Phase I Dam Inspection Report
National Dam Safety Program
Perry Co. Sportsman's Club Lake Dam (MO 31097)
Perry County, Missouri

Horner & Shifrin, Inc.

U.S. Army Engineer District, St. Louis
Dam Inventory and Inspection Section, LMSED-PD
210 Tucker Blvd., North, St. Louis, Mo. 63101

Approved for release; distribution unlimited.

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.
MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

PERRY COUNTY SPORTSMAN'S CLUB LAKE DAM

PERRY COUNTY, MISSOURI

MO 31097

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

MARCH 1980
DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
310 NORTH 14TH STREET
ST. LOUIS, MISSOURI 63101

SIGNED

9 APR 1980

APPROVED BY:

10 APR 1960

This report presents the results of field inspection and evaluation of the Perry County Sportsmen's Club Lake Dam (EM 11097).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-compliance by the St. Louis District as a result of the application of the following criteria:

1. Failure will not pass 70 percent of the Probable Maximum Flood without overtopping the dam.
2. Dams may cause in dam failure.
3. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

Chief, Engineering Division

9 APR 1980

APPROVED BY:

Colonel, CE, District Engineer

10 APR 1960
PERRY COUNTY SPORTSMAN'S CLUB LAKE DAM

MISSOURI INVENTORY N. 31397

PERRY COUNTY, MISSOURI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:
HORNSBY & SHEPPARD, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63102

FOR:
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

MARCH 1980

HS-7925
PHASE 1 REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Perry Co. Sportsman's Club Lake Dam
State Location: Missouri
County Located: Perry
Stream: Tributary Whitewater River
Date of Inspection: 4 October 1979

The Perry Co. Sportsman's Club Lake Dam, was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of these hydrologic/hydraulic investigations, the present general condition of the dam is considered to be somewhat less than satisfactory. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. The upstream face of the embankment has a sparse cover of grass to protect the slope from erosion. A grass covered slope is not considered adequate to prevent erosion by wave action or by fluctuations of the lake level.

2. With the exception of the crest area of the emergency spillway which for the most part is covered with grass, the earthwork...
sections of the principal spillway spillway, there is little or no fear of protection to prevent erosion. Further areas of spillway should be protected in order to prevent erosion by lake outflow.

3. At the time of the inspection the plume area on the crest and downstream area of the dam was approximately 31 feet high. Other areas on the dam in an indication of lack of regular maintenance.

According to a representative of the Corps, since construction of the dam, the lake has experienced problems with excessive leaching, as manifested by the inability to maintain a stable lake surface level. At the time of the inspection flow was observed occurring at two locations in the general area of the downstream channel approximately 300 feet below the dam. It was reported that the springs, each of which was flowing at a rate of about 5 cfs, did not exist prior to construction of the dam and that they are non- perennial. Within the scope of the investigations no procedures prescribed in the guidelines, it is not possible to conclude if the leaching that is presently occurring poses a hazard to the safety of the dam, the vegetation, or which is unknown. The leaching is, however, an impediment to the satisfactory operation of the lake.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Terry Co. Sportsman's Club Lake Dam, which is classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood (PMF). Considering the fact that a fairly large volume of water is impounded; the downstream floodplain is relatively narrow and flow in the stream will be long and with high velocities; and that several dwellings and a county road lie within the possible flood damage zone, it is recommended that the spillway for this dam be designed for the PMF. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic
conditions that are reasonably possible in the reservoir. The FMP is ordinarily accepted as the inflow design flood for the future failure of the structure would increase the danger to human life.

Results of a hydrologic/hydraulic analysis indicated that the existing spillways are inadequate to pass lake outflow resulting from a storm of FMP magnitude. The principal spillway is adequate to pass the lake outflow resulting from the 1 percent chance (100-year frequency) flood. Both spillways, principal plus emergency, are capable of passing lake outflow corresponding to about 12 percent of the FMP lake inflow. According to the St. Louis District, U.S. Corps of Engineers, the extent of the downstream damage zone, should failure of the dam occur, is estimated to be four miles. Accordingly, within the possible damage zone are County Highway 6B, three dwellings, and several associated outbuildings.

