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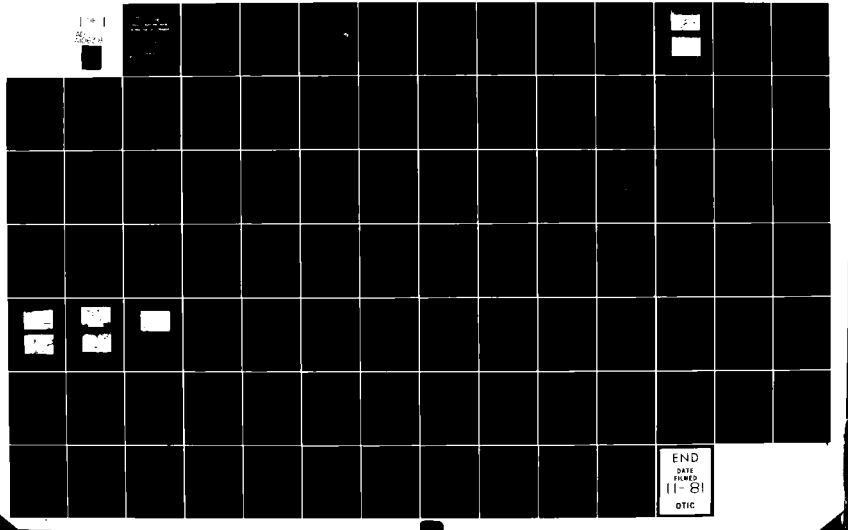


ROANOKE RIVER BASIN

Name Of Dam: LEATHERWOOD CREEK NO. 6

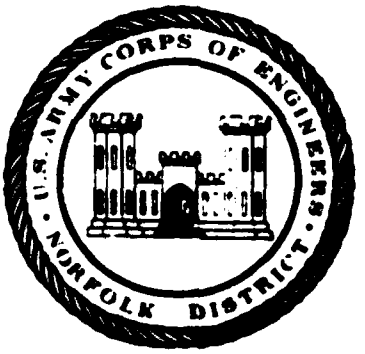
Location: HENRY COUNTY, VIRGINIA

Inventory Number: VA. NO. 08907

AD A106318

LEVEL II

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. TIDDENS 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.

ROANOKE RIVER BASIN

NAME OF DAM: LEATHERWOOD CREEK NO. 6 DAM
LOCATION: HENRY COUNTY, VIRGINIA
INVENTORY NUMBER: VA. NO. 08907

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.

TABLE OF CONTENTS

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. 6 Dam
State:	Virginia
Location:	Henry County
USGS Quad Sheet:	Martinsville East
Coordinates:	Lat 36° 41.6' Long 79° 47.8
Stream:	Camp Branch of Leatherwood Creek
Date of Inspection:	July 1, 1981

Leatherwood Dam No. 6 is a homogeneous earthfill structure about 500 ft long and 31.9 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 small in size and is assigned a significant hazard classification. The dam is located on Camp Branch of Leatherwood Creek approximately 2.4 miles east of Martinsville, Virginia. The dam is used for irrigation, flood control and recreational purposes, and is owned and maintained by Camp Branch Plantation, Inc.

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 30 percent of the Probable Maximum Flood (PMF) or 60 percent of the SDF without overtopping the dam. During the SDF, the dam will be overtopped

for a period of 2.0 hours up to a maximum of 1.4 feet and reach a maximum velocity of 5.1 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, and the downstream slope under steady seepage conditions were reviewed and found to be acceptable.

It is recommended that the owner implement an emergency action plan measure 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.

Bare and rutted areas created by vehicular traffic on the crest of the dam and in the emergency spillway should be backfilled and reseeded. Vehicular traffic should be restricted in these areas. Eroded areas present at pool level on the upstream slope should be monitored quarterly to detect any significant increase in erosion which may require the installation of riprap for slope protection. Fishermen should not be allowed to dig up the embankment and existing disturbed areas should be regraded and seeded.

Foot paths on the embankment should also be reseeded. The eroded area present below the berm on the downstream slope should be backfilled with compacted soil and reseeded.

Debris should be removed from the trash rack and vegetation should be removed from the left seepage drain outlet. A staff gage should be installed to monitor water levels.

SCHNABEL ENGINEERING ASSOCIATES, P.C./
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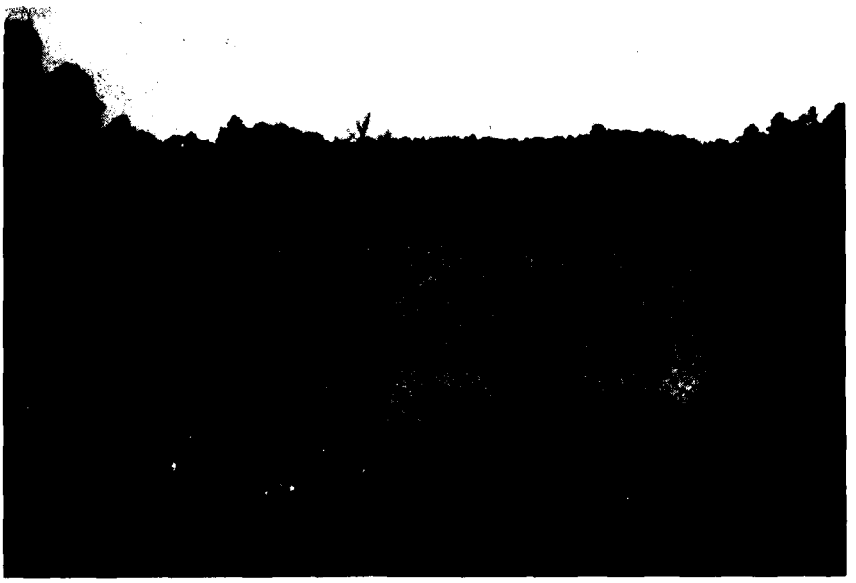
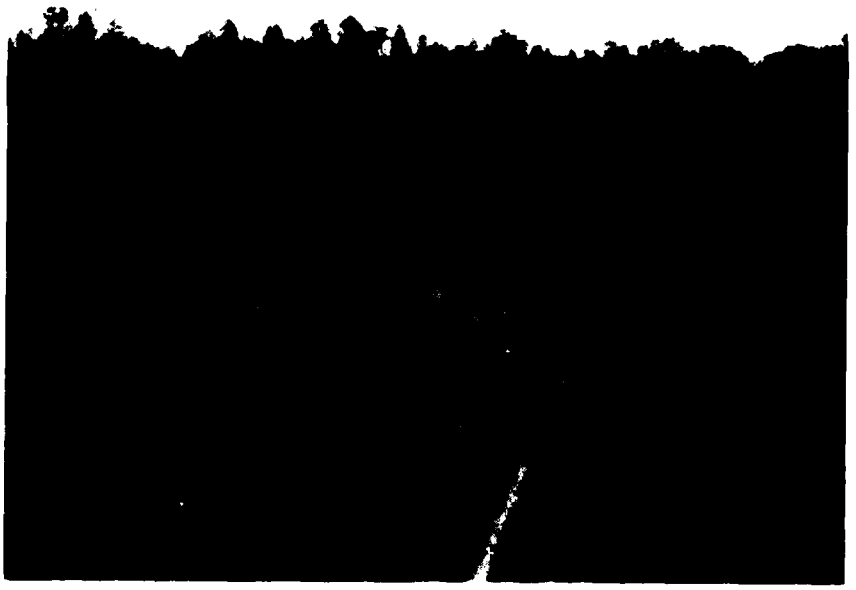
Date: SEP 23 1981



Leatherwood Dam No. 6 - 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. 6 Dam is a homogeneous earthfill structure approximately 500 ft long and 31.9 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 15 ft wide berm occurs between elevation 711.4 and 712.4 msl on the upstream slope. A 15 ft wide berm also exists between elevation 710 and 711 msl on the downstream slope. The upstream slope flattens to 3H:1V below the berm. The crest of the dam is at elevation 727.9 msl. "As built" drawings show the presence of a cutoff trench which extends into "firm bedrock" and a seepage drain beneath the downstream slope. There is no slope protection on the upstream face of the dam.

*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 21 ft high. The riser has a low flow orifice (2 ft by 1 ft) at an invert elevation of 710.9 msl and two overflow weirs (6 ft by 1 ft) at elevation 717.5 msl. A 24 inch diameter slide gate in the riser at an invert elevation of 700 msl is used to drain the lake. The outlet pipe is a 24 inch diameter reinforced concrete pipe which outlets at an elevation of 698 msl into a riprap lined plunge pool. (See Plate 5, Appendix I.)

The emergency spillway (EMS) consists of a vegetated earthen channel spillway located at the left abutment, having a crest elevation of 723.9 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 Plates [illegible] and 9, Appendix I)

1.2.2 Location: Leatherwood Dam No. 6 is located on Camp Branch of Leatherwood Creek, 2.4 miles east of Martinsville, Virginia. (See Plate 1, Appendix I.)

1.2.3 Size and Classification: The dam is classified as a small size structure based on its height and maximum lake storage potential as defined in Reference 1, Appendix VI.

1.2.4 Hazard Classification: The dam is located in a rural area; however, based upon the proximity of two commercial facilities located 1.2 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 Camp Branch Plantation, Inc. of Martinsville, Virginia.

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 711 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 723.9 msl. The 24 inch diameter gate at elevation 700 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 2.1 square miles.

1.3.2 Discharge at Dam Site:

Principal Spillway Discharge:

Pool Elevation at Crest of Dam (elev 727.9) 67 CFS

Emergency Spillway Discharge:

Pool Elevation at Crest of Dam (elev 727.9) 2123 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	727.9	37.6	500	4.5	.6
Emergency Spillway Crest	723.9	32	364	3.3	.5
Low Level Orifice Crest	710.9	12.2	68	.6	.3
Streambed at Downstream Toe of Dam	696	-	-	-	-

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 71 test pits and drilling 2 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 Plates 3 and 4 of Appendix I, while logs of the materials encountered are included as Plates 6, 7 and 8 of Appendix I.

The dam is a homogeneous, compacted earthfill embankment. The earthfill requirements shown on Plate 5 of Appendix I specify that MH, ML and SC materials be placed in the cutoff trench, center and upstream section of the dam. Soil classification is by the Unified Soil Classification System, ASTM D-2487. The non-plastic SM material was to be placed in the downstream section as directed by the Engineer. "As built" embankment slopes for the structure are illustrated on Plate 5 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.

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 3 ft minimum width trench of variable depth. It is approximately 348 ft in length and includes 320 ft of perforated and 48 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 left abutment. The spillway is a 100 ft wide trapezoidal earthen and weathered rock channel bounded by 3H:1V cut slopes. The spillway is entirely in cut materials, i.e., residual soils and weathered rock. 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 were assumed for the foundation materials while strength parameters used in design of the embankment were determined by consolidated-undrained triaxial compression tests. Strength parameters are listed below:

SECTION	SOIL	SHEAR STRENGTH PARAMETERS	
		Angle of Internal Friction	Cohesion
Embankment	ML	$\phi_{cu} = 28.0^{o}$	c = 200 psf
	MH	$\phi_{cu} = 15.5^{o}$	c = 525 psf
	SM	$\phi_{cu} = 28.5$	c = 500 psf
Foundation	ML	$\phi = 0$	c = 200 psf

The stability of the embankment was checked for two conditions using the Swedish Circle Method of Analysis. The first analysis considered the embankment alone with a fully developed phreatic line. In this analysis, a 2.5H:1V downstream slope without drainage was used and a factor of safety of 1.43 was calculated for the lowest strength materials tested. It was concluded that a slightly higher factor of safety would exist for an upstream slope of 2.5H:1V over 3H:1V with a 10 ft berm under full or rapid drawdown.

The second analysis considered 6 ft of foundation material with an in-situ shear strength of $\phi = 0$, c = 200 psf. Assuming a moist embankment, SCS stated that the conditions of this analysis represented a situation where

no consolidation of foundation soils would occur during construction. Using saturated shear strength values from triaxial tests, a factor of safety of 1.22 was calculated for the upstream slope (2.5H:1V over 3H:1V) and 1.07 for the downstream slope (2.5H:1V).

It was stated in the slope stability summary that, "It must be emphasized that this analysis is not conclusive since it is based on an average strength of c = 200 psf derived from pocket penetrometer readings."

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 85°F. The pool and tailwater levels at the time of inspection were 711 and 696 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 tall grass, brush, briers or blackberry bushes and honeysuckle making observation difficult. Scattered small trees less than 2 inches in diameter occur at various locations at pool level and up to 5 ft above pool level on the upstream slope. A roadway traverses the crest of the dam.

The embankment crest exhibited considerable rutting due to vehicular traffic. The ruts range from ½ to 1½ ft± in depth and are up to 1 ft± wide. Scattered shrinkage cracks were observed in non-vegetated areas of the embankment. Scattered shallow erosional channels or washes occur along the upstream slope, particularly near pool level. Three disturbed areas were also observed on the upstream slope just above pool level as shown on the Field Sketch, Appendix III. These areas are believed to be the result of fishermen digging for bait. Scattered erosional scarps 1 ft± high extend 1 to 2 ft± into the upstream slope at pool level and appear to be the result of wave erosion. A bare

foot path occurs along the right side of the upstream slope providing access to the lake. Another such path extends across the base of the upstream slope just above pool level. The only erosion observed on the downstream slope is an eroded area 1 ft$^{+}_{-}$ wide and 2 ft$^{+}_{-}$ deep which begins at the downstream slope berm extending half way down the remaining slope (see Field Sketch, Appendix III). A riprap channel lines the right abutment-downstream slope contact from the embankment crest to the lower berm. The riprap gutter appears to be rather new and may have been installed to restrict erosion. It is not shown on the "as built" drawings.

The downstream toe was dry and no seepage was observed. Two 6-inch CMP toe drains exist on either side of the principal spillway outlet. There was no flow from the left drain, the lower half of which was filled with vegetation. Flow from the right drain was clear and estimated at ½ gpm$^{+}_{-}$.

The riser structure and outlet pipe showed no signs of deterioration and were functioning properly at the time of inspection. Debris was present in the low flow intake trash rack. The plunge pool and outlet channel indicated no signs of deterioration. The emergency spillway was well vegetated except for some minor erosion caused by vehicle traffic.

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 with moderate side slopes. The water was clear and no sedimentation was observed.

3.1.4 Downstream Area: The downstream channel consists of a 10 ft wide channel located in a 200 ft wide flood plain, and a valley with steep side slopes. The valley is heavily wooded with thick underbrush. Approximately 1.2 miles downstream there are two 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 slope should be mowed at least once a year, but more preferable 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 and removed from the embankment.

The bare areas and rutting created by vehicular traffic on the crest of the dam and in the emergency spillway do not inhibit the proper performance of the dam, however, it is recommended that these areas be backfilled and reseeded. The presence of an adequately vegetated crest reduces the erodibility of the crest should overtopping of the dam occur during flooding. Vehicle traffic should be restricted on the dam and emergency spillway. The shrinkage cracks observed are believed to be the result of local drought conditions and do not require any special

attention. The erosion observed at pool level on the upstream slope was not widespread at the time of the inspection. If this erosion should increase significantly and become more widespread in occurrence, it may be necessary to place riprap for erosion protection. Fishermen should not be allowed to dig up the embankment,and existing disturbed areas should be regraded and seeded. The foot paths on the right upstream slope and just above pool level should also be reseeded. The eroded area present below the berm on the downstream slope should be backfilled with compacted soil and reseeded to prevent further erosion.

The right seepage drain outlet was functioning properly, however, the lower half of the left drain outlet was filled with vegetation. This vegetation should be removed. The outlet pipe and intake structures are in good structural condition. Debris should be removed from the trash rack. A staff gage should be installed to monitor water levels.

3.2.2 Downstream Area: A breach in the Leatherwood Creek No. 6 Dam during extreme flooding would create a hazard to the downstream dwellings.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The normal storage pool is elevation 711 msl or 0.1 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 717.5 msl, and automatically through the emergency spillway when the pool level exceeds elevation 723.9 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 inspection by SCS and Soil and Water Conservation District personnel. Maintenance deficiencies 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 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 Dam No. 6 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: Information on flood experience was not available.

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 and 100 year flood hydrographs were developed by the HEC-1 D B Computer Program (Reference 4, Appendix VI). Precipitation amounts for the flood hydrograph of the PMF and 100 year flood 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 711 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 723.9 msl and a combined principal and emergency discharges for pool elevations above 723.9 msl. Pool elevations above 727.9 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 (100 year flood, ½ PMF and PMF) are shown in the following Table 5.1:

TABLE 5.1 - RESERVOIR PERFORMANCE

			Hydrograph	
	Normal Flow	100 Year Flood	½ PMF	PMF
Peak Flow, CFS				
Inflow	2	2186	5089	10,178
Outflow	2	780	4947	10,178
Maximum Pool Elevation Ft, msl	711	725.9	729.3	731.4
Non-Overflow Section (Elev 727.9 msl)				
Depth of Flow, Ft	-	-	1.4	3.5
Duration, Hours	-	-	2	4
Velocity, fps*	-	-	5.1	8
Tailwater Elevation Ft, msl	696	700	703	705.2

*Critical velocity

5.7 Reservoir Emptying Potential: A 24 inch diameter gate at centerline elevation 701 msl is capable of draining the reservoir through the outlet pipe. Assuming that the lake is at normal pool elevation (711 msl) and there is 2 cfs inflow, it would take approximately one day to lower the reservoir to elevation 752.1 msl. This is equivalent to an approximate drawdown rate of 10 ft/day based on the hydraulic height measured from normal pool to the centerline 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 a small size, significant hazard dam is the 100 year flood to ½ PMF. Because of the risk involved, the ½ PMF has been selected as the SDF. The spillway will pass 30 percent of the PMF without overtopping the crest of the dam (60 percent of the SDF). During the SDF, the dam will be overtopped for a period of 2 hours up to a maximum of 1.4 feet and reach a maximum velocity of 5.1 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 Wissahickon Formation; 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 dark colored minerals. Less than 500 ft west of the dam site the Precambrian Leatherwood Granite is exposed. This material, typically granitic dikes and thin sheets on top of the Rich Acres Formation, is thought to be derived from the same magma as the Rich Acres Formation. 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.

Bedrock underlying the site includes a relatively thin weathered zone consisting of disintegrated rock and/or residual soils. At the dam site the residual soils are overlain by up to 9 ft of alluvial deposits. The alluvium generally consists of silts and silty clays underlain by saturated sands and gravels. The centerline of the dam was excavated to hard rock except at the abutments of the dam. No rock was encountered with the backhoe in either abutment. The foundation contains an irregular rockline due to the intrusion of more resistant dikes into the surrounding

host rocks. These dikes occur as ridges crossing the centerline at an acute angle. The centerline of the dam was placed on one of the wider ridges.

Gradual consolidation of underlying soils was anticipated during the application of fill materials. SCS recognized the presence of a 5 ft^{+} thick stratum of low strength ML material overlying the more permeable sands and gravels in the floodplain area. An overfill allowance of 1.5 ft over the floodplain section was suggested in the design report to compensate for residual consolidation in the fill and foundation. The underlying soils probably had essentially fully consolidated under the applied load not long after completion of construction. Based upon the performance history of this dam and the soils testing performed during the design phases, a stable foundation is assumed.

The potential for seepage through the foundation was recognized, and a cutoff was included in the design. It was estimated in the design report that approximately 30% of the stream flow was carried by the alluvial gravel underlying the dam site. A cutoff was designed to extend one ft into bedrock along the centerline of the dam. The designer recognized that some seepage may bypass the cutoff and a foundation drain was designed to accommodate this flow.

6.2.1 Materials: "As built" drawings describe the dam as a homogeneous structure. It was recommended that all MH, ML and SC materials be placed in the cutoff trench, center and upstream portion of the dam, while the SM materials were to be placed in the downstream section as directed by the engineer (see Plate 5, Appendix I). All fill materials

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 pages 2 and 3 of Appendix V. Specifications for maximum lift thickness and maximum rock sizes were not observed in the design data provided.

