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NATIONAL DAM SAFETY PROGRAM. RAINBOW DAM (NJ00092), ATLANTIC CO--ETC(U)
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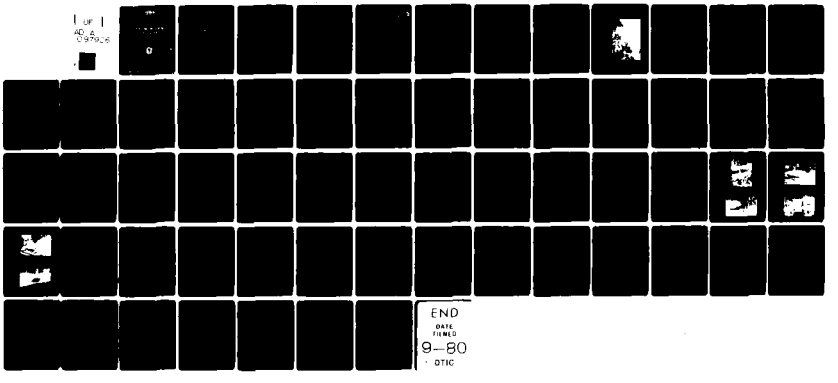

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ATLANTIC COAST BASIN
KETTLE CREEK, OCEAN COUNTY
NEW JERSEY

RAINBOW DAM
NJ 00092

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DACW61-79-C-0011

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: NJ00092	2. GOVT ACCESSION NO.: AD-A087 926
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11. CONTROLLING OFFICE NAME AND ADDRESS: NJ Department of Environmental Protection, Division of Water Resources, P.O. Box CN029, Trenton, NJ 08625	12. REPORT DATE: March, 1980
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Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Embankments
Structural Analysis
Visual Inspection
National Dam Safety Program
Rainbow Dam, New Jersey
Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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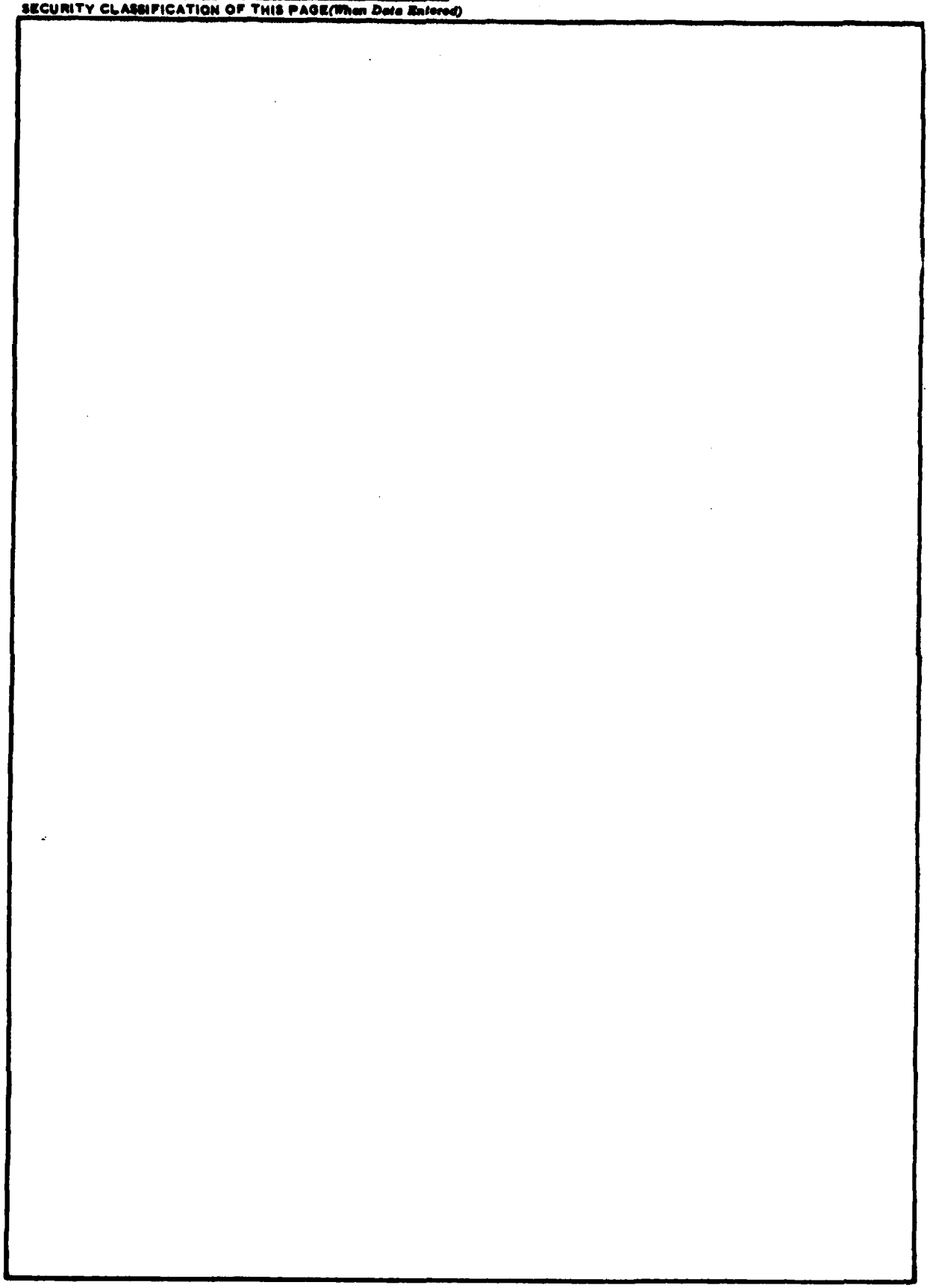


DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

05 AUG 1980

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Rainbow Lake Dam in Ocean County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Rainbow Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 11 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. Within twelve months from the date of approval of this report, the following remedial actions should be completed:

(1) Regrade the uneven crest and eroded zones on the slopes.

(2) Protect the downstream channel banks from further erosion.

(3) Remove all dead trees from the embankment.

(4) Rebuild the dam near the left abutment.

(5) Repair the low-level sluice gate.

(6) Remove debris from the spillway.

NAPEN-N
Honorable Brendan T. Byrne

c. The following actions should be initiated within twelve months from the date of approval of this report:

(1) Consideration should be given to removing the fence around the spillway and constructing a new trash rack system.

(2) The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam and establish a downstream warning system.

(3) The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Forsythe of the Sixth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

RAINBOW LAKE DAM (NJ00092)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 30 December 1979 and 11 January 1980 by Louis Berger and Associates, Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Rainbow Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 11 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. Within twelve months from the date of approval of this report, the following remedial actions should be completed:

(1) Regrade the uneven crest and eroded zones on the slopes.

(2) Protect the downstream channel banks from further erosion.

(3) Remove all dead trees from the embankment.

(4) Rebuild the dam near the left abutment.

(5) Repair the low-level sluice gate.

(6) Remove debris from the spillway.

c. The following actions should be initiated within twelve months from the date of approval of this report:

(1) Consideration should be given to removing the fence around the spillway and constructing a new trash rack system.

(2) The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam and establish a downstream warning system.

(3) The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: _____

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: _____

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

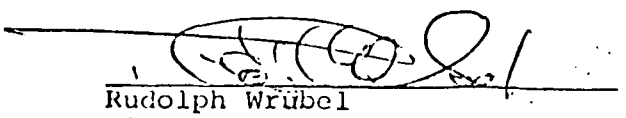
Name of Dam: Rainbow Dam Fed ID# NJ 00092

State Located New Jersey
County Located Ocean
Coordinates Lat. 4002.8 - Long. 7408.8
Stream Kettle Creek
Dates of Inspections 30 Dec. 1979 & 11 Jan. 1980

ASSESSMENT OF GENERAL CONDITIONS

Rainbow Lake Dam is in a fair overall condition and suffers from a long term neglect of maintenance. It is recommended that the hazard classification be downgraded to significant as a collapse of the dam could endanger the Riviera Lake Dam and Route 549 immediately downstream. No detrimental findings were observed to render a hazardous assessment but additional hydraulic studies are recommended. Remedial actions to be undertaken in the future include 1) regrade the crest and eroded zones on the slopes, 2) protect the downstream channel banks, 3) remove all dead trees and root systems, 4) rebuild the dam near the north embankment 5) repair the low-level sluicegate and 6) remove debris from spillway. Consideration should be given to removing the fence around the spillway and constructing a new trash rack system.

This dam has an inadequate spillway capacity, being able to accommodate only 10% of the 100 year design flood.



Rudolph Wrübel
Vice President
Louis Berger & Associates, Inc.

