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NATIONAL DAM SAFETY PROGRAM. LEATHERWOOD CREEK NUMBER 4 DAM (IN--ETC(U)
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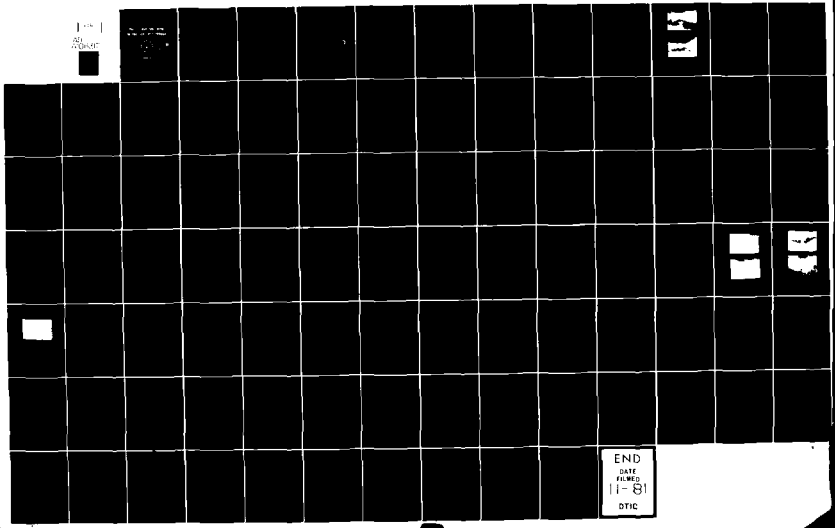

ROANOKE RIVER BASIN

Name Of Dam: LEATHERWOOD CREEK NO. 4

Location: HENRY COUNTY, VIRGINIA

Inventory Number: VA. NO. 08906

LEVEL II

AD A106317

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

SCHNEBEL ENGINEERING ASSOCIATES, P.C./
J. K. TIDSONS AND ASSOCIATES, INC.

JULY 1981

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. 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.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

(1)

ROANOKE RIVER BASIN

NAME OF DAM: LEATHERWOOD CREEK NO. 4 DAM
LOCATION: HENRY COUNTY, VIRGINIA
INVENTORY NUMBER: VA. NO. 08906

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED FOR
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMONS AND ASSOCIATES, INC.

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify 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 Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test 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 SAFETY PROGRAM

BRIEF ASSESSMENT OF DAM

Name of Dam:	Leatherwood Creek No. 4 Dam
State:	Virginia
Location:	Henry County
USGS Quad Sheet:	Martinsville East
Coordinates:	Lat 36° 44.5' Long 79° 45.7'
Stream:	Wet Branch of West Fork of Leatherwood Creek
Date of Inspection:	July 1, 1981

Leatherwood Creek No. 4 Dam is a zoned earthfill structure about 330 ft long and 41.5 ft high. The principal spillway consists of a reinforced concrete riser and a 24 inch diameter concrete outlet pipe which extends through the structure. An earth emergency spillway is located at the left abutment with a 100 ft wide bottom and 3H:1V side slopes. The structure is classified intermediate in size and is assigned a significant hazard classification. The dam is located on Wet Branch approximately 1.0 mile west of Leatherwood, Virginia. The dam is used for irrigation, flood control and recreational purposes, and is owned and maintained by Mr. Dana E. Barrow.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate Spillway Design Flood (SDF) is the ½ PMF. The spillways will pass 20 percent of the Probable Maximum Flood (PMF) or 40 percent of the SDF without overtopping the dam. During the SDF, the dam will be overtopped for

3.5 hours up to a maximum of 1.7 feet and reach a maximum velocity of 5.6 fps. Flows overtopping the dam during the SDF are not considered detrimental to the embankment with respect to erosion. The spillway is judged inadequate, but not seriously inadequate.

The visual inspection did not reveal any problems which would require immediate attention. A summary of the design stability analyses for the upstream slope under drawdown conditions were reviewed and found to be acceptable. The downstream slope meets requirements recommended by the U. S. Bureau of Reclamation, however, the embankment crest is 4 ft narrower than recommended.

It is recommended that the owner implement an emergency action plan to warn the downstream dwellings of any dangers which may be imminent.

The following routine maintenance and observation functions should be initiated within the next twelve months:

The grass and weeds on the dam embankment and in the emergency spillway should be cut at least once a year and preferably twice a year. Maintenance is recommended in the early summer and fall. Existing trees on the dam should be cut to the ground and removed. Previously cut trees laying on the embankment should also be removed.

The eroded areas present along the left and right downstream abutment-slope contacts should be stabilized by backfilling, compaction and seeding or placement of riprap.

The seepage drain outlets should be uncovered to allow free flow. The saturated area present above the discharge outlet should be monitored

quarterly to detect any enlargement of the area or development of flow rates which may cause piping within the embankment. A staff gage should be installed to monitor water levels.

SCHNABEL ENGINEERING ASSOCIATES, P.C./
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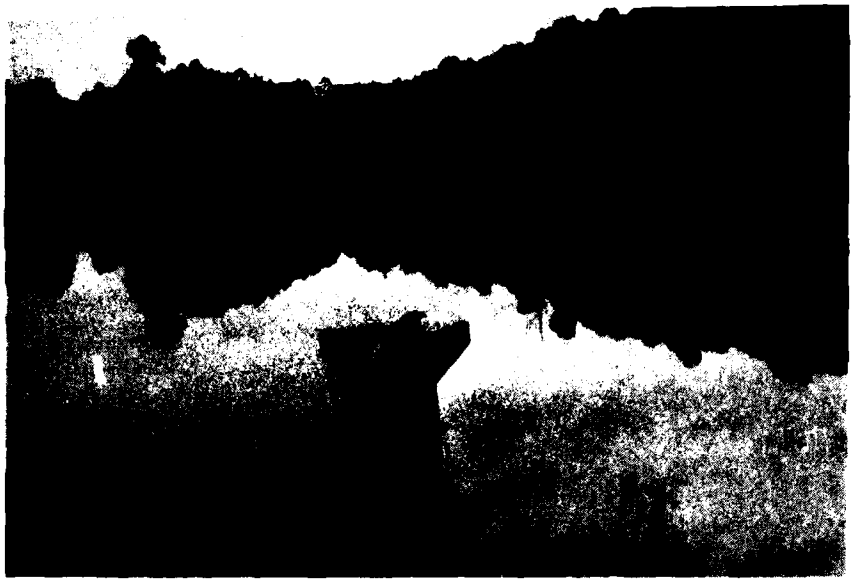
Colonel, Corps of Engineers
Commander and District Engineer

Date: SEP 23 1981



Leatherwood No. 4 - Lake

Dam

Overview Photographs

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspection of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (see Reference 1, Appendix VI). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Leatherwood Creek No. 4 Dam is a zoned earthfill structure approximately 330 ft long and 41.5 ft high.* The crest of the dam is 14 ft wide, and side slopes are approximately 2.5 horizontal to 1 vertical (2.5H:1V) on the upstream and downstream slopes of the dam. A 10 ft wide berm occurs between elevation 766.7 and 767.7 msl on the upstream slope. The upstream slope is 3H:1V below the berm. The crest of the dam is at elevation 788.5 msl. "As built" drawings show the presence of a cutoff trench which extends to "firm rock" and a seepage drain beneath the downstream slope. There is no slope protection on the upstream face of the dam.

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*Height is measured from the top of the dam to the downstream toe at the centerline of the stream.

The principal spillway consists of a reinforced concrete riser inlet. The riser has an internal opening of 6 ft by 2 ft, and is approximately 28 ft high. The riser has a low level orifice (1 ft by 1 ft) at an invert elevation of 766.2 msl and two overflow weirs at elevation 775.6 msl. A 24 inch diameter slide gate in the riser at an invert elevation of 751.1 msl is used to drain the lake. The outlet pipe is a 24 inch diameter reinforced concrete pipe which outlets at an elevation of 749.2 msl into a riprap lined plunge pool. (See Plates 5 and 8, Appendix I)

The emergency spillway (EMS) consists of a vegetated earthen channel spillway located at the left abutment, having a crest elevation of 784.8 msl. The EMS has a bottom width of 100 ft at the control section, 3H:1V side slopes, and is in a cut section. (See Plate 2, Appendix I.)

1.2.2 Location: Leatherwood Creek No. 4 Dam is located on Wet Branch of the West Fork of Leatherwood Creek, 1 mile west of Leatherwood, Virginia. (See Plate 1, Appendix I.)

1.2.3 Size and Classification: The dam is classified as an intermediate size structure based on its height as defined in Reference 1, Appendix V.

1.2.4 Hazard Classification: The dam is located in a rural area; however, based upon the proximity of an inhabited dwelling located 2 miles downstream, and several dwellings 5 miles downstream, the dam is assigned a "significant" hazard classification. The hazard

classification used to categorize a dam is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned and maintained by Mr. Dana E. Barrow of Henry County, Virginia.

1.2.6 Purpose: Recreation, irrigation and flood control.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of the United States Department of Agriculture (USDA), Soil Conservation Service (SCS). The structure was constructed by Larramore Construction Company and completed in 1964.

1.2.8 Normal Operational Procedures: The principal spillway is ungated, therefore, water rising above the low level orifice and overflow weirs of the riser outlet is automatically discharged downstream. Normal pool is maintained at elevation 766.5 msl just above the invert of the low level orifice in the riser. Flood discharges which cannot be absorbed by storage and the riser, flow through the emergency spillway at pool elevations above 784.8 msl. The 24 inch diameter gate at elevation 751.1 msl is manually operated, and is available to lower the lake elevation below normal pool for maintenance purposes.

1.3 Pertinent Data:

1.3.1 Drainage Area: The drainage area is 2 square miles.

1.3.2 Discharge at Dam Site: According to Mr. Barrow, the flood of record occurred in April 1977. A high water mark placed on a tree measured 16± ft above normal pool (Elev. 782). This corresponds to an approximate discharge of 65 cfs.

Principal Spillway Discharge:

Pool Elevation at Crest of Dam (elev 788.5) 71 CFS

Emergency Spillway Discharge:

Pool Elevation at Crest of Dam (elev 788.5) 2000 CFS

1.3.3 Dam and Reservoir Data: See Table 1.1, below:

Table 1.1 - DAM AND RESERVOIR DATA

	Reservoir				
			Storage		
	Elevation feet msl	Area Acres	Volume Acre Feet	Watershed Inches	Length Miles
Crest of Dam	788.5	26.9	432	4.2	.6
Emergency Spillway Crest	784.8	21.7	331	3.2	.5
Low Level Orifice Crest	766.[illegible]	9.1	68	[illegible]	.2[illegible]
Streambed at Downstream Toe of Dam	747	-	-	-	-

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of the USDA, Soil Conservation Service (SCS). "As built" drawings and design data are available in the office of the State Conservationist, U. S. Soil Conservation Service, Federal Building, Room 9201, 5th and Marshall Streets, Richmond, Virginia 23240.

A subsurface investigation was conducted at the site by the SCS during the initial design stages. The investigation consisted of excavating 45 test pits and drilling 4 hand augers. Subsurface profiles and a report of the investigation with foundation recommendations were prepared based upon geologic field reconnaissance, test pit and hand auger data, and laboratory testing. A copy of the design report is included as Appendix IV. Test pit and hand auger locations are provided on Plate 2 of Appendix I. Subsurface profiles are shown on Plate 3 of Appendix I, while logs of the materials encountered are included as Plates 6 and 7 of Appendix I.

The dam is a zoned, compacted earthfill embankment. The earthfill requirements shown on Plate 6 of Appendix I, specify that CL and ML materials be placed in Section No. 1 or the upstream face of the dam. Soil classificaion is by the Unified Soil Classification System, ASTM D-2487. The downstream face (Section No. 2) was to be constructed with ML and SM materials. Select borrow areas were specified for each

section of the embankment. "As built" embankment slopes for the structure are illustrated on Plate 4 of Appendix I.

A review of design data indicates the dam is founded on overburden and includes a cutoff trench which extends through alluvial and residual soils into "firm bedrock." The cutoff also extends to the same materials in both abutments. The cutoff trench has a bottom width of 12 ft and 1H:1V side slopes. No field permeability tests were taken during the subsurface investigation, however, the permeability rates for the foundation soils were estimated to range from 0.01 to 10 ft/day depending upon the amount of fines in the materials.

An internal drainage system was also constructed beneath the downstream slope to collect any seepage passing through the dam. The seepage drain consists of a 4 ft minimum width trench of variable depth. It is 171 ft in length and includes 164 ft of perforated and 20 ft of non-perforated bituminous coated corrugated metal pipe. The CMP is enclosed in an envelope of graded filter material. Details for the "as built" seepage drain are included on Plate 4 of Appendix I.

The principal spillway was designed as a drop inlet structure consisting of a reinforced concrete riser, a 24 inch conduit and plunge pool at the outlet end of the conduit. The emergency spillway (EMS) is designed as an earth cut at the left abutment. The principal spillway was designed to accommodate a 50 year flood without the pool elevation exceeding the EMS crest.

The emergency spillway is located in a moderately sloping hillside in the right abutment. The spillway is a 100 ft wide trapezoidal earthen channel bounded by 3H:1V cut slopes. The spillway is entirely in cut materials, i.e., residual soils. The emergency spillway was to be undercut 1 ft below final grade and backfilled with"semi-compacted"select borrow material. All materials encountered in the subsurface investigation were dry and well drained. Details of the spillway section are given on Plate 2 of Appendix I.

The design report and supplementary data provided by SCS (Appendix V) includes laboratory test data describing the physical properties of the materials used to construct the embankment. Shear strength parameters used in design of the embankment, and foundation material were determined by direct shear and consolidated undrained triaxial compression test as follows:

SECTION	SOIL	SHEAR STRENGTH PARAMETERS	
		Angle of Internal Friction	Cohesion
Embankment	SM	$\phi_{cu} = 20^{\circ}$	c = 500 psf
	ML or MH	$\phi_{cu} = 25.5^{\circ}$	c = 475 psf
	ML	$\phi_{cu} = 22^{\circ}$	c = 475 psf
Foundation	SM*	$\phi_{T} = 19^{\circ}$	c = 800 psf
	SM*	$\phi_{DS} = 25.5^{\circ}$	c = 100 psf

* Samples from Site 5. SCS assumes parameters are same as those at Leatherwood Creek No. 4 Dam site.

Embankment stability was checked by the Swedish Circle Method Analysis. The following is a summary of the stability analysis presented in Appendix V:

The analysis considered a 39.2 foot embankment. An arc through an upstream 2.5:1 slope like Sample 64W423 (ML) gave 1.43 as the safety factor against failure after rapid full drawdown. This analysis assumes that the foundation will consolidate rapidly and mobilize adequate strength to limit the potential of failure to the embankment only.

Since it was not certain that the foundation materials can drain rapidly enough to validate the above assumption, an additional arc through a 2.5:1 upstream slope like Sample 64W423 and 6 feet of foundation material replaced by material like Sample 64W423 was analyzed. A safety factor of 1.31 was determined.

Past experience has shown a 2.5:1 downstream slope without drainage to give safety factors that are higher than those determined for a 2.5:1 upstream slope under full drawdown. Therefore, the downstream slope was not analyzed.

2.2 Construction: The construction records were not furnished by the SCS office in Richmond, but they are available from the SCS office in Washington, D. C.

2.3 Evaluation: "As built" drawings are representative of the structure. Hydrologic and hydraulic calculations were available for evaluation. There is sufficient information to evaluate foundation conditions and embankment stability.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: At the time of inspection, the dam appeared to be in good condition. Field observations are outlined in Appendix III.

3.1.1 General: An inspection was made on July 1, 1981 and the weather was cloudy with a temperature of 78°F. The pool and tailwater levels at the time of inspection were 766.5 and 747 msl, respectively, which corresponds to normal pool and tailwater elevations. Ground conditions were dry at the time of the inspection. Maintenance inspections are performed jointly by SCS and the Blue Ridge Soil and Water Conservation District on an annual basis. Inspection reports are available in the Soil and Water Conservation District Office in Collinsville, Virginia.

3.1.2 Dam and Spillway: The embankment slopes were heavily vegetated with 3 to 5 ft± high brush, briers, and honeysuckle making observation difficult. Scattered cut cedars and pines generally less than two inches in diameter have been cut and left on the embankment slopes.

Scattered shrinkage cracks were noted along the embankment crest. Some were up to one inch wide, but no differential movement was noted. An erosional notch several ft wide and several ft deep was encountered along the lower 10 ft of the left downstream abutment-slope contact. This notch becomes 3 to 4 ft deep at the downstream toe. Another erosional notch several ft wide and several ft deep occurs along the right downstream toe at the right abutment contact.

The downstream toe was dry and no seepage was observed. Iron staining and a saturated area occur 7 ft± upstream of the discharge outlet and 6 inches to the right of the pipe cradle. "As built" drawings show the presence of two 6 inch cmp seepage drain outlets, however, neither one was observed.

The riser structure and outlet pipe showed no signs of deterioration and were functioning properly at the time of inspection. Debris was not present in the low level intake trash rack. The slide gate has not been operated since it was installed, according to the owner. The plunge pool and outlet channel indicated no signs of deterioration. The emergency spillway was well vegetated and the width measured 20 ft wider than shown on the "as built" plans.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was wooded. The reservoir is located in a valley with steep side slopes. Water was murky and sedimentation was observed in the upper end. The owner indicated that a 2-3 ft buildup of sediment had occurred since construction of the dam.

3.1.4 Downstream Area: The downstream channel consists of a 20 ft wide channel located in a 100 ft wide flood plain, and a valley with steep side slopes. This valley is heavily wooded with thick underbrush. Approximately 2 miles downstream there is a dwelling about 15 ft above the stream channel, and 5 miles downstream there are several dwellings about 10 ft above the stream channel, and several commercial facilities about 15 ft above the stream channel.

3.1.5 Instrumentation: No instrumentation (monuments, observation wells, piezometers, etc) was encountered for the structure. There is no staff gage.

