POTOMAC RIVER BASIN
LAKE FRONT ROYAL DAM
WARREN COUNTY, VIRGINIA
VA. NO. 18705

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

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

MAY 1981

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**Phase I Inspection Report**  
**National Dam Safety Program**  
**Lake Front Royal Dam, Warren County, VA**

**Authors:**  
Schmabel Engineering Associates, P.C.  
K. Limmons and Associates, Inc.

**Performing Organization Name and Address:**  
Schmabel Engineering Associates, P.C.  
K. Limmons and Associates, Inc.

**Controlling Office Name and Address:**  
U. S. Army Engineer District, Norfolk  
811 Front St., Norfolk, VA 23510

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

**Abstract**

(See Reverse Side)
Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Inspection is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspection. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

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

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

### NAME OF DAM: LAKE FRONT ROYAL DAM
### LOCATION: WARREN COUNTY, VIRGINIA
### INVENTORY NUMBER: VA. NO. 1870

**PHASE I INSPECTION REPORT**

NATIONAL DAM SAFETY PROGRAM

**INSPECTOR:**

[Name and details]

**DATE:**

[Date]

**REPORT NUMBER:**

[Number]

**ENGINEER:**

[Name and details]

**DATE:**

[Date]

**DISTRIBUTION STATEMENT A**

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A
This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams: for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.
Lake Front Royal Dam is a zoned earthfill structure about 1600 ft long and 26 ft high. The spillway consists of a 24 inch diameter corrugated metal pipe (CMP) riser inlet and an 18 inch diameter CMP outlet which extends through the structure. Inflow to the lake is controlled by a 12 inch diameter CMP at the upper end of the impoundment. The dam is a side-valley impoundment. The structure is classified small in size and is assigned a high hazard classification. The dam is located adjacent to Sloan Creek approximately 4 miles southeast of Front Royal, Virginia. The lake is used for recreational purposes, is owned by Price-Jalin Associates, Inc., and maintained by Lake Front Royal Property Owners Association, Inc.

Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate Spillway Design Flood (SDF) is the 1/5 PMF. The spillway will pass 15 percent of the Probable Maximum Flood (PMF) or 30 percent of the SDF without overtopping the dam. During the SDF, the dam will be overtopped by a maximum of .4 ft for a period of 4 hours at a maximum velocity of 2.7 fps. Flows overtopping the dam during the SDF are not considered detrimental to the embankment with respect to erosion. The spillway is judged inadequate, but not seriously inadequate.
The visual inspection revealed no apparent problems, however, two saturated areas encountered on the downstream embankment slope above the toe are of concern. An evaluation of the stability condition could not be made since there is insufficient design and construction data for this structure.

The following remedial measures should be implemented within one year of the date of this report:

1) The owner should engage the services of a qualified Professional Geotechnical Engineer to evaluate the two seepage areas present on the front and left downstream slope above the toe of the dam and make necessary recommendations. It is recommended that the other described saturated and iron stained areas present along the downstream toe be examined during this study to verify that no problem exists. The stability of the left upstream embankment slope should also be evaluated for the rapid drawdown condition and modified as necessary.

2) An emergency action plan should be developed.

The following routine maintenance and observation functions should be initiated:

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

2) Existing trees and brush on the dam should be cut to the ground. Trees greater than 3 inches in diameter should have their stumps and root structures removed and subsequent holes backfilled and reseeded.

3) The outlet channel should be protected against erosion by lining with riprap or utilizing some other effective measure.

4) A staff gage should be installed to monitor water levels.
The Lake Front Royal Property Owners Association, Inc., is presently in the process of acquiring ownership of the dam. They have expressed a willingness to address the remedial work recommended herein upon transfer of ownership.

Prepared by:
SCHNABEL ENGINEERING ASSOCIATES, P.C./J. K. TIMMONS & ASSOCIATES, INC.