OVERVIEW OF RAINBOW LAKE DAM

November, 1979

TABLE OF CONTENTS

FIGURES

APPENDIX

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 Chief of Engineers, Washington, D.C. 20314. The purpose of 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. 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 Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: RAINBOW LAKE DAM FED #NJ 00092
AND NJ ID #29-36

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of Rainbow Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Rainbow Lake Dam (a.k.a. Upper Lake Riviera and Irisado Lake) is an irregular earth embankment approximately 700 feet long and approximately 12 feet high. The crest was at one time used for public travel as evidenced by an abandoned highway culvert near the right abutment of the dam. A 4'x20' concrete box drop inlet spillway is located near the right abutment of the dam and discharges directly into Lake Rivera which is located immediately below the subject dam. Both the upstream and downstream slopes are approximately 2H:1V but are very irregular.

b. Location

Rainbow Dam is located on Kettle Creek near the Village of Cedar Bridge in Brick Township, Ocean County. The dam lies generally in a north-south

orientation 700 feet west of Route 549 (Moore Road) and is roughly 1¼ miles southeast of interchange 88 on the Garden State Parkway.

c. Size Classification

The maximum height of the dam is 12.5 feet and the maximum storage is 358 acre-feet. Therefore, the dam is placed in the small size category as defined by the Recommended Guidelines for Safety Inspection of Dams (storage impoundment less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classification

This dam is one of a series of 5 dams which impound small recreation lakes along Kettle Creek. The reservoir is completely surrounded by residential development but all are above maximum flood elevation. Immediately below the dam is a second dam impounding Lake Riviera which lies just west of Route 549, a busy 4-lane State highway. Because failure could damage this lower dam and the highway culvert carrying Kettle Creek eastward, it is recommended that the hazard classification be reduced to significant, as collapse could do some property damage but would endanger only a few lives.

e. Ownership

This dam is presently owned by Lake Riviera, Inc., 550 Brick Boulevard, Brick Township, Ocean County, New Jersey.

f. Purpose of Dam

The dam impounds a recreational lake for the surrounding lakeside residential development.

g. Design and Construction History

The present dam replaced an earlier structure known as Iron Mills Dam which was a 7 foot high, 400 foot long earth embankment with a timber gate structure. The dam, in its present configuration, was constructed in 1938 under State supervision. The older dam was used as the base of the earth fill for the new dam. The reconstruction was designed and installed by Mr. J.B. Campbell of the Campbell Water Wheel Company of Philadelphia for the owner, Mr. Alan Kissock who planned to install a small water wheel

generator at the site for electric power. The dam was sold to the present owner in 1953 when the name Lake Riviera was adopted for the reservoir.

h. Normal Operating Procedures

At the present time, there are no formal operating procedures in effect except for the annual spring removal of debris blocking the spillway inlet.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area is 5.8 square miles of rural, flat countryside containing several large residential developments.

b. Discharge of Dam Site

Total spillway capacity at top of dam elevation - 223 cfs.

c. Elevation (ft. above M.S.L.)

Top of dam - 20.8
Spillway crest - 16.8
Streambed at centerline of dam - 8.3
Normal tailwater elevation - 10.3

d. Reservoir

Length of maximum pool - 4,500 feet
Length of recreation pool - 4,000 feet

e. Storage (acre-feet)

Recreation pool - 55
Top of dam - 358

f. Reservoir Surface

Top of dam - 152
Recreation pool - 43

g. Dam

Type - Earth with a concrete drop inlet spillway
Length - 700 feet
Height - 12.5 feet
Top width - 14 feet
Sideslopes upstream: 1.5H:1V; Downstream 2H:1V

Zoning - Unknown
Cutoff - None

h. Diversion and Regulating Tunnel

None

i. Spillway

1) Principal Spillway

Type - Drop inlet with 60" diameter CMP outlet

Gates - One 18"x18" low level sluicegate (invert elevation +8.3 MSL)

j. Regulatory Outlets

Gate controlled, 18"x18" sluice. Not in operating condition.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The only information available for review consisted of one drawing prepared by Mr. J.B. Campbell, Hydraulic Engineer, under the title "Dam and Race for Alan Kissock, Esq." dated April, 1938. No design computations or structural analyses were included, and a search of the New Jersey State Division of Water Resources revealed nothing further on file of a technical nature. The spillway outlet has been altered since its 1938 construction, but it is unknown when this work was performed. Further, an earlier concrete box culvert outlet near the right abutmment has been backfilled by recent landfill operations and no longer accommodates any discharge. No plans were available for this structure. Regarding the geotechnical aspects, the dam is situated within a narrow strip of land where the surficial soils are comprised of recent sandy alluvium but contain appreciable amounts of silt, gravel and clay. Soils of the Cape May, Pensauken and Bridgeton formations occur at the ground surface in proximity to the dam and present a band of recent alluvium consisting of uniform medium to coarse sand with varying amounts of silt and gravel. Further away from the lake, sand and gravel with occasional pockets of silt and lenses of clay are present. Stratified marine deposits of the Cohansey and Kirkwood formations underlie the surficial soils and east of the lake the Kirkwood formation consists of fine micaceous sand with a small percentage of fines. The Cohansey sand occurs primarily on the west side of the lake and consists of medium to coarse sand with a small percentage of fines. The marine formations generally have good permeability and may be encountered at depths less than ten feet below the surface.

2.2 CONSTRUCTION

Construction of the concrete trunk spillway was done under the supervision of the State Water Policy Commission who regularly inspected the site during the installation. It appears Mr. Campbell's company may have done the actual construction work.

2.3 OPERATION

There are no records of the dam's operation except for a visual inspection conducted in 1969 at which time it is reported that the gates were not in working order.

2.4 EVALUATION

a. Availability

It is believed that sufficient engineering data is available to conduct the following assessment of overall structural stability and safety.

b. Adequacy

The original engineering data reviewed indicates that the concrete spillway was carefully designed, and built in accordance with the design plans. Since the work was periodically inspected by representatives of the State Water Policy Commission, it is believed that it was carried out in a proper manner. Information available is therefore considered adequate for the following assessment.

c. Validity

The validity of the information is not challenged and is accepted without recourse to further investigation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections were conducted on November 30, 1979 and January 11, 1980 during clear weather and stable water level conditions. The main spillway inlet was partially plugged with debris and apparently has not been cleaned for a considerable period of time. The overall condition of the dam is one of neglect except it appears that the bulkheads and lakeside appurtenances of the surrounding property owners are in a satisfactory condition.

b. Dam

The unpaved crest roadway is very uneven and contains several depressions almost one foot deep. The side-slopes are heavily overgrown with trees (4-18 inch) and secondary growth with extensive exposed root systems between which swales have formed in the fill material. For a considerable portion of the length a narrow undefined berm, one to two feet higher than the crest is established on the lake-side edge of the embankment. Although the design plans indicate 2H:1V engineered slopes, there is little or no evidence of these. The lakeside slope is completely overgrown and silted up while the backslopes blend naturally into the original ground surface.

The downstream slope area below the right abutment has recently been regraded where it appears some type of residential development may be contemplated. The auxiliary culvert in this area is now completely filled in and its outlet could not be located.

In the vicinity of the left abutment, the crest is only about 1.5 feet above normal reservoir level and it appears this zone has been overtopped in the recent past. However, no signs of unusual seepage or settlement were noted.

c. Appurtenant Structures

The principal spillway and outlet conduit are of reinforced concrete construction founded on untreated timber piles. The drop inlet is

4'x20'x8'-6" deep and contains a low-level gate, according to design plans. The 4'x6' flume was originally about 40 feet long but has been extended to over twice that length with a 60 inch CMP. There is a serious scour problem at the outlet where the banks are presently being undercut and collapsing. The CMP extension was apparently installed without permit.

A delapidated chain-link fence has been erected around the intake and is partially clogged with debris. Further, the outlet is approximately half submerged at the outlet by the normal pond level of Lake Riviera.

d. Reservoir Area

The shores of Rainbow Lake are gently sloping to well established bulkheads and dock facilities of the property owners. The sedimentation appears minor except at the dam face.

e. Downstream Channel

Kettle Creek discharges directly into Lake Riviera which is situated between the study dam and Route 549. A small earthen dam impounds this lake and discharges under the 4-lane highway in a culvert which appears to be hydraulically inadequate in view of the upstream conditions. Further east, Kettle Creek discharges into Barnegat Bay in its natural marshland channel.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team. Talks with the owner's representative revealed that little or no maintenance work is presently performed. The owner is reticent to undertake any repairs due to the professed lack of technical knowledge.

4.2 MAINTENANCE OF DAM

There has apparently been little or no continual maintenance of this dam other than the annual spring removal of debris blocking the spillway inlet.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operational facility is the 18" x 18" sluicegate which was inoperable at the time of inspection. The gate stem has been capped off to prevent vandals from dewatering the lake.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

There is no formalized warning system in effect.

