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BAKER (MICHAEL) JR INC BEAVER PA

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NATIONAL DAM SAFETY PROGRAM. LAKE ANNE DAM (INVENTORY NUMBER VA--ETC(U)

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DACW65-78-D-0016

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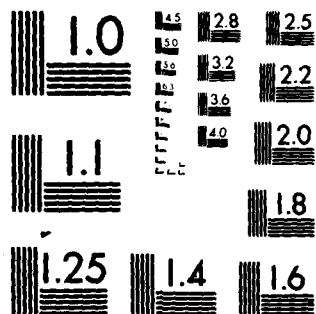
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POTOMAC RIVER BASIN

Name of Dam: Lake Anne Dam

Location: Fairfax County, State of Virginia

(Inventory Number: VA 05909)

Potomac River Basin, Fairfax County, Virginia.

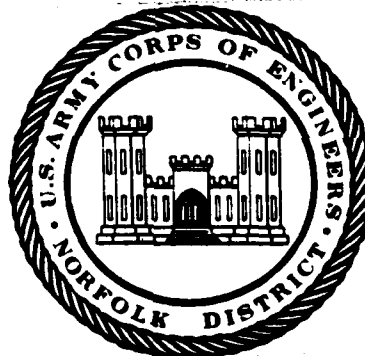
LEVEL II

PHASE I INSPECTION REPORT.

NATIONAL DAM SAFETY PROGRAM

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PREPARED FOR (11 Jul 84 1986)
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

80 10 30 08
PREPARED BY
MICHAEL BAKER, JR., INC.
BEAVER, PENNSYLVANIA 15009

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20. Abstract

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

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

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



PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the 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 continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. 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), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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NAME OF DAM: LAKE ANNE DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Anne Dam
State: Virginia
County: Fairfax
USGS 7.5 Minute Quadrangle: Vienna, VA-MD
Stream: Unnamed Tributary to Colvin Run
Date of Inspection: 16 April 1980

BRIEF ASSESSMENT OF DAM

Lake Anne Dam is a zoned earthfill embankment approximately 590 feet long and 47.1 feet high. The dam has a drop-inlet spillway consisting of a 6 foot by 6 foot concrete riser and a 4.33 foot by 5.5 foot concrete conduit. The dam, located in Reston, Virginia, is used for recreation. The dam is owned by the Reston Land Corporation. Lake Anne Dam is an "intermediate" size - "significant" hazard structure as defined by the Recommended Guidelines for Safety Inspection of Dams.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 1/2 Probable Maximum Flood (1/2 PMF) was selected as the spillway design flood (SDF). The SDF was routed through the reservoir and found to overtop the dam by a maximum depth of 0.3 foot with an average critical velocity of 2.7 f.p.s. Total duration of dam overtopping would be approximately 1.7 hours. The spillway is capable of passing up to 45 percent of the Probable Maximum Flood (PMF). The spillway is adjudged as inadequate, but not seriously inadequate.

Visual inspection and office analyses indicate no deficiencies requiring emergency attention.

A flood warning system should be developed and put into operation.

The following measures should be undertaken as part of a regularly scheduled inspection and maintenance program. The shrubs and trees on the upstream slope should be cut off at ground level or transplanted, as should the brush and saplings on the downstream slope. Any trees with a trunk diameter greater than 3 inches should also have their root systems removed. The bare areas on the embankment should be reseeded and a good grass cover established over the entire embankment. The riprap on the upstream slope should be extended a few feet higher to provide protection at higher

NAME OF DAM: LAKE ANNE DAM

reservoir levels. The areas of erosion in the junctions of the embankment and abutments should be repaired and a good grass cover established. The erosion on the sides of the stilling basin should be arrested and the sides of the basin should be riprapped so erosion does not reoccur. Repairs should be made to the concrete on the spillway intake structure where spalling is taking place. The fallen tree trunk and sections of guard rail should be removed from the stilling basin. The section of concrete pipe at the downstream end of the stilling basin should be removed. The sluice gates on the right side of the riser should be checked regularly and maintained in an operable condition, the vegetation on the embankment should be cut regularly, and a staff gage should be installed to monitor reservoir levels above normal pool.

MICHAEL BAKER, JR., INC.

SUBMITTED:

ORIGINAL SIGNED BY:
JOHN H. SALLEY

for James A. Walsh, P.E.
Chief, Design Branch

Original signed by
JACK G. STARR

RECOMMENDED:

Jack G. Starr, P.E.
Chief, Engineering

APPROVED:

Original signed by:
Douglas L. Haller

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

Date:

JUL 31 1980



NAME OF DAM: LAKE ANNE DAM



OVERALL VIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: LAKE ANNE DAM ID# VA 05909

SECTION 1 - PROJECT INFORMATION

1.1 General

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

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams. The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life and property.

1.2 Description of Project

1.2.1 Description of Dam and Appurtenances: Lake Anne Dam is a zoned earthfill embankment approximately 47.1¹ feet high and 590 feet long with a crest width of 66 feet. The design drawings show that the embankment is keyed into the foundation and that there is upstream slope protection. The downstream embankment slope is approximately 3H:1V (Horizontal to Vertical). The upstream embankment slope is approximately 3H:1V from the bottom to a 9 foot wide berm at elevation 327 feet above Mean Sea Level (M.S.L.). From the berm to the embankment crest the upstream embankment slope is approximately 2H:1V. The crest of the dam has a minimum elevation of 335.8 feet M.S.L. at a point near the left² abutment. Wiehle Avenue, a four-lane highway, runs along the crest of the dam. A macadam path runs along the berm on the upstream slope.

¹Measured from the streambed at the downstream toe to the embankment crest.

²Facing downstream.

NAME OF DAM: LAKE ANNE DAM

The spillway is a drop-inlet spillway with a fixed crest at elevation 325.0 feet M.S.L. The upper portion of the riser is a rectangular reinforced concrete platform; the top of the platform is at elevation 330 feet M.S.L. The 20 foot long end walls are concrete; the 18 foot long sides are open and provide a total weir length of 30 feet. There are two types of trash racks on the structure. Aluminum gratings cover the open sides from just below normal pool level to the top of the platform. Below the gratings there are sections of 1.25 inch diameter galvanized iron pipe positioned horizontally. The structure tapers to form a 6 foot by 6 foot reinforced concrete box riser with its invert at elevation 290.5 feet M.S.L. The outlet conduit is a 4.33 foot by 5.5 foot reinforced concrete box 300 feet long. At the outlet, the concrete top of the conduit terminates. In the next nine feet, at which point the concrete ends, the side walls slope down.

