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NATIONAL DAM SAFETY PROGRAM. WEST CARROLL TOWNSHIP WATER AND SE--ETC(U)
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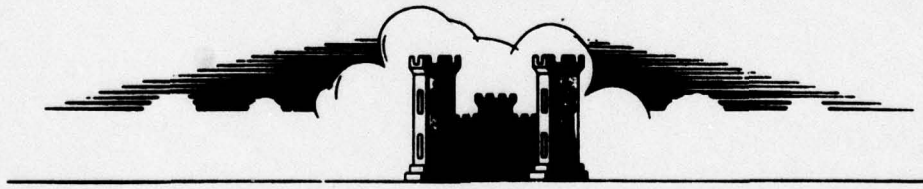
SUSQUEHANNA RIVER BASIN

WEST BRANCH SUSQUEHANNA RIVER, CAMBRIA COUNTY

PENNSYLVANIA

WEST CARROLL TOWNSHIP WATER AND SEWER AUTHORITY DAM (BAKERTON DAM)

PHASE I INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



Prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

By

EADS

1126 Eighth Avenue

Altoona, Pennsylvania 16602

JUNE 1978

LEVEL II

(1)

SUSQUEHANNA RIVER BASIN

WEST BRANCH SUSQUEHANNA RIVER, CAMBRIA COUNTY

PENNSYLVANIA

WEST CARROLL TOWNSHIP WATER AND SEWER AUTHORITY DAM

(BAKERTON DAM)

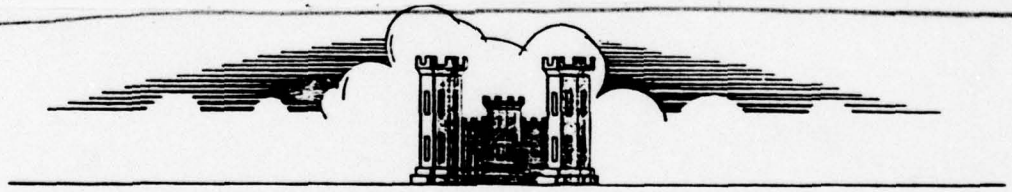
(12) 65 p.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

(6) NDI No. PA 436.

National Dam Safety Program. West Carroll Township Water and Sewer Authority Dam (Bakerton Dam) (NDI #PA-436), Susquehanna River Basin, West Branch Susquehanna River, Cambria County, Pennsylvania. Phase I Inspection Report.



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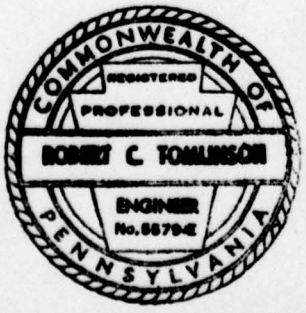
PHASE 1 REPORT
NATIONAL DAM SAFETY PROGRAM

West Carroll Township Water And Sewer Authority
(Bakerton Dam)
Pennsylvania
Cambria County
West Branch Susquehanna River
March 30 and 31, 1978
Inspection Team - EADS

The inspection of the Bakerton Dam and a review of all the available engineering data and records as supplied by the Department of Environmental Resources indicates that the dam is in poor condition and must be repaired or replaced in the not-to-distant future.

Of primary concern is the structural capacity of the inclined concrete slabs and buttresses to carry the superimposed loads under their present deteriorated condition. The inspection reports indicate that deterioration of the concrete started as early as 1924, and that the last repairs to the concrete was in 1944 when the necessary concrete surfaces were repaired by guniting. The inspection reports also indicate that leakage occurred through some of the joints the first time the dam was filled. Being that the inclined slab retains the impounded water and are supported by the concrete buttresses, the greater portion of the dam is exposed to the severe elements of the harsh winters of Cambria County. Because of these conditions, the Owner should initiate a feasibility study to determine if the present dam can be economically repaired or should it be replaced.

The Owner should also repair the scour damage caused by the 1977 flood to the downstream slopes of the embankments, as well as provide a sand filter and drain to the wet area of the right embankment.



Approved:

Robert C. Tomlinson

Robert C. Tomlinson, P.E.
Vice President, EADS

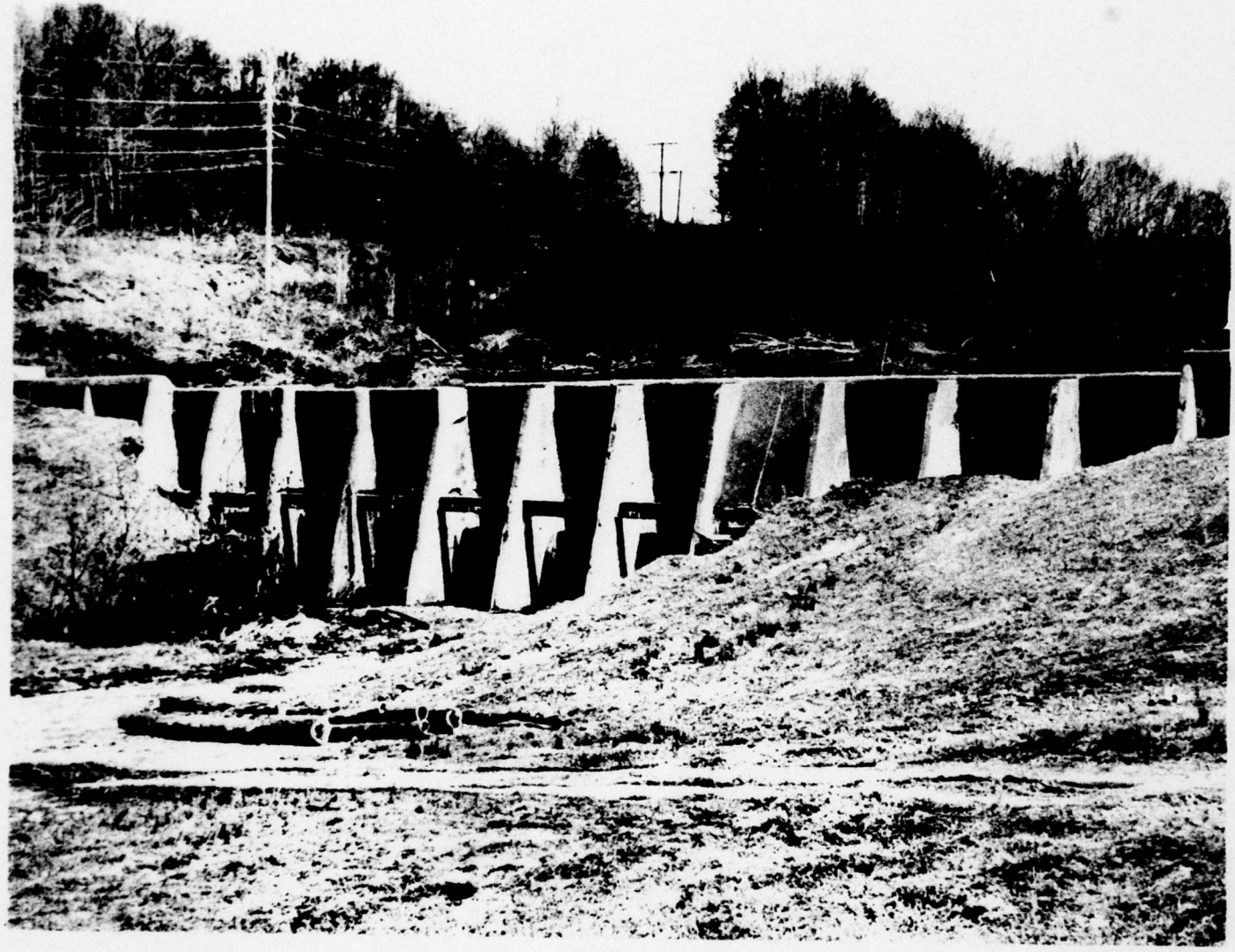
Date: June 9, 1978

APPROVED BY:

John H. Kenworthy

JOHN H. KENWORTHY
LTC, Corps of Engineers
Acting District Engineer

DATE: 14 June 1978



PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WEST CARROLL TOWNSHIP WATER AND SEWER AUTHORITY
BAKERTON DAM
ID NO. PA-436 (PA-11-47)

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

1.2 Description of Project

a. Dam and Appurtenances: The Bakerton Dam is a combination of an earthen and concrete dam. The main center portion of the dam, being known as an Ambursen Type dam, is 240 feet long and is constructed of a tilt-up reinforced concrete slab supported by buttresses founded on a reinforced concrete slab (See drawings in Appendix F). The right portion of the dam is a 73 foot long earthen embankment while the left end of the dam is a 143 foot long earthen embankment. The maximum height of the concrete portion of the dam is 24 feet and the maximum height of the earthfill portion is 17 feet. The concrete portion of the dam, which consists of seventeen simply supported reinforced concrete slabs tilted up at 45 degrees and supported by concrete buttresses (see drawings) contains the normal overflow spillway within two of these panels; while the emergency spillway, being 6 inches higher than the normal overflow spillway, includes the normal spillway as well as nine other panels, for a total length of about 130 feet. The remaining six panels (three at each end of the emergency section) are two feet below the top of the earthen embankment and could also serve as an emergency free over flow (straight drop) spillway. The area below these end sections have portions of earthen embankments tapering into them. The control valves for the dam are located between two of the buttresses and under the emergency overflow spillway of the dam. The water flowing over the normal spillway of this structure free falls onto the concrete foundation slab of the dam, which is a structural component of the structure, and then flows into the valley below. This valley is quite flat and varies in width from 200 feet to a width of 500 to 600 feet. The valley has considerable trees and underbrush growing in it. The water then flows to the town of Bakerton.

b. Location: The dam is located in Cambria County on the West Branch of the Susquehanna River and its headwater. The structure is shown on USGS 7½ minute quadrangle sheet, Carrolltown, PA. N40 35'17.3", E78 43'15.8". The town of Bakerton is located 1¼ miles downstream from the dam.

c. Size Classification: Small (25 feet high, and approximately 54 acre - feet).

d. Hazard Classification: Significant (due to possible loss of life)

e. Ownership: West Carroll Township Water And Sewer Authority, Bakerton, Pennsylvania.

f. Purpose of Dam: Water supply for Bakerton.

g. Design and Construction History: The dam was designed and constructed by Ambursen Construction Company, New York, New York. Construction began in August 1919, and was suspended from January, 1920 to April, 1920 and was completed in April, 1921. An engineer representing the State of Pennsylvania had been overseeing the construction of all the reinforced concrete sections because of type of construction being used. The concrete cut-off walls and core walls were all taken down to and keyed into bedrock everywhere except at one location on the left side of dam (looking downstream). In this region and 55 feet to the left of the concrete structure, the core wall was taken down only 12 feet below existing ground. The embankments for this structure were constructed by rolling materials consisting of yellow rock dust and clay mixed with sandstone fragments, which were available at the construction site. During the course of constructing the concrete section of the dam, which was done partly during cold weather, the tops of several concrete butresse had frozen and the said concrete removed. When the structure was being filled with water after its completion, it was noticed at that time that damp spots had occurred on the underside of the decks, due in most cases to seepage at the horizontal control joints. It was noticed in the periodic inspection reports performed by the State of Pennsylvania that in 1924 the concrete had started to show slight signs of disintegration to a point where steel reinforcing was exposed. These areas were not repaired until 1929. In 1938 after many prior reports of leakage through the deck, the entire upstream face of the concrete deck slab was painted with asphalt. In 1944 the disintegrated concrete areas of the dam were repaird by guniting; it also appears that the entire upstream face of the deck slab was also gunited. In 1965 reports were again found that more concrete areas were disintegrating and were repaired in 1966. In

1971 reports were again found of disintegrated concrete and no reports could be found that these areas were ever repaired, not even to this date of inspection. The slabs still leak to this date and are still in a disintegrated condition. In 1948, as recorded in previous inspection reports, it was noted that tthe earth embnakments were 6" to low at several location and it was recommended that impervious material be brought in to build up the embankments to top of the adjacent concrete spillways. In 1948 the embankments were raised and it also assumed at this same period of time additional length of downstream embankment was constructed. The embankments were extended under the overflow spillway at each end of the concrete structure. The embankment ends are being kept from encroaching under the spillway any further by the use of wood cribbing which create vertical walls approximately 10 feet high. One end of the wood cribbing stops adjacent to the entrance of the valve control house that is build inside the structure.

h. Normal Operation Procedure: There appears to be no fixed operating procedures except for visiting the site daily to check the operation of the chlorinator. When water is discharging over the normal spillway, the operator partly opens the 12 inch blow-off valve in the control house under the dam slab to try and remove as much silt from the bottom of the reservoir as possible. At the time of our visit, water was flowing over the normal spillway as well as from the partly opened 12 inch blow-off valve.