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, no flow was observed from the left seepage drain outlet, however, the right outlet was iron-stained and clear water was flowing from the outlet at ½ gpm±. In attempt to prevent piping around the principal spillway pipe, 5 anti-seep collars were included as shown on Plate 5 of Appendix I.

6.2.3 Stability: A stability analysis was performed for this structure and the report describing the engineering design data used is included as Appendix V. These data were reviewed along with the stablity analysis and were found to be acceptable. In the first condition, assuming the embankment alone with a fully developed phreatic line, a factor of safety of 1.43 was calculated for a 2.5H:1V downstream slope without drainage. A slightly higher factor of safety was concluded under full or rapid drawdown for an upstream slope of 2.5H:1V over 3H:1V with

a 10 ft berm. The second analysis considered 6 ft of foundation material with an in-situ shear strength of $\emptyset = 0$, c = 200 psf (based upon pocket penetrometer readings). Assuming a moist embankment and no consolidation of foundation soils during construction, a factor of safety of 1.22 was calculated for the upstream slope (2.5H:1V over 3H:1V) and a factor of safety of 1.07 for the downstream slope (2.5H:1V).

The dam is 32 ft high and has a crest width of 14 ft. The upstream slope is 2.5H:1V with a 15 ft wide berm at pool level between elevations 711.4 and 712.4 msl. The upstream slope then continues at a 3H:1V slope below normal pool. The downstream slope is 2.5H:1V with a 15 ft wide berm between elevations 711.0 and 710.0 msl dipping into the dam. The dam is subjected to a sudden drawdown since the lake level can be drawn down at a rate of 10 ft/day. This exceeds the critical rate of 0.5 ft per day for earth dams.

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: In the SCS stability report (Appendix V) uncertainties with regard to the strength of the soft ML zone were recognized. Consequently, the following recommendations were made: "(1) Removal of all or part of the low density material from the foundation...,(2) Determine the shear strength of the ML zone from undisturbed samples, (3) Or provide additional berming both upstream and downstream." The "as built" drawings indicate

that the last recommendation was utilized in design and construction of the dam.

For the purpose of this evaluation it is assumed that the additional berming provides adequate factors of safety, although it is not known if any further stability analyses were performed. It is likely that the factors of safety are above those recommended in Reference 1, Appendix VI, since (1) a conservative value (c = 200 psf) was originally assumed for the foundation soils, (2) the original factors of safety developed from slope stability analyses did not account for an increase of strength during consolidation, and (3) the berming on the downstream slope and additional berming on the upstream slope will modify the slope configuration resulting in a higher factor of safety. Based upon the visual inspection, performance history and the design report, the foundation is considered sound and the embankment is considered stable.

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.

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 711 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 30 percent of the PMF (60 percent of the SDF) without overtopping the crest of the dam. During the SDF, the dam will be overtopped for a period of 2.0 hours up to a maximum of 1.4 feet and reach a maximum velocity of 5.1 fps. Flows overtopping the dam at a maximum velocity of 5.1 fps during the SDF are not considered detrimental to the embankment with respect to erosion. The spillway is judged inadequate, but not seriously inadequate. 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 maintenace 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 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) Bare and rutted areas created by vehicular traffic on the crest of the dam and in the emergency spillway should be backfilled and reseeded.

d) Vehicle traffic should be restricted on the dam and in the emergency spillway.

e) Eroded areas present at pool level on the upstream slope should be monitored quarterly to detect any significant increase in erosion, which may require the installation of riprap for slope protection.

f) Fishermen should not be allowed to dig up the embankment and existing disturbed areas should be regraded and seeded.

g) Foot paths on the embankment should be reseeded.

h) The eroded area present below the berm on the downstream slope should be backfilled with compacted soil and reseeded.

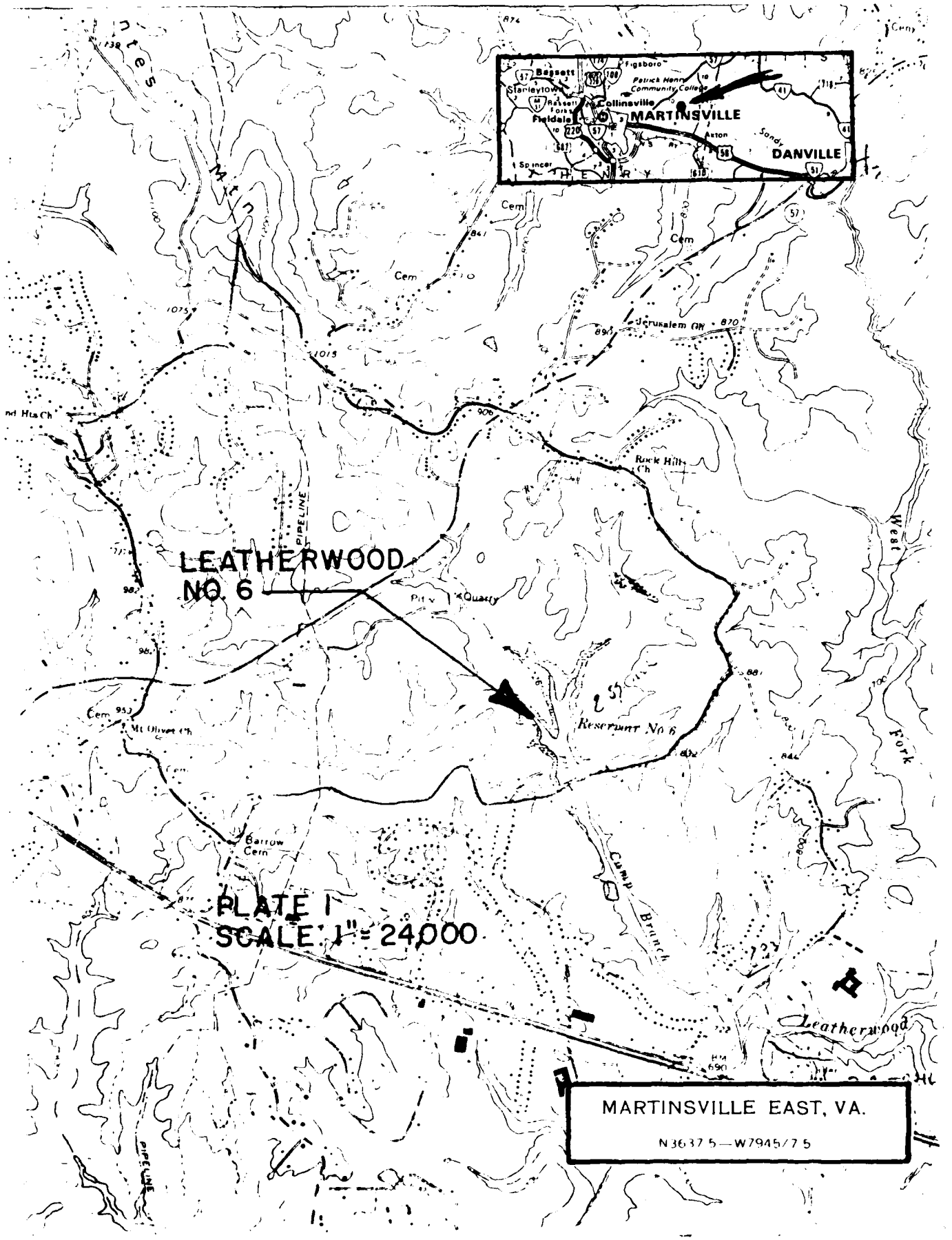
i) Debris should be removed from the trash rack.

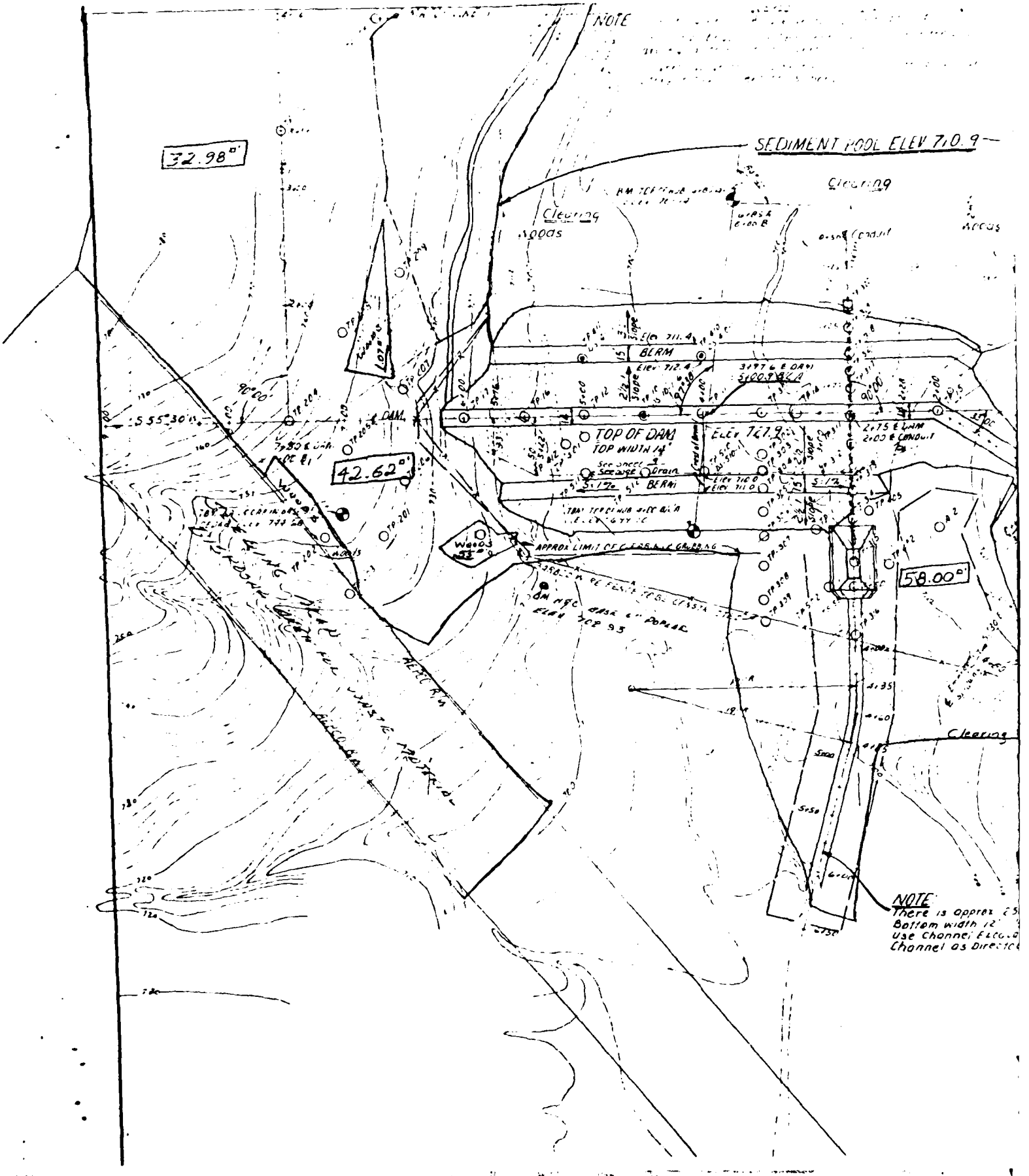
j) Vegetation should be removed from the left seepage drain outlet.

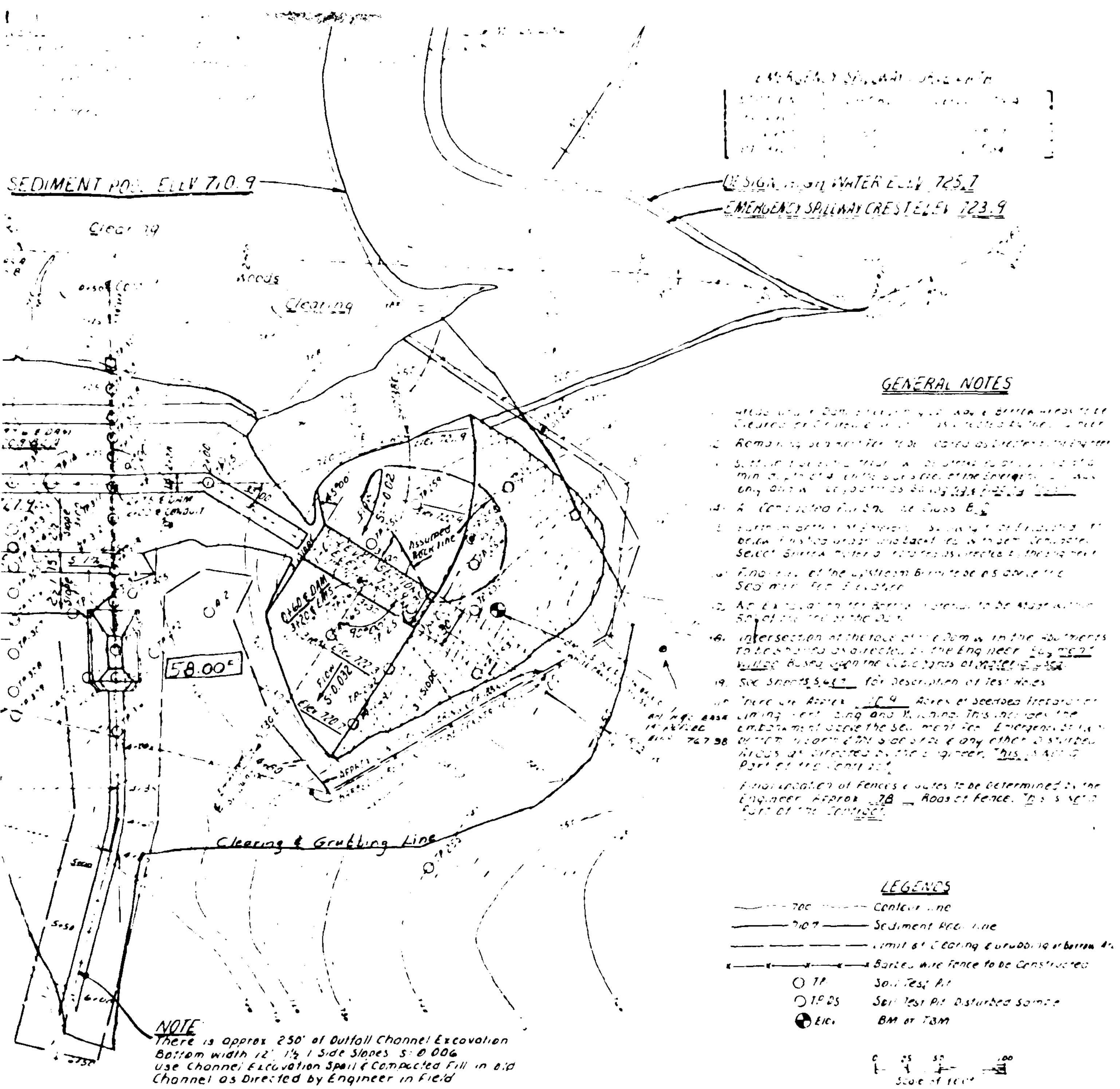
k. A staff gage should be installed to monitor water levels.

APPENDIX I

MAPS AND DRAWINGS


LEATHERWOOD
NO. 6
PLATE I
SCALE 1" = 2,000
MARTINSVILLE EAST, VA.
N3637.5—W7945/7.5
MARTINSVILLE
DANVILLE
Bassett
Collinsville
Fieldale
Figsboro
Spencer
Jerusalem
Rock Hill Ch
Reservoir No 6
Leatherwood
Camp Branch
PIPELINE
West Fork


NOTE
SEDIMENT POOL ELEV 710.9
32.98'
42.62'
58.00'
Clearing
Woods
BERM
TOP OF DAM
TOP WIDTH 14'
ELEV 717.9
DAM
Clearing
NOTE
There is approx 25
Bottom width 12
Use Channel Elev.
Channel as Direct



GENERAL NOTES

2. Remaining sediment pool to be cleared as directed by the engineer
4. A Compacted Fill Shall be Class B
6. Final ... of the upstream Berm to be as above the Sediment Pool Elevation
8. Intersection of the face of the Dam with the abutments to be shaped as directed by the Engineer ... Based upon the conditions of materials ...
9. See Sheets ... for Description of Test Holes
10. There are Approx. 10.9 Acres of Seeded Preparation ... This includes the embankment above the Sediment Pool, Emergency Spillway ... and any other Disturbed Areas as directed by the Engineer. This is a ... Part of the Contract.
11. Final location of Fences & Gates to be determined by the Engineer. Approx. 78 Rods of Fence. This is a ... Part of the Contract.

LEGENDS

——700——	Contour Line
——710.9——	Sediment Pool Line
— — — —	Limit of Clearing & Grubbing of Borrow Area
—x—x—x—	Barbed Wire Fence to be Constructed
O TP	Soil Test Pit
O TP DS	Soil Test Pit Disturbed Sample
⊕ Elev	BM or TBM

0 25 50 100
Scale of Feet

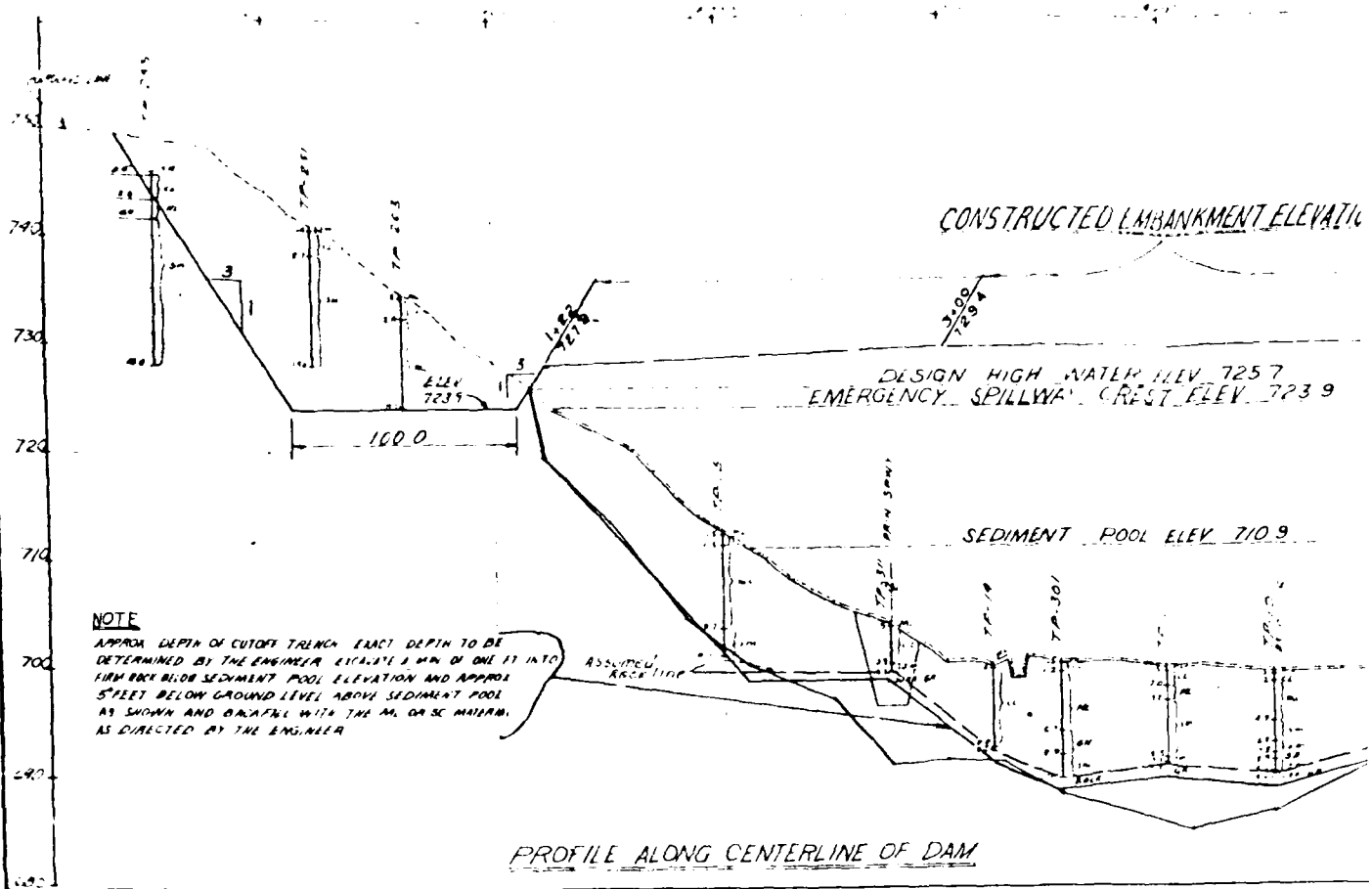
NOTE
There is approx. 250' of Outfall Channel Excavation
Bottom width 12', 1½:1 Side Slopes S=0.006
Use Channel Excavation Spoil & Compacted Fill in old Channel as Directed by Engineer in Field