The stilling basin is approximately 100 feet long and 30 feet wide. There is no riprap in the basin except for a 6 foot wide section at the upstream end, adjacent to the side walls of the outlet structure.

The proposed plans for the dam show an internal drainage system consisting of an 8 inch drain surrounded by a filter. The internal drainage system discharges into the spillway outlet conduit.

Facilities for draining the reservoir consist of two 24 inch diameter sluice gates on the right side of the riser, one at centerline elevation 315.0 feet M.S.L. and one at centerline elevation 297.6 feet M.S.L. The gates are operated manually from the platform on top of the riser.

- 1.2.2 Location: Lake Anne Dam is located on an unnamed tributary to Colvin Run in Reston, Fairfax County, Virginia. A Location Plan is included with this report.
- 1.2.3 Size Classification: The maximum height of the dam is 47.1 feet and the reservoir storage capacity at the crest of the dam (elevation 335.8 feet M.S.L.) is 745 acre-feet. Therefore,

NAME OF DAM: LAKE ANNE DAM

because of the height of the dam, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

- 1.2.4 Hazard Classification: Wiehle Avenue, a four-lane highway, runs along the crest of the dam. Lake Fairfax Dam is approximately 0.9 mile downstream of Lake Anne Dam, and the failure of Lake Anne Dam would increase the probability that Lake Fairfax Dam would fail. There is a picnic area containing 15 to 20 wooden tables immediately downstream of Lake Fairfax Dam. State Routes 7 and 674 are both within 1.8 miles downstream of Lake Fairfax Dam. Although loss of human life is not highly probable, severe economic loss due to the blockage of Wiehle Avenue and the possible failure of Lake Fairfax Dam and blockage of State Routes 7 and 674 is likely in the event of a dam failure. Lake Anne Dam is therefore considered in the "significant" hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.
- 1.2.5 Ownership: The dam is owned by the Reston Land Corporation, 11800 Sunrise Valley Drive, Suite 1400, Reston, Virginia 22091.
- 1.2.6 Purpose of Dam: The dam is used for recreation.
- 1.2.7 Design and Construction History: The dam was designed by Massey Engineers, Fairfax, Virginia, and constructed by Moore, Kelly, and Reddish. Construction was completed in 1962.
- 1.2.8 Normal Operational Procedures: The reservoir is normally operated at the crest of the spillway, elevation 325.0 feet M.S.L. No formal operating procedures are followed for this structure. See Paragraph 4.1 for detailed operating procedures.

1.3 Pertinent Data

- 1.3.1 Drainage Area: The drainage area tributary to the dam is 0.91 square mile.
- 1.3.2 Discharge at Dam Site: The maximum discharge from the reservoir is unknown. With the pool

NAME OF DAM: LAKE ANNE DAM

level at the top of the dam, the spillway is capable of passing a discharge of 735 c.f.s.

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

TABLE 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet M.S.L.	Area acres	Reservoir Capacity		Length feet
			Acre- feet	Watershed inches	
Top of dam (minimum)	335.8	49.6	745	15.4	3410
Principal spillway crest (normal pool)	325.0	24.8	365	7.5	2960
Streambed at downstream toe of dam	288.7	-	-	-	-

NAME OF DAM: LAKE ANNE DAM

SECTION 2 - ENGINEERING DATA

- 2.1 Design: Design plans were obtained for use in preparing this report but specifications and boring logs were not available.
- 2.2 Construction: Construction records, as-built plans, and inspection logs were not available for review. There was a revision note on the design plans indicating stone riprap had been placed on the upstream slope in 1964 after construction had been completed.
- 2.3 Evaluation: No stability analyses or hydrologic and hydraulic data were available for review. No construction records or as-built plans were available to adequately assess the condition of the dam. All evaluations and assessments in this report were based upon design plans, a previous inspection report, field observations, discussions with the owner, and office analyses.

NAME OF DAM: LAKE ANNE DAM

SECTION 3 - VISUAL INSPECTION

3.1 Findings

- 3.1.1 General: The field inspection was conducted on 16 April 1980. At the time of the inspection, the pool elevation was 325.1 feet M.S.L.; the tailwater elevation was 291.9 feet M.S.L. The weather was sunny and windy with temperatures in the low 50's°F. The ground surface at the embankment and abutments was generally dry. The dam and appurtenant structures at the time of inspection were found to be in good overall condition. Deficiencies found during the inspection are not believed to indicate any major stability problems although they will require remedial treatment. The following are brief summaries of deficiencies found during the inspection. A Field Sketch of conditions is shown as Plate 1. The complete visual inspection check list is given in Appendix III. Schnabel Engineering Associates performed an inspection of the dam in April 1978. Excerpts from their inspection report are included in this report as Appendix IV.
- 3.1.2 Dam: The embankment was found to be in generally good condition with no surface cracks or sloughs. Trees growing on the downstream slope were removed approximately within the last year and a good grass cover has not yet been re-established. Where the trees were removed, there is a cover of sparse grass and straw mulch, with scattered bare areas where erosion is taking place, especially on the left side of the slope. The rest of the embankment has an adequate cover of grass. There is a thick growth of brush and saplings on the downstream slope near the toe. Vertical and horizontal alignment of the crest both appear to be good. Wiehle Avenue, a four-lane highway, runs along the crest of the dam. There is riprap on the upstream slope between elevations 322 and 327 feet M.S.L. No riprap failures have occurred, but the stone is partially covered by soil in places and is deficient in thickness in a few places. Scattered shrubs and a few trees have been planted on the upstream slope, which has an adequate cover of grass.

NAME OF DAM: LAKE ANNE DAM

The junctions of the embankment and abutments are composed of vegetated earth. There is grouted riprap in the lower portions of the upstream junctions. There is some erosion along the junction of the downstream slope and left abutment, where the grass cover is sparse. There is also minor erosion in the junction of the right abutment and downstream slope approximately halfway up the slope.

Moist soil found on the left side of the downstream slope appears to be due to erosion. There is a 50 foot diameter wet area at the right downstream abutment approximately 10 feet above the toe, but beneath the surface the ground is dry. An area on the right side downstream of the toe was very wet and thickly vegetated. The wet areas at the right abutment and downstream of the toe appear to be due to run-off from the road and hillside. No seeps were observed during the inspection.