A review of available data did not disclose that seepage or stability analyses of this dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the owner take the necessary action within a reasonable period of time to correct or control the deficiencies and safety defects reported herein.

Harold B. Barker, Jr.
P.E. Missouri P-1789

Albert B. Barker, Jr.
P.E. Missouri P-9168
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1.1 GENERAL

4. Authority: The National Dam Inspection Act, Public Law 105-27, dated 8 August 1997, authorized the President of the United States Corps of Engineers to establish a program of national inspection of all dams throughout the United States. Pursuant to this statute, the U.S. Army Corps of Engineers, United States Army, Corps of Engineers, issued this emergency inspection of the Perry O. Stahl Dam and Reservoir.

4. Purpose of Inspection: The purpose of this special inspection of the Perry O. Stahl Dam and Reservoir is to determine the current condition of the dam and reservoir and to make an assessment of the general condition of the entire reservoir and surrounding area in the event of failure. Recommendations for remedial work, if needed, are to be included for the immediate and long-term safety of lives and property.

5. Evaluation Criteria: This evaluation was conducted to comply with the "Phase I" inspection procedures as outlined in the "United States Army Corps of Engineers' Guidelines for Safety Inspection of Dams," April 1, 1989, and the "Chief of Engineers, the National Dam Inspection Program, Proposed Draft," dated May 1993.

1.2 DESCRIPTION OF PROBLEM

4. Description of Dam and Appurtenances: The Perry O. Stahl Dam and Reservoir Club Lake Dam is an earthfill-type embankment dam approximately 14 feet above the original stream bed. The embankment has an upstream slope (above the waterline) of 6:1 on 1, a cross width of about 12 feet, and a.
The spillway consists of two sections. The first section is an emergency spillway located at the outlet of the dam. The emergency spillway is approximately 12 feet wide and 4 feet high, and is constructed of concrete. The second section is a permanent spillway. It is 15 feet wide and 6 feet high, and is constructed of concrete and steel. The spillway directs water into a natural stream that joins the downstream channel, or main tributary of the Whitewater River. The Whitewater River is located approximately 3,200 feet below the dam.

The emergency spillway, a nearly parallel, broad-sloped, earth section is cut into the hillside at the left of the right outlet. The section has a flat bottom of about 12 feet wide and is conformed on the left by the unprotected earth hillside and on the right by a narrow unpaved road. The earth barrier is approximately 2 feet high. Spillway from the outlet are directed away from the dam area, the forest area on the north side and toward the downstream channel.

b. Location. The dam and lake are located on an upper tributary of Whitewater River, approximately 6 miles northeast of Young, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located in Section 14, Township 14 North, Range 6 East, in Perry County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as small. This Table I, Recommended Guidelines for Safety Inspection of Dams.
a. General Description. The reservoir, located on the Osage River, is an earthen embankment dam with a spillway, and is an important recreational area. The dam is located on the Osage River, within the City of Perryville, County Highway 16, three miles north of Perryville, Missouri.

b. Ownership. The land and dam are owned by the Perry County Sportsmen's Club, Incorporated, a Missouri corporation, of which Mr. Albert Hessel is the current president. Mr. Hessel is a resident of 1106 Main, Perryville, Missouri 63775.

c. Purpose of Dam. The dam is used as a holding for recreational use by individuals who are members of the club.

d. Design and Construction History. According to a representative of the Owner, the dam was constructed in 1971 by the Harger Brothers Excavating and Grading Company of Perryville, Missouri. According to both a representative of the Owner and Mr. Norbert Motz, President of Harger Brothers, the dam was constructed without the benefit of formal engineering design data or plans.

