POTOMAC RIVER BASIN

Name Of Dam: SMITHLEIGH DAM
Location: AUGUSTA COUNTY, VIRGINIA
Inventory Number: VA. NO. 01523

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./
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JULY 1980 80 10 30 070
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**Phase I Inspection Report**
National Dam Safety Program
Smithleigh Dam
Augusta County, Virginia


U. S. Army Engineering District, Norfolk
803 Front Street
Norfolk, Virginia 23510

July 1980

Approved for public release: distribution unlimited.

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Dams - VA
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

(See reverse side)
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.
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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 aide 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.
Name of Dam: Smithleigh Dam
State: Virginia
County: Augusta
USGS Quad Sheet: Churchville
Coordinates: Lat 38° 09.1' Long 79° 12.8'
Stream: Middle River
Date of Inspection: April 15, 1980

BRIEF ASSESSMENT OF DAM

Smithleigh Dam is a zoned earthfill structure about 510 ft long and 18 ft high. The principal spillway consists of a concrete riser and a 36 inch diameter concrete outlet pipe which extends through the structure. There are two emergency spillways; one located at the center of the dam, and another at the right abutment. The emergency spillways consist of five 44" x 72" corrugated pipe arches and a 200 ft wide grass-lined earth channel with 1.5H:1V side slopes, respectively. The structure is classified small in size and is assigned a significant hazard classification. The dam is located on the Middle River about one-half mile south of Swoope, Virginia. The lake is used for recreation and is owned and maintained by Mr. R. R. Smith.

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 \( \frac{1}{2} \) PMF. The spillways will pass less than 10 percent of the Probable Maximum Flood (PMF) or 20 percent of the SDF. During the SDF, the dam will be overtopped to a depth of 4.8 ft maximum, at a maximum velocity of 9.4 fps, and will be overtopped for a period of 14 hours. The spillway is rated seriously inadequate.

An accurate check on stability could not be made since sufficient design data, calculations, and construction data were not available.
The embankment crest width and the downstream embankment slope meet the requirements recommended by the U. S. Bureau of Reclamation; however, the upstream slope is slightly steeper than recommended when subject to rapid drawdown. Stability is not believed to be a problem since the dam has been overtopped by 3 to 6 inches for about one hour in 1977 and also because the dam was subjected to rapid drawdown during construction of the secondary principal spillway.

Due to the inadequacy of the spillways, the dam will be subject to high, erosive stream velocities on the non-overflow section during the SDF. The potential for a dam failure exists because of the possible erosion caused by overtopping, which results in an increased hazard to loss of life for the downstream structure. Because of the potential hazard the dam is assessed "unsafe non-emergency".

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

It is therefore recommended that within two months of the date of notification of the Governor of the Commonwealth of Virginia, the Owner engage the services of a professional engineering consultant to complete a detailed evaluation of the downstream floodplain and of
the Spillway Design Flood appropriate to this dam. Remedial measures to be considered include modification to the dam, spillway, floodplain, and/or any other method of eliminating the danger imposed by the dam. The erosional effects of overtopping on the embankment should also be addressed.

Within six months of the notification of the Governor, the consultant's analyses and recommendations should be completed and the Owner should have an agreement with the Commonwealth of Virginia for a reasonable time period in which all remedial measures will be complete. In the interim, an emergency operation and warning plan should be developed.

The following routine maintenance and observation functions should be initiated:

1) Repair eroded areas on the outlet channel and downstream channel and provide erosion control measures such as riprap to prevent future erosion. Areas which are undermining the outlet channel should also be backfilled and protected.

2) The presence of trees on the embankment can result in the development of deep rooted vegetation and this type growth can encourage piping within the embankment. It is recommended that the trees presently growing on the embankment be cut to the ground and be continuously controlled during normal maintenance procedures.

3) A staff gage should be installed.
On July 22, 1980 a meeting was held at the dam site to discuss the preliminary Phase I Inspection Report for the dam. Discussion included the predicted overtopping of the dam during the SDF and the resulting increase in hazard to the downstream dwelling. The Owner indicated that he would reduce the downstream hazard by providing an early warning system. A memorandum of the site meeting is included as p.9 of Appendix III.

Prepared by:

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

Ray E. Martin, Ph.D., P.E.
Commonwealth of Virginia

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District Engineer

Recommended by:

Original Signed by:
Ronald G. Vann
Jack G. Starr, P.E., R.A.
Chief, Engineering Division

Date: AUG 9 1980
OVERVIEW PHOTOGRAPH
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 (see Reference 1, Appendix IV). 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: Smithleigh Dam is a zoned earth-fill structure approximately 510 ft long and 18 ft high.* The top of the dam is 20 ft wide and is at elevation 1582 msl. Side slopes are approximately 6 horizontal to 1 vertical (6H:1V) on the downstream side and 3 horizontal to 1 vertical (3H:1V) on the upstream side to elevation 1577 msl and then grades to 2 horizontal to 1 vertical (2H:1V).

*Height is measured from the top of the dam to the downstream toe at centerline of the stream.
The dam is keyed into the foundation and an internal drainage system exists. Existing vegetation on the embankment slopes provide adequate slope protection.

The principal spillway is a reinforced concrete riser type structure 3.0 ft square with a crest elevation of 1576.5 msl. The outlet pipe is a 36 inch corrugated metal pipe (CMP) which discharges into a paved outlet channel at the toe of the dam. The inlet invert of the 36 inch CMP is 1564.9 msl. A 36 inch diameter gate located on the riser structure at elevation 1565.9 msl is used to drain the lake.

There is a secondary principal spillway which consists of five 44" x 72" CMP arches through the dam at invert elevation 1577 msl, located near the center of the dam adjacent to the riser inlet.

The original emergency spillway has been raised to within 0.5 ft of the top of the dam. The new emergency spillway is a 200 ft wide grass lined earth spillway located in a fill section at the right abutment. This spillway crosses the access road and intersects the stream below the outlet channel (See Plates No. 2 and 4, Appendix I).

1.2.2 Location: Smithleigh Dam is located on the Middle River approximately ½ mile south of Swoope, Virginia. (See Plate 1, Appendix I).