- 3.1.3 Appurtenant Structures: Severe spalling of the concrete is taking place both on the inside and outside of the left downstream corner of the spillway intake structure near the normal reservoir level. The concrete of the outlet structure appears to be in good condition with no evidence of cracking or spalling. The high tailwater at the time of inspection prevented examination of the interior of the spillway conduit and the bottom of the stilling basin. Moderate erosion has occurred on the sides of the stilling basin. Drainage from a wet area on the right side of the basin has evidently caused some of this erosion. There are two sections of metal guard rail in the downstream end of the basin and a fallen tree trunk on the right side.

The sluice gates on the right side of the riser could not be examined closely, but appear to be in satisfactory condition.

- 3.1.4 Reservoir Area: The reservoir slopes are gently to moderately steep. They are covered by thin woods interspersed with lawns and other grassy areas. No evidence of erosion was observed. There are residences and private boat docks around the lake, with a

NAME OF DAM: LAKE ANNE DAM

small commercial mall at the upstream end. The extent of sedimentation was not directly observed, but it does not appear to be significant.

3.1.5 Downstream Channel: There is a 5 foot section of concrete pipe in the outlet of a tributary at the downstream left end of the stilling basin. Brush and small trees overhang the sides of the channel. The stream has a slope of approximately 1.1 percent downstream of the dam. Vegetation on the side slopes consists of moderately thick trees and brush. All homes downstream of the dam are at elevations well above the valley floor and would not be flooded in the event of a dam failure. Lake Fairfax is approximately 0.6 mile downstream from Lake Anne Dam.

3.1.6 Instrumentation: There was no instrumentation present at the dam.

3.2 Evaluation: In general, the dam and appurtenant structures are in good condition. The shrubs and trees on the upstream slope should be cut off at ground level or transplanted, as should the brush and saplings on the downstream slope. Any trees with a trunk diameter greater than 3 inches should also have their root systems removed. The bare areas on the embankment should be reseeded and a good grass cover established over the entire embankment. The riprap on the upstream slope should be extended a few feet higher to provide protection at higher reservoir levels. The areas of erosion in the junctions of the embankment and abutments should be repaired and a good grass cover established. The erosion on the sides of the stilling basin should be arrested and the sides of the basin should be riprapped so erosion does not reoccur. Repairs should be made to the concrete on the spillway intake structure where spalling is taking place. The fallen tree trunk and sections of guard rail should be removed from the stilling basin. The section of concrete pipe at the downstream end of the stilling basin should be removed. The sluice gates on the right side of the riser should be checked regularly and maintained in an operable condition, the vegetation on the embankment should be cut regularly, and a staff gage should be installed to monitor reservoir levels above normal pool.

NAME OF DAM: LAKE ANNE DAM

SECTION 4 - OPERATIONAL PROCEDURES

- 4.1 Procedures: Operation of the dam is an automatic function controlled by the spillway. Water entering the reservoir flows into the principal spillway at elevation 325.0 feet M.S.L.
- 4.2 Maintenance of Dam: Maintenance of the dam is the responsibility of the owner. The owner is currently in the process of implementing a "Maintenance and Monitoring Plan," whose major elements include:
- 1) Installation of six piezometers in the downstream embankment.
 - 2) Walk-over inspections and reading of piezometers every month; logs to be kept.
 - 3) More thorough inspections, including lubrication and operation of sluice gates, every six months.
- 4.3 Maintenance of Operating Facilities: The only operating facilities at the dam are the two 24 inch diameter sluice gates on the right side of the riser. The "Maintenance and Monitoring Plan" which the owner is currently implementing calls for lubricating and operating these gates every six months.
- 4.4 Warning System: At the present time, there is no warning system in operation. The owner is currently evaluating alternative proposed warning systems. The emergency action plan currently in operation basically consists of opening the sluice gates on the riser to drawdown the reservoir and provide additional storage if warning of a major storm is received.
- 4.5 Evaluation: The owner's "Maintenance and Monitoring Plan" should provide for adequate maintenance of the dam in the future. A thorough check list should be compiled for use by the owner or his representative as a guide for the inspection. The emergency action plan appears to be adequate. A warning system should be developed and put into operation.

NAME OF DAM: LAKE ANNE DAM

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

- 5.1 Design: No design data were available for use in preparing this report.
- 5.2 Hydrologic Records: No rainfall or streamflow records are available at the dam site.
- 5.3 Flood Experience: There were no exact high water marks from past floods available at the dam site. According to the owners, the reservoir level has never risen more than a few feet above normal pool.
- 5.4 Flood Potential: The Probable Maximum Flood (PMF) and the 1/2 Probable Maximum Flood (1/2 PMF) were developed and routed through the reservoir by use of the HEC-1 DB computer program (Reference 9, Appendix V) and appropriate unit hydrograph, precipitation, and storage-outflow data. Clark's T and R coefficients for the local drainage areas were estimated from basin characteristics. The rainfall applied to the unit hydrograph was taken from a publication by the National Oceanic and Atmospheric Administration (Reference 17, Appendix V). An initial loss of 1.0 inch and a constant loss rate of 0.05 inch per hour were used for the PMF and 1/2 PMF.
- 5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1, Paragraph 1.3.3.
- Regulation of flow from the reservoir is automatic. Normal flows are maintained by the crest of the riser with an elevation of 325.0 feet M.S.L.
- Outlet discharge capacity was computed by hand; reservoir area was planimeted from the Vienna, Virginia-Maryland, 7.5 minute USGS quadrangle; and storage capacity was computed by the HEC-1 DB program. All flood routings were begun with the reservoir level at normal pool.
- 5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance are shown in the following table:

NAME OF DAM: LAKE ANNE DAM

TABLE 5.1 RESERVOIR PERFORMANCE

Item	Normal(a)	Hydrographs	
		1/2 PMF	PMF(b)
Peak flow, c.f.s.			
Inflow	3	3631	7262
Outflow	3	756	5844
Peak elev., ft. M.S.L.	325.1	336.1	339.1
Non-overflow section (c) (elev. 335.8 ft. M.S.L.)			
Depth of flow, ft.	-	0.3	3.3
Average velocity, f.p.s.	-	2.7	8.4
Total duration of over- topping, hrs.	-	1.7	4.3
Tailwater elev., ft. M.S.L.	291.9	-	-

- (a) Conditions at time of inspection.
 (b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a region.
 (c) Velocity estimates were based on critical depth at control section.

5.7 Reservoir Emptying Potential: The reservoir can be drawn down by means of the two 24 inch diameter sluice gates on the right side of the riser. Neglecting inflow, the reservoir can be drawn down from normal pool in approximately 4.1 days. This is equivalent to an approximate drawdown rate of 6.9 feet per day, based on the hydraulic height measured from normal pool divided by the time to dewater the reservoir.