Submitted by:

Carl S. Anderson, Jr., P.E.
Acting Chief, Design Branch

Recommended by:

Original signed by:
JAMES A. WALSH

Date: SEP 11 1981

Approved:

Original signed by:
Ray E. Matia, Ph.D., P.E.
Commonwealth of Virginia

Original signed by:
Ronald E. Hudson
Colonel, Corps of Engineers
Commander and District Engineer
Lake Front Royal (Looking Upstream)

Lake Front Royal (Looking Downstream)

Overview Photographs

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SECTION 1 - PROJECT INFORMATION

1.1 General:

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

1.1.2 Purpose of Inspection: The purpose is to conduct Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (see Reference 1, Appendix II). 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: Lake Front Royal is a concrete earthfill structure approximately 1600 ft long and 26 ft high. The crest of the dam is 12 ft wide, and side slopes range from approximately horizontal to 1 vertical (2H:1V) to 3H:1V on the downstream slope and from 2H:1V to 3H:1V on the upstream slope of the crest. The crest of the dam is at elevation 960 ft. The enlargement enclosed the lake on 3 sides forming a side valley impoundment. The dam includes a 15 to 15 ft wide core trench which was excavated to 10 to 15 ft below the ground surface and extends upward to normal pool level. An internal drainage system was not provided. There is no slope protection on the upstream face of the dam.

*Height is measured from the top of the dam to the downstream toe of the centerline of the street.
The principal spillway consists of a 24 inch diameter CMP riser inlet. The riser is connected to an 18 inch diameter CMP outlet which runs through the dam. The riser crest is at elevation 977. A 12 inch diameter opening (sealed with plate glass) in the riser at an invert elevation of 966.6 msl is used to drain the lake. The outlet pipe has a length of approximately 100 ft with an invert elevation at the outlet structure at 954 msl (see Field Sketch 1, Appendix III).

Inlet to the lake is controlled by a 12 inch diameter CMP inlet located roadway along the upper embankment (see Field Sketch 1, Appendix III). There is no control device to regulate inflow. The inlet pipe has an invert elevation at 977.5 msl or approximately 0.5 ft above normal pool.

Location: Lake Front Royal Dam is located adjacent to

Lake Front 4 miles southwest of Front Royal, Virginia (see Plate 1, Appendix III).

... Classification: The dam is classified as a small size structure based on the lower and maximum lake storage potential as described in Appendix II.

... Hazard classification: The dam is located in a rural area:

However, based upon the proximity of two inhabited dwellings located

1 mile downstream and 5 inhabited dwellings located 2 miles downstream, the dam is assumed a "high" 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.

... Ownership: The dam is owned by Price-Radin Associates, Inc., and maintained by Lake Front Property Owners Association, Inc.
1.2.6 **Purpose:** Recreation.

1.2.7 **Design and Construction History:** There is no formal design for this structure. The dam was constructed under joint venture by Price-Radin Associates, Inc., and Moore, Kelly and Reddish, Inc., of Orange, Virginia. The contractor is no longer in business. The dam was completed in 1970.

1.2.8 **Normal Operational Procedures:** The spillway is ungated, therefore, water rising above the crest of the riser inlet is automatically discharged downstream. Normal pool is maintained at elevation 977 msl at the crest of the riser. The 12 inch diameter opening at elevation 955 is manually operated by breaking the glass seal, and is used to lower the lake elevation below normal pool for maintenance purposes. The glass seal can be broken by inserting connected small diameter pipe sections or steel rods into the outlet pipe until it reaches the glass seal at the riser. The seal is broken by pushing the pipe or rod through the glass.

The upstream inlet is ungated and receives flow from adjacent streams under normal conditions. During periods of runoff, inflow from Sloan Creek enters the lake when an overbank condition exists (2 ft above streambed).

1.3 **Pertinent Data:**

1.3.1 **Drainage Area:** The drainage area is 0.12 square miles, direct runoff.

1.3.2 **Discharge at Dam Site:** Information concerning a maximum pool elevation could not be obtained.