1.2.3 Size Classification: The dam is classified as a "small" size structure because of the dam height.

1.2.4 Hazard Classification: Smithleigh Dam is located in a rural area; however, based upon the downstream proximity of one dwelling located one-quarter mile 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.

-7-
1.2.5 **Ownership:** Mr. R. R. Smith owns and operates the dam.

1.2.6 **Purpose:** Recreation.

1.2.7 **Design and Construction History:** The dam was designed and constructed under the supervision of Johnson and Williams, Consulting Engineers, for the owner. The structure was constructed by Echols Brothers Construction Company and completed in 1968. The emergency spillway was modified in 1977 from its original design by raising the crest elevation. This action was taken due to erosion caused by the magnitude and frequency of use. During the modification a new emergency spillway was constructed by Valley Paving Company consisting of five CMP pipe arches and concrete discharge chute. This structure was designed by the owner.

1.2.8 **Normal Operational Procedures:** The principal spillway is ungated; therefore, water rising above the crest of the riser inlet automatically is discharged downstream. Similarly, water is automatically passed through the emergency spillway in the event of an extreme flood which creates a pool elevation above that of the emergency spillway crest. Normal pool is maintained at elevation 1576.5 msl.

1.3 **Pertinent Data:**

1.3.1 **Drainage Areas:** The drainage area is 25 square miles.

1.3.2 **Discharge at Dam Site:** Maximum known flood at the dam site occurred in April 1977 and an estimated pool elevation of 1582.5\(\pm\) msl was observed. This corresponds to a peak discharge of approximately 1816 CFS.

**Principal Spillway Discharges:**

- Pool Elevation at Crest of Dam (elev 1582) 133 CFS

**Emergency Spillway Discharges:**

- Pool at Crest of Dam (elev 1582) 982 CFS
1.3.3 Dam and Reservoir Data: See Table 1.1 below:

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elevation</td>
</tr>
<tr>
<td></td>
<td>Feet ms1</td>
</tr>
<tr>
<td>Crest of Dam</td>
<td>1582</td>
</tr>
<tr>
<td>Emergency Spillway</td>
<td>1581.5</td>
</tr>
<tr>
<td>Multiple CMP Arches</td>
<td>1577</td>
</tr>
<tr>
<td>Intake Riser Crest</td>
<td>1576.5</td>
</tr>
<tr>
<td>Streambed at Downstream Toe of Dam</td>
<td>1564</td>
</tr>
</tbody>
</table>
SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of Johnson and Williams, Consulting Engineers (Staunton, Virginia) for Mr. R. R. Smith. Design data and construction specifications are available at the office of Betz, Converse, Murdoch, Inc., 1205 North Augusta Street, P. O. Box 2277, Staunton, Virginia, 24401, the successor firm to Johnson and Williams. The hydrologic and hydraulic design report was not available and a stability analysis was not performed.

A subsurface investigation was conducted at the site by E. O. Gooch and Associates during the initial design stages. The investigation consisted of drilling 13 auger probe borings to obtain bulk samples and 7 test borings including standard penetration tests. A report of the investigation with foundation recommendations was prepared based upon geological reconnaissance, test borings, and laboratory soil testing. Boring logs are included as Appendix IV and their locations are shown on Plate No. 2 of Appendix I.

The dam is a zoned, compacted earthfill embankment (Plate No. 3, Appendix I.) The upstream slope is 3 horizontal to 1 vertical above elev 1577 and 2 horizontal to 1 vertical below elev 1577. Eighteen inches of stone riprap exists between elevations 1576 and 1579. The downstream slope is 6 horizontal to 1 vertical. Zone I was to be constructed with soils excavated from the emergency spillway, while remaining materials from the emergency spillway and soils
excavated from portions of the lake were to be included in Zone II. Laboratory test data indicate that virtually all of the on-site soils classified as silty clays (CL) in accordance with the Unified Soil Classification System and thus, from a technical viewpoint, the dam is considered homogeneous. Compaction requirements of 100 percent and 90 percent of maximum dry density were specified, however, for Zones I and II, respectively. It could not be determined from the construction specifications available whether the percent compaction was in accordance with ASTM D-1557 (modified proctor) or ASTM D-698 (standard proctor). All fill was to be placed in 6 inch layers (loose thickness) and compacted with a roller. Areas not accessible to the roller were to be placed in 4 inch layers and compacted with power tampers.

A drainage system is located under the downstream portion of the embankment to control the phreatic surface and to collect seepage. Construction specifications describe the filter material as consisting of, "well graded bankrun river bottom material about one (1) inch to two (2) inches in diameter, meeting the following consistency requirements:

- Gravel - 10 to 30 percent
- Sand - 25 to 40 percent
- Silt - 25 to 35 percent"

A review of design drawings (Plate No. 3, Appendix I) indicates the dam is founded on overburden and includes a 10 ft wide cutoff trench which extends to bedrock. Test borings encountered limestone bedrock at depths of 4 to 5 ft below ground surface in the flood
plain and from the ground surface to 8 ft depth on the adjacent
hillsides along center line of the dam.

The principal spillway consists of a concrete riser and 36 inch
diameter concrete outlet pipe, which extends through the structure.
Four anti-seep collars or "watertight diaphragms" were provided in
design, spaced 22 ft on center (Plate No. 3, Appendix I).

An emergency spillway was originally constructed in the right
abutment as shown on Plate No. 4 of Appendix I. According to the
Owner this emergency spillway was subjected to continual erosion,
therefore, in 1977 the spillway was raised and an additional emergency
spillway constructed. The original emergency spillway is now a 210
ft wide grass-lined earth channel with 1.5:1 side slopes. The new
emergency spillway which was designed by Mr. R. R. Smith, consists of
five 44 inch x 72 inch corrugated pipe arches with a concrete
discharge channel (Plate No. 6, Appendix I).