According to a representative of the Owner, a second roadway cut-off (it was reported) that a dam and was installed when the dam was constructed in 1971 was installed along the upstream side of the dam in about 1976, and that the dam was done by Lee sinker, a local excavation contractor.

e. Normal Operational Procedure. The lake level is unregulated.
1. GENERAL DATA

- Location: The area tributary to the lake is essentially
  undrained and in a native state covered with timber. The
  watershed above the dam amounts to approximately 451 acres. The
  watershed area is outlined on Plate 2.

2. Discharge at Capacity:
   (1) Estimated known maximum flood at intake ... 75 cfs
   (2) Spillway capacity (principal) ... 2/5 acre @ 6.9 ft. = Elev.
       834.8
   (3) Spillway capacity (principal + emergency) ... 1,377 ac
       (6.9 ft. = Elev. 834.8)

3. Elevation (Ft. above MSL). The following elevations were
   determined by survey and are based on topographic data shown on the 1955
   USGS Parker Lake, Missouri Quadrangle Map, 1:6 Wildlife Series.
   (1) Top of dam ... 896.8 (min.)
   (2) Normal pool spillway crest ... 891.0
   (3) Streambed at centerline of dam ... 876.5
   (4) Maximum tailwater ... Unknown

4. Reservoir:
   (1) Depth at normal pool (Elevation 891.0) ... 1.40 ft.
   (2) Depth at maximum pool (Elevation 876.5) ... 2.0 ft.

5. Storage:
   (1) Normal pool ... 8.5 ac ft.
   (2) Top of dam (permanent) ... 98 ft.

6. Reservoir Surface:
   (1) Normal Pool ... 3 acres
   (2) Top of rim (permanent) ... 89 ft.

*Based on an estimate of depth of flow as observed by a representative of
the Owner.
3. Dam.
   (1) Type ... Earthfill, concrete core.
   (2) Height ... 34 ft.
   (3) Top width ... 12 ft.
   (4) Side slopes:
      a. Upstream ... 1:3 on 3H
      b. Downstream ... 1v on 2H
   (5) Cut-off ... Clay core
   (6) Slope protection
      a. Upstream ... Grass
      b. Downstream ... Grass

4. Principal Spillway.
   (1) Type ... Uncontrolled, trapezoidal, broad-crested earth and rock section
   (2) Crest elevation ... 834.0
   (3) Approach channel ... Lake
   (4) Exit channel ... Earth cut, trapezoidal section

5. Emergency Spillway.
   (1) Type ... Uncontrolled, trapezoidal, broad-crested earth and rock section
   (2) Crest elevation ... 834.4
   (3) Approach channel ... Lake
   (4) Exit channel ... No defined section

6. Lake Drawdown Facility ... None

*Per builder of dam.
2.1 DESIGN

No engineering data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

No formal records were maintained during construction of the dam. According to Mr. Stortz, Secretary of the Club, Dr. Geisler, a club member, and Mr. Geisler, the contractor who built the dam, a core trench 10-to-12 feet wide was excavated along the centerline of the dam to the weathered clay-covered surface of bedrock. It was reported, however, that excavation was terminated at a depth at which a half-inch layer of the trench could no longer include bedrock and was not carried to solid rock throughout. The material used to backfill the trenches and construct the embankment, a stony red clay, was obtained from the area to be occupied by the lake and from a borrow area directly downstream of the north abutment. The contractor recalled that excavation of the fill was obtained using subcontracted equipment.

2.3 OPERATION

The lake level is uncontrolled and is varied by the cross-section of the principal spillway located at the right abutment. In summary, spillway, with a crest elevation approximately 1.3 feet higher than the crest elevation of the principal spillway and about 1.3 feet lower than the top of the dam at its lowest point, is located at the left abutment. A representative of the Owner reported that the dam had never been overtopped and that the highest lake level observed to date produced a depth of flow at the principal spillway estimated to be about 3 feet.
In conclusion, Mr. Williams recommends that at the bottom 2 feet, a layer of earth be used as a procedure in not only sealing but also as a limited chance of success.

