PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW CAMBRIA LAKE DAM
MACON COUNTY, MISSOURI
MO. 10387

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

UNITED STATES ARMY
CORPS OF ENGINEERS

ST. LOUIS DISTRICT

DEC. 1979
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# Phase I Dam Inspection Report

## National Dam Safety Program

New Cambria Lake Dam (MO 10387)

Macon County, Missouri

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**Performer:**

Consoer, Townsend and Associates, Ltd.

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**Performing Organization Name and Address:**

U.S. Army Engineer District, St. Louis

Dam Inventory and Inspection Section, LMSED-PD

210 Tucker Blvd., North, St. Louis, Mo. 63101

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**Monitoring Agency Name and Address:**

U.S. Army Engineer District, St. Louis

Dam Inventory and Inspection Section, LMSED-PD

210 Tucker Blvd., North, St. Louis, Mo. 63101

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**Abstract:**

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.
SUBJECT: New Cambria Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the New Cambria Lake Dam (Mo. 10387).

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

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

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: Chief, Engineering Division

APPROVED BY: Colonel, CE, District Engineer

SIGNED

24 MAR 1980

Date

Assessment For
MTIS GRAAL
DTIC TAB
Unannounced
Justification

By Distribution/
Availability Codes
Avail and/or
Dist Special

A 23
NEW CAMBRIA LAKE DAM
MACON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10387

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

DECEMBER 1979
Assessment of General Condition

New Cambria Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and State agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends approximately three and one-half miles downstream of the dam. Within the damage zone are eight dwellings, three buildings, one quarry and two crossings of U.S. Highway 36, which may be subjected to flood-
ing, with possible damage and/or destruction, and possible loss of life. New Cambria Lake Dam is in the small size classification since it is less than 40 feet high and impound less than 1,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of New Cambria Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. New Cambria Lake Dam being a small size dam with a high hazard potential, is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Considering the volume of water impounded, the relatively narrow valley, the large number of dwellings and the two crossings of a major highway downstream of the dam, the Probable Maximum Flood is considered the appropriate spillway design flood. It was determined that the reservoir/spillway system can accommodate 30 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation also indicates that the reservoir/spillway system can accommodate the 100-year flood without overtopping.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. The 100-year flood is defined as a flood having a one percent chance of being equalled or exceeded during any given year.

Other deficiencies noted by the inspection team were: a large tree growing on the upstream slope; the heavy vegetative growth on both the upstream and downstream embankment slopes; the undermining of the downstream end of the spillway chute; lack of trashrack on the spillway; heavy growth of trees and vegetation on the downstream channel; minor wave erosion on the upstream embankment slope; rodent activities on the embankment; a need for per-
iodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.
# PHASE I INSPECTION REPORT
## NATIONAL DAM SAFETY PROGRAM

**NEW CAMBRIA LAKE DAM, I.D. No. 10387**

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PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  

NEW CAMBRIA LAKE DAM, Missouri Inv. No. 10387

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for New Cambria Lake Dam was carried out under Contract DACW 43-79-C-0075 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of New Cambria Lake Dam was made on August 23, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.
c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an assessment of hydrologic and hydraulic conditions at the site; presents an assessment as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing, and detailed analyses were not within the scope of this study. The conclusions drawn herein, therefore, are based on the presence of, or absence of, obvious signs of distress. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the east abutment or side, and right to the west abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in the publication "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.
1.2 **Description of the Project**

a. **Description of Dam and Appurtenances**

It should be noted that design drawings were not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam is an earthfill structure between earth abutments. The crest width is 18 feet and the crest length is 412 feet. The crest elevation is 743.6 feet above M.S.L. Embankment slopes were measured as 1V to 3H. The upstream slope was measured from the reservoir water surface to the crest. The maximum height of the embankment is 21 feet.