4.5 EVALUATION

Little exists that could be evaluated regarding safe operational procedures. However, in view of the apparent lack of maintenance the present procedures are deemed to be less than adequate.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Based on the criteria in the Recommended Guidelines for Safety Inspection of Dams, Rainbow Lake Dam is small in size and is placed in the significant hazard category. Accordingly, a 100-year frequency event was selected as the design storm and an inflow hydrograph was calculated using precipitation data from Technical Paper 40 and NOAA Technical Memorandum NWS Hydro-35. Inflow to the reservoir was calculated utilizing the HEC-1 computer program, discharging a peak into the reservoir of 2,955 cfs. Routing this through the reservoir reduced the peak to 2,338 cfs. The spillway capacity before overtopping of the dam occurs is approximately 223 cfs and can therefore accommodate only 10% of the design flood.

b. Experience Data

There is no information available to the inspection team concerning the historical flooding at this structure except hearsay information from local residents indicate the dam has been overtopped at least twice in the last 20 years at the left abutment.

c. Visual Observations

The auxiliary spillway appears to have been blocked up within the last two years by the earthmoving operations south of the right abutment. As this stoppage appears permanent, this outlet was not included in the appended hydraulic calculations.

d. Overtopping

Based upon the appended data and the tendency of the chain-link fencing around the inlet to become constantly clogged, the spillway cannot accommodate the design flood and therefore can overtop the irregular crest, especially in the vicinity of the left abutment.

e. Drawdown

Assuming the 18" x 18" sluicegate at the base of the drop inlet is repaired, it would take approximately three days to dewater the lake.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based upon existing conditions and review of the single 1938 source of design plans for the main spillway conduit, the dam is judged to have a stable configuration. The low area near the left abutment would effectively serve as an auxiliary spillway and alleviate any further overtopping potential which conceivably could damage the sandy, loose material on the dam crest. No evidence of seepage was observed but excessive outlet velocities appear to be continually damaging the short downstream channel between the two reservoirs. The principal spillway appears to be in an adequate condition but could not be closely observed.

b. Design and Construction Data

Reviewing Section 2, sufficient design data was available of an adequate nature to allow a valid assessment of the spillway structure without recourse to gathering additional information. No data was available for the embankment construction.

c. Operating Records

No formal records have been maintained.

d. Post-Construction Changes

There is no evidence of post-1931 construction changes except the blockage of the auxiliary spillway and the sealing of the low-level sluice-gate in the drop inlet chamber.

e. Seismic Stability

The dam is located in Seismic Zone 1 and due to its embankment width vs. height, has negligible potential vulnerability regarding Zone 1 earthquake loadings. Experience indicates that dams in Zone 1 will have adequate stability under dynamic loadings if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, the Rainbow Dam is classified as being in a fair structural condition. The spillway is incapable of passing the design flood. The dam embankment was built of unknown composition but due to its broad width, impermeable condition and lack of any evidence of seepage, is felt to be sufficient to withstand normal hydraulic heads. The dam is poorly maintained but monitored by owner's maintenance forces who perform as-needed maintenance. The only element that could not be closely inspected was the concrete box sluiceway but the lack of evident damage and differential settlement indicate it is in an adequate structural condition.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam. However, no surveys or inspections have been made since 1969.

c. Urgency

No urgency is attached to implementing further studies or remedial measures. The owner might be advised that periodic inspections are required under present Title 58:4 Statutes.

d. Necessity for Further Study

In view of the significant hazard classification and the present spillway capacity, further engineering studies are believed to be necessary to ascertain more precisely the hydraulic conditions.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

On the basis of visual inspection, improvements to the present spillway are not warranted until

the hydraulic studies mentioned in the preceding paragraph are completed. However, the owner should consider the installation of a trash rack a suitable distance from the drop inlet. Further remedial repairs include: 1) regrading the crest and refilling the scoured out slope areas and depressions on the crest, 2) protecting the downstream channel banks from further erosion, 3) removing all dead trees and undergrowth root systems, 4) rebuilding the dam near the north embankment, 5) repairing the low-level sluicegate, and 6) removing debris from spillway.

b. O&M Maintenance and Procedures

In the near future the owner should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam. In addition, an emergency action plan should be developed in order to minimize downstream damage.