2.2 Construction: Construction records were not available. It
is not known whether full time construction inspection was required,
however, the inspection of designated areas and materials was specified
in the construction specifications. The dam was originally constructed
in 1968 by Echols Brothers Construction Company, Staunton, Virginia.
The new emergency spillway was constructed in 1977 by Valley Paving
Company, Staunton, Virginia.
2.3 Evaluation: Engineering calculations are not available and there are no records available for dam performance. Design drawings provided by Johnson and Williams appear to be generally representative of the "as built" structure. There is sufficient information to evaluate foundation conditions, but insufficient information to evaluate embankment stability.
SECTION 3 - VISUAL INSPECTION

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

3.1.1 General: An inspection was made 15 April 1980 and the weather was cloudy with a temperature of 40°F. The pool and tailwater levels at the time of inspection were 1578 and 1566 msl, respectively, which corresponds to above normal levels. Ground conditions were damp at the time of the inspection. No previous inspection reports were available.

3.1.2 Dam and Spillway: The embankment and abutment slopes and the right emergency spillway are all grassed and well maintained. Numerous small trees approximately 6 ft high and 1 to 3 inches in diameter occur along the upstream slope, which is blanketed with riprap. Ponded water was observed in two areas; first, along the downstream toe several hundred ft left of the concrete outlet channel and second, in a 60 ft x 25 ft² area about 75 ft below and to the left edge of the concrete channel. No iron staining was observed and both areas are believed to represent ponded runoff from earlier rainfalls. Just to the right of the second area, water was flowing through a small opening in the concrete channel at a rate of 5 to 10 gpm². This water is believed to represent water flowing beneath and along the side of the channel. Water was also flowing from beneath the concrete channel at a rate of 25 to 30 gpm². See Sheet 1, Appendix III. No foundation drains were observed; however, Mr. Cox recalled seeing several when there was no flow in the concrete outlet channel.
The abutments are grassed and no bedrock was exposed. No faults were observed in the field during this inspection and geologic maps of the area do not show the presence of faults in the immediate vicinity.

The intake structure showed no signs of deterioration, but was partially submerged and observation was hindered. The drain valve was reportedly in operational condition. The outlet pipe is a 36 inch diameter concrete pipe and was submerged. There was no staff gage located at the site.

The emergency spillway consists of a ground overflow section approximately 200 ft wide with a control section six inches (elev 1581.5) below the crest of the dam, and five 72" x 44" corrugated metal pipe arches through the dam embankment adjacent to the intake structure with an invert elevation of 1577± msl. The 72" x 44" pipe arches were flowing approximately one foot deep at the time of inspection.

The concrete discharge channel below the principal spillway outlet is severely eroded behind the concrete sidewalls. This erosion reportedly occurred primarily during the storm of April, 1977.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter is pasture. The reservoir is located in a broad valley streambed with side slopes at approximately 4H:1V. Sediment buildup was indicated near the upstream reaches by the farm manager.

3.1.4 Downstream Area: The downstream channel consists of a 20 ft wide by 2 ft deep channel located in a valley. The valley side slopes are approximately 4H:1V and consist of open pasture. For a distance of approximately 100 ft downstream of the outlet channel,
the stream banks are severely eroded. Approximately one-quarter mile downstream there is one home about 15 ft above the streambed. During the April 1977 storm, the stream level rose to within several feet of the dwelling and encroached within the yard area. The dam was overtopped during this storm by 3 to 6 inches for approximately one hour.

3.1.5 Instrumentation: No instrumentation (monuments, observation wells, piezometers, etc.) was encountered for the structure.

3.2 Evaluation: Overall, the dam was in good condition at the time of inspection. The embankment and abutment slopes are well maintained. A number of small trees exist on the upstream slope. Uncontrolled growth promotes the development of deep rooted vegetation and this type growth can encourage piping within the embankment. Small trees presently growing on the embankment should be cut to the ground.

Described wet areas on the downstream slope are believed to represent ponded runoff from earlier rainfalls and not seepage.

The intake and outlet structures are thought to be in good condition, although observation was hindered by high water.

The concrete outlet channel is in need of erosion protection. The downstream channel below the outlet channel is also in need of erosion control. The erosion on the outlet channel and downstream channel is severe enough to cause damage to the outlet channel if left unchecked. This could ultimately be detrimental to the dam performance.
A staff gage should be installed.

3.2.2 **Downstream Area**: The dwelling located immediately downstream of the dam could be jeopardized by a dam breach during periods of intense flooding.
SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Smithleigh Lake is used for recreational purposes only. The normal pool elevation (1577 msl) is maintained by the crest of a riser-type inlet acting as the principal spillway. Water automatically passes through the riser inlet as the water level rises above the crest of the riser inlet. Water will automatically pass through the multiple arch pipe spillway when the water level rises above the pipe invert. Large increases in flows which cannot be absorbed by storage and the riser-inlet and arch pipe spillway are automatically passed through the emergency spillway when the pool rises above elevation 1581.5 msl.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the Owner. A regular maintenance program consisting of inspection, debris removal, mowing of the vegetative cover, and repair is routinely performed. The operating appurtenances are reportedly in working order.

4.3 Warning System: No warning system exists.

4.4 Evaluation: The dam and appurtenances are in good operating condition and maintenance of the dam is adequate. Complete records of maintenance and inspections should be maintained for future reference. 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: No hydraulic/hydrologic data is available.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: An estimated maximum pool elevation of 1582.5\textsuperscript{+} msl occurred in April 1977, which corresponds to 1816 CFS.

5.4 Flood Potential: In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" (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), \frac{1}{2} PMF and 100 year hydrographs were developed by the SCS method. (Reference 4, Appendix IV). Precipitation amounts for the flood hydrographs of the PMF and 100 year flood are taken from the U. S. Weather Bureau Information (References 5 & 6, Appendix V). 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 Regulation: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 1576 msl. Reservoir stage-storage data and stage-discharge data were determined from the available plans, field measurement and USGS quadrangle sheets. Floods were routed through the reservoir using the principal and emergency spillways discharge up to a pool storage elevation of 1582 msl and a combined spillway and non-overflow section discharge of pool elevations above 1582 msl.
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 (PMF, ½ PMF and 100 year) are shown in the following Table 5.1.

