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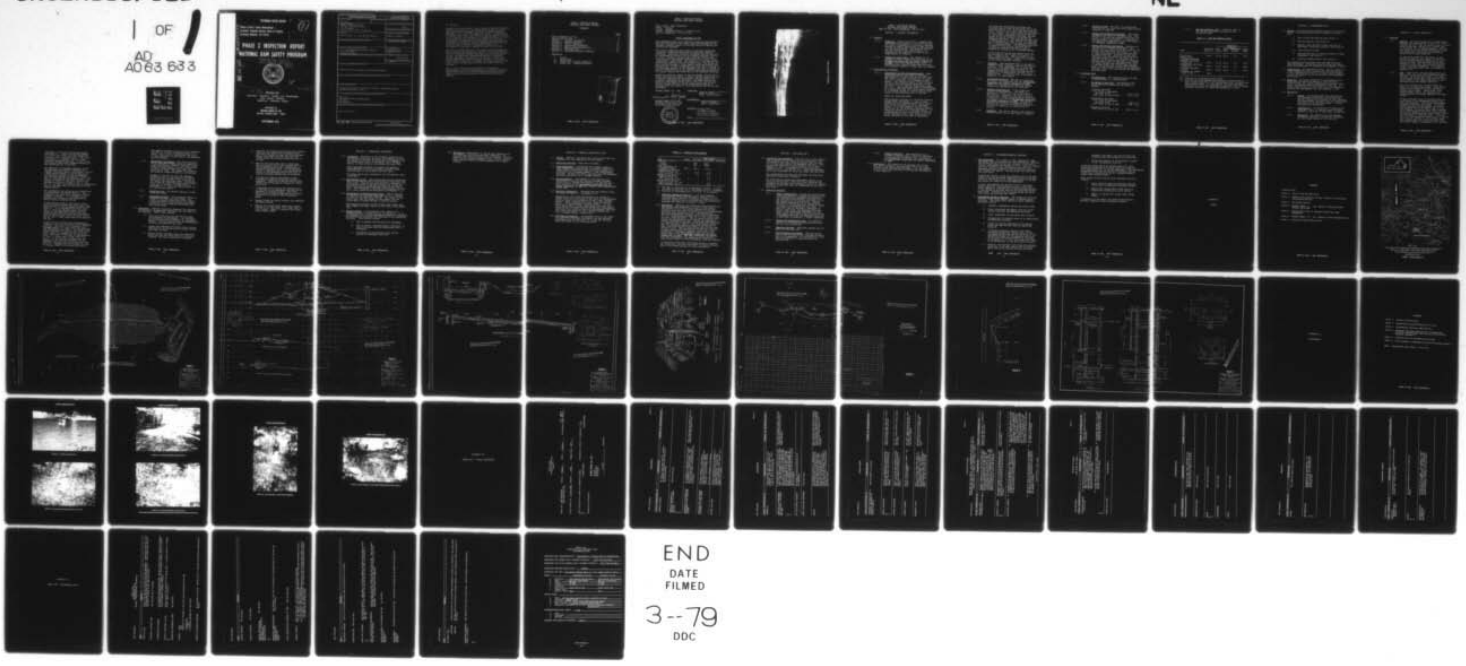

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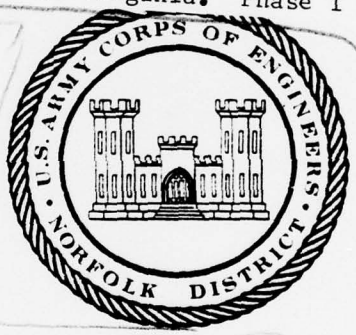
POTOMAC RIVER BASIN

Name of Dam: Camp Shenandoah Dam.
Location: Augusta County, State of Virginia
Inventory Number: VA 01515

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Camp Shenandoah Dam (VA 01515). Potomac River Basin. Augusta County, State of Virginia. Phase I Inspection Report.



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SEPTEMBER 1978

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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 investigation 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 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.

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 and 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.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Camp Shenandoah
State: Virginia
County: Augusta
Stream: Unnamed Tributary to Middle River
Date of Inspection: 12 July 1978

BRIEF ASSESSMENT OF DAM

Camp Shenandoah Dam is an earthfill structure approximately 550 feet long and 33 feet high, owned and operated by the Stonewall Jackson Council of the Boy Scouts of America for recreational purposes.

The visual inspection and review of available background information indicated deficiencies requiring immediate attention. Hydrologic analysis indicated that the dam will be overtopped by one-half of the Probable Maximum Flood by 0.3 foot. However, the spillway will pass the 100 year flood which is the minimum requirement for a "small" size-"significant" hazard dam. The stability of the dam may be affected by erosion along the northern toe, tree growth and poor surface drainage. Clear seeps, occurring beneath the concrete weir of the intermediate spillway and in a marsh in the discharge channel of the emergency spillway, indicate a possible undercutting of the concrete weir and the potential for piping through the earth berm of the emergency spillway.

Extensive clearing, repair of erosion damage, monitoring of seeps, possible correction of seeps, and the formulation of a regular inspection and maintenance program needs to be seriously considered by the owner. The owner should also perform a downstream survey and flood study, and devise a warning system that will alert downstream occupants to evacuate when the reservoir level approaches the top of the embankment.

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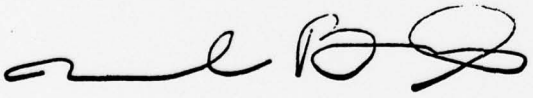

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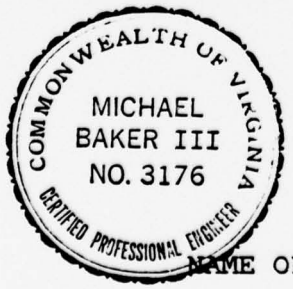
Chairman of the Board and
Chief Executive Officer



SUBMITTED: _____
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Zane M. Goodwin
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APPROVED: Original signed
by LEONARD C. GREGOR
Major Corps of Engineers
Acting District Engineer

Date: _____

OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: CAMP SHENANDOAH ID# VA 01515

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 inspections 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. The main responsibility is to expenditiously identify those dams which may be a potential hazard to human life or property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Camp Shenandoah Dam is an earthfill structure approximately 550 feet long and 33 feet high. The crest is 12 feet wide and lies at elevation 110.0 (relative to an assumed project datum). The upstream slopes of the structure are three and one-quarter horizontal to one vertical (3.25:1), and the downstream slopes are 2.5:1. The downstream slope is interrupted by a bench which has four catch basins connected to a drainage system to convey surface water runoff to the downstream toe of the dam.

There are three spillways.

The principal spillway is a concrete overflow intake tower (see Photo 1), with a crest elevation 104.5 (assumed datum) and a subsurface intake elevation of 104.17 (assumed datum). A 24 inch diameter concrete pipe is the outlet for the principal spillway with an invert at elevation 77.2 (assumed datum). A hand-operated 20 inch sluice gate is located on the upstream base of the intake tower to permit draining of the lake if necessary.

Two rock-cut side-channel spillways are situated side by side on the south end of the dam separated by a 20 feet wide shale bedrock dike. Plates 1 and 4 show these two spillways. In this report, the lower elevation spillway is called the intermediate spillway, and the higher elevation structure is called the emergency spillway. The intermediate spillway is approximately 45 feet wide at its base and has a concrete weir with a crest at elevation 105.0 (assumed datum). The emergency spillway is about 47 feet wide at the base and is crossed by an earth berm whose crest is situated at elevation 107.5 (assumed datum).

A plan view of the dam and typical sections are included in this report as Plates 1, 2 and 3, respectively. The spillways are not constructed as planned. Plate 4 is a sketch of the actual spillway features.

1.2.2 Location: Camp Shenandoah Dam is located in Augusta County, Virginia, west of the Town of Staunton. The impoundment is situated one-half a mile upstream from the mouth of the unnamed stream which passes through the small community of Trimbles Mill and flows into Middle River. A Location Plan is included in Appendix I of this report.

1.2.3 Size Classification: The dam is classified as "small" in accordance with the Recommended Guidelines for Safety Inspection of Dams based on its height of 33 feet and storage capacity of approximately 150 acre-feet.

1.2.4 Hazard Classification: A few houses are located at Trimbles Mill, and there is a possibility of loss of life in the event of dam failure. Therefore, the dam is given a "significant" hazard classification according to Section 2.1.2 of the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams 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 by the Stonewall Jackson Council of the Boy Scouts of America.

1.2.6 Purpose of Dam: The dam is a recreational facility for the local Boy Scout camp situated immediately upstream.

1.2.7 Design and Construction History: The design documents are dated 30 September 1949. The design of the dam was completed by Wiley and Wilson, Consulting Engineers. Construction was reportedly completed in 1960 according to the National Inventory of Dams.

1.2.8 Normal Operational Procedures: Operation of the dam is an automatic procedure. The normal pool is controlled by the inlet of the primary spillway tower (see Photo 1). The 20 inch sluice gate on the primary spillway is hand controlled. The gate is not used regularly, but was opened to partially drain the lake during 1977. In the event the capacity of the primary spillway is exceeded and the water level in the lake rises, water is routed through the intermediate spillway. In extreme cases with a water depth greater than 2.5 feet flowing through the intermediate spillway, water will flow across the emergency spillway berm.

1.3 Pertinent Data

1.3.1 Drainage Area: The watershed above the dam is approximately 1.4 square miles.

1.3.2 Discharge at Dam Site: The maximum flood at the dam site through the spillways is unknown.

Principal Spillway
Pool level at emergency spillway crest . . . . . 69.0 c.f.s.
Pool level at top of dam . . . . 72.0 c.f.s.

Intermediate Spillway
Pool level at emergency spillway crest . . . . . 528 c.f.s.
Pool level at top of dam . . . . 1485 c.f.s.

Emergency Spillway
Pool level at top of dam . . . .830.0 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet (a)	Reservoir Capacity: Area acres	Reservoir Capacity: Acre-feet	Reservoir Capacity: Watershed inches	Length feet
Top of dam	110.0	14.63	216.5	2.9	1323
Maximum pool, design surcharge					
Emergency spillway crest (b)	107.5	13.34	181.5	2.4	1214
Intermediate spillway crest (b)	105.0	12.05	149.8	2.0	1056
Principal spillway crest	104.5	11.80	143.8	1.9	1056
Streambed at center-line of dam	80.0	-	-	-	-

(a) Relative to an assumed project datum.
(b) Two rock-cut side-channel spillways are situated side by side on the south end of the dam separated by a 20 feet wide shale bedrock dike. In this report, the lower elevation spillway is called the intermediate spillway, and the higher elevation spillway is called the emergency spillway.

SECTION 2 - ENGINEERING DATA

2.1 Design: The design data available consist of blue line prints of the design plans which include the following:

1) Plan of Dam and Spillway (see Plate 1).

2) Spillway Details (see Plate 3).

3) Typical Cross Section of Dam, Profiles of Spillways, Catch Basin Details (see Plate 2).

4) Cross Section of Dam.

5) Construction Plan of Sanitary Sewer for Camp Shenandoah (see Plate 5).

6) Overflow Intake Details (see Plate 7).

The materials were borrowed from the camp office at Camp Shenandoah. Design was done by Wiley and Wilson, Consulting Engineers of Lynchburg and Richmond, Virginia.

2.2 Construction: No construction data, reports, photos or other information were available for this evaluation. A 1976 Construction Plan for a sanitary sewer showed a culvert and manhole in the north end of the embankment (see Plate 5).

2.3 Operation: No formal operation or maintenance procedures are followed with respect to this facility. Joseph Coogan, who resides immediately adjacent to the camp, has handled recent maintenance of the dam. Mr. Coogan reported that a sluice gate which is capable of draining the impoundment was last operated in 1977.