**Principal Spillway Discharge:**

Pool Elevation at Crest of Dam (elev 980) 45 CY
### DAM AND RESERVOIR DATA

**Table 1.1 - DAM AND RESERVOIR DATA**

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elevation</td>
</tr>
<tr>
<td></td>
<td>Feet</td>
</tr>
<tr>
<td>Crest Level</td>
<td>980</td>
</tr>
<tr>
<td>Incoming Stream</td>
<td></td>
</tr>
<tr>
<td>Storeage Tank</td>
<td></td>
</tr>
</tbody>
</table>

---

1.4.1 Dam and Reservoir Data: See Table 1.1, below:
SECTION 2 - ENGINEERING DATA

2.1 Design: There was no formal design for this structure, consequently, there is no design data available.

2.2 Construction: No construction records are available. The dam was constructed by Moore, Reddish and Kelly, Inc., and completed in 1970. The contractor is no longer in business.

According to Mr. Goodwin Moore the dam has a clay core which was constructed with silty clay soils from the reservoir area. The core trench is 12 to 15 ft wide and was excavated 10 to 15 ft below the ground surface to bedrock. The core extends up to normal pool level. The rest of the embankment was constructed with sandy clay material which includes considerable gravel to boulder-size rock. All fill is reported to have been placed in 1-ft thick lifts and compacted with sheepfoot rollers and tampers. Trench backfills were not performed to determine the shear strength.

2.3 Foundation: There is insufficient information to evaluate embankment stability and foundation strength.
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 on May 5, 1981. The weather was clear, the temperature was about 70°F, and the ground condition was dry. The pool and tailwater levels at the time of inspection were 976 and 954 msl, respectively. This corresponds to a below normal pool elevation and a normal tailwater elevation.

3.1.2 Dam and Spillway: The embankment is a side valley impoundment. For the purpose of this report the side paralleling Sloan Creek is termed the front of the dam, with the remaining two sides described as the left and right embankments.

The embankment slopes and crest are grassed and appear to be well maintained. Scattered trees up to 6 inches in diameter occur on the upstream slope. More trees occur on the downstream slope and there is considerable brush growing along the downstream toe. The upstream slope was measured at 3H:1V along the front of the dam and 4H:1V along the sides. The downstream slope is generally 2H:1V, but ranges from 3H:1V on the right side to 2H:1V near the highest point of the dam at the principal spillway (see Field Sketch 3, Appendix III).

Some scattered soil erosion or erosion was encountered. A bare area exists at the northeast or right end of the dam where boats are carried across the embankment for access into the lake. Scattered deep, eroded areas occur along the reservoir edge, particularly on the upstream slope, as a result of
wave action. The erosion extends into the embankment approximately 1 to 2 ft and varies from 1 to 3 ft in height. The upstream slope appears to be stable. An eroded notch approximately 10 ft long and 4 ft wide exists on the downstream slope 230 ft right of the principal spillway intake. The erosion is believed to have been caused by the creek during previous high water (see Field Sketch 3, Appendix III).

Scattered moist to saturated areas occur along the downstream toe. Sloan Creek flows along the toe, thus, it is difficult to verify whether the saturated toe condition is the result of seepage through the dam or related to flow of the creek. No flow or iron staining was observed. One saturated area of concern was encountered on the downstream slope 70 ft to the right of the principal spillway at a point estimated as being 6 ft below the crest of the dam. No flow or iron staining was observed. Considerable seepage was encountered along the left side of the dam. A saturated area ranging from 4 to 12 ft in width extends from the vicinity of the principal spillway intake to a point 103 ft to the south. No flow or iron staining were observed. An iron stained channel flowing at 1 cm was encountered directly left of the intake structure. Another area of concern exists approximately 153 ft left and behind the intake structure where a saturated area extends up the slope from 18 inches above the toe to a point 7 ft above the toe. No flow or iron staining was observed. Finally, a large saturated and water ponded area occurs along the downstream toe from a point 156 ft left and behind the principal spillway intake to the abutment area. There is considerable iron staining and flow is estimated at 1 cm in areas where the green surface slope. The saturated grassy area present along the right downstream slope is related to flow from nearby springs (see Field Sketch 3, Appendix III).
The riser, inlet and outlet pipe indicated no signs of deterioration and were functioning properly at the time of inspection. The drain opening has never been in use. The outlet channel was void of riprap and indicated some erosion.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was wooded except for the embankment portion. Side valley side slopes are at approximately 3H:1V. The lake was approximately one ft below normal due to drought conditions.