3.2 Evaluation:

3.2.1 Dam and Spillway: Overall, the dam was in good condition at the time of the inspection. An annual inspection and maintenance program exists for this structure, however, at the time of this inspection, maintenance appeared to be inadequate. The embankment, including its crest and slopes should be mowed at least once a year, but more preferably twice a year. The presence of trees on the embankment, particularly any at pool level on the upstream slope, may promote the development of deep rooted vegetation and this type growth can encourage piping within an embankment. All trees growing on the embankment should be cut to the ground during maintenance operations. Cut trees should be removed from the embankment.

The shrinkage cracks observed on the embankment crest are believed to be the result of local drought conditions and require no special attention. The eroded areas described along the right and left downstream abutment-slope contacts should be stabilized to prevent further erosion. This might be accomplished by backfilling, compacting and seeding these areas or by placing riprap.

The area observed above the discharge outlet is believed to be caused by blockage of the seepage drain outlets. The outlets should be uncovered to allow free flow. Although the saturated iron-stained area does not appear to present a hindrance to the normal functioning of the dam, it is recommended that this area be monitored quarterly to detect any significant

enlargement of the area or development of flow rates which may cause piping in the embankment. If enlargement or increased flows should occur, a Professional Engineer with expertise in Geotechnical Engineering should be contacted to evaluate the problem and make recommendations for required corrective measures.

The outlet pipe and intake structure are in good structural condition. A staff gage should be installed to monitor water levels.

3.2.2 Downstream Area: A breach in the Leatherwood Creek No. 4 Dam during extreme flooding would possibly create a hazard to the downstream dwellings.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The normal storage pool is elevation 766.5 msl or 0.3 ft above the crest of the principal spillway low flow inlet. The lake provides an irrigation supply, flood control and recreation. Water automatically passes through the principal spillway as the water level in the reservoir rises above the low level orifice. Water will also pass automatically through the riser overflow crest when the water level in the reservoir exceeds elevation 775.6 msl, and automatically through the emergency spillway when the pool level exceeds elevation 784.8 msl. A 24 inch diameter slide gate at the low point in the riser structure is provided to drawdown the reservoir below normal pool.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the owner and the Blue Ridge Soil and Water Conservation District. Maintenance is accomplished by a joint annual inspection by SCS and Soil and Water Conservation District personnel. Maintenance deficiences are noted and recommended remedial measures are made to the owner. If the owner fails to comply with these recommendations, maintenance is then performed by the Blue Ridge Soil and Water Conservation District.

4.3 Warning System: At the present time, there is no warning system or evacuation plan for the dam. The dam is monitored by SCS personnel during periods of heavy precipitation and runoff.

4.4 Evaluation: The dam and appurtenances are in good operating condition, but maintenance of the dam appeared to be inadequate. An emergency operation and warning plan should be developed. It is recommended that a formal emergency procedure be prepared and furnished to all operating personnel. This should include:

a. How to operate the dam during an emergency.

b. Who to notify, including public officials, in case evacuation from the downstream area is necessary.

SECTION 5 - HYDRAULICS/HYDROLOGIC DATA

5.1 Design: Leatherwood Creek No. 4 Dam was designed by the Soil Conservation Service (SCS) as a multi-purpose dam, and hydrologic and hydraulic data is available. Stage-storage and stage-discharge data from the design report were used in the evaluation. This structure is a Class "A" dam according to the SCS classification method.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: According to Mr. Barrow, an estimated maximum pool elevation of 782 msl occurred in April 1977. This corresponds to a peak flow of approximately 65 CFS.

5.4 Flood Potentials: In accordance with the established guidelines, the Spillway Design Flood (SDF) is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region), or fractions thereof. The Probable Maximum Flood (PMF) and ½ PMF hydrographs were developed by the HEC-1 DB Computer Program (Reference 4, Appendix VI). Precipitation amounts for the flood hydrograph of the PMF were taken from the U.S. Weather Bureau Information (References 5 and 6, Appendix VI). Appropriate adjustments for basin size and shape were accounted for. These hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 Reservoir Regulations: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 766.5 msl. Reservoir stage-storage data and stage-discharge data were utilized from the existing design report. Floods were routed through the reservoir using the principal spillway discharge up to a pool storage elevation of 784.8 msl and a combined principal and emergency discharge for pool elevations above 784.8 msl. Pool elevations above 786.5 msl were routed over the non-overflow section of the dam.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions (½ PMF and PMF) are shown in the following Table 5.1:

TABLE 5.1 - RESERVOIR PERFORMANCE

		Hydrograph	
	Normal Flow	½ PMF	PMF
Peak Flow, CFS			
Inflow	2	4930	9860
Outflow	2	4853	9860
Maximum Pool Elevation Ft, msl	766.5	790.2	791.8
Non-Overflow Section (Elev 788.5 msl)			
Depth of Flow, Ft	-	1.7	3.3
Duration, Hours	-	3.5	5.5
Velocity, fps *	-	5.6	7.8
Tailwater Elevation Ft, msl	747	755.5	759

*Critical velocity

5.7 Reservoir Emptying Potential: A 24 inch diameter slide gate at centerline elevation 758.1 msl is capable of draining the reservoir through the outlet pipe. Assuming that the lake is at normal pool elevation (766.5 msl) there is 2 cfs inflow, it would take approximately 1 day to lower the reservoir to elevation 752.1 msl. This is equivalent to an approximate drawdown rate of 14.4 ft/day based on the hydraulic height measured from normal pool to the invert of the drawdown pipe divided by the time to dewater the reservoir.

5.8 Evaluation: The U. S. Army, Corps of Engineers' guidelines indicate the appropriate Spillway Design Flood (SDF) for an intermediate size, significant hazard dam is the ½ PMF to PMF. Because of the risk involved, the ½ PMF has been selected as the SDF. The spillway will pass 20 percent of the PMF without overtopping the crest of the dam (40 percent of the SDF). During the SDF, the dam will be overtopped for 3.5 hours up to a maximum of 1.7 feet and reach a maximum velocity of 5.6 fps.

Hydrologic data used in the evaluation pertains to present day conditions with no consideration given to future development.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located along the western edge of the Piedmont Physiographic Province of Virginia. The original design report described the site as being underlain by the Leatherwood Granite; however, recent detailed mapping indicates the site is actually underlain by the Rich Acres Formation of Precambrian Age (1020 million years old). The Rich Acres Formation consists of coarse grained norites, metamorphosed gabbros and diorites. These rocks are similar in texture to granites, but are comprised of more basic or darker colored minerals. Detailed geologic maps of the area do not indicate the presence of any faults in the site vicinity. Site geology is presented in more detail in the Design Geologic Report, which is included as Appendix IV.

The subsurface investigation indicated that along centerline of the dam the site was underlain by shallow alluvial and residual soils over weathered bedrock. A 2.5 to 3.5 ft thick layer of alluvial clay and sand occur in the floodplain beneath the dam at a depth of approximately 3 ft. This layer is of low strength as indicated by pocket penetrometer readings ranging from 0.3 to 0.5 tsf. The bedrock surface was somewhat irregular. Bedrock underlies the right abutment at a uniform depth of 10 ft, extending to the right side of the stream channel. Bedrock was encountered in the left abutment from about 3 to 6 ft below the surface.

Above the bedrock is a layer of tightly cemented boulders from 1 to 3 ft below the ground surface. A thin dike crosses the centerline at right angles between stations 1+60 and 2+12. Along the stream,rock outcrops at the surface.

In a discussion of foundation materials, the SCS soil mechanics laboratory believed that the residual soils underlying the site were only moderately compressible and the more highly compressible alluvial soils would not cause any problems because they were relatively thin. SCS assumed less than 0.75 ft of consolidation would occur within foundation soils and much of this would occur during construction due to the free-draining nature of the majority of the soils.

The potential for seepage through the foundation was recognized, and a cutoff was included in the design. Moderate permeabilities ranging from 0.01 to 10 ft/day were anticipated for the foundation soils and the designer expected some seepage through the weathered bedrock. Consequently foundation drainage to a depth of about 6 to 7 ft was recommended below the design normal pool elevation (766.2 msl).

6.2 Embankment:

6.2.1 Materials: "As built" drawings describe the dam as a zoned structure. Section No. 1 of the dam, consisting of the cutoff and upstream section, was constructed with soils classifying as ML and CL. Section No. 2 (the downstream section) was constructed with ML and SM materials. All specified materials were excavated from select borrow areas. Fill materials in both sections were to be compacted to 95% of maximum dry density in accordance with ASTM Standard D-698 (Standard Proctor). Compacted

densities and shear strength values for the embankment materials are summarized on page 4 of Appendix V. Specifications for maximum lift thickness and maximum rock sizes were not observed in the design data provided.

The SCS soil mechanics laboratory estimated that the embankment fill was expected to settle approximately 2% of its height or 0.7 ft$^{\pm}$ between stations 1+00 and 2+00 due to consolidation of embankment materials after construction. It was recommended that 1 ft of overfill be placed between centerline stations 1+00 and 2+00 to compensate for residual consolidation of the fill and foundation materials.

6.2.2 Subdrains and Seepage: In attempt to control seepage, a cutoff was constructed into bedrock below the more permeable alluvial soils in the floodplain and extending into the abutments. Details are shown on Plate 3 of Appendix I. An internal drainage system was also constructed, consisting of a drainage trench beneath the downstream portion of the embankment to collect any seepage which may occur. Drainage pipes were provided for transmitting the collected water to the plunge pool. Details are provided on Plate 4 of Appendix I. During the field inspection, it could not be determined if the drains were functioning properly because their outlets could not be located. They are believed to be covered with riprap. In attempt to prevent piping around the principal spillway pipe, 7 anti-seep collars were included as shown on Plate 5 of Appendix I.

6.2.3 Stability: A stability analysis was performed for the upstream slope of this structure and the report describing the engineering

design data used is included in Appendix V. These data were reviewed along with the stability analysis and were found to be acceptable. The minimum factor of safety calculated for the upstream slope for the full drawdown condition is 1.31 as given in Appendix V. Reference 1, Appendix VI, recommends a factor of safety of 1.2. A stability analysis was not performed for the downstream slope. The design report (Appendix V) states, "Past experience has shown a 2½:1 downstream slope without drainage to give safety factors that are higher than those determined for a 2½:1 upstream slope under full drawdown. Therefore, the downstream slope was not analyzed."

The dam is 41.5 ft high and has a crest width of 14 ft. The upstream slope is 2.5H:1V with a 10 ft wide berm at pool level between elevations 766.7 and 767.7 msl. The upstream slope then continues at a 3H:1V slope below normal pool. The downstream slope is 2.5H:1V. The dam is subjected to a sudden drawdown since the lake level can be drawn down at a rate of 14.4 ft/day. This exceeds the critical rate of 0.5 ft per day for earth dams. According to the guidelines presented in the Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation for small homogeneous dams, with stable foundation, subjected to a drawdown and with an embankment of SM to ML materials, the recommended downstream slopes range from 2H:1V to 2.5H:1V. (A homogeneous dam was considered for this evaluation because there is no core.) The recommended crest width is 18 ft. Based upon these general guidelines, the downstream slope is adequate, however, the embankment crest is 4 ft narrower than recommended.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 2. Therefore, according to the Recommended Guidelines for Safety Inspection of Dams, the dam is considered to have no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: Based upon the visual inspection and the design report, the foundation is considered sound. The factor of safety for the upstream slope during the drawdown condition meets the U. S. Army, Corps of Engineers guidelines. Although a stability analysis was not performed for the downstream slope, the "as built" slope meets the requirements recommended by the U. S. Bureau of Reclamation. Overtopping is not considered detrimental to the dam with respect to erosion because of the shallow depth and short duration of flood. Also the critical velocity is slightly less than 6 fps, the assumed effective eroding velocity for a vegetated earth embankment. The embankment crest is 4 ft narrower than recommended by the U. S. Bureau of Reclamation, however, based upon the performance history of the structure and the low overtopping velocity, the narrow width is not considered a problem.

Since no undue settlement, cracking or sloughing was noted at the time of inspection, it appears that the embankment is adequate for maximum control storage with water at elevation 766.5 msl.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Sufficient engineering data is available for assessing the dam. The visual inspection revealed no findings that proved the dam to be unsound. There is an annual inspection and maintenance program for this structure, but there is no emergency operation and warning plan. Overall, the dam was in good condition at the time of inspection. U. S. Army, Corps of Engineers guidelines indicate the appropriate Spillway Design Flood (SDF) for this dam is the ½ PMF. The spillway will pass 20 percent of the PMF (40 percent of the SDF) without overtopping the crest of the dam. During the SDF the dam will be overtopped for a period of 3.5 hours up to a maximum of 1.7 feet and reach a maximum velocity of 5.6 fps. Flows overtopping the dam at a maximum velocity of 5.6 fps during the SDF are not considered detrimental to the embankment with respect to erosion. The spillway is judged inadequate, but not seriously inadequate. Field measurements indicate the embankment crest is 4 ft narrower than shown on the "as built" drawings. Review of available stability data indicates the structure is stable as designed.

7.2 Recommended Remedial Measures:

7.2.1 Emergency Operation and Warning Plan: It is recommended that a formal emergency procedure be prepared, prominently displayed, and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.
2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

7.3 Required Maintenance: The inspection revealed the following maintenance items that should be scheduled by the owner during a regular maintenance period within the next 12 months.

a) The grass and weeds on the dam embankment and in the emergency spillways should be cut at least once a year and preferably twice a year. Maintenance is recommended in the early summer and fall.

b) Existing trees on the dam should be cut to the ground. Cut trees should be removed from the embankment.

c) The eroded areas present along the left and right downstream abutment-slope contacts should be stabilized to prevent further erosion. Riprap or backfilling, compaction and seeding are recommended in these areas.

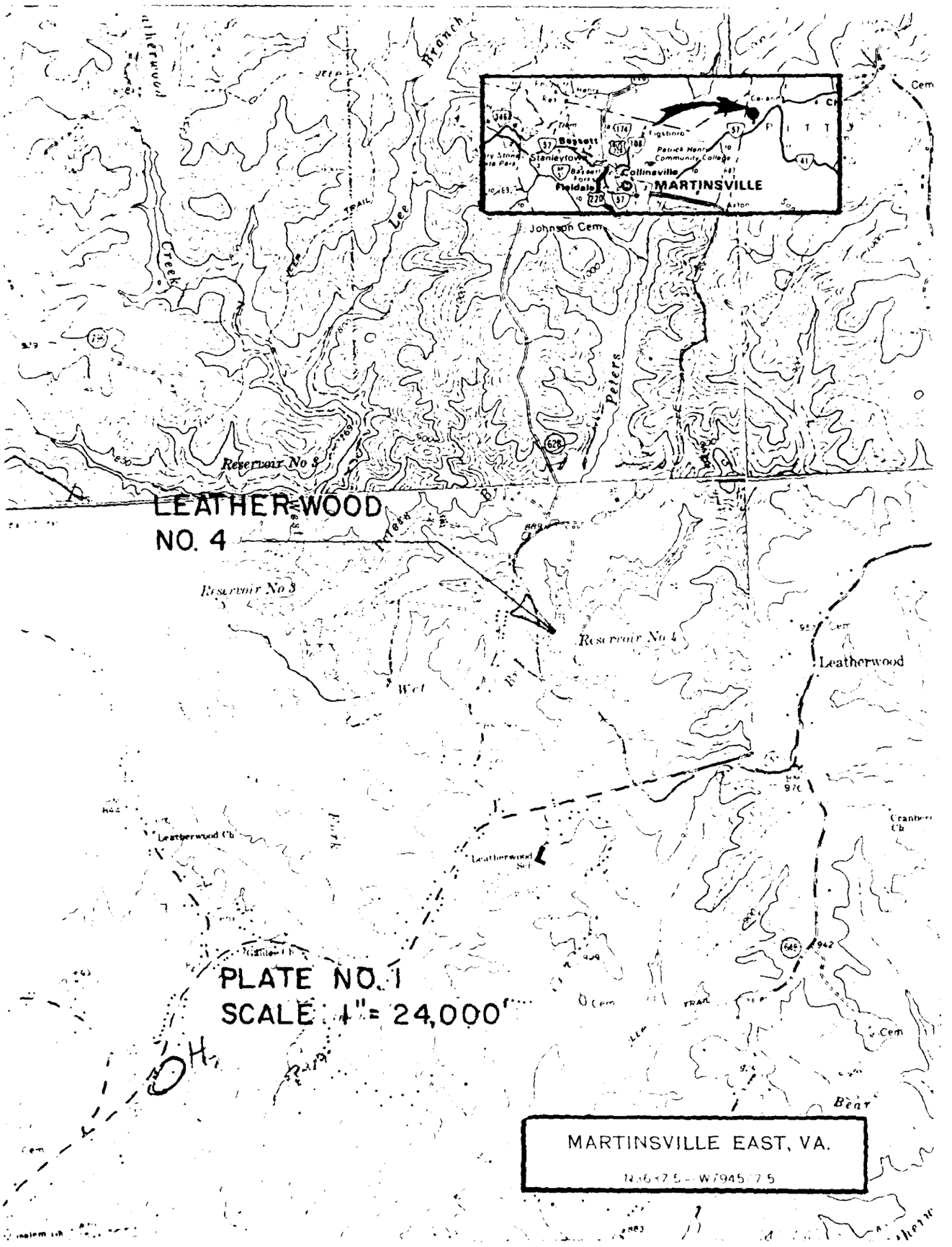
d) The seepage drain outlets should be uncovered to allow free flow.