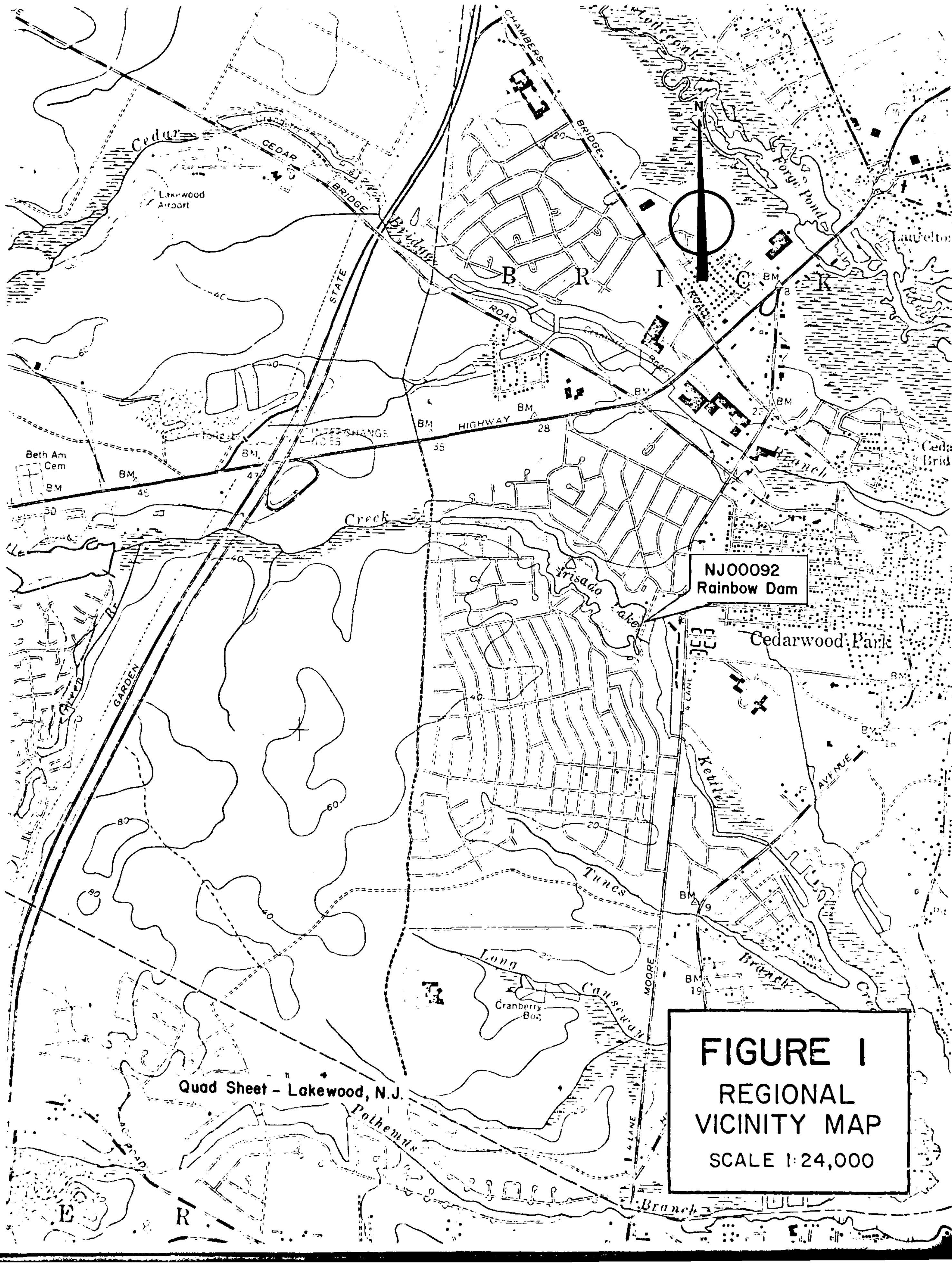


FIGURE I
REGIONAL VICINITY MAP
SCALE 1:24,000

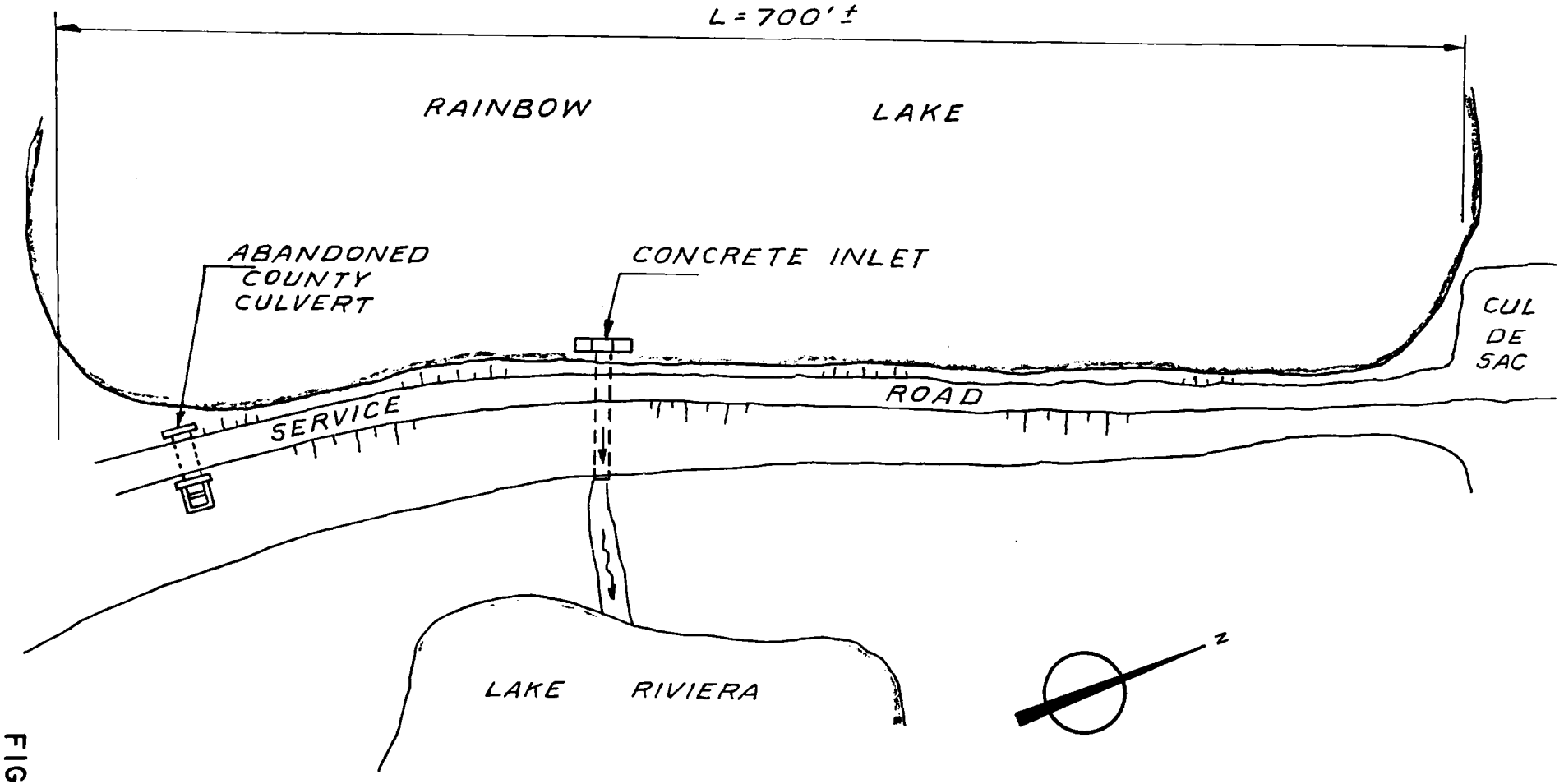
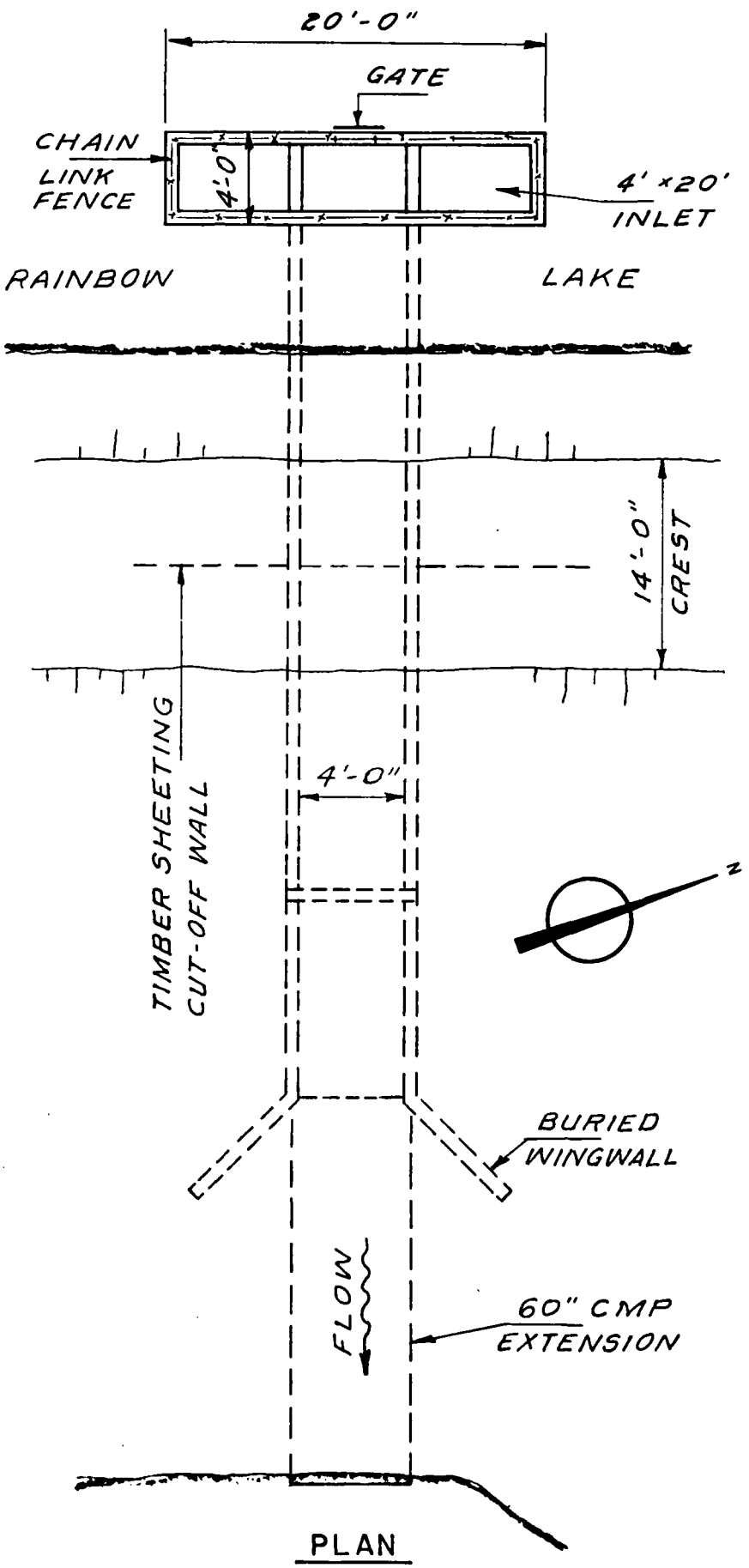


FIGURE 2

LOCATION PLAN
NOT TO SCALE



PLAN
NOT TO SCALE

FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam Rainbow Lake County Ocean State New Jersey Coordinators NJDEP

Date(s) Inspection 11/30/79 1/11/80 Weather clear Temperature 35°F

Pool Elevation at Time of Inspection 17± M.S.L. Tailwater at Time of Inspection 10± M.S.L.

Inspection Personnel:

D. Lang K. Jolls

L. Baines

M. Carter

D. Lang Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	Dam has been overtopped at north end. Corner at northeast is low spot.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None. Dam has irregular toe. Downstream slopes disappear into existing grade at south end.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Bicycle and foot trails especially around area of spillway.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Crest uneven and contains several depressions. Center of embankment is approximately 2'± below edge elevations due to vehicular traffic. Vehicular barrier at north end.	Regrade crest and refill depressions.
RIPRAP FAILURES	No riprap.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	Both upstream and downstream are heavily wooded with scrub pine trees and brush.	Remove all dead trees and undergrowth root systems.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No junction with spillway since it is separate from embankment.	
ANY NOTICEABLE SEEPAGE	No apparent seepage.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	See ungated spillway section.	
OUTLET STRUCTURE		
OUTLET CHANNEL	Dredged channel about 5' deep and 20' wide. Leads into lower lake. Severely scoured banks.	
EMERGENCY GATE /OUTLET	Some type of reinforced bridge/culvert structure at south end. Abandoned and filled with debris. Steel gate riser on main spillway has [illegible]	Make gate operable.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete overflow box approximately 4' by 18'. Completely surrounded by chainlink fence. Spillway blocked with debris.	Remove debris from fence.
APPROACH CHANNEL	Main lake reservoir.	
DISCHARGE CHANNEL	25' wide channel leading into lower lake.	
BRIDGE AND PIERS	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle slopes surround lake. Houses line shoreline. Some properties have bulkheads and docks.	
SEDIMENTATION	Minor. Primarily at upstream face of dam.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Lower Lake Riviera Dam as well as Rt. 549 highway culvert.	
SLOPES	Very flat	
APPROXIMATE NO. OF HOMES AND POPULATION	Apartments located along Route 549 along shore of lower lake. Above high water elevation.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not available
REGIONAL VICINITY MAP	Available - U.S.G.S. Quad - Lakewood, N.J.
CONSTRUCTION HISTORY	Limited amount available - NJDEP-Division of Water Resources-Bureau of Flood Plain Management-Trenton, New Jersey
TYPICAL SECTIONS OF DAM	Available - NJDEP
HYDROLOGIC/HYDRAULIC DATA	None available
OUTLETS - PLAN	Available - Drawing titled "Dam Race for Alan Kissock, Esq. - NJDEP
- DETAILS	None available
-CONSTRAINTS	None available
-DISCHARGE RATINGS	None available
RAINFALL/RESERVOIR RECORDS	None available

