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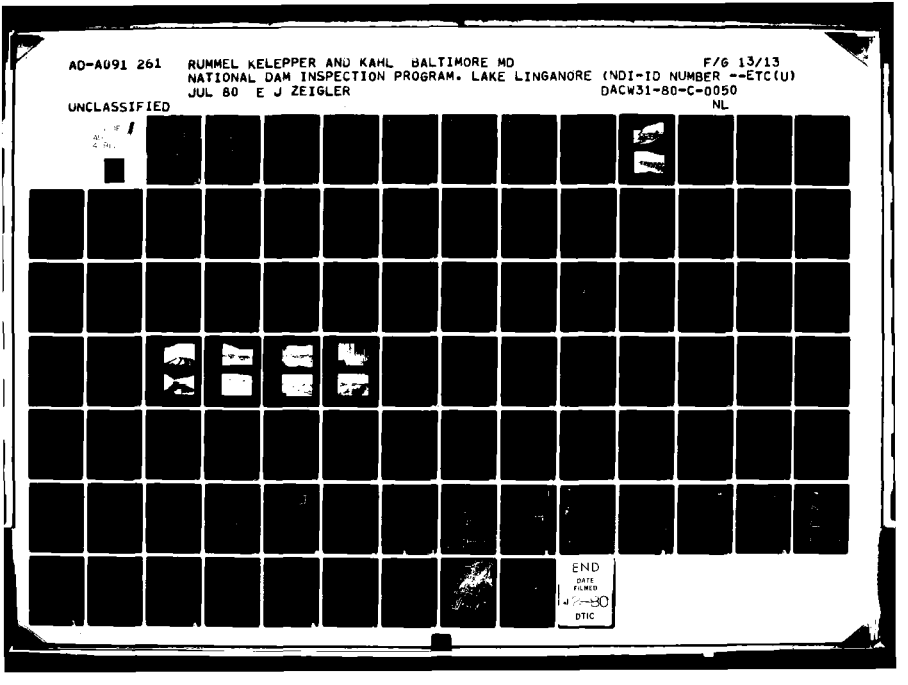

POTOMAC RIVER BASIN

LINGANORE CREEK, FREDERICK COUNTY

MARYLAND

LAKE LINGANORE

NDI ID NO. MD-21

LEVEL II

LAKE LINGANORE ASSOCIATION

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

DACW31-80-C-0050

By
RUMMEL, KLEPPER & KAHL
Consulting Engineers
Baltimore, Maryland 21202

JULY 1980

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(10) Edward J. Zeigler (1)

POTOMAC RIVER BASIN

LINGANORE CREEK, FREDERICK COUNTY

MARYLAND

(6) National Dam Inspection Program

LAKE LINGANORE

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1035 N. Calvert Street
Baltimore, Maryland 21202

July 1980

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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 Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

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

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

POTOMAC RIVER BASIN

LINGANORE CREEK, FREDERICK COUNTY

MARYLAND

LAKE LINGANORE

NDI ID NO. MD-21

LAKE LINGANORE ASSOCIATION

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

July 1980

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION
AND RECOMMENDED ACTION

Name of Dam:	Lake Linganore NDI ID NO. MD-21
Size:	Intermediate (7900 acre-feet, 62.5 feet high)
Hazard Classification:	High
Owner:	Lake Linganore Association New Market, Maryland 21774
State Located:	Maryland
County Located:	Frederick
Stream:	Linganore Creek
Dates of Inspection:	June 24, 1980 and July 15, 1980

Based on the visual inspection, available records, past operational performance, and in accordance with the guideline criteria established for these studies, the embankment of Lake Linganore Dam is judged to be in fair condition. However, since the spillway is seriously inadequate based on hydrologic and hydraulic analyses, the dam is classified unsafe, non-emergency.

Lake Linganore Dam is an earthfill embankment which is approximately 750 feet long and 62.5 feet high at its maximum section. Water level of the lake is generally maintained at elevation 308, the elevation of the crest of the ogee spillway. The water level of the lake can be lowered by opening a manually operated sluice gate located in the vault at the downstream toe of the dam.

In the Spring of 1980, extensive repairs were made to the Lake Linganore Dam. Concrete had to be pumped below a concrete apron in the spillway where bearing material had been partially removed by erosion. A crack in the apron which extended up the side of the left retaining wall of the spillway in two locations was sealed during the repairs. Extensive erosion had occurred along the banks of the stilling pond and at the base of the spillway, particularly at the base of the left retaining wall. As part of the repairs, additional riprap slope protection was placed downstream of the left retaining wall of the spillway. At the time of our inspection, the remedial measures appeared to have succeeded.

The downstream slope of the embankment was found to be covered with many small trees and shrubs. Some surface erosion was noted near the left end of the downstream slope, and a shallow erosion gully was noted near the right end of the downstream slope. A seepage area was noted near the toe of the downstream slope at the right end of the dam, and a wet area was noted downstream of the toe just left of the spillway. According to the dam crest survey, the low point along the crest is adjacent to the right retaining wall of the spillway. The elevation of this low point is less than the design crest elevation of the dam.

According to the hydrologic and hydraulic analyses, Lake Linganore Dam will overtop by 0.6 foot for a duration of 4 hours during a flood equalling 50% of the Probable Maximum Flood (PMF). The analyses indicate that the Lake Linganore Dam spillway can pass approximately 48% of the PMF without overtopping the dam. Consequently, the spillway capacity is rated as seriously inadequate, and the dam is unsafe, nonemergency. It is judged that the overtopping could result in a failure of the dam embankment. Since a dam failure would result in an increased hazard to loss of life and property downstream, a high hazard classification is warranted.

The following remedial measures are recommended to be accomplished by the Owner immediately:

1. Retain a Professional Engineer experienced in dam design and construction to perform detailed hydrologic and hydraulic analysis to further assess spillway adequacy and develop remedial measures to provide adequate spillway capacity.

2. Build up the dam crest as required to restore the original dam design crest elevation of +325.

3. Remove all woody vegetation from the downstream slope of the embankment.

4. Repair the surface erosion and erosion gully noted on the downstream slope.

5. Regularly inspect and monitor the spillway retaining walls, the seepage area noted near the toe of the embankment at the right end of the dam, and the wet area noted downstream of the left retaining wall of the spillway. If movement of the retaining walls is detected, remedial measures should be taken to repair the walls. If the rate or turbidity of the flow from the seepage area increases significantly, or if the wet area enlarges significantly, the Owner should retain the services of a Professional Engineer experienced in dam design and construction to investigate the source of the water and to recommend a means of controlling the flow.

6. Add a gate to the upstream end of the 48-inch diversion pipe to allow for cutting off flow under the dam should repairs to the pipe become necessary in the future.

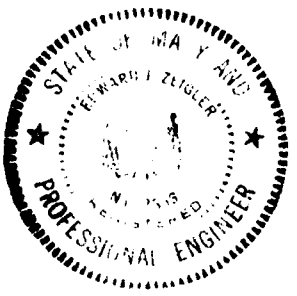
7. Develop a formal program of maintenance and inspection for the dam and appurtenant structures.

8. Develop a formal warning system to alert the downstream residents and the City of Frederick in the event of emergencies.

Lake Linganore
NDI ID NO. MD-21

Submitted by:

RUMMEL, KLEPPER & KAHL



Edward J. Zeigler

Edward J. Zeigler, P.E.
Associate

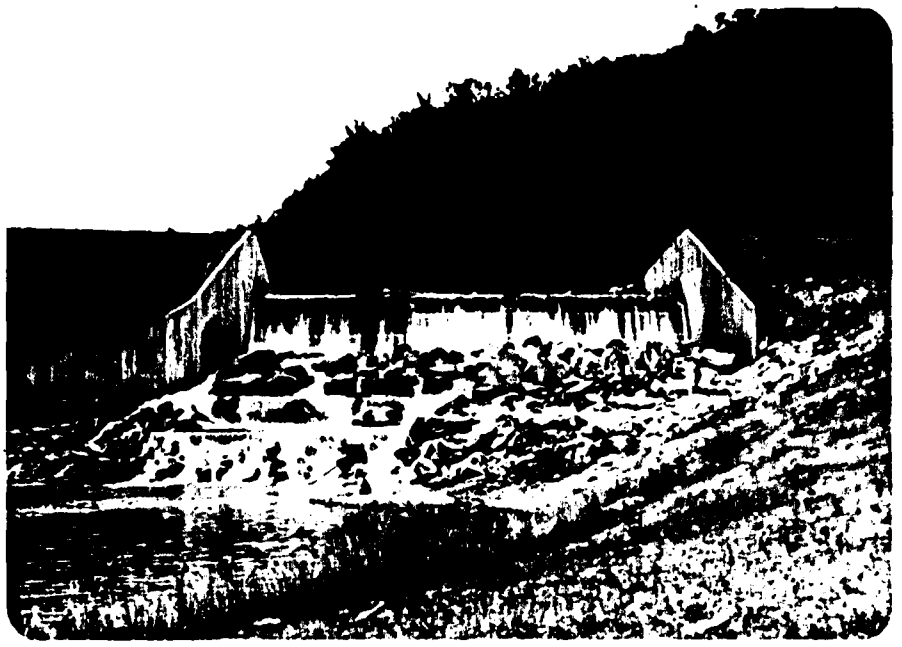
Date: August 21, 1981

Approved by:

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 22 Sep 1980



Spillway and stilling pond

Upstream face of dam and riprap slope protection

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LINGANORE
NDI ID NO. MD-21

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the dam inspection program is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. The Lake Linganore Dam consists of an earth embankment approximately 750 feet long and 62.5 feet high at its maximum section. The crest of the dam has a minimum crest width of 12 feet. The flood discharge facilities for the dam include a 48-inch diameter diversion pipe and sluice gate vault, and a 122 foot wide ogee crest spillway. Discharge from the ogee crest spillway flows into a riprap protected stilling pond bounded on the west by an embankment carrying Eagleshead Road over Linganore Creek. Water flows from the stilling pond into Linganore Creek through two corrugated steel pipes passing through the roadway embankment.

The water level of the lake is normally maintained at elevation 308, the crest elevation of the ogee spillway. The lake can be lowered below normal pool elevation by manually opening the sluice gate.

b. Location. The dam is located on Linganore Creek in the Potomac River drainage basin in Frederick County, Maryland. The location is shown on U.S.G.S. Quadrangle, Walkersville, Maryland, at latitude N 39° 25' 10" and longitude W 77° 20' 20". A location map is included in Plate E-1.

c. Size Classification. Intermediate (62.5 feet high, 7900 acre-feet).

d. Hazard Classification. High hazard. Failure of the Lake Linganore Dam would cause serious damage to the City of Frederick Water Purification Plant which is situated adjacent to Linganore Creek approximately 1.8 miles downstream of the dam. Dam failure could also flood two residences located between the dam and the water purification plant. Consequently, a high hazard classification is warranted.

e. Ownership. Lake Linganore Association, New Market, Maryland 21774

f. Purpose of Impoundment. Recreational lake.

g. Design and Construction History. The Lake Linganore Dam was constructed in 1972. Construction drawings, design information, and pertinent correspondence regarding the dam were obtained from the State of Maryland Water Resources Administration. The dam was designed and construction inspection was provided by Robert B. Balter, Soil and Foundation Consultants, Inc., of Owings Mills, Maryland. The dam was constructed by Dewey Jordon, Inc. of New Market, Maryland. Repairs which were made to the dam in the Spring of 1980 were recommended by both the Robert B. Balter Company, and Harris, Smariga & Associates, Inc. of Frederick, Maryland. Inspection of the repairs was provided by Harris, Smariga & Associates, Inc.

h. Normal Operating Procedure. The lake is maintained at the crest elevation of the ogee spillway. The water level in the lake can be lowered through the 48 inch diversion pipe, as it had to be to complete the required repairs in the Spring of 1980, by opening the manually operated sluice gate located in a vault at the downstream toe of the dam. A 16 inch pipe is constructed through the right end of the ogee spillway for the purpose of providing required low flow releases.

1.3 Pertinent Data.

a.	Drainage Area.	82 square miles
b.	Discharge at Dam Site(cfs).	29780

c. Elevation (Feet).

Top of Dam	325 (design) 324.5(low point on crest)
Maximum Pool	322.9 (design flood wall)
Normal Pool	308 (spillway crest)
Upstream Invert Outlet Works	265
Downstream Invert Outlet Works	262
Maximum Tailwater	Unknown
Downstream Toe	262
Invert 16 inch Low Flow Release Conduit	293

d. Reservoir Length (Feet).

Normal Pool	11,500±
Maximum Pool	84,000±

e. Storage (Acre-Feet).

Normal Pool Level	2700
Maximum Pool Level	7300
Top of Dam	7880

f. Reservoir Surface (Acres).

Normal Pool Level	215
Maximum Pool Level	388
Top of Dam	407

g. Dam.

Type	Earthfill
Volume of Fill	40,000 cubic yards
Length	750± feet
Height	62.5 feet
Width of Top	12± feet
Side Slopes	Downstream: 1V:2H Upstream: Above riprap: 1V:2.5H Below riprap: 1V:3H
Zoning	None
Impervious Core	None
Cutoff	Keyway comprised of compacted fill
Grout Curtain	None

h. Outlet Works (48-Inch Conduit).

Length	250± feet
Closure	48-inch Sluice gate
Access	Accessible from downstream Toe of Dam

i. Regulating Pipe (16-inch Conduit)

Length	20± feet
Location	Through right end of ogee spillway
Invert Elevation	293
Regulating facilities	12 inch orifice plate attached to upstream side of conduit

j. Spillway

Type	Ogee crest spillway
Length	122 feet
Crest Elevation	308
Gates	None
Upstream Channel	Lake
Downstream Channel	Stilling basin

SECTION 2
DESIGN DATA

2.1 Design.

a. Data Available. Construction drawings, design data, and correspondence files regarding the dam were obtained from the State of Maryland, Water Resources Administration. It should be noted that the construction drawings do not represent the as-built condition.

(1) Hydrology and Hydraulics. No design computations for hydrology and hydraulic analyses are available.

(2) Embankment. Construction drawings, slope stability analyses and seepage analyses are available.

(3) Appurtenant Structures. The available information includes construction drawings.

b. Design Features.

(1) Embankment. The typical section indicates that the embankment is constructed with compacted earthfill. Riprap slope protection is included on the upstream slope and along the downstream toe. A typical section of the dam is included as Plate E-2. The dam has a cutoff trench excavated to bedrock, and a toe filter.

(2) Appurtenant Structures. The appurtenant structures consist of a 48-inch diversion pipe and sluice gate vault, and a 122 foot wide ogee crest spillway at the left end of the dam. Immediately downstream of the ogee crest are two overlapping concrete aprons with boulders formed into them. The aprons serve as plunge pools and the boulders as energy dissipators. A 16 inch pipe is constructed through the right end of the ogee spillway for the purpose of providing low flow releases.

c. Design Data.

(1) Hydrology and Hydraulics. No design data is available.

(2) Embankment. Available data includes construction drawings and slope stability and seepage analyses.

2.2 Construction. The only data regarding construction of the dam are included on the construction drawings and within the correspondence file obtained from the State of Maryland Water Resources Administration.

Field observations indicate that the ogee crest spillway has been constructed in conformance with the construction drawings.

2.3 Operation. The level of the lake normally corresponds to the elevation of the ogee crest elevation, +308. To lower the water level of the lake, the sluice gate at the downstream end of the 48-inch diversion pipe must be opened. No operating records of the dam have been kept.

2.4 Other Investigations. The Robert B. Balter Company, Geotechnical Engineers, prepared a report entitled, "Linganore Creek Dam, Frederick County, Maryland," in June 1978. The purpose of the report was to identify problems related to the undermining of the upper concrete apron of the spillway, and to recommend measures for repairing the apron. The report also identified erosion along the banks downstream of the spillway, and cracks and joint separations in the spillway retaining wall. A supplementary investigation into the erosion and retaining wall problems was made by Harris, Smariga & Associates, Inc. of Frederick, Maryland in 1980. The recommended repairs, which consisted of injecting concrete beneath the undermined apron, repairing cracks and joint separations in the concrete apron and in the spillway retaining walls, and replacing riprap slope protection along eroded banks downstream of the spillway, were completed in the Spring of 1980.

2.5 Evaluation.

a. Availability. Design information was obtained from the State of Maryland, Water Resources Administration.

b. Adequacy. The available data is sufficient to make a technical assessment of the embankment.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The on site inspection of the Lake Linganore Dam consisted of:

(1) Visual inspection of the embankment and embankment toe.

(2) Visual examination of the appurtenant structures.

(3) Evaluation of the hazard potential.

The specific observations are shown on Plate A-1.

b. Embankment. The general inspection of the embankment consisted of a searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features. Small trees were noted throughout the downstream slope of the embankment. On the downstream slope, a zone of surface erosion was noted just right of the right retaining wall, and an erosion gully was noted at the right end of the dam. A seepage area, with an estimated flow rate of 5 gpm, was noted near the toe of the right end of the dam. The source of the seepage was not apparent. A zone of saturated soil was noted downstream of the left retaining wall of the spillway. The source of the wet area was not apparent, but springs have been reported in the general area.

The crest of the embankment was surveyed and the variance in elevation was 18 inches between the high and low points. The low point on the crest is located adjacent to the right spillway retaining wall and is 6 inches below the design dam crest elevation of 325. Freeboard at the time of inspection was approximately 16.5 feet. The dam crest profle is included as Plate C-2.

c. Appurtenant Structures. The ogee crest spillway, retaining walls, and sluice gate vault were examined for deterioration or other signs of distress. A small amount of leakage was observed around the 48-inch sluice gate housed in the outlet structure. With the exception of the structural cracks and joint separations in the retaining walls and concrete apron which were repaired in the Spring of 1980, the appurtenant structures were noted to be in satisfactory condition.

d. Reservoir Area. In general, gently sloping woodlands come up to the bank of the lake. No major erosion was noted along the banks of the lake and no significant amount of sedimentation was noted.

e. Downstream Channel. The spillway discharges into a stilling basin which has riprap slope protection. The downstream side of the stilling pond is bounded by an embankment carrying Eagleshead Road over Linganore Creek. It was reported that during Tropical Storm David in 1979, a portion of the embankment was breached. A temporary embankment was constructed in its place. Two steel pipes convey water from the stilling basin beneath Eagleshead Road to Linganore Creek. Two residences and the Frederick Water Purification Plant were noted downstream along Linganore Creek within 1.8 miles of the dam. Since a dam failure could result in damage to both the residences and the water purification plant, a high hazard classification is warranted for the Lake Linganore Dam.

3.2 Evaluation. The visual examination of the Lake Linganore Dam indicates that the dam embankment is in fair condition. The elevation of the dam crest should be increased to conform to the design crest elevation of 325. The seepage area noted near the toe at the right end of the dam and a zone of saturated soil noted downstream of the left retaining wall should be monitored. If flow or turbidity from the seepage area increases significantly or if the zone of saturated soil enlarges, the Owner should retain a Professional Engineer experienced in dam design and construction to investigate the source of the water and recommend a method of controlling the flow. The spillway retaining walls should also be monitored for deflections. Any cracks or joint separations in the walls should be repaired as soon as they are noted.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the Lake Linganore Dam. Currently, the lake is maintained at the crest elevation of the ogee spillway. To lower the lake level, as it was in the Spring of 1980 to facilitate repairs to the spillway, the manually operated sluice gate at the downstream end of the 48-inch diversion pipe must be opened.

4.2 Maintenance of the Dam. Maintenance of the dam appears to be on an unscheduled basis. The high grass and small trees growing on the downstream slope suggest that the embankment is not mowed on a regular basis.

4.3 Maintenance of Operating Facilities. The maintenance of the operating facilities appears to also be done on an unscheduled basis. Structural cracks and joint separations in the upper concrete apron and retaining walls of the spillway were repaired in the Spring of 1980. The sluice gate vault appeared to be in satisfactory condition. A small amount of seepage was noted along the sluice gate.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are not available near the site.

4.5 Evaluation. The maintenance of the dam and the operating facilities are considered fair. Since cracks and joint separations have already been noted and repaired on the spillway structure, the Owner should regularly inspect the dam and repair any new cracks and joint separations before they enlarge. Since there is no upstream shutoff for the 48-inch diversion pipe, a gate should be added on the upstream side of the dam.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. Computations forwarded to the Maryland Department of Water Resources by the Robert B. Balter Company, Geotechnical Engineers on April 13, 1980 suggest that the original spillway design for Lake Linganore Dam which incorporated bridge piers was rated at approximately 4500 cubic feet per second (cfs) when the reservoir was passing a design "freeboard hydrograph" having a peak discharge of approximately 32,000 cfs. During final design of the spillway, the bridge piers were eliminated and the spillway dimensions revised. A July 28, 1970 letter by the above mentioned consultant suggests that no flood routings were performed for the revised spillway design since the revised design "would not alter the hydrological or hydraulic considerations on which the original design was based".

b. Experience Data. No records of maximum pool levels are maintained. During rehabilitation of the dam in the Spring of 1980, data pertaining to the time required to drain the reservoir was recorded. The records indicate that it took 22 days to lower the lake level 12 feet from elevation +308 to elevation +296. It should be noted that the sluice gate was only 3/4 open during the 22 day period.