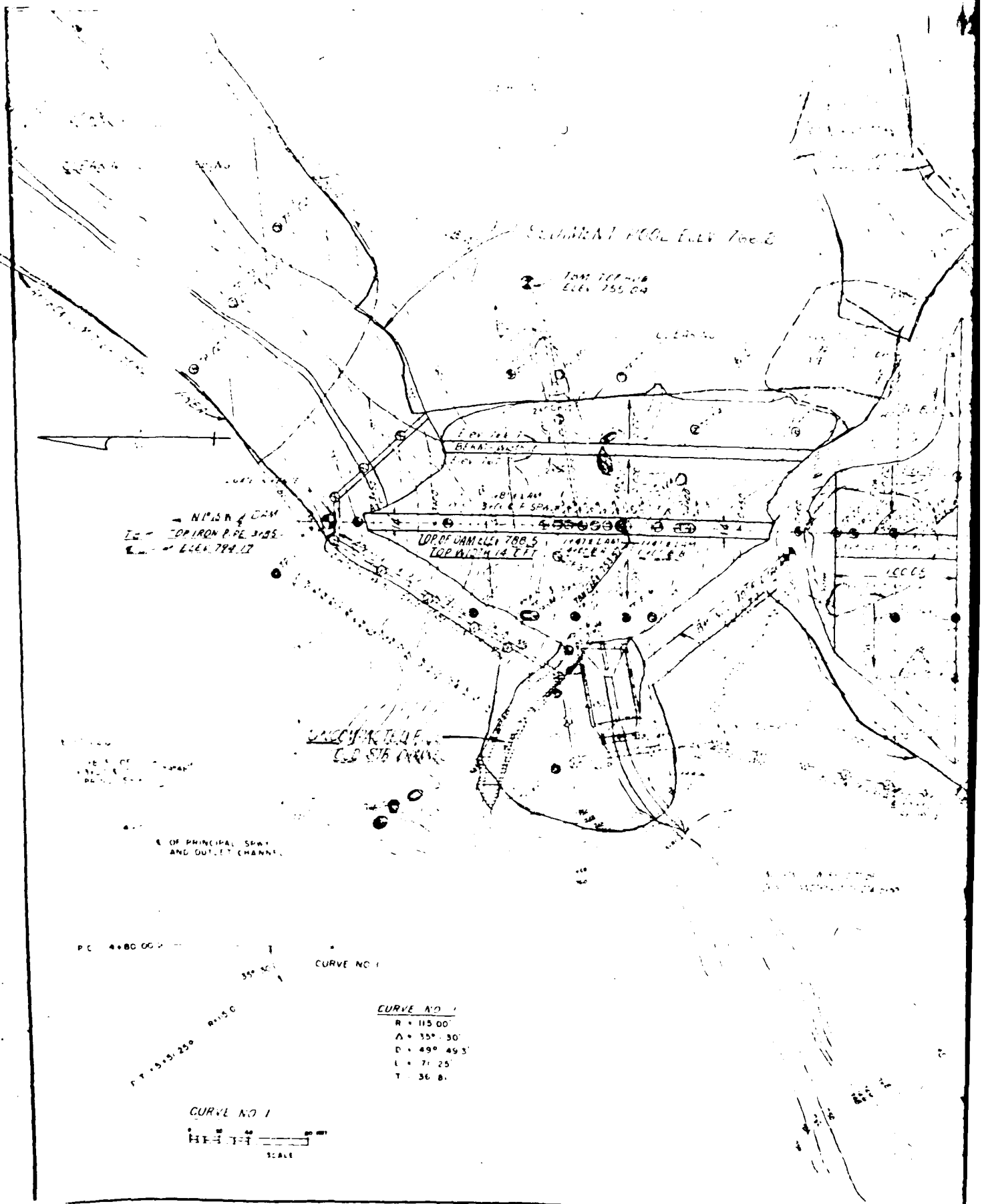
e) The saturated area present above the discharge outlet should be monitored quarterly to detect any significant enlargement of the area or development of flow rates which may cause piping within the embankment. If increased enlargement or flows should occur, a Professional Engineer with expertise in Geotechnical Engineering should be contacted to evaluate the problem and make recommendations for required corrective measures.

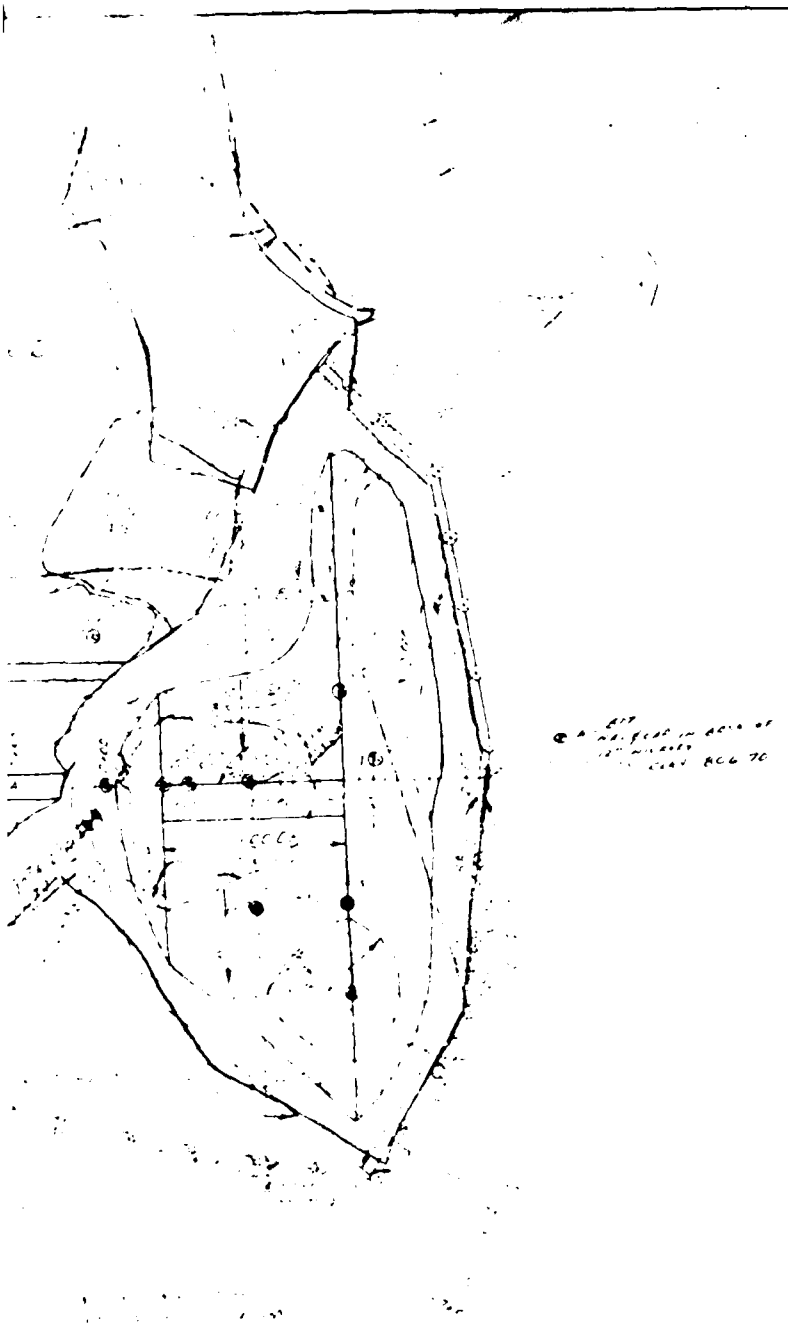
f) A staff gage should be installed to monitor water levels.

APPENDIX I

MAPS AND DRAWINGS


LEATHERWOOD
NO. 4
Reservoir No 3
Reservoir No 4
Leatherwood
Johnson Cem
Peters
Lee
Branch
Creek
Bear
Bassett
Stanleytown
Collinsville
Fieldale
MARTINSVILLE
Patrick Henry Community College
Figsboro
Leatherwood Ch
Leatherwood Sch
Cranberry Ch
Cem
PLATE NO. 1
SCALE 1" = 24,000'
MARTINSVILLE EAST, VA.
N36°45'-W79°45'-7.5


TOP OF DAM ELEV 788.5
CURVE NO 1
CURVE NO 1
R = 115.00'
Δ = 35° 30'
D = 49° 49.3'
L = 71.25'
T = 36.8'
CURVE NO 1
SCALE



[illegible]

[illegible]

[illegible]

[illegible]

[illegible] fill shall be [illegible].

[illegible] of emergency spillway to be [illegible] the engineer.

[illegible] of the spillway [illegible]

[illegible] for borrow material to be made within [illegible] feet of the [illegible] dam.

Interweaving of the face of the dam with the embankment to be shaped as [illegible] by the engineer. Payment will be based upon the [illegible] of material [illegible]

[illegible] for [illegible] of test holes.

[illegible] shall be:

(1) 15 feet (horizontal) beyond the sediment pool elevation if the slopes are equal or less than 1 foot vertical to 15 feet horizontal.

(2) 1 foot (vertical) above the sediment pool elevation if the slopes are steeper than 1 foot vertical to 15 feet horizontal.

There are approximately 5.[illegible] acres of seeded preparation, liming, fertilizing and seeding. This includes the embankment above the sediment pool, emergency spillway, notch in earth and the side slopes and any other disturbed areas as directed by the engineer. This is not a part of this contract.

Final location of fences and gates to be determined by the engineer. Approximately 7[illegible] rods of fence. This is not a part of this contract.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

CLEARING & GRUBBING

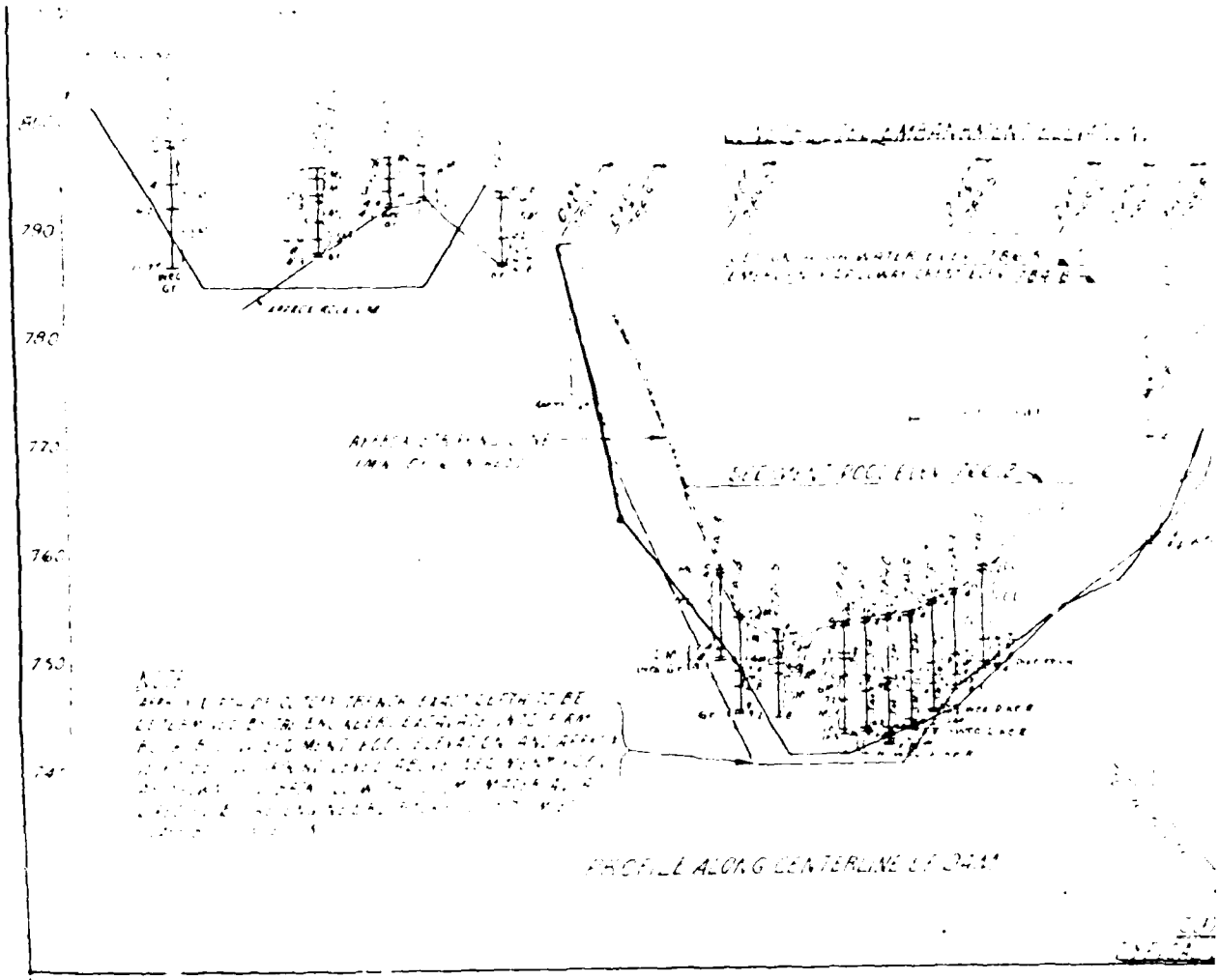
"AS BUILT"

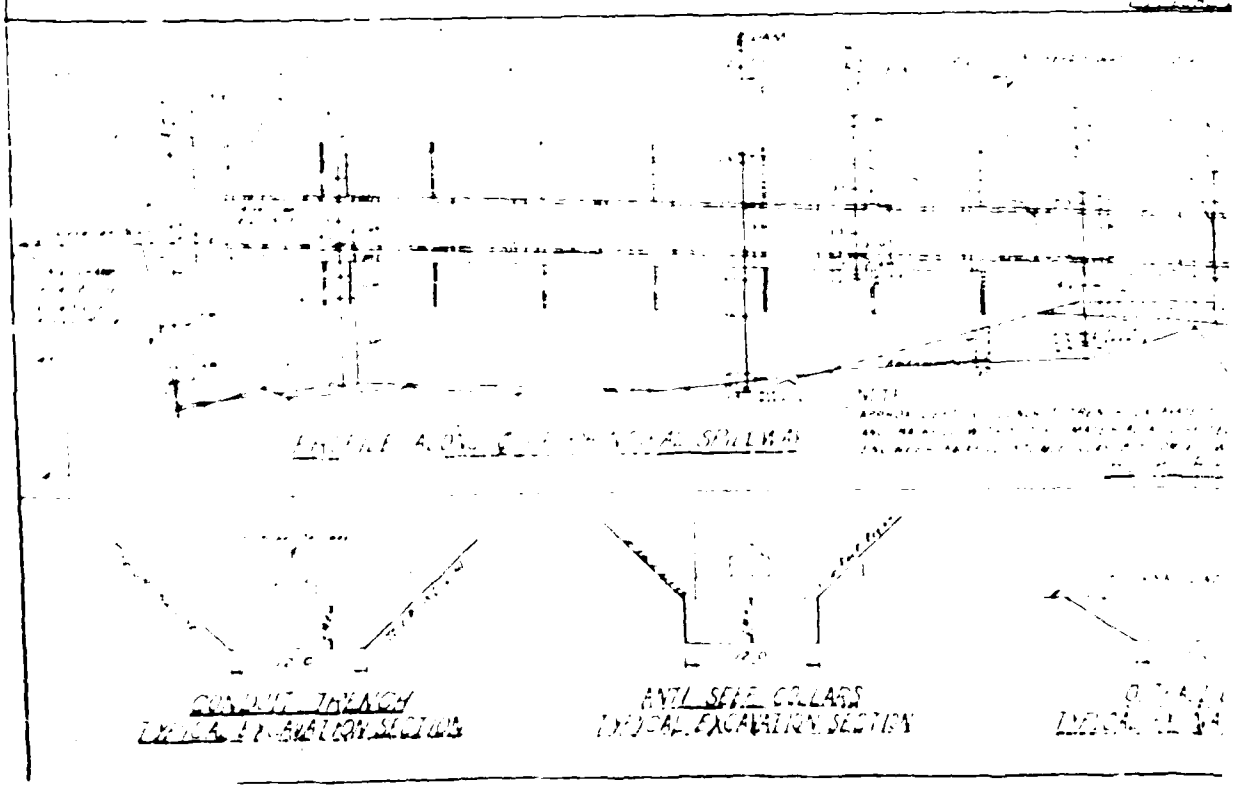
DAM NO 4 WEST FORK
LEATHERWOOD CREEK WATERSHED
[illegible]
PLAN OF DAM & EMERGENCY SPILLWAY

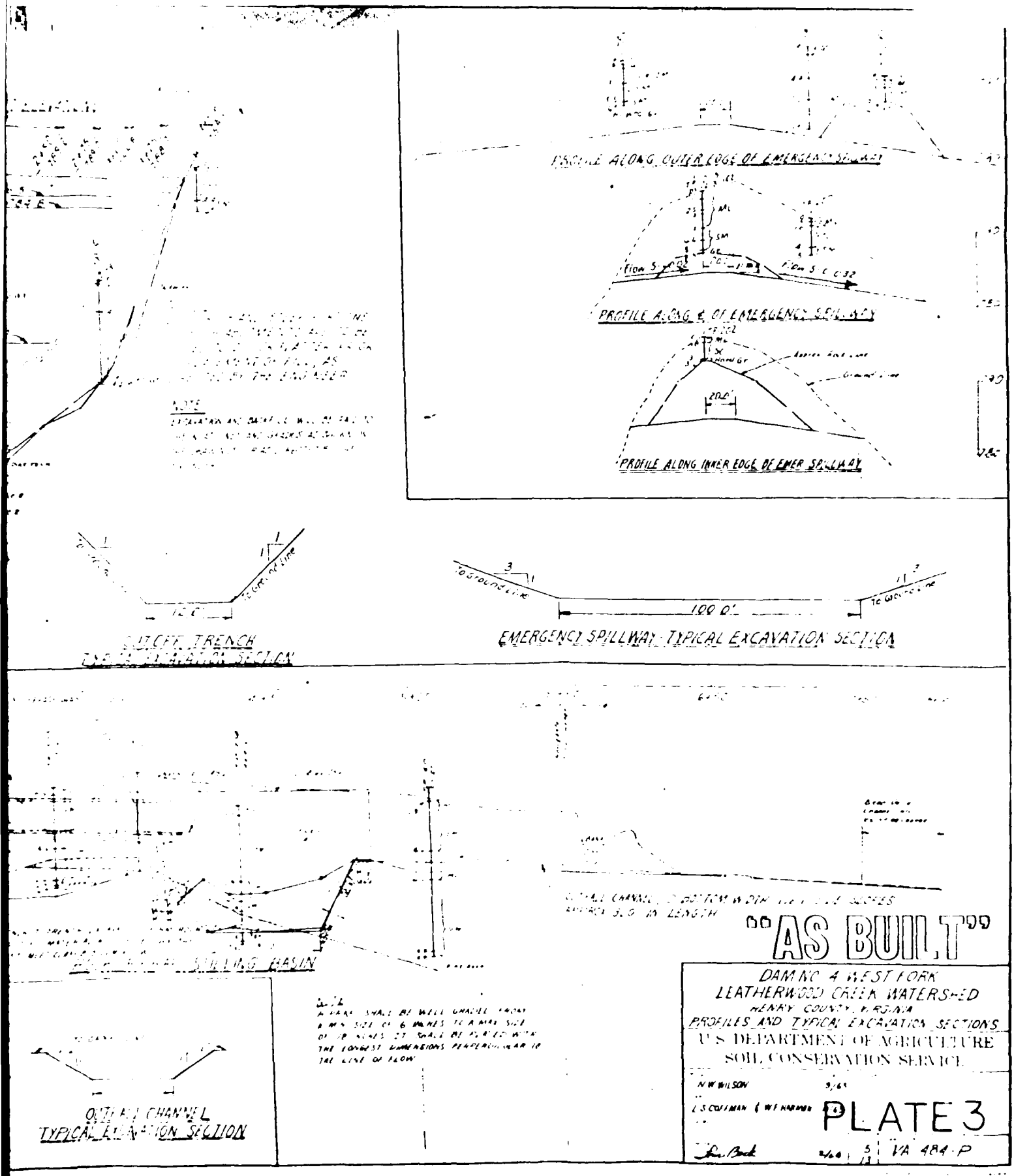
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