ITEM	REMARKS
SPILLWAY PLAN	Available - NJDEP
SECTIONS	Not available
DETAILS	Not available
OPERATING EQUIPMENT PLANS & DETAILS	None available

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	None available
BORROW SOURCES	Unknown

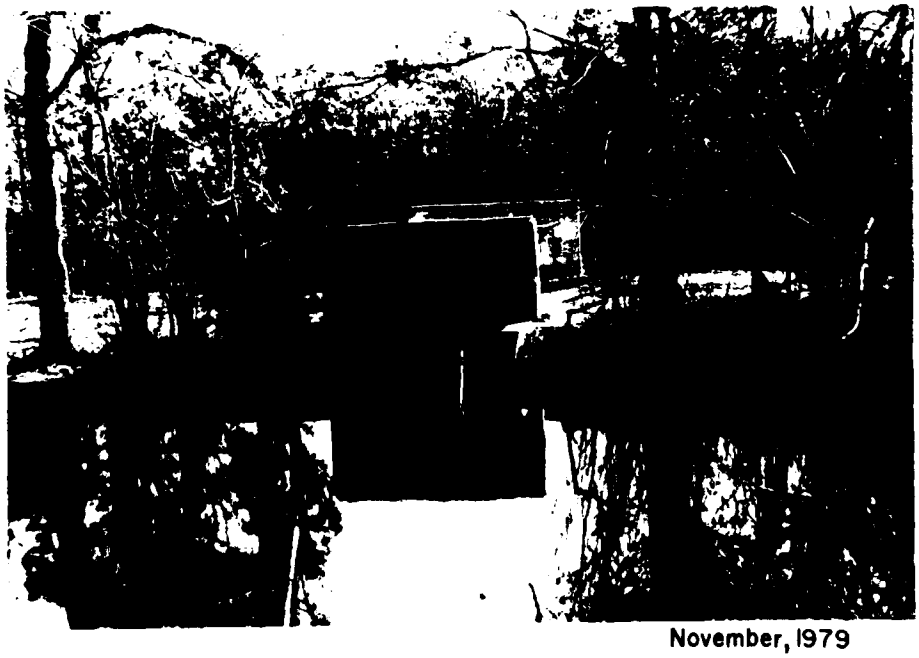
ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Modification made to spillway outlet - date of construction unknown.
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None known
MAINTENANCE OPERATION RECORDS	None available

View of Spillway January, 1980

View of Spillway Outlet November, 1979

November, 1979

View of Regraded Zone At Right Abutment



November, 1979

View of Abandoned Culvert at Right Abutment

November, 1979

View of Crest Looking North

November, 1979

View of Lower Lake Riviera Dam

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 5.8 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): +16.8 (55 AF)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: 22 M.S.L.

ELEVATION TOP DAM: +20.8 M.S.L. (358 AF)

CREST: Main Spillway

a. Elevation 16.8 M.S.L.
b. Type 4 sided concrete drop
c. Width 41
d. Length 20'
e. Location Spillover Near left abutment
f. Number and Type of Gates See below

OUTLET WORKS:

a. Type
b. Location
c. Entrance inverts
d. Exit inverts
e. Emergency draindown facilities 1 - 18"x18" sluicegate

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 223 cfs

BY RFB DATE 1-8-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1
CHKD. BY DATE RAINBOW LAKE DAM PROJECT C-24
SUBJECT

TIME OF CONCENTRATION:

LENGTH ALONG WATERCOURSE TO DRAINAGE DIVIDE = 23,200
= 4.39 MI

(OVERLAND FLOW NEGLIGIBLE)

$\Delta H = 127 - 17 = 110$ FT

SLOPE = $\frac{110 \times 100}{23,200} \cong \frac{1}{2}\%$ ASSUME VELOCITY = 2 FT/S

$t_c = \frac{23,200}{2 \times 3600} = 3.22$ HR

BY CALIFORNIA CULVERTS METHOD

$t_c = \left[\frac{11.9 L^3}{H}\right]^{0.385} = \left[\frac{11.9 (4.39)^3}{110}\right]^{0.385} = 2.25$ HRS

USE AVERAGE $t_c = 2.79$

$T_p = \frac{D}{2} + 0.6 \times t_c$

$T_p = \frac{0.5}{2} + 0.6(2.79) = 1.92$

BY L.B. DATE 4-80
CHKD. BY DATE
SUBJECT

LOUIS BERGER & ASSOCIATES INC.

RAINBOW LAKE DAM

SHEET NO. A 2 OF
PROJECT C-246

$$Q_p = \frac{256A(1)}{T_p} = \frac{256(5.8)1}{1.92} = 773 \text{ CFS}$$

UNITGRAPH

TIME HOURS	T/Tp	DIMENSIONLESS ORDINATE (D.O.)	Q(CFS) Qp x D.O.
0.5	0.26	0.46	356
1.0	0.52	0.49	379
1.5	0.78	0.90	696
2.0	1.04	0.99	765
2.5	1.30	0.92	711
3.0	1.56	0.80	618
3.5	1.82	0.68	526
4.0	2.08	0.56	433
4.5	2.34	0.49	379
5.0	2.60	0.43	332
5.5	2.86	0.38	294
6.0	3.13	0.33	255
6.5	3.39	0.26	201
7.0	3.65	0.25	193
7.5	3.91	0.22	170
8.0	4.17	0.20	155
8.5	4.43	0.19	147
9.0	4.69	0.18	139
9.5	4.95	0.16	124
10.0	5.21	0.15	116
10.5	5.47	0.14	108
11.0	5.73	0.12	93
11.5	5.99	0.11	85
12	6.25	0.1	77
12.5	6.51	0.08	61
13	6.77	0.07	54
		Σ	7467

CHECK $\frac{7467(12)/(36,325)}{52(5.8)(2)} = 1.0$

BY L.G. DATE 4-80 | **LOUIS BERGER & ASSOCIATES INC.** | SHEET NO. A3 OF

CHKD. BY DATE | RAINBOW LAKE DAM | PROJECT G-246

SUBJECT

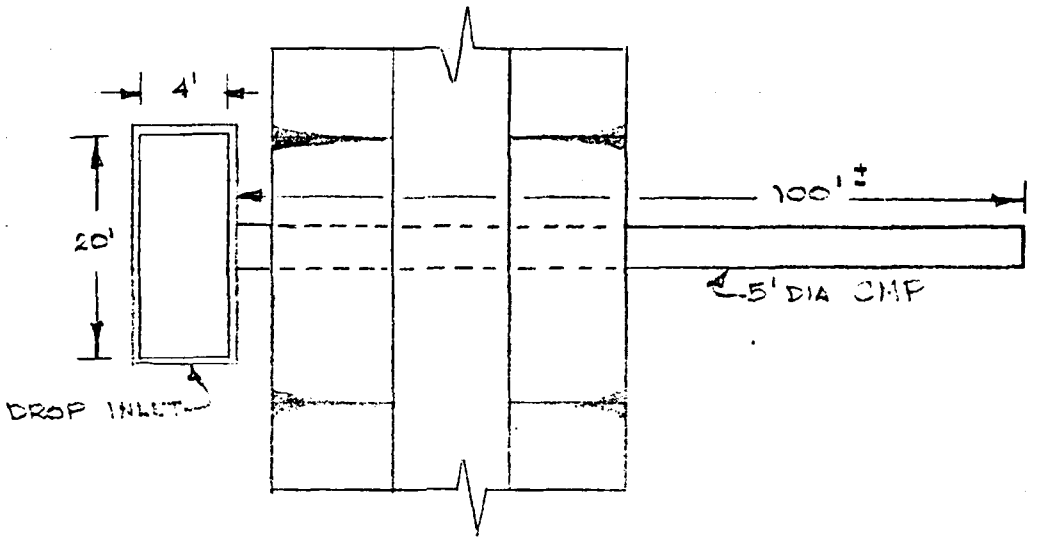
PRECIPITATION DATA FROM TP-40 & NOAA TECHNICAL MEMORANDUM NWS-35