The spillway for the New Cambria Lake Dam is a cut into the right abutment. The spillway is a concrete lined, uncontrolled open chute with vertical rock masonry side walls. The bottom width of the control section is 12.75 feet. The total length of the spillway chute is approximately 141 feet.

A regulated outlet pipe is provided for the dam. The outlet pipe is used as a water supply line. The water supply system consists of a centrifugal pump located on the crest of the dam 200 feet to the right of the left abutment. The intake to the pump is a 2-inch C.I.P. and the discharge line is a 2.5-inch C.I.P. The discharge line goes to a small water treatment plant located on the left abutment. The pump is housed in a concrete block pit.

No low level drain was provided for the dam.
b. Location

The New Cambria Lake Dam is located on an unnamed tributary to the Old Channel in Macon County, Missouri. The community of New Cambria is approximately one mile to the west of the dam. The dam and lake are located in Section 7, Township 57 North, Range 16 West on the Elmser Quadrangle Sheet (15 minute series).

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam size category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends approximately 3.5 miles downstream of the dam. Within the damage zone are eight dwellings, three buildings, one quarry and two crossings of U.S. Highway 36.
e. Ownership

The New Cambria Lake Dam is owned by the City of New Cambria. The mailing address is New Cambria City Hall, c/o Morris Avelin, Water Superintendent, New Cambria, Missouri, 63558.

f. Purpose of Dam

The main purpose of the dam is to impound water for domestic water supply and recreational use.

g. Design and Construction History

New Cambria Lake Dam was designed and built as a W.P.A. project with a completion date of 1936. The Contractor is listed as the Federal Government and, according to Mr. Dave Hoffman, Dept. of Natural Resources, Rolls, Missouri, and Mrs. Morris Avelyn, wife of Water Superintendent, New Cambria, Missouri, the dam was most likely built by local residents. It is not known who the original design engineer was.

h. Normal Operational Procedures

Normal procedure is to allow the reservoir to remain as full as possible. New Cambria Lake is used primarily for water supply and also for recreational purposes for the residents of New Cambria, Missouri. The water level below the spillway crest is controlled by rainfall, runoff and evaporation.
1.3 Pertinent Data

a. Drainage Area (square miles):
   0.18

b. Discharge at Damsite
   Estimated experienced maximum flood (cfs): NA
   Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs):
   229

c. Elevation (feet above MSL)
   Top of dam: 743.6
   Spillway crest: 740.0 (assumed)
   Normal Pool: 740.0
   Maximum Pool (PMF): 744.62

d. Reservoir
   Length of pool with water surface at top of dam elevation (feet):
   1,500

e. Storage (Acre-Feet)
   Top of dam: 70
   Spillway crest: 40
   Normal Pool: 40
   Maximum Pool (PMF): 90

f. Reservoir Surface (Acres)
   Top of dam: 10
   Spillway crest: 7
   Normal Pool: 7
   Maximum Pool (PMF): 11.5

g. Dam
   Type: Earthfill
   Length: 412 feet
   Structural Height: 21 feet
<table>
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<th>Feature</th>
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<tr>
<td>Hydraulic Height:</td>
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<tr>
<td>Top width:</td>
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</tr>
<tr>
<td>Side slopes:</td>
<td></td>
</tr>
<tr>
<td>Downstream</td>
<td>1V to 3H</td>
</tr>
<tr>
<td>Upstream</td>
<td>1V to 3H (crest to water surface)</td>
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<tr>
<td>Zoning:</td>
<td>Unknown</td>
</tr>
<tr>
<td>Impervious core:</td>
<td>Unknown</td>
</tr>
<tr>
<td>Cutoff:</td>
<td>Unknown</td>
</tr>
<tr>
<td>Grout curtain:</td>
<td>Unknown</td>
</tr>
<tr>
<td>h. Diversion and Regulating Tunnel</td>
<td>None</td>
</tr>
<tr>
<td>i. Spillway</td>
<td></td>
</tr>
<tr>
<td>Type:</td>
<td>Concrete lined chute, uncontrolled</td>
</tr>
<tr>
<td>Length of weir:</td>
<td>12.75 feet</td>
</tr>
<tr>
<td>Crest Elevation (feet above MSL):</td>
<td>740.0 (assumed)</td>
</tr>
<tr>
<td>j. Regulating Outlets</td>
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</tr>
<tr>
<td>Type:</td>
<td>Water supply system</td>
</tr>
<tr>
<td>Length:</td>
<td>Unknown</td>
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<tr>
<td>Closure:</td>
<td>Centrifugal Pump</td>
</tr>
<tr>
<td>Maximum Capacity:</td>
<td>Unknown</td>
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</table>
SECTION 2: ENGINEERING DATA