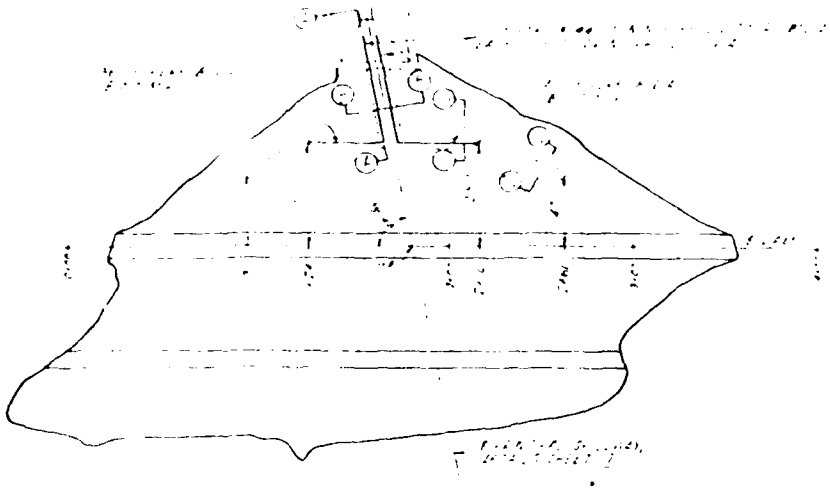
[illegible]

PLATE 2


790
780
770
760
750

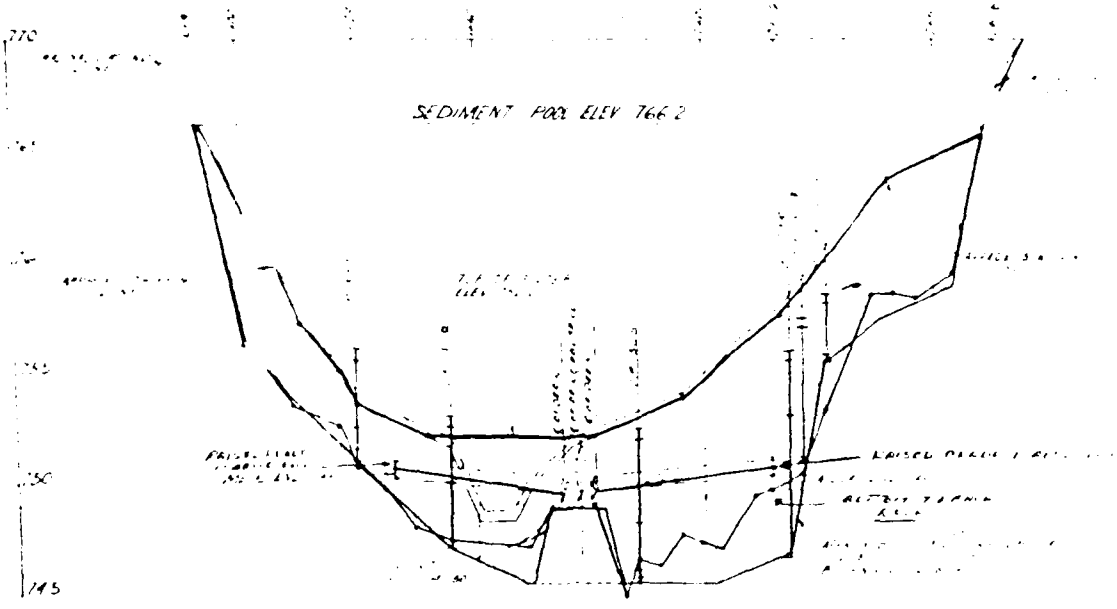

CONDUIT TRENCH
TYPICAL EXCAVATION SECTION
ANTI SEEP COLLARS
TYPICAL EXCAVATION SECTION


PROFILE ALONG OUTER EDGE OF EMERGENCY SPILLWAY
PROFILE ALONG ℄ OF EMERGENCY SPILLWAY
PROFILE ALONG INNER EDGE OF EMER SPILLWAY
20.0'
CUTOFF TRENCH
TYPICAL EXCAVATION SECTION
TO GROUND LINE
100.0'
EMERGENCY SPILLWAY TYPICAL EXCAVATION SECTION
"AS BUILT"
OUTLET CHANNEL
TYPICAL EXCAVATION SECTION
DAM NO 4 WEST FORK
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY, VIRGINIA
PROFILES AND TYPICAL EXCAVATION SECTIONS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
N.W. WILSON
PLATE 3
VA 484-P



PLAN VIEW OF SEEPAGE DRAIN

NOT TO SCALE



PROFILE ALONG ℄ OF TRENCH DRAIN - LOOKING DOWNSTREAM

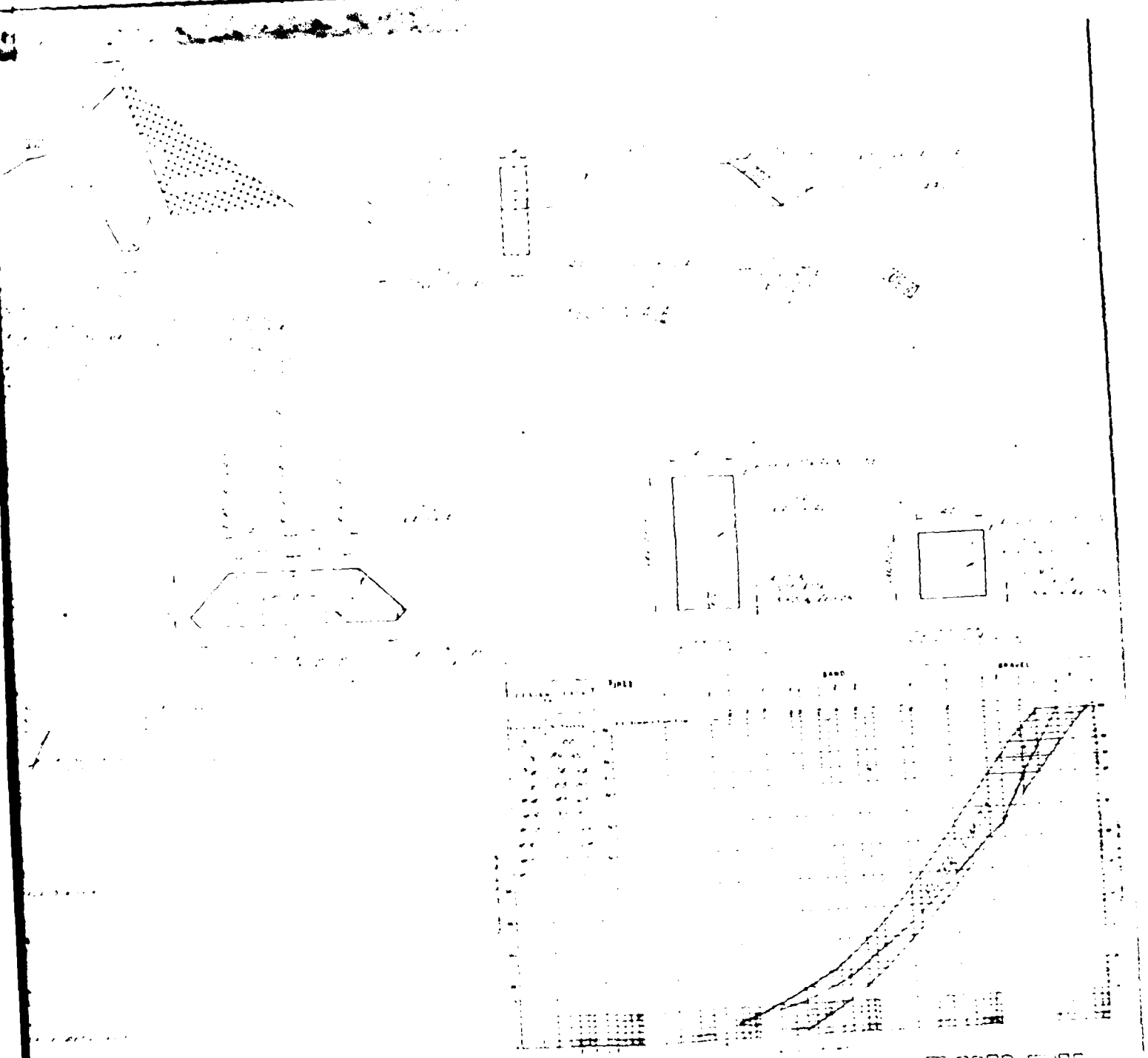
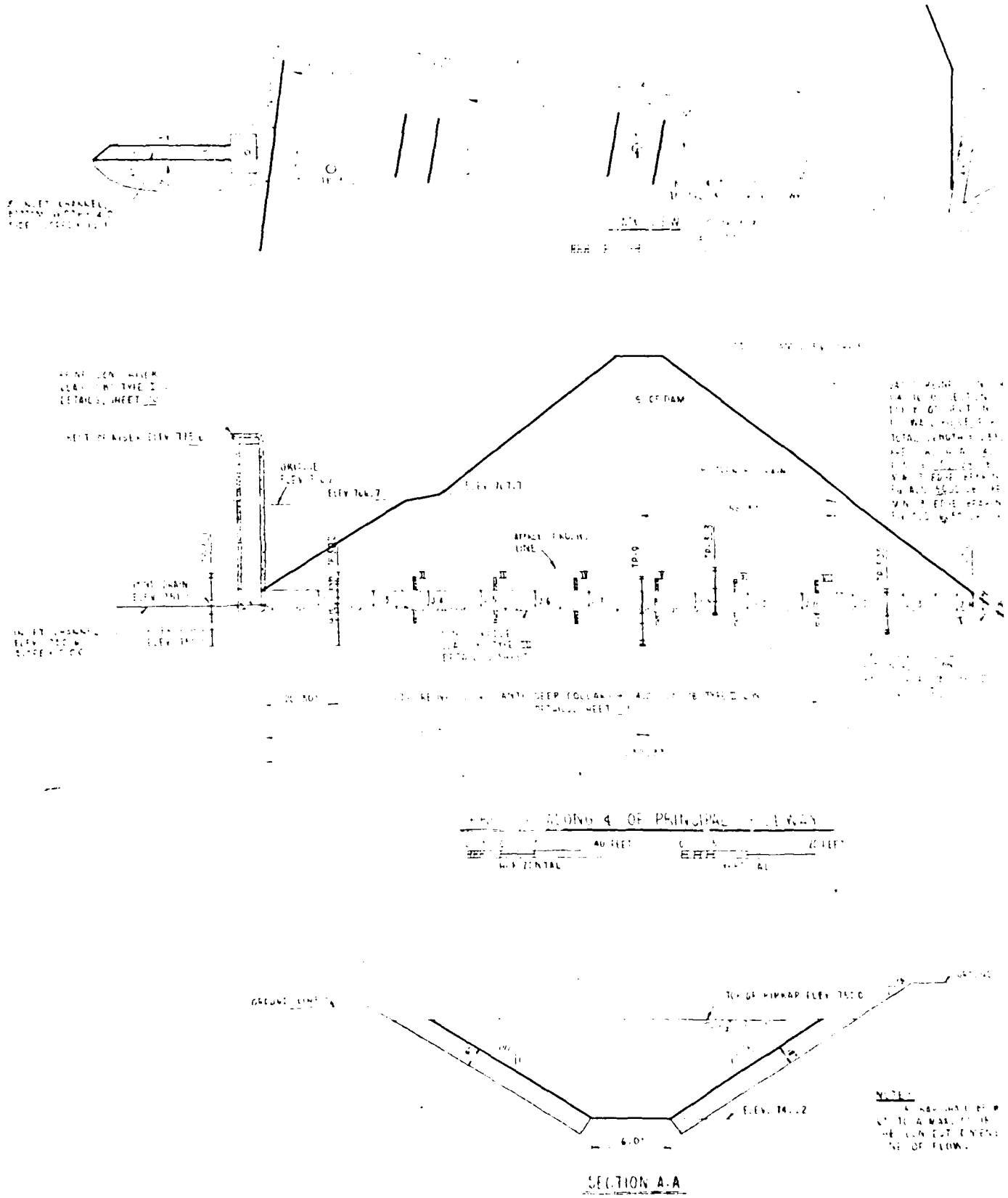
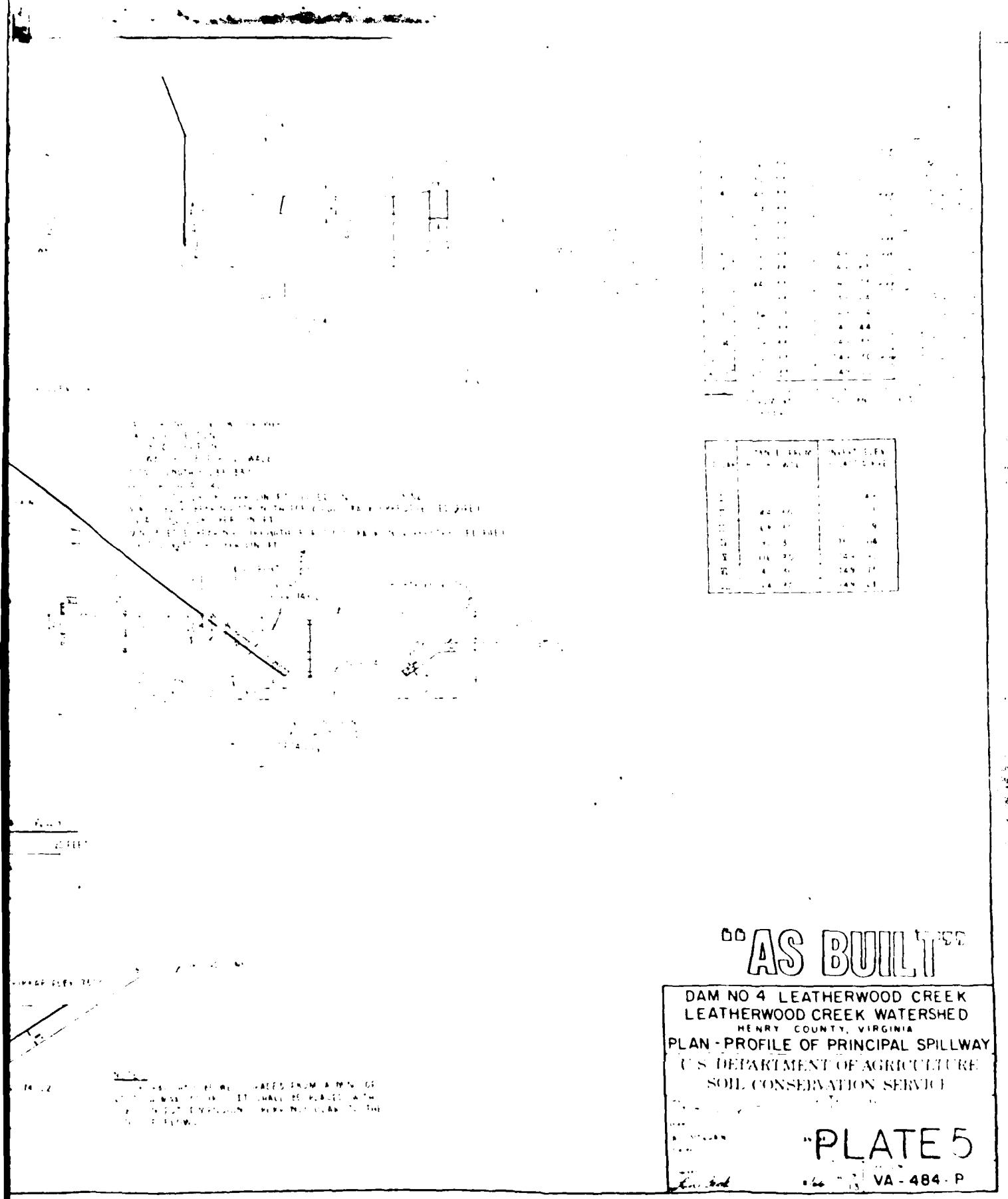


PLATE 4


SECTION A-A



"AS BUILT"

DAM NO 4 LEATHERWOOD CREEK
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY, VIRGINIA
PLAN - PROFILE OF PRINCIPAL SPILLWAY
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 5

VA - 484 - P

TEST PIT [illegible]
[illegible]

[illegible]

[illegible] [illegible] [illegible] - [illegible] - roots and leaves - topsoil

0.[illegible] [illegible] Gravel, silty - [illegible] - few roots - moist - [illegible] fragments in silt matrix.

[illegible] [illegible] Boulders [illegible] in [illegible] clay [illegible] granite slightly weathered.