2. EVALUATION

a. Availability. Engineering data for reservoir, the location of the dam and spillway were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommendations for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed in
appropriate loading conditions (including earthquake) have been a matter of record.
3.1 FINDINGS

3. General. Visual inspection of the Barrow Granite Club Lake Dam was made by Horner & Suhling Consulting Engineers, B.B.
Hoekett, Civil Engineer and Hydraulics, T.M. Davers, Consulting
Engineer, and A.H. Paffet, Jr., Civil and Soil Engineer, on 4 October
1979. An examination of the safe site and the surface of engineering
geologist, Laury S. Mihm, a consultant retained by Horner & Suhling
for the purpose of advising the area geologist. Also examined at the time
of the inspection was the area below the dam within the potential flood
damage area. Photographs of the area taken at the time of the inspection
are included in Tabs A-1 through A-3 of Appendix B. The locations of
the inspection photographs are indicated on Plate 1.

4. Area Geology. The safe site is located on the eastern flank of
the Oskar Holst or Lower Granite Orlovian and oldest rock. The
Granite formation, exposed at the surface in the area of the safe site,
is composed primarily of a light brown, weathered, medium- to coarse-
dolomite with a few thin, irregular quartz veins. Occasionally,
cellular and cuppy dolomite are a common characteristic of the Granite
Formation.

Intense solution weathering of the area has left a thin, reddish
covering of a very irregular bedrock surface. The surface, a product of
the overlying Rocksholex Formation, composed of a red, clayey clay and
clay having been derived from the Granite. Weathering of sandstone in this
area, tends to be relatively permeable and susceptible to erosion.

The soil material formed by Granite weathering has undergone
experienced some minor erosion. However, it appears stable with no
seepage evident at the toe or from the hillside immediately downstream.
The final abutment is formed by thick Miocene slurry clay located, overlying iron-bedecked chert breccia and dolomite. Bedrock has been exposed in the spillway cut and the abutment adjacent to the spillway. The spillway has been eroded to bedrock and in some places erosion has undercut the hillside slope resulting in small slumps.

No adverse geologic factors which would influence the performance of the dam or reservoir other than the erosion of the spillway channel were noted.

c. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1 and 2) appeared to be in sound condition, although erosion of the unprotected upstream slope had created a vertical face of about 6 to 12 inches high at the normal lake level waterline. Plant cover on the upstream and downstream faces of the dam was approximately 3 feet high at the time of the inspection, whereas the grass cover on the dam crest was about 6 inches high. No cracking of the surface or misalignment of the dam crest was noticed.

Both the right and left abutments through the areas where the spillways are located had virtually no plant cover or other form of protection to prevent erosion.

Seepage was observed emerging from two areas (springs) approximately 1,000 feet downstream of the dam. One of these springs was in line with the right side or abutment of the dam, whereas the other appeared to be more in line with the center of the dam. The spring on the right was characterized by soft ground and standing and running water (see Photo 9) which was estimated to be flowing at a rate of about 2 to 3 gpm. At the spring downstream of the center of the dam, a shallow pool, approximately 1 foot deep and 5 feet in diameter, was observed. Water leaving the pool (see Photo 10) was estimated to be flowing at a rate of about 5 to 8 gpm. Flow from both springs was clear and no sediment deposits were noticed in the stream bed. Mr. Herbert Nelson, a club member who was familiar with the area prior to construction of the dam, stated that
These springs appear shortly after construction of the dam and are perennial.

Judging by the eroded condition of the principal spillway (see Photos 3 and 4), the rock ledges at the spillway crest have been undercut up to several feet and minor sloughing of the right bank (west bank) was evident. It is apparent that this spillway has experienced considerable flow. In addition, erosion of the channel bottom (see Photo 5) below the spillway crest has exposed bedrock ledges which are jagged and uneven. The sides of the channel (see Photos 4 and 6) were unprotected and some erosion of these earthen slopes was noticed. The channel downstream of the junction with the natural draw (see Photo 6) is unimproved and was found to be congested with small trees and dense brush.

