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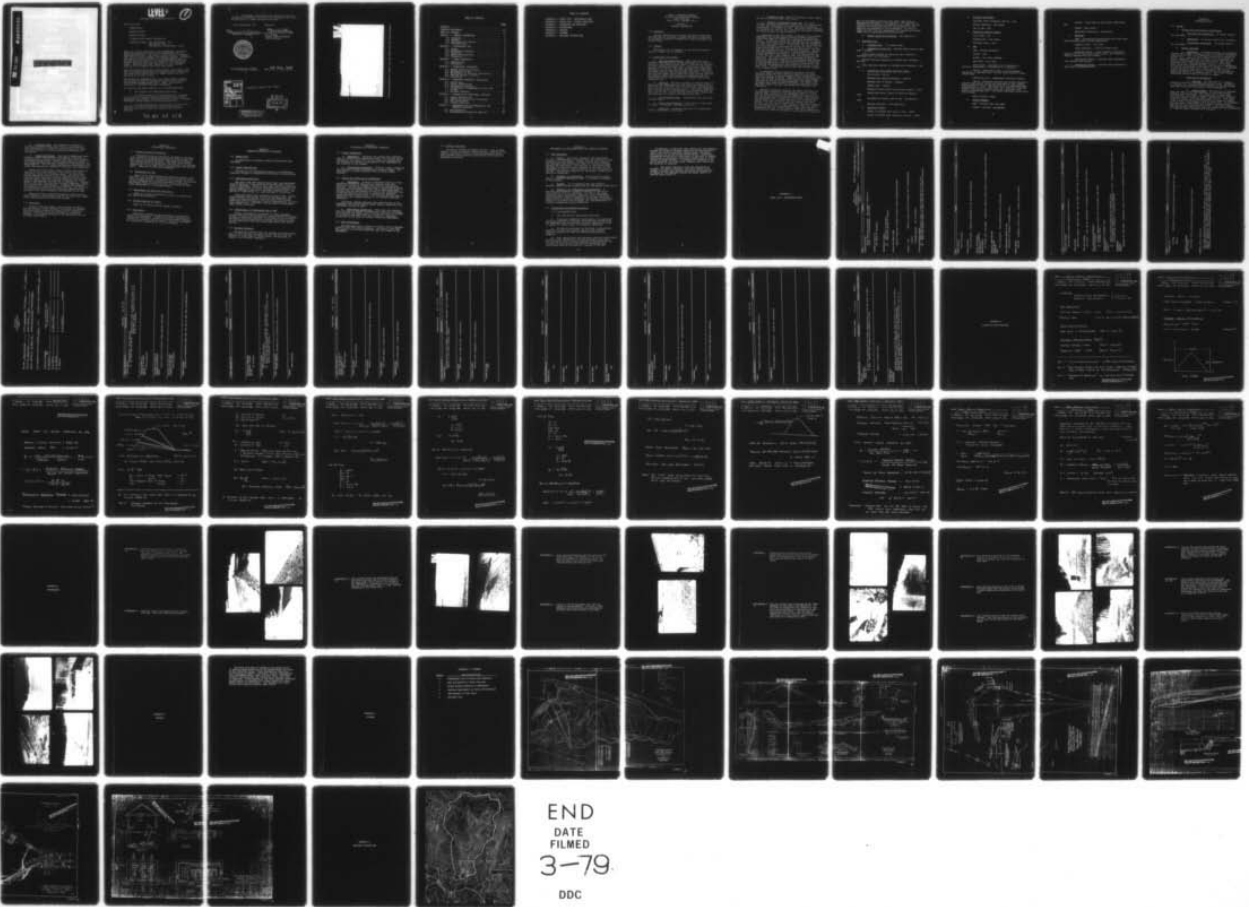
GAI CONSULTANTS INC MONROEVILLE PA
NATIONAL DAM INSPECTION PROGRAM. GREEN LICK DAM (NDI PA-219), 0--ETC(U)
JUN 78

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Green Lick Dam (NDI PA-219), Ohio River
Basin, Green Lick Run, Fayette County,
Pennsylvania. Phase I Inspection Report.

LEVEL II

PHASE I REPORT

National Dam Inspection Program



Green Lick Dam

Pennsylvania

Fayette County

Green Lick Run

27 April 1978 (visual inspection)

Inspection Team - GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

Based on a visual inspection, past performance, and available engineering data, the dam is considered to be in a dangerous condition. The facility has a history of embankment failure, major leakage, and remedial repairs. Currently, the owner, Municipal Authority of Westmoreland County, is drawing down the reservoir to investigate and/or evaluate leakage emanating from near the middle of the embankment slope. This area was also "repaired" in 1975, however, details of the remedial work were unavailable.

This facility has been out of full service since March 1978, and is currently maintained for emergency water supply only. The owner indicated an intent to repair and/or sell the facility in the near future.

The project is considered to be in a high hazard classification and the facility cannot pass and/or store one-half the Probable Maximum Flood (PMF). Thus, the spillway capacity is considered seriously inadequate.

In light of the above findings, it is recommended that:

1. The reservoir be completely drawn down.
2. A detailed subsurface investigation be conducted by the owner to evaluate the structural integrity of the embankment and determine necessary remedial action to ensure embankment safety under all operating conditions.
3. A study be performed, by the owner, to accurately ascertain the spillway capacity required and remedial measures necessary to make the spillway hydraulically adequate.

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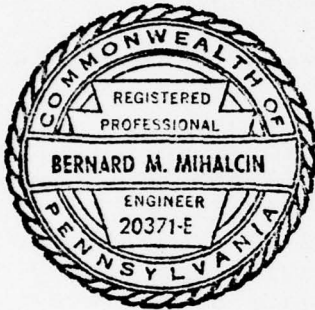
4. Embankment surveillance and evacuation plans be established to protect all downstream residences that could be affected by a sudden failure of the dam.

GAI Consultants, Inc.

Approved:

Bernard M. Mihalcin
Bernard M. Mihalcin, P.E.

G. K. Withers
G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

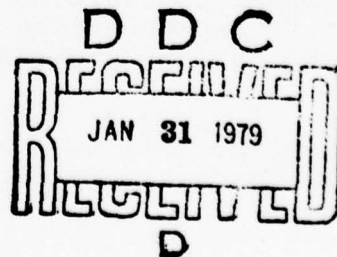


Date July 6, 1978

Date 28 July 1978

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Overview Photograph of Green Lick Dam Taken from the Right Abutment.

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
GREEN LICK DAM
NDI# PA-219, PENNDER# 26-19

SECTION 1
GENERAL INFORMATION

1.0 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.

1.1 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. Green Lick Dam is an earthfill structure built in 1901 and modified in 1910 to include a clay puddle cutoff trench to rock at the upstream toe and a masonry upstream slope. A concrete lined chute spillway is located at the right abutment which eventually discharges over a near-vertical rock face into Green Lick Run about 300 feet from the spillway structure. A blow-off pipe and two supply pipes (with high level intakes lying on the masonry slope) pass beneath the embankment and are controlled by gate valves located in a gate house at the downstream toe.

b. Location. The dam is located in Fayette County on Green Lick Run approximately 1,800 feet from Pennsylvania Route 982 and 5,000 feet from its confluence with Latta Run. The structure is shown on the U.S.G.S. 7.5 minute quadrangle sheet, Connellsville, Pennsylvania, at coordinates N40° 06' 20", E79° 30' 25". Green Lick Run enters into Jacobs Creek approximately two miles to the west of the dam.

c. Size Classification. Intermediate (61 feet high, 500 acre-feet).

d. Hazard Classification. High hazard (4 dwellings, 16 people, estimated. See Section 3.1.3).

e. Ownership. Municipal Authority of Westmoreland County, Greensburg, Pennsylvania.

f. Purpose of Dam. Back-up (emergency) water supply. Out of full service since March 1978.

g. History of Construction and Use. The first recorded detailed inspection of Green Lick Dam (constructed in 1901) was conducted by the Water Resource Commission (predecessor of PennDER) in 1914. The report which followed is the basis for most of the information available concerning the early history of this structure.

According to the 1914 report, a portion of the earthen embankment was placed during freezing weather producing clods which were not broken up or properly compacted when rolled. In addition, there was some question as to whether the clay puddle was carried deep enough into the foundation to serve as a cutoff wall. At any rate, the dam failed near its right abutment on the morning of July 14, 1904. The breach which developed is said to have been about 150 feet wide and extended to rock, a limestone formation. Repairs were made immediately; however, a considerable amount of leakage apparently continued to flow from beneath the dam. In 1909 and 1910, some remedial work was performed on the structure. The repairs consisted primarily of placing additional impervious material on the upstream face thereby flattening the slope. They also constructed a cutoff wall at the upstream toe of the dam which was faced by two feet of masonry and backed by a clay puddle wall which is four feet thick. The upstream face of the dam was then covered with a masonry face.

A subsequent report issued by the Water and Power Resources Board mentioned various problems at the site including slides on the downstream slope, settlement of the crest and seepage problems. However, more recent reports in 1940 and the last available state inspection report dated 1961 make no mention of these problems. The reports did recommend that some erosion protection be provided in the spillway channel and that the channel be cleared of any vegetation.

During an interview with Mr. Ken Baker (engineer for the Municipal Authority of Westmoreland County), it was learned that a portion of the embankment was repaired in 1975 to correct seepage that was apparently emanating from the downstream face. According to Mr. Baker, the program was successful and they were operating the reservoir at design level until recently when the seepage was again noticed. At the time of inspection, we noted that a portion of the downstream face of the embankment (near the center) had settled and that considerable seepage could be seen flowing beneath the riprap surface. The water company was proceeding to lower the reservoir level about six inches per

day (to presumably below the seep level) and plans an engineering assessment of the problem. The reservoir is currently being used as an emergency water supply and the Authority has indicated that its future plans for the facility are dependent on this assessment. On June 23 (about 39 days from our inspection) the reservoir had been drawn down to approximately elevation 1230.

h. Normal Operating Procedure. See Section 4.1.

1.3 Pertinent Data.

a. Drainage Area. 3.4 square miles.

b. Discharge at Dam Site. Maximum known flood at dam site - unknown.

Outlet works conduit at operating pool elevation - discharge curve not available.

Ungated spillway capacity at maximum pool elevation - 844 cfs.

Total spillway capacity at maximum pool elevation - 844 cfs.

c. Elevations (feet above mean sea level).

Top of Dam - 1256.6.

Maximum Pool Design Surcharge - Unknown.

Maximum Pool of Record - Unknown.

Normal Pool - 1252.6.

Upstream Portal Invert of Blow-off Conduit - 1197.

Downstream Portal Invert of Blow-off Conduit - 1193.

Streambed at Center Line of Dam - Estimated at 1196.

Maximum Tailwater - Not applicable.

d. Reservoir (feet).

Length of Maximum Pool (top of dam) \approx 2300.

Length of Normal Pool (elevation 1252.6) - 2150.

e. Storage (acre-feet).

Spillway Crest (elevation 1252.6) - 511.

Design Surcharge \approx Not known.

Top of Dam \approx 613.

f. Reservoir Surface (acres).

Top of Dam \approx 28.

Maximum Pool - Not known.

Spillway Crest - 25.4.

g. Dam.

Type - Rolled earthfill.

Length - 810.

Height - 61.0 feet maximum.

Top Width - 16.5 feet.

Side Slopes - Upstream 2.25 horizontal to 1 vertical; downstream 1.5 horizontal to 1 vertical.

Zoning - Homogeneous earth; 12-inch masonry (mortared) on upstream face, 18-inch loose riprap on downstream face.

Impervious Core - Homogeneous earthfill section.

Cutoff - Available drawings and records indicate a six-foot wide cutoff trench was excavated to rock (impermeable material) at the upstream toe of the embankment when reconstructed in 1910. The cutoff wall contains a two-foot masonry face on the upstream side and a four-foot clay puddle on downstream side. The depth reportedly varies from 8 to 36 feet.

Grout Curtain - None.

h. Outlet Conduit.

Type - 24-inch cast iron pipe.

Length - 260 feet (estimated).

toe. Closure - Gate valve in gate house, downstream

Access - Gate house.

Regulatory Facilities - Gate valve.

i. Spillway.

Type - Uncontrolled broad-crested weir with ogee-like structure about 16 feet downstream.

Length of Weir - 35.9 feet.

Crest Elevation - 1252.5 on broad crest.

Upstream Channel - Plans indicate rectangular channel with 12-inch paving stone invert (not visible as area is covered with rock rubble).

Downstream Channel - Concrete slab discharging into natural rock channel.

j. Regulating Outlets. Blow-off pipe regulated in gate house at downstream toe.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. No design reports are available.
2. Embankment. No design reports are available.
3. Appurtenant Structures. No design reports are available.

b. Design Features.

1. Embankment. Available drawings and historical records (see Figure 1) indicate that the original embankment constructed in 1901, was a homogeneous earthfill resting on natural soil. Later in 1910, about 9 feet (horizontal) of select, compacted, material was added to the upstream face which was then capped with a 12-inch masonry face (with mortared joints) (see Photographs 1 and 2). Three-inch drain pipes were extended through the new fill to apparently relieve pore pressures in the event of drawdown. In addition, a six-foot thick cutoff wall consisting of two feet of masonry backed by four feet of clay puddle was extended to impervious material (presumably rock). The cutoff trench reportedly varies from 8 to 36 feet in depth.

2. Appurtenant Structures.

- a) Spillway. The spillway is a concrete structure which has been modified several times. Presently, it consists of a combined broad-crested weir and downstream ogee-like structure (see Figure 4 and Photograph 9).

- b) Supply Outlets. The facility is equipped with two supply lines consisting of 16-inch and 20-inch diameter cast iron pipes. The intake end of these lines were modified circa 1926 to enable intake from two different reservoir levels (elevation 1226.5 and 1238.5). Plan locations and details of the modifications are shown on Figures 5 and 6 and in Photographs 13 and 14 dated 1926. As indicated, the high level intake pipes are seated on concrete piers doweled into the upstream masonry face. The plans indicate that the concrete structures are wire reinforced and constructed of "lummite cement concrete of 1:2:4 mix."

c) Outlet Works. A 24-inch blow-off pipe for drawdown and regulating pool level is shown on the construction drawings. This pipe is also valved in the gate house and near its discharge. A tap from the blow-off line presently supplies the adjacent fish hatchery with unchlorinated water.

c. Specific Design Data and Procedures. No specific design data is available.

2.2 Construction Records.

Construction data and/or records available for review consisted of the six drawings acquired from the owner and reproduced in Appendix E and photographs from both the owner and PennDER files some which are reproduced in Appendix C.

2.3 Operations Records.

Daily operating records for 1977 and 1978 were made available for review by the owner. These records include depth of outflow over the spillway, rainfall, and depth of inflow over the V-notch weirs located on Green Lick Run. The owner may be able to locate older records if necessary. Operating problems are well documented in PennDER files.

2.4 Other Investigations.

A recent investigation dated April 17, 1978, (using National Dam Inspection guidelines) was conducted by Bankson Engineers for the owner. Their report was made available by the owner. Several inspection reports from predecessors of PennDER are also available. Of particular interest are the detailed report of August 20, 1914, and inspection reports of July 9, 1928 and June 25, 1934, in which toe seepage and remedial regrading were noted.

2.5 Evaluation.

Although specific design reports are not available, there are sufficient data in the form of construction drawings and inspection reports for an adequate Phase I evaluation.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The overall appearance of the facility suggests that it is fairly well maintained. The steep downstream slope (1.5H:1V), seepage through the embankment, and related slump features, however, reflect questionable design and operation.

At the time of inspection (27 April 78), the pool level was approximately 7 feet below the embankment crest and being lowered at a rate of about 6 inches per day to facilitate evaluation of the observed seepage.

b. Dam. The dam embankment appears to be well maintained, except for the downstream face, where only the heavy vegetation was cleared. A significant seep, however, has developed at mid-height near the center of the embankment causing noticeable displacement and/or a depression in the riprapped slope. No estimate could be made of the seepage as the flow is contained within the riprap and does not exit at the toe (see Photographs 4 through 6 in Appendix C). Additional seepage is emanating through the right abutment beyond the embankment-abutment contact and is probably occurring through the sandstone bedrock. It is of interest to note that this seep existed in 1914 as shown on Photograph 7a.

The upstream surface has been covered with a mortared masonry face and cutoff wall, probably to reduce seepage through the embankment. Field inspection, however, showed the surface to contain at least one longitudinal crack two to three feet above the present water level and a regular pattern of vertical cracks spaced at 25 to 35-foot centers across the face. Thus, the facing is ineffective as a seepage barrier.

c. Appurtenant Structures.

1. Spillway. The spillway appearance is generally favorable exhibiting minor cracking in the wing walls, scaling with several pop-outs along the flow surfaces.

2. Gate House and Valves. The gate house is a stone structure in good condition. The regulating valves are apparently operable as the facility has been recently converted from full service status to drawdown status.

d. Reservoir Area. No evidence of sloughing or sliding was apparent along the slopes of the reservoir. Some sedimentation is occurring at the entrance of Green Lick Run; however, no survey records are available for evaluation.

e. Downstream Channel. The valley immediately downstream of Green Lick Dam for a distance of 1,500 feet is characterized as rather restricted (200 feet wide) bordered by steeply wooded slopes. Within this reach are located four permanent dwellings and a commercial fish hatchery (see Photograph 16). All of these dwellings are considered to be within the effects of a breach of the Green Lick embankment.

