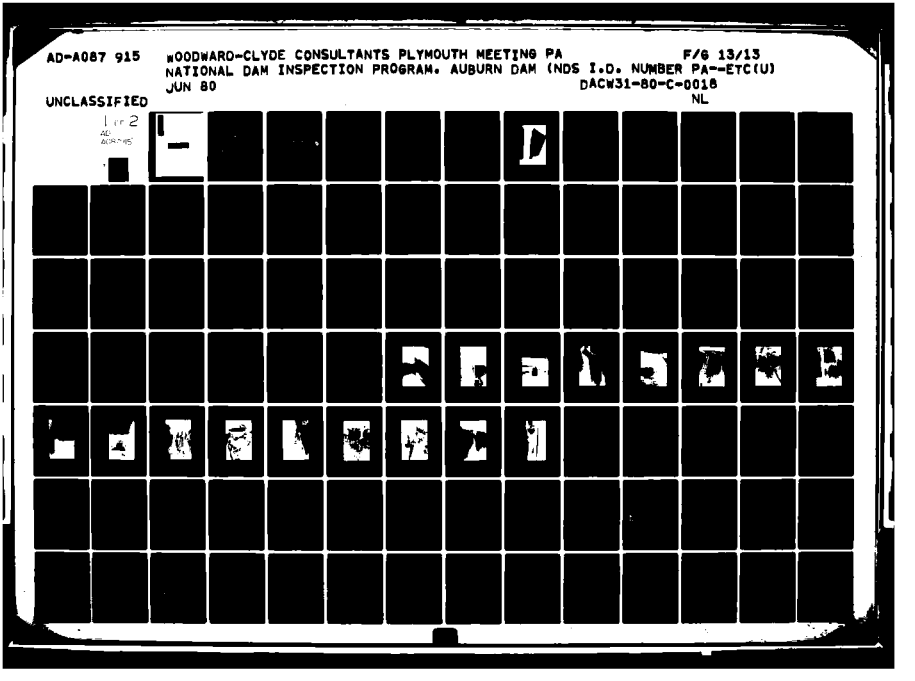
AD-A087 915 WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. AUBURN DAM (NDS I.D. NUMBER PA--ETC(U)
JUN 80 DACW31-80-C-0018
UNCLASSIFIED NL



DISCLAIMER NOTICE

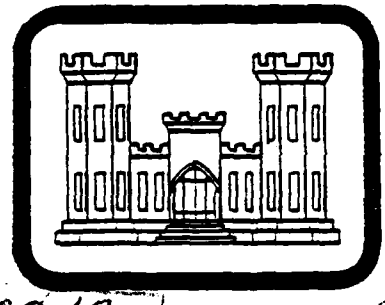
THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

DELAWARE RIVER BASIN

AUBURN DAM, SCHUYLKILL COUNTY PENNSYLVANIA

(NDS I.D. No. PA 00670
DER I.D. No. 54-163)

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DACW31-79-C-0018

Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

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

JUNE 1980

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 the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify 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 investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed 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. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety 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 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 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.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Auburn Dam
County Located:	Schuylkill County
State Located:	Pennsylvania
Stream:	Schuylkill River
Coordinates:	Latitude 40° 36.5'
	Longitude 76° 6.4'
Date of Inspection:	May 1, 1980

Auburn Dam is owned by the state of Pennsylvania under the jurisdiction of the Department of Environmental Resources, Office of Resource Management. The dam, built under Pennsylvania Act 441, entitled "Schuylkill River Act", was completed in October 1950. Visual inspection of the exposed sections of the dam and review of the limited available data and simplified calculations presented in Appendices D and G indicate that Auburn Dam is in good condition. It is noted that the entire spillway and apron were submerged and could not be inspected. Therefore, a complete visual assessment of the structure could not be performed.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification is the Probable Maximum Flood (PMF).

Calculations presented in Appendix D indicate that the structure will pass about 89 percent of the PMF without overtopping the embankment. Therefore, the spillway system for this structure is considered to be "Inadequate" but not "Seriously Inadequate".

It is recommended that the following items of routine maintenance and surveillance be undertaken as soon as practical.

(1) The remaining trees and brush on the left earth embankment section should be removed.

(2) Damaged pilasters should be repaired to prevent loss of support to the hand railing on the top of the dam.

(3) Surficial joint deterioration of the right non-overflow section should be periodically inspected. If deterioration of these zones becomes excessive, they should be cleaned and patched.

(4) Seepage through the right non-overflow section should also be periodically monitored and evaluated. Repairs to deteriorated joints caused by seepage would include sealing of the structure/joint from the upstream side of the dam.

An operation and maintenance manual for small dams has been prepared by the Department of Environmental Resources, Division of Completed Projects, Bureau of Operations. Portions of the manual apply to this structure. It is important that persons concerned with the structure are familiar with the procedures contained in the manual. Since there are no formal warning procedures for this structure, one should be developed to warn downstream residents of impending high flows.

Mary F. Beck — 7/2/80

Mary F. Beck, P.E.
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

Date

7/1/80

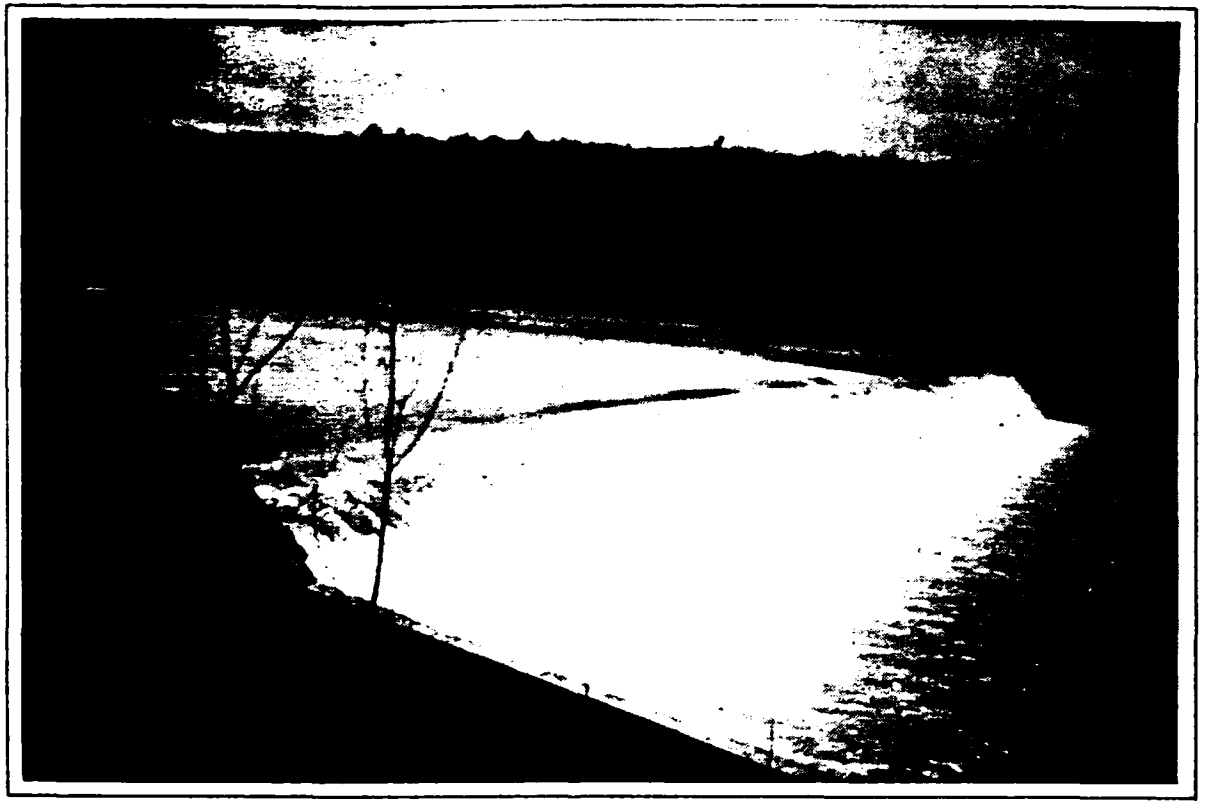
John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

Date

APPROVED BY:

31 July 1980

Date



OVERVIEW
AUBURN DAM, SCHUYLKILL COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
AUBURN DAM
NATIONAL ID NO. PA 00670
DER NO. 54-163

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 inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Auburn Dam was constructed across the Schuylkill River to form a desilting basin as part of the Schuylkill River Project, Pennsylvania Act 441. It is a concrete gravity structure consisting of a central 500 foot long ogee spillway section, non-overflow concrete sections at each end of the spillway, and a 120 foot earth embankment beyond the left non-overflow section. The overall length of the dam is about 820 feet.

The ogee gravity spillway, crest elevation 473, has a maximum design base width of about 61 feet and a maximum design height from the foundation to the crest of the non-overflow section of 58 feet. The maximum design height of the spillway crest above the downstream apron elevation is 39 feet, and the maximum design height of the non-overflow crest above the downstream apron is 51 feet. The bucket at the downstream toe of the spillway has a radius of 14 feet and a thickness of five feet, extending about 14.6 feet downstream from the projected toe of the ogee weir. The downstream apron design elevation is seven feet above the foundation elevation. As-built drawings or dimensions are not available to determine the actual heights or base width of the gravity sections, which are dependent on the foundation conditions encountered during construction. The "Final Report of the Schuylkill Project Engineers on Schuylkill River, Pennsylvania, 1947-

1951" states: "The maximum height of the dam is 46 feet of which about 28 feet are below the original river bed." Assuming the top of culm (Plate 2, Appendix E) as original river bed, the foundation elevation would be 426. Taking "height of dam" to mean spillway crest, the foundation elevation would be 427.

The dam foundation design included grouting with holes extending 25 feet below the foundation in a single line on five foot centers at the heel of the spillway and non-overflow sections. The cement grouting was apparently to be done after the gravity structure was constructed.

The gravity non-overflow sections at each end of the spillway have a width of eight feet for the top nine feet, plus concrete curbs which add an additional two feet of width near the top. Below the eight foot wide section, the downstream base batters at 6.5 on 10, and the upstream base has a batter of 1 on 20. The right non-overflow section has been backfilled with rock spoil and the left non-overflow section has been backfilled with zoned materials protected by derrick stone; see Plates 3 and 4, Appendix E.

Beyond the left non-overflow section is an earth embankment which ties the non-overflow section to natural ground. The earth embankment has a top width of about 30 feet. The upstream, central and core trench portions of the embankment are constructed of impervious fill, and the downstream portion is constructed of pervious fill. Both upstream and downstream slopes are 3H:1V and are protected by rock spoil. The core trench is 10 feet wide at the bottom, and both upstream and downstream slopes are 1.25H:1V.

The right non-overflow section is tied to the right abutment by a backfill zone approximately 25 feet in length. Impervious fill was used for the upstream and central portions, and pervious fill for the downstream portion. There is no core trench beneath the backfill. A one foot thick layer of rock spoil protects the slopes and the crest.

b. Location. The dam is located on the Schuylkill River, approximately one mile northwest of Auburn, Pennsylvania, in South Manheim and West Brunswick Townships, Schuylkill County, Pennsylvania. The site is shown on the USGS Quadrangle entitled "Auburn, Pennsylvania" at coordinates N 40° 36.5' W 76° 6.4'. A regional location plan of Auburn Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as an "Intermediate" size structure by virtue of its estimated 51 foot height and 4,500 acre-foot total storage capacity.

d. Hazard Classification. A "High" hazard classification is assigned consistent with the potential for extensive property damage and possible loss of life along the Schuylkill River downstream of the dam.

e. Ownership. The dam is owned by the Department of Environmental Resources, Office of Resource Management. All correspondence should be sent to Resources Management, Bureau of Operations, Department of Environmental Resources, Post Office Box 1467, Harrisburg, Pennsylvania 17120.

f. Purpose of Dam. The purpose of this dam is to create a desilting basin, originally to trap coal sediment.

g. Design and Construction History. Auburn Dam was constructed as a result of Pennsylvania Act 441, "Schuylkill River Desilting Project", June 1945. Auburn Dam is one of a series of several dams along the Schuylkill River constructed to form desilting basins to trap coal sediment carried by the river.

On September 3, 1947, Sprague & Henwood, Incorporated, was awarded the contract to provide test borings at several sites along the Schuylkill River as part of the Schuylkill River Project. All test borings were completed by February 11, 1948. Justin & Courtney* and Albright & Friel**, both of Philadelphia, Pennsylvania, were the engineers responsible for designing the dams across the Schuylkill River. Auburn Dam was constructed by the Arthur A. Johnson Corporation under Contract No. 35, Pennsylvania GSA No. 100-12. During the early stages of excavation, it was found that a more satisfactory foundation existed 45 feet downstream from the original site as determined from the core borings. The decision was made to move the site of the dam downstream to take advantage of the better foundation conditions. The dam is founded on a "dike of sandstone" approximately 60 feet wide.

The dam was constructed in two stages by the use of cofferdams and diversion channels. The right half of the dam was constructed first with diversion of the river through a temporary diversion channel and construction of an earth dike cofferdam. During the second stage of construction, the river was diverted by means of three 4 x 5 foot conduits through the completed spillway section near the right side. To provide for overflow during high water, the three upper five foot

---

* Justin & Courtney is now a division of O'Brien & Gere, Syracuse, New York.

** Albright and Friel has sinced merged with Betz-Converse-Murdoch-Inc., Plymouth Meeting, Pennsylvania.

lifts of one monolith section of the first stage construction were not poured until after the other monoliths were completed. After construction, the three conduits were closed off at the upstream end with concrete stoplogs. The final stoplogs were placed October 26, 1950. The dam was completed on October 31, 1950, for a total cost of $1,396,939.80.

h. Normal Operating Procedures. All water flows over the weir of the spillway.

1.3 Pertinent Data.

A summary of pertinent data for Auburn Dam is presented as follows.

a.	Drainage Area (square miles)	157
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood	Unknown
	At Top of Non-overflow Section	82,670
c.	Elevation (feet above MSL)	
	Top of Dam	
	Existing	485.2
	Design	485.0
	Spillway Crest	473.0
	Normal Pool	473+
	Tailwater (5/1/80)	451.0
	Downstream Apron (toe)(1)	434±
	Foundation Elevation(1)	427±
d.	Reservoir (feet)	
	Length at Normal Pool	12,000
	Fetch at Normal Pool (est)	2,500
	Length at Maximum Pool (est)	16,000
e.	Storage (acre-feet)	
	Normal Pool	1,900
	At Top of Non-overflow (est)	4,500
f.	Reservoir Surface (acres)	
	Normal Pool	186
g.	Dam Data	
	Type	Concrete gravity w/ zoned earth embankment at left end

(1) Based on discussion contained in Section 1.2, paragraph a.

	Length	820 feet
	Height (above downstream apron)(1)	51± feet
	Crest Width (concrete non-overflow section)	8 feet
	Volume	
	Concrete	32,000 cubic yards
	Earth	10,000 cubic yards
	Cutoff	Core trench w/impervious backfill beneath embankment at left end
	Grout Curtain	Single line grout curtain at heel of gravity sections
h.	Spillway	
	Type	Concrete ogee weir
	Elevation	473.0 feet
	Length	500 feet

(1) See note on previous page.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data for Auburn Dam is presented in the checklist attached as Appendix B.

b. Design Features. Principal design features are illustrated on the plan, profile and cross-sections of this structure, and are enclosed in Appendix E as Plates 2 through 8. These plates are reproduced from drawings supplied by the Department of Environmental Resources (DER). A description of the design features is presented in Section 1.2, entitled "Description of Project".

2.2 Construction.

A description of the construction history is presented in Section 1.2.

2.3 Operational Data.

There are no operational records maintained. Since all flow passes over the overflow section, there are no minimum flow requirements downstream.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and studied for this investigation were provided by the Pennsylvania DER, the Bureau of Dam Safety and the Bureau of Operations.

b. Adequacy. The data included in state files and information received from representatives of the Office of Resource Management were sufficiently adequate to evaluate the design features of the dam, with the exception of the spillway adequacy rating, and no stability analysis was provided.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated as follows. In general, the ogee section, non-overflow sections and earthen sections of the facilities appear to be in good condition and well maintained. At the time of the inspection, the river was flowing at a normal rate over the spillway, and thus, the ogee section and downstream apron of the spillway could not be inspected.

b. Dam. The vertical alignment of the non-overflow sections and earthen embankment was checked and is presented on sheet 5B of 11, Appendix A. There were no distortions in alignment or grade that would be indicative of either horizontal movement of the monoliths or embankment section or deep seated movement within the foundation.

1. Concrete Non-overflow Sections. The exposed portions of concrete of the non-overflow sections and spray walls were inspected and found to be in good condition. There were no changes in alignment or apparent rotation that would be indicative of foundation movement. Surficial concrete deterioration was limited to the railing pilasters on both left and right non-overflow sections, as shown in Photograph 8, and along some expansion joints on the right spray wall, as shown in Photograph 7. Visible on the outside spray wall surface and downstream gravity section of the right overflow section were leachate deposits, shown in Photographs 4 and 5, indicating a long-term leakage/seepage through the concrete. The leachate deposit shown in Photograph 6 is approximately 18 inches long, nine inches wide and nearly an inch thick.

The bottoms of concrete pilasters supporting railing posts have spalled off, as shown in Photograph 8, and some have been repaired within the last year. Surface cracks of the pilasters and walkway and around the railing posts have been sealed with bituminous material. The long-term existence of these cracks is demonstrated by the buildup of leachate at the bottom of at least one of them, which had water leaking out at the time of the inspection. This water is assessed to be rainwater. These cracks are routinely sealed in an effort to prevent freezing damage in the winter. Railings have recently been painted with aluminum paint.

The backfill around the right non-overflow section and the adjacent embankment, shown in Photograph 3, appears to be in good condition with no significant erosion or sloughing. The fill around the left non-overflow section is protected by derrick stone, shown in Photograph 11, which ranges from four to eight feet thick. It is noted that the interstices of this large stone are not filled with smaller stone. The derrick stone was designed to overlay a two foot thick layer of rock spoil, which in turn overlies a one foot thick layer of gravel bedding. A small amount of erosion was noted at the downstream toe of the left spray wall, shown in Photograph 15, probably resulting from a combination of wave action and foot traffic.

2. Left Embankment Section. There were no distortions in alignment or grade that would be indicative of deep seated movement of the embankment or foundation. The vertical profile is included on sheet 5B of 11, Appendix A. The crest, shown in Photograph 10, is unprotected by vegetation or rock spoil, and is slightly rutted by vehicle tire tracks. Near the junction of the earth embankment crest with the concrete non-overflow section were depressions filled with standing rainwater. Some trees and brush have been removed from the earth embankment adjacent to the non-overflow section, but both upstream and downstream embankment slopes are still covered with trees and light underbrush, as shown in Photograph 13. Rock spoil is visible underwater on the upstream side and is also evident under the forest litter on the upstream and downstream slopes. Minor erosion/settlement/vandalism appears to have occurred above the junction of derrick stone and rock spoil on the downstream slope. The junctions with the abutment are in good condition, both upstream and downstream. The downstream junction of the left embankment with the abutment is shown in Photograph 14. No seepage was noted at the toe of either the embankment section or the backfilled areas of the concrete non-overflow sections.

The dam was formerly lighted at night, and the base of a sawed-off timber utility pole remains in the embankment crest near the concrete left non-overflow section. Earlier this year, the utility pole had been cut off flush with the embankment. Apparently, vandals have tried to remove the electrical cable, and a hole has been dug at the base of the utility pole.

c. Appurtenant Structures.

The exposed portions of the ogee spillway were limited to the spray walls of the structure. Water flowing over the spillway crest was smooth with no indications of cracks or displacements between the monoliths, as shown in Photograph 1.

d. Reservoir. At the time of the inspection, the reservoir was at normal pool, and the slopes to the water's edge were well vegetated and stable. The reservoir is presently being dredged, and it is expected that about 200,000 cubic yards of material will be removed from the pool this summer. It is estimated that the pool capacity is presently reduced by about 20 percent by sediment accumulation.

e. Downstream Channel. The natural channel below the dam is the Schuylkill River, which appears to be in good condition with stable banks and a minimum amount of scour.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities disclosed no evidence of apparent past or present movement that would indicate an existing instability of the dam. Since flow was passing over the spillway at the time of the inspection, the toe of the spillway could not be inspected for undermining, scour or the condition of the apron section. There is no evidence to suggest that the observed seepage through the right non-overflow section is detrimental to structural stability at this time. All exposed structural features of the dam were observed to be in good condition. Trees and brush should be removed from the earth embankment and the slopes restored to their original condition. Although no embankment conditions, apparent erosion or depressions are sufficiently serious to require immediate repair, good practice would indicate repairs on a routine basis. As in the past, damaged pilasters should be repaired to prevent potential loss of support to the hand railing on the top of the dam. The effects of seepage through the right non-overflow section should be periodically monitored and evaluated.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operation of the dam does not require a dam tender. All flow discharges directly over the ogee section and downstream into the Schuylkill River.

4.2 Maintenance of the Dam.

The dam is inspected yearly by the Department of Environmental Resources (DER), Bureau of Operations, in Harrisburg. The local Schuylkill River Project office provides routine maintenance of the structure, which includes removal of debris, painting and sealing of any surficial cracks.

4.3 Maintenance of Operating Facilities.

There are no mechanical devices or operating facilities to maintain for this structure.

4.4 Warning Systems In Effect.

According to DER's representative during the time of the inspection, there are no formal warning procedures associated with Auburn Dam.

4.5 Evaluation.

Since there are no operating facilities and since the dam does not require a dam tender, it is judged that the current operating procedure is a satisfactory method of operating the dam. Since a warning procedure does not exist, it is recommended that one be established.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. No original design data were located. Some evaluation data were available in state files, and additional calculations for this investigation are presented in Appendix D.

The large, irregularly shaped watershed is about 14 miles long and ranges from 8 to 18 miles wide, having a total area of 157 square miles. Elevations range from 1,757 in the upper reaches to 473 at the weir elevation. This portion of the Schuylkill River Watershed has higher average rainfall and steeper topography than the lower portions of the river, producing a higher runoff. In the watershed above Auburn Dam are over 20 dams, generally concentrated in the upper portions of the watershed. One of the largest dams is located on Plum Creek about two miles above Auburn reservoir.

The total drainage area is less than 25 percent developed and about 75 percent wooded. Coal lands comprised about 76 square miles of the Schuylkill River Watershed concentrated in the extreme upper reaches. The original sediment problem was created by coal processing methods and, during every rainfall, considerable amounts of silt erode from "culm piles", or mine waste piles. It is not expected that runoff characteristics will change significantly in the near future.