**TABLE 5.1 - RESERVOIR PERFORMANCE**

<table>
<thead>
<tr>
<th>Hydrograph</th>
<th>Normal Flow</th>
<th>100 Year</th>
<th>½ PMF</th>
<th>PMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Flow, CFS</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflow</td>
<td>25</td>
<td>6418</td>
<td>22,843</td>
<td>45,686</td>
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<tr>
<td>Outflow</td>
<td>25</td>
<td>6336</td>
<td>22,182</td>
<td>44,570</td>
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<tr>
<td>Maximum Pool Elevation ft, msl</td>
<td>-</td>
<td>1583.6</td>
<td>1586.8</td>
<td>1589.9</td>
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<tr>
<td>Non-Overflow Section (Elev 1582 msl)</td>
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<td></td>
</tr>
<tr>
<td>Depth of Flow, ft</td>
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<td>1.6</td>
<td>4.8</td>
<td>6.9</td>
</tr>
<tr>
<td>Duration, Hours</td>
<td>-</td>
<td>11.2</td>
<td>14.4</td>
<td>19.0</td>
</tr>
<tr>
<td>Velocity, fps (a)</td>
<td>-</td>
<td>5.4</td>
<td>9.4</td>
<td>12.0</td>
</tr>
<tr>
<td>Tailwater Elevation ft msl</td>
<td>1565</td>
<td>1577</td>
<td>1584</td>
<td>1589.9</td>
</tr>
</tbody>
</table>

(a) Critical velocity at control section
5.7 Reservoir Emptying Potential: A 36-inch diameter gate at elevation 1565.7 msl is capable of draining the reservoir through the 36-inch diameter outlet pipe. Assuming that the lake is at normal pool elevation (1577 msl) and there is 25 cfs inflow, it would take approximately 1 day to lower the reservoir to elevation 1566 msl or at a rate of 11 ft per day.

5.8 Evaluation: Department of the 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 the \( \frac{1}{2} \) PMF. Because of the risk involved, the \( \frac{1}{2} \) PMF has been selected as the SDF. The spillway will pass 10 percent of the PMF (20% of the SDF). The SDF will overtop the dam a maximum of 4.1 ft, and remain above the dam for 14 hours with a maximum critical velocity of 9.4 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 in the Valley and Ridge Physiographic Province of Virginia. The structure and the eastern portion of the impoundment are underlain by the Edinburg Formation of upper Ordovician Age. The Edinburg consists basically of dark gray to black shaley limestone, shale, and coarse-grained, fossiliferous limestone. The western portion of the impoundment is underlain by slightly younger shales of the Martinsburg Formation. The geologic report by E. O. Gooch and Associates described the exposure of thin to medium-bedded limestone beds in the stream channel several hundred feet west of the dam site. Bedrock strikes to the north and dips of about 60 degrees to the east were reported. No bedrock or faults were observed at the site during the inspection.

A cutoff trench was provided in design. The trench was to extend through the overburden soils to the top of rock, having a bottom width of 10 ft and side slopes of 1 horizontal to 1 vertical. The horizontal extent of the cutoff was not shown on the drawings provided. The cutoff was to be backfilled with silty clay materials from the emergency spillway excavation.

The design geologic report indicates the presence of limestone bedrock at shallow depths below the preconstruction ground surface. Bedrock was encountered at depths of 4 to 5 ft in the flood plain and from the ground surface to depths of 8 ft in the adjacent hillsides along centerline of the dam. Although solution channels were observed by Gooch in limestone beds exposed 400 ft east of the dam site, no
such channels were reported at the dam site proper. Boring logs are included as Appendix IV. Overburden soils are apparently of residual and alluvial origin, consisting basically of silty clays (CL) and clays (CH) with assorted combinations of sand and rock fragments.

Laboratory test data indicates the overburden soils possess low to very low compacted permeabilities. Higher permeabilities would be expected in those soils which contained increased amounts of sand and rock fragments. A very high water table (3 ft below ground surface) was encountered in the flood plain during the subsurface investigation.

Based upon the design geologic data and performance history of the dam to date, a stable foundation is assumed. Gradual consolidation of underlying soils would be expected during application of fill materials. The underlying soils had probably essentially consolidated under the applied load not long after completion of construction.

6.2 Embankment:

6.2.1 Materials: The dam was constructed in 1968 as a zoned structure; however, basically the same quality silty clay (CL) and clay (CH) soils were used in both Zone I and Zone II, (see Plate No. 3, Appendix I). The distinction in zones was basically only related to the higher compaction requirements specified for Zone I. Therefore, the dam is considered a modified homogeneous dam with respect to stability. It could not be determined from the construction specifications whether compaction was in accordance with ASTM Standard D-1557 (modified proctor) or ASTM Standard D-698 (standard proctor).
However, compaction to 100% of maximum dry density was specified for Zone I and 90% for Zone 2.

6.2.2 Subdrains and Seepage: Design drawings (Plate No. 3, Appendix I) indicate the presence of a drainage system under the downstream portion of the embankment. Filter material consists of well graded bankrun sand, silt, and gravel. The drainage system is apparently functioning properly, as no seepage was encountered during the inspection. No foundation drains were observed during the inspection; however, Mr. Cox recalled seeing several when there was no flow in the concrete outlet channel.

6.2.3 Stability: There are no available stability calculations. The dam is 18 ft high and has a bottom width of approximately 120 ft and crest width of 20 ft along the principal spillway section of the dam. The upstream slope is 3H:1V above elevation 1577 msl and 2H:1V below. The downstream slope is 6H:1V. The dam is subject to rapid drawdown, as the lake can be lowered to the principal spillway invert, elevation 1565.7 msl in one day. This is at a rate of about 11 ft per day as compared to the accepted standard (Bureau of Reclamation) of 0.5 ft per day. For stability purposes, the structure was assumed to be homogeneous and constructed with CL to CH soils. According to the guidelines present in Design of Small Dams, U. S. Department of the Interior Bureau of Reclamation, for small homogeneous dams with a stable foundation subjected to drawdown and composed of CL to CH materials, the recommended slopes range from 2.5H:1V to 3.5H:1V for the downstream and upstream slopes respectively. The downstream slope is considered adequate, but the upstream slope is considered inadequate.
The recommended crest width is 13.6 ft, therefore, the existing crest width is considered to be adequate.