DAM NO. 6 CHAP BRANCH
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY VIRGINIA
PLAN OF DAM & EMERGENCY SPILLWAY
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

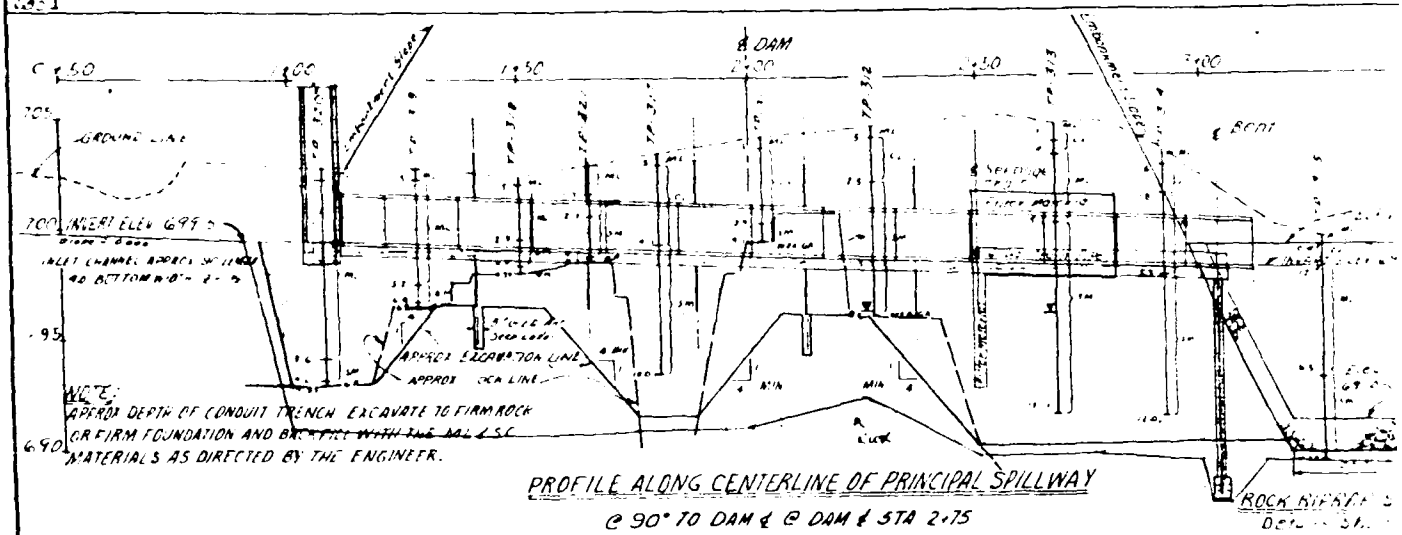
"AS BUILT"

PLATE 2

VA-495-P

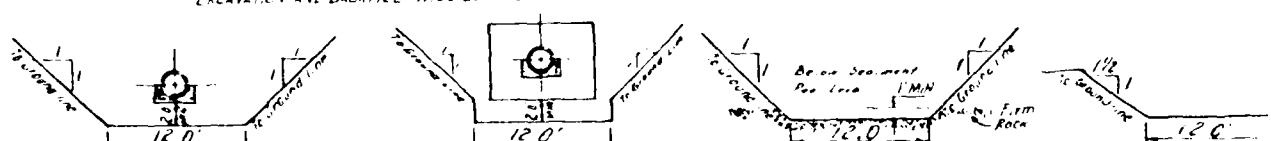


PROFILE ALONG CENTERLINE OF DAM



PROFILE ALONG CENTERLINE OF PRINCIPAL SPILLWAY
@ 90° TO DAM ℄ @ DAM ℄ STA 2+75

NOTE
EXCAVATION AND BACKFILL WILL BE PAID TO THE NEAT LINES AND GRADES AS SHOWN ON THE DRAWINGS OR AS DIRECTED BY T

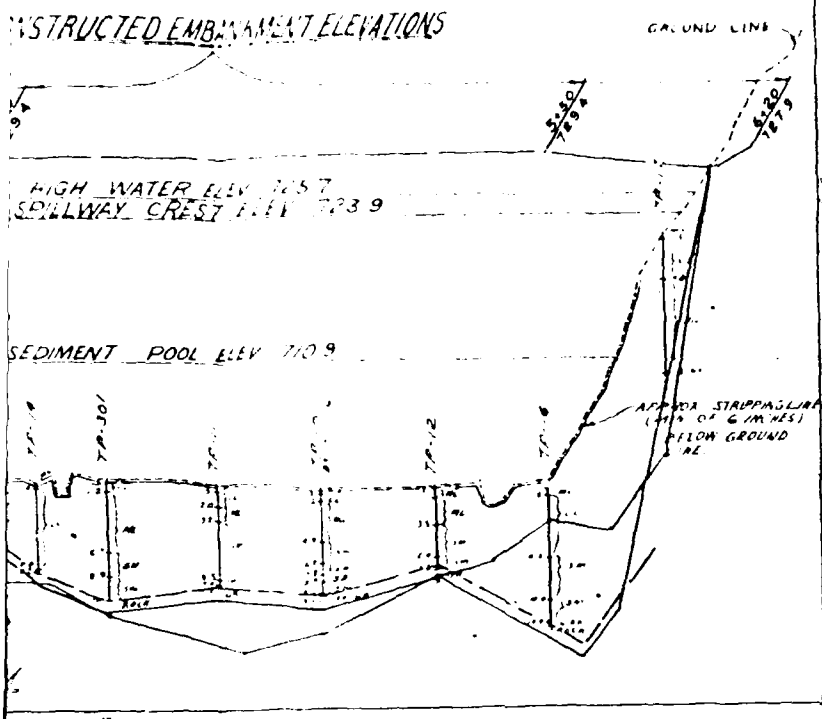


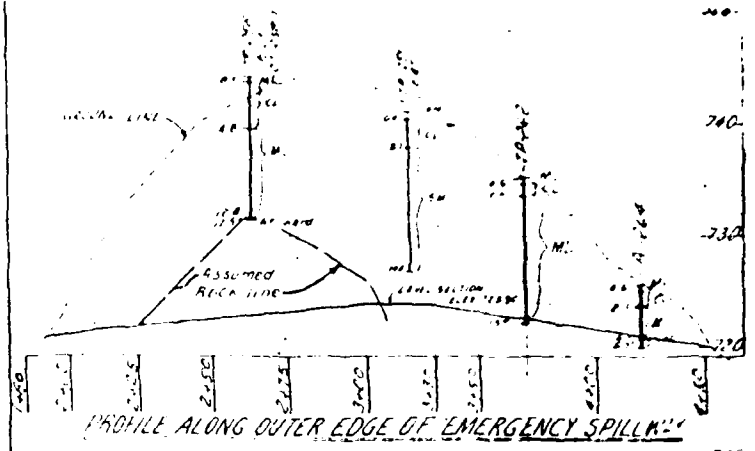
CONDUIT TRENCH
TYPICAL EXCAVATION SECTION

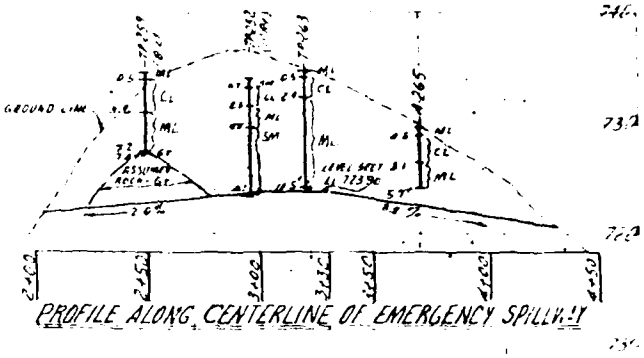
ANTI SEEP COLLARS
TYPICAL EXCAVATION SECTION

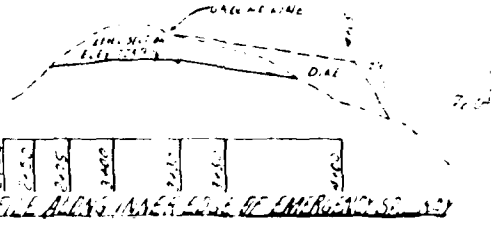
CUTOFF TRENCH
TYPICAL EXCAVATION SECTION

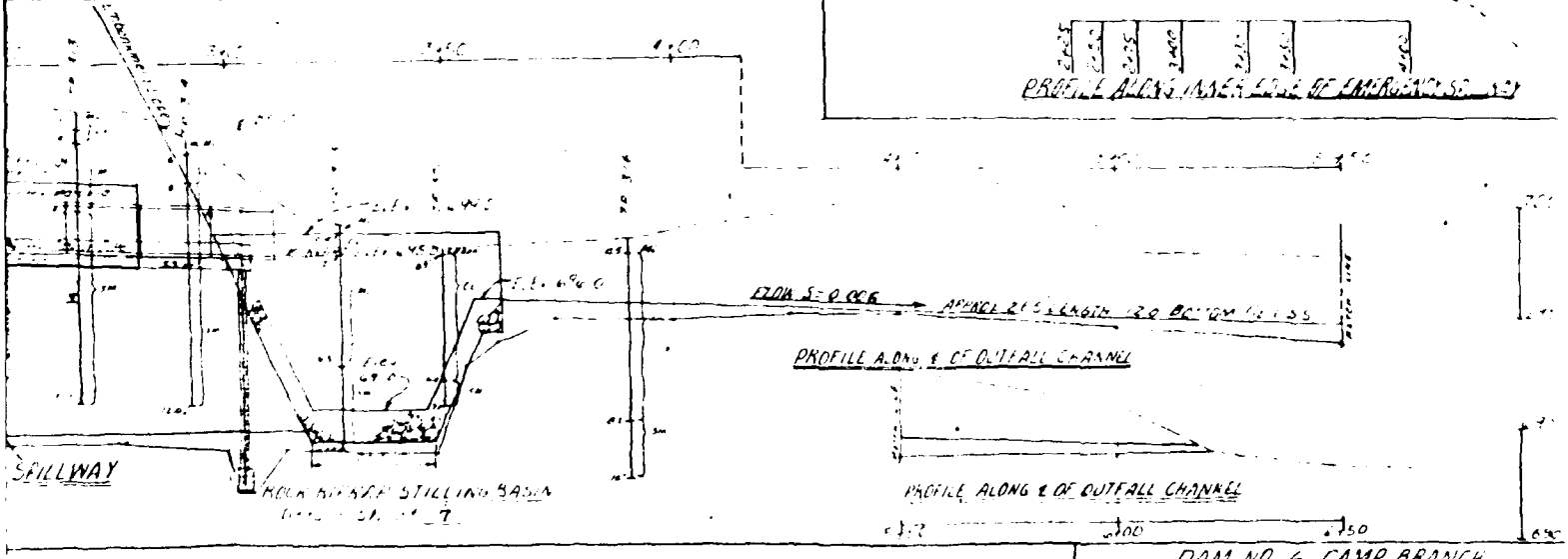
OUTFALL CHA
TYPICAL EXCAVATION

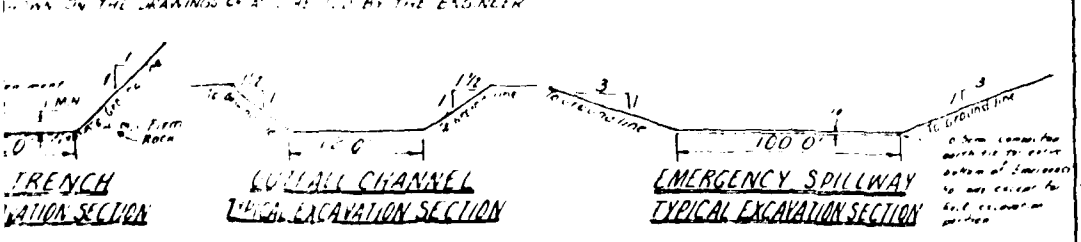












DAM NO 6 CAMP BRANCH
LEATHERWOOD CREEK WATERSHED

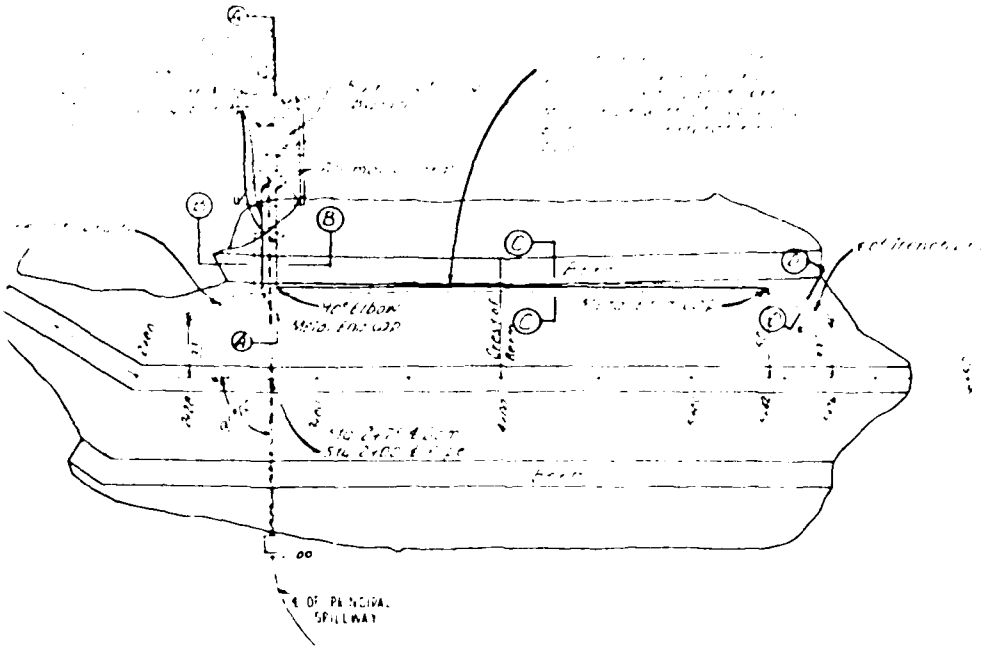
PROFILES & TYPICAL EXCAVATION SECTIONS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

