HARZA-EBASCO
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SUSITNA HYDROELECTRIC PROJECT

EXTERNAL REVIEW BOARD

MEETING

NOVEMBER 18-19, 1982

Acres American Incorporated
1000 Liberty Bank Building
Main at Court
Buffalo, New York 14202
Telephone (716) 853-7525

SUSITNA HYDROELECTRIC PROJECT

EXTERNAL REVIEW BOARD

MEETING

NOVEMBER 18-19, 1982

ACRES AMERICAN INCORPORATED
1000 Liberty Bank Building
Main at Court
Buffalo, New York 14202
Telephone (716) 853-7525

PROPOSED AGENDA

SUSITNA HYDROELECTRIC PROJECT

EXTERNAL REVIEW BOARD

Attendance: Dr. Ralph Peck
Dr. Andrew Merritt
Dr. Harry Seed

Time & Location: 18-19 November, 1982
Anchorage

09:00	APA - Introduction	D. Wozniak
09:10	Acres - Introduction	C. Debelius
09:20	Scope of Summer Program	S. Thompson
09:40	Geology of Watana Relict Channel	S. Thompson
10:15	Coffee Break	
10:30	Material Properties of Watana Relict Channel	D. W. Lamb
11:00	Borrow Area D	D. W. Lamb
11:30	Fog Lakes Relict Channel	S. Thompson
12:00	Lunch	
1:00	Damsite Geology	S. Thompson
1:20	Upstream & Downstream Portals	S. Thompson
1:45	Scope of Winter/Summer Programs	S. Thompson
2:15	Rockfill Concrete Faced Dam	D. W. Lamb
3:00	Discussion	
3:30	Wrap-up Summary of Board's Comments	

- SCOPE SUMMER PROGRAM

OBJECTIVE OF
82 SUMMER PROGRAM

- DAMSITE
- WATANA RELICT CHANNEL
- BORROW AREA D
- FOG LAKES RELICT CHANNEL

DAMSITE

- EXTENDED GEOLOGIC MAPPING
- CONFIRM & REFINE GEOLOGIC INTERPRETATION
- DETERMINE ROCK CONDITIONS & OVERBURDEN DEPTH BENEATH PROPOSED MAJOR CIVIL STRUCTURES

BORROW AREA D

- DEFINE STRATIGRAPHY & EXTENT OF IDENTIFIED UNITS
- DEFINE GEOHYDROLOGY & PERMAFROST
- MATERIAL PROPERTIES

- GEOLOGY OF WATANA RELICT CHANNEL

WATANA RELICT
CHANNEL

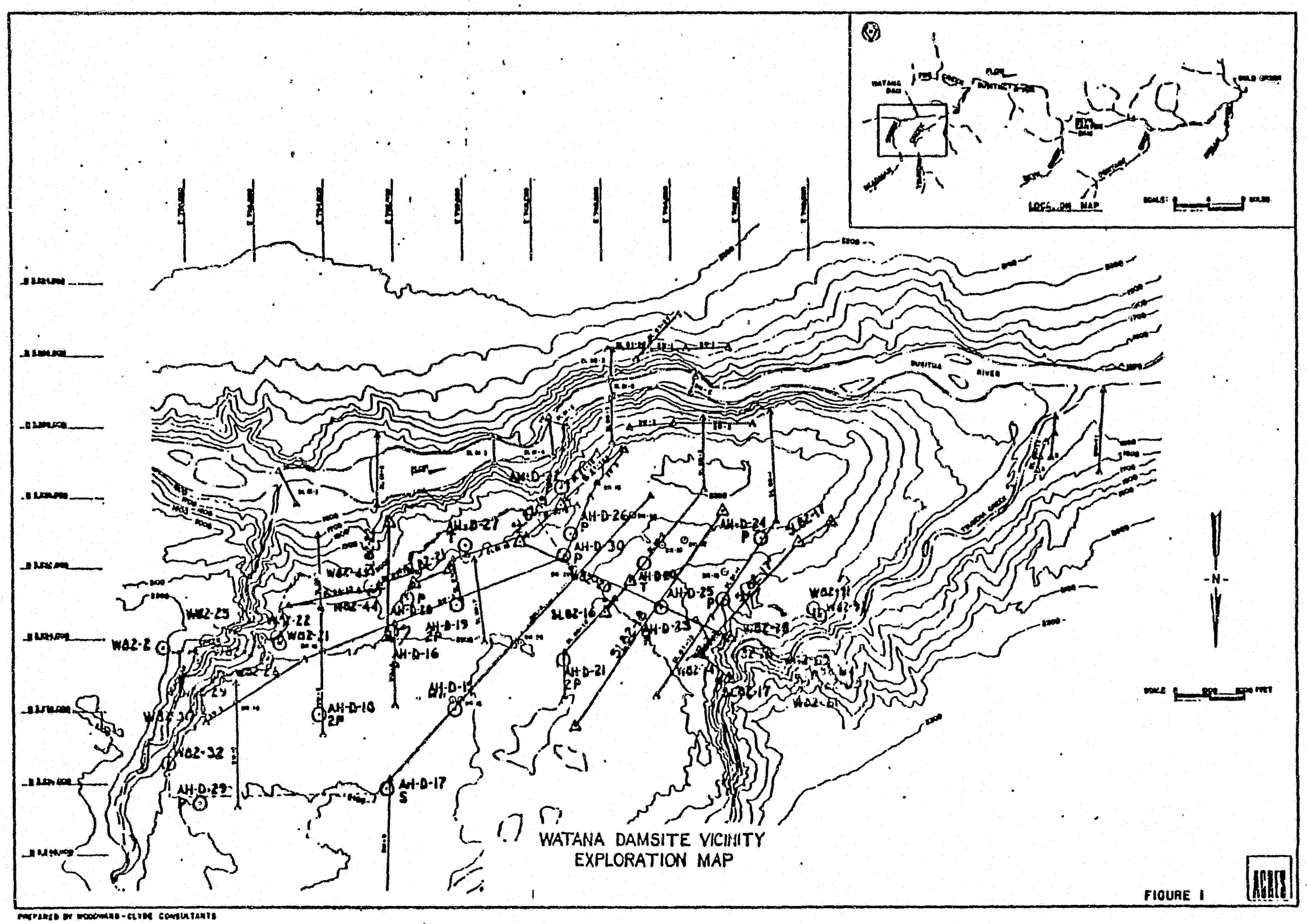
- DEFINE STRATIGRAPHY IN UPPER 200 FEET
- FURTHER DEFINE CHANNEL GEOMETRY
- DEFINE MATERIAL PROPERTIES
- DEFINE GEOHYDROLOGY
- DEFINE PERMAFROST CONDITIONS

FOG LAKES RELICT
CHANNEL

- DEFINE CHANNEL GEOMETRY

SCOPE OF 82-SUMMER PROGRAM

- DRILLING
  - 16 BOREHOLES IN BORROW AREA D/RELICT CHANNEL
- SEISMIC REFRACTION SURVEY
  - 22,000 LF-DAM SITE
  - 16,000 LF-BORROW AREA D/RELICT CHANNEL
  - 45,000 LF-FOG LAKES
- GEOLOGIC MAPPING
  - DAM SITE
    - LOCAL
    - REGIONAL
  - BORROW SITE
    - D
    - E
    - I
- LABORATORY TESTING
  - ATTERBERG LIMITS
  - GRADATIONS
  - HYDROMETERS
  - MOISTURE CONTENTS
  - PROCTORS



WATANA DAMSITE VICINITY
EXPLORATION MAP

FIGURE 1

PREPARED BY WOODWARD-CLYDE CONSULTANTS

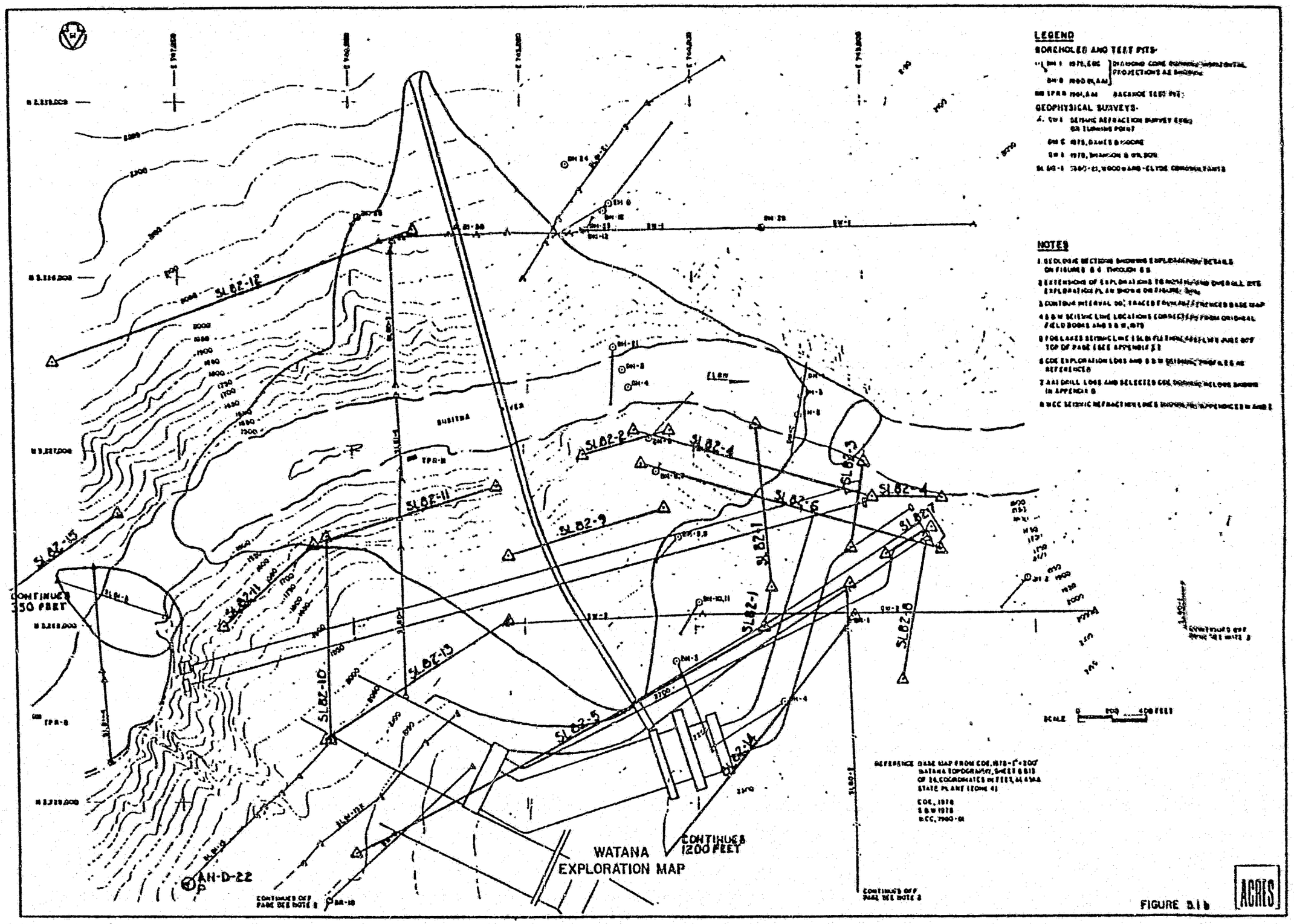
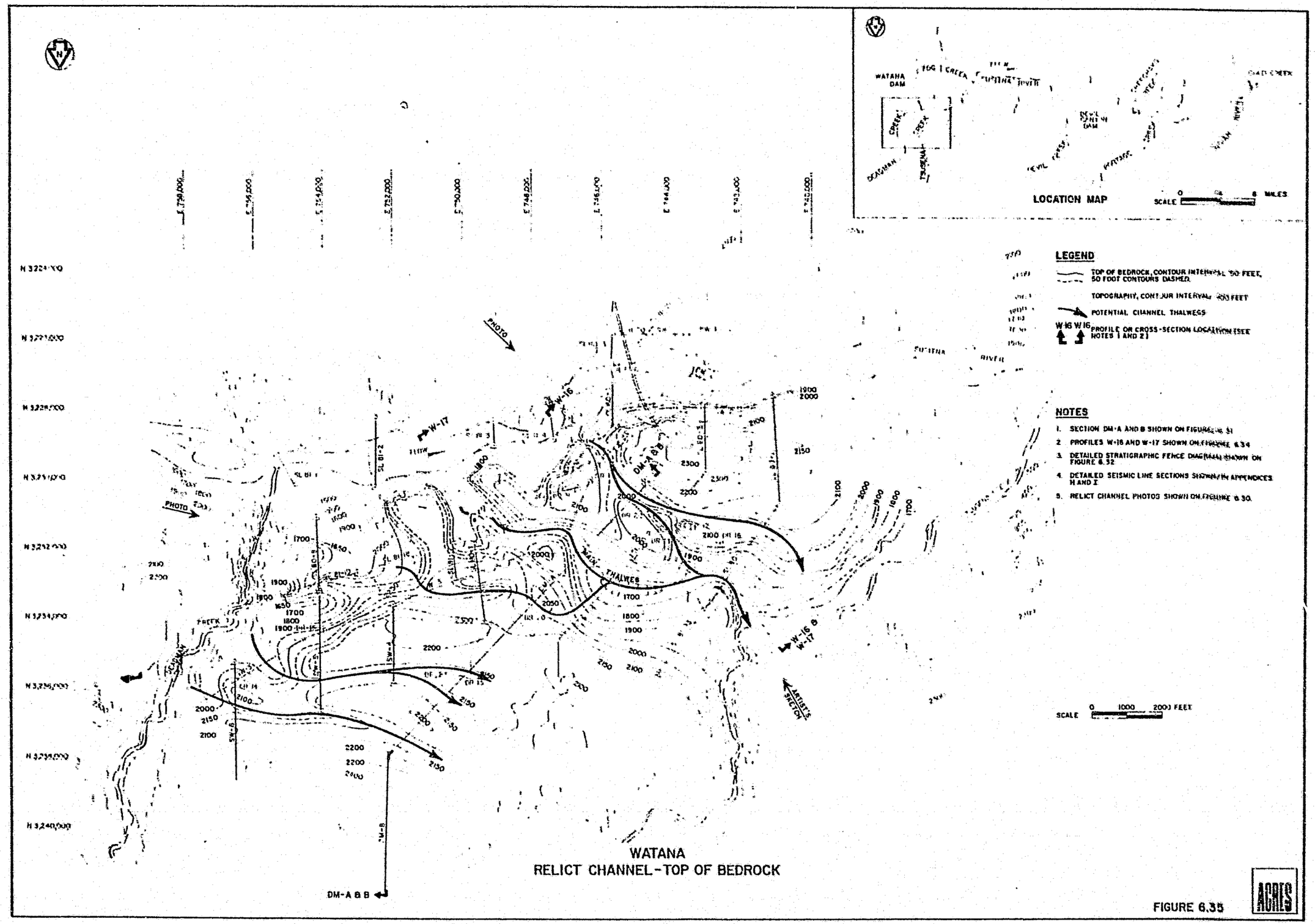


FIGURE 5.1b

ACRES

WATANA RELICT
CHANNEL CONCERNS

- POTENTIAL RESERVOIR LEAKAGE
- POTENTIAL PIPING
- POTENTIAL LIQUEFACTION
- POTENTIAL SETTLEMENT DUE TO SATURATION AND PERMAFROST THAWING



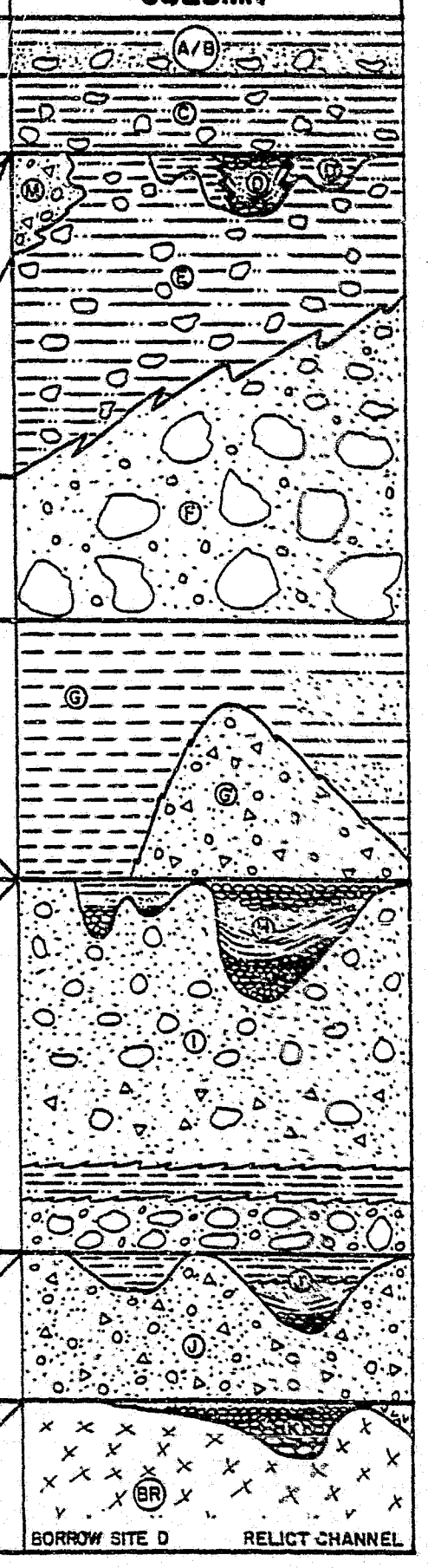
WATANA
RELICT CHANNEL-TOP OF BEDROCK

FIGURE 6.35

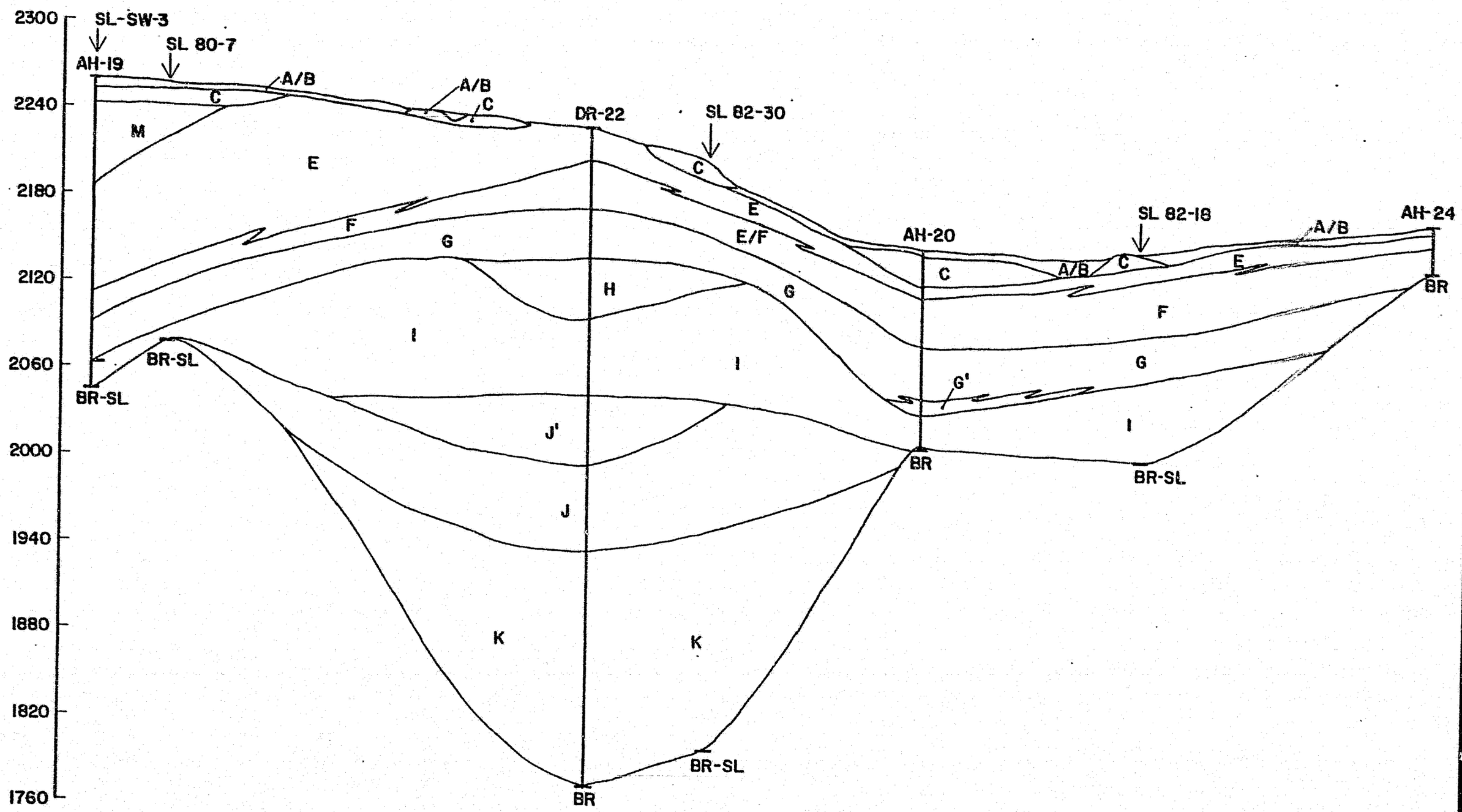
STRATIGRAPHIC COLUMN
WATANA RELICT CHANNEL AND
BORROW SITE D AREA

UNIT	TYPE	EVENT
A/B	SURFICIAL DEPOSITS	EROSION & FROST HEAVING
C	ICE DISINTEGRATION	ABLATION & MELTING
		ADVANCE
D	ALLUVIUM	INTERGLACIAL
D'	LACUSTRINE	PONDING LAKES INTERGLACIAL
		RETREAT
M	BASAL TILL	ADVANCE
E	OUTWASH	MELTING & RETREAT
F	OUTWASH	RETREAT
		DRAINING & RETREAT
G	GLACIOLACUSTRINE & WATERLAIN TILL	LAKES & FLOATING ICE
		BASAL MELTING
G'	BASAL TILL	ADVANCE
H	ALLUVIUM	INTERGLACIAL
I	OUTWASH (TILL ?)	RETREAT READVANCE MELTING & RETREAT
		RETREAT
J'	LACUSTRINE &/OR STRATIFIED DEPOSITS	MELTING
J	TILL	ADVANCE
K	ALLUVIUM	FLOWING WATER
BR	BEDROCK	