A U.S. Geological Survey streamflow gaging station is maintained approximately 0.5 mile downstream from the dam. Streamflow records indicate that the June 22, 1972 peak discharge of 20,100 cfs resulting from Hurricane Agnes represents the flood of record. The maximum river stage during this event was 19.5 feet. The Owner reports that the dam was not overtopped during Hurricane Agnes, but the road abutting the stilling basin at the base of the spillway was overtopped and severely damaged. The Owner indicates that the road was again overtopped and damaged during Tropical Storm David on September 6, 1979, and during several flashflood events subsequent to Tropical Storm David. Streamflow records for the Linganore gaging station indicate a peak discharge of 5390 cfs and a maximum river stage of 12.1 feet for the September 6, 1979 storm.

c. Visual Observations. Several observations made during the visual inspection of the Lake Linganore Dam are particularly relevant to the hydraulic and hydrological evaluation.

(1) Embankment. The survey of the dam crest profile performed during the visual inspection indicates that the existing crest is slightly lower than its design elevation of 325 feet above m.s.l. with its low point at elevation 324.5 feet above m.s.l. This low point occurs adjacent to the right abutment of the ogee spillway. The data for the existing crest was employed in subsequent hydraulic analyses.

(2) Ogee Spillway. The spillway crest appears to have been constructed in accordance with record contract drawings. During the visual inspection a medium sized tree trunk was trapped at the spillway crest. While the tree by itself would not significantly affect the spillway capacity, and most likely would become dislodged as the water rises, the spillway should be maintained free of any debris which could obstruct the spillway during peak flood events. The 16-inch low flow outlet pipe which is constructed in the spillway appeared to be functioning properly, as it was discharging freely at the times of inspection.

(3) Appurtenant Structures. The outlet structure at the toe of the dam embankment appears to have been constructed in accordance with the record contract drawings. During the visual inspection, some leakage was observed around the 48-inch sluice gate housed in the outlet structure.

(4) Downstream Conditions. Failure of the Lake Linganore Dam could cause serious damage to the 2.0-million gallon per day City of Frederick Water Purification Plant which is situated adjacent to Linganore Creek, approximately 1.8 miles downstream from the dam. During visual inspection of the purification facility, the plant operator reported that flood waters over topped the plant operating floor level during Hurricane Agnes. Failure of the dam could also cause flooding of two dwellings located between the dam and the purification plant. Based upon previous flood damage experience downstream from the dam, a dam failure would undoubtedly sever Eagleshead Drive, one of the few roadways connecting the north and south shores of the Lake Linganore development. Primarily because of the increased hazard of flooding downstream dwellings, and of the increased potential for serious damage of the City of Frederick Water Purification Plant, a high hazard classification is warranted for Lake Linganore Dam.

d. Overtopping Potential. According to the criteria promulgated by the Office of the Chief of Engineers, the recommended Spillway Design Flood (SDF) for a dam classified as "intermediate" with a "high" hazard potential is 100 percent of the Probable Maximum Flood (PMF).

The Probable Maximum Precipitation (PMP) index as adjusted for the Lake Linganore drainage area is 20.6 inches in 24 hours. Employing criteria established by the Corps of Engineers, Baltimore District, 100 percent and 50 percent PMF inflow hydrographs developed using the HEC-1 computer program have peaks of 67,800 and 33,900 cfs, respectively. It is interesting to note that the 20,100-cfs peak discharge of the June, 1972 flood of record amounted to nearly 30 percent of the Probable Maximum Flood.

PMF inflow hydrographs were routed through Lake Linganore for percentages ranging from 20 to 100 percent of the PMF with each routing starting at the normal pool level of 308 feet above m.s.l. The analyses suggest that the Lake Linganore spillway can pass approximately 48 percent of the PMF without overtopping the dam. However, for the 50 percent PMF routing, the reservoir water level would reach an elevation of 325.1 feet above m.s.l., overtopping the low point in the dam embankment by 0.6 feet. For the 100 percent PMF routing, the reservoir water level would reach an elevation of 329.7 feet above m.s.l., overtopping the embankment low point by 5.2 feet. Results for intermediate routings are found in Appendix D.

e. Spillway Adequacy. The analyses indicate that overtopping of the Lake Linagnore Dam embankment during the occurence of a 50 percent PMF event would have a duration of 4.0 hours. It is judged that a 0.6 foot maximum overtopping depth and 4.0-hour duration could be sufficient to result in failure of the dam embankment. Dam failure analyses have been performed for several different failure configurations for a 50-percent PMF event, assuming each failure begins when the dam first starts to be overtopped. (Failure configurations are identified in Appendix D). On the basis of these analyses, routing of the resultant flood wave downstream suggests that failure of Linganore Dam would raise water levels in the vicinity of the two downstream dwellings from as little as 0.3 foot to as much as 11 feet over the water surface that existed just prior to failure, depending upon the breach depth and configuration. Similarly, such a failure would raise water levels at the City of Frederick Water Purification Plant from as little as 0.4 foot to as much as 16 feet over that existing prior to the dam failure. Since the failures of the dam could result in an increased hazard to loss of life downstream, the spillway capacity is rated as seriously inadequate in accordance with Office of the Chief of Engineers guidelines.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) Embankment. The amount of surface erosion and small trees growing on the downstream slope of the embankment is not extensive enough to jeopardize the structural integrity of the embankment at this point. However, both the seepage area near the toe at the right end of the dam and the zone of saturated soil noted downstream of the left spillway retaining wall should be monitored. If the rate or turbidity of flow from the seepage area increases significantly, or if the zone of saturated soil enlarges, an investigation should be conducted to determine the source of the water and to determine a means of controlling the flow.

(2) Appurtenant Structures. The structural cracks and joint separations on the spillway retaining walls and apron were apparently the results of either the undermining of bearing material below the apron, or by earth pressure exerted on the retaining walls. Repairs were made to the spillway retaining walls and apron in the Spring of 1980, and at the time of the inspection, no further problems were noted. The 48-inch diversion pipe through the embankment could not be inspected, but the sluice gate vault was in satisfactory condtion. A small amount of leakage was noted along the sluice gate.

b. Design and Construction Data.

(1) Embankment. The available information consists of the construction drawings and slope stability and seepage analyses.

(2) Appurtenant Structures. Information such as the calculated earth pressures exerted against the retaining walls of the spillway is not available to assess the structural adequacy of the appurtenant structures.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. Repairs were made to the undermined apron and to cracks and joint separations in the spillway in the Spring of 1980. Additional riprap slope protection was placed along the bank downstream of the left retaining wall of the spillway.

e. Seismic Stability. The dam is located in Seismic Zone 1. Based on our visual observations, the static stability of the dam appears to be adequate. Consequently, the structure should present no hazard from earthquakes.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Assessment. The Lake Linganore Dam is an intermediate storage, high hazard impoundment. If the dam failed, the City of Frederick Water Purification Plant and two residences located downstream along Linganore Creek within 1.8 miles of the dam could sustain damage. The hydrologic and hydraulic analyses of the dam indicate that the spillway is seriously inadequate, resulting in an unsafe, non-emergency classification for the dam. The dam would be overtopped during a flood equalling 50% of the Probable Maximum Flood (PMF), but would not be overtopped by a flood equaling 48% of the PMF. The dam embankment is rated only fair because of the presence of limited surface erosion and an erosion gully, the presence of a seepage area at the right end of the dam and a wet area downstream of the left spillway retaining wall, and the low point on the crest which is 6 inches below the dam crest design elevation.

b. Adequacy of Information. Available information, in conjunction with visual observations, is considered to be sufficient to make the following recommendations.

c. Urgency. The remedial measures recommended below should be accomplished immediately.

d. Need for Additional Data. The Owner should retain the services of a Professional Engineer experienced in dam design and construction to perform detailed hydrologic and hydraulic analysis to further assess spillway adequacy and develop remedial measures to provide adequate spillway capacity.

7.2 Recommendation/Remedial Measures.

The following remedial measures are recommended to be accomplished by the Owner immediately:

a. Retain a Professional Engineer experienced in dam design and construction to perform detailed hydrologic and hydraulic analysis to further assess spillway adequacy and develop remedial measures to provide adequate spillway capacity.

b. Build up the dam crest as required to restore the original dam design crest elevation of +325.

c. Remove all woody vegetation from the downstream slope of the embankment.

d. Repair the surface erosion and erosion gully noted on the downstream slope.

e. Regularly inspect and monitor the spillway retaining walls, the seepage area noted near the toe of the embankment at the right end of the dam, and the wet area noted downstream of the left retaining wall of the spillway. If movement of the retaining walls is detected, remedial measures should be taken to repair the walls. If the rate or turbidity of the flow from the seepage area increases significantly, or if the wet area enlarges significantly, the Owner should retain the services of a Professional Engineer experienced in dam design and construction to investigate the source of the water and to recommend a means of controlling the flow.

f. Add a gate to the upstream end of the 48-inch diversion pipe to allow for cutting off flow under the dam should repairs to the pipe become necessary in the future.

g. Develop a formal program of maintenance and inspection for the dam and appurtenant structures.

h. Develop a formal warning system to alert the downstream residents and the City of Frederick in the event of emergencies.

APPENDIX A

VISUAL INSPECTION CHECKLIST

PHASE I

APPENDIX A
VISUAL INSPECTION CHECKLIST
PHASE I

Name of Dam: Lake Linganore County(or City): Frederick County State: Maryland

NDI ID. No.: MD-21 Type of Dam: Earth Hazard Category: High

Date(s) Inspection: 6/24/80 and 7/15/80 Weather: Partly Cloudy Temperature: 80's

Pool Elevation at Time of Inspection: 308 M.S.L. Tailwater at Time of Insp. _____ M.S.L.

Inspection Personnel:

J. D. Nauman

G. Stanford

Review Inspection Personnel:

E. J. Zeigler

J. G. Mintiens

J. D. Nauman

J. D. Nauman Recorder

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Shallow erosion gullies on downstream slope. Small area of surface erosion noted right of the right spillway retaining wall.	Small trees growing on downstream slope should be removed.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment satisfactory Vertical alignment of crest varies by 18"	
RIPRAP FAILURES	None at present; additional riprap was placed along bank of stilling pond in the Spring of 1980.	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Joint separation on right spillway retaining wall has been repaired with epoxy. Apparent cause is earth pressure exerted on wall. Cracks through concrete apron and left retaining wall have been fixed.	Repairs to spillway retaining wall and apron were made in the Spring of 1980. The owner should monitor the retaining walls.
ANY NOTICEABLE SEEPAGE	Seepage area noted near toe of right end of dam. Estimated flow 5 gpm. Wet area noted downstream of left spillway retaining wall. No flow noted	Both the seepage area and the wet area should be monitored. If the rate or turbidity of the flow from seepage area increases, the seepage should be controlled.
STAFF GAGE AND RECORDER	None at dam site. U.S.G.S. streamflow gaging station located 0.5 mile downstream from dam	
DRAINS	Toe drains	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None	
INTAKE STRUCTURE	48-inch ϕ prestressed concrete pipe riser with trash rack (submerged during inspection)	A gate should be added to upstream end of pipe to provide upstream closure.
OUTLET STRUCTURE	Sluice gate vault with manually operated gate	
OUTLET CHANNEL	Discharges into stilling pond, riprap on banks, west bank is earth embankment carrying Eagleshead Road over Linganore Creek	Two Armco steel pipes, 12'10" by 8'4" carry water under Eagleshead Road.
EMERGENCY GATE	A small amount of leakage was noted around the sluice gate	Sluice gate operation was not observed during the inspection.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY (PRINCIPAL SPILLWAY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Ogee spillway	
APPROACH CHANNEL	One large tree is located on crest of Ogee spillway	
DISCHARGE CHANNEL	Boulders cast in concrete slab act as baffles	Previous problems with loss of bearing beneath apron remedied with injection of concrete
BRIDGE AND PIERS	N/A	
Retaining Walls and Concrete Slabs	Right wall separated 4 inches (±) at expansion joint. Left wall cracked at two locations. Concrete aprons act as stilling pools.	Repairs have been satisfactorily performed.

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

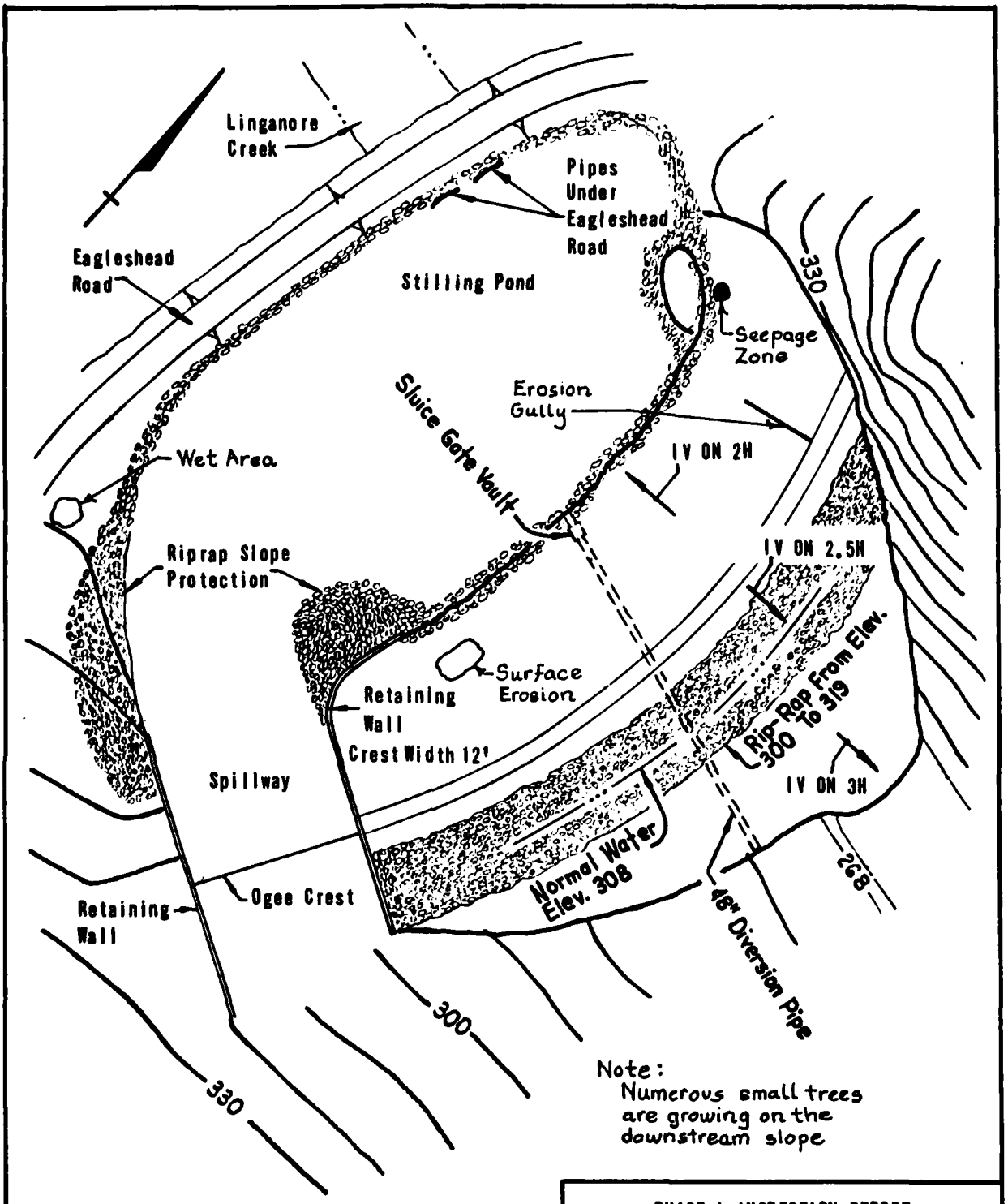
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None observed. Three piezometers were installed across dam section for monitoring during dam construction.	
OTHER		

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Upstream Embankment, Vegetated 2.5 Horizontal to 1 Vertical at and above riprap slope protection 3 Horizontal to 1 Vertical below riprap	
SEDIMENTATION	Nothing critical	
UPSTREAM RESERVOIRS	No reservoirs noted upstream of Lake Linganore	
WATERSHED DESCRIPTION	Watershed area is generally undeveloped. Few residences and recreational areas along shore of lake.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Crossing at Eagleshead Road directly downstream might impound water during heavy flow	Road was washed out during Tropical Storm David in 1979. Temporary embankment constructed
SLOPES	Riprap slope protection upstream from Eagleshead Road Below Eagleshead Road, flood plain narrow, with boulders and bedrock outcrops	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Two residences and Frederick Water Purification Plant located along Linganore Creek within 1.7± miles downstream of dam.	The residences and water purification plant could be flooded if the dam failed.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LINGANORE

LINGANORE COMMUNITY ASSOCIATION

RESULTS OF VISUAL INSPECTION

JULY 1980

PLATE A-1

APPENDIX B

ENGINEERING DATA CHECKLIST

PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lake Linganore

ID# NDI I.D. No. Md-21

ITEM	REMARKS
AS-BUILT DRAWINGS	Contract drawings titled "Linganore Creek Dam" by Robert B. Balter, Soil and Foundation Consultants, Inc. dated November 10, 1970, Sheets 1 of 12 thru 12 of 12 and Sheets R1, R2, and SC.
REGIONAL VICINITY MAP	A regional vicinity map is included as Plate E-1.
CONSTRUCTION HISTORY	Construction completed in 1971. Repairs made to concrete cracks in Spring of 1980
TYPICAL SECTIONS OF DAM	A typical section of the embankment is shown on the Contract drawings and is included as Plate E-2
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Contract drawings for outlet plans and details. Discharge ratings apparently not computed for final spillway design.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None at dam site. U.S.G.S. streamflow gaging station located 0.5 miles downstream from dam. Period of record: November, 1931 to March, 1932; September, 1934 to present
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Design computations for hydrology and hydraulics not available. For dam stability and seepage study, analyses, see July 28 and August 14, 1970 letters Maryland Department of Water Resources
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not available

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	Survey in conjunction with remedial work performed in Spring of 1980
BORROW SOURCES	UnKnown
MONITORING SYSTEMS	Three piezometers installed across dam section. Refer to August 14, 1970 letter to Maryland Department of Water Resources.
MODIFICATIONS	Repairs to cracked concrete made in Spring of 1980
HIGH POOL RECORDS	None

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	"Lingonore Creek Dam, Frederick County, Maryland" by the Robert B. Balter Company, Geotechnical Engineers, dated 6/15/78. Supplementary inspection made by Harris, Smariga & Associates, Inc. of Frederick, Md. in 1980.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	None
SPILLWAY PLAN SECTIONS DETAILS	Shown on Contract drawings.
OPERATING EQUIPMENT PLANS AND DETAILS	Shown on Contract drawings.

APPENDIX C

PHOTOGRAPHS

A. Crest of Dam

B. Lake Linganore immediately upstream of dam

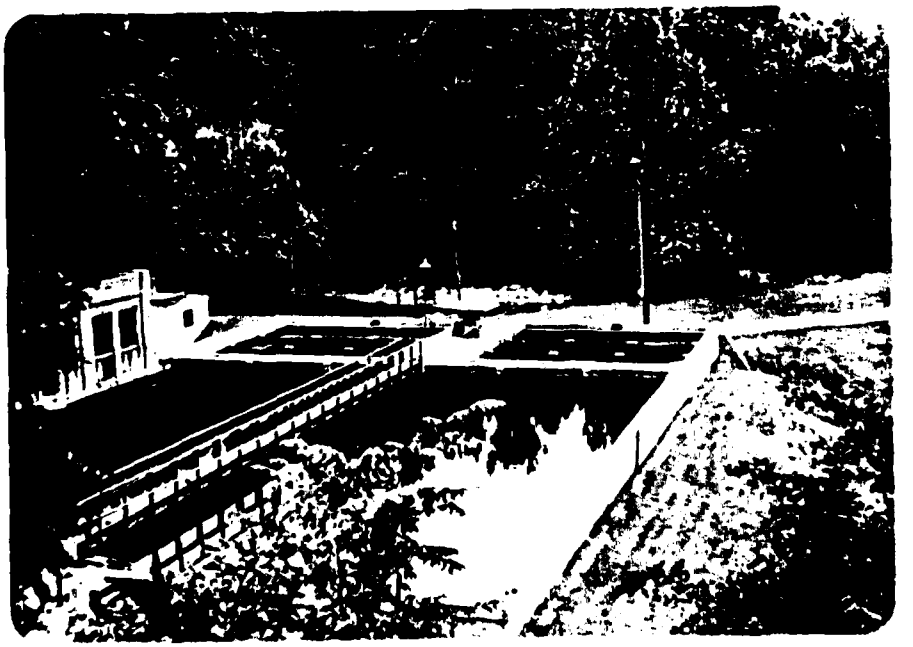
C. Downstream face of dam, sluice gate vault, and riprap slope protection

D. Small trees growing on downstream slope of dam

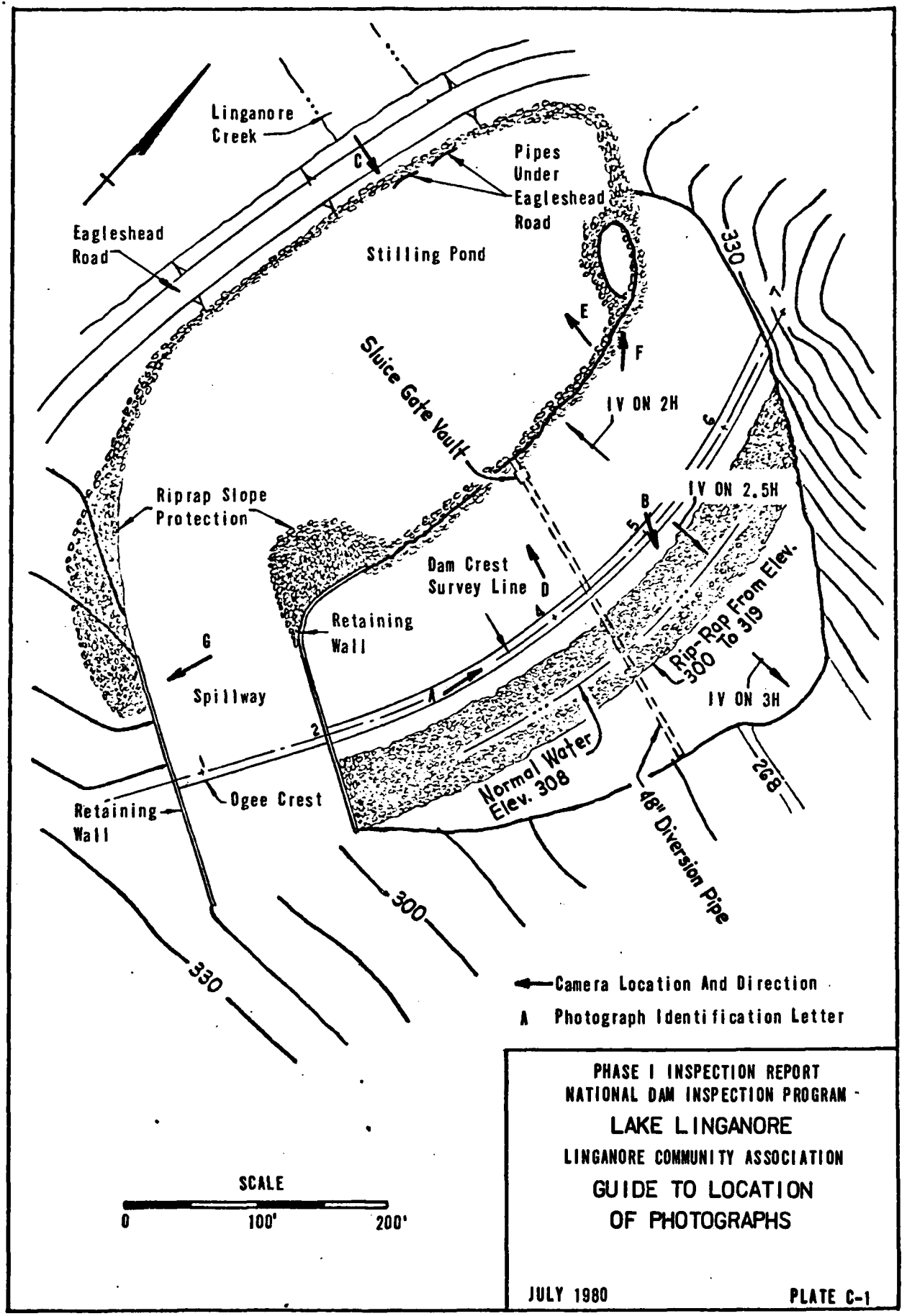
E. Two steel pipes which convey water beneath Eagleshead Road from stilling basin to Linganore Creek

F. Seepage noted where man stands near toe at right end of dam

G. Two cracks in the left retaining wall of the spillway have been repaired



H. Frederick Filtration Plant along Linganore Creek



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

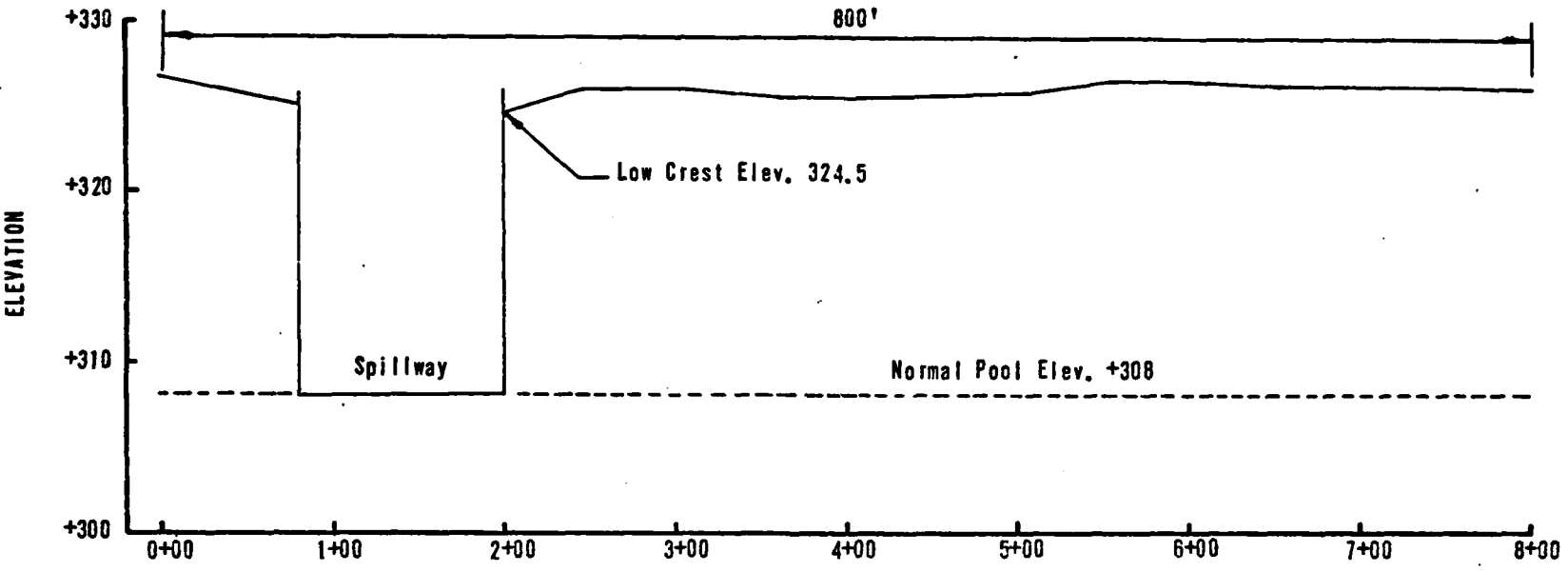
LAKE LINGANORE

LINGANORE COMMUNITY ASSOCIATION

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1980

PLATE C-1



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTE:

DAM CREST SURVEY STATIONS ARE SHOWN ON PLATE C-1

DATUM ELEVATION IS INTERPOLATED FROM 50 SCALE CONTRACT DRAWINGS.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LINGANORE

LINGANORE COMMUNITY ASSOCIATION

DAM CREST SURVEY

JULY 1980

PLATE C-2

APPENDIX D

HYDROLOGY AND HYDRAULICS

BASE DATA FOR DETERMINATION OF PROBABLE MAXIMUM FLOOD, UNIT HYDROGRAPH AND INFLOW HYDROGRAPHS

Name of Dam: Lake Linganore NDI-ID MD-21

Unit Hydrograph Parameters

Watershed Drainage Area	82 sq. miles
Main Channel Length L	18.4 miles
Main Channel to Centroid Length, Lca	10.5 miles
Lag Time $tp = Ct (L \times Lca)^{0.3}$	12.12 hours
Basin Zone Location from Unit Hydrograph Coefficient Map	33
Basin Coefficients	
Cp^1	1.25
Ct^1	2.5

Inflow Hydrograph Parameters[1]

Base Flow at Start of Storm	1.5 c.f.s./sq. mile
Initial Rainfall Loss	1 inch
Uniform Rainfall Loss	0.05 inches/hour
Ratio of Peak Discharge Used to Compute Base Flow wich Deviates from Hydrograph Falling Limb	0.05
Ratio of Recession Flow occuring 10 Tabulation Intervals Later	2.0

Rainfall Data[2]

Probable Maximum Precipitation Index for 24 hours and 200 square miles	24 inches
Percentage Adjustments of PMP for Drainage Area	
6 hour storm	92%
12 hour storm	100%
24 hour storm	110%

---

[1] Basin Coefficients and Hydrograph Data established by Corps of Engineers Baltimore District

[2] Hydrometeorological Report 33 by Corps of Engineers, Baltimore District

Tabulation of Reservoir Area and Storage Vs. Elevation[1]

Name of Dam: Lake Linganore NDI-ID MD-21

Pool Elevation feet above m.s.l.	Surface[1] Area acres	Reservoir[1] Storage acre-feet
265 (Reservoir Bottom)	0	0
270	2	10
280	15	100
290	55	450
300	130	1250
310	240	3100
320	355	6100
322.9[2] (Maximum Pool)	388	7300
324.5 (Top of Dam)	407	7900

---

[1] Computed by Rummel, Klepper and Kahl Using Adjusted Plainimetered Areas From 1000-scale USGS Mapping

[2] Based upon March 31, 1970 "Freeboard Hydrograph Routing" by Robert B. Balter, Soil and Foundation Consultants, Inc.

BASE DATA FOR OUTFLOW STRUCTURE
RATING CURVE FOR COMPUTER ANALYSIS

Name of Dam: Lake Linganore NDI-ID MD-21

Ogee Spillway:

Crest Elevation	308 feet above m.s.l.
Spillway Width	122 feet
Discharge Coefficient[1]	3.8
Flow Equation Exponent	1.5

Low Level Outlet:

Centerline Elevation of 16-inch Low Level Outlet	293.67 feet above m.s.l.
Orifice Plate Area for 12-inch Orifice	0.79 sq. feet
Discharge Coefficient[2]	0.594[1]
Flow Equation Exponent	0.5

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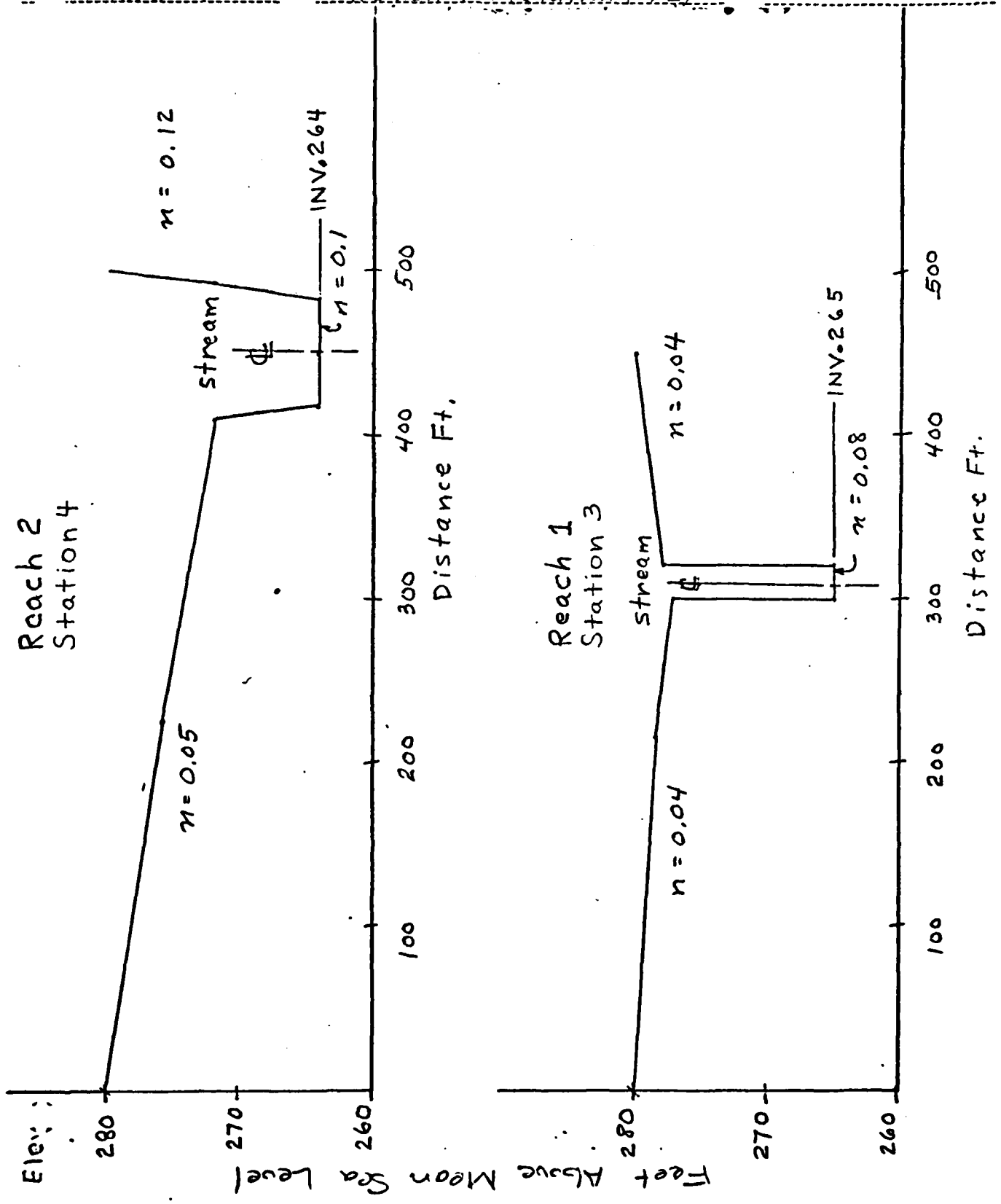
[1] Source: Design of Small Dam, U.S. Department of Interior, Bureau of Reclamation, 1960.

[2] Source: Handbook of Hydraulics, King of Brater, 1963.

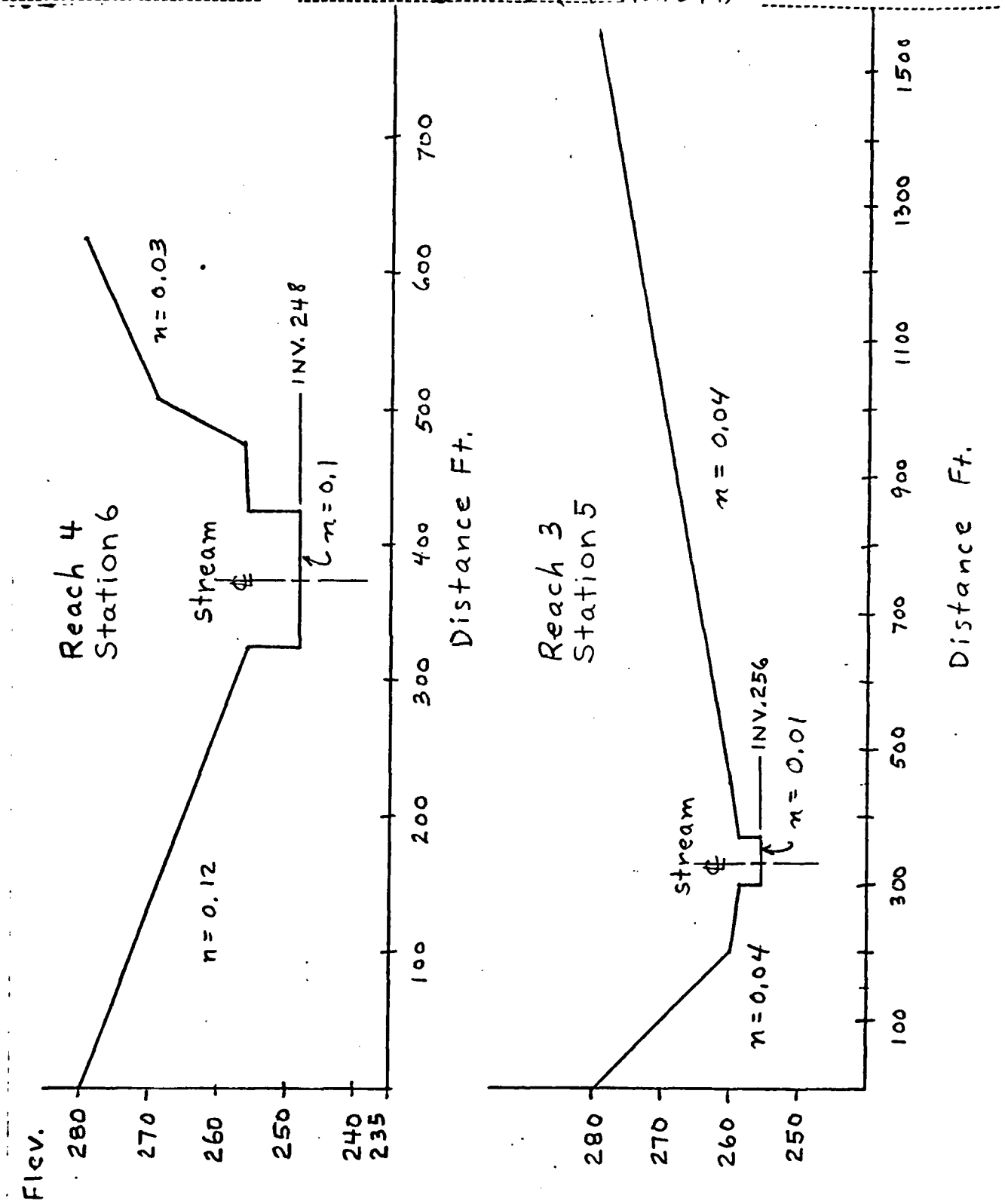
BY G.E.S. DATE 7/18/80 SUBJECT Phase I - Dam Inspection Program SHEET NO. 1 OF 2

CHKD. BY [illegible] DATE 7/18/80 Lake Linganore JOB NO. 580-21-20

Reach 1+2 (Station 1+2)



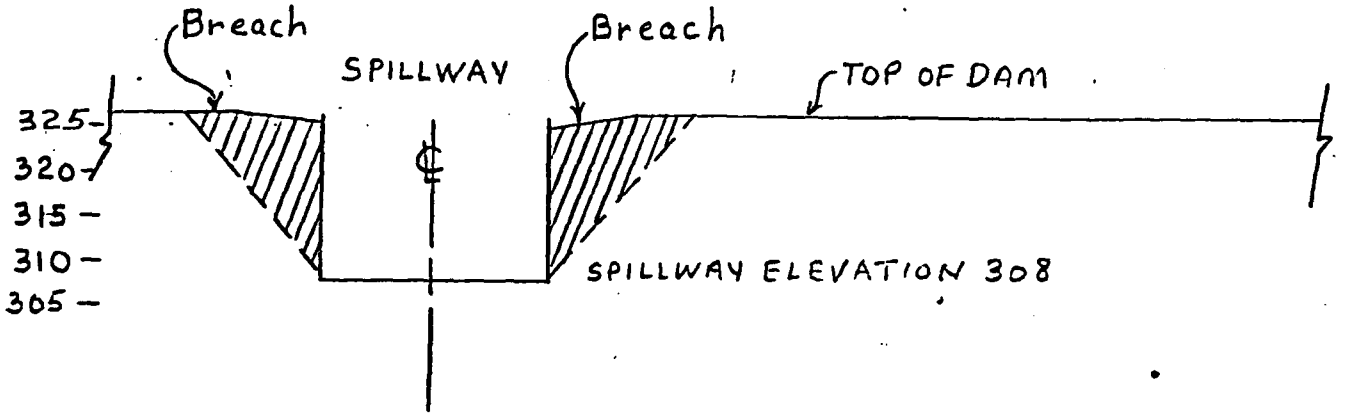
BY G.E.S. DATE 7/18/80 SUBJECT Phase I - Dam Inspection Program SHEET NO. 2 OF 2
CHKD. BY [illegible] DATE 7/18/80 Lake Lingenore JOB NO. 580-21-20
Reach 3 and 4 (Station 3+44)



BREACH DATA

Shape of Breach	V-Shape
Bottom Width of Breach	0 feet
Maximum Depth of Breach	16.5 feet
Side Slope of Breach	1 to 1
Water Level at Beginning of Breach	325
Time to Maximum Size	1 hour

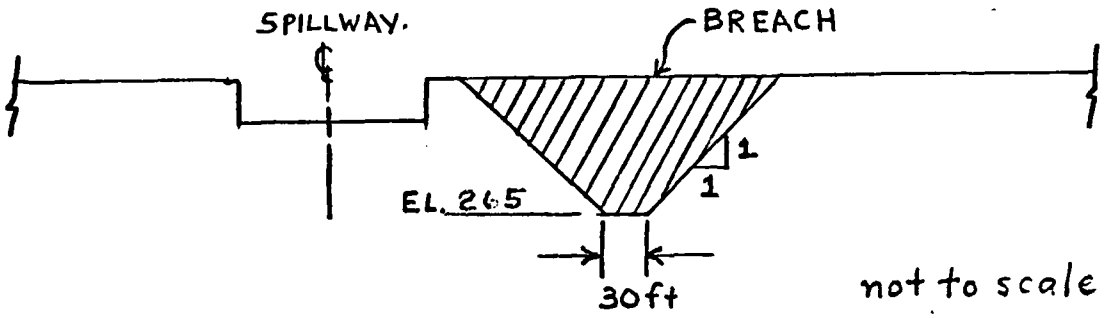
BREACH DIAGRAM



BREACH DATA

Shape of Breach	Trapezoid
Bottom Width of Breach	30 feet
Maximum Depth of Breach	59.5 feet
Side Slope of Breach	1 to 1
Water Level at Beginning of Breach	325 feet above m.s.l.
Time to Maximum Size	1 hour

BREACH DIAGRAM



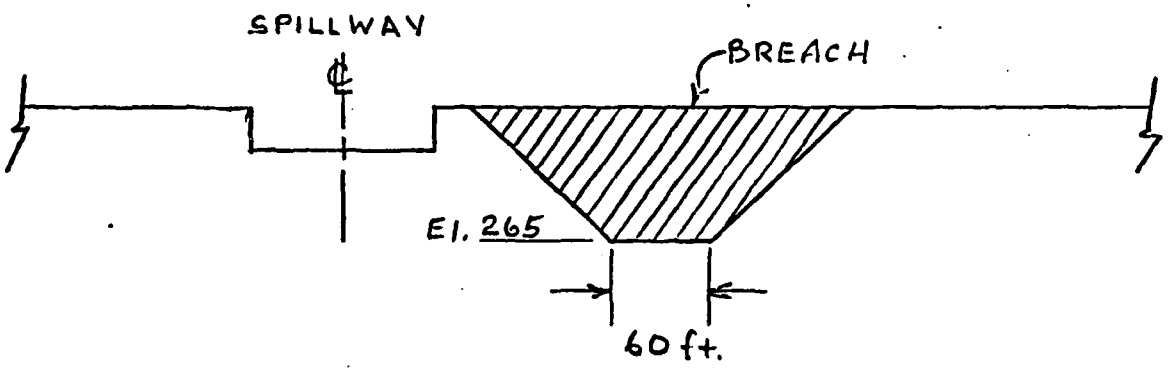
not to scale

BY G.F.S. DATE 7/18/80 SUBJECT Phase I - Dam Inventory Program SHEET NO. 3 OF 3
CHKD. BY JD DATE 7/18/80 Lake Linganore JOB NO. 580-21-20
Breach No. 3 (Plan 3)

BREACH DATA

Shape of Breach	Trapezoid
Bottom Width of Breach	60 feet
Maximum Depth of Breach	59.5 feet
Side Slope of Breach	1 to 1
Water Level at Beginning of Breach	325 feet above m.s.l.
Time to Maximum Size	1 hour

BREACH DIAGRAM



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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND OVERTOPPING ANALYSES FOR
    2                A2       20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% AND 100% PMF AT LAKE LINGANORE DAM
    3                A3       ND1-1.D.MD21   COMM.NO.580-21-2D
    4                B    150         1         0         0         0         0         0         0        -4         0
    5                B1     5
    6                J      1         9         1
    7                J1   0.2       0.3       0.4       0.5       0.6       0.7       0.8       0.9       1.0
    8                K      0         1                             0         0         1         0
    9                K1       CALCULATION OF SNYDER UNIT HYDROGRAPH TO LAKE LINGANORE
   10                M      1         1        82                82         0                             1
   11                P      0        24        92       100      110
   12                T                                                                   1      0.05
   13                W  12.12      1.25
   14                X   -1.5     -0.05       2.0
   15                K      1         2
   16                K1       ROUTED FLOWS THROUGH LAKE LINGANORE
   17                Y                                        1         1
   18                Y1     1                                                          2730         0
   19                $S     0        10       100       450      1250      3100      6100      7880     10200     11600
   20                $E   265       270       280       290       300       310       320     324.5       330       335
   21                $$   308       122      3.80       1.5    293.67     0.594       .79       0.5
   22                $D 324.5      2.63       1.5      10.0
   23                $L    10       188       488       678
   24                $V 324.5     325.5       326     326.3
   25                K      1         3                                                    1
   26                K1       ROUTED FLOWS MOD PULS REACH 1
   27                Y                                        1         1
   28                Y1     1
   29                Y6  0.04      0.08      0.04       265       320       375     0.004
   30                Y7     0       330       200       280       500       277       500       265       520       265
   31                Y7   520       278       620       280       850      .330
   32                K      1         4                                                   1
   33                K1       ROUTED FLOW MOD PULS REACH 2
   34                Y                                        1         1
   35                Y1     1
   36                Y6  0.05       0.1      0.12       264       310       200     0.004
   37                Y7     0       310       250       280       700       272       705       264       740       264
   38                Y7   775       264       825       280       900       310
   39                K      1         5                                                    1
   40                K1       ROUTED FLOW MOD PULS REACH 3
   41                Y                                        1         1
   42                Y1     1
   43                Y6  0.04       0.1      0.04     253.5       280      3700     0.003
   44                Y7     0       280       200       260       300       259       300       256       375       256
   45                Y7   375       259       450       260      1550       280
   46                K      1         6                                                    1
   47                K1       ROUTED FLOW MOD PULS REACH 4
   48                Y                                        1         1
   49                Y1     1
   50                Y6  0.12       0.1      0.03       248       280      5000     0.002
   51                Y7     0       280       325       256       325       248       425       248       425       256
   52                Y7   475       257       510       269       625       280
   53                K     99
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****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 06 FEB 80
****

SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND OVERTOPPING ANALYSES FOR
20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% AND 100% PMF AT LAKE LINGANORE DAM.
ND1-1. D. MD21 COMM. NO. 580-21-2D

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	1	0	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

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

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF SNYDER UNIT HYDROGRAPH TO LAKE LINGANORE

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	82.00	0.00	82.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	92.00	100.00	110.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.862

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 12.12 CP=1.25 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 23 END-OF-PERIOD ORDINATES, LAG= 12.08 HOURS, CP= 0.77 VOL= 1.00

353.	998.	1481.	1825.	2112.	2364.	2591.	2799.	2993.	3175.
3347.	3459.	3409.	3243.	3066.	2877.	2674.	2455.	2214.	1943.
1625.	1219.	580.							

0 END-OF-PERIOD FLOW

MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.76	20.89	1.87	1147534.
										(578.)	(531.)	(47.)	(32494.52)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.20	RATIO 2 0.30	RATIO 3 0.40	RATIO 4 0.50	RATIO 5 0.60	RATIO 6 0.70	RATIO 7 0.80	RATIO 8 0.90	RATIO 9 1.00
HYDROGRAPH AT	1	82.00	1	13560.	20341.	27121.	33901.	40681.	47461.	54242.	61022.	67802.
		(212.38)		(383.99)(	575.98)(	767.97)(	959.97)(	1151.96)(	1343.95)(	1535.95)(	1727.94)(	1919.93)
ROUTED TO	2	82.00	1	13100.	19740.	26189.	32845.	40237.	47081.	53826.	60611.	67490.
		(212.38)		(370.96)(	558.96)(	741.60)(	930.08)(	1139.38)(	1333.19)(	1524.18)(	1716.31)(	1911.10)
ROUTED TO	3	82.00	1	13101.	19735.	26191.	32848.	40221.	47084.	53859.	60604.	67467.
		(212.38)		(370.98)(	558.82)(	741.64)(	930.15)(	1138.93)(	1333.26)(	1525.11)(	1716.11)(	1910.45)
ROUTED TO	4	82.00	1	13102.	19743.	26193.	32853.	40218.	47085.	53878.	60610.	67477.
		(212.38)		(371.00)(	559.06)(	741.69)(	930.28)(	1138.85)(	1333.31)(	1525.64)(	1716.28)(	1910.74)
ROUTED TO	5	82.00	1	13117.	19723.	26218.	32845.	40244.	47120.	53910.	60612.	67375.
		(212.38)		(371.42)(	558.49)(	742.41)(	930.05)(	1139.57)(	1334.27)(	1526.56)(	1716.35)(	1907.84)
ROUTED TO	6	82.00	1	13121.	19743.	26237.	32876.	40213.	47155.	53907.	60715.	67485.
		(212.38)		(371.54)(	559.06)(	742.94)(	930.95)(	1138.71)(	1335.27)(	1526.47)(	1719.26)(	1910.96)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	308.00	308.00	324.50
STORAGE	2730.	2730.	7880.
OUTFLOW	14.	14.	31093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	317.27	0.00	5281.	13100.	0.00	28.00	0.00
0.30	320.19	0.00	6173.	19740.	0.00	28.00	0.00
0.40	322.72	0.00	7174.	26189.	0.00	29.00	0.00
0.50	325.09	0.59	8129.	32845.	4.00	28.00	0.00
0.60	326.75	2.25	8829.	40237.	10.00	28.00	0.00
0.70	327.73	3.23	9244.	47081.	13.00	28.00	0.00
0.80	328.57	4.07	9596.	53826.	15.00	28.00	0.00
0.90	329.33	4.83	9919.	60611.	16.00	27.00	0.00
1.00	330.05	5.55	10215.	67490.	17.00	27.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.20	13101.	283.0	28.00
0.30	19735.	284.3	28.00
0.40	26191.	285.6	28.00
0.50	32848.	286.6	28.00
0.60	40221.	287.7	28.00
0.70	47084.	288.6	28.00
0.80	53859.	289.4	28.00
0.90	60604.	290.2	27.00
1.00	67467.	291.0	27.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.20	13102.	278.9	29.00
0.30	19743.	280.6	28.00
0.40	26193.	281.9	29.00
0.50	32853.	283.1	28.00
0.60	40218.	284.2	28.00
0.70	47085.	285.2	28.00
0.80	53878.	286.1	28.00
0.90	60610.	286.9	27.00
1.00	67477.	287.7	27.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.20	13117.	265.5	29.00
0.30	19723.	266.9	29.00
0.40	26218.	268.1	29.00

0.50	32845.	269.1	29.00
0.60	40244.	270.0	28.00
0.70	47120.	270.8	28.00
0.80	53910.	271.5	28.00
0.90	60612.	272.2	28.00
1.00	67375.	272.8	27.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.20	13121.	267.7	29.00
0.30	19743.	271.2	29.00
0.40	26237.	273.9	29.00
0.50	32876.	276.1	29.00
0.60	40213.	278.1	28.00
0.70	47155.	279.8	28.00
0.80	53907.	281.4	28.00
0.90	60715.	283.0	28.00
1.00	67485.	284.6	28.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM BREAK ANALYSES
    2                A2       FOR LAKE LINGANORE DAM.
    3                A3       ND1-1.D.MD21  COMM. NO. 580-21-2D
    4                B    150       1       0       0       0       0       0       0      -4       0
    5                B1     5
    6                J      3       1       1
    7                J1   0.5
    8                K      0       1                               0       0       1       0
    9                K1       CALCULATION OF SNYDER UNIT HYDROGRAPH TO LAKE LINGANORE
   10                M      1       1      82                      82       0                       1
   11                P      0      24      92     100     110
   12                T                                                               1    0.05
   13                W  12.12    1.25
   14                X   -1.5   -0.05     2.0
   15                K      1       2
   16                K1       ROUTED FLOWS THROUGH LAKE LINGANORE
   17                Y                                       1       1
   18                Y1     1                                                       2730       0
   19                $S     0      10     100     450    1250    3100    6100    7880   10200   11600
   20                $E   265     270     280     290     300     310     320   324.5     330     335
   21                $$   308     122    3.80     1.5  293.67   0.594     .79     0.5
   22                $D 324.5    2.63     1.5    10.0
   23                $L    10     188     488     678
   24                $V 324.5   325.5     326   326.3
   25                $B     0       1     308     1.0     308     325
   26                $B    30       1     265     1.0     308     325
   27                $B    60     1.0     265     1.0     308     325
   28                K      1       3                                               1
   29                K1       ROUTED FLOWS MOD PULS REACH 1
   30                Y                                       1       1
   31                Y1     1
   32                Y6  0.04    0.08    0.04     265     320     375   0.004
   33                Y7     0     330     200     280     500     277     500     265     520     265
   34                Y7   520     278     620     280     850     330
   35                K      1       4                                               1
   36                K1       ROUTED FLOW MOD PULS REACH 2
   37                Y                                       1       1
   38                Y1     1
   39                Y6  0.05     0.1    0.12     264     310     200   0.004
   40                Y7     0     310     250     280     700     272     705     264     740     264
   41                Y7   775     264     825     280     900     310
   42                K      1       5                                               1
   43                K1       ROUTED FLOW MOD PULS REACH 3
   44                Y                                       1       1
   45                Y1     1
   46                Y6  0.04     0.1    0.04   253.5     280    3700   0.003
   47                Y7     0     280     200     260     300     259     300     256     375     256
   48                Y7   375     259     450     260    1350     280
   49                K      1       6                                               1
   50                K1       ROUTED FLOW MOD PULS REACH 4
   51                Y                                       1       1
   52                Y1     1
   53                Y6  0.12     0.1    0.03     248     280    5000   0.002
   54                Y7     0     280     325     256     325     248     425     248     425     256
   55                Y7   475     257     510     269     625     280
   56                K     99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
**********
                    SNYDER UNIT HYDROGRAPH, FLOOD ROUTING AND DAM BREAK ANALYSES
                    FOR LAKE LINGANORE DAM.
                    ND1-1.D.MD21   COMM.NO. 580-21-2D

                                    JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
         150        1        0        0        0        0        0        0       -4        0
                                    JOPER      NWT    LROPT    TRACE
                                        5        0        0        0


                                MULTI-PLAN ANALYSES TO BE PERFORMED
                                    NPLAN= 3 NRTIO= 1 LRTIO= 1

          RTIOS=    0.50

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

                                SUB-AREA RUNOFF COMPUTATION

                        CALCULATION OF SNYDER UNIT HYDROGRAPH TO LAKE LINGANORE
                                ISTAG   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                    1       0       0       0       0       0       1       0       0

                                            HYDROGRAPH DATA
          IHYDG     IUHG    TAREA     SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              1        1    82.00     0.00   82.00    0.00   0.000       0       1       0

                                            PRECIP DATA
                        SPFE     PMS      R6     R12     R24     R48     R72     R96
                        0.00   24.00   92.00  100.00  110.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.862

                                            LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.05    0.00    0.00

                                        UNIT HYDROGRAPH DATA
                                    TP= 12.12    CP=1.25    NTA=  0

                                        RECESSION DATA
                                STRTQ=   -1.50    GRCSN=   -0.05    RTIOR= 2.00

                    UNIT HYDROGRAPH 23 END-OF-PERIOD ORDINATES, LAG= 12.08 HOURS, CP= 0.77  VOL= 1.00
          353.     998.    1481.    1825.    2112.    2364.    2591.    2799.    2993.    3175.
         3347.    3459.    3409.    3243.    3066.    2877.    2674.    2455.    2214.    1943.
         1625.    1219.     580.

    0                                   END-OF-PERIOD FLOW
  MO. DA  HR. MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO. DA  HR. MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                        SUM  22.76  20.89   1.87  1147534.
                                                                            ( 578.)( 531.)(  47.)(32494.52)
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.50
HYDROGRAPH AT	1	82.00 (212.38)	1	33901. (959.97)(
			2	33901. (959.97)(
			3	33901. (959.97)(
ROUTED TO	2	82.00 (212.38)	1	35173. (995.98)(
			2	110469. (3128.13)(
			3	132193. (3743.28)(
ROUTED TO	3	82.00 (212.38)	1	35136. (994.94)(
			2	109553. (3102.18)(
			3	131062. (3711.26)(
ROUTED TO	4	82.00 (212.38)	1	35106. (994.09)(
			2	108897. (3083.61)(
			3	130255. (3688.40)(
ROUTED TO	5	82.00 (212.38)	1	34726. (983.34)(
			2	96194. (2723.89)(
			3	114372. (3238.65)(
ROUTED TO	6	82.00 (212.38)	1	34374. (973.37)(
			2	86779. (2457.30)(
			3	97883. (2771.75)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	308.00	308.00	324.50
STORAGE	2730.	2730.	7880.
OUTFLOW	14.	14.	31093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	325.11	0.61	8136.	35173.	3.70	29.00	28.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	308.00	308.00	324.50
STORAGE	2730.	2730.	7880.
OUTFLOW	14.	14.	31093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	325.10	0.60	8132.	110469.	2.52	29.00	28.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	308.00	308.00	324.50
STORAGE	2730	2730.	7880.
OUTFLOW	14.	14.	31093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	325.10	0.60	8132.	132193.	2.46	29.00	28.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	35136.	286.9	29.00

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	109553.	295.1	29.00

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	131062.	297.0	29.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	35106.	283.4	29.00

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	108897.	292.0	29.00

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	130255.	293.9	29.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	34726.	269.3	29.00

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	96194.	275.1	29.00

PLAN 3 STATION 5

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	114372.	276.3	29.00

PLAN 1 STATION 6

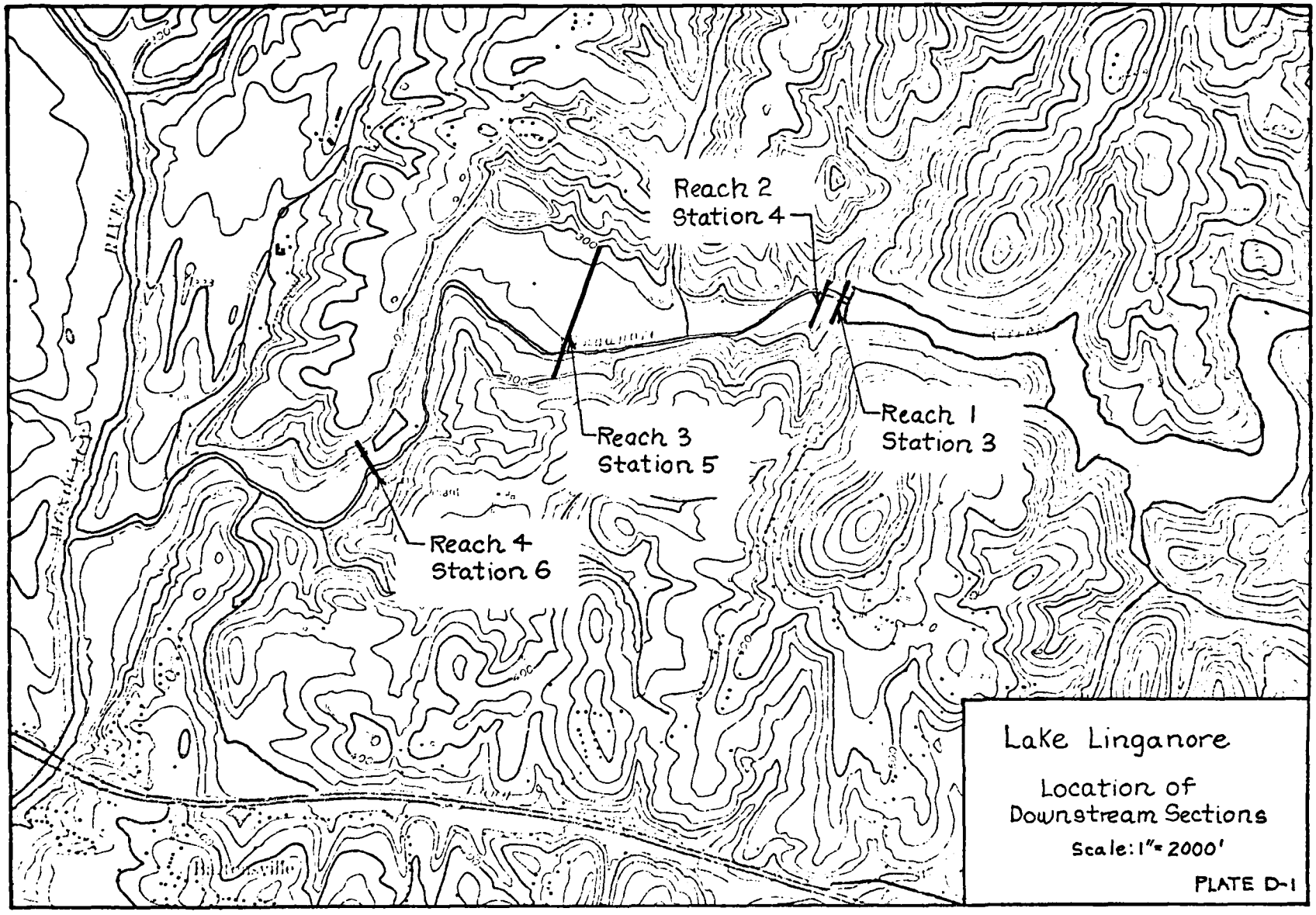
RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	34374.	276.5	30.00

PLAN 2 STATION 6

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	86779.	289.2	30.00

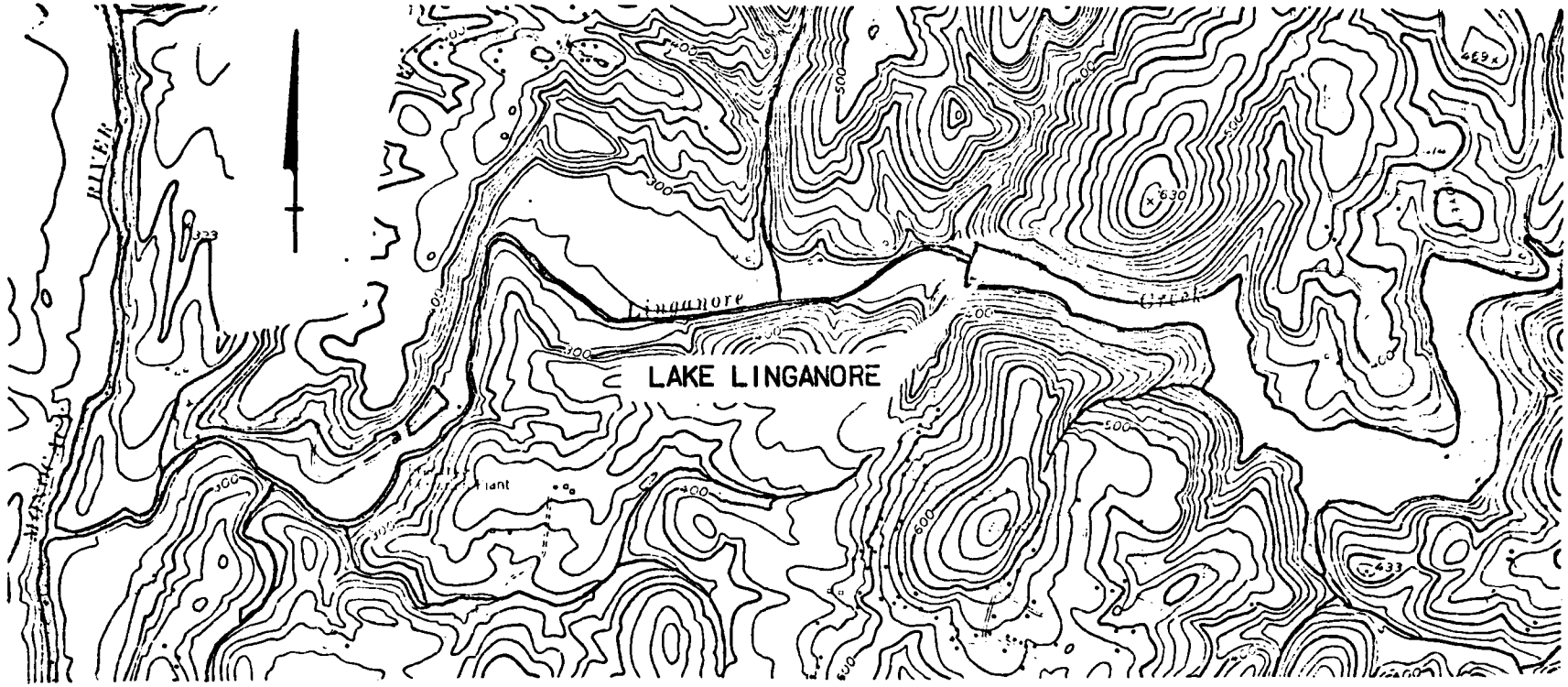
PLAN 3 STATION 6

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
0.50	97883	291.8	30.00


Reach 2
Station 4
Reach 1
Station 3
Reach 3
Station 5
Reach 4
Station 6
Lake Linganore
Location of
Downstream Sections
Scale: 1" = 2000'
PLATE D-1

APPENDIX E

PLATES



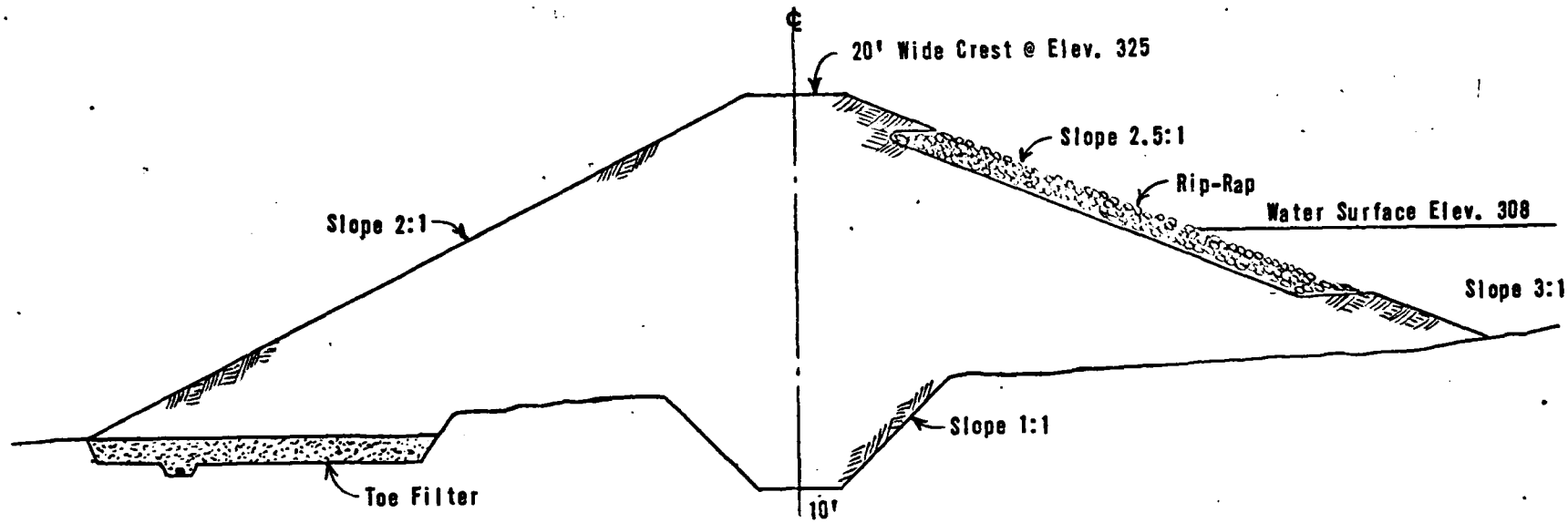
SCALE

0 ½ MI. 1 MI.

LAKE LINGANORE

LOCATION MAP

PLATE E-1



Scale 1" = 20'

TYPICAL SECTION

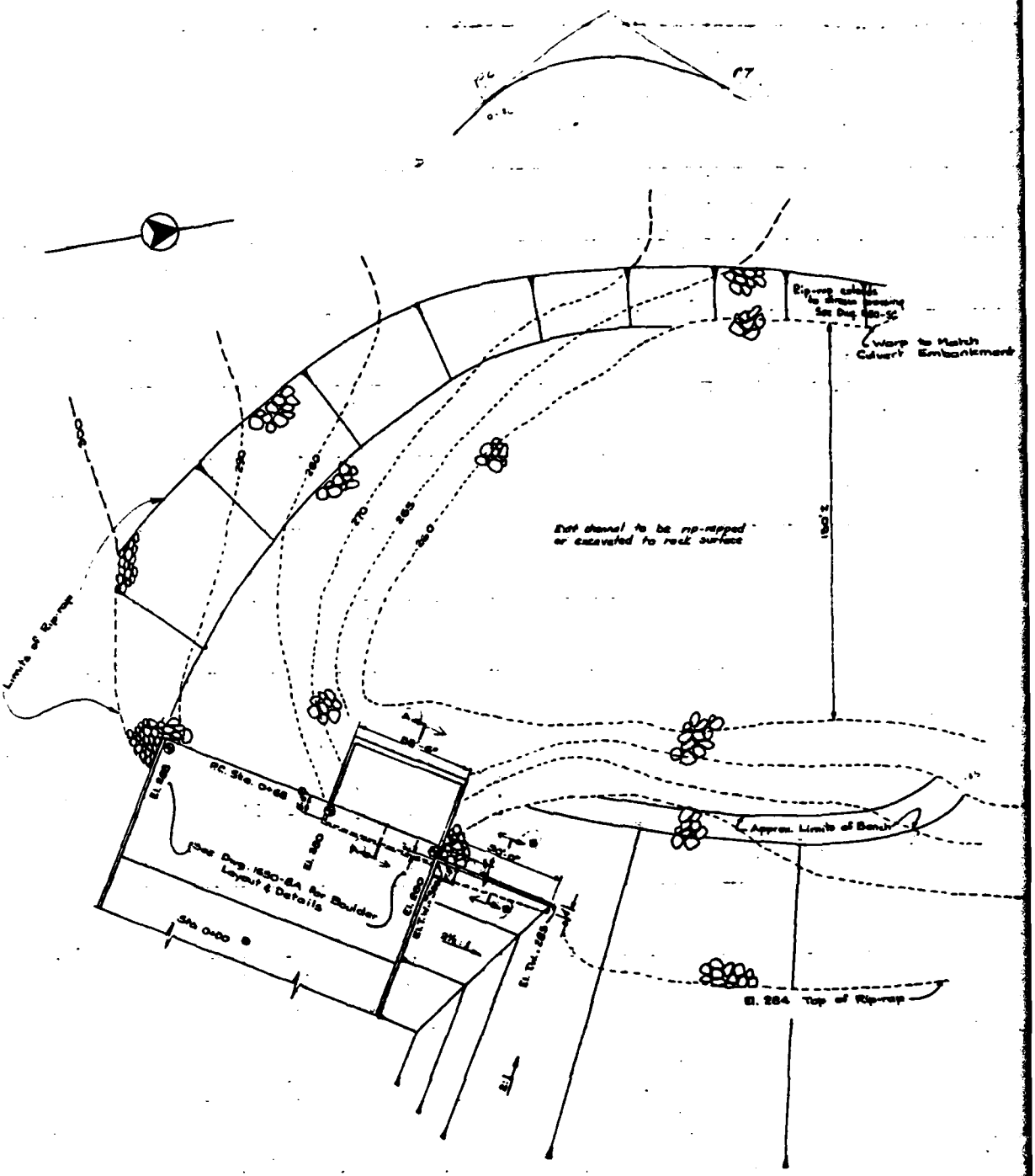
LAKE LINGANORE

FROM DESIGN DRAWING

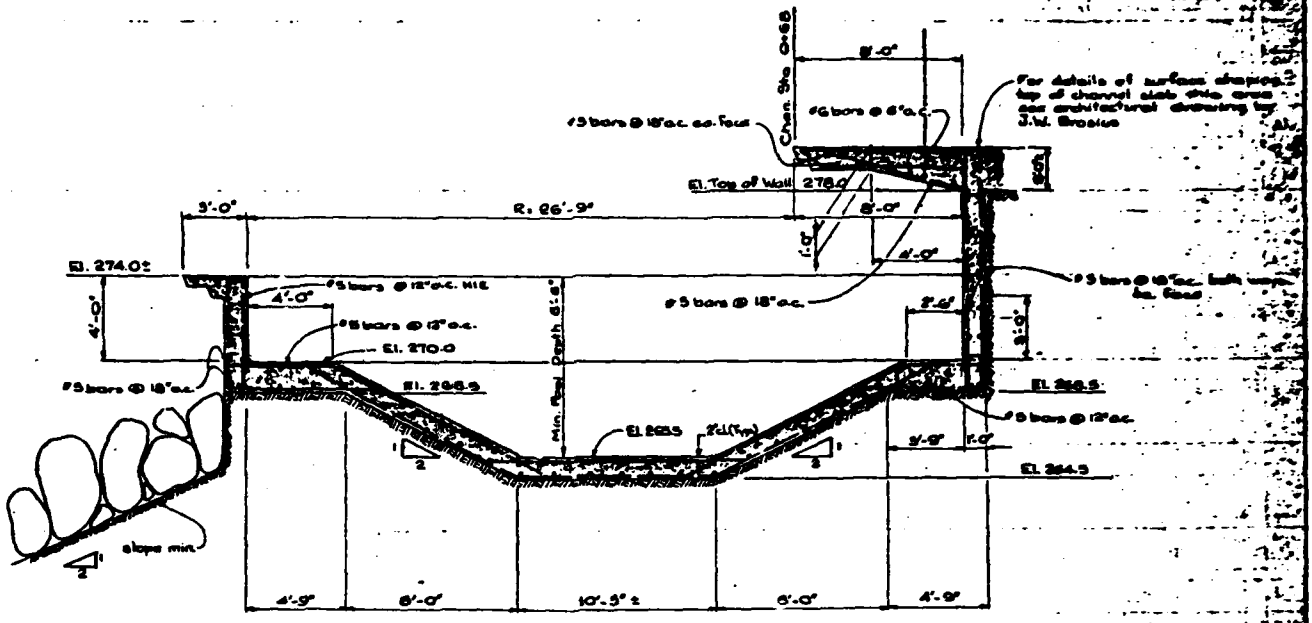
DATED APRIL 20, 1970

DRAWING NO. 1630-4

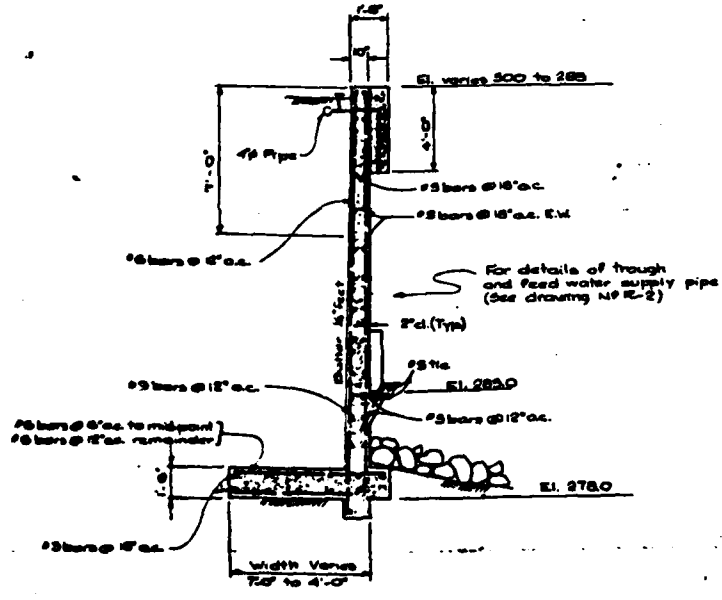
PLATE E-2


Limits of Riprap
Ditch channel to be rip-rapped or excavated to rock surface
Approx. Limits of Bench
El. 284 Top of Riprap
Warp to Match Culvert Embankment
Std. Dwg. 1650-6A Rip Rap Boulder Layout & Details
Sta 0+00

PLAN
1"=30'



SECTION A-A
¼" = 1'-0"



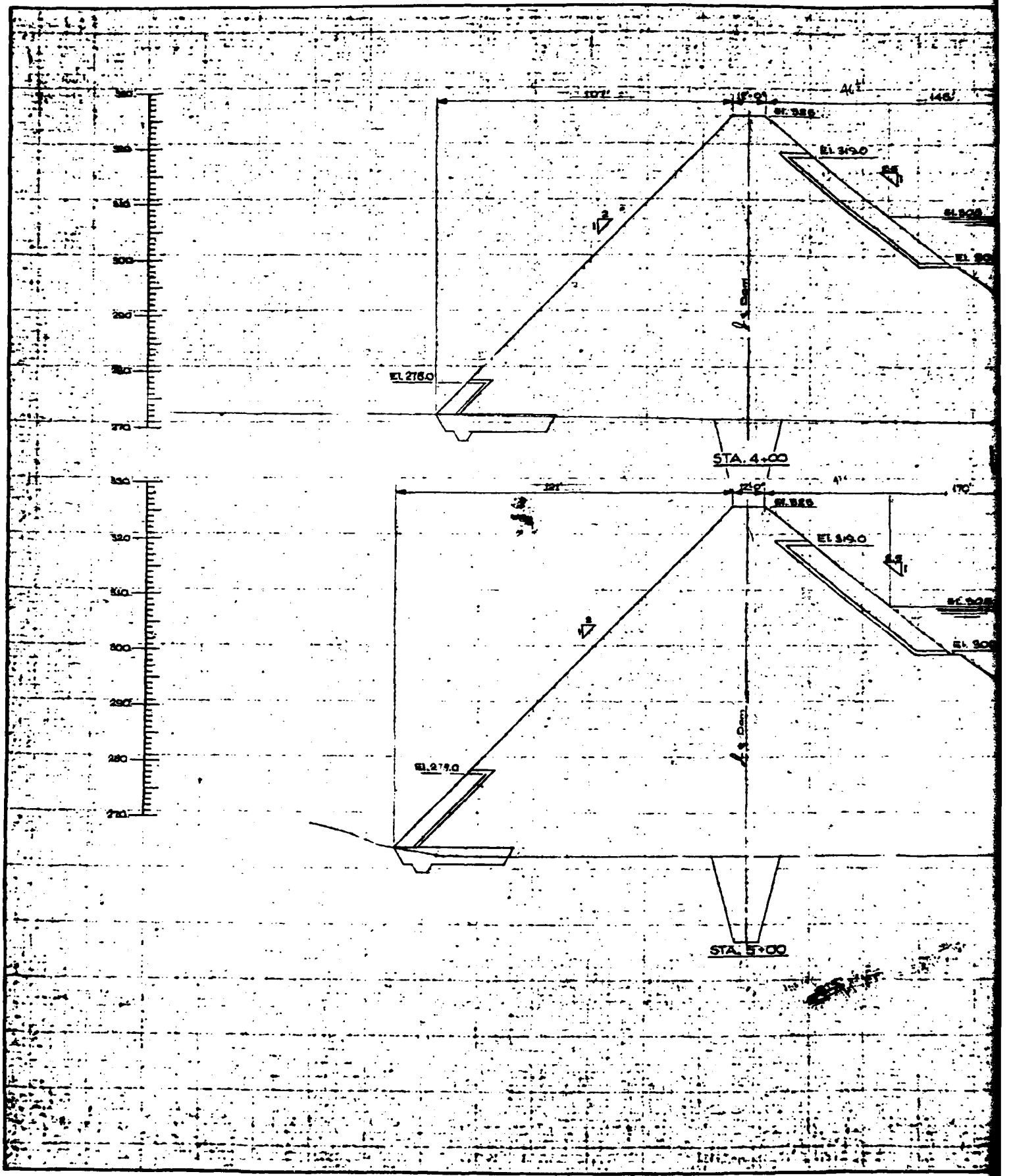
SECTION B-B
¼" = 1'-0"

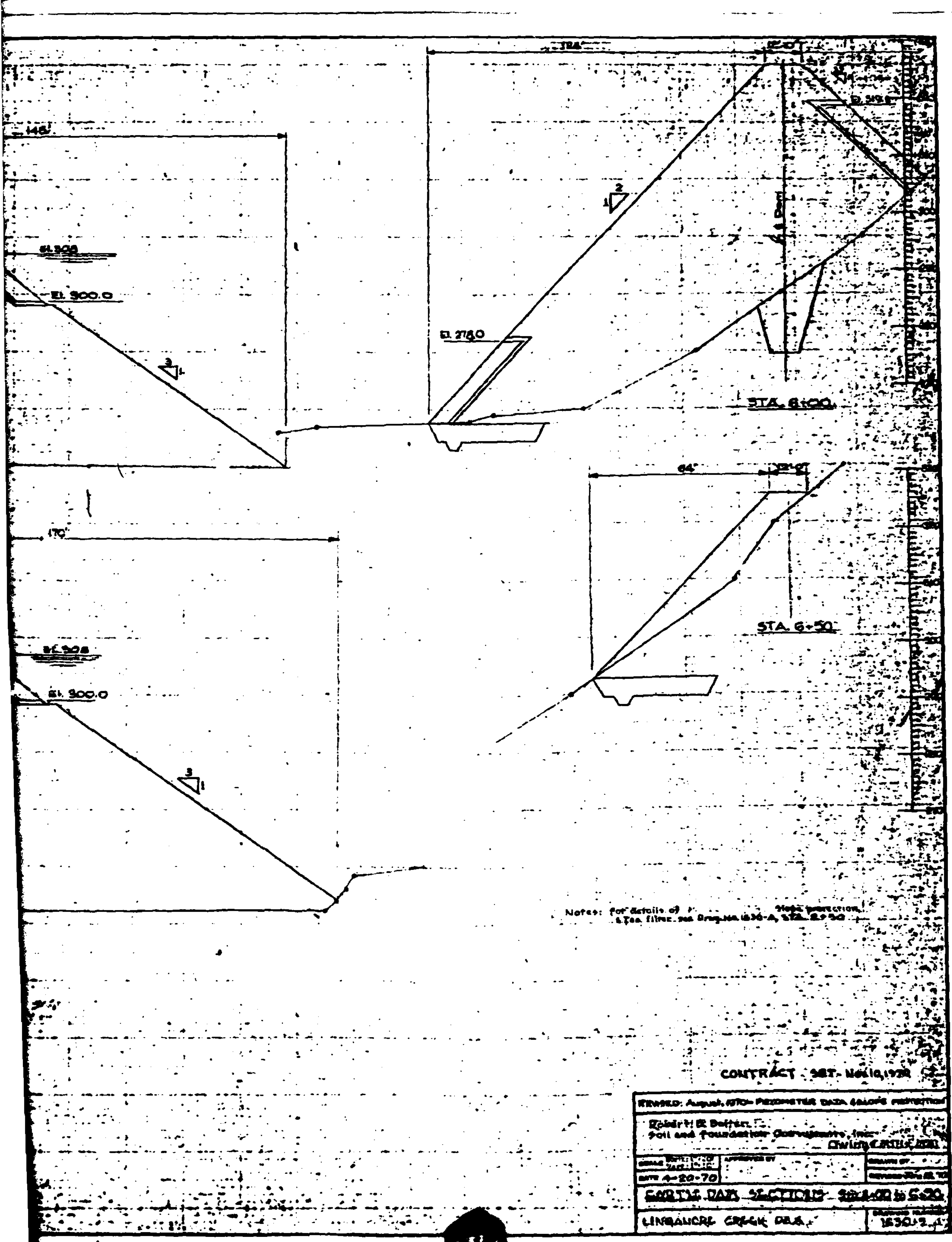
Robert B. Balter
Soil and Foundation Consultants, Inc.
Owings Mills, Maryland

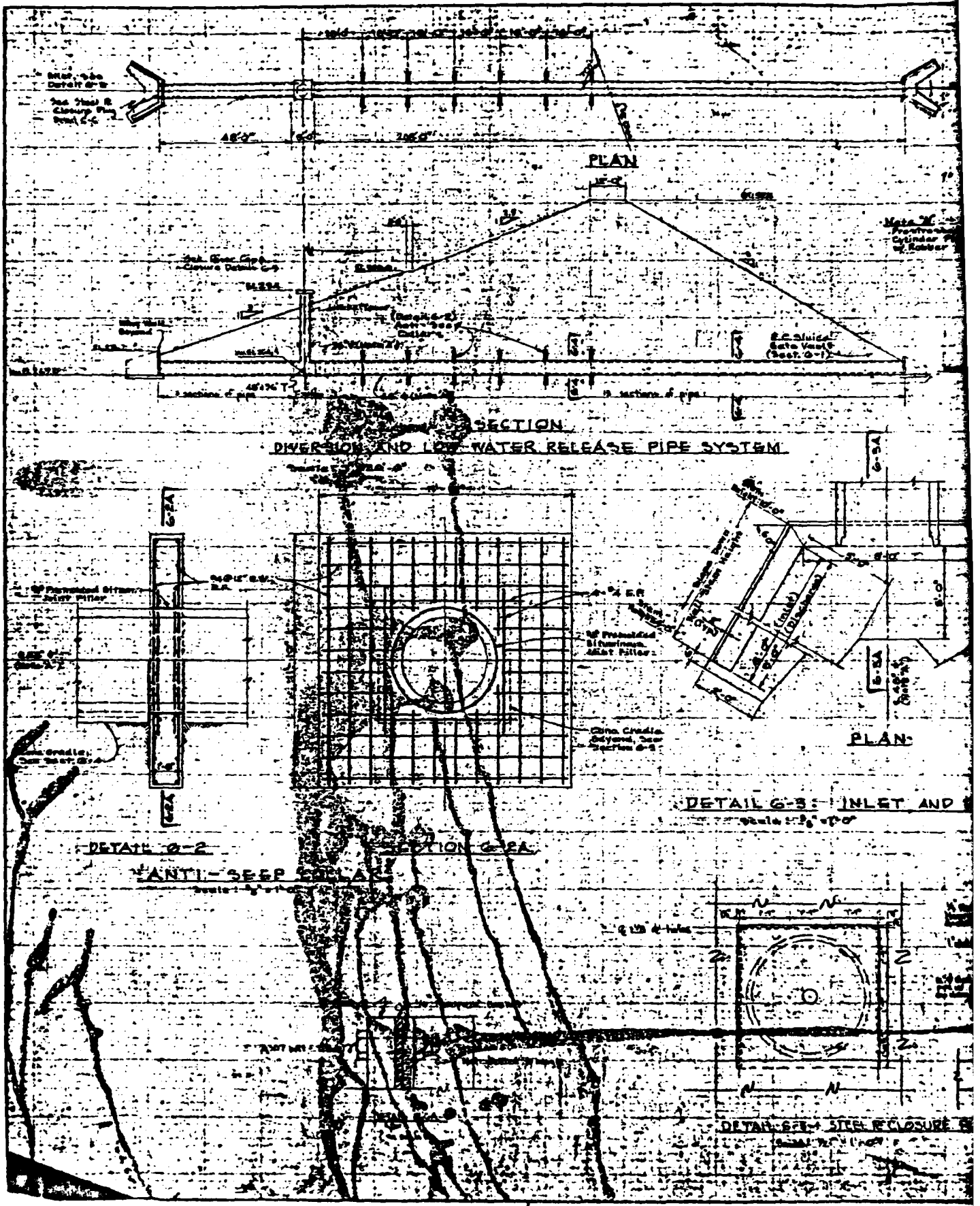
LAKE LINGANORE DAM -
DISCHARGE CHANNEL REVISIONS

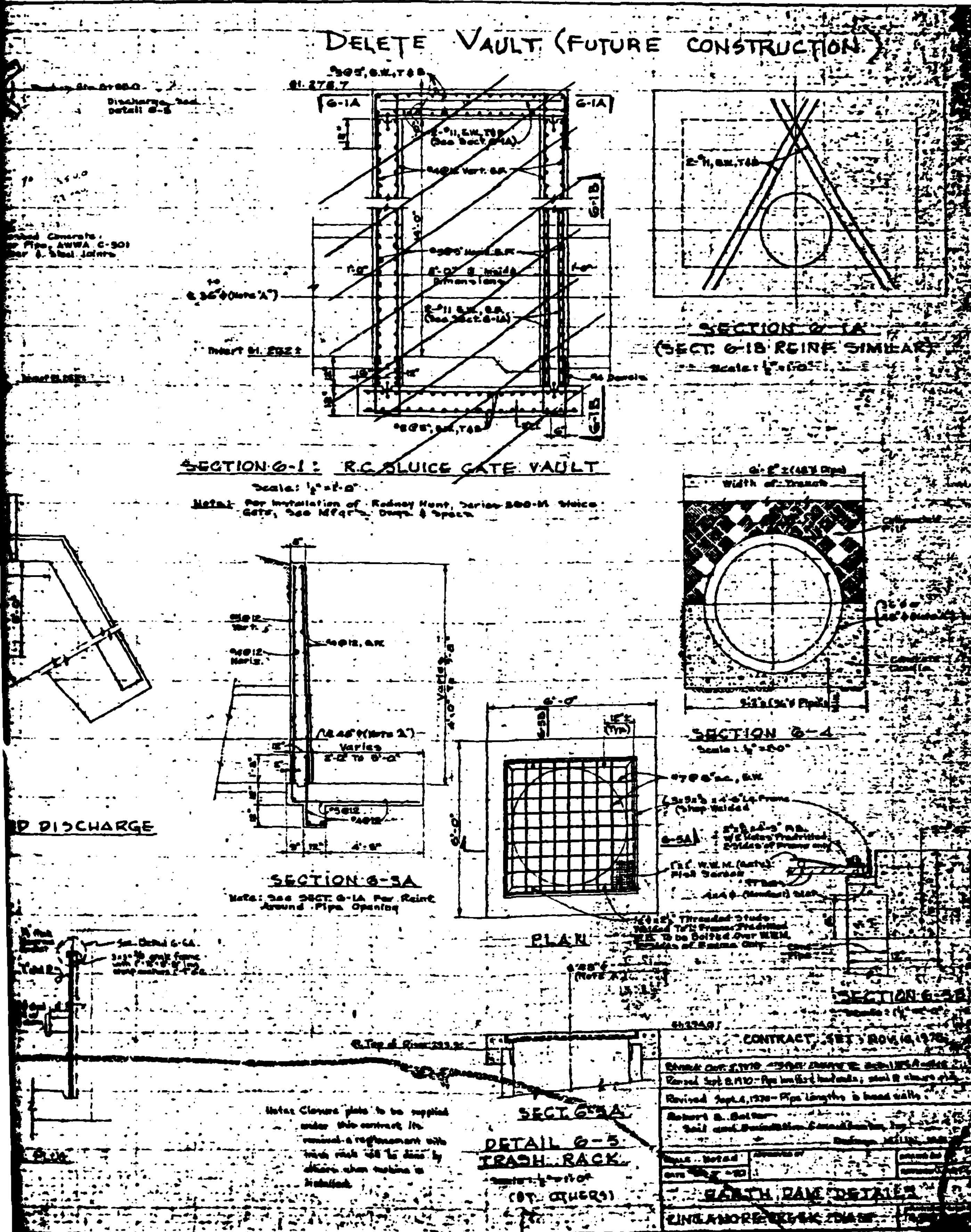
DRAWN	SCALE	DATE	APPROVED	DRAWING NUMBER
	As Noted	8-28-71		1830 - E-4

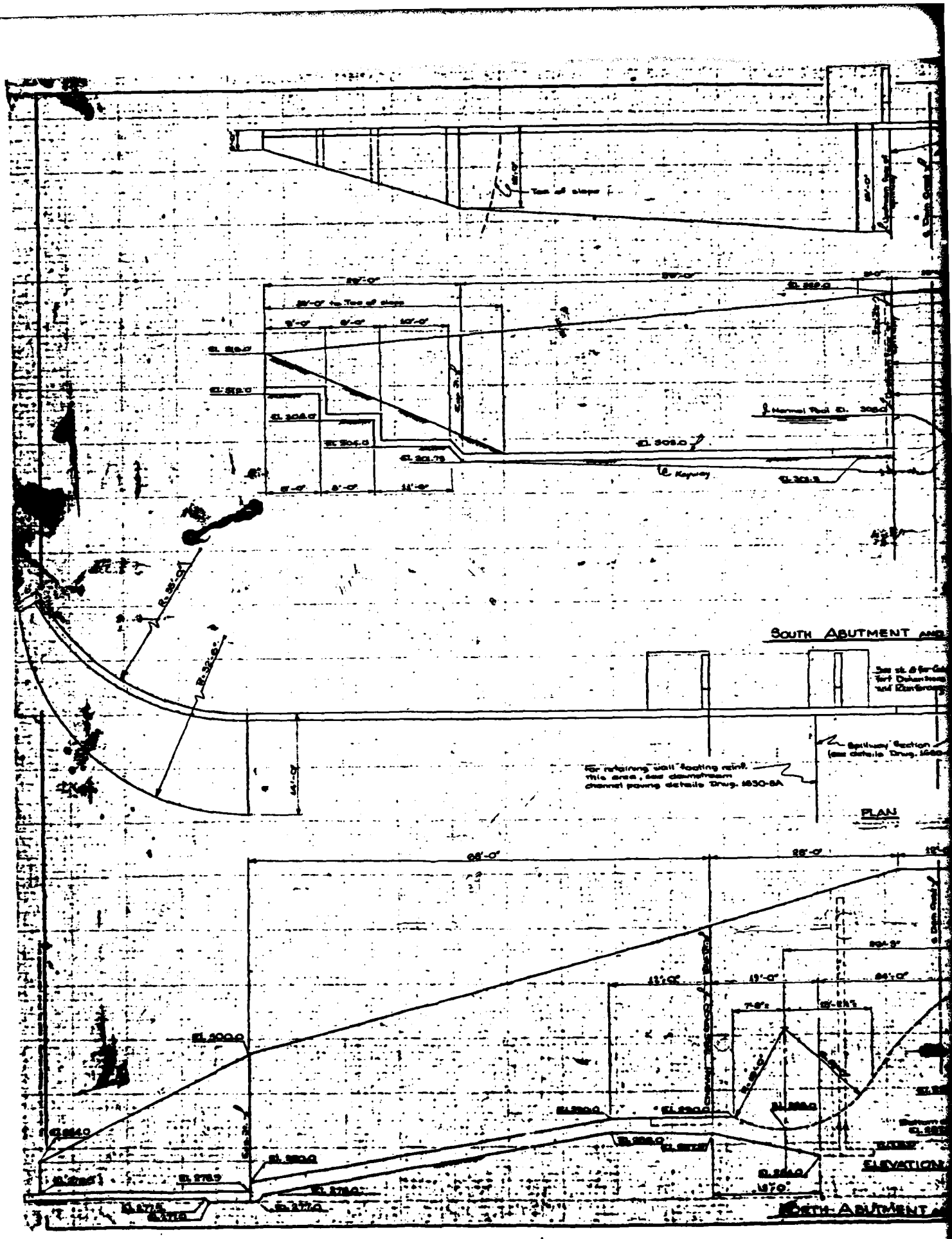
PLATE E-

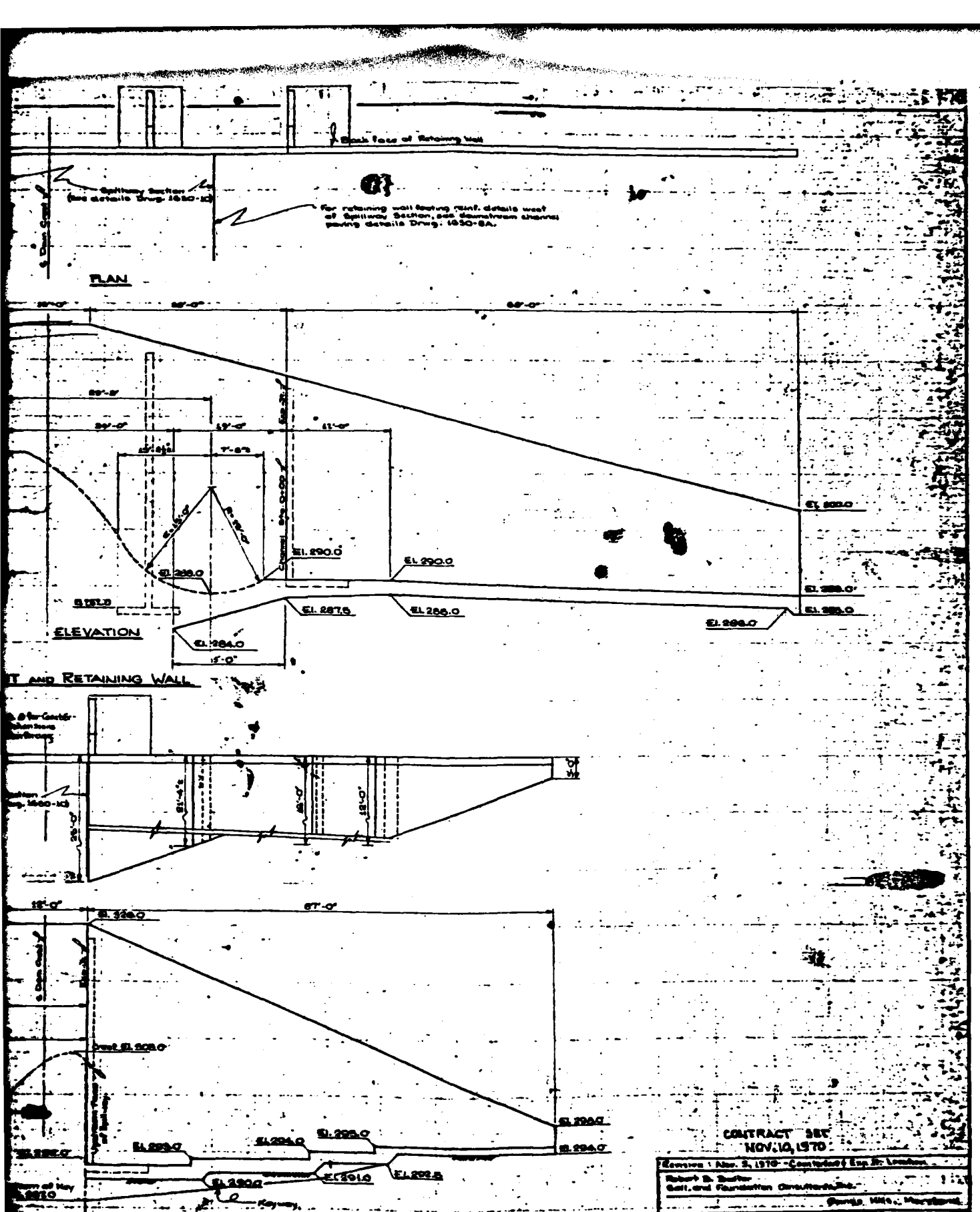

EL 276.0
STA. 4+00
EL 279.0
STA. 5+00


146'
El. 308
El. 300.0
El. 278.0
STA. 6+00
64'
STA. 6+50
170'
El. 308
El. 300.0
Notes: For details of ... slope protection
& Toe filter see Drwg. No. 1630-A, Sta. 2+50
CONTRACT SET- Nov.10,1970
REVISED: August, 1970- PIEZOMETER DATA & SLOPE PROTECTION
Robert E. Detter
Soil and Foundation Consultants, Inc.
DATE 4-20-70
EARTH DAM SECTIONS
LINGANORE CREEK DAM
1630-2


PLAN
SECTION
DIVERSION AND LOW WATER RELEASE PIPE SYSTEM
PLAN
DETAIL G-3: INLET AND
DETAIL G-2
SECTION G-2A
ANTI-SEEP COLLAR
DETAIL G-3: STEEL ENCLOSURE


DELETE VAULT (FUTURE CONSTRUCTION)
SECTION G-1: R.C. SLUICE GATE VAULT
Scale: 1/2"=1'-0"
SECTION G-1A
(SECT. G-1B REINF. SIMILAR)
SECTION G-4
SECTION G-3A
PLAN
D DISCHARGE
SECTION G-3B
DETAIL G-5
TRASH RACK
(BY OTHERS)
CONTRACT SET NOV. 10, 1970
EARTH DAM DETAILS


SOUTH ABUTMENT
PLAN
ELEVATION
NORTH ABUTMENT



CONTRACT 38C
NOV. 10, 1970

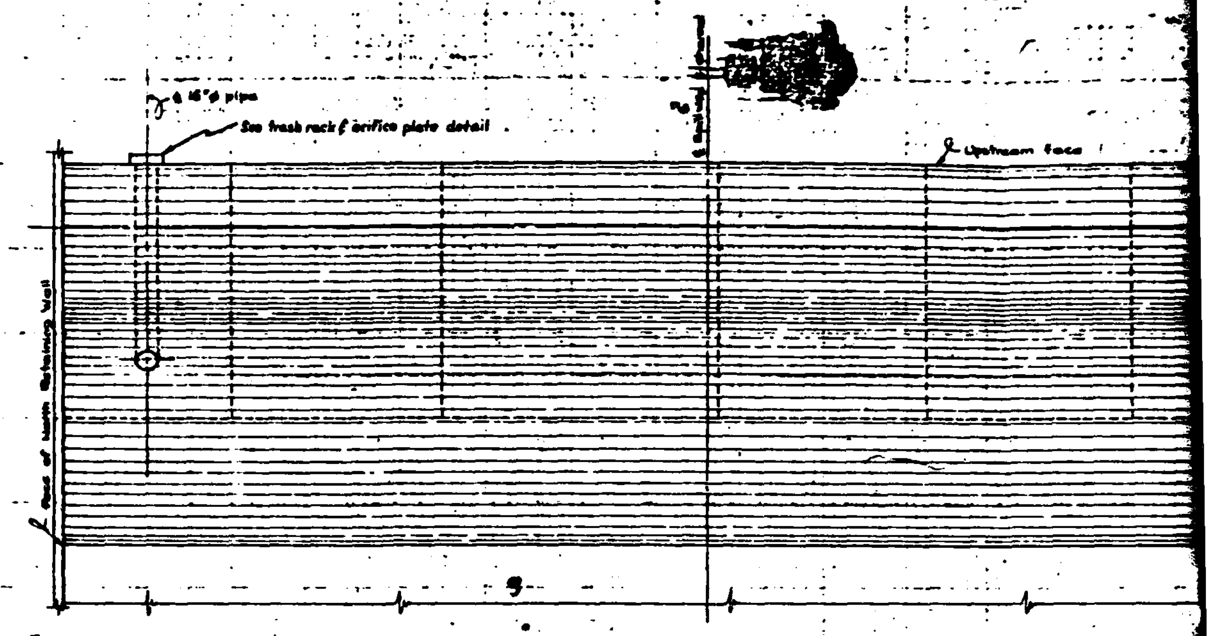
Revised Nov. 5, 1970 - Corrected Exp. Jt. Locations

Robert B. Shaffer
Soil and Foundation Consultants
Bowie, Md., Maryland

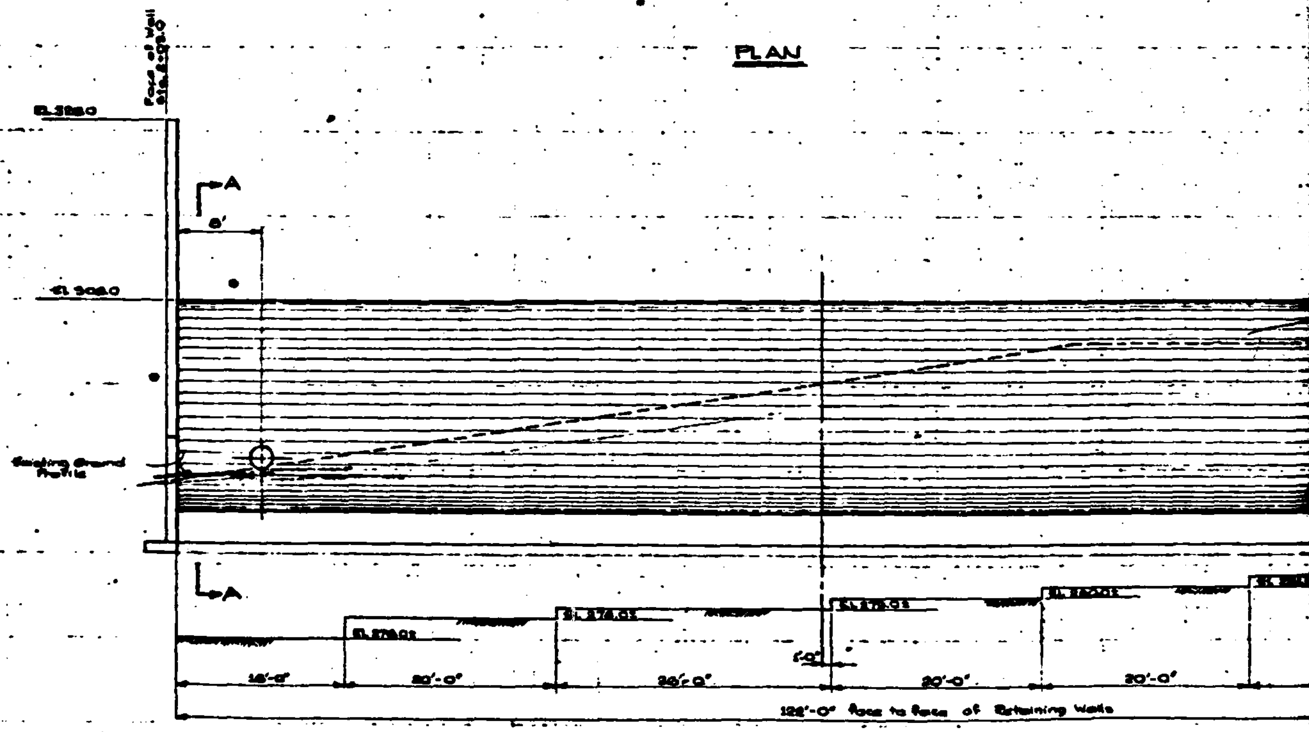
SCALE 1/8" = 1'-0"

RETAINING WALLS - PLANS and ELEVATIONS

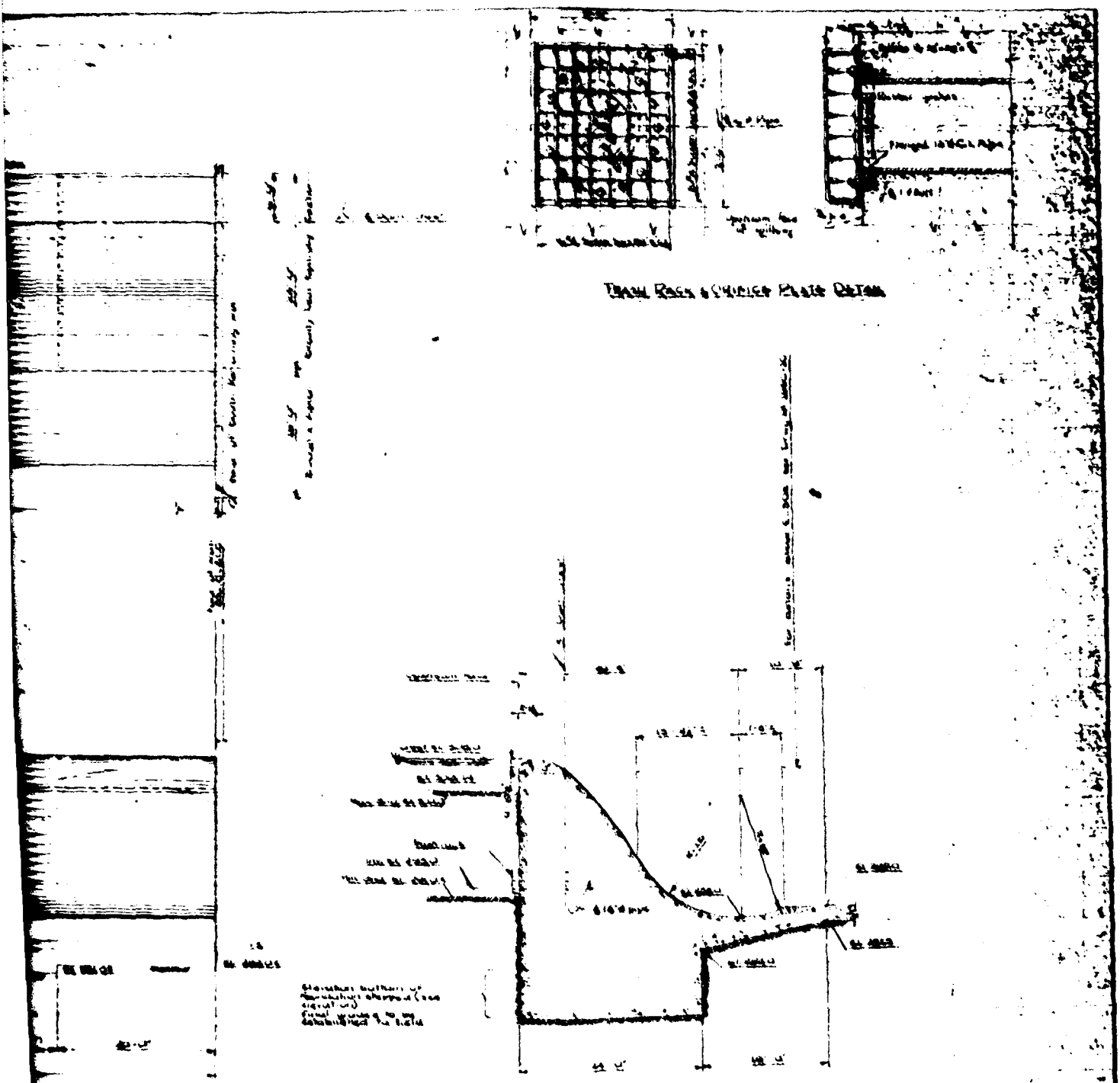
T. LINGANORE CREEK DAM



PLAN



ELEVATION



SECTION A-A

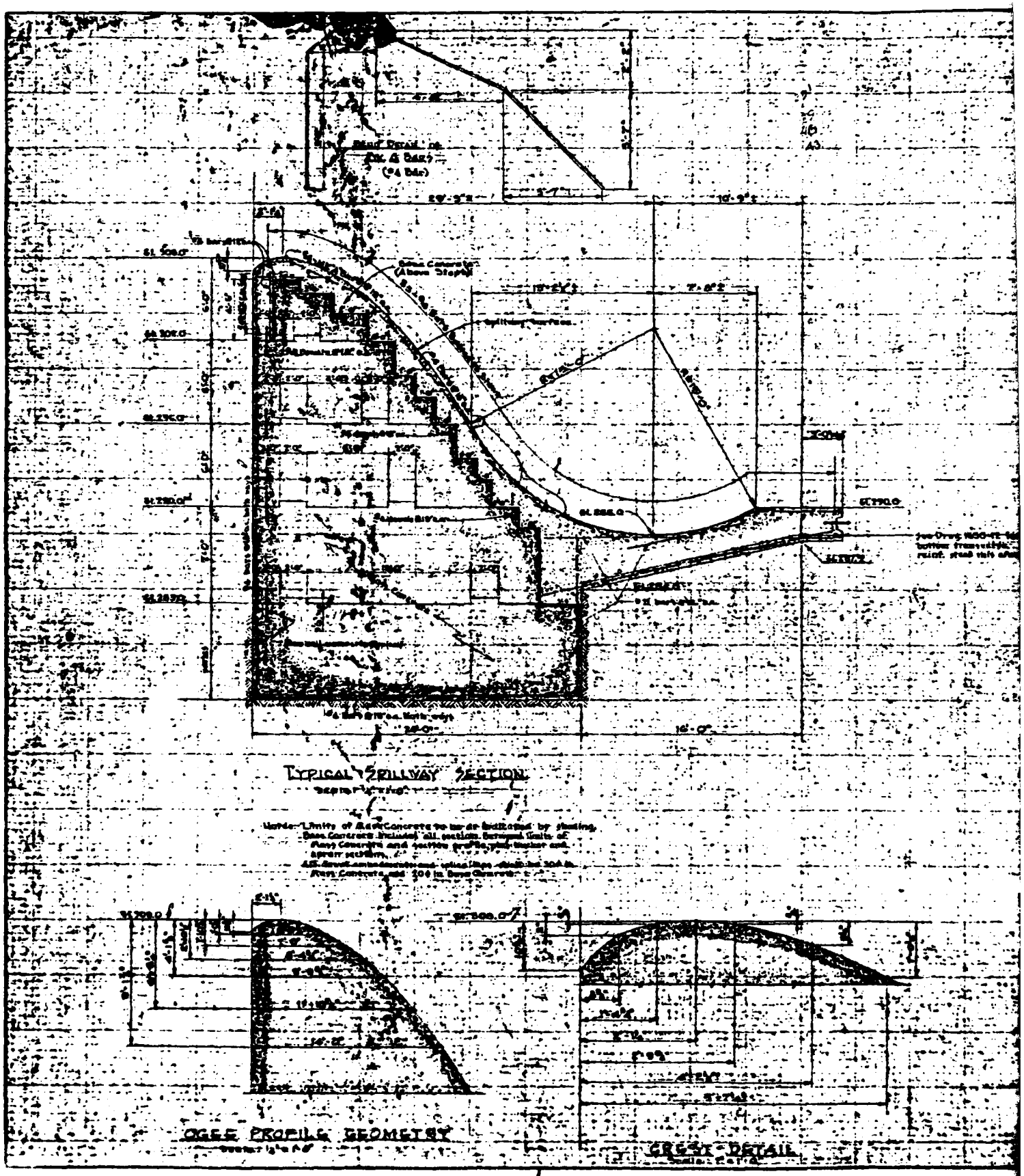
CONTRACT 3ST - NOV 10, 1970

Robert B. Stetler
Soil and Foundation Consultants, Inc.

George Hill, Maryland

SPILLWAY PLAN & ELEVATION

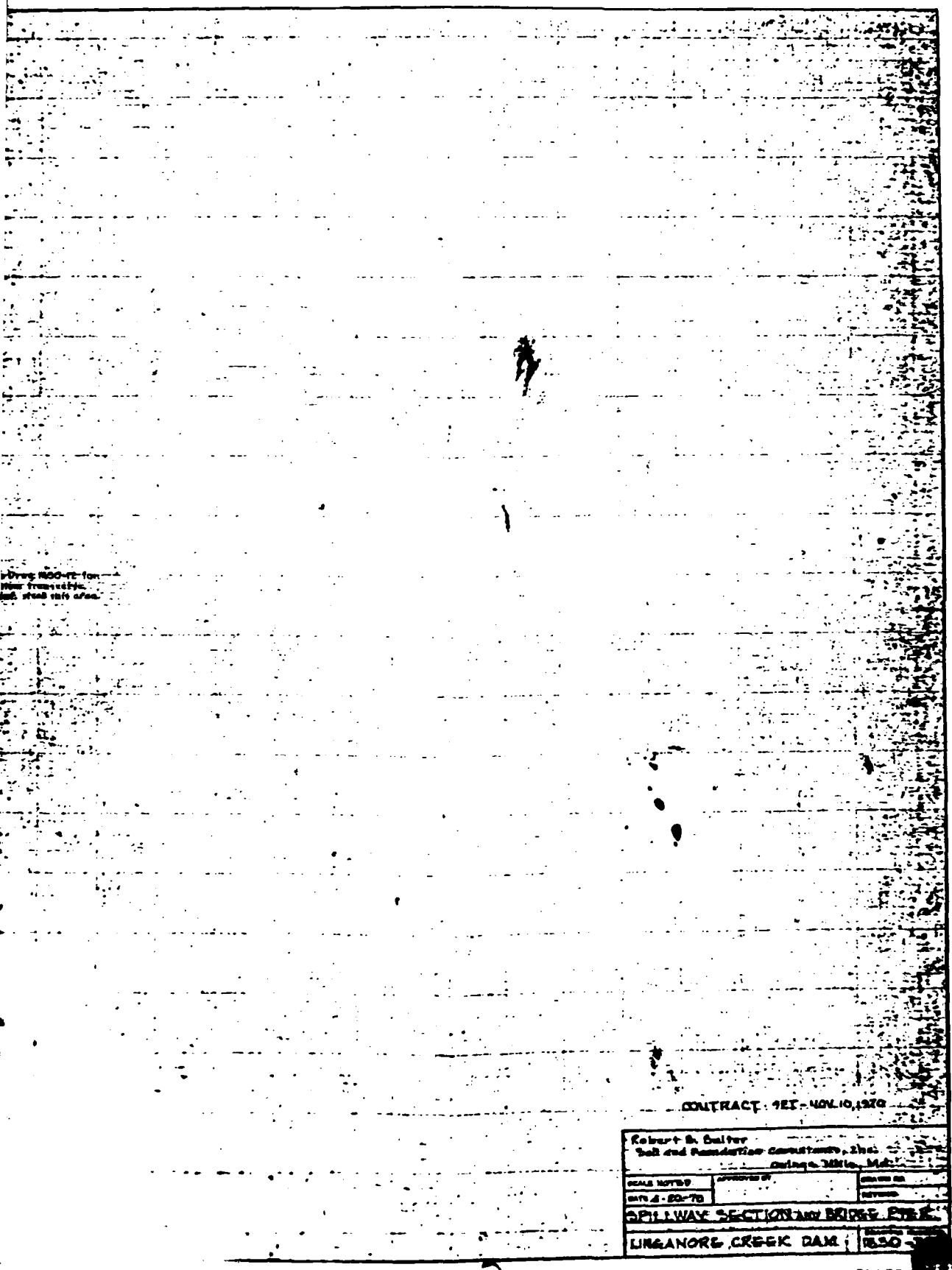
LINGANORE CREEK DAM



TYPICAL SPILLWAY SECTION

OGEE PROFILE GEOMETRY

CREST DETAIL



CONTRACT: YET-NOV.10,1970

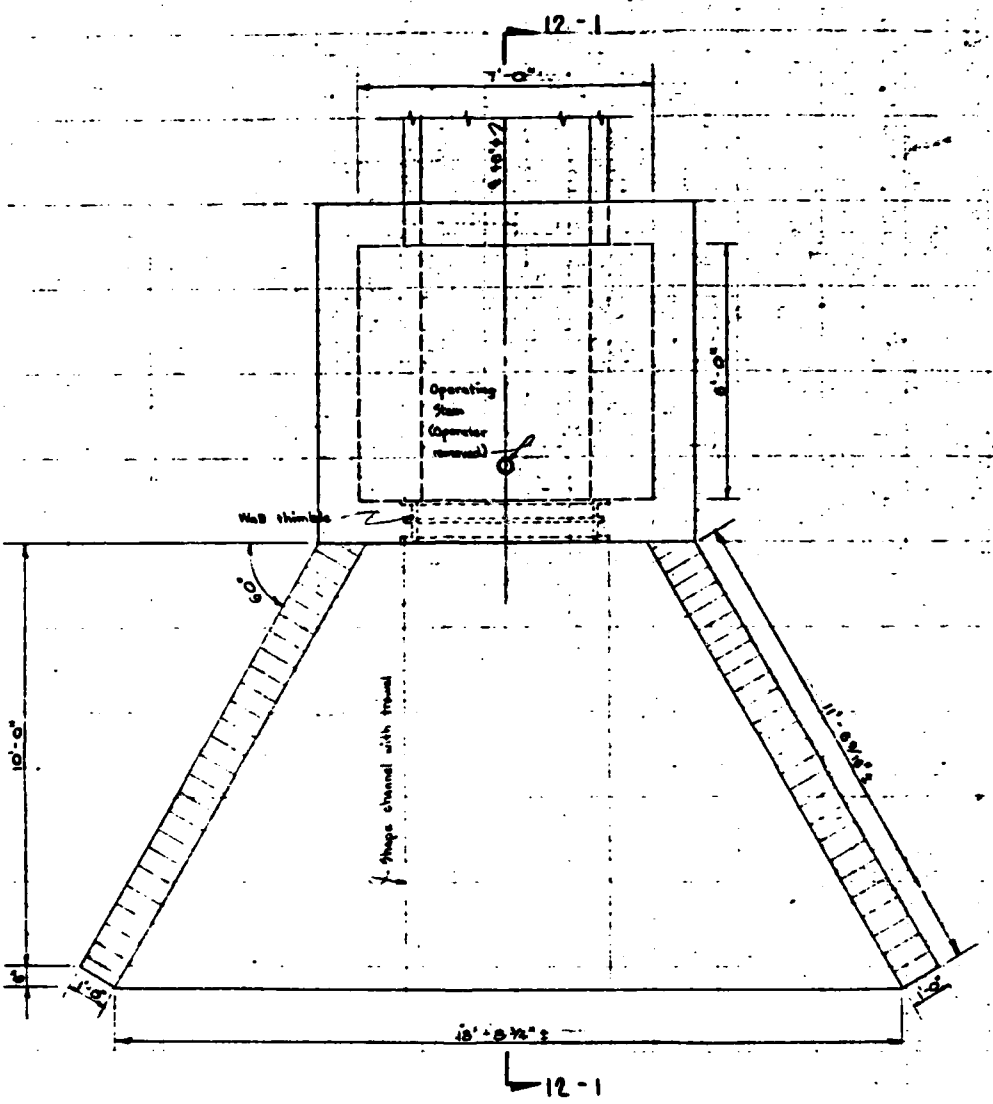
Robert B. Dalter
Soil and Foundation Consultants, Inc.
Spring Mills, Mich.

SCALE NOTED	APPROVED BY	DRAWN BY
DATE 6-20-70		REVISED

SPILLWAY SECTION AND BRIDGE PIER

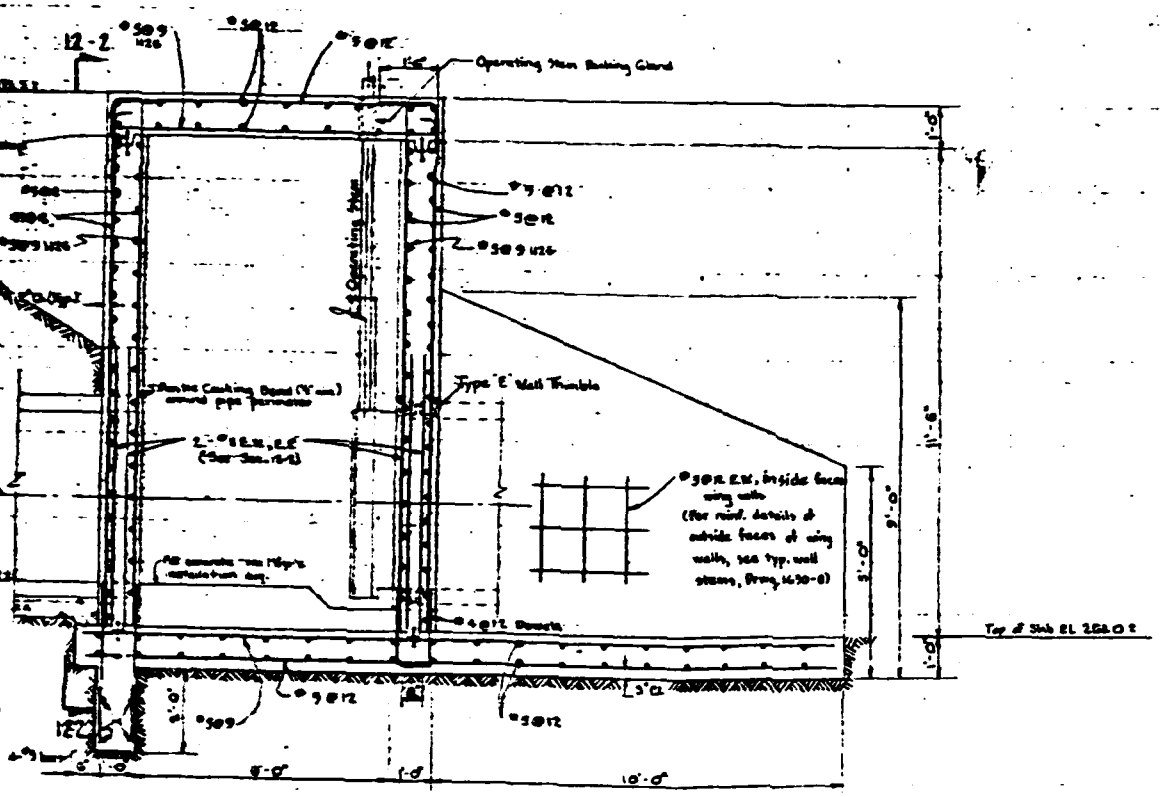
LINGANORE CREEK DAM | 1830

PLATE



PLAN

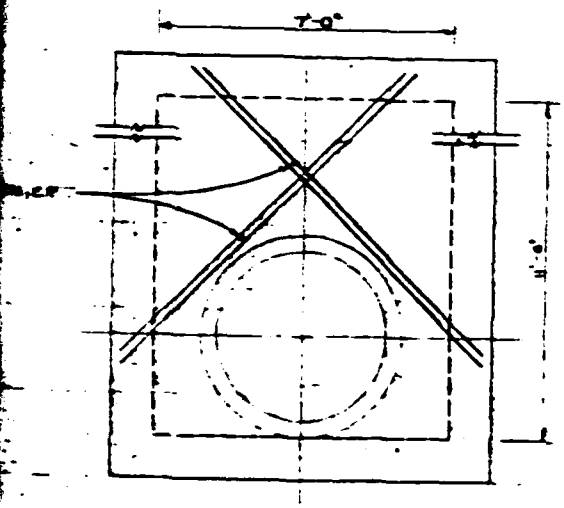
Scale: 1/2" = 1'-0"



SECTION 12-1

Scale: 1/2" = 1'-0"

Note: For installation of Armco, Series SS-10G Sluice Gate, see mfgr's. Dwgs. & Specs.
Gate to be supplied complete without thimble-Type E-11" long, fully drilled to mate with 125# flange; stem packing gland for sheet pile penetration; type CPE-20 operator w/ electric motor drive for 110/220 v, single phase operation; and all necessary mounting hardware, anchor bolts, etc.



SECTION 12-2

Scale: 1/2" = 1'-0"

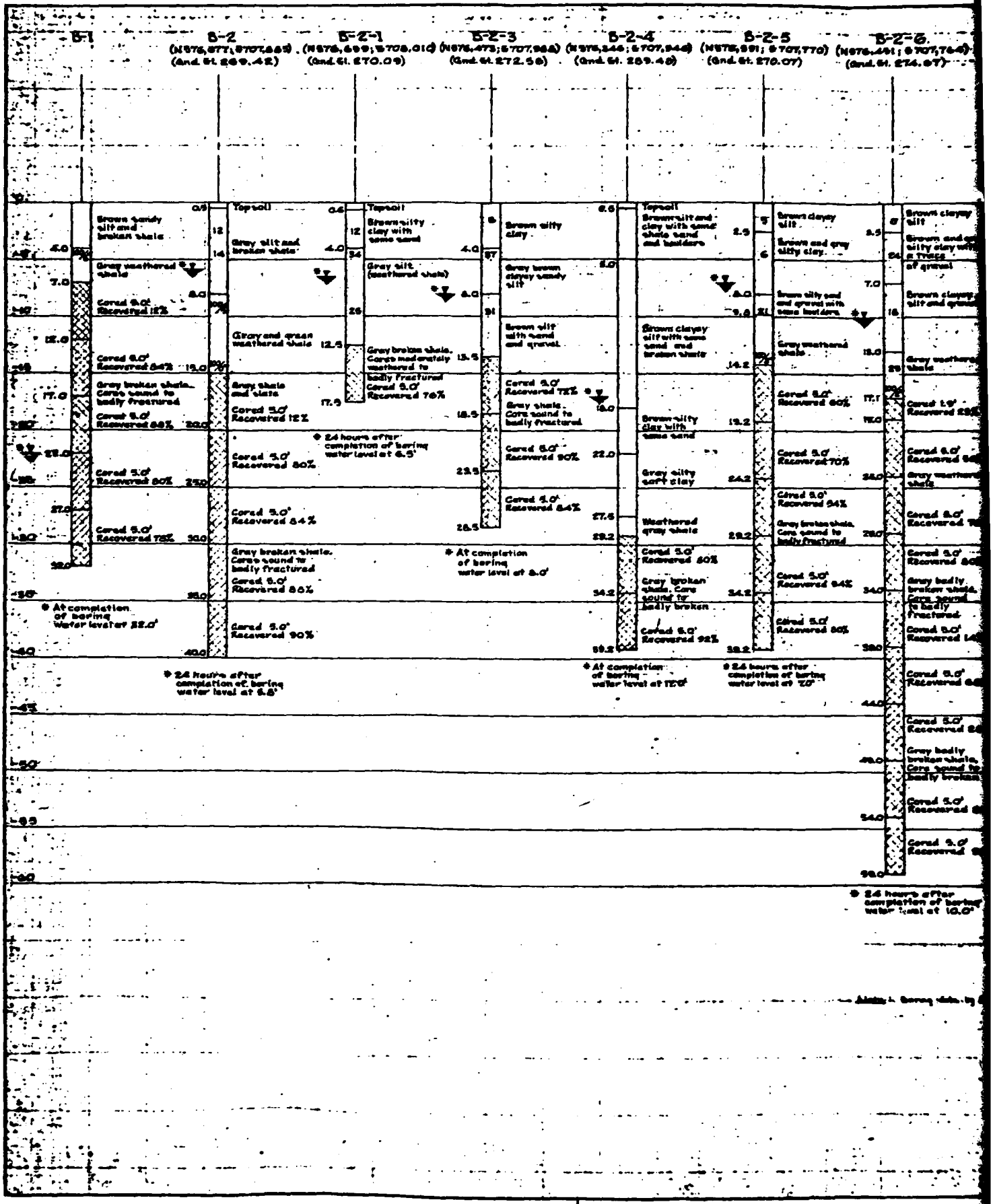
CONTRACT SET - NOV. 10, 1970

Robert B. Balfer
Soil and Foundation Consultants, Inc.
Chelsea, Mass.

SCALE Adjusted	APPROVED BY	DRAWN BY
DATE 10-26-70		REVISED

SLUICE GATE VAULT
LINGANORE CREEK DAM
DRAWING NUMBER 1630-12

PLATE


B-1
B-2
(N576,677; E707,865)
(Gnd. El. 269.42)
B-2-1
(N576,699; E708,012)
(Gnd. El. 270.09)
B-2-3
(N576,473; E707,984)
(Gnd. El. 272.58)
B-2-4
(N576,246; E707,948)
(Gnd. El. 269.48)
B-2-5
(N576,291; E707,770)
(Gnd. El. 270.07)
B-2-6
(N576,491; E707,764)
(Gnd. El. 274.87)
Brown sandy silt and broken shale
Gray weathered shale
Cored 5.0' Recovered 12%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 88%
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 72%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 90%
* At completion of boring water level at 32.0'
* 24 hours after completion of boring water level at 6.6'
Topsoil
Gray silt and broken shale
Gray and green weathered shale
Gray shale and slate
Cored 5.0' Recovered 12%
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 84%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 90%
* 24 hours after completion of boring water level at 6.5'
* At completion of boring water level at 8.0'
Topsoil
Brown silty clay with some sand
Gray silt (weathered shale)
Gray broken shale. Core moderately weathered to badly fractured
Cored 5.0' Recovered 76%
Brown silty clay
Gray brown clayey sandy silt
Brown silt with sand and gravel
Cored 5.0' Recovered 72%
Gray shale. Core sound to badly fractured
Cored 5.0' Recovered 90%
Cored 5.0' Recovered 84%
* At completion of boring water level at 17.0'
Topsoil
Brown silt and clay with some shale sand and boulders
Brown clayey silt with some sand and broken shale
Brown silty clay with some sand
Gray silty soft clay
Weathered gray shale
Cored 5.0' Recovered 80%
Gray broken shale. Core sound to badly broken
Cored 5.0' Recovered 92%
* 24 hours after completion of boring water level at 7.0'
Brown clayey silt
Brown and gray silty clay
Brown silty sand and gravel with some boulders
Gray weathered shale
Cored 5.0' Recovered 60%
Cored 5.0' Recovered 70%
Cored 5.0' Recovered 94%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 84%
Cored 5.0' Recovered 80%
* 24 hours after completion of boring water level at 10.0'

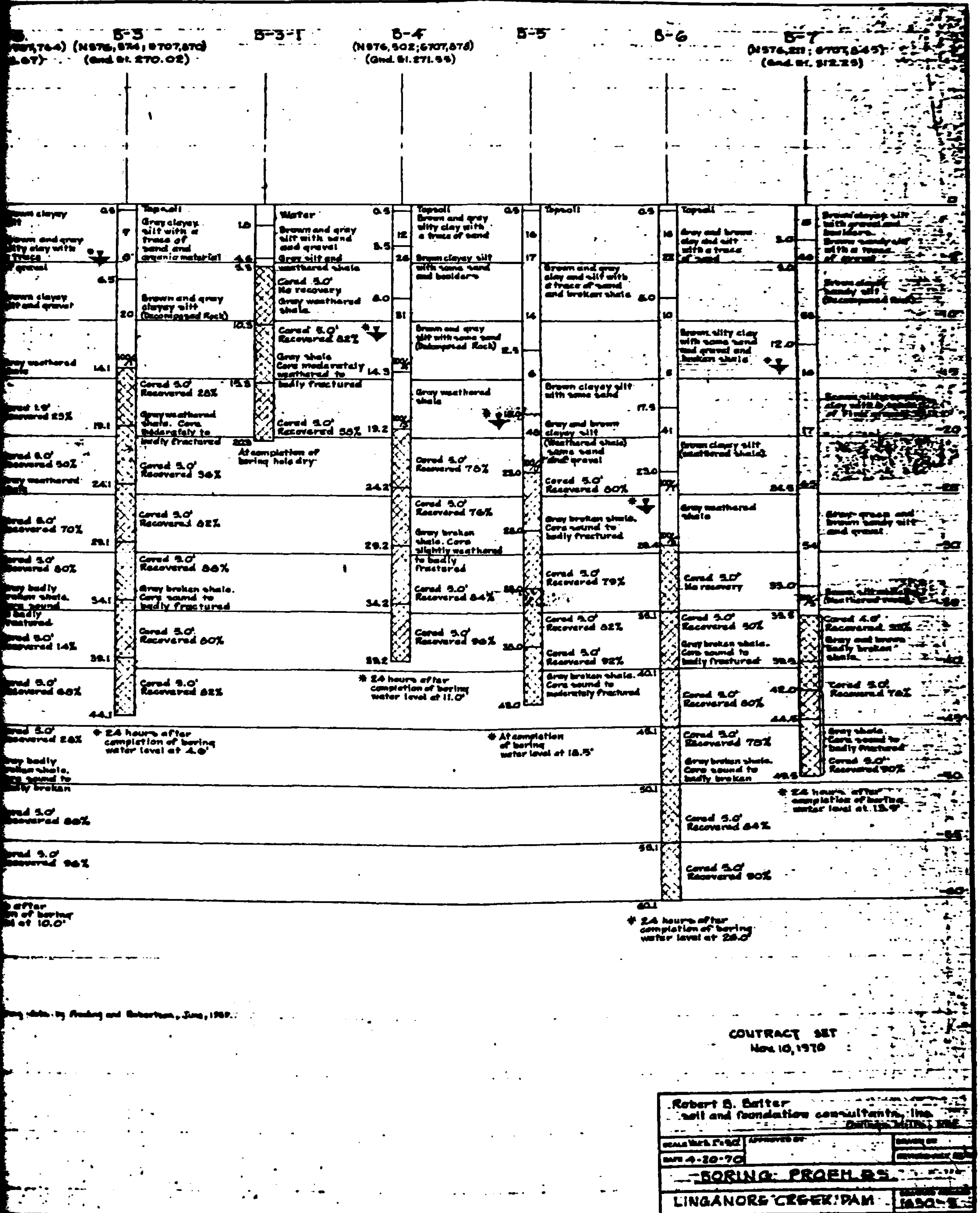

B-3
(N876,874; E707,870)
(Gnd. El. 270.02)
B-3-I
B-4
(N876,502; E707,878)
(Gnd. El. 271.55)
B-5
B-6
B-7
Topsoil
Gray clayey silt with a trace of sand and organic material
Brown and gray clayey silt (Decomposed Rock)
Cored 5.0' Recovered 28%
Gray weathered shale. Core moderately to badly fractured
Cored 5.0' Recovered 56%
Cored 5.0' Recovered 82%
Cored 5.0' Recovered 88%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 82%
* 24 hours after completion of boring water level at 4.0'
Water
Brown and gray silt with sand and gravel
Gray silt and weathered shale
Cored 5.0' No recovery
Gray weathered shale
Cored 5.0' Recovered 82%
Gray shale Core moderately weathered to badly fractured
Cored 5.0' Recovered 58%
At completion of boring hole dry
Topsoil
Brown and gray silty clay with a trace of sand
Brown clayey silt with some sand and boulders
Brown and gray silt with some sand (Decomposed Rock)
Gray weathered shale
Cored 5.0' Recovered 76%
Cored 5.0' Recovered 76%
Gray broken shale. Core slightly weathered to badly fractured
Cored 5.0' Recovered 84%
Cored 5.0' Recovered 90%
* 24 hours after completion of boring water level at 11.0'
Topsoil
Brown and gray clay and silt with a trace of sand and broken shale
Brown clayey silt with some sand
Gray and brown clayey silt (Weathered shale) some sand and gravel
Cored 5.0' Recovered 60%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 79%
Cored 5.0' Recovered 82%
Cored 5.0' Recovered 92%
Gray broken shale. Core sound to moderately fractured
* At completion of boring water level at 18.5'
Topsoil
Gray and brown clay and silt with a trace of sand
Brown silty clay with some sand and gravel and broken shale
Brown clayey silt (weathered shale)
Gray weathered shale
Cored 5.0' No recovery
Cored 5.0' Recovered 50%
Gray broken shale. Core sound to badly fractured
Cored 5.0' Recovered 80%
Cored 5.0' Recovered 78%
Gray broken shale. Core sound to badly broken
Cored 5.0' Recovered 84%
Cored 5.0' Recovered 90%
* 24 hours after completion of boring water level at 26.0'
Gray shale. Core sound to badly fractured
* 24 hours after completion of boring water level at 13.9'
COUTRACT SET
Nov. 10, 1970
Robert B. Balter
soil and foundation consultants, inc.
DATE 4-20-70
BORING PROFILES
LINGANORE CREEK DAM

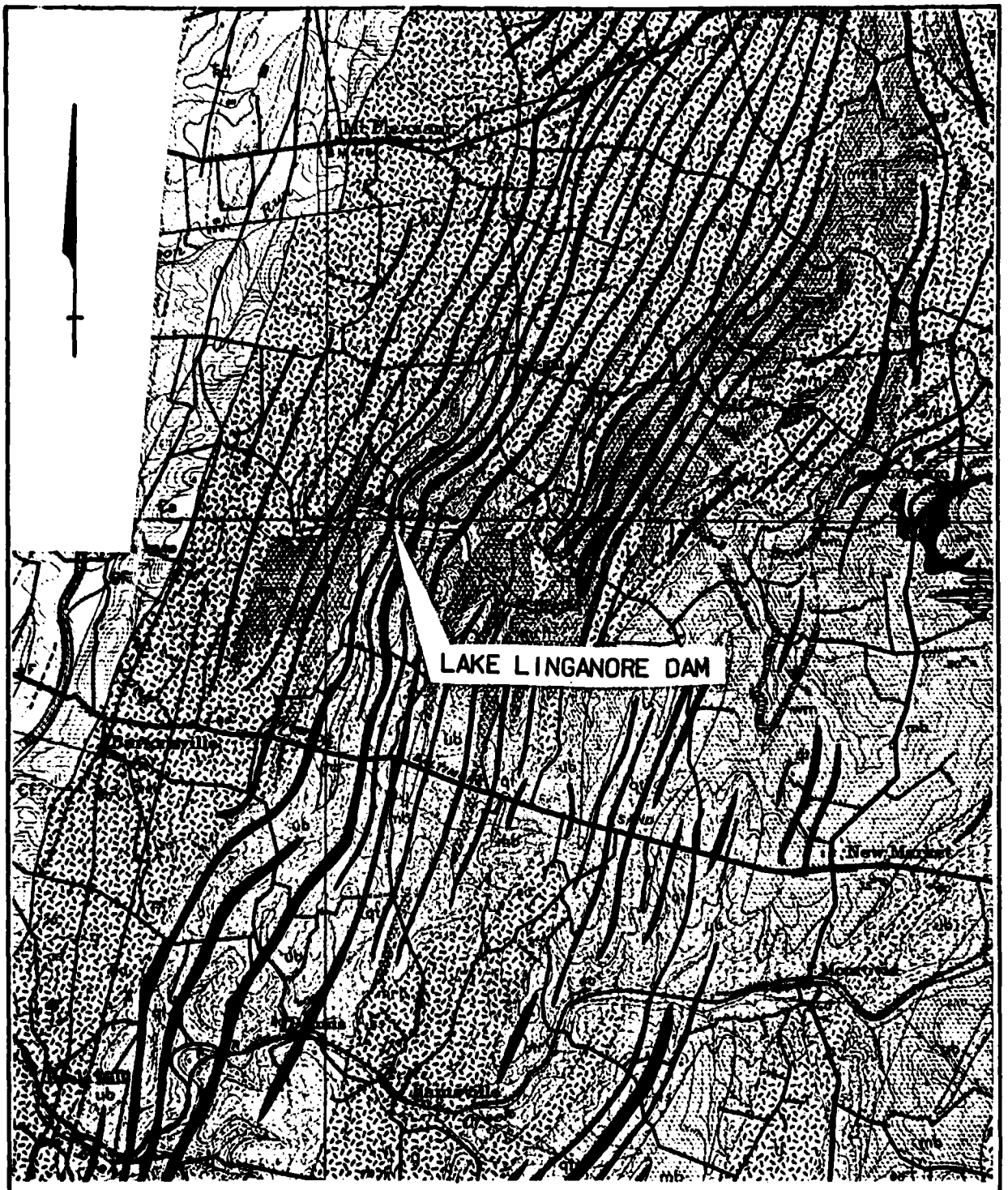
PLATE E-1

APPENDIX F

GEOLOGY

LAKE LINGANORE
APPENDIX F
REGIONAL GEOLOGY

The Lake Linganore Dam is located within the Piedmont Physiographic Province and is situated on rock strata consisting of Pre-Cambrian metarhyolite and metaandesite. These formations are included in a stratigraphic sequence of Pre-Cambrian metamorphic rock formations located immediately southeast of the Martic Overthrust, a thrust fault along which the Pre-Cambrian rocks were brought into contact with the Cambrian rock formations of the Frederick Valley. The strata in the vicinity of the dam dip moderately to steeply to the southeast.



SCALE

0 1 MI. 2 MI.

REFERENCE:

GEOLOGIC MAP OF FREDERICK COUNTY, PREPARED BY THE STATE OF MARYLAND, MARYLAND GEOLOGICAL SURVEY, DATED 1938

LAKE LINGANORE DAM

GEOLOGY MAP

RUMMEL, KLEPPER & KAHL

LEGEND

Quartzite beds

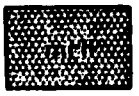
(Massive white quartzites with sericite partings; thinner purple, green, and white quartzites and sericitic quartzite, ferruginous and calcareous in part, probably a pyroclastic containing fine round white and blue ferruginous quartz grains and green sericitic quartzose pellets, conglomeratic in places. These quartzite beds are infolded with, and overlie, Marburg schist, Ijamsville phyllite, metaandesite, metarhyolite, and metabasalt. They are also interbedded and infolded with Urbana phyllite in the Sugarloaf mine line. Closely folded; transverse cleavage has sheared out the bedding, which is rarely visible; quartz veins fill the fractures)

Ijamsville phyllite

(Soft, blue, purple, and green phyllitic slate, in places with flattened amygdaloidal blebs; quartz injection parallel to the layers; composed of muscovite, chlorite or chloritoid, quartz, and fine ilmenite or iron oxide dust; contains some blue slate banded with quartzose layers; interbedded with metarhyolite and metaandesite flows. In part equivalent to Marburg schist)

Urbana phyllite

(Green ferruginous, quartzose, chlorite phyllite with green slaty layers, probably a pyroclastic facies of metabasalt; contains sericitic quartzite layers; thin calcareous layers, ubc, south of Park Mills, locally mapped)



Metarhyolite and metaandesite

(Reddish-purple to blue schistose amygdaloidal flows, containing fine ilmenite and iron oxide dust; only larger areas separately mapped; includes purple and white sericitic quartzite of pyroclastic origin and layers of metabasalt, not separately mapped)

Metabasalt

(Green schistose amygdaloidal flows, composed of albite, hornblende, chlorite, and epidote; includes interbedded layers of metaandesite and Ijamsville phyllite not separately mapped; amygdules are sheared out in more schistose facies)

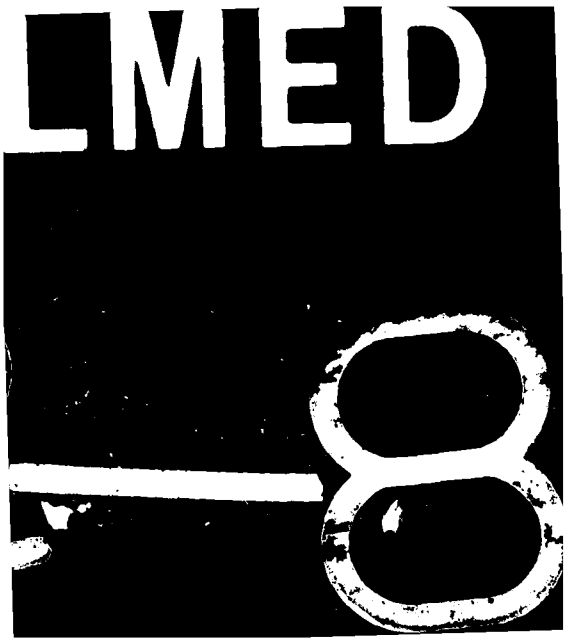
REFERENCE:

GEOLOGIC MAP OF FREDERICK COUNTY, PREPARED BY THE STATE OF MARYLAND, MARYLAND GEOLOGICAL SURVEY.

LAKE LINGANORE DAM

GEOLOGY MAP

RUMMEL, KLEPPER & KAHL


LMED