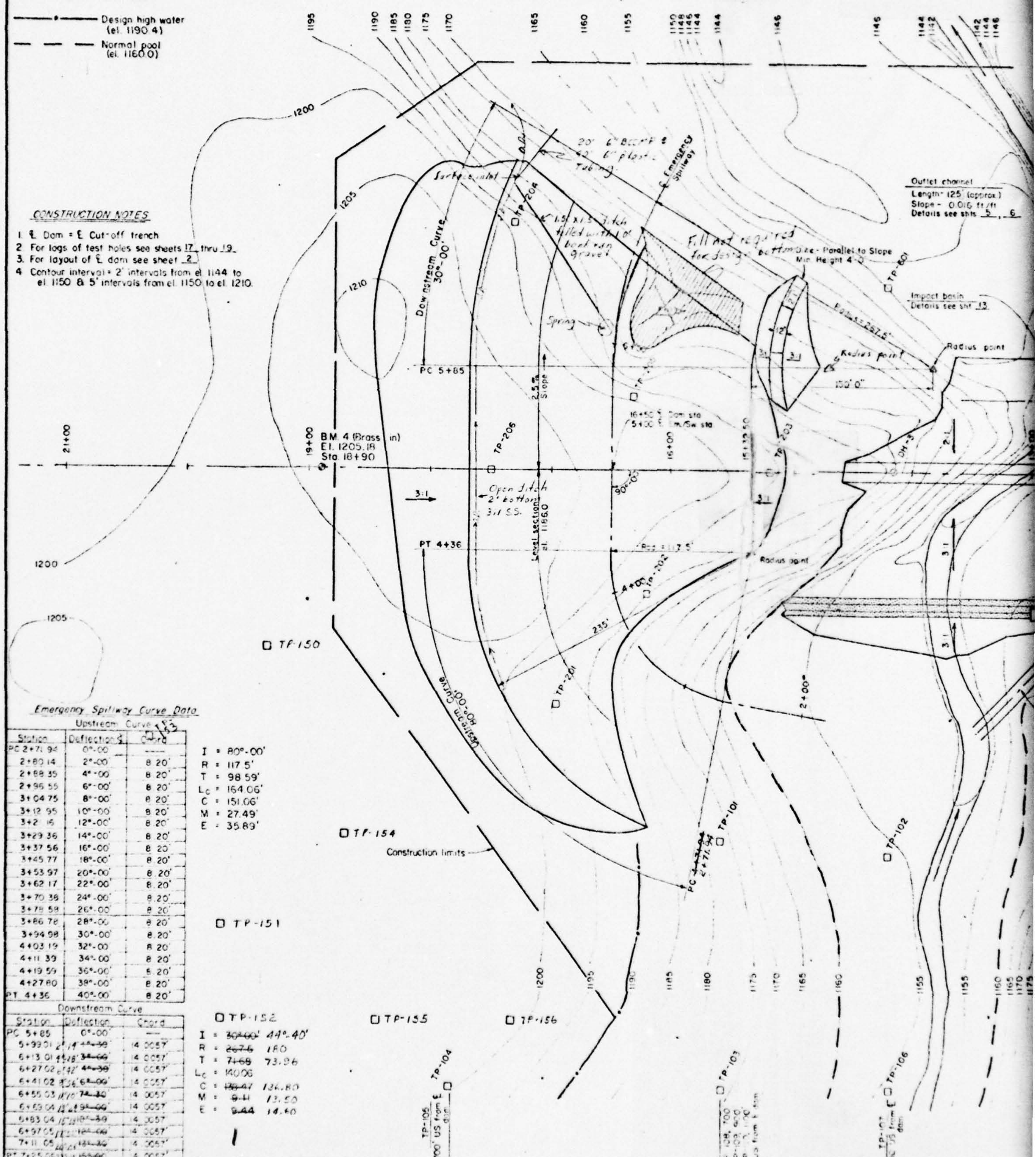
Test holes

Design high water (el. 1190.4)

Normal pool (el. 1160.0)

CONSTRUCTION NOTES

1. ℄ Dam = ℄ Cut-off trench
2. For logs of test holes see sheets 17 thru 19
3. For layout of ℄ dam see sheet 2
4. Contour interval = 2' intervals from el. 1144 to el. 1150 & 5' intervals from el. 1150 to el. 1210.



Emergency Spillway Curve Data

Upstream Curve

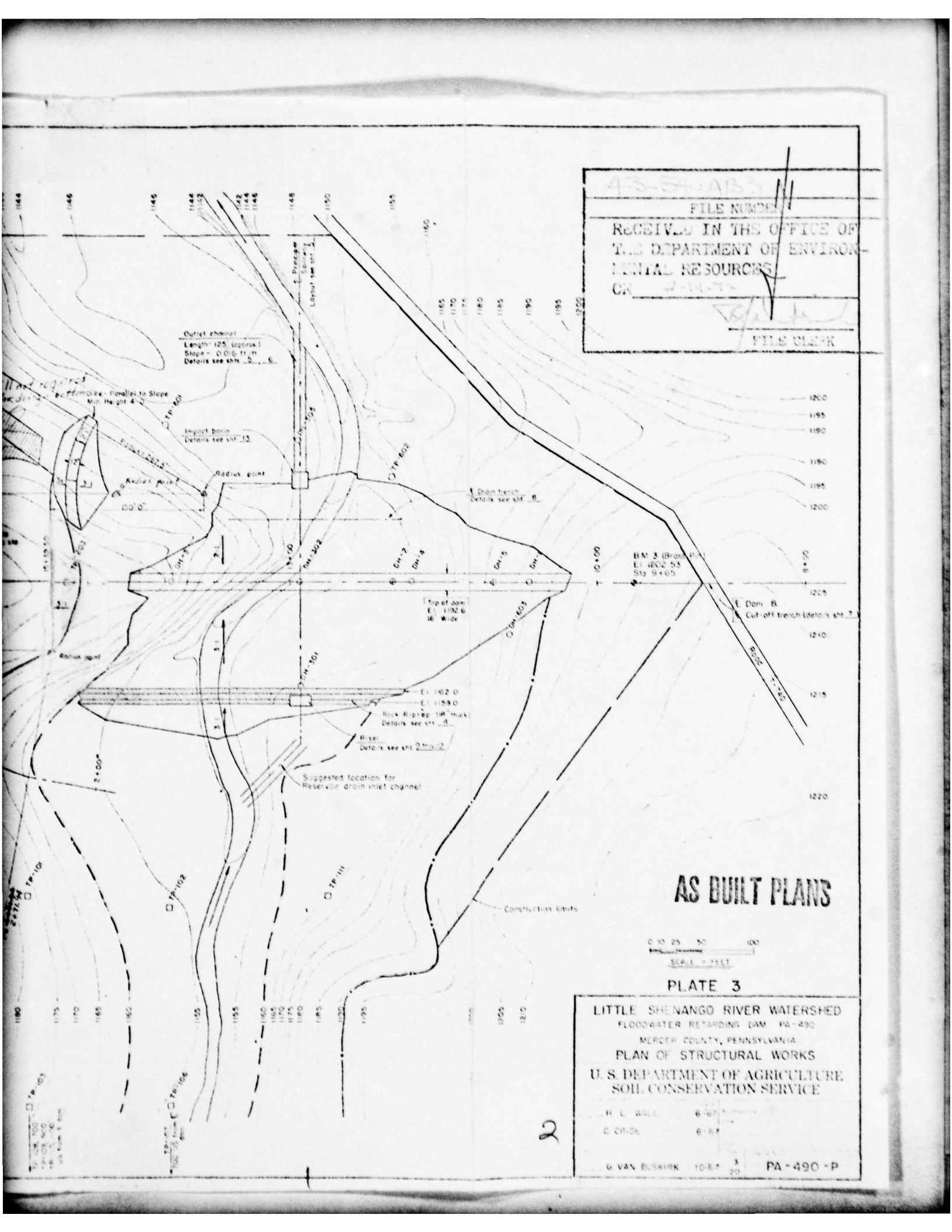
Station	Deflection	Chord
PC 2+71.94	0°-00'	----
2+80.14	2°-00'	8.20'
2+88.35	4°-00'	8.20'
2+96.55	6°-00'	8.20'
3+04.75	8°-00'	8.20'
3+12.95	10°-00'	8.20'
3+21.16	12°-00'	8.20'
3+29.36	14°-00'	8.20'
3+37.56	16°-00'	8.20'
3+45.77	18°-00'	8.20'
3+53.97	20°-00'	8.20'
3+62.17	22°-00'	8.20'
3+70.38	24°-00'	8.20'
3+78.58	26°-00'	8.20'
3+86.78	28°-00'	8.20'
3+94.98	30°-00'	8.20'
4+03.19	32°-00'	8.20'
4+11.39	34°-00'	8.20'
4+19.59	36°-00'	8.20'
4+27.80	38°-00'	8.20'
PT 4+36	40°-00'	8.20'

I = 80°-00'
R = 117.5'
T = 98.59'
L_c = 164.06'
C = 151.06'
M = 27.49'
E = 35.89'

Downstream Curve

Station	Deflection	Chord
PC 5+85	0°-00'	—
5+99.01	[illegible]	14.0057'
6+13.01	[illegible]	14.0057'
6+27.02	[illegible]	14.0057'
6+41.02	[illegible]	14.0057'
6+55.03	[illegible]	14.0057'
6+69.04	[illegible]	14.0057'
6+83.04	[illegible]	14.0057'
6+97.05	[illegible]	14.0057'
7+11.05	[illegible]	14.0057'
PT 7+25.052	[illegible]	14.0057'

I = ~~30°-00'~~ 44°-40'
R = ~~267.6~~ 180
T = ~~71.68~~ 73.96
L_c = 140.06
C = ~~138.47~~ 136.80
M = ~~9.11~~ 13.50
E = ~~9.44~~ 14.60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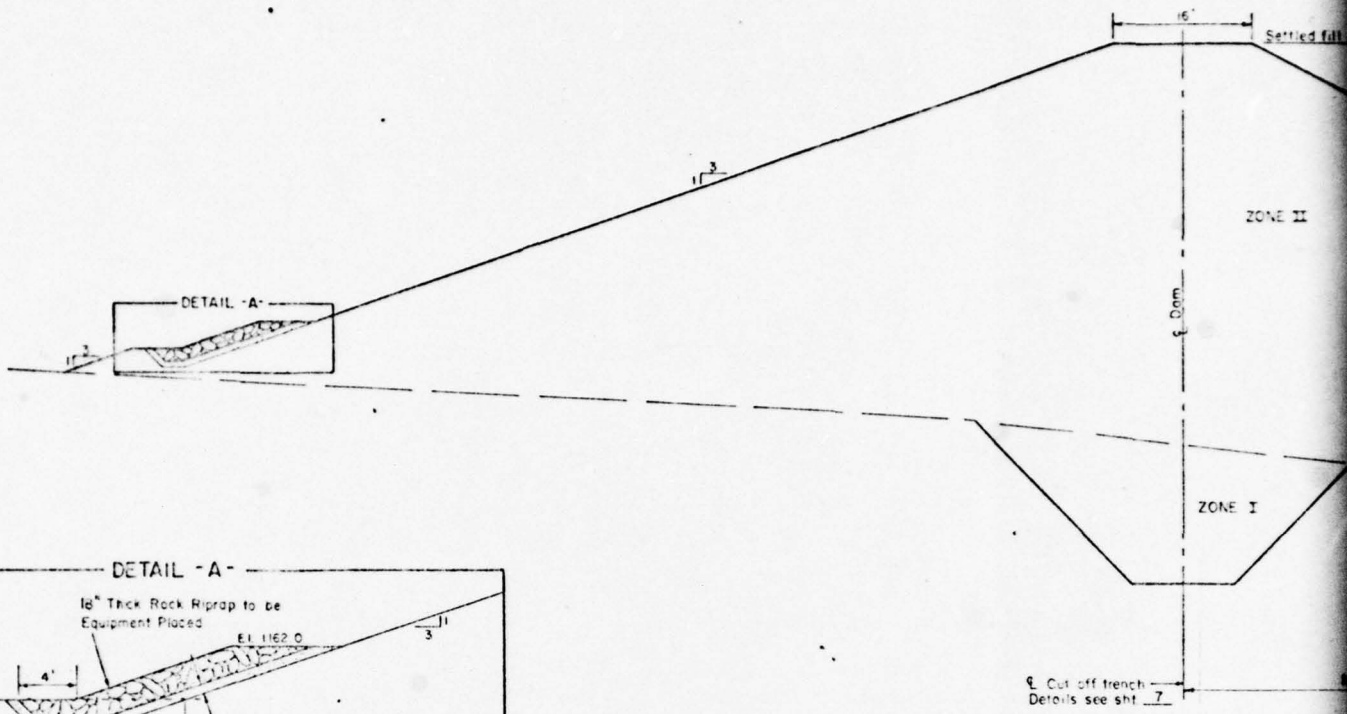
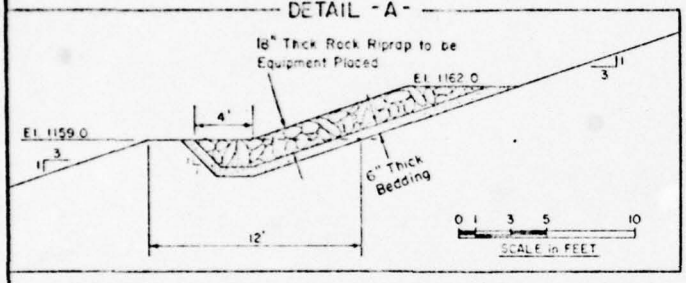
THE DEPARTMENT OF ENVIRONMENTAL RESOURCES
ON
FILE CLERK
Outlet channel
Length 125 (approx.)
Slope = 0.016 ft./ft.
Details see shts 5 & 6
Impact basin
Details see sht 13
Radius point
Drain trench
Details see sht 8
Top of dam
El. 1192.6
16' Wide
BM 3 (Brass Pin)
El. 1202.55
Sta. 9+65
E. Dam B
Cut-off trench (details sht 7)
Rock Riprap (18" thick)
Details see sht 4
Riser
Details see sht 2 & 12
Suggested location for
Reservoir drain inlet channel
Construction spoils
AS BUILT PLANS
SCALE = FEET
PLATE 3
LITTLE SHENANGO RIVER WATERSHED
FLOODWATER RETARDING DAM PA-490
MERCER COUNTY, PENNSYLVANIA
PLAN OF STRUCTURAL WORKS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. L. WALL 6-67
C. CRIDE 6-67
G. VAN BUSKIRK 10-67
PA-490-P