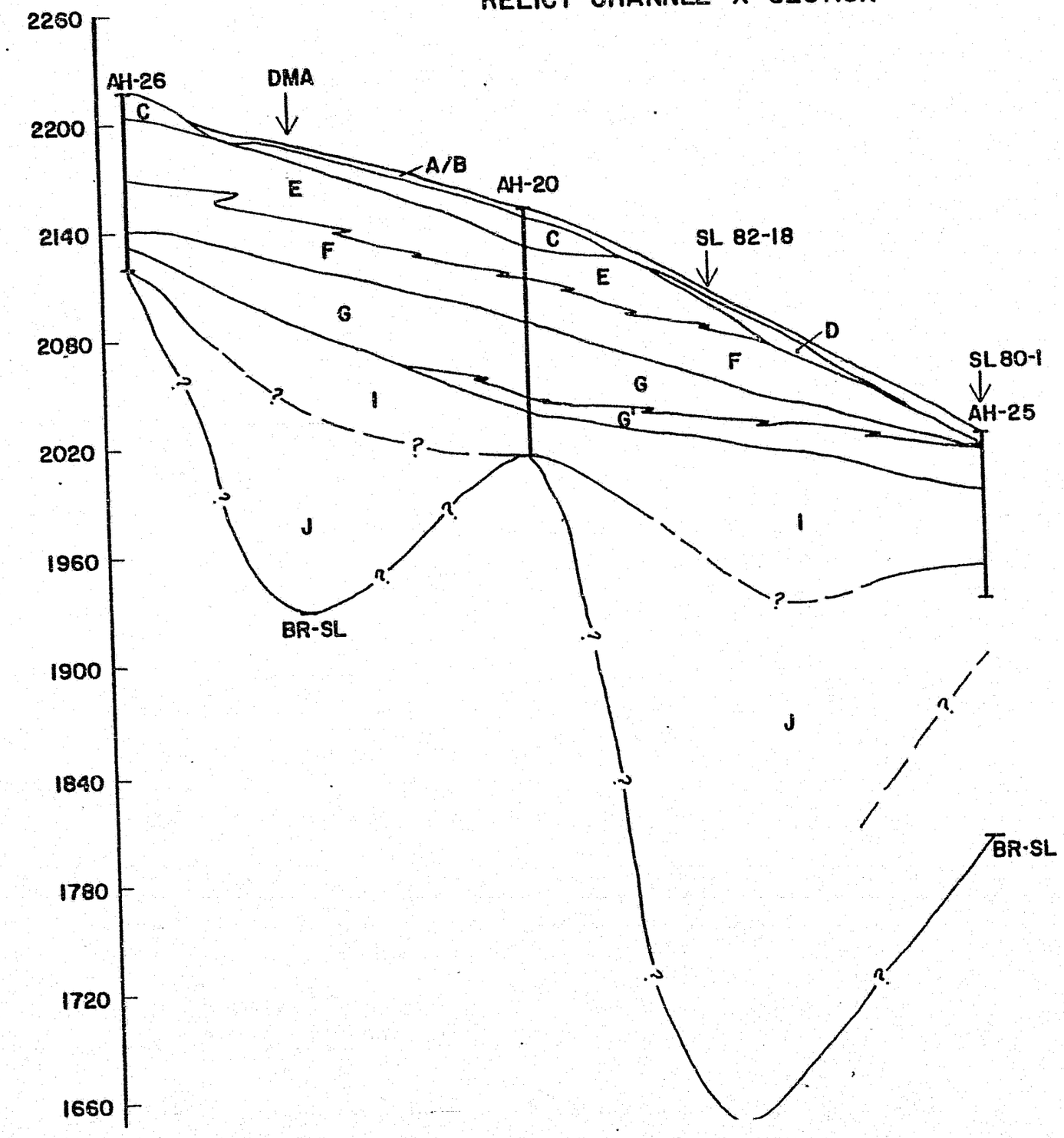
COLUMN

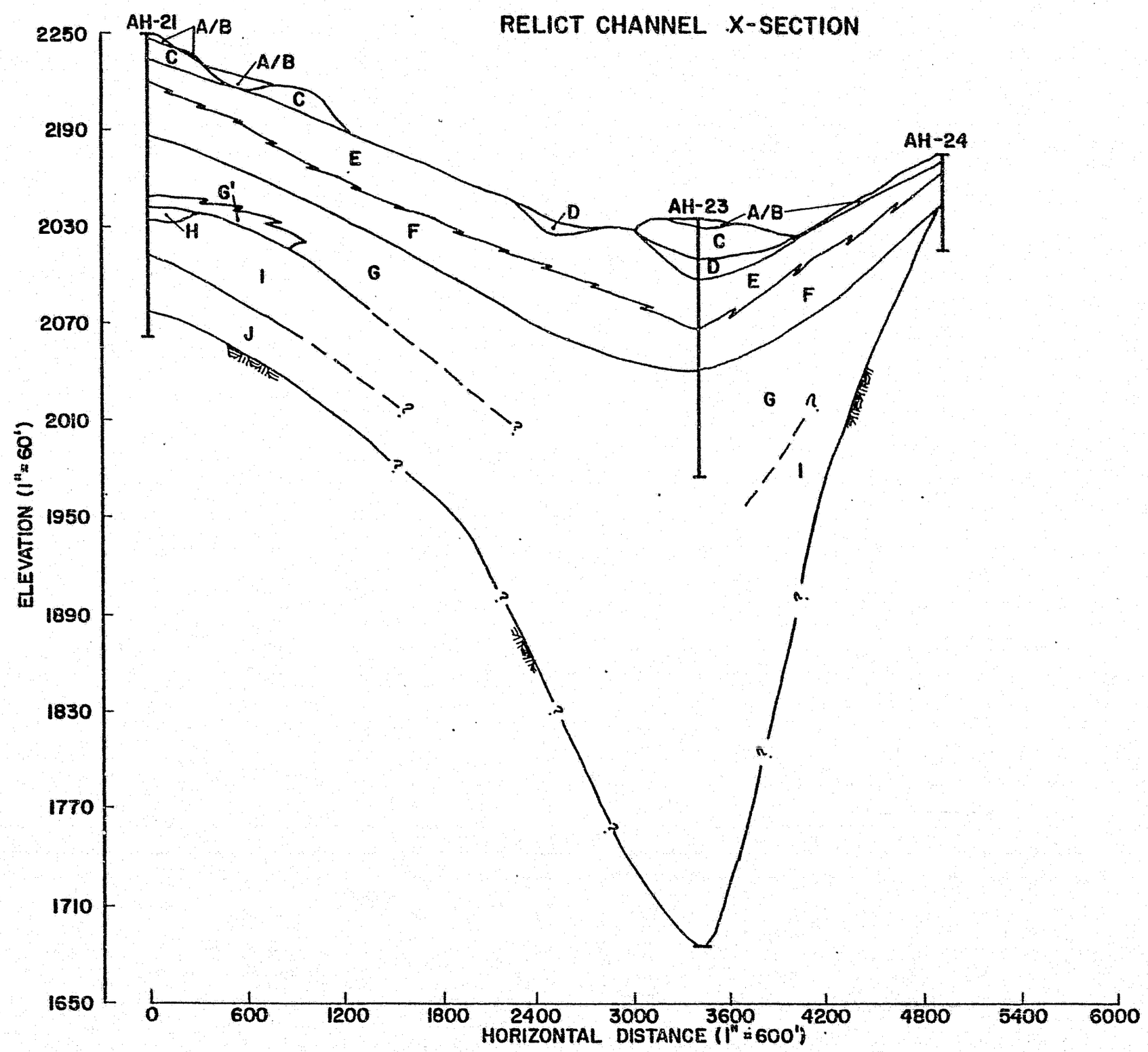


RELICT CHANNEL X-SECTION

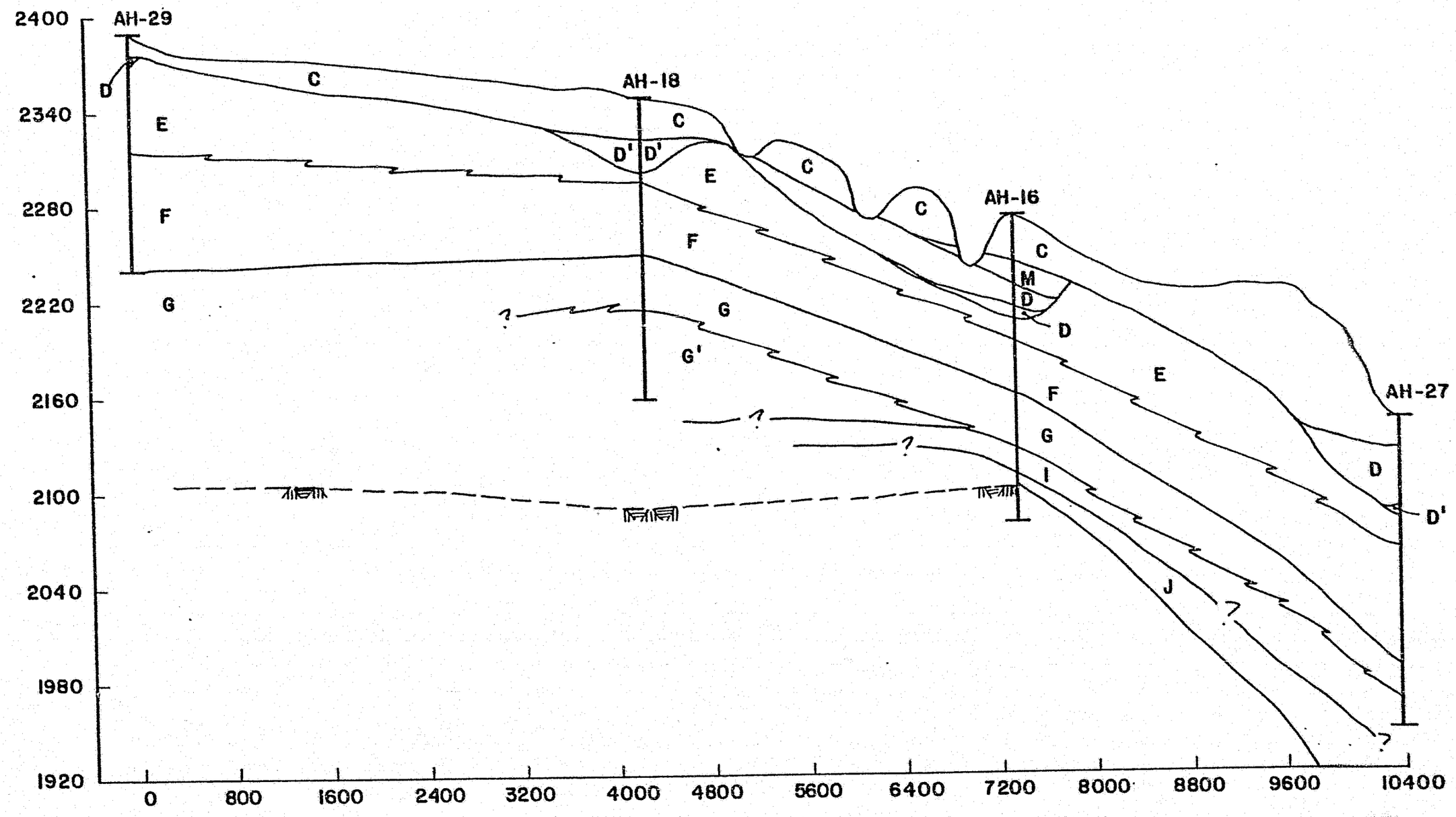


RELICT CHANNEL X-SECTION

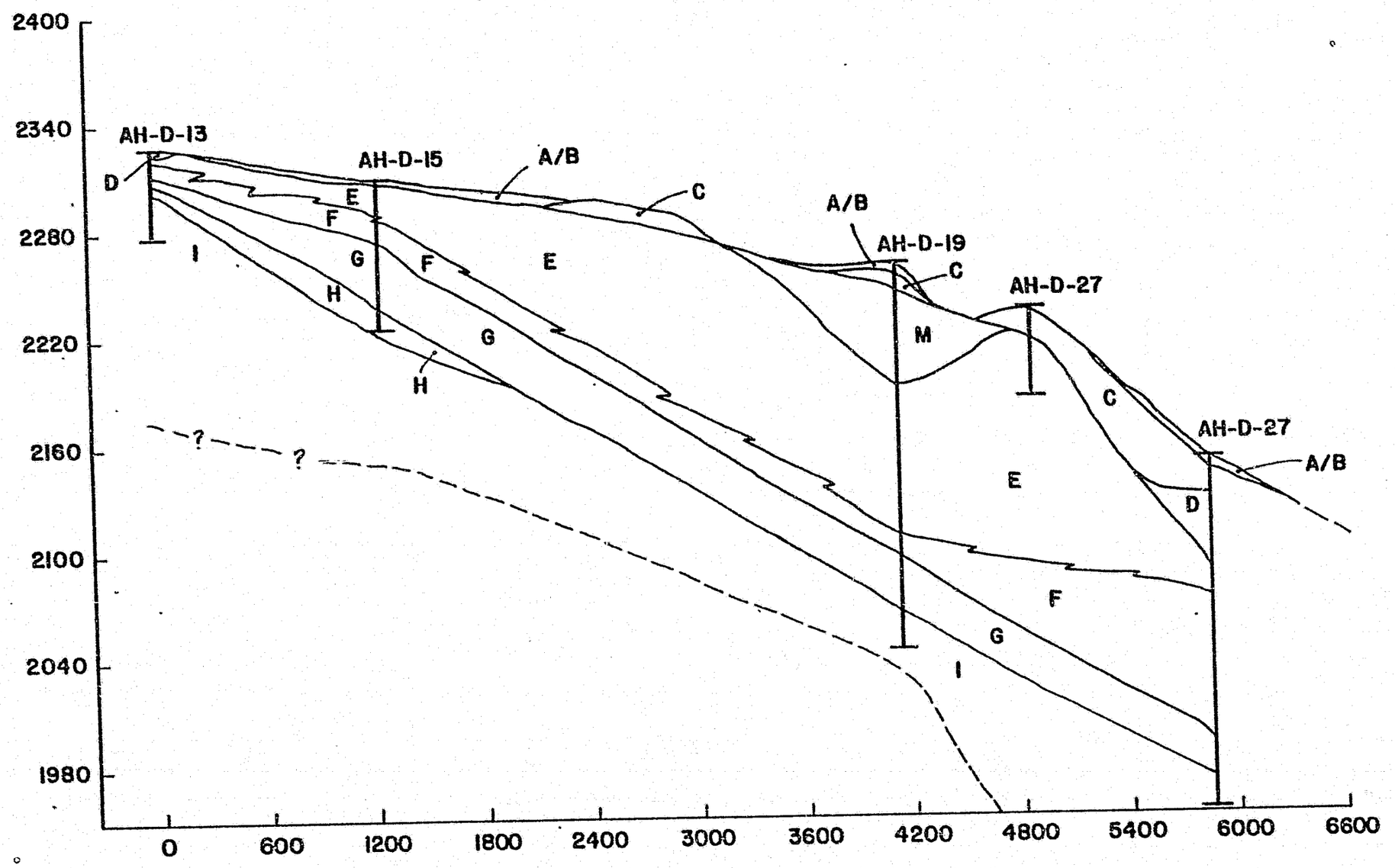



RELICT CHANNEL X-SECTION
AH-21
AH-23
AH-24
A/B
C
D
E
F
G
G'
H
I
J
ELEVATION (1" = 60')
2250
2190
2030
2070
2010
1950
1890
1830
1770
1710
1650
0
600
1200
1800
2400
3000
3600
4200
4800
5400
6000
HORIZONTAL DISTANCE (1" = 600')

