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NATIONAL DAM INSPECTION PROGRAM. TWO LICK CREEK DAM (NDI PA-285--ETC(U)
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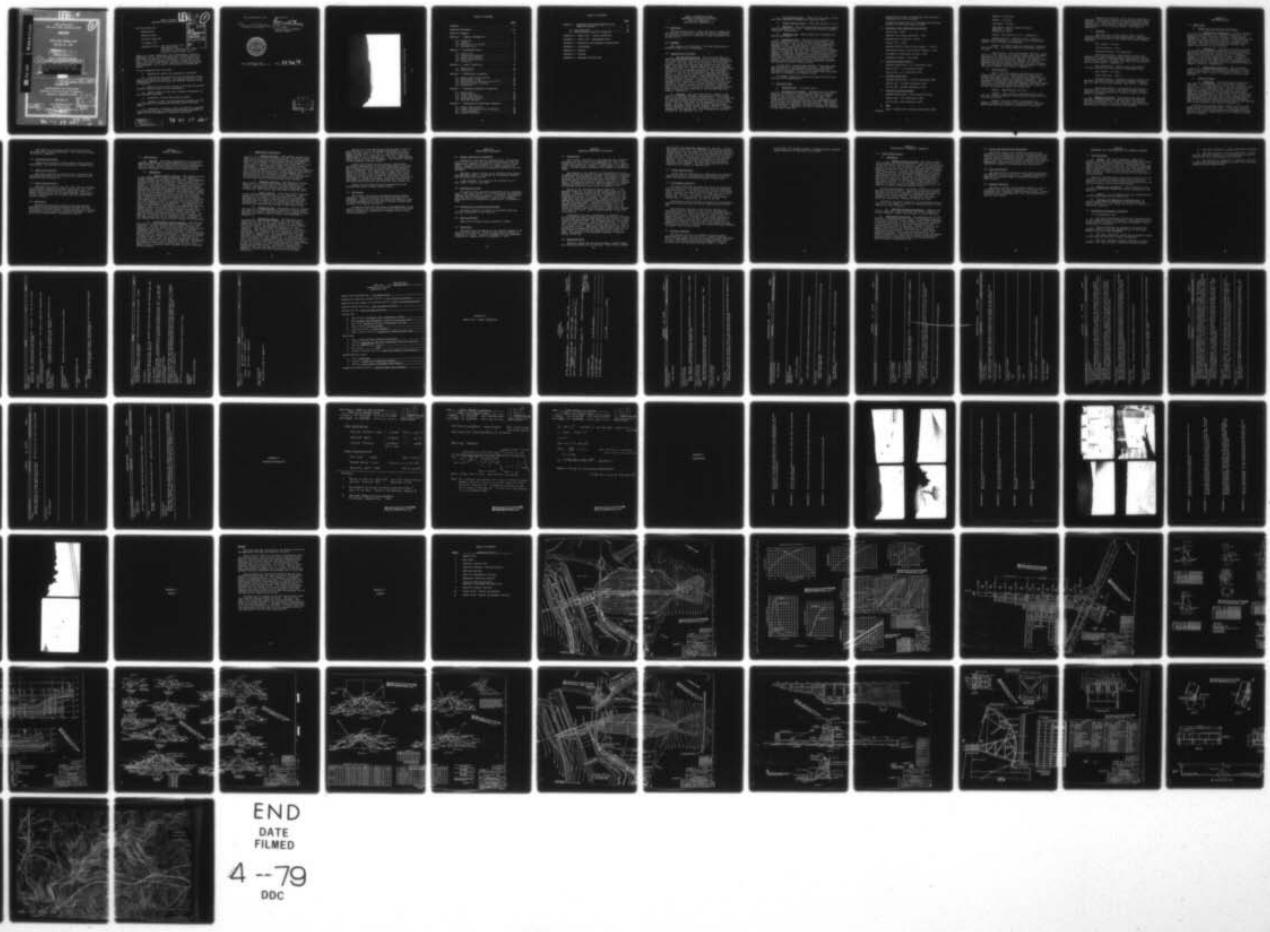

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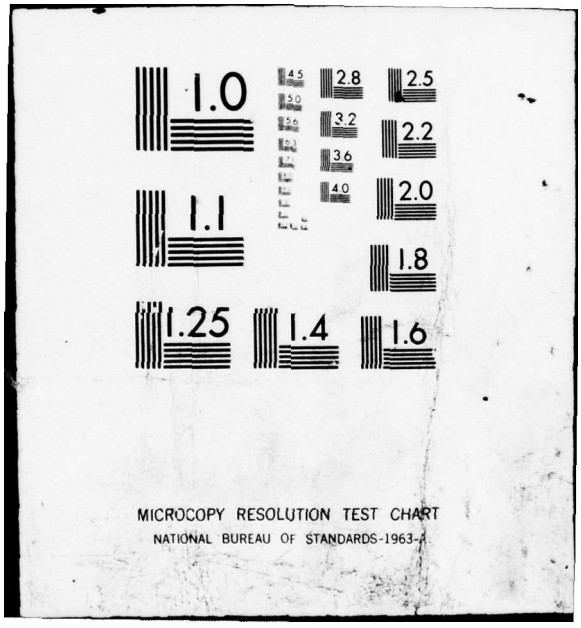
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LEVEL II

OHIO RIVER BASIN
TWO LICK CREEK, INDIANA COUNTY

PENNSYLVANIA

TWO LICK CREEK DAM
NDI No. Pa. - 285

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Two Lick Creek Dam (NDI PA-285), Ohio River Basin, Two Lick Creek, Indiana County, Pennsylvania. Phase I Inspection Report.

(15) DACW31-78-C-0052

PREPARED FOR

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

PREPARED BY

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570 BEATTY ROAD
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PHASE I REPORT
National Dam Inspection Program

Two Lick Creek Dam

Pennsylvania

Indiana County

Two Lick Creek Dam

11 August 1978

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

Contract No. DACW31-78-C-0052

Based on a visual inspection, past performance, available engineering data, and discussions with a representative of the owner, the facility is considered to be in good condition. The primary spillway is capable of passing the flow resulting from a storm of PMF intensity without overtopping the embankment. As a result, the spillway is deemed adequate.

It is recommended that the owner:

a. Immediately remove the embankment overgrowth.

b. Investigate the durability and suitability of the riprap and quarry run rockfill. Conclusions relative to its suitability should be developed and remedial measures taken if necessary.

c. Drain the water from the toe of the dam and provide positive drainage away from the embankment.

d. Repair damage to the right abutment downstream of the emergency spillway.

e. Establish a formal maintenance program.

f. Develop a formal warning system to provide for the safe evacuation of downstream residents should the need arise.

g. Establish a program to have the facility inspected on an annual basis by a registered professional engineer to check for the development of hazardous conditions.

GAI Consultants, Inc.

Bernard M. Mihalcin, P.E.

Date 13 Sept 78

Approved by:

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

Date 22 Sep 78

Overview Photograph of Two Lick Creek Dam

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
TWO LICK CREEK DAM
NDI# PA-285, PENNDER# 32-75

ABSTRACT

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.

ABSTRACT

1.2 Description of Project.

a. Dam and Appurtenances. Two Lick Creek Dam is a combination concrete gravity and earth- rockfill embankment. It is approximately 1,200 feet long with a maximum height of 115 feet. The right side of the structure is a concrete gravity dam with six concrete ogee-shaped overflow spillway bays. The three bays located nearest to the right abutment (defined as Bays 1, 2, and 3 of this report) are uncontrolled and function as the emergency spillway. The three bays located to the left of the emergency spillway (defined as Bays 4, 5, and 6 of this report) are equipped with mechanically operated radial gates. These bays function as the primary spillway with crests 33.5 feet lower than the crests of the emergency spillway. In addition, the facility is equipped with a discharge tunnel (concrete box culvert type) located to the right of the junction between the concrete and earth- rockfill sections of the structure. The left side of the structure is an earth- rockfill embankment which wraps around the left extremity of the concrete dam (see Figure 1, Appendix F).

b. Location. Two Lick Creek Dam is located on Two Lick Creek in White Township, approximately 3 miles southeast of the Borough of Indiana, Pennsylvania. U. S. Route 422 is constructed approximately parallel to the reservoir and is less than 1/2 mile south of the embankment at its closest point. The dam, reservoir, and watershed are contained within Barnesboro, Brush Valley, Clymer, Commodore, Marion Center, Rochester Mills, and Strongstown U.S.G.S. 7.5 minute quadrangles (see Appendix G). The coordinates of the dam are N40° 35' 30" and W79° 6.0' 0".

c. Size Classification. Large (115 feet high, 16,200 acre-feet capacity at design pool elevation 1183).

d. Hazard Classification. High (see Section 3.1.c.5).

e. Ownership. New York State Electric and Gas Corporation, Binghamton, New York. Pennsylvania Electric Company, Johnstown, Pennsylvania.

f. Purpose of Dam. Water supply for the Homer City generating station.

g. Historical Data. The facility was designed by Gilbert Associates, Inc., of Reading, Pennsylvania. Construction began in the spring of 1967 and was completed by December of 1968. The dam was built in conjunction with the Homer City Generating Station. Both facilities are jointly owned by the New York State Electric and Gas Corporation of Binghamton, New York, and the Pennsylvania Electric Company of Johnstown, Pennsylvania. Monthly construction progress reports were prepared by Bechtel Corporation of San Francisco, California, acting as construction managers for the project. These reports indicate the project was completed in general accordance with the preliminary schedule and apparently without a major problem.

In July 1977, a storm caused damage to the right abutment downstream of the emergency spillway. Subsequently, the facility was inspected by Gilbert Associates, Inc., and Penelec personnel. A copy of the report detailing their findings is available from Penelec files.

No PennDER inspection reports have been filed on this facility since construction.

1.3 Pertinent Data.

a. Drainage Area. 74 square miles.

b. Discharge at Dam Site. Discharge data is compiled daily at this facility. Conversations with Mr. Gallus of Pennsylvania Electric Company indicate that the maximum flood at this facility occurred on July 20, 1977. An investigation by Gilbert Associates, Inc., subsequent to the flood revealed that maximum high water reached approximately one foot over the emergency spillway (400 cfs). The extent of the opening of each gate is believed to have been approximately two feet. Therefore, the total discharge is estimated to have been 6,000 cfs.

Outlet Works Conduit at Operating Pool Elevation - Discharge curve not available.

Primary Spillway Capacity at Maximum Gate Opening ≈ 62,500 cfs (reservoir level at 1183).

c. Elevation (feet above mean sea level).

Top of Dam - 1195.

Maximum Pool Design Surcharge - 1185.

Maximum Pool of Record ≈ 1185.5.

Normal Pool - 1183.

Upstream Portal Invert Outlet Conduit - 1107.5.

Downstream Portal Invert Outlet Conduit - 1105.

Streambed at Centerline of Dam ≈ 1105.

Maximum Tailwater - Not known.

d. Reservoir Length (miles).

Maximum Design Pool ≈ 5.3 (elevation 1185).

Normal Pool ≈ 5.0 (elevation 1183).

Top of Dam ≈ 6.7 (elevation 1195).

e. Storage (acre-feet).

Maximum Design Pool ≈ 17,000 (elevation 1185).

Normal Pool ≈ 16,200 (elevation 1183).

Top of Dam ≈ 23,000 (elevation 1195).

f. Reservoir Surface (acres).

Maximum Design Pool ≈ 525 (elevation 1185).

Normal Pool ≈ 510 (elevation 1183).

Top of Dam ≈ 650 (elevation 1195).

g. Dam.

Type - Combination concrete gravity and earth-rockfill.

Length ≈ 1,200 feet.

Height ≈ 115 feet.

Top Width - 40 feet.

Side Slopes (earth- rockfill section -
upstream 1.5H:1V
downstream 1.5H:1V

Zoning - See Figures 6 and 7, (Appendix F).

Impervious Core - Figures 6 and 7, Appendix F, indicate the embankment is constructed with an impervious central core of varying cross-section.

Cutoff - A cutoff trench was reportedly extended into sound rock. The bottom width of the cutoff trench is 20 feet.

Grout Curtain - Contract drawings indicate a grout curtain in the center of the cutoff trench under the embankment section of the dam and upstream from the concrete gravity and spillway sections of the dam. The design report indicates the grout curtain was extended to a depth of approximately 80 feet across the valley, and into the abutment to a distance and depth sufficient to minimize appreciable water movement (see Figure 5, Appendix F).

h. Outlet Conduit.

Type - Contract drawings indicate that the discharge tunnel outlet is a 12-foot high by 14-foot wide concrete box type conduit. The conduit has intakes located at three different elevations along the structure. Flow is controlled by mechanical gates operated from within the structure. Two manually operated emergency gates are located atop the dam crest and enable the conduit to be sealed off so that the mechanical gates can be serviced.

Length ≈ Approximately 420 feet.

Closure - Gate valves at elevations 1165, 1145, and 1125. Manual emergency slide gates are controlled from atop the dam crest.

Access - The gate valves are accessible by chambers through the interior of the structure. The emergency slide gates are directly accessible at the crest.

Regulating Facilities - Gate valves, mechanically operated. A low level release with intake elevation 1107.5 located in the discharge tunnel provides emergency drawdown capabilities. This release is apparently regulated at the downstream end of the discharge tunnel. (see Figure 9, Appendix F).

i. Spillway.

Type (primary) - Three 30-foot wide overflow spillway bays with concrete ogee-shaped weirs. Mechanically operated 30-foot wide by 32-foot high radial gates regulate discharge.

Weir Length - 90 feet.

Crest Elevation - 1151.

Upstream Channel - Not applicable.

Downstream Channel - The primary spillway discharges into a spillway bucket before entering the natural downstream channel. A dike has been constructed to the left of the natural channel to divert flow away from the embankment toe (see Figure 1, Appendix F).

Type (emergency) - Three 34-foot wide ungated overflow spillway bays with concrete ogee-shaped weirs.

Weir Length - 102 feet.

Crest Elevation - 1184.5.

Upstream Channel - Available drawings indicate the emergency spillway bays have individual approach channels cut into rock on the right abutment (see Figure 1, Appendix F).

Downstream Channel - The emergency spillway bays discharge over a rock cliff on the right abutment before entering the natural downstream drainage as shown on Photograph 11, Appendix D.

j. Regulating Outlets. Flow through the concrete box-type discharge tunnel is mechanically regulated with intakes at elevations 1165, 1145, and 1125. In addition, the drawings indicate a low level release conduit which can apparently be utilized to draw down the reservoir.

SECTION 2
ENGINEERING DATA

2.1 Design Data.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. A report prepared by Gilbert Associates, Inc., entitled, "Report No. 1637, Design of Two Lick Creek Dam, Volume I, Design Report, December 15, 1966," contains a synopsis of the hydrology and hydraulics considered for this project. Included are low flow and flood flow hydrology along with spillway design criteria. The report is available from PennDER files. Design calculations are not included.

2. Embankment. Information available relative to the embankment design includes boring logs, foundation and borrow investigations (Volume II, Design Report), and a soils report (Volume III, Design Report). In addition, Volume I of the design report (see 1 above) includes a synopsis of the overall embankment design. Results of the stability analysis are shown on Figure 7 (see Appendix F). This information is available from the Pennsylvania Electric Company, Johnstown, Pennsylvania.

3. Appurtenant Structures. The only design information available pertaining to the appurtenant structures of the facility is contained within Volume I of the design report (see 1 above). No design calculations were obtained.

b. Design Features.

1. Embankment. Design drawings indicate the left side of the embankment is a zoned earth- rockfill structure. It is constructed on a 1.5H on 1V upstream slope and a 1.5H on 1V downstream slope. The outer slopes are composed of riprap and quarry run rockfill. Two 15-foot berms are provided on both the upstream and downstream slopes of the embankment. A sand filter layer is provided immediately beneath the outer rock layers. The filter zones bound the random rolled fill zone on the upstream side of the embankment and the impervious core on the downstream side of the embankment and the impervious core on the upstream side of the structure (see Figure 6, Appendix F).

A 20-foot wide (bottom width) cutoff trench was excavated beneath the impervious core. A grout cap forms the bottom of the cutoff trench beneath the embankment section. The grout curtain is approximately 80 feet deep and extends into the abutments.

The concrete non-overflow portion of the dam consists of Blocks 1, 2, 10, 11, 12, and 13. The minimum top width is 12 feet and the back slope is 0.7 on 1.0 (see Figure 9, Appendix F).

Typically, the concrete section, including the spillway, has a 4.5-foot wide drainage and inspection gallery with a floor elevation of 1130 and a top elevation of 1138. An 18-inch wide gutter, of varying depth is provided at the upstream face of the gallery. Uplift relief drains discharge into this gutter.

Blocks 1 and 2 are straight sections, 12 feet wide, which are primarily abutment connection blocks.

Block 10 has a design height of 68 feet, with a 12-foot top width and with the standard 0.7H on 1V back slope.

Block 11 has a design height of 75 feet, with a nominal top width of 18 feet. A 5-foot wide cantilevered deck is provided upstream of access and installation space for the slide gate hoists. In addition to the drainage and inspection gallery, Block 11 contains access galleries to each of the two higher level water release valves, discharge galleries of the water control system and a stairway connecting the lower level valve access gallery with the inspection and drainage gallery.

Block 12 has a design height of 95 feet, with a top width of 15 feet. The control building is located on the downstream face of Block 12. Block 12 contains the discharge tunnel. The lower 20 feet of this block lies within a trench excavated into sound rock and is restrained on three sides. The lower level water release valves, the low level control room, the discharge gallery, stairs connecting the upper and lower valve access galleries, and an access gallery into the control buildling are located in Block 12. Sump dewatering is also done from Block 12.

Block 13 has a design height of 90 feet, with a top width of 12 feet. A 6-foot equipment shaft is provided in Block 13 from the top of the dam to the inspection and drainage gallery. Exterior mounted stairs run down the back faces of Blocks 12 and 13 from the top of the dam to the control building. The primary point of design interest of Block 13 is that the impervious fill of the adjoining embankment wraps around the upstream and downstream faces to form a complete water barrier. All faces of Block 13, except where it adjoins Block 12, form a sloped surface for contact with earth.

2. Appurtenant Structures.

a) Primary Spillway. The primary spillway (Bays 4, 5, and 6) was designed with 30-foot wide bays and a crest at elevation 1151. Control is provided by three motor-operated radial gates (see Figures 9, 10, and 11, Appendix F).

b) Emergency Spillway. The emergency spillway (Bays 1, 2, and 3) was designed to be an uncontrolled discharge outlet. The three bays are equipped with concrete ogee-shaped weirs with crest elevations at 1184.5 (see Figure 9, Appendix F).

c) Outlet Conduit. The discharge tunnel outlet is a 12-foot high by 18-foot wide concrete box-type conduit. It is equipped with intakes at three different elevations. These intakes form what is known as the water control system at the facility.

d) Water Control System. The controlled water release system, to furnish make-up water to the power station cooling towers, is located in Blocks 11 and 12. Three individual motor control releases are provided, each at a different elevation, in order to take advantage of differences in chemical quality at different depths in the reservoir. The releases are located at elevation 1165, elevation 1145, and elevation 1125. An emergency, manual release (low level outlet) is located at elevation 1107.5 (see Figure 9, Appendix F, and Section 1.3.J).

c. Design Data.

1. Hydrology and Hydraulics. (see Section 5.1).

2. Embankment. The determining factors in design of the embankment section were availability of materials, and foundation conditions. The design was based on the geologic conditions (Vol. II of the design report) and the laboratory results of the subsurface exploration program (Vol. III of the design report).

Slope stability was performed with an IBM 1620 computer program, utilizing a modified Swedish circle method. Full consideration for saturated and submerged conditions are written into the program. The results obtained by this method are conservative. Nominal factors of safety were the desired results, since conservative soil strengths and method of analysis were used. For final analysis, 24 complete cases were run, many with varying strengths of earthfill. The results are shown on Figure 7, Appendix F, and are representative of the minimum factors of safety obtained.

The stability of various sections of the concrete structure were analyzed separately. The results are shown on Figure 4, Appendix F.

2.2 Construction Records.

Construction records including weekly status reports, photographs, and memoranda are available in PennDER files.

2.3 Operational Records.

The daily operation of the facility is monitored and recorded continuously at the control room located on the downstream face of Block 12.

2.4 Other Investigations.

Following the flood of July 20, 1977, both the Pennsylvania Electric Company and Gilbert Associates, Inc., conducted separate investigations to review the extent of damage to the facility and its appurtenances. The results of the investigations are available from the Pennsylvania Electric Company.

2.5 Evaluation.

Engineering data were provided by the Pennsylvania Department of Environmental Resources (PennDER) and the Pennsylvania Electric Company. Sufficient data are availale to indicate the structure was formally engineered in accordance with accepted modern engineering practice.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of this project indicates the dam and its appurtenances are currently in good condition. The features which have been incorporated into its design further indicate that the facility was formally engineered in accordance with modern practice.

b. Embankment.

1. Earth- Rockfill Section. The earthen portion of the embankment is in fair condition. No seepage is evident through the embankment or abutments. The embankment is well aligned and no appreciable crest settlement was detected at the time of inspection. Three deficiencies were noted: 1) The upstream and downstream slopes are heavily overgrown. Sizeable trees (6-inch diameter) whose growth have apparently remained unchecked for a number of years are visible over the entire embankment (see Photograph 2, Appendix D); 2) The riprap and quarry run rockfill placed on both the upstream and downstream slopes may be less resistant than intended although specifications were not available which would permit an accurate evaluation of its suitability (see Photograph 9, Appendix D); and 3) The entire length of the earth embankment toe is submerged by a standing pool of water (see Photograph 10, Appendix D). The somewhat triangular shaped pool is impounded by the embankment, the left abutment, and an earth dike located parallel to the discharge channel. Available design drawings reviewed prior to the inspection indicate a 24-inch diameter drain pipe is located through the downstream end of the earth dike. The pipe was not located by the inspection team. Furthermore, the owner apparently has no knowledge of its existence. It was assumed that this pipe is either clogged or non-existent.