The only information concerning spillway capacity is limited to statements in the "Final Report of the Schuylkill River Engineers on the Schuylkill River, Pennsylvania, 1947 - 1951", and an evaluation located in Department of Environmental Resources (DER) files. The design engineers indicate that the design depth of water on the crest was 12 feet, producing a maximum spillway capacity of 75,000 cfs. A memorandum in DER files indicates that the maximum spillway capacity is 79,000 cfs, based on a weir coefficient of 3.8.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard classification is the Probable Maximum Flood (PMF).

b. Experience Data. Reservoir levels are not maintained for this dam, and there are no estimates of previous high water levels.

c. Visual Observations. On the date of the inspection, there were no conditions observed that would indicate a reduced spillway capacity during an extreme event. Observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and discussed in greater detail in Section 3.

d. Overtopping Potential. This structure was evaluated by the use of the "HEC-1, Dam Safety Version" computer program. A brief description of the program is included in Appendix D. The presence of upstream dams has been conservatively neglected in computing the inflow hydrograph for Auburn Dam. The dam on Plum Creek has a drainage area of about three square miles and is not a flood control dam. Therefore, it will have a negligible effect on the PMF inflow hydrograph to Auburn Dam. The HEC-1 computed peak PMF inflow is about 93,800 cfs. Calculations for this investigation indicate that the maximum spillway capacity is about 82,670 cfs. Flood routing through the reservoir indicates that the earth embankment portion will be overtopped by about one foot during the full PMF event. Calculations indicate that the spillway is capable of passing about 89 percent of the PMF without overtopping the embankment. The outflow from Auburn Dam was routed downstream to estimate the likelihood that the weir would be submerged during the spillway design storm. A maximum stage of 473 feet at the downstream section during the PMF indicates the maximum spillway capacity would not be appreciably reduced by submergence of the weir.

e. Spillway Adequacy. As the spillway will not pass the full PMF without overtopping the embankment, but passes more than one-half the PMF without overtopping the structure, the spillway is rated as "Inadequate" but not "Seriously Inadequate".

f. Downstream Conditions. About 400 feet downstream of the dam, the Schuylkill River passes under the railroad bridge shown in Photograph 16. About 1.5 miles farther downstream, the Schuylkill River flows under the Route 895 highway bridge at Auburn, Pennsylvania. Auburn itself is built about 40 feet above the Schuylkill River floodplain. Across the river from Auburn is an industrial complex, shown in Photograph 17. Industrial buildings and at least one house at that location would be damaged in the event of a sudden failure of the dam. About eight river miles downstream of Auburn Dam is Port Clinton. Port Clinton is located at the confluence of the Schuylkill River and the Little Schuylkill River, immediately upstream of the point where the two combined rivers flow through a gap in the Blue Mountain Ridge. Portions of Port

Clinton are built within 20 feet above the river bank. The gap in the mountain ridge forms a constriction, possibly causing backwater effects at Port Clinton. Were the dam to fail, particularly not as a result of overtopping during an extreme event, extensive property damage and loss of life would occur, justifying a "High" hazard potential rating.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of existing or impending instability of the structure. All exposed items of the structure were inspected and found to be in good condition, except for deteriorated railing pilasters, minor surficial concrete deterioration and construction joint deterioration caused by seepage. However, the entire ogee section was covered with water and could not be thoroughly inspected. There was no distortion along the spillway crest to infer excessive scour downstream, monolith displacement or structural deterioration of the ogee section. Spaces were noted between the derrick stone on the downstream section and the embankment portion, most likely as a result of vandalism, but it is judged that this would not have a significant effect on the stability of the structure in the event it is overtopped.

Construction joint deterioration is occurring within the right non-overflow section and spray wall as evidenced by leachate deposits. There is no evidence detected by visual inspection that the structural integrity of the structure has been affected.

b. Design and Construction Data. No design calculations or as-built drawings were available from which to assess the stability of the overflow and non-overflow sections of the dam. Based on a review of the design drawings, the visual appearance of the structure, and a simplified stability analysis presented in Appendix G, the stability of the dam is judged to be adequate. Although the resultant falls outside the middle third of the base, toe pressures are not considered excessive.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. Since the completion of the dam in 1950, there have been no modifications made to this structure.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static conditions, it can be assumed safe for any expected earthquake conditions. Since the dam is assessed to be stable under static loading conditions at the present time, it can also reasonably be considered to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection of the exposed sections of the dam and review of the limited available data indicate that Auburn Dam is in good condition. It is to be noted that the entire spillway and bucket were submerged and could not be inspected. Therefore, a complete visual assessment of the structure could not be performed.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification is the Probable Maximum Flood (PMF). Calculations presented in Appendix D indicate the structure will pass about 89 percent of the Probable Maximum Flood without overtopping the embankment. Therefore, the spillway system for this structure is considered to be "Inadequate" but not "Seriously Inadequate".

b. Adequacy of Information. Information available for this investigation, the visual inspection and simplified calculations presented in Appendices D and G were sufficient to indicate that no further investigations are required for this structure beyond monitoring specified below.

c. Urgency. The recommendations presented in the following section should be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following items of routine maintenance and surveillance be undertaken.

(1) The remaining trees and brush on the left earth embankment section should be removed.

(2) Damaged pilasters should be repaired to prevent loss of support to the hand railing on the top of the dam.

(3) Surficial joint deterioration of the right non-overflow section should be periodically inspected. If deterioration of these zones becomes excessive, they should be cleaned and patched.

(4) Seepage through the right non-overflow section should also be monitored and evaluated. This work should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

b. Operation and Maintenance Procedures. An operation and maintenance manual for small dams has been prepared by the Department of Environmental Resources, Division of Completed Projects, Bureau of Operations. Portions of the manual apply to this structure. It is important that persons concerned with the structure are familiar with the procedures contained in the manual. Since there are no formal warning procedures for this structure, one should be developed to warn downstream residents of impending high flows.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Auburn Dam* County *Schuylkill* State *Pennsylvania* National ID # *PA 00670*

Type of Dam *Concrete gravity/earth* Hazard Category *High*

Date(s) Inspection *5/1/80* Weather *Sunny* Temperature *60's*

Pool Elevation at Time of Inspection *473.5* M.S.L. Tailwater at Time of Inspection *451.0* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist)
Vincent McKeever (Hydrologist)
Arthur H. Dvinoff (Geotechnical/Civil)
Raymond S. Lambert (Geologist)

Mary F. Beck Recorder

Remarks:

Mr. Clifford Romig, Bureau of Operations and Mr. Joseph Bullenger, Schuylill River Project, were on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*Slight seepage observed through concrete joint in right non-overflow section. No seepage was observed at toe.*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*Good condition.*	
DRAINS	*None*	
WATER PASSAGES	*None*	
FOUNDATION	*Could not be inspected.*	

CONCRETE/MASONRY DAMS

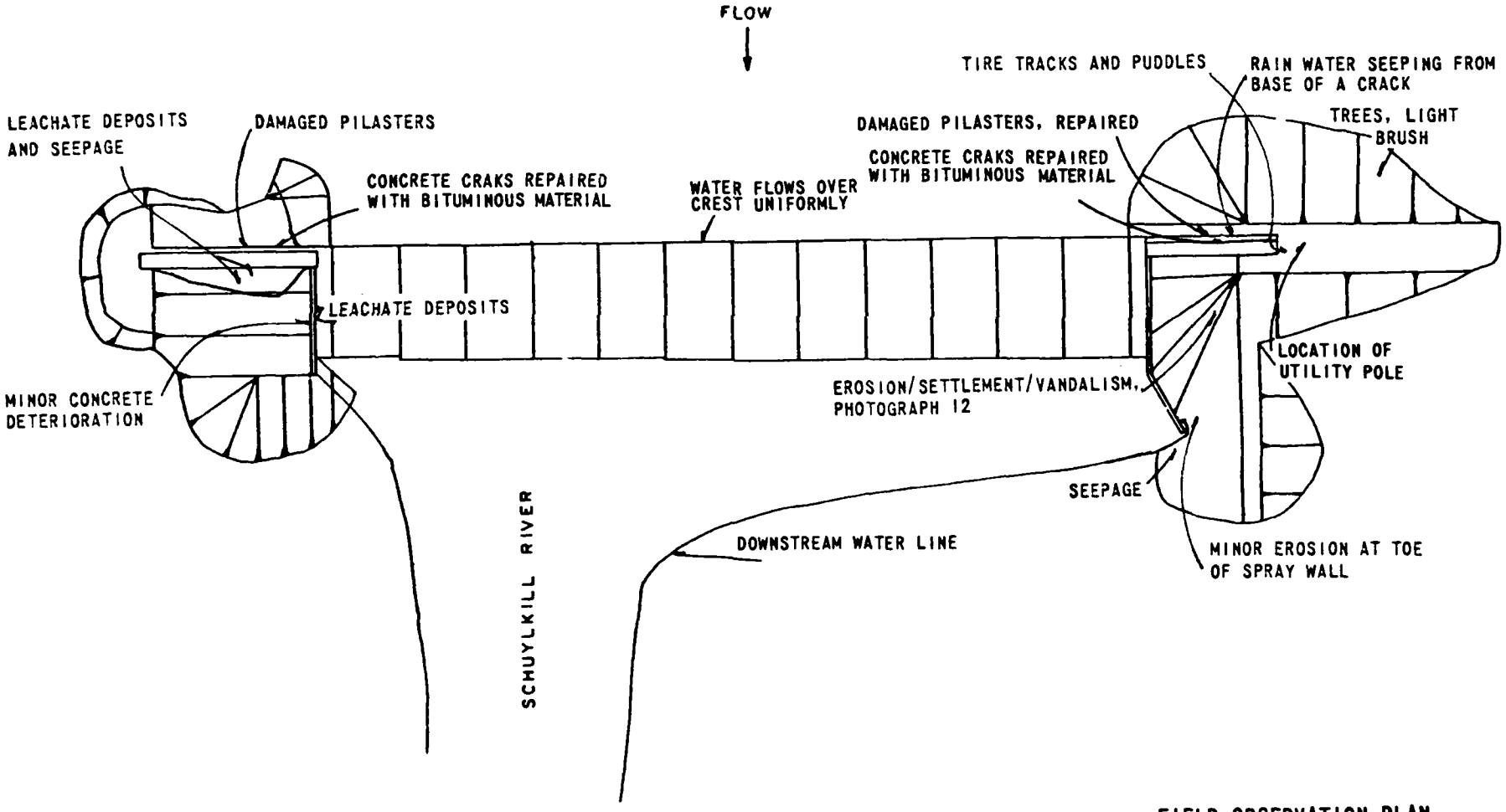
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*Water observed through cracks on right non-overflow section, a long-term condition as evidenced by leachate deposits.*	
STRUCTURAL CRACKING	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT	*Appeared good, see Sheet 5B of 11.*	
MONOLITH JOINTS	*Exposed joints in good condition.*	
CONSTRUCTION JOINTS	*Exposed joints in good condition with some minor deterioration of concrete on downstream side of right non-overflow section..*	

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	*Apparent erosion of downstream embankment above the contact with derrick stone.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*See Sheet 5B of 11.*	
RIPRAP FAILURES	*None observed.*	

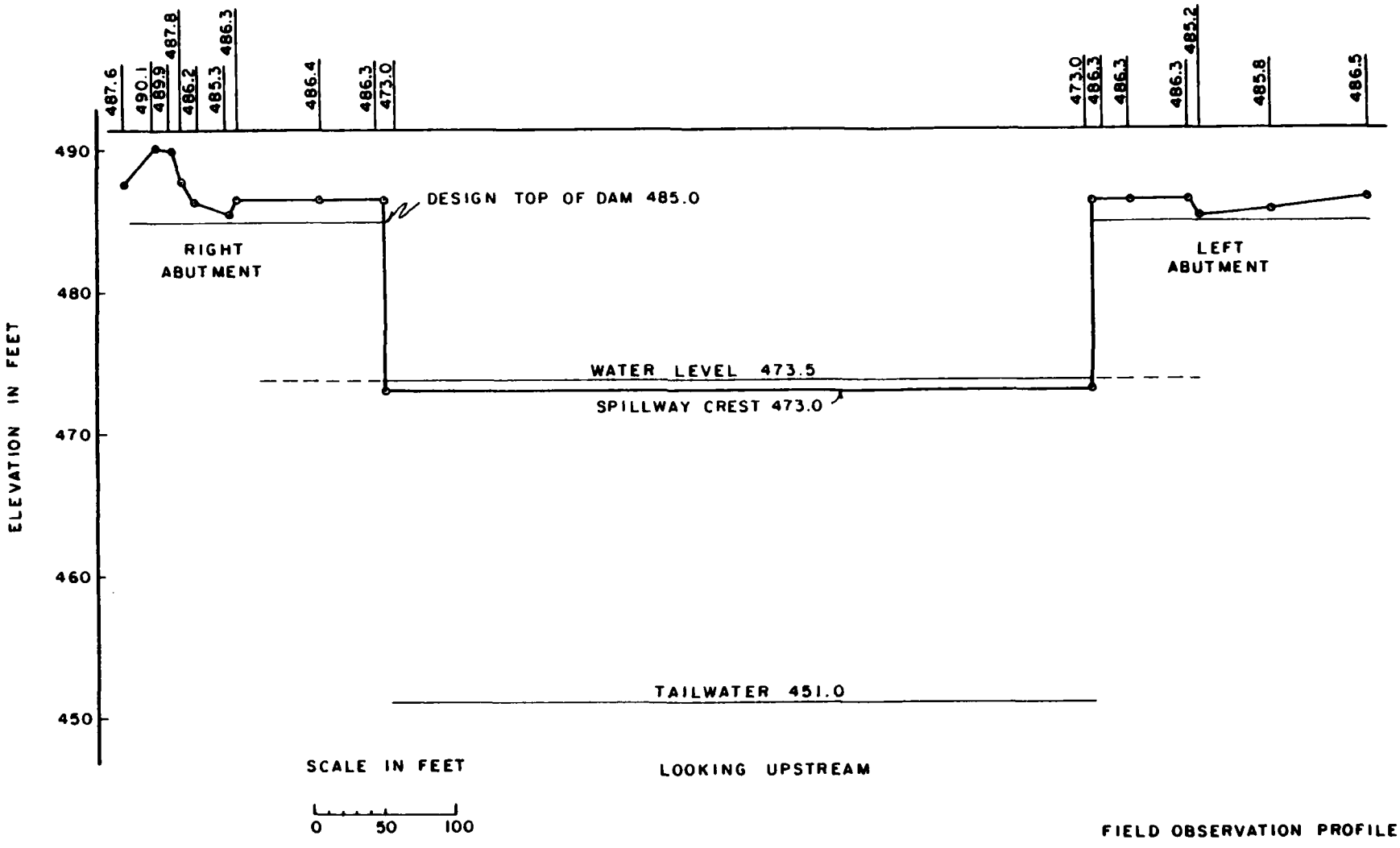
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	*Upstream and downstream slopes are covered with trees and light underbrush. The crest is unprotected and has vehicle tracks.*	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*Good condition.*	
ANY NOTICEABLE SEEPAGE	*None observed.*	
STAFF GAGE AND RECORDER	*None, remnants of staff gage visible on upstream side of left non-overflow section.*	
DRAINS	*None*	



FIELD OBSERVATION PLAN
AUBURN DAM

SHEET 5A OF 11



FIELD OBSERVATION PROFILE
AUBURN DAM

SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*None*	
INTAKE STRUCTURE	*None*	
OUTLET STRUCTURE	*None*	
OUTLET CHANNEL	*None*	
EMERGENCY GATE	*None. Three 4 ft. x 5 ft. conduits through spillway are closed at upstream end with concrete stop logs.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Flow over weir appeared uniform. Spillway could not be inspected.*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*Stable, but the channel at the base of the spillway could not be inspected for erosion or undercutting.*	
BRIDGE AND PIERS	*None*	

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*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir side slopes are moderate to steep and vegetated to waters edge with trees or grass. Debris was noted along reservoir edge.*	
SEDIMENTATION	*At the extreme upstream end of the reservoir sediment has formed bars in the river. It is estimated sediment has reduced normal capacity by 20 percent. The reservoir is being dredged.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*Schuylkill River forms the downstream channel and appears in good condition below the dam.*	
SLOPES	*The valley gradient below the dam is approximately 0.001.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*Failure of the dam is likely to wash out the railroad bridge 400 feet downstream of the dam and the Rt. 895 highway bridge 1.7 miles downstream of the dam. Immediately upstream of Rt. 895 is an industrial complex with many employees. Downstream of Rt. 895 is at least one house which would be damaged in the event of failure.*	

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Auburn Dam*

ID # *PA 00670*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available.*
REGIONAL VICINITY MAP	*Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*See text, Section 1.2*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*- See Appendix D*
RAINFALL/RESERVOIR RECORDS	*None*

ITEM	REMARKS
DESIGN REPORTS	*None available.*
GEOLOGY REPORTS	*See Appendix F.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*None available.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Boring records only*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*A borrow source is designated on the design drawings, located approximately 1,000 feet northwest of the dam.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*See Sheet 4 of 4 under Miscellaneous.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None, inspection records maintained by Bureau of Operations.*

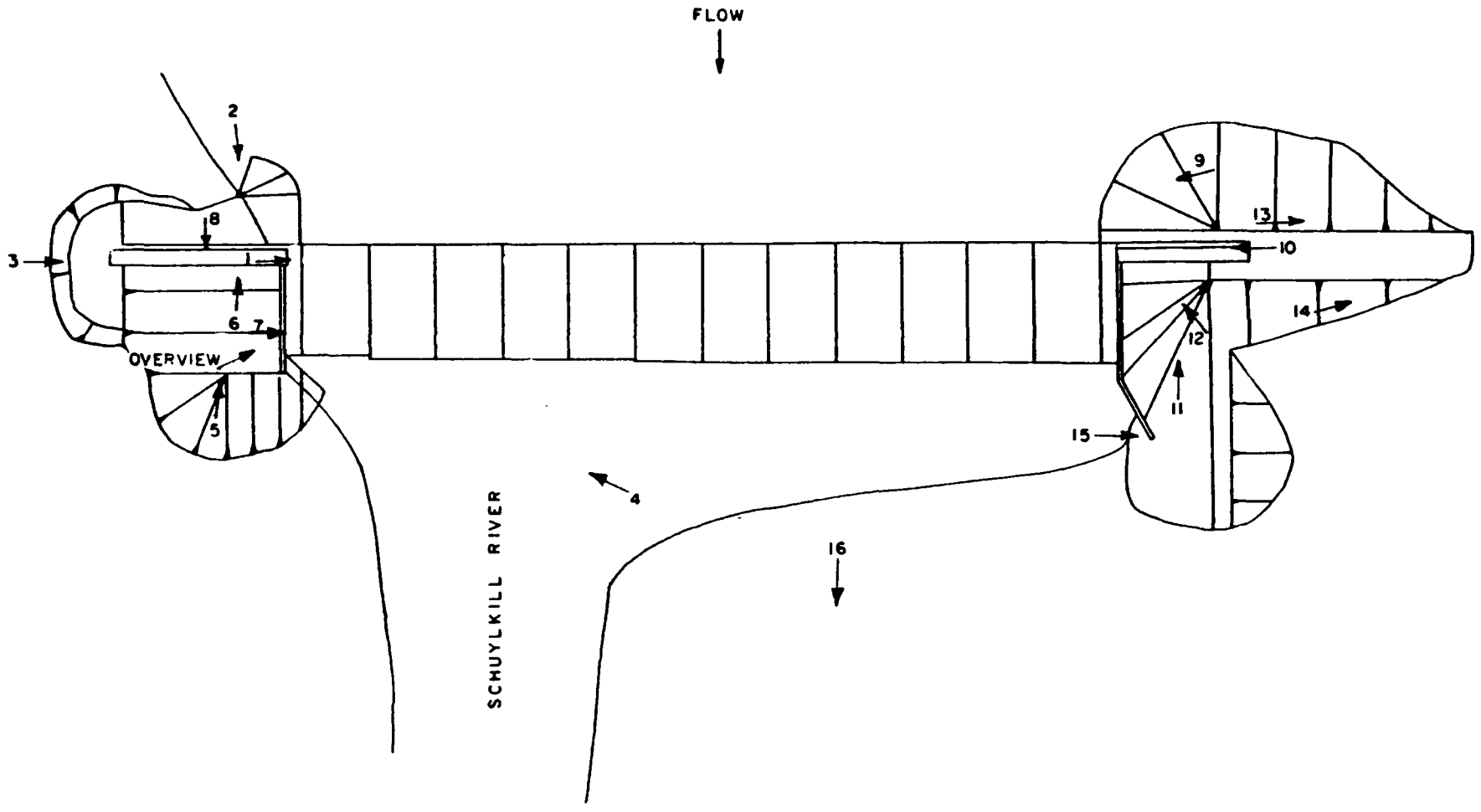
ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	*See Appendix E.*
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	*None*

MISCELLANEOUS

1. *"Final Report of Schuylkill River Project Engineers on Schuylkill River, PA 1947-1951," provided by local Schuylkill River Project Office.*
2. *File maintained by Bureau of Operations was available for review.*
3. *"Operation and Maintenace Manual for Small Dams", prepared by Bureau of Operations was supplied.*
   The following were supplied by Dept. of Environmental Resources, Bureau of Dam Safety and Waterways Management.
4. *A 14 sheet set of design drawings.*
5. *DER inspection reports.*
6. *Memorandum describing design features of dam.*
7. *Copies of inspection report files by local Schuylkill Project Engineers Office.*
8. *Three black and white photographs.*

APPENDIX

C



PHOTOGRAPH LOCATION PLAN
AUBURN DAM

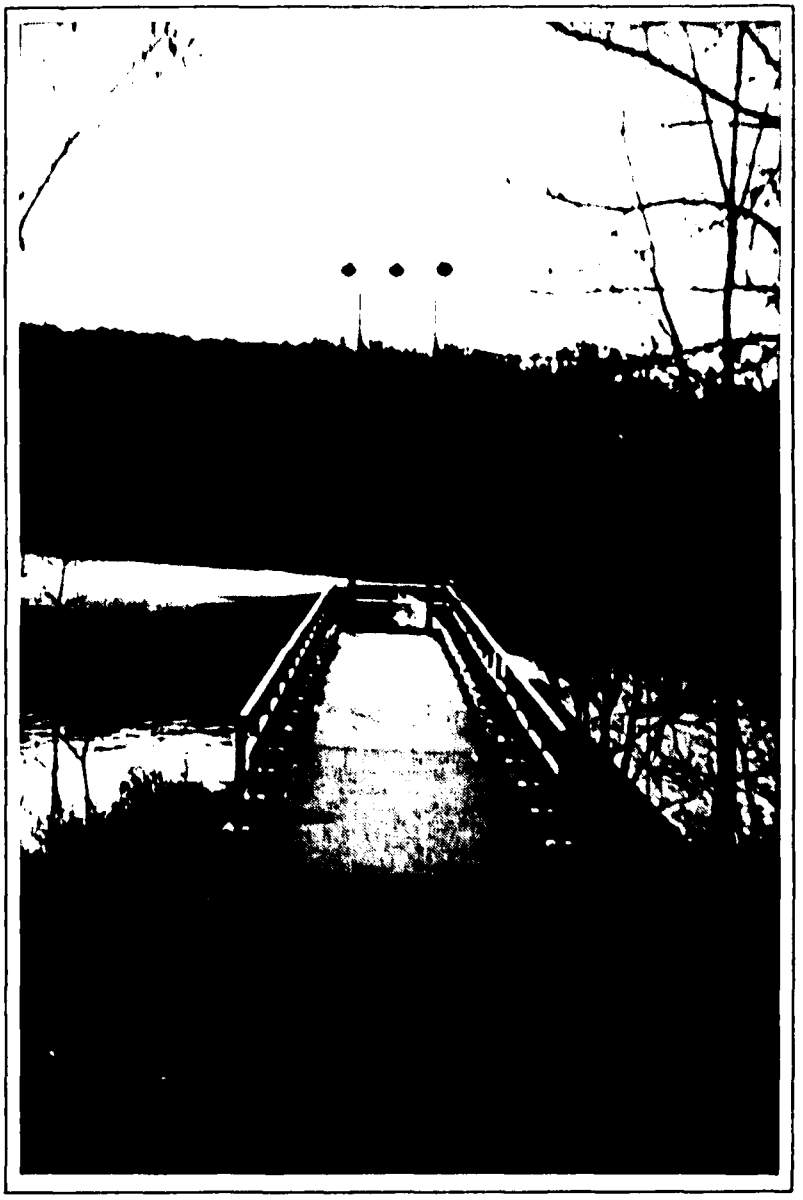
PLATE C-1

DISCHARGE IS UNIFORM OVER
SPILLWAY CREST.