5.8 Evaluation: Lake Anne Dam is an "intermediate" size - "significant" hazard dam requiring evaluation for a spillway design flood (SDF) in the range between the 1/2 PMF and the PMF. Because of the risk involved, the 1/2 PMF has been selected as the SDF. The 1/2 PMF was routed through the dam and found to overtop the dam by a maximum depth of 0.3 foot with an average critical velocity of 2.7 f.p.s. Total duration of dam overtopping would be 1.7 hours. The spillway is capable of passing up to 45 percent of the PMF.

Conclusions pertain to present-day conditions and the effect of future development on the hydrology has not been considered.

NAME OF DAM: LAKE ANNE DAM

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: There is no information available on the foundation conditions. The dam is located in the fall line where the Piedmont comes in contact with the Coastal Plain. The predominate deposit of the area had been previously mapped as Wissahickon schist but is now classified as a schist of uncertain age. According to the design plans, there is an 8 inch drain and filter in the foundation which discharges into the spillway outlet conduit. A cut-off trench backfilled with impervious core is shown on the plans in the foundation at the centerline of the dam. As noted in the visual inspection, there are no seeps, but a superficial wet area is located at the right downstream abutment and a swampy area where drainage collects is at least 20 feet away from the toe of the dam on the right side of the stilling basin.

6.2 Embankment

6.2.1 Materials: There are no construction records available on the nature of the embankment materials. The design plans show that the embankment consists of an impervious core covered by compacted earthfill at the top and on the downstream slope. The upstream face of the lower portion of the upstream embankment is formed by the upstream face of the impervious core. The embankment materials were to be compacted at 95 percent or greater of their maximum dry densities. The soils observed on the surface are comprised of residual silt and clay with variable amounts of rock fragments.

6.2.2 Stability: There are no available stability calculations. The dam is 47 feet high and the crest is 66 feet wide. It has an upstream slope of approximately 3H:1V from the bottom of the dam to a 9 foot wide berm at elevation 329 feet M.S.L. and a 2H:1V slope from the berm to the crest. The downstream slope is approximately 3H:1V. There is no freeboard since water flows into the drop-inlet in the riser at normal pool elevation 325 feet M.S.L. and through the spillway. The dam is subjected to a sudden drawdown because the approximate reservoir drawdown rate of 6.9 feet per day exceeds the critical rate of 0.5 foot per day for earth dams.

NAME OF DAM: LAKE ANNE DAM

According to the guidelines presented in Design of Small Dams by the U.S. Department of the Interior, Bureau of Reclamation, for zoned dams having a maximum core, with a stable foundation, subject to a drawdown, and composed of low-plastic fines and sand (CL, ML, and SM); the recommended slopes are 3H:1V upstream and 2.5H:1V downstream. The recommended width is 20 feet. Based on these guidelines, the dam has adequate embankment slopes and the width exceeds the recommended minimum.

6.2.3 Seismic Stability: Lake Anne 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: There is insufficient information to adequately evaluate the stability of the dam. Based on the Bureau of Reclamation guidelines, the width and a major portion of the slopes are adequate. The visual inspection revealed no seeps, but there is a superficial wet area on the dam at the right abutment and a large swampy area downstream from the toe of the dam which appears to be caused by surface drainage.

Despite the inability of the spillway to pass the SDF (as described in Section 5 of this report), the depth, duration, and rate of overtopping flows are not considered detrimental to the embankment. Overtopping flows are shallow and last only 1.7 hours, and the velocity is less than 6 f.p.s., the effective eroding velocity for a vegetated earth embankment.

A stability check is not required.

NAME OF DAM: LAKE ANNE DAM

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

- 7.1 Dam Assessment: The engineering data available for review were inadequate. No indication of any major stability problem was discovered during the field inspection and office analyses and a stability check of the dam was not required. The dam and appurtenant structures are generally in good condition; maintenance of the dam should be improved by the "Maintenance and Monitoring Plan" which the owner is currently implementing.

Using the Corps of Engineers' screening criteria for initial review of spillway adequacy, the 1/2 PMF was selected as the SDF for the "intermediate" size - "significant" hazard classification of Lake Anne Dam. It has been determined that the dam would be overtopped by the SDF by a maximum depth of 0.3 foot with an average critical velocity of 2.7 f.p.s. Duration of overtopping would be approximately 1.7 hours. The spillway is capable of passing up to 45 percent of the PMF.

Despite the inability of the spillway to pass the SDF, the depth, duration, and rate of overtopping flows are not considered detrimental to the embankment. Overtopping flows are shallow and last only 1.7 hours, and the velocity is less than 6 f.p.s., the effective eroding velocity for a vegetated earth embankment.

The spillway is adjudged as inadequate, but not seriously inadequate.

There is no flood warning system currently in operation. There is an emergency action plan currently in operation.

- 7.2 Recommended Remedial Measures: A flood warning system should be developed and put into operation.

The following measures should be undertaken as part of a regularly scheduled inspection and maintenance program. The shrubs and trees on the upstream slope should be cut off at ground level or transplanted, as should the brush and saplings on the downstream slope. Any trees with a trunk diameter greater than 3 inches should also have their root systems removed. The bare areas on the embankment should be reseeded and a good grass cover established over the entire embankment. The riprap on the upstream slope should be extended a few feet higher to provide protection at higher reservoir levels. The

NAME OF DAM: LAKE ANNE DAM

areas of erosion in the junctions of the embankment and abutments should be repaired and a good grass cover established. The erosion on the sides of the stilling basin should be arrested and the sides of the basin should be riprapped so erosion does not reoccur. Repairs should be made to the concrete on the spillway intake structure where spalling is taking place. The fallen tree trunk and sections of guard rail should be removed from the stilling basin. The section of concrete pipe at the downstream end of the stilling basin should be removed. The sluice gates on the right side of the riser should be checked regularly and maintained in an operable condition, the vegetation on the embankment should be cut regularly, and a staff gage should be installed to monitor reservoir levels above normal pool.