2.1 Design
Design drawings are not available for the dam and appurtenant structures.

2.2 Construction
No records or construction data are available for New Cambria Lake Dam.

2.3 Operation
No operational data are available for the lake and dam.

2.4 Evaluation

a. Availability
No design drawings, design computations, construction data, or operation data are available.

In addition, no pertinent data was available for review of hydrology, spillway capacity, flood routing through the reservoir, slope stability, seepage analysis, or foundation conditions.

b. Adequacy
The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluation design, operation and construction data,
but is based primarily on visual inspection, past performance history, and sound engineering judgment.

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. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record.

c. Validity

No valid engineering data are available.
SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the New Cambria Lake Dam was made on August 23, 1979. The dam generally is in poor condition. The following persons were present during the inspection:

<table>
<thead>
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<th>Name</th>
<th>Affiliation</th>
<th>Disciplines</th>
</tr>
</thead>
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<tr>
<td>Dr. M.A. Samad</td>
<td>Engineering Consultants, Inc.</td>
<td>Project Engineer, Hydraulics and Hydrology</td>
</tr>
<tr>
<td>Mark R. Haynes</td>
<td>Engineering Consultants, Inc.</td>
<td>Civil, Structural and Mechanical</td>
</tr>
<tr>
<td>Dawn L. Jacoby</td>
<td>Engineering Consultants, Inc.</td>
<td>Soils</td>
</tr>
<tr>
<td>Peter L. Strauss</td>
<td>Engineering Consultants, Inc.</td>
<td>Geology</td>
</tr>
<tr>
<td>Kevin Blume</td>
<td>Consoer, Townsend &amp; Assoc., Ltd.</td>
<td>Civil and Structural</td>
</tr>
</tbody>
</table>
Specific observations are discussed below.

b. Dam

The crest of the dam is protected against surface erosion by a cover of grass. The area adjacent to the spillway is covered by asphalt paving. One crack was observed on the dam crest near the left abutment. No significant deviations in horizontal or vertical alignment were apparent. A slight depression on the downstream side of the crest near the spillway appeared to be caused by vehicular traffic. There was no evidence of the dam ever being overtopped. Material taken from below the topsoil is a silty clay.

The upstream slope had riprap placed to approximately two feet above the water surface on the day of the inspection. The riprap is flat, slabby sandstone. In many areas, the sandstone has been broken down significantly so that protection from wave action is no longer provided. Minor erosion was observed in these areas. The upper section of the slope is covered with grass and bushes. One large tree was growing on the slope. No depressions or settlement were apparent on the slope. No cracks were observed. There was evidence of rodent activity on the embankment.

The downstream slope is overgrown by tall, dense vegetation. No bulges or depressions were apparent. The slope appeared to have been burned off at one time. One large tree stump was observed at the toe. A large pile of rubble and trash is located near the crest. Areas of seepage could not be readily identified since the surface was moist from a rainfall the previous evening. No flowing seepage was observed.
c. Project Geology and Soils

According to the "Missouri General Soil Map and Soil Association Description," published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Weller-Keswick-Lindley-Mandeville in the Central Mississippi Valley Wooded Slopes forest. The soils basically are formed from loess, glacial till and weathered shale. The permeability of these soils range from slow to moderate. The Lindley soils generally are quite erodible and would be particularly susceptible to erosion due to overtopping.