6.6 [illegible] Weathered granite and angular granite boulders - tight cementation with clay - can be dug - dry hole

Bottom of hole

TP 3, STA. C/L 2+0[illegible], EL. [illegible] (in trench)

0.0 0.[illegible] Clay, fine sandy - brownish gray - moist - loose - roots & leaves - topsoil. ([illegible])

0.[illegible] 7.2 Clay, fine sandy - [illegible] - moist - stiff - p.p. 2.5 - tree [illegible] - colluvial. ([illegible])

BB 3.1 1.0' - 7.0'

7.2 9.0 Sand, silty - dark gray - moist - hard p.p. 3.0 - weathered dike rock. (SM)

TE 3.2 7.5' - 9.0'

9.0 10.0 Clay, sandy - yellow-red - moist - hard - p.p. 3.5 - burned soil (CL)

10.0 10.3 Weathered dike rock - fractured - clay skins between fractures - digs to a SM - seep at 10.0

Bottom of hole

TP 4, STA. C/L 2+12, ELEV. 7[illegible].0 (in trench)

0.0 0.2 Clay, sandy - reddish-brown - moist - stiff - (CL) p.p. 2.0 - roots & leaves - topsoil.

0.2 6.7 Clay, fine sandy - red - moist - hard - (CL) p.p. 3.6 - micaceous - some dike rock angular cobble fragments - weathered aplite stringers - residual.

6.7 [illegible] Sand, silty - dark gray - moist - hard - (SM) p.p. 3.7 - weathered dike rock.

[illegible] [illegible] Dike rock - slightly weathered - fractured with clay skins in fractures - dry hole.

Bottom of hole

TP 5, STA. [illegible], ELEV. [illegible]

0.0 0.[illegible] Clay, sandy - reddish-brown - moist - medium - roots - topsoil. ([illegible])

0.2 [illegible] Clay, sandy - yellowish-red - moist - [illegible] - (CL) p.p. 3.7 - some tree roots - aplite stringers - mica - residual.

TE 5.1 [illegible]' - [illegible]'

[illegible] [illegible] Sand, silty - yellowish-brown - moist - (SM) hard - p.p. 2.7 - micaceous - residual.

DS 5.2 [illegible]' - [illegible]'

[illegible] [illegible] Weathered granite - hard in place fractured - crumbles when dug - dry hole.

Bottom of hole

AC, [illegible] C/L [illegible], ELEV. 7[illegible].0

[illegible] 0.2 Clay, silty - reddish-brown - moist - ([illegible]) topsoil.

0.2 [illegible] Clay, sandy - yellowish-red - moist - stiff - (CL) p.p. 2.5 - micaceous - residual

[illegible] [illegible].0+ Sand, silty - yellowish-brown - moist - ([illegible]) stiff - p.p. 2.0 - micaceous - dry hole.

Bottom of hole

T[illegible] [illegible], STA. C/L [illegible], EL. 7[illegible].2

0.0 0.[illegible] Clay, sandy - brownish-gray - moist - loose ([illegible]) roots & leaves - topsoil.

0.[illegible] 5.[illegible] Clay, fine, sandy - red & yellow-red - (CL) moist - hard - p.p. 3.5 - some fine mica - roots to 3' - colluvial.

5.[illegible] 7.6 Sand, silty - yellow-red - moist - micaceous - stiff - p.p. 2.7 - some weathered granite fragments. ([illegible])

7.[illegible] [illegible] Sand, silty - dark gray - moist - medium - (SM) p.p. 1.[illegible] - [illegible] weathered dike rock - water at [illegible] - [illegible] - dike rock.

[illegible] [illegible].2 Weathered dike rock - few joints with clay skins in joints.

Bottom of hole

[illegible]

[illegible] [illegible] [illegible] - roots & leaves - [illegible] ([illegible])

[illegible] [illegible] [illegible], clayey - [illegible] - moist - stiff - [illegible] - few roots to 2' - [illegible].

[illegible].7 [illegible] [illegible], clayey - [illegible] - [illegible] ([illegible])

[illegible] [illegible] Coarse sand, silty - [illegible] - moist at top, wet at bottom - [illegible] - seep at [illegible] ([illegible])

10.0 [illegible] Sand, silty - gray - moist - [illegible] p.p. [illegible] - [illegible] weathered dike rock. ([illegible])

10.6 10.[illegible] Weathered dike rock - [illegible] joints.

Bottom of hole

TP 1[illegible], STA. C/L [illegible], ELEV. 7[illegible]

[illegible] [illegible] Clay, fine sandy - [illegible] - topsoil. ([illegible])

0.[illegible] 5.[illegible] Fine sand, silty - moist - stiff - (SM) p.p. 2.6 - fine mica - [illegible] - colluvial.

5.9 7.[illegible] [illegible], clayey - [illegible] - moist - medium - ([illegible]) p.p. 1.2 - caves.

7.[illegible] 10.[illegible] Coarse sand, silty - yellow-red - moist (SM) at top, wet at bottom - angular feldspar grains - caves.

10.[illegible] 11.[illegible] Sand, silty - gray - moist - medium - p.p. (SM) 1.2 - highly weathered dike rock - seep at 10.0'.

11.6 1[illegible].[illegible] Weathered dike rock - few joints - [illegible] in joints.

Bottom of hole

TP 11, STA. C/L 1+00, ELEV. 7[illegible].5

[illegible].0 0.[illegible] Clay, fine sandy - [illegible] - loose (CL) topsoil - leaves.

0.[illegible] [illegible].3 Fine sand, silty - yellow-[illegible] - moist - (SM) medium - p.p. 1.5 - fine [illegible] - roots to 2' - colluvial.

5.3 [illegible] Coarse sand, silty - yellow-red - moist - (SM) medium - p.p. 1.[illegible] - angular [illegible] grains - seep at [illegible].0.

[illegible] [illegible] [illegible] ([illegible])

[illegible] [illegible]

[illegible] [illegible] Weathered [illegible]

Bottom of hole

TP 1[illegible], STA. [illegible]

[illegible] [illegible] Silt, [illegible] - loose to [illegible] - ([illegible]) leaves and roots.

[illegible] [illegible] Sand, silty - yellow-brown - [illegible] - soft - ([illegible]) p.p. 0.3 - [illegible] - dry density 55.63 lb/cu.ft.

[illegible] [illegible] Sand, silty - yellowish [illegible] - moist - (SM) [illegible]

[illegible] [illegible]' - [illegible]'

[illegible].5 [illegible].2 [illegible], silty - gray - wet - [illegible] - ([illegible]) [illegible] dry density [illegible] lb/cu.ft.

[illegible] [illegible] [illegible]' - [illegible].2'

[illegible].2 7.[illegible] Gravel, silty - bluish-gray - [illegible] - water (GM) bearing - seep at [illegible].3.

TE [illegible] [illegible]' - 7'

[illegible] [illegible] [illegible] - [illegible] ([illegible]) dry density [illegible] lb/cu.ft. US 12.1 7.5' - 8.5'

[illegible].0 10.5 Weathered dike rock [illegible] with clay skins

Bottom of hole

[illegible]

[illegible]

[illegible]

[illegible] [illegible] [illegible]

[illegible]

TP [illegible], STA. [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] sandy - [illegible]

[illegible] [illegible] [illegible], sandy - [illegible] - moist at [illegible]

[illegible] [illegible] [illegible] silt [illegible] - wet at [illegible] - [illegible] at [illegible]

[illegible] 9.[illegible] [illegible] - high [illegible]

Bottom of hole

TP 1[illegible], STA. C/L [illegible], ELEV. 7[illegible].5

0.[illegible] [illegible].0 Silt, brown - loose - [illegible] soil.

1.[illegible] 2.5 [illegible], stratified - coarse [illegible] - [illegible] - [illegible] can - [illegible] at [illegible]

2.5 [illegible] Gravel, silty - gray [illegible] wet - water bearing - [illegible]

[illegible] [illegible] [illegible], coarse grain, clean [illegible] poorly graded - water [illegible]

[illegible] [illegible] Sand, silty - [illegible] fair [illegible] - [illegible]

[illegible] [illegible] [illegible]

Bottom of hole

A[illegible] [illegible]

[illegible] [illegible] [illegible], silty - [illegible] micaceous - roots - [illegible]

[illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] - stiff - [illegible]

[illegible] [illegible] [illegible], gravel [illegible] [illegible] refusal [illegible]

Bottom of hole

T[illegible] [illegible]

[illegible] [illegible] [illegible] leaves & roots - topsoil.

[illegible] [illegible] [illegible] - red - moist - [illegible] - residual - [illegible]

[illegible] [illegible] [illegible], silty - [illegible]

[illegible] [illegible] [illegible] - stiff - [illegible]

[illegible] 1[illegible] Silt, sandy - [illegible] stiff - moist - [illegible]

Bottom of hole

TP 1[illegible], STA. [illegible]

[illegible] 0.6 Silt, fine, sandy - dark brown loose - topsoil.

[illegible] [illegible] Clay, silty - red - moist - [illegible] p.p. [illegible] - residual - some [illegible]

[illegible] 1[illegible].1 [illegible]' - [illegible]'

[illegible] 7.1 [illegible], clayey - [illegible] hard - p.p. 1.6 - residual - [illegible]

TE 1[illegible].2 [illegible]' - 7'

7.1 [illegible] Sand, silty - brown [illegible] p.p. 2.[illegible] - high mica - [illegible]

[illegible] 7.1' - [illegible]'

Bottom of hole

"AS BUILT"

DAMAC 4 WEST FORK
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY, VIRGINIA
LOGS OF TEST HOLES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 6

VA 484

[illegible]

Bottom of hole

[illegible]

Sandy silt [illegible]

[illegible] firm [illegible]

Bottom of hole

[illegible]

[illegible] stiff [illegible]

[illegible] stiff.

Bottom of hole

[illegible] *

[illegible] *

[illegible]

[illegible] stiff [illegible]

[illegible] 7.6 [illegible]

[illegible]

[illegible] water bear[illegible]

[illegible]

[illegible]

Borrow area [illegible]
Centerline of [illegible]
[illegible]
Cut [illegible]
Foundation [illegible]

GW [illegible] gravels, gravel-sand mixtures
GP [illegible] gravels
GM Silty gravels, gravel-sand-silt mixtures
GC Clayey gravels, gravel-sand-clay mixtures
SW Well graded sands, gravelly sands [illegible]
SP [illegible] sands
SM Silty sands, sand-silt mixtures
SC [illegible] sand-clay mixtures
ML [illegible] very fine sand, [illegible]
CL [illegible] low plasticity, [illegible] gravelly clays
CH [illegible] plasticity, fat clays
MH [illegible] silts
OL Organic silts and organic silty clays of low plasticity
OH Organic clays [illegible] silts of medium to high plasticity

US Undisturbed
PP Pocket penetrometer [illegible] expressed in tons per sq. ft.

All soil and rock descriptions and classifications were determined by visual examination June 17 - 2[illegible], 19[illegible].

BEDROCK SYMBOLS

GR GRANITE

* UNIFIED SOIL CLASSIFICATION SYMBOLS BY LABORATORY AND FIELD ARE AS FOLLOWS

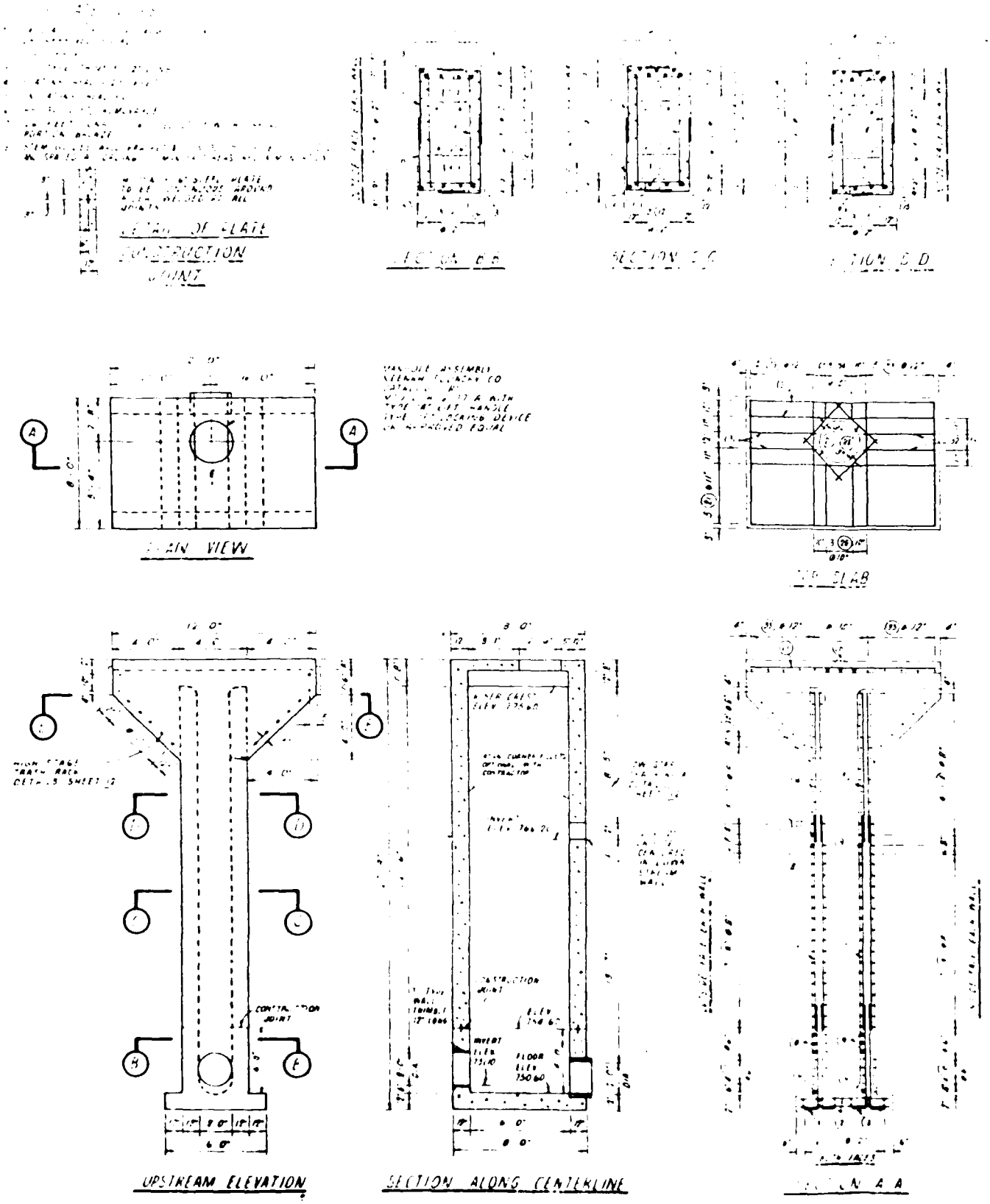
TEST PIT	DEPTH		CLASSIFICATION	
	FROM	TO	FIELD	LAB
TP 20[illegible]	[illegible]	11.7	SM	SM
TP [illegible]	[illegible]	3.0	CL	ML
TP [illegible]	3.0	5.0	SM	ML
TP [illegible]	[illegible]	2.4	CL	[illegible]
TP [illegible]	2.4	7.0	ML	ML, MH
TP [illegible]	[illegible]	9.8	SM	ML

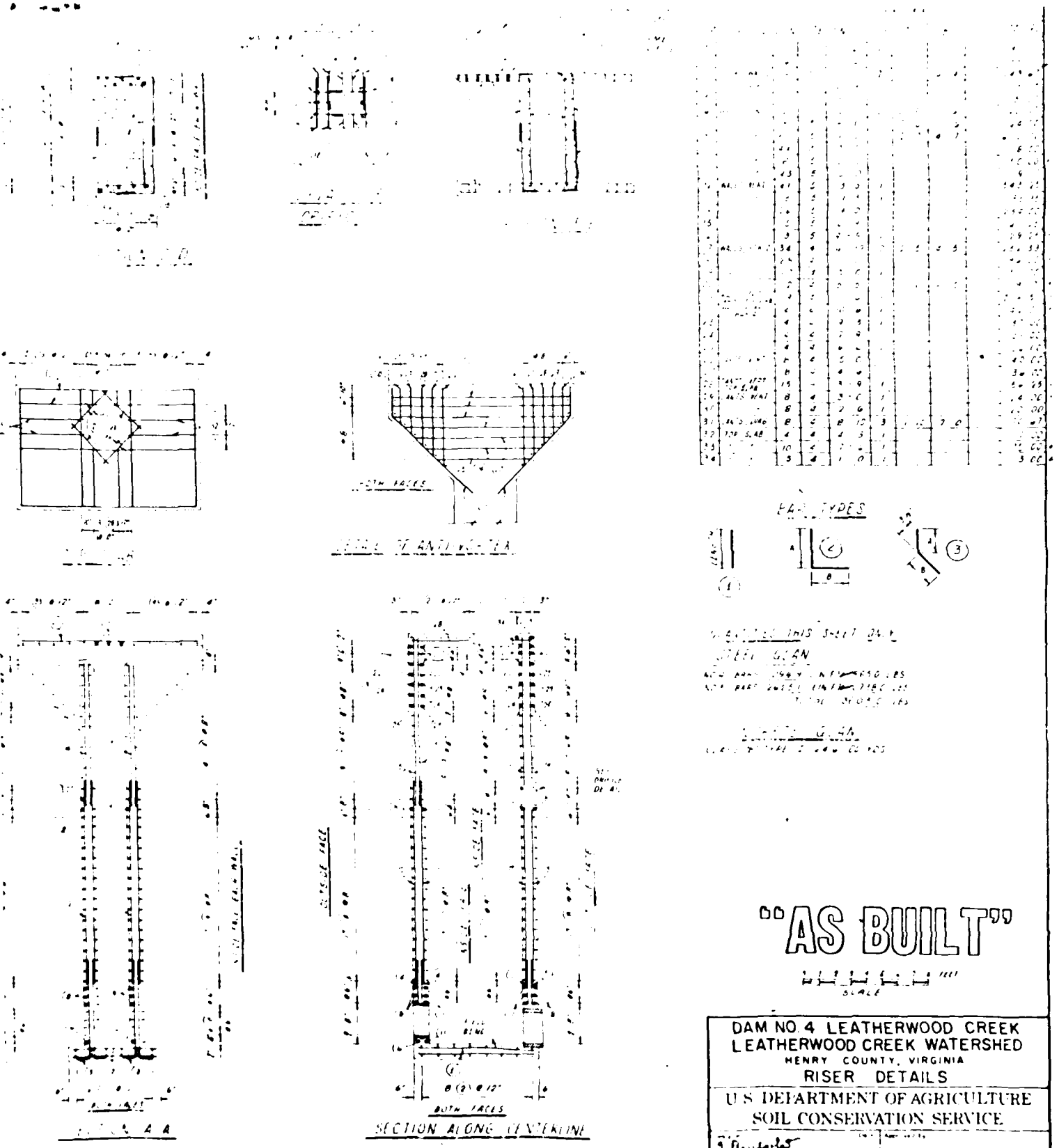
"AS BUILT"