NAME OF DAM: LAKE ANNE DAM

APPENDIX I

PLATES

CONTENTS

Location Plan

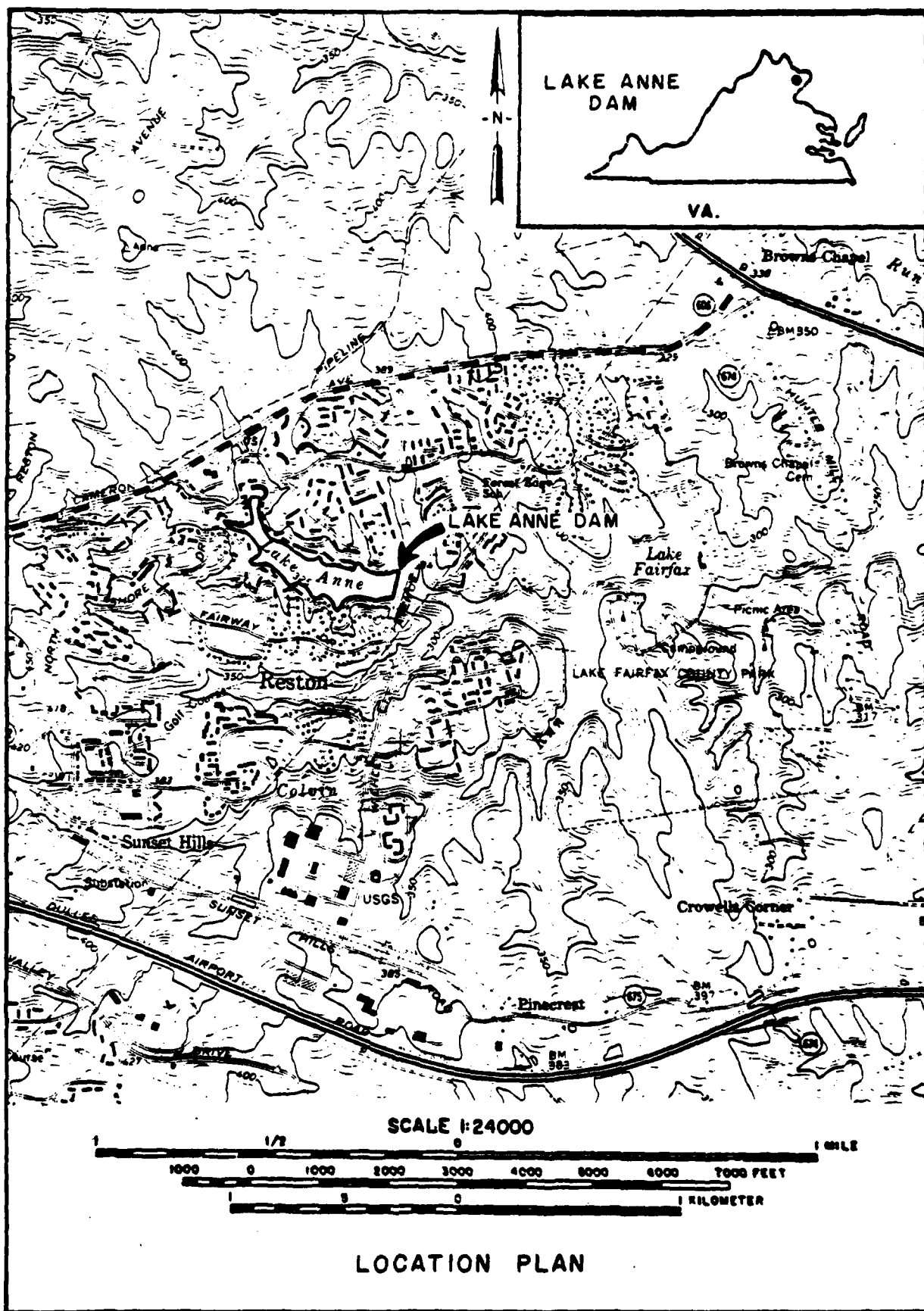
Plate 1: Field Sketch

Plate 2: Dam Plan and Section

Plate 3: Dam Details

Plate 4: Spillway Details

NAME OF DAM: LAKE ANNE DAM





S-691-1

Scale

Limit of Section

Slope 3:1

60' Berm

4' x 5.6' BOX CULVERT

N 51°04'40"E

30'

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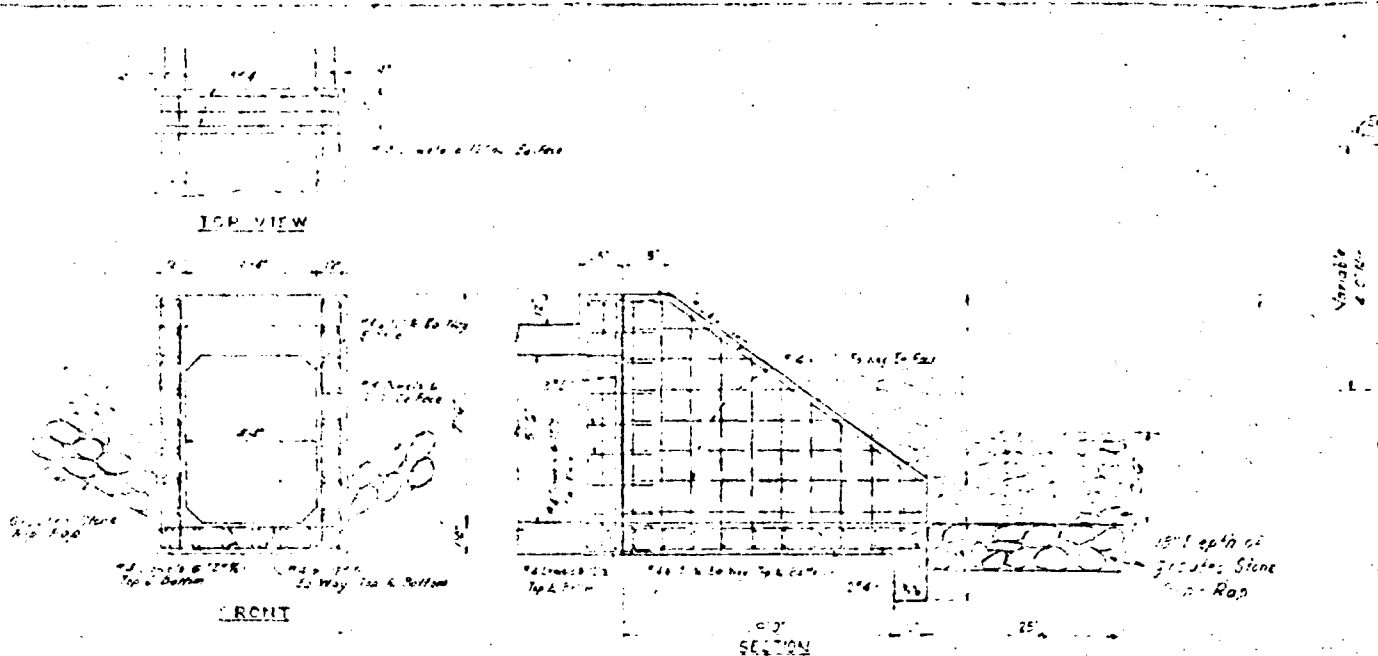
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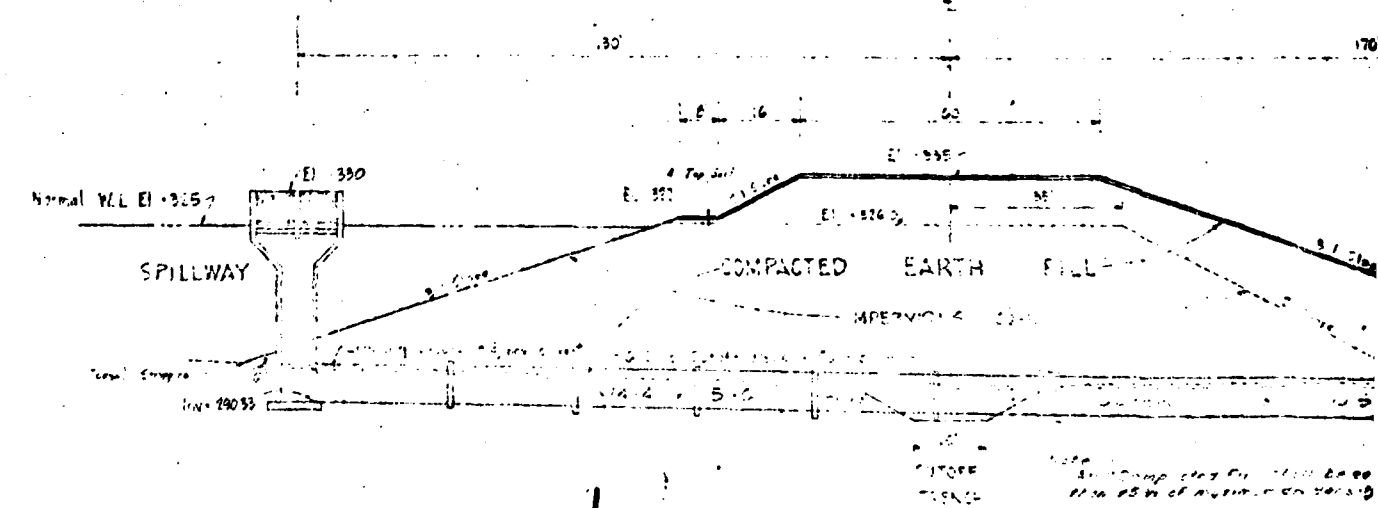
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ENDWALL & CHANNEL
Scale 1/4" = 1'