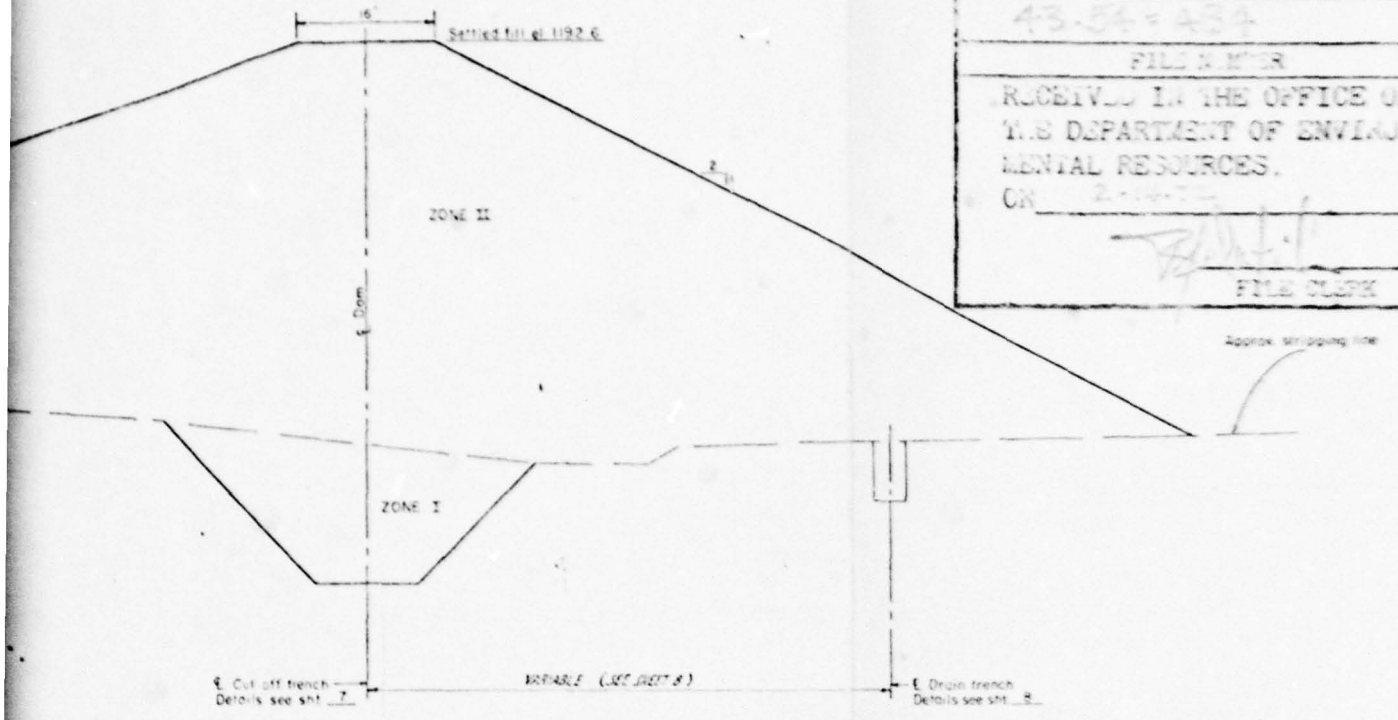


TYPICAL SECTION OF DAM



ZONE	MATERIAL	MAX ROCK SIZE	MAX LIFT [1]	REQ'D [2] WATER CONTENT	COMPACTION Class	COMPACTION Definition
I	Material as represented by TP-203, depth 1.0' to 9.0', classified as CL	6"	9"	Optimum − 2% to + 1%	A	100% Max. density by ASTM D-698 Method "A"
II	Material as represented by TP-203, depth 1.0' to 9.0', classified as CL and by TP-103, Depth 1.0' to 8.4' classified as ML	6"	9"	~~Optimum − 2% to + 2%~~ Minimum moisture content minus 2% optimum	A	95% Max. density by ASTM D-698 Method "A"

1. Maximum permissible lift thickness before compaction.
2. Water content of fill matrix at time of compaction



TYPICAL SECTION OF DAM

43-54-434

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ON _____

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FILE CLERK

CONSTRUCTION NOTES

1. Constructed slopes are
   2.95 : 1 upstream
   1.56 : 1 downstream
2. For constructed fill elevations see sht 7
3. For rock toe details see sht 8

AS BUILT PLANS

PLATE 4

LITTLE SHENANGO RIVER WATERSHED
FLOODWATER RETARDING DAM PA-490
MERCER COUNTY, PENNSYLVANIA
FILL PLACEMENT

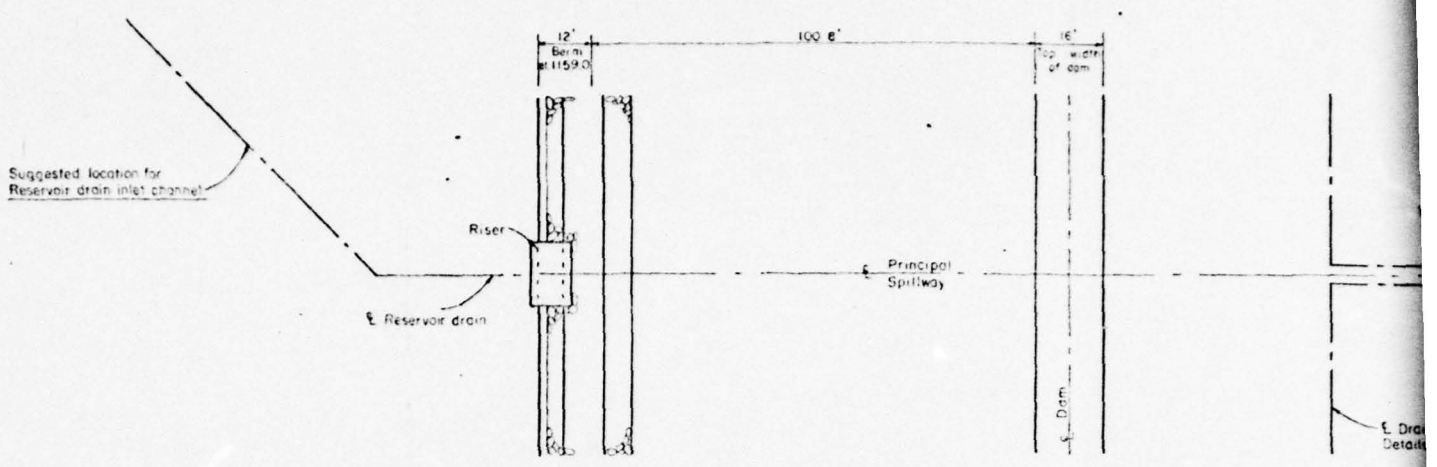
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

H.L. WALL 8-67
DESIGN 8-67

G. VAN BUSKIRK 10-67 PA-490-P

2

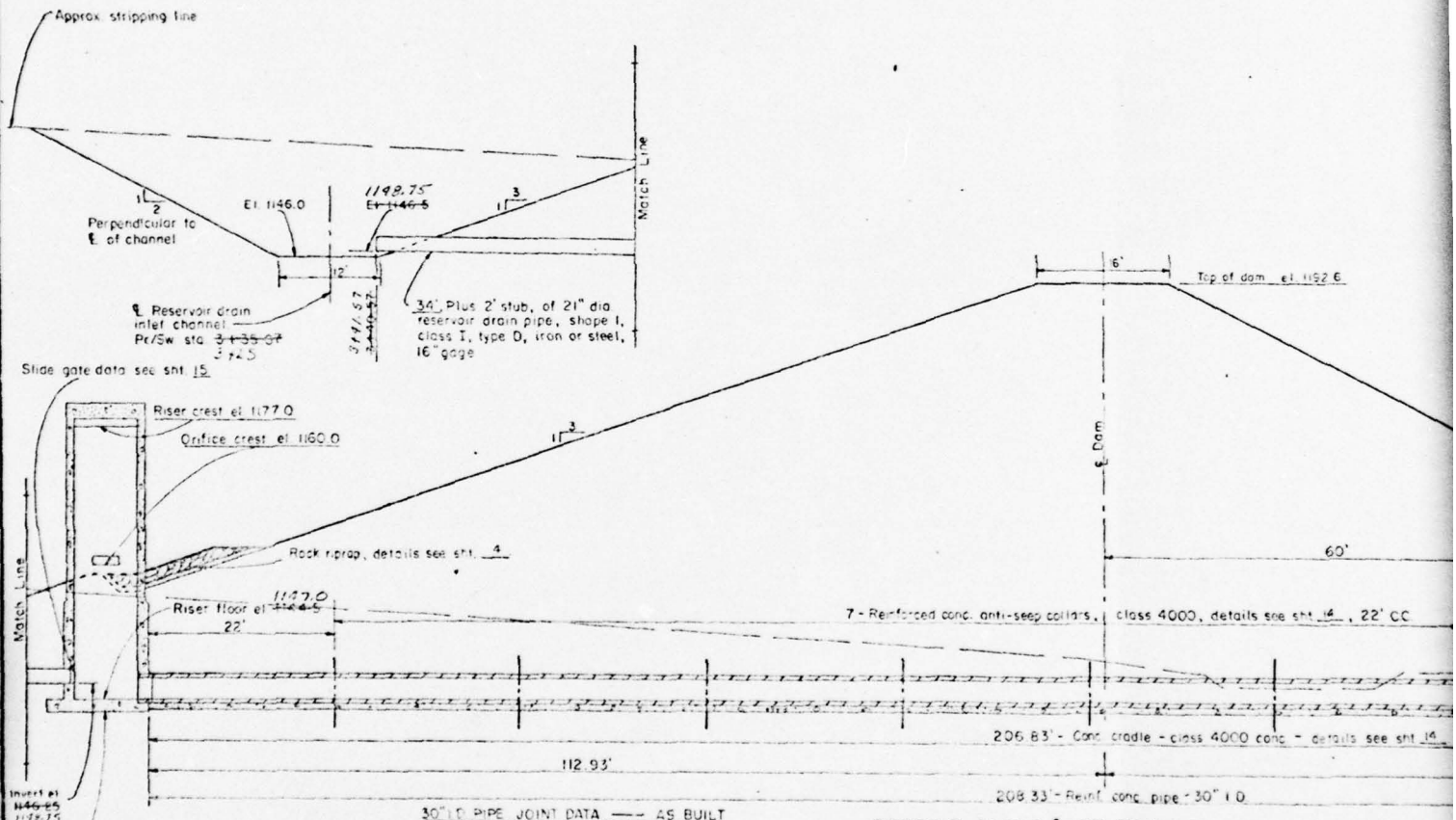
1



PLAN VIEW

0 5 10 20 40

SCALE IN FEET



PROFILE ALONG ℄ OF PRINCIPAL SPILLWAY

0 5 10 20

SCALE IN FEET

CONSTRUCTION DETAILS

1. Outlet end of pipe to be finished so that no metal is exposed
2. Pipe layout data will be furnished by the engineer

30" I.D. PIPE JOINT DATA — AS BUILT

JOINT	DIST. FROM RISER WALL	INVERT EL.
1	0.33	1147.00
2	20.33	1146.86
3	40.33	1146.66
4	60.33	1146.46
5	80.33	1146.26
6	100.33	1146.06
7	120.33	1145.76
8	128.33	1145.64
9	148.33	1145.17
10	168.33	1144.78
11	188.33	1144.39
Outlet	208.33	1144.00

AS BUILT

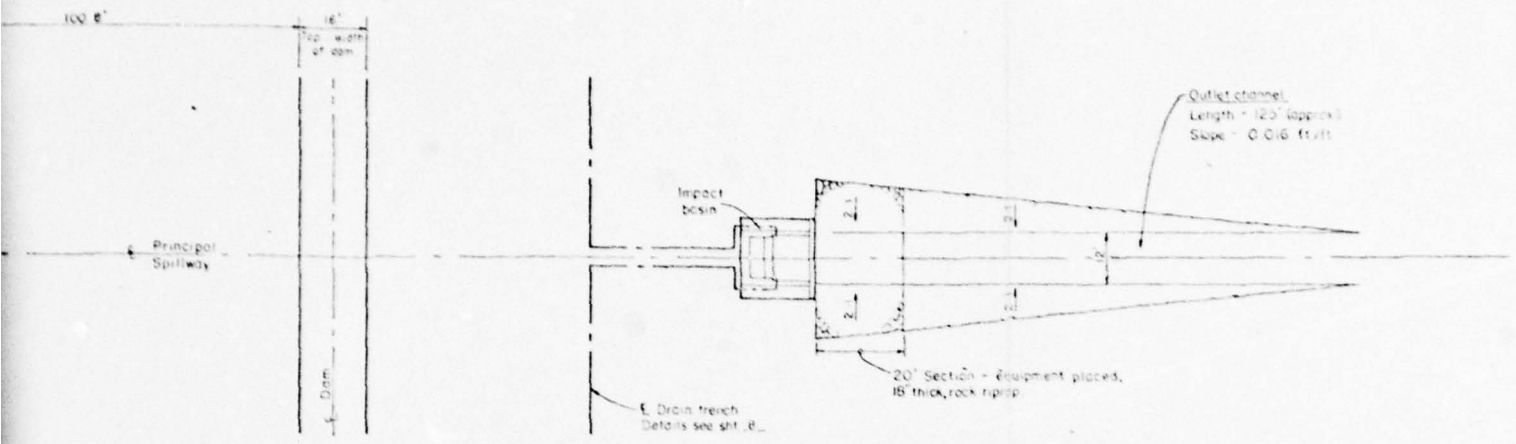
COLLAR DATA — FOR 30" I.D. PIPE

JOINT	DIST. FROM RISER WALL	INVERT EL.
1	22	1146.84
2	44	1146.62
3	66	1146.40
4	88	1146.18
5	110	1145.90
6	132	1145.50
7	154	1145.06

30" I.D. Reinf

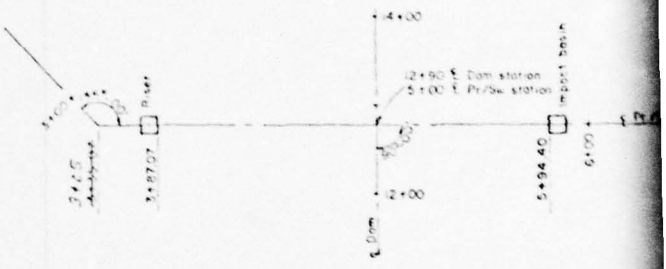
Max. Pressure
Load = 38,00
Min. 3 edge b
0.01" Cr
0.001" C

208.33' - Tota



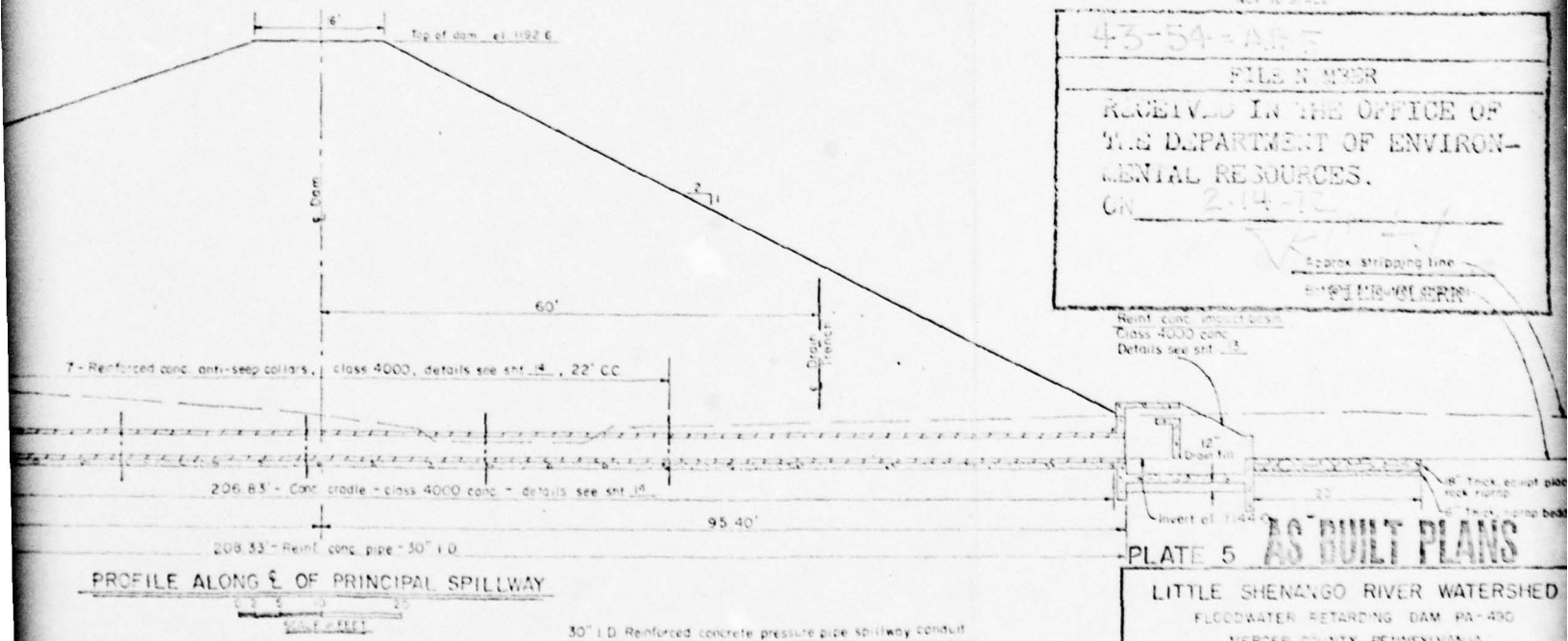
PLAN VIEW

SCALE - FEET



LAYOUT OF PRINCIPAL SPILLWAY

NOT TO SCALE



PROFILE ALONG ℄ OF PRINCIPAL SPILLWAY

SCALE - FEET

AS BUILT

AR DATA - FOR 30" I.D. PIPE

NT	DIST. FROM RISER ℄	INVERT EL.
1	22	1146.84
	44	1146.62
	66	1146.40
	88	1146.18
	110	1145.20
	132	1145.50
	154	1145.06

30" I.D. Reinforced concrete pressure pipe spillway conduit

Max. Pressure Head = 45' Min. Pressure Head = 0

Long = 38,000 lbs. per lin. ft., based O.D. of 2.96'

Min. 3 edge bearing strength for:

0.01" Crack non-prestressed pipe = 12,505 lbs. per lin. ft.