The emergency spillway appeared to be in sound condition, although some minor erosion of the unprotected left side and bottom area downstream of the crest (see Photo 7) was observed. The cut-off channel for this spillway is not discernible but it was apparent that fine-leaved vegetation would follow a course through an old narrow area (see Photo 8) that lies downstream of the dam. The banks are sparsely covered with grass and some minor erosion, particularly of the steeper side slopes, was noticed.

1. Downstream Channel. The channel downstream of the dam is unimproved and extends approximately 2,500 feet before joining the Whitewater River. At a distance of about 500 feet from the dam, a concrete low-water bridge crosses the Whitewater River providing access to Thompson Hollow. Three 24-inch corrugated metal pipes are provided at the bridge for service flow.

2. Reservoir. The area adjacent to the lake is for the most part in a natural state and wooded. The lake water surface elevation at the time of the inspection was about 7 feet below normal pool, leaving considerable length of shoreline exposed and without plant cover. The
amount of sediment within the lake could not be determined at the time of the inspection, however it is believed not to be significant.

1.2 EVALUATION

With the exception of the lack of protection to prevent erosion of the principal spillway, the deficiencies observed during the inspection and noted herein, are not considered significant to warrant immediate remedial action.
4.1 PROCEDURES

The spillways are uncontrolled. The water surface level is governed by precipitation runoff, evaporation, seepage, and the capacity of the uncontrolled principal and emergency spillways.

4.2 MAINTENANCE OF DAM

The crest of the dam appeared to have been recently moved or graded, as the crest was only about 3 feet high. The downstream face was grass covered, that was approximately 3 feet high at the time of the inspection. However, it was free of trees and brush. As previously indicated, both spillways have experienced erosion and with the exception of some grass cover on the emergency spillway, are unprotected. The disturbed areas of the hillside on the right abutment were not without plant cover to prevent erosion.

According to a representative of the Owner, about 1976 to an attempt to prevent excessive leakage under the dam, a trench was excavated along the toe of the upstream face of the dam between abutments and filled in with clay. However, it was reported that the excavation was not extended to sound rock throughout, but only to a depth where a deposit consisting in the trench could no longer remove large boulders and loose rock. Results by the inability of the reservoir to maintain a normal level, it appears that this most recent seepage cutoff had little effect in preventing loss of water from the lake. It was also reported that the principal spillway was lowered to rock at this time.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet operating facilities exist at this dam.
4.4 OBSERVATION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam warning system.

4.5 RECOMMENDATION

Considering the efforts made to prevent loss of lake water beneath the dam, it is recognized that members of the club are interested in maintaining the dam as well as promoting a successful operation. To this end, it is recommended that maintenance of the dam and spillways be performed on a regular basis and that records be kept of all maintenance work performed. In any event, it is recommended that the spillways be protected to prevent erosion.


d. **Emergency Use**: The drainage area and the relief area were determined from the U.S.G.S. aerial and Parkes Lake, Nevada, drainage maps. The proportions of direct loss of the spillway and its area developed from surveys made during the inspection.

e. **Additional Features**:

1. The principal spillway consists of a Y-shaped, broad-banked channel and some sections having a slightly curving, approximately 1:1 side slope or at least 1 in 1:50.

2. The principal spillway has been cut into the hillside at the right (north) abutment.

3. A cut approximately 2 feet wide and 4 feet deep in the invert of the principal spillway serves to control flow to the channel and protect the embankment. Spillway velocities required of the channel will not endanger the embankment since flow is conducted only from the dam.

4. A retaining bank extends above and below the crest of the embankment along the right bank of the spillway channel.

5. An emergency spillway, a nearly permeable earth embankment earth section, is cut into the hillside at the left (south) abutment. The section is approximately 10 feet wide and 2 feet deep. The channel is confined on the right by a narrow earth bank and on the left by the unprotected remnant of the hillside face.