MASSEY ENGINEERS Consultants

RESTON, American Industrial District, Fairfax County, Virginia

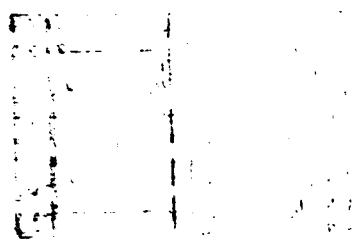


FIGURE 1
A. 1000

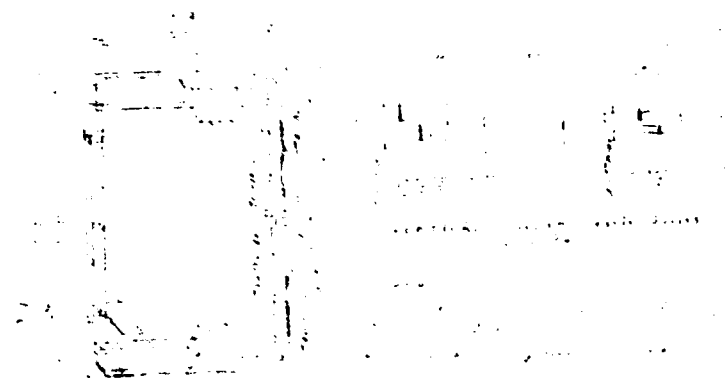
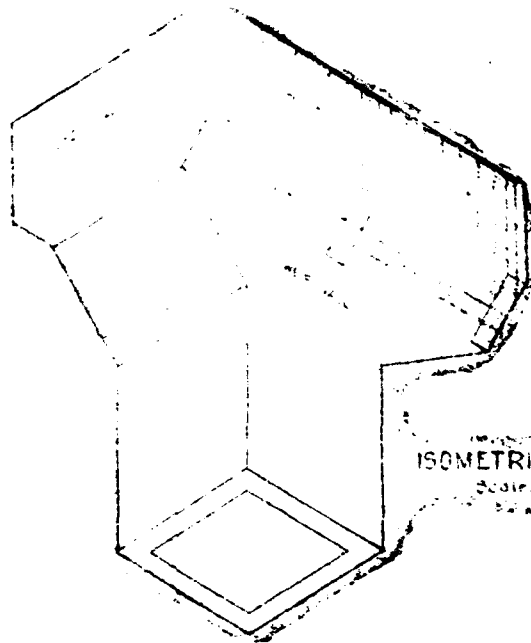
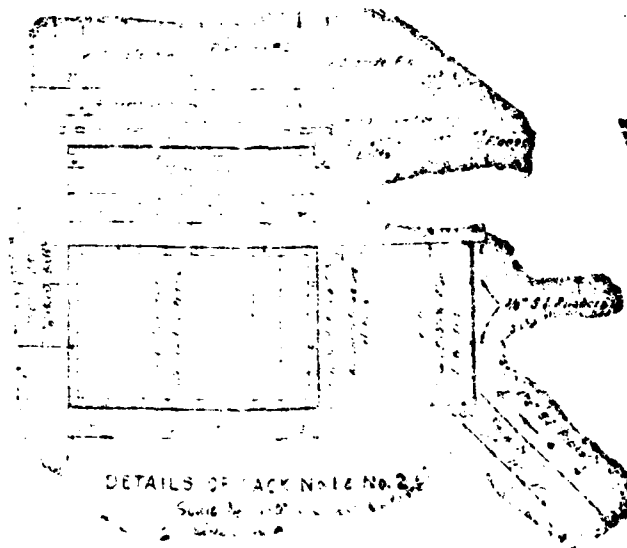


FIGURE 2
A. 1000

FIGURE 3
A. 1000



ISOMETRIC VIEW
Scale: 1/2" = 1"



DETAILS OF JACK NO. 16 No. 2

THIS PLATE IS BEST QUOTED IN PROPORTION
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APPENDIX II

PHOTOGRAPHS

CONTENTS

- Photo 1: Upstream Slope from Left Abutment
- Photo 2: Downstream Slope from Right Abutment
- Photo 3: Junction of Downstream Slope and Right Abutment
- Photo 4: Spillway Intake Structure
- Photo 5: Spillway Outlet Structure and Downstream Slope
- Photo 6: Downstream Channel from Embankment Crest

Note: Photographs were taken on 16 April 1980.