AS BUILT

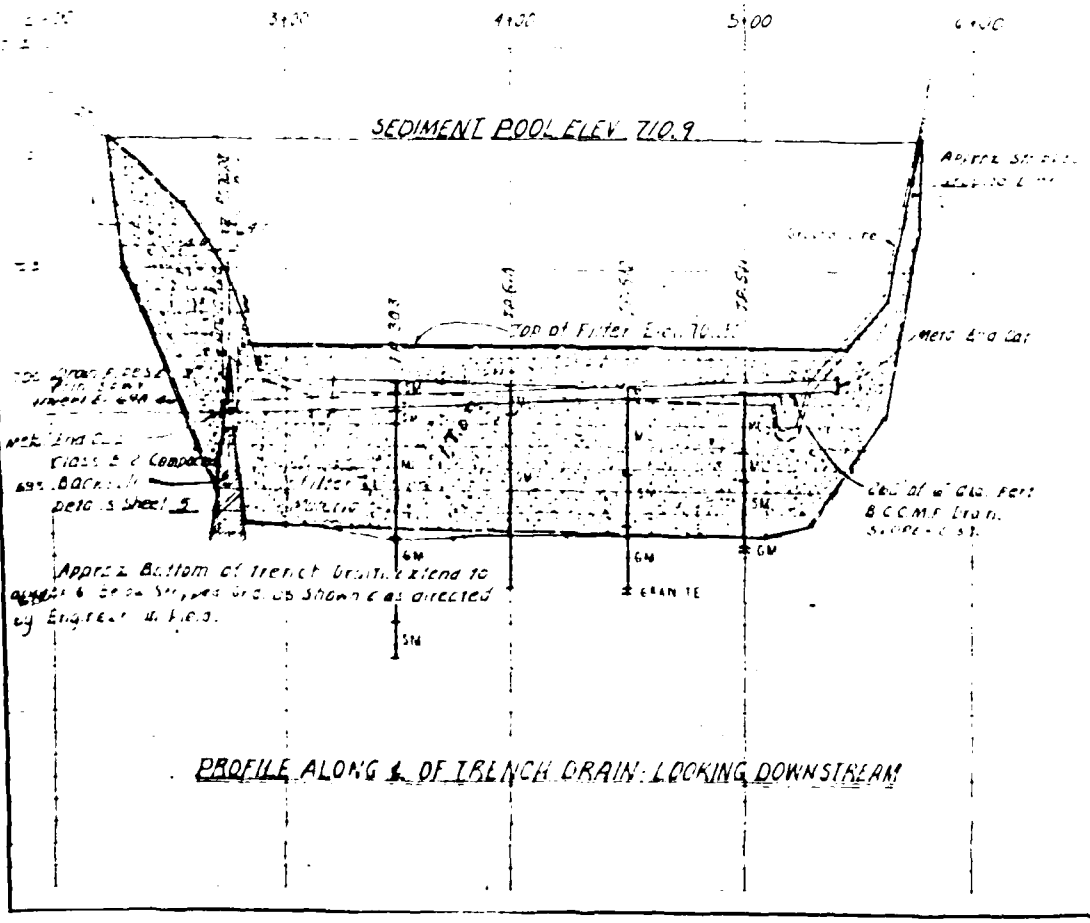
PLATE 3

VA 485-P

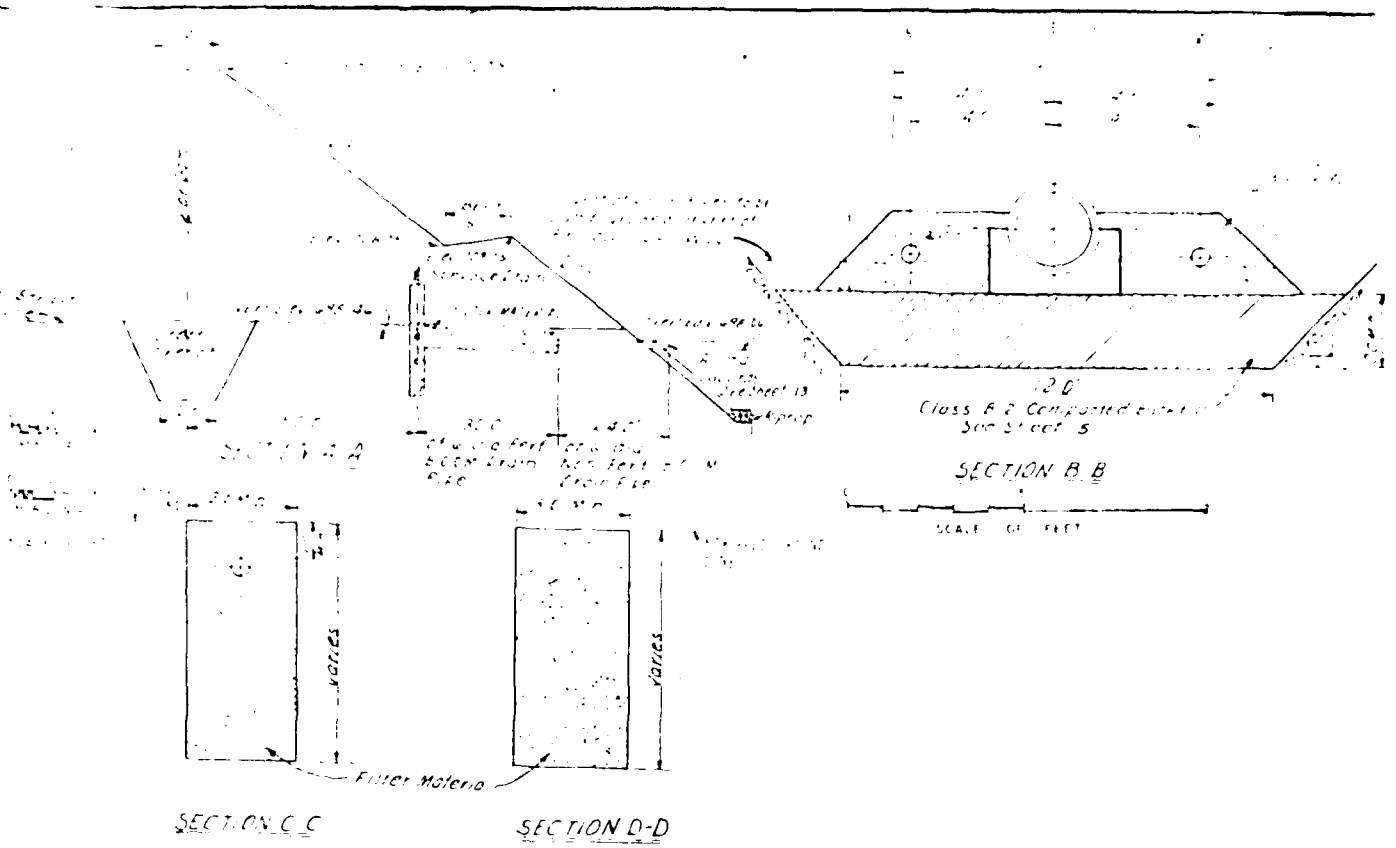


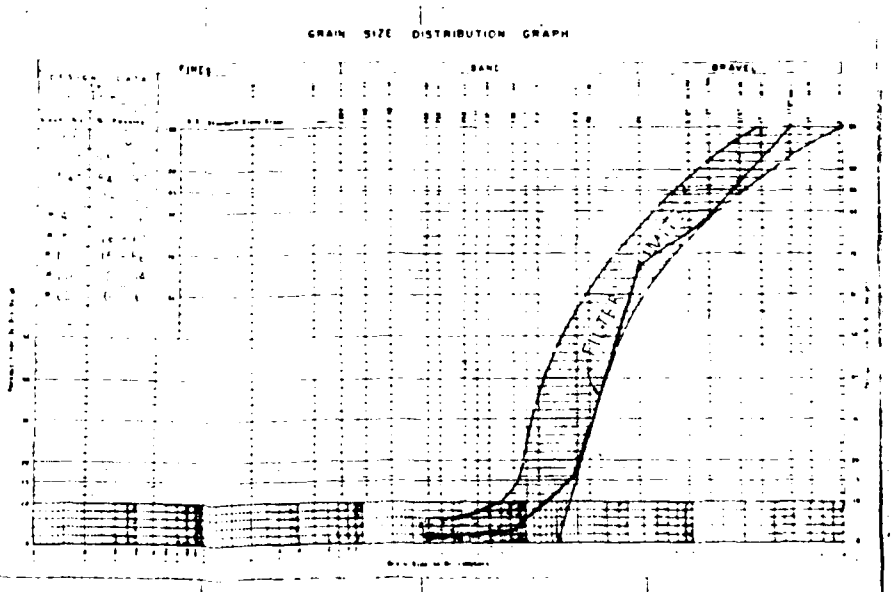
PLAN VIEW OF SEEPAGE DRAIN

0 25 50 100
Scale of feet



PROFILE ALONG ℄ OF TRENCH DRAIN: LOOKING DOWNSTREAM



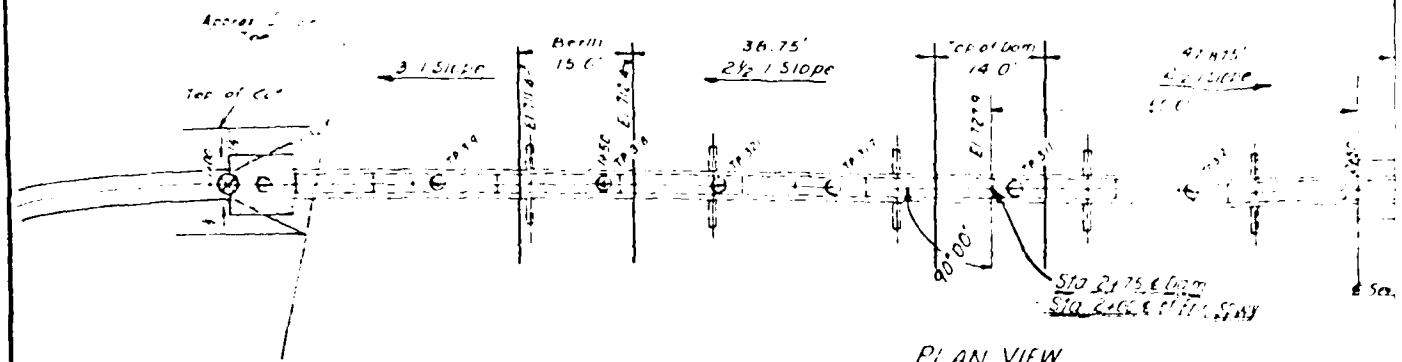


"AS BUILT"

DAM NO 6 CAMP BRANCH
LEATHERWOOD CREEK WATERSHED
HENRY COUNTY, VIRGINIA
DETAILS OF SEEPAGE DRAIN

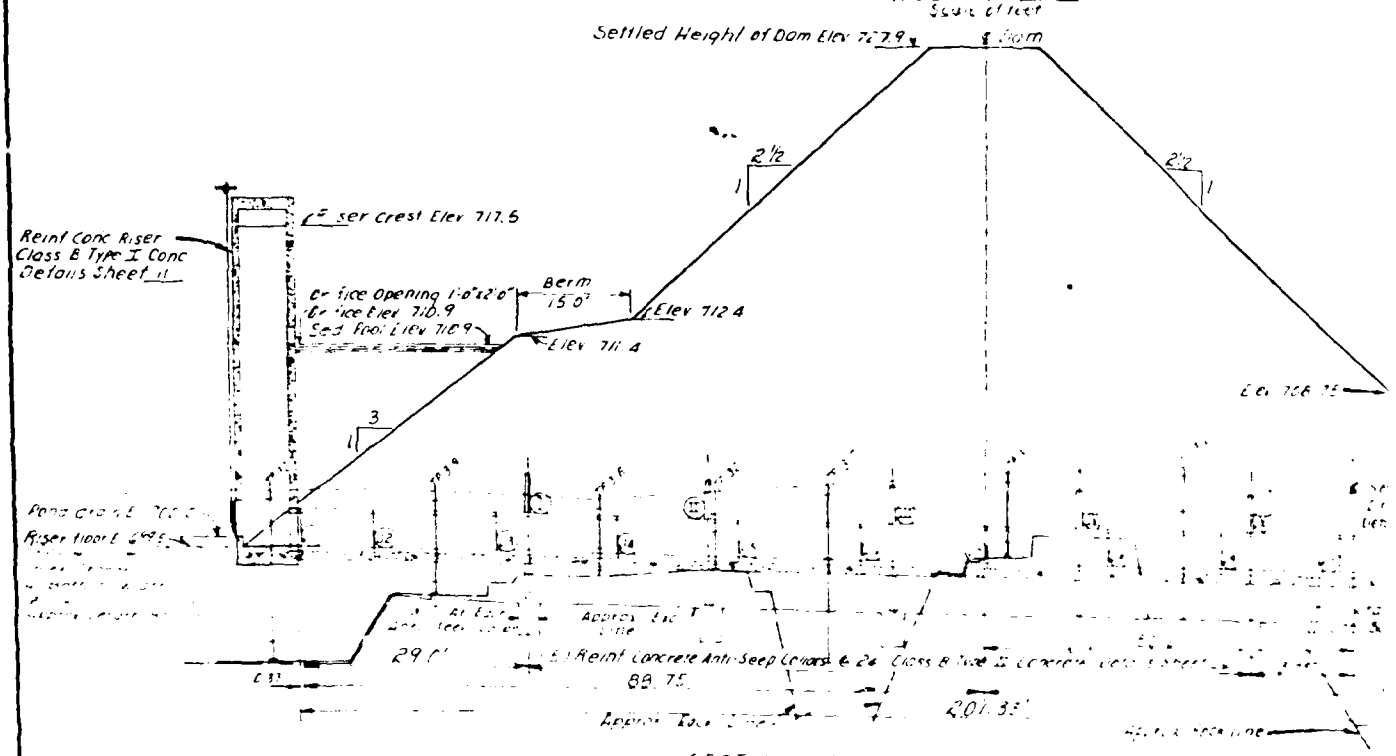
U.S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE,

Designed N.W. WILSON	Date 11/63	PLATE 4
Drawn L.S. COFFMAN	11/63	
Traced		
Checked	8/66	VA-485-P

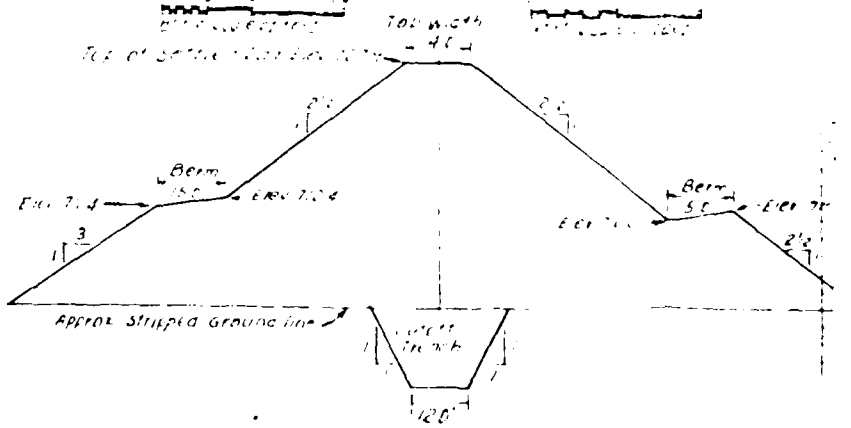


PLAN VIEW

Scale of Feet

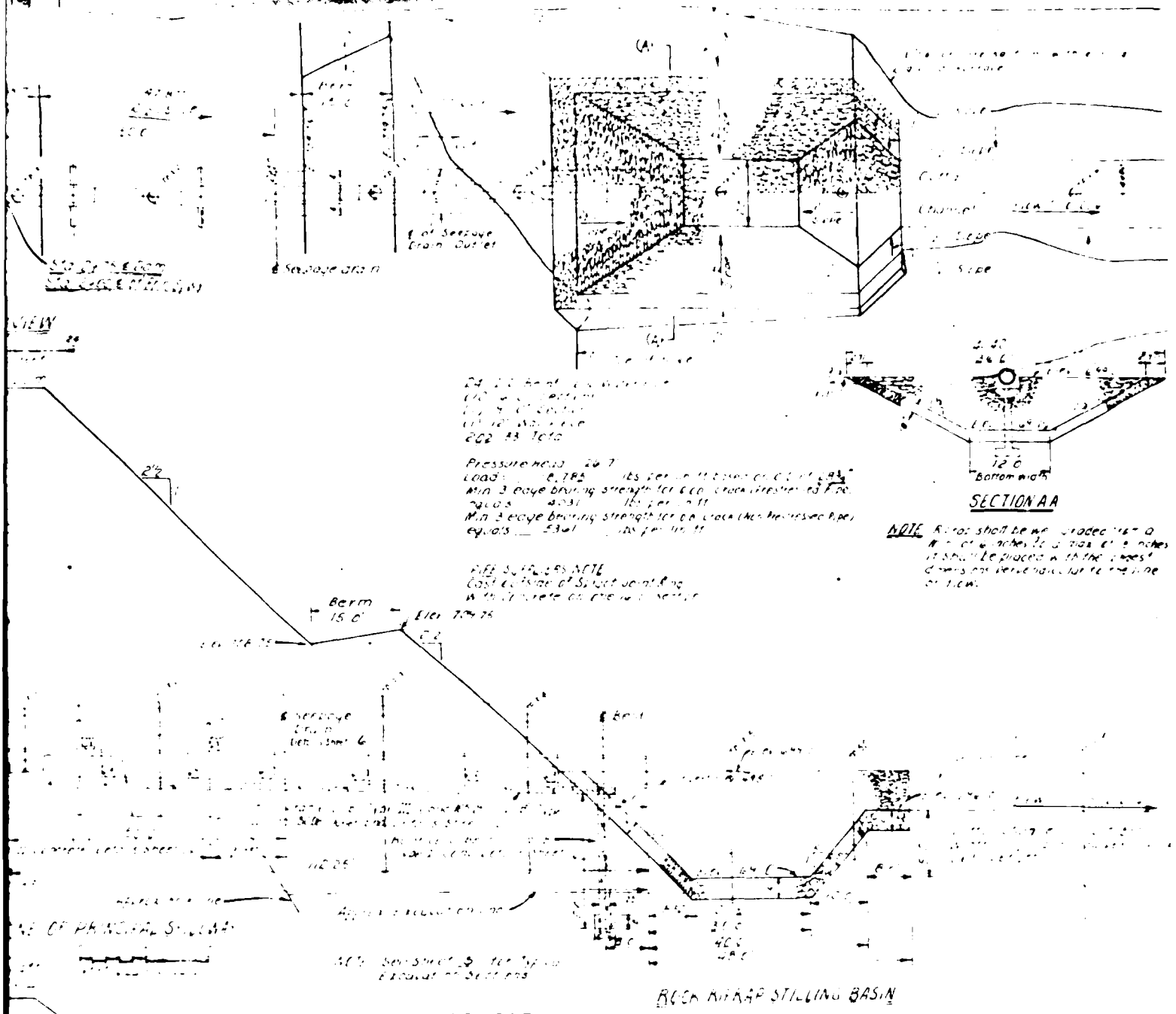


SECTION ALONG CENTERLINE OF PRINCIPAL SPILLWAY



NOTE
Place the Sm. M. & SC Material in the cutoff Trench center and upstream section of the Dam and the non plastic SM Material in the Downstream section as directed by the Engineer

TYPICAL SECTION OF COMPACTED DAM



NOTE
Above figures for distance from Riser to Base Joint are based on nominal lengths & do not include Creep

DAM NO 6 CAMP BRANCH
LEATHERWOOD CREEK WATERSHED
PLAN-PROFILE OF PRINCIPAL SPILLWAY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 5

VA 485 P

		[illegible]	
		Clay, silty - [illegible]	
2.[illegible]	5.2	Clay, silty - olive [illegible] gr - soft - moist to wet - seepage at [illegible]	(CL)
5.2	7.[illegible]	Clay, sandy - blue [illegible] gray - soft - wet - p.p. [illegible]	(CL)
7.[illegible]	9.[illegible]	Gravel, sandy - [illegible] gray - water bearing	(GP)
9.2	10.[illegible]+	Sand, silty - micaceous - olive brown - p.p. [illegible] - soft moist - [illegible] weathered material	(SM)

TP 2, STA. 1[illegible]' L C/L 2[illegible], [illegible]

0.[illegible]	[illegible]	Silt - fine sandy - [illegible] - [illegible] - topsoil	(ML)
[illegible]	3.7	Clay, silty - re[illegible] - hard - moist - Cecil soil - residual	(CL)
3.7	5.7+	Sand, silty - red [illegible] - hard - moist - high mica - dry hole	(SM)

TP 3, STA. 1[illegible]' L C/L 5[illegible], [illegible]

0.0	0.[illegible]	Silt, fine sandy - brown - topsoil	(ML)
0.[illegible]	1.0	Silt, clayey - yellow red - micaceous - rotten rock fragments - hard - moist	(ML)
1.0	2.[illegible]	Boulders tightly [illegible] together	
2.0	3.0+	Granite - dry hole	

TP 4, [illegible]

0.0	1.[illegible]	Silt, sandy - light [illegible] gray - topsoil - roots - Appling soil	(ML)
1.0	8.7	Sand silty - light yellow red - hard - moist - p.p. [illegible] - fragments of quartz and mica bound	(SM)
8.7	10.7+	Sand, silty - white - hard - p.p. 3.5 - moist - fragments of quartz - weathered coarse granite - dry hole	(SM)

TP [illegible]

[illegible]	[illegible]	Silt, fine sandy - gray topsoil - Durham soil	(ML)
1.[illegible]	8.[illegible]	Sand, fine silty - brownish red - moist - ram -	(SM)
8.[illegible]	1[illegible]+	Sand, fine silty - brown - hard - moist	(SM)
1[illegible]+		Granite - dry hole	

TP [illegible]

0.[illegible]	0.9	Silt, fine sandy - light gray topsoil - roots - Appling soil	(ML)
0.9	4.[illegible]	Silt, fine sandy - pale yellow red - hard - moist	(ML)
4.[illegible]	9.[illegible]+	Sand, silty - light brown and white - hard in place - granular - moist - weathered coarse granite - dry hole	(SM)

TP [illegible]

0.[illegible]	0.8	Silt, fine sandy - light gray topsoil - roots - Appling soil	(ML)
0.8	8.0	Sand, fine silty - pale yellow red - moist hard - DI [illegible]	(SM)
8.[illegible]	10.8+	Sand silty - white - moist fine - dry hole - weathered coarse granite - DI [illegible]	(SM)

TP [illegible]

0.[illegible]	1.[illegible]	Silt, fine sandy - gray - topsoil - Durham soil	(ML)
1.0	11.7+	Sand, silty, clayey - yellow red - moist - hard - p.p. [illegible] - micaceous - dry hole - weathered granite	(SM)

[illegible]

		Silt, fine sandy - red brown - [illegible] roots - Durham [illegible]	(M)
[illegible]	7.[illegible]	Clay, silty - red - hard - moist - [illegible] moist - hard - white stringers	(CL)
7.[illegible]	9.[illegible]	Sand, fine, silty - yellow brown - micaceous - hard - moist	(SM)
9.[illegible]	11.5+	Sand, fine silty - olive brown - micaceous - hard - moist - [illegible] to big mica - hard - moist - [illegible] hole - weathered granite	(SM)

TP [illegible]

[illegible]	0.1	Silt, fine sandy - gray - topsoil - roots - Durham soil	(ML)
[illegible]	6.1	Silt, fine sandy - micaceous brown - firm - moist	(ML)
6.1	6.0+	Sand, silty - white - rock fragments - cobble size - weathered granite - hard to dig	(SM)
6.0+		Granite - dry hole	

TP [illegible]

[illegible]	1.0	Silt, fine sandy - light brown - roots - topsoil - Appling soil	(ML)
1.[illegible]	7.2	Silt, fine sandy - yellow red - moist - hard - p.p. 4.[illegible] - micaceous	(ML)
7.2+		Hard granite - dry hole	

TP [illegible], STA. 10[illegible] L C/L [illegible]70, [illegible]

0.[illegible]	0.4	Silt, fine sandy - light gray - roots - topsoil - Appling soil	(ML)
0.4	2.0	Clay, silty - yellow red - hard - blocky - p.p. [illegible] - moist - Appling soil	(CL)
2.0	11.0+	Sand, silty, clayey - hard moist - white aplite stringers in yellow red soil - sand and gravel size angular feldspar particles - p.p. 4.[illegible] - dry hole	(SM)

TP [illegible], STA. [illegible] [illegible]

0.[illegible]	0.4	Silt, fine sandy - light gray roots - topsoil - Appling soil	(ML)
0.[illegible]	2.[illegible]	Clay, silty - red blocky - hard moist - Appling	(CL)
2.[illegible]	11.[illegible]	Sand, coarse, silty - brownish white - compact - damp - angular feldspar fragments	(SM)
11.[illegible]	11.[illegible]+	Sand, fine, silty - olive brown - hard - moist - high mica - weathered coarse granite - dry hole	(SM)

TP [illegible], STA. [illegible] [illegible]

[illegible]	0.2	Silt, fine sandy - light gray - roots - topsoil - Appling soil	(ML)
0.2	2.0	Clay, silty - yellow red - hard - moist - p.p. 4	(CL)
2.0	7.0	Sand, coarse, silty - brownish white - compact - damp - angular feldspar particles - hard - p.p. 4.[illegible]	(SM)
7.[illegible]	8.0+	Sand, fine, silty - micaceous with quartz sand - olive brown - moist - p.p. [illegible] - weathered coarse granite - dry hole	(SM)

TP [illegible], STA. 7+[illegible] C/L [illegible] [illegible]/0

0.0	0.6	Silt, fine sandy - brown - topsoil - Lloyd soil	(ML)
0.6	5.[illegible]	Clay, silty - red - blocky - hard - p.p. 4.5 - moist - clay seams	(CL)
5.[illegible]	12.6+	Sand, silty - high mica - red yellow - hard - moist - p.p. 4.7 - weathered granite - dry hole	(SM)

TP [illegible], STA. [illegible] [illegible]

0.0	0.6	Silt, fine sandy - red brown - topsoil - Lloyd soil	(ML)
0.6	2.5	Clay, silty - yellow red - moist - hard - p.p. 4.2	(CL)
[illegible]			
2.5	5.2	Silt, fine sandy - yellow red - moist hard and micaceous - p.p. [illegible] - dry hole	(ML)
[illegible]			

(TP [illegible] Contd.