PHOTOGRAPH NO. 1

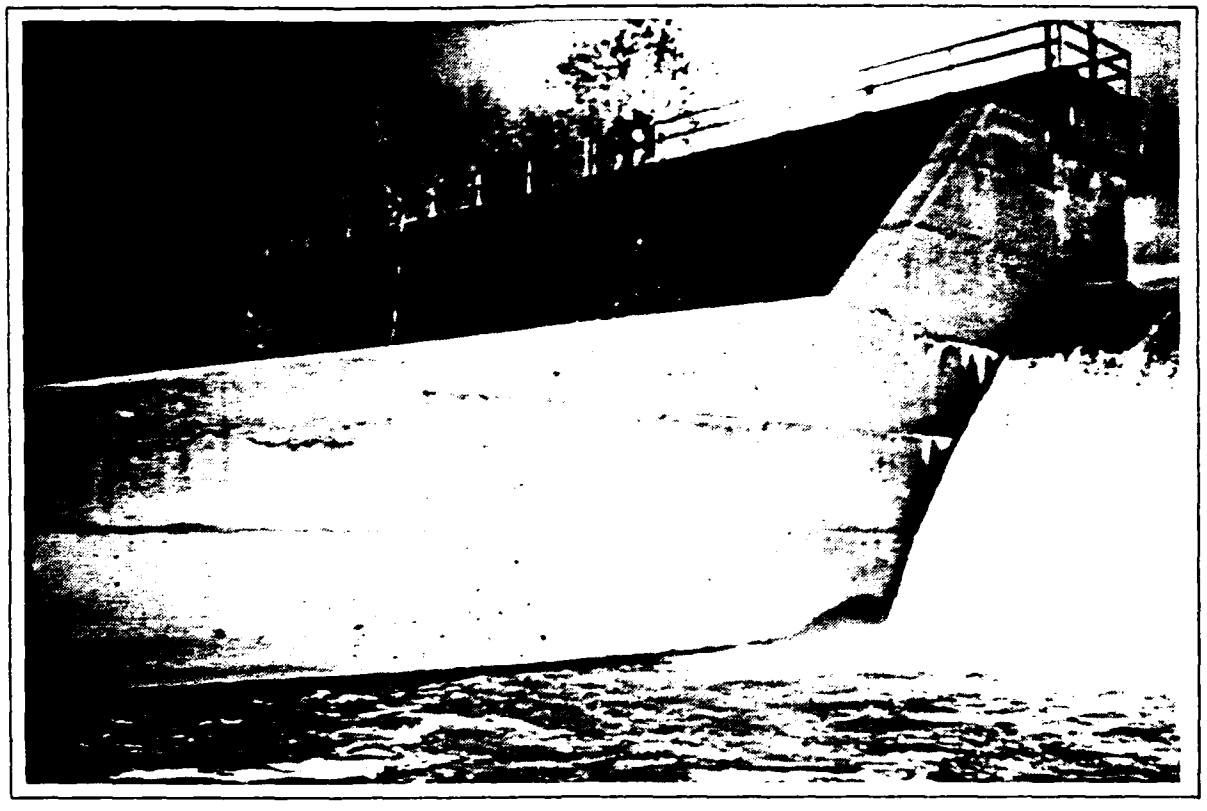
UPSTREAM SIDE, RIGHT NON-OVERFLOW
SECTION.

PHOTOGRAPH NO. 2



ABUTMENT AND TOP OF NON-OVERFLOW SECTION, RIGHT SIDE.

PHOTOGRAPH NO. 3



SPRAY WALL, RIGHT SIDE.

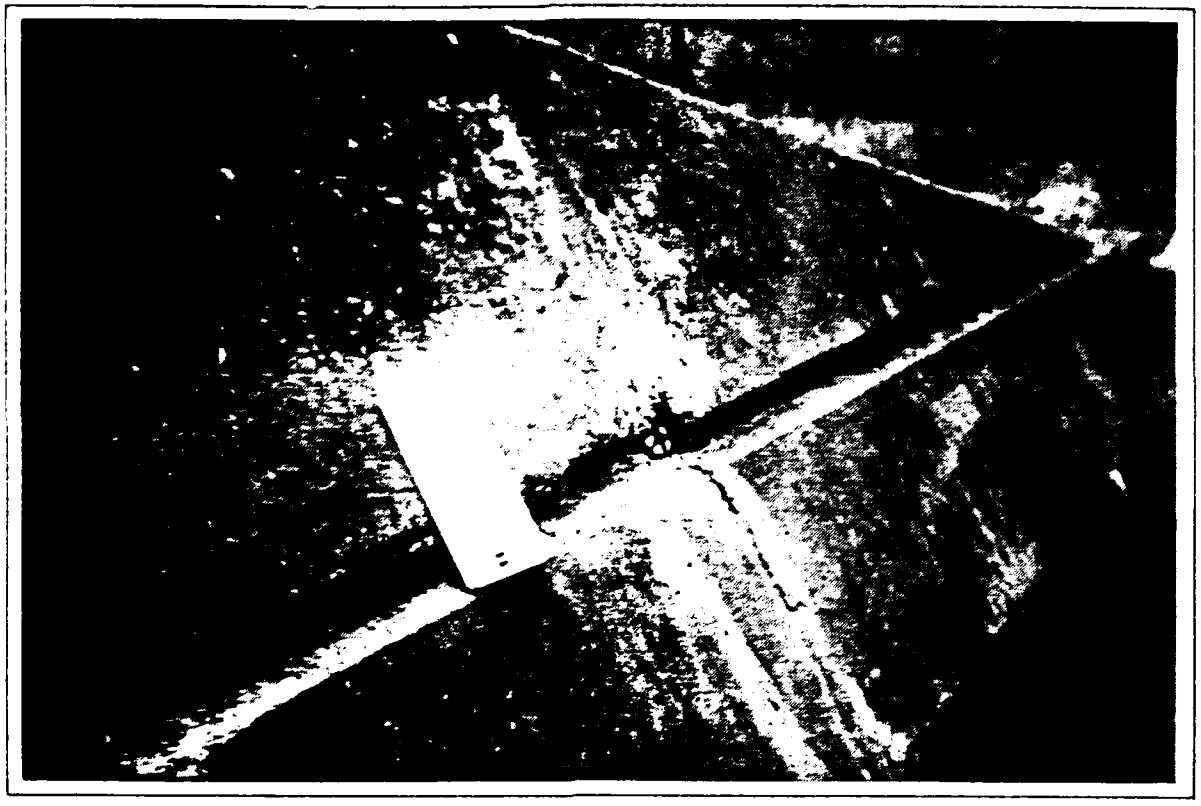
PHOTOGRAPH NO. 4

LEACHATE DEPOSITS ON DOWNSTREAM
SIDE OF RIGHT NON-OVERFLOW
SECTION.

PHOTOGRAPH NO. 5

CLOSE-UP OF LEACHATE
DEPOSIT WHICH IS ABOUT
ONE INCH THICK.

PHOTOGRAPH NO. 6

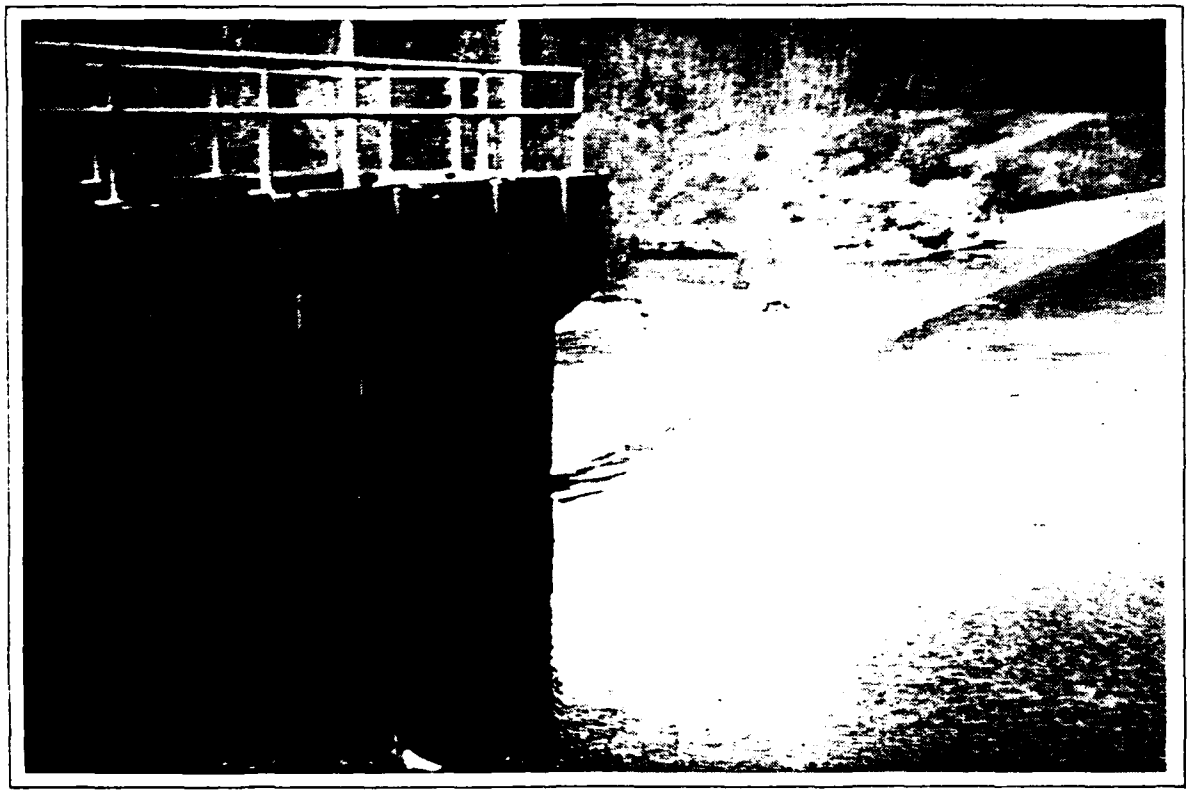


JOINT DETERIORATION ON INSIDE OF
RIGHT SPRAY WALL.

PHOTOGRAPH NO. 7

DETERIORATED PILASTER, UPSTREAM SIDE OF RIGHT NON-OVERFLOW SECTION.

PHOTOGRAPH NO. 8



UPSTREAM SIDE, LEFT NON-OVERFLOW
SECTION

PHOTOGRAPH NO. 9

EMBANKMENT CREST AND TOP OF
LEFT NON-OVERFLOW SECTION.

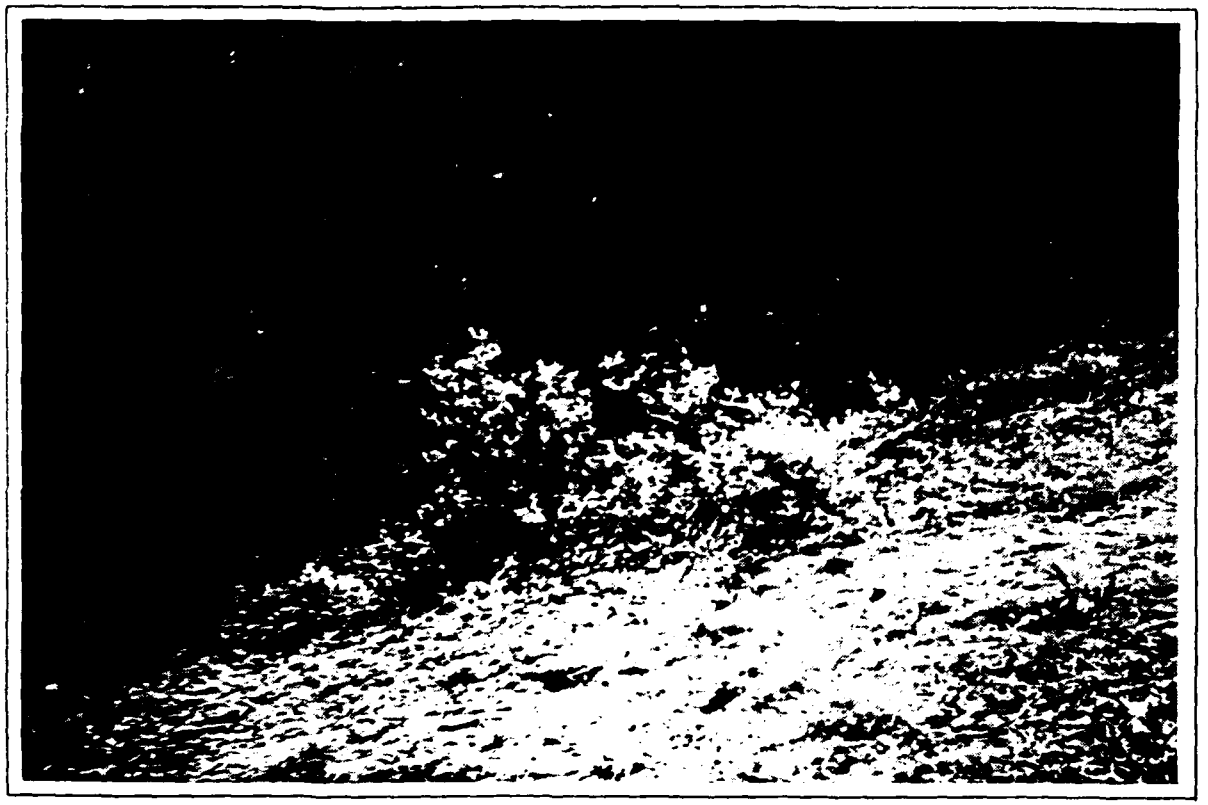
PHOTOGRAPH NO. 10

DOWNSTREAM DERRICK STONE, LEFT SIDE.

PHOTOGRAPH NO. 11

CONTACT BETWEEN DERRICK STONE
AND EMBANKMENT.

PHOTOGRAPH NO. 12



UPSTREAM SIDE OF EMBANKMENT SECTION.

PHOTOGRAPH NO. 13

DOWNSTREAM JUNCTION OF
EMBANKMENT AND LEFT
ABUTMENT.

PHOTOGRAPH NO. 14

MINOR EROSION AT DOWNSTREAM TOE OF
LEFT SPARY WALL.

PHOTOGRAPH NO. 15

DOWNSTREAM RAILROAD BRIDGE.

PHOTOGRAPH NO. 16

DOWNSTREAM DAMAGE CENTER AT
INDUSTRIAL COMPLEX NEAR AUBURN,
PENNSYLVANIA.

PHOTOGRAPH NO. 17

APPENDIX

D

AUBURN DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Large, rolling, 25% developed, coal mining in upper reaches.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *473.0 feet (1900 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *485.0 feet (4500 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: ----

ELEVATION TOP DAM: *485 feet.*

SPILLWAY

a. Elevation *473.0 feet.*

b. Type *Concrete ogee weir.*

c. Width *500 feet.*

d. Length ---

e. Location Spillover *Central portion of structure.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *Non-functional construction diversion conduits with concrete stop logs.*

b. Location

c. Entrance inverts *448.0 feet.*

d. Exit inverts *448.0 feet*

e. Emergency draindown facilities *None*

HYDROMETEOROLOGICAL GAGES:

a. Type *Two reporting National Weather Service Stations within the watershed.*

b. Location

c. Records *National Weather Service.*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

AUBURN DAM
HYDROLOGIC AND HYDRAULIC
BASE DATA

DRAINAGE AREA:(1) 16? square miles.

PROBABLE MAXIMUM PRECIPITATION (PMP)
FOR 10 SQ. MILES IN 24 HOURS:(2) 23.? inches.

ADJUSTMENT FACTORS FOR DRAINAGE AREA (%):(3)

Zone 8

6 Hours 88

12 Hours 93

24 Hours 108

48 Hours 117

SNYDER HYDROGRAPH PARAMETERS:(4)

Zone 8

C_p, C_t ?.??, ?.??

L(5) ?? miles

Lca (6) ?? miles

$tp=C_t\ (L \cdot Lca)^{0.3}$?.??

SPILLWAY CAPACITY AT MAXIMUM
WATER LEVEL(7) 52??? cfs

---

(1) Measured from USGS maps, 1:250,000 scale.
(2) Hydrometerological Report No. 33, Figure 1.
(3) Hydrometerological Report No. 33, Figure 2.
(4) Information received from Corps of Engineers, Baltimore District.
(5) Length of longest water course from outlet to basin divide, measured from USGS maps.
(6) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(7) See Sheet 11 of this Appendix.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

Classification (Ref. - Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "High" as there would be loss of life in the event of sudden failure of the dam.

2. The size classification is "Intermediate" based on its 51 ft. height and 4500 Ac-ft storage capacity.

3. The spillway design flood, based on size and hazard classification, is the Probable Maximum Flood (PMF).

Hydrology and Hydraulic Analysis

1. Design/Evaluation Data. No original design data was available. The "Final Report of Schuylkill River Engineers" lists the spillway capacity as 25,000 cfs with a design head of 12 ft. In 1951 the State estimated the spillway capacity as 79,000 cfs with a weir coefficient of 3.8.

2. Evaluation of Structure

Rainfall and Snyder's hydrograph parameters are shown on sheet 2. The presence of upstream dams has been conservatively neglected.

Elevation - Storage Data, shown on sheet 8

normal pool	473	186 Ac	- design value
	480	215 Ac	} measured from
	500	370 Ac	USGS map

Elevation - Discharge Data, shown on sheet 8

Shape of weir conforms to H_o (design head) = 12 ft. (Ref. Design of Small Dams, USBR, 2nd ed., p. 378)

P (height of weir) = 10 ft. a minimum value from design drawing

$P/H_o = 10/12 = 0.833$

$C = 3.87$

W.S.	H	H/Ho	C/Co	C	L	Q	
473	0					0	
474	1	0.08	0.81	3.13	500	1567	✓
475	2	0.17	0.84	3.25		4597	✓
476	3	0.25	0.86	3.33		8647	✓
478	5	0.42	0.90	3.48		19,470	✓
480	7	0.58	0.93	3.60		33,328	✓
483	10	0.83	0.98	3.79		59,966	✓
485	12	1.00	1.00	3.87		80,436	✓
486	13	1.08	1.0	3.91		91,604	✓
491	18	1.50	1.06	4.10		156,637	✓

The above assumes the weir is not submerged at high flows. Spillway flows are routed down stream (thru a cross section taken from USGS map) to estimate the likelihood of weir submergence.

3. Spillway Adequacy

As the spillway discharges more than 0.5PMF but less than 1.0 PMF without overtopping the embankment, the spillway is rated as "Inadequate" but not "Seriously Inadequate".

```
1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
 **********************************

 RUN  DATE* 80/05/17.
      TIME* 07.04.39.
```

AUBURN DAM
NAT ID NO. PA 00670 DER NO. 54-163
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	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= 4 LRTIO= 1

RTIOS= .50 .80 .90 1.00

SHEET 6 OF 11

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	157.00	0.00	157.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.00	85.00	93.00	103.00	117.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .877

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	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 7.65 CP= .40 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 81 END-OF-PERIOD ORDINATES, LAG= 7.69 HOURS, CP= .40 VOL= 1.00

216.	812.	1664.	2669.	3691.	4539.	5114.	5330.	5153.	4809.
4488.	4189.	3909.	3649.	3405.	3178.	2966.	2768.	2583.	2411.
2250.	2100.	1960.	1829.	1707.	1593.	1487.	1388.	1295.	1209.
1128.	1053.	982.	917.	856.	799.	745.	696.	649.	606.
565.	528.	493.	460.	429.	400.	374.	349.	325.	304.
283.	265.	247.	230.	215.	201.	187.	175.	163.	152.
142.	133.	124.	116.	108.	101.	94.	88.	82.	76.
71.	66.	62.	58.	54.	50.	47.	44.	41.	38.
36.									

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	23.61	21.06	2.54	2136057.
										(600.)	(535.)	(65.)	(60486.40)

SHEET 7 OF 11

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-473.	-1

STAGE	473.00	474.00	475.00	476.00	478.00	480.00	483.00	485.00	486.00	491.00
FLOW	0.00	1567.00	4597.00	8647.00	19470.00	33328.00	59966.00	80436.00	91604.00	156637.00
SURFACE AREA=		186.	215.	390.						
CAPACITY=		0.	1402.	7366.						
ELEVATION=		473.	480.	500.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
473.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
485.2	0.0	0.0	0.