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: An accurate check on the stability of this structure cannot be made since stability analyses were not performed for design, and construction records are not available. The embankment crest width and the downstream embankment slope meet the requirements recommended by the U. S. Bureau of Reclamation; however, the upstream slope is slightly steeper than recommended when subject to rapid drawdown. Stability is not believed to be a problem since the dam has been overtopped by 3 to 6 inches for about one hour in 1977 and also because the dam was subjected to rapid drawdown during construction of the secondary principal spillway. Overtopping is considered a problem because of the depth and duration of flood and also the velocity of 9.4 fps is greater than 6 fps, the effective eroding velocity for a vegetated earth embankment. Some erosion is anticipated on the downstream slope during overtopping; however, tailwater conditions will absorb the additional flow. The crest of the dam is occupied by a paved hard surface road which provides erosional protection for the crest during overtopping. Since no undue settlement, cracking, or seepage was noted at the time of inspection, it appears that the
embankment is adequate for maximum control storage with water at elevation 1577 msl. Based upon design data, construction methods and the performance history of the dam, no further studies are believed necessary.
SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 **Dam Assessment**: The Smithleigh Dam at the time of inspection appeared to be in good condition. The appropriate SDF for this dam is the $\frac{1}{2}$ PMF. The spillway will pass 10 percent of the PMF (20 percent of the SDF) without overtopping, and the dam will be overtopped by 4.8 ft during the SDF. The spillways are judged seriously inadequate.

The actual embankment structure appears to be similar to the design drawings with the exception of the addition of the emergency spillway pipe arches. The downstream embankment slope meets the requirement recommended by the U. S. Bureau of Reclamation, (Reference 2, Appendix VI); however, the upstream slope is slightly steeper than recommended when subject to rapid drawdown.

Due to the inadequacy of the spillways, the dam will be subject to high, erosive stream velocities on the non-overflow section during the SDF. The potential for a dam failure exists because of the possible erosion caused by overtopping, which results in an increased hazard to loss of life for the downstream structure. Because of the potential hazard the dam is assessed "unsafe, non-emergency".

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.
Maintenance of the structure is good. The dam appears to have been
constructed generally in accordance with design drawings, except for the
modifications to the emergency spillway.

7.2 Recommended Remedial Measures: It is recommended that
within two months of the date of notification of the Governor of
the Commonwealth of Virginia, that the Owner engage the services
of a professional engineering consultant to complete a detailed
evaluation of the downstream floodplain and of the Spillway Design
Flood appropriate to this dam. Remedial measures to be considered
include modification to the dam, spillway, floodplain, and/or any
other method of eliminating the danger imposed by the dam. The
erosional effects of overtopping on the embankment should also be
addressed.

Within six months of the notification of the Governor, the
consultant's report of appropriate remedial mitigating measures
should have been completed and the Owner should have an agreement
with the Commonwealth of Virginia for a reasonable time frame in
which all remedial measures will be complete.

Until corrective measures are completed, the dam should be
checked during periods of heavy runoff. If dam overtopping is
imminent, warning should be issued to the downstream inhabitants.

In the interim, an emergency operation and warning plan should
be promptly developed. 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 and Observation:

7.3.1 Repair eroded areas on the outlet channel and downstream channel, and provide erosion control measures such as riprap to prevent future erosion. Areas which are undermining the outlet channel should also be backfilled and protected.

7.3.2 The presence of trees on the embankment can result in the development of deep rooted vegetation and this type growth can encourage piping within the embankment. It is recommended that the trees presently growing on the embankment be cut to the ground and be continuously controlled during normal maintenance procedures.

7.3.3 A staff gage should be installed.
APPENDIX I

MAPS AND DRAWINGS
APPENDIX II

PHOTOGRAPHS
Intake Structure (Submerged by High Water)

Photograph No. 1

Emergency Spillway

Photograph No. 2
Outlet Channel

Photograph No. 3

Downstream Channel

Photograph No. 4
Downstream Face of Dam and Roadway
Across Top of Dam
Photograph No. 5

Abandoned (original) Emergency Spillway
Located at Right Abutment
Photograph No. 6
APPENDIX III

FIELD OBSERVATIONS
Check List
Visual Inspection
Phase I

Name Dam  R. R. Smith  County  Augusta  State  Virginia  Coordinators Lat. 38°-09.1'

Date(s) Inspection  4/15/80  Weather  Cloudy, Windy  Temperature  40° F

Pool Elevation at Time of Inspection  1578  msl  Tailwater at Time of Inspection  1566'  msl

Inspection Personnel:
Raymond A. DeStephen, P.E.  Robert G. Roop, P.E.
Stephen G. Werner (recorder)  Donald Balzer (recorder)

Mr. Carl Cox, Farm Manager
# EMBANKMENT

## VISUAL EXAMINATION OF SURFACE CRACKS
The slopes, crest, emergency spillway, and abutment contacts were inspected and no cracks were noted. The downstream slope was grassed and well maintained. Numerous small trees (approximately 6 ft tall and 1 to 3" diameter) occur along the upstream slope, which is blanketed with riprap.

## UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE
None observed

## SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES
None observed. The embankment and abutment slopes are grassed and are well maintained.

## VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST
Appeared to be good.

## RIPRAP FAILURES
None observed. Limestone blocks ranging from 3 to 12 inches extend to a height of 2 ft above the existing pool level. The riprap is present along the upstream slope and extends up the reservoir approximately 175 ft along both sides.
## EMBANKMENT

### VISUAL EXAMINATION OF EMBANKMENT AND DAM

**Observations**
- Good, no erosion was observed except along the edges of the concrete spillway.
- The embankment and abutments are well grassed. The existing riprap provides excellent protection for the upstream slope and lower reservoir slopes. The stream channel includes sandy to clayey materials with some gravel (alluvial). The dam and surrounding hillsides consist of silty clays and clayey silts with rock fragments. No bedrock was encountered. Erosion is described on the accompanying field sketch. No faults were observed and none are indicated on existing geologic maps.