The left abutment slopes gently upward from the crest. An erosion channel approximately 3 inches wide was observed along the access road along the left abutment contact area. The right abutment slopes upward from the crest at approximately IV to IH. No signs of instability were apparent.

The damsite is physiographically located in the Dissected Till Plains Section of the Central Lowlands Physiographic Province, according to Nevin Fennerman's "Physiography of the Eastern United States." This section is distinguished from the Young Drift section on the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain, submature to mature in its erosion cycle.

No faults have been identified in the vicinity of the dam.

Some minor folding has been identified in Macon County. The dam site lies about three miles to the southwest of the trace of the Macon-Sullivan Trough and about six miles to the northeast of the College Mound-Bucklin Anticline. The
Macon-Sullivan Trough had its last movement in post-Ordovician and the College Mount Bucklin Anticline had its last movement in late or post-Pennsylvanian. These minor structures have no effect on the dam.

The site bedrock geology, beneath the drift, as shown on the Geologic Map of Missouri, (1979) is interbedded Pennsylvanian age shales, limestones, and sandstones. These strata generally strike north-south and dip gently to the west.

No bedrock was seen at or in the vicinity of the dam site. The entire area is mantled by glacial drift.

d. Appurtenant Structures

(1) Spillway

The overall condition of the spillway chute appeared to be good. Minor spalling and minor temperature cracks were observed in the concrete lining of the spillway. The rock masonry side walls of the spillway appeared to be stable. The downstream end of the chute is starting to be undermined by discharges through the spillway. No trashrack for the spillway was provided, however, remnants of one was observed. The spillway was not obstructed. No instability was observed in the spillway.

Two pieces of a concrete slab were observed upstream of the spillway. They appear to have been the original weir section for the spillway.
(2) Outlet Works

The intake to the water supply line was inaccessible on the day of the inspection. The pump on the crest of the dam is operable. It is assumed that the entire water supply system is operable.

e. Reservoir Area

The water surface elevation was approximately 738.7 feet above M.S.L. on the day of the inspection.

The reservoir rim is gently sloped. No indication of instability or severe erosion was observed. The slopes above the reservoir are heavily grassed and wooded. No buildings or dwellings were observed around the reservoir rim. A pumphouse and water treatment plant are located on the left abutment.

f. Downstream Channel

The downstream channel is well defined and 25-feet wide and 3-feet deep for approximately 150 feet from the downstream end of the discharge channel to a concrete box culvert which passes under U.S. Highway 36. The channel is straight in alignment between the two points. The channel is obstructed by a heavy growth of vegetation and trees. The box culvert under U.S. Highway 36 is 6 feet wide and 5 feet high.

3.2 Evaluation

The visual inspection did not reveal any items which are sufficiently significant to indicate a need for immediate remedial action.
The following conditions were observed which could affect the safety of the dam or which will require maintenance within a reasonable period of time.

1. The tree and heavy vegetation growth observed on the upstream and downstream slopes should be removed from the slopes and an adequate protective grass cover retained on the slopes. The roots of the trees present possible paths for piping through the embankment. The root systems can also do damage from being uprooted by a storm. Therefore, the trees should be removed from the embankment under the guidance of an engineer experienced in the design and construction of earthen dams.

2. The existence of burrowing animals on the embankment could jeopardize the safety of the dam. The holes created by the animals make avenues for possible piping. The extent of damage to the embankment done by the burrowing animals should be determined and corrective measures undertaken as required.

3. No trashrack is provided for the spillway. A trashrack should be provided for and maintained for the spillway in order to prevent blockage of the spillway by debris.
SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

New Cambria Lake Dam is used for water supply purposes. A small pump pit is situated at the mid section of the dam. The pump is operated periodically to fill the storage tanks at the treatment plant located near the left abutment of the dam.