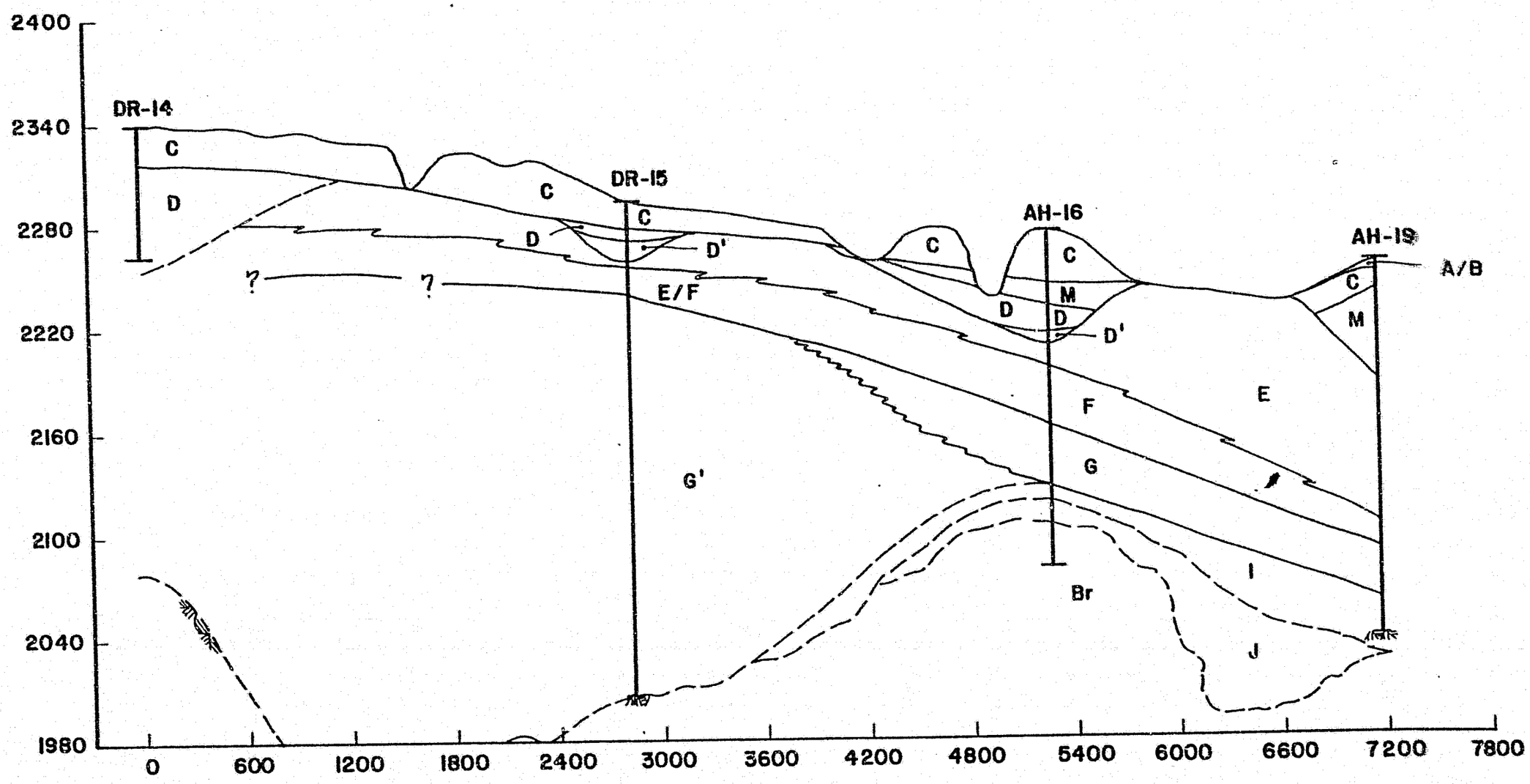
BORROW 'D' X-SECTIONS



BORROW 'D' X-SECTIONS



BORROW 'D' X - SECTIONS



- MATERIAL PROPERTIES - RELICT CHANNEL

SUMMARY OF INVESTIGATIONS - WATANA
RELICT CHANNEL & BORROW SITE D

	COE 1978	AAI 1980-81	AAI 1982
TEST PITS	14	2	29
AUGER HOLES	24	14	0
ROTARY/CORE BORINGS	11	0	16

LABORATORY TESTING

SOURCE OF SAMPLES	# SAMPLES	GRADATIONS	MOISTURES	ATTERBURGS
TEST PITS	51	51	2	3
AUGER HOLES	219	83	48	55
ROTAPY/CORE BORINGS	570	416	391	49
TOTAL TO DATE	840	550	441	107

WATANA BORROW SITE D & RELICT CHANNEL
STRATIGRAPHIC UNIT THICKNESS (EST)

UNIT		RANGE OF THICKNESSES	R.C. AVG.	BORROW"D"AVG.
A/B	SURFICIAL	0 - 7 FEET	3.5	3.0
C	DISINTEGRATION	0 - 40.5	10.5	12.4
D	ALLUVIUM	0 - 55+	4.6	6.2
D'	LACUSTRINE	0 - 38+	2.4	3.0
M	BASAL TILL	0 - 79	3.8	5.6
E/F	OUTWASH	0 - 131	39.9	47.2
G	LACUSTRINE/TILL	0 - 73.5	27.3	29.5
G'	BASAL TILL	0 - 231	17.2	25.2
H	ALLUVIUM	0 - 41	7.4	10.0
I	OUTWASH/TILL ?	0 - 77	29.2	25.8
J'	LACUSTRINE/STRATIFIED	0- 48	3.6	10.2
J	TILL	0 - 62	20.8	22.4
K	ALLUVIUM	0 - 161	15.6	57.3
BR	BEDROCK			

NOTE: ALL UNITS EXCEPT A&B, C, E/F, AND G HAVE STANDARD DEVIATIONS IN THICKNESS EXCEEDING AVERAGE UNIT THICKNESS. THIS IS STRONG INDICATION OF THE VARIABILITY IN UNIT THICKNESS AND DISTRIBUTION.

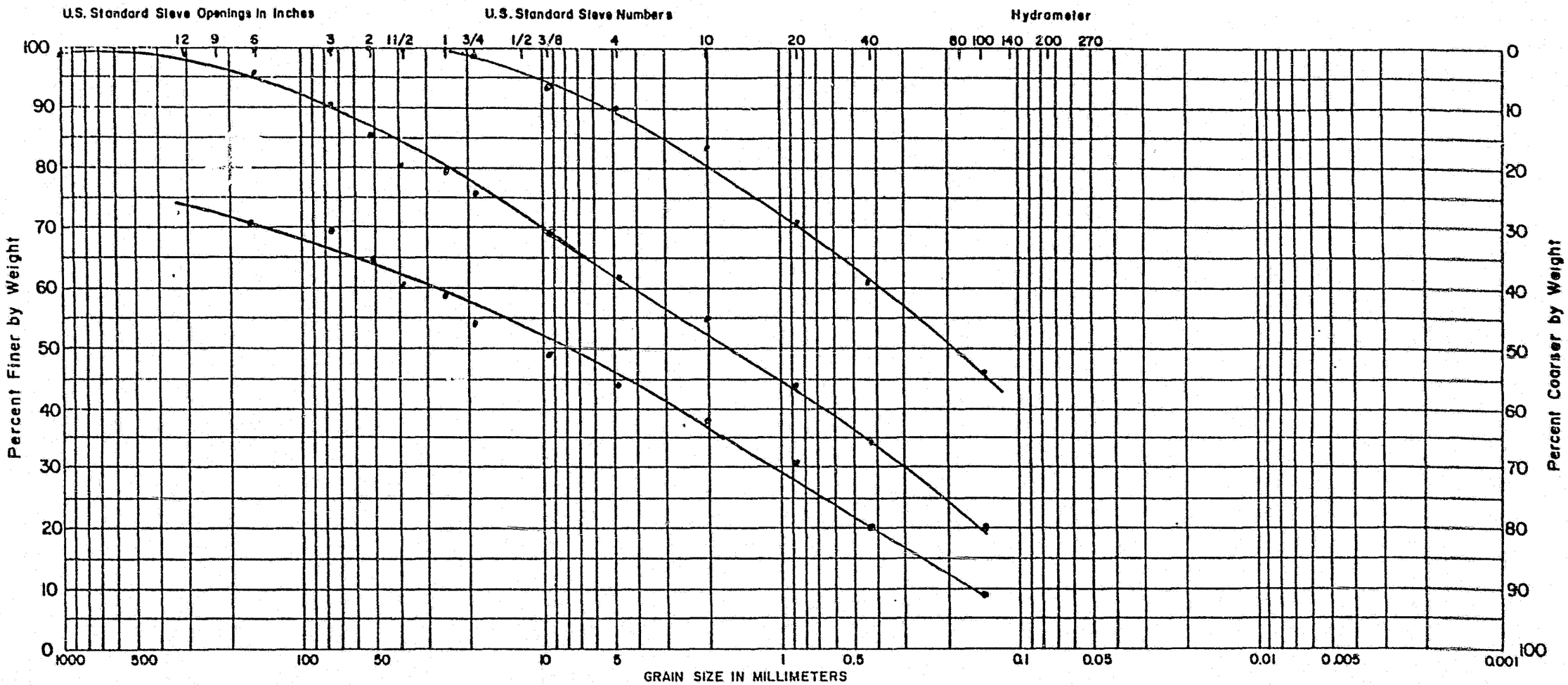
- BORROW AREA D

WATANA

BORROW SITE D

AREA - 1075 ACRES (ARBITRARY DEFINED LIMIT)

UNIT	AVG. THICKNESS	EST. VOLUME
A/B	3	5
C	12	21
D	6	20
D'	3	5
M	6	10
E/F	47	82
	77	133
FEASIBILITY REPORT	75	125
ORIGINAL ESTIMATE	125	220



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
W82	Bulk Samples	(6)			

ACRES

SUSITNA HYDROELECTRIC PROJECT

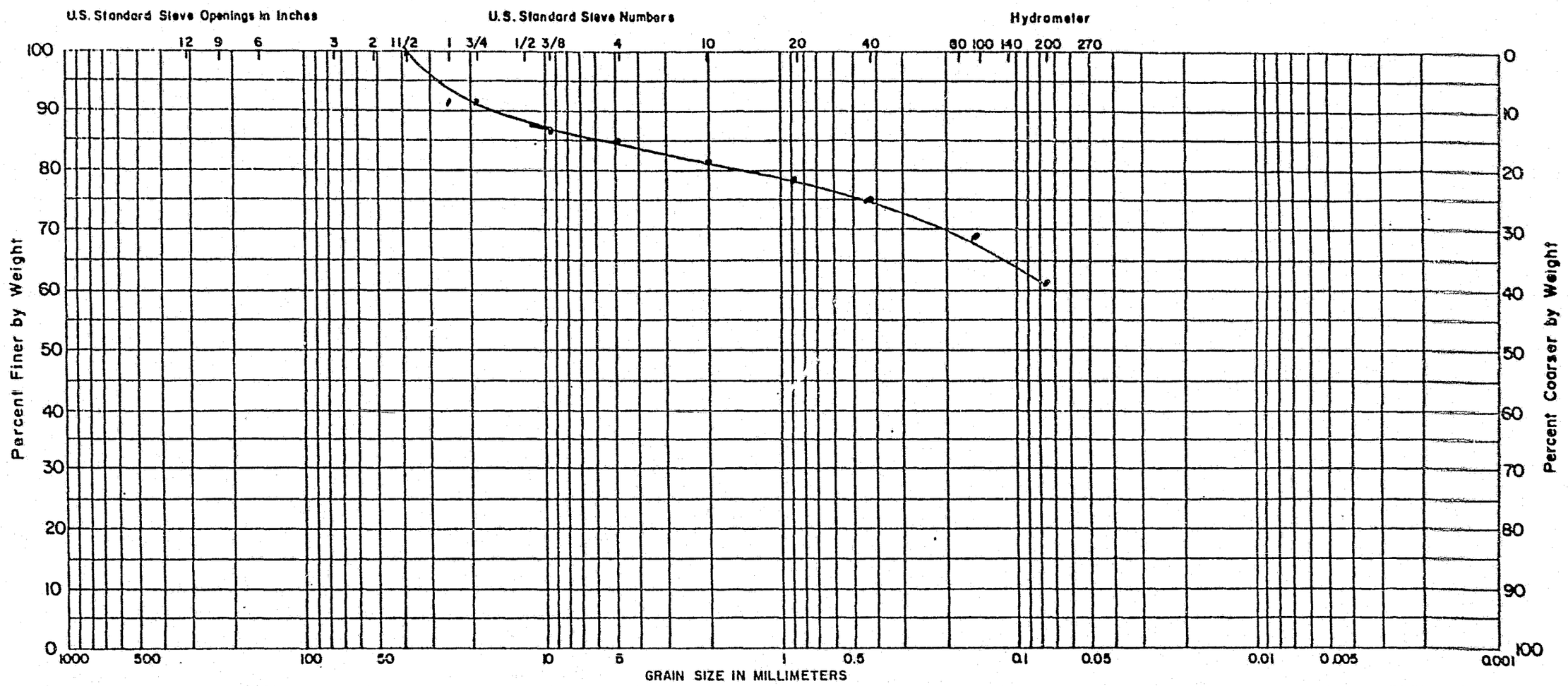
ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL

UNIT C

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
W8Z -	Bulk (1)				

ACRES

SUSITNA HYDROELECTRIC PROJECT

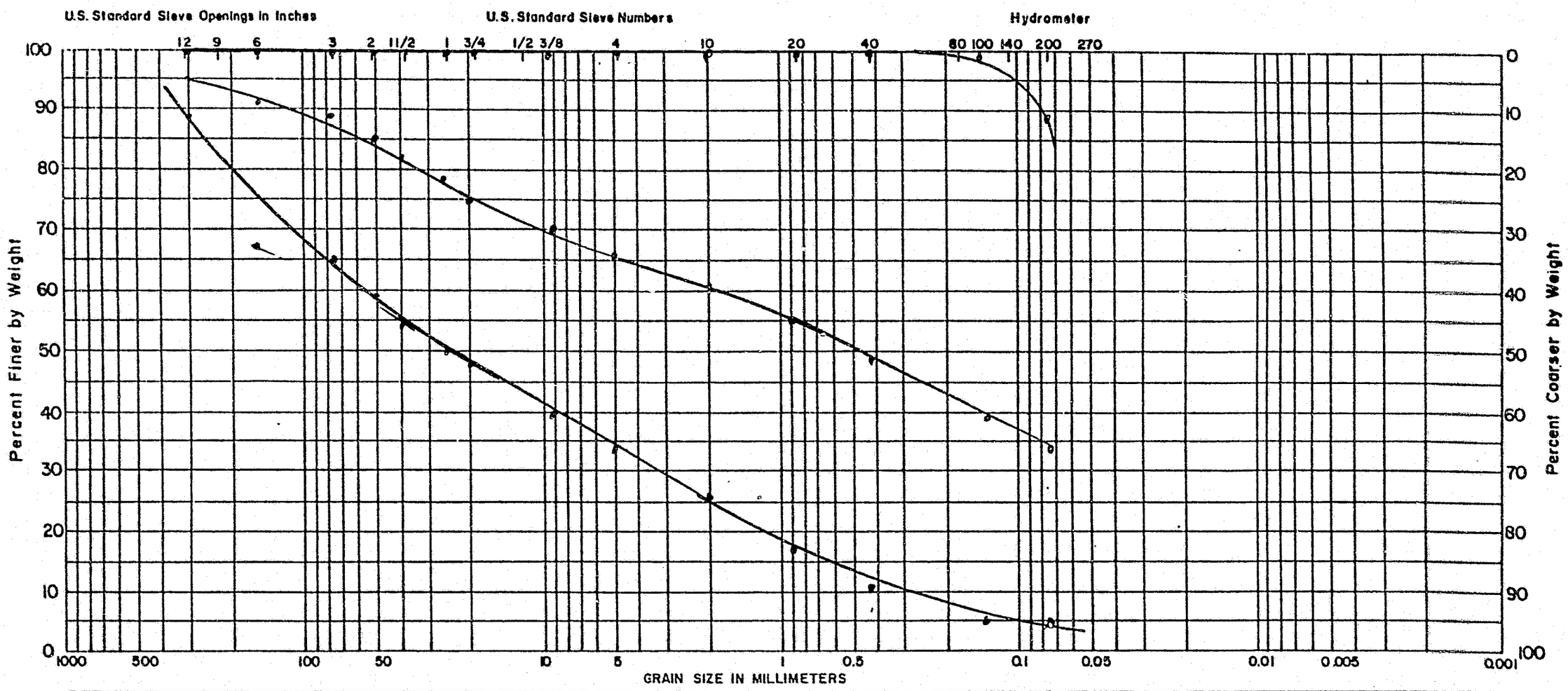
ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL

UNIT D'

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
WBZ-		BULK (10)			

ACRES

SUSITNA HYDROELECTRIC PROJECT

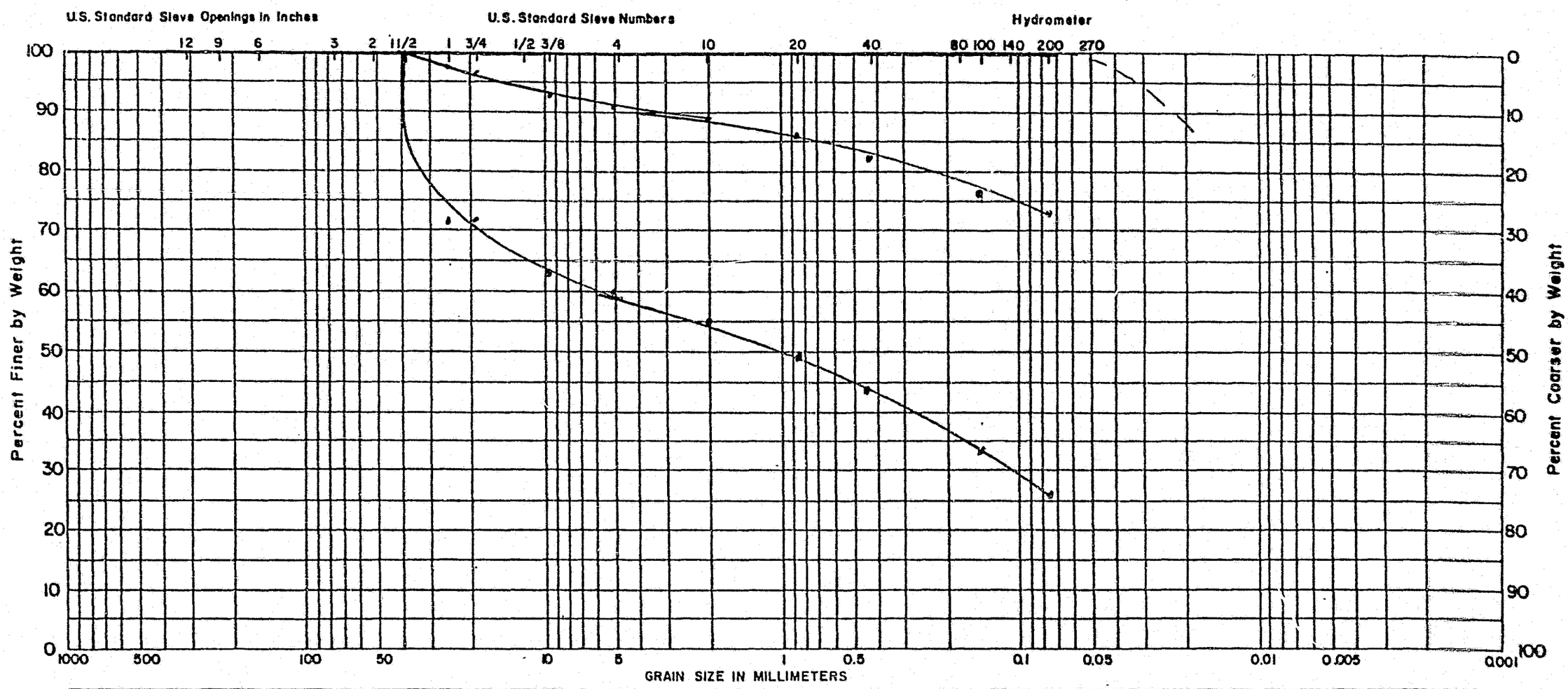
ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL

UNIT E/F

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
DR's		(18)			

