SUSITNA HYDROELECTRIC PROJECT

REPORT ON SPECIALIST CONSULTANTS
PANEL MEETING #5

FEBRUARY 17, 1982

Prepared by:

ACRES

ALASKA POWER AUTHORITY

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SUSITNA HYDROELECTRIC PROJECT

REPORT ON SPECIALIST CONSULTANT
PANEL MEETING NO. 5
FEBRUARY 17, 1982

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SUSITNA HYDROELECTRIC PROJECT

REPORT ON SPECIALIST CONSULTANT
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1. INTRODUCTION

Acres Specialist Consultants Panel Meeting No. 5 was held on February 17, 1982 in Buffalo. The meeting was attended by Dr. A. Hendron, Dr. R. Peck and Mr. M. Copen. Dr. Lynn Sykes was unable to attend the meeting. The objectives of this meeting were to review the project general arrangements prior to completion of the final draft feasibility report.

2. AGENDA

08:30	Introduction - J. D. Lawrence
08:45	Project general arrangements - J. D. Lawrence
09:15	Relict channel geology - S. N. Thompson
09:30	Relict channel treatment - D. W. Lamb
10:00	Reservoir level selection - J. W. Hayden
10:30	Discussion
11:00	Seismic design parameters for dams - J. D. Lawrence
11:30	Discussion
12:00	Lunch (brought in)
1:00	Watana Dam design and construction materials - D. W. Lamb
2:00	Discussion
2:30	Devil Canyon design - R. K. Ibbotson
3:00	Discussion
3:30	Wrap-up - J. D. Lawrence
4:30	Comments by panel
5:00	Adjourn

3. LIST OF ATTENDEES

Acres External Panel Members

Dr. R. Peck
Dr. A. Hendron
Mr. M. Copen
(Dr. L. Sykes was unable to attend)

3. LIST OF ATTENDEES (Cont'd)

Alaska Power Authority

R. Mohn

Acres

Dr. D. H. MacDonald
H. Eichenbaum
L. Wolofsky
I. McCaig
J. G. S. Thomson
D. C. Willett
J. D. Lawrence
J. W. Hayden
D. W. Lamb
S. N. Thompson
L. C. Duncan
R. Miller
R. K. Ibbotson

V. Singh/D. Peck - Recorders

4. INTRODUCTORY REMARKS (Speaker: J. D. Lawrence)

John Lawrence started the meeting by a welcoming address and briefly stated the objectives of the meeting. In particular, five major objectives, listed below, were outlined.

- Five Major Objectives:
  - (i) Seismic Design Parameters for Dams
  - (ii) Watana Dam Design and Construction Material
  - (iii) Devil Canyon Arch Dam Design
  - (iv) Reservoir Level Selection
  - (v) Relict Channel Treatment.

A brief description of each objective was given along with a summary report on the status of each objective.

5. PROJECT GENERAL ARRANGEMENT (Speaker: J. D. Lawrence)

First, the general arrangements for the Watana site were presented. The main features of the Watana project are main earthfill dam, underground powerhouse facilities located on the north bank, a 3-gated spillway with an emergency spillway (fuse plug type) on the north bank, a multi-level intake, and two diversion tunnels. The discussion on main dam was presented later by D. Lamb. The diversion facilities consist of an upstream cofferdam, two separate 35-ft diameter tunnels at different elevations and a downstream cofferdam. One of the tunnels will be modified into a low-level outlet during the project operation. The upstream cofferdam incorporates a slurry cutoff trench through the riverbed and an impervious core to reduce/control seepage during diversion. Gray Thomson stated that the cofferdam construction schedule was tight and that he was concerned. A discussion ensued on the aeration slots in the spillway. G. Thomson stated that a publication on Guri project in Venezuela presents an interesting discussion on slot size which are designed on the basis of model tests. Dr. Hendron had some questions about the spillway trajectory. John Hayden explained that the trajectory is aligned with the river centerline. All transformer facilities are underground.

After a discussion with APA Board, emergency spillway was widened at the inlet so that the earthen fuse plug height could be reduced. Construction should start early in 1985. The fill placement for the main dam is on critical path.

Devil Canyon general arrangements were discussed next. The main features are main arch dam, a saddle dam on the south bank, main gated spillway, emergency spillway with erodible fuse plug, underground powerhouse and multilevel intakes, diversion tunnels and a long tailrace tunnel. Additionally, seven gated openings with valves are provided in the arch dam for water release. Some questions were raised by the panel concerning the cold climate effects on the concrete in the arch dam. Acres' response was that they did not consider that to be a serious concern. Gray Thomson expressed reservations about deep vertical access shafts and preferred inclined adits. It was also suggested by the panel that a more permissive language should be used in the reports when discussing seepage cutoff, grouting and the like. No other serious questions were raised. A short discussion on construction schedule followed. It was stated that the construction of the Devil Canyon project is being pushed back.

6. <u>RELICT CHANNEL GEOLOGY</u> (Speaker: S. N. Thompson)

During a previous meeting with the APA Board in Anchorage, the question of potential for liquefaction and mitigating methods was raised. In that context, S. Thompson briefly described the geology of the relict channel and various stratigraphic units that depict different geological time and processes. Although the information available is of a limited nature, the correlations between data gathered from borings and seismic refraction surveys were developed to demonstrate that a preliminary understanding of the geology has been developed. It was pointed out that additional investigations will be conducted to further define the geology and gather more definitive data.

7. <u>RELICT CHANNEL TREATMENT</u> (Speaker: D. W. Lamb)

D. Lamb briefly described the four potential problem areas relating to the relict channel. These are (1) leakage, (2) piping, (3) permafrost, and (4) liquefaction. He stated that the first three were adequately discussed in Anchorage to the satisfaction of the APA Board; however, the question on liquefaction was still outstanding. Since then, Acres has made more detailed geologic interpretations of the area and evaluated potential alternatives. With the use of profile drawing, D. Lamb explained that the layers below layer "H" are believed to have been overconsolidated due to glacial ice loads and probably shaken by earthquakes several times under saturated conditions. Therefore, the concerns for liquefaction are more likely limited to the layers "H" and above. It was also pointed out that the normal operating reservoir level has been lowered to elevation 2185 and that the saddle dike across the relict channel would only provide freeboard during high flood conditions. An alternative was presented to deal with the liquefaction of layers above layer "H", should it be deemed necessary during future studies. This would include excavation of a trench (about 135-ft deep) and construction of an embankment within this trench. The total amount of excavation is estimated to be 30 x 10^6 cyd. It was stated that the cost of the alternative will be included in the project cost but the alternative will not be included in the design at this time. Future investigations and studies will be carried out to determine the need for it.

8. <u>RESERVOIR SELECTION STUDY</u> (Speaker: J. W. Hayden)

J. Hayden stated that the economic study was done on the reservoir level selection which indicated that the project economics will not change significantly if the reservoir level is lowered to elevation 2115 ft. Such a lowering will result in 50-million dollar loss of energy and 100-million dollar reduction in the cost. Panel made a comment that in that case it may be more desirable to lower the dam rather than pay the cost penalty which will also reduce the potential of liquefaction in the relict channel. However, there were other considerations including emergency spillway fuse plug and use of excess energy produced by the project. Given all these constraints, a normal operating reservoir level of 2185 was selected by Acres. There were no further discussions on this subject.

9. <u>SEISMIC DESIGN PARAMETERS FOR DAMS</u> (Speaker: J. D. Lawrence)

J. Lawrence described that after discussions with the APA panel, Acres has adopted the deterministic approach for the seismic design of the dams. The Watana Fill Dam will be designed using time history analysis for a Benioff Zone magnitude 8.5 event. Devil Canyon arch dam will be designed using response spectrum approach and trial load method of analysis. For this approach, the ground motions generated by a terrain earthquake of magnitude 6 to 6-1/4 near the site will be more severe than Benioff Zone earthquake. It was further stated that Dr. Seed believes the design of arch dam should be done for a Safety Evaluation Earthquake; however, the input motion in the analysis should be reduced to 0.8 of its peak value to compensate for the limitations in analytical procedures. This will be consistent with design approaches used on other important projects of similar critical nature. It was also stated that the design will be done for the 84th percentile ground motion for the Benioff Zone events and 80th percentile for the terrain events. There were some concerns raised by the panel as to the validity of reduction of ground motion to 80 percent and the use of a 10-percent damping in the concrete. Mr. Copen stated that he felt this was quite acceptable. It was further stated there were still some questions about the magnitude of the terrain earthquake to be used. Dr. Sykes believes that the magnitude should be 6-1/4 to 6-1/2, whereas WCC maintain that magnitude 6 should be an upper limit. APA panel in Anchorage stated that the design should be based on

6-1/4 magnitude. Some discussion took place about 1943 event which is magnitude 7.3. It was a general concensus that this event is probably related to a fault remote from the dam sites and that it was, in light of WCC's findings, not critically important to locate that fault.

10. WATANA DAM DESIGN AND CONSTRUCTION MATERIAL (Speaker: D. W. Lamb)

D. Lamb presented the design of Watana fill dam. The key features of this dam are central impervious core, wide u/w and d/s filters, a relatively free draining u/s shell and provisions for the grout curtain and the drainage curtain. The foundation treatment includes provisions for removal of all the overburden under the dam, weathered loose rock under the shells and excavation to sound rock under the core and the filters. Some discussion centered around the excavation volumes and philosophy and panel indicated that in its view too much rock was being excavated. It was clarified that up to 40 ft of rock excavated under the core and the filters included allowance for shaping for foundation, cleaning and preparation of deep gullies filled with weathered rock and overburden and allowances for the shear zones. The dam cross section used in the presentation did not show a filter blanket under the d/s shell and it was pointed out this will be shown on the final drawings. Panel stated that the arguments to have drainage galleries under the dam were not very convincing in the text although it did not object to having such galleries should there be need for them.

The proposed slopes of the dam are 2:4H:1V u/s and 2H:1V d/s. These slopes, particularly the u/s slope, may be revised during the final design phase. The u/s shell will be constructed using processed gravel/cobbles from the riverbed with minimum size of 1/2 in. to 3/4 in. and maximum size equal to 1/2 the lift thickness (lift thickness 36 inches). Panel indicated that normally the maximum size allowed is equal to 2/3 to full thickness of lift. For the core material, some questions were raised about the moisture content. Panel believes that it is not critical if the maximum density is not achieved during compaction. Some questions were raised about the availability of the material and related environmental concerns for mining of gravels/cobbles from the riverbed. It was stated that sufficient reserves have been located for the dam construction.

It was pointed out that allowance was made for post-construction settlement (1 percent of height) and slumping during seismic event (0.5 percent of height).

11. WATANA DAM EARTHQUAKE ANALYSIS (Speaker: A. S. Burgess)

A. Burgess presented results of earthquake analysis. The dam geometry analyzed included 2:4H:1V slopes upstream and 2H:1V slopes downstream. Two cases were anzlyzed: one with a soft core (K2 = 200) and one with a stiffer core (K2 = 700). The material properties were selected using data from the Oroville dam analysis. The properties for other materials were discussed. At the end of construction, some arching was noticed when soft core properties were used and almost no significant arching when stiffer core properties were used. The effective stresses in upstream shell were much smaller than those in downstream shell and shear stresses were also low in the upstream shell. Effective stresses in core were about 1/2 of the overburden load. The time history used in the analysis had a maximum peak acceleration of 0.55g and length of record between 10 sec and 30 sec. Three iterations were used and a good convergence achieved between second and third iterations. The maximum acceleration at the crest was 0.36g for the soft core and 0.39g for the stiff core. The dynamic shear stresses were within shear strength except in top of core and shallow depths in shell indicated some ravelling of slopes may occur. However, no large scale failure was indicated. The pore pressures in the upstream shell would dissipate. For the final design, slopes steeper than those used in this analysis will be investigated.

12. DEVIL CANYON ARCH DAM DESIGN (Speaker: R. K. Ibbotson)

Arch dam analysis was done using response spectra and trial load method of analysis. Program ADSAS was used. Response spectra representing maximum terrain earthquake was used. Critical damping for the concrete was 10 percent and the maximum acceleration was reduced to 80 percent of its value to obtain input motion for the analysis. The resulting stresses were discussed and found to be acceptable. It was discussed that greater arching effect can be obtained by shortening the radius but the gains were small. The stresses in cantilever portion were not too high. The natural period of the dam is between 0.14 and 0.5 seconds. The results indicated the dam to be safe under earthquake loading conditions.

13. ROCK MECHANICS CONSIDERATIONS (Speaker: S. N. Thompson)

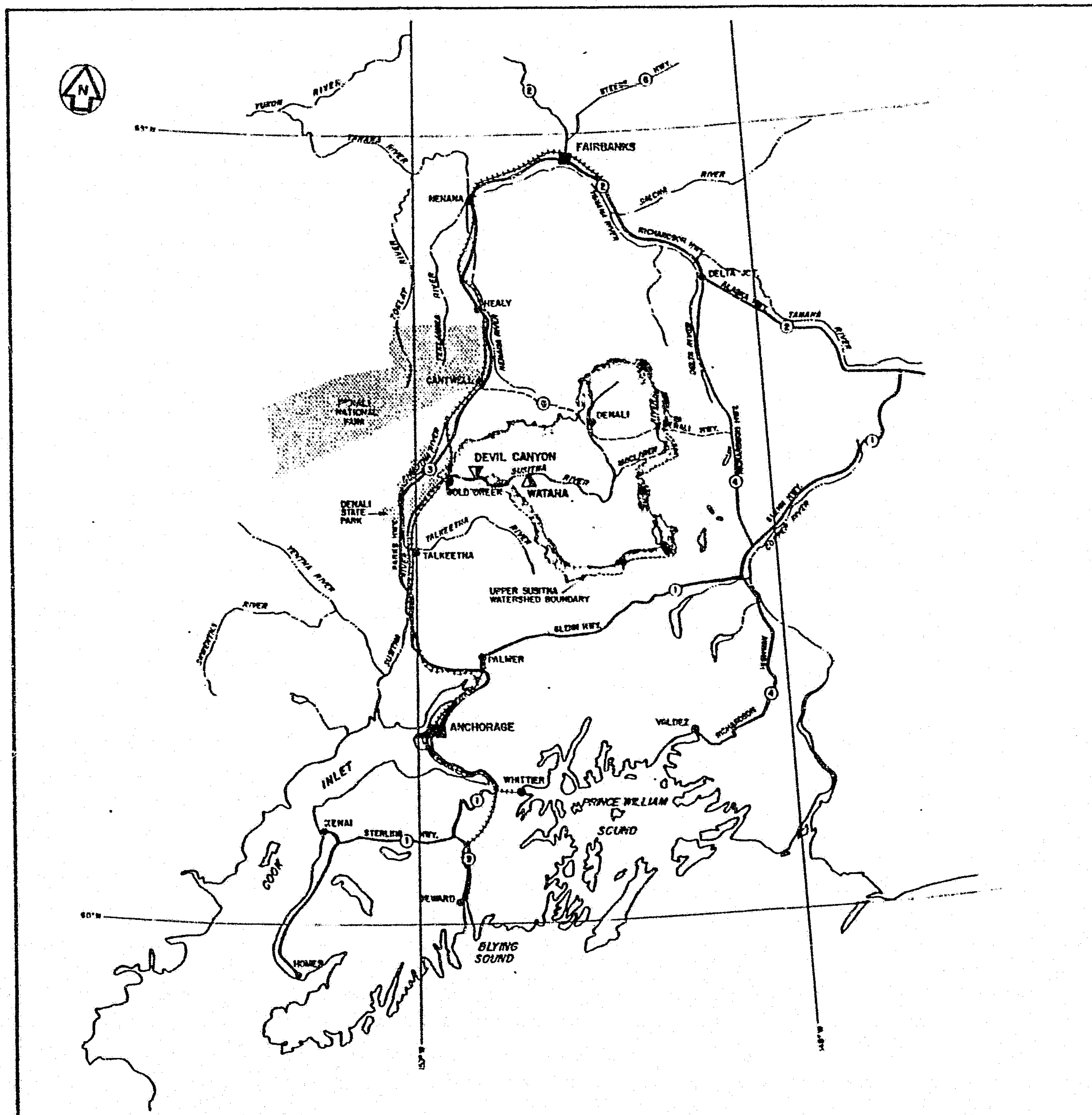
A discussion took place about rock mechanics considerations at both the sites. The d/s portals for the diversion tunnel is in favorable location. At the intake, the main problem is joint set II which is about 20 degrees oblique. The cut is about 200 ft. high and needs to be minimized. The cut is outside the shear zone and thus increases its height. The rock cuts are high and may have stability problems. Additional investigations will be required and the money should be included in the cost.

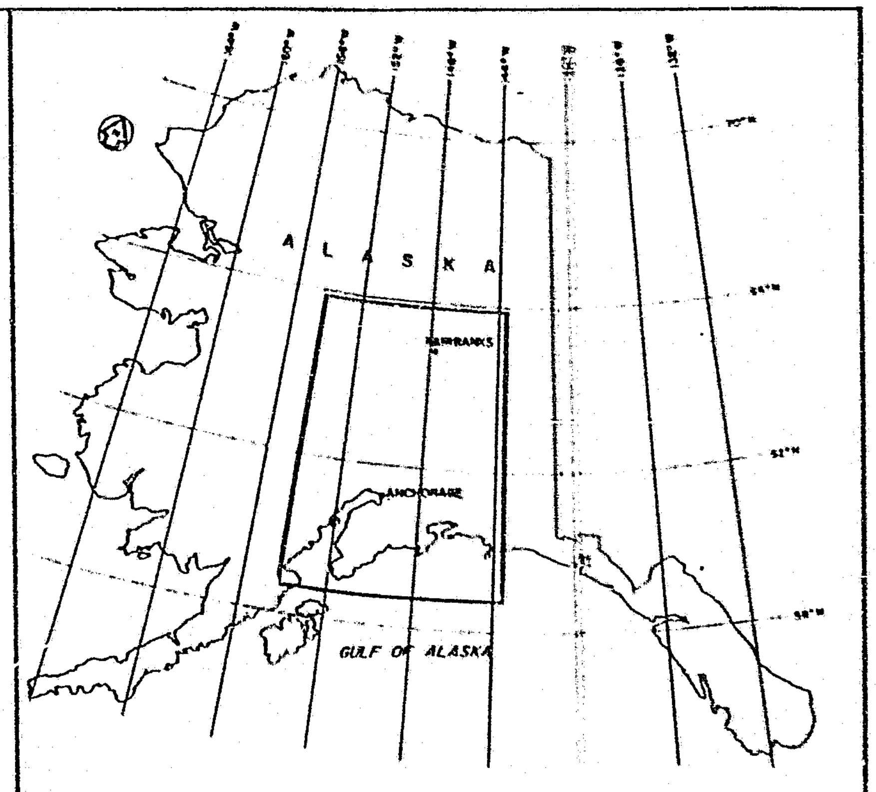
At the Devil Canyon site, major joint set I perpendicular to the main spillway cut and the secondary set is sub-parallel. The high cuts for the spillway channel are laid back along the bedding planes. Joint sets are favorable on that side for the tunnel. Joint set III is very localized.

Prepared by ______________________

VS/jh

14. PRESENTATION BY J. D. LAWRENCE





KEY MAP

LEGEND

- PRIMARY PAVED UNDIVIDED HIGHWAY
- SECONDARY PAVED UNDIVIDED HIGHWAY
- SECONDARY GRAVEL HIGHWAY
- RAILROAD
- RIVER

SCALE 0 20 40 MILES

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RAILBELT AREA

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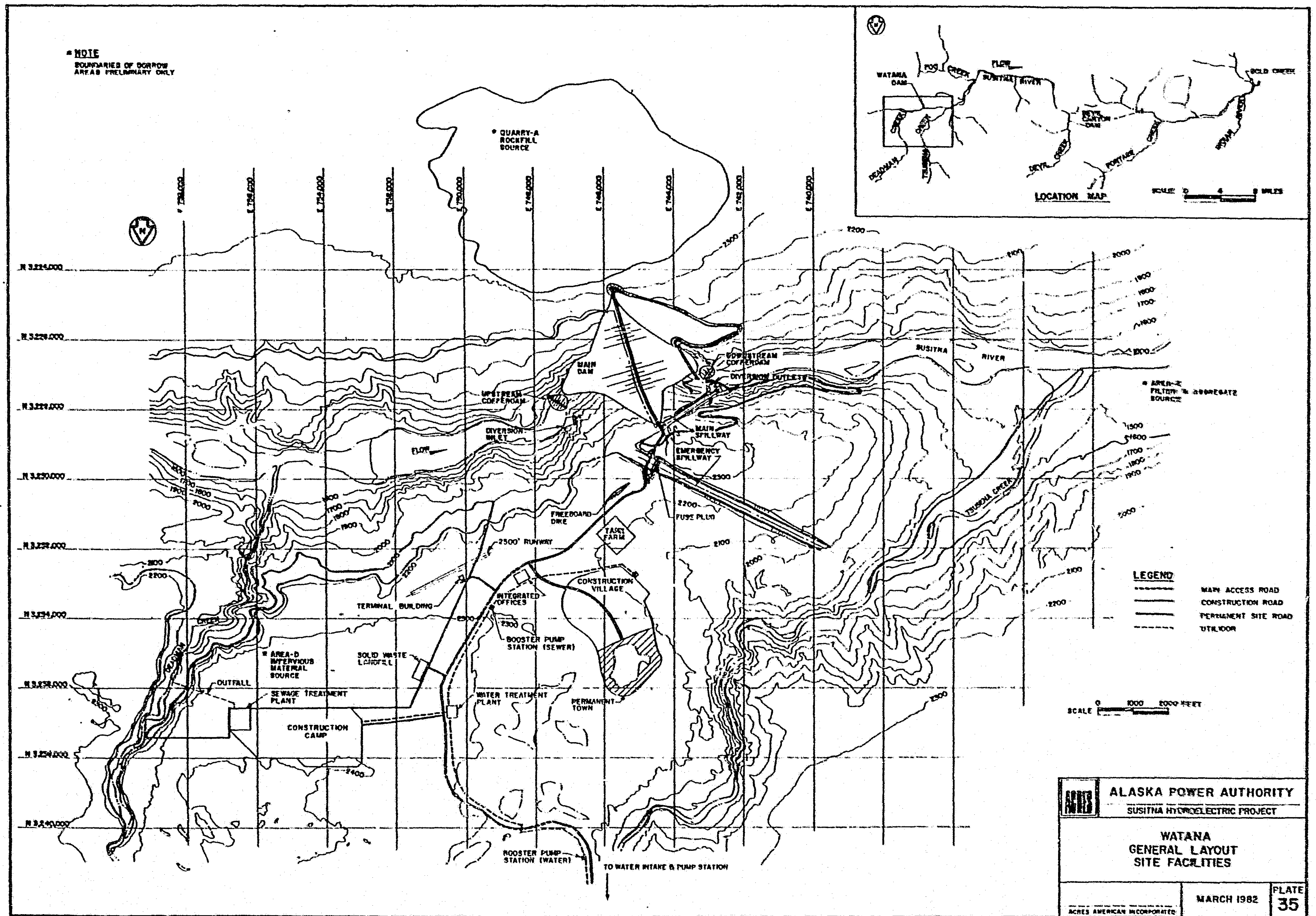

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SUSITNA HYDROELECTRIC PROJECT

WATANA
GENERAL LAYOUT
SITE FACILITIES

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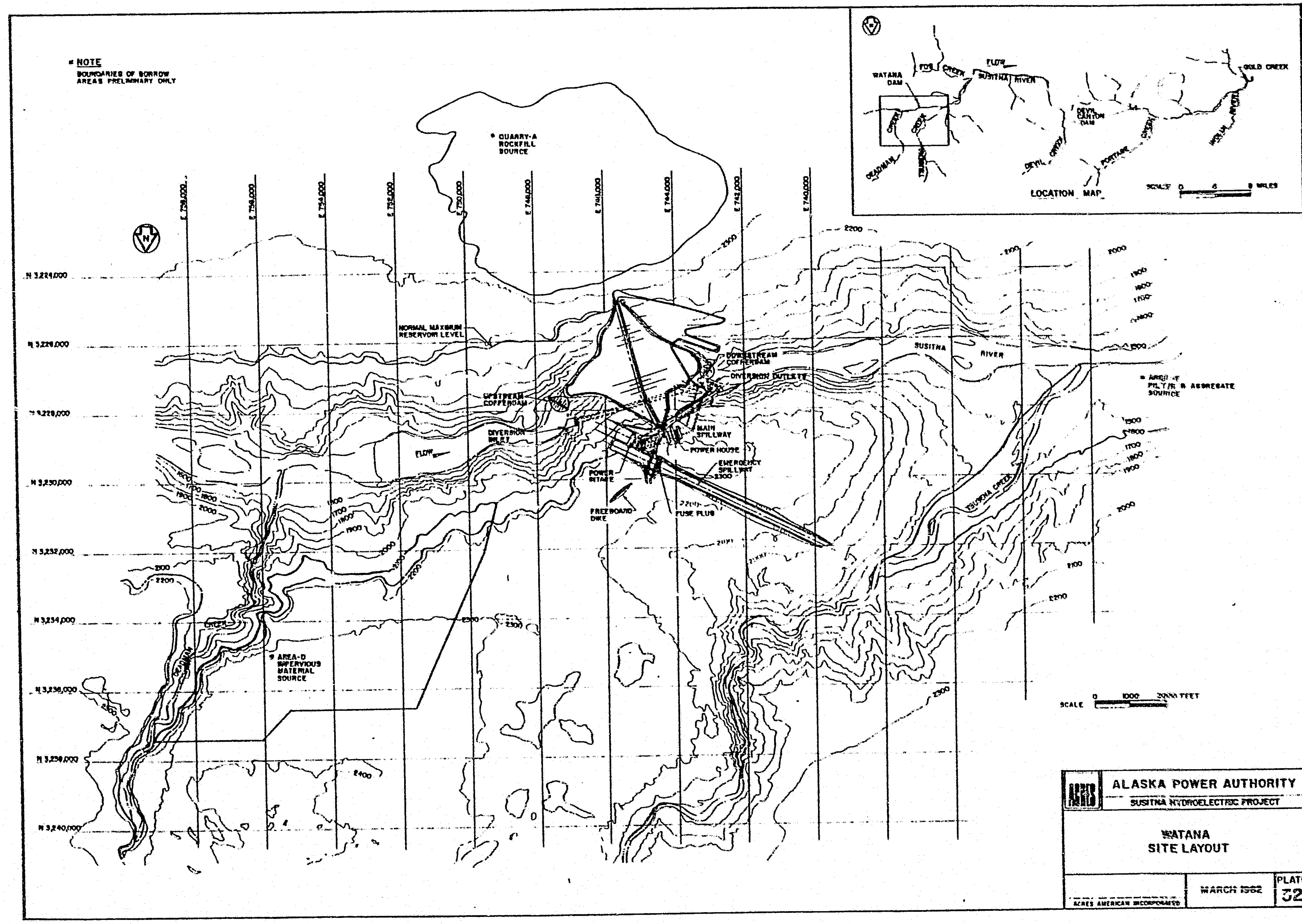
MARCH 1982

PLATE 35


* NOTE
BOUNDARIES OF BORROW AREAS PRELIMINARY ONLY
* QUARRY-A ROCKFILL SOURCE
NORMAL MAXIMUM RESERVOIR LEVEL
UPSTREAM COFFERDAM
DOWNSTREAM COFFERDAM
DIVERSION OUTLETS
DIVERSION INLETS
MAIN SPILLWAY
POWER HOUSE
EMERGENCY SPILLWAY
POWER INTAKE
FREEBOARD DIKE
FUSE PLUG
FLOW
SUSITNA RIVER
TSUSENA CREEK
* AREA-D IMPERVIOUS MATERIAL SOURCE
SCALE 0 1000 2000 FEET
LOCATION MAP
WATANA DAM
DEVIL CANYON DAM
GOLD CREEK
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
SITE LAYOUT
MARCH 1982
PLATE 32
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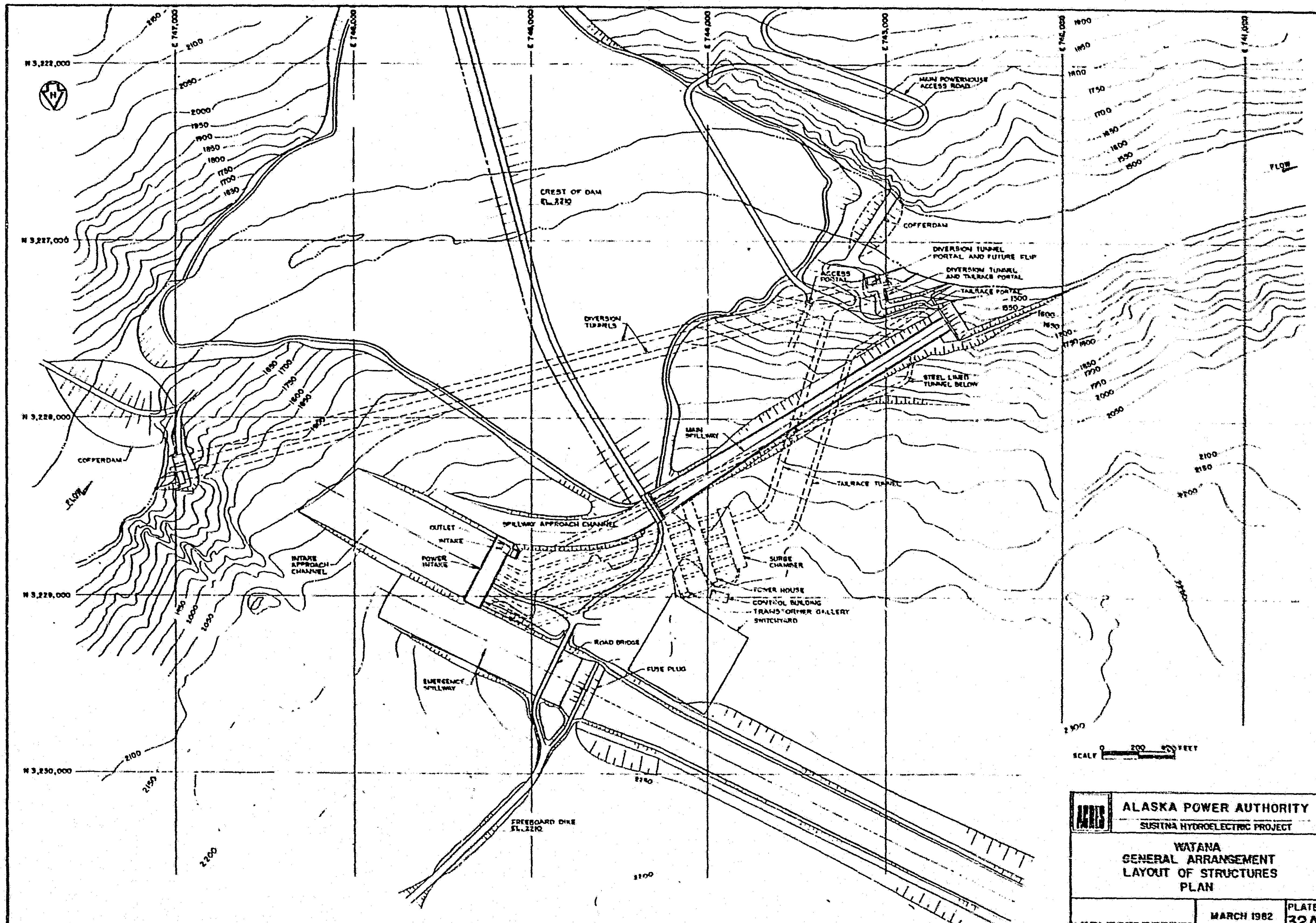

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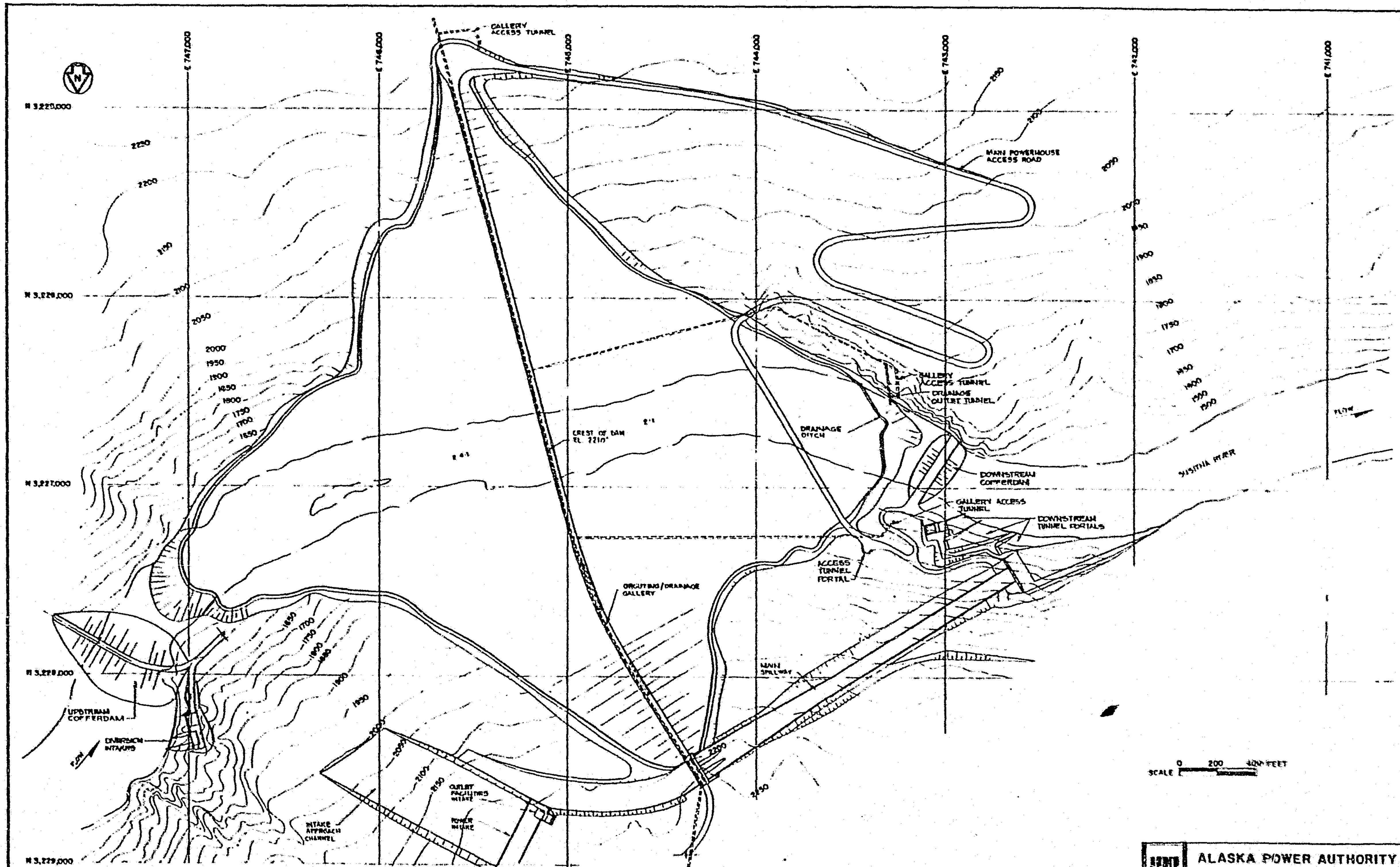
N 3,227,000
N 3,228,000
N 3,229,000
N 3,230,000
E 747,000
E 746,000
E 745,000
E 744,000
E 743,000
E 742,000
E 741,000
MAIN POWERHOUSE ACCESS ROAD
FLOW
CREST OF DAM EL. 2210
COFFERDAM
DIVERSION TUNNEL PORTAL AND FUTURE FLIP
DIVERSION TUNNEL AND TAILRACE PORTAL
TAILRACE PORTAL
ACCESS PORTAL
DIVERSION TUNNELS
STEEL LINED TUNNEL BELOW
MAIN SPILLWAY
TAILRACE TUNNEL
SPILLWAY APPROACH CHANNEL
OUTLET
INTAKE
POWER INTAKE
INTAKE APPROACH CHANNEL
SURGE CHAMBER
POWER HOUSE
CONTROL BUILDING
TRANSFORMER GALLERY
SWITCHYARD
ROAD BRIDGE
FUSE PLUG
EMERGENCY SPILLWAY
FREEBOARD DIKE EL. 2210
SCALE 0 200 400 FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
GENERAL ARRANGEMENT
LAYOUT OF STRUCTURES
PLAN
ACRES AMERICAN INCORPORATED
MARCH 1982
PLATE 32A



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WATANA MAIN DAM PLAN

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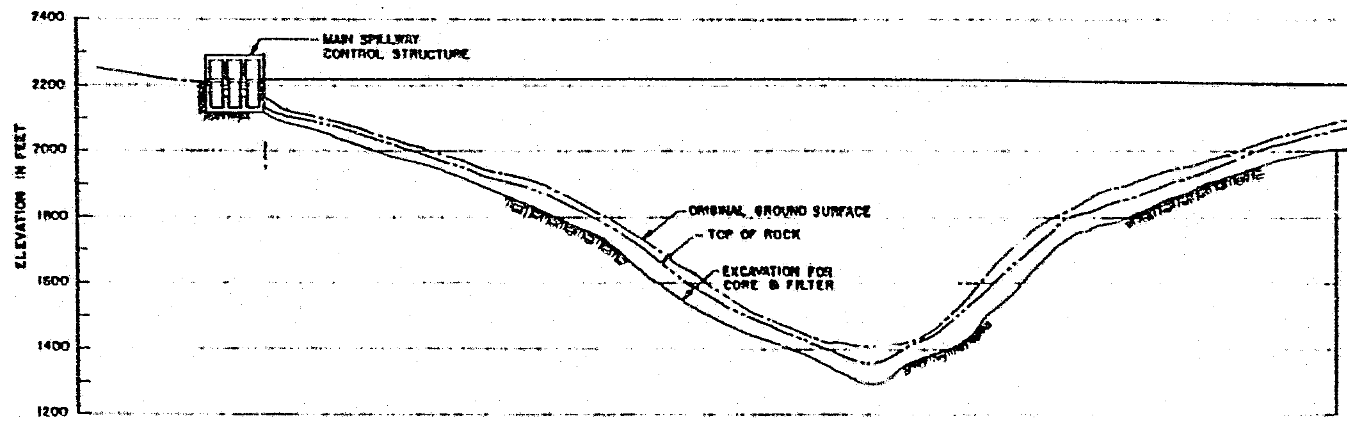
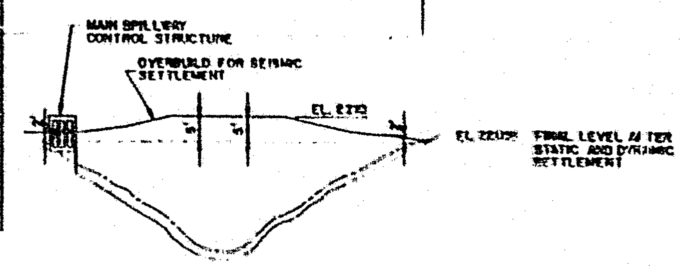
MARCH 1982

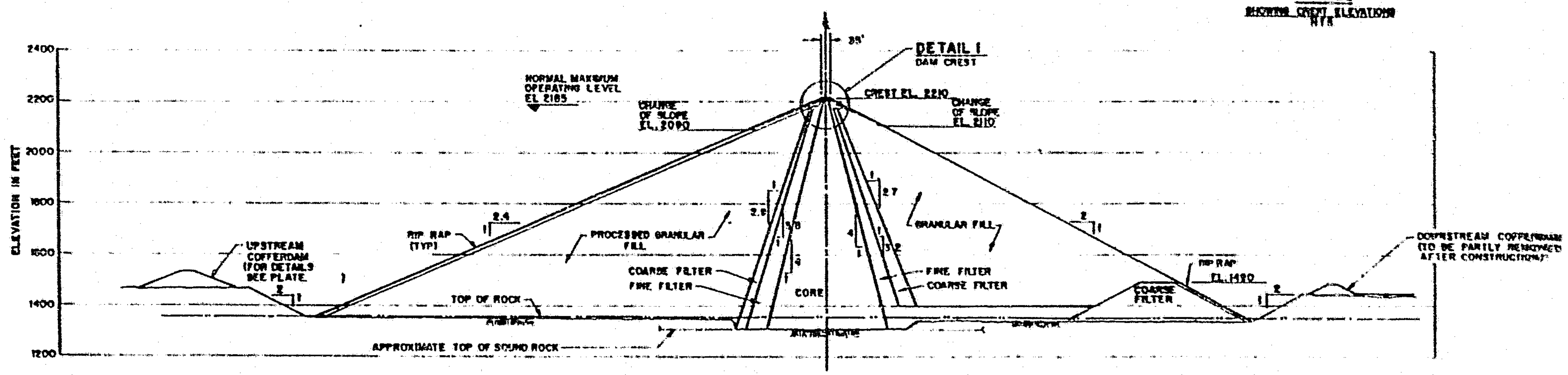
PLATE 44



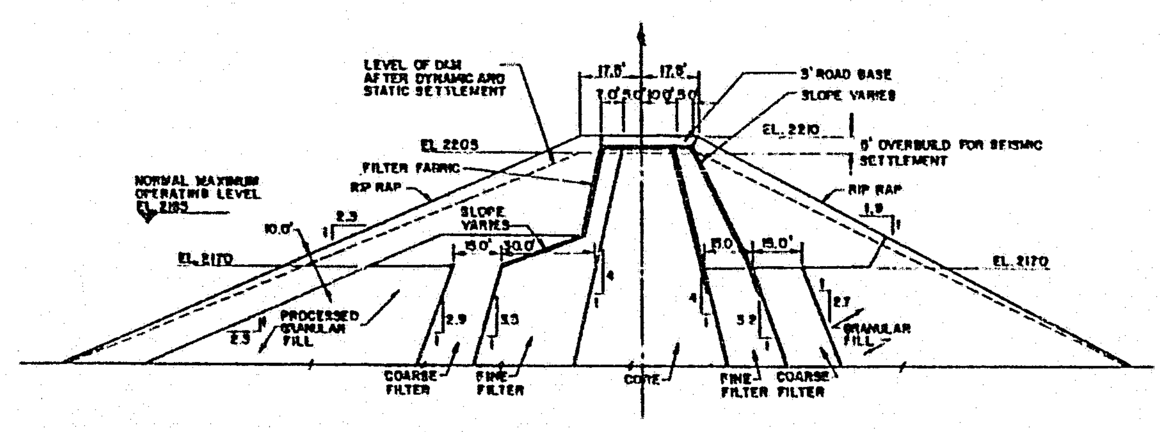
PROFILE (LOOKING UPSTREAM)
SCALE: A



PROFILE
SHOWING CREST ELEVATIONS
NTS



SECTION THROUGH MAIN DAM
AT MAXIMUM HEIGHT
SCALE A



DETAIL 1
CREST AT MAXIMUM HEIGHT SECTION
SCALE B

SCALE B 0 20 40 FEET
SCALE A 0 200 400 FEET

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SUSITNA HYDROELECTRIC PROJECT

WATANA
MAIN DAM
SECTIONS

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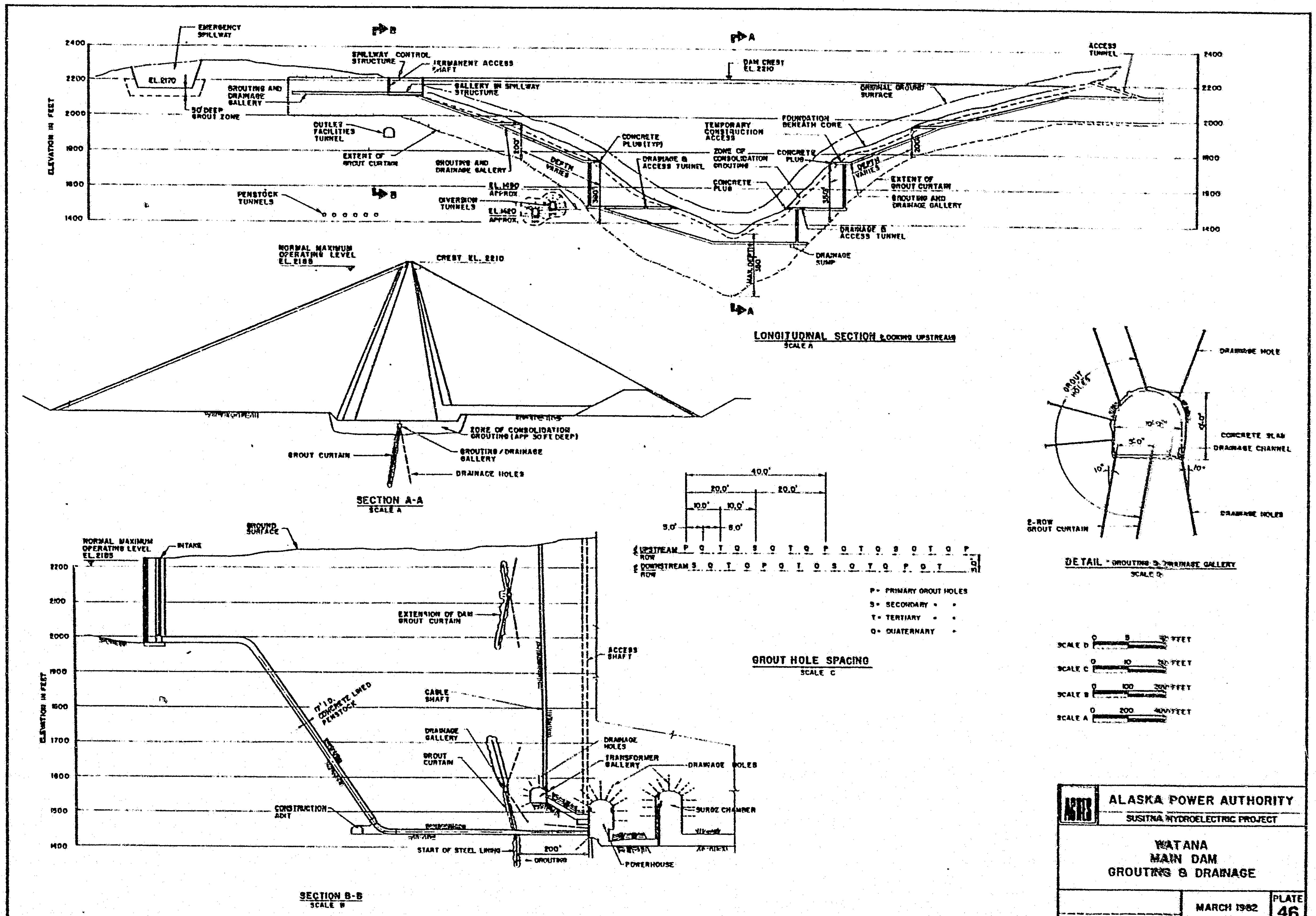

EMERGENCY SPILLWAY
EL. 2170
50' DEEP GROUT ZONE
SPILLWAY CONTROL STRUCTURE
PERMANENT ACCESS SHAFT
GALLERY IN SPILLWAY STRUCTURE
GROUTING AND DRAINAGE GALLERY
DAM CREST EL. 2210
ORIGINAL GROUND SURFACE
ACCESS TUNNEL
OUTLET FACILITIES TUNNEL
EXTENT OF GROUT CURTAIN
GROUTING AND DRAINAGE GALLERY
CONCRETE PLUG (TYP)
DRAINAGE & ACCESS TUNNEL
TEMPORARY CONSTRUCTION ACCESS
ZONE OF CONSOLIDATION GROUTING
FOUNDATION BENEATH CORE
CONCRETE PLUG
DEPTH VARIES
EXTENT OF GROUT CURTAIN
GROUTING AND DRAINAGE GALLERY
DRAINAGE & ACCESS TUNNEL
DRAINAGE SUMP
MAX. DEPTH 340'
PENSTOCK TUNNELS
DIVERSION TUNNELS
EL. 1490 APPROX.
EL. 1420 APPROX.
ELEVATION IN FEET
LONGITUDINAL SECTION LOOKING UPSTREAM
SCALE A
NORMAL MAXIMUM OPERATING LEVEL EL. 2185
CREST EL. 2210
ZONE OF CONSOLIDATION GROUTING (APP. 30 FT DEEP)
GROUTING / DRAINAGE GALLERY
GROUT CURTAIN
DRAINAGE HOLES
SECTION A-A
SCALE A
GROUT HOLES
DRAINAGE HOLE
CONCRETE SLAB
DRAINAGE CHANNEL
DRAINAGE HOLES
2-ROW GROUT CURTAIN
DETAIL - GROUTING & DRAINAGE GALLERY
SCALE D
40.0'
20.0'
10.0'
5.0'
UPSTREAM ROW
DOWNSTREAM ROW
P = PRIMARY GROUT HOLES
S = SECONDARY
T = TERTIARY
Q = QUATERNARY
GROUT HOLE SPACING
SCALE C
SCALE D
SCALE C
SCALE B
SCALE A
NORMAL MAXIMUM OPERATING LEVEL EL. 2185
INTAKE
GROUND SURFACE
EXTENSION OF DAM GROUT CURTAIN
ACCESS SHAFT
CABLE SHAFT
17' I.D. CONCRETE LINED PENSTOCK
DRAINAGE GALLERY
GROUT CURTAIN
DRAINAGE HOLES
TRANSFORMER GALLERY
DRAINAGE HOLES
SURGE CHAMBER
CONSTRUCTION ADIT
START OF STEEL LINING
200'
GROUTING
POWERHOUSE
SECTION B-B
SCALE B
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
MAIN DAM
GROUTING & DRAINAGE
MARCH 1982
PLATE
46
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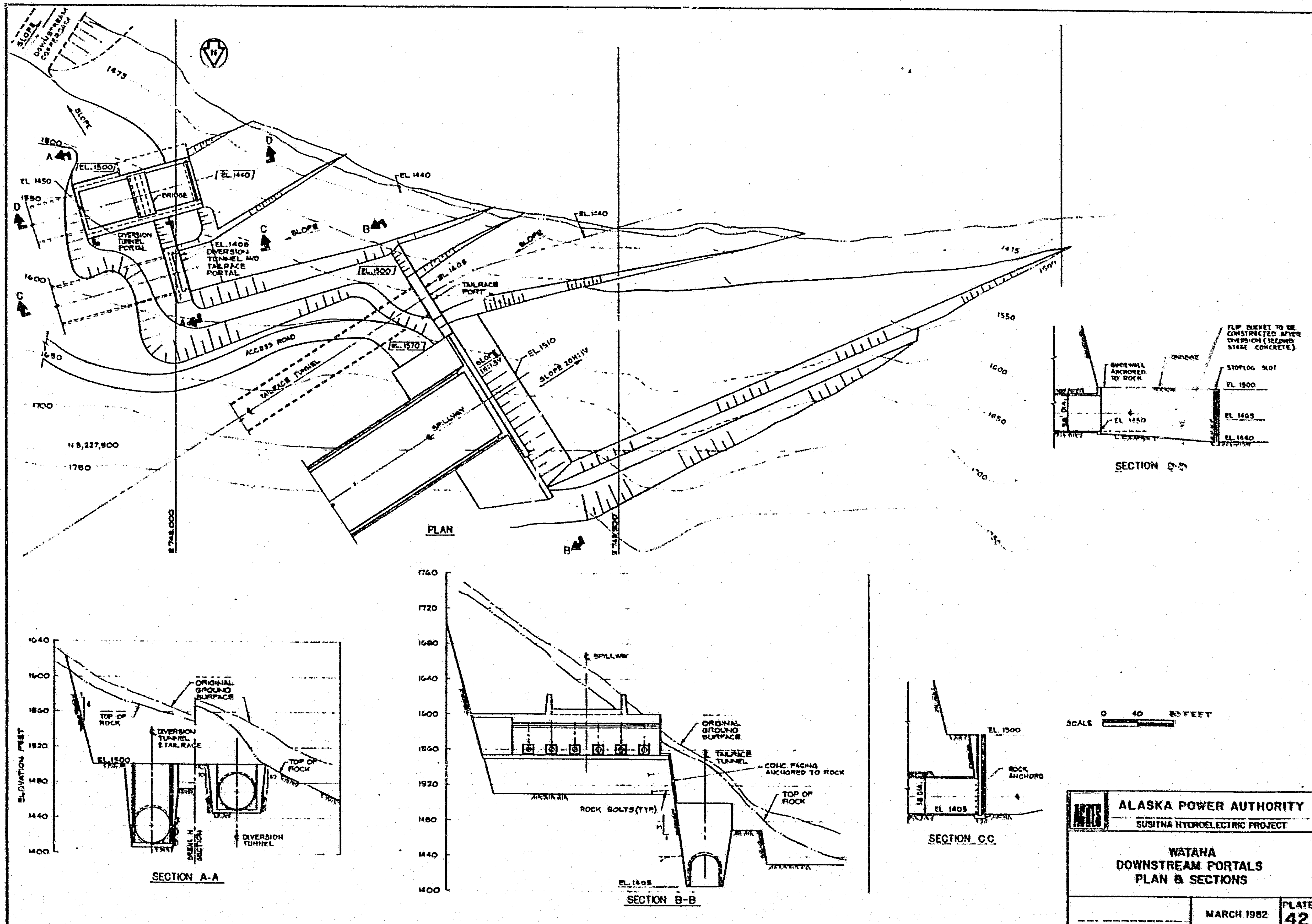

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WATANA DOWNSTREAM PORTALS PLAN & SECTIONS

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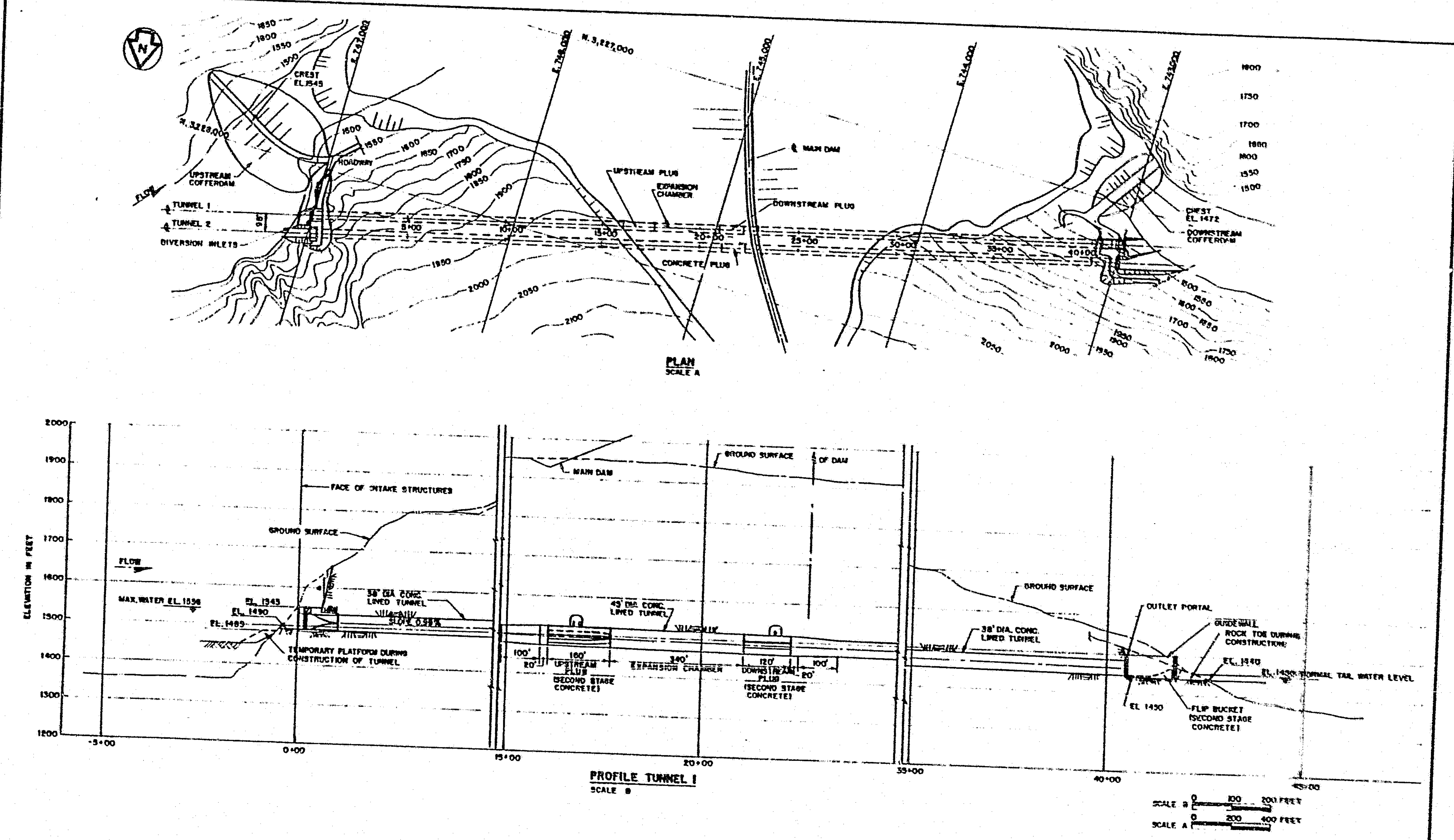
PLATE 42



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WATANA
DIVERSION
GENERAL ARRANGEMENT