[illegible]

		[illegible] fine sandy - brown gray - [illegible] - Appling soil	
[illegible]	[illegible]	[illegible] silty - red yellow - hard - [illegible] - moist	
[illegible]	[illegible]	[illegible] sandy - red yellow - hard - moist	
[illegible]	11.[illegible]+	Sand, coarse, silty - light brown powdery - damp - hard - p.p. [illegible] - feldspar fragments - dry hole - [illegible] coarse granite	

TP [illegible], STA. [illegible] [illegible]

0.[illegible]	0.9	Sand, silty - light olive brown - Lloyd soil	
0.9	7.8	Silt, fine sandy - yellow red - hard - p.p. 4.5 - quartz and feldspar fragments - digs hard - dry hole	
7.8+		weathered granite - can be rippe	

[illegible]

TP [illegible], STA [illegible]

[illegible] Silt, fine sandy [illegible] - topsoil [illegible]

[illegible] Clay, silty [illegible]

[illegible] Silt, fine sandy [illegible] - hard [illegible]

[illegible] Sand, silty [illegible] - weathered granite - dry hole

TP [illegible], STA [illegible]

[illegible] Silt, fine sandy [illegible] red - topsoil [illegible]

[illegible] Clay [illegible] - hard - moist - blocky [illegible]

[illegible] Silt, sandy - fine sandy - high fine mica - [illegible] (ML) - moist - weathered granite - dry hole

TP [illegible], STA [illegible]

[illegible] Sand, silty - reddish brown - topsoil [illegible] (SM)

[illegible] Clay, silty - red - hard - p.p. [illegible] - moist to wet - clay seams (CL)

[illegible] Silt, fine sandy - yellow brown - hard - p.p. [illegible] - moist (ML)

[illegible] Sand, silty, gravelly - pale brown - moist - hard - p.p. [illegible] - angular quartz gravel - mica [illegible] - weathered granite and coarse granite - dry hole (SM)

TP [illegible], STA [illegible]

[illegible] Sand, silty - reddish brown - topsoil - [illegible] (SM)

[illegible] 2.7 Clay, silty - red - hard moist (CL)

[illegible] Sand, silty - red yellow - hard - moist - high mica - weathered aplite stringers - weathered granite - dry hole (SM)

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

[illegible] Sand, silty - reddish brown - topsoil - [illegible] (SM)

[illegible] Clay, silty - red - hard - moist - p.p. [illegible] (CL)

[illegible] Silt, sandy - red - hard - p.p. [illegible] - moist (ML)

[illegible] Sand, silty - yellow red - moist - hard - [illegible] hole - weathered granite (SM)

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

[illegible] Sand, silty - reddish brown - topsoil - Lloyd [illegible] (SM)

[illegible] Clay, silty - red - moist - hard (CL)

[illegible] Silt, fine sandy - yellow red - moist - hard (ML)

[illegible] Sand, silty - red yellow - moist - hard - weathered granite - dry hole (SM)

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

[illegible] Silt, fine sandy - brown gray - dry - topsoil - Appling soil) (ML)

1.7 1.9 Clay, silty - red yellow - hard - blocky - p.p. [illegible] - moist (CL)

1.9 [illegible] Silt, sandy - red yellow - hard - p.p. [illegible] - moist (ML)

[illegible] 11.7+ Sand, coarse, silty - light brown and white - powdery - damp - hard - p.p. [illegible] - angular feldspar fragments - dry hole - weathered coarse granite (SM)

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

[illegible] [illegible] Sand, silty - light olive brown - topsoil - Lloyd soil (SM)

[illegible] 7.8 Silt, fine sandy - yellow red - moist - hard - p.p. [illegible] - quartz and feldspar fragments - digs hard - dry hole (ML)

7.8+ Weathered granite - can be ripped

[illegible]

TP [illegible], STA [illegible]

[illegible] Sand, silty - [illegible] - alluvial

[illegible] Clay, sandy, silty - [illegible] - moist - [illegible] (CL)

[illegible] Clay, silty - [illegible] - moist - [illegible] - p.p. [illegible] (CL)

[illegible] Sand, silty - [illegible] - wet - soft - p.p. [illegible] (SM)

[illegible] Sand, silty - light brown - [illegible] - moist (SM)

[illegible] Hard boulders [illegible]

TP [illegible], STA [illegible]

[illegible] Sand, silty - red brown - roots - topsoil - alluvial (SM)

[illegible] Clay, silty - brown - roots - moist - soft - p.p. [illegible] (CL)

[illegible] 6.7 Clay, silty - gray - moist to wet - soft - p.p. [illegible] - seep at [illegible] (CL)

6.7 9.7 Sand, coarse, gravelly - gray with white quartz gravels - water bearing - could not get Shelby tube in layer (SM)

9.7 1[illegible]+ Sand, silty - high mica - olive and red yellow - buried soil - stiff - p.p. 2.0 (SM)

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

[illegible] Sand, silty - red brown - roots - topsoil - alluvial (SM)

[illegible] 1.1 Clay, silty - brown red - moist - medium - p.p. 1.1 (CL)

1.1 1.5 Sand, silty - brown red - moist - soft - p.p. [illegible] (SM)

[illegible] Clay, silty - micaceous - gray - moist - soft - p.p. [illegible] - [illegible] moisture [illegible] (CL)

[illegible] Gravel, coarse, sandy - [illegible] - water bearing - quartz (GW)

[illegible] Sand, silty - micaceous - olive yellow - buried soil - medium (SM)

TP [illegible], STA [illegible]

[illegible] Sand, silty, clayey - red brown - topsoil, alluvial (SM)

[illegible] 1.5 Clay, silty - brown red - firm - p.p. 1.5 (CL)

[illegible] 2.0 Sand, silty, clayey - red on top - gray on bottom - moist - soft - p.p. [illegible] (SM)

2.0 7.0 Clay, silty - gray moist to wet soft p.p. 1 (CL)

7 + Hard unfractured granite

TP [illegible], STA [illegible]

0.0 0.5 Sand, silty, clayey - red brown - topsoil - alluvial (SC)

0.5 1.2 Clay, silty - red brown - moist - medium - p.p. 1.0 (CL)

1.2 4.0 Clay, silty - gray - soft - moist - p.p. 0.1 (CL)

4.0 5.8 Sand, silty, clayey - gray - moist to wet - medium - p.p. 1.5 (SC)

5.8 8.8 Sand, gravelly - gray - quartz gravels - water bearing (SW)

8.8 12.2+ Sand, silty - gray - micaceous - medium - weathered rock (SM)

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

0.0 0.5 Sand, silty, clayey - red brown - topsoil - alluvial (SM)

0.5 1.8 Clay, silty - brown red - medium - moist - p.p. 0.8 (CL)

1.8 2.6 Sand, silty - brown red - moist - medium (SM)

2.6 6.8+ Clay, silty - gray - soft - moist to wet - p.p. 0.1 (CL)

(TP [illegible] Con't)

[illegible]

[illegible] Sand, silty - [illegible] - water [illegible]

[illegible] Sand, silty [illegible]

TP [illegible], STA [illegible]

[illegible] Sand, silty, clayey - red brown - topsoil - alluvial (SM)

[illegible] Clay, silty - brown red - moist - medium - p.p. [illegible] (CL)

[illegible] Clay, silty - gray - moist to wet - soft - p.p. [illegible] (CL)

[illegible] Sand, silty - gray - medium - p.p. [illegible] - wet (SM)

[illegible] Sand, gravelly - gray with white quartz gravels - water bearing (SW)

[illegible] Sand, silty - gray medium - p.p. [illegible] - wet - weathered rock (SM)

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

[illegible] Sand, silty, clayey - red brown - topsoil - alluvial (SM)

1.5 [illegible] Clay, silty - gray - moist to wet - soft - p.p. [illegible] (CL)

3.1 6.7 Sand, silty - gray - seepage present - soft - p.p. 0.7 (SM)

6.7 9.1 Sand, silty, gravelly - water bearing (SM)

9.1 1[illegible]+ Sand, silty - gray blue - moist - medium - p.p. 0.7 - buried soil

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

0.0 0.5 Sand, silty, clayey - red brown - topsoil - (SM) alluvial

0.5 1.6 Clay, silty - brown red - soft - p.p. 0.6 - (CL) moist

1.6 1[illegible]+ Sand, silty, coarse - olive gray - water bearing - medium - p.p. [illegible] - hole fills with water faster than can be dug - stratified layers - dry density 11[illegible] - moisture 2[illegible]% (SM)

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

0.0 0.5 Silt, fine sandy - brown red - topsoil - Cecil soil) (ML)

0.5 3.6 Clay, silty - moist - hard - p.p. 3.7 (CL)

3.6 4.7 Sand, silty - light yellow - moist to wet - seep at 4.5 - weathered granite - hard to dig (SM)

4.7+ Weathered granite can be ripped with heavy machinery

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

[illegible] Silt, fine sandy - brown red - topsoil - Cecil soil (ML)

[illegible] 2.5 Clay, silty - yellow red - micaceous - moist - hard - p.p. [illegible] (CL)

2.5 8.6 Sand, silty - pale yellow and white - moist - hard - weathered granite - digs hard - double size quartz particles - water at [illegible] (SM)

8.6+ Weathered granite - too hard to dig

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

0.0 0.7 Silt, fine sandy - brown red - topsoil - Cecil soil) (ML)

0.7 1.4 Clay, silty - red - hard - p.p. 4.8 - moist (CL)

1.4 4.7 Silt, fine sandy - yellow red - hard - p.p. 3.4 - moist (ML)

4.7 11.1+ Sand, fine silty - red brown - high mica - moist to wet - water at [illegible] - stiff - p.p. 1.8 (SM)

[illegible]

LOGS OF TEST HOLES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Investigated by: T. [illegible] August, 1961

Drawn by:

Checked by:

Typed by: Martha O. [illegible]

Geologist

Sheet [illegible] of [illegible]

VA 455 P

		Silt, fine, sandy - dark brown - leaves - topsoil	(ML)
	2.	Clay, silty - brown red - micaceous - moist medium	(CL)
	3.2	Clay, silty - silver gray - moist to wet - soft - p.p. [illegible]	(CH)
	4.5	Sand, silty, gravelly - gray - soft - p.p. [illegible] - stratified - water bearing - water at [illegible]	(SM)
		Sand, silty - burnin' weathered bedrock	(SM)
	6.2+	White granite - too hard to dig	

TP [illegible], STA. [illegible], [illegible] E/W

	0.5	Silt, fine sandy - dark brown - leaves - topsoil	(ML)
	[illegible]	Clay, silty - red brown - moist - soft - p.p. [illegible]	(CL)
	[illegible]	Clay, silty - silver gray - moist medium - soft - p.p. [illegible]	(CL)
	[illegible]	Sand, silty - olive gray - soft - p.p. [illegible] - wet to moist - seam at [illegible]	(SM)
	7.5	Sand, silty - blue gray - water bearing - soft - p.p. [illegible]	(SM)
7.5+		White granite - hard - cannot be dug	

TP [illegible], STA. [illegible], [illegible] E/W

	0.5	Silt, fine, sandy - brown - loose - leaves - topsoil	(ML)
0.5	8.	Clay, fine, sandy - gray - moist - medium - p.p. [illegible] to 1	(CL)
8.	8.2+	White granite - hard fractured - water at 7.[illegible]	

TP [illegible], STA. [illegible], [illegible] E/W

0.	0.5	Silt, fine, sandy - brown red - loose - topsoil.	(ML)
0.5	1.5	Clay, silty - red - hard - p.p. [illegible]	(CL)
1.5	9.2	Silt, clayey - yellow red - hard - p.p. 4.0 - moist	(ML)
9.2	11.7+	Sand, silty - light brown yellow - moist - hard in place - p.p. 3.5 - dry hole	(SM)

TP [illegible], STA. [illegible], [illegible] E/W

0.	0.5	Silt, fine, sandy - brown red - loose - topsoil	(ML)
0.5	6.2	Clay, silty - red - moist - hard - p.p. 4.0	(CL)
6.2	11.0	Sand, silty - yellow - wet to moist - water at 9.0' - hard in place - p.p. 2.5	(SM)
11.0	17.5+	Sand, silty - gray salt and pepper - weathered rock - hard in place - p.p. 3.0	(SM)

TP [illegible], STA. [illegible], [illegible] E/W

		White granite - hard - fractured - dry hole	

TP [illegible], STA. [illegible], [illegible] E/W

0.	0.5	Silt, fine, sandy - brown - leaves - topsoil - Lloyd soil	(ML)
		Clay, silty - red - hard - p.p. 4.0 - moist	(CL)
	1.1	Clay, silty - yellow red - hard - moist - p.p. 4.0 - clay skins	(CL)
1.1	6.0	Silt, fine, sandy - yellow red - hard - moist	(ML)
6.	13.6+	Sand, silty - gray - salt and pepper color - hard in place - moist - dry hole	(SM)

TP [illegible], STA. [illegible], [illegible] E/W

0.	0.5	Silt, fine, sandy - brown - leaves - loose - topsoil - Lloyd soil	(ML)
0.5	1.1	Clay, silty - yellow red - hard - moist - p.p. 4.0 - clay skins	(CL)
1.1	6.0	Silt, fine, sandy - yellow red - hard - moist	(ML)
6.	13.6+	Sand, silty - gray - salt and pepper color - hard in place - moist - dry hole	(SM)

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.	0.5	Silt, fine, sandy - brown - leaves - loose - topsoil - Lloyd soil	(ML)
0.5	1.5	Clay, silty - yellow red - hard - moist - p.p. 4.0 - clay skins.	(CL)
1.5	5.1	Silt, fine, sandy - yellow red - hard - p.p. 3.5 - moist - clay skins	(ML)
5.1	14.2+	Sand, silty - gray salt and pepper color - hard in place - dry hole	(SM)

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine, sandy - brown gray leaves - Lloyd Soil	(ML,
0.5	1.8	Clay, silty - red - hard - p.p. 3.5 - clay skins - moist	(CL,
		DS 250.1 D - 1.8'	
1.8	12.8	Silt, clayey - yellow red - micaceous - moist - hard in place	(ML,
		IS 250.1 - 1.8' - 12.8'	
12.8	13.0+	Granite - hard - jointed - clay skins in joints - dry hole	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.	0.5	Silt, fine, sandy - brown gray, leaves - topsoil - Lloyd soil	(ML
0.5	3.6	Clay, silty - red - hard - p.p. [illegible]	(CL
3.6	7.2	Silt, fine, sandy - yellow red - micaceous - moist - hard - p.p. [illegible]	(ML
7.2	7.4+	Granite - jointed - clay skins in joints - dry hole	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.	0.5	Silt, fine, sandy - brown gray - leaves - topsoil - Lloyd soil.	(ML
0.5	4.1	Clay, silty - red - hard - p.p. [illegible] - moist	(CL)
4.1	7.2	Silt, clayey - yellow red - moist - hard - p.p. [illegible]	(ML)
7.2	10.9+	Sand, silty - brown - high mica - hard in place - p.p. 3.0 - dry hole	(SM
		DS 250.1 7.2' - 10.9'	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine, sandy - brown gray - leaves - topsoil - Lloyd soil	(ML)
0.5	5.2	Clay, silty - red - hard - p.p. 4.0 - moist	(CL)
5.2	8.6	Silt, clayey - yellow red - hard - p.p. 4.0 - moist	(ML)
8.6	14.7+	Sand, silty - brown - high mica - moist - hard - p.p. 4.0 - dry hole	(SM)

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine, sandy - brown gray - leaves - topsoil - Lloyd soil	(ML)
0.5	1.5	Clay, silty - red - hard - moist	(CL)
1.5	11.0+	Silt, clayey - yellow red - hard - moist - dry hole.	(ML)

[illegible]

		[illegible]	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

		[illegible]	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine, sandy - red brown - leaves - topsoil	(ML
0.5	2.2	Clay, silty - red - hard - moist -	
2.2	8.0	Silt, clayey - yellow red - moist - p.p. 3.0	
8.0	17.0+	Sand, silty - yellow red - micaceous - hard in place - p.p. 2.5 - dry h[illegible]	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine sandy - red brown - leaves - topsoil	(ML
0.5	1.1	Silt, sandy - red brown - leaves - topsoil	
1.1	2.1	Silt, sandy - red yellow - hard - moist	
2.1	4.1	Sand, silty - yellow white - weathered rock hard - p.p. 4.5 - moist	
4.1	4.6+	White granite - fractured - dry ho[illegible]	

TP [illegible], STA. [illegible], [illegible] E/W, [illegible]

0.0	0.5	Silt, fine sandy - red brown - leaves - topsoil	(ML
0.5	2.2	Clay, silty - red - hard - moist -	
2.2	8.0	Silt, clayey - yellow red - moist - p.p. 3.0	
8.0	17.0+	Sand, silty - yellow red - micaceous - hard in place - p.p. 2.5 - dry h[illegible]	

"AS BUILT"

U.S. DEPARTMENT OF AGRICULTURE
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PLATE 7

TP [illegible], STA. C/L 2+91 [illegible], ELEV. [illegible]

[illegible]	[illegible]	Silt, fine sandy - brown red topsoil - Cecil soil	(ML)
[illegible]	1.8	Clay, silty - red - moist - hard - p.p. 4.[illegible]	(CL)
[illegible]	5.3	Silt, clayey - red yellow - moist - hard - p.p. 3.0	(ML)
5.[illegible]	22.0*	Sand, silty - brown gray - high mica - moist to wet - weathered bedrock - seep at 7.4 - stiff - p.p. 2.0	(SM)