ACRES

SUSITNA HYDROELECTRIC PROJECT

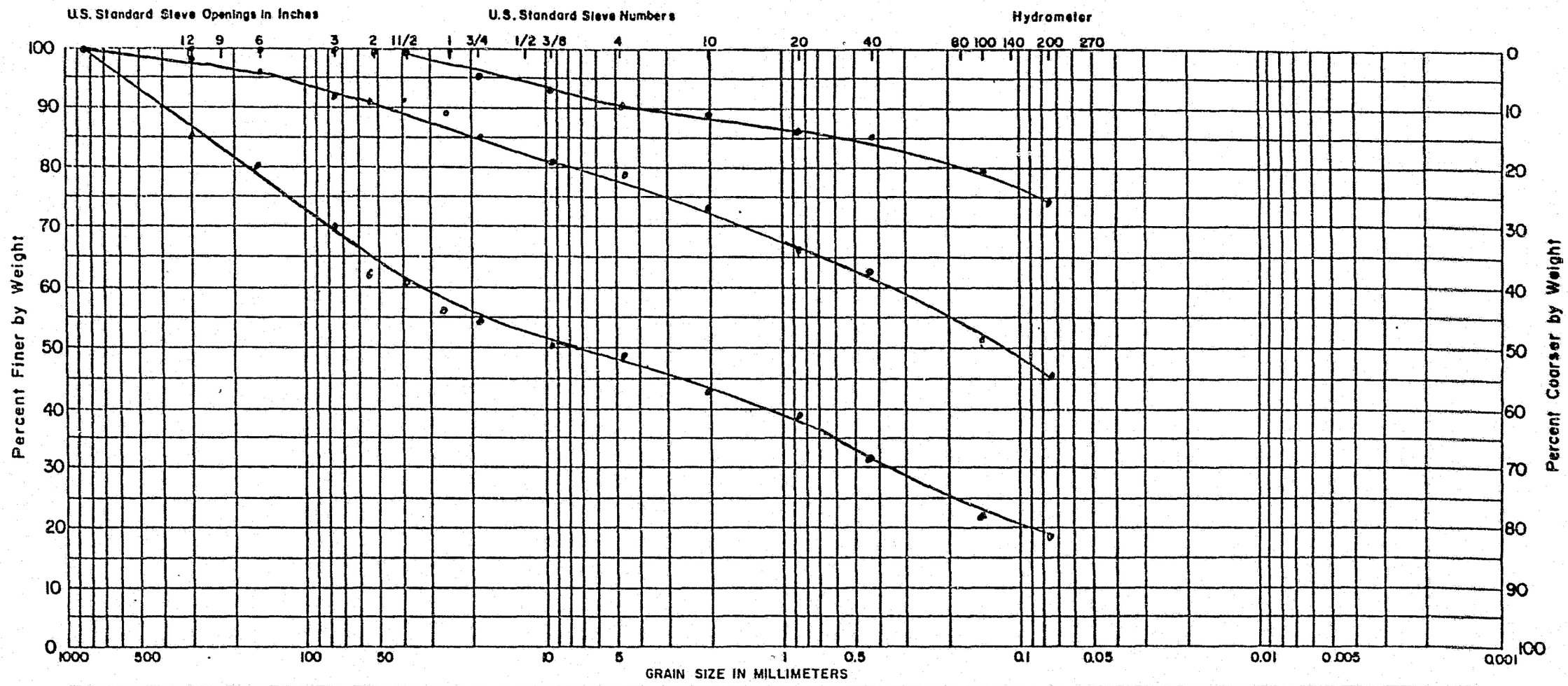
ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL

UNIT G

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
W82-	Bulk	(10)			

ACRES

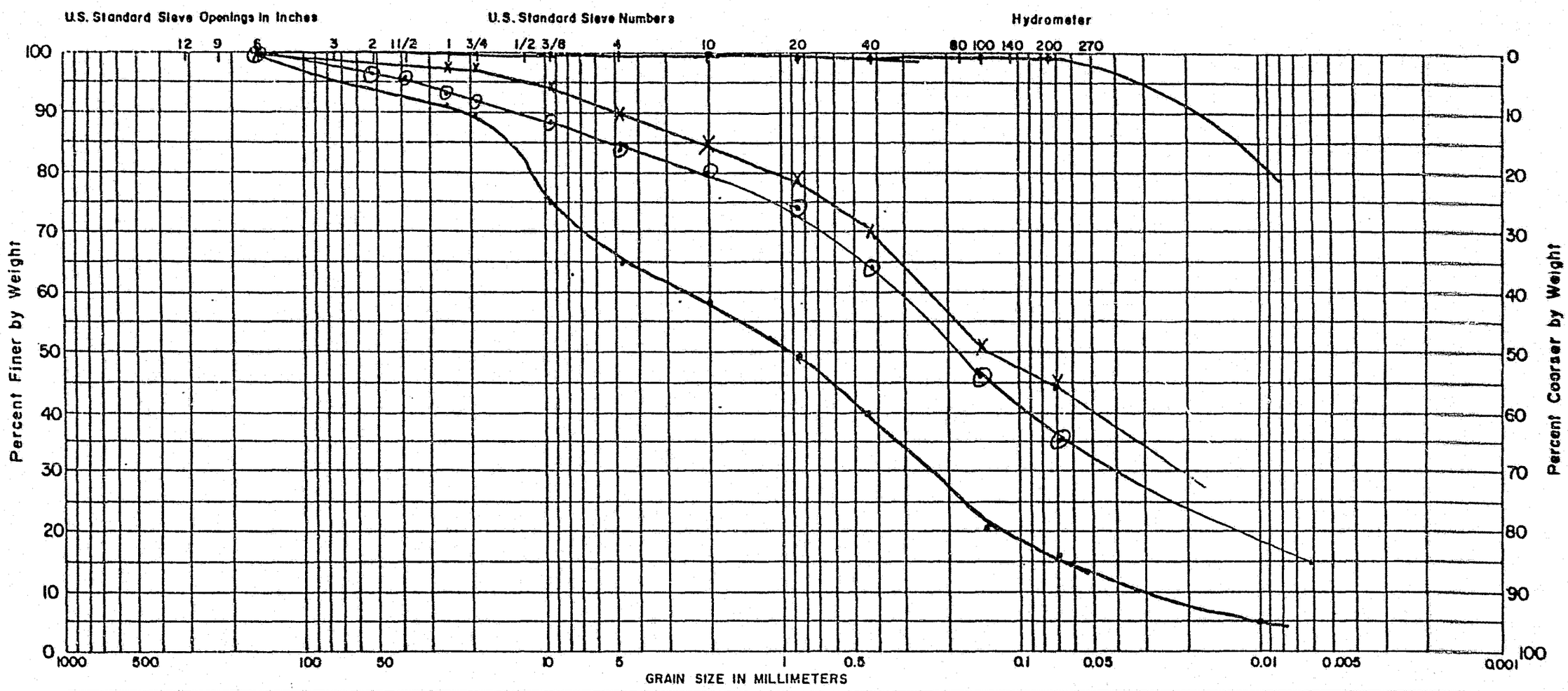
SUSITNA HYDROELECTRIC PROJECT

ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL
UNIT G'

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CURVE SYMBOL	CLASSIFICATION
AP's				X	
TP's				⊙	

ACRES

SUSITNA HYDROELECTRIC PROJECT

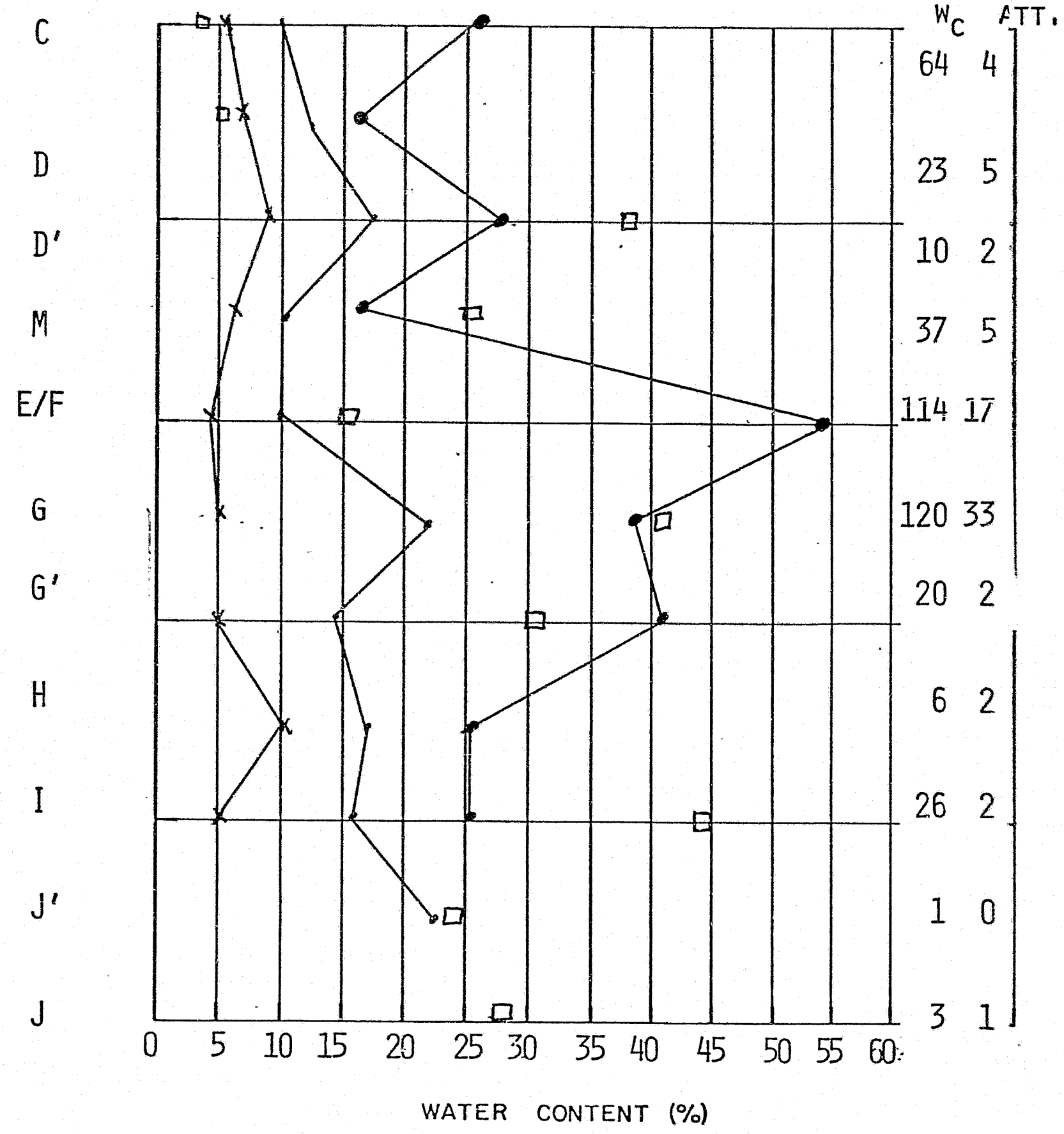
ALASKA POWER AUTHORITY

WATANA BORROW SITE D
AND RELICT CHANNEL

ALL COE TP, AP DATA

GRADATION ANALYSIS CURVES

ACRES AMERICAN INCORPORATED



NOTE:
MATERIAL PASSING 3/4" SIEVE

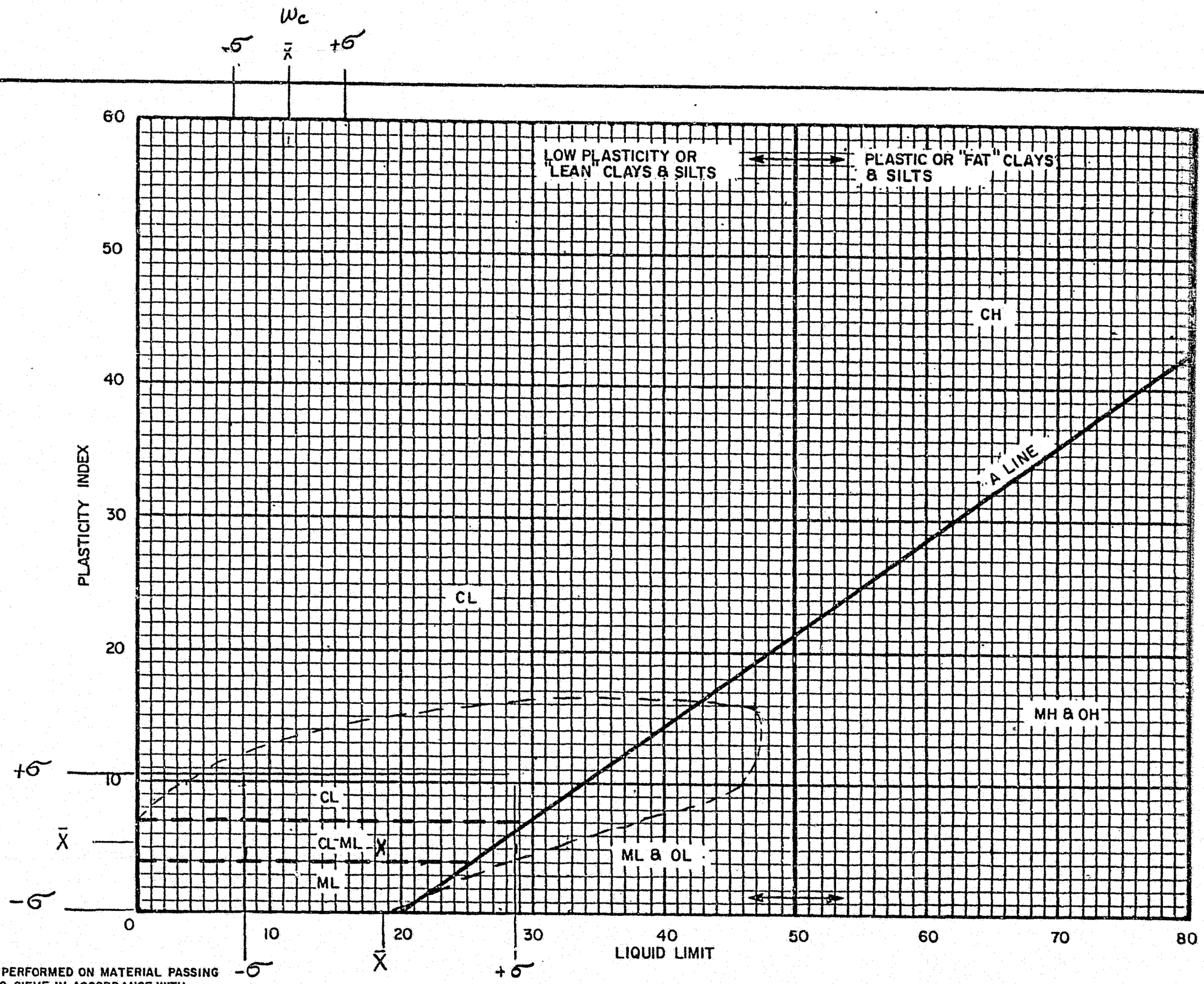
● = MAXIMUM

X = MINIMUM

□ = PL (MEAN)

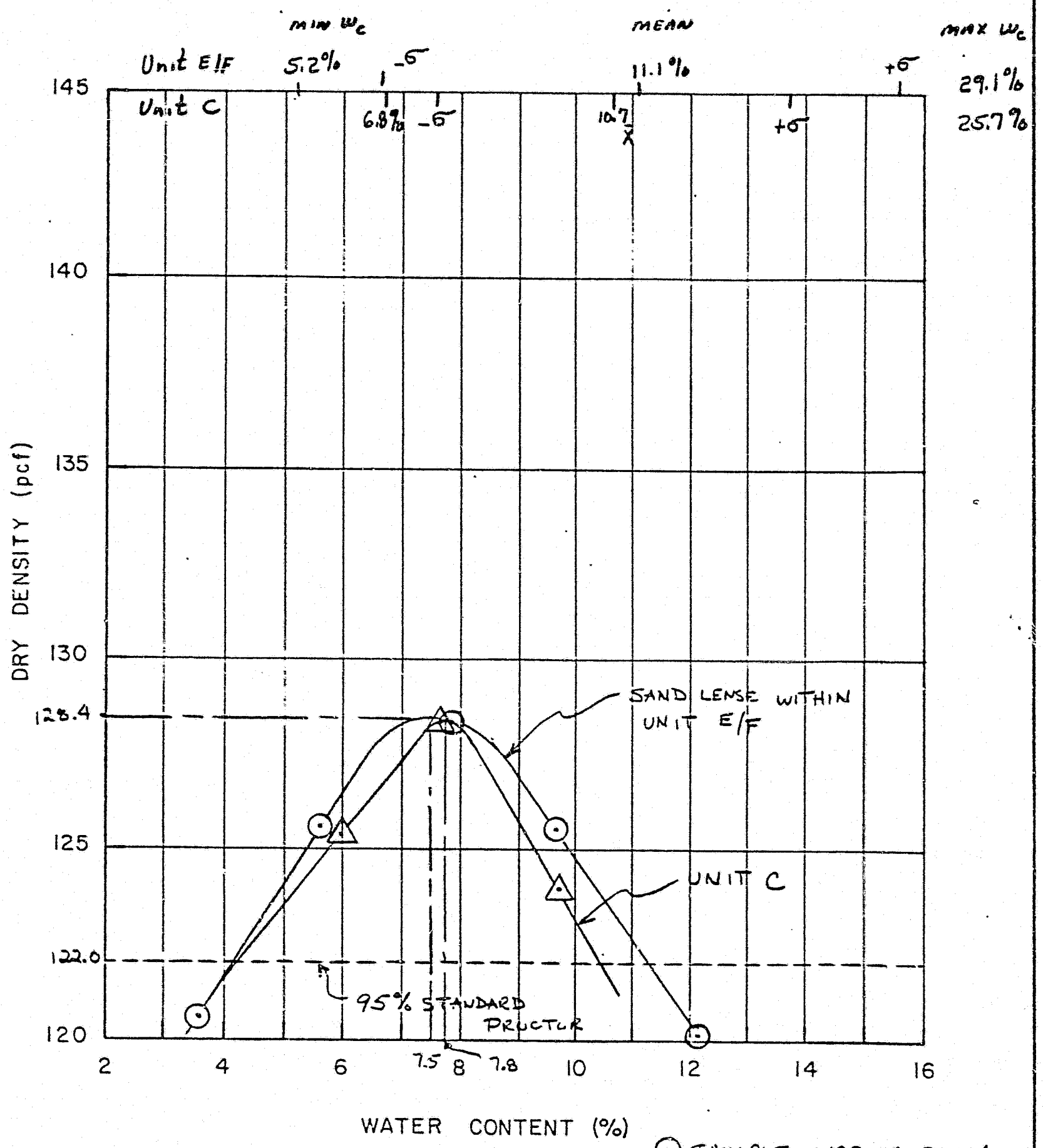
• = W_C (MEAN)

Note: Plastic limits are biased towards higher (more plastic) values.
Upper limit of moisture contents are extreme, rare cases; well above means.