4.2 Maintenance of Dam

The dam and appurtenant structures are maintained by the water superintendent, Mr. Morris Avelin, and city maintenance crews. There is an abundance of vegetation covering the upstream and downstream slopes of the dam. The crest is mowed periodically.

There is at this time, no trash rack for the spillway and some areas of spalling and cracking in the spillway slab were observed.

4.3 Maintenance of Operating Facilities

As mentioned in Section 4.2, the operating facilities at the damsite are maintained by the Water Superintendent, Morris Avelin and city maintenance crews. The pump pit which is situated at the mid section of the dam is in poor condition. Electrical connections to the pump motor are exposed and there is an inch or so of standing water in the pit. It appears that the water supply facilities located adjacent to the dam receive moderate attention.
4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in effect.

4.5 Evaluation

The crest of the dam is apparently the only area on the dam maintained. The vegetation growing on both the upstream and downstream slopes should be controlled. These, and other items listed in Section 7.2 should be corrected within a reasonable period of time.
SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The watershed area of New Cambria Lake Dam upstream from the dam axis consists of approximately 117 acres. Most of the watershed area is wooded and covered with grass. Land gradients in the watershed average roughly 14 percent. New Cambria Lake Dam is located on an intermittent stream which joins Old Channel, a tributary of the Chariton River. The reservoir is about one mile upstream from the confluence of the intermittent stream and Old Channel. At its longest arm the watershed is approximately 1/2 mile long. A drainage map showing the watershed area is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of New Cambria Lake Dam was based on criteria set forth in the Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams", and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The parameters of
The unit hydrograph are presented in Appendix B. The SCS method was used for determining the loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are also presented in Appendix B. The curve number, the unit hydrograph parameters, and the PMP rainfall were directly input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak discharges of the PMF and one-half of the PMF at New Cambria Lake Dam were routed through New Cambria Lake Dam reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. The peak discharges for the PMF and one-half of the PMF at New Cambria Lake Dam are 2,403 cfs and 1,201 cfs respectively.

Both the PMF and one-half of the PMF inflow hydrographs at New Cambria Lake Dam were routed through New Cambria Lake Dam reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF at New Cambria Lake Dam are 1,961 and 785 cfs, respectively. Both the PMF and one-half of the PMF when routed through the reservoir resulted in overtopping of New Cambria Lake Dam.

The size of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were determined from field notes, and sketches, prepared during the field inspection. The reservoir stage-capacity data were based on the U.S.G.S. Elmer Quadrangle topographic map (15 minute series). The spillway and dam overtop rating curve and the reservoir capacity curve for New Cambria Lake Dam are presented as Plates 2 and 3 in Appendix B.
From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erosive characteristics. The safe hydrologic design of an embankment dam requires a spillway discharge capability in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers design dams to safely pass the Probable Maximum Flood that is estimated could be generated from the dam's watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping.

b. Experience Data

It is believed that no records of reservoir stage or spillway discharge are maintained for this site.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1c(1) and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and one-half of the PMF at New Cambria Lake Dam are 1,961 cfs and 785 cfs, respectively. The PMF overtopped the dam crest by 1.02 feet.
and one-half of the PMF overtopped the dam crest by 0.50 feet. The total duration of embankment overflow is 4.67 hours during the PMF and 1.17 hours during one-half of the PMF. The spillway and the reservoir of New Cambria Lake Dam are capable of accommodating a flood equal to approximately 30 percent of the PMF before overtopping the dam. The reservoir/spillway system of New Cambria Lake Dam will accommodate the 100-year flood without overtopping.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately 3.5 miles downstream of the dam. Within the damage zone are eight dwellings, three buildings, one quarry and two crossings of U.S. Highway 36.
SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no signs of significant settlement or distress observed on the embankment or foundation during the visual inspection. The upstream slope of the embankment is exhibiting minor erosion due to wave action. This condition does not appear serious at this time, but it should be monitored and the slope stabilized as required. The embankment appears to be adequately protected against surface erosion. There were no indications of past or present slope instability. One shrinkage crack was observed on the dam crest near the left abutment. However, no tension crack was apparent. In the absence of seepage and stability analyses, no quantitative evaluation of structural stability of the dam can be made.