NAME OF DAM: LAKE ANNE DAM

LAKE ANNE DAM



PHOTO 1. Upstream Slope from Left Abutment



PHOTO 2. Downstream Slope from Right Abutment

LAKE ANNE DAM



PHOTO 3. Junction of Downstream Slope and Right Abutment



PHOTO 4. Spillway Intake Structure

LAKE ANNE DAM



PHOTO 5. Spillway Outlet Structure and Downstream Slope



PHOTO 6. Downstream Channel from Embankment Crest

APPENDIX III

VISUAL INSPECTION CHECK LIST

Phase 1
Visual Inspection
Check List

Name of Dam Lake Anne Dam County Fairfax State VA Coordinates Lat. 3857.9
Long. 7720.0

Date of Inspection 16 April 1980 Weather Cool, windy Temperature 50° F.

Pool Elevation at Time of Inspection 325.1 M.S.L. Tailwater at Time of Inspection 291.9 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

Jeffrey A. Quay
Jeffrey S. Maze
William L. Sheaffer

Virginia State Water Control Board:

Edwin B. Constantine, III
Timothy Perry
Andrew Pare

Owner's Representatives:

Don L. Rifenberg, Reston Land
Corporation
Charles Chambers, Gulf Reston, Inc.
Vernon J. Walker, Reston Home
Owners Association

William L. Sheaffer Recorder

EMBANKMENT

Name of Dam LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
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SURFACE CRACKS	None observed	
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UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
---	---------------	--

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Trees growing on the downstream slope were removed approximately within the last year and a good grass cover has not yet been reestablished. Where the trees were removed, there is a cover of sparse grass and straw mulch, with scattered bare areas where minor erosion is taking place, especially on the left side of the slope. The bare areas should be reseeded and a good grass cover reestablished.
--	---

EMBANKMENT

Name of Dam LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical and horizontal alignment of the crest both appear to be good. A four lane asphalt concrete highway with no median runs along the crest.	
RIPRAP FAILURES	There is riprap on the upstream slope between elevations 322 and 327 ft. M.S.L. No riprap failures have occurred, but the stone is partially covered by soil in places and deficient in thickness in a few places. There is grouted riprap, which appears to be in satisfactory condition, in the lower portions of the contacts between the abutments and upstream embankment.	The riprap on the upstream slope should be extended a few ft. higher to provide protection at higher reservoir levels.
VEGETATION	Trees and root systems were removed from a large portion of the downstream slope approximately within the last year and a good grass cover has not yet been re-established. The rest of the embankment has an adequate cover of grass. There is a thick growth of brush and saplings on the downstream slope near the toe. Scattered shrubs and a few trees have been planted on the upstream slope, which has an adequate cover of grass.	A good grass cover should be reestablished. The shrubs and trees on the upstream slope should be cut off at ground level or transplanted, as should the brush and saplings on the downstream slope. Any trees with a trunk diameter greater than 3 in. should also have their root systems removed.

EMBANKMENT MATERIALS

The embankment was apparently constructed of residual silt and clay with variable amounts of rock fragments and sand. A geotechnical report prepared by Schnabel Engineering Associates indicates that construction included a cut-off trench and impervious core. The depth to bedrock, which is mapped as schist, is not known.

EMBANKMENT

Name of Dam LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT	The junctions of the embankment and abutments are composed of vegetated earth. There is grouted riprap in the lower portions of the upstream junctions. There is some erosion along the junction of the downstream slope and left abutment, where the grass cover is sparse. There is also minor erosion in the junction of the right abutment and downstream slope approximately halfway up the slope. Otherwise, the junctions of the embankment and abutments appear to be in satisfactory condition.	The areas where erosion has occurred should be repaired and a good grass cover should be established.
ANY NOTICEABLE SEEPAGE	There is a 50 ft. diameter wet area at the right downstream abutment approximately 10 ft. above the toe, but beneath the surface the ground is dry. Moist soil found on the left side of the downstream slope appears to be due to erosion. An area on the right side downstream of the toe was very wet and thickly vegetated. No seeps were observed.	The wet areas at the right abutment and downstream of the toe appear to be due to run-off from the road and hillside.
STAFF GAGE AND RECORDER	None	A staff gage should be installed to monitor reservoir levels above normal pool.
DRAINS	The plans included in the geotechnical report by Schnabel Engineering Associates show an internal drainage system consisting of an 8 in. perforated C.M.P. embedded in filter materials. The outlet for the drainage system could not be located during the inspection.	According to the dam's designer, the drainage system discharges into the spillway outlet conduit.

SPILLWAY

Name of Dam: LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN SPILLWAY CONDUIT	The high tailwater elevation at the time of inspection prevented examination of the conduits interior. The conduit is a 4.33 ft. by 5.5 ft. rectangular concrete box conduit.	Repairs should be made to the concrete where spalling is taking place.
INTAKE STRUCTURE	The intake structure is a rectangular concrete box riser. Above the normal reservoir level it is 20 ft. long and 18 ft. wide. The 20 ft. long sides are solid; the 18 ft. sides are open except for the metal grills which act as trash racks. Below the normal reservoir level, the conduit narrows to 6 ft. by 6 ft. Severe spalling of the concrete is taking place both on the inside and outside of the riser near the normal reservoir level in the left downstream corner.	
OUTLET STRUCTURE	The concrete top of the conduit terminates at the outlet. In the next nine ft. at which point the concrete ends, the side walls gradually become lower. The concrete appears to be in good condition, with no evidence of cracking or spalling.	
OUTLET CHANNEL	The stilling basin is approximately 100 ft. long and 30 ft. wide. The bottom of the basin could not be examined due to the high tailwater elevation. There is no riprap on the sides of the basin except for sections approximately 6 ft. long adjacent to both side walls of the outlet structure. Moderate erosion has occurred on the sides of the basin.	The stilling basin appears to be adequate with no serious erosion. The fallen tree trunk and sections of guard rail should be removed. The erosion on the sides of the stilling basin should be arrested and the sides of the basin should be ripped so erosion does not reoccur.