TEST PERFORMED ON MATERIAL PASSING NO. 40 SIEVE IN ACCORDANCE WITH ASTM D423-66 (1972) AND D424-59 (1971)

ALL UNITS ESTIMATED: UNITS C-F



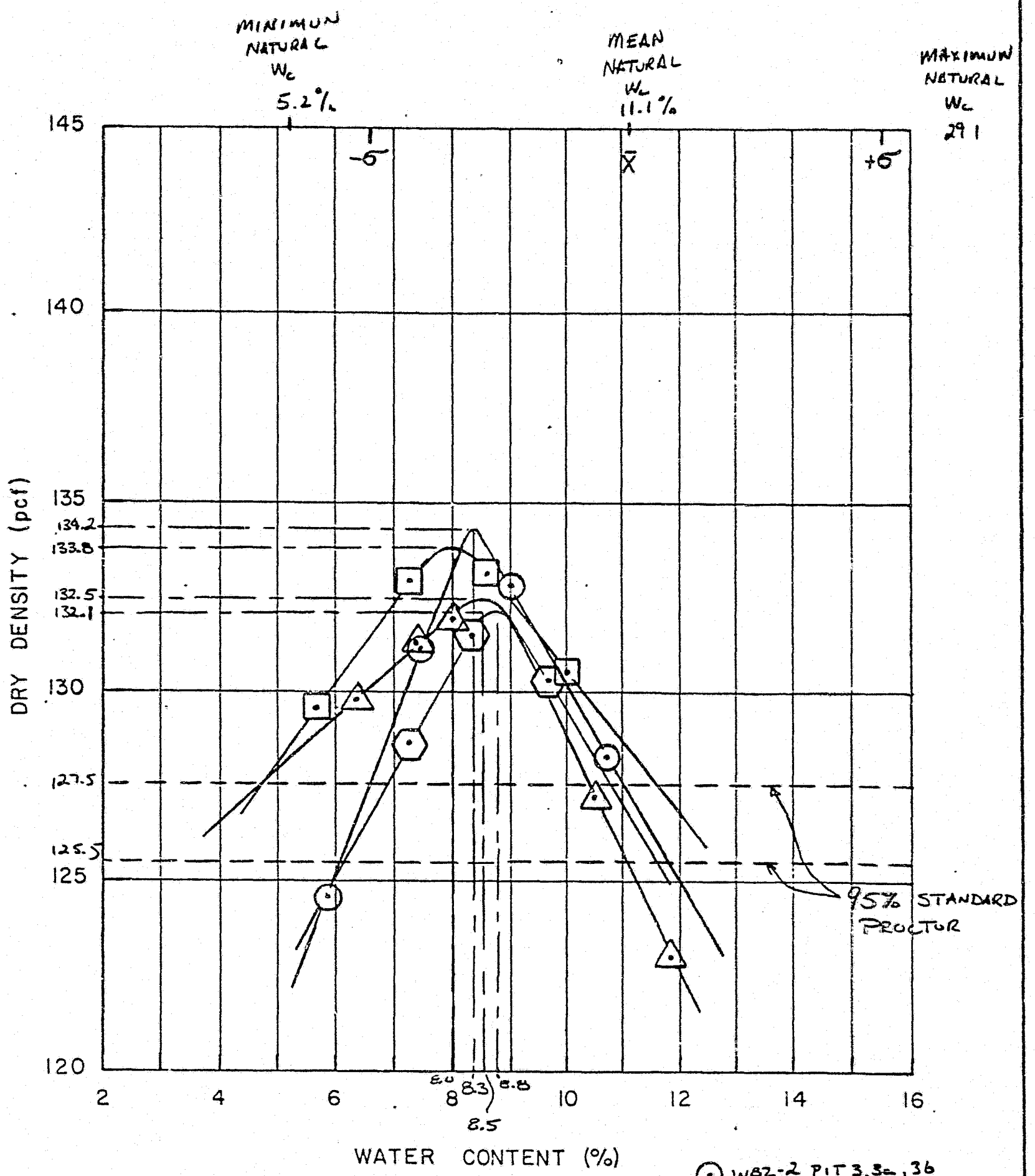
⊙ SAMPLE W82-26 PIT 4

△ SAMPLE W82-74

(1982 ACRES)

NOTE:
MATERIAL PASSING 3/4" SIEVE
ASTM D 698 METHOD C

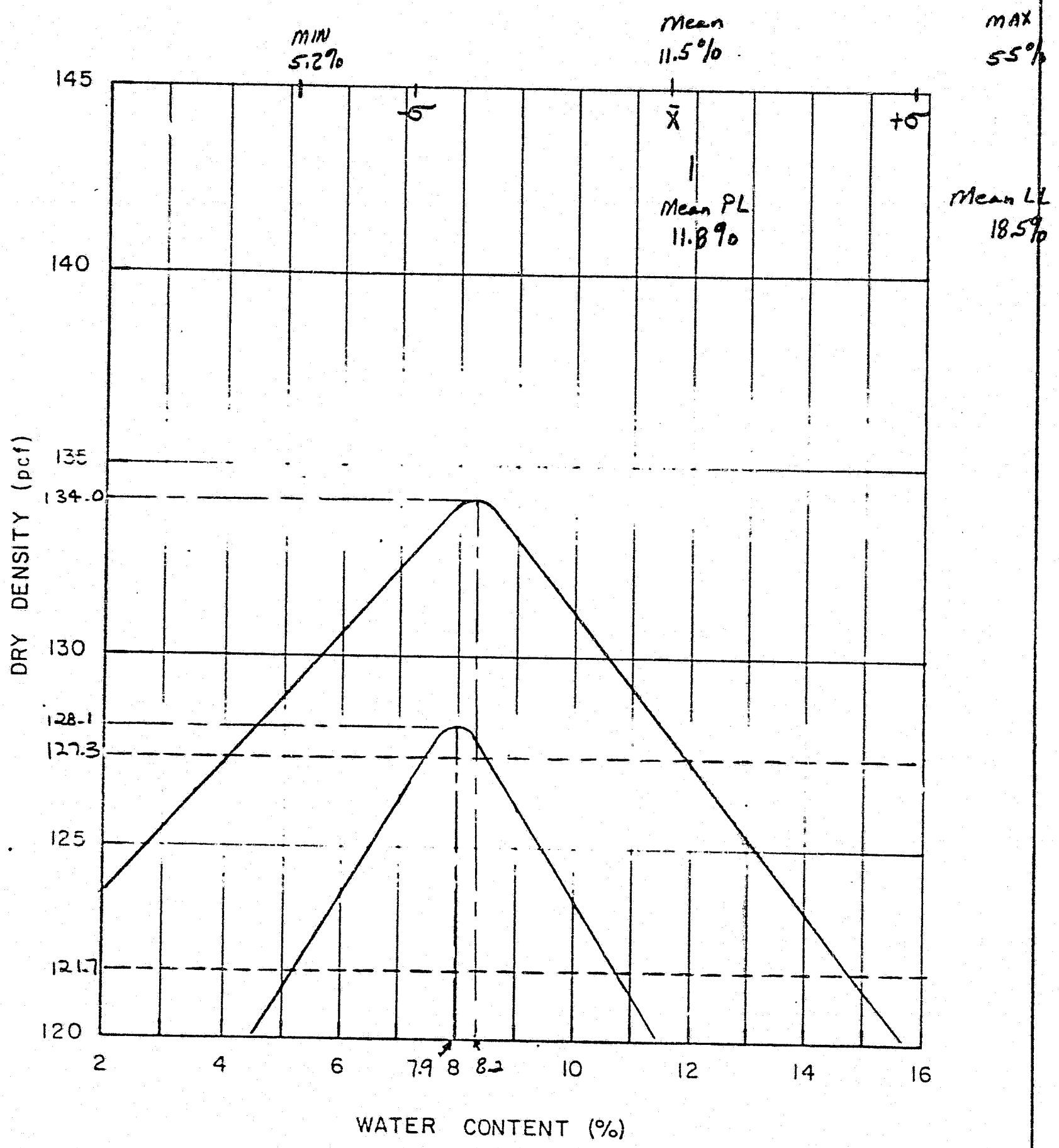
STANDARD PROCTOR



NOTE:
MATERIAL PASSING 3/4" SIEVE
ASTM D 698 METHOD C

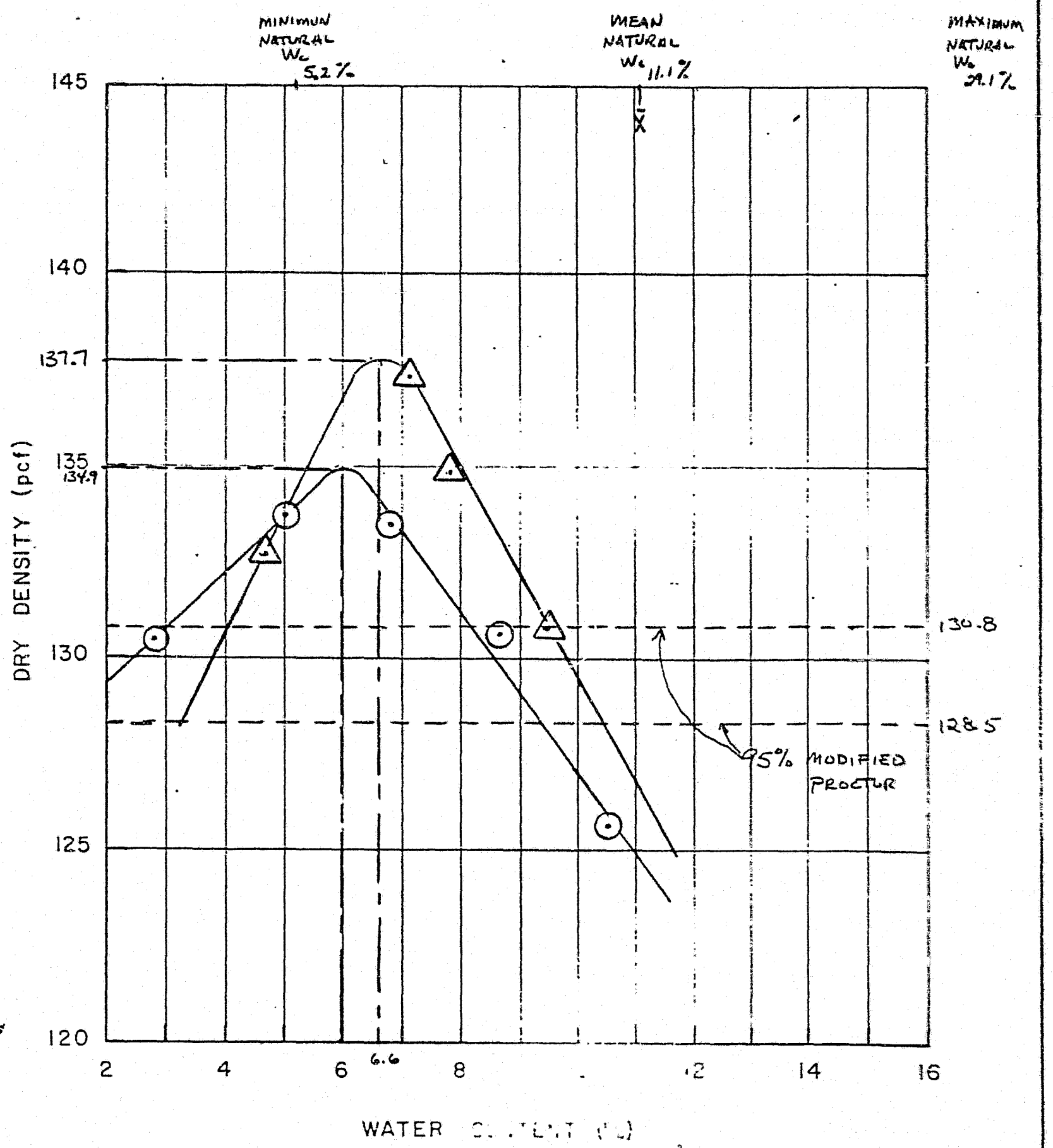
⊙ W82-2 PIT 3, 3a, 36
△ W82-30
⊡ W82-44 PIT 2
⬡ W82-91
(1982 ACRES)

UNIT E/F
STANDARD PROCTOR



NOTE
MATERIAL PASSING 3/4" SIEVE

RANGE OF ALL STANDARD
PROCTOR RESULTS BORROW SITE D
7 TESTS



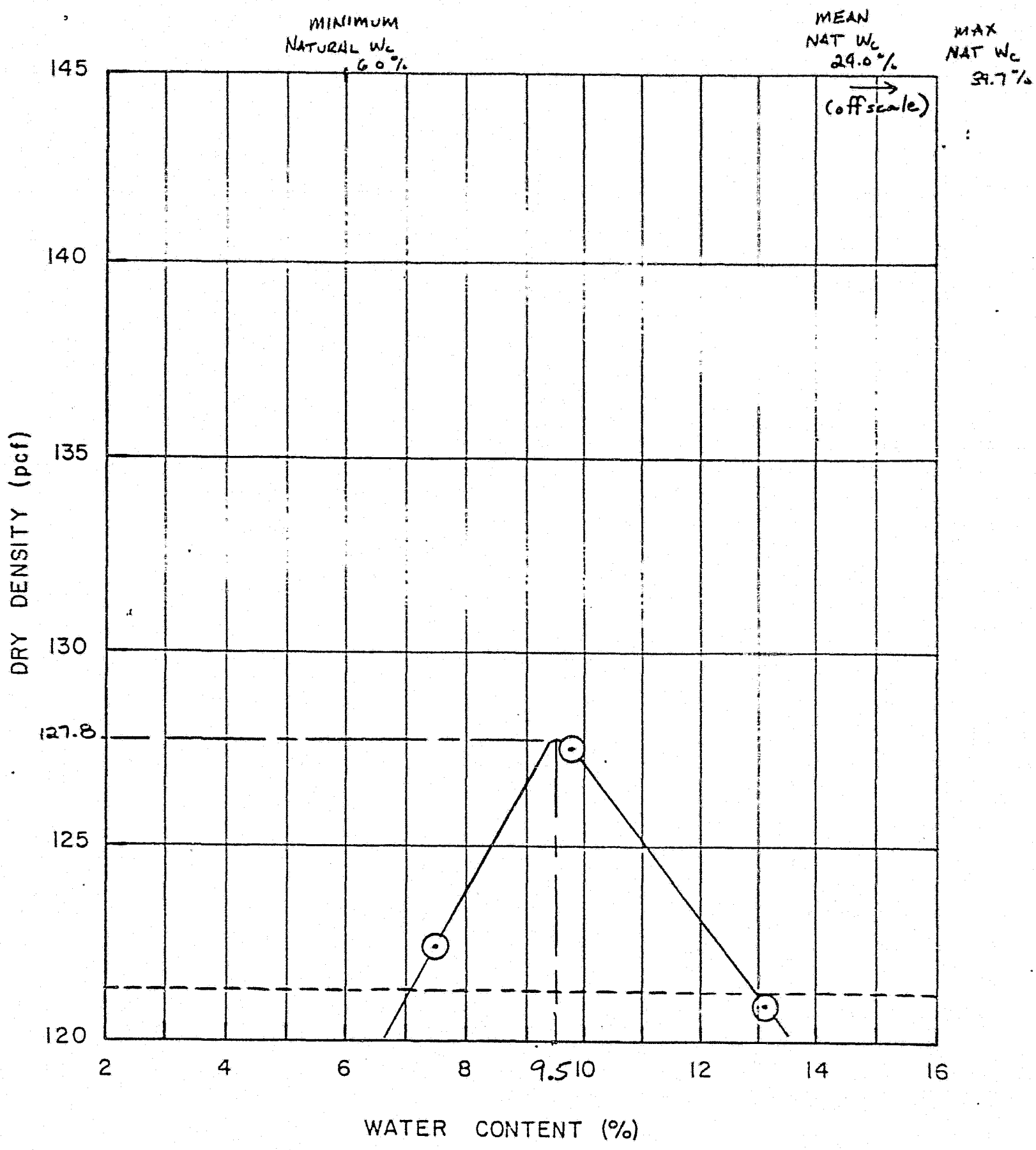
NOTE:
MATERIAL PASSING 3/4" SIEVE

UNIT E/F

△ SAMPLE W82-2 PIT 3,3a,3b
ASTM D1557 METHOD C
(1982 ACRES)

⊙ SAMPLE W80-300
AASHTO T-180 METHOD D
(1980 ACRES)