There were no signs of structural instability in the spillway chute.

b. Design and Construction Data

No design computations were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of
embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of the inspection was 1 foot 4 inches below the crest of the spillway, and it is assumed that the reservoir remains close to full at all times.

d. Post Construction Changes

No post construction changes are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1, as defined in "Recommended Guidelines For Safety Inspection of Dams" as prepared by the Corps of Engineers, and therefore, does not require a seismic stability analysis.
SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed 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.

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.

It is also 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 assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of New Cambria Lake Dam was found to be "Seriously Inadequate". The spillway/reservoir system will accommodate only 30 percent of the PMF without overtopping the dam. The surface soils on the dam is a silty clay. The dam is overtopped over one foot during the PMF and the duration of embankment overflow is over 4-1/2 hours. If the material in the dam is on the clayey side (CL or CH), the dam would be less susceptible to erosion and failure during overtopping than if it is on the silty side (ML).
No quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. 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. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record. The present embankment and appurtenant structures, however, appeared to have performed adequately since their construction without failure. No evidence of the dam ever being overtopped was observed.

The undermining of the downstream end of the spillway chute does not pose a danger to the safety of the spillway in its present condition. Nevertheless, remedial measures should be undertaken within a reasonable period of time.

The downstream channel is obstructed by trees and vegetation. The obstruction should be removed and the channel kept free of trees and debris.

b. Adequacy of Information

Pertinent information relating to the design of the dam and appurtenant structures is completely lacking. The conclusions presented in this report are based on field measurement, past performance and present condition of the dam. No information on the design hydrology, hydraulic design, and the operation and maintenance of the dam were available for review. 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.
c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time. The items recommended in Paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

Spillway capacity and/or height of dam should be increased to accommodate the PMF without overtopping the dam.

b. O & M Procedures

1. Remove the tree on the upstream slope and the heavy vegetative growth observed on both the upstream and downstream slopes and retain an adequate grass cover. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earthen dams.

2. Repair the undermining of the spillway chute and protect it from further damage.

3. Provide a trashrack for the spillway.
4. Remove the obstruction in the downstream channel.

5. Determine the extent of damage done to the embankment by burrowing animals, if any, and make corrective repairs as required.

6. Monitor the erosion of the upstream slope due to wave action and make repairs as necessary.

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.
LOCATION OF DAM

KEY MAP

SHOWING LOCATION OF COUNTY

MACON COUNTY

SCALE

LOCATION MAP - NEW CAMBRIA LAKE DAM
PENNSYLVANIAN

\begin{array}{l}
\text{Pm} - \text{MARMATON GROUP} \\
\text{Pcc} - \text{CHEROKEE GROUP,} \\
\text{CABANISS SUBGROUP}
\end{array}

X - LOCATION OF DAM, MO. 10387

REFERENCE:
GEOLOGIC MAP OF MISSOURI
MISSOURI GEOLOGIC SURVEY
1979

GEOLOGIC MAP
OF
MACON COUNTY
AND
ADJACENT AREA
SEISMIC ZONE MAP OF CONTIGUOUS STATES

SEISMIC PROBABILITY COEFFICIENT

ZONE DAMAGE COEFF.
0 0
1 0.05
2 0.1
3 0.2
4 0.5

Approximate Location of New Cambria Lake Dam

From TM S-809-10, NAVFAC P-355, AFM 88-3, Chapter 13; April 1973
APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION
OVERVIEW

PHOTO INDEX
FOR
NEW CAMBRIA LAKE DAM
New Cambria Lake Dam

Photo 1. - View of the downstream slope of the embankment.