1.3 Pertinent Data

a. Drainage Area: 0.81 square miles.

b. Discharge at Dam Site: There are no known records or data available for any past flooding conditions. However, it was reported by the dam caretaker that the water "was flowing over all the spillway." From this data, it is estimated that the maximum flow over the emergency spillway was 780 cfs.

c. Elevation (feet above mean sea level):

Top of dam - 1820.0
Maximum pool design discharge - 1817.5
Maximum pool of record - 1818.0 (unofficially)
Normal pool - 1816.0
Streambed at centerline of dam - 1795.0
Maximum tailwater - none available

d. Reservoir

Length of maximum pool - 800' (estimated)
Length of normal pool - 750' (estimated)

e. Storage (acre-feet)

Spillway crest - 36.83 (12 millions gallons)
Design Surcharge - 44.0 (estimated)
Top of dam - 54.0 (estimated)

f. Reservoir surface (acres)

Top of dam - 6.3 acres (estimated)
Maximum pool - 5.5 acres (estimated)
Spillway crest - 4.3 acres

g. Dam

Type - reinforced concrete (Amburson Type) with rolled earth embankments

Item	Concrete Section	Earth Embankment
Length	204'	216'
Height	24'	17'
Top Width	2'	16'
Side slopes (upstream)	45	2H on 1V
(downstream)	none	2H on 1V
Zoning	--	selected material
Impervious core	--	a. Concrete core wall keyed into bedrock b. Hand placed riprap upstream face
Cutoff	Concrete wall keyed into bed rock	concrete wall keyed into bed rock
Grout curtain	none	none

h. Diversion and Regulating Tunnel: This dam does not have a diversion and regulating tunnel.

i. Spillway

Type - uncontrolled, broad crested weir
Length of weir - 131.0'
Crest elevation - normal spillway 1816, emergency spillway 1816.5
Upstream channel - none
Downstream channel - unpaved channel
Spillway capacity - 780 cfs (estimated)

j. Regulating Outlets

The only regulation outlet is a 12 inch blow off valve located in the valve control house.

SECTION 2 - ENGINEERING DATA

2.1 Design

a. Data Available

(1) Hydrology and hydraulics: A report was prepared by the Water Supply Commission of Pennsylvania, now the Pennsylvania Department of Environmental Resources (PennDER) in August, 1919. This report states that the capacity of the spillway is 527 cfs with the water surface at elevation 1817.5, or two and one-half feet below the top of earth embankment.

(2) Embankment: The report prepared by the Water Supply Commission of Pennsylvania contained only general comments that the site was well adopted for earth embankments, but no designs computations are available.

(3) Concrete Structure: The report prepared by the Water Supply Commission of Pennsylvania contained a summary of the analysis performed for this structure. A set of analysis computations were also available. The report also stressed that, because of the type of construction proposed, a member of the Commission should be present during its entire construction.

b. Design Features

(1) Embankment: The construction drawings show that the embankment is not an homogenous earthfill structure, but has a reinforced concrete core wall, 16 inches thick in original ground and 12 inches thick in the rolled embankment, and located slightly off center (downstream). The top of the core wall is two feet below the top of the embankment, while the bottom is keyed into rock everywhere, except at one location where it supposively is keyed into impervious material. The embankments have 2H on 1V slopes on the upstream and downstream slopes. The upstream portion of the embankment has hand-placed riprap on its face.

(b) Concrete Structure: The drawings indicate that the structure consists of buttresses, spaced 12 feet apart, setting on a concrete mattress or carpet 16 inches thick, supporting a upstream deck inclined at an angle of 45 degrees that varies in thickness from 9 inches at the top to 18 inches at the bottom. Under the upstream edge, connected by reinforcing to the carpet, is the reinforced cut-off wall extending to rock. This structure has a normal flow spillway built into it, and another portion will serve as an free overflow straight drop spillway. The valve control house was also built inside the structure.

c. Design Data

(1) Hydrology and Hydraulics: The Commission report states that the spillway maximum design flow is calculated to be 527 cfs with 2½ feet of freeboard.

(2) Embankment: There wasn't any design data available for this portion of the structure.

(3) Concrete structure: There were analysis computations performed by the Commission available for this structure. The results of the analysis show that the reinforcing steel was found to be within the safe limits, the maximum being 16,300 pounds per square inch. In all other cases it is 16,000 pounds per square inch. The maximum stress in the concrete was also found to be within the allowables for each type of concrete. (See Appendix A) The analysis of the structure shows that the resultant falls very close to center of the base (no ice load condition was performed) and maximum foundation pressure was 1170 pounds per square foot (maximum). The coefficient of friction required to provide lateral stability is 0.33; the concrete cut off wall also provides lateral stability. Without the concrete cut off wall the coefficient of friction required was 0.56. The structure also has a key at its center and downstream wall that weren't taken into account.

2.2 Construction

Construction data available for review included the original contract drawings, specifications, construction photographs and daily reports made by an Engineer representing the Commission. The only items of concern was that when the structure was filled with water, leaks and wet spots were noticed on the deck slabs; also that portions of the concrete structures built during the cold weather had portions removed because of freezing.

2.3 Operation

No formal records of operational problems were available for review.

2.4 Other Investigations

No other investigation reports were available.

2.5 Evaluation

a. Availability: Engineering data available were provided by the Pennsylvania Office of Dams and Encroachments (PennDER).

b. Adequacy

(1) Hydrology and Hydraulics: The hydrologic and hydraulic analysis for the Bakerton dam was not very extensive. Not knowing the complete history of the operation of the dam, its seems apparent that it has thus far been able to pass all floods without any loss of life or property.

(2) Embankment: There wasn't any design data available for the embankment, so its adequacy will be based on outward appearance. The embankment had proved to be adequate thus far, due to periodic maintenance throughout the years, and still appears to be adequate. There is a wet spot and small surface slough about 12 - 15 feet in diameter and 6 - 12 inches deep about one-third to one-half the distance up the right downstream embankment slope, in the area where additional fill was added sometime in the past. From available data in the past dam records, it was reported that this minor seepage seems to be coming from the adjacent hillside. The left upstream face of the embankment has a considerable number of small trees growing on it.

(3) Concrete Structure: A general review of the design computations, specification and construction drawings reveals that they were done in accordance with the engineering technology being practiced at that point in time. The concrete and guniting is presently disintegrating in many locations to a point where steel reinforcing is exposed. The structure shows no outward signs of structural distress at this time and appears to be safe. One item which should be reviewed thoroughly is the effect that the embankment fill, that's being retained vertically by several of the concrete buttresses and wood cribbing, will have on its structural carrying capacity at peak flood conditions. The reason for concern is that it appears these buttresses were not originally designed for lateral loads because the only reinforcement steel in them is located around their perimeter and laterally at their mid heights. This reinforcement consists of only 2 #6 bars on each face. The construction drawings show no steel reinforcement tying the concrete buttress to the concrete mattress; thus the only resistance to lateral movement is friction.

c. Operating Records: While no formal operating records were available for review, the structure has withstood all past floods. However, some scouring of the earthen embankment within

the areas of emergency spillway did occur, and is to be repaired with funds being supplied by thy Federal Disaster Assistance Administration in accordance with the DSR report for this work. The repair work has not yet been completed.

d. Post-Construction Changes: The earthen embankments on each side of the structure had been extended to within the spillway section of the dam. The files reviewed for the dam contain no records as to when this work was completed.

e. Seismic Stability: This dam is located in Seismic Zone No. 1 (a zone of low seismicity) and it is our opinion that the structural stability of the concrete section of the dam could be affected because the cutoff wall is keyed into bedrock. Seismic forces could be transmitted directly to the structure which is constructed out of thin sections with no reinforcement tying the structural components into an integral structure. However, this is only an opinion; no studies or calculations were performed to substantiate it.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General: The general appearance of this dam especially the concrete portion, is that it is badly in need of repairs or replacement. The other portions of the project appear to be adequate but in need of maintenance.

b. Dam: (Earth and Concrete Portions) The maintenance of the dam appears to have been neglected for some time. This is evidenced by the deteriorated condition of the concrete, exposed reinforcing steel, trees growing on the dam and downstream channel bank, floatable logs and brush adjacent to the lake, slight sloughing of right downstream slope with no evidence of providing drainage and lack of good houskeeping in general. The embankments built under the spillway area could cause problems because of their locations.

c. Operating Facilities: The blow-off valve is opened often, but has limited discharge capacity and drainage facility to the tail channel. The screen and valves show evidence of severe corrosion and no evidence of recent operation.

d. Reservoir Area: The only sedimentation observed in the reservoir was where the two streams enter the reservoir, but this sedimentation didn't appear to be extensive. The area around the reservoir was recently timbered and considerable brush and sizeable logs are within the maximum high water elevation.

e. Downstream Channel: The access road to the dam and reservoir is located approximately 150 feet downstream from the axis of the dam. This location is such that, when the reservoir is discharging above the normal spillway, the access road will be inundated because of its low profile, the inadequate size of the discharge channel pipe under the access road and brush in the tailwater area that could cause additional backwater. The discharge channel downstream from the access road is relatively shallow and the overbank areas are overgrown with brush and trees.

3.2 Evaluation

The observed condition of the project is considered very poor. The deficiencies observed would prevent access to the valve control house. The embankments that were built under the spillway regions of the dam could create currents that could undermine the upper portions of adjacent embankments, and if the wood crib wall failed it would completely block entrance to the valve control house. The earthen embankments are built adjacent to and supported by the concrete buttresses are inadequately reinforced for lateral forces. No provisions have been made to repair and/or drain the wet area on the right embankment, or to repair the scour areas made during the July 1977 flood.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

There appears to be no fixed operating procedures for the dam except the discharging of the 12" blow-off valve to try and control sedimentation in the reservoir.

4.2 Maintenance of dam

There appears to be no maintenance program as evidenced by extensive cracking and peeling of gunite, some trees growing on dam, floatable logs and brush adjacent to lake, sloughing of downstream slope with seepage and no evidence of providing drainage and a lack of good houskeeping in general. No maintenance records were reviewed for this project.

4.3 Maintenance of Operating Facilities

The 12 inch blow-off valve is opened on occasion with limited discharge capacity and no drainage facility to the tail channel. At the time of the field inspection, this valve was partly opened. However, upon questioning the dam operator, he reported that the 8 inch supply line valves had not been operated for some time and he doesn't know if they would operate. He also reported that the screen in the screen pot chamber (see drawings) has not been removed and cleaned for some time. The steel lid on the screen pot chamber and the nuts and bolts showed evidence of severe corrosion; the 8 inch valves also showed evidence of severe corrosion.

4.4 Warning System in Effect

There are no warning systems in effect other than what may be provided by the dam operator from actual site visitations. The operator is employed full time by another employer.

4.5 Evaluation

The dam is poorly maintained by the Authority, as evidenced by the condition of the dam and project area. Although the dam is small, some daily or weekly reports should be made by the dam operator to the Authority. The operator should also see that all operational parts (valves) are used occasionally.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features

a. Design Data: A limited amount of hydrologic and hydraulic data was available from PennDER for the Bakerton Dam. The information available consisted of hydraulic computations to determine the spillway capacity and a report prepared by the Water Supply Commission of Pennsylvania (now PennDER) addressing the drainage area characteristics, downstream conditions, and spillway capacity. The PennDER data indicates a maximum anticipated runoff of 600 to 650 cfs per square mile, or 485 to 525 cfs for the Bakerton Dam drainage area. The latter data did not estimate the maximum spillway discharge capacity. However, check computations (see Appendix D) did indicate that the 525 cfs as reported in the PennDER files was probably the capacity of the emergency spillway; our computations indicates this capacity to be 782 cfs. An estimate of the maximum discharge capacity of the dam, utilizing the crest of the concrete dam and a pool elevation of 1819.5 (6 inches below top of earthen embankments) indicated a maximum discharge capacity of 2,525 cfs.