MODIFIED PROCTOR

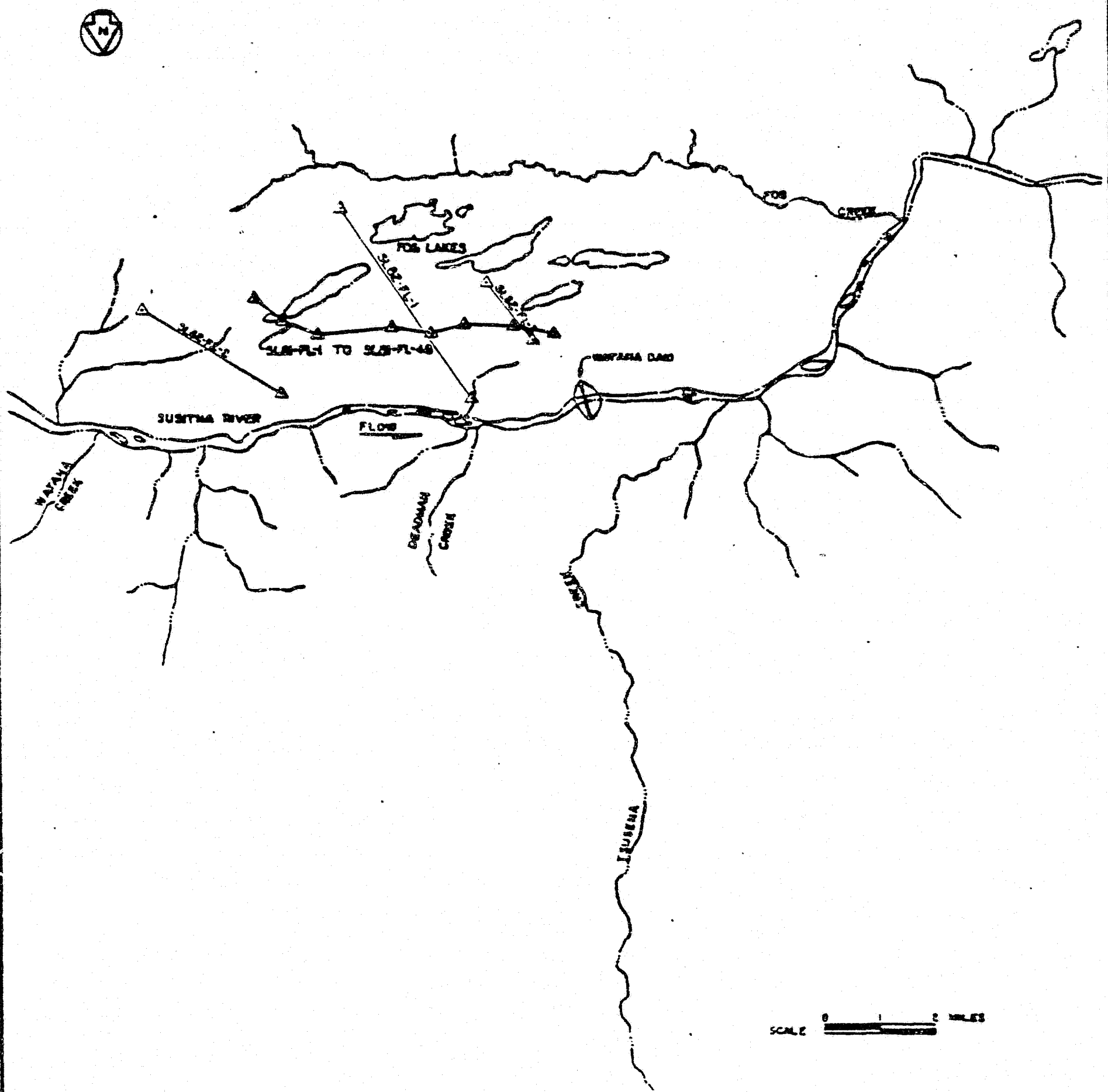


SAMPLE
W82-2 PIT 5,6,7

MATERIAL PASSING 3/4" SIEVE

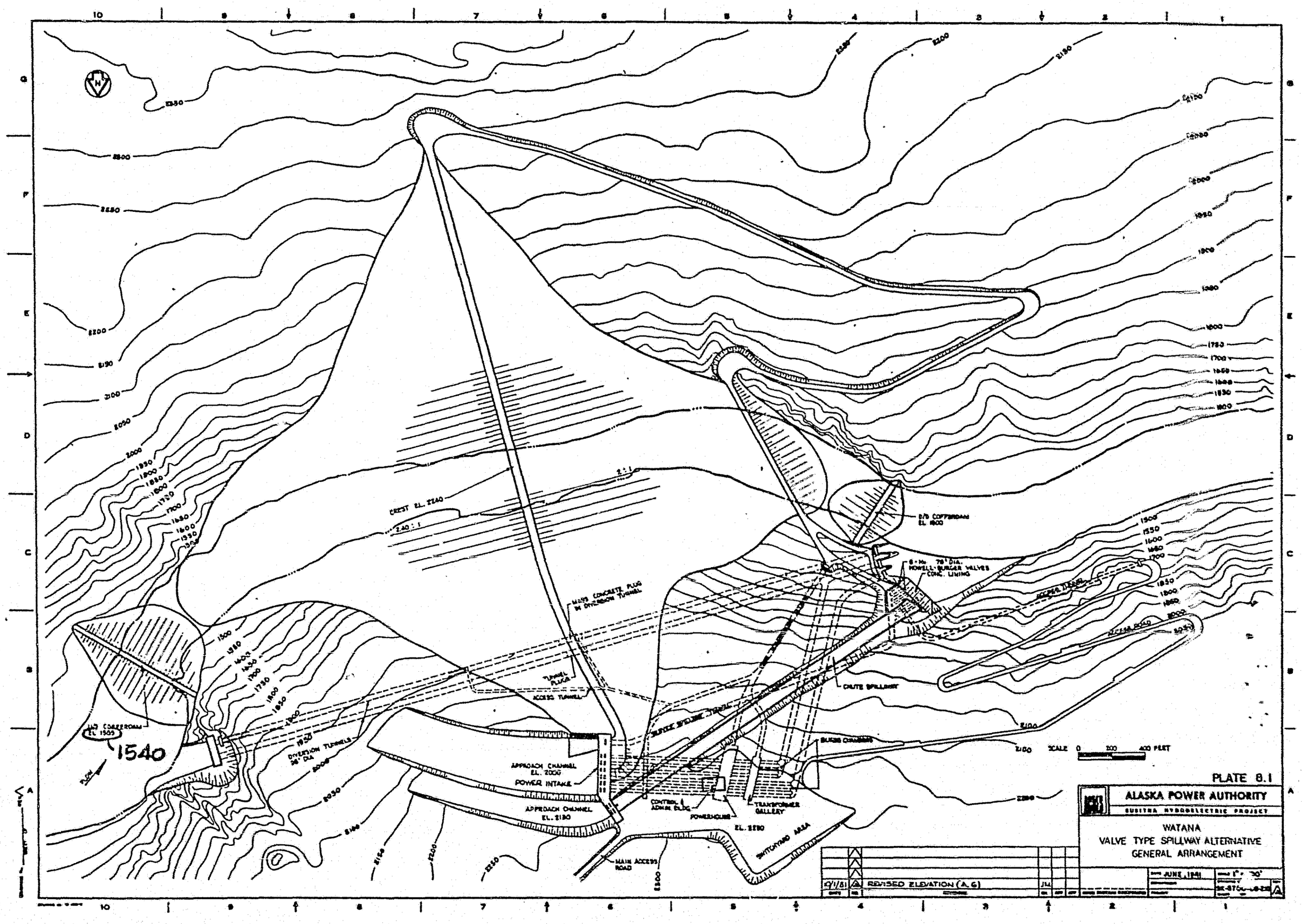
UNIT G
MODIFIED PROCTOR

- FOG LAKES RELICT CHANNEL



FOG LAKES RELICT CHANNEL
EXPLORATION MAP

- DAM SITE GEOLOGY


CREST EL. 2240
2.40 : 1
2 : 1
MAIN CONCRETE PLUG IN DIVERSION TUNNEL
TUNNEL PLUGS
ACCESS TUNNEL
DIVERSION TUNNELS 38' DIA.
1540
APPROACH CHANNEL EL. 2000
POWER INTAKE
APPROACH CHANNEL EL. 2180
CONTROL & ADMIN BLDG.
POWERHOUSE
TRANSFORMER GALLERY
EL. 2280
SWITCHYARD AREA
MAIN ACCESS ROAD
CHUTE SPILLWAY
BURSTS CHAMBERS
8/10 COFFERDAM EL. 1800
8 - No. 78" DIA. HOWELL-BUNGER VALVES CONC. LINING
SCALE 0 200 400 FEET
PLATE 8.1
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
VALVE TYPE SPILLWAY ALTERNATIVE
GENERAL ARRANGEMENT
JUNE, 1981
10/1/81 REVISED ELEVATION (A.G.)

- UPSTREAM & DOWNSTREAM PORTAL

EXISTING DIVERSION ARRANGEMENT

1. TWO - 38' Ø CONCRETE LINED TUNNELS

2. MULTI-LEVEL INTAKES
   EL 1420
   EL 1490

3. LOWER TUNNEL REDUCES WATER LEVEL IN COFFERDAM FOR CONSTRUCTION IN STANDING WATER.

4. LOWER TUNNEL AT DOWNSTREAM TO BE USED AS TAILRACE

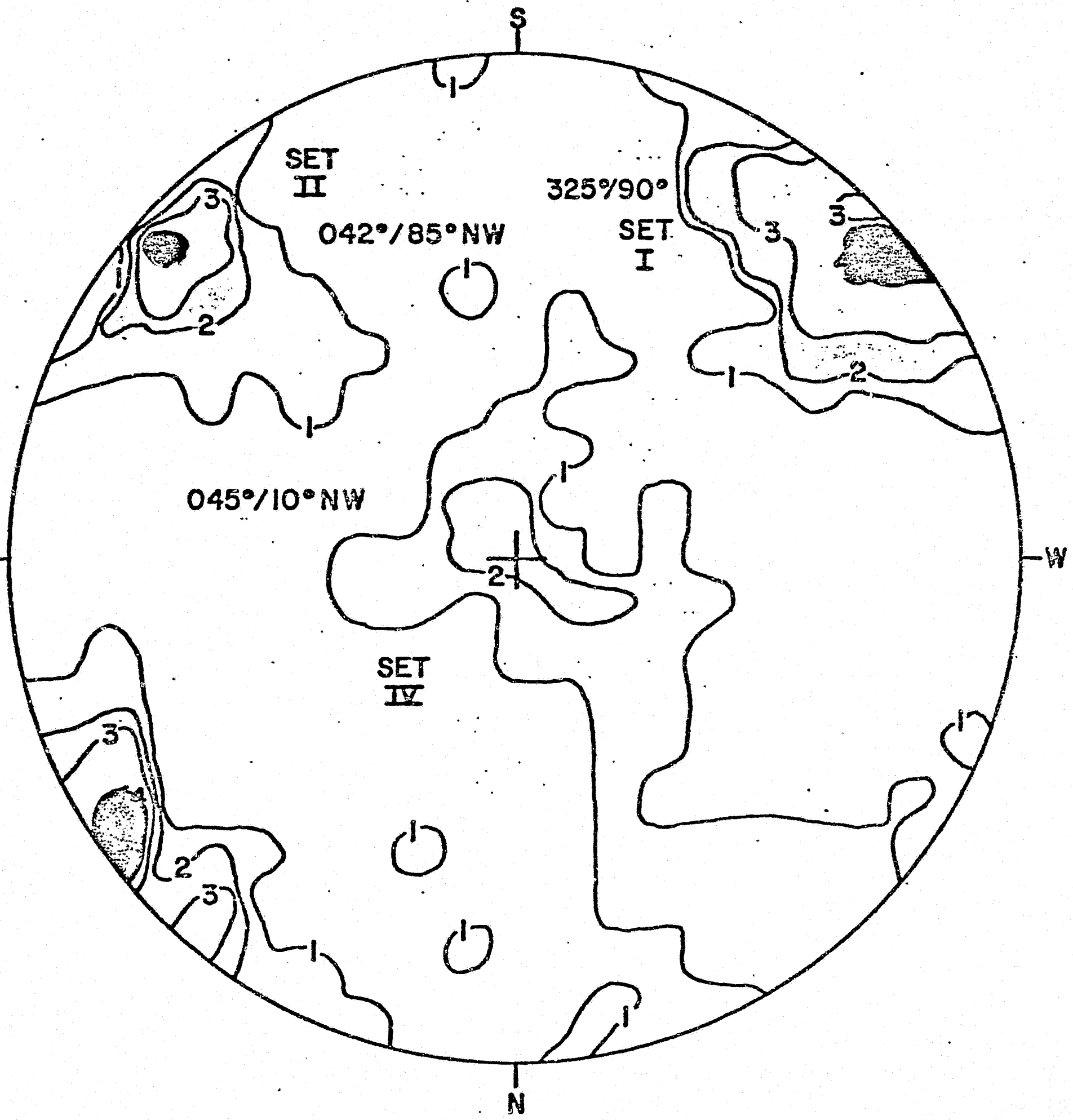
5. HIGHER TUNNEL REQUIRED FOR FLOOD ONLY

6. HIGHER TUNNEL USED FOR LOW LEVEL RELEASE - MUST BE HIGH TO AVOID SILTING

7. LOWER TUNNEL IS PRESSURE TUNNEL.

8. CLOSURE STRUCTURES REQUIRED TO ENABLE PLUG AND LOW WATER RELEASE TO BE CONSTRUCTED.

9. LOCATION OF TUNNELS SET BETWEEN COFFERDAM AND "THE FINS" STRUCTURE.



JOINT PLOT
UPSTREAM PORTAL AREA

ACRES

ALTERNATIVE TO LOCATION OF
UPSTREAM DIVERSION PORTAL

1. LEAVE AT PRESENT LOCATION

2. LEAVE AT PRESENT LOCATION WITH MODIFICATIONS

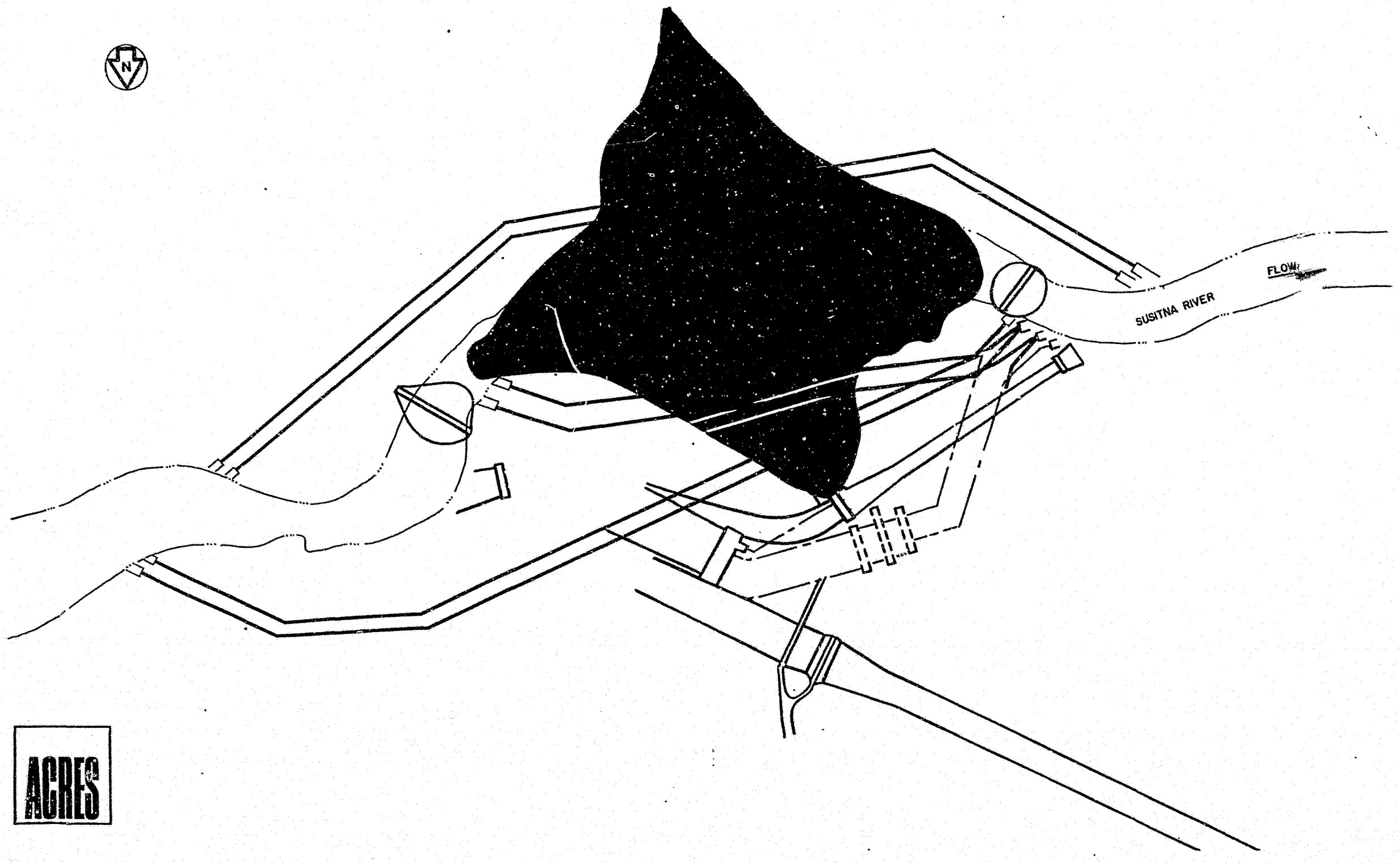
3. LOCATE UPSTREAM OF "THE FINS"

4. LOCATE FURTHER DOWNSTREAM

5. LOCATE ON SOUTH ABUTMENT

WATANA DIVERSION TUNNELS

ALTERNATE ALIGNMENTS



ACRES

LEAVE AT PRESENT LOCATION

ADVANTAGES

1. EXCAVATED ROCK CAN BE USED IN COFFERDAM CONSTRUCTION
2. GOOD HYDRAULIC LOCATION
3. REMOVED FROM MAIN CONSTRUCTION AREA

DISADVANTAGES

1. REQUIRES 300-FOOT HIGH CUTS
2. EXTENSIVE ROCK SUPPORT MAY BE REQUIRED
3. REQUIRES COMPLEX CONSTRUCTION COFFERDAM ARRANGEMENT
4. DIFFICULT ACCESS PROBLEMS

PRESENT POSITION WITH MODIFICATIONS

MODIFICATIONS

1. SEPARATE PORTALS AND STAGGERED CUT FACES
2. MOVE CUT FACES NEARER TO RIVER
3. REVERSE TUNNELS - MAKING LOWER TUNNEL ON SOUTH SIDE

MODIFICATION #1

ADVANTAGES

- MINIMIZES SIDE ROCK CUTS
- INCREASES WORK AREA

DISADVANTAGES

- LESS EXCAVATED MATERIAL FOR COFFERDAM
- INCREASES DIFFICULTY IN ACCESS TO NORTH TUNNEL

MODIFICATION #2

ADVANTAGES

- MINIMIZES ROCK CUTS
- IMPROVES CONSTRUCTION SCHEDULE
- BETTER CONSTRUCTION ACCESS

DISADVANTAGES

- REQUIRES LARGER CONSTRUCTION COFFERDAM AND GREATER RIVER CONSTRAINTS
- LESS EXCAVATED MATERIAL FOR COFFERDAM

MODIFICATION #3

ADVANTAGES

- LESS CONSTRUCTION PROBLEM FOR BOTH PORTALS
- REDUCES ROCK CUTS

DISADVANTAGES

- REDESIGN OF TAILRACE THAT COULD RESULT IN LOSS OF ENERGY AND/OR LARGER TAILRACE TUNNELS
- CONSTRUCTION PROBLEMS IN DOWNSTREAM PORTAL

PORTAL MOVED UPSTREAM

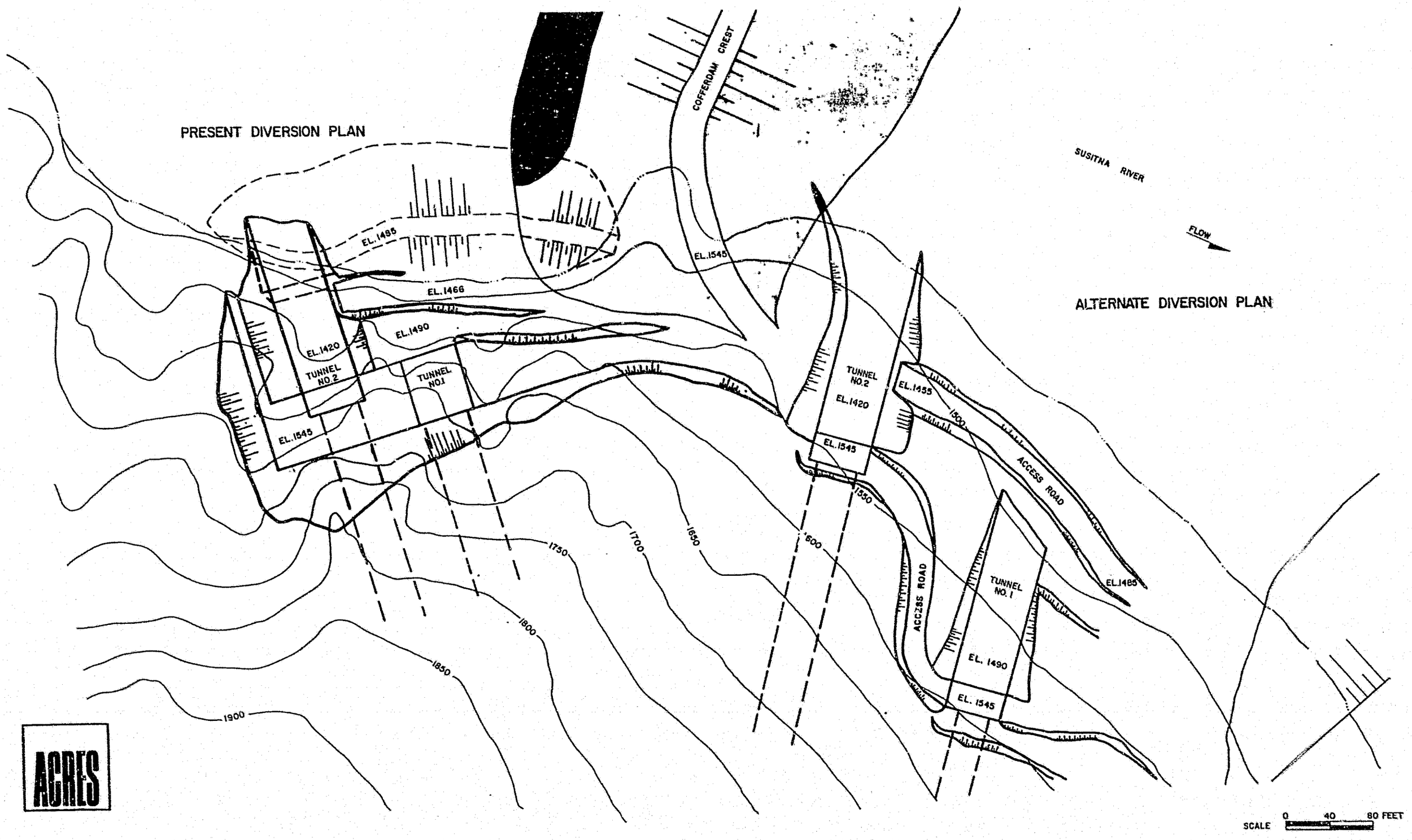
ADVANTAGES

- PORTAL WOULD BE ON FLATTER SLOPES
- REMOVES DIVERSION AS UPSTREAM CONSTRAINT ON DAM
- MOVES DIVERSION CONSTRUCTION AWAY FROM MAIN DAM
- INCREASED WORK AREA

DISADVANTAGES

- LENGTH OF TUNNEL
- LARGER DIAMETER TUNNEL
- POTENTIAL POOR GEOLOGY IN PORTAL AREA
- REQUIRES EXCAVATION THRU "THE FINS"
- POSSIBLE OVERBURDEN PROBLEM
- DIFFICULT ACCESS
- POORER TUNNEL ALIGNMENT
- IMPACTS CONSTRUCTION SCHEDULE

UPSTREAM DIVERSION PORTALS MAP



ACRES

DOWNSTREAM PORTAL

ADVANTAGES

- BETTER ROCK CUTS
- SHORTER TUNNEL
- BETTER GEOLOGY
- EASIER ACCESS

DISADVANTAGES

- POOR HYDRAULIC ALIGNMENT
- INTERFERES WITH COFFERDAM
- REQUIRES THAT COFFERDAM (OR PART OF) BE INCLUDED IN MAIN DAM OR,
- REQUIRES FANCY INTAKE DESIGN
- PORTAL ALIGNMENT NOT AS FAVORABLE FOR GEOLOGY
- MAY INTERFERE WITH MAIN DAM CONSTRUCTION
- MAY REQUIRE UNDERWATER CHANNEL CUT