3.1.4 Downstream Area: The downstream channel consists of a 6 ft wide channel located in a valley with side slopes of 2H:1V where the stream is adjacent to Route 522. There is also a 200 ft wide flood plain and 3H:1V side slopes above the flood plain. The valley is cultivated in the flood plain area and wooded above the flood plain. Approximately ½ to ¾ mile downstream there are two dwellings about 10 ft above the streambed. Approximately 2 to 2.5 miles downstream there are 5 dwellings adjacent to the stream.

3.1.5 Instrumentation: No instrumentation (monuments, observers, wires, pressure gauges, etc.) was encountered for the structure. There is no staff gauge.

3.2 Evaluation:

3.2.1 Dam and Spillways: Overall the dam was in good condition at the time of inspection. It is recommended that a routine maintenance program be initiated and documented. The embankment, including the crest and slopes should be mowed at least once a year but more preferably twice a year. The presence of trees on the embankment may promote the development of deep rooted vegetation and thus type growth can encourage...
piping within an embankment. All trees growing on the embankment should be cut to the ground. Trees greater than 3 inches in diameter should have their stumps and root structures removed. Subsequent holes should be filled with compacted soil and seeded. The brush present below the downstream toe along the creek channel provides erosion protection from high water. It is not necessary to remove this vegetation; however, it should not be allowed to grow on the downstream slope.

Erosion noted along the upstream slope is due to wave activity. This does not require any special attention because considerable gravel and boulders are present in the fill which act as riprap once the finer grained soils are washed away. The eroded notch in the downstream toe and the bare area caused by boat access are not hindrances to the normal functioning of the dam and no special attention is required.

The two saturated areas observed on the downstream slope (areas B and D, Field Sketch III) are of concern because they occur above the downstream toe and are believed to be related to seepage through the dam. It is recommended that a Professional Engineer with expertise in Geotechnical Engineering be contacted to evaluate these two areas and make recommendations for any required remedial measures. The other saturated and/or iron stained areas (E, I and F, Appendix III) do not present a hindrance to the normal functioning of the dam, however, it is recommended that they also be reviewed, particularly the iron stained areas (E and F), by the Geotechnical Engineer to verify that no problem exists. The saturated grassy area along the right downstream slope is the result of ponded spring water and does not require any attention.
The outlet and inlet pipes and intake structure are in good structural condition. Riprap should be placed in the outlet discharge channel to reduce erosion during future flooding. A staff gage should be installed to monitor water levels.

3.2.2 Downstream Area: A breach in the Lake Front Royal Dam during extreme flooding would create a hazard to the downstream dwellings.
SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The normal storage pool is elevation 977 msl at the crest of the spillway inlet. The lake provides recreation. Water automatically passes through the spillway as the water level in the reservoir rises above the spillway crest. Water will also pass automatically into the lake through the inlet pipe when the stream level reaches the inlet pipe elevation. A 12 inch opening in the 24 inch diameter riser structure is provided to drawdown the reservoir below normal pool.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the owner. Maintenance consists of inspection, debris removal, mowing of vegetative cover and repair. Maintenance is not routinely performed.

4.3 Warning System: At the present time, there is no warning system or evacuation plan for the dam.

4.4 Evaluation: The dam and appurtenances are in good operating condition, and maintenance of the dam appeared to be adequate. Documentation and establishment of a routine maintenance program should be developed for this structure. 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.
5.1 **Design:** There was no formal design for Lake Front Royal Dam and there is no hydrologic or hydraulic data available.

5.2 **Hydrologic Records:** There are no records available.

5.3 **Flood Experience:** Information on flood experience was not available.