DAM NO 4 WEST FORK
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY VIRGINIA
LOGS OF TEST HOLES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 7
VA 484


CONSTRUCTION JOINT
SECTION B-B
SECTION C-C
SECTION D-D
MAIN VIEW
TOP SLAB
UPSTREAM ELEVATION
SECTION ALONG CENTERLINE
SECTION A-A
CONSTRUCTION JOINT
FLOOR ELEV 750.60



DAM NO. 4 LEATHERWOOD CREEK
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY, VIRGINIA
RISER DETAILS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

C B FORD

PLATE 3

VA - 484-P

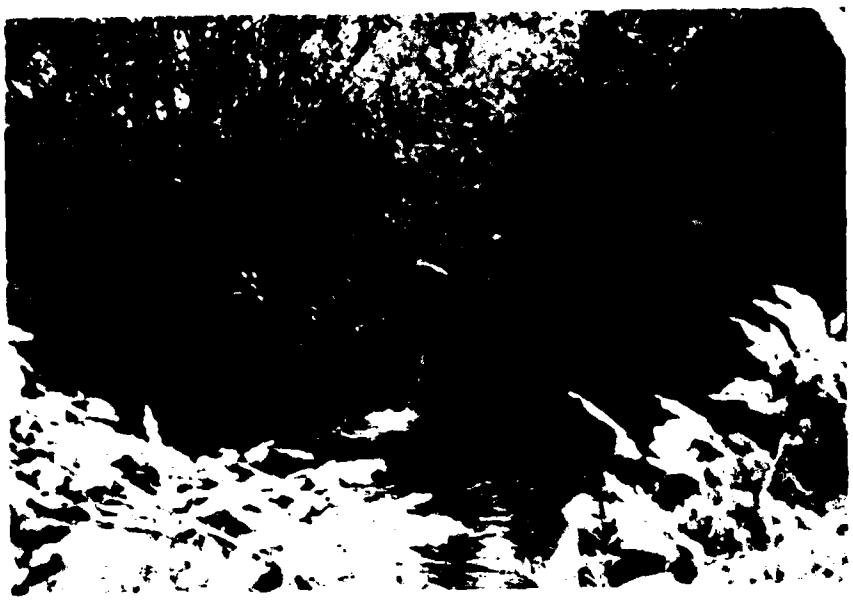
APPENDIX II

PHOTOGRAPHS

Photograph No. 1 - Upstream Slope

Photograph No. 2 - Downstream Slope

Photograph No. 3 - Intake Structure



Photograph No. 4 - Outlet Pipe and Plunge Pool

Photograph No. 5 - Emergency Spillway

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Leatherwood No. 4 County Henry State Virginia Coordinates Lat 36°-44.5' Long 79°-45.7'

Date(s) Inspection July 1, 1981 Weather Cloudy Temperature 78°F

Pool Elevation at Time of Inspection 766.5 msl Tailwater at Time of Inspection 747 msl

Inspection Personnel:

Schnabel Engineering Associates, P.C.
James J. Seli
Stephen G. Werner
Raymond A. DeStephen, P.E.*

J. K. Timmons & Associates
Robert G. Roop, P.E.
Steve Oddi

State Water Control Board
Leon Musselwhite

Werner/Oddi - Recorders

* Not present during the inspection but visited the site on August 17, 1981.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The embankment was heavily vegetated making observation difficult. Scattered shrinkage cracks were noted along the crest. Some were up to 1 inch wide, but no differential movement was noted. Ground conditions were dry at the time of the inspection.	The vegetation should be controlled.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements were noted on the dam or beyond the downstream toe.	-
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing was noted, however, the embankment was densely vegetated making observation difficult. An erosional notch several ft wide and several ft deep occurs along the lower 10 ft± of the left downstream slope left abutment contact. This notch becomes 3 - 4 ft± deep at the downstream toe. Another erosional notch several ft wide and several ft deep occurs along the right downstream toe at the right abutment contact.	These areas should be back-filled and seeded.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	The vertical and horizontal alignment of the dam appeared to be good. Field measurements indicate the crest is 14 ft wide. The embankment slopes are 2.5H:1V and a 10 ft± wide berm occurs at pool level on the upstream slope.	-
RIPRAP FAILURES	There was no riprap on the upstream slope. Riprap blocks 1 to 3 ft± in length line the plunge pool. The riprap appears to be functioning properly and is in good condition.	-

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Both ends of the embankment tie in properly with the abutments. The contacts were densely vegetated making observation difficult. The lower reaches of the embankment-abutment contacts on the downstream slope have experienced some erosion. (Described on preceeding page).	-
ANY NOTICEABLE SEEPAGE	No seepage was encountered. The downstream toe is dry. Iron staining and a wet or saturated area occur 7 ft± upstream of the discharge outlet and 6 inches right of the pipe cradle. Coarse riprap blankets the downstream slope along the plunge pool to 3 ft± above the discharge pipe.	The outlets should be uncovered.
DRAINS	The iron staining and saturated conditions are believed to be caused by flow from one or two 8 inch toe drains, which are apparently covered. No toe drains were observed, however, as built drawings show 8 inch diameter toe drains located 3.5 ft to the left and right of the discharge outlet.	-
MATERIALS	Embankment soils consist of light gray to brown silt, trace to some fine to coarse sand, with gravel and mica (ML)	-
VEGETATION	Very dense vegetation present on the embankment. Consists of 3 to 5 ft± high briers, brush and weeds. Too dense to effectively observe the embankment. Scattered dried, cut cedars and pines lay on the embankment where they were cut. They are generally less than 2 inches in diameter.	

[illegible] SUMMARY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONTROL SECTIONS	Concrete riser type structure with low level orifice and high level weir. Includes a trash rack.	In good condition.
APPROACH CHANNEL	None	-
DISCHARGE CHANNEL	24 inch cylinder pipe 15 ft above plunge pool. Riprap lining the plunge pool is intact.	Good condition.
BRIDGE AND PIERS	-	-
EMERGENCY GATE	-	-
GATES AND OPERATION	According to the owner the existing gate and wheel stem have never been in use.	-

[illegible] SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL STRUCTURES	120 [illegible] wide. [illegible] vegetative cover.	In good condition. Vegetation needs mowing.
APPROACH CHANNEL	No defects. Heavy vegetation.	Good condition. Needs mowing.
DISCHARGE CHANNEL	No defects. Heavy vegetation.	Good condition. Needs mowing.
BRIDGE AND PIERS	-	-
MISCELLANEOUS	-	-

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	-
OBSERVATION WELLS	None	-
WEIRS	None	-
PIEZOMETERS	None	-
STAFFGAGES	None	Should be installed.
OTHER	-	-

VISUAL EXAMINATION	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SLOPES	The left side of the reservoir is densely wooded to the edge of the lake. The right side includes trees to pool level, but is more open. The upper right end is pasture. Moderate (3H:1V) slopes bound the reservoir. Side slopes are 4H:1V± and heavily wooded. The shoreline appears to be stable and was free of debris.	-
SEDIMENTATION	Murky water. Approximately 2 - 3 ft of sediment buildup at the upper reaches of the lake according to the owner. Sediment buildup observed during the inspection.	-

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel is 20 ft wide and 6 ft high. It is completely overgrown with thick underbrush and heavy woods. The flood plain is 100 ft± wide and covered with thick woods and underbrush.	n = 0.06 n = 0.1 n = 0.1
SLOPES	Steep side slopes.	-
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 2 miles downstream there is a dwelling 15 ft± above the stream channel. Approximately 5 miles downstream there are several dwellings 10 ft above the channel and several commercial facilities 15 ft± above the channel.	-

[illegible] LIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, OPERATION

ITEM		REMARKS
REGIONAL VICINITY MAP	Martinsville East, Quadrangle topographic map (U.S.G.S.)	-
DESIGN/CONSTRUCTION HISTORY	Designed by USDA, SCS. Constructed by Larramore Construction Company and completed in 1964.	-
PLAN OF DAM	See Appendix I	-
TYPICAL SECTIONS OF DAM	See Appendix I	-
OUTLETS - PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	See Appendix I	-
SPILLWAY- PLAN SECTION DETAILS	See Appendix I	-
OPERATING EQUIPMENT - PLAN DETAILS	See Appendix I	-

ITEM		REMARKS
MONITORING SYSTEMS	None	-
RAINFALL/RESERVOIR HIGHPOOL RECORDS	The owner has noted water over the intake structure on several occasions. Highest water was in the Spring of 1977.	Highwater mark 4 ft. above the intake structure.
GEOLOGY REPORTS	See Appendix II and References 3, Appendix VI	-
BORROW SOURCES	See Appendix I	-
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY-FIELD TEST DATA	See Appendix I	-
HYDROLOGIC/HYDRAULIC DATA	Design data available at USDA, SCS office in Richmond, Virginia	-

ITEM		REMARKS
DESIGN REPORTS	Summary included as Appendix IV. Complete design report available at USDA, SCS office in Richmond, Virginia.	-
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Available at USDA, SCS office in Richmond, Virginia.	-
POST CONSTRUCTION ENGINEERING STUDIES RECORDS, SURVEYS	As built drawings included in Appendix I.	-
MODIFICATIONS	None	-
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None	-
MAINTENANCE OPERATION RECORDS	None	-

APPENDIX IV

DESIGN REPORT

This floodwater retarding structure is located [illegible] of the West Fork of Beaverdam Creek [illegible] Martinsville, Virginia. [illegible] Virginia-[illegible] by the U. S. Geological Survey, [illegible] structure.

A summary of pertinent design information is given on sheet [illegible] of this report.

Criteria and procedures used in this design are given in the following Soil Conservation Service publications:

- National Engineering Memorandum No. [illegible], Limiting Criteria for the Design of Earth Dams
- National Engineering Memorandum No. [illegible], Reinforced Concrete Pipe Drop Inlet Barrels
- National Engineering Handbook No. 4, Hydrology, Supplement A, "The Hydrology Guide"
- National Engineering Handbook No. 5, Hydraulics, and No. 8, Geology
- National Engineering Handbook No. [illegible], Structural Design
- Engineering Division Technical Release No. [illegible], Earth Spillways
- Engineering Division Technical Release No. 5, Structural Design of Underground Conduits
- Engineering Division Technical Release No. 1[illegible], Storage-Floodwater Retarding Structures
- Engineering Division Technical Release No. 1[illegible], Procedure for Computing Sediment Requirements for Retarding Reservoirs

[illegible] is one of five flood retention structures designed to reduce flooding in the Leatherwood Valley. It will retard a 5[illegible]-year frequency storm without [illegible] flowing in the emergency spillway.

[illegible] hydraulic computations are given on sheet [illegible].

The structure consists of a compacted earth fill with a cutoff extending through silty clay, sand and gravel to bedrock below the permanent water elevation. A drainage system is located under the downstream portion of the earth fill to collect seepage.

The principal spillway is a drop inlet structure consisting of a reinforced concrete riser, [illegible]-inch diameter concrete water pipe and a riprapped stilling basin to dissipate energy at the outlet end of the conduit.

The emergency spillway is excavated into earth and rock in the left abutment of the dam.

Copies of reports concerning geologic conditions and soil engineering tests are included in the design folder.

U. S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

[illegible] REPORT STUDY

I. Watershed data

A.	Structure class	(a)	
B.	Drainage area	1,[illegible]	Ac.
C.	Time of concentration - T_c	[illegible]	Hrs.
D.	Hydrologic curve number - C_n		
	1. Moisture condition II	7[illegible]	
	2. Moisture condition III	8[illegible]	

II. Principal spillway

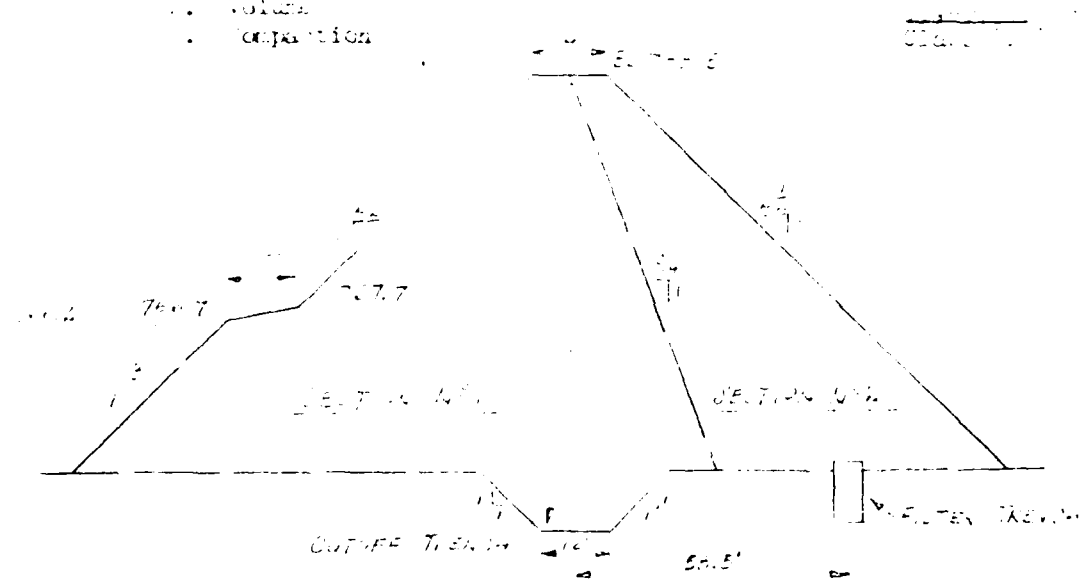
A.	Conduit		
	1. Size (I.D.)	24	In.
	2. Length	2[illegible]	Ft.
B.	Riser		
	1. Size	2[illegible]	Ft.
	2. Height	25	Ft.
C.	Weir length	12	Ft.
D.	Orifice size	1[illegible]	In.
E.	Pond drain size	24	In.
F.	Type of energy discipator	Riprap stilling basin	

III. Emergency spillway

A.	Width	100	Ft.
B.	Side slopes	2:1	
C.	Length of level section	[illegible]	Ft.
D.	Exit slope	0.[illegible]	Ft/Ft.
E.	Maximum velocity at control section (E.H.W.)	5.[illegible]	Ft/Sec.
F.	Duration of flow (E.H.W.) through emergency spillway	[illegible]	Hrs.
G.	Frequency of use	once in 5 years	

IV. Earth fill

A.	Height	[illegible]	Ft.
B.	Volume	[illegible]	C.Y.
C.	Compaction	[illegible]	



Typical Cross Section

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

U. S. DEPARTMENT OF AGRICULTURE – SOIL CONSERVATION SERVICE

Element of Structure	Determining Factor	Elevation	Surface Area Acres	Storage		Inflow		Peak Outflow c.f.s.
				Acre-Feet	Inches*	Volume Inches*	Rate c.f.s.	
Invert of orifice	50-year sediment accumulation	[illegible]	9.1	6.1 1/	-	-	-	-
Crest of riser	1[illegible]	[illegible] 2/	13.5	1[illegible] 2/	1.00	-	-	17
Crest of emergency spillway	50-year frequency storm, moisture condition II	[illegible] 3/	11.7	[illegible].5 3/	2.40	-	-	[illegible]
Design high water	1.0 X 6-hour point rainfall, moisture condition II	[illegible]	[illegible]	79 3/	2.37	4.53	9.1	[illegible]
Top of dam	1.0 X 6-hour point rainfall, moisture condition II	[illegible].5	28.9	55.0 3/	3.37	9.37	2425	[illegible]

*Inches of runoff from controlled area of [illegible] acres.
Time required to empty flood storage is [illegible] days.

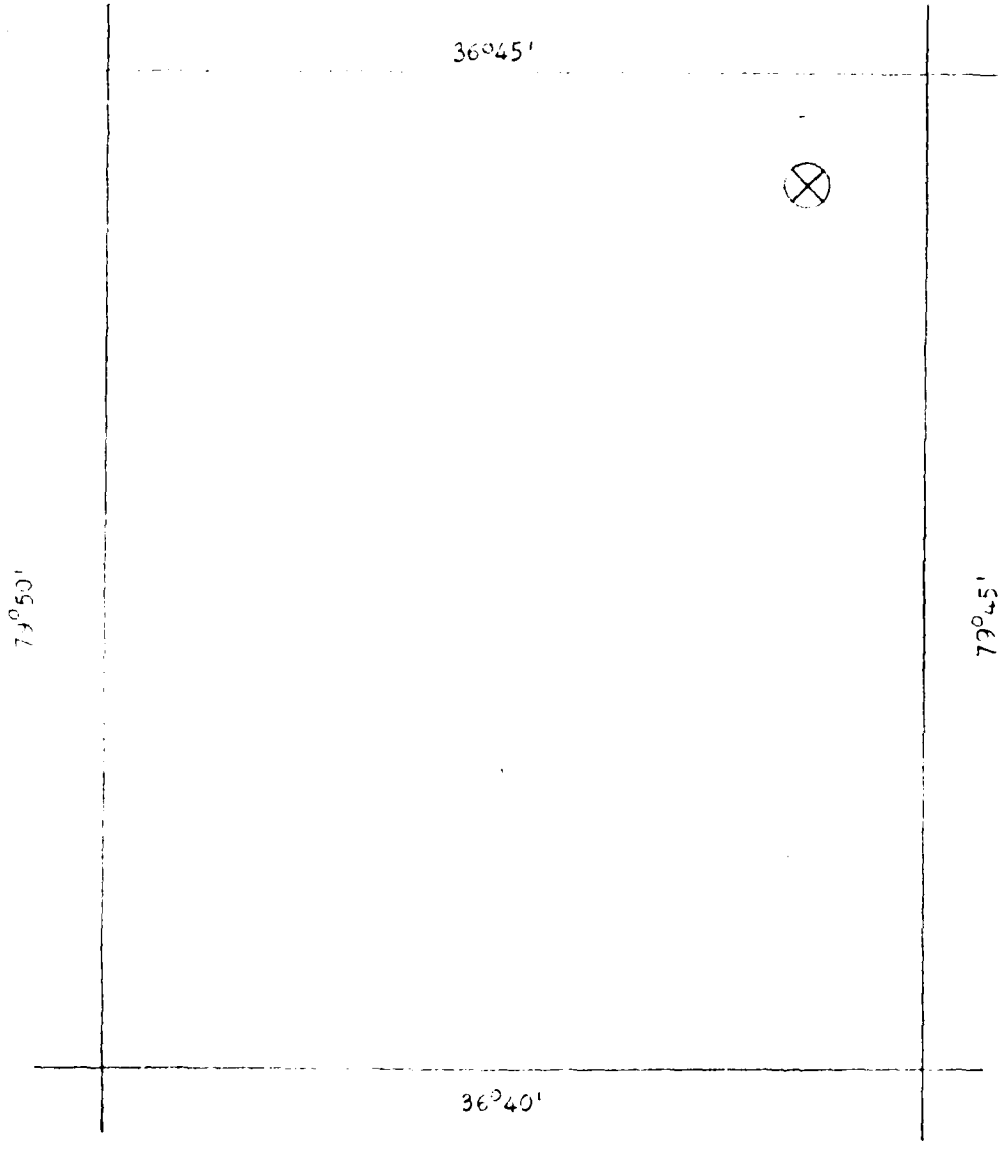
1/ Does not include 5 acre-feet of sediment allocated to flood pool.
2/ Does not include storage allocated to sediment.
3/ Established by procedure described in technical release No. 10.