CREST LENGTH	0.	250.	320.
AT OR BELOW ELEVATION	485.2	486.3	490.0

SHEET 8 OF 11

HYDROGRAPH ROUTING

DOWNSTREAM SECTION

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0250	.0250	.0250	445.0	480.0	200.	.00100

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 480.00 450.00 460.00 490.00 450.00 495.00 445.00 635.00 445.00
640.00 450.00 650.00 460.00 700.00 480.00

STORAGE	0.00	1.20	2.43	3.69	5.02	6.43	7.92	9.48	11.12	12.96
	15.18	17.79	20.79	24.17	27.95	32.12	36.68	41.62	46.96	52.69
OUTFLOW	0.00	728.53	2308.33	4557.49	7484.04	11028.03	15184.86	19954.40	25339.76	31073.97
	37832.11	45701.75	54790.17	65215.19	77092.17	90532.00	105641.28	122522.68	141275.50	161996.00
STAGE	445.00	446.84	448.68	450.53	452.37	454.21	456.05	457.89	459.74	461.58
	463.42	465.26	467.11	468.95	470.79	472.63	474.47	476.32	478.16	480.00
FLOW	0.00	728.53	2308.33	4557.49	7484.04	11028.03	15184.86	19954.40	25339.76	31073.97
	37832.11	45701.75	54790.17	65215.19	77092.17	90532.00	105641.28	122522.68	141275.50	161996.00

SHEET 9 OF 11

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 .50	RATIO 2 .80	RATIO 3 .90	RATIO 4 1.00
HYDROGRAPH AT	IN	157.00	1	46894.	75031.	84410.	93789.
		(406.63)		(1327.90)(	2124.64)(	2390.22)(	2655.80)(
ROUTED TO	OUT	157.00	1	46623.	74608.	84042.	93408.
		(406.63)		(1320.21)(	2112.67)(	2379.82)(	2645.03)(
ROUTED TO	DS1	157.00	1	46609.	74612.	84044.	93419.
		(406.63)		(1319.82)(	2112.76)(	2379.85)(	2645.33)(

SHEET 10 OF 11

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	473.00	473.00	485.20
STORAGE	0.	0.	2624. Flood water
OUTFLOW	0.	0.	82670. storage only

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
.50	481.50	0.00	1733.	46623.	0.00	47.00	0.00
.80	484.43	0.00	2430.	74608.	0.00	47.00	0.00
.90	485.32	.12	2656.	84042.	2.00	47.00	0.00
1.00	486.12	.92	2863.	93408.	5.00	47.00	0.00

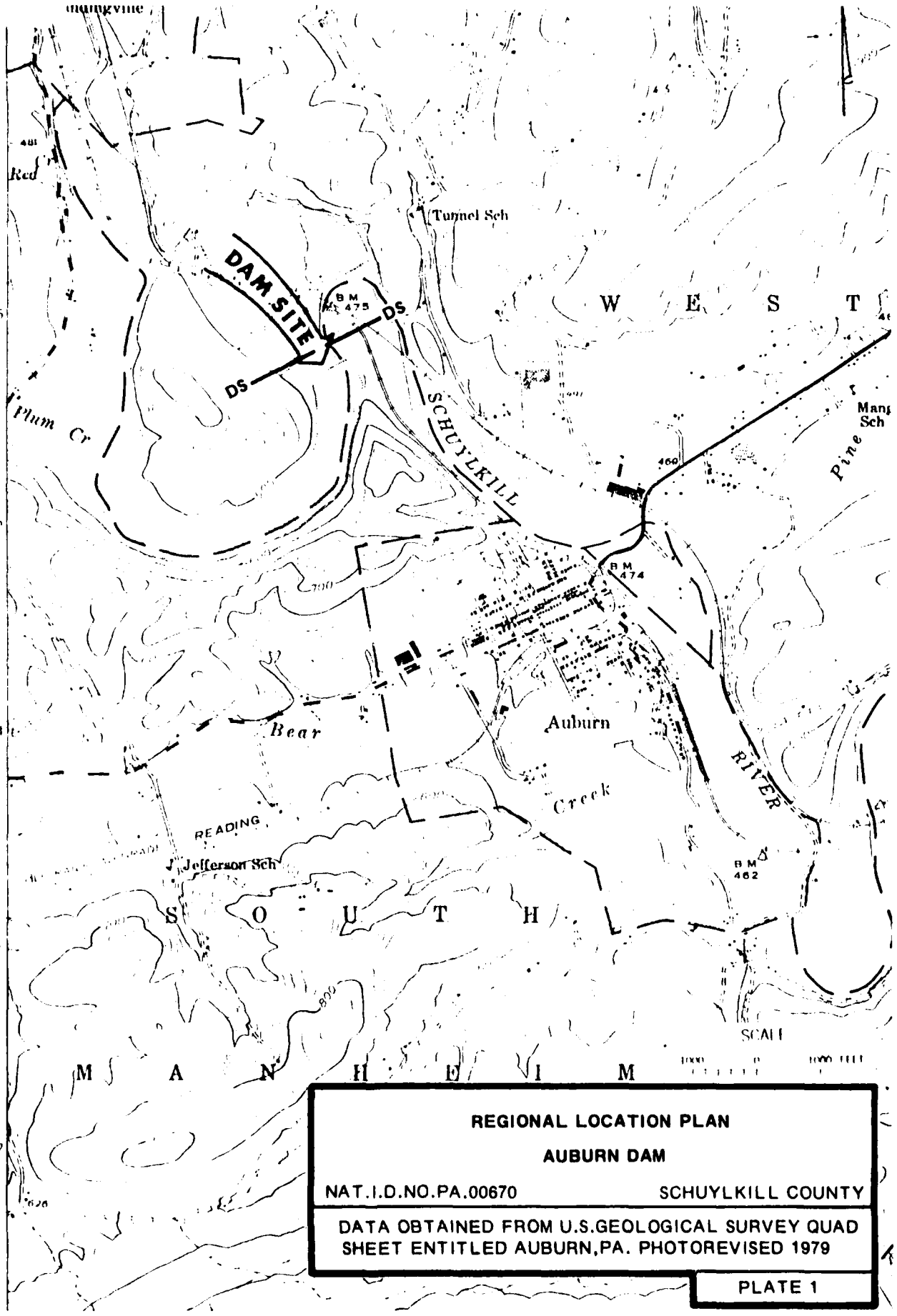
PLAN 1 STATION DS1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	46609.	465.4	47.00
.80	74612.	470.4	47.00
.90	84044.	471.7	47.00
1.00	93419.	473.0	47.00

SHEET 11 OF 11

APPENDIX

E



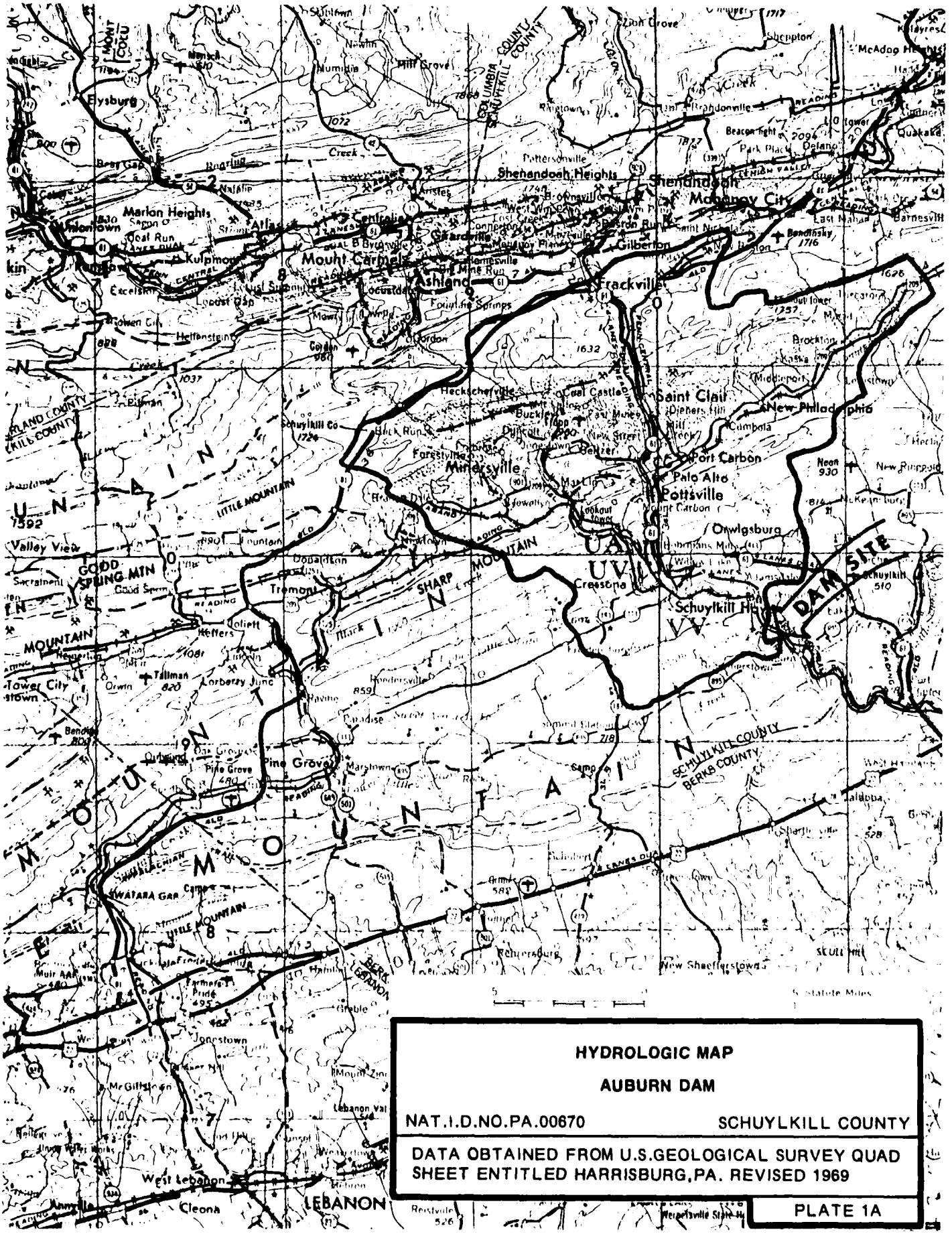
REGIONAL LOCATION PLAN

AUBURN DAM

NAT.I.D.NO.PA.00670 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED AUBURN,PA. PHOTOREVISED 1979

PLATE 1



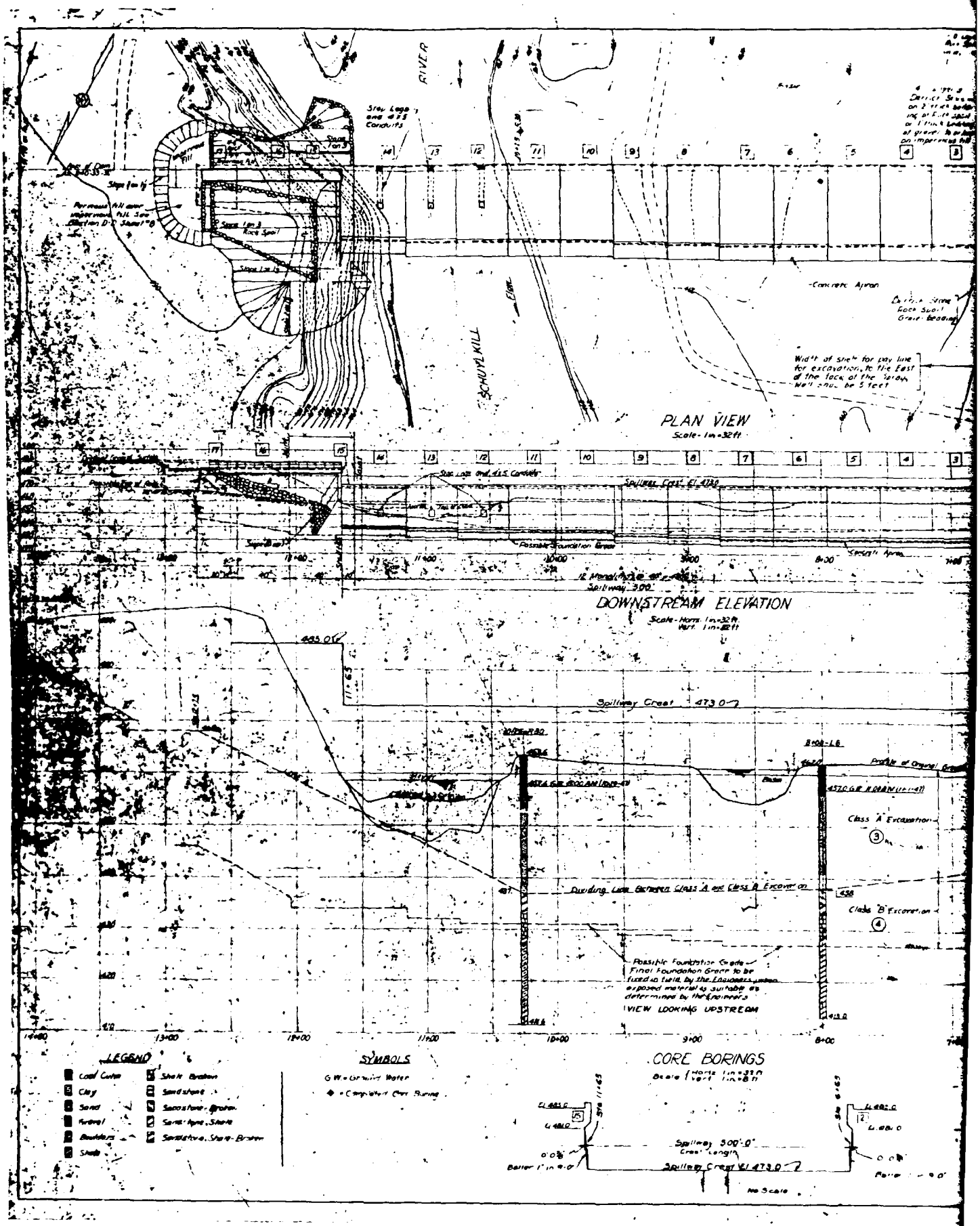
HYDROLOGIC MAP

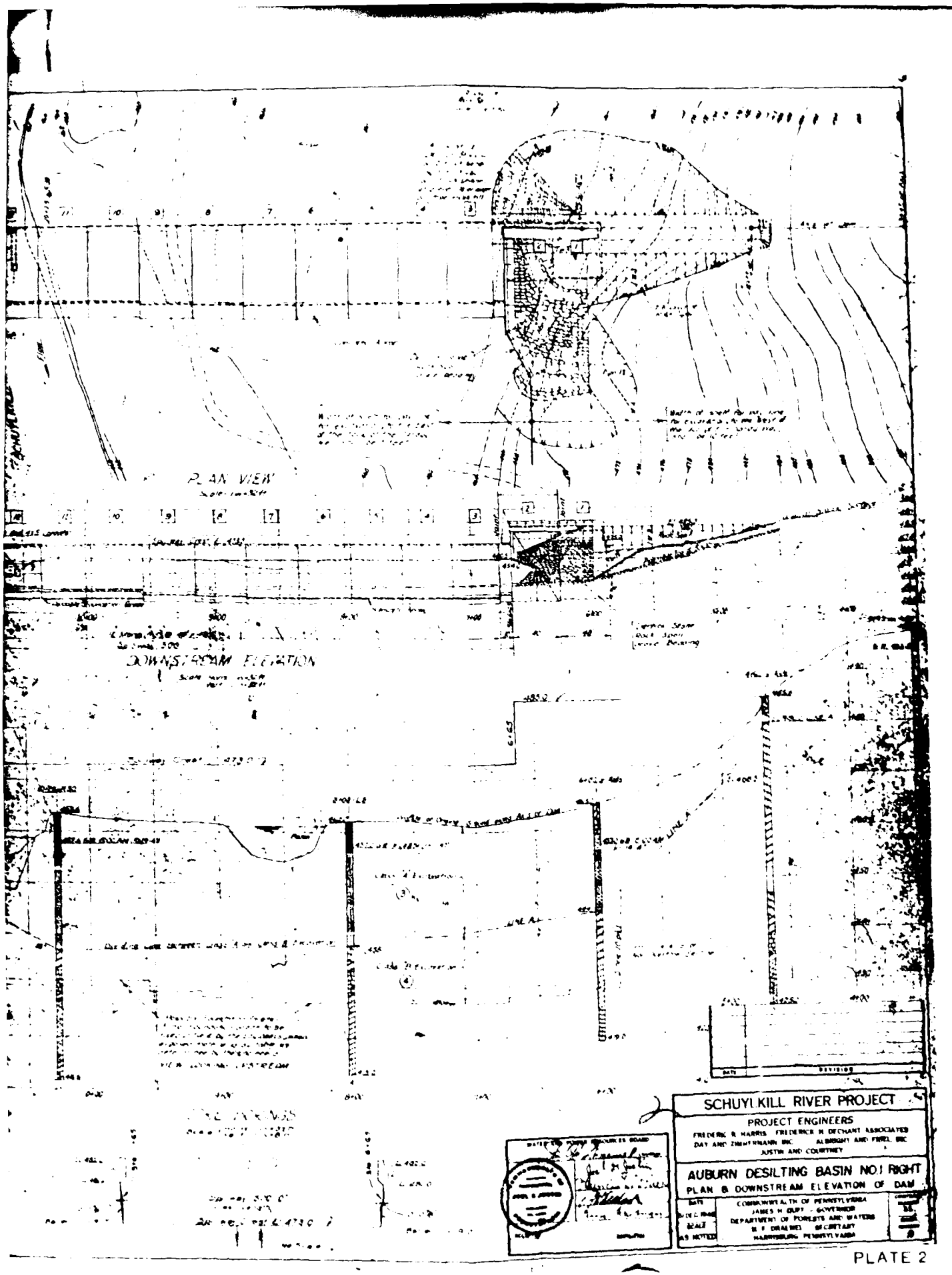
AUBURN DAM

NAT.I.D.NO.PA.00670 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED HARRISBURG,PA. REVISED 1969

PLATE 1A


PLAN VIEW
Scale - 1in = 32ft
SCHUYLKILL RIVER
Concrete Apron
Width of shaft for pay line for excavation, to the East of the face of the Spillway Wall shall be 5 feet
DOWNSTREAM ELEVATION
Scale - Horiz. 1in = 32ft. Vert. 1in = 8ft
Spillway Crest 473.0
Spillway 300'
Class 'A' Excavation
Class 'B' Excavation
Dividing Line Between Class A and Class B Excavation
Possible Foundation Grade
Final Foundation Grade to be fixed in field, by the Engineers, when exposed material is suitable as determined by the Engineers
VIEW LOOKING UPSTREAM
LEGEND
Coal Culm
Clay
Sand
Gravel
Boulders
Shale
Shale Broken
Sandstone
Sandstone Broken
Sand-stone, Shale
Sandstone, Shale-Broken
SYMBOLS
G.W. = Ground Water
CORE BORINGS
Scale (Horiz. 1in = 32ft Vert. 1in = 8ft)
Spillway 300'-0" Crest Length
Spillway Crest El 473.0
No Scale