2.4 Evaluation

2.4.1 Design: The design plans were satisfactory for background information concerning the general construction features of the structure. The side-channel spillways were not constructed according to the original design. As-built drawings were unavailable.

2.4.2 Construction: An evaluation of construction technique, data, or reports cannot be made because of the lack of sufficient information.

2.4.3 Operation: The operation and maintenance procedures presently followed are inadequate for the proper upkeep of the facility.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

3.1.1 General: The field inspection of Camp Shenandoah Dam was conducted on 12 July 1978. The weather was fair, and the reservoir was 0.2 foot above normal pool design level (normal pool is elevation 104.5 [assumed datum]). The dam was found to be very poorly maintained, while the appurtenant structures were generally noted to be in good condition.

It should be noted that the detail of the photos included in this report is limited by the thick and extensive vegetation on and around the dam. The important deficiencies observed in the field are described briefly in the following paragraphs. The complete visual inspection check list is included in Appendix III.

3.1.2 Dam: Large trees, and high dense brush and grass cover the crest and downstream slope of the dam. The thick tree cover on the downstream slope of the dam in the area of the 24 inch conduit outlet made inspection of the discharge pipe and channel difficult.

Four catch basins are situated along the bench on the downstream slope. These catch basins are intended to collect and drain surface water runoff. Dense brush cover, miscellaneous rubble, and apparent poor grades prevent the proper operation of these drains.

An open drainage ditch is located along the north side of the impoundment between the road and shoreline. This ditch was probably intended to handle road runoff. The ditch drains eastward and discharges just beyond the northern end of the dam by way of a 24 inch diameter corrugated metal pipe (reduced to 18 inch diameter at outlet) which extends through the north abutment (see Plates 5 and 6 for locations of ditch and pipe). From the outlet of the corrugated metal pipe, a significant erosion channel, up to four feet deep with steep sides, has formed directly along the entire northern downstream toe of the dam

extending to the outlet discharge channel (see Photo 2). Water from the impoundment will enter this ditch from the culvert at elevation 106.9 (assumed datum). The ditch and culvert, at present, act as a crude secondary emergency spillway. Flows in the ditch have significantly damaged one-half of the downstream toe of the dam.

The approach and discharge channels of the two spillways are heavily overgrown and clogged with heavy debris (see Photos 3 and 4). A deep erosion channel in shale bedrock in the discharge channel of the intermediate spillway has rapidly progressed to within 15 feet of undercutting the concrete weir. The erosion is likely to continue, because the bedding orientation (strike N. 65° E., dip SE. 25°) is such that running water is essentially able to get under and lift the strata by the bedding planes.

The intermediate spillway was not constructed as indicated by the design details. The compacted clay liner with overlying concrete pavement is absent. It is unknown if the concrete weir extends to any appreciable depth forming a seepage barrier.

An approximate three to five g.p.m. clear seep is occurring under the north end of the concrete weir of the emergency spillway (see Photo 5). It is suspected that this clear seep is occurring through nearly vertical joints in the underlying shale which are oriented about in-line with the longitudinal axis of the spillway (joint strike N. 80° E., dip NW. 83°). This clear seep could undercut the weir.

A heavily tree covered berm constructed of clayey fill acts as the crest of the emergency spillway. The crest is at elevation 107.5 (assumed datum) (2.5 feet above the crest of the intermediate spillway). The design width across the crest of the berm was eight feet; actual width is a maximum of four to five feet. The width at the base is approximately 20 feet. A clear seep of less than five g.p.m., in the form of a marshy area, was observed in the discharge channel of the emergency spillway just below the berm (see Photo 6). Seepage may flow through the berm or through joints in the underlying shale.

The exposed southern rock-cut of the emergency spillway is in shale at approximately a 1:1 slope. This slope is weathering, and talus is contributing to restriction of the emergency spillway channel.

3.1.3 Appurtenant Structures: The inlet structure, outlet pipe and emergency gate are generally in good condition. However, the mesh of the trash rack (see Photo 1) on the intake tower is small (three-fourths of an inch) and could easily clog. The ladder for access to the tower is rusted through in a few places.

Neither of the two (2) six inch diameter underdrain outlets indicated on the design plans could be located in the field due to the dense tree and brush cover. Similarly, one of the two indicated bench drain outlets could not be located. As explained in paragraph 3.1.2, the bench drain inlets are not operating properly.

3.1.4 Reservoir Area: No adverse reservoir conditions were noted.

3.1.5 Downstream Channel: The discharge channel is overgrown by trees and thick brush. No riprap is present around the outlet conduit. A stilling basin is not present, and riprap protection in the immediate discharge area was not provided.

3.2 Evaluation: Numerous corrective measures are necessary and should be accomplished immediately by the owner or his designer. These items include:

1) Clear all trees from the dam and spillways, and reinspect the embankment. Cut and keep the brush overgrowth trimmed to an acceptable height. Clear all debris from the intermediate spillway and emergency spillway.

2) Locate the underdrain and bench drain outlets indicated by the design plans and make certain that they are open.

3) Restore proper drainage along the downstream bench and into the catch basins by clearing, cleaning, and minor regrading if required.

4) Backfill the drainage ditch along the northern shoreline and remove the corrugated metal pipe which extends through the north abutment. Repair and reseed the area that has been eroded along the northern downstream toe of the dam.

5) Monitor the clear seep that is occurring below the north end of the concrete weir of the intermediate spillway to determine if undercutting might occur. If the potential exists, a compacted clay liner protected by riprap on the upstream side of the weir or similar abatement measure may be necessary.

6) A method of stopping the erosion in the intermediate spillway discharge channel is necessary. Backfilling the existing erosion channel and paving may be required to accomplish this.

7) A compacted clay liner on the upstream side of the berm in the emergency spillway may be necessary to prevent piping. This berm should also be widened and made more erosion resistant by riprap or other acceptable means.

8) Riprap around the outlet conduit and immediate discharge channel.

9) Replace the intake tower trash rack (three-fourths of an inch mesh) with larger mesh or a bar screen. Repair or replace the intake tower access ladder.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Operation is an automatic function controlled by the primary spillway, intermediate spillway and emergency spillway as discussed in paragraph 1.2.8. The normal pool level, at elevation 104.5 (assumed datum), is controlled by the primary spillway inlet.

Rapid emergency drawdown is possible by opening a crank-operated 20 inch sluice gate located on the upstream base of the primary spillway tower.

No formal operational procedures are followed for this impoundment.

4.2 Maintenance of Dam: The dam has been poorly maintained. Most of the dam is heavily overgrown by large trees and thick brush. Erosion has been allowed to progress to a detrimental degree along the northern toe of the dam. Bench drainage on the downstream slope of the dam is poor. The intermediate spillway and emergency spillway are in poor condition as explained in paragraph 3.1.2.

4.3 Maintenance of Operating Facilities: The sluice gate is operable and was reportedly used in 1977. However, the gate is not regularly checked. The ladder on the inlet tower used for access to the control for the sluice gate is rusted through in several places.

Approximately one-half of the intake tower trash rack was clogged with small debris at the time of the inspection.

4.4 Warning System: At the present time, there is no warning system or evacuation plan in operation. It is recommended that a formal emergency procedure be prepared and 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.

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

4.5 Evaluation: Maintenance of the dam and inspection of the operating facilities has been inadequate, considering the overall present state of the dam. Periodic checks of the operable equipment and a regular maintenance schedule should be made subsequent to a repair program.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: Hydraulic and hydrologic calculations were not available for the completion of this report.

5.2 Hydrologic Records: None were available.

5.3 Flood Experience: Discussions with Joseph Coogan of Camp Shenandoah indicated that on several occasions in recent years, water has flowed over the concrete wier (elevation 105.0 [assumed datum]) in the intermediate spillway. He does not recall any flow over the emergency spillway (elevation 107.5 [assumed datum]).

5.4 Flood Potential: Performance of the reservoir was determined by routing the one-half Probable Maximum Flood (P.M.F.) through the reservoir as required for a dam classified by the Recommended Guidelines for the Safety Inspection of Dams as a "small" size-"significant" hazard dam.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, paragraph 1.3.3.

Regulation of flow from the reservoir is automatic. Normal flows are controlled by the crest of the principal spillway riser at an elevation of 104.5 feet (assumed datum). Water entering this inlet flows through the dam in a 24 inch diameter concrete conduit. In the event the reservoir level rises above the riser crest, flood waters flow past the dam through the intermediate spillway with a concrete weir and the emergency spillway with crest elevations of 105.0 (assumed datum) and 107.5 (assumed datum), respectively.

5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on the reservoir performance for the one-half P.M.F. and the 100 year flood are shown in the following table:

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal	Hydrographs 100 Year	1/2 P.M.F.	P.M.F.(a)
Peak flow, c.f.s.				
Inflow	-	349	2859	-
Outflow	-	322	2784	-
Peak elevation, ft. (assumed datum)	104.5	106.6	110.3	-
Intermediate spillway				
Depth of flow, ft.	-	0.9	3.2	-
Avg. velocity, f.p.s.	-	5.4	10.2	-
Emergency spillway				
Depth of flow, ft.	-	-	1.5	-
Avg. velocity, f.p.s.	-	-	7.0	-
Non-overflow section				
Depth of flow, ft. (b)	-	-	0.3	-
Avg. velocity, f.p.s.	-	-	2.5	-

(a) The dam is classified as "significant" hazard. It does not have to pass the P.M.F. according to C.O.E. standards.
(b) Duration of overtopping for 1/2 P.M.F. is 52 minutes.

5.7 Reservoir Emptying Potential: A 24 inch diameter sluice-gated outlet with an invert elevation of 80.0 (assumed datum) permits a discharge of about 65 c.f.s. with the reservoir level at normal pool and essentially dewaters the reservoir in about 1.5 days.

5.8 Evaluation: Hydraulic and hydrologic determinations of the project were computed as a part of this report. The one-half P.M.F. was routed through the dam and reservoir starting with the reservoir at the intermediate spillway crest (elevation 105.0 [assumed datum]). The routing produced a maximum water surface elevation of 110.3 (assumed datum) which is 0.3 foot higher than the top of dam elevation. The 100 year flood was also routed and determined to pass through the reservoir without overtopping the dam. Since Camp Shenandoah Dam is classified as a "small" size-"significant" hazard dam, the discharge capacity should be sufficient to pass a spillway design flood between the 100 year and one-half P.M.F. The spillway has sufficient capacity to pass approximately 43 percent of the P.M.F. and therefore is considered adequate under definitions established in the Recommended Guidelines for Safety Inspections of Dams. The heavy vegetation growing in both the intermediate and emergency spillways has a significant effect on flood discharges from the reservoir.

It should be noted that conclusions pertain to present day conditions, and that the effect of future development on the hydrology has not been considered.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The clay core of the subject dam is seated on brown shale which is exposed in the intermediate spillway discharge channel and the rock-cut on the south side of the emergency spillway. This stratum was measured to be striking N. 65° E. and dipping SE. 25°. A prominent joint was measured to strike N. 80° E. and dip NW. 83°. Earth and weathered shale were excavated to solid rock under the core area.

The intermediate spillway and emergency spillway were apparently excavated to bedrock.

The upstream and downstream embankments appear to be built on native soils. Test pits were dug along the alignment of the dam crest according to Plate 1; however, the soils encountered were not documented in the available plans.

6.2 Stability Analysis

6.2.1 Visual Observations: During the field inspection, no sliding or sloughing associated with the embankment and abutments was observed. The vertical and horizontal alignment of the dam appeared to be satisfactory. However, the entire downstream toe of the northern one-half of the dam has been eroded by runoff to a depth of approximately four feet. In addition, much of the dam is overgrown by fairly large trees, and drainage along the bench of the downstream embankment is poor. Clear seeps were noted in the vicinity of the intermediate spillway and emergency spillway, as described in Section 3 - Visual Inspection.