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet 3

U S DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

LEATHERWOOD CREEK
WATERSHED PROTECTION PROJECT
DAM NO. 4
HENRY COUNTY, VIRGINIA



ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet 4

U.S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

Copies of the publications referred to in this report may be obtained from Mr. [illegible], State Conservationist, USDA, Soil Conservation Service, Bluefield, Virginia.

Concurred:

Gerald E. Oman
Design Engineer

R. C. Farmer, Jr.
State Conservation Engineer

Vincent McCarver
Hydrologist

Robert F. Fenner
Geologist

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet 5.

Form SCS-347
Sheet 1 of 8

10-59

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Virginia County Henry ¼ ¼ Sec. T. R. Watershed Leatherwood Creek

Subwatershed West Fork Fund class FP 08 (FP, WF, I, etc.) Site number 4 Site group I Structure class a

Investigated by Mack, T., Geologist (Name and title) Equipment used Case 760 backhoe (Type, size, make, model, etc.) Date June 1963

SITE DATA

Drainage area size 1.95 sq. mi. 1248 acres Type of structure Earth fill Purpose Flood Prevention

Direction (valley terrain, windward) SW Maximum height of fill 40.4 feet. Length of fill 380 feet

Estimated volume of compacted fill required 32,194 cubic yards

STORAGE ALLOCATION

	Volume (acre-feet)	Surface Area (acres)	Depth at Dam (feet)
Sediment	73	8.3	18
Floodwater	387	26.5	39.4

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Piedmont province Topography rolling Attitude of beds Dip none Strike none

Steepest abutment slope 30 percent Right 25 percent Width of floodplain at centerline of dam 25 feet

General geologic notes The site is underlain by the Leatherwood granite formation. The age of this formation is probably Paleozoic. In this locality the Leatherwood formation has three rock types present. One is a syenite which has the same mineral composition as a granite with the exception of quartz. The local syenite contains white orthoclase feldspar and black biotite mica. In another rock type the biotite content has increased to the point that the rock has a gneissic structure. This is called an orthogneiss to show that it is still an igneous rock. The content of biotite ranges up to 40 per cent. It gives this rock a black color. Towards the northwest the syenite becomes a diorite or monzonite. Here the feldspar tends to be plagioclase instead of orthoclase. As these three facies of the Leatherwood formation have the same strength, their various locations do not influence the foundation conditions of the dam. But the diorite weathers to a Lloyd soil, and the syenite and biotite gneiss weather to a Cecil soil.

Also present under the recent stream alluvium is an amphibolite dike. This dike rock has hornblende as its major mineral with a minor amount of plagioclase feldspar. The rock is black and has no direction in the orientation of the hornblende crystals.

VA 484 0

It tends to weather more deeply than the high biotite syenite that surrounds it. However, it is just hard as the syenite with equal bearing strength.

The west fork of Leatherwood Creek flows through a narrow valley at the dam site. Several large outcrops of biotite syenite and amphibolite are present in the stream channel in the foundation area. The stream flows in shallow banks that range from 2 to 3 feet below the flood plain. The stream is degrading. Traces of former meanders are present. The stream and its tributaries flow in a strongly entrenched dendritic pattern. The tops of the hills are generally flat. This shows this presence of former peneplaination. The topography has reached early maturity.

Centerline of Dam-

Bedrock underlies the right abutment at a uniform depth of 15 feet. This depth to bedrock also holds uniform to the stream channel on this side. In the left abutment the bedrock is closer to the surface. It ranges from 3 to 6 feet of the surface. Above the bedrock is a layer of tightly cemented syenite boulders that range from 1 to 3 feet below the ground surface. This layer is tight and can be penetrated only with difficulty with the backhoe. A thin dike of amphibolite crosses the dam centerline at right angles. It occurs from station 1 + 60 to station 2 + 12. The left abutment is underlain by black high biotite mica syenite. The right abutment is underlain by gray syenite.

The recent sediments in the dam centerline are extremely complex as can be seen from the profile. Generally they are characterized by recent reddish brown oxidized silt alluvium to a depth of 5 feet. Below this is a layer of steel blue clayey sand. Below this is a layer of either yellow red or gray sand. A firmer layer of slightly weathered amphibolite or a buried yellowish silt is encountered before bedrock is reached. A typical buried stream channel crosses the dam centerline between station 1 + 60 to 1 + 90.

Foundation-

The foundation contains a slightly irregular rockline. Along the stream rock outcrops are present. Downstream from the proposed riser location no rock was encountered to a depth of 1[illegible] feet. The flood plain under the dam contains a gray clay and sand layer. It has low pocket penetrometer readings that range from .3 to .5 tons per square foot. This layer is the remains of an old swamp and stream channel. It occurs approximately 3 feet below ground surface. It ranges in thickness from 2.5 to 3.5 feet. This layer is bordered above by an oxidized layer that has higher pocket penetrometer readings. It is underlain by a gravel layer and a hard weathered layer that also has higher pocket penetrometer readings. This gray reduced generally unstable layer covers most of the upstream toe of the dam. Downstream it occurs only in small area in the flood plain on the right side of the stream.

A rock ledge dropping off 5 feet was found on the right abutment at the toe drain. Another rock ledge was found on the left abutment at the dam centerline. This ledge drops off 3 feet.

Principal Spillway

Six test pits were dug along the proposed conduit centerline. Firm bedrock was encountered downstream from the centerline of the dam in all test pits. At 3+15 on the conduit centerline hard cemented amphibolite boulders occur at 7 feet below the ground surface. An outcrop of biotite gneiss occurs 10 feet left of station 4+20 on the pipe centerline.

Upstream from the centerline of the dam on the conduit centerline no hard bedrock was encountered in the 2 test pits dug. But firm gray saprolite was found here. This material is weathered in place from either amphibolite or biotite gneiss. At station 2+15 it is 6 feet below the ground surface. At station 1+[illegible] it is [illegible] feet below the ground surface.

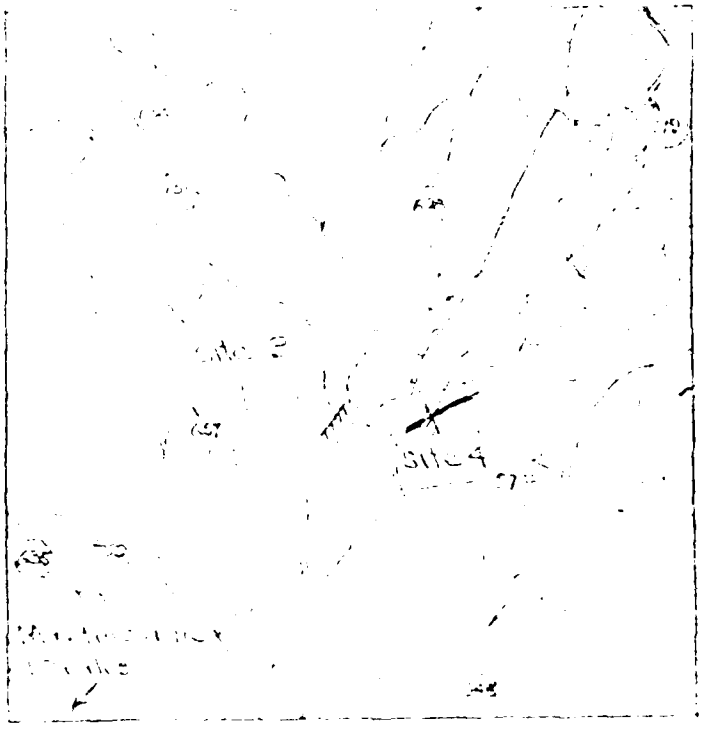
Emergency Spillway

Test pits in the emergency spillway showed two rock spines to be present. The larger of these follows the right side of control section to 25 feet left of the emergency spillway centerline. Here it passes below grade. The smaller spine is located between station 2+90 and 3+30 on the spillway centerline at right angles to this line. To bring the emergency spillway to grade will require approximately 10[illegible] cubic yards of rock excavation.

The soil present in the emergency spillway is Cecil soil. It has a high clay content in the B horizon. The C horizon is micaceous and contains grains of weathered feldspar.

Borrow Area

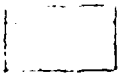
Two soil types are present in borrow area. The Lloyd soil occurs closest to the dam site on the upstream slope of the right abutment. It is a red soil with a deep red clay B horizon. The C horizon is, however, micaceous. Cecil soil occurs in the borrow area [illegible] feet upstream from the dam site. It has a shallower B horizon than Lloyd soil. It is of a lighter reddish color and is more micaceous. In this area it has a lower clay content than the Lloyd soil.



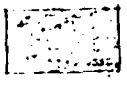
Metamorphic granite and gneiss with [illegible]

[illegible] granite with orthogneiss structure (boundary surface)

Metamorphic granite with staurolite [illegible]



Amphibolite dike



GEOLOGIC MAP OF THE AREA SURROUNDING SITE NO. 4
LEATHERWOOD CLUB A/S, HENRY COUNTY, VIRGINIA

VA 484 9

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SAMPLE LIST
SOIL AND FOUNDATION INVESTIGATIONS

Location Henry County, Virginia Owner

Watershed Leatherwood Creek Sub-watershed West Fork Site No. 4

Submitted by Mack, T. Date June 19 63

Sent by Truck (carrier) Government B/L No.

Lab. No.	Field Sample No.	Sample Description: Location	Sample Description: Grid or Station	Depth: From	Depth: To	Type of Sample: Undist.	Type of Sample: Dist.
		LARGE					
	103.1	Borrow Area	137' L. E A 8+15	1.0	2.4		x
	103.2	"	Ditto	2.4	7.0		x
	103.3	"	"	7.1	9.8		x
	213.1	E. Spillway	-(0+83) C/L Dam	1.0	3.0		x
	213.2		Ditto	3.0	5.0		x
	201.1		12' R. C/L Dam -(1+50)	6.2	11.0		x
		SMALL					
	~~3.2~~	~~C/L Dam~~	~~C/L Dam 2+00~~	~~7.5~~	~~9.0~~		x
	~~3.1~~	~~Ditto~~	~~Ditto~~	~~1.0~~	~~7.0~~		x
	5.1	"	C/L Dam 2+90	2.0	4.0		x
	5.2	"	Ditto	5.0	10.0		x
	11.1	"	C/L Dam 1+60	7.0	10.0		x
	12.1	"	C/L Dam 1+50	1.0	3.5		x
	12.2	"	Ditto	3.5	5.2		x
	12.3	"	"	6.0	7.0		x
	12.4	"	"	7.5	8.5		x
	715.1	Foundation Area	40' R. C/L Pipe 1+75	6.1	7.5		x
	715.2	Ditto	Ditto	8.4	10.8		x
	716.1	"	10' L. C/L Pipe (4+05)	1.0	2.0		x

Original to Soils Laboratory
Copy to E and WP Unit
Distribute other copies as directed by State Conservationist

VA-484 G

Sheet 6 of 6 Sheets

Methods and Remarks

1. Pocket penetrometer readings were taken and recorded in the test pit logs. The abbreviation PP stands for pocket penetrometer. The readings are in tons per square foot. The moisture of the layer has to be taken into account in estimating the bearing strength. When a material is wet it has much less bearing strength than when it is dry.

2. The small samples are not correlated to the test pits in the correlation chart. This is due to the complexity of the alluvial soils. But these samples are correlated to the different layers in the cross sections.

3. Soils that will be present in the construction material are classified for easier correlation. Standard description of these soils are included.

4. In the logs the underlying rock is referred to as a granite or dike rock. This is for simplification into easily understandable terms. Actually the "granite" is a syenite or a monzonite. The name syenite refers to a rock having orthoclase feldspar and mica as the major minerals. It contains no quartz. The monzonite means that some of the feldspar is plagioclase. When the plagioclase feldspar becomes dominant, the rock is a diorite.

Amphibolite is the name for the rock referred to as "dike rock" in the logs of the test pits. This means that the rock has a high content of amphibole, which in this case is hornblende. Plagioclase feldspar is present in minor amounts. The rock is metamorphic.

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USDA SCS

10-69

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Virginia County Henry Watershed Leatherwood Creek Subwatershed West Fork

Site number 4 Site group I Structure class [illegible] Investigated by Mack, T., geologist (signature and title) Date June 1963

INTERPRETATIONS AND CONCLUSIONS

1. Foundation conditions for the proposed conduit are as adequate as any. But some rock excavation will have to be made at station 3 + 25. To avoid this the pipe can be moved four feet towards the left abutment. Or it can be angled 10 degrees to the right upstream using the centerline of the dam as a pivot point. This latter alternative will give the riser a more stable foundation. Test pit 715 shows a stable foundation at 8.5 feet below ground surface.

2. A cutoff trench needs to be installed. Excavation should be made one foot into bedrock. In the flood plain area it is approximately 10.5 feet below the ground surface.

3. The design of the dam should take into consideration the 3 foot thick layer of gray reduced unstable material between oxidized alluvial soil and weathered bedrocks. The low pocket penatrometer readings show that this material has low bearing strength. But removal may not be practical. Design of the dam however should be adapted to the situation.

4. The borrow should be taken from the part of the borrow area closest to the dam. This will make use of the deep red clayey soils. If the borrow area is to be extended, it should be extended uphill near the dam. The Lloyd soils with a deep B horizon extend into this area. Obtaining borrow material from the floodplain is to be discouraged for here mottled wet to moist soil is within 3 to 4 feet of the ground surface. Borrow material taken from the left abutment will involve transportation problems. For this borrow will have to be taken across two creeks and a low floodplain.

5. A toe drain needs to be installed to intercept seepage through the dam. Use can be made of the rock excavated from the emergency spillway and the gravel in the stream channel (sample 716-1)

6. The low rock ledges occuring where both abutments join the floodplain should be sloped. Here the more plastic fill material should be placed. This is to account for settling in the foundation.

R.A. Burns Jr.

VA-484 G

APPENDIX V

STABILITY DATA

UNITED STATES GOVERNMENT

Memorandum

TO : R. C. Barnes, State Conservation Engineer, SCS, Richmond, Virginia

DATE: September 26,

FROM : Rey S. Decker, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska 68508

SUBJECT: Virginia WP-08, Leatherwood Creek Watershed, Site No. 4 - Supple Report

The original report referred to a permeability test on Sample 64W-15 which was in progress when the report was completed. This test is now completed.

The test was performed on material remolded to approximate what was thought to be the in-place density of the material, 81.7 p.c.f. The test specimen was molded to [illegible] p.c.f., and it rebounded to a density of [illegible].7 p.c.f. due to its mineralogical nature. The permeability test was allowed to run a total of [illegible] hours of testing time. Initially the sample had a permeability rate of 0.2 feet per day, but this value decreased as the test progressed. This decrease was probably due to particle rearrangement taking place. During the last 72 hours of testing, the permeability rate leveled off at approximately 0.1 ft./d.

The 64W-15 was [illegible] because its gradation indicated that it [illegible] the least permeable of the [illegible]'s sampled. Its rate of permeability [illegible] would be quite slow [illegible] substantial consolidation and strength [illegible] with further structures since drainage paths are short. Therefore, it is believed that the assumptions of the original analysis are valid and that further samples and study are not needed.

Prepared by:

Thomas A. Heard

Reviewed and Approved by:

Roland B. Phillips

cc: R. C. Barnes (5)
EWP Unit, Upper Darby, Pa. (2)

UNITED STATES GOVERNMENT

Memorandum

TO : R. C. Barnes, State Conservation Engineer, SCS, Richmond, Virginia

DATE: September 16, 1973

FROM : Roy S. Decker, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska 68506

SUBJECT: Virginia WP-08, Leatherwood Creek Watershed, Site No. 4

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 3 sheets.
2. Form SCS-355, Triaxial Shear Test Data, 2 sheets.
3. Form SCS-352, Compaction and Penetration Resistance Report, 6 sheets.
4. Form SCS-353, Filter Material, 1 sheet.
5. Form SCS-357, Summary - Slope Stability Analysis, 1 sheet.
6. Form SCS-372, Recommended Use of Excavated Material, 1 sheet.
7. Investigational Plans and Profiles.

DISCUSSION

FOUNDATION MATERIALS

A. Classification: Bedrock at the site is in the Leatherwood formation [illegible] mostly of syenite. An amphibolite dike crosses the centerline between Stations 1+60 and 2+12. Bedrock ranges in depth below the surface to more than 10 feet and is moderately irregular. Recent sediments are complex, consisting of micaceous sand, silt and clay mixtures. A few feet below the surface there is the remains of an old swamp and stream channel. Below this is a gravel layer. Relatively clean sands are also present in this shallow foundation.

[illegible] from the foundation are SM (mostly non-plastic), SC-SM, [illegible] and poorly graded, clean gravel (probably GM-GP). Samples [illegible] moderately to highly micaceous.