SCHUYLKILL RIVER PROJECT

PROJECT ENGINEERS

FREDERIC R. HARRIS FREDERICK H. DECHANT ASSOCIATES
DAY AND ZIMMERMANN INC ALBRIGHT AND FIBEL INC
JUSTIN AND COURTNEY

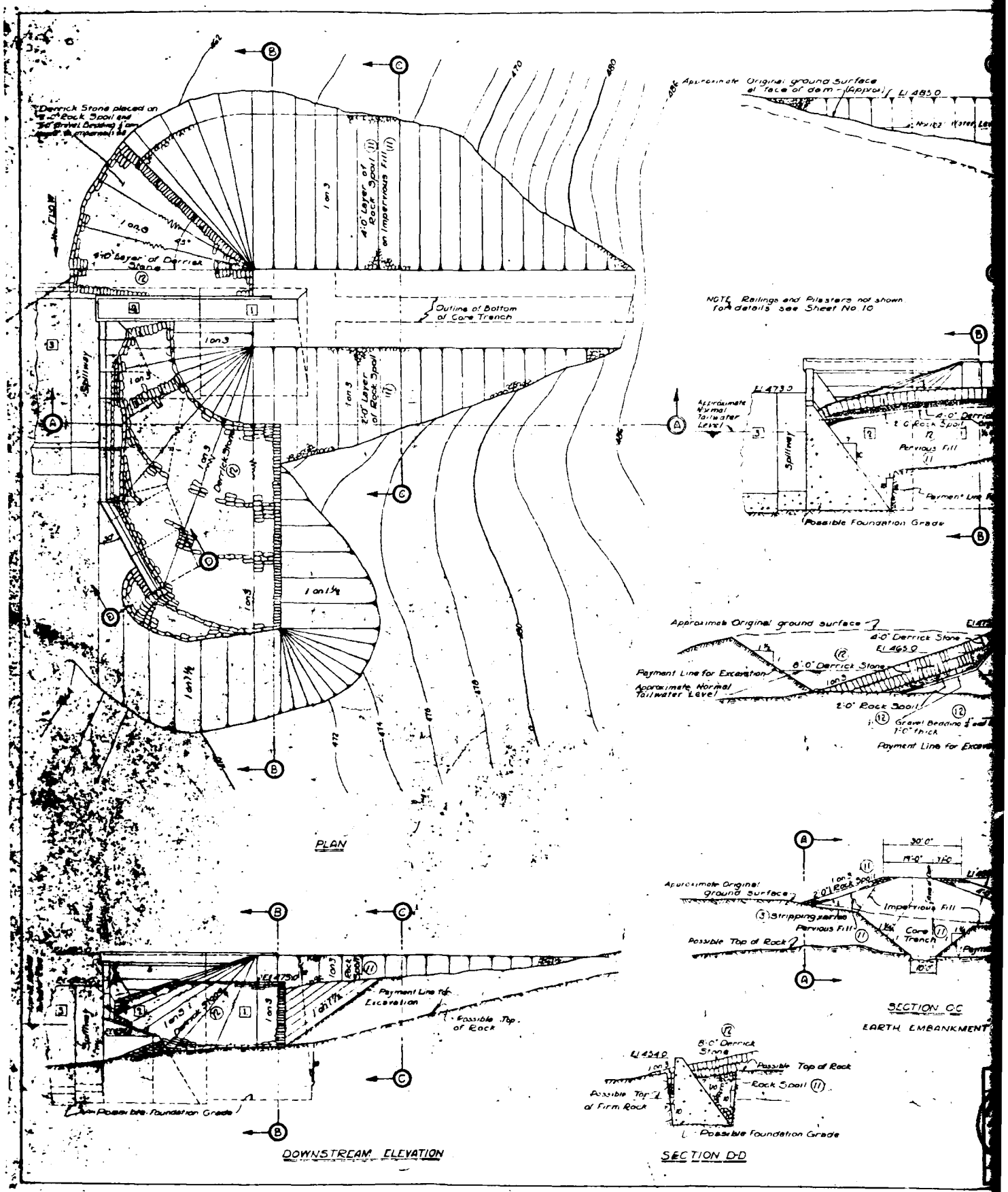
AUBURN DESILTING BASIN NO.1 RIGHT

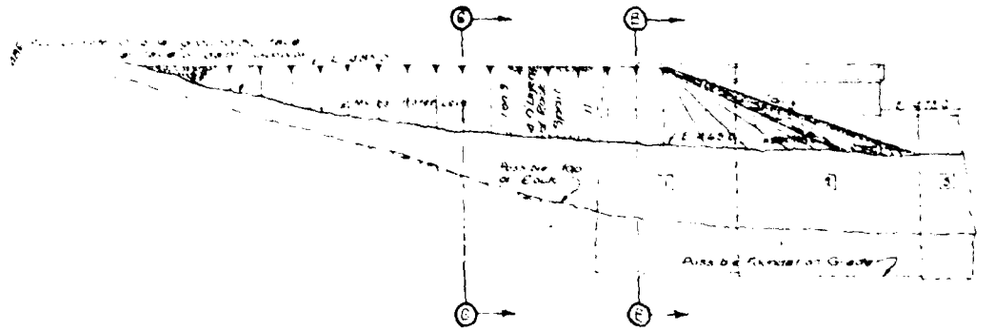
PLAN & DOWNSTREAM ELEVATION OF DAM

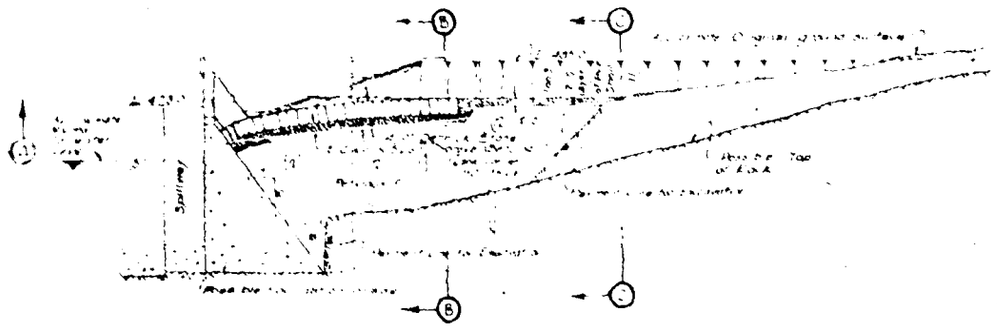
DATE
DECEMBER
SCALE
AS NOTED

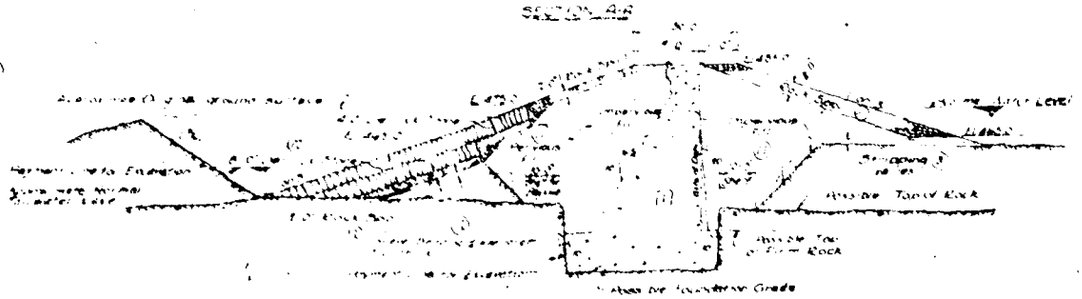
COMMONWEALTH OF PENNSYLVANIA
JAMES H. DUFF - GOVERNOR
DEPARTMENT OF FORESTS AND WATERS
R. F. DRAKER - SECRETARY
HARRISBURG, PENNSYLVANIA

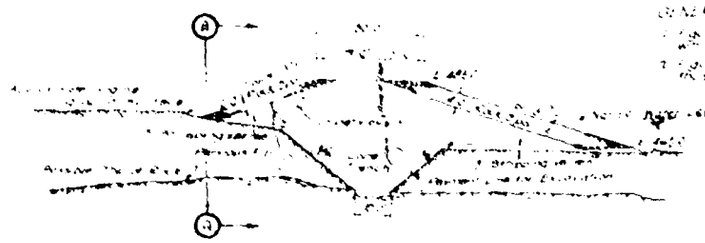
PLATE 2

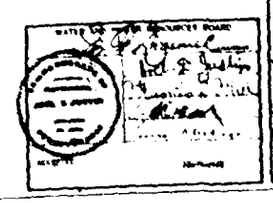

Derrick Stone placed on 4'-0" Rock Spoil and 3rd Gravel Bedding Layer
4'-0" Layer of Rock Spoil (11) on Impervious Fill (11)
1 on 3
1 on 2
45°
4'-0" Layer of Derrick Stone (12)
Outline of Bottom of Core Trench
Spillway
2'-0" Layer of Rock Spoil (11)
Derrick Stone (12)
1 on 1¼
PLAN
Approximate Original ground surface at face of dam - (Approx.)
EL 485.0
NOTE Railings and Pilasters not shown for details see Sheet No 10
EL 473.0
Approximate Normal Tailwater Level
4'-0" Derrick Stone
2'-0" Rock Spoil
Pervious Fill (11)
Payment Line for Excavation
Possible Foundation Grade
Approximate Original ground surface
EL 465.0
8'-0" Derrick Stone (12)
2'-0" Rock Spoil (11)
Gravel Bedding 1'-0" thick (12)
Payment Line for Excavation
30'-0"
19'-0"
Approximate Original ground surface
2'-0" Rock Spoil (11)
Impervious Fill (11)
Stripping as req'd (3)
Pervious Fill (11)
Core Trench (11)
Possible Top of Rock
SECTION CC
EARTH EMBANKMENT
EL 479.0
Payment Line for Excavation
Possible Top of Rock
Possible Foundation Grade
DOWNSTREAM ELEVATION
8'-0" Derrick Stone (12)
EL 454.0
Possible Top of Rock
Rock Spoil (11)
Possible Top of Firm Rock
Possible Foundation Grade
SECTION D-D





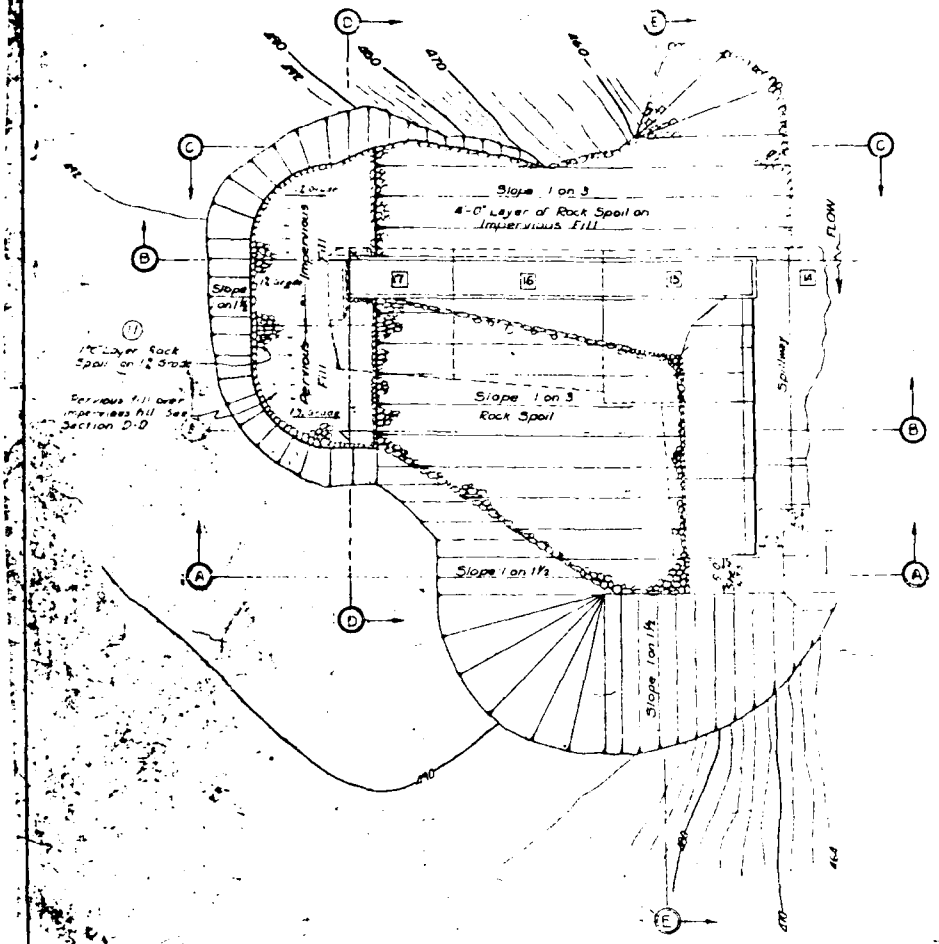






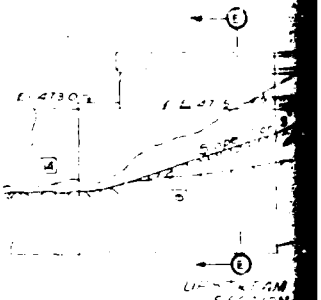
SCHUYLKILL RIVER PROJECT		
PROJECT ENGINEERS FREDERIC R HARRIS FREDERICK N DECHANT ASSOCIATES DAY AND ZIMMERMANN INC ALBRIGHT AND FRIEL INC JUSTIN AND COURTNEY		
AUBURN DESILTING BASIN NO.I RIGHT LEFT ABUTMENT & EMBANKMET OF DAM		
DATE DECEMBER	COMMONWEALTH OF PENNSYLVANIA JAMES H DUFF — GOVERNOR DEPARTMENT OF FORESTS AND WATERS M F DREXEL — SECRETARY HARRISBURG PENNSYLVANIA	CONTRACT NUMBER 38
SCALE 1"=16'		SHEET NUMBER 7

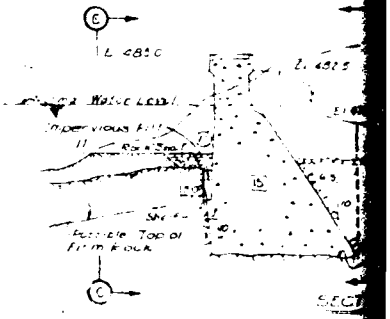
PLATE 3

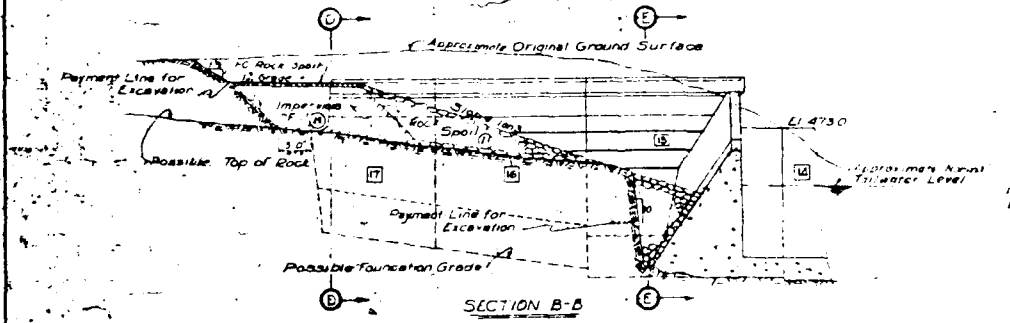


PLAN.

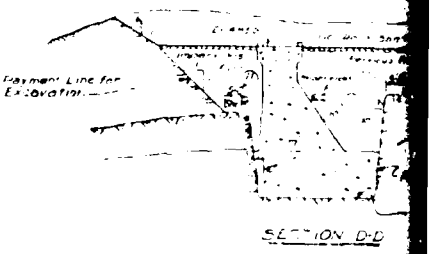
NOTE :- Railing and Pilasters not shown See Sheet No 12 for details

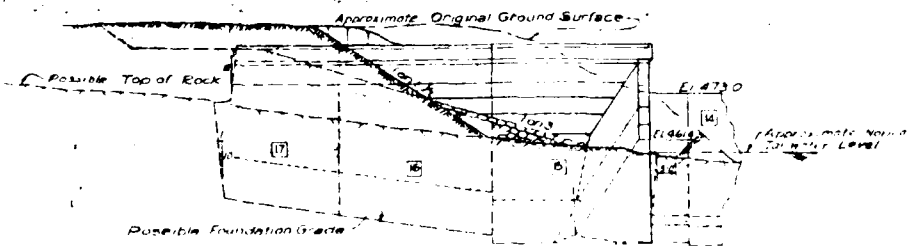






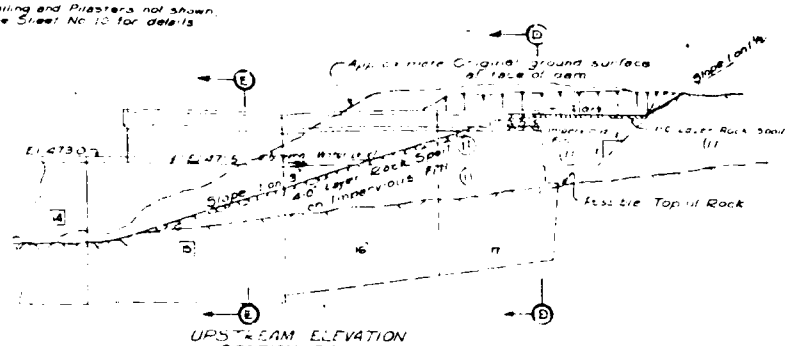
SECTION B-B



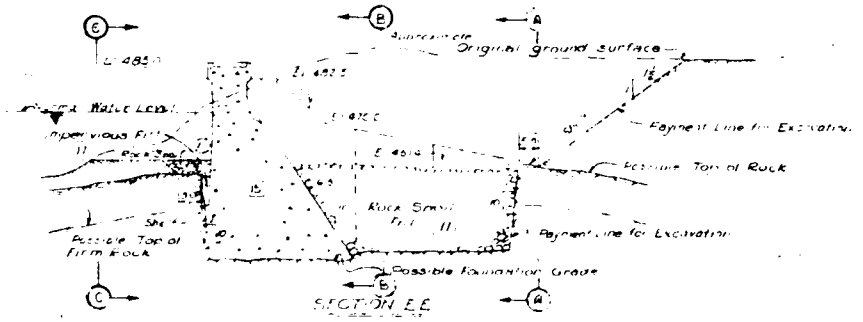


DOWNSTREAM ELEVATION
SECTION A-A

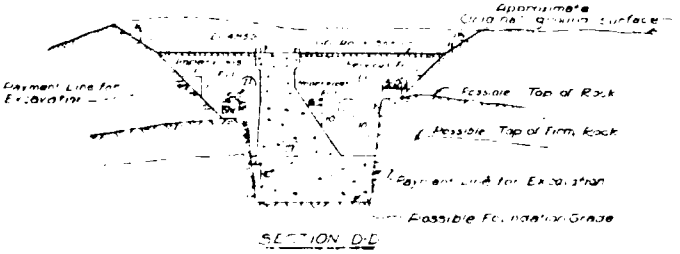
NOTE :- Railing and Pilasters not shown. See Sheet No 10 for details



UPSTREAM ELEVATION
SECTION C-C



SECTION E-E



SECTION D-D

GENERAL NOTES:

1. Figures in circles indicate item numbers under which payment will be made, thus (4).
2. Figures in squares indicate monolith numbers, thus [1]
3. N.T.S. Not to scale

DATE	REVISION

WATER AND POWER RESOURCES BOARD

SCHUYLKILL RIVER PROJECT

PROJECT ENGINEERS
FREDERIC R HARRIS FREDERICK H DECHANT ASSOCIATES
DAY AND ZIMMERMANN INC ALBRIGHT AND FRIEL INC
JUSTIN AND COURTNEY

AUBURN DESILTING BASIN NO.1 RIGHT
RIGHT ABUTMENT OF DAM

DATE	COMMONWEALTH OF PENNSYLVANIA	CONTRACT NUMBER
5 DEC 1960	JAMES H DUFF — GOVERNOR	35
SCALE	DEPARTMENT OF FORESTS AND WATERS	SHEET NUMBER
1" = 16'	M F DRAKNEL — SECRETARY	8
	HARRISBURG, PENNSYLVANIA	

PLATE 4

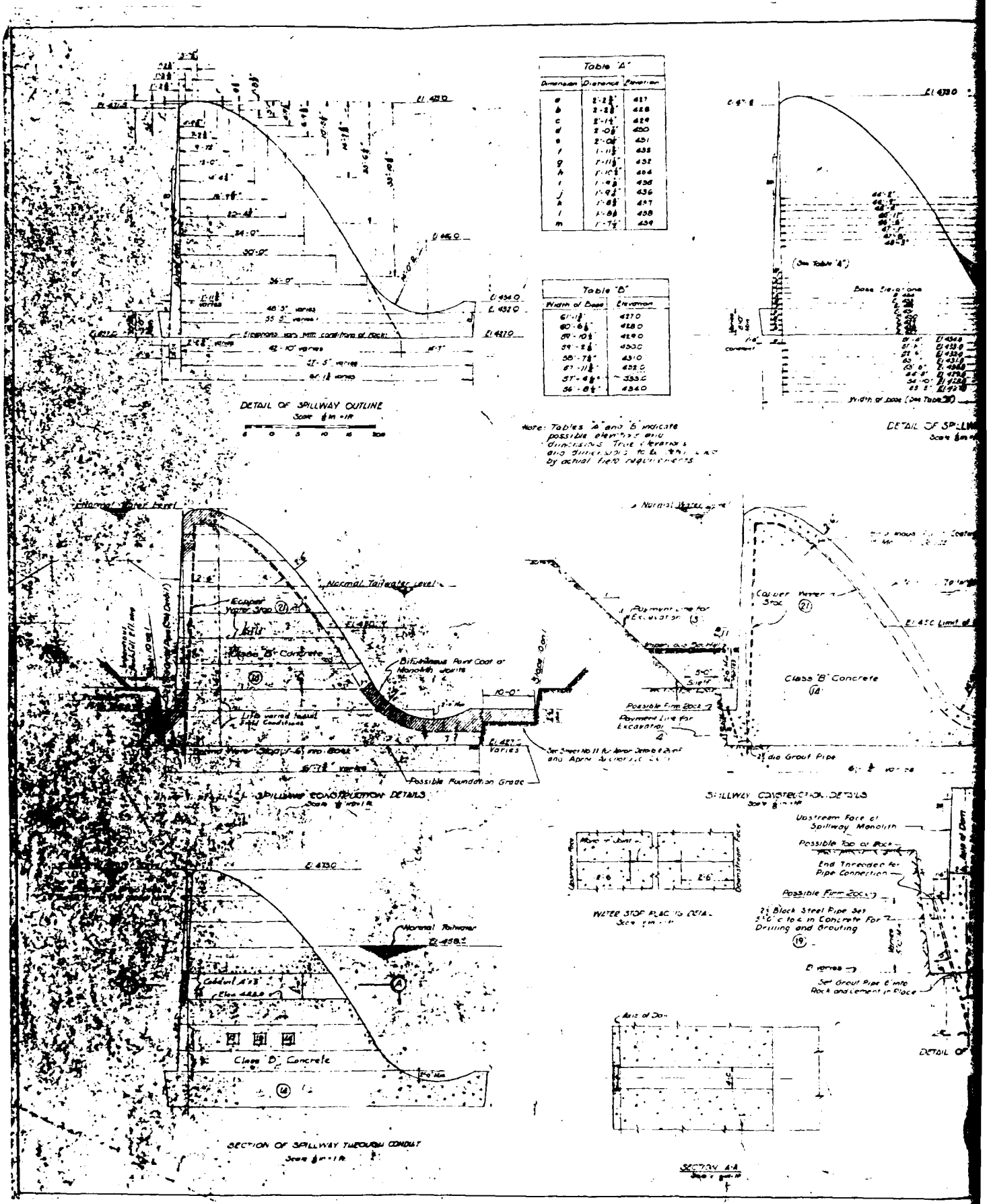
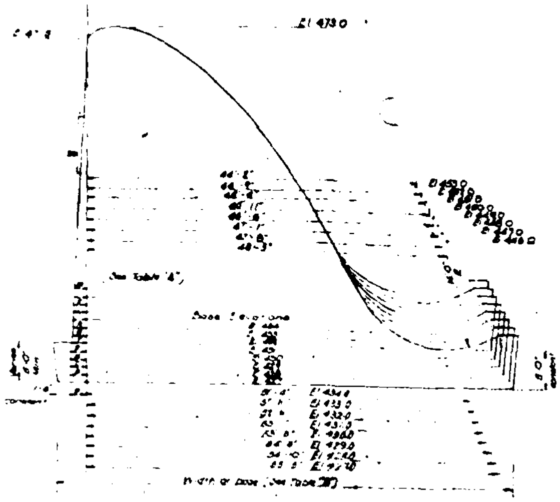
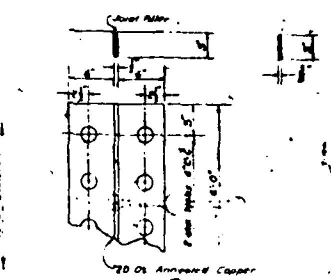


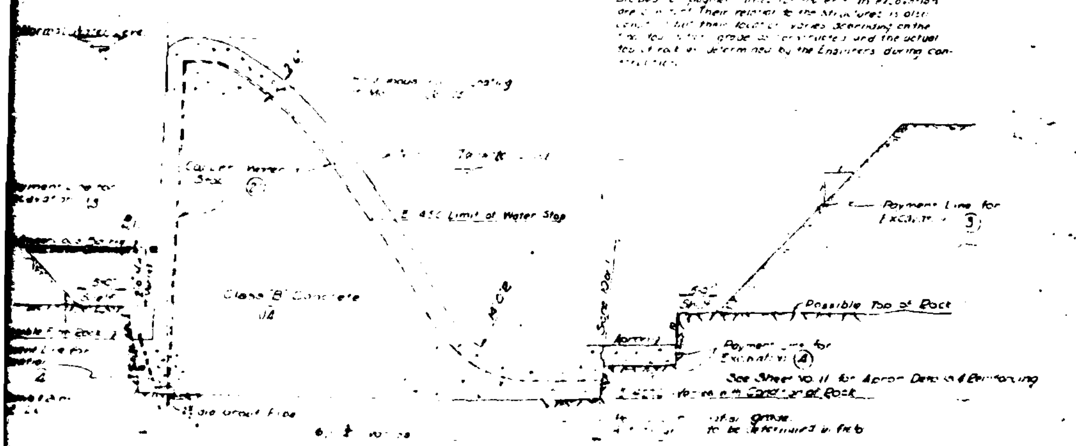
Table 'A'
Table 'B'
DETAIL OF SPILLWAY OUTLINE
Note: Tables 'A' and 'B' indicate possible elevations and dimensions. True elevations and dimensions to be determined by actual field requirements
DETAIL OF SPILLWAY
Normal Tailwater Level
Class 'B' Concrete
Bituminous Paint Coat at Monolith Joints
Possible Foundation Grade
SPILLWAY CONSTRUCTION DETAILS
Payment Line for Excavation
Possible Firm Rock
2" dia Grout Pipe
SPILLWAY CONSTRUCTION DETAILS
Upstream Face of Spillway Monolith
Possible Top of Rock
End Threaded for Pipe Connection
Possible Firm Rock
WATER STOP PLACING DETAIL
Normal Tailwater
Class 'D' Concrete
SECTION OF SPILLWAY THROUGH CONDUIT
SECTION A-A
DETAIL O



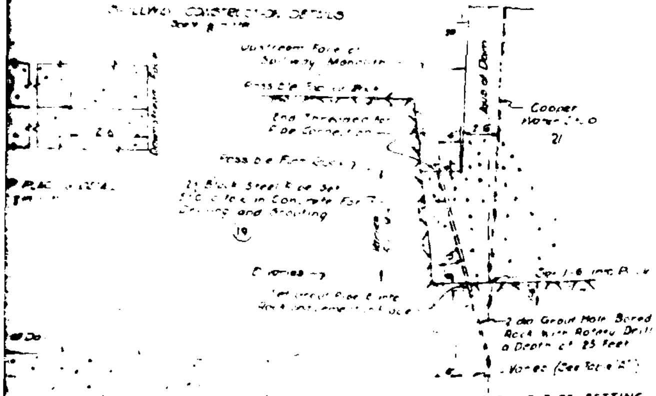
DETAIL OF SPILLWAY OUTLINE
Scale 1/8 in = 1 ft



(21)
DETAIL OF COPPER WATER STOP
AND JOINT FILLER.
Scale 1 1/2 in = 1 ft



SPILLWAY CONSTRUCTION DETAILS



DETAIL OF GROUT PIPE SETTING
Scale 1/2 in = 1 ft

GENERAL NOTES:-

1 Figures in circles indicate the item number under which payment will be made.

2 Figures in squares indicate monolith numbers thus [2].

3 All exposed corners of concrete shall be chamfered 1 1/2 inches except on curbing.

4 All reinforcing bars shall be deformed. All bends shall be made around an 8" diameter pin. Lap all bars 40 diameters unless otherwise noted.