5.4 **Flood Potentials:** In accordance with the established guidelines, the Spillway Design Flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region), or fractions thereof. The Probable Maximum Flood (PMF) and 1/3 PMF and 100 year flood hydrographs were developed by the HEC-1 method (Reference 4, Appendix IV). Precipitation amounts for the flood hydrograph of the PMF and 100 year flood were taken from U. S. Weather Bureau Information (References 5 and 6, Appendix IV). Appropriate adjustments for basin size and shape were accounted for. These hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 **Reservoir Regulations:** For routing purposes, the pool at the beginning of flood was assumed to be at elevation 977 ms1. Reservoir stage-storage data and stage-discharge data were computed from field sketches and available topographic data. Floods were routed through the reservoir using the spillway discharge up to a pool storage elevation of
980 msl. Inflow to the lake was restricted to direct runoff and the inlet pipe capacity. Pool elevations above 980 msl were routed over the non-overflow section of the dam.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions (100 year flood, \( \frac{1}{2} \) PMF and PMF) are shown in the following Table 5.1:

<table>
<thead>
<tr>
<th>Hydrograph</th>
<th>Normal Flow</th>
<th>100 Year Flood</th>
<th>( \frac{1}{2} ) PMF</th>
<th>PMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflow, CFT</td>
<td>394</td>
<td>711</td>
<td>1421</td>
<td></td>
</tr>
<tr>
<td>Outflow, CFT</td>
<td>131</td>
<td>608</td>
<td>968</td>
<td></td>
</tr>
<tr>
<td>Maximum Pool Elevation, Ft, m</td>
<td>980.4</td>
<td>980.1</td>
<td>980.5</td>
<td>980.6</td>
</tr>
<tr>
<td>Non-Overflow Section (Elev 980 msl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth of Flow, Ft</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Duration, hour</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Velocity, fps</td>
<td>-</td>
<td>2.7</td>
<td>3.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Tailwater Elevation, Ft, msl</td>
<td>964</td>
<td>960.1</td>
<td>963.9</td>
<td>968.2</td>
</tr>
</tbody>
</table>

* Critical velocity
5.7 Reservoir Emptying Potential: A 12 inch diameter gate at elevation 955 msl is capable of draining the reservoir through the outlet pipe. Assuming that the lake is at normal pool elevation (977 msl) and there is .2 cfs inflow, it would take approximately 2.5 days to lower the reservoir to elevation 955 msl. This is equivalent to an approximate drawdown rate of 8.8 ft/day based on the hydraulic height measured from normal pool to the invert of the drawdown pipe divided by the time to dewater the reservoir.

5.8 Evaluation: The U.S Army, Corps of Engineers' guidelines indicate the appropriate Spillway Design Flood (SDF) for a small size, high hazard dam is the 1/10th to 1/5th. Because of the risk involved, the 1/10th PMF has been selected as the SDF. The spillway will pass 10 percent of the PMF without overtopping the crest of the dam and 40 percent of the SDF.

During the SDF, the dam will be overtopped by a maximum of 0.4 ft for a period of 4 hours at a maximum velocity of 2.7 ft/s.

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

6.1 Foundation and Abutments: The dam is located along the western
edge of the Blue Ridge physiographic province of Virginia. The appurtenant
and structure are underlain by the Catawba Formation of late miocene age.
The catawba consists of a mixture of greenstone, phyllite, schist, and metaruphotic marble and sandstone. No faults have been mapped in the
immediate area.

The potential for seepage within the foundation was apparently
recognized by the contractor, since it was reported that a cutoff trench was
constructed. According to Mr. Moore, a 15 to 16 ft wide cutoff was undercut
and extended at depths ranging from 10 to 16 ft below the ground surface.

In lieu of the foundation, the underlying soil would be expected during
the course of fill construction. The fill encountered primarily silt and essentially
organic materials where the embankment was placed after completion of
construction. Hence, the fill structure functioned as填 dam and the
comprehensive analysis indicated a stable foundation for

6.2 Elevation

6.2.1 Dam: The core was constructed as a zone core embankment. The
zone core materials (C) encountered on site were placed in the core trench
d and central portion of the dam. The remaining of the embankment was
constructed with clayey sand (SC) materials which include considerable gravel
and boulders. The fill was placed in 12 inch layers and compacted with sheep
foot rollers and pans. No field density tests were taken to determine the
percent compaction.