0.001" Crack prestressed pipe = 9,402 lbs. per lin. ft.

208.33' - Total length

2

1

AS BUILT PLANS

PLATE 5

LITTLE SHENANGO RIVER WATERSHED

FLOODWATER RETARDING DAM PA-490

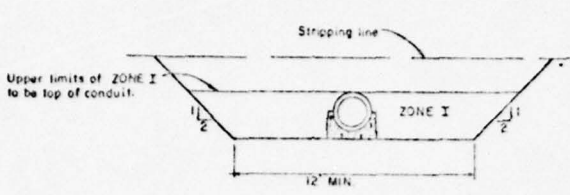
MERCER COUNTY, PENNSYLVANIA

PRINCIPAL SPILLWAY

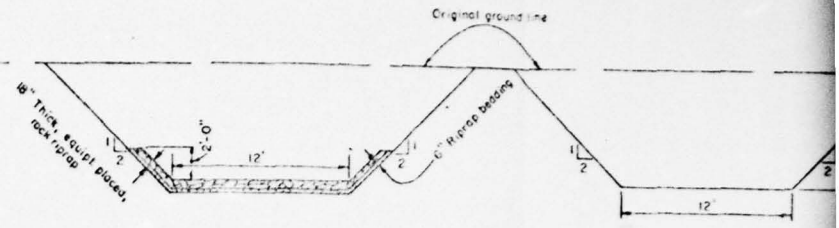
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

H. L. WALL	7-67	
C. CRIDE	7-67	
G. VAN BUSKIRK	10-67	5

PA-490-P

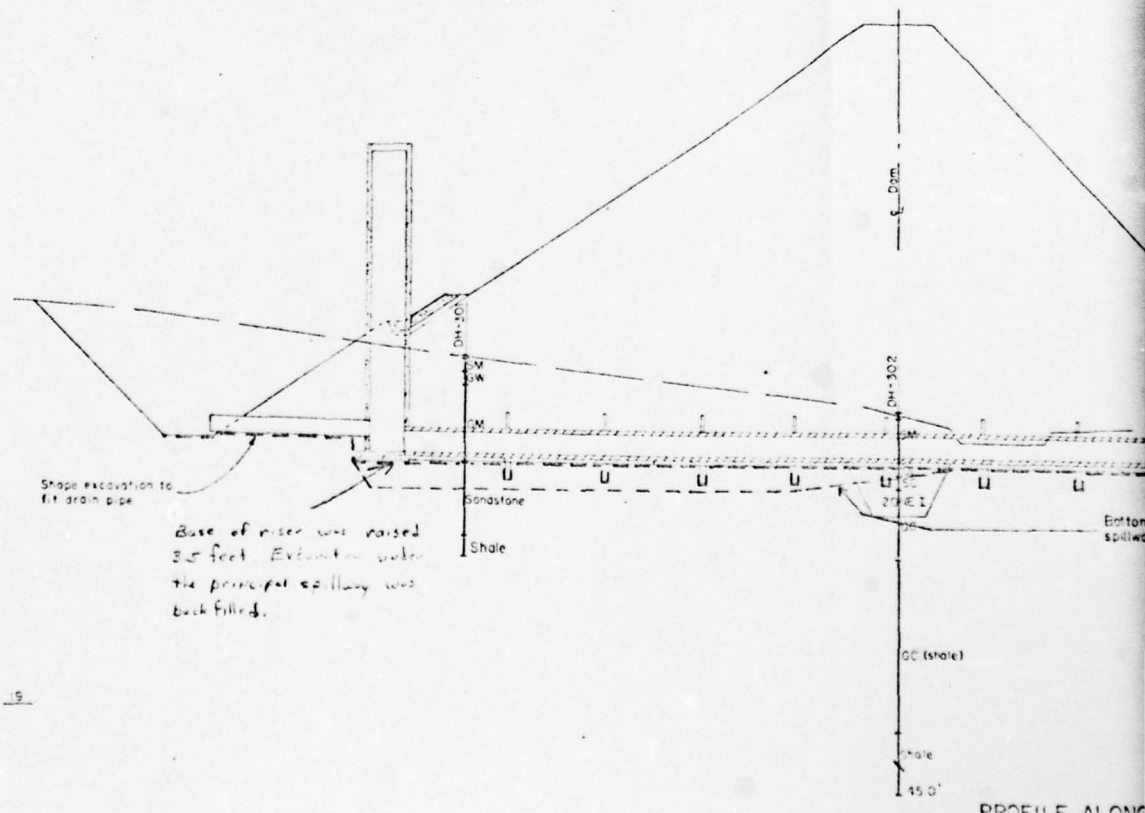


PR./SW. BACKFILL DETAIL



OUTLET CHANNEL
20' ROCK RIPRAP SECTION

OUTLET CHANNEL



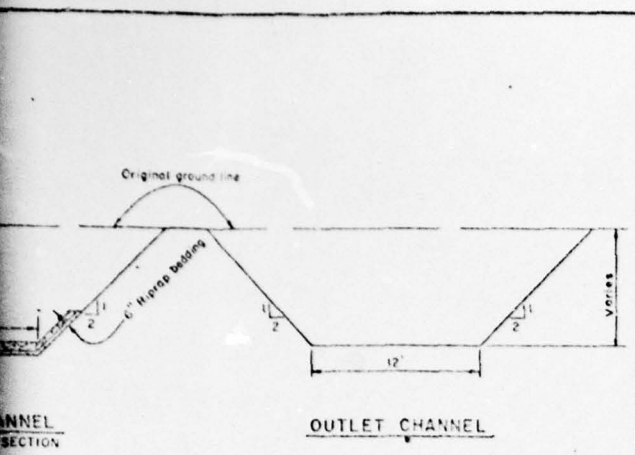
Note

For logs of test holes see sht. 17 thru 19

PROFILE ALONG

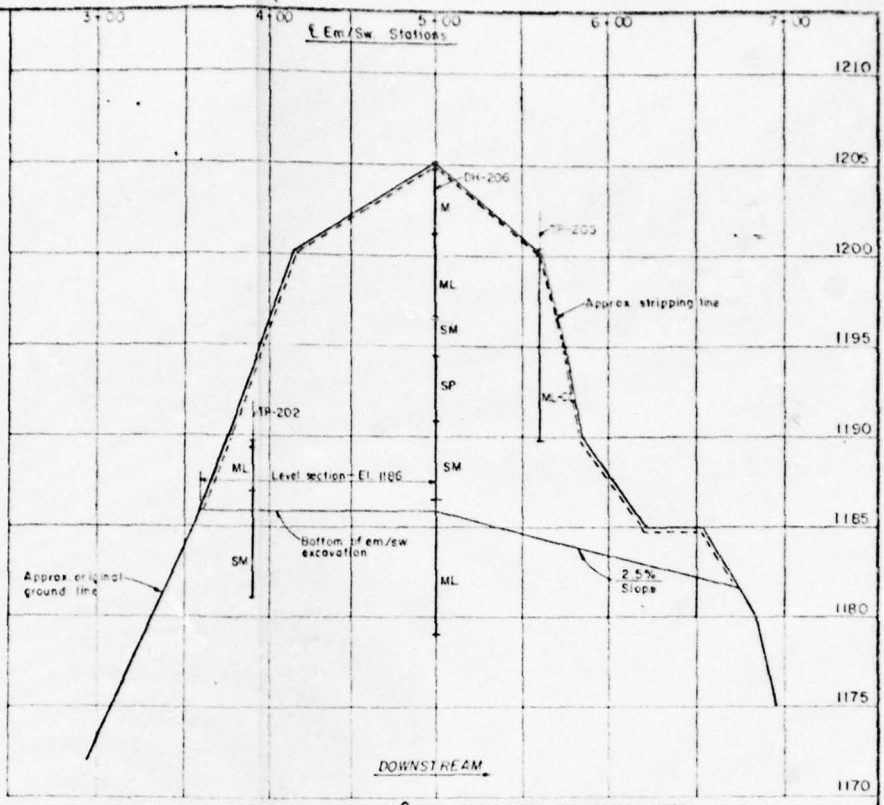
0 2

VERTICAL

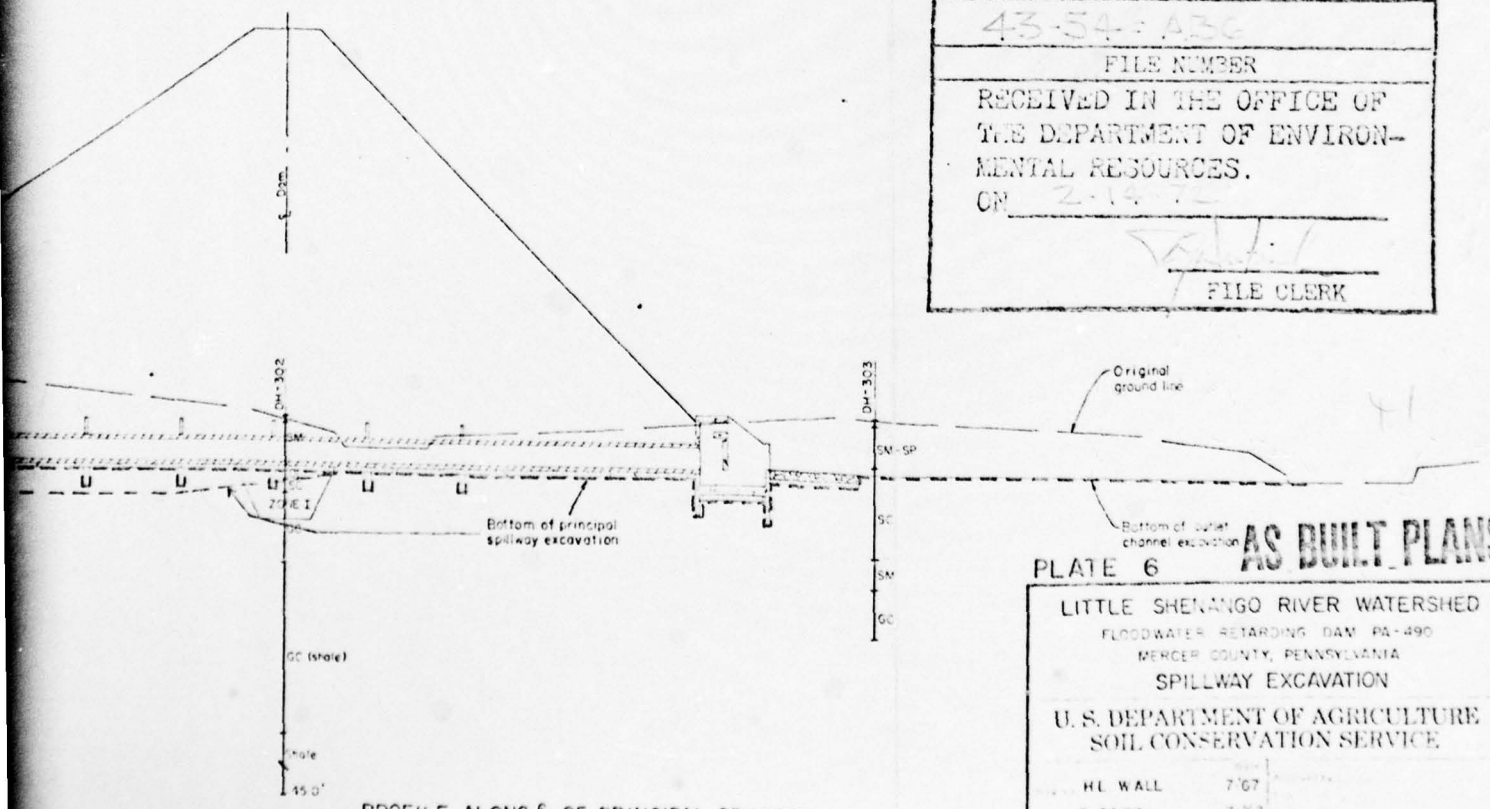


NNEL
SECTION

OUTLET CHANNEL



PROFILE ALONG ℄ OF EMERGENCY SPILLWAY



PROFILE ALONG ℄ OF PRINCIPAL SPILLWAY

0 2 5 2 20 0 4 2 4
VERTICAL HORIZONTAL
SCALE in FEET

43-54-A36
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ON 2-14-72
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AS BUILT PLANS

PLATE 6

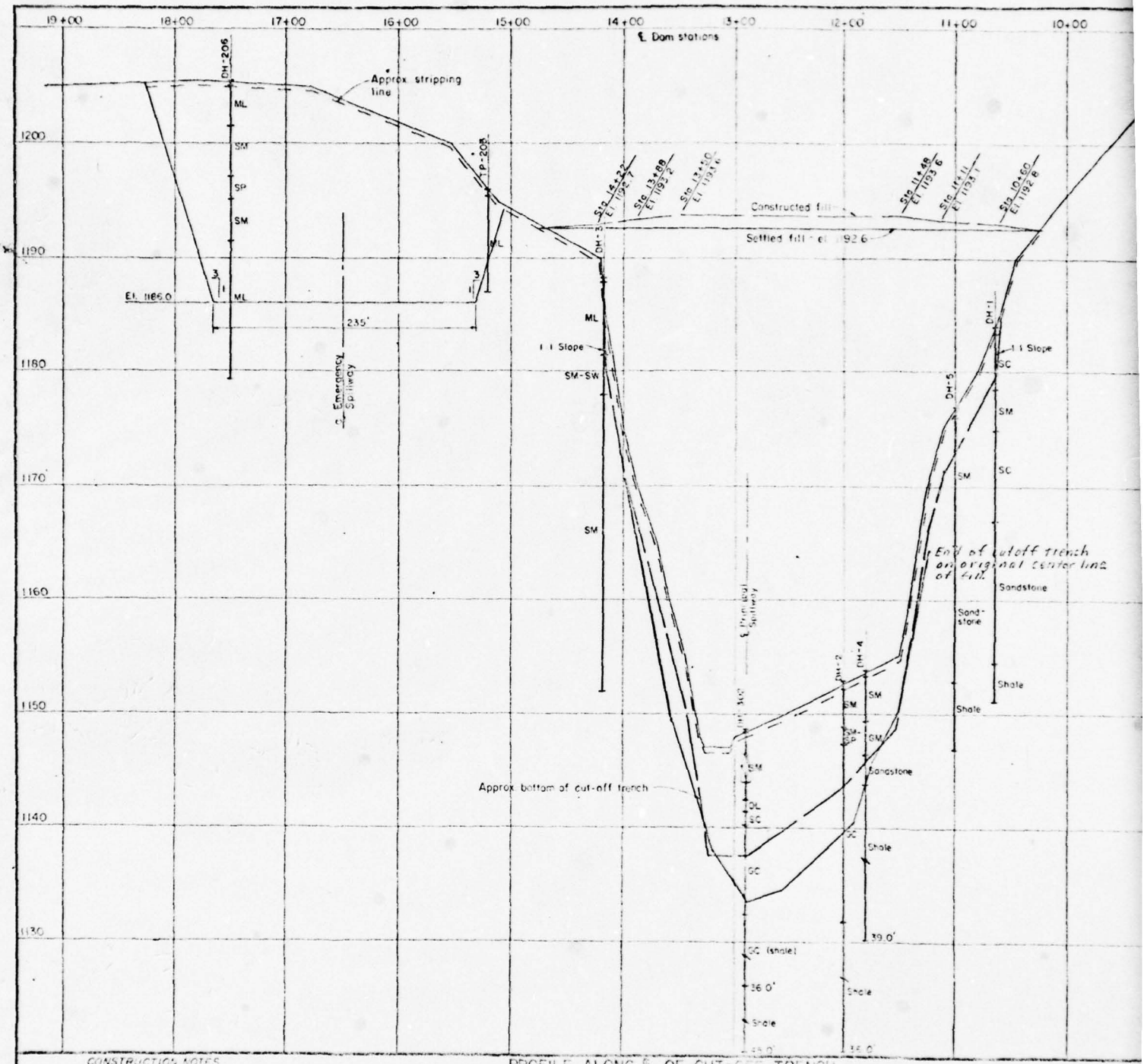
LITTLE SHENANGO RIVER WATERSHED
FLOODWATER RETARDING DAM PA-490
MERCER COUNTY, PENNSYLVANIA
SPILLWAY EXCAVATION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