6.2.2 Design and Construction Data: No stability analysis or construction records were available for this evaluation.

6.2.3 Operating Records: Operating records are not kept for this facility.

6.2.4 Post-Construction Changes: With the exception of the 18 inch culvert through the north end of the embankment, no alternations to the dam were apparent or reported since its construction.

6.2.5 Seismic Stability: Camp Shenandoah Dam is located in Seismic Zone 2 which is considered a non-hazardous earthquake zone according to the Recommended Guidelines for Safety Inspection of Dams.

6.3 Evaluation: The erosion of the northern toe of the dam, poor drainage of surface water off of the bench located on the downstream embankment, and root penetration of trees covering much of the dam are detrimental to dam stability.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: As a result of this inspection, Camp Shenandoah Dam is determined to have detrimental features. The three spillways do not pass one-half of the P.M.F. without overtopping the dam by 0.3 foot. This overtopping would be reduced if the intermediate spillway and emergency spillway channels were not heavily overgrown and clogged with debris. The spillways will pass the 100 year flood.

Significant erosion, along the northern toe of the dam, coupled with the potential temporary pooling of surface runoff on the bench on the downstream slope of the dam may affect the stability of the embankment.

A clear seep beneath the concrete weir of the intermediate spillway could undercut the weir with time. Clear seepage to a marshy area in the discharge channel of the emergency spillway may be occurring through the earth berm. A possibility of piping though the earth berm exists during high lake levels.

7.2 Recommended Remedial Measures: The inspection revealed numerous items which require repair or monitoring by the owner. The items which should be given immediate attention include:

1) Perform a downstream survey and flood study.

2) Clear overgrowth and debris from the intermediate spillway and emergency spillway.

3) Clear overgrowth in the entire dam vicinity.

4) Reinspection of cleared areas by an experienced professional engineer.

5) Locate all drains indicated on the design plans and make certain they are operating properly.

6) At monthly intervals monitor clear seeps occurring beneath the concrete weir of the intermediate spillway and at the marsh in the discharge channel of the emergency spillway. Follow with corrective measures as outlined in paragraph 3.2 if the clear seeps are found to be detrimental to the spillway structures.

7) Backfill the drainage ditch along the northern shoreline of the dam, remove the corrugated metal pipe which extends through the north

abutment, and repair the erosion that has occurred along the northern toe of the dam.

8) Arrest the erosion of the discharge channel of the intermediate spillway.

A warning system should be devised that will alert downstream occupants to evacuate when the reservoir level approaches the top of the embankment. The downstream occupants should also be advised to evacuate during storms that coincide with the U.S. Weather Bureau's flash flood warning system.

Other items of which can be given secondary priority include:

1) Place riprap around the principal spillway outlet and its immediate discharge channel.

2) Replace the intake tower trash rack with larger mesh screening or a bar screen.

3) Repair or replace the intake tower access ladder.

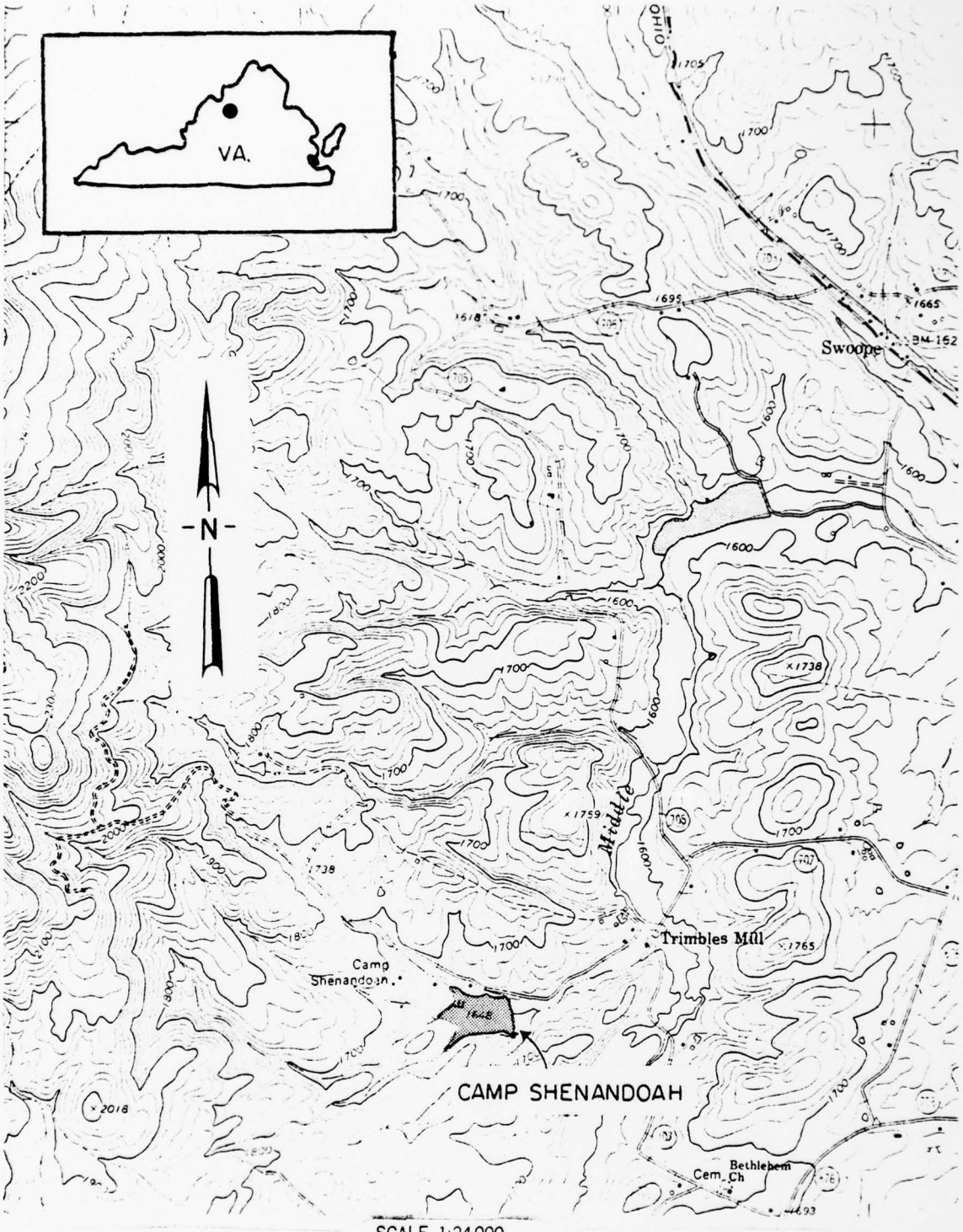
In addition to the above, the owner should begin a periodic inspection and maintenance program.