TP [illegible]5, STA. C/L 3+28 [illegible], ELEV. 699.4

0.[illegible]	0.4	Silt, fine sandy - brown red - topsoil - Seneca soil	(ML)
0.[illegible]	1.2	Clay, silty - yellow red - moist - hard - p.p. 4.1	(CL)
1.2	6.5	Silt, clayey - red yellow - moist - p.p. 2.6 - strong spring at 6.4	(ML)
6.5	10.3*	Sand, silty - olive gray - micaceous - stiff - p.p. 1.9 - wet to moist - highly weathered colluvial or residual material	(SM)

TP [illegible]6, STA. C/L 3+91 [illegible], ELEV. 69[illegible].6

0.0	0.5	Silt, fine sandy - brown red - topsoil - Seneca soil	(ML)
0.5	8.2	Clay, silty - red - moist to wet - hard - p.p. 4.3 - clay skins - small seep 6.[illegible]	(CL)
[illegible].2	10.7*	Sand, silty, gravelly - light yellow - feldspar and quartz - angular gravels - colluvial - hard - p.p. 4.0 - moist to wet	(SM)

TP [illegible], STA. 19' L C/L 5+[illegible] DAM, ELEV. 699.7

0.0	0.5	Sand, silty - red brown - roots - topsoil - alluvial	(SM)
0.5	1.2	Clay, silty - brown red - soft - moist - p.p. 0.2 - roots	(ML)
1.2	3.1	Clay, silty - brown gray - soft - p.p. [illegible] moist	(CL)
3.1	7.2	Sand, silty - gray - soft - p.p. 0.5 - moist at top - wet at bottom - seep at [illegible]	(SM)
7.2	[illegible]	Sand, gravelly - water bearing - pockets of quartz gravel	(SP to [illegible])
[illegible]	[illegible]	Sand, silty - high mica - olive yellow - moist - p.p. [illegible] - on top and [illegible] on bottom - weathered granite	(SM)

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

[illegible]	[illegible]	Silt, fine sandy - brown - topsoil - Seneca soil	(ML)
[illegible]	[illegible]	Clay, silty - yellow red - hard - p.p. [illegible] - moist	[illegible]
5.[illegible]	[illegible]*	Gravel, silty - brown - [illegible] - compact - with clay cement - moist - [illegible] at [illegible] to 7.[illegible] - dry [illegible] - strong spring at [illegible]	(GM)

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

[illegible]	[illegible]	[illegible]	
[illegible]	6.[illegible]	Clay, silty - red - hard - p.p. [illegible] - colluvial - Seneca soil	[illegible]
[illegible]	7.[illegible]*	Sand, silty - yellow brown - micaceous - hard - p.p. [illegible]	[illegible]

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

[illegible]	[illegible]	Sand, silty, clayey - red brown - topsoil - alluvial	
[illegible]	[illegible]	Sand, silty - yellow red on top - olive gray on bottom - moist to wet	[illegible]
2.[illegible]	[illegible]	Clay, silty - olive gray - wet - soft - p.p. [illegible]	(CL)
3.[illegible]	[illegible]	Sand, silty - olive gray - wet - soft - p.p. [illegible]	SM
[illegible]	9.2*	Sand, gravelly - gray - water bearing - rounded cobbles	(SM)

LEGEND

TEST PIT NUMBERING SYSTEM

Centerline of dam	1 - 99
Borrow area	101 - 199
Emergency Spillway	201 - 299
Centerline of outlet structure	301 - 399
Stream channel	401 - 499
Relief wells	501 - 599
	601 - 699
	701 - 799

UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOLS

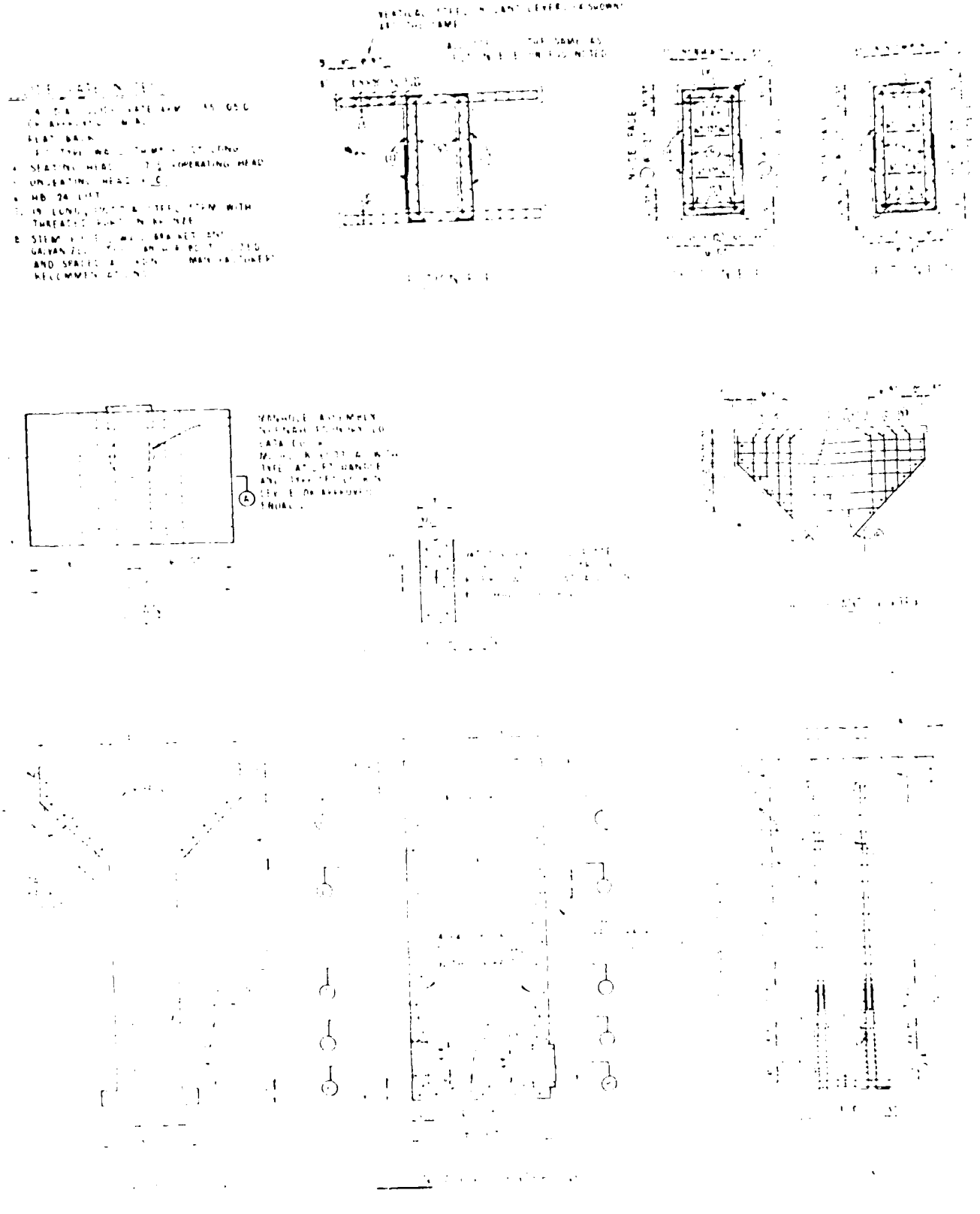
GW	Well graded gravels; gravel-sand mixtures
GP	Poorly graded gravels
GM	Silty gravels; gravel-sand-silt mixtures
GC	Clayey gravels; gravel-sand-clay mixtures
SW	Well graded sands; sand-gravel mixtures
SP	Poorly graded sands
SM	Silty sands; sand-silt mixtures
SC	Clayey sands; sand-clay mixtures
ML	Silts; silty, v. fine sands; sandy or clayey silts
CL	Clays of low to medium plasticity; silty, sandy or gravelly clays
CH	Clays of high plasticity; fat clays
MH	Elastic silts; micaceous or diatomaceous silts
OL	Organic silts and organic silty clays of low plasticity
OH	Organic clays or silts of medium to high plasticity

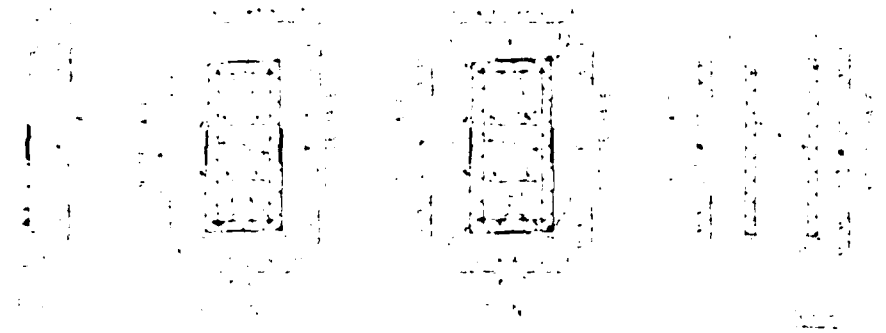
All soil and rock descriptions and classifications were determined by visual examination July, 197[illegible]

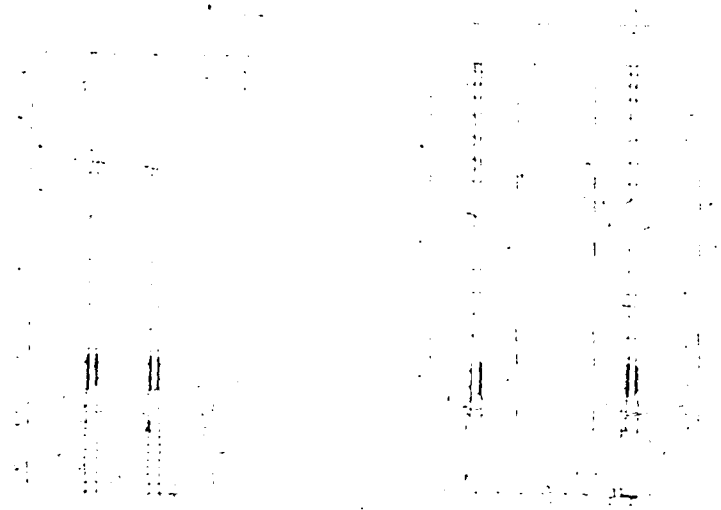
"AS BUILT"

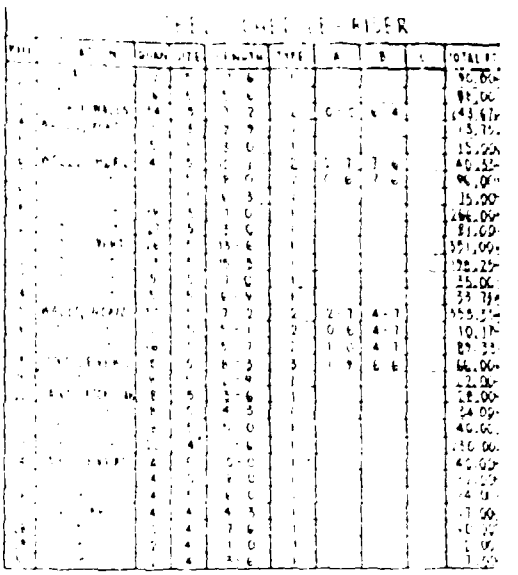
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

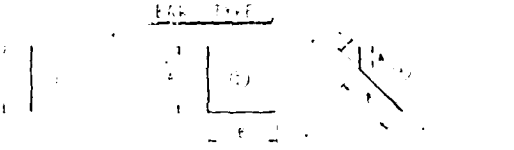
PLATE 3

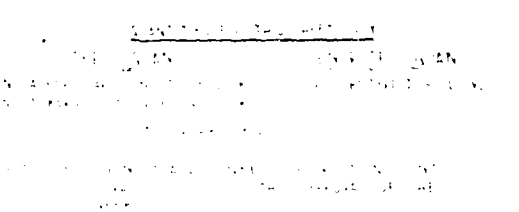


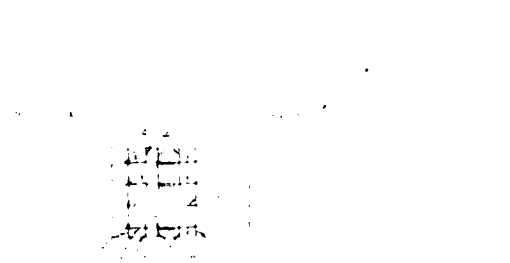












DAM NO 6 LEATHERWOOD CREEK
LEATHERWOOD CREEK WATERSHED
RISER DETAILS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PLATE 9

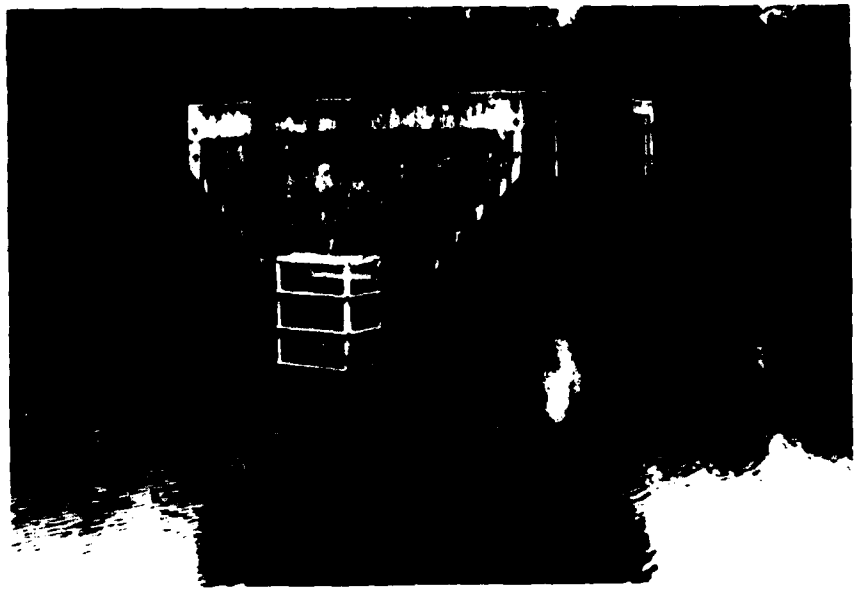
VA - 485 - P

APPENDIX II

PHOTOGRAPHS

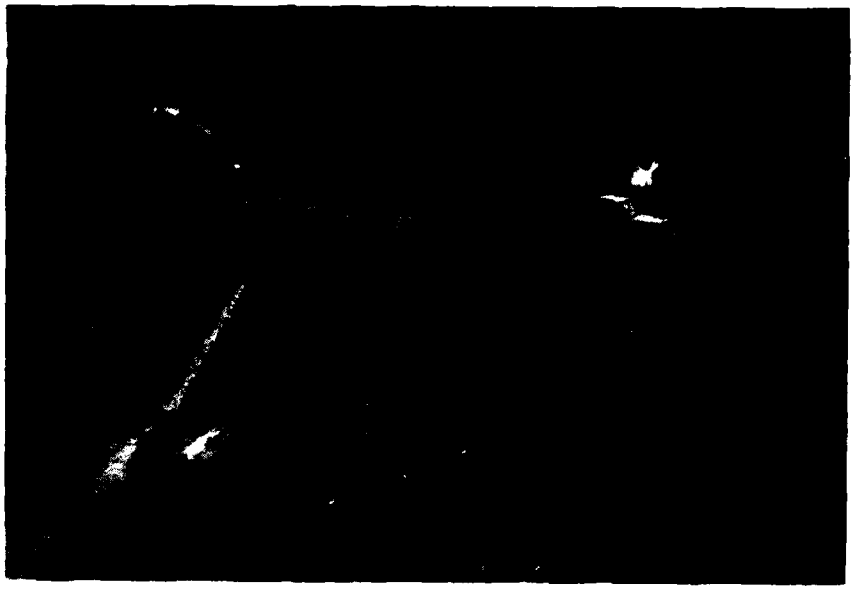
Photograph No. 1 - Upstream Slope

Photograph No. 2 - Downstream Slope



Photograph No. 3 - Intake Structure
(Note Debris in Low Flow Inlet)

Photograph No. 4 - Outlet Pipe and Plunge Pool



Photograph No. 5 - Emergency Spillway
(Note Erosion Due to Vehicular Traffic)

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Leatherwood No. 6 County Henry State Virginia Coordinates Lat 36° - 41.6' Long 79° - 47.8'

Date(s) Inspection July 1, 1981 Weather Cloudy Temperature 85° F

Pool Elevation at Time of Inspection 711 msl Tailwater at Time of Inspection 696 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

Recorders
Stephen G. Werner
Steve Oddi

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

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Some cracking was observed in non-vegetated areas of the embankment. The cracks are believed to be shrinkage cracks. Dense vegetation on the embankment made observation difficult. Ground conditions were dry at the time of the inspection.	Vegetation should be maintained.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements were noted on the dam beyond the downstream toe.	-
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	The embankment crest is not vegetated. It includes a meandering road with numerous ruts ½ to 1 ft± deep. One rut is 2 ft± deep. There is a 1 ft wide x 1-1½ ft± deep rut from the left side of the pool up the EMS approach channel. Approximately 50 ft right of this area is a dug up area 20 ft± long x 5 ft± wide - may be caused by digging for fishing worms. There are two similar areas, one near the intake structure and another 100 ft± left of the right end of the upstream slope-abutment contact. Scattered shallow erosional channels or washes also occur along the upstream slope, particularly near pool level. Bare footpaths occur along the right side of the upstream slope and across the base of the upstream slope just above pool level.	See Field Sketch 1
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The vertical and horizontal alignment of the dam appeared to be good. Field measurements indicate a crest width of 14 ft. The embankment slopes are 2.5H:1V. A 15 ft wide berm exists on the downstream slope and also on the upstream slope at pool level.	-
RIPRAP FAILURES	No riprap on the upstream slope. Scattered erosional notches 1 ft± high extend 1 to 2 ft± into the upstream slope. This erosion is related to the low pool level. Riprap, 1-3 ft± long lines the plunge pool. It appears to be functioning properly and is in good conditon.	-

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 access road extends across the left EMS and abutment area into the dense woods. A riprap channel lines the right abutment downsteam slope contact from the crest to the downstream berm. The left abutment shows old erosion in the form of shallow washing along the bench on the downstream slope.	Riprap gutter appears to be rather new and may have been installed to restrict erosion.
ANY NOTICEABLE SEEPAGE	The downstream toe is dry and no seepage was encountered.	The thick vegetative cover make observation difficult.
DRAINS	Two 6 inch cmp toe drains bound each side of the outlet pipe, 2 ft from the edges of the concrete cradle. The right pipe is iron stained and clear water was flowing from the pipe at approximately ½ gpm. No flow was observed from the left pipe, the lower half of which was filled with vegetation.	Vegetation should be removed from the left toe drain and outlet.
MATERIALS	The embankment appears to be constructed with fine to coarse sand, some silty clay, with gravel and mica, moist to dry - light brown to gray (SC)	-
VEGETATION	The upstream and downstream slopes are heavily vegetated with tallgrass, brush, briers (or blackberry bushes) and honeysuckle. Scattered trees occur at various locations at pool level and up to 5 ft above pool level on the upstream slope. The trees are generally less than 2 inches in diameter.	Vegetation should be controlled and properly maintained.