5 The clear distance of bars from face of concrete shall be 4 inches unless otherwise noted.

6 Reinforcing steel will be paid for at the contract price Item No 17.

DATE	REVISION

WATER AND POWER RESOURCES BOARD
CHAIRMAN
ACCEPTED
CONTRACTOR

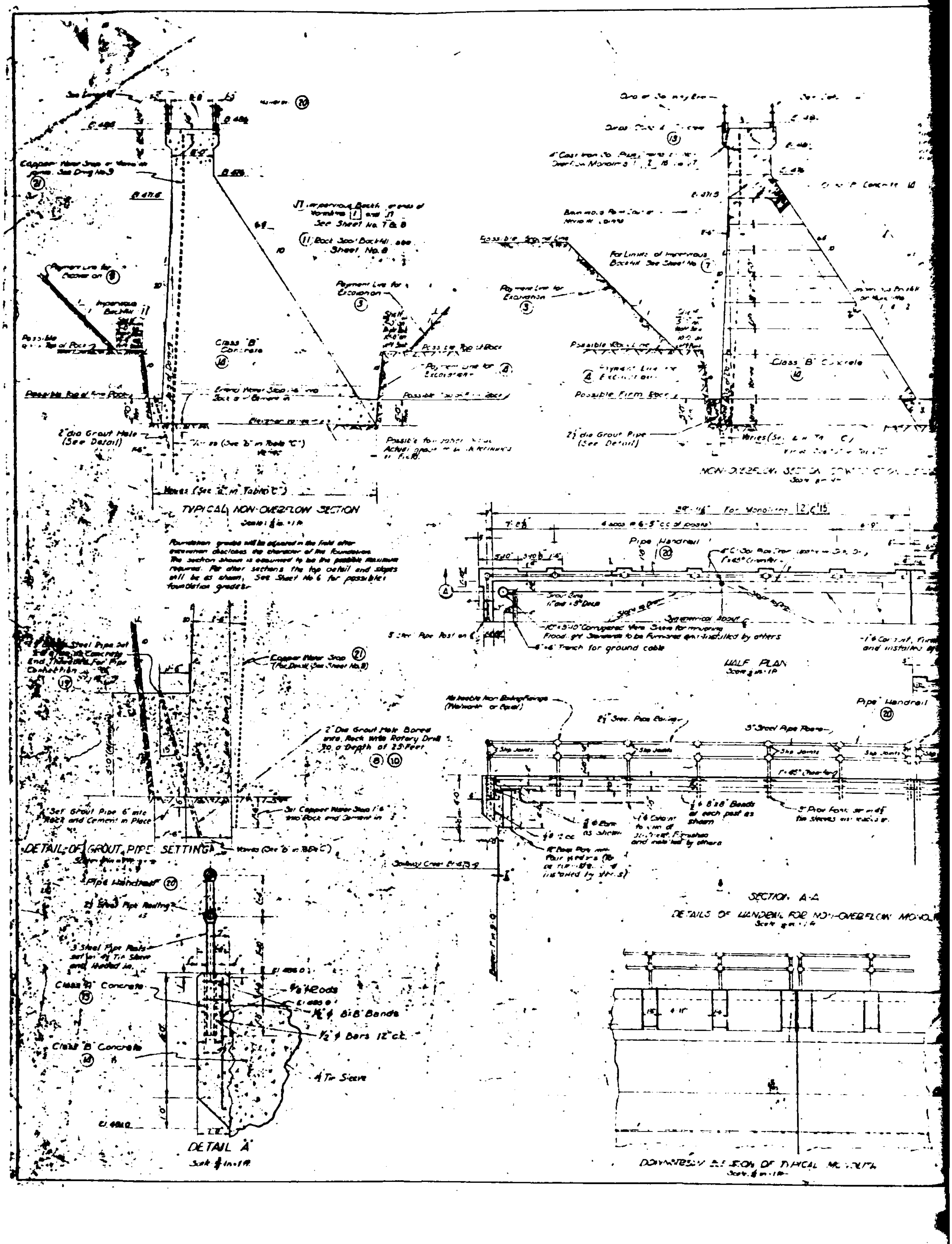
SCHUYLKILL RIVER PROJECT

PROJECT ENGINEERS
FREDERIC R HARRIS · FREDERICK H DECHANT ASSOCIATES
DAY AND ZIMMERMANN INC. · ALBRIGHT AND FRIEL INC.
JUSTIN AND COURTNEY

AUBURN DESILTING BASIN NO.1 RIGHT
OVERFLOW SECTION OF DAM

DATE		CONTRACT NUMBER
31 DEC 1948	COMMONWEALTH OF PENNSYLVANIA JAMES H DUFF – GOVERNOR DEPARTMENT OF FORESTS AND WATERS M F DRAEMEL – SECRETARY HARRISBURG PENNSYLVANIA	35
SCALE 1/2" = 1'-0"		SHEET NUMBER 9

PLATE 5



TYPICAL NON-OVERFLOW SECTION
Class "B" Concrete
Possible Firm Rock
2" dia Grout Hole (See Detail)
Foundation grades will be adjusted in the field after excavation discloses the character of the foundation. The section shown is assumed to be the possible maximum required. For other sections the top detail and slopes will be as shown. See Sheet No 6 for possible foundation grades.
Copper Water Stop
2" Dia Grout Hole Bored into Rock With Rotary Drill to a Depth of 25 Feet
Set Grout Pipe 6" into Rock and Cement in Place
DETAIL OF GROUT PIPE SETTING
Pipe Handrail
Class "B" Concrete
1/2" ∅ Bars 12" c.c.
4" Tin Sleeve
DETAIL "A"
Class "B" Concrete
Possible Firm Rock
2 1/2" dia Grout Pipe (See Detail)
Pipe Handrail
Trench for ground cable
HALF PLAN
Pipe Handrail
3" Steel Pipe Posts
SECTION A-A
DOWNSTREAM ELEVATION OF TYPICAL MONOLITH

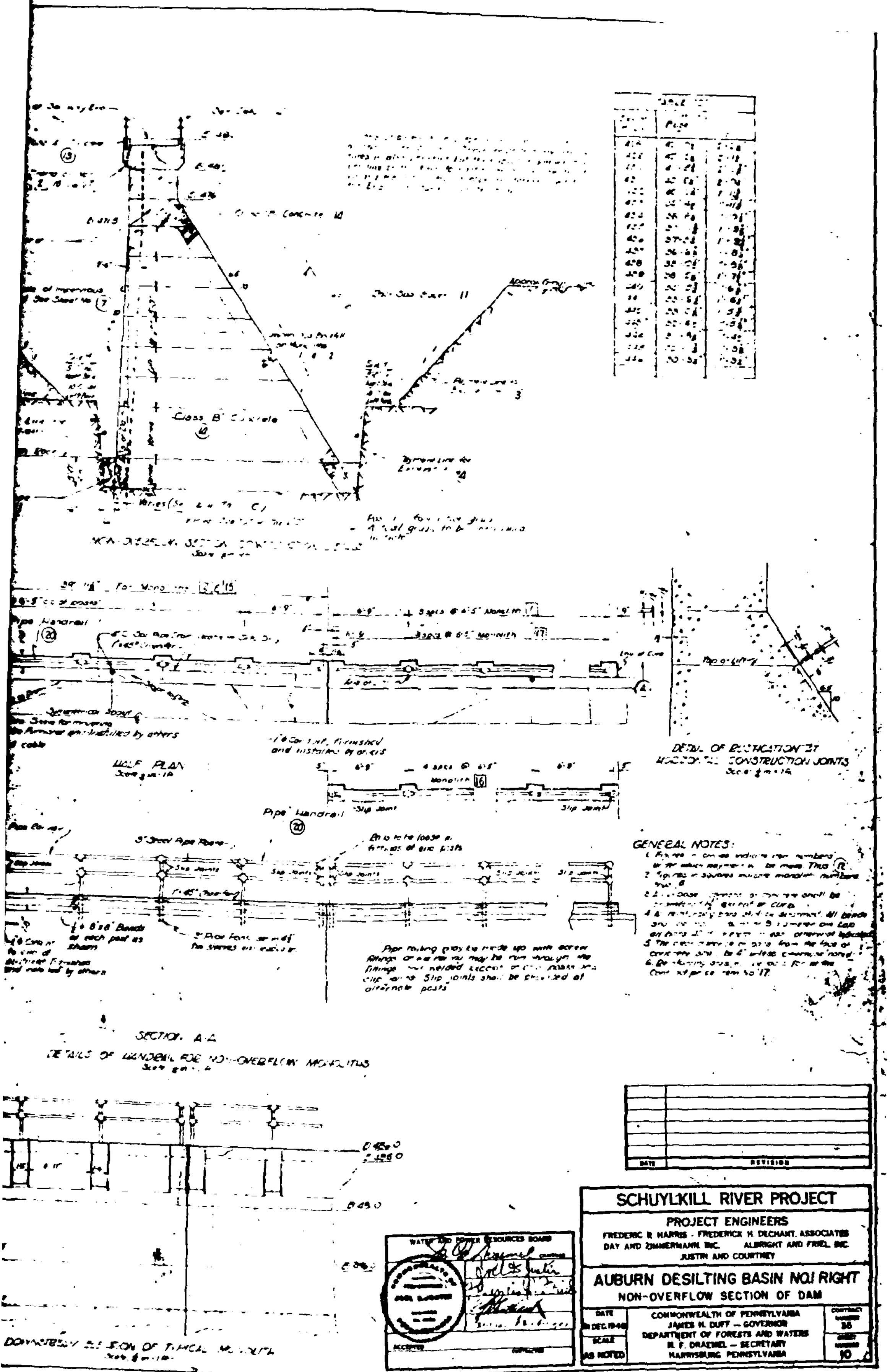

SCHUYLKILL RIVER PROJECT
PROJECT ENGINEERS
FREDERIC R. HARRIS - FREDERICK H. DECHANT, ASSOCIATES
DAY AND ZIMMERMANN INC. ALBRIGHT AND FRIEL INC.
JUSTIN AND COURTNEY
AUBURN DESILTING BASIN NO.1 RIGHT
NON-OVERFLOW SECTION OF DAM
COMMONWEALTH OF PENNSYLVANIA
JAMES H. DUFF — GOVERNOR
DEPARTMENT OF FORESTS AND WATERS
M. F. DRAEMEL — SECRETARY
HARRISBURG PENNSYLVANIA
SCALE
AS NOTED
GENERAL NOTES:
HALF PLAN
SECTION A-A
Class B Concrete
Pipe Handrail

PLATE 6

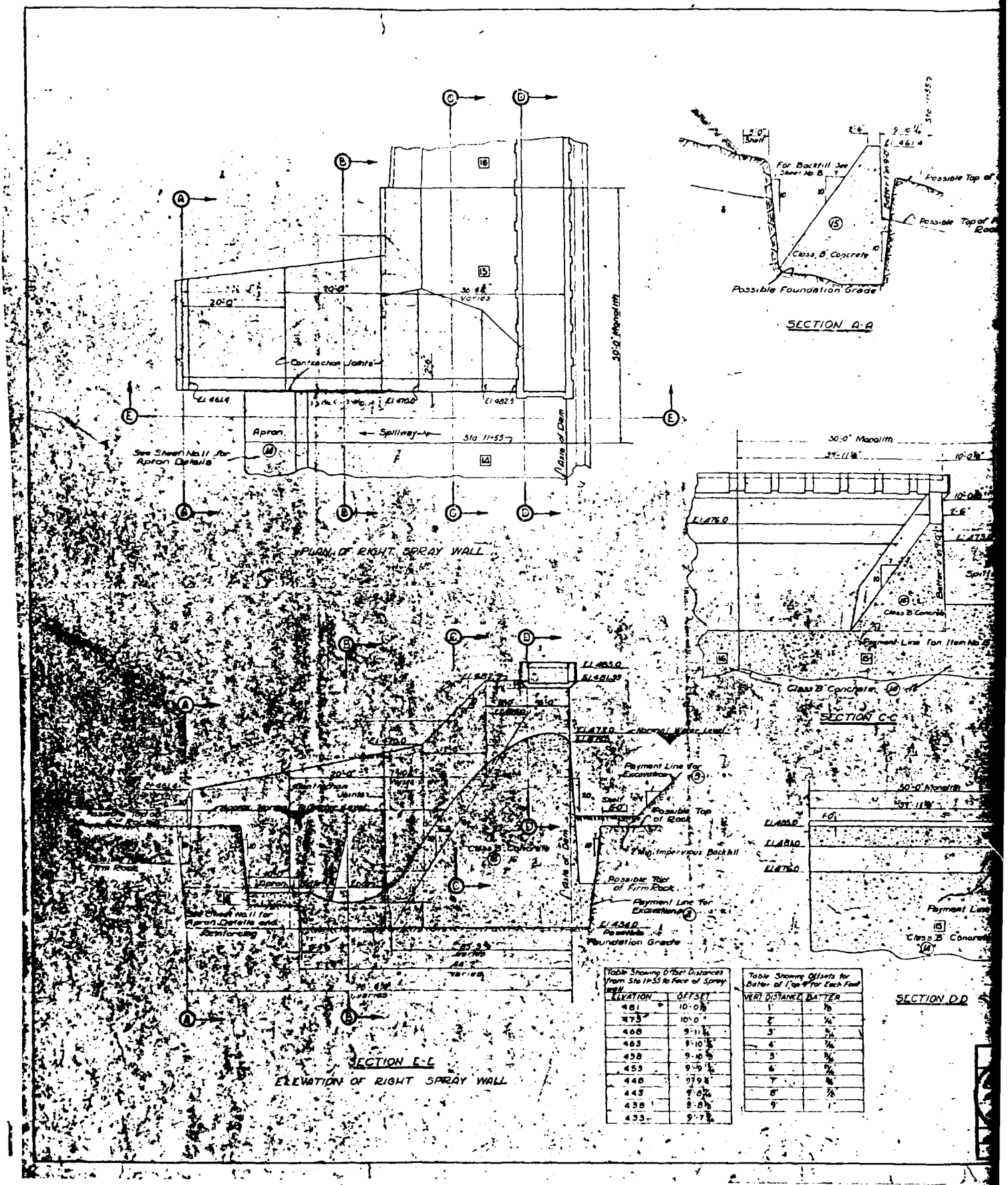
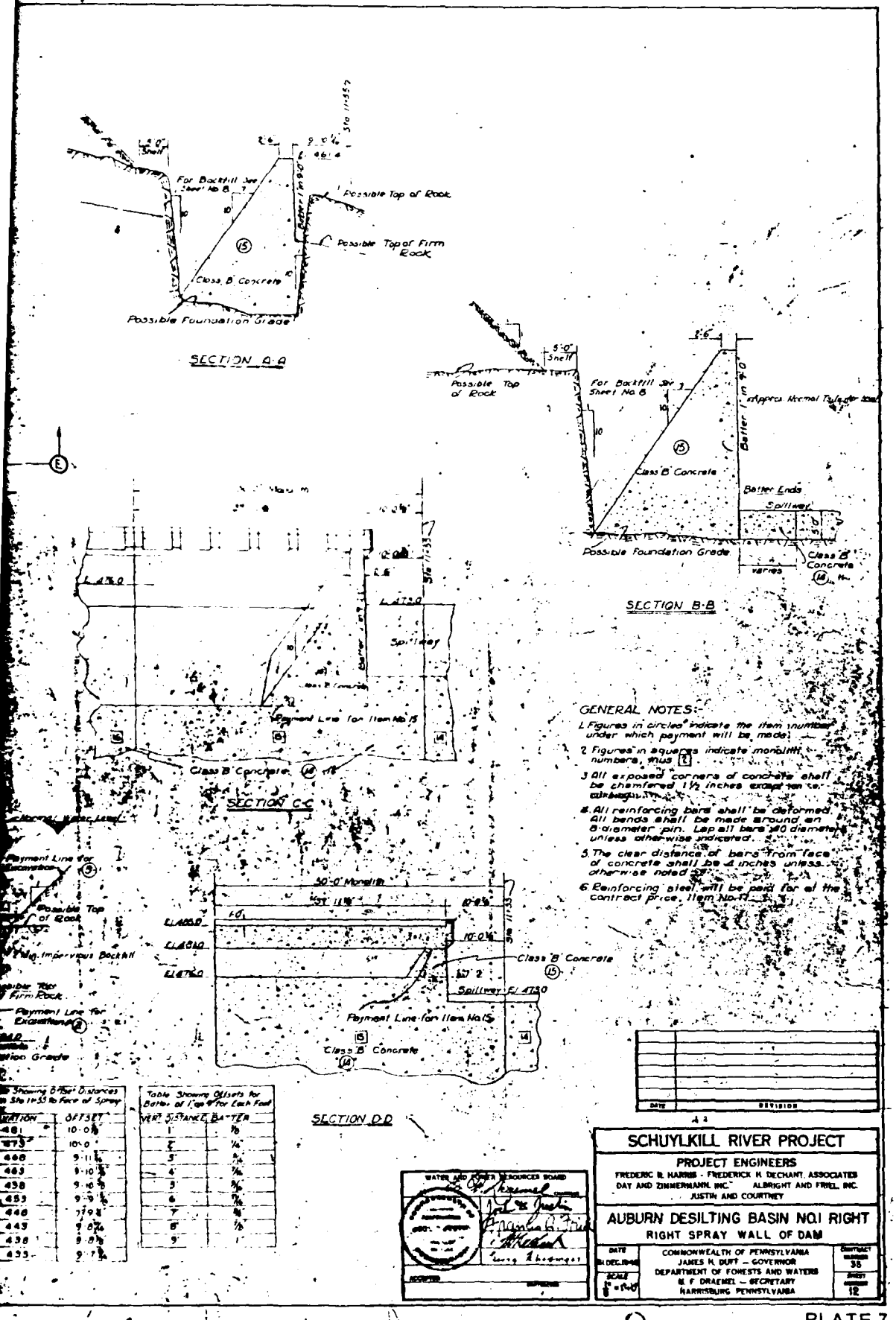


Table Showing Offset Distances from Sta 11+55 to Face of Spray Wall

ELEVATION	OFFSET
481	10'-0"
473	10'-0"
468	9'-11"
463	9'-10"
458	9'-9"
453	9'-9"
448	9'-9"
443	9'-8"
438	9'-8"
433	9'-7"

Table Showing Offsets for Batter of 1"on 4" for Each Foot

VERT. DISTANCE	BATTER
1'	1/4
2'	1/2
3'	3/4
4'	1"
5'	1 1/4
6'	1 1/2
7'	1 3/4
8'	2"
9'	2 1/4



GENERAL NOTES:-

1. Figures in circles indicate the item number under which payment will be made.
2. Figures in squares indicate monolith numbers, thus [1].
3. All exposed corners of concrete shall be chamfered 1½ inches except as otherwise indicated.
4. All reinforcing bars shall be deformed. All bends shall be made around an 8-diameter pin. Lap all bars 30 diameters unless otherwise indicated.
5. The clear distance of bars from face of concrete shall be 4 inches unless otherwise noted.
6. Reinforcing steel will be paid for at the contract price, Item No.11.