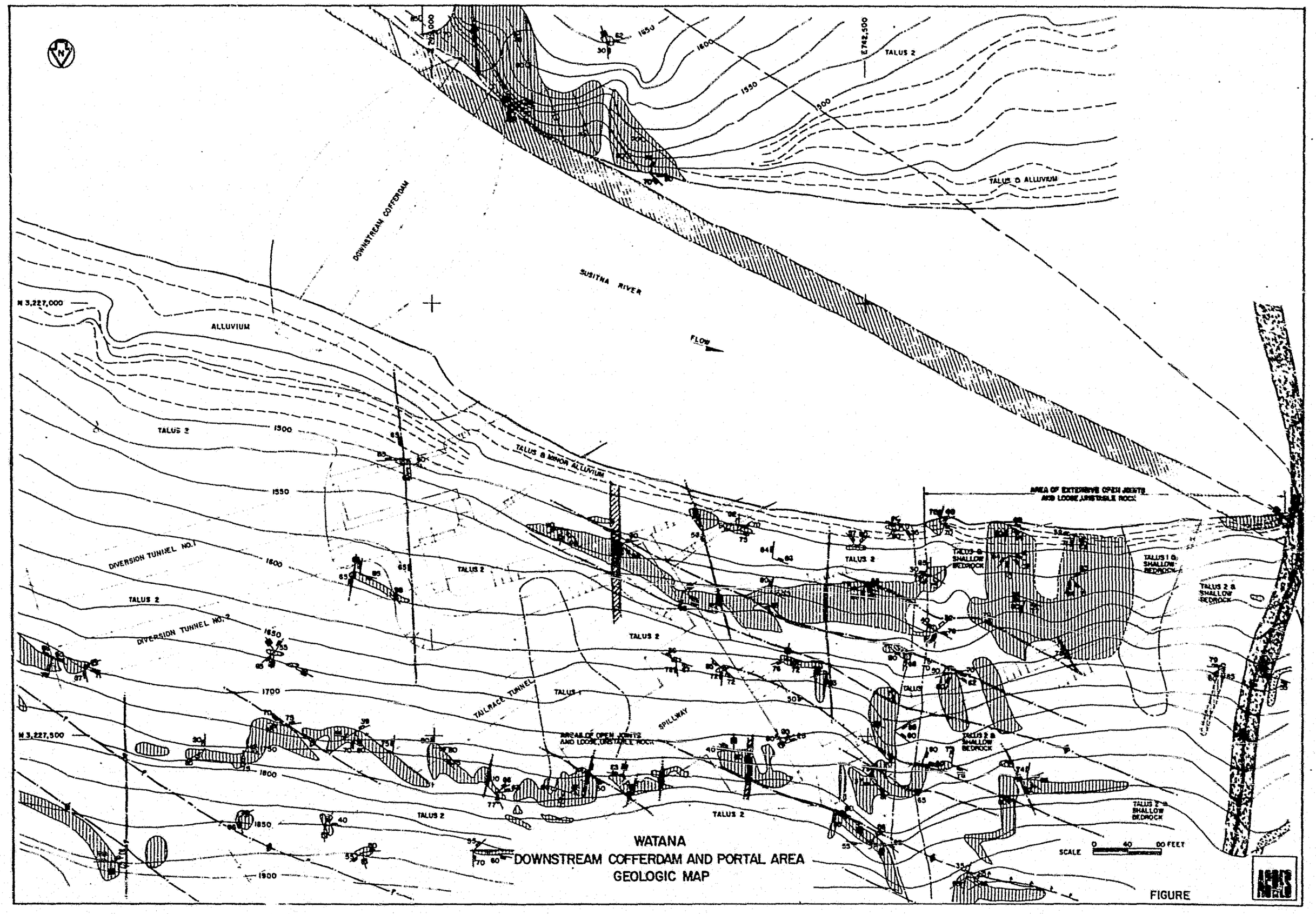
PORTAL ON SOUTH ABUTMENT

ADVANTAGES

- SEPARATED FROM ALL OTHER CONSTRUCTION ACTIVITIES
- NO LEAKAGE CONCERN TO UNDERGROUND STRUCTURES
- RELIEVES D/S PORTAL AND DOWNSTREAM COFFERDAM CONJESTION

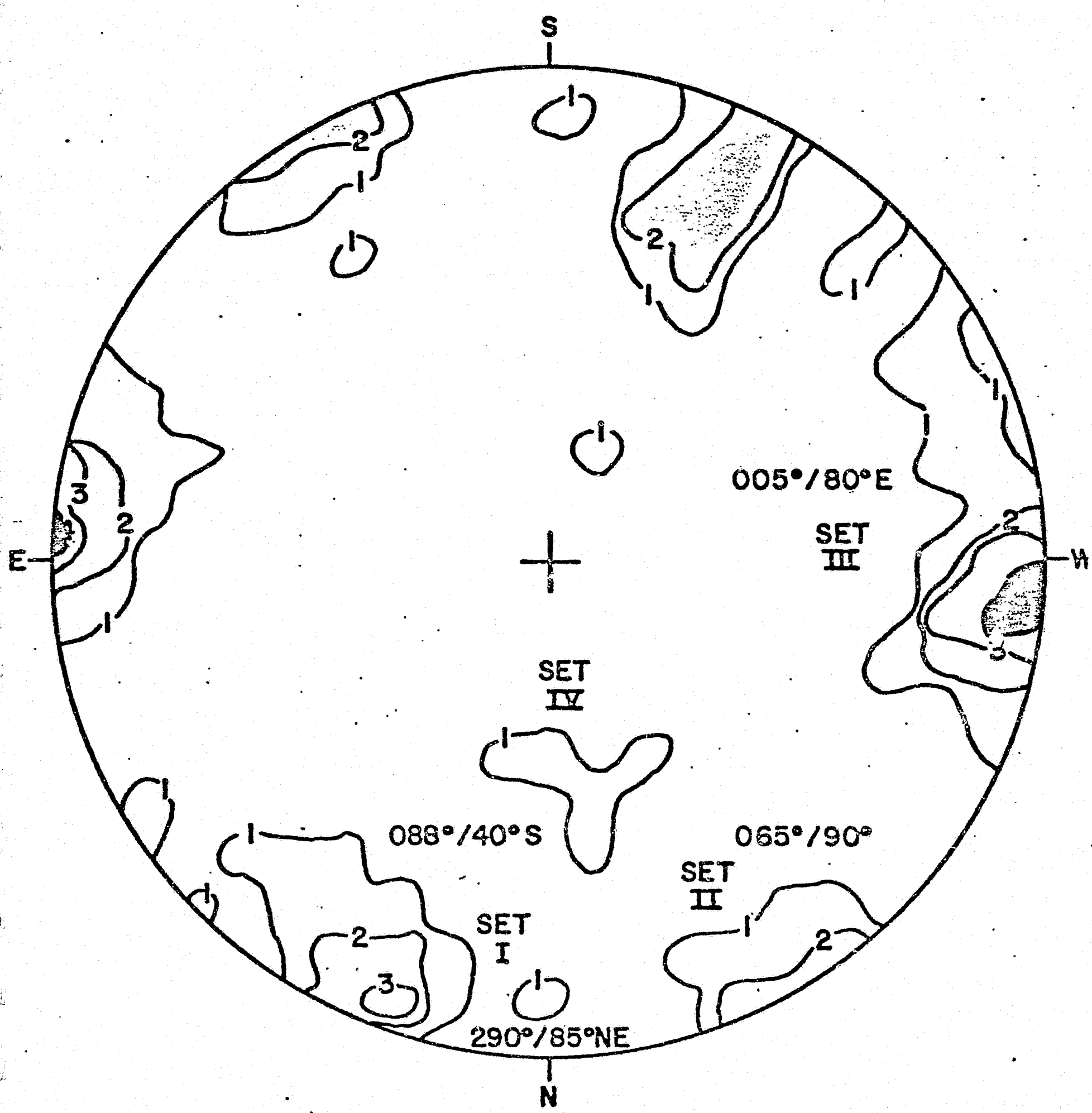
DISADVANTAGES

- LONG TUNNEL
- POOR GEOLOGY
- POTENTIAL PERMAFROST
- ACCESS REQUIRES BRIDGE
- IMPACTS CONSTRUCTION SCHEDULE
- LARGE ROCK CUTS AT U/S PORTAL
- POOR HYDRAULICS
- POTENTIAL IMPACT WITH COFFERDAM CONSTRUCTION
- REQUIRES ADDITIONAL TAILRACE TUNNEL



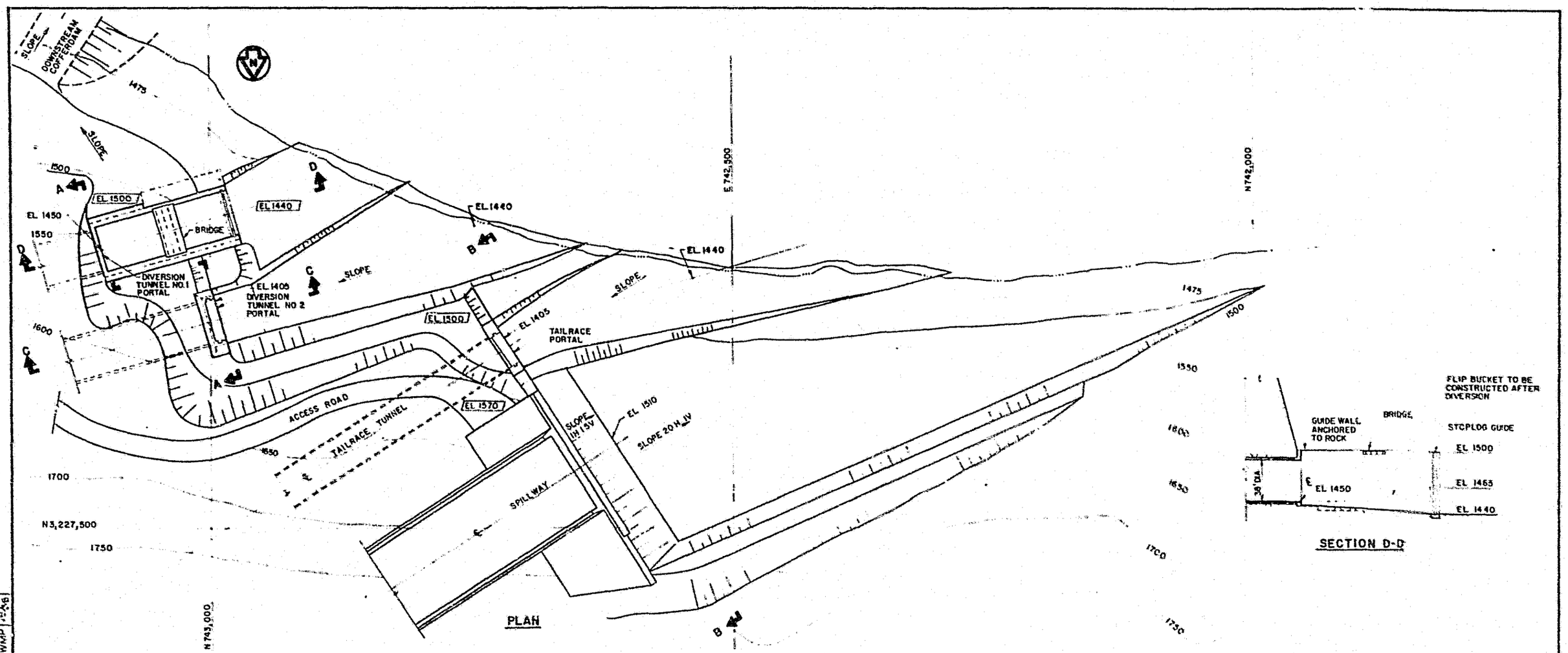
WATANA
DOWNSTREAM COFFERDAM AND PORTAL AREA
GEOLOGIC MAP

FIGURE

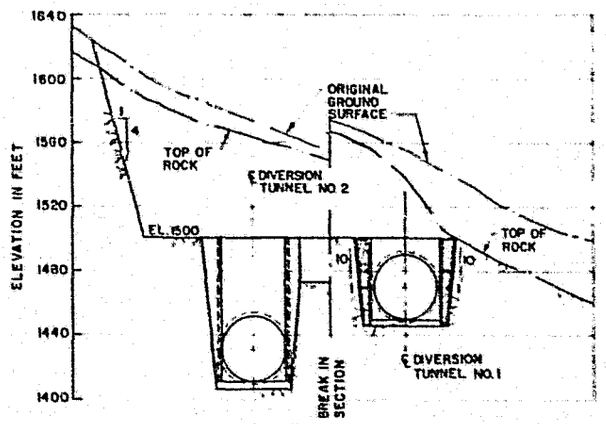


JOINT PLOT
DOWNSTREAM PORTAL AREA

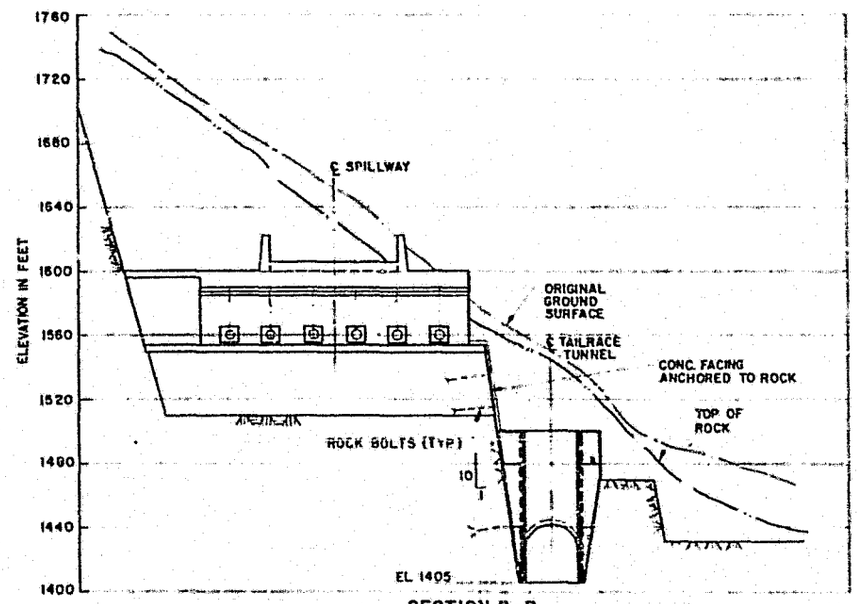
ACRES



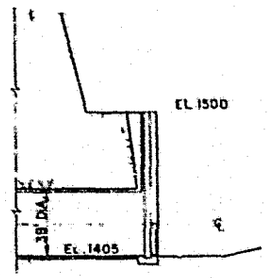
SECTION D-D



SECTION A-A



SECTION B-B



SECTION C-C

SCALE 0 40 80 FEET (1 INCH = 40 FEET)