[illegible] Moisture: Dry density measurements of 71.1 p.c.f. to 81.8 [illegible] were determined in the field for soils (SM's and ML) at [illegible].

[illegible] meter readings were determined in most of the soils [illegible], but reliable interpretation of these data for the [illegible] is difficult if not impossible.

[illegible] It is believed that the residual soils present are [illegible] compressible, and that highly compressible alluvial [illegible] problems since they are rather thin. It is [illegible] than 0.75 foot of consolidation will be realized

under the floodplain and that a large portion of this will be during construction due to the free-draining nature of a majority of the soils.

D. Permeability: On the basis of grain size distributions, the permeability rates of foundation soils should be in the order of 0.01 to 10 ft./day, depending on the amount of fines in the materials. Permeability tests on cores from Site 5 substantiate this estimated range.

E. Shear Strength: Shear tests on two portions of Sample 62W3516 from Site 5 were considered in evaluating the strength of the foundation. Sample 62W3516T had a gradation similar to that of 64W415 and that of Sample 64W417. A triaxial shear test on Site 5 material gave shear parameters of $\phi = 19°$ and $c = 800$ p.s.f. The average test density was 77.3 p.c.f. (1.24 gm/cc) as compared to an in-place density of 81.5-81.8 p.c.f. believed representative for Samples 64W415 and 64W417. Sample 62W3516B from Site 5 had a gradation similar to Sample 64W414. Sample 62W3516B had a test density of 72.0 p.c.f. (1.15 gm/cc); whereas, Sample 64W414 is believed to be represented by a density of 71.1 p.c.f. The Site 5 sample had shear parameters of $\phi = 25.5°$ and $c = 100$ p.s.f. according to results of a saturated, direct shear test.

The above test results are interpreted as indicating the ability of the materials to consolidate and mobilize appreciable strength. Thus, it was concluded that the low density soils at the site will be able to mobilize adequate strengths during construction, if they are able to consolidate rapidly. Their ability to consolidate rapidly depends on their permeability.

This is being checked by means of a permeability test on Sample 64W415 remolded to approximately 81.8 p.c.f. The results of this test affect the validity of the assumptions of the stability analysis, and will be reported in a supplement to this report.

EMBANKMENT MATERIALS

A. Classification: A thousand cubic yards of rock excavation in the emergency spillway is anticipated.

The borrow materials are Cecil and Lloyd soils, which are clayey in the "B" horizon and micaceous especially in the "C" horizons. Samples from the borrow area and emergency spillway are non-plastic

3 -- R. C. Barnes -- 9/10/63
Roy S. Decker
Subj: Virginia WP-08, Leatherwood Creek Watershed, Site No. 4

SM and ML's and MH's with high liquid limits and relatively low plasticity indices. Their clay activities, the ratios of the plasticity indices to the 0.002 mm. clay contents, are generally low, attesting to their micaceous nature. The samples are sandy.

B. Compacted Dry Density: Standard compaction tests were performed on the six borrow samples submitted to the laboratory. Maximum Standard densities range from 108.0 p.c.f. for the SM's to 87.0 p.c.f. for MH.

Each of the samples was also compacted using Standard effort and soil containing natural moisture retained when the sample was received. Two of the samples had moisture contents well below optimum. Three of these tests gave densities several p.c.f. below the normal Standard curve but above 95 percent of Standard density.

C. Permeability: Most of the embankment materials appear to have high enough clay contents to limit the rate of transmission of water to moderately low values at the placement densities to be recommended.

The "B" horizon of these materials is noted to be an accumulation zone and contains a noticeably higher clay content.

Materials like the SM (Sample 64W-21) may transmit water at moderately rapid rates.

D. Fill Strength: Consolidated, undrained triaxial shear tests were performed on Samples 64W-23 (ML) and 64W-25 (ML or MH). Test specimens from Sample 64W-23 were remolded to average 93.1 percent of Standard density and had test moisture contents in excess of 91.8 percent of theoretical saturation. Test results indicate that the material has shear parameters of ϕ = 22° and 475 p.s.f. Test specimens from Sample 64W-25 were remolded to average 92.3 percent of Standard density, and had initial test moisture contents in excess of 92.2 percent of theoretical saturation. The results of this test indicate the material to have shear parameters of ϕ = 25.5° and c = 475 p.s.f.

E. Consolidation: The fill is expected to settle about 2 percent of its height (approximately 0.7 foot) between ℄ Stations 1+00 and 2+00 due to consolidation of embankment materials after construction.

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STABILITY ANALYSIS

The Form SCS-356 proposed an upstream slope design of 2 1/2:1 over 3:1 with the slope change and a 10-foot berm at 776.7. Since it appeared that a 2 1/2:1 upstream design would give an adequate safety factor and laboratory charts based on such a design were available, a 2 1/2:1 upstream slope was analyzed to verify the stability of the proposed design. The charts used are based on a modification of the Swedish Circle method and give numerically correct factors as opposed to the conservative, approximate factors given on the charts in the "Field Guide."

The analysis considered a 39.2-foot embankment. An arc through an upstream 2 1/2:1 slope like Sample 6-W-23 gave 1.43 as the safety factor against failure after rapid full drawdown. This analysis assumes that the foundation will consolidate rapidly and mobilize adequate strength to limit the potential of failure to the embankment only.

Since it was not certain that the foundation materials can drain rapidly enough to validate the above assumption, an additional arc through a 2 1/2:1 upstream slope like Sample 6-W-23 and 6 feet of foundation material replaced by material like Sample 6-W-23 was analyzed. A safety factor of 1.31 was determined.

Past experience has shown a 2 1/2:1 downstream slope without drainage to give safety factors that are higher than those determined for a 2 1/2:1 upstream slope under full drawdown. Therefore, the downstream slope was not analyzed.

RECOMMENDATIONS

A. Cutoff: The presence of clean sand and gravel deep in the foundation that would tend to render the proposed drain ineffective dictates the installation of a cutoff into bedrock. Therefore, this feature is recommended. If the rock line is much deeper than 10 feet above the normal pool elevation, limiting the cuts to about 10 feet should be satisfactory in those areas. This appears to be the case. The soils from the "B" horizon compacted to 95 percent of Standard should be used as backfill.

B. Drainage: It is not certain that the cutoff will be positive in action because of the type of bedrock present and the types of material to be used in constructing the cutoff. (The cutoff will

serve its intended purpose, however.) Because of the uncertain action of the cutoff, foundation drainage to a depth of about 6 to 7 feet is recommended below the normal pool elevation (766.2). This drain can be successfully incorporated into a rock toe drain which will serve to prevent piping of the embankment soils. It is recommended that this type of drainage be installed if the rock from the emergency spillway can be depended on for use in the drain. This will depend on the manner in which the rock breaks down during excavation and its durability. The alternative to this is to install a trench drain with a perforated pipe pickup at c = 0.6b.

In materials like those available for the embankment it is desirable to extend filter material entirely around the conduit. This is recommended in consideration of the tendency of localized piping to develop along the conduit.

An attached Form SCS-353 shows limits recommended for filter material to be placed against foundation and embankment soils, along with suggested limiting D_{15} values for a transition between the filter and rock toe materials. The recommended filter material can be used with a minimum filter thickness of 12 inches. The conclusions included with the geologic report indicated an intent of using gravel from the stream bottom represented by Sample 64W.20 (Field No. 716.1). This material is slightly finer at the D_{85} size than the recommended filter material. It may in fact have no more carrying capacity than some of the soils to be drained. A material any finer than this at the D_{85} size or containing any more minus 200 particles would almost certainly be inadequate. It seems probable that normal borrowing operations would produce a dirtier material. If it is necessary to use this material, it seems highly desirable to wash it or in some other manner remove the finer. In addition, the minimum filter thickness should be increased to 24 inches to assure adequate carrying capacity.

C. Principal Spillway: The conclusions on relocating the principal spillway included in the geologic report are concurred with. While the sands and gravels which make up part of the proposed foundation are probably not very compressible, it seems likely that they are more compressible than the bedrock. This would tend to induce stress concentrations in the conduit. Therefore, shifting to take advantage of a more uniform foundation, as recommended, seems quite desirable.

Backfill adjacent to the conduit should be some of the more plastic soils available from the "B" horizon compacted to 95 percent of Standard density.

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Rey S. Decker
Subj: Virginia WP-08, Leatherwood Creek Watershed, Site No. 4

D. Embankment Design: The following are recommended tentatively, pending the outcome of a permeability test on Sample 64W415:

1. Slopes.

Upstream - 2 1/2:1 or flatter (2 1/2:1 over 3:1 with a 10-foot berm at 776.7 is satisfactory. The flatter slope may be desirable in view of questionable strength in the foundation materials.)

Downstream - 2 1/2:1.

2. Placement of Materials. Selective placement of materials to utilize coarser soils in the downstream portion of dam and the more clayey "B" horizon soils in the upstream portion. This may possibly be accomplished by zoning borrow according to depth. Compaction of soils to 95 percent of Standard density (B-2 specifications); placement moisture contents within the ranges indicated on the Form SCS-372.

3. Overfill. Provide 1.0 foot of overfill between ℄ Stations 1+00 and 2+00 as allowance for residual consolidation of embankment and foundation materials.

If the permeability test now in progress indicates that the low density soils in the foundation will not be able to drain and mobilize strength rapidly, it will be necessary to re-analyze the stability of the slopes and verify a safe design, or to remove about 6 feet of foundation soils. An undisturbed sample of the weak materials described in the conclusions of the geologic report would be needed for additional analysis if removal were not deemed to be a satisfactory measure. It seems doubtful that this will be the case, however.

Prepared by:

Thomas A. Heard

Attachments

Reviewed and Approved by:

cc: R. C. Barnes (5)
E&WP Unit, Upper Darby, Pa. (2)

Roland B. Phillips

Sheet 1 of 1

FORM SCS-357
10-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY

SUMMARY - SLOPE STABILITY ANALYSIS

State [illegible] Project [illegible]

Date [illegible] Analysis Made By [illegible] Checked By [illegible]

Method of Analysis [illegible]

Location of Material					[illegible]		[illegible]			
Sample No.					[illegible]		[illegible]			
γ_d					82.4		82.1			
γ_m					100.0		102.5			
γ_s					116.0		112.0			
γ_b					53.5		50.5			
Condition	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.
ϕ						22°		25.5		
Tan ϕ						0.404		0.479		
K										
C						475		425		

UPSTREAM SLOPE

Trial	Slope	Conditions	Fs
1	[illegible]	[illegible]	
		[illegible]	
		[illegible]	
		[illegible]	1.[illegible]
2	[illegible]	[illegible]	
		[illegible]	
		[illegible]	
		[illegible]	
		[illegible]	[illegible]

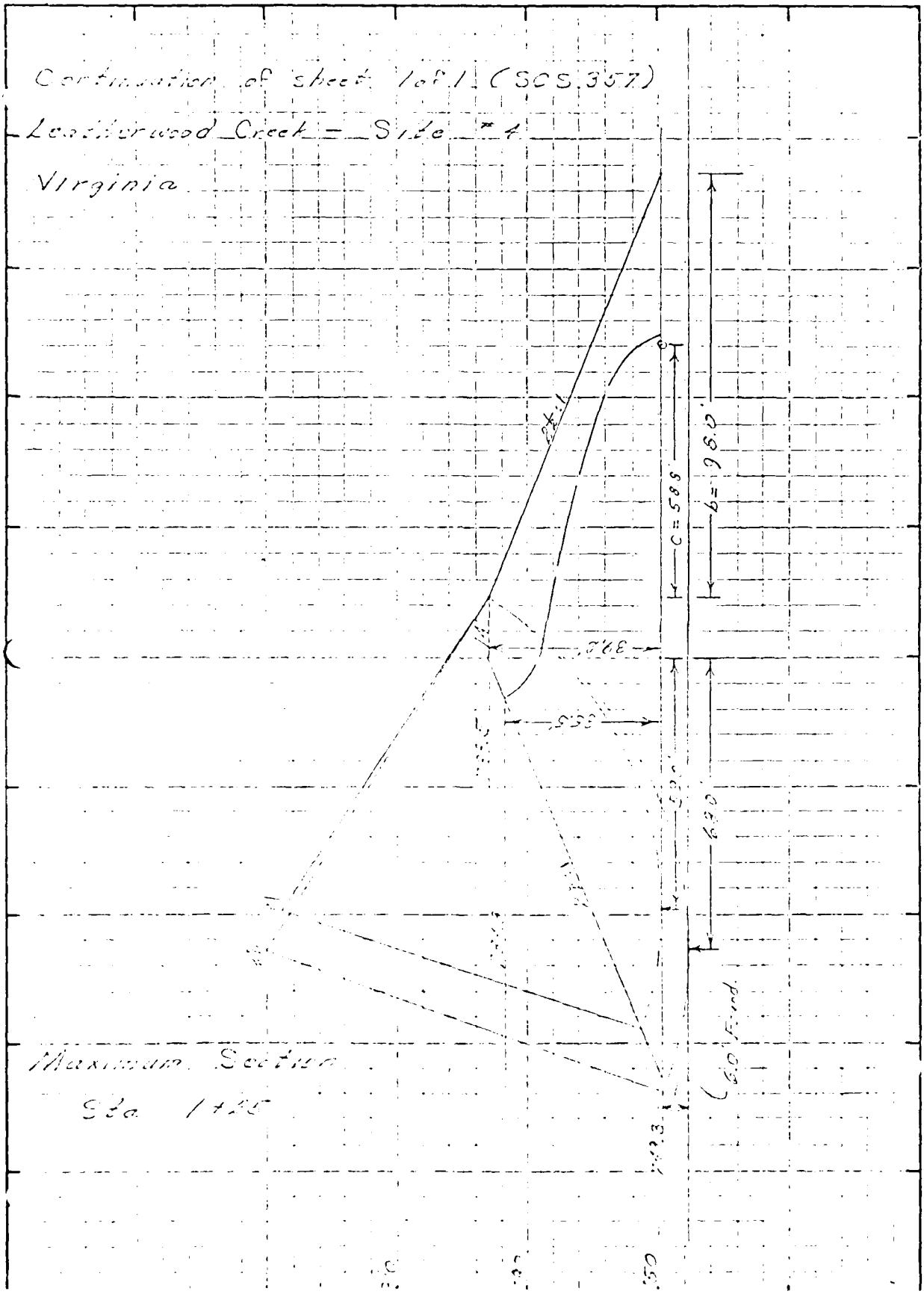
DOWNSTREAM SLOPE

Trial	Slope	Conditions	Fs

Continuation of sheet 1 of 1 (SCS 357)

Leatherwood Creek - Site #4

Virginia



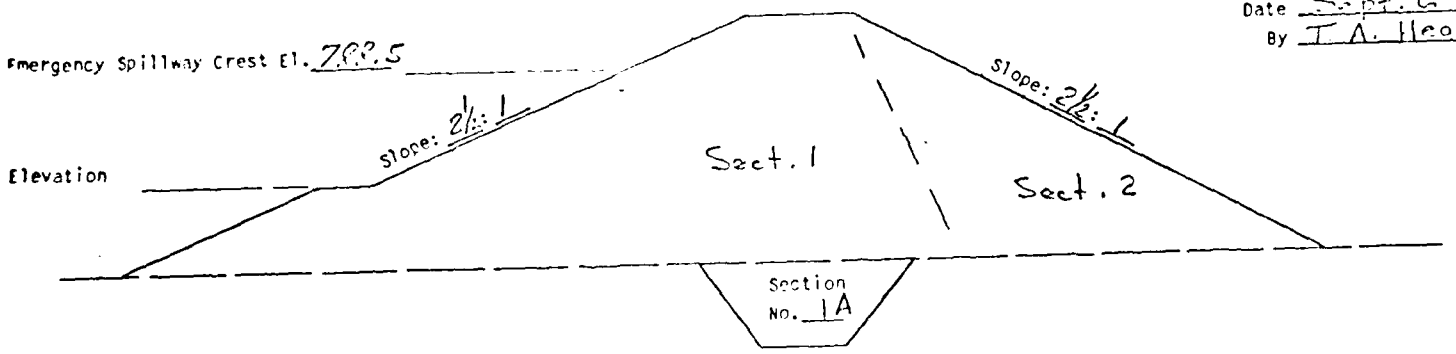
SCS-372
(3/59)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

RECOMMENDED USE OF EXCAVATED MATERIAL

☐ Formal Zoning Plan ☒ Selective Placement Plan

State Virginia
Project Leatherwood Site 4
Date Sept. 6, 1963
By T. A. Heard



TYPICAL EMBANKMENT SECTION

Embankment Section		Source of Fill Material			Lab. Sample No.	Lab Test Standard		Lab. Curve No.	Compaction Requirements Class of Fill		
			Ave. Depth						Minimum Density	Moisture Range	
Sec. No.	Description	Location	From	To	64 W	Max. Den.	Optm. Moist.		Lbs. per Cu.Ft.	Percent From	Percent To
2	Downstream	E. Spwy. 12' R. -(1+50) ℄ Dam	6.2	11.0	421	108.0	15.0	1	102.5	13.0	17.5
1	Upstream	E. Spwy. -(0+83) ℄ Dam	1.0	3.0	422	95.5	24.5	2	90.5	22.5	26.5
2	Downstream	E. Spwy. -(0+83) ℄ Dam	3.0	5.0	423	95.0	23.5	3	90.5	21.5	26.0
1	Upstream, Trenches	Borrow 137' L. ℄ A 8+15	1.0	2.4	424	87.0	33.0	4	83.0	30.5	35.5
1	Upstream, Trenches	" " " "	2.4	7.0	425	89.0	30.5	5	84.5	25.0	32.5
2	Downstream	" " " "	7.1	9.8	426	96.5	22.0	6	92.0	20.0	24.0

APPENDIX VI - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of the Chief of Engineers, 46 pp.
2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation, 1974, 816 pp.
3. Geology of the Snow Creek, Martinsville East, Price and Spray Quadrangles, Virginia by J. F. Conley and W. S. Henika, Virginia Division of Mineral Resources Reports of Investigations 33, 71 pp.
4. HEC-1 Dam Break Version, Flood Hydrograph Package, Users Manual for Dam Safety Investigations, the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Setpember, 1978.
5. Hydrometerological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D. C., April, 1956.
6. Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau, Washington, D. C., May, 1961.

END

DATE
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