HL WALL	7-67	
C GRADE	7-67	
G VAN BUSKIRK	10-67	6/20

PA-490-P

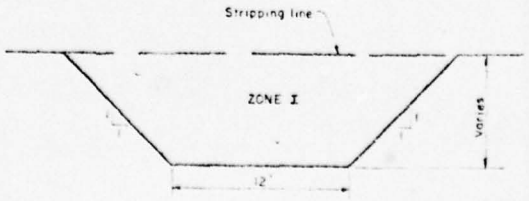
2



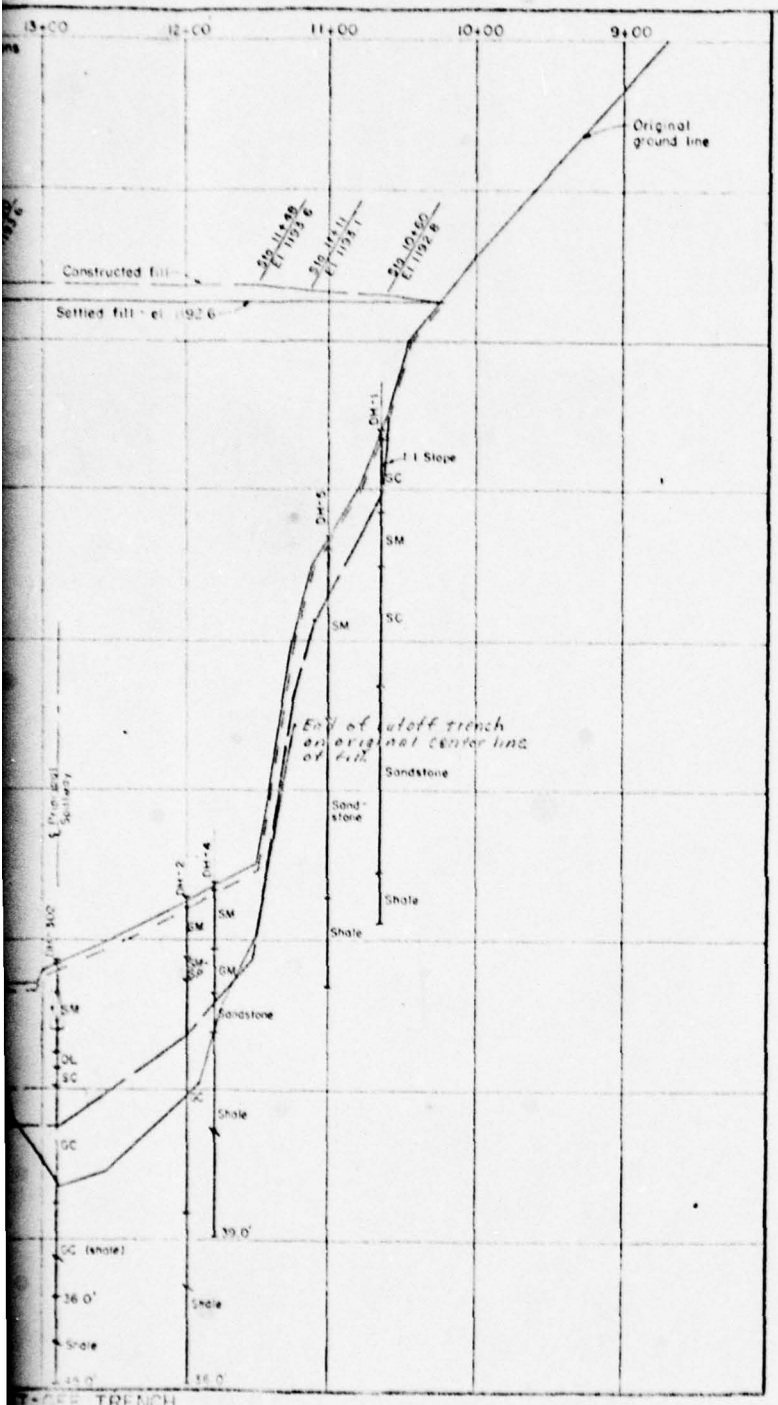
PROFILE ALONG ℄ OF CUT-OFF TRENCH
LOOKING DOWNSTREAM

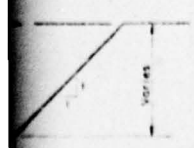
CONSTRUCTION NOTES

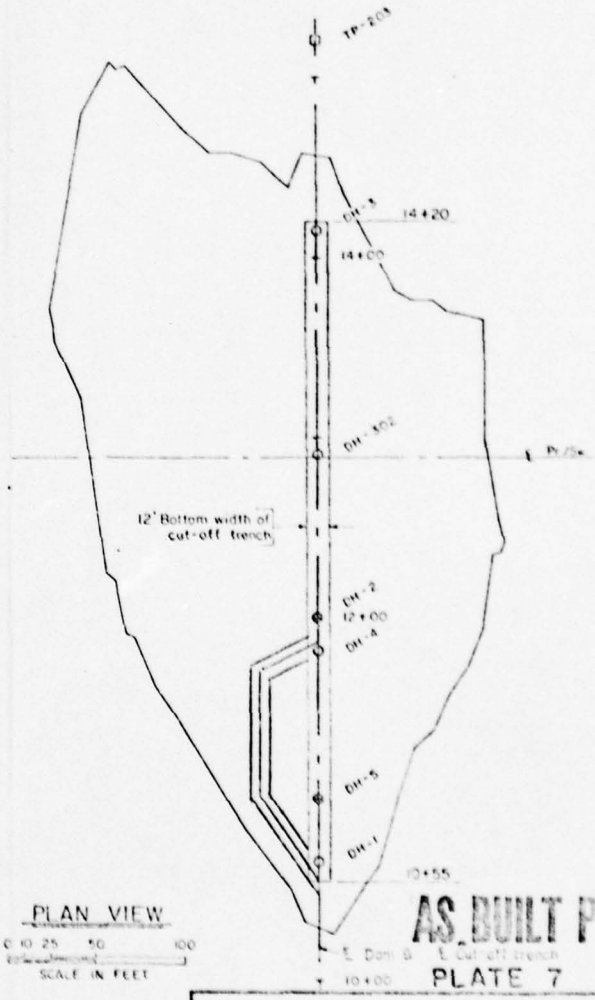
1. For logs of test holes see shts. 17 thru 19.
2. ℄ Dam = ℄ Cut-off trench



TYPICAL SECTION OF CUT-OFF TRENCH







PLAN VIEW

0 10 25 50 100

SCALE IN FEET

AS BUILT PLANS

PLATE 7

45-54-A87

FILE NUMBER

RECEIVED IN THE OFFICE OF THE DEPARTMENT OF ENVIRONMENTAL RESOURCES.