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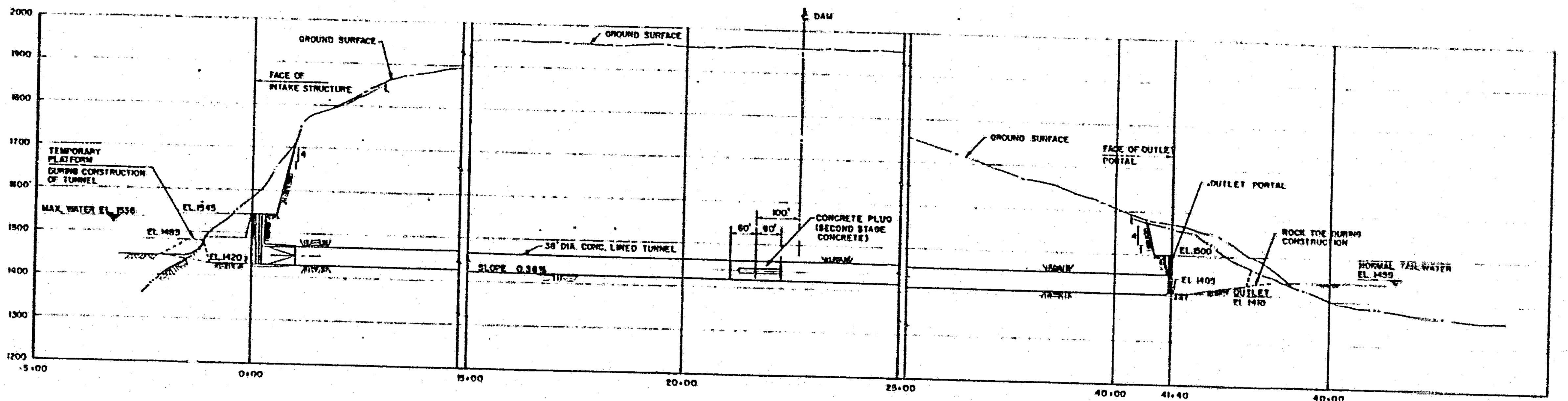
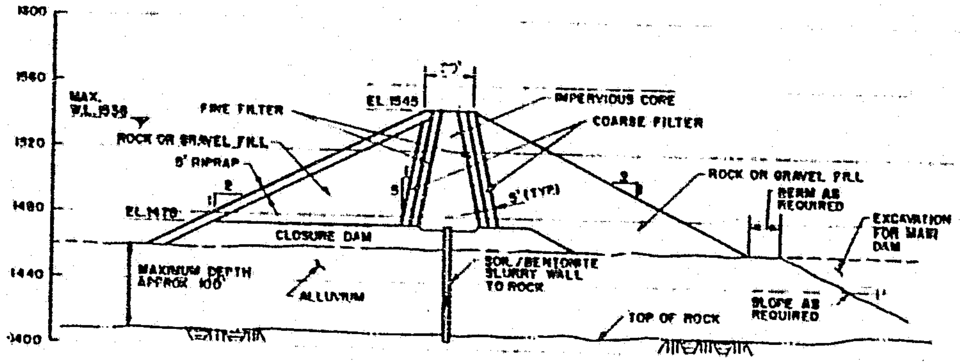
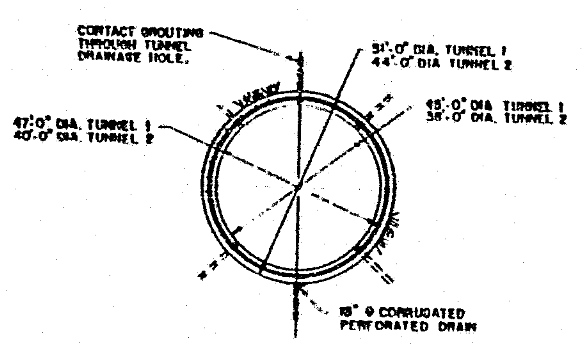
PLATE 39



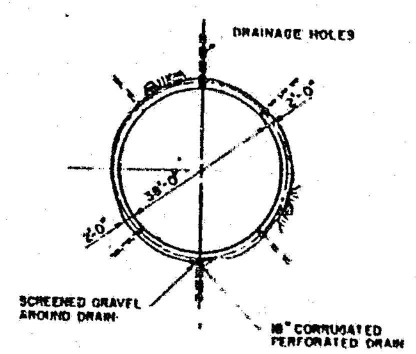
PROFILE - TUNNEL 2
SCALE A



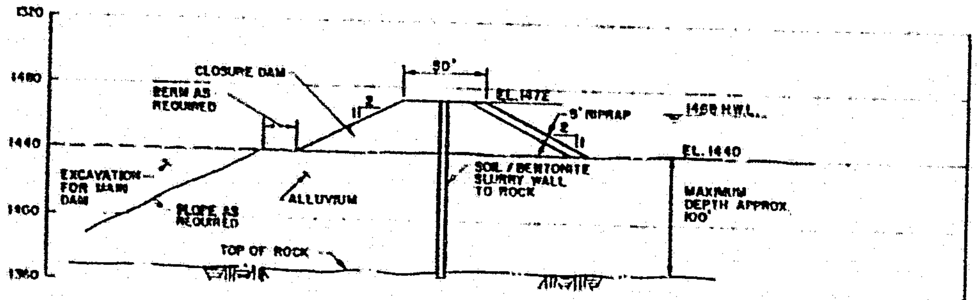
WATANA UPSTREAM COFFERDAM
SCALE B



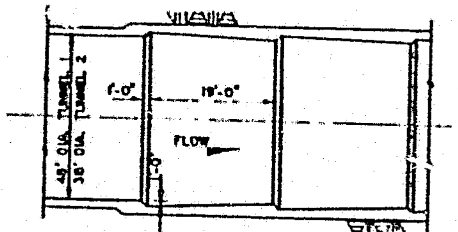
CROSS SECTION AT PLUG (TYPICAL)
NTS



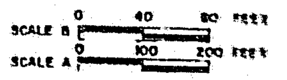
TYPICAL CROSS SECTION
NTS



WATANA DOWNSTREAM COFFERDAM
SCALE B



SECTION ALONG ℄ OF TUNNEL AT PLUG LOCATION
NTS



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SUSITNA HYDROELECTRIC PROJECT

WATANA DIVERSION SCHEME SECTIONS

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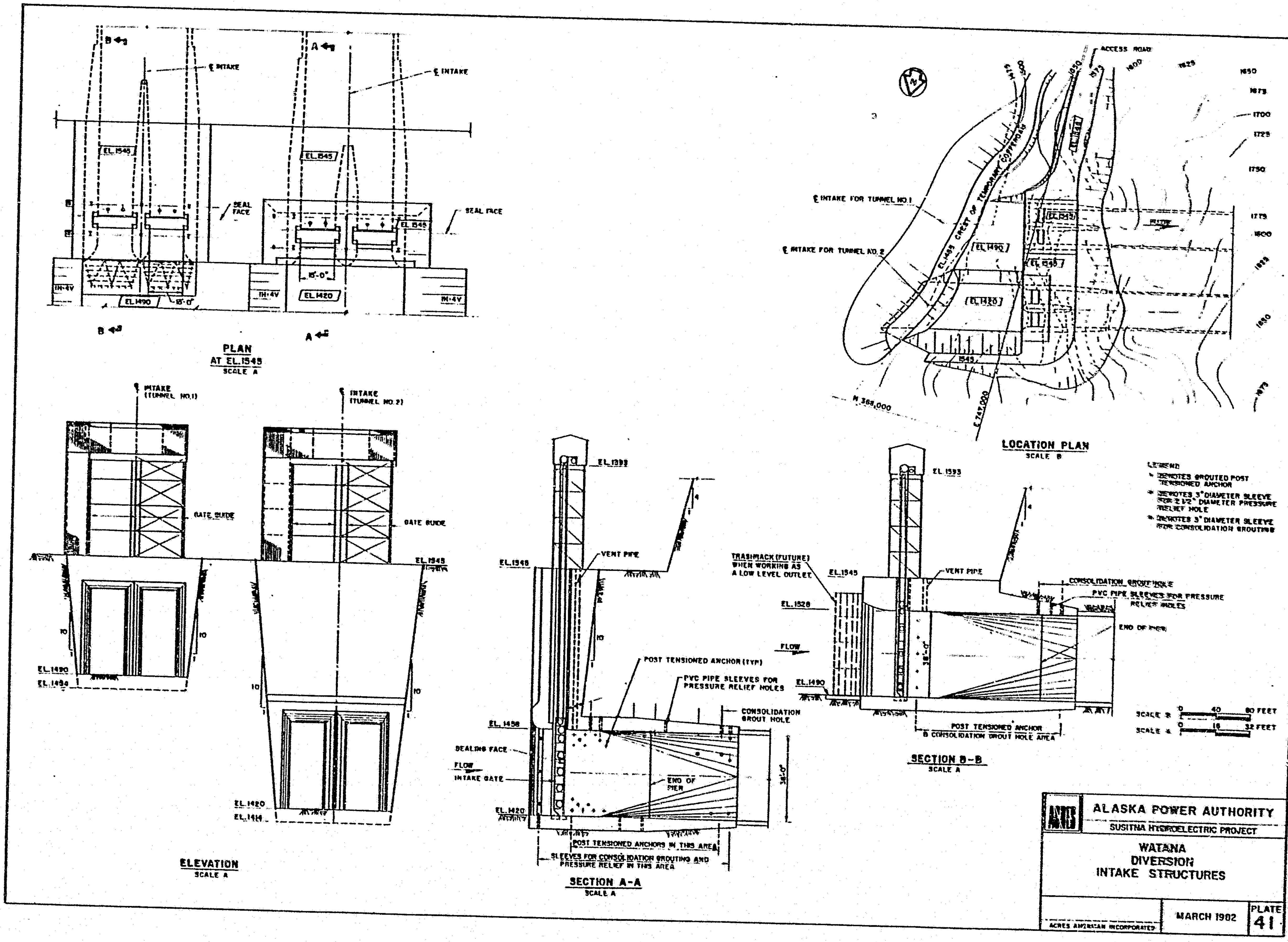
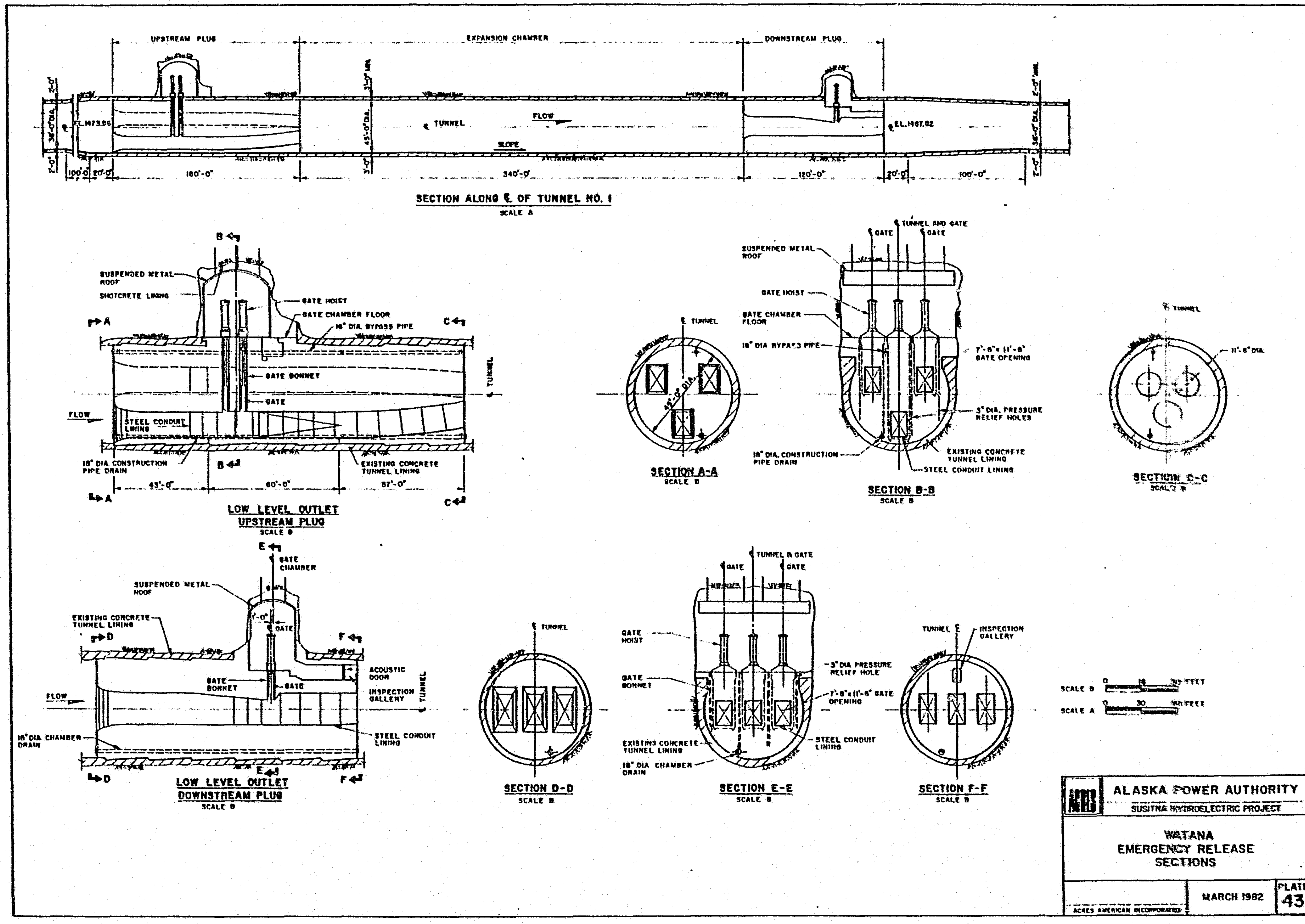
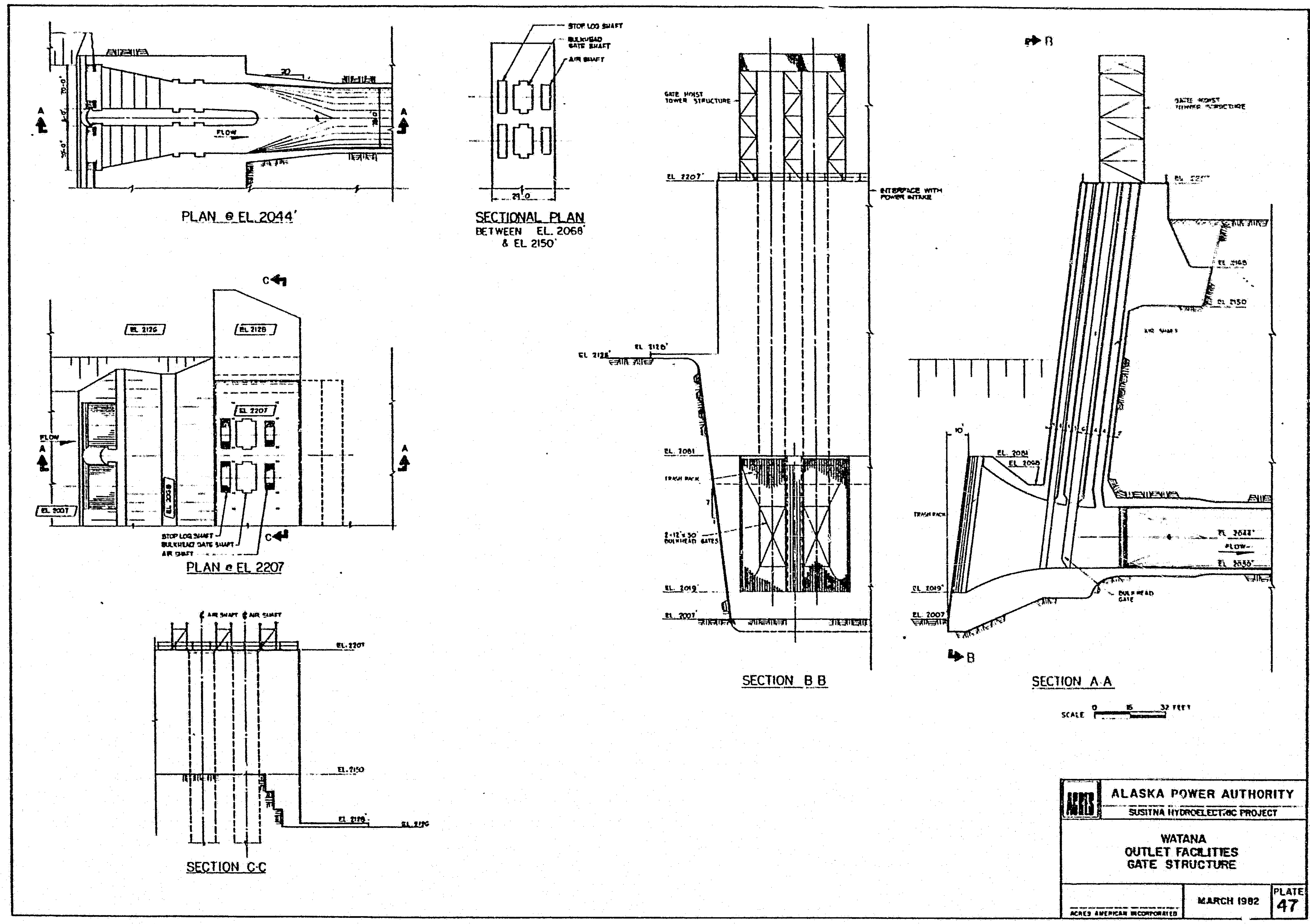
PLATE 40



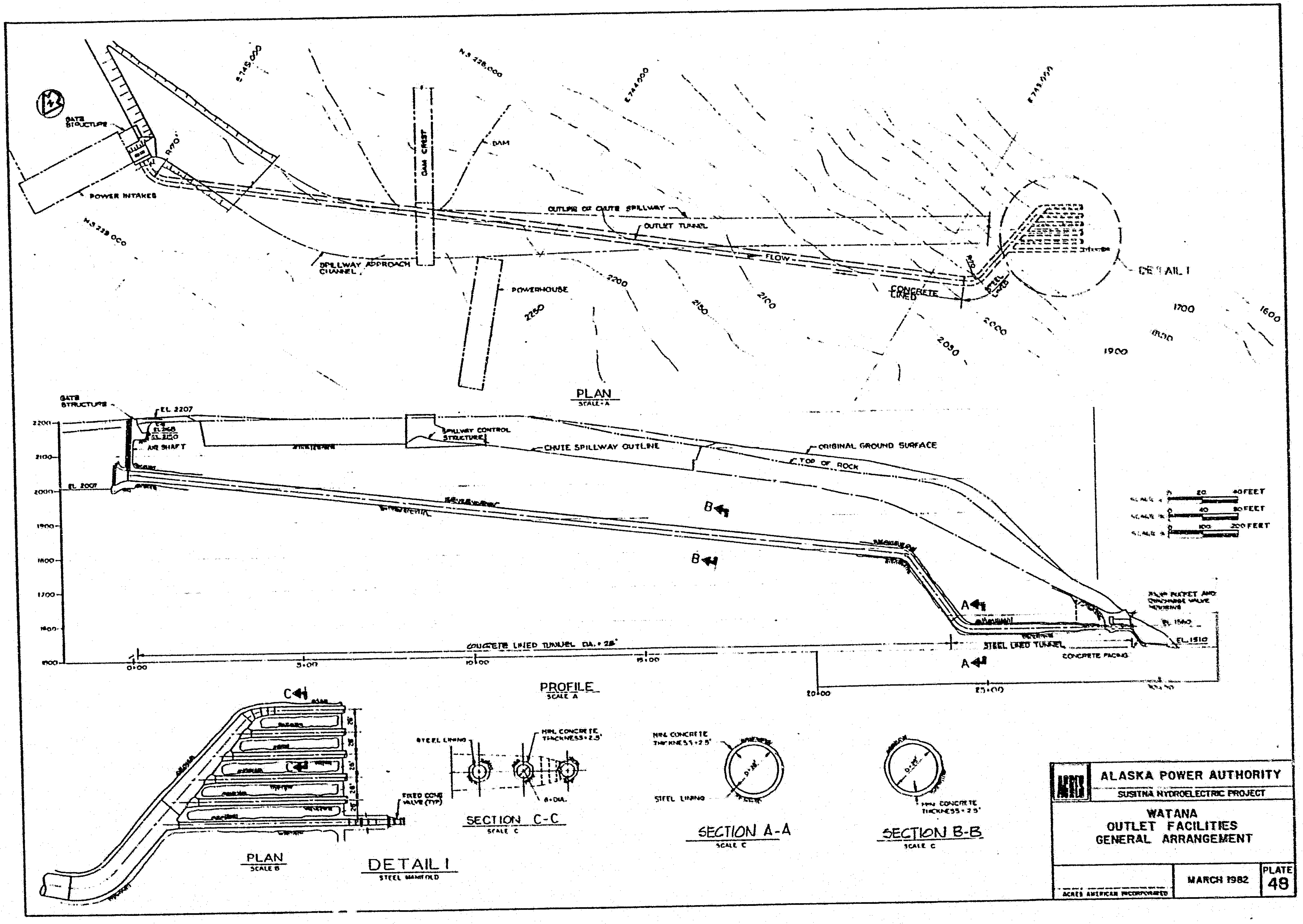
PLAN
AT EL.1545
SCALE A
ELEVATION
SCALE A
SECTION A-A
SCALE A
SECTION B-B
SCALE A
LOCATION PLAN
SCALE B
SEAL FACE
GATE GUIDE
VENT PIPE
POST TENSIONED ANCHOR (TYP)
PVC PIPE SLEEVES FOR PRESSURE RELIEF HOLES
CONSOLIDATION GROUT HOLE
SEALING FACE
FLOW
INTAKE GATE
END OF PIER
POST TENSIONED ANCHORS IN THIS AREA
SLEEVES FOR CONSOLIDATION GROUTING AND PRESSURE RELIEF IN THIS AREA
TRASHRACK (FUTURE) WHEN WORKING AS A LOW LEVEL OUTLET
CONSOLIDATION GROUT HOLE AREA
℄ INTAKE FOR TUNNEL NO.1
℄ INTAKE FOR TUNNEL NO.2
ACCESS ROAD
LEGEND
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
DIVERSION
INTAKE STRUCTURES
ACRES AMERICAN INCORPORATED
MARCH 1982
PLATE 41

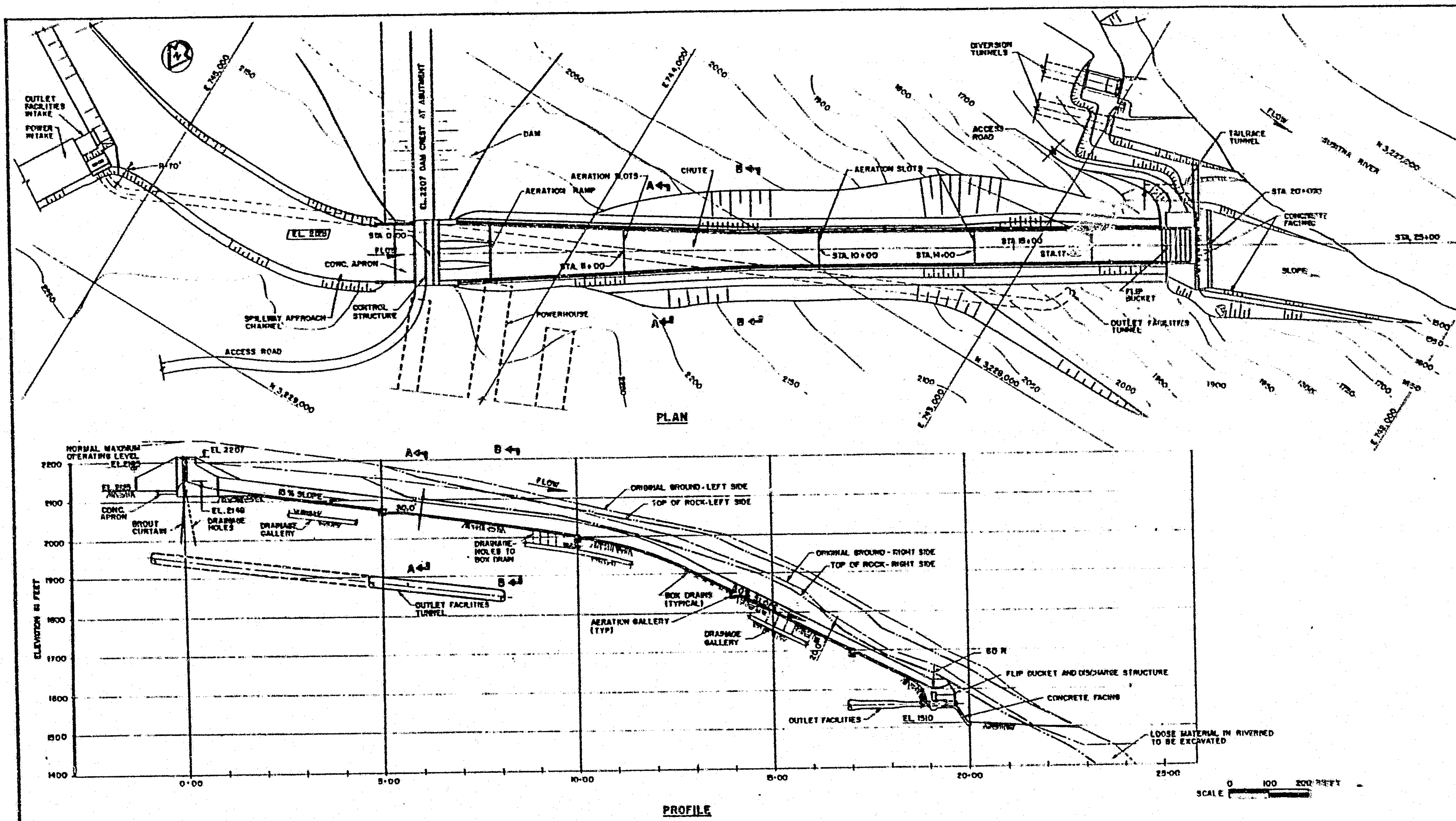


UPSTREAM PLUG
EXPANSION CHAMBER
DOWNSTREAM PLUG
TUNNEL
FLOW
SLOPE
180'-0"
340'-0"
120'-0"
100'-0"
SECTION ALONG ℄ OF TUNNEL NO. 1
SCALE A
SUSPENDED METAL ROOF
SHOTCRETE LINING
GATE HOIST
GATE CHAMBER FLOOR
18" DIA. BYPASS PIPE
GATE BONNET
GATE
STEEL CONDUIT LINING
18" DIA. CONSTRUCTION PIPE DRAIN
EXISTING CONCRETE TUNNEL LINING
43'-0"
60'-0"
57'-0"
LOW LEVEL OUTLET UPSTREAM PLUG
SCALE B
SECTION A-A
SCALE B
℄ TUNNEL AND GATE
℄ GATE
7'-6" x 11'-6" GATE OPENING
3" DIA. PRESSURE RELIEF HOLES
SECTION B-B
SCALE B
℄ TUNNEL
11'-6" DIA.
SECTION C-C
GATE CHAMBER
ACOUSTIC DOOR
INSPECTION GALLERY
18" DIA. CHAMBER DRAIN
LOW LEVEL OUTLET DOWNSTREAM PLUG
SCALE B
SECTION D-D
SCALE B
℄ TUNNEL & GATE
3" DIA PRESSURE RELIEF HOLE
SECTION E-E
SCALE B
SECTION F-F
SCALE B
SCALE B
SCALE A
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
EMERGENCY RELEASE
SECTIONS
MARCH 1982
PLATE
43
ACRES AMERICAN INCORPORATED



PLAN @ EL. 2044'
FLOW
SECTIONAL PLAN
BETWEEN EL. 2068' & EL 2150'
STOP LOG SHAFT
BULKHEAD GATE SHAFT
AIR SHAFT
21'-0
PLAN @ EL 2207
EL 2126
EL 2128
EL 2207
EL 2007
SECTION C-C
EL. 2207
EL. 2150
EL. 2126
GATE HOIST TOWER STRUCTURE
INTERFACE WITH POWER INTAKE
EL. 2207'
EL. 2126'
EL. 2081
TRASH RACK
2-12'x 30' BULKHEAD GATES
EL. 2019'
EL. 2007'
SECTION B B
EL. 2098
BULKHEAD GATE
EL 2044'
EL 2035'
SECTION A-A
SCALE 0 16 32 FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
OUTLET FACILITIES
GATE STRUCTURE
MARCH 1982
PLATE 47
ACRES AMERICAN INCORPORATED


GATE STRUCTURE
POWER INTAKES
DAM CREST
DAM
OUTLINE OF CHUTE SPILLWAY
OUTLET TUNNEL
FLOW
SPILLWAY APPROACH CHANNEL
POWERHOUSE
CONCRETE LINED
STEEL LINED
DETAIL I
PLAN
SCALE A
EL 2207
AIR SHAFT
EL 2007
SPILLWAY CONTROL STRUCTURE
CHUTE SPILLWAY OUTLINE
ORIGINAL GROUND SURFACE
TOP OF ROCK
CONCRETE LINED TUNNEL DIA. = 28'
STEEL LINED TUNNEL
CONCRETE FACING
EL 1560
EL 1510
PROFILE
SCALE A
PLAN
SCALE B
DETAIL I
STEEL MANIFOLD
FIXED CONE VALVE (TYP)
STEEL LINING
MIN. CONCRETE THICKNESS = 2.5'
SECTION C-C
SCALE C
MIN. CONCRETE THICKNESS = 2.5'
STEEL LINING
SECTION A-A
SCALE C
MIN. CONCRETE THICKNESS = 2.5'
SECTION B-B
SCALE C
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
OUTLET FACILITIES
GENERAL ARRANGEMENT
ACRES AMERICAN INCORPORATED
MARCH 1982
PLATE
48



ALASKA POWER AUTHORITY

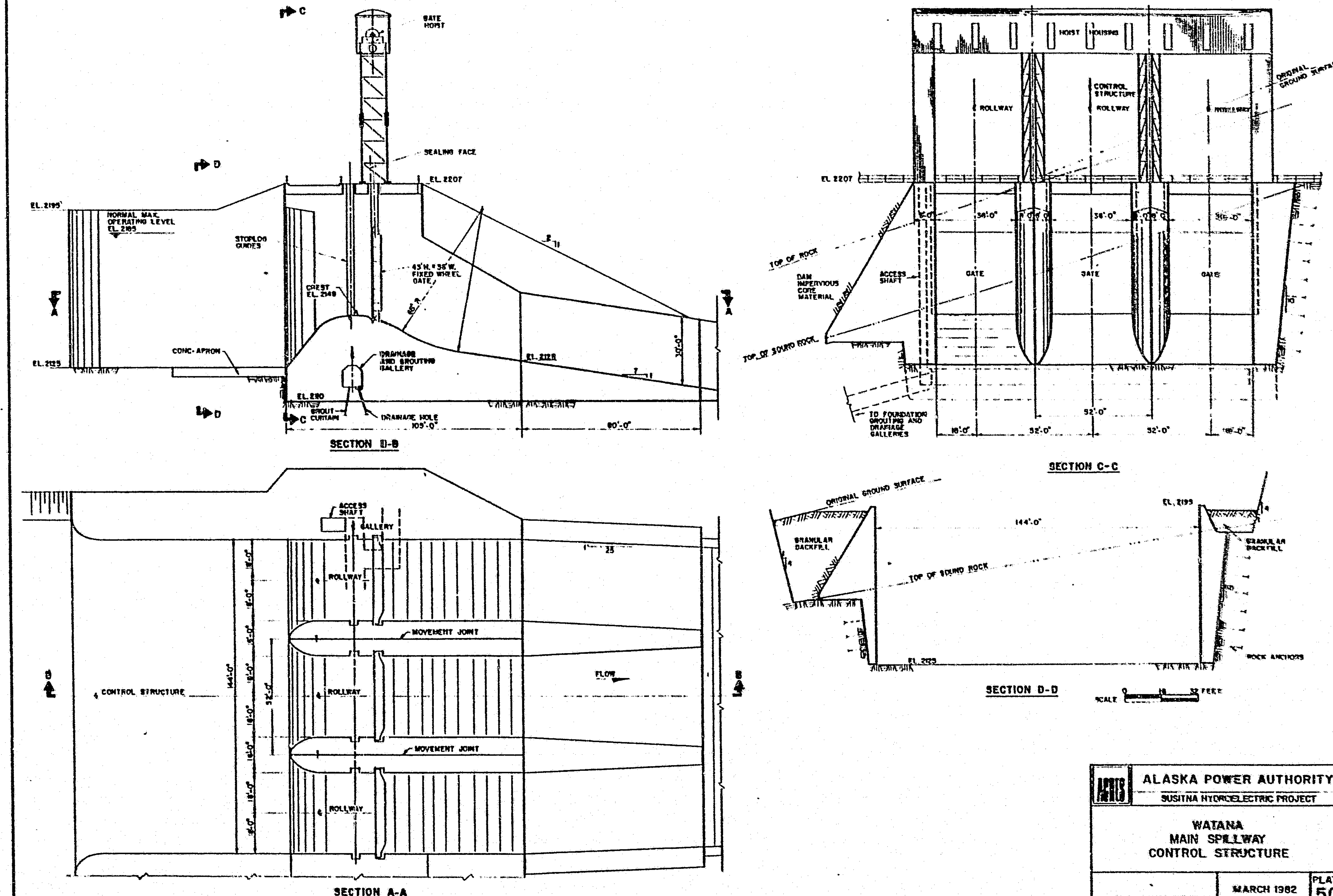
SUSITNA HYDROELECTRIC PROJECT

WATANA
MAIN SPILLWAY
GENERAL ARRANGEMENT
PLAN & PROFILE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 49



ALASKA POWER AUTHORITY

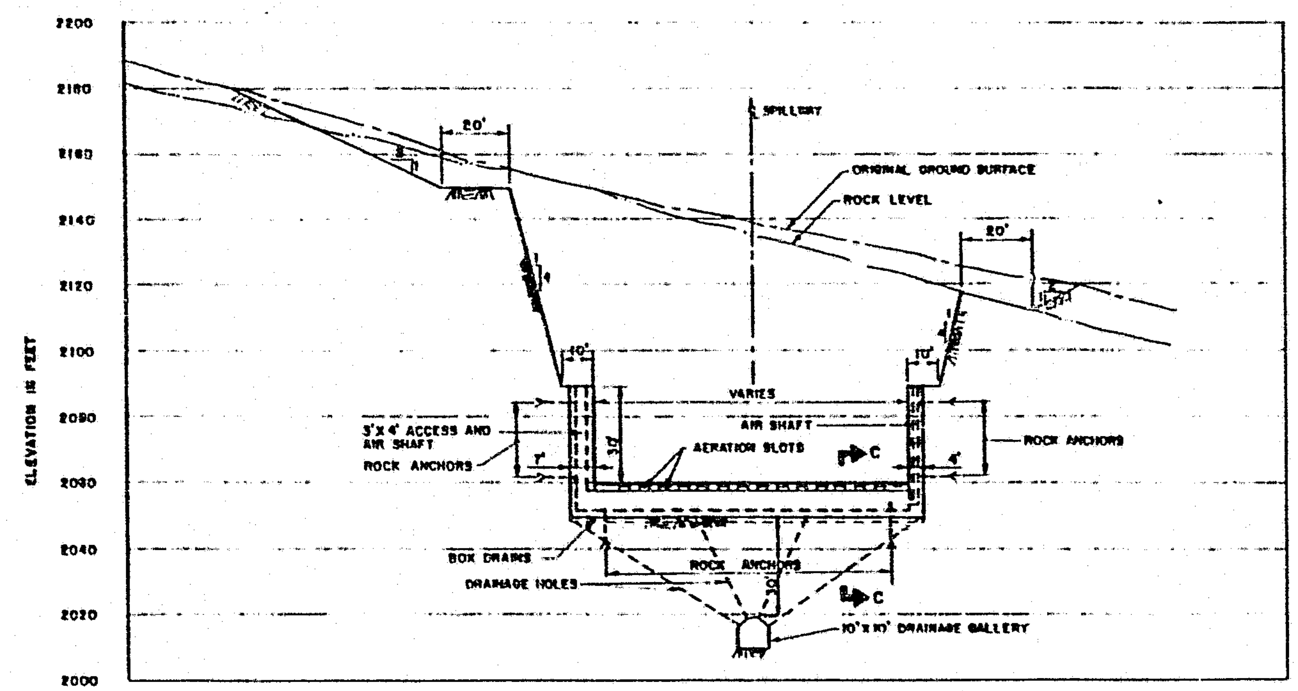
SUSITNA HYDROELECTRIC PROJECT

WATANA
MAIN SPILLWAY
CONTROL STRUCTURE

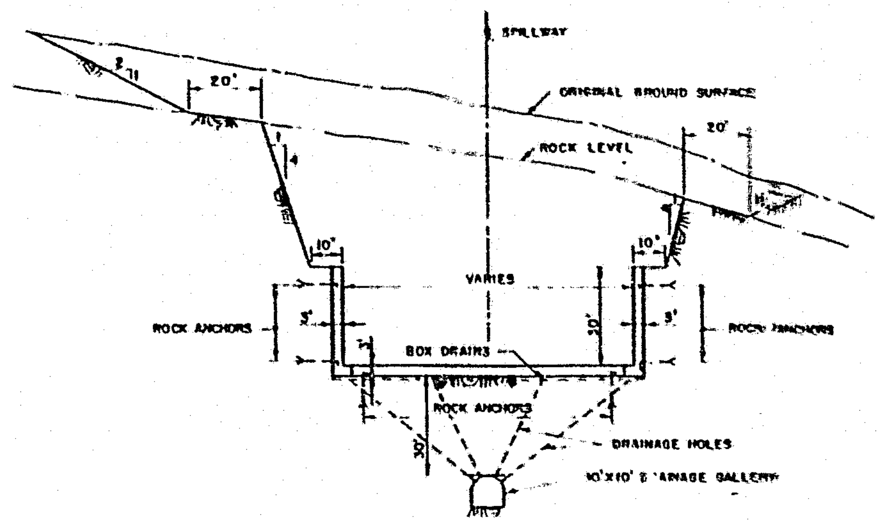
ACRES AMERICAN INCORPORATED

MARCH 1982

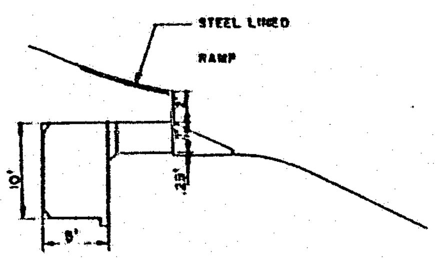
PLATE 50



SECTION A-A



SECTION B-B (TYPICAL)



SECTION C-C
N.T.S.

SCALE 0 20 40 FEET

ALASKA POWER AUTHORITY

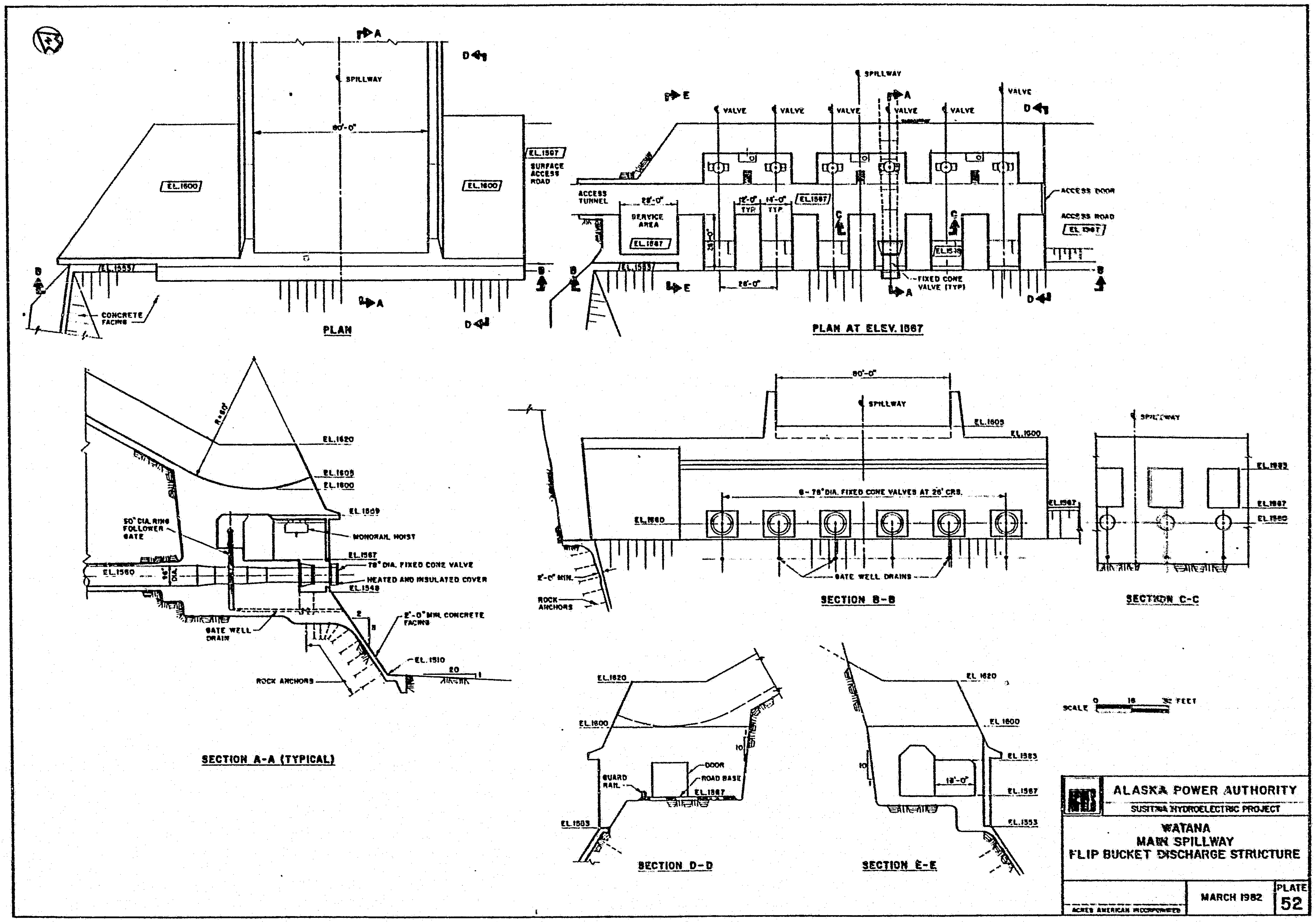
SUSITNA HYDROELECTRIC PROJECT

WATANA
MAIN SPILLWAY
CHUTE SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 51



ALASKA POWER AUTHORITY

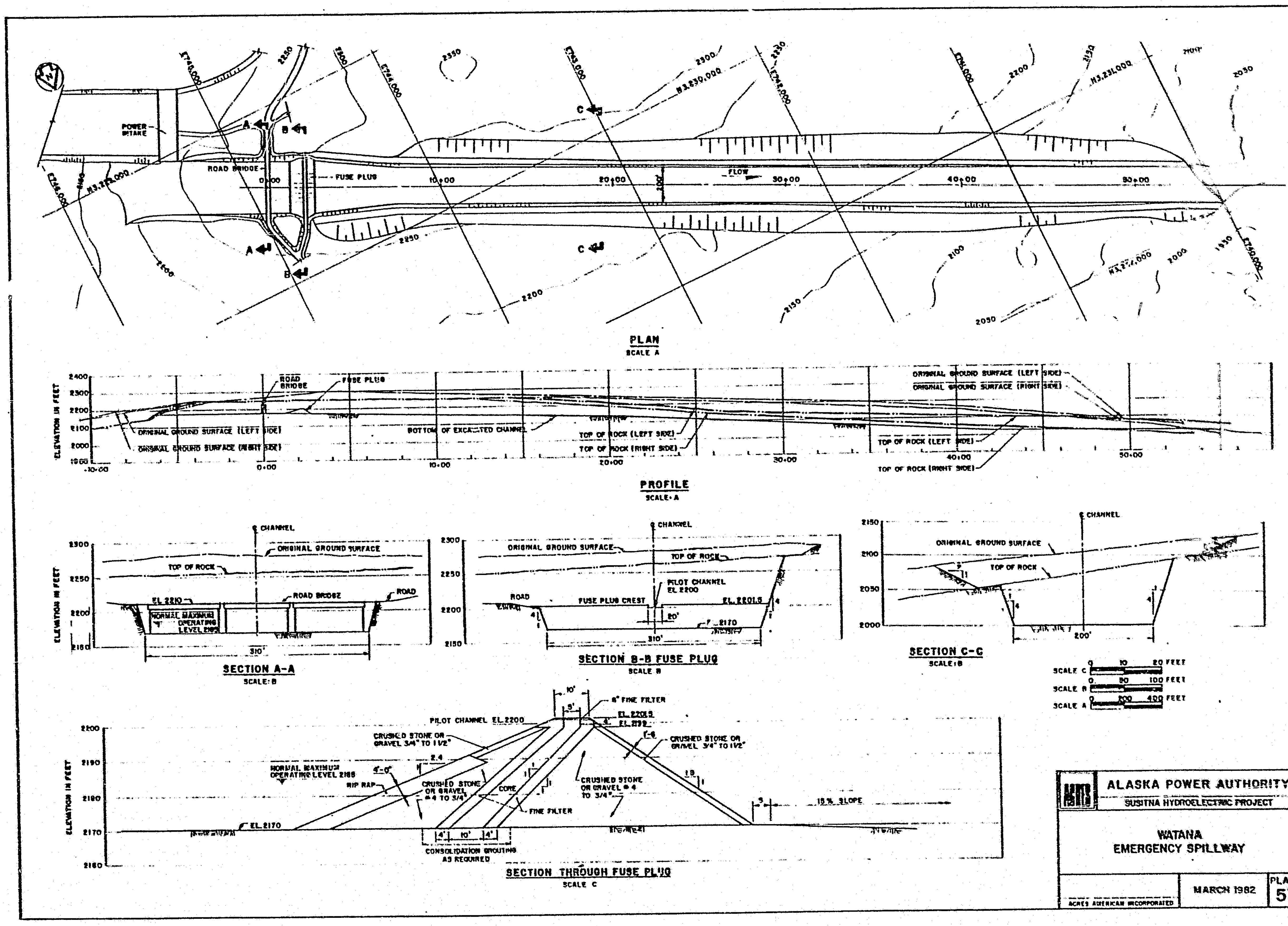
SUSITNA HYDROELECTRIC PROJECT

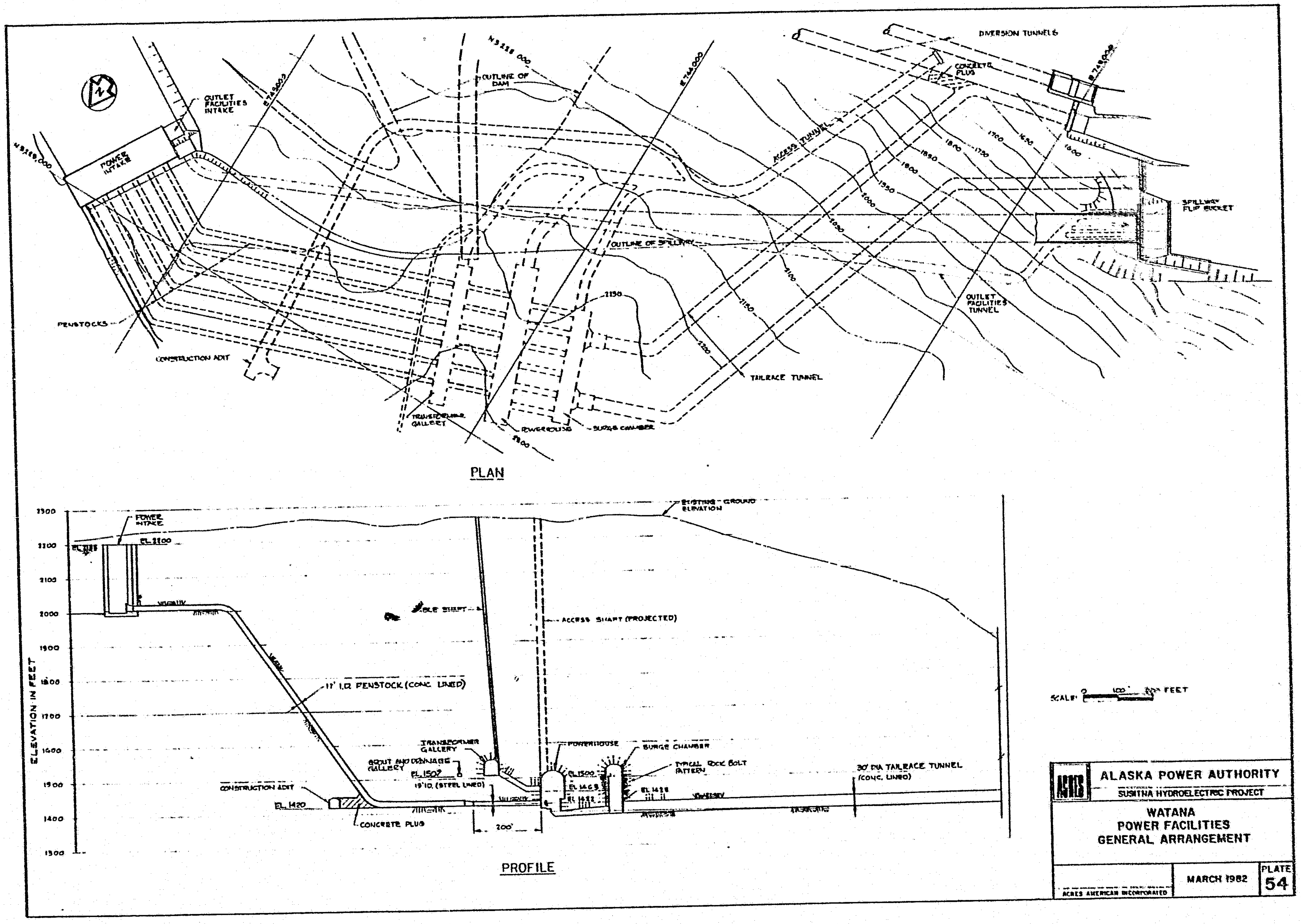
WATANA
MAIN SPILLWAY
FLIP BUCKET DISCHARGE STRUCTURE

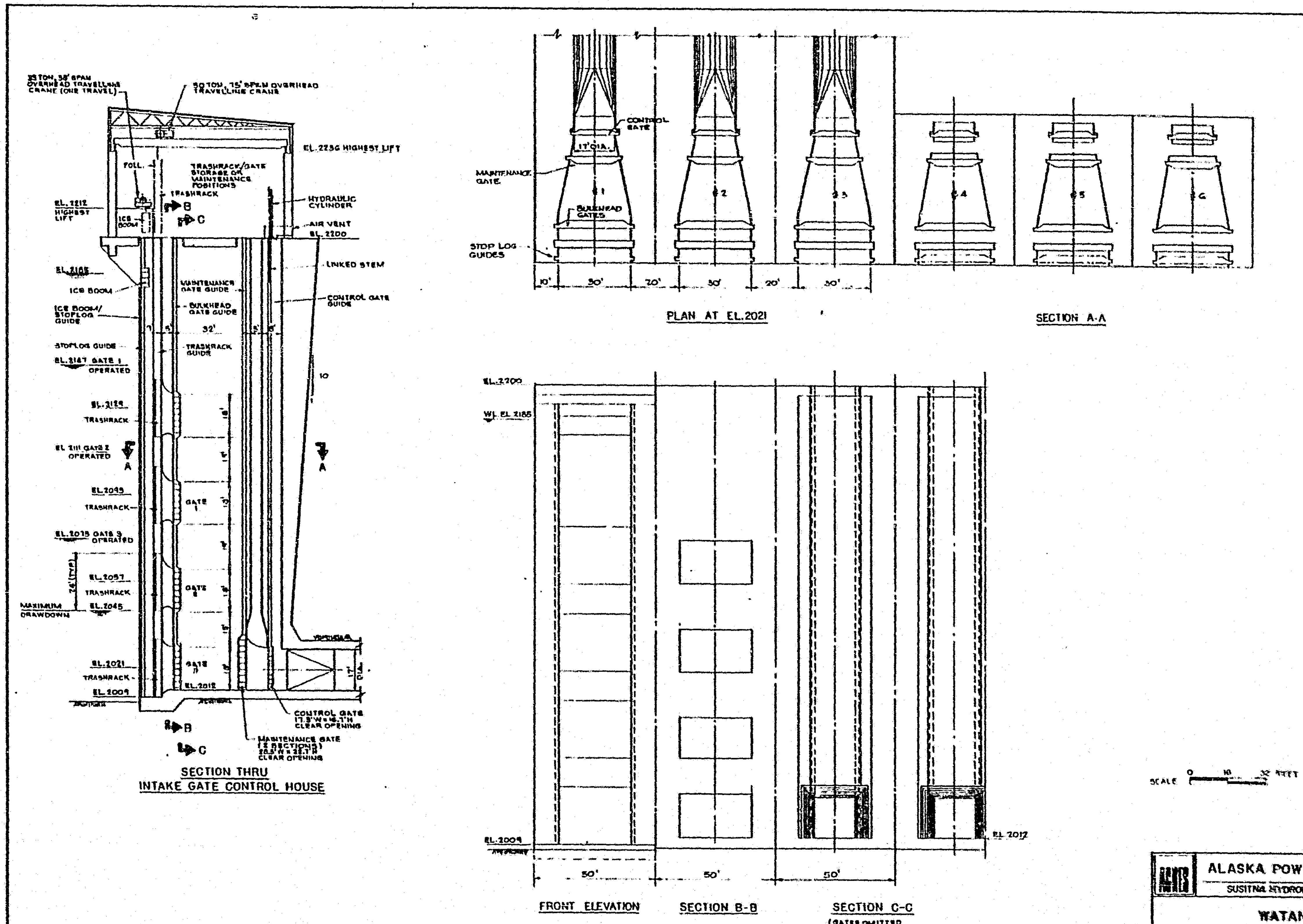
ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 52


PLAN
SCALE A
POWER INTAKE
ROAD BRIDGE
FUSE PLUG
FLOW
PROFILE
SCALE A
ELEVATION IN FEET
ROAD BRIDGE
ORIGINAL GROUND SURFACE (LEFT SIDE)
ORIGINAL GROUND SURFACE (RIGHT SIDE)
BOTTOM OF EXCAVATED CHANNEL
TOP OF ROCK (LEFT SIDE)
TOP OF ROCK (RIGHT SIDE)
SECTION A-A
SCALE: B
CHANNEL
ORIGINAL GROUND SURFACE
TOP OF ROCK
ROAD BRIDGE
ROAD
EL 2210
NORMAL MAXIMUM OPERATING LEVEL 2185
310'
SECTION B-B FUSE PLUG
SCALE B
PILOT CHANNEL EL 2200
FUSE PLUG CREST
EL 2201.5
EL 2170
SECTION C-C
SCALE: B
200'
SCALE C 0 10 20 FEET
SCALE B 0 50 100 FEET
SCALE A 0 200 400 FEET
SECTION THROUGH FUSE PLUG
SCALE C
PILOT CHANNEL EL 2200
6" FINE FILTER
EL 2201.5
EL 2199
CRUSHED STONE OR GRAVEL 3/4" TO 1 1/2"
NORMAL MAXIMUM OPERATING LEVEL 2185
RIP RAP
CRUSHED STONE OR GRAVEL #4 TO 3/4"
CORE
FINE FILTER
10 % SLOPE
EL 2170
CONSOLIDATION GROUTING AS REQUIRED
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
EMERGENCY SPILLWAY
ACRES AMERICAN INCORPORATED
MARCH 1982
PLATE 53


DIVERSION TUNNELS
CONCRETE PLUG
OUTLINE OF DAM
OUTLET FACILITIES INTAKE
POWER INTAKE
ACCESS TUNNEL
SPILLWAY FLIP BUCKET
OUTLINE OF SPILLWAY
OUTLET FACILITIES TUNNEL
PENSTOCKS
CONSTRUCTION ADIT
TAILRACE TUNNEL
TRANSFORMER GALLERY
POWERHOUSE
SURGE CHAMBER
PLAN
EXISTING GROUND ELEVATION
POWER INTAKE
EL. 2200
ACCESS SHAFT (PROJECTED)
17' I.D. PENSTOCK (CONC. LINED)
ELEVATION IN FEET
TRANSFORMER GALLERY
GROUT AND DRAINAGE GALLERY
POWERHOUSE
SURGE CHAMBER
TYPICAL ROCK BOLT PATTERN
30' DIA TAILRACE TUNNEL (CONC. LINED)
CONSTRUCTION ADIT
EL. 1420
CONCRETE PLUG
19' I.D. (STEEL LINED)
200'
PROFILE
SCALE 0 100' 200' FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
POWER FACILITIES
GENERAL ARRANGEMENT
MARCH 1982
PLATE 54
ACRES AMERICAN INCORPORATED