PRINCIPAL SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONTROL SECTIONS	Concrete riser type structure with low level orifice, high level weir and trash rack. There was debris in the trash rack.	Debris in and around the trash rack should be removed.
APPROACH CHANNEL	None	-
DISCHARGE CHANNEL	24 inch concrete pipe; 3 ft$^{+}_{-}$ from pipe invert to plunge pool. The plunge pool is lined with riprap which appeared to be intact.	In good condition
BRIDGE AND PIERS	-	-
EMERGENCY GATE	Drain valve stem attached to top of intake structure. No wheel on the stem.	-
GATES AND OPERATION	-	-

EMERGENCY SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONTROL SECTIONS	100 ft wide. Well vegetated except for bare and eroded areas caused by vehicular traffic.	Bare and eroded areas should be corrected and reseeded.
APPROACH CHANNEL	Some erosion along road leading to toe of embankment. Rut is 1.5 ft± deep. Well vegetated except for bare and eroded areas caused by vehicular traffic.	Bare and eroded areas should be corrected and reseeded.
DISCHARGE CHANNEL	Well vegetated except for bare and eroded areas caused by vehicular traffic.	Bare and eroded areas should be corrected and reseeded.
BRIDGE AND PIERS		
MISCELLANEOUS		

INSTRUMENTATION

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

VISUAL EXAMINATION		REMARKS AND RECOMMENDATIONS
SLOPES		
SEDIMENTATION		

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Heavy underbrush; the channel is tree lined.	n = 0.1
	The channel is 10 ft wide and 8 ft high	n = 0.05
	The floodplain is 200 ft wide on the right side and is covered with heavy brush.	n = 0.1
SLOPES	3H:1V side slopes	
APPROXIMATE NO. OF HOMES AND POPULATION	Two commercial facilities are located 1.2 miles downstream about 15 ft above the streambed.	Potential hazard

CHECK LIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, OPERATION

ITEM		REMARKS
REGIONAL VICINITY MAP	Martinsville East 7½ minute topographic map (U.S.G.S)	-
DESIGN/CONSTRUCTION HISTORY	Designed by USDA, SCS. Constructed by Larramore Construction Co. 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	-

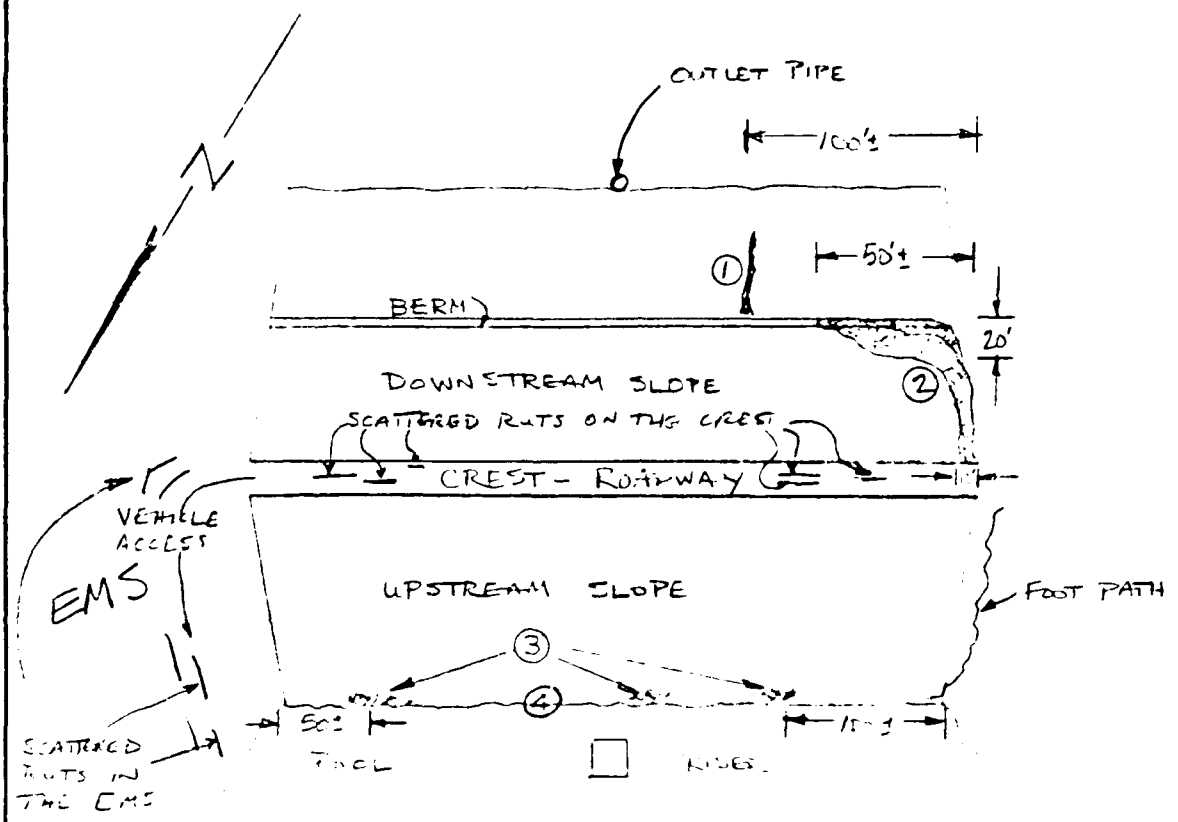
ITEM		REMARKS
MONITORING SYSTEMS	None	-
RAINFALL/RESERVOIR HIGHPOOL RECORDS	None	-
GEOLOGY REPORTS	See Appendix II and Reference 3, Appendix VI	-
BORROW SOURCES	See Appendix I	-
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY-FIELD TEST DATA	See Appendix I	-
HYDROLOGIC/HYDRAULIC DATA	Design data available 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	-

BY JW DATE 7-1-81 **SCHNABEL ENGINEERING ASSOCIATES** SHEET NO. 1 OF 1

CHKD BY DATE **CONSULTING ENGINEERS** JOB NO. V 81301

SUBJECT FIELD SKETCH OF DAM – LEATHERWOOD NO. 6



NO SCALE

① ERODED AREA 1 FT± WIDE AND 2 FT± DEEP EXTENDING HALF WAY DOWN THE LOWER FACE OF THE SLOPE.

② RIGHT DOWNSTREAM ABUTMENT – SLOPE CONTACT LINED WITH 2 INCH – 6 INCH ROCK BUT INCLUDES SOME BOULDERS UP TO 3 FT± IN LENGTH.

③ LEFT AREA 20 FT± LONG X 5 FT± WIDE. OTHER TWO AREAS SIMILAR IN SIZE. THESE AREAS CONSIST OF DISTURBED SOIL – MAY BE CAUSED BY FISHERMEN DIGGING FOR BAIT.

④ SCATTERED EROSIONAL SCARPS (1 FT± HIGH AND 1-2 FT± DEEP) PRESENT AT POOL LEVEL.

APPENDIX IV

DESIGN REPORT

U S DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

This floodwater retarding dam is located on the Camp branch which is a tributary of Leatherwood Creek approximately 4 miles east of Martinsville, Virginia. Sheet 4 of this report, together with the Martinsville, Virginia-North Carolina 15-minute quadrangle published by the U.S. Geological Survey, may be used to locate the structure.

A summary of pertinent design information is given on sheet 2 of this report.

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

National Engineering Memorandum No. 27, Limiting Criteria for the Design of Earth Dams
National Engineering Memorandum No. 42, 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. 6, Structural Design
Engineering Division Technical Release No. 3, Earth Spillways
Engineering Division Technical Release No. 5, Structural Design of Underground Conduits
Engineering Division Technical Release No. 10, Storage-Floodwater Retarding Structures
Engineering Division Technical Release No. 12, Procedure for Computing Sediment Requirements for Retarding Reservoirs

This is one of five flood retention structures designed to reduce flood damages in the Leatherwood area. It will retard a 5-year frequency flood which damages occurring in the emergency spillway.

[illegible] of this dam and [illegible] are given on sheet [illegible] of this report.

The dam is a compacted earth fill with a cutoff through [illegible], sand, gravel and gravel. A drainage system is located under the downstream portion of the earth fill to control seepage.

The principal spillway is a drop inlet structure consisting of a reinforced concrete riser, 24-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.

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

U. S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

[illegible] STRUCTURE

I. Watershed data

A. Structure class	[illegible]	
B. Drainage area	[illegible]	Ac.
C. Time of concentration - t_c	[illegible]	Hrs.
D. Hydrologic curve number - C_n		
1. Moisture condition II	[illegible]	
2. Moisture condition III	[illegible]	

II. Principal spillway

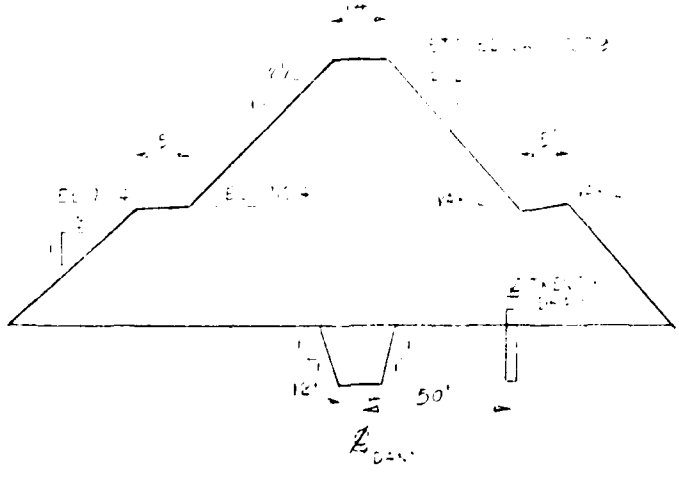
A. Conduit		
1. Size (I.D.)	[illegible]	In.
2. Length	[illegible]	Ft.
B. Riser		
1. Size	[illegible]	Ft.
2. Height	[illegible]	Ft.
C. Weir length	[illegible]	Ft.
D. Orifice size	[illegible]	In.
E. Pond drain size	[illegible]	In.
F. Type of energy dissipator	[illegible]	

III. Emergency spillway

A. Width	[illegible]	Ft.
B. Side slopes	[illegible]	
C. Length of level section	[illegible]	Ft.
D. Exit slope	[illegible]	Ft./Ft.
E. Maximum velocity at control section (E.H.W.)	[illegible]	Ft./Sec.
F. Duration of flow (E.H.W.) through emergency spillway	[illegible]	Hrs.
G. Frequency of use	[illegible]	%

IV. Earth Fill

A. Height	[illegible]	Ft.
B. Volume	4383	C.Y.
C. Compaction	[illegible]	



Typical Cross Section

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet

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	.	.	-1/	-	-	-	-
Crest of riser	. .	.	.	-1/	1.	-	-	
Crest of emergency spillway	50-year frequency storm, moisture condition	. -2/	.	2.-1/	. -	-	-	
Design high water	. X 6-hour point rainfall, moisture condition	.	.	-1/	.	.		
Top of dam	. . X 6-hour point rainfall, moisture condition	.	.	. -1/	.	.		

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

1/ Does not include 5 acre-feet of sediment storage in detention flood pool.
2/ Does not include storage above crest of spillway.
3/ Established by provisions of Section 4 of Watershed Memorandum No. 1.

ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet

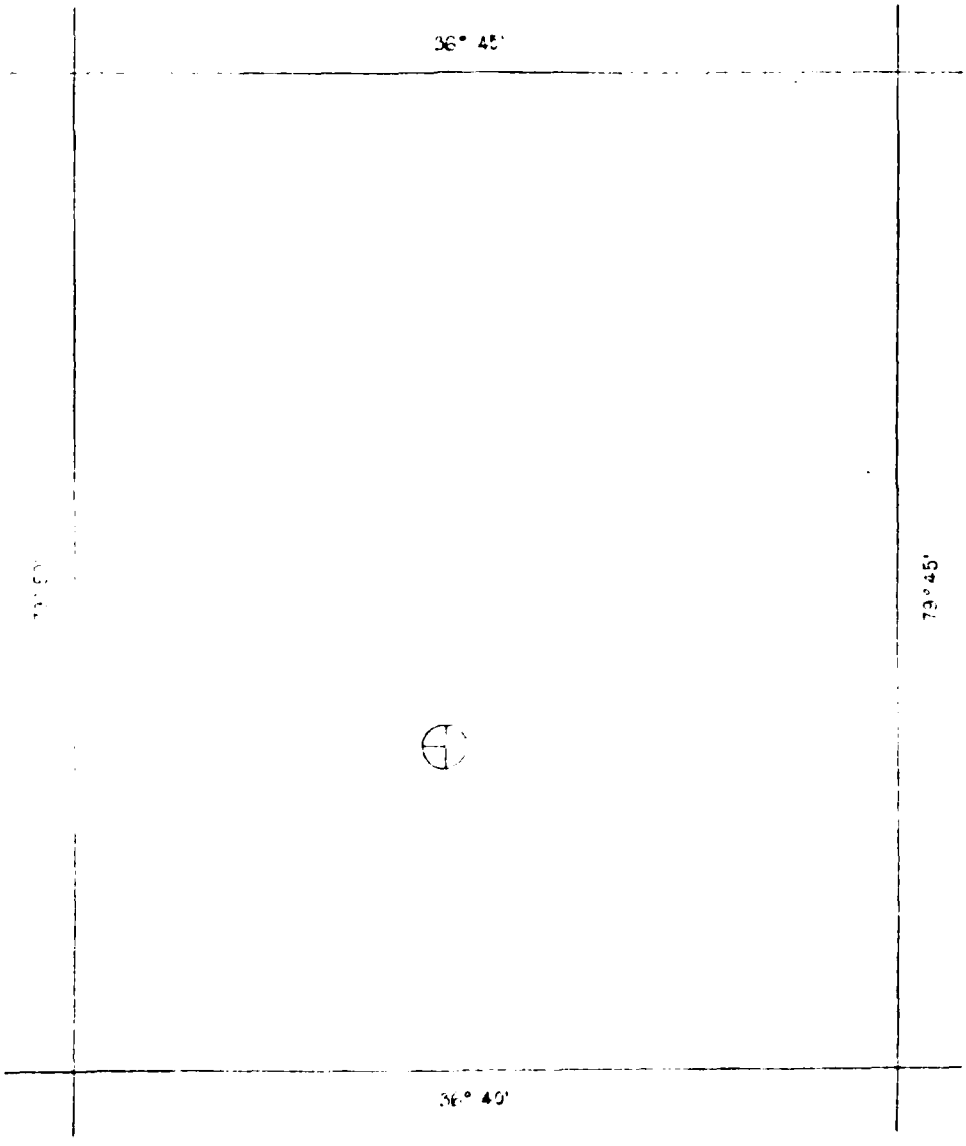
U. S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

[illegible]

[illegible]

VA-[illegible]

HENRY COUNTY, VIRGINIA



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ENGINEERING & WATERSHED PLANNING UNIT, UPPER DARBY, PA

Sheet [illegible]

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, [illegible], Pa.

Concurred:

[signature]
[illegible]
Design Engineer

[signature]
E. L. Barnes, Jr.
State Conservation Engineer

[signature]
for V. M.
[illegible]
Hydrologist

[signature]
[illegible]
Geologist

Methods and Procedures

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 to the samples. Standard description of these soils are included.

4. In the logs the underlying rock is referred to as granite and coarse granite. This is for simplification into easily understandable terms. Actually the "granite" is a gneissic syenite. This is a rock that has orthoclase feldspar and biotite mica as the major minerals. It contains little, if any, quartz. Plagioclase feldspar and muscovite mica are present in minor ammounts.

The geologic name for the "coarse grained granite" is pegmatite. It is composed of large crystals of orthoclase feldspar, muscovite mica and quartz. It is more acid than the local granite. The pegmatite occurs as dikes in the mass of gneissic granite.

5. The centerline of the dam was moved 100 feet upstream. This was to insure that the cut-off trench rest on a firmer foundation. This made it necessary to make two investigations on this dam site. As a result of this, there are two lists of test pit logs. On the plans test pit numbers that would normally designate the different parts of the dam are not in those locations. Subsequent test pits were dug to investigate the geologic conditions of these latter locations.

VA 485 G
1 of 7

Sheet 2 of 7

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Virginia County Henry - ¼ - ¼ Sec - T - R - , Watershed Leatherwood Cre

Subwatershed - Fund class FP-08 (FP 2, WP 1 etc.) Site number 6 Site group I Structure class a

Investigated by Mack, T., Geologist (signature and title) Equipment used Case backhoe (Type, size, make, model, etc.) Date 7/63

SITE DATA

Drainage area size 2.08 sq mi, 1331 acres Type of structure Earth Fill Purpose Flood Prevention

Direction of valley trend (downstream) SE Maximum height of fill 31.4 feet, Length of fill 500 fee

Estimated volume of compacted fill required 37,899 cubic yards

STORAGE ALLOCATION

	Volume (ac ft)	Surface Area (acres)	Depth at Dam (feet)
Sediment	73	13.5	10.6
Floodwater	418	37.0	26.3

SURFACE GEOLOGY AND PHYSIOGRAPHY

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

Steepness of abutments Left 15 percent Right 45 percent Width of floodplain at centerline of dam 275 fe

General geology of site Dam site #6 is underlain by the Wissahickon formation according to 1928 Geologic Map of Virginia. However, on this map the boundary of the Leatherwood granite and the Wissahickon formation is only one mile upstream.

The rock present is a syenite gneiss. The major minerals of the syenite gneiss are orthoclase feldspar and biotite mica. This gneiss weathers to a Cecil soil. When plagioclase feldspar is present as part of the total feldspar content the gneiss weathers to a Lloyd soil. This syenite gneiss is similar to the orthogneiss in the Leatherwood formation. Detailed geologic mapping would perhaps classify it as an orthogneiss bordering the Leatherwood granite.

This rock is cut by pegmatite dikes in the area of the dam site. These dikes are composed of large crystals of orthoclase feldspar, muscavite mica, and quartz. They weather a little more deeply than does the

VA 485 G

adjacent syenite gneiss. The pegmatite dikes form an Appling Soil.

Two small streams are present in the stream valley. The larger of the two is next to the left abutment. Between these streams is a low floodplain that rises only from one to one and a half feet above the stream channel. The streams are agrading. They join 550 feet downstream from the proposed centerline of the dam. The stream valley is part of a dendritic drainage pattern in which the streams are strongly entrenched.

Centerline of Dam -

No rock was found with the backhoe in either abutments of the dam. But hard rock was encountered along the entire length of dam centerline across the floodplain. It appears fairly regular. It is deepest in the center of the floodplain. Here it was found at 9.5 feet at station 4+50 on the centerline of the dam. Firm bedrock becomes somewhat shallower in depth towards each abutment. It is most shallow under the centerline of the proposed conduit. This rock can best be classified as a greisen. It is a hard contact metamorphic rock that has formed between the pegmatite dikes and the syenite country rock. The pegmatite is downstream from the dam centerline and the syenite is upstream. Minerals in this rock are quartz, feldspar, actinolite and muscovite mica. It is hard and is more resistant to erosion and weathering than either the pegmatite or the syenite. The rock is white in color.

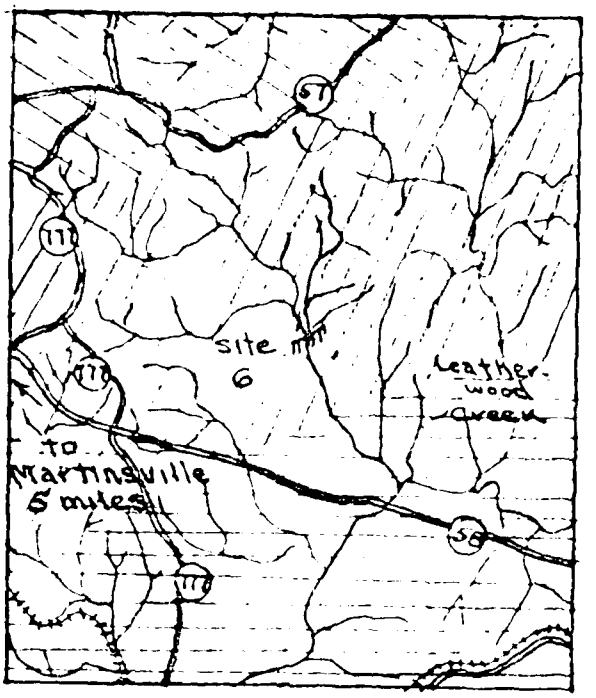
The recent sedimentation along the dam centerline in the floodplain is extremely complex as can be seen from the profile. However, one layer is common to most test pits in the floodplain. This is the water bearing sand and gravel layer that occurs approximately 6 feet below the ground surface. It is through this layer that approximately one third of the water in the stream valley flows. Below this water bearing layer is a buried residual soil. This old soil is not wet but has remained moist. This is due to the compact nature of the soil.