### ANY NOTICABLE SEEPAGE

- Ponded water was observed in two areas: (1) along the downstream toe, several 100 ft left of the concrete discharge channel and (2) in an area 60 ft x 25 ft about 75 ft below and to the left of the left edge of the concrete channel. No iron staining was observed and both areas are believed to represent ponded runoff from rainfalls of the proceeding day. Just right of area (2) water was flowing through a small opening in the concrete channel at a rate of 5 to 10 gpm. This water is believed to represent water which was flowing beneath and along the side of the spillway. Water also flowing from beneath the concrete channel at rate of 25 to 30 gpm. See accompanying field sketch.

### STAFF GAGE AND RECORDER

- None observed.

### DRAINS

- None observed; however, Mr. Cox recalls seeing several when there was no flow in the spillway.
# EMERGENCY SPILLWAY

<table>
<thead>
<tr>
<th>VISUAL EXAMINATION OF</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTLET</strong></td>
<td>Earth spillway at right abutment was modified by raising the crest to within 0.5 ft of top of dam. Five 72&quot; x 44&quot; CMP arches located at center of dam adjacent to the intake structure. Invert elevation approximately 1.5 ft above intake elevation.</td>
<td>Good condition, no erosion. Depth of flow was one ft in the CMP arches.</td>
</tr>
<tr>
<td><strong>APPROACH CHANNEL</strong></td>
<td>None</td>
<td></td>
</tr>
<tr>
<td><strong>DISCHARGE CHANNEL</strong></td>
<td>Concrete chute tying into the principal spillway channel. Concrete is good condition. Channel flowing approximately 6&quot; deep.</td>
<td></td>
</tr>
<tr>
<td><strong>BRIDGE AND PIERS</strong></td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Note: Comments from Mr. Cox indicated that the 72" x 44" CMP arches were installed recently and the original emergency spillway crest raised because of severe erosion occurring in the emergency spillway due to the magnitude and frequency of use. The emergency spillway as designed was used several times a year.
### OUTLET WORKS

<table>
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<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT</td>
<td>Outlet conduit was submerged by emergency spillway overflow and could not be observed.</td>
<td></td>
</tr>
<tr>
<td>INTAKE STRUCTURE</td>
<td>Partially submerged, but appeared to be in good condition. Value was reported to be operational.</td>
<td></td>
</tr>
<tr>
<td>OUTLET STRUCTURE</td>
<td>Submerged, not visible</td>
<td>No apparent problems</td>
</tr>
<tr>
<td>OUTLET CHANNEL</td>
<td>Ten ft long and 1 to 2 ft wide erosion gully located behind the right end of the concrete channel, extending 25 ft back along the side. This erosion occurred during the storm of April, 1977 according to Mr. Oox. See field sketch.</td>
<td>Repair erosion and line with riprap</td>
</tr>
<tr>
<td>EMERGENCY GATE</td>
<td>Reported to be operable and appeared to be in good condition.</td>
<td>III-5</td>
</tr>
<tr>
<td>RESERVOIR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VISUAL EXAMINATION OF</td>
<td>OBSERVATIONS</td>
<td>REMARKS OR RECOMMENDATIONS</td>
</tr>
<tr>
<td>SLOPES</td>
<td>Gentle to moderate grassed slopes (4H:1V) surround the reservoir. No debris was observed in the reservoir.</td>
<td>Good condition</td>
</tr>
<tr>
<td>SEDIMENTATION</td>
<td>Some sediment in the upper reaches of the lake according to Mr. Cox</td>
<td>Not serious</td>
</tr>
</tbody>
</table>
# DOWNSTREAM CHANNEL

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>OBSERVATIONS</th>
<th>REMARKS OR RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion in stream channel to a point</td>
<td>100 ft downstream on right and 50 ft downstream on left side from the concrete spillway.</td>
<td>Provide riprap lining of stream banks for 100 ft downstream of outlet channel termination.</td>
</tr>
<tr>
<td>Erosion consists basically of 3 ft high vertically eroded slopes.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| SLOPES | |
| Gentle (4:1), grassed slopes (pasture) occur above the stream bank. The stream is 20 ft wide, with vertical slopes 2 ft high. | Good condition |

| APPROXIMATE NO. OF HOMES AND POPULATION | One house is located ½ mile downstream. Water level was up to the yard of this house in April 1977. The house is 15 ft above the streambed. | Dam failure presents a hazard to this house. |

**Note:** The dam was overtopped by 3 to 6 inches for a period of one hour in April 1977.
MEMORANDUM FOR RECORD:


SUBJECT: Smithleigh Dam, Phase I Inspection Report
         Augusta County, VA

DATE: July 22, 1980

A meeting was held this date at the Smithleigh Dam site
to discuss the preliminary Phase I Inspection Report for the
dam. The following persons were present at the meeting:

1. R. G. Roop - J. K. Timmons & Associates (Corps Representative)
2. Robert V. Gay - State Water Control Board (SWCB)
3. Hugh Gildea - SWCB
4. R. R. Smith - Owner
5. Marshall Craig - Betz, Converse, Murdoch, Inc. (Owner's)
6. R. C. Newman - " " " " "
7. Bob Noland - " " " " "

A discussion was held in which the dam assessment and remedial
measures as recommended in the preliminary report were explained
to the owner and his engineer. Discussion included the predicted
overtopping of the dam during the spillway design flood (SDF),
and the resulting increase in hazard to the downstream dwelling.