Beyond the first reach, Green Lick Run turns about 90 degrees to the north entering a wide (600 to 800 feet), cultivated valley with moderate slopes. The first downstream restriction occurs in this reach and consists of a concrete bridge carrying a two-lane paved road over Green Lick Run about 3,000 feet from the reservoir (see Photograph 17 and Regional Vicinity Map in Appendix F). Approximately 4,500 feet from the dam is a small community (church and approximately 8 structures). Although the community lies within the floodplain of Green Lick Dam, the effect of a catastrophic failure on the structures appears minimal because of the broad floodplain and distance to the dam.

Beyond the above mentioned community, Green Lick Run flows through an unpopulated reach to its entry into Jacobs Creek approximately two miles from the dam.

3.2 Evaluation.

Access to the gate house, a dry spillway condition, and the presence of the Authority's engineer for specific operating details enabled an adequate field inspection. Physical conditions generally conformed to available drawings. The leakage observed on the downstream face is of major significance.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedures.

Discussions with Mr. Ken Baker, engineer of the Municipal Authority of Westmoreland County, indicate that the pool level is controlled during high flows by regulating flow through the blow-off pipe. According to Mr. Baker, the blow-off valve is opened when the flow over the spillway reaches one foot of depth (this occurred about one time per year). There are no low flow procedures.

4.2 Maintenance of Dam.

There is no formal maintenance program; however, until May 1978, the facility was maintained by a full-time caretaker residing on-site. Currently, the caretaker is assigned to work elsewhere but maintains residence at the site. Maintenance (such as grass cutting) is performed by work crews dispatched on an as-needed basis.

4.3 Maintenance of Operating Facilities.

There is no formal maintenance manual or program for the operating facilities.

4.4 Warning Systems in Effect.

There is no formal warning system in effect.

4.5 Evaluation.

Sufficient information was provided to evaluate the operational procedures. Although no formal procedures or manuals are available, informal procedures appear adequate. A definitive warning system, however, should be developed for downstream residences in case of emergency.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No hydrologic or hydraulic design calculations were available.

5.2 Visual Observations.

The dam and its appurtenances were in a satisfactory condition relative to hydrologic and hydraulic calculations.

5.3 Overtopping Potential.

The ratio "PMF Peak Flow/Drainage Area" was determined from an empirical curve supplied by the Baltimore District, Corps of Engineers. Based on this curve and a drainage area of 3.4 square miles (U.S.G.S. Connellsville and Donegal 7.5 minute quadrangles dated 1967 and 1964, respectively), Peak PMF Q/A = 1,800 cfs/sq. mi., and Peak PMF Q = 6,120 cfs.

Using the normal pool elevation of 1252.6 feet, calculations indicate that during a storm of PMF magnitude, the required storage volume of 3,913 acre-feet would greatly exceed the available storage volume of approximately 100 acre-feet (Appendix D). Therefore, the dam would be overtopped under these conditions.

5.4 Significance of Overtopping Due to PMF.

Because overtopping is expected to cause embankment failure and raise the tailwater to a level which will inundate at least 4 dwellings otherwise not affected by the tailwater, overtopping would significantly increase the hazard to loss of life downstream from that which would exist just before failure.

5.5 Spillway Adequacy.

Calculations indicate that the facility will pass and/or store a flood of only 19 percent of the PMF and since the facility is classified as "high hazard", the spillway is judged to be seriously inadequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Inspection.

a. Embankment. Sloughing and seepage were observed near the middle of the downstream slope. At the time of the inspection, the owners were in the process of drawing down the reservoir to permit an assessment of the embankment in the vicinity of the leakage.

b. Appurtenant Structures. Based on visual inspection the spillway structure although worn, appears stable. The gate house is in good condition and all valves appear operable.

6.2 Design and Construction Techniques.

a. Embankment. No data is available relative to the embankment design and construction methods other than historical records in PennDER files and the construction drawings. The drawings indicate that no downstream drainage was provided and coupled with the steep slope downstream, seepage could be anticipated to occur on the downstream face of the dam above the toe with an ineffective upstream impervious section and cutoff. The upstream masonry face is ineffective as a seepage barrier in its present fractured condition.

Historical reports indicate that some portions of the embankment were placed during winter weather resulting in an embankment failure in 1904.

b. Appurtenant Structures. Other than the construction drawings, no design or construction data were available. Both blow-off and supply lines from the reservoir are valved at the downstream gate house and, therefore, cannot be controlled in the event of rupture inside the embankment.

6.3 Past Performance.

The embankment has a history of failure (due to improper construction) and leakage problems. Currently a leak that was repaired in 1975 has reappeared near the middle of the embankment.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and is thus subject to minor earthquake induced forces. Because of the apparent saturated condition and steep embankment slopes, minor seismic forces could be significant with respect to embankment stability.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

- a. Safety. The visual inspection and operational history of the embankment indicate that the integrity of the structure is questionable. Leakage through the center of the embankment has prompted the owner to initiate drawdown measures for evaluation. The spillway in conjunction with the blow-off pipe and storage capacity to the crest of the embankment can pass a flood equivalent to only 19 percent of the PMF. The spillway capacity is, therefore, judged to be seriously inadequate.
- b. Adequacy of Information. The information available is considered adequate to make a reasonable assessment of the project.
- c. Urgency. It is suggested that the remedial measures and/or actions listed below be implemented immediately.
- d. Necessity for Additional Investigations. A detailed investigation is deemed necessary if the use of this facility is to be continued. In view of the steep downstream slope and seepage condition, this investigation should include a stability analysis of the dam, entailing explorations of existing embankment and foundation materials, testing to determine soil strength, and instrumentation to evaluate seepage and piping potentials.

7.2 Recommendations/Remedial Measures.

It is recommended that:

- a. The reservoir be completely drawn down.
- b. A detailed subsurface investigation (as described above) be conducted to evaluate the structural integrity of the embankment and the necessary remedial measures be taken to ensure its safety under all operating conditions.
- c. A study be performed, by the owner, to accurately ascertain the spillway capacity required and remedial measures necessary to make the spillway hydraulically adequate.
- d. That surveillance and evacuation plans be established to protect the residences of the two permanent dwellings and two mobile homes situated immediately downstream of the facility as well as any others further downstream that potentially might be effected by a failure of the dam.

Furthermore, in the event that inflow into the reservoir exceeds the present discharge capability and the reservoir level rises above the present seepage level, continuous surveillance of the dam should be maintained. Evacuation proceedings should be put into effect if the rate of seepage significantly increases or indicates transporting of fines (cloudy or muddy seepage), if sloughing or cracking of the dam is observed, or if any other evidence that failure may be occurring is observed.

e. The owner institute a plan for regulating or blocking (in case of emergency) the outlet pipes at the intakes (upstream end) thereby minimizing the possibility of damage to the embankment should the pipes rupture or develop leaks within it.

APPENDIX A
CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

NAME OF DAM Green Lick Dam

DESIGN, CONSTRUCTION, OPERATION
PHASE I

ID # NDI# PA-219; PennDER# 26-19

ITEM _____ REMARKS _____ SHEET 1

AS-BUILT DRAWINGS

Seven drawings available. One marked "obsolete".
Eight 8 x 10 photographs, circa 1926.

REGIONAL VICINITY MAP

Not shown on drawings.

CONSTRUCTION HISTORY

- a) Owner has no records.
- b) DER files source of history.

TYPICAL SECTIONS OF DAM

Typical sections on above as-built and/or proposed drawings.

OUTLETS - PLAN

Shown on above as-built drawings and in photographs.

- DETAILS

- DISCHARGE RATINGS Not available.

RAINFALL/RESERVOIR RECORDS

- a) Owner has rainfall gage in South Connellsville since 1971.
- b) Weirs and gaging station on Green Lick Run as it enters reservoir.

ITEM

REMARKS

ID # PA-219

SHEET 2

DESIGN REPORTS

None available.

GEOLOGY REPORTS

None available. Bedrock described on two available drawings.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

No formal data available. Reservoir capacity table shown on topographic plan drawing.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

None available. Some subsurface data on drawings.

POST-CONSTRUCTION SURVEYS OF DAM

Reference to surveys in Pennder files.

BORROW SOURCES

Unknown - probably on-site soils. Riprap source unknown.

ITEM

REMARKS

ID # PA-219

SHEET 3

MONITORING SYSTEMS

Stream gaging station upstream of reservoir.

MODIFICATIONS

Modified intakes, upstream slope, and spillway, circa 1926 as indicated on available drawings.

HIGH POOL RECORDS

Not known. Data may be available, if necessary, from Scottdale office.

POST CONSTRUCTION ENGINEERING
STUDIES AND REPORTS

- 1) Bankson Engineers study 4/17/78 available from owner.
- 2) PennDER files.

PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS

- 1) Several problems described in PennDER files.
- 2) Leak recently repaired in 1975 has reappeared in 1978. Reservoir being drawn down (6-inches/day) presently to evaluate problem.

MAINTENANCE
OPERATION
RECORDS

Records not available. Caretaker lives on site but is assigned elsewhere during day.

ITEM

REMARKS

ID # PA-219

SHEET 4

SPILLWAY PLAN

SECTIONS

Available on construction drawings provided by owner.

DETAILS

OPERATING EQUIPMENT
PLANS & DETAILS

Available from construction drawings provided by owner.

CURRENT USE OF FACILITY

The owner states that this facility has been in limited use since March 1978. It is kept partially full for emergency use only and they intend to sell the facility in near future. Presently, they are drawing down reservoir at rate of 6 inches per day because of leakage observed during Bankson Engineers inspection dated April 17, 1978.

CHECK LIST ID # PA-219
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Primarily wooded (\approx 75%); Farmland (\approx 25%).

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1252.6 (166.5 million gal.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): _____

ELEVATION MAXIMUM DESIGN POOL: 1256.6

ELEVATION TOP DAM: 1256.6

SPILLWAY DATA:

- a. Crest Elevation 1252.6
- b. Type Concrete chute with broad-crested weir and D/S ogee-like structure.
- c. Weir Length 36.0 feet
- d. Channel Length In concrete \approx 40 feet; in rock cut \approx 250 feet.
- e. Location Spillover Right abutment
- f. Number and Type of Gates Ungated

OUTLET WORKS:

- a. Type 16" and 20" (high level inlets) on upstream face
- b. Location Inlets on upstream face direct flow to outlet pipes at
- c. Entrance Inverts 16" at 1226.5; 20" at 1238.5; 24" at 1197 base
- d. Exit Inverts 24" blow-off at 1193; 16" and 20" unknown
- e. Emergency Draindown Facilities 24" blow-off pipe. Valved in gate house.

HYDROMETEOROLOGICAL GAGES:

- a. Type Gaging station (multiple weirs) on stream above reservoir
- b. Location Immediately upstream of reservoir
- c. Records Available from owner

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

APPENDIX B

CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

DAM NAME Green Lick Dam COUNTY Westmoreland STATE Penna. ID # Pa-219

TYPE OF DAM Earth Fill HAZARD CATEGORY High

DATE(S) INSPECTION 27 April 78 WEATHER Partly Cloudy TEMPERATURE 50°+60°

POOL ELEVATION AT TIME OF INSPECTION 1249.6 M.S.L. TAILWATER AT TIME OF INSPECTION N/A M.S.L

INSPECTION PERSONNEL:

GAI

Reps. of Municipal Auth.
of Westmoreland Co.

B. Mihalcin

J. P. Nairn

K. Baker (Engr.)

K. H. Khilji

D. Nebiolo

B. M. Mihalcin RECORDER

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

SURFACE CRACKS

- 1) T/Embankment - None observed.
- 2) U/S Face (Paving Stone) - Longitudinal crack in paved face about 2'-3' above water level. Vertical cracks at 25 ft. to 35 ft. intervals.

UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE
None observed.

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES

Minor erosion of natural slope adjacent spillway.

VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST

Good alignment.

RIPRAP FAILURES

Bulging on downstream slope near toe and at seep near mid-embankment.

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM

No problems.

ANY NOTICEABLE SEEPAGE

Two Significant Seeps.

- 1) At centerline of dam, mid-height of downstream slope.
- 2) About 1/3 up slope about 100 ft. west of crest in natural slope (below discharge channel).

STAFF GAGE AND RECORDER

Staff gage on upstream end of spillway wall, in good condition.

DRAINS

None observed.

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

CRACKING AND SPALLING OF
CONCRETE SURFACES IN
OUTLET CONDUIT
Not applicable.

INTAKE STRUCTURE

Intakes are inundated.

OUTLET STRUCTURE

Endwall at exit of 24-inch blow-off pipe in good condition.

OUTLET CHANNEL

Rock lined channel in good condition.

EMERGENCY GATE

Valved in Gate house - valve is functional.

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

CONCRETE WEIR

Concrete weir in good shape. Some aggregate exposed; minor cracking; Appears to have been recently capped.

APPROACH CHANNEL

Rock rubble to edge of weir - unobstructed.

DISCHARGE CHANNEL

Natural rock (sandstone) in good condition.

BRIDGE AND PIERS

None.

CONCRETE SILL

N/A

APPROACH CHANNEL

N/A

DISCHARGE CHANNEL

N/A

BRIDGE AND PIERS

N/A

GATES AND OPERATION
EQUIPMENT

N/A

INSTRUMENTATION

ID # Pa-219

SHEET 6

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

VISUAL EXAMINATION

MONUMENTATION/SURVEYS

None observed.

OBSERVATION WELLS

None

WEIRS

Spillway functions as weir - good condition with staff gage.

PIEZOMETERS

None

OTHERS

Series of V-notch weirs upstream of reservoir

RESERVOIR

ID # Pa-219

SHEET 7

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

Moderate to steep wooded slopes in good condition.

SEDIMENTATION

Delta deposits at stream entry. Volume not determined.

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

CONDITION

(OBSTRUCTIONS,
DEBRIS, ETC.)

In rock and unobstructed for several hundred feet to vertical drop of about 25 feet. Channel then becomes flat meandering stream.

SLOPES

Gentle in stream valley.

APPROXIMATE NO.
OF HOMES AND
POPULATION

Caretaker's house; Fish Hatchery and House Trailer; 2 or 3 house trailers. Approximately 16 people in immediate vicinity (estimated). Community of Paradise Church about 1 mile downstream however valley is very wide in this area.

APPENDIX C
HYDRAULICS AND HYDROLOGY

SUBJECT

DAM SAFETY INSPECTION

GREENLICK DAM

DLB

DATE

7-3-78

PROJ. NO.

78-501-219

CHKD. BY

JTS

DATE

7-6-78

SHEET NO.

1

OF 18



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LOCATION

CONNELLSVILLE QUADRANGLE
DONEGAL QUADRANGLE

} U.S.G.S.
7.5 MINUTE MAP

DAM STATISTICS

MAXIMUM HEIGHT OF DAM = 61 FT (FIELD MEASUREMENT)

DRAINAGE AREA = 3.45 SQ. MI OR 2176 ACRES (PLANIMETERED)

SIZE CLASSIFICATION

DAM SIZE = INTERMEDIATE (REF 2, TABLE 1)

STANDARD DESIGN FLOOD (SDF)

HAZARD RATING = HIGH (REF 2, TABLE 2)

REQUIRED SDF = PMF (REF 2, TABLE 3)

REF 1 : "WATER RESOURCES ENGINEERING" by R.K. LINSLEY & J.B. FRANZINI

REF 2 : "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS"
DEPT OF ARMY - OFFICE OF CHIEF ENGINEER (APPENDIX D)

REF 3 : "HANDBOOK OF HYDRAULICS" by H.W. KING AND E.F. BRATER
1963

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SUBJECT DAM SAFETY INSPECTION

GREENLICK DAM

DLR DATE 7-3-78 PROJ. NO. 78-501-219

CHKD. BY JTS DATE 7-6-78 SHEET NO. 2 OF 18

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DRAINAGE AREA = 3.4 SQ. MI.