Foundation -

The foundation contains an irregular rockline. This is due to ridges of greisen crossing the foundation at approximately right angles to the strike of the stream channel. As can be seen from the detailed geologic and soil map, the strike of the greisen is approximately M 67° E. This forms an acute angle with the centerline of the dam which strikes M 58° E. At least two ridges of white greisen were found in the foundation. The narrower is downstream from the dam centerline. It is on the wider one that the centerline of the dam is placed.

Several distinct layers of alluvium are present in the foundation area. The highest of these is a brown red oxidized layer of silty clay. Below this all sedimentary layers are reduced. The upper of these reduced layers is a silty clay that has a high moisture content, a low dry density and a low pocket penetrometer reading. Below this is a layer of water bearing sand and gravel. Through this flows much of the water of the stream valley. This water bearing layer is thick in the toe drain area.

from a pegmatite dike that cuts the syenite in this area. At a depth of greater than 10 feet in this soil angular sand and gravel size particles occur. On the right abutment 800 feet upstream the syenite is within 7 feet of the ground surface. Here a Durham soil occurs. This soil type has a sandy texture. It contains some silt and clay. No rock was encountered in the borrow area closer than 750 feet to the centerline of the dam on the right abutment.



Scale 0 ½ 1 2 3

Leatherwood granite and syenite with pegmatites

Leatherwood syenite with orthogneissoid structure and pegmatites

Wissahickon schist & gneiss

GEOLOGIC MAP OF THE AREA SURROUNDING SITE NO. 6
LEATHERWOOD CREEK W/S, HENRY COUNTY, VIRGINIA

VA 485 G
6 of 7

MAY 55

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 Spring Branch Site No. 6

Submitted by R. C. Barnes. Date 8 19 63

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

Lab. No.	Field Sample No.	Sample Description		Depth		Type of Sample	
		Location	Grid or Station	From	To	Undist.	Dist.
			LARGE				
	258 - 1	E. Spillway	50' L C/L 2+50 E.	1.0	4.8		V
	258 - 2	"	"	4.8	12.8		V
	260 - 1	"	50' L C/L 1+50 E.	7.2	10.9		V
	102 - 1	Borrow Area		1.0	10.0		V
	104 - 1	"		1.0	8.0		V
	104 - 2	"		8.0	10.8		V
			SMALL				
	10 - 1	C/L Dam	4+50 C/L D.	1.0	1.2		V
	10 - 2	"	"	1.2	4.9		V
	10 - 3	"	"	4.9	6.8		V
	10 - 4	"	"	6.8	7.8		V
	10 - 5	"	"	7.8	8.4		V
	10 - 6	"	"	8.4	9.5		V
	411 - 1	Foundation	50' R C/L D 4+00	8.4	10.5		V
	411 - 1	"	50' R C/L D 5+00	8.1	8.6		V
	510 - 1	Toe Drain	25' L C/L D 4+00	1.3	8.2		V

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

VA 485 G

Sheet 7 of 7 Sheet

Form SCS-376
Sheet 1 of 5
For IA-Service Use Only

10-68

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Virginia County Henry Watershed Leatherwood Creek Subwatershed Camp Branch

Site number 6 Site group I Structure class a Investigated by T. Mach, Geologist (signature and title) Date July 1963

INTERPRETATIONS AND CONCLUSIONS
FOR IN-SERVICE USE ONLY

1. It is necessary that a cutoff be installed and anchored one foot into bedrock. This is to intercept the flow of water through the water bearing sand and gravel present in the floodplain. As at least one third or possibly two fifths of the water flowing downthe valley passes through this layer, a good cutoff is mandatory.

2. The residual soil along the centerline of the proposed conduit is fairly hard in place. Although the downstream portion of the proposed conduit will not be on rock, use can be made of this firm soil to support the cradle.

3. The proposed conduit can be moved to the right to lower the rockline. The slope of the rockline in this area of the left abutment is 1 to 6. But the white greisen rock here is fractured and can probably be ripped with heavy machinery.

4. The toe drain area contains a layer of water-bearing sand and gravel (DS 510-1). This layer allows free passage of water through much of the floodplain. But at some places this flow is stopped in the toe drain area. TP 303 located 65 feet downstream from the centerline of the dam shows the water-bearing sand and gravel to be absent. This information can be taken into consideration in design of the toe drain.

5. A layer of soft, moist gray clay (cl) blankets most of the foundation of the dam. It occurs from approximately two to seven feet below the ground surface. As removal of this from the foundation will be expensive, the design of the dam should be adapted to this condition.

6. From examination of its surface the rock in the emergency spillway is thought to be rippable with heavy machinery. However, this opinion is from the surface conditions of the rock and may not be true at depth. At least 10 feet of this syenite rock has to be removed.

7. Approximately 30 percent of the borrow material for the dam will come from the Lloyd soil in the emergency spillway. Of this material the most suitable for construction is the tight red clay that is closest to the surface. The next most suitable is the yellowish-red silt below the clay. The poorest construction material in the area is the brown mica material below the silt. This is to go only on the downstream slopes.

8. The Lloyd soil in the borrow area should be used only down through the red silt horizon. The brown mica material is to be discouraged unless it has to be removed as in the emergency spillway. The Appling soil of the borrow area is fairly good construction material. It has a low clay content. But this clay may be enough to tie the sand together. A good SC construction material could be made by mixing pan load for pan [illegible] B2 horizon clay with white C_1 horizon, Appling sand. The Durham soil is present in the borrow area. It is silty and sandy. Compared to the other [illegible] it forms a fair construction material.

9. [illegible] enough borrow material available in the right abutment. But of the [illegible] good clay material for the cutoff and core is scarce.

VA 485-G
1 of 5

APPENDIX V

STABILITY DATA

OPTIONAL FORM NO. 10
5010-104

UNITED STATES GOVERNMENT

Memorandum

TO : R. C. Barnes, State Conservation Engineer, SCS, Richmond, Virginia 23240

DATE: October 20, 1963

FROM : Roy S. Decker, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska 68501

SUBJECT: Virginia WP-08, Leatherwood Creek, Site No. 6

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 3 sheets.
2. Form SCS-355, Triaxial Shear Test Data, 3 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. Investigational Plans and Profiles.

DISCUSSION

Foundation

A. Classification: The alluvial soil materials overlying bedrock in the floodplain consist of three general zones. The surface zone, which is generally less than 2 feet in depth, consists of a low density (67 to 69 p.c.f.), high liquid limit silt. The zone from about the 2-foot to 7-foot depth consists of a low density plastic ML that has an in-place density of about 75 p.c.f. The third zone consists of a stratified of lenticular sandy silt with materials ranging from fine-grained ML's to SM. The thickness of this sandy zone is variable but is generally in the range of 5 feet.

The alluvium are classified primarily as ML. Bedrock was not encountered at the investigational depths.

The bedrock in the valley is variable as described in the geology report.

B. Density: The surface few feet of the valley alluvium has a low density of 69 p.c.f. From about 2 to 7 feet, the low plasticity ML material has a density of from 71.3 to 78 p.c.f. This zone is described as soft. The sandy stratum is relatively dense. A test in this zone showed an in-place density of 118 p.c.f.

C. Strength: Based on density, it may be assumed that the strength of the stratified, sandy zone will be adequate for the size of structure planned.

The available information on the soft ML zone overlying the stratified sands indicates that this material has low shear strength. The moisture content of this material is in the range of 50 percent; therefore, saturation may be assumed. Pocket penetrometer readings as low as 0.1 t.s.f. were obtained and were generally in the range of 0.1 to 0.3 t.s.f. The pocket penetrometer is calibrated to read compressive strength in tons/ft.^{2}. Shear strength equals one-half the compressive strength; therefore, the indicated shear strength based on the pocket penetrometer readings would range from c = 100 p.s.f. to c = 300 p.s.f.

As an additional check on this material, a Harvard miniature compaction test was made on classification Sample 64W716 to provide a basis for evaluating the consistency of the soft CL zone.

Compaction with the Harvard miniature device, which approximates Standard Proctor effort, produced a density of 96 p.c.f. This would indicate an in-place density about equivalent to 80 percent of Standard Proctor, which would tend to confirm the low strength indicated by the pocket penetrometer.

The [illegible] of the material in the soft zone plus the fact that it is underlain by a more pervious material indicates that consolidation may be expected during the construction, in which case the present in-place strength would probably represent a conservative design value. We do not have any basis for estimating the consolidated strength and without undisturbed samples for test, we suggest a design value of ϕ = 0, c = 200 p.s.f. for this soft ML zone.

EMBANKMENT

A. Classification: Borrow samples submitted are classed as MH, ML, SC and SM. The occurrence of these materials appears to be normal for micaceous soils in that the more plastic, finer grained materials occur in the surface zones.

B. Compacted Density: Standard Proctor compaction tests were made on all of the borrow samples submitted. The samples were submitted in moisture-proof bags and the first point on the Proctor curve represents the moisture content of the samples as received. The compacted density of the MH and ML material from the emergency spillway is low. The densities obtained were 77.0 p.c.f. for both materials.

3 -- R. C. Barnes -- 10/10/63
Rey S. Decker
Subj: Virginia WP-08, Leatherwood Creek, Site No. 6

The compacted density of the SM, ML and SC materials from the borrow area appear to be normal for this type of material. The compacted density of the borrow samples ranged from 96.5 p.c.f. to 103 p.c.f. The importance of submitting materials of this nature at natural moisture content is shown by the following comparison of compacted density for the low density spillway samples.

Sample No.	Class	LL	PI	Compaction Test Started from Natural Moisture Content		Compaction Test After Air Drying Water Added with Spray Gun and Test Made Immediately		Compaction Test After Air Drying Water Added and the Mixture Cured 3 Days Before Test	
				γ_d (p.c.f.)	w_o	γ_d (p.c.f.)	w_o	γ_d (p.c.f.)	w_o
64W726	MH	75	37	77	37.0	83.5	34.0	84.0	34.0
64W727	ML	Non-plastic		77	34.5	84.0	29.0	84.0	29.0

You will note that both the compacted density and the optimum moisture content are significantly affected by drying prior to the compaction tests. The low density soil used from the spillway (samples 64W726 and 64W727) are probably affected more by drying than the higher density materials from the borrow areas. In the past we have observed density differences in the range of 5 p.c.f. between tests made on air dried and tests made from natural moisture content which would appear to be a more reasonable range for the borrow area samples.

C. Shear Strength: Triaxial shear tests were made on Samples 64W726 (MH), 64W727 (ML) and 64W728 (SC) to represent the range in borrow materials submitted. The tests were made at 95 percent of Standard Proctor density at saturation. The shear test values obtained are summarized as follows:

Sample No.	Class	Test γ_d (p.c.f.)	% Standard	ϕ (Degrees)	c (p.c.f.)
64W726	MH	72.4	94.0	15.5	525
64W727	ML	71.1	92.4	28.0	200
64W728	~~SC~~ SM	96.1	94.2	28.5	500

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Subj: Virginia WP-08, Leatherwood Creek, Site No. 6

The test values are considered representative and are satisfactory design values for the embankment materials.

SLOPE STABILITY

The stability of the proposed embankment was checked for two conditions. One analysis considered the embankment alone with a fully developed phreatic line. For this condition the analysis was made on a 2 1/2:1 downstream slope without drainage. The factor of safety obtained for a homogeneous fill of the lowest strength materials tested (64W727) was 1.43. The upstream slope proposed is 2 1/2:1 over 3:1 with a 10-foot berm. The factor of safety for the upstream slope under full drawdown would be slightly higher than that shown for the downstream slope.

The other analysis considered 6 feet of foundation material with in-place shear strength of $\phi = 0$, $c = 200$ p.s.f. A moist embankment was assumed. The conditions of the analysis would represent a situation where no foundation consolidation occurred during the construction of the fill. The saturated shear strength values obtained on the triaxial tests were used for the embankment. The factor of safety obtained for these conditions were $F_s = 1.22$ for the proposed upstream slope (2 1/2:1 over 3:1) and $F_s = 1.07$ for the 2 1/2:1 downstream slope.

It must be emphasized that this analysis is not conclusive since it is based on an average strength ($c = 200$ p.s.f. derived from pocket penetrometer readings. The strength indicated by pocket penetrometer readings ranged from about $c = 100$ p.s.f. to about $c = 300$ p.s.f.

RECOMMENDATIONS

A. Foundation: Because of the uncertainties regarding the strength of the soft ML strata, the following alternatives are suggested: (1) Removal of all or part of the low density material from the foundation. It may not be necessary to remove the entire ML strata to remove the lower strength material because it appears that this strata is variable. (2) Determine the shear strength of the ML strata from undisturbed samples. (3) Or provide additional berming both upstream and downstream.

B. Cutoff Trench: The cutoff trench should bottom on bedrock through the floodplain section. A minimum trench depth of 5 feet is suggested for the abutments.

The trench should be backfilled with ML or SC material like Sample 64W729 and 64W730. The backfill should be compacted to a minimum of 95% of Standard Proctor density.

C. Principal Spillway: The alternate principal spillway in the vicinity of ℄ Station 2+75 is a better location from a foundation standpoint than the abandoned location at ℄ Station 3+50.

At the ℄ Station 2+75 location the conduit will be bedded in bedrock throughout most of its length. At the proposed grade the upper end and the lower end will not be on bedrock. It may be possible, however, to skew the conduit or shift it more to the left and obtain better foundation conditions in the vicinity of the riser.

D. Drainage: The bedrock is variable and in some zones it is logged or weathered and we anticipate that some seepage may be expected to bypass the cutoff in the floodplain section as well as in the abutments where the cutoff trench does not bottom in bedrock. We suggest a toe drain to provide a safe outlet for foundation seepage and also to control the phreatic line within the embankment.

The drain will be located at about c/c = 0.6 and extend up the [illegible] to normal pool level. A trench depth of about 6.0 feet is [illegible] for the floodplain and a minimum trench depth of 5 feet is [illegible] for the abutments.

A drain filter with a gradation between the limits shown on the attached Form SCS-378 will provide protection against piping for the range of materials represented by the samples submitted.

E. Embankment Design:

1. Selection of Materials: We recommend selective placement during construction to place the MH, ML and SC material in the center and upstream sections and the non-plastic SM in the downstream section. The SM has adequate shear strength and may be used anywhere in the fill; however, placement in the downstream section would facilitate control of the phreatic line within the embankment.

All materials should be placed at a minimum of 95% of Standard Proctor density with the moisture content controlled slightly on the wet side of optimum.

C -- R. C. Barnes -- 10/10/63
Roy S. Decker
Subj: Virginia WP-08, Leatherwood Creek, Site No. 6

2. Slopes. The following alternate slope designs are suggested:

a. If the low strength zones of ML material in the foundation are removed. The proposed 2 1/2:1 over 3:1 upstream slope with a 10-foot berm and the 2 1/2:1 downstream slope have satisfactory factors of safety and are recommended.

b. If the low strength zones of ML are not removed from the foundation we suggest that the berm width be increased to 15 feet on the upstream slope and that a 15-foot berm be added to the downstream slope at about elevation 711.

3. Settlement. An overfill allowance of 1.5 feet over the flood-plain section is suggested to compensate for residual consolidation in the fill and foundation.

Prepared by:

Lorn P. Dunnigan

Reviewed and Approved by:

Robert B. Phillips

Attachment

cc: R. C. Barnes
L. M. Hendon, Upper Darby, Pa.
C. W. Green, Upper Darby, Pa.

FORM SCS 357
10-58

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY

SUMMARY - SLOPE STABILITY ANALYSIS

State _____ Project _____

Date _____ Analysis Made By _____ Checked By _____

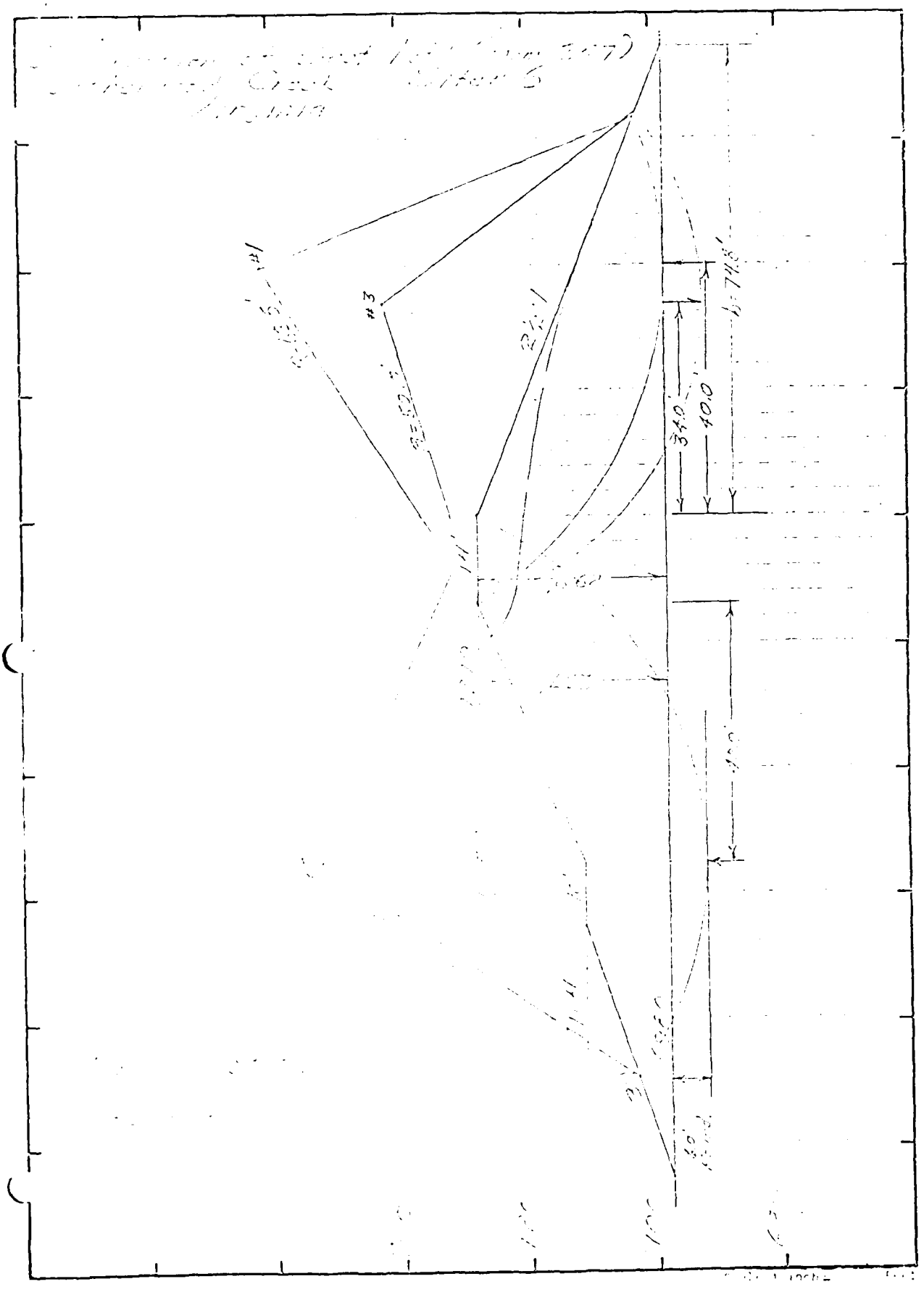
Method of Analysis _____

Location of Material										
Sample No.										
γ_d										
γ_m										
γ_s										
γ_c										
Condition	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.	Opt.	Sat.
Φ										
Tan Φ										
K										
C										

UPSTREAM SLOPE			
Trial	Slope	Condition	F.S.

DOWNSTREAM SLOPE			
Trial	Slope	Condition	F.S.

For the purpose of this analysis, the following soil properties were used for slope stability analyses and the results of the analyses. The attached sketch of the embankment on which the analyses have been made.


#1
#3
340'
400'
715'

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

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