Photo 2. - View of the crest. Note the location of the concrete block pit for the pump.

Photo 3. - View of the upstream slope of the embankment.

Photo 4. - Closeup view of the riprap on the upstream slope.

Photo 5. - View of a crack on the crest near the left abutment.

Photo 6. - View of the spillway looking downstream.

Photo 7. - View of the discharge channel looking downstream. Note concrete box culvert in background.

Photo 8. - View of the discharge channel from the downstream end.

Photo 9. - View of the pump located on the crest of the dam.

Photo 10. - View of the reservoir rim.
New Cambria Lake Dam

Photo 1

Photo 2
New Cambria Lake Dam

Photo 3

Photo 4
New Cambria Lake Dam

Photo 5

Photo 6
New Cambria Lake Dam

Photo 7

Photo 8
New Cambria Lake Dam

Photo 9

Photo 10
APPENDIX B

HYDROLOGIC COMPUTATIONS
NEW CAMBRIA LAKE DAM (MO. 10387)
SPILLWAY & OVERTOP RATING CURVE
<table>
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<th>ELEV. M.S.L. (FT)</th>
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NEW CAMBRIA LAKE DAM (NO. 10387)
RESERVOIR CAPACITY CURVE
### Dam Safety Inspection

**Sheet No. 1 of 1**

**Missouri Dam 14227**

**Job No. 1231-02**

**Proposed Maximum Recipitation**

**By** (Sign) **Date** 9-17-2?

---

**1) Determination of Drainage Area**

- **A.A. = 1.7 Ac. (0.71 Sq. Mi.)**

**2) Determination of Inundation Area**

- **Rainfall: 5/24/72**
  - **Location of Survey of Basin**
    - **Long 92° 43' 56"**
    - **Lat 39° 46' 2"**
  - **Rainfall 0.24"**

**3) Determine Basin Rainfall in Terms of Percentage of Pop Index Rainfall For Various Durations:**

- **Location Long 92° 43' 56"**
  - **Lat 39° 46' 2"**
  - **Zone 2A**

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<th>Total Rainfall (in)</th>
<th>Rainfall Duration (in-hrs)</th>
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**ECI-4 ENGINEERING CONSULTANTS, INC.**
1) Drainage Area = 117 Acres = 0.18 Square Mils.

2) Length of Stream = (2.4 x $\frac{3440}{25}$) = 2087.12 = 3.24 Mils.

3) Elevation at Drainage Divide Along the Longest Stream
   $H_1 = 8.50'$

4) Reservoir Elevation at Spillway Crest, $H_2 = 7.10'$

5) Difference in Elevation, $AH = 8.50 - 7.10 = 1.4'$

6) Average Slope of Stream = $\frac{AH}{H_2} = \frac{1.4}{8.50} = 0.165$

7) Time of Concentration:
   a) By Mirkovich Formula:
      $T_c = \left( \frac{H_1 + 3 \times 1.3}{0.705} \right) = \left( \frac{117 + 3 \times 3.3}{11} \right) 0.705$
      $T_c = 0.14$ hrs.
   b) By Velocity Estimate:
      Average slope = 0.33
         $\frac{H_2}{V} = \frac{2087.12}{4800} = 0.43$
      Use $T_c = 0.14$ hrs.

8) Lag Time = $0.6 \times T_c = 0.6 \times 0.14 = 0.084$ hrs.

9) Unit Duration
   $O \pm \frac{H_2}{3} = \frac{0.029}{3} = 0.029$ hrs.
      Use $O = 0.083$ hrs = 5 min.

10) Time to Peak, $T_p = \left( \frac{2H_2}{3} \right) = \frac{0.029}{3} = 0.016$ hrs.