6. No hose or shored facilities are provided.

d. Overtopping Potential. The spillways (principal and emergency) are inadequate to meet the probable maximum flood or 1/2 the probable
maximum flood without overtopping the dam. They are adequate, however, to pass the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of a dam overtopping analysis are as follows:

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Elevation 438.1 was found to be the lowest point in the dam crest. The flow safely passing the spillways just prior to overtopping was determined to be approximately 1,077 cfs, which amounts to about 24 percent of the probable maximum flood inflow. This flow is lower than the outflow from the 1 percent chance (100-year frequency) flood. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 2.3 feet and overtopping will extend the entire length of the dam crest.

e. Evaluation. Experience indicates that the reservoir, a red clay, can under certain conditions, such as high velocity flow, be very erodible. Evidence of such erosion was observed at the principal spillway. For the PMF, when large lake outflow with corresponding high velocities occur both at the spillways and over the top of the dam, and since the depth of flow overtopping the dam, (2.3 feet maximum) and the duration of flow over the dam (3.3 hours), are substantial, serious damage by erosion due to overtopping of the dam is likely. The extent of these damages is not predictable, however, there is the possibility that they could result in failure of the dam.
f. References. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow passing the spillways and dam crest are presented on Pages B-1 and B-2 of the Appendix. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood and the 100-year frequency flood are shown on Pages B-3 and B-4 of the Appendix. A copy of the computer output table entitled "Summary of Dam Safety Analysis" is presented on Page B-5 and the inflow and outflow hydrographs for the probable maximum flood are shown on Page B-6 of the Appendix. Rating curves for the spillways are presented on Plate 3 and area-storage curves for the reservoir are shown on Plate 6.
SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No construction data relating to the structural stability of the dam are known to exist.

c. Operation Records. No appurtenant structures or facilities requiring operation exist at this dam. According to a representative of the Owner, no records are kept of the lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. With the exception of construction of a second seepage cutoff along the upstream side of the dam and lowering the spillway crest to rock, both of which were undertaken in about 1972, it was reported that no additional post construction changes have been made or have occurred which would affect the structural stability of the dam.

e. Seismic Stability. The dam is located within a Zone II seismic probability area, and an earthquake of the magnitude predicted for this area is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.
7.1 DAM ASSESSMENT

a. **Safety.** A hydraulic analysis indicated that the spillways (principal plus emergency) are capable of passing lake outflow of about 1,077 cfs without the level of the lake exceeding the high point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicated that for storm runoff of probable maximum flood magnitude, the lake outflow would be of the order of 7,002 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 170 cfs.

Items noticed during the inspection that could adversely affect the safety of the dam include lack of adequate erosion protection at the spillways and along the upstream face of the dam.

Within the scope of this investigation it is not possible to conclude if the leakage that the reservoir is experiencing poses a hazard to the safety of the dam. There is a possibility that loss of water from the lake can lead to a piping condition (erosive erosion and liquefaction) if the location of the leak or leaks is through the dam structure. Since there is evidence, two springs believed to be charged by the lake are observed downstream of the dam, that an aquifer exists in the immediate area of the dam, the possibility of a piping condition cannot be discounted.

Seepage and stability analyses of the dam were not available for review and therefore no judgment could be made with respect to the structural stability of the dam.

b. **Adequacy of Information.** Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessment of the
hydrology of the watershed and capacities of the spillways were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of the Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

d. Urgency. The items concerning the safety of the dam noted in Paragraph 7.1a and the remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic probability area, and an earthquake of the magnitude predicted for this area is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

1. Based upon criteria set forth in the recommended guidelines, alterations to the design of the dam should be made in order to pass lake outflow resulting from a storm of probable maximum flood magnitude.

2. Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of dams.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

7-2
(1) Provide some means of preventing excessive seepage from the reservoir in order that the lake may be operated as intended. In this respect, it is important that seepage (excepted at the dam be controlled in order to prevent piping (progressive internal erosion) which could result in failure of the dam.

(2) Restore the eroded areas of the spillway channel and provide some form of protection particularly along the dam side of the outlet channel in order to prevent future erosion by spillway flows.