A review of the design data indicates the maximum assumed inflow of 525 cfs is far below the Probable Maximum Flood (PMF) peak inflow figures available for the Bakerton Area (See Article b below). However, the assumptions made in calculating the spillway discharge capacities appear highly conservative. It is difficult to imagine both the normal and emergency spillways to be completely blocked with debris to their full height. Also, the assumed discharge coefficient of 2.6 appears to be too low for the beveled approach - rounded concrete dam crest.

b. Experience Data: The Army Corps of Engineers has calculated the PMF for a potential dam site to be constructed on Chest Creek in the nearby vicinity of the Bakerton Dam. The Chest Creek site has a drainage area of 38 square miles. The Probable Maximum Flood (PMF) peak inflow was calculated to be 65,000 cfs. Transposing this data to the Bakerton Dam by the use of a ratio of the corresponding drainage areas raised to the 0.8 power results in an estimated PMF peak flow for the Bakerton Dam of 2,990 cfs (See Appendix D).

c. Visual Observations: On the date of inspection, it was noted that timbering operations had been conducted around vitually the entire perimeter of the reservoir. These operations are resulting in the deposition of tree limbs, timbers and debris within the maximum high water elevation of the reservoir. During a flood event, this debris could become lodged in the overflow spillway and restrict the discharge of water over the dam.

d. Overtopping Potential: Based upon guidelines and data submitted by the U. S. Army Corps of Engineers, the recommended Spillway Design Flood (SDF) for this particular dam should equal one-half the PMF. The estimated peak inflow for this flood (1/2 PMF) is 1,496 cfs. The estimated ultimate spillway capacity of 2,525 cfs (See Appendix D) indicates little potential for overtopping of the Bakerton Dam.

e. Spillway Adequacy: Within the context of the guidelines published by the U. S. Army Corps of Engineers, (Recommended Guidelines For Safety Inspection of Dams, Appendix D, page D-12) the spillway can be considered adequate. However, the estimated ultimate spillway capacity of 2,525 cfs is less than the PMF of 2,990 cfs. An estimate of the storage effect of the Bakerton reservoir shows the reservoir not to have sufficient storage capacity available to pass the PMF without overtopping the dam. Consequently, in view of the fact that the spillway will not pass the PMF, it should be considered inadequate, but not seriously so. The maximum estimated tailwater elevation of the downstream channel at a flow equal to the maximum estimated spillway discharge capacity of 2,525 cfs is 1,805.0. Assuming the overtopping of the Bakerton Dam would ultimately cause its failure due to erosion of the earthen portion of the side embankments and adjacent abutments, the failure would have to be extremely rapid and complete to add significantly to the probable flooding downstream already created by the tailwater. Considering the small size of the reservoir (12,000,000 gallons), and the probability of a gradual release of at least part of the reservoir capacity in the event of a failure due to overtopping, the failure of the Bakerton Dam would not significantly increase the hazard to loss of life or property damage downstream from that which would exist just before overtopping failure.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Earthen Embankment: The only visual item of major concern is the earthen embankment that was added to the original structure at some point in time and the wet spot and slough on the downstream slope of the right embankment. The embankment is located under the spillway area of the dam and is terminated vertically by wood cribbing and part of the concrete structure (concrete buttresses with light steel reinforcing). This earth embankment was partially eroded away during the flood of July 1977. The embankment needs some minor maintenance and repair; other than that, it appears to be stable.

(2) Concrete structure: Based on our observations the concrete and guniting is disentegrating in many locations. There are wet spots and leakage coming through the deck slabs in many locations, but this has been happening ever since the structure was filled with water. There is a slight separation between the deck slab and baffle for the low flow spillway. This separation appears to have been caused by ice build-up. This area was completely blocked with ice during our initial field inspection on March 8, 1978. The concrete in this region, the top of baffle and the top of the concrete buttress, are lightly reinforced, but the failure of this top section in our opinion would not lead to total collaspe of the structure. The loss of the steel reinforcing section due to the continuous corrosion conditions over the years and the existing strength of the concrete could become factors at peak flood conditions. The steel reinforcing that we observed showed no major loss of section. The concrete structure at this time shows no outside sign of distress, but the question arises as to what's the condition of the steel reinforcing and concrete that's covered with earth. The right portion of the structure has had sulfurized water permeating through the earthen embankment and weep holes possibly since it was constructed or for some time. The reason for this condition is that during construction a seam of coal at elevation 1810 was unexpectly uncovered. This area was of much concern at the time, but it was finally decided by the engineers and inspector (from DER records) that the material was impervious enough so the core wall was not extended into the coal laden material. The major area of concern is the differential in earth pressure at several buttresses. The buttresses are not reinforced for the lateral forces which are presently being generated from

the earth itself but these forces can be increased substantiatly from slope and crib wall failure at or after peak flood conditions. The collapse of these buttresses could cause a progressive type failure. In December 1977 there was supposed to have been a hole develop in one of the sloped deck slabs; the area was reportedly discharging at a rate equal to a 2 inch pipe, but our investigation did not uncover any such sizeable flow. The point at which the hole was reported would be under approximately 10 feet of static head. At the time of our inspection the ground was still saturated from the melting snow. So all things taken into account, the flow was minimal. In conclusion, we feel that since the condition of the steel and concrete in the concrete portion of the structure is questional the structure could become unstable when subjected to high stresses during peak flooding conditions.

b. Design and Construction Data

(1) Embankment: There were no stability analysis performed for the embankments in the dam files of DER. The only data available was that it was to be rolled in place in 6 inch layers using the material available at the site. (yellow rock dust and clay mixed with sandstone fragments)

(2) Concrete Structure: The data available for review included specifications, daily construction reports written by an Engineer and hand-written analysis computations from the DER files. The structure was originally designed in accordance with the engineering technology being utilized at that time. The computations indicated that the resultant of all combined forces falls at the mid-point of the structure, with the maximum foundation pressure being only 1170 pound per square foot. The cutoff wall would add sustantially to the resisting uplift but was not included in the computations. The coefficient of friction necessary to resist sliding was reported to be only 0.33 which seems to be relatively low. The structure also has two keys (see Drawings, Appendix F) at the midpoint and downstream end of the foundation slab that weren't taken into account for resistance to sliding. These values appear to be well within the soil characteristics of the foundation material of the dam.

c. Operating Records: While no formal operating records were available for review, the structure has withstood all past floods except for the flood of July 1977. The embankments within the spillway region received considerable scour damage at that time.

d. Post-Construction Changes: The earthen embankment on each side of the structure had been extended to within the spillway section of the dam. However, there were no records showing when the work was performed.

e. Seismic Stability: This dam is located in Seismic Zone No. 1 and it is our opion that the structural stability of the concrete section of the dam could be affected because the cutoff wall is keyed into bedrock. Seismic forces could be transmitted directly to the structure which is constructed out of thin sections with no reinforcement tying the structural components into an integral structure. However, this only an opinion; no studies or calculations were performed to substantiate it.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/REMEDIAL

7.1 Dam Assessment

a. Safety: A thorough review of the structural design of the concrete structure, its capability of passing the recommended spillway design flood (1/2 PMF) without overtopping and no outward signs of structural distress indicates that the dam was originally well designed and in accordance with accepted engineering practices in use at the time of construction. However, the results of the present visual inspection, past inspection reports and the history of continuous deteriorated conditions and repairs indicate the presence of severe weathering conditions and sulfides from past mining operations. The unknown total effect of the corrosive conditions over the years on the strength of the concrete, the extent of corrosive damage to the steel reinforcement, the embankments built against the concrete buttresses, the poor location of the blow-off valve which partially is used to control the pool elevation, no standard operating procedures and little maintenance performed for a considerable length of time all present potential failure conditions; but these failure conditions could become more extreme during the recommended Spillway Design Flood (SDF).

b. Adequacy of Information; The information that was available exclusive of soil data and slope stability analysis was considered sufficient to make a reasonable assessment of the project, along with the ability of the dam to withstand past floods.

c. Urgency: It is considered that the recommendations suggested be taken immediately.

7.2 Recommendations/Remedial Measures

a. Facilities: In order to reassure everyone about the condition of the Bakerton Dam, we recommend the following:

(1) The Owner retain a competent consulting engineering firm to make a feasibility study and cost analysis to determine whether the existing dam is economically feasible to repair, or should it be replaced by another dam downstream from the existing facilities. The study should be completed as soon as possible, with immediate action concerning the remedial solution to follow in the near future.

(2) All tree growth and brush on the upstream and downstream embankment slopes be removed completely and the disturbed areas repaired and restored to the original condition.

(3) The floatable debris within the immediate overbank area of the reservoir and maximum high water level be removed.

(4) The seepage and small slough area on the downstream slope of the right embankment be provided with a tile drain and sand filter for adequate drainage, and the surface restored to the original shape.

(5) Barricades be installed that will prohibit the use of the downstream slope of the embankment by motor bikes and cycles.

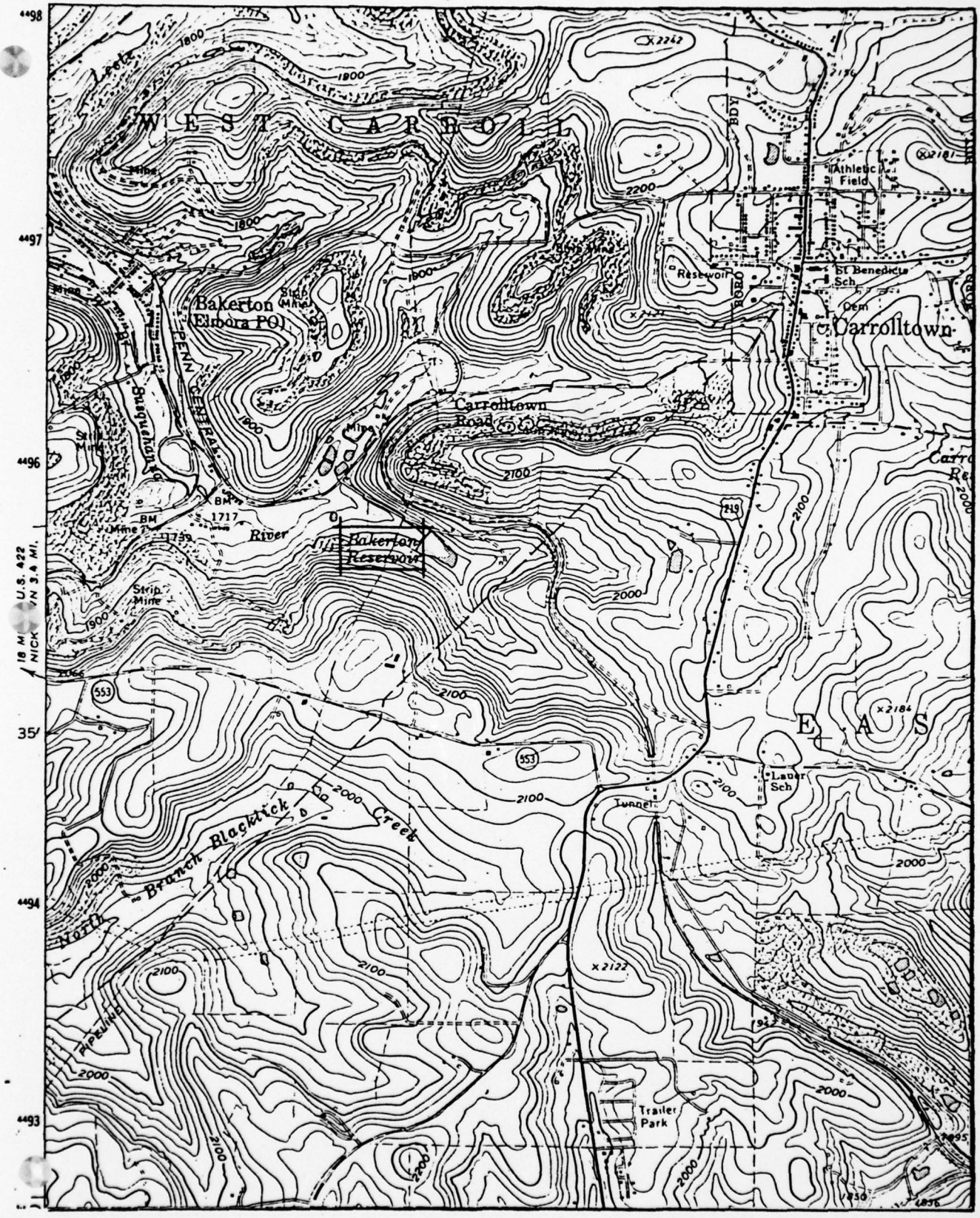
(6) The scour areas of the embankment damaged by the July 1977 flood be repaired immediately.

b. Operation and Maintenance Procedures: While the dam is maintained in poor condition, it is considered important that the following items be attended to as early as practical:

(1) The Owner should develop a formal warning system in the event of emergencies. Any emergency plan should include around the clock surveillance during periods of high precipitation to allow early detection of problems.

APPENDIX A

1. Regional Vicinity Map
2. Design Specifications (Steel and Concrete)



REGIONAL VICINITY MAP

A-1

UNIT STRESSES:—

In the various parts of the structures herein described the following unit stresses shall in no case be exceeding. Bearing power of soil for floors, etc. one (1) ton per sq. ft.

Buttresses in dompression	300	lbs. per sq. in.
Buttresses in direct shear	100	" " " "
Footings, Compression in Bending	500	" " " "
Footings, tension	0	" " " "
Footings, shear	75	" " " "
Deck and Aprons, Compression in Bending	650	" " " "
Tension in Bending	0	" " " "
Shear in Bending	60	" " " "
Steel Reinforcement Tension	16,000	" " " "
Structural Steel	16,000	" " " "

STEEL FOR REINFORCEMENT:

All steel for reinforcing concrete shall be of the sizes shown on the drawings or ordered by the ENGINEER. It shall be rolled from new medium carbon billets and no re-rolled material shall be allowed. It shall show the following physical and chemical proportions:--

Ultimate Tensile Strength --	not less than	80,000	lbs.	per sq. in
Yield Point.....	" " "	50,000	"	" " "
Elongation in eight inches	" " "	10	per centum	
Phosphorous.....	" more "	0.06	"	"
Sulphur	" " "	0.06	"	"
Manganese.....	" " "	0.80	"	"
Manganese.....	" less "	0.40	"	"

All bars must be free from injurious seams, flaws and cracks and have a workmanlike finish and before being used in

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Bakerton Dam

ID # PA 436

ITEM	REMARKS
AS-BUILT DRAWINGS	Construction as-built drawings were available.
REGIONAL VICINITY MAP	Project is shown on Carrolltown, PA Quadrangle sheet N 4030 - W 7837.5/7.5 1961 Photorevised 1972
CONSTRUCTION HISTORY	Daily construction reports by a representative of the State of Pennsylvania were available for the concrete portion of the dam.
TYPICAL SECTIONS OF DAM	Construction drawings show the type proposed of section proposed were available.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	Construction drawings of the outlet valve works were available.
RAINFALL/RESERVOIR RECORDS	None.

ITEM	REMARKS
DESIGN REPORTS	Design report prepared by the Water Supply Comm. of Pennsylvania, now PennDER, were available.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS	There was minimal hydrology and hydraulic data available.
DAM STABILITY SEEPAGE STUDIES	No formal studies.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Test pits were dug at the dam site and results were available.
POST-CONSTRUCTION SURVEYS OF DAM	Post-construction surveys performed by the Water Supply Comm. were available.
BORROW SOURCES	The design specifications indicate that the borrow area should be within the dam area.

ITEM	REMARKS
MONITORING SYSTEMS	
MODIFICATIONS	Additional downstream embankments under the spillway region of the dam.
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	Maintenance records were available for review.

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	Construction Drawings containing the spillway plan sections and details were available.
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	None

APPENDIX C

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase I

Name Dam Bakerton Dam (Bakerton Water Co.) County Cambria State Pennsylvania ID # 436 (PA 11-47)

Type of Dam Concrete and Earth Embankment Hazard Category Significant

Date(s) Inspection 3-30-78, 3-31-78 Weather Partial Cloudy Temperature 35°+ to 50°+

C-1

Pool Elevation at Time of Inspection 1816.17 M.S.L. Tailwater at Time of Inspection 1794.0 M.S.L.

Inspection Personnel:

Robert C. Tomlinson, P.E.
R. Lynn Young
Tom Venesky - Water Company
John B. Smilnak, P.E.
R. Eric Critchfield, P.E.
Dennis M. Stidinger

Robert C. Tomlinson, P.E. Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Some sloughing on right embankment approximately 35 feet downstream, area wet enough to prevent maintenance of slope. Scour on top of embankments, under spillway area, occurred during July, 77 flood.	Provide drains in wet area to relieve the condition for maintenance.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	O.K.	
RIPRAP FAILURES	Some evidence of slight settlement at water surface.	Realign rip-rap to prevent further settlement.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
TREE GROWTH	Numerous saplings growing on upstream embankment at left abutment	Remove
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	OK	
ANY NOTICEABLE SEEPAGE	Seepage along concrete structure, visable at crib walls, at the time inspection the snow has just melted, snow was approximately 48 inches deep.	Seepage should be checked during the summer months or dry weather.
STAFF GAGE AND RECORDER	No staff gage or recorder	
DRAINS	No down drains. Weep holes in bottom of foundation mat. Where visible, minimum flow present.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Several locations were found where water is seeping slightly through the concrete deck that spans the concrete buttresses. Calcium build up approximately 1/2" thick where water is running down the slab.	Check concrete for structural soundness and try to prevent further seepage.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Concrete deteriorated	Repair deteriorated areas
DRAINS	Visiable drains are in the concrete mattress only and are for relief of hydrostatic pressure. Other drains, if any, are covered. Iron deposit build up can be seen around the drains.	
WATER PASSAGES	No evidence	
FOUNDATION	Foundation appears to be stable and good. No apparent evidence of movement. Downstream end of foundation mat in area of outlet works and adjacent panels deteriorating badly.	Should have been repaired many years ago.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Numerous area of this dam had been gunited and many surface cracks could be seen in the gunite and original concrete. (Steel reinforcing exposed).	Repair or pressure mortar all cracks surface area to prevent further deterioration.
STRUCTURAL CRACKING	Only at the overflow low flow spillway area; construction joint separation due to ice build up	Repair area to prevent complete separation.
VERTICAL AND HORIZONTAL ALIGNMENT	OK There doesn't seem to be any apparent movement, both horizontal and vertical.	
MONOLITH JOINTS	No evidence of expansion joints. Monolith joints of sloping slab has some slight seepage.	
CONSTRUCTION JOINTS	Some deterioration at several locations	Repair deteriorated areas
STAFF GAGE OF RECORDER	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No outlet conduit	
INTAKE STRUCTURE	No intake structure	
OUTLET STRUCTURE	Built into concrete portion of dam, poor, location, not easily accessable during flooding conditions. Flanged piping severely rusted.	Needs rusted areas removed to get a better look at condition. (poor maintenance)
OUTLET CHANNEL	Main outlet channel unpaved and overgrown with some bursh and trees. Outlet channel from drain pipe paved to main channel.	Downstream channel should have riprap protection.
EMERGENCY GATE	12" gave valve (blow-off)	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None	
APPROACH CHANNEL	None	
DISCHARGE CHANNEL	Channel is the existing ground that contains gravel and boulders, some scour adjacent to concrete mattress and on low flow channel banks; trees growing in channel.	Should have larger material such as riprap placed and trees removed
BRIDGE AND PIERS	None	

INSTRUMENTATION

VISUAL EXAMINATION OF	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	Appear to be stable, but considerable amounts of floatable debris is within the highwater areas of reservoir and several trees adjacent to the present shore line could become unstable at high entrance flows.	Remove debris and trees adjacent to shore line.
SEDIMENTATION	Some sedimentation where the two channel enter the reservoir, doesn't appear to be extensive. Caretaker says sedimentation more prominent than is evident.	Doesn't seem to be extensive.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Floatable debris lcoated just below the spillway, pipe under road to valve house appears to be inadequate and considerable areas need turf.	Remove debris and reseed disturbed areas.
SLOPES	OK	
APPROXIMATE NO. OF HOMES AND POPULATION	Without some survey work, it would appear that may be only a few homes would be destroyed by flood. Even downstream in Bakerton, it would appear that the majority of the homes would be above the high water elevation.	

APPENDIX D

HYDRAULICS AND HYDROLOGY

CHECK LIST

HYDROLOGIC AND HYDRAULIC

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Roughly trapezoidal in shape with steep slopes

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1816.0 (12,000,000 gallons)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): _____

ELEVATION MAXIMUM DESIGN POOL: 1817.5

ELEVATION TOP DAM: 1820.0

CREST:

a. Elevation 1816.0 (low flow), 1816.5 (2nd level), 1818.0 (3rd level)
b. Type broad crested weir
c. Width 2.0
d. Length 22' (low flow), 130' (2nd level) 204' (3rd level)
e. Location Spillover middle of structure
f. Number and Type of Gates 1 - 8" flanged gate valve

OUTLET WORKS:

a. Type 12" blow-off & 8" water supply line
b. Location approximately in middle of concrete portion of the dam
c. Entrance inverts unknown
d. Exit inverts unknown
e. Emergency draindown facilities 12" blow-off

HYDROMETEOROLOGICAL GAGES:

a. Type None
b. Location _____
c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: Not available

SURFACE AREA @ NORMAL POOL EL. OF 1816.0 = 4.3 AC
SURFACE AREA @ MAX. POOL EL. OF 1819.5 = 5.5 AC

STORAGE AVAILABLE ABOVE NORMAL POOL ELEVATION

$$= \frac{(4.3+5.5)}{2} \times 3.5' = 17.2 \text{ ACRE-Ft}$$

USING SHORTCUT METHOD SUGGESTED BY NAD

MAX. SPILLWAY DISCHARGE = 2525 CFS
PMF PEAK INFLOW (Q_{IMAX}) = 2992 CFS

$$P = \frac{\text{MAX. SPILLWAY DISCHARGE}}{\text{PMF PEAK INFLOW}} = \frac{2525}{2992} = .84$$

$$\therefore (1-P) = \frac{\text{REQUIRED RESERVOIR STORAGE}}{\text{VOLUME OF INFLOW HYDROGRAPH}} = .16$$

VOLUME OF INFLOW HYDROGRAPH (V)

Assuming a Triangular Shape

Total Time (T) = 20 Hrs. (From Plot of Total Time vs Drainage Area (D.A.) for D.A. = 0.81 MI^2

$$V = \tfrac{1}{2}(Q_{IMAX})(T) = \tfrac{1}{2}(2992 \text{ CFS})(20 \text{ Hrs})\left(\frac{\text{acre}}{43{,}560 \text{ ft}^2}\right)\left(\frac{3600 \text{ sec}}{\text{Hr.}}\right)$$

V = 2473 ACRE-Ft

REQUIRED RESERVOIR STORAGE = 0.16 (2473)
= 428 ACRE-Ft

STORAGE AVAILABLE = 17.2 ACRE-Ft < 396 ACRE-Ft

∴ BAKERTON RESERVOIR WILL NOT BE ABLE TO CONTAIN THE PMF WITHOUT BEING OVERTOPPED.

HAZARD CLASSIFICATION : SIGNIFICANT
SIZE " : SMALL
DRAINAGE AREA = 0.81 MI²

NO UPSTREAM IMPOUNDMENTS

RECOMMENDED SDF = ½ PMF

EST. MAX. SPILLWAY CAPACITY = 2525 CFS (SEE ATTACHED SHEET)

TRANSPOSE DATA FOR CHEST CREEK DAM

CHEST CREEK DAM - DRAINAGE AREA (DA) = 38 MI²

SPILLWAY DESIGN FLOOD (PMF) PEAK INFLOW = 65,000 CFS

USING 0.8 rule to transpose data to Bakerton Dam

$$\left(\frac{D.A._{Bakerton}}{D.A._{Chest\ Crk.}}\right)^{0.8} = \frac{PMF_{Bakerton}}{PMF_{Chest\ Creek}}$$

$$\left(\frac{0.81}{38}\right)^{0.8} = \frac{PMF_{Bakerton}}{65{,}000\ CFS} \Rightarrow PMF_{Bakerton} = 2992\ CFS$$

½ PMF = ½ · 2992 CFS = 1496 CFS < 2525 CFS

∴ SPILLWAY CAN BE ASSUMED TO BE ABLE TO PASS THE DEFINED PMF WITHOUT OVERTOPPING THE DAM.