TIME	PRECIPITATION	Δ	REARRANGE Δ
0.50	2.4	2.4	0.12
1.00	3.1	0.7	0.12
1.50	3.7	0.6	0.14
2.00	4.00	0.3	0.17
2.50	4.22	0.22	0.18
3.00	4.40	0.18	0.22
3.50	4.57	0.17	0.7
4.00	4.71	0.14	2.4
4.50	4.84	0.13	0.6
5.00	4.96	0.12	0.3
5.50	5.08	0.12	0.13
6.00	5.20	0.12	0.12

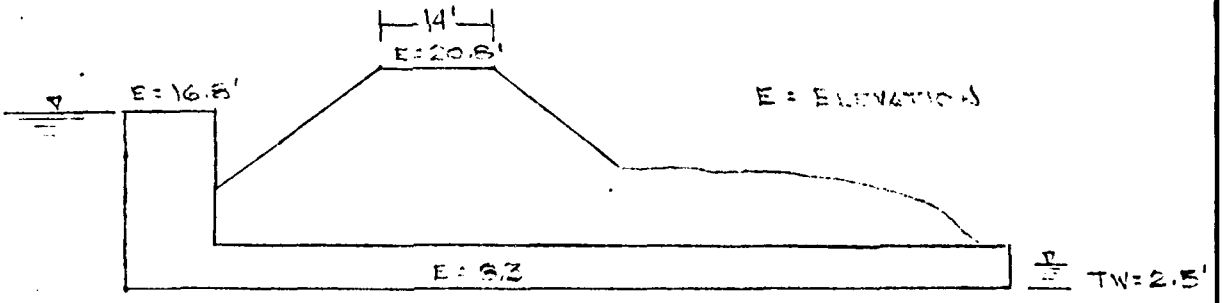
BY REB DATE 1-9-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A4 OF

CHKD. BY DATE RAINBOW LAKE DAM PROJECT C-246

SUBJECT SPILLWAY ANALYSIS



PLAN VIEW SPILLWAY



ELEV. VIEW SPILLWAY

ASSUME CULVERT AS SUBMERGED CULVERT AND CONTROL FLOW RATE; USE $Q = CA\sqrt{2gH}$

ASSUME DOWNSTREAM LAKE RISES AT SAME RATE AS RAINBOW LAKE, THEREFORE ΔH IS A CONSTANT AND $\Delta H = 16.8 - (8.3 + 2.5) = 6.0$ FT

FROM KING'S HANDBOOK OF HYDRAULIC'S TABLE 4:11 FOR CORRUGATED METAL PIPE, $d = 5.0'$, & $L = 100'$

$C = 0.58$

BY RFE DATE 1-9-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. A5

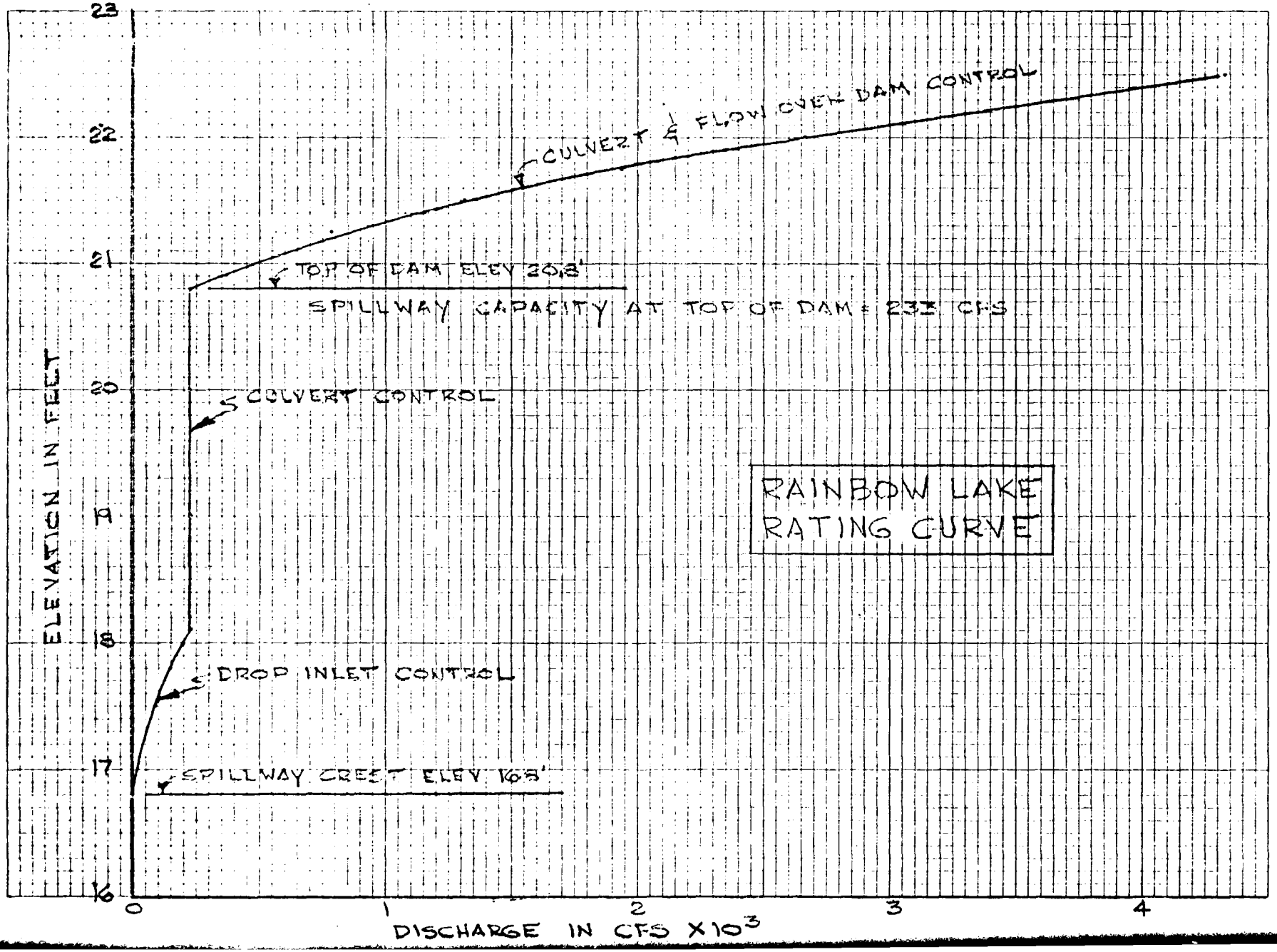
CHKD. BY _____ DATE _____ RANDOLPH LAKE DAM PROJECT NO. 2246

SUBJECT _____ SPILLWAY RATING CURVE

ELEV	DROP INLET				CULVERT FLOW				OVLL EMBANKMENT				ΣQ
FT	C	L*	H	Q	C	A	H	Q	C	L	H	Q	CFS
16.8	3.2	47	0	0	.58	19.6	6'	0	2.7	667	0	0	0
17.5			0.7	88				—			0	0	88
18.0			1.2	198				—			0	0	198
19.0			2.2	410				223			0	0	223
20.0			3.2					223			0	0	223
20.8			4.0					223			0	0	223
21.5								223			0.7	1086	1309
22.0								223			1.2	2438	2661
23.0								223			2.2	6053	6276
24.0								223			3.2	10618	10841
25.0								223			4.2	15966	16189
26.0								223			5.2	21996	22219
27.0											6.2	28636	28636

L* = EFFECTIVE LENGTH = 47'

** TOP OF DAM ELEV. 20.8

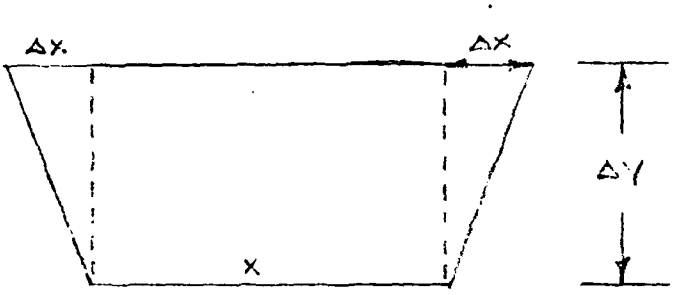


BY REB DATE 1-9-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A7 OF
CHKD. BY DATE RAINBOW LAKE DAM PROJECT C-246
SUBJECT SURCHARGE STORAGE