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... Dam Design and Seepage: There is no internal drainage system for this structure. Saturated ground conditions present along the downstream toe are believed to be related to Sloan Creek. Saturated and iron stained areas present on the left side of the embankment are believed to be related to seepage through the dam. Two saturated areas (B and D) occur above the downstream toe and are of concern because they also are believed to be the result of seepage through the dam. The saturated grassy area along the right end of the slope is related to flows from nearby springs.

Conclusions: A stability analysis was not performed for this structure. The dam is 11 ft high and has a crest width of 12 ft. Side slopes are approximately 3H:1V along the front side and 2H:1V on the sides of the structure. The downstream slope ranges from 3.5H:1V on the right side to 5H:1V on the front and left side. (see Field Sketch 3, Appendix III).

The dam was constructed as a road earth embankment and was reported to consist of road material in the bottom and 8' material with gravel and sand as covering material. The actual width of the core is not available. The embankment was considered to be water stable because the critical seepage rate was 0.036 ft per day, which is less than the critical rate of 0.005 ft per day. According to guidelines presented in Bulletin 96 of the U.S. Department of the Interior, Bureau of Reclamation the minimum recommended initial crest width for a dam subject to a drawdown of 60 feet or more would be 15 feet. The minimum slopes are 1H:2V on the left side, 1.5H:1V on the right side. The recommended crest width is 15 ft. Also, the crest is covered with a 1 ft blanket of material except at the drawdown where critical seepage rates exceed the critical rate. The left and right upstream
slopes are considered too steep for the rigid embankment condition, and the embankment crest is too narrow.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 1.

Therefore, according to the Recommended Guidelines for Safety Inspections of Dams, the dam is considered to have no natural (non-earthquake) problem.

Static stability conditions are satisfactory, and potential safety factors exist.

6.3 Evaluation: An accurate check on the stability of the dam cannot be made since there was no stability analysis and foundation test data available. Foundation conditions are not known, and a stable foundation is assumed based upon the visual inspection and available roadway maps. The downstream embankment slope and the upstream embankment slope are not requirements recommended by the U.S. Bureau of Reclamation.

Due to static stability conditions, the dam is considered stable. No additional work is required on the dam itself. The downstream slopes also are considered satisfactory, but the criteria required to evaluate the stability of the dam are not fully met for complete evaluation. The embankment crest is set too narrow according to the Bureau of Reclamation standards, but this deficiency is not considered a problem since it is not considered detrimental to the dam with respect to erosion because of the shallow depth and short duration of flood. Also, the velocity is considerably less than 6 fps, the effective velocity for a vegetated earth embankment. Since no undue settlement, cracking, or seepage was noted at the time of inspection,
It appears that the embankment is adequate for control storage at elevation 907 ft.

The two saturated areas observed on the downstream slope (areas B and D, Field Sketch 3, Appendix III) are of concern because they occur above the downstream toe and are believed to be related to seepage through the dam. It is recommended that a Professional Engineer with an expertise in Geotechnical Engineering be contacted to evaluate these two areas and make recommendations for any required remedial measures. Although other saturated areas are considered less serious, it is recommended they also be examined by the Geotechnical Engineer to verify that a problem does not exist.
7.1 Dam Assessment: There is insufficient information for complete foundation conditions and embankment stability. The visual inspection revealed no findings that proved the dam to be unsafe. However, the saturated areas on the downstream slope above the toe are of concern. Also, the left embankment upstream slope is considered inadequate and a stability review is required. A routine maintenance program does not exist. Also, there is no emergency operation and warning plan. Overall, the dam was in poor condition at the time of inspection. The U.S. Army Corps of Engineers' guidelines indicate the appropriate Spillway Design Flood (SDF) for this dam is the 1 in 500. The spillway will pass 15 percent of the 1 in 500 percent of the SDF without overtopping the crest of the dam. Flow overtopping the crest at a maximum velocity of 2.7 fps during the SDF is not expected in embankment with respect to erosion. Flow overtopping the crest is not expected in the embankment.

The Department's Remedial Measure: The left embankment saturated areas need to be remediated at time the dam is next inspected.