2. Non-Overflow Concrete Section. The non-overflow portion of the concrete gravity embankment is in good condition. Several isolated areas of minor cracking and spalling are visible upon close inspection but these are not considered significant. The control room and interior inspection galleries are in good condition. These areas are well maintained. Some condensation is visible on the gallery ceilings and effloresence is visible at construction joints in several areas. With the exception of one gate valve currently under repair, the operating mechanisms and monitoring systems appear to be in excellent condition. Similarly, the mechnical winch system located atop the crest also appears to be in working order although it was not operated in our presence.

c. Appurtenant Structures.

1. Primary Spillway. The primary spillway bays (Bays 4, 5, and 6) are in good condition. The three radial gates were in a fully closed position during the inspection and were not operated in the presence of the inspection team. A small amount of water was issuing from Bays 5 and 6 indicating an imperfect seal between the spillway gates and wingwall. The mechanical system, including the gates and winches, appeared to be in good condition and are reported to be in proper operating order. Minor spalling and scaling were visible on the surfaces of the ogee-shaped weirs, particularly at the construction joints. The spillway apron is deteriorated in some areas, possibly due to etching action acidic outflow associated with mine drainage.

2. Emergency Spillway. The emergency spillway bays (Bays 1, 2, and 3) are in excellent condition. No signs of concrete deterioration or discoloration were visible. The emergency spillway bays have reportedly discharged only once; during the area flood of July 20, 1977.

3. Outlet Conduit. The outlet conduit appeared to be functioning properly during the inspection. The majority of the conduit is not accessible for inspection; consequently, its overall condition was not ascertainable. The only portion visible to the inspection team was the discharge end. At this point, flow through the conduit is automatically measured and recorded in the control room.

4. Reservoir Area. The general area surrounding the reservoir is characterized by moderate to steep slopes. The area is primarily wooded although a few isolated cleared sections are visible along the shore (see Photograph 5, Appendix D).

5. Downstream Channel. The downstream area considered in this section extends left from the emergency spillway bays at the right abutment to the channel immediately beyond the discharge end of the outlet conduit. For the most part, the downstream channel is in good condition. The channel floor is predominantly a durable sandstone. What appears to be to an excess of loose rocks and boulders are scattered over the downstream area (see Photograph 1, Appendix D). At the present time, however, flow does not appear to be obstructed. It is noted that revised Drawing C-726-412, Exhibit 16, by Gilbert Associates, Inc., (see Figure 8, Appendix F) shows an earth dike (top elevation 1125.0) across the downstream channel perpendicular to the flow located at a point approximately 50 yards beyond the spillway crests. The owner's representative indicated that the dike depicted in this drawing was a temporary structure that was removed prior to project completion.

The portion of the downstream channel which is not in good condition is that area immediately beyond the emergency spillway (Bays 1, 2, and 3). Significant erosional damage occurred as a result of the July 1977, flood (see Photographs 11 and 12, Appendix D). The area, nevertheless, appears sound in spite of the damage. All concrete sections of the embankment remained intact.

A small water works serving Indiana, Pennsylvania, is located approximately 1-1/2 miles downstream of the dam. The facility is situated on the Two Lick Creek floodplain and is undoubtedly in an area that would be affected by a breach of the dam. The communities of Upper Two Lick and Homer City located 3-1/2 and 8 miles, respectively, downstream of the dam contain residences that could easily be affected by a breach of the dam. A conservative estimate of the number of persons that reside within the influence of the flood waters from Two Lick Creek Dam would exceed 100.

Because of the above mentioned considerations the facility was given a "high" hazard rating.

3.2 Evaluation.

The facility has several deficiencies which require attention. These deficiencies include overgrowth of the embankment, apparent poor quality riprap and rockfill, lack of proper drainage at the toe, and an erosion problem downstream of the emergency spillway.

It must be noted that the owner is knowledgeable of the overall condition of the facility and that some of the above mentioned items were scheduled for remedial service prior to our inspection.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operational Procedures.

According to the owner's representative, the spillway gates at the facility are operated in accordance with the operational procedure presented in Volume I of the design report. However, the system is no longer automatic as originally designed and is now manually operated by on-site personnel.

The water control system, which regulates flow through the discharge tunnel, is reported to be operated remotely from the generating station.

A dam caretaker is on hand at the facility on a 7-day a week, 24-hour a day basis.

4.2 Maintenance of Dam.

The dam has been reportedly maintained on an as-needed basis. The recent advent of a full-time staff has apparently upgraded the maintenance program. In addition, discussions with the owner's representative indicate that remedial maintenance work is scheduled to begin prior to September 1, 1978.

4.3 Maintenance of Operating Facilities.

No formal schedule or manual is available detailing required maintenance of the facility.

4.4 Warning Systems.

There are no formal warning systems in effect.

4.5 Evaluation.

The operational procedures at the facility appear to be clear and well defined. No formal maintenance program is currently in effect. Extensive remedial work is reportedly scheduled to commence prior to September 1, 1978.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

The criteria considered in the hydrology and hydraulic evaluation of this project are summarized in a report by Gilbert Associates, Inc., entitled "Report No. 1637, Design of Two Lick Creek Dam" (Volume I, Design Report, December 15, 1966). The main points included in the report are presented below.

The purpose of the facility, as previously stated, is to supply sufficient amounts of water to meet the requirements of the Homer City Generating Station. The required reservoir capacity, as determined from the plant and downstream make up requirements, is 16,200 acre-feet at full pool (elevation 1183). The required reservoir capacity coupled with upstream flooding considerations at the town of Clymer, established the maximum flood pool level to be at elevation 1185.

By use of the Hydrometeorological Report No. 33 and Technical Paper No. 40 (both by the United States Weather Bureau), a "Maximum Probable Storm" was determined for the drainage area of Two Lick Creek Dam. Probable storms for recurrence intervals of 10 years, 25 years, 100 years, and 1,000 years were also determined. Design flood peaks were computed by various empirical formulas and by unitgraph. For the unitgraph flood, a "Maximum Probable Storm" was assumed which produced a rainfall of 26 inches, over the entire drainage basin, in a period of 24 hours, with 14 inches of rainfall occurring the first 3 hours and producing 12.5 inches of runoff. Such a storm produced a flood peak of 66,100 cfs.

Considering the above requirements in combination, it was determined that a gated spillway section was necessary. The spillway was designed with three 30-foot wide bays, with crests at elevation 1151. The spillway capacity, with gates fully open and reservoir level at elevation 1183, is 62,500 cfs. To pass a flood peak of 66,100, the reservoir level is at elevation 1184.2. Additional flood discharge capacity is provided by the emergency spillway whose crest elevation is set at 1184.5, while the top of dam is set at elevation 1195. The capacity of the emergency spillway is approximately 10,500 cfs.

5.2 Experience Data.

Reservoir levels and low flow discharge are monitored on a continuous basis at the facility. The records indicate

the facility has performed adequately in the past. During the flood of July 1977, the emergency spillway inadvertently discharged causing the damage to the right abutment which is visible today. The situation occurred because the automatic radial gate mechanism was wired to shut down when the gate opened two feet. Consequently, the water in the reservoir steadily rose until it discharged through the emergency spillway. The mechanism has since been repaired and the limiting device removed. The gates have been tested and reportedly are capable of opening fully.

5.3 Visual Observations.

On the date of inspection, no conditions were observed that would indicate the appurtenant structures of the dam could not operate satisfactorily during a flood event.

5.4 Overtopping Potential.

The ratio "PMF Peak Flow/Drainage Area" was determined from an empirical curve supplied by the Corps of Engineers, Baltimore District. The curve used was the Ohio River Basin curve. Based on this curve and a drainage area of 74 square miles, Peak PMF Q/A = 760 cfs/sq. mi., and Peak PMF Q = 56,240 cfs. The size category is "large" and the hazard rating "high". Consequently, the SDF is the PMF.

Calculations were performed to evaluate the overtopping potential using spillway and storage capacities during the PMF.

The discharge capacity of the primary spillway was considered with the reservoir level set at elevation 1183. This corresponds to the top elevation of the maximum opening of the radial gates. When the reservoir level is at or below this elevation, discharge will be solely through the primary spillway. With all three radial gates open full, the primary spillway discharge is equal to 62,560 cfs. A comparison of Peak PMF Q (56,240 cfs) with primary spillway discharge (62,560 cfs) indicates the primary spillway discharge is greater than the peak inflow.

5.5 Spillway Adequacy.

The spillway and dam are capable of passing and/or containing the runoff resulting from a storm of PMF magnitude. This is accomplished solely by the primary spillway (Bays 4, 5, and 6) and without the additional discharge capacity available from the emergency spillway (Bays 1, 2, and 3).

As a result, the spillway system is deemed adequate assuming proper operation of the radial gate system.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment.

1. Earth- Rockfill Section. The visual inspection revealed this area to possess the most serious deficiencies associated with the facility. These are, as discussed in Section 3.1.b.1, the overgrown slopes, the apparent poor quality riprap and quarry run fill, and the lack of adequate drainage at the toe. Project specifications were not available; consequently, the design requirements for the riprap and quarry run rock are not known. Nevertheless, there is considerable slaking of the riprap on the upstream face as well as the quarry run rockfill on the downstream slope. The owner is currently considering alternate solutions to the riprap problem. It is not known if the random rock beneath the surface is also degraded which would affect the need for necessary immediate remedial action.

As for the overgrowth, the owner is aware of the problem and reportedly plans to remove the trees before winter. The water at the toe of the dam is apparently the result of surface runoff being impounded by the earth dike that parallels the stream channel. Periodically, the water reportedly evaporates, temporarily drying the area.

Presently, the above conditions are considered undesirable but do not appear to present an immediate threat to the stability of the structure.

2. Non-Overflow Concrete Section. Based on the visual inspection, this portion of the facility appears to be well designed, stable, and presently in good condition.

b. Appurtenant Structures. The appurtenances of this facility, including both the primary and emergency spillway, and the low discharge tunnel, appear to be in good condition. A complete evaluation of their overall structural integrity is not possible without first hand observation of the associated mechanisms in operation. However, based on the general appearance of the appurtenances, no structural deficiencies are apparent. The July 1977, flood caused significant damage to the area just downstream of the emergency spillway. Conversations with the owner's representative indicates that provisions to repair the damage are presently under consideration and that corrective work should commence by September 1978.

6.2 Design and Construction Techniques.

The design reports and information received from PennDER and the Pennsylvania Electric Company indicate the facility has been adequately designed in conformance with accepted modern engineering practice. Additional information in the form of "revised" design drawings, construction photographs, and reports reinforce our opinion that the structure is stable in both concept and construction.

6.3 Past Performance.

The facility has survived the storm which resulted in the Johnstown flood on July 1977. Available records indicate the facility performed as designed throughout its short history.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and it is thought that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations, investigations, etc., were performed to confirm this opinion.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection, operational history, and available engineering data suggest that certain conditions at the facility require further study while others require immediate attention. Conversations with the owner's representative indicate that the owner is knowledgeable of the deficiencies at the facility. Furthermore, the owner appears to possess a positive attitude relative to their resolution. The overall condition of the facility is considered good.

Hydraulic and hydrologic calculations indicate that the spillway is capable of passing and/or storing the flow resulting from a storm of PMF intensity and consequently the spillway capacity can be considered adequate.

b. Adequacy of Information. The available data are considered sufficient to make an accurate assessment of the facility.

c. Urgency. It is suggested that the recommendations listed below be implemented immediately.

d. Necessity for Additional Investigations. An investigation (refer to Section 7.2) of the durability and/or suitability of the riprap and quarry run rockfill is considered necessary.

7.2 Recommendations/Remedial Measures.

It is recommended that:

a. The owner investigate the physical characteristics of the riprap and quarry run rockfill. Conclusions relative to its suitability should be developed and remedial action implemented, if necessary.

b. Positive drainage be provided to eliminate the ponding condition along the downstream toe of the earth-rockfill portion of the embankment.

c. The owner immediately remove the overgrowth visible on both sides of the earth- rockfill embankment.

d. The owner implement remedial measures to repair damage to the right abutment (emergency spillway outlet).

e. The owner formalize a regular maintenance program.

f. The owner develop a warning system that will provide for the safe evacuation of all downstream inhabitants in the event of an inordinantly heavy rainfall.

g. The facility be inspected on a periodic basis by a registered professional engineer to check for deleterious conditions which might develop.

APPENDIX A

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Two Lick Creek Dam

ID # NDI# PA-285 PennDER 32-75

ITEM	REMARKS	SHEET 1

AS-BUILT DRAWINGS

Specific "as-built" drawings are not available. Design drawings are available in the Appendix of the design report, Volume I entitled "Report No. 1637, Design of Two Lick Creek Dam". The report is available from both Penelec and PennDER.

REGIONAL VICINITY MAP

See Appendix G.

CONSTRUCTION HISTORY

Construction status report, memoranda, and photographs are available from PennDER.

TYPICAL SECTIONS OF DAM

See Figures 6, 7, 9, 10, and 1 in Appendix F.

OUTLETS - PLAN See Figure 3 in Appendix F.

- DETAILS See Figures 9, 10, and 1 in Appendix F.

- DISCHARGE RATINGS See Figure 2 in Appendix F.

RAINFALL/RESERVOIR RECORDS

Reservoir levels are monitored continuously and recorded at the facility. Rainfall records are compiled at the Homer City Generating Station. Reports are available from Penelec.

ITEM	REMARKS	ID #	SHEET 2

DESIGN REPORTS

"Report No. 1637, Design of Two Lick Creek Dam": Volumes I, II, and III by Gilbert Associates, Inc. are available from PennDER.

GEOLOGY REPORTS

Contained within design report Volume II. The report is subtitled "Foundation and Borrow Investigation."

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

A summary of the hydrology and hydraulic design criteria are contained within design report, Volume I.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

Contained within all three design report volumes.

POST-CONSTRUCTION SURVEYS OF DAM

None

BORROW SOURCES

Discussed in design report Volume II and depicted on one of the design drawings contained in the appendix of design report Volume I.

ITEM	REMARKS	ID #	SHEET 3

MONITORING SYSTEMS

The entire operation of the facility is continuously monitored and recorded. System records are available from PennDER.

MODIFICATIONS

Following the flood of July, 1977, the automatic spillway gate system was modified such that the system is now controlled manually.

HIGH POOL RECORDS

Available from PennDER. The highest pool of record occurred July 20, 1977. At this time the reservoir level was measured to be at approximate elevation 1185.5 or one foot over the emergency spillway.

POST CONSTRUCTION ENGINEERING
STUDIES AND REPORTS

Seperate investigations were performed by Penelec and Gilbert Associates, Inc., following the flood of July, 1977. The investigations pertained to the damage incurred as a result of flood waters. Results of the investigations are available from Penelec.

PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS

See "Post Construction Engineering Studies and Reports" above.

MAINTENANCE
OPERATION
RECORDS

Available from Penelec.

ITEM	REMARKS	ID #	SHEET 4

SPILLWAY PLAN — See Figures 1, 3, and 8, Appendix F.

SECTIONS — See Figure 9, Appendix F.

DETAILS — See Figure 1, Appendix F.

OPERATING EQUIPMENT PLANS & DETAILS

See Figures 10 and 11, Appendix F.

NDI# PA-285

CHECK LIST ID # PennDER 32-75

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 74 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1183 (16,200 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1184.5 (16,700 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: 1185 (17,000 acre-feet)

ELEVATION TOP DAM: 1195 (23,000 acre-feet)

SPILLWAY DATA:

a. Crest Elevation (primary) 1151; (emergency) 1184.5
b. Type (primary and emergency) concrete ogee-shaped weirs
c. Weir Length (primary) 90 feet; (emergency) 102 feet
d. Channel Length Not applicable.
e. Location Spillover right abutment
f. Number and Type of Gates 3 mechanical radial tainter gates

OUTLET WORKS:

a. Type 12 by 14 foot concrete box-culvert
b. Location junction of the earth embankment with the concrete gravity dam
c. Entrance Inverts 1107.5
d. Exit Inverts 1105
e. Emergency Draindown Facilities low level release (see Figure 9)

HYDROMETEOROLOGICAL GAGES:

a. Type Rain gage
b. Location Homer City Generating Station
c. Records daily records available from Penelec

MAXIMUM NON-DAMAGING DISCHARGE: Specific data not available.

APPENDIX B

CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

DAM NAME Two Lick Creek Dam COUNTY Indiana STATE PA ID # NDI# PA-285 PennDER 32-75

TYPE OF DAM Concrete & earth- and rockfill HAZARD CATEGORY high

DATE(S) INSPECTION 8/11/78 WEATHER Hazy & warm TEMPERATURE 73°

POOL ELEVATION AT TIME OF INSPECTION 1176.8 M.S.L. TAILWATER AT TIME OF INSPECTION None at M.S.L. gates, low flow in stream throug outflow.

INSPECTION PERSONNEL:

B. M. Mihalcin (GAI) R. Gallus (Penelec)

J. P. Nairn (GAI)

D. L. Bonk (GAI)

D. L. Bonk RECORDER

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed. The downstream toe was partially submerged by a pool of water, 1 foot to 3 feet deep, between the toe and discharge channel dike.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Rock disintegration is profuse across both the upstream and downstream slopes. Many trees have accumulated on the dam slopes.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good.	
RIPRAP FAILURES	Much of the riprap and rockfill zone on the upstream slope has deteriorated and appears to be composed primarily of non-durable siltstones and silty shales.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	None observed.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Excellent condition.	
DRAINS	Relief drains are visible throughout the concrete section of the structure.	
WATER PASSAGES	Outflow structure open. Monitoring weir located at the discharge end was flowing full during the inspection.	
FOUNDATION	Not observed. Structure is founded on rock. A grout curtain has been provided beneath the dam.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition.	
ANY NOTICEABLE SEEPAGE	No visible seepage along the downstream face. The downstream toe is completed inundated by approximately 1 to 3 feet of water.	
STAFF GAGE AND RECORDER	A staff gage is attached to the upstream face of the concrete portion of the structure. It is located to the left of Bay 6 (spillway bay furthest from the right abutment) and to the right of the discharge conduit intakes.	
DRAINS	No drains were observed through the earth portion of the embankment.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Minor cracking and some slight spalling and scaling were visible on the crest and the main spillway bays. Extensive scaling is visible on the primary spillway apron.	
STRUCTURAL CRACKING	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT	Good.	
MONOLITH JOINTS	Good.	
CONSTRUCTION JOINTS	Good condition. No separation or deterioration observed.	
STAFF GAGE OR RECORDER:	See embankment.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete surfaces appear to be in good condition. Much of the concrete displays a redish-orange tint. This is likely to be due to the acidic nature of the water in the reservoir. Deep coal mines are present in the general area and consequently, acid mine drainage is likely to be prevalent.	
INTAKE STRUCTURE	Intakes were submerged during the inspection. Gate valves and gate controls were observed from within the structure via several access chambers. One of the gate valves was in the process of being repaired while the rest of the equipment appeared to be in good condition. None of the equipment was operated in the presence of the inspection team.	
OUTLET STRUCTURE	Good condition. Redish-orange tinted concrete is visible at and below the flow line. Stainless steel, flow monitoring weir at the discharge end appears to be in good condition. Flow is monitored from the control room situated below the crest and on the left downstream face of the concrete portion of the facility.	
OUTLET CHANNEL	Good condition. The base of the channel appears to be sound bedrock.	
EMERGENCY GATE	The dam is provided with a reservoir drawdown system that is apparently controlled with gates located at the discharge end of the discharge tunnel.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

CONCRETE WEIR

Six spillway bays with ogee-shaped weirs. Bays 4, 5, and 6 (left to right) are the main discharge outlets and are controlled by mechanically operated radial gates. The operating mechanisms are located atop the dam crest and directly above their respective bays. Bays 4, 5, and 6 are 30 feet by 32 feet. Bays 1, 2, and 3 are for emergency use only and are uncontrolled. Bays 1, 2, and 3 are 34 feet wide by 7 feet high. None of the bays were discharging during the inspection.

APPROACH CHANNEL

The drawings indicate Bays 1, 2, and 3 to have individual approach channels cut into rock along the right abutment. The channels were submerged and only the channel for Bay 1, which appears to be the most shallow could be observed. It was submerged by approximately 2 feet of water and appears to be in good condition.

DISCHARGE CHANNEL

Bays 1, 2, and 3 have no well defined discharge channels and merely discharge flow onto the right abutment hillside. The rains which caused the Johnstown Flood of 1977 caused Bays 1, 2, and 3 to discharge. The result was extensive damage to the area immediately beyond the spillway bays. Much of the rock was stripped away by the flood waters.

BRIDGE AND PIERS

The dam crest is designed to be used as a serviceway which spans all 6 spillway bays. The elevation of the underside of the serviceway is 1191.36 while the elevation of the top of dam is 1195.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Ogee-shaped weir.	
APPROACH CHANNEL	Submerged during inspection. Available drawings do not indicate a clearly defined approach channel for Bays 4, 5, and 6 as is the case for Bays 1, 2, and 3. The drawings do indicate the depth behind the spillway crest to be 21 feet.	
DISCHARGE CHANNEL	Main Bays 4, 5, and 6 discharge into a natural channel cut out of rock immediately downstream. A 10-foot dike has been constructed along the left side of the channel to divert flow away from the toe of the earth portion of the embankment. Some large boulders partially obstruct flow and are the likely result of damage caused by the flood of 1977.	
BRIDGE AND PIERS	See ungated spillway.	
GATES AND OPERATION EQUIPMENT	Mechanically operated radial spillway gates are manually controlled from atop the crest. Gates for the discharge conduit are also operated from the crest. All other operating mechanisms are controlled from within the interior of the structure.	

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

MONUMENTATION/SURVEYS

None observed.

OBSERVATION WELLS

None observed.

WEIRS

Stainless steel monitoring weir is located at the discharge end of the discharge tunnel. Another weir located at a small dam downstream measures stream flow. Flow from both weirs is recorded at the operations room located on the downstream face to the left of Bay 6.

PIEZOMETERS

Several piezometers are visible at various locations and elevations across the downstream face. They reportedly will be read and recorded on a periodic basis by a private consultant. No formal monitoring program now exists.

OTHERS

The operations room appears to contain the majority of the instrumentation associated with this facility. It is accessible by a stairway from the crest located along the left downstream face of the concrete portion of the structure.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Generally moderate to steep adjoining hillsides. The majority of the area is heavily wooded with the exception of a few small grassy areas.	
SEDIMENTATION	None observed.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	See "discharge channel, gated and ungated spillways" (Sheets 4 and 5)	
SLOPES	Moderate to steep and heavily wooded on left. Moderately sloped and grassy floodplain on right.	
APPROXIMATE NO. OF HOMES AND POPULATION	Waterworks facilities are located on the floodplain approximately 1-1/2 miles downstream. Homer City, located ≈ 8 miles downstream is also likely to experience significant damage in the event of a breach. Total population affected easily exceeds 100.	

APPENDIX C

HYDRAULICS/HYDROLOGY

SUBJECT DAM SAFETY INSPECTION
TWO LICK CREEK DAM

BY DLS DATE 8-9-78 PROJ. NO. 78-501-285

CHKD. BY EJM DATE 8-25-78 SHEET NO. 1 OF 3

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

MAXIMUM HEIGHT OF DAM = 115 FEET (REF 1: pg 3)

DRAINAGE AREA = 74 SQ. MI. (" pg 2)

STORAGE CAPACITY = 16,200 AC-FT @ EL 1183 (" pgs 2&3)

SIZE CLASSIFICATION

DAM SIZE - LARGE (REF 2: TABLE 1)

HAZARD RATING - HIGH (POSSIBLE LOSS OF LIFE >3)

REQUIRED SDF = PMF (REF 2: TABLE 3)

REFERENCES

1: "DESIGN OF TWO LICK CREEK DAM", VOLUME I, DESIGN REPORT, GILBERT ASSOCIATES, INC., DECEMBER 15, 1966

2: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS" DEPT. OF THE ARMY - OFFICE OF CHEIF ENGINEER, APPENDIX D

3: STANDARD HANDBOOK FOR CIVIL ENGINEERS F.S. MERRITT, MCGRAW-HILL 1976

SUBJECT DAM SAFETY INSPECTION
TWO LICK CREEK DAM

BY DLB DATE 8-9-78 PROJ. NO. 78-501-285

CHKD. BY EJM DATE 8-25-78 SHEET NO. 2 OF 3

gai CONSULTANTS, INC.
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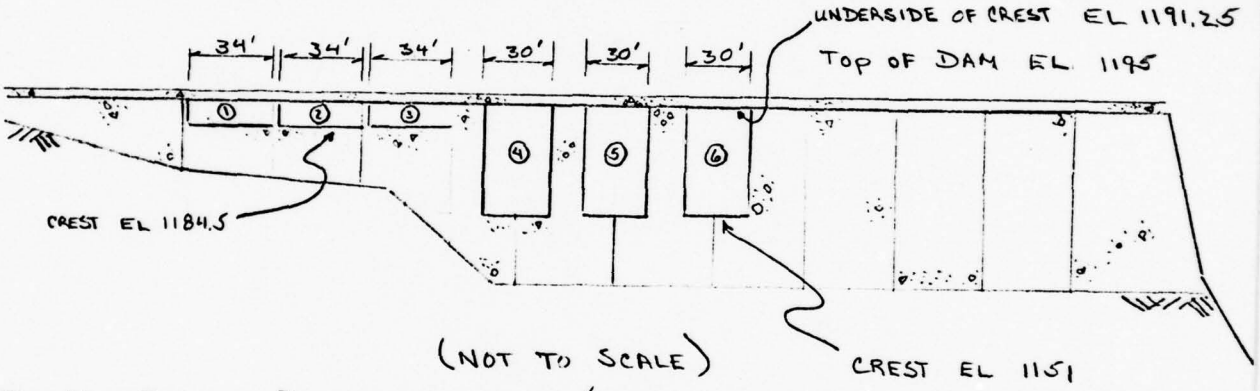
Environmental Specialists

PMF (PEAK FLOW)/AREA = 760 CFS/SQ.MI. (REF: C OF E CURVE, OHIO RIVER BASIN)

PEAK INFLOW Q = (760 CFS/SQ.MI)(74 SQ.MI) = 56,240 CFS

SPILLWAY CAPACITY



(NOT TO SCALE)

TYPICAL FOREBAY DEPTH ≈ 21 FEET (SEE REFERENCE ON SHEET 3)

NOTE: ALL ELEVATIONS ARE EXTRACTED FROM DRWG C-726-422 "CONCRETE; GENERAL SECTIONS". DIMENSIONS ARE FROM DRWG C-726-458 by GILBERT ASSOCIATES, INC. OF READING, PENNSYLVANIA, EXCEPT FOR THE WIDTHS OF SPILLWAY BAYS 1, 2, & 3 WHICH WERE MEASURED IN THE FIELD (REVISION II)

SUBJECT DAM SAFETY INSPECTION
TWO LICK CREEK DAM

BY DLB DATE 8-14-78 PROJ. NO. 78-501-285

CHKD. BY EVM DATE 8-25-78 SHEET NO. 3 OF 3

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$Q_1 = 3CL_1H_1^{3/2}$ = DISCHARGE OF SPILLWAY BAYS 4, 5 & 6 (REF 3, EQ 21-121)

$L_1 = 30$ FT (SHEET 2)

$H_1 = 32$ FT

(FROM FIG 21-67, REF. 3)

$P/H_D = 21'/32 = 0.66$

NOTE: P = 21 FT, IS THE FOREBAY DEPTH SHOWN ON DRWG C-726-422

$\therefore C \approx 3.84$

$Q_1 = (3)(3.84)(30\text{FT})(32\text{ FT})^{3/2} = 62,560$ CFS

MAXIMUM PRIMARY SPILLWAY DISCHARGE (62,560 CFS) > . . .

. . . > PMF PEAK INFLOW Q (56,240 CFS)

APPENDIX D

PHOTOGRAPHS

PHOTOGRAPH 1 View of Two Lick Creek Dam taken from a point approximately 500 feet downstream. A portion of the left side of the embankment is not visible on the photograph.

PHOTOGRAPH 2 View of the earth portion of Two Lick Creek Dam taken from downstream of the right abutment.

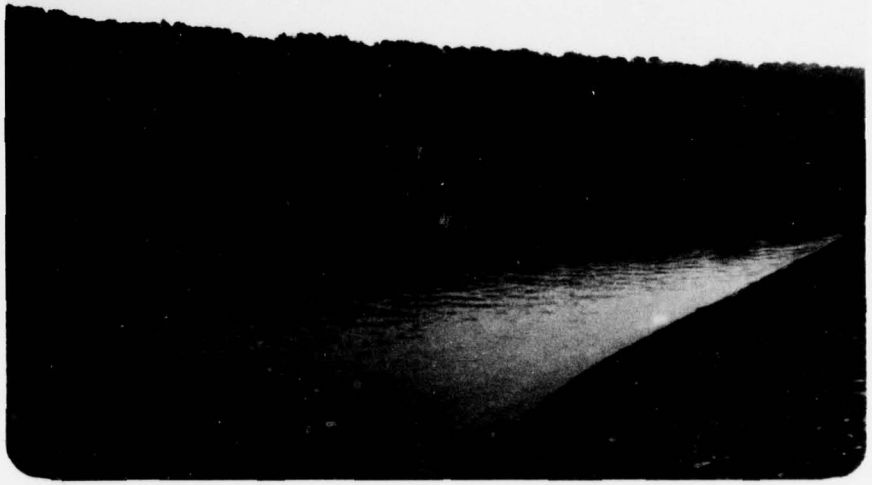
PHOTOGRAPH 3 View of the crest of Two Lick Creek Dam taken from the left abutment.

PHOTOGRAPH 4 View of the upstream face of Two Lick Creek Dam.

1

2

3



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PHOTOGRAPH 5 View of the reservoir area showing the wooded slopes surrounding the reservoir.

PHOTOGRAPH 6 View of the mechanically operated radial gates (primary spillway) at the Two Lick Creek facility.

PHOTOGRAPH 7 View of the motor controls for the radial gates shown in the previous photograph.

PHOTOGRAPH 8 View of the outlet end of the discharge tunnel at the Two Lick Creek facility.

5

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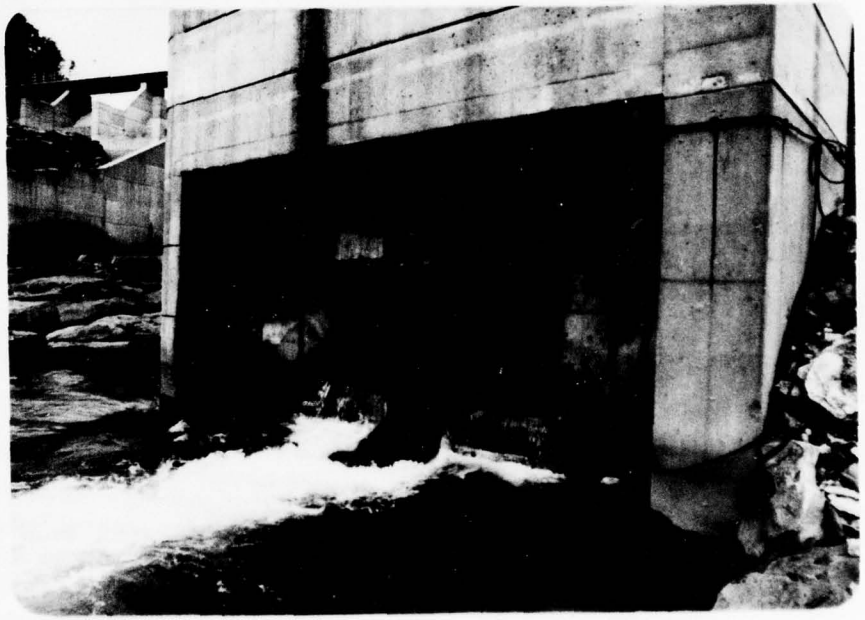

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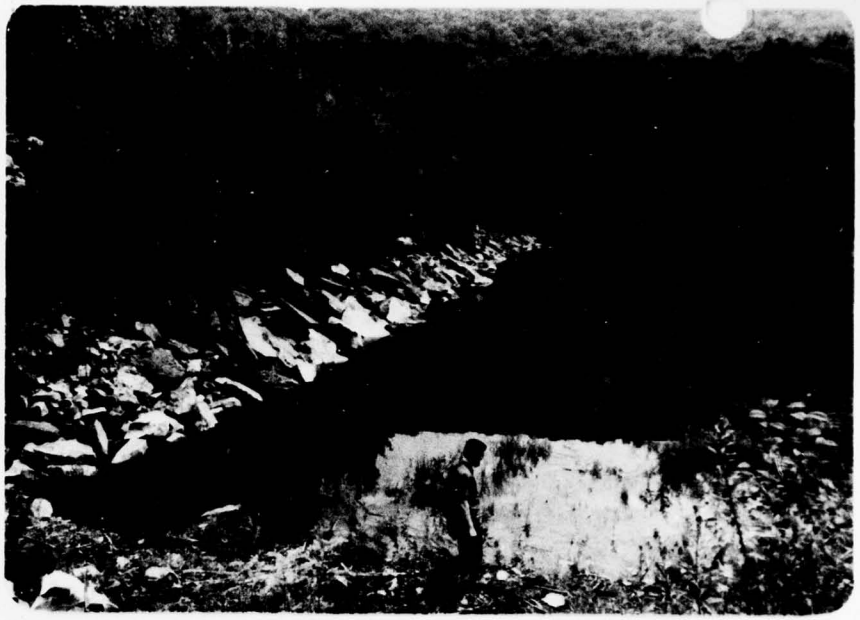
PHOTOGRAPH 9 Close-up view of materials comprising the downstream face of the earth section of Two Lick Creek Dam.

PHOTOGRAPH 10 View of the standing water at the toe of Two Lick Creek Dam. The water is impounded by an earthen dike which serves as the left bank of the stream just downstream of the dam (see Photograph 11).

PHOTOGRAPH 11 View of erosion in the rock channel at the outlet of the emergency spillway (foreground). The pool of water and earth dike mentioned in the previous photograph can be seen in the left background. Note the character of the valley just downstream of the dam.

PHTOGRAPH 12 View of erosion damage at the intersection of the emergency spillway and the rock abutment. A coal seam was eroded out in this area.

9



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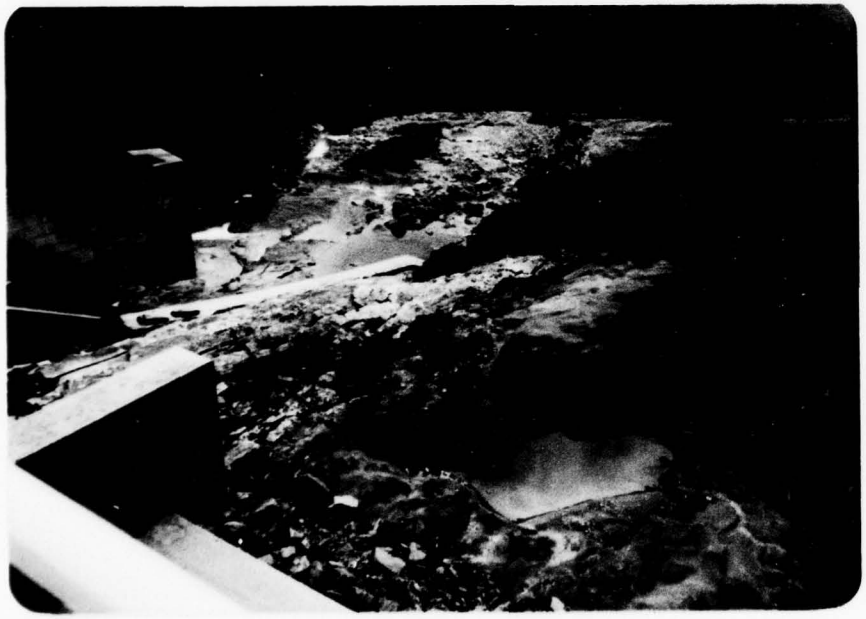

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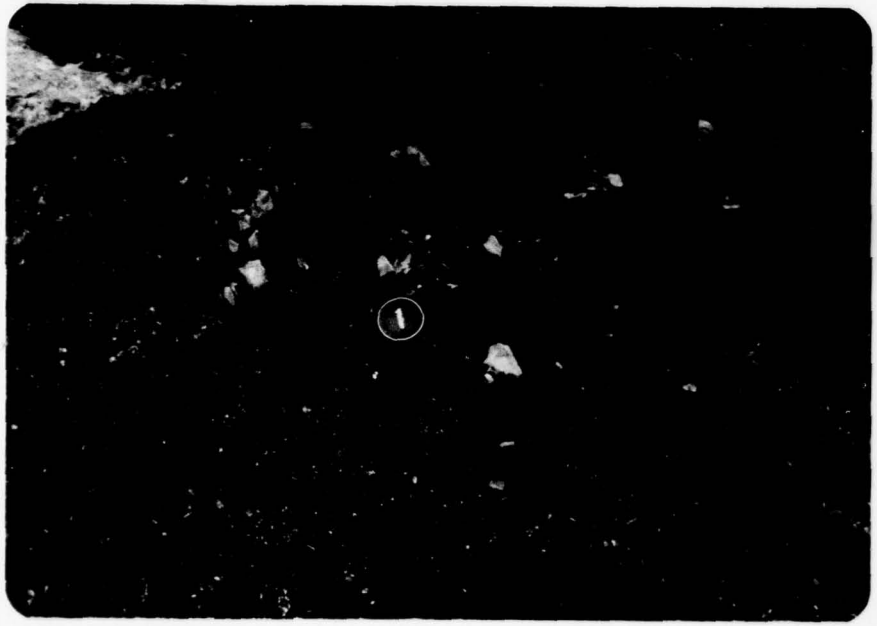
12

PHOTOGRAPH 13 Close-up view of concrete deterioration on the primary spillway apron. The orange-brown color suggests that the discharge may be corrosive in nature.

PHOTOGRAPH 14 View of the first major obstruction downstream of Two Lick Creek Dam consisting of a concrete bridge over a secondary road approximately 3-1/2 miles downstream of the dam. About six homes are located adjacent to the creek at this point.



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APPENDIX E

GEOLOGY

GEOLOGY

Two Lick Creek Dam is located in the eastern portion of the Appalachian Plateau Physiographic Province.

Soils in the vicinity of the dam are principally alluvial and colluvial. The alluvial soils occupy the floodplain of Two Lick Creek and are sometimes intermixed with colluvial soils which moved down the steep sided slopes characteristic of this valley. The thicknesses of the alluvial materials varied from 0 to 20 feet and the colluvium had a thickness range of 3 to 15 feet. Within the dam's substantial drainage area, the majority of soils are residual and have overburden thicknesses from 2 to 20 feet.

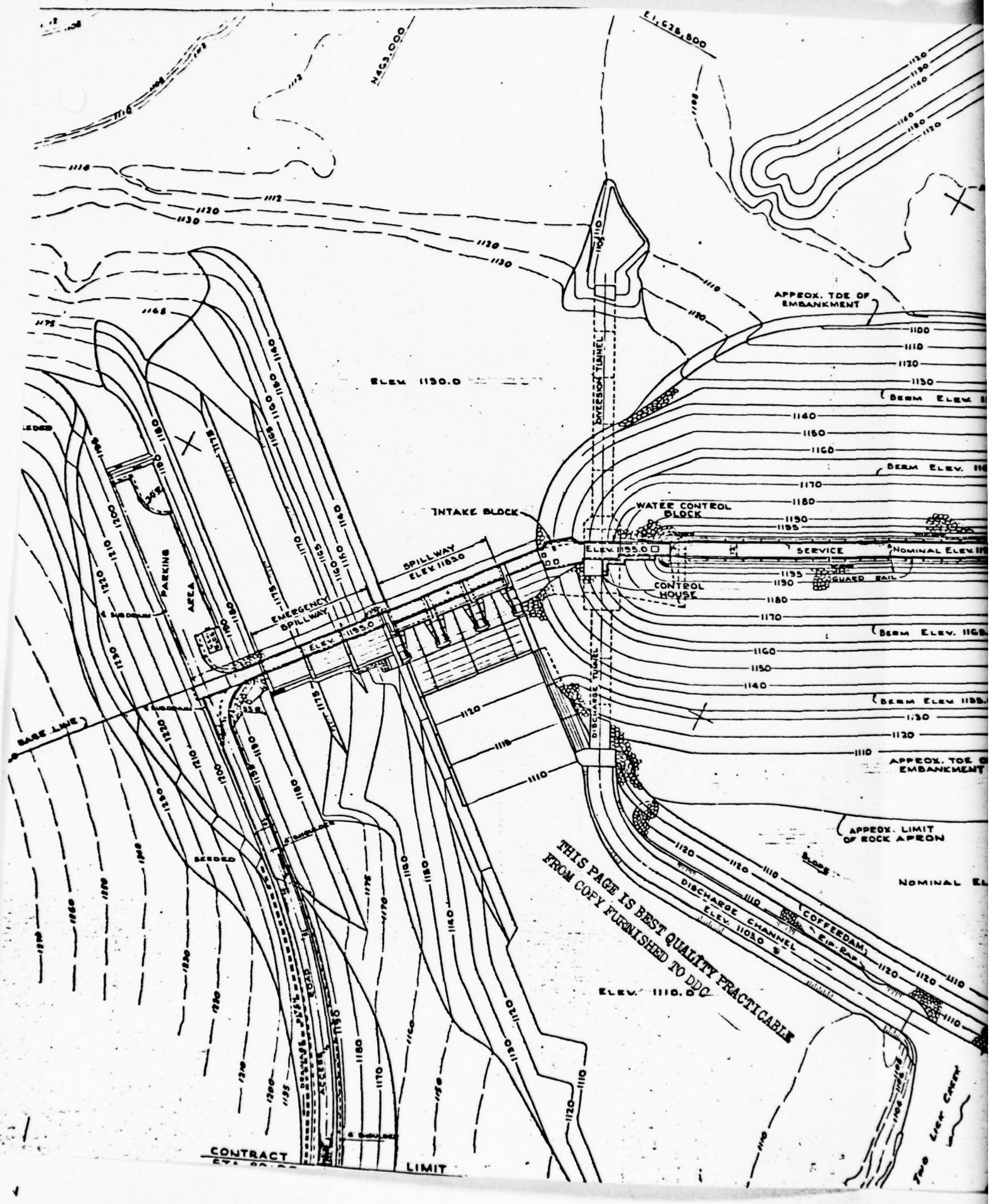
Stratigraphically, the bedrock beneath the dam site consists of strata from the lower portion of the Allegheny Group of Pennsylvanian age. This sequence is composed chiefly of sandstone with some shale, siltstone, and coal. Rocks within the dam's watershed are all Pennsylvanian age and include strata from the Conemaugh Formation and the Allegheny and Pottsville Groups. The extent of mining at the dam site was limited to two small country bank operations in the Lower Kittanning coal upstream of the dam. Numerous mining operations occur within the drainage area of the dam and are chiefly strip mines.

The dam site is located on the west limb of the northeast trending Chestnut Ridge anticline. The rocks are nearly flat lying with minor dip to the northwest. One fault was located upstream of the dam during investigations prior to dam construction. A maximum vertical displacement of 10 feet was estimated for the fault. No major shear zone was associated with this fault and no subsurface faulting was disclosed by the drilling investigation.

APPENDIX F

FIGURES

TABLE OF CONTENTS



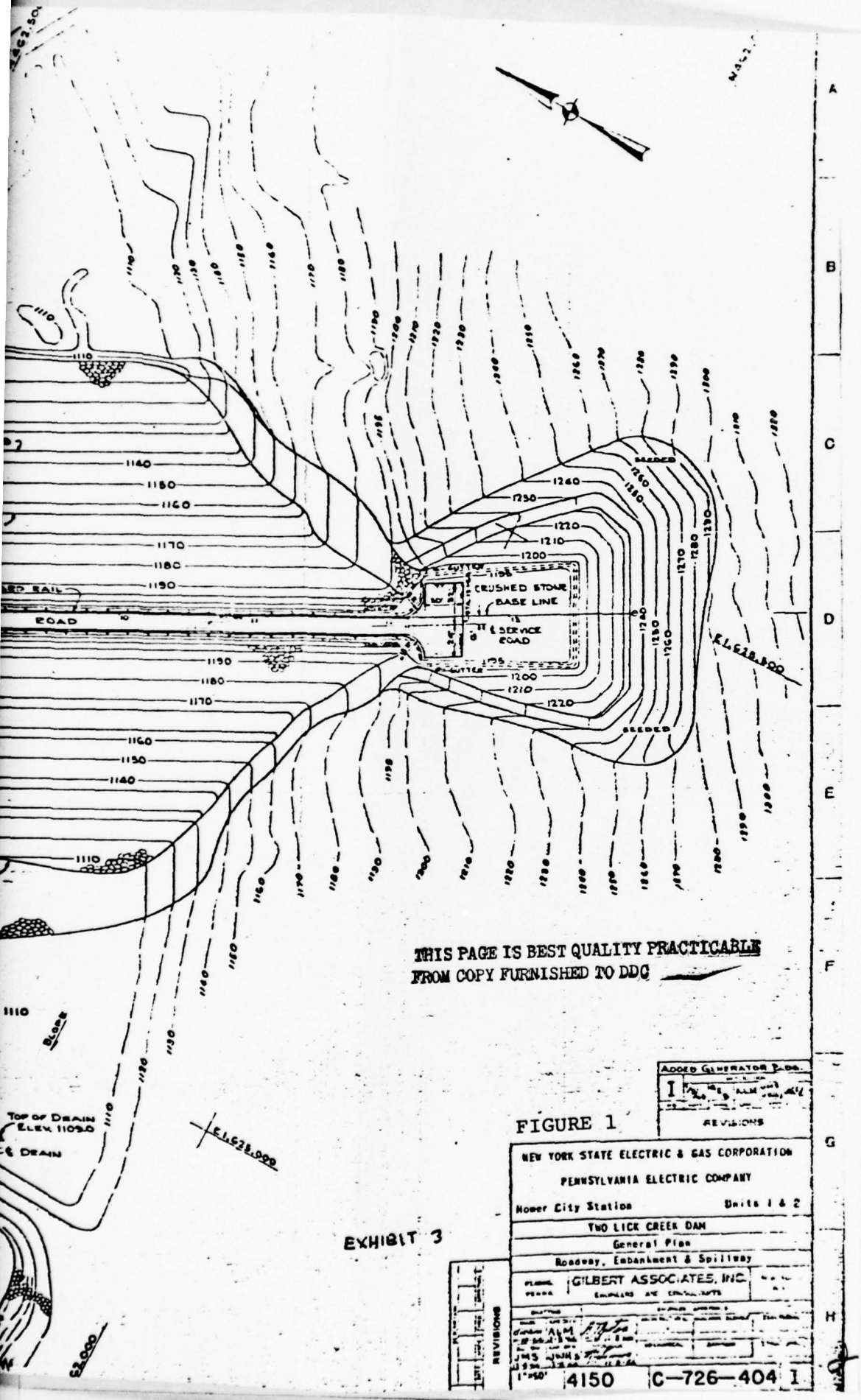


FIGURE 1

EXHIBIT 3

ADDED GENERATOR P. DG.

REVISIONS

NEW YORK STATE ELECTRIC & GAS CORPORATION

PENNSYLVANIA ELECTRIC COMPANY

Homer City Station Units 1 & 2

TWO LICK CREEK DAM

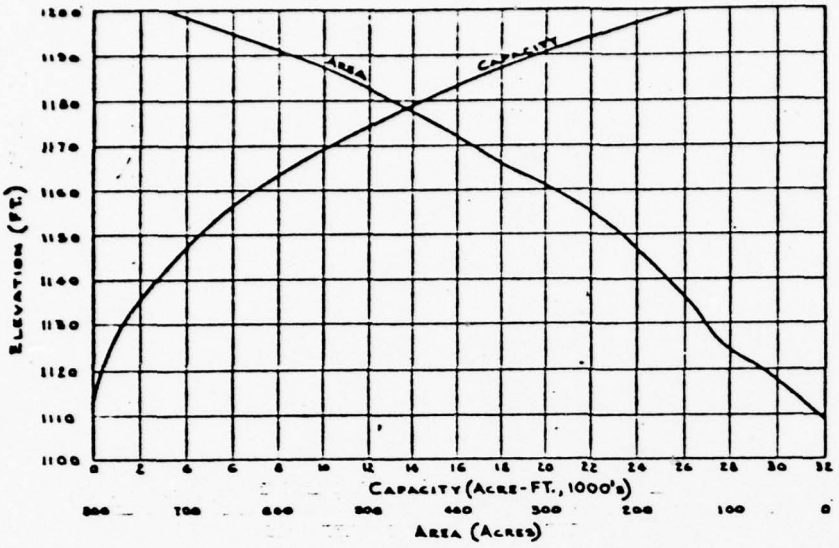
General Plan

Roadway, Embankment & Spillway

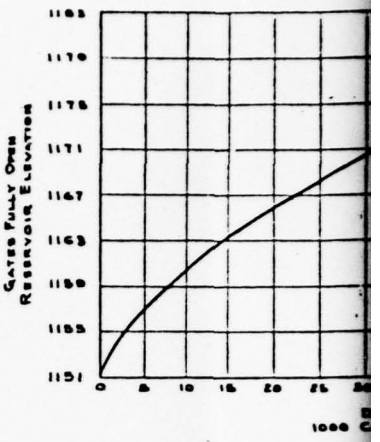
GILBERT ASSOCIATES, INC.

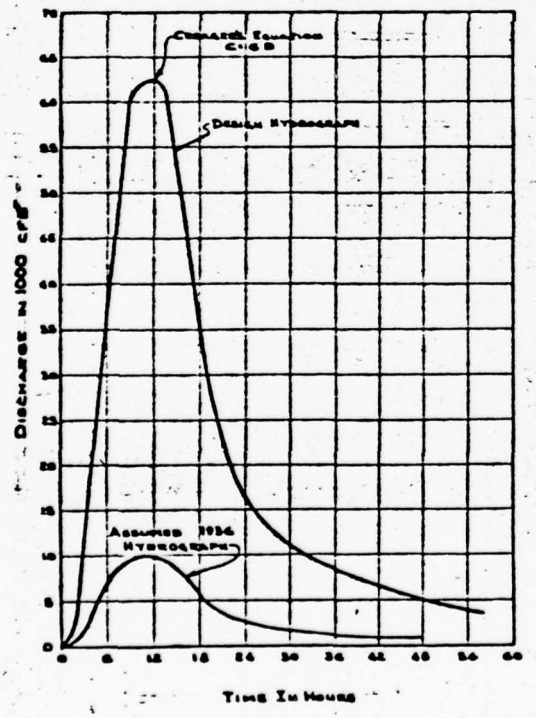
1"=50' 4150 C-726-404 1

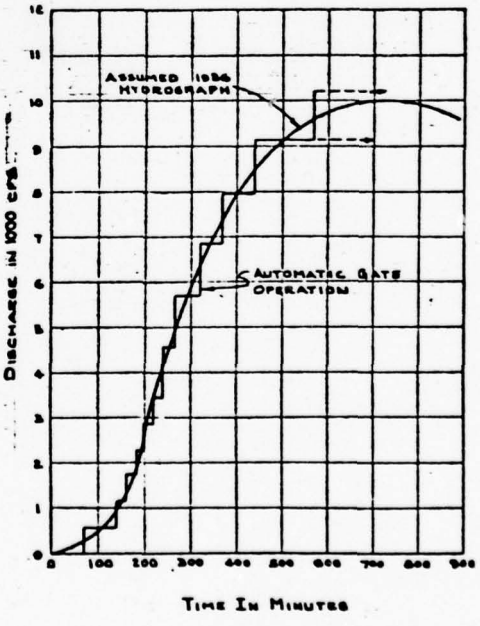
Reservoir Capacity Area Curves

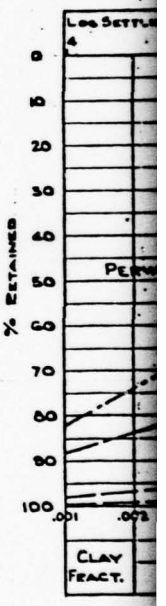


Spillway



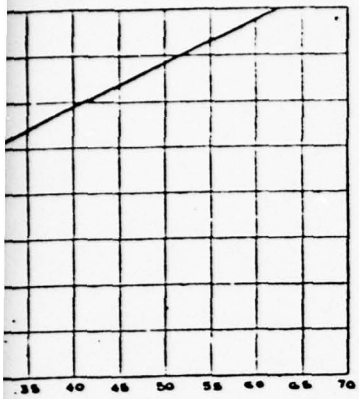






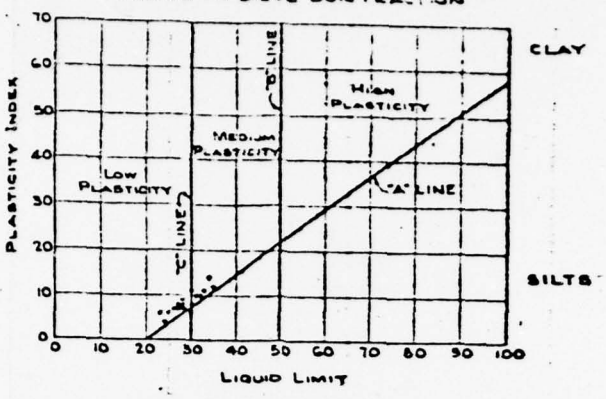
Hydrographs

RATING CURVE

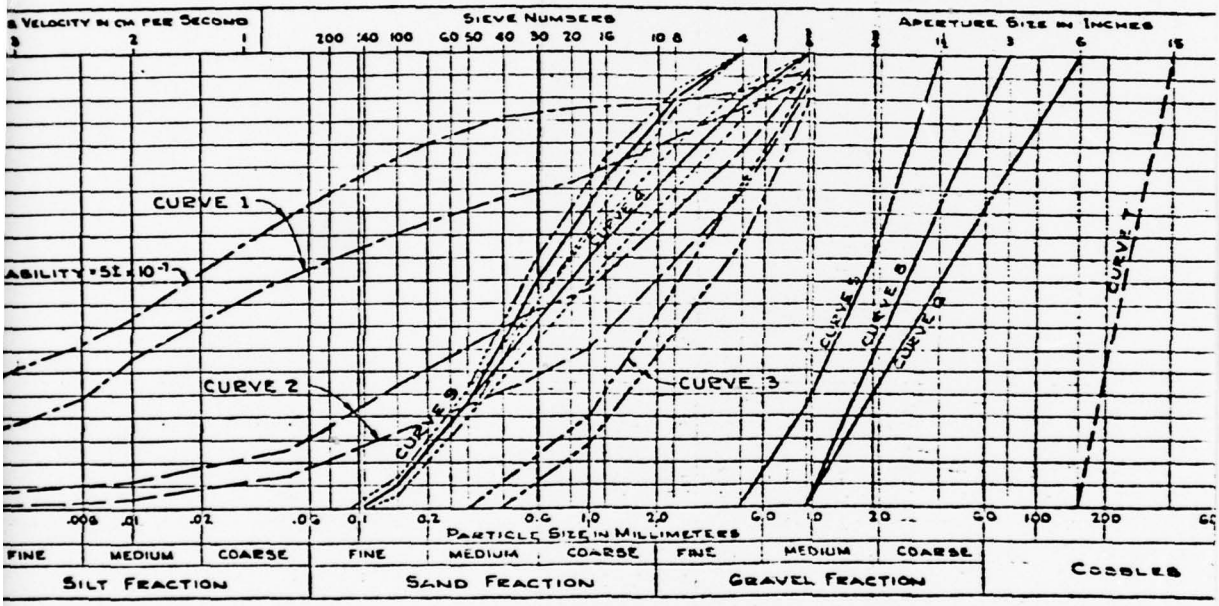


DISCHARGE
CUBIC FEET PER SEC.

MINUS #4 SIEVE SOIL FRACTION

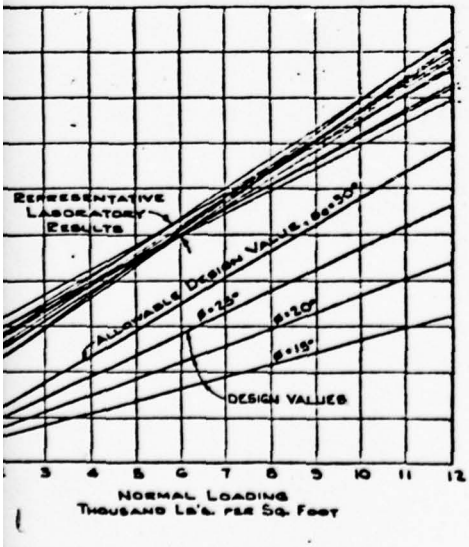


GRADATION CURVES



CURVE	AVERAGE GRADATION OF:
1	Impervious Core Material - Zone A
2	Transitional Earth Fill - Zone B
3	Fine Filter - Zone C
4	Sand (Fine aggregate) Interior Concrete
5	Coarse aggregate - Face Concrete
6	Coarse Filter (Finer Quarry-run rock)
7	Quarry-run rock (Approx.)
8	Coarse aggregate - Interior Concrete
9	Sand (Fine aggregate) Face Concrete

STRENGTH PARAMETERS

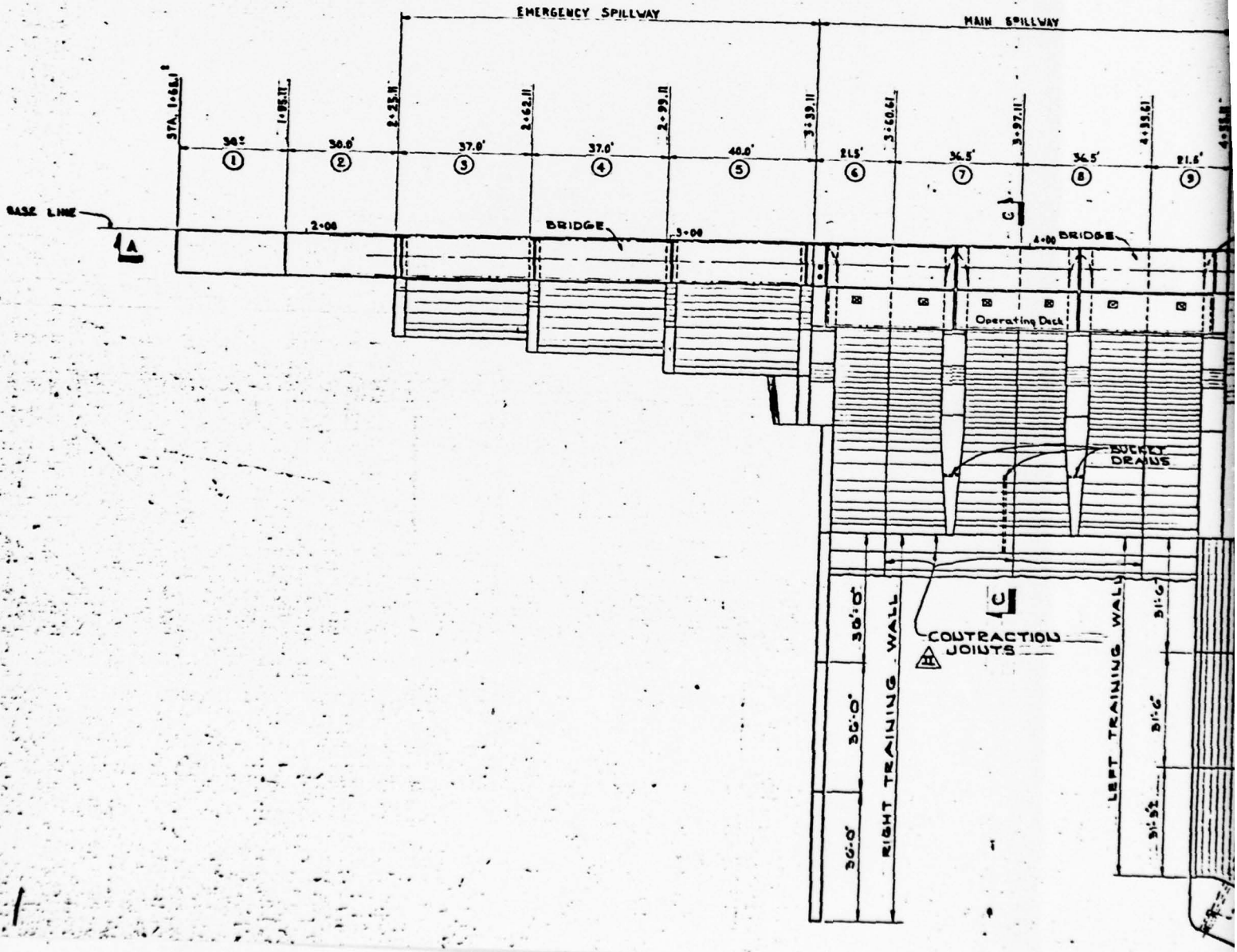


Laboratory results are total stresses obtained from Consolidated Undrained Triaxial Tests.

FIGURE 2

EXHIBIT B

NEW YORK STATE ELECTRI
PENNSYLVANIA ELE
Homer City Station
TWO LICK C
Data S
GILBERT ASSO
Name 4150 C-



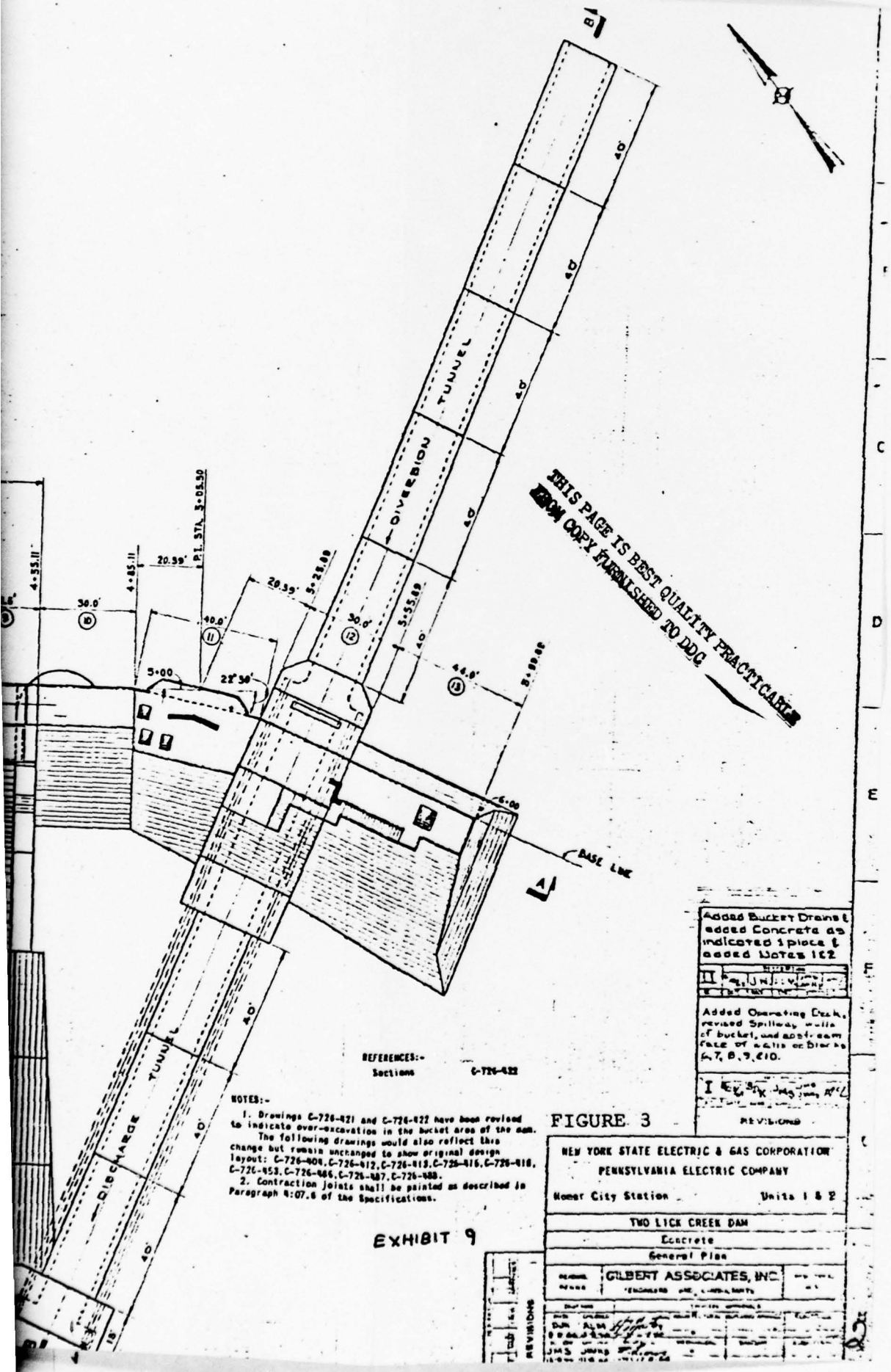
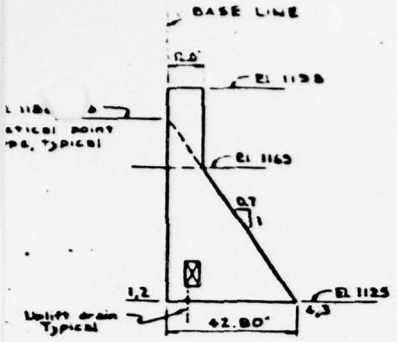


FIGURE 3

EXHIBIT 9



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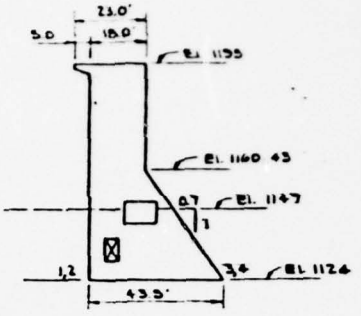

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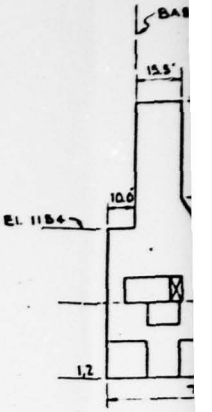
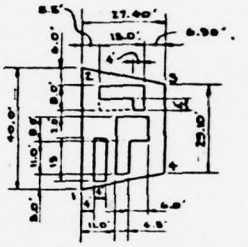
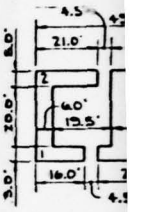


BLO

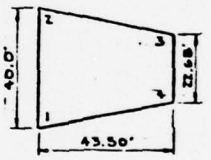
BASE	CASE	ΣH	ΣV	STRESSES LBS/SQ. IN.					
				fv		fd		fb	fv
				1	2	3	4		
1160	I		46.8	27.1	27.1	27.1	27.1	0.0	
	II	6.2	43.3	14.8	14.8	35.4	35.4	3.1	63.3
	III	6.2	43.3	14.8	14.8	35.4	35.4	3.1	63.3
	IV	16.5	41.1	-13.5	-13.5	+63.7	+63.7	2.6	63.3
1125	I		222.2	74.0	74.0	-3.8	-3.8		
	II	1080	190.0	17.1	17.1	44.6	44.6	17.10	63.9
	III	1020	170.0	14.8	14.8	41.3	41.3	16.5	63.8
	IV	1400	130.0	-7.5	-7.5	65.8	65.2	22.7	64.6

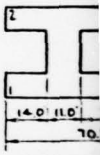


BASE AT EL. 1147.0

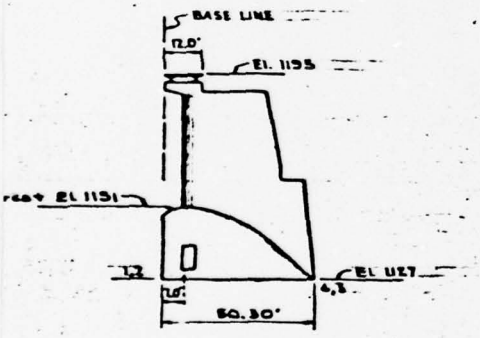


BASE AT





BASE A



BLOCK 7 & 8

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

BASE EL.	CASE	ΣH KIPS	ΣV KIPS	STRESSES LBS/SQ. IN.					
				fv		fd		fb	fv
				1	2	3	4		
1147.0	I	25	4285	68.1	71.8	11.9	9.3	0.3	65.2
	II	1470	4213	24.7	25.4	46.9	48.1	13.1	64.7
	III	1470	4213	24.4	25.4	46.9	48.1	13.1	64.7
	IV	2298	4213	1.1	-6.5	77.4	83.3	23.5	65.0
1124	I	149	7642	68.3	67.1	14.0	15.4	0.8	65.5
	II	3775	7093	7.0	5.8	83.2	84.9	19.2	66.0
	III	3672	6971	4.2	3.0	70.5	72.2	18.7	65.0
	IV	4720	6564	8.2	7.0	60.0	61.5	24.0	63.5

BASE EL.	CASE	ΣH KIPS	ΣV KIPS
1130	I	150	840
	II	2338	710
	III	2313	698
	IV	3518	72 7
1105	I	439	1051
	II	4870	1382
	III	4030	1322
	IV	6270	1355

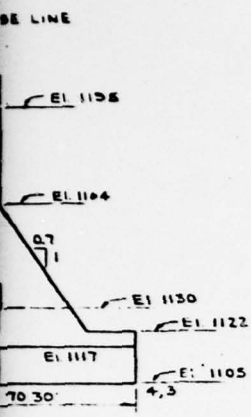
BASE	CASE	ΣH KIPS	ΣV KIPS	STRESSES LBS/SQ. IN.					
				fv		fd		fb	fv
				1	2	3	4		
1127	I	—	4790	48.8	48.8	-15.5	-15.5	—	63.9
	II	2103	4328	10.5	10.5	41.0	41.0	15.5	63.6
	III	1487	3843	16.2	16.2	32.8	32.8	9.5	63.2
	IV	2796	4411	-3.1	-3.1	55.6	55.8	18.0	63.7

Uplift Assumptions
(100% of Base Area)

1. Where drains exist against rock
   Upstream-full headwater
   At Drains-Tailwater plus ⅔ (Headwater minus Tailwater)
   Downstream-full tailwater
2. In concrete (No Drains)
   Full headwater to tailwater
   Diagram at 67% intensity

NOTES:-
1. Dimensions a
purposes only and
2. Design cases:
Case I:
Case II:
Case III:
Case IV:
3. In Case IV:
4. 10% passive
5. Seals are at

SYMBOLS:
ΣH - Algebraic
ΣV - Algebraic
fv - Base stre
fd - Base stre
fb - Average
fv - Allowable
fv = 1/5



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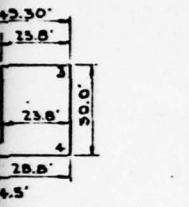
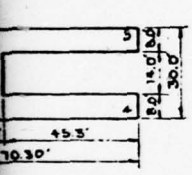
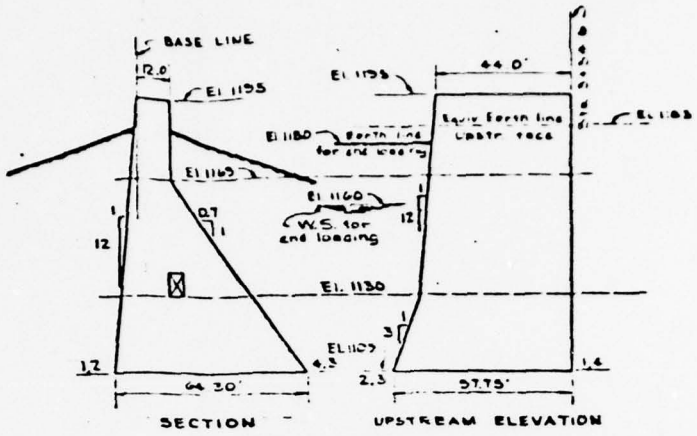


T EL. 1130



AT EL. 1105

	STRESSES LBS/SQ.IN.					
	f_u		f_d		f_b	f_v
	1	2	3	4		
03	82.0	82.0	35.5	35.5	1.0	67.7
09	55.5	55.5	55.8	55.4	15.5	65.9
85	35.1	35.1	54.3	49.5	16.3	65.6
79	17.3	17.3	71.4	71.0	22.0	65.8
19	103.2	102.1	77.3	77.3	2.4	71.7
27	10.4	9.9	155.1	155.9	24.5	70.8
22	8.9	8.4	136.1	136.9	22.0	62.3
57	-12.3	-12.3	182.1	182.5	34.1	71.0



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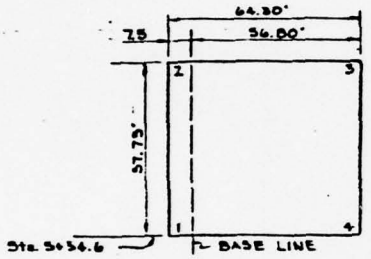


BASE AT EL 1105

BASE EL.	CASE	ΣH KIPS	ΣV KIPS	STRESSES LBS/SQ.IN. f_u 1	f_u 2	f_d 3	f_d 4	f_b	f_v
1189	I	140	3853	82.0	82.0	-2.4	-1.1	1.6	65.3
	II	125	3662	84.3	84.7	-2.1	7.0	1.5	65.4
	III	125	3662	84.3	84.7	-2.1	7.0	1.5	65.4
	IV	298	4454	48.7	48.6	44.8	55.5	3.3	64.3
1130	I	1870	12331	79.4	86.9	13.5	27.4	5.5	68.0
	II	3200	10231	35.4	45.3	33.6	57.0	11.6	68.0
	III	3200	10107	35.4	49.2	53.1	55.9	11.6	65.0
	IV	3550	10603	22.0	5.1	44.8	71.1	13.1	66.0
1105	I	4870	21082	103.2	38.3	-6.1	42.8	2.1	66.8
	II	7200	22410	55.8	-4.6	24.9	83.3	17.2	66.3
	III	7300	22166	55.3	10.7	23.2	84.7	14.7	63.6
	IV	8050	23192	50.3	-0.6	36.5	74.6	16.2	65.5

and foundation elevations shown are for design
nd are not to be used for construction.
ad:
Dead load of concrete, fill in place,
reservoir empty.
UW El.1183.0', TW El.1110.0'.
UW El.1183.0', TW El.1135.0'
spillway gates fully open.
UW El.1192.0', TW El.1125.0'
Spillway gates closed, Case IV is
an emergency design case only.
uplift of Case II used.
pressure used in Case IV for block 11 & 13.
at 4' downstream of base line.

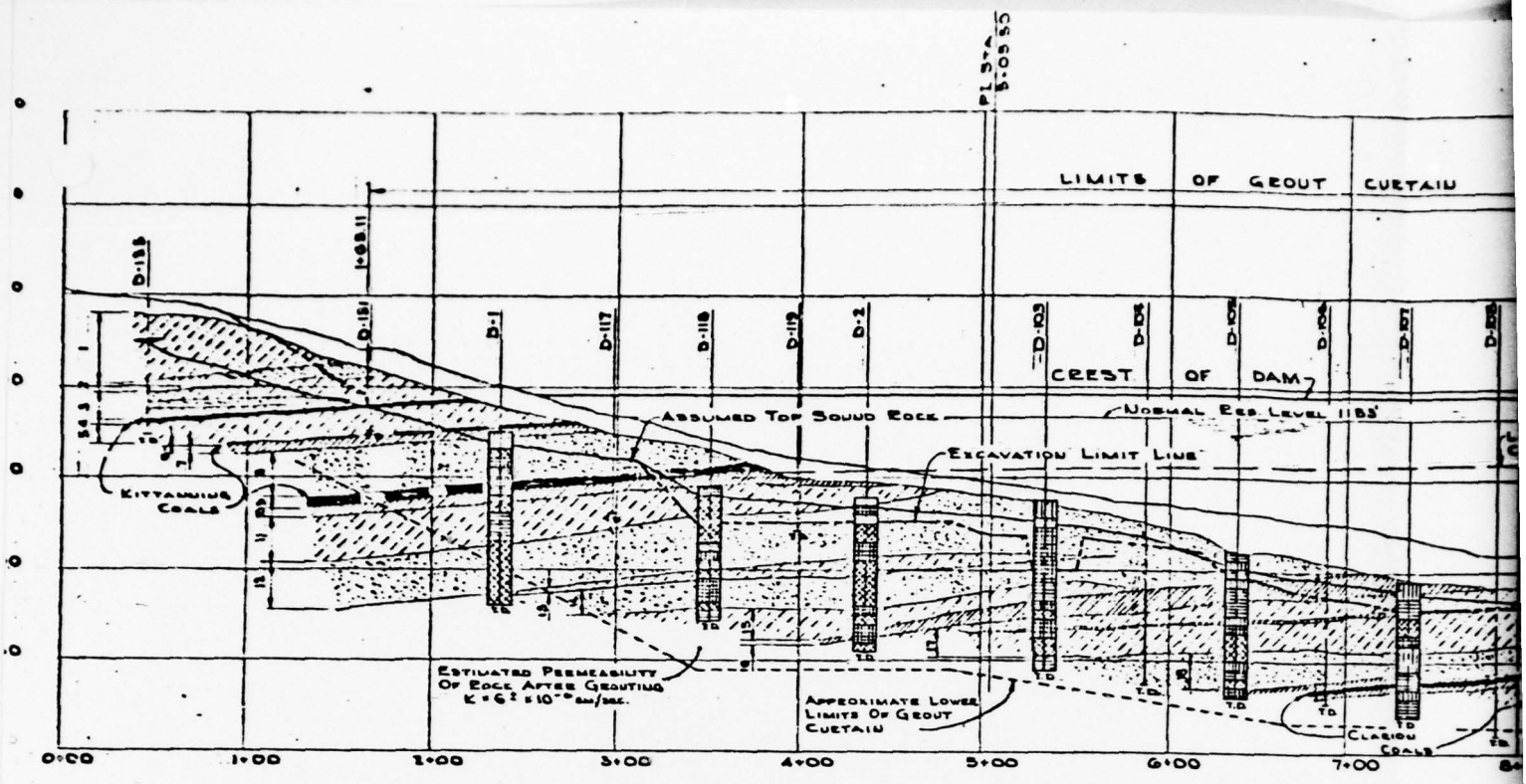
ic summation of forces parallel to base of section.
ic summation of forces normal to base of section.
ress at upstream face.
ress at downstream face.
shear stress on base.
o shear stress on base. (Rock surface only:
) (300 + 0.65 average vertical stress)

FIGURE 4

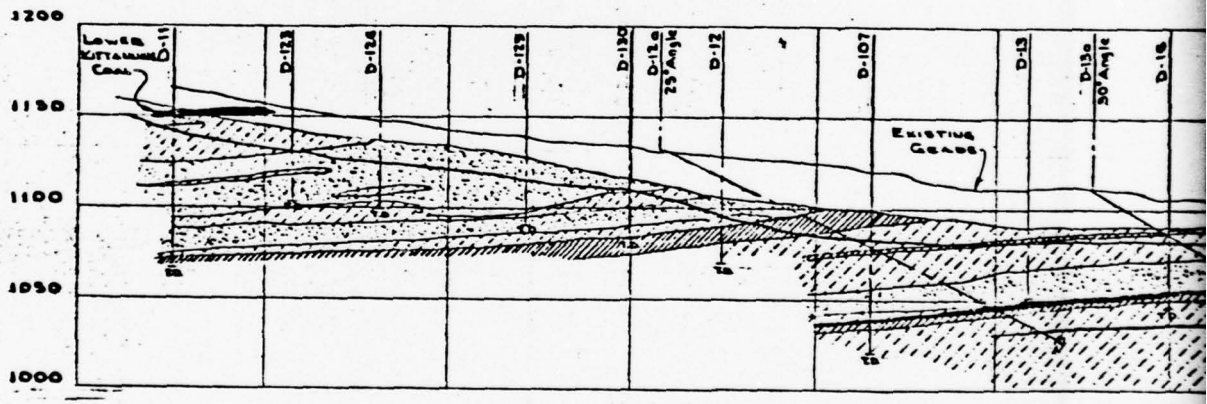
NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station Units 1 & 2
TWO LICK CREEK DAM
Stability Analysis
Concrete Section
GILBERT ASSOCIATES, INC.

REVISIONS

EXHIBIT 10



SECTION A-A

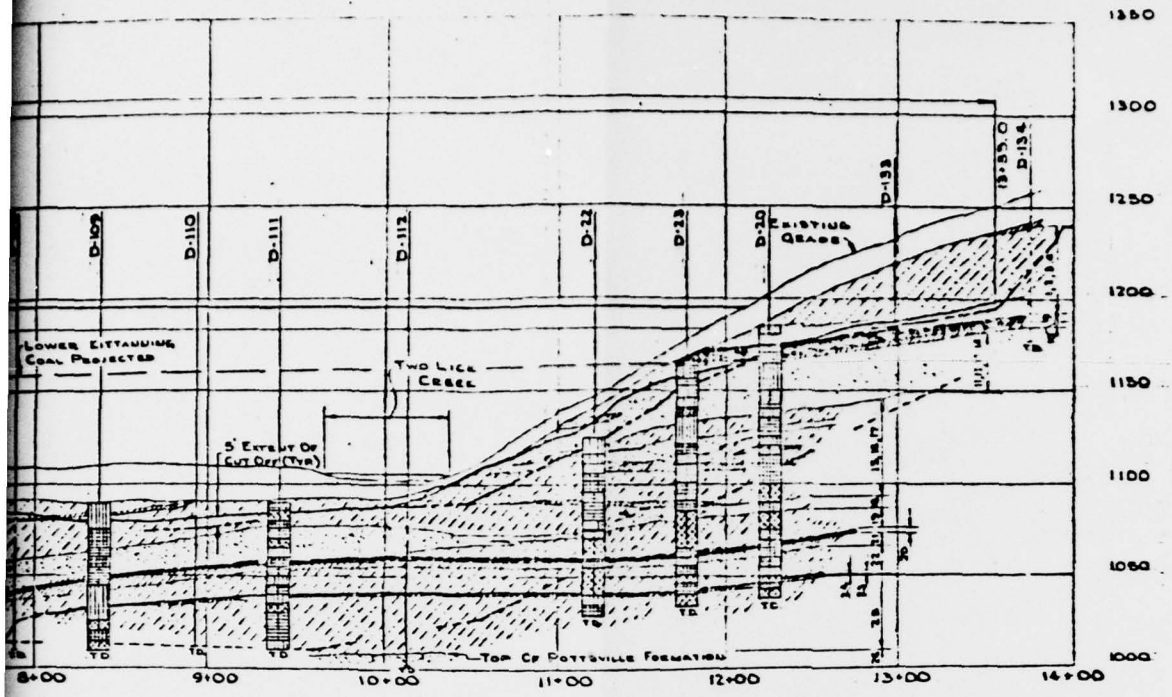


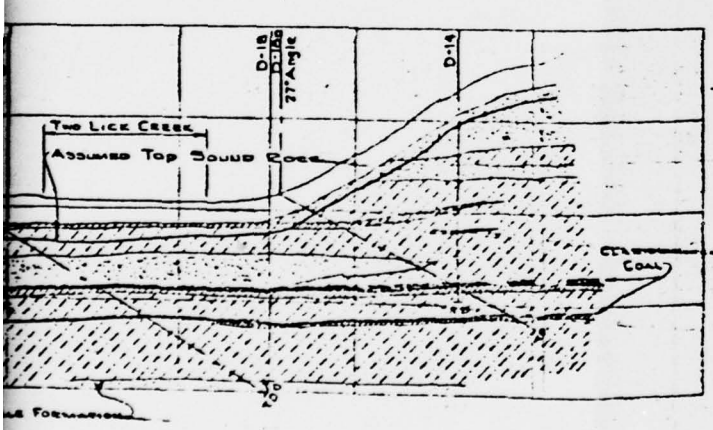
TOP OF POTTSVILLE

SECTION B-B

NOTES:-

1. Refer to Volume II Report No.1637 for detailed log of individual borings.
2. Subsurface data is correct at borings only, and conditions may vary between borings.
3. Water pressure tests were conducted in five foot intervals, exact depth of test interval can be obtained from detailed logs in Volume II Report No. 1637.





L E G E N D

- Overburden
- Sandstone
- Siltstone-Some Interbedded Sandstone & Shale
- Coal-(Some Seams Include Shale Layers)
- Underclay
- T.D. - Total Depth

PRESSURE TEST-PERMEABILITY IN CM/SEC

- 10^{-3}
- 10^{-4}
- 10^{-5}
- Less than 10^{-6}

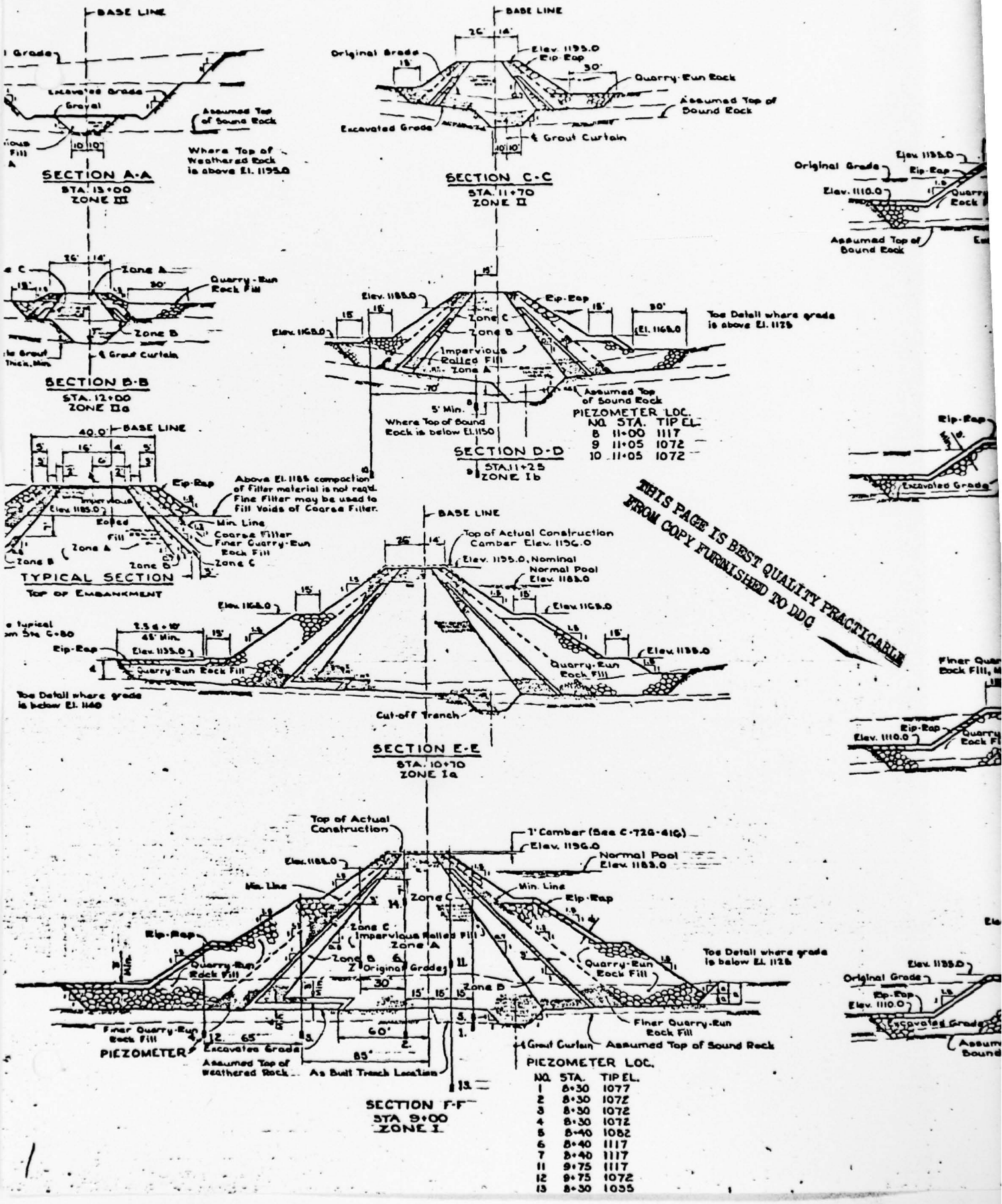
REFERENCE:-
Plot Plan C-796-806

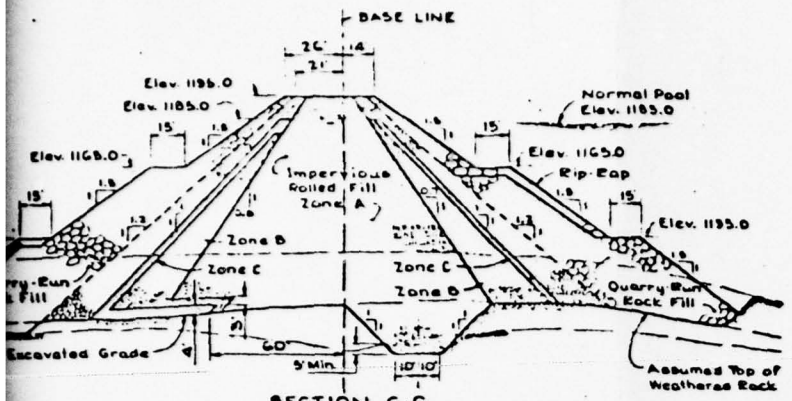
FIGURE 5

REVISIONS

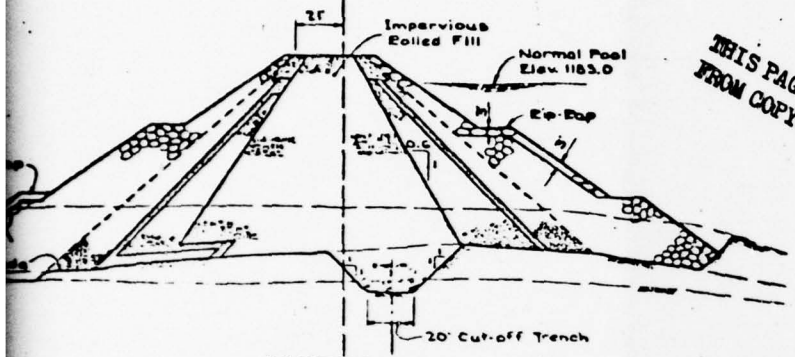
NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station Units 1 & 2
TWO LICK CREEK DAM
Geologic Sections
GILBERT ASSOCIATES, INC.

EXHIBIT 12

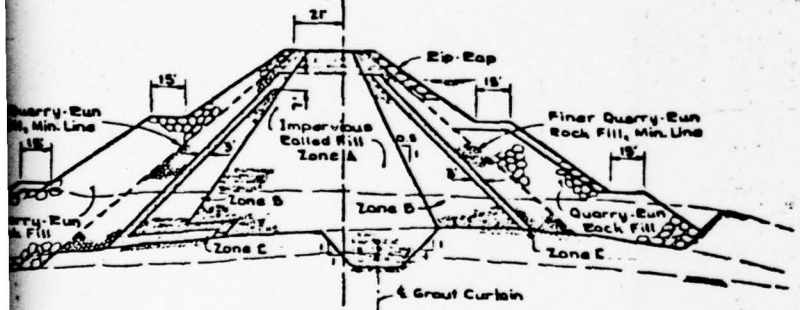




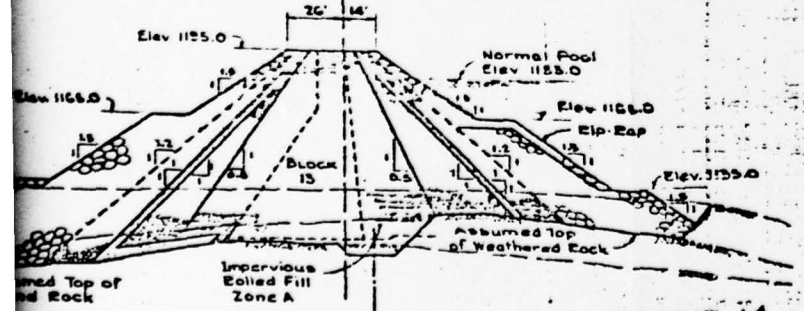
SECTION G-G
STA. G+80
BEGIN TRANSITION



SECTION H-H
STA. G+60
TRANSITION ZONE



SECTION J-J
STA. G+40
TRANSITION ZONE



SECTION K-K
STA. G+24
END TRANSITION

REFERENCES:-
Plan C-725-416

FIGURE 6

EXHIBIT 14

ADDED PERMANENT PIEZOMETER LOC

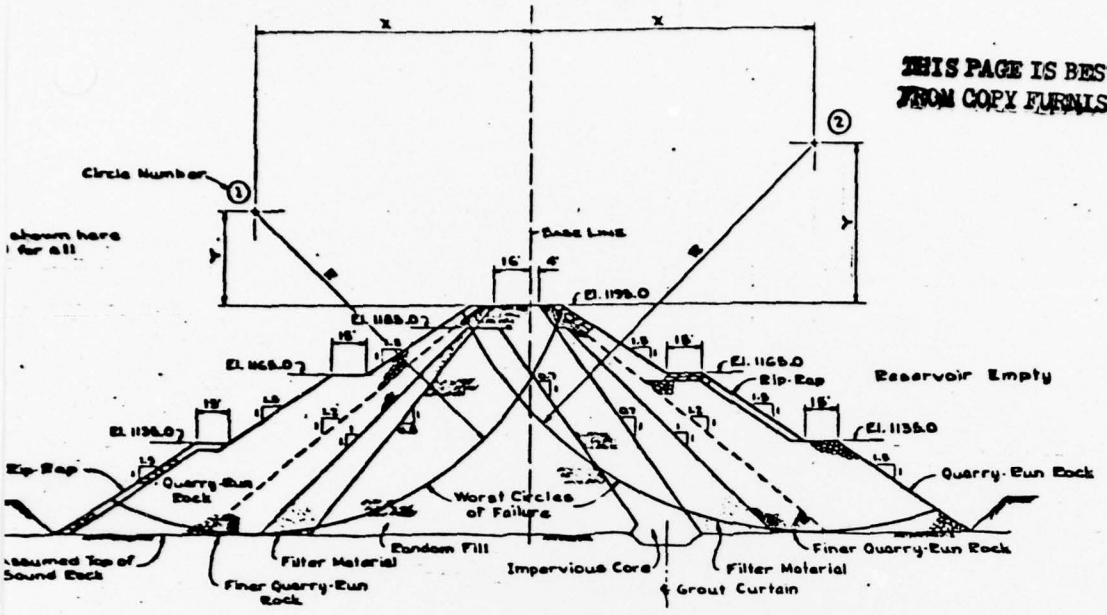
II			
I			

Revised Embankment Core
Added Zones A, B, & C

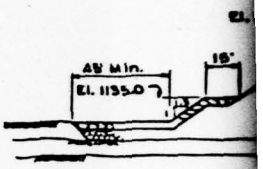
REVISIONS

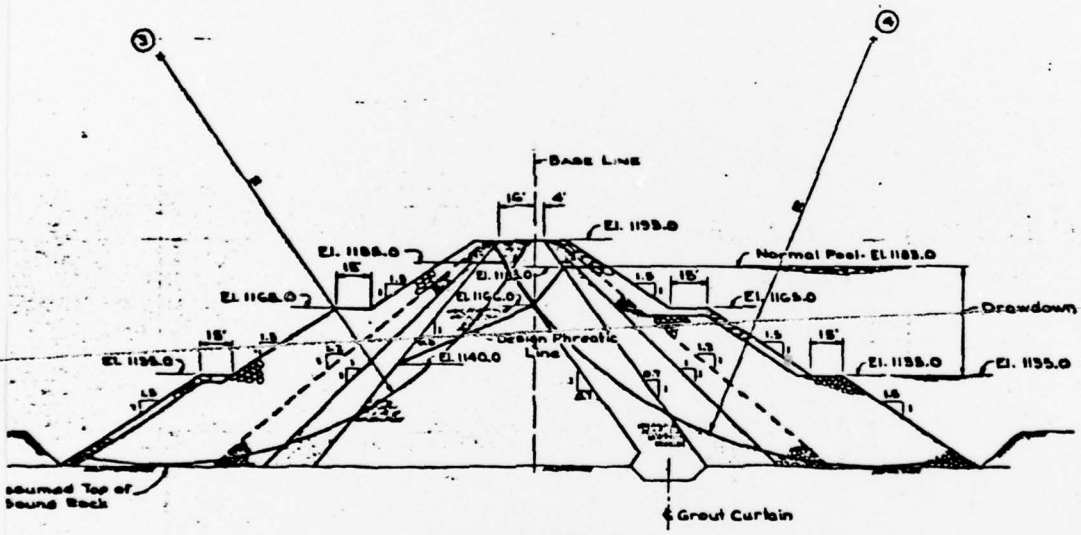
NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station Units 1 & 2
TWO LICK CREEK DAM
Rock Fill Embankment
Sections
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

DESIGNED ALM
DRAWN
CHECKED JMS



MAXIMUM SECTION





MAXIMUM SECTION

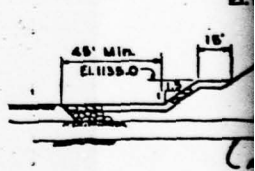


TABLE I

Mode of Circle	Case I	Case II	Case III
I	20°	20°	25°
II	15°	20°	25°
III	15°	20°	25°

$\phi = 15°$, $\tan 15° = .268$, $p = 54\%$
$\phi = 20°$, $\tan 20° = .364$, $p = 38\%$
$\phi = 25°$, $\tan 25° = .466$, $p = 20\%$

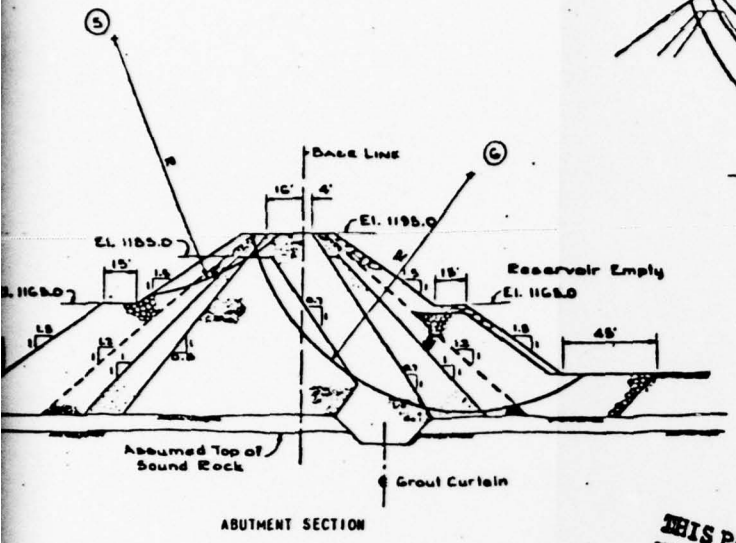
SUMMARY - CIECLE ANALYSIS

Section	Circle	Case	X Feet	Y Feet	E Feet	ΣN tan φ Pounds	Lc	ΣT Pounds	Fs	Mode
Maximum	1	I	120.6	41.8	141.8	486,290	0	370,780	1.25	III
"	2	I	124.0	70.0	170.0	521,680	0	380,550	1.37	III
"	3	II	164.6	81.8	181.8	406,220	0	285,150	1.39	III
"	4	III	148.6	83.8	189.9	433,950	0	286,460	1.52	III
Abutment	5	I	84.0	84.0	112.0	31,120	0	22,710	1.37	I
"	6	I	76.0	26.0	102.0	277,180	0	215,340	1.29	II
"	7	II	76.0	68.0	96.0	34,810	0	25,090	1.39	I
"	8	III	96.0	70.0	142.0	290,070	0	211,510	1.37	II

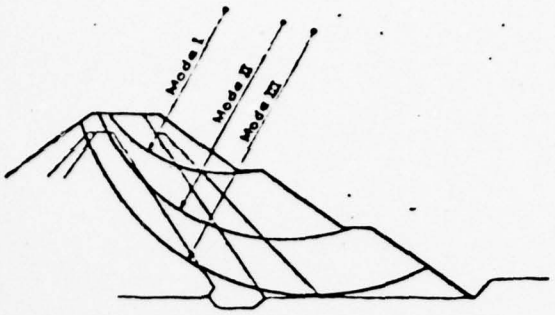
PROPERTIES OF MAT

Material	Moist Weight lbs/cu.ft.	Saturated Weight lbs/cu. ft.	Buoyant Weight lbs/cu.ft.
Rip-Rap	110	-	70
Quarry Run Rock	110	-	70
Finer Quarry Run Rock	110	-	70
Filter Material	110	-	70
Impervious Core	129	141	78.5
Random Fill	129	141	78.5
Overburden	118	135	78.5

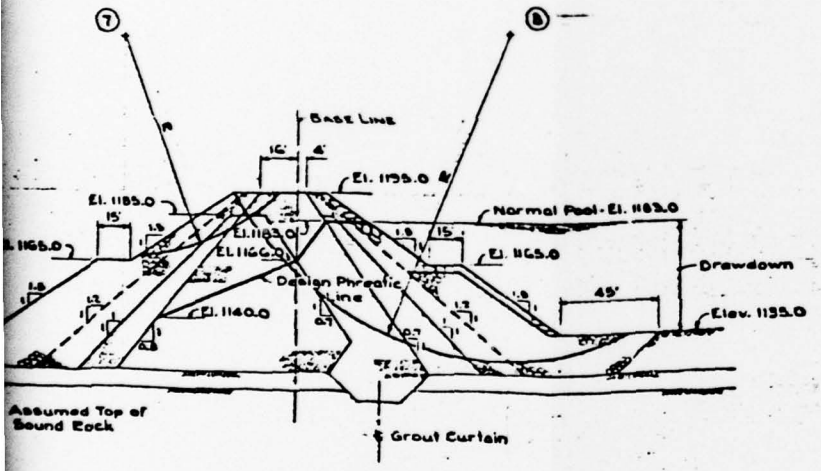
DESIGN STRENGTH
$S = (W-U) \tan 30° +$
$P = 100$ #



ABUTMENT SECTION



For each section of discontinuous slope there is a seperate mode of failure which will give a "minimum" factor of safety. Materials at higher elevations in the fill have higher design strengths due to smaller pore pressures. Table I gives the phi angle values by case & mode. The lower modes are shown on the maximum section & the higher modes are shown on the abutment section.



ABUTMENT SECTION

ERIALS

φ	tan φ	C lbs/sq. ft.
43°	.933	0
43°	.933	0
43°	.933	0
36°	.726	0
See Table 1		0
See Table 1		0
15°	.268	0

OF EARTH
f tan φ
&

Case I : End of Construction
Reservoir Empty

Case II : Normal Operating Condition
HW El. 1183.0
TW El. 1110.0
Fully Developed Phreatic Line

Case III : Sudden Drawdown Condition
HW El. 1135.0
TW El. 1110.0
Fully Developed Phreatic Line

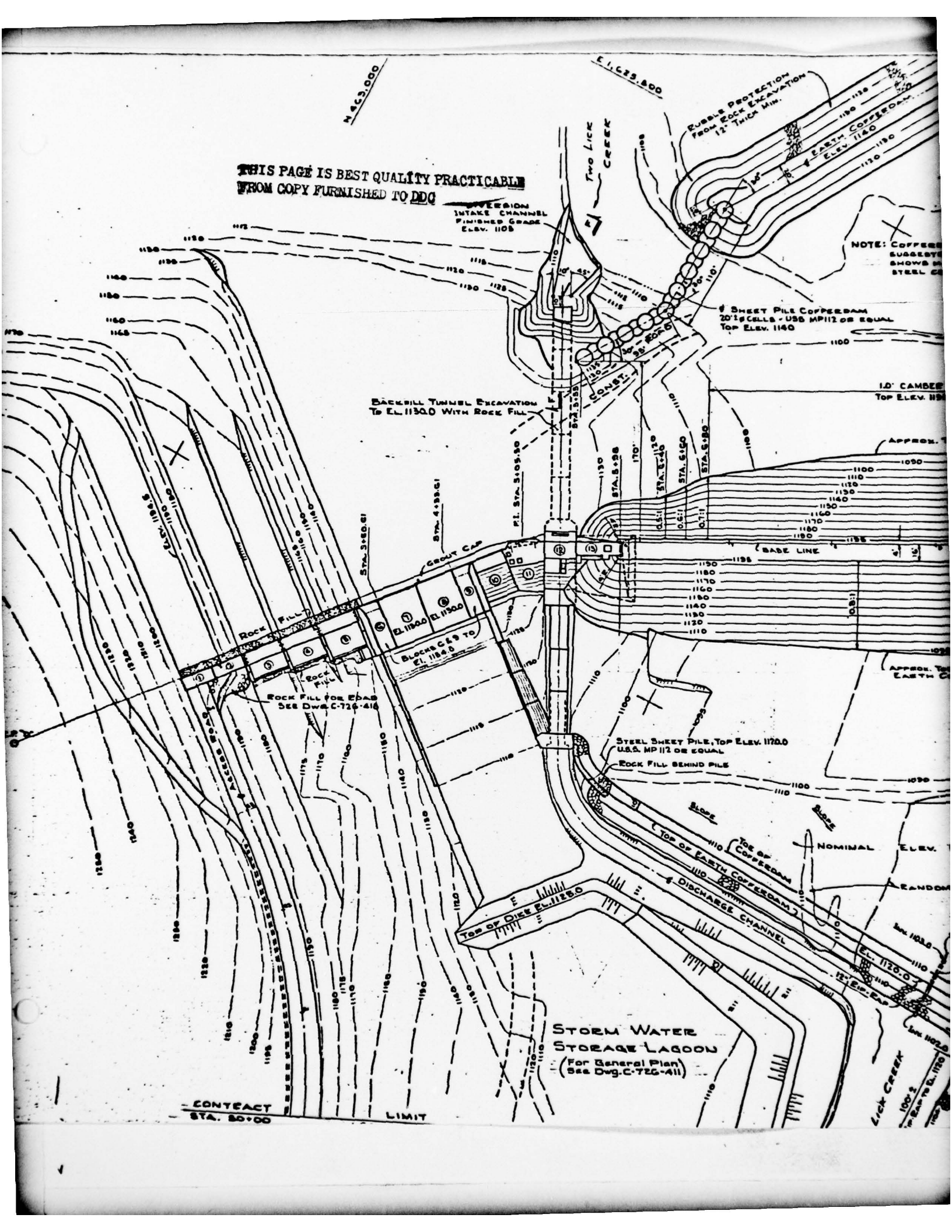
Dimensions & Elevations given are for design purposes only & are not to be used for construction.

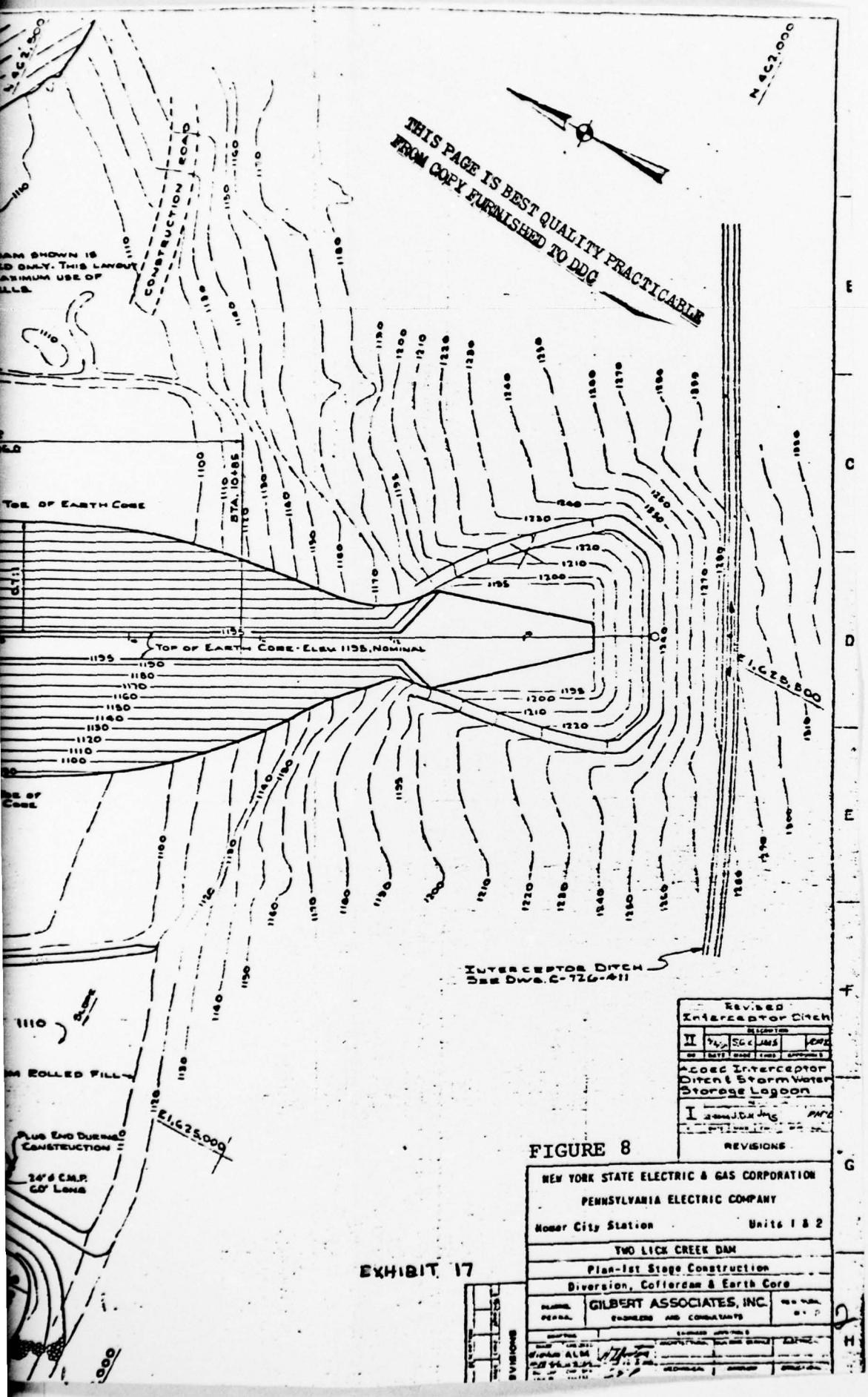
EXHIBIT 15

FIGURE 7

REVISIONS

NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station — Units 1 & 2
TWO LICK CREEK DAM
Embankment Stability Analysis
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS





Revised Interceptor Ditch

II		SGC	JMS		
NO	DATE	DSGN	CHKD	APPROVED	

Access Interceptor Ditch & Storm Water Storage Lagoon

I — REVISIONS

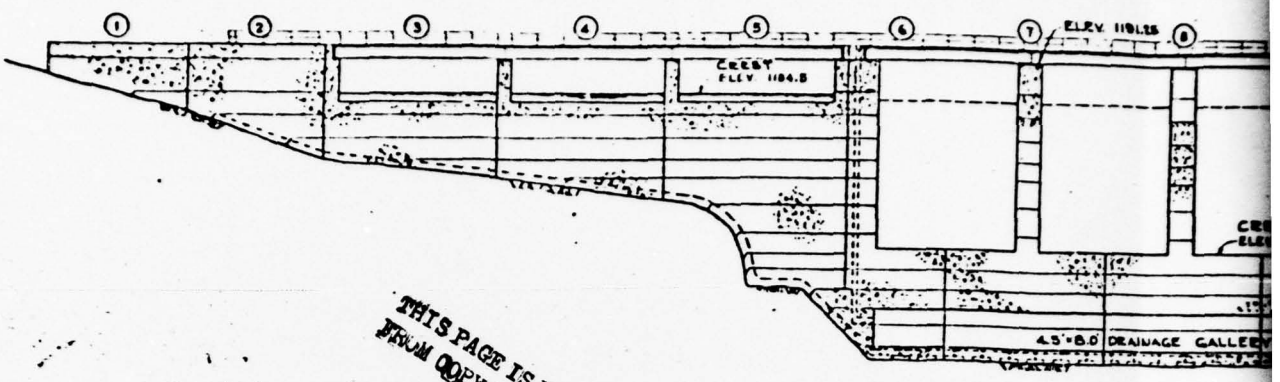
FIGURE 8

NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station — Units 1 & 2

TWO LICK CREEK DAM
Plan-1st Stage Construction
Diversion, Cofferdam & Earth Core

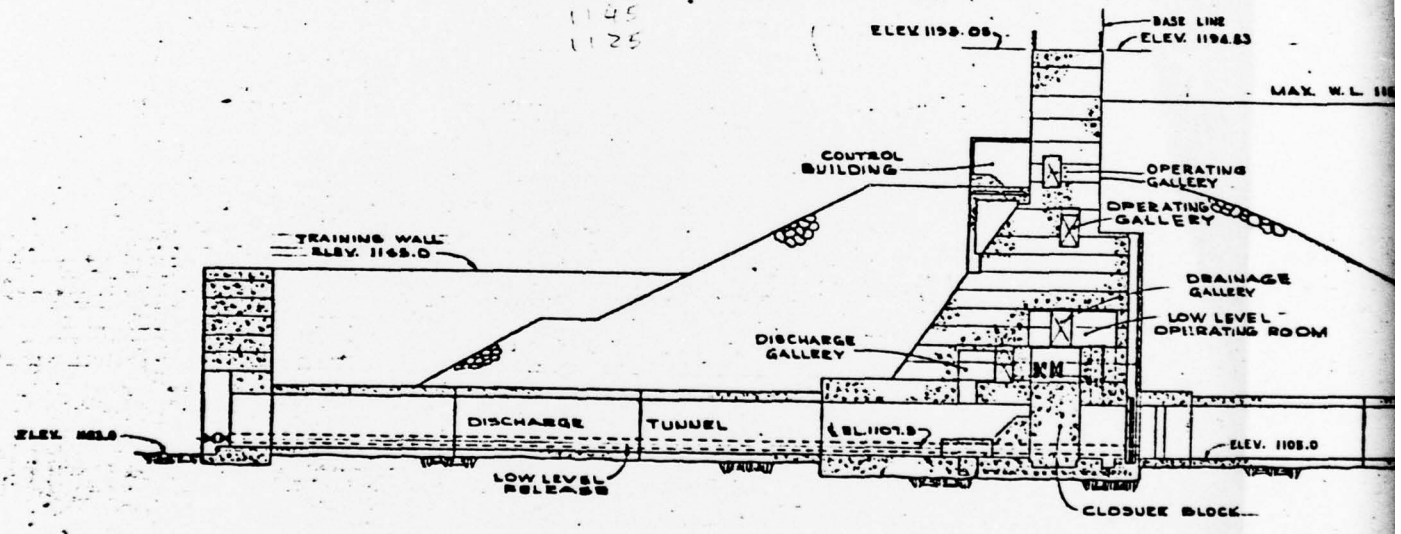
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

EXHIBIT 17

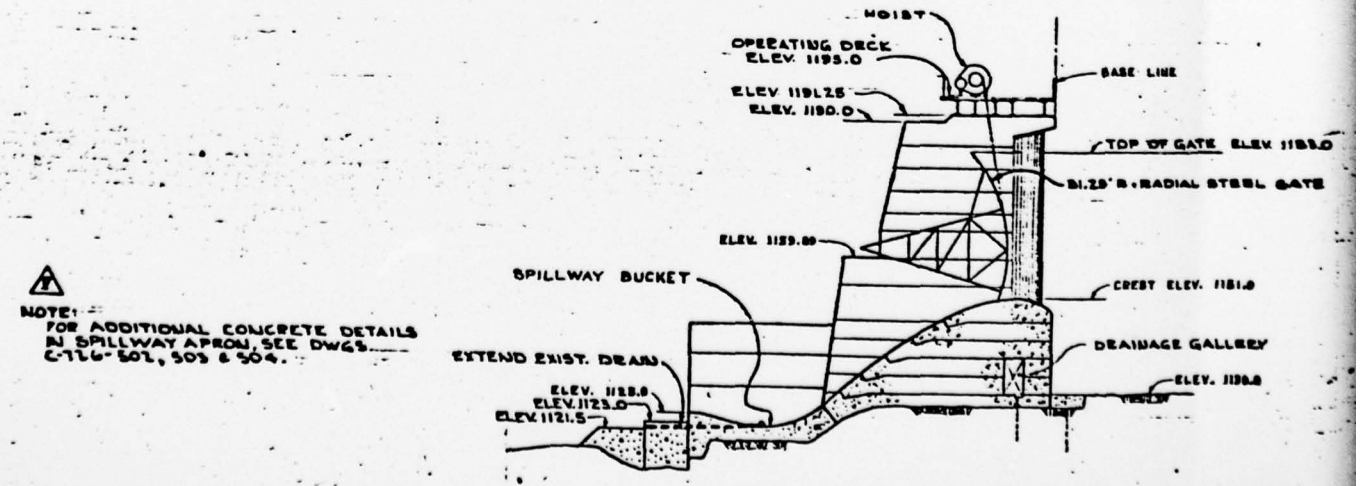


SECTION A-A

1165
1145
1125

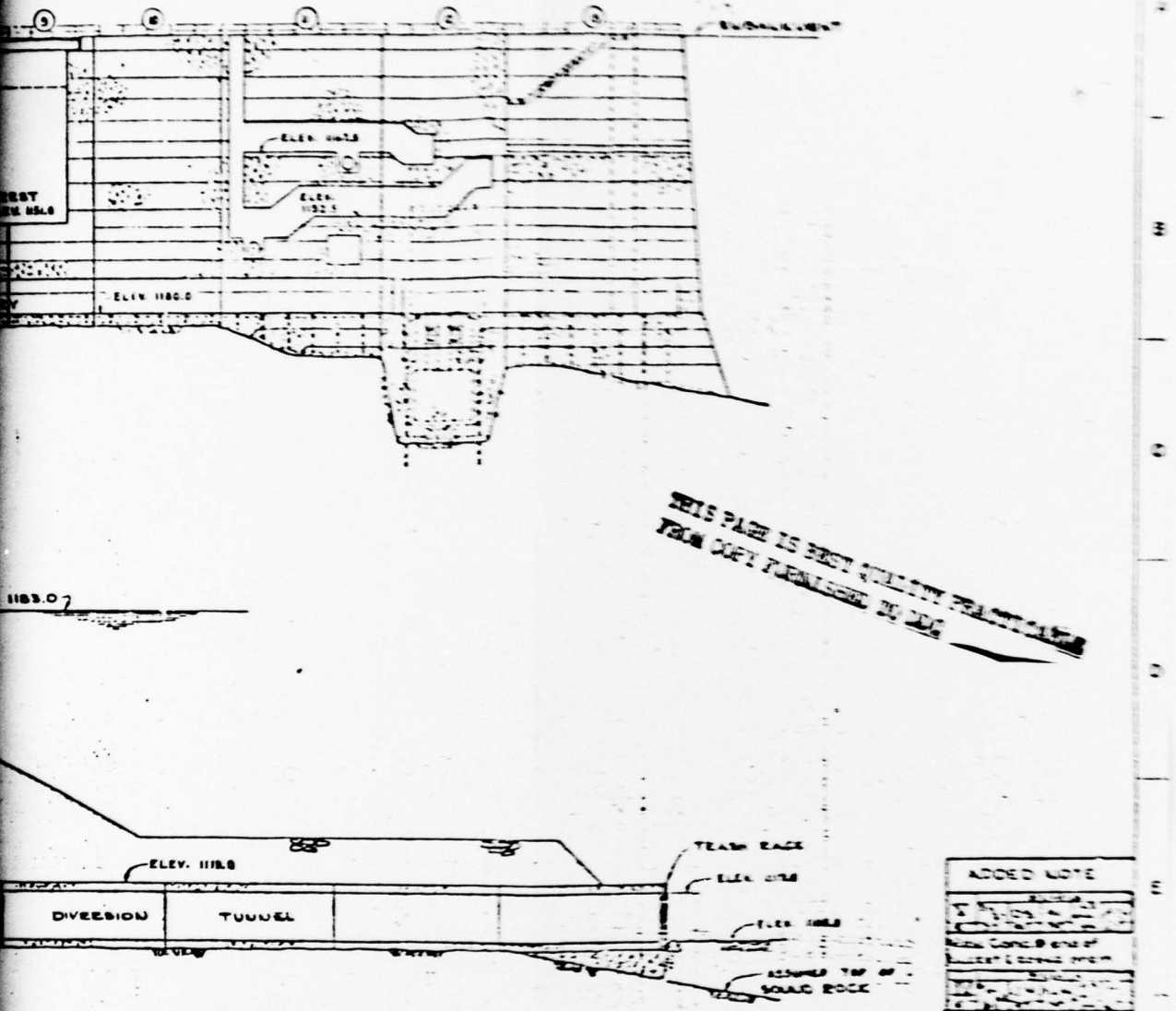


SECTION B-B



SECTION C-C

NOTE:
FOR ADDITIONAL CONCRETE DETAILS IN SPILLWAY APRON, SEE DWGS. C-776-502, 503 & 504.



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ADDED NOTE

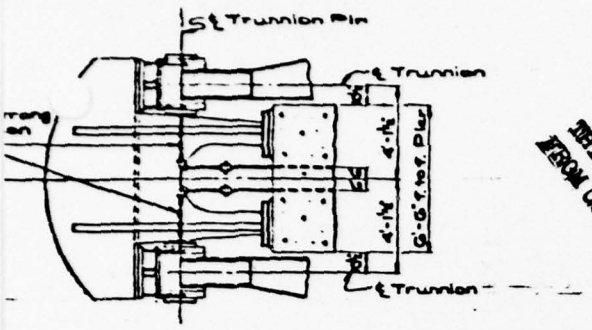
REFERENCES:-

General Plan	C-726-522
Plan-Excavation Contours	C-726-502
Sections-Additional Concrete	C-726-503
Sections-Additional Concrete	C-726-506

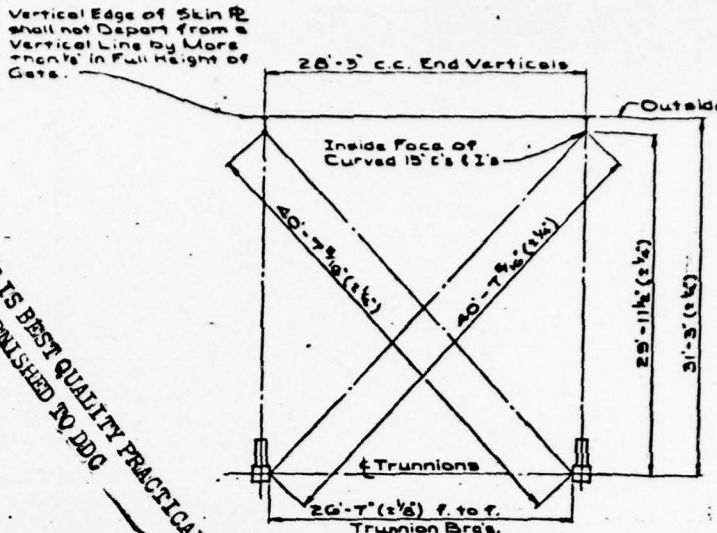
FIGURE 9

EXHIBIT 18

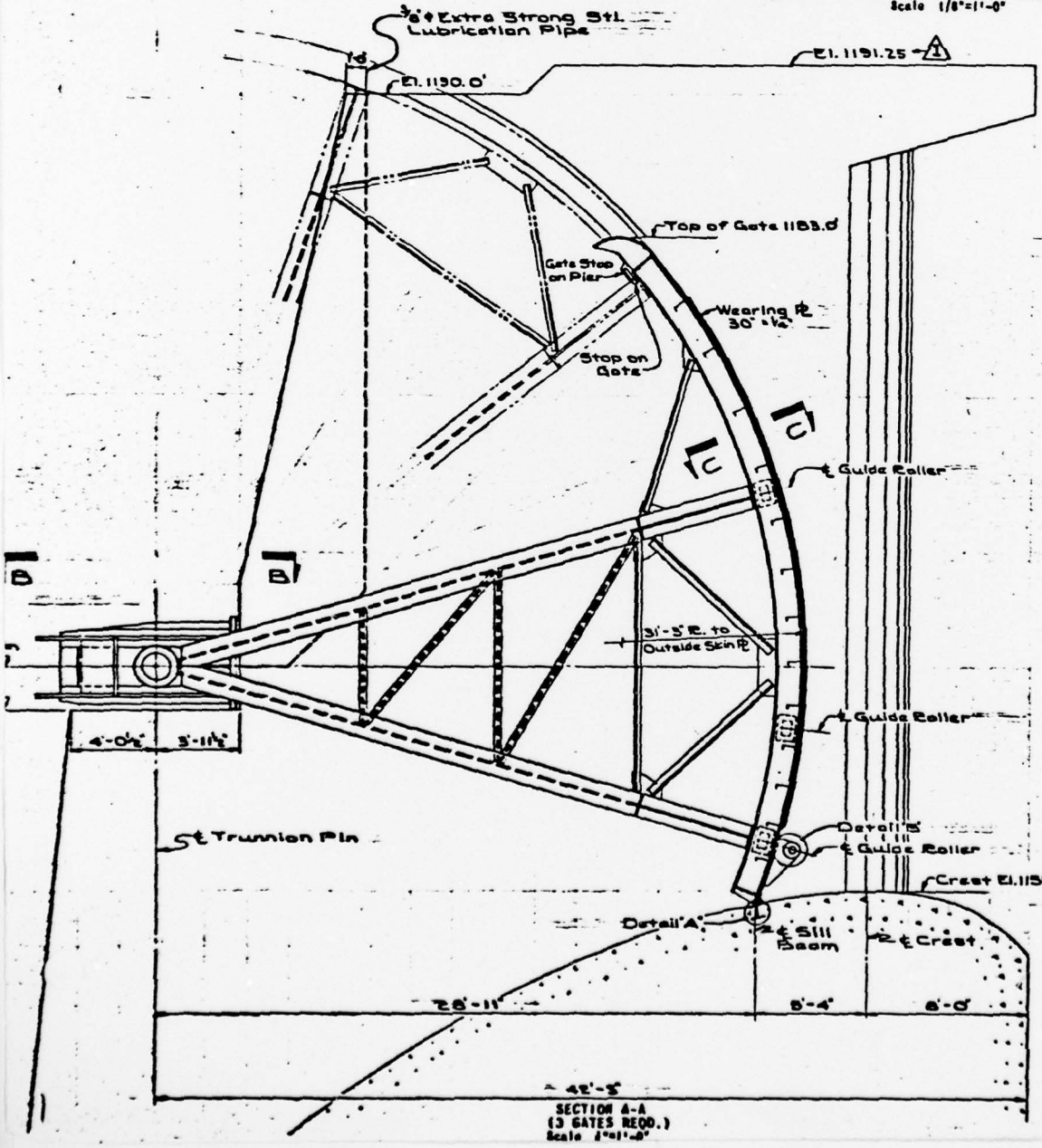
NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station Units 1 & 2
TWO LICK CREEK DAM
Concrete
General Sections
GILBERT ASSOCIATES, INC
ENGINEERS AND CONSULTANTS



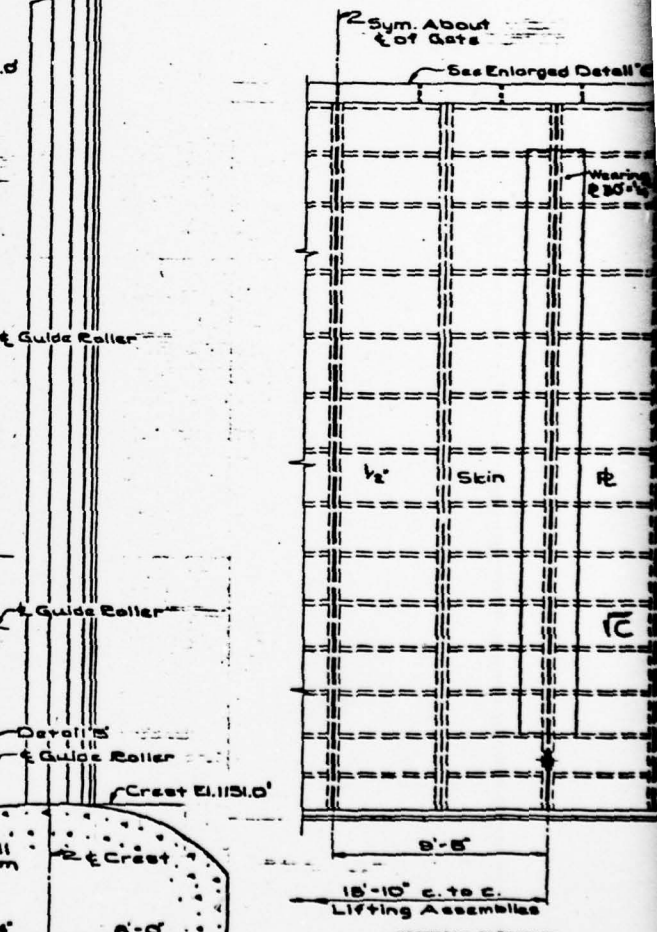
PLAN B-B
Scale 1"=1'-0"



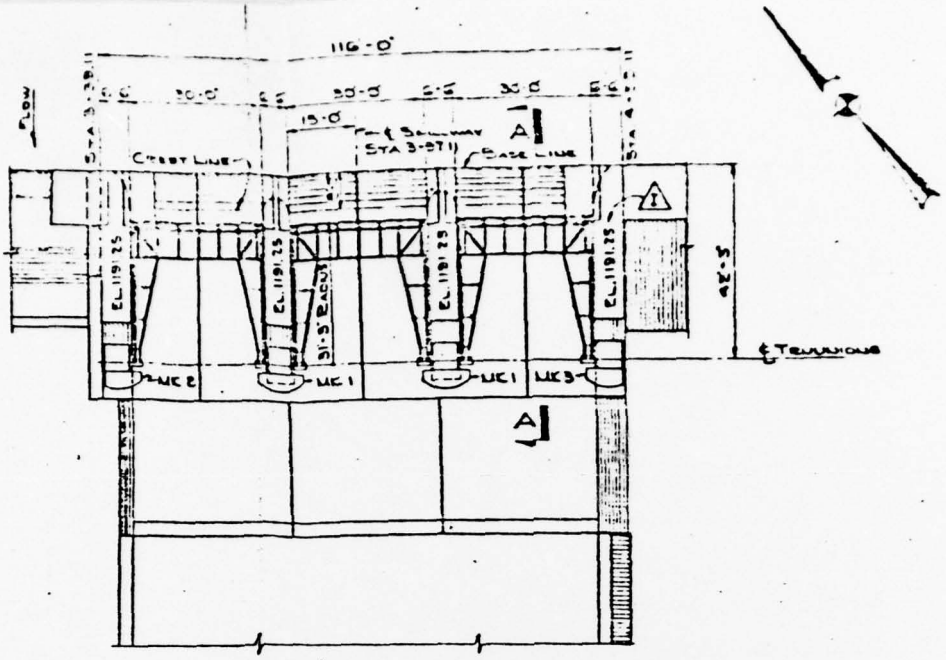
ASSEMBLY TOLERANCES
(FOR ANY RADIAL PLANE)
Scale 1/8"=1'-0"



SECTION A-A
(3 GATES REQD.)
Scale 1"=1'-0"



UPSTREAM ELEVATION
Scale 1"=1'-0"



KEY PLAN-GATES & ANCHORAGES
Scale 1"=20'-0"

BILL OF MATERIAL				BILL OF MATERIAL			
MARK	DESCRIPTION	NO. REQD.	MATERIAL	MARK	DESCRIPTION	NO. REQD.	MATERIAL
	Gate Structure	3	Structural Steel	726-462-1	Guide Roller Bearing	18	Steel Casting
726-462-1	Lifting Bar	6	Steel Forging	2	Guide Roller	18	Steel Forging
2	Clevis	8	Steel Forging	3	Guide Roller Bushing	18	Bronze & Graphite
3	Pin & Cotter	12	Steel Forging	4	Guide Roller Pin	18	Steel Forging
				5	Lock Plate	18	Steel
				6	Hex Head Cap Screw 5/8"@x1½" lg.	36	Bronze
726-463-1	Gate Trunnion Bearing	6	Steel Casting	7	Dowel Pin 3/8"@x5/8" lg.	108	Steel
2	Trunnion Bearing Bushing	6	Bronze	8	Finished Bolt	72	Bolt Steel
3	Finished Bolt	144	Bolt Steel	9	Hex.Head Cap Screw 7/8"@x2½" lg.	36	Bronze
4	Fixed Trunnion Bearing	6	Steel Casting	10	Shims	18	Steel
5	Trunnion Pin	6	Steel Forging				
6	Lock Plate	12	Steel	726-465-1	Bottom Rubber Seal	3	Rubber
7	Hex Head Cap Screw 1"@x2½" lg.	24	Bronze	2	Corner Rubber Seal	6	Rubber
8	Flat Point Set Screw 5/8"@x1½" lg.	24	Bolt Steel	3	Side Rubber Seal	3	Rubber
9	Flat Point Set Screw 5/8"@x2½" lg.	36	Bolt Steel	4	Side Rubber Seal	3	Rubber
10	Dowel Pin 1"@x1" lg.	48	Steel	5	Side Seal Bar	6	Steel
11	Machine Bolts	72	Bolt Steel	6	Bottom Seal Bar	3	Steel
				7	Seal Bolt (Side)	684	Bolt Steel
				8	Seal Bolt (Bottom)	288	Bolt Steel
				9	Bevel Washer	288	Steel

REFERENCES:-
Details C-726-469

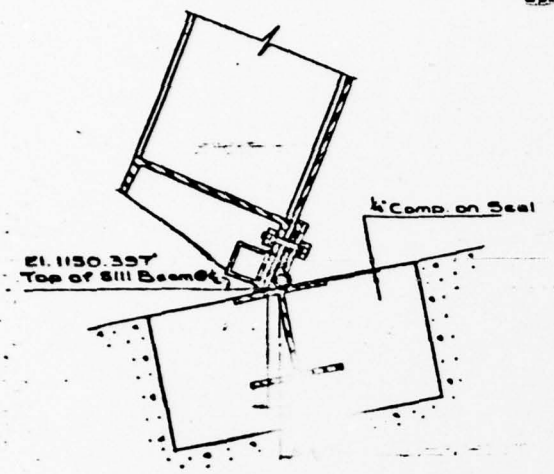
Revised Top of Wall Elevation
I
REVISIONS

FIGURE 10

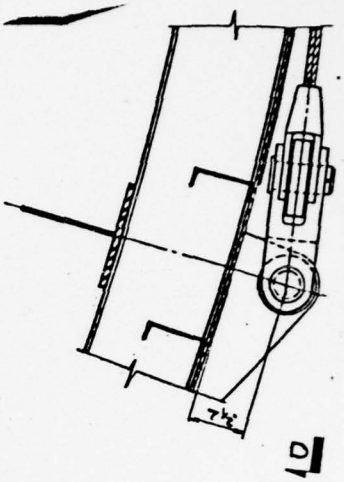
NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station Units 1 & 2
TWO LICK CREEK DAM
Radial Gates
General Arrangement
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

EXHIBIT 19

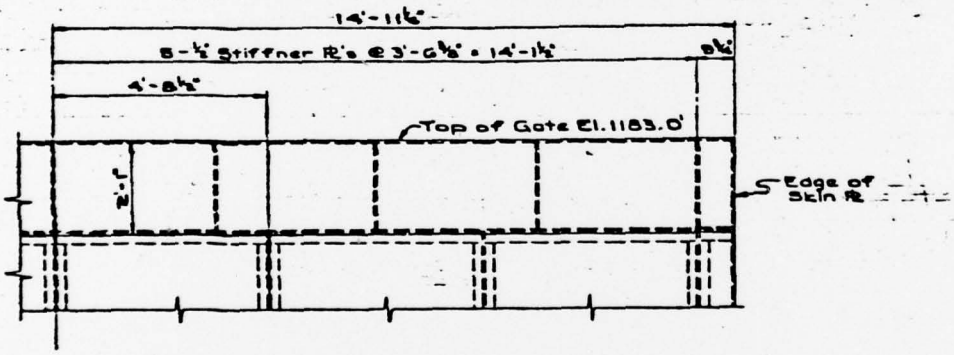
REVISIONS



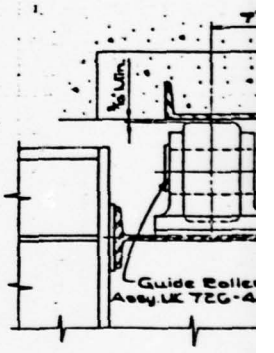
DETAIL "A"
Scale 1½"=1'-0"



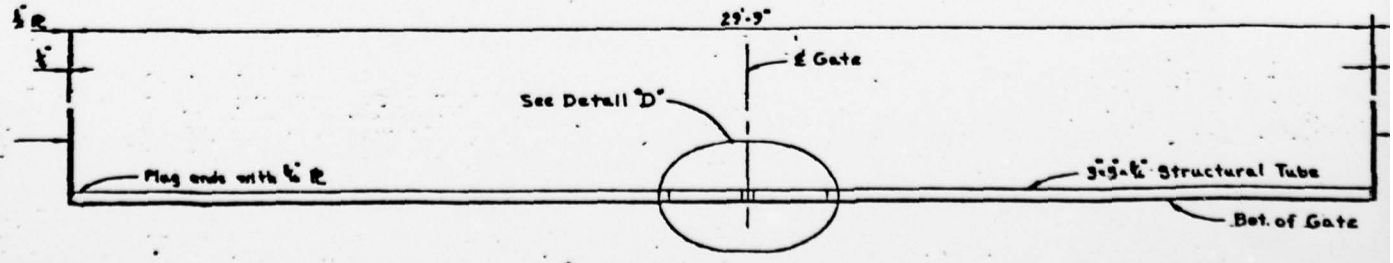
DETAIL "B"
Scale 1"=1'-0"



DETAIL "C"
Scale 1"=1'-0"



SECTION
Scale 1½"=



ELEVATION-TUBE FOR HEATING ELEMENT

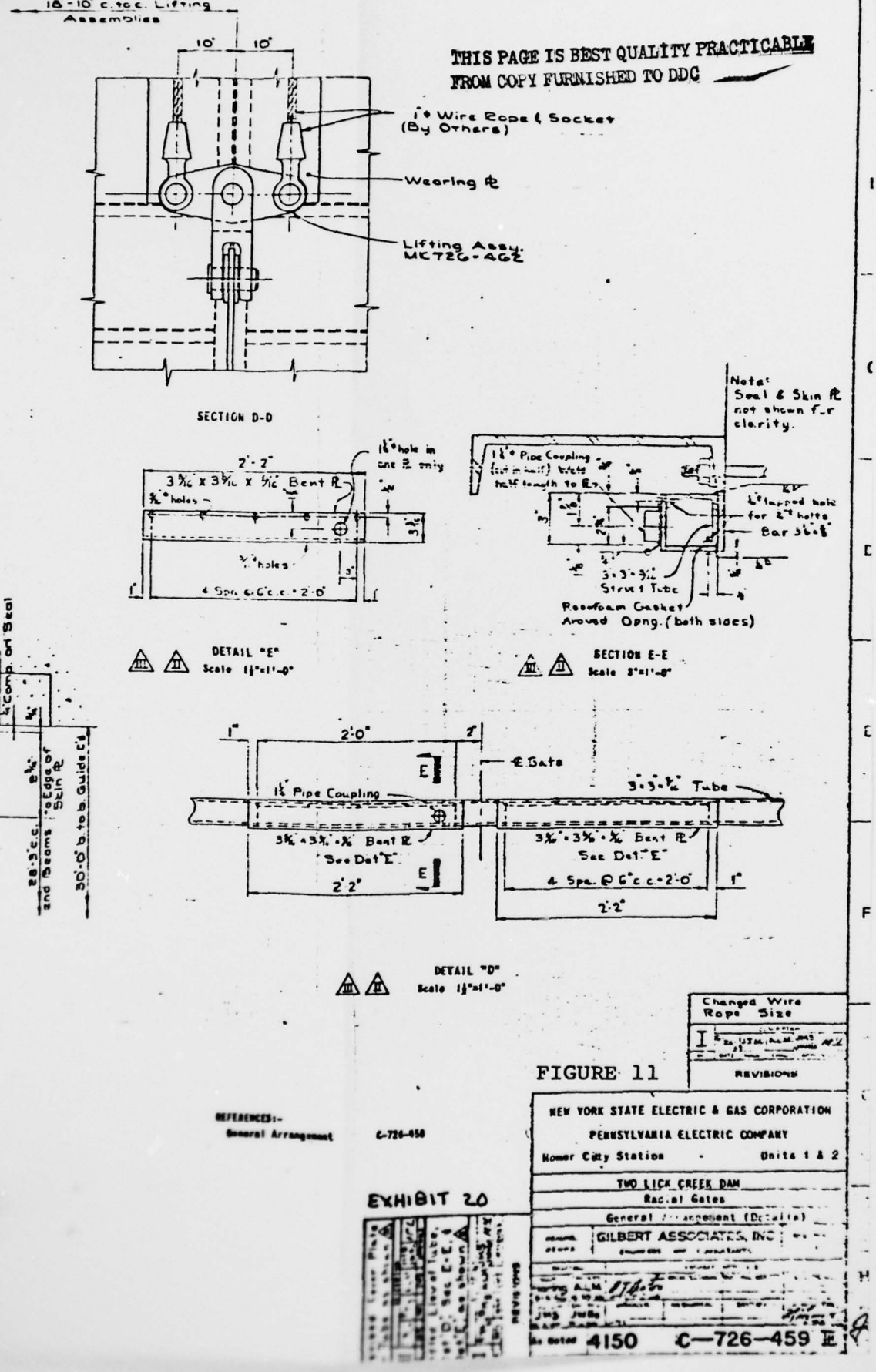


FIGURE 11

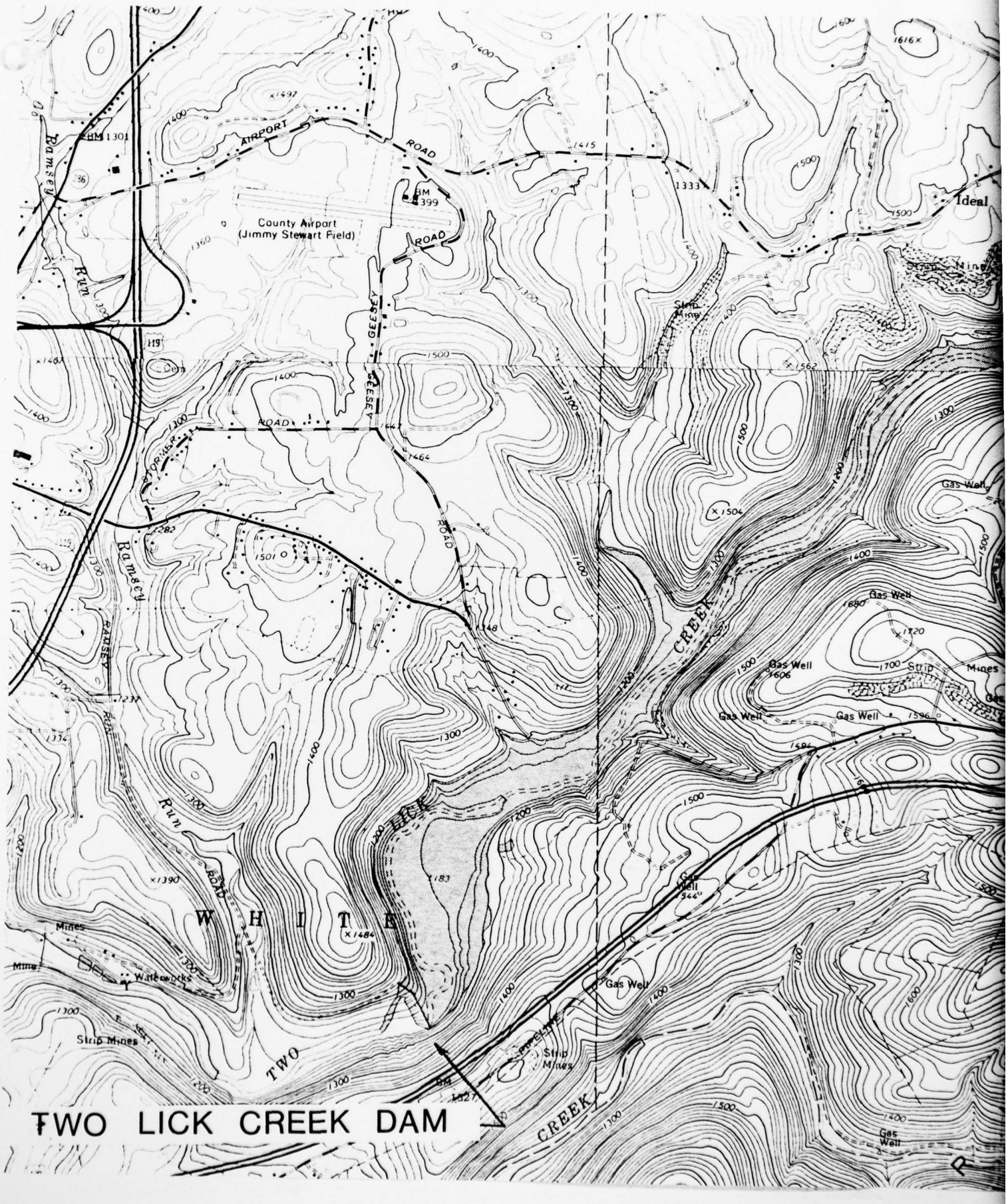
REFERENCES:-
General Arrangement C-726-458

NEW YORK STATE ELECTRIC & GAS CORPORATION
PENNSYLVANIA ELECTRIC COMPANY
Homer City Station - Units 1 & 2
TWO LICK CREEK DAM
Radial Gates
General Arrangement (Details)
GILBERT ASSOCIATES, INC
4150 C—726—459

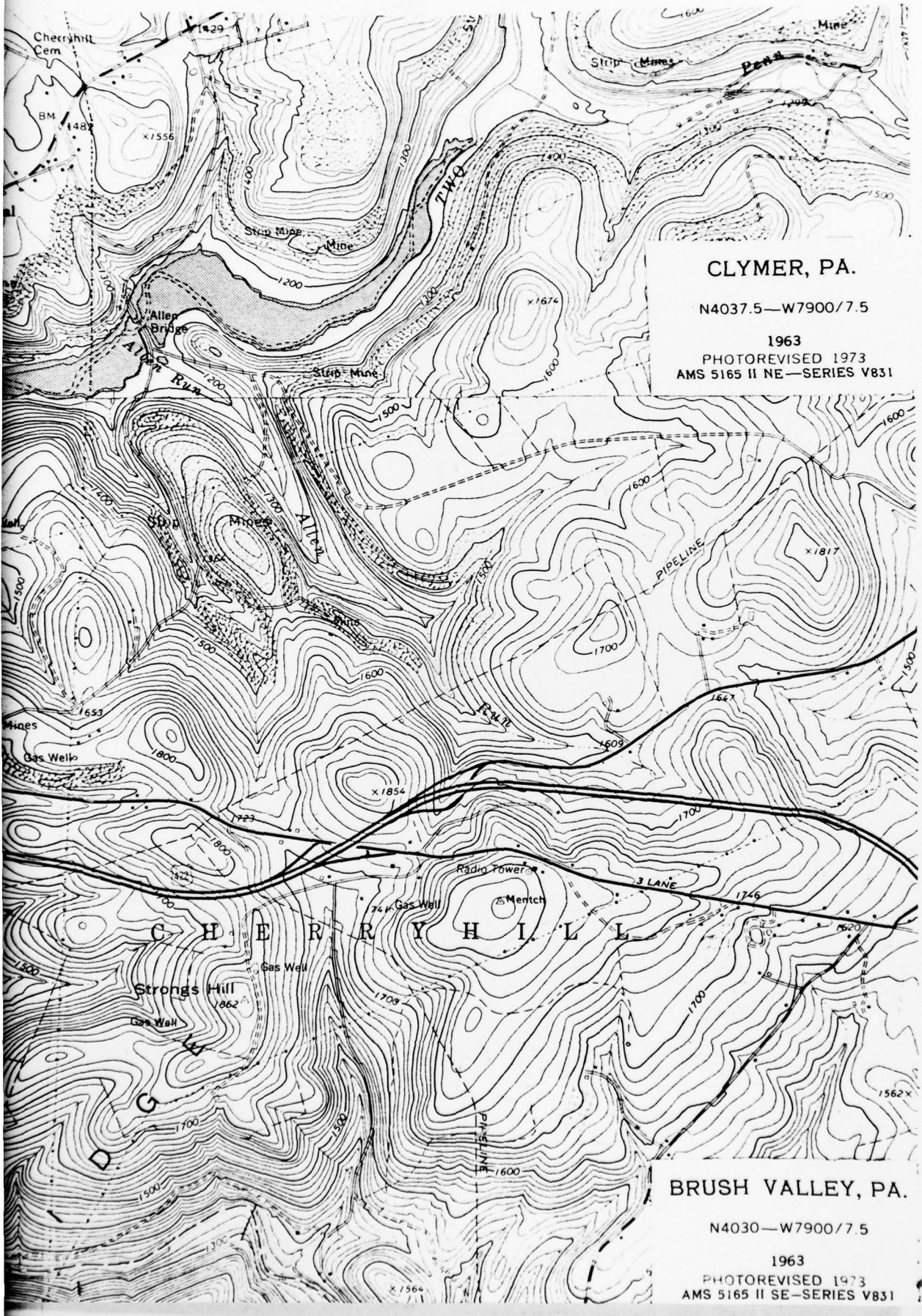
EXHIBIT 20

APPENDIX G

REGIONAL VICINITY MAP



TWO LICK CREEK DAM



CLYMER, PA.

N4037.5—W7900/7.5

1963
PHOTOREVISED 1973
AMS 5165 II NE—SERIES V831

BRUSH VALLEY, PA.

N4030—W7900/7.5

1963
PHOTOREVISED 1973
AMS 5165 II SE—SERIES V831