Table Showing Offsets for Batter of 1 on 0 for Each Foot

VERT. DISTANCE	BATTER
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	1

Table Showing Offsets for Batter of 1 on 0 for Each Foot

STATION	OFFSET
481	10-0
479.5	10-0
468	9-11
469	9-10
458	9-10
459	9-9
448	9-9
449	9-8
438	9-8
439	9-7

DATE	DIVISION

WATER AND POWER RESOURCES BOARD

SCHUYLKILL RIVER PROJECT

PROJECT ENGINEERS

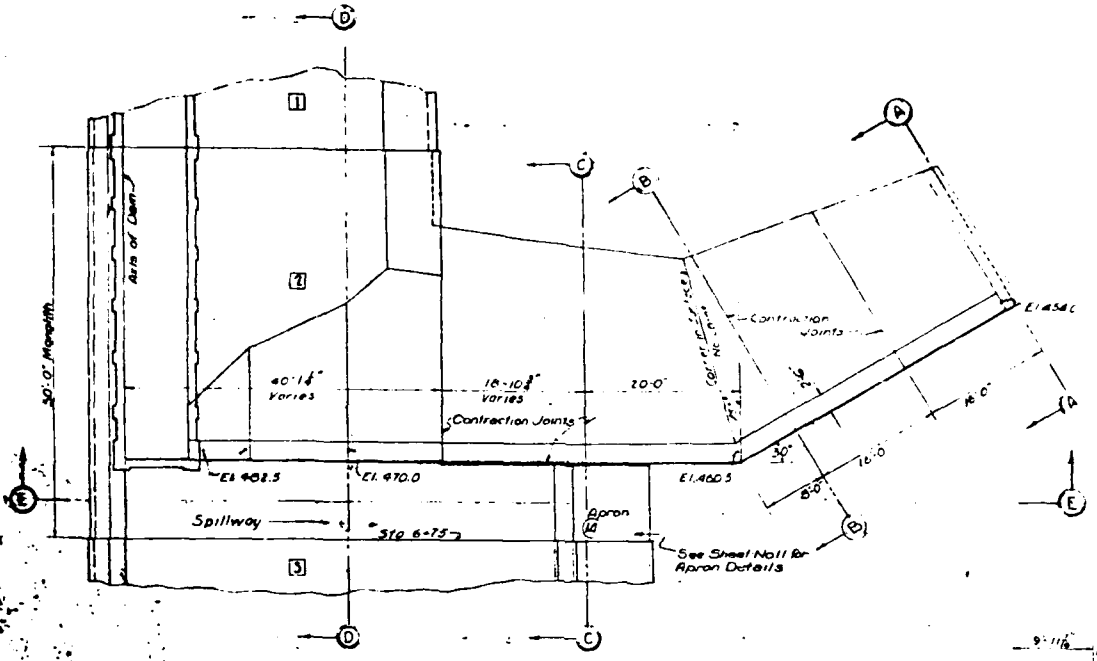
FREDERIC R. HARRIS - FREDERICK H. DECHANT, ASSOCIATES
DAY AND ZIMMERMANN, INC. - ALBRIGHT AND FRIEL, INC.
JUSTIN AND COURTNEY

AUBURN DESILTING BASIN NO.1 RIGHT

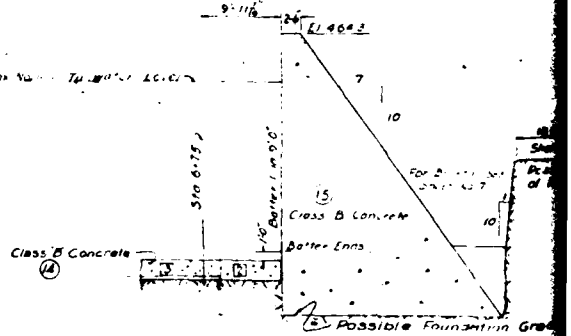
RIGHT SPRAY WALL OF DAM

DATE	COMMONWEALTH OF PENNSYLVANIA	CONTRACT NUMBER
DECEMBER	JAMES H. DUFF — GOVERNOR	35
SCALE	DEPARTMENT OF FORESTS AND WATERS	SHEET NUMBER
1" = 5'-0"	M. F. DRAEBEL — SECRETARY	12
	HARRISBURG, PENNSYLVANIA	

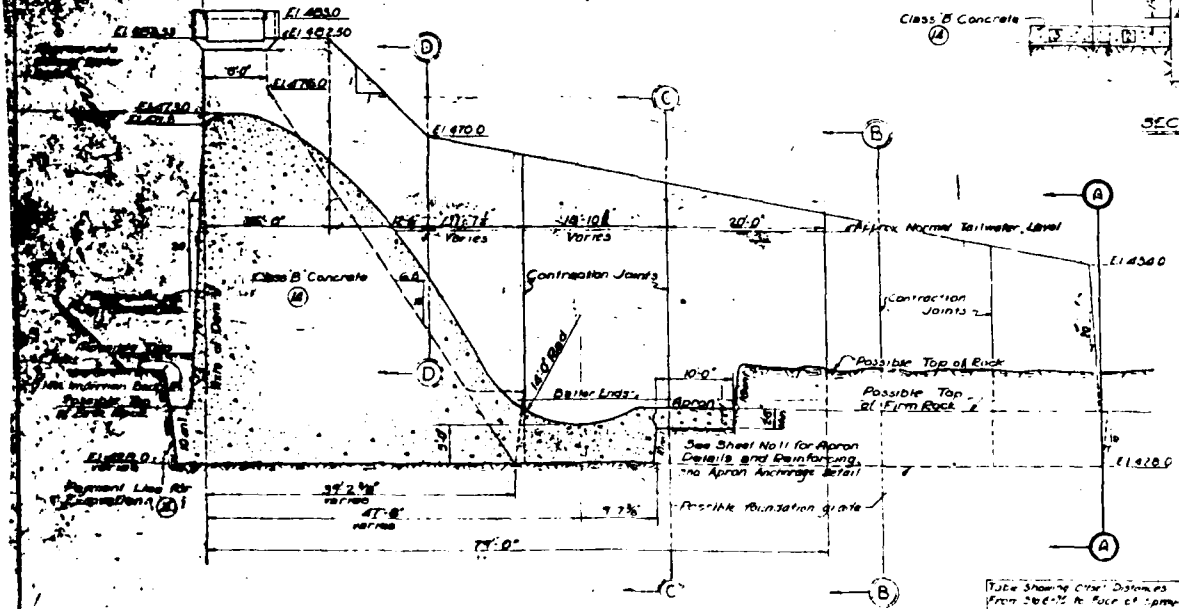
PLATE 7



PLAN OF LEFT SPRAY WALL

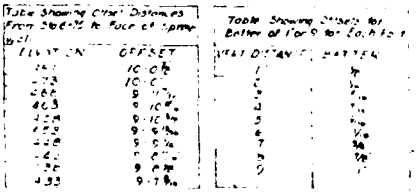


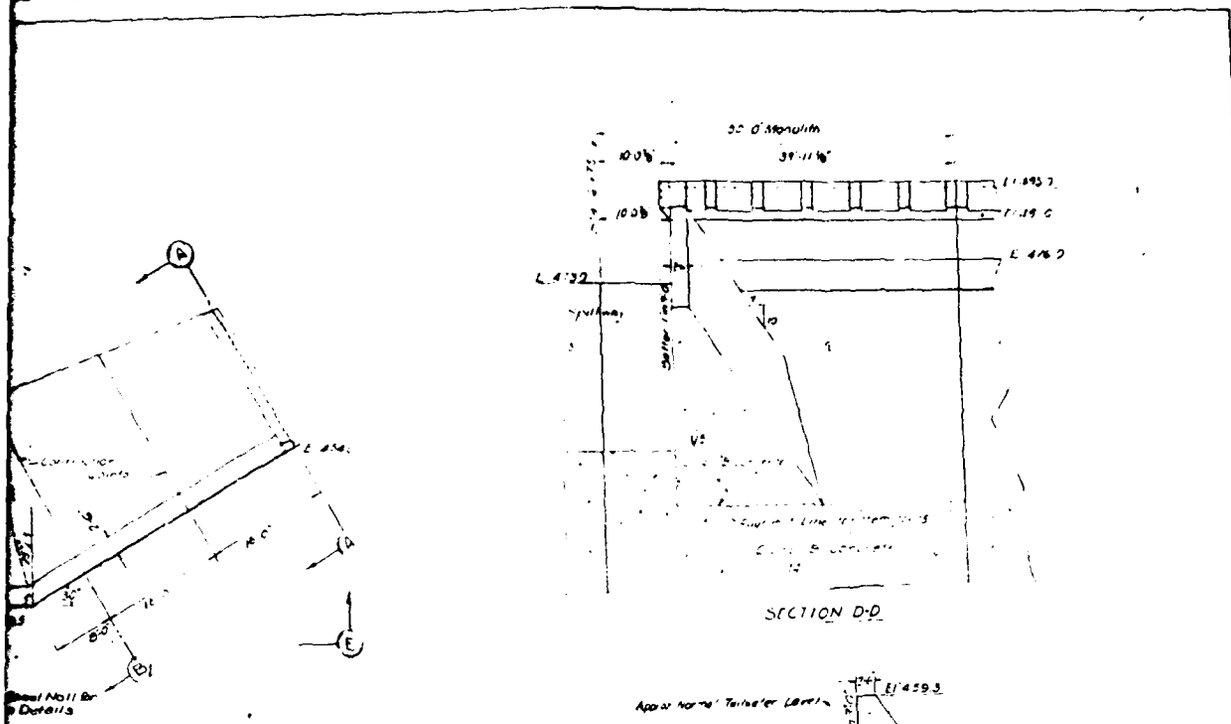
SECTION C-C

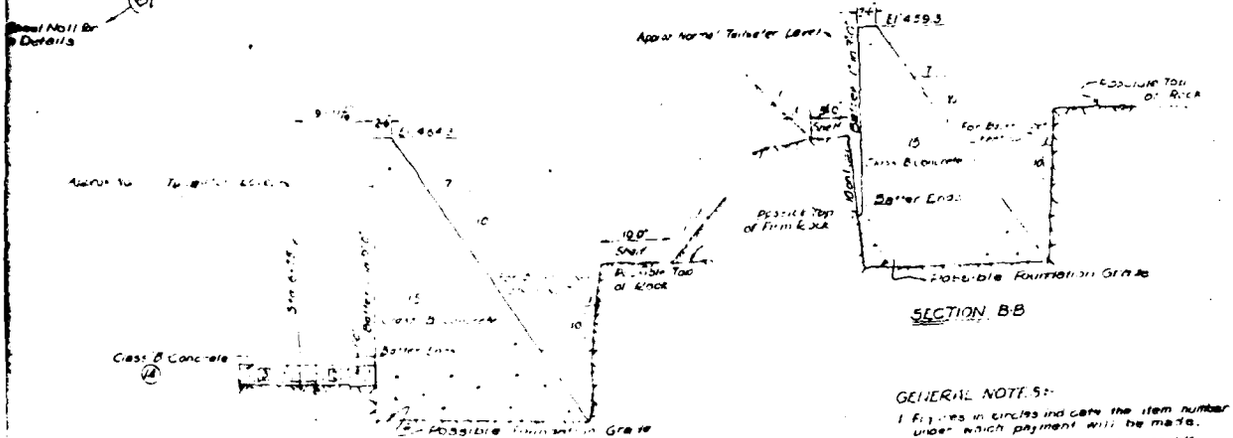


SECTION E-E

ELEVATION OF LEFT SPRAY WALL

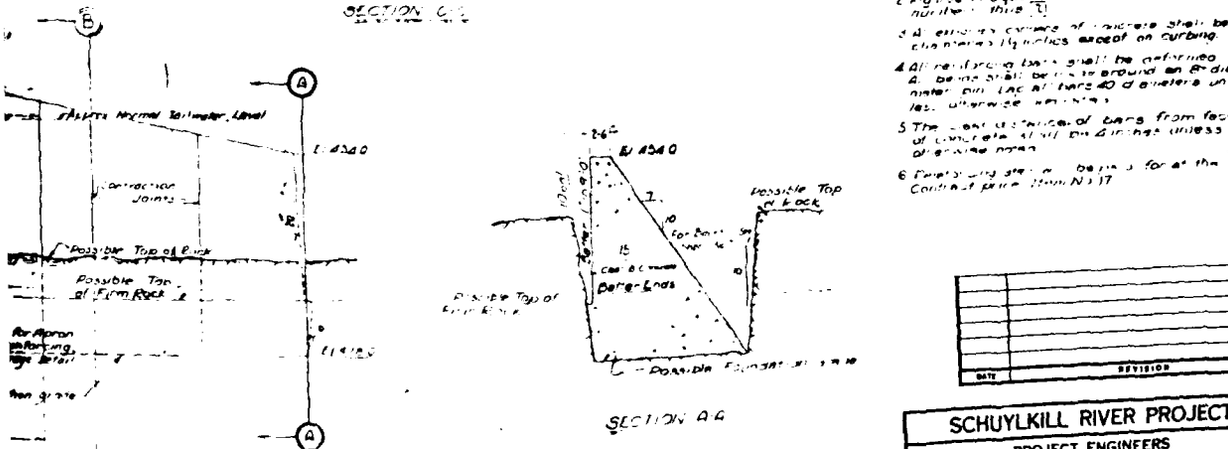






GENERAL NOTES:

1. Figures in circles indicate the item number under which payment will be made.
2. Figures in squares indicate monolith number.
3. All exposed corners of concrete shall be chamfered 1½ inches except on curbing.
4. All reinforcing bars shall be deformed. A bend shall be made around an 8" diameter pin. (AC at bars 40 diameters unless otherwise indicated.)
5. The clear distance of bars from face of concrete shall be 2 inches unless otherwise noted.
6. Finished grading shall begin at the Contract price [illegible] N 3 17



DATE	REVISION

SCHUYLKILL RIVER PROJECT

PROJECT ENGINEERS

FREDERIC R. HARRIS - FREDERICK H. DECHANT, ASSOCIATES
DAY AND ZIMMERMANN INC. ALBRIGHT AND FRIEL, INC.
JUSTIN AND COURTNEY

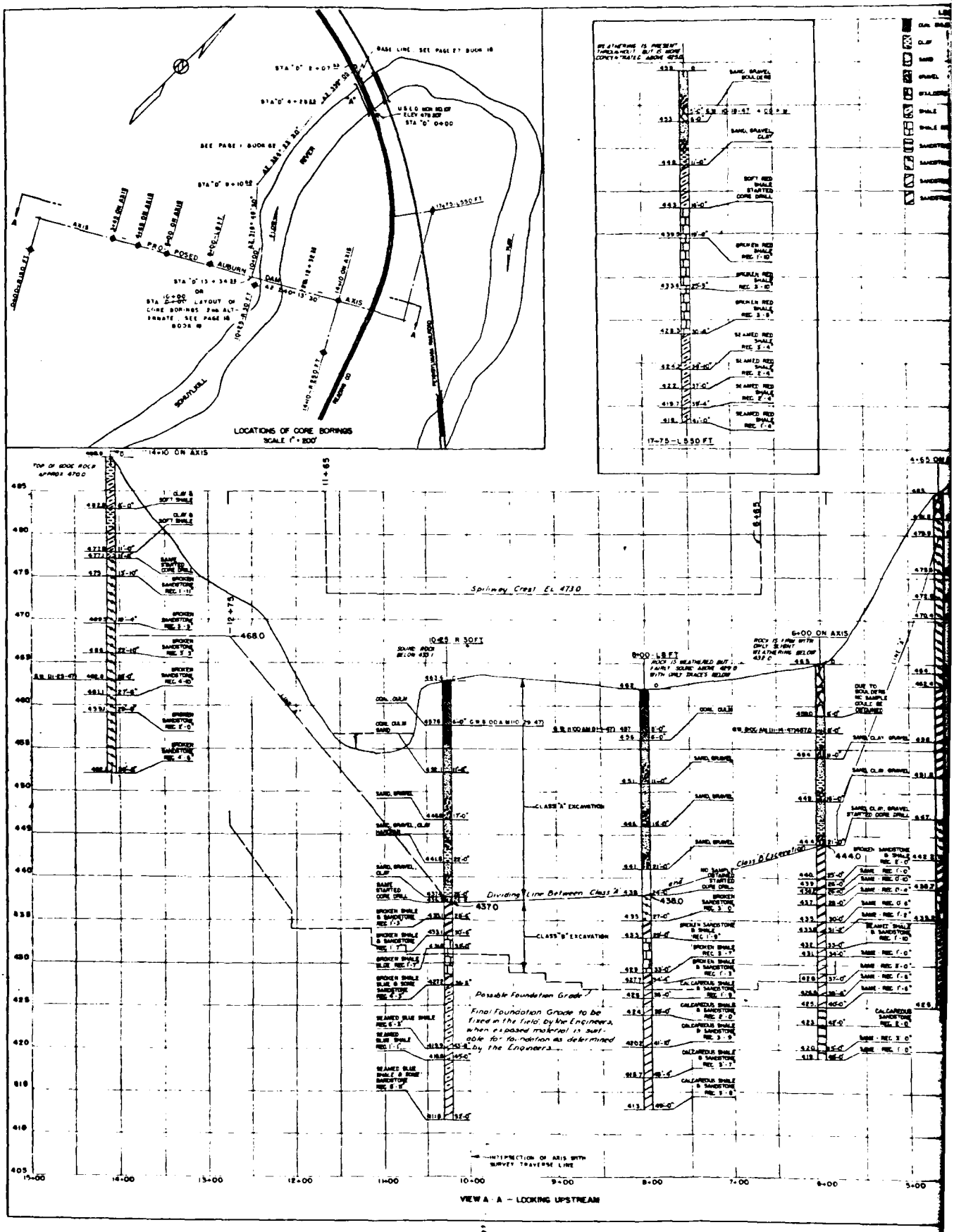
AUBURN DESILTING BASIN NO. I RIGHT

LEFT SPRAY WALL OF DAM

DATE	COMMONWEALTH OF PENNSYLVANIA	CONTRACT NUMBER
31 DEC 1948	JAMES H. DUFF — GOVERNOR	38
SCALE 1" = 1'-0"	DEPARTMENT OF FORESTS AND WATERS	SHEET NUMBER
	M. F. DRAKEL — SECRETARY	13
	HARRISBURG PENNSYLVANIA	

WATER AND POWER RESOURCES BOARD
ACCEPTED

PLATE 8


LOCATIONS OF CORE BORINGS
SCALE 1" = 800'
VIEW A - A - LOOKING UPSTREAM
Spillway Crest El. 4730
Dividing Line Between Class 'A' & 'B' Excavation
CLASS 'A' EXCAVATION
CLASS 'B' EXCAVATION
Possible Foundation Grade
Final Foundation Grade to be fixed in the field by the Engineers, when exposed material is suitable for foundation as determined by the Engineers
INTERSECTION OF AXIS WITH SURVEY TRAVERSE LINE
17+75 - L 550 FT
14+10 ON AXIS
6+00 ON AXIS
10+65 R 30 FT
9+00 - L 8 FT
11+65
12+75
468.0
457.0
436.0
444.0

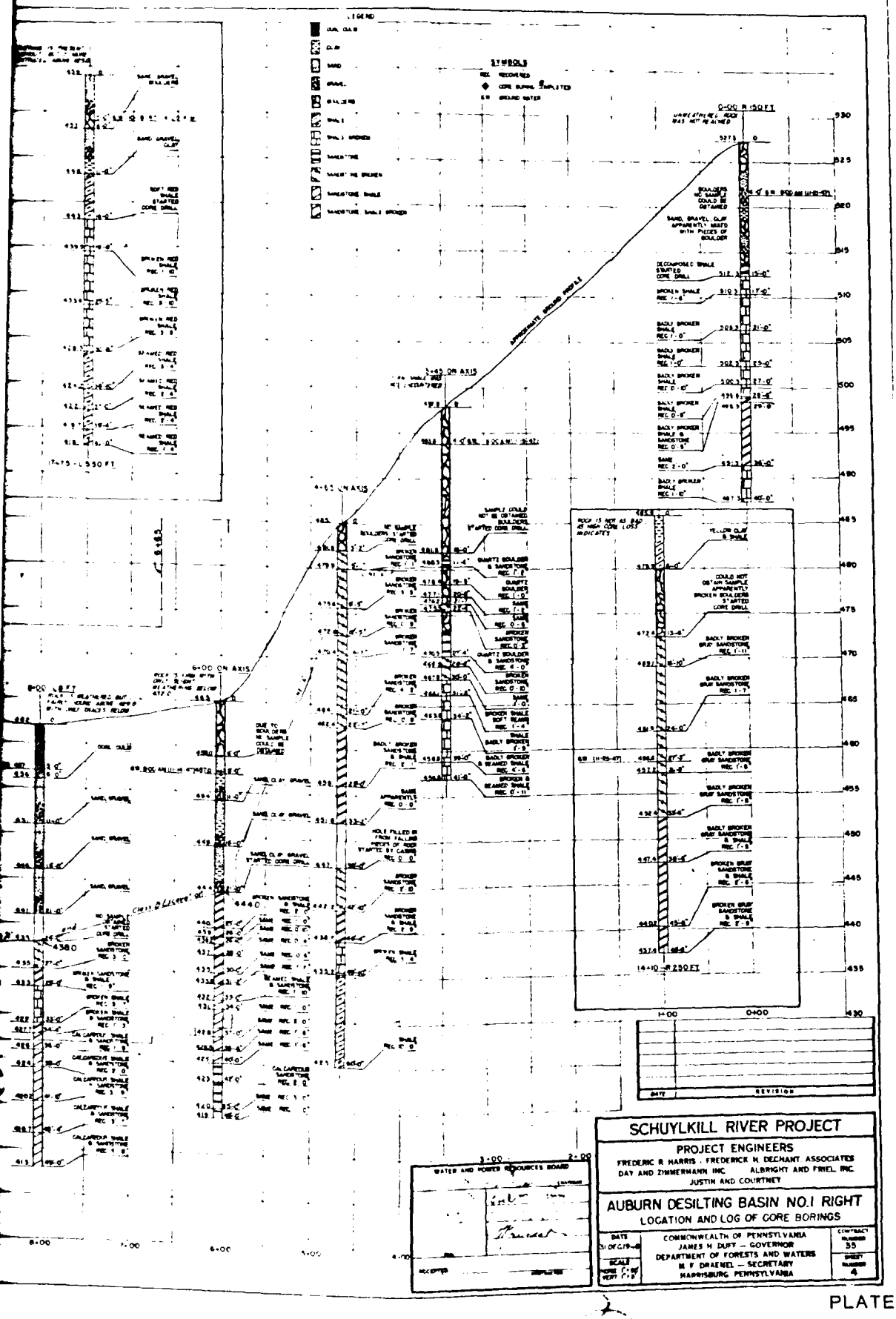

LEGEND
SYMBOLS
APPROXIMATE GROUND PROFILE
1+65 ON AXIS
4+65 ON AXIS
6+00 ON AXIS
0+00 R 150 FT
14+10 R 250 FT
7+75 L 550 FT
8+00 L 0 FT
SCHUYLKILL RIVER PROJECT
PROJECT ENGINEERS
FREDERIC R HARRIS - FREDERICK M DECHANT ASSOCIATES
DAY AND ZIMMERMANN INC ALBRIGHT AND FRIEL INC
JUSTIN AND COURTNEY
AUBURN DESILTING BASIN NO.1 RIGHT
LOCATION AND LOG OF CORE BORINGS
COMMONWEALTH OF PENNSYLVANIA
JAMES H DUFF – GOVERNOR
DEPARTMENT OF FORESTS AND WATERS
M F DRAENEL – SECRETARY
HARRISBURG PENNSYLVANIA
WATER AND POWER RESOURCES BOARD
ACCEPTED
DATE
REVISION
CONTRACT NUMBER 55
SHEET NUMBER 4