APPENDIX I

PLATES

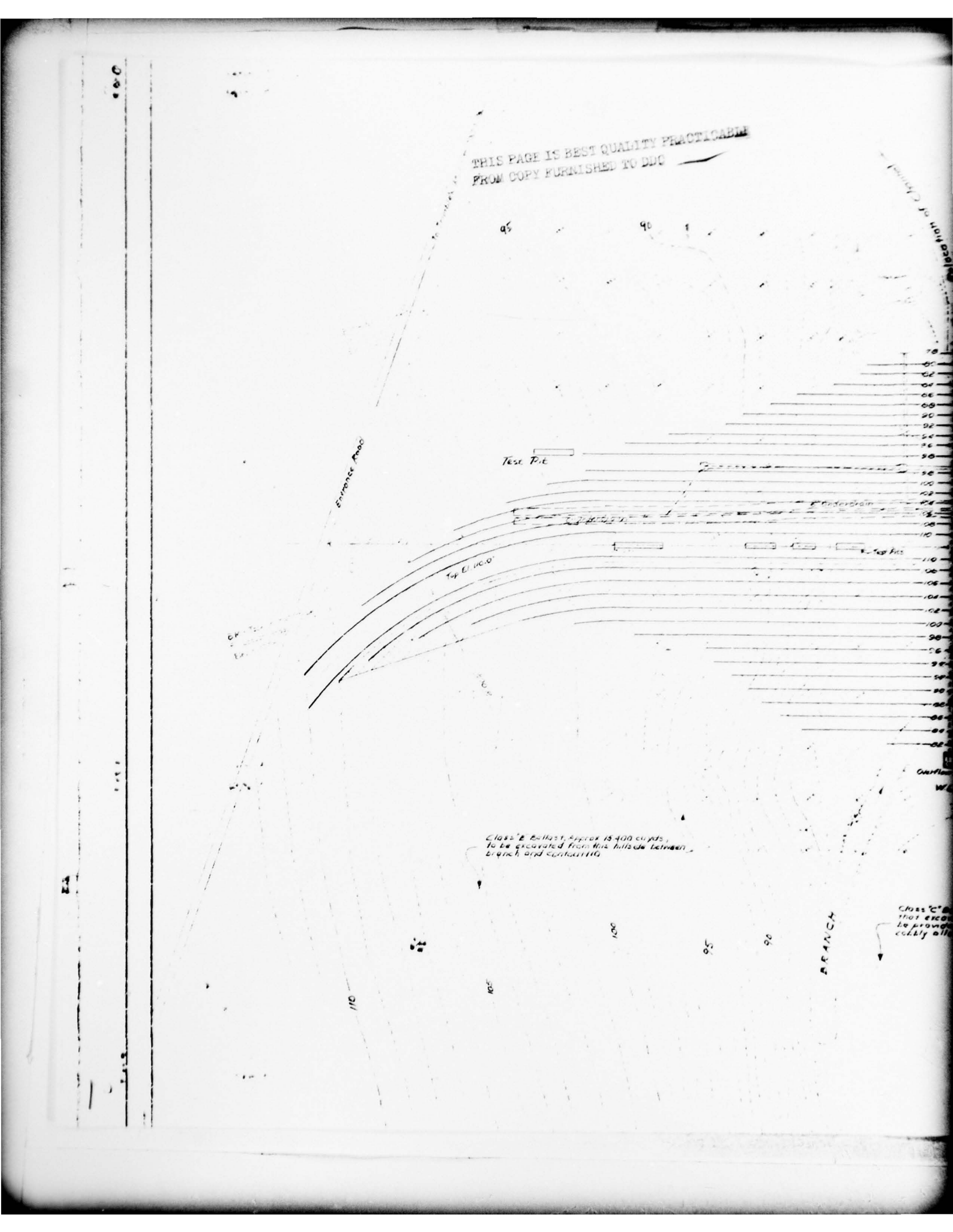
CONTENTS

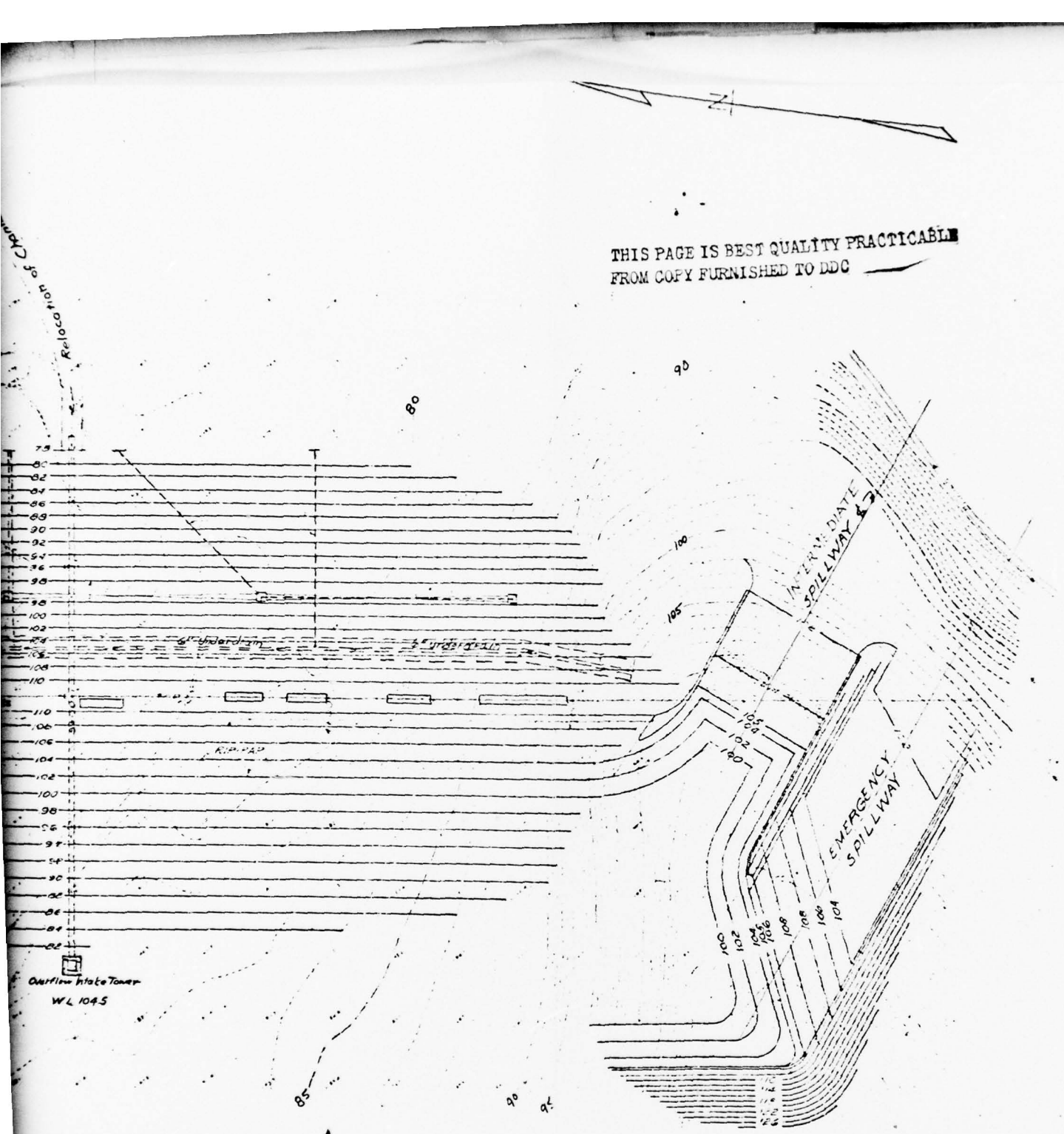
NAME OF DAM: CAMP SHENANDOAH



LOCATION PLAN

CAMP SHENANDOAH





Class "C" Ballast, Approx 7,100 cu yds. In addition to that excavated under dam and spillway areas to be provided by excavating all the gravelly and sandy alluvium from this flood plain as required.

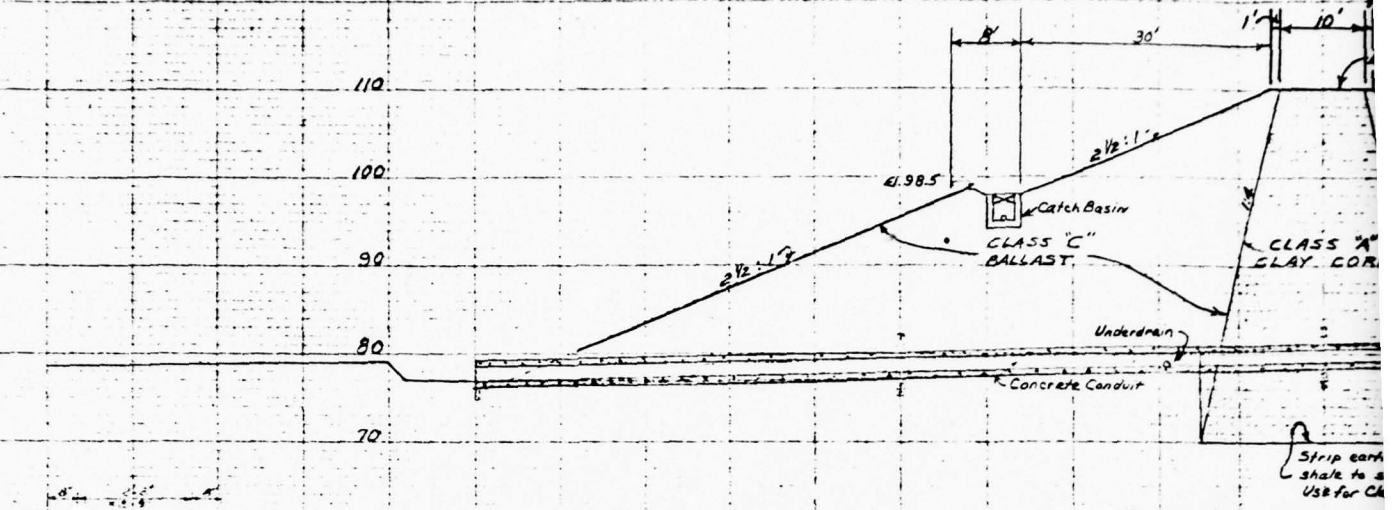
PLATE 1

PLAN OF DAM & SPILLWAY

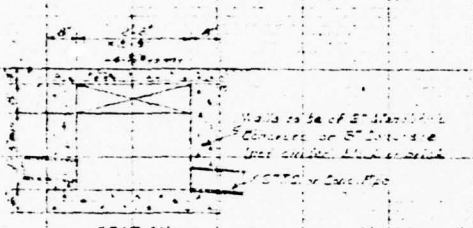
CAMP DEVELOPMENT
FOR THE
STONEWALL JACKSON COUNCIL
BOY SCOUTS OF AMERICA
STAUNTON, VIRGINIA

WILEY & WILSON
CONSULTING ENGINEERS
LYNCHBURG, VA. RICHMOND, VA.

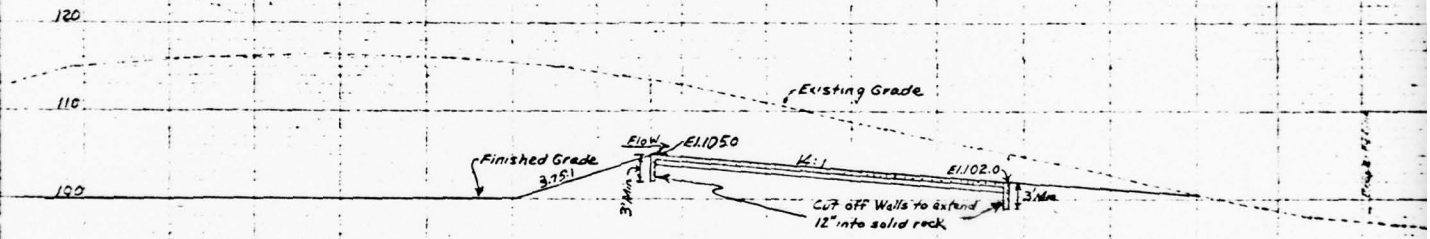
MADE BY C. J. S.	SCALE 1" = 2'
TRACED BY C. J. S.	DATE SEPT. 30, 1945
APPROVED BY R. E. M'N	JOB NO. 4214
DESIGN	SHEET 1