After much discussion concerning this matter, it was determined
that the owner could effectively reduce the downstream hazard
because the dwelling of concern is the property of the owner, and
the occupants are in his employ. The owner indicated that he would
reduce the downstream hazard by providing an early warning system.
The SWCB representatives indicated that they would provide a
guideline to the owner for the early warning system, and review his
submittal.
**Ponded Areas Along Downstream Slope**

- Crest
- Downstream
- Slope 75'
- Ponded water 25' x 60'
- Ponded water 25' x 60'
- Water flowing from concrete at 5-10 gpm

**Erosion, Concrete Discharge Channel**

- Water flowing 5-10 gpm
- Flow from beneath channel
- Concrete channel
- Eroded area 10'
- 25'

No Scale
APPENDIX IV

TEST BORING LOGS
**Test Boring Record**

**E.O. Gooch, and Associates**
**Charlottesville, Virginia**

**Hole No:** A-1

**Surface Elev.**

**Date**

**Ground Water**

**Depth**

**Sampled Hammer WT:** 140 lb drop 30 inches

**Location:** Sucope, VA

**Started:** 7/67

**Completed:** 7/14/7

**Sampled Size:** 2" in O.D.

<table>
<thead>
<tr>
<th>Level</th>
<th>Depth</th>
<th>Casing Hammer Bows</th>
<th>Log</th>
<th>Remarks</th>
<th>Sample Depth</th>
<th>Blows on Sampled</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td><strong>Yellow Clay</strong></td>
<td></td>
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**IV-1**
<table>
<thead>
<tr>
<th>Depth</th>
<th>Sampler</th>
<th>Material</th>
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<td>No sampler</td>
<td>Yellow clay</td>
</tr>
<tr>
<td>2 ft</td>
<td>No sampler</td>
<td>Yellow clay</td>
</tr>
<tr>
<td>4 ft</td>
<td>No sampler</td>
<td>Yellow clay</td>
</tr>
<tr>
<td>6 ft</td>
<td>No sampler</td>
<td>Yellow clay</td>
</tr>
</tbody>
</table>

Note: The diagram shows a boring log for a test boring record. The locations are "D. Gooch & Associates, Charlottesville, Virginia." The log details the depth, sampler type, and material encountered at each depth interval.
<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Casing Hammer Blows</th>
<th>Log</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>0'</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>4'</td>
<td></td>
<td></td>
<td>Yellow clay silt</td>
<td>Bag sample</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rock</td>
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</table>

**Test Boring Record**

E. D. Gooch and Associates
Charlottesville, Virginia

Well No. A-3
Surface Elev.

Date

Ground Water: Dry

Sampler Hammer Wt. 140 lb. Drop 30 inches

Location: Clifton, VA

Started 7/67, Completed 7/67

Sampler Size 2" in Od
## Test Boring Record

**E. O. Gooch and Associates**

**Charlottesville, Virginia**

**Site Location:**  
Swoope, VA

**Date:** 7-1-67  
**Started:** 7-1-67  
**Completed:** 7-1-67

**Test Boring for:**  
R. R. Smith

**Test Boring No.:** A-4

**Surface Elevation:**

**Depth:** 3.0

**Round Water:**

**Amplifier Hammer Weight:** 140 LB  
**Drop:** 30 Inches

**Sample:**

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</thead>
<tbody>
<tr>
<td>0'</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3'</td>
<td></td>
<td></td>
<td></td>
<td>Dark Grey Silty Clay No Sample</td>
</tr>
<tr>
<td>5'</td>
<td></td>
<td></td>
<td></td>
<td>Wet Blue Sandy Clay</td>
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**Rock**
### Test Boring Record

**E O Gooch and Associates**

**Charlottesville, Virginia**

**Site:** F.R. Smith Dam

**Location:** Swoope, VA

**Started:** 2-1-67  **Completed:** 7-1-67

**Sampler Size:** 2" in O.D.

**Amplifier Hammer Wt.:** 140 lb drop 30 inches

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<th>Depth (ft)</th>
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<th>Log</th>
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<td>7</td>
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</table>

**Log:**

- Brown Silty Clay
- Wet Brown Silty Clay
- Rock

**Remarks:**

**Sample Depth**

**Blows on Sampler**
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<td>Rock</td>
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LOCATION: Swoope, VA
STARTED: 7-1-67
COMPLETED: 7-1-67
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<th>Depth</th>
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<td>LOG</td>
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<tr>
<td>8</td>
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Test Boring Record
E.O. Gooch and Associates
Charlottesville, Virginia

Well No. A-8
Surface Elev. 80""
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<td>Dark grey silty clay</td>
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</tbody>
</table>

**Rock**

**TEST BORING RECORD**
E. O. GOOCH AND ASSOCIATES
CHARLOTTESVILLE, VIRGINIA

HOLE NO. A-9  SURFACE ELEV
DATE
GROUND WATER 2.5'
SAMPLER HAMMER WT. 140 LB. DROP 30 INCHES

FOR R. R. Smith Data
LOCATION SWORLFE VA
STARTED 2-1-67 COMPLETED 3-1-67
SAMPLER SIZE 2" IN D.D.

IV-9
<table>
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<th>CASING HAMMER BLOWS</th>
<th>LOG</th>
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<th>SAMPLE DEPTH</th>
<th>BLOWS ON SAMPLE</th>
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<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.0</td>
<td>TAN CLAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>BLUE SANDY CLAY (MUCK)</td>
<td></td>
<td></td>
<td>No Sample</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HOLE NO. A-10  
SURFACE ELEV.  
DATE  
GROUND WATER  
SAMPLER HAMMER WT: 140 LB. DROP 30 INCHES  
FOR R.R. SMITH DAM  
LOCATION SPOOPE VA  
STARTED 7-1-67  
COMPLETED 7-1-67  
SAMPLER SIZE 2" IN O.D.  

IV-10
<table>
<thead>
<tr>
<th>LEVATION</th>
<th>DEPTH</th>
<th>CASING HAMMER BLOWS</th>
<th>LOG</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td></td>
<td></td>
<td>Yellow Tan Sandy Clay</td>
<td>Bag Sample</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rock</td>
<td></td>
</tr>
</tbody>
</table>
HOLE NO. A-12  SURFACE ELEV.  FOR  B. R. SMITH  DAY
DATE  DEPTH  LOCATION  S. Hooper  VA
GROUND WATER  DRY  STARTED  7-1-67  COMPLETED  7-1-67
SAMPLER HAMMER WT. 140 LB. DROP 30 INCHES  SAMPLER SIZE 2" IN O.D