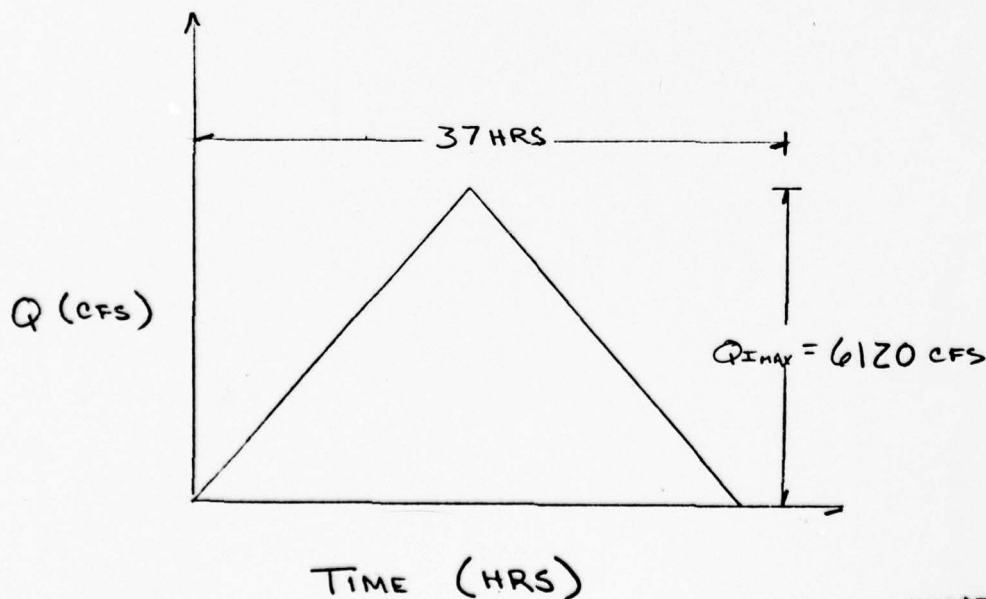
PMF (PEAK FLOW)/AREA = 1800 CFS/SQ. MI (SHEET 17)

PMF = 3.4 SQ. MI. (1800 CFS/SQ. MI.) = 6120 CFS

DEVELOP INFLOW HYDROGRAPH

$Q_{\text{INFLOW MAX}} = \text{PMF} = 6120$

TOTAL TIME OF FLOW = 37 HRS (SHEET 18)



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SUBJECT DAM SAFETY INSPECTION

GREENLICK DAM

DLE DATE 7-2-78 PROJ. NO. 78-501-219

CHKD. BY JTS DATE 7-6-78 SHEET NO. 3 OF 18

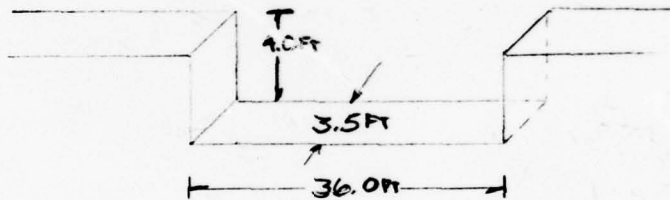


SPILLWAY CAPACITY

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BROAD CRESTED CONCRETE SPILLWAY

DIMENSIONS TAKEN IN FIELD ARE SHOWN BELOW.



MAXIMUM HEAD OF WATER AVAILABLE BEFORE OVERTOPPING
OF THE EMBANKMENT WILL BE 4.0 FT

$$Q = CLH^{3/2} \quad (\text{REF 3 EQ. 5-10})$$

WHERE C = DISCHARGE COEFFICIENT (TABLE 5-3, REF 3)
L = LENGTH OF WEIR (FT.)
H = HEAD (FT.)

$$\therefore C = (3.07 + 2.79) / 2 = 2.93$$

$$Q = 2.93 (36 \text{ FT}) (4.0 \text{ FT})^{3/2} = 844 \text{ CFS}$$

PEAK INFLOW (6120 CFS) > MAXIMUM SPILLWAY DISCHARGE (844 CFS)

SUBJECT

DAM SAFETY INSPECTION

GREENLICK DAM

D.L.B.

DATE

7-3-78

PROJ. NO.

78-501-219

CHKD. BY

JTS

DATE

7-6-78

SHEET NO.

4

OF 18



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VOLUME OF INFLOW HYDROGRAPH

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$$V = \frac{1}{2} (Q_{IMAX}) (TIME)$$

$$= \frac{1}{2} (6120 \text{ FT}^3/\text{SEC}) (37 \text{ HRS}) (3600 \text{ SEC/HR}) (ACRES/43,560 \text{ FT}^2)$$

$$= 9357 \text{ ACRE-FEET}$$

DETERMINE THE AVERAGE RAINFALL IN INCHES REQUIRED TO
PRODUCE THE INFLOW VOLUME ABOVE

$$\frac{(9357 \text{ AC-FT}) (1 \text{ SQ. MI} / 640 \text{ ACRES}) (12 \text{ IN/FT})}{(3.4 \text{ SQ. MI})} = 51.6 \text{ INCHES}$$

VOLUMES PRODUCED BY RAINFALLS IN EXCESS OF 26 INCHES
MUST BE RECALCULATED USING 26 INCHES AS AN UPPER BOUND

$$(26 \text{ INCHES}) (3.4 \text{ SQ. MI}) (640 \text{ ACRES/SQ. MI.}) (1 \text{ FT}/12 \text{ IN}) = 4715 \text{ AC-FT.}$$

$$\text{VOLUME OF INFLOW (RECALCULATED)} = 4715 \text{ AC-FT.}$$

NOTE: Q_{IMAX} REMAINS CONSTANT.

STORM DURATION DECREASES IN ACCORDANCE WITH THE
DECREASE OF INFLOW VOLUME.

$$\text{STORM DURATION} = (4715 \text{ AC-FT}) (2) (43,560 \text{ FT}^2/\text{ACRE}) / (3600 \text{ SEC/HR}) (6120 \text{ FT}^3/\text{SEC})$$

$$= 18.6 \text{ HRS}$$

BY DLB DATE 7-3-78 PROJ. NO. 78-501-219
CHKD. BY JTS DATE 7-6-78 SHEET NO. 5 OF 18

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USING SHORT CUT METHOD SUGGESTED BY NDA

MAXIMUM SPILLWAY DISCHARGE = 844 CFS

MAXIMUM INFLOW PMF = 6120 CFS

$$p = \frac{\text{MAX. SPILLWAY DISCHARGE}}{\text{MAXIMUM INFLOW}} = \frac{844}{6120} = 0.14$$

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

$$(1-0.14) = \frac{\text{R. R. S}}{4715 \text{ AC. FT.}}$$

$$\begin{aligned} \text{REQUIRED RESERVOIR STORAGE} &= 0.86 (4715) \\ &= 4055 \text{ ACRE-FT.} \end{aligned}$$

STORAGE AVAILABLE \approx 100 AC-FT (PLANIMETER ESTIMATE OFF FIG 1)

SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM

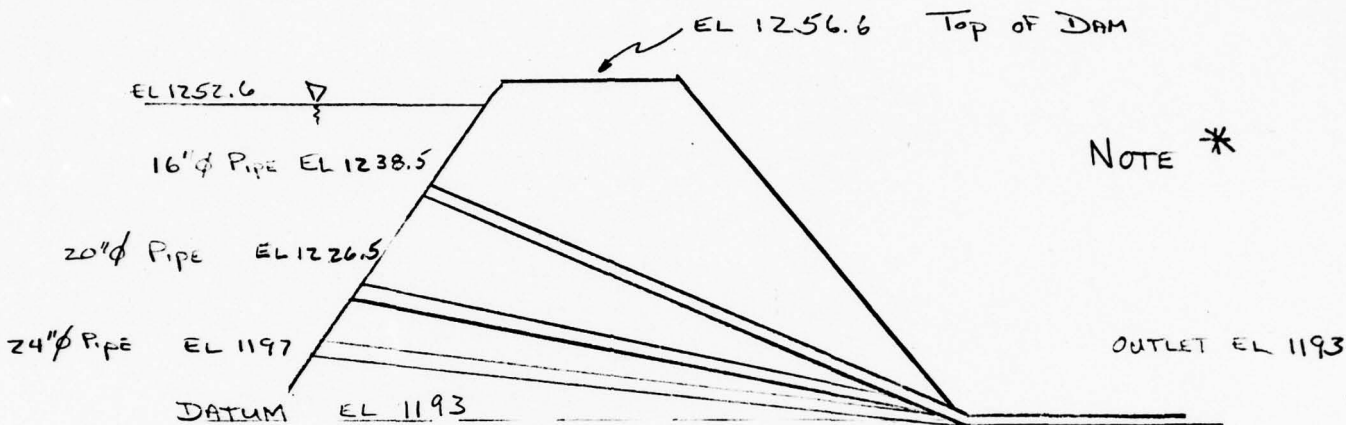


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CHKD. BY JTS DATE 7-6-78 SHEET NO. 6 OF 18

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CALCULATION OF DISCHARGE CAPACITY FOR 1 - 20" ϕ C.I. PIPE
AND 1 - 16" ϕ C.I. PIPE AND 1 - 24" ϕ C.I. PIPE



USE BERNOULLI'S EQUATION

(REF 4, EQ 21-12)

$$Z_1 + P_1/\omega + V_1^2/2g = Z_2 + P_2/\omega + V_2^2/2g + h_f + h_e$$

FOR 16" ϕ PIPE

Z_1	= HEIGHT OF INLET ABOVE DATUM	= 45.5'
Z_2	= " " OUTLET " "	= 0
P_1/ω	= PRESSURE HEAD AT INLET	= 14.1'
P_2/ω	= " " " OUTLET	= 0

* ALL ELEVATIONS ARE TAKEN FROM FIG 1 IN APPENDIX F, by
CITIZENS WATER CO.

REF 4 : "STANDARD HANDBOOK FOR CIVIL ENGINEERS"
F.S. MERRITT

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SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM

BY DLB DATE 5-11-78 PROJ. NO. 78-501--9

CHKD. BY JTS DATE 7-6-78 SHEET NO. 7 OF 18



$V_1 =$ VELOCITY AT INLET = 0
 $V_2 =$ VELOCITY AT OUTLET = SOLVE FOR
 $g = (32.2 \text{ FT/SEC}^2)$

$h_f =$ HEAD LOSS DUE TO FRICTION

$$h_f = f \frac{LV^2}{2gD} \quad (\text{REF 4, EQ 21-30})$$

* $L =$ LENGTH OF PIPE $\approx 250'$
 $D =$ DIAMETER OF PIPE $= 1.3'$

$f =$ FRICTION FACTOR - BASED ON TURBULENT FLOW WITH
A REYNOLD'S NUMBER $= 1.0 \times 10^7$ AND A FRICTION COEFFICIENT
OF ROUGHNESS $E = 0.00085$ (REF 1, TABLE 21-3)

$$f = 0.017 \quad (\text{REF 1, FIG 21-14})$$

$h_e =$ HEAD LOSS AT INLET

$$h_e = K_e \frac{V^2}{2g} \quad (\text{REF 4, EQ 21-42})$$

$$K_e = \text{COEFFICIENT OF FRICTION} = 0.50 \quad (\text{REF 1, TABLE 21-7})$$

* LENGTH OF PIPE SCALED FROM FIG 1 IN APPENDIX by
CITIZENS WATER CO.

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SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM

BY DLB DATE 5-12-78 PROJ. NO. 78-501-77

CHKD. BY JTS DATE 7-6-78 SHEET NO. 8 OF 18



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SOLVE BERNOULLI'S EQ

$$45.5' + 14.1' + 0 = 0 + 0 + \frac{v^2}{2(32.2\text{ft/s}^2)} + \frac{(0.017)(250')v^2}{(2)(32.2\text{ft/s}^2)(1.3')} + \frac{(0.50)(v^2)}{2(32.2\text{ft/s}^2)}$$

$$59.6' = 0.016v^2 + 0.051v^2 + 0.008v^2$$

$$v^2 = 59.6' / 0.075$$

$$v = 28.2 \text{ fps}$$

$$Q = VA = (28.1 \text{ ft/s})(\pi)(0.67 \text{ ft})^2$$

$$Q_{16} = \underline{\underline{39.8 \text{ cfs}}}$$

20" ϕ PIPE

$$z_1 = 33.5'$$

$$z_2 = 0$$

$$P_1/w = 26.1'$$

$$P_2/w = 0$$

$$v_1 = 0$$

$$v_2 = \text{SOLVE FOR}$$

$$q = 32.2$$

$$z_1 + P_1/w + v_1^2/2q = z_2 + P_2/w + v_2^2/2q + h_f + h_e$$

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SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM



BY DLB DATE 5-12-78 PROJ. NO. 78-501-219

CHKD. BY JTS DATE 7-6-78 SHEET NO. 9 OF 18

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$$h_f = f \frac{LV^2}{2gD}$$

$$L = 250'$$

$$D = 1.67'$$

$$f = 0.017$$

$$h_e = K_E V^2 / 2g$$

$$K_E = 0.50$$

SOLVE BERNOULLI'S EQUATION

$$33.5' + 26.1' + 0 = 0 + 0 + \frac{V^2}{2(32.2)} + \frac{(0.017)(250)V^2}{(2)(32.2)(1.67)} + \frac{(0.5)(V^2)}{(2)(32.2)}$$

$$59.6' = 0.016V^2 + 0.04V^2 + 0.008V^2$$

$$V^2 = 59.6' / 0.064$$

$$V = 30.5 \text{ fps}$$

$$Q = VA = (30.5 \text{ ft/s})(\pi)(0.83 \text{ ft})^2$$

$$Q_{20} = 66.9 \text{ cfs}$$

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SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM



BY DLB DATE 5-11-78 PROJ. NO. 7A-501-719

CHECKED BY JTS DATE 7-6-78 SHEET NO. 10 OF 18

24" ϕ PIPE

$$z_1 = 4'$$

$$z_2 = 0$$

$$P_1/w = 55.6$$

$$P_2/w = 0$$

$$V_1 = 0$$

$$V_2 = \text{SOLVE FOR}$$

$$q = 32.2$$

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$$h_f = f \frac{LV^2}{2gD}$$

$$L = 250'$$

$$D = 2'$$

$$f = (0.017)$$

$$h_e = K_E V^2 / 2g$$

$$K_E = 0.50$$

SOLVE BERNOULLI'S EQUATION

$$55.6' + 4' + 0 = 0 + 0 + \frac{V^2}{64.4} + \frac{(0.017)(250')V^2}{64.4(2')} + \frac{0.50V^2}{64.4}$$

$$59.6 = 0.016V^2 + 0.033V^2 + 0.008V^2$$

SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM

BY DLB DATE 5-12-78 PROJ. NO. 78-501-79

CHKD. BY JTS DATE 7-6-78 SHEET NO. 11 OF 18



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$$V^2 = 59.6' / 0.057$$

$$V = 32.3 \text{ fps}$$

$$Q = VA = (32.3 \text{ FT/S})(\pi)(1 \text{ FT})^2$$

$$Q_{24} = 101.5 \text{ cfs}$$

$$\text{TOTAL PIPE DISCHARGE } Q_{\text{TOTAL}} = Q_{16} + Q_{20} + Q_{24}$$

$$Q_{\text{TOTAL}} = (39.8 + 66.0 + 101.5) \text{ cfs} = \underline{\underline{207.3 \text{ cfs}}}$$

$$\text{AVAILABLE SPILLWAY DISCHARGE} = 844 \text{ cfs}$$

NOTE: ALL PIPES WERE CALCULATED TO FLOW FULL (OUTLET CONTROL) DUE TO THE HIGH HEAD UNDER WHICH THEY ARE PLACED.

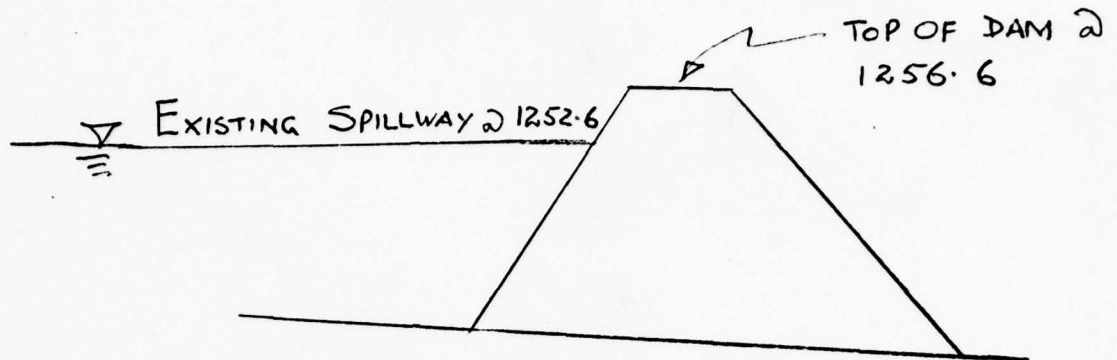
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SUBJECT DAM SAFETY PROGRAM - GREENLICK DAM

BY KHK DATE 4/29/78 PROJ. NO. 78-501-219

CHKD. BY DLB DATE 5/2/78 SHEET NO. 17 OF 18

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• AREA OF RESERVOIR = 23.9 ACRES (PLANIMETERED)

$$\begin{aligned} \text{VOLUME OF STORAGE AVAILABLE} &= (1256.6 - 1252.6) \times 23.9 \\ &= 95.6 \text{ ACRE-FT.} \end{aligned}$$

USE 100 AC-FT WHICH IS A PLANIMETERED ESTIMATE TAKEN FROM FIG 1, APPENDIX F

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SUBJECT DAM SAFETY INSPECTION - GREENLICK DAM

BY KHK DATE 5/18/78 PROJ. NO. 78-501-219

BY DLB DATE 5/26/78 SHEET NO. 13 OF 18



MAXIMUM DISCHARGE THROUGH PIPES = 207 CFS (SHEET 11)

MAXIMUM DISCHARGE THROUGH SPILLWAY = 844.0 CFS (SHEET 3)

TOTAL 1051 CFS.