Field Test Methodology: The left saturated areas need to be remediated. Testing for the development of a SDF, the upstream slope above crest of the dam, and the saturated areas need to be examined to verify that no problem exists. Furthermore, the embankment of the left upstream embankment slope should also be evaluated and remediated as necessary.

7.2.2. An emergency operation and warning plan should be developed to warn downstream dwellers of any danger which may be imminent. This
8. How to operate the dam during an emergency.
9. How to notify, including public officials, in case evacuation from the downstream area is necessary.

9. Regular Maintenance and Observations: It is recommended that a regular maintenance program be established and documented for

annual inspections. The inspection consists of the following maintenance

checks that can be conducted by the maintenance personnel:

4. The grass and weeds on the dam embankment should be cut at

least twice a year and preferably twice a year. Maintenance is recommended

at least once a year.

5. The bars in the top should be cut to the ground.

6. The grass at the base should be cut to the ground.

7. The bars should be examined and inspected.

8. The spillway at the top should be inspected

periodically to ensure the effectiveness of the protective measures.
Photograph No. 1 - Upstream Slope and Inlet Pipe

Photograph No. 2 - Downstream Slope
Photograph No. 1 - Intake Structure
Photograph No. 5 - Stream (Arrow) at Toe of Embankment

Photograph No. 6 - Downstream Channel
Visual Inspection
Phase I

Name Dam: [Insert Name]
Town: [Insert Town]
County: [Insert County]
State: [Insert State]
Construct.: [Insert Construct.]  

Date(s) Inspection: May 5, 1981
Weather: Sunny-Clear
Temperature: 72°F

Pool Elevation at Time of Inspection: 976 masl
Tailwater at Time of Inspection: [Insert Value]

Inspection Personnel:

Schnabel Engineering Associates, P.C.
Gilbert T. Sebelis
Stephen G. Ranney
Raymond A. DeStephen, P.E.*

J. K. Tomkins & Associates
Robert J. Hoops, P.E.
Steve Garl

[Signature]

*Not present during the inspection, but named by contract. Base...
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>No unusual movements were noted on the area or beyond the downstream toe.</td>
</tr>
</tbody>
</table>

### Design or Section of Element

<table>
<thead>
<tr>
<th>Location or Section of Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Sliding at the corner due to rust access into the base. No real problem except a hole near the section of the downstream toe along the front side of the wall at a distance of 10 ft. from the main pipe. chattels heavily crooked along the upstream face. 10 to 15 inches from level and has 1 1/2&quot; at the toe. The rusting of the beam at the point of wave action. These shows are HH123.</td>
</tr>
</tbody>
</table>

### Vertical and Horizontal Alignment of the Beam

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The vertical and horizontal alignment of the beam appear to be correct.</td>
</tr>
</tbody>
</table>

### Repair Failures

<table>
<thead>
<tr>
<th>Repair Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>The repair work placed on the structure. This includes considerable metal and concrete work. Inspection of the repair along the upstream slope at joint levels has been warranted from the hill.</td>
</tr>
</tbody>
</table>
PARTIALS

According to Dr. Turner, in the change from 1 to 2, it was felt that the
influence of the initial condition, the initial position of the
constructed structure, and the wind loaded segments, could be
considered. Hand and Raman were also mentioned. The
factors observed include C1, C2, and C3 materials.

WATERFRONT

The engineering is designed and appears to be well maintained and
adequate for a range up to 4 meters in diameter on the west bank of the
river and for the downstream slope and there is considerable other
water on the downstream side.
<table>
<thead>
<tr>
<th>INSTRUMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>VISUAL EXAMINATION OF</td>
</tr>
<tr>
<td>OBSERVATIONS</td>
</tr>
<tr>
<td>ADJACENT SURVEYS</td>
</tr>
<tr>
<td>OBSERVATION WELLS</td>
</tr>
<tr>
<td>WELLS</td>
</tr>
<tr>
<td>HYDROMETERS</td>
</tr>
<tr>
<td>STAFFAGES</td>
</tr>
<tr>
<td>OTHER</td>
</tr>
</tbody>
</table>


SLOPES

None. The water is clear. Mr. Moore reported that the lake was about 15 ft deep.