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>CASING HAMMER BLOWS</th>
<th>LOG</th>
<th>REMARKS</th>
<th>SAMPLE DEPTH</th>
<th>BLOWS ON SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Yellow Clay</td>
<td>Rock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL</td>
<td>DEPTH</td>
<td>CASING HAMMER BLOW</td>
<td>LOG</td>
<td>REMARKS</td>
<td>SAMPLE DEPTH</td>
<td>BLOWS ON SAMPLER</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
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<td>-----</td>
<td>---------</td>
<td>--------------</td>
<td>------------------</td>
</tr>
<tr>
<td>0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td><strong>Yellow clay silt</strong></td>
<td>No Sample</td>
<td></td>
</tr>
</tbody>
</table>

**Rock**
# Test Boring Record

**Location:** Swoope, VA  
**Date:** 1-1-62  
**Completed:** 7-1-67  
**Sampler Size:** 2" in O.D.

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Casings</th>
<th>Hammer Bows</th>
<th>Log</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Brown Plastic Clay</td>
<td></td>
<td></td>
<td>Rock</td>
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</tr>
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</table>

**Surface Elev.:**  
**Ground Water:** 4.0

**Sampler Hammer WT. 140 LB DROP 30 INCHES**
**Test Boring Record**

_E. O. Gooch and Associates_  
_Charlottesville, Virginia_

<table>
<thead>
<tr>
<th>HOLE NO</th>
<th>P-2</th>
<th>SURFACE ELEV.</th>
<th></th>
<th>FOR</th>
<th>R. R. Smith Dam</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td></td>
<td>DEPTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUND WATER</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAMPLER HAMMER WT.</td>
<td>140 LB DROP 30 INCHES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STARTED</td>
<td>7-1-67</td>
<td>COMPLETED</td>
<td>7-1-67</td>
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<table>
<thead>
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<th>LEVATION</th>
<th>DEPTH</th>
<th>CASING HAMMER BLOWS</th>
<th>LOG</th>
<th>REMARKS</th>
<th>SAMPLE DEPTH</th>
<th>BLOW ON SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.5</td>
<td></td>
<td><strong>Brown Plastic Clay</strong></td>
<td></td>
<td>No Sample</td>
<td>3</td>
<td>7</td>
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*Rock*
<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Casing Hammer Blows</th>
<th>Log</th>
<th>Remarks</th>
<th>Sample Depth</th>
<th>Blows on Sampler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td>Brown Plastic Clay</td>
<td>Sample</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lock

IV-16
**TEST BORING RECORD**

**E O GOOCH AND ASSOCIATES**

**CHARLOTTESVILLE, VIRGINIA**

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Casing Hammer Blows</th>
<th>Log</th>
<th>Remarks</th>
<th>Sample Depth</th>
<th>Blows on Sampler</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>GREY SILTY CLAY</td>
<td></td>
<td>No Sample</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IV-17**
### Test Boring Record

**EO Gooch and Associates**
**Charlottesville, Virginia**

**HOLE NO:** PS
**SURFACE ELEV.**

**DATE:** DEPTH
**GROUND WATER:** 3.0

**LOCATION:** SWOPE, VA
**STARTED:** 7-1-62

**SAMPLER HAMMER WT. 140 LB DROP 30 INCHES**
**SAMPLER SIZE 2" IN O.D.**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>DEPTH</th>
<th>CASING HAMMER BLOWS</th>
<th>LOG</th>
<th>REMARKS</th>
<th>SAMPLE DEPTH</th>
<th>BLOW ON SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1/2</td>
<td></td>
<td>Dark Grey Silt Clay</td>
<td>100/Rec.</td>
<td>2/3</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>Saturated Blue Sandy Clay</td>
<td>Rock</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IV-18**
<table>
<thead>
<tr>
<th>DEPT.</th>
<th>LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DگREY PLASTIC CLAY</td>
</tr>
<tr>
<td>10</td>
<td>WET BLUE PLASTIC SANDY CLAY</td>
</tr>
<tr>
<td></td>
<td>Rock</td>
</tr>
</tbody>
</table>

**Test Boring Record**

E O Gooch and Associates
Charlottesville, Virginia

**Details**

- **Date of Boring**: 7-1-67
- **Location**: Swoope, VA
- **Surface Elevation**: 47.0

**Equipment**

- **Hammer Weight**: 40 lb
- **Drop**: 30 inches

**Log**

- **Depth**:
  - 0
  - 5
  - 10

- **Remarks**:
  - 100% Rec
  - 5 - 5

**Sample**

- **Sample Depth**:
  - 3
  - 5

**Blows**

- **Blows on Sampler**:
  - 7

- **Notes**:
  - IV-19
## Test Boring Record

**EO Gooch and Associates**

**Location:** Swoope, VA

**Started:** 7-1-67  **Completed:** 7-1-67

<table>
<thead>
<tr>
<th>Depth</th>
<th>Casing Hammer Blows</th>
<th>Log</th>
<th>Remarks</th>
<th>Sample Depth</th>
<th>Blows on Sampler</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td></td>
<td></td>
<td></td>
<td>50% Rec. 3.7</td>
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<tr>
<td>5</td>
<td></td>
<td>Dark Grey Plastic Clay</td>
<td>100% Rec. 5 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Wet Blue Plastic Sandy Clay</td>
<td>Rock</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IV-19
**TEST BORING RECORD**

EO GDOCH AND ASSOCIATES
CHARLOTTESVILLE, VIRGINIA

<table>
<thead>
<tr>
<th>IDLE NO.</th>
<th>SURFACE ELEV.</th>
<th>DATE</th>
<th>DEPTH</th>
<th>LOCATION</th>
<th>STARTED</th>
<th>COMPLETED</th>
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<tbody>
<tr>
<td>P7</td>
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<td></td>
<td>Swoope, VA</td>
<td>7-1-67</td>
<td>7-1-67</td>
</tr>
</tbody>
</table>

**GROUND WATER:** 5.0 feet

**SAMPLER HAMMER WT. 140 LB DROP 30 INCHES**

**EAVATION** | **DEPTH** | **LOG** | **REMIXKS** | **SAMPLE DEPTH** | **BLOWS ON SAMPLER** |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 0            |           |         |              |                   |                      |
| 4            |           | Dark Grey Silty Clay | Sample Pulled Out |                   |                      |
| 5            |           | Wet Blue Sandy Clay | Rock             |                   |                      |

**IV-20**
APPENDIX V - REFERENCES