EADS

gwin engineers, inc.

1126 Eighth Avenue
Altoona, Pennsylvania 16602

SUBJECT Dam Safety Inspection — Spillway Capacity — SHEET NO. 1 OF 1 — JOB NO.

DRAWN BY — DATE — CHKD. BY

Computations for Spillway Capacity for Bakerton Dam.

Normal Spillway Capacity

$Q = C_w L h^{3/2}$ where $C_w = 3.0$, $L = 22'$, $h = 0.5'$

$Q = 3.0 \times 22 \times 0.5^{3/2} = 23.3$ cfs

Normal and Overflow Spillway Capacity

$L_n = 22'$ & $h_n = 2.0'$

$L_e = 108'$ & $h_e = 1.5$

$Q = 3.0\,(22)(2.0)^{3/2} + 3.0\,(108)(1.5)^{3/2}$

$= 187 + 595 = 782$ cfs (DER value is 525 cfs)

Normal + Emergency + Concrete Crest of Dam

$L_n = 22'$ & $h_n = 3.5'$

$L_e = 108'$ & $h_n = 3.0'$

$L_c = 74'$ & $h_n = 1.5'$ (0.5' below top of dam)

$Q = 3.0(22)(3.5)^{3/2} + 3.0(108)(3.0)^{3/2} + 3.0(74)(1.5)^{3/2}$

$= 432 + 1684 + 408 = 2525$ cfs

APPENDIX E

GEOLOGY

GEOLOGY

The project is located in the Appalachian Plateau Province a short distance west of the Allegheny Front. The region is characterized by generally hilly terrain composed of broad, rounded divides of concordant altitude from which the surface descends rapidly to streams having little bottom land.

The surface formations of the area are entirely of sedimentary origin consisting of Pennsylvania age strata. The project area is underlain by rocks of the Kittanning Formations, Allegheny Group. The Allegheny Group consists of an irregular series of alternating shales and sandstones with several workable coal beds and accompanying underclays. Locally the Allegheny Group averages 300 feet in thickness. It is delineated by Upper Freeport coal, its "uppermost" member, and the base of the Brookville coal underclay. The Group contains seven significant coal seams: the Brookville, Clarion, Lower, Middle and Upper Kittanning, and the Lower and Upper Freeport.

Structurally, the project area lies on the western limb of the Laurel Hill Anticline, very near the anticlinal crest. The strata strikes approximately N 15 E and dips are gently, less than 2% to the west.

Local outcrops are generally soft, somewhat carbonaceous shales badly broken and moderately weathered where exposed. The Lower Kittanning coal outcrops at approximately 1,800 feet and has been strip mined just below the reservoir. There was no surficial evidence of faulting, locally.

APPENDIX F

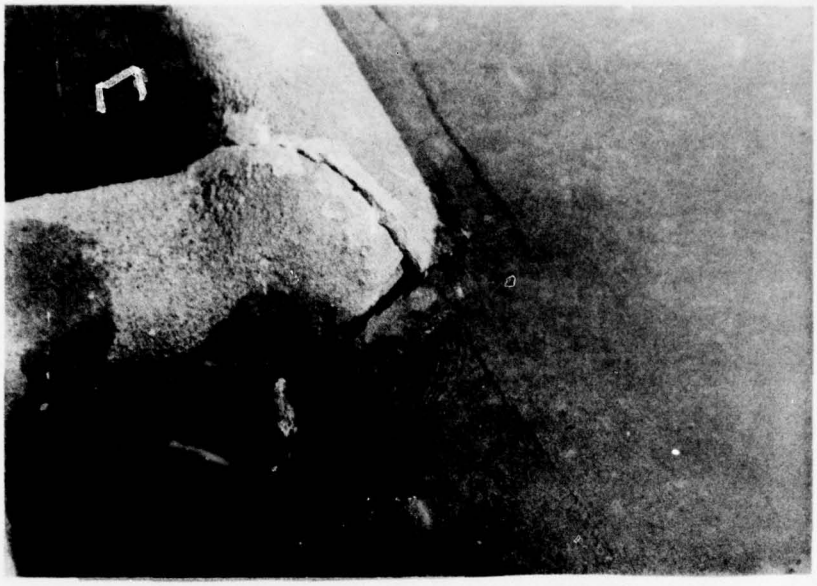
PHOTOGRAPHS

AND

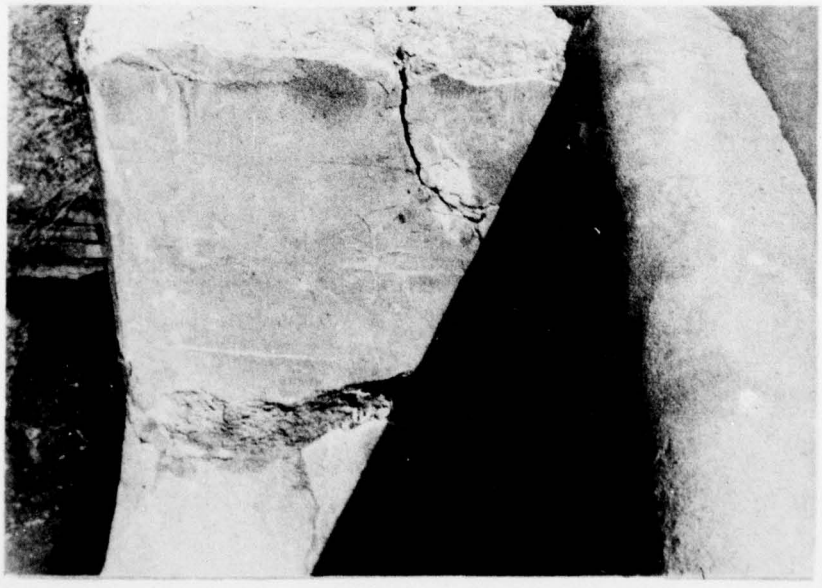
DRAWINGS

CENTERLINE VIEW OF TOP OF DAM LOOKING
SOUTHWEST, SHOWING ALIGNMENT

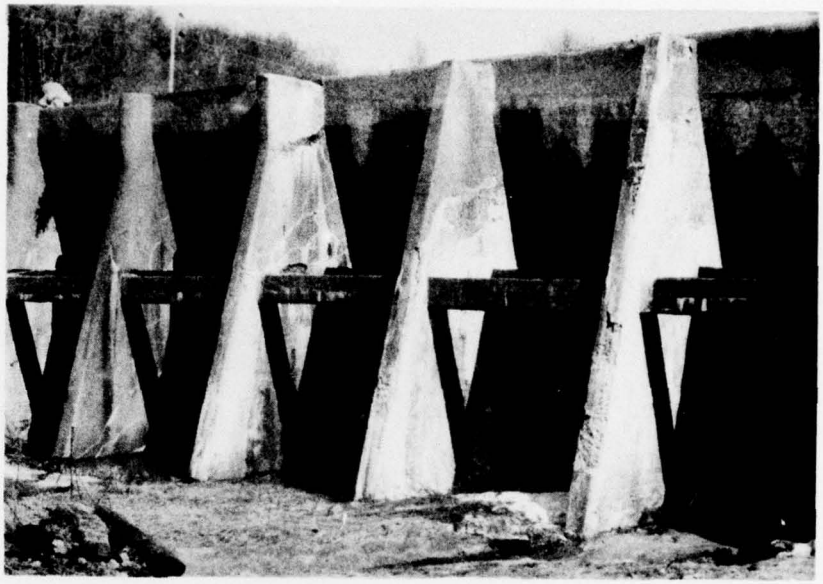
VIEW SHOWING VALVE HOUSE LOCATION AND
JULY, 1977 FLOOD DAMAGE BEHIND CRIBBING



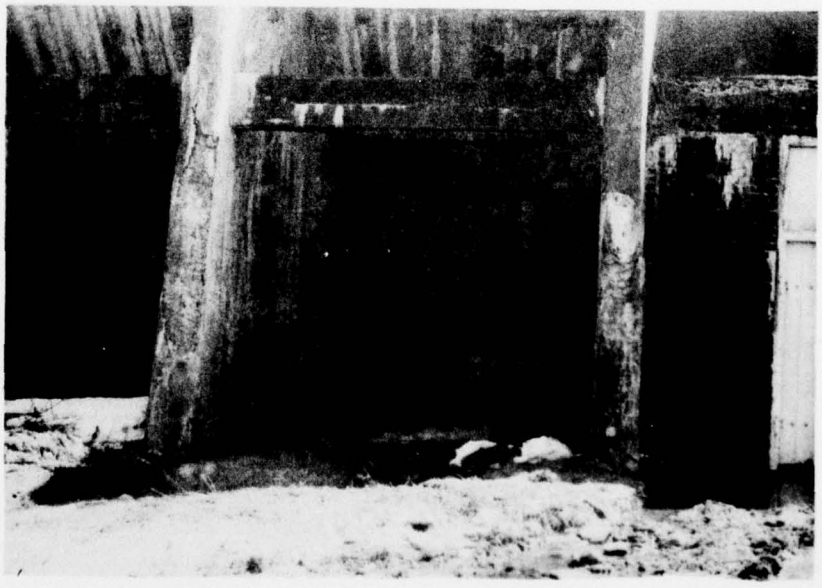
CLOSEUP VIEW OF LARGE CRACK AT NORTHERN
END OF RECTANGULAR DROP-TYPE SPILLWAY



CLOSEUP VIEW SHOWING CONCRETE DETERIORATION
AT NORTHERN END OF EMERGENCY SPILLWAY



GENERAL VIEW OF CENTER SECTION OF DAM
SHOWING CONDITION OF CONCRETE DAM



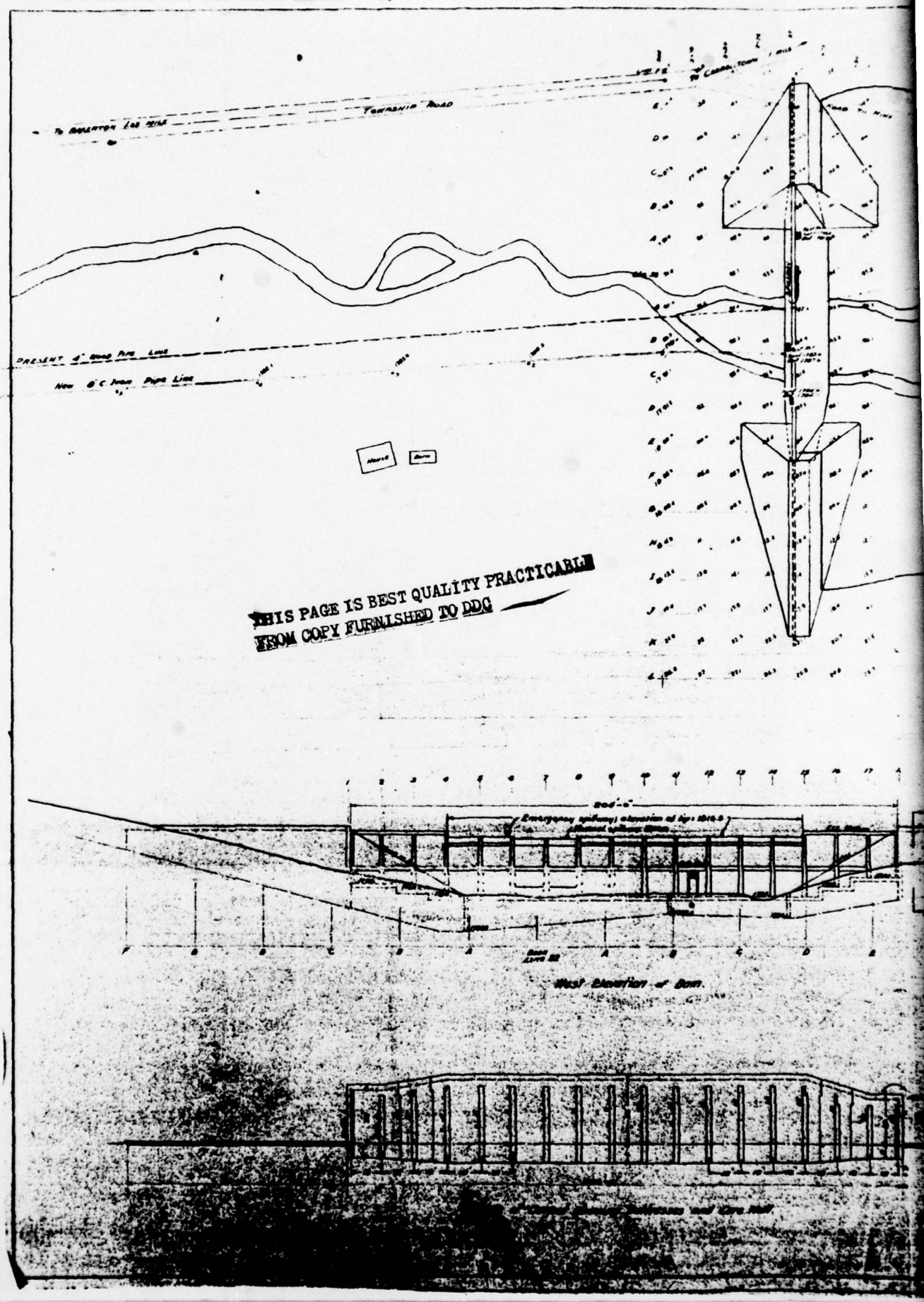
GENERAL VIEW OF TYPICAL BAY OF DAM

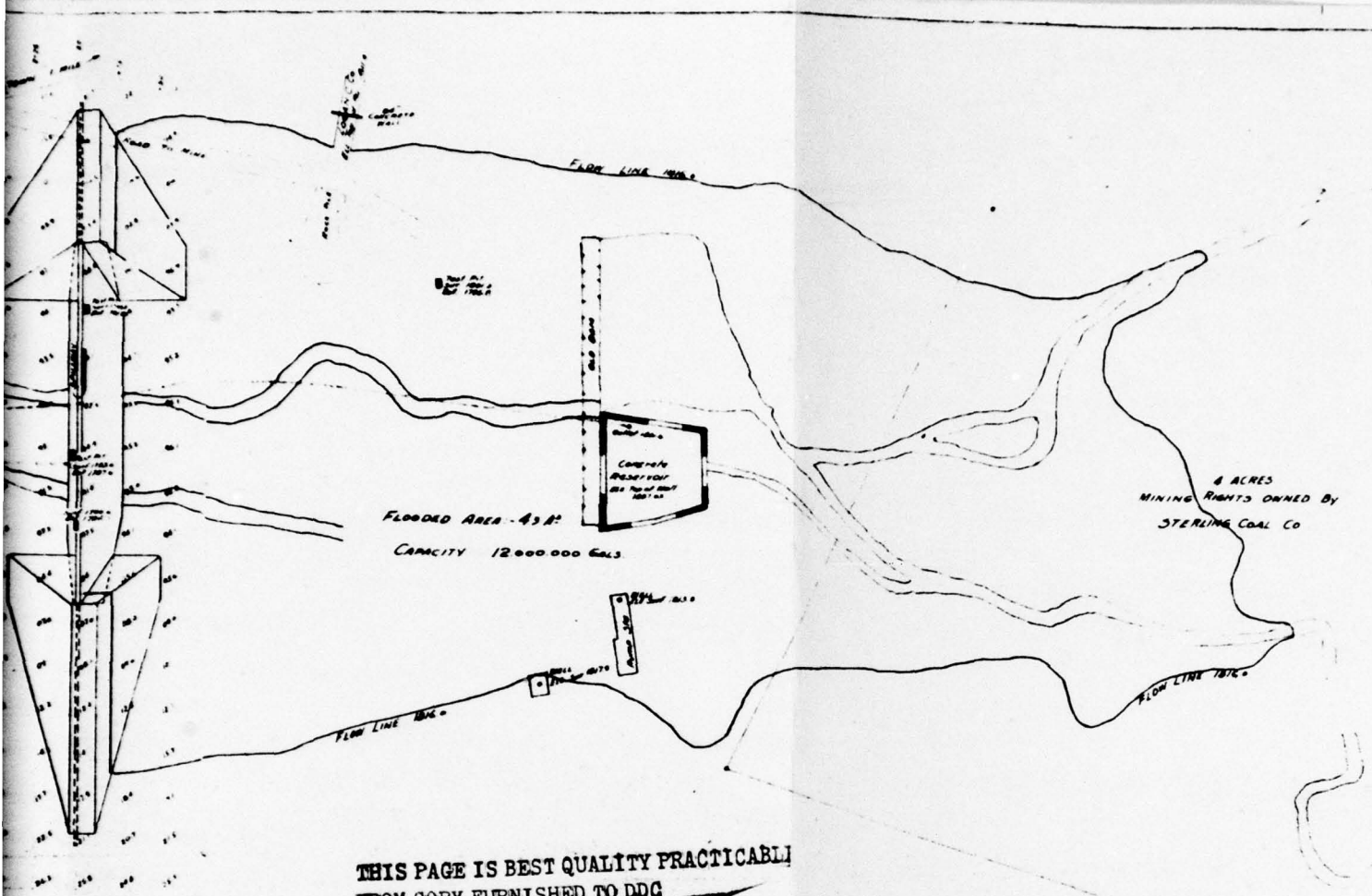
SLOUGH ON NORTHERN FACE OF EMBANKMENT

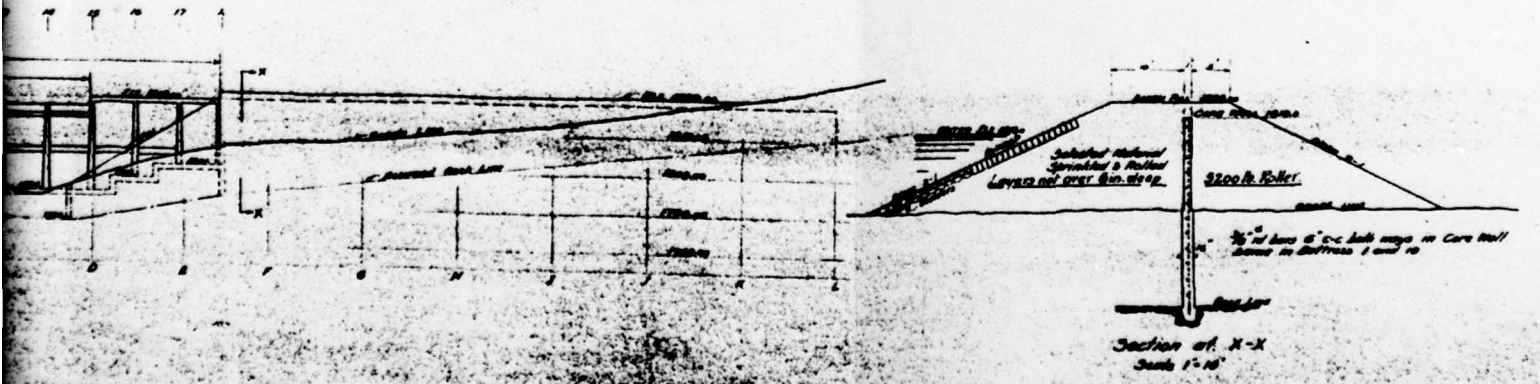
TYPICAL VIEW OF DOWNSTREAM CHANNEL
WITH CHLORINATION BUILDING AT LEFT

CONCRETE DETERIORATION OF UNDERFACE
OF 45° INCLINED SLAB

GENERAL VIEW OF NORTHERN PORTION OF DAM

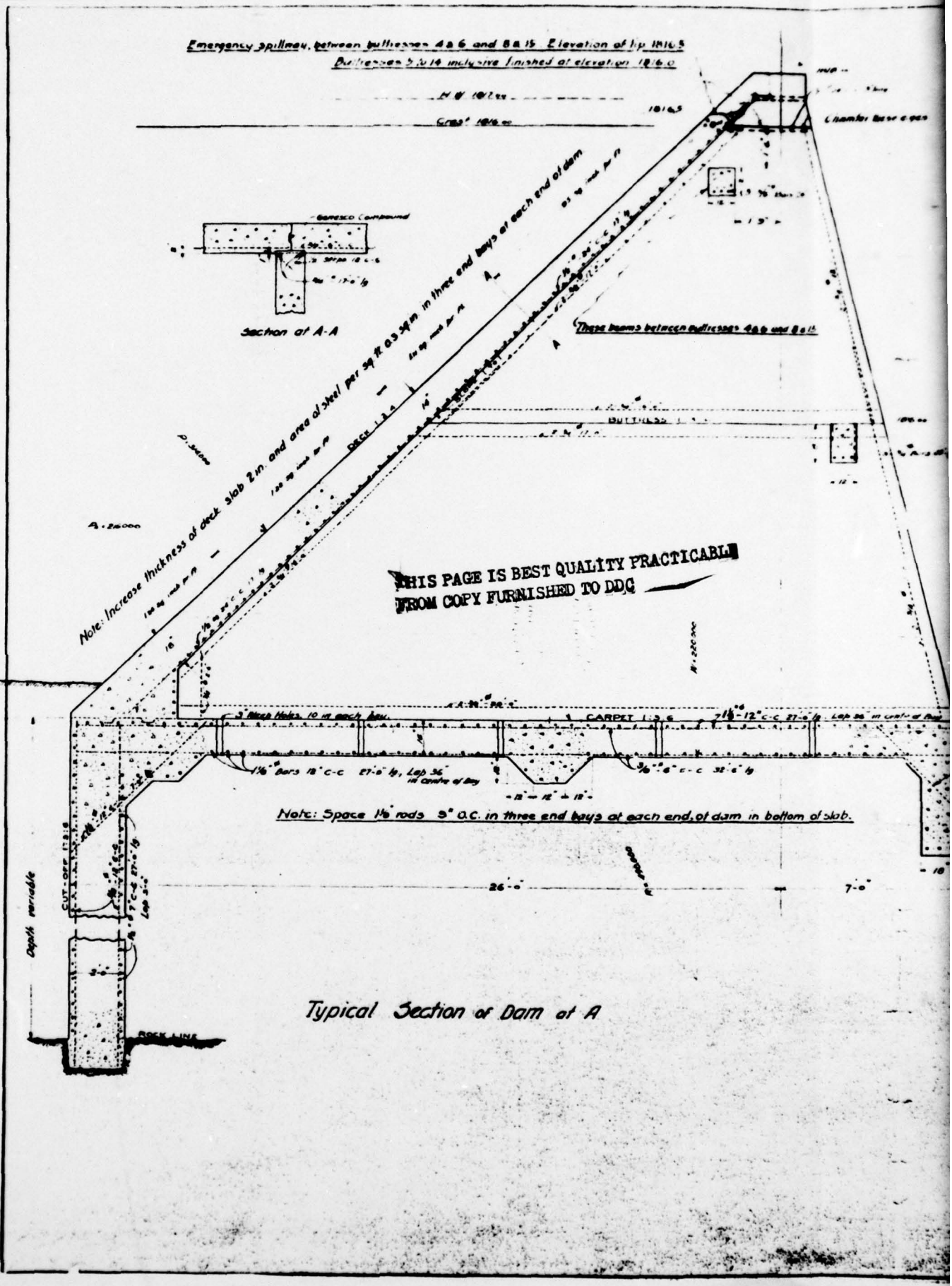


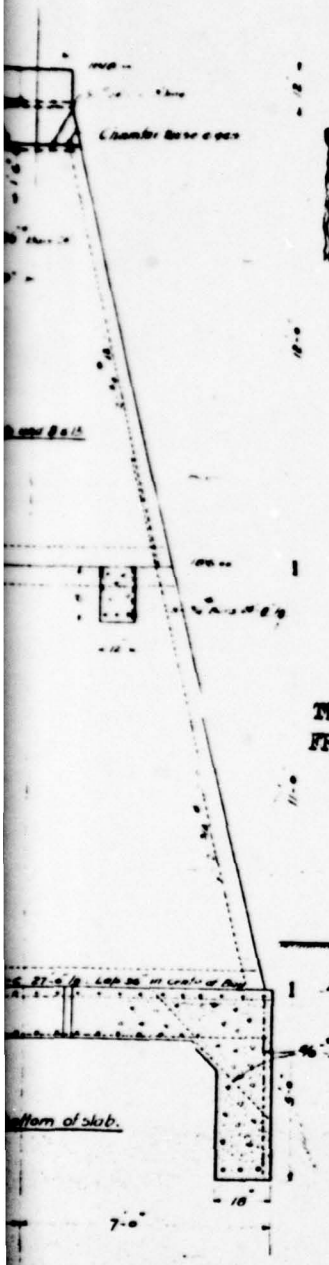


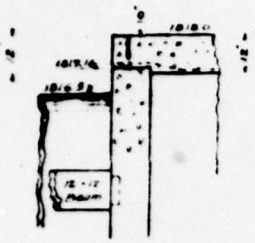


GENERAL PLAN OF DAM
BAKERTON WATER COMPANY
BAKERTON, CAMDENS COUNTY, PENNA.