ALASKA POWER AUTHORITY

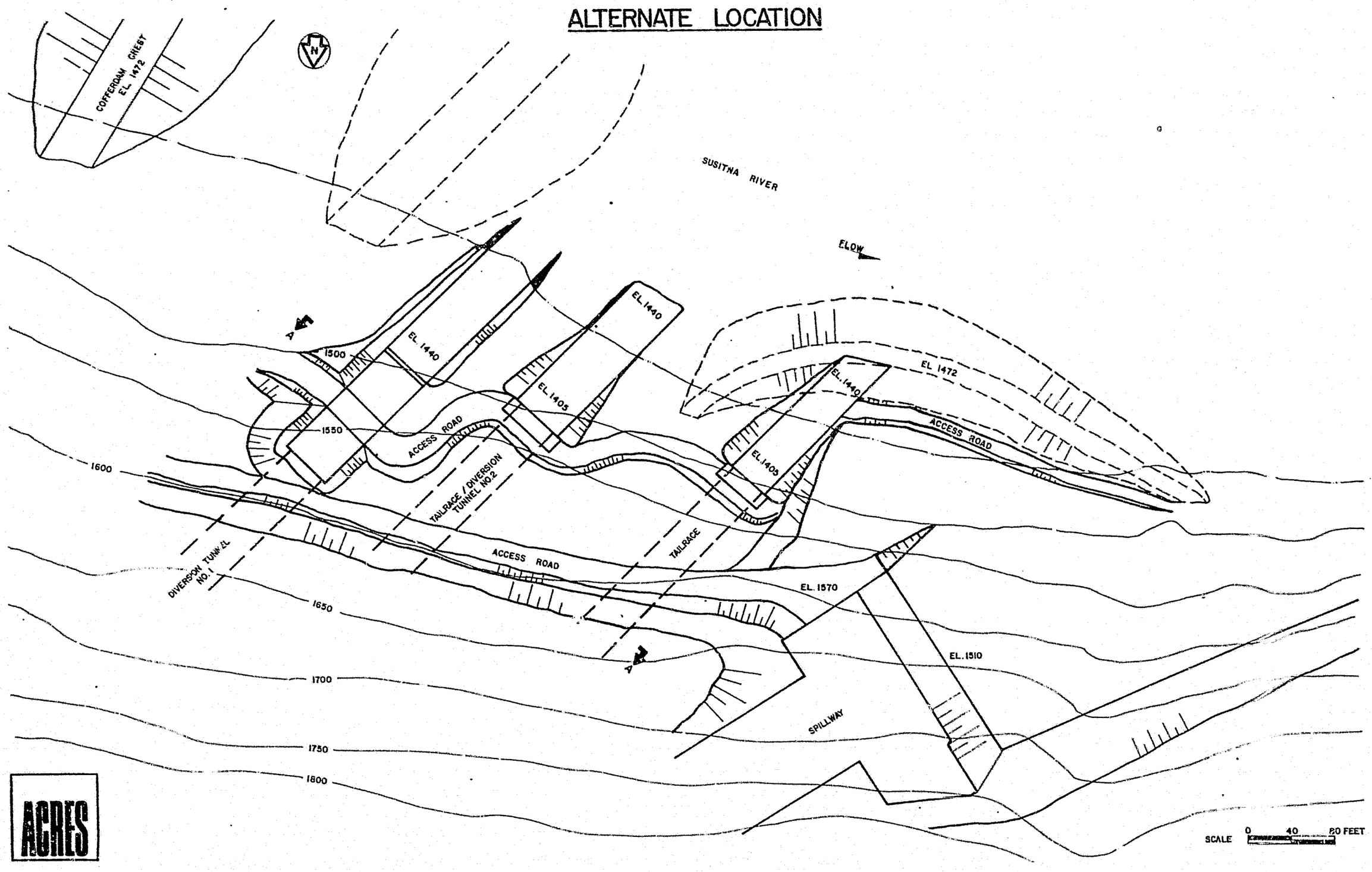
SUSITNA HYDROELECTRIC PROJECT

WATANA
DOWNSTREAM PORTALS
PLAN & SECTIONS

EXHIBIT F | PLATE F20

DOWNSTREAM DIVERSION AND TAILRACE PORTALS MAP

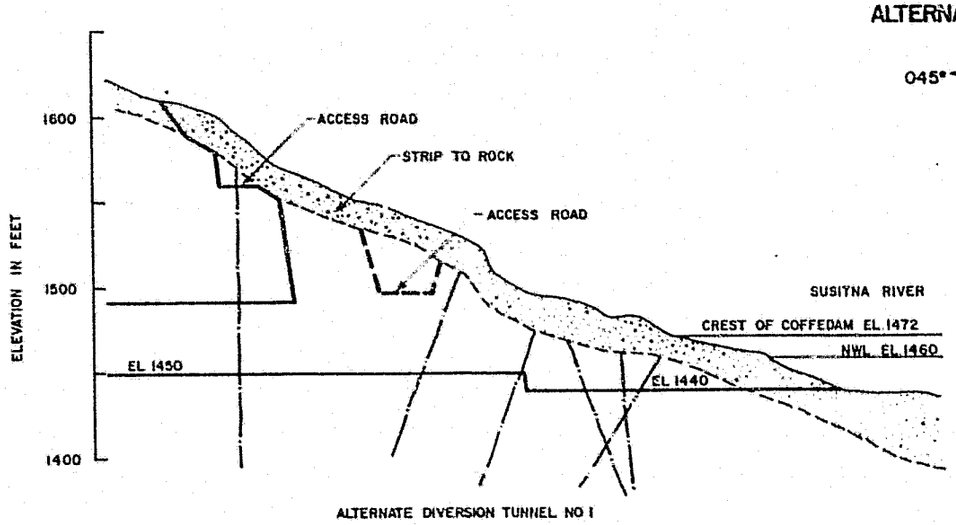
ALTERNATE LOCATION



ACRES

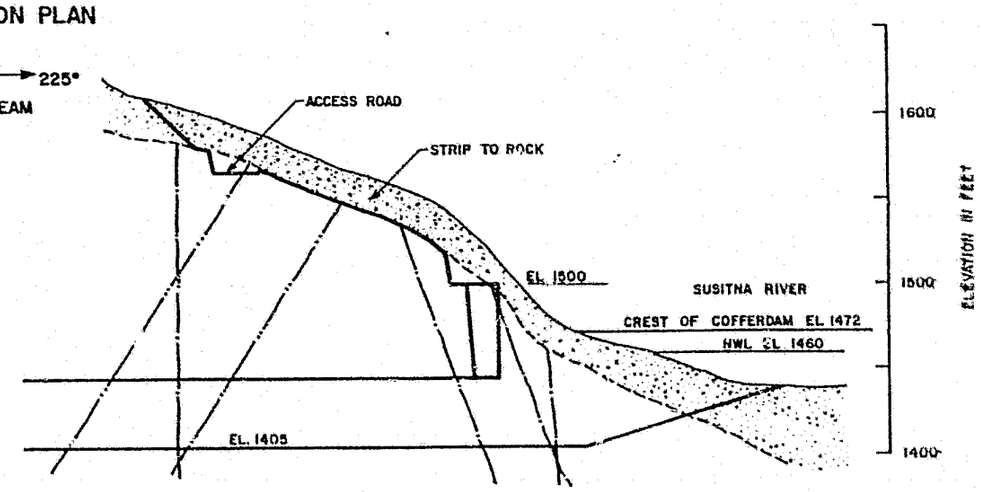
DOWNSTREAM DIVERSION PORTALS SECTIONS

ALTERNATE DIVERSION PLAN

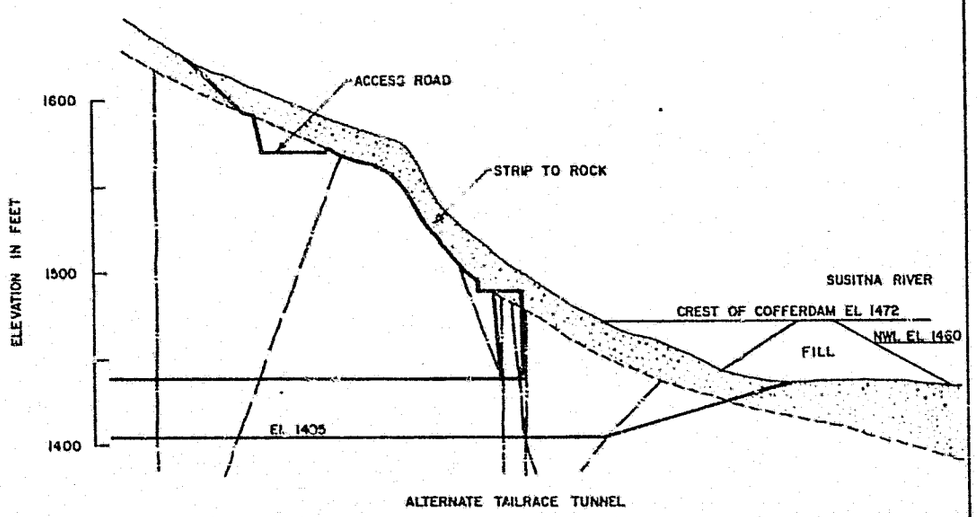


ALTERNATE DIVERSION TUNNEL NO 1

045° ← AZIMUTH OF SECTION → 225°
LOOKING UPSTREAM

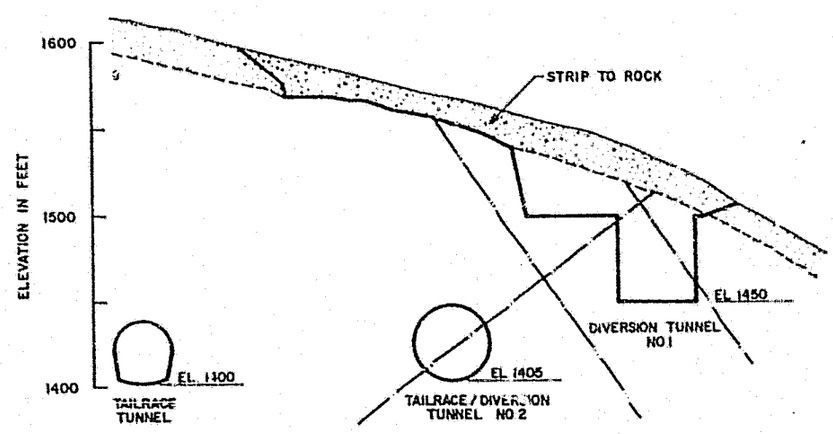


ALTERNATE TAILRACE / DIVERSION TUNNEL NO 2



ALTERNATE TAILRACE TUNNEL

135° ← AZIMUTH OF SECTION → 315°
LOOKING NORTH



SECTION A-A

ACRES

SCALE 0 40 80 FEET

- SCOPE OF WINTER/SUMMER PROGRAM

WINTER GEOTECHNICAL PROGRAM

DAMSITE

OBJECTIVES

OBTAIN DESIGN LEVEL DATA TO FINALIZE GENERAL ARRANGEMENT TO ESTABLISH CONSTRUCTION COSTS AND SCHEDULES

DATA TO BE OBTAINED:

- ENGINEERING PROPERTIES OF BEDROCK & ALLUVIUM
- THICKNESS OF ALLUVIUM
- DAMSITE GEOLOGY
- GEOHYDROLOGY

SCOPE

APPROXIMATELY 2000-LF HAMMER DRILLING

- COFFERDAM
- MAIN DAM
- DOWNSTREAM COFFERDAM
- U/S PORTAL
- PLUNGE POOL

APPROXIMATELY 15,000-LF SEISMIC REFRACTION SURVEYS

- U/S COFFERDAM
- MAIN DAM
- D/S COFFERDAM
- U/S PORTAL
- PLUNGE POOL

WINTER

GEOTECHNICAL

PROGRAM

RELICT CHANNEL/BORROW AREA D

OBJECTIVES

OBTAIN DESIGN LEVEL DATA TO DETERMINE ENGINEERING AND DESIGN REQUIREMENTS AND TO DETERMINE CONSTRUCTION COSTS AND SCHEDULE.

SCOPE

- DRILLING APPROXIMATELY 4,300-LF BY HAMMER DRILLING
- INSTALL PIEZOMETERS AND THERMISTORS
- INSTALL WELLS
- PERFORM FIELD PERMEABILITY TESTING

SUMMER 1983
GEOTECHNICAL
PROGRAM

OBJECTIVE

TO CONTINUE IN OBTAINING DESIGN LEVEL DATA

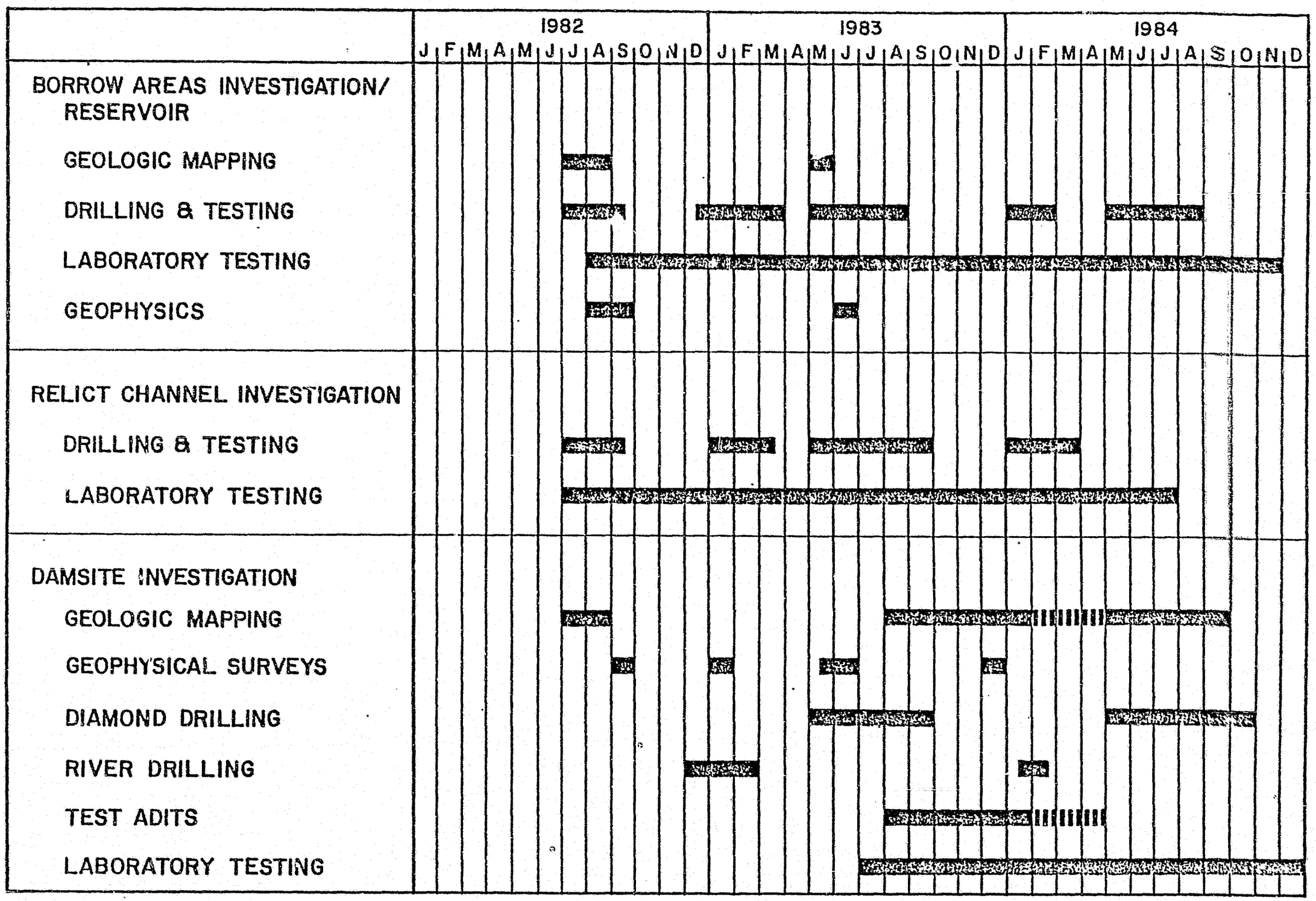
SCOPE

TECHNIQUES TO BE CONSIDERED:

- MAPPING
- REMOTE SENSING
- DRILLING
  - PLUG/PROBE
  - CORING (VERTICAL TO HORIZONTAL)
  - OVERBURDEN SAMPLING
- EXCAVATION
  - TEST TRENCHING
  - TEST PIT/BLAST
  - CAISSON/SHAFT
  - ADIT
- SURFACE GEOPHYSICS
  - SEISMIC REFRACTION
  - SEISMIC REFLECTION
  - RESISTIVITY
  - RADAR
  - ETC.
- DOWNHOLE INSTRUMENTATION
  - THERMAL
  - PIEZOMETRIC
  - DEFORMATION

- DOWNHOLE TESTING
    - PERMEABILITY
    - SEISMIC VELOCITY
    - IMAGERY
    - DENSITY/MOISTURE
    - MODULUS
    - HARDNESS
    - IN-SITU STRESS
    - INCLINATION DEFORMATION
- MATERIAL TESTING
    - ROUTINE SOIL & ROCK TESTING
    - DYNAMIC TESTING
    - CONCRETE TESTING

WATANA 1982-85 PROPOSED GEOTECHNICAL INVESTIGATION PROGRAM



- ROCKFILL CONCRETE FACED DAM

CONCRETE FACE FILL DAM

AT WATANA

CONCRETE FACE FILL DAM
ALTERNATIVE AT WATANA

PERCEIVED ADVANTAGES:

- ELIMINATION OF EARTH CORE LESS DEPENDENCE ON WEATHER CONDITIONS
- STEEPER SLOPES
  1.5:1 INSTEAD OF 2 AND 2.4:1, HENCE
  - LESS MATERIAL
  - LESS FOUNDATION PREPARATIONS
  - MORE FLEXIBILITY IN LAYOUT - PARTICULARLY TUNNEL PORTALS
- IMPROVED SCHEDULE
- IMPROVED STABILITY UNDER SEISMIC LOADING
- STABILITY NOT DEPENDENT ON INTEGRITY OF FACE SLAB - CAN WITHSTAND VERY HIGH LEAKAGE RATES
- LOWER COST

CONCRETE FACE FILL DAM
ALTERNATIVE AT WATANA

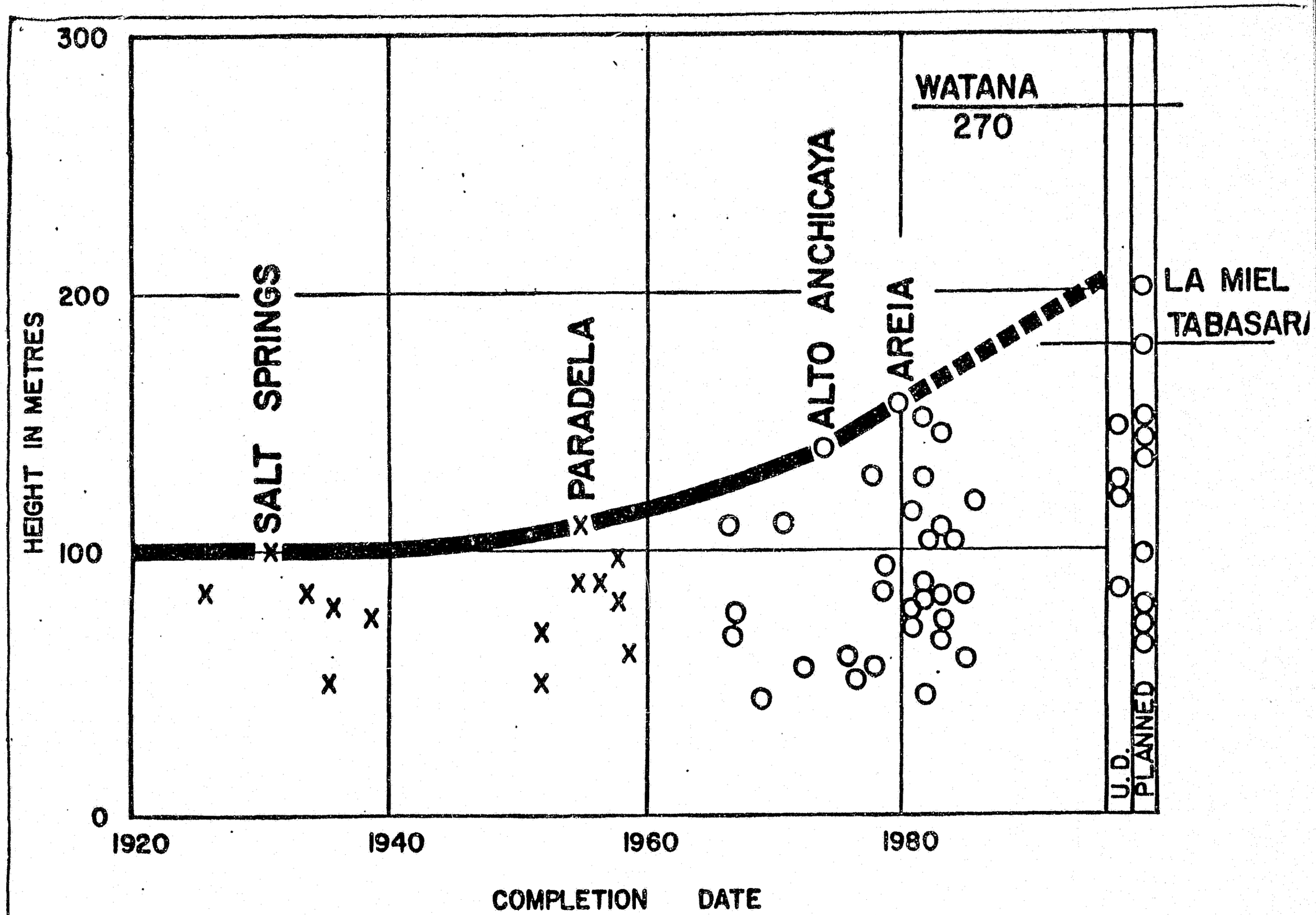
DISADVANTAGES:

- NO PRECEDENT FOR HEIGHT - 70% INCREASE OVER AREIA
- NO PRECEDENT FOR CLIMATE
- NO PRECEDENT FOR SEISMICITY
- MUST COMPLETE ROCK FILL BEFORE CONSTRUCTING FACE SLAB
- PRECEDENTS INCLUDE IMPERVIOUS EARTH COVER BASE OF FACE
- LATE START FOR IMPOUNDMENT
- DIFFICULT AND COSTLY TO REMEDY ANY LEAKAGE THROUGH FACE SLAB

CONCRETE FACE FILL DAM

PRECEDENT STURCTURES

DAM	YEAR COMPLETED	HEIGHT FEET	% INCREASE
1. SALT SPRINGS	1930	330	
2. PARADELA	1955	370	12
3. ALTO ANCHICAYA	1974	460	24
4. AREIA	1980	525	14
5. WATANA	198?	885	68
TABASARA	198?	590	12
LA MIEL	198?	650	24



CONCRETE FACE ROCK FILL DAMS

EARTH ROCK FILL DAM
ALTERNATIVE AT WATANA

- WITHIN PRECEDENT - PROVEN STABILITY
- MATERIALS READILY AVAILABLE AT OPTIMUM MOISTURE CONTENT
- SELF-HEALING LEAKAGE
- EARLY START TO IMPOUNDMENT
- GOOD CHANCE OF INCORPORATING COFFERDAM(S) IN STRUCTURE - LAYOUT IMPROVED

EARTH - ROCK FILL ALTERNATIVE

SUPPORTING EVIDENCE

1. LG 2

- CONCRETE FACE APPROXIMATELY 5% CHEAPER
- CONSULTANTS RECOMMENDED MANAGER STAY WITH PROVEN TYPE FOR SITE CLIMATIC CONDITIONS - NO PRECEDENT (PECK)

2. TABASARA

- BOARD OF CONSULTANTS CONSIDERED 180 M PRUDENT MAXIMUM HEIGHT FOR CONCRETE FACE FILL DAM - 15% HIGHER THAN MAXIMUM TO DATE.
  SEISMICITY - 0.4 G (COOKE, DEERE, MAC DONALD)

USE CONCRETE FACE FILL DAM

IF:

- NO SUITABLE CORE MATERIALS AVAILABLE
- HEIGHT WITHIN 10-20% OF PRECEDENT
- CLIMATIC CONDITIONS VERY WET
- RESERVOIR CAN BE DRAWN DOWN ECONOMICALLY
- SLAB NOT EXPOSED TO SEVERE FREEZE-THAW CYCLES
- EARLY IMPOUNDMENT NOT CRITICAL
- CHEAPER THAN ALTERNATIVE(S)