MAXIMUM INFLOW = 6120 CFS (SHEET 2)

USING SHORTCUT METHOD SUGGESTED BY NAD -

$$p = \frac{\text{MAXIMUM OUTFLOW}}{\text{PMF PEAK FLOW}} = \frac{1051}{6120} = 0.17$$

$$\therefore (1-p) = \frac{\text{REQUIRED RESEVOIR STORAGE}}{\text{VOLUME OF INFLOW HYDROGRAPH}} = 0.83$$

VOLUME OF INFLOW HYDROGRAPH = 4715 - ACRE-FT (SHEET 4)

REQUIRED RESERVOIR STORAGE = .83 x 4715
= 3913.4 ACRE-FT.

STORAGE AVAILABLE = 100 ACRE-FT (SHEET-12)

100 < 3913.4 ACRE-FT.

CONCLUSION: GREENLICK DAM WILL NOT BE ABLE TO CONTAIN THE PMF WITHOUT BEING OVERTOPPED, EVEN WHEN ALL THE OUTLET PIPES ARE FULLY FUNCTIONAL.

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SUBJECT DAM SAFETY INSPECTION

GREENLICK DAM

BY DLP DATE 6-1-78 PROJ. NO. 78-501-219

CHKD. BY JTS DATE 7-6-78 SHEET NO. 14 OF 18



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CALCULATE PERCENT PMF THAT IS PASSABLE.

$$P = \frac{\text{MAX DISCHARGE RATE}}{Q_{\text{IMAX}}} = \frac{1051 \text{ CFS}}{Q_{\text{IMAX}}}$$

$$1 - P = \frac{\text{AVAILABLE STORAGE VOLUME}}{\text{VOLUME OF INFLOW HYDROGRAPH}}$$

$$1 - \frac{1051}{Q_{\text{IMAX}}} = \frac{100 \text{ AC-FT}}{\frac{1}{2}(Q_{\text{IMAX}})(18.6 \text{ HRS})(3600 \text{ SEC/HR})(1 \text{ ACRE}/43,560 \text{ FT}^2)}$$

$$0.77 Q_{\text{IMAX}} - 809 \text{ AC-FT} = 100 \text{ AC-FT}$$

$$0.77 Q_{\text{IMAX}} = 909 \text{ AC-FT}$$

$$Q_{\text{IMAX}} = 1181 \text{ CFS}$$

$$\text{SDF} = \text{PMF} = 6120 \text{ CFS}$$

$$Q_{\text{IMAX}} = 19.3\% \text{ PMF}$$

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SUBJECT DAM SAFETY INSPECTION
GREENLICK DAM
 DLR DATE 6-12-78 PROJ. NO. 78-501-719
 CHKD. BY JTS DATE 7-6-78 SHEET NO. 15 OF 18



CONSIDER WHETHER OR NOT MAXIMUM DISCHARGE OVER THE SHARP BROAD CRESTED WEIR AT SPILLWAY ENTRANCE IS LARGE ENOUGH TO CAUSE OVERTOPPING OF THE SPILLWAY WALLS AT ANY DISTANCE DOWNSTREAM

MAXIMUM DISCHARGE OF SPILLWAY = 844 CFS
 (SHEET 3)

$$Q = 844 \text{ CFS}$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} \quad (\text{REF 4, EQ 21-90})$$

$$A = \text{AREA OF FLOW} = (36.0')(x)$$

$$R = \text{HYDRAULIC RADIUS} = \frac{\text{AREA OF FLOW}}{\text{WETTED PERIMETER}} = \frac{(36')(x)}{(36 + 2x)}$$

$$S = \text{SLOPE} = 0.02 \quad (\text{ASSUMED VALUE})$$

$$n = \text{MANNINGS COEFFICIENT} = 0.015 \quad (\text{REF 4, TABLE 21-11})$$

(AVG VALUE FOR CONCRETE LINED CHANNELS)

NOTE: SPILLWAY DIMENSIONS TAKEN FROM CALCULATION SHEET 2

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SUBJECT

DAM SAFETY INSPECTIONGREENLICK DAM

DLP

DATE

6-12-78

PROJ. NO.

79-501-219CHKD. BY JTS

DATE

7-6-78

SHEET NO.

16 OF 18

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$$Q = \frac{1.486}{(0.015)} (36x) \left[\frac{(36x)}{(36+2x)} \right]^{2/3} (0.02)^{1/2}$$

$$844 \text{ cfs} = 504x \left[\frac{36x}{(36+2x)} \right]^{2/3}$$

$$24,520 = 11,315x^{3/2} \left[\frac{36x}{(36+2x)} \right]$$

$$882720 + 49040x = 407340x^{5/2}$$

$$0 = 8.3x^{5/2} - x - 18$$

$$x < 1.5 \text{ FT}$$

CONCLUSION : MAXIMUM DISCHARGE OVER BROAD CRESTED WEIR WILL NOT CAUSE OVERTOPPING OF WING WALLS SINCE NO WING WALL IS LESS THAN 2 FEET HIGH

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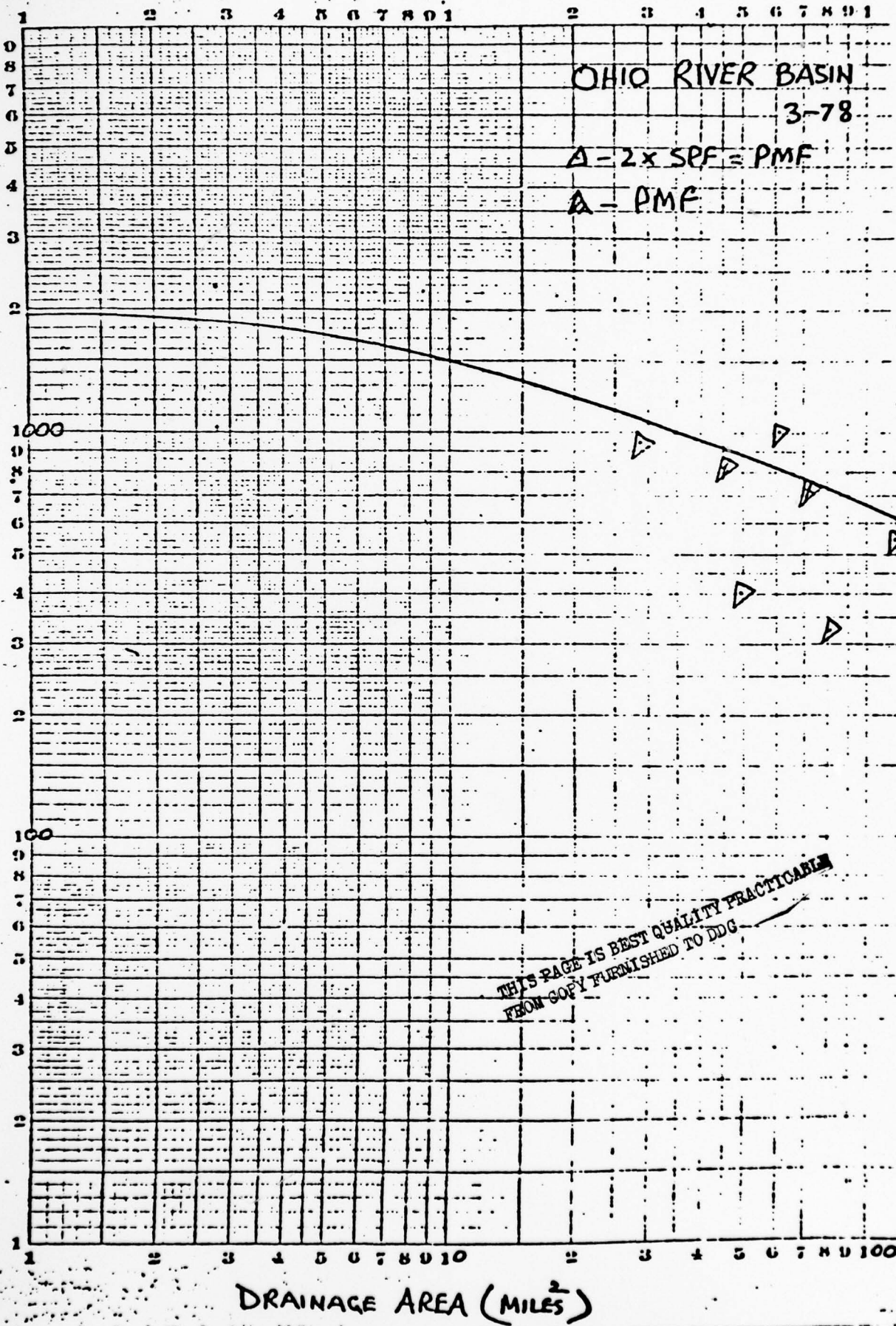
CODER BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

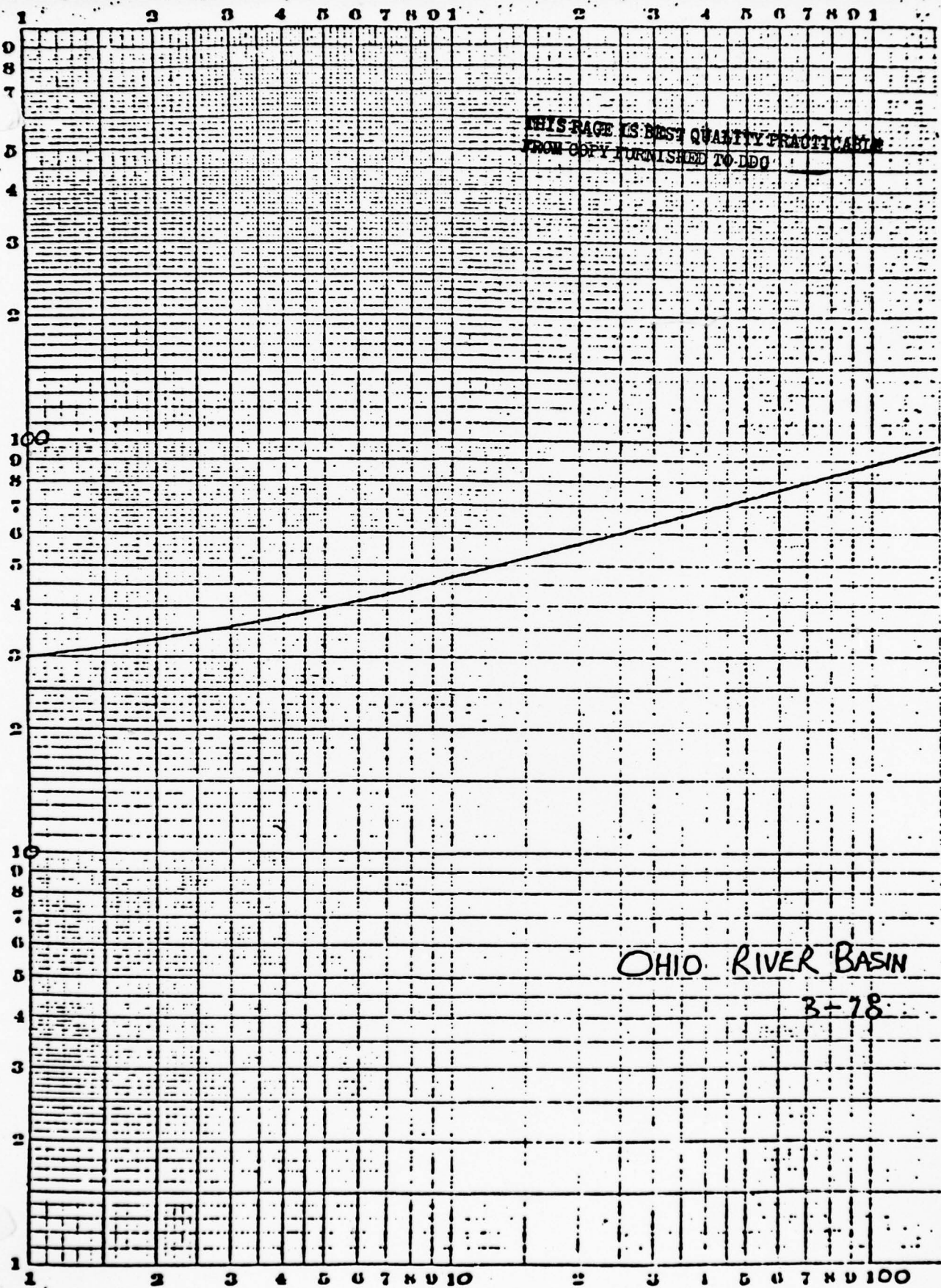


CFS/MI²

PMF PEAK FLOW/AREA

NO. 4122. LOGARITHMIC 8 BY 10 INCH CYCLES.





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OHIO RIVER BASIN
3-78

DRAINAGE AREA (MILE²)

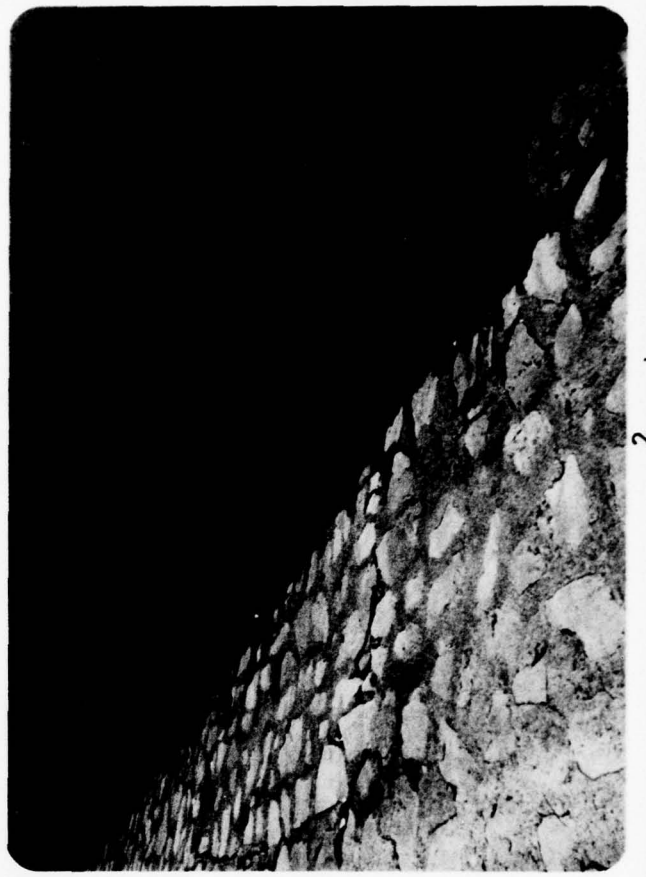
APPENDIX D
PHOTOGRAPHS

PHOTOGRAPHS 1, View looking across the top of the Green
1a Lick Dam embankment as it appeared in 1926
(1) and as it appears today (1a). The
upstream portion of the embankment is covered
with a masonry face which extends below the
water level.

PHOTOGRAPH 2 Close-up view of the upstream face of Green
Lick Dam. Note the masonry construction.



1



2



1a

PHOTOGRAPHS 3, View looking across the downstream face of
3a the Green Lick Dam from the right abutment.
The gate house can be seen at the bottom of
the embankment. Photograph 3a is a similar
view of the embankment taken in 1920, showing
sloughing of the riprap face.



3



3a

PHOTOGRAPH 4 View looking downstream from the crest of the Green Lick Dam. The members of the field team are standing in a depressed area. At this location, one could see and hear water running through the riprap face.

PHOTOGRAPH 5 View of a linear depressed area near the center of the embankment. The hole in the immediate foreground extends approximately two feet back from the face of the dam.



5



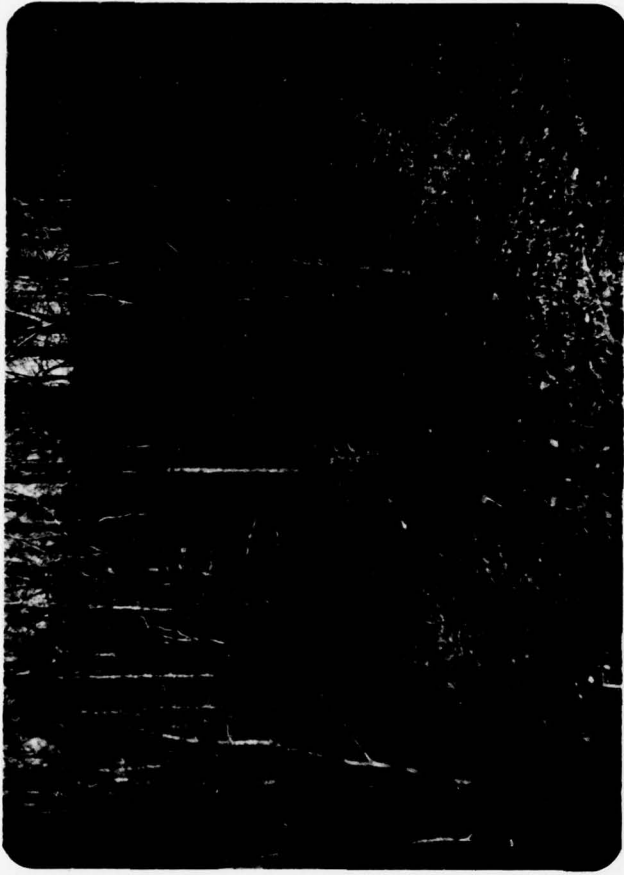
4

PHOTOGRAPH 6 Close-up view of another cavity in the downstream face of the Green Lick Dam embankment. We estimated the flow to be between five and ten gallons per minute at this point.