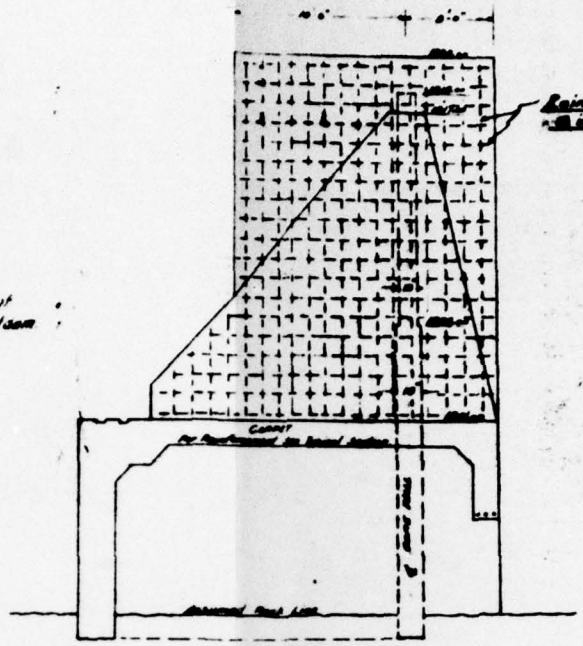
ABBURREN CORPORATION — Consulting Engineers



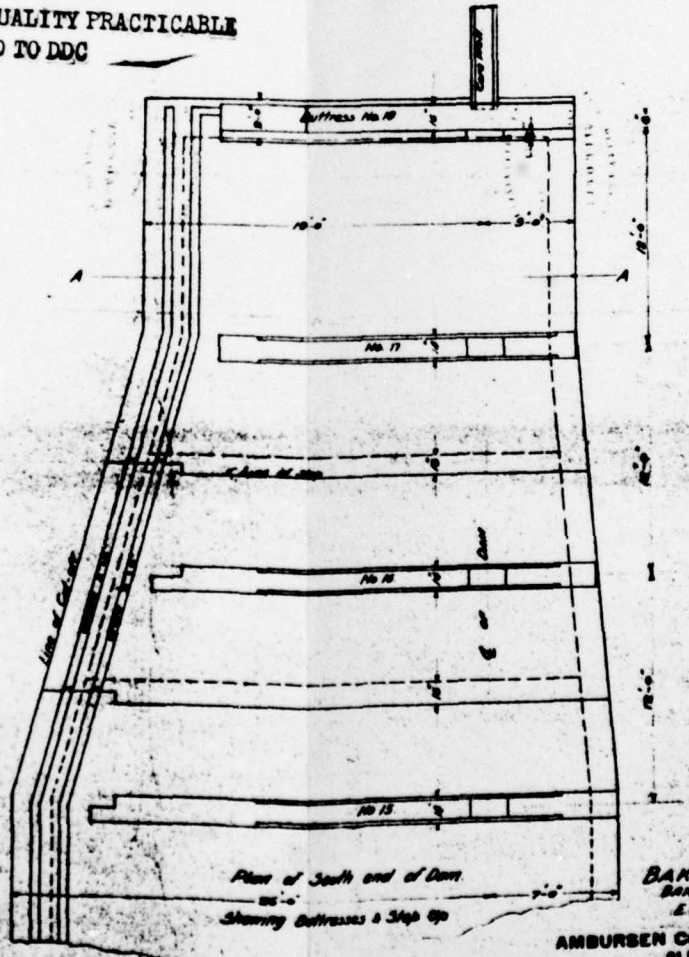




Section thru Buttress No 15
Showing continuation of deck slab over top of buttresses for three and two spans at each end of dam



Section of A-A



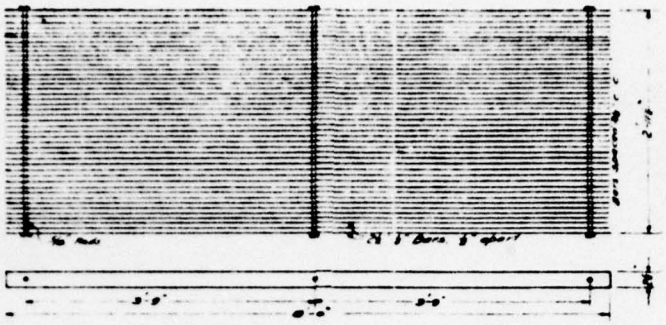
Plan of South end of Dam
Showing Buttresses & Slab Up

SECTION OF DAM
BAKERTON WATER COMPANY
BAKERTON, CAMBRIA COUNTY, PENNA
E. M. Hood, Engr. CLEARFIELD, PA.

AMBURSEN CONSTR. CO. INC. ENGINEER-CONTRACTORS
61 BROADWAY, NEW YORK

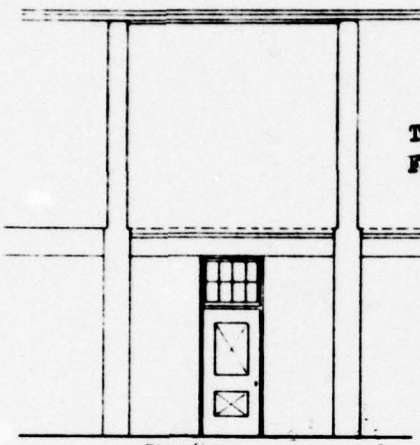
1903

2

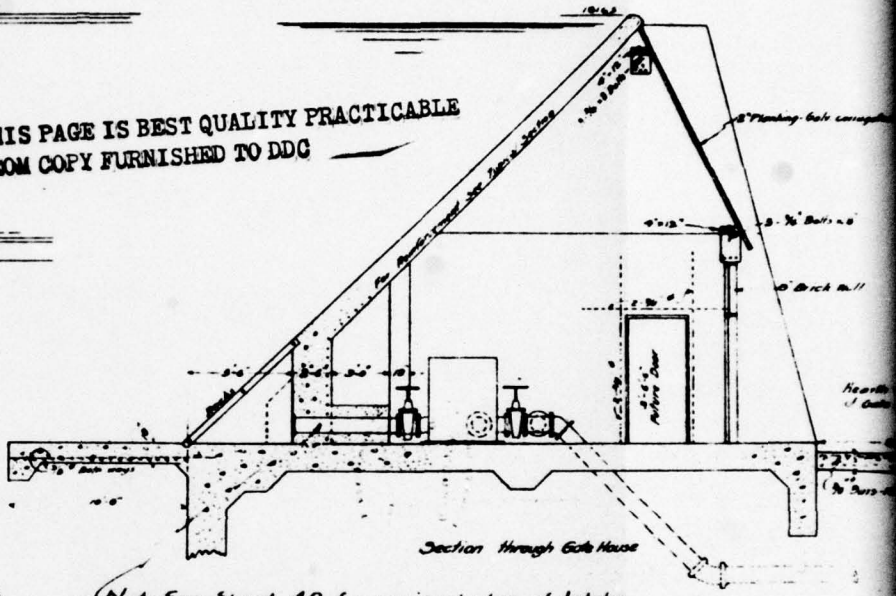


Detail of Racks Note 3 This

See Sheet 4-A Revision of racks

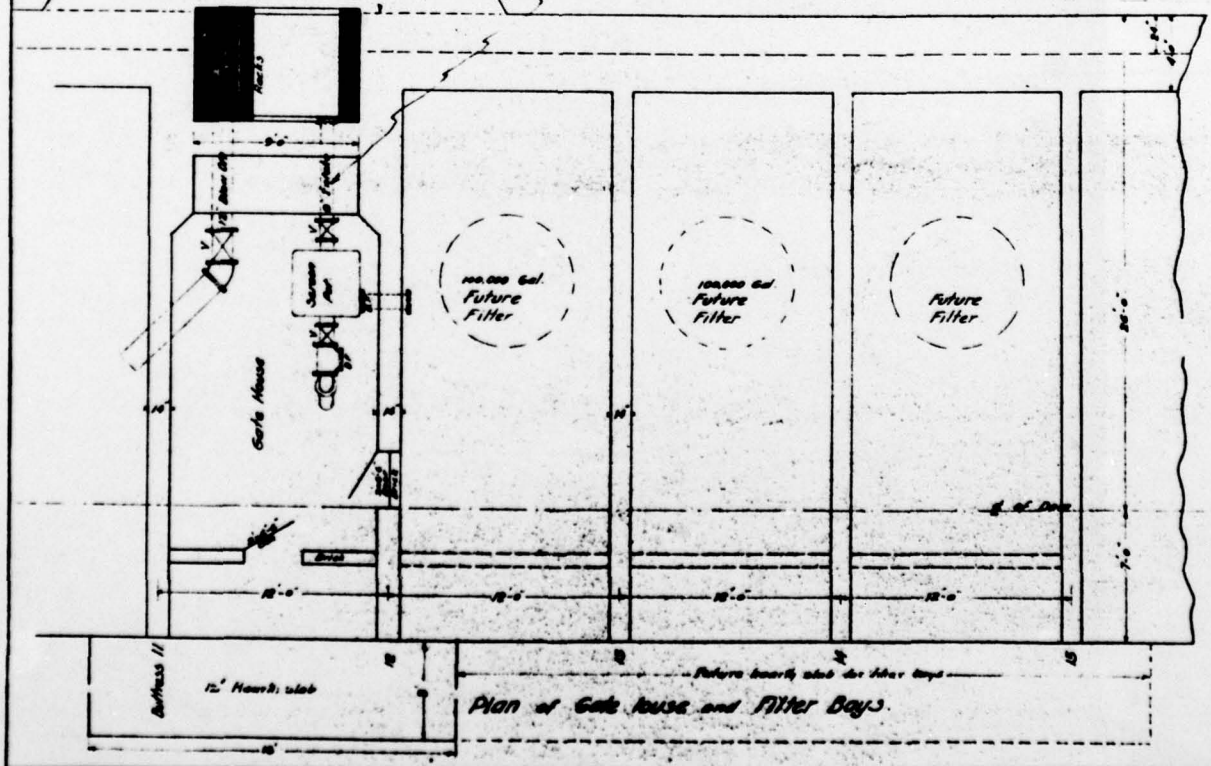


Elevation



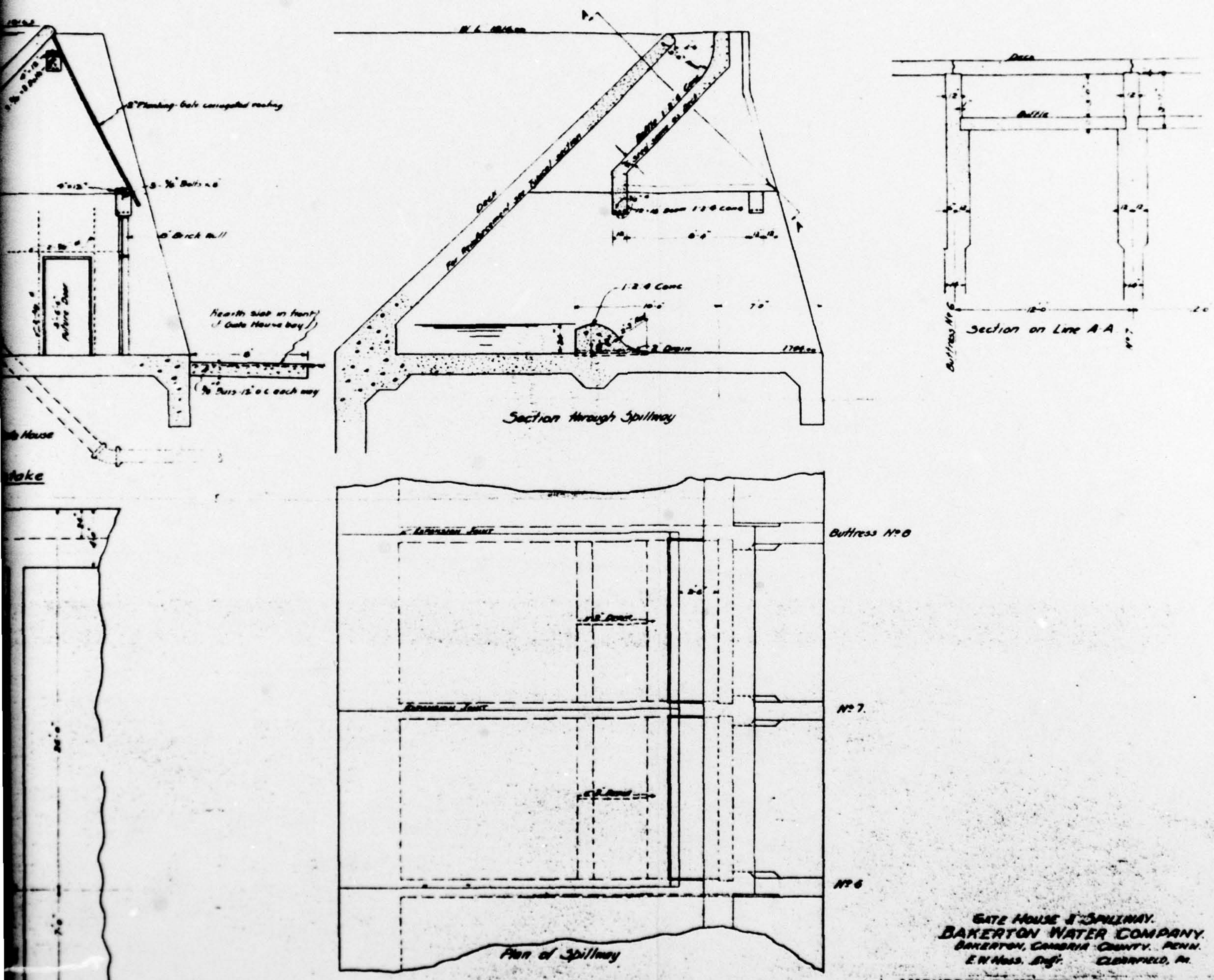
Section through Gate House

Note See Sheet 4A for revised plan of Intake



Plan of Gate house and filter Bays

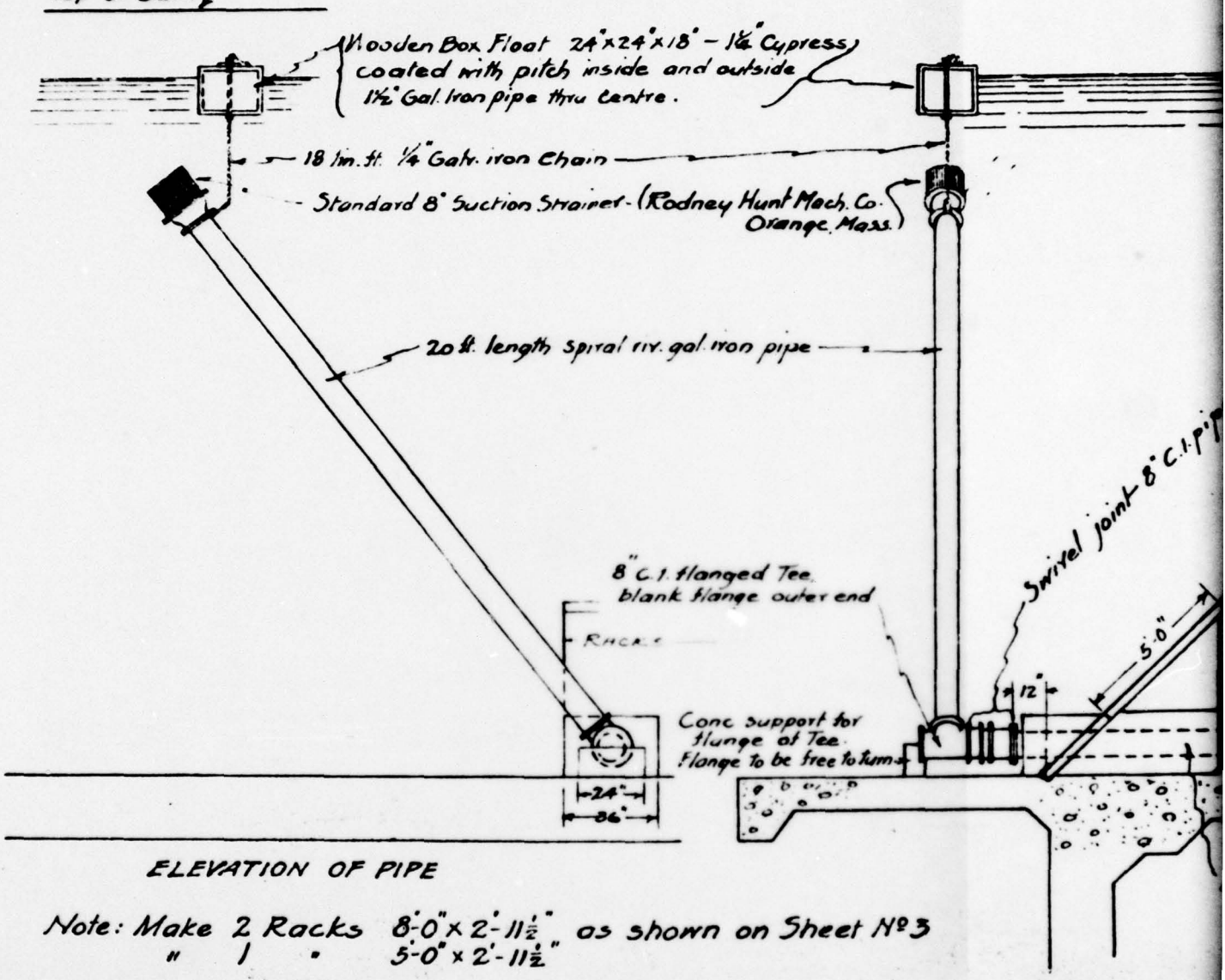
Sheet 4A Revision of racks.



GATE HOUSE & SPILLWAY.
BAKERTON WATER COMPANY.
BAKERTON, CAMBRIA COUNTY, PENN.
E.W. Moss, Engr. CLEARFIELD, PA.

AMBURSEN CONST. CO. ENGINEER-CONSTRUCTORS
61 BROADWAY, NEW YORK.

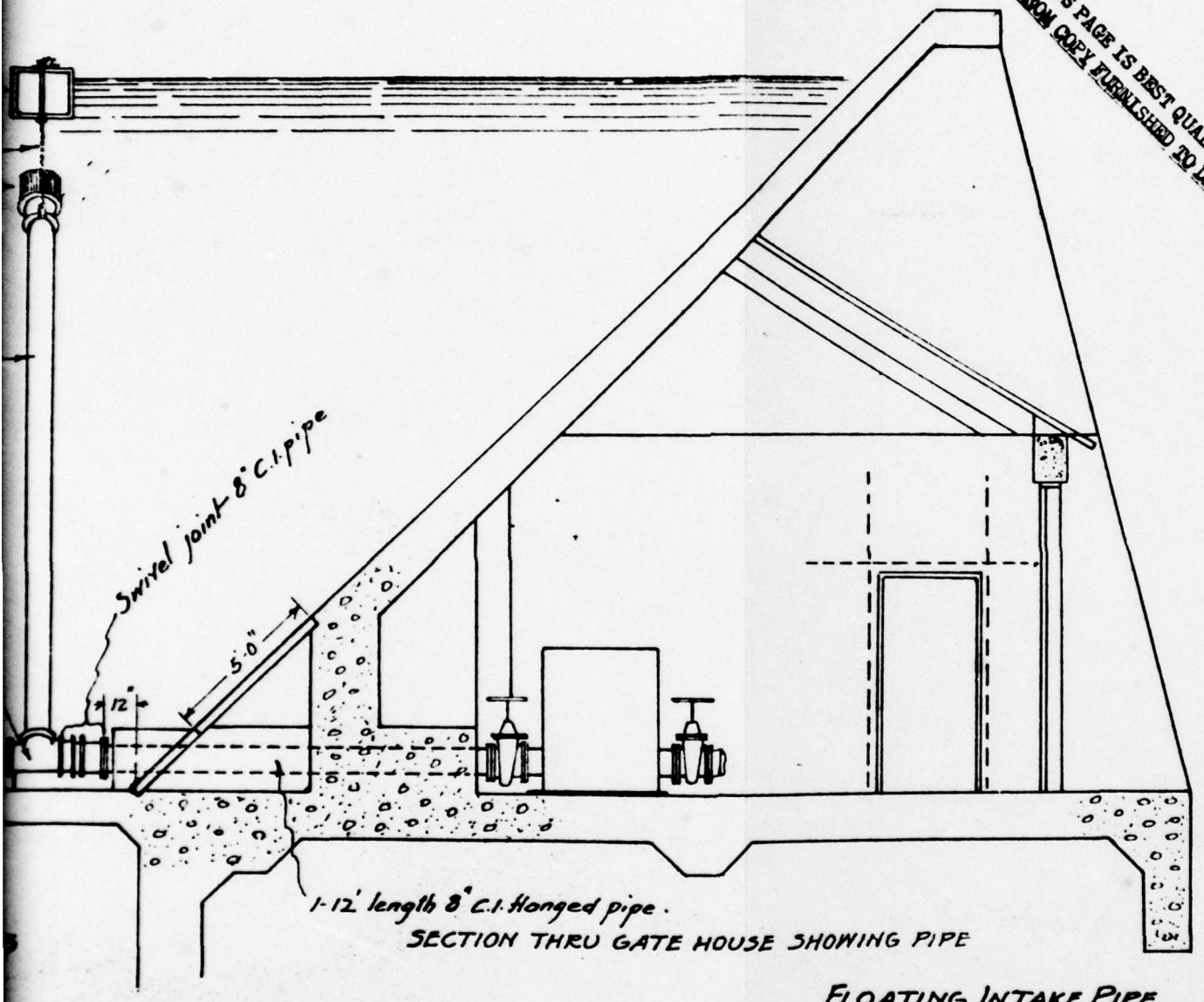
DRAWN	JOB NUMBER	1903
TRACED		
CHECKED	SCALE	SHEET NUMBER
APPROVED	1/4" = 1 FT.	3



ELEVATION OF PIPE

Note: Make 2 Racks 8'-0" x 2'-11½" as shown on Sheet No 3
" 1 " 5'-0" x 2'-11½"

Note: This Sheet supersedes Sheet No 3 in respect to Intake Pipe and



SECTION THRU GATE HOUSE SHOWING PIPE

FLOATING INTAKE PIPE
BAKERTON WATER COMPANY
BAKERTON, CAMBRIA COUNTY, PENNA.
E.W. Hess, Engr CLEARFIELD, PA.

AMBURSEN CONST. CO. – ENGINEER-CONSTRUCTORS.
61 BROADWAY, NEW YORK.

DRAWN 4/2 1919 BY E.J. REVISED ..... 19..... BY		JOB NUMBER 1903
TRACED 4/3 1919 BY E.J. ..... 19..... BY		
CHECKED ..... 19..... BY	SCALE ¼" - 1'	DRAWING NUMBER 4A
APPROVED		

Intake Pipe and Racks.