SEDIMENTATION
### Visual Examination of

<p>| Condition (Obstructions, Debris, Etc.) | Vegetation with underbrush. Flooding occurred above the floodplain. |
| SLOPES | The floodplain is marked by changes in elevation and has multiple changes in channel alignment with approximately 20%. |
| Approximate No. of Homes and Population | Two homes occurred at the southern end, approximately 0.3 miles from the location. Normal stream flow has caused structural damage to buildings occurring several thousand feet downstream. |</p>
<table>
<thead>
<tr>
<th>ITEM</th>
<th>DETAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE VISIBILITY MAP</td>
<td>Front Royal, Virginia 15 mi. 7 minute topographic map</td>
</tr>
<tr>
<td>CONSTRUCTION HISTORY</td>
<td>The dam was designed and constructed by the U.S. Army Corps of Engineers at Orange, Virginia, and completed in 1950. The dam is 12-15 ft deep, 12 to 15 ft wide at crest. The remainder of the dam was appurtenant with 400 ft long, 60 ft wide, 18 ft deep, 12 to 15 ft wide at crest, composed of herringbone spillway, rockfill, and concrete. None available</td>
</tr>
<tr>
<td>PLAN OF DAM</td>
<td>None available</td>
</tr>
<tr>
<td>TYPICAL SECTIONS OF DAM</td>
<td>None available</td>
</tr>
<tr>
<td>PLAN - DETAILS</td>
<td>None available</td>
</tr>
<tr>
<td>CONCRETE - DETAILS</td>
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</tr>
<tr>
<td>MILLIN - PLAN</td>
<td>None available</td>
</tr>
<tr>
<td>MILLIN - SECTION</td>
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<tr>
<td>MILLIN - DETAILS</td>
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<td>CHEMICAL EQUIPMENT - PLAN</td>
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<tr>
<td>CHEMICAL EQUIPMENT - DETAILS</td>
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</tbody>
</table>

III-9
<table>
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<tr>
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<tbody>
<tr>
<td>MONITORING SYSTEMS</td>
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</tr>
<tr>
<td>RAINFALL/RESERVOIR HIGHPOOL RECORDS</td>
<td>None</td>
</tr>
<tr>
<td>GEOLOGY REPORTS</td>
<td>Geology of the Front Royal Quadrangle, Virginia by E. K. Rader &amp; T. H. Bridges, Virginia Division of Mineral Resources, Reports of Investigations XXXXX</td>
</tr>
<tr>
<td>BORROW SOURCES</td>
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<td>MATERIALS INVESTIGATIONS</td>
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<td>BORING RECORDS</td>
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<td>LABORATORY-FIELD TEST DATA</td>
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<td>----------------------------------------------------------------------</td>
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<td>DESIGN REPORTS</td>
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<td>HYDROLOGY &amp; HYDRAULICS DAM STABILITY SEEPAGE STUDIES</td>
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<td>POST CONSTRUCTION ENGINEERING STUDIES RECORDS, SURVEYS</td>
<td>None</td>
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<td>MODIFICATIONS</td>
<td>None</td>
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<tr>
<td>PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS</td>
<td>None</td>
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<tr>
<td>MAINTENANCE OPERATION RECORDS</td>
<td>None</td>
</tr>
</tbody>
</table>
PLAN
FRONT ROYAL LAKE
FIELD SKETCH 1
5 MAY 1981
APPENDIX IV - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams,
   Department of Army, Office of the Chief of Engineers, 46 pp.

2. Design of Small Dams, U. S. Department of Interior, Bureau
   of Reclamation, 1974, 816 pp.

3. Geology of the Front Royal Quadrangle Virginia, by E. K. Rader
   and T. H. Biggs, Virginia Division of Mineral Resources, Reports
   of Investigation No. 40, 91 pp.

   For Dam Safety Investigations, the Hydrologic Engineering Center,

5. Hydrometeorologic Report No. 33, U. S. Department of Commerce,
   Weather Bureau, U. S. Department of Army, Corps of Engineers,
   Washington, D. C., April, 1956.

END
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