(3) Provide some form of slope protection other than grass for the upstream face of the dam at and above the normal waterline in order to prevent erosion. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by a fluctuating lake level.

(4) Maintain the plant cover on the dam at a height that will not conceal animal burrows or hinder inspection of the dam. Holes created by burrowing animals can provide pathways for lake seepage that can lead to piping and possibly failure of the dam.

(5) Provide maintenance of all areas of the dam and spillways on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(6) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.
NOTE.

EMERGENCY SPILLWAY

GE 850 A-M W - LOW POINT U-W EL. 838.8

S 840 - SPILLWAY CREST E EL. 838.8

PROF. SCA

PHOTO LOCATION & KEY (SEE APPENDIX A)
NOTE: LOCATIONS OF PHOTOS 9 & 10 (NOT SHOWN) APPROX. 1,000' DOWNSTREAM OF DAM.

GENERAL PLAN OF DAM
SCALE: 1"=50'

PROFILE DAM CREST
SCALES: 1"=10'V, 1"=50'H.
DAM CROSS SECTION STA 3+30

Scales: 1" = 10' V, 1' = 20' H

NORMAL POOL
EL. 834.0

PROFILE SPILLWAY

Scales: 1" = 10' V, 1' = 20' H.
LOCATION: NE ¼ SW ¼ NW ¼ sec. 14, T. 34 N., R. 8 E., (Parker Lake).

SUITABILITY: Poor from the geologic aspect of water retention.

GEOLOGIC SETTING:

Bedrock exposed in the valley on the south side consists of the Cascadita dolomite. For the most part, however, the region is underlain by the residuum of the overlying formation, the Nubidoux. This residuum, predominantly a silt-gravel mixture makes up most of the watershed and reservoir area. Weathering of both the Nubidoux and Cascadita has produced a valley that is filled with gravelly silt. Soils on the hillslopes are made up of silty clay, again mixed with an abundance of stones. Typically, the silty gravel in the flood plain is moderately to highly permeable as evidenced by the poorly defined stream channel. Sustained stream flow is inadequate to erode and maintain a clean and well defined stream channel. Absence of terraces on the valley floor further notes that the stream is active only when intense storms occur. Lack of sustained flow is evidenced also by the absence of fine textured soils, lack of segregation of these soils into lenses of silts, sands and clays and subsidence of soil accumulated at the hillislope-floodplain contact.

RECOMMENDATIONS:

It is most important that no sealant procedures be undertaken without a thorough foundation investigation of the dam and lake as it exists at present. However, even after thorough investigation and controlled remedial procedures followed, in attempts to seal the lake, the opportunity for maintaining a permanent pool level is perhaps no greater than 50 percent.

First step recommended is to explore the characteristics of the foundation, at least to depths of 20 feet. This can best be done with a backhoe or backhoe and dozer combination. It is of importance to note both if there are clay lenses present in the gravels and if so the persistence of these lenses. If the material that is present in the lower valley floor even at depths, is poorly sorted and predominantly a mixture of boulders, gravels and sands with little fine textured soils, that is clay, then the possibility of sealing the lake would be remote.

It is hoped that seepage is passing under the dam and that the backhoe exploration will confirm this hope. If this is the characteristic of the site then a deep core trench could be constructed at the upstream toe of the dam. This trench backfilled with clay would intercept seepage under the dam and retain water in the lake. However, if backhoe trenches reveal permeable gravel deposits at depths of 20 foot or more, the opportunity to successfully construct an intercepting core to retard seepage is nil. It is also suggested that several exploration pits be located with the reservoir butt. The intent of this would be to reveal the characteristics of the subsoil, that is stream alluvial deposits, within the reservoir region to ascertain if leakage is occurring vertically throughout the lake area.
Again it would be important to examine the characteristics of the subsoil or allu-
viial deposits to note if there are fine textured materials present and how these
deposits were formed. If possible, these holes could be partially filled with
water to determine the rate of seepage from the exploration pits.