11) Peak Discharge, $Q_p = 284.1 = \frac{487 \times 0.8}{0.12}$
    $Q_p = 691$. CFS
NEW CAMBRIA LAKE DAM

HYDROLOGIC SOIL GROUP AND CURVE NUMBER

1. WATERSHED SOILS CONSIST PRIMARILY OF
   GROUP C AND GROUP D SOILS, WITH
   GROUP C BEING PREDOMINANT. ASSUME
   GROUP C FOR THE ENTIRE WATERSHED.

2. THIS WATERSHED IS PRIMARILY FLOODED.
   ASSUME THE HYDROLOGIC CONDITION OF THIS
   WATERSHED IS "FLOOD".

   THUS CN = 73 (WOODS) FOR GROUP
   SOILS WITH AMC III

   ⇒ CN = 87 WITH AMC III
INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS
### Flood Hydrograph Package (HCC-11)

#### Dam Safety Version
- **DATE:** July 1978
- **LAST MODIFICATION:** Feb 79

---

**DAM SAFETY INSPECTION - MISSOURI**

**NEW CARROLTON LAKE DAM (#12153)**

**2,500 FPM AND 95 PERCENT FMP**

---

**JOB SPECIFICATION**

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**MULTI-PLAN ANALYSES TO BE PERFORMED**

- **PLAN: 1 RATIO 2 RATIO 1**

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**RATIOS**

- **P100:** 1.00

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**SUM-AREA RUNOFF COMPUTATION**

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**INPUT PRECIPITATION VALUES, RATIOS AND UNIT HYDROGRAPH PARAMETERS**

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**CURVE NO. = 07.00 WATNUS = 1400 EFFECT CN = 47.00**

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**TIME INCREMENT TOO LARGE - FMG IS OF (EADD)**

---

**UNIT HYDROGRAPH END OF PERIOD ORBITATES, TC = 0.00, HOURS, LAGE = 4**

---

**VOL = 1.00**
SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING
PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-LATTI ECONOMIC COMPUTATIONS

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FLUWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)
PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY
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**DAM DATA**

| TOPEL | GOOG | EXPO | DAPUG | TAPUG |}

**HYDROGRAPH ROUTING**

**ROUTE HYDROGRAPH THROUGH NEW CAMBRIA LAKE DAM**

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</table>

**STAGE**

1. **STAGE 740.00**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**
2. **STAGE 741.48**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**
3. **STAGE 743.60**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**
4. **STAGE 744.00**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**
5. **STAGE 745.00**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**
6. **STAGE 752.80**, **FLOW 620.00**, **ELEVATION 700.00**, **CEMEL 950.00**, **SPEW 800.00**, **COGW 750.00**

**PEAK DUFFLOW**

1. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**
2. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**
3. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**
4. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**
5. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**
6. **PEAK DUFFLOW 15.42 AT TIME 15.92 HOURS**

**SUMMARY**

- **STAGE**: 740.00, 741.48, 743.60, 744.00, 745.00, 752.80
- **FLOW**: 620.00, 620.00, 620.00, 620.00, 620.00, 620.00
- **ELEVATION**: 700.00, 700.00, 700.00, 700.00, 700.00, 700.00
- **CEMEL**: 950.00, 950.00, 950.00, 950.00, 950.00, 950.00
- **SPEW**: 800.00, 800.00, 800.00, 800.00, 800.00, 800.00
- **COGW**: 750.00, 750.00, 750.00, 750.00, 750.00, 750.00

**DAM DATA**

- **TOPEL**: 6000
- **GOOG**: 6000
- **EXPO**: 6000
- **DAPUG**: 6000
- **TAPUG**: 6000

**Notes:**

- The table above represents the hydrograph routing through New Cambria Lake Dam, showing stages, flows, and elevations at various points.
- The peak dufflow is given at specific times and stages, indicating the maximum flow at each point in the graph.