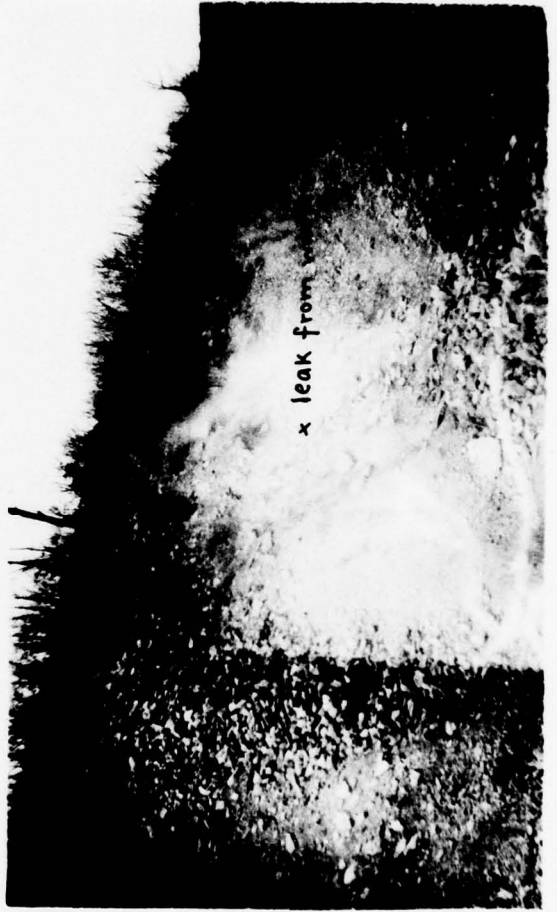
PHOTOGRAPHS 7, View of a large area of seepage on the right abutment of the Green Lick embankment. At the time of inspection, the seepage at this point was estimated to be between five and ten gallons per minute. The spillway is immediately behind this area of seepage. Photograph 7a shows seepage issuing from the same area as it appeared in 1914.



6



7



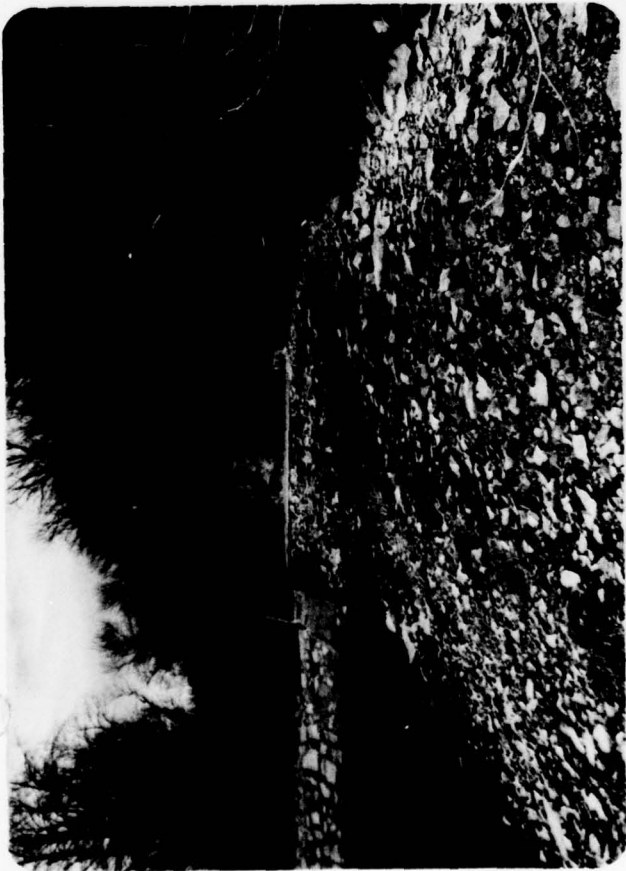
x leak from

7a

PHOTOGRAPHS 8, View looking downstream at the approach
8a channel to the Green Lick spillway as it
appears presently (8), and as it appeared in
1914 (8a).

PHOTOGRAPH 9 View looking upstream at the Green Lick Dam
spillway taken from the natural rock channel
located immediately downstream of the spill-
way.

PHOTOGRAPH 10 View looking upstream from the natural rock
channel. The concrete portion of the spillway
can be seen in the background of the photo-
graph.



8



Green Lick Dam - Spillway - 10-21-14.

8a



9

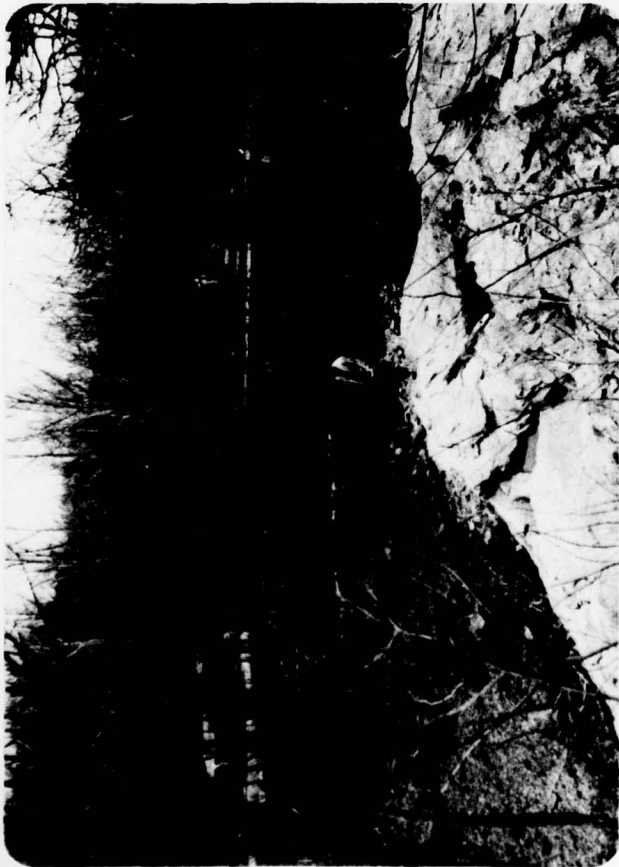


10

PHOTOGRAPH 11 The spillway waters pass around the right abutment of Green Lick Reservoir discharging into the natural drainage approximately 300 feet downstream of the spillway. A waterfall, roughly 25 feet high, occurs shortly before the waters re-enter the natural drainage.

PHOTOGRAPHS 12, 12a View looking upstream from the area just downstream of the Green Lick embankment. The water in the foreground is discharging from a 24-inch blow-off pipe which passes beneath the embankment. This 24-inch blow-off pipe was being used to lower the water level within the reservoir at the time of inspection. Photograph 12a shows the blow-off pipe exit as it appeared in 1914.

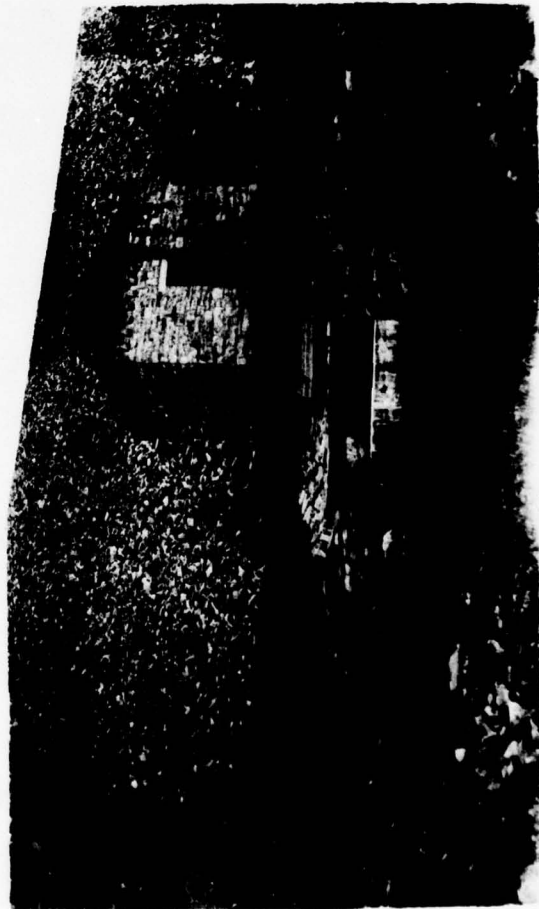
PHOTOGRAPH 13 View of the inlet ends of the 20-inch (foreground) and 16-inch (background) supply pipes as they appeared in 1926. Note the vertical steel trash racks on the inlet boxes.



11



12



Green Lick Dairy - Gate House and Blow Off Pipe 1872-14

12a



13

PHOTOGRAPH 14 View of the inlet end of the 24-inch blow-off pipe as it appeared in 1926.

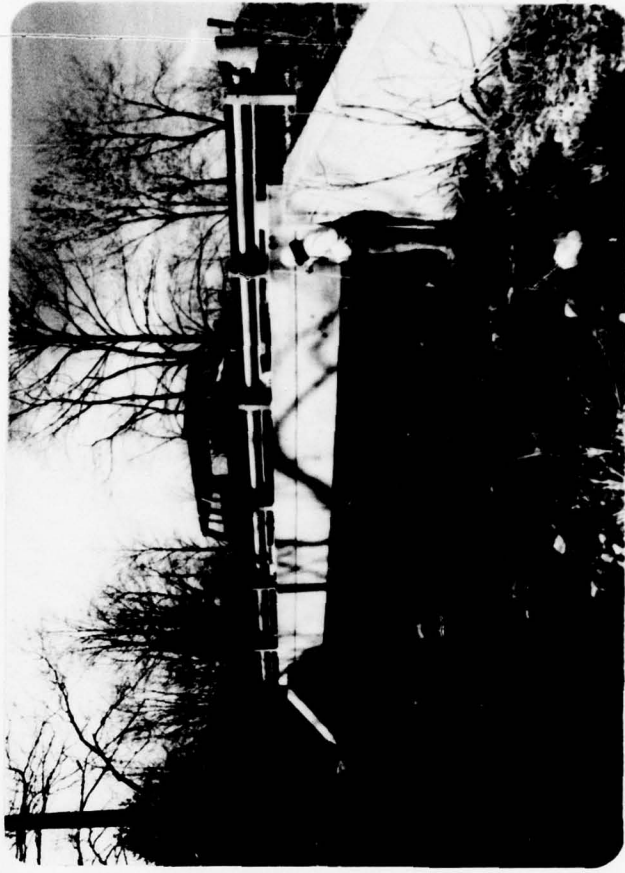
PHOTOGRAPH 15 View taken from the area where Green Lick Run discharges into Green Lick Reservoir. The Green Lick Dam can be seen in the extreme background of the photograph.

PHOTOGRAPH 16 View taken from the crest of the Green Lick embankment showing the area immediately downstream which contains approximately four permanent dwellings.

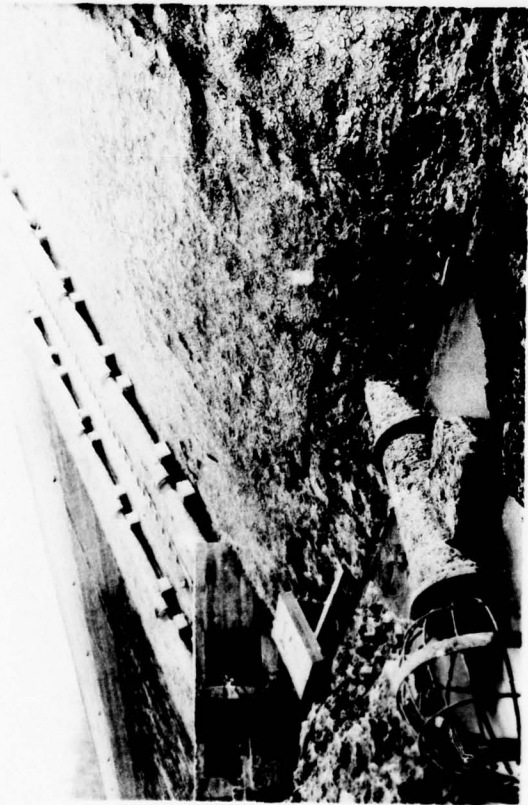
PHOTOGRAPH 17 View of a bridge over Latta Creek located approximately 3,000 feet downstream of the dam.



15



17



14



16

APPENDIX E
GEOLOGY

The Green Lick Dam is located on the western flank of Chestnut Ridge Anticline in the Pennsylvanian age rocks of the Pottsville Group. These sedimentary strata are characterized as massive sandstones, locally conglomeritic with interbedded shale, clay, and coal beds. Historical evidence indicates that the foundation of the dam rests on limestone. Rocks exposed on the right abutment consisted predominantly of sandstone with lesser amounts of interbedded shales and siltstones. The sandstone was highly jointed and contained numerous open joints.

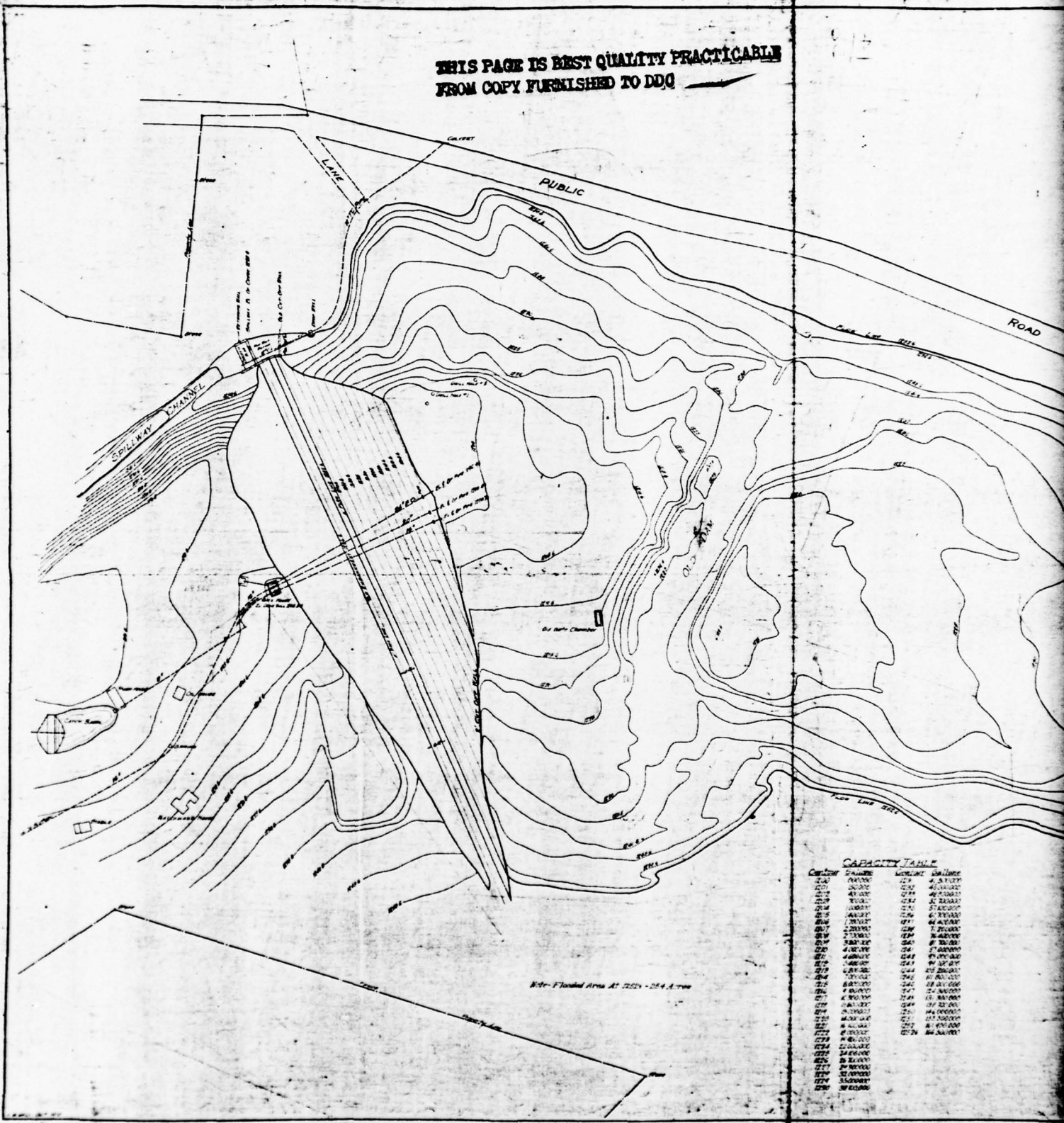
APPENDIX F

FIGURES

APPENDIX F - FIGURES

<u>Figure</u>	<u>Description/Title</u>
1	Topographic Plan of Green Lick Reservoir
2	Plan and Details of Green Lick Dam
3	Sketch Showing Addition to Embankment
4	Pipeline Improvement at Green Lick Reservoir
5	Improvements at Gate House
6	Spillway Plan

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CAPACITY TABLE

Capacity	Storage	Volume	Area
200	100000	100	4.50000
210	120000	120	4.10000
220	140000	140	3.70000
230	160000	160	3.30000
240	180000	180	2.90000
250	200000	200	2.50000
260	220000	220	2.10000
270	240000	240	1.70000
280	260000	260	1.30000
290	280000	280	0.90000
300	300000	300	0.50000
310	320000	320	0.10000
320	340000	340	0.00000
330	360000	360	0.00000
340	380000	380	0.00000
350	400000	400	0.00000
360	420000	420	0.00000
370	440000	440	0.00000
380	460000	460	0.00000
390	480000	480	0.00000
400	500000	500	0.00000
410	520000	520	0.00000
420	540000	540	0.00000
430	560000	560	0.00000
440	580000	580	0.00000
450	600000	600	0.00000
460	620000	620	0.00000
470	640000	640	0.00000
480	660000	660	0.00000
490	680000	680	0.00000
500	700000	700	0.00000

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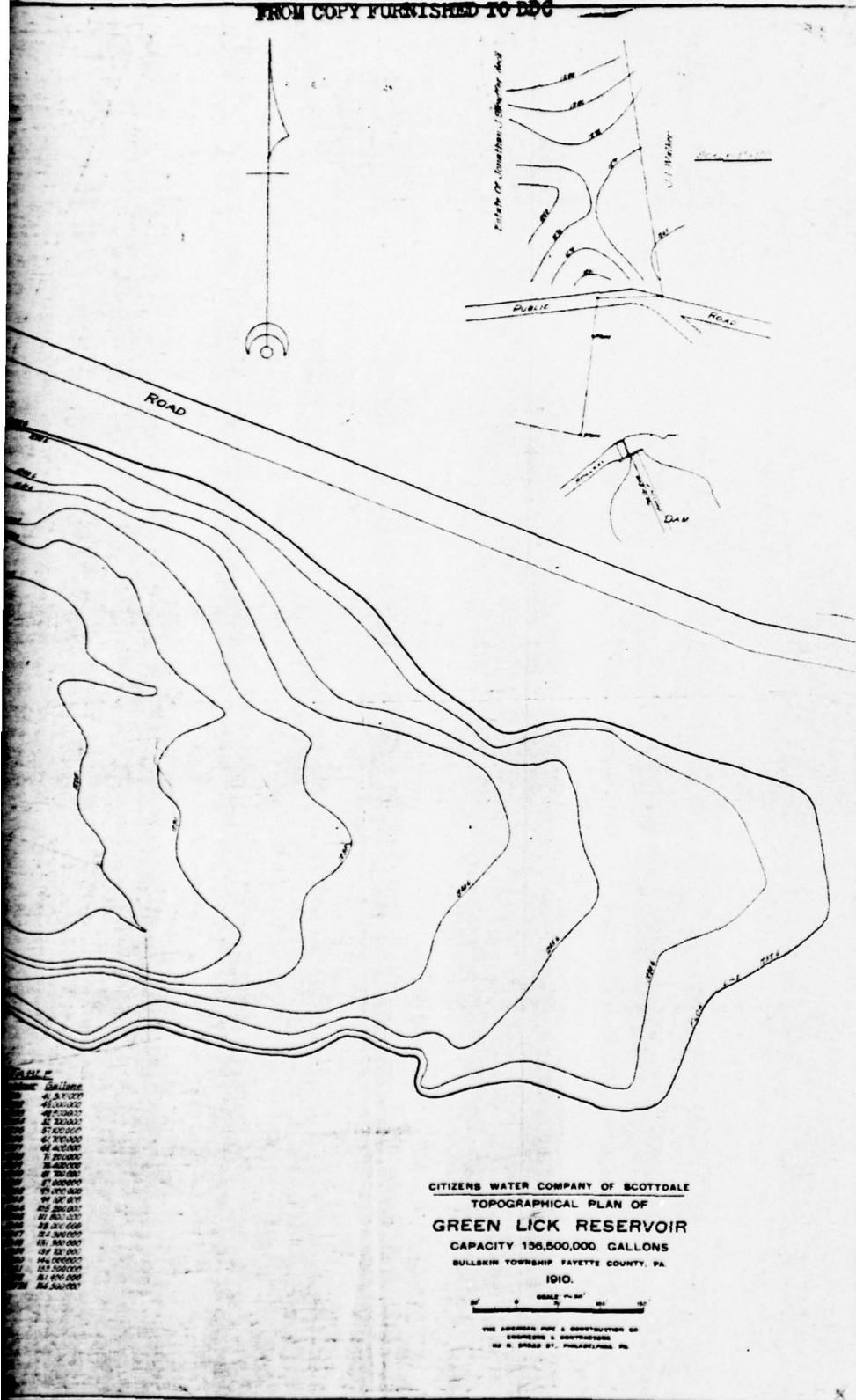
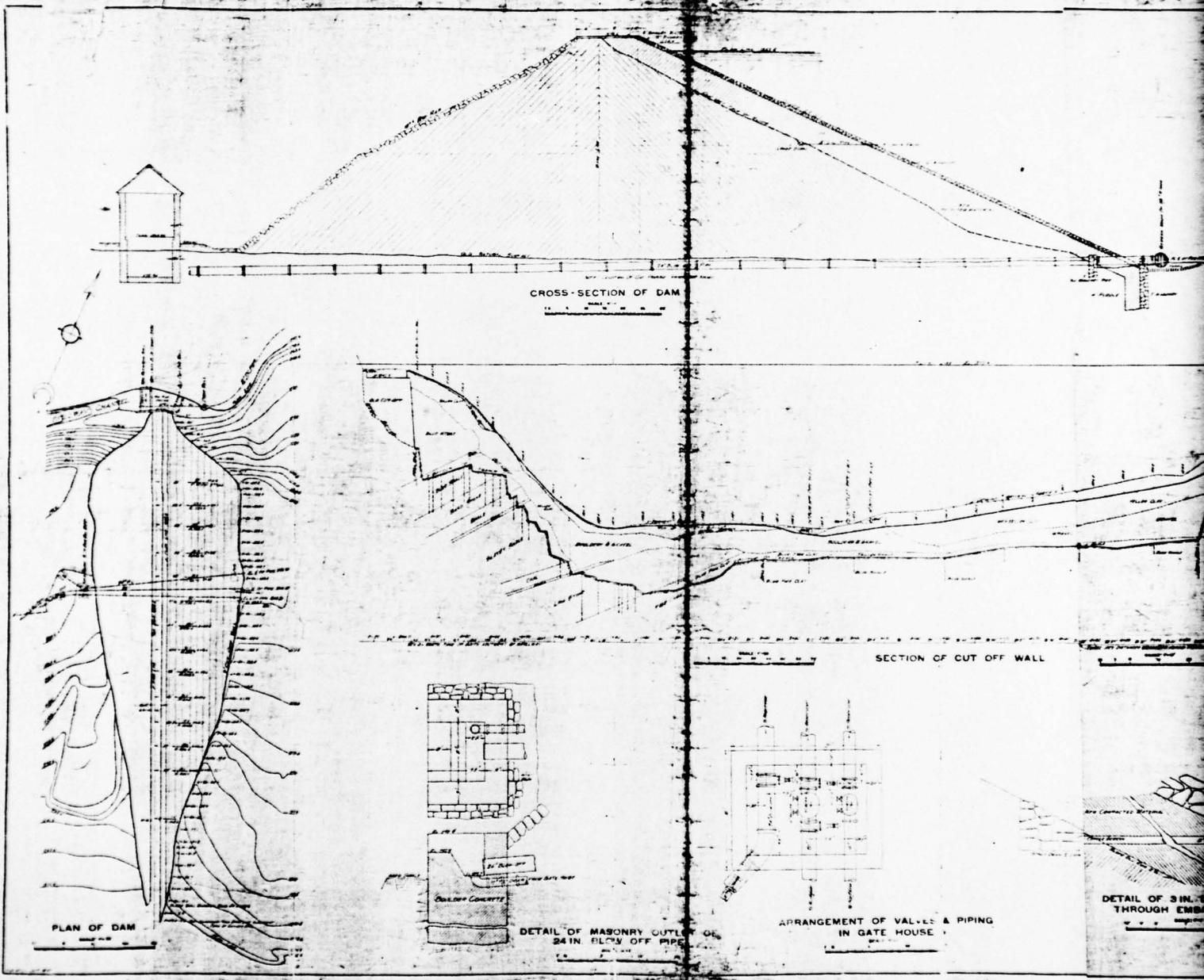


FIGURE 1

2

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1

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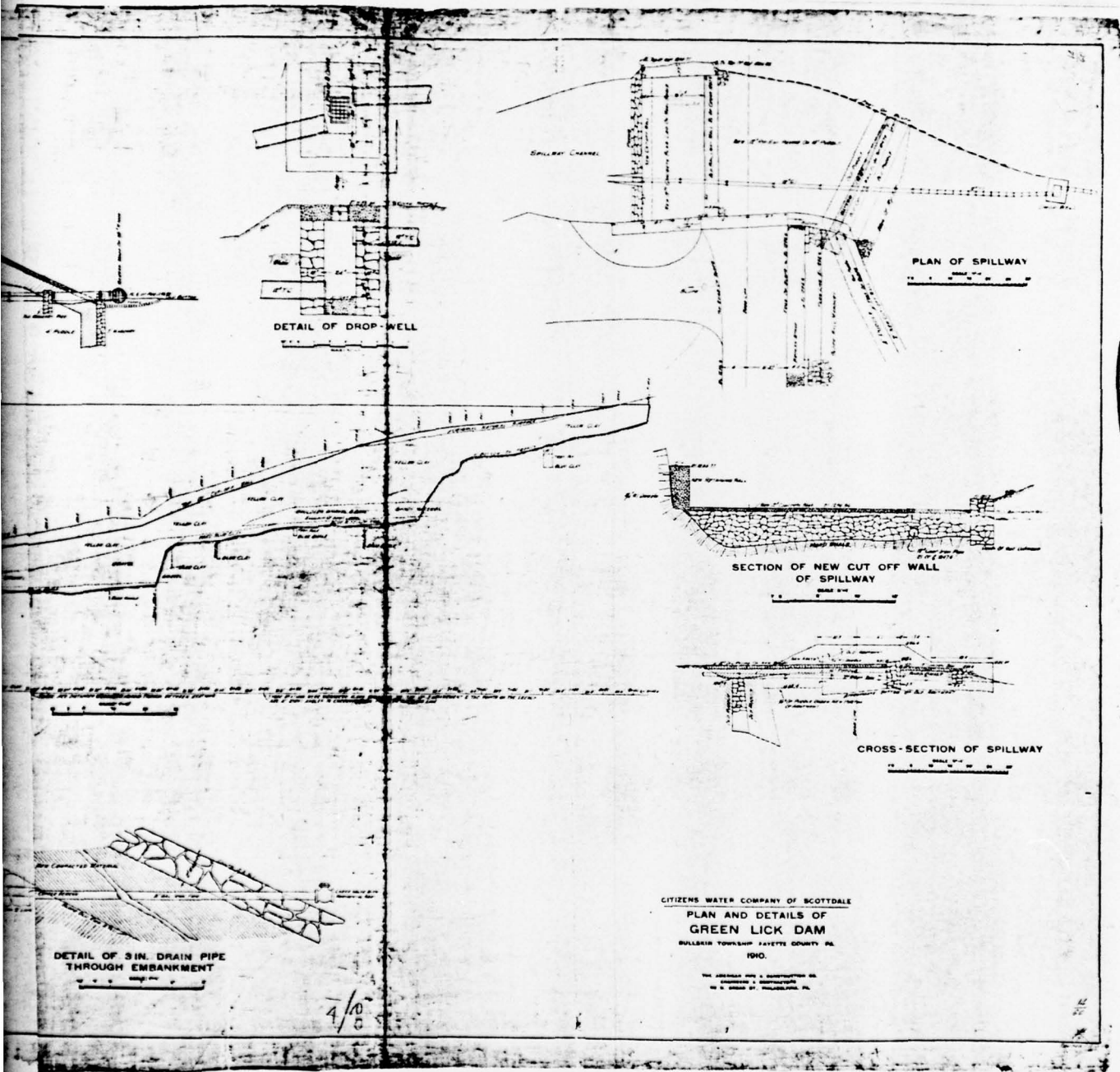
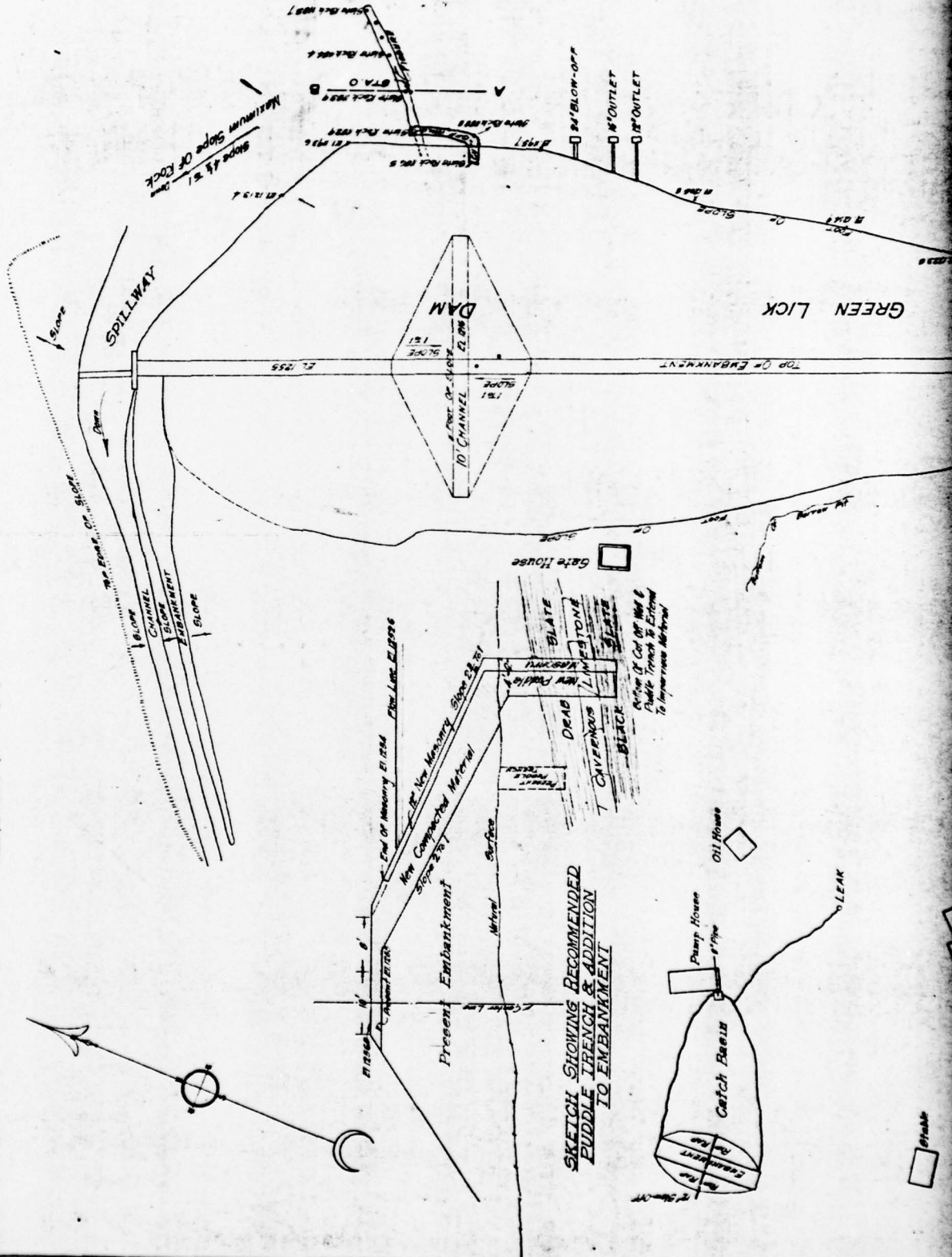


FIGURE 2

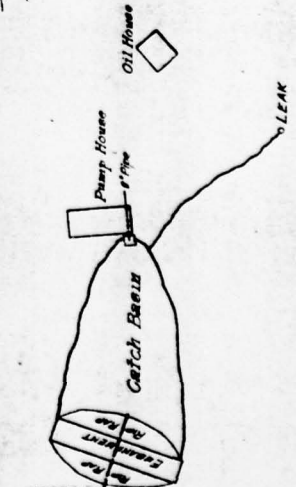
2

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Scale 1:18
Sketch showing outline of opening in limestone rock in bottom of Greenlick Reservoir. The hole was filled with cement grout in three lead lines marked A, B, and C. The limestone made from material by G. B. Claryway.

SKETCH SHOWING RECOMMENDED
PUDDLE TRENCH & ADDITION
TO EMBANKMENT



Area of Cut Off Wall & Puddle Trench to Extend to Impervious Material

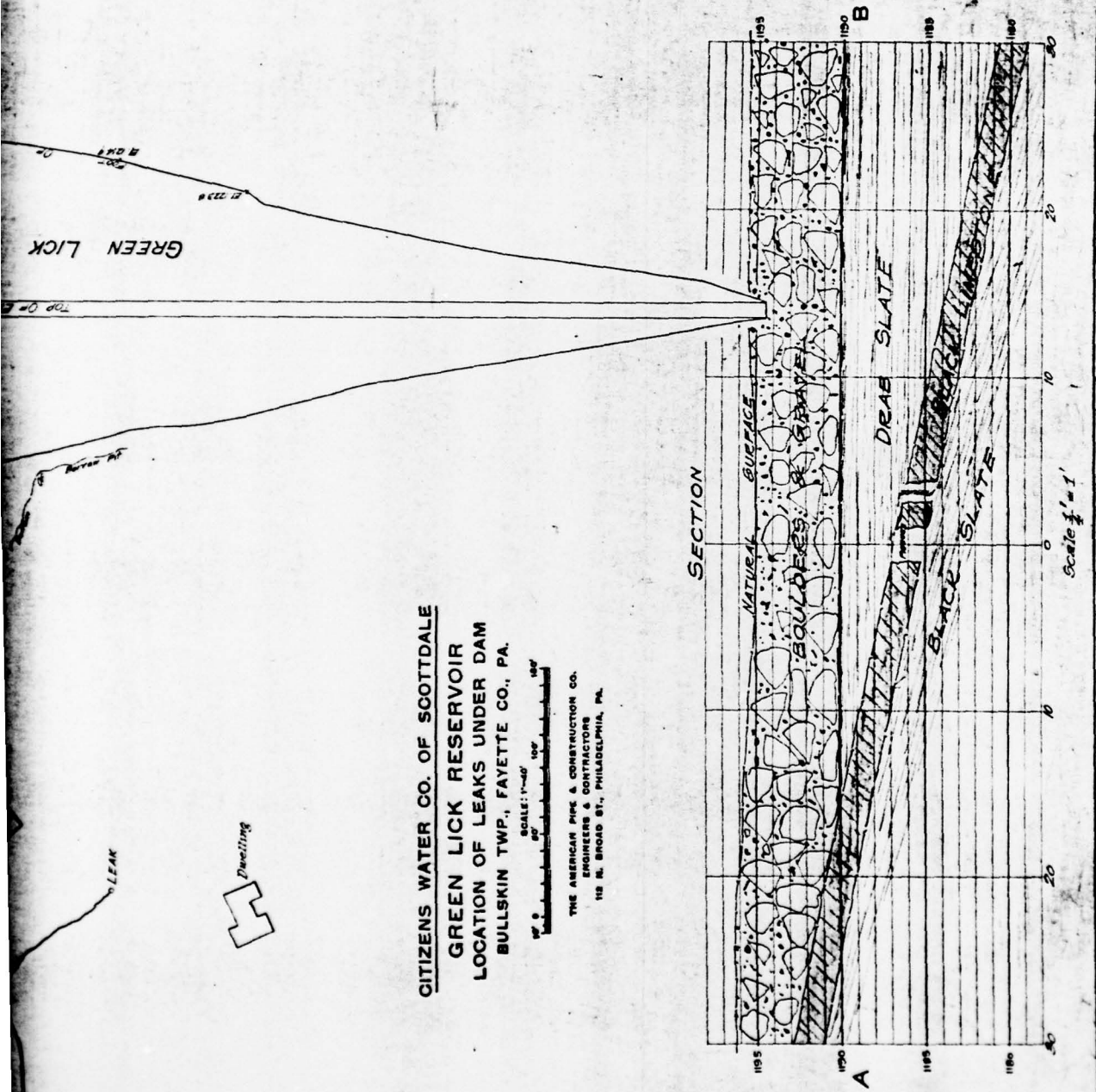
End of Memory 21.224 Elev. Loc. 21.224
New Compacted Material
Slope 2 1/2 H. 1 V. 1
Present Embankment



Sketch

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232 4449.

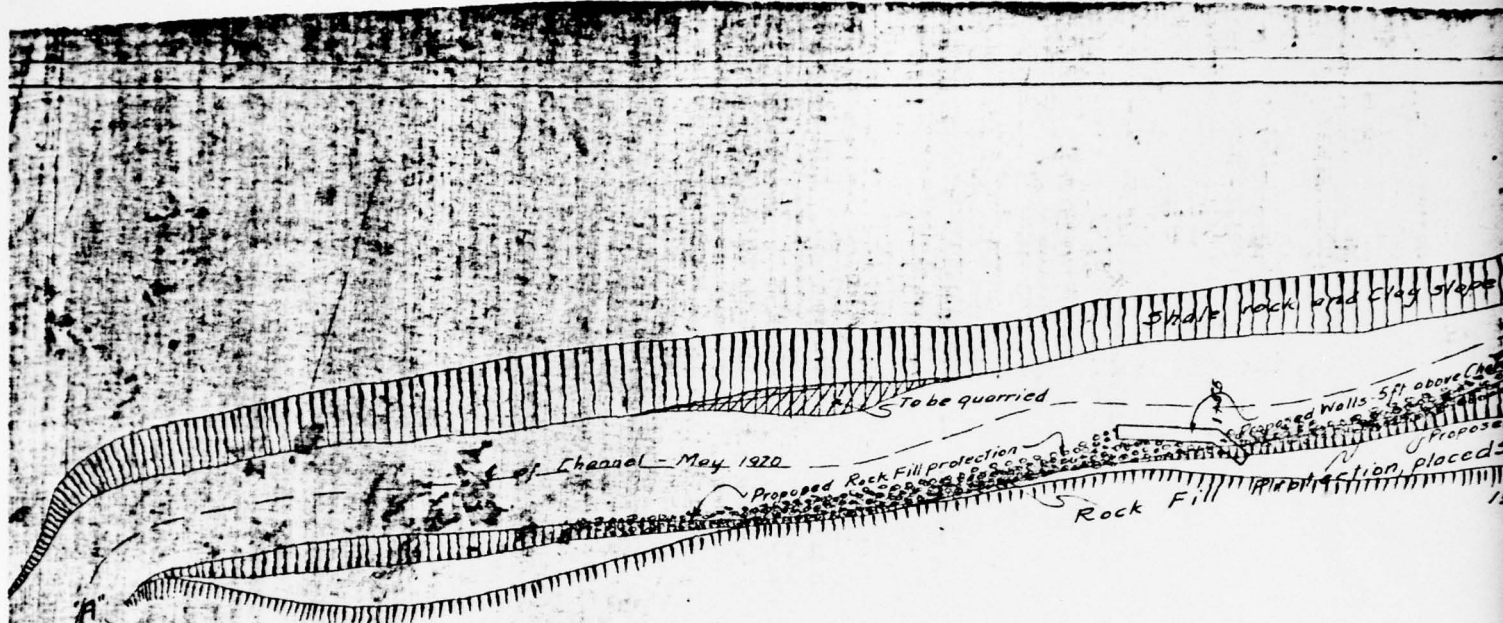


CITIZENS WATER CO. OF SCOTTDALE
GREEN LICK RESERVOIR
LOCATION OF LEAKS UNDER DAM
BULLSKIN TWP., FAYETTE CO., PA.

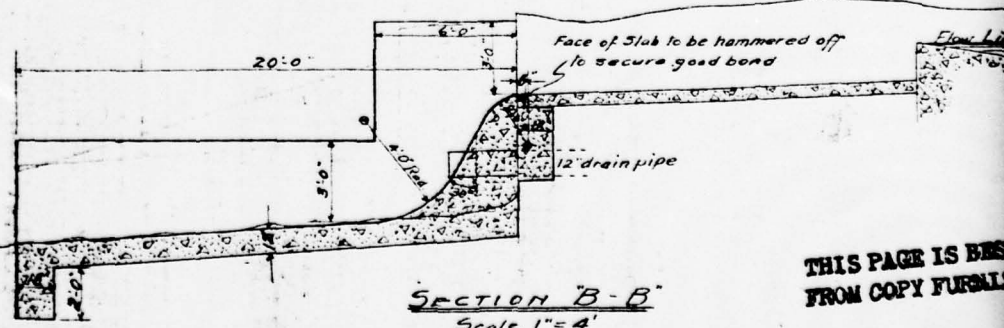
SCALE: 1"=40'
100'
200'
THE AMERICAN PIPE & CONSTRUCTION CO.
ENGINEERS & CONTRACTORS
112 N. BROAD ST., PHILADELPHIA, PA.



FIGURE 3

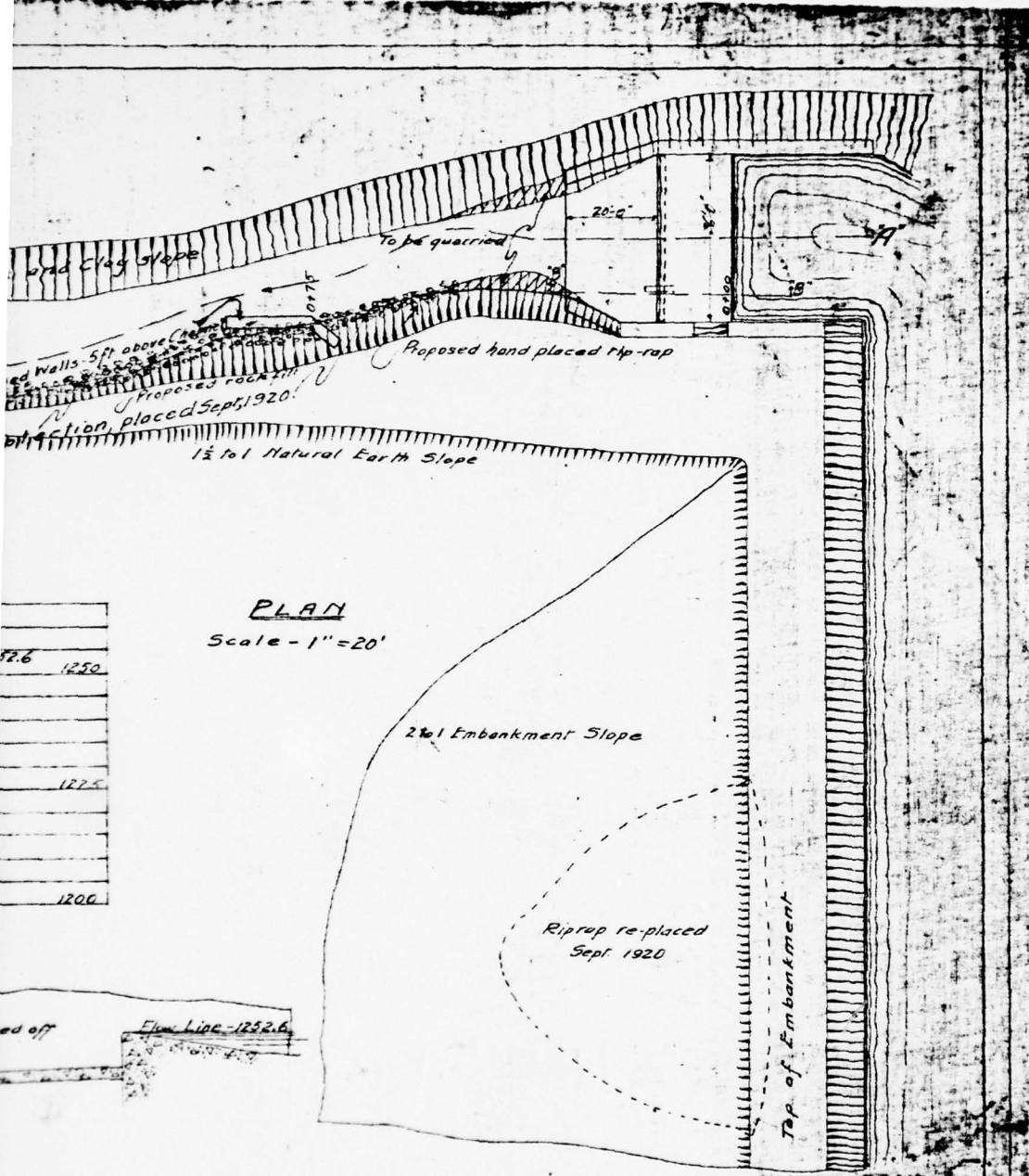


PROFILE
 along & of Channel "A-A"
 Hor. 1" = 40'
 Vert. 1" = 20'



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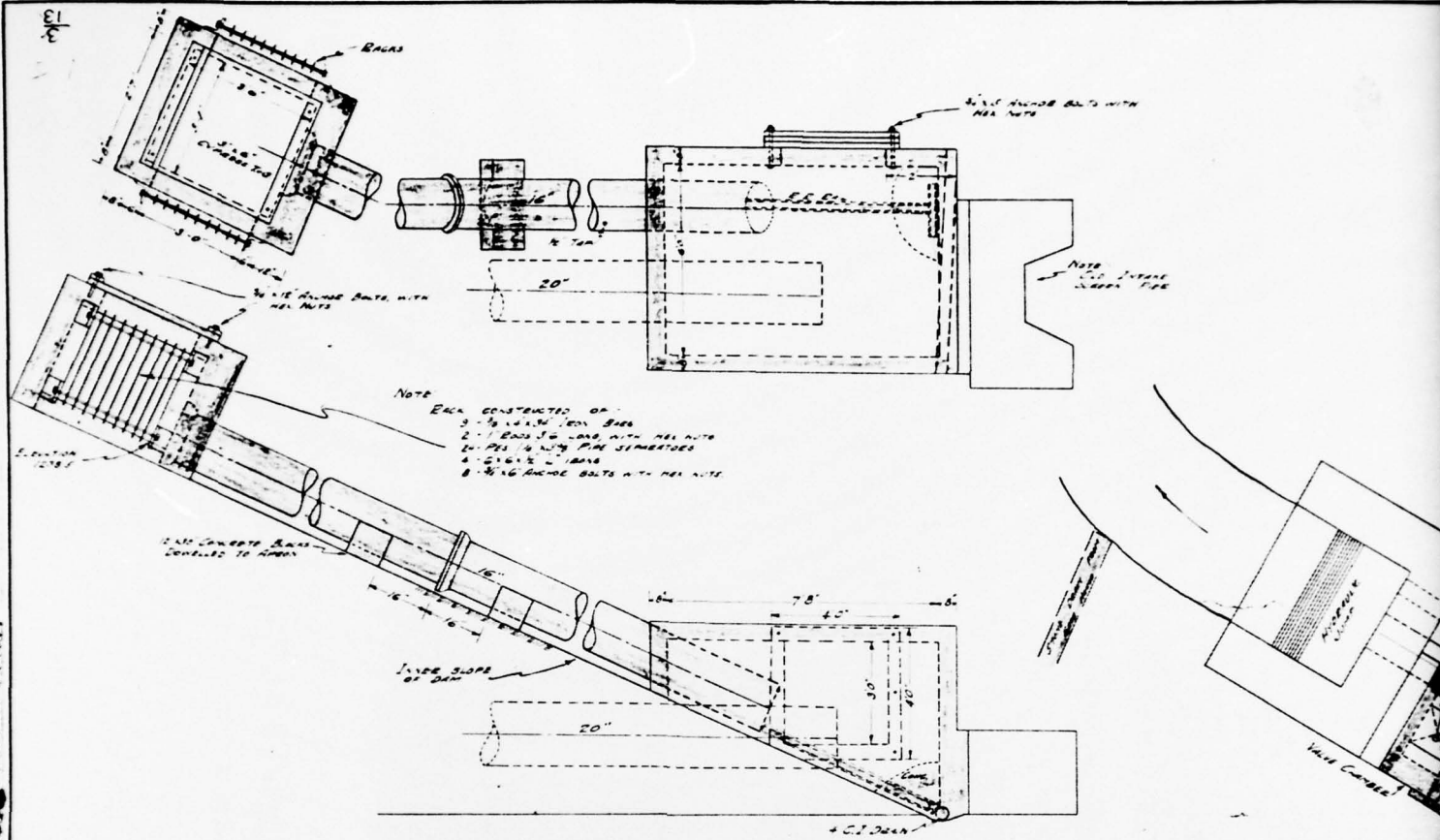
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Handwritten notes and calculations:
 52
 -42

 10

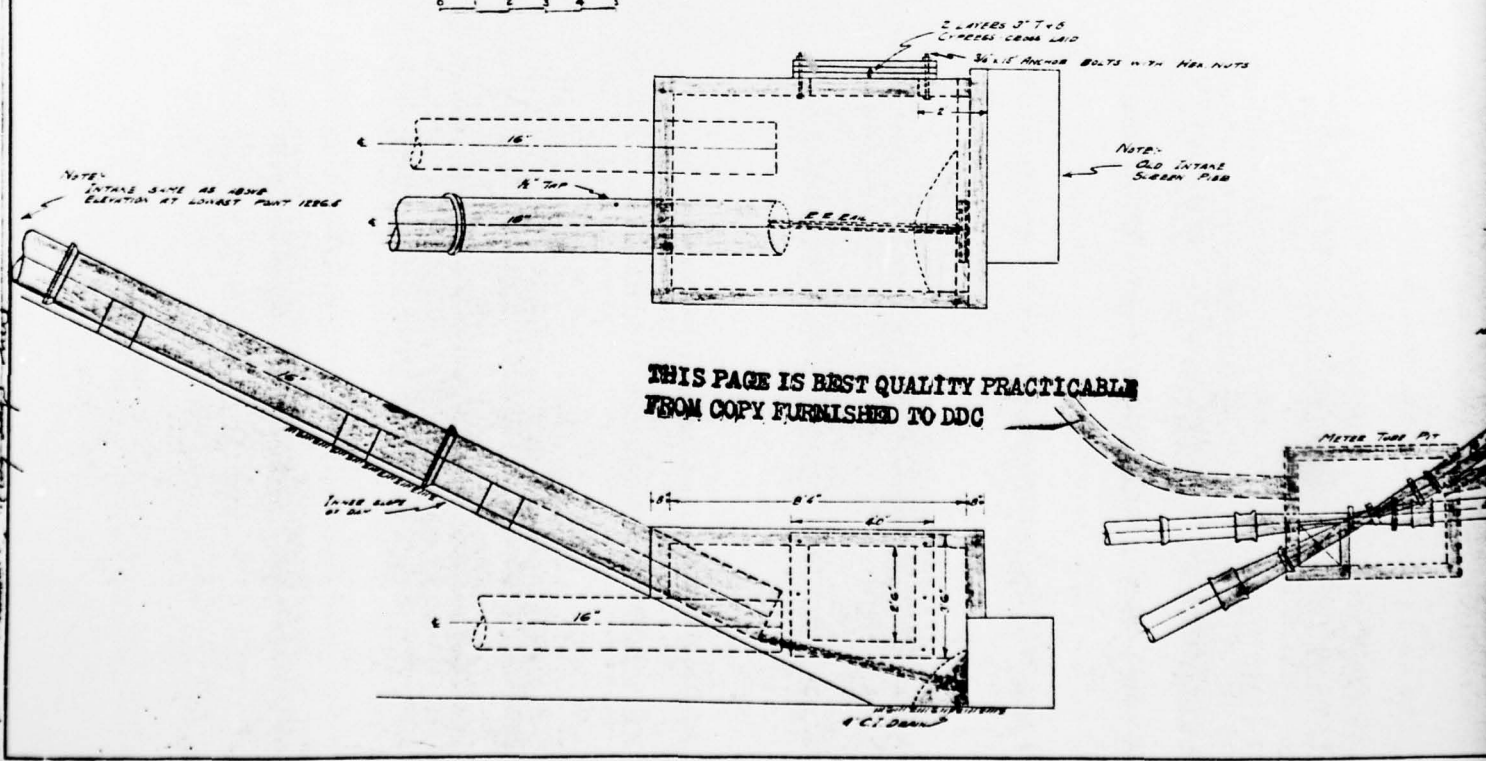
FIGURE 4 2

81



NOTE
 EACH CONSISTED OF:
 3 - 3/4" DIA. IRON BARS
 2 - 1" DIA. IRON RODS WITH HELI NUTS
 4 - 1/2" DIA. IRON PIPE STIMULATORS
 4 - 5/16" DIA. IRON BARS
 8 - 3/16" ANCHOR BOLTS WITH HELI NUTS

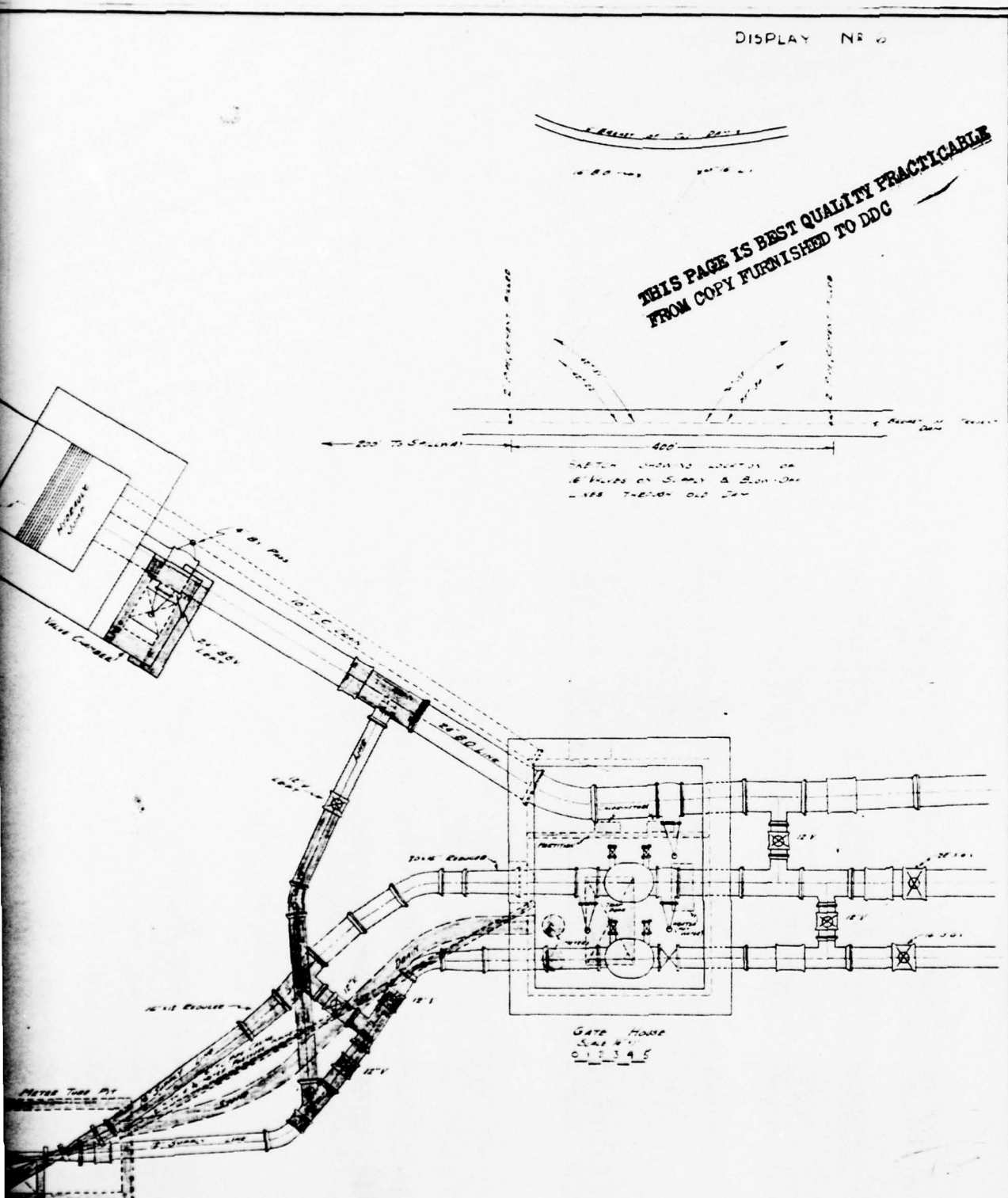
2 HIGH LEVEL INTAKES
 SCALE 1/4" = 1'
 PORTLAND CEMENT USED IN ALL CONCRETE 1 1/2 - 2%
 HEAVY 11-12 MIL THICK USED FOR REINFORCING TOP SLABS



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METER TUBE PT.

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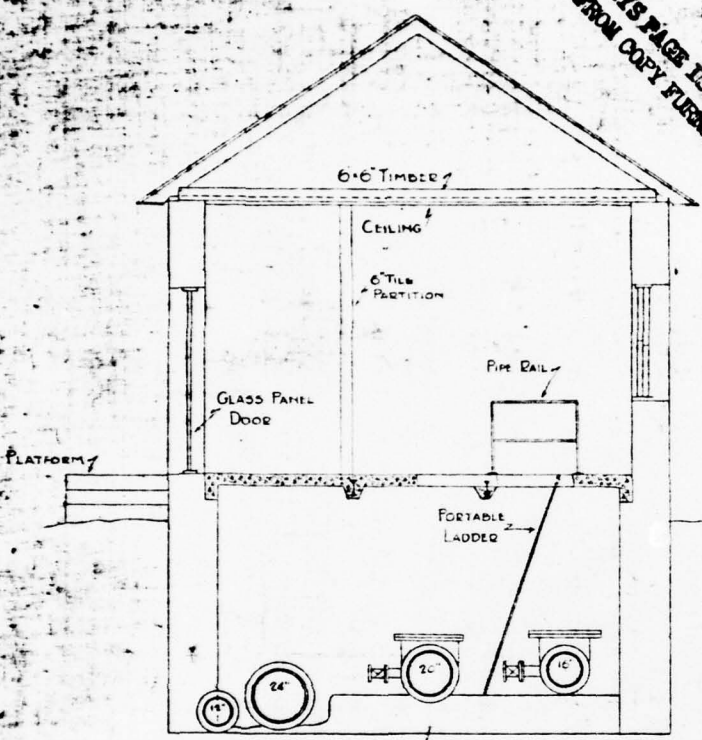


CITIZENS WATER CO OF SCOTTDALE
 HIGH LEVEL INTAKE & PIPE LINE IMPROVEMENTS AT
 GREENLICK RESERVOIR - MADE IN 1926
 SCALE - AS SHOWN NO. FEB 19 1927
 OFFICE OF SUPERINTENDENT
 GREENSBURG PENNA

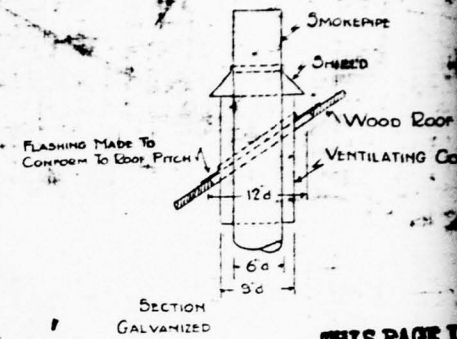
3/13

FIGURE 5 2

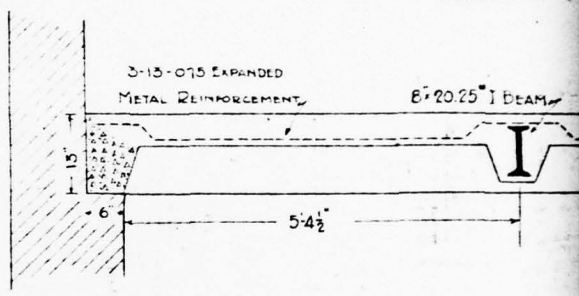
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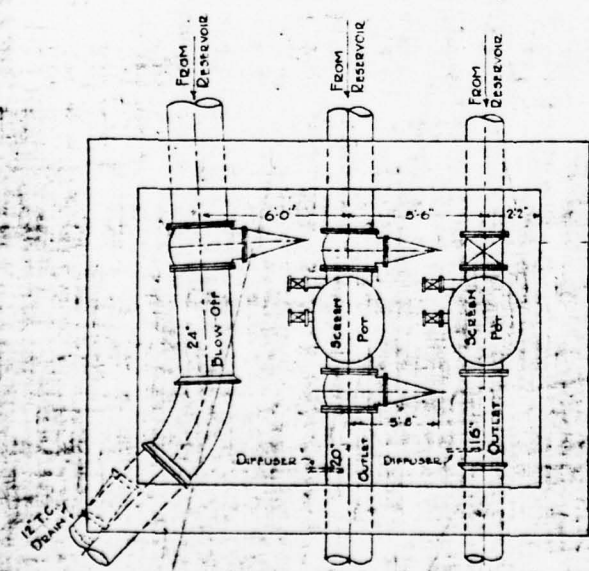
SECTIONAL ELEVATION
Scale: 1/4" = 1'-0"



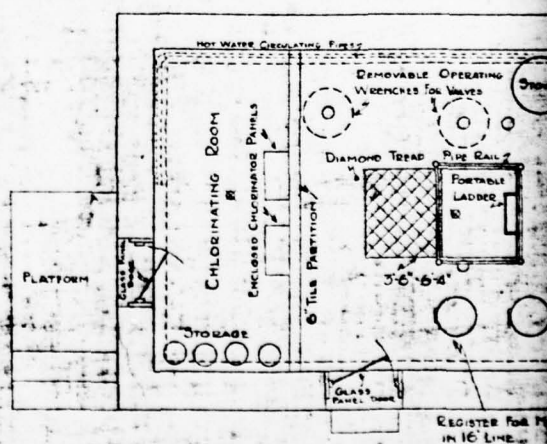
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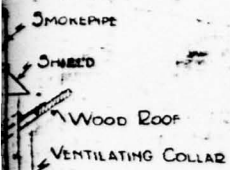
DETAIL OF FLOOR
Scale: 3/4" = 1'-0"



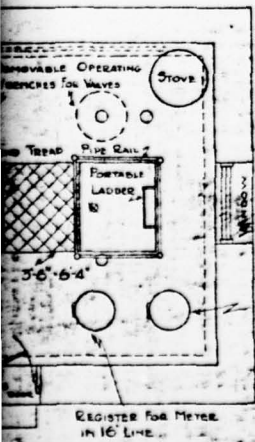
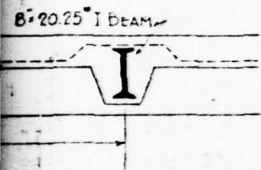
BASEMENT PLAN
Scale: 1/4" = 1'-0"



FLOOR PLAN
Scale: 1/4" = 1'-0"



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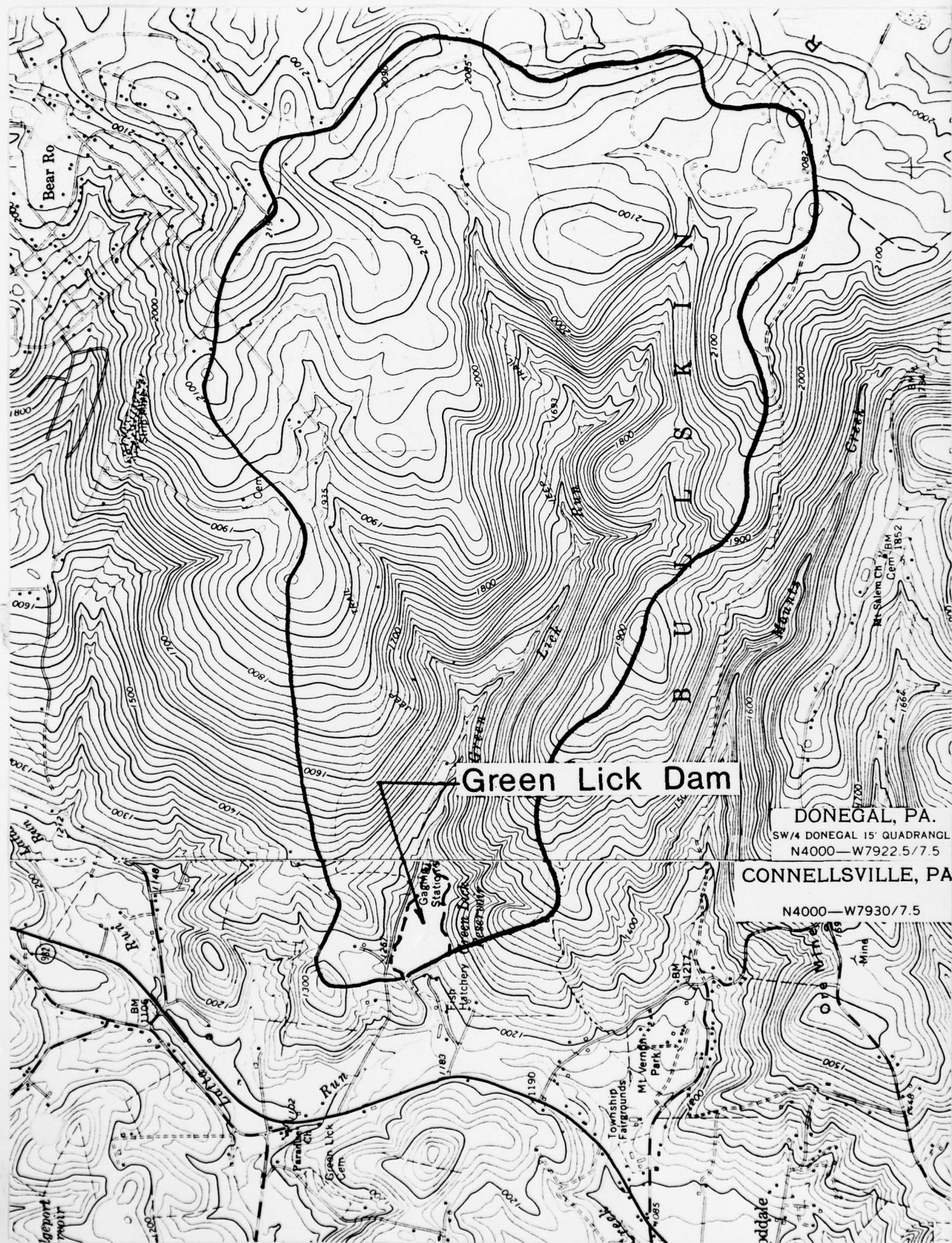


CITIZENS WATER COMPANY OF SCOTSDALE
GREENLICK RESERVOIR
IMPROVEMENTS AT GATE HOUSE
AS BUILT
SCALES AS SHOWN ERW. FEB 23, 1926
OFFICE OF GENERAL SUPERINTENDENT

24
50

FIGURE 6

APPENDIX G
REGIONAL VICINITY MAP



Green Lick Dam

DONEGAL, PA.

SW/4 DONEGAL 15' QUADRANGLE
N4000—W7922 5/7.5

CONNELLSVILLE, PA

N4000—W7930/7.5