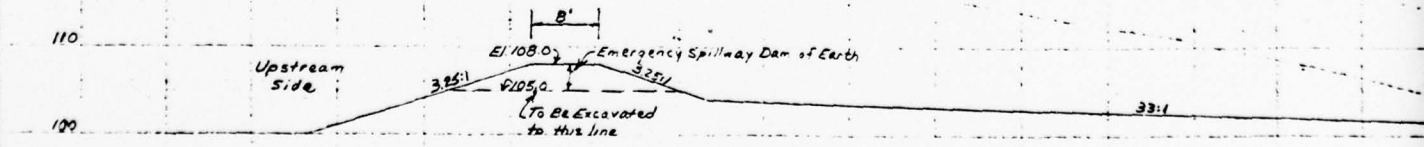
TYPICAL CROSS S



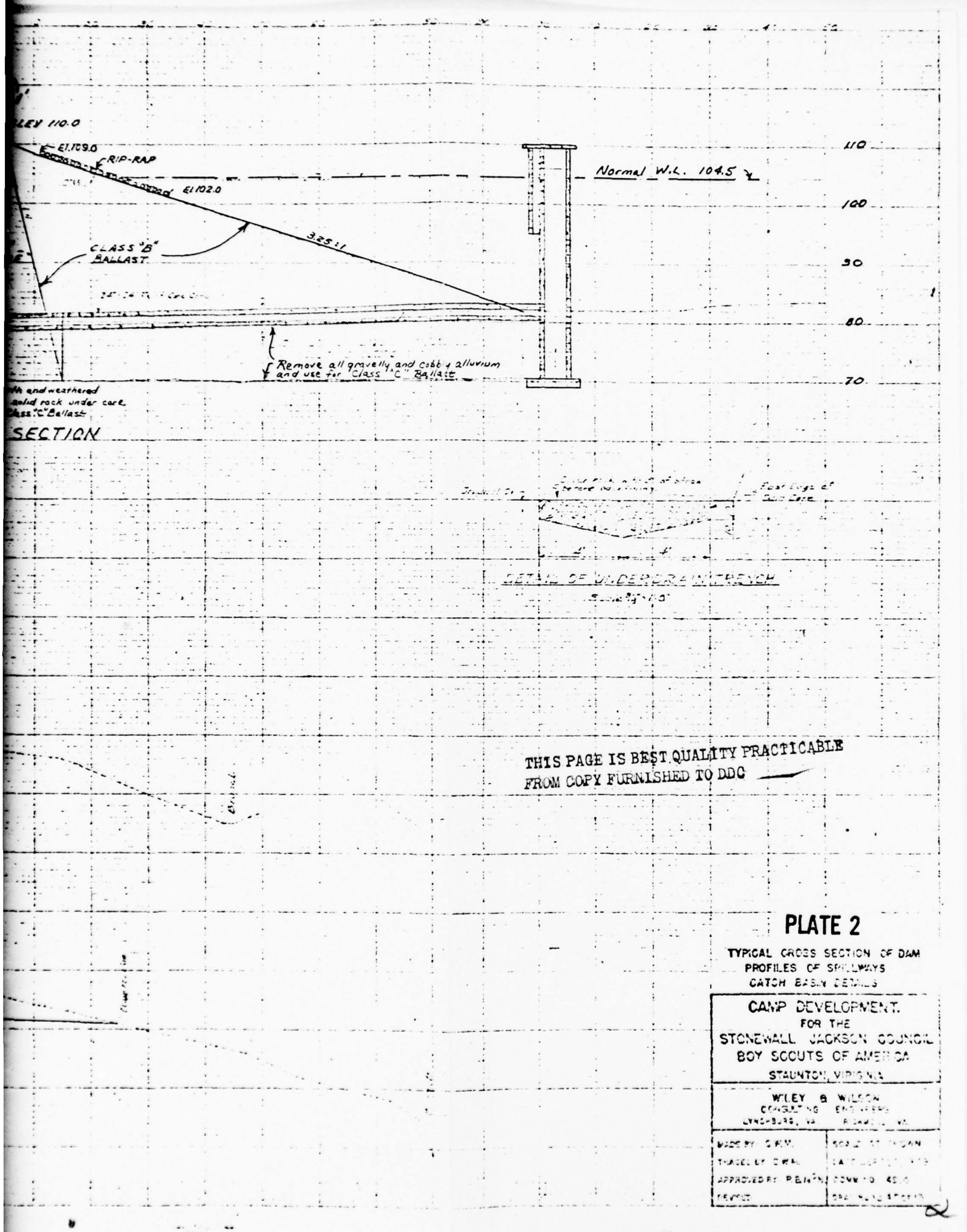
SECTION
TYPICAL CATCH BASIN

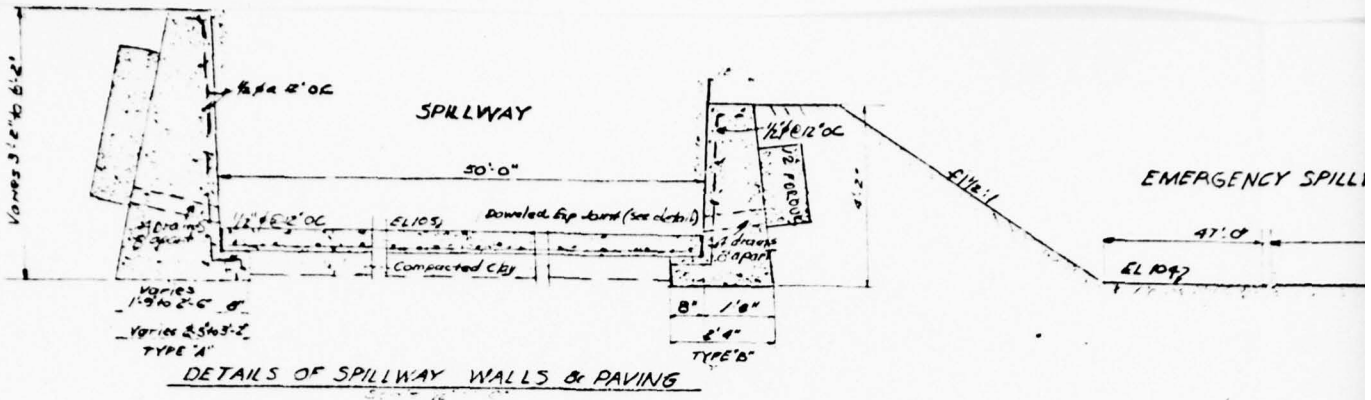


PROFILE ALONG ℄ OF SPILLWAY



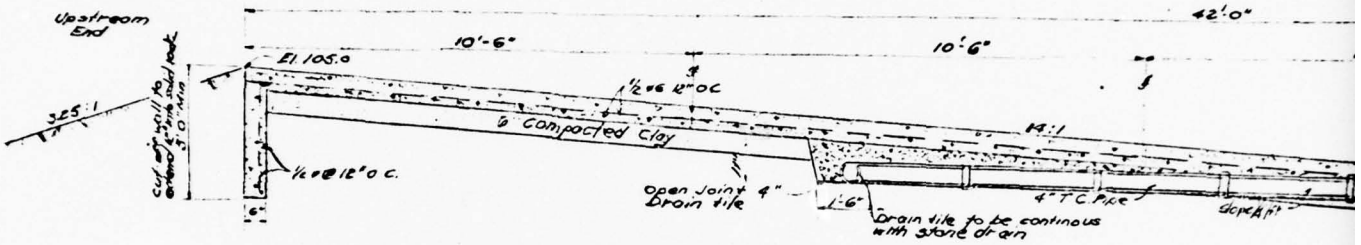
PROFILE ALONG ℄ OF EMERGENCY SPILLWAY.





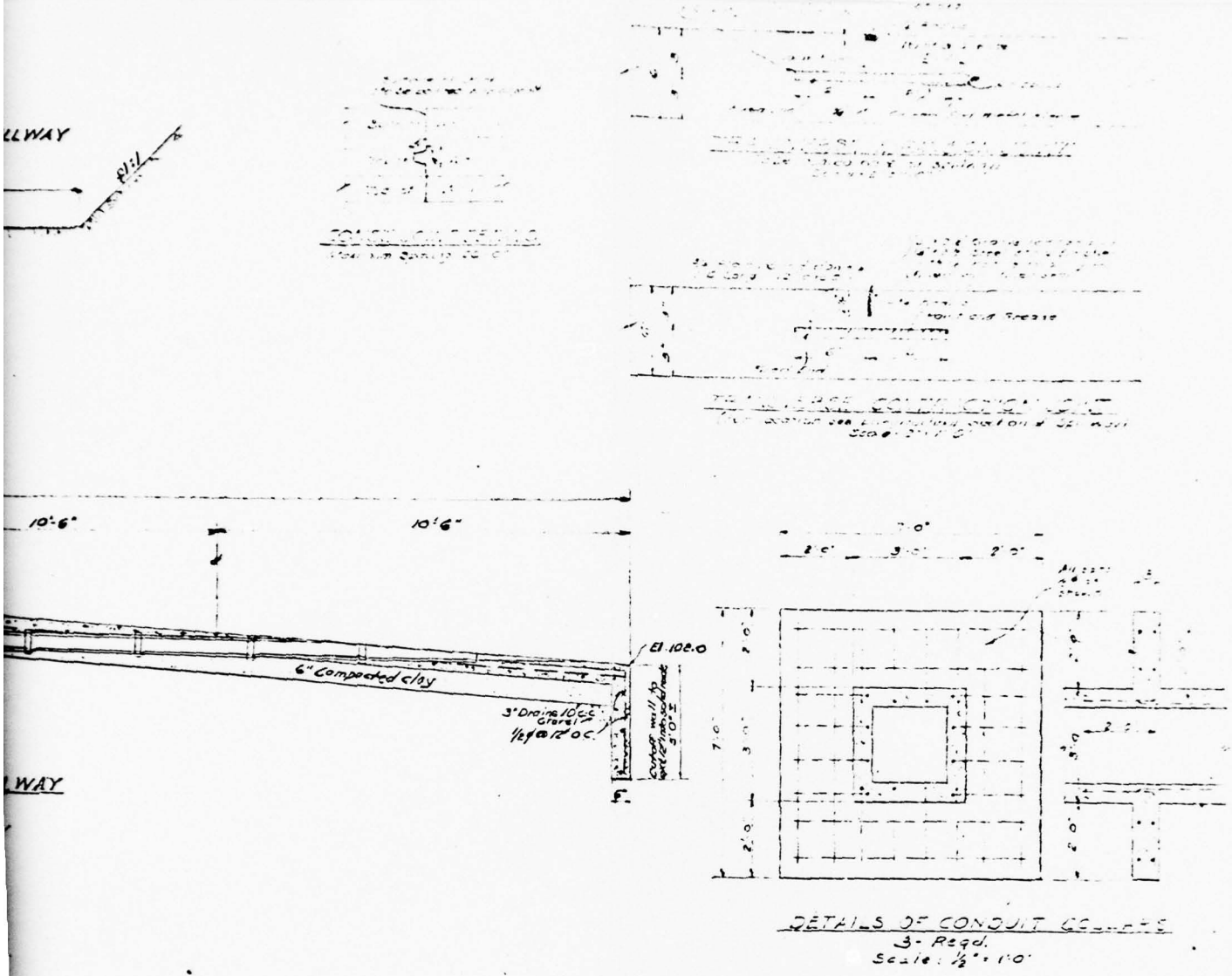
DETAILS OF SPILLWAY WALLS & PAVING

INTERMEDIATE SPILLWAY



LONGITUDINAL SECTION OF SPILLW

INTERMEDIATE SPILLWAY



DETAILS OF CONDUIT COLLARS
3- Reqd.
Scale: 1/2" = 1'-0"

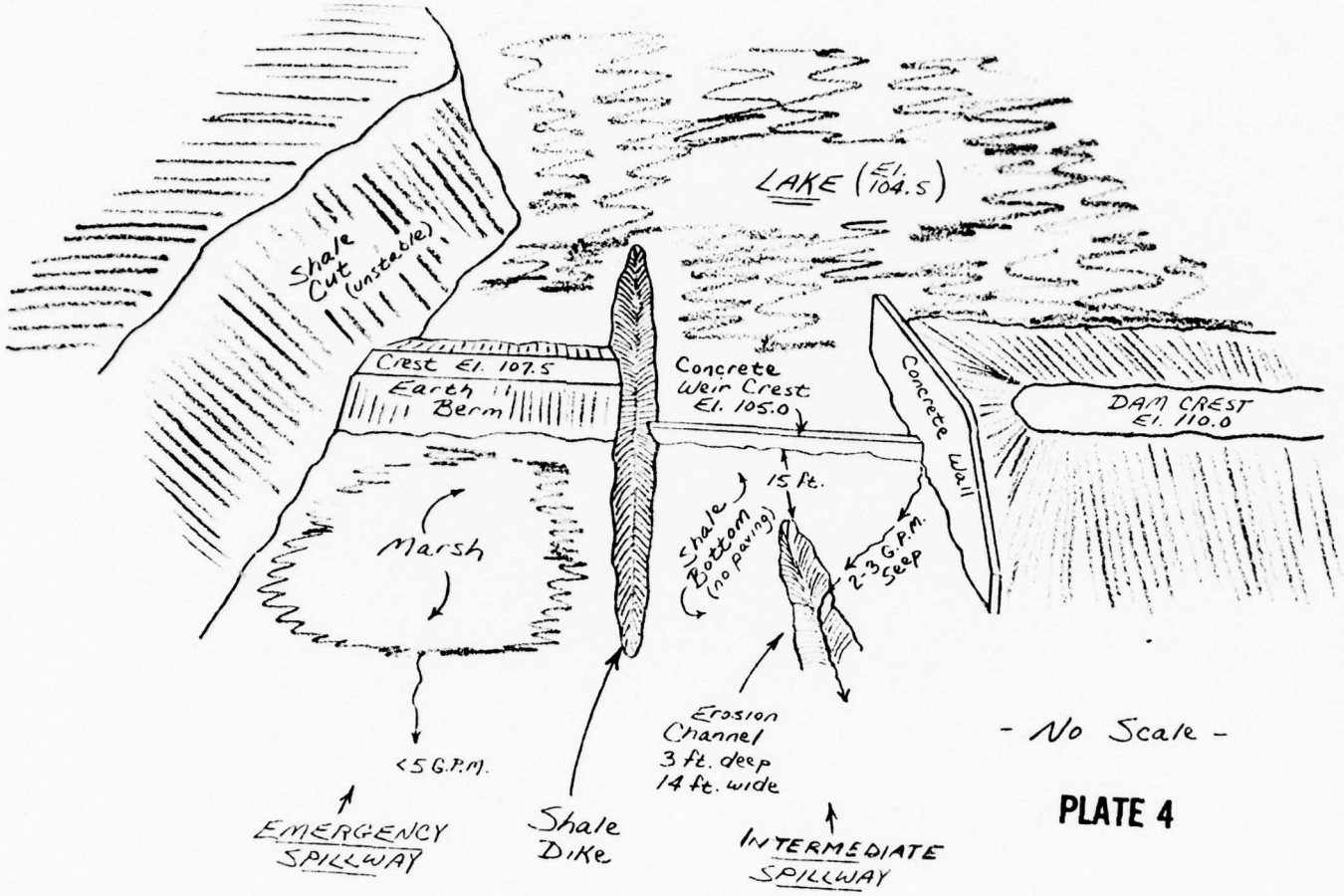
PLATE 3

SPILLWAY DETAILS

CAMP DEVELOPMENT
FOR THE
STONEWALL JACKSON COUNCIL
BOY SCOUTS OF AMERICA
STAUNTON, VIRGINIA

WILEY & WILSON
CONSULTING ENGINEERS
LYNCHBURG, VA. RICHMOND, VA.