PLATE 9

APPENDIX

F

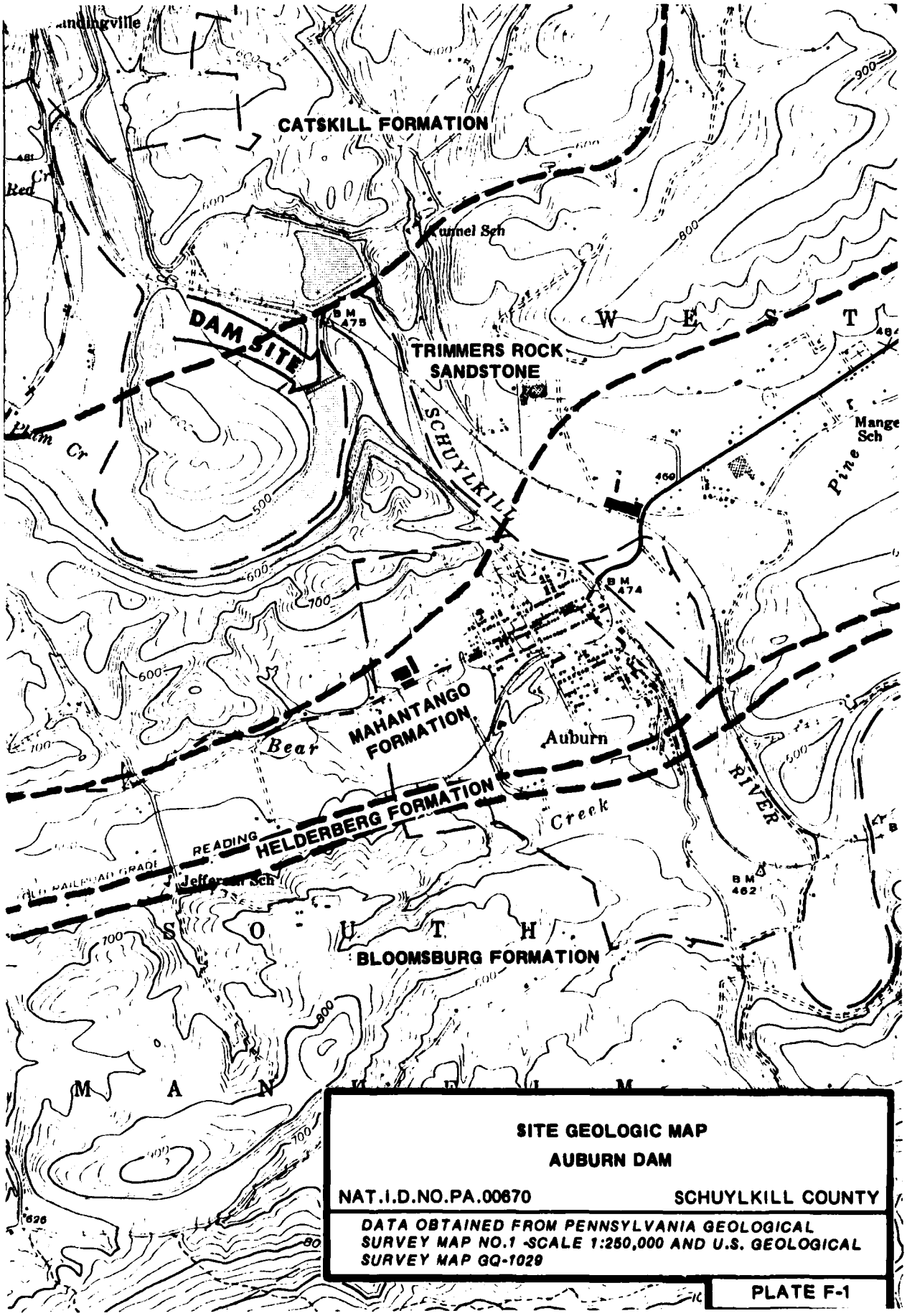
SITE GEOLOGY
AUBURN DAM

Auburn Dam is located within the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. As shown on Plate F-1, the dam is constructed upon the Trimmers Rock Sandstone Formation of Upper Devonian age. This area is situated upon the southern limb of a regional north-northeast trending syncline which crosses much of southern Schuylkill County. Bedrock is exposed on both the upstream and downstream sides of the right abutment. This exposure consists of tan-brown fine grained sandstone with siltstone interbeds and red-brown shale. Bedding strikes to the east-northeast, subparallel to the dam axis, and dips downstream approximately 35 degrees to the north. The shale is fissile and slakes, but the sandstone which dips under the right abutment is sound. Information contained in the Schuylkill River Project report of 1951, states that the dam is founded upon a "dike of sandstone" approximately 60 feet ide, which strikes parallel to the dam alignment. Bedrock jointing strikes to the northwest (nearly parallel to the dam axis) and dips nearly vertical. No bedrock exposures were observed at the left abutment area.

AD-A087 915 WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. AUBURN DAM (NDS I.D. NUMBER PA-ETC(U)
JUN 80 DACW31-80-C-0018

UNCLASSIFIED NL

END
DATE FILMED
9-80
DTIC



SITE GEOLOGIC MAP

AUBURN DAM

NAT.I.D.NO.PA.00670 SCHUYLKILL COUNTY

DATA OBTAINED FROM PENNSYLVANIA GEOLOGICAL SURVEY MAP NO.1 -SCALE 1:250,000 AND U.S. GEOLOGICAL SURVEY MAP GQ-1029

PLATE F-1

APPENDIX

G

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 1 of 7
	Project: AUBURN DAM	Job No./File No. 79C01167-19
System:		Calculator AMD Date 5/30/80
Calculation for: STABILITY		Reviewer MFB Date 6/3/80

AUBURN DAM - STABILITY ANALYSIS

ASSUMPTIONS:

UNIT WEIGHT OF CONCRETE = 150 PCF ✓

UNIT WEIGHT OF WATER = 62.4 PCF ✓

SUBMERGED WEIGHT OF SILT = 40 PCF ✓

EARTH PRESSURE COEFFICIENT OF SILT = 0.5 ✓

COEFFICIENT OF FRICTION OF ROCK = 0.7 ✓

COMPRESSIVE STRENGTH OF ROCK = 600 KSF ✓

ALLOWABLE CONCRETE SHEAR STRENGTH = 55 PSI ✓

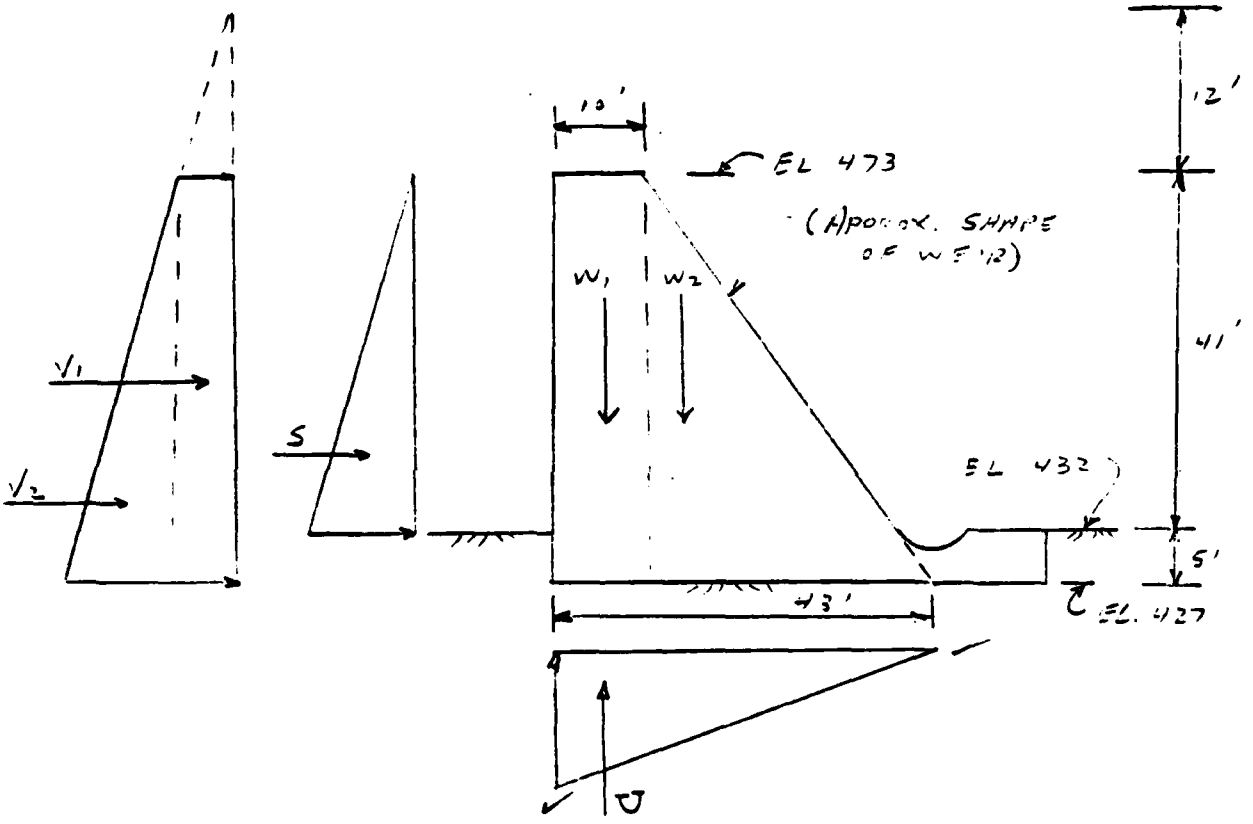
FOR CONSERVATISM AND SIMPLICITY, NEGLECT UPSTREAM BATTER OF OVERFLOW AND NON-OVERFLOW SECTIONS.

DETERMINE RESISTANCE OF DAM TO OVERTURNING AND SLIDING FOR CONDITION OF FULL POOL AND FULL SILT LOAD TO TOP OF SPILLWAY. NEGLECT TAILWATER

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 2 of 7
	Project: AUBURN DAM	Job No./File No. 79C01167-19
System:		Calculator AMD Date 5/30/80
Calculation for: STABILITY		Reviewer MEB Date 6/3/80

OVERFLOW SECTION:



$W_1 = (0.150)(10)(46) = 69.0$ KIPS

$W_2 = \frac{1}{2}(0.150)(33)(46) = 113.8$ KIPS

$V_1 = (12)(0.0624)(46) = 34.4$ KIPS

$V_2 = \frac{1}{2}(0.0624)(46)^2 = 66.0$ KIPS

$S = \frac{1}{2}(0.50)(0.040)(41)^2 = 16.8$ KIPS

$U = \frac{1}{2}(0.0624)(58)(43) = 77.8$ KIPS

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 3 of 7
	Project: AUBURN DAM	Job No./File No. 79C01167-19
System:		Calculator AHD Date 5/30/80
Calculation for: STABILITY		Reviewer MFB Date 6/9/80

REVISED 6/30/80 AHD ✓

$$\sum \overset{\curvearrowright}{M}_{TOE} = (34.4)(23) + (66.0)\left(\tfrac{46}{3}\right) + (72.8)\left(\tfrac{2}{3}\right)(43) + (16.8)(18.67)$$

$$= 791.2 + 1012.0 + 2230.3 + 313.6$$

$$= 4347.1 \quad FT\text{-}KIPS \checkmark$$

$$\sum \overset{\curvearrowleft}{M}_{TOE} = (65.0)(38) + (113.8)\left(\tfrac{2}{3}\right)(33)$$

$$= 2622.0 + 2503.6$$

$$= 5125.6 \quad FT\text{-}KIPS \checkmark$$

$$F.S._{O.T.} = \frac{5125.6}{4347.1} = 1.18 \checkmark \quad OK$$ FOR EXTREME LOADING AND CONSERVATIVE ASSUMPTIONS

$$\sum \overset{\curvearrowleft}{M}_{TOE} = 5125.6 - 4347.1 = 778.5 \ KIPS \checkmark$$

$$\sum V_{BAT} = W_1 + W_2 - U = 65.0 + 113.8 - 77.8 = 105.0^{K} \downarrow \checkmark$$

$$e = \frac{\sum M}{\sum V_{BAT}} = \frac{778.5}{105.0} = 7.41 \ FT \checkmark \quad FROM \ TOE$$

$$4/3 = \frac{43}{3} = 14.33 \ FT > 7.41 \ FT$$

$\therefore$ RESULTANT IS OUTSIDE OF MIDDLE THIRD ✓

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 4 of 7
	Project: HUBURN DAM	Job No./File No. 79c01167-19
System:		Calculator AHP Date 6/30/80
Calculation for: STABILITY		Reviewer MFB Date 6/30/80

TOE PRESSURE : $\frac{2}{3} \cdot \frac{V}{e} = \frac{2}{3} \cdot \frac{105.0}{7.41} = 9.45$ KSF

ALTHOUGH RESULTANT FALLS OUTSIDE OF MIDDLE THIRD OF BASE, THE TOE PRESSURE IS NOT EXCESSIVE FOR ROCK.

SHEAR AT ELEV. 432:

$V_{432} = \frac{1}{2}(0.0624)(53)^2 - \frac{1}{2}(0.0624)(12)^2 = 83.1$ KIPS

$N_{MAX} = \frac{3}{2}\frac{V}{6L} = \frac{3}{2}\left(\frac{83.1+16.8}{1 \times 35.5}\right) = 3.79$ KSF $= 26.4$ PSI < 55 PSI OK

SLIDING:

ASSUME ROCK SHEAR STRENGTH IS 7% OF COMPRESSIVE STRENGTH.

$$F.S. = \frac{\Sigma V_{VERT} \tan\phi + cA + 2cD}{V_1 + V_2 + S}$$

$$= \frac{(69.0 + 113.8 - 77.8)(0.7) + (0.07)(600)(43) + (2)(0.07)(600)(5)}{34.4 + 66.0 + 16.8}$$

$$= \frac{73.5 + 1806 + 420}{117.2}$$

$= 19.6$ OK

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers..Geologists and Environmental Scientists	Owner:	Page 6 of 7
	Project: AUBURN DAM	Job No./File No. 79C01167-19
System:		Calculator AHD Date 5/30/80
Calculation for: STABILITY		Reviewer HBB Date 6/3/80

REVISED 6/30/80 AHD

$$\Sigma \overset{\frown}{M}_{TOE} = \tfrac{1}{3}(58)(105.0) + \left[\tfrac{1}{3}(41)+5\right](16.8) + \tfrac{2}{3}(40)(72.4)$$

$$= 2030.0 + 313.6 + 1930.7$$

$$= 4274.3 \text{ FT-KIPS} \checkmark$$

$$\Sigma \overset{\frown}{M}_{TOE} = (69.6)(36) + (117.6)\tfrac{2}{3}(32) =$$

$$= 2505.6 + 2508.8$$

$$= 5014.4 \text{ FT-KIPS} \checkmark$$

$$F.S._{O.T.} = \frac{5014.4}{4274.3} = 1.17 \checkmark \text{ OK FOR EXTREME CONDITIONS AND CONSERVATIVE ASSUMPTIONS}$$

$$\Sigma M_{TOE} = 5014.4 - 4274.3 = 740.1 \text{ FT-KIPS}$$

$$\Sigma V_{VERT} = W_1 + W_2 - U = 69.6 + 117.6 - 72.4 = 114.8 \text{ KIPS} \downarrow$$

$$e = \frac{\Sigma M_{TOE}}{\Sigma V_{VERT.}} = \frac{740.1}{114.8} = 6.45 \text{ FT FROM TOE}$$

$$\frac{L}{3} = \frac{40}{3} = 13.33 \text{ FT} > 6.45 \text{ FT}$$

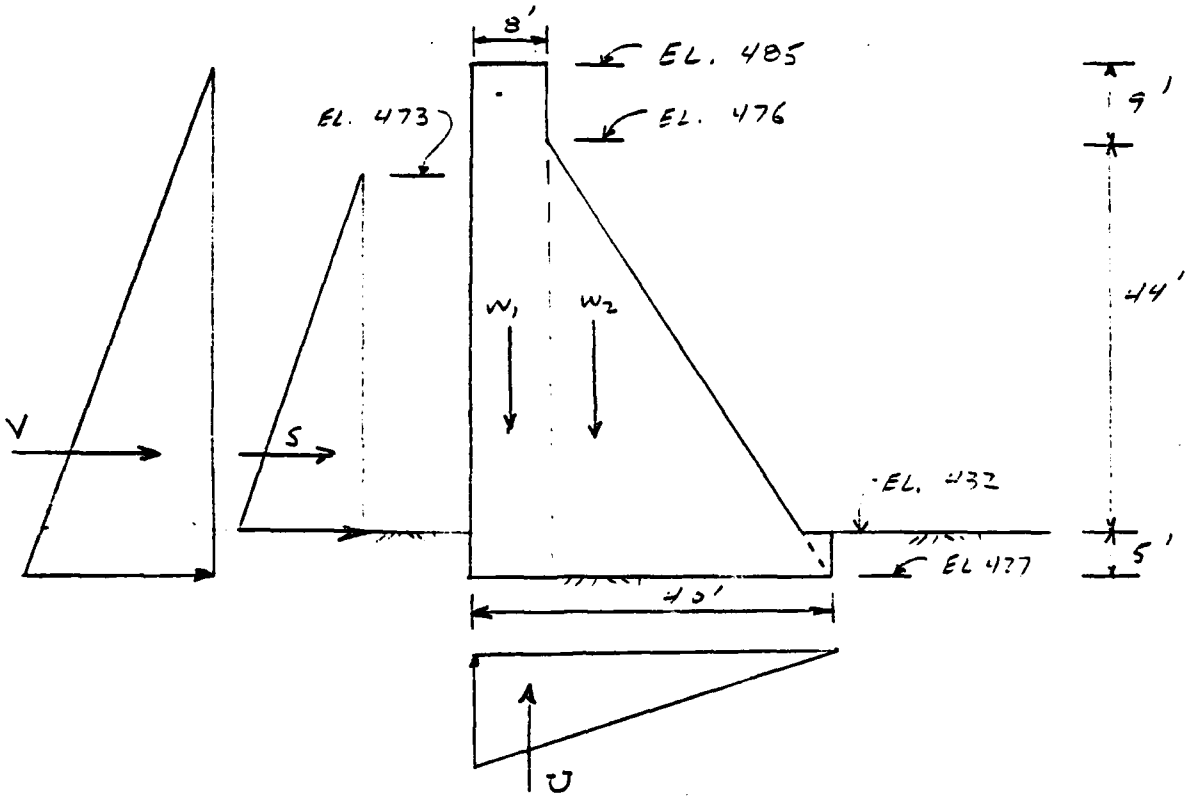
$\therefore$ RESULTANT IS OUTSIDE OF MIDDLE THIRD

WCC-AD-12

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 5 of 7
	Project: AUBURN DAM	Job No./File No. 79C01167-19
System:		Calculator AMD Date 5/30/80
Calculation for: STABILITY		Reviewer MEB Date 6/3/80

NON-OVERFLOW SECTION:



$W_1 = (0.150)(8)(58) = 69.6$ KIPS ✓

$W_2 = \frac{1}{2}(0.150)(49)(32) = 117.6$ KIPS ✓

$V = \frac{1}{2}(0.0624)(58)^2 = 105.0$ KIPS ✓

$S = \frac{1}{2}(0.50)\frac{(40)}{1000}(41)^2 = 16.8$ KIPS ✓

$U = \frac{1}{2}(0.0624)(58)(40) = 72.4$ KIPS ✓

DESIGN CALCULATIONS

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	Owner:	Page 7 of 7
	Project: AUBURN DAM	Job No./File No. 79c01167-19
System:		Calculator AHD Date 6/30/80
Calculation for: STABILITY		Reviewer MFB Date 6/30/80

$$\text{TOE PRESSURE} = \frac{2}{3}\cdot\frac{V_{VERT}}{e} = \frac{2}{3}\cdot\frac{114.8}{6.45} = 11.9 \text{ KSF}$$

ALTHOUGH RESULTANT FALLS OUTSIDE OF MIDDLE THIRD OF BASE, THE TOE PRESSURE IS NOT EXCESSIVE FOR ROCK.

SHEAR AT ELEVATION 432 (IN CONCRETE):

$$V_{432} = \tfrac{1}{2}(0.0624)(53)^2 = 87.6 \text{ KIPS}$$

$$N_{MAX} = \frac{3}{2}\cdot\frac{V}{bL} = \frac{3}{2}\cdot\frac{87.6+16.8}{1\times 36.75} = 4.26 \text{ KSF}$$

$$= 29.6 \text{ PSI} < 55 \text{ PSI OK}$$

SLIDING:

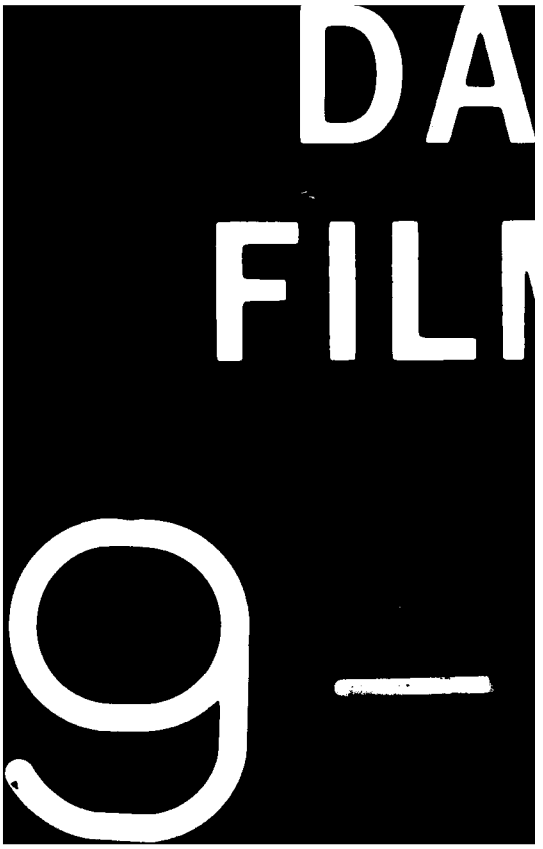
ASSUME ROCK SHEAR STRENGTH IS 7% OF COMPRESSIVE STRENGTH

$$F.S. = \frac{\Sigma V_{VERT}\tan\phi + cA + 2cD}{V + S}$$

$$= \frac{(69.6+117.6-72.4)(0.7) + (0.07)(600)(40) + (2)(0.07)(600)(5)}{105.0 + 16.8}$$

$$= \frac{80.36 + 1680 + 420}{121.8}$$

$$= 17.9 \quad \text{OK}$$


DA
FIL
9