If conclusions are that the leakage is occurring throughout the reservoir,
the only possible way of sealing the lake is to pad the floor of the lake. This
of course requires borrowing the padding material from areas adjacent to the lake
and spreading a dirt pad of 2 feet or more in thickness across the entire lake
floor. Such remedial procedures have limited chance of success and are costly.
However, sealing of the reservoir floor by degrees could be considered, that is,
a dirt pad placed for a short distance upstream of the dam, the extent of padding
being more regulated by the amount of funds available rather than by any geologic
criteria. Observation as to the success of this pad could be made for perhaps
a year or more. If padding is successful and more funds become available, addi-
tional padding further upstream could then be considered. Over a period of years
a lake at least partially successful could perhaps be obtained with using this
procedure.

James R. Williams
Geologist and Chief
Engineering Geology Section
Missouri Geological Survey
August 11, 1971
APPENDIX A

INSPECTION PHOTOGRAPHS
NO. 1: UPSTREAM FACE OF DAM

NO. 2: DOWNSTREAM FACE OF DAM
NO. 5: ROCK LEDGES IN SPILLWAY CHANNEL

NO. 6: JUNCTION OF SPILLWAY CHANNEL AND DRAW
NO. 7: CREST OF EMERGENCY SPILLWAY (LOOKING UPSTREAM)

NO. 8: BORROW AREA DOWNSTREAM OF DAM
NO. 9: SEEPAGE FLOW FROM SPRING BELOW RIGHT SIDE OF DAM

NO. 10: SEEPAGE FLOW FROM SPRING BELOW CENTER OF DAM
APPENDIX B

HIDROLOGIC AND HYDRAULIC ANALYSIS
HYDRAULIC AND HYDRAULIC COMPUTATION

1. The HEC-1 Dam Safety Version (July 1979, Modified 26 February 1979) program was used to develop inflow and outflow hydraulic and stability overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (296 sq. mile, historic area = 17.5 inches, from Hydro meteorological Report No. 11. The precipitation data used in the analysis of the 1 percent (100-year frequency) flood are provided by the St. Louis District, Corp of Engineers.

b. Drainage area = 0.72 square mile = 461 acres.

c. SCS parameters:

   Lag time = 0.18 hours
   Soil Group C = 100 percent
   Soil type CN = 88 (ARC III, SWAT condition)
   = 75 (ARC II, 100-yr. condition)
   Lag Time = 2.6 Tc (SCS Method)
   Time of Concentration (Tc) = \( \left( \frac{11.91}{H} \right) \) Tc

   Where:
   \( T_c \) = Travel time of water from hydraulically most distant point to point of interest, hours
   \( L \) = Length of lowest water course, miles
   \( H \) = Elevation difference, feet.

2. The principal and emergency spillway sections consist respectively of broad-crested, trapezoidal and dish-shaped sections for which conventional weir formulas do not apply.
a. Spillway crest elevation was determined and the critical depths were computed for various depths, z.

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth was computed as
\[ d_c = \left( \frac{8}{g} \right)^{1/3} \left( \frac{Q}{R} \right) \]
for the various depths. Corresponding velocities \( v_c \) and velocity heads \( h_{vc} \) were determined using conventional formulas.

c. Static lake levels corresponding to the various values computed over the spillway were computed as critical depths plus critical velocity head \( h_c = h_{vc} \), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

d. The discharges for the principal and emergency spillways for equal elevations were summed for entry on the Y4 and Y5 cards.

e. The profile of the dam crest between the principal spillway and emergency spillway is irregular and flow over the dam crest cannot be determined by conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the WREL program on the $4$ and the $9V$ cards. The program computes internally the flow over the dam crest and adds this flow to the flow over the principal and emergency spillway as entered on the Y4 and Y5 cards.
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ANALYSIS OF DAM OVERTOPPING USING RATIOS OF WPW HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF PERRY CO SPORTSMAN CLUB LAKE DAM
### SUMMARY OF DAM SAFETY ANALYSIS

#### RATIOS OF PHF

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### SUMMARY OF DAM SAFETY ANALYSIS

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