MADE BY D.J.S	SCALE AS SHOWN
TRACED BY D.J.S. O.W.M.	DATE SEPT. 20, 1949
APPROVED BY R.B.W.M.	DRWG. NO. 49-6
REVISED	PROJECT NO. 3001-18



- No Scale -

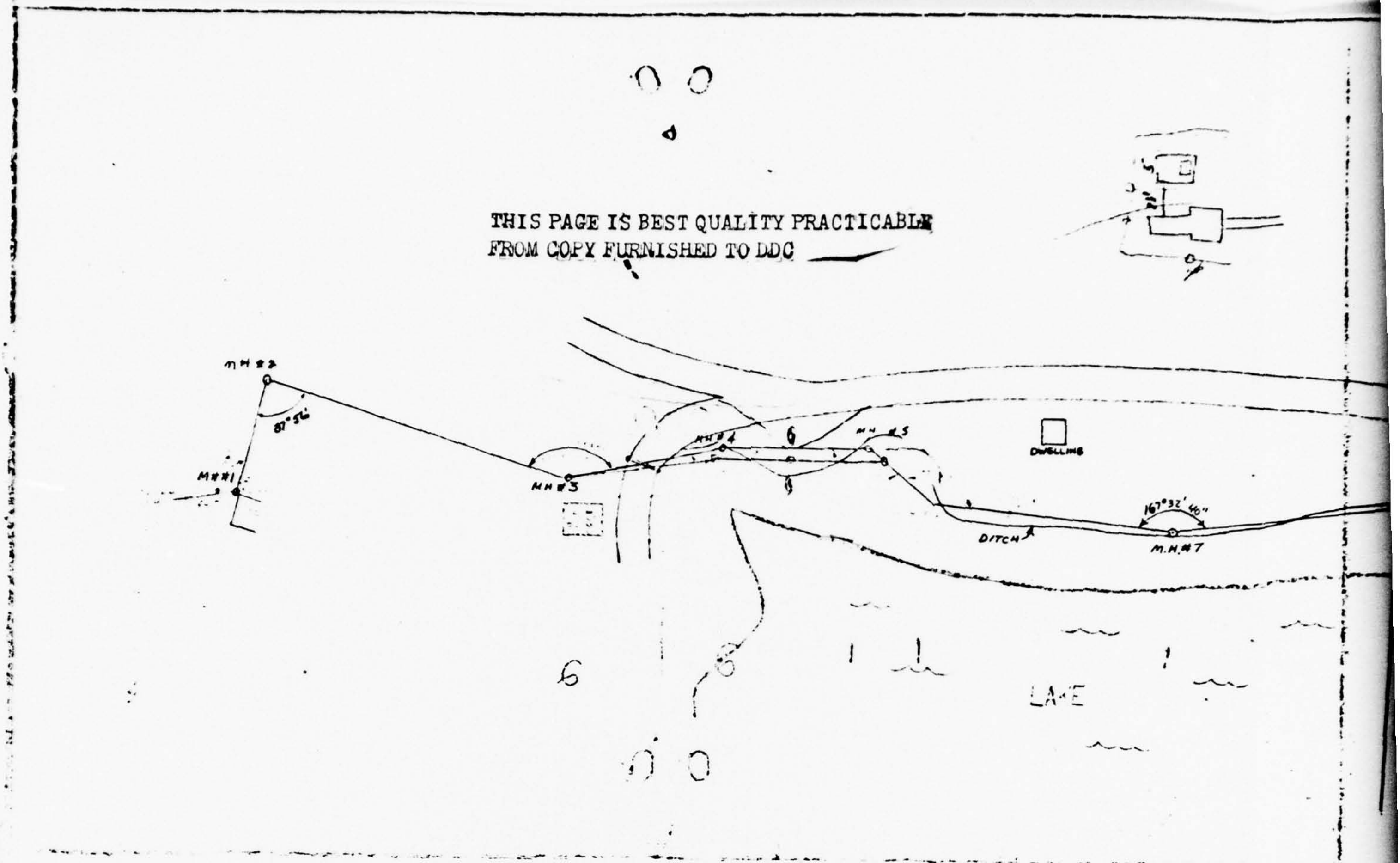
PLATE 4

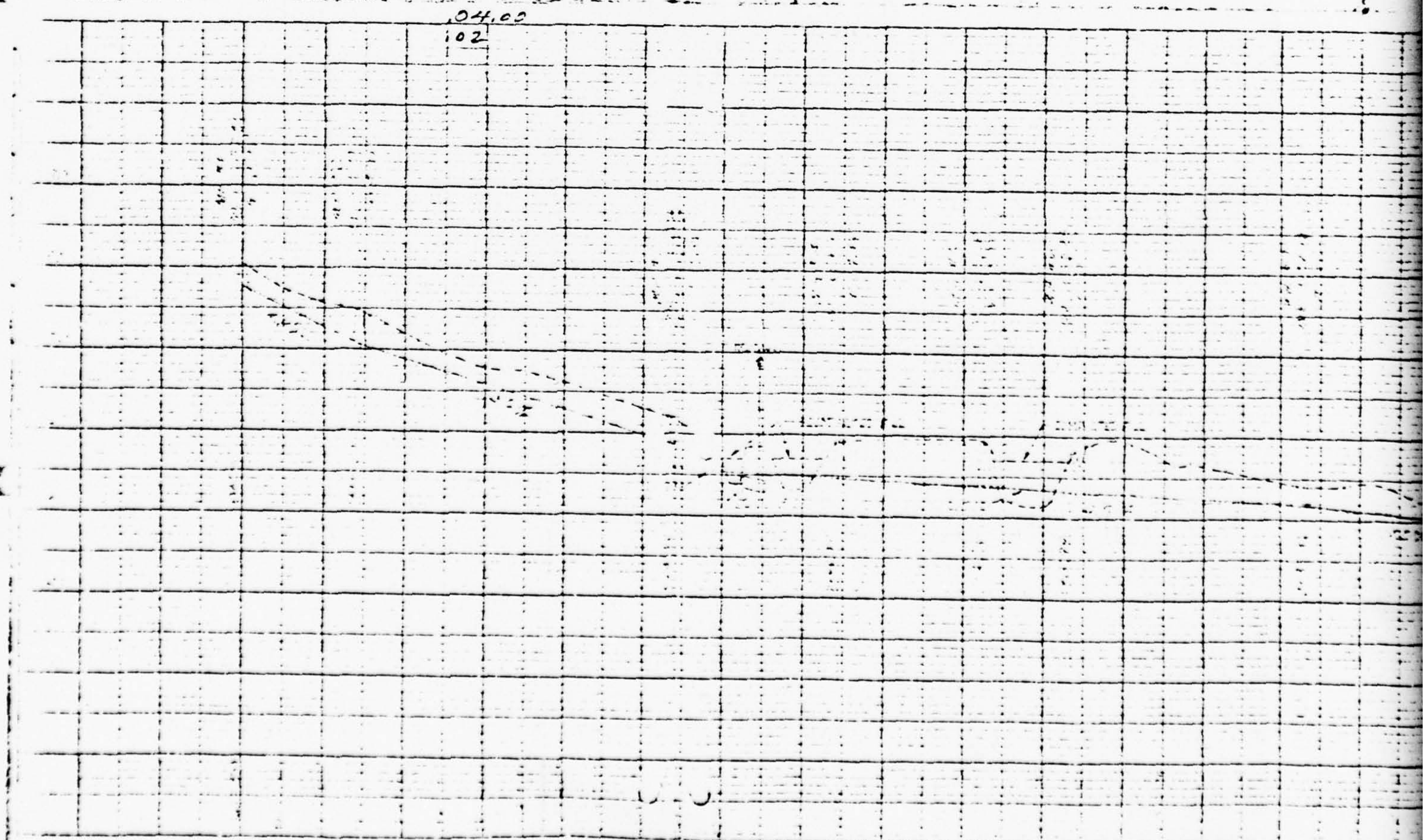
- CAMP SHENANDOAH DAM, VIRGINIA -

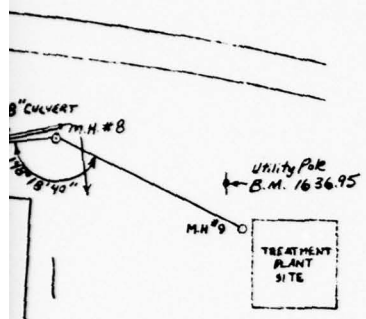
SKETCH OF EXISTING SIDE CHANNEL SPILLWAYS

- MICHAEL BAKER, JR., INC. -

- JULY, 1978 -







Construction Plan of
Sanitary Sewer for
CAMP SHENANDOAH
(Boy Scouts of America)