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA

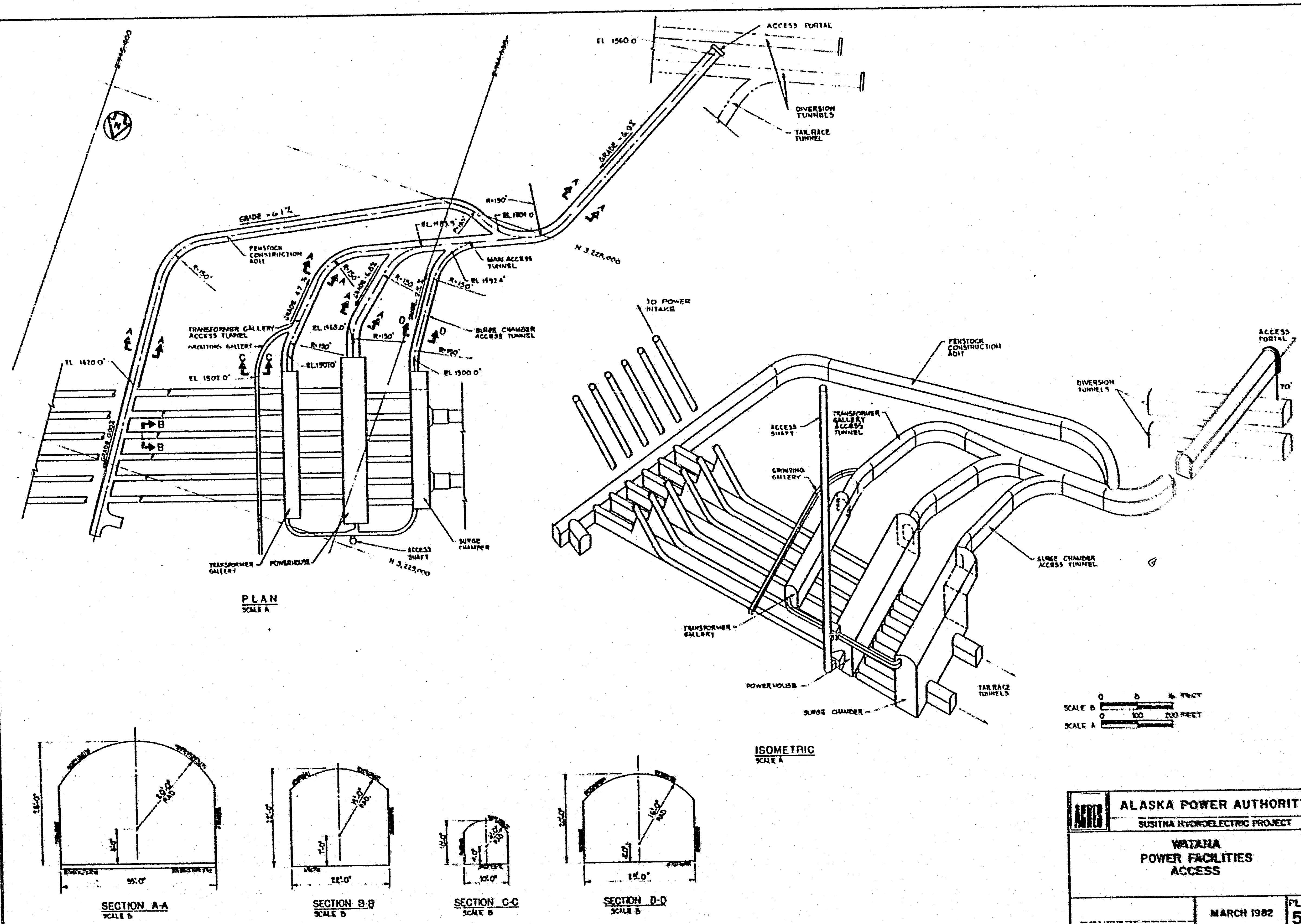
POWER INTAKE

PLANS, SECTIONS & ELEVATION

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 55A



ACRES

ALASKA POWER AUTHORITY

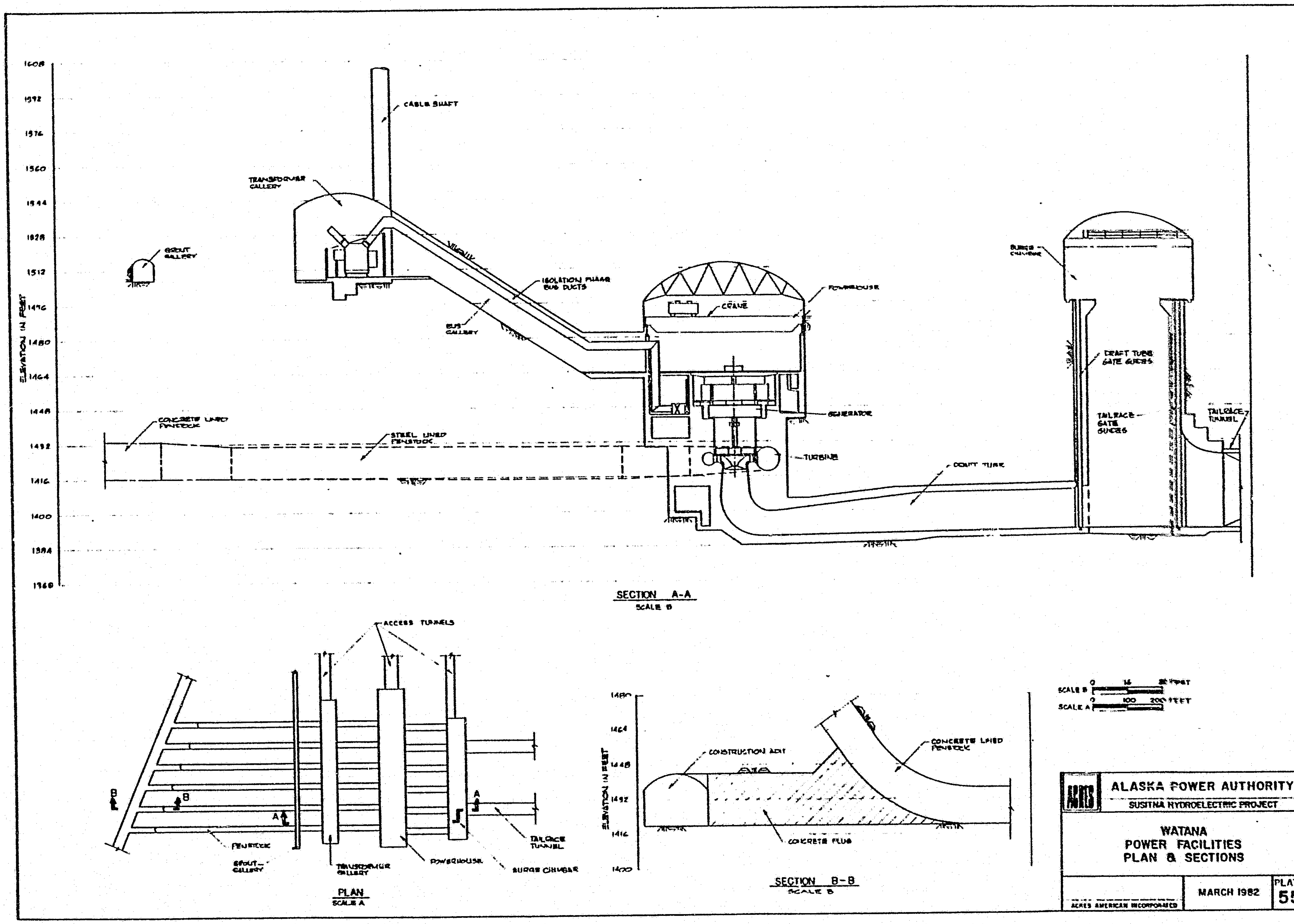
SUSITNA HYDROELECTRIC PROJECT

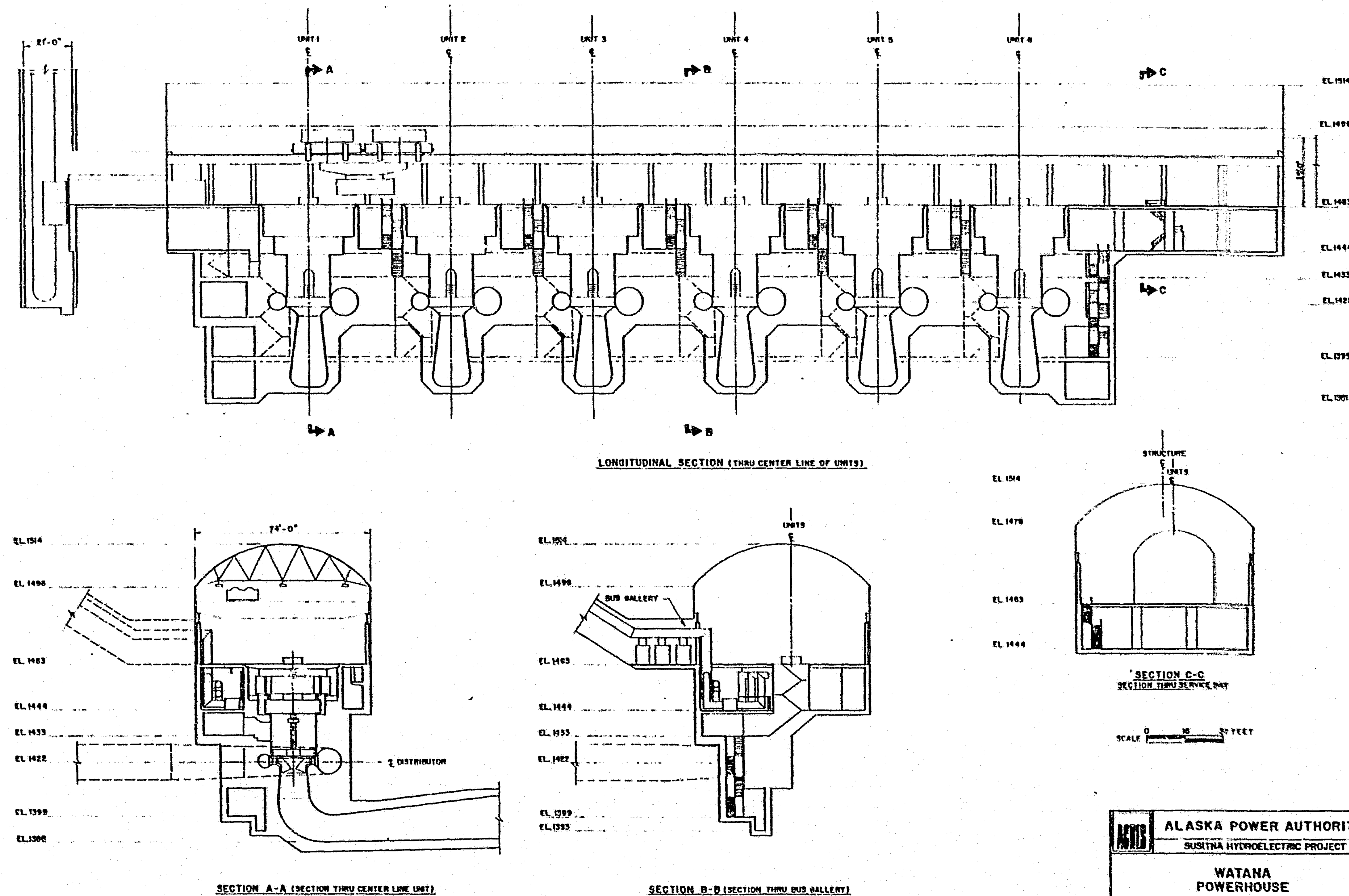
WATANA
POWER FACILITIES
ACCESS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 56


CABLE SHAFT
TRANSFORMER GALLERY
GROUT GALLERY
ISOLATION PHASE BUS DUCTS
BUS GALLERY
POWERHOUSE
CRANE
SURGE CHAMBER
DRAFT TUBE GATE GUIDES
TAILRACE GATE GUIDES
TAILRACE TUNNEL
GENERATOR
TURBINE
DRAFT TUBE
CONCRETE LINED PENSTOCK
STEEL LINED PENSTOCK
ELEVATION IN FEET
1608
1592
1576
1560
1544
1528
1512
1496
1480
1464
1448
1432
1416
1400
1384
1368
SECTION A-A
SCALE B
ACCESS TUNNELS
PENSTOCK
GROUT GALLERY
TRANSFORMER GALLERY
POWERHOUSE
SURGE CHAMBER
TAILRACE TUNNEL
PLAN
SCALE A
CONSTRUCTION ADIT
CONCRETE LINED PENSTOCK
CONCRETE PLUG
SECTION B-B
SCALE B
SCALE B
SCALE A
FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
POWER FACILITIES
PLAN & SECTIONS
MARCH 1982
PLATE
55
ACRES AMERICAN INCORPORATED



ALASKA POWER AUTHORITY

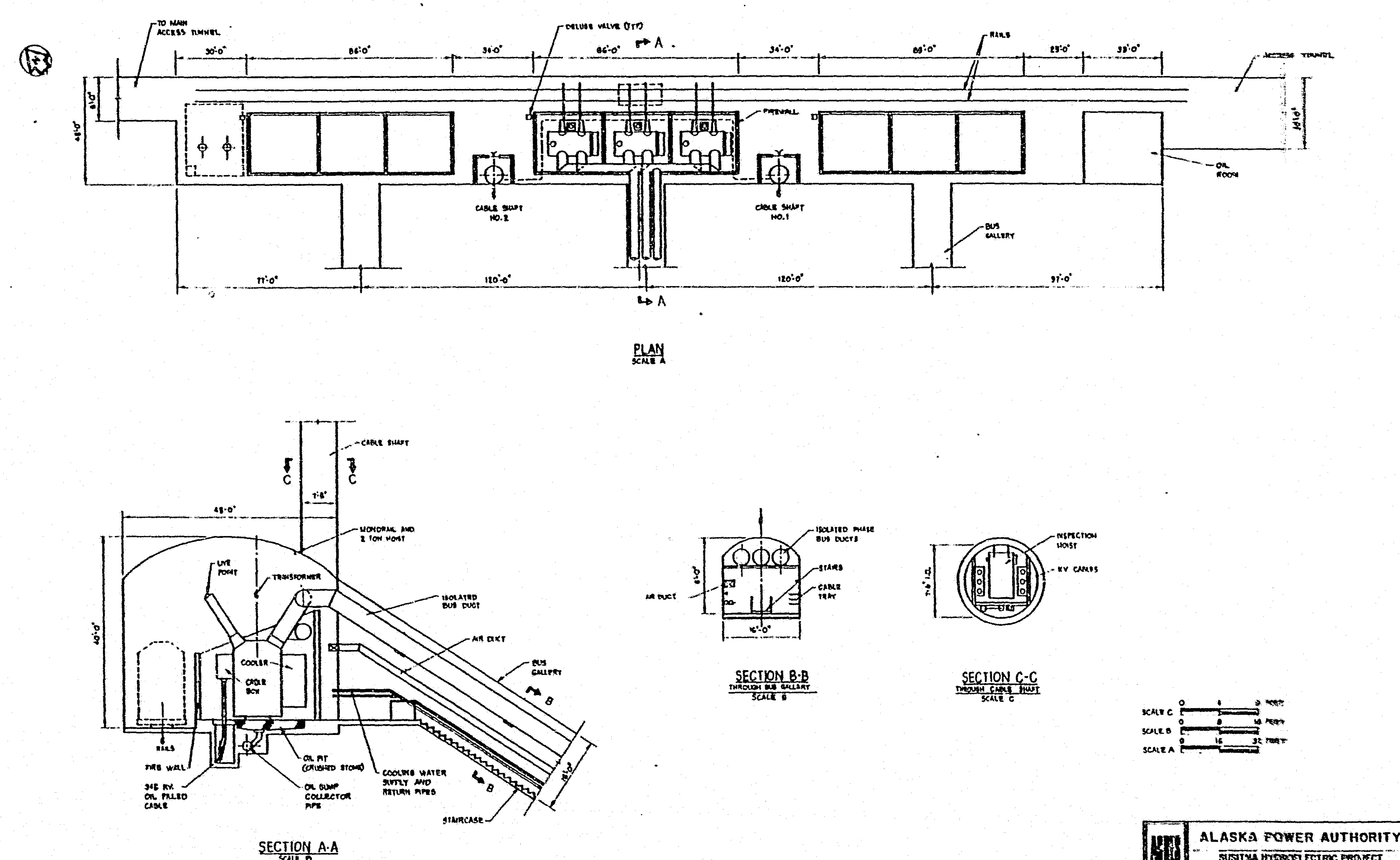
SUSITNA HYDROELECTRIC PROJECT

WATANA POWERHOUSE SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 58



ALASKA POWER AUTHORITY

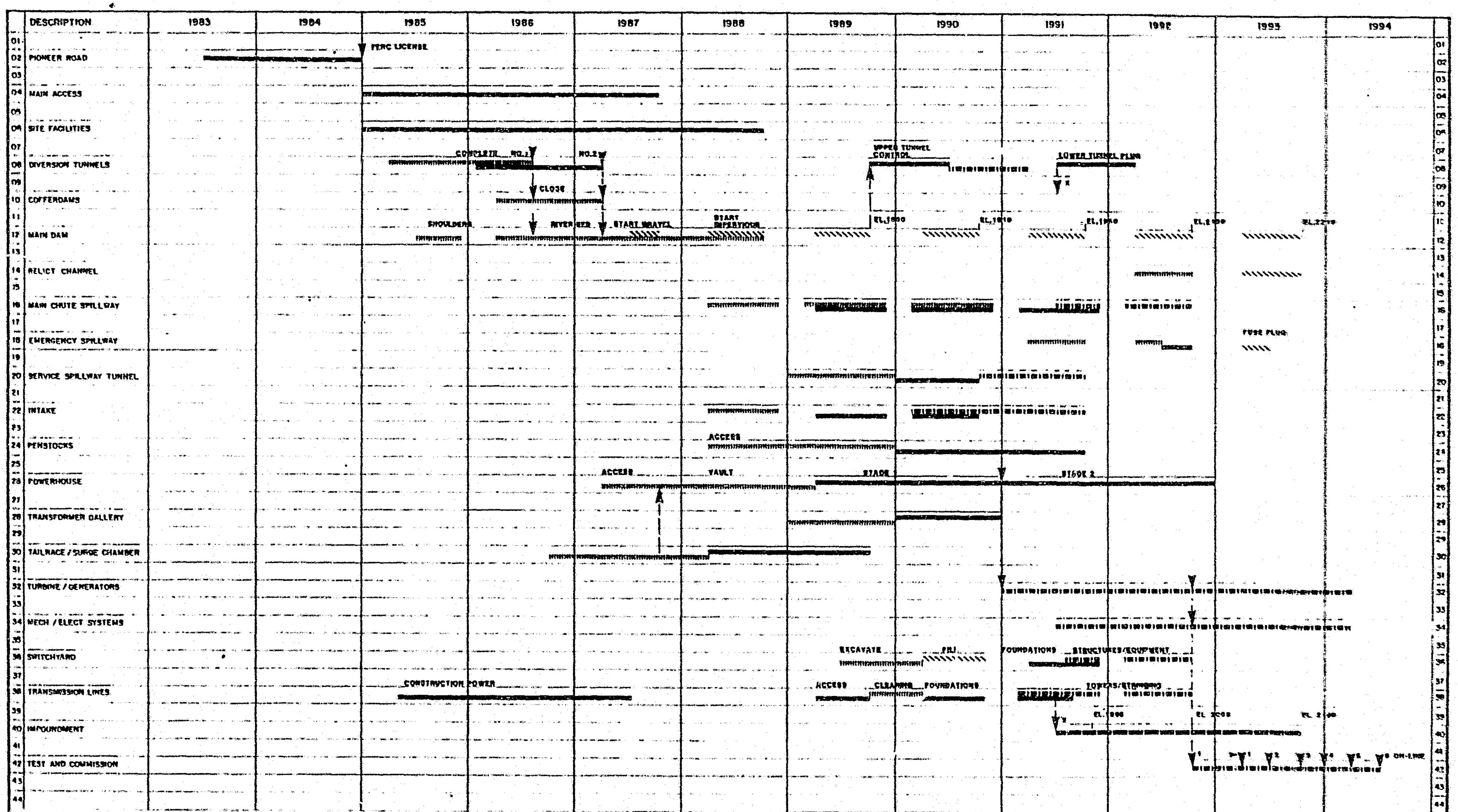
SUSITNA HYDROELECTRIC PROJECT

WATANA
TRANSFORMER GALLERY
PLAN & SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 59



LEGEND

- ACCESS/FACILITIES
- EXCAVATION/FOUNDATION TREATMENT
- FILL
- CONCRETE
- MECHANICAL/ELECTRICAL
- IMPOUNDMENT

ISSUED 30JAN82

ACRES

ALASKA POWER AUTHORITY

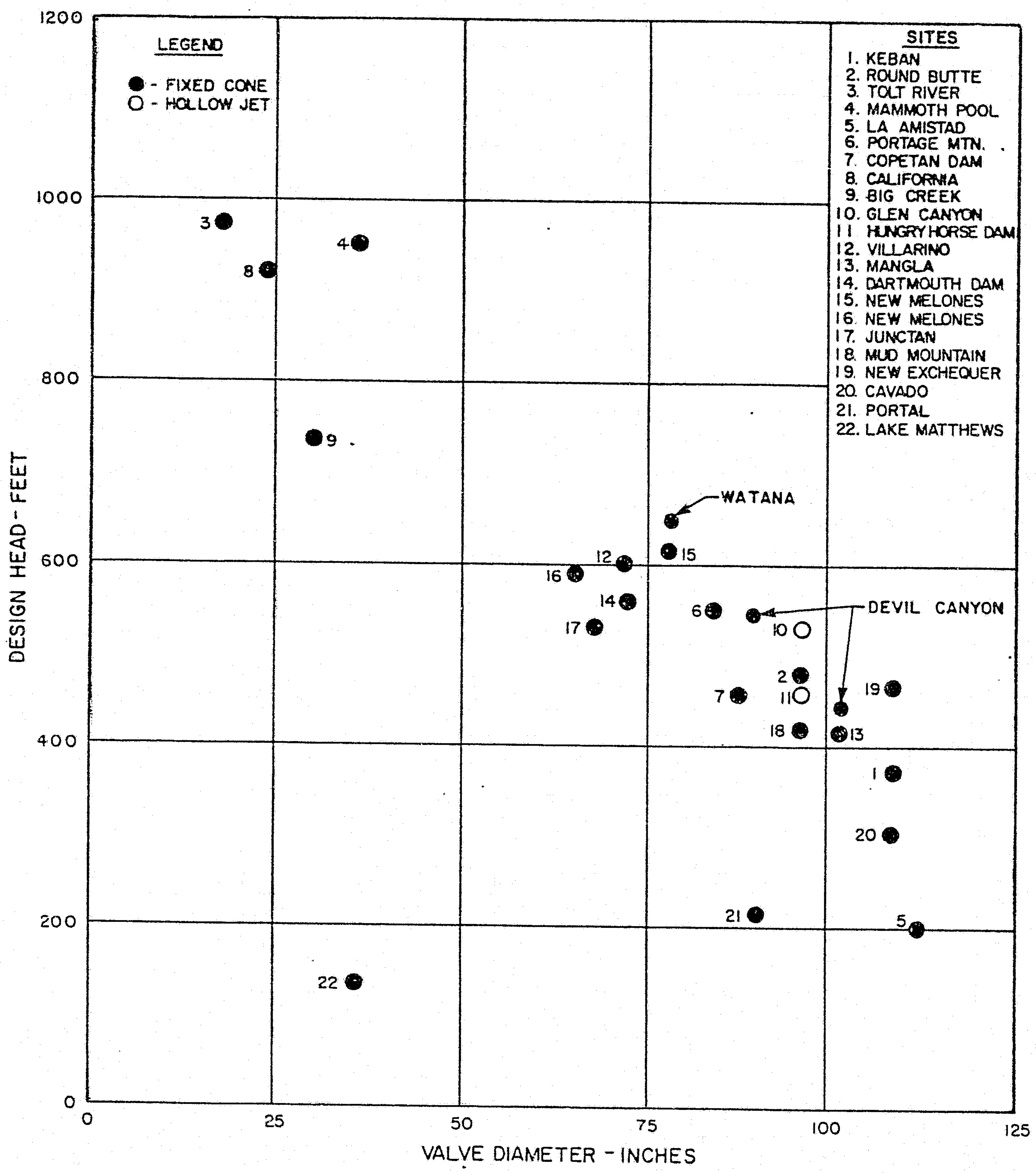
SUSITNA HYDROELECTRIC PROJECT

WATANA
CONSTRUCTION SCHEDULE

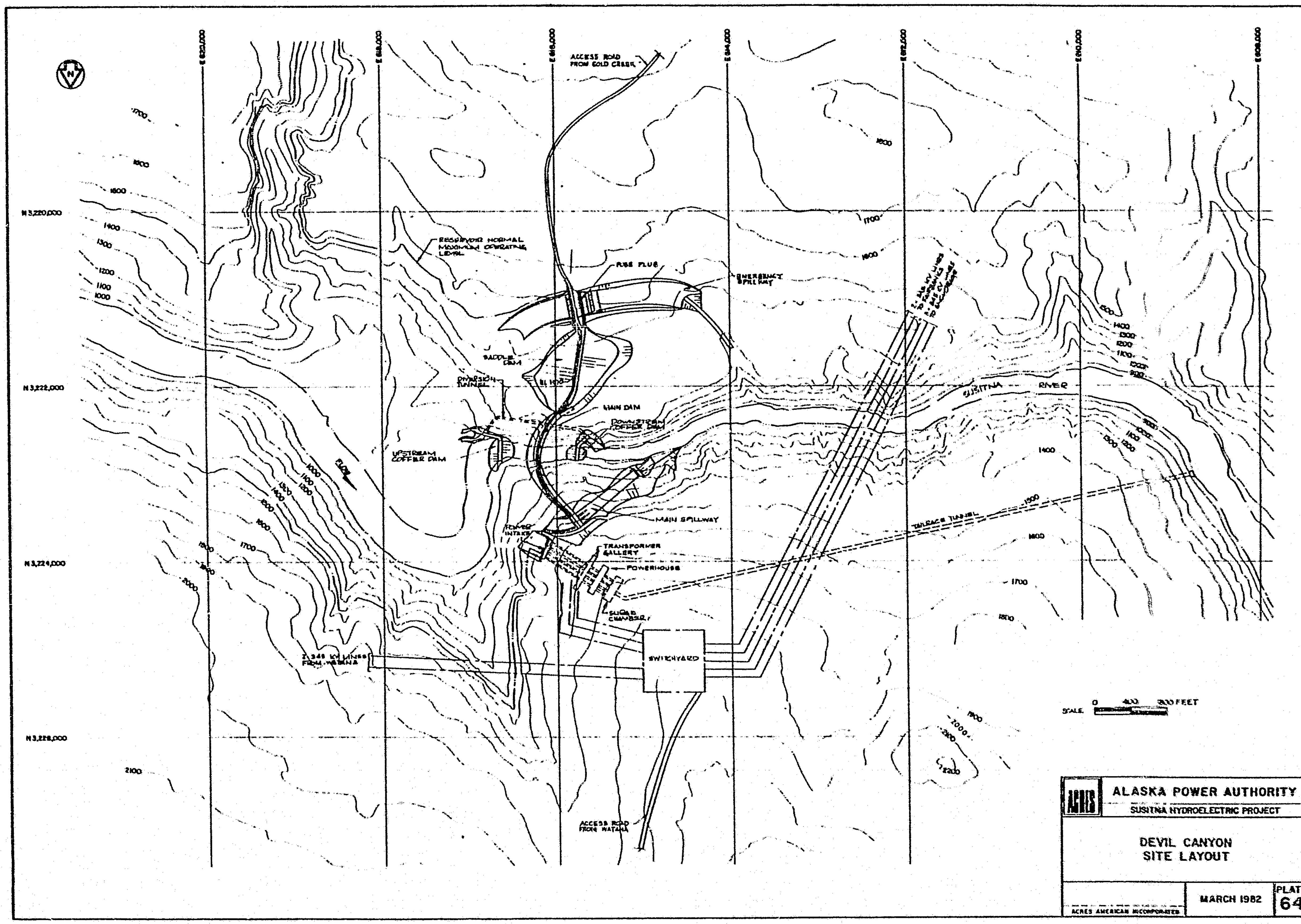
ACRES AMERICAN INCORPORATED

MARCH 1982

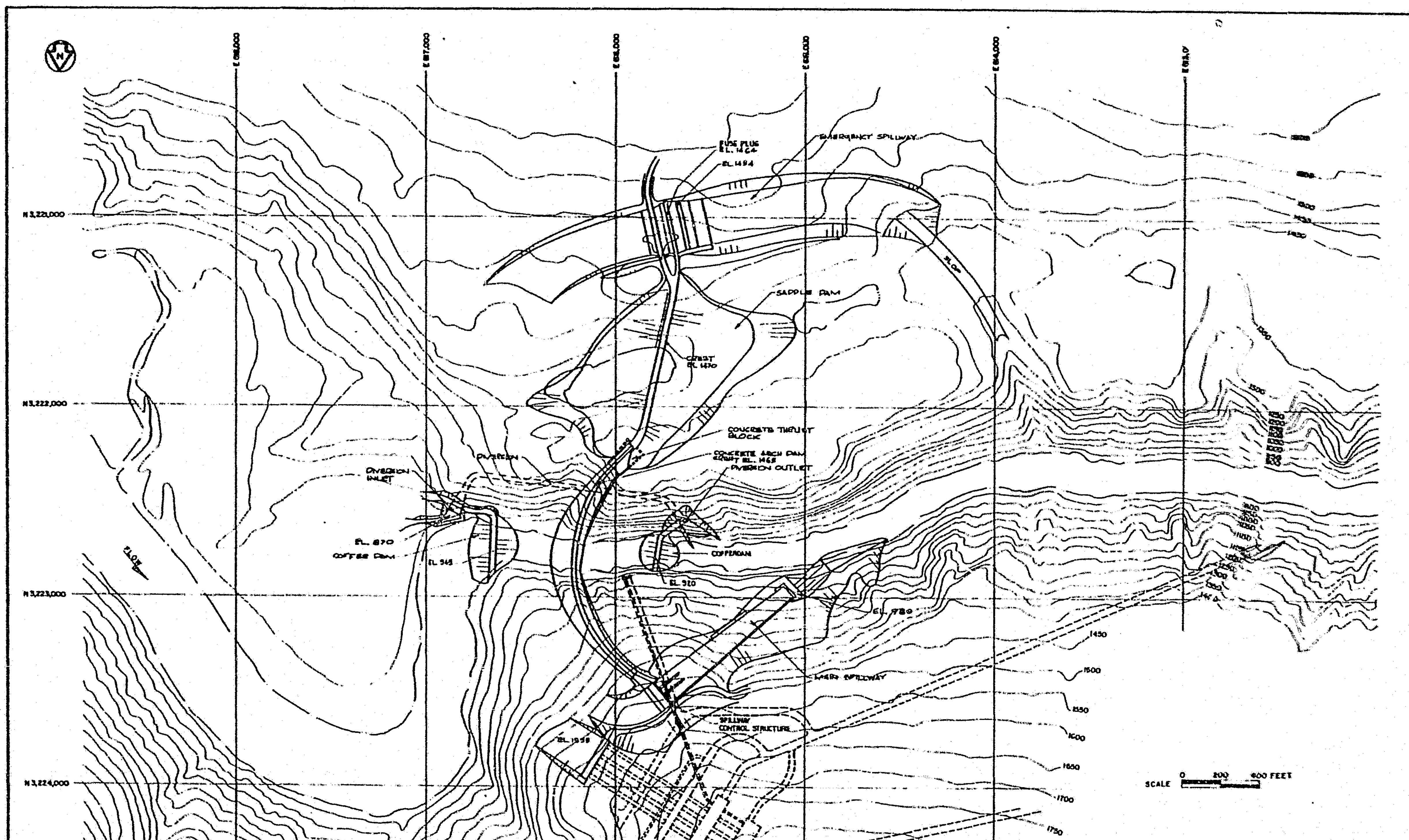
PLATE 90



FREE DISCHARGE VALVE
EXPERIENCE PLOT



ACCESS ROAD FROM GOLD CREEK
N 3,220,000
N 3,222,000
N 3,224,000
N 3,226,000
RESERVOIR NORMAL MAXIMUM OPERATING LEVEL
FUSE PLUG
EMERGENCY SPILLWAY
SADDLE DAM
DIVERSION TUNNEL
MAIN DAM
DOWNSTREAM COFFER DAM
UPSTREAM COFFER DAM
FLOW
SUSITNA RIVER
MAIN SPILLWAY
POWER INTAKE
TRANSFORMER GALLERY
POWERHOUSE
SURGE CHAMBER
TAILRACE TUNNEL
SWITCHYARD
2-345 KV LINES FROM WATANA
ACCESS ROAD FROM WATANA
SCALE 0 400 800 FEET
ACRES
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON SITE LAYOUT
MARCH 1982
PLATE 64
ACRES AMERICAN INCORPORATED



ALASKA POWER AUTHORITY

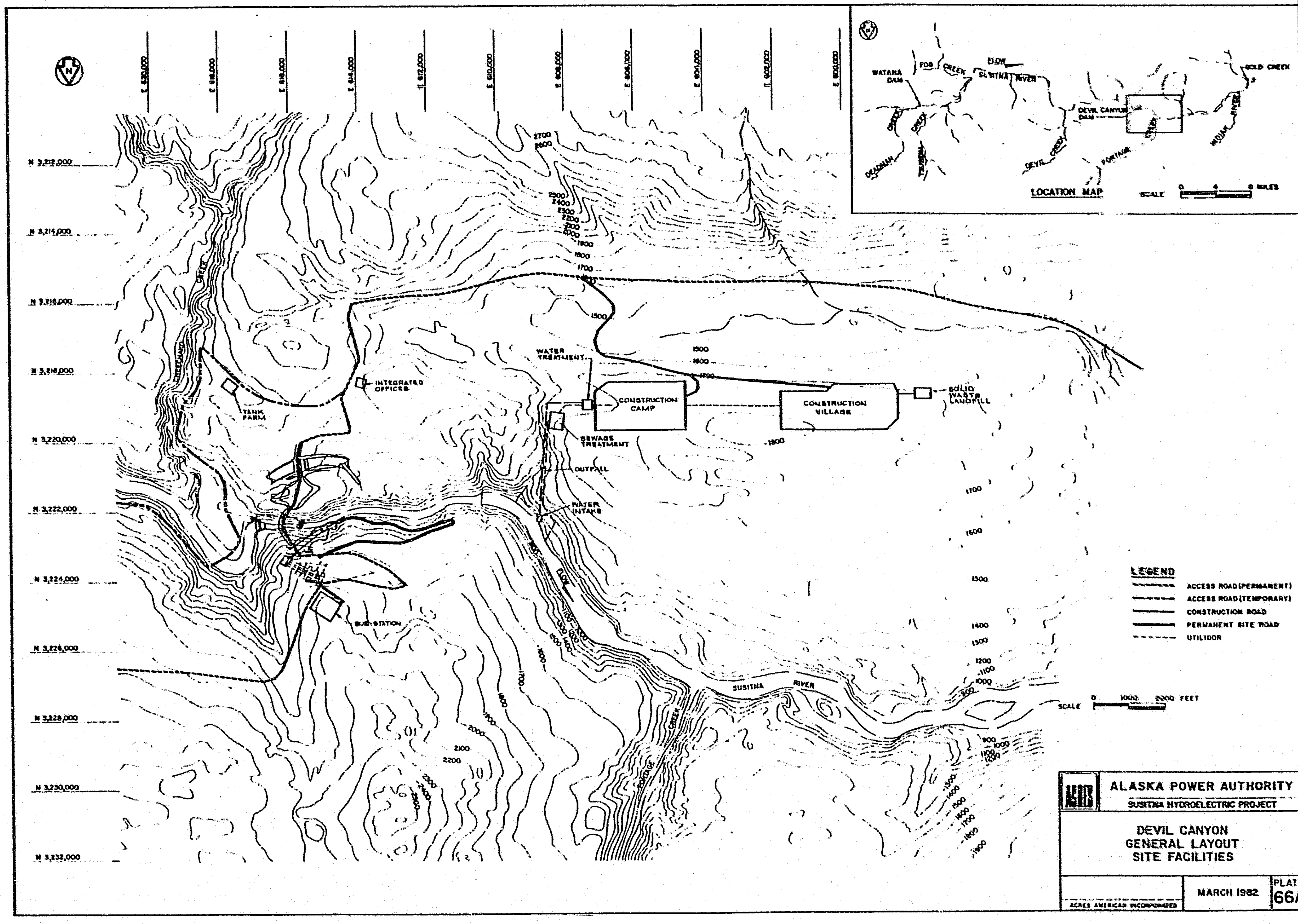
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
GENERAL ARRANGEMENT
LAYOUT OF STRUCTURES

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 64A



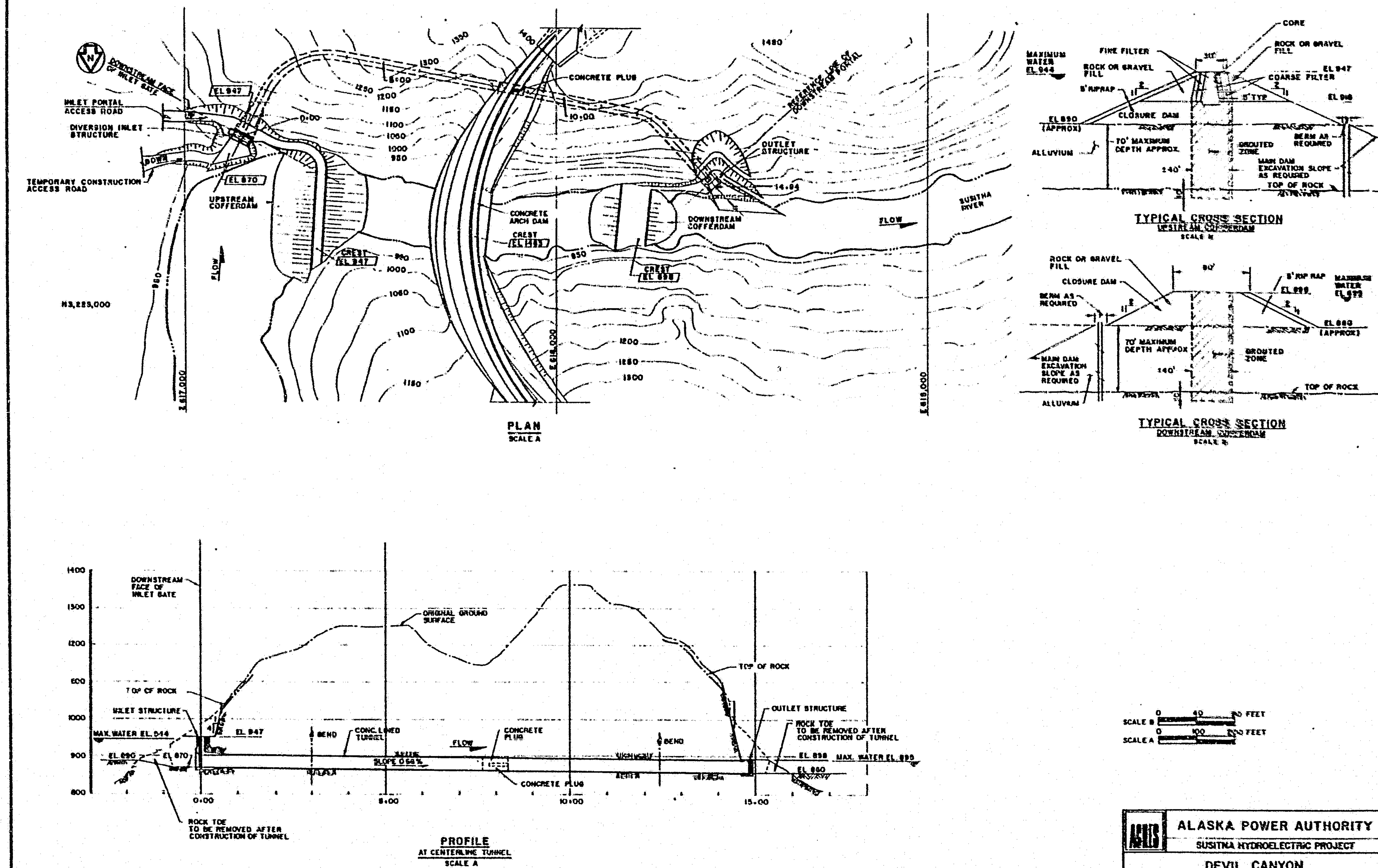
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
GENERAL LAYOUT
SITE FACILITIES

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 66A



ACRES

ALASKA POWER AUTHORITY

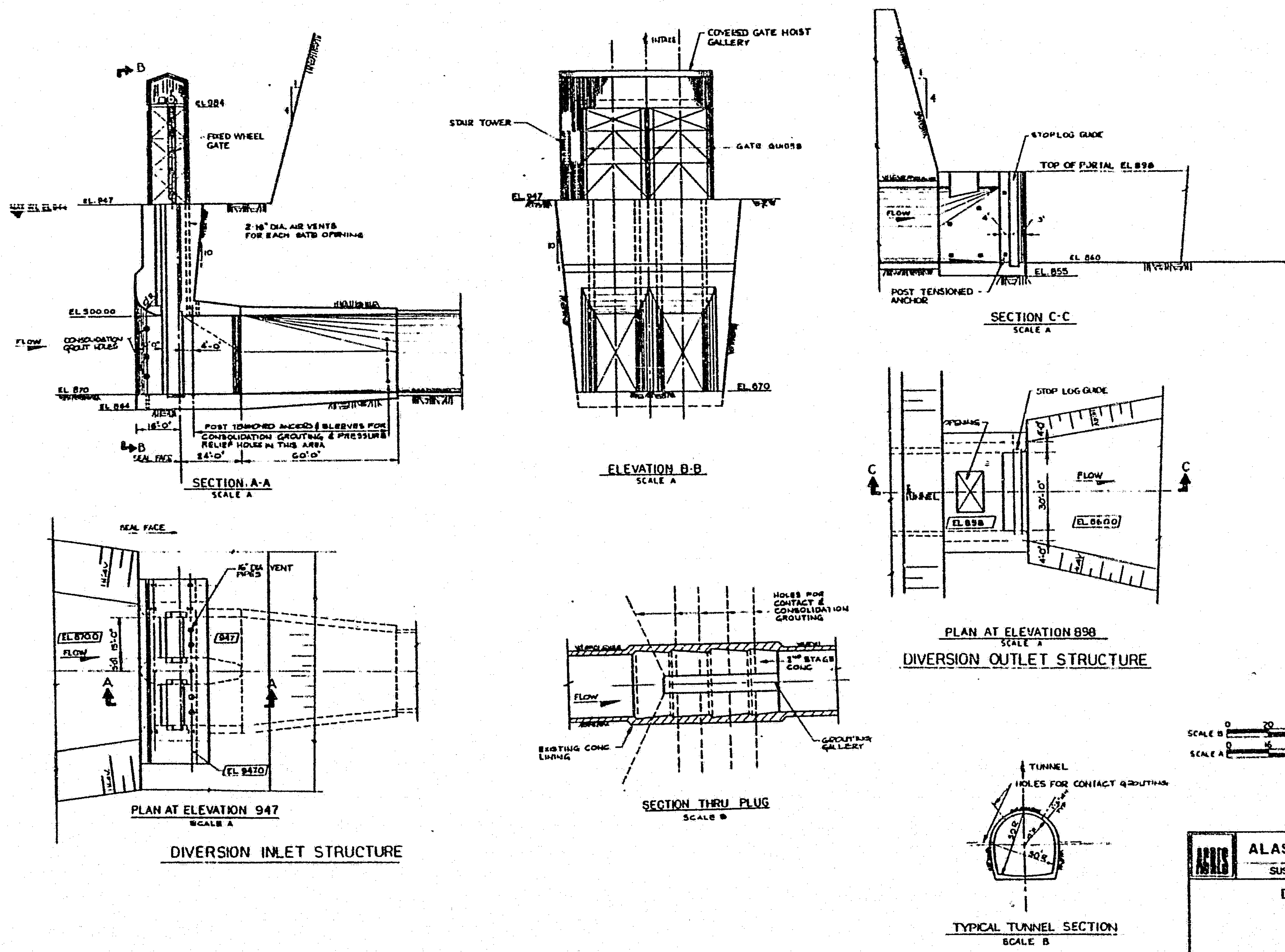
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON DIVERSION GENERAL ARRANGEMENT

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 69



ALASKA POWER AUTHORITY

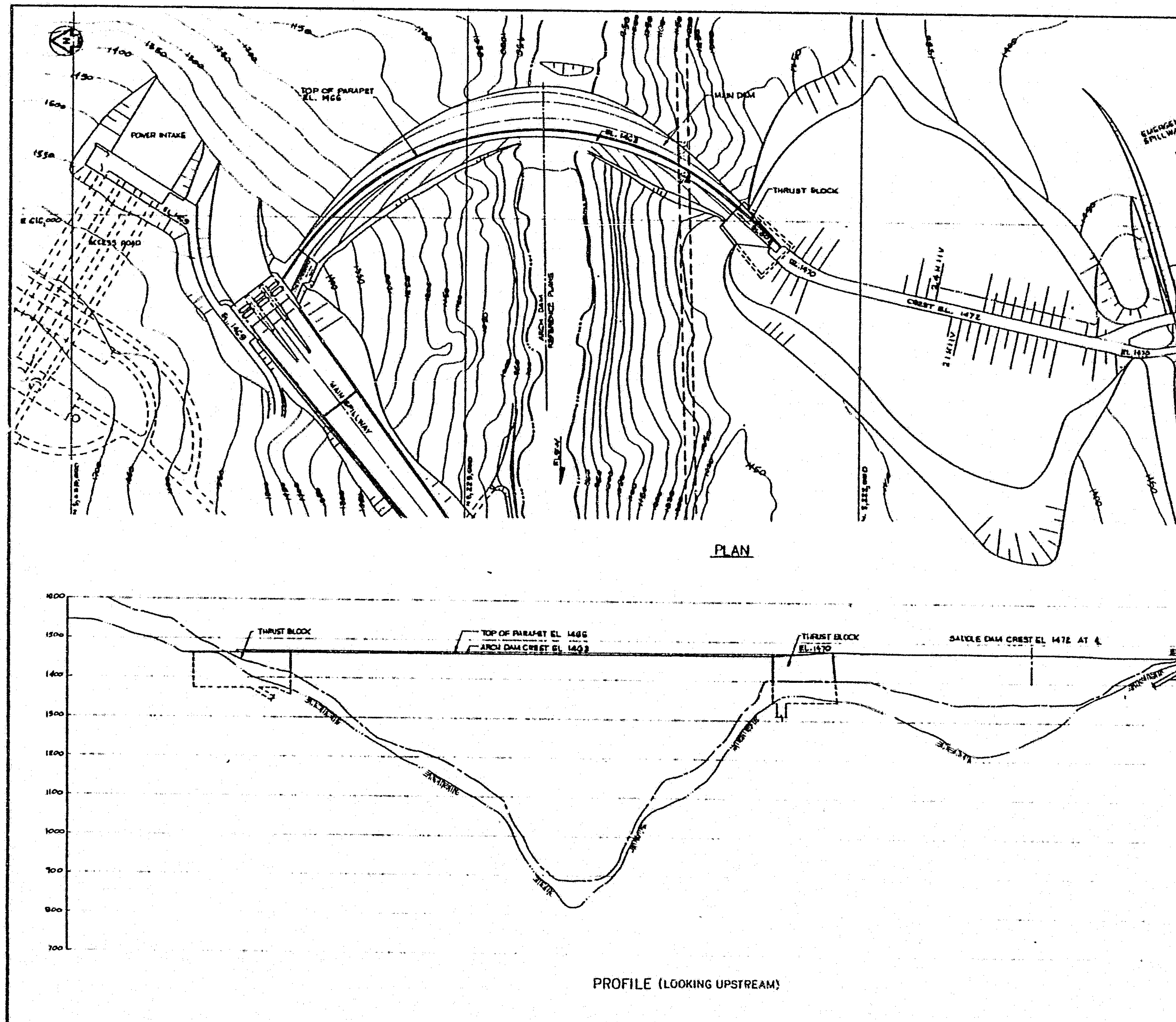
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON DIVERSION SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 70



ALASKA POWER AUTHORITY

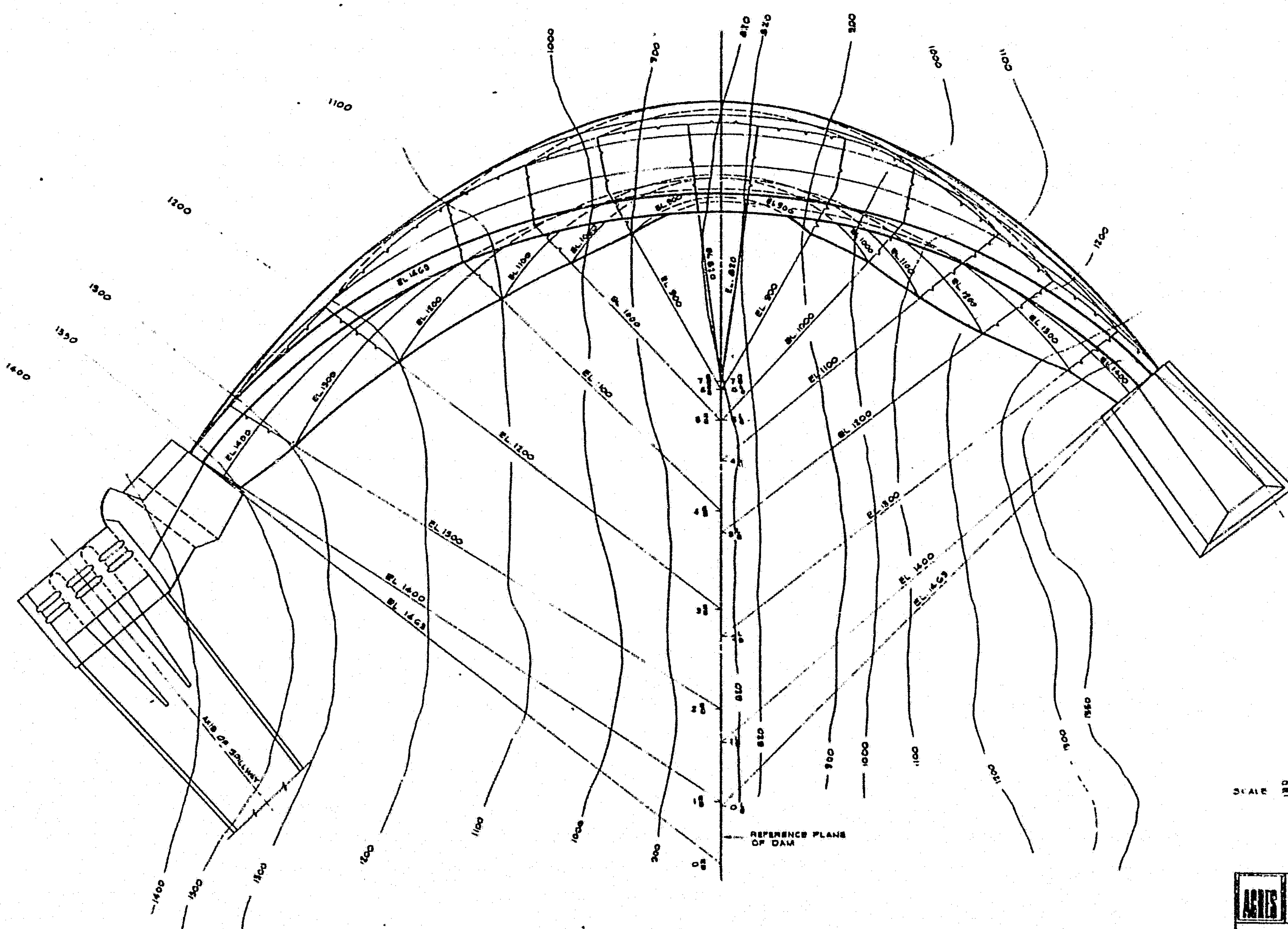
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON DAMS PLAN AND PROFILE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 71



PLAN OF ARCH

ACRES

ALASKA POWER AUTHORITY

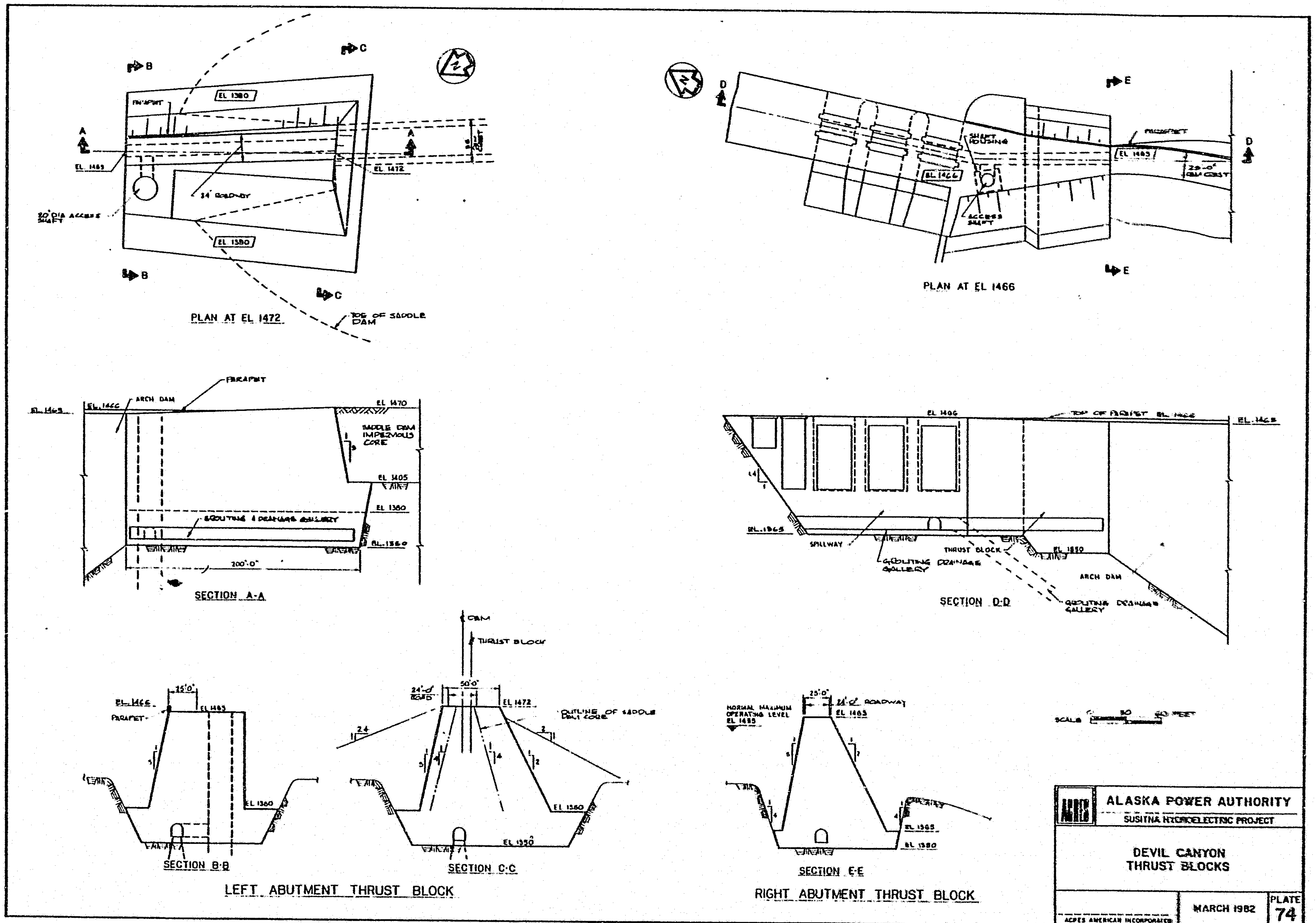
SUSITNA HYDROELECTRIC PROJECT

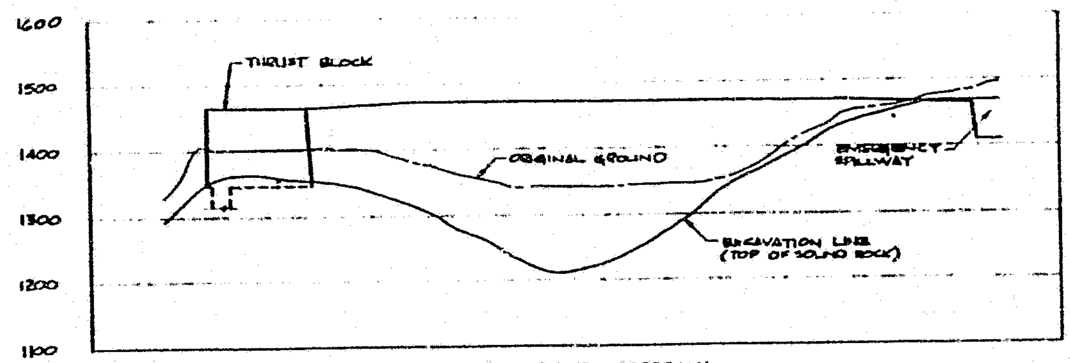
DEVIL CANYON
MAIN DAM
GEOMETRY

ACRES AMERICAN INCORPORATED

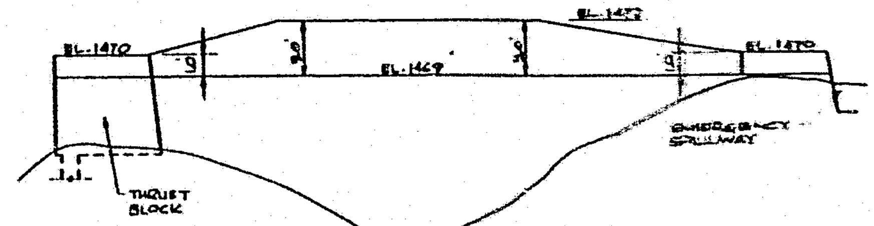
MARCH 1982

PLATE 72

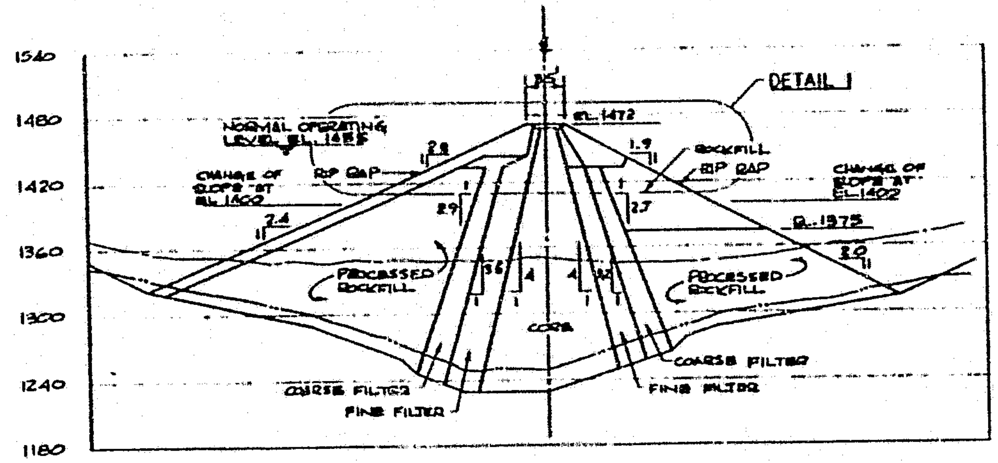

PLAN AT EL 1472
PLAN AT EL 1466
SECTION A-A
SECTION D-D
SECTION B-B
SECTION C-C
SECTION E-E
LEFT ABUTMENT THRUST BLOCK
RIGHT ABUTMENT THRUST BLOCK
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON
THRUST BLOCKS
MARCH 1982
PLATE
74
ACRES AMERICAN INCORPORATED



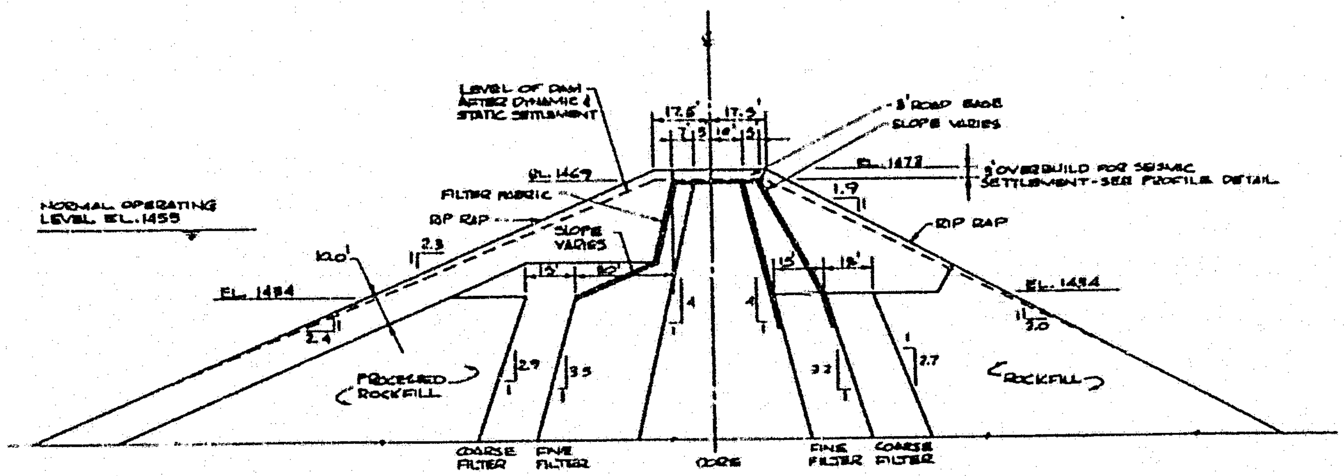
PROFILE (LOOKING UPSTREAM)
SCALE A



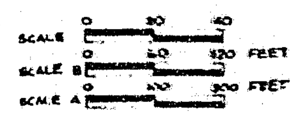
PROFILE
SHOWING CREST ELEVATIONS
NTS



SECTION THROUGH SADDLE DAM
SCALE B



DETAIL 1
CREST AT MAXIMUM HEIGHT SECTION
SCALE C



ACRES

ALASKA POWER AUTHORITY

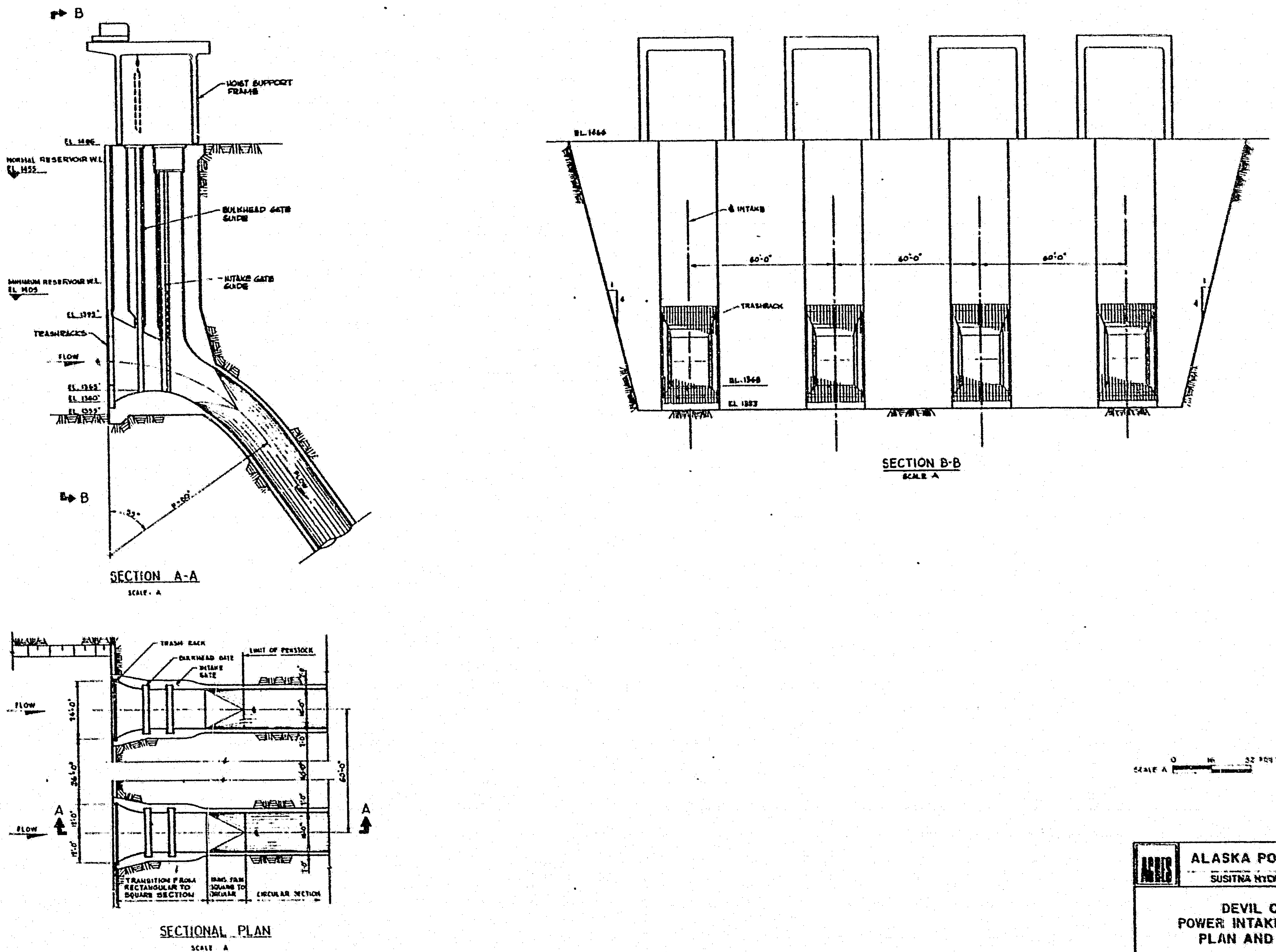
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON SADDLE DAM GENERAL ARRANGEMENT SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 76



ALASKA POWER AUTHORITY

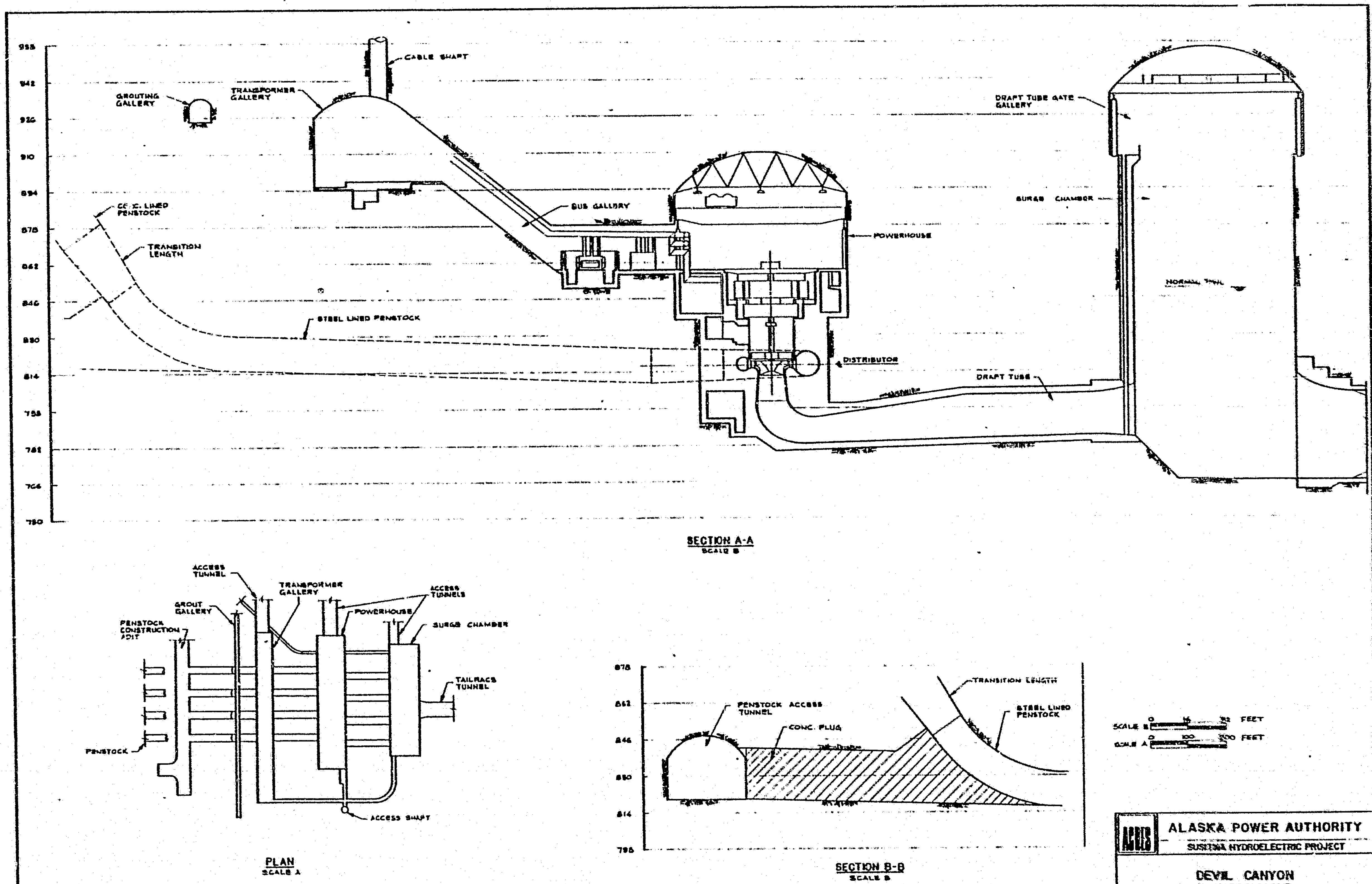
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
POWER INTAKE STRUCTURE
PLAN AND SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 83



ALASKA POWER AUTHORITY

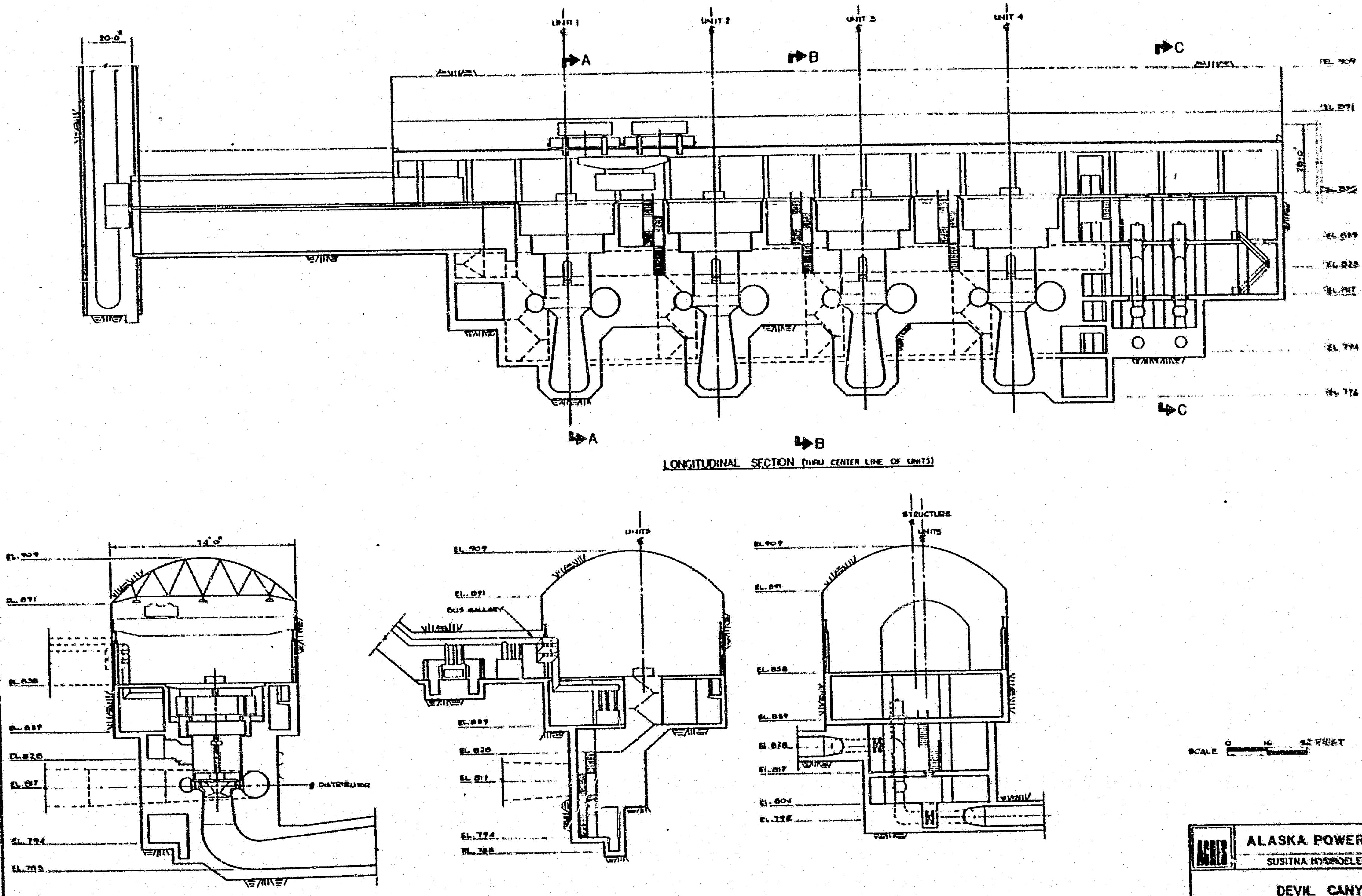
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON POWERHOUSE PLAN & SECTIONS

MARCH 1982

PLATE 86

ACRES AMERICAN INCORPORATED



LONGITUDINAL SECTION (THRU CENTER LINE OF UNITS)

SECTION A-A (SECTION THRU CENTER LINE UNIT)

SECTION B-B (SECTION THRU BUS GALLERY)

SECTION C-C (SECTION THRU SERVICE BAY)

ALASKA POWER AUTHORITY

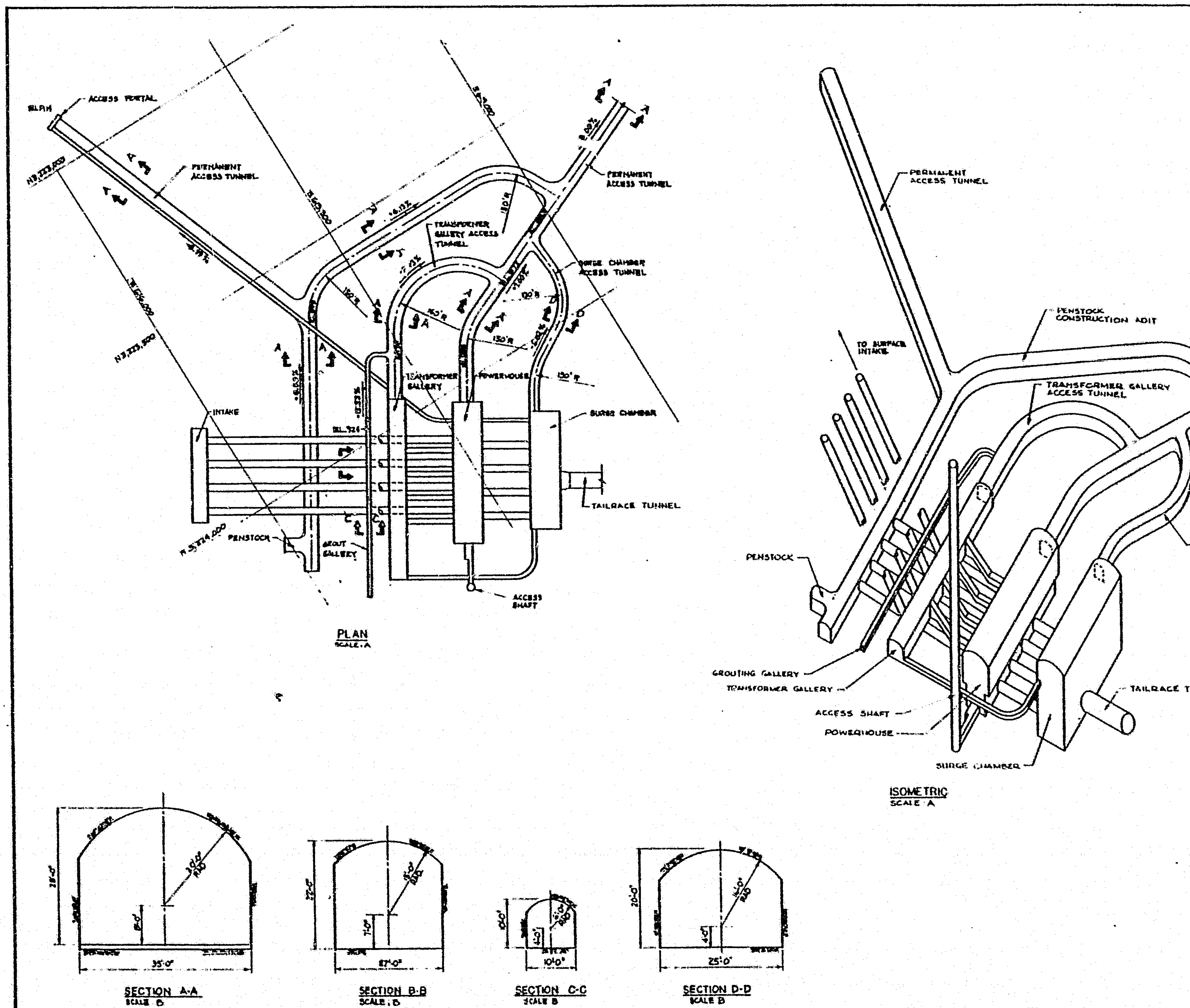
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON POWERHOUSE SECTIONS

MARCH 1982

PLATE 87

ACRES AMERICAN INCORPORATED



ALASKA POWER AUTHORITY

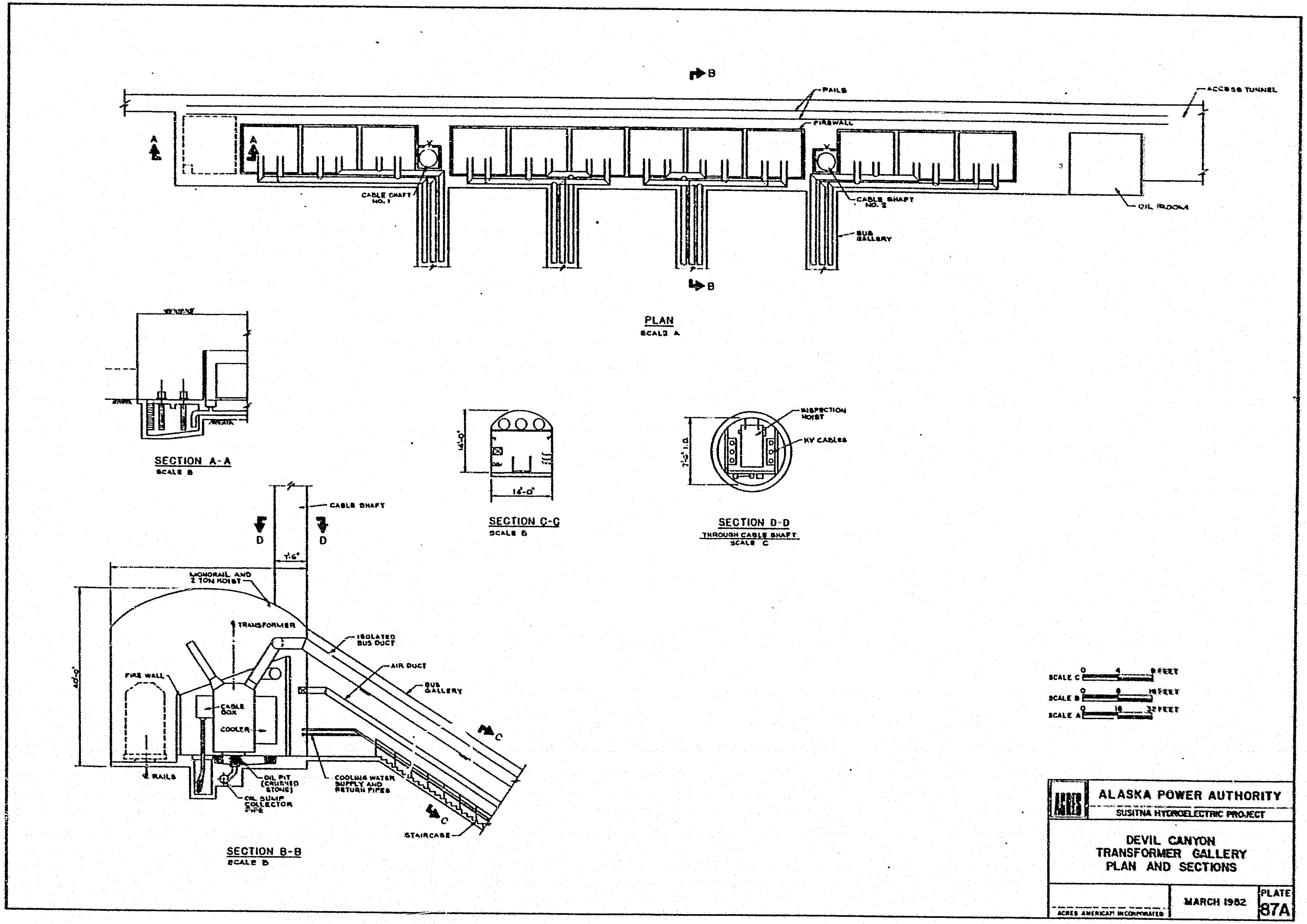
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON POWER FACILITIES ACCESS

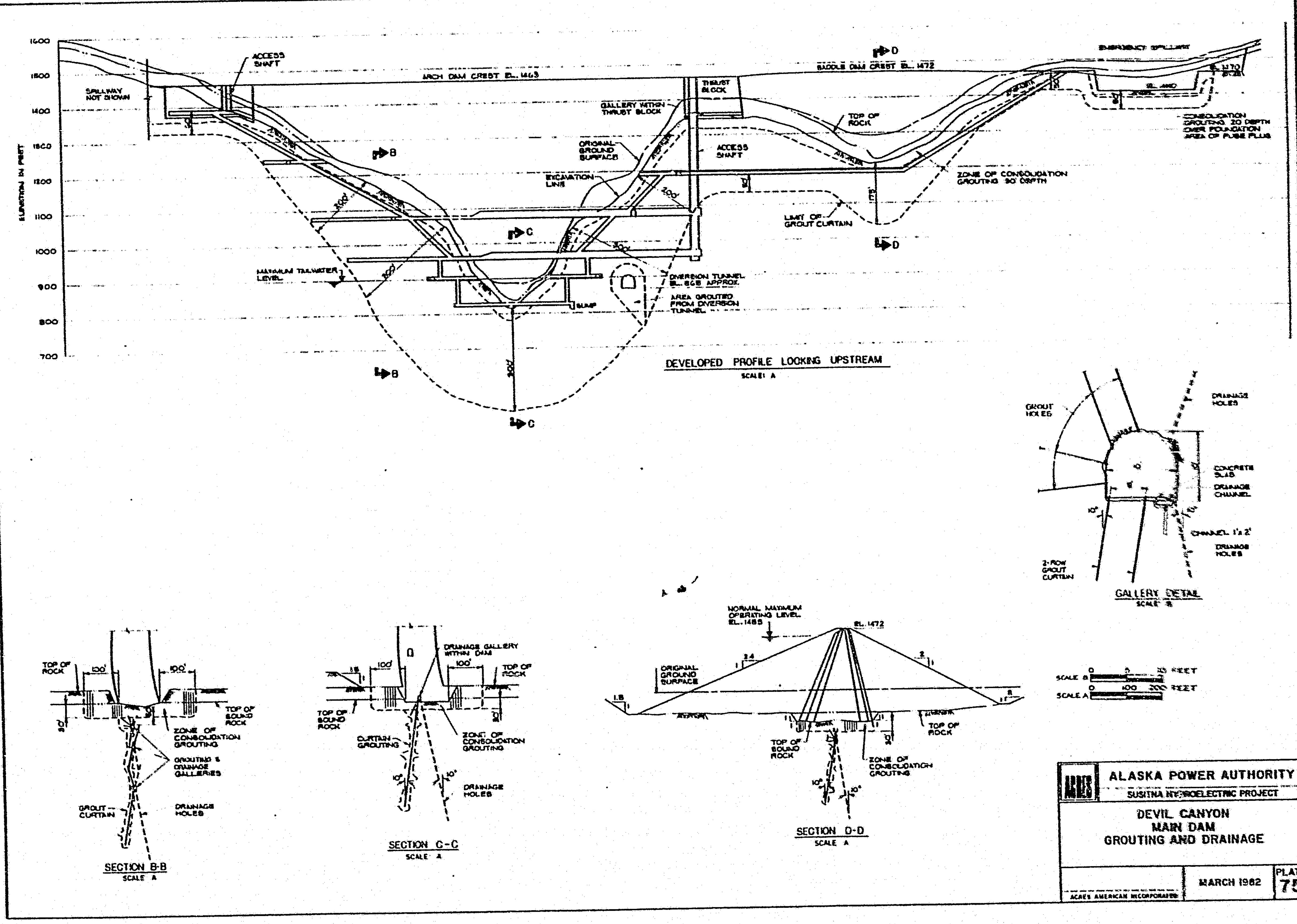
ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 84



B
RAILS
ACCESS TUNNEL
FIREWALL
A
CABLE SHAFT NO. 1
CABLE SHAFT NO. 2
BUS GALLERY
OIL ROOM
PLAN
SCALE A
SECTION A-A
SCALE B
14'-0"
16'-0"
SECTION C-C
SCALE B
INSPECTION HOIST
KV CABLES
SECTION D-D
THROUGH CABLE SHAFT
SCALE C
CABLE SHAFT
D
7'-6"
MONORAIL AND 2 TON HOIST
TRANSFORMER
ISOLATED BUS DUCT
AIR DUCT
BUS GALLERY
FIRE WALL
CABLE BOX
COOLER
40'-0"
C
RAILS
OIL PIT (CRUSHED STONE)
OIL SUMP COLLECTOR PIPE
COOLING WATER SUPPLY AND RETURN PIPES
STAIRCASE
SECTION B-B
SCALE B
SCALE C 0 4 8 FEET
SCALE B 0 8 16 FEET
SCALE A 0 16 32 FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON
TRANSFORMER GALLERY
PLAN AND SECTIONS
ACRES AMERICAN INCORPORATED
MARCH 1982
PLATE 87A



ALASKA POWER AUTHORITY

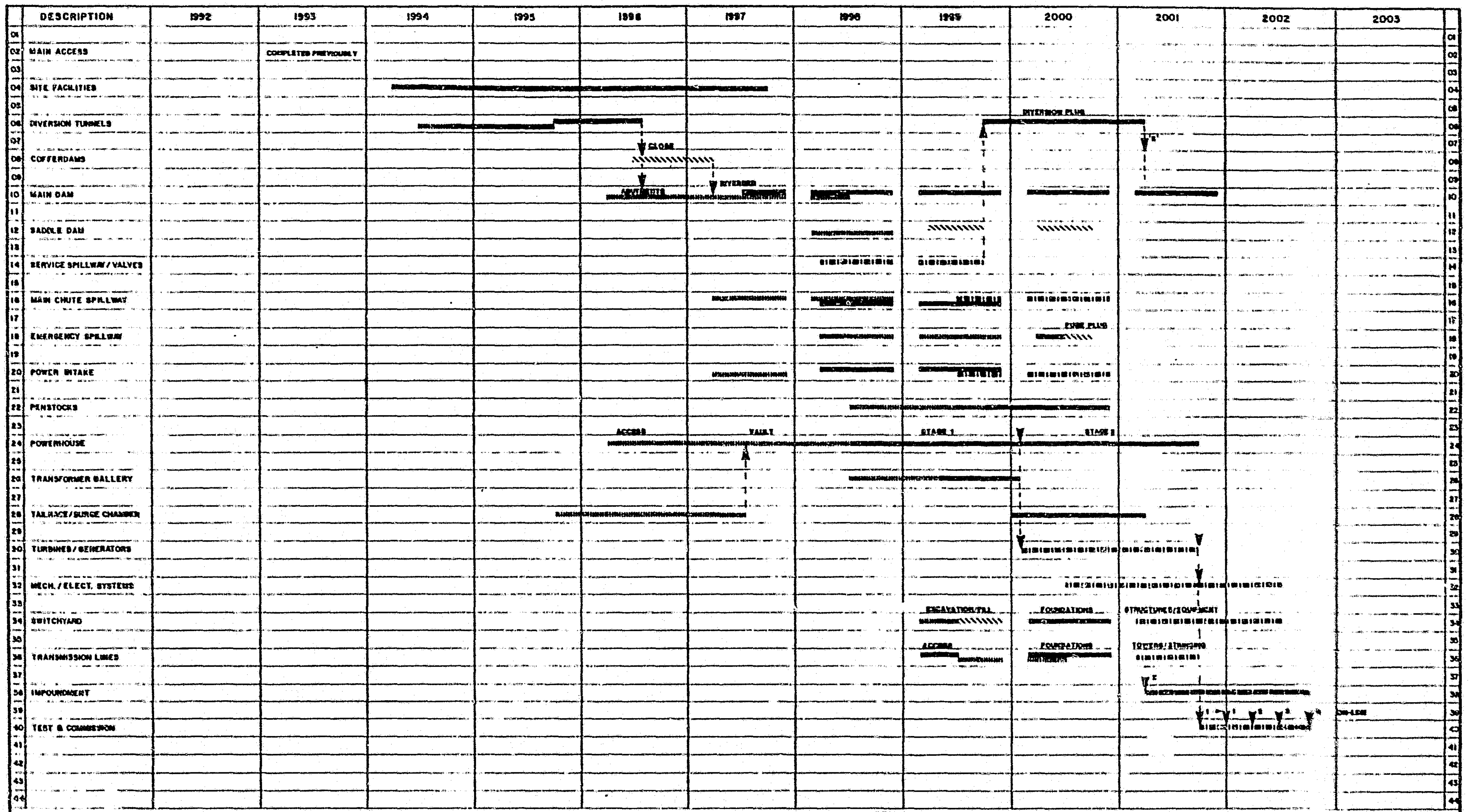
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
MAIN DAM
GROUTING AND DRAINAGE

MARCH 1982

PLATE 75

ACRES AMERICAN INCORPORATED



LEGEND

- ACCESS /FACILITIES
- EXCAVATION/FOUNDATION TREATMENT
- FILL
- CONCRETE
- MECHANICAL ELECTRICAL
- IMPOUNDMENT

ISSUED 30JAN82

ACRES

ALASKA POWER AUTHORITY

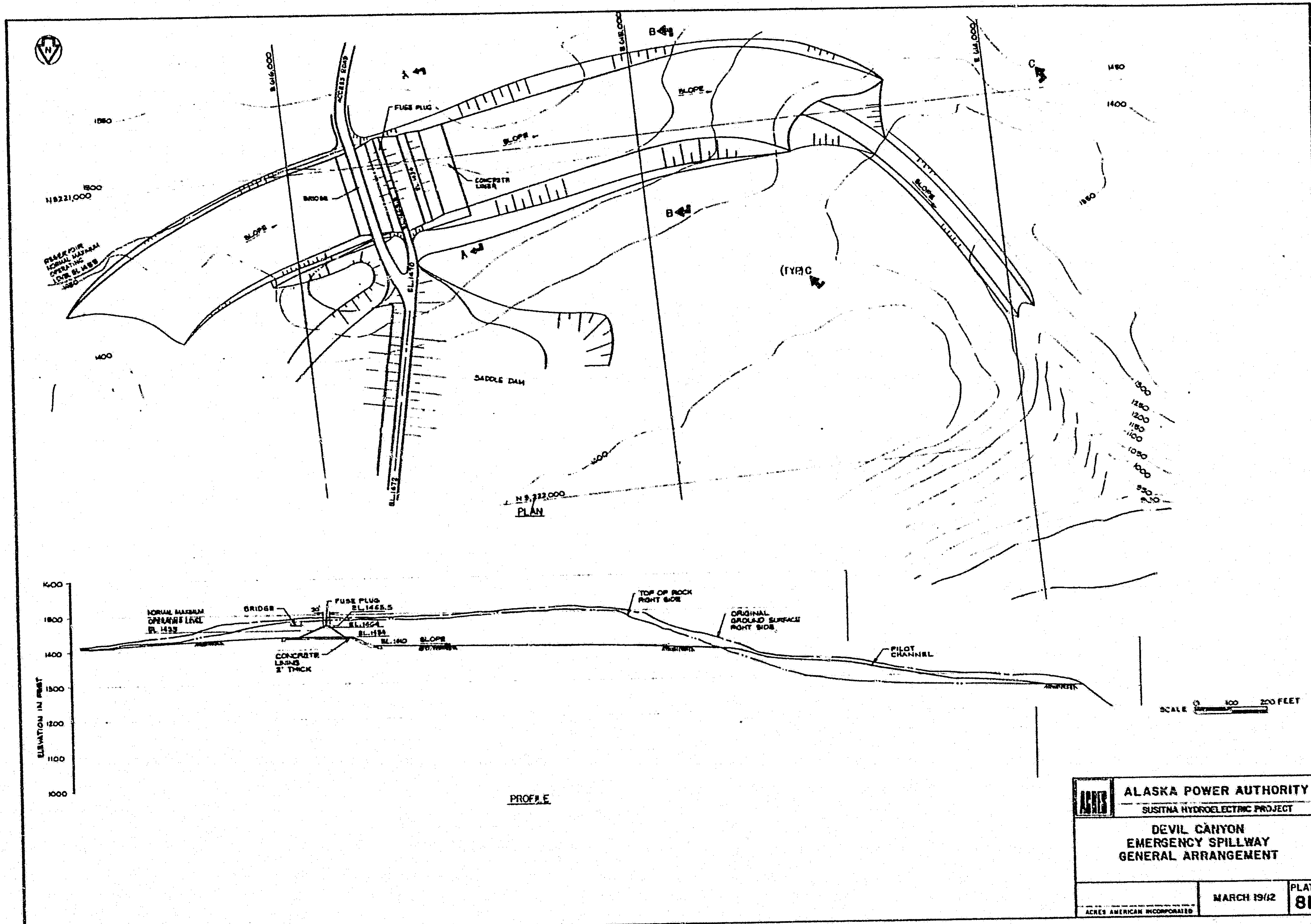
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
CONSTRUCTION SCHEDULE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 91



ALASKA POWER AUTHORITY

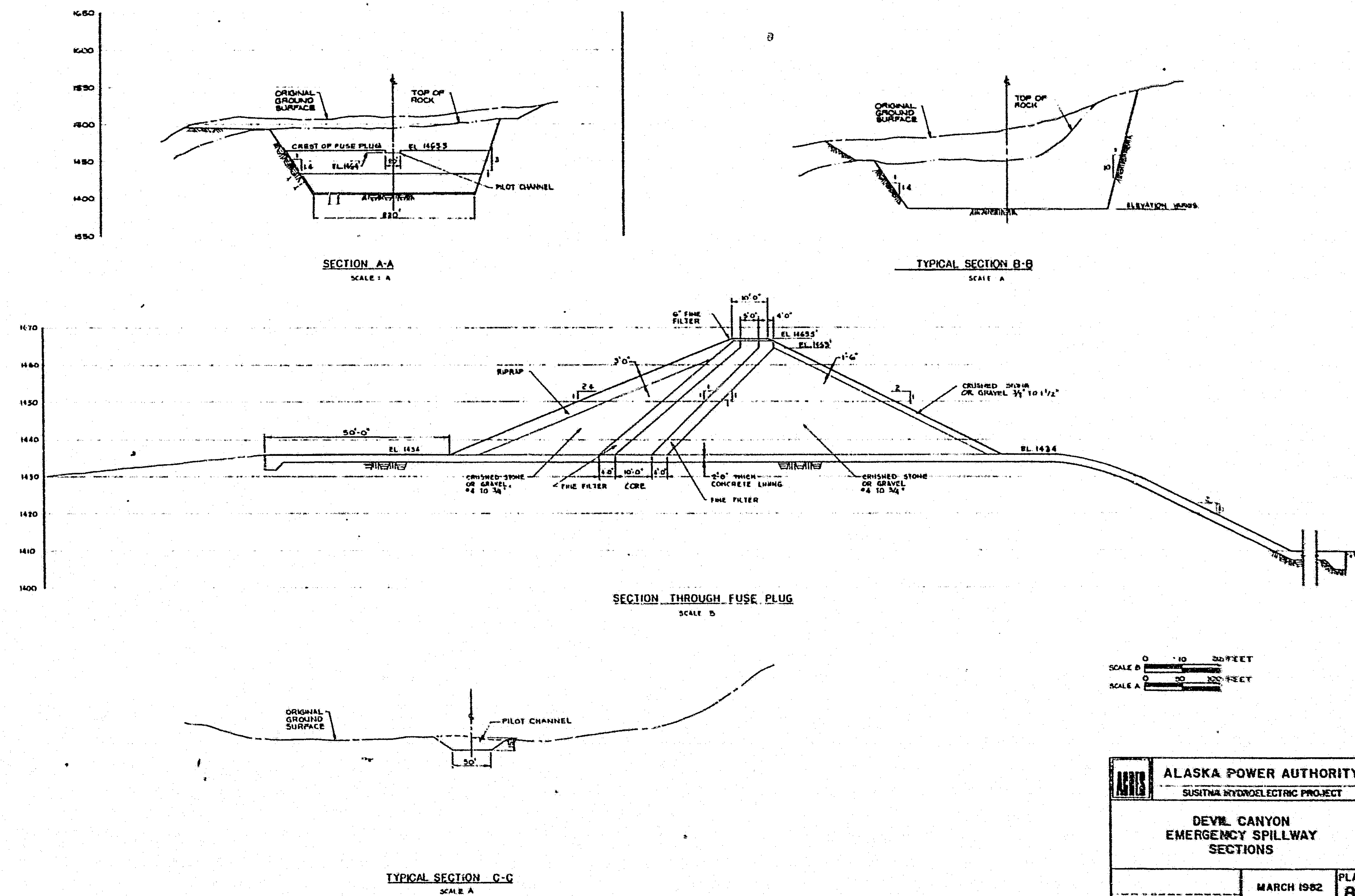
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON EMERGENCY SPILLWAY GENERAL ARRANGEMENT

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 81



ALASKA POWER AUTHORITY

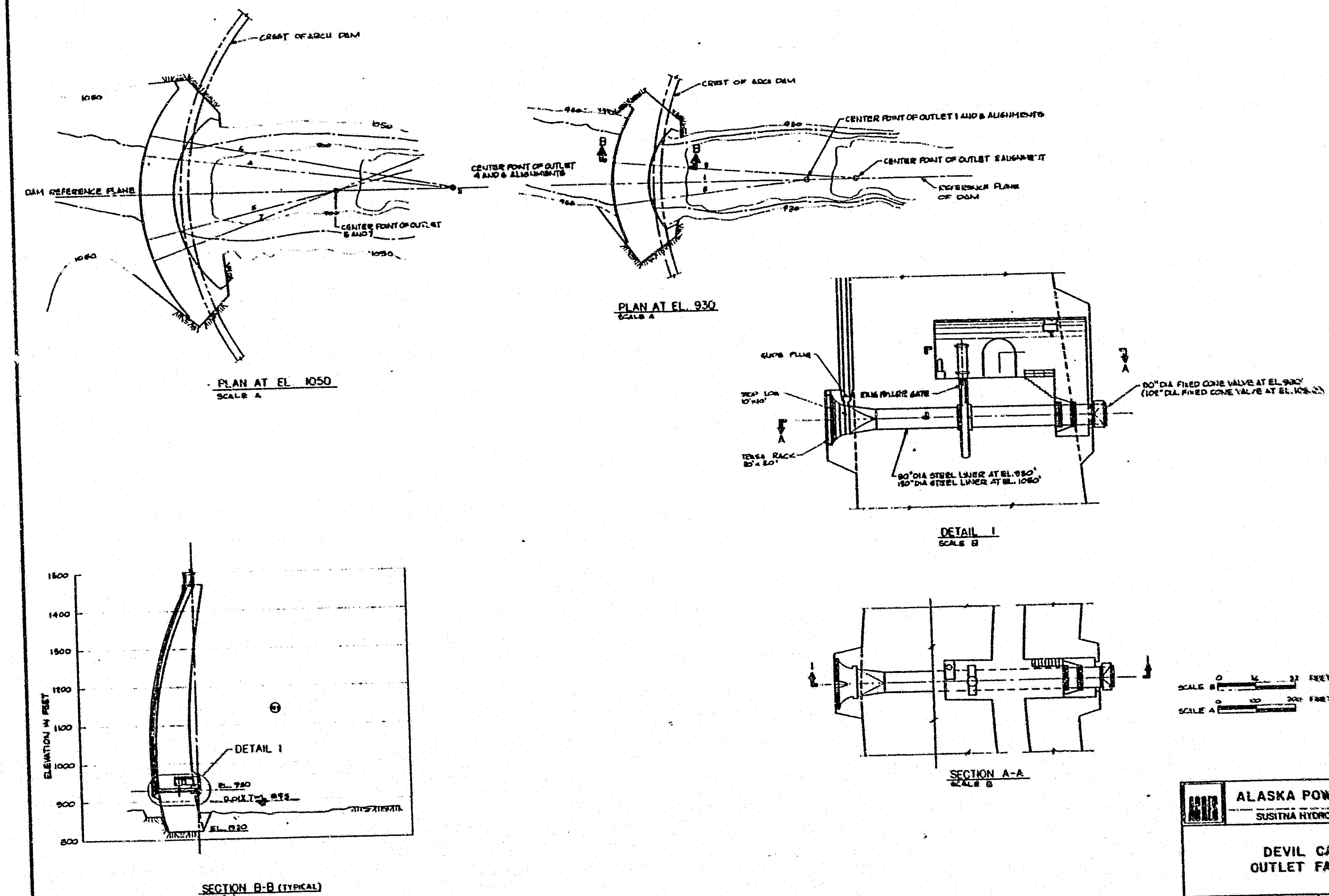
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON EMERGENCY SPILLWAY SECTIONS

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 82



ALASKA POWER AUTHORITY

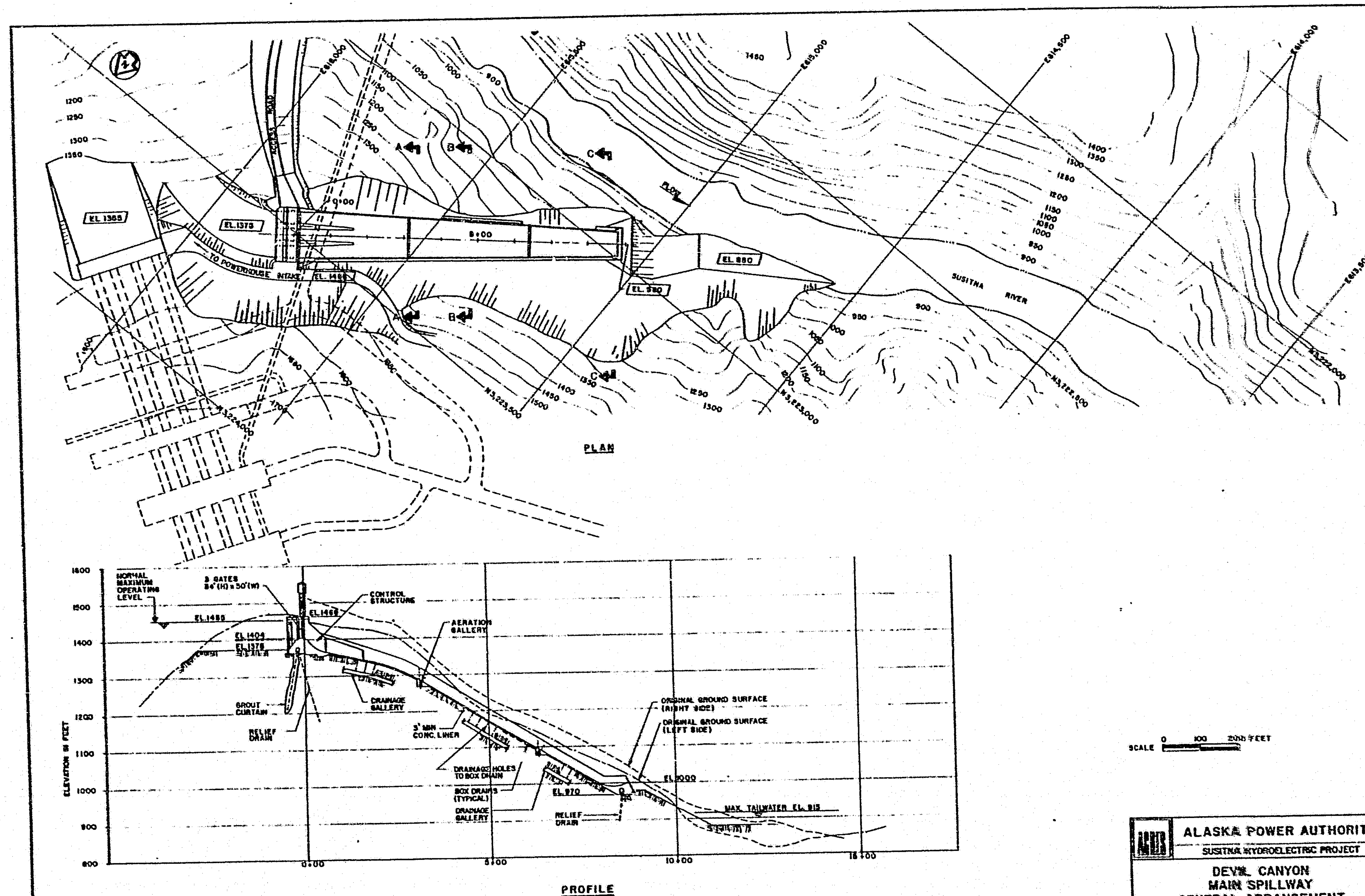
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON OUTLET FACILITIES

MARCH 1982

PLATE 76A

ACRES AMERICAN INCORPORATED



ALASKA POWER AUTHORITY

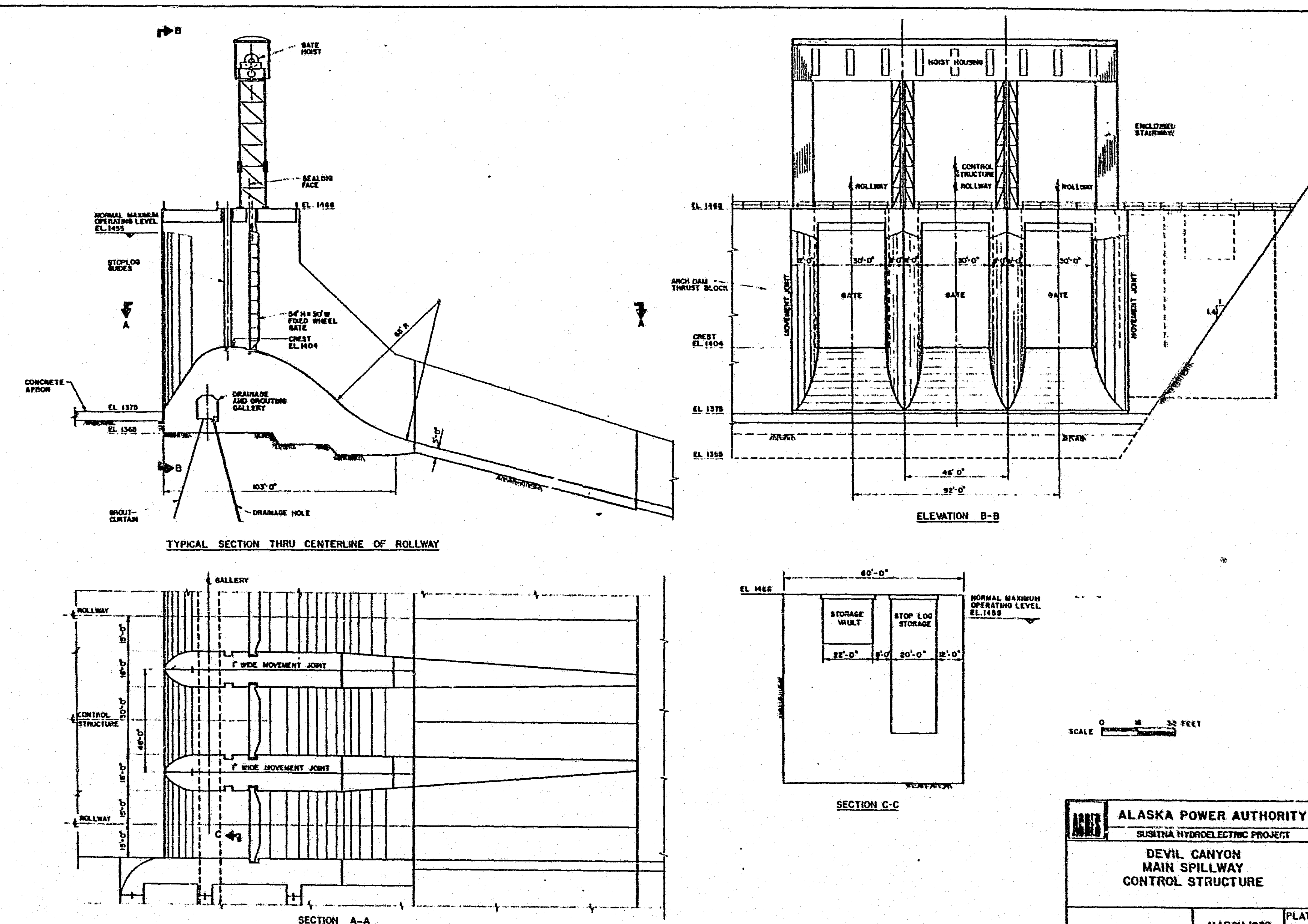
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
MAIN SPILLWAY
GENERAL ARRANGEMENT
PLAN AND PROFILE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 77



ALASKA POWER AUTHORITY

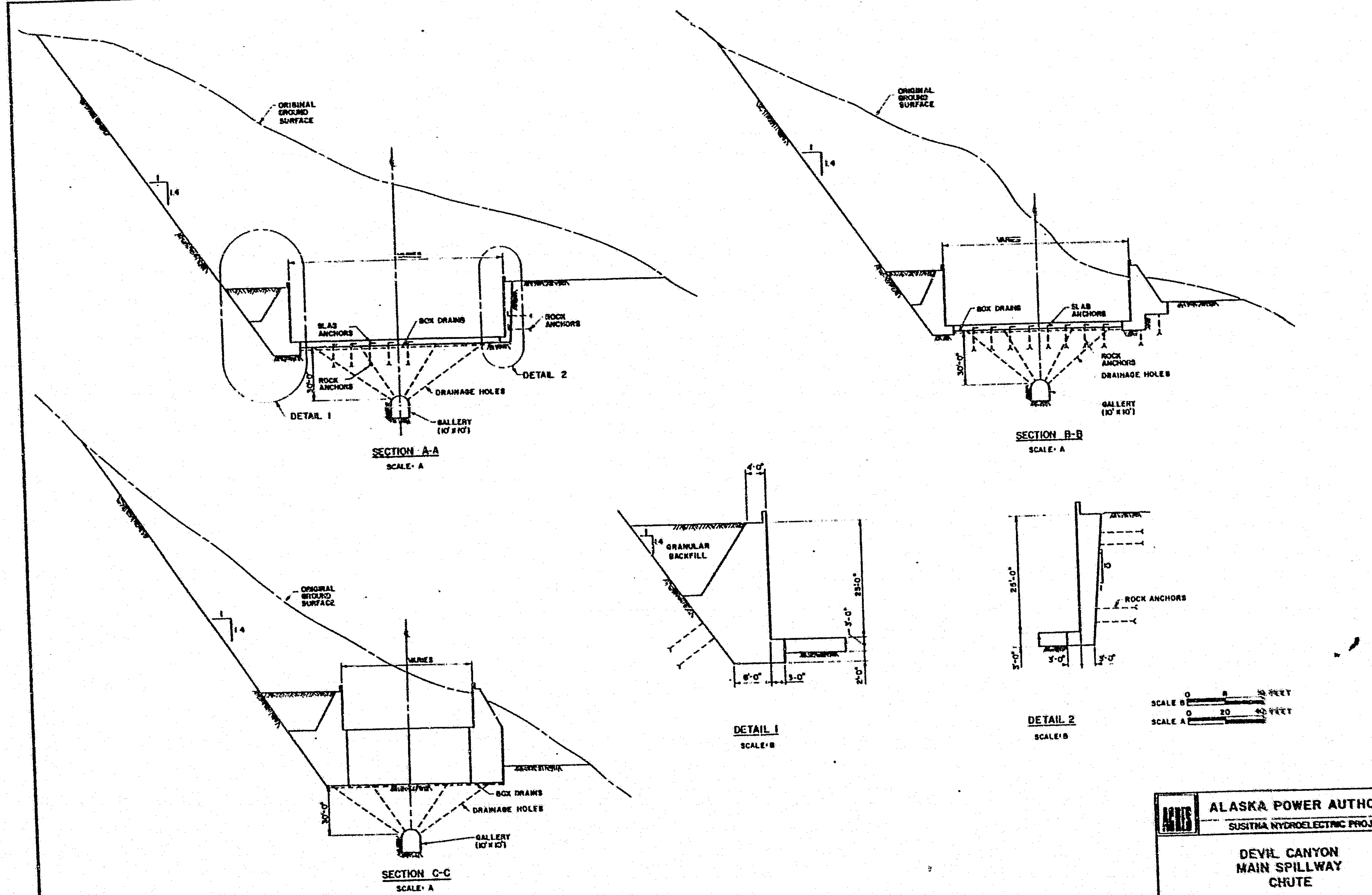
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON MAIN SPILLWAY CONTROL STRUCTURE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 78



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON MAIN SPILLWAY CHUTE

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 79

EARTHQUAKE

GROUND MOTIONS

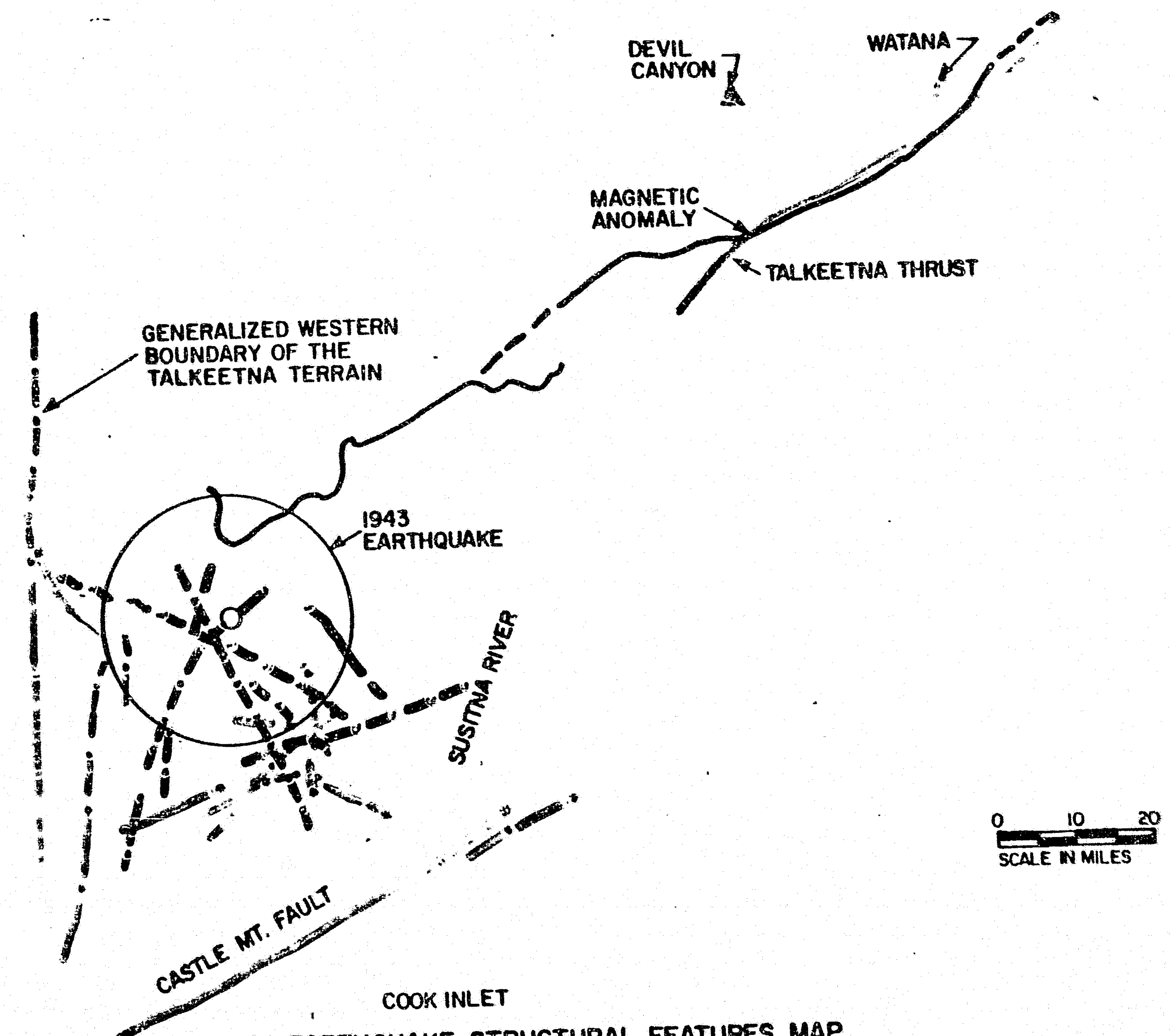
SOURCE	BENIOFF	TERRAIN	
MAGNITUDE	8½	6	6½
SIGNIFICANT DURATION (SEC)	45	6	10
WATANA			
DISTANCE (KM)	63	10	10
MEAN PEAK ACCELERATION (G)	0.35	0.50	?
84TH PERCENTILE ACCELERATION (G)	?	?	?
DEVIL CANYON			
DISTANCE (KM)	90	10	10
MEAN PEAK ACCELERATION (G)	0.30	0.50	0.50
84TH PERCENTILE ACCELERATION (G)	?	?	?

DR. SYKES REVIEW

OF WCC REPORT

TERRAIN EQ.
MAGNITUDE
6¼ TO 6½

1943 EARTHQUAKE
RELATIONSHIP TO
SITES

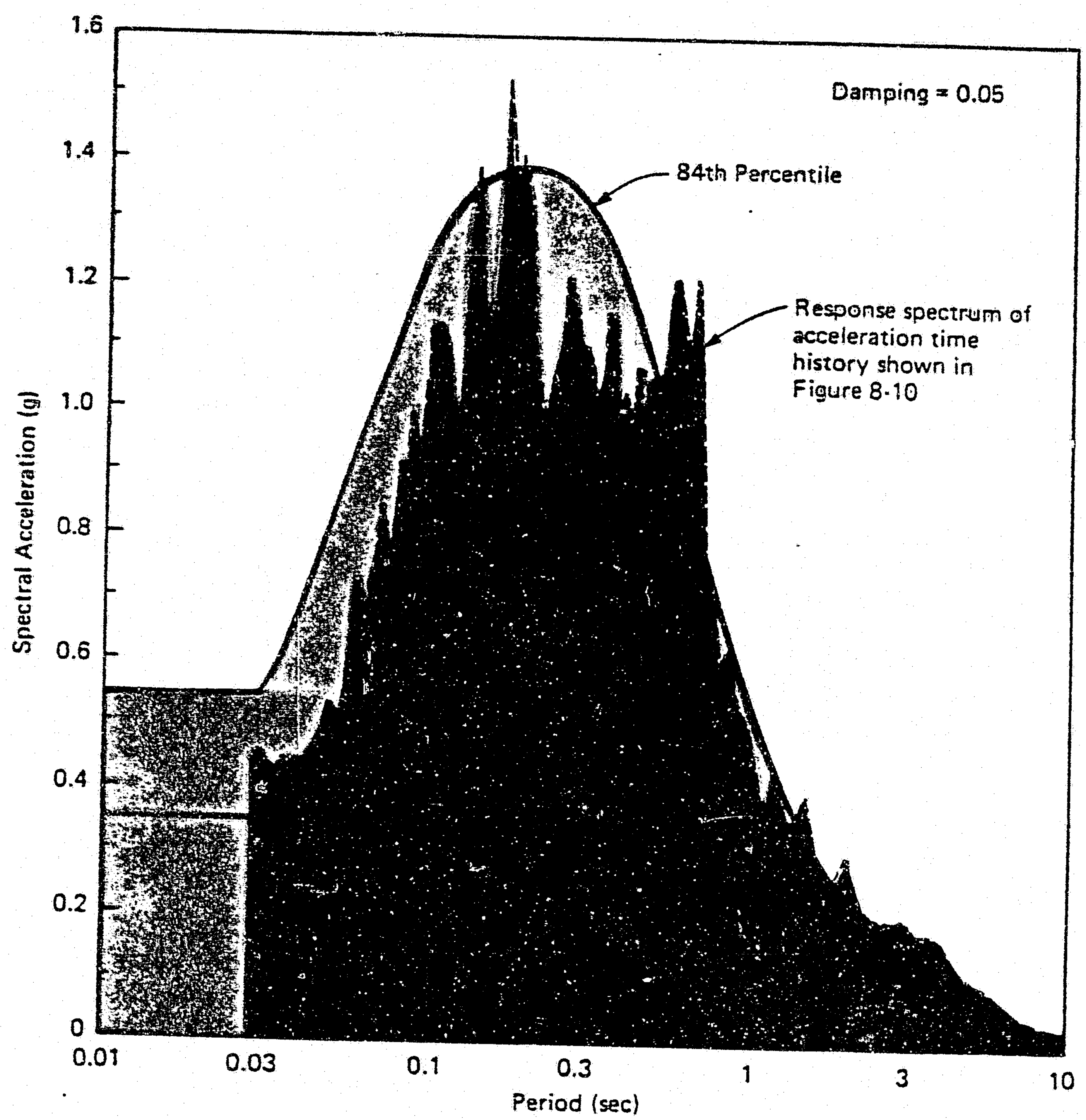


1943 EARTHQUAKE STRUCTURAL FEATURES MAP

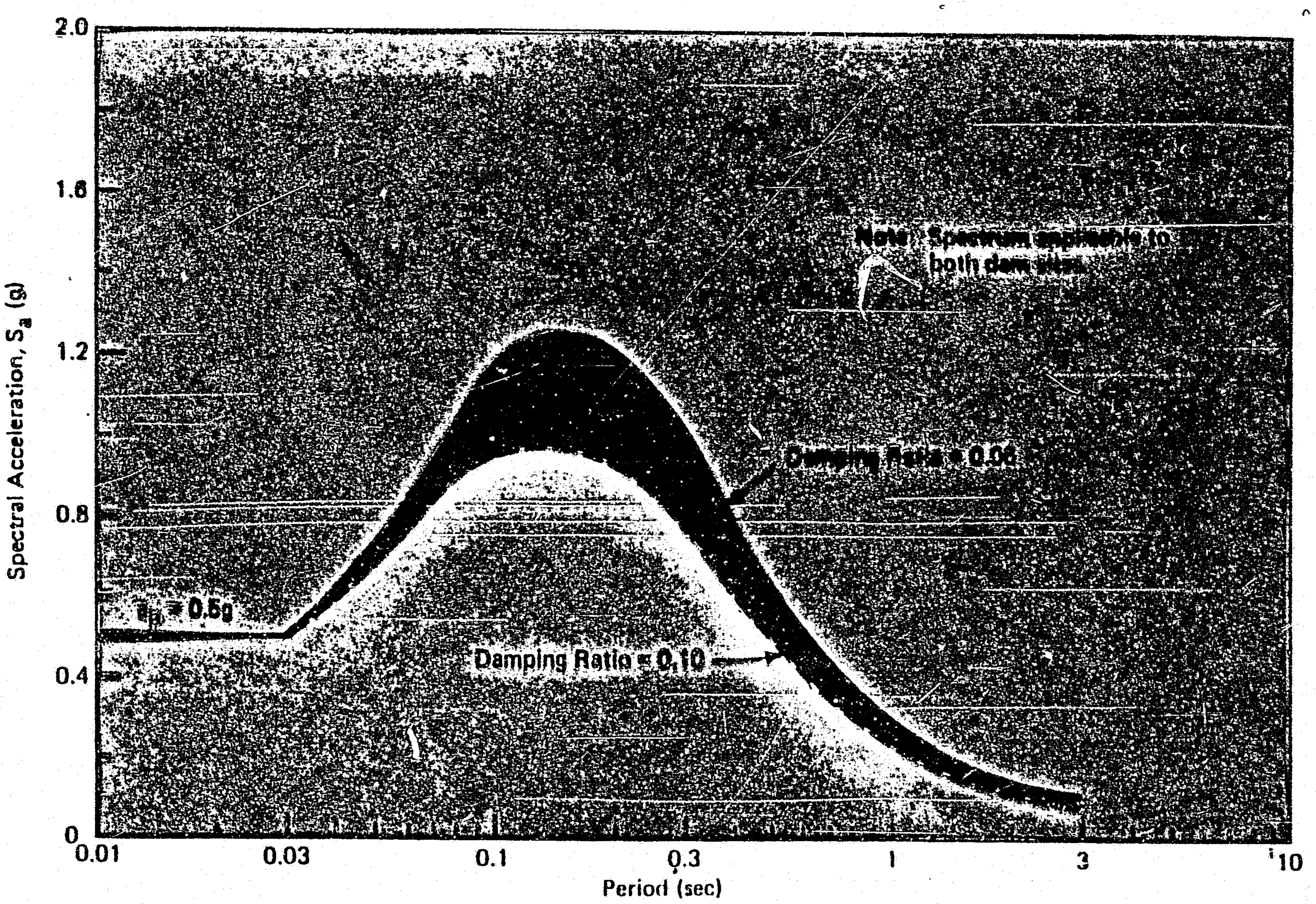
APPROACH TO SEISMIC DESIGN OF STRUCTURES

- DETERMINISTIC
- FILL DAMS - TIME HISTORY DYNAMIC ANALYSIS
- ARCH DAM - RESPONSE SPECTRA - TRIAL LOAD (ADSAS) ANALYSIS

4



RESPONSE SPECTRA FOR A MAXIMUM EARTHQUAKE ON THE BENIOFF ZONE



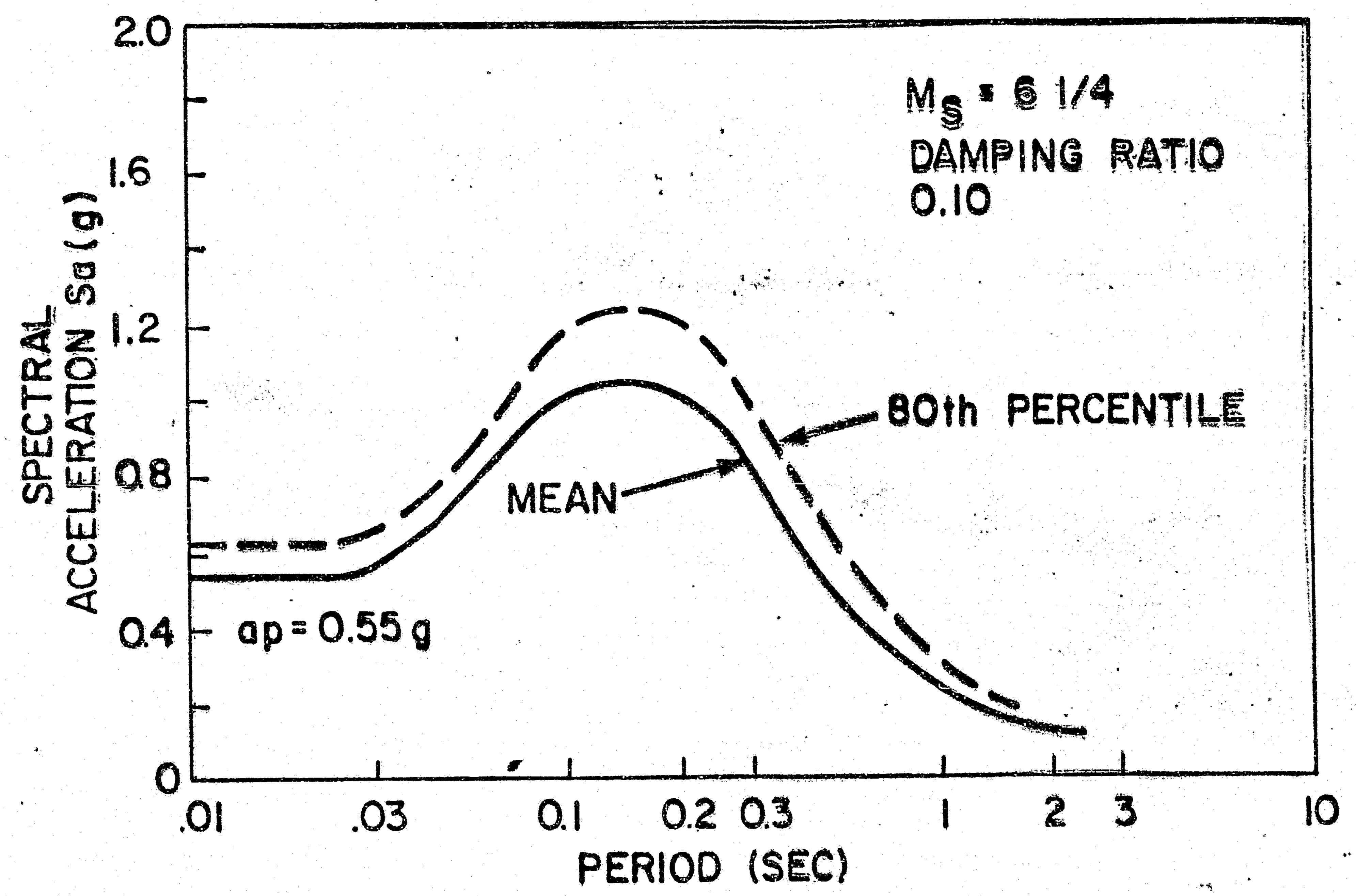
MEAN RESPONSE SPECTRA FOR MAXIMUM
TERRAIN EARTHQUAKES

EARTHQUAKE GROUND MOTIONS

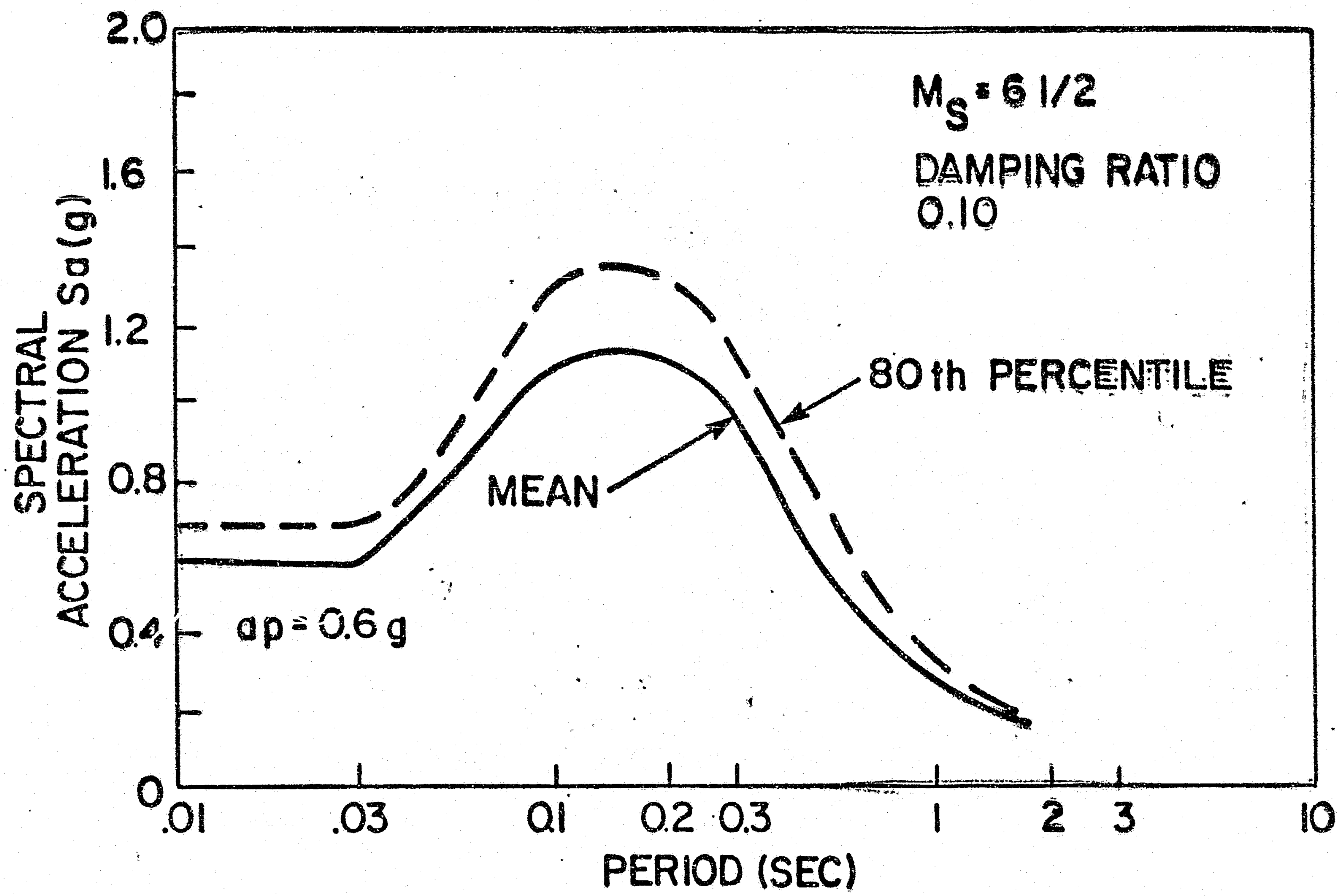
SOURCE	BENIOFF	TERRAIN	
MAGNITUDE	8 1/2	6	6 1/2
SIGNIFICANT DURATION (SEC)	45	6	~10
WATANA			
DISTANCE (KM)	63	<10	<10
MEAN PEAK ACCELERATION (g)	0.35	0.50	0.60?
84th PERCENTILE ACCELERATION (g)	0.55	0.60?	0.70?
DEVIL CANYON			
DISTANCE (KM)	90	<10	<10
MEAN PEAK ACCELERATION (g)	0.30	0.50	0.60?
84th PERCENTILE ACCELERATION (g)	0.47	0.60?	0.70?

ARCH DAM

- SAFETY EVALUATION EARTHQUAKE (SEE D)
- BASED ON TERRAIN EARTHQUAKE MOTIONS
- MAGNITUDE "6 1/4 TO 6 1/2" CENTER 10 KM FROM DAM
- STRUCTURE DESIGNED ~~TO WITHSTAND~~ USING EFFECTIVE PEAK ACCELERATION OF 0.8 x 80th PERCENTILE SEE ACCELERATION



MEAN RESPONSE SPECTRA
MAX. TERRAIN EQS



MEAN RESPONSE SPECTRA
MAX. TERRAIN EQS

APPROACH TO
SEISMIC DESIGN
OF STRUCTUES

- DETERMINISTIC
- FILL DAMS - TIME HISTORY DYNAMIC ANALYSIS
- ARCH DAM - RESPONSE SPECTRA - TRIAL LOAD (ADSAS) ANALYSIS

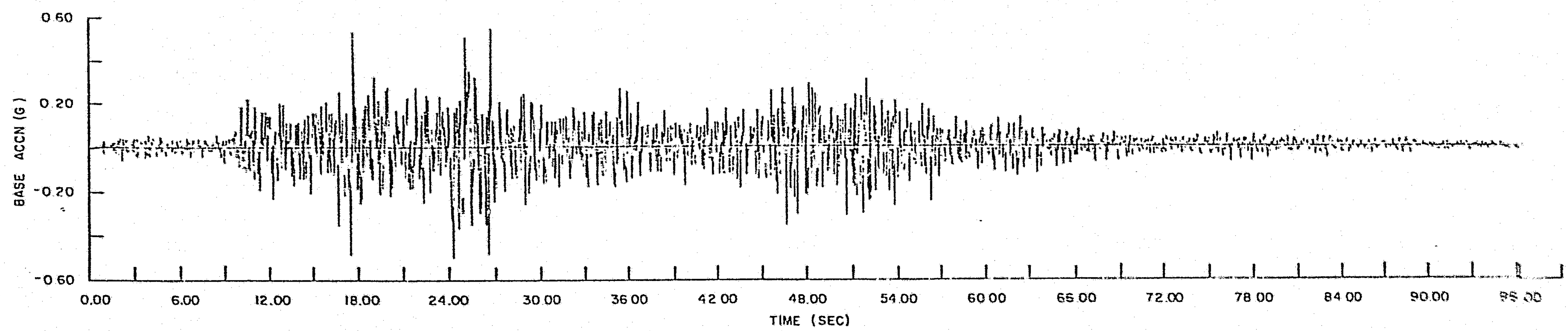
ARCH DAM

- SAFETY EVALUATION
  EARTHQUAKE (SEE)

- BASED ON TERRAIN
  EARTHQUAKE MOTIONS

- MAGNITUDE "6¼ TO 6½"
  CENTER 10KM FROM DAM

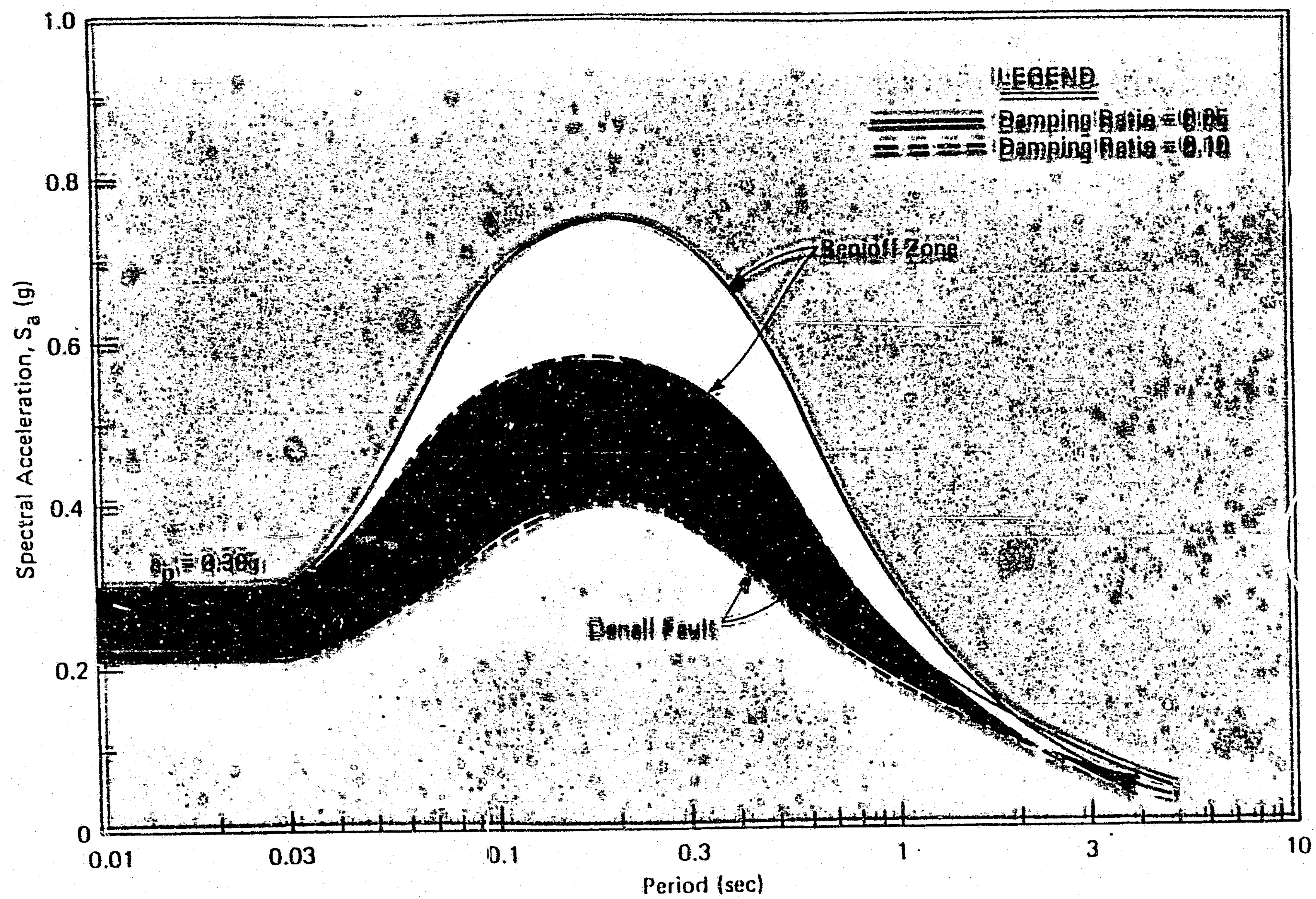
- STRUCTURE DESIGNED TO
  WITHSTAND EFFECTIVE
  PEAK ACCELERATION OF
  0.8 x 80TH PERCENTILE
  SEE ACCELERATION



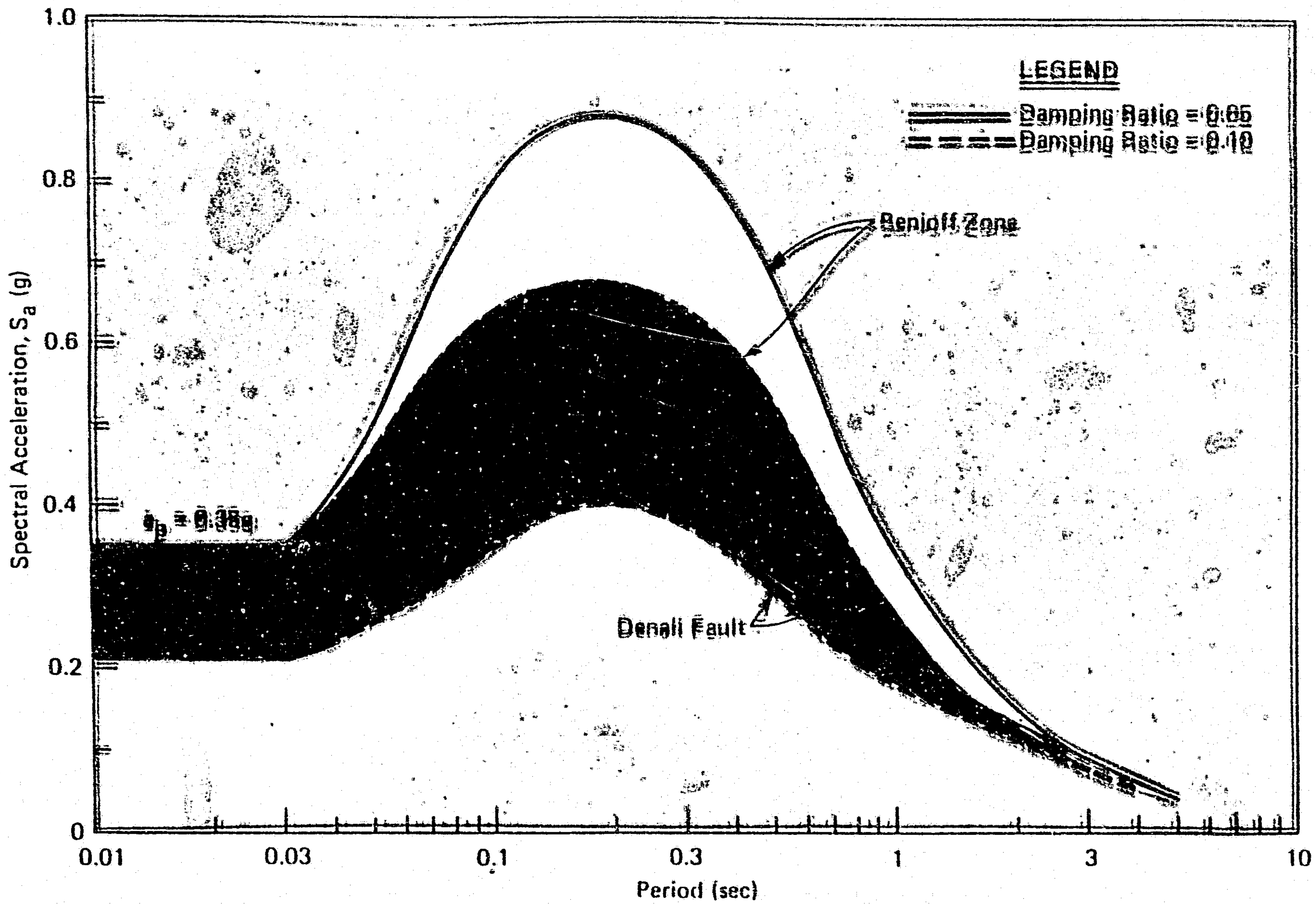
EARTHQUAKE TIME HISTORY

FIGURE B6.17

ACRES

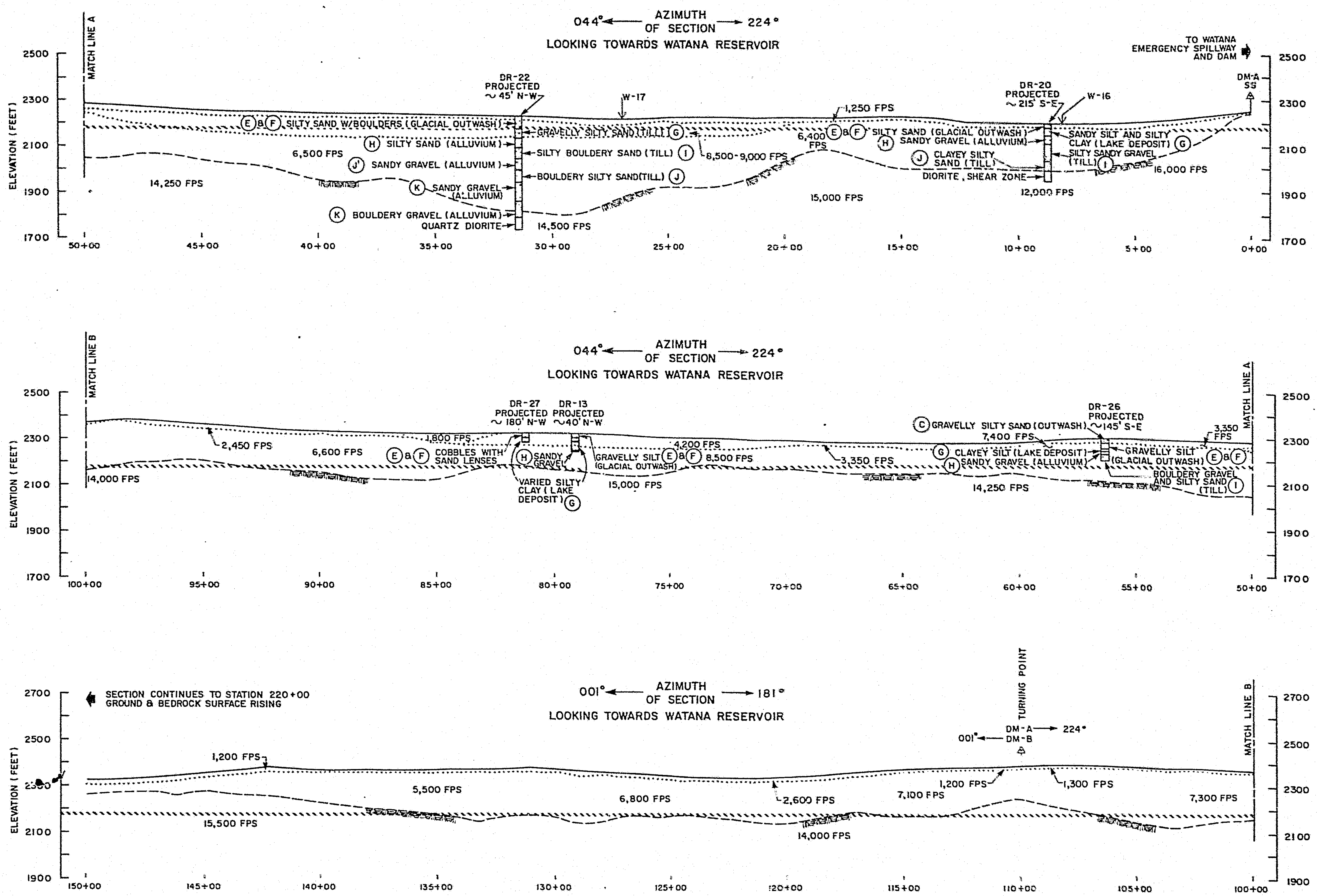


MEAN RESPONSE SPECTRA FOR MAXIMUM EARTHQUAKES
ON THE BENIOFF ZONE AND DENALI FAULT -
DEVIL CANYON DAM SITE



MEAN RESPONSE SPECTRA FOR MAXIMUM EARTHQUAKES
ON THE BENIOFF ZONE AND DENALI FAULT
WATANA DAM SITE

15. PRESENTATION BY S. N. THOMPSON



LEGEND

LITHOLOGY:

BEDROCK (INFERRED TO BE DIORITE)

OVERBURDEN, STRATIGRAPHIC UNITS AS SHOWN

CONTACTS:

APPROXIMATE TOP OF ROCK

NORMAL MAXIMUM OPERATING LEVEL EL. 2185

BOREHOLES: DR-20

(G) STRATIGRAPHY

DR-20 COE ROTARY DRILL BORING

GEOPHYSICAL SURVEYS:

DM-A SEISMIC REFRACTION SURVEY END OR TURNING POINT - 1975, DAMES & MOORE

SEISMIC VELOCITY CHANGE

12,000 FPS SEISMIC VELOCITY IN FEET PER SECOND

OTHER:

W-16 INTERSECTION WITH CROSS SECTION W-16

NOTES

1. SECTIONS READ FROM TOP TO LOWER LEFT (STA. 0+00 TO 150+00) SEISMIC LINES DM-A & B
2. SECTION LOCATION SHOWN ON FIGURE 6.35
3. SECTIONS W-16 & W-17 SHOWN ON FIGURE 6.35
4. VERTICAL AND HORIZONTAL SCALE EQUAL
5. SECTION ELEVATIONS FROM COE 1" = 200' TOPOGRAPHY, 1978.
6. SECTION COINCIDES CLOSELY WITH DIVIDE BETWEEN SUSITNA RIVER AND TSUSENA CREEK DRAINAGES. THIS SECTION REPRESENTS NARROWEST RELICT CHANNEL WIDTH WHERE GROUND SURFACE IS ABOVE MAXIMUM POOL ELEVATION.
7. SECTION LIES ON DAMES AND MOORE SEISMIC LINE DM-A AND DM-B, 1975.
8. SEISMIC LINE ELEVATIONS CORRECTED AS PER COE SURVEY AND NPAS AIR PHOTO MAPS, 1978
9. REFER TO TABLE 6.1 FOR SEISMIC VELOCITY AND MATERIAL CORRELATION.
10. SEE FIGURE 6.32 FOR STRATIGRAPHIC COLUMN AND GENERAL NOTES.

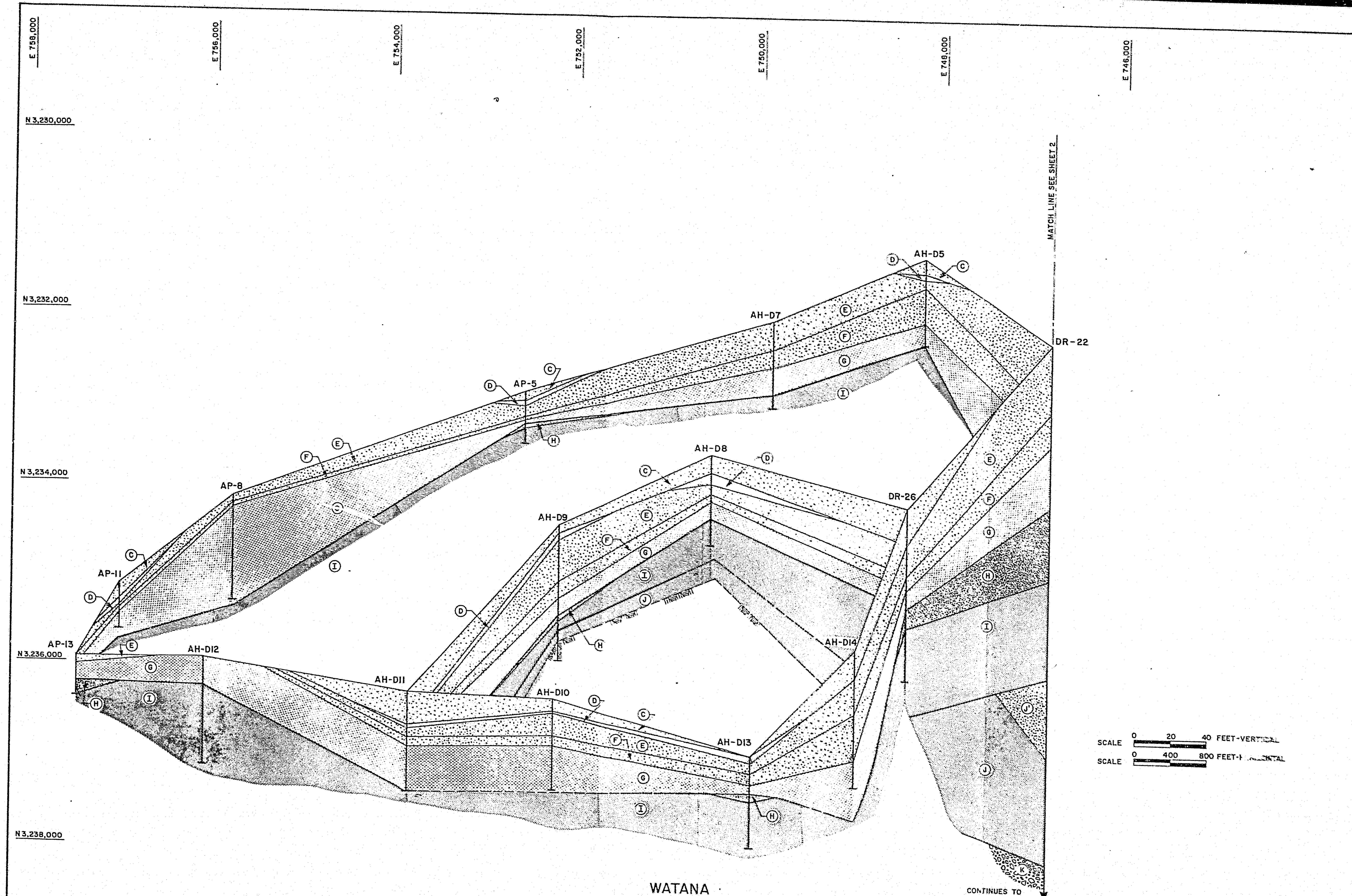
SCALE 0 200 400 FEET

REFERENCE: DAMES & MOORE, 1975.
COE, 1979.

WATANA RELICT CHANNEL SECTION

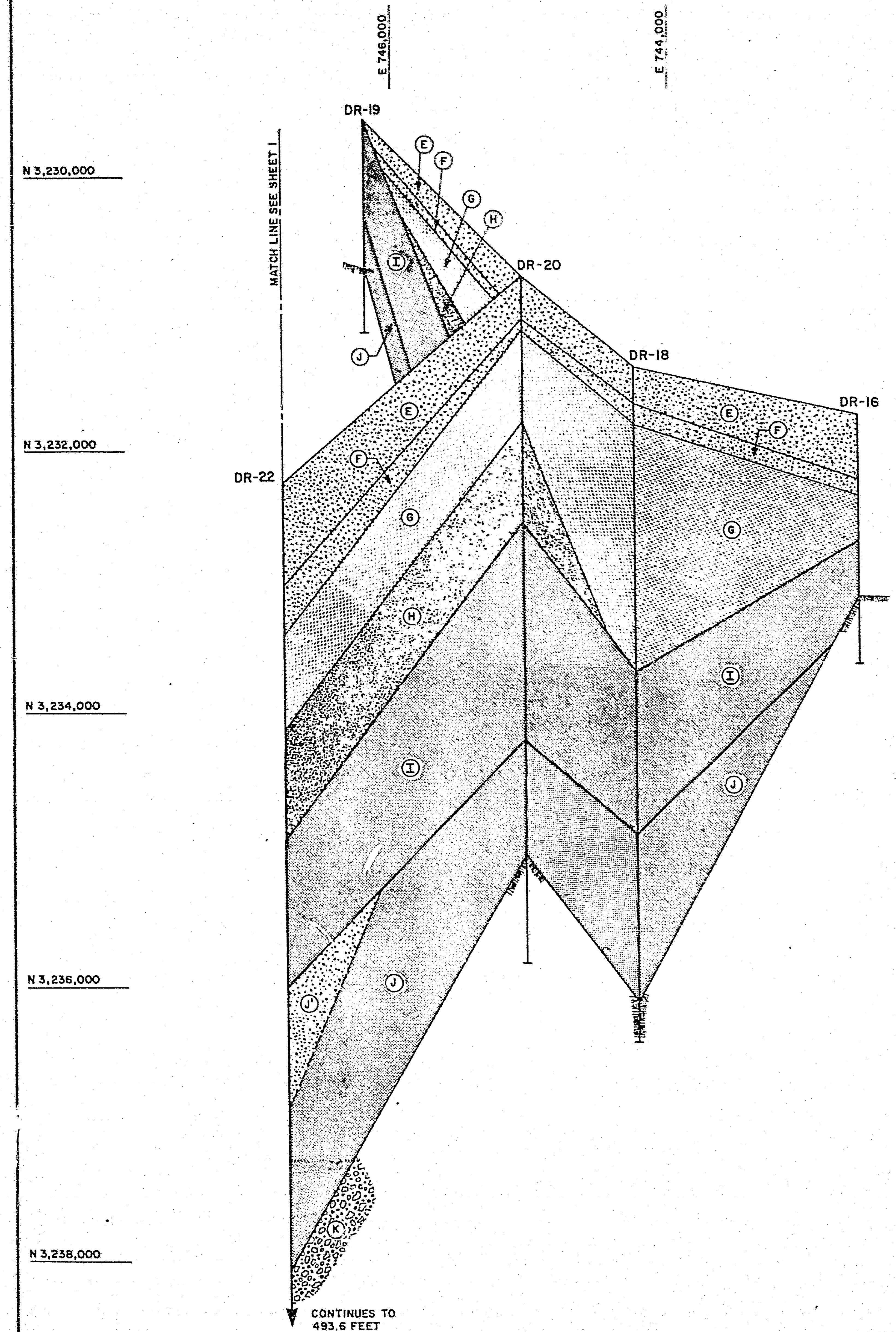
FIGURE 6.31

ACRES



WATANA
RELICT CHANNEL & BORROW SITE D
STRATIGRAPHIC FENCE DIAGRAM
SHEET 1 OF 2

FIGURE 6.32



GENERALIZED STRATIGRAPHIC COLUMN
BORROW SITE D AND RELICT CHANNEL

COLUMN UNIT:		ESTIMATED THICKNESS:	DESCRIPTION:
-	SURFICIAL	0–5'	BOULDERS, ORGANIC SILTS AND SANDS.
C	OUTWASH	0–18' 12' AVERAGE	SILTY SAND WITH SOME GRAVEL AND OCCASIONAL COBBLES. USUALLY BROWN, BECOMES GRAY IN LIMITED AREAS. THICKEST IN NORTHERN PORTIONS OF AREA. THINNING SOUTHWARD, OFTEN ABSENT NEAR SUSITNA RIVER.
D	ALLUVIUM & FLUVIAL DEPOSITS	0–15'	SAND WITH SOME SILT, OCCASIONAL GRAVEL. GENERALLY BROWN, FOUND ONLY ALONG COURSE OF LIMITED DRAINAGE CHANNELS FORMED IN OUTWASH E. GENERALLY SORTED.
E & F	OUTWASH	0–35' 15' AVERAGE	SAND, SILT, GRAVEL AND COBBLES, PARTLY SORTED, WITH FRAGMENTS SUB-ANGULAR TO ROUNDED. SILT AND SAND LENSES OFTEN PRESENT. BROWN TO GRAY BROWN WITH A COBBLE/BOULDER ZONE OFTEN PRESENT AT THE BASE OF UNIT F. CONTACT BETWEEN E & F IS OFTEN POORLY DEFINED.
G	TILL/WATERLAIN TILL	2–50' 12' AVERAGE	CLAYEY, SILTY SAND, USUALLY GRAY, OFTEN PLASTIC. CONTAINS COBBLES AND GRAVEL IN MANY AREAS. OCCASIONALLY PRESENT AS A LACUSTRINE DEPOSIT SHOWING LAMINATIONS AND/OR VARVES. GENERALLY A TILL DEPOSITED THROUGH OR NEAR STANDING WATER.
H	ALLUVIUM	0–40'	SAND, SILT, GRAVEL, PARTLY TO WELL SORTED. OFTEN ABSENT BETWEEN UNITS G & I UNIT REPRESENTS PERIOD OF MELTING PRODUCING ALLUVIUM/OUTWASH BETWEEN THESE DEPOSITS. APPEARS AS NARROW BANDS REPRESENTING CHANNEL FILLINGS. THICKEST IN WESTERN PORTION OF THE AREA.
I & J	TILL	> 10' TO 65' 20' AVERAGE	POORLY SORTED SAND, SILT, GRAVEL AND COBBLES, OCCASIONALLY WITH CLAY. GENERALLY GRAY TO GRAY BROWN. CONTINUITY UNCERTAIN DUE TO LACK OF INFORMATION AT DEPTH. SILT OR SAND LAYER 2 INCHES-6 INCHES THICK OFTEN FOUND IN CENTER OF UNIT I. BASE UNIT ON TOP OF BEDROCK, EXCEPT IN BURIED CHANNEL THALWEG. CONTACT BETWEEN I & J OFTEN POORLY DEFINED, AND LOCALLY INCLUDES AN ALLUVIUM DESIGNATED J'
J'	ALLUVIUM		
K	ALLUVIUM	TO 160'	SAND, GRAVEL, COBBLES, BOULDERS, FEW FINES, PERMEABLE. FOUND ONLY IN THALWEG OF BURIED CHANNEL. TOP AT 292 FEET, EXTENDING TO ROCK AT 454 FEET IN DEPTH IN DR-22.
	BEDROCK, DIORITE		

NOTES

1 EXPLORATION LOCATIONS SHOWN ON FIGURES 5.1 AND 6.40.

2 FOR LEGEND OF SYMBOLS SEE FIGURE 6.33

3 EXPANDED SECTION FROM DR-13 THROUGH DR-20 SHOWN ON FIGURE 6.33.

4 LETTERS USED TO DEFINE UNITS ARE ARBITRARY AND WERE USED FOR CORRELATION PURPOSES.

5 THE ACCURACY AND THICKNESS OF SOIL AND ROCK STRATA IS SUBJECT TO VERIFICATION.

6 THIS FIGURE IS GENERALIZED FOR GRAPHIC PRESENTATION FOR MORE SPECIFIC INFORMATION REFER TO TEXT AND BORING LOGS

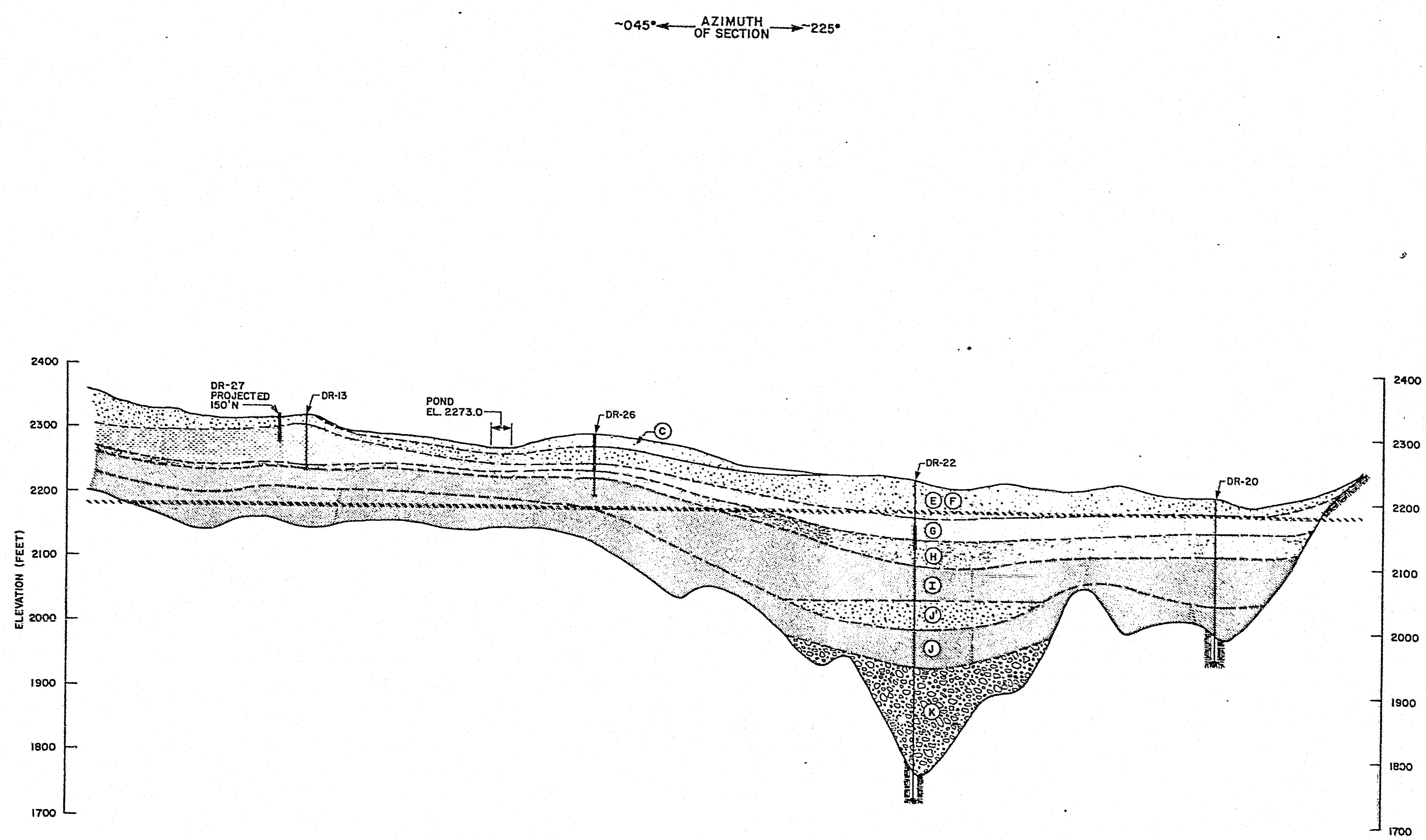
SCALE 0 20 40 FEET-VERTICAL

SCALE 0 400 800 FEET-HORIZONTAL

WATANA
RELICT CHANNEL & BORROW SITE D
STRATIGRAPHIC FENCE DIAGRAM
SHEET 2 OF 2

FIGURE 6.32

ACRES



LEGEND

LITHOLOGY:

C
E, F
G
H
I
J'
J
K

CONTACTS:

KNOWN UNIT CONTACT
INFERRED UNIT BOUNDARY
BEDROCK SURFACE WHERE DRILLED.
NORMAL MAXIMUM OPERATING LEVEL EL. 2185

BOREHOLES:

DR-26 COE ROTARY CORE BORINGS
NOTED AS FROZEN DURING DRILLING

NOTES

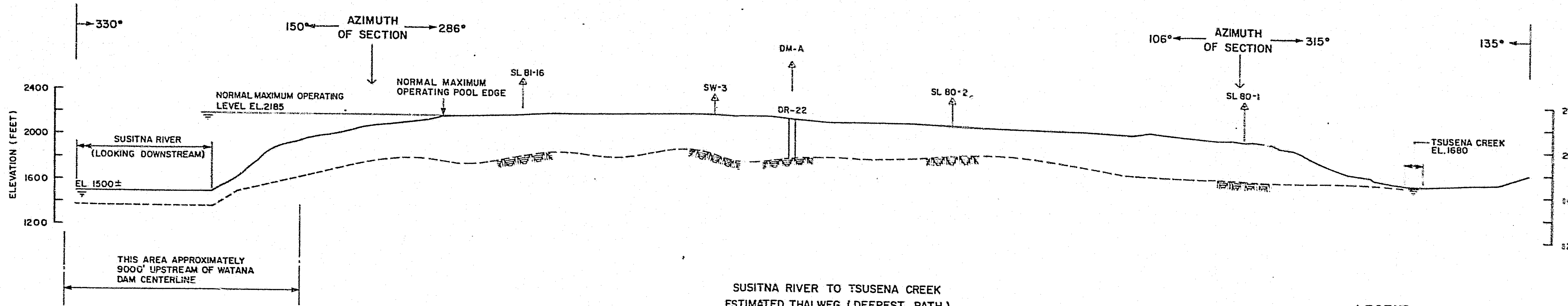
1. SEE FIGURE 6.32 FOR STRATIGRAPHIC COLUMN AND GENERAL NOTES.
2. SEE FIGURE 6.31 FOR TRUE SCALE SECTION OF SAME GENERAL AREA.
3. VERTICAL TO HORIZONTAL SCALES 5:1.
4. PERMAFROST DATA (TEMPERATURE PLOTS ON FIGURE 6.28).
   DR-13 NO TEMPERATURE DATA
   DR-20 NO PERMAFROST
   DR-22 FROZEN 72' TO 110'
   DR-26 FROZEN 19' TO 55'
   DR-27 FROZEN 0' TO 44'
5. BEDROCK ELEVATIONS BASED ON SEISMIC REFRACTION. DATA (FIG. 5.1)
6. THE ACCURACY AND THICKNESS OF SOIL AND ROCK STRATA IS SUBJECT TO VERIFICATION.
7. THIS FIGURE IS GENERALIZED FOR GRAPHIC PRESENTATION. FOR MORE SPECIFIC INFORMATION REFER TO TEXT AND BORING LOGS.

SCALE 0 80 160 FEET VERTICAL

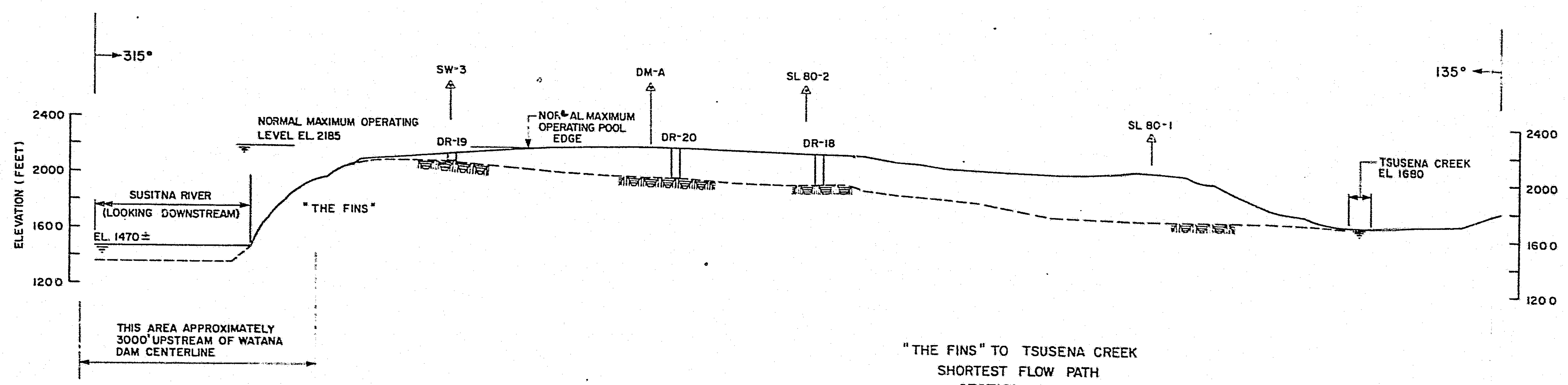
SCALE 0 400 800 FEET HORIZONTAL

WATANA
RELICT CHANNEL-EXPANDED THALWEG SECTION

FIGURE 6.33



SUSITNA RIVER TO TSUSENA CREEK
ESTIMATED THALWEG (DEEPEST PATH)
SECTION W-17



"THE FINS" TO TSUSENA CREEK
SHORTEST FLOW PATH
SECTION W-16

LEGEND

CONTACTS:

----- APPROXIMATE TOP OF ROCK

GEOPHYSICAL SURVEYS:

SW-1 INTERSECTION WITH SEISMIC REFRACTION LINE

DM-C 1975, DAMES & MOORE

SW-1 1978, SHANNON & WILSON

SL 80-1 1980, WOODWARD-CLYDE CONSULTANTS

SL 81-2 1981, WOODWARD-CLYDE CONSULTANTS

BOREHOLES:

DR-19 COE ROTARY DRILL BORING

NOTES

1. PROFILE AND SEISMIC LINE LOCATIONS SHOWN ON FIGURE 6.35.
2. SECTION ALONG DM-A SHOWN ON FIGURE 6.31.
3. VERTICAL AND HORIZONTAL SCALE EQUAL.
4. SURFACE PROFILE FROM 1"= 200' TOPOGRAPHY, COE 1978 TOPOGRAPHY GENERALIZED TO ±25 FEET.
5. TOP OF ROCK NORTHWEST OF SL 80-1 IS PROJECTED UP TO 300 FEET TO PORTRAY ACTUAL THALWEG PROFILE.

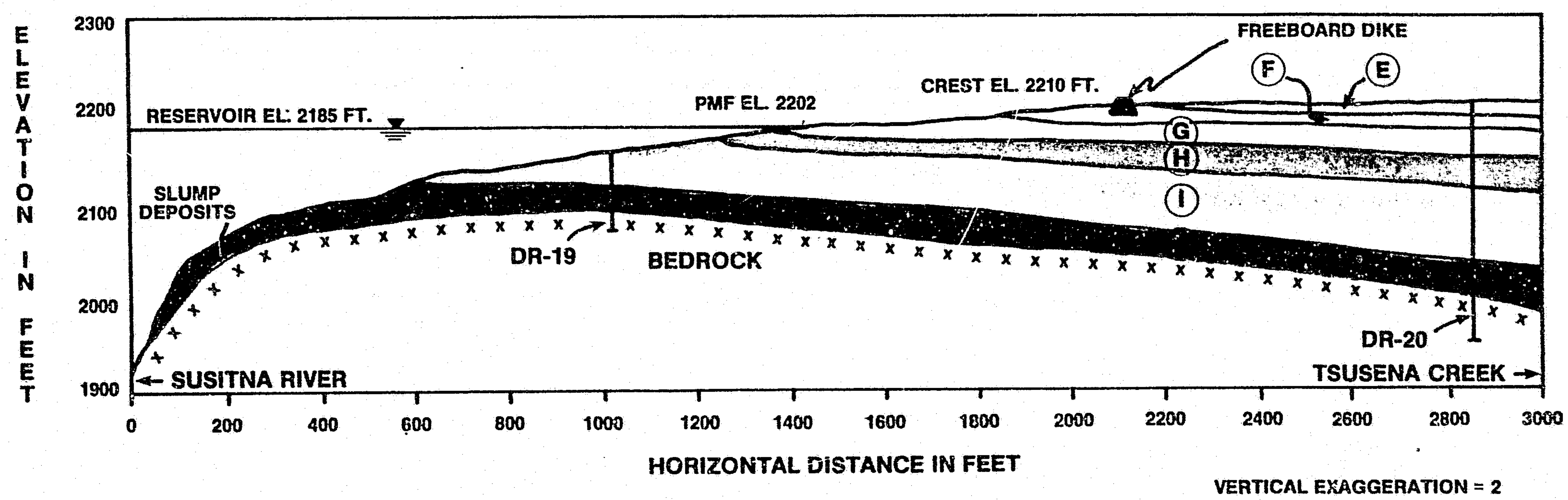
SCALE 0 400 800 FEET

WATANA
RELICT CHANNEL PROFILES

ACRES

FIGURE 6.34

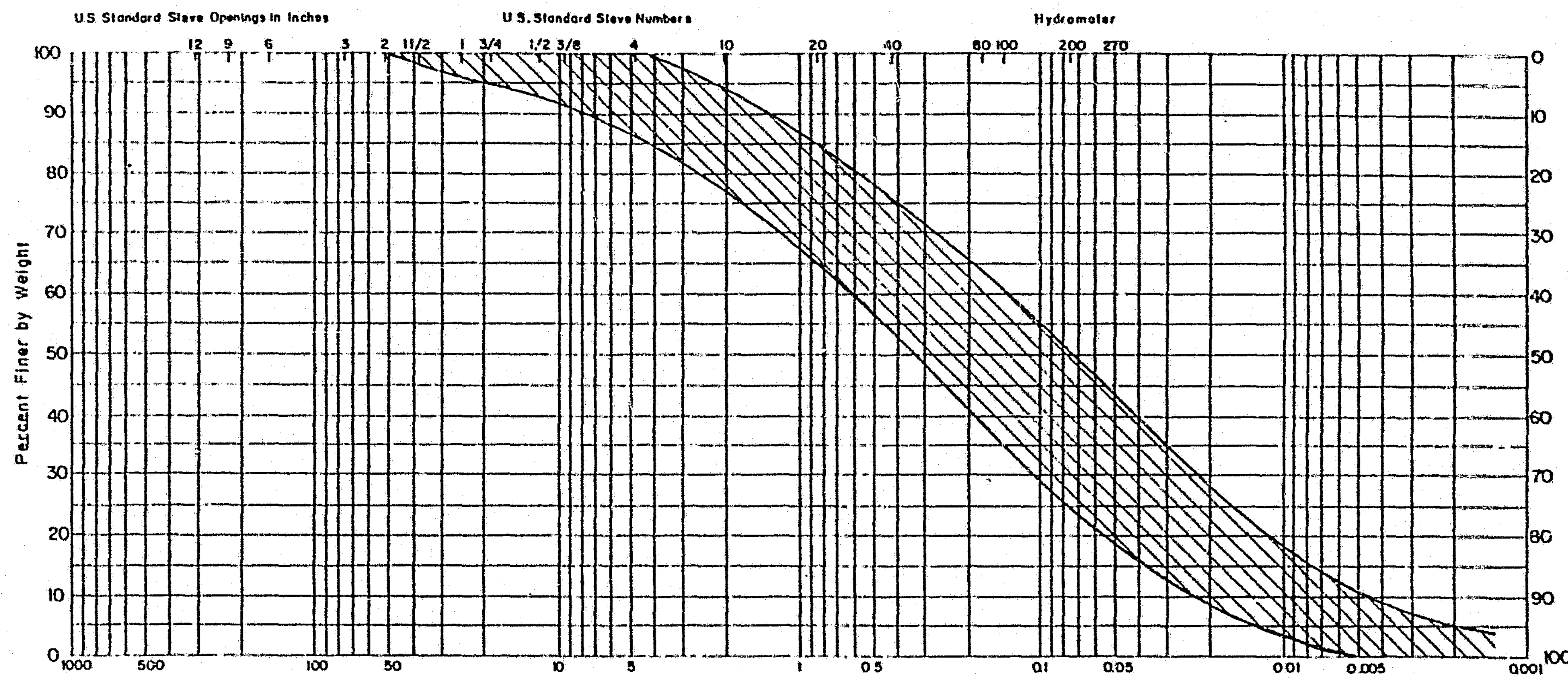
16. PRESENTATION BY D. W. LAMB



WATANA RESERVOIR FREEBOARD DIKE CROSS SECTION

GRADATION RESULTS
WATANA BORROW AREA D

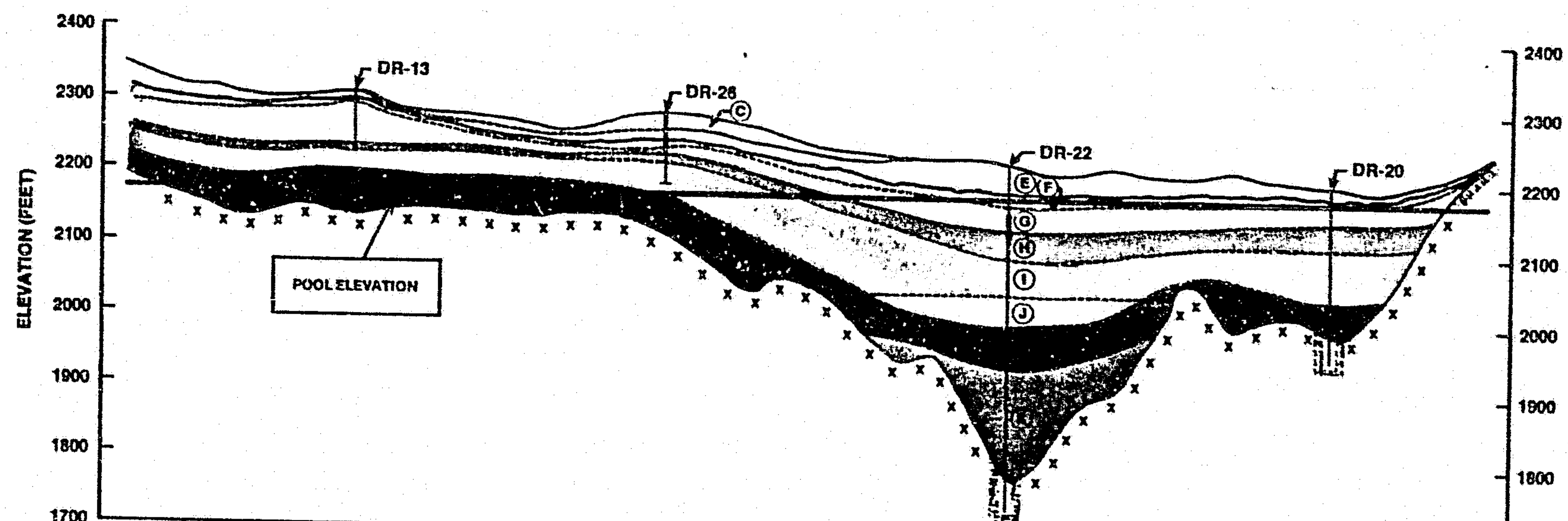
SOIL UNIT	PERCENTAGE OF TOTAL SAMPLE			PI	UNIFIED SOIL CLASSIFICATION
	COARSER THAN #4	BETWEEN #4 & #200	FINER THAN #200		
COMPOSITE SAMPLE	15%	40%	45%		SILTY SAND (SM)
C & D MEAN	5%	60%	35%	NP	(SM)
E & F MEAN	12%	53%	35%	NP	(SM)
G MEAN	0%	45%	55%	10	(ML)
H MEAN	0%	73%	27%	NP	(SM)
I & J MEAN	15%	53%	32%	7.5	(SM)



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

	RANGE	AVERAGE
MOISTURE CONTENT	8-21 %	12.8 %
LIQUID LIMIT	0-17	12.1
PLASTICITY INDEX	NP-2	NP

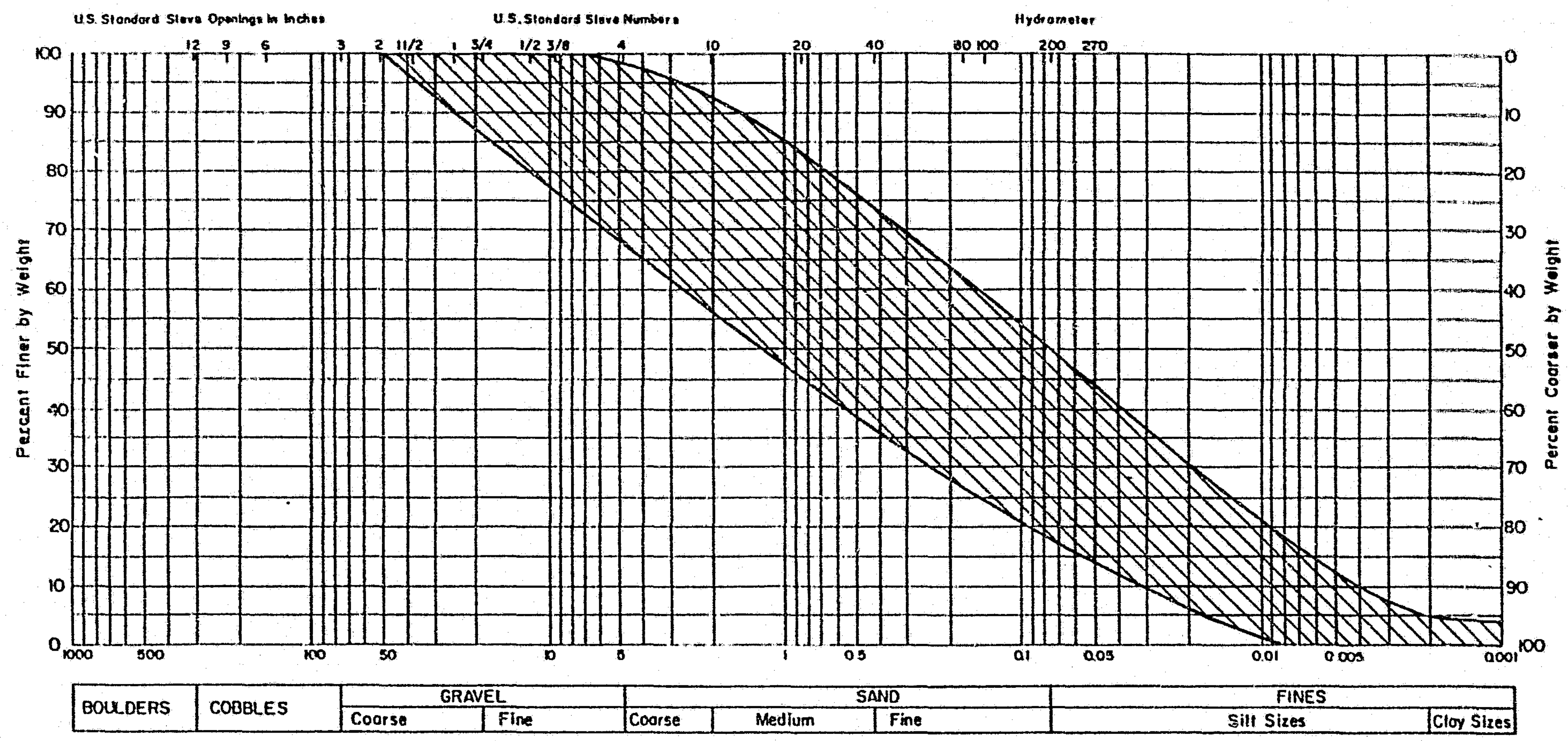
WATANA-BORROW AREA D
GRAIN SIZE CURVES – UNITS C,D + C/D



WATANA
RELICT CHANNEL—
EXPANDED THALWEG SECTION

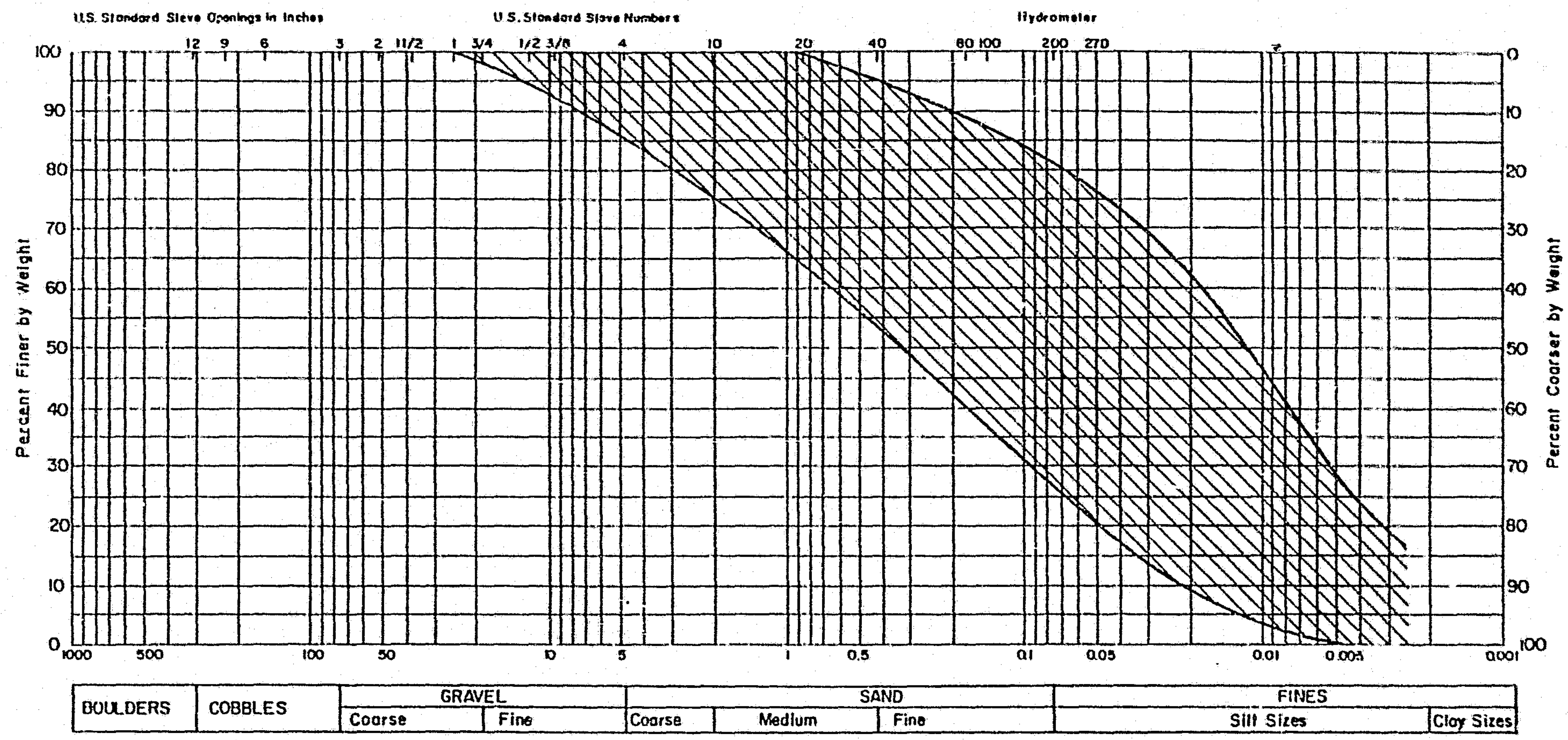
QUATERNARY STRATIGRAPHY OF THE BURIED CHANNEL AREA

SYMBOL	UNIT	MAXIMUM THICKNESS	MATERIAL TYPE
[redacted]			
C	OUTWASH	18'	SILTY SAND WITH GRAVEL AND COBBLES.
[redacted]			
E & F	OUTWASH	55'	SILT, SAND, GRAVEL, COBBLES, PARTLY SORTED.
G	TILL/WATERLAIN TILL	65'	CLAYEY SILTY SAND, WITH GRAVEL AND COBBLES, OFTEN PLASTIC.
H	ALLUVIUM	40'	SILT, SAND AND GRAVEL, SORTED.
I	TILL	60'	SILT, SAND, GRAVEL, COBBLES, POORLY SORTED.
J'	INTERGLACIAL ALLUVIUM	45'	SAND, GRAVEL WITH OCCASIONAL SILT, SORTED.
J	TILL	60'	SILT, SAND, GRAVEL COBBLES, POORLY SORTED.
K	ALLUVIUM	[illegible]	GRAVEL, COBBLES, BOULDERS, FEW FINES.



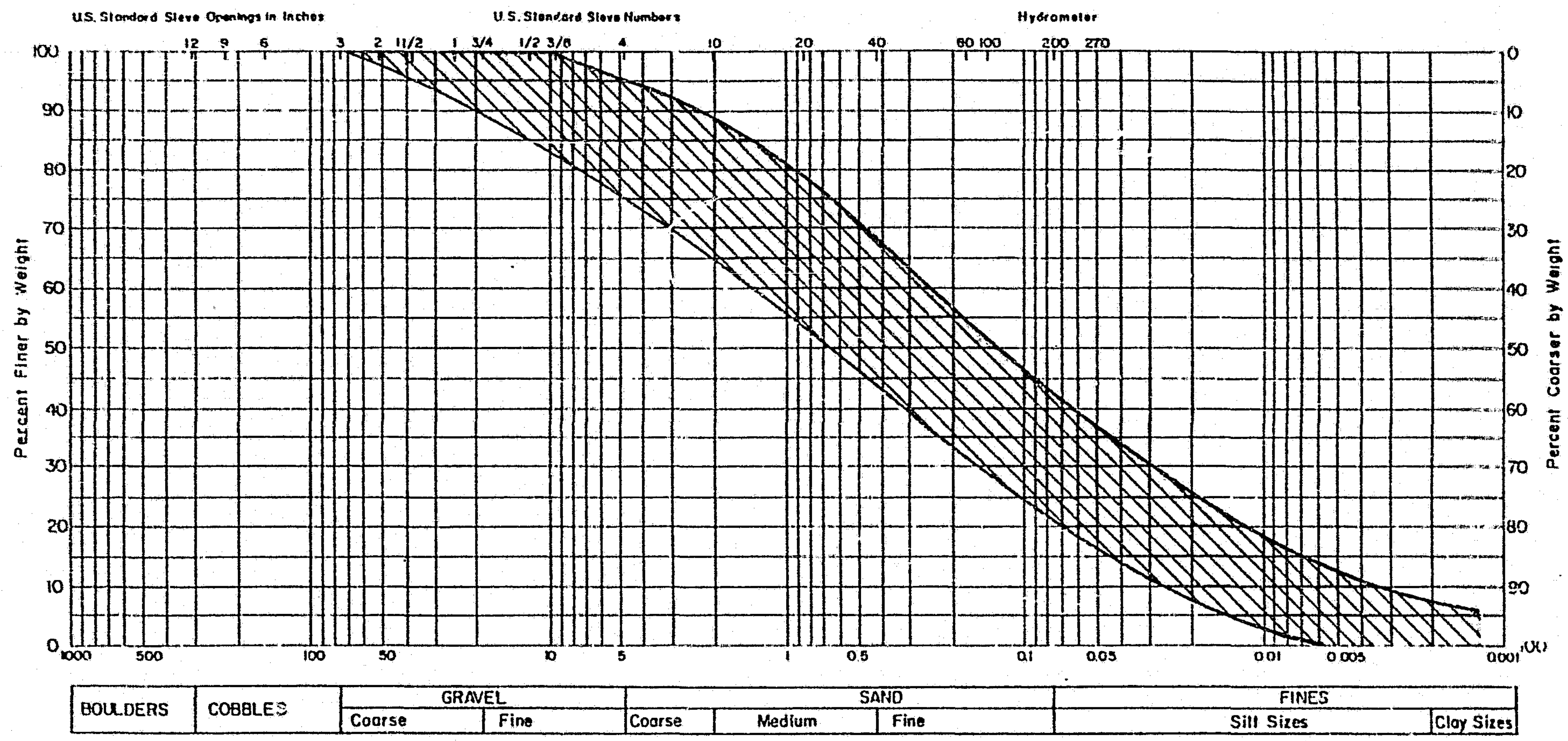
	RANGE	AVERAGE
MOISTURE CONTENT	6.6-13 %	10.2 %
LIQUID LIMIT	0-17	12.8
PLASTICITY INDEX	NP-2	NP

WATANA-BORROW AREA D
GRAIN SIZE CURVES – UNITS E,F + E/F



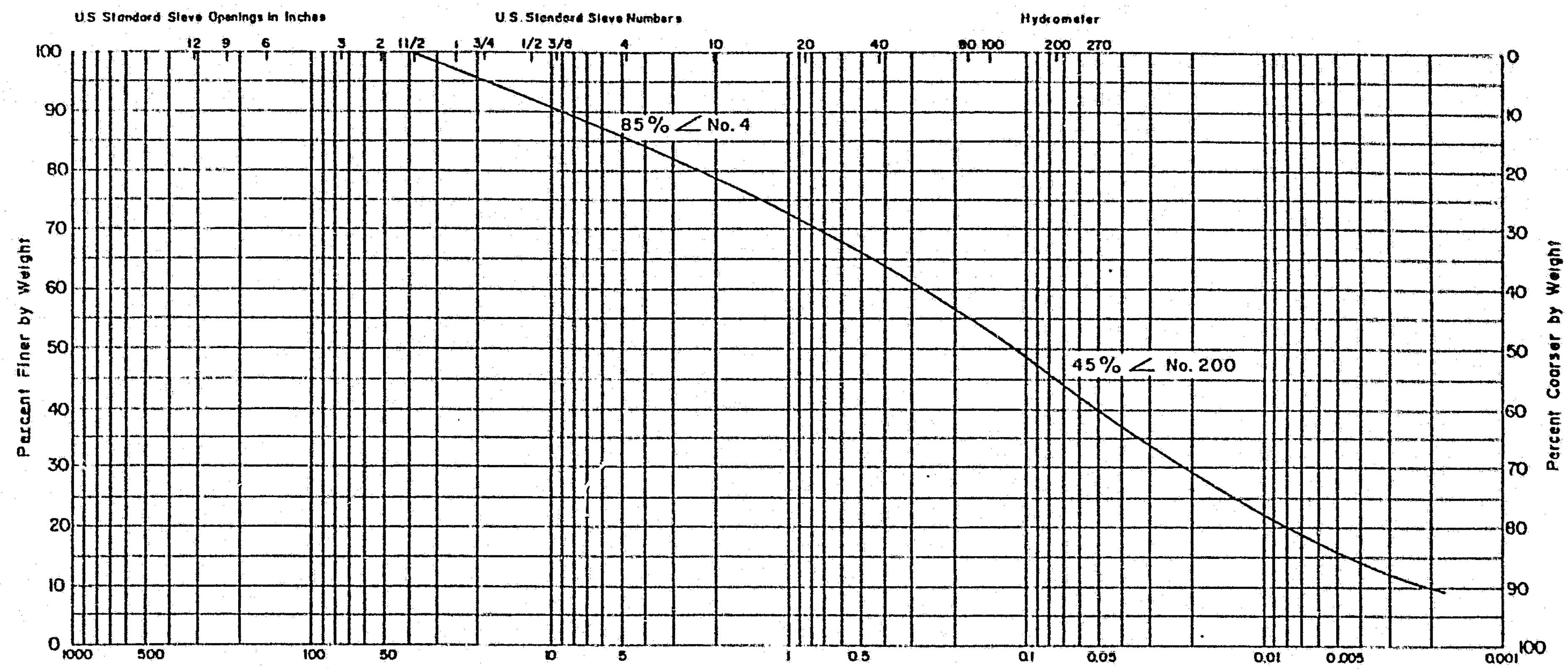
	RANGE	AVERAGE
MOISTURE CONTENT	6-40 %	20.2 %
LIQUID LIMIT	17-35	26
PLASTICITY INDEX	NP-15	10

WATANA-BORROW AREA D
GRAIN SIZE CURVES — UNITS G+F/G



	RANGE	AVERAGE
MOISTURE CONTENT	9-13 %	10.3 %
LIQUID LIMIT	19.2-39	29.1
PLASTICITY INDEX	0.9-14	7.5

WATANA-BORROW AREA D
GRAIN SIZE CURVES – UNITS I,J+I/J

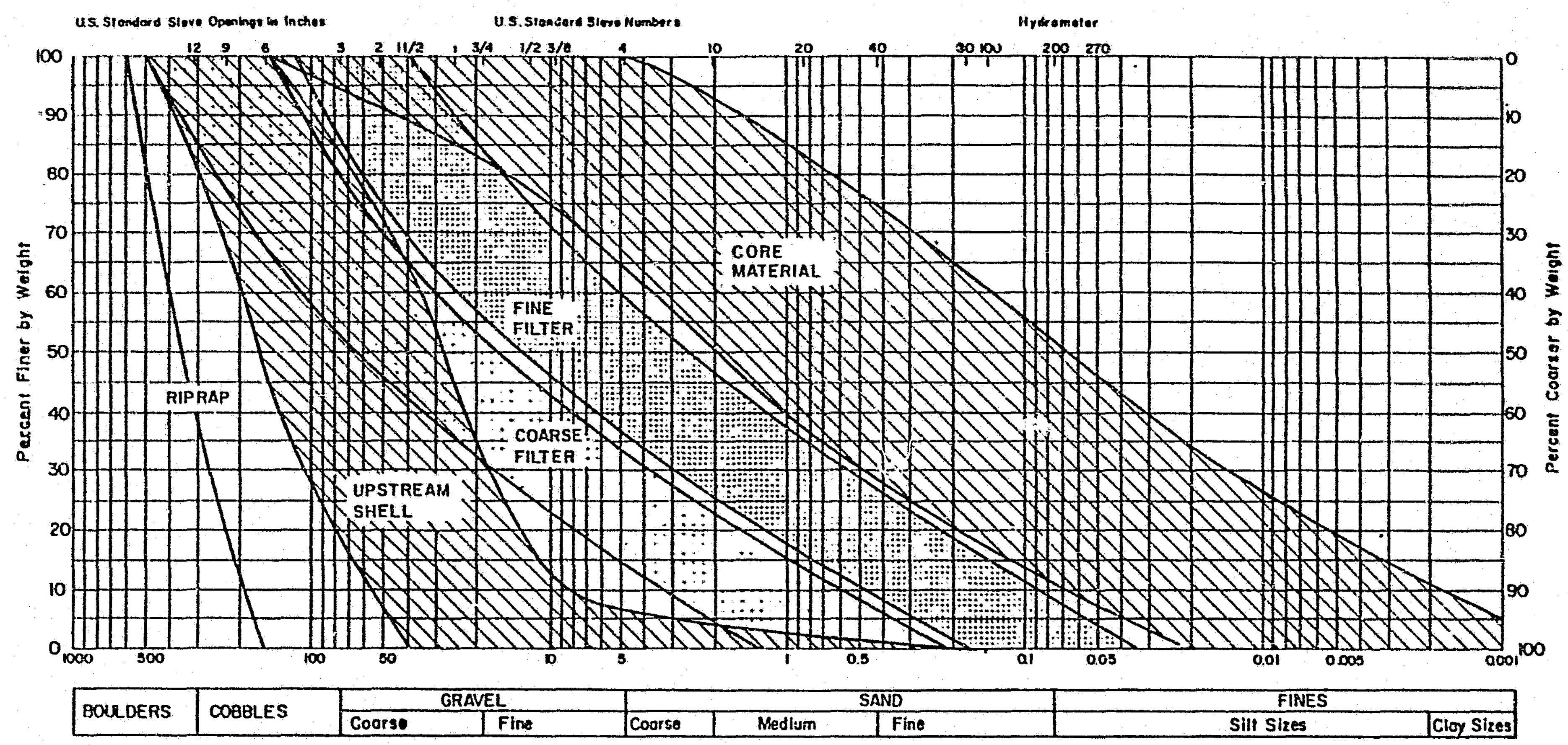


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

G = 2.71

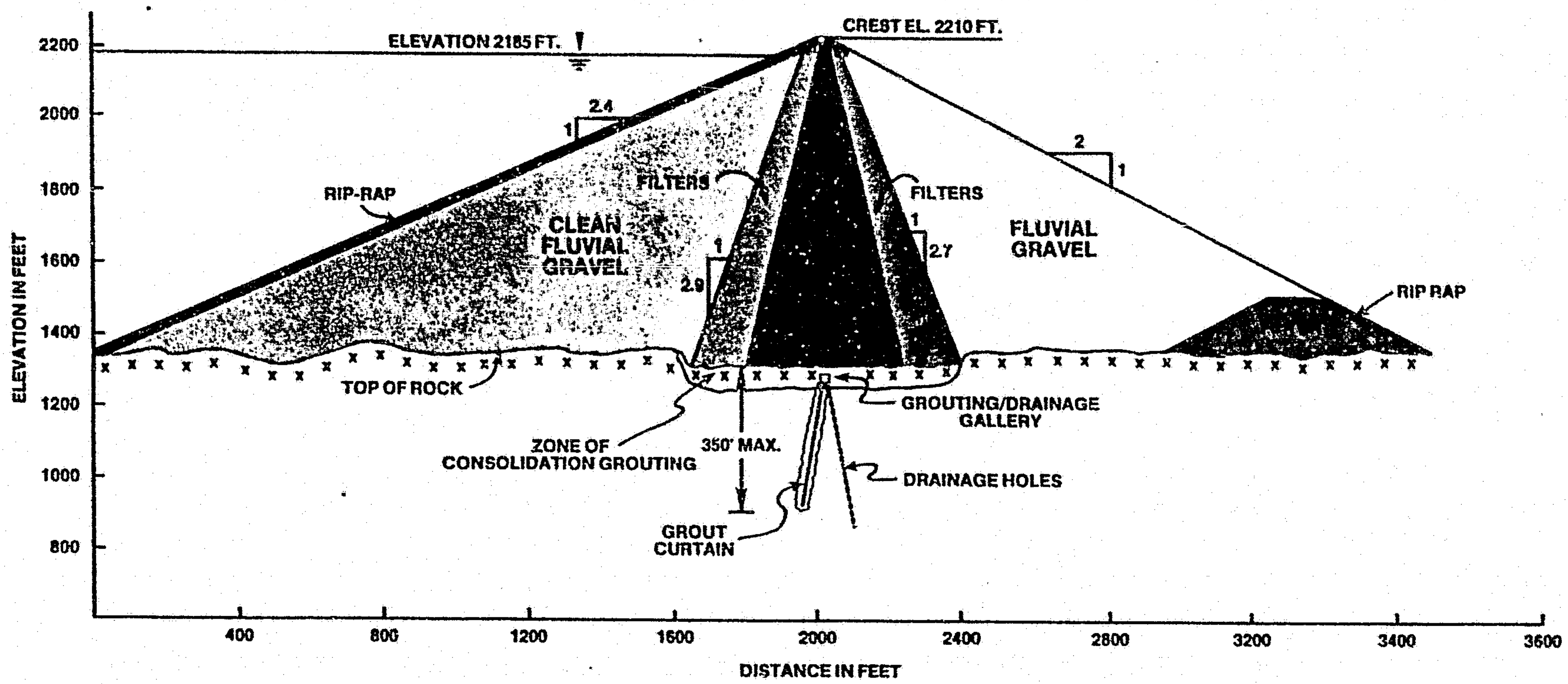
WATANA

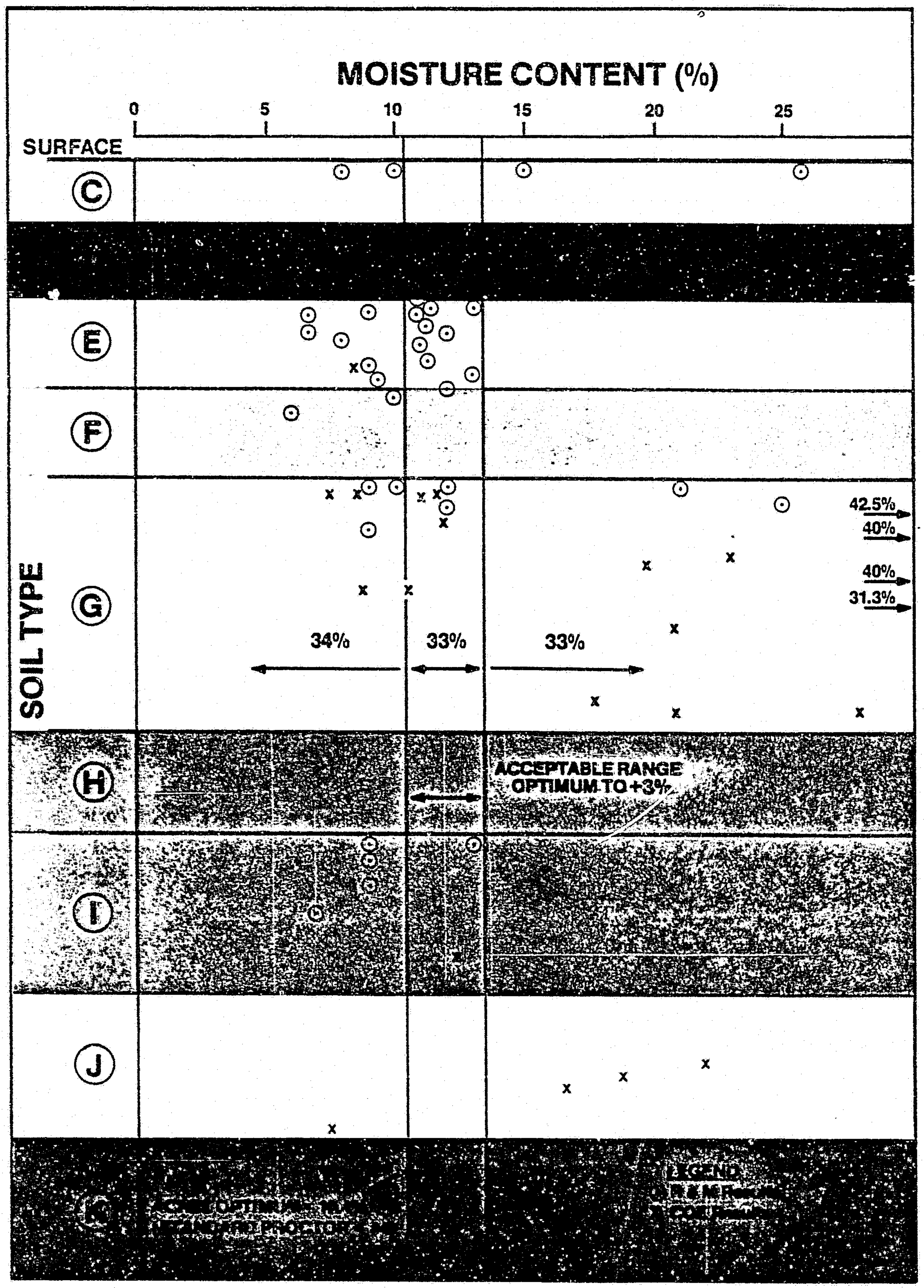
COMPOSITE GRAIN SIZE CURVE—BORROW AREA D



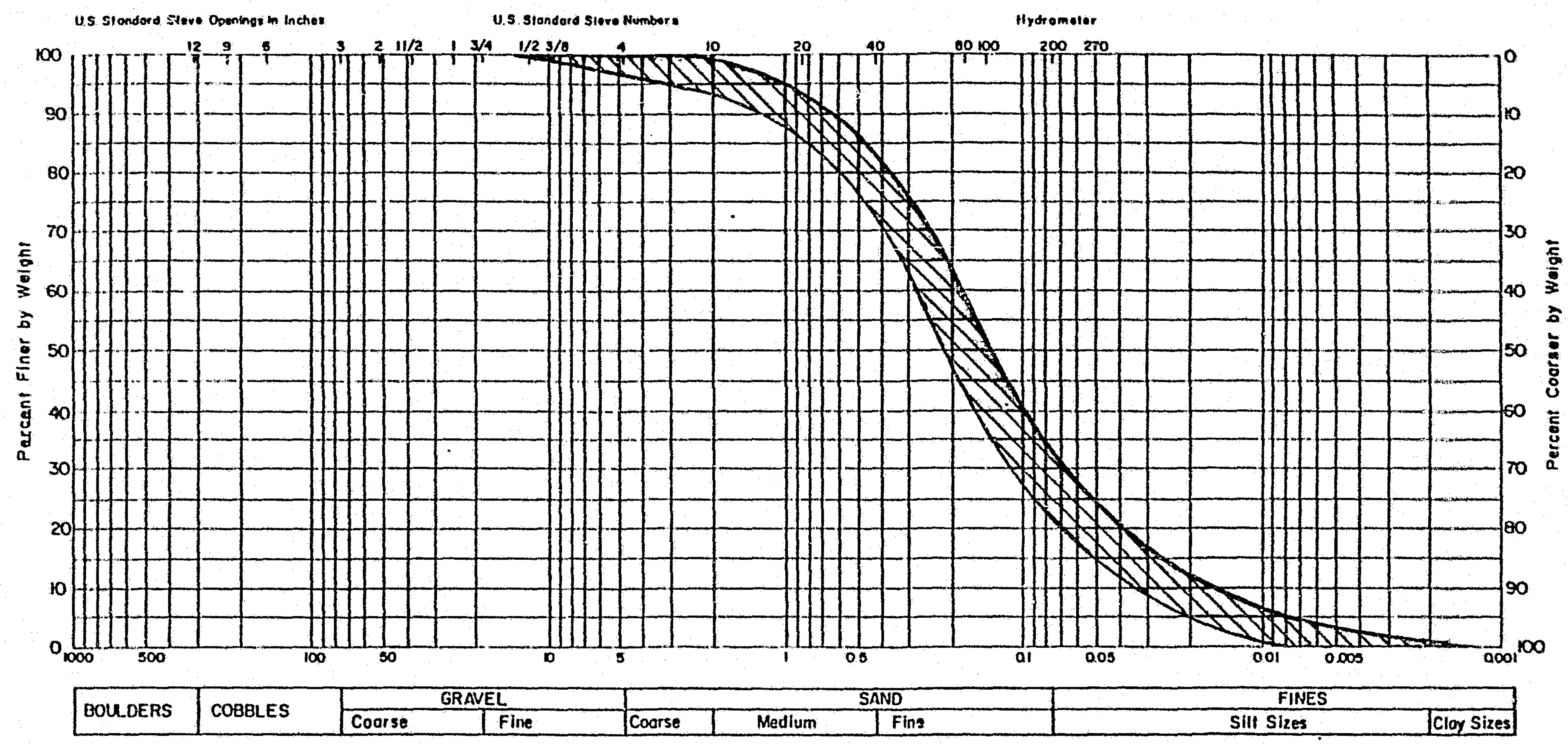
WATANA
REQUIRED GRAIN SIZE CURVES
MAIN DAM

WATANA
SECTION THROUGH MAIN DAM
AT MAXIMUM HEIGHT

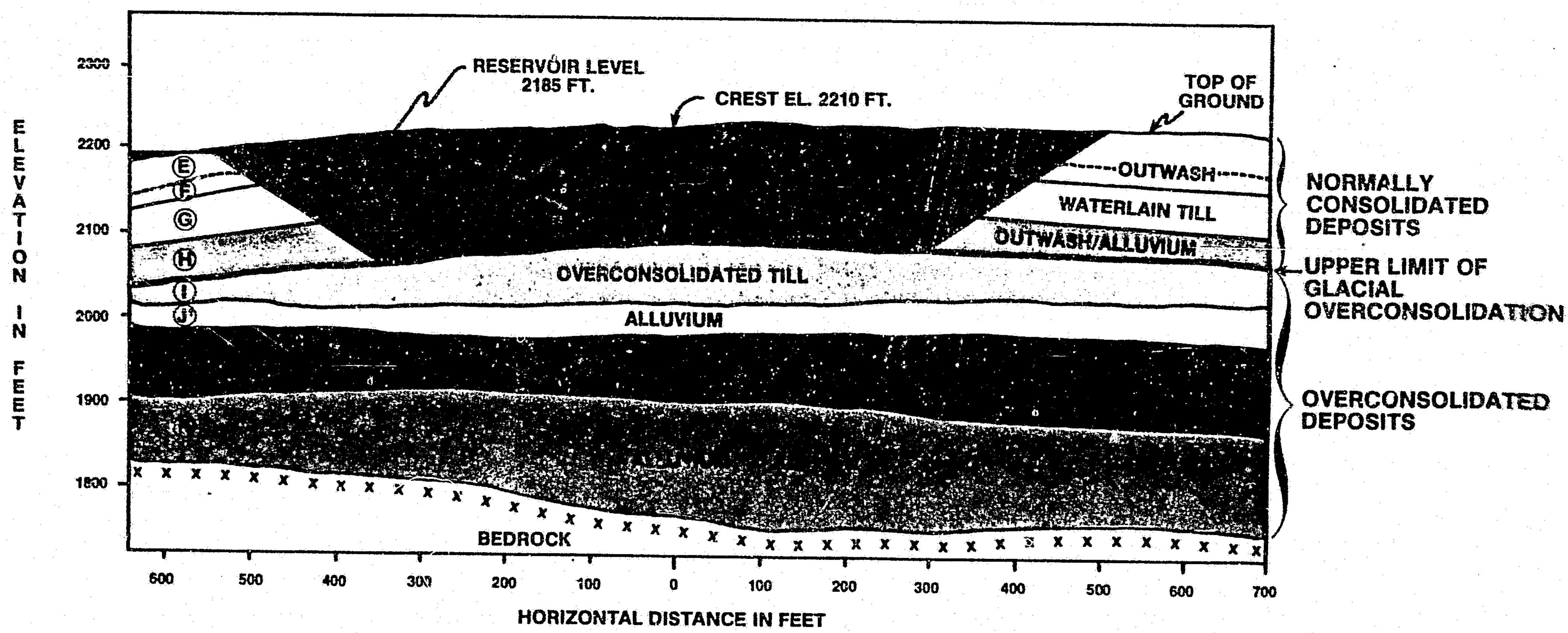




MOISTURE CONTENT (%)
0
5
10
15
20
25
SURFACE
C
E
F
G
H
I
J
SOIL TYPE
42.5%
40%
40%
31.3%
34%
33%
33%
ACCEPTABLE RANGE
OPTIMUM TO +3%



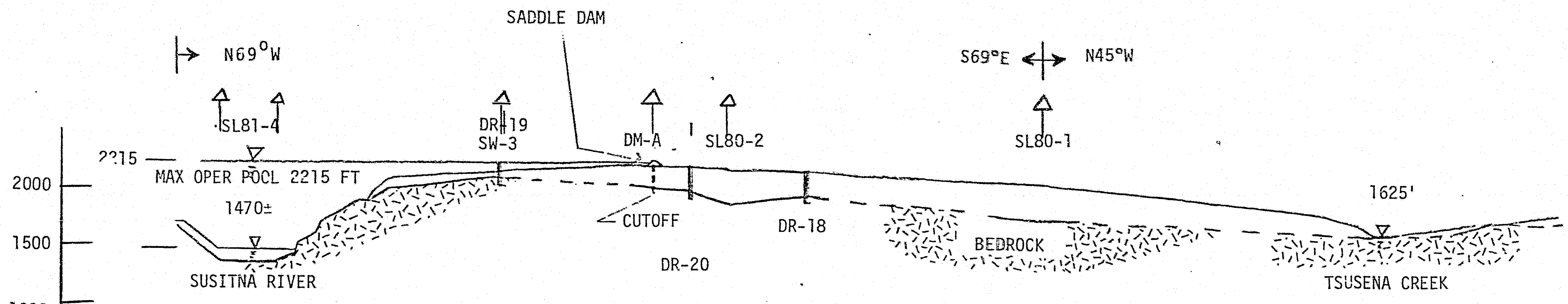
WATANA-BORROW AREA D
GRAIN SIZE CURVES - UNIT H



TOTAL CUT = 13 MILLION CU. YD.
DAM VOLUME = 4.5 MILLION CU. YD.

BURIED CHANNEL ALTERNATIVE SOLUTION

WATANA - RELICT CHANNEL PROFILE

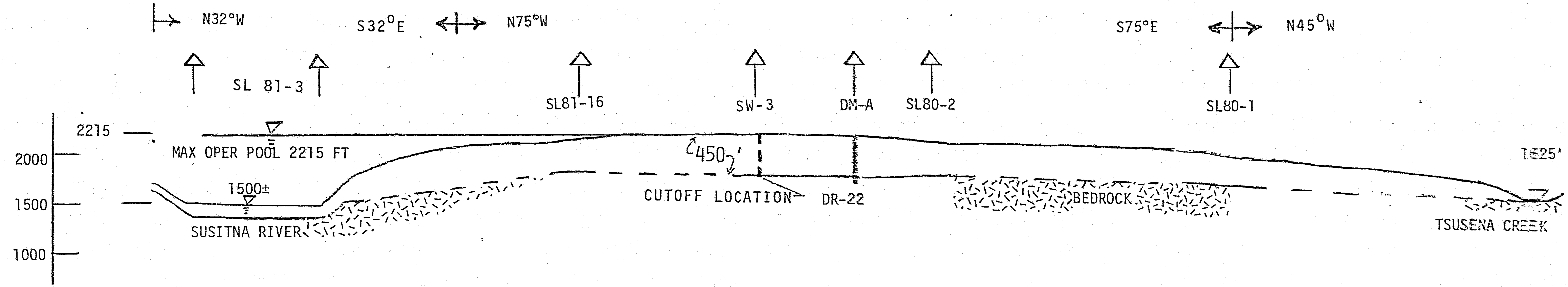


SECTION A - A

"THE FINS" to TSUSENA CREEK

EXISTING EDGE OF RIVER TO TSUSENA CREEK = 9300'
OPERATING POOL = 6200'

DIRECT LINE, SHORTEST DISTANCE ON UPSTREAM FLANK OF DAM SITE PLUTON



EXISTING EDGE OF RIVER TO TSUSENA CREEK = 12,000'
OPERATING POOL TO TSUSENA CREEK = 7,700'

SECTION B - B

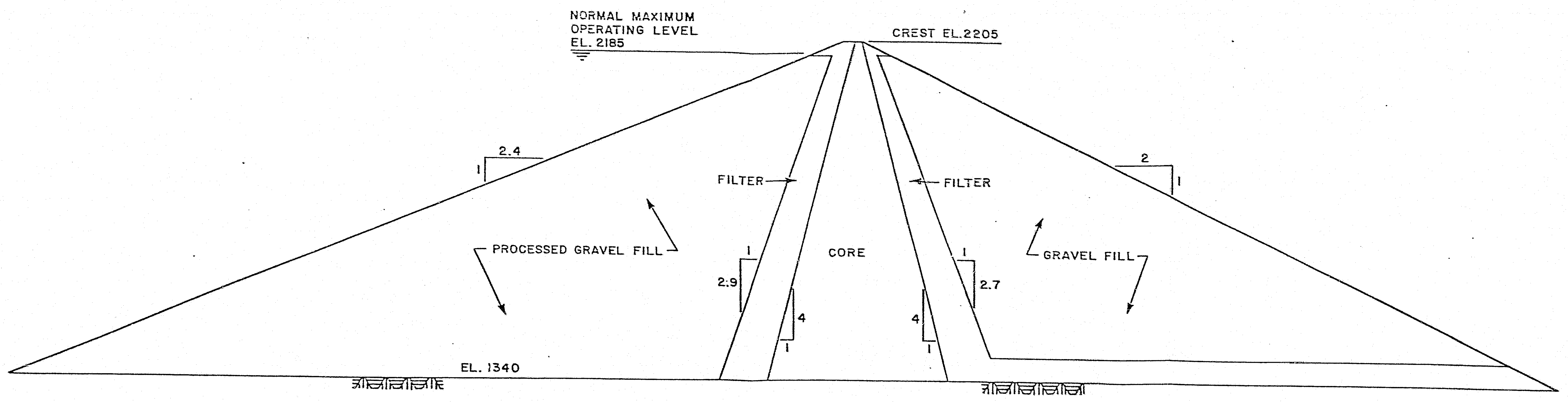
SECTION ON APPROXIMATE THALWEG, LOCATION ABOUT 4000' UPSTREAM OF UPSTREAM COFFERDAM

1"=1000'

LOOKING DOWNSTREAM

RELICT CHANNEL PROFILES

17. PRESENTATION BY A. S. BURGESS

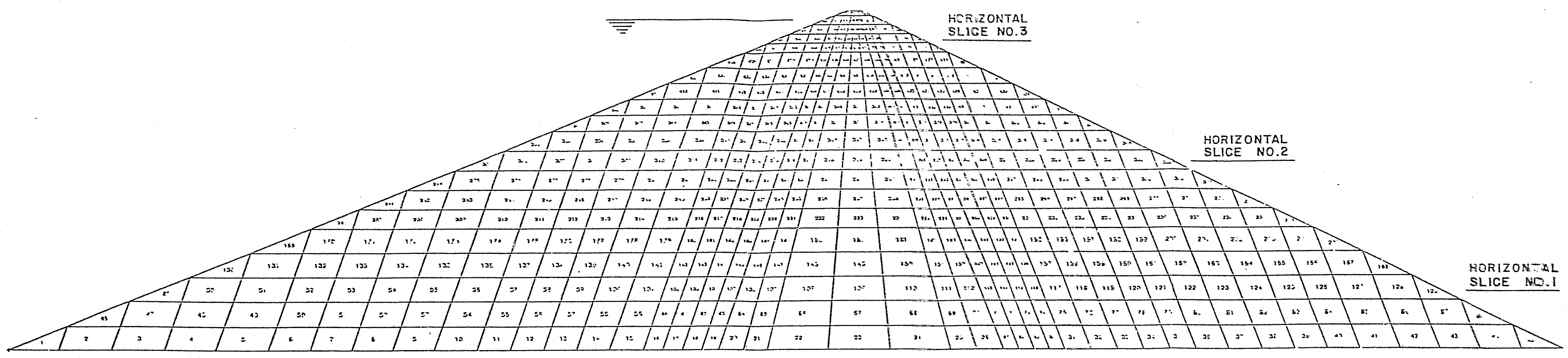


NOTE:
FOR DETAILED CROSS SECTION SEE PLATE 9
IN VOLUME 3 OF FEASIBILITY REPORT.

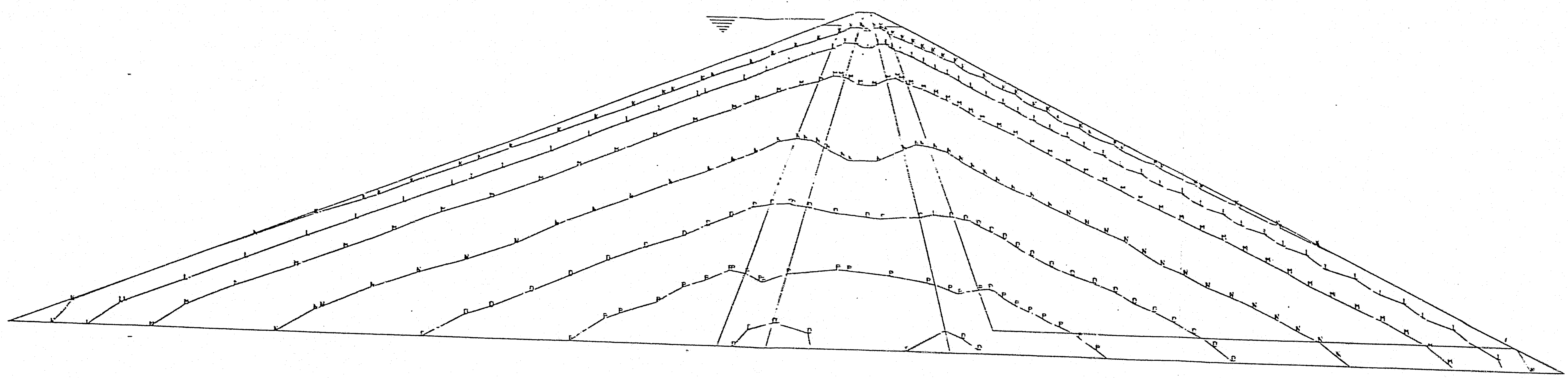
WATANA DAM
MAXIMUM CROSS SECTION

FIGURE B6.1

ACRES

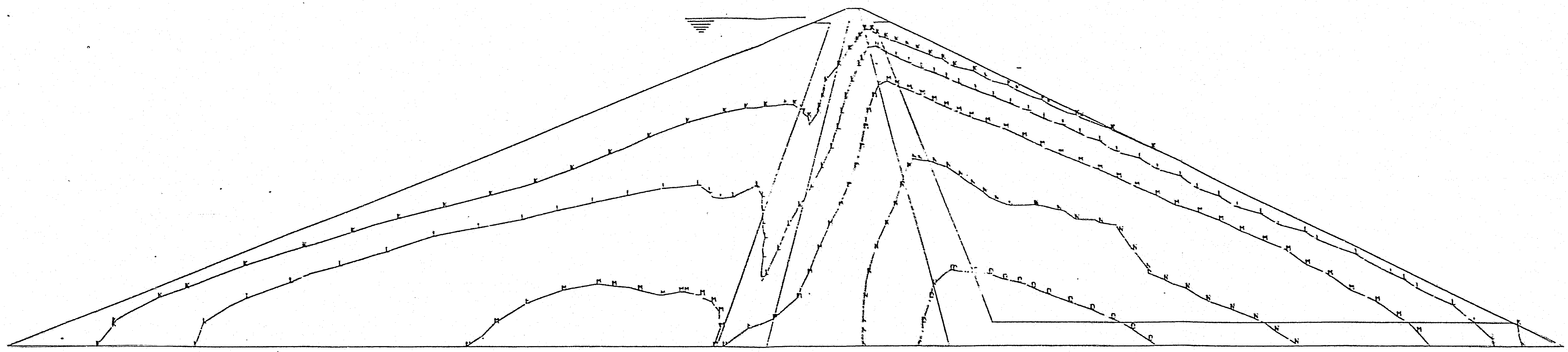


FINITE ELEMENT MODEL



SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	-140.	-120.	-100.	-80.	-60	-40.	-20.	-10.	-5.	0.
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	5.	10.	20.	40.	60.	80.	100.	120.	140.	

END OF CONSTRUCTION
STATIC RUN SOFT CORE
VERTICAL STRESS (SIGv) (KSF)

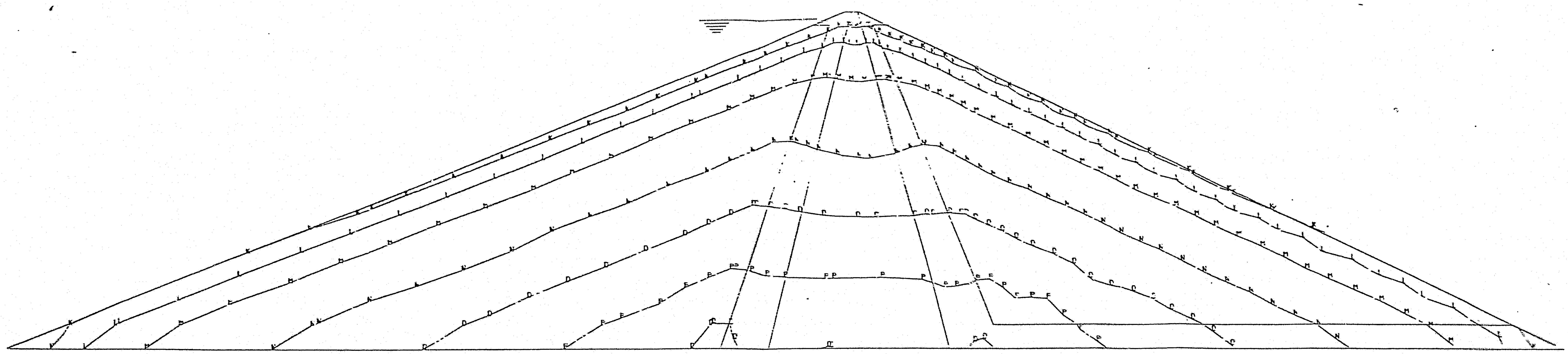


SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	-140.	-120.	-100.	-80.	-60.	-40.	-20.	-10.	-5.	0
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	5.	10.	20.	40.	60.	80.	100.	120.	140.	

STATIC RUN SOFT CORE

2-D EFFECTIVE CONFINING STRESS (SIG 2')(KSF)

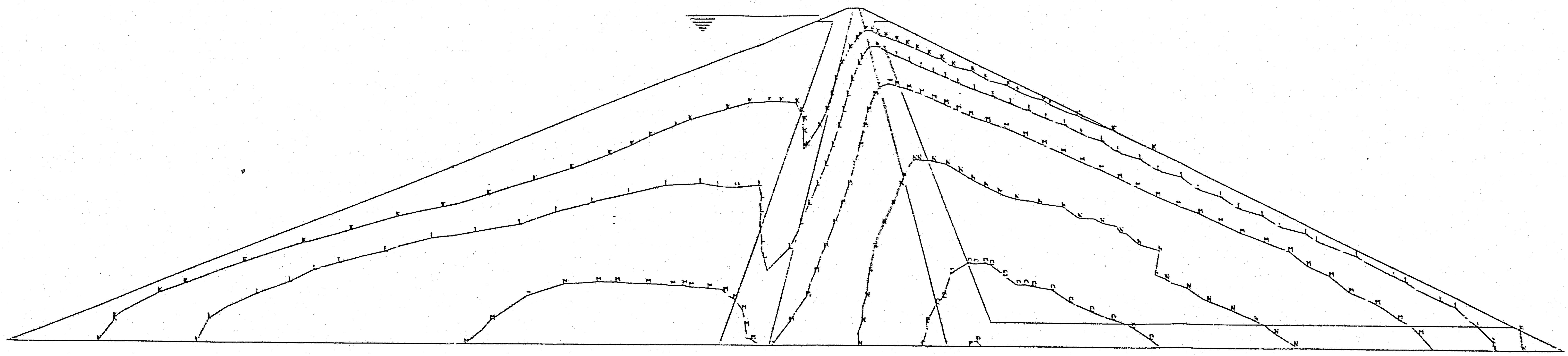
FIGURE B6.10



SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	-140.	-120.	-100.	-80.	-60.	-40.	-20.	-10.	-5.	0.
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	5.	10.	20.	40.	60.	80.	100.	120.	140.	

END OF CONSTRUCTION
STATIC RUN STIFF CORE
VERTICAL STRESS (SIGv) (KSF)

FIGURE B6.12

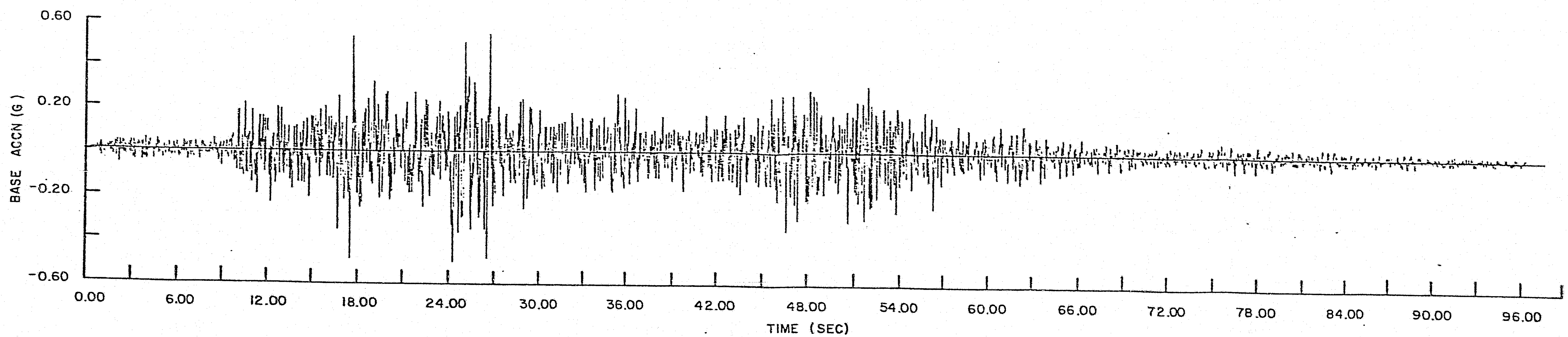


SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	-140.	-120.	-100.	-80.	-60.	-40.	-20.	-10.	-5.	0.
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	5.	10.	20.	40.	60.	80.	100.	120.	140.	

STATIC RUN STIFF CORE

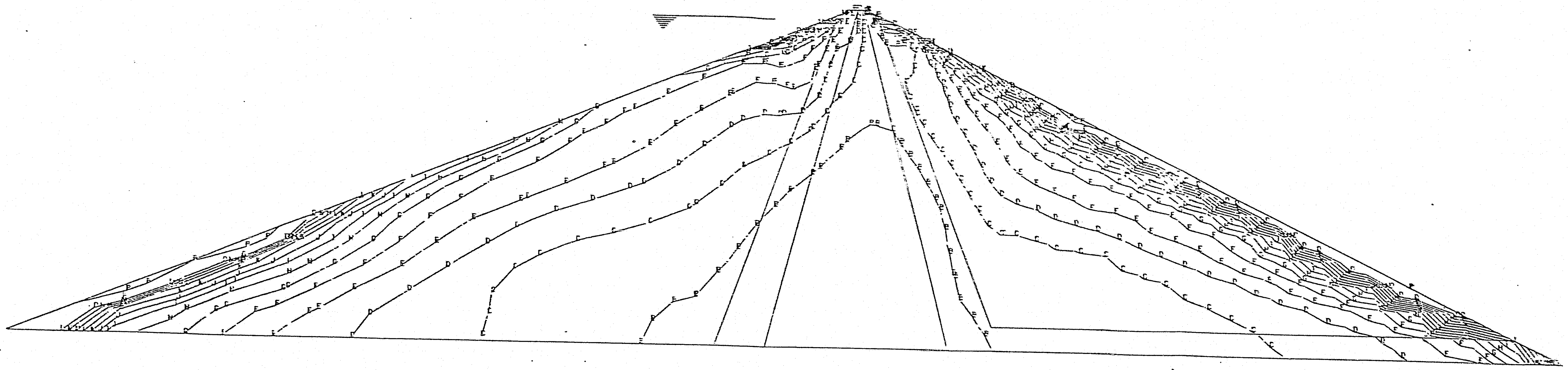
2-D EFFECTIVE CONFINING STRESS (SIG2') (KSF)

FIGURE B6.15



EARTHQUAKE TIME HISTORY

FIGURE B6.17

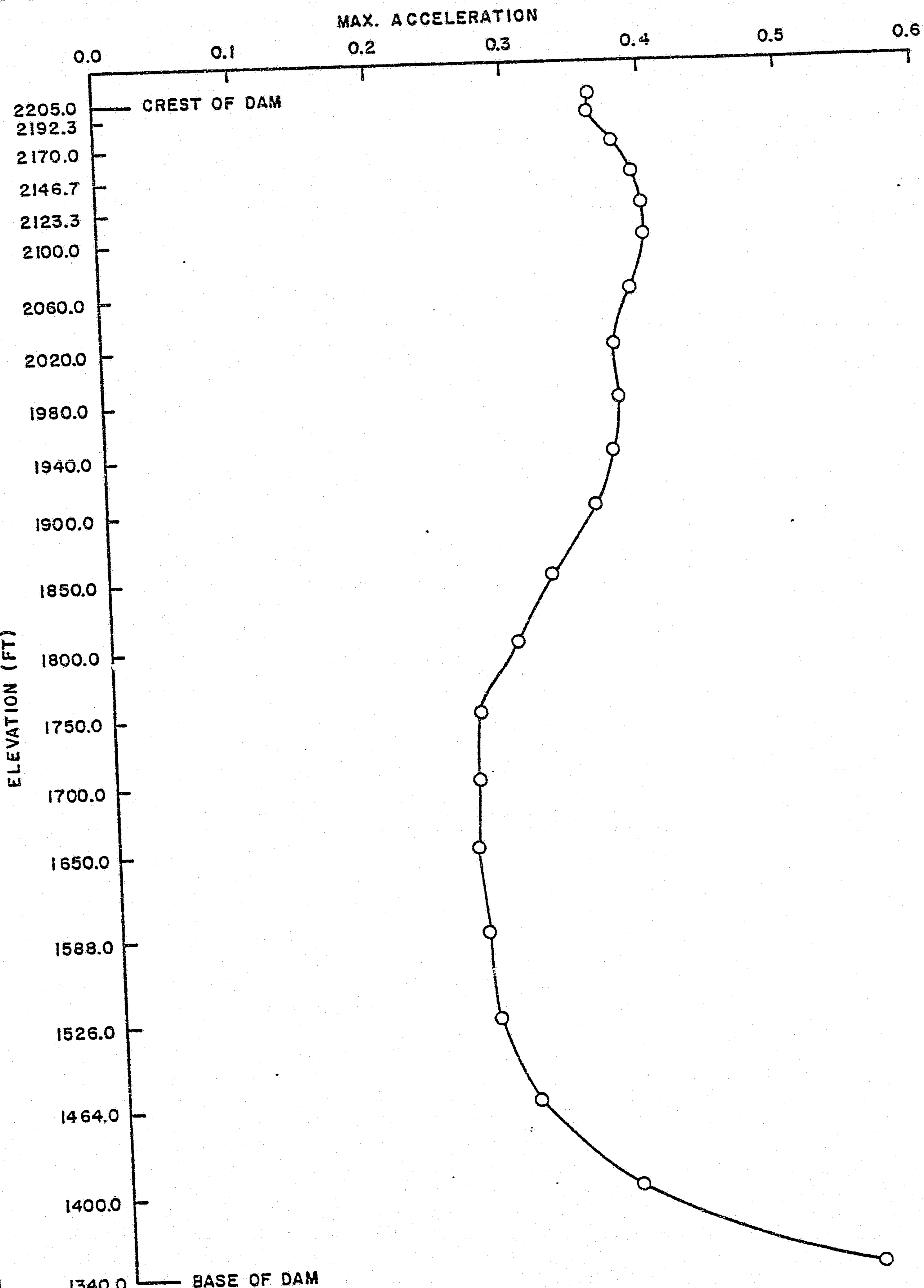


SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	1.1	1.2	1.3	1.4	1.5	2.0	4.0	6.0	8.0	

DYNAMIC RUN SOFT CORE

DRAINED SHEAR STRESS EXCEEDANCE (TAUdeff/TAUfd)

FIGURE B6.19

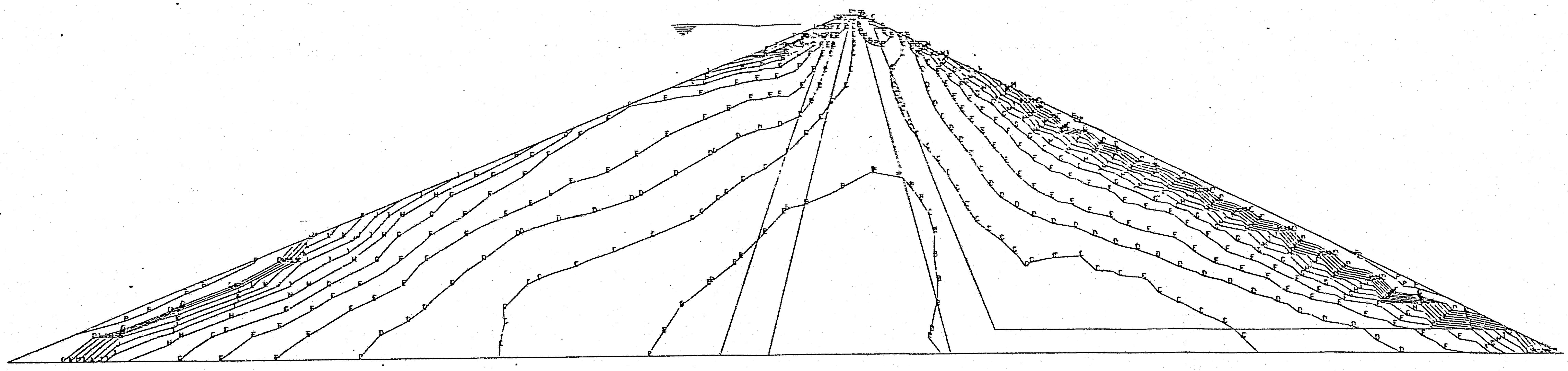


DYNAMIC RUN SOFT CORE

MAXIMUM ACCELERATION VS. HEIGHT

ACRES

FIGURE B6.27

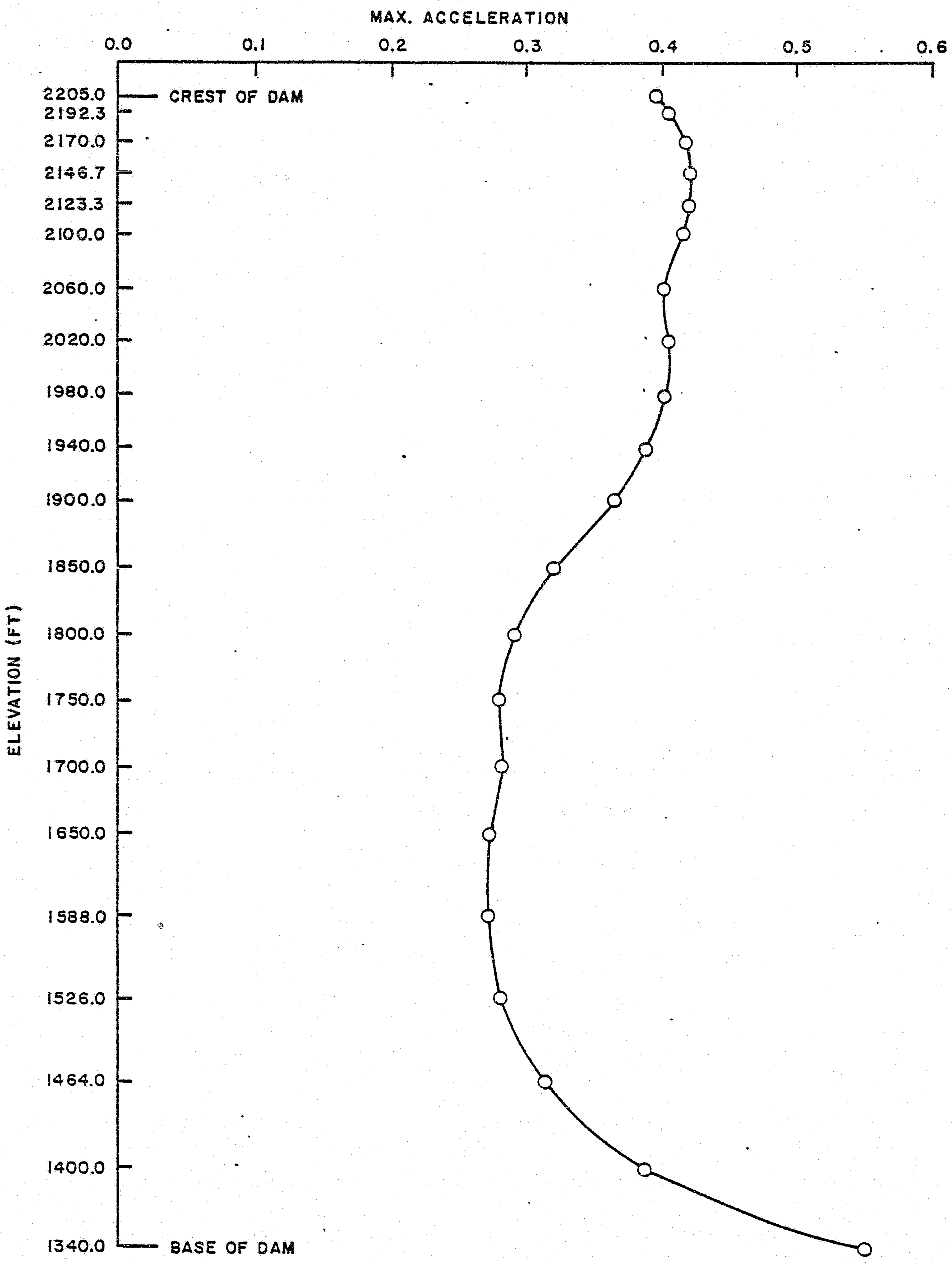


SYMBOL	A	B	C	D	E	F	G	H	I	J
VALUE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
SYMBOL	K	L	M	N	O	P	Q	R	S	
VALUE	1.1	1.2	1.3	1.4	1.5	2.0	4.0	6.0	8.0	

DYNAMIC RUN STIFF CORE

DRAINED SHEAR STRESS EXCEEDANCE (TAUdeff/TAUfd)

FIGURE B6.28

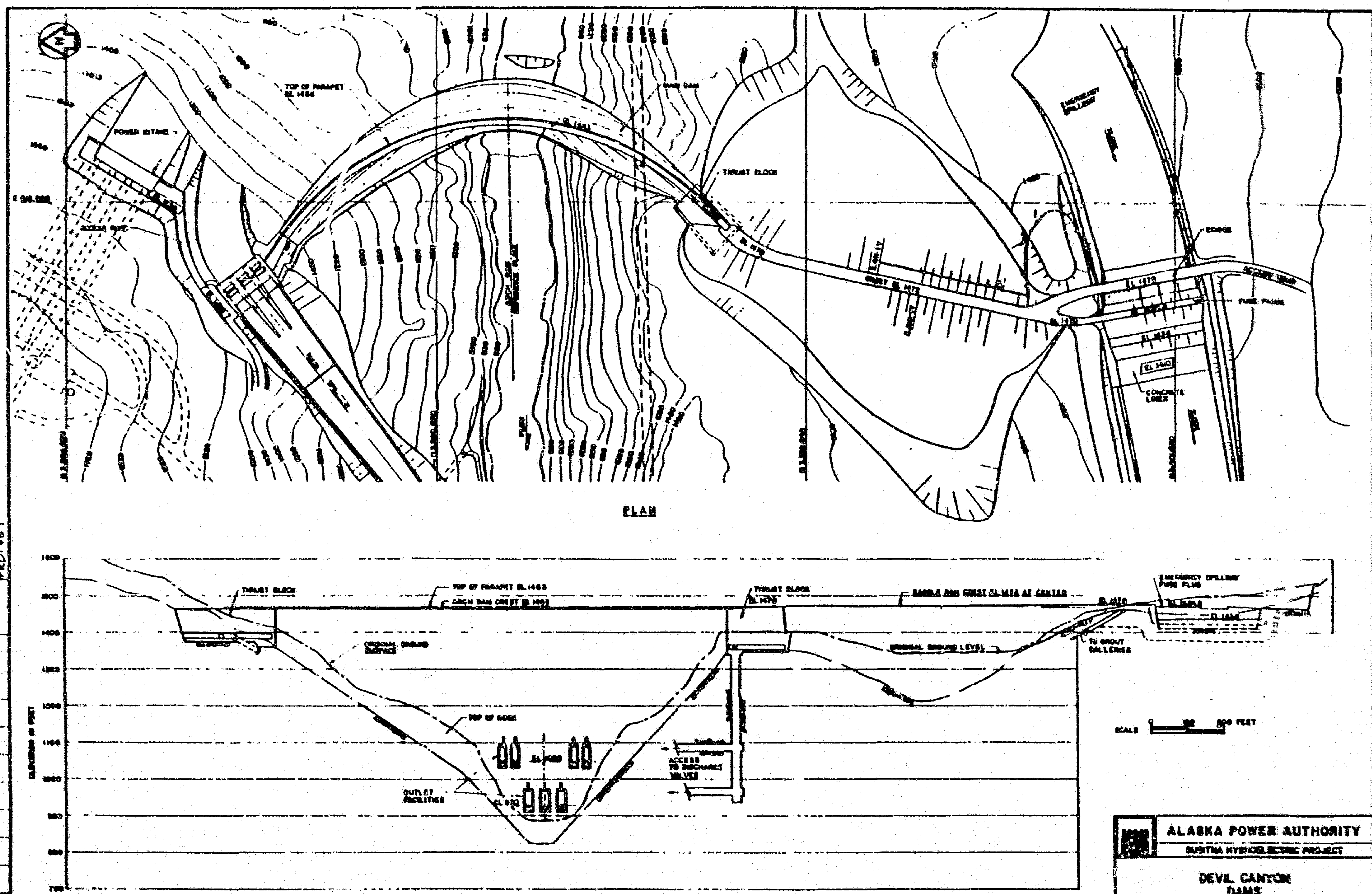


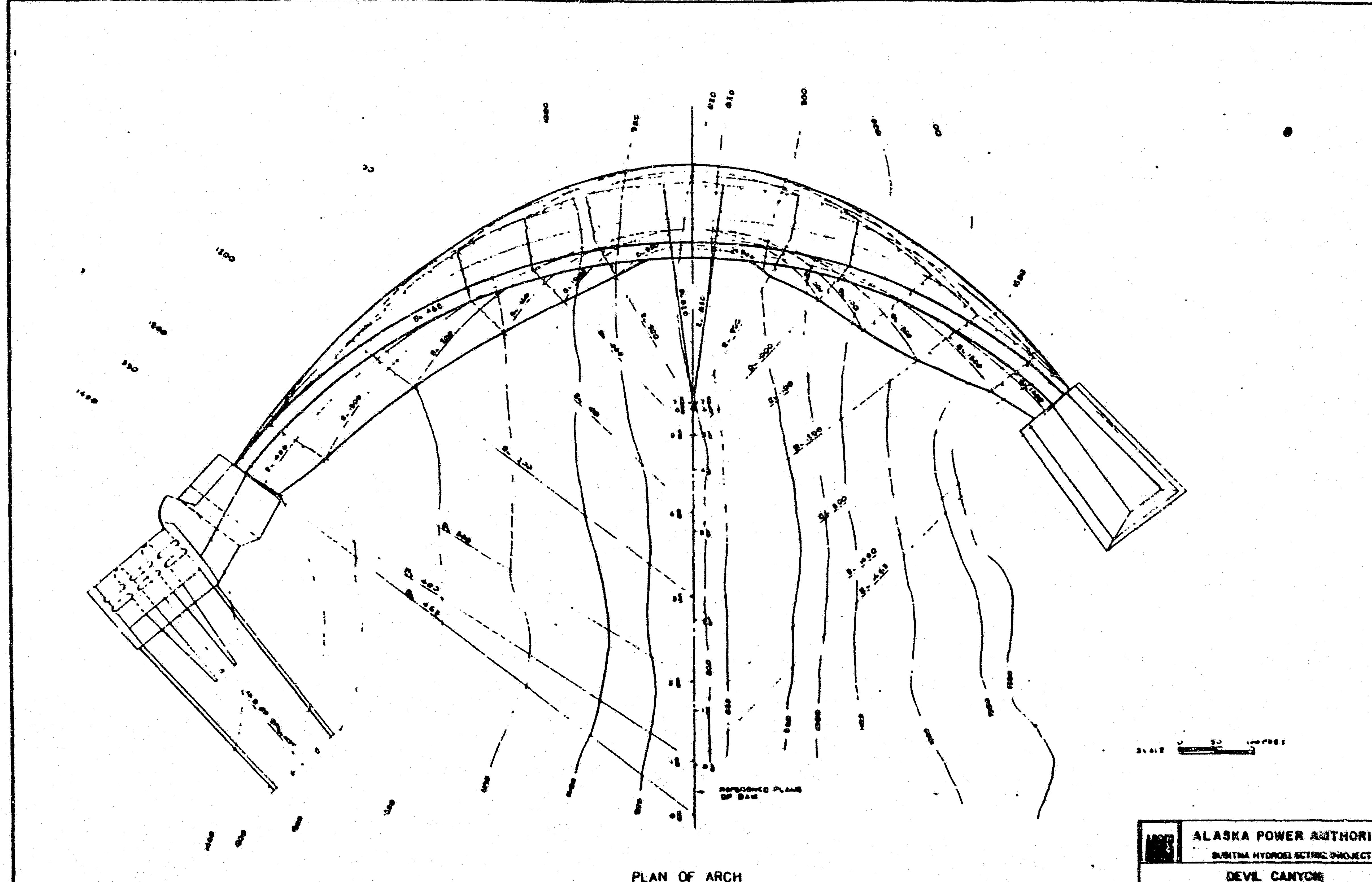
DYNAMIC RUN STIFF CORE
MAXIMUM ACCELERATION VS. HEIGHT

ACRES

FIGURE B6.36

18. PRESENTATION BY R. K. IBBOTSON


TOP OF PARAPET EL 1466
MAIN DAM
POWER INTAKE
THRUST BLOCK
EMERGENCY SPILLWAY
BRIDGE
ACCESS ROAD
FUSE PLUG
CONCRETE LINER
PLAN
THRUST BLOCK
TOP OF PARAPET EL 1463
ARCH DAM CREST EL 1463
SADDLE DAM CREST EL 1473 AT CENTER
EMERGENCY SPILLWAY FUSE PLUG
ORIGINAL GROUND SURFACE
ORIGINAL GROUND LEVEL
TO GROUT GALLERIES
TOP OF ROCK
ACCESS TO DISCHARGE VALVES
OUTLET FACILITIES
ELEVATION IN FEET
SCALE 0 200 400 FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON DAMS



ALASKA POWER AUTHORITY

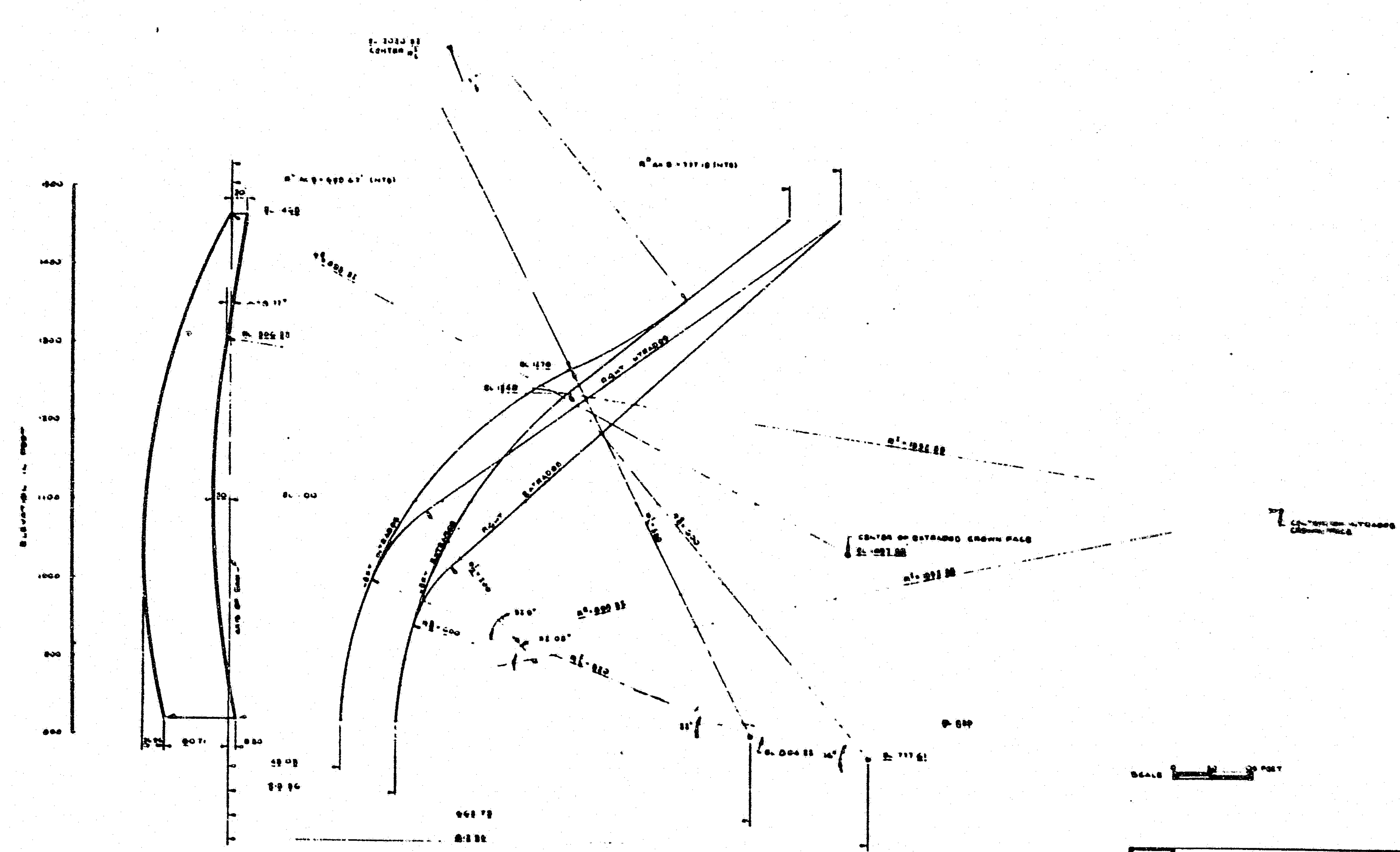
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
MAIN DAM
GEOMETRY

MARCH 1982

PLATE 72

614A



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
MAIN DAM
GEOMETRY
CROWN SECTION

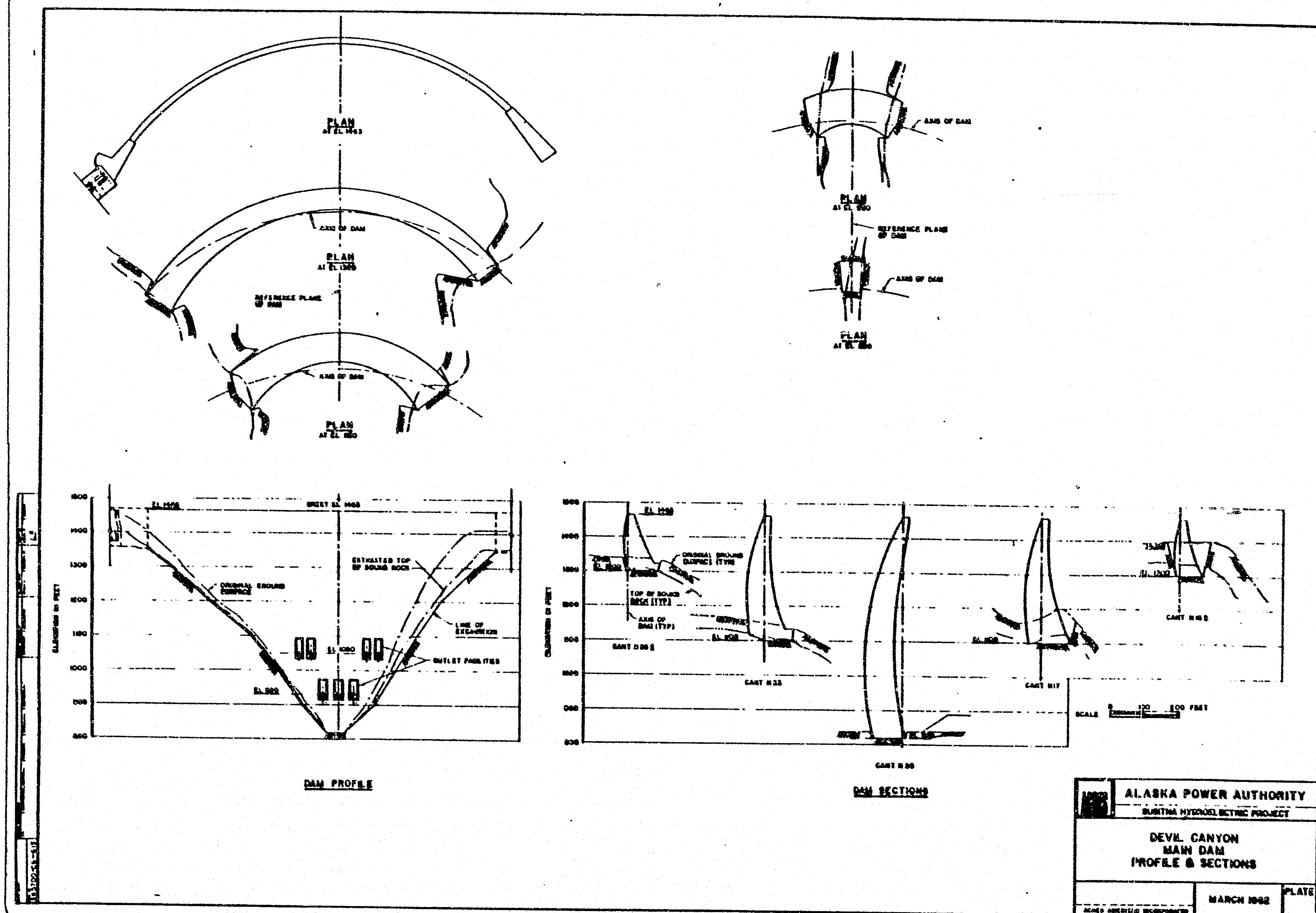
MARCH 1982

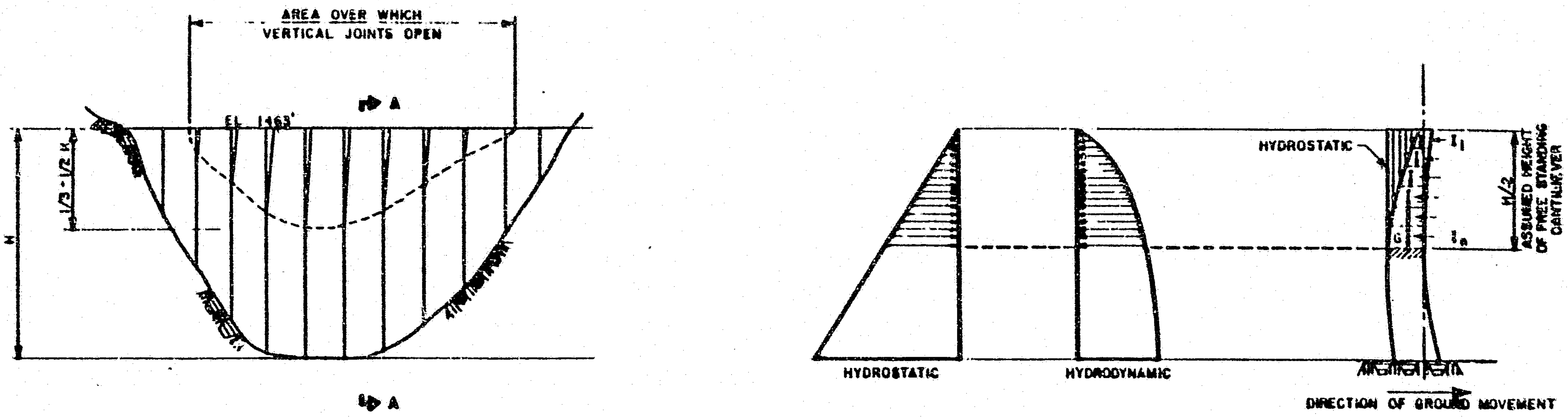
PLATE 73

ACRES AMERICAN INCORPORATED

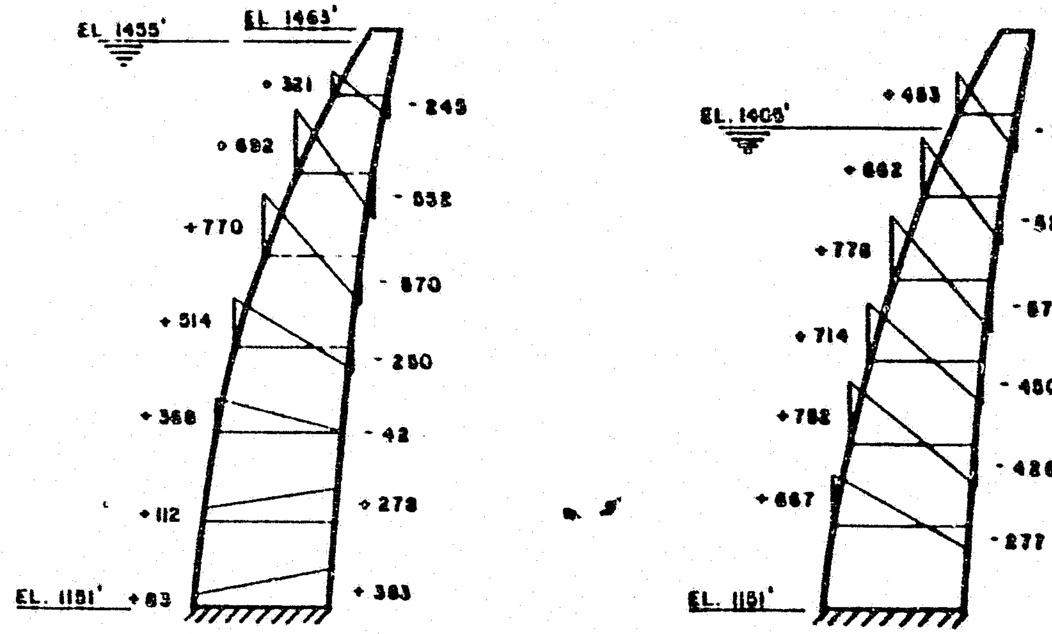
614B

Plate 40 - Feasibility Report


PLAN
PLAN
AXIS OF DAM
REFERENCE PLANE OF DAM
PLAN
AXIS OF DAM
PLAN
AXIS OF DAM
REFERENCE PLANE OF DAM
AXIS OF DAM
PLAN
DAM PROFILE
ORIGINAL GROUND SURFACE
ESTIMATED TOP OF SOUND ROCK
LINE OF EXCAVATION
OUTLET FACILITIES
ELEVATION IN FEET
DAM SECTIONS
ORIGINAL GROUND SURFACE (TYP)
TOP OF SOUND ROCK (TYP)
AXIS OF DAM (TYP)
SCALE 0 100 200 FEET
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
DEVIL CANYON
MAIN DAM
PROFILE & SECTIONS
MARCH 1982
PLATE



LOAD DISTRIBUTIONS

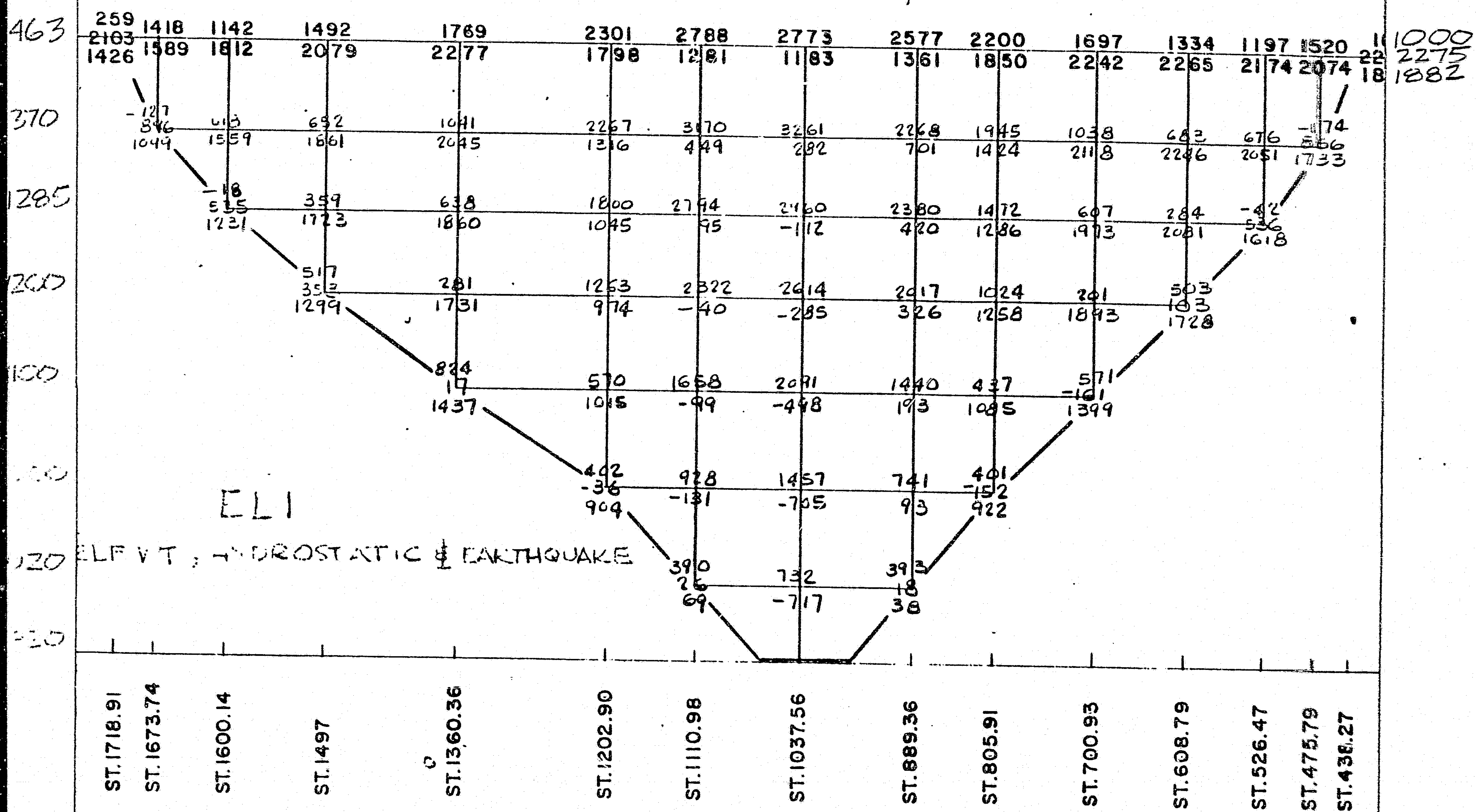


UNRESTRAINED CANTILEVER STRESSES (PSI)
SECTION A-A

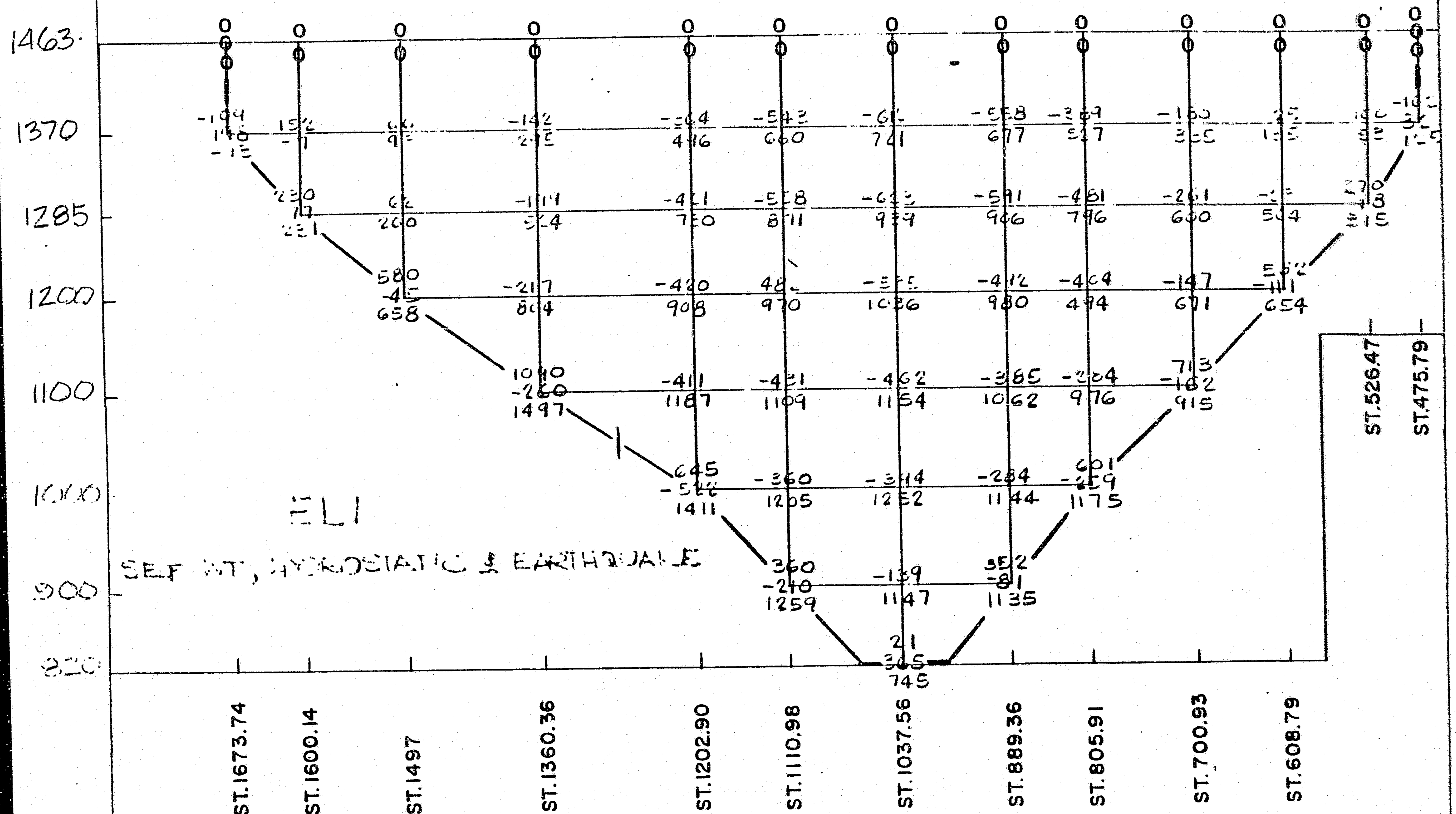
NOTES:
- (MINUS) INDICATES TENSILE STRESS.
+ (PLUS) INDICATES COMPRESSIVE STRESS.

DEVIL CANYON ARCH DAM DYNAMIC ANALYSIS
(ACCELERATION 0.5g, DAMPING 10%)

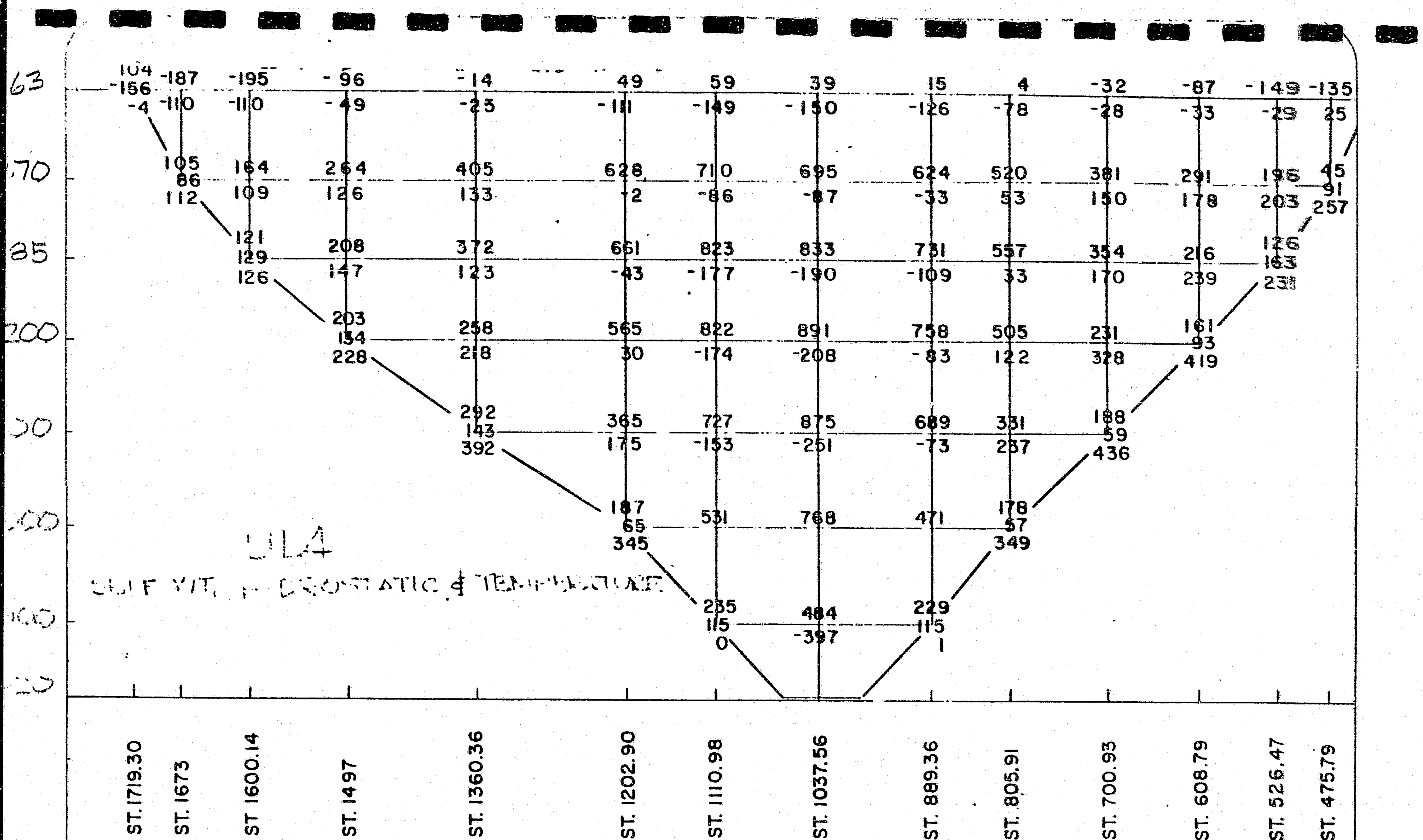
FIGURE



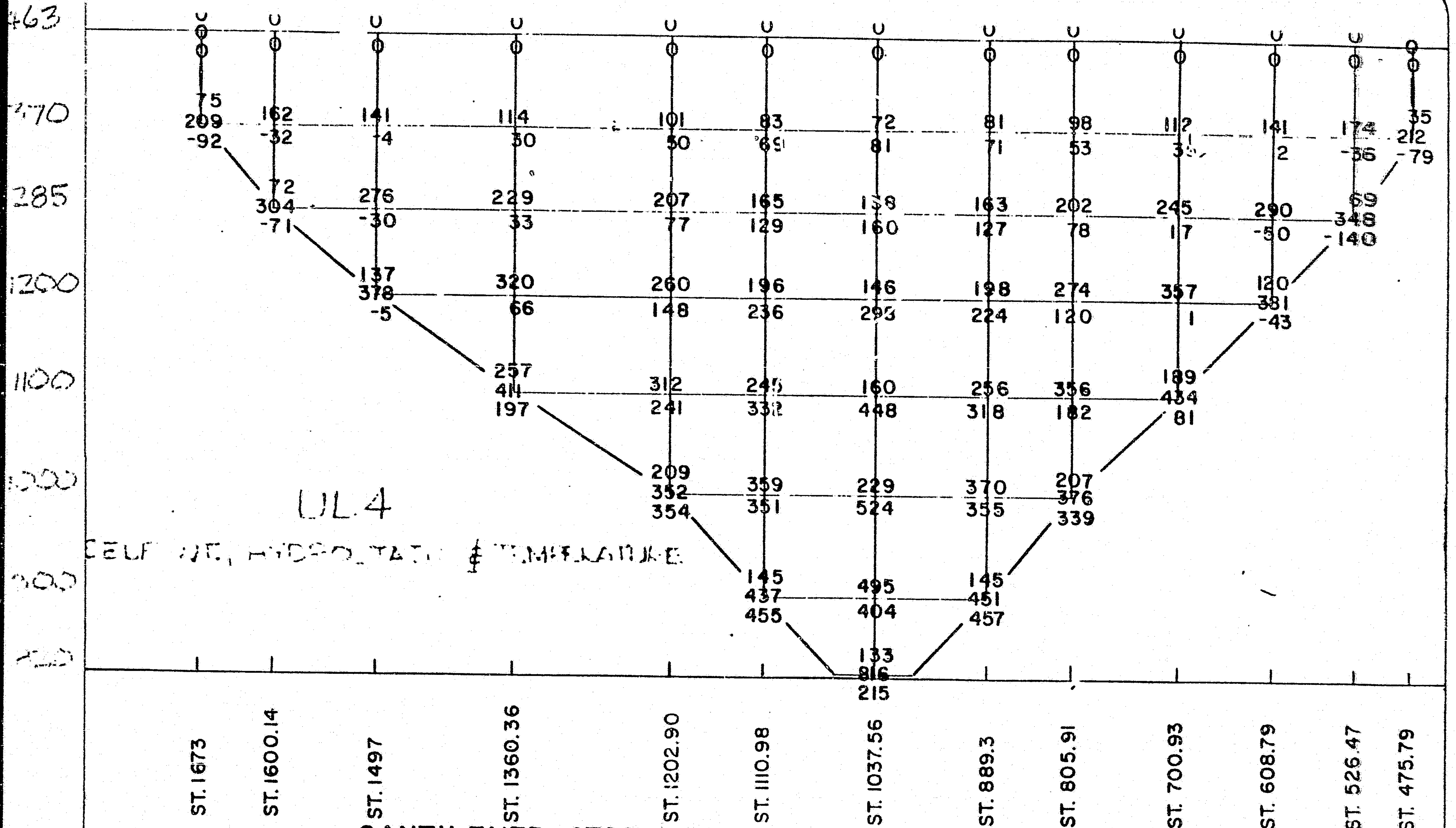
ARCH STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



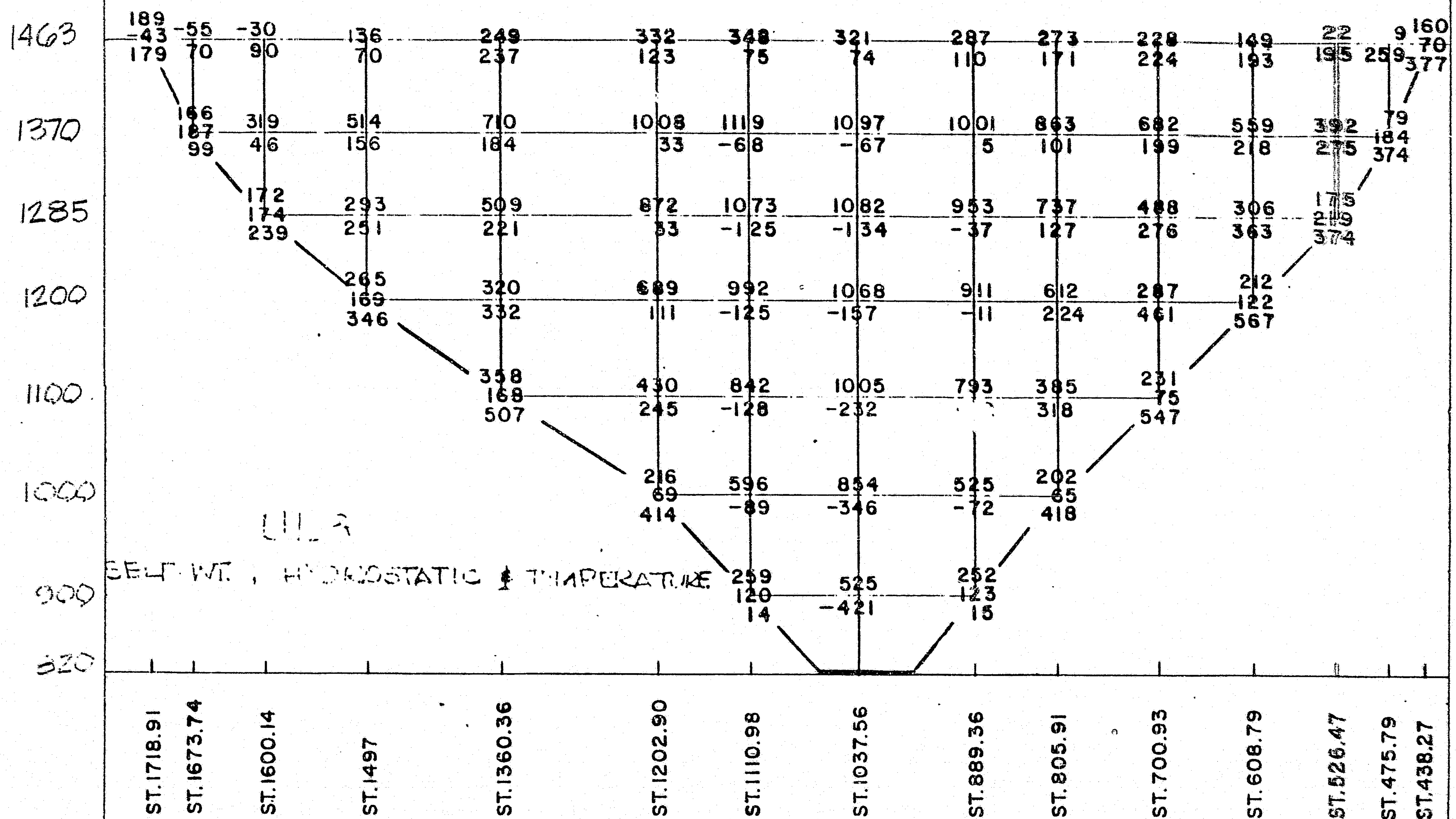
CANTILEVER STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



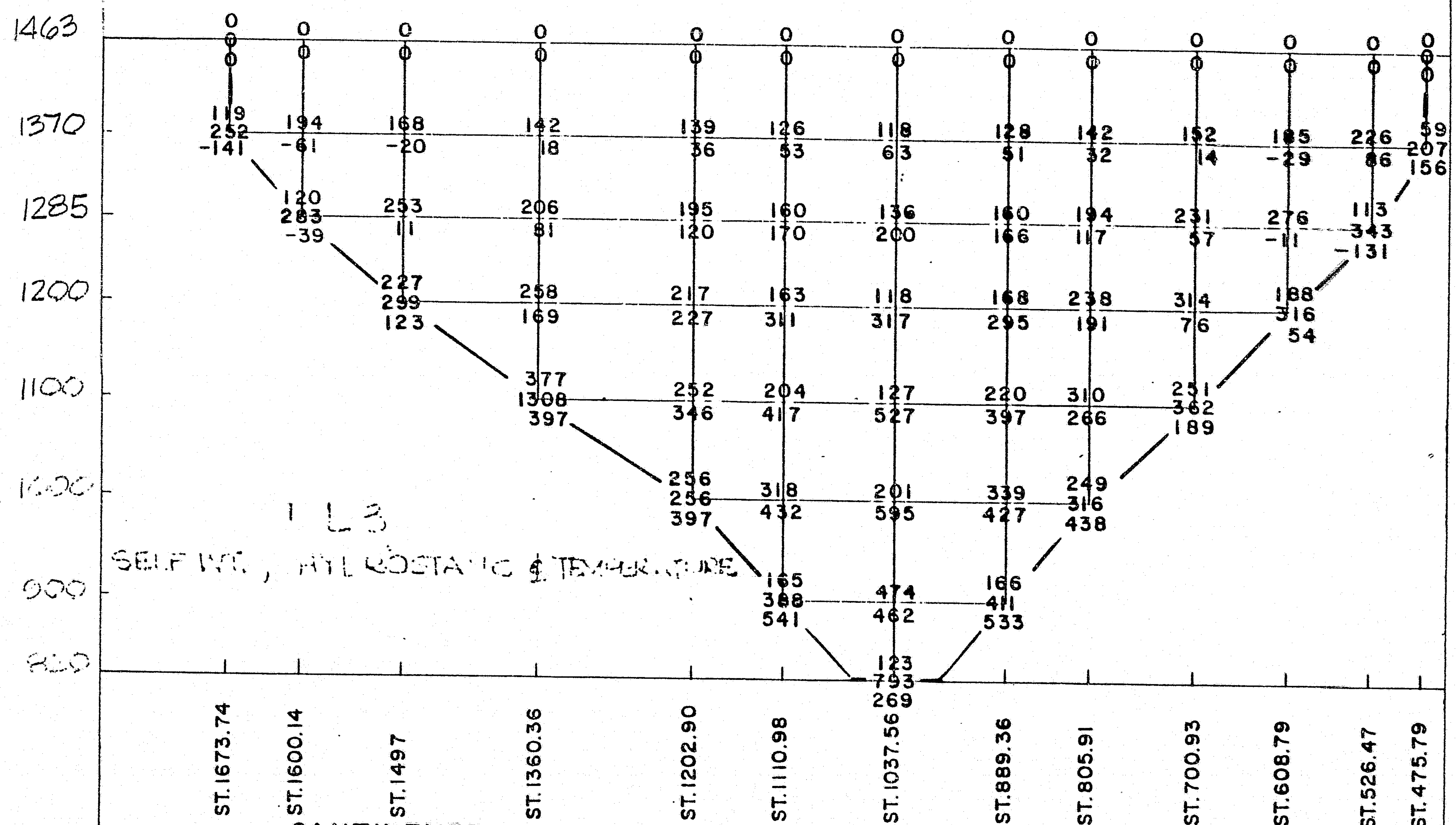
ARCH STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



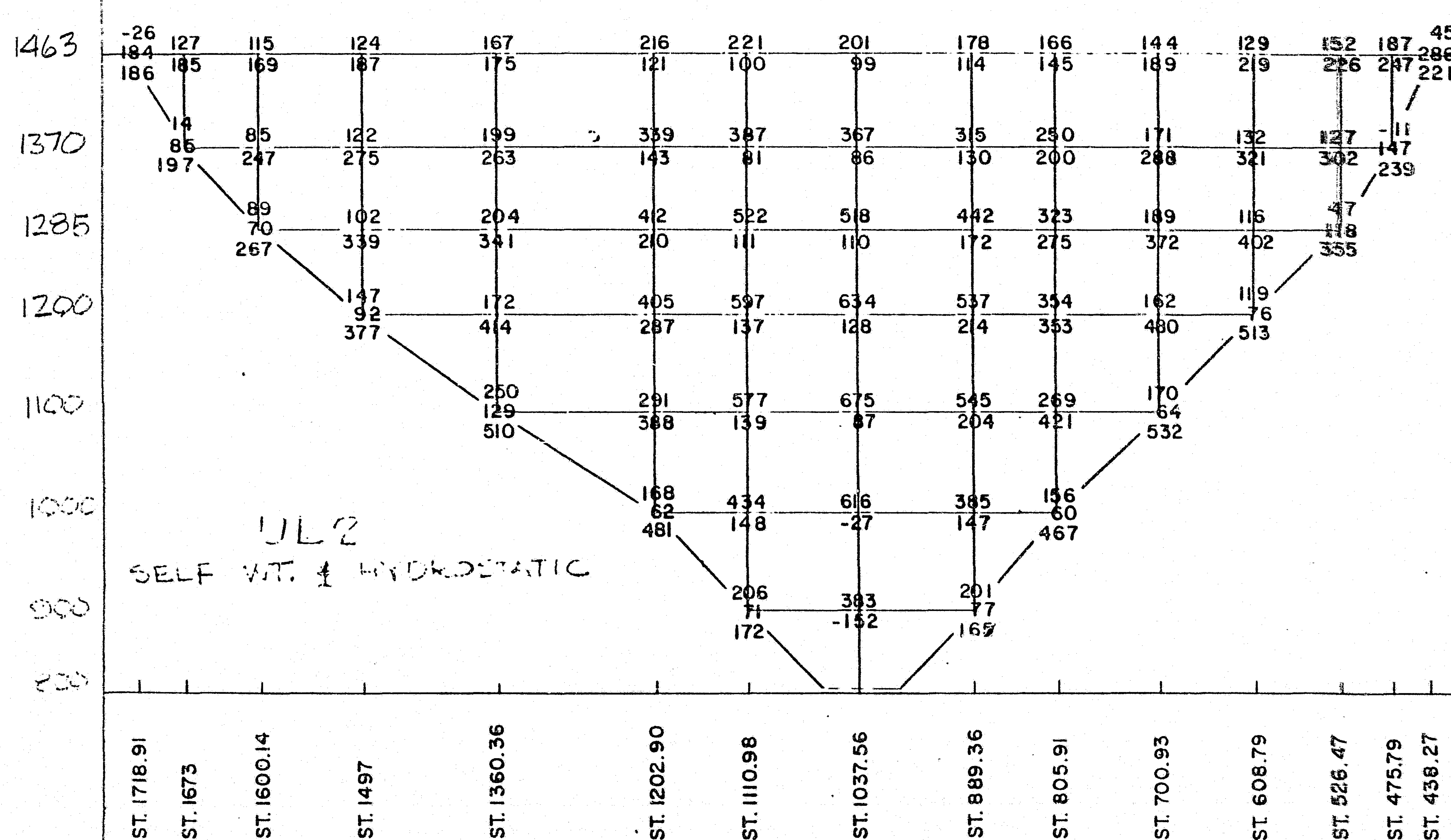
CANTILEVER STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



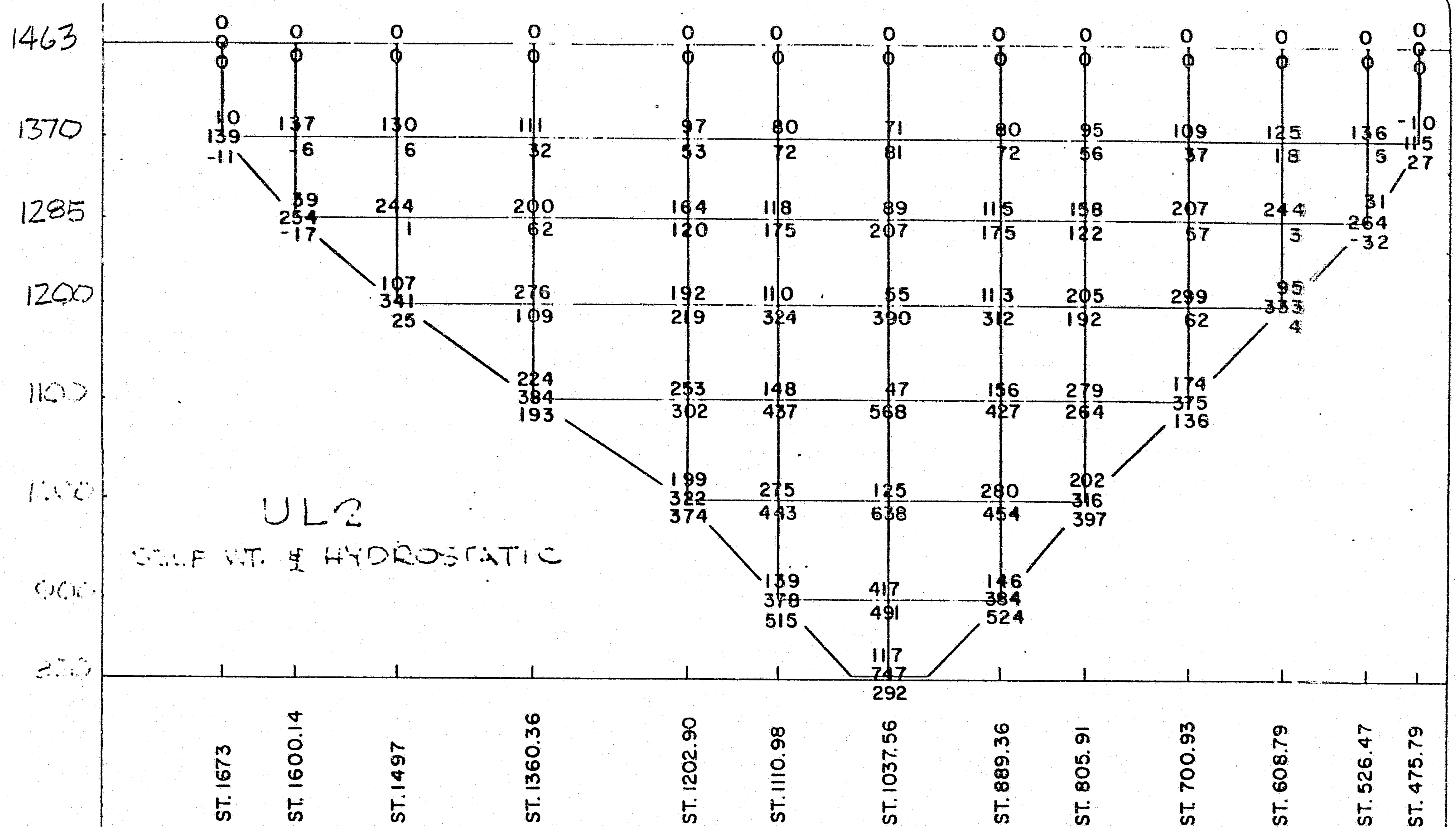
ARCH STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



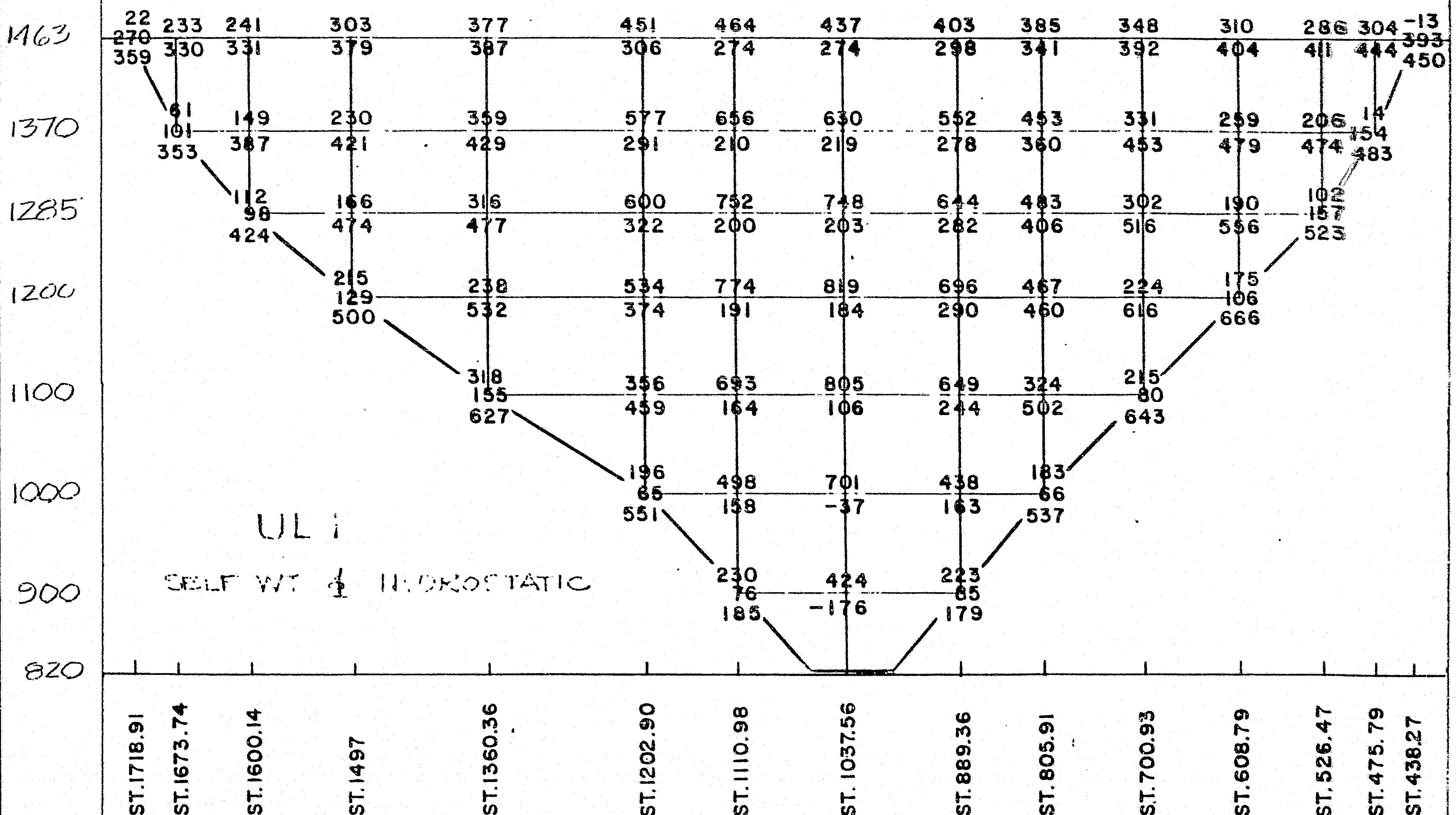
CANTILEVER STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM



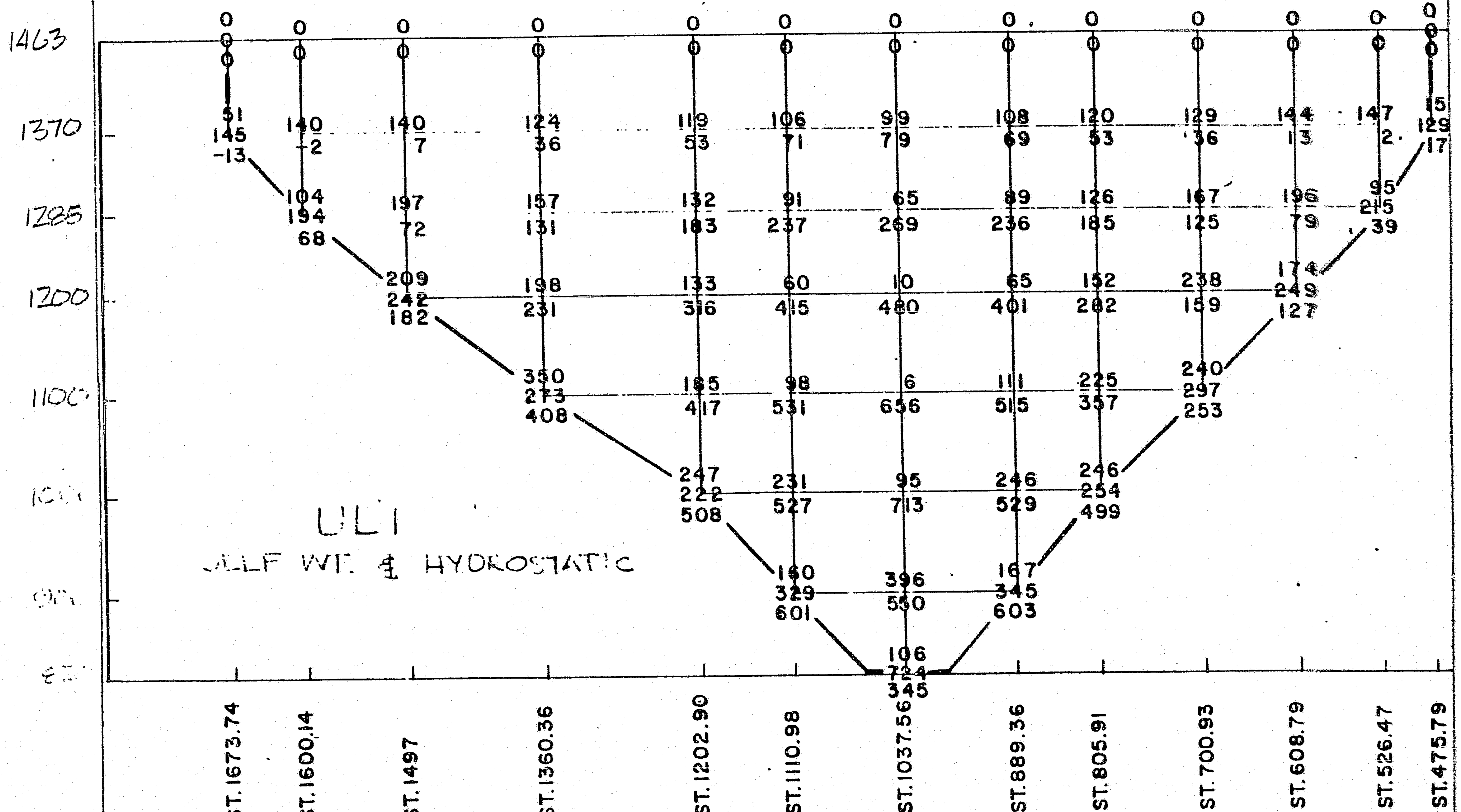
ARCH STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)



CANTILEVER STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)

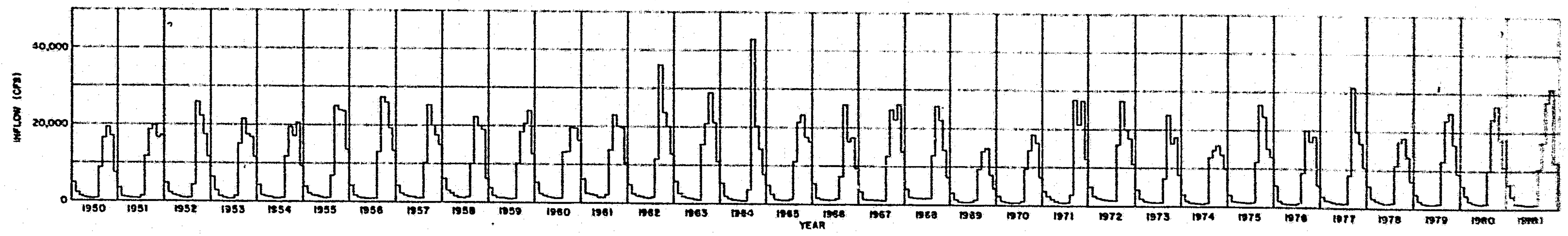


ARCH STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)

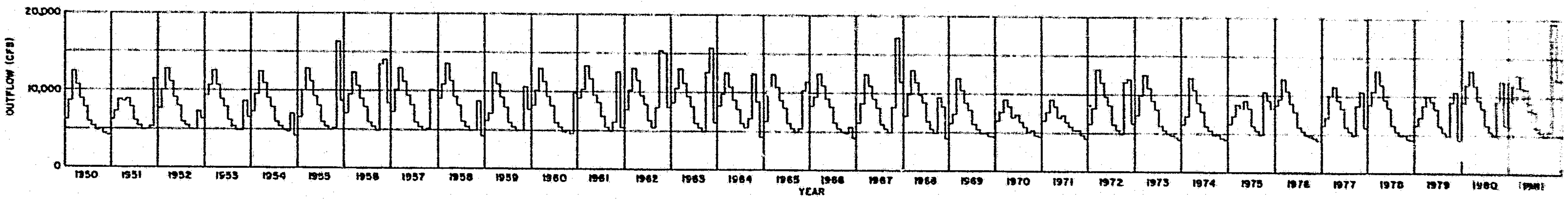


CANTILEVER STRESSES (PARALLEL TO THE FACE OF THE DAM LOOKING UPSTREAM)

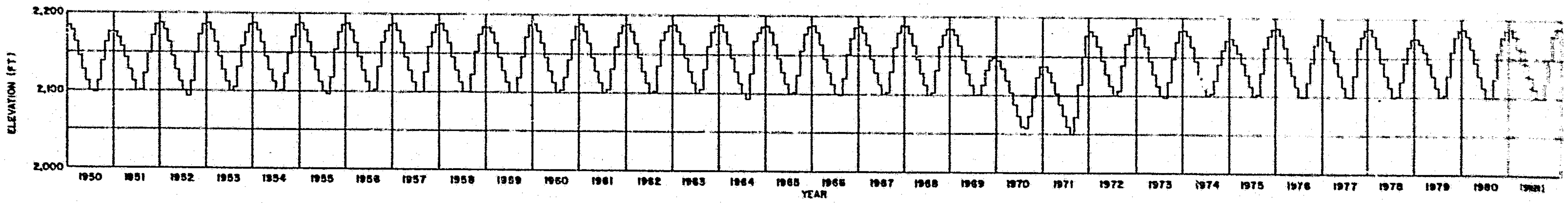
19. PRESENTATION BY J. W. HAYDEN



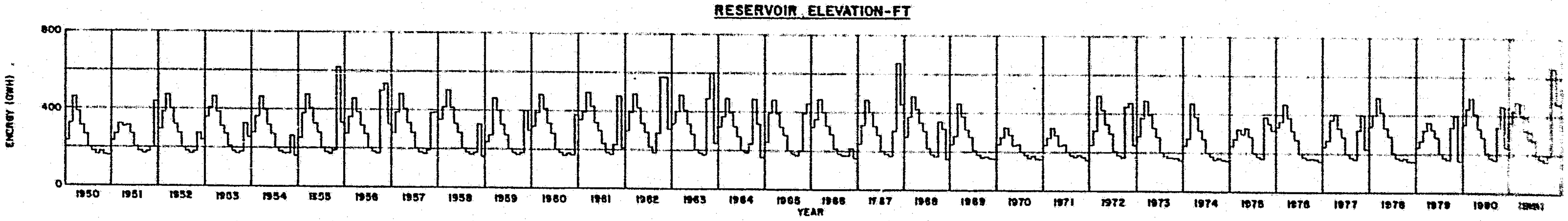
WATANA
INFLOW-CFS



WATANA
TOTAL OUTFLOW-CFS



WATANA
RESERVOIR ELEVATION-FT



WATANA
ENERGY-GWH

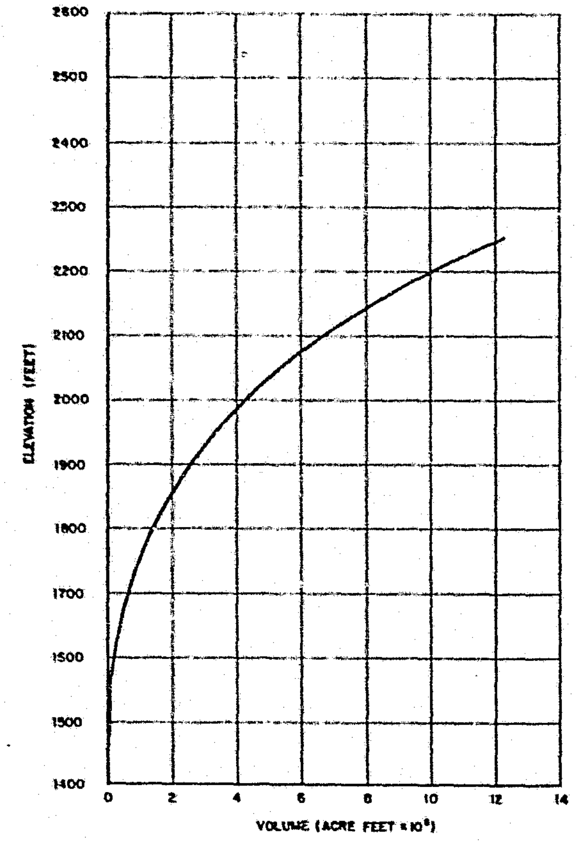
NOTES:

1. ALL YEARS ARE WATER YEARS: OCTOBER THROUGH SEPTEMBER.

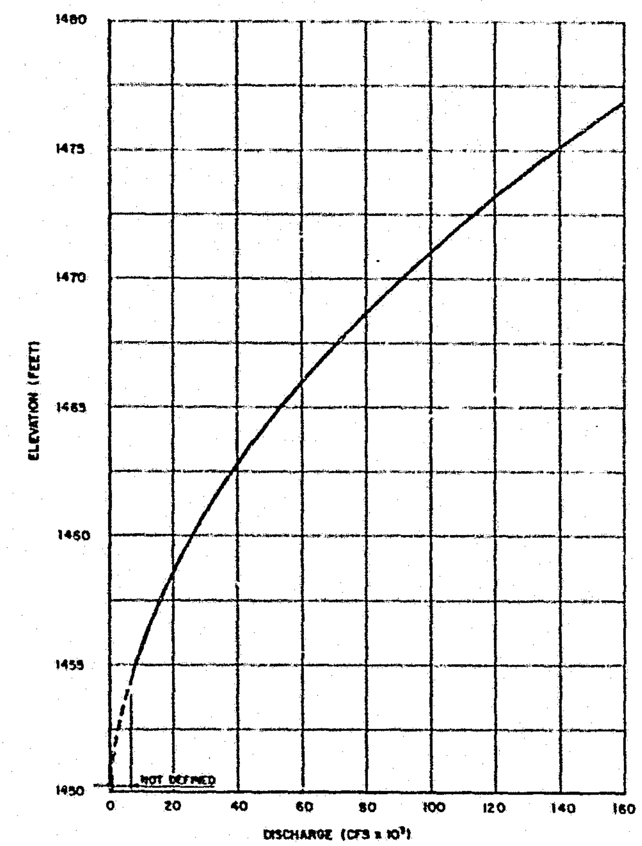
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

WATANA
SIMULATED RESERVOIR OPERATION

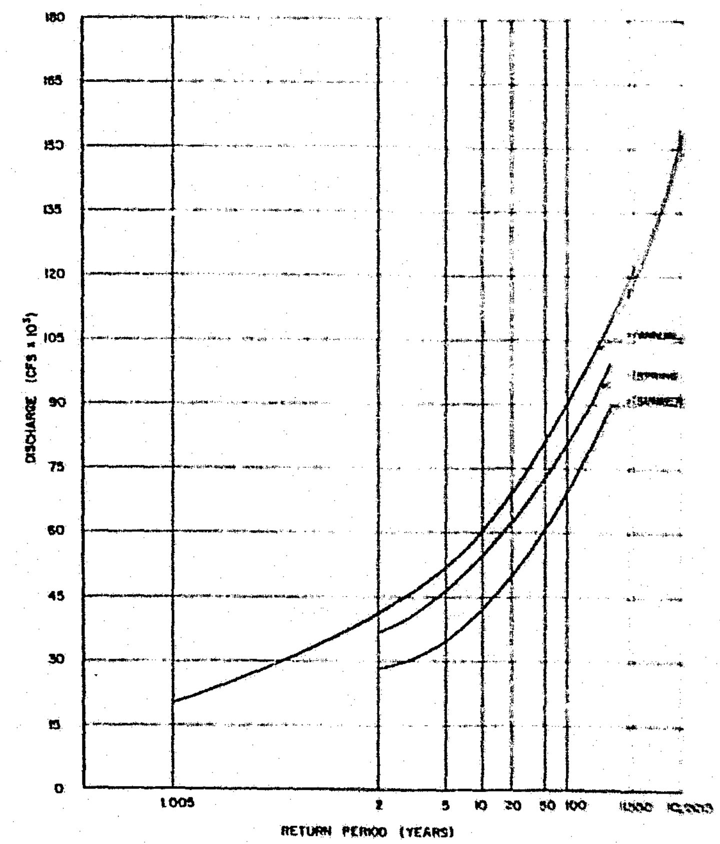
ACRES AMERICAN INCORPORATED | MARCH 1982 | PLATE 22



RESERVOIR VOLUME



TAILWATER RATING



FLOOD FREQUENCY
AFTER ROUTING

ALASKA POWER AUTHORITY

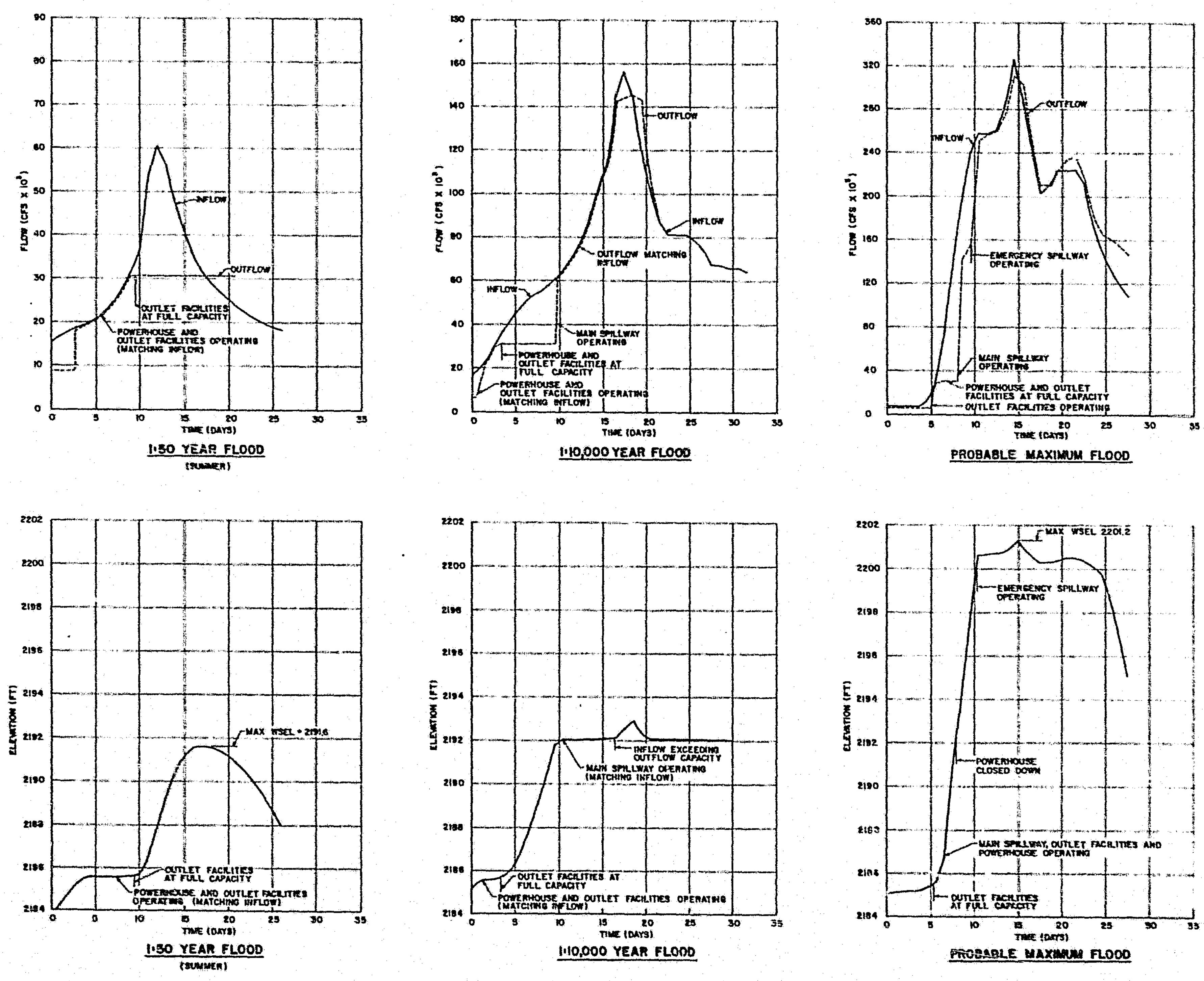
SUSITNA HYDROELECTRIC PROJECT

WATANA
HYDROLOGICAL DATA
SHEET 1

ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 33



ALASKA POWER AUTHORITY

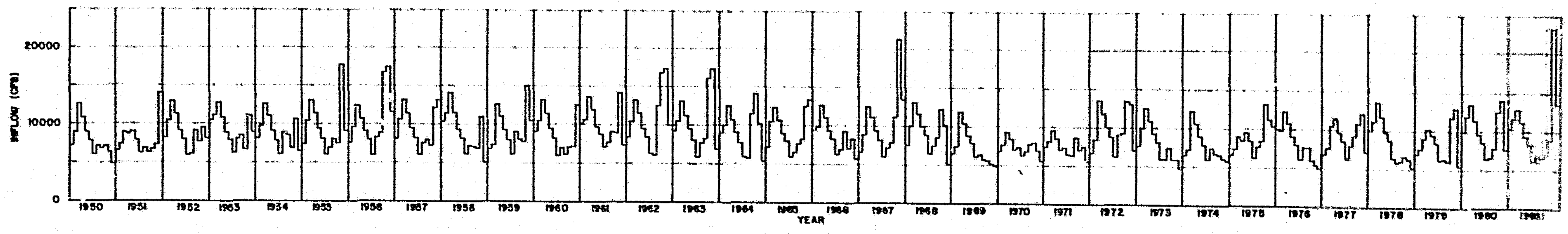
SUSITNA HYDROELECTRIC PROJECT

WATANA HYDROLOGICAL DATA SHEET 2

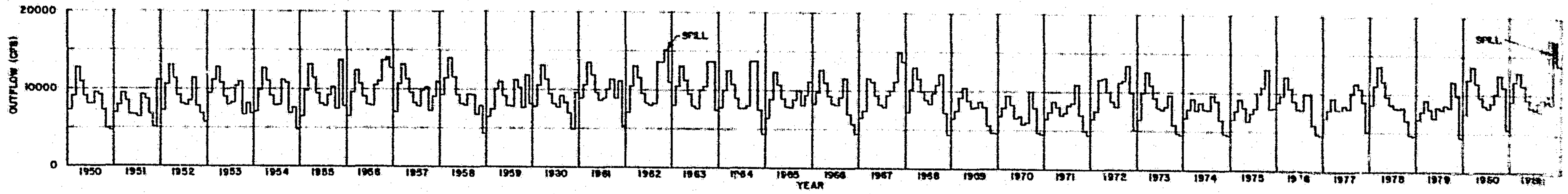
ACRES AMERICAN INCORPORATED

MARCH 1982

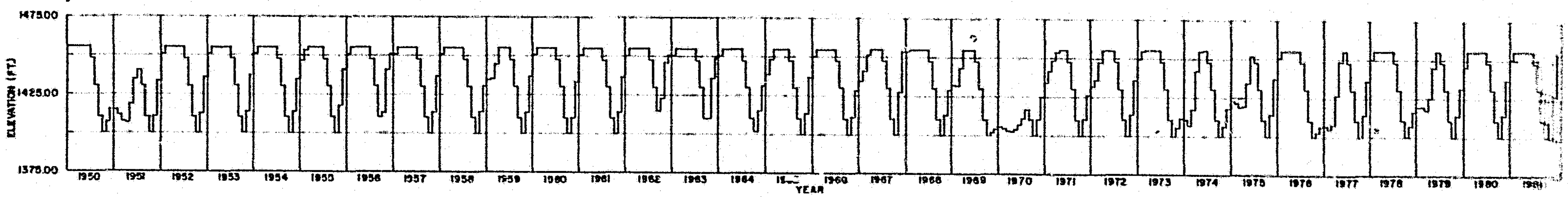
PLATE 34



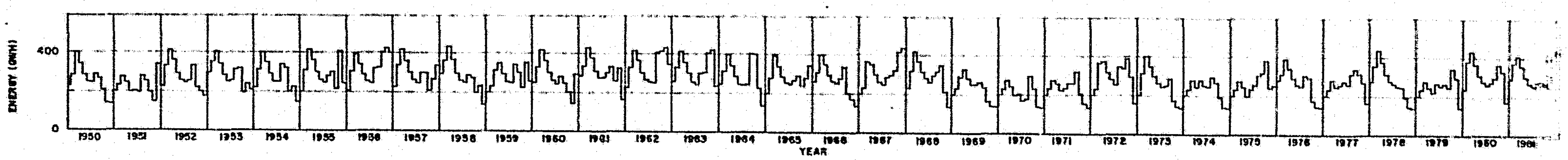
DEVIL CANYON
INFLOW(2) - CFS



DEVIL CANYON
TOTAL OUTFLOW - CFS



DEVIL CANYON
RESERVOIR ELEVATION - FT



DEVIL CANYON
ENERGY - GWH

NOTES:

1. ALL YEARS ARE WATER YEARS: OCTOBER THROUGH SEPTEMBER.
2. INFLOW TO DEVIL CANYON EQUALS TOTAL OUTFLOW FROM WATANA PLUS CONTRIBUTION FLOW FROM INTERVENING AREA BETWEEN DAM SITES.

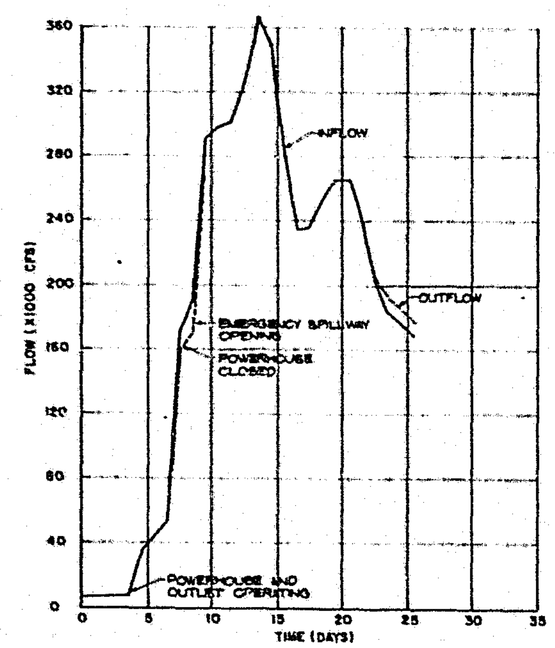
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
SIMULATED RESERVOIR OPERATION

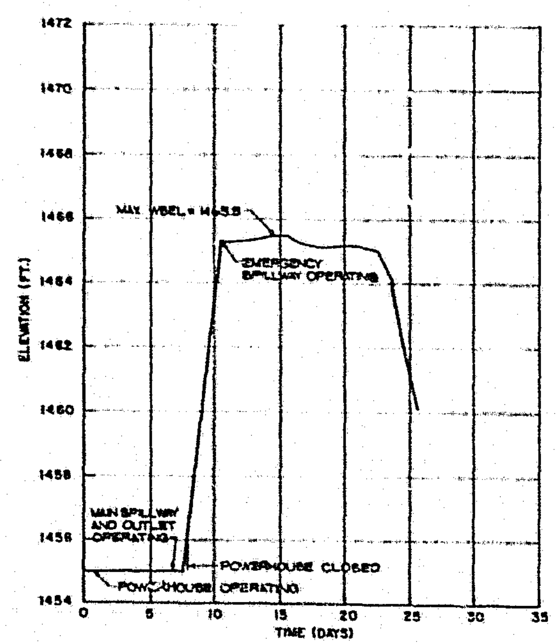
ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 22A



PROBABLE MAXIMUM FLOOD



PROBABLE MAXIMUM FLOOD

ALASKA POWER AUTHORITY

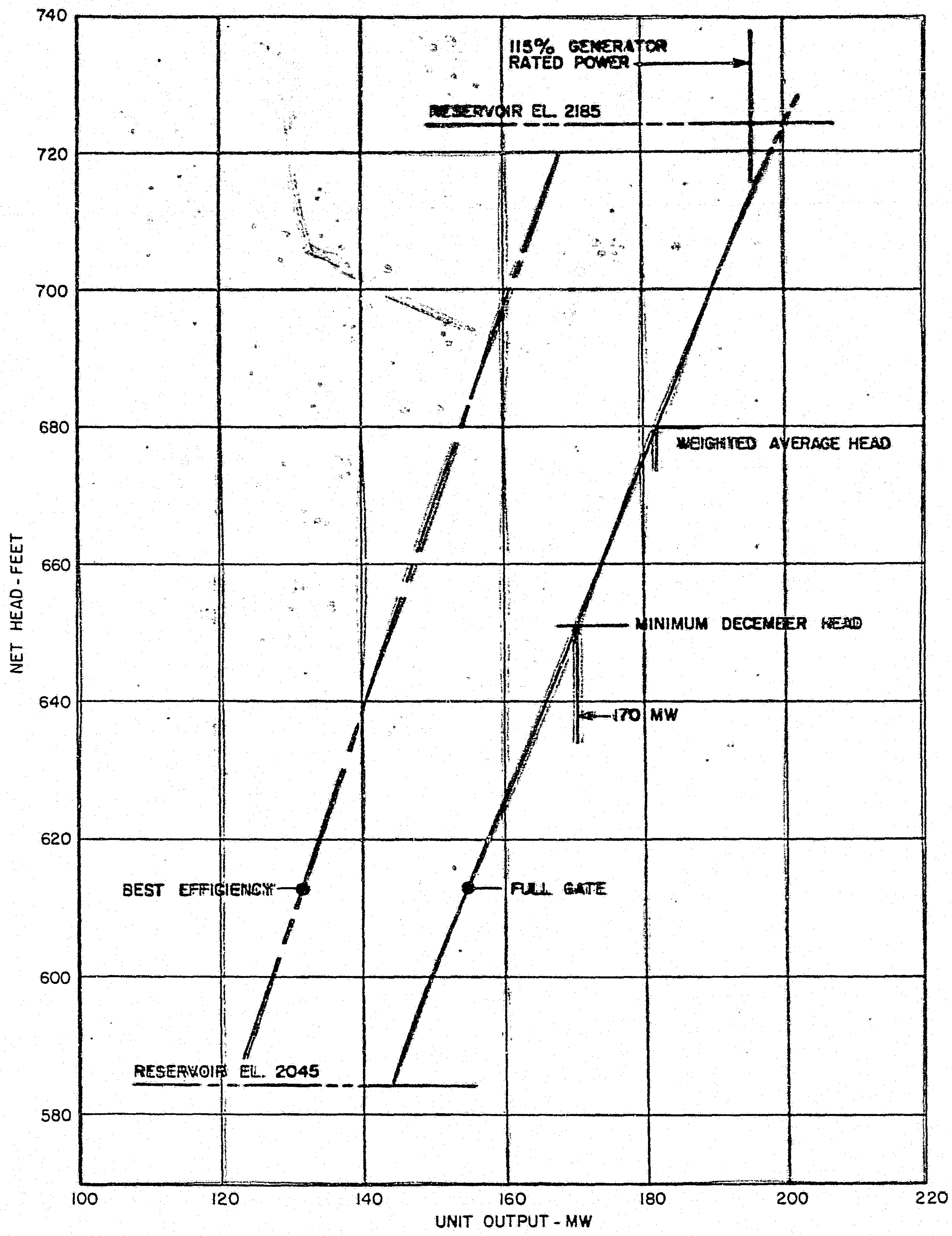
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
HYDROLOGICAL DATA
SHEET 2

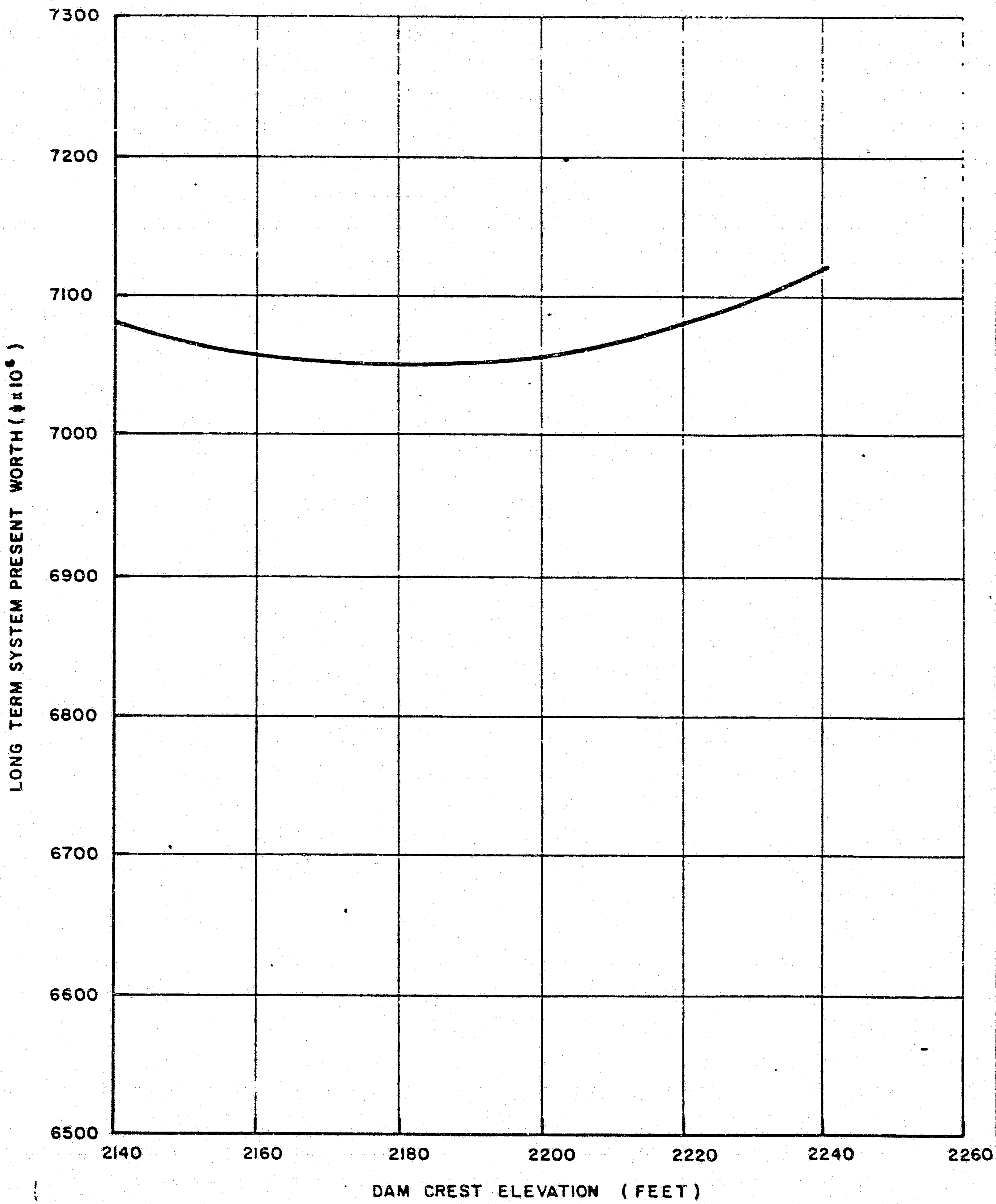
ACRES AMERICAN INCORPORATED

MARCH 1982

PLATE 66



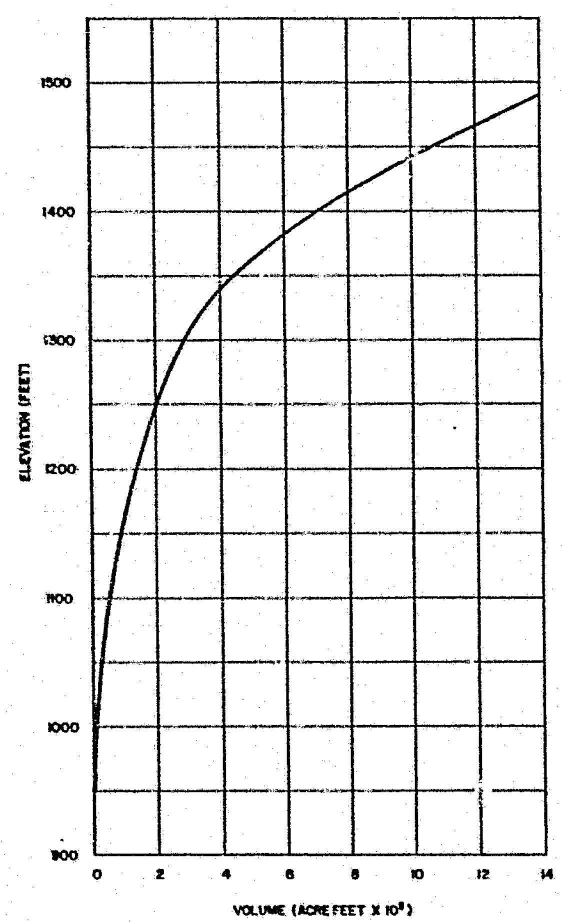
WATANA - UNIT OUTPUT



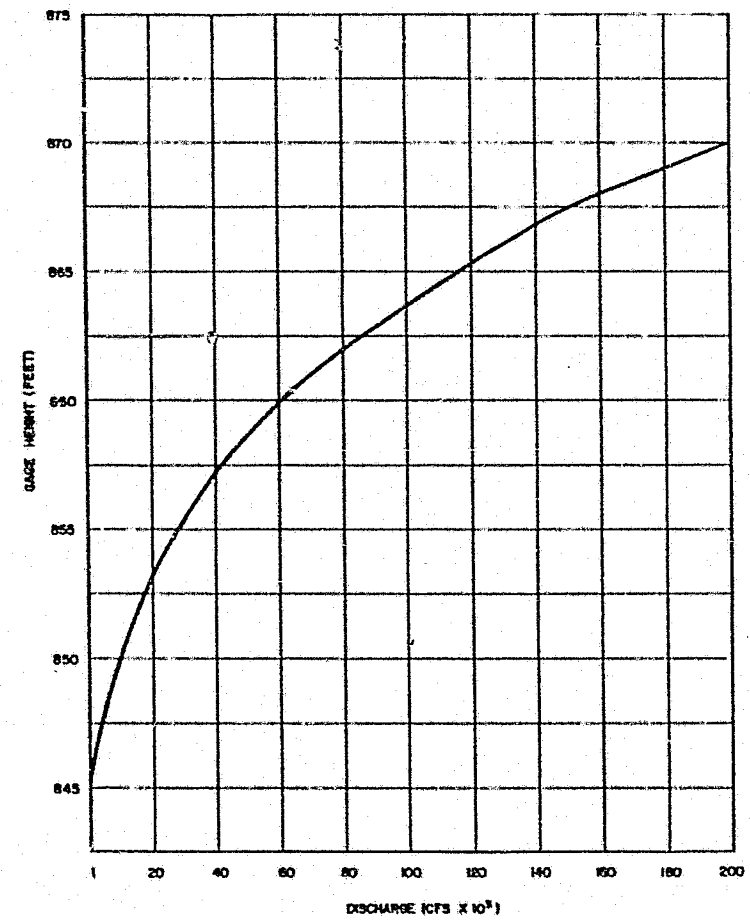
SELECTION OF RESERVOIR LEVEL

ACRES

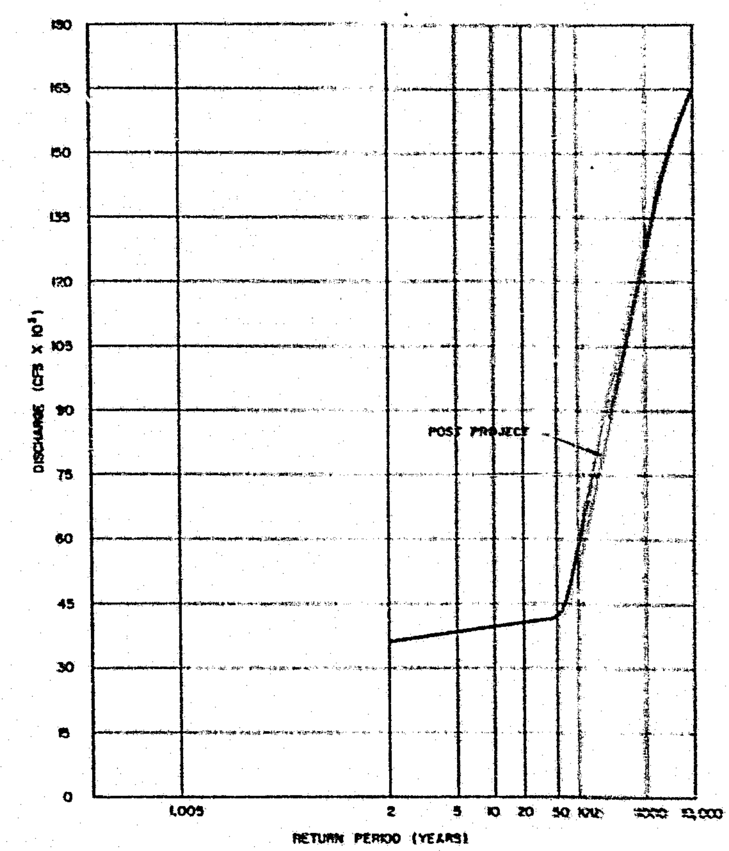
FIGURE 9.17



RESERVOIR VOLUME



TAILWATER RATING CURVE



FLOOD FREQUENCY CURVE

ALASKA POWER AUTHORITY

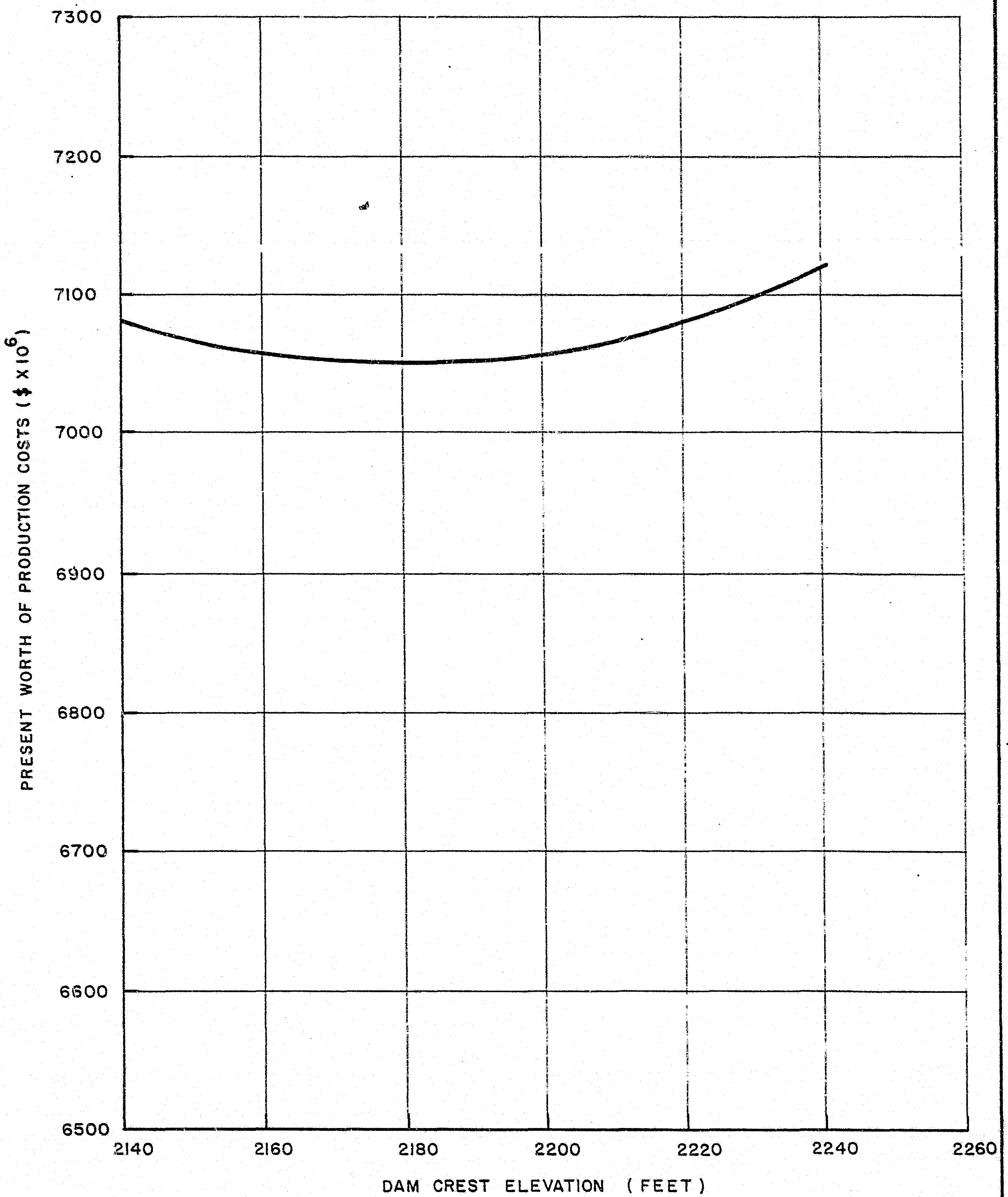
SUSITNA HYDROELECTRIC PROJECT

DEVIL CANYON
HYDROLOGICAL DATA
SHEET 1

MARCH 1982

PLATE 65

ACRES AMERICAN INCORPORATED

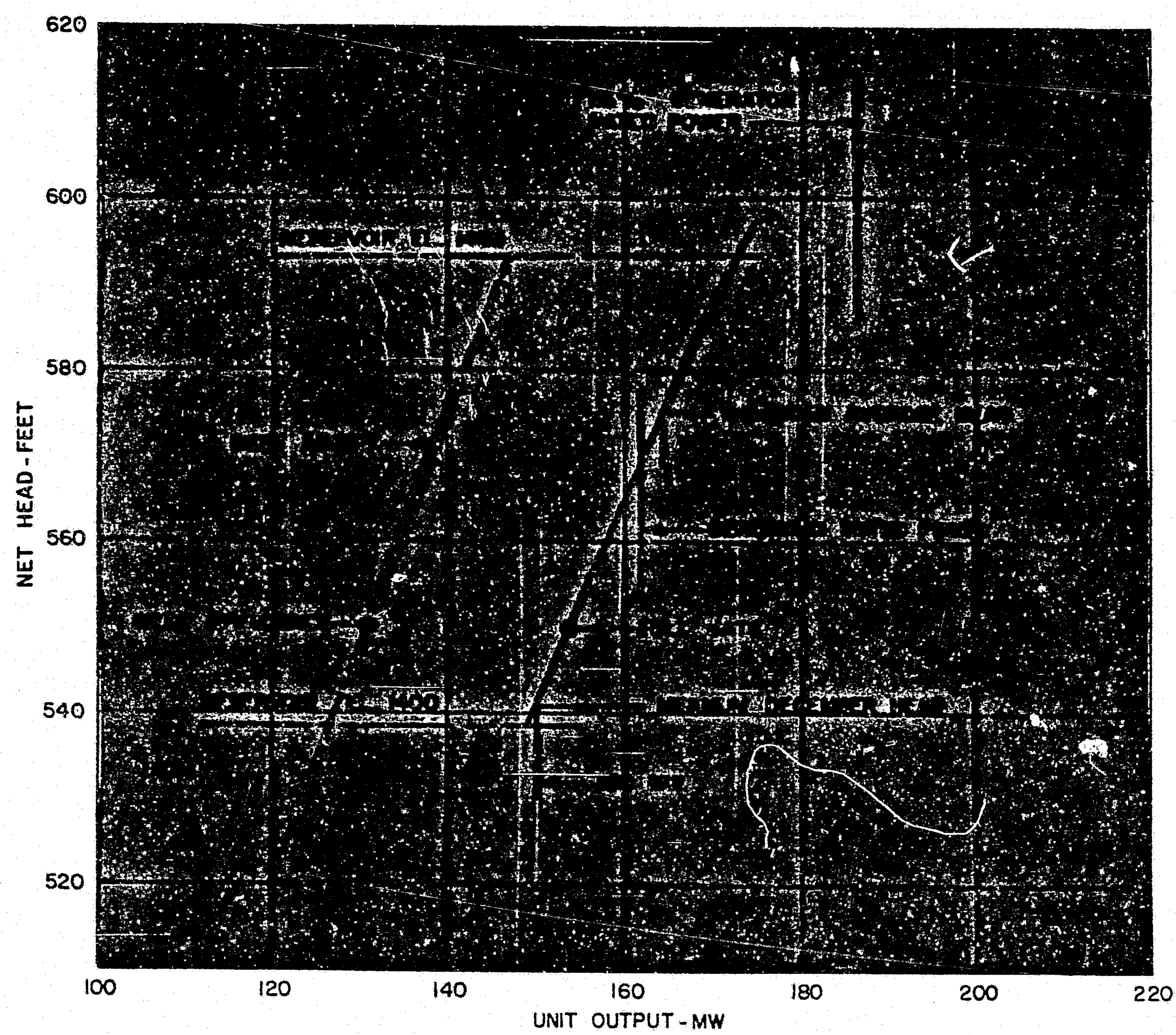


WATANA RESERVOIR

DAM CREST ELEVATION / PRESENT WORTH OF PRODUCTION COSTS

ACRES

FIGURE 9.4



DEVIL CANYON - UNIT OUTPUT

20. REPORT BY SPECIALIST CONSULTAN'.S

February 18, 1982

SUSITNA HYDROELECTRIC PROJECT
ALASKA POWER AUTHORITY EXTERNAL REVIEW PANEL
REPORT NO. 5

INTRODUCTION

The Alaska Power Authority External Review Panel for the Susitna Hydroelectric project met with the Acres Review Panel on February 18, 1982. The Acres External Review Panel had convened independently on February 17. Both meetings were conducted at the Acres American offices in Buffalo.

In addition to Panel Members, Robert Mohn of the Alaska Power Authority and representatives of Acres American were present.

The objective of these meetings was to discuss the few remaining topics regarding the project which required resolution. Various members of Acres American staff presented discussions regarding geotechnical questions, seismicity, hydraulics and design.

The Panel appreciates the courtesies extended to it by Acres American and the planning and preparation of discussions presented in the meetings.

Design Earthquake for Devil Canyon Dam

The studies conducted by Acres' consultants on seismology (Woodward-Clyde Consultants and Dr. Sykes) have indicated the need to design both Watana and Devil Canyon Dams for an earthquake occurring in the Talkeetna Terrain very close to the damsites and having a magnitude of the order of M = 6¼.

For this purpose, it is recommended that both dams be designed to withstand motions having a peak acceleration of 0.65g, a spectral shape similar to that presented in the Woodward-Clyde reports, and a duration of strong shaking of about 8 seconds. These are appropriately conservative motions for critical structures such as the dams of the Susitna Project.

For the purposes of engineering analysis, the motions used for excitation of an analytical model of a dam may well be different from those of the Seismic Safety Evaluation Earthquake discussed above. For the type of analysis being used by Acres to evaluate the seismic safety of Devil Canyon Dam the Panel believes that it is appropriate for this structure to base the analysis on design motions having the following characteristics:

Peak acceleration:	0.55g
Damping Ratio :	10%
Spectral Shape :	As recommended in Woodward-Clyde report for 10% damping

The use of these motions for analysis and design purposes is in keeping with those used for similar earthquakes for critical structures in other highly seismic regions and will provide the required degree of assurance of the ability of Devil Canyon Dam to withstand very strong motions (peak acceleration = 0.65g) in the remote possibility that a local earthquake of magnitude = 6¼ should occur.

It should be noted that the above recommendation applies only to the proposed Devil Canyon concrete arch dam and that design motions for other structures in the Project may be different from that recommended above, depending on the characteristics of the structures and the analysis procedure being used for evaluating their earthquake resistance.

Hydraulic Design of Spillways and Outlets

Acres responded to questions raised by the External Review Panel in its review of Watana and Devil Canyon drawings which are to be included in the final draft of the Feasibility Report. The Panel concurs in the answers to these questions and the design revisions that have been made with the exception that it still is of the opinion that the Tarbela air slot design for the spillway chutes would be more effective than the proposed aeration gallery with outlet ducts. However, this question will need to be resolved by large-scale hydraulic model tests in the final design of the spillways.

The Panel concurs that the revised emergency excavated spillway channel with a long relatively small invert slope to a pilot channel with a steep slope is superior to the previously proposed excavated channel with several invert drops. It is suggested that in final design the slope of the excavated channel be reduced as much as is practical in order to decrease velocities and erosion in this channel.

Liquefaction Potential of Soils in Relict Channel

At its last meeting in January, the Panel requested that Acres investigate the possible effects of earthquake-induced liquefaction in the surface soils of the relict channel. This question has been addressed in the report of Acres External Review Panel, dated February 18, 1982. We agree with the recommendations expressed in this report relative to the liquefaction potential of the soil in the relict channel.

H. Bolton Seed

Jacob H. Douma

Merlin D. Copen