ON 2-18-72

FILE CLERK

LITTLE SHENANGO RIVER WATERSHED

FLOODWATER RETARDING DAM PA-490

MERCER COUNTY, PENNSYLVANIA

CUT-OFF TRENCH DETAILS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

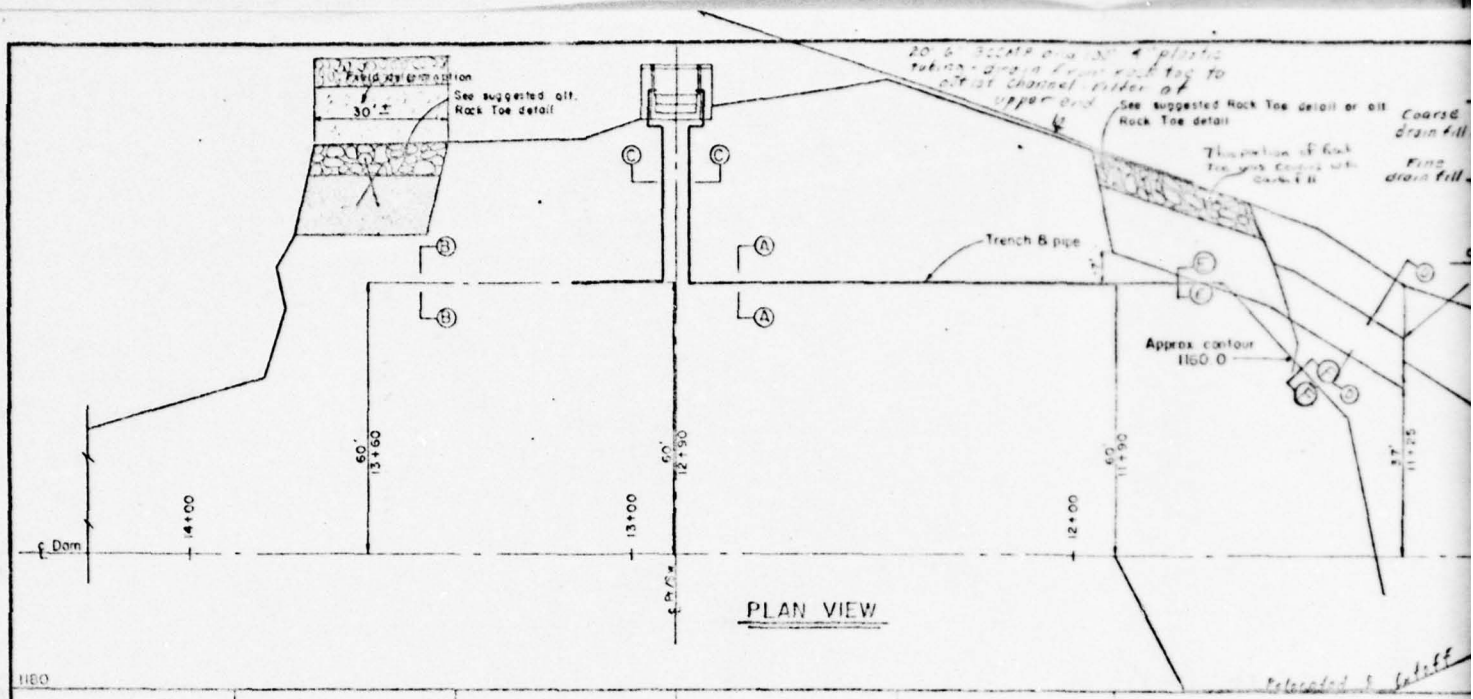
H. L. WALL 7-67

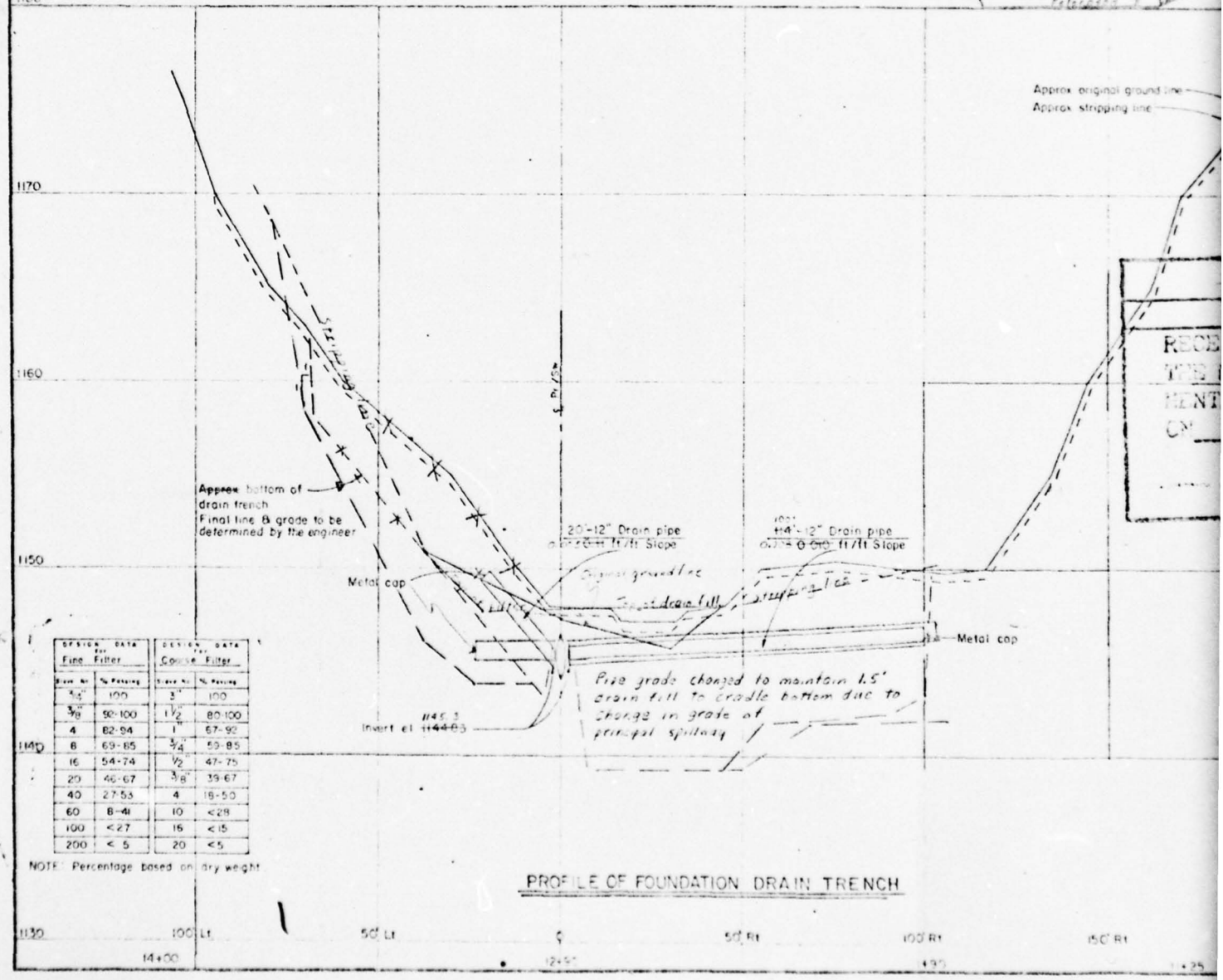
C. CRISE 7-67

G. VAN BUSKIRK 10-67 7/20

PA-490-P

2

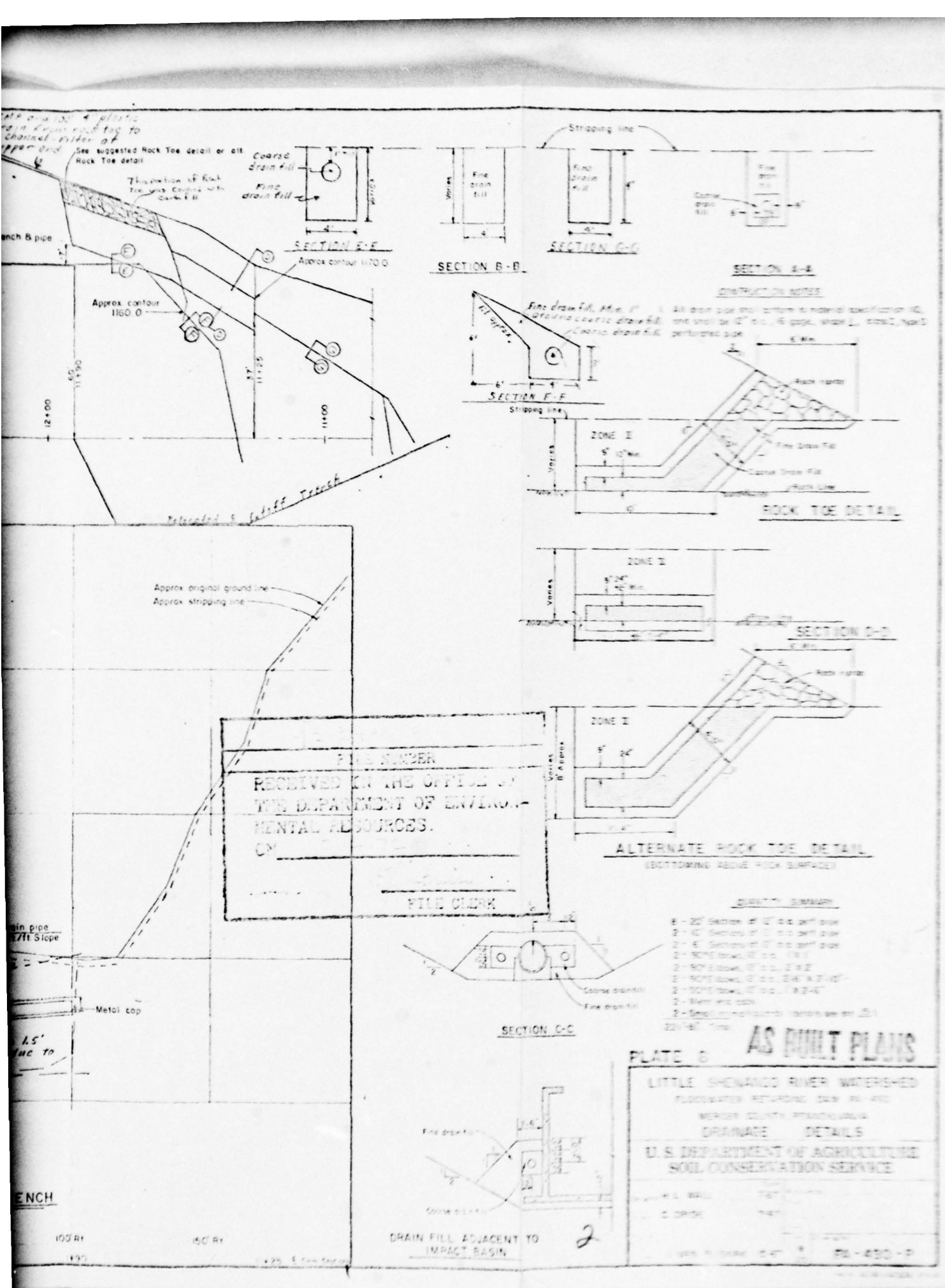




DESIGN DATA For Fine Filter		DESIGN DATA For Coarse Filter	
Sieve No.	% Passing	Sieve No.	% Passing
3/4"	100	3"	100
3/8"	90-100	1 1/2"	80-100
4	82-94	1"	67-92
8	69-85	3/4"	59-85
16	54-74	1/2"	47-75
30	40-67	3/8"	39-67
40	27-53	4	18-50
60	8-41	10	<28
100	<27	16	<15
200	< 5	20	<5

NOTE: Percentage based on dry weight

PROFILE OF FOUNDATION DRAIN TRENCH



APPENDIX A

CHECK LIST - VISUAL INSPECTION, SEEPAGE AND PIPING SUPPLEMENT, AND FIELD SKETCH

Check List
Visual Inspection
Phase 1

Name of Dam LITTLE SHENANGO County Mercer State PA Coordinates Lat. N 41°24.3'
NDI # PA 00246
PennDER # 43-54
Long. W 80°11.0'

Date Inspection 6 Dec. 1978 Weather Sunny to Partly Cloudy Temperature 30-40°F.

Pool Elevation at Time of Inspection 1160.7 ft. M.S.L. Tailwater at Time of Inspection 1144.4 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
Rodney E. Holderbaum
James V. Hamel

Owner's Representative
Mercer County Conservation District:

James Mondok (part-time)

James V. Hamel Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: LITTLE SHENANGO
NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: LITTLE SHENANGO
NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

EMBANKMENT

Name of Dam: LITTLE SHENANGO
NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None were observed.	The embankment is well vegetated with grasses and crown vetch.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None were observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or surficial erosion was observed. Evidence of piping (internal erosion) was observed at several locations; see field sketch and attached Seepage and Piping Supplement. Sloughing or sliding may eventually develop in seepage and piping areas along junction of downstream slope with left abutment below El. 1163± ft. (field sketch).	See attached Seepage and Piping Supplement.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No problems were observed.	
RIPRAP FAILURES	None were observed.	The upstream slope only has riprap from El. 1159 ft. to El. 1162 ft. for wave protection at normal pool level, El. 1160 ft.

EMBANKMENT

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	See attached Seepage and Piping Supplement.	
ANY NOTICEABLE SEEPAGE	See attached Seepage and Piping Supplement.	
STAFF GAGE AND RECORDER	There is no staff gage or recorder.	
DRAINS	Two 12-in. diameter toe drainpipes, with small animal guards, discharge from the outlet structure on either side of the outlet pipe. A 6-in. diameter drainpipe, with small animal guards, discharges in right (west) side of outlet channel 25 ft. downstream from outlet structure; this pipe drains the wet area along the downstream right abutment junction. All three drainpipes, which were trickling clear water at the time of inspection, appeared to be functioning properly. Some moss, slime, and debris was observed in the small animal guard on eacn pipe.	Moss, slime, and debris in the small animal guards at the drain outlets should be removed during routine maintenance in 1979. Drain performance should be further evaluated in the seepage and piping investigation.

OUTLET WORKS

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No problems were observed.	
INTAKE STRUCTURE	There was some debris on the trash rack of the low-level orifice inlet (and also around the pond perimeter just above normal pool level).	Debris should be removed from the trash rack and pond perimeter during routine maintenance in 1979.
OUTLET STRUCTURE	No problems were observed.	
OUTLET CHANNEL	An outlet channel about 100 ft. long and 12 ft. wide extends straight downstream from the outlet structure to the pre-existing channel of Calvin Clark Run. The outlet channel is riprap-lined to El. 1150± ft. (top of outlet structure) for a distance of 25 ft. downstream from the outlet structure. The channel was excavated with 2H:1V side slopes and a 1.6% downstream slope in dense, well graded glacial till with silt to cobble size particles.	The outlet channel is considered stable from geotechnical and hydraulic standpoints.
EMERGENCY GATE	The pond drain line (21-in. diameter metal pipe extending 34 ft. upstream from riser structure) reportedly has a steel plate bolted on its inlet end.	The pond cannot readily be drained below the low-level orifice inlet in the riser structure (normal pool, El. 1160 ft.).

UNGATED SPILLWAY

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	There is no concrete weir. The spillway is a well vegetated earth channel which was excavated in glacial soils (of probable ice contact origin) in the left abutment.	According to James Mondok, three small slides with a total breadth of 75 ft. occurred in the excavated slope on the left side of the spillway soon after the dam was constructed. These slides were repaired and drainage measures were installed in 1973. No problems have developed since this remedial work.
APPROACH CHANNEL	Minor seepage was observed all along the toe of the 3H:1V excavated slope on the left (east) side of the spillway. Minor seepage was also observed along the toe of the 3H:1V excavated slope or the right (west) side of the spillway.	Seepage along the toes of the excavated spillway slopes results from natural groundwater flow and is not considered detrimental to stability or operation of the spillway.
DISCHARGE CHANNEL	Seepage and surface runoff have produced an erosion ditch and piping tunnels along the right downstream side of the spillway, adjacent to the spillway outlet dike.	See attached Seepage and Piping Supplement.
BRIDGE AND PIERS	There are no bridges or piers.	

GATED SPILLWAY - Not Applicable

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

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

INSTRUMENTATION - There is no instrumentation.

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS		
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER		

RESERVOIR

Name of Dam: LITTLE SHENANGO

NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The moderately steep, well vegetated reservoir slopes consist of glacial soil deposits of ice contact (i.e., kame) origin. Most of these soils are sands and gravels, but there are local pockets and zones of silt.	The reservoir slopes are quite stable from geotechnical and hydraulic standpoints.
SEDIMENTATION	Minor sedimentation was observed around the edges of the 4 acre pond upstream from the dam. This pond acts essentially as a sediment and debris basin.	Sedimentation is relatively insignificant due to watershed characteristics. The pond was designed by the SCS with allowance for a 50-year sediment storage.

DOWNSTREAM CHANNEL

Name of Dam: LITTLE SHANANGO
NDI # PA 00246

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Calvin Clark Run extends from the dam approximately 1000 ft. downstream to its confluence with the Little Shenango River. The slightly meandering channel has a width on the order of 20 ft. in a floodplain with a glacial outwash, meltwater, and runoff discharged through this valley.	The reach of Calvin Clark Run from the dam to the Little Shanango River is uninhabited and essentially free of obstructions and debris.
SLOPES	The stream channel is eroded in dense, well graded glacial till. The longitudinal slope is quite flat. Channel side slopes are moderately steep. The well vegetated valley walls are steep slopes on ice contact (kame-type) soil deposits.	Downstream channel slopes are stable from geotechnical and hydraulic standpoints.
APPROXIMATE NO. OF HOMES AND POPULATION	The reach of Calvin Clark Run extending 1000 ft. downstream from the dam to the Little Shanango River is uninhabited. A feed mill is located on the left (south bank of the Little Shanango River about 100 ft. downstream from the confluence of Calvin Clark Run. A small bridge carries an unpaved secondary road across the river about 100 ft. downstream from the mill. This road extends along the right (west) wall of Calvin Clark Run valley from the dam to the bridge. The 500 ft. length of road north of the bridge might be subject to inundation during heavy flood flows in Calvin Clark Run. From the bridge near the house and feed mill, the Little Shenango River extends about 4 miles westerly through a fairly wide, uninhabited valley to the village of Hadley which has an estimated population of 500 persons, most of whom reside well above river level. The village of Clarks Mills with an estimated population of 200 persons lies about 0.5 mile southeast of the feed mill and upstream from the confluence of Calvin Clark Run.	Most of Clarks Mills lies more than 10 feet above the floodplain of the Little Shenango River. Some six houses are located in the Little Shenango River valley between Clavin Clark Run and Clarks Mills. Some of these houses, plus the feed mill and the house near the feed mill, might be subjected to damage and "more than a few" lives might be lost in the event of failure of Little Shenango Dam.

LITTLE SHENANGO DAM
NDI NO. PA 00246, PennDER No. 43-54

SEEPAGE AND PIPING SUPPLEMENT

During the field inspection on 6 December 1978, seepage and evidence of piping (internal erosion of fine soil particles) was observed at several locations in the dam embankment and its abutments. These seepage and piping areas are shown on the attached field sketch and they are described briefly below.

A 3-inch diameter piping tunnel was noted at a depth of about 1 foot in silty fill on the right (west) side of the upstream slope of the dam at El. 1174± feet. This tunnel appeared to extend horizontally some 50 feet left from the right abutment contact before turning into the embankment in an area where the fill is denser and well graded. It seems likely that this tunnel was produced by piping due to flow from springs in the right abutment as normal pool level is El. 1160 feet.

Surface water flow along the downstream right (west) side of the spillway, perhaps in combination with flow from springs in the left (east) abutment area, has produced a line of erosion gullies and piping tunnels with maximum depths of 2 to 3 feet from the downstream right side of the spillway toward the stream (El. 1180-1170± feet). These features are in silt of glacial ice contact (i.e., kame) origin. Minor seepage and piping indications were also observed (1) some 50 to 100 feet right (west) of the above-mentioned area in similar silt deposits lower on the downstream left (east) abutment at El. 1163± feet, (2) along the contact of the downstream slope with the right (west) abutment at El. 1172± feet, and (3) at several locations along the downstream toe of the dam at El. 1155-1160± feet. No significant migration of fine soil particles was observed at any of these areas during the inspection but numerous "ratholes" and tunnels from a fraction of an inch to a few inches in diameter were observed.

It appears that piping features in abutment soils resulted mainly from natural groundwater flow. Groundwater flow from the abutments probably contributed to piping indications observed in the embankment fill. Seepage from the impoundment may also have contributed to piping features observed along the downstream toe of the dam. The situation was not considered to require emergency action for the following reasons:

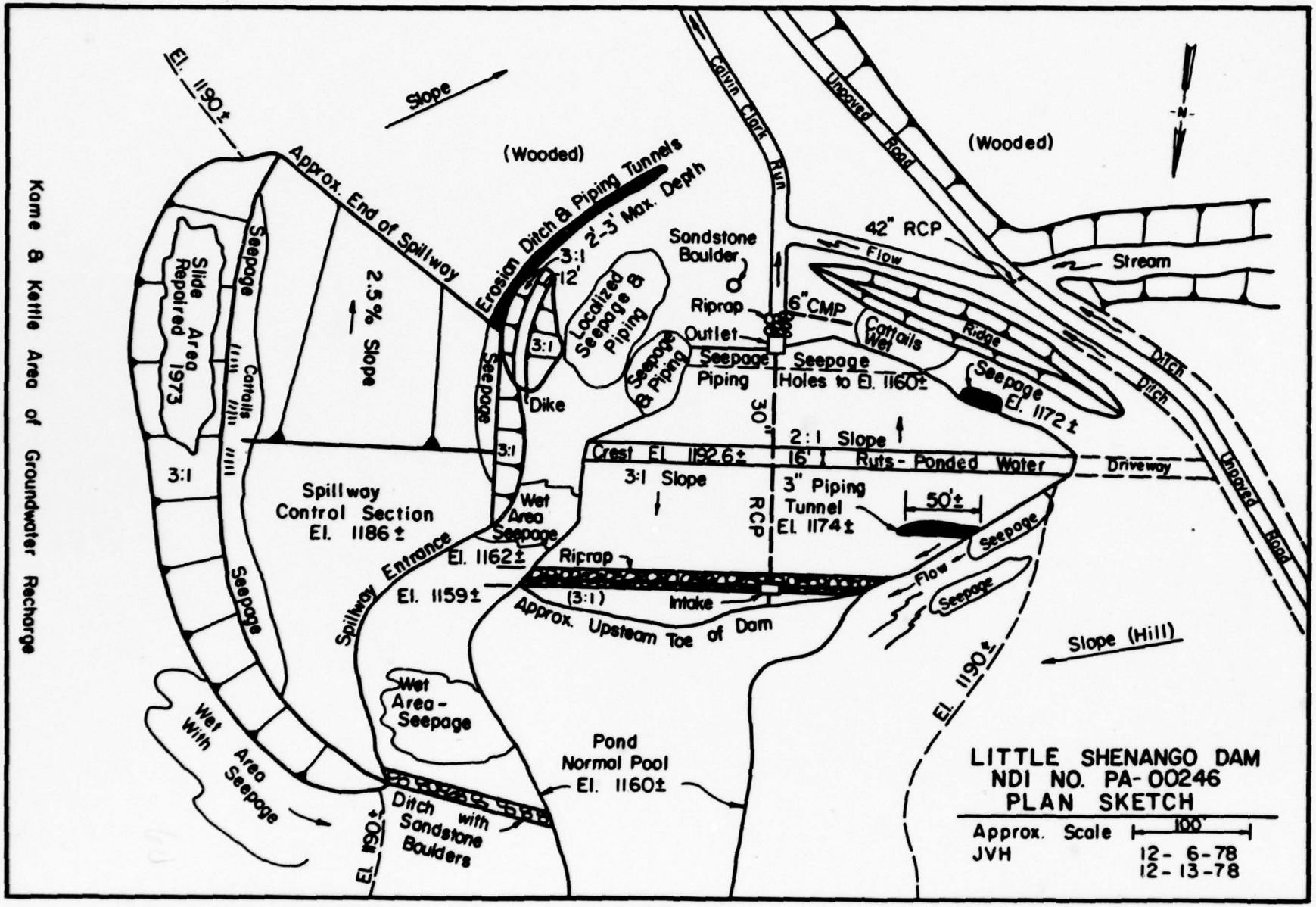
1) The pool level is low and no indications of active piping were observed during the inspection.