Feb 17, 1976

R. E. FUNK - C.L.S.

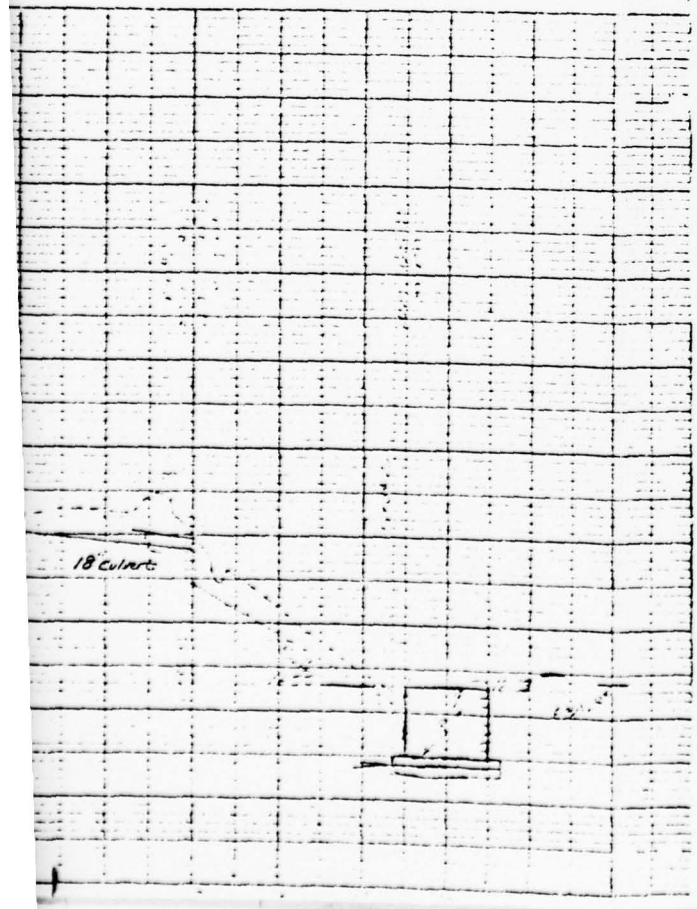


PLATE 5

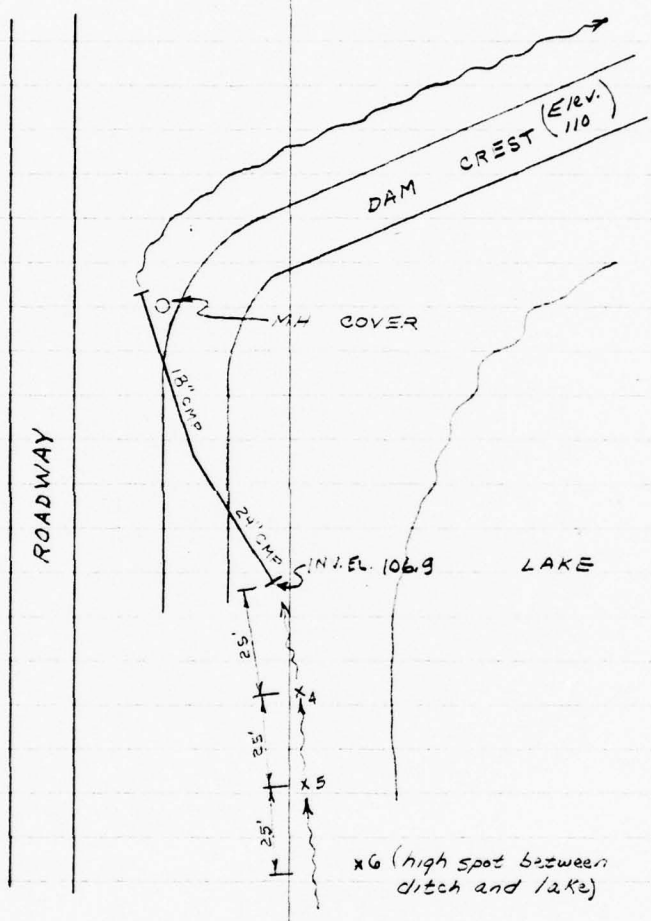
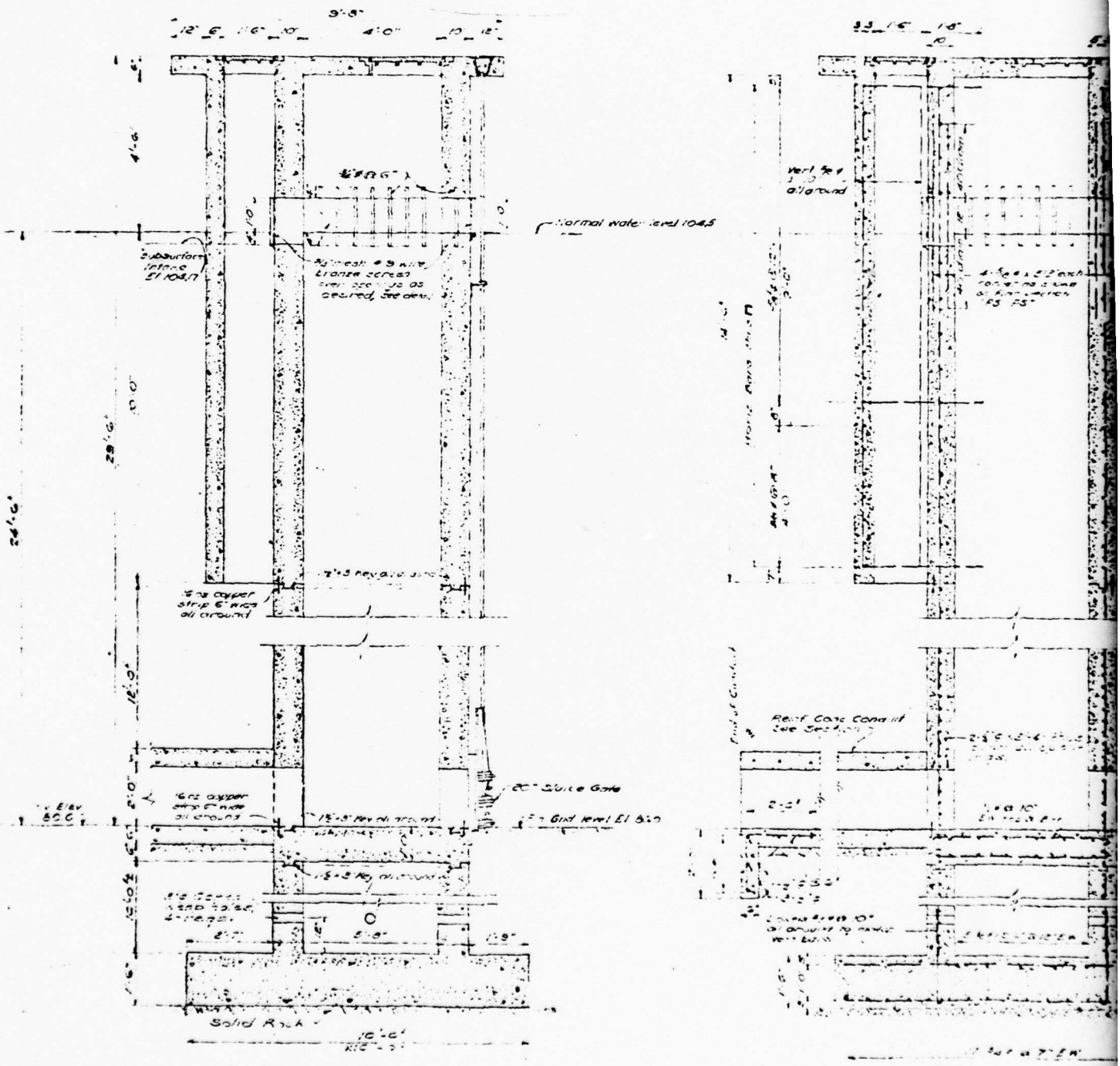
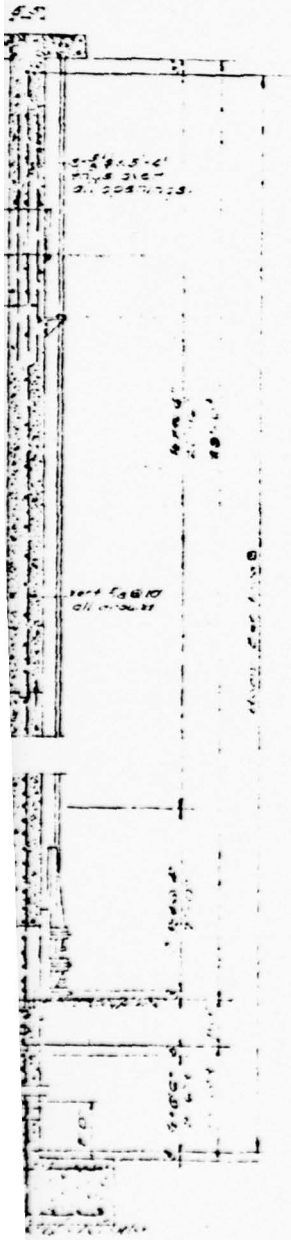
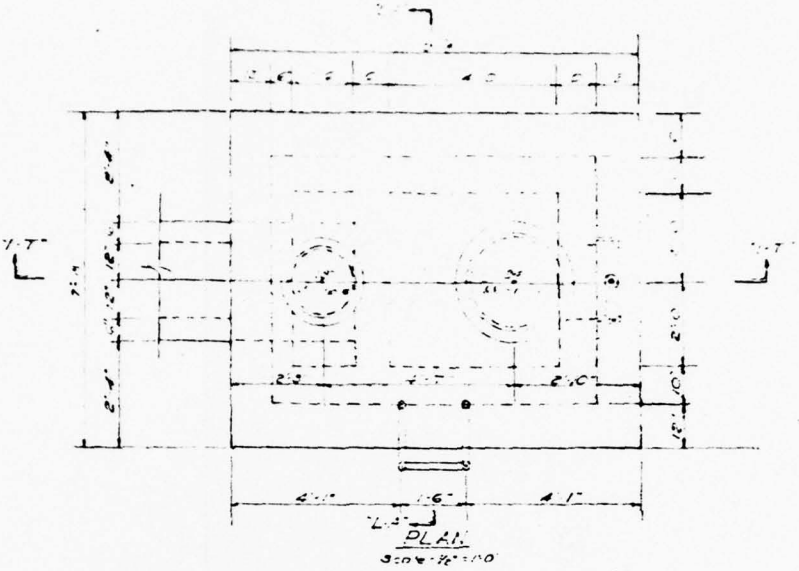


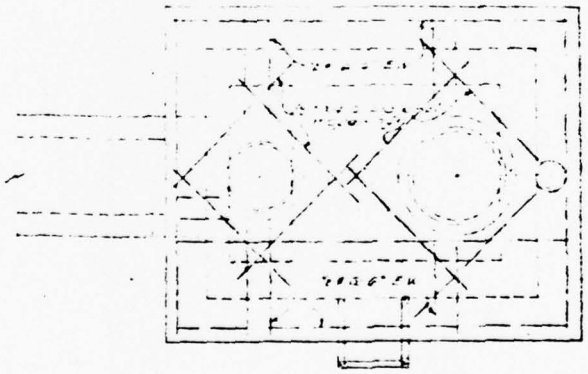
PLATE 6







PLAN



PLAN
REINFORCING DETAILS

PLATE 7

OVERFLOW INTAKE TOWER DETAILS

CAMP DEVELOPMENT
FOR THE
STONEWALL JACKSON COUNCIL
BOY SCOUTS OF AMERICA
STAUNTON, VIRGINIA

WILEY & WILSON
CONSULTING ENGINEERS
LYNCHBURG, VA. RICHMOND, VA.

MADE BY T.C.E., C.W.M.	SCALE AS SHOWN
TRACED BY C.W.M.	DATE SEPT. 30, 1949
APPROVED BY R.B.M.N.	C.W.M. NO. 4914
REVISED	DRAWING NO. 2 OF 13

2

APPENDIX II

PHOTOGRAPHS

CONTENTS

Note: Photographs were taken 12 July 1978.