AREA OF LAKE @ ELEV 16.8 = 43 ACRES

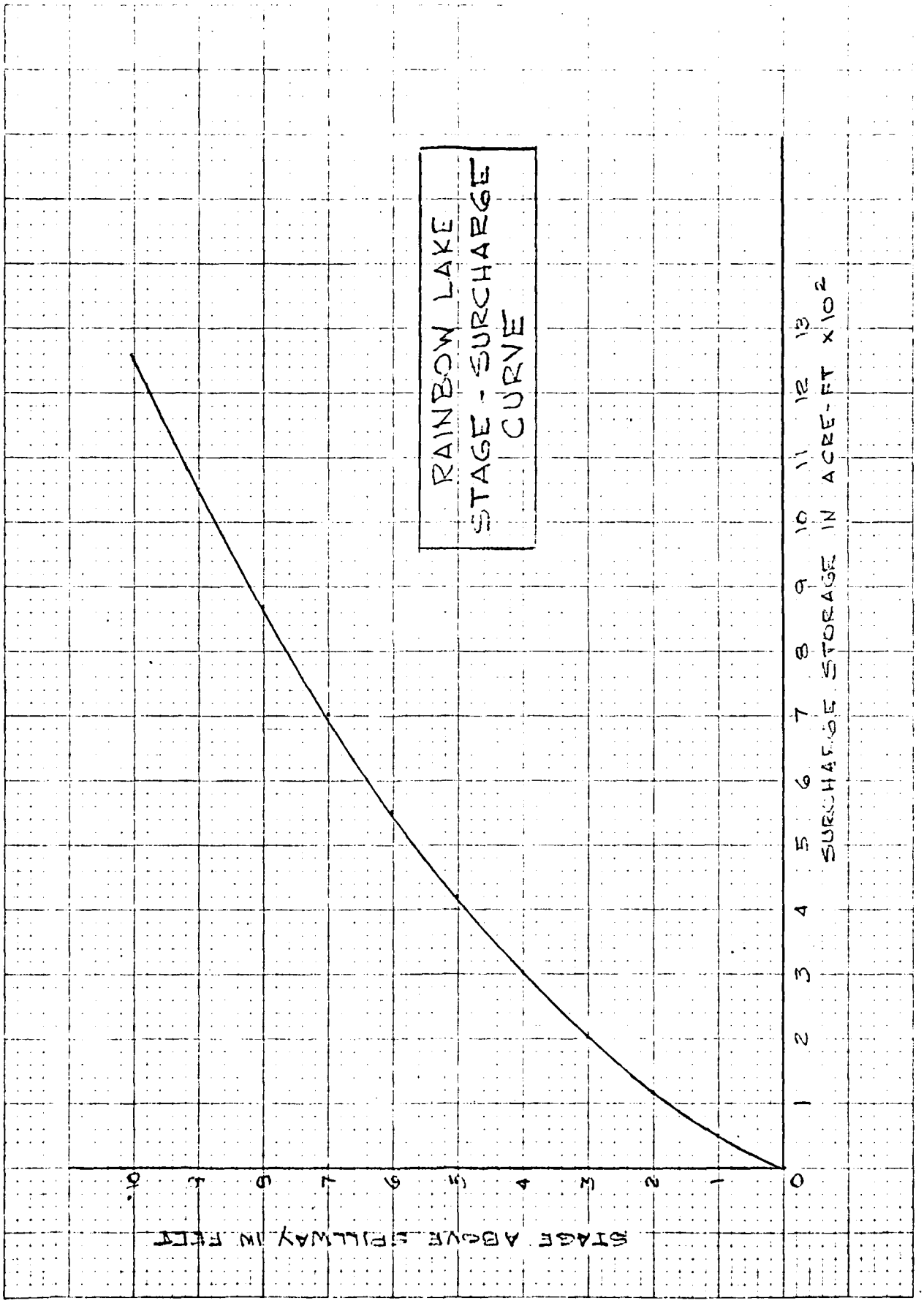
AREA @ 20 FT CONTOUR = 45.4 ACRES

ASSUME POOL AREA ABOVE 20 FT PROJECTS AT SAME RATE.



$$\Delta V = \Delta Y (X + \Delta X)$$

HEIGHT ABOVE SPILLWAY CREST	A ACRES	SURCHARGE STORAGE ACRE-FT.
0	43	0
1	59.4	51
2	75.8	119
3	92.1	202
4	108.5	302
5	124.9	420
6	141.2	553
7	157.6	702
8	174.0	868
9	190.4	1050
10	206.8	1249



10 Squares to the Inch

BY LJB DATE

CHKD. BY DATE

SUBJECT DRAINE

LOUIS BERGER & ASSOCIATES INC.

RAINBOW LAKE

SHEET NO A-3

PROJECT C-246

SLUICE GATE INCREMENTAL, BUT ASSUME IT IS OPERATIONAL

SIZE: 18" x 18" = 2.25 SQ. FT

HEAD AT NORMAL POOL ELEV = 8.5 FT

ASSUME CONSTANT TAILWATER OF 2.5' AND INFLOW OF 6 CFS

STORAGE @ NORMAL POOL = 55 ACRE-FEET

AVAILABLE HEAD WITH TAILWATER = 6'

STAGE 1

$H = 4.5$

$Q = CA\sqrt{2gH}$ $\quad C = 0.55$

$Q = 0.55(2.25)\sqrt{64.4(4.5)}$

$Q = 21 \text{ CFS} - 6 = 15 \text{ CFS}$

$$\text{time} \cong \frac{55 \text{ acre-feet} \times 43560 \frac{\text{ft}^2}{\text{acre}}}{2 \times 15 \text{ ft}^3/\text{sec} \times \frac{3600 \text{ sec}}{1 \text{ hr}}}$$

$= 22 \text{ HRS}$

STAGE 2

$H = 1.5'$

$Q = 0.55(2.25)\sqrt{64.4 \times 1.5}$

$= 12.2 - 6 = 6.2$

$$\text{TIME} = \frac{55 \times 43560}{2 \times 6.2 \times 3600}$$

$= 54 \text{ HRS}$

TOTAL TIME = 22 + 54 = 76 HRS = 3.2 DAYS

BY RFB DATE 1-10-63 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A10
CHKD. BY ____ DATE ____ RAINBOW LAKE DAM PROJECT C-24
SUBJECT ____

COMPUTER Y2 & Y3 CARD INPUT FROM COMPUTATIONS AND CURVES

STAGE OVER SPILLWAY CREST	Q CFS	SURCHARGE ACRE-FT
0	0	0
0.7	88	34
1.2	198	68
1.3	223	70
2.7	223	176
4.0	223	307
4.7	1309	393
5.2	2661	445
6.2	6276	581
7.2	10841	734

```
A   RAINBOW LAKE  DAM

A   RAINBOW LAKE  DAM
A   BY LB
A   APRIL, 1980
B    150                30
J      3
K      0        1                                    1
J   INFLOW TO RESERVOIR
M      0       -1      5.0              5.8
O     12
I     12       12      14       17      18       22      70     2 40     0.60     0.30
I     13       12
I                                                    0.5      0.1
O     26
I    356      379     696      765     711      618     526      433      379      332
I    274      255     201      193     170      155     147      139      124      116
I    103       93      55       77      61       54
X      0        0       1
K      1        1                                    1
J   ROUTING THROUGH RESERVOIR
Y                             1
I      1
O      0       34      62       70     176      303     383      445      581      734
O      0       83     198      223     223      223    1309     2661     6276    10841
K     92
A
A
A
A
A
```

****
HEC-1 VERSION DATED JAN 1973
UPDATED AUG 78
CHANGE NO 01
****

RAINBOW LAKE DAM
BY LB
APRIL, 1980

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	30	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	5.80	0.00	5.80	0.00	0.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
12	0.00	0.00	0.00

PRECIP PATTERN

0.12	0.12	0.14	0.17	0.18	0.22	0.70	2.40	0.60	0.30
0.12	0.12								

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.00	0.00	1.00	0.00	0.00	1.00	0.50	0.10	0.00	0.00

GIVEN UNIT GRAPH, NUHGG= 26

356.	379.	696.	765.	711.	618.	526.	433.	379.	332.
294.	255.	201.	193.	170.	155.	147.	139.	124.	116.
100.	93.	85.	77.	61.	54.				

UNIT GRAPH TOTALS 7467. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.12	0.00	0.
2	0.12	0.00	0
3	0.14	0.00	0.

4	0.17	0.04	13.
5	0.18	0.13	60.
6	0.22	0.17	134.
7	0.70	0.65	413.
8	2.40	2.35	1326.
9	0.60	0.55	1783.
10	0.30	0.25	2650.
11	0.13	0.08	2955.
12	0.12	0.07	2882.
13	0.00	0.00	2593.
14	0.00	0.00	2263.
15	0.00	0.00	1922.
16	0.00	0.00	1666.
17	0.00	0.00	1450.
18	0.00	0.00	1271.
19	0.00	0.00	1096.
20	0.00	0.00	919.
21	0.00	0.00	835.
22	0.00	0.00	745.
23	0.00	0.00	679.
24	0.00	0.00	633.
25	0.00	0.00	591.
26	0.00	0.00	538.
27	0.00	0.00	498.
28	0.00	0.00	457.
29	0.00	0.00	405.
30	0.00	0.00	363.
31	0.00	0.00	317.
32	0.00	0.00	257.
33	0.00	0.00	193.
34	0.00	0.00	57.
35	0.00	0.00	24.
36	0.00	0.00	9.
37	0.00	0.00	4.
38	0.00	0.00	0.
39	0.00	0.00	0.
40	0.00	0.00	0.
41	0.00	0.00	0.
42	0.00	0.00	0.
43	0.00	0.00	0.
44	0.00	0.00	0.
45	0.00	0.00	0.
46	0.00	0.00	0.
47	0.00	0.00	0.
48	0.00	0.00	0.
49	0.00	0.00	0.
50	0.00	0.00	0.
51	0.00	0.00	0.
52	0.00	0.00	0.
53	0.00	0.00	0.
54	0.00	0.00	0.
55	0.00	0.00	0.
56	0.00	0.00	0.
57	0.00	0.00	0.
58	0.00	0.00	0.

59	0.00	0.00	0.
60	0.00	0.00	0.
61	0.00	0.00	0.
62	0.00	0.00	0.
63	0.00	0.00	0.
64	0.00	0.00	0.
65	0.00	0.00	0.
66	0.00	0.00	0.
67	0.00	0.00	0.
68	0.00	0.00	0.
69	0.00	0.00	0.
70	0.00	0.00	0.
71	0.00	0.00	0.
72	0.00	0.00	0.
73	0.00	0.00	0.
74	0.00	0.00	0.
75	0.00	0.00	0.
76	0.00	0.00	0.
77	0.00	0.00	0.
78	0.00	0.00	0.
79	0.00	0.00	0.
80	0.00	0.00	0.
81	0.00	0.00	0.
82	0.00	0.00	0.
83	0.00	0.00	0.
84	0.00	0.00	0.
85	0.00	0.00	0.
86	0.00	0.00	0.
87	0.00	0.00	0.
88	0.00	0.00	0.
89	0.00	0.00	0.
90	0.00	0.00	0.
91	0.00	0.00	0.
92	0.00	0.00	0.
93	0.00	0.00	0
94	0.00	0.00	0.
95	0.00	0.00	0.
96	0.00	0.00	0.
97	0.00	0.00	0.
98	0.00	0.00	0.
99	0.00	0.00	0.
100	0.00	0.00	0.
101	0.00	0.00	0.
102	0.00	0.00	0.
103	0.00	0.00	0.
104	0.00	0.00	0.
105	0.00	0.00	0.
106	0.00	0.00	0.
107	0.00	0.00	0.
108	0.00	0.00	0.
109	0.00	0.00	0.
110	0.00	0.00	0.
111	0.00	0.00	0.
112	0.00	0.00	0.
113	0.00	0.00	0.

114	0.00	0.00	0.
115	0.00	0.00	0.
116	0.00	0.00	0.
117	0.00	0.00	0.
118	0.00	0.00	0.
119	0.00	0.00	0.
120	0.00	0.00	0.
121	0.00	0.00	0.
122	0.00	0.00	0.
123	0.00	0.00	0.
124	0.00	0.00	0.
125	0.00	0.00	0.
126	0.00	0.00	0.
127	0.00	0.00	0.
128	0.00	0.00	0.
129	0.00	0.00	0.
130	0.00	0.00	0.
131	0.00	0.00	0.
132	0.00	0.00	0.
133	0.00	0.00	0.
134	0.00	0.00	0.
135	0.00	0.00	0.
136	0.00	0.00	0.
137	0.00	0.00	0.
138	0.00	0.00	0.
139	0.00	0.00	0.
140	0.00	0.00	0.
141	0.00	0.00	0.
142	0.00	0.00	0.
143	0.00	0.00	0.
144	0.00	0.00	0.
145	0.00	0.00	0.
146	0.00	0.00	0.
147	0.00	0.00	0.
148	0.00	0.00	0.
149	0.00	0.00	0.
150	0.00	0.00	0.
SUM	5.20	4.29	32001.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2955	1988.	667.	222.	31998.
INCHES		3.19	4.28	4.28	4.28
AC-FT		986.	1323.	1323.	1323.

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HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.000	0.000	0.000	0.

STORAGE=	0.	34.	63.	70.	176.	303.	383.	445.	581.	734.
OUTFLOW=	0.	88.	198.	223.	223..	223.	1309.	2661.	6276.	10841.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	6.	1.
5	2.	36.	4.
6	5.	97.	14.
7	15.	274.	40.
8	48.	870.	140.
9	104.	1554.	223.
10	187.	2217.	223.
11	293.	2802.	223.
12	382.	2918.	1302.
13	423.	2737.	2191.
14	430.	2428.	2338.
15	423.	2092.	2186.
16	412.	1794.	1942.
17	401.	1558.	1703.
18	391.	1360.	1490.
19	383.	1183.	1302.
20	373.	1007.	1173.
21	363.	877.	1043.
22	355.	790.	930.
23	348.	712.	836.
24	342.	656.	757.
25	338.	612.	694.
26	333.	564.	637.
27	330.	518.	585.
28	326.	478.	538.
29	323.	431.	491.
30	319.	384.	444.
31	316.	340.	398.
32	312.	287.	350.
33	308.	225.	295.
34	303.	125.	223.
35	295.	40.	223.
36	287.	16.	223.
37	278.	6.	223.
38	269.	2.	223.
39	259.	0.	223.
40	250.	0.	223.
41	241.	0.	223.
42	232.	0.	223.
43	223.	0.	223.
44	213.	0.	223
45	204.	0.	223.

46	195.	0.	223.
47	186.	0.	223.
48	176.	0.	223.
49	167.	0.	223.
50	158.	0.	223.
51	149.	0.	223.
52	140.	0.	223.
53	130.	0.	223.
54	121.	0.	223.
55	112.	0.	223.
56	103.	0.	223.
57	93.	0.	223.
58	84.	0.	223.
59	75.	0.	223.
60	66.	0.	209.
61	58.	0.	179.
62	51.	0.	153.
63	45.	0.	131.
64	40.	0.	112.
65	36.	0.	96.
66	32.	0.	84.
67	29.	0.	75.
68	26.	0.	68.
69	23.	0.	61.
70	21.	0.	55.
71	19.	0.	49.
72	17.	0.	44.
73	15.	0.	40.
74	14.	0.	36.
75	12.	0.	32.
76	11.	0.	29.
77	10.	0.	26.
78	9.	0.	23.
79	8.	0.	21.
80	7.	0.	19.
81	6.	0.	17.
82	6.	0.	15.
83	5.	0.	14.
84	5.	0.	12.
85	4.	0.	11.
86	4.	0.	10.
87	3.	0.	9.
88	3.	0.	8.
89	3.	0.	7.
90	2.	0.	6.
91	2.	0.	6.
92	2.	0.	5.
93	2.	0.	5.
94	2.	0.	4.
95	1.	0.	4.
96	1.	0.	3.
97	1.	0.	3.
98	1.	0.	3.
99	1.	0.	2.
100	1.	0.	2.

101	1.	0.	2.
102	1.	0.	2.
103	1.	0.	2.
104	1.	0.	1.
105	0.	0.	1.
106	0.	0.	1.
107	0.	0.	1.
108	0.	0.	1.
109	0.	0.	1.
110	0.	0.	1.
111	0.	0.	1.
112	0.	0.	1.
113	0.	0.	1.
114	0.	0.	0.
115	0.	0.	0.
116	0.	0.	0.
117	0.	0.	0.
118	0.	0.	0.
119	0.	0.	0.
120	0.	0.	0.
121	0.	0.	0.
122	0.	0.	0.
123	0.	0.	0.
124	0.	0.	0.
125	0.	0.	0.
126	0.	0.	0.
127	0.	0.	0.
128	0.	0.	0.
129	0.	0.	0.
130	0.	0.	0.
131	0.	0.	0.
132	0.	0.	0.
133	0.	0.	0.
134	0.	0.	0.
135	0.	0.	0.
136	0.	0.	0.
137	0.	0.	0.
138	0.	0.	0.
139	0.	0.	0.
140	0.	0.	0.
141	0.	0.	0.
142	0.	0.	0.
143	0.	0.	0.
144	0.	0.	0.
145	0.	0.	0.
146	0.	0.	0.
147	0.	0.	0.
148	0.	0.	0.
149	0.	0.	0.
150	0.	0.	0.
SUM			31998.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2338.	1537.	613.	222.	31998.

	INCHES		2.46	3.93	4.28	4.28
	AC-FT		762.	1217.	1323.	1323.

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RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	2955.	1988.	667.	222.	5.80
ROUTED TO	1	2338.	1537.	613.	222.	5.80