2) The volume of impounded water is small--less than 20 acre-feet.

3) This floodwater retarding dam seldom impounds much water and the pool is drawn down fairly quickly following flood storage events.

It is recommended that a more detailed investigation of abutment, embankment, and foundation seepage and piping conditions be made as expeditiously as possible. In this investigation, particular attention should be directed to determination of (1) nature and extent of glacial soil deposits at the dam site, (2) local patterns of natural groundwater flow, (3) locations and extents of silt and find sand zones in the dam embankment and abutments, (4) locations and extents of piping (internal erosion) conduits in the dam embankment and abutments, (5) seepage patterns in the dam embankment, and (6) condition and efficacy of granular drains in the dam foundation and abutments.

12 December 1978 James V. Hamel


El. 1190±
Slope
Approx. End of Spillway
(Wooded)
Calvin Clark Run
Unpaved Road
(Wooded)
N
Erosion Ditch & Piping Tunnels
2'-3' Max. Depth
3:1
12'
Sandstone Boulder
42" RCP
Flow
Stream
Riprap
6" CMP
Outlet
Cattails Wet
Ridge
Ditch
Ditch
Localized Seepage & Piping
Seepage & Piping
Seepage
Piping
Seepage
Holes to El. 1160±
Seepage
El. 1172±
Slide Area Repaired 1973
Seepage
Cattails
2.5% Slope
Seepage
3:1
Dike
30"
2:1 Slope
Crest El. 1192.6±
16'
Ruts - Ponded Water
Driveway
3:1
3:1 Slope
3" Piping Tunnel El. 1174±
50'±
RCP
Spillway Control Section El. 1186±
Wet Area Seepage
Seepage
Spillway Entrance
El. 1162±
Riprap
Flow
Seepage
El. 1159±
(3:1)
Intake
Approx. Upstream Toe of Dam
Slope (Hill)
Wet Area - Seepage
Wet With Area Seepage
Pond Normal Pool El. 1160±
El. 1190±
El. 1160±
Ditch with Sandstone Boulders
Kame & Kettle Area of Groundwater Recharge
LITTLE SHENANGO DAM
NDI NO. PA-00246
PLAN SKETCH
Approx. Scale
100'
JVH
12-6-78
12-13-78

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: LITTLE SHANANGO
NDI # PA 00246

ITEM	REMARKS
PLAN OF DAM	Reference Drawings: "Little Shenango River Watershed, Floodwater Retarding Dam PA-490, Mercer County, Pennsylvania," U.S. Department of Agriculture, Soil Conservation Service (SCS), "As Built" Plans, 21 sheets, 1971. (prints available in files of PennDER); Plan of Dam - Sheets 2, 3, 7, and 8. (Sheets 3, 7, and 8 included in this report as Plates 3, 7, and 8).
REGIONAL VICINITY MAP	Reference Drawings - Sheet 1; Section of U.S.G.S. Hadley, Pennsylvania, 7.5 minute quadrangle in this report as Plate 1.
CONSTRUCTION HISTORY	Information in the files of PennDER and in files of Mercer office of SCS indicates the dam was constructed by Kirila Contractors, Inc. of Brookfield, Ohio from May 1970 through May 1971. No work except some spillway excavation was done over the winter from mid-November 1970 through mid-April 1971.
TYPICAL SECTIONS OF DAM	Reference Drawings - Sheets 4-8 (included in this report as Plates 4-8).
HYDROLOGIC/ HYDRAULIC DATA	Some hydrologic/hydraulic data are included in the "Little Shenango River Watershed Work Plan" report prepared by the Mercer County Soil Conservation District, et. al., April 1963. Other information is included in the Dam Permit Application Report prepared by the Pennsylvania Department of Forests and Waters on 5 April 1968. This report is in PennDER files. Additional data are included in the undated SCS "Design Report Site PA-490, Pennsylvania" available in files of the Harrisburg SCS office.
OUTLETS - PLAN	Reference Drawings - Sheets 3 and 5 (included in this report as Plates 3 and 5).
- DETAILS	Reference Drawings - Sheets 5, 6, and 9-15 (Sheets 5 and 6 included in this report as Plates 5 and 6.
- CONSTRAINTS	No information is readily available.
- DISCHARGE RATINGS	PennDER's Dam Permit Application Report indicates a maximum conduit outflow of 114 c.f.s. Additional information is available in the SCS "Design Report."
RAINFALL/RESERVOIR RECORDS	None were readily available.

Name of Dam: LITTLE SHENANGO
NDI # PA 00246

ITEM	REMARKS
DESIGN REPORTS	The undated SCS "Design Report, State PA-490, Pennsylvania," is available in the files of the Harrisburg SCS office. Some design information is included in the "Little Shenango River Watershed Work Plan" and in PennDER's Dam Permit Application Report.
GEOLOGY REPORTS	Geology information is included in the SCS "Design Report." Some geology information is also included in the "Little Shenango River Watershed Work Plan" and in PennDER's Dam Permit Application Report.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Design computations are included in the SCS "Design Report."
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Boring and test pit locations and logs are shown on Sheets 3, 6, 7, and 17-19 of the Reference Drawings. Curves from two laboratory (Standard Proctor) compaction tests on samples of borrow material are shown on Sheet 20 of the Reference Drawings. Results of several field permeability tests are given on Sheet 18 of the Reference Drawings. All available information is included in the SCS "Design Report."
POST-CONSTRUCTION SURVEYS OF DAM	Annual inspections have been made from 1972 to 1978 by representatives of the Mercer County Commissioners and the SCS. Copies of all inspection reports are available in the Mercer office of the SCS and copies of most inspection reports are available in PennDER files.
BORROW SOURCES	Kame terrace glacial soil deposits in the spillway area; Plan - Reference Drawings - Sheet 3 (included in this report as Plate 3). Boring and Test Pit Logs - Reference Drawing - Sheets 6, 7, and 17-19.

Name of Dam: LITTLE SHENANGO

ITEM	REMARKS
MONITORING SYSTEMS	There are no monitoring systems.
MODIFICATIONS	According to Mr. James Mondok of the Mercer County Conservation District, three small slides with a total breadth of 75 ft. occurred in the excavated slope on the left (east) side of the spillway soon after the dam was constructed. These slides were repaired and drainage measures were installed in 1973. No problems have developed there since this remedial work.
HIGH POOL RECORDS	No information is readily available. According to Mr. Mondok, the maximun pool of record was probably near the top of the straight portion of the riser structure, El. 1170± ft.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Annual inspections have been made from 1972 to 1978 as noted under "POST-CONSTRUCTION SURVEYS OF THE DAM" on page B-2.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	There have been no accidents or failures.
MAINTENANCE OPERATION RECORDS	No maintenance or operations records are readily available.

Name of Dam: LITTLE SHENANGO
NDI # PA 00246

ITEM	REMARKS
SPILLWAY PLAN	Reference Drawings - Sheet 3 (included in this report as Plate 3).
SECTIONS	Reference Drawings - Sheets 6 and 7 (included in this report as Plates 6 and 7).
DETAILS	Reference Drawings - Sheet 3 (included in this report as Plate 3).
OPERATING EQUIPMENT PLANS & DETAILS	There is no operating equipment.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.29 sq. mi. of well vegetated, moderately rolling terrain covered with glacial soil deposits

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1160 ft. (19 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1186 ft. (472 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: 1190.4 ft. (680 ac.-ft.)

ELEVATION TOP DAM: 1192.6 ft. (790 ac.-ft.)

SPILLWAY:

a. Elevation 1186 ft. (control section, emergency spillway)
b. Type Vegetated earth channel, curved in plan
c. Width 235 ft.
d. Length 320 ft. (on centerline)
e. Location spillover Left abutment
f. Number and Type of Gates There are no gates.

OUTLET WORKS:

a. Type Reinforced concrete riser and 30-in. diameter reinforced concrete outlet pipe
b. Location Base of embankment near center of valley
c. Entrance inverts El. 1160 ft. (low level), El. 1177 ft. (high level)
d. Exit inverts El. 1144 ft.
e. Emergency drawdown facilities Pump water into low-level inlet. (Steel plate bolted on end of pond drainpipe, entrance invert El. 1149 ft.)

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Not available

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View - View East Over Dam from Right (West) Abutment
(Pond and intake structure at left edge of photo; spillway across top-center of photo; outlet channel at right edge of photo.)

Photo 1 - View East across Upstream Slope of Dam from Right (West) Abutment
(Pond and intake structure at left side of photo; spillway inlet above intake structure.)

Photo 2 - View West over Downstream End of Spillway and Downstream Slope of Dam from Top of Excavated Slope on Left (East) Side of Spillway
(Pond behind dam in right-center of photo; outlet channel at left edge of photo.)

Photo 3 - View Northwest at Downstream Slope of Dam
(Outlet structure at bottom-center of photo; outlet channel in bottom left corner of photo.)

Photo 4 - View Upstream at Outlet Structure

Photo 5 - View Upstream over Intake Structure and Pond from Center of Dam Crest

Photo 6 - View Downstream over Outlet Channel from Right (West) Side of Dam Crest
(Outlet structure in bottom left corner of photo; sandstone boulder with dam name plaque in left-center of photo; unpaved road in top right corner of photo.)

Photo 7 - View West Across Upstream Slope
[Intake structure and pond at bottom left corner of photo; piping tunnels (close-up in Photo 8) extend approximately 50 feet along right (west) side of upstream slope between two men in center of photo.]

Photo 8 - Close-up of Piping Tunnels in Right (West) Side of Upstream Slope (Center of Photo 7)
(One-inch diameter tunnel above 3-inch diameter water-filled tunnel in silt at approximately El. 1174 feet.)

Note: Photographs were taken on 6 December 1978.

Photo 9 - View East across Downstream Slope
[R. E. Holderbaum on outlet structure in bottom-center of photo; J. G. Ulinski on seepage and piping area (close-up in Photo 10) near center of photo above outlet structure.]

Photo 10 - Close-Up of Seepage and Piping Area near Center of Photo 9
[Seepage occurs in silt along contact of downstream slope with left (east) abutment at approximately El. 1163 feet.]

Note: Photographs were taken on 6 December 1978.

LITTLE SHENANGO DAM

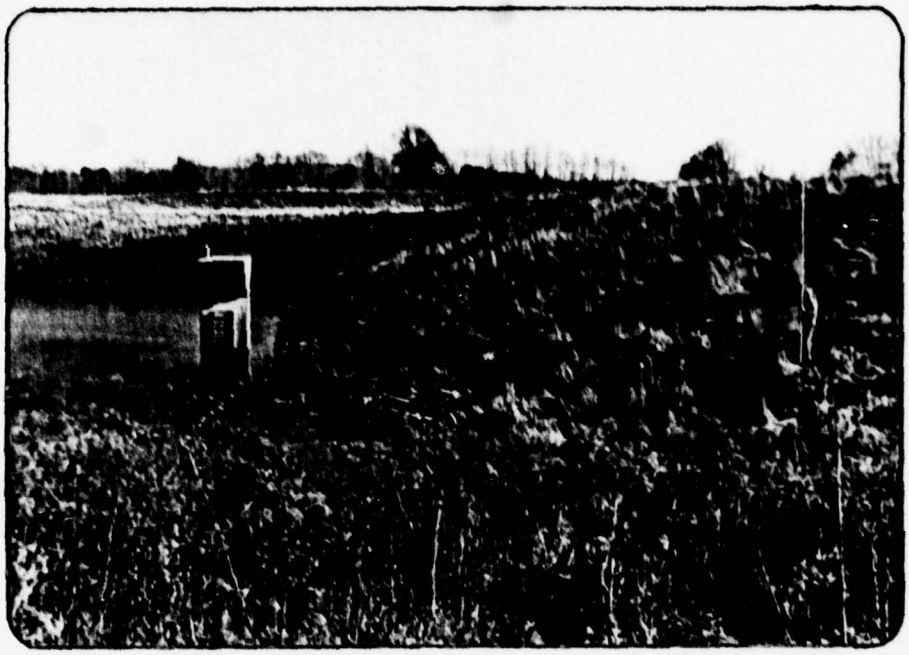


PHOTO 1. View East across Upstream Slope

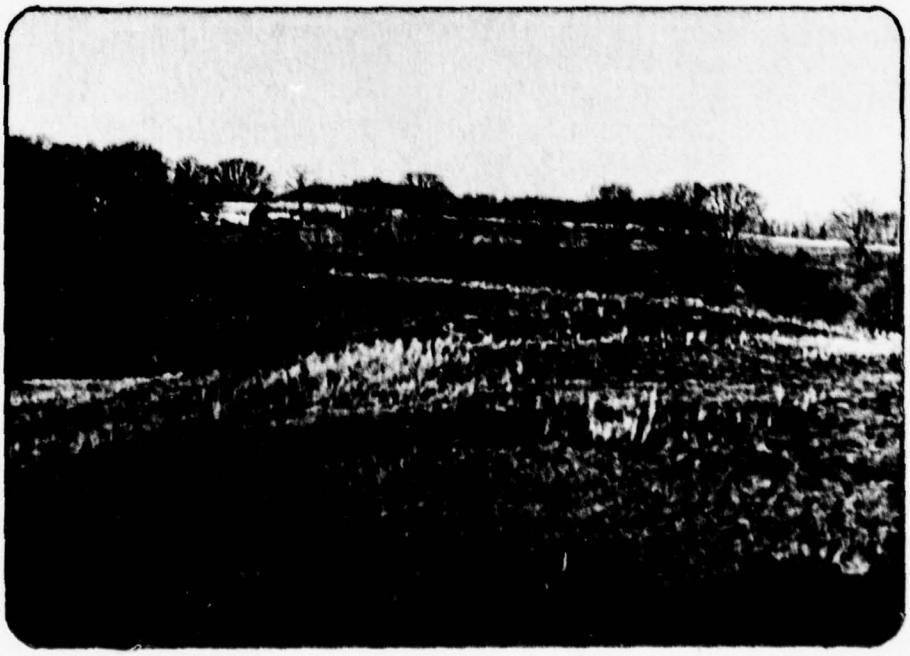


PHOTO 2. View West across Downstream Slope

PHOTO 3. View Northwest at Downstream Slope and Outlet Structure

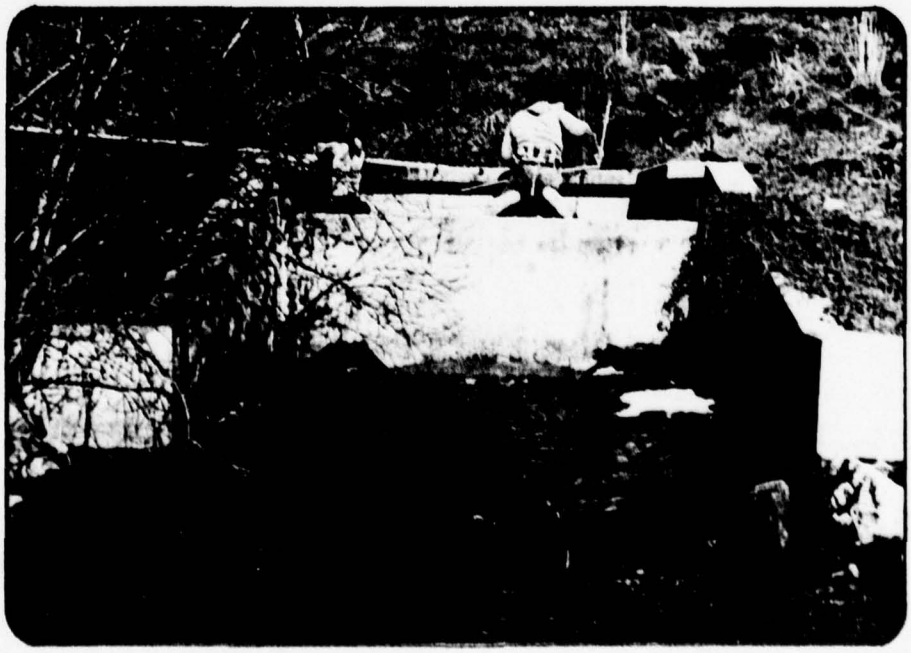


PHOTO 4. View Upstream at Outlet Structure

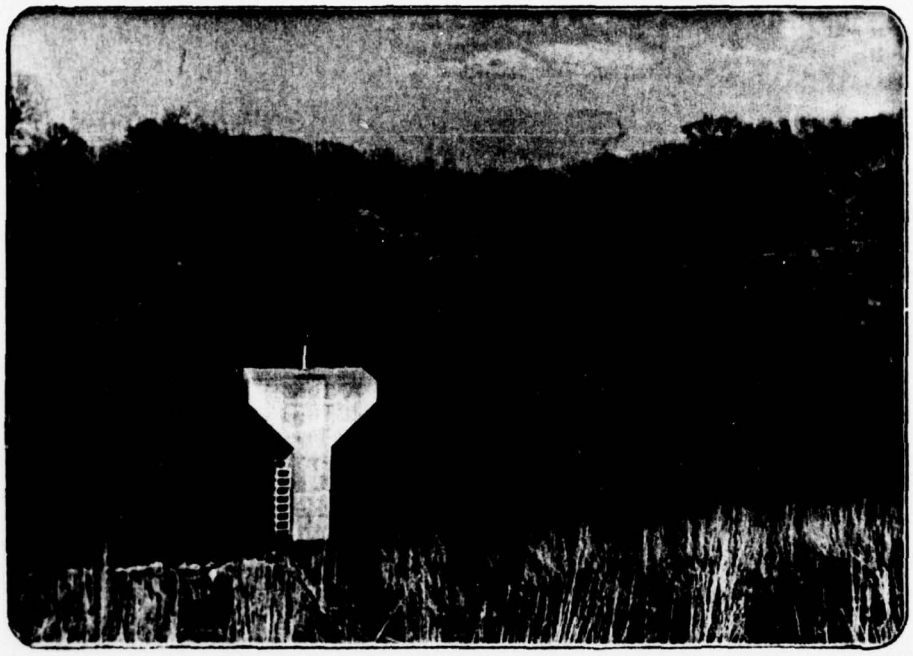


PHOTO 5. View Upstream from Dam Crest

PHOTO 6. View Downstream from Dam Crest

PHOTO 7. View West across Upstream Slope

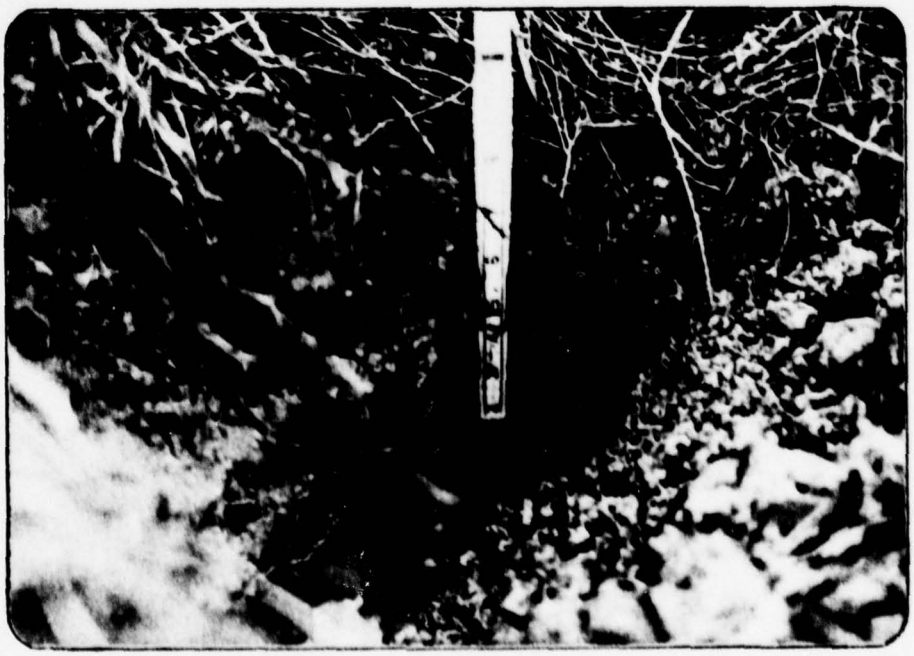


PHOTO 8. Close-up of Piping Tunnels in Upstream Slope

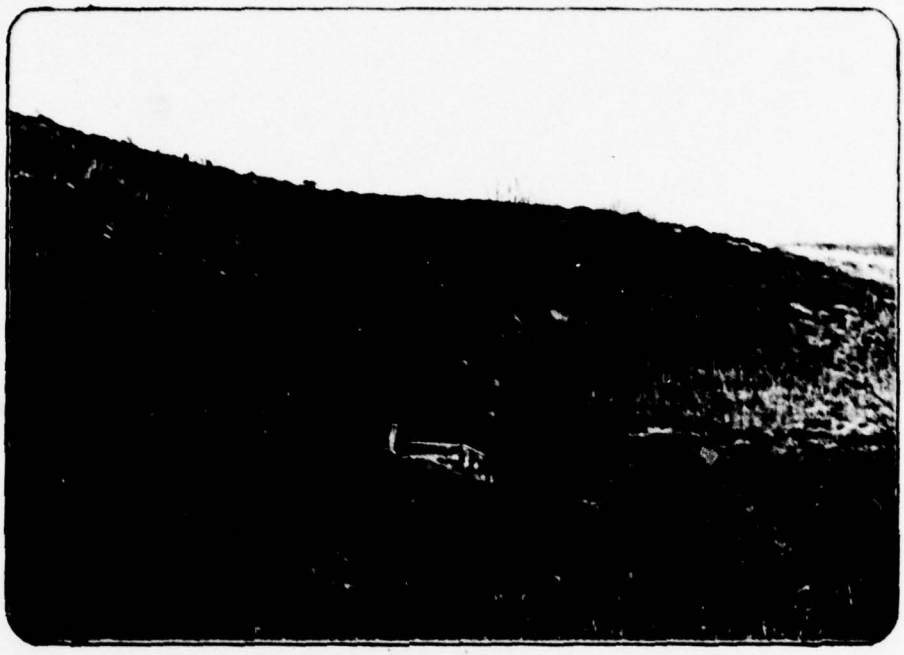


PHOTO 9. View East across Downstream Slope

PHOTO 10. Close-up of Seepage and Piping Area in Downstream Slope

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Little Shenango Dam S.O. No. _____

_____ Sheet No. _____ of _____

_____ Drawing No. _____

Computed by _____ Checked by _____ Date _____

Table of Contents

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Little Sheranga Dam — S.O. No.
Rainfall Data — Sheet No. 1 of 11
Snyder Coefficients — Drawing No.
Computed by G.A.S. — Checked by REH — Date 2-19-79

Rainfall Data from HMR 33
Located in Zone 2

$DA_A = 1.63\ mi^2$
$DA_B = 1.66\ mi^2$
$DA_{A+B} = 3.29\ mi^2$

$PMP_{24hr} = 200\ mi^2 = 23.2$ in

Due to small DA, used 10 mi^2 values on graph

$P_{6hr} = 11.7\%$
$P_{12hr} = 12.7\%$
$P_{24hr} = 14.1\%$
$P_{18hr} = 15.1\%$

Snyder Coefficients

Drainage Area is located in zone 2 (Beaver River Basin)

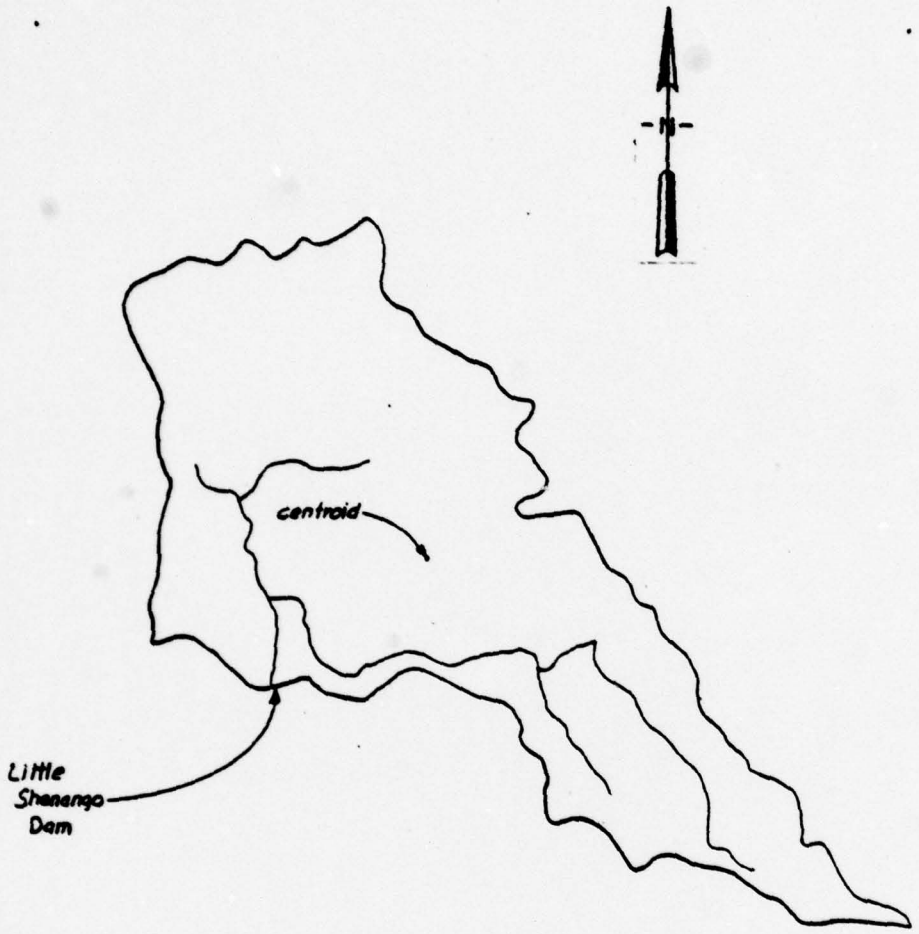
$C_p = 0.10$ $t_p = 2.1(C_p L L_{ca})^{0.3}$, $t_R = 20$ min

$L = 4.49$ mi $L_{ca} = 1.36$ mi.

$t_p = 2.1(C_p L L_{ca})^{0.3}$
$= 2.1[(0.10)(4.49)(1.36)]^{0.3}$
$= 1.65$ hrs

$t_r = t_p / 3.3$
$= 1.65 / 3.3$
$= 0.83$ hrs

$t_{pR} = t_p + 0.25(t_R - t_r)$
$= 1.65 + 0.25(\frac{20}{60} - .83)$
$= 1.52$ hrs



- Quad: Hadley
Drainage Area = 3.29 mi.²
L = 4.49 mi. Lca = 1.36 mi.

SCALE
0 4000 8000

DATE: 3-28-79 g.e.s.

Calvin Clark Run Watershed
at
Little Shenango Dam

MICHAEL BAKER JR. INC.
Consulting Engineers & Surveyors

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Little Shenango Dam S.O. No.
Stage v/s Discharge Sheet No. 3 of 11
Drawing No.
Computed by G. A. S. Checked by REH Date 2-19-79

From Design Data

Stage	Discharge	
1160.0	0	Orifice Crest
1160.5	4	
1162.3	23	
1166	37	
1171	51	
1177	64	Principal Spillway Crest
1178	101	
1179	103	
1181	106	
1183	110	
1183.5	114	
1187.9	1307	
1188.9	2198	
1190.3	4914	
1191.3	7355	
1192.3	9821	
1193.8	12304	

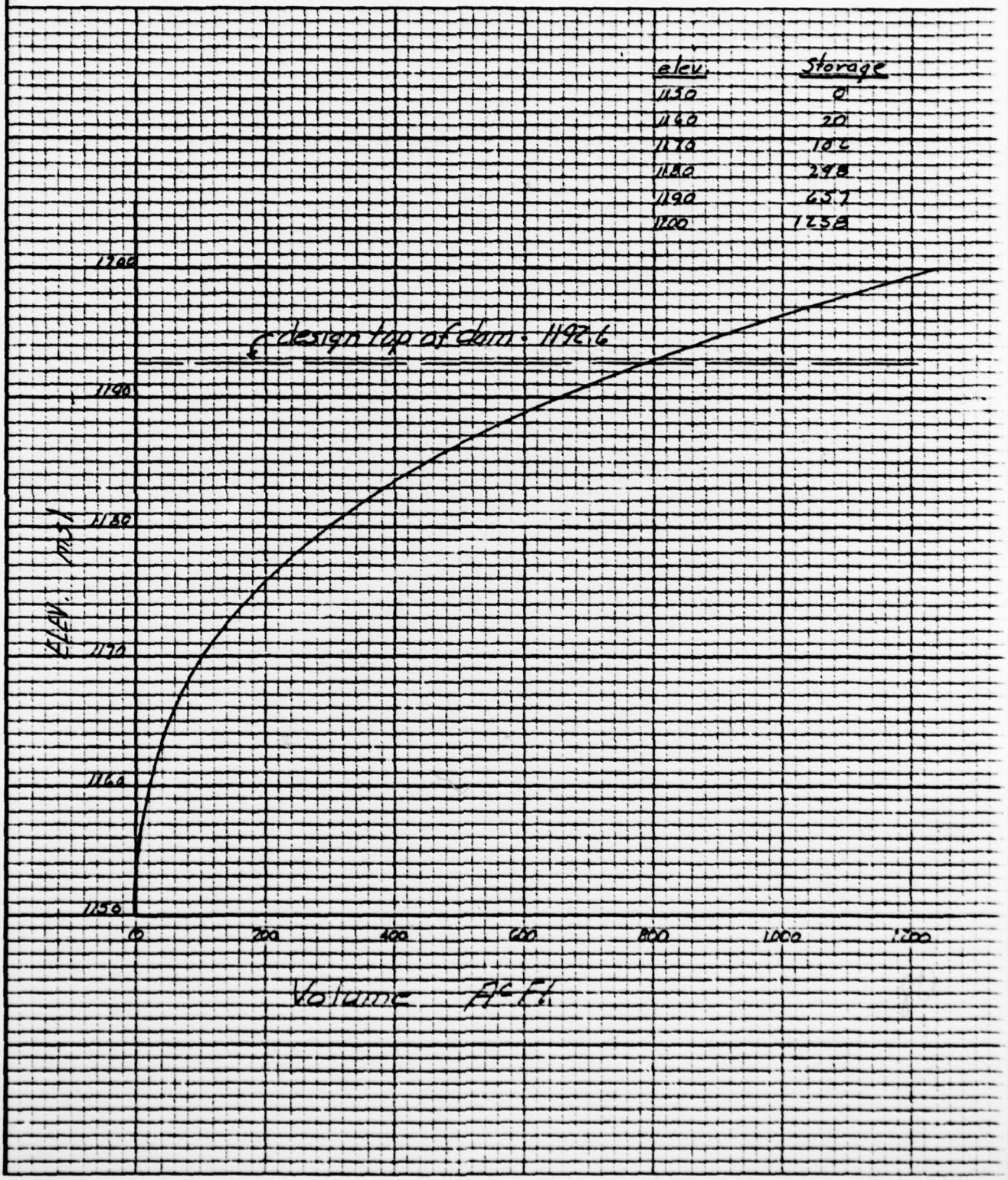
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Little Shenango Dam S.O. No.
Stage v/s Storage Sheet No. 4 of 11
Drawing No.
Computed by G.A.S Checked by REH Date 7-19-79