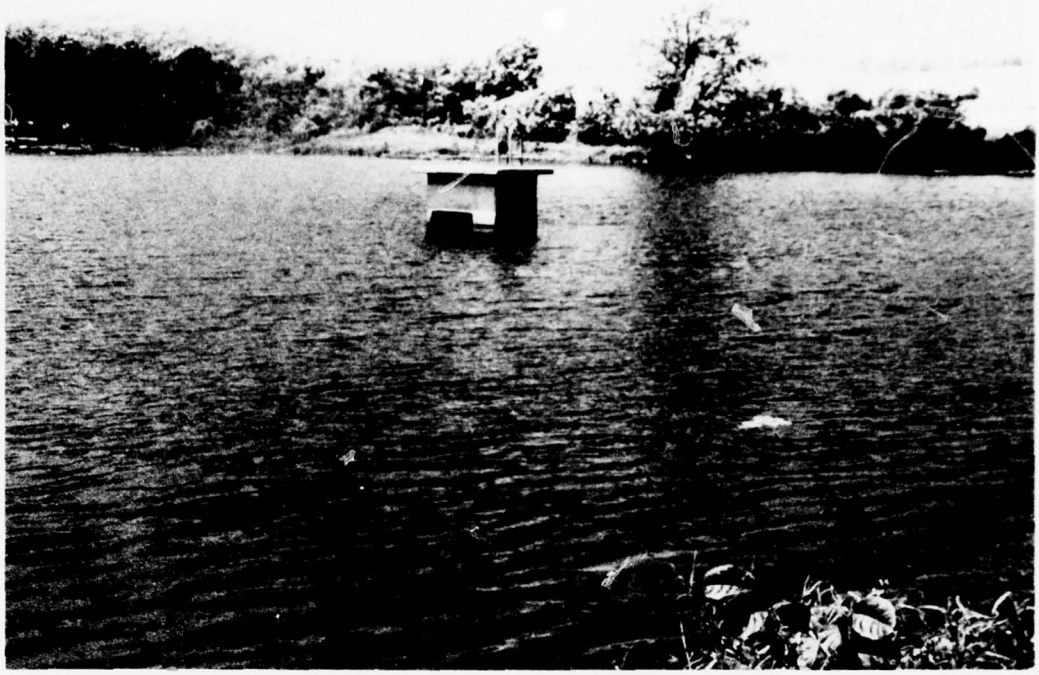


PHOTO 1. Overflow Intake Tower

PHOTO 2. Eroded Ditch Along Northern Toe of Dam

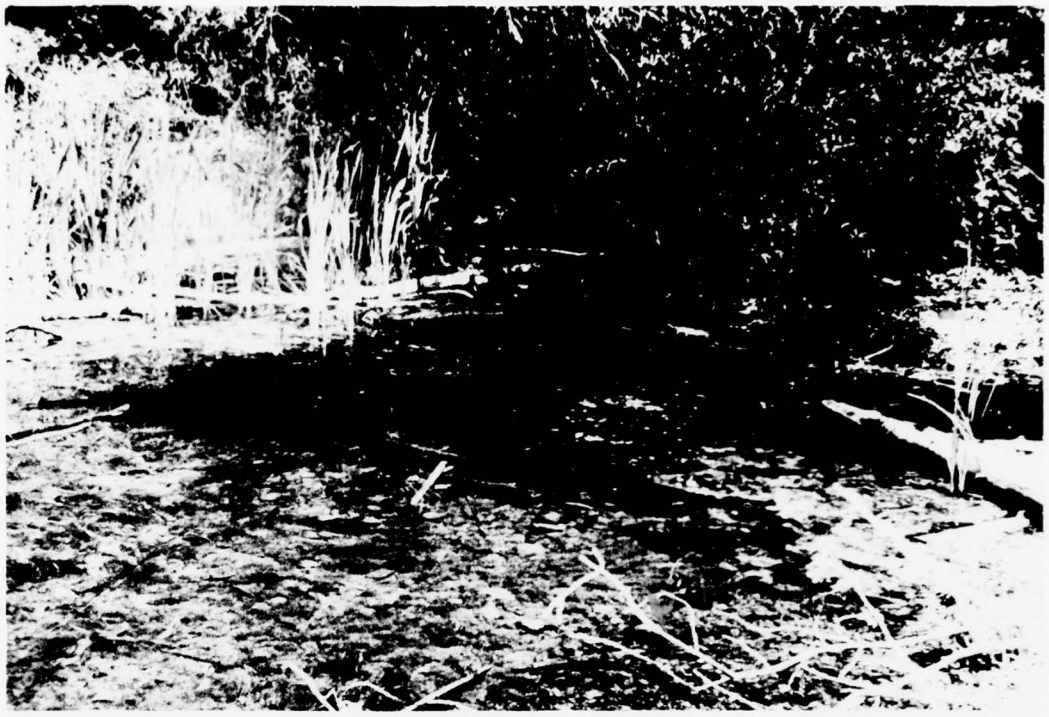


PHOTO 3. Intermediate Spillway Approach End

PHOTO 4. Emergency Spillway Approach End
(Intermediate Spillway and Emergency Spillway Are Two Distinct, Adjacent Channels.)

PHOTO 5. Concrete Weir in Intermediate Spillway

PHOTO 6. Clear Seepage in Emergency Spillway Discharge Channel

APPENDIX III

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name Dam Camp Shenandoah (Boy Scout Facility) County Augusta State Virginia Coordinates Lat. 3808.0 Long. 7913.6

Date Inspection 12 July 1978 Weather Sunny Temperature 80°F.

Pool Elevation at Time of Inspection 104.7 (Assumed Datum) Tailwater at Time of Inspection 77.2 (Assumed Datum)

Inspection Personnel:

MICHAEL BAKER, JR., INC.:

Ed Brill
Michele Mill
David Hupe

M. Mill Recorder

Camp Shenandoah

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks were observed. However, an adequate examination was hindered by heavy brush growth.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None was observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or significant erosion noted on embankment or abutment slopes. Heavy brush and tree cover on downstream slope of dam and spillways, and around outlet pipe and channel.	Heavy brush and tree growth should be removed and periodically recut.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical alignment is satisfactory according to a field survey (elevations range from 109.9 to 110.4 - design elevation is 110.0 [assumed datum]). Horizontal alignment is satisfactory.	
RIPRAP FAILURES	Riprap on upstream slope of embankment is in good condition (two to four inch limestone fragments). Riprap is not present around outlet pipe; however, area appears to be stable.	

Camp Shenandoah

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION	Brown weathered shale is exposed in the spillways. The shale has a strike of N. 65° E. and a dip of SE. 25°. Joints strike N. 80° E. and dip NW 83°.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	A drainage channel is located on the north side of the lake between the road and shoreline. A 24 inch diameter corrugated metal pipe (which is reduced to 18 inches at the outlet) drains the above channel through the north abutment of the dam. From this outlet a significant erosion channel has formed along the northern downstream toe of the dam extending all the way to the outlet pipe and channel.	This entire drainage channel should be eliminated and the existing erosion damage repaired.
ANY NOTICEABLE SEEPAGE	No seepage was observed emanating from the embankment.	
STAFF GAGE AND RECORDER	There were none.	
DRAINS	Two underdrain outlets, as indicated on construction plans, could not be located because of dense tree and brush cover. One terrace drain outlet located immediately south of main dam drain - no discharge. One remaining terrace drain outlet could not be located. Drainage to terrace drain inlets is hindered by dense vegetative cover.	Dense brush and trees should be removed. Drains should be located and reexamined. Terrace drainage should be restored by clearing and slight regrading if necessary.

Camp Shenandoah

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete appears to be sound.	
INTAKE STRUCTURE	Concrete is apparently in good condition, but the small mesh (three-fourths of an inch) of the trash rack could be easily clogged.	Replace the old trash rack with a trash rack with larger mesh openings.
OUTLET STRUCTURE	Outlet is 24 inch inner diameter concrete pipe. Concrete apron around outlet may have been present at one time but is broken.	Possibly, riprap should be placed around the outlet.
OUTLET CHANNEL	Heavily overgrown meandering channel. The channel is not riprapped.	The outlet channel should be kept clear of brush. Riprap may be desirable along outlet channel.
EMERGENCY GATE	There is a 20 inch sluice gate which is operated by a hand crank. It appears to be in operating order; last used by camp personnel in 1977. The sluice gate's bottom elevation is 80.0 feet (assumed datum). The gate will drain the lake.	Periodically test the emergency gate to insure that it is in operating order.

UNGATED SPILLWAY

Camp Shenandoah

THERE ARE TWO SPILLWAYS. AN INTERMEDIATE SPILLWAY WITH A CONCRETE WEIR AND AN ADJACENT EMERGENCY SPILLWAY WITH AN EARTH BERM FOR A CREST (SEE PLATES 1 AND 4).

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR (INTERMEDIATE SPILLWAY)	Slightly eroded, but no structural defects were observed. No flow over weir at time of inspection (crest elevation 105.0 [assumed datum]). An approximate three to five g.p.m. seep is occurring under the north end of the weir. This seep probably occurs through joints in the shale bedrock observed to be originated about in line with the longitudinal axis of the spillway.	Monitor seep under weir to determine if undercutting could occur.
APPROACH CHANNEL	The approach channel is heavily overgrown with brush and trees. Debris up to six inches in diameter was found (in both the intermediate spillway and emergency spillway).	Clear the approach channel of all growth, except grasses.
DISCHARGE CHANNEL	1) Intermediate and emergency spillways are heavily overgrown with brush and trees. Severe erosion up to four feet deep was found to within approximately 15 feet of the weir of the intermediate spillway.	1) Clear the discharge channel of heavy vegetation. With time, the erosion could progress to and undermine the concrete weir of the intermediate spillway. Protection such as concrete paving or riprap is warranted to stop erosion downstream of the weir. A concrete apron, for such protection, is indicated on the construction plans but was not built.
	2) Rock-cut in shale on the south end of the emergency spillway is steep and talus deposits are forming. This condition could contribute to restriction of the emergency spillway.	2) The slope of the emergency spillway cut should be flattened.

(Continued on next page)

UNGATED SPILLWAY

Camp Shenandoah

SEE NOTE ON SHEET 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
DISCHARGE CHANNEL (continued)	3) The earth berm across the emergency spillway is only four to five feet, maximum, in width at its crest. The design width is eight feet. The existing berm could be eroded easily if the berm is overtopped. The crest of the berm is at elevation 107.5 (assumed datum).	3) Widen the berm and riprap it for protection.
	4) A small (less than five g.p.m.) seep is occurring through or beneath the berm of the emergency spillway area in the discharge channel.	4) To maintain the berm, a clay liner berm may be desirable to prevent piping under high water conditions.
BRIDGE AND PIERS	Not Applicable	

Camp Shenandoah

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Two nails in tree roots, indicated on the construction plans, located on the north abutment could not be found in the field.	
OBSERVATION WELLS	There are none.	
WEIRS	There were none observed.	
PIEZOMETERS	There are none.	
OTHER	There are none.	

Camp Shenandoah

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes are gentle and stable.	
SEDIMENTATION	Sedimentation was not apparent. The elevation of the lake bed around the intake structure is at the bottom of the sluice gate.	

DOWNSTREAM CHANNEL

Camp Shenandoah

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is a meandering stream through pasture land. Erosion was found.	
SLOPES	The slopes are eroded but not to a significant degree.	
APPROXIMATE NO. OF HOMES AND POPULATION	No dwellings are in danger. Two buildings, (lowest in the valley at Trimbles Mill), indicated on the 1972 photorevised 7.5 Minute U.S.G.S. Churchville, Virginia Topographic Qudrangle have been removed.	

APPENDIX IV

CHECK LIST - ENGINEERING DATA

Camp Shenandoah

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Plans of the dam were obtained from Camp Shenandoah. Significant differences were found between the plans and the actual construction. The available plan view of the dam is included in this report as Plate 1.
REGIONAL VICINITY MAP	The Location Plan is included.
CONSTRUCTION HISTORY	The available plans are dated 1949. Design by Wiley & Wilson, Consulting Engineers of Lynchburg and Richmond, Virginia for the Stonewall Jackson Council of the Boy Scouts of America, Staunton, Virginia.
TYPICAL SECTIONS OF DAM	Typical sections are included in the design plans. A typical section is included in this report as Plate 2.
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN AND - DETAILS	are included in the design plans obtained from the camp.
- CONSTRAINTS AND - DISCHARGE RATINGS	are unavailable.
RAINFALL/RESERVOIR RECORDS	Not available at the dam. Rainfall data is available from Virginia Climatological Records.

Camp Shenandoah

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available. Test pits are indicated on the design plans in line with the crest of the dam.
POST-CONSTRUCTION SURVEYS OF DAM	Have not been done.
BORROW SOURCES	Class "A" Clay Core - was hauled in from a location downstream. Class "B" Ballast - used to construct upstream part of dam, borrowed from northern reservoir area. Material type not described. Class "C" Ballast - used to construct downstream part of dam, borrowed from southern reservoir area (gravelly and cobbly alluvium). Also includes earth and weathered shale excavated from below dam and spillway areas.

Camp Shenandoah

ITEM	REMARKS
MONITORING SYSTEMS	Consist of the overflow intake tower and concrete weir of spillway.
MODIFICATIONS	There were none.
HIGH POOL RECORDS	Not available directly. Large debris in spillway channels and deep erosion channel around north end and toe of dam indicate that the dam may have been close to overtopping at some time.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Sanitary sewer line plans (1976) around north end of dam. Plans (borrowed from Camp Shenandoah) show a culvert that extends through northern dam embankment. The culvert should be eliminated.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
MAINTENANCE OPERATION RECORDS	Maintenance has not been done. Sluice gate is operable and was opened last during 1977.

Camp Shenandoah

ITEM		REMARKS
SPILLWAY PLAN		
	SECTIONS	A plan and sections for the operating and emergency spillways are included in the design plans.
	DETAILS	Spillways were not constructed as planned; however, overall dimensions conform as observed in the field.
OPERATING EQUIPMENT PLANS & DETAILS		Hand operated sluice gate on intake tower. Details included in the design plans.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Approximately 1.4 square miles of forested area

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 104.5 (144 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 107.5 (150 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 110.0 design (Michael Baker, Jr., Inc. recent survey of 109.9)

CREST:	Intermediate Spillway	Emergency Spillway
a. Elevation	105.0 design (105.04 actual)	108.0 design (107.5 actual)
b. Type	Rock cut side channel	Rock cut side channel
c. Width	45 feet	47 feet
d. Length	75 feet	75 feet
e. Location Spillover	South side of dam	South side of dam
f. Number and Type of Gates	None	None

OUTLET WORKS:

a. Type 24 inch square concrete conduit (according to plans)
b. Location Center of dam
c. Entrance inverts 104.17 inlet tower subsurface intake
d. Exit inverts 77.0 design (76.88 surveyed elevation)
e. Emergency draindown facilities 20 inch sluice gate, bottom at elevation 80.0

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown