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NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. HORSEYS POND DAM (DE 00022). NANTI--ETC(U)
APR 79 T T MOORE

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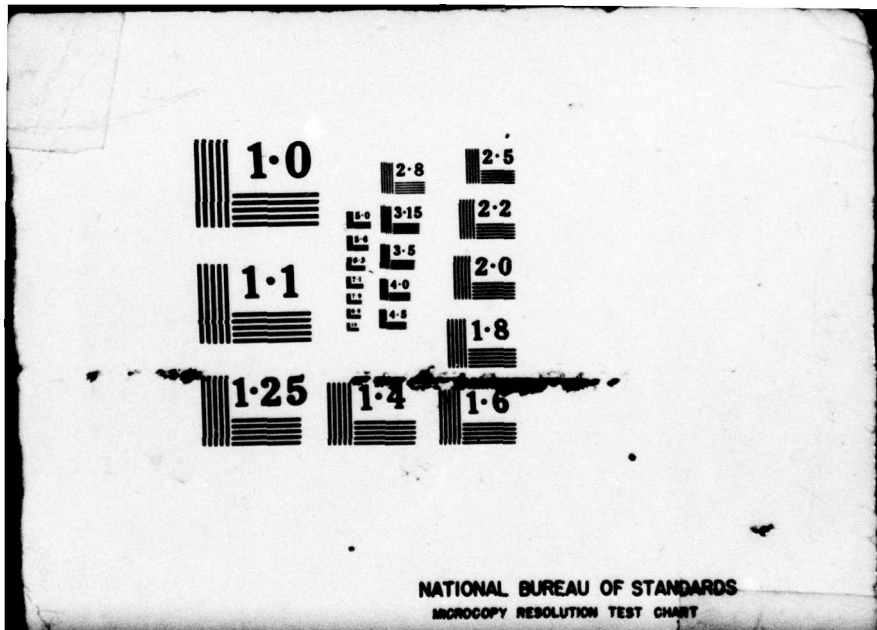
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7

³ NANTICOKE RIVER BASIN
LITTLE CREEK, SUSSEX COUNTY
DELAWARE

LEVEL II

² HORSEYS POND DAM

DE 00022

DA069215

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Horseys Pond Dam (DE 00022). Nanticoke River Basin. Little Creek, Sussex County, Delaware. Phase 1 Inspection Report.

Approved for public release; distribution unlimited



Final rept.

10 Thomas Tyler/Moore

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DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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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-D

Honorable Pierre S. DuPont
 Governor of Delaware
 Dover, Delaware 19901

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9 MAY 1979

Dear Governor DuPont:

Inclosed is the Phase I Inspection Report for Horseys Pond Dam in Sussex County, Delaware 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, Horseys Pond 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 good overall condition. The dam's spillway is considered inadequate since 53 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is the 100-year Flood). To insure 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. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within three months from the date of approval of this report, a program should be initiated to monitor the seepage occurring on the east and west side of the box culvert so that significant changes in seepage flow can be noted. The seepage should be monitored every three months for a period of three years, and every six months thereafter.

c. Within six months from the date of approval of this report the area between the spillway and the box culvert entrance should be cleaned of all debris. Periodic visits should be made every six months to prevent further accumulations of debris.

NAPEN-D

Honorable Pierre S. DuPont

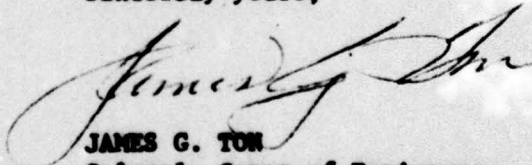
d. Within one year from the date of approval of this report an annual inspection program should be initiated to enable the owner to notice variations in appearance of specific portions of the dam. It is recommended that the owner use a check list similar to the visual inspection check list included in this report.

A copy of the report is being furnished to Mr. Austin P. Olney, Delaware Department of Natural Resources and Environmental Control, 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 Thomas B. Evans. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, thirty 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 Safety 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 yours,



JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies Furnished:

Mr. Austin P. Olney, Secretary
Delaware Department of Natural Resources and
Environmental Control
Edward Tatnall Building
Dover, DE 19901

Mr. William R. Ratledge, Director
Division of Soil & Water Conservation
Delaware Dept. of Natural Resources & Environmental
Control
Edward Tatnall Building
Dover, DE 19901

HORSEYS POND DAM (DE00022)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 8 December 1978 by Thomas Tyler Moore and Lippincott Engineering Associates, joint venture under contract to the U.S. Army Engineer District, Philadelphia, in accordance with the National Dam Inspection Act, Public Law 92-367.

Horseys Pond 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 good overall condition. The dam's spillway is considered inadequate since 53 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is the 100-year Flood). To insure 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. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within three months from the date of approval of this report, a program should be initiated to monitor the seepage occurring on the east and west side of the box culvert so that significant changes in seepage flow can be noted. The seepage should be monitored every three months for a period of three years, and every six months thereafter.

c. Within six months from the date of approval of this report the area between the spillway and the box culvert entrance should be cleaned of all debris. Periodic visits should be made every six months to prevent further accumulations of debris.

d. Within one year from the date of approval of this report an annual inspection program should be initiated to enable the owner to notice variations in appearance of specific portions of the dam. It is recommended that the owner use a check list similar to the visual inspection check list included in this report.

APPROVED: 

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 May 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

NAME OF DAM - Horseys Pond Dam ID #DE00022

STATE LOCATED - Delaware

COUNTY LOCATED - Sussex

STREAM - Little Creek

DATE OF INSPECTION - 8 December 1978

Assessment of General Condition of Dam

• Horseys Pond Dam was found to be in good overall condition at the time of inspection. The visual inspection and review of engineering data indicate no deficiencies adverse to the dam's adequacy. However, the spillway has the capacity to pass 52% of the routed 100-year flood prior to overtopping of the dam, and is therefore considered hydraulically inadequate.

• To insure adequacy of the structure, the following actions are recommended:

- 1) A further study should be performed to determine the feasibility of increasing the spillway capacity. It is recommended that the study be completed in the near future.

- 2) The seepage occurring on the east and west side of the box culvert should be monitored so that significant changes in seepage flow can be noted. The seepage should be monitored every three months for a period of three years, and every six months thereafter.

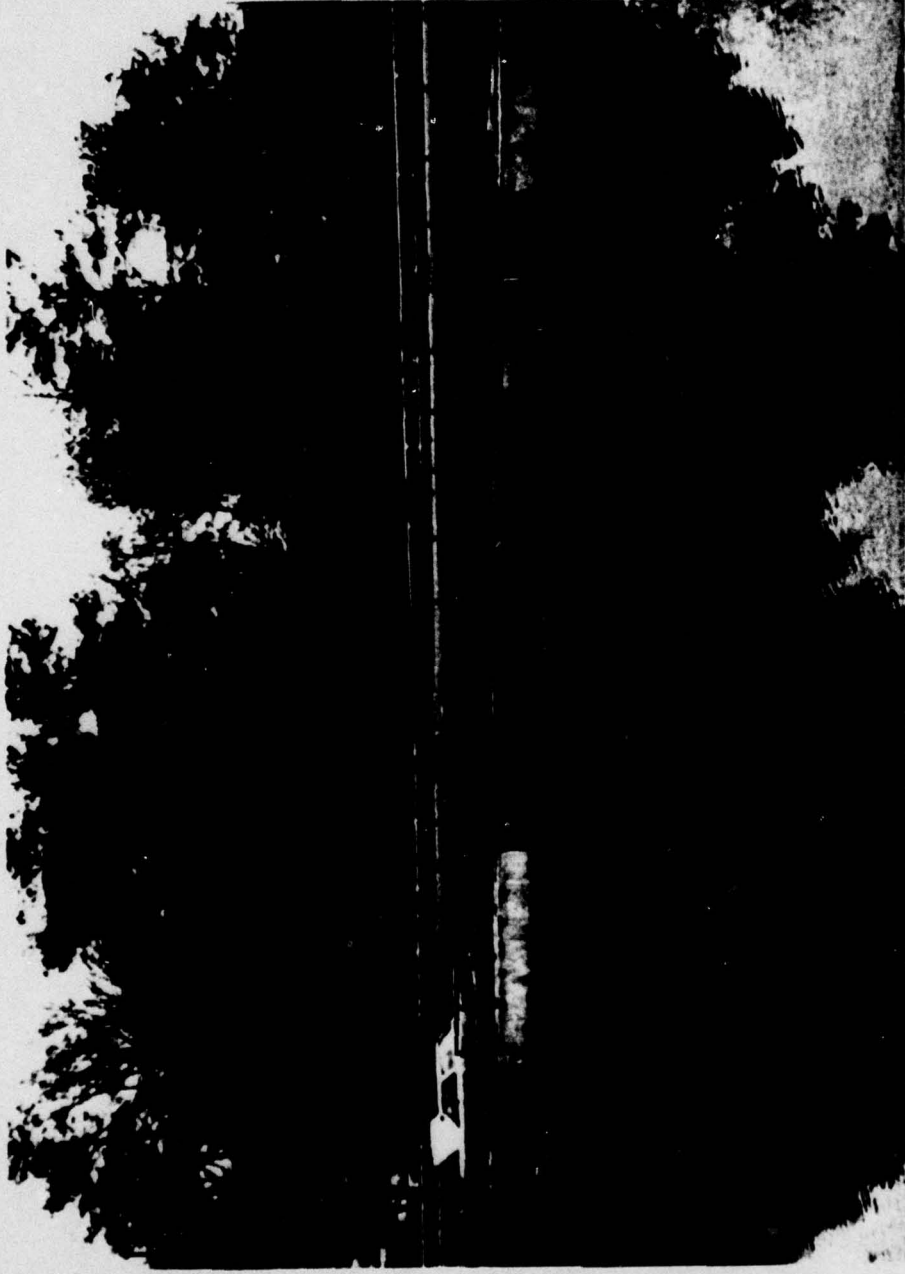
- 3) The area between the spillway and the box culvert entrance should be cleaned of all debris. This should be done soon. Periodic visits should be made every six months to prevent further accumulations of debris.

MOORE & LIPPINCOTT - ENGINEERS

Thomas Tyler Moore

Thomas Tyler Moore, P.E.
Project Manager

TTM:lg



OVERALL VIEW
OF
DAM

DEC. 7, 1978

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ASSESSMENT OF GENERAL CONDITION OF DAM

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LOCATION MAP
PLAN, SECTIONS, & PROFILE OF DAM
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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 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 available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigation, 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 aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: HORSEYS POND DAM
ID # DE 00022**

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. **Authority** - The Dam Inspection Act, Public Law 92-367, dated August 8, 1972, provides for the report herein. The inspection of Horseys Pond Dam was initiated under Contract DACW61-79-C-006 with the Department of the Army, Philadelphia District, Corps of Engineers by the engineering firms of Thomas Tyler Moore and Lippincott Engineering Associates under a joint venture.
- b. **Purpose of Inspection** The purpose of the inspection is to evaluate the general condition of Horseys Pond Dam and bring to the attention of the owner those conditions which are a threat to the public. The National Inventory of Dams will be updated by the data accumulated during this inspection.

1.2 DESCRIPTION OF PROJECT

- a. **Description of Dam and Appurtenances** - Horseys Pond Dam consists of an overflow structure fronting a double cell box culvert under the roadway embankment of Route 24, a 2 lane paved road. The roadway embankment extends approximately 130 feet west of the overflow structure and 50 feet east of the overflow structure. The overflow structure is 48 feet wide.

NAME OF DAM: HORSEYS POND DAM

Horseys Pond varies in depth, but according to the Division of Fish and Wildlife, State of Delaware, the pond depth at the upper end is approximately six inches and the maximum depth occurs at the dam. Our field measurements indicated a pond depth at the dam of 11 feet.

Horseys Pond extends 6,000 feet upstream of the dam axis. The banks are moderately sloped and well vegetated.

One house exists immediately downstream on the west side of the stream, approximately 9 feet above the streambed.

- b. **Location** - Horseys Pond Dam is located on a tributary known as Little Creek approximately 10,000 feet downstream (north) of the intersection of Meadow Branch and Holly Branch tributaries, and 6,000 feet upstream (south) of its confluence with Broad Creek in Sussex County. Horseys Pond Dam is located at the southwest fringe of the Town of Laurel.
- c. **Size Classification** - The maximum height of the dam (top of roadway) is 18 feet. The maximum reservoir volume at the top of dam is 912 acre-feet. Therefore, as determined by the criteria in the "Recommended Guidelines for Safety Inspection of Dams", the size category of the dam is "Small", i.e., the height is less than forty feet and the storage volume is less than 1,000 acre-feet.

NAME OF DAM: HORSEYS POND DAM

- d. **Hazard Classification** - Visual inspection of the downstream channel indicates that breach of the dam would not cause excessive damage to the downstream residence. Therefore, as determined by the criteria in the "Recommended Guidelines for Safety Inspection of Dams" , Horseys Pond Dam is considered a Significant Hazard Dam.
- e. **Ownership** - The State of Delaware
- f. **Purpose of Dam** - The purpose of the dam is to impound water for recreational purposes. The prime activity is fishing.
- g. **Design and Construction History** - The overflow structure fronting the box culvert under Route 24 was constructed in 1956 according to the State Division of Fish and Wildlife. "As Built" drawings do not exist for the overflow structure. According to our survey, additional lifting logs were installed so as to raise the pond elevation by 1.8 feet. This action, according to the Division of Fish and Wildlife, was necessary so that many of the tree stumps on the upper end of the pond would be covered by water.

Information on the design and construction history of the box culvert and embankment was not available.

- h. **Normal Procedures** - The dam is controlled by the Division of Fish and Wildlife for the State of Delaware. According to Fish and Wildlife, the pond has been partially drained on occasion so as to allow home owners upstream to build bulkheads and/or improve grading on their property.

NAME OF DAM: HORSEYS POND DAM

Since construction of the overflow structure and development of the pond there have been no recorded overtoppings of Route 24. The pond level, however, is controlled by employees of Fish and Wildlife who live within two miles of the dam. In anticipation of a severe rainfall, stop logs are raised.

1.3 PERTINENT DATA

- a. Drainage Area - 15.35 square miles.
- b. Discharge At Damsite - Maximum known flood at damsite is unknown.
- | | |
|---|----------|
| Warm water outlet at pool elevation: | None |
| Diversion tunnel low pool outlet at pool elevation: | N/A |
| Diversion tunnel outlet at pool elevation: | N/A |
| Gated spillway capacity at pool elevation: | N/A |
| Gated spillway capacity at maximum pool elevation: | N/A |
| Ungated spillway capacity at maximum pool elevation: | 3106 cfs |
| Total spillway capacity at maximum pool elevation | 3106 cfs |
| Total spillway capacity at top of dam (top of roadway): | 1609 cfs |
- c. Elevation (feet above Mean Sea Level (M.S.L.)) -
- | | |
|--------------------------------|---------------------------|
| Top Dam (Top of Roadway): | 24.4 ft. M.S.L. (minimum) |
| Maximum pool-design surcharge: | 25.6 ft. M.S.L. |
| Full flood control pool: | N/A |

NAME OF DAM: HORSEYS POND DAM

Normal Pool:	18.6 ft. M.S.L. ±
Spillway Crest (ungated):	18.4 to 18.8 ft. M.S.L.
Spillway Crest (gated):	N/A
Upstream portal invert diversion tunnel:	N/A
Downstream portal invert diversion tunnel:	N/A
Streambed at centerline of dam:	6.2 ft. M.S.L.
Maximum tailwater:	Tailwater controlled by downstream channels and bridges.

d. Reservoir (feet) -

Length of Maximum Pool - 10,000 feet
 Length of Normal Pool - 6000 feet
 Length of Flood Control Pool - N/A

e. Storage (acre-feet) -

Normal Pool - 346
 Flood Control Pool - N/A
 Top of Dam - 912
 Design Surcharge - 1057

f. Reservoir Surface (acres) -

Normal Pool - 68
 Top of Dam - 110
 Flood Control Pool - N/A
 Maximum Pool - 133
 Recreational Pool - 68

NAME OF DAM: HORSEYS POND DAM

g. **Dam** -

Type - Earth-fill embankments and concrete bridge/spillway with wooden stop logs

Length - 180 feet of earth-fill, 48 feet of concrete bridge/spillway

Height - 18 feet

Top Width - 47 feet ±

Side Slopes - 3H to 1V Upstream; 2H to 1V Downstream

Impervious Core: Unknown
Cutoff: Unknown
Grout Curtain: Unknown

h. **Spillway** -

Type - Wooden stop logs between concrete piers

Length of Weir - 9 openings at 4.5 feet± = 40.5 feet total

Crest Elevation - 18.4 to 18.8 feet M.S.L.

Retaining Wall Elevation - varies (see plan)

Gates - None

Upstream Channel - None

Downstream Channel - twin 9' x 7.5' box culvert discharging into stream channel

i. **Regulating Outlets** - Wooden stop logs may be added or removed as desired.

j. **Design & Construction** - The spillway and additional earthen embankment was added adjacent to the existing box culvert and roadway embankment of Route 24 by the State of Delaware Dept. of Transportation in 1956.

NAME OF DAM: HORSEYS POND DAM

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Drawings available from the Delaware State Highway Department adequately define the dam as it stands today. There are six drawings outlining the construction of an overflow dam to be attached to an existing two-cell box culvert under Route 24. Also included is a seventh drawing showing drainage along Route 24 at the dam. The various drawings, although not noted as being "As-Builts", have been verified by our survey crew, and except for the modifications marked on the drawings, are true and correct. (See visual inspection for modification, Section 3.1b.) A description of each drawing is as follows (See Plates, Appendix B):

Plate 2

This drawing serves as cover sheet, giving location of dam and index of the following sheets.

Plate 3

This drawing is entitled, "General Plan", giving grading along upstream side of roadway and general descriptions of the dam structure.

Plate 4

This drawing is entitled, "Layout and Masonry Details", giving details for attachment of overflow structure to box culvert.

Plate 5

This drawing is entitled, "Layout of Reinforcing Steel", showing reinforcing for spillway wingwalls and splashway floor.

NAME OF DAM: HORSEYS POND DAM

Plate 6

This drawing is entitled, "Structural Steel and Creo. Timber Structures", giving details of pedestrian bridge.

Plate 7

This drawing is entitled, "Sheet Piling Plan and Borings", giving foundation plan, details, and soil descriptions.

Plate 8

Drainage plan and profile of Route 24 at dam site.

2.2 CONSTRUCTION

The available data on construction uncovered for this report came from drawings supplied to us by Delaware State Department of Transportation and conversations with the Delaware Division of Fish and Wildlife.

The dam was constructed incorporating an existing box culvert under Route 24. Approximately 23 feet south of the box culvert, precast concrete columns were erected and horizontal struts were attached to the top of the columns and top of existing culvert. Stop logs were then placed between the columns to dam-up the existing 15-foot wide stream. Fifteen-foot long steel sheet piles were driven to support the new columns and retaining wingwalls that now adjoined the box culvert on the upstream side.

Thus, the existing roadway embankment became a dam. Data on the construction of the existing embankment was not available.

NAME OF DAM: HORSEYS POND DAM

2.3 OPERATION

The dam is operated by the Division of Fish and Wildlife, State of Delaware. During periods of significant rainfall, the lake level is controlled by adjusting the stop logs.

2.4 EVALUATION

- a. **Availability** - The fact that engineering data in the form of computations are not available is discussed in Section 7.
- b. **Adequacy** - The adequacy of the information available on the drawings to assess the safety of the dam is discussed in Section 7.
- c. **Validity** - The validity of the drawings assembled for this report are discussed in Section 7.

NAME OF DAM: HORSEYS POND DAM

SECTION 3 - VISUAL INSPECTION**3.1 FINDINGS**

- a. **General** - Horseys Pond Dam was found to be in good overall condition at the time of inspection. The problems noted during inspection are considered minor in nature.

- b. **Dam**
 - Earthfill/Embankment** - Seepage was observed on the downstream side of the box culvert at the junction of the earth embankment and the ends of the culvert wingwalls. Seepage was barely noticeable on the east side and a trickle was noted on the west side.

 - Spillway** - The spillway was found to be in good overall condition at the time of inspection. Minor concrete deterioration was noted just below the water line in the concrete piers supporting the stop logs in the spillway.

- c. **Appurtenant Structures** - Debris in the form of tree stumps and large metal drums was noted at the upstream end of the box culvert under the Route 24 roadway.

- d. **Reservoir Area** - Only that portion of the reservoir bounded by the dam was accessible. All other portions of the reservoir would require access by boat or passage through private property. However, it appeared from the downstream location that sloughing of the heavily vegetated, moderately steep bank, was not occurring. No significant accumulation of silt was noticeable.

NAME OF DAM: HORSEYS POND DAM

- e. **Downstream Channel** - The spillway overflows onto a concrete splashway forty-seven feet wide, which then funnels into a double box culvert consisting of two openings, 9'-0"x7'-6". The box culvert extends under Route 24 and empties into a narrow meandering channel. The immediate downstream channel appears to have been recently reshaped and regraded. A small island was constructed with walkway bridges leading to the embankment on either side. The banks are well graded and vegetated. The timber bulkhead along the stream is in need of some repair although the integrity of the bulkhead is not essential to the functioning of the dam. The lowest home located on the banks of the immediate downstream channel is approximately 9 feet above the streambed.

3.2 EVALUATION

- a. The need to monitor the seepage occurring on either side of the box culvert will be discussed in Section 7.
- b. The need for a general clean-up of the culvert will be discussed in Section 7.

NAME OF DAM: HORSEYS POND DAM

SECTION 4 - OPERATIONAL PROCEDURES**4.1 PROCEDURES**

Horseys Pond Dam is operated by the Division of Fish and Wildlife, State of Delaware. When significant rainfall is anticipated, the stop logs are adjusted to control pond elevation.

4.2 MAINTENANCE OF DAM

Maintenance of the roadway embankment and box culvert is the responsibility of the Department of Transportation, Division of Highways. According to the Bridge Engineer this type of structure is inspected every two years.

Maintenance of the overflow structure and spillway adjacent to the box culvert is the responsibility of the Division of Fish and Wildlife. There is no formal or systematic maintenance program at the present time. Maintenance is on an "as-needed" basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

The stop logs of the overflow structure are maintained by the Division of Fish and Wildlife on an "as-needed" basis.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

There is no warning system in effect.

4.5 EVALUATION

- a. The need for a warning system is discussed in Section 7.
- b. The need for a formal maintenance program is discussed in Section 7.

NAME OF DAM: HORSEYS POND DAM

SECTION 5 - EVALUATION OF HYDROLOGIC AND HYDRAULIC FEATURES

5.1 EVALUATION OF FEATURES

- a. Design Data - The only design data available for the hydrology of the watershed was listed on the design drawings of the dam prepared by the State Department of Transportation. This listed the size of the watershed as 14.6 square miles and the design flow as 900 cfs. For the purpose of this report, the data presented in this report supercedes the hydrologic data listed on the design drawings. For the hydrologic evaluation used in this report, watershed parameters measured from USGS 7.5 minute quadrangles were used with Snyder coefficients and loss rates specified by the Corps of Engineers to compute peak inflows to the pond. The HEC-1 DB computer program was used to compute the inflow into the pond and to perform the flood routing through the pond.

The dimensions of the dam and spillway as shown on the design plans prepared by the State Department of Transportation were verified by a field survey. Basically the dam was constructed as designed. The only significant difference from the design drawings was that additional wooden stop logs had been placed in the dam to raise the normal pool elevation. The spillway capacity was calculated from the field survey information by standard engineering methods. A typical cross-section of the stream channel below the dam and box culvert under Route 24 was also measured in order to calculate the tailwater on the box culvert from the channel.

NAME OF DAM: HORSEYS POND DAM

Based on the size and hazard potential classification for this dam, the recommended spillway design flood is 50 years to 100 year. For evaluating the adequacy of the spillway the 100-year flood was used as the SDF.

- b. **Experience Data** - No measurements of outflows from the dam or flows within the watershed of the dam are available.

- c. **Overtopping Potential** - From the HEC-1 DB Program, the peak inflow to the pond for the SDF equals 3271 CFS. After routing this SDF through the pond the peak outflow was 3106 CFS. The maximum water surface elevation of 25.6 would overtop the low point of the roadway of Route 24 by 1.2 feet.

The spillway capacity at the low point of the roadway (elevation 24.4) is 1609 CFS, which is equivalent to 52 percent of the routed SDF. A rating curve for the spillway and a summary of the routings through the pond is included in Appendix D.

- d. **Emergency Drawdown** - The water in the pond may be drained by removing the wooden stop logs from the spillway. The maximum flow thru the spillway area would be about 1800 cfs with the water surface at normal pool Elevation 18.6. With no inflow it would take at least 22 hours to drain the reservoir.

NAME OF DAM: HORSEYS POND DAM

SECTION 6 - STRUCTURAL STABILITY**6.1 EVALUATION OF STRUCTURAL STABILITY**

- a. **Visual Observation** - No structural inadequacies were noted during the visual inspection of the dam.
- b. **Design and Construction Data** - No computations have been made available for checking the stability of the embankment, spillway or box culvert structures. However, past performance of these structures and our visual inspection reveal no significant structural inadequacies.
- c. **Operating Records** - Operating records have not been kept for Horseys Pond Dam.
- d. **Post-Construction Changes** - No modifications to the dam have been made since construction in 1956.
- e. **Seismic Stability** - Horseys Pond Dam is located in Zone 1 of the Seismic Zone Map of the United States. Experience has shown that structures having adequate static stability will also have adequate stability under seismic activity. Thus, the dam is considered stable under seismic loading.

NAME OF DAM: HORSEYS POND DAM

SECTION 7 - ASSESSMENT/RECOMMENDATIONS,
PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. **Safety** - The dam has been inspected visually, in accordance with procedures by the Corps of Engineers for a Phase I Report. Since no engineering data was available for review, our assessment is subject to those limitations inherent in a visual inspection.

The spillway at maximum capacity can pass 52% of the routed Spillway Design Flood. Although Horseys Pond Dam is a Significant Hazard Dam (see Sec. 1.2 d), further studies are recommended to determine the feasibility of increasing spillway capacity.

Seepage occurring on the east and west side of the box culvert does not present a piping or stability problem with respect to the embankment as long as the current rate of flow (trickle) remains unchanged. It is recommended that this seepage be monitored every three months for the next three years, and every six months thereafter.

Based upon information supplied to us by the Delaware Department of Transportation, an accurate independent assessment of the concrete overflow structure was not attempted since "as-built" drawings and computations do not exist. However, based upon past record of performance and our visual inspection, no potential stability problem conditions are evident that would indicate a potential stability problem.

NAME OF DAM: HORSEYS POND DAM

- Based upon the location of downstream houses on high ground, no warning system is deemed necessary.
 - An annual inspection program is needed so as to enable the owner to notice variations in appearance of specific portions of the dam. It is recommended that the owner use forms similar to the federal visual inspection form included in this report.
- b. **Adequacy of Information** - No additional information is needed to complete an assessment of the safety of the dam.
- c. **Urgency** -
- A study to determine the feasibility of increasing spillway capacity should be completed in the near future.
 - Seepage occurring on the east and west side of the box culvert should be monitored every 3 months for a period of 3 years and every six months thereafter.
 - It is recommended that all debris be removed from the dam site soon so as to avoid a build-up between the overflow structure and box culvert. This should be inspected every six months and cleaned as necessary.
- d. **Necessity for Additional Data/Evaluation**
- As demonstrated in Section 7.1 a, additional evaluation is recommended.

NAME OF DAM: HORSEYS POND DAM

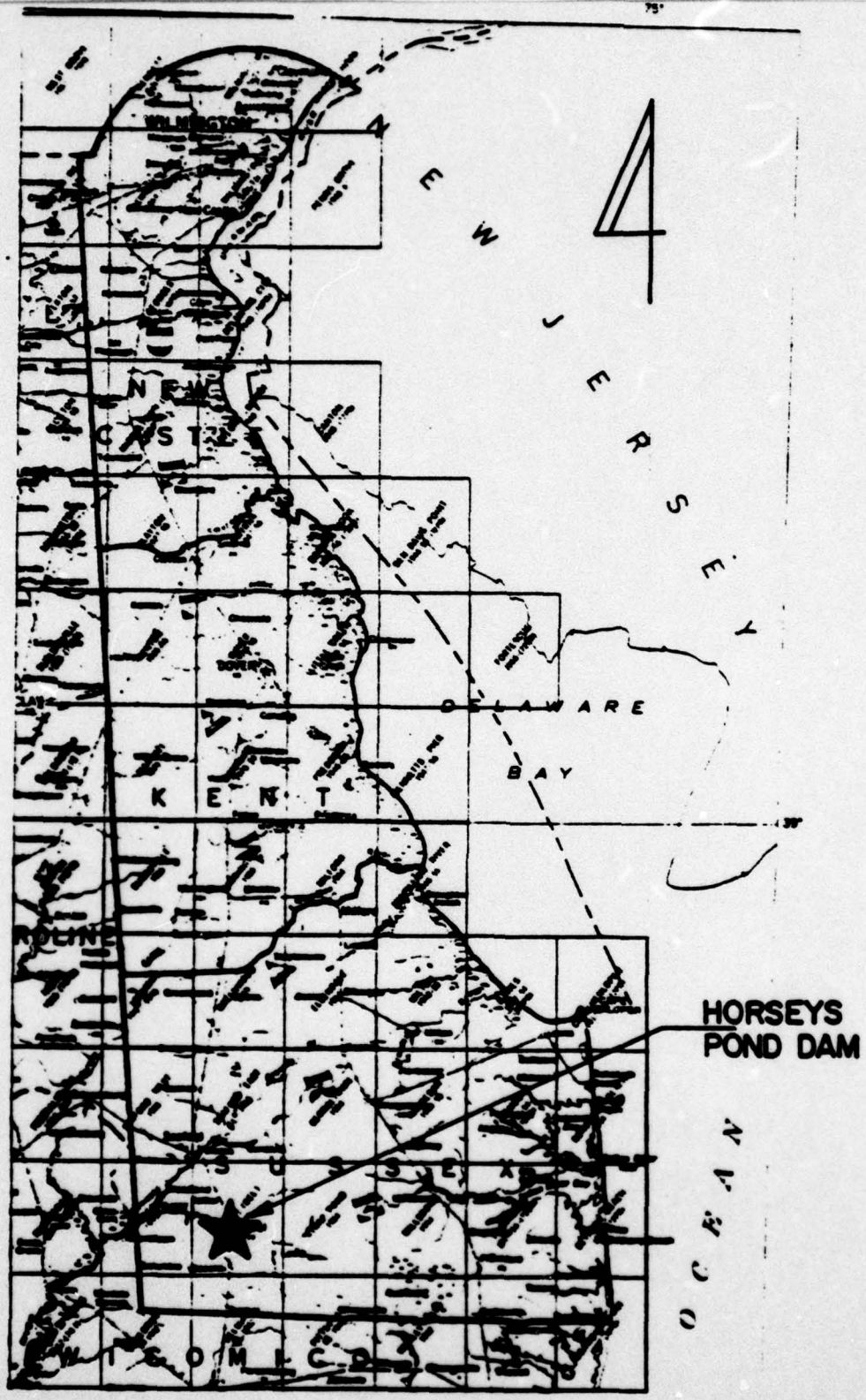
7.2 REMEDIAL MEASURES

a. Alternatives - As part of the recommended further study (see Section 7.1) regarding increasing the spillway capacity, the following alternatives should be investigated as part of that study:

1. Lower the normal pool elevation of the pond.
2. Armoring the downstream embankment of route 24 at the low point where it would be overtopped.

NAME OF DAM: HORSEYS POND DAM

PLATES



LOCATION MAP

HORSEYS POND DAM

PLATE I

THE STATE

STATE HIGHWAY

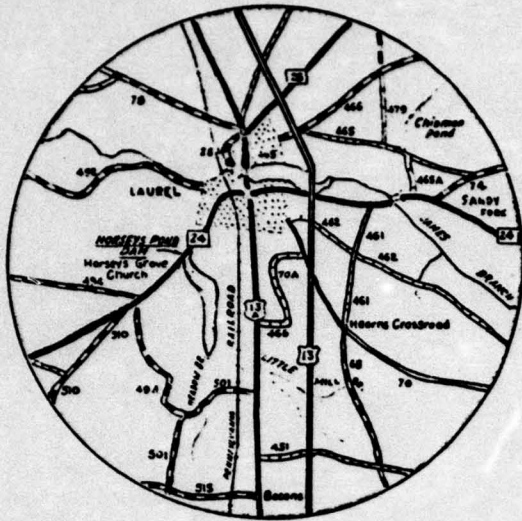
PL

CONSTRUCTION

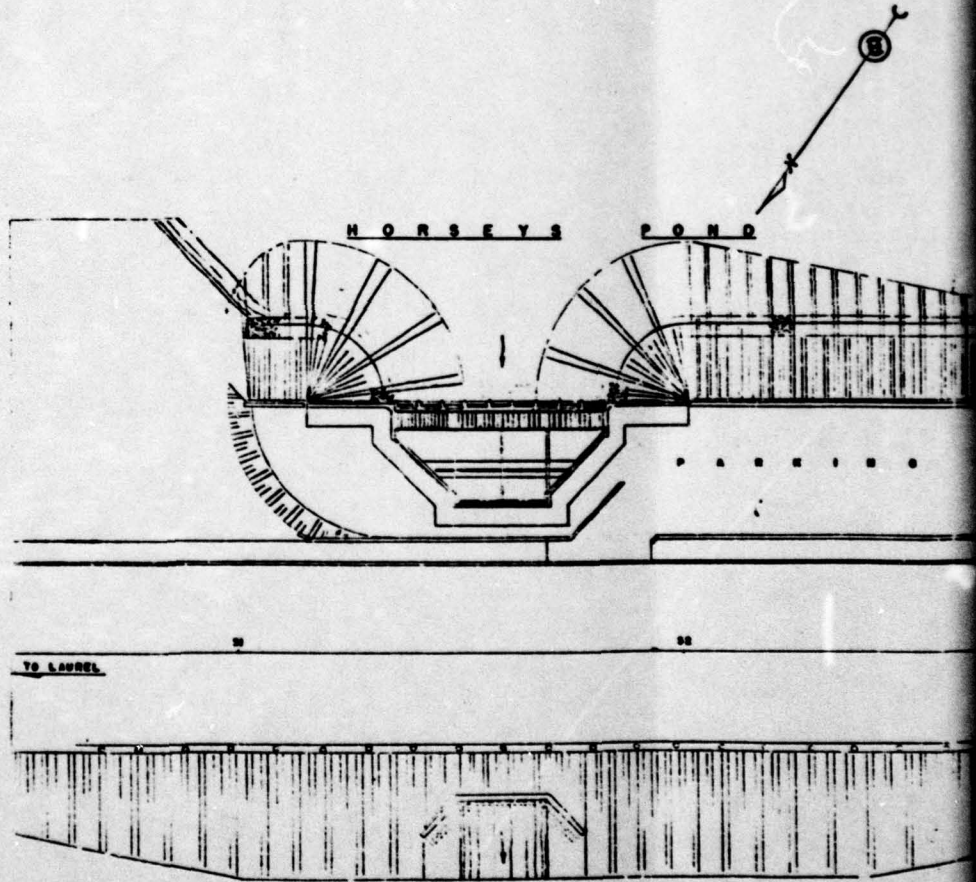
STA. TO STA.
FEET:

SCALE: PLAN: 1 IN. = 40 FT.
PROFILE: HOR. 1 IN. = 40 FT.
VERT. 1 IN. = 10 FT.

FEDERAL ROAD ADMINISTRATION

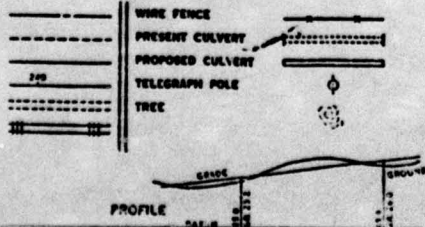


SCALE 1/4" = 100'



CONVENTIONAL SIGNS

- COUNTY LINE
- TOWN LINE
- OF WAY LINE
- CENTRE LINE PROPOSED ROAD
- HACADAM, TRAVELLED ROAD
- TOLLEY OR RAILROAD



INDEX OF SHEETS

- SHEET No 1 TITLE SHEET
- 2 TYPICAL SECTION
- 2 PLAN AND PROFILE
- 3-6 BRIDGE STRUCTURES
- 6 QUANTITIES
- 7 STANDARDS - '1'

OF DELAWARE



AY DEPARTMENT

LAN
FOR
OF CONTRACT N^o 1459

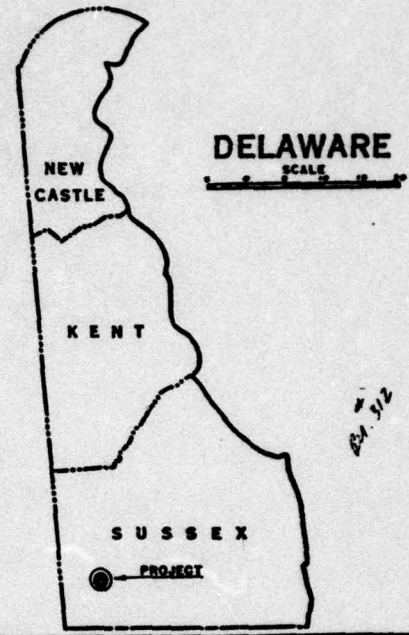
TA.
MILES

FT.
FT.

~~PROJECT N^o~~

COUNTY	CONTRACT	P. O. NO.	STATE	SCALE	PROJECT	DATE
SUSSEX	1459	2	DEL.			

HORSEYS POND DAM



BOOK NUMBER LOOSE LEAF

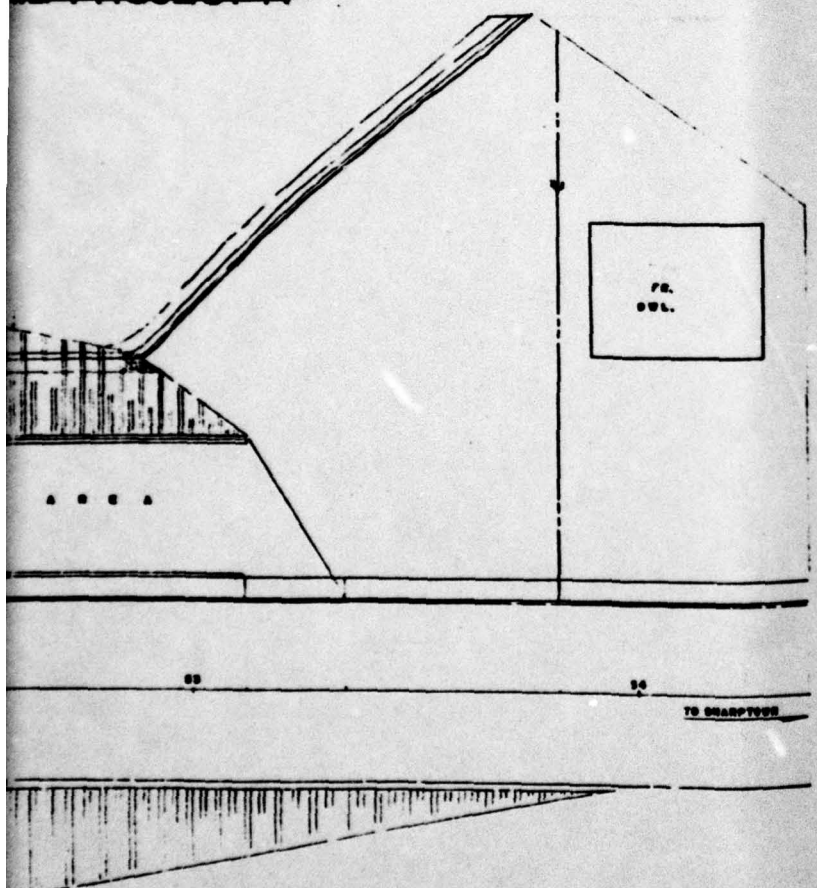
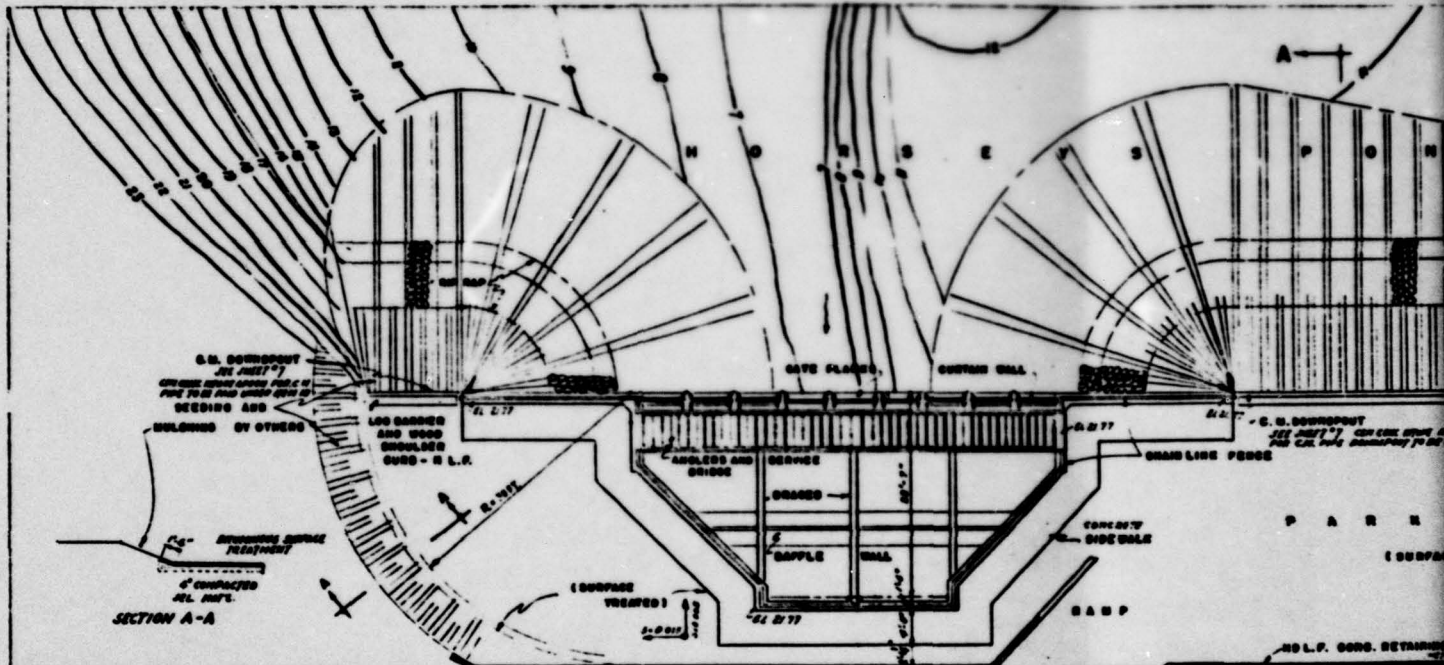
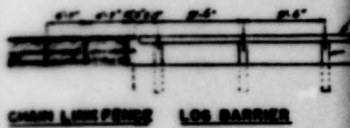


PLATE 2

RECOMMENDED 5/8 1922 *Joe S. Robinson* CIVIL ENGINEER
 RECOMMENDED 5-11 1956 *A.W. Kowarski* CONTRACTOR ENGINEER
 APPROVED 5-11 19 *A.W. Kowarski* CIVIL ENGINEER

DEPARTMENT OF COMMERCE	
DIVISION OF PUBLIC WORKS	
APPROVED:	DATE:
CITY ENGINEER	



222.6
2 3/4
3
5

SECTION A-A

DIBWALE BY OTHERS (CON' 1000)

T.S.P. CONC. RETAINING WALL AND 6\"/>

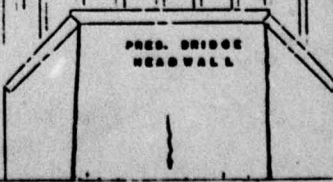
31

32

A

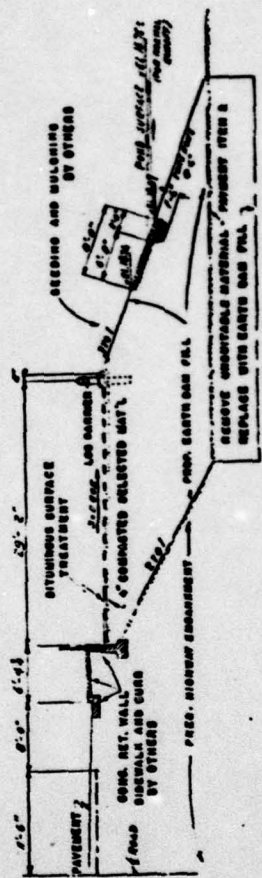
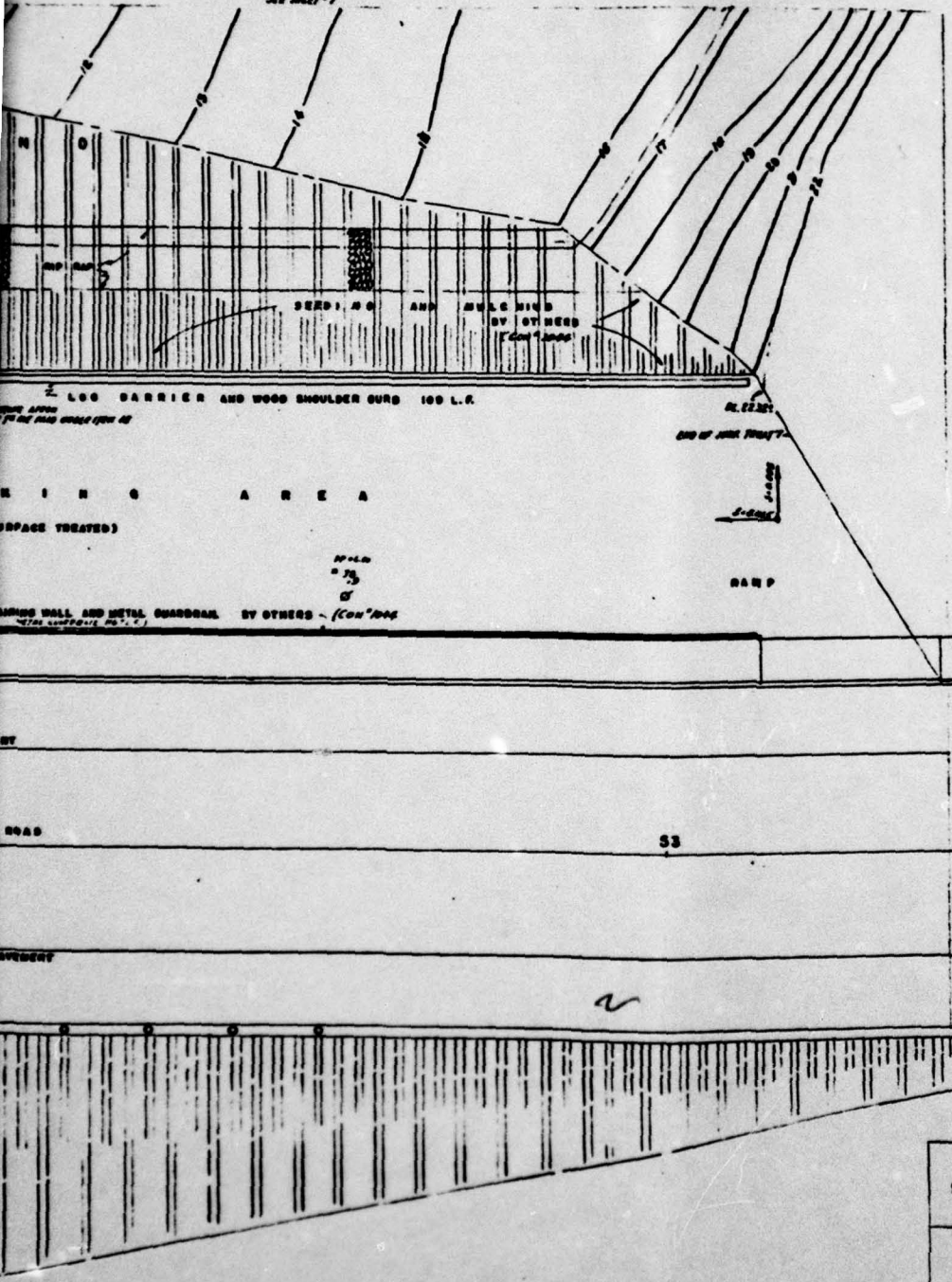
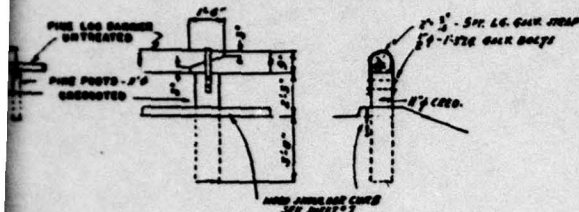
EDGE OF PAVEMENT

WIRE ROPE BOARD FENCE
NOT IN THIS CONTRACT
SEE CON. 1000



COUNTY	CONTRACT	S. N. & E. S. NO.	DATE	FED. AID PROJECT NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
SUSSEX	1489	2	DEL.			2	7

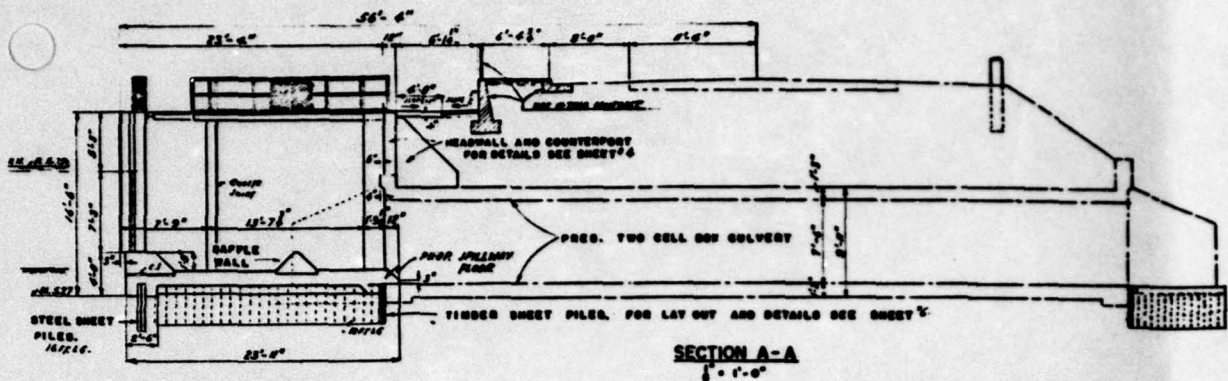
HORSEYS POND DAM



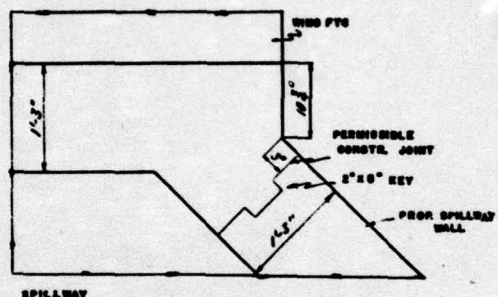
SECTION A-A
1" = 10 FT.

PLATE 3

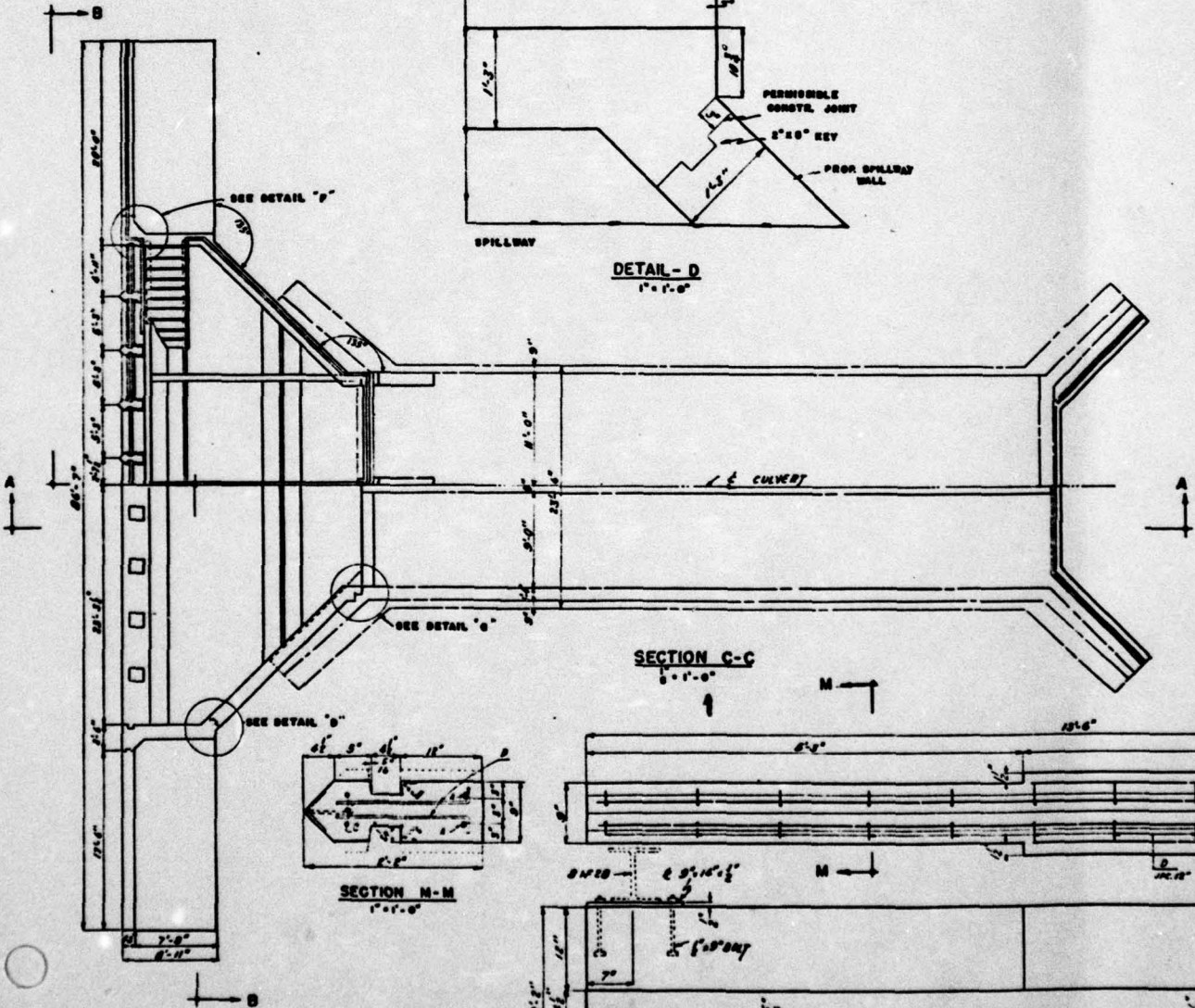
DELAWARE STATE HIGHWAY DEPARTMENT FOR GAME AND FISH COMMISSION		
GENERAL PLAN		
DRAWN BY: J.L.B. TRACED BY: J.L.B. CHECKED BY: J.L.B.	SCALE 1" = 10 FT.	APPROVED BY: <i>Joe S. Robinson</i> BRIDGE ENGR.



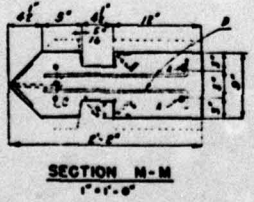
SECTION A-A
1'-1'-0"



DETAIL - D
1'-1'-0"



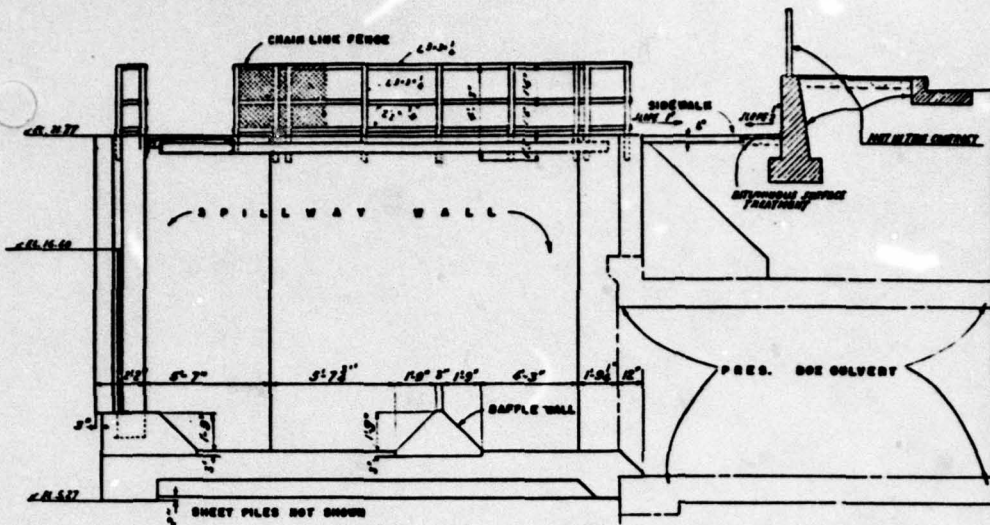
SECTION C-C
1'-1'-0"



SECTION M-M
1'-1'-0"

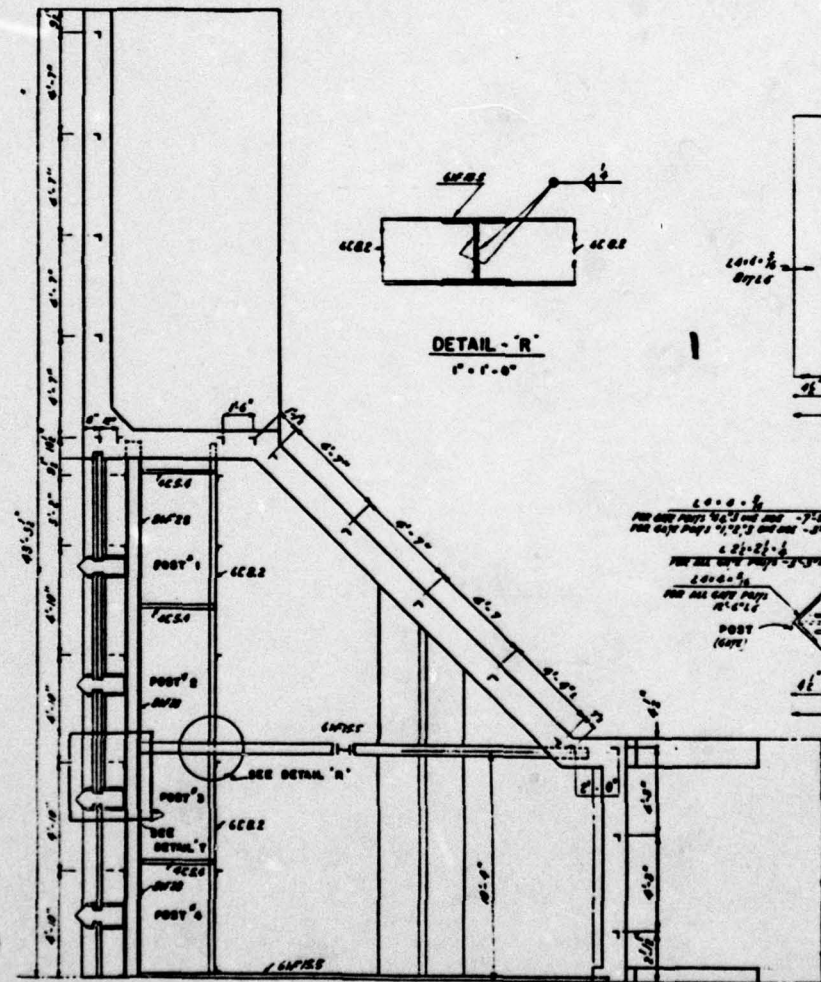


PRECAST R.C. POST



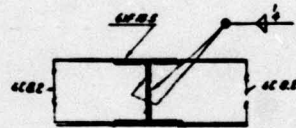
LONGITUDINAL SECTION

1" = 1'-0"



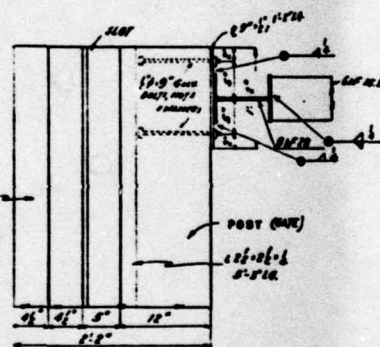
HALF PLAN

1" = 1'-0"



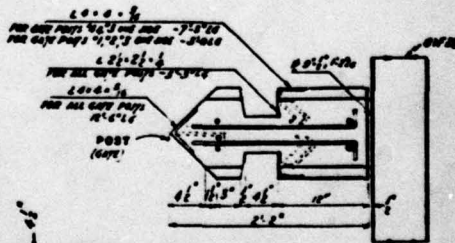
DETAIL - R

1" = 1'-0"



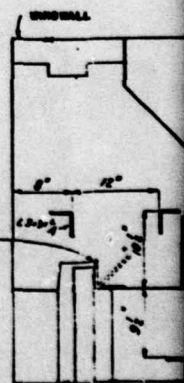
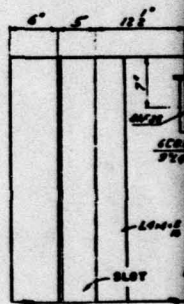
DETAIL - T, ELEVATION

1" = 1'-0"



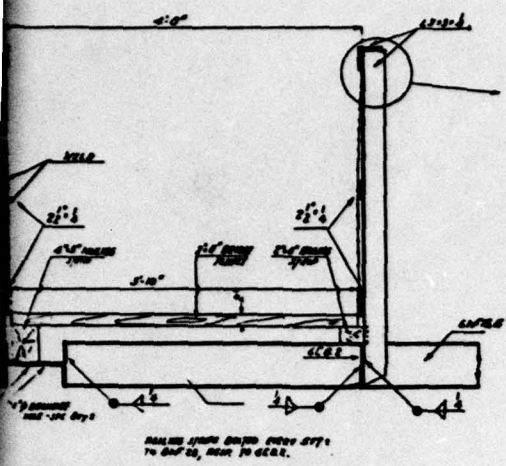
DETAIL - T, PLAN

1" = 1'-0"



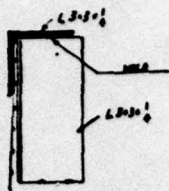
COUNTY	CONTRACT	D. R. S. DIST. NO.	DATE	FILE AND PROJECT NO.	D. R. S. NO.	DATE	TOTAL SHEETS
SUSSEX	1439	2	DEL.				8 / 7

HORSEYS POND DAM



SERVICE AND ANGLERS BRIDGE SECTION

1" = 1'-0"



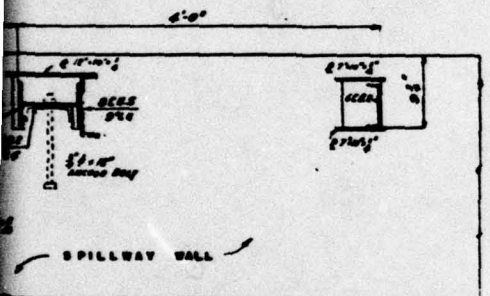
FENCE DETAIL

1" = 1'-0"



GATE PLANK

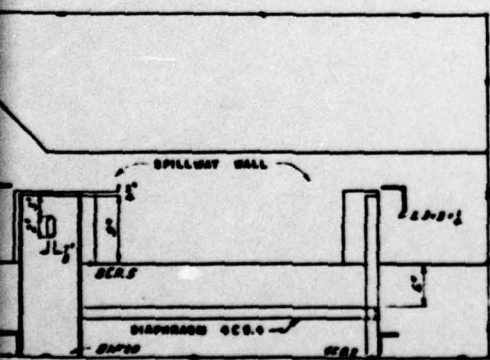
1" = 1'-0"



SPILLWAY WALL

SERVICE BRIDGE BEARING SEATS ELEVATION

1" = 1'-0"



SERVICE BRIDGE BEARING SEATS PLAN

1" = 1'-0"

STRUCTURAL STEEL

LOCATION	SECTION	LENGTH	PCS.	TOTAL LENGTH	WEIGHT	NOTES
CHORDS	CEC 2	12'-0"	22	288'-0"	422	
RAILS	CEC 2	0'-3"	24	72'-0"	708	
RAILS	CEC 2	-	-	20'-0"	1003	
	CEC 2	2'-0"	-	40'-0"	872	
GATE RAILS	CEC 2	12'-0"	2	24'-0"	220	
	CEC 2	-	-	20'-0"	736	
	CEC 2	2'-0"	70	140'-0"	300	
SERVICE BRIDGE:						
CHORD	CEC 2	20'-0"	2	40'-0"	1526	
RAIL	CEC 2	13'-0"	2	26'-0"	226	
BRACE	CEC 2	10'-0"	2	20'-0"	183	
BRACE	CEC 2	2'-0"	2	4'-0"	107	
BRACE	CEC 2	20'-0"	2	40'-0"	220	
BRACE	CEC 2	20'-0"	2	40'-0"	220	
SPILLWAY WALL:						
BRACE	CEC 2	0'-0"	2	0'-0"	17	
BRACE	CEC 2	0'-0"	2	0'-0"	17	
	CEC 2	0'-0"	2	0'-0"	17	
	CEC 2	0'-0"	2	0'-0"	20	
	CEC 2	0'-0"	2	0'-0"	153	
				TOTAL	7922	

CRED. TIMBER STRUCTURES

LOCATION	TYPE	SIZE	NO.	WEIGHT
GATE RAILS	2x4	0'-3"	24	0.221
RAILS	2x4	0'-3"	24	0.276
RAILS	2x4	0'-3"	24	0.276
RAILS	2x4	0'-3"	24	0.276
RAILS	2x4	0'-3"	24	0.276

PLATE 6

DELAWARE
STATE HIGHWAY DEPARTMENT
FOR GAME AND FISH COMMISSION

**STRUCTURAL STEEL
AND
CRED. TIMBER STRUCTURES**

DESIGNED BY J. E. ROBINSON
CHECKED BY J. E. ROBINSON
DATE 5/7/26

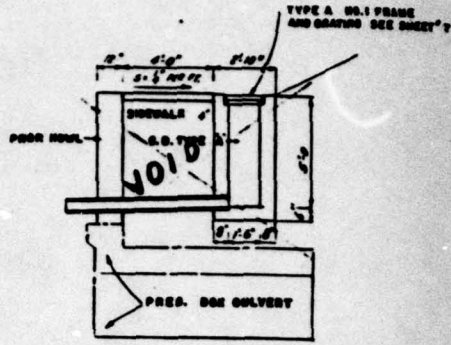
SCALE
AS SHOWN

APPROVED BY
J. E. Robinson
BRIDGE ENGINEER

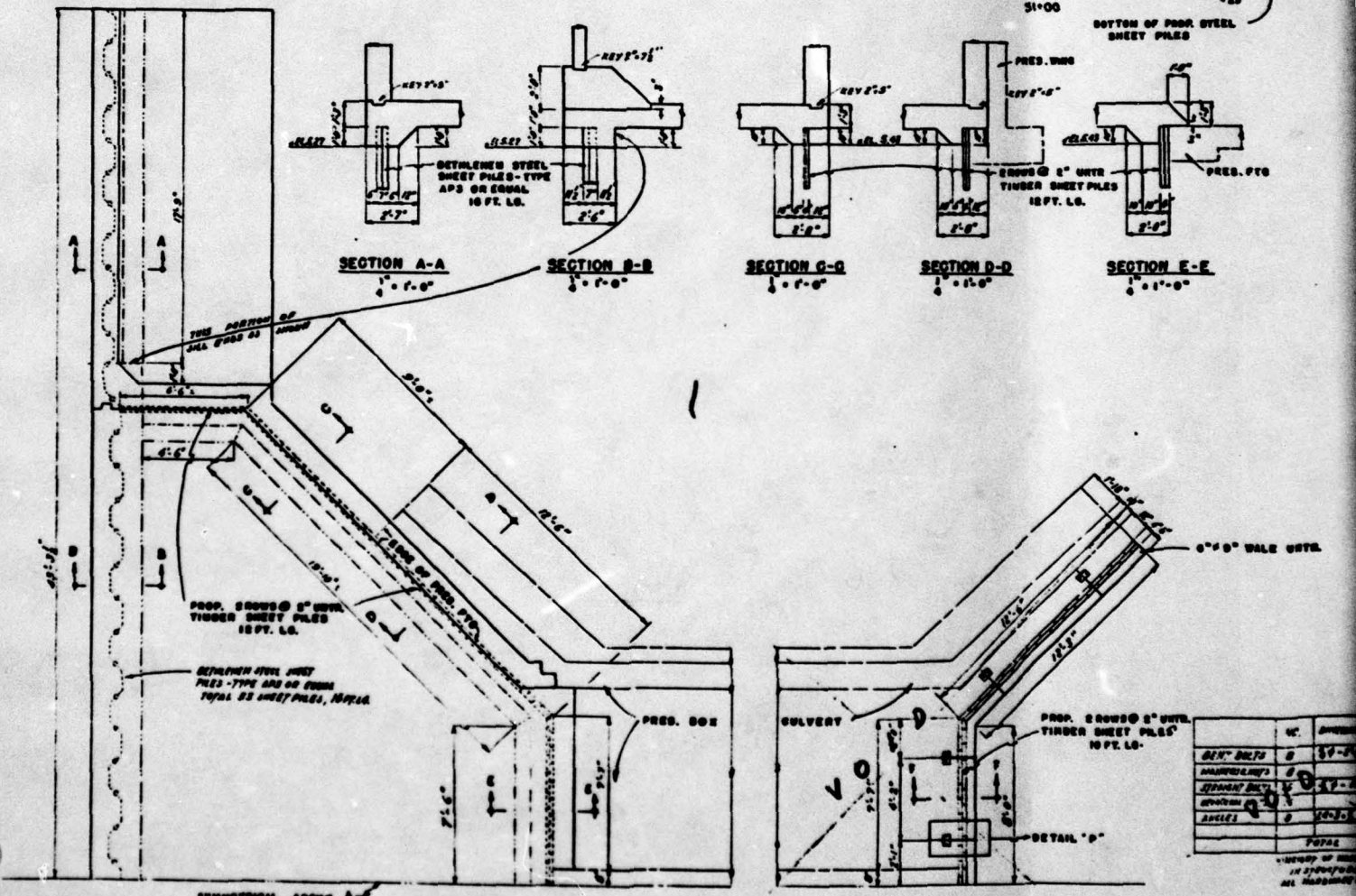
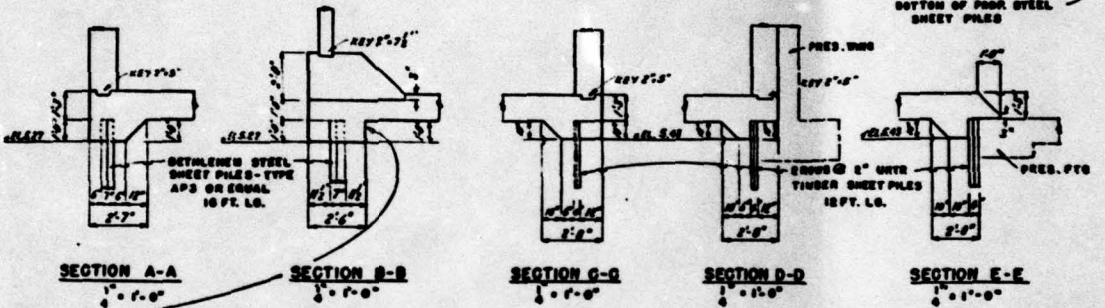
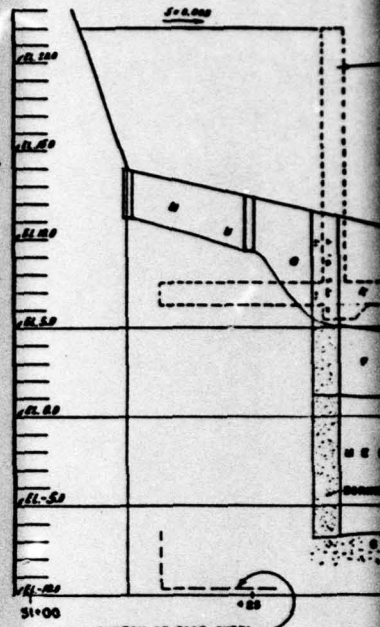
GENERAL NOTES

This structure is located in Sussex County on Meadow Branch at Road #24 (see title sheet map), State of Delaware State Highway Department Standard Specifications dated January 1, 1956. Impermeable waterproofing to be applied to the vertical surfaces of wings and spillway walls in contact with earth backfill. Timber for gate planks and bridge flooring shall be creosoted, all structural steel and hardware shall be galvanized. For the construction methods of earth dam and control structure refer to special provisions.

DRAINAGE AREA - 3200 AC. OR 14.6 S. MI.
Q_{MAX} = 900 CFS.



SECTION THROUGH C.B.
1/2" = 1'-0"



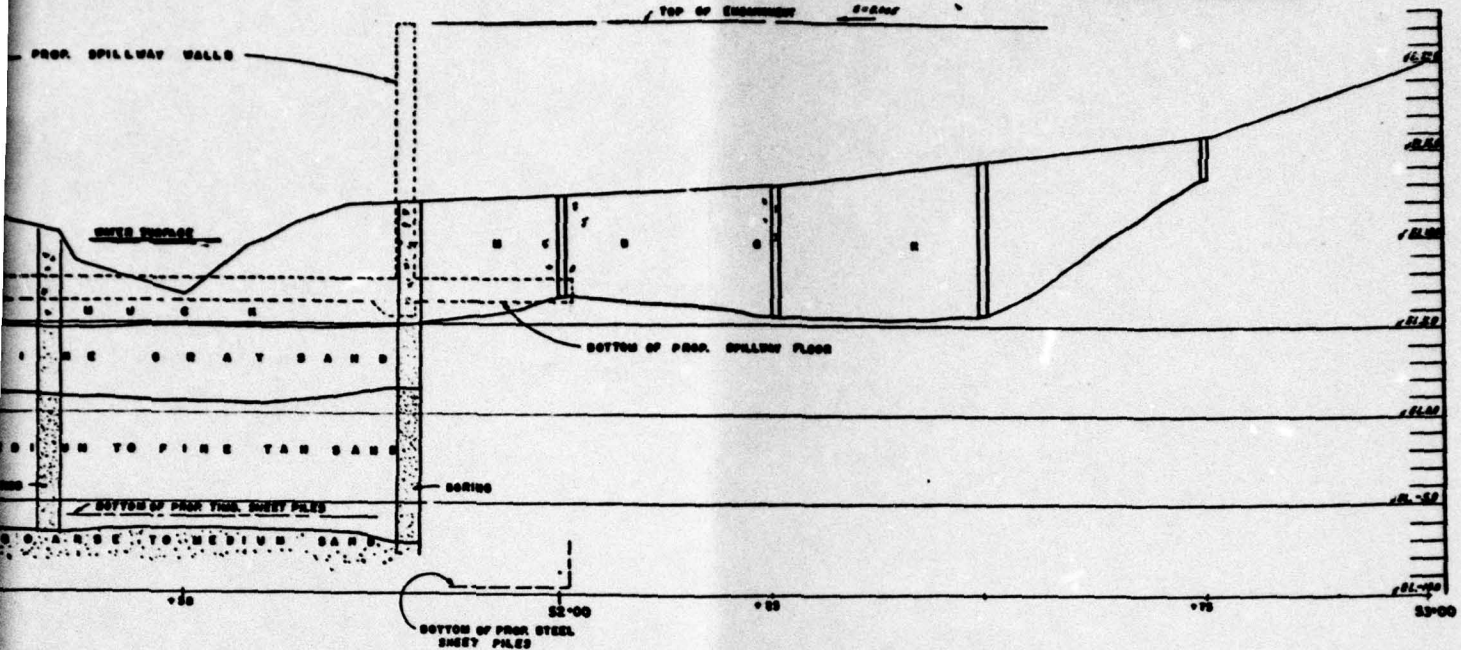
SHEET PILING PLAN
1/2" = 1'-0"

NO.	DESCRIPTION	AMOUNT	UNIT
1	STEEL SHEET PILES	25	LINEAL FEET
2	TIMBER SHEET PILES	20	LINEAL FEET
3	WALK W/TH	1	PIECE
TOTAL			

DEPTH OF PILE - 45' L. OF ROAD
 470.50-00 5'-6"
 470.52-00 6'-6"
 470.52-00 5'-6"
 470.52-00 5'-6"
 470.52-00 5'-6"

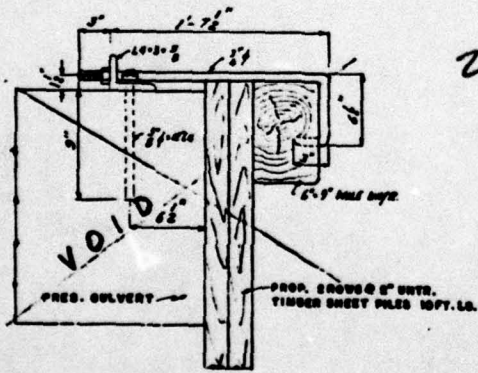
COUNTY	CONTRACT	P. O. NO.	DATE	PREP. AND REVISION NO.	DATE	SCALE	NO.
SUBSEX	1489	2	DEL.				6 7

HORSEYS POND DAM

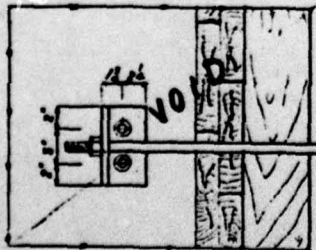


SECTION 54' LOF ROAD (SEE SHEET 5)

V - 1" = 5'-0"
 H - 1" = 10'-0"



SECTION F-F
 1/2" = 1'-0"



PLAN - DETAIL "P"
 1/2" = 1'-0"

QUANTITIES			
ITEM	DESCRIPTION	UNIT	TOTAL
2	EXCAVATION	C. Y.	1300 1400
4	EXCAVATION FOR STRUCTURES	C. Y.	221 250
7	SELECTED BORROW	C. Y.	3500 4000
17	CRED. TIMBER STRUCTURES	MFTBM	0.904 1.100
18	CEMENT CONC. MASONRY	C. Y.	163.5 170.0
19	SUPERFICIAL WATERPROOFING	SQ. Y.	215 220
20	BAR REINFORCEMENT (INCL. WIRE MESH)	LBS.	14700 15000
22	STRUCTURAL STEEL (INCL. GRAIN LINK PERDS)	LBS.	7922 8200
33	TIMBER SHEET PILES (UNTREATED)	MFTBM	3.400 4.000
	RIP RAP	SQ. Y.	200 220
	STEEL SHEET PILES	LBS.	18676 20000
	MISCELLANEOUS ITEMS	L.S.	L.S.
BITUMINOUS SURFACE TREATMENT SEE APPROX. QUANTITIES LISTED BELOW.			

APPROX. QUANTITIES FOR L.S. ITEMS			
WOOD SHOULDER CURB AND LOG BARRIER 120 L.F. CONC.			
SIDEWALK APPROX. 52 SQ. Y. CORR. METAL PIPE 24 L.F.			
ASPHALT	SLAG CHIPS	CRUSHED STONE	SEL. BORROW
NO-1	NO-2	OR GRAVEL	
500 GAL. 500 GAL.	11.2 TON	11.2 TON	63 C.Y. 70

* APPROXIMATE QUANTITY FOR SURFACE TREATMENT SEE DR. V.
 ** INCLUDED IN ITEM 7

PLATE 7

DELAWARE
 STATE HIGHWAY DEPARTMENT
 FOR GAME AND FISH COMMISSION

SHEET PILING PLAN
 AND BORINGS

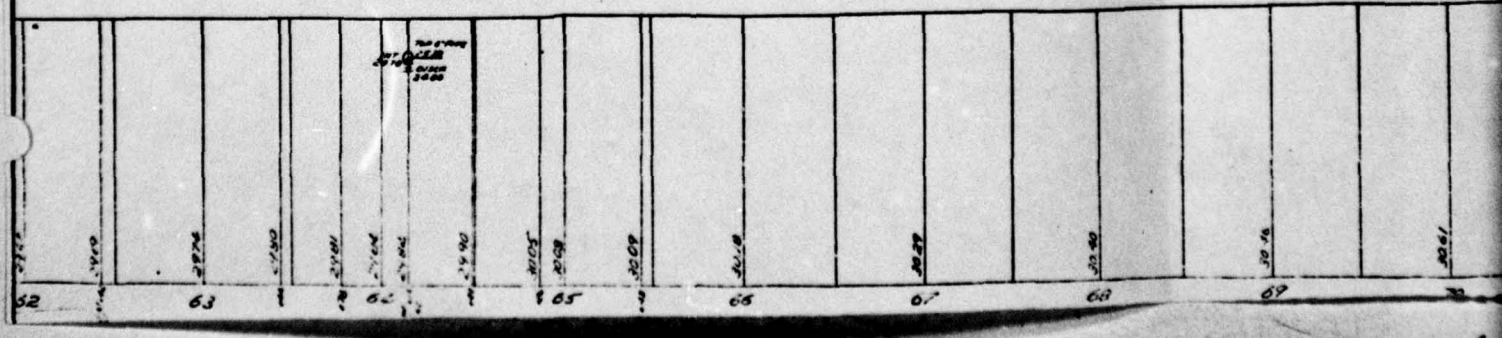
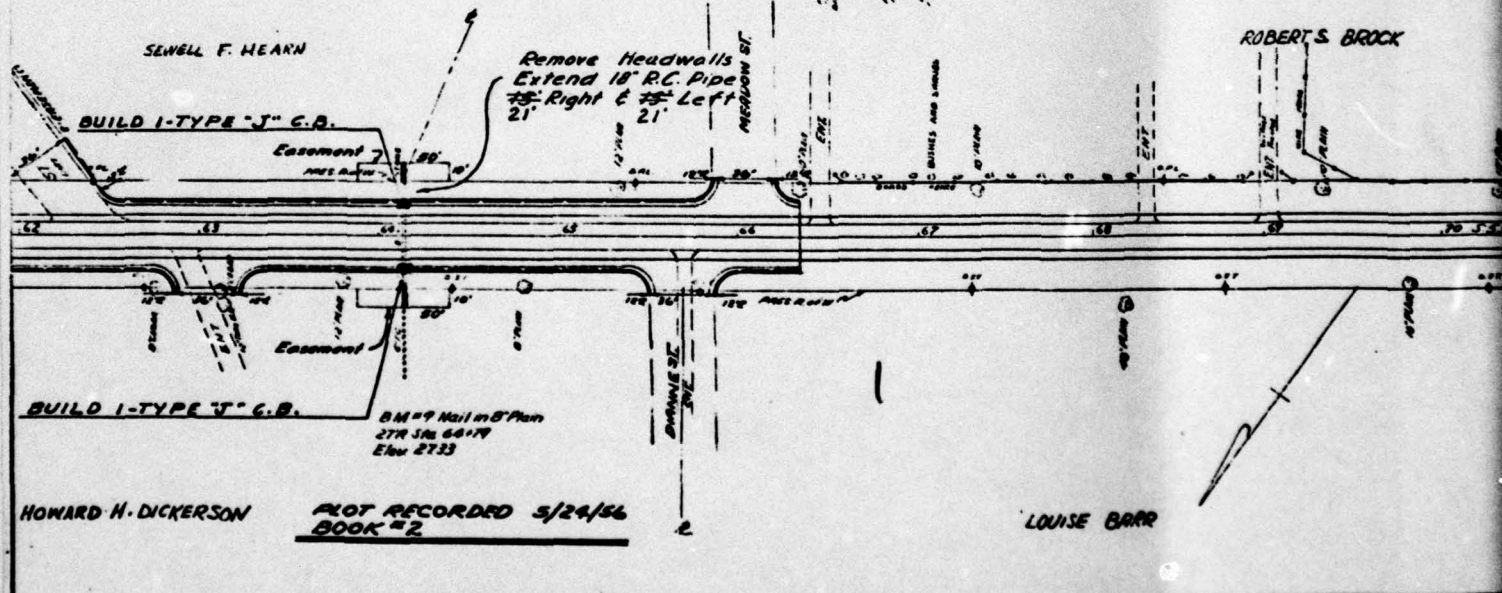
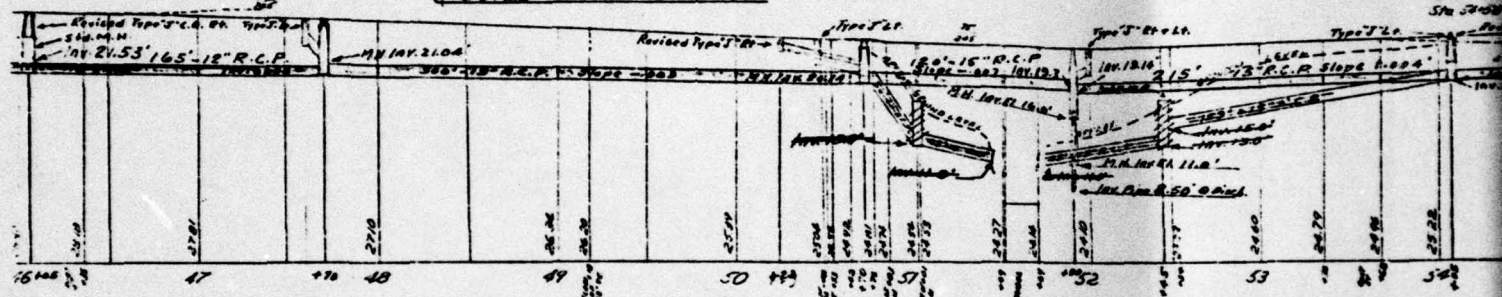
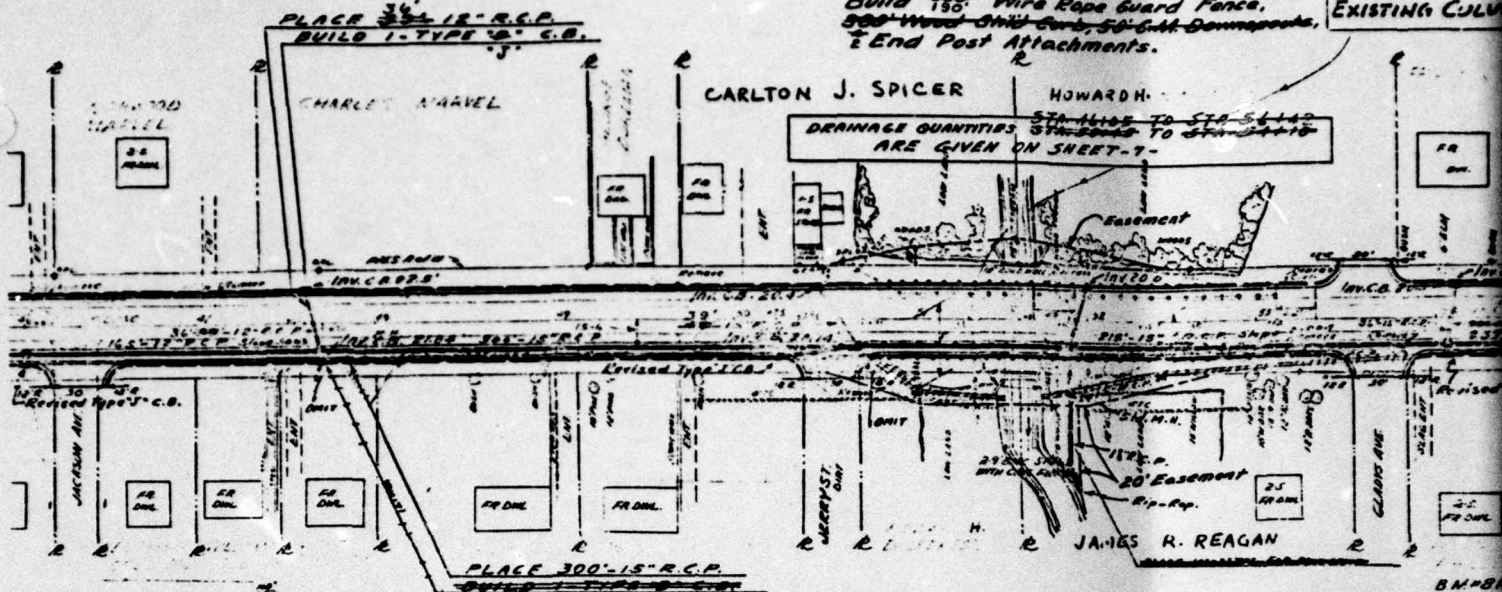
DRAWN BY J. J. ...
 CHECKED BY ...
 5/7/60

SCALE AS SHOWN

APPROVED
 J. S. Robinson
 BRIDGE ENGINEER

Sta. 50+85 to Sta. 52+75, R.
 Build 15" Wire Rope Guard Fence,
 500' Wood Chip Curb, 50' Sub-Drainage,
 & End Post Attachments.

CONSTRUCT &
 EXISTING CULV



ADDITIONS TO
 PART. SEE SHEET #2:

COUNTY	CONTRACT	S.P. NO.	DATE	REV. AND PROJECT NO.	SHEET NO.
SUSSEX	1094	1	DEC. 1912	F 31(2)	8

LAUREL TO SHARPTOWN

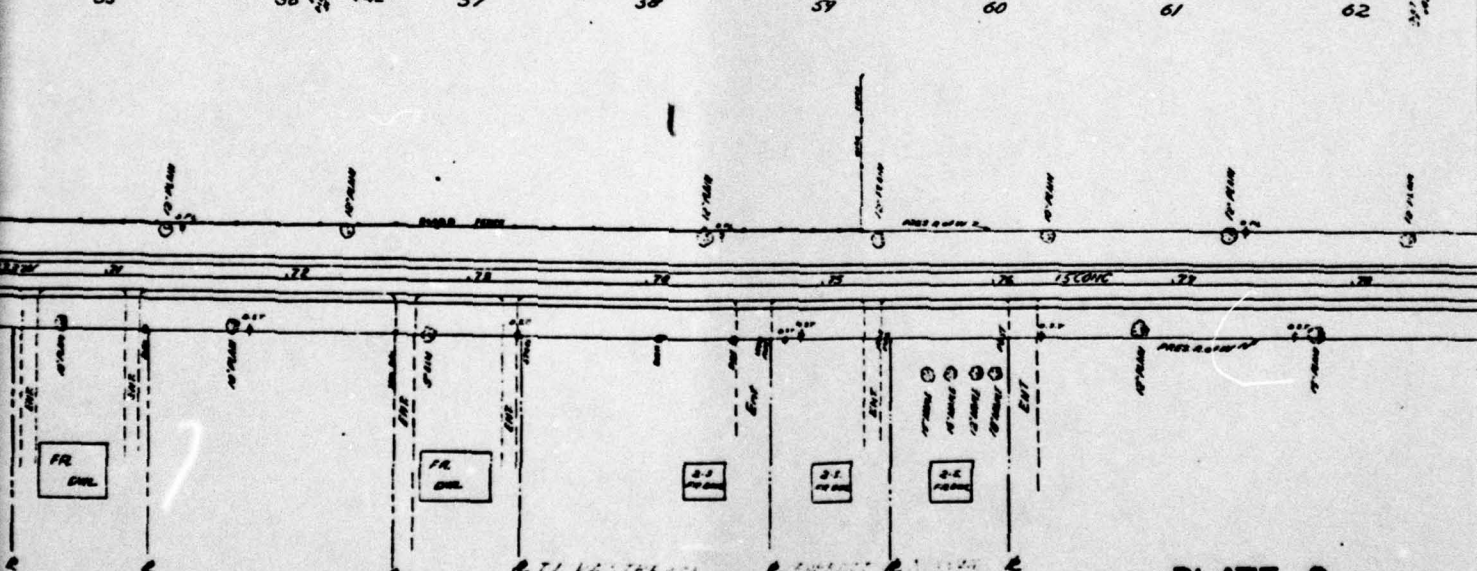
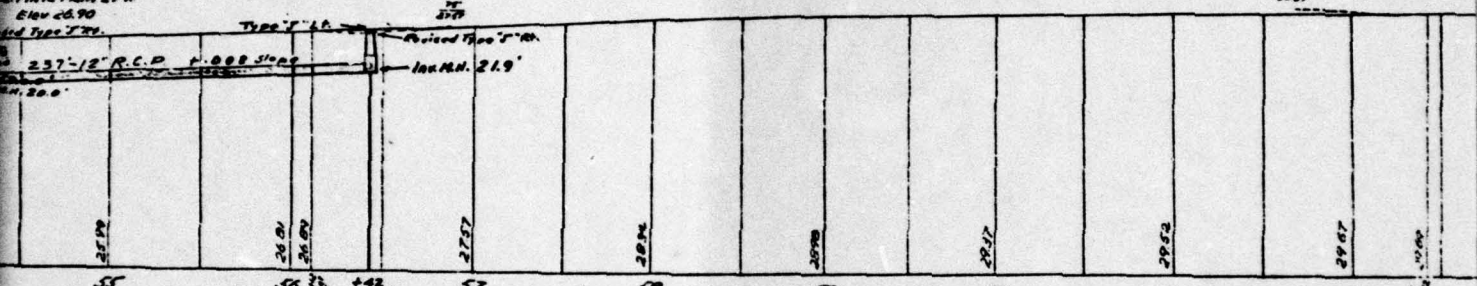
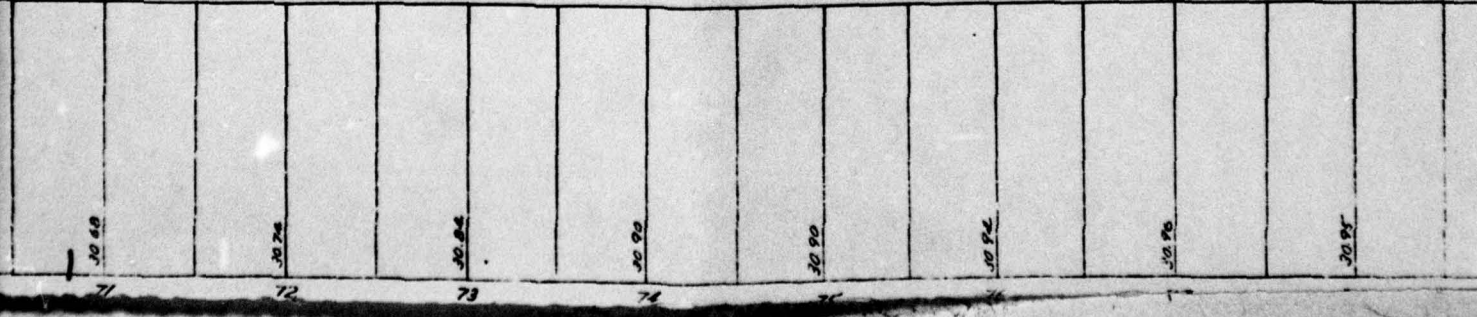
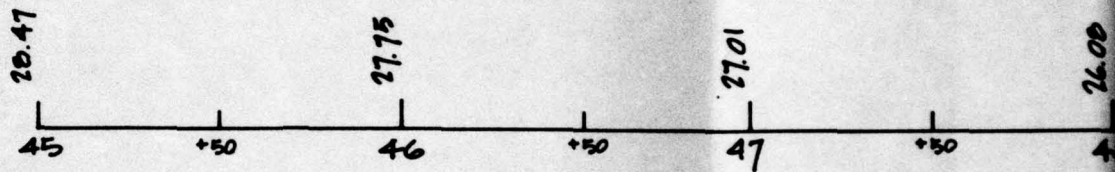


PLATE 8

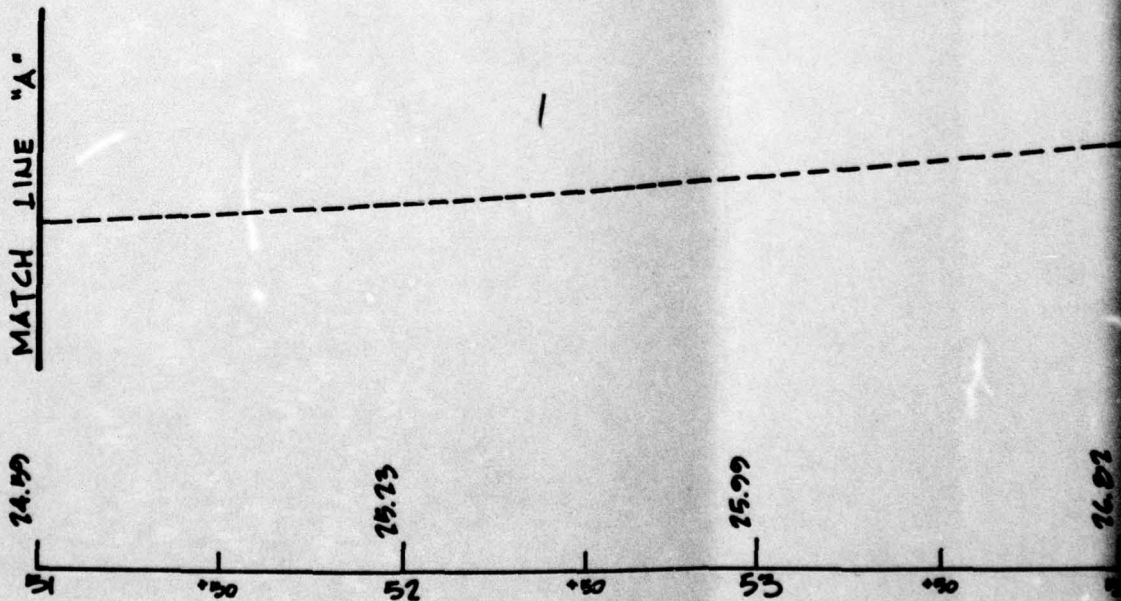
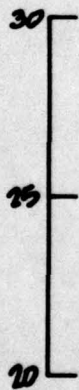
BM=10 Nail in 12' Plan 26X
 Sta. 76+00 Elev 31.18



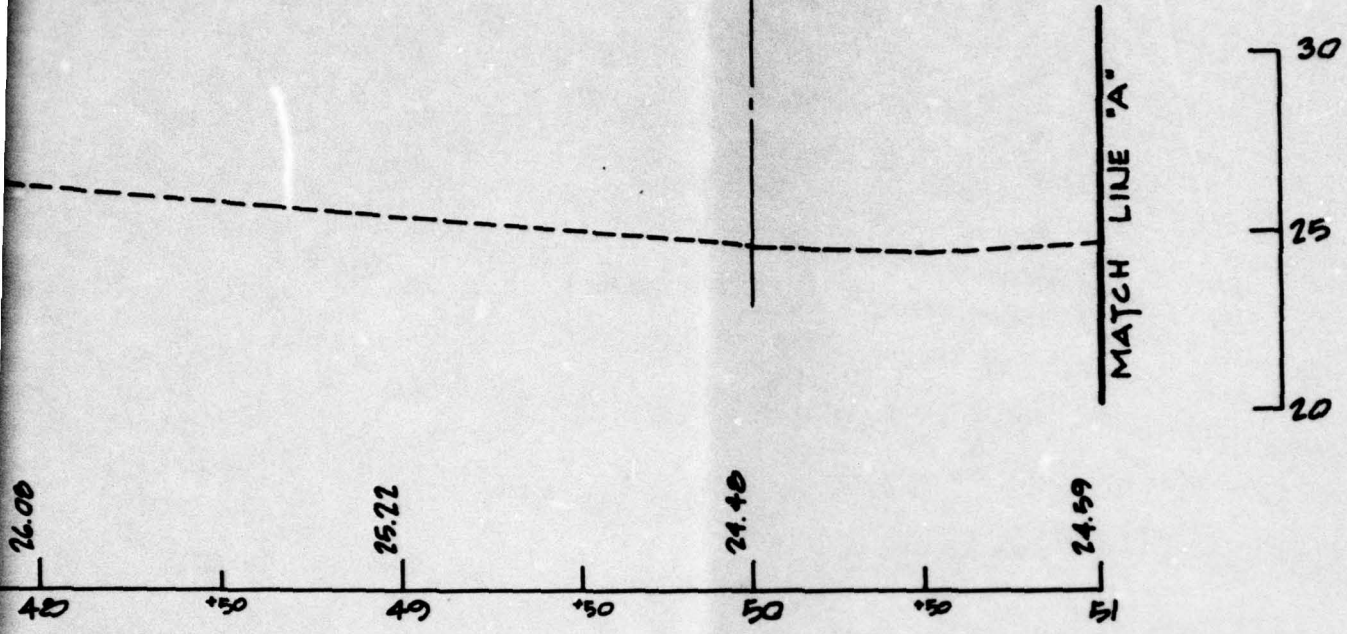


§ PROFILE RT. 24
 (HORSEY'S POND)

SCALE: HORIZ 1" = 50'
 VERT 1" = 5'



† of HORSEY'S DAM
BRIDGE



24
2)

FIELD SURVEY INFORMATION
BY
MOORE - LIPPINCOTT ENGINEERS
DECEMBER 1978

2

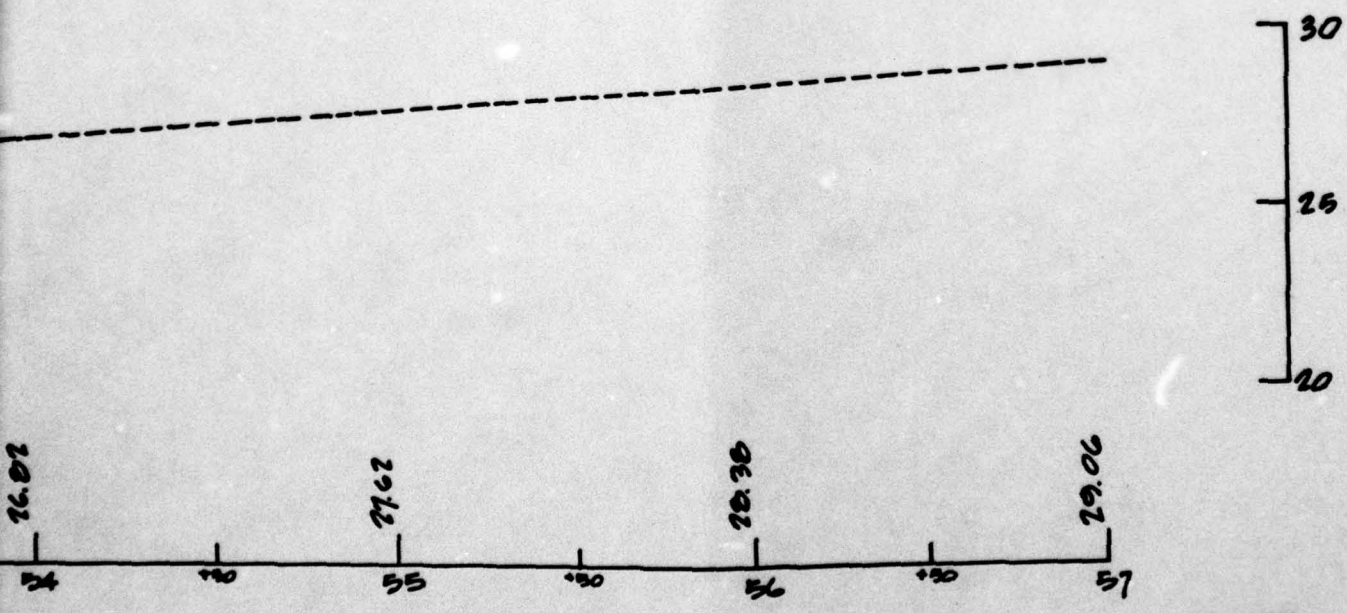
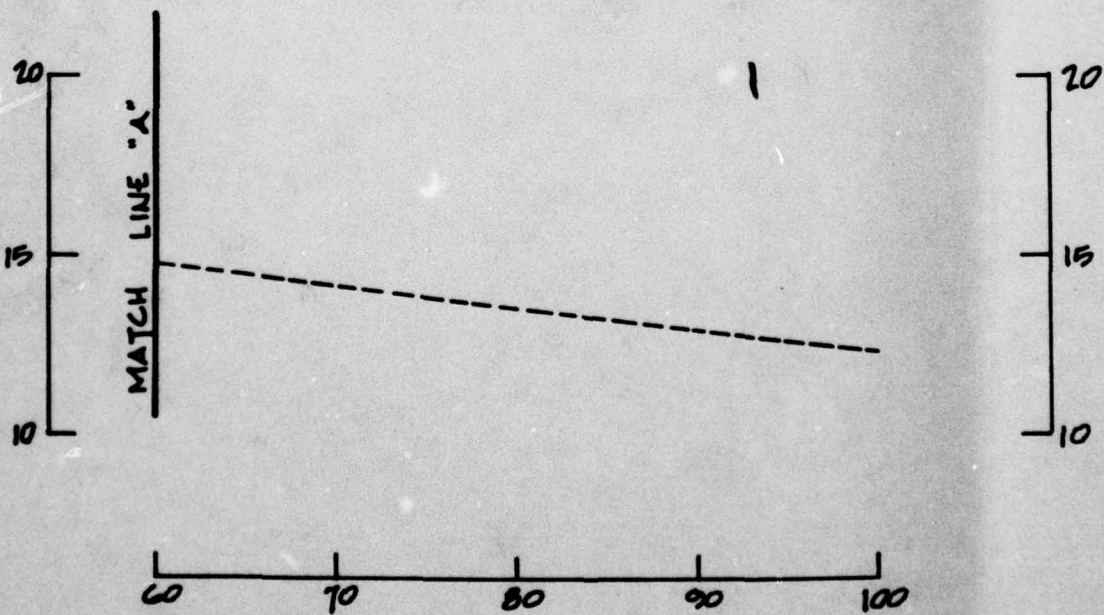
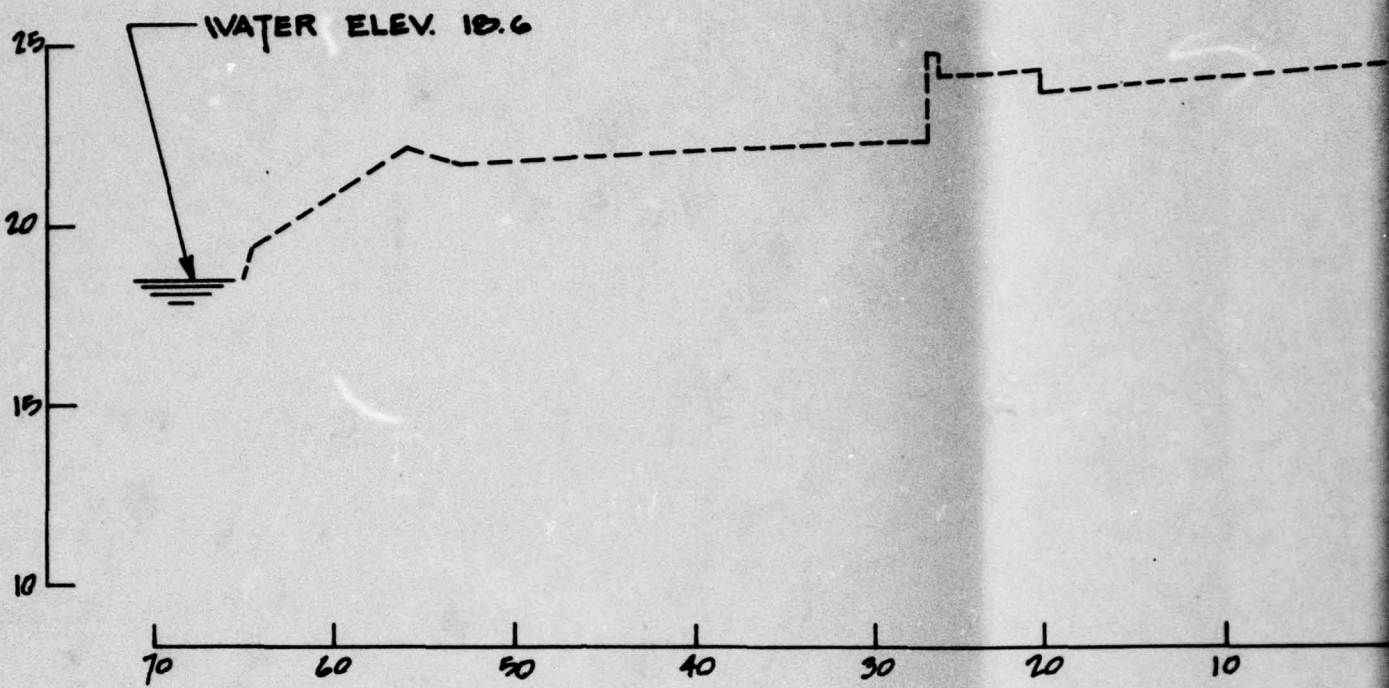
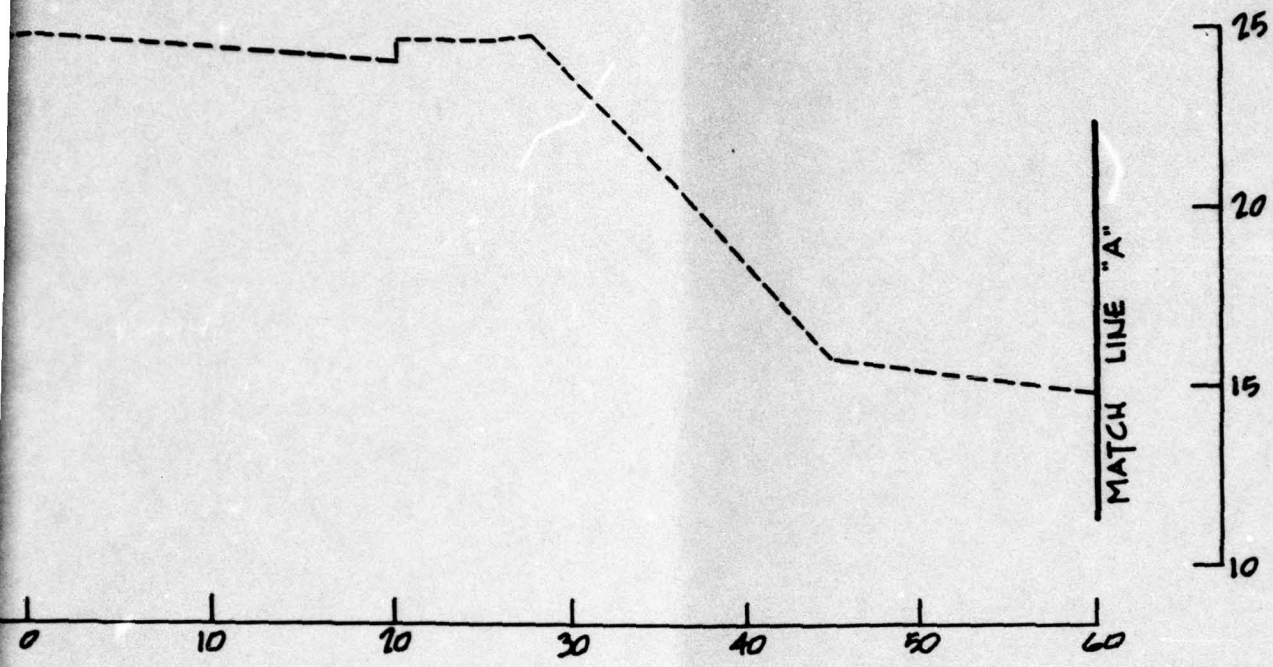


PLATE 9





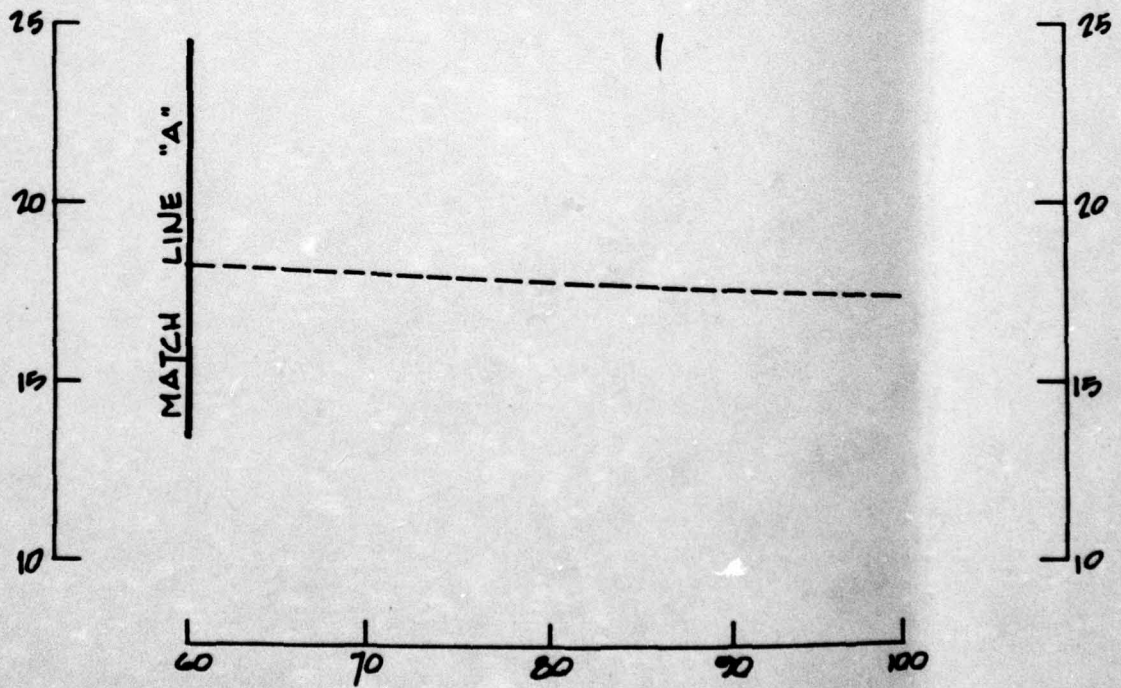
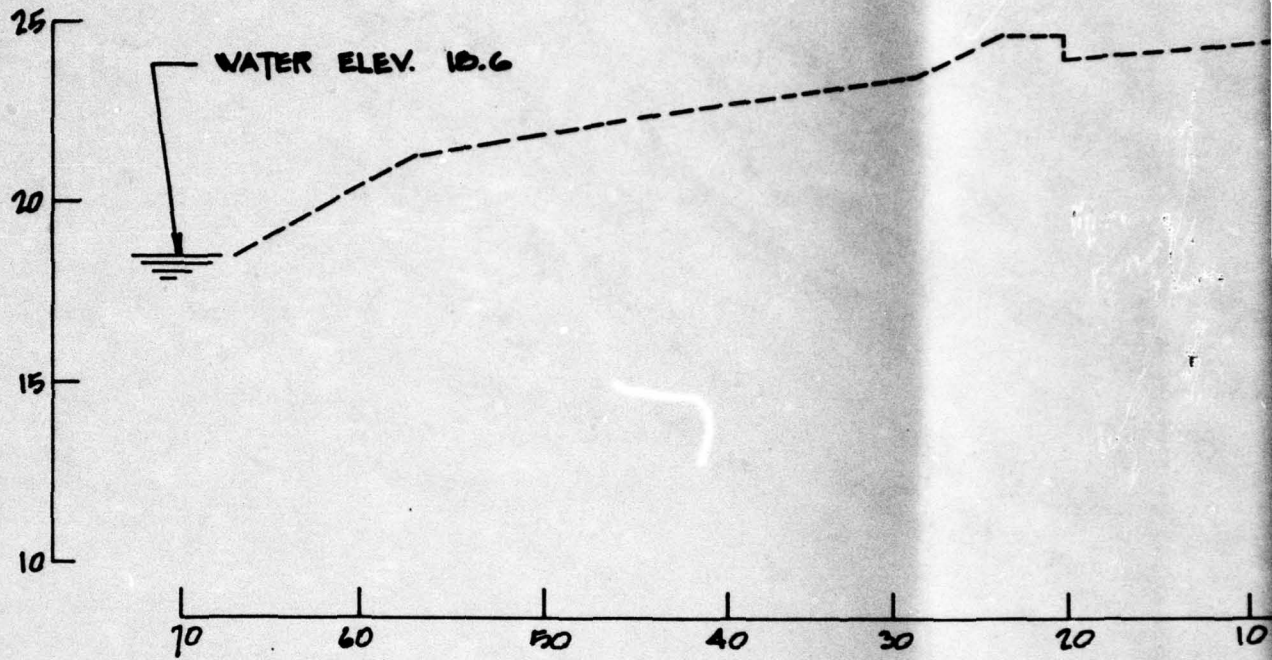
2

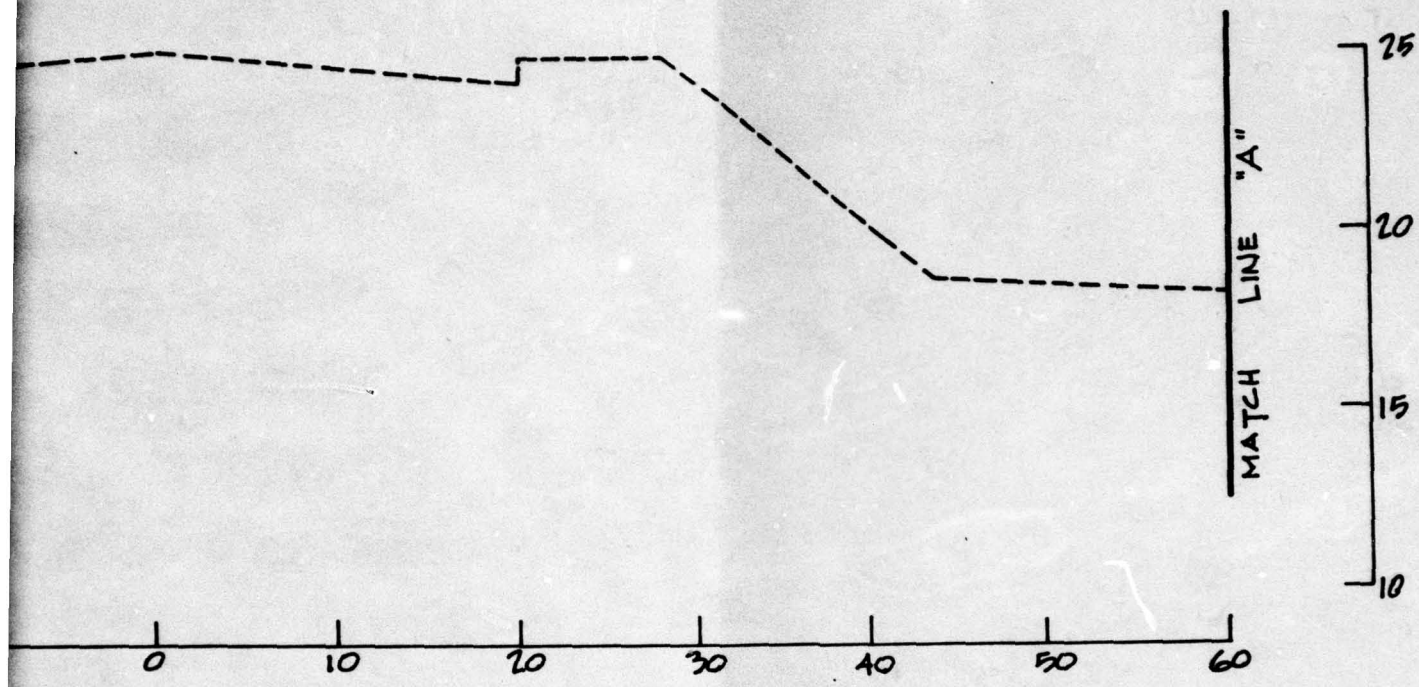
CROSS-SECTION @
 STA. 51+00
 HORSEY'S POND

SCALE: HORIZ 1" = 10'
 VERT 1" = 5'

FIELD SURVEY INFORMATION
 BY
 MOORE - LIPPINCOTT ENGINEERS
 DECEMBER 1970

PLATE 10





2

**CROSS-SECTION @
STA. 49+50
HORSEY'S POND**

SCALE: HORIZ. 1" = 10'
VERT. 1" = 5'

FIELD SURVEY INFORMATION
BY
MOORE - LIPPINCOTT ENGINEERS
DECEMBER 1978

PLATE II

ACCORDING TO OUR PHONE CONVERSATION WITH ROBERT R. JORDAN,
STATE GEOLOGIST WITH THE DELAWARE GEOLOGICAL SURVEYS, THE
GEOLOGY OF THE SUSSEX COUNTY AREA HAS NOT BEEN MAPPED FOR
PUBLICATION AS OF THE WRITING OF THIS REPORT.

GEOLOGIC INFORMATION

PLATE 12

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

**CHECK LIST - ENGINEERING, CONSTRUCTION
MAINTENANCE DATA**

Check List
Visual Inspection
Phase 1

Name Dam Horseys Pond County Sussex State Delaware Coordinates Lat: 38°32'05"
Long: 75°35'00"

Date(s) Inspection 12-7-78 Weather Cloudy Temperature 50°F

Pool Elevation at Time of Inspection 18.6 M.S.L. Tailwater at Time of Inspection 7.6 M.S.L.

Inspection Personnel:

Dan Jacobs _____

Joe Mahan _____

Joe Mahan Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

SEEPAGE OR LEAKAGE

N/A

STRUCTURE TO
ABUTMENT/EMBANKMENT
JUNCTIONS

N/A

WATER PASSAGES

N/A

FOUNDATION

N/A

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF **OBSERVATIONS** **REMARKS OR RECOMMENDATIONS**

**SURFACE CRACKS
CONCRETE SURFACES**

N/A

STRUCTURAL CRACKING

N/A

**VERTICAL AND HORIZONTAL
ALIGNMENT**

N/A

MONOLITH JOINTS

N/A

CONSTRUCTION JOINTS

N/A

EMBANKMENT

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SURFACE CRACKS

None Observed

**UNUSUAL MOVEMENT OR
CRACKING AT OR BEYOND
THE TOE**

None Observed

**SLOUGHING OR EROSION OF
EMBANKMENT AND ABUTMENT
SLOPES**

None Observed

**VERTICAL AND HORIZONTAL
ALIGNMENT OF THE CREST**

Large patch in roadway at east end of
box culvert. Might have been sinkhole
caused by seepage on east side.

If area requires patching again, study
should be initiated and prevent further
seepage.

RIPRAP FAILURES

None Observed

EMBANKMENT

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

**JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM**

Seepage noted on each side of box culvert through roadway. Barely noticeable on East downstream side and slow trickle on West downstream side.

This seepage should be monitored at least every three months for three years and every six months thereafter.

ANY NOTICEABLE SEEPAGE

Seepage noted - see above.

STAFF GAGE AND RECORDER

None Observed

DRAINS

None Observed

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None Observed	
INTAKE STRUCTURE		No deterioration spalling noted in concrete. Lifting boards of overflow structure in good overall condition.
OUTLET STRUCTURE		Box culvert bridge relatively new and in good overall condition.
OUTLET CHANNEL		N/A
EMERGENCY GATE		N/A

UNGATED SPILLWAY

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

CONCRETE WEIR

Overflow structure consists of wooden stop logs spanning between concrete piers. Slight deterioration of center concrete pier near water line on upstream side - not appreciable.

APPROACH CHANNEL

POND

DISCHARGE CHANNEL

Box Culvert has some trash in it, including large metal drums and logs.

Debris should be removed.

BRIDGE AND PIERS

N/A

GATED SPILLWAY

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

CONCRETE SILL

N/A

APPROACH CHANNEL

N/A

DISCHARGE CHANNEL

N/A

BRIDGE AND PIERS

N/A

**GATES AND OPERATION
EQUIPMENT**

N/A

RESERVOIR

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

Low sloping banks - well vegetated.

SEDIMENTATION

None Observed

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

**CONDITION
(OBSTRUCTIONS,
DEBRIS, ETC.)**

Timber bulkheads constructed immediately downstream - fairly new construction and no obstructions noted.

SLOPES

Relatively low sloping.

**APPROXIMATE NO.
OF HOMES AND
POPULATION**

One home and six people.
House approximately 9' above streambed.

INSTRUMENTATION

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION

MONUMENTATION/SURVEYS

Box Culvert recently constructed. State of Delaware Department of Transportation provided plans with roadway elevations on it.

OBSERVATION WELLS

N/A

WEIRS

N/A

PIEZOMETERS

N/A

OTHER

N/A

**CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION**

<u>ITEM</u>	<u>REMARKS</u>
PLAN OF DAM	Available from Delaware State Department of Transportation
REGIONAL VICINITY MAP	" " " " " " " " " " " "
CONSTRUCTION HISTORY	" " " " " " " " " " " "
TYPICAL SECTIONS OF DAM	" " " " " " " " " " " "
HYDROLOGIC/HYDRAULIC DATA	Design cales not available, but drainage area and design "Q" indicated on design plans.
OUTLETS - PLAN	Available from Delaware State Department of Transportation
- DETAILS	" " " " " " " " " " " "
- CONSTRAINTS	" " " " " " " " " " " "
- DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Not available

ITEM

REMARKS

MONITORING SYSTEMS

N/A

MODIFICATIONS

N/A

HIGH POOL RECORDS

Unknown.

**POST CONSTRUCTION ENGINEERING
STUDIES AND REPORTS**

N/A

**PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS**

N/A

**MAINTENANCE
OPERATION
RECORDS**

N/A

ITEM

REMARKS

DESIGN REPORTS

Not Available

GEOLOGY REPORTS

Not Available

**DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES**

Not Available

**MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD**

Given on construction plans available from Delaware State Department of Transportation
Not Available

POST-CONSTRUCTION SURVEYS OF DAM

N/A

ROW SOURCES

Unknown

APPENDIX B

PHOTOGRAPHS

PHOTOS TAKEN DURING DECEMBER, 1978

DETAILED PHOTOGRAPH DESCRIPTIONS

- Overall View of Dam - View of Upstream Face of Embankment and Box Culvert Spillway Structure, December 8, 1978

PHOTO 1 - View looking upstream at Horseys Pond

PHOTO 2 - View looking downstream at grading and island

PHOTO 3 - View of horizontal struts supporting overflow structure

PHOTO 4 - View looking east of roadway and upstream wingwall

PHOTO 5 - View downstream of overflow structure - downstream of box culvert

PHOTO 6 - View of downstream end of double box culvert

PHOTO 7 - View of house located on downstream embankment



PHOTO 1



PHOTO 2

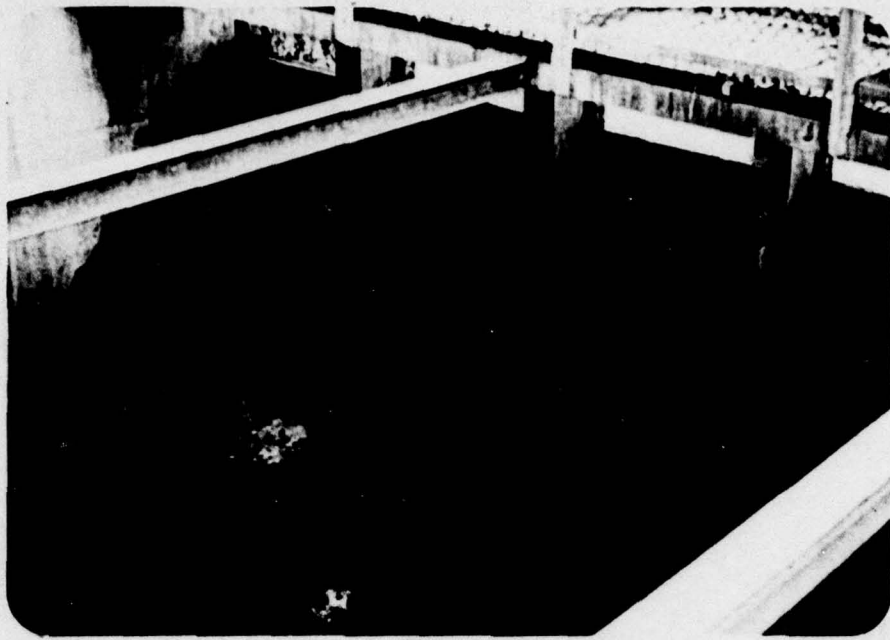


PHOTO 3

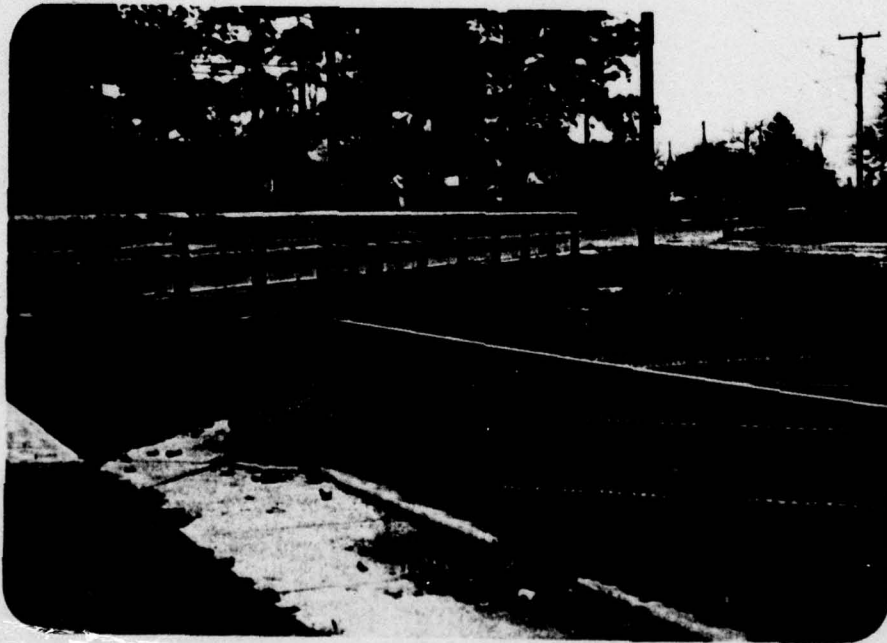


PHOTO 4

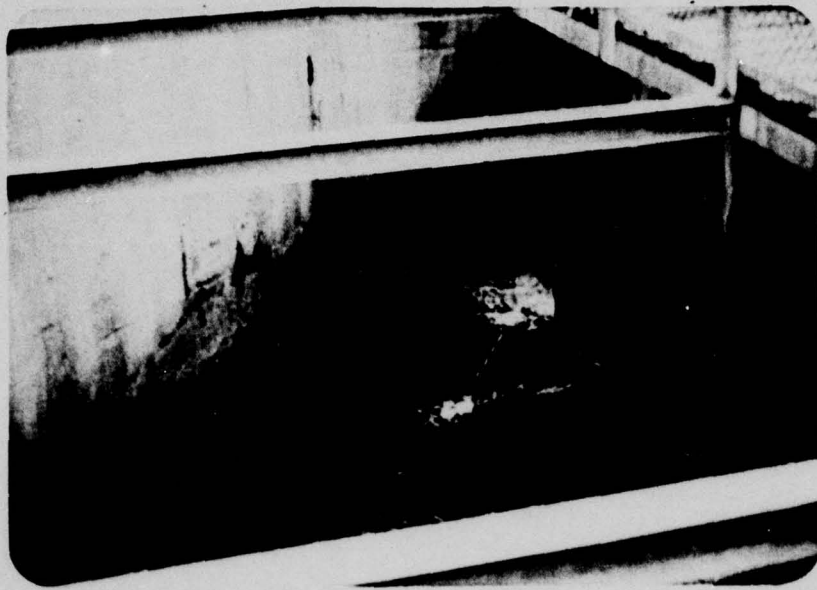


PHOTO 5

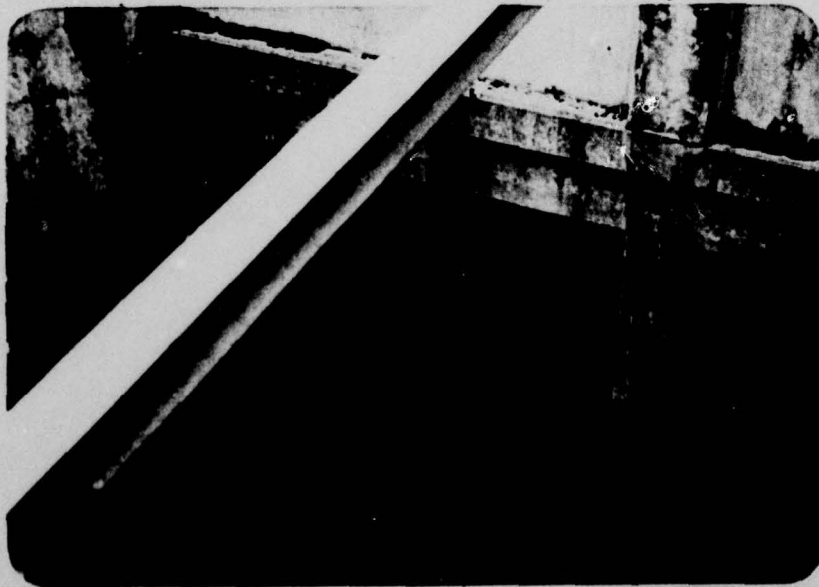


PHOTO 6

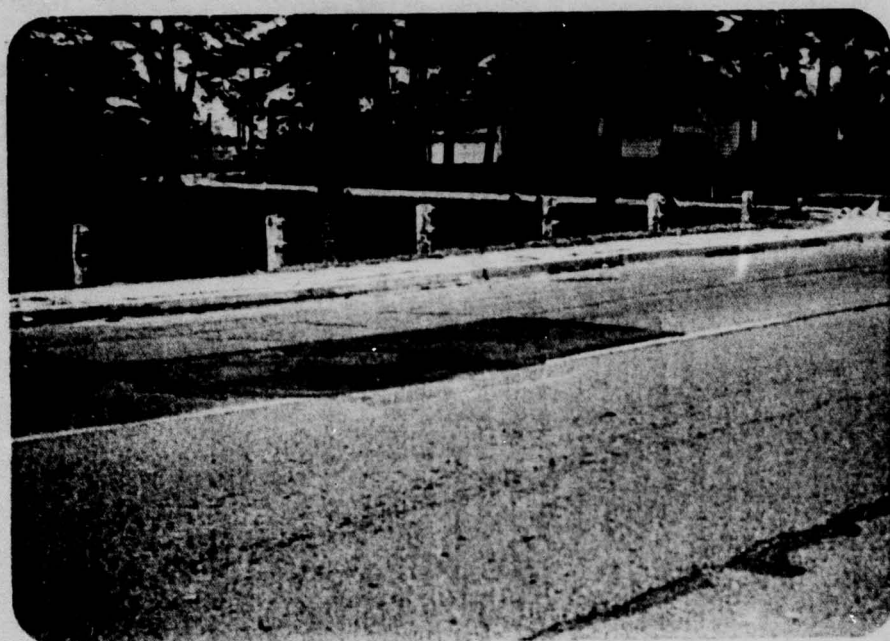


PHOTO 7

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 15.35 Sq. Mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 18.6 ft. M.S.L.(346Ac.Ft.)

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

ELEVATION MAXIMUM DESIGN POOL: 25.6 ft. M.S.L. (1057 Ac.Ft.)

ELEVATION TOP DAM: 24.4 ft. M.S.L. (low point in roadway)

CREST: _____

- a. Elevation 18.4 to 18.8 ft. M.S.L.
- b. Type Wooden stop logs
- c. Width 4"
- d. Length 9 @ 4.5' = 40.5 feet
- e. Location Spillover N/A
- f. Number and Type of Gates N/A

OUTLET WORKS: _____

- a. Type Wooden stop logs Length = 2 @ 4'-6" = 9'-0"
- b. Location Main Spillway
- c. Entrance inverts N/A
- d. Exit inverts 9.2 ft. M.S.L.
- e. Emergency draindown facilities stop logs could be removed

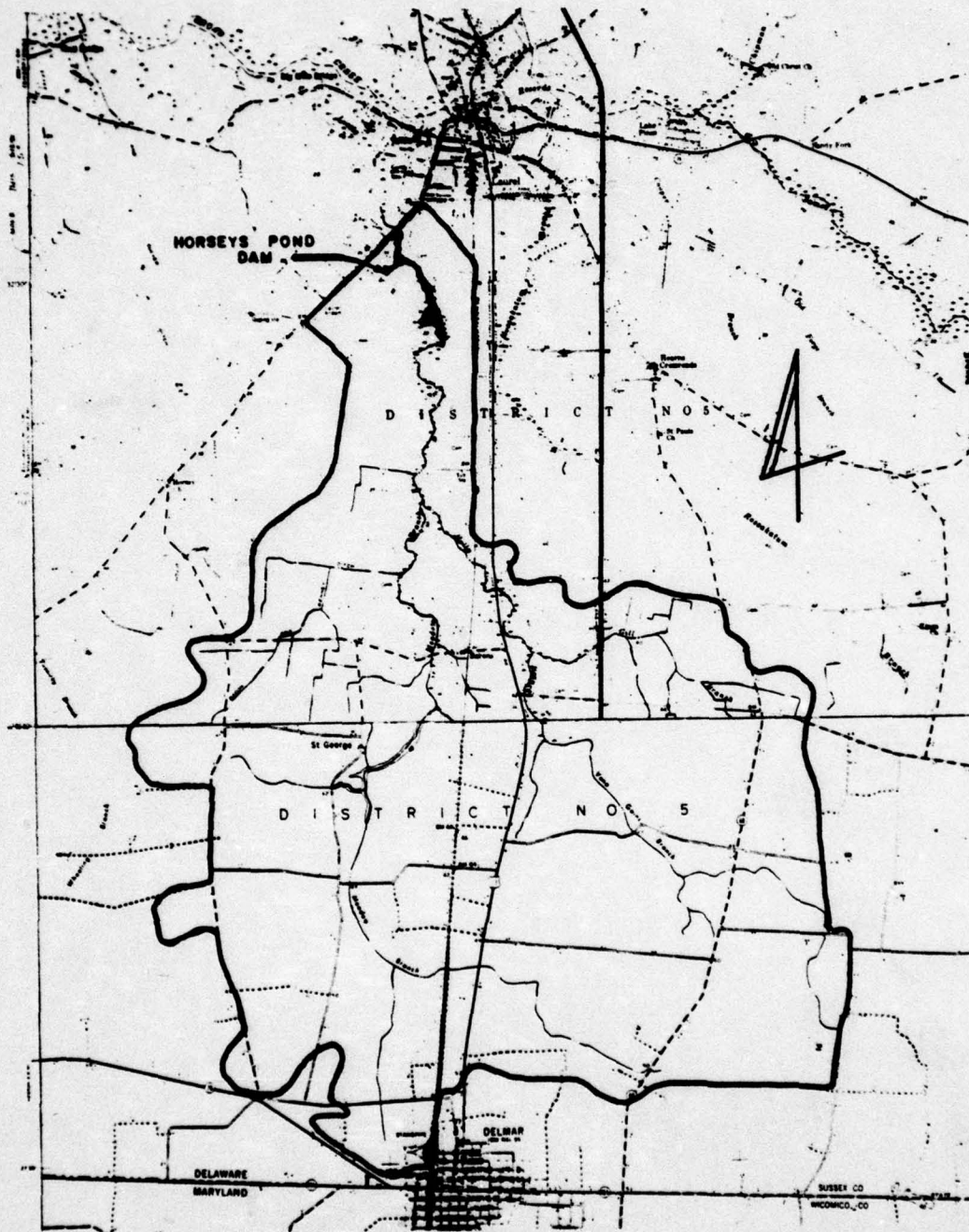
HYDROMETEOROLOGICAL GAGES: None

- a. Type N/A
- b. Location N/A
- c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE: 1609 CFS @ El. 24.4

APPENDIX D

HYDROLOGIC COMPUTATIONS



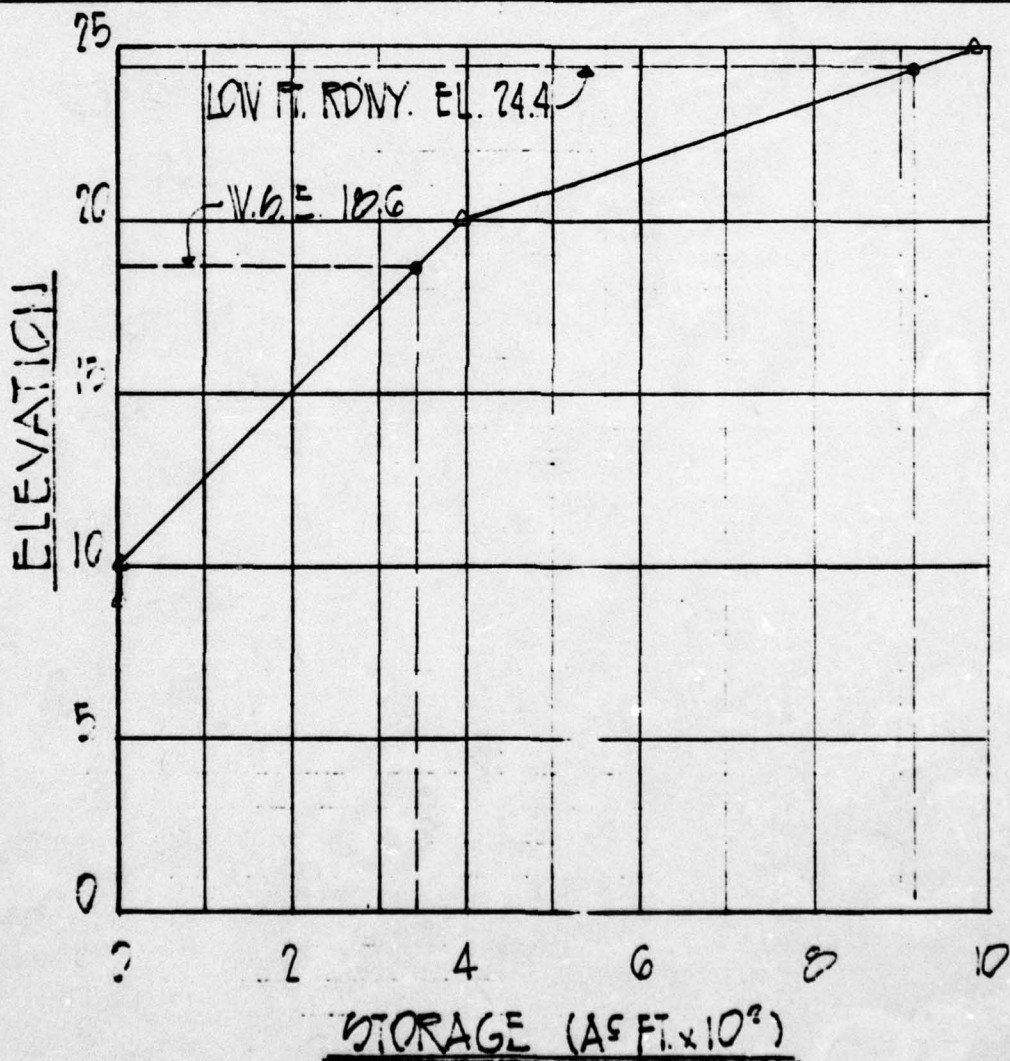
CONTOUR INTERVAL 20 FEET

WATERSHED MAP

HORSEYS POND DAM

THOMAS TYLER MOORE ASSOCIATES, INC.
 PROFESSIONAL ENGINEERS AND LAND SURVEYORS

ELEV	AREA (FT ²)	AVG. AREA (FT ²)	DEPTH (FT)	VOL. (FT ³)	Σ VOL (FT ³)	Σ VOL (A ⁵ FT)
9'	0	6.650	1	6.650	0	0
10	13.300	1.776.650	10	17,766.500	6,650	0.15
20	3,440,000	5,100,000	5	25,500,000	11,273,150	396.5
25	6,760,000				42,773.5	981.9



cl N^o

3-00-301

C.A.R.
 Calculated By

Checked By

12/5/78
 Date

Date

Calculations For:
 STAGE-STORAGE
 HORSEYS FOND
 (DATA OBTAINED FROM QUERIES)

Sheet 1

of

STAGE-DISCHARGE CALCULATIONS FOR TYPIC 9'x7.5' BOX
CULVERT UNDER INLET CONTROL AND WEIR FLOW OVER
ROADWAY.

BOX CULVERT DATA:

INV. ELEV. = 6.3

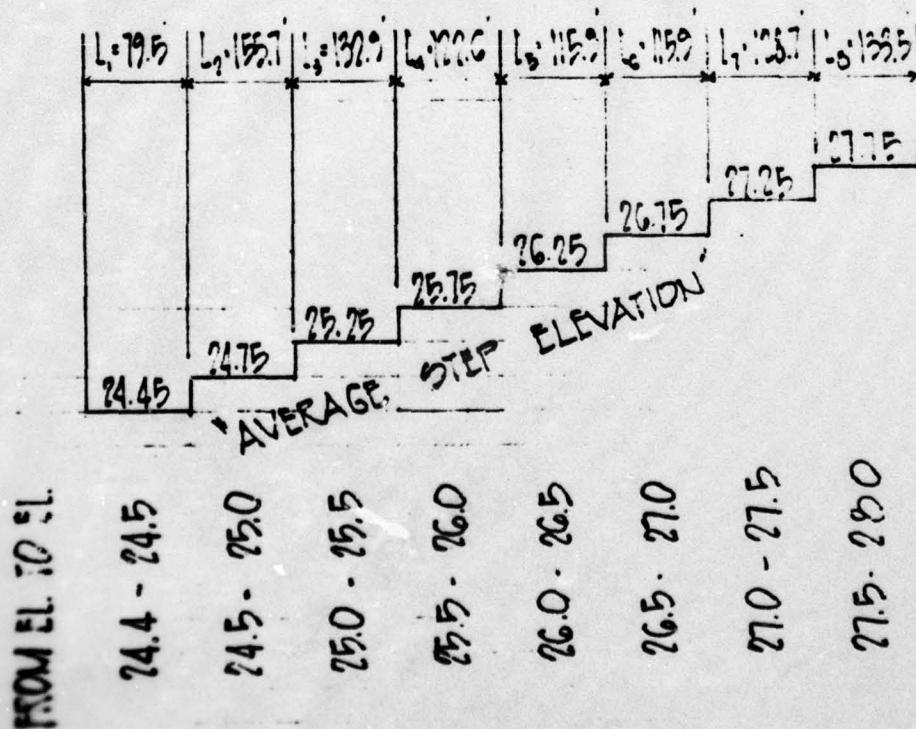
D = 7.5'

D = 2 x 9.18'

TYPE (I) ENTRANCE CONDITION

WEIR FLOW OVER RD'WAY BEGINS AT ELEV. 24.4

'EFFECTIVE WEIR LENGTH AND ELEV USED IN ANALYSIS'



Calculations For:

Sheet 2
 Of

WEIR FLOW OVER RDINY. $Q = CLH^{3/2}$

Project No _____
 Calculated By _____
 Checked By _____
 Date _____
 Calculations For:
STAGE-DISCHARGE
FOR FLOW OVER RDINY.
 Sheet _____
 of _____

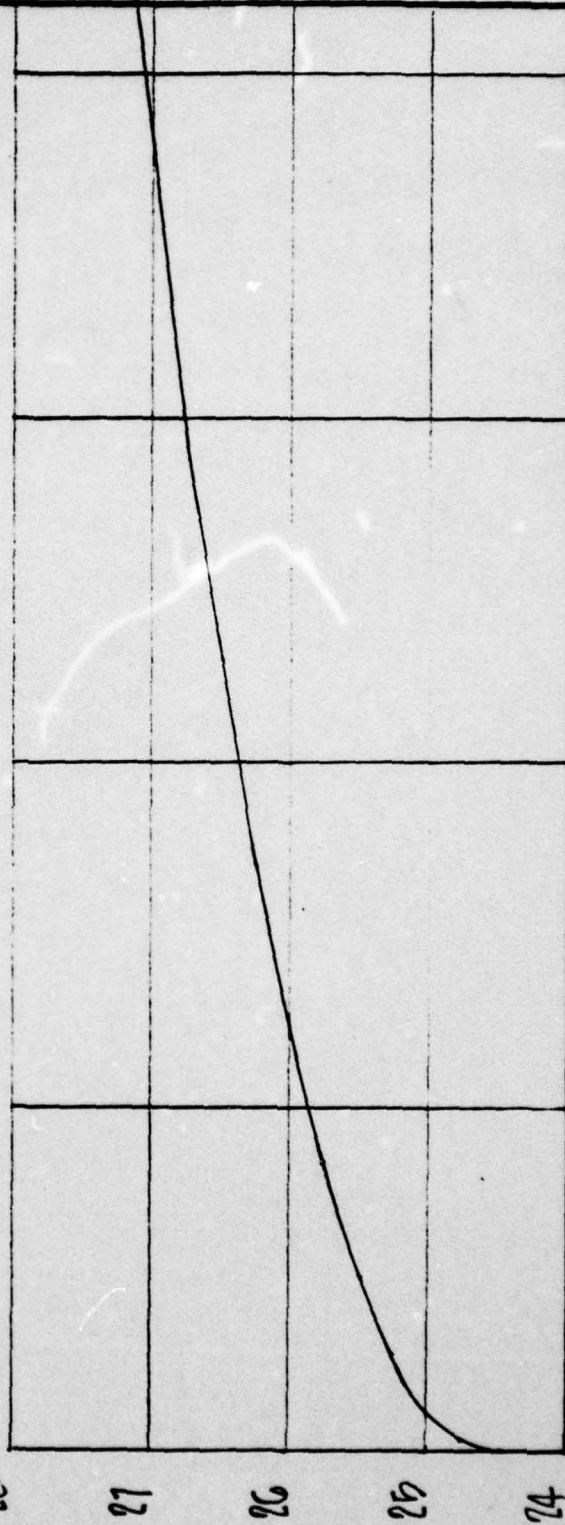
EL	H	H ₂	H ₃	H ₄	H ₅	H ₆	H ₁	H ₀	C _e	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	H ₁ ^{3/2}	H ₂ ^{3/2}	H ₃ ^{3/2}	H ₄ ^{3/2}	H ₅ ^{3/2}	H ₆ ^{3/2}	H ₁ ^{3/2}	H ₀ ^{3/2}	Q
24.45	0								2.6	7.95								0								0
24.75	0.3	0									155.7							0.16	0							33
25.25	0.8	0.5	0									132.9						0.72	0.35	0						149
25.75	1.3	1.0	0.5	0									122.6					1.40	1.00	0.35	0					306
26.25	1.8	1.5	1.0	0.5	0									115.9				2.41	1.84	1.00	0.35	0				490
26.75	2.3	2.0	1.5	1.0	0.5	0									115.9			3.99	2.83	1.84	1.00	0.35	0			721
27.25	2.8	2.5	2.0	1.5	1.0	0.5	0									128.7		4.69	3.95	2.83	1.84	1.00	0.35	0		969
27.75	3.3	3.0	2.5	2.0	1.5	1.0	0.5	0									133.5	5.99	5.20	3.95	2.83	1.84	1.00	0.35	0	1280
28.0	3.55	3.25	2.75	2.25	1.75	1.25	0.75	0.25										6.69	5.86	4.56	3.37	2.32	1.40	0.65	0.13	1583

H ₁ ²	H ₂ ²	H ₃ ²	H ₄ ²	H ₅ ²	Q ₁	Q ₂	Q ₃	Q ₄	Q ₅	Q ₆	Q ₇	Q ₈	Σ Q
					0								0
					33	0							33
					149	142	0						291
0					306	405	121	0					832
0.25	0				490	745	346	112	0				1701
1.00	0.35	0			721	1146	636	319	105	0			2917
1.84	1.00	0.35	0		969	1599	976	586	301	105	0		4535
2.83	1.84	1.00	0.35	0	1288	2205	1365	902	554	301	117	0	6582
3.37	2.32	1.40	0.65	0.13	1583	2377	1576	1074	699	472	218	45	7769

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"WEIR FLOW OVER ROADWAY"



ELEVATION

28
27
26
25
24

0 1 2 3 4

DISCHARGE (CFS x 10³)

Sheet No

Calculated By _____
 Checked By _____

Date _____
 Date _____

Calculations For:
 STAGE-DISCHARGE
 WEIR FLOW OVER ROADWAY.

Sheet 4
 of 1

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H.V./D (ASSUME)	RATIO Q/B (READ)	Q-RATIO x B (CALC. IN C.F.S)	H.V. - H.V./D x 7.5 (CALC. IN FT.)	H.V. EL. - 6.3 + H.V.
0.53	74	432	4.0	10.3
0.67	33	594	5.0	11.3
0.8	44	792	6.0	12.3
0.93	54	972	7.0	13.3
1.06	64	1152	8.0	14.3
1.2	75	1350	9.0	15.3
1.33	85	1530	10.0	16.3
1.47	93	1674	11.0	17.3
1.6	100	1800	12.0	18.3
1.75	108	1944	13.0	19.3
1.87	115	2070	14.0	20.3
2.0	120	2160	15.0	21.3
2.13	125	2250	16.0	22.3
2.27	132	2376	17.0	23.3
2.41	138	2484	18.0	24.4
2.47	140	2520	18.5	24.8
2.53	142	2556	19.0	25.3
2.6	148	2664	19.5	25.8
2.67	150	2700	20.0	26.3
2.73	152	2736	20.5	26.8

1 N ²	Calculated By _____	Date _____	Calculations For: <u>STAGE-DISCHARGE</u> <u>HORSEY'S POND</u> <u>TWIN 9x7.5 BOX CULVERT INLET CONTROL</u>	Sheet <u>5</u>
	Checked By _____	Date _____		Of _____

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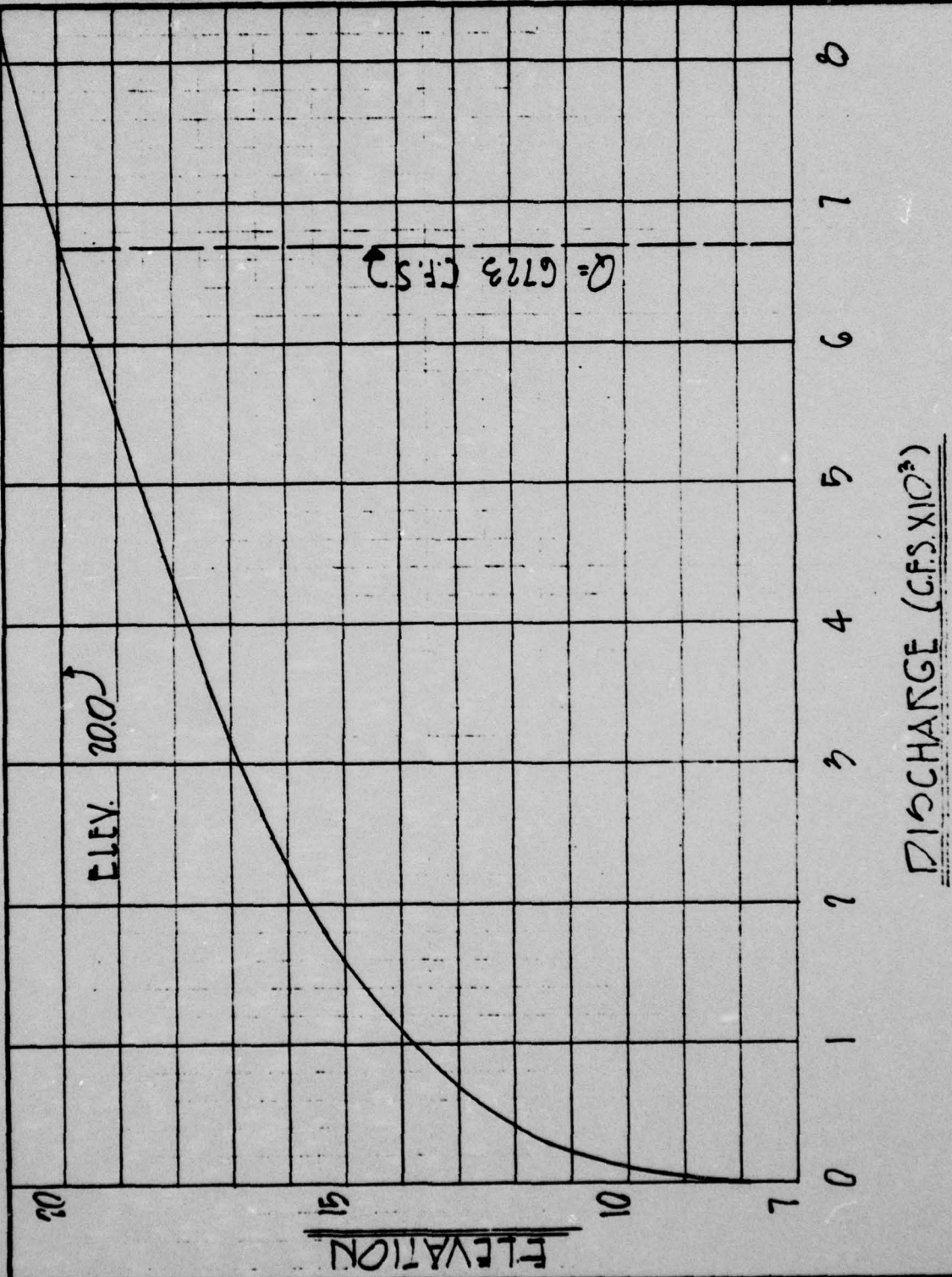
2.80	155	2790	21.0	27.3
2.87	157	2826	21.5	27.8
2.89	158	2844	21.7	28.0

COMBINED FLOWS THROUGH TWIN 9'x7.5' BOX CULVERT (INLET CONTROL)
PLUS WEIR FLOW OVER RD'VY.

ELEV	Q (BOX CULVERT) (CFS.)	Q (RD'VY.) (CFS)	Q ACCUM. (CFS)
24.4	2484	0	2484
24.8	2520	33	2553
25.3	2556	291	2847
25.8	2664	832	3496
26.3	2700	1701	4401
26.8	2736	2917	5653
27.3	2790	4538	7328
27.8	2826	6582	9408
28.0	2844	7789	10633

N ^o	Calculated By _____	Date _____	Calculations For: <u>STAGE-DISCHARGE</u> <u>COMBINED INLET CONTROL & RD'VY.</u>	Sheet <u>6</u>
	Checked By _____	Date _____		Of _____

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1 N2
 2-05-301

Calculated By CAR
 Checked By _____

Date 1/10/79
 Date _____

Calculations For:
STAGE-DISCHARGE
CHANNEL SECTION 65 FT FROM
MOUTH OF CULVERT

Sheet 2
 of 1

STAGE-DISCHARGE CALCULATIONS FOR TWIN 9'x7.5' BOX
 CULVERT UNDER OUTLET CONTROL AND VEIR FLOW OVER RDWAY

BOX CULVERT DATA:

L = 81 FT.

$n_o = 0.025\%$

$K_e = 0.4$

$n = 0.015$

D = 7.5'

B = 18'

$$d_c = 0.315 \sqrt[3]{(Q/B)^2}$$

$$H = \left[1 + K_e + \frac{29 n^2 L}{R^{1.33}} \right] V^2 / 2g$$

$$H = \left[1 + 0.4 + \frac{29 \times (0.015)^2 \times 81}{(2.045)^{1.33}} \right] V^2 / 64.4$$

$$H = 0.025 V^2$$

$$H.W = H + h_o \text{ (ORT.W.)} - L S_o$$

N^o

Calculated By _____

Date _____

Calculations For: _____

Sheet 10

Checked By _____

Date _____

Of _____

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Q	dc	dc + D/2	h _o	EL. h _o	T.V.	EL. T.V.	A	V	H	L ₅₀	H.V.	EL. H.V.
492	2.6	5.1	5.1	11.2	6.1	12.2	1098	3.9	0.4	0.2	6.3	12.6
594	3.2	5.4	5.4	11.5	6.6	12.7	1188	5.0	0.6		7.0	13.3
794	3.9	5.7	5.7	11.8	7.1	13.2	1278	6.2	1.0		7.9	14.2
912	4.5	6.0	6.0	12.1	7.7	13.8	1350	7.2	1.3		8.8	15.1
1152	5.0	6.3	6.3	12.4	8.1	14.2		8.5	1.8		9.7	16.0
1350					8.5	14.6		10.0	2.5		10.8	17.1
1530					8.8	14.9		11.3	3.2		11.8	18.1
1674					9.1	15.2		12.4	3.8		12.7	19.0
1800					9.3	15.4		13.3	4.4		13.5	19.8
1944					9.5	15.6		14.4	5.2		14.5	20.8
2070					9.6	15.7		15.3	5.8		15.2	21.5
2160					9.7	15.8		16.0	6.4		15.9	22.2
2250					9.9	16.0		16.7	7.0		16.7	23.0
2376	<u>BEGIN COMBINED FLOW</u>				10.0	16.1		17.6	7.7		17.5	23.8
	<u>Q'VEIR</u>		<u>COMBINED Q'</u>									
2450	0		2450		10.1	16.2		18.1	8.2		18.1	24.4
2475	25		2500		10.2	16.3		18.3	8.4		18.4	24.7
2490	60		2550		10.2	16.3		18.4	8.5		18.5	24.8
2500	150		2650		10.4	16.5		18.5	8.6		18.8	25.1
2510	240		2750		10.5	16.6		18.6	8.6		18.9	25.2
2515	485		3000		10.7	16.8		18.6	8.7		19.2	25.5

N ^o	<u>Calculated By</u>	<u>Date</u>	Calculations For:	Sheet <u>11</u>
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2490	1010	3500	11.2	17.3	19.5	18.4	8.5	0.2	19.5	25.8
2415	1925	4000	11.6	17.7	↓	18.3	8.4	↓	19.8	26.1
2440	2060	4500	12.1	18.2	↓	18.1	8.2	↓	20.1	26.4
2415	2485	5000	12.5	18.6	↓	17.9	8.0	↓	20.3	26.6
2390	3110	5500	12.9	19.0	↓	17.7	7.8	↓	20.5	26.8
2340	3660	6000	13.3	19.4	↓	17.3	7.5	↓	20.6	26.9
2305	4195	6500	13.7	19.8	↓	17.1	7.3	↓	20.8	27.1
2280	4720	7000	14.1	20.2	↓	16.9	7.1	↓	21.0	27.3

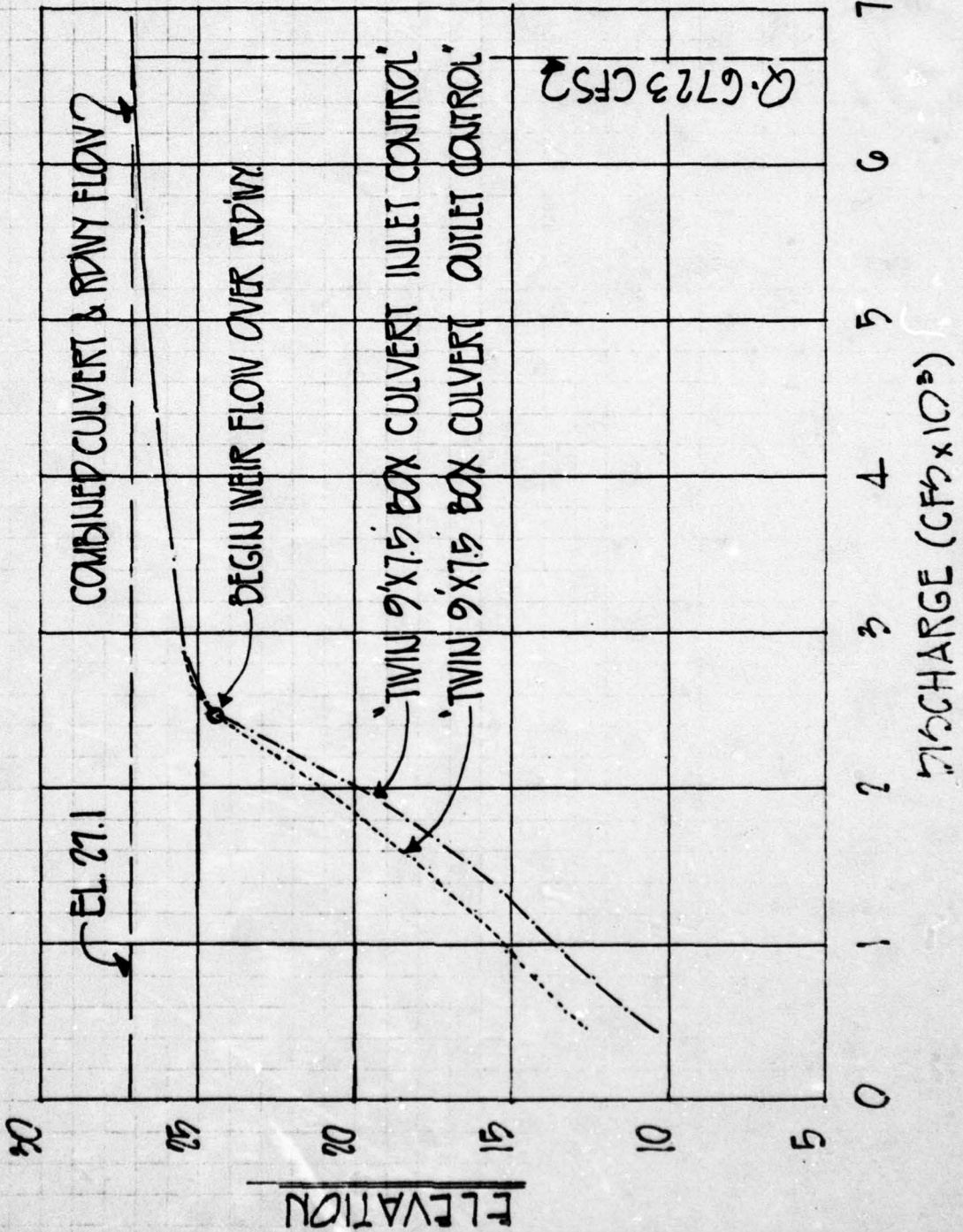
↑ N^o

Calculated By _____

Date _____

Calculations For: _____

Sheet 12



N²

Calculated By _____

Date _____

Checked By _____

Date _____

Calculations For:
RATING CURVE
 TWIN BOX CULVERT WITH ROADWAY FLOW

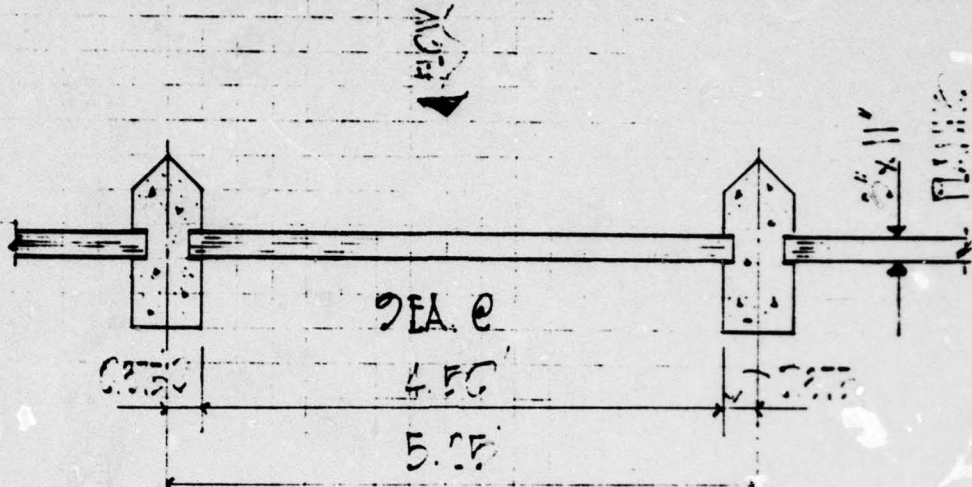
Sheet

12

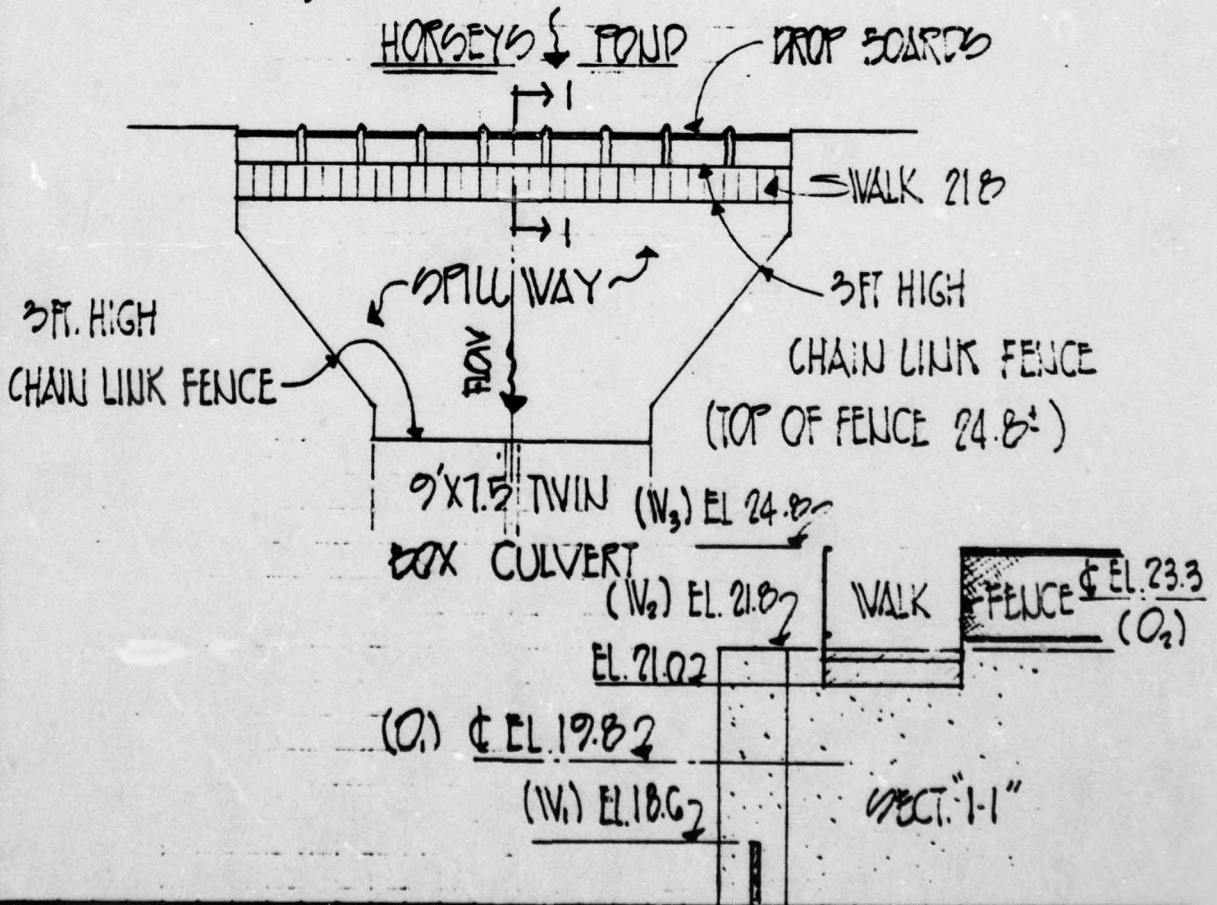
of

12

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6 @ EL. 18.8 }
 3 @ EL. 18.4 } USE 18.6 FOR ANALYSIS C = 3.3



N ^o	Calculated By _____	Date _____	Calculations For: <u>HORSEYS POND</u> <u>PRINCIPAL SPILLWAY</u>	Sheet <u>14</u>
	Checked By _____	Date _____		Of _____

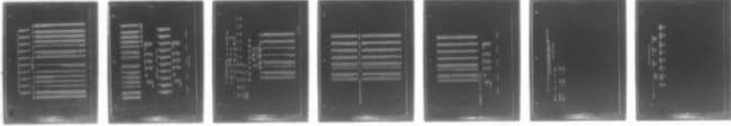
AD-A069 215

NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. HORSEYS POND DAM (DE 00022). NANTI--ETC(U)
APR 79 T T MOORE DACW61-78-C-0124

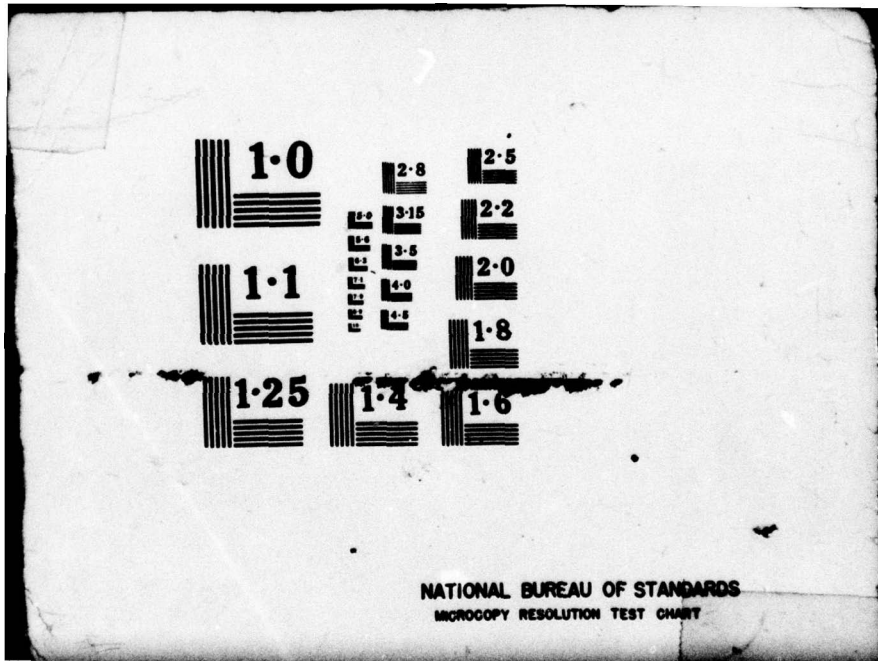
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2 of 2
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END
DATE
FILMED
7 79
DDC



1·0

2·8

2·5

3·2
3·6
4·0
4·5

3·15

2·2

1·1

3·5

2·0

1·8

1·25

1·4

1·6

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

FOR ANALYSIS CONSIDER THE FOLLOWING:

- 1.) WEIR FLOW CONDITIONS OVER DROPBOARDS
 (IV₁) ELEV. 18.6 TO ELEV. 21.0, C=3.3, L=40.5 FT

- 2.) ORIFICE FLOW CONDITIONS BETWEEN DROP BOARDS
 AND BOTTOM OF SIDEWALK BEAM @ ELEV. 21.0
 (Q₁) CENTER LINE OF ORIFICE ELEV. 19.8, C₀=0.6, A₀=97.2 FT²

- 3.) WEIR FLOW CONDITIONS OVER TOP OF SIDEWALK AND
 SIDES OF SPILLWAY @ ELEV. 21.8 TO COMPENSATE
 FOR AREA REDUCTION, CLOGGING FACTOR & SUBMERGENCE REDUCE
 (IV₂) "C" VALUE BY 50%. C=2.6 x 0.5 = 1.3, L=111.0 FT.

- 4.) ORIFICE FLOW CONDITIONS BETWEEN SIDES OF
 SPILLWAY AND TOP RAIL OF FENCE @ ELEV. 24.8
 (Q₂) CENTER LINE OF ORIFICE ELEV. 23.3, C₀=0.3, A=333 FT²
 C₀ REDUCED BY 50% TO COMPENSATE FOR AREA REDUCTION
 AND CLOGGING.

$$Q = 0.3 (111 \times 3) (64.4 H)^{1/2} = 807 (H)^{1/2}$$

- 5.) WEIR FLOW CONDITIONS OVER TOP OF FENCE
 @ ELEV. 24.8, C=3.3, L=111.0 FT
 (IV₃) Q = 3.3 (111) (ELEV. 24.8)^{3/2} = 366.3 (ELEV. 24.8)^{3/2}

ject N^o

Calculated By _____

Date _____

Checked By _____

Date _____

Calculations For:

Sheet 15

of _____

THOMAS TYLER MOORE ASSOCIATES, INC.
PROFESSIONAL ENGINEERS AND LAND SURVEYORS

6) WEIR FLOW CONDITIONS OVER ROADWAY @ ELEV. 24.4
DISCHARGE VALUES OBTAINED FROM PGS. 3 & 4.

№

Calculated By _____

Date _____

Calculations For:

Sheet 16

Checked By _____

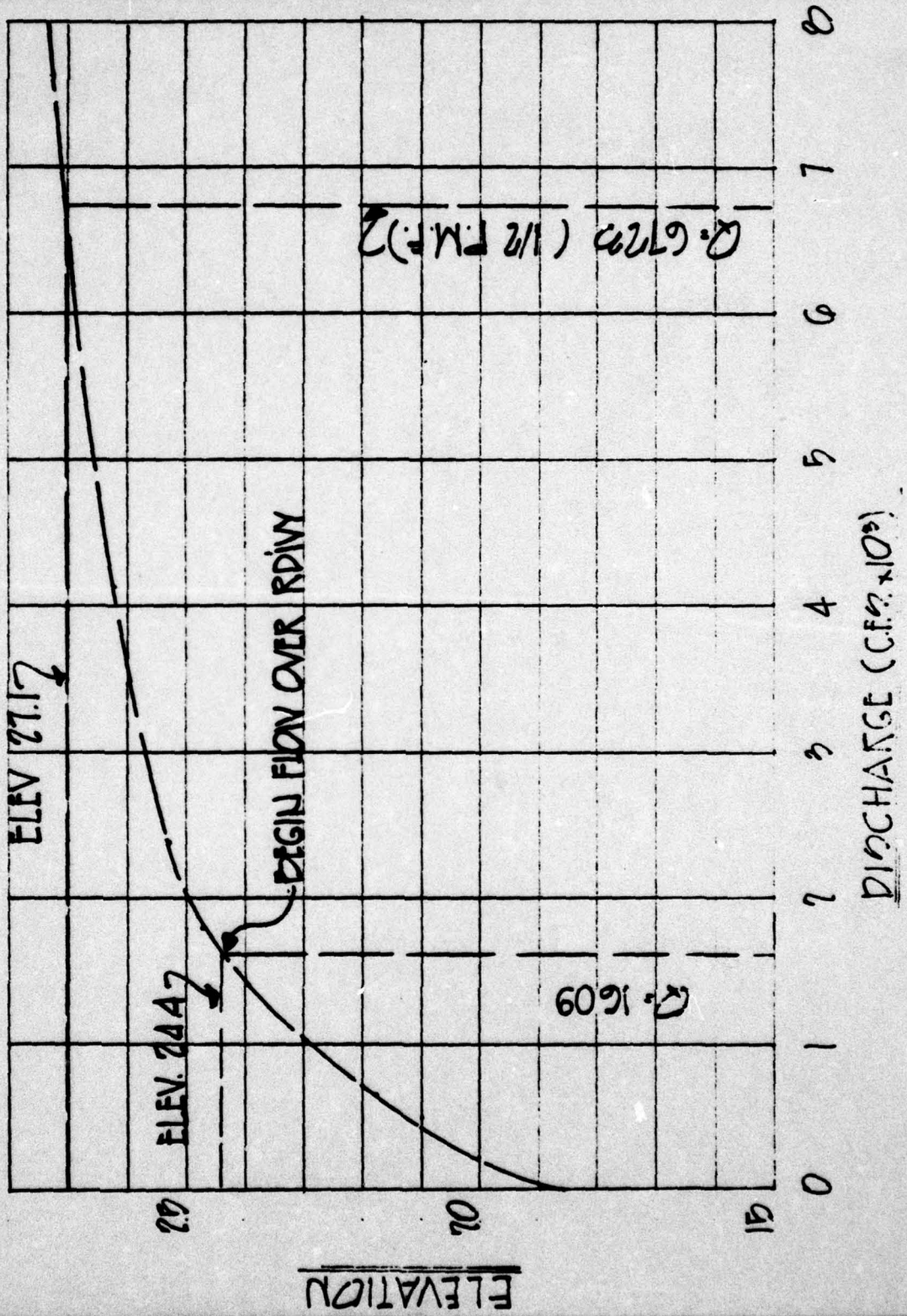
Date _____

Of _____

Sta	Q ₁	Q ₂	Q ₃	Q ₄	Σ Q _{in}	Q _{out}	Σ Q _{out}	COMMENTS
0					0		0	
33					33		33	
77					77		77	
171	527				497		497	
662	0				662		662	
694	17				707		707	
857	189				1026		1026	
797	470				1427		1427	
1041	792				1773	35	1806	BEGIN FLOW OVER RD/WY @ EL 24.4
810		1119	110		2099	291	2390	
670		1140	641		2459	1701	4160	
619		1061	96		2676	2917	5593	
619		1061	1403		3083	4530	7621	
637		1071	1887		3585	6582	10167	
662		1194	2075		3891	7189	11680	

THOMAS TYLER MOORE ASSOCIATES, INC.
 PROFESSIONAL ENGINEERS AND LAND SURVEYORS

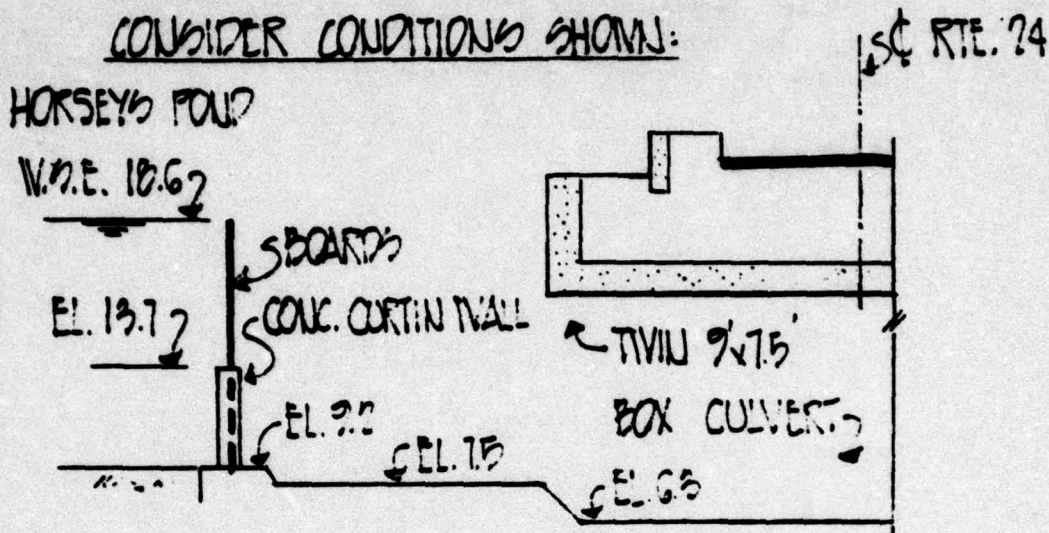
THOMAS TYLER MOORE ASSOCIATES, INC.
 PROFESSIONAL ENGINEERS AND LAND SURVEYORS



NS	Calculated By <u>CAR</u>	Date <u>2/14/75</u>	Calculations For: <u>STAGE-DISCHARGE</u> <u>HORSEY'S POND</u>	Sheet <u>10</u>
	Checked By _____	Date _____		Of _____

HORSEYS POND - DRAWDOWN CALCULATIONS

CONSIDER CONDITIONS SHOWN:



- 1) INITIAL W.S.E. 18.6
- 2) CONC. CURTAIN WALL EXTENDS FROM EITHER ABUTMENT FOR TOTAL DISTANCE OF 91.5 FT. (12, WEIR LENGTH FROM EL. 18.6 TO EL. 13.7 = 4.5' x 7 = 31.5 FT, WEIR LENGTH FROM EL. 18.6 TO EL. 9.2 = 4.5' x 2 = 9 FT.)
- 3) ALL BOARDS REMOVED INSTANTANEOUSLY
- 4) BROAD-CRESTED WEIR CONDITIONS:

$$Q = CLH^{3/2} \quad \text{USE: } C = 3.3 \text{ (FROM EL. 18.6 TO 13.7)} \text{ \& } C = 2.6 \text{ (FROM 13.7 TO 9.2)}$$

$$\text{EFFECTIVE LENGTH OF WEIR: } L = L' - 2(NK_p + K_s)H_e$$

$$A) \text{ FROM EL. 18.6 TO EL. 13.7 USE AVG } H_e \text{ OF } 2.45 \text{ FT.}$$

$$L = 31.5 - 2(8 \times 0.0 + 0.2)2.45 = 30.5 \text{ FT.}$$

$$B) \text{ FROM EL. 18.6 TO EL. 9.2 USE AVG } H_e \text{ OF } 4.7 \text{ FT.}$$

$$L = 9 - 2(1 \times 0.0 + 0.2)4.7 = 7.1 \text{ FT.}$$

Calculated By _____

Date _____

Checked By _____

Date _____

Calculations For:

HORSEYS POND
DRAWDOWN CALCULATIONS

Sheet

19

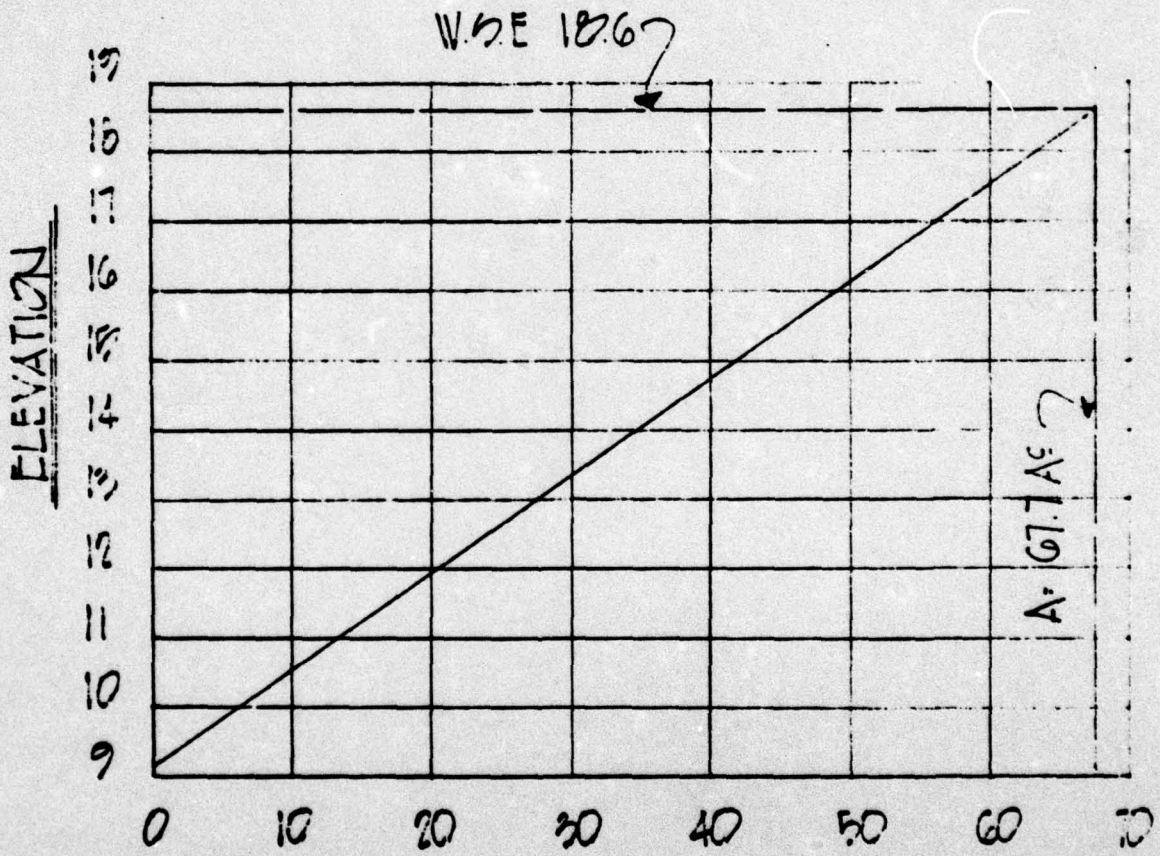
Of _____

RESERVOIR AREA VS HEAD

ASSUME A STRAIGHT LINE RELATIONSHIP FROM NORMAL
 POOL EL. 10.6 TO TOP OF SILL EL. 9.2

AREA AT EL. 10.6 = 67.7 A_F

AREA AT EL. 9.2 = 0 A_F



AREA - A_F
 $AREA = (ELEV. - 9.2) / 0.139$

sect N2

Calculated By _____

Date _____

Checked By _____

Date _____

Calculations For:

Sheet 20

Of _____

THOMAS TYLER MOORE ASSOCIATES, INC.
 PROFESSIONAL ENGINEERS AND LAND SURVEYORS

DRAWDOWN TIME COMPUTATIONS WITH NO INFLOW

ELEV.	AREA	AVG. AREA	VOL.	HEAD ON W. WEIR '1'	HEAD ON W. WEIR '2'	Q ₁ WEIR '1'	Q ₂ WEIR '2'	Q _{TOTAL} (Q ₁ +Q ₂)	TIME $\frac{VOL \times 24}{1.98 \times Q}$
	(A ²)	(A ²)	(A ² FT)	(FT)	(FT)	(FT ³ /SEC)	(FT ³ /SEC)	(FT ³ /SEC)	(HRS)
18.6	67.7	65.5	39.3	9.1	4.6	507	393	1500	0.32
18.0	63.3	59.7	59.7	8.3	3.8	441	246	1187	0.61
17.0	56.1	52.5	52.5	7.3	2.8	364	472	836	0.76
16.0	48.9	45.3	45.3	6.3	1.8	292	243	535	1.03
15.0	41.7	38.1	38.1	5.3	0.8	225	72	297	1.55
14.0	34.5	33.4	10.0	4.7	0.2	180	9	197	0.62
13.7	32.4	29.8	20.9	4.2		159		159	1.59
13.0	27.3	23.7	23.7	3.3		111		111	2.59
12.0	20.1	16.5	16.5	2.3		64		64	3.12
11.0	12.9	9.3	9.3	1.3		27		27	4.18
10.2	5.8	2.9	2.3	0.4		5		5	5.58
9.2	0								

Σ TIME = 22.0 HR.

Project No

Calculated By

Date

Calculations For:

Sheet

21

of

THOMAS TYLER MOORE ASSOCIATES, INC.
PROFESSIONAL ENGINEERS AND LAND SURVEYORS

$$TP = C_t (L \times L_{eq})^{0.3}$$

$$= 3.0 (0.24 \times 3.93)^{0.3}$$

$$= 0.5 \text{ HR.}$$

ect N2

Calculated By

Date

Calculations For:
TIME OF CONCENTRATION
HORSEYS POND

Sheet

22

Checked By

Date

Of

.....
 FLOOD HYDROGRAPH PALKAIRE (MFC-1)
 DAM SAFETY VERSION JULY 1974
 LAST MODIFICATION 21 MAR. 75

RUN DATE: 79/02/21.
 TIME: 14.11.26.

MORSEYS POND DAM
 PHASE I DAM INSPECTION -- STATE OF DELAWARE
 PATRICK A. KENNEDY, THOMAS TYLEY MOORE ASSOCIATES

JOH SPECIFICATION
 NHD 0 NMIN 30 IUDY 0 IUDY 0 MEINC 0
 120 0 30 JUMP 5 NPT 0 LKOPT 0 TRALE 0
 IPLT 0 IPRT 0 NSTAN 0

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLANE 1 NRTIO= 1 IRTIO= 1

RTIOS= 1.00

..... SUR-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO MORSEYS POND
 IRTAU 0 ICOMP 0 ITCO 0 ITAPE 0 JPT 0 JBT 0 INAME 1 IASTG 0 IAUTO 0

HYDROGRAPH DATA
 IHYDG 0 IUMG 1 IAPFA 15.35 SHAP 0.00 TRSDA 15.35 TRSPC 0.00 RATIO 0.000 ISNOW 0 ISAME 1 LOCAL 0

PRECIP DATA
 NP 4R STOMH 7.90 UAJ 0.00 IIAK 0.00
 PRECIP PATTERN
 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01
 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01
 .02 .03 .05 .07 .04 .03 .01 .01 .01 .01
 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01

LUSS DATA
 LKOPT 0 STHKH 0.00 ULTR-Y 0.00 PTIOL 1.00 ERAIN 0.00 STKKS 0.00 PTIOR 1.00 STPHL 1.00 CNSTL 0.05 ALSMK 0.00 RTIMP 0.00

UNIT HYDROGRAPH DATA
 TP= 0.50 CP= .50 NFA= 0

RECESSION DATA
 STRTIO= 0.00 UMCSH= 0.00 RTIOR= 1.00
 APPROXIMATE C-LADA COEFFICIENTS FROM GIVEN SPTIEM CP AND TP AVE TC=17.78 AND R=22.98 INTERVALS

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

1
2
DUNOFF HYDROGRAPH AT
-ROUTE HYDROGRAPH TO
END OF NETWORK

.....
 FLOOD HYDROGRAPH PACKAGE (HEL-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 21 AUG 78

LINE NO.	DESCRIPTION	UNIT	VALUE	UNIT	VALUE	UNIT	VALUE	UNIT	VALUE
1	MORSEYS POND DAM								
2	PHASE I DAM INSPECTION -- STATE OF DELAWARE								
3	PAULICK A. KENNEDY, THOMAS TYLER MOORE ASSOCIATES								
4	120	0	30	0	0	0	0	0	0
5	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1
7	1.0	1	1.0	1	1.0	1	1.0	1	1.0
8	INFLU HYDROGRAPH TO MORSEYS POND								
9	0	0	15.35	0	0	0	0	0	0
10	48	7.9		0.065	0.065	0.065	0.065	0.065	0.065
11	01	.0055	.0055	.01	.01	.01	.01	.01	.01
12	01	.008	.008	.044	.044	.044	.044	.044	.044
13	01	.023	.023	.009	.009	.009	.009	.009	.009
14	01	.015	.015	.006	.006	.006	.006	.006	.006
15	01	.006	.006	1.0	1.0	1.0	1.0	1.0	1.0
16	01	.006	.006						
17	T	8.5	.50						
18	X	0.0	0.0						
19	X	0.0	0.0						
20	K	1	2						
21	K	1	1						
22	ROUTE FLOWS THROUGH MORSEYS POND DAM								
23	Y	1	1						
24	Y1	19.0	19.0	20.0	20.0	21.0	21.0	21.0	21.0
25	Y4	18.6	24.75	25.25	26.25	21.0	21.0	21.0	21.0
26	Y5	0	33	175	222	497	662	707	707
27	Y5	1806	1840	2389	4159	662	662	662	662
28	Y5	0	397	982	1360	662	662	662	662
29	Y5	0	20	25	24	662	662	662	662
30	Y5	18.6	18.6						
31	Y5	24.4	24.4						
32	Y5	99	99						

.....
 24.0 24.45
 1429 1631
 23.0 23.0
 1026 1026
 -18.6 22.0
 707 707

1.01	22.30	44	0.05	0.02	0.03	2482.	1.03	4.30	105	0.00	0.00	251.
1.01	23.00	44	0.05	0.02	0.03	2496.	1.03	5.00	106	0.00	0.00	240.
1.01	23.30	47	0.05	0.02	0.03	2410.	1.03	5.30	107	0.00	0.00	230.
1.02	0.00	44	0.00	0.00	0.00	2728.	1.03	6.00	104	0.00	0.00	220.
1.02	1.00	50	0.00	0.00	0.00	2634.	1.03	6.30	109	0.00	0.00	211.
1.02	1.30	51	0.00	0.00	0.00	2554.	1.03	7.00	110	0.00	0.00	202.
1.02	1.40	51	0.00	0.00	0.00	2470.	1.03	7.30	111	0.00	0.00	193.
1.02	2.00	52	0.00	0.00	0.00	2387.	1.03	8.00	112	0.00	0.00	185.
1.02	2.30	53	0.00	0.00	0.00	2305.	1.03	8.30	113	0.00	0.00	177.
1.02	3.00	54	0.00	0.00	0.00	2225.	1.03	9.00	114	0.00	0.00	170.
1.02	3.30	55	0.00	0.00	0.00	2145.	1.03	9.30	115	0.00	0.00	162.
1.02	4.00	56	0.00	0.00	0.00	2067.	1.03	10.00	116	0.00	0.00	155.
1.02	4.30	57	0.00	0.00	0.00	1988.	1.03	10.30	117	0.00	0.00	148.
1.02	5.00	58	0.00	0.00	0.00	1913.	1.03	11.00	118	0.00	0.00	140.
1.02	5.30	50	0.00	0.00	0.00	1839.	1.03	11.30	119	0.00	0.00	133.
1.02	6.00	60	0.00	0.00	0.00	1766.	1.03	12.00	120	0.00	0.00	125.

SUM 7.90 6.11 1.79 110004.
 (201.1) (155.1) (45.1) (3343.77)

PEAK 3271.
 93.
 CFS 3061.
 CMS 87.
 INCHES 1.06
 M4 4.99
 AC-FT 47.12
 TMINS CU 4 151.39
 4877.
 6016.

24-HOUR 2057.
 58.
 4.99
 126.62
 4079.
 5031.

72-HOUR 984.
 28.
 5.96
 151.39
 4877.
 6016.

TOTAL VOLUME 118021.
 3342.
 151.39
 4877.
 6016.

HYDROGRAPH AT STA 1 FOR PLAN 1. RT10 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
44.	71.	132.	246.	405.	596.	814.	1052.	1307.	1582.	1837.	2092.	2347.
1851.	2126.	2382.	2612.	2896.	3149.	3405.	3661.	3917.	4173.	4429.	4685.	4941.
3271.	3149.	3067.	2942.	2896.	2810.	2724.	2639.	2554.	2469.	2384.	2299.	2214.
2670.	2305.	2225.	2145.	2067.	1989.	1913.	1839.	1766.	1692.	1618.	1544.	1470.
1695.	1559.	1494.	1431.	1370.	1312.	1256.	1202.	1151.	1100.	1050.	1000.	950.
1102.	1010.	967.	926.	887.	849.	813.	778.	745.	713.	682.	652.	622.
713.	654.	626.	599.	574.	549.	526.	503.	482.	462.	442.	422.	402.
461.	423.	405.	386.	371.	355.	340.	326.	312.	299.	286.	274.	262.
249.	246.	242.	238.	234.	230.	226.	221.	211.	202.	193.	184.	175.
193.	177.	170.	162.	155.	148.	140.	133.	125.	118.	110.	102.	94.

PEAK 3271.
 93.
 CFS 3061.
 CMS 87.
 INCHES 1.06
 M4 4.99
 AC-FT 47.12
 TMINS CU 4 151.39
 4877.
 6016.

24-HOUR 2057.
 58.
 4.99
 126.62
 4079.
 5031.

72-HOUR 984.
 28.
 5.96
 151.39
 4877.
 6016.

TOTAL VOLUME 118021.
 3342.
 151.39
 4877.
 6016.

.....

HYDROGRAPH ROUTING

.....

1.01	14.10	74	14.50	1057.	312.	435.	20.3
1.01	15.00	30	15.00	1307.	392.	469.	20.6
1.01	15.30	31	15.50	1575.	689.	511.	21.0
1.01	16.00	32	16.00	1651.	577.	559.	21.4
1.01	16.30	33	16.50	2126.	678.	616.	21.9
1.01	17.00	34	17.00	2382.	834.	678.	22.4
1.01	17.30	35	17.50	2612.	1011.	743.	23.0
1.01	18.00	36	18.00	2812.	1234.	808.	23.5
1.01	18.30	37	18.50	2988.	1457.	872.	24.1
1.01	19.00	38	19.00	3113.	1707.	933.	24.6
1.01	19.30	39	19.50	3210.	2110.	985.	25.0
1.01	20.00	40	20.00	3264.	2645.	1028.	25.3
1.01	20.30	41	20.50	3271.	2904.	1041.	25.5
1.01	21.00	42	21.00	3223.	3047.	1052.	25.6
1.01	21.30	43	21.50	3149.	3105.	1056.	25.6
1.01	22.00	44	22.00	3067.	3106.	1057.	25.6
1.01	22.30	45	22.50	2982.	3072.	1054.	25.6
1.01	23.00	46	23.00	2896.	3017.	1050.	25.6
1.01	23.30	47	23.50	2810.	2949.	1044.	25.5
1.02	0.00	48	24.00	2724.	2873.	1036.	25.4
1.02	.30	49	24.50	2639.	2794.	1032.	25.4
1.02	1.00	50	25.00	2554.	2711.	1025.	25.3
1.02	1.30	51	25.50	2470.	2628.	1019.	25.3

ITERATIVE SOLUTION DID NOT CONVERGE 52 1 0.000 2.525E+01 -1.067E+02 2.526E+01 1.760E+02

1.02	2.00	52	26.00	2387.	2582.	1015.	25.3
1.02	2.30	53	26.50	2305.	2357.	1010.	25.2
1.02	3.00	54	27.00	2225.	2326.	1007.	25.2
1.02	3.30	55	27.50	2145.	2279.	1002.	25.2
1.02	4.00	56	28.00	2067.	2222.	996.	25.1
1.02	4.30	57	28.50	1989.	2158.	990.	25.1
1.02	5.00	58	29.00	1913.	2089.	983.	25.0
1.02	5.30	59	29.50	1839.	2014.	975.	24.9
1.02	6.00	60	30.00	1766.	1939.	968.	24.9
1.02	6.30	61	30.50	1695.	1865.	961.	24.8
1.02	7.00	62	31.00	1626.	1811.	954.	24.8
1.02	7.30	63	31.50	1559.	1770.	945.	24.7
1.02	8.00	64	32.00	1494.	1724.	936.	24.6
1.02	8.30	65	32.50	1431.	1675.	927.	24.5
1.02	9.00	66	33.00	1370.	1626.	916.	24.4
1.02	9.30	67	33.50	1312.	1584.	905.	24.3
1.02	10.00	68	34.00	1256.	1540.	894.	24.2
1.02	10.30	69	34.50	1202.	1494.	882.	24.1
1.02	11.00	70	35.00	1151.	1447.	870.	24.0
1.02	11.30	71	35.50	1102.	1403.	857.	23.9
1.02	12.00	72	36.00	1055.	1360.	845.	23.8
1.02	12.30	73	36.50	1010.	1317.	832.	23.7
1.02	13.00	74	37.00	967.	1273.	820.	23.6
1.02	13.30	75	37.50	926.	1230.	807.	23.5
1.02	14.00	76	38.00	887.	1187.	795.	23.4
1.02	14.30	77	38.50	849.	1144.	782.	23.3
1.02	15.00	78	39.00	813.	1103.	770.	23.2
1.02	15.30	79	39.50	778.	1062.	758.	23.1
1.02	16.00	80	40.00	745.	1023.	747.	23.0
1.02	16.30	81	40.50	713.	991.	735.	22.9
1.02	17.00	82	41.00	683.	960.	724.	22.8
1.02	17.30	83	41.50	654.	929.	712.	22.7
1.02	18.00	84	42.00	626.	898.	701.	22.6
1.02	18.30	85	42.50	599.	868.	690.	22.5

1.02	14.00	86	63.00	574.	838.	674.	22.4
1.02	14.30	87	63.50	544.	808.	668.	22.3
1.02	20.00	88	64.00	526.	779.	658.	22.2
1.02	20.30	89	64.50	503.	751.	647.	22.1
1.02	21.00	90	65.00	482.	724.	637.	22.1
1.02	21.30	91	65.50	461.	700.	627.	22.0
1.02	21.00	92	66.00	442.	681.	617.	21.9
1.02	22.30	93	66.50	423.	662.	607.	21.8
1.02	23.00	94	67.00	405.	644.	598.	21.7
1.02	23.30	95	67.50	388.	627.	588.	21.6
1.03	0.00	96	68.00	371.	609.	578.	21.5
1.03	1.00	97	68.50	355.	592.	568.	21.5
1.03	1.30	98	69.00	340.	575.	558.	21.4
1.03	1.30	99	69.50	326.	558.	549.	21.3
1.03	2.00	100	50.00	312.	541.	539.	21.2
1.03	2.30	101	50.50	299.	525.	530.	21.1
1.03	3.00	102	51.00	286.	508.	520.	21.1
1.03	3.30	103	51.50	274.	491.	511.	21.0
1.03	4.00	104	52.00	262.	470.	503.	20.9
1.03	4.30	105	52.50	251.	450.	494.	20.8
1.03	5.00	106	53.00	240.	431.	486.	20.8
1.03	5.30	107	53.50	230.	413.	478.	20.7
1.03	6.00	108	54.00	220.	396.	471.	20.6
1.03	6.30	109	54.50	211.	379.	464.	20.6
1.03	7.00	110	55.00	202.	363.	457.	20.5
1.03	7.30	111	55.50	193.	348.	450.	20.5
1.03	8.00	112	56.00	185.	333.	444.	20.4
1.03	8.30	113	56.50	177.	319.	438.	20.4
1.03	9.00	114	57.00	170.	305.	433.	20.3
1.03	9.30	115	57.50	162.	293.	427.	20.3
1.03	10.00	116	58.00	155.	280.	422.	20.2
1.03	10.30	117	58.50	148.	268.	417.	20.2
1.03	11.00	118	59.00	140.	257.	412.	20.1
1.03	11.30	119	59.50	133.	246.	407.	20.1
1.03	12.00	120	60.00	125.	235.	402.	20.0

PEAK OUTFLOW IS 3106. AT TIME 22.00 HOURS

PEAK	3106.	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	88.	2402.	1935.	973.	116758.
CMS	88.	82.	55.	28.	3306.
INCHES		1.76	4.69	5.90	5.90
MM		44.68	119.14	149.77	149.77
AC-FT		1439.	3836.	4825.	4825.
T-HOUS CU Y		1775.	4736.	5951.	5951.

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

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN RATIO	PLAN RATIO
			1	1.00
HYDROGRAPH AT	1	15.35 (39.76)	1	3471. (92.62)
ROUTED TO	2	15.35 (39.76)	1	3106. (87.95)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STOPPAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	TIME OF FAILURE HOURS
		14.00	18.00	24.40	
		340.	340.	912.	
		0.	0.	1609.	
RATIO OF PWF	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF FAILURE HOURS
1.00	1.14	1057.	3106.	14.50	0.00
	25.50			22.00	