From design data

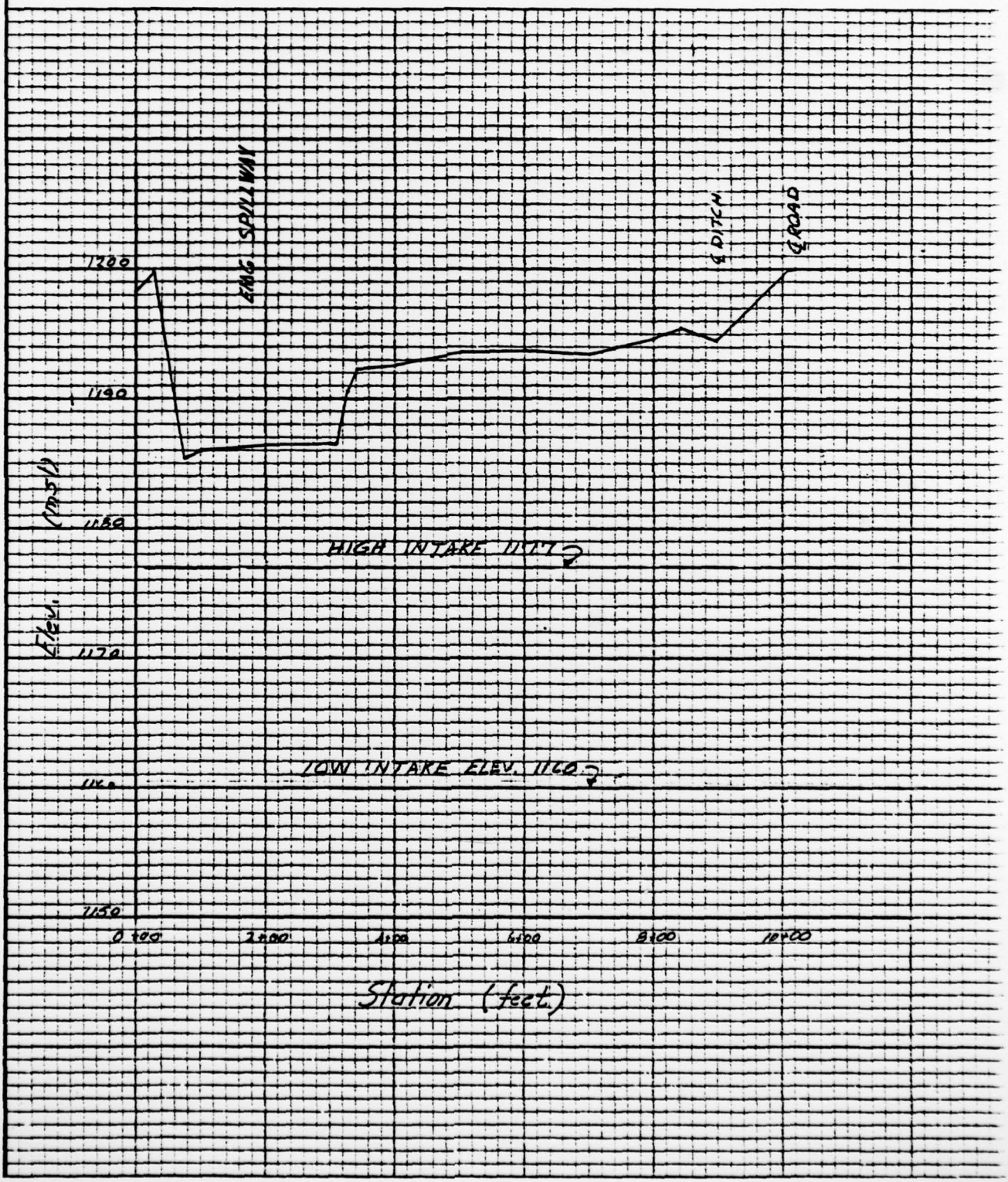
elev.	Storage
1150	0
1160	20
1170	102
1180	298
1190	657
1200	1258

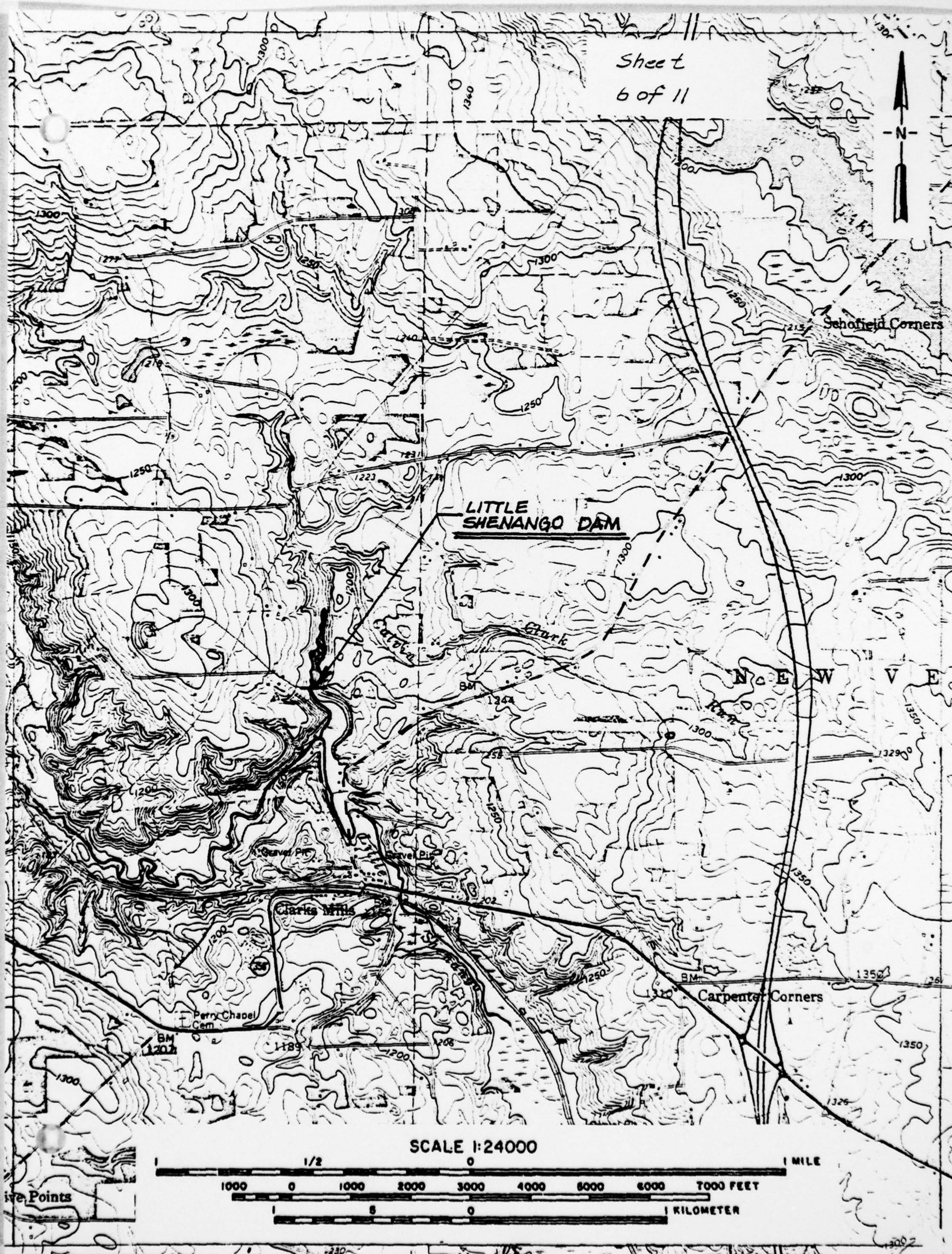


MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Little Shenango Dam — S.O. No.
Top of Dam Profile — Sheet No. 5 of 11
Drawing No.
Computed by G.A.S. — Checked by — Date 2-19-79




Sheet 6 of 11
N
LITTLE SHENANGO DAM
Schofield Corners
NEWVE
Clark
Run
Clarks Mills
Carpenter Corners
Gravel Pit
Perry Chapel Cem
BM
ive Points
SCALE 1:24000
1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 5 0 1 KILOMETER

```
**********
** SDH HYDROGRAPH PACKAGE (HEC-1)
** DAM SAFETY VERSION     JULY 1978
**  LAST MODIFICATION  25 SEP 78
**********
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF LITTLE SHENANGO MBJ  09
    3              A3       PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD
    4              B    300       0      20       0       0       0       0       0      -4       0
    5              B1     5
    6              J      1       3       1
    7              J1   1.0    0.75    0.50
    8              K      0       1                                               1
    9              K1             SNYDER HYDROGRAPH
   10              M      1       1    3.29
   11              P             23.2     117     127     141     151
   12              T                                                     1.0    0.05
   13              W    4.52    0.40
   14              Y    -1.5   -0.05     2.0
   15              K      1     DAM                                             1
   16              K1             THIS IS A ROUTING AT LITTLE SHENANGO DAM
   17              Y                                      1       1
   18              Y1     1                                                -1160.0      -1
   19              Y41160.0  1160.5    1163    1166    1171    1177    1178    1179    1181    1183
   20              Y41185.5  1187.9  1188.9  1190.3  1191.5  1192.5  1193.4
   21              Y5     0       4      25      37      51      64     101     103     106     110
   22              Y5   114    1302    2498    4914    7355    9821   12304
   23              $S     0      20     102     298     657    1238
   24              $E  1150    1160    1170    1180    1190    1200
   25              $$1160.0
   26              $D1192.6    2.65     1.5     502
   27              K     99
```

Sheet 7 of 11

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********************************

RUN  DATE 04/02/79
     TIME    09.20
```

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF LITTLE SHENANGO MBJ 09
PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	20	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 0.75 0.50

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

SUB-AREA RUNOFF COMPUTATION

SNYDER HYDROGRAPH

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	3.29	0.0	3.29	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.20	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	CLTKR	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= 4.52 CP=0.40 NTA= 0

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

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.53 HOURS, CP= 0.40 VOL= 0.97

3.	13.	26.	42.	61.	81.	102.	124.	143.	160.
174.	184.	191.	193.	189.	182.	175.	168.	161.	155.
149.	143.	138.	132.	127.	122.	117.	113.	109.	104.
100.	96.	93.	89.	86.	82.	79.	76.	73.	70.
67.	65.	62.	60.	58.	55.	53.	51.	49.	47.

45.	44.	42.	40.	39.	37.	36.	34.	33.	32.
31.	29.	28.	27.	26.	25.	24.	23.	22.	21.
21.	20.	19.	18.	18.	17.	16.	16.	15.	14.
14.	13.	13.	12.	12.	11.	11.	11.	10.	10.
9.	9.	9.	8.	8.	8.	7.	7.	7.	7.

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	28.03	25.59	2.44	160097.
										(712.)(650.)(62.)(4533.45)			

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

HYDROGRAPH ROUTING

THIS IS A ROUTING AT LITTLE SHENANGO DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	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	-1160.	-1

STAGE	1160.00	1160.50	1163.00	1166.00	1171.00	1177.00	1178.00	1179.00	1181.00	1183.00
	1185.50	1187.90	1188.90	1190.30	1191.50	1192.50	1193.40			
FLOW	0.0	4.00	25.00	37.00	51.00	64.00	101.00	103.00	106.00	110.00
	114.00	1302.00	2498.00	4914.00	7355.00	9821.00	12304.00			
CAPACITY=	0.	20.	102.	298.	657.	1238.				
ELEVATION=	1150.	1160.	1170.	1180.	1190.	1200.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1160.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1192.6	2.6	1.5	502.

PEAK OUTFLOW IS 3816. AT TIME 44.33 HOURS

PEAK OUTFLOW IS 2861. AT TIME 44.33 HOURS

PEAK OUTFLOW IS 1829. AT TIME 45.33 HOURS

11 to 6 Peaks

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

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 1.00	RATIO 2 0.75	RATIO 3 0.50
HYDROGRAPH AT	1	3.29	1	3829.	2872.	1914.
		(8.52)		(108.42)(	81.32)(	54.21)(
ROUTED TO	DAM	3.29	1	3816.	2861.	1829.
		(8.52)		(108.04)(	81.01)(	51.78)(

Sheet 10 of 22

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1160.00	1160.00	1192.60
STORAGE	20.	20.	808.
OUTFLOW	0.	0.	12009.

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	1189.66	0.0	645.	3818.	0.0	44.33	0.0
0.75	1189.11	0.0	625.	2861.	0.0	44.33	0.0
0.50	1188.34	0.0	597.	1829.	0.0	45.33	0.0

APPENDIX E

REGIONAL GEOLOGY

LITTLE SHENANGO DAM
NDI NO. PA 00246, PennDER No. 43-54

REGIONAL GEOLOGY

Little Shenango Dam is located in the northwestern glaciated portion of the Appalachian Plateaus physiographic province. Bedrock consists of flat-lying shales and sandstones of the Mississippian age Pocono Formation (Mercer County Soil Conservation District, et al, 1963; Ellam, 1968). These rock strata are overlain by glacial soil deposits of various types and thicknesses (Shepps, et al., 1959; White, et al., 1969). Topographically, the area has broad, gently sloping uplands and steep sided valleys. The dam is located in a steep sided reach of Calvin Clark Run about 1000 feet upstream from its confluence with the Little Shenango River.

Glacial soil deposits of this area are among the most complex in North America. Continental ice sheets advanced into northwestern Pennsylvania from the Lake Erie basin at least seven times during the Pleistocene Epoch (Shepps, et al., 1959). For long intervals of time, more or less stationary ice masses produced extensive kame-type ice contact soil deposits as well as various tills, moraines, lake bed, and outwash deposits (Shepps, et al., 1959; White, et al., 1969). Little Shenango Dam is located in an area of kames and kame terraces surrounding by glacial tills of the Kent ground moraine and Kent end moraine (Shepps, et al., 1959).

Field observations during dam inspection on 6 December 1978 confirmed the above description of glacial soil deposits in the area. Both abutments of the dam consist of silty kame or kame terrace deposits. The vegetated earth channel spillway in the left (east) abutment was apparently excavated in silty kame materials and most of the excavated soils were incorporated in the dam embankment. A small ridge of kame or moraine material lies on the right abutment downstream from the dam. The channel of Calvin Clark Run downstream from the dam is eroded in dense, well graded glacial till.

Relatively pervious glacial soil deposits on uplands along both sides of Calvin Clark Run function as groundwater recharge areas. This is particularly true for the area of kame and kettle topography east and northeast of the dam (Plate 1). Calvin Clark Run loops through this area at El. 1180 feet to El. 1250 feet. Groundwater recharge from this reach of stream is probably a significant contributor to the extensive spring flow observed on both valley walls at the dam site. Infiltration of surface water, particularly

in kettle-type depressions on the hilltop east of the dam (Plate 1), contributes to groundwater discharge on the east side of the valley. Surface water infiltration in the upland west of the dam contributes to groundwater discharge on the west side of the valley.

REFERENCES

1. Ellam, J. J. (1968). "Dam Permit Application Report."

2. Mercer County Soil Conservation District, et al., (1963). "Little Shenango River Watershed Work Plan," 47 pp.

3. Shepps, V. C. et al., (1959). "Glacial Geology of Northwestern Pennsylvania," Bulletin G-32, Pennsylvania Geological Survey, 59 pp. + map.

4. White, G. W., et al., (1969). "Pleistocene Stratigraphy of Northwestern Pennsylvania," General Geology Report G-55, Pennsylvania Geological Survey, 88 pp.

GEOLOGIC MAP
Little Shenango Dam
NDI No. PA 00246 Mercer County

Reproduced from Map of the Glacial Deposits of Northwestern Pennsylvania, Bulletin G-32, Pennsylvania Geological Survey, 4th Series

Scale: One Inch Equals Approximately Two Miles
See Legend, Next Page

LEGEND

PLEISTOCENE

WISCONSIN

CARY

Kent Till

kem	Kent end moraine Till (sandy loam)
kfm	Findley Lake recessional moraine Till (loam)
kcm	Clymer recessional moraine Till (loam)
kgm	ground moraine Till (loam becoming sandy loam toward the east and southeast)

ILLINOIAN

Inner phase

ii	ground (?) moraine Thin, discontinuous, weathered till blanket

Outer phase

io	ground moraine (?) Rare patches of thin weathered till over bedrock; scattered erratics

ILLINOIAN OR WISCONSIN

Undifferentiated members of units above

k	kames, kame terraces, kame moraines, and eskers Sand and gravel

Undifferentiated members of units above

ol	outwash (valley trains), river terraces, lake deposits including beaches of former high levels of Lake Erie Bedded sand, silt, and clay; sand and gravel

RECENT OR PRE-PLEISTOCENE

Undifferentiated

	stream alluvium and bedrock