(continued next page)

SPILLWAY

Name of Dam: LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
OUTLET CHANNEL (continued)	Drainage from a wet area on the right side of the stilling basin has evidently caused some of this erosion. There are two sections of metal guard rail in the downstream end of the basin and a fallen tree trunk on the right side.	
EMERGENCY GATE	There are two 24 in. diameter sluice gates on the right side of the riser, one at elevation 315.0 ft. M.S.L. and one at elevation 297.5 ft. M.S.L. The gates are operated manually from the top of the riser. The gates could not be examined closely, but appeared to be in satisfactory condition.	The gates should be checked regularly and maintained in an operable condition.

INSTRUMENTATION

Name of Dam: LAKE ANNE DAM

<u>VISUAL EXAMINATION</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
MONUMENTATION/SURVEYS	No permanent markers were found.	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

Name of Dam: LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The slopes are gently to moderately steep. They are covered by thin woods interspersed with lawns and other grassy areas. No evidences of erosion was observed. There are residences and private boat docks around the lake with a small commercial mall at the upstream end.	

SEDIMENTATION The extent of sedimentation was not directly observed, but it did not appear to be significant.

DOWNSTREAM CHANNEL

Name of Dam: LAKE ANNE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	There is a 5 ft. section of concrete pipe in the outlet of a tributary at the downstream left end of the stilling basin. Brush and small trees overhang the sides of the channel. There are no other major obstructions.	The section of pipe should be removed and the vegetation should be trimmed back.
SLOPES	The stream has a slope of approximately 1.1% downstream of the dam. There is a swampy area, apparently caused by drainage from the right hillside and abutment, on the right overbank 20 to 60 ft. downstream of the toe. Vegetation on the side slopes consists of moderately thick trees and brush.	A small channel should be dug to provide drainage from the swampy area into the downstream channel. The swampy area does not affect the stability of the dam.
APPROXIMATE NO. OF HOMES AND POPULATION	All homes downstream of the dam are at elevations well above the dam crest. Lake Fairfax is approximately 0.6 mile downstream of Lake Anne Dam. There is a picnic area immediately downstream of Lake Fairfax Dam.	

APPENDIX IV

**EXCERPTS FROM INSPECTION REPORT
BY SCHNABEL ENGINEERING ASSOCIATES**

V. RESULTS OF FIELD INSPECTION

A trip was made to the dam site by our project geotechnical engineer on May 2, 1978, to visually examine various structures. The weather was sunny with moderate temperature and the reservoir was full at intake level of El 325. The weather was also clear and dry for the past few days before the visit.

A. Embankment Structures

1. Settlement and Slope Stability

- a. Crest - The top of embankment is now Wiehle Avenue, serving major north-south traffic in Reston, Virginia.
- b. Upstream face - Smooth, uniform and grass-covered surface was observed throughout the area above the normal lake level. No localized settlement, depressions or surface cracks were present to indicate any settlement and slope stability problems (See Photo 13).
- c. Downstream Face - The surface area is covered by either grass or weed of a couple of feet high (See Photos 14 & 15). Few small to medium size trees were noted at about the midheight of the embankment across the dam. The downstream face appeared to be very smooth and uniform throughout with no indication of localized cracking and subsistence.
- d. Abutments - The transitions between embankment and both left and right abutments were smooth with no erosion and slope sloughing indicated.

2. Slope Protection

The upstream riprap was practically submerged with lake at El 325. Although the Construction Drawing indicates riprap to El 327 where the Macadam path is located, it actually appears that the top of riprap is about 2 feet below the surface of the path (See Photo 13). Very minor erosion of embankment soils

above the slope protection zone due to wave action was observed.

3. Drainage System

No outlet of internal 8" drain was observed. A possibility is that these transverse drains terminate and discharge their collected seepage water into the box culvert. Since a pool was formed downstream of the end wall structure, it was not possible to estimate the flow rate coming out of the box culvert (See Photo 15).

4. Seepage

No springs or any seepage signs were observed on the downstream embankment slope.

B. Spillway and Outlet Works

1. Drop Inlet Spillway

Intake structure was observed from a distance on the Macadam path. The concrete surface appeared to be in very good condition. Trash racks on both sides of the intake were clean and the water was flowing into the intake without obstruction (See Photo 13).

2. End Wall of Box Culvert at Downstream Toe

The concrete surface was also in good condition (See Photo 14).

C. Reservoir

As described briefly in Section II, Description of Dam, all the areas along shoreline have been developed for residential dwellings. The houses are generally constructed at about 5 feet or more above the normal lake level at El 325 (See Photo 13). Water along the shoreline behind the backyard of these houses appears to be fairly clear. Erosion and sedimentation seems not to be a problem as long as the lake level can be maintained at a relatively stable level. Erosion is anticipated in some areas during reservoir drawdown (if there is), because of the existence of relatively steep side slopes along the

shore below the normal lake level. The watershed runoff potential should have been established with the full developed status in real estate along the shoreline area.

D. Downstream Area

The downstream channel below the end wall structure has been widened to a pool before the water is discharging into the existing stream. The downstream valley is heavily wooded with relatively steep slopes at higher elevations on both sides of the valley. There are few scattered houses situated to the left on top of the valley slope. No spring activity was noticed at both abutment areas immediately below the dam.

VI. ASSESSMENT OF THE GENERAL CONDITION OF THE DAM AND CORRECTIVE MEASURES

It is our opinion that the overall design and construction of the embankment is in accordance with generally accepted principles of engineering practice. The dam also appears to be in very good condition. However, few very minor unfavorable conditions observed during field inspection should be corrected.

A. Trees should be removed from the downstream slope. This is considered essential to eliminate the creation of short seepage paths and possibly piping potential through the embankment soils.

B. Elevation below which the upstream surface was covered by riprap for slope protection against wave action appears to be not high enough for the situation where the lake is at its normal level. We recommend to cover the upstream surface with riprap to the elevation of Macadam path (El 327) as indicated originally in Construction Drawing.

VII. ADDITIONAL STUDY REQUIRED

One linkage which is missing in this study is the lake level rising analysis to evaluate the suitability of spillway capacity. The original hydrologic and hydraulic study, prepared by Massey Engineers, however, was not available for our presentation.

It should be noted that the requirements of spillway capacity for this type of small size reservoir and low water head dam have been considerably raised since the early 1960's. Very likely, criteria implemented in the original design of hydraulic structures are not going to meet the current standards imposed by the federal regulations. For this reason, we suggest a thorough "lake level rising study" be re-evaluated to determine whether any corrective measures are required. We believe this work should be more effectively and economically conducted by Massey Engineers because of their familiarity with the background and development of this project.

APPENDIX V

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GENERAL REFERENCES

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NAME OF DAM: LAKE ANNE DAM

